♦ PRECISION INSTRUMENTS FOR TEST AND MEASUREMENT ♦

SRac Series

Resistance Standard
User and Service Manual

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SRac im/January 2019

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WARRANTY

We warrant that this product is free from defects in material and workmanship and, when properly used, will perform in accordance with applicable IET specifications. If within one year after original shipment, it is found not to meet this standard, it will be repaired or, at the option of IET, replaced at no charge when returned to IET. Changes in this product not approved by IET or application of voltages or currents greater than those allowed by the specifications shall void this warranty. IET shall not be liable for any indirect, special, or consequential damages, even if notice has been given to the possibility of such damages.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

Safety Symbols

General definitions of safety symbols used on the instrument or in manuals are listed below.

Caution symbol: the product is marked with this symbol when it is necessary for the user to refer to the instruction manual.

Hazardous voltage symbol: the product is marked with this symbol when high voltage maybe present on the product and an electrical shock hazard can exist.

Indicates the grounding protect terminal, which is used to prevent electric shock from the leakage on chassis. The ground terminal must connect to earth before using the product

Direct current.

Alternating current.

Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

On supply.

Off supply.

Hot surface. Avoid contact. Surfaces are hot and may cause personal injury if touched.

Waste Electrical and Electronic Equipment (WEEE) Directive 2002/96/EC
This product complies with the WEEE Directive (2002/96/EC) marking requirements.
The affixed label indicates that you must not discard this electrical/ electronic product in domestic household waste.
Product Category: With reference to the equipment types in the WEEE directive Annex 1, this product is classified as a “Monitoring and Control instrumentation” product.

Do not dispose of electrical appliances as unsorted municipal waste, use separate collection facilities.

Contact your local government for information regarding the collection systems available. If electrical appliances are disposed of in landfills or dumps, hazardous substances can leak into the groundwater and get into the food chain, damaging your health and well-being.

When replacing old appliances with new one, the retailer is legally obligated to take back your old appliances for disposal.

Proposition 65 Warning for California Residents

WARNING: Cancer and Reproductive Harm - www.P65Warnings.ca.gov.

This product may contain chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm

⚠ SAFETY PRECAUTIONS ⚠

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific WARNINGS elsewhere in this manual may impair the protection provided by the equipment. Such noncompliance would also violate safety standards of design, manufacture, and intended use of the instrument.

IET Labs assumes no liability for the customer's failure to comply with these precautions.

This is an indoor use product.

DANGEROUS PROCEDURE WARNINGS

Comply with all WARNINGS - Procedures throughout in this manual and instructions on the instrument prevent you from potential hazard. These instructions contained in the warnings must be followed.

BEFORE APPLYING POWER

Verify that all safety precautions are taken. Make all connections to the instrument before applying power. Note the instrument's external markings described under "Safety Symbols".

- DO NOT Operate in an Explosive Atmosphere
- Do not operate the instrument in the presence of inflammable gasses or fumes
- Operation of any electrical instrument in such an environment clearly constitutes a safety hazard
- Use Caution around live circuits and whenever hazardous voltages > 45 V are present
- Operators must not remove instrument covers
- Component replacement and internal adjustments must be made by qualified maintenance personnel only
- DO NOT substitute parts or modify the instrument
- When working with high voltages; post warning signs, train personnel and keep unauthorized personnel away.

To avoid the danger of introducing additional hazards, do not install substitute parts or perform unauthorized modifications to the instrument.

Return the instrument to an IET Labs for service and repair to ensure that safety features are maintained in operational condition.

WARNING

OBSERVE ALL SAFETY RULES
WHEN WORKING WITH HIGH VOLTAGES OR LINE VOLTAGES.

Dangerous voltages may be present inside this instrument. Do not open the case
Refer servicing to qualified personnel

HIGH VOLTAGES MAY BE PRESENT AT THE TERMINALS OF THIS INSTRUMENT

WHENEVER HAZARDOUS VOLTAGES (> 45 V) ARE USED, TAKE ALL MEASURES TO AVOID ACCIDENTAL CONTACT WITH ANY LIVE COMPONENTS.

USE MAXIMUM INSULATION AND MINIMIZE THE USE OF BARE CONDUCTORS WHEN USING THIS INSTRUMENT.

Use extreme caution when working with bare conductors or bus bars.

WHEN WORKING WITH HIGH VOLTAGES, POST WARNING SIGNS AND KEEP UNREQUIRED PERSONNEL SAFELY AWAY.

CAUTION

DO NOT APPLY ANY VOLTAGES OR CURRENTS TO THE TERMINALS OF THIS INSTRUMENT IN EXCESS OF THE MAXIMUM LIMITS INDICATED ON THE FRONT PANEL OR THE OPERATING GUIDE LABEL.

Contents

Figures and Tables

Chapter 1
INTRODUCTION

1.1 Introduction

The SRac Series (Figure 1.1) are stable, laboratory or portable resistance standards. Their ruggedness and small size plus their low temperature coefficient makes the SRac Series ideal for any applications outside of laboratory environment within the temperature range of 18°C to 28°C. Because of the low temperature coefficient, they require no oil-or-temperature bath.

The SRac series units are available in values ranging from 1 mΩ to 10 MΩ, with custom values available, to satisfy any requirement. The SRac series feature excellent stability and low temperature coefficient.

To reduce errors caused by temperature changes, the SRac units are built with a low temperature coefficient at 23°C.

The 5-way binding posts are constructed of low-thermal emf material.

Figure 1-1: SRac Series Resistance Standard

Chapter 2
SPECIFICATIONS

For convenience to the user, the pertinent specifications are given in an **OPERATION GUIDE**, shown in Figures 1-1.

SPECIFICATIONS

Calibration conditions:
At 23°C, low power, traceable to SI units.
Connections as indicated in table.

Terminals:
Gold plated, tellurium copper, high current, heavy duty,low thermal-emf binding position standard 3/4 inch spacing. A case **GROUND** terminal is provided on all units.

Dimensions: 8.6 cm H x 10.5 cm W x 12.7 cm D (3.4" x 4.15" x 5")

Operating temperature range: 15 to 30°C.

Transit case:
Optional **Model SRC-100** lightweight transit case with handle, suitable for transporting and storing two units. The case provides mechanical protection and insulation from temperature changes during transportation or shipping.

Optional **Model SRC-100-5** lightweight transit case with handle, suitable for transporting and storing 5 SRC/SRX resistance standards.

bnc option:
Option -bnc changes Hi and Lo binding posts to 4 x bnc connectors plus the ground binding post.

SRC-100-5 Lightweight transit case for 5 standards

Model SRac-	Nominal (Ω)	Initial adjustment to nominal (ppm)	Stability 1 year (ppm)	Tempco (ppm/°C)	Resistor type	Calibration uncertainty dc (Typical) (ppm)	dc to ac change at 1 kHz (Typical) (ppm)	Max. power (W)	Max. voltage (V)	Max. current (A)	Terminals
0.001	0.001	200	50	20	Manganin strip	200	25	0.2	0.015	14	4 bp's + gnd
0.01	0.01	200	50	20	Manganin wire	100		0.6	0.15	4.5	
0.1	0.1	100	20	1	Foil	60		0.3	0.17	1.7	
1	1			1		10		0.3	0.54	0.54	
10	10			2		5		0.6	2.45	0.245	
100	100			1		5			24.5	0.024	
1K	1 k			1		5			77.5	7.7 mA	
10K	10 k			1		2			245	2.5 mA	
100K	100 k			1		2			300	2 mA	
1M	1 M			5	Wirewound	5	250	0.5	700	0.7 mA	
10M	10 M			15	Film	10	2500	0.1	1000	0.1 mA	

Foil resistors have a power coefficient of resistance (PCR) of ±5ppm at rated power due to internal heating
Foil resistors have a voltage coefficient (VC) of < 3ppm/V

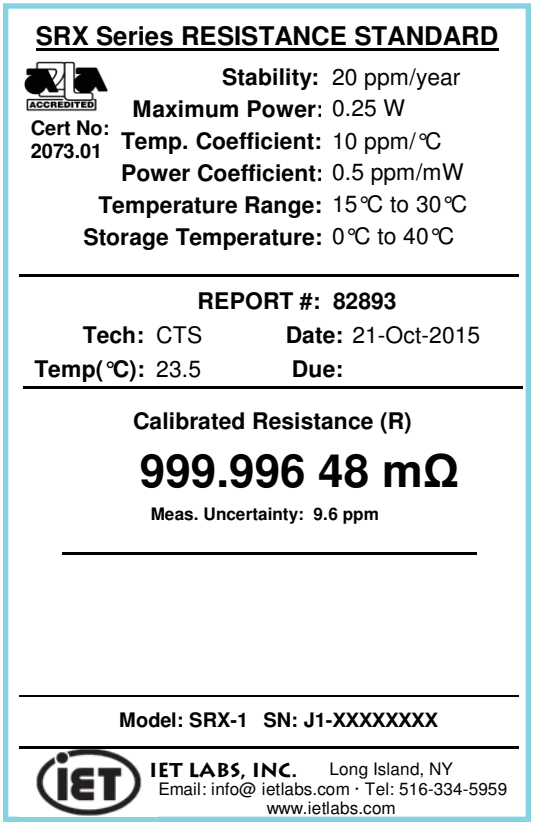

Figure 1-1: Typical Operating Guide Affixed to Unit

Chapter 3
OPERATION

3.1 Initial Inspection and Setup

This instrument was carefully inspected before shipment. It should be in proper electrical and mechanical order upon receipt.

An **OPERATION GUIDE** is attached to the case of the instrument to provide ready reference to specifications.

3.2 Connections

All SRac have four insulated low thermal emf binding posts for four-terminal measurements as shown in Figure 3-1. As an option -bnc is available which replaces the 4 binding posts with bnc connectors.

The fifth binding post **GND** is connected to the case.

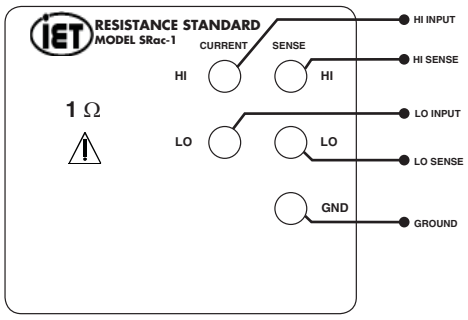

Figure 3-1: Connections

Binding Post	Function
CURRENT HI	Current input from source (e.g. ohmmeter)
CURRENT LO	Current return to source (e.g. ohmmeter)
SENSE HI	Measurement point for a four-wire ohmmeter
SENSE LO	Measurement point for a four-wire ohmmeter
GND	Guard or shield

Table 3-1: Connections

3.3 Thermal emf Considerations

High-quality, gold-plated, tellurium-copper binding posts serve to minimize the thermal emf effects which would artificially reflect a change in ac resistance measurements. All other conductors within the instrument, as well as the solder used, contain no metals or junctions that could contribute to thermal emf problems.

There nevertheless may be some minute thermal emf generated at the test leads where they contact the gold banana jacks. This voltage will also be eliminated if a meter with so called “True Ohm” capability is used. Otherwise the generated emf may represent itself as a false component of the dc resistance measurement.

Always use low emf test leads when working with SRac models. In particular, avoid brass or steel conductors.

3.4 Environmental Conditions

3.4.1 Operating Temperature

For optimal accuracy, SRac Models should be used in an environment of 23°C. They should be allowed to stabilize at those temperatures after any significant temperature variation.

3.4.2 Storage Temperature

The SRac Series should be maintained within the storage temperature range of 0°C to 40°C to retain its accuracy within the specified limits.

3.5 Shipping and Handling

The SRac Series should not be exposed to any excessive shock or temperature extremes. The option SRC-100, a lightweight transit case capable of storing two SRac units, is recommended for shipping or transporting the models.

3.6 Frequency Response

The SRac Series was designed to have minimal change between dc values and ac values at 1 kHz.

This also makes calibration easy as the SRac can be calibrated at dc rather than ac.

For resistance values below 1 MΩ it is recommended to use the dc value for the ac value at 1 kHz. This is due to the uncertainty for the dc measurement is significantly better than the ac measurement uncertainty.

For resistance values of 1 MΩ and 10 MΩ it is recommended to use the ac value.

The frequency response of the foil resistors is based upon the formula below;

$$R_s = \frac{R_{dc}}{(1-\omega^2 LC)^2 + (\omega R_{dc} C)^2}$$

$$R_p = R_{dc}(1 + (\omega L/R_{dc})^2)$$

Where worse case L = 0.1 µH and C = 1 pF

Figure 3-2 Rs and Rp formulas for foil resistors

It is important to realize that when measuring using an LCR meter or similar device that Rs or Rp should be selected depending upon the resistance value.

Rs should be used for values < 100 kΩ as the model for the resistor is a resistance with a series inductance.

Figure 3-3 Equivalent circuit for Rs

Rp should be used for values of 100 kΩ and higher. as the model is a resistance with capacitance in parallel.

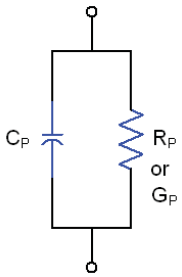

Figure 3-4 Equivalent circuit for Rp

Chapter 4
MAINTENANCE

4.1 Maintainability and Reliability

It is possible to maintain SRac units indefinitely. They are reliable due to their closed, rugged design and sealed resistors. The units are resistant to electromagnetic interference (EMI) because of their metal enclosure.

4.2 Preventive Maintenance

Keep the SRac units in a clean environment. This will help prevent possible contamination.

The front panel may be cleaned to eliminate any leakage paths from near or around the binding posts. To clean the front panel:

Wipe the front panel clean using alcohol and a lint-free cloth.

4.3 Calibration

The SRac units may be employed as stand-alone instruments or as an integral components of a system. If used as part of a system, they should be calibrated as part of the overall system to provide an optimum system calibration.

If an SRac model is employed as a stand-alone device, the following should be observed:

- Calibration Interval
- General Considerations
- Required Equipment
- Calibration Procedure

4.3.1 Calibration Interval

The recommended SRac Series calibration interval is twelve (12) months.

If the instrument is used to transfer resistance values only, recalibration is not required, assuming that there has been no drastic change of value.

4.3.2 General Considerations

Before starting the calibration procedure, you need to consider the following:

- Calibration environment should be 23°C and less than 50% relative humidity.
- Test instruments should be sufficiently more accurate than the SRac unit, and/or the uncertainty of the measurement instrumentation has to be considered in the calibration Test Uncertainty Ratio (TUR).
- The testing equipment and the SRac unit should stabilize at laboratory conditions for at least 24 hours.
- Kelvin type 4-wire test leads should be used to obtain accurate low resistance measurements.
- Steps should be taken to minimize thermal emf effects, such as using a meter with “True Ohm” capacity.
- Accepted metrology practices should be followed.

4.3.3 Required Equipment

Many combinations of standards, transfer standards, meters, and bridges may be used to calibrate this instrument. The following are some possible choices:

- Resistance Standards or Transfer Standards for the required values with traceable calibrations, such as the following standards available from IET Labs
    - SR-102 100 Ω
    - SR-103 1 kΩ
    - SR-104 10 kΩ
    - SRL series
- Precision resistance measurement bridge or multimeter, with a transfer accuracy of ±l ppm. Options include:
    - Guildline Model 9975
    - Measurements International Model 6010C
    - ESI model 242, 242A, 242C, or 242D
    - A high-precision, high-stability digital multimeter (e.g. Fluke 8508A) along with a set of resistance standards for ratio mode.

4.3.4 Calibration Procedure

To calibrate an SRac unit, proceed as follows:

1. Set up the calibration equipment in the resistance measurement mode.
2. Confirm the resistance of the unit.
3. Confirm that the resistance is consistent with historical measurements.

4.4 Replaceable Parts List

Reference	IET Pt No	Description
1	BP-1000-RD	Binding Post, Red
2	BP-1000-BK	Binding Post, Black
3	BP-1000-GN	Binding Post, Green
Not Shown	SRac-*-Res	SRac resistor assembly
*Replace * with nominal resistance value*		

Table 4-1: Replaceable Parts List

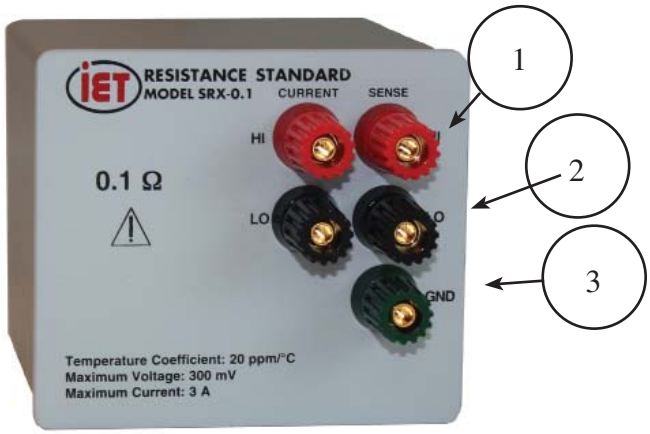

Figure 4-1: SRac Replaceable Parts