♦ PRECISION INSTRUMENTS FOR TEST AND MEASUREMENT ♦

R-X SERIES

Decade Resistor

Instruction Manual

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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 MERCHANTIBILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

WARNING

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

ELECTRICAL SHOCK HAZARD. DO NOT OPEN CASE.
REFER SERVICING TO QUALIFIED PERSONNEL.

HIGH VOLTAGE MAY BE PRESENT WITH **HIGH VOLTAGE OPTIONS.**

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.

REMOVE POWER WHEN HANDLING UNIT.

POST WARNING SIGNS AND KEEP 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.

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Figures

Chapter 1

INTRODUCTION

The **RX** series of resistance decade substituters is a family of instruments providing a very broad choice of high-performance resistance sources. Any number of decades from one to eleven is available in a choice of accuracies.

The **RX** is a precision resistance source with excellent characteristics of stability, temperature coefficient, power coefficient, and frequency response.

The **RX** Series employs very-low-resistance switches with silver-alloy contacts. A special design keeps zero resistance to less than 1 mΩ per decade. Self cleaning keeps the silver contacts from becoming tarnished when unused, or when only low currents are passed through them. This is most often the case when only minute test currents are drawn by digital multimeters or other test instruments. Contact resistance is stable and remains low and repeatable.

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

The standard models offer a choice of one through eleven decades. The panels are clearly labeled showing the step size and maximum voltage and current limitations for each decade.

With a resolution as low as 1 mΩ and a maximum available resistance of over 111 MΩ, the **RX** series may be used for exacting precision measurement applications requiring high accuracy, good stability, and low zero-resistance. They can be used as components of dc and ac bridges, for calibration, as transfer standards, and as RTD simulators.

The **RX** Series may be rack-mounted to serve as components in measurement and control systems.

Figure 1.1. RX Series High-Accuracy Resistance Substituter

Chapter 2

SPECIFICATIONS

For convenience to the user, the pertinent specifications are given in an **OPERATING GUIDE** affixed to the case of the instrument. Figure 2.1 shows a typical example.

SPECIFICATIONS

Resistance per Step	Total Decade Resistnace	Stability (±ppm/year)	Long-Term Stability (±ppm/3years)	Temperature Coefficient (±ppm/°C)	Max Power (W/step)	Max Current (per decade)	Max Voltage (per step)
1 mΩ	10 mΩ	100	700	50	0.04	8 A	5 mV
10 mΩ	100 mΩ	50	350	20	0.16	4 A	40 mV
100 mΩ	1 Ω	30	50	20	0.25	1.6 A	0.16 V
1 Ω	10 Ω	20	25	20	0.6	0.8 A	0.8 V
10 Ω	100 Ω	20	25	15	0.6	0.25 A	2.5 V
100 Ω	1 kΩ	20	25	5	0.6	80 mA	8 V
1 kΩ	10 kΩ	20	25	5	0.5	23 mA	23 V
10 kΩ	100 kΩ	20	25	5	0.5	7 mA	70 V
100 kΩ	1 MΩ	20	25	5	0.5*	2.3 mA*	230 V*
1 MΩ	10 MΩ	20	25	10	0.5*	0.7 mA*	700 V*
10 MΩ	100 Ω	50	40	10	0.1*	0.1 mA*	1000 V*

Subject to maximum of 2000 V to case.

Accuracy: After subtraction of zero resistance, at 23°C; traceable to NIST.

Zero Resistance: <1 mΩ per decade, at dc; slightly higher for 7-10 decades.

Maximum Voltage to Case: 2000 V peak.

Switch Type: 11 positions; "0"-"10"; multiple solid silver alloy contacts.

Switch Capacitance: <4 pF per switch.

Terminals: Low-thermal-emf beryllium-copper binding posts with standard 3/4 inch spacing, plus shield terminal; connections on the rear of the instrument are available (**RO** option). Single decade units have solder-terminal connections.

Mechanical:

Model	Dimensions	Weight
1 decade	7.7 cm W x 7.7 cm H x 8.4 cm D (3" x 3" x 3.3")	0.45 kg (1 lb)
2-3 decade	31 cm W x 8.9 cm H x 10.2 cm D (12.2" x 3.5" x 4")	1.7 kg (3.8 lb)
4-5 decade	37.5 cm W x 8.9 cm H x 10.2 cm D (14.75" x 3.5" x 4")	2.0 kg (4.3 lb)
6 decades	43.9 cm W x 8.9 cm H x 10.2 cm D (17.3" x 3.5" x 4")	2.2 kg (4.8 lb)
7 decades		2.4 kg (5.3 lb)

RX SERIES HIGH ACCURACY DECADE RESISTANCE SUBSTITUTER

CONSULT INSTRUCTION MANUAL FOR PROPER INSTRUMENT OPERATION

Resistor Type: Resistance wire for 0.1 Ω steps and under; wirewound, noninductive for 1 Ω through 1 MΩ steps; resistance film for 10 MΩ steps.

Accuracy: ±(0.01% + 2 mΩ) after subtraction of zero resistance, at 23°C; traceable to SI.

Zero Resistance: ≤1 mΩ per decade, typical at dc.

Power per Step: 25 mW for 1 mΩ steps;
0.2 W for 10 mΩ steps;
0.25 W for 100 mΩ steps;
0.6 W for 1 Ω through 100 Ω steps;
0.5 W for 1 kΩ through 1 MΩ steps;
0.1 W for 10 MΩ steps;
subject to a maximum of 2000 V.

Temperature Coefficient: <±50 ppm/°C for 1 mΩ steps;
<±20 ppm/°C for 10 mΩ through 1 Ω steps;
<±15 ppm/°C for 10 Ω steps;
<±5 ppm/°C for 100 Ω through 100 kΩ steps;
<±10 ppm/°C for 1 MΩ and 10 MΩ steps.

Switch Type: Multiple solid silver alloy contacts.

Switch Capacitance: Less than 4 pF per switch.

Operation: If switches have not been operated for an extended period, they should be rotated a few times to restore contact resistance to specifications.

MODEL: R6-111.111 **SN: C1-01191538**

WARNING

Observe all safety rules when working with high voltages or line voltages. Connect the (G) terminal to earth ground in order to maintain the case at a safe voltage. Whenever hazardous voltages (>45 V) are used, take all measures to avoid accidental contact with any live components: a) Use maximum insulation and minimize the use of bare conductors. b) Remove power when adjusting switches. c) Post warning signs and keep personnel safely away.

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Figure 2.1. 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 **OPERATING GUIDE** is attached to the case of the instrument to provide ready reference to specifications.

3.2 Connection

3.2.1 General Considerations

The **RX** Series Decade unit provides three terminals labeled **H** (high), **L** (low), and **G** (ground). The **H** and **L** terminals are connected to the ends of the resistance being set; the **G** terminal is connected to the case. The **G** terminal may be used as a guard or shield terminal. It may also be connected (using a shorting link) to the **L** terminal to allow two-terminal as opposed to three-terminal measurements.

In order to make the most stable measurements, determine which is the more sensitive of the two user leads, i.e. the one going into a higher impedance. This lead should be connected to the more protected one of the two **RX** terminals. That would either be the **RX** terminal that is shorted to the case, or the **LOW RX** terminal whenever neither is connected to the case.

If switches have not been operated for an extended period, they should be rotated a few times to restore contact resistance to specifications.

3.2.2 Electrical Considerations

In order to make proper use of the full performance capabilities of the **RX** unit, especially if low resistance or low-resistance increments are important, take care when connecting to the terminals of the decade box. In particular, in order to keep contact resistance to a minimum, take the most substantial and secure connection to the binding posts. They accept banana plugs, telephone tips, spade lugs, alligator clips, and bare wire. The largest or heaviest mating connection should be made, and, where applicable, the binding posts should be securely tightened.

These considerations may be relaxed whenever single milliohms are considered insignificant for the task being performed.

3.2.3 Four-Wire Kelvin Lead Connections

Whenever possible, 4-wire Kelvin leads, the ideal connection, should be employed. Such a connection minimizes the effects of contact resistance and approaches ideal performance.

If the four terminals are available as clamps similar to alligator clips, they may be connected to the necks of the binding posts. If the four terminals are available separately, the optimal connection is shown in Figure 3.1, where the current leads are introduced into the top of the binding posts, and the voltage leads at the necks.

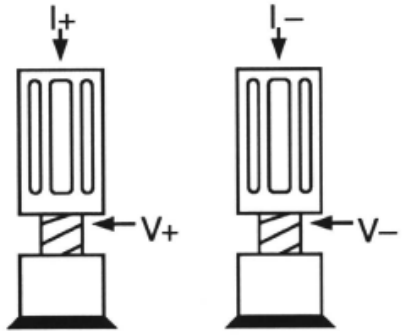

Figure 3.1 Optimal 4-Wire Kelvin Lead Connection

3.2.4 Thermal emf Considerations

The highest-quality low-emf components are used in the **RX** Series. There nevertheless may be some minute thermal emf generated at the test leads where they contact the gold-plated binding posts.

This emf will not reflect itself if an ac measurement instrument is employed. It will also be eliminated if a meter with a "True Ohm" capability is used. Otherwise it may represent itself as a false component of the dc resistance measurement. It is also possible to take a second measurement with the leads reversed and average the readings.

3.3 Dial Setting

Whenever the dials are used in positions 0-9, the resulting resistance is read directly. Both the decimal point and the steps are clearly marked on the panel.

For additional flexibility and range, each decade provides a "10" position setting. This "10" position on any one decade equals the "1" position on the next higher decade. It adds about 11% to the nominal total decade resistance.

To determine the resistance obtained when one or more "10" settings are used, simply add "1" to the next higher decade. For example, a setting of 3-6-10-0-10 Ω becomes:

```
  3          3 0 0 0 0
  6            6 0 0 0
 10            1 0 0 0
  0              0 0
 _10             1 0
_____________________________
 TOT          3 7 0 1 0
```

and a setting of 10-10-10-l0-10.10 Ω becomes:

```
 10         1 0 0 0 0 0.0
 10           1 0 0 0 0.0
 10             1 0 0 0.0
 10               1 0 0.0
 10                 1 0.0
.10                   1.0
_____________________________
 TOT        1 1 1 1 1 1.0
```

3.4 Environmental Conditions

For optimal accuracy, the decade box should be used in an environment of 23°C. It should be allowed to stabilize at that temperature after any significant temperature variation.

Humidity should be maintained at laboratory conditions. This is especially important if high resistances are involved.

4.2 Schematic

Refer to Figure 4.1 for a schematic of the **RX** decade unit.

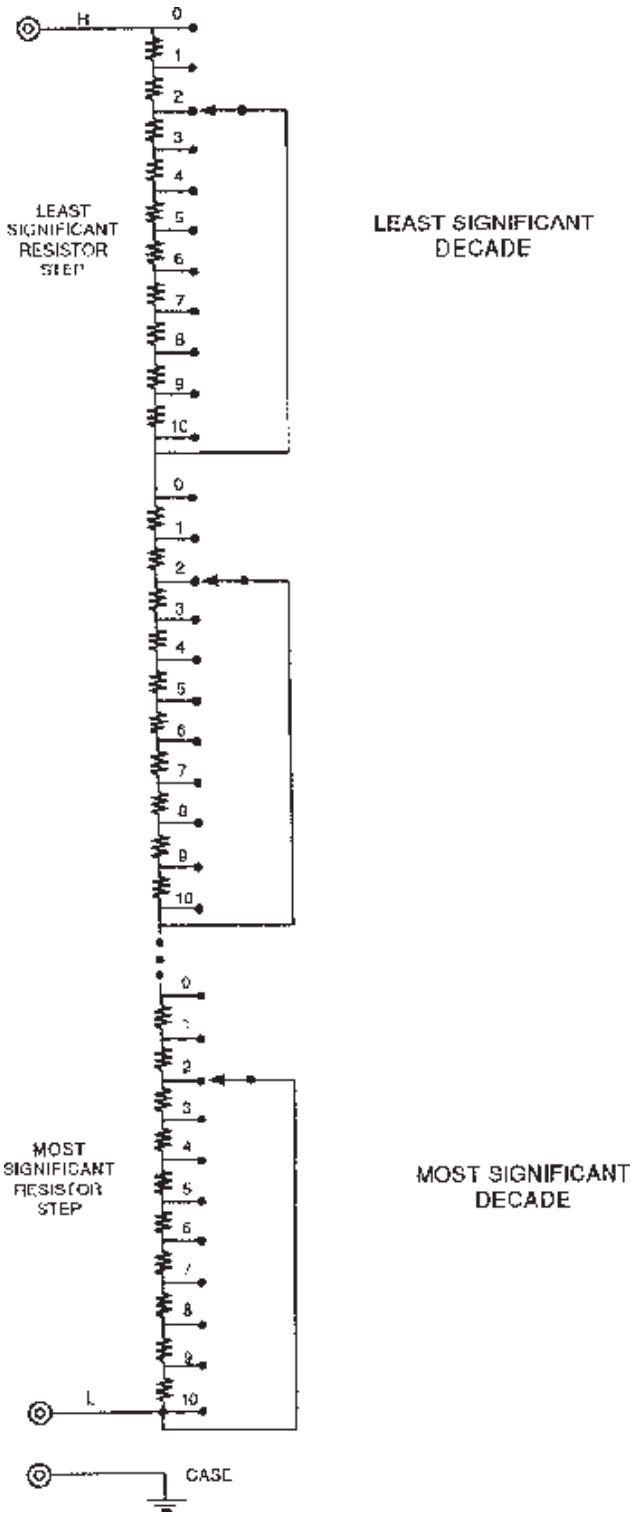

Figure 4.1. RX Series Schematic Diagram

4.3 Replaceable Parts List

Table 4.2: Replacement List

Model Ref	IET Pt No	Description
1	01-1033-8-0312	Binding Post, Red
2	01-1033-8-0310	Binding Post, Black
3	01-1008-1-0310	Binding Post, Gold
4	HARS-X-4300-KNB	Knob Assembly
Not Shown	HARS-X-3100	Foot
Not Shown	HARS-4000-X-.001	1 mΩ/step Decade Switch Assembly
Not Shown	HARS-4000-X-0.01	10 mΩ/step Decade Switch Assembly
Not Shown	HARS-4000-X-0.1	100 mΩ/step Decade Switch Assembly
Not Shown	HARS-4000-X-1	1 Ω/step Decade Switch Assembly
Not Shown	HARS-4000-X-10	10 Ω/step Decade Switch Assembly
Not Shown	HARS-4000-X-100	100 Ω/step Decade Switch Assembly
Not Shown	HARS-4000-X-1k	1 kΩ/step Decade Switch Assembly
Not Shown	HARS-4000-X-10k	10 kΩ/step Decade Switch Assembly
Not Shown	HARS-4000-X-100k	100 kΩ/step Decade Switch Assembly
Not Shown	HARS-4000-X-1M	1 MΩ/step Decade Switch Assembly
Not Shown	HARS-4000-X-10M	10 MΩ/step Decade Switch Assembly

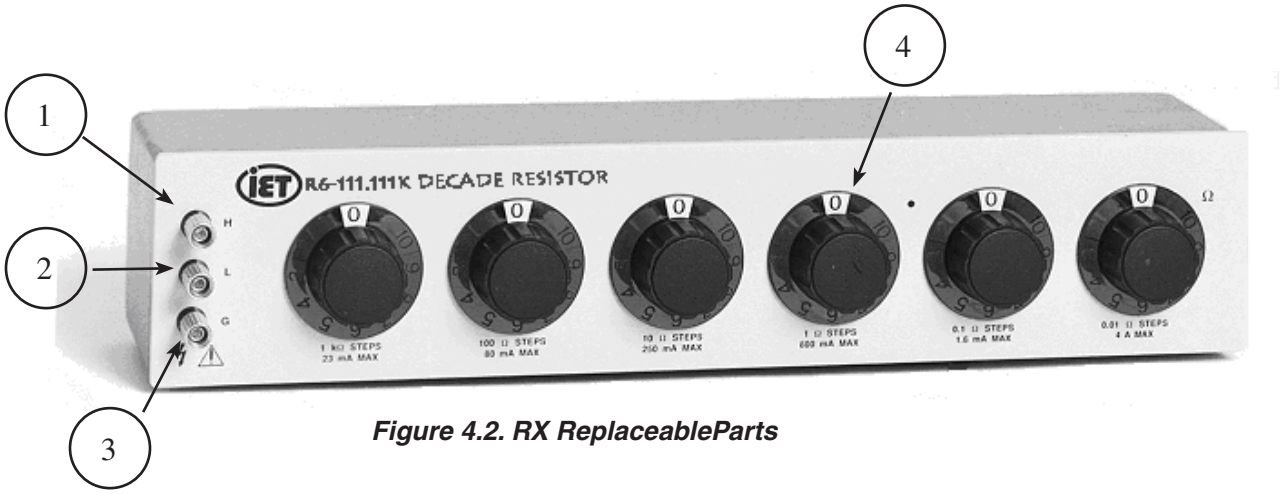

Figure 4.2. RX ReplaceableParts

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