♦ PRECISION INSTRUMENTS FOR TEST AND MEASUREMENT ♦

HRRS SERIES

High Resistance Decade Substituter

User and Service Manual

HRRS im/February, 2001

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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.

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Figures and Tables

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.

Chapter 1

INTRODUCTION

The High Resistance Decade Substituter (**HRRS** Series) is a family of instruments offering a broad choice of high range, excellent performance resistance sources (Figure 1.1). High resistance value resistors are made available without sacrificing other electrical properties

The HRRS Series employs state of the art precision resistors, of various types for high accuracy, high stability, and low temperature and voltage coefficients of resistance.

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

The binding posts are insulated with Kel-F high resistance non moisture absorbing material to ascertain that no leakage occurs between them.

With a resolution as low as 10 Ω and a maximum available resistance of over 1 TΩ (= 1000 GW = 1000 kMΩ), the HRRS Series may be used for exacting precision high value resistance applications. Maximum voltage capacities of 5 kV or higher are available. See Chapter 2.

Applications include calibration of meters and meghommeters, checking of electrochemical and biomedical sensors and instruments. These instruments are useful developments tool wherever small currents and high resistances are required, such as insulation testing, low power circuits, and high impedance amplifiers.

The HRRS series complements the HARS series which provides resistance steps as low as 1 mΩ. The units may be rack mounted to serve as components in measurement and control systems.

Figure 1.1. HRRS Series High Resistance Decade Substituter

Chapter 2

SPECIFICATIONS

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

SPECIFICATIONS

Decade Resistance	Resistance Per Step	Accuracy Option**			Max Voltage (Per Step)	5 kV Max Voltage Available	Temp. Coefficient ±ppm/°C	Voltage Coefficient ±ppm/V	Stability ±ppm/year
		Q	B	F					
100 Ω	10 Ω	±0.01%	±0.03%	±0.1%	2.5 V	N	15	0	10
1 kΩ	100 Ω	±0.01%	±0.03%	±0.1%	8 V	N	5	0	10
10 kΩ	1 kΩ	±0.01%	±0.03%	±0.1%	23V	N	5	0	10
100 kΩ	10 kΩ	±0.01%	±0.03%	±0.1%	70 V	N	5	0	10
1 MΩ	100 kΩ	±0.01%	±0.03%	±0.1%	333 V*	5000 V	5	0	10
10 MΩ	1 MΩ	±0.03%	±0.1%	±0.5%	1000 V*	5000 V	10	0.2	10
100 MΩ	10 MΩ	±0.03%	±0.1%	±1%	1000 V*	5000 V	10	0.2	25
1 GΩ	100 MΩ	±0.1%	±0.2%	±1%	1000 V*	5000 V	25	1.5	100
10 GΩ	1 GΩ	±0.2%	±0.5%	±1%	1000 V*	5000 V	80	5	500
100 GΩ	10 GΩ	±0.5%	±1%	±1%	1000 V*	5000 V	80	5	500
1 TΩ	100 GΩ	±0.5%	±1%	±1%	1000 V*	5000 V	200	5	500

* Subject to maximum of 1000 V (dc + ac peak);
** Traceable to NIST.

Zero Resistance: <3 mΩ per decade at dc.

Operating Conditions: 10°C to 23 °C; <50% RH.

Terminals: Two five-way binding posts on 2 special, low leakage, Kel-F insulating sockets and one metal ground post electrically connected to the case.

Setting of value:

Standard: 11 positions, "0"-"10"; silver contacts, ceramic dielectric switch.

Model	Dimensions	Weight
3 decades	31.2 cm W x 8.9 cm H x 10.2 cm D (12.3" x 3.5" x 4.0")	1.4 kg (3.0 lb)
4 decades	37.5 cm W x 8.9 cm H x 10.2 cm D (14.8" x 3.5" x 4.0")	1.6 kg (3.5 lb)
5 decades		1.9 kg (4.0 lb)
6 and 7 decades	43.9 cm W x 8.9 cm H x 10.2 cm D (17.3" x 3.5" x 4.0")	2.0 kg (4.5 lb)

ORDERING INFORMATION

Model* (For 5 kV version add -5KV where shown.)**	Total Resistance (Ω)	No. of Decades	Resolution (Ω)
HRRS-F-1-100G(-5KV)	1 T	1	100 G
HRRS-B-2-1M(-5KV)	110 M	2	1 M
HRRS-B-2-10M(-5KV)	1.1 G	2	10 M
HRRS-B-2-100M(-5KV)	11 G	2	100 M
HRRS-B-2-1G(-5KV)	110 G	2	1 G
HRRS-B-2-10G(-5KV)	1.1 T	2	10 G
HRRS-B-3-100K	111 M	3	100 k
HRRS-B-3-1M	1.11 G	3	1 M
HRRS-B-3-10M(-5KV)	11.1 G	3	10 M
HRRS-B-3-100M(-5KV)	111 G	3	100 M
HRRS-B-3-1G(-5KV)	1.11 T	3	1 G
HRRS-B-4-10K	111.1 M	4	10 k
HRRS-B-4-100K	1.111 G	4	100 k
HRRS-B-4-1M	11.11 G	4	1 M
HRRS-B-4-10M(-5KV)	111.1 G	4	10 M

***** Replace **"B"** with **"Q"** for higher grade accuracy; replace **"B"** with **"F"** for 1% accuracy.

Model*	Total Resistance (Ω)	No. of Decades	Resolution (Ω)
HRRS-B-5-1K	111.11 M	5	1 k
HRRS-B-5-10K	1.111 1 G	5	10 k
HRRS-B-5-100K	11.111 G	5	100 k
HRRS-B-5-1M	111.11 G	5	1 M
HRRS-B-6-10	11.111 1 M	6	10
HRRS-B-6-100	111.111 M	6	100
HRRS-B-6-1K	1.111 11 G	6	1 k
HRRS-B-6-10K	11.111 1 G	6	10 k
HRRS-B-6-100K	111.111 G	6	100 k
HRRS-B-7-10	111.111 1 M	7	10
HRRS-B-7-100	1.111 111 G	7	100
HRRS-B-7-1K	11.111 11 G	7	1 k
HRRS-B-7-10K	111.111 1 G	7	10 k

Single Decade Version See HARS-X data sheet.

OPTIONS

- **RM** Rack mountable case for standard 19" rack
- **K** Kelvin type 4-terminal binding posts
- **RO** Rear outputs

Chapter 3

INSTALLATION

3.2 Initial Inspection

IET instruments receive a careful mechanical and electrical inspection before shipment. Upon receipt, verify that the contents are intact and as ordered. The instrument should then be given a visual and operational inspection.

If any shipping damage is found, contact the carrier and IET Labs. If any operational problems are encountered, contact IET Labs and refer to the warranty at the beginning of this manual. IET Labs will work with you until you are satisfied that your instrument is operating to fulfill the needs of your applications.

Save all original packing material for convenience in case shipping of the instrument should become necessary.

3.2 Installation

For a rack mounted model, installation on a 19 inch rack may be made using the slots in the rack mounting ears. A mounting location that does not expose the unit to excessive heat is recommended.

For bench models, no installation as such is required, because this instrument series is not powered. Since it is a high accuracy instrument, it is recommended that a bench space be provided that would not expose it to abuse and keep it protected from temperature extremes and contaminants.

For all high resistance instruments, it is highly recommended that they be stored sealed in a plastic bag or other well sealed environment to minimize any contamination that would lead to electrical leakage and degradation of performance.

Minimize handling of the binding post area and especially the Kel-F insulating washers.

Keep unit in a sealed environment when not in use.
Maintain binding post area clean for minimum electrical leakage.

3.3 Repackaging for Shipment

If the instrument is to be returned to IET Labs, contact the Service Department at the number or address, shown on the front cover of this manual, to obtain a "Returned Material Authorization" (RMA) number and any special shipping instructions or assistance. Proceed as follows:

1. Attach a tag to the instrument identifying the owner and indicate the service or repair to be accomplished. Include the model number, the full serial number of the instrument, the RMA number, and shipping address.
2. Wrap the instrument in heavy paper or plastic.
3. Protect the front panel and any other protrusions with cardboard or foam padding.
4. Place instrument in original container or equally substantial heavy carton.
5. Use packing material around all sides of instrument.
6. Seal with strong tape or bands.
7. Mark shipping container "DELICATE INSTRUMENT," "FRAGILE," etc.

3.4 Storage

If this instrument is to be stored for any lengthy period of time, it should be sealed in plastic and stored in a dry location. It should not be subjected to temperature extremes beyond the specifications. Extended exposure to such temperatures can result in an irreversible change in resistance, and require recalibration

Chapter 4

OPERATION

4.1. Connection

4.1.1 General Considerations

The HRRS 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 resistor 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 either terminal to allow two-terminal as opposed to three-terminal measurement. See Figure 5.1.

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 test instrument impedance. This lead should be connected to the HRRS terminal that is shorted to the case, or the **L** terminal whenever neither is connected to the case, i.e. the more protected one of the two HRRS terminals.

4.1.2 Electrical Considerations

In order to make proper use of the full performance capabilities of the HRRS unit, care should be taken to obtain good results with the very high resistance values involved.

Whenever possible, shielding should be employed. The case itself can be grounded using the **G** terminal, and shielded cables to the other terminals should be employed.

Because of the high resistances involved, leakage from all sources should be kept to a minimum. The ambient humidity should be under 50% RH. Also, the instrument should be kept clean, and should not be handled at the terminals. Any contamination could act as a leakage across the device resistance. The unit may be cleaned with alcohol or naphtha.

Keep unit in a sealed environment when not in use.
Maintain binding post area clean for minimum electrical leakage.

Since high resistance applications are invariably associated with high voltages, it is important to observe all precautions and safety rules.

CONNECT THE G (GND) TERMINAL TO EARTH OR OTHER SUITABLE 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:

-USE MAXIMUM INSULATION AND MINIMIZE THE USE OF BARE CONDUCTORS.

- REMOVE POWER WHEN ADJUSTING SWITCHES.

- POST WARNING SIGNS AND KEEP PERSONNEL SAFELY AWAY.

4.2 Dial Setting

Whenever the dials are used for positions 0-9, the resulting resistance is simply read off from the panel dial setting in a direct fashion. 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 any 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 MΩ becomes:

3	3	0	0	0	0	
6		6	0	0	0	
10		1	0	0	0	
0				0	0	
10				1	0	
TOTAL	3	7	0	1	0	

and 10-10-10-10.-10 MWs become

10	1	0	0	0	0	0	0	. 0
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
TOTAL	1	1	1	1	1	1	1	. 0

4.3 Environmental Conditions

For optimal accuracy, the decade box should be used in an environment of 23^{0}C. It should be allowed to stabilize at that temperature for at least two hours after any significant temperature variation. Humidity should be maintained <50% RH.

Chapter 5

MAINTENANCE

5.1 Preventive Maintenance

The HRRS Decade Substituter is packaged in a closed case which will limit the entry of contaminants and dust to the inside of the instrument. If it is maintained in a generally clean or air conditioned environment, cleaning will be seldom required. In a contaminated atmosphere, cleaning may be required.

It is important to avoid handling the binding posts and to keep them clean to minimize the possibility of shunt leakage across the internal resistors. Wiping with alcohol or naphtha, is recommended. Household cleaners or any solvents that leave a residue should not be used.

To maintain optimal accuracy and stability, it is best not to open the case of the unit. If it is opened, then it is necessary to handle the internal components with clean rubber or cotton gloves.

In normal service, the switches require no additional lubrication. During the manufacturing process, a light lubrication is applied which in most instances is sufficient for the service life of the switches, and yet will not tend to collect dust.

5.2 Verification of Performance

5.2.1 Calibration Interval

The HRRS Series instruments should be verified for performance at a calibration interval of twelve (12) months. This procedure may be carried out by the user, if a calibration capability, is available, by IET Labs, or by a certified calibration laboratory. If the user should choose to perform this procedure, then the considerations below should be observed.

5.2.2 General Considerations

It is important, whenever testing the HRRS Series Decade Units, to be very aware of the capabilities and limitations of the test instruments used. There are a some bridges and direct reading resistance meters or digital multimeters available that can verify the accuracy of these units, *especially* when used in conjunction with standards that can serve to confirm or improve the accuracy of the testing instrument.

Such instruments would have to be *significantly* more accurate than the specified accuracies for all applicable ranges, in order to perform this task, allowing for a band of uncertainty of the instrument itself. A few commercial models, bridges and meters, do exist that can do this; consult IET Labs for information.

It is important to allow both the testing instrument and the HRRS Substituter to stabilize for a number of hours at the nominal operating temperature of 23^0C, and at < 50% RH. There should be no temperature gradients across the unit under test.

Proper metrology practices should be followed in performing this verification.

5.2.3 Procedure

1. Confirm the zero resistance of the unit.

2. Determine the allowable upper and lower limits for each resistance setting of each decade following the specified accuracy given in the Specifications Section of Chapter 2.

3. Confirm that the resistances fall within these limits.

4. If any resistances fall outside these limits, the associated switch assembly may be trimmed repaired or replaced. Refer to the Parts List below for the appropriate part number.

5.3 Schematic and Replacement Parts

Refer to Figure 5.1 for a schematic of the HRRS decade unit. In order to locate the replacement parts associated with a particular model in the HRRS series, use Table 5.1 to locate the code letter for the relevant model, and then see Tables 5.2 and 5.3 for the parts which apply to the model code letter. See Figure 5.2 for an assembly diagram of the unit.

It is recommended that service be performed only by IET Labs or by qualified personnel.

5.4 Troubleshooting

If the verification procedure results in a failure, use the schematic of Figure 5.1 to determine the suspect decade or component. In a clean environment, and using gloves, disassemble the unit as described below, and examine the parts in question to determine the necessary repair or replacement.

5.5 Disassembly, Component Replacement, and Reassembly

5.5.1 Disassembly

Referring to Figure 5.2 to locate part numbers, proceed as follows:

1. Work in a clean environment, and use gloves to handle any components.

2. Place the instrument on a flat surface and remove the 4 housing screws (HARS-X-3200) from the bottom of the instrument. The housing ((HRRS-30*0) may now be removed.

5.5.2 Component Replacement

Determine and locate any faulty component that requires replacement as described in the troubleshooting section 5.4.

To remove a decade switch assembly
(HRRS-6500-*), proceed as follows:
1. Desolder the bus wire connecting the switch assembly.
2. Pry off the cap from the knob
(HARS-X-4300-CAP), and remove the nut under it.
3. Pull off the knob (HARS-X-4300-KNB), and remove the nut under it.
4. The decade switch assembly may now be removed.
5. Replace the assembly by reversing the above steps.
6. Replace the knob and cap, making certain that the figure dial (HARS-X-4300-FD) and the stator (HARS-X-4300-ST) are properly aligned for the particular switch setting.

5.5.3 Reassembly

1. Make certain that the 4 standoffs (HARS-X-3300) have not become loose. If so tighten them.
2. Replace the housing, match the holes, and attach the 4 housing screws.

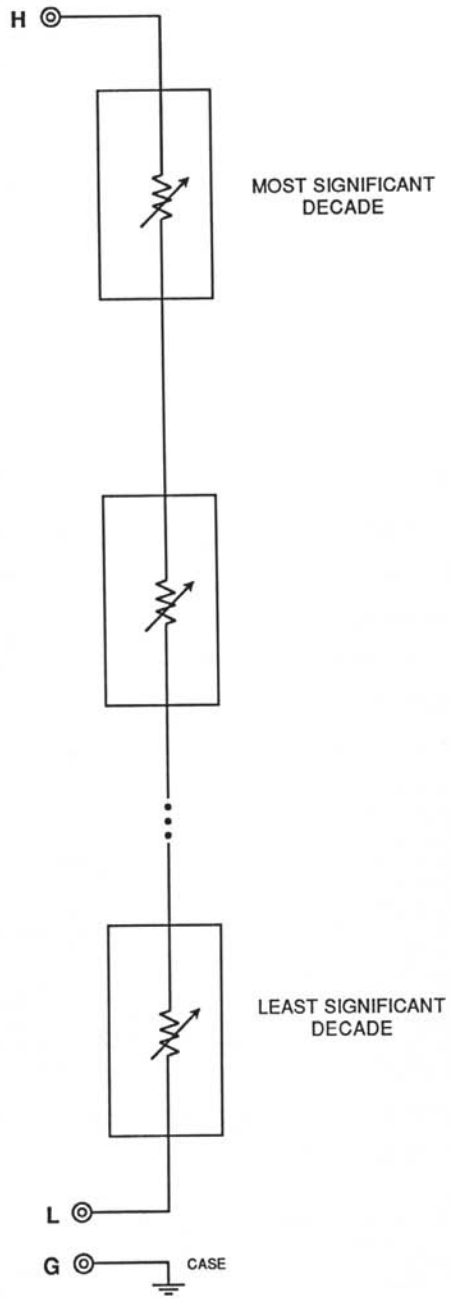


Figure 51. HRRS Series Schematic Diagram

Table 5.1 Model Reference Codes

Model letter	Reference code letter	Model	Reference code
HRRS-B-3-1M	a	HRRS-B-5-0.1M	c
HRRS-B-4-0.1M	b	HRRS-B-6-.01M	d

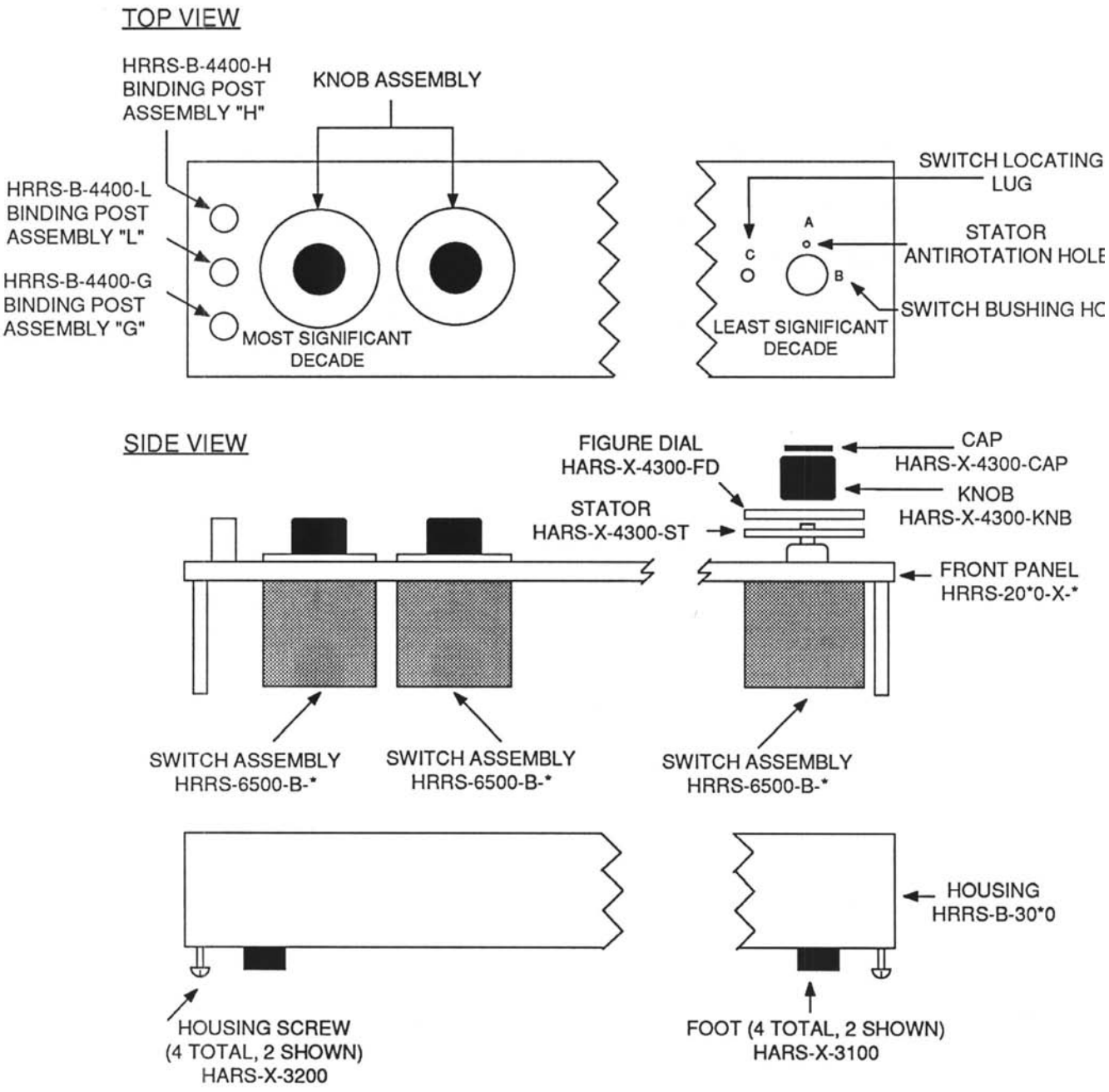
NOTE: Code letter followed by RM designates a rack mount model

Table 5.2 Replacement Parts List

Model Ref	IET Part No.	Description	Qty	Fed. Mfr. Code	Mfr. Part No.
d	HRRS-6500-B-0.01M	Decade Switch Assembly 0.01M Ω/step	1	62015	Same as IET No.
b,c,d	HRRS-6500-B-0.1M	Decade Switch Assembly 0.1 MΩ/step	1	62015	Same as IET No.
a,b,c,d	HRRS-6500-B-1M	Decade Switch Assembly 1 MΩ/step	1	62015	Same as IET No.
a,b,c,d	HRRS-6500-B-10M	Decade Switch Assembly 10 MΩ/sMtep	1	62015	Same as IET No.
a,b,c,d	HRRS-6500-B-100M	Decade Switch Assembly 100 MΩ/stMep	1	62015	Same as IET No.
c,d	HRRS-6500-B-1G	Decade Switch Assembly 1 GΩ/step	1	62015	Same as IET No.
d	HRRS-2060-B-0.01M	Front panel, bench model	1	62015	Same as IET No.
d-RM	HRRS-2060-B-0.01-RM	Front panel, rack mount	1	62015	Same as IET No.
c	HRRS-2050-B-0.1	Front panel, bench model	1	62015	Same as IET No.
c-RM	HRRS-2050-B-0.1-RM	Front panel, rack mount	1	62015	Same as IET No.
b	HRRS-2040-B-0.1	Front panel, bench model	1	62015	Same as IET No.
b-RM	HRRS-2040-B-0.1-RM	Front panel, rack mount	1	62015	Same as IET No.
a	HRRS-2030-B-1	Front panel, bench model	1	62015	Same as IET No.
a-RM	HRRS-2030-B-1-RM	Front panel, rack mount	1	62015	Same as IET No.
all	HRRS-X-4300-KNB	Knob	3-6	76096	020-6525
all	HARS-X-4300-CAP	Knob cap	3-6	76096	040-6025
all	HARS-X-4300-FD	Figure dial	3-6	76096	042-6100
all	HARS-X-4300-ST	Stator	3-6	76096	043-6220
all	HRRS-B-4400-H	Binding post assembly "H" terminal	1	62015	Same as IET No.
all	HRRS-B-4400-L	Binding post assembly "L" terminal	1	62015	Same as IET No.
all	HRRS-B-4400-G	Binding post assembly "G" terminal	1	62015	Same as IET No.
c,d	HRRS-B-3050	Housing	1	62015	Same as IET No.
a,b	HRRS-B-3030	Housing	1	62015	Same as IET No.
all	HARS-X-3100	Foot	4	18310	760-3509
all	HARS-X-3200	Housing screw	4	62051	Same as IET No.

Table 5.3 Commercial And Government Entity (CAGE) Codes/FSCM

Code	Manufacturer
18310	Concord Electronics Corp., 30 Great Jones St., New York, NY 10012
62015	IET Labs, Inc., 534 Main St., Westbury, NY 11590
76096	Elma Electronics Inc., 41440 Christy St., Fremont, CA 94538



NOTE:
* REFER TO PARTS LIST FOR COMPLETE PART NUMBER DEPENDING ON THE PARTICULAR MODEL IN SERIES

IET LABS, INC. 534 MAIN STREET WESTBURY, NY 11590 (516) 334-5959				FSCM NO: 62015
SCALE: NA	DATE: 9-20-88		DRAWN BY: SS/SG	SIZE: NA
APPROVED BY:	REVISED: 01-15-91			
DESC: ASSEMBLY DWG FOR HRRS SERIES				
PART NO: HRRS-B-3-1M, HRRS-B-4-0.1M, HRRS-B-0.1M, HRRS-B-6-0.1M				
DRAWING NO: HRRS-IM-AD			REV: B1	

V1.4

Figure 5.2 Assembly Diagram