

# CabResMeter-1M

# System for measuring the resistance of electrical cables



- Flexible and scalable structure: **current source**, model Keithley 6220/1, max. 100mA or AMETEK, max. 3000A, **dual-channel nanovoltmeter**, model Keithley 2182A, **fixing bench for cable under test**, model OFRIM Engineering **LowResCabBench**.
- Nanovoltmeter **Keithley 2182A** enables a simplified procedure (delta mode) for low resistance measurements in conjunction with a high precision current source with built-in functions, like **Keithley 6220/1**.
- **LowResCabBench** has a configurable system for fixing, stretching and connecting the cable under test, in accordance with its shape and dimensions.
- Manual or semi-automatic tests for measuring the resistance of 1m length electrical cables.
- Software packages, **Delta Mode** and **LowResCabTest**, for computer assisted manual or semi-automatic operation.
- Measures temperature of cable under test to determine the resistance at 20°C or any other reference temperature.
- Ease of acquisition, processing and interpretation of test results.
- Possibility to command and control additional equipments.

The system for measuring the resistance of electrical cables (**Cable Resistance Meter**), **CabResMeter-1M**, is designed for automatic and semi-automatic resistance measurements for single core, multi core, tape, bar or any other type of electrical cables. This system is usually used for 1m length cables, but it can also be used for measuring resistance and resistivity of cables with different lengths.

The system for cable fixing and connecting, **LowResCabBench**, is flexible and customizable, which allows the usage of the same equipment for different types, lengths and sections of the cables under test. It can be connected to both Keithley and AMETEK/Sorensen current sources.

The system provides additional information on the resistance and resistivity values, including the change in value over time with regards to temperature variation, due to its feature for direct measurement of cable temperature. In addition, **CabResMeter-1M** enables generation and printing of test reports and/or building experimental database.

This system for measuring resistance of electrical cables is based on the requirements stipulated by the IEC 60468 international standard.

**CabResMeter-1M** allows both manual and PC-based semi-automatic operation using the specialized software application **LowResCabTest**.

To ensure all the features, the system is composed of:

1. **Current source** – model Keithley 6220 / 6221, for test currents of maximum 100mA or AMETEK/Sorensen, for test currents larger than 100mA, up to 3000A.
2. **Nanovoltmeter** – model Keithley 2182A, for measuring voltage drop across the measuring points – channel 1, and for measuring temperature of cables under test – channel 2.
3. **System for fixing and connecting cables under test** – model OFRIM Engineering, **LowResCabBench**, customizable according to the shape and dimension of the cable under test.

## Test parameters configuration

**Configuration**

**Communication**

GPIB Board: GPIB0  
622x Addr: 12  
2182A Addr: 7

**Calibration**

p temperature coefficient  
 $\alpha$ : 0.00393  $\Omega^*m/^{\circ}C$

**conductor's dimensions**

width: 8.41 mm  
height: 1.61 mm  
radius: 0.5 mm

Buttons: OK, Save, Load

## Operation and results display

**OFRIM LowResTest**

**Operator Info**

Name: Brad Collins  
Position: Technical Engineer  
Comments: Copper resistance  
Second group

**Measurement Type**

Res (CH1): 0.81692  
Temp (CH2): 16.842  
Temperature: 1.69E-08  
Performance: High

**Measurement Mode**

One Time Mode  
Continuous Mode

Interval (s):

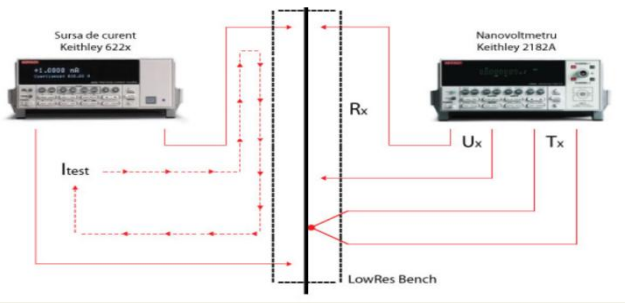
Test (max 100mA): 100 mA  
Resistance ID: #11CD-03

Buttons: Test, Read, Stop, Clear, Save

Results Table:

Res (m)	Res (m) - 20°C	T (°C)	Test Current (mA)	
#11CD-01	0.80721	16.836	0.81756	1.69E-08
#11CD-02	0.80721	16.836	0.81756	1.69E-08
#11CD-03	0.80502	16.842	0.81902	1.69E-08

# Structure and operation principle of CabResMeter-1M system



The structure of **CabResMeter-1M** allows two ways of operation:

- **Manual**, with no PC connection.

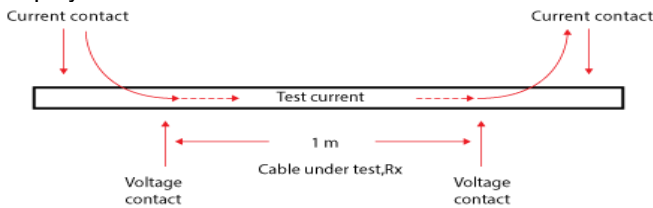
In this setup, the value of the measured resistance is displayed by the 2182A/6220 or 2182A/6221 system operating in delta model, or it can be determined using the values displayed by the AME TEK/Sorensen current source and Keithley 2182A nanovoltmeter and applying the following formula:  $R = U_{meas} / I_{test}$ .

- **Semi-automatic**, connected to PC.

Using this setup, the value of the measured resistance is displayed on the PC together with additional information regarding the experimental results.

**Temp Option** allows measuring temperature of the cable under test to determine the resistance and resistivity values at 20°C or any other reference.

The resistance of the 1m length cables is estimated to be less than 1Ω. **CabResMeter-1M** performs 4-wire measurements (Kelvin mode) by generating a known test current; this way, 2 wires are used for injecting current and 2 additional wires are used for measuring voltage drop between 2 points at a known distance. This method provides accurate results for resistance values less than 100Ω. The functional scheme is displayed beneath.



## Ordering Information

- **CabResMeter-1M/6220**, Complete Delta Mode System, w/DC current Source, Nanovoltmeter, Bench, Delta Mode software

- **CabResMeter-1M/6221**, Complete Delta Mode System, w/AC and DC current Source, Nanovoltmeter, Bench, Delta Mode software

# System for fixing and connecting cables under test - LowResCabBench

**LowResCabBench**, see figure below, is composed of 2 subsystems for fixing and connecting cables, 1m distance apart. Each subsystem contains 2 pairs of contacts/plots, for injecting current and measuring voltage, disposed up and down in relation to the cable under test to improve system performance. The contacts/plots have specific geometry, in accordance to their specific function; one allows current injection while the other enables measuring the voltage drop between 2 points at a distance of 1m apart. Additionally, their geometry is related to the type and section shape of cables under test. The fixing system allows the change of the contacts/plots according to the type of cables tested.



**Option Tens** allows fixing and stretching cables with sections less than 30 mm<sup>2</sup>.

## Main technical features

### Keithley 2182A Nanovoltmeter

#### Volts Specifications (20% over range)

CONDITIONS: 1PLC with 10 reading digital filter or 5PLC with 2 reading digital filter.

CHANNEL 1 RANGE	RESOLUTION	INPUT RESISTANCE	ACCURACY: ±(ppm of reading + ppm of range) (ppm = parts per million) (e.g., 10ppm = 0.001%)			
			24 Hour <sup>1</sup> T <sub>CAL</sub> ±1°C	90 Day T <sub>CAL</sub> ±5°C	1 Year T <sub>CAL</sub> ±5°C	2 Year T <sub>CAL</sub> ±5°C
10.00000 mV <sup>2,3,4</sup>	1 nV	>10 GΩ	20 + 4	40 + 4	50 + 4	60 + 4
100.00000 mV	10 nV	>10 GΩ	10 + 3	25 + 3	30 + 4	40 + 5
1.0000000 V	100 nV	>10 GΩ	7 + 2	18 + 2	25 + 2	32 + 3
10.000000 V	1 μV	>10 GΩ	2 + 1 <sup>5</sup>	18 + 2	25 + 2	32 + 3
100.00000 V <sup>4</sup>	10 μV	>10 MΩ ±1%	10 + 3	25 + 3	35 + 4	52 + 5
<b>CHANNEL 2<sup>5,10</sup></b>						
100.00000 mV	10 nV	>10 GΩ	10 + 6	25 + 6	30 + 7	40 + 7
1.0000000 V	100 nV	>10 GΩ	7 + 2	18 + 2	25 + 2	32 + 3
10.000000 V	1 μV	>10 GΩ	2 + 1 <sup>5</sup>	18 + 2	25 + 2	32 + 3

### Keithley 6220/6221 Current Source

#### SOURCE SPECIFICATIONS

RANGE (+5% over range)	ACCURACY (1 Year) 23°C ±5°C ±(% rdg. + amps)	PROGRAMMING RESOLUTION	TEMPERATURE COEFFICIENT <sup>1/2</sup> 0°-18°C & 28°-50°C	TYPICAL NOISE (peak-peak)/rms 0.1Hz-10Hz
2 nA	0.4 % + 2 pA	100 fA	0.02 % + 100 fA	400 / 80 fA
20 nA	0.3 % + 10 pA	1 pA	0.02 % + 200 fA	4 / 0.8 pA
200 nA	0.3 % + 100 pA	10 pA	0.02 % + 2 pA	20 / 4 pA
2 μA	0.1 % + 1 nA	100 pA	0.01 % + 20 pA	200 / 40 pA
20 μA	0.05% + 10 nA	1 nA	0.005% + 200 pA	2 / 0.4 nA
200 μA	0.05% + 100 nA	10 nA	0.005% + 2 nA	20 / 4 nA
2 mA	0.05% + 1 μA	100 nA	0.005% + 20 nA	200 / 40 nA
20 mA	0.05% + 10 μA	1 μA	0.005% + 200 nA	2 / 0.4 μA
100 mA	0.1 % + 50 μA	10 μA	0.01 % + 2 μA	10 / 2 μA

- **LowResCabTest**, software for PC-based semi-automatic operation (acquisition, processing, data storage)
- **Option Temp**, thermocouple K for measuring the temperature of cables under test.
- **Option Tens** for fixing and stretching cables with sections less than 30 mm<sup>2</sup>.



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