


Sonel®

# MEASUREMENT INSTRUMENTS

EXPERIENCE AND RELIABILITY

# ergonomic functional innovative from Sonel



## Quality & Safety

Our products have found recognition among many domestic and foreign customers.

We owe our high market position to continuous technological and functional development of our products, as well as adapting them to market requirements. It was confirmed by achieving internationally recognised ISO 9001:2008 Quality Management System and ISO 14001:2004 Environmental Management System certificates. Our instruments meet the EN 61557 and EN 61010 standards as well as the EMC Directive requirements, allowing us to use the CE mark on our products with full responsibility and allow for measurement in networks compilant with BS 7671 and VDE 0100.

Work Safety PN-N-18001:2004 ▸ Voluntary participation in regular monitoring — DEKRA Certification — DEKRA certified

Environmental Management ISO 14001:2004 ▸ Voluntary participation in regular monitoring — DEKRA Certification — DEKRA certified

Quality Management ISO 9001:2008 ▸ Voluntary participation in regular monitoring — DEKRA Certification — DEKRA certified

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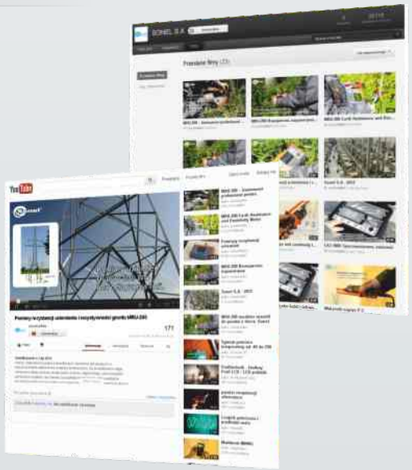
Product support can be found on our website:
recent firmware, software, drivers, manuals, technical data and publications



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Excellent products, good logistic service, efficient warranty and after-warranty service and after-sales Customer support are the most important elements of our strategy.

Our offer is not limited to measurement instruments.

We provide calibration services related to virtually all devices related to testing electric shock protection, as well as other electrical meters, thermal imagers, pyrometers, illuminance meters.

Many companies have already tried our services related to the Surface Mount Technology (SMT) assembly, and these who have not tried them yet, are invited to start cooperation with us in this area. We offer assembly services of Surface Mount Devices (SMD) on our professional automatic assembly line from FUJI. We have two Surface Mount Technology (SMT) assembly lines, Through-Hole Technology (THT) lines and three inspection stations.

Product assembly is carried in accordance with the IPC-A-610D standard.

We invite you to become familiar with our latest SONEL S.A. product catalogue. It provides clear and accessible help to our Customers. Mainly, we have presented technical specifications and usability features of our instruments. We guarantee top quality and professionalism and wish our Customers success in performing measurements.

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# ELECTRICAL SAFETY MEASUREMENTS

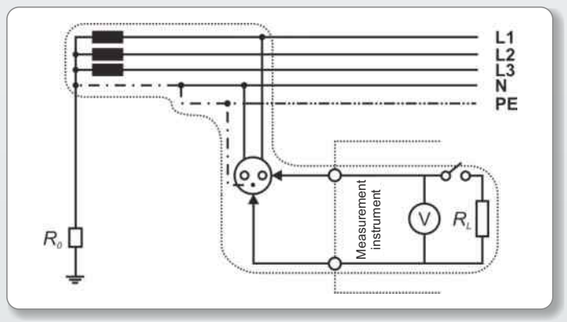
Current regulations require performing electrical system measurements during the rough-in inspection (after assembly, after each change or expansion of the system) and regularly during operation. The scope of inspection or periodic checks is specified in the HD 60364-6 standard. The requirements set 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 loop 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 loop 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:

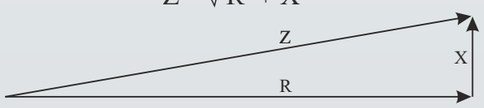
$$Z_s = U_n / I_A$$

where: $Z_s$ - short-circuit loop 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.

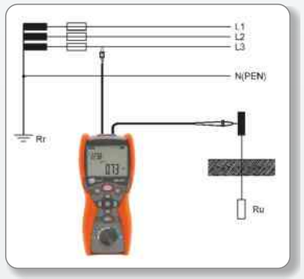



The $Z_s$ impedance value, necessary for determining whether the protection is proper or not, must be measured. During measurements of short-circuit loop current with the use of the technical method, an "artificial short-circuit" is created. The instrument performs voltage measurement under no-load conditions, and then under a short-time load with a short-circuit resistor. The short-circuit loop impedance is calculated based on the voltage drop difference. This measurement is provided by the short-circuit loop 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 loop 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 loop impedance.




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

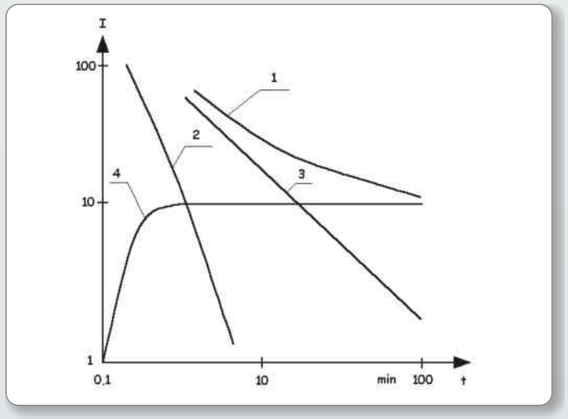
Short-circuit loop meters can be used for earth resistance measurement with the use of an auxiliary voltage source (phase conductor). Therefore the measured value is overstated - the measurement result is a sum of the measured resistance to earth, operational earthing resistance and the line conductor 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.

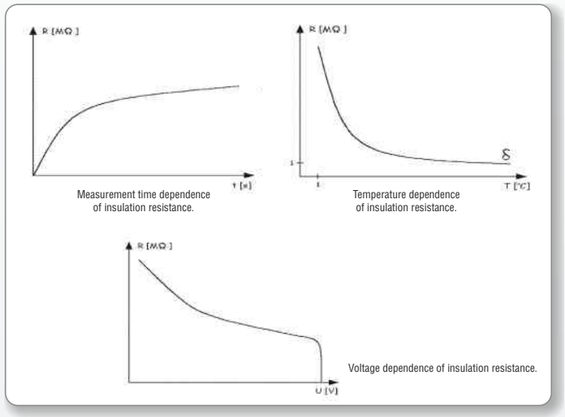
Systematic examinations of insulation condition is necessary in order to detect any deterioration of insulation and is a permanent element of inspection and measurement works. In the case of measurements of industrial equipment, the tendency of resistance value changes is of key importance, because it 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:

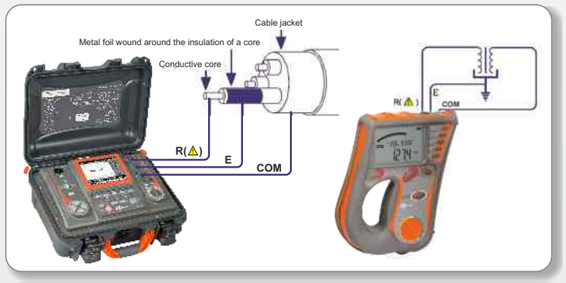



- the capacitance charging current (2) - depending on the capacitance (e.g. the length of measured cable),
- the absorption current (3) - resulting from charge and dipole movement in the electric field,
- the insulation leakage current (4) - the sum of currents flowing through and on the surface of the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

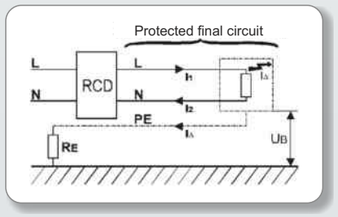



The use of the three-lead method is relevant in case of measurements of objects of very large resistance values (above 100 MΩ).

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.



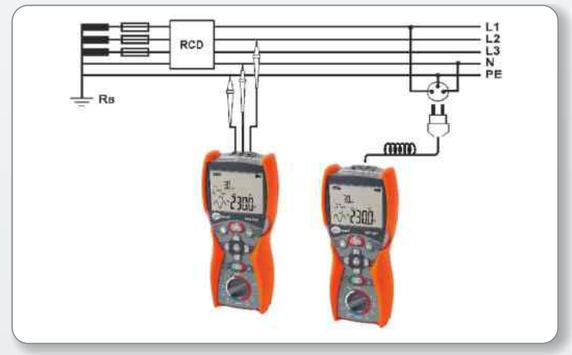

When there are no faults in the circuit protected by the RCD (residual current $I_\Delta = 0$), the $I_1$ input current equals the $I_2$ output current. In the event of a fault (e.g. insulation breakdown), the $I_\Delta$ fault current starts to flow, and the $I_2$ value is smaller than $I_1$. The RCD 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.



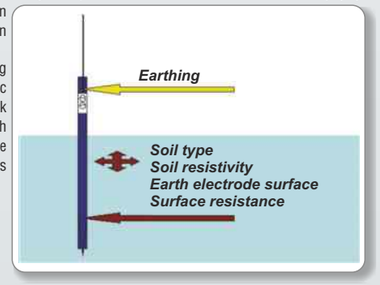

During each measurement procedure (except for alternating current voltage), the meter checks whether the resulting touch voltage exceeds the defined value of allowed long-term touch voltage. If this value be exceeded, the measurement will be automatically aborted (i.e. the differential measurement current 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.**

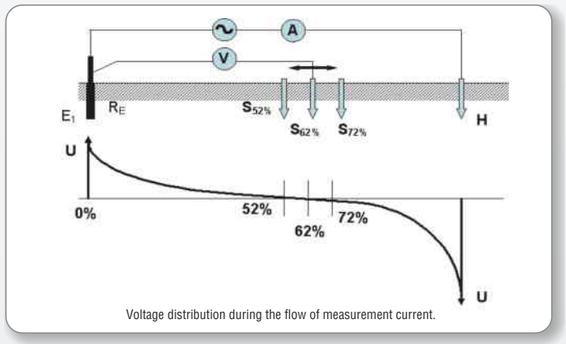
Measurements of earth resistance are performed in order to check electrical systems and fulfil the requirements related to the protection against electric shock. Besides protection against lightning, earthing also provides other functions related to safety (e.g. discharging electric charges in facilities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



## All the instruments meet the requirements of European Directives related to electromagnetic compatibility (EMC) as well as safety, and bear the CE marking.

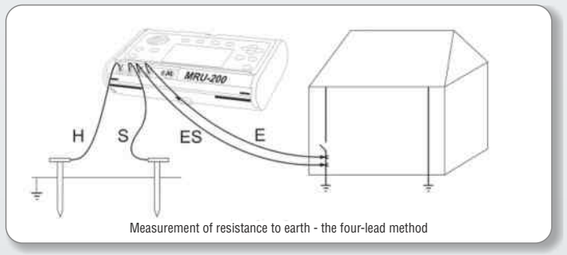
Earthing measurements can be performed with multi-function meters equipped with an appropriate function as well as with the specialized MRU series meters. For earth measurement resistance, the technical method is used most frequently - the meter calculates the resistance value by measuring voltage on 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.

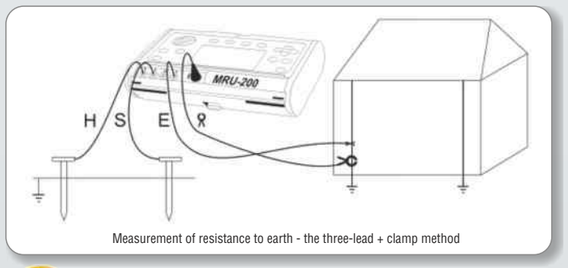
The voltage electrode is stuck into the ground between the measured earthing and the current electrode in the area of the so-called zero potential. In practice, performance of three measurements is recommended, with the voltage electrode relocated by 6 meters towards and away from the examined earthing. 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.



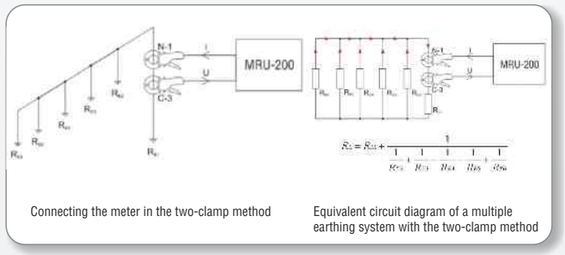
Measurement of resistance to earth - the four-lead method

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

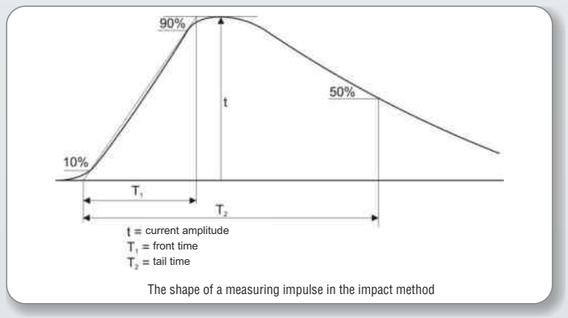
The two-clamp method is employed for measuring multiple earthing systems that are not connected underground. If the earthing systems are connected underground, this method allows for circuit continuity measurement only in the earthing system considered for electric shock protection, the behaviour of 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 ($Z_c$), 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.

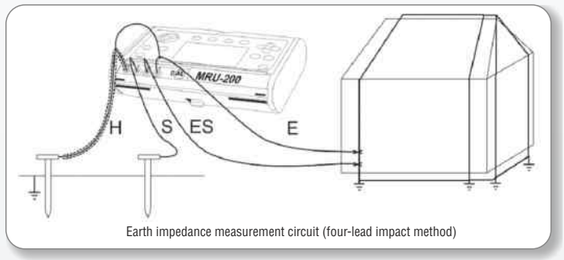
The measurement impulse parameters (simulating the shape of lightning discharge) are defined by two numbers: the front time $T_1$ and the tail time $T_2$. The MRU-200 meter allows for selecting one of the three shapes of impulses: 10/350µs, 8/20µs or 4/10µs.

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.



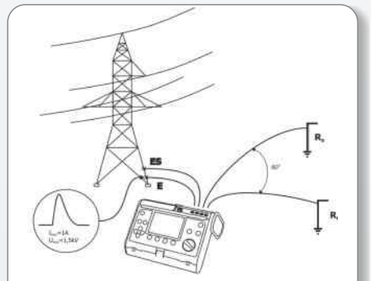
The shape of a measuring impulse in the impact method

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.



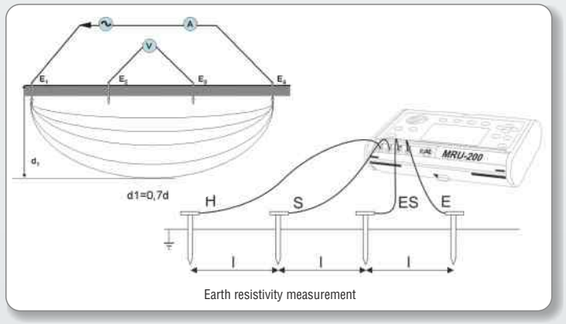
Earth impedance measurement circuit (four-lead impact method)

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.

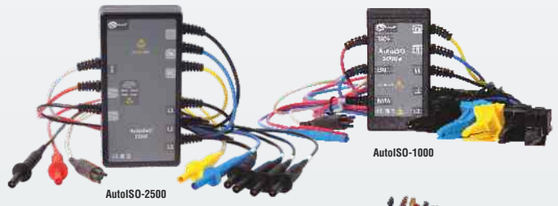
**Measurement facilities**

During measurements performed on live systems (short-circuit loop 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).

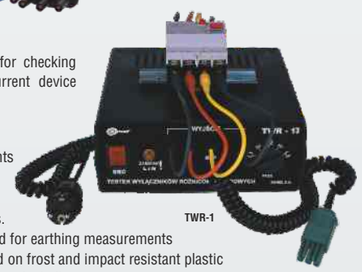
Moreover, the WS-01 and WS-03 adapters have buttons for triggering measurements and saving the results in memory. For three-phase or high-current measurements, one of the following adapters can be optionally used: the AGT-16P, AGT-32P, AGT-63P, AGT-16C, AGT-32C adapter for three-phase sockets or the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

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


TWR-1

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

Index: WMGBMPI530

Bluetooth® | IP 54 | CAT III 600V | CAT IV 300V

### Measurements of short-circuit loop impedance:

- impedance measurement with resolution 0.001 Ω and 23 A current (44 A phase-to-phase)
- short-circuit resistor $R_{SW}$=10 Ω
- measurement range: 95...440 V, frequency 45...65 Hz,
- measurement of short circuit loop 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 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 loop 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 and additional clamp,
- measurement with 2-clamp method,
- measurement of earth 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 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; 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** |
| - 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 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).**

### Additional wireless mini-keyboard:

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

### Measurement of the $Z_{L-PE}$, $Z_{L-N}$, $Z_{L-L}$ short-circuit loop 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. + 3 digits) |
| 20.00...199.99 Ω | 0.01 Ω | |
| 200...1999.9 Ω | 0.1 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 loop 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 | | |

### Selective earth 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 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 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 loop 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 loop 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 loop 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)

## Measurement of the $Z_{L-PE}$, $Z_{L-N}$, $Z_{L-L}$ short-circuit loop 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 loop 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 loop 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<br>Short-time delay | $0.5*I_{\Delta n}$ | 0...300ms | 1ms | ±(2% m.v. + 2 digits)<br>for RCD of $I_{\Delta n}$=10 mA and the measurement with $0,5xI_{\Delta n}$, error: |
| | $1*I_{\Delta n}$ | | | |
| | $2*I_{\Delta n}$ | 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 $0.5*I_{\Delta n}$ -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 | $0.3 \times I_{\Delta n}$...$1.0 \times I_{\Delta n}$ | ± 5% $I_{\Delta n}$ |
| 30mA | 9.0...30.0mA | | | |
| 100mA | 33...100mA | 1mA | | |
| 300mA | 90...300mA | | | |
| 500mA | 150...500mA | | | |
| 1000mA | 330...1000mA | | | |

- 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 | $0.4 \times I_{\Delta n}$ ...$2.0 \times I_{\Delta n}$ | ± 10% $I_{\Delta n}$ |
| 30mA | 10.5...42.0mA | | $0.4 \times I_{\Delta n}$ ...$1.4 \times I_{\Delta n}$ | |
| 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 | $0.4 \times I_{\Delta n}$ ...$2.0 \times I_{\Delta n}$ | ± 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)

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## 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 loop 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 loop 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 loop 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)

## Measurement of the $Z_{L-PE}$, $Z_{L-N}$, $Z_{L-L}$ short-circuit loop 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 loop 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 loop 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<br>Short-time delay | $0.5*I_{\Delta n}$ | 0...300ms | 1ms | ±(2% m.v. + 2 digits)<br>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 | | |
| 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)

CAT IV 300V

IP 54

DO YOU KNOW...

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

## Measurement of short-circuit loop 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 loop 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

## Multifunction electrical installations meter

# MPI-505

Index: WMGBMPI505

### 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 loop 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 | |

- $U_{L-N}/U_{L-L}$ 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 loop 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 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)

**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 x $I_{\Delta n}$...2.0 x $I_{\Delta n}$ | ± 10% $I_{\Delta n}$ |
| 30mA | 12.0...42.0mA | | | |
| 100mA | 40...140mA | 1mA | 0.35 x $I_{\Delta n}$...1.4 x $I_{\Delta n}$ | |
| 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

CAT IV 300V

IP 67

DO YOU KNOW...

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

## Measurement of short-circuit loop parameters:

- measurements of short-circuit loop 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 loop resistance and the $X_S$ short-circuit loop reactance,
- **measurement of short-circuit loop 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 $R_S$ and $U_S$ 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 $t_A$, 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)

## Multifunction electrical installations meter

# MPI-502

Index: WMGBMPI502

### 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 loop 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 loop 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 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 | | | |

· 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 x $I_{\Delta n}$...2.0 x $I_{\Delta n}$ | ± 10% $I_{\Delta n}$ |
| 30mA | 12.0...42.0mA | | | |
| 100mA | 40...140mA | 1mA | 0.35 x $I_{\Delta n}$...1.4 x $I_{\Delta n}$ | |
| 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 |
|---|---|---|---|---|---|
| **Measurement of short-circuit loop impedance [Ω]** | 0…1999 | 0…1999 | 0…1999 | 0…1999 | 0…1999 |
| Resolution of short-circuit loop 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 loop 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 ☐ 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 $t_A$ 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 all resistance combinations with the use of the additional AutoISO adapters | — | — | YES | YES | YES |
| Automatic measurement of multi-core cables with the AutoISO adapter | — | — | — | 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 |
| **Catalogue page** | 15 | 14 | 12 | 10 | 8 |

## WME-6

**(MPI-502, MIC-2510, CMP-400)**

Index: WMGBWME6

### The sets enable the performance of measurements in accordance with the HD 60364-6 standard:

- measurements of short-circuit loop parameters,
- measurements of AC and A type residual current devices,
- measurements of protective connection continuity,
- measurements of insulation resistance with voltage up to 2.5 kV (WME-6) or up to 1000 V (WME-5),
- measurement of voltage, current and frequency.

### Standard equipment of the WME-6 set:

| | |
|---|---|
| - MPI-502 meter | **WMGBMPI502** |
| - MIC-2510 meter | **WMGBMIC2510** |
| - CMP-400 meter | **WMGBCMP400** |
| - 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** |
| - "Crocodile" clip K04; 5kV; black | **WAKROBL20K04** |
| - "Crocodile" clip K05; 5kV; red | **WAKRORE20K05** |
| - Pin probe 5kV with banana connector; red | **WASONREOGB2** |
| - Pin probe 5kV with banana connector; black (MIC-2510) | **WASONBLOGB2** |
| - Power supply adaptor Z7 | **WAZASZ7** |
| - Rechargeable battery pack | **WAAKU10** |
| - Hanging straps | **WAPOZSZE2** |
| - Adapter WS-05 with UNI-Schuko | **WAADAWS05** |
| - Receiver – interface for radio transmission OR1 (USB) | **WAADAUSBOR1** |
| - Hanging straps | **WAPOZSZE4** |
| - Aluminium hard case for meters and accessories | **WAWALL4** |
| - Sonel Reader software | |
| - Calibration certificates (MPI-502, MIC-2510) | |
| - Batteries (MPI-502, CMP-400) | |

### 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)

## Measurement sets

## WME-5

**(MPI-502, MIC-10, CMP-400)**

Index: WMGBWME5

### Additionally:

**Wireless transmission of measurement results from the MPI-502 and MIC-2510 meter memory to a computer with the use of the included OR-1 adapter.**

**The sets and their accessories are placed in a convenient and durable aluminium hard case.**

### Standard equipment of the WME-5 set:

| | |
|---|---|
| - MPI-502 meter | **WMGBMPI502** |
| - MIC-10 meter | **WMGBMIC10** |
| - CMP-400 meter | **WMGBCMP400** |
| - Test lead with banana plug; 1,2m; black | **WAPRZ1X2BLBB** |
| - Test lead with banana plug; 1,2m; red | **WAPRZ1X2REBB** |
| - Test lead with banana plug; 1,2m; yellow | **WAPRZ1X2YEBB** |
| - Pin probe with banana connector; red | **WASONREOGB1** |
| - Pin probe with banana connector; blue | **WASONBUOGB1** |
| - Pin probe with banana connector; yellow | **WASONYEOGB1** |
| - „Crocodile" clip K01; black | **WAKROBL20K01** |
| - "Crocodile" clip K02; yellow | **WAKROYE20K02** |
| - Adapter WS-05 with UNI-Schuko | **WAADAWS05** |
| - Receiver – interface for radio transmission OR1 (USB) | **WAADAUSBOR1** |
| - Hanging straps (2 sets) | **WAPOZSZE4** |
| - Handle to suspend the meter (2 pcs) | **WAPOZUCH1** |
| - Set of test leads (CMP-400) | **WAPRZCMP1** |
| - Sonel Reader software | |
| - Aluminium hard case for meters and accessories | **WAWALL1** |
| - Batteries | |
| - Calibration certificates for MIC-10, MPI-502 | |

HIGH NOISE IMMUNITY UP TO 500 V INDUCED VOLTAGE!

CAT III 1000V

CAT IV 600V

IP 54

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,
- 1,2mA, 3mA or 5mA 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.**

**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,**

**Online data transfer for special request,**

**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)





HIGH NOISE IMMUNITY UP TO 500 V INDUCED VOLTAGE!

CAT III 1000V

CAT IV 600V

IP 54

## 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 ..... IP54 (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".

CAT IV 300V

IP 54

## Insulation resistance meter

# MIC-5000

Index: WMGBMIC5000

### Insulation resistance measurements:

- test voltage in range 250...5000 V with 50 V step, or predefined 250, 500, 1000, 2500, 5000 V,
- 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,
- direct measurement of one or two absorption coefficients,
- 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 absorption coefficients (DAR, PI),
- indication of actual measurement voltage during measurement,
- protection against measurements of live objects.

### Additionally:

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

**Memory of 999 measurement results and capability of data transfer to a PC.**

**Automatic selection of measurement sub-ranges.**

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

**Power supply from a rechargeable battery pack:**
- built-in circuit for automatic charging of internal batteries providing optimal operation and prolonged service life,
- signalling of the battery charge level.

### Electrical safety:

- type of insulation ..... double, in acc. with EN 61010-1 and IEC 61557
- measurement category ..... CAT IV 300 V (CAT III 600 V) acc. to EN 61010-1
- protection class acc. to EN 60529 ..... IP54

### Nominal operating conditions:

- operating temperature .....-10...+50°C
- accuracy of voltage setting ($R_{ISO}$[Ω] ≥ 1000*Un[V]) ..... -0...+10% of set value
- thermal stability of voltage better than.....0,2% /°C
- converter output current..... minimum 1.0 mA at each nominal voltage
- readout frequency..... approx. 1 measurement/second

### Other technical specifications:

- power supply of the meter..... NiMH rechargeable battery pack
- display..... segment LCD
- minimal measurement time 5 kV/1 mA defined in accordance with EN 61557 (5 s/25 s).... ..... 5 h or 600 measurements
- auto-off timeout:

$R_{ISO/R}$ measurement function ..... the longest programmed time $T_3$, $T_2$, $T_1$ + 300 s.
other measurement functions..... 300 s

### Standard accessories of MIC-5000 meter:

| | |
|---|---|
| - NiMH battery package 7,2V 3Ah | WAAKU05 |
| - Test lead with banana plug; 1,8m; 5kV; red | WAPRZ1X8REBB |
| - Test shielded lead with banana plug; 1,8m; 5kV; black | WAPRZ1X8BLBB |
| - Test lead with banana plug; 1,8m; 5kV; blue | WAPRZ1X8BUBB |
| - "Crocodile" clip K04; 5kV; black | WAKROBL20K04 |
| - "Crocodile" clip K05; 5kV; blue | WAKROBU20K05 |
| - "Crocodile" clip K05; 5kV; red | WAKRORE20K05 |
| - Pin probe 5kV with banana connector; black | WASONBLOGB2 |
| - Pin probe 5kV with banana connector; red | WASONREOGB2 |
| - Carrying case L1 | WAFUTL1 |
| - Hanging straps | WAPOZSZE1 |
| - Cable for battery charger | WAPRZLAD230 |
| - RS-232 serial transmission cable | WAPRZRS232 |
| - Calibration certificate | |
| - Sonel Reader software | |

### Measurement of insulation resistance

Measurement range in acc. with IEC 61557-2: $R_{ISOmin}$...5.0TΩ; $R_{ISOmin}=U_{ISOnom}/1mA$

| 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...5.000TΩ | 0.001TΩ | |

• thermal stability better than 0.2%/°C

### Minimal value of measured insulation resistance without limiting the measurement current limiter

| Voltage | Min. value |
|---|---|
| 250V | 250kΩ |
| 500V | 500kΩ |
| 1000V | 1.0MΩ |
| 2500V | 2.5MΩ |
| 5000V | 5.0MΩ |

"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)

CAT IV 600V

IP 54

## Insulation resistance meters

# MIC-2510, MIC-2505

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

### 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

### 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 | |

### Measurement of insulation resistance

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

## Insulation resistance meter

# MIC-30

Index: WMGBMIC30

CAT IV 600V

IP 67

### 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) |

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)

## Insulation resistance meter

# MIC-10

Index: WMGBMIC10

CAT IV 600V

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### 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 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)

## 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 to facilitate capturing time characteristics,
- protection against measurements of energised objects.

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

- measurement with current < 10 mA and the resolution of 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)

## Summary of the insulation resistance meters

| | MIC-10k1 | MIC-5050 | MIC-5010 | MIC-5005 | MIC-5000 | MIC-2510 | MIC-2505 | 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 | 250…5000 | 50…2500 | 500,1000, 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 | 20kΩ…15TΩ | 250kΩ…5TΩ | 50kΩ...2TΩ | 500kΩ...2TΩ | 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 | 1…600s | 15,60,600s | 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 | — | — | YES | — | YES | YES | — | YES | YES | YES |
| Automatic measurement of 3, 4 and 5-core wires with the AutoISO adapter | YES | YES | — | — | — | YES | — | — | — | — | YES | YES | — |
| Automatic measurement of 3, 4 and 5-core cables with the AutoISO adapter | YES | YES | — | — | — | YES | — | — | — | — | YES | — | — |
| Measurement of voltage | 0…750V | 0…750V | 0…600V | 0…600V | 0…600V | 0…600V | 0…600V | 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 | — | — | — | — | — | — | — |
| 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 / 10000* | 990 |
| Data transfer | USB, Bluetooth® | USB, Bluetooth® | USB, OR-1 | USB, OR-1 | RS-232 | USB, OR-1 | — | OR-1 | — | — | USB, OR-1 | USB, OR-1 / USB, Bluetooth®* | USB |
| Dimensions [mm] | 390x310x170 | 390x310x170 | 390x310x170 | 390x310x170 | 295x222x95 | 260x190x60 | 260x190x60 | 220x100x60 | 220x100x60 | 240x60x30 | 288x223x75 | 288x223x75 | 260x190x60 |
| Weight [kg] | 7 | 7 | 7 | 7 | 2.2 | 1.3 | 1.3 | 0.6 | 0.6 | 0.3 | 2.2 | 2.2 | 2.2 |
| Catalogue page | 18 | 18 | 19 | 19 | 20 | 21 | 21 | 22 | 23 | 24 | 10 | 8 / 12* | 14 |

Automatic measurement of insulation resistance of multiple core cables with the use of the AutoISO-2500 adapter.

## High-current short-circuit loop impedance meter

# MZC-310S

Index: WMGBMZC310S

CAT IV 300V

IP 20

### Measurement of short-circuit loop impedance:

- measurements of low impedance values of short-circuit loops (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 loop: 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 loop 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 loop 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 loop 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 loop parameters (four-lead, $I_{max}$=280A)

**High-current measurement of short-circuit loop 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 loop 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) |

## Short-circuit loop 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 loop impedance:

- measurement of short-circuit loop 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 loop 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 loop 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 loop 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 loop impedance meter

# MZC-304

Index: WMGBMZC304

CAT IV 300V

IP 67

### Measurement of short-circuit loop parameters:

- measurements of short-circuit loop 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 loop 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 loop resistance and $X_s$ short-circuit loop 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 loop impedance, as well as resistance and reactance

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 loop 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 $I_{\Delta n}$≥30mA,

DO YOU KNOW...

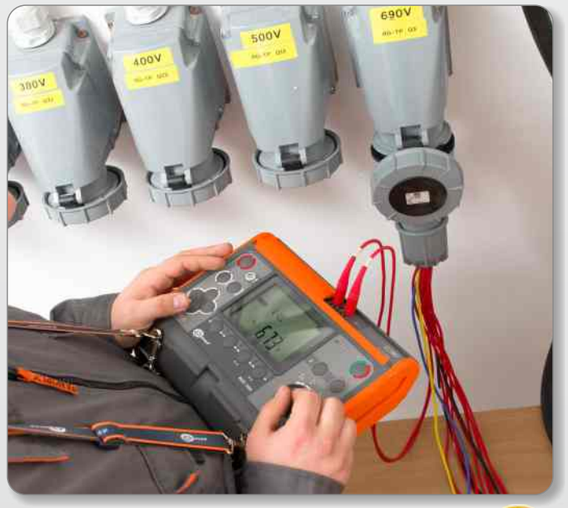
**MZC-304 meter always measures impedance as well as its components - resistance and reactance - regardless of phase shift.**

### 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)

## Summary of the short-circuit loop meters

| | MZC-310S | MZC-306 | MZC-304 | 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 | 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 | 95..440 | 95..440 | 100...440 | 180...460 |
| Display range [Ω] | 0…199.9 | 0…1999 | 0…1999 | 0…1999 | 0…1999 | 0…1999 | 0…1999 |
| Max. resolution[Ω] | 0.0001 | 0.01 | 0.01 | 0.001 | 0.01 | 0.01 | 0.01 |
| Max. resolution for the measurement without tripping RCDs [Ω] | — | 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 | 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 | 0.130…1999 | 0.13…1999 | 0.13…1999 | 0.13…1999 |
| Display of short-circuit loop resistance and reactance | YES | YES | YES | YES | YES | YES | YES |
| Calculation of prospective short-circuit current | 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 |
| 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 |
| Dimensions [mm] | 295x222x95 | 288x223x75 | 220x98x58 | 288x223x75 | 288x223x75 | 260x190x60 | 220x98x58 |
| Weight [kg] | 2.2 | 2.2 | 1 | 2.2 | 2.2 | 2.2 | 1 |
| Catalogue page | 26 | 27 | 28 | 8 | 10. 12 | 14 | 15 |


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-200GPS).**
**Coordinates of the measurement are stored in meter memory (only MRU-200GPS)**
**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-200GPS

Index: WMGBMRU200
WMGBMRU200GPS

## 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; 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: **0.100Ω...19.99kΩ**

| Display range | Resolution | Accuracy |
|---|---|---|
| 0.000...3.999Ω | 0.001Ω | ±(2% m.v. + 4 digits) |
| 4.00...39.99Ω | 0.01Ω | ±(2% m.v. + 2 digits) |
| 40.0...399.9Ω | 0.1Ω | |
| 400...3999Ω | 1Ω | |
| 4.00kΩ...19.99kΩ | 0.01kΩ | ±(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: **0.120Ω...1999Ω**

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

### Measurement of multiple earthing with two clamps

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

### Measurement of impedance to earth ($Z_E$) with the impulse method (four-lead, $\frac{U}{I}$)

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

## 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%






## 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%

### Earth resistance meter

# MRU-120

Index: WMGBMRU120

## 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; shielded. | **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: **0.30Ω...19.9kΩ**

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

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: **0.44Ω...1999Ω**

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

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...19.99Ω | 0.01Ω | ±(10% m.v. + 3 digits) |
| 20.0...149.9Ω | 0.1Ω | ±(20% m.v. + 3 digits) |

Earth resistance meters

# MRU-105 and MRU-106

Index: WMGBMRU105
Index: WMGBMRU106

CAT III 300V

IP 54

## Standard accessories of the meter:

| | |
|---|---|
| - Test lead on a reel with banana plugs; 50m; shielded. | **WAPRZ050YEBBSZ** |
| - Test lead on a reel with banana plugs; 25m; red | **WAPRZ025REBBSZ** |
| - Pin probe with banana connector; yellow | **WASONYEOGB1** |
| - Test lead with banana plug; 1,2m; yellow | **WAPRZ1X2YEBB** |
| - Test lead with banana plug 2,2m; black | **WAPRZ2X2BLBB** |
| - Earth contact test probe (rod); 0,30m - 2 pcs | **WASONG30** |
| - "Crocodile" clip K01; black | **WAKROBL20K01** |
| - Carrying case L2 | **WAFUTL2** |
| - USB cable | **WAPRZUSB** |
| - Hanging straps | **WAPOZSZE1** |
| - Calibration certificate, batteries | |

## Measurements of earth ground resistance:

- with the use of auxiliary probes and the three-lead method,
- with the use of auxiliary probes and the four-lead method,
- measurement of multiple earthing with the use of the three-lead method without disconnecting measured earthing (with measurement clamp),
- supervision of measurement conditions (e.g. presence of interfering voltages, influence of the $R_n$ and $R_s$ resistance of measurement probes and the condition of batteries),
- high resistance to interfering voltages.

## Measurement of soil resistivity (with Wenner method):

- with the capability of selecting the distance of measurement electrode spacing - measurement on various depths.

## Additionally:

**Measurement of resistance with the use of the two or four-lead method.**

**Memory of 300 measurement results, data transfer to a computer (over the USB interface).**

DO YOU KNOW...

**The MRU-105 meter performs measurements with current of 128 Hz frequency, which makes it highly resistant to interference from 50 Hz power systems. MRU-106 is dedicated to measurements 60Hz power networks (154 Hz)**

## 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 PN-EN 61010-1 and IEC 61557
- power supply..... LR14 alkaline batteries (size C) or NiMH .....rechargeable battery back (optional)
- battery charger power supply..... 100...250 V, 50...60 Hz
- display..... LCD

## Nominal operating conditions:

- operating temperature..... 0...+40˚C
- maximal interfering AC+DC voltage during measurement..... 24 V (68 $V_{p-p}$)
- measurement current for the resistance value of 100 Ω..... not smaller than 225 mA
- maximal measurement voltage..... 40 V
- measurement current frequency (MRU-105)..... 128 Hz
- measurement current frequency (MRU-105)..... 154 Hz

### Measurement of earth resistance (3p, 4p)

Measurement range in acc. with IEC 61557-5: **0.13Ω...20.0kΩ**

| Display range | Resolution | Accuracy |
|---|---|---|
| 0.00...9.99Ω | 0.01Ω | ±(3% m.v. + 3 digits) |
| 10.0...99.9Ω | 0.1Ω | ±(2% m.v. + 2 digits) |
| 100...999Ω | 1Ω | |
| 1.00...9.99kΩ | 0.01kΩ | |
| 10.0...20.0kΩ | 0.1kΩ | |

DO YOU KNOW...

**The MRU-105 and MRU-106 meters allows for the measurement of resistance to earth of multiple earthing systems employing the technical method, with the use of additional clamp, without the necessity for disconnecting test connections.**

### Measurement of earth resistance with the use of a clamp

Measurement range in acc. with IEC 61557-5:: **0.16Ω...20.0kΩ**

| Display range | Resolution | Accuracy |
|---|---|---|
| 0.00...9.99Ω | 0.01Ω | ±(8% m.v. + 3 digits) |
| 10.0...99.9Ω | 0.1Ω | ±(8% m.v. + 2 digits) |
| 100...999Ω | 1Ω | |
| 1.00...9.99kΩ | 0.01kΩ | |
| 10.0...20.0kΩ | 0.1kΩ | |

### Measurement of earth resistivity

| Display range | Resolution | Accuracy |
|---|---|---|
| 0.00...9.99Ωm | 0.01Ωm | ±(8% m.v. + 3 digits) |
| 10.0...99.9Ωm | 0.1Ωm | Depends on the accuracy of the $R_s$ four-lead measurement, but not lower than 1 digit |
| 100...999Ωm | 1Ωm | |
| 1.00...9.99kΩm | 0.01kΩ | |
| 10.0...99.9kΩm | 0.1kΩ | |
| 100...999kΩm | 1kΩm | |

Earth resistance meters

# MRU-20

Index: WMGBMRU20

CAT III 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 $R_n$,
- 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%

Earth resistance meters

# MRU-21

Index: WMGBMRU21

CAT III 300V

IP 54

## 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)

## Summary of the earthing measurement instruments

| | MRU-200 | MRU-120 | MRU-105 | MRU-21 / MRU-20* | MPI-530 | MPI-525/520/520Start |
|---|---|---|---|---|---|---|
| **Three-lead method (3p)** | 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 |
| **Technical method with additional clamp (3p+clamp)** | YES | YES | YES | — | YES | — |
| **Impulse method - earth ground impedance** | YES | — | — | — | — | — |
| **2-clamp method** | 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 |
| Internal current source | YES | YES | YES | YES | YES | YES |
| Measurement of resistance | YES | YES | YES | YES | YES | YES |
| Battery charger, rechargeable battery | YES | YES | YES | — | YES | YES/Optional/Optional |
| Memory (number of records) | 990 | 990 | 300 | 990 / —* | 10000 | 990 |
| Measurement of interfering voltages | YES | YES | YES | YES | YES | YES |
| Measurement of auxiliary probe resistance | YES | YES | YES | YES | YES | YES |
| Dimensions [mm] | 288x223x75 | 288x223x75 | 295x223x95 | 288x223x75 / 260x190x60* | 288x223x75 | 288x223x75 |
| Weight [kg] | 2 | 2 | 1.7 | 1.4 / 1.3* | 2.2 | 2.2 |
| Catalogue page | 30 | 31 | 32 | 33 | 8 | 10. 12 |







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%

RCD meter

# MRP-201

Index: WMGBMRP201

### 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 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 | | | |

- 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 x $I_{\Delta n}$...2.0 x $I_{\Delta n}$ | ± 10% $I_{\Delta n}$ |
| 30mA | 4.5...42.0mA | | 0.15 x $I_{\Delta n}$...1.4 x $I_{\Delta n}$ | ± 10% $I_{\Delta n}$ |
| 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 x $I_{\Delta n}$...2.0 x $I_{\Delta n}$ | ± 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.

## Summary of standard and additional accessories for protection system measurement instruments


| | Accessories | Fig. | Catalogue index | MPI-530 | MPI-525 | MPI-520 | MPI-520S | MPI-505 | MPI-502 | MIC-10K1 | MIC-5050 | MIC-5010 | MIC-5005 | MIC-5000 | MIC-2510 | MIC-2505 | MIC-30 | MIC-10 | MIC-2 | MRP-201 | MRU-20 | MRU-21 | MRU-105 | MRU-120 | MRU-200 | MZC-304 | MZC-306 | MZC-310S |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ADAPTERS | Triple 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 |
| | Triple 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 |
| | 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 |
| | Triple 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 |
| | Triple 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 |
| | 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 |
| | Triple 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 |
| | AutoISO-1000C Adapter | 8 | WAADAAISO10C | O | | O | O | | | | | | | | | | | | | | | | | | | | | |
| | AutoISO-2500 Adapter | 9 | WAADAAISO25 | | O | | | | | | | | | | O | | | | | | | | | | | | | |
| | AutoISO-5000 Adapter | 10 | WAADAAISO5 | | | | | | | O | O | | | | | | | | | | | | | | | | | |
| | RCD breaker testing adapter TWR-1J (universal pin) | 11 | WAADATWR1J | O | O | O | O | O | O | | | | | | | | | | | O | | | | | | | | |
| | Adapter with START button with UNI-Schuko (WS-01) | 12 | WAADAWS01 | | | | | ● | O | | | | | | | | | | | O | | | | | | O | O | |
| | Adapter with START button with UNI-Schuko (WS-03) | 12 | WAADAWS03 | ● | ● | ● | ● | | | | | | | | | | | | | | | | | | | | | |
| | Adapter WS-04 with UNI-Schuko | 13 | WAADAWS04 | O | O | O | O | | | | | | | | | | O | | | | | | | | | | | |
| | Adapter WS-05 with UNI-Schuko | 13 | WAADAWS05 | | | | | O | ● | | | | | | | | | | | ● | | | | | | ● | O | |
| | AC line splitter AC-16 | 14 | WAADAAC16 | O | O | O | O | | | | | | | | | | | | | | | | | | | | | |
| | MPI-LP Adapter | 15 | WAADAWS06 | O | | | | | | | | | | | | | | | | | | | | | | | | |
| | Magnetic voltage adapter (4 pcs) | 65 | WAADAUMAGKPL | O | O | O | O | O | O | | | | | | | | | | | O | | | | | | O | O | O |
| | Voltage Adapter with M4/M6 (5 pcs) | 66 | WAADAM4M6 | O | O | O | O | O | O | | | | | | | | | | | O | | | | | | O | O | O |
| BATTERIES | NiMH 4,8V 4,2Ah rechargeable battery | 16 | WAAKU07 | ● | ● | O | O | | | | | | | | | | | | | | | | | O | ● | | ● | |
| | NiMH battery package 7,2V 3Ah | 17 | WAAKU05 | | | | | | | | | | | ● | | | | | | | | | O | | | | | |
| | NiMH 9.6 V rechargeable battery | 18 | WAAKU10 | | | | | | | | | | | | ● | ● | | | | | | | | | | | | |
| POWER SUPPLY | Charging set (chargers + battery) | * | WAKPLLADMPI520 | ● | O | O | O | | | | | | | | | | | | | | | | | O | ● | | | |
| | Box for batteries | 16 | WAPOJ1 | O | O | ● | ● | | | | | | | | | | | | | | | ● | | O | O | | O | |
| | Cable for battery charging with car plug 12V | 19 | WAPRZLAD12SAM | ● | O | O | O | | | | | | | | O | O | | | | | | | | O | ● | | O | |
| | Cable for battery charger | 20 | WAPRZLAD230 | ● | ● | O | O | | | | | | | ● | ● | ● | | | | | | | O | ● | ● | | | |
| | Cable for battery charger (IEC plug) | 21 | WAPRZ1X8BLIEC | | | | | | | ● | ● | ● | ● | | | | | | | | | | | | | | | |
| | Power supply adaptor Z7 | 22 | WAZASZ7 | ● | ● | O | O | | | | | | | | ● | ● | | | | | | | | | ● | | ● | |
| CLAMPS | C-3 clamp (Ø 52mm) | 23 | WACEGC30KR | O | | O | O | | | | | | | | | | | | | | | | O | O | O | | | |
| | C-6 clamp | 26 | WACEGC60KR | O | | | | | | | | | | | | | | | | | | | | | | | | |
| | F-1 clamp (Ø 360mm) | 24 | WACEGF10KR | O | | | | | | | | | | | | | | | | | | | | | O | | | |
| | F-2 clamp | 24 | WACEGF20KR | O | | | | | | | | | | | | | | | | | | | | | O | | | |
| | F-3 clamp | 24 | WACEGF30KR | O | | | | | | | | | | | | | | | | | | | | | O | | | |
| | N-1 clamp (Ø 52mm, with test lead) | 25 | WACEGN1BB | O | | | | | | | | | | | | | | | | | | | | O | O | | | |
| ALLIGATOR CLIPS AND CLAMPS | „Crocodile" clip K01; black | 30 | WAKROBL20K01 | | | | | | | | | | | | | | O | ● | ● | | ● | ● | ● | ● | ● | | | |
| | "Crocodile" clip K03; black | 27 | WAKROBL30K03 | | | | | | | | | | | | | | | | | | | | | | | | | ● |
| | "Crocodile" clip K02; red | 30 | WAKRORE20K02 | ● | ● | ● | ● | O | O | | | | | | | | O | O | | O | | | | | O | O | O | |
| | Kelvin's clamp | 29 | WAKROKELK06 | | | | | | | | | | | | | | | | | | | | | | | | | ● |
| | "Crocodile" clip K02; blue | 30 | WAKROBU20K02 | O | O | O | O | O | O | | | | | | | | ● | O | | O | ● | ● | | | | O | ● | |
| | "Crocodile" clip K02; yellow | 30 | WAKROYE20K02 | ● | ● | ● | ● | ● | ● | | | | | | | | | | | ● | | | O | | | ● | O | |
| | "Crocodile" clip 5,5 kV; black | 28 | WAKROBL32K07 | | ● | | | | | ● | ● | ● | ● | ● | ● | ● | | | | | | | | | | | | |
| | "Crocodile" clip 5,5 kV; red | 28 | WAKRORE32K07 | | O | | | | | ● | ● | ● | ● | ● | ● | ● | | | | | | | | | | | | |
| | "Crocodile" clip 5,5 kV; blue | 28 | WAKROBU32K07 | | | | | | | ● | ● | ● | ● | ● | ● | ● | | | | | | | | | | | | |
| | "Crocodile" clip 5,5 kV; yellow | 28 | WAKROYE32K07 | | O | | | | | O | O | | | | O | | | | | | | | | | | | | |
| | Cramp | 30 | WAZACIMA1 | O | O | O | O | | | | O | | | | | | | | | | O | O | O | O | ● | | | |
| LEADS AND LEADS ON REELS | Test lead with banana plug; 1,2m; black | 31 | WAPRZ1X2BLBB | | | | | | | | | | | | | | | ● | | | | | | | | | | ● |
| | Test lead with banana plug; 1,2m black, shielded | 32 | WAPRZ1X2BLBBE | | | | | | | | | | | | | | ● | | | | | | | | | | | |
| | Test lead with banana plug; 1,2m; red | 31 | WAPRZ1X2REBB | ● | ● | ● | ● | ● | ● | | | | | | | | ● | ● | | ● | | | | ● | ● | ● | ● | |
| | Test lead with banana plug; 1,2m; blue | 31 | WAPRZ1X2BUBB | ● | ● | ● | ● | ● | ● | | | | | | | | ● | O | | ● | ● | ● | | | | ● | ● | |
| | Test lead with banana plug; 1,2m; yellow | 31 | WAPRZ1X2YEBB | ● | ● | ● | ● | ● | ● | | | | | | | | | | | ● | | | ● | | | ● | ● | ● |
| | Test shielded lead with banana plug; 1,8m; 5kV; black | 33 | WAPRZ1X8BLBB | | ● | | | | | | | | | ● | ● | ● | | | | | | | | | | | | |
| | Test lead with banana plug; 1,8m; 5kV; red | 33 | WAPRZ1X8REBB | | ● | | | | | | | | | ● | ● | ● | | | | | | | | | | | | |
| | Test lead with banana plug; 1,8m; 5kV; blue | 33 | WAPRZ1X8BUBB | | | | | | | | | | | ● | ● | ● | | | | | | | | | | | | |
| | Test lead with banana plug; 1.8m; 10 kV; black, shielded | 37 | WAPRZ1X8BLBB10KE | | | | | | | O | O | ● | ● | | | | | | | | | | | | | | | |
| | Test lead with banana plug; 1.8m; 10 kV; red | 37 | WAPRZ1X8REBB10K | | | | | | | O | O | ● | ● | | | | | | | | | | | | | | | |
| | Test lead with banana plug; 1.8m; 10 kV; blue | 37 | WAPRZ1X8BUBB10K | | | | | | | O | O | ● | ● | | | | | | | | | | | | | | | |
| | Test lead with banana plug; 2m; double wire | 34 | WAPRZ002DZBB | O | | | | | | | | | | | | | | | | | | | | O | O | | | |
| | Test lead with banana plug 2,2m; black | 31 | WAPRZ2X2BLBB | | | | | | | | | | | | | | | | | | | ● | ● | ● | ● | ● | | |
| | Test lead with banana plug; 3m; double wire | 35 | WAPRZ003DZBBU1I1 | | | | | | | | | | | | | | | | | | | | | | | | | ● |
| | Test lead with banana plug; 3m; double wire | 35 | WAPRZ003DZBBU2I2 | | | | | | | | | | | | | | | | | | | | | | | | | ● |
| | Test lead with banana plug; 3m; 10 kV; black, shielded | 37 | WAPRZ003BLBB10KE | | | | | | | ● | ● | O | O | | | | | | | | | | | | | | | |
| | Test lead with banana plug; 3m; 10 kV; red | 37 | WAPRZ003REBB10K | | | | | | | ● | ● | O | O | | | | | | | | | | | | | | | |
| | Test lead with banana plug; 3m; 10 kV; blue | 37 | WAPRZ003BUBB10K | | | | | | | ● | ● | O | O | | | | | | | | | | | | | | | |
| | Test lead with banana plug, 5m, blue | 36 | WAPRZ005BUBB | | | | | | | | | | | | | | O | O | | | | | | | | | | |
| | Test lead with banana plug; 5m; 5kV; blue | 33 | WAPRZ005BUBB5K | | | | | | | | | | | | ● | ● | | | | | | | | | | | | |
| | Test lead with banana plug; 5m, black, shielded | 32 | WAPRZ005BLBBE | | | | | | | | | | | | | | O | O | | | | | | | | | | |
| | Test lead with banana plug; 5m; 5kV; black, shielded | 33 | WAPRZ005BLBBE5K | | | | | | | | | | | | O | O | | | | | | | | | | | | |
| | Test lead with banana plug 5m; red | 36 | WAPRZ005REBB | O | O | O | O | O | O | | | | | | | | O | O | | O | | | | | | O | O | |
| | Test lead with banana plug; 5m; 5kV; red | 33 | WAPRZ005REBB5K | | | | | | | | | | | | O | O | | | | | | | | | | | | |
| | Test lead with banana plug 5m; yellow | 36 | WAPRZ005YEBB | | | | | | | | | | | | | | | | | | | | | | | | | O |
| | Test lead with banana plug; 5m; 10 kV; black, shielded | 37 | WAPRZ005BLBB10KE | | | | | | | O | O | O | O | | | | | | | | | | | | | | | |
| | Test lead with banana plug; 5m; 10 kV; red | 37 | WAPRZ005REBB10K | | | | | | | O | O | O | O | | | | | | | | | | | | | | | |
| | Test lead with banana plug; 5m; 10 kV; blue | 37 | WAPRZ005BUBB10K | | | | | | | O | O | O | O | | | | | | | | | | | | | | | |
| | Test lead with banana plug;10m; 5kV; black, shielded | 33 | WAPRZ010BLBBE5K | | | | | | | | | | | | O | O | | | | | | | | | | | | |
| | Test lead with banana plug 10m; red | 36 | WAPRZ010REBB | O | O | O | O | O | O | | | | | | | | | | | O | | | | | | O | O | |
| | Test lead with banana plug; 10m; 5kV; red | 33 | WAPRZ010REBB5K | | | | | | | | | | | | O | O | | | | | | | | | | | | |
| | Test lead with banana plug; 10m; 5kV; blue | 33 | WAPRZ010BUBB5K | | | | | | | | | | | | O | O | | | | | | | | | | | | |
| | Test lead with banana plug 10m; yellow | 36 | WAPRZ010YEBB | | | | | | | | | | | | | | | | | | | | | | | | | O |

● standard accessories of the meters  O additional accessories  *) figure 16+19+20+22

| | Accessories | Fig. | Catalogue index | MPI-530 | MPI-525 | MPI-520 | MPI-520S | MPI-505 | MPI-502 | MIC-10k1 | MIC-5050 | MIC-5010 | MIC-5005 | MIC-5000 | MIC-2510 | MIC-2505 | MIC-30 | MIC-10 | MIC-2 | MRP-201 | MRU-20 | MRU-21 | MRU-105 | MRU-120 | MRU-200 | MZC-304 | MZC-306 | MZC-310S |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Test lead with banana plug; 10m; 10 kV; black, shielded | 37 | WAPRZ010BLBB10KE | | | | | | | o | o | o | o | | | | | | | | | | | | | | | |
| | Test lead with banana plug; 10m; 10 kV; red | 37 | WAPRZ010REBB10K | | | | | | | o | o | o | o | | | | | | | | | | | | | | | |
| | Test lead with banana plug; 10m; 10 kV; blue | 37 | WAPRZ010REBB10K | | | | | | | o | o | o | o | | | | | | | | | | | | | | | |
| | Test lead with banana plug 20m; red | 36 | WAPRZ020REBB | o | o | o | o | o | o | | | | | | | | | | | o | | | | | | o | o | |
| | Test lead with banana plug 20m; yellow | 36 | WAPRZ020YEBB | | | | | | | | | | | | | | | | | | | | | | | | | o |
| | Test lead with banana plug; 20m; 10 kV; black, shielded | 37 | WAPRZ020BLBB10KE | | | | | | | o | o | o | o | | | | | | | | | | | | | | | |
| | Test lead with banana plug; 20m; 10 kV; red | 37 | WAPRZ020REBB10K | | | | | | | o | o | o | o | | | | | | | | | | | | | | | |
| | Test lead with banana plug; 20m; 10 kV; blue | 37 | WAPRZ020BUBB10K | | | | | | | o | o | o | o | | | | | | | | | | | | | | | |
| | Teast leand on a reel with banana plug; 15m; blue | 38 | WAPRZ015BUBBSZ | ● | ● | ● | o | | | | | | | | | | | | | | ● | ● | | | | | | |
| | Test lead on a reel with banana plug; 25m; red | 38 | WAPRZ025REBBSZ | | | | | | | | | | | | | | | | | | | | ● | ● | ● | | | |
| | Test lead on a reel with banana plug; 25m; blue | 38 | WAPRZ025BUBBSZ | o | o | o | o | | | | | | | | | | | | | | o | o | o | ● | ● | | | |
| | Test lead on a reel with banana plug; 30m; red | 38 | WAPRZ030REBBSZ | ● | ● | ● | o | | | | | | | | | | | | | | ● | ● | | | | | | |
| | Test lead on a reel with banana plug; 50m | 38 | WAPRZ050YEBBSZ | o | o | o | o | | | | | | | | | | | | | | o | o | ● | ● | | | | |
| | Test lead on a reel with banana plug; 50m; shielded | 38 | WAPRZ050YEBBSZE | | | | | | | | | | | | | | | | | | | | | | ● | | | |
| | Test wire reel | 39 | WAPOZSZP1 | o | o | o | o | | | | | | | | | | | | | | o | o | o | o | o | | | |
| CASES | Carrying case L1 | 40 | WAFUTL1 | | | | | | | | | | | ● | | | | | | | | | | | | | | ● |
| CASES | Carrying case L2 | 40 | WAFUTL2 | ● | ● | ● | | | | | | | | | | | | | | | | | ● | ● | ● | | | |
| CASES | Carrying case L3 | 41 | WAFUTL3 | o | o | o | o | | | | | | | | | | | | | | o | o | o | o | o | | | o |
| CASES | Carrying case L4 | 42 | WAFUTL4 | | | | ● | ● | | ● | ● | ● | ● | | ● | ● | | | | | ● | ● | | | | | ● | |
| CASES | Carrying case M6 | 44 | WAFUTM6 | | | | | | ● | | | | | | | | ● | ● | | ● | | | | | | ● | | |
| CASES | Carrying case M7 | | WAFUTM7 | | | | | | | o | o | o | o | | | | | | | | | | | | | | | |
| CASES | Carrying case S2 | 45 | WAFUTS2 | | | | | | | | | | | | | | | | o | | | | | | | | | |
| CASES | Backpack for meter and accessories L7 | | WAFUTL7 | | | | | | | o | o | o | o | | | | | | | | | | | | | | | |
| CASES | Aluminum case L1 | 61 | WAWALL1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| CASES | Aluminium case L4 | 61 | WAWALL4 | | | | | | | | | | | | | | | | | | | | | | | | | |
| HARNESSES, HOLDERS | Hanging straps | 46 | WAPOZSZE1 | | | | | | | | | | | ● | | | | | | | | | ● | | | | | ● |
| HARNESSES, HOLDERS | Hanging straps | 47 | WAPOZSZE2 | | | | | ● | | | | | | | ● | ● | | | | | ● | | | | | | | |
| HARNESSES, HOLDERS | Hanging straps | 48 | WAPOZSZE4 | | | | | | ● | | | | | | | | ● | ● | | ● | | | | | | ● | | |
| HARNESSES, HOLDERS | Hanging straps | 49 | WAPOZSZEKPL | ● | ● | ● | ● | | | | | | | | | | | | | | | ● | | ● | ● | | ● | |
| HARNESSES, HOLDERS | Hanging straps | 50 | WAPOZUCH1 | | | | | | ● | | | | | | | | ● | ● | | ● | | | | | | ● | | |
| DATA TRANSFER | Hardware Adapter for Sonel PE | 51 | WAADAKEY1 | o | o | o | o | o | o | o | o | o | o | o | o | | o | | | o | | o | o | o | o | o | o | o |
| DATA TRANSFER | USB/RS adapter | 52 | WAADAUSBRS232 | | | | | | | | | | | o | | | | | | | | | | | | | | o |
| DATA TRANSFER | Receiver – interface for radio transmission OR1 (USB) | 53 | WAADAUSBOR1 | | o | o | o | | ● | | | o | o | | o | | ● | | | ● | | | | o | o | ● | | |
| DATA TRANSFER | USB cable | 54 | WAPRZUSB | ● | ● | ● | ● | ● | | ● | ● | ● | ● | | ● | | | | | | | ● | ● | ● | ● | | ● | |
| DATA TRANSFER | RS-232 serial transmission cable | 55 | WAPRZRS232 | | | | | | | | | | | ● | | | | | | | | | | | | | | ● |
| DATA TRANSFER | Bluetooth mini-keyboard with cover on hand | 63 | WAADAMKZ | o | | | | | | o | o | | | | | | | | | | | | | | | | | |
| PROBES | Pin probe with banana connector; black | 56 | WASONBLOGB1 | | | | | | | | | | | | | | ● | ● | ● | | | | | | | | | ● |
| PROBES | Pin probe 5kV with banana connector; black | 56 | WASONBLOGB2 | o | o | | | | | | | | | ● | ● | ● | | | | | | | | | | | | |
| PROBES | Pin probe with banana connector; red | 56 | WASONREOGB1 | ● | ● | ● | ● | ● | ● | | | | | | | | ● | ● | | ● | ● | | | | | ● | ● | |
| PROBES | Pin probe 5kV with banana connector; red | 56 | WASONREOGB2 | | ● | | | | | | | | | ● | ● | ● | | | | | | | | | | | | |
| PROBES | Pin probe with banana connector; blue | 56 | WASONBUOGB1 | ● | ● | ● | ● | ● | ● | | | | | | | | o | o | | ● | | | | | | ● | ● | |
| PROBES | Pin probe with banana connector; yellow | 56 | WASONYEOGB1 | ● | ● | ● | o | ● | o | | | | | | | | | | | | | | ● | | | ● | ● | ● |
| PROBES | Pin probe 5.5kV with banana connector; black | 56 | WASONBLOGB5X5 | | | | | | | ● | ● | ● | ● | | | | | | | | | | | | | | | |
| PROBES | Pin probe 5.5kV with banana connector; red | 56 | WASONREOGB5X5 | | | | | | | ● | ● | ● | ● | | | | | | | | | | | | | | | |
| PROBES | Folding pin probe - length of 2 m | 64 | WASONSP2M | o | o | o | o | o | o | | | | | | | | o | o | o | o | | | | | | o | o | o |
| PROBES | Earth contact test probe (rod); 0,30m | 57 | WASONG30 | ● | ● | ● | o | | | | | | | | | | | | | | ● | ● | ● | ● | ● | | | o |
| PROBES | Earth contact test probe (rod); 0,80m | 58 | WASONG80 | o | o | o | o | | | | | | | | | | | | | | o | o | o | o | o | | | o |
| PROBES | High-current probe with a banana socket | 59 | WASONSPGB1 | | | | | | | | | | | | | | | | | | | | | | | | | ● |
| PROBES | ST-1 temperature probe | 60 | WASONT1 | | | | | | | o | o | | | o | | | | | | | | | | | | | | |
| PROBES | LP-1 illuminance measurement probe (contain adapter MPI-LP) | 62 | WAADALP1KPL | o | | | | | | | | | | | | | | | | | | | | | | | | |

● standard accessories of the meters  o additional accessories




SONEL PE software

# SONEL REPORTS PLUS

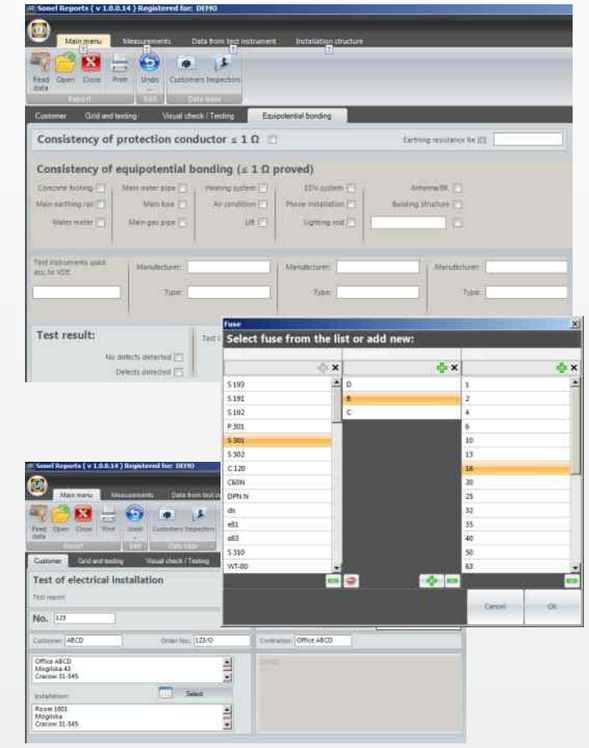
Index: WASONREPORTPLUS

**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).





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



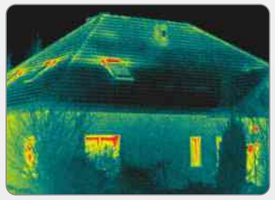
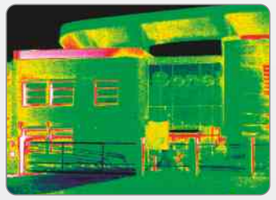
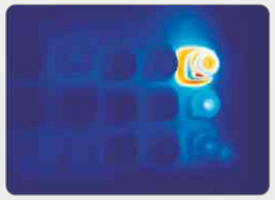
Demo versions are available from www.en.sonel.pl.

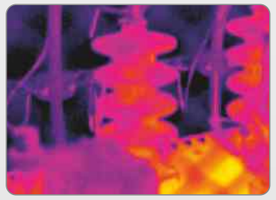
# NON-CONTACT TEMPERATURE MEASUREMENTS

**Thermal imaging** is a process based on processing infrared radiation, or heat emitted by objects, into a visual image, which allows for non-contact assessment of temperature distribution on the surface of an object 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 non-contact infrared spectrum measurement for remote ascertainment of surface temperature. Because every object of temperature higher than absolute zero emits heat radiation of similar characteristic (called black body radiation) by measuring this radiation and knowing emissivity coefficient of a given object, its temperature can be measured.

Professional radiometric thermal imagers record temperature separately for each point of an image. E.g. in the case of an imager of 384x288 resolution, temperature is recorded simultaneously for each one of the 110592 points. This allows for detailed analysis of recorded thermal images, presenting differing temperatures as various colours.

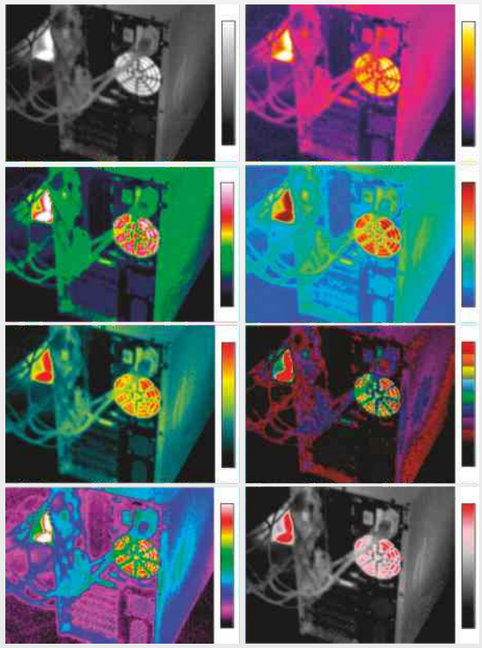




All information recorded in a thermal image can be processed by specialised software bundled with the thermal imager. The analysis of a thermal image allows for finding points of minimal or maximal temperature, correcting emissivity coefficient for a part or the entire thermal image, reading temperature in 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 images as well as merged image modes, allowing for merging visual and thermal images and displaying them as penetrating each other.


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 value in a given spot is more important than its distribution.

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.






HD Thermal Resolution 640x480

InfraFusion

IP 54 · WiFi · TOUCH SCREEN

## Thermal imager

# KT-640

Index: WMXXKT640

| Technical data | |
|---|---|
| Detector type | Uncooled microbolometric matrix (**640 x 480 pixel**, 25 µm) |
| Spectral range | 8-14 µm |
| Thermal sensitivity | ≤0.05°C at 30° |
| Field of view/ Focus distance | **standard**: 25.8° x 19.5° / 35 mm /F1.0<br>**option**: 11,4° x 8.6° / 80mm/F1.1, **option**: 45.7° x 35.1° / 19mm/F1.1 |
| Focus | Automatic or manual |
| Recording of visual images | 5 Mpix |
| External display | 5.7'' high resolution touch screen color VGA LCD 640 x 480 pixels |
| Viewfinder | 0.6''built-in high resolution color OLED, 640 x 480 pixels |
| Video output | VGA / 50 Hz PAL / 60 Hz NTSC |
| InfraFusion technology | Combining visual and IR image |
| Temperature range | Two range: **-20 °C to 250 °C** and **200 °C to 800 °C** |
| Accuracy | ±2°C or 2% reading (±1°C or 1% reading on first range) |
| Emissivity correction | Variable from 0.01 to 1.00 |
| Optical transmission correction | Auto, based on signals from sensors |
| Measurement properties | - 8 moving points, display of maximum, minimum or average values.<br>- 8 vertical and horizontal lines profiles, isotherms in live / frozen for the picture or video.<br>- Automatic hot spot and an automatic alarm.<br>- Enlarging images and video. |
| Image storage | Removable 16 GB SD card (max. 32 GB) |
| File format | JPEG (an invidual file consists of infrared image, visual image, voice annotation / AVI video |
| Voice annotation | Up to 60 secound per file |
| Laser pointer | Class 2, semiconductor laser |
| Batteries | 2 x Li-ion rechargeable |
| Charging | Built-in charger + external |
| Battery opetaring time | Over 2 hours of continuous use |
| AC operation | AC adapter - 110/230 VAC, 50/60Hz |
| Working temperature | -15°C to 50°C |
| Storage temperature | -20°C to 60°C |
| Humidity | < 95% |
| Casing | IP54, IEC 60529 |
| Shock | Working: 25G, IEC 60068-2-29 |
| Vibration | Working: 2G, IEC 60068-2-6 |
| Communication | - USB 2.0: transfer of image and voice to PC; video real-time transfer,<br>- Wi-Fi (802.11.a/b.g) |
| Weight | 1.3 kg (including batteries and LCD screen) |
| Dimensions | 186 mm x 106 mm x 83 mm |

**DO YOU KNOW...** KT-640 camera allows for capturing video in infrared to an SD memory card as well as directly to a computer memory.

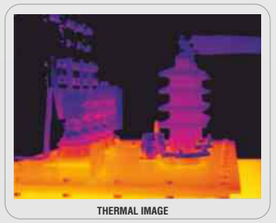
## Standard accessories:

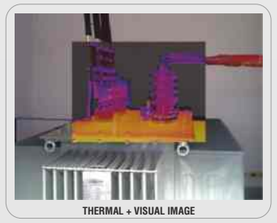
| | |
|---|---|
| - LCD screen | |
| - SD card/reader | **WAADAUSBMEM** |
| - battery charger | |
| - universal AC adapter 110 / 230 V | |
| - power cable with lemo interface | |
| - VGA cable | |
| - USB extension cable | **WAPRZUSBMNIB5** |
| - video / RS232 cable with lemo interface | |
| - safety case | **WAWALXL640** |
| - SD Memory Card (16 GB) | **WAPOZSD1** |
| - gloves, | |
| - cloth cleaner | |
| - Sonel ThermoAnalyze software and the driver | |
| - lens cover | |

**DO YOU KNOW...** KT-640 have 3 types of lenses available as additional!

## Features:

- a fully radiometric camera which records temperature at each point of the image - high resolution **640 x 480**,
- 5,7" LCD touch screen + 0,6'' OLED 640x480 viewfinder,
- recording in the extended jpg format (all data is included in the file but the image can be viewed as simple graphics),
- live IR video recording - record video to SD card or PC's HDD / live view on PC,
- Infra Fusion technology – viewing a combined real and infrared image for effective locating of the measurement place,
- video PAL/NTSC output to connect an external display or a recording unit and perform monitoring in real time,
- automatic hot spot and an automatic alarm. Enlarging images and video. 8 moving points, 8 vertical and horizontal line profile, isotherm,
- simple, clear menu and configuration - easily navigable even for beginners,
- recording visual imagex,
- 8 colour palettes available,
- built-in Wi-Fi and USB,
- voice annotation - up to 60 secounds per file,
- built-in laser sight and LED flashlight,
- large memory capacity - SD card 16 GB,
- image refreshing rate: 50/60 times per second,
- digital zoom x4,
- stable, sharp images without the need of a tripod.


THERMAL IMAGE


THERMAL + VISUAL IMAGE


THERMAL IMAGE FOR RANGES + VISUAL IMAGE


VISUAL IMAGE

## Thermal imager

# KT-384

Index: WMXXKT384 (Imager with 25 mm lens)
WMXXKT384V13 (Imager with 13mm lens)
WMXXKT384V42 (Imager with 42mm lens)
WMXX384V70 (Imagerwith 70mm lens)


IP 54

HD Thermal Resolution 384x288

InfraFusion

| Technical data | |
|---|---|
| Detector type | Uncooled microbolometric array (**384×288 pixels**, 25 µm) |
| Spectral range | 8-14µm. |
| Thermal sensitivity | 0.08 ˚C at 30 ˚C |
| Field of view / focal length / IFOV | optional: 21,7˚ x 16,4˚ / 25mm / 0,99mrad, 40,53˚ x 30,96˚ / 13mm / 1,923mrad, 13,4˚ x 9,8˚ / 42mm / 0,595mrad, 7,85˚ x 5,89˚ / 70mm / 0,356mrad |
| Focus adjustment | Manual |
| Recording of visual image | CMOS sensor, 1600x1200 pixels, "true colour" mode (24 bit) |
| External display | 3.6 inches LCD TFT, **640x480** |
| Video output | PAL/NTSC |
| InfraFusion technology | Combination of visual and infrared images |
| Temperature range | **-20 ˚C to 400 ˚C** |
| Accuracy | ±2 ˚C or ±2% of readout |
| Emissivity coefficient | Adjustable from 0.01 to 1.00 (in increments of 0.01) |
| Measurement features | Automatic correction based on distance, relative humidity, accounting for atmospheric transmission and external optics |
| Correction of optical transmission | Automatic, based on signals received from sensors |
| Image store | 2 memory types: removable 4 GB SD memory card (max. 8 GB) and 150 MB built-in memory |
| File format | JPEG with thermal data, visible view of the captured image and voice annotation |
| Voice annotation | up to 60 sec. |
| Power supply | AA rechargeable batteries, capability of using alkaline AA batteries |
| Charging system | Built-in charger |
| Battery operation time | Over 2 hours of continuous operation |
| External power supply | AC power supply adapter 110/230 VAC, 50/60 Hz |
| Operating temperature | -10˚C to 50˚C |
| Storage temperature | -20˚C to 60˚C |
| Humidity | Operating and storage: 10% to 95%, without condensation |
| Enclosure | IP54 IEC 60529 enclosure |
| Shocks | Operating: 25 G, IEC 60068-2-29 |
| Vibrations | Operating: 2 G, IEC 60068-2-6 |
| Communications | USB 2.0: image, measurements and voice transfer to a computer, "live transfer" of video image, video output |
| Weight | 0.79 kg (with batteries) |
| Dimensions | 112x182x252 mm (without lens) |

DO YOU KNOW... KT-384 camera allows for capturing video in infrared to an SD memory card as well as directly to a computer memory.

## Standard accessories:

| | |
|---|---|
| - lenses - depending on configuration | |
| - universal power supply 110/230 V | **WAZASZ8** |
| - USB cable | **WAPRZUSBMNIB5** |
| - hand strap | **WAPOZPAS1** |
| - case | **WAFUTM7** |
| - transport hard case | **WAWALL3** |
| - external memory card reader with a USB cable | **WAADAUSBMEM** |
| - sun visor | **WAPOZOSL2** |
| - lens cover | |
| - 4 GB SD memory card | |
| - 2 sets of 6 AA size rechargeable batteries | |
| - video cable | |
| - full version of Sonel ThermoAnalyze® software with operating manual + PC drivers | |
| - gloves, cloth | |

## Additional features:

- fully radiometric imager,
- recording temperature of each point of an image,
- simple and clear menu as well as software in the English, Russian, Spanish, Polish language,
- easy navigation for inexperienced users,
- 60 Hz refresh rate, 2x/4x digital zoom,
- vibration and shock resistant,
- stable and sharp images without using a tripod,
- 8 colour palettes are available,
- built-in laser pointer and a LED torch,
- thermal video recording,
- recording to a SD memory card or directly to a computer disc,
- measurement of dew point,
- indication of differential temperature.

DO YOU KNOW... True resolution of KT-384 IR matrix is 384x288.


THERMAL IMAGE


THERMAL + VISUAL IMAGE


VISUAL IMAGE


DO YOU KNOW... KT-384 allows dew point measurement.

## Thermal imagers

# KT-160A / KT-160
# KT-150 / KT-140 / KT-130

Index: WMXXKT160 (KT-160)
WMXXKT160A (KT-160A)
WMXXKT150 (KT-150)
WMXXKT140 (KT-140)
WMXXKT130 (KT-130)


| Parameter | | KT-160A | KT-160 | KT-150 | KT-140 | KT-130 |
|---|---|---|---|---|---|---|
| Focus adjustment: | automatic | x | x | x | x | |
| | manual | x | x | x | x | x |
| Visible images: CMOS sensor, 1600x1200 pixels, "true colours" mode (24-bit) | | x | x | x | | |
| Video output: PAL/NTSC | | x | x | | | |
| Image refresh rate (Hz) | | 50/60 | 50/60 | 50 | 50 | 50 |
| InfraFusion technology - combining visual and thermal images | | x | x | x | | |
| Voice annotation up to 60 seconds | | x | x | | | |
| Temperature range | | -20˚C ...350˚C | -20˚C ...250˚C | -20˚C ...250˚C | -20˚C ...250˚C | -20˚C ...250˚C |
| Colour palettes | | 8 | 8 | 6 | 4 | 4 |
| Laser pointer (A1 GaInP semiconductor, diode laser) | | x | x | x | | |
| Image store | removable 2 GB SD memory card | x | x | x | x | x |
| | built-in memory | x | x | x | | |
| | recording visual image of the examined area | x | x | x | | |
| Thermal video image capture (over USB) | | x | x | | | |

DO YOU KNOW... KT series imagers are fully radiometric - the temperature of each individual point of an image is recorded.

| Common features of KT-160A, KT-160, KT-150, KT-140 | |
|---|---|
| Fully radiometric imager | Temperature of each individual image point is recorded |
| File format: | JPEG with thermal data |
| Detector type: | Uncooled - FPA microbolometer (160× 120 pixels, 25µm) |
| Spectral range: | 8-14µm |
| Thermal sensitivity: | ≤0,1°C at 30°C |
| Accuracy: | ±2°C or ±2% of readout |
| Emissivity coefficient | Adjustable from 0.01 to 1.00 (in increments of 0.01) |
| Measurement features: | Automatic correction based on distance, relative humidity, accounting for atmospheric transmission and external optics |
| Correction of optical transmission: | Automatic, based on signals received from sensors |
| Field of view / focal length / IFOV: | 20.6° x 15.5° / 11 mm / 2,273mrad (built-in lens), 32° x 24° / 7mm / 3,530mrad (option KT-160, 160A) 7,6° x 5,7° / 30mm / 0,833mrad (option KT-160, 160A) |
| External display: | 3.6 inches LCD TFT, 640x480 |
| Power supply: | AA rechargeable batteries, capability of using alkaline AA batteries |
| Charging system: | Built-in charger |
| Battery operation time: | Over 3 hours of continuous operation |
| External power supply: | AC power supply adapter 110/230 VAC, 50/60 Hz |
| Operating temperature: | -10°C to 50°C |
| Storage temperature: | -20°C to 60°C |
| Humidity: | Operating and storage: 10% to 95%, without condensation |
| Enclosure: | IP54 IEC 60529 enclosure |
| Shocks: | Operating: 25G, IEC 60068-2-29 |
| Vibrations: | Operating: 2G, IEC 60068-2-6 |
| Communications: | USB 2.0 |
| Weight: | 0.73 kg (with batteries) |
| Dimensions: | 112x182 x252 mm |

## Standard accessories:

| | |
|---|---|
| - built-in lens 11 mm | |
| - universal power supply 110/230 V | **WAZASZ8** |
| - USB cable | **WAPRZUSBMNIB5** |
| - hand strap | **WAPOZPAS1** |
| - case (not included in KT-130) | **WAFUTM7** |
| - transport hard case (not included in KT-130) | **WAWALL3** |
| - external memory card reader with a USB cable | **WAADAUSBMEM** |
| - lens cover | **WAPOZOSL1** |
| - sun visor (KT-160, KT-160A) | **WAPOZOSL2** |
| - 2 GB SD memory card | |
| - 2 sets of 6 AA size rechargeable batteries (KT-130: 6 pieces of AA batteries) | |
| - video cable (KT-160A, KT-160) | |
| - full version of Sonel ThermoAnalyze® software with operating manual + PC drivers | |
| - gloves, cloth | |

DO YOU KNOW... KT series imagers are powered by standard AA size batteries or rechargeable batteries.

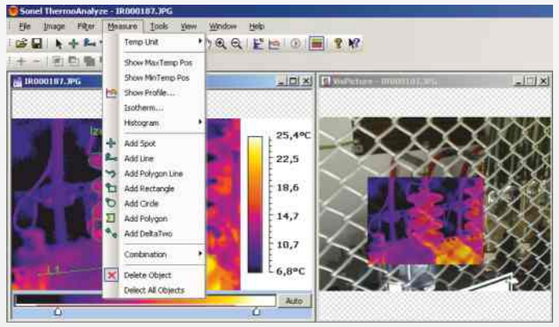
DO YOU KNOW... KT-160 camera also allows for recording infrared video.

# SONEL THERMOANALYZE SOFTWARE

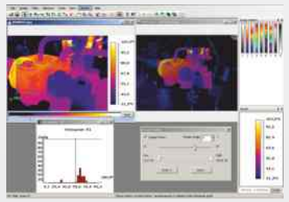
**Capability of correcting emissivity coefficient** for a part or the entire thermal image – the coefficient can be corrected for each selected area individually.

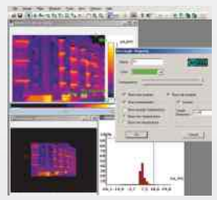
**Selection of analysed areas –** selecting rectangular, oval or arbitrary shape area; selecting intersection of marked areas, joining, cropping, as well as moving selection borders.

**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).

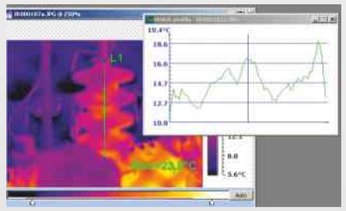


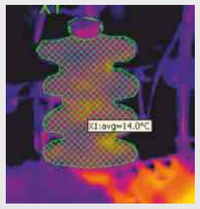

**Use of the Infra Fusion technology – the thermal image is overlaid on part of the visual image** in any user-selected palette. The thermal image is overlaid **with selected transparency**, allowing for optimal presentation and marking areas of interest, especially, if it is difficult to compare visually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





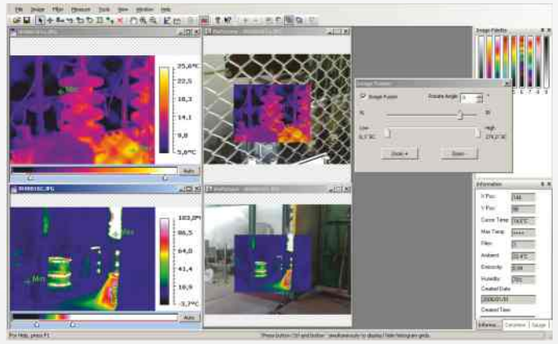
**Determining and readout of minimal, maximal and mean temperature for the entire area, as well as for each selected area.** Selection of a section (straight or polygonal line) for which the mean temperature can be determined, and along which the distribution of temperature profile can be automatically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



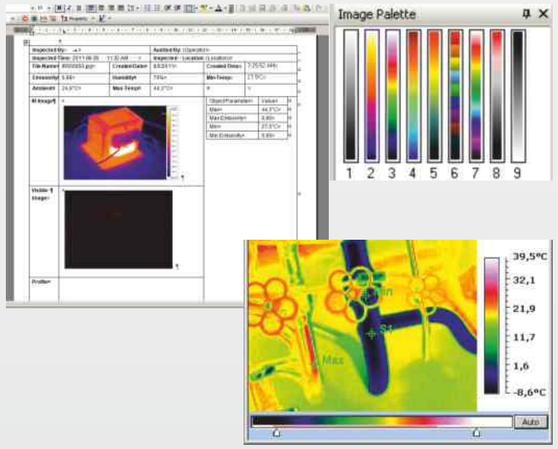

**Automatic creation of a histogram** for the entire image as well as for each selected area; including graphical presentation of the percent distribution of areas with temperatures falling into individual ranges.

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

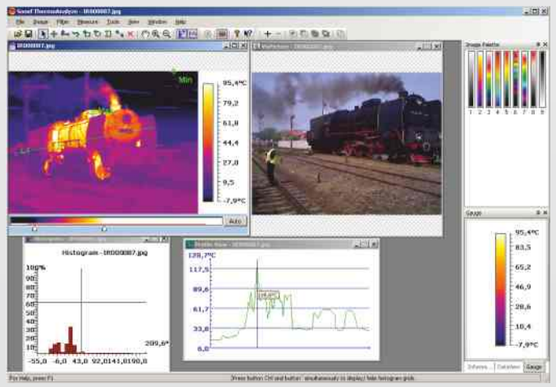


**Report creation –** also as an overlay for MS Word or Excel software – a report is built with simple drag-and-drop method to include all required elements **– thermal images, respective visual images, analysis results for a selected part of the entire image; histograms, etc.**

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<br>-25.6...716°F | 13:1 | 0.1°C<br>0.1°F | -32...-20°C<br>-25.6...-4°F | ±5°C<br>±9°F |
| | | | -20...200°C<br>-4...392°F | ±(1.5% m.v. + 2°C)<br>±(1.5% m.v. + 3.6°F) |
| | | | 200...380°C<br>392...716°F | ±(2.0% m.v. + 2°C)<br>±(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<br>-58...999.9°F | 50:1 | 0.1°C<br>0.1°F | -50...20°C<br>-58...68°F | ±2.5°C<br>±4.5°F |
| | | | 20...400°C<br>68...752°F | ±(1.0% m.v. + 1°C)<br>±(1.0% m.v. + 1.8°F) |
| 1000...1600°C<br>1000...2912°F | | 1°C<br>1°F | 400...800°C<br>752...1472°F | ±(1.5% m.v. + 2°C)<br>±(1.5% m.v. + 3.6°F) |
| | | | 800...1600°C<br>1472...2912°F | ±2.5% w.m. |

### K probe temperature range

| TK temperature range | Resolution | Accuracy |
|---|---|---|
| -50...999.9°C<br>-58...999.9°F | 0.1°C<br>0.1°F | ±(1.5% m.v. + 3°C)<br>±(1.5% m.v. + 5°F) |
| 1000...1370°C<br>1000...2498°F | 1°C<br>1°F | ±(1.5% m.v. + 2°C)<br>±(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!**

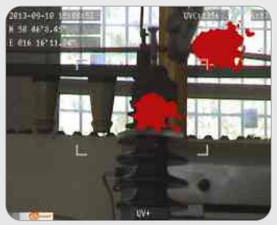
| Technical data | |
|---|---|
| **UV - Optical Properties** | |
| Image Type | Monochrome video |
| Minimum UV Sensitivity | 3 x 10-18 watt / cm2 |
| Minimum Discharge Detection | 1.5pC @ 8 meters |
| Spectral range | UV 240 ~ 280 nm |
| Field of View H x V | 5.5˚ x 4.0˚ |
| Focus | Full manual and auto for UV and visible channels |
| Focus distance | 2 m. - ∞ |
| Detector Life Span | No degradation |
| Frequency | 50 Hz / 60 Hz |
| **Visible - Optical Properties** | |
| Type | Color video |
| Video Standard | Better than 1 milliradian |
| Modes | 0.1 lux |
| Corona Shades | 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



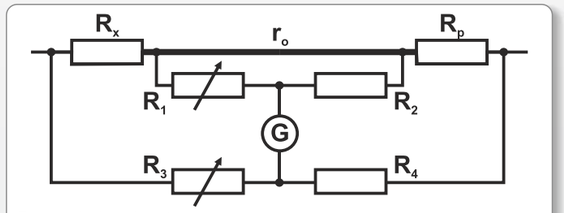




# LOW RESISTANCE MEASUREMENTS

Measurements of low resistances are performed during testing resistance of connections: welded, equipotential bondings, joints, cable connections and low-resistance coils. Low resistance meters can also be used for testing windings of electrical equipment, such as transformers or motors. These tests also include checking the quality of soldered connections and the continuity of earthing conductors.

Measurements of low resistance can be performed with the use of several methods. The most popular is the technical method and the measurement with the Thomson bridge (six-arm bridge). For small (microohm) values of resistance, the resistance of test leads and contacts is significant, therefore the bridge provides separate current and voltage terminals for Rx and Rp resistors. It is recommended, that all other resistors have resistance 1000-times higher than the resistance of test leads.



Thomson bridge schematic

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

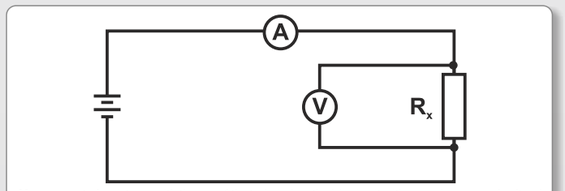
$$R_x = \frac{R_p R_1}{R_2}$$

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 measurement depends on the reference reconstruction error related to the quality of execution of individual 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.

Due the flaws and limitations of traditional technical bridges, a tendency exists for constructing electronic meters intended for measuring low resistances ranging from single microohms to several hundred ohms. These instruments allow for measuring very small resistances with the resolution as high as 0.1 μΩ. Important features of modern microohm meters are: their ease of use, various measurement modes and the capability of cooperation with a computer. These instruments measure resistance with the use of the technical method. 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 with properly measured voltage is used for small resistances, when the current flowing through the measured element is much larger than the current flowing through the voltmeter, that measures voltage drop across the element. The resistance resulting from the measurement is calculated with the formula:

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

$I_v$ - current flowing through the voltmeter.

For a very large resistance of the voltmeter, the current flowing through it is negligible, and the resistance of its leads 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**

Due to very low values of measured resistances, the four-lead method was employed, allowing for performing accurate measurements without the need for accounting for the resistance of test leads. Therefore there is no need for manual calibration of the meter and its test leads, however such a capability is available (e.g. in the event of using test leads of other type), and it is always possible to restore factory calibration of the instrument.

Before commencing 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 (e.g. exceedance of the maximal power dissipated on the measured object), limitation of the maximal current flowing through the object might be desirable. MMR-620 has a lock allowing for setting the upper allowable measurement current value.

The instrument measures resistance by forcing a flow of current through the measured object (with its current leads), and simultaneously checking 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 conventional "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 variation 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.

CAT III 300V

IP 54

## 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)

### Microohmmeters

# MMR-620, MMR-630

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

## 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**





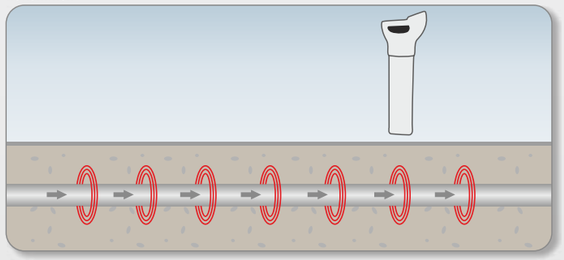
# CABLE AND BURRIED SERVICES LOCATION

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.

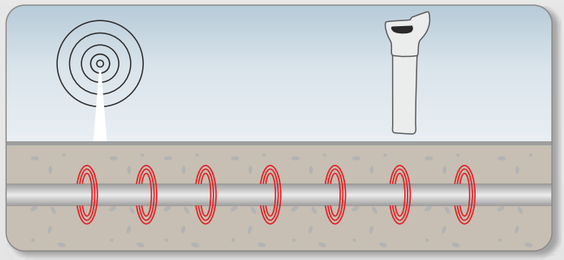
The location kit (LKZ-1000), makes possible precise determination of the depth and the directions of utilities that conduct electricity (power and telecommunication cables, metal pipes, etc.) as well as plastic and concrete pipes, using additional probes. Earthworks are conducted in difficult conditions (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.

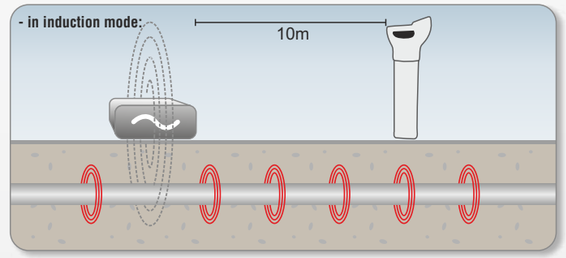


**8 kHz** – this mode is used for accurate determination of the location of a specific utility (cable, pipe, etc.). The frequency of the generated signal (8 kHz) ensures longer range and lower tendency for signal transmission to other objects. The method requires using the signal generating transmitter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

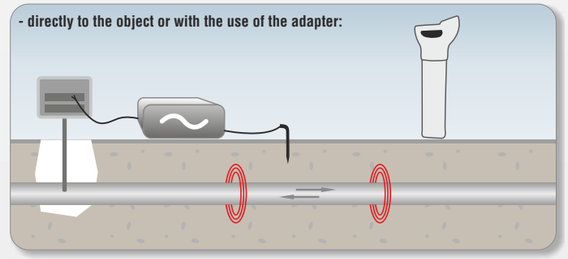
**33 kHz** – this mode is used to determine the location of a specific utility (cable, pipe, etc.). This frequency is used the most often to determine the location of underground utilities; it provides the highest effectiveness, although it also has the greatest tendency of signal transmission to other 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:

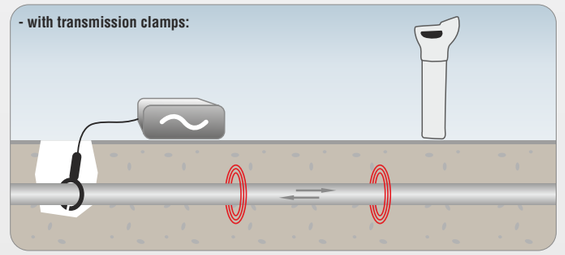
**- in induction mode:**




**- directly to the object or with the use of the adapter:**



**- with transmission clamps:**



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.

NEW MORE POWERFUL TRANSMITTER INCLUDED


IP 65 transmitter

IP 54 receiver

## 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



### 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 | |

## 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)
**WAADAAS1US** (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.

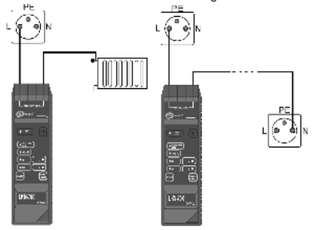
In the case of LKZ-700, the transmitter can operate in one of five sequentially changeable modes of transmission:
- operation in the "M" mode of generating the magnetic field component (current mode) - energised circuits;
- operation in the "E" mode of generating the electric field component (voltage 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:

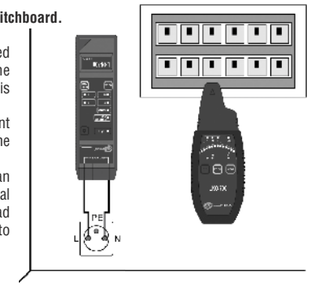



**Locating short-circuits between conductors.**

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.

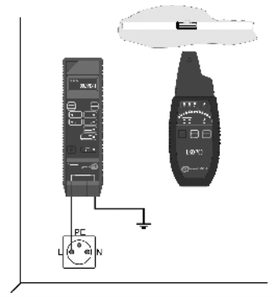
**Identification of fuses in the switchboard.**

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.



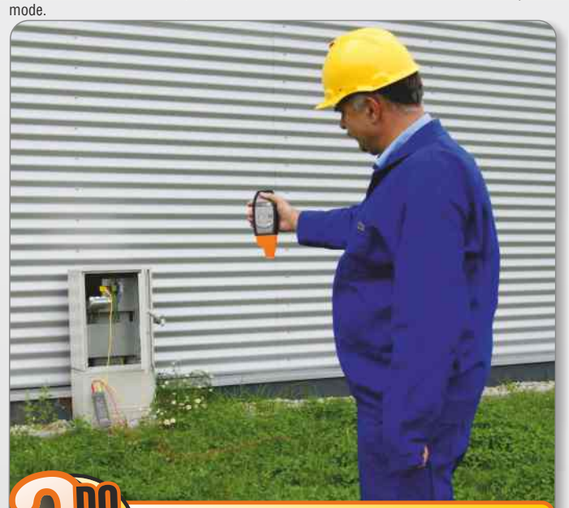

**Locating breakages in conductors.**

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.



**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.**

The LKZ-710 locator is a simplified version of the LKZ-700 model, to be used for occasional location of conductor routes or location of protective devices.

LKZ-710 is a locator operating in the current mode only (in an energised circuit); for non-energised circuits, an additional power supply can be used (e.g. 12 V rechargeable battery). Due to the use of the transmitter-modulator generating own signal of especially selected frequency, the accuracy of finding conductors in walls is incomparably higher than with the use of a non-contact neon lamp.

# LKZ-700

Index: WMGBLKZ700


CAT III 300V

IP 40

## Location of live (LKZ-700, LKZ-710) as well as non-energised conductors and cables (LKZ-700):

- detection of conductors in ceilings, walls and floors,
- location of breakages in conductors (LKZ-700),
- 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 (LKZ-700),
- tracing routes of conductive water or central heating pipes (LKZ-700),
- 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 (LKZ-700) or two (LKZ-710) levels of transmitter signal amplification,
- automatic or manual selection of the mode of operation of the transmitter (LKZ-700),
- automatic selection of the indication range of the receiver - the ZOOM function (LKZ-700),
- four modes of operation of the locator: voltage, current, current-voltage and power (LKZ-700) + Auto mode,
- transmitter power supply from rechargeable batteries (LKZ-700).

## 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

## Other technical specifications of LKZ-710:

- type of insulation..... double, in acc. with EN 61010-1
- power supply of the locator.....external AC supply min. 24 V or DC min. 12 V
- maximal operating voltage of the transmitter.....250 Vrms (353 VP-P)
- dimensions of the transmitter.....128x66x28 mm
- weight of the transmitter.....approx. 300 g
- maximal range of the locator.....60 cm
- 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





### Conductor and cable locators

# LKZ-710

Index: WMGBLKZ710


CAT III 300V

IP 40

**DO YOU KNOW...** LKZ-710 transmitter can cooperate with the P-3 voltage indicator when identifying power system phases.

## Standard accessories of the tracers:

| | |
|---|---|
| - Test lead with banana plug; 1,2m; black (LKZ-700) | WAPRZ1X2BLBB |
| - Test lead with banana plug; 1,2m; yellow (LKZ-700) | 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 (LKZ-700) | WAFUTM6 |
| - Carrying case M1 (LZK-710) | WAFUTM1 |
| - Test lead on a reel with banana plugs; 20m; red(LKZ-700) | WAPRZ020REBBSZ |
| - Earth contact test probe (rod); 0,26m (LKZ-700) | WASONG26 |
| - Power supply adaptor Z1, pin, 3,5mm (LKZ-700) | WAZAS3X5Z1 |
| - NiMH battery package 9,6V 2Ah (installed in the LKN-700 transmitter) (LKZ-700) | 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:**

**LKZ-710:**



### TDR cable fault locator

# TDR-410

Index: WMGBTDR410


NEW!

IP 54

## 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.

## Nominal operating conditions:

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

## Technical specifications:

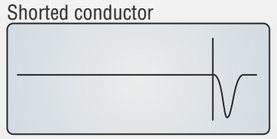
- ranges meters:.....7, 15, 30, 60, 120, 250, 500, 1 km, 2 km, 3 km, 4 km
- ranges feet.....20, 45, 90, 180, 360, 750, 1500, 3000, 6000, 10000, 14000.
- range selection .....manual range control / auto range
- accuracy..... 1% of selected range*
- resolution.....approx 1% of range
- minimum cable length.....4m (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

## Standard accessories:

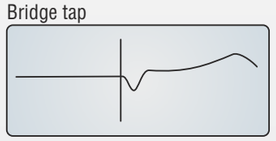
| | |
|---|---|
| - time-domain reflektometer TDR-410 | WMGBTDR410 |
| - 0,6 m double-wire lead, | WAPRZ0X6DZBB |
| - red crocodile clip, | WAKRORE20K02 |
| - black crocodile clip, | WAKROBL20K01 |
| - cover M-2, | WAFUTM2 |
| - alkaline batteries 1.5V AA (4 pieces), | |

**DO YOU KNOW...** TDR-410 locator allows cable testing up to length of 4 km.

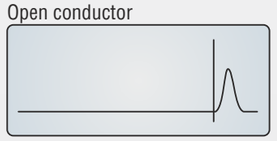
Shorted conductor



Bridge tap

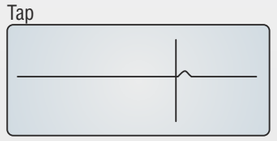


Open conductor



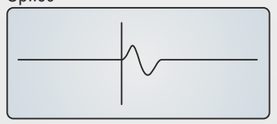
Water ingress

Tap



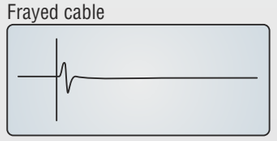
Wet splice / water

Splice

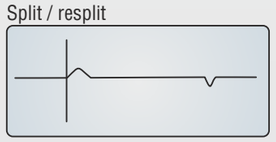


Splitter

Frayed cable



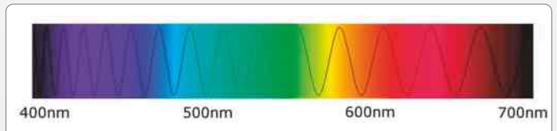
Split / resplit



# 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 $V_\lambda$ 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.).

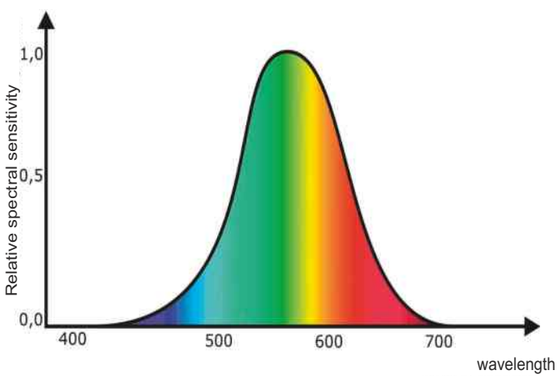
Measurements of parameters allowing for the assessment of lighting conditions should be performed at the rough-in inspection of new lighting equipment, when upgrading the existing lighting equipment as well as periodically, every 5 years. **It is recommended to carry out the measurements every 2 years, 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.

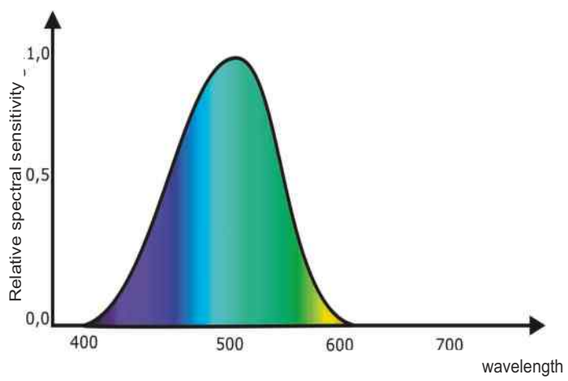
For lighting measurements of spaces with daylight, measurements must be performed, in order to determine the daylight factor value. In order to do that, simultaneous measurements with two luxmeters are performed inside and outside the spaces with window or skylight day light access (luxmeters equipped with real time clocks would be helpful, e.g. LXP-1 model).

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 $V_\lambda$ 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.



## Basic features of the instrument:

- resolution of illuminance measurement within range of 0.1 lx…0.1 klx (0.01 FC…0.01 kFC),
- high accuracy and short reaction time,
- DATA-HOLD function for freezing measurement results on the display,
- automatic zeroing,
- correction factor for non-standard light sources does not have to be calculated manually,
- short reaction times to changes of illuminance,
- PEAK-HOLD function for freezing peak measurement values, allowing for the measurement of peak light impulse of time shorter than 10 µs,
- automatic power-off after 15 minutes (with the capability of disabling this function),
- measurements of maximal and minimal values,
- relative readouts,
- large and readable backlit display,
- USB interface for connecting the instrument to a computer,
- four measurement ranges,
- memory for 99 measurements to be read out by the meter,
- recording 16000 measurements in the memory of the recorder.

**DO YOU KNOW...**

**LXP-1 is equipped with the recorder with adjustable sampling time.**

## Other technical specifications:

- display.....3¾ digits, LCD with a 40-segment bargraph
- range exceedance.....'OL' symbol
- repeatability.....±3%
- spectral sensitivity.....CIE photopic (the CIE curve of human eye sensitivity)
- cosine adaptation error (f2').....±2%
- sampling.....1.3 times/s
- power source..... 9 V battery
- photodetector.....one silicone photodiode and a spectral curve filter
- detector cord length.....approx. 150 cm
- dimensions of the photodetector .....115×60×20 mm
- dimensions of the meter.....170×80×40 mm
- weight.....390 g
- warranty..... 24 months

## Nominal operating conditions:

- operating temperature ..... 0...40 °C
- operating relative humidity..... 0...80%
- storage temperature.....-10...50 °C
- storage relative humidity..... 0...70%

Light meter

# LXP-1

Index: WMXXLXP1

## Standard accessories of LXP-1 luxmeter:

| | |
|---|---|
| - USB cable | **WAPRZUSBMNI5** |
| - the "Light Meter" software for controlling the meter and reading out data | |
| - calibration certificate, | |
| - hard case | |
| - 9 V battery (1 pc) | |

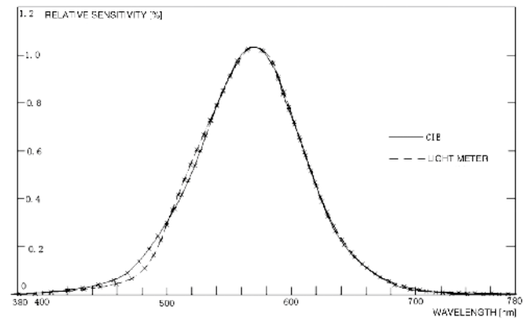
## Measurement of illuminance

| Display range | Spectral uncertainty | Accuracy |
|---|---|---|
| 400.0 lx<br>40.00 FC | f1'± 6% function | ±(3% m.v. + 0.5% r.)<br>(<10.000 lx) |
| 4000 lx<br>400.0 FC | | |
| 40.00 klx<br>4000 FC | | ±(4% m.v. + 10 digits)<br>(>10.000 lx) |
| 400.0 klx<br>40.00 kFC | | |

NOTE: 1klx=1000lx; 1kFC=1000FC

"r." = "full range".
"m.v." = "measured value".

**Spectral sensitivity characteristic curve**
The used photodiode with filters allows for a good match of the spectral sensitivity characteristic curve and the requirements of the CIE curve (INTERNATIONAL COMMISSION ON ILLUMINATION).The V(λ) sensitivity characteristic curve - as described on the graph below.



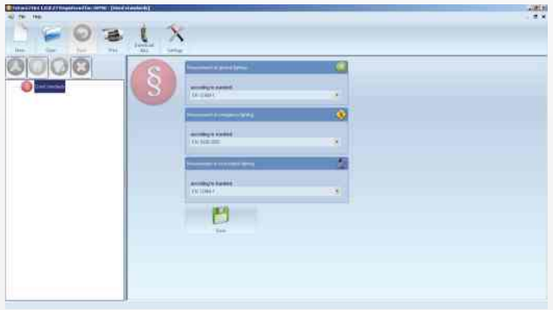
Spectral sensitivity characteristic curve.

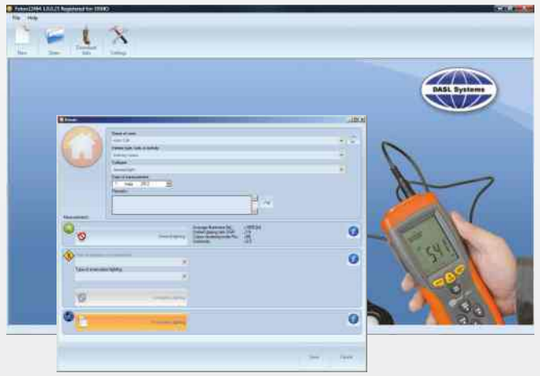
# FOTON 2

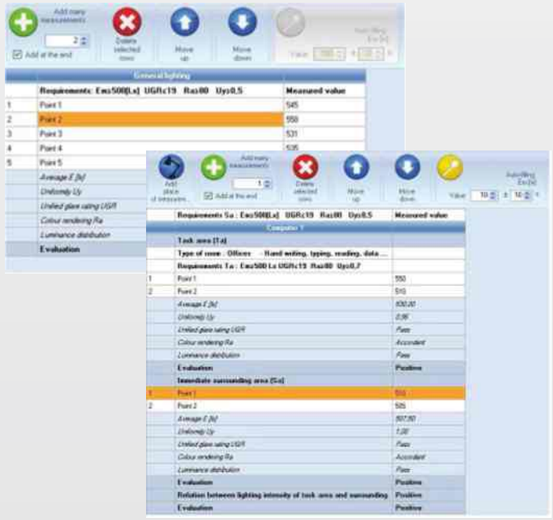
Index: WAPROFOTON

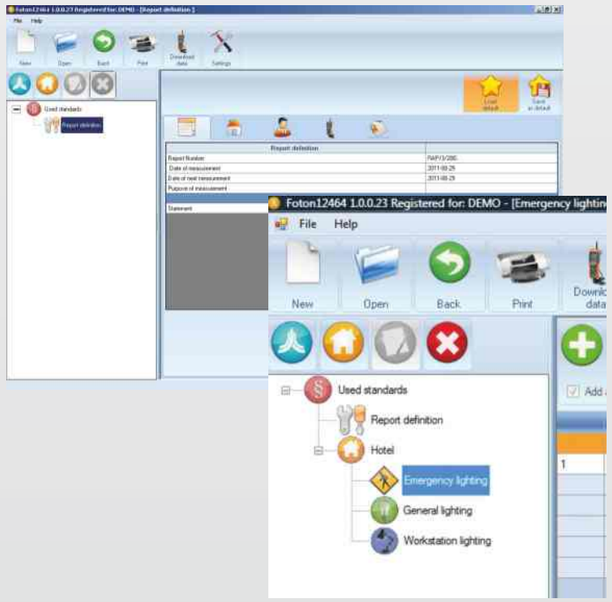
**Features of the FOTON 2 software:**

- creating lighting measurements reports in accordance with the EN 12464 standard:
  - automatic calculation of mean value of a measured quantity,
  - automatic calculation of uniformity ratio of illuminance,
  - analysis of illuminance on a work place,
  - a form allowing for preparing a general lighting measurement report,
  - a form allowing for preparing an emergency lighting illuminance measurement report,
  - a form allowing for preparing a work place lighting measurement report,
- basis of space classification included in the EN 12464 standard,
- data analysis based on standards:
  - „EN 12464 Light and lighting – Lighting of work places, Part 1: Indoor work places" – for testing lighting in work places,
  - „EN 1838 Lighting Applications - Emergency Lighting" – for testing emergency lighting,- tree-like structure of a report – reflects the layout of rooms in a facility,
- 3 types of tests assigned to a room (general, emergency, work place),
- the room type definition is in accordance with the classification specified in the EN 12464-1 standard – automatic selection assessment criteria for the chosen room type,
- communication and downloading data saved in the LXP-1 meter,
- capability of manual data entry,
- real time calculation of mean illuminance and uniformity ratio, as well as other necessary factors,
- functions accelerating creation of documentation:
  - room cloning,
  - entry of many metering points with just one click,
  - calculation of minimal number of points in a given room,
  - serial filling of metering point names,
- multi-part report printout:
  - title page, including information about to the contractor and place of measurements, types of tests, conditions of measurements,
  - table of contents, including a list of all rooms,
  - measurement theory, where basic definitions related to lighting measurements are presented, and designations used in the software are explained,
  - summary, including information about persons performing measurements, instruments used, as well as the statement of a positive or negative test result,
- data is stored in files (documents), and therefore is easily archived on any media or sent, e.g. as an email attachment,
- capability of printing out protocols in the PDF file format,
- updates over the Internet,
- demo version available from the www.en.sonel.pl.












# 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.

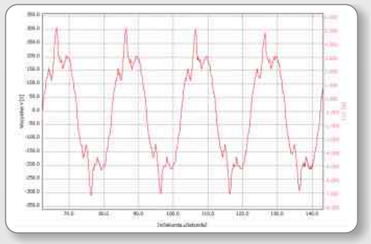
Problems caused by bad electric power quality are very serious and can make lives of electric power consumers difficult, and often cause significant material losses. Therefore maintaining satisfactory quality of electric power is of key importance. This pertains to the supplier as well as the consumer 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).

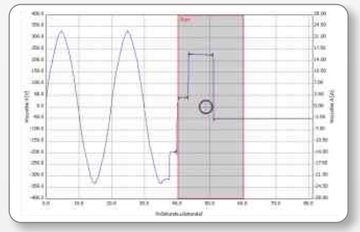


An example deformed current wave form.

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.

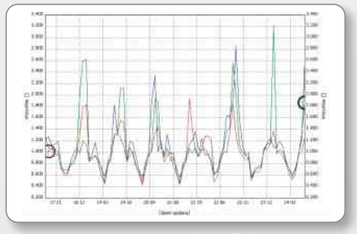


An example of voltage loss (power loss).

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.

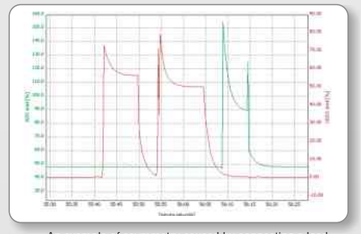
**Light flicker –** a phenomenon of periodic change of luminous flux due to changes in supply voltage. Light flicker is a result of voltage drops due to connecting and disconnecting high-power loads (e.g. welders, arc furnaces, etc.).

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°.



An example of asymmetry caused by connecting a load

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.

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-703 / PQM-702

Index: WMGBPQM703
WMGBPQM702

NEW!

THE ANALYZERS RECORDS ALL POWER SYSTEM PARAMETERS IN ACCORDANCE WITH THE A CLASS OF THE EN 61000-4-30 STANDARD

CAT III 1000V

CAT IV 600V

IP 65

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 automatically send text message to your mobile phone.

### 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-703/702 can operate in any climate conditions (- 20 °C ... + 55 °C).

### 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 severity ($P_{LT}$) (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 graphs 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 (PQM-703 only)

### 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** |
| - Receiver – interface for radio transmission 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 an independent power supply socket, 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 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 allows measurement of transients up to ±6000 V.

DO YOU KNOW... The price of the instrument includes a full version of intuitive software for recording analysis results.

*More parameters - see page 60*







## Power quality analyzers

# PQM-701/701Z/701Zr

Index: WMGBPQM701
WMGBPQM701Z
WMGBPQM701ZR

THE ANALYZERS RECORDS POWER SYSTEM PARAMETERS IN ACCORDANCE WITH THE A CLASS OF THE EN 61000-4-30 STANDARD


CAT IV 600V

IP 65

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.

### 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... 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.

*More parameters - see page 60*

## Parameters of analyzers 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% $U_h$ 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% $I_h$ 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% $U_h$ for 3...15% $U_h$ |
| Transients (PQM-703 only) | | ±6000 V | 5 V | ±(5% + 25 V) |

*Clamp F-1, F-2, F-3:0..3000A (10000$A_{p-p}$) *Clamp C-4: 0..1000A (3600$A_{p-p}$)*Clamp C-5: 0..1000A (3600$A_{p-p}$)*Clamp C-6: 0..10A (36$A_{p-p}$) (without current transformers)

## Additional accesories for analyzers:

| Clamp | C-4 | C-5 | C-6 | C-7 | F-1 | F-2 | F-3 |
|---|---|---|---|---|---|---|---|
| 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 | | |

- 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


## 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-702 can be powered directly from measured power line for almost all types of networks from 64 V to 690 V, and is very to easy install. Includes independent power supply, which is very helpful during voltage transformer and DC circuit measurement.

## 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.
- **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.

## 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-700 can operate in any climate conditions (- 20 °C ... + 55 °C).

**DO YOU KNOW...** PQM-700 has an independent power supply socket, especially suited for voltage measurements for transformers and DC circuits.

## Measured parameters (EN 50160-4-30 class S):

- 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 includes a full version of intuitive software for recording results analysis.

## 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% $U_n$<br>±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% $I_n$<br>± 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-1, F-2, F-3:0..3000A (10000$A_{p-p}$) *Clamp C-4: 0..1000A (3600$A_{p-p}$)*Clamp C-5: 0..1000A (3600$A_{p-p}$)*Clamp C-6: 0..10A (36$A_{p-p}$) (without current transformers) Clamp C-7: 0...100 A (360$A_{p-p}$)

# SONEL ANALYSIS SOFTWARE

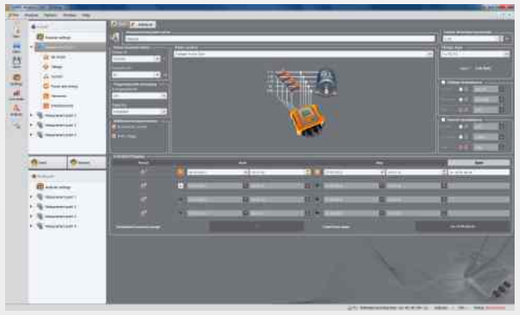
**The SONEL Analysis software is necessary for working with the PQM series analyzers and is supplied as standard accessory.**

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**

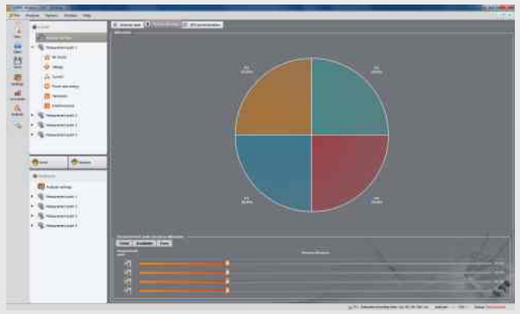
The program allows for configuring all key parameters of the analyzer. The configuration is prepared on a computer, and then transferred to the analyzer. The configuration can also be saved on the HDD/PC or other data media, in order to be used at a later time.

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,
- selecting power system type, where the analyzer will record all defined parameters.



**DO YOU KNOW...**

**...that software Sonel Analysis enables compensation of noise current for clamps on inactive objects?**







# Analysis

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.

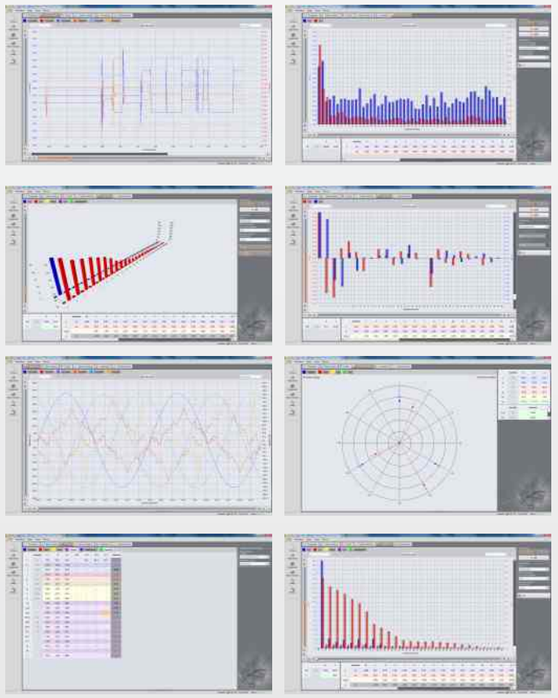
**Readout of instantaneous data (live mode)**

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.

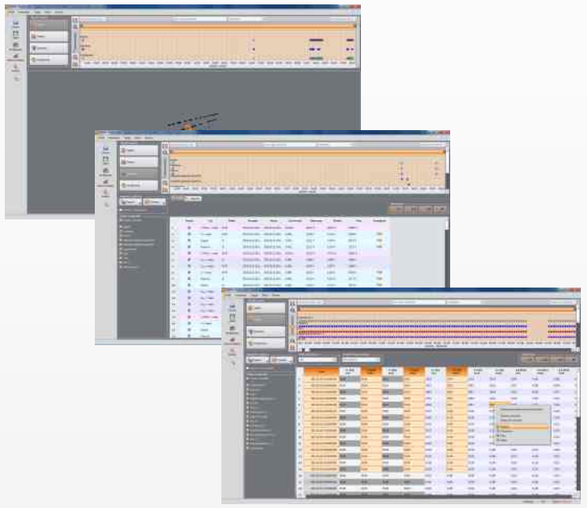
The user can view:
- voltage and current wave form graphs (oscilloscope),
- voltage and current graphs as a function of time,
- phasors,
- measurements of multiple parameters,
- harmonics and harmonics powers.

**Data analysis**

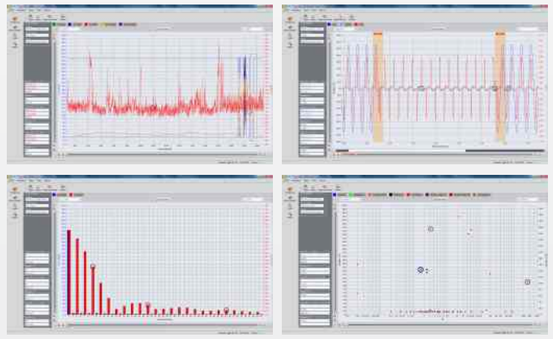
With the software, the user can read and analyse data recorded on the memory card. The data can also be saved to the HDD of PC to be processed at a later time. This also provides the way of archiving data from consecutive recordings.



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.).

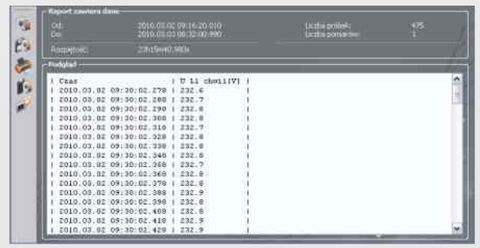


The software provides various types of graphs, enabling the User to easily visualise the data recorded by the analyser:



- **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-815

Index: WMGBPAT815

NEW!


CAT II 300V | IP 40 | TOUCH SCREEN

## Common features of the instruments:

- **measurement of protective conductor resistance with the currents: 200 mA, 10 A , 25 A,**
- **measurement of insulation resistance – three measurement voltages: 100 V, 250 V and 500 V,**
- measurement of equivalent leakage current,
- measurement of residual leakage current,
- measurement of touch leakage current,
- measurement of U, I,
- measurement of power S, P, power factor PF,
- measurement of current consumption using clamps C3,
- IEC lead test,
- measurement of mains voltage and frequency,
- automatic measurement of all RCD parameters.

## Other features:

- intuitive user interface, large clear touch display
- manual tests and auto tests, the ability to describe auto test with standards or any name,
- 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 user accounts with log-in function (as an option),
- supports USB flash drive;
- communication with PC via USB,
- works with the program Sonel PAT Reader and Sonel PAT; measurement and settings configuration from the meter and also from PC, data analysis.

## Standard accessories of the meter:

| | |
|---|---|
| - Power supply cord | **WAPRZZAS1** |
| - USB cable | **WAPRZUSB** |
| - GsLGs test lead with crocodile clip, SP-4-F input; 1,8m; orange | **WAPRZ1X80RKS** |

## Measurement of earth continuity

- upper limit settable within the range: 10 mΩ ...1.99Ω with 0.01 Ω resolution
- adjustable measurement time 1...60 s with 1 s resolution

**Measurement of earth conductor resistance I = 200 mA (protection class I)**

| Display range | Resolution | Accuracy |
|---|---|---|
| 0.00...0.99 Ω | 0.01 Ω | ±(4% m.v. + 2 digits) |
| 1.00...19.99 Ω | | ±(4% m.v. + 3 digits) |

- **measurement current: I = 200 mA for R = 0.2..1,99Ω**

**Measurement of earth conductor resistance I = 10 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 of measurement providing high accuracy of results
- **measurement current: I=10 A for R≤0.5 Ω**

**Measurement of earth conductor resistance 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 of measurement providing high accuracy of results
- **measurement current: I=25 A for R≤0.2 Ω**

## 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 | |

- measurement limit settable
- adjustable measurement time
- automatic discharge of the measured object capacitance after the measurement
- protection against measuring live devices

**DO YOU KNOW...** PAT-815 allows for full automatic device test after single START pressing.

## PAT-815 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

STANDARD ACCESSORIES:

**Measurement of PE and residual leakage current:**

| Display range | Resolution | Accuracy |
|---|---|---|
| 0.00...3.99 mA | 0.01 mA | ±(5% m.v. + 2 digits) |
| 4.0...19.9 mA | 0.1 mA | |

- adjustable limit
- adjustable measurement time

**Measurement of equivalent leakage current:**

| Display range | Resolution | Accuracy |
|---|---|---|
| 0.00...3.99 mA | 0.01 mA | ±(5% m.v. + 2 digits) |
| 4.0...19.9 mA | 0.1 mA | |

- adjustable limit
- adjustable measurement time
- open circuit voltage 25...40 V

**Measurement of touch leakage current:**

| Display range | Resolution | Accuracy |
|---|---|---|
| 0.00...4.999 mA | 0.001 mA | ±(5% m.v. + 3 digits) |

- adjustable limit
- adjustable measurement time

### Measurements of RCD parameters

**RCD trigger and response time test $t_a$**

Test range according to IEC 61557: 0 ms ... to the upper limit of displayed value

| Typ RCD | Factor | Range | Resolution | Accuracy |
|---|---|---|---|---|
| General | 0.5*$I_{\Delta n}$ | 0...300ms | 1ms | ±(2% m.v. + 2 digits[1]) |
| | 1* $I_{\Delta n}$ | | | |
| | 2* $I_{\Delta n}$ | 0...150ms | | |
| | 5*$I_{\Delta n}$ | 0...40ms | | |

[1] - accuracy of residual current application $I_{\Delta n}$ = 10 mA i 0,5 $I_{\Delta n}$: ± 2% m.v. ±3 digits

### Measurement of RCD disconnection current IA for sinusoidal differential current

Test range according to IEC 61557: (0,3...1,0)$I_{\Delta n}$

| Selected nominal current of RCD | Test range | Resolution | Test current | Basic uncertainty |
|---|---|---|---|---|
| 10 mA | 3,3...10,0 mA | 0,1 mA | 0,3 x $I_{\Delta n}$...1,0 x $I_{\Delta n}$ | ± 5% $I_{\Delta n}$ |
| 15 mA | 4,5...15,0 mA | | | |
| 30 mA | 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: 0,5$I_{\Delta n}$, 1$I_{\Delta n}$, 2$I_{\Delta n}$ i 5$I_{\Delta n}$,

### Measurement of current consumption using clamps C3

| Display range | Resolution | Accuracy |
|---|---|---|
| 100...999 mA | 1 mA | ±(5% m.v. + 5 digits) |
| 1.00...9.99 A | 0.01 A | |
| 10.0...24.9 A | 0.1 A | |

- adjustable measurement time

### 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 W | 1 W | ±(5% m.v. + 3 digits) |
| 1,00 k...3,99 kW | 0,01 kW | |

### Power factor PF

| Display range | Resolution | Accuracy |
|---|---|---|
| 0,00...1,00 | 0,01 | ±(10 % m.v. + 3 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 |
|---|---|---|
| 187...265,0 V | 0,01 V | ±(2% w.m. + 2 cyfry) |

**Intuitive user interface with large touch display:**




### Additional accessories of the meter:

| | |
|---|---|
| - 2D Bar code reader | **WAADAC2D** |
| - Portable USB D2 Sato printer | **WAADAD2** |

**For more additional accessories/adapters compatible with PAT-815 go to page 69**

### 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
- enclosure protection rating acc. to EN 60529:.....IP67(with lid closed)

### Other technical specifications:

- power supply of the meter.....187...265V, 50Hz
- load current.....max. 16A (230V)
- data transfer to a PC..... USB
- dimensions..... 390 x 310 x 170 mm
- weight of the meter.....approx. 6.8 kg

### Nominal operating conditions:

- operating temperature ..... 0...+40°C
- storage temperature..... -20...+70°C
- humidity..... 20...80%







## 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.

***More parameters - see pages 68, 69***

## 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

## Additional accessories of the meters:

| | |
|---|---|
| - 1.2 m 10/25 A two-core test lead "U1/I1" (PAT-805, PAT-806) | **WAPRZ1X2DZBB1** |
| - 1.2 m 10/25 A two-core test lead "U2/I2" (PAT-805, PAT-806) | **WAPRZ1X2DZBB2** |
| - Sonel high-current probe (PAT-805, PAT-806) | **WASONSPGB1** |
| - Kelvin clip (PAT-805, PAT-806) | **WAKROKELK06** |
| - 1 kV black "crocodile" clip (PAT-800) | **WAKROBL20K01** |
| - 1 kV black "crocodile" clip (PAT-805, PAT-806) | **WAKROBL30K03** |
| - 1 kV black probe | **WASONBLOGB1** |
| - 1.2 m black test lead terminated with banana plugs, black (PAT-800) | **WAPRZ1X2BLBB** |
| - 1.2 m black test lead terminated with banana plugs, black (PAT-805, PAT-806) | **WAPRZ1X2BLBB2X5** |
| - Cord - Schuko/IEC adapter (for testing extension cords) | **WAADAPATIEC2** |
| - 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 | **WAADAPAT16F1** |
| - 32 A industrial socket adapter | **WAADAPAT32F1** |
| - IEC adapter for testing IEC cords terminated with a "Mickey Mouse" connector | **WAADAPATIEC1** |
| - Sonel PAT software | **WAPROSONPAT1** |
| - USB bar code reader | **WAADACK1** |
| - Portable USB report/bar code | **WAADAD1** |
| - Stickers with bar codes (a reel of 100 stickers) | **WANAKKODPAS** |
| - Permanent adhesive tape | **WANAKD1** |

Portable USB report/bar code printer **WAADAD1**

Permanent adhesive tape **WANAKD1**

USB bar code reader **WAADACK1**

Stickers with bar codes **WANAKKODPAS**

Three-phase socket adapters
16 A: **WAADAPAT16P**
32 A: **WAADAPAT32P**

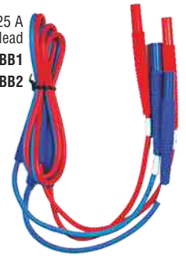
Industrial socket adapters
16 A: **WAADAPAT16F1**
32 A: **WAADAPAT32F1**

Switched three-phase socket adapters
16 A: **WAADAPAT16PR**
32 A: **WAADAPAT32PR**

Cord - Schuko/IEC adapter **WAADAPATIEC2**

High-current probe **WASONSPGB1**

1.2 m 10/25 A two-core test lead
**WAPRZ1X2DZBB1**
**WAPRZ1X2DZBB2**



IEC adapter **WAADAPATIEC1**

Kelvin clip **WAKROKELK06**

# SONEL PAT SOFTWARE

Index: WAPROSONPAT1

**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.**

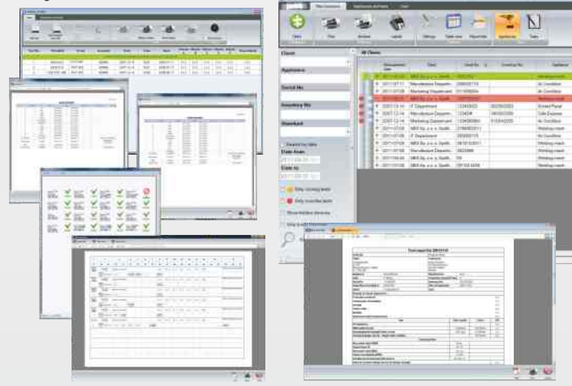
**Capability of advanced configuration of the meters from the program.**

**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 service 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.

**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


CAT III 600V

IP 40

## 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.

## 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%

## Clamp meter with wireless data transmission

# CMP-600

Index: WMXXCMP600

### 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

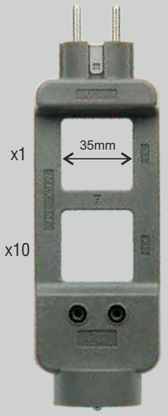
| Display range | Resolution | Accuracy |
|---|---|---|
| 5Hz | 0.001Hz | ±(0.7% m.v. + 5 digits) |
| 50Hz | 0.01Hz | |
| 500Hz | 0.1Hz | |
| 5kHz | 0.001kHz | |
| 50kHz | 0.01kHz | |
| 100kHz | 0.1kHz | |

## 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.




## 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) |

### 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

## 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:

**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

CAT IV 600V

IP 65

## Voltage testers

# P-2, P-3

Index: WMGBP2 (P-2)
WMGBP3 (P-3)

### 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)






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)

### 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

### 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-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

### 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.

### Standard accessories:

| | |
|---|---|
| - Test leads (2 pcs) | **WAPRZCMP1** |
| - K type thermocouple | **WASONTEMK** |
| - Case | |
| - Watertight plug for socket protection (2 pcs) | |
| - 9 V battery | |

### 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

## 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%


## Leakage current alarm signaller

# MPU-1

Index: WMGBMPU1

**Standard accessories:**

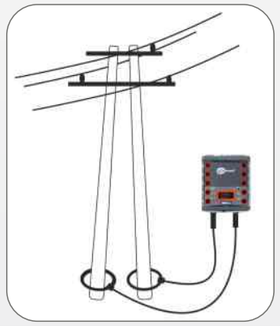
| | |
|---|---|
| - Carrying case L5 | **WAWALL5** |
| - Power supply adaptor Z11 | **WAZASZ11** |
| - Cable for charger | **WAPRZLAD230** |
| - Mounting strap | **WAPOZOPAKPL** |

**Additional accessories:**

| | |
|---|---|
| - F-1 clamp (ø 38 cm) | **WAWALL5** |
| - F-2 clamp (ø 25 cm) | **WAZASZ11** |
| - F-3 clamp (ø 12 cm) | **WAPRZLAD230** |
| - Lead for battery charging from socket of car lighter (12V) | **WAPRZLAD12V2** |

**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.**

### 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%

### 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.

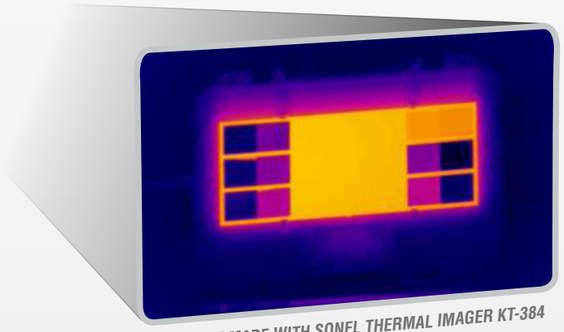




## Demonstration board

# 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.

### 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

**SOLID CASE**


**EXPERIMENTAL PLATE**

**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.**

## 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).

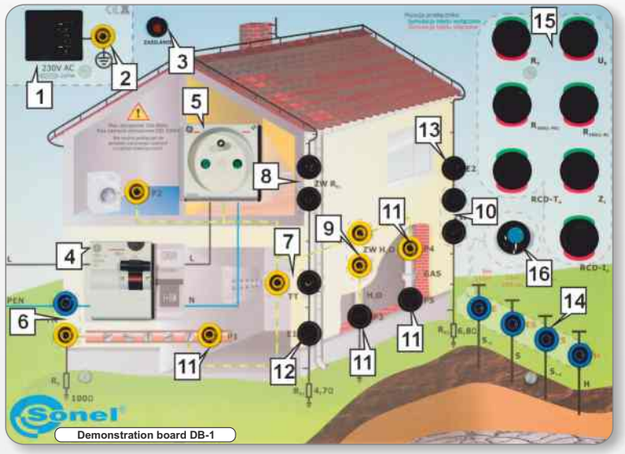
**Resistance to earth.**
**Measurement with the use of:**
- the two-lead method,
- the three-lead method,
- the four-lead method,
- the three-lead method and clamp,
- the two-clamp method,
- a short-circuit loop meter.

**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.**

**DO YOU KNOW...**

**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 | Accuracy 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"

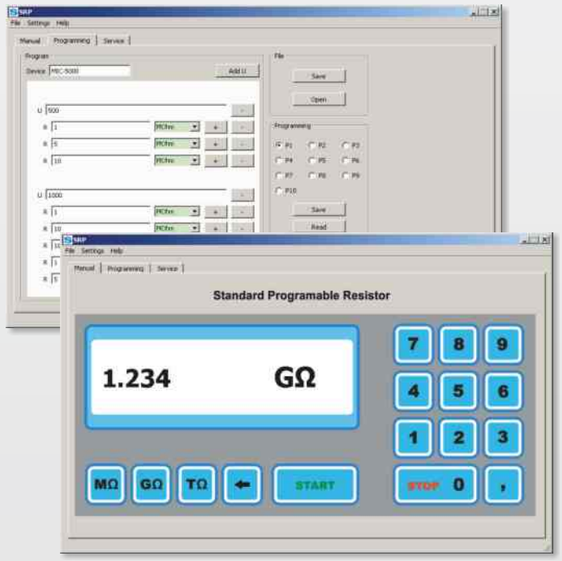
### About the software:

**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

**Our meters are made according to latest SMT and THT technologies of electronic assembly. Except manufacturing of measuring instruments we also perform complex services of Surface Mount Technology and Through-Hole Technology.**

## Design

We have selected a specialized team of design engineers who, with their determination and enormous potential, can come up with a perfect solution for you.

## Purchase and logistics

With almost twenty years of experience in supply chain management, we absolutely guarantee the top quality of materials and components used to fulfill every order, on-time deliveries and attractive prices. By offering you a comprehensive service, we save your time and money.

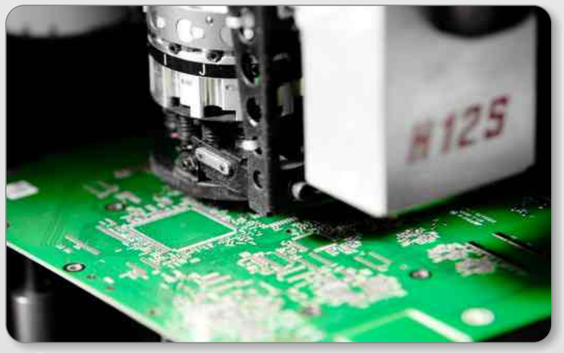
## Production

For us production means quality, precision, time and – most of all – a perfectly fulfilled order, in which a modern technology meets extensive knowledge.


## Production line

**SMT:**

- → **MPM MOMENTUM** screen printer,
- → **FUJI NXT** automatic line
- → **ERSA HOTFLOW2/20** reflow (soldering in the nitrogen atmosphere with addition of residual oxygen).
- → **ASYS** transport line
- → **DEK 265 Mk1** screen printer,
- → **FUJI GL2** dispenser,
- → **FUJI FCP-III-4000** high speed chip placer,
- → **FUJI FIP-III** universal automatic chip placer (additionally featuring acoplanarity check)




Our customer is our partner!

# ELECTRONIC MANUFACTURING SERVICES

## Production line

**THT:**

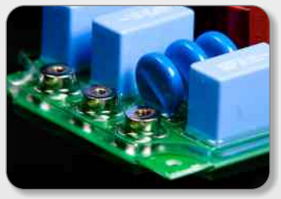
- → **ERSA-WAVE 330** wave soldering system (soldering in the nitrogen atmosphere)
- → **70 stands** for manual and complementary mounting.

## Testing

- electrical tests of printed circuit boards
- AOI (Automatic Optical Inspection)
- ion cleanliness testing (Ionograph)
- functional tests

## Protective coats

Programmable selective coating (on any area of the PCB) with a protective varnish or resin is performed automatically which increases capacity and saves precious time.



## Packaging

Each part is carefully protected and packed according to the customer guidelines.

## Servicing

Servicing of components (assembly, disassembly) is offered as an extra service.

## Quality and environment

Each order is fulfilled with utmost accuracy in a suitable environment (ion cleanliness testing) to ensure the top quality of your product.

**If you are interested in ordering electronic assembly, please contact:**

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NOTES

## Worldwide distribution network

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