

# Low resistance meters

MMR-6700  
MMR-6500



MMR-650



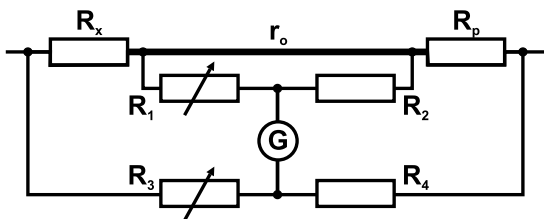
MMR-630  
MMR-620

# 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 and R 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:

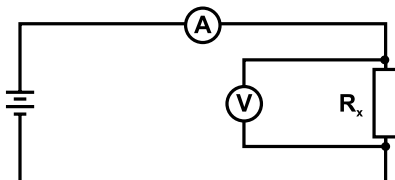
$$R_x = \frac{R_p R_1}{R_2}$$

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

Sonei 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 [Ω]	Resolution [Ω]	Accuracy	Test current
0.0...999.9 μ	0.1 μ	±(0.25% + 2 digits)	100 A < I ≤ 200 A*
0.0...999.9 μ	0.1 μ		50 A < I ≤ 100 A
1.0000...1.9999 m	0.0001 m		20 A < I ≤ 50 A
0.0...999.9 μ	0.1 μ		10 A < I ≤ 20 A
1.0000...3.9999 m	0.0001 m		
0.0...999.9 μ	0.1 μ		
1.0000...7.9999 m	0.0001 m		

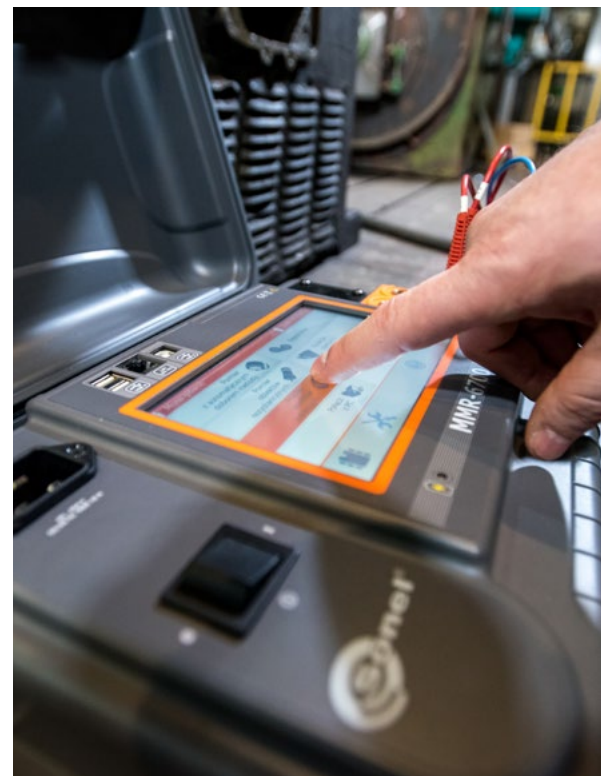
\* MMR-6700 only

### Measurements of resistance and inductive objects using low current

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

### 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 mm²)	WAPRZ003BLI1
Current carrying test lead 3 m black I2 (200 A, 25 mm²)	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	WAPRZ003DZBBU111
Doble-wire test lead 3 m (10 A / 25 A) U2/I2	WAPRZ003DZBBU212
USB cable	WAPRZUSB
Mains cable with IEC C19 plug	WAPRZZAS1
ST-3 temperature probe	WASONT3
Case L12	WAFUTL12
Calibration certificate issued by an accredited laboratory	
Sonei Reader software	WAPROREADER



## Winding and low resistance meter

# SONEL MMR-650

index: WMGBMMR650



CAT IV

300 V

IP67

closed cover

IP54

open cover

TOUCH SCREEN

### 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.



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

### Resistance measurement

Range [Ω]	Resolution [Ω]	Accuracy*	Test current
0...999.9 μ	0.1 μ	±(0.25% + 2 digits)	10 A
1.0000...1.9999 m	0.0001 m		10 A
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 of the meter:

L11 carrying case	WAFUTL11
2x Kelvin clamp, 1 kV, 25 A	WAKROKELK06
Doble-wire test lead 3 m (10 A / 25 A) U1/I1	WAPRZ003DZBBU11
Doble-wire test lead 3 m (10 A / 25 A) U2/I2	WAPRZ003DZBBU212
Mains cable with IEC C13 plug	WAPRZ1X8BLIEC
Mains cable with IEC C7 plug	WAPRZLAD230
USB cable	WAPRZUSB
2x double-tip Kelvin probe (banana sockets)	WASONKEL20GB
ST-3 temperature probe	WASONT3
PC software: Sonel Reader	WAPROREADER
Li-Ion 7.2 V rechargeable battery	WAAKU27

Calibration certificate issued by an accredited laboratory



## 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 of the meters:

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
Two-core cord; 3 m (10 / 25 A) U1/I1	WAPRZ003DZBBU111
Two-core cord; 3 m (10 / 25 A) U2/I2	WAPRZ003DZBBU212
230 V power cord (IEC C7 plug) (MMR-630)	WAPRZLAD230
RS-232 serial transmission cable	WAPRZRS232
2x double-tip Kelvin probe (banana sockets)	WASONKEL20GB
Meter strap (Unisonel type)	WAPOZSZE1
Calibration certificate issued by an accredited laboratory	

### Resistance measurement

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



# MMR

## Set of standard and optional accessories

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

Photo	Name	Index	MMR-6700	MMR-6500	MMR-650	MMR-630	MMR-620
	Adapter - converter USB / RS-232	WAADAUSBRS232				•	•
	NiMH battery 4.8 V 3.2 Ah for MMR-620/630	WAAKU03				1	1
	C-5A current clamps (φ=39 mm)	WACEGC5AOKR	•	•			
	Barcode scanner 2D (USB)	WAADACK2D	•	•	•	•	•
	D2 portable USB report / barcode printer (Sato)	WAADAD2	•	•	•	•	•
	L1 carrying case	WAFUTL1				1	1
	L11 carrying case	WAFUTL11			1		
	L12 carrying case	WAFUTL12	1	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
	PC software: Sonel Reader	WAPROREADER				1	1
	Double-wire test lead 10 m (Kelvin crocodile clip / banana plug)	WAPRZ010DZBKEL			•		
	Double-wire test lead 25 m (Kelvin crocodile clip / banana plug)	WAPRZ025DZBKEL			•		
	Doble-wire test lead 3 m (10 A / 25 A) U1/I1	WAPRZ003DZBBU1I1	1	1	1	1	1
	Doble-wire test lead 3 m (10 A / 25 A) U2/I2	WAPRZ003DZBBU2I2	1	1	1	1	1
	Current carrying test lead 3 m black I1 (200 A, 25 mm²)	WAPRZ003BLI1	1	1			
	Current carrying test lead 3 m black I2 (200 A, 25 mm²)	WAPRZ003BLI2	1	1			
	Current carrying test lead black I1 6 m / 10 m / 15 m	WAPRZ006BLI1 WAPRZ010BLI1 WAPRZ015BLI1	•	•			
	Current carrying test lead black I2 6 m / 10 m / 15 m	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			
	Mains cable with IEC C7 plug	WAPRZLAD230				1	
	LAN cable (RJ45)	WAPRZRJ45	•	•	•		
	Protective gloves (for operating the touchscreen)	WAREK1	•	•			
	Temperature probe ST-1	WASONT1	•	•	•		
	ST-3 temperature probe	WASONT3	1	1	1		
	Double pin Kelvin probe with banana connector	WASONKEL20GB	•	•	2	2	2
	UNI-SONEL hanging straps	WAPOZSZE1				1	1
	Label Roll - Black on White for D2 printer (SATO)	WANAKD2	•	•	•	•	•
	Ribbon for D2 printer (SATO)	WANAKD2BAR	•	•	•	•	•
	Kelvin vice with cables	WAZACKEL1	•	•	•	•	•
	Li-Ion battery Li-Ion 7.2 V	WAAKU27				1	

