♦ PRECISION INSTRUMENTS FOR TEST AND MEASUREMENT ♦

RS 925D

Resistance Standard

User and Service Manual

RS-925D im/Dec, 2008

IET LABS, INC.
formerly manufactured by
esi/Tegam

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IET Model RS-925D

This RS-925D is the IET Labs version of the original esi RS 925D Decade Resistance Standard.

The IET unit is updated and features a number of significant performance improvements. Among these are:

-Sealed resistors for better stability and imperviousness to moisture.

-Sealed switches for lower and more stable contact resistance.

-Improved stability and accuracy.

Please see the specifications on the label on the unit.for the relevant data. The data on the label is the operative data.

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.

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

TABLE OF CONTENTS

SECTION I

INTRODUCTION

1.1 DESCRIPTION

ESI Model RS 925D Resistance Standard is a wide-range, four-terminal decade resistor with four decades that can be trimmed to maintain high accuracy indefinitely. The use of trimmed decades, special ESI resistors, and multiple-contact low-resistance switches assures high accuracy and short-term accuracy of better than 2 parts per million.

1.2 SPECIFICATIONS

Resistance Range: 10^{-2} Ω to 1.2×10^{6} Ω

Resolution: 20 microhms

Accuracy after Adjustment of Trimmed Decades:

100 kΩ	±1.5 ppm
10 kΩ	±1.0 ppm
1 kΩ	±1.5 ppm
100 Ω	±2.0 ppm

Initial Accuracy of the Untrimmed Decades: ±(20 ppm + 0.001 Ω)

Stability after Adjustment: ±(20 ppm + 0.0005 Ω/year)

Short Term Resistance Reset Repeatability: Better than 100 μΩ

Calibration Conditions: 4-terminal measurement
23°C ±1°C. 30% to 70% R.H.

Temperature Coefficient:

100 Ω/step and higher	±3 ppm/°C
10 Ω/step	±15 ppm/°C
1 Ω/step and lower	±20 ppm/°C
Wiring and Switches	±50 μΩ/°C

Power Coefficient of Resistance:

100 Ω/step and higher	±0.1 ppm/mW/step
10 Ω/step	±0.3 ppm/mW/step
1 Ω/step	±0.4 ppm/mW/step
0.1 and 0.01 Ω/step	±1.0 ppm/mW/step
Wiring and Switches	+ 50 μΩ/W Total

Power Rating: 1.0 watt/step or 5.0 watts total, or 2.0 ampere maximum current.

Breakdown Voltage: 1500 V peak to case

Dimensions: Width 19 in. (48.25 cm), Height 7 in. (17.8 cm), Depth 8 in. (20.3 cm)

Weight: 14 lbs (6.4 kg)

SECTION II

OPERATION

2.1 RESISTANCE CONTROLS

The first knob on the left in the top row is used to change the four-terminal resistance in steps of 100 kilohms. The successive seven knobs are used to adjust the resistance in units down to 10 milliohms. The last knob in the bottom row varies a 10.5 milliohm potentiometer which is connected as a four-terminal variable resistor. The dial reading in the window above each knob is an in-line resistance reading.

Engraved above each window is the resistance per step of that decade. A decimal point is engraved on the panel to the left of the 0.1 ohm per step decade.

The minimum reading on the 0.01 ohm per step decade is 0.01 ohm, since this is the minimum internal resistance of the RS 925D. An effective zero reading may be obtained on the 0.01 ohm per step dial by reducing the setting of the 0.1 ohm per step dial one position and setting the 0.01 ohm per step dial at (TEN).

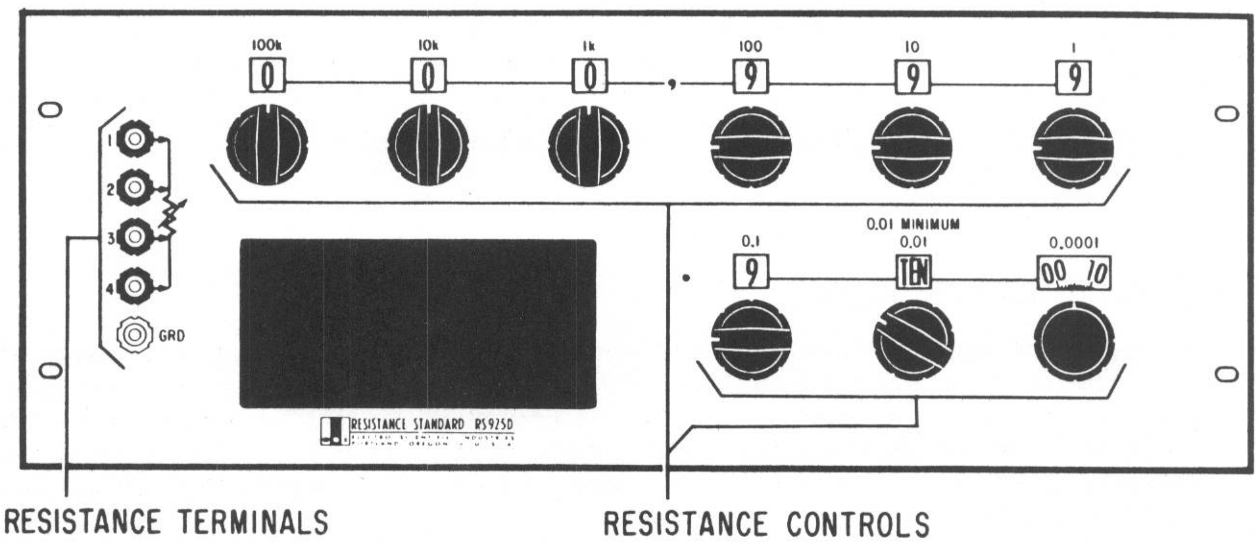


Figure 2-1. Model RS 925D Panel Controls

2.2 RESISTANCE TERMINALS

The terminals provided permit four-terminal connection to an external circuit. The ground terminal is provided for convenience.

ESI Model RS 925D is constructed so that it resembles electrically the diagram shown in Figure 2-2. Resistance R is varied by the front-panel controls from 0.01 ohm to more than 1.2 megohms. R3 and R4 are resistances of the connecting wiring; R1 and R2 include interpolation rheostat resistances which vary slightly with dial setting. The schematic diagram (Figure 4-1) shows the exact circuit of the interpolation rheostat, but it is sufficient to consider only how different settings affect the equivalent circuits R1 and R2 and R.

R changes directly with the setting of the rheostat, which is the desired condition. R2 varies through a range of 0.01 ohms in a predictable manner, but R1 represents contact resistance of the rheostats as well as other resistive effects. If thermoelectric or triboelectric voltages are present, they are most likely to appear at R1. For these reasons, it is advisable to connect R1 to a part of the circuit where lead resistance changes and small voltage effects will have little or no effect.

If current is passed from one of the four terminals to a terminal at the opposite end of the resistor R, and the voltage is measured between the remaining two terminals, the resistance of R is the ratio of the measured voltage to the current. Four-terminal resistors are normally used for meter shunt applications and as resistance standards for Kelvin bridge measurements.

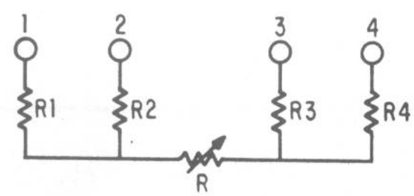


Figure 2-2. Four-Terminal Resistance

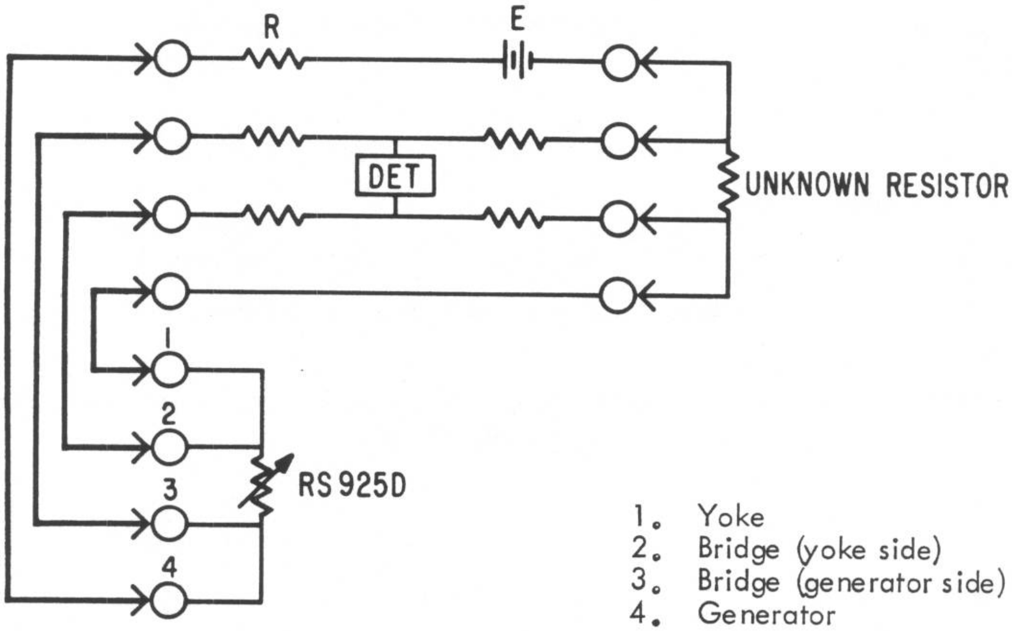
2.3.1 Meter Shunt Applications

To measure the current in a four-terminal resistor, the voltage drop is measured between the two terminals of the resistor not connected to the current source. The current is then determined by the ratio of the measured voltage to the known resistance. Use of the four-terminal technique avoids measuring errors caused by 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.

2.3.2 Kelvin Bridge Applications

A four-terminal resistance standard is used for all Kelvin bridge measurements. When connected as shown, 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.

For optimum performance with a Kelvin bridge, connect the Model RS 925D terminals as follows:



1. Yoke
2. Bridge (yoke side)
3. Bridge (generator side)
4. Generator

Figure 2-3. Kelvin Bridge Connections

For maximum protection and accuracy it is recommended that the available power to the Model RS 925D Resistance Standard be limited to ONE WATT. This is 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 is the value in ohms of the power limiting resistor

E is the open circuit voltage of the generator

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

SECTION III

CALIBRATION PROCEDURE

3.1 BASIC PROCEDURE

If the Model RS 925D Resistance Standard is part of a resistance measuring system such as ESI Model 242D Resistance Measuring System, it should be calibrated as part of the system rather than as a separate instrument. The combined adjustments of the system can be made more accurate than the adjustments of separate instruments.

The recommended procedure for calibrating the instrument as part of ESI Model 242D Resistance Measuring System is described in the instruction manual for that system. The recommended procedure for calibrating the Model RS 925D where it must be used separately is outlined as follows:

1. Calibrate 100-ohms-per-step, 1-kilohm-per-step, 10-kilohms-per-step, and 100-kilohms-per-step transfer standards.

2. Compare transfer standards to decades of Model RS 925D, using substitution methods with a Kelvin ratio bridge and adjust each step of each decade for correct resistance.

All steps in the following procedure assume the use of recommended test equipment. If any other equipment is used, the procedure should be modified appropriately.

3.2 EQUIPMENT REQUIREMENTS

1. Resistance Transfer Standards: 100 ohms, 1 kilohm, 10 kilohms, and 100 kilohms per step, calibrated to ±10 ppm. (ESI Models SR 1010 and SR 1050 or equivalent.)

2. Precision Resistance Measuring System: Transfer accuracy ±1 ppm. (ESI Models 242, 242A, 242C or 242D Precision Resistance Measurement System or equivalent.)

3.3 PRELIMINARY OPERATIONS

Calibrate the resistance transfer standards in order to find their errors. Record the deviation of each resistor in each transfer standard and calculate the cumulative deviation of the series-connected sets of resistors. (This procedure is described in the Instruction Manual for ESI Model SR 1010 Resistance Transfer Standard, SECTION IV.)

3.4 CALIBRATION PROCEDURE

Perform all steps in this procedure for each setting of the first four (100 kΩ through 100 Ω) decades of the instrument. (Control and setting nomenclature refer specifically to the recommended equipment.)

1. Set Generator Detector controls as follows:

OUTPUT: OFF

POWER LIMIT: 100

Decade to be Calibrated	GENERATOR RANGE	DETECTOR RANGE
100 Ω	1 kΩ	30 MICROVOLTS
1 kΩ	1 kΩ	100 MICROVOLTS
10 kΩ	10 kΩ	300 MICROVOLTS
100 kΩ	10 kΩ	100 MICROVOLTS

2. Set Kelvin Ratio Bridge controls to read "1 x STANDARD + 1 ppm x ..."

NOTE: Perform steps 3 through 9 for each of the 41 dial settings of the instrument to be calibrated.

3. Connect the appropriate transfer standard to the UNKNOWN terminals of the bridge using four-terminal connection as illustrated in Figure 3-1. Start with two resistors of the 100-ohms-per-step standard, then proceed to three resistors in series and so forth to eleven resistors. Then do likewise with the 1-kilohm-per-step transfer standard, the 10-kilohms-per-step and the 100-kilohms-per-step transfer standards. (See Table 3-1.)

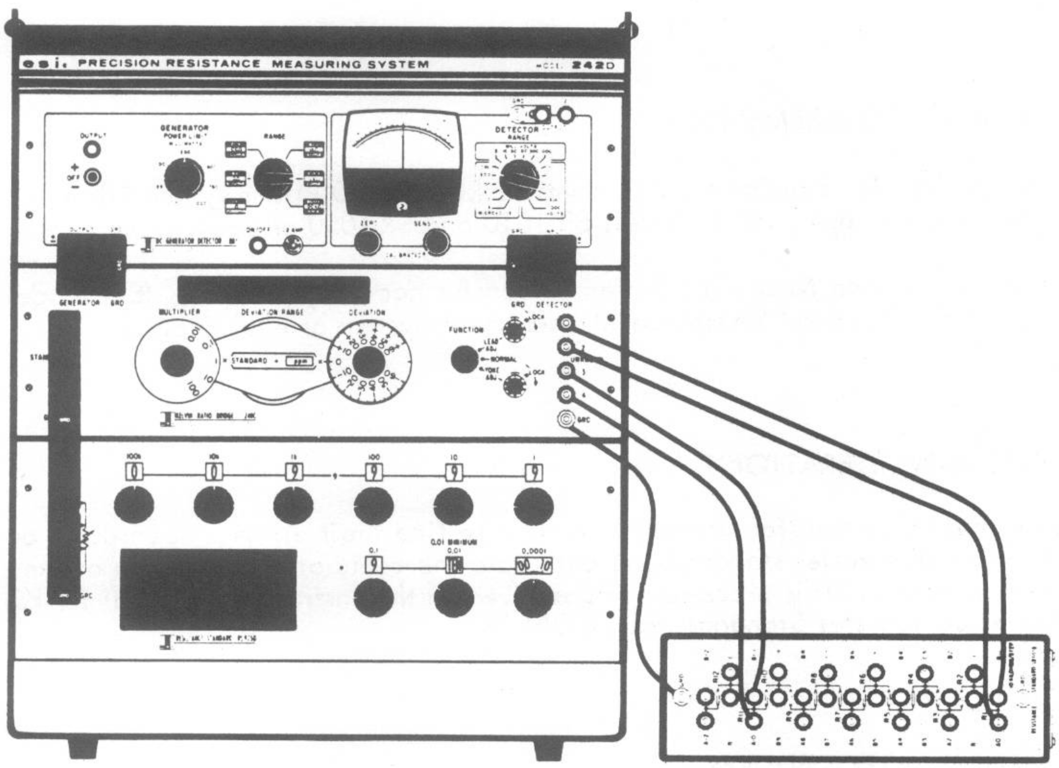


Figure 3-1. Transfer Standard Connection

4. Set the DEVIATION dial of the Kelvin Ratio Bridge to the cumulative deviation of the resistors connected to the bridge. (This is the cumulative deviation that was determined in Section 3.3.)

5. Set the resistance standard of the measurement system to the nominal value of the transfer standard connected.

6. Adjust the ZERO control of the detector for null while the generator is still off.

7. Set the GENERATOR OUTPUT switch to + .

8. Adjust the resistance standard of the measurement system for detector null. Do not adjust DEVIATION control.

9. Set the GENERATOR OUTPUT to OFF and record resistance standard setting.

10. Disconnect the transfer standard from the measurement system and connect the instrument to be calibrated to the UNKNOWN terminals of the bridge.

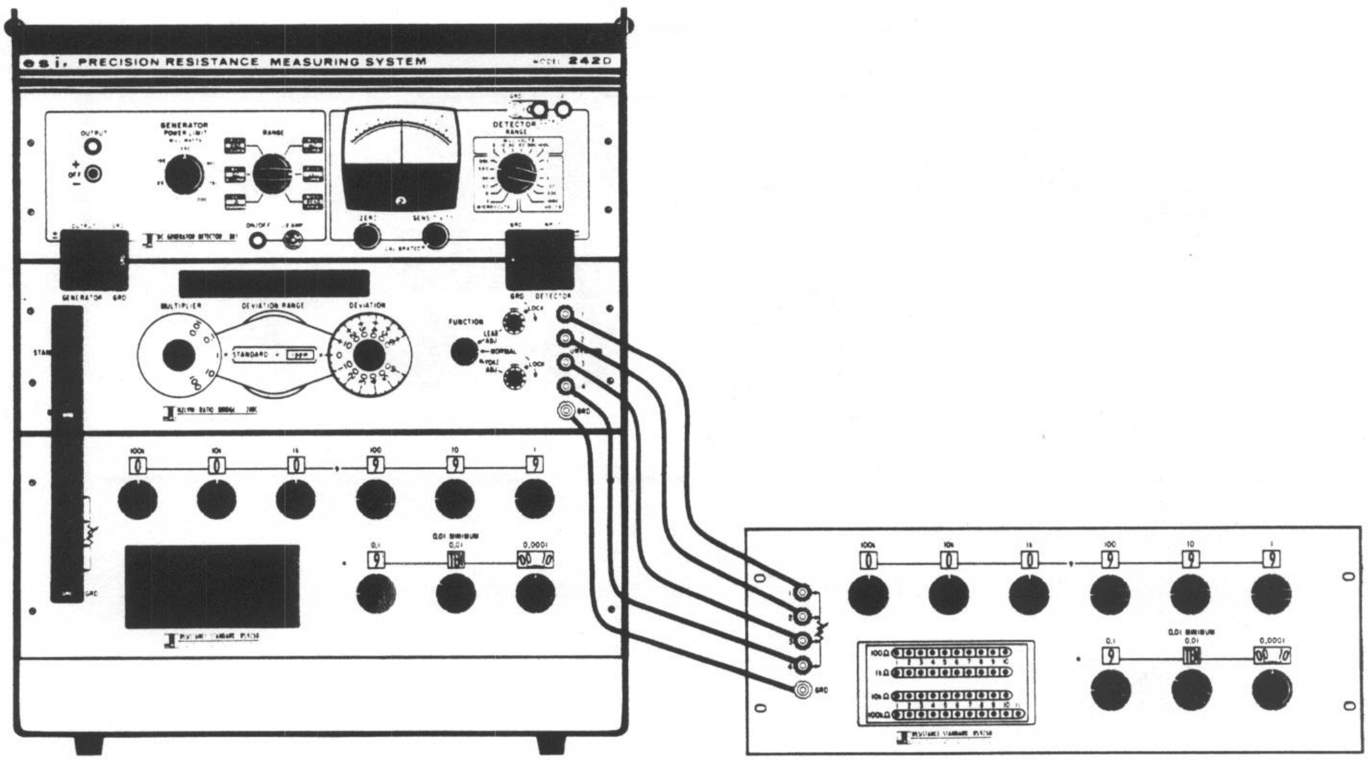


Figure 3-2. Test Instrument Connection

11. Set the controls of the instrument to be calibrated as follows:

    Set all decades to the left of the decade to be calibrated to 0. Set all decades to the right of the decade to be calibrated to 9. Set the rheostat to 100.

12. Set DEVIATION dial of Kelvin Ratio Bridge to 0.

13. Set the resistance standard of the measurement system to the setting recorded for that resistance in step 9.

14. Adjust the ZERO control of detector for null while the generator is still off.

15. Set the GENERATOR OUTPUT switch to + .

16. Adjust the trimmer that corresponds to the setting of the decade being calibrated. See Figure 3-3 and Table 3-1.

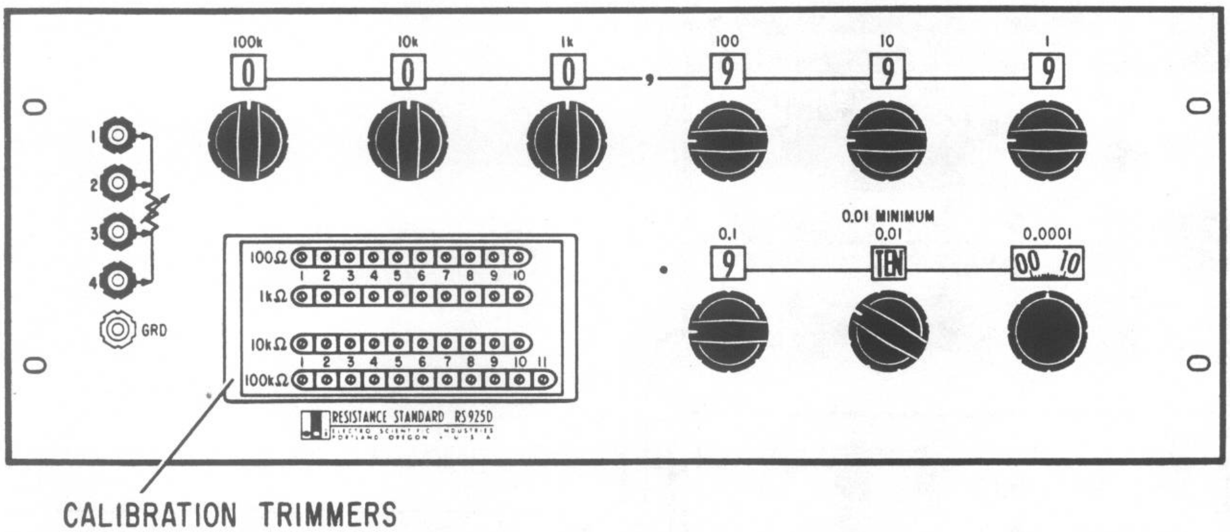


Figure 3-3. Trimmer Locations

Test Instrument Dial Setting	Transfer Standard Value per Step	Transfer Standard Number of Resistors	Trimmer Row	Trimmer Number
000199.9999	100 Ω	2	100 Ω	1
000299.9999		3		2
000399.9999		4		3
000499.9999		5		4
000599.9999		6		5
000699.9999		7		6
000799.9999		8		7
000899.9999		9		8
000999.9999		10		9
000 TEN 99.9999		11		10
001999.9999	1 kΩ	2	1 kΩ	1
002999.9999		3		2
003999.9999		4		3
004999.9999		5		4
005999.9999		6		5
006999.9999		7		6
007999.9999		8		7
008999.9999		9		8
009999.9999		10		9
00 TEN 999.9999		11		10
019999.9999	10 kΩ	2	10 kΩ	1
029999.9999		3		2
039999.9999		4		3
049999.9999		5		4
059999.9999		6		5
069999.9999		7		6
079999.9999		8		7
089999.9999		9		8
099999.9999		10		9
0 TEN 9999.9999		11		10
199999.9999	100 kΩ	2	100 kΩ	1
299999.9999		3		2
399999.9999		4		3
499999.9999		5		4
599999.9999		6		5
699999.9999		7		6
799999.9999		8		7
899999.9999		9		8
999999.9999		10		9
1099999.9999		11		10
1199999.9999		12		11

Table 3-1

SECTION IV

PERIODIC MAINTENANCE

The following procedures should be performed approximately once a year to insure maximum accuracy and reliability from the ESI Model RS 925D Resistance Standard.

If the need for major repairs is apparent, it is recommended that the unit be sent to the factory for service. The service department will be happy to furnish the necessary information and replacement parts for minor repairs. Unauthorized repairs, however, will invalidate the instrument warranty.

4.1 ACCESSING COMPONENTS

Prepare a soft, clean place to set the instrument. Be sure that no projections or pointed objects will be underneath it, and that there are no metal filings in the area.

To remove the instrument from the rack remove the four mounting screws on the front panel. Place it face down on the prepared surface, remove the 2 screws on the back of the instrument, and carefully slide the dust cover off.

4.2 VISUAL INSPECTION

Inspect the outside of the unit for dial orientation and damage to binding posts and binding post caps. Check for dirt around binding post insulators. Inspect the interior for loose or broken connections, damaged or dirty switch contacts, worn or dirty potentiometers and sliders, heat-damaged resistors, and resistors touching each other or the grounded switch structure.

4.3 CLEANING AND LUBRICATION

Clean the front panel with a soft, dry, lint-free cloth, being particularly careful to remove all dirt from around the binding post insulators.

The only internal component that may require cleaning and lubrication are the potentiometer and, occasionally, the switch decks. Clean and lubricate the potentiometer as follows:

CAUTION

Do not use solvents on the potentiometer. Solvents will leave a residue which may affect their performance.

1. Polish the contact surface lightly with an abrasive cloth (Crocus cloth or equivalent).

2. Remove loose particles by wiping with a nylon cloth.

3. Apply a moderate amount of pure petroleum jelly to the contact surface.

tamination by the dust cover. They should rarely, if ever, require maintenance. It is recommended that they be cleaned or lubricated *only* if they are not making good electrical contact. In such a case, proceed as follows:

1. Place instrument horizontally on bench, with a sheet of white paper under switch to be cleaned. Spray switch with Freon TF degreaser in aerosol can (Miller Stephenson Co. or equivalent) until no more residue appears on white paper. Drying is not necessary.

2. Lubricate with a low-conductivity oil (Viscosity Oil Co., No. 7069, available from ESI as Part No. 13500). Apply one drop to each rotor tab and one drop to the rotor ring contact using a hypodermic needle. With a small brush, apply a dab of petroleum jelly to each switch bearing and detent mechanism. DO NOT OVERLUBRICATE.

4.4 REPLACING THE DUST COVER

Be sure that the interior of the unit is completely clear of all foreign material.

Slip the dust cover over the unit, being careful not to touch any resistors, and replace the screws.

4.5 REPLACEMENT PARTS LIST

The following parts are listed alphabetically by description. All parts are available from Electro Scientific Industries, Inc.

The Federal Supply Code for Manufacturers (FSCM) for Electro Scientific Industries is 11837.

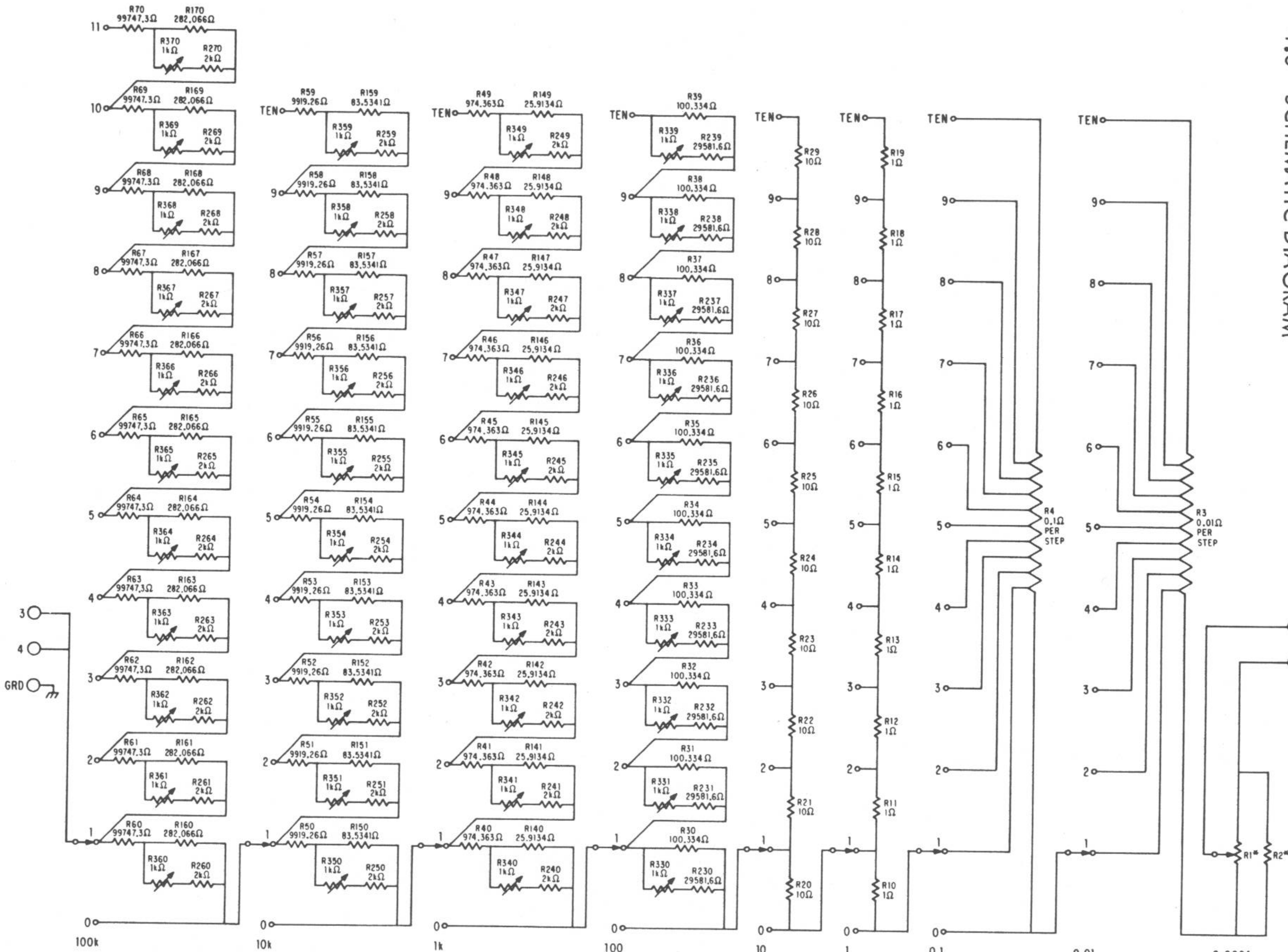
When ordering parts, please include the following information:

Model and serial number of the instrument
ESI part number
Description of part

DESCRIPTION	PART NO.	QTY USED
Cap, Binding Post, Black	1170	4
Cap, Binding Post, Gold	1172	1

Due to the requirement for critical adjustment of high-precision resistors *after* replacement, the Model RS 925D is considered non-repairable in the field. Any unauthorized field repair will void the warranty of the unit.

4.6 SCHEMATIC DIAGRAM



*VALUE SELECTED DURING MANUFACTURE

Figure 4-1. Model RS 925D Schematic Diagram