TermResMeter

System for measuring the contact resistance between terminals and 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 and terminal**, model OFRIM Engineering LowResConBench.

- 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

- **LowResConBench** has a configurable system for fixing and connecting the cable-terminal ensemble, in accordance with its shape and dimensions.

- Manual or semi-automatic tests for measuring the contact resistance of electrical cable terminals with different lengths.

- Software packages, **Delta Mode** and **LowResTest**, for computer assisted manual or semi-automatic operation.

- Measures temperature of cable under test to determine the resistance at 20^{0}C or any other reference temperature

- Ease of acquisition, processing and interpretation of test results.

The system for measuring the contact resistance between terminals and electrical cables (Cable Wire **Term**inal Connector Contact **Res**istance **Meter**), **TermResMeter**, is designed for automatic and semi-automatic measurements of contact resistance between different sized and shaped terminals and single core, multi core, tape, bar or any other type of electrical cables. This system enables contact resistance measurements in any point of contact.

The system for fixing and connecting the terminal-cable ensemble is flexible and customizable, which allows the usage of the same equipment for different types and sizes of terminals and various types and sections of electrical cables, with known lengths.

The system provides additional information regarding the contact resistance between terminals and cables, including the change in value over time with regards to the temperature variation, due to its feature for direct measurement of cable temperature. In addition, the system enables generation and printing of test reports and building experimental database.

TermResMeter allows both manual and PC-based semi-automatic operation using the specialized software application **LowResConTest**.

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 the terminal-cable ensemble** – model OFRIM Engineering, **LowResConBench**, customizable according to the shape and size of the terminals and cables.

Test parameters configuration

Operation and results display

InterNET SRL, www.inter-net.ro

TermConResMeter

OFRIM® engineering

Structure and operation principle of TermResMeter System
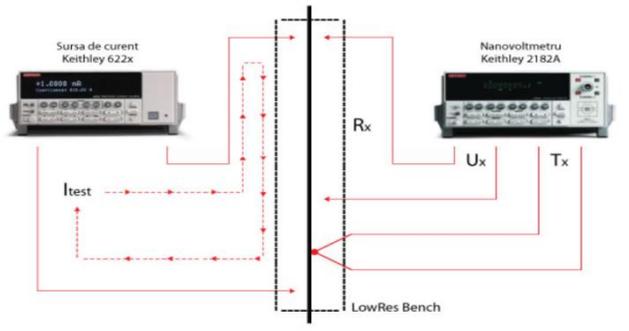
The structure of TermResMeter allows two ways of operation:

- **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 AMETEK/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 values at 20^0C or any other reference.

The value of the contact resistance between the terminal and electrical cable is estimated to be less than 100mΩ.

TermResMeter 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.
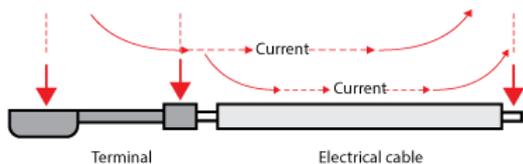

Ordering Information
- **TermResMeter/6220**, Complete Delta Mode System, w/DC current Source, Nanovoltmeter, Bench, Delta Mode software
- **TermResMete/6221**, Complete Delta Mode System, w/AC and DC current Source, Nanovoltmeter, Bench, Delta Mode software

System for fixing and connecting cables - LowResConBench

LowResConBench, see figure below, is composed of 2 subsystems for fixing and connecting the electrical cable. Each subsystem contains 2 pairs of contacts/plots, for injecting current and measuring voltage, 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. 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.

LowResConBench can be used both with Keithley 6220/6221, maximum 100mA test current, and with AMETEK/Sorensen, enabling a maximum 3000A test current.
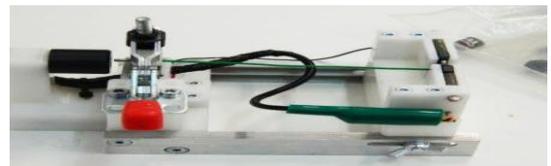
Main technical features
Keithley 2182A Nanovoltmeter
Volts Specifications (20% over range)

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

ACCURACY: ±(ppm of reading + ppm of range) (ppm = parts per million) (e.g., 10ppm = 0.001%)

CHANNEL 1 RANGE	RESOLUTION	INPUT RESISTANCE	24 Hour[1] $T_{CAL} \pm 1°C$	90 Day $T_{CAL} \pm 5°C$	1 Year $T_{CAL} \pm 5°C$	2 Year $T_{CAL} \pm 5°C$
10.000000 mV[2,3,4]	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[5]	18 + 2	25 + 2	32 + 3
100.00000 V[4]	10 μV	10 MΩ ±1%	10 + 3	25 + 3	35 + 4	52 + 5
CHANNEL 2[6,10]						
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[5]	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/°C 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

- **LowResConTest,** software for PC-based semi-automatic operation (acquisition, processing, data storage)
- **Temp Option**, thermocouple K for measuring the temperature of cables under test.

No. INT-003EN   Rev.A / 250113