

		S-24 VLF	S-36 VLF	S-44 VLF (230 V)	S-44 VLF (110 V)	S-57 VLF
Power supply		230 V (±10%) 10 A, 50/60 Hz	230 V (±10%) 10 A, 50/60 Hz	230 V (±10%) 10 A, 50/60 Hz	110 V (100 V...127 V) 15 A, 50/60 Hz	230 V (±10%) 10 A, 50/60 Hz
Output voltage		0...24 kV _{RMS} VLF 0.1 Hz (option: 0.05 Hz + 0.02 Hz) ± 0...34 kV DC	0...36 kV _{RMS} VLF 0.1 Hz (option: 0.05 Hz + 0.02 Hz) ± 0...52 kV DC	0...44 kV _{RMS} VLF 0.1 Hz (option: 0.05 Hz + 0.02 Hz) ± 0...62 kV DC	0...44 kV _{RMS} VLF 0.1 Hz (option: 0.05 Hz + 0.02 Hz) ± 0...62 kV DC	0...57 kV _{RMS} VLF 0.1 Hz (option: 0.05 Hz + 0.02 Hz) ± 0...62 kV DC
Voltage waveshape	VLF	similar sine-wave, symmetrical, with True RMS measurement				
	DC	direct voltage, negative and positive polarity				
Overcurrent trip (DC)		10 mA				
Max. testable cable length, max. capacitance (VLF)		up to 60 km (15 µF at 24 kV _{RMS} * 0.02 Hz)*	up to 60 km (15 µF at 18 kV _{RMS} * 0.02 Hz)*	up to 60 km (15.0 µF at 18 kV _{RMS} * 0.02 Hz)*	up to 60 km (15.0 µF at 6 kV _{RMS} * 0.02 Hz)*	up to 60 km (15.0 µF at 18 kV _{RMS} * 0.02 Hz)*
*at a cable capacitance of approx. 0.25 µF/km						
Max. load at max. output voltage (VLF) and 0.1 Hz		5 µF at 24 kV _{RMS}	2.4 µF at 36 kV _{RMS}	1.6 µF at 44 kV _{RMS}	1.0 µF at 44 kV _{RMS}	0.55 µF at 57 kV _{RMS}
Discharge - integrated automatic discharge device		max. 9000 J	max. 12500 J	max. 12500 J	max. 12500 J	max. 12500 J
Voltage measuring range		-40...0...40 kV accuracy ±1%	-60...0...60 kV accuracy ±1%	-70...0...70 kV accuracy ±1%	-70...0...70 kV accuracy ±1%	-70...0...70 kV accuracy ±1%
Current measuring ranges		±0...100 µA / 1 mA / 10 mA				
Operating temperature		-20...+45°C				
Storage temperature		-25...+70°C				
Duty		continuous operation				
PC interface		USB stick				
Construction		in two parts: operation unit and high voltage unit				
Dimensions and weight	Operation unit	37 x 34 x 20 cm 17 kg				
	High voltage unit	40 x 41 x 24 cm 38 kg	40 x 44 x 24 cm 48 kg	40 x 44 x 24 cm 49 kg	40 x 44 x 24 cm 49 kg	40 x 44 x 24 cm 49 kg



SONEL UV-260

index: WMGBV260



Standard accessories:

Power supply	
2x Li-Ion rechargeable battery 7.2 V 2.2 Ah	WAAKU22
External battery charger	WAADALB220
RCA/RCA video cable	WAPRZVIDRCA
Battery charging cable for 12 V car sockets	WAPRZLAD12SAM1
Camera strap	WAPRZSZEUV260
Headphone set with microphone	WAPRZSLU2
Hard briefcase	WAWALXL11
SD card 4 GB	WAPRZSD4

Description of the device:

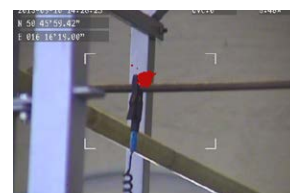
The UV-260 is a high-class, professional, and simultaneously lightweight and intuitive device enabling quick and simple remote diagnostics of a system without interfering in its operation. Its design, placing emphasis on high functionality, allows for detection and monitoring of corona, arc and surface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



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

Additional features:

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



Specifications of UV section

Image type	Monochromatic
Minimum UV sensitivity	$2.2 \times 10^{-18} \text{ W/cm}^2$
Minimum detectable discharge	1 pC from a distance of 10 meters
Spectral range	UV 240 ... 280 nm
Field of vision (WxS)	5.5° x 4.0°
Sharpness setting	Automatic and manual (UV and visible spectrum)
Sharpness range	2 m ... ∞
Detector life	Non-consumable
Frequency:	50 Hz

Specifications of visible spectrum section

Image type	Full color
Accuracy of UV/visible image superposition	Better than 1 milliradian
Minimum sensitivity	0.1 lux
Zoom	25x optical and 12x digital

Display

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

Processing and communication

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

Data storage

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

Power supply

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

Other specifications

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

Low resistance meters

MMR-6700
MMR-6500



MMR-650



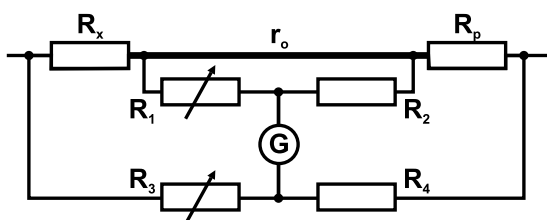
MMR-630
MMR-620

Low resistance measurements

Low resistance measurements are made when testing the resistance of the following connections: welded, equipotential, contacts, cable connections and coils of low resistance. Meters for low resistance measurement are also used to test motor and transformer windings. These tests also include testing the quality of solder joints or continuity of earthing cables.

Low resistance measurements may be performed by several methods. The most popular is **the technical method**.

For small resistance values (microohms), the wiring and contact resistances in connection points are of significant importance. Therefore, the design of the bridge provides separate current and voltage terminals at the R_x and R_p resistors. It is recommended that all other resistors have a resistivity 1000 times greater than the resistance of the leads.



Circuit diagram of Thomson bridge

At the balanced state of the bridge, the current flowing in the branch of the galvanometer is equal to zero. The formula for the measured resistance is as follows:

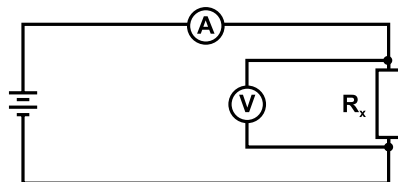
$$R_x = \frac{R_p R_1}{R_2}$$

The accuracy of the measurement with Thomson bridge is affected insensitivity deviation, which for low resistances of $R_x = 10^{-6} \dots 10^{-5} \Omega$ order is particularly evident. The accuracy also depends on the error in recreating the model, which is related to the quality of particular elements of the bridge. During the measurement, there may be additional errors due to current overloads of the tested and reference resistors, temperature changes and the presence of additional electromotive forces in the system.

Due to defectiveness and limitations of traditional technical bridges, currently we witness a tendency to construct electronic meters for the measurement of low resistances in the range from single micro-ohms to several hundred ohms. Instruments can measure very small resistances even with a resolution of $0.1 \mu\Omega$. An important feature of modern micro-ohm meters is ease of use, application of different measurement modes and the option to cooperate with a computer. These devices measure the resistance using the technical method. Any conductive element may be described by the formula according to Ohm's law:

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

U_x - voltage drop in tested object,
 I - intensity of flowing current,
 R_x - measured resistance.



Resistance measurement using technical method
(circuit with correctly measured voltage)

The circuit with correctly measured voltage is used for small resistances, when the current flowing through the tested object is several times greater than the current of the voltmeter, which measures the voltage drop on the object. The resistance obtained by the measurement is calculated from the formula:

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

I_v - current flowing through the voltmeter.



Measurements with MMR-650

With a voltmeter of very high resistance, the current flowing in its circuit is negligibly low, so the measurement result is not affected by the resistance of test leads. This is so called 4-pole method. This type of measurement, which eliminates the impact of the resistance of wires, is used in low resistance meters of MMR series.

Due to very low values of the measured resistance, the four-wire method is used, which allows user to perform accurate measurements without taking into account the impact of the resistance of test leads. Therefore, the manual calibration of the meter and test leads is not necessary, but it is possible (e.g. when using other type of test probes). In addition, it is always possible to restore the factory calibration settings of the device.

Before starting the measurement, select the maximum measurement current (range: from 0.1 mA to 10 A). The measuring range (and thus the current) is selected manually or automatically. In some cases (e.g. exceeding the allowable power generated at the object), it may be desirable to limit the maximum current flowing through the tested object. MMR devices have a lock that allows user to set the upper limit of the measuring current.

The device measures the resistance by causing a current to flow through the tested object (using current leads), at the same time controlling the voltage drop across the terminals of the voltage lines. A break in any circuit will be adequately signalled and the resistance measurement will not be possible.

Operating mode

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

- » in manual mode, each measurement must be triggered by the operator by pressing "Start" button;
- » in automatic mode, the measurement starts at the moment of connecting the last measurement terminal
- » for the continuous mode, measurements are performed every three seconds (resistive mode) or continuously (inductive mode).

The measurements may be performed using the current:

- » flowing only in one direction or
- » flowing in two opposite directions.

Testing with unidirectional current makes the measurements faster, whereas using bidirectional current eliminates errors resulting caused by the presence of internal voltages and electrothermal forces in the tested object. The main result of measurements using the bidirectional current is the average of two measurements of the resistance with the currents flowing in opposite directions. In addition, supplemental results are displayed, i.e. R_f resistance with the current flowing in theoretical "forward" direction and R_b resistance with the current flowing in theoretical "backward" direction.

The normal duration of the measurement is 3 seconds. In order to measure an inductive object, the extended measurement time may be selected. For objects with a high inductance, the measurement time is extended to a few minutes and after completed measurement, the tested object is discharged.

There is an option of using fast measurement mode for inductive devices/objects (FAST mode), which at a slightly lower accuracy accelerates the measurement procedure.

Another operation mode is the window mode, which allows the user to set the upper and lower limits for the measurement result. Results outside this range are additionally signalled by the meter.

The limits of the acceptable range of variability of results are determined by the user.

When using the automatic and continuous mode, exceeding the pre-set range limits will interrupt a series of measurements and the meter will wait for a reaction of the user.

Contact resistance meters

SONEL MMR-6700 / MMR-6500

index: WMGBMMR6700 / WMGBMMR6500



Application

MMR-6xxx micrometers series are devices with a **state of art design** with unprecedented approach to measuring small resistances. The instruments allow to **measure resistive objects with a high current** and have a unique in his measurement class module for inductive current objects **up to 10 A**.

Device capabilities

Sonel microohmmeter MMR-6xxx series thanks to the use of special algorithms, measuring functions and a stabilized, non-pulsing measurement current allow user to work in difficult conditions. Possibility of use measurement current **up to 200 A** and a high power source allows you to measure the contacts of the HV switch with basic uncertainty from 0.25%.

Simplicity of readings

The MMR-6700 microcontroller is equipped with readable, touch screen, 5 inch color display with a resolution of 800x480 pixels for convenience of readings measurement results.

Help system

The use of a large, readable display allowed for use helpful appetent drawings how to use the meter.

Product features

- » measurements of resistive objects with current up to **100/200 A**
- » measurements of induction objects **up to 10 A**
- » measurements of objects earthed on both sides (i.e. main joints of HV switches)
- » measurement with one- or both-way current flow
- » high immunity to outside interference
- » measurements temperature of windings
- » automatic compensation temperature of objects measured
- » a state of the art interface with a touch screen and expanded memory
- » work with a printer and a 2D barcode reader
- » Wi-Fi, USB and LAN communication
- » IP67

Measurements of contact resistance using high current

Range	Resolution	Accuracy	Test current
0.0...999.9 μΩ	0.1 μΩ	±(0.25% + 2 digits)	100 A < I ≤ 200 A*
0.0...999.9 μΩ	0.1 μΩ		50 A < I ≤ 100 A
1.0000...1.9999 mΩ	0.0001 mΩ		
0.0...999.9 μΩ	0.1 μΩ		20 A < I ≤ 50 A
1.0000...3.9999 mΩ	0.0001 mΩ		
0.0...999.9 μΩ	0.1 μΩ		10 A < I ≤ 20 A
1.0000...7.9999 mΩ	0.0001 mΩ		

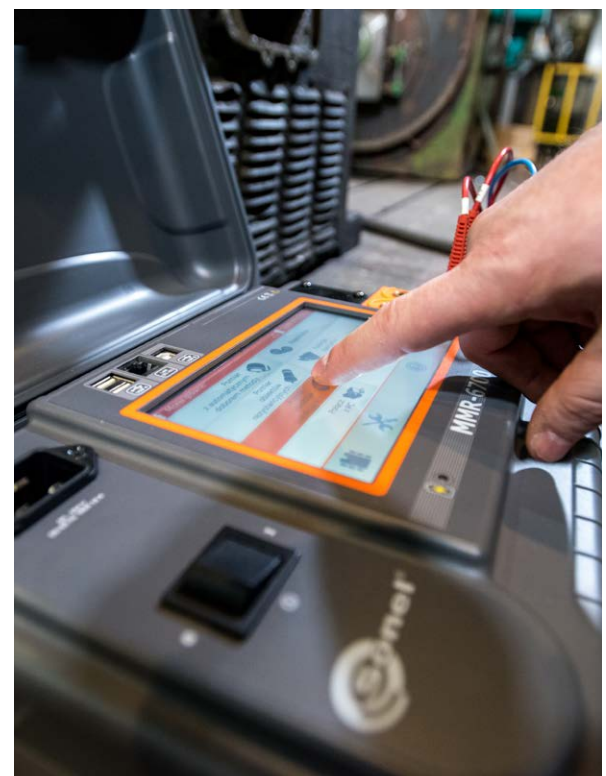
* MMR-6700 only

Measurements of resistance and inductive objects using low current

Range	Resolution	Accuracy	Test current
0...999.9 μΩ	0.1 μΩ	±(0.25% + 2 digits)	10 A
1.0000...1.9999 mΩ	0.0001 mΩ		10 A
2.000...19.999 mΩ	0.001 mΩ		10 A / 1 A
20.00...199.99 mΩ	0.01 mΩ		1 A / 0.1 A
200.0...999.9 mΩ	0.1 mΩ		0.1 A
1.0000...1.9999 Ω	0.0001 Ω		10 mA
2.000...19.999 Ω	0.001 Ω		1 mA
20.00...199.99 Ω	0.01 Ω		
200.0...1999.9 Ω	0.1 Ω		

Standard accessories:

2x crocodile clip, black, 1 kV, 32 A	WAKROBL30K03
2x Kelvin clamp, 1 kV, 25 A	WAKROKELK06
Current carrying test lead 3 m black I1 (200 A, 25 mm ²)	WAPRZ003BLI1
Current carrying test lead 3 m black I2 (200 A, 25 mm ²)	WAPRZ003BLI2
Test lead 3 m blue 1 kV U1 (banana plug)	WAPRZ003BUBBU1
Test lead 3 m blue 1 kV U2 (banana plug)	WAPRZ003BUBBU2
Doble-wire test lead 3 m (10 A / 25 A) U1/I1	WAPRZ003DZBBU1I1
Doble-wire test lead 3 m (10 A / 25 A) U2/I2	WAPRZ003DZBBU2I2
USB cable	WAPRZUSB
Mains cable with IEC C19 plug	WAPRZZAS1
ST-3 temperature probe	WASONT3
L-4 carrying case	WAFUTL4
Factory calibration certificate	



Winding and low resistance meter

SONEL MMR-650

index: WMGBMMR650



Product features

- » measurement of winding resistance (including amorphous core transformers)
- » transformer core demagnetization function
- » automatic temperature compensation function (temperature probe)
- » function of determining the temperature of a motor under load
- » high immunity to disturbances
- » measurement of resistant objects using bipolar current

Application

The MMR-650 winding resistance and low resistance meter is designed to measure very low very low resistance of both windings - including amorphous core transformers - and resistive objects. This product is made to be used in power plants, railways and maintenance companies to measure:

- » windings of power transformers and motors,
- » breakers, contacts,
- » earthing conductors, equipotential bondings,
- » welded and soldered connections,
- » bolted connections,
- » and other resistive and inductive objects.

MMR-650 can be also utilized on production lines (eg. at the final production control stage).

Device capabilities

The MMR-650 winding resistance and low resistance meter provides an innovative combination of a **high-performance measuring device** with a **modern user interface** and advanced **data management system**. Wireless data transmission, enhanced system of 2D codes and ability to print labels to identify test items, all contribute to bringing new quality of work and allow the user to perform a wide range of measurements.

Easy readout

The MMR-650 winding resistance and low resistance meter is equipped with a readable colour touchscreen that, due to its 800 x 480 pixel resolution, provides both high comfort of interacting with the interface and high readability of the measurement results.

Durable and practical casing

In response to the customers needs the MMR-650 microohmmeter has been designed to operate in difficult environmental conditions. A unique casing with the IP67 ingress protection rating ensures that the device is both waterproof and dustproof.

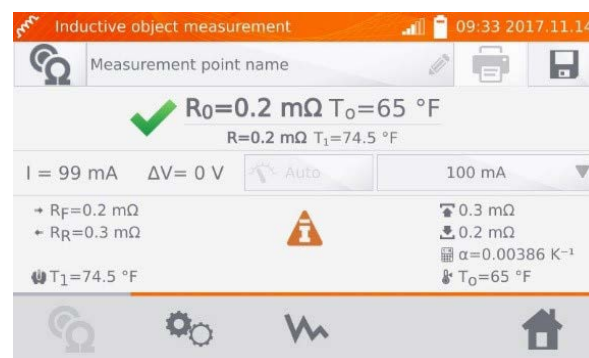
Resistance measurement

Range [Ω]	Resolution [Ω]	Accuracy*	Test current
0...999.9 μ	0.1 μ	±(0.2% + 2 digits)	10 A
1.0000...1.9999 m	0.0001 m		10A
2.000...19.999 m	0.001 m		10 A/1 A
20.00...199.9 m	0.01 m		1 A/0.1 A
200.0...999.9 m	0.1 m		0.1 A
1.0000...1.9999	0.0001		10 mA
2.000...19.999	0.001		1 mA
20.00...199.99	0.01		
200.0...1999.9	0.1		

*for resistive objects

Standard accessories:

L-11 carrying case	WAFUTL11
2x Kelvin clamp, 1 kV, 25 A	WAKROKELK06
Doble-wire test lead 3 m (10 A / 25 A) U1/I1	WAPRZ003DZBBU111
Doble-wire test lead 3 m (10 A / 25 A) U2/I2	WAPRZ003DZBBU212
Mains cable with IEC C13 plug	WAPRZ1X8BLIEC
USB cable	WAPRZUSB
2x double-tip Kelvin probe (banana sockets)	WASONKEL20GB
ST-3 temperature probe	WASONT3
Li-Ion 7.2 V rechargeable battery	WAAKU27
Factory calibration certificate	



The MMR-650 allows single-channel measurement resistance of transformer windings with amorphous cores.

SONEL MMR-630 / MMR-620

index: WMGBMMR630 / WMGBMMR620



CAT III

300 V

IP54

Measurements of objects resistive in nature:

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

Measurements of objects inductive in nature:

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

Additional functions of the meters:

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

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

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

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

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

Window mode:

- » makes possible to set an upper and lower limit within the measurement result should remain; sound signal triggered when the result is beyond set range,
- » capability of performing measurements even under disturbances of a value five times greater than the measured signal.

Instruments meet the requirements set forth in the standards:

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



MMR-630/620 microohmmeters enable accurate measurements of both connections resistance (welded, soldered, bolted) and winding resistance of electrical motors and power transformers.

Standard accessories:

NiMH rechargeable battery 4.8 V 3 Ah	WAAKU03
L-1 carrying case	WAFUTL1
4x black "crocodile" clip 1 kV 32 A	WAKROBL30K03
2x Kelvin clamp 1 kV 25 A	WAKROKELK06
Doble-wire test lead 3 m (10 A / 25 A) U1/I1	WAPRZ003DZBBU1I1
Doble-wire test lead 3 m (10 A / 25 A) U2/I2	WAPRZ003DZBBU2I2
230 V mains cable (IEC C7 plug) (MMR-630)	WAPRZLAD230
RS-232 serial transmission cable	WAPRZRS232
2x double-tip Kelvin probe (banana sockets)	WASONKEL20GB
UNI-SONEL hanging straps	WAPZSZSE1
Factory calibration certificate	

Resistance measurement

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

Accuracy ±(0.25% m.v. + 2 digits)

"m.v." = "measured value"

Other technical specifications:

- » type of insulation double, as per EN 61010-1 and IEC 61557
- » meter power supply SONEL/Ni-MH 4.8 V rechargeable battery pack
- » charger built-in
- » battery charging time approx. 2.5 hours
- » number of measurements with 10 A current 300
- » time until auto-OFF 120 seconds
- » electric hum immunity additional error ≤1% for 50 Hz voltage
- » ≤100 mV RMS
- » maximum lead resistance for 10A current 100 mΩ
- » measurement current input accuracy ±10%
- » time of resistance measurement:
 - resistance mode, with two-directional current flow 3 seconds
 - induction mode max 10 min (depends on R and L of the object)
- » dimensions 295 x 222 x 95 mm
- » meter weight approx. 1.7 kg
- » operating temperature range 0...+40°C



Test leads for measuring low resistance and testing lightning protection of wind turbines

Compatible accessories

WAADAPRZxxxBDP

Test lead 25 m | index: WAADAPRZ025BDP

Test lead 50 m | index: WAADAPRZ050BDP

Test lead 75 m | index: WAADAPRZ075BDP

Test lead 100 m | index: WAADAPRZ100BDP

Test lead 25 m



Test lead 50 m / 75 m / 100 m



Capabilities

Sonel BDP test leads series has been designed for effective measurement of lightning protection of wind turbines and precise measurements of low resistance. Together with compatible accessories, it is a comprehensive solution for controlling very large objects.

Together with Sonel MMR-650 low resistance meter, the test leads enable measurements of small resistance with a measuring current of **up to 10 A**, at long distances - even **up to 150 m**. This is especially important in situations where resistance is significant!

Overview

Sonel BDP test leads are a reliable tool for professionals who measure low resistances and monitor the effectiveness of lightning protection in the area of wind turbines. They consist of a current conductor and a voltage conductor, protected by a common, durable braid. Sonel BDP test leads have different lengths (25, 50, 75, 100 m), which allow to create a measurement system for specific distance requirements. They are compatible with **Sonel MMR-650** low resistance meter.

The test leads are terminated with separate banana plugs on one end and an integrated PAT socket on the other. The latter allows you to connect accessories that have been developed for use when measuring wind turbines.

Sonel BDP test leads are made of the highest quality materials, characterized by both high conductivity and ruggedness to mechanical damages. The quality of workmanship, durability and flexibility of configuration make them indispensable equipment for specialists who care about the safety and efficiency of renewable energy installations.

Features

WAADAPRZxxxBDP

- » Impact resistant connector
- » PAT socket
- » Protective braid
- » Reels for convenient carrying

UIW-1

- » PAT plug / banana plug adapter

WS-10

- » 2-pin Kelvin probe
- » PAT plug

Kelvin KEL-2

- » Kelvin clamp
- » PAT plug

WA...

Kelvin KEL-2 | index: WAZACKEL2

Kelvin 20GB | index: WASONKEL20GB

Kelvin 20GB2 | index: WASONKEL20GB2

Kelvin K-06 | index: WAKROKELK06

UIW-01 | index: WAADAUIW01

WS-10 | index: WAADAWS10



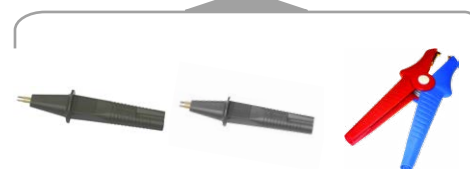
WS-10

Kelvin KEL-2



UIW-01

+



Kelvin 20GB

Kelvin 20GB2

Kelvin K-06

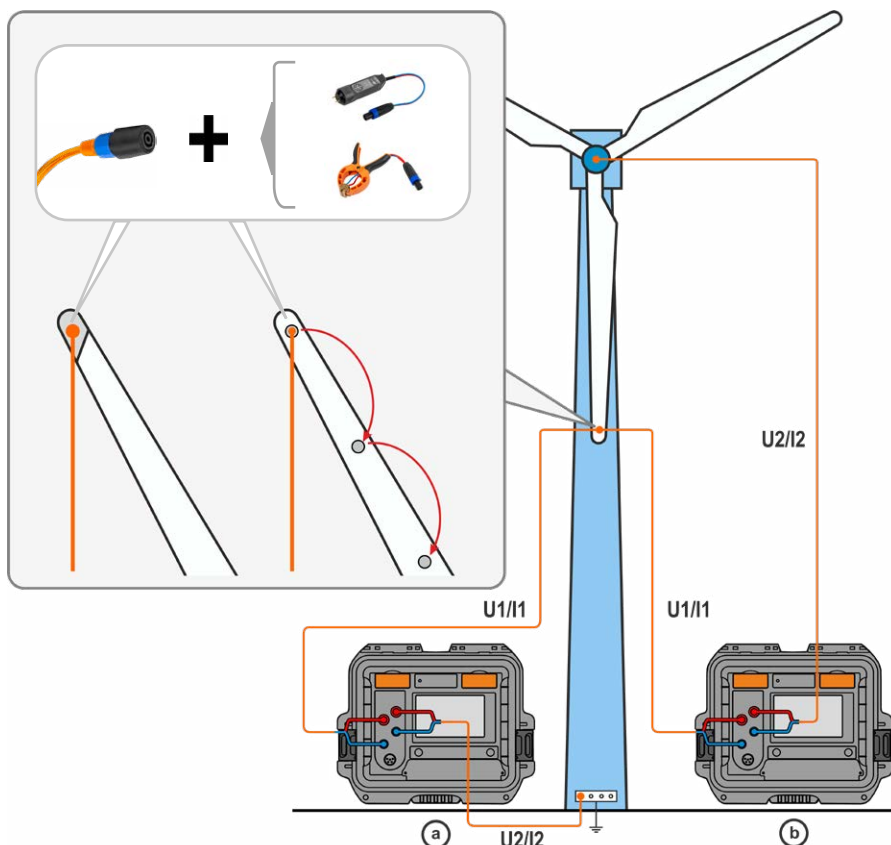


Photo	Name	Index	MMR-6700	MMR-6500	MMR-650	MMR-630	MMR-620
	Small resistance standard	WAADAWMR2			•		
	USB / RS-232 converter	WAADAUSBRS232				•	•
	C-5A current clamp (Φ39 mm)	WACEGC5AOKR	•	•			
	Barcode scanner 2D (USB)	WAADACK2D	•	•	•		
	D2 portable USB report / barcode printer (Sato)	WAADAD2	•	•	•		
	L-1 carrying case	WAFUTL1				1	1
	L-7 backpack	WAFUTL7	•	•			
	L-4 carrying case	WAFUTL4	1	1			
	L-11 carrying case	WAFUTL11			1		
	Crocodile clip, black, 1 kV, 32 A	WAKROBL30K03	2	2		4	4
	Kelvin clamp, 1 kV, 25 A	WAKROKELK06	2	2	2	2	2
	Double-wire test lead 10 m (Kelvin crocodile clip / banana plug)	WAPRZ010DZBKEL			•		
	Double-wire test lead 3 m (10 A / 25 A) U1/I1	WAPRZ003DZBBU1I1	1	1	1	1	1
	Double-wire test lead 3 m (10 A / 25 A) U2/I2	WAPRZ003DZBBU2I2	1	1	1	1	1
	Double-wire test lead 6 m / 10 m / 15 m (10 A / 25 A) U1/I1	WAPRZ006DZBBU1I1 WAPRZ010DZBBU1I1 WAPRZ015DZBBU1I1	•	•	•	•	•
	Double-wire test lead 6 m / 10 m / 15 m (10 A / 25 A) U2/I2	WAPRZ006DZBBU2I2 WAPRZ010DZBBU2I2 WAPRZ015DZBBU2I2	•	•	•	•	•
	Double-wire test lead 25 m	WAADAPRZ025BDP			•		
	Double-wire test lead 50 m / 75 m / 100 m	WAADAPRZ050BDP WAADAPRZ075BDP WAADAPRZ100BDP			•		
	Current carrying test lead black I1 3 m (200 A, 25 mm²)	WAPRZ003BLI1	1	1			
	Current carrying test lead black I2 3 m (200 A, 25 mm²)	WAPRZ003BLI2	1	1			
	Current carrying test lead black I1 6 m / 10 m / 15 m (200 A, 25 mm²)	WAPRZ006BLI1 WAPRZ010BLI1 WAPRZ015BLI1	•	•			
	Current carrying test lead black I2 6 m / 10 m / 15 m (200 A, 25 mm²)	WAPRZ006BLI2 WAPRZ010BLI2 WAPRZ015BLI2	•	•			

Photo	Name	Index	MMR-6700	MMR-6500	MMR-650	MMR-630	MMR-620
	Test lead 3 m blue 1 kV U1 (banana plug)	WAPRZ003BUBBU1	1	1			
	Test lead 3 m blue 1 kV U2 (banana plug)	WAPRZ003BUBBU2	1	1			
	Test lead blue 1 kV U1 (banana plug) 6 m / 10 m / 15 m	WAPRZ006BUBBU1 WAPRZ010BUBBU1 WAPRZ015BUBBU1	•	•			
	Test lead blue 1 kV U2 (banana plug) 6 m / 10 m / 15 m	WAPRZ006BUBBU2 WAPRZ010BUBBU2 WAPRZ015BUBBU2	•	•			
	USB cable	WAPRZUSB	1	1	1		
	RS-232 serial transmission cable	WAPRZRS232				1	1
	Mains cable with IEC C13 plug	WAPRZ1X8BLIEC			1		
	Mains cable with IEC C19 plug	WAPRZZAS1	1	1			
	230 V mains cable (IEC C7 plug)	WAPRZLAD230				1	
	LAN cable (RJ45)	WAPRZRJ45	•	•	•		
	Protective gloves (for operating the touchscreen)	WAREK1	•	•			
	ST-1 temperature probe	WASONT1	•	•	•		
	ST-3 temperature probe	WASONT3	1	1	1		
	Double pin Kelvin probe with banana connector	WASONKEL20GB	•	•	2	2	2
	UNI-SONEL hanging straps	WAPZSZE1				1	1
	Label Roll – Black on White for D2 printer (SATO)	WANAKD2	•	•	•	•	•
	Ribbon for D-2 printer (SATO)	WANAKD2BAR	•	•	•	•	•
	Kelvin vice with cables	WAZACKEL1	•	•	•	•	•
	NiMH battery 4.8 V 3.2 Ah	WAAKU03				1	1
	Li-Ion battery Li-Ion 7.2 V	WAAKU27			1		
	PC software: Sonel Reader	WAPROREADER	•	•	•	•	•

Location of hidden infrastructure and faults



LKZ-2500

LKZ-720



TDR-420
TDR-410



Detecting cables and underground infrastructures



Earthworks that include various types of excavation, but also installation of sewer and water pipes or cables - are associated with a **high risk of damage to underground systems**, which could lead to a dangerous accident. European Union law requires from the contractor of such works to ensure safety to employees, third parties and private property. In order to reduce the risk of accidents, a number of activities are carried out, including the mandatory detection of existing underground installations and systems. The contractors are never absolutely sure whether all underground utilities are shown on the maps. Therefore, in order to identify all potentially hazardous installations and systems, **additional checks are necessary**, which may be performed with cable locators.

LKZ-2500 is a set for locating wires and pipes, **which precisely determine the depth and direction** of conductive systems (power and telecommunications cables, metal pipes) and with additional probes it is able to detect plastic and concrete pipes. Earthworks are carried out in difficult conditions (moisture, dirt), so both devices meet the requirements of IP65, while the transmitter with closed cover provides ingress protection of IP67.

Location and tracking underground infrastructure elements is performed in a wide range of conditions. LKZ-2500 can operate in several different modes, adapted to different situations:

Power - used to locate electric cables. It is a **passive mode**, where the transmitter is not required: the signal is generated by the live cable itself.

Radio - used to locate metal objects (pipes, reinforcement elements), which re-emit radio signals. It is also a **passive method**: the signal is present in the tested object, which re-emits radio waves.

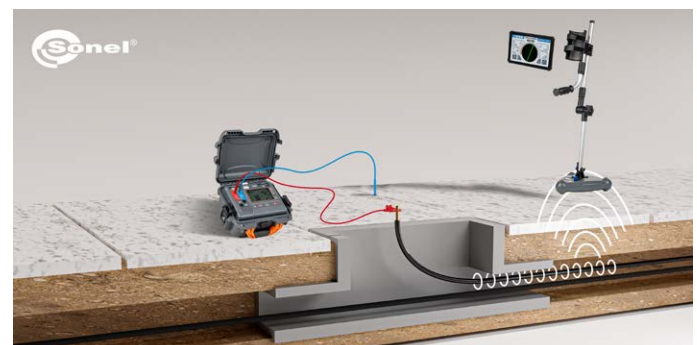
8 kHz - used for precise location of a particular type of systems (cables, pipes, etc.). The frequency of the generated signal (8 kHz) has better range than 33 kHz and lower tendency to transfer the signal to other objects. This is an active method, because it requires the use of a signal generator.

32 kHz - used for location of a particular type of systems (cables, pipes, etc.). This frequency is most often used to locate underground installations. It ensures the highest efficiency, but it has a greater tendency to transfer the signal to other systems/installations. This method also requires the use of a signal generator (**active method**).

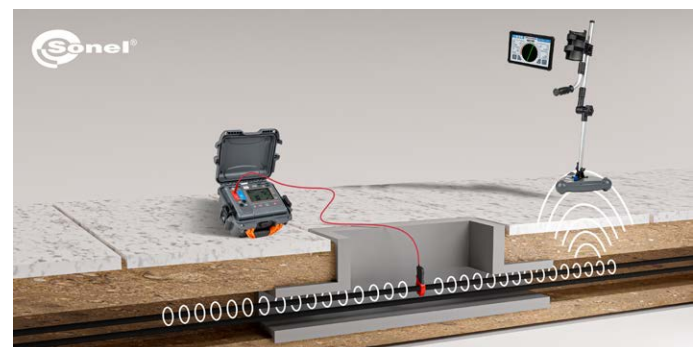
LKN-2500 generator (transmitter) generates a signal which is tracked in the detected system. Depending on the situation, in active modes, the transmitter may be connected as shown in one of the following images.



Inductive method



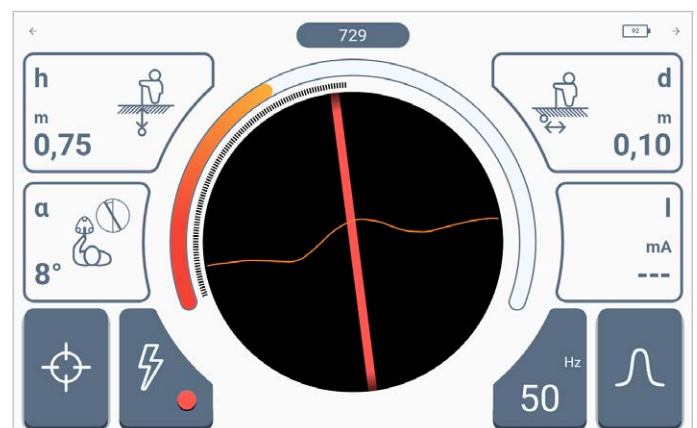
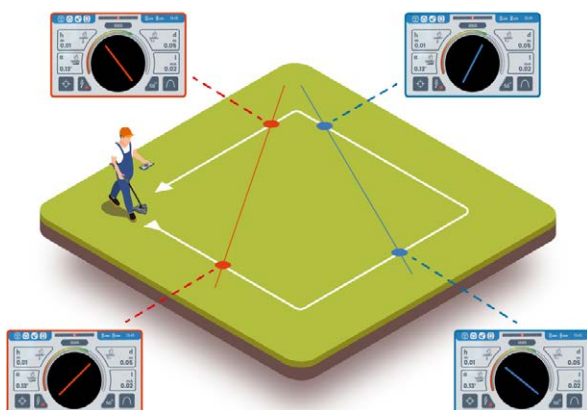
Galvanic method



Clamp method

Additionally, LKZ-2500 set allows the user to precisely determine the depth of a particular system within 3 meters. In such detection, the device must operate in active modes of 6 kHz or 33 kHz, which use the transmitter and receiver.

In metal systems, the signal may be generated without wires by induction or by direct connection of test leads or by using transmitting clamps. In non-conductive systems, the signal may be generated by introducing a transmitting probe (in the form of a coiled cable or "floating" probe) directly to the detected system (plastic, concrete pipes etc.). In addition to determining the direction and depth of pipes, the user may also locate their blockages by using additional probes.



SONEL LKZ-2500



Choose the best set for your needs

LKZ-2500

Location set with transmitter, detector, control panel and long handle

index: WMGBLKZ2500

LKZ-2500 Start

Location set with transmitter, detector and long handle

index: WMGBLKZ2500START

LKZ-2500 Lite

Location set with transmitter, detector and short handle

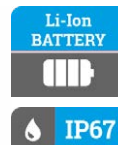
index: WMGBLKZ2500LITE

LKD-2500

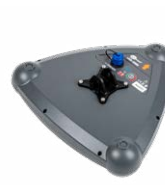
Location set with detector and short handle

index: WMGBLKD2500

LKN-2500 transmitter



LKD-2500 detector



The LKZ locator set consists of a LKN transmitter and LKD detector. It allows for location, identification and tracking of the route of objects buried in the ground. It allows to trace:

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

The sets of LKZ series are an invaluable support in earthworks carried out for various industries, including energy, installation, construction, railway, telecommunications, water and sanitary, heating, geodetic and many others.

LKN-2500 transmitter injects a locating signal into an underground object. **LKD-2500 detector** placed along the object traces this signal along the object. The information about position of the traced object is displayed on the **Sonel LKZ Mobile app** which is connected with the detector. Determination of the object's route is possible based on observation of compass readings and the level of the detected signal.

The system has the ability to trace cables and record routes via the mobile application. Such files can be exported and shared with other users – including those who do not have the LKN-2500 / LKD-2500 device.

The system is capable of operating in passive mode (without the use of the LKN-2500 transmitter) and active mode (with the use of the LKN-2500 transmitter). The active mode allows to introduce the signal in three different methods:

- » **galvanic** – injects tracing signal into the object directly, through crocodile clips and test leads,
- » **clamp** – injects tracing signal into the object through an inductive clamp,
- » **inductive** – injects tracing signal into the object inductively, using the instrument's internal antenna.

LKN-2500 transmitter:

- » ingress protection IP67
- » power supply Li-ion 7.2 V 9.8 Ah rechargeable battery
- » operating temperature -10...+50°C
- » dimensions 318 x 257 x 152 mm
- » weight 3.4 kg

LKD-2500 detector:

- » ingress protection IP65
- » power supply Li-ion 3.6 V 6.7 Ah rechargeable battery
- » operating temperature -10...+50°C
- » dimensions 290 x 275 x 100 mm
- » weight 1.2 kg

LKN-2500 transmitter

- » Operation in direct galvanic or inductive connection mode – internal transmitting antenna
- » Compatible with transmitting clamps
- » Rugged housing

LKD-2500 detector

- » **Active mode**
 - work with LKN-2500 transmitter at the frequencies of 8 kHz, 32 kHz (Signal mode)
- » **Passive mode** – work at the frequencies of:
 - 50 Hz, 60 Hz (Power mode)
 - 2...65 kHz (Radio mode)



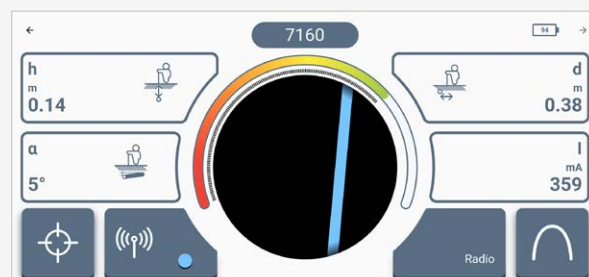
SONEL LKZ MOBILE

index: WAPROLKZMOBILE

The application works with Sonel LKD-2500 detector. It enables tracing of objects, recording of routes in the memory of the mobile device along with GPS positions of waypoints and additional readings.

The application additionally enables:

- » live positioning preview,
- » measuring the distance to a specific waypoint,
- » export of routes to other mobile devices,
- » reading routes from the mobile device's memory,
- » preview of all recorded parameters,
- » merging routes,
- » adding notes to routes and measurement points.



Choose the best set for your needs

transmitter

detector

control panel

long handle

short handle

LKZ-2500

includes transmitter, detector, control panel and long handle



LKZ-2500 Start

includes transmitter, detector and long handle



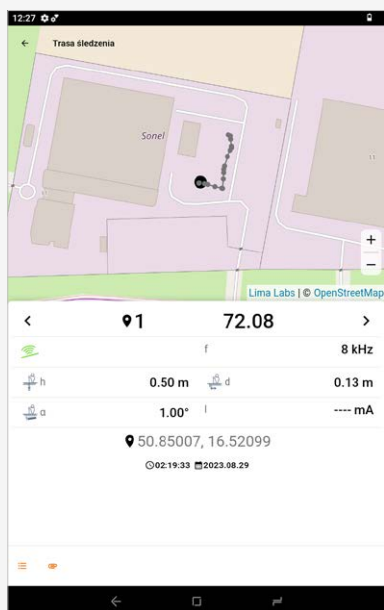
LKZ-2500 Lite

includes transmitter, detector and short handle



LKD-2500

includes detector and short handle



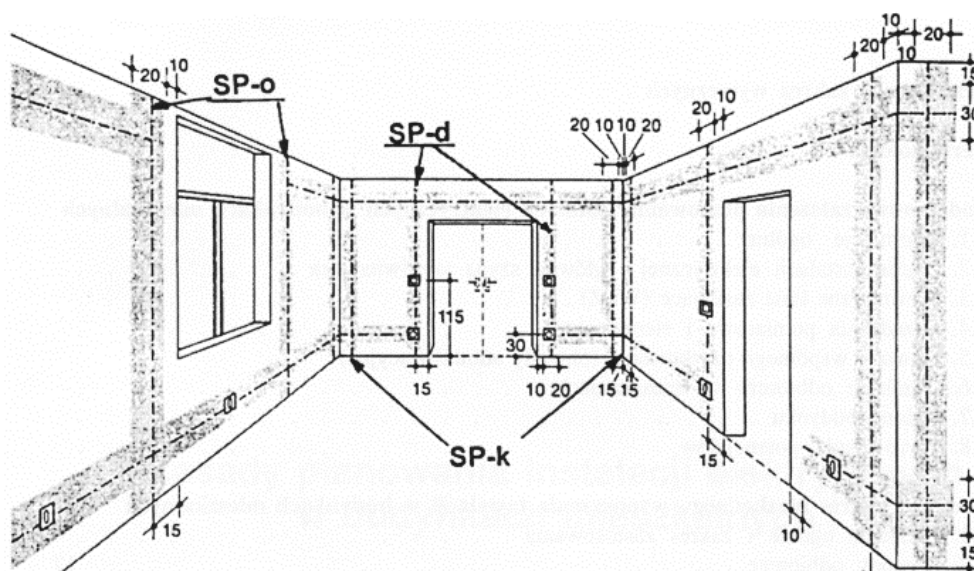
Standard accessories:

		LKZ-2500	LKZ-2500 Start	LKZ-2500 Lite	LKD-2500
		WMGBLKZ2500	WMGBLKZ2500START	WMGBLKZ2500LITE	WMGBLKD2500
LKN-2500 transmitter	WMGBLKN2500	✓	✓	✓	
LKD-2500 detector	WMGBLKD2500	✓	✓	✓	✓
Control panel	WAPOZTAB8	✓			
2x test lead 5 m, red, 1 kV (banana plugs)	WAPRZ005REBB	✓	✓	✓	
Test lead 5 m, blue, 1 kV (banana plugs)	WAPRZ005BUBB	✓	✓	✓	
3x crocodile clip, red, 1 kV, 20 A	WAKRORE20K02	✓	✓	✓	
Crocodile clip, blue, 1 kV, 20 A	WAKROBU20K02	✓	✓	✓	
2x earth contact test probe (rod), 30 cm	WASONG30	✓	✓	✓	
Z-7 power supply	WAZASZ7	✓	✓	✓	
Z-32 power supply	WAZASZ32	✓	✓	✓	✓
L-10 carrying case	WAFUTL10			✓	✓
XL-1 carrying case	WAFUTXL1	✓	✓		
Shoulder harness, design 1	WAPOZSZE7	✓	✓		
Short handle	WAPOZUCH14			✓	✓
Long handle	WAPOZUCH15	✓	✓		
Holder for control panel	WAPOZUCH16	✓	✓		
Declaration of verification		✓	✓	✓	✓

Detecting cables and wires

Works on detecting underground cables and wires and their routes are always challenging and quite difficult for people performing this task. Despite **good practice and guidelines included in standards and recommendations, which define places for routing cables in the walls, contractors often perform their tasks inconsistently and negligently**. In result electric wires are found often in at least expected places. Naturally, floors and ceilings are also areas used for installing cables. Therefore, **electrical systems can be found in many locations**, causing problems during renovation and finishing works. Performing works without prior routing of cables and wires may cause their damage by drilling, puncture, or short-circuit by a metal screw.

SONEL S.A., due to its continuous contact with installers and contractors, thoroughly recognizes the problems faced by specialists repairing electrical installations. This resulted in designing and producing **LKZ-720** a locator of wires and pipes, intended mainly for **detecting cables in buildings with various construction environments (concrete, brick, wood)**. Apart from tracking cables in ceilings, walls and floors, detecting interrupted and shorted circuits, LKZ-720 has the ability to detect 50/60 Hz electric field (non-contact voltage tester) and identify system safety devices such as circuit breakers, differential switches. The device is equipped with a special 3D spatial antenna, which significantly facilitates detection and provides transfer of many useful information.



Recommended areas for laying cables in residential premises...



... and cables immediately before installation

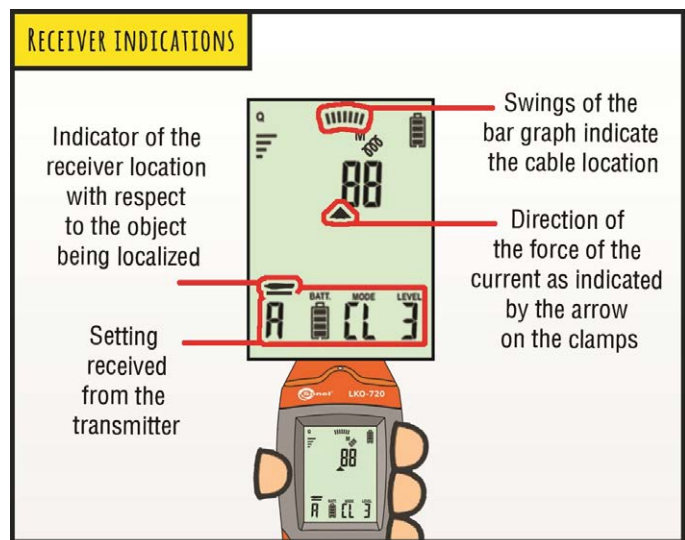
Another problem often encountered after completed finishing works is **the difficulty in finding termination of cables and pipes, which disappeared from eyesight after plastering**. Inventorying old systems (often installed in a surprising way), identification of safety devices, finding short-circuits and interrupted electrical circuits are difficult tasks, even for experienced professionals.

In order to determine the routing of wires and to locate their damages, the device uses physical phenomena, especially the propagation of the electromagnetic field. After connecting an open circuit to the transmitter, which emits a modulated signal of AC voltage, this circuit acts as an antenna emitting an electric field. When the transmitter is connected to a closed circuit, or a circuit under voltage, a magnetic field will be generated. The receiver is designed to present the received signal strength in numerical and graphical form. Changes in presented indications allow user **determine the position of an object** that emits electromagnetic field.

Due to its features, **LKZ-720 set** (LKN-720 transmitter and LKO-720 receiver) enables user to easily, fast and precisely locate cable and wire routes, as well as their potential defects. Definitely, the easiest method is to use a two-step technique:

- » quickly and roughly locate the searched object using the 2D method, and then
- » use the 3D method to precisely determine the position of the object or location of the defect.

This is **particularly useful**, when dealing with the **effect of work that does not match the documentation of the system**. During the tracking process, the receiver informs the user about the direction from which the signal is transmitted, i.e. the place of connecting the transmitter. In addition, the indicators on the display show the direction and position of the localized conductor in relation to the receiver. With this information, determining the location is quick, efficient and very intuitive.



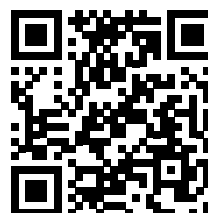
Manual in images



Video tutorials



See the manual in images and video tutorials that are available on the product website and on YouTube.



SONEL LKZ-720 / LKZ-720 KIT

index: WMGBLKZ720 / WMGBLKZ720KIT



LKN-720 transmitter:

- » type of insulation double, as per EN 61010-1
- » measurement category CAT III 600 V according to EN 61010-1
- » ingress protection IP67
- » power supply 4x 1.5 AA alkaline battery or 4x 1.2 Ni-MH rechargeable battery
- » maximum operating voltage 500 V (RMS)
- » operating temperature -10...+50°C
- » dimensions 221 x 102 x 62 mm
- » weight ca. 0.7 kg

LKO-720 receiver:

- » ingress protection IP40
- » maximum depth of the analysed object ("I" mode) 2 m
- » maximum range of contactless neon probe 50 cm (in air)
5 cm (in concrete)
- » power supply 9 V 6LR61 alkaline battery
- » operating temperature -10...+50°C
- » dimensions 245 x 77 x 52 mm
- » weight ca. 0.4 kg

Standard accessories:

		LKZ-720 WMGBLKZ720	LKZ-720 KIT WMGBLKZ720KIT	LKO-720 WMGBLK0720	LKN-720 WMGBLK720	LKN-720 KIT WMGBLK720KIT
LKN-720 transmitter	WMGBLK720	1	4		1	3
LKN-720 receiver	WMGBLK0720	1	1	1		
L-2 carrying case	WAFUTL2		1			1
M-6 carrying case	WAFUTM6	1		1		
Test lead 1.2 m, red, 1 kV (banana plugs)	WAPRZ1X2REBB	1	4		1	3
Test lead 1.2 m, blue, 1 kV (banana plugs)	WAPRZ1X2BUBB	1	4		1	3
Crocodile clip, red, 1 kV, 20 A	WAKRORE20K02	1	5		1	4
Crocodile clip, blue, 1 kV, 20 A	WAKROBU20K02	1	4		1	3
Pin probe, red 1 kV (banana socket)	WASONRE0GB1	1	4		1	3
Pin probe, blue 1 kV (banana socket)	WASONBU0GB1	1	4		1	3
Test lead 20 m, red, 1 kV (on a reel, banana plugs)	WAPRZ020REBSZ	1	1		1	
Earth contact test probe (rod), 25 cm	WASONG25	1	2		1	1
Non-contact probe	WASONBDOT	1	1	1		
Mini-USB cable	WAPRZUSBMNIB5	1	1	1		
M-1 hanging straps	WAPZSZSE4	1	1		1	1
1.5 V battery		4	16		4	12
9 V battery		1	1	1		
Declaration of verification		1	1	1	1	1

Description

The Sonel LKZ-720 cable and wire locator is a device consisting of the LKN-720 transmitter and the LKO-720 receiver. This instrument is dedicated to finding cables and other underground infrastructures. The LKZ-720 allows the location of both metallic objects (cables) and non-conductive objects (PVC pipes, concrete, etc.). The locator is mainly dedicated to use in the energy and installation industry, among others.

Features

- » Detection of wires and cables (live or not).
- » Tracing underground cables.
- » Tracing conductive water and heating pipelines.
- » Flow and accurate locating the object.
- » Phase detection mode.
- » Operation in wide range of rated voltage, up to 500 V RMS.
- » Five modes of wire tracer operation: voltage, current, current-voltage, power and clamp.
- » Additional accessories enable precise localization - such as contact or non-contact probes and measurement clamp.

Special features

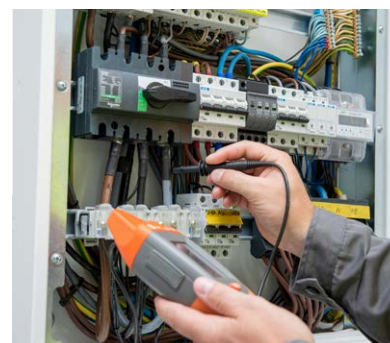
LKO-720

- » Receiver operation with max. 4 transmitters at the same time to locate interruptions or distinguish wires.
- » Receiving status information from the LKN-720 transmitter.
- » The function 3D - detecting the direction of current.
- » A LED torch.
- » Headphone socket.
- » Software upgrade via USB.
- » Screen backlight for work in dark.

LKN-720

- » 4 codes of the transmitted signal.
- » Transmission of information about the transmitter settings and battery charge level.
- » Measurement of voltage at the object to 500 V RMS.
- » Three levels of amplification.
- » Automatic or manual selection of operation modes.
- » Screen backlight for work in dark.

See the video tutorials available on YouTube.



LKZ

Set of standard and optional accessories

1, 2, 4 - number of standard accessories
- - optional accessories

Photo	Name	Index	LKZ-2500	LKZ-2500 Start	LKZ-2500 Lite	LKZ-720 KIT	LKZ-720
	LKN-720 transmitter	WMGBLKN720				4	1
	LKO-720 receiver	WMGBLK0720				1	1
	LKN-2500 transmitter	WMGBLKN2500	1	1	1		
	LKD-2500 detector	WMGBLKD2500	1	1	1		
	Control panel	WAPOZTAB08	1	•	•		
	C-3 clamp adapter	WAADALKOC8				•	•
	Magnetic voltage adapter, black	WAADAUMAGKBL				•	•
	Magnetic voltage adapter, blue	WAADAUMAGKBU				•	•
	N-1 transmitting clamp (Ø52 mm)	WACEGN1BB	•	•	•	•	•
	N-4 transmitting clamp (Ø110 mm)	WACEGN4	•	•	•		
	N-5 transmitting clamp (Ø125 mm)	WACEGN5	•	•	•		
	C-8 clamp probe (Ø52 mm)	WASONCEGC8				•	•
	L-2 carrying case	WAFUTL2				1	
	L-10 carrying case	WAFUTL10			1		
	M-6 carrying case	WAFUTM6					1
	XL-1 carrying case	WAFUTXL1	1	1	•		

Photo	Name	Index	LKZ-2500	LKZ-2500 Start	LKZ-2500 Lite	LKZ-720 KIT	LKZ-720
	Crocodile clip, red, 1 kV, 20 A	WAKRORE20K02	3	3	3	5	1
	Crocodile clip, blue, 1 kV, 20 A	WAKROBU20K02	1	1	1	4	1
	Test lead 2,0 m black CAT IV 1000 V (banana plugs with 10 A fuse)	WAPRZ002BLBBF10				•	•
	Test lead 2,0 m blue CAT IV 1000 V (banana plugs with 10 A fuse)	WAPRZ002BUBBF10				•	•
	Test lead 2,0 m green CAT IV 1000 V (banana plugs with 10 A fuse)	WAPRZ002GRBBF10				•	•
	Test lead 2,0 m red CAT IV 1000 V (banana plugs with 10 A fuse)	WAPRZ002REBBF10				•	•
	Test lead 2,0 m yellow CAT IV 1000 V (banana plugs with 10 A fuse)	WAPRZ002YEBBF10				•	•
	Test lead 1.2 m, red, 1 kV (banana plugs)	WAPRZ1X2REBB				4	1
	Test lead 1.2 m, blue, 1 kV (banana plugs)	WAPRZ1X2BUBB				4	1
	Double-wire test lead 2 m, for N-1 clamp (banana plugs)	WAPRZ002DZBB				•	•
	Test lead 5 m, red, 1 kV (banana plugs)	WAPRZ005REBB	2	2	2		
	Test lead 5 m, blue, 1 kV (banana plugs)	WAPRZ005BUBB	1	1	1		
	Test lead 20 m, red, 1 kV (on a reel, banana plugs)	WAPRZ020REBBSZ				1	1
	PN-50 wire to locate non-metallic installations 50 m	WAPRZPN50	•	•	•		
	PN-80 wire to locate non-metallic installations 80 m	WAPRZPN80	•	•	•		
	USB cable MINI-B 5	WAPRZUSBMNIB5				1	1

LKZ

Set of standard and optional accessories

1, 2, 4 - number of standard accessories
• - optional accessories

Photo	Name	Index	LKZ-2500	LKZ-2500 Start	LKZ-2500 Lite	LKZ-720 KIT	LKZ-720
	Non-contact probe	WASONBDOT				1	1
	Earth contact test probe (rod), 25 cm	WASONG25				2	1
	Earth contact test probe (rod), 30 cm	WASONG30	2	2	2		
	Contact probe	WASONDOT				•	•
	Pin probe, black 11 kV (banana socket)	WASONBLOGB11				•	•
	Pin probe, red 1 kV (banana socket)	WASONREOGB1				4	1
	Pin probe, blue 1 kV (banana socket)	WASONBUOGB1				4	1
	M-1 hanging hook straps	WAPOZUCH1				•	•
	Magnetic hanging strap	WAPOZUCH6				•	•
	Short handle	WAPOZUCH14	•	•	1		
	Long handle	WAPOZUCH15	1	1	•		
	Holder for control panel	WAPOZUCH16	1	1			
	M-1 hanging straps	WAPOZSZE4				1	1
	Shoulder harness, design 1	WAPOZSZE7	1	1			
	Z-7 power supply	WAZASZ7	1	1	1		
	Z-32 power supply	WAZASZ32	1	1	1		



SONEL TDR-420 / TDR-410

index: WMGBTDR420 / WMGBTDR410



Diagnose faults with instruments from the TDR series

- » fault location in power and telecommunication cables
- » **TDR-420** | two independent cursors to indicate two fault locations and the distance between them
- » **TDR-420** | trace hold and compare feature allows displaying and comparing two traces
- » fault location in coaxial cables
- » fault location in infrastructure cables
- » detection of breaks, short-circuits, damage caused by moisture and other changes in cable impedance
- » graphic presentation of cable faults with an indication of the distance to the fault on the display

Application

TDR-410 and TDR-420 time-domain reflectometers are designed for faults locating in metal wires. These products are designed for electrical wholesalers and cable dealers, electrical installation companies, maintenance personnel at manufacturing plants and building personnel. These devices meet the expectations of all those who have to accurately locate a fault and wire end in either power or telecommunication cables.

Device capabilities

SONEL reflectometers are distinguished for their long operating range (**up to 6,000 m for TDR-420**), very low margin of error in measurement (in the order of 1%) and the ability to adjust both the velocity of propagation and the impedance of the cable which is under investigation. By using **two cursors** there should be no problem with determining both the distance to two faults and the distance between them.

Easy readout

The **TDR-420** reflectometer is equipped with a readable **colour display** that, due to its 320 x 240 pixel resolution, allows the fault location to be indicated even more accurately.

Integrated Help

In the **TDR-420** device a **handy help** function has been added to facilitate the interpretation of the result obtained during measurement. Thanks to this function, a user can quickly determine the type of anomaly that is present in the cable segment which is being examined, by comparing the displayed reflectogram with typical fault shapes.

Durable and practical casing

In response to the customers needs the **new model of TDR-420** has been designed to operate in difficult environmental conditions. A unique **casing with the IP67 ingress protection rating** ensures that the device is both waterproof and dustproof. An additional advantage is the elastomer coating of the casing that prevents the device from slipping out of the hands and provides protection if accidentally dropped.

Standard accessories:		TDR-420	TDR-410
Double-wire test lead 0.6 m	WAPRZ0X6DZBB	✓	✓
Crocodile clip, red, 1 kV, 20 A	WAKRORE20K02	✓	✓
Crocodile clip, black, 1 kV, 20 A	WAKROBL20K01	✓	✓
M-6 carrying case	WAFUTM6	✓	
M-13 carrying case	WAFUTM13		✓
M-1 hanging straps	WAPZSZE4	✓	
4x alkaline 1.5 V AA battery		✓	✓
Declaration of verification		✓	✓

Parameters	TDR-420 Advanced reflectometric measurements in all fields	TDR-410 Basic cable faults measurements
measuring ranges	7 m, 15 m, 30 m, 60 m, 120 m, 250 m, 500 m, 1 km, 2 km, 3 km, 6 km , 20, 45, 90, 180, 360, 750, 1500, 3000, 6000, 10000, 20000 [ft]	7 m, 15 m, 30 m, 60 m, 120 m, 250 m, 500 m, 1 km, 2 km, 3 km, 4 km, 20, 45, 90, 180, 360, 750, 1500, 3000, 6000, 10000, 14000 [ft]
accuracy	1% of selected range	
resolution	approx. 1% of range	
minimum cable length	4 m	
velocity of propagation	within 10...99% or 15...148.5 m/μs	within 1...99% or 1...148 m/μs
output impulse	5 V _{pp} for an open circuit	
output impedance	25, 50, 75, 100, 125, 200 Ω	25, 50, 75, 100 Ω
impulse width	3 ns...3 μs (depending on the range)	
scanning type	up to 3 scans/s or a single scan (ONCE mode)	2 scans/s or a single scan
tone generator	810 – 1100 Hz	
operating time on a full battery	up to 8 hours of continuous scanning	up to 30 hours of continuous scanning
power supply	4 x alkaline batteries 1.5 V AA type or 4 x NIMH AA rechargeable batteries	4 x alkaline batteries 1.5 V AA type
auto-off function	1, 3, 5, 10, 15 minutes or deactivated	1, 2, 3, 5 minutes or deactivated
display	colour 3.5" LCD TFT, 320 x 240 pixels	graphical, backlit, 128 x 64 pixels
overvoltage protection	400 V DC / 250 V AC	
operating temperature	-20...+70°C	-10...+50°C
storage temperature	-30...+80°C	-20...+70°C
dimensions	220 x 102 x 61 mm	165 x 90 x 37 mm
weight	487 g	350 g
electromagnetic compatibility standards (EMC)	EN 61326-1	
ingress protection	IP67	IP54

TDR

Set of standard and optional accessories

1, 2, 4 - number of standard accessories
- - optional accessories

Photo	Name	Index	TDR-420	TDR-410
	Magnetic adapter, black	WAADAUMAGKBL	•	•
	Magnetic adapter, blue	WAADAUMAGKBU	•	•
	Voltage adapter with M4 / M6 thread, black	WAADAM4M6BL	•	•
	Voltage adapter with M4 / M6 thread, blue	WAADAM4M6BU	•	•
	Crocodile clip, black 1 kV 20 A	WAKROBL20K01	1	1
	Crocodile clip, red 1 kV 20 A	WAKRORE20K02	1	1
	Test lead 2,0 m black CAT IV 1000 V (banana plugs with 10 A fuse)	WAPRZ002BLBBF10	•	•
	Test lead 2,0 m blue CAT IV 1000 V (banana plugs with 10 A fuse)	WAPRZ002BUBBF10	•	•
	Test lead 2,0 m red CAT IV 1000 V (banana plugs with 10 A fuse)	WAPRZ002REBBF10	•	•
	Double-wire test lead 0.6 m	WAPRZ0X6DZBB	1	1
	M-1 hanging straps	WAPZSZE4	1	
	Magnetic hanging strap	WAPZUCH6	•	
	M-6 carrying case	WAFUTM6	1	
	M-13 carrying case	WAFUTM13		1

Illuminance measurements

Our perceptive capability and psychophysical condition depend to a very large extent on the surrounding environment. Light stimuli are decisive factors in the psychological comfort. Prolonged exposure to artificial light may accelerate fatigue and contribute to eyesight defects and other diseases. Negative **impact of improper lighting** on people is particularly important in terms of safety and **work efficiency**. The perception of light stimuli, although dependent on the individual characteristics of a person, is in general similar for majority of people. Therefore, regulations have been defined to define values and types of lighting in places where people live and work. The light visible to humans is an electromagnetic wave with a length from approx. 380 nm to approx. 780 nm. The sensitivity of a human eye is not the same in all conditions - it results from its structure and location of receptors, as well as from the nature of the light. In daylight conditions the eye is most sensitive to green colour, whereas at night or in poor lighting, the eye sensitivity shifts to blue colour - this is why we have a subjective impression that at night everything is grey.

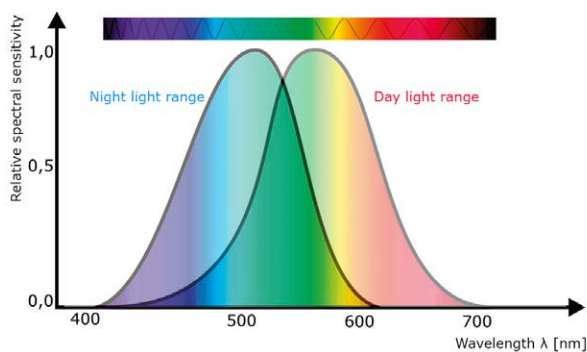


Fig. 1. Visible range of electromagnetic waves during the day and night

Despite the adaptability of the eye to changing light intensity, the measurements require to set the measuring device to have a sensitivity similar to an eye adapted to bright daylight. Spectral curve that corresponds to this sensitivity is called the photopic curve $V(\lambda)$. It is useful to calculate photometric values. In determining the criteria for proper lighting parameters, consider the following:

- » recommendations of the International Commission on Illumination (CIE) (determination of optimal conditions for the illumination of rooms, depending on their use)
- » local regulations (i.e. GB 50034, JIES-008, CIE S 008/E-2001, SNiP 23-05-95, AS 1680.1-2006).

For testing workplace lighting, it is recommended to observe guidelines defined in **binding standard EN 12464**. When discussing illuminance measurements, it is useful to define the illuminance. It is the ratio of luminous flux on a specified area and the surface of this area. The unit of illuminance is lux (lx) [lm/m^2]. In addition, CIE provides recommended **illuminance uniformity E_m** in the field of view, i.e. the way of lighting the workplace. High irregularity of illumination (e.g. exposed light sources in the field of view) creates a risk of glare which may reduce the ability to recognize details or cause a discomfort. In addition, due to the time needed for eyes to adapt to changes, the illumination uniformity should be maintained over time. Therefore, the level of ripple is important and this relates to flicker.

The light colour is another factor that has a significant impact on the well-being of people present in the room. For a man the most optimal lighting has the spectral composition most similar to daylight. Light sources are classified according to the colour temperature into warm, cool and neutral light. The colour temperature may be determined based on **colour rendering index Ra**, which reflects the difference between the colour of object illuminated by natural light and the object illuminated by tested light. Light sources with relatively high Ra index include standard bulbs, halogen bulbs or LEDs. Sources with Ra below 70 include sodium and mercury lamps. Measurements of parameters that help to assess lighting conditions should be carried out during the acceptance of new lighting devices and during the modernization of existing devices or periodically every 5 years. **It is recommended to carry out the tests at least every two years.** The tests shall be carried out:

- » after dark or with curtains drawn
- » in operating conditions - the test area shall not be specially prepared (creating unrealistic conditions) for the tests.

Luminaires with discharge lamps must be switched on at least 30 minutes before testing. Other types of light sources such as halogen bulbs or LEDs, may be examined directly after switching on. Discharge lamps must not be new; they should operate at least 100 hours before measurements; in case light bulbs and halogen lighting this operation period is only one hour. The person performing the measurements can not affect the results. Therefore, it is advisable to wear dark clothing, and the distance from the measuring device should be as large as possible. Measurements

should be performed in the plane of the task (e.g. desk surface) with the photometer head set in parallel and directly on the test surface.

In **EN 12464-1** standard, the term **illuminance of the immediate surrounding area** appears. It depends on illuminance in the task area and it shall provide an even distribution of luminance in the field of view. This standard recommends minimum dimensions of the task area and related dimensions of the immediate surrounding area (a strip with a width of at least 0.5 m around the task area) and a background area (a strip with a width of at least 3 m adjacent to immediate surrounding area).

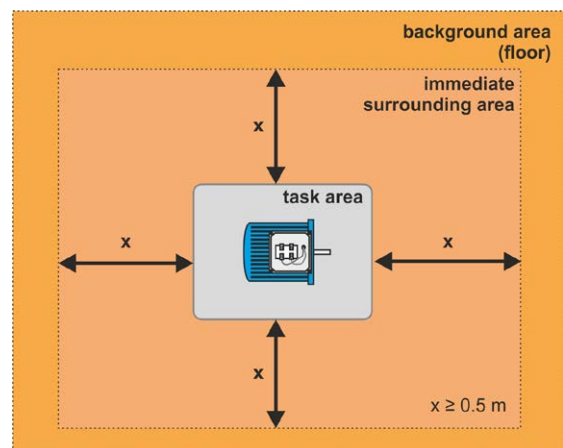


Fig. 2. Visual task, immediate surrounding area and background area

In order to determine the measuring points of all three areas, create grid with a mesh of approximately square shape. The ratio of length to width of the mesh should be between 0.5 and 2. The measurement points should be located inside the mesh of the lighting grid. The maximum grid size shall be:

$$p = 0,2 \cdot 5^{\log_{10} d}$$

where:

p - maximum dimension of the grid [m],

d - longer dimension of the calculated area [m].

Basing on the measurements, **lighting uniformity U_0** may be calculated for a given workplace.

To measure lighting in interiors with daylight, carry out the measurements that determine the daylight index. For this purpose, use two luxmeters to perform measurements simultaneously outside and inside the rooms lit via windows or skylights. On the other hand, when **measuring emergency lighting** the illuminance values are very low. The requirements in this matter are defined in standard **EN 1838:2013**. It should be mentioned that for escape routes with a width of 2 meters, the minimum value of illuminance measured at the floor is **1 lux**, which affects the selection of an appropriate measuring device. In recent years, LED illumination sources become more and more popular. Their measurements are currently based on the same requirements as other types of light sources. In case of **measurements on white LED light**, consider the guidelines of CIE concerning parameter f_1 , i.e. the size of mismatch between luxmeter sensitivity and curve $V(\lambda)$. The Commission recommends the use of luxmeter with f_1 **not exceeding 3%**.

Sonel LXP-10A light meter of Class A meets this condition. In case of light meters LXP-10B and LXP-2 of Class B, having the declared error value of spectral correction $f_1 < 6\%$, the error value f_1 must be also taken into account, which results from differences in spectral distribution of the measured and calibration light source. The illuminance measurement formula requires taking into account the correction factors for the LED light. As in luxmeters of Class A and B, the correction factors k take values close to 1, they do not have a significant impact on the measured illuminance value.

When selecting the measuring instrument, **attention should be paid to a valid calibration certificate, which confirms its efficiency and the fact that it meets declared levels of basic and spectral uncertainty. The photoelectric cell, which is used as a sensor, is ageing over time**, so it should be subject to metrological periodic checks.

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

index: WMGBLXP10A / WMGBLXP10B / WMGBLXP2



LXP-10A

Device of the highest class A according to DIN 5032-7 thanks to cooperation with LP-10A measuring probe. LXP-10A has all advantages that can be found in LXP-10B. Furthermore, it allows to make the most accurate measurements in industrial zones and public facilities. In addition, the instrument has the ability to wirelessly send data to Sonel Reader PC software.

LXP-10B

The model allows, among other things, to verify the illuminance values at workplaces and in areas where emergency lighting fixtures are used. It works with LP-10B measuring probe (class B according to DIN 5032-7). The device has internal memory of 999 measurements and additional logger for recording data with a selectable sampling rate.

LXP-2

Model for everyone who makes basic lighting measurements of indoor and outdoor workplaces. The device works with LP-1 measuring probe (class B according to DIN 5032-7) which allows to proceed with measurements in a reliable way. The non-integrated probe eliminates the influence of the user to the measurement result.

Main features

- » measurements of all types of light - also LED lighting
- » no need to using correction factors
- » displaying results in lux and foot-candle
- » measurements of emergency lighting

Product functions

- » data HOLD
- » PEAK HOLD
- » MAX and MIN results save
- » measurements of relative (REL) values
- » data logger with memory
- » auto power off



LXP-10B and LXP-10A enable wireless data transfer to a PC via the OR-1 adapter

Standard accessories:

LP-1 light meter probe (miniDIN-4P) (only LXP-2)	WAADALP1
LP-10A light meter probe (miniDIN-4P) (only LXP-10A)	WAADALP10A
LP-10B light meter probe (miniDIN-4P) (only LXP-10B)	WAADALP10B
USB cable MINI-B 5	WAPRZUSBMNIB5
9 V battery	

Factory calibration certificate

Basic technical specifications:

	LXP-10A the most recommended for professionals	LXP-10B precise measurements of workplaces	LXP-2 basic measurements of workplaces
class	A	B	B
measurement range	0.000...399.9k lx 0.000...39.99k fc	0.00...399.9k lx 0.000...39.99k fc	0.0...19.99k lx 0.00...1999 fc
resolution (lx/fc)	up to 0.001	up to 0.01 / 0.001	up to 0.1 / 0.01
accuracy	±(2% + 5 digits)	±(5% + 5 digits)	
spectral uncertainty f_1	±2%	±6%	
cosine matching error f_2	±1.6%	±3%	
number of ranges	6	5	3
sampling rate	1.3 Hz		
spectral sensitivity	CIE spectral sensitivity (CIE human eye sensitivity)		
photodetector	one silicon photodiode and spectral sensitivity filter		

Other technical specifications:

- » memory 99 results (LXP-2), 999 results (LXP-10)
- » memory of recorder 16,000 results
- » communication interface USB and radio link (only LXP-10B, LXP-10A)
- » display 3½ digits, LCD with 40-segment bar indicator
- » power source 9 V battery or 8.4 V rechargeable battery
- » exceeding of range „OL“ symbol
- » operating temperature 0...50°C
- » storage temperature -20...+70°C
- » relative humidity 0...80%
- » photodetector lead length approx. 150 cm
- » photodetector dimensions 115 × 60 × 20 mm
- » meter dimensions 170 × 80 × 40 mm
- » weight 390 g



LXP

Set of standard and optional accessories

1, 2, 4 - number of standard accessories
• - optional accessories

Photo	Name	Index	LXP-10A	LXP-10B	LXP-2
	LP-1 light meter probe (miniDIN-4P plug)	WAADALP1			1
	LP-10A light meter probe (miniDIN-4P plug)	WAADALP10A	1	•	
	LP-10B light meter probe (miniDIN-4P plug)	WAADALP10B	•	1	
	Light meter probe holder (stick)	WAPOZUCH9	•	•	•
	Light meter probe holder (trolley)	WAPOZUCH10	•	•	•
	LP-1 light meter probe (miniDIN-4P plug)	WAPRZUSBMNIB5	1	1	1
	OR-1 USB wireless receiver	WAADAUSBOR1	•	•	
	Free software to transfer data from meters	WAPROREADER	•	•	•



Light meter probe holder (stick)

index: WAPOZUCH9

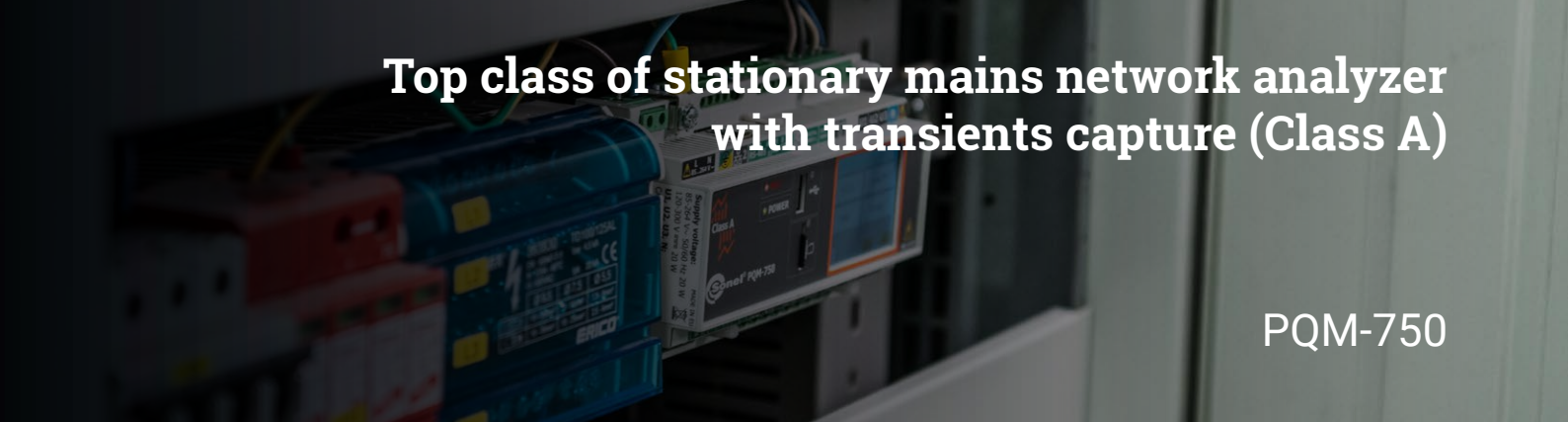
The telescopic handle of the light meter probe is designed to reduce the influence of the person performing the measurement on the obtained results. The base has been specially designed for the shape of the LP-1, LP-10B and LP-10A measuring heads.



Light meter probe holder (trolley)

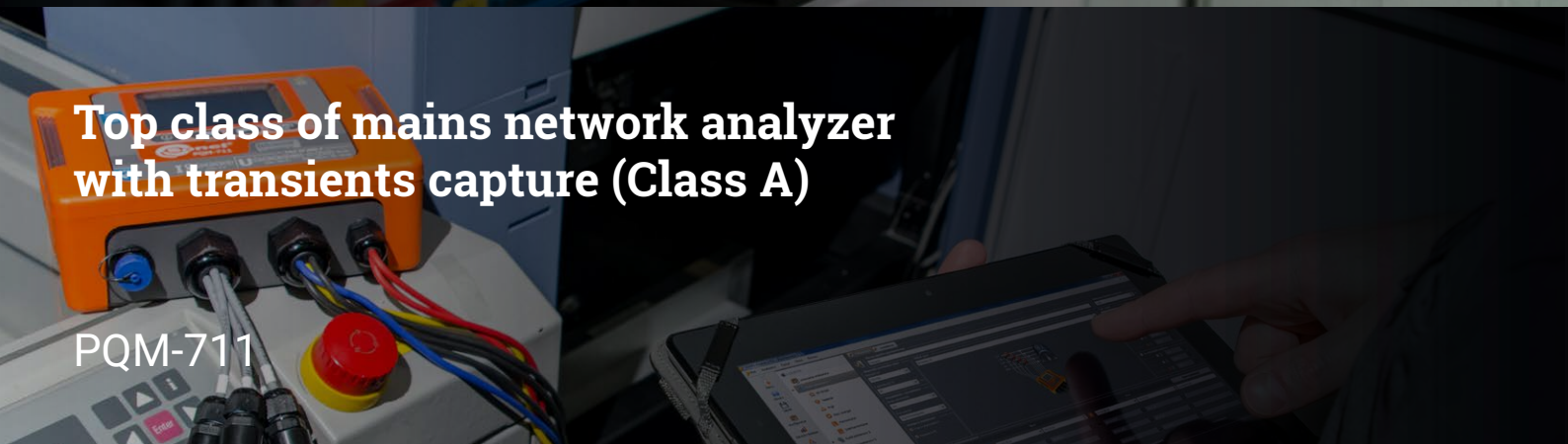
index: WAPOZUCH10

A light meter probe holder in the form of a trolley. Its task is to facilitate the measurements of the emergency lighting intensity by reducing the influence of the measurement operator on the measurement results. The base has been specially designed for the shape of the LP-1, LP-10B and LP-10A measuring heads.

A blue and white network analyzer unit is shown installed in a rack. It has various ports and a small display screen. The unit is labeled 'PQM-750' and 'Class A'.

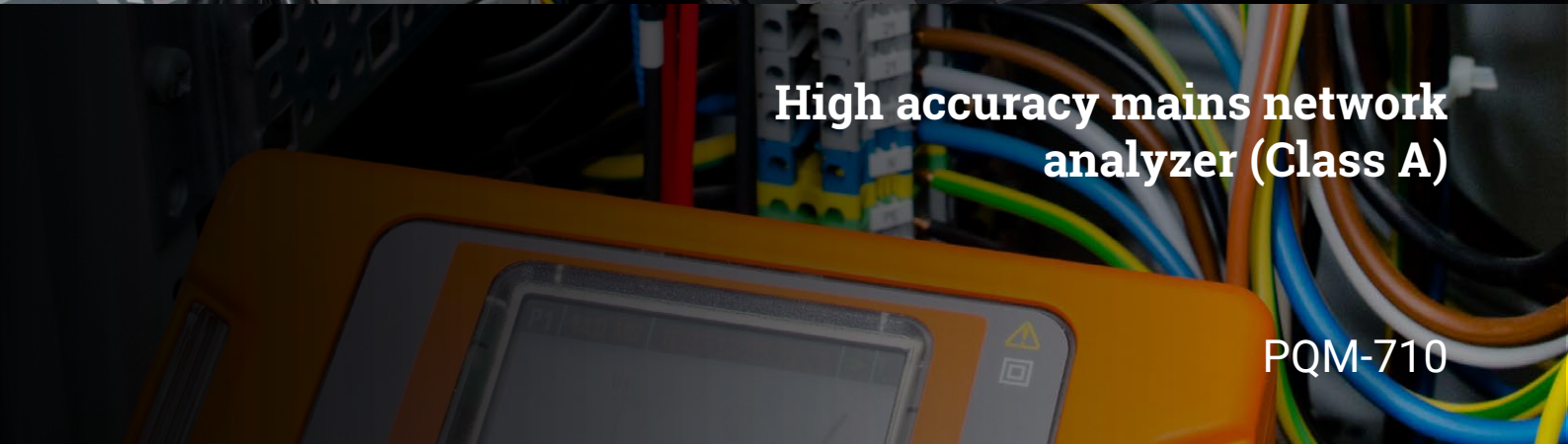
**Top class of stationary mains network analyzer
with transients capture (Class A)**

PQM-750

A white and orange network analyzer unit is shown with several cables connected to its ports. A hand is holding a tablet displaying a software interface. The unit is labeled 'PQM-711' and 'Class A'.

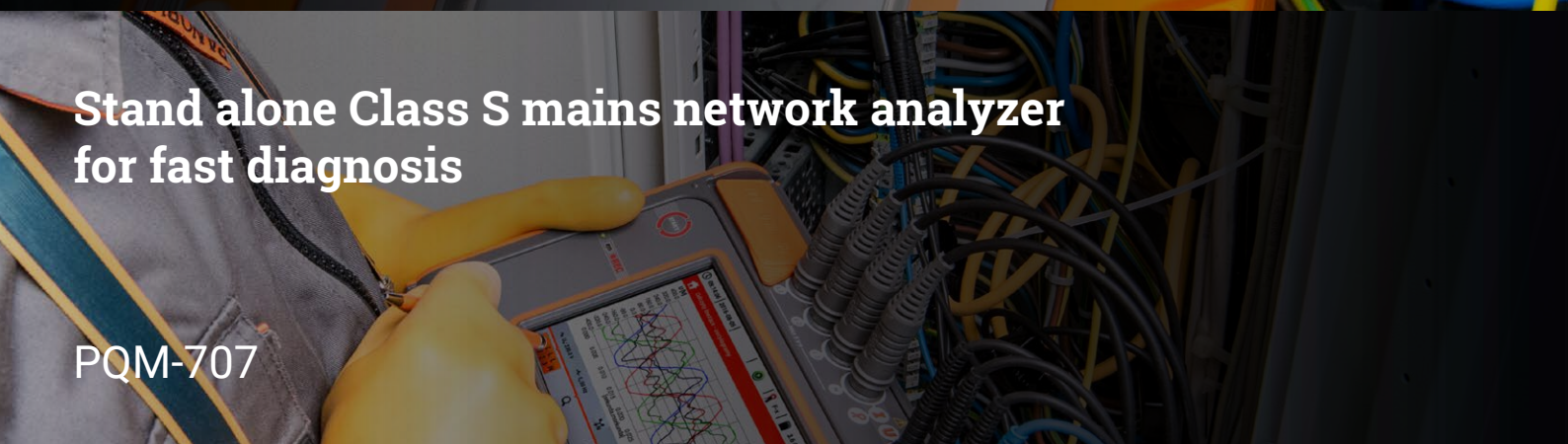
**Top class of mains network analyzer
with transients capture (Class A)**

PQM-711

A yellow and orange network analyzer unit is shown with a large number of colorful cables connected to its ports. The unit is labeled 'PQM-710' and 'Class A'.

**High accuracy mains network
analyzer (Class A)**

PQM-710

A person wearing yellow gloves is holding a grey and orange network analyzer unit. The unit's screen displays a waveform. The unit is labeled 'PQM-707' and 'Class S'.

**Stand alone Class S mains network analyzer
for fast diagnosis**

PQM-707

A yellow and orange network analyzer unit is shown mounted on a wall. It has a small screen and several ports. The unit is labeled 'PQM-700' and 'Class S'.

**Portable Class S analyzer
for basic and long term analysis**

PQM-700

Power quality analysis

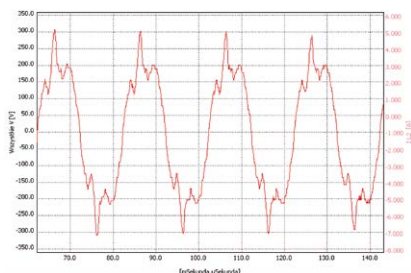
Electricity produced in electric power industry is a typical commercial product. Therefore, it is subject to the same rules as all goods available on the market, taking into account the fact that both the provider and the receiver use the same power grid, which affects the final quality of the power supply. The industry clearly defined power quality parameters, criteria and conditions for their evaluation and rules of distribution and control. Power distribution requires the control of power quality parameters, conditions of receiving process and recording all incidents of exceeded tolerance values. Data gathered in the control process is used for statistical evaluation of the compliance of recorded parameters with applicable standards, legal requirements and contracts. The final result is a confirmation of correctness which ends the assessment or a non-compliance statement, which is related to further analysis of the problem to indicate the responsibility for exceeding limits, which may result in financial consequences.

Wide availability of electricity means that the public networks supply industrial facilities, public buildings, and the vast majority of households. Rapid technological progress resulted in a situation, where typical electric line machines, such as motors, light bulbs, resistive heaters are provided with additional power electronics that ensure easy control of the energy flow, power control and improved efficiency. The consequences of this progress, supported by the need to minimize costs, are significantly simpler solutions that cause higher levels of current and voltage distortion and interference. Power networks are now exposed to new types of impacts that deteriorate power quality, causing additional losses, which is particularly visible with increasing use of new devices.

Consumer electronics involves small power devices, but a very large number of them may significantly affect the quality of power supply in public networks.

Power electronics in industry is related to much higher values of active and passive power, systematically repeated changes of load and type of reactive power, asymmetries of single-phase and two-phase loads, current distortion, voltage dips caused by temporary network overloads and equipment failures. Therefore, the industry supply networks experience troublesome voltage fluctuations causing light flickering lights, short voltage dips, higher levels of harmonic voltages and currents as well as dangerous resonance phenomena. Other adverse incidents include discontinuities and interruptions of power supply that cause losses in production or even hazards to the life of employees. The increased amount of negative impacts causes faster and unpredictable wear of machine parts, making it difficult to plan maintenance activities. Moreover, the risk of losses due to unforeseen failures also significantly increases.

Instruments for analysing and diagnosing power quality are required to provide two basic functionalities. The first one is to assess the conformity or non-conformity of power supply parameters with binding standards and law requirements. This function is provided by all instruments offered on the market. The second functionality is to capture the phenomena that deteriorate power quality and those, which disturb proper and efficient operation of power equipment, providing flexibility to diagnose different types of networks with different nominal voltages. Presence of this feature in offered devices depends mainly on the initiative of producers of measuring equipment.



Example of the deformed current waveform

The offer of our company includes a wide range of products tailored to the needs of users:

- » Class S: **PQM-700, PQM-707,**
- » Class A: **PQM-710, PQM-711.**

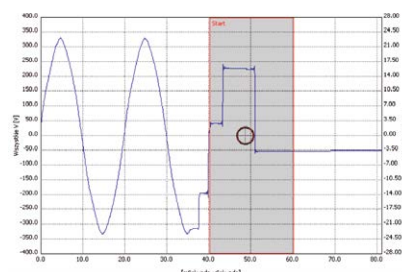
The main tasks of PQM-7xx analyzers, equipped with a wide range of accessories, include the use of a high-speed memory to simultaneously record up to 4500 network parameters, including: average values, MIN and MAX values, waveforms of voltages and currents at the end of each averaging cycle. Monitored parameters include voltage increases, dips and interruptions with recorded waveforms and RMS (1/2) graphs. In addition, instruments check for exceeding tolerance values, acceptable levels or other parameters. PQM-711 analysers offer also quick waveform recording of transient currents up to 8000 V. Smart solutions used in the analyzers enable them to operate continuously **with power supply from the tested network, up to 1000 V AC for CAT IV 600 V** of overvoltage resistance over a wide temperature range. The analyzers also maintain full functionality for a few hours on their own battery power. Class A devices have a **built-in GPS**, which provides high time accuracy and a GSM modem for distant remote communication.

For close communication, the analyzers use USB connection and some types have built-in Wi-Fi module.

The measurement results provided by PQM analyzers may be used for the following purposes:

Assessment of the quality of power supply in relation to the regulations binding in Poland or to EN 50160 standard. The conformity assessment report indicates which parameters are exceeded in relation to their threshold values, showing percentage values on the observation period scale. The assessment covers average values of voltages and frequencies, asymmetry, flicker factor P_{ST} , THD U, voltage harmonics and additionally the maximum average active power of 15 min and tg, when necessary.

Diagnosis and identification of voltage dips to indicate their cause. Basing on simultaneous recording of average and limit values, as well as RMS (1/2) of voltages and currents, it is possible to indicate whether the dips were caused by outside factors or by own operation of devices. Recording the oscillograms helps to capture transients during power outages, returns or high voltage surges.

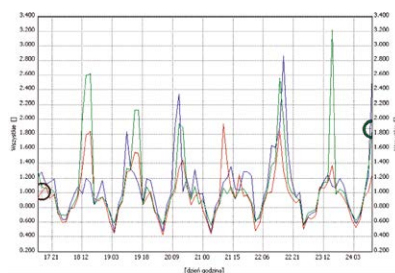


Example of power supply failure

own devices. Relating the high level of changes in active and reactive power to the waveform of the P_{ST} factor and propagation of changes with synchronous recording in several points of the network allows identifying the direction leading to the source of disturbed loads.

Diagnosis of active and reactive power helps to select parameters of the compensator that eliminate penalties for exceeding the reactive power limits and to verify the effectiveness and conditions of operating the battery compensating the reactive power, ensuring trouble-free operation.

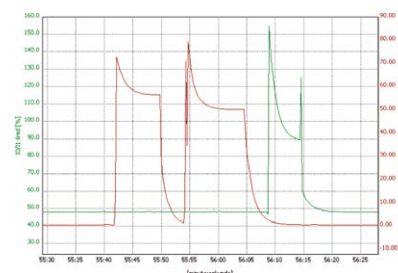
Diagnosis of voltages and currents, used for assessing the operational conditions for electrical machines with rotating field, basing on the behaviour of symmetrical components of voltages and currents. Uneven operation of three-phase motors powered directly from the network, interferences in the work of transformers with the risk of ferro-resonances may be identified basing on the interdependence of the various parameters in combination with the waveforms of symmetrical components. The detection of these phenomena may reduce the risk of failure, increasing operational reliability of machines.



Example of exceeded P_L indicator

Diagnosis of harmonics based on the behaviour of voltage, current and power harmonics, which enables the user to evaluate the effects of power supply to non-line devices and their impact on the parameters of the power grid and power quality. High level of harmonics causes additional heat losses of the energy system elements, endangering the operation of these devices and generating additional costs. It is also possible to assess these risks for other power equipment supplied from the network that increase the risk of unexpected failure.

Diagnosis of interharmonics allows user to identify transients and dangerous behaviour of the grid that may threaten the operation of other devices. These phenomena may occur at any frequency. Interharmonics complement the harmonics in the analysis of 0 - 2500 Hz band.



Example of asymmetry caused by connection process

Diagnosis of voltage fluctuations and flicker that presents the levels of voltage fluctuations and the degree of flicker nuisance, indicating the relation with the turbulent operation of

Comparison of power quality analyzers

					
	PQM-750	PQM-711	PQM-710	PQM-707	PQM-700
STANDARDS					
Compliance class acc. IEC 61000-4-30	A	A	A	S	S
Certificate from independent laboratory	✓	✓	✓	-	✓
EN 50160	✓	✓	✓	✓	✓
GOST 32144	-	✓	✓	✓	✓
AS 61000.3.100	✓	✓	✓	✓	✓
MEASUREMENT INPUTS					
Number of voltage inputs	5	5	5	5	4
Number of current inputs	5	4	4	4	4
GPS input	OPTION	1	1	-	-
Temperature input	✓	-	-	-	-
I/O					
Binary inputs	✓	-	-	-	-
Relay outputs	✓	-	-	-	-
MEASUREMENTS					
1-phase, split-phase, 3-phase system	✓	✓	✓	✓	✓
Frequency	✓	✓	✓	✓	✓
TRMS voltage	✓	✓	✓	✓	✓
Crest factor U	✓	✓	✓	✓	✓
voltage THD and harmonics	✓	✓	✓	✓	✓
voltage TID and interharmonics	✓	✓	✓	-	-
Monitoring of 2...150 kHz bandwidth	✓	-	-	-	-
Voltage unbalance	✓	✓	✓	✓	✓
Voltage transients (10 MHz sampling)	OPTION	✓	-	-	-
Short term flicker	✓	✓	✓	✓	✓
Long term flicker	✓	✓	✓	✓	✓
TRMS current	✓	✓	✓	✓	✓
Crest factor I	✓	✓	✓	✓	✓
Current THD and harmonics	✓	✓	✓	✓	✓
Current TID and interharmonics	✓	✓	✓	-	-
Current unbalance	✓	✓	✓	✓	✓
Inrush	✓	✓	✓	✓	✓
Harmonic power	✓	✓	✓	✓	-
Angles between harmonics	✓	✓	✓	-	-
K-factor	✓	✓	✓	-	-
Mains signalling	✓	✓	✓	-	-
Power (P, Q, D, S) acc. to IEEE 1459 or Budeanu method	✓	✓	✓	✓	✓
Power factor	✓	✓	✓	✓	✓
Cos(φ)	✓	✓	✓	✓	✓
Tan(φ)	✓	✓	✓	✓	✓
Energy (E _p , E _q , E _s)	✓	✓	✓	✓	✓
4-quadrants energy measurements	✓	✓	✓	✓	✓
PV inverter efficiency	-	-	-	✓	-
Maximal number of parameters measurements at the same time	15000	3655	3655	1300	1200
Maximum recording time					
• Linear recording	100 years	100 years	100 years	18 years	18 years
• Circular recording	UNLIMITED	-	-	-	-
Integration period	200 ms ... 30 min	half cycle ... 120 min	half cycle ... 120 min	1 s ... 30 min	half cycle ... 30 min
SAFETY					
Measurement category	CAT III 600 V	CAT IV 600 V CAT III 1000 V	CAT IV 600 V CAT III 1000 V	CAT IV 600 V CAT III 760 V	CAT IV 300 V CAT III 600 V
EN 61010	✓	✓	✓	✓	✓
EN 61326	-	✓	✓	✓	✓
EN 61000-6-5 / EN 55032	✓	-	-	-	-
Anti-theft function	-	✓	✓	-	-



PQM-750



PQM-711



PQM-710



PQM-707



PQM-700

ENVIRONMENTAL CONDITIONS

Working temperature [°C]	-20..+55	-20..+55	-20..+55	-10..+50	-20..+55
Built-in heater	-	✓	✓	-	✓
Ingress protection	IP30	IP65	IP65	IP51	IP65
All-weather measurements	-	✓	✓	-	✓
Pole mounting	-	✓	✓	-	✓
Wall mounting	✓	-	-	-	-
DIN rail mounting	✓	✓	✓	-	✓

MEMORY AND COMMUNICATION

Memory	8 GB	8 GB (max. 32 GB)	8 GB (max. 32 GB)	4 GB (max. 32 GB)	4 GB (max. 32 GB)
Replaceable memory card	✓	-	-	✓	✓
USB	✓	-	-	✓	✓
USB 2.0 High Speed	✓	✓	✓	-	-
Ethernet	✓	-	-	-	-
RS-485	✓	-	-	-	-
Wi-Fi	-	✓	✓	-	-
GSM (LTE) modem	OPTION	✓	✓	-	-

POWER SUPPLY

Built-in Li-Ion battery	✓	✓	✓	-	✓
Replaceable Li-Ion battery	-	-	-	✓	-
Battery operating time	min. 1 h	min. 2 h	min. 2 h	min. 6 h	min. 6 h
Battery charger	internal	internal	internal	external	internal
USB charging	-	-	-	✓	-

GENERAL

LCD display	-	✓	✓	-	-
LCD touch screen	✓	-	-	✓	-
GPS time synchronisation	OPTION	✓	✓	-	-
IRIG-B time synchronisation	✓	-	-	-	-
NTP time synchronisation	✓	-	-	-	-
Multilanguage Sonel Analysis software	-	✓	✓	✓	✓
Built-in network interface (webserver)	✓	-	-	-	-
Paper and PDF user manual	✓	✓	✓	✓	✓
Weight	0.6 kg	1.6 kg	1.6 kg	1.75 kg	1.6 kg
Dimensions	157x87x59 mm	200x175x75 mm	200x175x75 mm	216x111x45 mm	200x175x75 mm

PQM-750



PQM-711



PQM-710



PQM-707



PQM-700



Portable Class S analyzer
for basic and long term
analysis

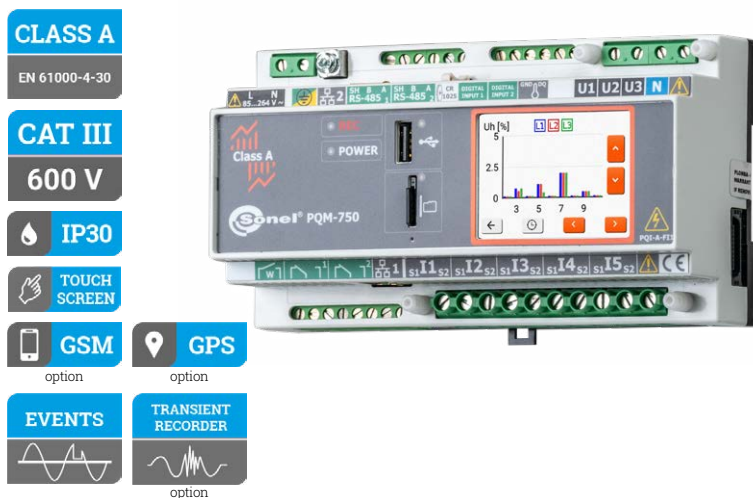
Stand alone Class S mains
network analyzer for fast
diagnosis

Class A high accuracy mains
network analyzer

Top class of mains network an-
alyzer with transients capture

SONEL PQM-750

index: WMGBPQM750AC1R1CT5



Measured parameters

Built-in software (web interface – webserver) allows you to configure the device and view actual data. It allows measurement of the following parameters.

- » Phase RMS voltage **U** for L1, L2, L3+N/PE
- » Phase-to-phase RMS voltages **U** for L12, L23, L31
- » RMS currents **I** of all phases + N + PE
- » Crest factor **CF** of voltages and currents
- » Network frequency **f** for L1
- » Active power **P** for L1, L2, L3
- » Active power **P1** (separated 50 Hz) for L1, L2, L3
- » Reactive power **Q** for L1, L2, L3
- » Reactive power **Q1** (separated 50 Hz) for L1, L2, L3
- » Apparent power **S** for L1, L2, L3
- » Apparent power **S1** (separated 50 Hz) for L1, L2, L3
- » Three-phase total power **P_{3F}**, **Q_{3F}**, **S_{3F}**
- » Three-phase total power **P_{13F}**, **Q_{13F}**, **S_{13F}**
- » **cosφ** for L1, L2, L3, **cosφ_{3F}**
- » Power factor **PF** for L1, L2, L3, **PF_{3F}**
- » **tgφ** for L1, L2, L3, **tgφ_{3F}**
- » Distortion power **D** for L1, L2, L3
- » Three-phase total distortion power **D_{3F}**
- » Distortion power factor **DPF** for L1, L2, L3
- » Shape of phase voltages and currents for events
- » Phase diagrams for currents and voltages
- » Active energy for L1, L2, L3 – taken **E_{p+}** or given **E_{p-}**
- » Three-phase active energy – drawn **E_{p3F+}** or given **E_{p3F-}**
- » Inductive reactive energy for L1, L2, L3 for consumption – **E_{OL+}**
- » Capacitive reactive energy for L1, L2, L3 for consumption – **E_{QC+}**
- » Three-phase reactive energy for consumption – inductive **E_{OL3F+}** and capacitive **E_{QC3F+}**
- » Apparent energy for L1, L2, L3 – **E_s**
- » Three-phase apparent energy **E_{s3F}**
- » Harmonics **h_n** to 256th in current and voltage
- » Interharmonics up to 256th in current and voltage
- » Angles between current and voltage harmonics
- » Monitoring of 2...150 kHz bandwidth
- » **U_{dc}** phase voltage components
- » Shares of harmonic currents and voltages in relation to RMS value (%) – **h_{NR}**
- » Shares of harmonic currents and voltages in relation to the fundamental harmonic **h₁** (%) – **h_{hF}**
- » **THD_v** for voltages and currents calculated against RMS value (%)
- » **THD_i** for voltages and currents calculated relative to the fundamental harmonic (%)
- » **TID_v** for voltages and currents calculated against RMS value (%)
- » **TID_i** for voltages and currents calculated relative to the fundamental harmonic (%)
- » Active and reactive harmonic powers
- » K-factor for **I₁**, **I₂**, **I₃**, **I_N**
- » Factor **K** (Europe)
- » Symmetrical voltage components: zero **U₀**, direct **U₁**, inverse **U₂**
- » Symmetrical components of current: zero **I₀**, direct **I₁**, inverse **I₂**
- » Short-term light flicker factor **P_{st}**
- » Long-term light flicker factor **P_{lt}**
- » Voltage unbalance
- » Current unbalance
- » Transients **U** up to 6000 V
- » Ripple control signals
- » Temperatures: **T_w** (analyzer internals), **Tz1...Tz4** (1-wire)

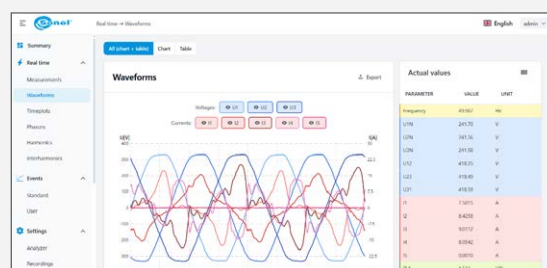
WEB INTERFACE

The analyzer's web interface (webserver) allows for:

- » meter configuration,
- » real-time monitoring of the meter status and measured parameters,
- » browsing the list of recorded events along with waveforms and RMS_{1/2} graphs,
- » managing users.

The following sections are available in the interface.

- » Real time readings
 - Measurements
 - Waveforms
 - Timeplots
 - Phasors
 - Harmonics
 - Interharmonics
- » Events
 - Standard events
 - User events
- » Analyzer and recording settings



Standard accessories:

Seal for voltage and current terminals (set of 2 pcs.)	WAPOZPLOKPL
Fork terminal for grounding terminal	WAZACWID
8 GB microSD card	WAPOZMSD8
Wall mounting kit	WAPOZUCH17
USB data transmission cable	WAPRZUSB
LAN network cable, shielded, 1.5 m	WAPRZRJ451X5EKR
Factory calibration certificate	

The instrument is intended for operation in networks:

- » with rated frequency 50/60 Hz,
- » with rated voltages: up to 1000 V referred to ground,
- » in the following configurations:
 - single-phase,
 - two-phase with common N,
 - three-phase - star with and without N conductor,
 - three-phase - delta.
- » Capable of working with transducers.
- » A built-in rechargeable battery allows for max. one hour of operation in the event of a power failure.

The instrument meets the requirements set forth in the standards:

- » Product standards:
 - IEC 62586-1
 - IEC 62586-2
- » Standards for measuring network parameters:
 - IEC 61000-4-30
 - IEC 61000-4-7
 - IEC 61000-4-15
 - EN 50160
- » Safety standards:
 - IEC 61010-1
 - IEC 61010-2-030
- » Standards for electromagnetic compatibility:
 - EN 55032
 - IEC 61000-6-5

Parameters of PQM-750

Parameter		Measuring range	Max. resolution	Accuracy
Alternating voltage (TRMS) $U_{L-L,MAX} = 2000\text{ V}$ for $U_{L-L,MAX} = 1000\text{ V}$	—	0.0...1000.0 V	4 significant digits	$\pm 0.1\% U_{din}$
Crest Factor	Voltage	1.0...6.5 (1.65 for voltage of 690 V)	0.01	$\pm 5\%$
	Current	1.00...10.00	0.01	$\pm 5\%$
Alternating current (TRMS)	—	0...20 A	4 significant digits	$\pm 0.2\%$
Frequency	—	40.000...70.000 Hz	0.001 Hz	$\pm 0.01\text{ Hz}$
Active power IEC 62053-22 class 0,2S	—	depending on voltage and current ratio	4 significant digits	$\pm 0.2\%$
Reactive power IEC 62053-24 class 0,5S	—	depending on voltage and current ratio	4 significant digits	$\pm 0.5\%$
Apparent power	—	depending on voltage and current ratio	4 significant digits	$\pm 0.2\%$
Active energy IEC 62053-22 class 0,2S	—	depending on voltage and current ratio	4 significant digits	$\pm 0.2\%$
Reactive energy IEC 62053-24 class 0,5S	—	depending on voltage and current ratio	4 significant digits	$\pm 0.5\%$
Apparent energy	—	depending on voltage and current ratio	4 significant digits	$\pm 0.2\%$
cosφ and power factor (PF)	—	-1.000...1.000	0.001	0.05
tanφ	—	-10.000...10.000	0.001	depends on error of active and reactive power
Harmonics and interharmonics	Voltage	DC, 0...256	4 significant digits	$\pm 0.05\% U_{din}$ for m.v. < 1% U_{din} $\pm 5\%$ m.v. for m.v. $\geq 1\% U_{din}$
	Current	0...256	4 significant digits	$\pm 0.15\% I_{rin}$ for m.v. < 3% I_{rin} $\pm 5\%$ m.v. for m.v. $\geq 3\% I_{rin}$
THD-F	Voltage	0...20%	0.01%	$\pm 0.3\%$ (absolute error)
	Current	0...100%	0.01%	$\pm 0.3\%$ (absolute error)
Active and reactive power of harmonics	—	depending on voltage and current ratio	4 significant digits	—
Angle between current and voltage harmonics	—	-180.0...+180.0°	0.1°	$\leq 0.05^\circ$ for $n = 1$ $\leq 1^\circ$ for $2 \leq n \leq 60$ at $f_{nom} = 50\text{ Hz}$ $\leq 4^\circ$ for $61 \leq n \leq 256$ at $f_{nom} = 50\text{ Hz}$
K-Factor	—	1.0...50.0	0.01	$\pm 10\%$
Flicker index	—	0.20...10.00	0.01	$\pm 5\%$
Unbalance factor	Voltage and current	0.0...20.0%	0.1%	$\pm 0.15\%$ (absolute error)
Measurement of control signals	Voltage	up to 15% U_{din} at $f_R = 5\text{...}30000\text{ Hz}$	4 significant digits	unspecified for <1% U_{din} $\pm 0.15\%$ for 1...3% U_{din} $\pm 5\%$ for 3...15% U_{din}
Emissions in band	2...9 kHz	a single frequency that is multiple of 200 Hz	0.01 V	$\pm 0.1\% U_{din}$ for m.v. < 2% U_{din} $\pm 5\%$ m.v. for m.v. $\geq 2\% U_{din}$
	8...150 kHz	a single frequency that is multiple of 2 kHz	0.01 V	$\pm (5\% + 0.1\text{ V})$

Additional features

Standard transmission protocols

- » Modbus TCP/IP
- » Modbus RTU
- » IEC 61850
- » PQdif

Web interface (webserver)

- » Access to the interface from any web browser

Modularity

The instrument can be expanded with additional communication protocols and physical and software functionality.

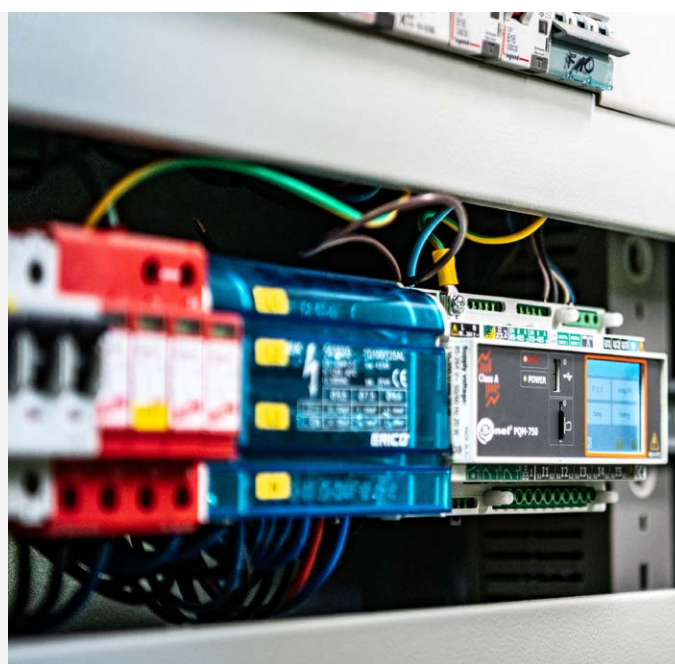
Additional internal modules*

- » Transient module
- » SSR relay module
- » 18...60 V DC power supply unit

Additional external modules*

- » LTE GSM module
- » GPS module with IRIG-B output
- » I/O module
- » LCD 7" touch panel for full operation of the analyzer at the mounting location

* coming soon



SONEL PQM-711 / PQM-710

index: WMGBPQM711BTW / WMGBPQM710BTW



The instrument is intended for operation in networks:

- » with rated frequency 50/60 Hz,
- » with rated voltages: 64/110 V, 110/190 V, 115/200 V, 120/208 V, 127/220 V, 220/380 V, 230/400 V, 240/415 V, 254/440 V, 277/480 V, 290/500 V, 400/690 V, 480/830 V (for systems with N conductor),
- » with direct current,
- » in the following configurations:
 - single-phase,
 - two-phase with common N,
 - three-phase - star with and without N conductor,
 - three-phase - delta.
- » A built-in rechargeable battery allows for max. two hours of operation in the event of a power failure.

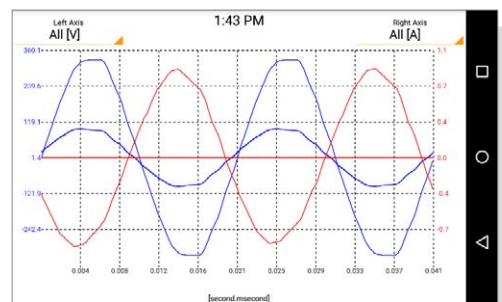
Measured parameters:

- » voltages L1, L2, L3, N-PE (five measurement inputs) – mean, minimum and maximum values, instant values within the range up to 1000 V, interoperability with voltage transformers,
- » currents L1, L2, L3, N (four measurement inputs) - mean, minimum and maximum values, instant values, direct current measurement within the range up to 6 kA (depending on applied current clamp), interoperability with current transformers,
- » crest factors for current (CFI) and voltage (CFV),
- » frequency within the range of 40 Hz – 70 Hz,
- » active power (P), reactive power (Q), distortion power (D), apparent power (S) with identification of the nature of reactive power (capacitive, inductive),
- » calculation of reactive power using the:
 - Budeanu method,
 - IEEE 1459,
- » active energy (E_p), reactive energy (E_q), apparent energy (E_s),
- » power factor (PF), $\cos\phi$, $\tan\phi$,
- » K factor (transformer overload due to harmonics),
- » harmonics up to the 50th in voltage and current,
- » interharmonics measured as groups,
- » total harmonic distortion THD for current and voltage,
- » short-term (P_{ST}) and long-term (P_{LT}) light flicker index (in compliance with IEC 61000-4-15 class A),
- » unbalance of voltages and currents,
- » registration of overvoltages, voltage dips and breaks along with oscillograms,
- » event logging for current along with oscillograms (up to 1 s) as well as 10 ms RMS charts with maximum registration time of 30 s,
- » registration of current and voltage oscillograms after every averaging period,
- » measurement of control signals up to 3000 Hz,
- » **PQM-711 | measurement of transients up to ± 8000 V with maximum sampling frequency of 10 MHz.** The minimum transient time that can be registered is 650 ns,
- » sampling frequency: 10.24 kHz,
- » **all parameters in compliance with Class A of IEC 61000-4-30.**



SONEL ANALYSIS MOBILE

Mobile version of the program supports PQM-711 and PQM-710 power quality analyzers. It can be downloaded from Google Play.



Standard accessories:

3x crocodile clip, black, 1 kV, 20 A	WAKROBL20K01
2x crocodile clip, red, 1 kV, 20 A	WAKRORE20K02
Crocodile clip, blue, 1 kV, 20 A	WAKROBU20K02
Crocodile clip, yellow, 1 kV, 20 A	WAKROYE20K02
AC-16 line splitter	WAADAAC16
AZ-3 power supply adapter (mains plug/ banana inputs)	WAADAAZ3
Voltage adapter with M4/M6 thread (5 pcs.)	WAADAM4M6
Magnetic voltage adapter (4 pcs.)	WAADAUMAGKPL
Straps for mounting on the pole for PQM (set)	WAPOZOPAKPL
DIN rail mounting bracket with positioning catches	WAPOZUCH3
2x fastener and bands for mounting the analyzer on a pole	WAPOZUCH4
XL-2 hard case	WAWALXL2
USB cable	WAPRZUSB
Sonel Analysis 4 PC software	WAPROANALIZA4
Factory calibration certificate	

The instrument meets the requirements set forth in the standards:

- » IEC 61000-4-30 (class A) (electromagnetic compatibility - measurement methods)
- » IEC 61000-4-7 (class I) (measurements of harmonics)
- » IEC 61000-4-15 (class A) (light flicker)
- » IEC 50160 (supply voltage measurements)
- » IEC 61010-1 (safety of measuring instruments)



PQM-711/710 have an independent power source, making them particularly suited for measurements with voltage transducers.



PQM-711 enables measurement of transients up to ± 8000 V with maximum sampling frequency of 10 MHz.



It is possible to wirelessly configure the measurements and analyze measurement data using Sonel Analysis PC software.

Parameters of PQM-711, PQM-710 analyzers

Parameter		Measuring range	Max. resolution	Accuracy
Alternating voltage (TRMS)	—	0.0...1000.0 V	4 significant digits	$\pm 0.1\% U_{nom}$
Crest factor	Voltage	1.00...10.00 (≤ 1.65 for 690 V voltage)	0.01	$\pm 5\%$
	Current	1.00...10.00 ($\leq 3.6 I_{nom}$)	0.01	$\pm 5\%$
Alternating current (TRMS)	—	depending on clamp*	4 significant digits	$\pm 0.1\% I_{nom}$ (error does not account for clamp error)
Frequency	—	40.00...70.00 Hz	0.01 Hz	± 0.01 Hz
Active, reactive, apparent and distortion power	—	depending on configuration (instrument transformers, clamp)	4 significant digits	depending on configuration (instrument transformers, clamp)
Active, reactive apparent energy	—	depending on configuration (instrument transformers, clamp)	4 significant digits	as power error
cos ϕ and power factor (PF)	—	-1.00...1.00	0.01	± 0.03
tg ϕ	—	-10.00...10.00	0.01	depends on error of active and reactive power
Harmonics and inter-harmonics	Voltage	DC, 1...50	as for alternating voltage True RMS	$\pm 0.05\% U_{nom}$ for m.v. < 1% U_{nom} $\pm 5\%$ m.v. for m.v. $\geq 1\% U_{nom}$
	Current	DC, 1...50	as for alternating current True RMS	$\pm 0.15\% I_{nom}$ for m.v. < 3% I_{nom} $\pm 5\%$ m.v. for m.v. $\geq 3\% I_{nom}$
THD	Voltage	0.0...100.0% (relative to RMS value)	0.1%	$\pm 5\%$
	Current			$\pm 5\%$
Active and reactive power of harmonics	—	depending on configuration (instrument transformers, clamp)	depends on minimum current and voltage values	—
Angle between current and voltage harmonics	—	-180.0...+180.0°	0.1°	$\pm (n \times 1^\circ)$
K-Factor	—	1.0...50.0	0.1	$\pm 10\%$
Flicker index	—	0.20...10.00	0.01	$\pm 5\%$
Voltage unbalance	Voltage and current	0.0...20.0%	0.1%	$\pm 0.15\%$ (absolute error)
Measurement of control signals	Voltage	up to 15% U_{nom} at 5.00...3000.00 Hz	4 significant digits	unspecified for <1% U_{nom} $\pm 0.15\%$ for 1...3% U_{nom} $\pm 5\%$ for 3...15% U_{nom}
PQM-711 Measurement of transients	Voltage	± 8000 V	4 significant digits	$\pm (5\% + 25 \text{ V})$

*F-1A1, F-2A1, F-3A1 clamp: 0...1500 A AC (10 000 A_{pp}) • F-1A, F-2A, F-3A clamp: 0...3000 A AC (10 000 A_{pp}) • F-1A6, F-2A6, F-3A6 clamp: 0...6000 A AC (10 000 A_{pp})

C-4A clamp: 0...1000 A AC (3600 A_{pp}) • C-5A clamp: 0...1000 A AC/DC (3600 A_{pp}) • C-6A clamp: 0...10 A AC (36 A_{pp}) • C-7A clamp: 0...100 A AC (360 A_{pp})



SONEL PQM-707

index: WMGBPQM707 / WMGBPQM707NC (without F-3A coils)



Measured parameters:

- » voltages L1, L2, L3, N-PE (five measurement inputs) – mean, minimum and maximum values within the range up to 760 V, interoperability with voltage transformers,
- » Currents L1, L2, L3, N (four measurement inputs) - mean, minimum and maximum values, current measurement within the range up to 6 kA (depending on applied current clamp), interoperability with current transformers,
- » Crest factors for current (CFI) and voltage (CFU),
- » Frequency within the range of 40 Hz – 70 Hz,
- » Active power (P), reactive power (Q), distortion power (D), apparent power (S) with identification of the nature of reactive power (capacitive, inductive),
- » Power registration: Budeanu method, IEEE 1459,
- » Active energy (E_p), reactive energy (E_q), apparent energy (E_s),
- » Power factor (PF), $\cos\varphi$, $\tan\varphi$,
- » Harmonics up to the 50th in voltage and current,
- » Total harmonic distortion THD for current and voltage,
- » Short-term (P_{st}) and long-term (P_{lt}) light flicker index (in compliance with IEC 61000-4-15 class S),
- » Unbalance of voltages (in compliance with IEC 61000-4-30 class S) and currents,
- » Event logging for current and voltage along with oscillograms and half-period RMS charts,
- » Inrush current,
- » Energy cost calculator,
- » Testing the efficiency of PV inverters,
- » sampling frequency: 10.24 kHz,
- » **All parameters are registered in compliance with class S acc. to standard IEC 61000-4-30.**

Parameters of PQM-707

Parameter		Measuring range	Max. resolution	Accuracy
Alternating voltage (TRMS)	—	0.0...760.0 V	4 significant digits	$\pm 0.5\% U_{nom}$
Crest factor	Voltage	1.00...10.00 (≤ 1.65 for 690 V voltage)	0.01	$\pm 5\%$
	Current	1.00...10.00 ($\leq 3.6 I_{nom}$)	0.01	$\pm 5\%$
Alternating current TRMS	—	depending on clamp*	$0.01\% I_{nom}$	$\pm 0.2\% I_{nom}$ (error does not account for clamp error)
Frequency	—	40.00...70.00 Hz	0.01 Hz	± 0.05 Hz
Active, reactive, apparent and distortion power	—	depending on configuration (instrument transformers, clamp)	4 significant digits	depending on configuration (instrument transformers, clamp)
Active, reactive apparent energy	—	depending on configuration (instrument transformers, clamp)	4 significant digits	as power error
$\cos\varphi$ and power factor (PF)	—	0.00...1.00	0.01	± 0.03
$\tan\varphi$	—	0.00...10.00	0.01	depends on error of active and reactive power
Harmonics	Voltage	DC, 1...50	as for alternating voltage True RMS	$\pm 0.15\% U_{nom}$ for m.v. < 3% U_{nom} $\pm 5\%$ m.v. for m.v. $\geq 3\% U_{nom}$
	Current	DC, 1...50	as for alternating current True RMS	$\pm 0.5\% I_{nom}$ for m.v. < 10% I_{nom} $\pm 5\%$ m.v. for m.v. $\geq 10\% I_{nom}$
THD	Voltage	0.0...100.0% (relative to RMS value)	0.1%	$\pm 5\%$
	Current			$\pm 5\%$
Flicker index	—	0.40...10.00	0.01	$\pm 10\%$
Unbalance factor	Voltage and current	0.0...10.0%	0.1%	$\pm 0.15\%$ (absolute error)
Inrush current	Current	depending on clamp*	$0.01\% I_{nom}$	$\pm 4\%$ m.v. for m.v. $\geq 10\% I_{nom}$ $\pm 4\% I_{nom}$ for m.v. < 10% I_{nom} (RMS1/2)

*F-1A1, F-2A1, F-3A1 clamp: 0...1500 A AC (10 000 A_{pp}) • F-1A, F-2A, F-3A clamp: 0...3000 A AC (10 000 A_{pp}) • F-1A6, F-2A6, F-3A6 clamp: 0...6000 A AC (10 000 A_{pp})

C-4A clamp: 0...1000 A AC (3600 A_{pp}) • C-5A clamp: 0...1000 A AC/DC (3600 A_{pp}) • C-6A clamp: 0...10 A AC (36 A_{pp}) • C-7A clamp: 0...100 A AC (360 A_{pp})

Standard accessories:

3x crocodile clip, black, 1 kV, 20 A	WAKROBL20K01
2x crocodile clip, red, 1 kV, 20 A	WAKRORE20K02
Crocodile clip, blue, 1 kV, 20 A	WAKROBU20K02
Crocodile clip, yellow, 1 kV, 20 A	WAKROYE20K02
4x F-3A flexible coil (Ø120 mm)	WACEGF3AOKR
Test lead 2.2 m, black, 1 kV with L1 marker (banana plugs)	WAPRZ2X2BLBBL1
Test lead 2.2 m, black, 1 kV with L2 marker (banana plugs)	WAPRZ2X2BLBBL2
Test lead 2.2 m, black, 1 kV with L3 marker (banana plugs)	WAPRZ2X2BLBBL3
Test lead 2.2 m, blue, 1 kV (banana plugs)	WAPRZ2X2BUBB
Test lead 2.2 m, yellow / green, 1 kV (banana plugs)	WAPRZ2X2GRYEBB
Magnetic voltage adapter (set - 4 pcs)	WAADAUMAGKPL
AC-16 line splitter	WAADAAC16
Li-Ion battery 11.1 V 3.4 Ah	WAAKU15
AZ-2 power supply adapter (IEC C7 plug/ banana connectors)	WAADAAZ2
230 V mains cable (IEC C7 plug)	WAPRZLAD230
Cable for battery charging from car cigarette lighter socket (12 V)	WAPRZLAD12SAM
Z-7 power supply	WAZASZ7
L-2 hanging straps (set)	WAPOZSZEKPL
L-4 carrying case	WAFUTL4
USB cable	WAPRZUSB
Touchscreen pen	WAPOZTPEN
Sonei Analysis PC software	WAPROANALIZA4
Factory calibration certificate	

The instrument is intended for operation in networks:

- » with rated frequency 50/60 Hz,
- » with rated voltages: 58/100 V, 64/110 V; 110/190 V; 115/200 V; 120/208 V, 127/220 V; 133/230 V, 220/380 V; 230/400 V; 240/415 V; 254/440 V; 290/500 V, 400/690 V,
- » with direct current.

Supported network configurations:

- » single-phase,
- » two-phase with common N,
- » three-phase - star with and without N conductor,
- » three-phase - triangle.

SONEL PQM-700

index: WMGBPQM700

CLASS S

IEC 61000-4-30

CAT IV

300 V

IP65



The instrument is intended for operation in networks:

- » with rated frequency 50/60 Hz,
- » with rated voltages: 64/110 V; 110/190 V; 115/200 V; 120/208 V; 127/220 V; 220/380 V; 230/400 V; 240/415 V; 254/440 V; 277/480 V; 290/500 V; 400/690 V,
- » with direct current,
- » in the following configurations:
 - single-phase,
 - two-phase with common N,
 - three-phase - star with and without N conductor,
 - three-phase - triangle.

The device conforms to class S according to IEC 61000-4-30

- » IEC 61000-4-30 (electromagnetic compatibility - measurement methods)
- » IEC 61000-4-7 (measurements of harmonics)
- » IEC 61000-4-15 (light flicker)
- » IEC 50160 (supply voltage measurements)
- » IEC 61010-1 (safety of measuring instruments)
- » IEC 61326 (electromagnetic compatibility - electrical equipment for measurement)



PQM-700 has an independent power source, making it particularly suited for measurements with voltage transducers.

Parameters of PQM-700

Parameter		Measuring range	Max. resolution	Accuracy
Alternating voltage (TRMS)	—	0.0...760.0 V	4 significant digits	$\pm 0.5\% U_{nom}$
Crest factor	Voltage	1.00...10.00 (≤ 1.65 for 690 V voltage)	0.01	$\pm 5\%$
	Current	1.00...10.00 ($\leq 3.6 I_{nom}$)	0.01	$\pm 5\%$
Alternating current TRMS	—	depending on clamp*	4 significant digits	$\pm 0.2\% I_{nom}$ (error does not account for clamp error)
Frequency	—	40.00...70.00 Hz	0.01 Hz	± 0.05 Hz
Active, reactive, apparent and distortion power	—	depending on configuration (instrument transformers, clamp)	4 significant digits	depending on configuration (instrument transformers, clamp)
Active, reactive apparent energy	—	depending on configuration (instrument transformers, clamp)	4 significant digits	as power error
$\cos \varphi$ and power factor (PF)	—	0.00...1.00	0.01	± 0.03
$\tan \varphi$	—	0.00...10.00	0.01	depends on error of active and reactive power
Harmonics	Voltage	DC, 1...40	as for alternating voltage True RMS	$\pm 0.15\% U_{nom}$ for m.v. < 3% U_{nom} $\pm 5\%$ m.v. for m.v. $\geq 3\% U_{nom}$
	Current	DC, 1...40	as for alternating current True RMS	$\pm 0.5\% I_{nom}$ for m.v. < 10% I_{nom} $\pm 5\%$ m.v. for m.v. $\geq 10\% I_{nom}$
THD	Voltage	0.0...100.0% (relative to RMS value)	0.1%	$\pm 5\%$
	Current			$\pm 5\%$
Flicker index	—	0.40...10.00	0.01	$\pm 10\%$
Unbalance factor	Voltage and current	0.0...10.0%	0.1%	$\pm 0.3\%$ (absolute error)

*F-1A1, F-2A1, F-3A1 clamp: 0...1500 A AC (10 000 A_{pp}) • F-1A, F-2A, F-3A clamp: 0...3000 A AC (10 000 A_{pp}) • F-1A6, F-2A6, F-3A6 clamp: 0...6000 A AC (10 000 A_{pp})
C-4A clamp: 0...1000 A AC (3600 A_{pp}) • C-5A clamp: 0...1000 A AC/DC (3600 A_{pp}) • C-6A clamp: 0...10 A AC (36 A_{pp}) • C-7A clamp: 0...100 A AC (360 A_{pp})

Standard accessories:

3x crocodile clip, black, 1 kV, 20 A	WAKROBL20K01
2x crocodile clip, red, 1 kV, 20 A	WAKRORE20K02
Crocodile clip, blue, 1 kV, 20 A	WAKROBU20K02
AZ-3 power supply adapter (mains plug/ banana inputs)	WAADAAZ3
4x magnetic voltage adapter (set - 4 pcs)	WAADAUMAGKPL
Straps for mounting on the pole for PQM (set)	WAPOZOPAKPL
DIN rail mounting bracket with positioning catches	WAPOZUCH3
2x fasteners and bands for mounting the analyzer on a pole	WAPOZUCH4
L-18 carrying case	WAFUTL18
USB cable	WAPRZUSB
Sonel Analysis 4 software	WAPROANALIZA4
Factory calibration certificate	

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

- » voltages L1, L2, L3 (four measurement inputs) – mean, minimum and maximum values, instant values within the range up to 760 V, interoperability with voltage transformers,
- » currents L1, L2, L3, N (four measurement inputs) - mean, minimum and maximum values, instant values, current measurement within the range up to 6 kA (depending on applied current clamp), interoperability with current transformers,
- » crest factors for current (CFI) and voltage (CFV),
- » frequency within the range of 40 Hz – 70 Hz,
- » active power (P), reactive power (Q), distortion power (D), apparent power (S) with identification of the nature of reactive power (capacitive, inductive),
- » calculation of reactive power using the:
 - Budeanu method,
 - IEEE 1459,
- » active energy (E_p), reactive energy (E_q), apparent energy (E_s),
- » power factor (PF), $\cos \varphi$, $\tan \varphi$,
- » harmonics up to the 40th in voltage and current,
- » total harmonic distortion THD for current and voltage,
- » short-term (P_{ST}) and long-term (P_{LT}) light flicker index (in compliance with EN 61000-4-15 class S),
- » unbalance of voltages (in compliance with EN 61000-4-30 class S) and currents,
- » event logging for current and voltage along with oscillograms and half-period RMS charts,
- » sampling frequency: 10.24 kHz,
- » all parameters are registered in compliance with class S according to standard EN 61000-4-30.

Optional accessories for analyzers



C-4A

WACEGC4AOKR



C-5A

WACEGC5AOKR



C-6A

WACEGC6AOKR



C-7A

WACEGC7AOKR

	C-4A WACEGC4AOKR	C-5A WACEGC5AOKR	C-6A WACEGC6AOKR	C-7A WACEGC7AOKR
Rated current	1000 A AC	1000 A AC 1400 A DC	10 A AC	100 A AC
Frequency	30 Hz...10 kHz	DC...5 kHz	40 Hz...10 kHz	40 Hz...1 kHz
Max. diameter of measured conductor	52 mm	39 mm	20 mm	24 mm
Minimum accuracy	≤0.5%	≤1.5%	≤1%	0,5%
Battery power	—	✓	—	—
Lead length	2.2 m	2.2 m	2.2 m	3 m
Measurement category	IV 300 V	IV 300 V	IV 300 V	III 300 V
Ingress protection	IP40			



F-1A1 / F-1A / F-1A6

WACEGF1A1OKR
WACEGF1AOKR
WACEGF1A6OKR



F-2A1 / F-2A / F-2A6

WACEGF2A1OKR
WACEGF2AOKR
WACEGF2A6OKR



F-3A1 / F-3A / F-3A6

WACEGF3A1OKR
WACEGF3AOKR
WACEGF3A6OKR



F-2AHD

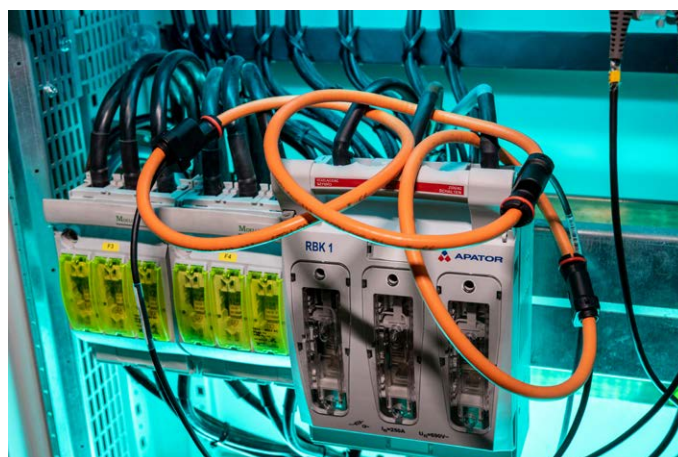
WACEGF2AHDOKR



F-3AHD

WACEGF3AHDOKR

	WACEGF1AOKR	WACEGF2AOKR	WACEGF3AOKR		
Rated current	1500 / 3000 / 6000 A AC	1500 / 3000 / 6000 A AC	1500 / 3000 / 6000 A AC	3000 A AC	
Frequency	40 Hz...10 kHz			10 Hz...20 kHz	
Max. diameter of measured conductor	380 mm	250 mm	140 mm	290 mm	145 mm
Minimum accuracy	0.5%			0.5%	
Battery power	—			—	
Lead length	2.5 m			2.5 m	
Measurement category	IV 600 V			IV 600 V	
Stopień ochrony obudowy	IP67			IP65	



PQM

Set of standard and optional accessories

1, 2, 4 - number of standard accessories
• - optional accessories

Photo	Name	Index	PQM-750	PQM-711	PQM-710	PQM-707	PQM-700
	AGT-16C adapter (for 3-phase outlets)	WAADAAGT16C		•	•	•	•
	AGT-16P adapter (for 3-phase outlets)	WAADAAGT16P		•	•	•	•
	AGT-16T adapter (for industrial outlets)	WAADAAGT16T		•	•	•	•
	AGT-32C adapter (for 3-phase outlets)	WAADAAGT32C		•	•	•	•
	AGT-32P adapter (for 3-phase outlets)	WAADAAGT32P		•	•	•	•
	AGT-32T adapter (for industrial outlets)	WAADAAGT32T		•	•	•	•
	AGT-63P adapter (for 3-phase outlets)	WAADAAGT63P		•	•	•	•
	Cable adapter for control terminals CAT II / 1000 V (5 pcs.)	WAADAPRZKPL1		•	•	•	•
	Voltage adapter for energy measuring terminal block (5 pcs)	WAADASKA		•	•	•	•
	Magnetic adapter (4 pcs.)	WAADAUMAGKPL		1	1	1	1
	Magnetic adapter, black	WAADAUMAGKBL		•	•	•	•
	Magnetic adapter, blue	WAADAUMAGKBU		•	•	•	•
	Voltage adapter with M4 / M6 thread	WAADAM4M6		1	1	•	•
	Voltage adapter with M4 / M6 thread, black	WAADAM4M6BL		•	•	•	•
	Voltage adapter with M4 / M6 thread, blue	WAADAM4M6BU		•	•	•	•
	Voltage adapter with M4 / M6 thread, yellow	WAADAM4M6YE		•	•	•	•
	AC-16 line splitter adapter	WAADAAC16		1	1	1	•
	AZ-2 power supply adapter (IEC C7 plug / banana sockets)	WAADAAZ2				1	
	AZ-3 power supply adapter (mains plug / banana sockets)	WAADAAZ3		1	1		1
	Li-Ion 3.6 V 4.5 Ah battery (replaceable in the SONEL S.A. service)	WAAKU11		1	1		1

PQM

Set of standard and optional accessories

1, 2, 4 - number of standard accessories
• - optional accessories

Photo	Name	Index	PQM-750	PQM-711	PQM-710	PQM-707	PQM-700
	Li-Ion 11.1 V 3.4 Ah battery	WAAKU15				1	
	GPS antenna	WAPOZANT10GPS		•	•		
	GSM signal repeater	WAPOZANTREPEATER		•	•		
	Flexible clamp F-1A (Ø 380 mm) 3 kA	WACEGF1AOKR		•	•	•	•
	Flexible clamp F-2A (Ø 255 mm) 3 kA	WACEGF2AOKR		•	•	•	•
	Flexible clamp F-3A (Ø 140 mm) 3 kA	WACEGF3AOKR		•	•	4	•
	Flexible clamp F-1A1 (Ø 380 mm) 1.5 kA F-1A6 (Ø 380 mm) 6 kA	WACEGF1A1OKR WACEGF1A6OKR		•	•	•	•
	Flexible clamp F-2A1 (Ø 250 mm) 1.5 kA F-2A6 (Ø 250 mm) 6 kA	WACEGF2A1OKR WACEGF2A6OKR		•	•	•	•
	Flexible clamp F-3A1 (Ø 140 mm) 1.5 kA F-3A6 (Ø 140 mm) 6 kA	WACEGF3A1OKR WACEGF3A6OKR		•	•	•	•
	Flexible clamp F-2AHD (Ø 290 mm) 3 kA	WACEGF2AHDOKR		•	•	•	•
	Flexible clamp F-3AHD (Ø 145 mm) 3 kA	WACEGF3AHDOKR		•	•	•	•
	C-4A current clamp (Ø 52 mm) 1000 A AC	WACEGC4AOKR		•	•	•	•
	C-5A current clamp (Ø 39 mm) 1000 A AC/DC	WACEGC5AOKR		•	•	•	•
	C-6A current clamp (Ø 20 mm) 10 A AC	WACEGC6AOKR		•	•	•	•
	C-7A current clamp (Ø 24 mm) 100 A AC	WACEGC7AOKR		•	•	•	•
	L-4 carrying case	WAFUTL4				1	
	L-18 carrying case	WAFUTL18					1
	L-19 backpack	WAFUTL19				•	
	Crocodile clip, black 1 kV 20 A	WAKROBL20K01		3	3	3	3
	Crocodile clip, red 1 kV 20 A	WAKRORE20K02		2	2	2	2

PQM

Set of standard and optional accessories

1, 2, 4 - number of standard accessories
• - optional accessories

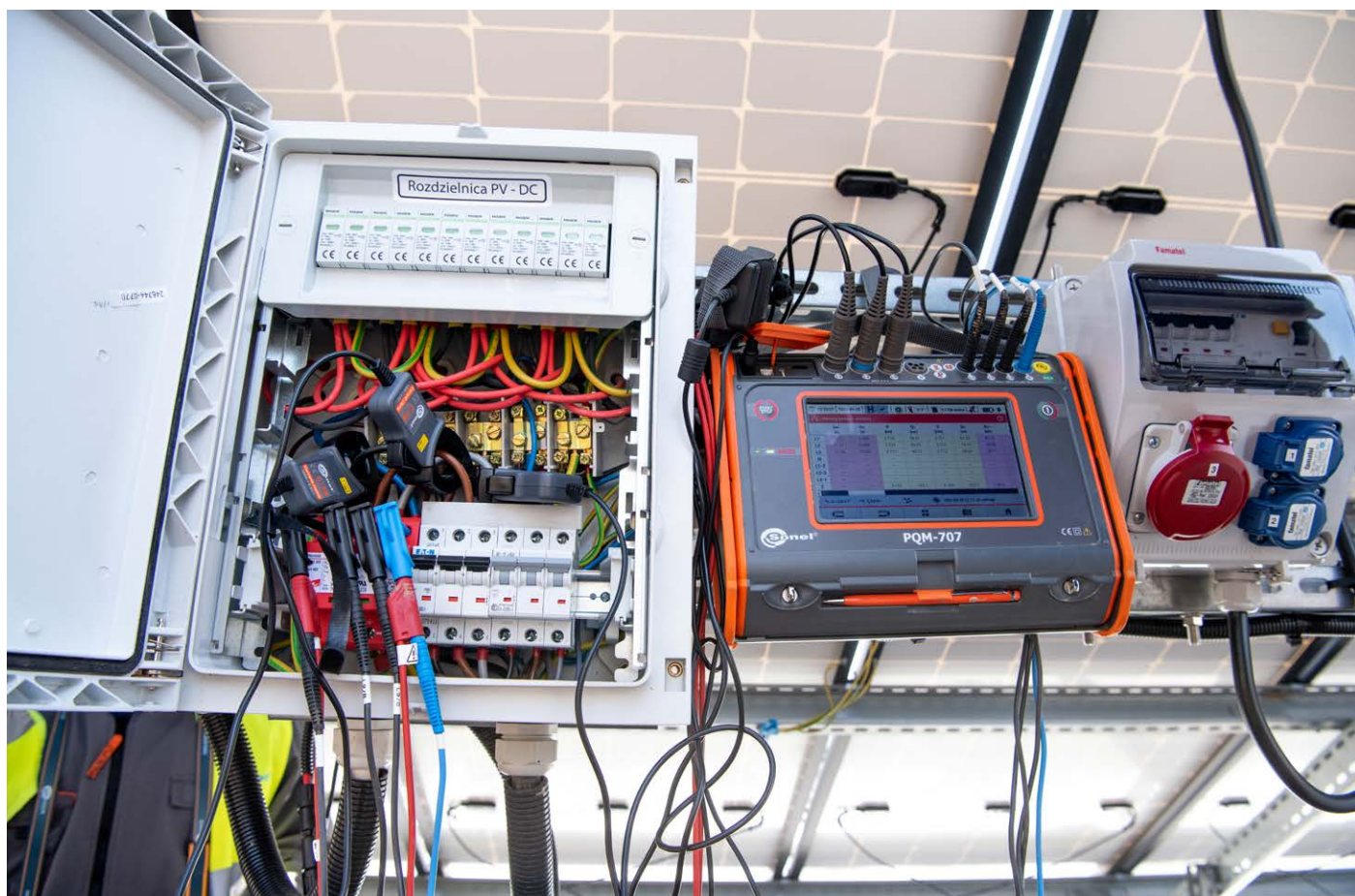
Photo	Name	Index	PQM-750	PQM-711	PQM-710	PQM-707	PQM-700
	Crocodile clip, blue 1 kV 20 A	WAKROBU20K02		1	1	1	1
	Crocodile clip, yellow 1 kV 20 A	WAKROYE20K02		1	1	1	
	Test lead 2.2 m, black 1 kV with L1 marker (banana plugs)	WAPRZ2X2BLBBL1				1	
	Test lead 2.2 m, black 1 kV with L2 marker (banana plugs)	WAPRZ2X2BLBBL2				1	
	Test lead 2.2 m, black 1 kV with L3 marker (banana plugs)	WAPRZ2X2BLBBL3				1	
	Test lead 2.2 m, blue 1 kV (banana plugs)	WAPRZ2X2BUBB				1	
	Test lead 2.2 m, yellow-green 1 kV (banana plugs)	WAPRZ2X2GRYEBB				1	
	USB data transmission cable	WAPRZUSB	1	1	1	1	1
	LAN network cable, shielded, 1.5 m	WAPRZRJ451X5EKR	1				
	Pin probe, black 1 kV (banana socket)	WASONBLOGB1				•	
	Pin probe, red 1 kV (banana socket)	WASONREOGB1				•	
	Pin probe, blue 1 kV (banana socket)	WASONBUOGB1				•	
	Pin probe, yellow 1 kV (banana socket)	WASONYEGB1				•	
	Voltage probe with grasper (5 pcs.)	WASONKGB1KPL		•	•	•	•
	Flat test clip for busbars (5 pcs.)	WASONCGB1KPL		•	•	•	•
	Flat test clip for busbars black	WASONBLCGB1		•	•	•	•
	Flat test clip for busbars blue	WASONBUCGB1		•	•	•	•
	Flat test clip for busbars green	WASONGRCGB1		•	•	•	•
	ASX-1 piercing adapter (4 pcs.)	WAADAPRZASX1KPL		•	•	•	•
	Hanging straps (type L-2)	WAPOZSZEKPL				1	

PQM

Set of standard and optional accessories

1, 2, 4 - number of standard accessories
• - optional accessories

Photo	Name	Index	PQM-750	PQM-711	PQM-710	PQM-707	PQM-700
	Strap for mounting on the pole (set)	WAPOZOPAKPL		1	1		1
	DIN rail mounting bracket with positioning catches	WAPOZUCH3		1	1		1
	Plates for pole mounting	WAPOZUCH4		2	2		2
	Magnetic holder for mounting the meter (2 pcs.)	WAPOZUCH5		•	•		•
	Case for hanging with a magnetic strap (universal)	WAPOZUCH8				•	
	Cover (universal)	WAPOZUCH12				•	
	Wall mounting kit	WAPOZUCH17	1				
	Hard carrying case for clamps	WAWALL2		•	•	•	•
	XL-2 hard case	WAWALXL2		1	1		•
	XL-12 hard case	WAWALXL12				•	
	Cable for battery charging from the car lighter socket 12 V	WAPRZLAD12SAM				1	
	230 V mains cable (IEC C7 plug)	WAPRZLAD230				1	
	Z-7 power supply adaptor	WAZASZ7				1	
	8 GB microSD card	WAPOZMSD8	1				
	Seal for voltage and current terminals (set of 2 pcs.)	WAPOZPLOKPL	1				
	Fork terminal for grounding terminal	WAZACWID	1				
	Touchscreen pen	WAPOZTPEN				1	



SONEL ANALYSIS

index: WAPROANALIZA4

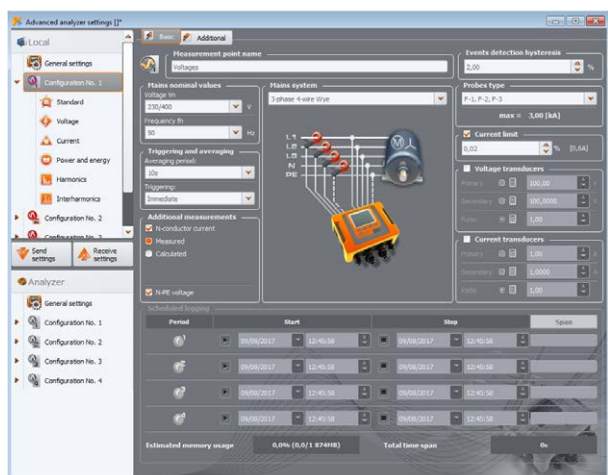


"SONEL Analysis" software - application delivered as standard accessory, indispensable for working with PQM-series analyzers. It enables:

- » analyzer configuration,
- » data reading from logger,
- » preview of network parameters in real time (with capability of reading via GSM modem),
- » deletion of data in the analyzer,
- » data presentation in tables,
- » data presentation in charts,
- » data analysis and generating reports in compliance with standard EN 50160 (reports) and other user defined reference conditions - also for PV micro-installations up to 50 kW, a breakdown for active power states $P > 0$, $P < 0$ and $P = 0$ and taking into account the graphs $Q_1 = f(U_1/U_n)$ and $\cos\varphi = f(P/P_n)$,
- » independent support of multiple analyzers,
- » analyzer firmware updates.

Analyzer configuration

The application enables configuration of all analyzer settings. Configuration is performed on a computer and then sent to the analyzer. A configuration can also be saved on a hard disk or other data carriers for later use.



The application enables configuration of, among other things:

- » selection of measurement points and arbitrary memory assignment to individual measurement points,
- » configurable analyzer time,
- » button blockade,
- » PIN code protection against unauthorized access by third parties,
- » configurable averaging time,
- » selection of current and voltage transformers,
- » selection of triggering mode (instant after an event occurs or according to set time schedule),
- » selection of clamp type, selection of additional parameters to be registered in N and PE conductors,
- » selection of the network type for which the analyzer will register all parameters set by the user.

The analyzer has four, mutually independent measurement points. Each measurement point can be configured separately so that four different registrations can be performed later without the need for reprogramming the analyzer in each instance.

The following can be configured for each measurement point:

- » whether the analyzer is to perform registration in terms of compliance with standard EN 50160 and/or according to user-defined parameters,
- » the user may define whether the logger will save instant, mean, maximum or minimum values for each parameter,
- » limits can be defined for most parameters, and the analyzer will log an event if these limits are crossed.

Readout of current data

Sonel Analysis software enables readout of selected parameters and their visualization on the computer screen in real time. These parameters are measured independently from the registration saved on the memory card. The user can view:

- » charts of voltage and current progression (oscilloscope),
- » charts of voltage and current over time,
- » phasor diagrams,
- » measurements of multiple parameters,
- » harmonics and harmonic powers (estimating the direction of harmonics),
- » interharmonics.

Data analysis

Using the application, the user can read and analyze data saved on the memory card. Read data can also be saved on the computer's hard disk for later processing. Thanks to this, archiving of data from successive registrations is possible.

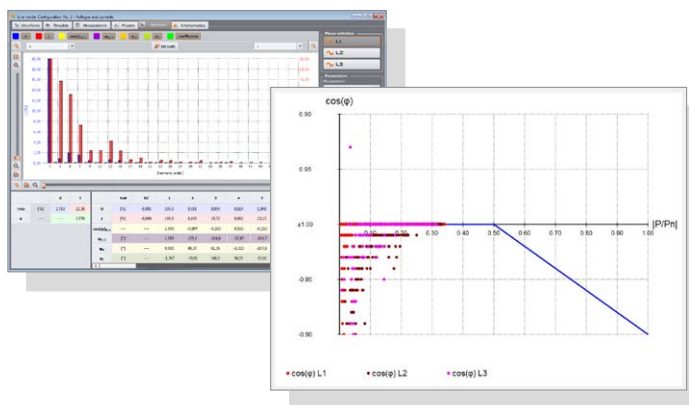
After data reading, the user can conduct analysis. There are three windows to choose from:

- » **General** – all individual types of data are displayed in the form of dots (Measurements, Events and Oscillograms),
- » **Measurements** – all measurement types registered are displayed in the form of dots according to averaging time (voltage, frequency, etc.),
- » **Events** – all types of detected events are displayed in the form of dots (dips, overvoltages, breaks, etc.),
- » **Configuration** – all settings with which data was registered are displayed.

Various types of charts are available in the application, enabling the user to view data registered by the analyzer in a simple way:

- » **Time chart** – displays the progressions of selected parameters over time,
- » **Oscillogram** – instant progressions of voltages and currents during events or at the end of an averaging cycle,
- » **Harmonics chart** – bar graph presenting the level of harmonics of orders 1..50,
- » **value/Time chart** – displays events in the form of dots as a function of the duration of these events.

User-defined reports can be generated using data read from the analyzer, which can then be saved to a hard disk in PDF, HTML, CSV or TXT file format. The application enables generation of a report on compliance with standard EN 50160 and the systems regulation.

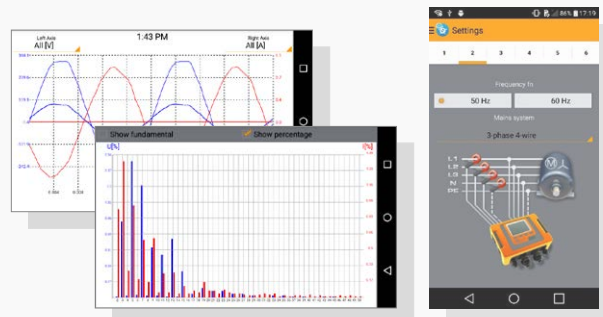


SONEL ANALYSIS MOBILE



Mobile version of the program cooperating with PQM-711 and PQM-710 from Sonel company. With the application, you can connect directly to your device via the Wi-Fi interface and check of current readings of network parameters to which the analyzer is connected.

Useful for users can be remotely start/stop recording, and to change the measurement point (configuration) in the analyzer.



Portable appliance testers



PAT-96
PAT-95



PAT-10
PAT-2E
PAT-2

Safety of electrical equipment

The rules and obligations concerning use of various types of electrical equipment, in both private and professional life, are defined by a broad range of regulations, which, besides imposing the obligation of creating products compliant with the relevant standards on the manufacturer, also **impose responsibility for the technical condition of this equipment and tools on their owners**. These regulations additionally define proper performance of regular tests and inspections as well as checks of equipment after repairs. Therefore, it is worth inspecting the technical condition of owned electrical equipment in the proper manner and with the appropriate frequency. Defective equipment, often damaged without the user's knowledge, poses a great threat to the user, but it can also be the cause of serious financial loss, e.g. in the event of a fire. In such a case, if it is proven that equipment was not fully operational (e.g. damaged insulation), **the manufacturer's liability for the incident is transferred to the owner**. In addition, this may constitute grounds for the insurer's refusal to pay damages.

In 2020, CENELEC (European Committee for Electrotechnical Standardization) published EN 50678 standard on the protective measures of electrical equipment after repair and EN 50699 standard on periodic testing. Both standards (EN 50678 and EN 50699) have been implemented as national standards in many countries – e.g. in Germany and Slovakia – whereas other countries are planning to implement these standards in the near future.

Every tester who uses a safety meter for electrical equipment assumes great responsibility for the both the health and life of users, as well as for their property, when making the decision on whether or not to approve tested equipment for use. Such a person should have a professional meter at their disposal, guaranteeing high accuracy and correct results.

The functions and technical specifications of testers for electrical equipment should allow for complete inspection of the technical condition of electrical equipment and tools, including checks of basic parameters of three-phase equipment. In addition, to ensure the user's work safety and proper measurement results, instruments should be capable of measuring the parameters of the power network (i.e. voltage, frequency, continuity resistance and voltage on protective conductor) immediately after start-up. The capability of performing tests is very useful considering:

- » **automatic mode** – with configuration of custom measurement sequences of parameters selected by the user,
- » **manual mode I** – due to the diversity of tests and standards for different equipment.

Preliminary test (visual) – the meter checks the continuity of L-N conductor and then it shows on the screen the moment when the (visual) inspection the device should take place. Then the tested object should be checked for:

- » condition of the housing,
- » operation of switches,
- » power cord and mains plug,
- » mechanical components,
- » condition of warning and safety elements.

Measurement of protective conductor (PE) resistance – it is carried out with 200 mA current, 10 A or 25 A depending on the requirements and regulations. Resistance of the measurement cable must not affect the measurement result, therefore autozeroing should be performed on the wire measurement cable using the four-wire method.

Insulation resistance measurement – typically required measuring voltage is 500 V DC, but some of the equipment (especially IT) requires a reduced voltage of 250 V or even 100 V. In contrast, industrial machinery and equipment may be tested in some cases with a higher voltage – up to 1000 V.

Measurement of leakage currents – the ability to measure equivalent leakage current, differential leakage current, touch leakage current and PE leakage current. The device should provide testing in a wide frequency band.

Functional test – consists in measuring the parameters of power supply while the tested device is activated. The following parameters are measured/tested: power values, voltage, current, factors of cosφ PF and THD.

Test of IEC cables and extension cords – automatic check of basic parameters of IEC cables and additionally (when a suitable adapter is used) tests on extension cords and cables with IEC 60320-C5 plug. The measurement sequence is performed automatically, and consists of:

- » measurement of PE core insulation resistance,
- » measurement of PE core resistance (continuity),
- » continuity test of L and N conductors and a check for short circuit between them,
- » polarity check.

After setting the measurement duration, programming limit values and completing the measurement, the meter is able to assess the condition of the tested device. With the option of creating measurement sequences, the meter may automatically perform measurements and assess the test results (a positive/negative).

A very important safety element is the documentation and records of tested devices. The system of QR codes that may be printed immediately after the measurements, helps in keeping the records. Data stored in the code, by referring to the device and performed test, will accelerate the operational tests and facilitate the maintenance work.

PC software Sonel PAT Analysis allows user to read and store data from PAT meters, including the settings of devices. Basing on measurement data, the device generates test reports and a measurement schedule is kept, whereas a cloud-based solution provides:

- » smooth data management and transfer in real time,
- » work in a web browser,
- » work in the task ordering mode,
- » protection of staff and fleet,
- » and many more.

	First start-up and modifications	Tests after repair	Periodical tests	Type tests / procedural tests
	DIN VDE 0751:2001	DIN VDE 0701-0702 DIN VDE 0751:2001 EN 62353 IEC 60601 EN 50678:2020	DIN VDE 0701-0702 E-08400:1988 DIN VDE 0751:2001 British standards EN 62353 IEC 60601 EN 60974-4 EN 50699	DIN EN 60950/50116 EN 61010 DIN EN 60335/50106 EN 60745-1 IEC 60601
Equipment tested in compliance with standards				
Laboratory instruments		•	• • •	•
Measuring and inspection instruments		•	• • •	• •
Voltage-generating equipment		•	• • •	•
Electric tools		•	• • • •	• • •
Heating equipment		•	• • •	• •
Equipment with electrical drive		•	• • • •	• • •
Lighting lamps		•	• • •	• •
Multimedia and telecommunications devices		•	• • •	• •
Cable reels, extension cords, connector cables		•	• • •	• •
Data processing devices and office appliances		•	• • •	• •
Electrical equipment for medical applications, components of applications	•	• • •	• • •	•
Welding equipment				•