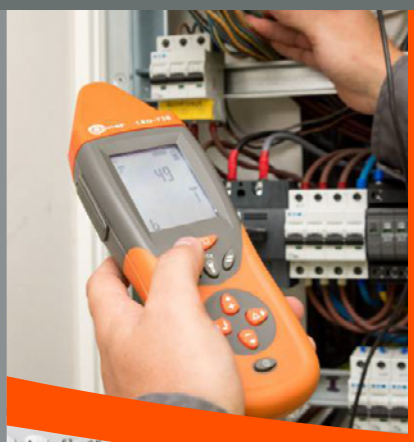


Sonel®

MEASUREMENT INSTRUMENTS

EXPERIENCE AND RELIABILITY

ergonomic functional innovative from Sonel


THERMAL IMAGERS


PAT TESTERS


HAND-HELD MULTI-FUNCTION METERS


EARTH GROUND RESISTANCE


INSTALLATION SHOCK PROTECTION


LOGGERS, ENERGY, POWER QUALITY


INSULATION TESTERS

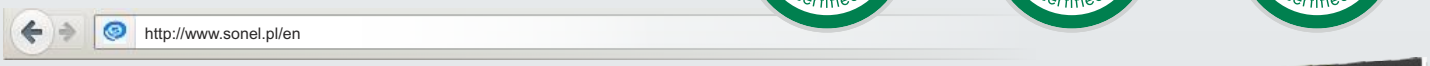
QUALITY & SAFETY

Sonel designs, manufactures, and markets high-quality measuring instruments to users all around the world. We believe in continuous technological development of our products, as well as adapting them to the needs of our customers in industrial, commercial, and utility markets globally. Our instruments are dependable, reliable, and provide accurate results. Our track record over 25 years confirms our success. Sonel instruments are ergonomically both easy to use, and safe to use. To ensure the safety our products they are rigorously tested and certified.

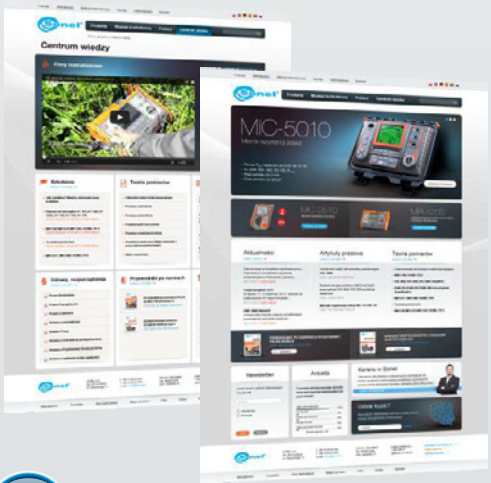
STANDARDS AND CERTIFICATIONS WORLD-WIDE

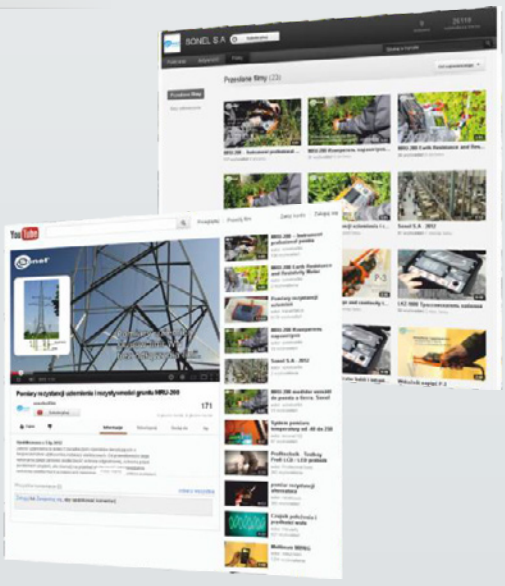
Sonel has been awarded ISO 9001:2008 Quality Management System and ISO 14001:2004 Environmental Management System certificates. Our instruments meet EN 61557 and EN 61010 standards as well as EMC Directive requirements, including the CE mark, and compliant with BS 7671 and VDE 0100.

VISIT OUR WEBSITE!



Product support can be found on our website:
recent firmware, software, drivers, manuals, technical data and publications





http://www.sonel.pl/en/

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WORLD-CLASS MANUFACTURING

Sonel has invested in a state-of-the-art manufacturing facility. So good in fact that Sonel also fulfills contract manufacturing for many high-tech companies. Sonel has deployed Surface Mount Technology (SMT) and Surface Mount Device (SMD) assembly on our professional automatic assembly line from FUJI. Sonel has two Surface Mount Technology (SMT) assembly lines, a Through-Hole Technology (THT) line, and three inspection stations. Product assembly is carried in accordance with the IPC-A-610D standard. We cordially invite other companies to take advantage of our contract volume-manufacturing services.
Contact us at: http://www.sonel.pl/en/assembly-smd-tht.html

SERVICES

Excellent products depend on many interconnected activities: Engineering, manufacturing, logistics, and excellent service in both pre-sales and after-sales customer support. We provide repair and calibration services related to testing of electric shock protection, as well as for electrical meters, thermal imagers, pyrometers, and illuminance meters.

Product support can be found on our website: firmware, software,

ELECTRICAL SAFETY MEASUREMENTS

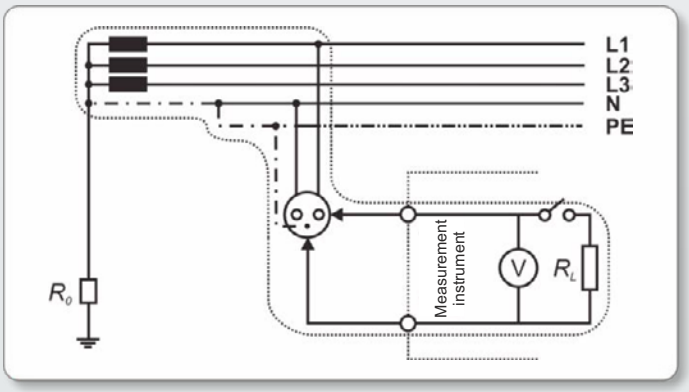
Current regulations require performing electrical system measurements during the rough-in inspection (after assembly, after each change or expansion of the system) and regularly during operation. The scope of inspection or periodic checks is specified in the HD 60364-6 standard. The requirements set for measurement instruments are specified on individual sheets of the EN 61557 standard. Electrical safety measurements include, depending on the requirements, the measurements of: short-circuit impedance, insulation resistance, continuity of protective connections and equipotential bonding,earth resistance, residual current device parameters. Additional regulations specify the requirement for legal metrological inspection of instruments used for the performance of measurements.

Measurements of short-circuit impedance.

The most commonly used method of protection against electric shock - the protection against direct contact in circuits equipped with overcurrent protection devices - relies on automatic power cut-off in case of hazardous touch voltage on accessible current-conducting elements of electrical equipment. A flow of current occurs in the circuit between the phase and protective conductors, called the short-circuit current, that trips the overcurrent breaker and cuts off the power. Because accessible elements cannot be under a hazardous touch voltage for too long, the protection must trip in a sufficiently short time defined by the standards. The condition for proper protection is described by the formula:

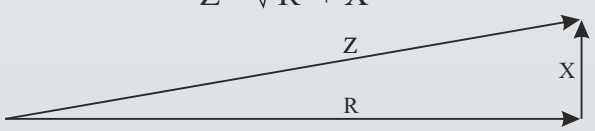
$$Z_s = U_n / I_A$$

where: Z_s - short-circuit impedance, I_A - the operating current that trips the overcurrent breaker within the required time (depending on the time-current characteristics of the breaker and the required trip time), U_n - rated phase-to-earth voltage.



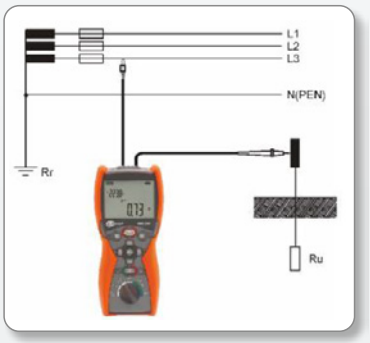
The Z_s impedance value, necessary for determining whether the protection is proper or not, must be measured. During measurements of short-circuit current with the use of the technical method, an "artificial short-circuit" is created. The instrument performs voltage measurement under no-load conditions, and then under a short-time load with a short-circuit resistor. The short-circuit impedance is calculated based on the voltage drop difference. This measurement is provided by the short-circuit impedance meters: MZC-304, MZC-306 and MZC-310S, as well the multifunction instruments: MPI-502, MPI-505, MPI-520, MPI-525, MPI-530 - all of these instruments also indicate the components of impedance, i.e. resistance and reactance.

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



Short-circuit impedance meters (except for MZC-310S) also allow for measurements in L-PE circuits in systems protected with residual current devices without any interference in the circuit. Such a measurement, performed with current smaller than 15 mA, is extended in time, whereas the resolution of the result is 0.01 Ω, just like for other measurements. The MZC-310S high-current meter allows for performing measurements with the resolution of 0.1 mΩ (power distribution points, switchboards, substations) with the maximal measurement current of 280 A. This allows for measurements in accordance with the EN 61557 standard, even for the circuits with miliohm values of short-circuit impedance.

The MZC-306 meter are distinguished by their ability to perform measurements for any AC voltages up to 750 V, including industrial systems.



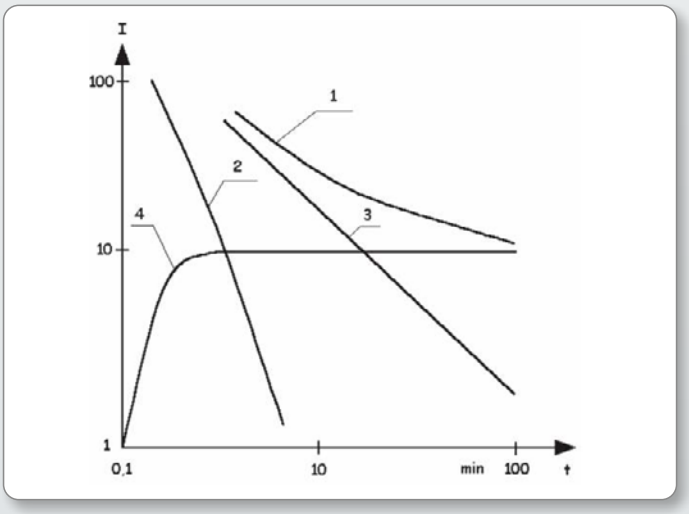
Short-circuit meters can be used for earth resistance measurement with the use of an auxiliary voltage source (phase conductor). Therefore the measured value is overstated - the measurement result is a sum of the measured resistance to earth, operational earthing resistance and the line conductor resistance. However, if it is smaller than the value allowed for the examined earthing, it can be considered correct and there is no need to employ more accurate measurement methods.

Measurements of insulation resistance.

Insulation condition is the key factor of operational safety and correct operation of electrical devices and systems, and in addition, it is a protection against direct contact.

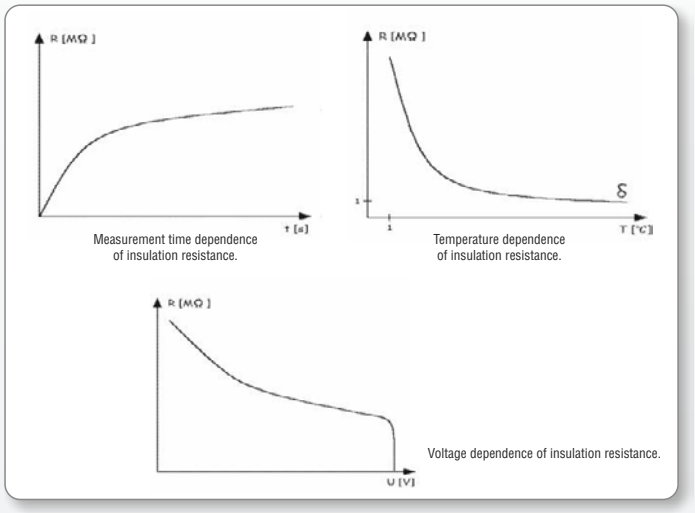
Systematic examinations of insulation condition is necessary in order to detect any deterioration of insulation and is a permanent element of inspection and measurement works. In the case of measurements of industrial equipment, the tendency of resistance value changes is of key importance, because it can indicate gradual deterioration of insulation condition. Basic elements influencing deterioration of insulation are: electrical and mechanical exposures, chemical aggression, thermal exposures and environmental pollution; as a result of their influence during normal operation of electrical equipment, its insulation is subjected to ageing. Insulation resistance measurements are performed with direct current in order to eliminate the influence of capacitance.

The method for performing insulation resistance measurements and the required measurement voltages are defined in the standards: HD 60364-6, E-04700, EN 61557-2. After applying measurement voltage, physical phenomena occur in insulation, causing the flow of current. During resistance measurement, the following components of the current flowing through insulation (1) can be distinguished:

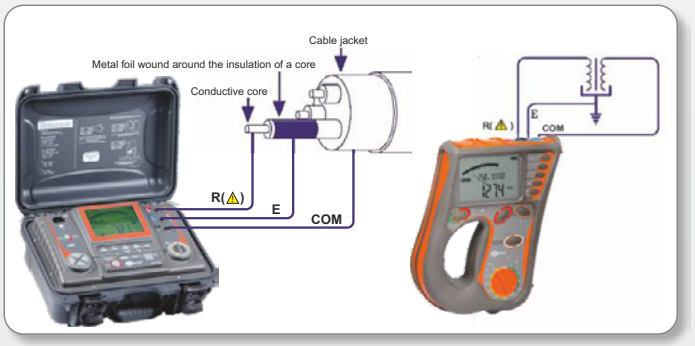


- the capacitance charging current (2) - depending on the capacitance (e.g. the length of measured cable),
- the absorption current (3) - resulting from charge and dipole movement in the electric field,
- the insulation leakage current (4) - the sum of currents flowing through and on the surface of the material.

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



The three-lead method, used in all advanced instruments, allows for eliminating the influence of the surface leakage current. In the case of cables, the core insulation must be wrapped in a metal foil connected to the shield terminal of the instrument - only the leakage current flowing through insulation is measured. Measurement with the three-lead method is recommended for large surfaces exposed to pollution (large diameter cables, transformers, HV switches):

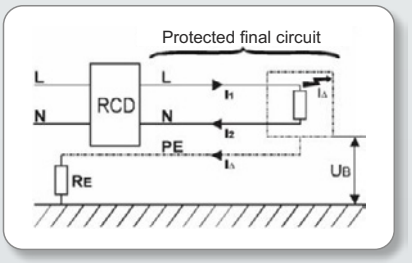


The use of the three-lead method is relevant in case of measurements of objects of very large resistance values (above 100 MΩ).

The MIC-10k1, MIC-5050, MIC-5010, MIC-5005, MIC-5000, MIC-2510, MIC-30 and MIC-2505 instruments, as well as the MPI-525 multifunction meter allow for insulation measurements within a defined time, as well as for readouts at user-defined time intervals. Based on the results, one or two absorption coefficients are calculated, also providing information related to insulation condition. Before performing measurements make sure, that the measured object is disconnected from power supply. In the event of voltage detection on the measured object (or voltage appearing during the measurement), the instrument aborts the measurement and acoustically signals abnormality. During measurement, actual instantaneous resistance value or actual value of leakage current is displayed. After finishing the measurement, values measured at the ends of user-defined time intervals (selectable from the range of 1...600 s) are saved, and the measured object is discharged by the instrument.

Measurements of residual current device parameters.

The main function of a residual current device (RCD) is additional protection against electric shock by disconnecting the protected circuit from power supply in the event of excessive earth current in this circuit.



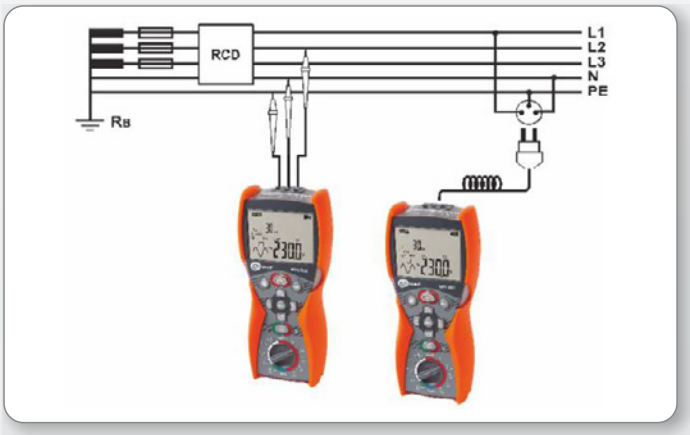
When there are no faults in the circuit protected by the RCD (residual current $I_\Delta = 0$), the I_1 input current equals the I_2 output current. In the event of a fault (e.g. insulation breakdown), the I_Δ fault current starts to flow, and the I_2 value is smaller than I_1. The RCD will trip (cut off power supply), if the measured difference of the I_1 and I_2 values exceeds the specified fiducial value of the RCD. During the flow of the fault current, the U_B voltage will appear on the casing of the protected device, according to the Ohm's law:

$$U_B = I_\Delta * R_E$$

The rated RCD current $I_{\Delta n}$ value must be selected to prevent the touch voltage, resulting from the fault current flow, from exceeding the maximal long-term touch voltage U_L:

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

Due to safety reasons, installation must be equipped with a PE protective conductor. Therefore RCDs cannot be installed in systems lacking a separate protective conductor. A residual current device does not limit the value of fault current, but the duration of its flow. However, because the fault current exceedance over the value of the rated current of the RCD is used as the criterion for the RCD tripping, the RCD should be selected appropriately to the types of protected loads. In regards to the tripping time, the RCDs are divided into: general, short-time delay G - intended for loads and circuits with small instantaneous leakage current values, and selective S - characterized by a minimal inaction time, i.e. the time when the RCD will not tripping despite a difference between the input and output current values in a circuit. Depending on the shape of the tripping fault current, RCDs can be further divided as: AC type - ~ - reacting to residual sinusoidal alternating current; A type - ⌇ - reacting to residual sinusoidal alternating current, residual pulsating unidirectional current, residual pulsating unidirectional current with 6mA direct current offset; and B type - ≋ - reacting to residual sinusoidal alternating current, residual pulsating unidirectional current, residual pulsating unidirectional current with direct current offset and direct current. The capability of performing residual current device measurements is provided by the MRP-201 meter, as well as the MPI-502, MPI- 505, MPI-520, MPI-525 and MPI-530 multifunction meters.



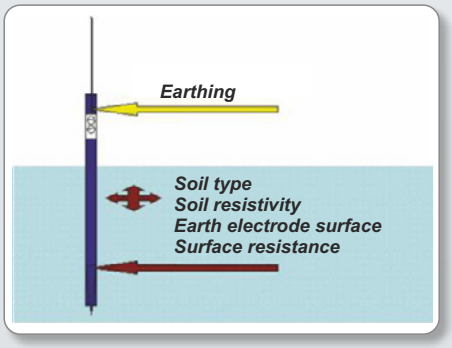
During each measurement procedure (except for alternating current voltage), the meter checks whether the resulting touch voltage exceeds the defined value of allowed long-term touch voltage. If this value be exceeded, the measurement will be automatically aborted (i.e. the differential measurement current will be cut off). The value of allowed long-term touch voltage can be set to 25 V or 50 V, and additionally 12.5 V for selective RCDs. The RCD tripping time is measured from the start of residual current flow until the moment of RCD tripping; positive or negative initial phase (or polarisation) can be selected. Maximal measured values of tripping time are 300 ms for general use, and 500 ms for selective RCD measurements. The RCD operating current is measured with forcing a linearly rising residual current in the examined circuit. The current rises from approx. 30% $I_{\Delta n}$ to the moment of RCD tripping or exceeding $I_{\Delta n}$ in the case of AC (140% and 200%, respectively, for A and B type RCDs).

Thanks to employing a touch electrode, the RCD measurement instruments can be used for checking of correctness of connections in power sockets. If the voltage between the touch electrode and the protective conductor (PE) connected to the socket exceeds 50 V, this condition will be signalled.

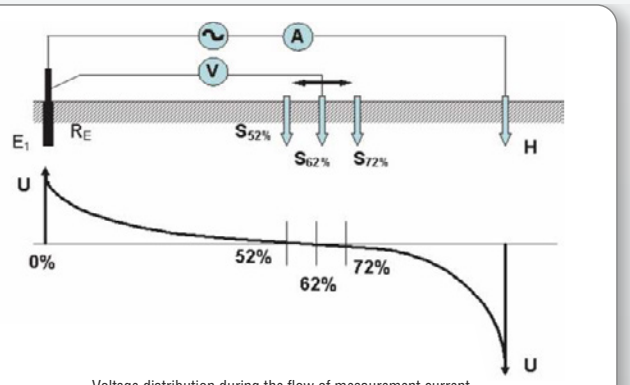
Measurements of earth resistance.

Measurements of earth resistance are performed in order to check electrical systems and fulfil the requirements related to the protection against electric shock. Besides protection against lightning, earthing also provides other functions related to safety (e.g. discharging electric charges in facilities with explosion hazard).

During operation, earthing system is subject to periodic inspections in order to check whether corrosion or earth resistivity changes have significantly impacted its parameters.



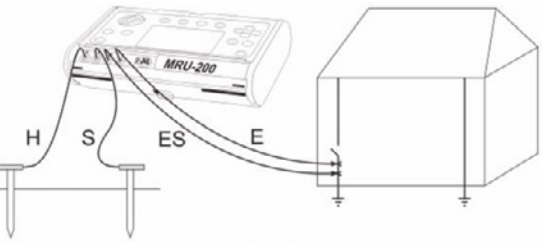
Earthing measurements can be performed with multi-function meters equipped with an appropriate function as well as with the specialized MRU series meters. For earth measurement resistance, the technical method is used most frequently - the meter calculates the resistance value by measuring voltage on the terminals after forcing the measurement current. For measurement of single earth systems, the three-pole potential drop method is used. This method bases on forcing a flow of current in the circuit: meter - examined earthing - current electrode - meter. Distances between electrodes should be possibly large; the current electrode should be placed in a distance at least 10-times larger than the physical length of the measured earthing; in practice, the distance of approximately 40 m between the examined earthing and the current electrode is accepted.



Voltage distribution during the flow of measurement current.

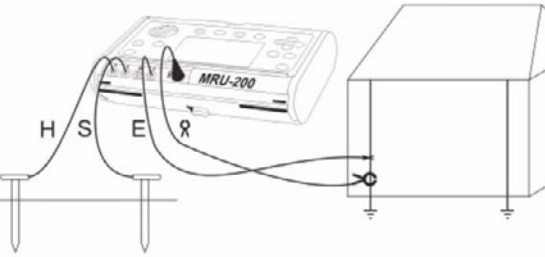
The voltage electrode is stuck into the ground between the measured earthing and the current electrode in the area of the so-called zero potential. In practice, performance of three measurements is recommended, with the voltage electrode relocated by 6 meters towards and away from the examined earthing. If the results are the same, the place for sticking the voltage electrode was selected properly. The measurement is performed with a current of frequency allowing for avoiding interferences and noise of power system frequency (50 Hz or 60 Hz) and its harmonics. Before starting the measurement, the MRU series advanced earthing meters check and signal the magnitude of interfering voltages. Additionally, these meters calculate the additional error related to too high resistance of measurement probes.

Advanced instruments have the capability of performing measurements with the four-lead method, allowing for the elimination of influence the lead connecting the instrument and the examined earthing.



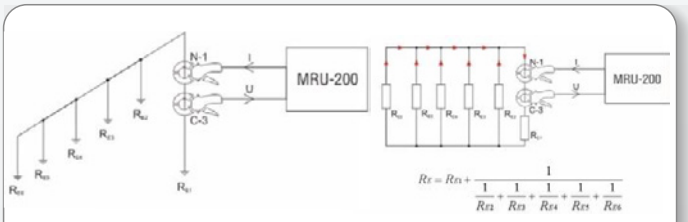
Measurement of resistance to earth - the four-lead method

Inconveniences resulting from the necessity for disconnecting individual earthing systems during multiple earthing system measurements can be overcome by employing the technical method with the use of an additional clamp (MRU-105, MRU-120, MRU-200). The current and voltage electrodes are placed as with the three-pole method, but the current is measured by the clamp fixed on the examined earthing. The meter calculates resistance by knowing the current flowing through the examined earthing. However, this measurement method cannot be employed in multiple earthing systems, where individual earthing systems are connected with each other underground.



Measurement of resistance to earth - the three-lead + clamp method

The two-clamp method (MRU-120, MRU-200, MPI-530) allows for measuring the resistance of multiple earthing systems without the need for placing auxiliary probes in the ground. During this measurement, the current generated by the transmitting clamp flows in the circuit: examined earthing + parallel system of the remaining earthing and is measured by the receiving clamp - based on this measurement, the circuit resistance is calculated. Because the parallel connection of several resistances creates net resistance of much lower value, the result is overstated as compared to the examined resistance. The difference gets smaller, as the number of earthing systems in the measured object grows.



Connecting the meter in the two-clamp method

Equivalent circuit diagram of a multiple earthing system with the two-clamp method

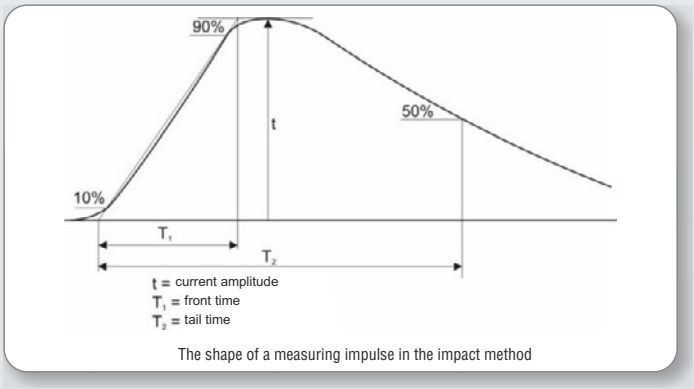
The two-clamp method is employed for measuring multiple earthing systems that are not connected underground. If the earthing systems are connected underground, this method allows for circuit continuity measurement only in the earthing system considered for electric shock protection, the behaviour of low-frequency currents is important (50, 60 Hz). The purpose of **lightning protection earthing** is to carry the lightning surge to the ground. The impulse nature of such a discharge causes the inductive component of the examined earthing to become important; only the part of the earthing system closest to the point of strike is used effectively for carrying the lightning current.

Therefore earthing of low static resistance, guaranteeing good basic protection, does not have to provide sufficient lightning protection parameters – this is especially true in the case of extensive earthing systems that can have impedance several times higher than their low static resistance. Measurement with the use of the impulse method (MRU-200) in accordance with the standard: EN 62305 allows for diagnosing dynamic parameters of lightning protection earthing systems. Due to the impulse nature of the measurement, disconnecting earthing in the case of multiple earthing system or energised objects is not necessary, because the measurement current impulse operates only in limited distance, just like the lightning strike. The measurement performs in accordance with the definition from the EN 62305 standard. This method allows for determining a conventional value described as an impact impedance (Z_E), being the ratio of peak voltage value and the peak current value.

Impedance specified by the standard is a conventional value, because usually, the voltage and current peaks do not occur simultaneously. Impedance is considered as an index of earthing effectiveness in the conditions of stricter or special protection.

The measurement impulse parameters (simulating the shape of lightning discharge) are defined by two numbers: the front time T_1 and the tail time T_2. The MRU-200 meter allows for selecting one of the three shapes of impulses: 10/350µs, 8/20µs or 4/10µs.

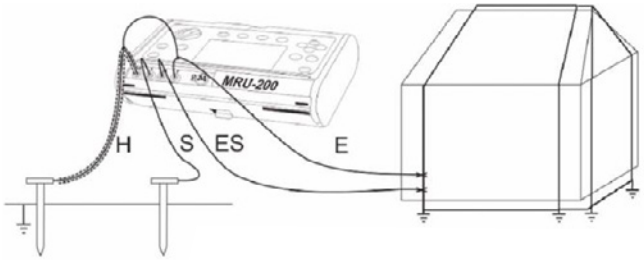
According to the EN 62305 standard, the impulse of shape 10/350µs is typical for the first impact of the lightning current. The same impulse is given as the calibration impulse by the EN 62305-1 standard.



The shape of a measuring impulse in the impact method

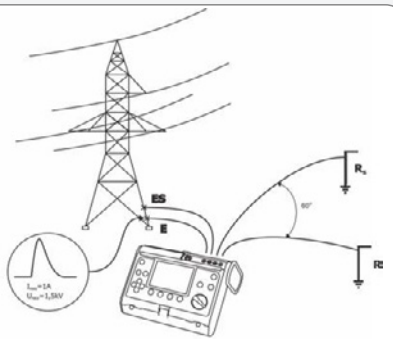
During the measurement of multiple earthing with the use of the impulse method, where individual earthing is connected both over and underground, the measurement impulse operates in close distance from the given earthing only, allowing for earthing measurement without the necessity for disconnecting test connections and disconnecting the equipotential bonding – that is, without the necessity for disconnecting power supply of the object.

electromagnetic compatibility (EMC) as well as safety, and bear the CE marking.



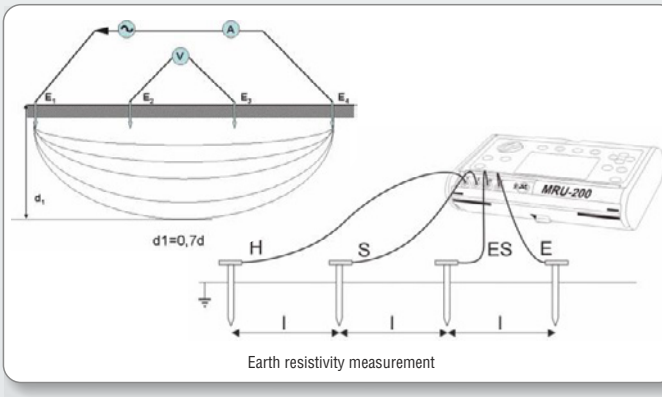
Earth impedance measurement circuit (four-lead impact method)

The impulse method can also be used for earthing measurements of HV pylons and allows for determining eart impedance of the entire pylon, including both ring iron systems and the resistance of pylons legs. Moreover, it can be used without turn-off the examined HV line and partial disassembly of earthing.



HV pylon earthing measurement

Knowledge of earth resistivity (MRU-105, MRU-120, MRU-200) matters at the earthing design stage. Knowing the cross-section of soil, the type of earthing can be selected - e.g. for low values of resistivity occurring at a certain depth, a single, deep-buried vertical earth electrode will be designed, whereas for soil of low resistivity at a shallower depth and rock at a higher depth it will be a set of earthing systems comprising multiple shorter vertical earthing electrodes connected with ring iron.



Earth resistivity measurement

The measurement of earth resistivity is carried with the use of four rods placed in a straight line with equal spacing (the Wenner method). Earth resistivity is measured at the depth equal to 0.7 of distance between rods.

Measurement facilities

During measurements performed on live systems (short-circuit impedance, residual current device parameters, voltage, phase sequence), use test leads terminated with test probes or crocodile clips (meeting relevant measurement category requirements, of shape preventing finger slipping), or adapters appropriate for sockets, in which the measurements are performed.

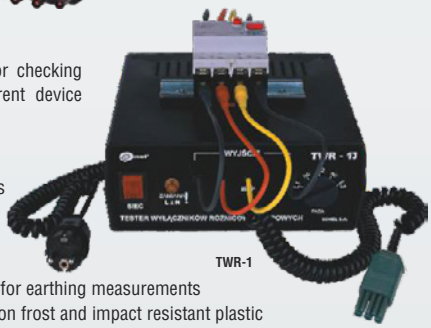
The meters connected to a system equipped with sockets through a cord terminated with a power plug, or with cords in other cases, automatically check the correctness and signal any abnormalities of connections. Measurements in single-phase sockets are possible with adapters terminated with a UNI-Schuko plug. These measurements are also performed in the case of swapped phase and neutral conductors (without the need for rewiring or using additional adapters).

Moreover, the WS-01 and WS-03 adapters have buttons for triggering measurements and saving the results in memory. For three-phase or high-current measurements, one of the following adapters can be optionally used: the AGT-16P, AGT-32P, AGT-63P, AGT-16C, AGT-32C adapter for three-phase sockets or the AGT-16T and AGT-32T adapter for high-current sockets.

The AutoISO family of adapters, with the use of an appropriate instrument, allows for performing insulation resistance measurements of 3, 4 and 5-core cords without the need for manual selection of pairs and combinations of measured cores. Leads protruding from the adapter are terminated with alligator clips (depending on situation: 3, 4 or all 5) and fastened to the cores of the cord to be measured. Then the measurement is started, and the adapter, connected to the meter, will perform all the required sequence of measurements. The AutoISO-2500 adapter used with the MPI-525 or MIC-2510 meter also allows for performing such measurements of cables (with the voltage of 2500 V).


AutoISO-2500

AutoISO-1000


TWR-1

The TWR-1J adapter allows for checking the parameters of a residual current device before installing it in a system.

The earth resistance instruments are delivered with a rich set of ergonomic accessories facilitating the performance of measurements. Due to the length of test leads used for earthing measurements (50, 30, 25, 15 m), they are wound on frost and impact resistant plastic reels allowing for quick unwinding and winding up.

Sonel provides the capability of supplementing the measurement set with 80 cm long rods with an appropriate sheath, a high sensitivity and accuracy clamp (C-3, N-1), allowing for current measurements or earthing measurements without disconnecting test connections, as well as a special cramp guaranteeing secure contact.

Measurement instruments are delivered with appropriate soft or hard cases, matching the shapes of respective instruments and equipped with compartments and internal holders allowing for transporting measurement accessories as well.

A detailed list of standard and additional accesories is presented on pages 36…38.

Multifunction electrical installations meters

MPI-530 / MPI-530-IT

Index: WMGBMPI530 / WMGBMPI530IT

Bluetooth · IP 54 · lux CLASS A · CAT III 600V · CAT IV 300V

Measurements of short-circuit impedance:

- impedance measurement with resolution 0.001 Ω and 23 A current (44 A phase-to-phase)
- short-circuit resistor R_{2W}=10 Ω
- measurement range: 95...440 V, frequency 45...65 Hz,
- measurement of short circuit impedance with resolution 0.01 Ω, in protected systems without tripping the RCD's with $I_{\Delta n} \geq 30$ mA
- automatic calculation of short-circuit current, differentiating between phase-to-phase and phase-to-neutral voltage,
- measurements using UNI-Schuko plug with measurement triggering button (also when L and N leads are exchangeable) or 1.2 m, 5 m, 10 m, 20 m test leads, with optional use of 3-phase socket adapters (AGT),
- selection of installation protections and automatic evaluation of measurements results

Examination of AC, A, B and F type residual current devices

- **MPI-530-IT allows measurements in IT network,**
- measurement of general, short-time delay and selective RCDs of rated residual current 10, 30, 100, 300, 500 and 1000 mA,
- a function of automatic measurement of the full set of RCD parameters (after a single push of the "START" button, the meter performs the entire defined cycle of measurements, including the L-PE short-circuit impedance measurement with 15 mA current),
- the shape of leakage current characteristics selected by the user: sinusoidal (starting with the rising or falling edge), pulsating unidirectional current (positive or negative), pulsating unidirectional current with 6mA direct current offset (positive or negative), direct current (positive or negative),
- measurement of the I_A operating current with rising current,
- measurement of the t_A tripping time for $\frac{1}{2}I_{\Delta n}$, $I_{\Delta n}$, $2I_{\Delta n}$, $5I_{\Delta n}$,
- measurement of the U_B touch voltage and the R_E protective conductor resistance without tripping the RCD,
- detection of swapped L and N conductors in a socket; no influence on the performance of measurements,
- capability of the I_A tripping current and the t_{Ai} actual tripping time measurement with just one RCD tripping,
- voltage measurements in the range of 95...270 V.

Insulation resistance measurements:

- test voltages: 50 V, 100 V, 250 V, 500 V, 1000 V,
- insulation resistance measurements up to 10 GΩ,
- capability of in-socket measurement with the use of the UNI-Schuko adapter,
- acoustic signalling of 5-second time intervals to facilitate capturing time characteristics,
- protection of the meter against the presence of voltage on the object and the appearance of voltage during measurement,
- automatic discharge of capacitance of the object after finishing the measurement,
- automatic measurement of all resistance combinations of 3, 4 and 5-core cords with the use of the additional AutoISO-1000C adapter.

Measurements of earth resistance and earth resistivity

- measurement with 3- or 4-lead technical method and 2 auxiliary electrodes,
- measurement with the 3-pole method with additional clamp,
- measurement with 2-clamp method,
- measurement of soil resistivity - range of measurement: 0.0 Ωm...9.99 kΩm, input of rods spacing distances in meters (1...30 m) or in feet (1...90 ft)

Other technical specifications:

- type of insulation ..... double, in acc. with EN 61010-1 and IEC 61557
- operating temperature ..... 0...+50°C
- power supply of the meters.....NiMH rechargeable battery or LR14 alkaline batteries

Standard accessories of the MPI-530 / MPI-530-IT meters:

- Adapter with START button with UNI-Schuko (WS-03)	**WAADAWS03**
- Test lead with banana plug; 1,2m; yellow	**WAPRZ1X2YEBB**
- Test lead with banana plug; 1,2m; blue	**WAPRZ1X2BUBB**
- Test lead with banana plug; 1,2m; red	**WAPRZ1X2REBB**
- Test lead on a reel with banana plugs; 15m; blue	**WAPRZ015BUBBSZ**
- Test lead on a reel with banana plugs; 30m; red	**WAPRZ030REBBSZ**
- USB cable	**WAPRZUSB**
- Pin probe with banana connector; yellow	**WASONYEOGB1**
- Pin probe with banana connector; red	**WASONREOGB1**
- Pin probe with banana connector; blue	**WASONBUOGB1**
- "Crocodile" clip K02; yellow	**WAKROYE20K02**
- "Crocodile" clip K02; red	**WAKRORE20K02**
- Earth contact test probe (rod); 0,30m (2 pcs)	**WASONG30**
- Bluetooth mini-keyboard	**WAADAMK**
- Carrying case L2	**WAFUTL2**
- Set of hanging straps	**WAPOZSZEKPL**
- NiMH rechargeable battery	**WAAKU07**
- Lead for battery loading from the socked of car lighter (12V)	**WAPRZLAD12SAM**
- Cable for battery charger	**WAPRZLAD230**
- Power supply adapter Z7	**WAZSZ7**
- Sonel Reader software	
- Calibration certificate	

DO YOU KNOW...

MPI-530 / MPI-530-IT meter allow for performing measurements in sockets with swapped L and N conductors.

Low-voltage measurement of protective connection and equipotential bonding resistance:

- measurement of the protective conductor continuity with current 200 mA in both directions (in accordance with the EN 61557-4 standard),
- low-current measurement of resistance with acoustic and light signalling,
- automatic calibration of test leads - capability of using test leads of any length.

Illuminance measurements:

- range of measurement: 0.1 lx...19.9 klx,
- measurement in lux (lx) or foot-candle (fc),
- measurement using external photo detector (optional)

Additionally:

Measurement and recording of voltage, frequency, AC, cosφ and power (active,reactive and apparent), voltage and current harmonics up to 40, THD.

Quick verification of correctness of the PE conductor connection with the use of a touch electrode.

Phase sequence checking.

Innovative memory with possibility of description of: measurement points, facilities, names of customers (max. 10000 results of each measurement).

Power supply from rechargeable of disposable batteries (optional).

Bluetooth mini-keyboard:

DO YOU KNOW...

MPI-530 / MPI-530-IT meter allow for automatic insulation resistance measurement of 3, 4 and 5-core cords and cables with the use of additional AutoISO-1000C adapter.

2 YEAR WARRANTY

Measurement of the Z_{L-PE}, Z_{L-N}, Z_{L-L} short-circuit impedance

Measurement with current 23/40 A - measurement range in acc. with IEC 61557-3: **0.130…1999 Ω** (for a 1.2 m long test lead):

Display range	Resolution	Accuracy
0.000...19.999 Ω	0.001 Ω	±(5% m.v. + 0,03 Ω)
20.00...199.99 Ω	0.01 Ω	±(5% m.v. + 0,3 Ω)
200...1999.9 Ω	0.1 Ω	±(5% m.v. + 3 Ω)

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

Measurement of the Z_{L-PE} short-circuit impedance in the RCD mode

Measurement with current 15 mA - measurement range in acc. with IEC 61557-3: **0.50…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	

Nominal voltage: 95…270 V
Frequency: 45…65 Hz

Measurements of the R_E earth resistance with 3p, 4p, 3p with clamp

Measurement range in acc. with IEC 61557-5: **0.50 Ω…1.99 kΩ** (3p, 4p, U=50V)
1.00 Ω …1.99 kΩ (3p with clamp)

Display range	Resolution	Accuracy of 3p, 4p	Accuracy 3p + clamp
0.00...9.99 Ω	0.01 Ω	±(2% m.v. + 4 digits)	±(8% m.v. + 4 digits)
10.0...99.9 Ω	0.1 Ω	±(2% m.v. + 3 digits)	
100...999 Ω	1 Ω		
1.00...1.99 kΩ	0.01 kΩ		

Earth resistance measurement with two clamps

Display range	Resolution	Accuracy
0.00...9.99 Ω	0.01 Ω	±(10% m.v. + 4 digits)
10.0...19.9 Ω	0.1 Ω	
20...99.9 Ω		±(20% m.v. + 4 digits)

Measurement of insulation resistance

Measurement range in acc. with IEC 61557-2:
- for U_n = 50 V: **50 kΩ…250 MΩ**
- for U_n = 100 V: **100 kΩ…500 MΩ**
- for U_n = 250 V: **250 kΩ…1 GΩ**
- for U_n = 500 V: **500 kΩ…2 GΩ**
- for U_n = 1000 V: **1 MΩ…9.99 GΩ**

Display range *)	Resolution	Accuracy
0...1999 kΩ	1 kΩ	±(3% m.v. + 8 digits)
2.00...19.99 MΩ	0.01 MΩ	
20.0...199.9 MΩ	0.1 MΩ	
200...999 MΩ	1 MΩ	
1.00...9.99 GΩ	0.01 GΩ	±(4% m.v. + 6 digits)

Indication of phase sequence

- Indication of phase sequence: complaint, opposite
- U_{L-L} power system voltage range: 95...500 V (45...65 Hz)
- Displaying of phase-to-phase voltage

Analysis and recording of single-phase system

- **Voltage measurement U_{L-N}: 0…500 V (TRUE RMS), frequency range 45…65 Hz**
- **Power measurement P, Q, S: 0…1.5 M (W, var, VA), frequency range 45…65 Hz**
- **Frequency measurement: 45.0…65.0 Hz for 50…500 V voltages**
- **cosφ measurement: 0.00…1.00 (resolution 0.01)**
- **Measurement voltage and current harmonics (h02…h40)**
- **Measurement THD in relation to the first harmonic**
- **AC current measurement (True RMS) using clamps:**

Clamp	Display range	Resolution	Accuracy
C-3, C-6	0.0...99.9 mA	0.1 mA	±(5% m.v. + 3 digits)
	100...999 mA	1 mA	
C-3, C-6, F-2, F-3	1.00...9.99 A	0.01 A	±(5% m.v. + 5 digits) (C-3, C-6)
	10.0...99.9 A	0.1 A	
	100...999 A	1 A	±(0.1% I_n + 2 digits) (F-1, F-2, F-3)
F-1, F-2, F-3	1.00...3.00 kA	0.01 kA	

DO YOU KNOW...

MPI-530 / MPI-530-IT meter allow for accurate short-circuit loop impedance measurement in L-PE circuits in power systems with RCDs (with measurement current 15 mA).

Measurement of RCD parameters (operating voltage range 95…270 V):

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

RCD type	Factor	Range	Resolution	Accuracy
General Short-time delay Selective	0.5*$I_{\Delta n}$	0...300ms	1ms	±(2% m.v. + 2 digits) for RCD of $I_{\Delta n}$=10 mA and the measurement with 0,5x$I_{\Delta n}$, error
	1* $I_{\Delta n}$			
	2* $I_{\Delta n}$	0...150ms		
	5*$I_{\Delta n}$	0...40ms		

Accuracy of residual current setting: 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 the I_A RCD tripping current for sinusoidal residual current (AC type)

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

Start the measurement from a positive or negative half-period of forced leakage current (AC type)

Measurement of the I_A RCD operating current for residual pulsating unidirectional current with 6mA direct current offset (type A)

Nominal current	Measurement range	Resolution	Measurement current	Accuracy
10mA	3.5...20.0mA	0.1mA	0.4 x $I_{\Delta n}$ ...2.0 x $I_{\Delta n}$	± 10% $I_{\Delta n}$
30mA	10.5...42.0mA			
100mA	35...140mA	1mA	0.4 x $I_{\Delta n}$ ...1.4 x $I_{\Delta n}$	
300mA	105...420mA			
500mA	175...700mA			

Capability of measurement for positive or negative half-periods of forced leakage current

Measurement of the I_A RCD operating current for residual direct current (type B)

Nominal current	Measurement range	Resolution	Measurement current	Accuracy
10mA	2.0...20.0mA	0.1mA	0.4 x $I_{\Delta n}$ ...2.0 x $I_{\Delta n}$	± 10% $I_{\Delta n}$
30mA	6...60mA	1mA		
100mA	20...200mA			
300mA	60...600mA			
500mA	100...1000mA			

Capability of measurement for positive or negative forced leakage current
I_A - rated residual current value

Illuminance measurement

Display range	Resolution	Accuracy
0.1...19.99 lx	0.1 lx	±(5% m.v. + 2 digits)
100...999 lx	1 lx	
1.00...9.99 lx	0.01 lx	
10.0...19.9 klx	0.1 lx	

"m.v." = "measured value".

DO YOU KNOW...

MPI-530 / MPI-530-IT meter allow for the measurement of the tripping time and tripping current of an RCD with just one RCD trip.

The instruments meet the requirements set forth by the standards:

EN 61010-1, EN 61010-031 (general and particular requirements related to safety)
EN 61326 (electromagnetic compatibility)
EN 61557, IEC 61557 (requirements for measurement instruments)
HD 60364-6 (performance of measurements - checking)
HD 60364-4-41 (performance of measurements - protection against electric shock)
EN 04700 (performance of measurements - rough-in inspection tests)
EN 12464 (lighting workplaces)
BS 7671 (British Standard)
VDE 0100 (erection of power installations with rated voltages below 1000)

Multifunction electrical installations meter

MPI-525

Index: WMGBMPI525

IP 54

CAT IV 300V

Measurements of short-circuit impedance:

- impedance measurement with 23 A current (40 A for phase-to-phase voltage),
- resistor limiting the current: 10 Ω,
- range of measurement voltage: 95...440 V, frequency 45...65 Hz,
- measurement of short-circuit impedance with the resolution of 0.01 Ω in systems protected with RCDs of $I_{\Delta n} \geq 30$ mA without tripping them,
- automatic calculation of short-circuit current; differentiation between line and phase-to-phase voltage,
- measurements with the use of a UNI-Schuko plug with a measurement triggering button (also with swapped L and N conductors) or leads of lengths 1.2, 5, 10, 20 m, with possible use of three-phase socket adapters (AGT).

Examination of AC, A and B type residual current devices:

- measurement of general, short-time delay and selective RCDs of rated residual current 10, 30, 100, 300, 500 and 1000 mA,
- a function of automatic measurement of the full set of RCD parameters (after a single push of the "START" button, the meter performs the entire defined cycle of measurements, including the L-PE short-circuit impedance measurement with 15 mA current),
- the shape of leakage current characteristics selected by the user: sinusoidal (starting with the rising or falling edge), pulsating unidirectional current (positive or negative), pulsating unidirectional current with 6mA direct current offset (positive or negative), direct current (positive or negative),
- measurement of the I_A operating current with rising current,
- measurement of the t_A tripping time for $1/2I_{\Delta n}$, $I_{\Delta n}$, $2I_{\Delta n}$, $5I_{\Delta n}$,
- measurement of the U_B touch voltage and the R_E protective conductor resistance without tripping the RCD,
- detection of swapped L and N conductors in a socket; no influence on the performance of measurements,
- capability of the I_A tripping current and the t_{Ai} actual tripping time measurement with just one RCD tripping,
- voltage measurements in the range of 95...270 V.

Insulation resistance measurements:

- test voltages: 50 V, 100 V, 250 V, 500 V, 1000 V and 2500 V,
- insulation resistance measurements up to 10 GΩ,
- acoustic signalling of 5-second time intervals to facilitate capturing time characteristics,
- measurement of 2 absorption coefficients (DAR, PI or Ab1, Ab2), adiustable elapsing T_1, T_2, T_3 times from the range of 1...600 s,
- protection of the meter against the presence of voltage on the object and the appearance of voltage during measurement,
- automatic discharge of capacitance of the measured object after finishing the measurement,
- automatic measurement of all resistance combinations of 3, 4 and 5-core cords and power cables with the use of the additional AutoISO-2500 adapter.

Measurements of earth resistance:

- measurement with the three-pole technical method and 2 auxiliary rods,
- internal voltage source of frequency appropriate for 50 or 60 Hz power system (selectable in the meter).

Standard accessories of the MPI-525 meter:

- Adapter with START button with UNI-Schuko (WS-03)	WAADAWS03
- Test lead with banana plug; 1,2m; yellow	WAPRZ1X2YEBB
- Test lead with banana plug; 1,2m; blue	WAPRZ1X2BUBB
- Test lead with banana plug; 1,2m; red	WAPRZ1X2REBB
- Test lead on a reel with banana plugs; 15m; blues	WAPRZ015BUBBSZ
- Test lead on a reel with banana plugs; 30m; red	WAPRZ030REBBSZ
- "Crocodile" clip K02; yellow	WAKROYE20K02
- Pin probe with banana connector; yellow	WASONYEOGB1
- Pin probe with banana connector; red	WASONREOGB1
- Pin probe with banana connector; blue	WASONBUOGB1
- Test lead with banana plug; 1,8m; 5kV; red	WAPRZ1X8REBB
- Test shielded lead with banana plug; 1,8m; 5kV; black	WAPRZ1X8BLBB
- Pin probe 5kV with banana connector; red	WASONREOGB2
- "Crocodile" clip K04; 5kV; black	WAKROBL20K04
- Earth contact test probe (rod); 0,30m - 2 pcs	WASONG30
- USB cable	WAPRZUSB
- Carrying case L2	WAFUTL2
- NiMH rechargeable battery	WAAKU07
- Cable for battery charger	WAPRZLAD230
- Power supply adaptor Z7	WAZASZ7
- Set of hangind straps	WAPOZSZEKPL
- Sonel Reader software, calibration certificate	

DO YOU KNOW...

MPI-525 meter is one of the few multifunction meters on the market allowing for insulation resistance measurements with the voltage of 2500 V.

Low-voltage measurement of protective connection and equipotential bonding resistance:

- measurement of the protective conductor continuity with current 200 mA in both directions (in accordance with the EN 61557-4 standard),
- low-current measurement of resistance with acoustic and light signalling,
- automatic calibration of test leads - capability of using test leads of any length.

Additionally:

Quick verification of correctness of the PE conductor connection with the use of a touch electrode.

Phase sequence checking.

Memory of 990 measurements (57500 individual results), data transfer to a PC over the USB or wireless interface.

Battery or rechargeable battery power supply.

Real time clock (RTC) - measurement time saved in memory.

DO YOU KNOW...

MPI-525 meter allows for performing measurements in sockets with swapped L and N conductors.

Other technical specifications:

- type of insulation ..... double, in acc. with EN 61010-1 and IEC 61557
- operating temperature ..... 0...+50°C
- power supply of the meter ..... NiMH rechargeable battery or LR14 alkaline batteries .....(4 pcs - optional)

2 YEAR WARRANTY

Measurement of the Z_{L-PE}, Z_{L-N}, Z_{L-L} short-circuit impedance

Measurement with current 23/40 A - measurement range in acc. with IEC 61557-3: **0.13…1999 Ω**, (for a 1.2 m long test lead):

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

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

Measurement of the Z_{L-PE} short-circuit impedance in the RCD mode

Measurement with current 15 mA - measurement range in acc. with IEC 61557-3: **0.50…1999 Ω**

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

Nominal voltage: 95…270 V
Frequency: 45…65 Hz

Measurements of the R_E earth resistance

Measurement range in acc. with IEC 61557-5 **0.50 Ω…1.99 kΩ** for measurement voltage of 50 V
0.56 Ω…1.99 kΩ for measurement voltage of 25 V

Display range	Resolution	Accuracy
0.00...9.99Ω	0.01Ω	±(2% m.v. + 4 digits)
10.0...99.9Ω	0.1Ω	±(2% m.v. + 3 digits)
100...999Ω	1Ω	
1.00...1.99kΩ	0.01kΩ	

Measurement of insulation resistance

Measurement range in acc. with IEC 61557-2:

- for U_n = 50V: **50kΩ…250MΩ**
- for U_n = 100V: **100kΩ…500MΩ**
- for U_n = 250V: **250kΩ…1GΩ**
- for U_n = 500V: **500kΩ…2GΩ**
- for U_n = 1000V: **1MΩ…3GΩ**
- for U_n = 2500V: **2.5MΩ…9.99GΩ**

Display range *)	Resolution	Accuracy
0...1999kΩ	1kΩ	±(3% m.v. + 8 digits)
2.00...19.99MΩ	0.01MΩ	
20.0...199.9MΩ	0.1MΩ	
200...999MΩ	1MΩ	
1.00...9.99GΩ	0.01GΩ	±(4% m.v. + 6 digits)

*) not exceeding the measurement range for a given voltage.

DO YOU KNOW...

MPI-525 meter allows for automatic insulation resistance measurement of 3, 4 and 5-core cords and cables with the use of the additional AutoISO-2500 adapter.

Indication of phase sequence

- Indication of phase sequence: complaint, opposite
- U_{L-L} power system voltage range: 95...500 V (45...65 Hz)
- Displaying of phase-to-phase voltage

Low-voltage measurement of circuit continuity and resistance

Measurement of the protective conductor continuity with current ±200 mA
Measurement range in acc. with IEC 61557-4: **0.12…400Ω**

Display range	Resolution	Accuracy
0.00...19.99Ω	0.01Ω	±(2% m.v. + 3 digits)
20.0...199.9Ω	0.1Ω	
200...400Ω	1Ω	

- Voltage on open terminals: 4...9 V
- Output current at R<2Ω: min. 200mA
- Automatic calibration of test leads
- Measurements for both current polarisations

DO YOU KNOW...

MPI-525 meter, as one of the few, allows for accurate short-circuit impedance measurement in L-PE circuits in power systems with RCDs (with 15 mA measurement current).

Measurement of RCD parameters (operating voltage range 96…270 V):

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

Typ RCD	Factor	Range	Resolution	Accuracy
General	0.5*$I_{\Delta n}$	0...300ms	1ms	±(2% m.v. + 2 digits) for RCD of $I_{\Delta n}$=10 mA and the measurement with 0,5x$I_{\Delta n}$, error:
	1* $I_{\Delta n}$			
Short-time delay	2* $I_{\Delta n}$	0...150ms		
	5*$I_{\Delta n}$	0...40ms		
Selective	0.5*$I_{\Delta n}$	0...500ms		
	1* $I_{\Delta n}$			
	2* $I_{\Delta n}$	0...200ms		
	5*$I_{\Delta n}$	0...150ms		

Accuracy of residual current setting: 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 the I_A RCD tripping current for sinusoidal residual current (AC type)

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

- Possibility of starting the measurement from a positive or negative half-period of forced leakage current (AC type)

Measurement of the I_A RCD operating current for residual pulsating unidirectional current with 6mA direct current offset (type A)

Nominal current	Measurement range	Resolution	Measurement current	Accuracy
10mA	3.5...20.0mA	0.1mA	0.4 x $I_{\Delta n}$ ...2.0 x $I_{\Delta n}$	± 10% $I_{\Delta n}$
30mA	10.5...42.0mA		0.4 x $I_{\Delta n}$ ...1.4 x $I_{\Delta n}$	
100mA	35...140mA	1mA		
300mA	105...420mA			
500mA	175...700mA			

- Capability of measurement for positive or negative half-periods of forced leakage current

Measurement of the I_A RCD operating current for residual direct current (type B)

Nominal current	Measurement range	Resolution	Measurement current	Accuracy
10mA	2.0...20.0mA	0.1mA	0.4 x $I_{\Delta n}$ ...2.0 x $I_{\Delta n}$	± 10% $I_{\Delta n}$
30mA	6.0...60mA	1mA		
100mA	20...200mA			
300mA	60...600mA			
500mA	100...1000mA			

- Capability of measurement for positive or negative forced leakage current I_A - rated residual current value

"m.v." = "measured value".

DO YOU KNOW...

MPI-525 meter allows for measuring the actual tripping time and tripping current of an RCD with just one RCD trip.

The instrument meets the requirements set forth by the standards:

EN 61010-1, EN 61010-031 (general and particular requirements related to safety)
EN 61326 (electromagnetic compatibility)
EN 61557, IEC 61557 (requirements for measurement instruments)
HD 60364-6 (performance of measurements - checking)
HD 60364-4-41 (performance of measurements - protection against electric shock)
EN 04700 (performance of measurements - rough-in inspection tests)
BS 7671 (British Standard)
VDE 0100 (erection of power installations with rated voltages below 1000)

Multifunction electrical installations meters

MPI-520, MPI-520 Start

Index: WMGBMPI520 (MPI-520)
WMGBMPI520S (MPI-520 Start)

IP 54

CAT IV 300V

Standard accessories of the meters:

- Adapter with START button with UNI-Schuko (WS-03)	WAADAWS03
- Test lead with banana plug; 1,2m; yellow	WAPRZ1X2YEBB
- Test lead with banana plug; 1,2m; blue	WAPRZ1X2BUBB
- Test lead with banana plug; 1,2m; red	WAPRZ1X2REBB
- Test lead on a reel with banana plugs; 15m; blue (MPI-520)	WAPRZ015BUBBSZ
- Test lead on a reel with banana plugs; 30m; red (MPI-520)	WAPRZ030REBBSZ
- USB cable	WAPRZUSB
- Pin probe with banana connector; yellow (MPI-520)	WASONYEOGB1
- Pin probe with banana connector; red	WASONREOGB1
- Pin probe with banana connector; blue	WASONBUOGB1
- "Crocodile" clip K02; yellow	WAKROYE20K02
- "Crocodile" clip K02; red	WAKRORE20K02
- Earth contact test probe (rod); 0,30m	WASONG30
- Carrying case L2 (MPI-520)	WAFUTL2
- Carrying case L4 (MPI-520Start)	WAFUTL4
- Set of hanging straps	WAPOZSZEKPL
- Box for batteries	WAPOJ1
- Batteries	
- Sonel Reader software	
- calibration certificate	

Measurements of short-circuit impedance:

- impedance measurement with 23 A current (40 A for phase-to-phase voltage),
- resistor limiting the current: 10 Ω,
- range of measurement voltage: 95...440 V, frequency 45...65 Hz,
- measurement of short-circuit impedance with the resolution of 0.01 Ω in systems protected with RCDs of $I_{\Delta n}$ ≥30 mA without tripping them,
- automatic calculation of short-circuit current; differentiation between line and phase-to-phase voltage,
- measurements with the use of a UNI-Schuko plug with a measurement triggering button (also with swapped L and N conductors) or leads of lengths 1.2, 5, 10, 20 m, with possible use of three-phase socket adapters (AGT).

Examination of AC, A and B type residual current devices:

- measurement of general, short-time delay and selective RCDs of rated residual current 10, 30, 100, 300, 500 and 1000 mA,
- a function of automatic measurement of the full set of RCD parameters (after a single push of the "START" button, the meter performs the entire defined cycle of measurements, including the L-PE short-circuit impedance measurement with 15 mA current),
- the shape of leakage current characteristics selected by the user: sinusoidal (starting with the rising or falling edge), pulsating unidirectional current (positive or negative), pulsating unidirectional current with 6mA direct current offset (positive or negative), direct current (positive or negative),
- measurement of the I_A operating current with rising current,
- measurement of the t_A tripping time for $1/2I_{\Delta n}$, $I_{\Delta n}$, $2I_{\Delta n}$, $5I_{\Delta n}$,
- measurement of the U_B touch voltage and the R_E protective conductor resistance without tripping the RCD,
- detection of swapped L and N conductors in a socket; no influence on the performance of measurements,
- capability of the I_A tripping current and the t_{Ai} actual tripping time measurement with just one RCD tripping,
- voltage measurements in the range of 95...270 V.

Insulation resistance measurements:

- test voltages: 50 V, 100 V, 250 V, 500 V, 1000 V,
- insulation resistance measurements up to 3GΩ,
- capability of in-socket measurement with the use of the UNI-Schuko adapter,
- acoustic signalling of 5-second time intervals to facilitate capturing time characteristics,
- protection of the meter against the presence of voltage on the object and the appearance of voltage during measurement,
- automatic discharge of capacitance of the measured object after finishing the measurement,
- automatic measurement of all resistance combinations of 3, 4 and 5-core cords with the use of the additional AutoISO-1000C adapter.

Measurements of earth resistance

- measurement with the three-lead technical method and 2 auxiliary electrodes,
- internal voltage source of frequency appropriate for 50 or 60 Hz power system (selectable in the meter).

DO YOU KNOW...

MPI-520 and MPI-520 Start meters allow for automatic insulation resistance measurement of 3, 4 and 5-core cords and cables with the use of the additional AutoISO-1000C adapter.

Low-voltage measurement of protective connection and equipotential bonding resistance:

- measurement of the protective conductor continuity with current 200 mA in both directions (in accordance with the EN 61557-4 standard),
- low-current measurement of resistance with acoustic and light signalling,
- automatic calibration of test leads - capability of using test leads of any length.

Additionally:

Measurement of voltage, frequency as well as alternating current (with the use of an additional clamp), cosφ and power (active, reactive, apparent).

Quick verification of correctness of the PE conductor connection with the use of a touch electrode.

Phase sequence checking.

Memory of 990 measurements (57500 individual results), data transfer to a PC over the USB or wireless interface.

Battery or rechargeable battery power supply (optional).

Real time clock (RTC) - measurement time saved in memory.

DO YOU KNOW...

MPI-520 and MPI-520 Start meters allow for performing measurements in sockets with swapped L and N conductors.

Other technical specifications:

- type of insulation ..... double, in acc. with EN 61010-1 and IEC 61557
- operating temperature ..... 0...+50°C
- power supply of the meters ..... LR14 alkaline batteries (4 pcs) or a NiMH rechargeable battery (optional)

2 YEAR WARRANTY

Measurement of the Z_{L-PE}, Z_{L-N}, Z_{L-L} short-circuit impedance

Measurement with current 23/40 A - measurement range in acc. with IEC 61557-3: **0.13…1999Ω** (for a 1.2 m long test lead):

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

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

Measurement of the Z_{L-PE} short-circuit impedance in the RCD mode

Measurement with current 15 mA - measurement range in acc. with IEC 61557-3: **0.50…1999Ω**

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

Nominal voltage: 95…270 V
Frequency: 45…65 Hz

Measurements of the R_E earth resistance

Measurement range in acc. with IEC 61557-5: **0.50Ω…1.99kΩ** for measurement voltage of 50V
0.56Ω …1.99kΩ for measurement voltage of 25V

Display range	Resolution	Accuracy
0.00...9.99Ω	0.01Ω	±(2% m.v. + 4 digits)
10.0...99.9Ω	0.1Ω	±(2% m.v. + 3 digits)
100...999Ω	1Ω	
1.00...1.99kΩ	0.01kΩ	

Measurement of insulation resistance

Measurement range in acc. with IEC 61557-2:
- for U_n = 50V: **50kΩ…250MΩ**
- for U_n = 100V: **100kΩ…500MΩ**
- for U_n = 250V: **250kΩ…1GΩ**
- for U_n = 500V: **500kΩ…2GΩ**
- for U_n = 1000V: **1MΩ…3GΩ**

Display range *)	Resolution	Accuracy
0...1999kΩ	1kΩ	±(3% m.v. + 8 digits)
2.00...19.99MΩ	0.01MΩ	
20.0...199.9MΩ	0.1MΩ	
200...999MΩ	1MΩ	
1.00...3.00GΩ	0.01GΩ	±(4% m.v. + 6 digits)

*) not exceeding the measurement range for a given voltage.
**) during measurements with an additional UNI-Schuko plug, additional error of ±2% occurs

Low-voltage measurement of circuit continuity and resistance

Measurement of the protective conductor continuity with current ±200 mA
Measurement range in acc. with IEC 61557-4: **0.12…400Ω**

Display range	Resolution	Accuracy
0.00...19.99Ω	0.01Ω	±(2% m.v. + 3 digits)
20.0...199.9Ω	0.1Ω	
200...400Ω	1Ω	

- Voltage on open terminals: 4...9 V 4…9V
- Output current at R<2Ω: min. 200mA
- Automatic calibration of test leads
- Measurements for both current polarisations

Indication of phase sequence

- Indication of phase sequence: complaint, opposite
- U_{L-L} power system voltage range: 95...500 V (45...65 Hz)
- Displaying of phase-to-phase voltage

Measurement of alternating voltage and current, cosφ as well as power

- P, Q, S power measurement: 0...200 k(W, var, VA).
- Measurement of alternating current (True RMS) with the use of a clamp probe (0...400 A), max. resolution 0.1 mA
- U_{L-N} voltage measurement: 0...500 V
- Frequency range of measured voltages: 45.0...65.0 Hz
- Measurement of frequency for voltages 50...500 V within the range of 45.0...65.0 Hz (max. accuracy ±0,1% m.v. + 1 digit)
- Measurement of cosφ: 0.00...1.00 (resolution 0.01)

DO YOU KNOW...

MPI-520 and MPI-520 Start meters allow for accurate short-circuit impedance measurement in L-PE circuits in power systems with RCDs (with measurement current 15 mA).

Measurement of RCD parameters (operating voltage range 96…270 V):

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

Typ RCD	Factor	Range	Resolution	Accuracy
General	0.5*$I_{\Delta n}$	0...300ms	1ms	±(2% m.v. + 2 digits) for RCD of $I_{\Delta n}$=10 mA and the measurement with 0,5x$I_{\Delta n}$, error:
	1* $I_{\Delta n}$			
Short-time delay	2* $I_{\Delta n}$	0...150ms		
	5*$I_{\Delta n}$	0...40ms		
Selective	0.5*$I_{\Delta n}$	0...500ms		
	1* $I_{\Delta n}$			
	2* $I_{\Delta n}$	0...200ms		
	5*$I_{\Delta n}$	0...150ms		

Accuracy of residual current setting: 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 the I_A RCD tripping current for sinusoidal residual current (AC type)

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

- Possibility of starting the measurement from a positive or negative half-period of forced leakage current (AC type)

Measurement of the I_A RCD operating current for residual pulsating unidirectional current with 6mA direct current offset (type A)

Nominal current	Measurement range	Resolution	Measurement current	Accuracy
10mA	3.5...20.0mA	0.1mA	0.4 x $I_{\Delta n}$ ...2.0 x $I_{\Delta n}$	± 10% $I_{\Delta n}$
30mA	10.5...42.0mA		0.4 x $I_{\Delta n}$ ...1.4 x $I_{\Delta n}$	
100mA	35...140mA	1mA		
300mA	105...420mA			
500mA	175...700mA			

- Capability of measurement for positive or negative half-periods of forced leakage current

Measurement of the I_A RCD operating current for residual direct current (type B)

Nominal current	Measurement range	Resolution	Measurement current	Accuracy
10mA	2.0...20.0mA	0.1mA	0.4 x $I_{\Delta n}$ ...2.0 x $I_{\Delta n}$	± 10% $I_{\Delta n}$
30mA	6.0...60mA	1mA		
100mA	20...200mA			
300mA	60...600mA			
500mA	100...1000mA			

- Capability of measurement for positive or negative forced leakage current I_A - rated residual current value

"m.v." = "measured value".

DO YOU KNOW...

MPI-520 and MPI-520 Start meters allow for the measurement of the tripping time and tripping current of an RCD with just one RCD trip.

The instruments meet the requirements set forth by the standards:

EN 61010-1, EN 61010-031 (general and particular requirements related to safety)
EN 61326 (electromagnetic compatibility)
EN 61557, IEC 61557 (requirements for measurement instruments)
HD 60364-6 (performance of measurements - checking)
HD 60364-4-41 (performance of measurements - protection against electric shock)
EN 04700 (performance of measurements - rough-in inspection tests)
BS 7671 (British Standard)
VDE 0100 (erection of power installations with rated voltages below 1000)

Multifunction electrical installations meter

MPI-505

Index: WMGBMPI505

CAT IV 300V

IP 54

DO YOU KNOW...

MPI-505 meter has improved immunity to unfavourable operating conditions.

Measurement of short-circuit parameters:

- impedance measurement in power systems of 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 short-circuit impedance with current 15 mA **with the resolution of 0.01Ω, without tripping residual current devices.**

Examination of AC and A type residual current devices:

- measurement of general use and selective RCDs of rated residual current 10, 30, 100, 300, 500 and 1000 mA,
- measurement of the I_A tripping current,
- 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,
- a function of automatic measurement of residual current device parameters.

Insulation resistance measurements:

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

Low-voltage measurement of protective connection and equipotential bonding resistance:

- measurement of the protective conductor continuity with current > 200 mA in both directions (in accordance with the EN 61557 standard),
- compensation of test lead resistance - capability of using any test leads,
- low-current measurement of resistance with acoustic signalling,

Additionally:

Quick verification of correctness of the PE conductor connection with the use of a touch electrode.

Measurement of alternating voltage.

Indication of phase sequence (100…400 V).

Memory of 990 measurement results, data transfer to a computer over the USB interface.

Measurement of insulation resistance

Measurement range in acc. with IEC 61557-2:

- for U_n = 100V: **100kΩ…500MΩ**
- for U_n = 250V: **250kΩ…1GΩ**
- for U_n = 500V: **500kΩ…2GΩ**
- for U_n = 1000V: **1MΩ…3GΩ**

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

*) not exceeding the measurement range for a given voltage.

- Detection of voltage before the measurement
- Discharge of capacitance of the measured object after the measurement

Standard accessories of the MPI-505 meter:

- Adapter with START button with UNI-Schuko (WS-01)	**WAADAWS01**
- Test lead with banana plug; 1,2m; red	**WAPRZ1X2REBB**
- Test lead with banana plug; 1,2m; yellow	**WAPRZ1X2YEBB**
- Test lead with banana plug; 1,2m; blue	**WAPRZ1X2BUBB**
- USB cable	**WAPRZUSB**
- Pin probe with banana connector; red	**WASONREOGB1**
- Pin probe with banana connector; yellow	**WASONYEOGB1**
- Pin probe with banana connector; blue	**WASONBUOGB1**
- "Crocodile" clip K02; yellow	**WAKROYE20K02**
- "Crocodile" clip K02; red	**WAKRORE20K02**
- Carrying case L4	**WAFUTL4**
- Hanging straps	**WAPOZSZE2**
- Calibration certificate, Sonel Reader software, batteries	

Measurement of the Z_{L-PE}, Z_{L-N}, Z_{L-L} short-circuit impedance

Measurement with current 23/40 A - measurement range in acc. with IEC 61557-3: **0.13…1999Ω** (for a 1.2 m long test lead):

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

- U_{nL-N}/U_{nL-L} nominal operating voltage: 115/200 V, 127/220 V, 220/380 V, 230/400 V, 240/415 V
- Operating voltage range: 100…254 V (for Z_{L-PE} and Z_{L-N}), and 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} short-circuit impedance in the RCD mode

Measurement range in acc. with IEC 61557-3: **0.50…1999Ω**

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

- Operating voltage range: 100…264 V

Measurement of RCD parameters (operating voltage range 100…264 V):

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

Factor	Range ☐	Range S	Resolution	Accuracy
$0.5*I_{\Delta n}$	0...300ms	0...500ms	1ms	±(2% m.v. + 2 digits)
$1*I_{\Delta n}$				
$2*I_{\Delta n}$	0...150ms	0...200ms		
$5*I_{\Delta n}$	0...40ms	0...150ms		

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

Measurement of the I_A RCD tripping current for sinusoidal residual current

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

- Start the measurement from a positive or negative half-period of forced leakage current (AC)

Measurement of the I_A RCD operating current for residual pulsating unidirectional current

Nominal current	Measurement range	Resolution	Measurement current	Accuracy
10mA	4.0...20.0mA	0.1mA	$0.35 \times I_{\Delta n}$...$2.0 \times I_{\Delta n}$	± 10% $I_{\Delta n}$
30mA	12.0...42.0mA		$0.35 \times I_{\Delta n}$...$1.4 \times I_{\Delta n}$	
100mA	40...140mA	1mA		
300mA	120...420mA			
500mA	200...700mA			

- Capability of measurement for positive or negative half-periods of forced leakage current
- Max duration of measurement current flow max. 3200 ms

Low-voltage measurement of circuit continuity and resistance

Measurement of the protective conductor continuity with current ±200 mA

Measurement range in acc. with IEC 61557-4: **0.12…400Ω**

- Voltage on open terminals: 4...9 V
- Output current at R<2Ω: min. 200mA
- Compensation of test lead resistance
- Measurements for both current polarisations

2 YEAR WARRANTY

Multifunction electrical installations meter

MPI-502

Index: WMGBMPI502

CAT IV 300V

IP 67

DO YOU KNOW...

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

Measurement of short-circuit parameters:

- measurements of short-circuit impedance in power systems of rated voltages: 220/380 V, 230/400 V, 240/415 V and frequencies of 45...65 Hz,
- indications of the R_S short-circuit resistance and the X_S short-circuit reactance,
- **measurement of short-circuit impedance with current 15 mA without tripping residual current devices,**
- maximal measurement current: 7.6 A (at 230 V), 13.3 A (at 400 V).

Examination of AC and A type residual current devices:

- measurement of general, short-time delay and selective RCDs of rated residual current 10, 30, 100, 300 and 500 mA,
- measurement of the I_A tripping current and the t_A trip time for currents $1/2I_{\Delta n}$, $I_{\Delta n}$, $2I_{\Delta n}$, $5I_{\Delta n}$,
- measurement of R_E and U_B without tripping RCDs,
- extended AUTO function for measuring RCDs, including the capability of measuring Z_{L-PE} with low current,
- measurement of I_A and t_{AI} with just one RCD trip.

Measurement of protective connection and equipotential bonding resistance:

- measurement of continuity of protective connections with current ±200 mA in accordance with the EN 61557-4 standard,
- automatic calibration of test leads - capability of using any test leads,
- low-current measurement of resistance with acoustic signalling.

Additionally:

Detection of swapped L and N conductors in a socket and respective automatic correction during measurement.
Verification of correctness of the PE conductor connection with the use of a touch electrode.
Measurement of power system voltage (0…500 V) and frequency.
LR6 battery power supply, capability of using NiMH rechargeable batteries.
Memory of 990 measurement results, wireless data transfer to a computer.
LCD and keyboard backlit.

DO YOU KNOW...

MPI-502 meter allows for performing measurements in sockets with swapped L and N conductors.

The instruments meets the requirements set forth by the standards:

EN 61010-1, EN 61010-031 (general and particular requirements related to safety)
EN 61326 (electromagnetic compatibility)
EN 61557, IEC 61557 (requirements for measurement instruments)
HD 60364-6 (performance of measurements - checking)
HD 60364-4-41 (performance of measurements - protection against electric shock)
EN 04700 (performance of measurements - rough-in inspection tests)
BS 7671 (British Standard)
VDE 0100 (erection of power installations with rated voltages below 1000)

Standard accessories of the MPI-502 meter:

- Adapter WS-05 with UNI-Schuko	**WAADAWS05**
- Test lead with banana plug; 1,2m; red	**WAPRZ1X2REBB**
- Test lead with banana plug; 1,2m; yellow	**WAPRZ1X2YEBB**
- Test lead with banana plug; 1,2m; blue	**WAPRZ1X2BUBB**
- Pin probe with banana connector; red	**WASONREOGB1**
- Pin probe with banana connector; blue	**WASONBUOGB1**
- "Crocodile" clip K02; yellow	**WAKROYE20K02**
- Receiver – interface for radio transmission OR1 (USB)	**WAADAUSBOR1**
- Carrying case M6	**WAFUTM6**
- Hanging straps	**WAPOZSZE4**
- Handle to suspend the meter	**WAPOZUCH1**
- Calibration certificate, batteries, Sonel Reader software	

Measurement of the Z_{L-PE}, Z_{L-N}, Z_{L-L} short-circuit impedance

Measurement with current 7.6/13.3 A - measurement range in acc. with : **0.13…1999Ω:**

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

Measurement of the Z_{L-PE} short-circuit impedance in the RCD mode

Measurement with current 15 mA - measurement range in acc. with IEC 61557-3 **0.51…1999Ω**

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

Measurement of RCD parameters (operating voltage range 180…270 V):

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

RCD Type	Factor	Range	Resolution	Accuracy
General	$0.5*I_{\Delta n}$	0...300ms	1ms	±(2% m.v. + 2 digits)
	$1*I_{\Delta n}$			
	$2*I_{\Delta n}$	0...150ms		
	$5*I_{\Delta n}$	0...40ms		
Selective	$0.5*I_{\Delta n}$	0...500ms		
	$1*I_{\Delta n}$			
	$2*I_{\Delta n}$	0...200ms		
	$5*I_{\Delta n}$	0...150ms		

Measurement of the I_A RCD operating current for sinusoidal residual current

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

· Measurement starts from a positive of negative half-period of forced current

Measurement of the I_A RCD operating current for residual pulsating unidirectional current

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

• Measurement for positive or negative half-periods of forced leakage current

Summary of the multifunction meters

	MPI-502	MPI-505	MPI-520, MPI-520 Start	MPI-525	MPI-530 / MPI-530-IT
Measurement of short-circuit impedance [Ω]	0.13…1999	0.13…1999	0.13…1999	0.13…1999	0.130…1999
Resolution of short-circuit impedance measurement [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 short-circuit impedance measurement without RCD tripping [Ω]	0,01	0.01	0.01	0.01	0.01
Calc. of short-circuit current based on the nominal voltage	YES	YES	YES	YES	YES
Calc. of short-circuit current based on the measured voltage	—	—	—	—	YES
Examination of RCD	AC, A ☐ G S	AC, A ☐ S	AC, A, B ☐ G S	AC, A, B ☐ G S	AC, A, B, F ☐ G S
Automatic measurement of the full set of parameters	YES	YES	YES	YES	YES
Measurement of the I_A tripping current 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_{Ai} during one RCD tripping	YES	YES	YES	YES	YES
Measurement of tripping time for rated current (multiplicity factors)	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 the U_B touch voltage	YES	YES	YES	YES	YES
Detection of swapped L and N conductors	YES	YES	YES	YES	YES
Measurement of insulation resistance	—	YES	YES	YES	YES
Test voltages [V]	—	100, 250, 500, 1000	50, 100, 250, 500, 1000	50, 100, 250, 500, 1000, 2500	50, 100, 250, 500, 1000
Measurement range [Ω]	—	3G	3G	10G	10G
Automatic in-socket measurement	—	—	YES	—	YES
Protection against the appearance of voltage	—	YES	YES	YES	YES
Automatic discharge of the measured object after the measurement	—	YES	YES	YES	YES
Automatic measurement of insulation resistance of multi-core cables with AutoISO adapter	—	—	YES	YES	YES
Acoustic signalling of time intervals for capturing characteristics	—	YES	YES	YES	YES
Calc. of absorption coefficients (DAR, PI)	—	—	—	YES	—
Measurement of continuity with current ≥ 200 mA	YES	YES	YES	YES	YES
Low-voltage measurement of resistance	YES	YES	YES	YES	YES
Measurement of earth resistance (3p)	—	—	YES	YES	YES
(3p, 4p, 3p+clamp, 2 clamps, soil resistivity)	—	—	—	—	YES
Setting limits for results	—	—	—	—	YES
Quick verification of correctness of the PE conductor connection	YES	YES	YES	YES	YES
Measurement of voltage [V]	0…500	0…440	0…500	0…500	0…500
Measurement of frequency [Hz]	YES	—	YES	YES	YES
Measurement of alternating current [A]	—	—	optional 0...400	—	optional 0...3000
Measurement of power and cosφ	—	—	YES	—	YES
Measurement of harmonics	—	—	—	—	YES
Measurement of THD	—	—	—	—	YES
Phase sequence checking	—	100…440	95…500	95…500	95…500
Memory (number of records)	990	990	990	990	10 000 for each type
Power supply	batteries or rechargeable batteries	batteries or rechargeable batteries	batteries or rechargeable batteries	rechargeable batteries or batteries	rechargeable batteries or batteries
Built-in battery fast charger	—	—	YES	YES	YES
Data transfer	OR-1	USB	USB, OR-1	USB, OR-1	USB, Bluetooth
Dimensions [mm]	220x98x58	260x190x60	288x223x75	288x223x75	288x223x75
Weight [kg]	1	2	2.2	2.2	2.2
Catalog page	15	14	12	10	8

Insulation resistance meters

MIC-5001

Index: WMGBMIC5001

CAT IV 300V | CAT III 600V | IP 65

Additionally:

- two and three-lead measurement method
- RampTest Insulation resistance measurement and measurement of breakdown voltage with increments up to ~ 1 kV / s
- measurement of alternating and direct voltages in the 0...750 V range
- 990 cells of memory (11880 records), data transmission to a PC through a USB cable
- built-in rechargeable battery pack.
- the instruments meet the requirements of the EN 61557 standard.
- the ability to charge from car lighter (12 V) socket (additional accessories).

Insulation resistance measurements:

- measuring voltage selectable in the 50 ... 500 V range with 50 V step, and in the 500 V to 5000 range with 100 V step,
- continuous indication of insulation resistance or leakage current,
- automatic capacitance discharge of tested object after the insulation resistance measurement,
- acoustic signalling of five-second periods during measurement,
- isolation resistance measurement with three times T1, T2 and T3 and calculation of absorption coefficient DAR and polarization index PI,
- indication of actual test voltage during the measurement,
- protection against measuring live objects.

Standard accessories of the meters:

- test lead with banana plug; 1.8 m; 5 kV; red	**WAPRZ1X8REBB**
- test lead with banana plug; 1.8 m; 5 kV; blue	**WAPRZ1X8BUBB**
- test lead with banana plug; 1.8 m; 5 kV; black	**WAPRZ1X8BLBB**
- USB transmission cable	**WAPRZUSB**
- crocodile clip K09; black; 11 kV	**WAKROBL32K09**
- crocodile clip K09; red; 11 kV	**WAKRORE32K09**
- crocodile clip K09; blue; 11 kV	**WAKROBU32K09**
- pin probe 5kV red	**WASONREOGB2**
- pin probe 5kV black	**WASONBLOGB2**
- carrying case M8	**WAFUTM8**
- power supply adapter Z7	**WAZASZ7**
- battery pack	
- SONEL Reader software	
- calibration certificate	
- warranty card	

Insulation resistance measurement (two-lead)

Measurement range in acc. with IEC 61557-2 for $R_{ISOmin}=U_{ISOnom}/I_{ISOmax}$...1TΩ ($I_{ISOmax}$=1mA)

Display range	Resolution	Accuracy
0,0...999,9 kΩ	0,1 kΩ	±(3% m.v. + 20 digits)
1,000...9,999 MΩ	0,001 M.Ω	
10,00...99,99 MΩ	0,01 M.Ω	
100,0..999,9 MΩ	0,1 M.Ω	
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...5,000 TΩ	1 GΩ	±(4% m.v. + 50 digits)

Measurement range vs applied voltage

Voltage U_{ISO}	Measurement 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

RampTest Insulation resistance measurement

Display range	Resolution	Accuracy
0,0…999,9 kΩ	0,1 kΩ	±(5% m.v. + 40 digits)
1,000…9,999 MΩ	0,001 MΩ	
10,00…99,99 MΩ	0,01 MΩ	
100,0…999,9 MΩ.	0,1 MΩ	
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	

The measurement of breakdown voltage in RampTest mode

Range	Resolution	Chosen U_{ISO}	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)

DC and AC voltage measurement

Range	Resolution	Accuracy
0...299,9 V	0,1 V	±(3% m.v. + 2 digits)
300...750 V	1V	

• Frequency range : 45...65 Hz

Electrical safety:

- type of insulation ..... double, in acc. with EN 61010-1 and IEC 61557
- measurement category ..... CAT IV 300 V (III 600 V) acc. to EN 61010-1
- enclosure protection rating acc. to EN 60529 ..... IP65

Other technical specifications:

- power supply of the meter ..... NiMH 9.6 V - 2 Ah battery pack and power supply 12 V
- weight of the meter ..... approx. 0.9 kg
- dimensions ..... 200 x 180 x 77 mm
- display ..... LCD segment display
- measurement results memory ..... 990 cells, 11880 records
- transmission of measurement results ..... USB

The acronym “m.v.” stands for a “measured reference value”.

HIGH NOISE IMMUNITY UP TO 500 V INDUCED VOLTAGE!

CAT III 1000V

CAT IV 600V

Bluetooth®

Insulation resistance meters

MIC-10k1, MIC-5050

Index: WMGBMIC10K1
WMGBMIC5050

Standard accessories of meters:

- test lead banana plug; 3 m; 10 kV; red	**WAPRZ003REBB10K**
- test lead banana plug; 3 m; 10 kV; blue	**WAPRZ003BUBB10K**
- test lead banana plug; 3 m; 10 kV; black; shielded	**WAPRZ003BLBB10K**
- USB cable	**WAPRZUSB**
- "crocodile" clip 5,5 kV; black	**WAKROBL32K07**
- "crocodile" clip 5,5 kV; red	**WAKRORE32K07**
- "crocodile" clip 5,5 kV; blue	**WAKROBU32K07**
- pin probe 5,5 kV with banana connector; red	**WASONREOGB5X5**
- pin probe 5,5 kV with banana connector; black	**WASONBLOGB5X5**
- carrying case L4 for accesories	**WAFUTL4**
- power cord	**WAPRZ1X8BLIEC**
- battery pack (built-in)	
- SONEL Reader software	
- calibration certificate	

Insulation resistance measurements:

- **up to 40 TΩ for MIC-10k,**
- **up to 20 TΩ for MIC-5050,**
- test voltage in range:
  - 50...5000 V for MIC-5050 (50...1000 V with 10 V step, 1...5 kV with 25 V step),
  - 50…10000 V for MIC-10k1 (50...1000 V with 10 V step, 1...10 kV with 25 V step),
- continuous indication of measured insulation resistance or leakage current,
- automatic discharge of measured object capacitive voltage after the completion of insulation resistance measurement,
- acoustic signaling of 5 seconds intervals to facilitate capturing time characteristics,
- slection of T_1, T_2 and T_3 test times for measuring one or two absorption coefficients from the range of 1…600 s,
- adjustable measuring time from 0'01" to 99'59",
- polarization index (PI) and dielectric absorption ratio (DAR),
- indication of actual test voltage during measurement,
- **1,2 mA, 3 mA or 5 mA test current,**
- two-lead or three-lead measurement,
- measurements with test leads up to 20m,
- protection against measuring live objects,
- **automatic measurement of multiple core cables with the use of the additional AutoISO-5000 adapter (for MIC-10k1 max. voltage 5 kV),**
- measurement of capacitance during the measurement of R_{ISO},
- step voltage insulation resistance measurement (SV),
- Dielectric Discharge calculation (DD),
- damage location (burning function).

Additionally:

Continuity measurement of protective connections and equipotential bonding in accordance with EN 61557-4 with current > 200 mA.

Adjustable limits for measured resistance R_{ISO} and R_{CONT}.

Measurement of leakage current during insulation resistance testing.

Measurement of capacitance during the measurement of R_{ISO}.

DC and AC voltage measurement in the range of 0…750 V.

Stable measurement at 765 kV substations (option-only MIC-10s-1).

Real time on screen graph printing during resistance measurement.

Temperature measurement (with additional adapter WASONT1).

Innovative memory max. 10000 results for each measurement with possibility of measurement point and customer names description,

Ability to work with wireless *Bluetooth*® keyboard (option).

Clear, backlit LCD graphic display 5.6",

Power supply: battery packs or mains; low battery warning indicator, built-in fast charger.

Backlit keyboard.

Digital filters function for measurements in high noise environment (10s, 30s, 60s).

High noise level rejection, noise immunity in accordance with EN-61326.

Measurement of direct and alternating voltages

Range	Resolution	Accuracy
0.0...299.9 V	0.1 V	±(2% m.v. + 6 digits)
300...750 V	1 V	±(2% m.v. + 2 digits)

Measurement of insulation resistance

Measurement range in acc. with IEC 61557-2:
R_{ISOmin} = 50kΩ…20 (40) TΩ (I_{ISOmax} = 1.2 mA, 3 mA or 5 mA)

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

Maximal values of measured insulation resistance depending on test voltage

Test voltage	Max. value
250 V	500 GΩ
500 V	1.00 TΩ
1000 V	2.00 TΩ
2500 V	5.00 TΩ
5000 V	20.0 TΩ
10000 V (only MIC-10k1)	40.0 TΩ

Continuity measurement of protective connections and equipotential bondings with 200 mA current

Measurement range acc. to EN 61557-4: 0.10...999Ω

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...24V
- Output current at R < 2Ω: I_{min} > 200mA (I_{SC}: 200...250mA)
- Compensation of test lead resistance
- Current flowing in both directions, mean value of resistance is displayed

Capacity measurement

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

- Capacity measurement result is displayed after the R_{ISO} measurement

"m.v." = "measured value".

The instrument meets the requirements set forth by the standards:

EN 61010-1 (general requirements related to safety)
EN 61010-031 (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 - protection against electric shock)
EN 04700 (performance of measurements - rough-in inspection tests)

2 YEAR WARRANTY

Insulation resistance meters

MIC-5010, MIC-5005

Index: WMGBMIC5010
WMGBMIC5005

Standard accessories of meters:

- test lead banana plug; 1,8 m; 10 kV; red	**WAPRZ1X8REBB10K**
- test lead banana plug; 1,8 m; 10 kV; blue	**WAPRZ1X8BUBB10K**
- test lead banana plug; 1,8 m; 10 kV; black; shielded	**WAPRZ1X8BLBBE10K**
- USB cable	**WAPRZUSB**
- "crocodile" clip 5,5 kV; black	**WAKROBL32K07**
- "crocodile" clip 5,5 kV; red	**WAKRORE32K07**
- "crocodile" clip 5,5 kV; blue	**WAKROBU32K07**
- pin probe 5,5 kV with banana connector; red	**WASONREOGB5X5**
- pin probe 5,5 kV with banana connector; black	**WASONBLOGB5X5**
- carrying case L4 for accesories	**WAFUTL4**
- power cord	**WAPRZ1X8BLIEC**
- battery pack (built-in)	
- SONEL Reader software	
- calibration certificate	

Insulation resistance measurements:

- test voltage in range 50…1000 V with 10 V step and 1000 V...5000 V with 25 V step,
- continuous indication of measured insulation resistance or leakage current,
- automatic discharge of measured object capacitive voltage after the completion of insulation resistance measurement,
- acoustic signaling of 5 seconds intervals to facilitate capturing time characteristics,
- selection of T_1, T_2 and T_3 test times for measuring one or two absorption coefficients from the range of 1…600 s,
- adjustable measuring time from 0'01" to 99'59",
- polarization index (PI) and dielectric absorption ratio (DAR),
- indication of actual test voltage during measurement,
- 1.2mA or 3mA test current,
- two-lead or three-lead measurement,
- step voltage insulation resistance measurement
- Dielectric Discharge calculation (DD),
- protection against measuring live objects,
- measurements with test leads up to 20m.

Additionally:

Continuity measurement of protective connections and equipotential bonding in accordance with EN 61557-4 with current > 200 mA.

Adjustable limits for measured resistance R_{ISO} and R_{CONT}. (MIC-5010 only)

Measurement of leakage current during insulation resistance testing.

Measurement of capacity during the measurement of R_{ISO}.

DC and AC voltage measurement in the range of 0…600 V.

990 cells of memory (11880 records) with the capability of wireless data transmission to a PC (with the USB-OR-1 adapter) or through a USB cable.

Power supply: battery packs, low battery warning indicator, built-in fast charger.

Clear, backlit LCD display 5.6",

Backlit keyboard,

Digital filters function for measurements in high noise environment (10s, 30s, 60s),

High noise level rejection, noise immunity in accordance with EN-61326

Electrical safety:

- type of insulation ..... double, in acc. with EN 61010-1 and IEC 61557
- measurement category ..... CAT IV 600 V (CAT III 1000 V) acc. to EN 61010-1
- protection class acc. to EN 60529 ..... IP40 (IP67 with lid closed)

Nominal operating conditions:

- operating temperature .....-20...+50°C
- storage temperature .....-25...+70°C
- humidity .....20%...80%
- altitude .....≤3000 m
- reference temperature .....+23°C ± 2°C
- reference humidity .....40%...60%

Other technical specifications:

- power supply of the meter..... built-in battery pack
  .....or mains 90 V ÷ 260 V 50/60 Hz
- weight ..... approx. 7 kg
- dimensions .....390 x 310 x 170 mm
- display MIC-10k1 i MIC-5050.....LCD 5,6" graphic
- display MIC-5010 i MIC-5005.....LCD 5,6" segment
- data transmision MIC-10k1 and MIC-5050 .....USB or *Bluetooth*®
- data transmision MIC-5010 and MIC-5005 .....USB or radio (OR1)

DO YOU KNOW...

MIC-10k1, MIC-5050, MIC-5010 and MIC-5005 meters can work in places where are large distortion up to 500 V induced.

Measurement of insulation resistance

Measurement range in acc. with IEC 61557-2:
R_{ISOmin} = 50kΩ…15 TΩ (I_{ISOmax} = 1.2 mA or 3 mA)

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

• thermal stability better than 0.2%/°C

Maximal values of measured insulation resistance depending on test voltage

Test voltage	Max. value
250V	500 GΩ
500V	1.00 TΩ
1000V	2.00 TΩ
2500V	5.00 TΩ
5000V	15.0 TΩ

Continuity measurement of protective connections and equipotential bondings with 200 mA current (MIC-5010)

Measurement range acc. to EN 61557-4: 0.10...999Ω

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...24V
• Output current at R < 2Ω: I_{min} > 200mA (I_{SC}: 200...250mA)
• Compensation of test lead resistance
• Current flowing in both directions, mean value of resistance is displayed

Capacity measurement

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

• Capacity measurement result is displayed after R_{ISO} measurement

"m.v." = "measured value".

Insulation resistance meters

MIC-2510, MIC-2505

Index: WMGBMIC2510 (MIC-2510)
WMGBMIC2505 (MIC-2505)

CAT IV 600V

IP 54

Standard accessories of the meters:

- Test lead with banana plug; 1,8m; 5kV; red	**WAPRZ1X8REBB**
- Test lead with banana plug; 1,8m; 5kV; blue	**WAPRZ1X8BUBB**
- Test shielded lead with banana plug; 1,8m; 5kV; black	**WAPRZ1X8BLBB**
- USB cable (MIC-2510)	**WAPRZUSB**
- "Crocodile" clip K04; 5kV; black	**WAKROBL20K04**
- "Crocodile" clip K05; 5kV; red (MIC-2510)	**WAKRORE20K05**
- "Crocodile" clip K05; 5kV; blue	**WAKROBU20K05**
- Pin probe 5kV with banana connector; red	**WASONREOGB2**
- Pin probe 5kV with banana connector; black (MIC-2510)	**WASONBLOGB2**
- Carrying case L4	**WAFUTL4**
- Power supply adaptor Z7	**WAZASZ7**
- Cable for battery charger	**WAPRZLAT230**
- Rechargeable battery pack	**WAAKU10**
- Hanging straps	**WAPOZSZE2**
- Sonel Reader software, calibration certificate	

Insulation resistance measurements:

- selectable test voltage 500 V, 1000 V, 2500 V (MIC-2510, MIC-2505) as well as 100 V, 250 V or any within range 50...2500 V with 10 V step (MIC-2510),
- continuous indication of the measured insulation resistance or leakage current value,
- automatic discharge of capacitance of the measured object after finishing the insulation resistance measurement,
- recording resistance characteristics and leakage current (MIC-2510),
- acoustic signalling of 5-second time intervals to facilitate capturing time characteristics (MIC-2505),
- selection of T_1, T_2, T_3 times from the range of 1...600 s for the measurement of one or two absorption coefficients PI, DAR (MIC-2510), or fixed times 15 s, 60 s, 600 s (MIC-2505),
- automatic measurement of multiple core cables with the use of the additional AutoISO-2500 adapter (MIC-2510),
- indication of actual measurement voltage during measurement,
- protection against measurements of energised objects,
- measurement of leakage current during insulation resistance measurement,
- measurement of capacitance during the R_{ISO} measurement (MIC-2510),
- three-lead measurement.

Measurement of protective connection and equipotential bonding continuity (MIC-2510):

- with current > 200 mA in accordance with the EN 61557-4 standard, bidirectional flow of current,
- low-voltage measurement of resistance with acoustic signalling.

DO YOU KNOW...

During resistance measurement,MIC-2510 meter also performs temperature measurement.

Other functions of the meters:

Continuous measurement of ambient temperature with the capability of saving the result in memory (MIC-2510).
Measurement of direct and alternating voltages within the range of 0...600 V.
Memory of 990 cells (11880 records), data transfer to a PC over the USB or the OR-1 wireless interface (MIC-2510).
Power supply from a rechargeable battery pack.

Electrical safety:

- type of insulation ..... double, in acc. with EN 61010-1 and IEC 61557
- measurement category ..... CAT IV 600 V (III 1000 V) acc. to EN 61010-1
- enclosure protection rating acc. to EN 60529 ..... IP54

Other technical specifications:

- power supply of the meter..... SONEL L-1 NiMH 9.6 V battery pack
- dimensions.....approx. 260x190x60 mm
- weight of the meter.....approx. 1.3 kg
- display.....segment LCD

Measurement of insulation resistance

Measurement range in acc. with IEC 61557-2 for $R_{ISOmin}=U_{ISOnom}/I_{ISOmax}...2T\Omega$ ($I_{ISOmax}=1mA$)

Display range	Resolution	Accuracy
0.0...999.9kΩ	0.1kΩ	±(3% m.v. + 20 digits)
1.000...9.999MΩ	0.001MΩ	
10.00...99.99MΩ	0.01MΩ	
100.0...999.9MΩ	0.1MΩ	
1.000...9.999GΩ	0.001GΩ	
10,00...99.99GΩ	0.01GΩ	
100.0...999.9GΩ	0.1GΩ	
1.000...2.000TΩ	0.001TΩ	

Maximal values of measured insulation resistance depending on the test voltage

Test voltage	Max. value
50V (MIC-2510)	50GΩ
100V (MIC-2510)	100GΩ
250V (MIC-2510)	250GΩ
500V	500GΩ
1000V	1TΩ
2500V	2TΩ

Measurement of capacitance (MIC-2510)

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

The instruments meet the requirements set forth by the standards:

EN 61010-1 (general requirements related to safety)
EN 61010-031 (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 - protection against electric shock)
EN 04700 (performance of measurements - rough-in inspection tests)

2 YEAR WARRANTY

Insulation resistance meters

MIC-2501

Index: WMGBMIC2501

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

Insulation resistance measurements:

- continuous indication of insulation resistance or leakage current,
- automatic discharge of capacitance of tested object after the insulation resistance measurement,
- acoustic signalling of five-second periods to facilitate obtaining time characteristics,
- measured test times T_1, T_2 i T_3 to measure one or two absorption coefficients in 15, 60 and 600 s,
- indication of actual test voltage during the measurement,
- protection against measuring live objects,
- two and three-lead measurement method,
- ability to save characteristic in 15s, 30s and 60s intervals during measurements

Additionally:

Continuity measurement of protective and equipotential conductors according to EN 61557-4 with the >200 mA current.

Leakage current measurement.

Measurement of alternating and direct voltages in the 0...750 V range.

Built-in rechargeable battery pack.

The instruments meet the requirements of the EN 61557 standard.

The ability to charge from car lighter (12 V) socket (additional accessories).

DO YOU KNOW...

You can recharge the meter during measurement, with any external Power Bank 12V / 2Ah with 5,5mm / 2,1mm DC plug.

Electrical safety:

- type of insulation ..... double, in acc. with EN 61010-1 and IEC 61557
- measurement category ..... CAT IV 600 V (III 1000 V) acc. to EN 61010-1
- enclosure protection rating acc. to EN 60529 ..... IP65

Other technical specifications:

- power supply of the meter ..... NiMH 9.6 V - 2 Ah battery pack and power supply 12 V
- weight of the meter ..... approx. 0.9 kg
- dimensions ..... 200 x 180 x 77 mm
- display ..... LCD segment display
- measurement results memory ..... 990 cells, 11880 records
- transmission of measurement results ..... USB

The acronym "m.v." stands for a "measured reference value".

Standard accessories of the meters:

- test lead with banana plug; 1,8m; 5kV; red	**WAPRZ1X8REBB**
- test lead with banana plug; 1,8m; 5kV; blue	**WAPRZ1X8BUBB**
- test lead banana plug; 1,8 m; 5 kV; black	**WAPRZ1X8BLBB**
- USB cable	**WAPRZUSB**
- "crocodile" clip 5,5 kV; black	**WAKROBL20K07**
- "crocodile" clip 5,5 kV; red	**WAKRORE20K07**
- "crocodile" clip 5,5 kV; blue	**WAKROBU20K07**
- pin probe 5 kV with banana connector; red	**WASONREOGB2**
- pin probe 5 kV with banana connector; black	**WASONBLOGB2**
- carrying case	**WAFUTM8**
- power supply adaptor Z7	**WAZASZ7**
- hanging straps	
- DVD with software, including "SONEL Reader" (reading data from memory)	
- calibration certificate	
- warranty card	

Insulation resistance measurement (two-lead)

Measurement range in acc. with IEC 61557-2 for $R_{ISOmin}=U_{ISOnom}/I_{ISOmax}$...1TΩ ($I_{ISOmax}$=1mA)

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

Values of measured resistance depending on measurement voltage

Voltage U_{ISO}	Measurement range
100 V	50 GΩ
200...400 V	100 GΩ
500...900 V	250 GΩ
1000...2400 V	500 GΩ
2500 V	1000 GΩ

Continuity measurement of protective connections and equipotential bonding with 200 mA current

Measurement range acc. to EN 61557-4: 0.10...999Ω

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

- Voltage on open terminals: 8...24 V
- Output current at R <2 Ω: I_{SC} >200 mA
- Compensation of test lead resistance
- Current flowing in both directions, mean value of resistance is displayed

DC and AC voltage measurement

Range	Resolution	Accuracy
0...750 V	1 V	±(3% w.m. + 2 digits)

- Frequency range : 45...65 Hz

Insulation resistance meter

MIC-30

Index: WMGBMIC30

CAT IV 600V

IP 67

DO YOU KNOW...

MIC-30 meter allows for automatic measurement of resistance for all combinations or any pair of conductors in a power socket.

Insulation resistance measurements:

- selectable test voltage: 50, 100, 250, 500, 1000 V or any within range 50...1000 V with 10 V step,
- automatic measurement in sockets with the use of the UNI-Schuko adapter with the capability of configuring pairs of measured conductors,
- continuous indication of the measured insulation resistance or leakage current value,
- automatic discharge of capacitance of the measured object after finishing the insulation resistance measurement,
- acoustic signalling of 5-second time intervals to facilitate capturing time characteristics,
- selection of T_1, T_2, T_3 times from the range of 1...600 s for the measurement of one or two absorption coefficients ,
- indication of actual measurement voltage during measurement,
- protection against measurements of energised objects,
- three-lead measurement,
- **measurement of leakage current,**
- **measurement of capacitance during R_{ISO} measurement.**

Measurement of protective connection and equipotential bonding continuity:

- with current ≥ 200 mA in accordance with the EN 61557-4 standard, bidirectional flow of current.

Additionally:

Low-voltage measurement of circuit continuity and resistance.

Measurement of direct and alternating voltages within the range of 0…600 V.

Memory of 990 cells (11880 records), data transfer to a PC over the OR-1 wireless interface.

LCD and keyboard baklit.

Other technical specifications:

- type of insulation ..... double, in acc. with EN 61010-1 and IEC 61557
- power supply of the meter..... 4 alkaline batteries or NiMH rechargeable batteries of size AA
- display.....segment LCD

The instrument meets the requirements set forth by the standards:

EN 61010-1 (general requirements related to safety)
EN 61010-031 (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 - protection against electric shock)
EN 04700 (performance of measurements - rough-in inspection tests)

Standard accessories of the meter:

- Test lead with banana plug; 1,2m; red	**WAPRZ1X2REBB**
- Test lead with banana plug; 1,2m; blue	**WAPRZ1X2BUBB**
- Test lead 1,2m black, shielded	**WAPRZ1X2BLBBE**
- "Crocodile" clip K02; blue	**WAKROBU20K02**
- Receiver – interface for radio transmission OR1 (USB)	**WAADAUSBOR1**
- Pin probe with banana connector; black	**WASONBLOGB1**
- Pin probe with banana connector- red	**WASONREOGB1**
- Carrying case M6	**WAFUTM6**
- Hanging straps	**WAPOZSZE4**
- Handle to suspend the meter	**WAPOZUCH1**
- Sonel Reader software	
- Batteries	
- Calibration certificate	

Measurement of insulation resistance

Measurement range in acc. with IEC 61557-2 for:

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

Display range	Resolution	Accuracy
0.0...999.9kΩ	0.1kΩ	±(3% m.v. + 8 digits) [±(5% m.v. + 8 digits)]*
1.000...9.999MΩ	0.001MΩ	
10.00...99.99MΩ	0.01MΩ	
100.0...250.0MΩ (for Un = 50V)	0.1MΩ	
100.0...500.0MΩ (for Un = 100V)	0.1MΩ	
100.0...999.9MΩ (for Un≥ 250V)	0.1MΩ	
1.000...2.000GΩ (for Un=250V)	0,001GΩ	
1.000...9.999GΩ (for Un≥ 500V)	0.001GΩ	±(4% m.v. + 6 digits) [±(6% m.v. + 6 digits)]*
10.00...20.00GΩ (for Un≥ 500V) **	0.01GΩ	
10.00...99.99GΩ (for Un = 1000V)	0.01GΩ	
100.0GΩ (for Un = 1000V)	0.1GΩ	

*for the WS-04 adapter
**for the WS-04 adapter, range up to 10GΩ

- Measurements for the WS-04 adapter with voltage up to 500 V

Measurement of capacitance

Display range	Resolution	Accuracy
1...999nF	1nF	±(5% m.v. + 10 digits)
1.00...9.99µF	0.01µF	

- Measurement result displayed after R_{ISO} measurement
- For measurement voltages lower than 100 V and the measured resistance lower than 110MΩ , the capacitance measurement accuracy is not specified

Measurement of protective connection and equipotential bonding continuity with current 200 mA

Measurement range in acc. with IEC 61557-4: **0.10…1999Ω**

Range	Resolution	Accuracy
0.00...19.99Ω	0.01Ω	±(2% m.v. + 3 digits)
20.0...199.9Ω	0.1Ω	
2000...1999Ω	1Ω	±(4% m.v. + 3 digits)

2 YEAR WARRANTY

Insulation resistance meter

MIC-10

Index: WMGBMIC10

CAT IV 600V

IP 67

Insulation resistance measurements:

- selectable test voltage: 50, 100, 250, 500 or 1000 V,
- continuous indication of the measured insulation resistance value,
- automatic discharge of capacitance of the measured object after finishing the insulation resistance measurement,
- acoustic signalling of 5-second time intervals to facilitate capturing time characteristics,
- indication of actual measurement voltage during measurement,
- protection against measurements of energised objects,
- three-lead measurement,
- **measurement of capacitance during R_{ISO} measurement.**

Measurement of protective connection and equipotential bonding continuity:

- with current ≥ 200 mA in accordance with the EN 61557-4 standard, bidirectional flow of current.

Additionally:

Low-voltage measurement of circuit continuity and resistance.

Measurement of direct and alternating voltages within the range of 0…600 V.

LCD and keyboard backlit.

DO YOU KNOW...

Besides the insulation resistance measurements, MIC-10 meter allows for the measurement of protective connection and equipotential bonding continuity in accordance with the EN 61557 standard.

Other technical specifications:

- type of insulation ..... double, in acc. with EN 61010-1 and IEC 61557
- power supply of the meter..... 4 alkaline batteries or NiMH rechargeable batteries of size AA
- display.....segment LCD

The instrument meets the requirements set forth by the standards:

EN 61010-1 (general requirements related to safety)
EN 61010-031 (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 - protection against electric shock)
EN 04700 (performance of measurements - rough-in inspection tests)

Standard accessories of the meter:

- Test lead with banana plug; 1,2m; black	**WAPRZ1X2BLBB**
- Test lead with banana plug; 1,2m; red	**WAPRZ1X2REBB**
- "Crocodile" clip K01; black	**WAKROBL20K01**
- Pin probe with banana connector; black	**WASONBLOGB1**
- Pin probe with banana connector; red	**WASONREOGB1**
- Carrying case M6	**WAFUTM6**
- Hanging straps	**WAPOZSZE4**
- Handle to suspend the meter	**WAPOZUCH1**
- Calibration certificate	
- Batteries	

Measurement of insulation resistance

Measurement range in acc. with IEC 61557-2 for:

- U_n=50V: **50kΩ…250.0MΩ**
- U_n=100V: **100kΩ…500.0MΩ**
- U_n=250V: **250kΩ…2.000GΩ**
- U_n=500V: **500kΩ…5.00GΩ**
- U_n=1000V: **1000kΩ…10.00GΩ**

Display range	Resolution	Accuracy
0.0...999.9kΩ	0.1kΩ	±(3% m.v.. + 8 digits)
1.000...9.999MΩ	0.001MΩ	
10.00...99.99MΩ	0.01MΩ	
100.0...250.0MΩ (for Un = 50V)	0.1MΩ	
100.0...500.0MΩ (for Un = 100V)	0.1MΩ	
100.0...999.9MΩ (for Un≥250V)	0.1MΩ	
1.000...2.000GΩ (for Un=250V)	0.001GΩ	
1.000...5.000GΩ (for Un≥500V)	0.001GΩ	±(4% m.v.. + 6 digits)
5.00...10.00GΩ (for Un = 1000V)	0.01GΩ	

Measurement of capacitance

Display range	Resolution	Accuracy
1...999nF	1nF	±(5% m.v. + 10 digits)
1.00...9.99µF	0.01µF	

- Measurement result displayed after the R_{ISO} measurement .
- For measurement voltages lower than 100 V and the measured resistance lower than 10MΩ, the capacitance measurement error is not specified

Measurement of protective connection and equipotential bonding continuity with the current of 200 mA

Measurement range in acc. with IEC 61557-4:: **0.10…1999Ω**

Range	Resolution	Accuracy
0.00...19.99Ω	0.01Ω	±(2% m.v. + 3 digits)
20.0...199.9Ω	0.1Ω	
200...1999Ω	1Ω	±(4% m.v. + 3 dgits)

Insulation resistance meter

MIC-2

Index: WMGBMIC2

CAT IV 600V

IP 65

DO YOU KNOW...

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

Insulation resistance measurements:

- selectable test voltage 250 V or 500 V,
- continuous indication of the measured insulation resistance value,
- automatic discharge of capacitance of the measured object after finishing the insulation resistance measurement,
- acoustic signalling of 5-second time intervals during measurements,
- protection against measurements of energised objects.

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

- measurement with current < 10 mA and with the resolution 0,1Ω,
- quick acoustic signalling for the circuit of resistance smaller than 10Ω.

Additionally:

Measurement of direct and alternating voltages within range of 0…600 V:

- automatic detection of voltage type (direct/alternating).

Automatic selection of measurement ranges.

LCD and keyboard backlit.

Automatic power-off of an unused instrument (AUTO-OFF).

Electrical safety:

- type of insulation ..... double, in acc. with EN 61010-1 and IEC 61557
- measurement category ..... CAT IV 600 V (III 1000 V) acc. to EN 61010-1
- enclosure protection rating acc. to EN 60529 ..... IP65

Other technical specifications:

- power supply of the meter.....2 LR03 batteries (size AAA) or 2 AAA rechargeable batteries
- dimensions.....approx. 240 x 60 x 30 mm
- weight of the meter.....approx. 0.3 kg
- R_{ISO} measurement current .....1.2 mA ± 0.2 mA
- max. interference voltage, at which the R_{ISO} measurement is performed ..... 20 V
- number of R_{ISO} measurements (alkaine batteries)..... > 500
- auto-off timeout.....5 minutes
- electromagnetic compatibility.....compliance with the EN 61000-6-3 .....and EN 61000-6-2 standards

Nominal operating conditions:

- operating temperature .....0...+40°C
- reference temperature.....23 ± 2°C
- storage temperature.....20...+70°C

Standard accessories of MIC-2 meter:

- "Crocodile" clip K01; black	**WAKROBL20K01**
- Pin probe with banana connector, black	**WASONBLOGB1**
- Calibration certificate, batteries	

Measurement of insulation resistance:

U_{ISO}=**250V**

Measurement range in acc. with IEC 61557-2: **250kΩ…1000MΩ**

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

U_{ISO}=**500V**

Measurement range in acc. with IEC 61557-2: **500kΩ…1999MΩ**

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

DO YOU KNOW...

In the event of voltage detection on the object during insulation resistance measurement or low-voltage resistance measurement, MIC-2 meter automatically switches to the voltage measurement mode.

Measurement of resistance

Display range	Resolution	Accuracy
0.0...199.9Ω	0.1Ω	±(4% m.v. + 3 digits)
200...1999Ω	1Ω	

- continuous sound signal for R < 10Ω
- measurement current (for short-circuited terminals for U_{BAT} > 3,0V): < 10mA
- maximal voltage on opened terminals: 4...24 V
- maximal interfering voltage at which the measurement is performed: +7 V/-1 V DC, 5 AC

The instrument meets the requirements set forth by the standards:

EN 61010-1 (general requirements related to safety)
EN 61010-031 (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 - protection against electric shock)
EN 04700 (performance of measurements - rough-in inspection tests)

2 YEAR WARRANTY

Probe insulation resistance of floors and walls

PRS-1

Index: WASONPRS1GB

Optional for meters:

- MIC-5000
- MIC-2510
- MIC-30
- MIC-2505
- MIC-10
- MIC-2501
- MPI-520
- MPI-525
- MPI-530
- MPI-520Start
- MPI-530-IT

Insulation resistance measurements:

Three-way PRS-1 test probe, in the shape of an equilateral triangle, has been made in accordance with the requirements contained in HD 60364-6 and EN 1081 standards.

Summary of the 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-525	MPI-520 (Start) / MPI-530*	MPI-505
Test voltage [V]	50…10000	50…5000	50…5000	50…5000	50…2500	500,1000, 2500	1000...2500	50…1000	50,100,250 500,1000	250,500	50,100,250 500,1000, 2500	50,100,250 500,1000	100,250, 500,1000
Measurement range	10kΩ…40TΩ	20kΩ…20TΩ	20kΩ…15TΩ	10kΩ…5TΩ	50kΩ...2TΩ	500kΩ...2TΩ	50kΩ...1TΩ	50kΩ... 100GΩ	50kΩ... 10GΩ	250kΩ... 1999MΩ	50kΩ... 9,99GΩ*	50kΩ... 3GΩ / 9,99GΩ*	100kΩ... 3GΩ
Setting of 3 measurement times	1…600s	1…600s	1…600s	1…600s	1…600s	15,60,600s	1...600s	1…600s	—	—	1...600s	—	—
Three-lead method	YES	YES	YES	YES	YES	YES	YES	YES	YES	—	—	—	—
DAR, PI	YES	YES	YES	YES	YES	YES	YES	YES	—	—	YES	—	—
Measurement of leakage current	YES	YES	YES	YES	YES	YES	YES	YES	—	—	—	—	—
Automatic discharge after the measurement	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Built-in battery charger	YES	YES	YES	YES	YES	YES	YES	—	—	—	YES	YES	—
Power supply	rechargeable battery/mains	rechargeable battery/mains	rechargeable battery	rechargeable battery	rechargeable battery	rechargeable battery	rechargeable battery	batteries or rechargeable batteries	batteries or rechargeable batteries	batteries or rechargeable batteries	rechargeable battery	batteries or rechargeable batteries / rechargeable battery*	batteries or rechargeable batteries
Low-voltage measurement of resistance	—	—	—	—	YES	—	—	YES	YES	YES	YES	YES	YES
Measurement of continuity with current ≥ 200 mA (res. 0,01Ω)	YES	YES	YES (MIC-5010)	—	—	YES	YES	YES	YES	—	YES	YES	YES
Automatic measurement of 3, 4 and 5-core cables with the AutoISO adapter	YES	YES	—	—	—	YES	—	—	—	—	YES	YES	—
Measurement of voltage	0…750V	0…750V	0…600V	0…600V	0…750V	0…600V	0...750V	0…600V	0…600V	0…600V	0…500V	0…500V	0…440V
Measurement of temperature	YES	YES	—	—	—	YES	—	—	—	—	—	—	—
Recording insulation resistance and current leakage characteristics	YES	YES	—	—	YES (SonelReader)	YES	YES	—	—	—	—	—	—
Automatic in-socket measurement	—	—	—	—	—	—	—	YES	—	—	—	YES	—
Capacitance measurement	YES	YES	YES	YES	—	YES	—	YES	YES	—	—	—	—
Memory (number of records)	10000	10000	990	990	990	990	990	990	—	—	990	990 / 10000*	990
Data transfer	USB, Bluetooth®	USB, Bluetooth®	USB, OR-1	USB, OR-1	USB	USB, OR-1	USB	OR-1	—	—	USB, OR-1	USB, OR-1 / USB, Bluetooth®*	USB
Dimensions [mm]	390x310x170	390x310x170	390x310x170	390x310x170	200x150x75	260x190x60	200x150x75	220x100x60	220x100x60	240x60x30	288x223x75	288x223x75	260x190x60
Weight [kg]	7	7	7	7	1	1.3	0.9	0.6	0.6	0.3	2.2	2.2	2.2

High-current short-circuit impedance meter

MZC-310S

Index: WMGBMZC310S

CAT IV 300V

IP 20

Measurement of short-circuit impedance:

- measurements of low impedance values of short-circuits (with the resolution of 0.1 mΩ) with 150 A current at 230 V; max. 280 A at 440 V,
- measurements with 23 A current at 230 V, max. 42 A at 440 V,
- measurements in power systems of rated voltages: 220/380 V and 230/400 V and frequencies of 45...65 Hz,
- measurement in short-circuit: phase-to-phase, phase-to-protective, phase-neutral,
- differentiation between phase and phase-to-phase voltage in short-circuit current calculations,
- selection of test lead length change (23/42 A measurement),
- four-lead method, no need for test lead calibration (150/280 A measurement),
- measurement and display of short-circuit impedance components: the resistance R_s and the reactance X_s.

Additionally:

Measurement of prospective touch voltage or shock touch voltage (with 1 kΩ resistor).

Measurement of frequency.

Measurement of alternating voltages within the range of 0…440 V.

Memory of 990 measurement results, data transfer to a PC.

DO YOU KNOW...

MZC-310S allows for the measurement of very small values of short-circuit impedance (below 0.01Ω) in accordance with the EN 61557 standard.

The instrument meets the requirements set forth by the standards:

EN 61010-1 (general requirements related to safety)
EN 61010-031 (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 - protection against electric shock)
EN 04700 (performance of measurements - rough-in inspection tests)

Other technical specifications:

- type of insulation ..... double, in acc. with EN 61010-1 and IEC 61557
- power supply of the meter..... LR14 alkaline batteries (size C) (5 pcs)
- current-limiting resistor:.....for four-lead measurement: 1.5 Ω,
.....for two-lead measurement: 10 Ω
- number of short-circuit measurements (alkaline batteries)..... min. 2000 (4/min)
..... min. 4000 (2/min)
- temperature coefficient..... ±0,1% of measured value /˚C

Nominal operating conditions:

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

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	**WASONYEOGB1**
- Pin probe with banana connector; black	**WASONBLOGB1**
- Pin probe for high-currents (2 pcs)	**WASONSPGB1**
- Test lead 3m “U1, I1” (2 pcs)	**WAPRZ003DZBBU1I1**
- Test lead 3m “U2, I2” (2 pcs)	**WAPRZ003DZBBU2I2**
- "Crocodile" clip K03; black (4 pcs)	**WAKROBL30K03**
- Kelvin’s clamp (2 pcs)	**WAKROKELK06**
- Carrying case L1	**WAFUTL1**
- RS-232 serial transmission cable	**WAPRZRS232**
- Hanging straps	**WAPOZSZE1**
- Calibration certificate	
- Batteries	
- Sonel Reader software	

High-current measurement of short-circuit parameters (four-lead, I_{max}=280A)

High-current measurement of short-circuit impedance Z_s:
Measurement range in acc. with IEC 61557-3: **7.2mΩ…1999mΩ**

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

Short-circuit current indications:
Measurement range in acc. with IEC 61557-3: for U_n = 230V **115.0A…32.0kA**
for U_n = 400V **200A…55.7kA**

Display range	Resolution	Accuracy
115.0...199.9A	0.1A	Depends on Z_s accuracy
200...1999A	1A	
2.00...19,99kA	0.01kA	
20.0...199.9kA	0.1kA	
200kA... *	1kA	

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

DO YOU KNOW...

MZC-310S is the only meter on the market allowing for touch voltage or shock touch voltage measurement, which can be used during safety assessment of examined installations.

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

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

Measurement of Z_s short-circuit impedance with standard current (two-lead, I_{max}=42A)

Measurement range for 1.2 m test leads in accordance with IEC 61557:: **0.13Ω…199.9Ω**

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

2 YEAR WARRANTY

Short-circuit impedance meters

MZC-306

Index: WMGBMZC306

MEASUREMENTS IN SYSTEMS UP TO max. 750V!

CAT IV 600V

IP 54

DO YOU KNOW... The meter calculates the value of prospective short-circuit current in accordance with the HD 60364-6 standard.

Measurement of short-circuit impedance:

- measurement of short-circuit impedance with the resolution of 0.01Ω,
- low-current measurement of impedance in circuits protected with 30 mA RCDs with the resolution of 0.01Ω (100…440 V),
- operation in systems of voltages: 110/190 V, 115/200 V, 127/220 V, 220/380 V, 230/400 V, 240/415 V, 290/500 V and 400/690 V (operating range 100…750 V), operating frequency 45...65 Hz,
- calculation of short-circuit current,
- automatic differentiation between phase-to-neutral and phase-to-phase voltage,
- capability of using 1.2, 5, 10, 20 m long test leads or an adapter terminated with a power plug,
- measurement with swapped L and N conductors,
- measurement of resistance and reactance components.

Additionally:

Voltage measurement up to 750 V AC, with the resolution of 0.1 V up to 250 V.

Memory of 990 measurements, data transfer to a PC over the USB interface.

Power supply from batteries or rechargeable batteries (4 x size AA).

Verification of correctness of the PE terminal connection with the use of a touch probe.

The instrument meets the requirements set forth by the standards:

EN 61010-1 (general requirements related to safety)
EN 61010-031 (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 - protection against electric shock)
EN 04700 (performance of measurements - rough-in inspection tests)

DO YOU KNOW... MZC-306 meter measures short-circuit impedance in industrial systems of any voltage up to 750 V.

Electrical safety:

- type of insulation..... double, in acc. with EN 61010-1
- test leads.....EN 61010-2-031

Other technical specifications:

- power supply of the meter.....rechargeable battery pack or (optional) alkaline batteries
- erformance capacity of rechargeable or alkaline batteries..... min. 3000 measurements
- display..... backlit LED

Nominal operating conditions:

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

Standard accessories of the meter:

- Test lead with banana plug; 1,2m; yellow	WAPRZ1X2YEBB
- Test lead with banana plug; 1,2m; blue	WAPRZ1X2BUBB
- Test lead with banana plug; 1,2m; red	WAPRZ1X2REBB
- "Crocodile" clip K02; blue	WAKROBU20K02
- "Crocodile" clip K02; red	WAKRORE20K02
- Pin probe with banana connector; blue	WASONBUOGB1
- Pin probe with banana connector; red	WASONREOGB1
- Pin probe with banana connector; yellow	WASONYEOGB1
- Carrying case L4	WAFUTL4
- USB cable	WAPRZUSB
- calibration certificate, Sonel Reader software	
- Hanging straps	WAPOZSZEKPL
- 4.8 V 4.2 Ah NiMH rechargeable battery	WAAKU07
- Z7 battery charging power supply adapter	WAZASZ7

Measurement of the Z_{L-PE}, Z_{L-N}, Z_{L-L} short-circuit impedance

Measurement range in acc. with IEC 61557-3 for 1.2 m test leads: **0.13…1999Ω**

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

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

Measurement of the Z_{L-PE} short-circuit impedance in the RCD mode

Measurement range in acc. with IEC 61557-3 for 1.2 m test leads: : **0.43…1999Ω**

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

Short-circuit impedance meter

MZC-304

Index: WMGBMZC304

CAT IV 300V

IP 67

Measurement of short-circuit parameters:

- measurements of short-circuit impedance in power systems of rated voltages: 220/380 V, 230/400 V, 240/415 V and frequencies of 45...65 Hz,
- measurement of short-circuit impedance with current 15 mA without tripping residual current devices,
- detection of swapped L and N conductors in a socket and respective automatic correction during measurement,
- operating voltage range: 180…270 V (for Z_{L-PE} and Z_{L-N}) and 180…460 V (for Z_{L-L}),
- operating frequency range: 45…65 Hz,
- maximal measurement current: 7.6 A for 230 V (3x10 ms), 13.3 A for 400 V (3x10 ms),
- calculation of short-circuit current for nominal voltages,
- indications of R_s short-circuit resistance and X_s short-circuit reactance.

Low-voltage measurement of resistance, protective connections and equipotential bonding:

- **measurement of continuity of protective connections with current ±200 mA in accordance with the EN 61557 standard,**
- automatic calibration of test leads - capability of using any test leads,
- low-current measurement of resistance with acoustic signalling.

Additionally:

Quick verification of correctness of the PE conductor connection with the use of a touch probe.

Measurement of power system voltage and frequency.

LCD and keyboard backlit.

LR6 battery power supply, capability of using NiMH rechargeable batteries.

Memory of 990 measurement results, wireless data transfer to a PC with the OR-1 adapter.

DO YOU KNOW...

MZC-304 meter calculates the value of prospective short-circuit current in accordance with the HD 60364-6:2008 standard.

Electrical safety:

- type of insulation..... double, in acc. with EN 61010-1
- test leads.....EN 61010-2-031
- measurement category.....III 600 V (CAT IV 300 V) acc. to EN 61010-1
- enclosure protection rating acc. to EN 60529.....IP67

Other technical specifications:

- power supply of the meter.....alkaline or rechargeable battery pack (size AA, 4 pcs)
- number of measurements (rechargeable batteries)..... min. 5000 measurements

Nominal operating conditions:

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

Standard accessories of the meter:

- Adapter WS-05 with UNI-Schuko	**WAADAWS05**
- Test lead with banana plug; 1,2m; yellow	**WAPRZ1X2YEBB**
- Test lead with banana plug; 1,2m; blue	**WAPRZ1X2BUBB**
- Test lead with banana plug; 1,2m; red	**WAPRZ1X2REBB**
- "Crocodile" clip K02; yellow	**WAKROYE20K02**
- Pin probe with banana connector - blue	**WASONBUOGB1**
- Pin probe with banana connector - red	**WASONREOGB1**
- Carrying case M6	**WAFUTM6**
- Receiver – interface for radio transmission OR1 (USB)	**WAADAUSBOR1**
- Hanging straps	**WAPOZSZE4**
- Handle to suspend the meter	**WAPOZUCH1**
- Batteries, calibration certificate, Sonel Reader software	

Measurement of the Z_{L-PE}, Z_{L-N}, Z_{L-L}, short-circuit impedance, as well as impedance

Measurement range in acc. with IEC 61557-3 for 1.2 m test leads: **0.13Ω…1999Ω**

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

DO YOU KNOW...

MZC-304 meter measures short-circuit loop impedance with the resolution of 0.01Ω in circuits protected with RCDs without tripping them.

Measurement of the Z_{L-PE} short-circuit impedance in the RCD mode (without tripping RCDs)

Measurement range in acc. with IEC 61557-3 for 1.2 m test leads: **0.51Ω…1999Ω**

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

• Does not cause tripping of RCDs I_n≥30mA,

DO YOU KNOW...

MZC-304 meter always measures impedance as well as its components - resistance and reactance - regardless of phase shift.

The instrument meets the requirements set forth by the standards:

EN 61010-1 (general requirements related to safety)
EN 61010-031 (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 - protection against electric shock)
EN 04700 (performance of measurements - rough-in inspection tests)

2 YEAR WARRANTY

Short-circuit impedance meter

MZC-20E

Index: WMGBMZC20E

Measurement of short-circuit parameters

The meter has been designed for fitters and measurement technicians performing services in residential buildings, office blocks, manufacturing plants and any facilities possessing a low-voltage electrical system. The instrument is also recommended for electrical maintenance personnel.

Standard accessories of the meter:

- test lead 1.2 m, red	**WAPRZ1X2REBB**
- test lead 1.2 m, blue	**WAPRZ1X2BUBB**
- crocodile clip, K02	**WAKRORE20K02**
- pin probe with a banana plug, red	**WASONREOGB1**
- pin probe with a banana plug, blue	**WASONBUOGB1**
- rigid hanger with a hook	**WAPOZUCH1**
- carrying case for the instrument and accessories	**WAFUTM10**
- hanging straps	**WAPOZSZE4**
- SONEL CD	
- user manual	
- warranty card	
- calibration certificate	
- 4x LR6 batteries	

Electrical safety:

- type of insulation.....double, according to EN 61010-1 and IEC 61557
- measurement category.....III 300 V according EN 61010-1
- enclosure protection rating acc. to EN 60529.....IP67

Other technical data:

- power supply.....LR6 alkaline batteries or NiMH rechargeable AA batteries (4 pcs.)
- dimensions.....220x98x58 mm
- instrument weight incl. batteries.....509 g
- storage temperature.....-20...+70°C
- working temperature.....-10...+50°C
- humidity.....20...80%
- reference temperature.....+23 ± 2°C
- reference humidity.....40...60%
- altitude.....< 2000 m
- Auto-OFF time.....max. 900 sec.
- number of Z measurement (for rechargeable batteries).....>5000 (2 measurement/minute)
- display.....LCD segment
- quality standard.....developed, designed and manufactured acc. to ISO 9001
- the instrument is compliant with the requirements of.....IEC 61557
- the instrument complies with.....EN 61326-1:2006 and EN 61326-2-2:2006

Measurements of impedance in a short-circuit Z_s within the range of 0.24…200Ω

Short-circuit current IK: 1,15 - 958,3 A (U^n =230 V) AC voltage measurement: 0 - 440 V

Display range	Resolution	Accuracy
0,00...19,99Ω	0.01Ω	±(2,5% m.v. + 5 digits)
20,0...99,9Ω	0.1Ω	±(2,5% m.v. + 3 digits)
100...200Ω	1Ω	±(3% m.v. + 3 digits)

- Rated operating voltage U_{nL-N} / U_{nL-L}: 220/380V, 230/400V, 240/415V
- Operating voltage range: 180…270V (for Z_{L-PE} i Z_{L-N}) and 180…440V (for Z_{L-L})
- Rated network frequency f_n: 50Hz, 60Hz
- Frequency operating range: 45…65Hz
- Maximum measurement current: 15,3 A for 230 V (10ms) and 26,7 A for 400 V (10ms)

Short-circuit resistance R and reactance X display range:

Display range	Resolution	Accuracy
0,00...9,99Ω	0.01Ω	±(5% m.v. + 5 digits) of Z_s value

- Calculated and displayed fori Z_s <10 Ω

Measurements of impedance in a short-circuit Z_s within the range of 0.24…200Ω

Measuring range according to IEC 61557 can be calculated based on Z_s measuring range and rated voltage values.

Display range	Resolution	Accuracy
1,15…9,99 A	0,01 A	Calculated based on the accuracy for the short-circuit accuracy
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	

Short-circuit impedance Z measurement

Measuring cable	Z_s measuring range
1,2m	0,24...200Ω
5m	0,26...200Ω
10m	0,28...200Ω
20m	0,35...200Ω

Voltage measurement

Display range	Resolution	Accuracy
0...440 V	1 V	±(2,5% m.v. + 2 digits)

Summary of the short-circuit meters

	MZC-310S	MZC-306	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	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	180...460	180...460	95..440	95..440	100...440	180...460
Display range [Ω]	0…199.9	0…1999	0…1999	0…200	0…1999	0…1999	0…1999	0…1999
Max. resolution[Ω]	0.0001	0.01	0.01	0.01	0.001	0.01	0.01	0.01
Max. resolution for the measure - ment without tripping RCDs [Ω]	—	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Max. measurement current [A]	150/280	12.2...36.7	7.6/13.3	15.3/26.7	23/44	23/44	23/44	7.6/13.3
Measurement range in acc. with IEC 61557 [Ω]	0.0072…199.9	0.13…1999	0.13…1999	0.24…200	0.130…1999	0.13…1999	0.13…1999	0.13…1999
Display of short-circuit resistance and reactance	YES	YES	YES	YES	YES	YES	YES	YES
Calculation of prospective short-circuit current	YES	YES	YES	YES	YES	YES	YES	YES
Memory (number of records)	990	990	990	—	10000	990	990	990
Four-lead method	YES	—	—	—	—	—	—	—
Measurement of prospective touch voltage and shock touch voltage	YES	—	—	—	—	—	—	—
Selection of test leads	YES	YES	YES	YES	YES	YES	YES	YES
In-socket measurement with the adapter-plug	—	Optional	YES	—	YES	YES	YES	YES
Triggering measurements from the adapter	—	Optional	Optional	—	YES	YES	YES	Optional
Measurement of alternating voltage	YES	YES	YES	YES	YES	YES	YES	YES
Dimensions [mm]	295x222x95	288x223x75	220x98x58	220x98x58	288x223x75	288x223x75	260x190x60	220x98x58
Weight [kg]	2.2	2.2	1	0,5	2.2	2.2	2.2	1

DO YOU KNOW...

MRU-200 is the only meter allowing for the measurement of impedance to earth of lightning protection earthing systems in accordance with the EN 62305 standard.

Measurement of earth ground impedance:

- **with the use of the impulse method (without the necessity for disconnecting the measured earthing systems),**
- **three types of the measurement impulse (4/10µs; 8/20µs; 10/350µs)**

Measurements of earth ground resistance:

- **with the use of auxiliary probes (three and four-lead methods),**
- **with the use of auxiliary probes and clamp (for measurements of multiple earthing, three-lead + clamp),**
- **with the use of double clamps (for earthing measurements, when the use of auxiliary probes is not possible),**
- resistance of auxiliary probes R_S and R_H,
- voltage and frequency of the interfering signal,
- in the presence of interfering voltages in power systems with the frequency of 16⅔ Hz, 50 Hz, 60 Hz and 400 Hz (with the automatic or manual selection of proper measurement signal frequency),
- selection of maximal measurement voltage (25 V or 50 V),
- calibration of clamp used.

Measurements of soil resistivity (with Wenner method):

- input of probes spacing distances in metres (m) or in feet (ft).

Measurements of protective connection and equipotential bonding continuity:

- with auto-zero function - with current ≥ 200 mA - in accordance with EN 61557-4.

Additionally:

Memory of 990 measurements (10 banks, each of 99 cells).
Built in GPS (only MRU-200-GPS).
Coordinates of the measurement are stored in meter memory (only MRU-200-GPS)
Real time clock (RTC).
Data transfer to a computer (USB or wireless - OR-1).
Indication of condition of rechargeable batteries.

DO YOU KNOW...

MRU-200 meter is a unique instrument on the market using all known measurement methods and performing measurements with the resolution of 0.001 Ω.

Earth resistance and impedance meter

MRU-200 / MRU-200-GPS

Index: WMGBMRU200
WMGBMRU200GPS

Standard accessories of the meters:

- Test lead with banana plug; 1,2m; red	**WAPRZ1X2REBB**
- Test lead with banana plug 2,2m; black	**WAPRZ2X2BLBB**
- Test lead on a reel with banana plugs; 25m; red	**WAPRZ025REBBSZ**
- Test lead on a reel with banana plugs; 25m; blue	**WAPRZ025BUBBSZ**
- Test lead on a reel with banana plugs; 50m; shielded.	**WAPRZ050YEBBSZE**
- USB cable	**WAPRZUSB**
- Cable for battery charg with car plug 12V	**WAPRZLAD12SAM**
- Earth contact test probe (rod); 0,30m	**WASONG30**
- Carrying case L2	**WAFUTL2**
- NiMH rechargeable battery	**WAAKU07**
- "Crocodile" clip K01; black	**WAKROBL20K01**
- "Crocodile" clip K02; red	**WAKRORE20K02**
- Cramp	**WAZACIMA1**
- Power supply adaptor Z7	**WAZASZ7**
- Cable for battery charger	**WAPRZLAD230**
- Hanging straps	**WAPOZSZEKPL**
- Sonel Reader software, calibration certificate	

Measurement of earth resistance (three and four-lead method)

Measurement range in acc. with EN 61557-5: **0.100 Ω...19.99 kΩ**

Display range	Resolution	Accuracy
0.000...3.999 Ω	0.001 Ω	±(2% m.v. + 4 digits)
4.00...39.99 Ω	0.01 Ω	±(2% m.v. + 2 digits)
40.0...399.9 Ω	0.1 Ω	
400...3999 Ω	1 Ω	
4.00kΩ...19.99 kΩ	0.01k Ω	±(5% m.v. + 2 digits)

Measurement of multiple earthing resistance with the use of a clamp (three-lead + clamp)

Measurement range in acc. with EN 61557-5: **0.120...1999 Ω**

Display range	Resolution	Accuracy
0.000...3.999 Ω	0.001 Ω	±(8% m.v. + 4 digits)
4.00...39.99 Ω	0.01 Ω	±(8% m.v. +3 digits)
40.0...399.9 Ω	0.1 Ω	
400...1999 Ω	1 Ω	

Measurement of multiple earthing 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)

Measurement of impedance to earth (Z_E) with the impulse method (four-lead,)

Display range	Resolution	Accuracy
0.0...99.9 Ω	0.1 Ω	±(2.5% m.v. + 3 digits)
100...199 Ω	1 Ω	

The instrument meets the requirements set forth by the standards:

EN 62305-1 (lightning protection)
EN 61010-1 (general requirements related to safety)
EN 61010-031 (particular requiremen1ts related to safety)
PN-EN 61326 (electromagnetic compatibility)
EN 61557 (requirements for measurement instruments)
HD 60364-6 (performance of measurements - checking)
HD 60364-4-41 (performance of measurements - protection against electric shock)
EN 04700 (performance of measurements - rough-in inspection tests)

Other technical specifications:

- type of insulation..... double, in acc. with EN 61010-1 and IEC 61557
- number of measurements performed with one set of rechargeable batteries..... > 1200

Nominal operating conditions:

- operating temperature..... -10...+50°C
- storage temperature..... -20...+80°C
- humidity..... 20...85%

Earth resistance meter

MRU-120

Index: WMGBMRU120

Measurements of earth ground resistance:

- **with the use of auxiliary probes (three and four-lead methods),**
- **with the use of auxiliary probes and clamp (for measurements of multiple earthing),**
- **with the use of double clamps (for earthing measurements, when the use of auxiliary probes is not possible),**
- measurement current frequency: 125 Hz (for 50 Hz power systems) or 150 Hz (for 60 Hz power systems),
- resistance of auxiliary probes R_S and R_H,
- measurement of the interfering voltage,
- measurement of the interfering signal frequency,
- measurement in the presence of interfering voltages in power systems with the frequency of 50 Hz and 60 Hz,
- selection of maximal measurement voltage (25 V or 50 V),

Measurements of soil resistivity (the Wenner method):

- input of probes spacing distances in metres (m) or in feet (ft).

Measurements of protective connection and equipotential bonding continuity:

- with auto-zero function - with current ≥ 200 mA - in accordance with EN 61557-4.

Additionally:

Memory of 990 measurements (10 banks, each of 99 cells).

Real time clock (RTC).

Data transfer to a computer (USB or wireless - OR-1).

Indication of condition of rechargeable batteries.

The instrument meets the requirements set forth by the standards:

EN 61010-1 (general requirements related to safety)
EN 61010-031 (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 - protection against electric shock)
EN 04700 (performance of measurements - rough-in inspection tests)

Other technical specifications:

- type of insulation..... double, in acc. with EN 61010-1 and IEC 61557
- number of measurements performed with one set of rechargeable batteries..... > 800

Nominal operating conditions:

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

Standard accessories of the meter:

- Test lead with banana plug; 1,2m; red	**WAPRZ1X2REBB**
- Test lead with banana plug 2,2m; black	**WAPRZ2X2BLBB**
- Test lead on a reel with banana plugs; 25m; red	**WAPRZ025REBBSZ**
- Test lead on a reel with banana plugs; 25m; blue	**WAPRZ025BUBBSZ**
- Test lead on a reel with banana plugs; 50m; yellow.	**WAPRZ050YEBBSZ**
- USB cable	**WAPRZUSB**
- Pin probe with banana connector; yellow	**WASONYEOGB1**
- Earth contact test probe (rod); 0,30m - 4 pcs	**WASONG30**
- Carrying case L2	**WAFUTL2**
- "Crocodile" clip K01; black	**WAKROBL20K01**
- Power supply adaptor Z7	**WAZASZ7**
- NiMH rechargeable battery	
- Cable for battery charger	**WAPRZLAD230**
- Set of hanging straps	**WAPOZSZEKPL**
- Sonel Reader software, calibration certificate	

Measurement of earth resistance (three and four-lead method)

Measurement range in acc. with IEC 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	
2.0k...9.99 kΩ	0.01 kΩ	±(5% m.v. + 4 digits)
10.0k...19.9 kΩ	0.1 kΩ	

DO YOU KNOW...

MRU-120 meter allows for performing earthing measurements with the use of the two-clamp method without additional rods.

Measurement of multiple earthing resistance (three-lead method + clamp)

Measurement range in acc. with IEC 61557-5: **0.44...1999 Ω**

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	

DO YOU KNOW...

MRU-120 meter allows for performing multiple earthing measurements without disconnecting test connections.

Measurement of multiple earthing resistance with the use of two clamps

Display range	Resolution	Accuracy
0.0...19.99 Ω	0.01 Ω	±(10% m.v. + 3 digits)
20.0...149.9 Ω	0.1 Ω	±(20% m.v. + 3 digits)

2 YEAR WARRANTY

Earth resistance meter

MRU-30

Index: WMGBMRU30

CAT III 300V

IP 65

Possible measurements:

- earth resistance measurement with 3-pole, 4-pole method,
- earth resistance measurement with clamp (no influence from parallel earths; no opening of rusty junctions is needed),
- continuity of eqipotential bondings and protecting conductors,
- two clamps earth resistance measurement without auxiliary test probs,
- earth resistivity measurement.

Meter allows to take the measurements of:

- earth resistance using auxiliary electrodes,
- earth resistance using auxiliary electrodes and clamp (for measurements of multiple earthing),
- earth resistance using double clamps (for measurement of earthing when it is impossible to use auxiliary electrodes),
- ground resistivity (Wenner method)
- continuity of equipotential bondings and protective conductors (complies with IEC 60364) with auto-zero function – with current 200 mA.

Additional measurements:

- measurement of resistance of of auxiliary electrodes resistance R_S and R_H,
- measurement of interference voltage,
- measurement in the presence of interference voltage from the power network with frequency 50 Hz, 60 Hz,
- selection of maximum measuring voltage (25V and 50V),
- selection of the length unit in meter (m) or in feet (ft) for the distance between electrodes for resistivity measurement,
- memory of 990 measurements (10 banks of 99 cells each),
- calibration of clamp used,
- data transmission to the computer (USB),
- indication of battery state.

Electric security:

- type of insulation.....double, according to EN 61010-1 i IEC 61557
- safety rating.....CAT III 300V according to EN 61010-1
- protection class acc. to EN 60529.....IP65

Rated operational conditions:

- operating temperature.....-10...+50˚C
- storage temperature.....-20...+60˚C
- humidity.....20...85%

Other technical data:

- LCD display.....segment, backlit
- dimensions.....200x150x73 mm

Measurement of interference voltage U_N (RMS)

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

Measurement of continuity of equipotential bondings and protective conductors (R_{cont})

measurement range in acc. with IEC 61557-4:2007: 0,13 Ω...1999 Ω

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	

- measurement current: under short circuit >200mA
- frequency of measurement current: 125 Hz (for networks 50 Hz) and 150 Hz (for networks 60 Hz)

Measurement of the resistance to earth (method 3- and 3-pole + clamps)

measurement range in acc. with IEC 61557-5:2007: 0,53 Ω...9999 Ω (for 50 V)

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 >200 mA
- frequency of measurement current: 125 Hz (for networks 50 Hz) and 150 Hz (for networks 60 Hz)

Measurement of multiple earthing resistance using double clamps

Range	Resolution	Accuracy
0,00...19,99 Ω	0.01 Ω	±(10% m.v. +8 digits)
20,0...99,9 Ω	0.1 Ω	±(20% m.v. +3 digits)

- frequency of measurement current: 125 Hz (for networks 50 Hz) and 150 Hz (for networks 60 Hz)

Measurement of ground resistivity

Measurement method: Wenner, $\rho=2\pi LR_E$

Range	Resolution	Accuracy
0,00...9,99 Ωm	0,01 Ωm	Depends on the basic uncertainty of the R_E 4P measurement but not less 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 probes: 1...50 m.. or 1...150 ft

Measurement of auxiliary electrodes resistance R_H and R_S

Range	Resolution	Accuracy
0...999 Ω	1 Ω	±(5% (R_S+R_E+R_H) +8 digits)
1,00...9,99 kΩ	0,01 kΩ	
10,0...19,9 kΩ	0,1 kΩ	

MRU-20

Index: WMGBMRU20

CAT III 600V

CAT IV 300V

IP 54

MRU-21

Index: WMGBMRU21

CAT III 600V

CAT IV 300V

IP 54

DO YOU KNOW...

MRU-21 and MRU-20 meters are the basic earthing measurement instruments allowing for the performance of measurements in accordance with the EN 62305 standard.

Measurement of earth ground resistance:

- with the use of the three-lead method with auxiliary probes, measurements with the resistance of auxiliary probes up to 50 kΩ ,
- measurement of resistance of auxiliary probes R_s and R_H,
- measurement of the interfering voltage,
- measurement in the presence of interfering voltages from the power system,
- selection of maximal measurement voltage (25 V or 50 V).

Two-lead measurement of resistance:

- auto-zero of test leads.

Measurements of protective connection and equipotential bonding continuity:

- meeting the requirements of the EN 61557-4 standard with the auto-zero function, with current ≥ 200 mA.

Additionally:

Memory of 990 measurements, data transfer to a computer over the USB interface (MRU-21).

Indication of charge level of batteries or rechargeable batteries.

Battery or rechargeable battery power supply.

Auto-off after 5 minutes.

DO YOU KNOW...

MRU-20 and MRU-21 meters have improved immunity to unfavourable operating conditions.

Other technical specifications:

- type of insulation..... double, in acc. with EN 61010-1 and IEC 61557
- display..... backlit segment LCD
- number of measurements performed on one set of alkaline batteries..... 1000 (5 Ω, 2 measurements/min)
- dimensions..... 288x223x75 mm
- weight (including batteries).....1.4 kg
- the product meets the EMC requirements in accordance with the EN 61326-1:2006 ..... and EN 61326-2-2:2006 standards
- power supply of the meter..... 4 x 1.5 V batteries or rechargeable C type batteries (MRU-21) ....8 x batteries or rechargeable AA type batteries (MRU-20)

Nominal operating conditions:

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

Standard accessories of the meters:

- Test lead with banana plug; 1,2m; blue	**WAPRZ1X2BUBB**
- Test lead with banana plug 2,2m; black	**WAPRZ2X2BLBB**
- Test lead on a reel with banana plugs; 30m; red	**WAPRZ030REBBSZ**
- Test lead on a reel with banana plugs; 15m; blue	**WAPRZ015BUBBSZ**
- "Crocodile" clip K02; blue	**WAKROBU20K02**
- USB cable (MRU-21)	**WAPRZUSB**
- Earth contact test probe (rod); 0,30m - 2 pcs	**WASONG30**
- Carrying case L4	**WAFUTL4**
- "Crocodile" clip K01; black	**WAKROBL20K01**
- Hanging straps (MRU-21)	**WAPOZSZEKPL**
- Hanging straps (MRU-20)	**WAPOZSZE2**
- LR14 battery container (size C) (MRU-21)	**WAPOJ1**
- Batteries	
- Calibration certificate	
- Sonel Reader software (MRU-21)	

Measurement of earth resistance (3p)

Measurement range in acc. with IEC 61557-5:
0.50Ω...1.99kΩ for U_n=50V; **0.68Ω...1.99kΩ** for U_n=25V;

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

• measurement current: during short-circuit > 20 mA • measurement current frequency: 125 Hz

Measurement of protective connection and equipotential bonding continuity

Measurement range in acc. with IEC 61557-4: **0.13Ω...199Ω**

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

The instruments meet the requirements set forth by the standards:

EN 61010-1 (general requirements related to safety)
EN 61010-031 (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 - protection against electric shock)
EN 04700 (performance of measurements - rough-in inspection tests)

NEW!

CAT IV 300V

IP 67

Adapter for measurement of earth resistance of transmission line pylons.

ERP-1

Index: WAADAERP1, WAADAERP1V2, WAADAERP1V3

Standard accessories:

- Sonel ERP-1 adapter,
- flexible clamps FS-2
- user manual,
- soft carrying case,
- 3x batteries AA (LR6) 1,5V.

Additional accessories:

- flexible clamps FSX-3	**WACEGFSX30KR**
- hard carrying case XI8	**WAWALXL8**

Measurement of earth resistance:

Sonel ERP-1 adapter is used for earth resistance measurements of electricity pylons using flexible clamp - Rogowski coil.

It is designed to operate with the Sonel's earth resistance meters (MRU series), in 3-wire with clamp measurement function. Ergonomic, handy and user friendly design of casing makes the measurements of pylons earth resistance quick and easy.

The adapter works with the following meters: Sonel MRU-120, Sonel MRU-200, Sonel MRU-200-GPS.

For this measurement we offer clamps in several length versions and different electrical specifications.

Other data:

- storage temperature ..... -20...+80°C,
- storage humidity ..... 20...85%,
- operating temperature ..... -10...+50°C,
- operating humidity..... 20...85%,
- dimensions ..... 88 x 33 x 146 mm,
- weight with batteries / without batteries ..... 340 g / 270 g,
- protection class IP67

Pylon earth resistance measurement adapter specification:

- measurement range..... up to 5 A,
- operating frequency ..... up to 125Hz (for work in 50Hz network), 150Hz (for work in 60Hz network)
- power supply ..... 3 x battery LR6 1,2 – 1,5 V
- safety rating ..... CAT IV 300 V in accordance with IEC 61010-1

Summary of the earthing measurement instruments

	MRU-200	MRU-120	MRU-30	MRU-21	MRU-20	MPI-530	MPI-525/520/ 520Start
Three-lead method (3p)	YES	YES	YES	YES	YES	YES	YES
Four-lead method (4p)	YES	YES	YES	—	—	YES	—
Maximal resolution [Ω]	0.001	0.01	0.01	0.01	0.01	0.01	0.01
Fall of potential method with additional clamp (3p+clamp)	YES	YES	YES	—	—	YES	—
Impulse method - earth ground impedance	YES	—	—	—	—	—	—
2-clamp method	YES	YES	YES	—	—	YES	—
Soil resistivity	YES	YES	YES	—	—	YES	—
Measurement of current using clamp	YES	—	—	—	—	YES	MPI-520/520Start
Measurement of current with the use of flexible clamp (Rogowski coil)	YES	—	—	—	—	YES	—
Measurement of protective connection and equipotential bonding continuity in acc. with the EN 61577 standard	YES	YES	YES	YES	YES	YES	YES
Internal current source	YES	YES	YES	YES	YES	YES	YES
Measurement of resistance	YES	YES	YES	YES	YES	YES	YES
Battery charger, rechargeable battery	YES	YES	YES	—	—	YES	YES/Optional/Optional
Memory (number of records)	990	990	990	990	—	10000	990
Measurement of interfering voltages	YES	YES	YES	YES	YES	YES	YES
Measurement of auxiliary probe resistance	YES	YES	YES	YES	YES	YES	YES
Dimensions [mm]	288x223x75	288x223x75	200x150x73	288x223x75	260x190x60	288x223x75	288x223x75
Weight [kg]	2	2	1,1	1.4	1.3	2.2	2.2

RCD meter
MRP-201

Index: WMGBMRP201

CAT IV 300V

IP 67

DO YOU KNOW...

MRP-201 meter is intended for measuring RCDs: general, selective, short-time delay - AC, A, B type.

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

- measurement of general, short-time delayed and selective RCDs of the $I_{\Delta n}$ rated residual current 10, 30, 100, 300 and 500 mA,
- measurement of the tripping current I_A and the tripping time t_A with currents $0{,}5I_{\Delta n}$, $1I_{\Delta n}$, $2I_{\Delta n}$, $5I_{\Delta n}$,
- simultaneous measurement of the tripping current I_A and the t_{Ai} trip time,
- measurement of R_E and U_B without tripping RCDs,
- the AUTO function for RCD measurement (automatic measurement of selected parameters without tripping),
- automatic measurement of all A and B type RCDs for all current shapes.

Additional features:

Measurement of alternating voltage and frequency.
Verification of correctness of the connections of protective conductor .
Measurement result memory (990 cells, 10000 records).
Communication with a computer over the OR-1 wireless interface.
LCD and keyboard backlit.

DO YOU KNOW...

MRP-201 meter is the only one having 2 kinds of automatic measurement mode, especially useful during the measurements of A and B type RCDs.

The instrument meets the requirements set forth by the standards:

EN 61010-1 (general requirements related to safety)
EN 61010-031 (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 - protection against electric shock)
EN 04700 (performance of measurements - rough-in inspection tests)

Other technical specifications:

- type of insulation ..... double, in acc. with EN 61010-1 and IEC 61557
- power supply of the meters ..... alkaline batteries (size AA, 4 pcs)
  .....or a rechargeable battery back (optional)
- weight.....1 kg
- dimensions.....220x98x58 mm

Nominal operating conditions:

- operating temperature ..... -10...+50 ˚C
- storage temperature..... -20...+70 ˚C
- humidity..... 20...80%

Standard accessories of the meter:

- Adapter WS-05 with UNI-Schuko	**WAADAWS05**
- Test lead with banana plug; 1,2m; yellow	**WAPRZ1X2YEBB**
- Test lead with banana plug; 1,2m; red	**WAPRZ1X2REBB**
- Test lead with banana plug; 1,2m; blue	**WAPRZ1X2BUBB**
- "Crocodile" clip K02; yellow	**WAKROYE20K02**
- Pin probe with banana connector; red	**WASONREOGB1**
- Pin probe with banana connector, blue	**WASONBUOGB1**
- Carrying case M6	**WAFUTM6**
- Hanging straps	**WAPOZSZE4**
- Receiver – interface for radio transmission OR1 (USB)	**WAADAUSBOR1**
- Handle to suspend the meter	**WAPOZUCH1**
- Sonel Reader software, calibration certificate, batteries	

RCD tripping test and measurement of the t_A triping time

Measurement range in acc. with IEC 61557-6: **0ms...up to the upper limit of displayed value**

RCD type	Factor	Measurement range	Resolution	Accuracy
General use or short-time delayed	$0.5*I_{\Delta n}$	0...300ms	1ms	±(2% m.v. + 2 digits)
	$1*I_{\Delta n}$			
	$2*I_{\Delta n}$	0...150ms		
	$5*I_{\Delta n}$	0...40ms		
Selective	$0.5*I_{\Delta n}$	0...500ms		
	$1*I_{\Delta n}$			
	$2*I_{\Delta n}$	0...200ms		
	$5*I_{\Delta n}$	0...150ms		

- Accuracy of residual current setting: for $1*I_{\Delta n}$, $2*I_{\Delta n}$ and $5*I_{\Delta n}$: 0...8%; for $0.5*I_{\Delta n}$: -8...0%,
- Operating voltage range: 180...270 V
- Operating frequency range: 45...65 Hz.

Measurement of the I_A RCD tripping current for sinusoidal residual current

Measurement range in acc. with IEC 61557-6: **$(0.3...1.0)I_{\Delta n}$**

Nominal current	Measurement range	Resolution	Measurement current	Accuracy
10mA	3.3...10.0mA	0,1mA	$0.3 \times I_{\Delta n}$...$1.0 \times I_{\Delta n}$	± 5% $I_{\Delta n}$
30mA	9.0...30.0mA			
100mA	33...100mA	1mA		
300mA	90...300mA			
500mA	150...500mA			

- Possibility of starting the measurement from a positive or negative half-period of forced leakage current (AC type)
- Measurement current flow time at f=50.0 Hz max. 7510 ms

Measurement of the I_A RCD tripping current for residual unidirectional pulsating current and residual unidirectional pulsating current with 6mA direct current offset (type A)

Measurement range in acc. with IEC 61557-6: **$(0.15...1.4)I_{\Delta n}$** for $I_{\Delta n} \geq 30$mA and **$(0.15...2)I_{\Delta n}$** for $I_{\Delta n}$=10mA

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

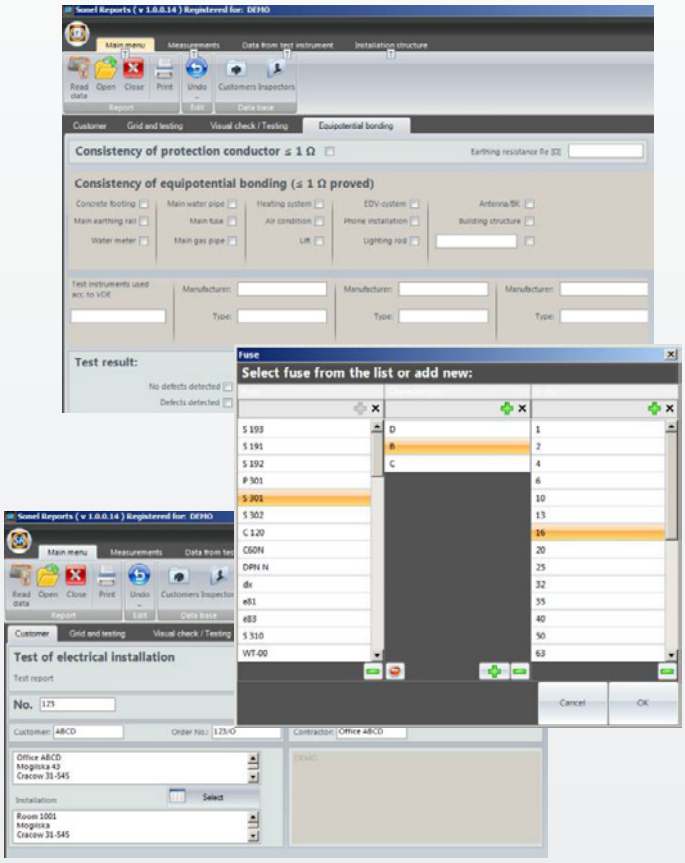
- Capability of measurement for positive or negative half-periods of forced leakage current
- Measurement current flow time at f=50.0 Hz max. 14710 ms

Measurement of the I_A RCD tripping current for residual direct current

Measurement range in acc. with IEC 61557-6: **$(0.2...2)I_{\Delta n}$**

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

- Capability of measurement for positive or negative leakage current
- Measurement current flow time at f=50.0 Hz max. 4500 ms.



SONEL PE software

SONEL REPORTS PLUS

Index: WASONREPORTPLUS

SONEL Reports software for creation of reports from electrical safety measurements.

Main software functions:
-easy and clear creation of reports,
-user friendly interface,
-library of test points and fuses,
-communication and data download from Sonel testers.

Software supports following type of measurements:
- loop impedance test (TN-C-S, TT),
- RCD parameters test,
- circuit insulation resistance test(TN-C, TN-S).

Hardware requirements:
- operating system: Windows 2000, Windows XP, Windows Vista, Windows 7 and higher (32 and 64-bit).

INDEX: WAADAUSBOR1

Additionally available:
Hardware key - expansion of licence to include another workstation or a portable licence (WAADAKEY1)

	Accessories	Fig.	Catalogue index	MPI-530 / 530-IT	MPI-525	MPI-520	MPI-520S	MPI-505	MPI-502	MIC-10K1	MIC-5050	MIC-5010	MIC-5005	MIC-2510/5001	MIC-2505	MIC-2501/	MIC-30	MIC-10	MIC-2	MRP-201	MRU-20	MRU-21	MRU-30	MRU-120	MRU-200/GPS	MZC-304	MZC-305	MZC-306	MZC-310S	MZC-20E
ADAPTERS	Three-phase socket adapter AGT-16C	1	WAADAAGT16C	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o						o		o	o	o
	Three-phase socket adapter AGT-16P	2	WAADAAGT16P	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o		o	o	o	o	o
	Industrial socket adapter AGT-16T	3	WAADAAGT16T	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Three-phase socket adapter AGT-32C	4	WAADAAGT32C	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Three-phase socket adapter AGT-32P	5	WAADAAGT32P	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Industrial socket adapter AGT-32T	6	WAADAAGT32T	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Three-phase socket adapter AGT-63P	7	WAADAAGT63P	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	AUTO ISO-1000C Adapter	8	WAADAAISO10C	o	o	o	o																							
	AUTO ISO-2500 Adapter	9	WAADAAISO25	o	o	o	o	o	o	o	o	o	o	o																
	AUTO ISO-5000 Adapter	10	WAADAAISO5	o	o	o	o	o	o	o	o																			
	RCD breaker testing adapter TWR-1J (universal pin)	11	WAADATWR1J	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
	Adapter with START button with UNI-Schuko (WS-01)	12	WAADAWS01	o	o	o	o	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	
	Adapter with START button with UNI-Schuko (WS-03)	13	WAADAWS03	●	●	●	●																							
	Adapter WS-04 with UNI-Schuko	14	WAADAWS04	o	o	o	o	o	o	o	o	o	o	o	o	o	o													
	Adapter WS-05 with UNI-Schuko	15	WAADAWS05	o	o	o	o	o	●	o	o	o	o	o	o	o	o	o	o	o	●	o	o	o	o	o	●	o	o	o	o
	AC line splitter AC-16	16	WAADAAC16	o	o	o	o																								
	ERP-1 Adapter	17	WAADAERP1	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
BATTERIES	NiMH 4,8V 4,2Ah rechargeable battery	18	WAAKU07	●	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	●	o	o	●	o	o
	NiMH 9.6 V rechargeable battery	19	WAAKU10	o	o	o	o	o	o	o	o	o	o	o	o	●	●	o	o	o	o	o	o	o	o	o	o	o	o	o
POWER SUPPLY	Charging set (chargers + battery)	20	WAKPLLADMPI520	●	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Box for batteries	21	WAPOJ1	o	o	●	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o	●	o	o	o	o	o	o	o	o
	Cable for battery charging with car plug 12V	22	WAPRZLAD12SAM	●	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	●	o	o	o	o	o
	Cable for battery charger	23	WAPRZLAD230	●	●	o	o	o	o	●	o	o	o	•	•	o	o	o	o	o	o	o	o	o	●	●	o	o	o	o
	Cable for battery charger (IEC plug)	24	WAPRZLAD230IEC	o	o	o	o	o	o	●	●	●	●	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Power supply adapter Z7	25	WAZASZ7	●	●	o	o	o	o	o	o	o	o	●	●	●	o	o	o	o	o	o	●	●	●	o	o	●	o	o
CLAMPS	C-3 clamp (ø 52mm)	26	WACEGC3A0KR	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	C-6 clamp	27	WACEGC6A0KR	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	F-1 clamp (ø 360mm)	28	WACEGF1A0KR	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	F-2 clamp	29	WACEGF2A0KR	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	F-3 clamp (ø 120 mm)	30	WACEGF3A0KR	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	N-1 clamp (ø 52 mm, with test lead)	31	WACEGN1BB	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
ALIGATOR CLIPS AND CLAMPS	"Crocodile" clip K01; black	32	WAKROBL20K01	o	o	o	o	o	o	o	o	o	o	o	o	o	o	●	●	o	●	●	●	●	●	o	o	o	●	o
	"Crocodile" clip K02; red	33	WAKRORE20K02	●	●	●	●	o	o	o	o	o	o	o	o	o	o	o	o	o	●	o	o	o	●	o	●	o	o	●
	Kelvin's clamp	34	WAKROKELK06	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	●	o
	"Crocodile" clip K02; blue	35	WAKROBU20K02	o	o	o	o	o	o	o	o	o	o	o	o	o	●	o	o	o	●	●	o	o	o	o	●	●	o	o
	"Crocodile" clip K02; yellow	36	WAKROYE20K02	●	●	●	●	●	●	o	o	o	o	o	o	o	o	o	o	●	o	o	o	o	o	●	o	o	o	o
	"Crocodile" clip 11 kV; black	37	WAKROBL32K08	o	o	o	o	o	o	●	●	●	●	o	o	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	"Crocodile" clip 11 kV; red	38	WAKRORE32K08	o	o	o	o	o	o	●	●	●	●	o	o	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	"Crocodile" clip 11 kV; blue	39	WAKROBU32K08	o	o	o	o	o	o	●	●	●	●	o	o	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Cramp	40	WAZACIMA1	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	●	o	●	o	o	o	o	o
LEADS AND LEADS ON REELS	Test lead with banana plug; 1,2m; black	41	WAPRZ1X2BLBB	o	o	o	o	o	o	o	o	o	o	o	o	o	o	●	o	o	o	o	o	o	o	o	o	o	●	o
	Test lead with banana plug; 1,2m black, shielded	42	WAPRZ1X2BLBBE	o	o	o	o	o	o	o	o	o	o	o	o	o	●	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug; 1,2m; red	43	WAPRZ1X2REBB	●	●	●	●	●	●	o	o	o	o	o	o	●	●	o	●	o	o	●	●	●	●	●	●	o	●
	Test lead with banana plug; 1,2m; blue	44	WAPRZ1X2BUBB	●	●	●	●	●	●	o	o	o	o	o	o	●	●	o	●	●	●	●	o	o	●	●	●	o	o	●
	Test lead with banana plug; 1,2m; yellow	45	WAPRZ1X2YEBB	●	●	●	●	●	●	o	o	o	o	o	o	o	o	o	●	o	o	o	o	o	o	o	●	●	●	o
	Test shielded lead with banana plug; 1,8m; 5kV; black	46	WAPRZ1X8BLBB	o	●	o	o	o	o	o	o	o	o	●	●	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug; 1,8m; 5kV; red	47	WAPRZ1X8REBB	o	●	o	o	o	o	o	o	o	o	●	●	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug; 1,8m; 5kV; blue	48	WAPRZ1X8BUBB	o	o	o	o	o	o	o	o	o	o	●	●	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug; 1.8m; 10 kV; black, shielded	49	WAPRZ1X8BLBBE10K	o	o	o	o	o	o	o	o	●	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug; 1.8m; 10 kV; red	50	WAPRZ1X8REBB10K	o	o	o	o	o	o	o	o	●	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug; 1.8m; 10 kV; blue	51	WAPRZ1X8BUBB10K	o	o	o	o	o	o	o	o	●	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug; 5m; 10 kV; black, shielded	52	WAPRZ002DZBB	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	●	o	o	o	o	o	o	o
	Test lead with banana plug; 5m; 10 kV; red	53	WAPRZ2X2BLBB	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	●	●	o	●	●	o	o	o	o	o
	Test lead with banana plug; 5m; 10 kV; blue	54	WAPRZ003DZBBU1I1	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	●	o
	Test lead with banana plug; 2m; double wire	55	WAPRZ003DZBBU2I2	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	●	o
	Test lead with banana plug 2,2m; black	56	WAPRZ003BLBBE10K	o	o	o	o	o	o	●	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug; 3m; double wire	57	WAPRZ003REBB10K	o	o	o	o	o	o	●	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug; 3m; double wire	58	WAPRZ003BUBB10K	o	o	o	o	o	o	●	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug; 3m; 10 kV; black, shielded	59	WAPRZ005BUBB	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug; 3m; 10 kV; red	60	WAPRZ005BUBB5K	o	o	o	o	o	o	o	o	o	o	●	●	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug; 3m; 10 kV; blue	61	WAPRZ005BLBBE	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug, 5m, blue	62	WAPRZ005BLBBE5K	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug; 5m; 5kV; blue	63	WAPRZ005REBB	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug; 5m, black, shielded	64	WAPRZ005REBB5K	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug; 5m; 5kV; black, shielded	65	WAPRZ005YEBB	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug 5m; red	66	WAPRZ005BLBBE10K	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug; 5m; 5kV; red	67	WAPRZ005REBB10K	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug 5m; yellow	68	WAPRZ005BUBB10K	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug;10m; 5kV; black, shielded	69	WAPRZ010BLBBE5K	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug 10m; red	70	WAPRZ010REBB	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug; 10m; 5kV; red	71	WAPRZ010REBB5K	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug; 10m; 5kV; blue	72	WAPRZ010BUBB5K	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug 10m; yellow	73	WAPRZ010YEBB	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug; 10m; 10 kV; black, shielded	74	WAPRZ010BLBBE10K	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug; 10m; 10 kV; red	75	WAPRZ010REBB10K	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug; 10m; 10 kV; blue	76	WAPRZ010REBB10K	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug 20m; red	77	WAPRZ020REBB	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug 20m; yellow	78	WAPRZ020YEBB	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug; 20m; 10 kV; black, shielded	79	WAPRZ020BLBBE10K	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug; 20m; 10 kV; red	80	WAPRZ020REBB10K	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead with banana plug; 20m; 10 kV; blue	81	WAPRZ020BUBB10K	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Teast leand on a reel with banana plug; 15m; blue	82	WAPRZ015BUBBSZ	●	●	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o	●	●	o	●	●	o	o	o	o	o
	Test lead on a reel with banana plug; 25m; red	83	WAPRZ025REBBSZ	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	●	●	●	o	o	o	o	o
	Test lead on a reel with banana plug; 25m; blue	84	WAPRZ025BUBBSZ	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test lead on a reel with banana plug; 30m; red	85	WAPRZ030REBBSZ	●	●	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o	●	●	o	●	o	o	o	o	o	o
	Test lead on a reel with banana plug; 50m	86	WAPRZ050YEBBSZ	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	●	o	●	o	o	o	o	o
	Test lead on a reel with banana plug; 50m; shielded	87	WAPRZ050YEBBSZE	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Test wire reel	88	WAPOZSZP1	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	●	o
CASES	Carrying case L1	89	WAFUTL1	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	●	●	o	o	o	●	o
	Carrying case L2	90	WAFUTL2	●	●	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Carrying case L3	91	WAFUTL3	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	●	●	o	o
	Carrying case L4	92	WAFUTL4	o	o	o	●	●	o	●	●	●	●	●	●	o	o	o	o	o	o	●	o	o	o	●	o	o	o	o
	Carrying case L10	93	WAFUTL10	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	●	o	o	o	o	o	o	o	o
	Carrying case M6	94	WAFUTM6	o	o	o	o	o	●	o	o	o	o	o	o	o	●	●	o	●	o	o	o	o	o	o	o	o	o	o
	Carrying case M7	95	WAFUTM7	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Carrying case M9	96	WAFUTM9	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	●	o	o	o	o	o	o	o	o	o
	Carrying case S2	97	WAFUTS2	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	Aluminium case L4	98	WAWALL4	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	●	o
HARNESSES, HOLDERS	Hanging straps	99	WAPOZSZE1	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	●	o	o	o
	Hanging straps	100	WAPOZSZE2	o	o	o	o	●	o	o	o	o	o	●	●	o	o	o	o	o	●	o	o	o	o	●	o	o	o	o
	Hanging straps	101	WAPOZSZE4	o	o	o	o	o	●	o	o	o	o	o	o	o	●	●	o	●	o	o	o	●	●	o	o	●	o	●
	Set of hangind straps	102	WAPOZSZEKPL	●	●	●	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o	●	o	o	o	●	o	o	o	o
	Handle to suspend the meter	103	WAPOZUCH1	o	o	o	o	o	●	o	o	o	o	o	o	o	o	●	●	o	●	o	o	o	o	o	o	o	o	●

	Accessories	Fig.	Catalogue indexs	MPI-530 / 530-IT	MPI-525	MPI-520	MPI-520S	MPI-505	MPI-502	MIC-10k1	MIC-5050	MIC-5010	MIC-5005	MIC-2510	MIC-2505	MIC-2501	MIC-30	MIC-10	MIC-2	MRP-201	MRU-20	MRU-21	MRU-30	MRU-120	MRU-200/0GPS	MZC-304	MZC-305	MZC-306	MZC-310S	MZC-20E
DATA TRANSFER	Dongle for software Sonel PE	104	WAADAKEY1	o	o	o	o	o	o	o	o	o	o	o			o			o		o						o	
	USB1.1/RS232 converter	105	WAADAUSBRS232	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	●	o	o	o	o
	OR1 (USB) Transmitter	106	WAADAUSBOR1		o	o	o		●			o	o	o			●			●				●	●		●	●	o	
	USB data cable	107	WAPRZUSB	●	●	●	●	●		o	o			●		●						●	●						●	
	RS-232 data cable	108	WAPRZRS232																										●	
	Wireless Bluetooth® keyboard	109	WAADAMK	●						o	o													o	o				●	
PROBES	Tip probe (black) with banana socket	110	WASONBLOGB1														●	●	●		o	o								
	Tip probe (black) with banana socket 5kV	111	WASONBLOGB2	o	o									●	●	●								●	o	●	●	●		
	Tip probe (red) with banana socket	112	WASONREOGB1	●	●	●	●	●	●								●	●		●	●	o	●							●
	Tip probe (red) with banana socket 5kV	113	WASONREOGB2		●									●	●	●								o	o	●	●	●		
	Tip probe (blue) with banana socket	114	WASONBUOGB1	●	●	●	●	●	●							o	o	o	●	o	o		o	o	●	●	●	●		
	Tip probe (yellow) with banana socket	115	WASONYEOGB1	●	●	●	o	●	o											o	o									
	Tip probe 5,5 kV (black)	116	WASONBLOGB5X5							●	●	●	●																	
	Tip probe 5,5 kV (red)	117	WASONREOGB5X5							●	●	●	●													o		o	o	
	Foldable tip probe 2m length	118	WASONSP2M	o	o	o	o	o	o											o				●	●				o	
	Soil probe 30 cm	119	WASONG30	●	●	●	o														●	●	●	o	o				o	
	Soil probe 80 cm	120	WASONG80	o	o	o	o														o	o	o						●	
	High current probe with banana socket	121	WASONSPGB1																										●	
	Temperature probe ST-1	122	WASONT1							o	o			o																
	LP-1 probe for illuminance measurement	123	WAADALP1KPL	o																										
	LP-10A probe for illuminance measurement	124	WAADALP10AKPL	o																										
	LP-10B probe for illuminance measurement	125	WAADALP10BKPL	o																										
	PRS-1 probe	126	WASONPRS1PL	o	o	o				o	o	o	o	o	o	o	o	o												

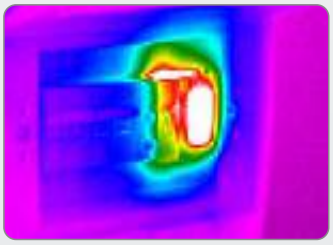
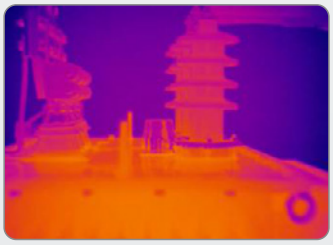
● standard accessories of the meters ○ additional accessories

NON-CONTACT TEMPERATURE MEASUREMENTS

Thermal imaging is a visualization process based on measurement of infrared radiation intensity (heat emitted by the objects) that provides images. Such an image obtained without the contact allows detailed assessment of the temperature distribution on the surface under examination.
This is important for measuring temperature in hard-to-access and hazardous places, and also allows for quick measurement of temperature on arbitrary size surfaces, or for locating invisible with bare eye points of heat escape, related to building insulation defects and faults made during construction – such as thermal bridges.

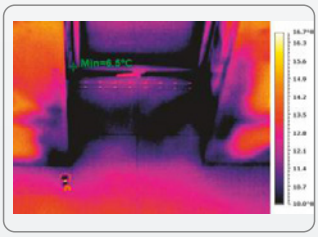
Thermal imaging analysis employs an image of infrared radiation from the object obtained in order to determine surface temperature. Every object with temperature higher than absolute zero emits heat radiation of similar characteristic to black body radiation. By measuring the heat radiation and knowing the emissivity coefficient of a given object its temperature can be measured.
Professional radiometric thermal imagers record temperature separately for each point (pixel) of an image. E.g. in the case of a 2D (two dimensional) detector of 384 pixels x 288 pixels, temperature is recorded simultaneously for each one of 110592 points. This allows for detailed (spacially resolved) analysis of recorded thermal images, that are colour coded with various palettes for easier and quick interpretation.



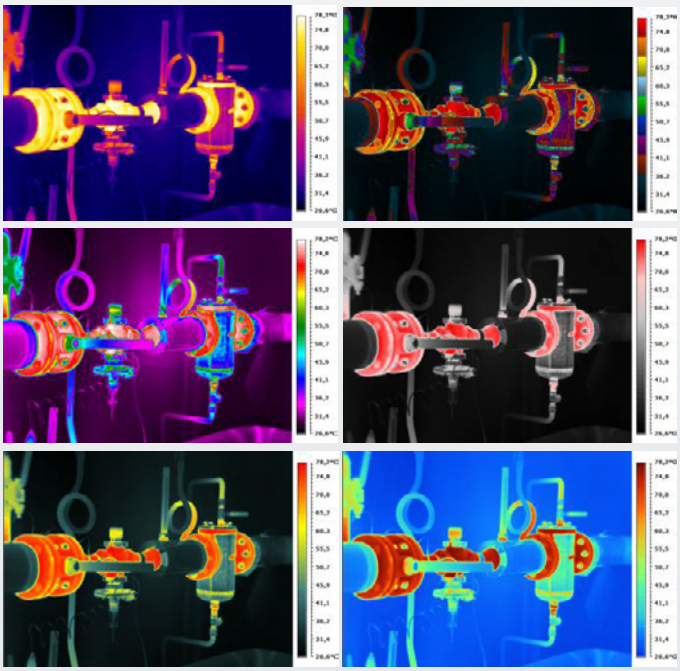



All information recorded in a thermal image can be processed by specialised software bundled with the thermal imager. The analysis of a thermal image allows for finding points of minimal or maximal temperature, correcting emissivity coefficient for a part or the entire thermal image, reading temperature at any point of the image, calculating mean temperature, presenting the distribution of temperature with histograms or isotherms, merging thermal and visual image (just like on the camera screen) in order to precisely locate spots of specified temperature, or changing colour palette to any other in order to better reflect the distribution of temperature.

A very useful function of thermal imagers is the capability of capturing visual and thermal images at the same time, what allows for displaying two merged images on top of each other using specialized alogorithm.




A thermal image is presented on the screen with the use of a user-selected palette, allowing for the best reflection of individual temperature ranges:



Pyrometers also are devices used for non-contact measurement of temperature, and employing the analysis of thermal radiation emitted by an object under examination. These devices are used for remote measurement of temperature of a given object, where temperature distribution in a given spot is averaged out to give mean value.

In the case of a pyrometer, the key factors are: measured temperature ranges, accuracy, and the ratio of distance and the spot size at this distance.
The narrower the beam, the smaller spot at the given distance, and the smaller objects can be measured remotely.




Thermal imagers

KT-670, KT-650, KT-560

Index: WMXXKT670
WMXXKT650
WMXXKT560

HD Thermal Resolution 640x480

InfraFusion

IP 54

WiFi

TOUCH SCREEN

Technical data

Model	KT-560	KT-650	KT-670
Detector type	400x300	640x480	
Spectral range	8 to 14um		
Thermal sensitivity	50mk	40mk	30mk
Lens (FOV / focal length)	22.6°*17.1°25mm (optional: 42.1°*32.2°/13mm or 10.4°*7.8°/55mm)	24.6°*18.5°/25mm (optional: 45.4°*34.9°/13mm or 11.3°*8.5°/55mm)	
Display	5", 1280x720, HQ touch LCD		
Viewfinder	1280*960 LCOS		
Picture type	IR image/Visual image/PIP/MIF (combined)		
Zoom	0.1...4		0.1...10
Temperature range	Filter 1: -20°C to 150°C, Filter 2: 150°C to 800°C, Optional Filter: up to 2000°C		
Accuracy	±2°C or 2% of reading	±1°C or 1% of reading for Filter 1: -20°C to 150°C ±2°C or 2% of reading for Filter 2 or optional 2000°C Filter: 150°C to 800°C	
Image Analysis Modes	5 points, 2 lines, 5 polygons; temperature display: min, max, avg; isotherm; dew point; temperature alarm	8 points, 8 lines, 8 polygons; temperature display: min, max, avg; isotherm; dew point; temperature alarm	10 points, 10 lines, 10 polygons; temperature display: min, max, avg; isotherm; dew point; temperature alarm
Palette	8		10
Emissivity	adjustable from 0.01 to 1.00 or from the list of materials		
Measurement correction	adjustable: distance, relative humidity, ambient temperature		
File format	JPG or RAW		
Notes to pictures	Voice note (up to 60s), text, graphical		Voice note (up to 60s), text, graphical, additional visual pictures
Reports module	Reports to PDF, printing via WiFi directly from the camera, or via PC		
Video file format	H.264 (with temperature info)		
Bulit-in functions	Visual camera 5MP, LED flashlight, GPS, laser pointer, microphone, loudspeaker, digital compass, light sensor		
Wireless communication	WiFi		WiFi/Bluetooth
Interface	SD card, LAN 1 Gb/s, mini HDMI, micro USB 2.0		
Power	Li-ion battery (work time >4 hours), built-in charger, AC adapter 110-230 V, 50/60Hz		
Work temperature	-15°C...50°C		
Storage temperature	-40°C...70°C		
Humidity	10%...95%		
Shock / vibration	25G, IEC 60068-2-29/ 2G, IEC 60068-2-6		
Casing	Ip54		
Weight	1,3 kg (with battery)		

Features:

Polish manufacturer of measuring instruments introduces the new high level cameras with many usable features, matched with a wide variety of IR lenses. A fully radiometric, high resolution cameras which records temperature at each point of the image. This cameras make shooting professional IR images fast and easy as never before. Everything is closed in a durable, water and dust proof casing and is relatively small and light. Can you expect more? Yes, and Sonel gives you more. More features, options and functions (compass, GPS, IR analysing functions, Wi-Fi reports printing, others). Additionally we offer you professional and intuitive software for image analysis, editing and creating reports completly for free.

Cechy kamery:

- High resolution IR images up to 120,000 pixels (400x) and 307,200 pixels (640x480) alternative
- Visible light digital camera 5MP resolution with LED lamp provides sharp images regardless of lighting conditions
- 5 inch 720P high resolution LCD touch screen for better image clarity and easy operation
- Rotating LCD display up to 270° for easy viewing angle
- Rotating lens provides up to 70° for easy viewing angle
- 4x (10x for plus version) continuous zoom with auto/motorized focus
- Android based operation system with open platform for various APP developments and convinient program updating
- Powerful onboard analysis and reporting capabilities
- Multiple image presentation including IR visible, PIP and IR blending
- WiFi&Bluetooth wireless communication
- Optional high temperature range measuring up to 2000°C (3632°F) targeting electrical and industrial applications
- Optional 11° telephoto or 45° wide angle lens

DO YOU KNOW...

KT-670/650/560 have built-in analysis tools

Standard accessories:

- LAN cable
- HDMI cable
- AC adapter
- USB cable
- Hand strip
- Li-Ion battery
- Carrying case
- Soft carrying case
- SD memory card

Thermal imagers

KT-80

Index: WMGBKT80

UP TO 4H CONTINUOUS WORK

HIGH BRIGHTNESS LCD

IP 43

OPTION: WiFi

Features:

- Friendly UI, easy to use without training,
- Affordable as entry level diagnostic tool,
- Removable large capacity Li-ion battery,4 hour working time,
- 3,5" large screen with no image cropping, high brightness screen to show image with no detailed information lost outdoor or in highlight,
- Compact design, metal internal structure,
- Standard Micro USB interface for data transmission and charging,
- Wi-Fi connection (Optional).

Standard accessories:

- memory SD card,	**WAPOZSD1**
- power adapter 100~240V (with adapters for different sockets)	
- USB-micro USB cable,	
- DVD with Sonel ThermoAnalyze 2 software,	
- instruction manual,	
- instruction manual for Sonel ThermoAnalyze 2,	
- hand strip,	

Parameter	KT-80
Lens	8 mm
Detector type	≤ 80 x 80
Focal length / FOV	8 mm / 8,5°X 18,5°
Digital zoom	-
Palette	4
Temp. range	0°C...+350°C
Measurement parameter calibration	Emissivity adjustable (0.01-1.00)
Measurement functions	Center point temperature, area auto tracking, area auto tracking

Common features of KT-80	
File format	JPG / removable SD memory card
Spectral range	8-14 µm.
Focus	Manual
Thermal sensitivity	≤ 0.08 °C @30 °C
Interface	micro USB
Display	Hi-brightness LCD 3.5" LCD (resolution 320 x 240) Brightness adjustable
Frame	50 Hz
Accuracy	±2°C or ±2%
Battery type	3,7 V 4200 mAh Li-Ion
Charging system	In camera charging or external battery charger (option)
Power adapter	110/230 VAC, 50/60 Hz
Battery operating system	up to 4 hours
Enclosure protection	IP 43
Dimensions	103 mm x 98 mm x 258 mm
Weight	755 g
Operating temperature	-10°C...50°C
Storage temperature	-20°C...60°C
Humidity	10% to 95 without condensation
Shock	25G, IEC 68-2-29
Vibration	2G, IEC 68-2-29

DO YOU KNOW...

KT-80 have friendly UI, possible to use even without training,

DO YOU KNOW...

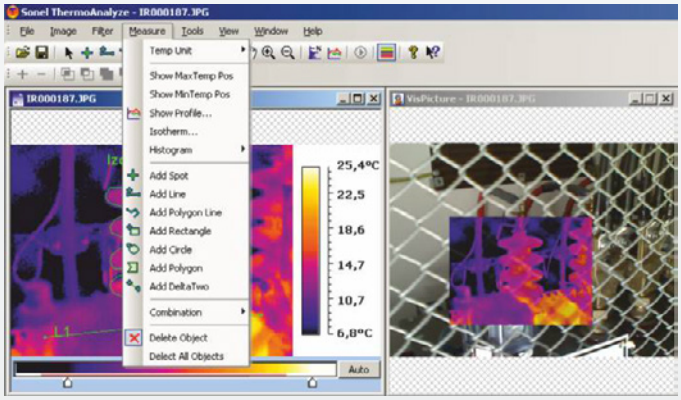
KT-80 is efficient, budget-friendly and professional infrared camera.

SONEL THERMOANALYZE SOFTWARE

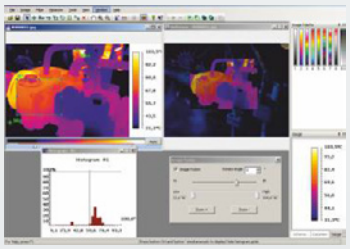
Capability of correcting emissivity coefficient for a part or the entire thermal image – the coefficient can be corrected for each selected area individually.

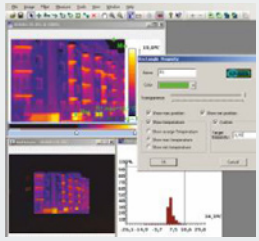
Selection of analysed areas – selecting rectangular, oval or arbitrary shape area; selecting intersection of marked areas, joining, cropping, as well as moving selection borders.

Readout of temperature in any point – moving the cursor over the "Information" window results in **continuous display of temperature and coordinates** as well as other available information (maximal temperature, humidity, emissivity).

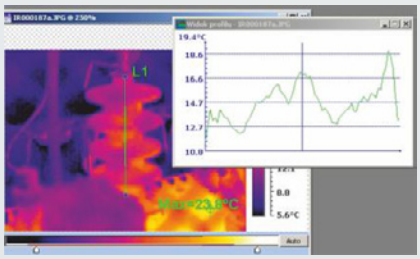


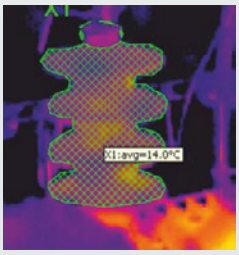
Use of the Infra Fusion technology – the thermal image is overlaid on part of the visual image in any user-selected palette. The thermal image is overlaid **with selected transparency**, allowing for optimal presentation and marking areas of interest, especially, if it is difficult to compare visually places from the thermal image with the details of the visual image of the observed object.



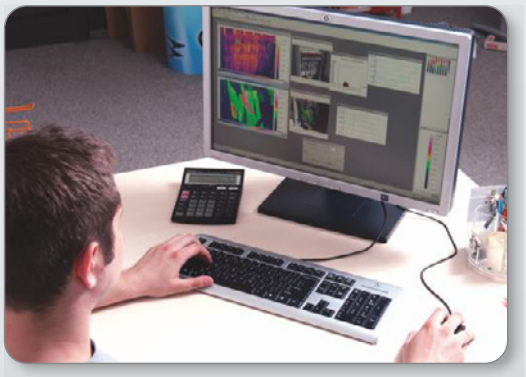


Determining and readout of minimal, maximal and mean temperature for the entire area, as well as for each selected area. Selection of a section (straight or polygonal line) for which the mean temperature can be determined, and along which the distribution of temperature profile can be automatically created.

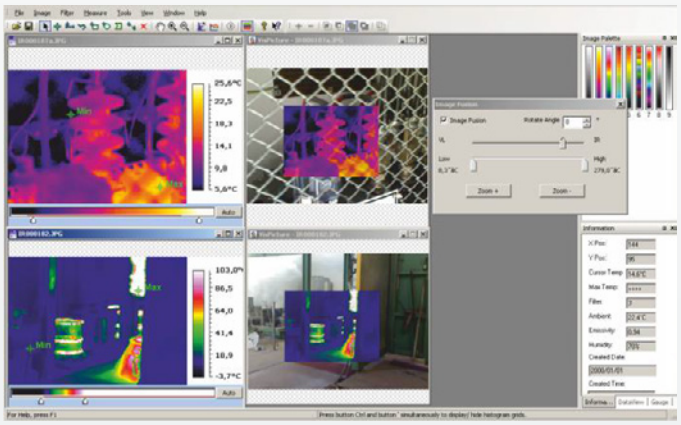




Automatic creation of a histogram for the entire image as well as for each selected area; including graphical presentation of the percent distribution of areas with temperatures falling into individual ranges.

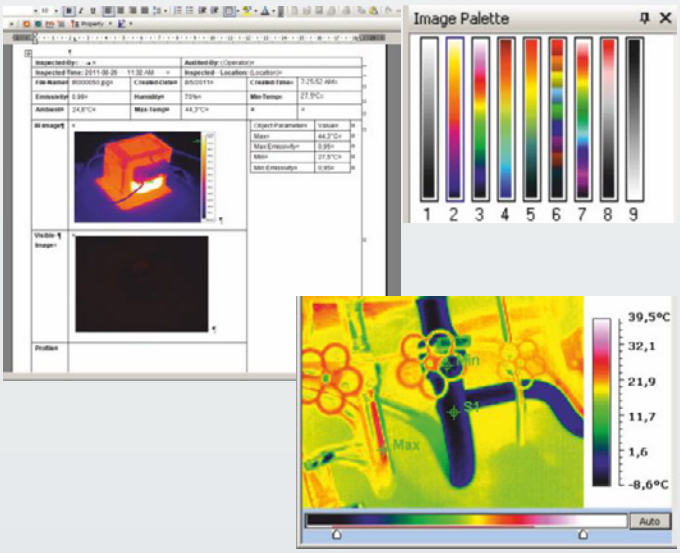


Sharpening, smoothing, averaging, edge enhancement of objects on the thermal image. Rotating or creation of mirror image.

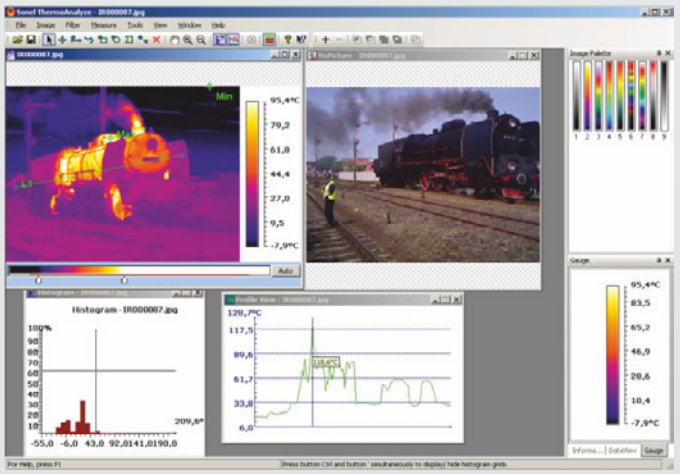


Report creation – also as an overlay for MS Word or Excel software – a report is built with simple drag-and-drop method to include all required elements **– thermal images, respective visual images, analysis results for a selected part of the entire image; histograms, etc.**

Record of all introduced corrections as well as characteristic points, in order to enable further analysis at a later time.



Selection of visually optimal colour palette (from 9 palettes available in the software) **for the best visual presentation of temperature changes**. Definition of the temperature range **for the best presentation of temperature distribution** (manual or automatic mode is available).



Pyrometers

DIT-130, DIT-500

Index: WMXXDIT130
WMXXDIT500

Measurements:

- accurate non-contact measurement of temperature,
- measurements of temperature with a **K** type probe.

Additionally:

Automatic "Data Hold" function (freezing of the displayed measurement data)
Automatic power-off.
°C/F unit switch.
Emissivity coefficient adjusted digitally within the range of 0.10 to 1.00.
Displaying maximal, minimal, mean and differential temperature.
Backlit LCD display.
Automatic selection of the measurement range.
Resolution of 0.1 °C (0.1 °F).
Measurement lock.
High and low temperature value alarm.
Fast response to changes of temperature (below 150 ms) (DIT-500).
Double laser pointer (DIT-500).
Memory (LOG) for 100 measurements (DIT-500).
Transfer of current readouts to a computer over the USB interface (DIT-500).
Memory (LOG) for 20 measurements (DIT-130).

Other technical specifications:

- display..... backlit segment LCD
- spectral sensitivity .....8~14 µm
- emissivity adjusted digitally .....from 0.10 to 1.0
- semiconductor laser diode: output < 1 mW, wavelength of 630~670 nm, class 2(II) laser
- power supply..... NEDA 1604A or IEC 6LR61 9 V alkaline battery

Nominal operating conditions:

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

DIT-130:

- indication of range exceedance: .....the display will indicate symbols "-OL", "OL"
- response time..... below 1 second
- weight .....290 g
- dimensions 190x111x48 mm

DIT-500:

- indication of range exceedance: .....the display will indicate the "---" symbol
- response time..... 150 ms
- weight .....350 g
- dimensions .....230x155x54 mm

Standard accessories of DIT-500 meter:

- 9 V battery (1 pc)	
- USB cable	**WAPRZUSBMNIB5**
- computer software for data readout and analysis	
- K type temperature probe	**WASONTEMK**
- mini tripod	**WAPOZSTATYW**
- hard case	

Standard accessories of DIT-130 meter:

- 9 V battery	
- case	
- K type temperature probe	**WASONTEMK**

Temperature range in infrared for DIT-130

Temp. range in infrared	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)

Temperature range in infrared for DIT-500

Temp. range in infrared	D:S	Resolution	Accuracy	
-50...999.9°C -58...999.9°F	50:1	0.1°C 0.1°F	-50...20°C -58...68°F	±2.5°C ±4.5°F
1000...1600°C 1000...2912°F		1°C 1°F	20...400°C 68...752°F	±(1.0% m.v. + 1°C) ±(1.0% m.v. + 1.8°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% w.m.

K probe temperature range

TK 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)

The abbreviation "D:S" indicates the spot size in relation to the distance from the examined object.
"m.v." = "measured value".

Corona camera

UV-260

Index: WMXXUV260

Standard accessories:

- AC power adapter,
- 2 pcs Li-ion battery,
- charger, SD card,
- SD card reader,
- video cable,
- car power adapter,
- software CD,
- warranty card,
- strap,
- transport case
- manual

DO YOU KNOW...

UV-260 isan innovative NDT - Non Destructive Testing equipment, that detects, pinpoints and documents flash-arc corona and arcing partial discharge camera!

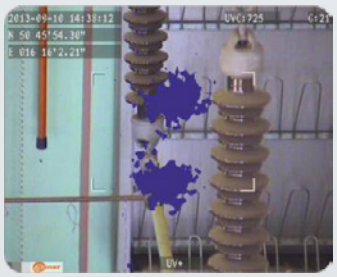
Technical data	
UV - Optical Properties	
Image Type	Monochrome video
Minimum UV Sensitivity	3 x 10-18 watt / cm2
Minimum Discharge Detection	1.5pC @ 8 meters
Spectral range	UV 240 ~ 280 nm
Field of View H x V	5.5˚ x 4.0˚
Focus	Full manual and auto for UV and visible channels
Focus distance	2 m. - ∞
Detector Life Span	No degradation
Frequency	50 Hz / 60 Hz
Visible - Optical Properties	
Image Type	Color video
UV/Visible Overlay Accuracy	Better than 1 milliradian
Minimum visible light sensitivity	0.1 lux
Zoom factor	26x optical and 12x digital
Display	
Type	5.7" VGA color LCD, folding and touchable
Video Standard	PAL/NTSC switchable
Modes	Combined (UV & visible), UV only, Visible only
Corona Shades	White, Red, Blue
Processing & Communications	
Video standard	H.264
Alarms	LED
Menu	Button operation or touchable operation
Audio	Microphone input for audio notes
GPS	Yes
Data Storage	
Storage Media	SD card
Image Format	JPG
Video Storage	AVI compressed format
Storage Capacity	8000 images, or >4 hours videos
Data download	card reader
Power system	
Power Consumption	10 W
Battery Type	Rechargeable li-ion battery (2 pcs.)
Battery Run Time	2 hours
Charge	Online charging or charger
External supply	9-12 V, 10 VA
Power adapter	110-240 VAC, 50-60 Hz/12 VDC 3.8 A
Others	
Operating temperature	-10˚C- 50˚C
Storage temnperature	-25˚C- 60˚C
Humidity	95% Non condensing
Size	238 mm x 165 mm X 91 mm
Weight	2,5 kg
Power interface	Yes
SD card slot	Yes
Video output	Yes
Audio input / output	Microphone / Headphones

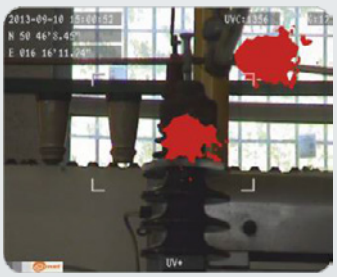
Description:

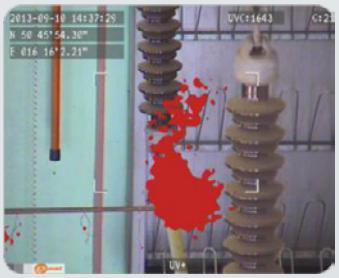
Being with high sensitivity UV-260 is a power tool to detect UV emission in full daylight with high signals from faraway and nearby sources. UV-260 is an ideal predictive maintenance device for overhead transmission lines and high voltage substations. UV-260 is newest genaration of UV imaging system with an emphasis on high performance functionality and easy operation, it is widely used in transmission line inspection, electrical utilities, HV research institutes, HV electrical component inspection, HV panal inspection, service providers, laboratories and more.

Additional features:

- high sensitivity to UV signals
- precise location of corona emitting sources
- auto focus of UV and visible channels
- background noise reduction
- 5.7" folding and touch color LCD
- voice or LED UV events alarm
- rapid optical zoom of the visible channel
- video & image capturing, recording and playback
- built-in GPS
- UV events counter
- UV-260 report software for documentation



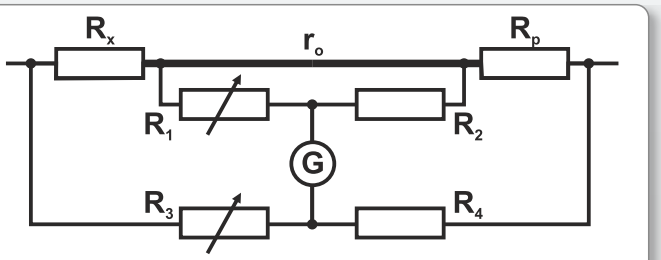




LOW RESISTANCE MEASUREMENTS

Low resistanace measurements are performed using special meters called micro-ohm-meters. Low resistance can be measured on objects such as: welded connections, equipotential bondings, joints, cable connections, low resistance coils etc. Most important feature of low resistance tests are capability of quality veryfication of conductor continuity and of all types of joints for instance welded and soldered joints. Special application of micro-ohm-meters involves winding testing of electrical equipment such as transformers and motors.

The most popular methods are: measurement with the Thomson bridge (six-arm bridge) and Technical Method. The popularity of these two methods is related to their insensitivity to the resistance of connections and test leads. Because for very small values of resistance (in the micro-ohm range), the resistance of test leads and contacts is comparable to the measured resistance. The Thomson bridge is presented in the image below. The measured resistance is Rx. All auxilary resistors except Rp have to have resistance 1000-times higher than resistance of test leads. 1000-times higher than the resistance of test leads.



Thomson bridge schematic

In the bridge balanced state, current flowing through the galvanometer (G) branch equals zero. The formula for the measured resistance is:

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

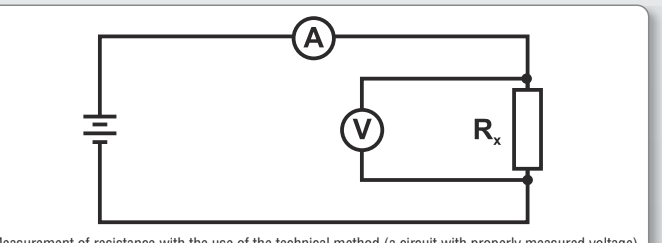
The accuracy of measurement with the Thomson bridge is affected by the insensitivity error, especially visible for small resistances $R_x = 10^{-6} .. 10^{-5}\ \Omega$. The accuracy of the measurement depends on the quality of individual resistor elements of the bridge. During the measurement, additional errors can be encountered, resulting from current overload of the tested and reference resistances, temperature changes as well as the occurrence of additional electromotive forces in the circuit.

There exist a tendency for constructing electronic resistance meters that are reliable and are capable of measuring low resistance ranging from single microohms up to higher resistance of hundred ohms. Due to flaws and limitations of the Thomson bridge, a Technical Method offers more reliable and simpler way for measuring low resistance. The instruments based on this method allow the measurement of very small resistance with the resolution as high as 0.1 uOhm.

Important features of modern microohm meters are: their ease of use, short time of measurement, insensitivity to external noise and capability of cooperation with a computer. These instruments measure resistance with the use of Technical Method, which is based on a simple circuit shown in the image below. Any conductive element can be described with the Ohm law formula:

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

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



Measurement of resistance with the use of the technical method (a circuit with properly measured voltage)

The circuit shown in the image above is used to measure low resistance R_x. The measurement of a total current is done by the ammeter and voltage drop on the resistor element Rx is measured by the voltmeter. The total curent is a sum of two currents according to the Kirchhoff's law i.e. it is the sum of the current flowing through the element and through the voltmeter $I = I_{tot} - I_v$. The resistance resulting from the measurement is calculated by the formula:

$$R_x = \frac{U_x}{I_{tot} - I_v}$$

$_{tot}$ - total current
I_v - current flowing through the voltmeter.

For a very large resistance of the voltmeter, the current flowing through it is negligible, and also the resistance of all leads connected to the resistor Rx does not affect the result of the measurement. This is the, so-called, four-lead method. Such a measurement type, eliminating the influence of test lead resistance, is employed in the MMR series of low resistance meters.

Measurements with MMR-620 and MMR-630 instruments

The application of four-lead method allows the measurement of very low values of resistance. Such method employed in our devices eliminates the influence of the resistance of test leads and the need for calibration of the meter. However the calibration capability is still available in the meters and any type of test leads can be used with the calibration procedure. It is always possible to restore factory settings and original callibration parameters.

Before starting the measurement, it is necessary to select, using the rotary switch, the maximal measurement current from the range of 0.1 mA to 10 A. The measurement range and current are selected manually or automatically. In some cases, the maximal power dissipaded in the object during the measurement can not be exceeded. In this case the upper limit for current can be set in the meters.

The instrument measures resistance by forcing a flow of current through the measured object, and simultaneously checks the voltage drop across the terminals of its voltage leads. Opening any of the circuits will be signalled appropriately, and the measurement of resistance will not be possible.

Modes of operation:

The user selects the method of measurements in one of several available modes:
- in the manual mode, each measurement must be triggered by the user with the "Start" button,
- in the automatic mode, the measurement starts when, the last test terminal is connected,
- in the continuous mode, measurements are performed cyclically every 3 seconds (resistive mode) or continuously (inductive mode).

Measurements can be performed with current flowing in one direction or with current flowing in two opposite directions. Testing with unidirectional current speeds up the measurements, whereas testing with bidirectional current allows for the elimination of errors resulting from internal voltages and electrothermal forces present in the measured object. In the case of measurement with bidirectional current, the mean value of resistance from two measurements with currents flowing in opposite directions, is displayed as the main result. Besides that, the supplementary results are displayed, i.e. the RF resistance for current flowing in the conventional "forward" direction, and the RR resistance for current flowing in the "reverse" direction.

Duration of a normal measurement is 3 seconds. In order to measure an object of inductive nature, an extended measurement time can be selected. For objects of high inductance, duration of measurement can be extended up to several minutes. The object is discharged after finishing the measurement.

It is possible to use an accelerated mode of measurement for devices of inductive nature (FAST mode), allowing for faster measurement procedure at the cost of slightly worse accuracy.

Another mode is the window mode, allowing for setting the upper and lower limits for the result. Results outside of such a range are signalled with two prolonged sound signals.

The limits of allowable result range are defined by the user.
In the case of automatic and continuous modes, exceeding the defined range causes interrupting the measurement series and awaiting user action.

Microohmmeters

MMR-650

Index: WMGBMMR650

Standard accessories of meter:

- two-wire 3m test lead (2pcs),	**WAPRZ003DZBBU1I1 / WAPRZ003DZBBU2I2**
- Kelvin's clamp (2pcs),	**WAKROKELK06**
- double pin probe (2pcs),	**WASONKEL2OGB**
- Power Cord,	**WAPRZLAD230**
- Carrying case for meter and accessories,	
- USB cable,	
- User Manual,	
- Calibration Certificate,	
- PC software (Sonel Reader).	

DO YOU KNOW...

MMR-650 enables measurement of inductive objects of amorphous core (including transformers)

Measurement of resistance

Range	Resolution	Measurement current	Accuracy
0...999,9 µΩ	0,1 µΩ	10 A (20 mV)	±(0,25% + 2 digits)
1,0000...1,9999 mΩ	0,0001 mΩ		
2,000...19,999 mΩ	0,001 mΩ	10A (200 mV)	
20,00...199,9 mΩ	0,01 mΩ	10 A/1 A (2 V/200 mV)	
200,0...999,9 mΩ	0,1 mΩ	1 A/0,1 A (2 V/200 mV)	
1,0000...1,9999 Ω	0,0001 Ω		
2,000...19,999 Ω	0,001 Ω	0,1 A (2 V)	
20,00...199,99 Ω	0,01 Ω	10 mA (2 V)	
200,0...1999,9 Ω	0,1 Ω	1 mA (2 V)	

Measurements of objects of resistance nature:

Designed to measure very low resistances of both resistive and inductive types of objects, including amorphous core transformers. This product is made for variety of applications and branches of industry e.g. power plants, railway and maintenence companies etc. The device can be used to measure welded and soldered connections, equipotential bondings, earthing conductors, contacts, bolted connections, windings of motors and power transformers and other resistive and inductive objects.

MMR-650 can be also utilized on a production lines (e.g. at the final production control stage). An innovative combination of a high-performance measuring device with a modern user interface and advanced data management system. Wireless data transmission, enhanced system of 2D codes and ability to print labels to identify test items, all contribute to bringing new quality of work and allow the user to perform a wide range of measurements.

Additional features:

- Measurement of resistive and inductive loads (including transformers with amorphous core)
- Automatic temperature compensation (temp. probe)
- Function to determine the temperature of the engine under load,
- Demagnetization of the transformer core function,
- High noise immunity,
- 4-wire measurement,
- Measuring voltage up to 10V,
- Limits and signaling setup,
- Rechargeable Li-Ion battery and mains adapter 90 - 260 VAC,
- IP54 - opened case, IP67 – closed case.
- Robust shock-resistant design of the meter,
- available printer and a 2D code reader,
- Touch screen, intuitive user interface,
- USB, WiFi, Wireless LAN (optional)
- Operating temperature -10 to + 50 ˚C,
- Category 600 V CAT III / 300 V CAT IV,
- Protection against external voltage up to 600 VDC,
- Software: Sonel PE and Sonel Reader.

Additional accessories of meter:

- Kelvin vice with 2.6m two-wire cable,	**WAZACKEL1**
- Sticker - printer ribbon SATO D2 - 100m,	**WANAKD2BAR**
- Sticker - paper tape for SATO D2 printer,	**WANAKD2**
- Portable USB report/bar code printer,	**WAADAD2**
- two-wire 10m test lead with crocodile clip,	
- two-wire 25m test lead with crocodile clip,	
- LAN cable	

CAT III 300V

IP 54

Microohmmeters

MMR-620, MMR-630

Index: WMGBMMR620 (MMR-620)
WMGBMMR630 (MMR-630)

Measurements of objects of resistance nature:

- welded and soldered connections, equipotential bondings, earthing conductors,
- contacts, railway rail joints, conductors and cables,
- measurement with the use of the four-lead method.

Measurements of objects of inductive nature:

- windings of motors, transformers, low-resistance coils.

Additionally:

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

Selection of measurement mode adapted to the type of the measured object:
- fast measurement (3 seconds), for measuring objects of resistance nature,
- extended measurement for measuring objects of inductive nature (a shorter mode with slightly limited accuracy is available); including automatic discharge after the measurement.

Choice of measurement mode depending on application (e.g. inspection of series of products):
- measurement in normal mode - triggered after pressing the "START" button,
- measurement in automatic mode - the instrument awaits for connecting all four test leads to the object, and then automatically starts measurement with current flow in one or two directions, and calculates the mean value of resistance,
- measurement in continuous mode - every 3 seconds, the meter repeats measurement cycles with pauses (for objects of resistive nature), or performs continuous measurement (for objects of inductive nature).

Window mode:
- allows for setting the upper and lower limits for the measurement result; exceedance of such a range is signalled acoustically.

Capability of performing measurements with interferences of values even five times higher than the measured signal.

DO YOU KNOW...

MMR series microohmmeters allow for accurate measurements of resistance of electric motor and power transformer windings.

MMR series meet the requirements set forth by the standards:

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

Standard accessories of meters:

- Test lead 3m ("U1/I1")	**WAPRZ003DZBBU1I1**
- Test lead 3m ("U2/I2")	**WAPRZ003DZBBU2I2**
- "Crocodile" clip K03; black (4 pcs)	**WAKROBL30K03**
- Kelvin's clamp (2 pcs)	**WAKROKELK06**
- Carrying case L1	**WAFUTL1**
- Cable for battery charger	**WAPRZLAD230**
- NiMH battery package 4,8V 3Ah	**WAAKU03**
- RS-232 serial transmission cable	**WAPRZRS232**
- Double-tip Kelvin probe with banana sockets (2 pcs)	**WASONKEL20GB**
- Hanging straps	**WAPOZSZE1**
- Calibration certificate	
- Sonel Reader software	

Measurement of resistance

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

Voltage for the full 200 mV scale except *) - 20 mV
Accuracy ±(0.25% m.v. + 2 digits), input impedance of the voltmeter: ≥ 200 kΩ
The abbreviation "m.v." stands for a "measured reference value".

Other technical specifications:

- type of insulation..... double, in acc. with EN 61010-1 and IEC 61557
- power supply of the meter..... SONEL NiMH 4.8 V battery pack
- battery charger..... built-in
- rechargeable battery charging time..... approx. 2.5 h
- number of measurements with 10 A current..... 300
- auto-off timeout..... 120 s
- immunity to interference..... additional error of 1% for voltage 50 Hz 100 mV rms
- maximal resistance of test leads for 10 A current..... 0.1 Ω
- maximal inductance of measured object..... 40 H
- accuracy of measurement current setting..... ±10%
- duration of resistance measurement:
resistive mode, with bidirectional flow of current..... 3 s
inductive mode.....up to several minutes depending on the resistance and inductance of the object
- dimensions..... 295x222x95 mm
- weight of the meter..... approx. 1.7 kg
- operating temperature..... 0...+40 °C

Additional accessories of meters:

Additional external charger **WAZASZ6**

Kelvin vice **WAZACKEL1**

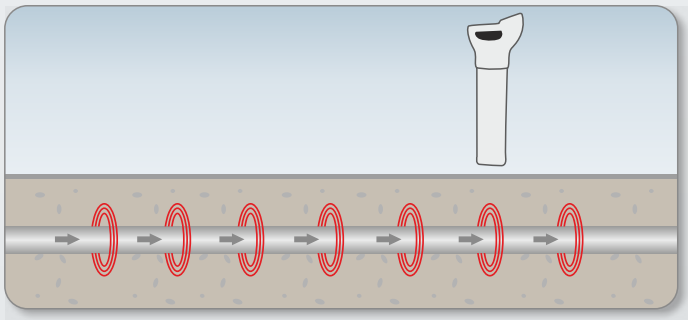
UNDERGROUND CABLE AND PIPE LOCATION

Earthworks that consist not only in various excavations but also in laying sewer pipes, water supply pipes, and cables involve a high risk of damage to underground utilities, which may result in dangerous accidents. The law require the contractor to ensure the safety of workers, third parties, and their private property. In order to limit the risk of an accident, a number of actions must be taken, which must include determination of the location of the existing underground utilities. To do so, surveyors use plans and maps so as to determine the directions of gas and water supply pipelines, as well as power and telecommunication cables. However, one can never be sure if all the underground utilities are shown on the map. In order to make sure that all potentially dangerous utilities have been identified and marked, an additional check must be performed. This can be done with cable and pipe locators.

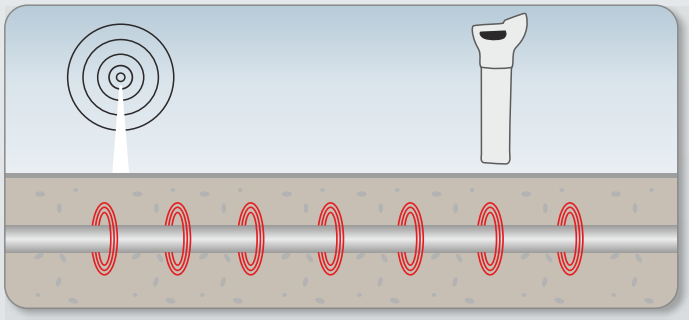
The location kit (LKZ-1000), makes possible precise determination of the depth and the directions of utilities that conduct electricity (power and telecommunication cables, metal pipes, etc.) as well as plastic and concrete pipes, using additional probes. Earthworks are conducted in difficult conditions (moisture, dirt, etc.); this is why both devices have the IP54 protection rating, and the rating of the transmitter with the cover closed is IP67.

Determination of the location and the directions of underground utilities is performed in various conditions. The locator can work in several different modes, depending on the situation:

Power – this mode is intended to determine the location of electrical cables. This is a passive mode, as the signal is generated by the live cable, without the need to activate the transmitter.



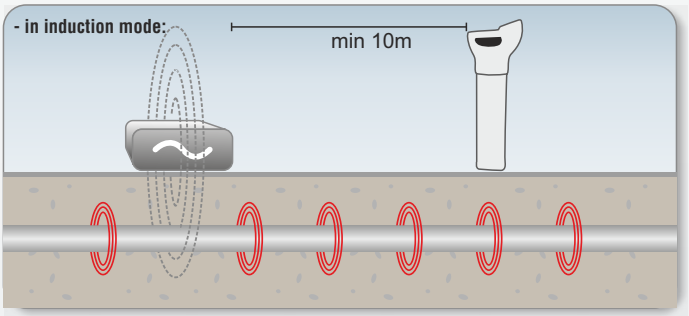
Radio – this mode is used to determine the location of metal objects (pipes, reinforcements, etc.) which re-emit radio signals. This is also a passive mode, as the signal is generated by the object which re-emits radio waves.

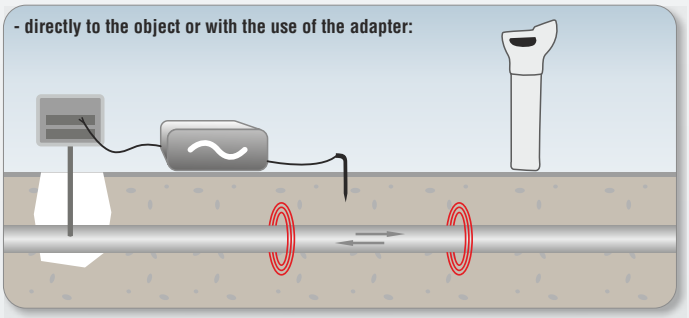


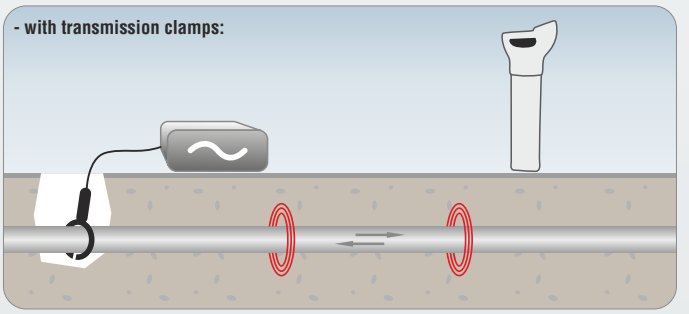
8 kHz – this mode is used for accurate determination of the location of a specific utility (cable, pipe, etc.). The frequency of the generated signal (8 kHz) ensures longer range and lower tendency for signal transmission to other objects. The method requires using the signal generating transmitter and, thus, is an active method.

33 kHz – this mode is used to determine the location of a specific utility (cable, pipe, etc.). This frequency is used the most often to determine the location of underground utilities; it provides the highest effectiveness, although it also has the greatest tendency of signal transmission to other objects. The method also requires using the signal generating transmitter and, thus, is an active method.

The LKN-1000 generator (transmitter) generates a traced signal in the utility whose direction is being determined. In active modes, depending on the situation, transmitter may be connected:







Automatic mode provides the advantages of both the Power and the Radio mode; it is very convenient for preliminary scanning of the area.

The LKZ-1000 kit also enables accuate determination of the depth of specific utilities, down to 3 m. To do so, the equipment must work in the 8 kHz or 33 kHz active modes where both the transmitter and the locator are used.

In non-conductive utilities, the signal can be generated by introducing a transmitter probe (taking the form of a rolled or "floating" cable) directly into the utility (plastic and concrete pipes, etc.). By using additional probes, one can determine not only the direction and depth of the pipes, but also the location of potential obstructions.

Thanks to its intuitive menu and clear graphic display, the LKO-1000 locator is very user-friendly. It also has a number of options and functionalities that enhance the safety and ease of work.

Wires and pipe locator

LKZ-2000

Index: WMXXLKZ2000

New model of LKZ series - more powerful, easier to use!

The complexity of large underground utilities networks is continually increasing. So obtaining precise information on the location of specific buried cables and pipes has never been so important in order to protect burried assets during ground excavation work and supporting the mapping and surveying of these existing utilities .

Sonel LKZ-2000 system has a unique flexible operating modes to help you easily decide the right mode for your locating application and site conditions. The intelligent utility locator monitors the signal interference levels in all available modes and recommends which to use for the best results.Saving you time and giving you increased confidence in your results.

The best system for most challenging conditions:

- power industry
- civil engineering and construction industries
- rail industry
- telecom industry
- gas & oil industries
- water industries

Standard accessories of LKZ-2000:

ULTRA locator bag
WAFUTL9

Additional accessories of LKZ-2000:

A frame
WAADALKZ-A

transmission clamps
WACEGN3

reeled transmission wire to locate non-metallic installations:
- 30 meters **WAPRZPN30**
- 50 meters **WAPRZPN50**
- 80 meters **WAPRZPN80**

transmission probe (8 kHz, 33 kHz)
WASONNAD1

Locator

Frequency / Mode (factory enabled): Power mode 50 Hz, 100 Hz, 450 Hz / 60 Hz, 120 Hz, 540 Hz, Radio mode 15 kHz to 60 kHz. Transmitter mode 512 Hz, 3140 Hz, 8192 Hz, 32768 Hz and 83.1kHz (22 frequencies user configurable)
Antenna configurations: Single peak, twin peak, null, total signal or left/right (cable only)
Depth: Power to 3 m (10 ft.), Radio to 2 m (6 ft.), Transmitter modes to 4.6 m (15 ft.), Sonde to 6 m (20 ft.)
Depth Estimation: 5% of depth in line or sonde (0.2 m to 4.6 m depth range), 10% of depth sonde 4.6 m to 6 m.
Bluetooth: For remote control transmitte
Battery type: 2 x LR20
Battery life: 60 hours intermittent use (at 20˚C / 68˚F)
Auto-off: Selectable after 5, 10, 20 or 30 minutes
Operating temperature range: -20˚C to 50˚C (-4˚F to 122˚F)
Dimensions: 700 mm (H) x 325 mm (L) x 122 mm (W) (27"" H x 1.8'' L x 4.8'' W
Weight: 2.18 kg (94.8 lbs) including batteries
IP rating: IP65

DO YOU KNOW...

Allows for remote control of the transmitter from locator, saving a time and improving operating.

Transmitter

Operating frequencies (factory enabled): 512 Hz, 3140 Hz, 8192 Hz, 32768 Hz, 83.1 kHz, 200 kHz (12 frequencies user configurable)
Output power control: 5 levels
Induction (max): 3 Watt
Direct connection (max): 12 Watt when connected to a buried service with an impedance of 100 Ohms
Battery type: 10 x LR20
Battery life: up to 100 hours intermittent use (level 2 output at 20˚C / 68˚F)
Shutdown: Selectable auto shutdown after 1, 2, 3, 4, 5, 6, 7, 8 hours
Operating temperature range: -20˚C to 50˚C (-4˚F to 122˚F)
Dimensions: 255 mm (H) x 190 mm (D) x 305 mm (W) - (10'' H x 12'' L x 8'' W)
Weight: 3.5 kg (8 lbs) including batteries
IP rating: IP65

DO YOU KNOW...

You can find earth return fault with additional accessories A-frame.

NEW MORE POWERFUL TRANSMITTER INCLUDED

IP 65 transmitter

IP 54 receiver

Wires and pipe locator

LKZ-1000

Index: WMXXLKZ1000

Standard accessories of the tracers:

- tracer LKO-1000	**WMXXLKO1000**
- transmitter LKN-1000	**WMXXLKN1000**
- case L6	**WAFUTL6**
- set of cables with "crocodile" clips	**WAPRZLKZ1000**
- earth contact probe	**WASONG15**
- batteries	

Smaller, more powerful, easier to use transmitter!

Improved LKN-1000 transmitter delivers significantly higher power than previous model, which allows to:
Tracking underground services over a, longer distances.
Improve service detection in areas of high signal interference.
Improve depth estimation.

Other benefits of the new transmitter:
Four adjustable output levels with maximum output level, of 1 W.
Durable waterproof design environmental protection rating of IP65.
Smaller and lighter designed to work in harsh conditions.
Choice of 3 tracing signals, 8 kHz or 33 kHz, in conductive mode 8 kHz and 33 kHz at the same time.
Clear visual and visual signals for easier operation.
In built test function – allowing operators to test the hardware and software functionality of the LKN-1000 before use.
Externally located control buttons, ensure a waterproof.

Features of the instrument:

- passive or active modes of tracing.
- detection of underground live wires.
- detection of underground wires with no voltage (radio mode).
- detection of underground wires with no voltage using a transmitter (galvanised, inductive or clamp-based connection).
- tracing metallic or non-conductive pipes using an additional probe.
- tracing non-conductive pipelines using a "floating" probe.
- tracing a determined cable.
- determining the depth of a cable.

Characteristic features:

- backlit LCD with contrast (auto on-off),
- automatic adjustment of detection sensitivity,
- 5 operating modes,
- warning about shallowly located cables,
- measuring cable locations up to 3 m deep,
- determining the direction of a cable,
- sound signals to facilitate locating or tracing,
- adjustment of power and selection of frequencies for the transmitter.

Electric security:

- LKN-1000 transmitter's protection class acc. to PN-EN 60529.....IP65 (closed cover)
- LKO-1000 tracer's protection class acc. to PN-EN 60529.....IP54

Other technical data:

- transmitter's power supply.....4 x batteries LR14
- transmitter's dimensions.....180 x 280 x 260 mm
- transmitter's weight.....<3 kg
- tracer's maximum range.....4 m
- receiver's power supply.....6 x battery LR6
- receiver's dimensions.....760 x 250 x 85 mm
- receiver's weight.....< 2.9 kg

Rated operational conditions:

- operating temperature.....-20...+50 ˚C

Operating modes:

- passive, with 50 Hz or 60 Hz – enables to locate live wires and cables (POWER):
- passive RADIO (15-30 kHz) – enables a quick, non-selective locating operation for an underground structure (metallic installations):
- active (with transmitter) (8 kHz and 33 kHz), enables:
  - a locating operation using the inductive mode (all one has to do is to place the transmitter over the object traced):
  - a locating operation through connecting the transmitter directly to an object that is not live:
  - a locating operation using transmission clamps (it is necessary to close the clamps over the object tested):
  - a locating operation using a transmission wire or transmission probes (enables to locate non-metallic objects):
  - a locating operation sing a separating adapter (connecting the transmitter LKN-1000 directly to a 230 V socket).

It also has a number of options and functionalities that enhance the safety and ease of work:

Hazard zone – generates an alarm signal that indicates close location of conduits (approx. 30 cm). It works in the Power, 8 kHz, and 33 kHz, and automatic operating modes.
Auto-test – enables a self-test of the locator. After successful completion of the test, the display shows the PAS message; otherwise, ERR is displayed.
Automatic mode – has the advantages of both simultaneous detection in the Power mode and the Radio mode, and makes it possible to confirm the presence of underground utilities in the initial stage of the test, which makes utility detection easier and safer.
Automatic illumination of the display – the light sensor automatically switches on the illumination of the display whenever it is needed.
Digital indication of signal strength – switches on the digital indication of the signal strength on the display, thus facilitating the detection of underground utilities.

DO YOU KNOW...

Automatic mode - combines the benefits of the simultaneous detection. Power and radio mode allows us to confirm the presence of underground infrastructure durning the initial location phase.

Standard accessories of LKZ-1000:

Additional accessories of LKZ-1000:

separating adapter
WAADAAS1PL ("French", Europe type)
WAADAAS1CH (Switzerland type)
WADAAS1US (US type)
WAADAAS1AU (Australian type)

transmission clamps
WACEGN2XLR

reeled transmission wire to locate non-metallic installations:
- 30 meters **WAPRZPN30**
- 50 meters **WAPRZPN50**
- 80 meters **WAPRZPN80**

transmission probe (8 kHz, 33 kHz)
WASONNAD1

WIRE AND CABLE TRACING

Often there is a need for tracing cable routes or metal elements located inside a wall or buried underground. Employing physical phenomena - propagation of an electromagnetic field - cable routes as well as locations of conductor faults (breakage, short-circuit) can be determined.

In the event of connecting a modulated signal of an alternating voltage transmitter to an open circuit, it will emit an electromagnetic field, acting as an antenna. Connecting modulated signal to a closed or energised circuit will create a magnetic field. The role of a receiver is to indicate the strength of the received signal. Based on changes of the strength of the received signal, the location of the object emitting the electromagnetic field can be determined.

The LKZ series locators are simple and handy tools, providing a wide range of capabilities, particularly in the case of the LKZ-700 model. The instrument is intended for detecting electric cables in various environments (concrete, brick, wood, soil), both live (without the need for disconnecting any devices from the tested power system) and dead. Depending on situation and thus the selected mode of operation of the transmitter and receiver, it allows for detecting elements (e.g. conductors, cables) hidden in the structure of a building or underground, to which the transmitter signal is connected. The search can be performed both in inactive and energised circuits. By selecting the level of signal from the transmitter, the location of tested conductor (cable) or its fault can be determined. Automatic selection of sensitivity of the receiver allows for maximal ease of use of the LKZ-700 locator.

Besides detecting conductors in ceilings, walls and floors, the instrument allows for locating conductor breakages, identifying circuit-breakers and fuses, locating routes of short-circuited conductors (including the location of a short-circuit), locating faults of earthing conductors, tracing routes of conductive water or central heating pipes, and identifying conductors. Tracing routes of underground cables up to the depth of 2 m is possible with the use of the special "power" mode, generating a very strong magnetic field.

The LKZ instruments consist of two devices: the transmitter and the receiver. The LKN transmitter is connected to the conductor to be located, and forces the creation of, appropriately, a magnetic or electric field around the conductor. The magnetic field is created as a result of the modulated current flow through the tested, closed circuit. The electric field is created as a result of generating a modulated voltage in the tested, open circuit.

Electromagnetic signals emitted by the transmitter are received in a manner allowing for their differentiation among other signals in the located circuit or its vicinity.

In the case of LKZ-700, the transmitter can operate in one of five sequentially changeable modes of transmission:

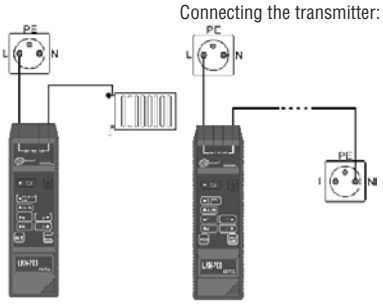
- operation in the "M" mode of generating the magnetic field component (current mode) - energised circuits;
- operation in the "E" mode of generating the electric field component (voltage mode) - non-energised, open circuits, (location of breakages, etc.);
- operation in the "E+M" current-voltage mode - non-energised, closed circuits (e.g. short-circuit) - the transmitter itself generates a current signal that creates the magnetic field component received by the receiver;
- the "AUTO" mode - the transmitter checks the tested circuit and automatically selects the mode of transmission;
- the "power" mode - the transmitter with the selected "E" voltage mode is connected to a closed, non-energised circuit. Because the current generated by the transmitter is much higher than the one in the current-voltage mode, a stronger magnetic field is created, providing significantly larger detection range.

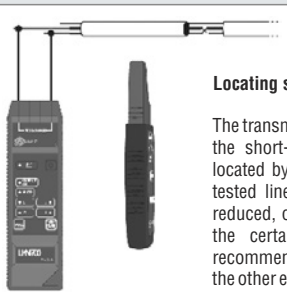
EXAMPLES OF USING LKZ-700:

Locating energised conductors.

After connecting the transmitter, the required level of signal amplification must be set. In order to avoid the compensation effect occurring with current flowing in opposite directions in two cores of the tested cable, it is necessary to use earthing from a remotely located socket, or an earthed metal central heating or water pipe.

Connecting the transmitter:



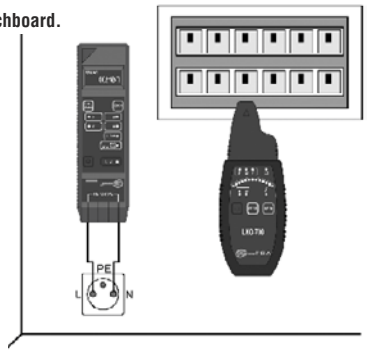


Locating short-circuits between conductors.

The transmitter must be connected to conductors where the short-circuit occurred. The short-circuit can be located by moving the head of the receiver along the tested line; the generated signal will be significantly reduced, or will cease completely. In order to improve the certainty of the short-circuit location, it is recommended to repeat this procedure, starting from the other end of the tested cable.

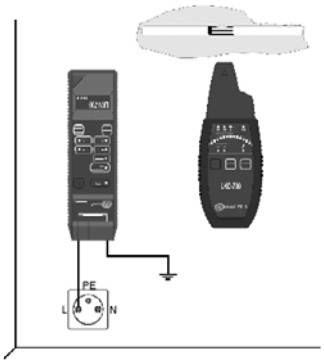
Identification of fuses in the switchboard.

The transmitter must be connected to the circuit, to which the protective device to be located is connected.
It is necessary to select the current or automatic mode, because the circuit is energised.
The desired protective device can be identified based on the maximal signal level, by moving the head from one protective device to another.



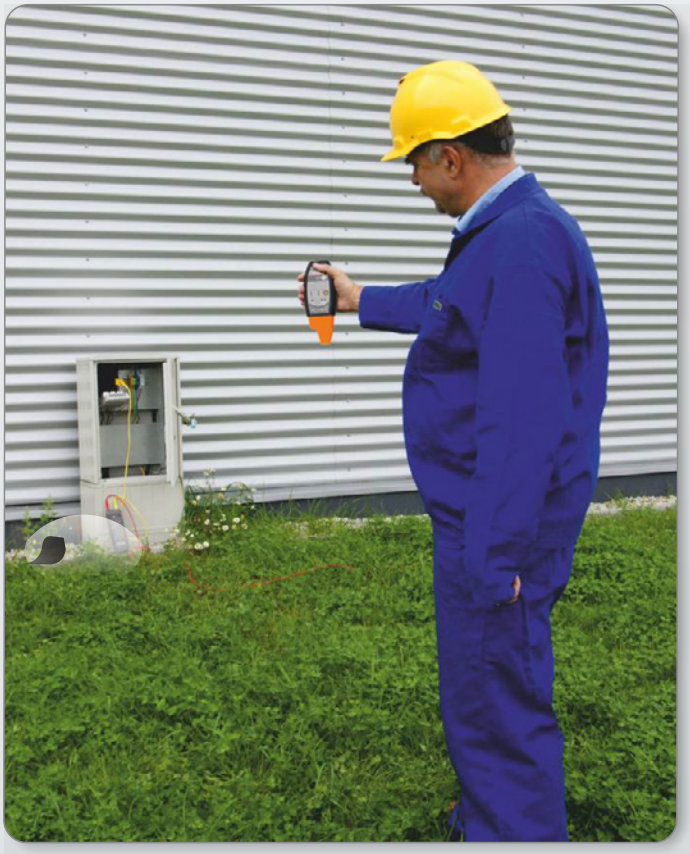
Locating breakages in conductors.

When locating breakages in conductors, one output of the transmitter must be connected to earthing, and the other to the phase conductor of the tested circuit.
The other end of the tested conductor must be connected to earthing.
Additionally, all conductors, except for the tested one, must be earthed as well, preferably on both ends, in order to prevent cross-talk between these conductors.



Tracing underground cable routes.

In the case of cables buried underground (energised or non-energised), one lead from the transmitter must be connected to separate earthing (e.g. in the form of a probe stuck in the ground), as far from the switchboard as possible, and the other lead to the PE or PEN conductor of the tested cable, and the transmitter in such a case must be set to the power mode.



Conductor and cable locators

LKZ-720

Index: WMGBLKZ720

IP 67

CAT III 600V

Detection of wires and cables (live or not):

- detection of cables in ceilings, walls and floors,
- detection of breaks in cables,
- tracing cables in building installation,
- locating power points and switches in buildings,
- locating short circuits between leads,
- tracing shielded cables,
- tracing cables in metal ducts.
- identification of fuses on the distribution board.
- tracing underground cables.
- tracing conductive water and heating pipelines.
- non-contact detection of live cables

Additionally:

- the function 3D in the receiver - detecting the direction of current flow and accurate localization of the objects,
- phase detection mode,
- receiver operation with four transmitters at the same time to locate interruptions or distinguish wires,
- a LED bright torch,
- headphone socket in the receiver,
- screens backlight for work in the dark,
- transmission battery status and settings of the transmitter and the receiver
- operation in wide range of rated voltage, up to 500V RMS,
- measurement of voltage at the object to 500 Vrms,
- three levels of transmitter amplification,
- automatic or manual selection of transmitter operation modes,
- five modes of wire tracer operation - voltage, current, current-voltage, power and clamp,
- software upgrade via USB,
- additional accessories enable precise localization - such as contact or non-contact probes and measurement clamp

Electric security:

- type of insulation.....double, according to EN 61010-1
- safety rating.....CAT III 600V acc. to EN 61010-1
- transmitter's protection class acc. to EN 60529.....IP67
- receiver's protection class acc. to EN 60529.....IP40

Other technical data:

- transmitter's power supply.....four AA alkaline battery or NiMH rechargeable battery
- transmitter's max working voltage.....500 Vrms (707 Vampl)

- receiver's power supply.....battery 9V 6LR61 alkaline
- detector's max range („I" mode).....2m
- non-contact neon max range.....20 cm (in air), 3 cm (in concrete)

Operational conditions:

- operating temperature.....-10˚C...+50˚C

Standard accessories of the tracers:

- Crocodile clip K02; red	WAKRORE20K02
- Crocodile clip K02; blue	WAKROBU20K02
- Earth contact test probe (rod); 26 cm	WASONG26
- Pin probe with banana connector - blue	WASONBUOGB1
- Pin probe with banana connector - red	WASONREOGB1
- Test lead with banana plugs; 20 m; red	WAPRZ020REBB
- Test lead with banana plug; 1.2 m; red	WAPRZ1X2REBB
- Test lead with banana plug; 1.2 m; blue	WAPRZ1X2BUBB
- Carrying case M6	WAFUTM6

LKZ-720:

Conductor and cable locators

LKZ-700

Index: WMGBLKZ700

CAT III 300V

IP 40

Locator:

Location of live as well as non-energised conductors and cables:

- detection of conductors in ceilings, walls and floors,
- location of breakages in conductors,
- tracing installation routes in an entire building,
- detection of sockets and switches in the installation of a building,
- location of short-circuits between conductors,
- tracing routes of shielded cables,
- tracing routes of conductors laid in metal pipes,
- identification of fuses in a switchboard,
- tracing underground cable routes,
- tracing routes of conductive water or central heating pipes,
- non-contact detection of energised conductors.

Additionally:

- signalling operation of the transmitter and receiver with acoustic signals,
- indication of the received signal level on a multi-point light bar of the receiver as well as with acoustic signals,
- operation in a wide range of rated voltages up to 500 V RMS,
- three levels of transmitter signal amplification,
- automatic or manual selection of the mode of operation of the transmitter,
- automatic selection of the indication range of the receiver - the ZOOM function,
- four modes of operation of the locator: voltage, current, current-voltage and power + Auto mode,
- transmitter power supply from rechargeable batteries.

Nominal operating conditions:

- operating temperature..... -20...+50 °C

Other technical specifications of LKZ-700:

- type of insulation..... double, in acc. with EN 61010-1
- power supply of the transmitter.....SONEL/NiMH 9.6 V 2 Ah rechargeable battery pack
- maximal operating voltage of the transmitter.....500 Vrms (707 VP-P)
- dimensions of the transmitter.....230x67x36 mm
- weight of the transmitter.....approx. 490 g
- battery charging temperature..... 0...+40 °C
- maximal range of the locator (power mode):..... 2 m
- maximal range of the non-contact neon lamp:.....20 cm (in air), 3 cm (in concrete)
- power supply of the receiver..... 6LR61 9 V alkaline battery
- dimensions of the receiver.....210x82x24 mm
- weight of the receiver.....approx. 200 g

Standard accessories of the tracers:

- Test lead with banana plug; 1,2m; black	WAPRZ1X2BLBB
- Test lead with banana plug; 1,2m; yellow	WAPRZ1X2YEBB
- Pin probe with banana connector; yellow	WASONYEOGB1
- Pin probe with banana connector; black	WASONBLOGB1
- „Crocodile" clip K01; black	WAKROBL20K01
- "Crocodile" clip K02; yellow	WAKROYE20K02
- Carrying case M6	WAFUTM6
- Test lead on a reel with banana plugs; 20m; red	WAPRZ020REBBSZ
- Earth contact test probe (rod); 0,26m	WASONG26
- Power supply adaptor Z1, pin, 3,5mm	WAZAS3X5Z1
- NiMH battery package 9,6V 2Ah	WAAKU04
- 9 V battery (power supply of the receivers)	

DO YOU KNOW...

LKZ-700 locator allows for tracing underground cable routes (in a closed circuit) up to the depth of 2 m.

LKZ-700:

DO YOU KNOW...

In the set, an instructional video is included, allowing for easy familiarisation with the wide range of the LKZ-700 locator capabilities.

TDR cable fault locator

TDR-410

Index: WMGBTDR410

Locator

IP 54

Standard accessories:

- time-domain reflektometer TDR-410	**WMGBTDR410**
- 0,6 m double-wire lead,	**WAPRZ0X6DZBB**
- red crocodile clip,	**WAKRORE20K02**
- black crocodile clip,	**WAKROBL20K01**
- cover M-2,	**WAFUTM2**
- alkaline batteries 1.5V AA (4 pieces),	

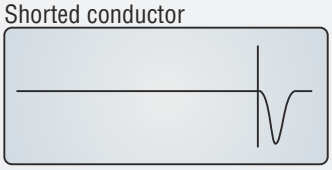
DO YOU KNOW...

TDR-410 locator allows cable testing up to length of 4 km.

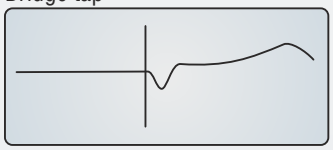
Features:

Automatic or manual mode:
- the automatic fault location (AFL),
- mode with manual range selection and sensitivity,
- single measurement triggered manually or scanning continuous.
- 11 available ranges from 7 m to 4000 m selected in manual mode or matched automatically,
- maximum length of cable up to 4000 m one end of the cable,
- "Dead zone" measure limited to 0.5 m.,
- 2.5 "LCD screen with backlight,
- scan automatically or manually trigger,
- sensitivity set manually or automatically adjusted,
- adjustable impedance matching,
- propagation coefficient adjustment 1% to 99%,
- waterproof and resistant to mechanical housing.
- small size and weight.
- economical power system - 30 hours of continuously scan on one battery set.

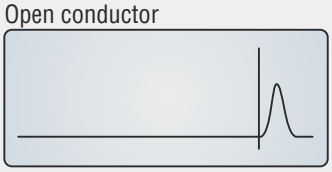
Shorted conductor



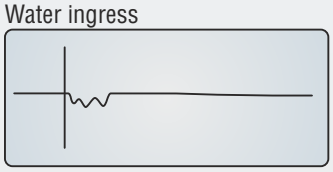
Bridge tap



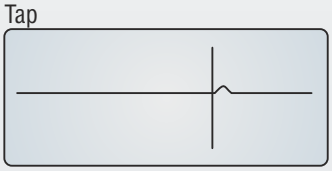
Open conductor



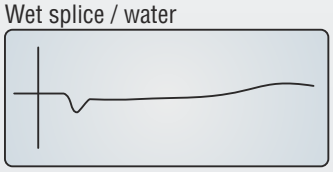
Water ingress



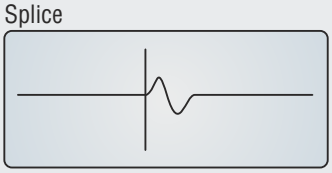
Tap



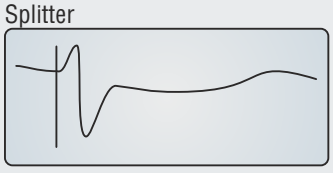
Wet splice / water



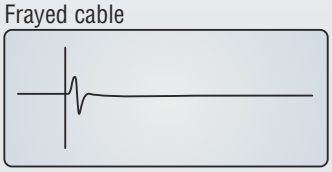
Splice



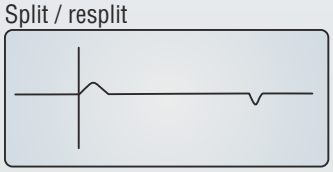
Splitter



Frayed cable



Split / resplit



Nominal operating conditions:

- operating temperature..... -10...+50 °C

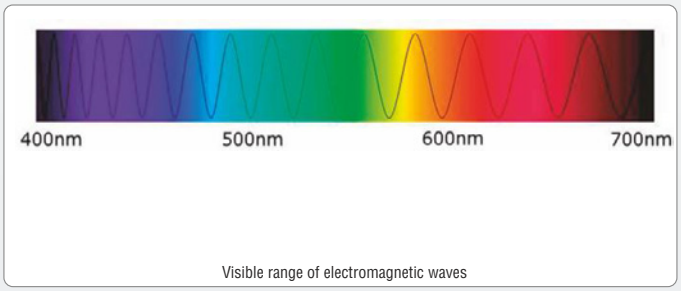
Technical specifications:

- ranges meters:.....7, 15, 30, 60, 120, 250, 500, 1 km, 2 km, 3 km, 4 km
- ranges feet.....20, 45, 90, 180, 360, 750, 1500, 3000, 6000, 10000, 14000.
- range selection .....manual range control / auto range
- accuracy..... 1% of selected range*
- resolution.....approx 1% of range
- minimum cable length.....4m (14ft)
- sensitivity.....min 3 pixel return at 4 km on 0.6mm Ø, PE, TP
- velocity factor.....adjustable from 1% to 99%
- output pulse.....5 volts peak to peak into open circuit
- output impedance.....selectable 25, 50, 75 & 100Ω
- output pulse.....width 3 ns to 3 µs, automatic with range
- scan rate.....2 scans/second or scan held, pre set for each range scale
- tone generator.....810 – 1100Hz
- battery life.....30 hours continuous scanning
- power supply.....6 volts 4 x 1.5 AA alkaline cells, on-screen low voltage indicator
- power down.....selectable 1, 2, 3, 5 minutes or disabled
- back lit display.....128 x 64 pixel
- voltage protection.....250 volts AC
- operating temp.....-10˚ - 50 ˚C
- storage temp.....-20˚ - 70 ˚C
- dimensions.....165 x 90 x 37 mm (6.5 x 3.5 x 1.5 ins)
- weight.....350 g (12oz)
- safety.....IEC 61010-1, EN 60950
- EMC..... BS/EN 61326-1
- water/dust proof.....IP54

ILLUMINANCE MEASUREMENTS

Perceptual capabilities and psycho-physical condition of a person mainly depend on the environment, to which the person is presently exposed. Light stimuli are key factors affecting psychic comfort - presence in places with artificial lighting can not only accelerate fatigue or cause the development of vision defects, but also influences the creation of other diseases, seemingly not related to the influence of light onto a human body. The possible negative impact of lighting onto a human body is particularly important in the sense of occupational safety and efficiency. Perception of light stimuli depends on individual characteristics of a given person, however it is approximately the same for different persons, and for this reason, appropriate regulations were established to regulate the required values and types of lighting in places, where persons stay and work.

The light seen by a person is an electromagnetic wave of length ranging from approx. 380 to approx. 780 nm. Human eye sensitivity is not equal in every conditions; this results from the construction and placement of receptors inside an eye and from the nature of the light itself.



Visible range of electromagnetic waves

In daylight conditions, human eye is more sensitive to green colours, whereas at night or in poor lighting, this sensitivity shifts towards blue colours (causing the subjective perception that all is grey at night) - see the drawing at the bottom of the page.

Regardless of the adaptive abilities of an eye in response to illuminance, during measurements it is required that the characteristic of the measurement corresponds to the one of an eye adapted to brightness. The spectral curve corresponding to such a sensitivity is called the V_λ photopic curve, and is useful for calculating photometric values. When establishing the criteria for selecting lighting properties, it is necessary to account for the recommendations of the International Commission on Illumination (CIE), specifying optimal conditions for illumination of spaces depending on their purpose, as well as local regulations.

The CIE recommendations specify threshold values of luminance for optimal sighting conditions, but because it is easier to measure illuminance values, the requirements are specified for this value. Additionally, the recommended uniformity ratio of illuminance in the field of view is given - i.e. how exposed can be the place with the work to be done. Excessive non-uniformity of illuminance (e.g. bare sources of light within the field of view) can cause glare which could reduce the ability to recognise details or cause the sensation of discomfort.

Uniformity ratio of illuminance should also be maintained in time due to a certain time of eye adaptation to changes. Therefore the level of light ripple and flicker is important.

The colour of light is another factor significantly influencing the comfort of persons occupying a room. Optimal lighting is the one of spectral composition as close as possible to daylight. Light sources, by colour temperature, can be categorised as warm, white and cool. For lower illuminance (up to 300...500 lx), it is recommended to use warm colour light sources.
Colour temperature can be determined based on the colour rendering index (Ra), reflecting the difference in the colour of an object illuminated with natural and tested light.
Regular incandescent light bulbs are an example of sources of relatively high value of the Ra index. In the majority of production spaces, fluorescent lamps of the Ra index value above 70 can be used. Light sources of the Ra index value below 70 (mercury-discharge lamps, sodium-discharge lamps) are used in places, where colour recognition is of secondary importance (lighting of hallways, warehouses, etc.).

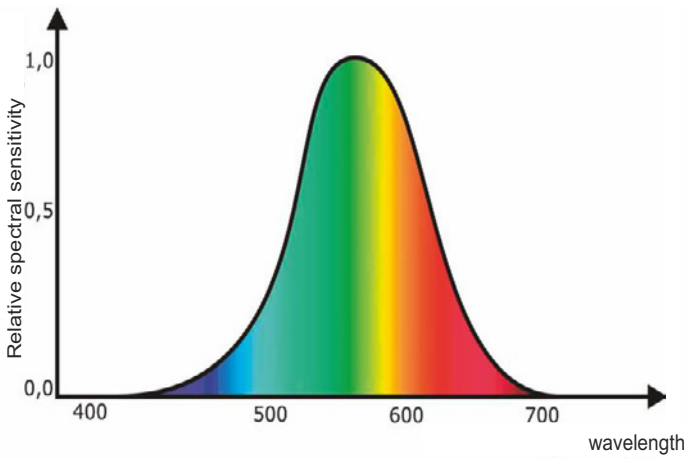
Measurements of parameters allowing for the assessment of lighting conditions should be performed at the rough-in inspection of new lighting equipment, when upgrading the existing lighting equipment as well as periodically, every 5 years. **It is recommended to carry out the measurements every 2 years, or more often**. Measurements of lighting equipment inside buildings should be performed with no outside lighting, with completely covered windows, and at night, if only possible. The silhouette of a measurement engineer cannot influence the measurement results, therefore the engineer must be in dark clothing, and assume position as far from the point of measurement as possible. An optimal meter would be the instrument allowing for as large as possible distance to its probe. The measurements should performed in working plane (e.g. on the surface of a desk), by placing the probe directly on, and in parallel to the plane. If discharge lamps are used as light sources, they should be switched on for at least half an hour before the measurement. Discharge lamps cannot be new; before measurements, they should be in operation for at least 100 hours (for regular light bulbs and halogen lighting it is only one hour, and measurements can be performed immediately after switching the lighting on).

In spaces with specific work places, metering points are specified directly on each work place (usually 4...9 points). In small rooms, the measurements are performed every 1m (a grid can be overlaid on the drawing). In the case of larger rooms, minimal quantity of metering points can be calculated for a given room, depending on its dimensions and the height at which the light sources are fixed. **Uniformity ratio of illuminance** for a given place (working plane, circulation route) can be calculated based on the measurements.

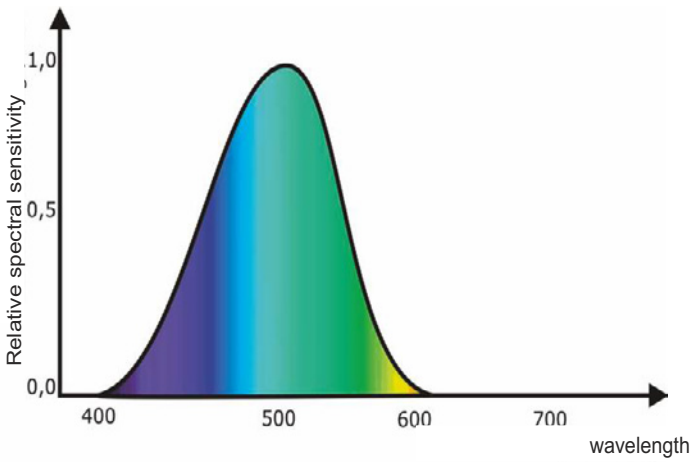
For lighting measurements of spaces with daylight, measurements must be performed, in order to determine the daylight factor value. In order to do that, simultaneous measurements with two luxmeters are performed inside and outside the spaces with window or skylight day light access (luxmeters equipped with real time clocks would be helpful, e.g. LXP-10A, LXP-10B.

During **measurements of emergency lighting**, very small values of illuminance are dealt with, and the instrument used must also be capable of measuring these values. Similar situation is in high-risk zones, where the measurement of uniformity ratio of illuminance must be performed with a very high resolution.

When choosing an instrument, it is necessary to **pay attention to its official calibration certificate, because a photovoltaic cell used as the sensor is subject to ageing**, and should be subjected to periodic metrological inspection. An instrument with a silicon cell would be a definitely better choice, because the cell requires calibration every 2 years (6 months in the case of selenium cells). The sensor must have correction for non-perpendicular, oblique light (cosine correction). **The V_λ spectral sensitivity characteristic curve** must comply with the requirements of the **CIE curve**.



Spectral sensitivity graph for day-time vision.



Spectral sensitivity graph for night-time vision.

Light meters

LXP-2 / LXP-10B / LXP-10A

Index: WMXXLXP2 / WMXXLXP10B / WMXXLXP10A

Basic features of the instrument:

- Measurement resolution 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 and fast response,
- Data-hold function for holding measuring values,
- No need for correction factors calculating for different light sources thanks to a very good fit spectral sensitivity guaranteeing the correct measurement of intensity of the illumination regardless of the nature of radiation,
- Peak-hold function for tracing the peak signal of light pulse with duration longer than 0.1 s (0.4 s for LXP-2) and less than 1 s,
- Capable of selecting measuring mode in Lux or fc scale alternatively,
- Auto power off (5,10 or 15minutes) or disable AUTO power off,
- Maximum and minimum measurements,
- Relative reading,
- Easy to read large backlit display,
- USB port for PC communication,
- Data transmission via radio connection using an optional adapter OR-1 (only LXP-10B and LXP-10A),
- four - LXP-2, five - LXP-10B and six LXP-10A measurement ranges,
- Built-in memory - 99 result for LXP-2 or 999 for LXP-10A and LXP-10B, with can be checked in the meter or PC,
- 16000 values records data logger (traceable only in PC).

DO YOU KNOW...

LXP-10B and LXP-10A enables wireless data transmission using an optional adapter (OR-1).

Other technical data:

- display.....3¾ digit LCD with high speed 40 segment bargraph
- over range indication.....„0L" displayed
- spectral response.....CIE photopic (CIE human eye response curve)
- cosine response (f2').....±3%
- sampling rate.....1,3 times/sec
- power supply.....battery 9V or rechargeable battery 8,4 V
- photo detector.....one silicon photo diode and spectral response filter
- memory.....99 results LXP-2, 999 results LXP-10A/10B
- photo detector lead length.....approx. 150 cm
- photo detector dimensions.....115 × 60 × 20 mm
- meter dimensions.....170 × 80 × 40 mm
- weight.....390 g
- data transmission.....USB cable or wireless radio interface OR-1 (LXP-10B, LXP-10A only)

Rated operational conditions:

- operating temperature.....0...50 °C
- operating relative humidity..... 0% do 80%
- storage temperature and humidity.....-20...70 °C
- storage relative humidity..... 0% do 70%

Standard accessories:

- LXP-2 or LXP-10 meter,
- measurement probe LP-1, LP-10B or LP-10A,

Warning: LP-1 probe is not compatible with LXP-10A and LXP-10B meter

- USB cable, **WAPRZUSBMNIB5**
- data CD with "Foton 2" software,
- operating manual, carrying case, 9 V battery, warranty card.

Illuminance measurement probe LP-1

Display Range [lx]	Resolution [lx]	Spectral uncertainty	Accuracy
0...399,9	0,1	f1 ≤ 6%	±(5 % + 5 digits)
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	Accuracy
0...39,9	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		

- display result in lx or fc
- meter class B

Illuminance measurement probe LP-10B

Display Range [lx]	Resolution [lx]	Spectral uncertainty	Accuracy
0...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	Accuracy
0...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		

- display result in lx or fc
- meter class B

Illuminance measurement probe LP-10A

Display Range [lx]	Resolution [lx]	Spectral 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 [fc]	Resolution [fc]	Spectral 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		

- display result in lx or fc
- meter class A

POWER QUALITY ANALYSIS

Electric energy is a product - therefore, just like other products, it should meet relevant quality requirements. In order to ensure proper operation of electrical equipment it is recommended, that the value of supply voltage (as well as other power supply parameters) is within the specified tolerance.

Formerly, the majority of loads was of linear nature, and motors without converters were used for driving machines. The few existing then non-linear loads, such as rectifier stations, electrolytic cells and induction heaters, as a rule worked in separate systems, therefore their influence onto the electric power grid was not significant. Presently, the majority of devices (in particular electronics and computers) require high quality power. Unfortunately, these devices are often the source of distortion of voltage in power systems due to drawing non-sinusoidal current at sinusoidal supply voltage. Together with the development of technology, as well as the removal of economic barriers, connected to the system were large quantities of devices processing electrical energy before its final transformation into current. Instead of building expensive mechanical gearboxes, motors are more and more often controlled with inverters, that not only allow for continuous speed adjustment, but also are easily controlled, e.g. by a process line computer.

In a household, besides light bulbs and electric kettle, there also are microwave ovens, computers and AV equipment, that draw highly-deformed current, and a phase controller can be found even in a vacuum cleaner or a kitchen mixer. In office buildings, thousands of compact fluorescent lamps draw current of deformation level exceeding 150%, and office equipment – copiers, computers, UPS – are significant sources of deformations.

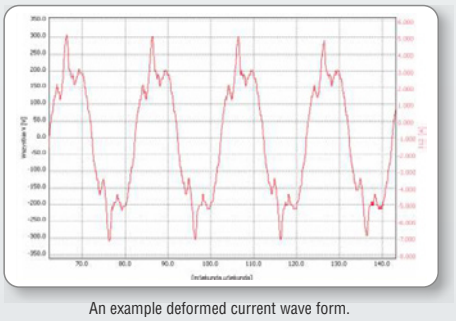
Problems caused by bad electric power quality are very serious and can make lives of electric power consumers difficult, and often cause significant material losses. Therefore maintaining satisfactory quality of electric power is of key importance. This pertains to the supplier as well as the consumer of electric power. In practice, the level of electric power quality is a compromise between the supplier and the consumer. If electric power quality is not appropriate, means of its improvement should be applied, including the performance of cost and benefit analysis. Costs of low quality electric power, most often, exceed the costs of means necessary for its improvement. Different sources report, that losses resulting from low quality electric power in the EU can sum up to even 100 billion Euro a year.

Because electric power is a specific product and cannot be easily stored for quality measurement at a later time, its measurements must be performed at the point of its consumption and at the time, when it is supplied. These measurements constitute a complex problem, because the suppliers and the consumers, whose devices are not only sensitive to bad power supply parameters, but also are sources of disturbances, have different points of view.

The PQM-701 analyzer, intended for the measurement of power quality, is adapted to both indoor and outdoor operation (IP65 protection rating, built-in heater switched on in temperatures below 0 ˚C). The capability of operation in all LV circuits (from 100 V to 690 V, 6 types of measurement clamps of various diameters and current ranging from 10 A to 3000 A) as well as with transformers, makes it a universal tool for measurements of power quality. The supplied intuitive software allows for operating the analyzer, reading out data and analysing all disturbances causing bad power quality, where the most important ones are:

Higher harmonics – caused by non-linear current consumption by devices.

From practice, it is known that harmonics of order above 20 occur very rarely, and usually have low values, therefore the EN 50160 standard specifies recording of harmonics of order up to 25. Maximal thresholds for harmonics differ (these are single percentage values - max. 6% for the fifth harmonic).

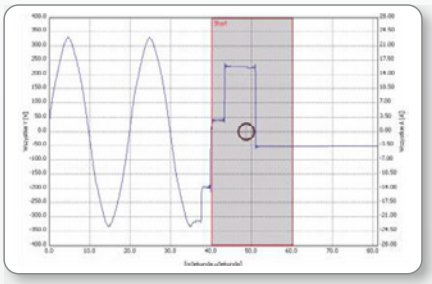


An example deformed current wave form.

Higher harmonics can cause different adverse phenomena in the power system, such as: overheating of neutral conductors, losses in transformers, damage of transformers, damage of capacitors in reactive power compensation circuits at harmonics resonance, losses in motors, faulty operation of electronic devices, including their damage.

Voltage dips, interruptions and swells – voltage dip is a drop in the voltage value within the range of 90% to 5% of rated voltage, whereas a drop below 5% is considered to be a interruption.

Swells occurs when the supply value exceeds 110% of rated voltage. Voltage dips are mainly caused by switching on high-power loads in the power system, both on the consumer side and the supplier side. This phenomenon occurs more often for higher impedance lines (e.g. villages, where overhead LV lines of small core conductor cross-sections, with simultaneous increase of consumed power). Less frequently occurring cause of dips are short-circuits in distribution and load systems.

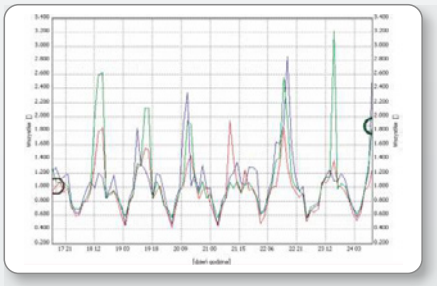


An example of voltage loss (power loss).

Voltage dips, interruptions and swells can cause many adverse effects: improper operation of electrical equipment, and - in extreme cases - their damage; light flicker; serious financial losses caused by stopped production processes.

Light flicker – a phenomenon of periodic change of luminous flux due to changes in supply voltage. Light flicker is a result of voltage drops due to connecting and disconnecting high-power loads (e.g. welders, arc furnaces, etc.).

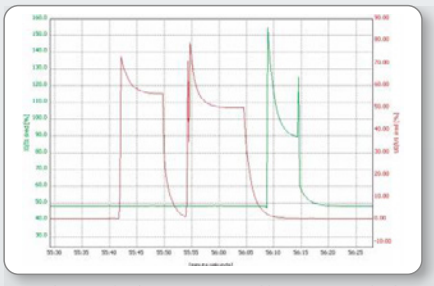
Research shows, that flicker severity is perceptible mainly at the frequency of approx. 9 changes of illuminance per second. The traditional incandescent light bulbs are the most susceptible to flicker. The fluorescent lamps exhibit the best "resistance" to flicker. On the graph presented below, it is clearly noticeable that the limit value of one is exceeded over three times in the tested system. The graph shows, that devices were switched on every day, causing too large fluctuations of supply voltage, and thus too burdensome light flicker. Light flicker phenomenon causes irritation, headaches, reduction of comfort, etc.



An example of exceeding the P_{LT} index

Power supply asymmetry – is a concept related to three-phase power systems and can be referred to the asymmetry of supply voltages, asymmetry of load currents or asymmetry of a load. Asymmetry of voltages (currents) occurs in three-phase power systems when phase voltage (current) values differ from each other and/or angles between individual phases differ from 120˚.

The most common source of asymmetry is a non-uniform load of individual phases. A good example would be connecting high single-phase loads, such as rail traction motors, to power systems.



An example of asymmetry caused by connecting a load

Asymmetry can cause adverse results, such as: difficult start-up of induction motors and faster mechanical wear, increased power losses in transmission lines and transformers.

Power quality analyzers

PQM-711 / PQM-710

Index: WMPLPQM711
WMPLPQM710

CAT III 1000V
CAT IV 600V
IP 65
GPS
GSM
WiFi

PQM-711:
TRANSIENT max. 10MHz RECORDER

HEAVY DUTY -20 °C + 55°C

Power Standards Lab PSL CLASS A IEC 61000-4-30 Edition 2 230V 50/60Hz

Standard accessories of PQM-711/710 :

- Test leads 2.2 m; 7 pcs (installed),	WAKROBL20K01
- "Crocodile" clip K01; black; 3 pcs,	WAKROYE20K02
- "Crocodile" clip K02; yellow,	WAKROBU20K02
- "Crocodile" clip K02; blue,	WAKRORE20K02
- "Crocodile" clip K02; red; 2 pcs,	WAPRZUSB
- USB cable,	WAADAAZ1
- Power supply plug (L1 and N),	WAADAAC16
- Adapter AC-16,	WAWALXL2
- heavy duty backpack for analyzer, tablet and accessories	WAPOZOPAKPL
Straps for PQM,	WAPOZUCH3
- DIN Rail Mounting Clip (ISO) (3 - elements),	WAADAM4M6
- Voltage Adapter with M4/M6 thread; 5 pcs,	WAADAUMAGKPL
- Magnetic voltage adapter; 4 pcs,	WAPOZUCH4
- Fasteners and bands for mounting the analyzer on a pole; 2 pcs,	
- Sonel Analysis software for data analysis,	
- tablet with case, power supply and USB cable,	
- Built-in rechargeable battery,	
- instruction manual, calibration certificate.	

Basic features of the instrument:

- **designed for operation in power systems of rated frequency of 50/60 Hz,**
- **designed for operation in power systems of 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, 400/690 V,
- **configurations of power systems:**
- single-phase,
- two-phase with common N conductor,
- three-phase star connection with and without the N conductor,
- three-phase delta connection,
- **power system configuration from the computer program,**
- built-in rechargeable battery (works up to 2 hours without power)

DO YOU KNOW...

PQM-711/710 has an independent power supply socket, especially suited for voltage measurements for transformers and DC circuits.

The instruments meets the requirements set forth by 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 (measurements of supply voltage)
IEC 61010-1 (safety of measurement instruments)

DO YOU KNOW...

PQM-711 allows measurement of transients up to ±6000 V with max. sampling frequency 10 Mhz.

Measured parameters:

- voltage L1, L2, L3, N-PE (5 inputs) - average, minimum, maximum and instantaneous values, range to 760 V, ability to work with voltage transformers,
- current L1, L2, L3, N (4 inputs) - average, minimum, maximum and instantaneous values, measurement current with range to 3 kA (depends on used clamp), ability to work with current transformers,
- crest factor for voltage and current,
- frequency from 40 Hz to 70 Hz ,
- active, reactive, distortion, apparent power, including the type of reactive power (capacitive, inductive),
- power recording:
  - budeanu method,
  - IEEE 1459,
- active, reactive, apparent energy,
- power factor, cosφ, tgφ,
- K factor (transformer overload caused by the harmonics),
- up to 50th harmonics for voltage and current,
- total Harmonic Distortion (THD) for voltage and current,
- short-term (P_{ST}) and long-term (P_{LT}) flicker,
- unbalance of voltage (EN 61000-4-30 class A) and current,
- current events detection including waveforms recording,
- current and voltage events recording with waveforms (up to 1s) and RMS 10 ms graphs with 30 s maximum recording time,
- current and voltage waveforms recording after each averaging period,
- mains signaling up to 3000 Hz,
- **transients up to ±6000 V with max. sampling frequency 10 Mhz,**
- **minimal transient time is 650 ns (PQM-711 only).**

DO YOU KNOW...

PQM-703/702 has built-in GSM modem and GPS module with anti-theft function. In case of changing position, meter will automaticly send text message to your mobile phone.

More parameters - see page 63

Power quality analyzers

PQM-707

Index: WMGBPQM707

NETWORK AC/DC | CAT IV 600V | IP 51 | Operation: -10...50°C | TOUCH SCREEN

Standard accessories of PQM-707 :

- test lead with banana plug 2,2 m.; black; 3 pcs	WAPRZ2X2BLBB
- test lead with banana plug; 2,2 m; blue	WAPRZ2X2BUBB
- test lead with banana plugs; 2,2m; yellow	WAPRZ2X2YEBB
- crocodile clip K01; black; 3 pcs	WAKROBL20K01
- crocodile clip K02; blue	WAKROBU20K02
- crocodile clip K02; red; 2 pcs	WAKRORE20K02
- crocodile clip K02; yellow	WAKROYE20K02
- USB transmission cable,	WAPRZUSB
- AC line splitter AC-16,	WAADAAC16
- flexible clamp F-3A; 4 pcs	WACEGF3AOKR
- adapter power supply AZ-2,	WAADAAZ2
- power supply adapter Z7,	WAZASZ7
- magnetic voltage adapter. 4 pcs	WAADAUMAGKPL
- carrying case L4,	WAFUTL4
- Sonel Analysis software for data analysis,	
- akumulator Li-Ion,	WAAKU15
- cable for battery charger	WAPRZLAD230
- car-lighter adapter (12 V),	WAPRZLAD12SAM
- touch screen stylus,	
- 4GB microSD memory card,	
- instruction manual, calibration certificate.	

Possible measurements:

- Measurements according to EN 50160,
- Voltage L1, L2, L3, N-PE (five inputs) - average, minimum, maximum values, range up to 760 V, ability to work with voltage transformers,
- Current L1, L2, L3, N (four inputs) - average, minimum, maximum values, measurement current with range up to 3 kA (depends on used clamp), ability to work with current transformers,
- Crest factor for voltage and current,
- Frequency from 40 Hz to 70 Hz ,
- Active, reactive, distortion, apparent power, including the type of reactive power (capacitive, inductive),
- Power recording: Budeanu method, IEEE 1459,
- Active, reactive, apparent energy,
- Power factor, cosφ, tgφ,
- Up to 40th harmonics for voltage and current,
- Total Harmonic Distortion (THD) for voltage and current,
- Short-term (PST) and long-term (PLT) flicker,
- Unbalance of voltage and current,
- Current and voltage events registration including waveforms and half period RMS time plots,
- Inrush current,
- Calculator of energy fee based on energy tariffs,
- Analyzer measures and records according to the IEC 61000-4-30 Class S standard.

The device is designed to work with networks:

- with nominal frequency 50/60Hz,
- with nominal voltage: 64/110 V; 110/190V; 115/200V; 127/220V; 220/380V; 230/400V; 240/415V; 254/440V; 290/500 V; 400/690V.
- DC network

Supported networks:

- single-phase,
- two-phase with common N conductor,
- three-phase star connection with and without N conductor,
- three-phase delta.

Parameters of analyzer:

Parametr		Measurement range	Max. resolution	Accuracy
Alternating voltage (TRMS)	—	0,0…760,0 V	0,01 % U_{nom}	±0,5% U_{nom}
Crest Factor	Voltage	1,00…10,00 (≤1,65 for 690 V voltage)	0,01	±5%
	Current	1,00…10,00 (≤3,6 I_{nom})	0,01	± 5% m.v.
Alternating current TRMS	—	depending on clamp*	0,01% I_{nom}	±2% m.v. for m.v. ≥ 10% I_{nom} ±2% I_{nom} for m.v. < 10% I_{nom} (error does not account for clamps error)
Frequency	—	40,00...70,00 Hz	0,01Hz	±0,05 Hz
Active, reactive, apparent and distortion power	—	depending of configuration (trasformers, clamp)	up to for decimal places	depending on configuration (transformers, clamps)
Active, reactive apparent energy	—	depending of configuration (transformers, clamp)	up to for decimal places	as power error
cosφ and power factor (PF)	—	0,00...1,00	0,01	±0,03
tg φ	—	0,00...10,00	0,01	depends on active and reactive power error
Harmonics	Voltage	as for alternating voltage True RMS	as for alternating voltage True RMS	±5% m.v. for m.v. ≥ 3% U_{nom} ±0,15% U_{nom} for m.v.. < 3% U_{nom}
		as for alternating voltage True RMS	as for alternating voltage True RMS	±5% m.v. for m.v.. ≥ 10% I_{nom} ±0,5% I_{nom} for m.v. < 10% I_{nom}
THD	Voltage	0.0...100.0% (in regards to the rms value)	0,1%	±5%
	Current			±5%
Flicker severity P_{ST}, P_{LT}	—	0,40...10,00	0,01	±10%
Voltage asymmetry	Voltage and current	0,0...10,0%	0,1%	±0,15% (absolute error)
Inrush current	—	depending on clamp*	0,01% I_{nom}	±4% m.v. for m.v. ≥ 10% I_{nom} ±4% I_{nom} for m.v. < 10% I_{nom} ($RMS_{1/2}$)

*Clamp F-1A, F-2A, F-3A: 0..3000 A (10000 A_{p-p}) *Clamp C-4A: 0..1000 A (3600 A_{p-p})*Clamp C-5A: 0..1000 A (3600 A_{p-p})*Clamp C-6A: 0..10 A (36 A_{p-p}) *Clamp C-7A: 0...100 A (360 A_{p-p})

2 YEAR WARRANTY

Power quality analyzers

PQM-703 / PQM-702

Index: WMGBPQM703
WMGBPQM702

Standard accessories of PQM-703 / 702

- Test lead with banana plug 2,2m; black (7 pcs, integrated)	
- „Crocodile" clip K01; black (3 pcs)	**WAKROBL20K01**
- "Crocodile" clip K02; yellow	**WAKROYE20K02**
- "Crocodile" clip K02; blue	**WAKROBU20K02**
- "Crocodile" clip K02; red (2 pcs)	**WAKRORE20K01**
- USB cable	**WAPRZUSB**
- Power system plug with banana inputs (L1 and N)	**WAADAAZ1**
- AC-16 adapter	**WAADAAC16**
- radio transmitter/receiver - OR1 (USB)	**WAADAUSBOR1**
- Hard carrying case	**WAWALXL2**
- Mounting strap	**WAPOZOPAKPL**
- DIN rail mounting clip (ISO) (3 pcs)	**WAPOZUCH3**
- stabilizing grips (2 pcs)	**WAPOZUCH4**
- build-in battery	**WAAKU11**
- **Sonel Analysis software for reading and analysing data (full version)**	
- calibration certificate	

DO YOU KNOW... PQM-703/702 has built-in GSM modem and GPS module with anti-theft function. In case of changing position, meter will automaticly send text message to your mobile phone.

DO YOU KNOW... PQM-703/702 has an in-build power supply adapter, especially suited for voltage measurements for transformers and DC circuits.

Basic features of the instrument:

- **designed for operation in power systems of rated frequency of 50/60 Hz,**
- **designed for operation in power systems of 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, 400/690 V,
- **types of power systems that can be measured:**
- single-phase,
- two-phase with common N conductor,
- three-phase star connection with and without the N conductor,
- three-phase delta connection,
- **configuration of the analyzer in the computer program,**
- built-in rechargeable battery (works up to 2 hours without power)

The instrument meets the requirements set forth by 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 (measurements of supply voltage)
IEC 61010-1 (safety of measurement instruments)

DO YOU KNOW... PQM-703/702 can operate in any climate conditions (- 20 ˚C ... + 55 ˚C).

DO YOU KNOW... PQM-703 allows measurement of transients up to ±6000 V.

Measured parameters (EN 61000-4-30 class A):

- L1, L2, L3, N-PE voltages (five measurement inputs) - average, minimal and maximal values, instantaneous values within the range up to 760 V, capability of cooperation with voltage transformers,
- L1, L2, L3, N currents (four measurement inputs) - average, minimal and maximal values, instantaneous values within the range up to 3 kA (depending on the measurement clamp used), capability of cooperation 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, including the specification of reactive power nature (capacitive, inductive),
- power recording:
  -the Budeanu method,
  -IEEE 1459,
- active energy (E_P), reactive energy (E_Q), apparent energy (E_S),
- power factor, cosφ, tgφ,
- K factor (transformer overload caused by 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 flicker (P_{LT}) (fulfilled EN 61000-4-15 class A requirements),
- current and voltage unbalance,
- recording of overvoltages, voltage dips and interruptions, including oscillograms,
- current and voltage event registration with waveforms (up to 1s) and RMS 10ms time plots with maximum recording time up to 5s.
- recording of current and voltage oscillograms after each averaging period.
- mains signalling up to 3000 Hz (PQM-703 only)
- transients up to ±6000 V with max. sampling frequency 10 Mhz
- minimal transient time is 650 ns (PQM-703 only).

DO YOU KNOW... The price of the instrument includes a full version of intuitive software for recording analysis results.

More parameters - see page 63

THE ANALYZERS RECORDS POWER SYSTEM PARAMETERS IN ACCORDANCE WITH THE A CLASS OF THE EN 61000-4-30 STANDARD

Power quality analyzers

PQM-701/701Z/701Zr

Index: WMGBPQM701
WMGBPQM701Z
WMGBPQM701ZR

Standard accessories of PQM-701/701Z/701Zr:

- Test lead with banana plug 2,2m; black (PQM-701 - 3 pcs, PQM-701Z (Zr) - 4 pcs)	**WAPRZ2X2BLBB**
- Test lead with banana plug 2,2m; yellow	**WAPRZ2X2YEBB**
- Test lead with banana plug 2,2m; blue (PQM-701 - 1 pcs, PQM-701Z (Zr) - 2 pcs)	**WAPRZ2X2BUBB**
- „Crocodile" clip K01; black (PQM-701 - 3 pcs, PQM-701Z (Zr) - 4 pcs)	**WAKROBL20K01**
- "Crocodile" clip K02; yellow	**WAKROYE20K02**
- "Crocodile" clip K02; blue (PQM-701 - 1 pcs, PQM-701Z (Zr) - 2 pcs)	**WAKROBU20K02**
- USB cable	**WAPRZUSB**
- Power system plug with banana inputs (L1 and N)	**WAADAAZ1**
- Receiver – interface for radio transmission OR1 (USB)	**WAADAUSBOR1**
- **Sonel Analysis software for reading and analysing data (full version)**	
- SD card	**WAPOZSD1**
- Hard carrying case	**WAWALXL1**
- Mounting strap	**WAPOZOPAKPL**
- DIN rail mounting clip (ISO) (2 pcs)	**WAPOZUCH2**
- F-3 clamp up to 3 kV AC (Ø14 cm) (4 pcs)	**WACEGF3OKR**
- Built-in rechargeable battery, calibration certificate	
- RS-232 cable (only PQM-701Zr)	**WAPRZRS232**

DO YOU KNOW...

PQM-701 series analysers are capable of recording data with half-period averaging time.

Basic features of the instrument:

- **intended for operation in power systems of rated frequency of 50/60 Hz,**
- **intended for operation in power systems of 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, 400/690 V,
- **configurations of power systems:**
- single-phase,
- two-phase with common N conductor,
- three-phase star connection with and without the N conductor,
- three-phase delta connection,
- **power system configuration from the computer program,**
- instantaneous power supply from the tested mains (all models)
- independent power supply (PQM-701Z, PQM-701Zr)
- built-in rechargeable battery (works up to 4 hours without power)

DO YOU KNOW...

PQM-701 series analyzers can operate in any climatic conditions (- 20 °C ... + 55 °C).

Measured parameters:

- L1, L2, L3, N-PE voltages (five measurement inputs, fulfilled EN 61000-4-30 class A requirements) - average, minimal and maximal values, instantaneous values within the range up to 760 V, capability of cooperation with voltage transformers,
- L1, L2, L3, N currents (four measurement inputs) - average, minimal and maximal values, instantaneous values within the range up to 3 kA (depending on the measurement clamp used), capability of cooperation with current transformers,
- crest factors for current (CFI) and voltage (CFU),
- frequency within the range of 40 Hz – 70 Hz (fulfilled EN 61000-4-30 class A requirements),
- active power (P), reactive power (Q), distortion power (D), apparent power, including the specification of reactive power nature (capacitive, inductive),
- power recording:
  -the Budeanu method,
  -IEEE 1459,
- active energy (E_P), reactive energy (E_Q), apparent energy (E_S),
- power factor, cosφ, tgφ,
- K factor (transformer overload caused by harmonics),
- harmonics up to the 50th in voltage and current (fulfilled EN 61000-4-7 class I requirements),
- total harmonic distortion (THD) for current and voltage,
- short-term (P_{ST}) and long-term flicker severity (P_{LT}) (fulfilled EN 61000-4-15 class A requirements),
- current and voltage unbalance (compiles with EN 61000-4-30 class A requirements),
- recording of overvoltages, voltage dips and interruptions, including oscillograms (fulfilled EN 61000-4-30 class A requirements),
- recording of events for current, including oscillograms,
- recording of current and voltage oscillograms after each averaging period.

DO YOU KNOW...

The PQM-701 series analyzers allows for quick readout of data recorded on a SD card.

DO YOU KNOW...

The price of the instruments includes a full version of intuitive software for recording results analysis.

The instruments meets the requirements set forth by 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 (measurements of supply voltage)
IEC 61010-1 (safety of measurement instruments)

DO YOU KNOW...

PQM-701Z/701Zr have an independent power supply socket, especially suited for voltage measurements for transformers and DC circuits.

2 YEAR WARRANTY

Parameters of analyzers PQM-711, PQM-710, PQM-703, PQM-702, PQM-701, PQM-701Z, PQM-701Zr:

Parameter		Measurement range	Max. resolution	Accuracy
Alternating voltage (TRMS)	—	0.0…760.0V	0.01 % U_n	±0.1% U_n
Crest factor	Voltage	1.00…10.00 (≤1.65 for 690 V voltage)	0.01	±5%
	current	1.00…10.00 (≤3,6 I_{nom})	0.01	± 5% m.v.
Alternating current 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	0.01Hz	±0.01 Hz
Active, reactive, apparent and distortion power	—	depending on configuration (transformers, clamp)	up to four decimal places	depending on configuration (transformers, clamp)
Active, reactive apparent energy	—	depending on configuration (transformers, clamp)	up to four decimal places	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 active and reactive power error
Harmonics and interharmonics - PQM-702 only	Voltage	as for alternating voltage True RMS	as for alternating voltage True RMS	±5% U_h for U_h<1% U_n ±0.05% U_n for U_h<1% U_n
	Current	as for alternating voltage True RMS	as for alternating voltage True RMS	± 5% I_h forI_h<3% I_n ± 0.15% I_h for I_h<3% I_n
THD	Voltage	0.0..100.0% (in regards to the rms value)	0.1%	±5%
	Current			±5%
Active and reactive power of harmonics	—	depending on configuration (transformers, clamp)	depending on minimal 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 severity P_{ST}, P_{LT}	—	0.20...10.00	0.01	±5%
Voltage unbalance	Voltage and current	0.0...20.0%	0.1%	±0.15% (absolute error)
Mains signalling (PQM-703 only)	Voltage	5...3000 Hz	0.01HZ	±0.15% U_h for 1...3% U_n, 5% U_n for 3...15% U_h
Transients (PQM-703 only)		±6000 V	5 V	±(5% + 25 V)

*Clamp F-1A, F-2A, F-3A:0..3000A (10000A_{p-p}) *Clamp C-4A: 0..1000A (3600A_{p-p})*Clamp C-5A: 0..1000A (3600A_{p-p})*Clamp CA-6: 0..10A (36A_{p-p}) (without current transformers)

Additional accesories for analyzers:

Clamp	C-4A	C-5A	C-6A	C-7A	F-1A	F-2A	F-3A
INDEX	WACEGC40KR	WACEGC50KR	WACEGC60KR	WACEGC70KR	WACEGF10KR	WACEGF20KR	WACEGF30KR
Rated current	1000A AC	1000A AC 1400A DC	10A AC	100 A AC	3000A AC		
Max. overload current	1200A AC	1000A AC 3000A DC	20A AC	100 A AC	10kA AC		
Minimal measurable current	100mA	500mA	10mA	20 mA	1A		
Frequency	30Hz…10kHz	DC…5kHz	40Hz…10kHz	40 Hz…1 kHz	40Hz…10kHz		
Input signal level	1mV / 1A	1mV / 1A	100mV / 1A	500 mV / 1A	38.8µV / 1A		
Max. diameter of measured cord	52mm	39mm	20mm	24 mm	360mm	235mm	120mm
Minimal basic accuracy	≤0.5%	≤1.5%	≤1%	0,5%	1%		
Battery power supply	—	+	—	—	—		
Lead length	2.2m	2.2m	2.2m	3 m	2.2m		
Measurement category	IV 300V	IV 300V	IV 300V	III 300 V	IV 600V		
Protection class	IP 40	IP 40	IP 40	IP 40	IP 67		

- C-4 clamp up to 1000 A AC	**WACEGC40KR**
- C-5 clamp up to 1000 A AC/DC	**WACEGC50KR**
- C-6 clamp up to 10 A AC	**WACEGC60KR**
- C-7 clamp up to 100 A AC	**WACEGC70KR**
- F-1 clamp up to 3 kA AC (Ø38 cm)	**WACEGF10KR**
- F-2 clamp up to 3 kA AC (Ø25 cm)	**WACEGF20KR**
- GPS antenna with 10 m cord (PQM-702)	**WAPOZANT10GPS**
- rechargeable battery (replaceable in the SONEL service shop)	**WAAKU09**
- hard case for clamps	**WAWALL2**

Power quality analyzer

PQM-700

Index: WMGBPQM700

Operation:
-20...55°C
CAT IV
300V
IP 65

Standard accessories of PQM-700:

- Test lead with banana plug 2,2m; black (7 pcs, integrated)	
- „Crocodile" clip K01; black (3 pcs)	**WAKROBL20K01**
- "Crocodile" clip K02; blue	**WAKROBU20K02**
- "Crocodile" clip K02; red (2 pcs)	**WAKRORE20K02**
- USB cable	**WAPRZUSB**
- Power system plug with banana inputs (L1 and N)	**WAADAAZ1**
- Carrying case	**WAFUTL5**
- Mounting strap (2 pcs)	**WAPOZOPAKPL**
- DIN rail mounting clip (ISO) (3 pcs)	**WAPOZUCH3**
- stabilizing grips (2 pcs)	**WAPOZUCH4**
- build-in battery	
- **Sonel Analysis software for reading and analysing data - full version**	
- calibration certificate	

DO YOU KNOW...

PQM-700 has an in-build power supply adapter, especially suited for voltage measurements for transformers and DC circuits.

The instrument meets the requirements set forth by the standards:

EN 61000-4-30 (class S) (electromagnetic compatibility - measurement methods)
EN 61000-4-7 (class I) (measurements of harmonics)
EN 61000-4-15 (light flicker)
EN 50160 (measurements of supply voltage)
IEC 61010-1 (safety of measurement instruments)

DO YOU KNOW...

PQM-700 can operate in harsh climate conditions (- 20 °C ... + 55 °C).

Basic features of the instrument:

- **intended for operation in power systems of rated frequency of 50/60 Hz,**
- **intended for operation in power systems of rated voltages:** 64/110 V; 110/190V; 115/200V; 127/220V; 220/380V; 230/400V; 240/415V; 254/440V; 290/500 V; 400/690V.
- **types of power systems that can be measured:**
- single-phase,
- two-phase with common N conductor,
- three-phase star connection with and without the N conductor,
- three-phase delta connection,
- **configuration of the analyzer in the computer program,**
- built-in rechargeable battery.

Measured parameters:

• Voltage L1, L2, L3:
- average, minimum, maximum and instantaneous values, range to 760 V, ability to work with voltage transformers,
• Current L1, L2, L3, N (four inputs):
- average, minimum, maximum and instantaneous values, measurement current with range to 3 kA (depends on used clamp), ability to work with current transformers,
• Crest factor for voltage and current,
• Frequency from 40 Hz to 70 Hz ,
• Active, reactive, distortion, apparent power, including the type of reactive power (capacitive, inductive),
• Power recording:
- Budeanu method,
- IEEE 1459,
• Active, reactive, apparent energy,
• Power factor, cosΦ, tgΦ,
• Up to 40th harmonics for voltage and current,
• Total Harmonic Distortion (THD) for voltage and current,
• Short-term (PST) and long-term (PLT) flicker,
• Unbalance of voltage and current,
• Current events detection including waveforms recording,

DO YOU KNOW...

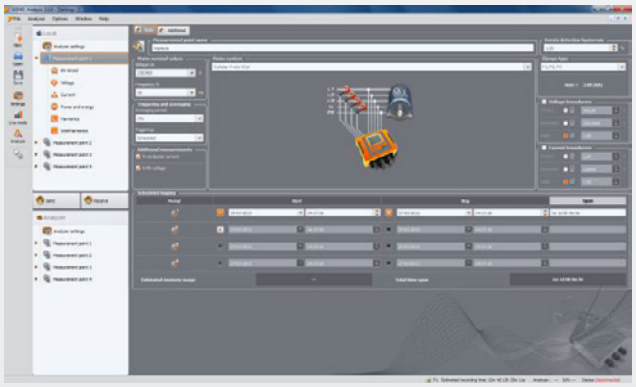
The price of the instrument include a full version of intuitive software for analysis of measurement results.

Parameters of analyzer PQM-700:

Parameter		Measurement range	Max. resolution	Accuracy
Alternating voltage (TRMS)	—	0.0…760 V	0.01 % U_n	±0.5% U_n
Crest factor	Voltage	1.00…10.00 (≤1.65 for 690 V voltage)	0.01	±5%
	current	1.00…10.00 (≤3,6 I_{nom})	0.01	± 5% m.v.
Alternating current 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 (transformers, clamp)	up to four decimal places	depending on configuration (transformers, clamp)
Active, reactive apparent energy	—	depending on configuration (transformers, clamp)	up to four decimal places	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 active and reactive power error
Harmonics	Voltage	as for alternating voltage True RMS	as for alternating voltage True RMS	±5% U_h for U_h≥1% U_n ±0.05% U_n for U_h<1% U_n
	Current	as for alternating voltage True RMS	as for alternating voltage True RMS	± 5% I_h for I_h≥3% I_n ± 0.15% I_n for I_h<3% I_n
THD	Voltage	0.0..100.0% (in regards to the rms value)	0.1%	±5%
	Current			±5%
Flicker severity P_{ST}, P_{LT}	—	0.40...10.00	0.01	±10%
Voltage asymmetry	Voltage and current	0.0...10.0%	0.1%	±0.3% (absolute error)

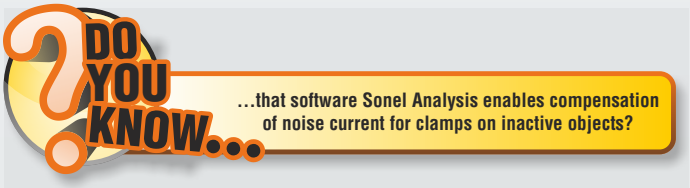
*Clamp F-1A, F-2A, F-3A:0..3000A (10000A_{p-p}) *Clamp C-4A: 0..1000A (3600A_{p-p})*Clamp C-5A: 0..1000A (3600A_{p-p})*Clamp C-6A: 0..10A (36A_{p-p}) (without current transformers) Clamp C-7A: 0...100 A (360A_{p-p})

SONEL ANALYSIS SOFTWARE



The SONEL Analysis software is necessary for working with the PQM series analyzers and is supplied as standard accessory.

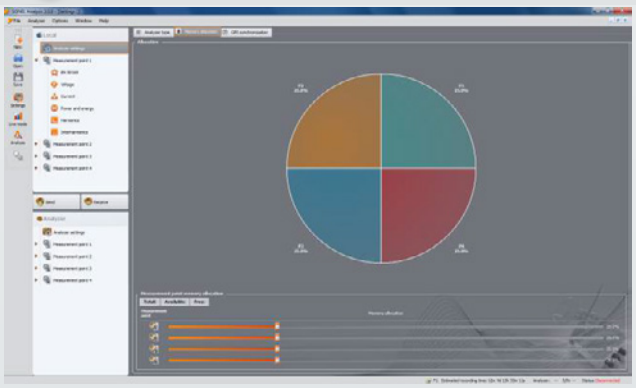
It allows for:
- configuring the analyzer,
- reading data from the recorder,
- viewing real time parameters of a power system (the ability to read data through GPRS modem),
- erasing data in the analyzer,
- presenting data in tables,
- presenting data as graphs,
- analysing data in compliance with the EN 50160 standard (reports) and other user-defined reference conditions,
- independent operation with multiple analyzers,
- updating to the latest versions through a WWW page.



Configuration of the analyzer

The program allows for configuring all key parameters of the analyzer. The configuration is prepared on a computer, and then transferred to the analyzer. The configuration can also be saved on the HDD/PC or other data media, in order to be used at a later time.

The software allows for:
- selecting Metering Points as well as arbitrarily assigning memory for individual Measurement Points,
- setting the time of analyzer,
- enabling button lock,
- protecting the analyzer with a PIN code to prevent unauthorised access,
- setting averaging time,
- selecting current and voltage transformers,
- selecting the triggering mode (instantaneous, after the occurrence of an event or in accordance with the defined time schedule),
- selecting clamp type, specifying whether the analyzer has to record additional parameters in N and PE channels,



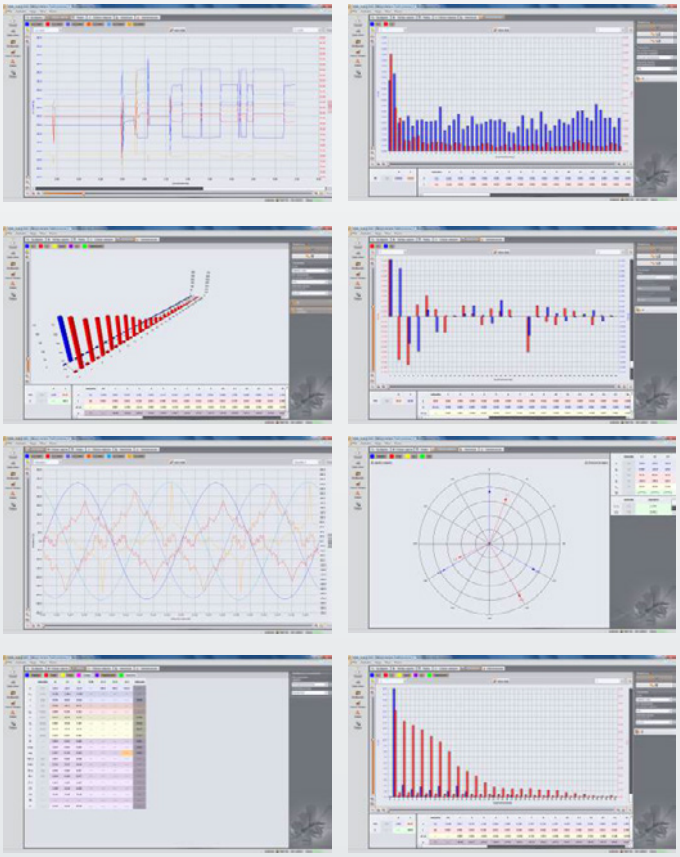
The analyzer has four independent measurement points. Each Measurement Point can be configured separately, to later carry out four different recordings without the need for reprogramming the analyzer.

The following can be configured for each Measurement Point:
- whether the analyzer has to perform recording for compliance with the EN 50160 standard or in accordance with arbitrary user-defined parameters,
- for arbitrary recording, the user can specify the parameters to be recorded by the analyzer (switch on or off),
- for individual parameters, the user can define, whether the recorder should record instantaneous, mean, maximal or minimal values,
- thresholds can be defined for almost all parameters, to trigger recording of an event by the analyzer.

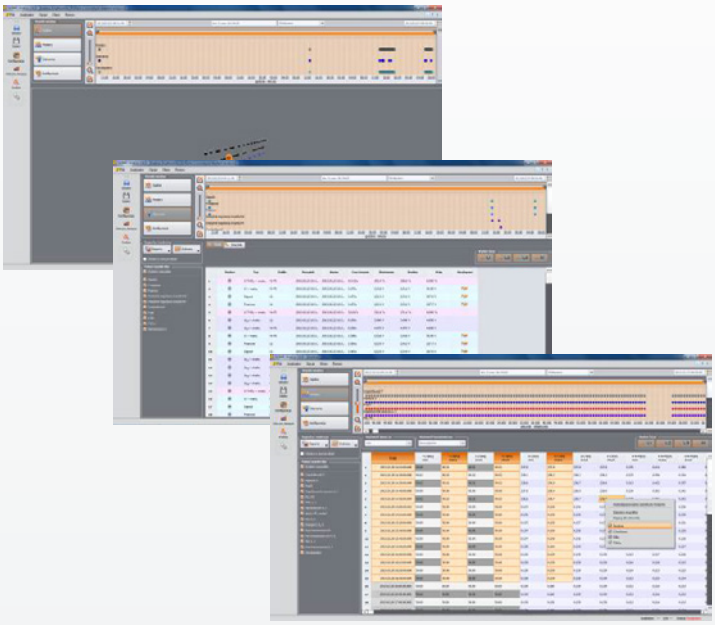
Readout of instantaneous data (live mode)
The Sonel Analysis software allows for reading selected parameters and their graphical presentation on a computer screen in real time. These parameters are independent from recording data to the memory card.

The user can view:
- voltage and current wave form graphs (oscilloscope),
- voltage and current graphs as a function of time,
- phasors,
- measurements of multiple parameters,
- harmonics and harmonics powers.

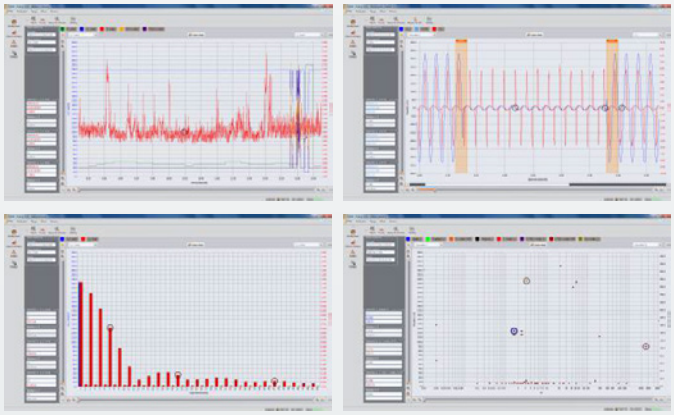
Data analysis
With the software, the user can read and analyse data recorded on the memory card. The data can also be saved to the HDD of PC to be processed at a later time. This also provides the way of archiving data from consecutive recordings.



After reading out the data, the user can perform data analysis. There is a choice of three screens:
- **General** – all data of particular types are presented in a dot form (Measurements , Events and Oscillograms),
- **Measurements** – all types of measurements recorded by averaging time are presented in a dot form (voltage, frequency, etc.),
- **Events** – all kinds of detected events are presented in a dot form (voltage dips, overvoltages, interruptions, etc.).

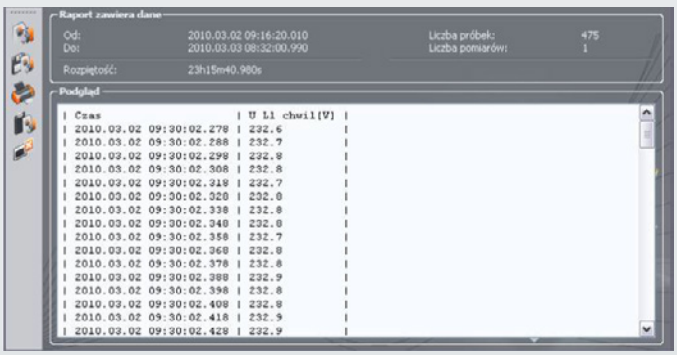


The software provides various types of graphs, enabling the User to easily visualise the data recorded by the analyser:



- **Time graph** – shows time-based wave forms of selected parameters,
- **Oscillogram** – instantaneous voltage and current wave forms during events or at the end of averaging time,
- **Harmonics graphs** – bar graph showing the level of 1...50th order harmonics,
- **Value/Time graph** – events are presented in a dot form as a function of their duration time.

User reports can be created from the data read out from the analyzer, to be saved as files in the PDF, HTML, CSV or TXT format. The software allows for creating the report of conformity with the EN 50160 standard.



ELECTRICAL EQUIPMENT SAFETY

Rules and duties related to the operation of various types of electrical equipment, both privately and professionally, are specified by a wide spectrum of regulations that, besides imposing the manufacturer's duties related to development of products in compliance with relevant standards, **define the owner's responsibility for technical condition of the equipment and tools**. Additionally, these regulations assign specific bodies to perform regular examinations and inspections of the equipment after repairs.

Therefore it is worthwhile to perform, in a proper way and with an appropriate frequency, inspection of technical condition of the electrical equipment in possession. Faulty equipment, often damaged without the user's knowledge, causes a significant threat to the user, and can also cause serious financial losses, e.g. due to fire. In such an event, if it is proven that the equipment was not fully operational (e.g. due to damaged insulation), the responsibility for the event is transferred from the manufacturer to the owner, and this can also constitute the basis for the refusal of compensation payout by the insurer.

In various countries, there are standards defining the duty, scope or intervals for performing tests of power tools as well as other electrical equipment (including the equipment quite often omitted in safety - extension cords, power cords, office equipment) in operation. **However, there is a duty of acting in accordance with the recognised technical rules**. According to the current regulations, electrical equipment must be operated and checked in accordance with the guidelines included in the operating instructions provided by the manufacturer. However, the information included in the operating instructions is not sufficient and other knowledge sources can be used, as long as they do not conflict with the operation instructions. The notion of tests appears in many regulations. Standards like EN 60745-1 define the rules for the performance of such tests by the manufacturers and include allowable values of measured parameters. European standards can also be used here, including VDE 701 and VDE 702.

Every measurement professional using an electrical equipment safety meter and deciding about the acceptance or non-acceptance of operation of tested equipment, assumes serious responsibility for the health, life as well as the property of users of this equipment. Such a person must be equipped with a professional meter guaranteeing high accuracy and correctness of results.

The functionality and technical parameters of electrical equipment testers should allow for a full inspection of technical condition of electrical equipment and tools, including checking basic parameters of three-phase devices. Additionally, in order to ensure the safety of user works as well as correct measurements results, the instruments should check the power supply system parameters (i.e. voltage, frequency, continuity and voltage of the protective conductor). Very useful is the capability of performing measurements in an automatic mode with setting custom measurement sequences of selected parameters, as well as in a manual mode – due to the diversity of tests for various devices and standards:

A preliminary test, visual inspection of the examined device - the meter performs a preliminary check of the L-N circuit continuity and allows for checking the fuse, and then gives an on-screen indication of the moment to carry the visual inspection of the equipment - obviously, this inspection must be carried by the user alone, before commencing next measurements. After finishing the inspection, the user provides a positive or negative grade. The visual inspection should include:

- checking the enclosure (no mechanical damage),
- checking the operation of the mains power switch (whether it is possible to switch the device on and off),
- checking the power cord and the power plug (no cracks or signs of overheating),
- checking the fuse (whether its rating complies with the specifications).

Measurement of the earthing conductor (PE) resistance with the current of 200 mA, 10 A or 25 A - various standards require measurements to be performed with one of these values, additionally there must be the capability of auto-zeroing of test leads in order to eliminate this additional measurement error (or the four-lead method is used). The current source must have high output performance, allowing for a stable current within the entire measurement range. Measurements of continuity should be performed in two ways, with the use of a measurement socket or with conductors alone, which allows for testing conductors or devices not equipped with a plug.

Testing insulation resistance. The voltage of 500 V is required, however the instrument can also provide other measurement voltages that might be useful for testing based on specific regulations. Two measurement possibilities should be available: with a measurement socket or with conductors alone.

Measurement of leakage current – capability of measuring the equivalent leakage current, residual leakage current, touch leakage current as well as the PE leakage current. The instrument should allow for the performance of measurements in a wide frequency range.

Measurement of power – checking whether the device consumes power in accordance with the manufacturer's specifications, including simultaneous measurement of voltage and current.

IEC cords and extension cords testing - automatic checking of the basic parameters of IEC cords, and additionally, with the use of an additional adapter, extension cords and cords terminated with the IEC-60320-C5 plug, i.e. the so-called "Mickey Mouse" connector. The measurement sequence should be run automatically, and should include:

- insulation resistance measurement of the PE conductor,
- resistance (continuity) measurement of the PE conductor,
- the L and N conductors continuity and short-circuit tests,
- polarisation check.

For all measurement functions, where necessary, setting measurement times and result limits should be possible, allowing for comparing a given result with the defined limit, and automatic assessment: "correct" or "incorrect".

A very useful feature of measurement instruments is their capability of saving the results to memory or printing the results directly after the measurement.

Saving should be possible for a sequence of measurements as well as for single measurements (performed in a manual mode). Due to the type of measured devices, bar code assignment should be possible as well (e.g. acquired with an additional reader).

Another useful accessory might be the software, allowing for keeping a database of tested devices (including information about the necessity of re-testing), creating and printing abbreviated and extended measurement reports, creating reports in compliance with 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).

	Start-up and modifi - cations	After-repair tests				Periodic tests							Type tests / procedural tests				
Devices tested in accordance 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		●				●			●								
Measurement and monitoring instruments		●				●			●					●			
Voltage generating devices		●				●			●								
Electrical power tools		●				●	●		●						●	●	
Heating equipment		●				●			●						●		
Electrically driven devices		●				●	●		●						●	●	
Lighting lamps		●				●			●						●		
Multimedia and teleco - mmunications equipment		●				●			●						●		
Cable reels, extension cords, connecting cables		●				●			●						●		
Data processing and office equipment		●				●							●				
Electrical equipment for medical applications, application parts	●		●	●	●			●		●	●						●
Welding equipment												●					

Portable appliance tester

PAT-820/815/810

Index: WMGBPAT820
WMGBPAT815
WMGBPAT810

CAT II 300V | IEC 61557 | FLASH TEST HIGH VOLTAGE PAT-820 | TOUCH SCREEN | IP 40 | WiFi | QR CODE SYSTEM 2D

Electrical safety:

- the product meets the EMC requirements in accordance with the EN 61326-1:2013 and EN 61326-2-2:2013 standards
- measurement category.....II 300V acc.to EN 61010-1
- enclosure protection rating acc. to EN 60529:.....IP40 (IP67 with lid closed)

Other technical specifications:

- power supply of the meter.....195...265V, 50Hz
- load current.....max. 16A (230V)
- data transfer to a PC.....USB 2.0
- dimensions.....330 x 235 x 120 mm
- weight of the meter.....approx. 6.2 kg

Nominal operating conditions:

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

Meters can be used to test the equipment performed in accordance with standards:

- **EN 60745-1** Hand-held motor-operated electric tools. Safety. General requirements
- **EN 61029** Safety of transportable motor-operated electric tools - General requirements
- **EN 60335-1** Household and similar electrical appliances -Safety -Part 1: General requirements
- **EN 60950** Safety of information technology equipment (IT Equipment)
- **AS/NZS 3760:2010** In-service safety inspection and testing of electrical equipment
- **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

Functionality of the meter:

- intuitive user interface, large and clear touch display,
- manual tests and auto tests, the ability to describe auto test with standards or any name;
- option to skip single measurement in the auto test, with the recording that choice of skipping of specified measurement was made conscious, the option does not apply to build-in auto tests.
- typing with QWERTY keyboard on the touch screen
- description of test equipment, measurement location, customer data, assigning the serial number of the device under test and the index can be stored in meter memory, ability to write notes about the device under the test
- base of the appliances, customers, description of the equipment and damage.
- the results can be printed (also automatically after every measurement), reports (works with the printer), two labels can be printed after a single test (for the device and a removable wire)
- support for barcode reader (including 2D), readings of the original serial numbers for the appliances and registration codes and auto test codes,
- build-in help with instructions how to connect test equipment and how to perform measurement,
- ability to create many user accounts with log-in function (as an option),
- supports USB flash drive;
- communication with PC via USB and via Wi-Fi,
- works with the program Sonel PAT Reader and Sonel PAT; measurement and settings configuration from the meter and also from PC, data analysis.

Intuitive user interface with large 7'' touch display:

Basic functions:

- **measurement of earth bond/continuity resistance with the currents: 200 mA (PAT-810/815/820), 10 A and 25 A (only PAT-815/820) (protection class I),**
- **measurement of insulation resistance – three measurement voltages: 100 V and 250 V (only PAT-815/820), 500 V (PAT-810/815/820),**
- measurement of substitute leakage current,
- measurement of differential leakage current,
- measurement of touch leakage current,
- measurement of power,
- measurement of current consumption,
- IEC lead test,
- check of the L-N circuit test,
- measurement of mains voltage and frequency,
- RCD testing,
- flash test / high voltage test (only PAT-820).

Standard accessories of the meter:

- power supply cord	**WAPRZZAS1**
- test lead 1,8 m; SP-4 plug, orange	**WAPRZ1X8ORKS**
- test lead with banana plug; 1.8 m; 5 kV; red (only PAT-820 - 2 pcs)	**WAPRZ1X8REBB**
- pin probe 5kV with banana connector - red (only PAT-820 - 2 pcs.)	**WASONREOGB2**
- USB cable	**WAPRZUSB**
- fuse 0314 015.VXP 15 A 250 VAC 6.3x32 mm Littlefuse 2 pcs	**WAPOZB15PAT**
- instruction manual	
- warranty card	

STANDARD ACCESSORIES:

Other:

- automatic measurement range selection,
- professional software for data processing and reporting,
- cooperation with a barcode reader and printer,
- supports pendrive flash memory,
- large and clear touch display,
- ergonomic operation.

2 YEAR WARRANTY

Measurement of continuity resistance I=200 mA (protection class I):

Display range	Resolution	Accuracy
0,00...0,99 Ω	0,01 kΩ	±(4% m.v. + 2 digits)
1,00...19,99 Ω		±(4% m.v. + 3 digits)

- adjustable measurement limit
- adjustable measurement time
- automatic discharge of the measured object capacitance after the measurement
- protection against measuring live devices

Measurement of continuity resistance I=200 mA (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	

- technical method
- test current: ł10 A for RŁ0,5 Ω
- adjustable limit
- adjustable measurement time

Measurement of earth bond I=25 A (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	

- technical method
- test current: ł25 A for RŁ0,2 Ω
- adjustable limit
- adjustable measurement time

Measurement of insulation resistance:

Measurement range in accordance with IEC 61557-2 for: U_n=100V: **100 kΩ...99.9 MΩ**
U_n=250V: **250 kΩ...199.9 MΩ**, U_n=500V: **500 kΩ...599.9 MΩ**

U_n	Display range	Resolution	Accuracy
100 V	0...1999 kΩ	1 kΩ	±(5% m.v. +8 digits)
	2.0...19.99 MΩ	0.01 MΩ	
	20.0...99.9 MΩ	0.1 MΩ	
250 V	0...1999 kΩ	1 kΩ	
	2.00...19.99 MΩ	0.01 MΩ	
	20.0...199.9 MΩ	0.1 MΩ	
500 V	0...1999 kΩ	1 kΩ	
	2...19.99 MΩ	0.01 MΩ	
	20.0...599.9 MΩ	0.1 MΩ	

- adjustable measurement limit
- adjustable measurement time
- automatic discharge of the measured object capacitance after the measurement
- protection against measuring live devices

Measurement of differential leakage current:

Display range	Resolution	Accuracy
0,00...3,99mA	0,01mA	±(5% m.v. + 2 digits)
4,0...19,9mA	0,1mA	

- adjustable limit
- adjustable measurement time

Measurement of substitute leakage current:

Display range	Resolution	Accuracy
0,00...3,99mA	0,01mA	±(5% m.v. + 2 digits)
4,0...19,9mA	0,1mA	

- adjustable limit
- adjustable measurement time
- open circuit voltage 25...50 V

Power factor PF

Display range	Resolution	Accuracy
0,00...1,00	0,01	±(10% m.v. + 5 digits)

Measurement of current consumption:

Display range	Resolution	Accuracy
0,00...15,99 A	0,01 A	±(2% m.v. + 3 digits)

Voltage measurement:

Display range	Resolution	Accuracy
195,0...265,0 V	0,01 V	±(2% m.v. + 2 digits)

Measurement of touch leakage current:

Display range	Resolution	Accuracy
0,00...4,999mA	0,0001mA	±(5% m.v. + 3 digits)

- adjustable limit
- adjustable measurement time

Measurements of RCD parameters

RCD trip time test tA
Test range according to IEC 61557: 0 ms ... to the upper limit of displayed value

RCD type	Factor	Range	Resolution	Accuracy
General	0,5*I	0...300 ms	1 ms	±(2% m.v. + 2 digits[1])
	1* I_{Dn}			
	2* I_{Dn}	0...150 ms		
	5*I_{Dn}	0...40 ms		

[1]) - a differential leakage current I_{Dn} = 10 mA I 0,5$_{Dn}$ I_{Dn}: ± 2% m.v. ±3 digits

Measurement of RCD disconnection current I for sinusoidal differential current A

Test range according to IEC 61557: (0,3...1,0)I_{Δ}n

Selected nominal current of RCD	Test range	Resolution	Test current	Basic uncertainty
0,5*I	3,3...10,0 mA	1 ms	0,3 x I ... 1,0 x I_{Dn}	± 5% I_{Dn}
1* I_{Dn}	4,5...15,0 mA			
2* I_{Dn}	9,0...30,0 mA			

- it is possible to start the measurement from the positive of the negative half of forced leakage current
- test current passage time max. 3200 ms
- automatic measurement of RCD disconnection time (tA) and disconnection current
- measurement for: 0,5I_{Δ}n, 1I_{Δ}n, 2I_{Δ}n i 5I_{Δ}n.

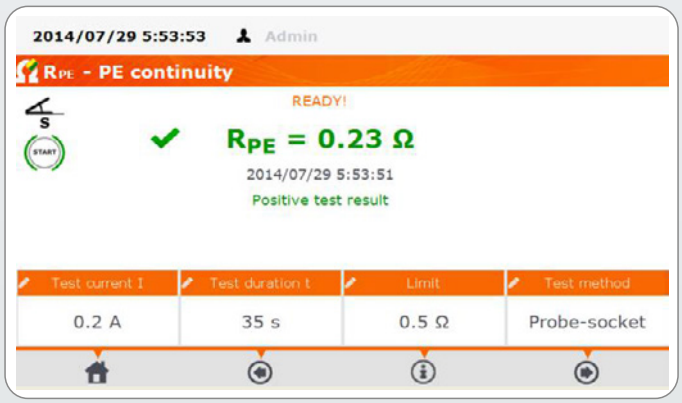
Measurement of power S:

Display range	Resolution	Accuracy
0...999 VA	1 VA	±(5% m.v. + 3 digits)
1,00 k...3,99 kVA	0,01 kVA	

Measurement of power P

Display range	Resolution	Accuracy
0...999 VA	1 VA	±(5% m.v. + 5 digits)
1,00 k...3,99 kVA	0,01 kVA	

Intuitive and user friendly interface:



Additional accessories of the meter:

- adapter IEC 60320 C6 Plug to IEC 60320 C13 Connector Block	**WAADAPATIEC1**
- current clamp C-3 (only for PAT-820/815)	**WACEGC3OKR**
- three phase socket adapter 16A	**WAADAPAT16P**
- three phase socket adapter 16A switchable	**WAADAPAT16PR**
- three phase socket adapter 32A	**WAADAPAT32P**
- three phase socket adapter 32A switchable	**WAADAPAT32PR**
- adapter for industrial sockets 16A	**WAADAPAT16F1**
- adapter for industrial sockets 32A	**WAADAPAT32F1**
- test lead; 1.5 m;	**WAPRZ1X5DZBB**
- test lead; 2.1 m...; IEC (only for PAT-820/815)	**WAPRZ2X1DZIECB**
- cable - adapter Shuko / IEC (for testing extensions)	**WAADAPATIEC2**
- Sonel PAT+ software	**WAPROSONPAT2**
- USB barcode reader	**WAADACK2D**
- portable USB report/bar code printer	**WAADAD2**

Portable appliance tester

PAT-805

Index: WMGBPAT805 (PAT-805)

CAT II 300V

IP 40

Common features of the instruments:

- measurement of protective conductor resistance with current:
  - PAT-805, PAT-806: 200 mA, 10 A, 25 A - protection class I,
- measurement of insulation resistance - measurement voltages:
  - PAT-805, PAT-806: 100 V, 250 V and 500 V,
- measurement of substitute leakage current,
- measurement of PE leakage current,
- measurement of residual leakage current,
- measurement of touch leakage current,
- measurement of power,
- measurement of current,
- IEC cord test,
- fuse checking,
- measurement of the L-N circuit resistance,
- measurement of power system voltage and frequency,
- automatic programmable test procedures.

Other features:

Automatic selection of the measurement range.
990 cells of measurement result memory with the capability to be transferred to a PC over the USB interface, or printed out.
Professional software for processing data and creating reports (optional).
Compatible with a bar code reader and a printer (optional).
Compatible with a pendrive memory.
Large, clear backlit segment display.

Standard accessories of the meters:

- Power supply cord	WAPRZZAS1
- „Crocodile" clip K03; black (2 pcs)	WAKROBL30K03
- Pin probe with banana connector; black	WASONBLOGB3
- Test lead with banana plug; 1,2m; black (2 pcs)	WAPRZ1X2BLBB2X5
- USB cable	WAPRZUSB
- 0314 015.VXP 15 A 250 VAC 6.3x32 mm Littlefuse fuse (2 pcs)	WAPOZB15PAT
- Carrying case L5	WAFUTL5
- Sonel Reader software	
- Calibration certificate	

Portable appliance and welding machines tester

PAT-806

Index: WMGBPAT806

EN 60974-4

CAT II 300V

IP 40

The parameters and specifications same for PAT-805, additionally:

Measurement of parameters of arc welding machines (EN 60974-4):
- Welding machine no-load voltage measurement.
- UP voltage measurement (peak)
- Welding circuit leakage current measurement

PAT-806 additionaly allow for measurements in accordance with:

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.

No-load voltage measurement for welding machines.
Voltage measurement U_R (r.m.s.)

Display range	Resolution	Accuracy
5.0...170.0 V	0.1 V	±(2.5% m.v. + 5 digits)

• measurement upper limit settable within the range of: 5,0...170,0 V with resolution of 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)

• measurement upper limit settable within the range of: 5,0...240,0 V with resolution of 1 V

Welding circuit leakage current measurement I_L:

Display range	Resolution	Accuracy
0.00...14.99 mAV	0.01 mA	±(5% m.v. + 5 digits)

• current measurement range results from the applied measurement system which is in accordance with EN 60974-4
• measurement upper limit settable within the range of: 0,10 mA…14,90 mA with resolution of 0,1 mA
• measurement time settable within the range of: 3 s…60 s with resolution of 1 s

Other parameters - see PAT-805

The instruments allow for measurements in accordance 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: Safety of household and similar electrical appliances. General requirements.
EN 60950: Safety of information technology equipment including electrical business equipment.
VDE 0701-0702: Prüfung nach Instandsetzung, Änderung elektrischer Geräte. Wiederholungsprüfung elektrischer Geräte. Allgemeine Anforderungen für die elektrische Sicherhei.

Measurement of earth continuity

- upper limit settable within the range: 10 mΩ …1.99Ω with 0.01Ω resolution
- adjustable measurement time 1...60s with 1 s resolution

Measurement of earth conductor resistance I = 200 mA (protection class I)

Display range	Resolution	Accuracy
0.00...0.99Ω	0.01Ω	±(4% m.v. + 2 digits)
1.00...19.99Ω		±(4% m.v. + 3 digits)

- **measurement current: ≥200mA for R≤1.99Ω**

Measurement of earth conductor resistance I = 10 A (protection class I)

Display range	Resolution	Accuracy
0...999mΩ	1mΩ	±(3% m.v. + 4 digits)
1.00...1.99Ω	0.01Ω	

- technical method of measurement providing high accuracy of results
- **measurement current: ≥10A for R≤0.5Ω**

Measurement of earth conductor resistance I = 25 A (protection class I)

Display range	Resolution	Accuracy
0...999mΩ	1mΩ	±(3% m.v. + 4 digits)
1.00...1.99Ω	0.01Ω	

- technical method of measurement providing high accuracy of results
- **measurement current: ≥25A for R≤0.2Ω**

DO YOU KNOW...

The PAT series meters perform programmed measurement sequences, allowing for automatic testing of devices in accordance with standards or individual needs of the user.

Measurement of insulation resistance:

Measurement range in accordance with IEC 61557-2 for: U_n=100V: **100kΩ…99.9MΩ** (PAT-805, -806),U_n=250V: **250kΩ…199.9MΩ** (PAT-805, -806), U_n=500V: **500kΩ…599.9MΩ**

U_n	Display range	Resolution	Accuracy
100V	0...1999kΩ	1kΩ	±(5% m.v. +8 digits)
	2.0...19.99MΩ	0.01MΩ	
	20.0...99.9MΩ	0.1MΩ	
250V	0...1999kΩ	1kΩ	
	2.00...19.99MΩ	0.01MΩ	
	20.0...199.9MΩ	0.1MΩ	
500V	0...1999kΩ	1kΩ	
	2...19.99MΩ	0.01MΩ	
	20.0...599.9MΩ	0.1MΩ	

- measurement limit settable within the range of : 0.01...9.9MΩ with the resolution of 0.1MΩ
- adjustable measurement time: continuous measurement (Cont) or from 4 s to 3 min, with the resolution of 1 s
- automatic discharge of the measured object capacitance after the measurement
- protection against measurements of energised objects
- max. output current 1.4 mA

DO YOU KNOW...

PAT-805 and PAT-806 perform measurements with actual current of 25 A up to the resistance value of 0.2Ω.

Electrical safety:

- the product meets the EMC requirements in accordance with the EN 61326-1:2006 and EN 61326-2-2:2006 standards
- type of insulation..... double, in acc. with EN 61010-1 and IEC 61557

Other technical specifications:

- power supply of the meter.....187...265V, 50Hz
- load current.....max. 16A (230V)
- measurement result memory.....990 cells
- data transfer to a PC..... USB interface
- dimensions..... 330 x 235 x 120mm
- weight of the meter..... PAT-800 approx. 4.05 kg, PAT-805 and PAT-806 approx. 4.75 kg

Nominal operating conditions:

- operating temperature ..... 0...+40°C
- storage temperature..... -20...+70°C
- humidity..... 20...80%

Measurement of L-N circuit resistance

Display range	Resolution	Accuracy
0...999Ω	1Ω	±(5% m.v. +5 digits)
1.00...4.99kΩ	0.01kΩ	

- measurement voltage 4…8 V, short-circuit voltage: max. 5 mA

Measurement of PE leakage current and residual current

Display range	Resolution	Accuracy
0.00...3.99mA	0.01mA	±(5% m.v. + 2 digits)
4.0...19.9mA	0.1mA	

- measurement limit settable within the range of 0.01...9.9 mA, with the resolution of 0.01 mA/0.1 mA
- adjustable measurement time: continuous measurement (Cont) or 4...60 s, with the resolution of 1 s
- after elapsing half the measurement time, the meter automatically switches polarity on the measurement socket outlet and displays the higher value
- bandwith ofcurrent measurement up to 100kHz

Measurement of substitute leakage current

Display range	Resolution	Accuracy
0.00...3.99mA	0.01mA	±(5% m.v. + 2 digits)
4.0...19.9mA	0.1mA	

- measurement limit settable within the range of 0.01...9.9 mA, with the resolution of 0.01 mA/0.1 mA
- adjustable measurement time: continuous measurement (Cont) or 1...60 s, with the resolution of 1 s
- open circuit voltage: 25...50 V

Measurement of touch leakage current

Display range	Resolution	Accuracy
0.000...4.999mA	0.001mA	±(5% m.v. + 3 digits)

- measurement limit settable within the range of 0.01...1.99 mA, with the resolution of 0.01 mA
- adjustable measurement time: continuous measurement (Cont) or 1...60 s, with the resolution of 1 s
- bandwith of current measurement up to 100 kHz

DO YOU KNOW...

PAT-805 and PAT-806 are the only safety meters also enabling the measurement of resistance with the use of the four-lead method.

Measurement of S power:

Display range	Resolution	Accuracy
0...999VA	1VA	±(5% m.v. + 3 digits)
1...3.99kVA	0.01kVA	

- adjustable measurement time: continuous measurement (Cont) or 1...60 s, with the resolution of 1 s

Measurement of current consumption:

Display range	Resolution	Accuracy
0.00...15.99A	0.01A	±(2% m.v. + 3 digits)

- adjustable measurement time: continuous measurement (Cont) or 1...60 s, with the resolution of 1 s

Measurement of voltage:

Display range	Resolution	Accuracy
187.0..265.0V	0.1V	±(2% m.v. + 2 digits)

Measurement of network frequency:

Display range	Resolution	Accuracy
45.0...55.0 Hz	0.1 Hz	±(2% m.v. + 2 digits)

- measurement of the mains voltage frequency of power supply to the meter

Measurement of PE network (mains) voltage:

Display range	Resolution	Accuracy
0.0..59.9 V	0.1 V	±(2% m.v. + 2 digits)

- measurement of the mains voltage between PE and N of power supply to the meter

* for U < 5V accuracy ic not specified

Resistance measurement for L - N circuit:

Display range	Resolution	Accuracy
0...999 Ω	1 Ω	±(5% m.v. + 5 digits)
1.00...4.99 kΩ	0.01 kΩ	

- test voltage: 4 ... 8V AC
- short-circuit current: max. 5mA

SONEL PAT / PAT+ SOFTWARE

Index: WAPROSONPAT1 / WAPROSONPAT2

Additional accessories of the meters:

- 1.2 m 10/25 A two-core test lead "U1/I1"	**WAPRZ1X2DZBB1**
- 1.2 m 10/25 A two-core test lead "U2/I2" (PAT-806)	**WAPRZ1X2DZBB2**
- 1 kV black "crocodile" clip (PAT-806)	**WAKROBL30K03**
- 1 kV black probe (PAT-806)	**WASONBLOGB1**
- 1 kV black probe	**WASONBLOGB3**
- 1.2 m black test lead terminated with banana plugs, black	**WAPRZ1X2BLBB2X5**
- Cord - Schuko/IEC adapter (for testing extension cords)	**WAADAPATIEC2**
- high-current probe with banana connector	**WASONSPGB1**
- kelvins clamp K06	**WAKROKELK06**
- PAT IPE Adapter (PAT-806)	**WAADAPATIPE**
- 16 A three-phase socket adapter	**WAADAPAT16P**
- 16 A switched three-phase socket adapter	**WAADAPAT16PR**
- 32 A three-phase socket adapter	**WAADAPAT32P**
- 32 A switched three-phase socket adapter	**WAADAPAT32PR**
- 16 A industrial socket adapter (PAT-806)	**WAADAPAT16F1**
- 32 A industrial socket adapter	**WAADAPAT32F1**
- IEC adapter for testing IEC cords terminated with a "Mickey Mouse" connector	**WAADAPATIEC1**
- Sonel PAT plus software	**WAPROSONPAT2**
- USB bar code reader	**WAADACK1**
- portable USB report/bar code	**WAADAD1**
- fail stickers (a reel of 50 stickers)	**WANAKNSPR**
- pass stickers (a reel of 50 stickers)	**WANAKSPR**
- stickers with bar codes (a reel of 100 stickers)	**WANAKKODPAS**

portable USB report/bar code
WAADAD1

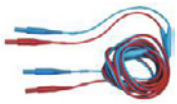
USB bar code reader
WAADACK1

PAT IPE Adapter
WAADAPATIPE

Three-phase socket adapter
16 A: **WAADAPAT16P**
32 A: **WAADAPAT32P**

Switched three-phase socket adapter
16 A: **WAADAPAT16PR**
32 A: **WAADAPAT32PR**

Industrial socket adapter
16 A: **WAADAPAT16F1**
32 A: **WAADAPAT32F1**



1.2 m 10/25 A two-core test lead
U1/I1: **WAPRZ1X2DZBB1**
U2-I2: **WAPRZ1X2DZBB2**

1.2 m black test lead terminated with banana plugs, black
WAPRZ1X2BLBB2X5

Cord - Schuko/IEC adapter (for testing extension cords)
WAADAPATIEC2

1 kV black "crocodile" clip
WAKROBL30K03

1 kV black probe
WASONBLOGB1
WASONBLOGB3

IEC adapter for testing IEC cords terminated with a "Mickey Mouse" connector
WAADAPATIEC1

fail stickers
WANAKNSPR

pass stickers
WANAKSPR

stickers with bar codes
WANAKKODPAS

high-current probe with banana connector
WASONSPGB1

kelvins clamp K06
WAKROKELK06

SONEL PAT

Intended for companies performing measurements of electrical equipment safety.

Perfect for manufacturers, power tool rental, service, etc. facilities.

Hierarchical structure of entered data - the device is assigned to a specific company or a division.

Capability of collecting information about the device, tracking history of tests of the device.

Cooperation with Sonel PAT series meters. Data recorded by the meter are included in the test report for the selected device.

Capability of advanced configuration of the meters from the program.

Available report forms:
- full report from a single test - A4 size page, with full data related to the device as well as full testing series,
- test report (history) for the device - all measurement results in accordance with query criteria are printed (from a given period of time),
- abbreviated report/record card - prints out the history of tests with basic information about the device, as well as with the information concerning its servi ce approval.

Print labels on standard self - adhesive paper.

Capability of creating a custom measurement standard with the use of the protocol editor.

Capability of scheduling measurements - each device includes a "Measurement cycle" feature - the program automatically displays devices with approaching or expired testing date.

Protocol printout in accordance with 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 601.1.

SONEL PAT+

Sonel PAT plus software is designed for companies carrying out testing of portable electrical appliances.

It is ideal solution for big industrial companies, hospitals, rent and service of electrical appliances etc. Sonel PAT plus communicates with PAT-810, 815, 820 and iPAT testers. All data saved in tester memory are transferred automatically to proper tables and worked in the software.

Software produces reports according to below standards:
VDE 0701:1, VDE 0701:200, VDE 0701:240, VDE 0701:260, DIN VDE 0702, DIN VDE 0751, EN 61010,EN 60335, EN 60950, IEC 60601, EN 62353.

Software collects, analyzes and archives PAT test results and follows tests history. Every appliance is associated with concrete company and department.

Tests can be printed out in 4 versions:

- Test report – shows on one page all tests and all features of appliance.
- History of tests – shows in one table all test results.
- Short history of tests – prints basic information about test of appliance.
- Summary report - sorted according to the category of measurement. This option enables to add new print data on existing appliance card. Software automatically locate place of printed data in first, free row. Complete documentation can be also saved to PDF file. All data and test results are administered by Scheduler.
- For every appliance user set "Test cycle" Thanks to this function software automatically displays appliances with overdue test validity and can send email notification to the customer.

Requirements:
operating system: Windows XP SP2, Windows Vista, Windows 7 or higher (32 or 64-bit.)
Internet Explorer: 6.0 or higher, FrameWork 2.0 or higher

Leakage current alarm signaller

MPU-1

Index: WMGBMPU1

Standard accessories:

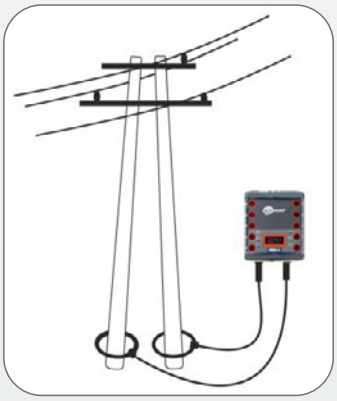
- Carrying case L5	WAWALL5
- Power supply adaptor Z11	WAZASZ11
- Cable for charger	WAPRZLAD230
- Mounting strap	WAPOZOPAKPL

Additional accessories:

- F-1 clamp (ø 38 cm)	WACEGF1OKR
- F-2 clamp (ø 25 cm)	WACEGF2OKR
- F-3 clamp (ø 12 cm)	WACEGF3OKR
- F-4 clamp	WACEGF4OKR
- Lead for battery charging from socket of car lighter (12V)	WAPRZLAD1212V2

The device shall be connected to measured power network or device according to the pictures below:

Device working with single clamp.



Device working with two clamps.

Carrying case L5 for standard and additional accessories.

Measurements:

MPU-1 is dedicated to control (measure) leakage current in AC, low and medium voltage power networks. It is designed to make measurements, which results define network's safety condition for leakage current.
The device enables to set limit for maximum safe value of flowing leakage current and for values above this limit visual and sound alarm is activated.

The most important features of MPU-1 are:

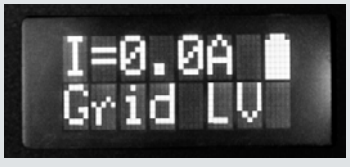
- constant controlling of current flowing on earthing,
- measurement with the use of single clamp or two clamps simultaneously. In case of using two clamps, current value is summed up, which allows for checking twin pylons (rotational), with independent clamp for each component pylon,
- work mode LED indicator,
- visual and sound alarm (speaker built in cover) in case of higher value of leakage current than defined limit (factory default set to 1 A),
- no DC current measurement,
- measurement with flexible clamps (Rogowski coil) – Sonel F series,
- measurement in 50 Hz or 60 Hz frequency low and medium voltage networks,
- auto ranging,
- battery level monitoring,

Leakage current measurement with 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: 50 or 60Hz
- F-1 clamps

Work in medium voltage mode – alarm limit value and battery level can be seen on the screen.



Work in low voltage mode – value of current measured with the clamp and battery level can be seen on the screen.

Other technical data:

- degree of housing protection acc. to EN 60529: IP67
- max. noise voltage AC+DC, for which measurement is possible: 24 V
- max. measured nosie voltage: 100 V
- power supply: SONEL battery package NiMH 9,4V 2,4 Ah
- operating time for standby mode: >20h
- operating time for alarm mode: >3h
- dimensions: 125 x 150 x 95 mm
- weight (including battery): ok. 1,1 kg
- altitude (above sea level): <2000 m
- quality standard: design and manufacturing are ISO 9001 compliant
- the product meets EMC requirements (immunity for industrial environment) according to the following standards: EN 61326-1:2006 and EN 61326-2-2:2006

Nominal operating conditions:

- working temperature: -10..+50 °C
- charger working temperature: +10..+35 °C
- reference temperature: 23 ±2 °C
- storage temperature: -20..+80 °C
- relative humidity: 20..85%
- relative nominal humidity: 40..60%

Clamp meter with wireless data transmission

CMP-600

Index: WMXXCMP600

CAT III 600V

IP 40

DC and AC (TRUE RMS - 50...500Hz) current measurement

Display range	Resolution	Accuracy (DC)	Accuracy (AC)
400A	0.1A	±(1.8% m.v. + 10 digits)	±(1.8% m.v. + 10 digits) for f=50...500Hz
600A	1A	±(1% m.v. + 5 digits)	±(1% m.v. + 5 digits) for f=50...500Hz

DC and AC (TRUE RMS - 50...500Hz) voltage measurement

Display range	Resolution	Accuracy	
		DC	AC
400mV*	0.1mV	±(0.75% m.v. + 3 digits)	-
4V	0.001V	±(1% m.v. + 3 digits)	±(1.5% m.v. + 10 digits)
40V	0.01V		
400V	0.1V		±(1.5% m.v. + 5 digits)
600V	1V		

* - only DC

Resistance measurement

Display range	Resolution	Accuracy
400Ω	0.1Ω	±(1% m.v. + 5 digits)
4kΩ	0.001kΩ	
40kΩ	0.01kΩ	
400kΩ	0.1kΩ	
4MΩ	0.001MΩ	±(3% m.v. + 5 digits)
40MΩ	0.01MΩ	±(5% m.v. + 5 digits)

Frequency measurement

Display range	Resolution	Accuracy
5Hz	0.001Hz	±(0.7% m.v. + 5 digits)
50Hz	0.01Hz	
500Hz	0.1Hz	
5kHz	0.001kHz	
50kHz	0.01kHz	
100kHz	0.1kHz	

Standard accessories of the meter:

- test leads (2 pcs.)	**WAPRZCMP1**
- UBS cable	**WAPRZUSBMNIB5**
- 1.5V AA battery (4 pcs.)	
- case for the meter and accessories	
- software	

Measurements:

- DC and AC (TRUE RMS) current measurement up to 600A,
- DC and AC (TRUE RMS) voltage measurement up to 600V,
- acoustic signalling programmable for instances of exceeding the MAX/MIN values set,
- resistance measurement and continuity test: continuity test with acoustic signalling (for resistance below 1000),
- frequency measurement,
- diode test,
- can be wirelessly connected to many transmitters,
- CMP-600R receiver made compatible with a computer via USB interface.

Additionally:

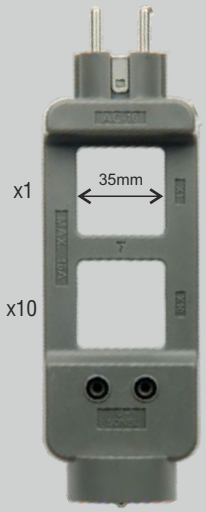
- safe, insulated measuring clamps (ø 30 mm or 35 x 10 mm bus bar),
- automatic range selection switchable to the manual range selection mode
- "HOLD" function for holding measured values on the LCD,
- "DC ZERO" function – DC of the instrument can be zeroed, and the absolute measurement mode can be restored, at any time,
- relative measurement mode for AC,
- storage of minimum and maximum values,
- estimation of electric energy costs made by the program provided.

AC-16 adapter to simplify measurements of current (for all clamps meters)

AC-16

Index: WAADAAC16

- transformation ratio x1, x10
- power line rate: 230V, 15A max.



Electric security:

- measurement category.....CAT III 600V acc. to EN 61010-1:2004
- casing protection class acc. to EN 60529.....IP40

Other technical data:

- power supply for transmitter and receiver.....2 x 1.5V batteries type LR6
- display.....LCD, 4 digits
- uninterrupted work time.....300 h transmission off, 100 h transmission on (t=2s)
- transmitter's dimensions.....220 x 64 x 35 mm
- receiver's dimensions.....179 x 72 x 32 mm
- transmitter's weight (without batteries).....ca. 251 g
- receiver's weight (without batteries).....ca. 177 g
- LCD refresh rate.....3 x/s transmission off and 1 x/s transmission on
- transmission frequency.....433,62MHz
- polarisation.....automatic, negative polarisation indicated (-)
- accordance with the following standards.....EN 61010-1:2004, EN 61010-2-032

Rated operational conditions:

- operating temperature.....-10..+50˚C, rel. hum. < 80%
- storage temperature.....-20..+60˚C, rel. hum. < 70%

2 YEAR WARRANTY

Clamp meter

CMP-2000

Index: WMXXCMP2000

CAT III 1000V

CAT IV 600V

Standard accessories of the meter:

- test leads (2 pcs.)	**WAPRZCMP1**
- K type temperature probe	**WASONTEMK**
- 9 V battery	
- case	
- calibration certificate	

Measurements:

- **AC current measurement (TRUE RMS) up to 1500 A and DC up to 2000 A.**
- **measurement of INRUSH current in start-up phase of electrical device (high frequency of sampling).**
- **AC voltage measurement (TRUE RMS) up to 750 V and DC up to 1000 V.**
- resistance measurement and continuity test: continuity test with acoustic signalling (beeper) for resistance below 30 Ω.
- capacitance measurement.
- temperature measurement (Fahrenheit or Celsius).
- frequency measurement.
- duty cycle measurement.
- diode test.

Additionally:

- safe, insulated measuring clamps **(ø 57 mm or 70 x 18 mm bus bar),**
- autoranging,
- „DATA HOLD" function, for holding measured values,
- backlit LCD,
- „DC ZERO" mode of measurement for DC current, possibility to zero the display and reading relative actual value less stored „zero" value,
- „MAX/MIN" function,
- overrange indication,
- „AUTO-OFF" function after 30min.

Electric security:

- measurement category.....CAT IV 600 V acc. to EN 61010-1
- casing protection class acc. to EN 60529.....IP20

Other technical data:

- power supply.....9 V battery type 6LR61
- display.....6600 counts, backlit LCD
- continuity test.....threshold 30 Ω
- diode test.....test current of 0.8 mA, typical; open circuit voltage 3.2V DC, typical
- low battery indication.....BAT displayed
- overrange indication.....'OL' displayed
- temperature sensor.....type K thermocouple
- input impedance.....ca.10 MΩ (V DC i V AC)
- AC bandwidth.....50...500 Hz
- auto power OFF.....30 minutes
- dimensions/weight.....281 x 108 x 53 mm/570 g (with battery)
- accordance with following standards.....EN 61010-1; EN 61010-2-032

Rated operational conditions:

- able to open the clamp:.....ø 57 mm wire; 70 x 18 mm bus bar
- operating temperature/storage temperature.....0...+50 ˚C/-20...+60 ˚C
- operating altitude.....max 2000m

DC current measurement

Range	Resolution	Accuracy
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

AC current measurement (TRUE RMS)

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
660...1500 A	1 A	±(2.5% m.v. + 10 digits) for 50...60 Hz and 660...1000 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

Voltage measurement (DC, AC - TRUE RMS)

Range	Resolution	Accuracy
0.000...6.599 V	0.001 V	±(0.5% m.v. + 2 digits) - DC
6.60...65.99 V	0.01 V	
66.0...659.9 V	0.1 V	±(1.5% m.v. + 8 digits) for 50...500 Hz - AC
660...1000 V (DC) 660...750 V (AC)	1 V	

Resistance measurement

Range	Resolution	Accuracy
0.0...659.9 Ω	0.1Ω	±(1.0% m.v. + 5 digits)
0.660...6.599 kΩ	0.001kΩ	
6.60...65.99 kΩ	0.01kΩ	
66.0...659.9 kΩ	0.1kΩ	
0.660...6.599 MΩ	0.001MΩ	±(2.0% m.v. + 5 digits)
6.60...66.00 MΩ	0.01MΩ	±(3.5% m.v. + 5 digits)

Capacitance measurement

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...559.9 nF	0.1 nF	±(3.0% m.v. + 30 digits)
6.600...59.999 µF	0.001 µF	±(3.0% m.v. + 10 digits)
66.00...659.99 µF	0.01 µF	
660...659.999 µF	0.100 µF	
0.660...6.600 mF	0.001 mF	

Frequency measurement

Range	Resolution	Accuracy
10...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	

Temperature measurement

Range	Resolution	Accuracy
-20...0 °C	1 °C	±(2.0% m.v. + 3 °C)
0...399 °C		±(1.0% m.v.. + 2 °C)
400...1000 °C		±(2.0% m.v. + 3 °C)
-4...31 °F	1 °F	±(2.0% m.v. + 6 °F)
32..749 °F		±(1.0% m.v. + 4 °F)
750...1832 °F		±(2.0% m.v. + 6 °F)

Duty cycle measurement

Range	Resolution	Accuracy
5...95%	0,1%	±(2.0% m.v. + 10 digits)

• frequency range: 40 Hz...20 kHz.

"m.v."= measured value

Clamp meters

CMP-400, CMP-401

Index: WMXXCMP400 (CMP-400)
WMXXCMP401 (CMP-401)

CAT III 600V

IP 40

Standard accessories of the meters:

- Test leads (2 pcs)	WAPRZCMP1
- K type temperature probe	WASONTEMK
- 9 V battery	
- Case	

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 connection continuity test with acoustic signalling of circuit continuity (for the value of resistance smaller than 50 Ω),
- 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..... 6LR61 type 9 V battery
- display.....4000 readouts, backlit LCD
- continuity test.....I < 0.5 mA, acoustic signal for R < 50 Ω
- diode test.....I = 0.3 mA, U_0 = 1.5 V DC
- indication of range overflow ......"OL" symbol
- frequency of measurements.....2 readouts per second
- input impedance.....10 MΩ (V DC and V AC)
- clamp size.....opening approx. 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..... 0...+40 °C
- storage temperature.....-20...+60 °C
- operating humidity..... max. 80% up to 31 °C decreasing linearly to 50% at 40 °C
- operating altitude .....max. 2000 m

Measurement of alternating voltage and direct voltage

Display range	Resolution	Accuracy		
		CMP-400 (AC)	CMP-401 (AC)	CMP-400, -401 (DC)
400.0 mV	0.1 mV	±(1.5%m.v.+30digits)	±(1.5%m.v.+30digits)	±(0.8%m.v.+2digits)
4.000 V	0.001 V	±(1.8%m.v.+8digits)	±(1.5%m.v.+5digits)	±(1.5%m.v.+2digits)
40.00 V	0.01 V			
400.0 V	0.1 V			
600.0 V	1 V	±(2.5%m.v.+8digits)	±(2%m.v.+5digits)	±(2%m.v.+2digits)

• frequency range: 50...400 Hz

Measurement of alternating current

Display range	Resolution	Accuracy CMP-400	Accuracy CMP-401
4.000 A	0.001 A	±(2.5% m.v. + 12 digits)	no range
40.00 A	0.01 A	±(2.5% m.v. + 8 digits)	±(2.5% m.v. + 8 digits)
400.0 A	0.1 A	±(2.8% m.v. + 8 digits)	±(2.8% m.v. + 5 digits)

• frequency range: 50Hz...60Hz

Measurement of direct current (CMP-401 only)

Display range	Resolution	Accuracy
40.00 A	0.01 A	±(2.5% m.v. + 5 digits)
400.0 A	0.1 A	±(2.8% m.v. + 5 digits)

Measurement of resistance

Display range	Resolution	Accuracy
400.0 Ω	0.1 Ω	±(1.0% m.v. + 4 digits)
4.000 kΩ	0.001kΩ	±(1.5% m.v. + 2 digits)
40.00 kΩ	0.01 kΩ	
400.0 kΩ	0.1 kΩ	
4.000 MΩ	0.001 MΩ	±(2.5% m.v. + 3 digits)
40.00 MΩ	0.01 MΩ	±(3.5% m.v. + 5 digits)

"m.v." = "measured value".

Leakage current clamp meter

CMP-200

Index: WMXXCMP200

CAT II 600V

IP 40

Measurement of alternating current up to 200 A:

- high resolution (0.1 mA),
- 3 measurement sub-ranges: 200 mA, 2 A, 200 A.

Measurement of current

Display range	Resolution	Accuracy
199.9 mA	0.1 mA	±(5% m.v. + 8 digits)
1.999 A	0.001 A	±(5% m.v. + 10 digits)
199.9 A	0.1 A	±(2.5% m.v. + 10 digits)

2 YEAR WARRANTY

Clamp meter

CMP-1006

Index: WMXXCMP1006

CAT III 600V

IP 40

Standard accessories of the meter:

- Test leads (2 pcs)	WAPRZCMP1
- K type thermocouple	WASONTEMK
- 9 V battery	
- Case	

Measurements:

- measurement of alternating (TRUE RMS) and direct current up to 1000 A,
- measurement of initialmotor starting current (very high sampling frequency - INRUSH function).
- measurement of direct and alternating (TRUE RMS) voltage up to 600 V,
- measurement of resistance and connection continuity test with acoustic signalling of circuit continuity (for the value of resistance smaller than 40 Ω),
- measurement of temperature (Fahrenheit or Celsius),
- measurement of frequency,
- measurement of duty cycle,
- diode test.

Additional functions of the meter:

3½ digits LCD (max. 1999).
White light backlit display.
Internal diameter of clamp approx. 30 mm (1.2").
"HOLD" function, allowing for freezing the result on the display.
"MAX" function, allowing for capturing maximal values.
Automatic power-off of an unused instrument.
Reinforced, impact resistant enclosure.

Other technical specifications:

- type of insulation.....double, in acc. with EN 61010-1 and IEC 61557
- power supply of the me..... 2 AAA size 1.5V batteries
- frequency of measurements.....2 readouts per second
- display.....LCD, 3½ digits (max. 1999)
- dimensions.....182x61x34 mm
- weight of the meter (including batteries).....225 g
- auto-off idle timeout.....approx. 15 minutes
- compliance with standards..... EN 61010-1, EN 61010-2-032

Nominal operating conditions:

- operating temperature ..... 0...+30 °C (humidity up to 90%) ..... 30...40 °C (humidity up to 75%), 40...50 °C (humidity up to 45%)
- storage temperature..... -25...+60 °C at humidity <90%
- operating altitude ..... max. 3000 m

Additional functions of the meter:

Safe, insulated measurement clamp.
Automatic selection of ranges with the capability of switching over to the manual selection mode.
"HOLD" - freezing the result on the display.
Backlit LCD.
"DC ZERO" - relative measurement mode for direct current - capability of zeroing the instrument at any moment and returning to the absolute measurement mode.
Capturing minimal and maximal values.
Indication of range exceedance.
Auto power-off.

Measurement of direct and alternating current (TRUE RMS)

Display range	Resolution	Accuracy (DC)	Accuracy (AC)
0...659.9A	0.1A	±(2.5% m.v. +5 digits)	±(2.5% m.v. + 8 digits) for f=50...60Hz
660...1000A	1A	±(2.8% m.v. +8 digits)	±(2.8% m.v. + 8 digits) for f=50...60Hz

Measurement of direct and alternating voltage (TRUE RMS)

Display range	Resolution	Accuracy (DC)	Accuracy (AC)
0...6.599V	0.001V	±(1.5% m.v. + 3 digits)	±(1.8%m.v.+5digits) for f=50...60Hz
6.60...65.99V	0.01V		
66.0...600.0V	0.1V		

Measurement of resistance

Display range	Resolution	Accuracy
0.0...659.9Ω	0.1 Ω	±(1.0% m.v. + 4 digits)
0.660...6.599kΩ	0.001kΩ	±(1.5% m.v. + 2 digits)
6.60...65.99kΩ	0.01 kΩ	
66.0...659.9kΩ	0.1 kΩ	
0.660...6.599MΩ	0.001 MΩ	±(2.5% m.v. + 3 digits)
6.60...66.00MΩ	0.01 MΩ	±(3.5% m.v. + 5 digits)

Measurement of frequency

Display range	Resolution	Accuracy
30.0...999.9Hz	0.1Hz	±(1.2% m.v. + 2 digits) sensitivity: 30Hz...5 kHz: 10 Vrms min. 5kHz...15 kHz: 40 Vrms min. for 20...80% of duty cycle
1.000...9.999kHz	0.001kHz	
10.00...15.00kHz	0.01kHz	

"m.v." = "measured value".

Other technical specifications:

- power supply of the meter..... 6LR61 type 9 V battery
- display..... 6600 readouts, backlit LCD
- continuity test..... threshold 40; measurement current < 0.5 mA
- diode test..... typical measurement current 0.3 mA ..... typical open circuit voltage < 3 V DC
- indication of low battery level..... the 'BAT' symbol is displayed
- indication of range overflow ....."OL" symbol
- frequency of measurements..... 2 readouts per second, nominal value
- INRUSH..... integration time 100 ms
- temperature sensor..... K type thermocouple
- input impedance..... 10 MΩ (V DC and V AC)
- AC bandwidth..... 50...400 Hz (A AC and V AC)
- auto-off timeout..... approx. 25 minutes
- dimensions..... 229x80x49 mm
- weight..... 303 g
- compliance with standards..... EN 61010-1, EN 61010-2-032

Nominal operating conditions:

- internal diameters of clamps..... Ø = 34/52 mm
- operating temperature ..... +5...+50°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 altitude ..... max. 2000 m

Voltage testers
P-2, P-3

Index: WMGBP2 (P-2)
WMGBP3 (P-3)

CAT IV 600V

IP 65

Indication and measurement of direct and alternating voltages:

- indication on the LED bargraph: 12, 24, 50, 120, 230, 400, 690 V (also operates without batteries),
- display of the measurement result on the LCD screen,
- determining voltage: alternating or polarity of direct voltage.

Measurement of resistance and circuit continuity:

- display of the measurement result on the LCD screen,
- signalling for resistance < 400 kΩ.

Phase rotation indicator:

- indication of phase sequence for voltage > 100 V.

Single-pole phase determination:

- indication with the use of the touch electrode,
- optical and acoustic signalling for voltage > 50 V.

Residual current device test:

- testing RCDs of $I_{\Delta n}$ ≤ 100 mA.

Phase identification and phasing (P-3 only):

- determining phase at a given point in reference to some other point,
- capability of determining phase at a given point with the use of an additional transmitter - no time limit related to the synchronisation of power system.

DO YOU KNOW...

The P series indicators allow for voltage measurement even with discharged batteries. P-3 is the only indicator allowing for phase identification.

Additional functions of the indicators:

Ø 2 mm/4 mm test probes.
Lighting of measurement place.
"HOLD" function - freezing the measurement result (P-2 only).

The instruments meet the requirements set forth by the standards:

EN 61010 (safety of measurement instruments)
IEC/EN 61243-3 (two-pole indicators)

Additional accessories of the testers:

S-2 case **WAFUTS2**

S-3 case for the transmitter **WAFUTS3**

LKN-710P transmitter (P-3) **WMGBLKN710P**

Measurement of direct and alternating voltage

Range	Resolution	Accuracy (AC)	Accuracy (DC)
2.5...49.9V	0.1V	±(3% m.v. + 4 digits)	±(2% m.v. + 3 digits)
50...750V	1V	±(2% m.v. + 3 digits)	

Resistance measurement

Display range	Resolution	Accuracy
0...1999Ω	1Ω	±(3% m.v. + 8 digits)

"m.v." = "measured value".

Other technical specifications:

- type of insulation..... double, in acc. with EN 61010-1
- power supply of the meter..... LR03 (size AAA) alkaline batteries (2 pcs)
- reaction time of the indicator..... < 0.1 s
- frequency range for single-pole phase indicator..... 50...400 Hz
- accuracy of voltage indication..... in acc. with EN 61243-3

Nominal operating conditions:

- operating temperature..... -10...+55°C
- operating frequency for voltage indication..... 15...400 Hz
- maximal measurement current..... I_s < 0.2 A/I_s (5 s) < 3.5 mA

Voltage detector
VT-2

Index: WMXXVT2

CAT III 1000V

- indicators: LED and audible beeper
- voltage range: 100~1000VAC (50/60Hz)
- category: category III - 1000V
- battery: 2 x 1.5V batteries (LR03)

2 YEAR WARRANTY

CAT IV 300V

IP 42

Phase sequence testers

TKF-12, TKF-13

Index: WMGBTKF12 (TKF-12)
WMGBTKF13 (TKF-13)

TKF-12:

- indication of phase sequence (field rotation direction) in networks of nominal line-to-line voltages of 120...690 V AC with LEDs,
- operation in power systems of frequency 10...70 Hz,
- indication of voltage presence in individual phases with the use of neon lamps,
- power supply from the tested power system (for the max. voltage, continuous operation for up to 15 minutes),
- protection against erroneous indication of field rotation direction (indication for connecting the instrument to three differing phases only).

TKF-13:

- indication of phase sequence (field rotation direction) in networks of nominal line-to-line voltages of 120...690 V AC with LEDs,
- operation in power systems of frequency 2...70 Hz,
- indication of voltage presence in individual phases with the use of neon lamps,
- indication of the motor rotation direction:
  - in non-energised condition, with the test leads,
  - non-contact, during the operation of the motor,
- detection of magnetic field presence,
- automatic power-off of the unused meter.

DO YOU KNOW...

TKF-13 tester allows for determining the motor rotation direction both in non-energised condition and non-contact, during the operation of the motor.

The instruments meet the requirements set forth by the standards:

EN 61010-1 (general requirements related to safety)
EN 61010-031 (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 - protection against electric shock)
EN 04700 (performance of measurements - rough-in inspection tests)

Standard accessories of the testers:

- Test lead with banana plug; 1,2m; black (TKF-13)	**WAPRZ1X2BLBB**
- Test lead with banana plug; 1,2m; red (TKF-13)	**WAPRZ1X2REBB**
- Test lead with banana plug; 1,2m; yellow (TKF-13)	**WAPRZ1X2YEBB**
- Pin probe with banana connector; black	**WASONBLOGB1**
- Pin probe with banana connector; red	**WASONREOGB1**
- Pin probe with banana connector; yellow	**WASONYEOGB1**
- „Crocodile" clip K01; black	**WAKROBL20K01**
- 9V battery (TKF-13)	

Additional accessories of the testers:

- Triple phase socket adapter AGT-16P	**WAADAAGT16P**
- Triple phase socket adapter AGT-32P	**WAADAAGT32P**
- Triple phase socket adapter AGT-63P	**WAADAAGT63P**
- Triple phase socket adapter AGT-16C	**WAADAAGT16C**
- Triple phase socket adapter AGT-32C	**WAADAAGT32C**
- Carrying case S1	**WAFUTS1**

TKF-12

TKF-13

TKF-12

Other technical specifications:

- type of insulation..... double, in acc. with EN 61010-1
- power supply of the tester.....from the tested power system, ... up to 15 minutes for max. voltage
- dimensions (including the holster, and without test leads).....130x70x35 mm
- weight without test leads.....approx. 200 g
- warranty..... 36 months

Nominal operating conditions:

- range of nominal line-to-line voltage.....120...690 V AC
- maximal operating line-to-line voltage.....760 V AC
- frequency range.....10...70 Hz
- operating temperature ..... -10...+45 ˚C
- storage temperature..... -20...+60 ˚C

TKF-13

Other technical specifications:

- type of insulation..... double, in acc. with EN 61010-1
- power supply of the tester.....6LR61 alkaline battery (9 V)
- dimensions (including the holster, and without test leads).....130x70x35 mm
- weight, excluding batteries.....approx. 150 g
- battery condition blinking period.....approx. 1 s
- auto-off timeout..... approx. 5 min
- warranty..... 36 months

Nominal operating conditions:

- range of work line-to-line voltage..... 120...760 V AC
- SEM voltage range of motors..... 1...760 V AC
- frequency range..... 2...70 Hz
- operating temperature ..... -10...+45 ˚C
- storage temperature..... -20...+60 ˚C

Industrial multimeter

CMM-40

Index: WMXXCMM40

CAT IV 600V

IP 67

Standard accessories:

- Test leads (2 pcs)	WAPRZCMP1
- K type thermocouple	WASONTEMK
- Case	
- Watertight plug for socket protection (2 pcs)	
- 9 V battery	

Measurements:

- direct and alternating (TRUE RMS) voltage,
- direct and alternating (TRUE RMS) current,
- resistance,
- frequency,
- duty cycle,
- temperature,
- diode test.

Additional functions of the meter:

Automatic or manual selection of ranges.

HOLD function, allowing for reading measurements in insufficient lighting or in difficult to access places.

REL function, allowing for performing relative measurements.

MAX/MIN function.

Peak value hold function.

Memory for 2000 measurement results.

Acoustic signalling of circuit continuity (beeper).

Automatic power-off of an unused instrument.

4¾ digits display (max. 40000).

Measurement of direct and alternating voltage (TRUE RMS)

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...1000 Hz.

Measurement of direct and alternating current (TRUE RMS)

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	

• 20 A: maximally 30 seconds with limited accuracy.

Measurement of resistance

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	
40.000 MΩ	0.001 MΩ	±(2.0% m.v. + 10 digits)

Measurement of capacitance

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	

Measurement of electronic frequency

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	
100.00 MHz	0.01 MHz	unspecified value

• Sensitivity: minimal effective value of voltage of 0.8 V at 20% to 80% of duty cycle and < 100 kHz; minimal effective value of voltage of 5 V at 20% to 80% of duty cycle and > 100 kHz.

Other technical data:

- type of insulation..... double, in acc. with EN 61010-1 and IEC 61557
- power supply of the mete..... 6LR61 type 9 V battery
- diode test..... I = 0.9 mA, U0 = 2.8 V DC
- continuity test..... I < 0.35 mA, acoustic signal for R < 35 Ω
- indication of range exceedance..... "OL" symbol
- peak 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 readouts per second
- input impedance.....10 MΩ (V DC), 9 MΩ (V AC)
- display..... LCD with bar graph, 4¾ digits (max. 40000)
- number of results in memory..... 2000
- dimensions..... 187x81x55 mm
- total weight..... 342 g
- fuses..... range mA, µA: 0.5 A/1000 V high-speed ceramic fuse ..... range A: 10 A/1000 V high-speed ceramic fuse
- auto-off idle timeout..... 15 minutes
- compliance with standards..... EN 61010-1, EN 61010-2-032

Nominal operating conditions:

- operating temperature..... 0...+40 °C
- storage temperature.....-20...+60 °C
- humidity..... max. 80% up to 31 °C decreasing linearly to 50% at 40 °C
- operating altitude..... max. 2000 m

2 YEAR WARRANTY

Multimetr
CMM-10
Index: WMXXCMM10

CAT II 600V

IP 40

Measurements:

- direct and alternating voltage,
- direct and alternating current,
- resistance,
- capacitance,
- duty cycle,
- temperature,
- diode test.

Additional functions of the meter:

Automatic or manual selection of ranges.

HOLD function, allowing for reading measurements in insufficient lighting or in difficult to access places.

REL function, allowing for performing relative measurements.

Acoustic signalling of circuit continuity (beeper).

Automatic power-off of an unused instrument.

3⅞ digits display (max. 5000).

Measurement of alternating and direct voltage

Display range	Resolution	Accuracy ~	Accuracy =
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)	±(1.2% m.v. + 2 digits)
40.00 V	0.01 V	±(1.5% m.v. + 3 digits)	
400.0 V	0.1 V		
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 ~	Accuracy =
400.0 µA	0.1 µA	±(1.5% m.v. + 5 digits)	±(1.0% m.v. + 3 digits)
4 000 µA	1 µA	±(1.8% m.v. + 5 digits)	±(1.5% m.v. + 3 digits)
40.00 mA	0.01 mA		
400.0 mA	0.1 mA		
4.000 A	0.001 A	±(3.0% m.v. + 7 digits)	±(2.5% m.v. + 5 digits)
10.00 A	0.01 A		

Standard accessories:

- Test leads (2 pcs)	**WAPRZCMP1**
- K type thermocouple	**WASONTEMK**
- 9 V battery	

Measurement of resistance

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	±(1,2% m.v. + 2 digits)
400.0 kΩ	0.1 kΩ	
4.000 MΩ	0.001 MΩ	
40.00 MΩ	0.01 MΩ	±(2,0% m.v. + 3 digits)

Measurement of capacitance

Display range	Resolution	Accuracy
40.00 nF	0.01 nF	±(5.0% m.v. + 7 digits)
400.0 nF	0.1 nF	±(3.0% m.v. + 5 digits)
4.000 µF	0.001 µF	
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	±(1.2% m.v. + 3 digits)
5.000 kHz	0.001 kHz	
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: minimal effective value of voltage 8 V.

Measurement of duty cycle

Display range	Resolution	Accuracy
0.1...99.9%	0.1%	±(1.2% m.v. + 2 digits)

- sensitivity: minimal effective value of voltage 8 V,
- impulse width: 100 µs - 100 ms,
- frequency range: 5Hz...150kHz.

Other technical data:

- type of insulation..... double, in acc. with EN 61010-1 and IEC 61557
- power supply of the meter..... 6LR61 type 9 V battery
- diode test..... I = 0.3 mA, U0 = 1.5 V DC
- continuity test..... I < 0.3 mA, acoustic signal for R < 50 Ω
- indication of range overflow..... "OL" symbol
- frequency of measurements..... 2 readouts per second
- input impedance..... 7.8 MΩ (V AC/DC)
- display..... LCD, readout 5000, including function indicators
- dimensions..... 138x68x37 mm
- total weight..... 210 g
- fuses..... range mA, µA: 0.5 A/250 V high-speed
  .....range A: 10 A/250 V high-speed
- auto-off idle timeout..... 30 minutes
- compliance with standards..... EN 61010-1, EN 61010-2-032

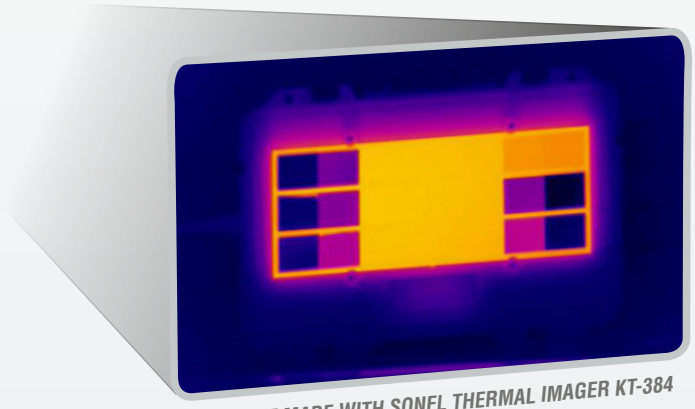
Nominal operating conditions:

- operating temperature..... 0...+50 ˚C at humidity < 70%
- storage temperature..... -20...+60 ˚C at humidity < 80%

Demonstration board

DB-THERMO

Index: WMXXDBTHERMO



PICTURE MADE WITH SONEL THERMAL IMAGER KT-384

Accessories:

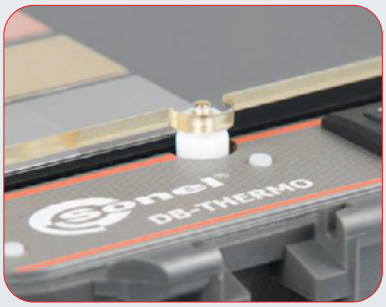
- IEC power cord	**WAPRZLAD230IEC**
- Experimental plate	

DB-Thermo demonstration board is an essential device for every training on non-contact temperature measurement or thermal imaging. DB-Thermo helps to understand emissivity effects of various materials and material surface type effects which influence temperature measurement.

DB-Thermo set includes a manual describing all infrared measurement issues. The device is protected by a solid case with removable lid.

DB-thermo hot plate has 0.96 emissivity, also includes various common material samples with different emissivity and matt or polished surface. Correct temperature of the hot plate guarantees programmable logic controller PLC. User has ability to set temperature from 40 ˚C to 60 ˚C which is displayed in real time on the LCD display.

SOLID CASE



EXPERIMENTAL PLATE

Technical specifications:

- hot plate temperature range ..... 40 ˚C to 60 ˚C
- power consumption ..... max.: 250 VA
- accuracy of hot plate temperature measurement ..... ± 1%
- temperature display resolution ..... 0.1 ˚C
- temperature setting resolution ..... 0.1 ˚C
- hysteresis ..... ± 3 ˚C
- temperature stabilization time ..... < 3 min
- hot plate emissivity and dimensions ..... 0.96 - 110 x 110mm
- copper, polished and matte ..... 70 x 30 mm
- brass polished and matte ..... 70 x 30 mm
- steel polished and matte ..... 70 x 30 mm
- laminate ..... 70 x 30 mm
- aluminum polished and matte ..... 70 x 30 mm
- chrome steel polished and matte ..... 70 x 30 mm

Electrical Safety:

- fuse protection ..... 2 x 250V F1A
- thermal protection ..... 75 ˚C

Other technical data:

- power supply ..... 230V AC
- display ..... LED, 4 digits (11mm) with graphical icons
- heating plate dimensions ..... 275 x 110 mm
- housing dimensions (W. / L. / H.) ..... 330 x 260 x 140 mm
- weight ..... approx. 3 kg

Heat plate emissivity 0.96 - matt blacked aluminium (110 x 110 mm).
Emissivity of materials (plates 70 x 30 mm):

	Emissivity	
Material:	**polished**	**matt**
Copper	0.05	0.51
Brass	0.05	0.54
Steel	0.05	0.62
Laminate	0.95	0.96
Aluminium	0.05	0.65
Chrome steel	0.05	0.67

DO YOU KNOW...

DB-THERMO demonstration board has built-in programmable driver, which monitors the temperature of heating plate.

2 YEAR WARRANTY

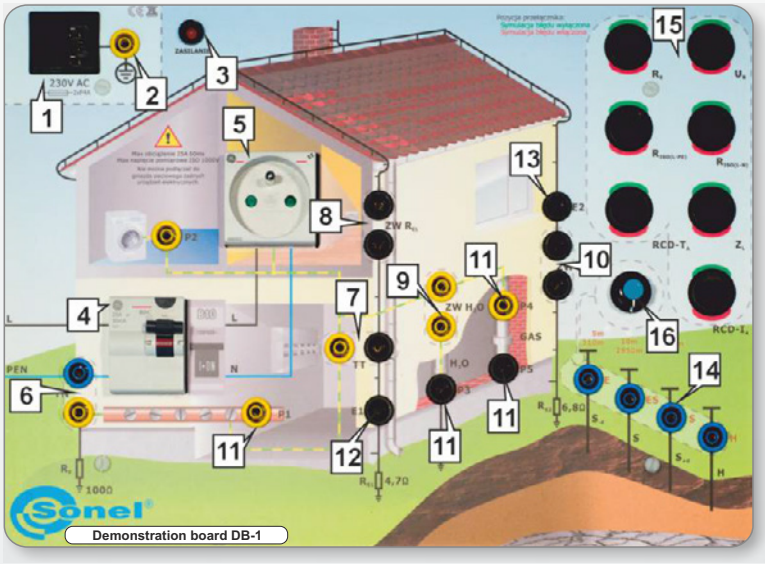
Demonstration board

DB-1

Index: WMGBDB1

CAT II 300V

IP 40



The DB-1 demonstration board allows for demonstrating the performance of the following measurements:

- short-circuit loop impedance in order to assess the condition of automatic disconnection of supply,
- RCD parameters,
- resistance to earth,
- soil resistivity,
- continuity of equipotential bonding,
- insulation resistance,
- supply system voltage.

This demonstration board allows for simulating typical defects and abnormalities in consumer power systems.

Technical specifications of the DB-1 board and properties of individual functions:

Short-circuit loop impedance:
- measurement of L-N short-circuit loop with impulse currents up to 25 A and 60 ms,
  measurement of L-PE short-circuit loop with currents up to 20 mA.

Measurement of RCD parameters (30 mA device):
- measurement of the RCD trip time,
- measurement of the RCD operating current,
- measurement of resistance to earth,
- measurement of touch voltage.

Soil resistivity:
- measurement of resistivity for three kinds of soil (14 Ωm; 300 Ωm; 6.2 kΩm).

Resistance to earth.
Measurement with the use of:
- the two-lead method,
- the three-lead method,
- the four-lead method,
- the three-lead method and clamp,
- the two-clamp method,
- a short-circuit 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.

Measurement of voltage:
- measurement of voltage in socket outlets.

Simulation of abnormalities:
- no continuity of earth conductor (RE),
- exceedance of safe voltage during the RCD measurement (UB),
- leakage current (IErr),
- too low L-N insulation resistance (RISO(L-N))
- too low L-PE insulation resistance (RISO(L-PE))
- too high short-circuit loop impedance (ZL),

1) Socket outlet 230 V.
2) Additional PE socket.
3) 230 V power supply status light.
4) RCD.
5) Measuring socket.
6) TN system jumper.
7) TT system jumper.
8) RE1 earth (ZW RE1).
9) Water pipe equipotential bonding jumper (ZW H2O).
10) RE2 earth (ZW RE2).
11) Metering points P1, P2, P3, P4, P5.
12) RE1 earthing metering point (E1).
13) RE2 earthing metering point (E2).
14) Test lead sockets.
15) Abnormality selector switches.
16) Soil type selector switch for measurements of soil resistivity.

DO YOU KNOW...

The DB-1 demonstration board allows for simulating various types of faults and abnormalities of a power system.

Other technical specifications:

- mains power supply..... 230 V
- warranty..... 24 months
- dimensions..... 405x300x140 mm
- weight of the instrument..... approx. 3.6 kg
- quality standard..... preparation, design and production in accordance with ISO 9001
- protection..... 2 x T3,14A 250 V, or 2xF4A 250 V
- power consumption..... approx. 15 mW
- RCD type.....30 mA AC type

Nominal operating conditions:

- operating temperature..... +10...+40 °C
- storage temperature..... -20...+60 °C
- humidity..... 20...80%

Standard Programable Resistors

SRP-50k0-5T0
Index: WMGBSRP50K05T0

SRP-50k0-10G0
Index: WMGBSRP50K010G0

SRP-50k0-100G0
Index: WMGBSRP50K0100G0

The SRP series standard programable resistors are a source of high resistances used as a reference equipment for calibration and check tests of analogue and digital insulation resistance meters.

Resistance provided by the calibrator can be connected to an external voltage up to 5000 V (SRP-50k0-5T0) or 2500 V (SRP-50k0-10G0 and SRP-50k0-100G0) for a prolonged time, if only current in the measuring circuit does not exceed 3 mA (SRP-50k0-5T0) or 1.5 mA (SRP-50k0-10G0 and SRP-50k0-100G0).

The required resistance is set by the user with the use of its touch keyboard or with the external PC application. Setting the required value is performed automatically thanks to the commutation of accurate resistance matrix. The controlling processor calculates the required combination of resistors, allowing for achieving an appropriate accuracy of resistance.

Standard accessories of SRP series calibrators:

- SRP software,	
- Test lead with banana plug; 1,8m; 5kV; blue	**WAPRZ1X8BUBB**
- Test lead banana plug; 1,8m; 5kV; red	**WAPRZ1X8REBB**
- Shielded cable with banana plugs; 2,2m; red	**WAPRZ2X2BLBBE**
- power supply cord	
- calibration certificate	

The calibrators are intended for operation in ambient temperature ranging from 10 to 30˚C, relative humidity ranging from 25 to 60% and atmospheric pressure ranging from 630 to 800 mmHg.

SRP-50k0-5T0 allows for setting any resistance within the range of 50 kΩ...5 TΩ for voltage up to 5 kV.

SRP-50k0-5T0 technical specifications:

Display range	Resolution	Accuracy
0.05...999.95 MΩ	0.05 MΩ	1.5 % s.v.
0.001...999.999 GΩ	0.001 GΩ	
0.0001...5.0000 TΩ	0.0001 TΩ	

·5TΩ = 5 000 GΩ = 5 000 000 MΩ = 5 000 000 000 kΩ = 5 000 000 000 000 Ω

SRP-50k0-10G0 and SRP-50k0-100G0 technical specifications:

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 MΩ	0.2% s.v.	0.1% s.v.
200.1...1000.0 MΩ	0.1 MΩ	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.

*- SRP-50k0-100G0 only; s.v. = "selected value"

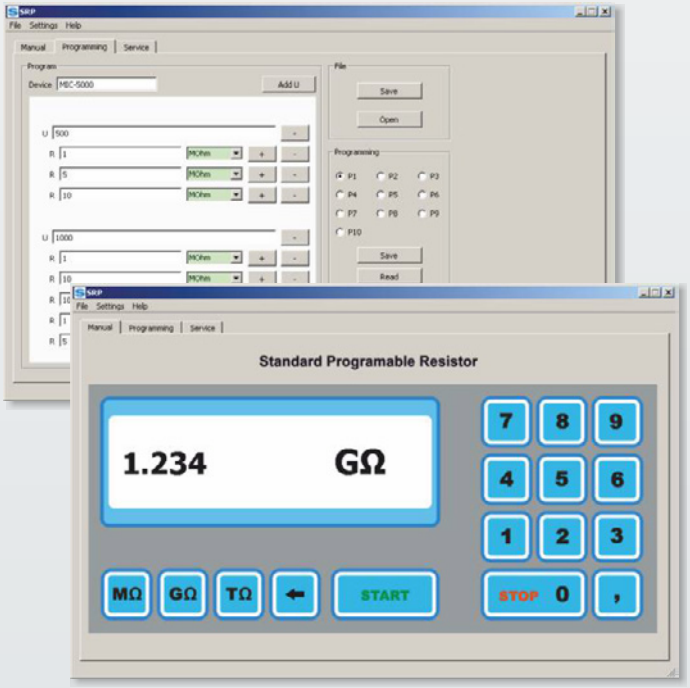
About the software:

SRP software is used for cooperation with the SRP series resistance calibrators with a computer.

The software is easy to use and is a useful tool for testing devices with the use of calibrators. The calibrator must be connected to a computer through the USB interface.

Capabilities of the software:

- remote control of the calibrator,
- creating and saving automatic programs for checking tested devices,
- enabling the calibrator keyboard lock and setting the time for switching over to suspend mode,
- changing display brightness and keyboard pressing sounds,
- selection of the software user interface language,
- updating calibrator software from a computer through the USB interface.



Other technical specifications:

- power supply voltage..... 100...240 V AC (50/60 Hz)
- maximal power consumption..... 75 VA
- operating temperature range..... +10...30°C
- maximal current in the measuring circuit.....3mA (SRP-50k0-5T0)
  .....1.5mA (SRP-50k0-10G0 and SRP-50k0-100G0)
- maximal operating voltage..... 5000 V DC (SRP-50k0-5T0)
  .....2500 V DC (SRP-50k0-10G0 and SRP-50k0-100G0)
- long-term stability of resistors..... < 1%
- dimensions..... 540x450x200 mm
- weight..... approx. 16 kg
- max. altitude.....2000m

2 YEAR WARRANTY

Worldwide distribution network

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