

**HARS-LX SERIES**  
**Laboratory Standard Decade**  
**Resistance Substituter**  
**User and Service Manual**



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HARS-LX im/April 2009



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◆ PRECISION INSTRUMENTS FOR TEST AND MEASUREMENT ◆



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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.



## **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.

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# Chapter 1

## INTRODUCTION

The Laboratory Standard (HARS-LX) Series of resistance decade substituters (Figure 1.1) is a family of instruments providing a very broad choice of high-performance resistance sources. Any number of decades from one to ten is available.

The HARS-LX-8-0.01-RH is a direct replacement for the model RS925D.

The HARS-LX substituter is a precision resistance source with excellent characteristics of accuracy, stability, temperature coefficient, and power coefficient. All these features serve to make it a laboratory resistance standard, exceeded in performance only by stand-alone standard resistors.

Hermetically sealed wirewound resistors are used for 1  $\Omega$  steps and over. These resistors are carefully conditioned under power and temperature in order to develop the best stability characteristics. Actual experience has shown them to exhibit a storage stability of better than 5 ppm/year, improving as they age. The low-resistance resistors are constructed with resistance wire with a minimum of copper resistance in series to limit temperature coefficient effects.

The unit has a fixed minimum resistance of 10 m $\Omega$ . This is implemented by mechanically limiting the 10 m $\Omega$  decade from going below the “1” position. In this manner, no zero resistance subtractions have to be made, and the accuracy given is for the absolute reading.

The HARS-LX series employs completely enclosed dust-tight very low contact resistance switches. They feature solid silver alloy contacts and quadruple-leaf silver alloy wipers which keep switch contact

resistance to under 1 m $\Omega$  per decade, and more importantly, keep switch contact resistance *reproducible*, insuring repeatable instrument performance.

High quality gold plated tellurium copper binding posts 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 contribute to thermal emf problems.

The HARS-LX is designed to allow very convenient maintenance of calibration over time. Most decades are calibratable without changing components or soldering resistors. The decades for the 100  $\Omega$  through 100 k $\Omega$  steps are calibrated with convenient trimmers. Trimming of the lower decades is also possible.

With a resolution as low as 1 m $\Omega$  and a maximum available resistance of over 12.2 M $\Omega$ , the HARS-LX Series may be employed for exacting precision measurement applications requiring high accuracy and stability. They can be used as components of dc and low frequency ac bridges, for calibration, as transfer standards, and as RTD simulators.



**Figure 1-1: HARS-LX Laboratory Standard Decade Resistance Substituter**

## Chapter 2

# SPECIFICATIONS

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

### Resistor Type:

Resistance wire for 0.1  $\Omega$  steps and under; hermetically sealed, low inductance wirewound, for 1  $\Omega$  steps and over;

### Minimum Resistance:

10 m $\Omega$   $\pm$  0.5 m $\Omega$ ; limited by the lowest settable position, "1", of the 10 m $\Omega$ /step decade.

### Range

See Model information on next page.

### Resolution

See Model information on next page.

### Accuracy:

$\pm(20 \text{ ppm} + 0.5 \text{ m}\Omega)$ ; at 23°C, 4-terminal "true-ohm" measurement, 30-70% RH, absolute reading, **no zero subtraction required**, SI traceable.

### Stability:

$<\pm(20 \text{ ppm} + 0.5 \text{ m}\Omega)/\text{year}$ ;  
 $<\pm 5 \text{ ppm}/\text{year}$ , typical.

### Max Power:

1 W/step up to 5 W total, or 2 A, or 1500 V, whichever applies first.

### Resistance Repeatability:

Better than 100  $\mu\Omega$ , short term, average value.

### Leakage Resistance:

$>10^{10} \Omega$ .

### Resistance Temperature Coefficient:

$<\pm 20 \text{ ppm}/^\circ\text{C}$  for 1  $\Omega$  steps and under;  
 $<\pm 15 \text{ ppm}/^\circ\text{C}$  for 10  $\Omega$  steps;  
 $<\pm 3 \text{ ppm}/^\circ\text{C}$  for 100  $\Omega$  steps and over;  
 $<+50 \mu\Omega/^\circ\text{C}$  for wiring and switch resistance.

### Resistance Power Coefficient:

$<\pm 1 \text{ ppm}/\text{mW}$  for 0.1  $\Omega$  steps and under;  
 $<\pm 0.4 \text{ ppm}/\text{mW}$  for 1  $\Omega$  steps;  
 $<\pm 0.3 \text{ ppm}/\text{mW}$  for 10  $\Omega$  steps;  
 $<\pm 0.1 \text{ ppm}/\text{mW}$  for 100  $\Omega$  steps and over;  
 $<+50 \mu\Omega/\text{W}$  total for wiring and switch resistance.

### Breakdown Voltage:

1500 V peak to case.

### Operating Temperature:

0°C to 55°C.

### Storage Temperature:

-40°C to 70°C.

### Switch Type:

11 position "0"- "10" (12 position, "0"- "11" for highest decade); multiple solid silver contacts; dust tight diallyl-phthalate body. To allow continuous rotation, a blank position is added on most decades.

### Terminals:

Four, 5-way, gold-plated, tellurium-copper binding posts with low thermal emf and low resistance, for four terminal Kelvin measurements, plus one binding post connected to the case for shielding. Rear outputs are available as an option.

### Dimensions:

Rack model: 48.3 cm W x 17.8 cm H x 19.7 cm D (19.0" x 7.0" x 7.75")

### Weight:

5.1 kg (13 lb)

## MODEL INFORMATION

Model	Total Resistance ( $\Omega$ )	No. of Decades	Resolution ( $\Omega$ )
HARS-LX-1-0.001	0.01	1	0.001
HARS-LX-1-0.01	0.1	1	0.01
HARS-LX-1-0.1	1	1	0.1
HARS-LX-1-1	10	1	1
HARS-LX-1-10	100	1	10
HARS-LX-1-100	1 k	1	100
HARS-LX-1-1K	10 k	1	1 k
HARS-LX-1-10K	100 k	1	10 k
HARS-LX-1-100K	1 M	1	100 k
HARS-LX-1-1M	10 M	1	1 M
HARS-LX-2-0.001	0.11	2	0.001
HARS-LX-2-0.01	1.1	2	0.01
HARS-LX-2-0.1	11	2	0.1
HARS-LX-2-1	110	2	1
HARS-LX-2-10	1.1 k	2	10
HARS-LX-2-100	11 k	2	100
HARS-LX-2-1K	110 k	2	1 k
HARS-LX-2-10K	1.1 M $\Omega$	2	10 k
HARS-LX-2-100K	11 M $\Omega$	2	100 k
HARS-LX-3-0.001	1.11	3	0.001
HARS-LX-3-0.01	11.1	3	0.01
HARS-LX-3-0.1	111	3	0.1
HARS-LX-3-1	1.11 k	3	1
HARS-LX-3-10	11.1 k	3	10
HARS-LX-3-100	111 k	3	100
HARS-LX-3-1K	1.11 M	3	1 k
HARS-LX-3-10K	11.1 M	3	10 k

Model			
HARS-LX-4-0.001	11.11	4	0.001
HARS-LX-4-0.01	111.1	4	0.01
HARS-LX-4-0.1	1.111 k	4	0.1
HARS-LX-4-1	11.11 k	4	1
HARS-LX-4-10	111.1 k	4	10
HARS-LX-4-100	1.111 M	4	100
HARS-LX-4-1K	11.11 M	4	1 k
HARS-LX-5-0.001	111.11	5	0.001
HARS-LX-5-0.01	1.111 1 k	5	0.01
HARS-LX-5-0.1	11.111 k	5	0.1
HARS-LX-5-1	111.11 k	5	1
HARS-LX-5-10	1.111 1 M	5	10
HARS-LX-5-100	11.111 M	5	100
HARS-LX-6-0.001	1.111 11 k	6	0.001
HARS-LX-6-0.01	11.1111 k	6	0.01
HARS-LX-6-0.1	11.111 k	6	0.1
HARS-LX-6-1	1.111 11 M	6	1
HARS-LX-6-10	11.111 1 M	6	10
HARS-LX-7-0.001	11.111 11 k	7	0.001
HARS-LX-7-0.01	111.111 1 k	7	0.01
HARS-LX-7-0.1	1.111 111 M	7	0.1
HARS-LX-7-1	11.111 11 M	7	1
HARS-LX-8-0.001	111.111 11 k	8	0.001
HARS-LX-8-0.01	1.211 111 1 M	8	0.01
HARS-LX-8-0.1	1.211 111 M	8	0.1
HARS-LX-9-0.001	1.211 111 11 M	9	0.001
HARS-LX-9-K-RM	1.211 111 11 M	9	0.001
HARS-LX-9-0.01	12.111 111 1 M	9	0.01
HARS-LX-10-0.001	12.11111111 M	10	0.001
HARS-LX-11-0.001	121.111 111 11 M	11	0.001

### OPTIONS:

- **RH** 10 m $\Omega$  rheostat for lowest decades, 20  $\mu\Omega$  resolution.
- **RO** Rear output binding posts
- **RM** Rack-mountable case for standard 19" rack

### HARS-LX SERIES OPERATING GUIDE

CONSULT INSTRUCTION MANUAL FOR PROPER INSTRUMENT OPERATION

<p><b>Resistor Type:</b> Resistance wire for 0.1 <math>\Omega</math> steps and under; hermetically sealed, wirewound, low inductance, for 1 <math>\Omega</math> through 100 k<math>\Omega</math> steps.</p>	<p><b>Stability:</b> <math>\leq \pm(20 \text{ ppm} + 0.5 \text{ m}\Omega)/\text{year}</math>.</p>
<p><b>Range and Resolution:</b> 10 m<math>\Omega</math> minimum to 1,211,111.11 <math>\Omega</math>, in 9 decades, with 10 m<math>\Omega</math> resolution.</p>	<p><b>Short-Term Resistance Repeatability:</b> Mean value of variation of total switch contact resistance: &lt;100 <math>\mu\Omega</math>.</p>
<p><b>Minimum Resistance:</b> 10 m<math>\Omega \pm 0.5 \text{ m}\Omega</math>; determined by lowest settable position, "1", of the 10 m<math>\Omega</math> per step switch.</p>	<p><b>Power Coefficient:</b> <math>\leq \pm 1 \text{ ppm/mW/step}</math> for 0.1 <math>\Omega</math> steps and under; <math>\leq \pm 0.4 \text{ ppm/mW/step}</math> for 1 <math>\Omega</math> steps; <math>\leq \pm 0.3 \text{ ppm/mW/step}</math> for 10 <math>\Omega</math> steps; <math>\leq \pm 0.1 \text{ ppm/mW/step}</math> for 100 <math>\Omega</math> to 100 k<math>\Omega</math> steps; <math>\leq +50 \mu\Omega/\text{W}</math> total for wiring and switch resistance.</p>
<p><b>Accuracy:</b> <math>\pm(20 \text{ ppm} + 0.5 \text{ m}\Omega)</math> at 23<math>^{\circ}\text{C}</math>, four-terminal- "true-ohm" measurement, 30%<math>\pm</math>70% RH, absolute reading; <b>no zero subtraction</b> required, SI traceable.</p>	<p><b>Breakdown Voltage:</b> 1500 V peak to case.</p>
<p><b>Resistance Temperature Coefficient:</b> <math>\leq \pm 20 \text{ ppm}/^{\circ}\text{C}</math> for 0.1 <math>\Omega</math> steps; <math>\leq \pm 10 \text{ ppm}/^{\circ}\text{C}</math> for 1 <math>\Omega</math> and 10 <math>\Omega</math> steps; <math>\leq \pm 3 \text{ ppm}/^{\circ}\text{C}</math> for 100 <math>\Omega</math> to 100 k<math>\Omega</math> steps; <math>\leq +50 \mu\Omega/^{\circ}\text{C}</math> for wiring and switch resistance, to be considered wherever significant.</p>	<p><b>Switch Type:</b> 11 position, 0-10 (12 position, 0-11 for 100 k<math>\Omega</math> decade); multiple solid silver contacts; dust tight diallyl phthalate body. To allow continuous rotation, a blank position is added on most decades.</p>
<p><b>Maximum Power:</b> 1 W per step up to 5 W total, or 2 A max, whichever applies first.</p>	<p><b>Switch Operation:</b> Whenever the unit has been idle, turn each switch 7-10 times both ways before using. This switch "break-in" procedure is standard metrology practice required for best accuracy. It removes any silver oxide film on the contact surfaces.</p>

**MODEL:** HARS-LX-9-0.001    **SN:** D3-0913280

**WARNING**  
Observe all safety rules when working with high voltages or line voltages. Connect the (GND) 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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HARS-LX-9-0.001-12-98

Figure 2-1: Typical Operating Guide Affixed to Unit

## Chapter 3 Installation

### 3.1 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.

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 in 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 there is no required installation.

Since this is a high accuracy instrument, it is recommended that a space be provided that would not expose it to mechanical abuse and keep it maintained at laboratory standard temperatures near 23°C.

### 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 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.

### 4.2 Connection

#### 4.2.1 General Considerations

Four insulated low-thermal-emf binding posts labeled **CRNT HI**, **CRNT LO**, **SENSE HI**, and **SENSE LO** provide two current and two potential terminals, respectively, for 4-terminal measurement. 2-terminal measurements may be made by shorting **CRNT HI** to **SENSE HI**, and **CRNT LO** to **SENSE LO**, preferably with shorting links or other substantial means. The four terminal connection is important of course for low resistances.

A fifth metal binding post labeled **GND** (Ground) is connected to the case and may be used as a guard or shield terminal. It may also be connected using the shorting link to either terminal to implement a 2-terminal as opposed to a 3-terminal measurement.

### 4.3 Electrical Considerations

In order to make proper use of the full performance capabilities of the HARS-LX unit, especially if low resistance or low resistance increments are important, care must be taken in connecting to the terminals of the decade box.

In particular, to keep contact resistance to a minimum, 4-terminal connections should be employed, and the most substantial and secure connection to the binding posts should be made. 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 not considered significant for the task being performed.

#### 4.3.1 Thermal emf Considerations

The highest quality low emf components are used in the HARS-LX Series. In particular, the terminals are made of gold plated tellurium copper, which exhibits low emf and low resistance. There nevertheless may be some minute thermal emf generated at the user's test leads where they contact the HARS-LX banana jacks. This will depend on the test lead material. Whenever this is critical, brass and iron materials should be avoided.

This emf will not manifest itself if an ac measurement instrument is employed. It will also be eliminated if a meter with so called "True Ohm" capability is used. Otherwise it may appear as a false component of the dc resistance measurement, and can be the order of milliohms.



### 4.8 Meter Shunt Applications

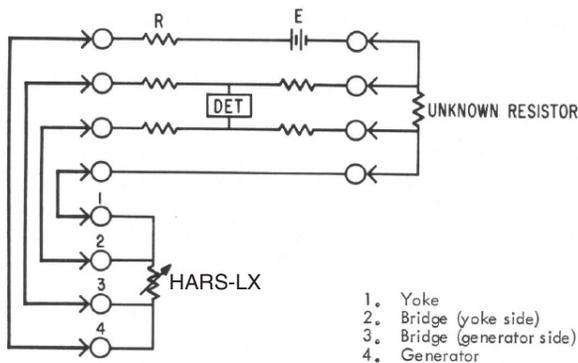
To measure the current in a 4-terminal resistor:

1. Measure the voltage drop between the two terminals of the resistor not connected to the current source.
2. Determine the current by the ratio of the measured voltage to the known resistance.

Using the 4-terminal technique helps avoid errors caused by the voltage drops in the current-carrying leads and contacts. Errors caused by lead and contact resistances in the voltage measuring circuit are negligible if the current in this circuit is small.

### 4.9 Kelvin Bridge Applications

Use 4-terminal resistance standard for all Kelvin bridge measurements. When connected as shown in Figure 4-1, errors caused by lead and contact resistances can be made negligible because they appear as part of the generator or yoke resistance, or in series with high resistance bridge arms.



**Figure 4-1: Kelvin Bridge Connections**

For maximum protection and accuracy, limit power input to HARS-LX to 1Watt. This may be accomplished by placing a resistor in series with the bridge generator or battery.

The value of this resistance can be calculated from the following formula:

$$R = \frac{E^2}{4}$$

where:

- R = value of the power-limiting resistor
- E = open circuit voltage of the generator

The protective resistor should have a power rating of 4 W or more. Input power should be limited to 1/10 W or less for most accurate measurements.

# Chapter 5

## MAINTENANCE

### 5.1 Maintainability and Reliability

It is possible to maintain Model HARS-LX indefinitely. It is reliable due to its closed design and sealed switches and resistors. It is possible to adjust the unit, if necessary, because it has 6 trimmable decades. The unit is resistant to electromagnetic interference (EMI) because of its metal enclosure.

### 5.2 Preventive Maintenance

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

The Model HARS-LX is packaged in a closed case and uses completely sealed switches. This limits the entry of contaminants and dust to the inside of the switches. If it is maintained in a clean or air-conditioned environment, cleaning will seldom be required.

Should cleaning be needed:

1. Remove the 4 housing screws from the side of the instrument, and remove the housing.
2. Remove any dust or debris using optical grade dry compressed air or a clean brush.
3. Replace the housing and reattach the 4 housing screws.

The front panel should be periodically 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.

### 5.3 Calibration

The Model HARS-LX may be employed as a stand-alone instrument or as an integral component of a system. If used as part of a system, it should be calibrated as part of the overall system to provide an optimum system calibration.

If the HARS-LX is employed as a stand alone device, the following should be observed:

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

#### 5.3.1 Calibration Interval

The recommended HARS-LX 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 in the deviations of any individual resistors.

### 5.3.2 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 HARS-LX 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 HARS-LX 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.

### 5.3.3 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 1 Ω, 10 Ω, 100 Ω, 1 kΩ, 10 kΩ, 100 kΩ, 1 MΩ, and 10 MΩ per step, calibrated to ±10 ppm. IET options include the following models:
  - HATS-LR
  - HATS-Y
  - SRL Series

The 1 Ω, and 10 Ω transfer standards are optional, and are only used to take advantage, if desired, of the trimmability of these two decades

- Precision resistance measurement bridge or multimeter, with a transfer accuracy of ±1 ppm. Options include:
  - Guildline Model 9975
  - Measurements International Model 6000A

- 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.

### 5.3.4 Calibration Procedure

To calibrate the HARS-LX unit, proceed as follows:

1. Set up the calibration equipment in the resistance measurement mode and exercise the switches 10 times in each direction.
2. Allow the switches to cool for 15 minutes.
3. Confirm the minimum resistance of the unit.

*Allow a confidence band for the uncertainty of the measuring instrument and setup.*

4. Determine the allowable upper and lower limits for each resistance setting of each decade based on the specified accuracy and the confidence band.

*For the HARS-LX series, the limits for any resistance “R” are:*

$$[R \pm (20 \times 10^{-6}R + 0.0005\Omega)].$$

5. Confirm that the resistances fall within these limits after subtraction of the zero resistance.
6. If any resistances fall outside these limits, the associated switch assembly may require service or replacement.

## 5.4 Adjustments

If one or more resistances fall outside the limits, the associated resistor should be trimmed. This applies for 1  $\Omega$  steps and over. There is a trimming network provided for each resistance in these ranges. These may be accessed by removing the housing and accessing the particular decade PC board.

If the minimum 10 m $\Omega$  needs to be adjusted, consult IET Labs. For other resistors, adjust the resistors from lowest to highest. The order of decades does not matter.

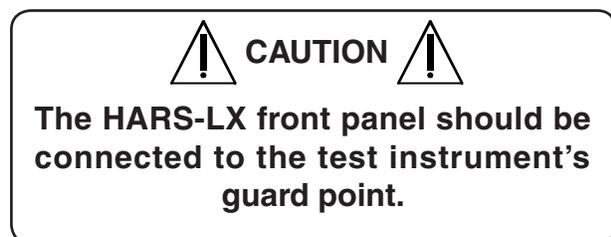
Whereas it is possible to adjust any one resistance step, note that the  $n^{\text{th}}$  step of a decade is the sum of resistances 1 through  $n$ , so that errors are cumulative. It is therefore recommended that whenever any resistance of a particular decade is trimmed, that all the resistances of that decade be tested and trimmed as required.

To adjust any of the resistances, the following should be observed:

- Trimming considerations
- Trimming procedure

### 5.4.1 Trimming Considerations

Before trimming any resistances, observe the following:

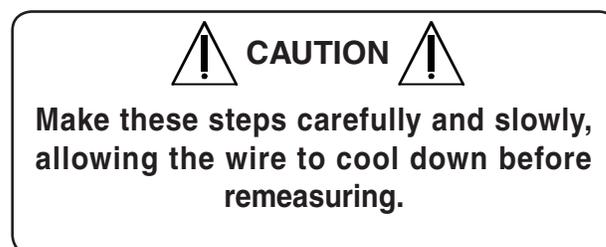


The equipment measuring the unit should conform to the guidelines provided in Section 5.3.

### 5.4.2 Trimming Procedure

To trim any resistances, **proceed as follows**:

1. Stabilize HARS-LX at laboratory temperature of 23 °C for at least 8 hours.
2. Remove the 4 housing screws from the sides of the instrument and remove the housing.
3. Using the binding posts in the 4-terminal connection, connect HARS-LX to a resistance meter.
4. Rotate all knobs approximately 10 times.  
*Breaking in the switches helps eliminate any residual contact corrosion resistance.*
5. Set all dials to 0, except for the 10 m $\Omega$  decade.  
*10 m $\Omega$  decade has a minimum stop at position 1.*
6. Measure the 10 m $\Omega$  setting  
*If an adjustment is needed, consult IET technical support.*
7. Measure 1 m $\Omega$ , 10 m $\Omega$ , and 100 m $\Omega$  steps. If adjustment is needed, proceed as follows:
  - If the resistance is **high**, reduce it by adding a small bit of solder to an exposed portion of the wire
  - If the resistance is **low**, increase it by gently filing the wire in one spot.

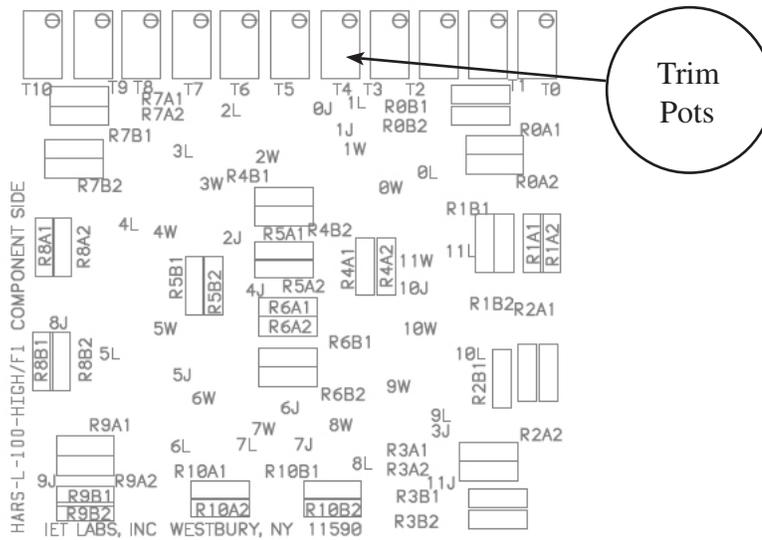


8. Measure the higher decades. If an adjustment is needed, proceed as follows:  
Starting with the lowest setting, adjust the associated trim pots.  
*See Table 5-1 and Figure 5-1 for reference*
9. Replace the housing and reinstall the 4 housing screws.

Switch Position	Potentiometer Designation*
1	T0 or T1
2	T1 or T2
3	T2 or T3
4	T3 or T4
5	T4 or T5
6	T5 or T6
7	T6 or T7
8	T7 or T8
9	T8 or T9
10	T9 or T10
11	T10 or T11 (100 k steps only)

\*Designation may vary for different decades

**Table 5-1: Trimming Potentiometers**



**Figure 5-1: Typical Trimmer Board**

5.5 Replaceable Parts 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-LX-4300-KNB	Knob Assembly
Not Shown	HARS-LX-3100	Foot
Not Shown	HARS-4000-LX-.001	1 mΩ/step Decade Switch Assembly
Not Shown	HARS-4000-LX-0.01	10 mΩ/step Decade Switch Assembly
Not Shown	HARS-4000-LX-0.1	100 mΩ/step Decade Switch Assembly
Not Shown	HARS-4000-LX-1	1 Ω/step Decade Switch Assembly
Not Shown	HARS-4000-LX-10	10 Ω/step Decade Switch Assembly
Not Shown	HARS-4000-LX-100	100 Ω/step Decade Switch Assembly
Not Shown	HARS-4000-LX-1k	1 kΩ/step Decade Switch Assembly
Not Shown	HARS-4000-LX-10k	10 kΩ/step Decade Switch Assembly
Not Shown	HARS-4000-LX-100k	100 kΩ/step Decade Switch Assembly
Not Shown	HARS-4000-LX-1M	1 MΩ/step Decade Switch Assembly
Not Shown	HARS-4000-LX-10M	10 MΩ/step Decade Switch Assembly

Table 5-2: Replaceable Parts List



Figure 5-2: HARS-LX Replaceable Parts

