MODEL SR1050

RESISTANCE TRANSFER STANDARD

Instruction Manual

PN# 6853
Publication Date: SEPTEMBER 2004
REV. B

TEGAM INC.

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NOTE: This user's manual was as current as possible when this product was manufactured. However, products are constantly being updated and improved. Because of this, some differences may occur between the descriptions in this manual and the product received. Please refer to www.tegam.com for future updates of this manual.

TEGAM is a manufacturer of electronic test and measurement equipment for metrology, calibration, and production test. We also provide repair, calibration, and other support services for a wide variety of test and measurement equipment including RF power sensor calibration systems, RF attenuation measurement systems, resistance standards, ratio transformers, arbitrary waveform generators, micro-ohmmeters, LCR meters, handheld temperature calibrators, thermometers, humidity and temperature control devices, and more.

TEGAM also repairs and calibrates test and measurement equipment formerly manufactured by Electro-Scientific Industries (ESI), Gertsch, Keithley Instruments, Lucas Weinschel, and Pragmatic Instruments. A complete list can be viewed on our Product Service Directory at www.tegam.com

For more information about TEGAM and our products, please visit our website at www.tegam.com: or contact one of our customer service representatives at sales@tegam.com or 800-666-1010.

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INTRODUCTION

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1.1 Instrument Description

Precision transfer measurements up to 110 megohms relative to a single 10 kilohm resistance standard can be obtained with the SR 1050 high value 1 megohm and 10 megohm resistance standards.

The SR 1050 utilizes a transfer technique that consists of switching resistance sections in parallel, series, or series-parallel sections. An outstanding design feature is a structure in which leakage resistance to ground appears only at the terminals in any resistor configuration. Therefore, leakage can be effectively eliminated in a three-terminal measurement. There are no solid insulation leakage paths to ground other than at the terminal points, regardless of the configuration into which the individual resistance steps may be switched. A unique and outstanding design characteristic of the TEGAM SR 1050 Resistance Transfer Standard obviates the need to support resistors from a common insulating sheet or from insulators mounted on a common conducting surface. Therefore, resistance accuracies cannot be degraded by leakage paths to ground at random points within the string.

Each active resistance step consists of three wire-wound elements connected in series, plus a fixed trimming element for obtaining precise final value adjustment. The reduced head concentration that results from distributing the dissipated power over three elements rather than in a single resistor improves the thermal characteristics of an already low-temperature-coefficient resistance element.

The SR 1050 will also function as a voltage divider. In this mode, the only solid insulation leakage paths to ground are from the three terminals. These leakages will range between 10^{13} and 10^{16} ohms, except under the most adverse environmental conditions.

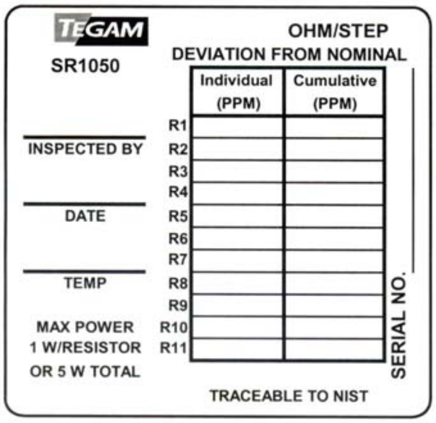
1.2 SPECIFICATIONS

Resistance Values:	1 megohm and 10 megohms per step.
Transfer Accuracy:	Limited only by short-term repeatability of resistance values. Typical repeatability ±2 ppm.
Calibration Accuracy:	10 ppm for 1 megohm and 15 ppm for 10 megohm steps.
Initial Accuracy (including calibration accuracy allowance):	±25 ppm, matched within 10 ppm, for 1 megohm steps, ±30 ppm, matched within 10 ppm, for 10 megohm steps.
Long Term Accuracy:	±50 ppm of nominal value guaranteed for 1 year, typically maintained for life of instrument.
Calibration Conditions:	23°C, 50% relative humidity, three-terminal measurement.
Temperature Coefficient of Resistors:	±5 ppm/°C, matched within 5 ppm/°C.
Power Coefficient for Typical Measurement Duty Cycle:	±0.05 ppm/mW per resistor
Power Rating:	1 W/step, or 5W distributed over 10 steps, or maximum applied voltage of 2.5kV where this value does not result in power in excess of 1W per resistor.
Breakdown Voltage:	5kV peak between active terminals and case.
Leakage Resistance:	Greater than 10^{13} Ω from terminals to case.
Calibration Data:	Initial calibration readings are affixed to instrument.
Dimensions:	Width 17 in. (43.2 cm), height 6.4 in. (16.25 cm), depth 5.6 in. (14.2 cm).
Weight:	8.5 lb. (3.4 kg).

2.1 Using the Calibration Chart

The calibration chart on the end of the enclosure for each SR1050 gives resistance calibration data for individual resistors and groups of resistors in the SR1050, in terms of their deviation from nominal value, expressed in parts per million.

A sample calibration chart is shown in Figure 2-1.



SR1050

OHM/STEP
DEVIATION FROM NOMINAL

	Individual (PPM)	Cumulative (PPM)
R1		
R2		
R3		
R4		
R5		
R6		
R7		
R8		
R9		
R10		
R11		

INSPECTED BY

DATE

TEMP

MAX POWER
1 W/RESISTOR
OR 5 W TOTAL

SERIAL NO.

TRACEABLE TO NIST

Figure 2-1 Calibration Chart

The first column gives the measured deviation of each resistor from its nominal value. The second column gives the cumulative average of the deviation figures in the first column, rounded to the same number of significant figures as the first column. For example, to the right of R_7, the figure in the first column is the measured deviation of R_7 from the nominal, while the figure in the second column is the calculated average deviation of resistors R_1 through R_7.

The cumulative average deviation in the second column calibrates any series, parallel, or series-parallel connection of the corresponding group of resistors in which the power divides equally among all the resistors in the group. For example, the first nine resistors in a 1-megohm-per-step box can be connected in series for a nominal value of 9 megohms, in parallel for 1/9 of a megohm, or in series-parallel for 1 megohm; the actual value of each of these three alternate connections will be exactly the same number of parts per million away from the nominal value for that connection. (See paragraph 3.4 for further details on transfer accuracy.)

The calibration chart data supplied initially with each SR1050 is traceable to the U.S. National Institute of Standards and Technology (NIST) with the specified accuracy under the stated laboratory environmental conditions.

2.2 HIGH-ACCURACY CALIBRATION TRANSFER

It is desirable to have as few standards that must be calibrated by national laboratories as possible. The best plan in the case of resistance is to have 1 ohm or 10 kilohm standard resistors for reference standards. One can then compare by ratio techniques the transfer standards to the reference standards.
The technique for transferring from 1 ohm to higher levels (such as 10 kilohms) is described in the Instruction Manual for Model SR 1010 Resistance Transfer Standard.

The technique is based on the fact that ten nominally equal resistors in series have ten times the resistances as one; ten resistors in parallel have one-tenth the resistance of one. Furthermore, the resistance deviation of either the series or parallel case is the same as the average deviation of the ten resistors. This is discussed in detail in Section 3.4.
The Model SR 1050 Transfer Standards can be used to transfer resistance from 10 kilohms to 100 megohms using only 1-to-1 comparisons as on a comparison bridge or other ratio technique. The procedure, briefly, is to set a 100 kilohm-per-step transfer standard (such as the Model SR 1010 or SR 1030) for one-tenth the step resistance (10 kilohms) and compare it to the standard resistor. This gives the average deviation of the ten 100 kilohm resistors. The next step is to set the 100 kilohm-per-step transfer standard for ten times the step resistance (1 megohm) and compare it to a 10 megohm-per-step transfer standard for ten times the step resistance (1 megohm) and compare it to a 10 megohm-per-step transfer standard that is set to one-tenth the step resistance (also 1 megohm). This gives the average deviation of the ten 1 megohm resistors, which can be set in series to be 100 megohms with the same deviation.

Figures 2-2 and 2-3 illustrate switch positions for one-tenth and ten times the nominal value of the transfer standard, in each case using the same resistors. Figure 2-4 illustrates method of switching to connect nine resistors in series-parallel to equal the nominal resistance of one step.

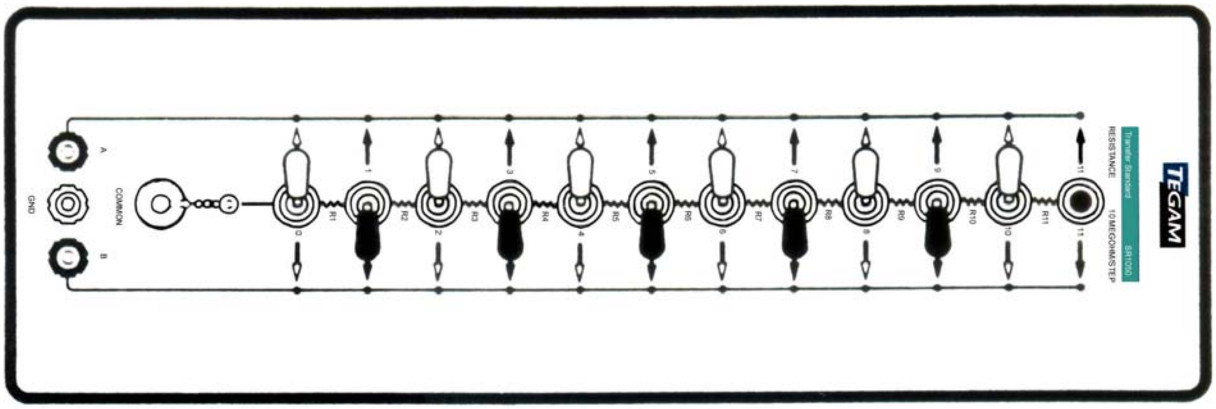


Figure 2-2 Switch Positions for One-Tenth Nominal Step Resistance

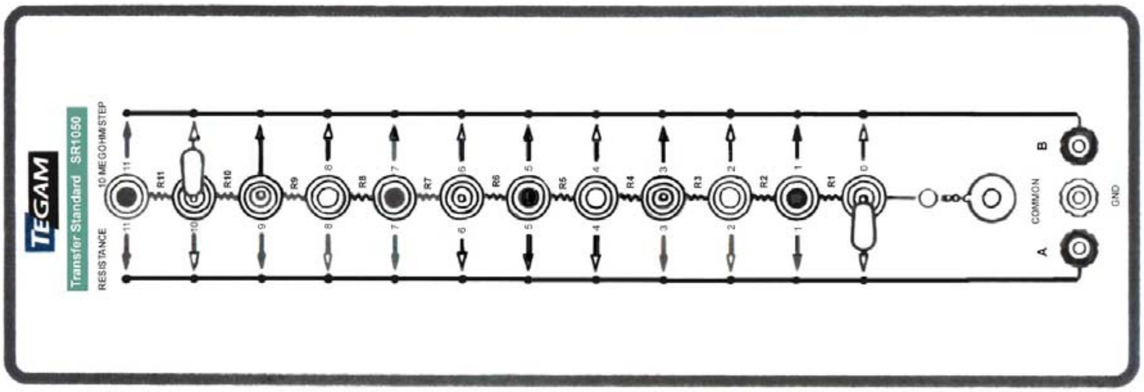


Figure 2-3 Switch Positions for Ten Times Nominal Step Resistance

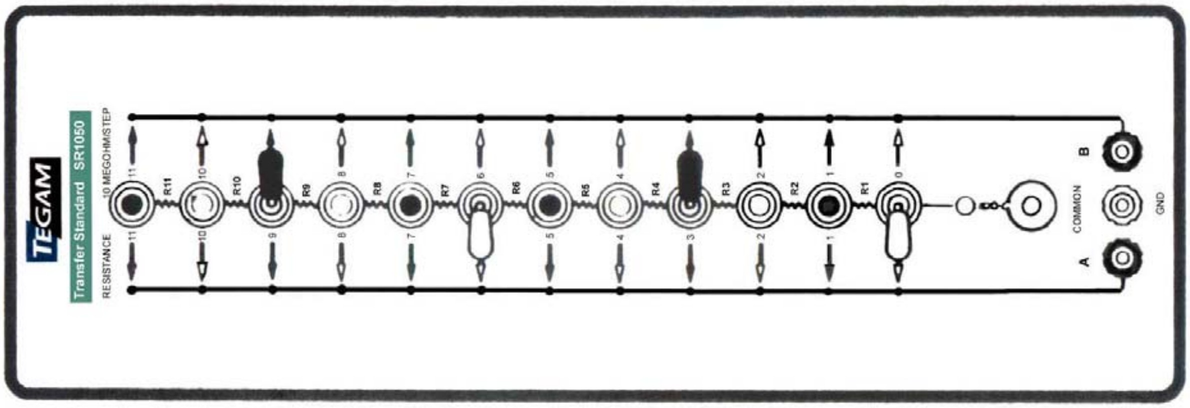


Figure 2-4 Switch Positions for Series-Parallel Connection Equal to Nominal Value of One Step

2.3 VOLTAGE DIVIDER OPERATION

The Model SR1050 Transfer Standard may be used as a voltage divider. A coaxial fitting, nominally capped, connects to one end of the resistor string, and may be used as either the high or low voltage end of the divider. If it is so used, one of the other terminals, A or B, forms the opposite end of the divider and the remaining terminal is the tap.

Figure 2-5 shows an example of the Model SR1050 Transfer Standard connected as a voltage divider.

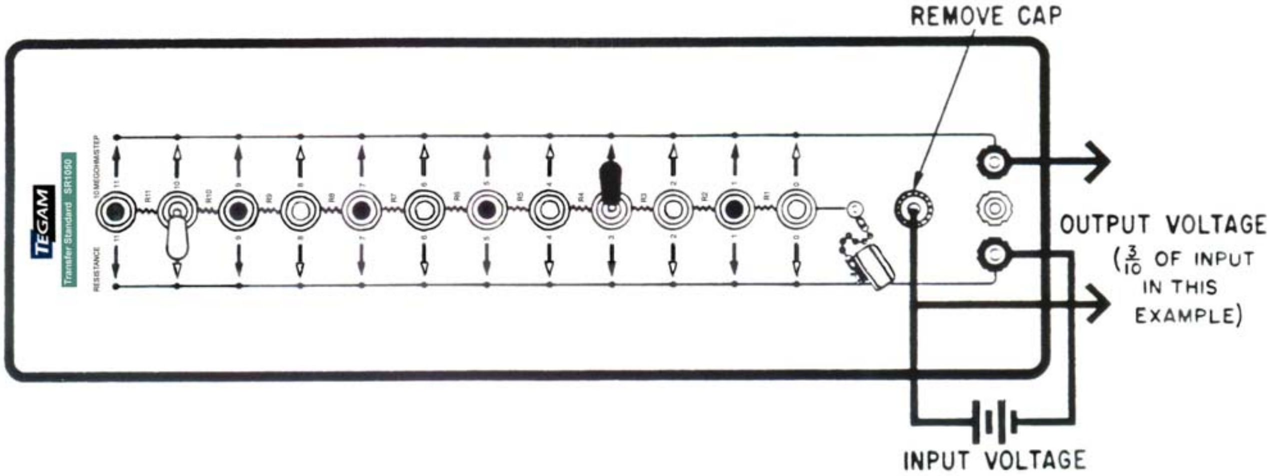


Figure 2-5 Voltage Divider Connections

3.1 THREE-TERMINAL RESISTANCE MEASUREMENTS OF SINGLE RESISTORS

When a resistor is mounted between two terminals on a terminal board made of insulating material, the leakage resistance of the board shunts the resistor. However, when the resistor is mounted between insulators on a metal terminal board (Figure 3-1), the leakage is all to the metal board. A three-terminal measurement using the metal board as the third terminal can give the true value of the resistor with no measureable effect from the leakage.

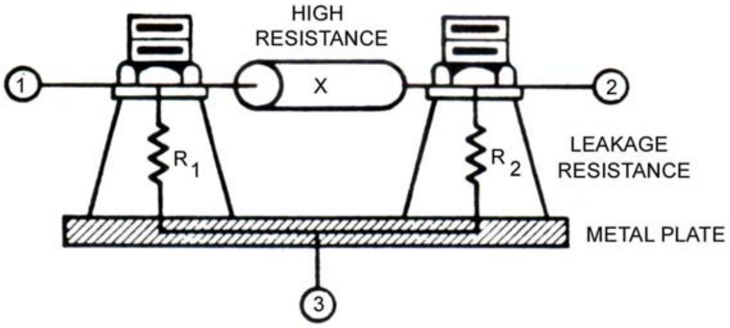


Figure 3-1 Three-Terminal Resistor

The third terminal (the case of mounting plate) is connected to a Wheatsone bridge as shown in Figure 3-2. Note that leakage resistance R_2 is now across the detector, and causes no error. R_2 is usually larger than the meter resistance and merely reduces the latter's sensitivity slightly.

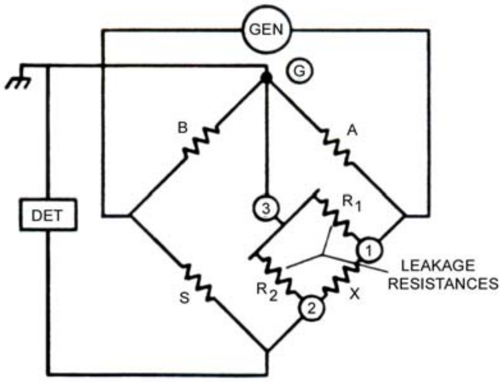


Figure 3-2 Three-Terminal Measurement Bridge

Leakage resistance R1 is across resistor A and does change its value slightly. With good insulation materials the resistance of R1 can be made so much higher than that of A that this change can be neglected. Thus, with the three-terminal connection, the resistor can be measured to high accuracy even though its resistance and the leakage resistances are of the same order of magnitude (as might be true on a humid day).

Figure 3-3 shows the method of making three-terminal connections when using the Kelvin bridge circuit. Here both the standard S and the unknown X can be connected as three-terminal resistors. When the resistances of X and S are high, the circuit on the right is a good approximation of the measurement condition. The leakage resistance R_2 R_3 are across relatively low-resistance bridge arms so that normal leakage values do not give measurement errors.

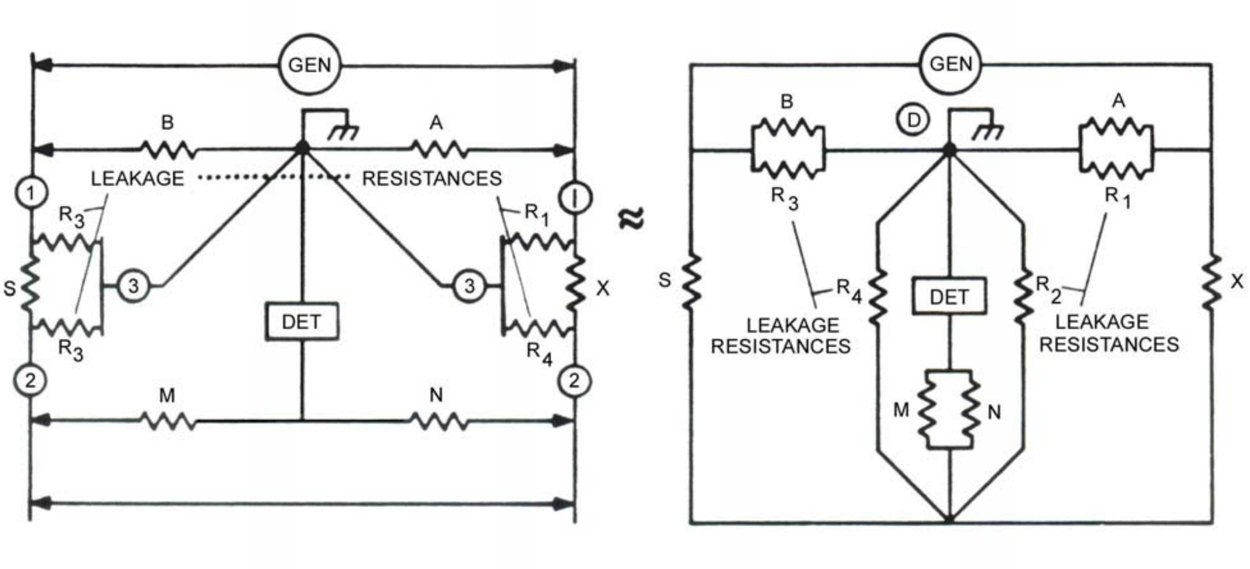


Figure 3-3 Kelvin Bridge Three-Terminal Connections

3.2 THREE-TERMINAL RESISTANCE MEASUREMENTS OF SERIES AND PARALLEL PARALLEL GROUPS OF RESISTORS

When resistors are connected in parallel, the shunting resistance of the insulators holding each resistor is the same value as the resistance shunting each resistor when it is measured individually. Thus the parallel value of the resistors is precisely related to the individual values of the resistors. The errors caused by leakage can be eliminated in the same manner as in measurement of a single resistor.

Resistors in series, however, have a more serious problem. If a set of resistors, each independently supported, is connected in series, the leakage of the insulators is shunted across different parts of the resistance string. Figure 3-4 illustrates such a series string of resistors. In this case, the resistance of the series string, measured with a bridge of any configuration, will be less than the sum of the resistances measured separately.

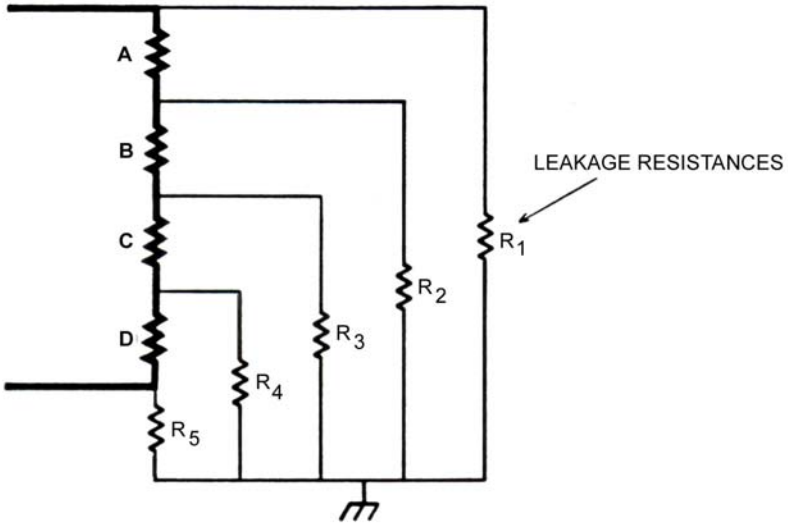


Figure 3-4 Leakage Resistances with Series Resistors

3.3 CONSTANT LEAKAGE

Such errors are eliminated in the Model SR1050 Transfer Standard by special construction. Controlled leakage construction is illustrated in Figure 3-5. The leakage resistance of the insulator that supports each resistor is shunted across each resistor. With this construction, the leakage resistance across each resistor is the same in all series and parallel connections and the same as when the resistor is measured individually. Since this is the case, the accuracy of the transfer of resistance from parallel to series connections is theoretically perfect.

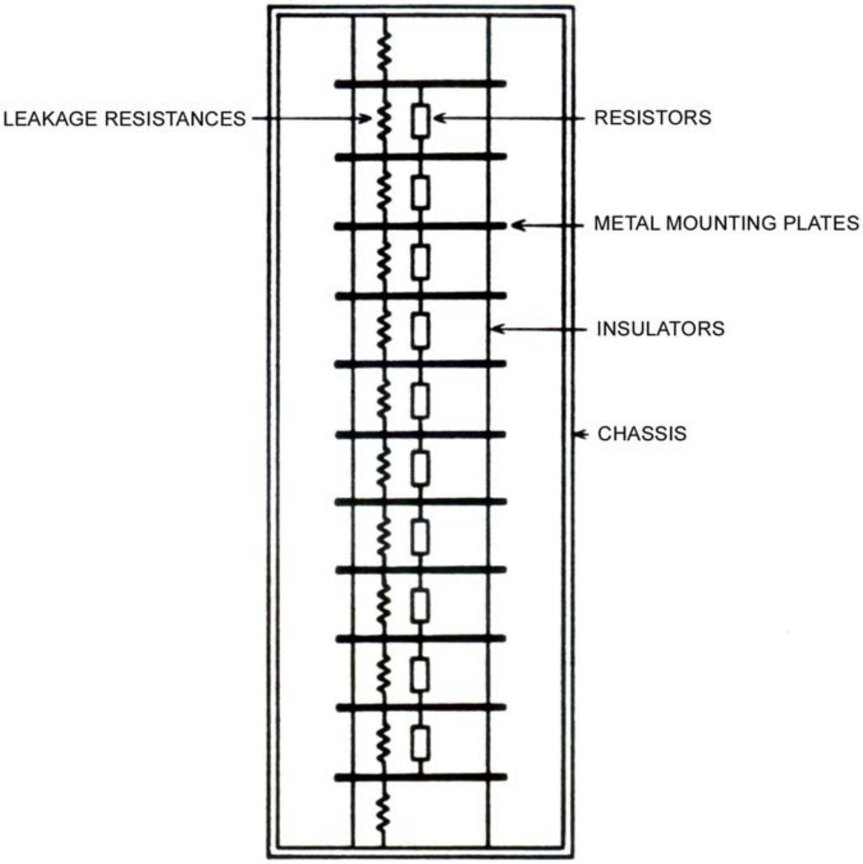


Figure 3-5 Constant Leakage Construction

It might be noted that the switches that connect the resistors in the Model SR1050 Transfer Standard allow no significant leakage since there is no mechanical connection, even though insulation, between the switched bus or the case and the resistor to be contacted unless the switch is operated. Such leakage that does occur is only between the switched bus and the instrument case. It is eliminated as a source of error in three-terminal measurements as described in Paragraph 3.1.

Figure 3-6 illustrates schematically the Model SR1050 Transfer Standard.

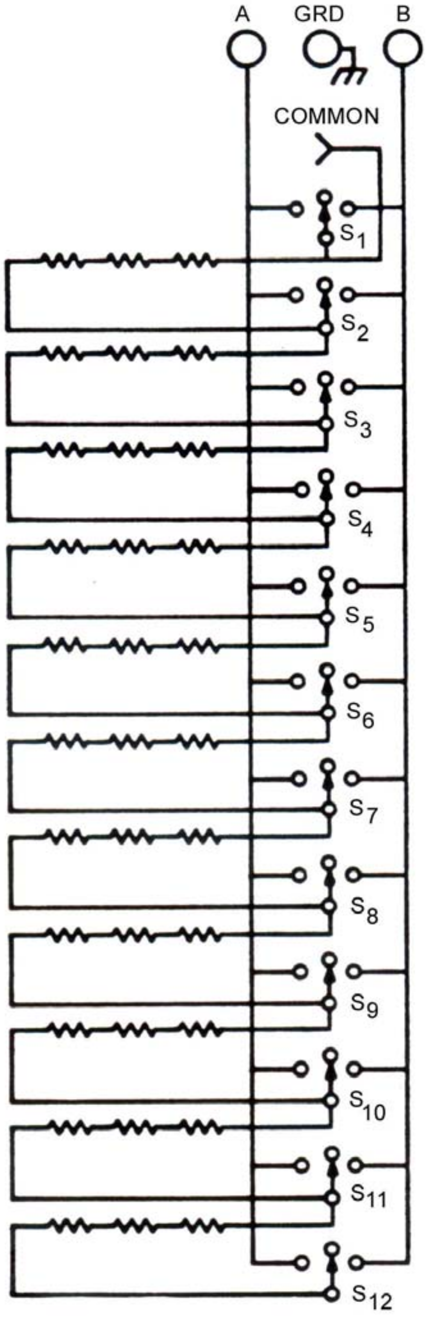


Figure 3-6 Model SR1050 Schematic

3.4 BASIC TRANSFER ACCURACY

To make transfer measurements which do not depend on the absolute accuracy of the transfer standard but only on its short term stability, it is necessary to assume that ten resistors in parallel are exactly equal to one one-hundredth of the same ten resistors in series. To see how valid this assumption is let **R** be the nominal value of the individual resistors and d_n the deviation from nominal of this nth resistor. The value of the nth resistor will then be $R_n = R\left(1+d_n\right)$. The value of the ten resistor in series will be:

$$R_s = \sum_{n=1}^{10} R\left(1+d_n\right) = 10R\left(1+\frac{1}{10}\sum_{n=1}^{10} d_n\right)$$

$$d_{av}^{10} = \frac{1}{10}\sum_{n=1}^{10} d_n$$

where:

d_{av}^{10} is the average of the deviation d_n for ten resistors.

$$R_s = 10R\left(1+d_{av}^{10}\right)$$

The resistance of the same ten resistors in parallel will be:

$$R_p = \frac{1}{\displaystyle\sum_{n=1}^{10}\frac{1}{R\left(1+d_n\right)}}$$

$$\frac{1}{R\left(1+d_n\right)} = \frac{1}{R}\left(1-d_n+d_n^2-d_n^3 \cdots\right)$$

$$R_p = \frac{1}{\displaystyle\sum_{n=1}^{10}\frac{1}{R}\left(1-d_n+d_n^2 \cdots\right)}$$

$$R_p = \frac{R}{10}\;\frac{1}{1+\frac{1}{10}\displaystyle\sum_{n=1}^{10}\left(-d_n+d_n^2 \cdots\right)}$$

$$R_p = \frac{R}{10}\left(1+\frac{1}{10}\sum_{n=1}^{10} d_n-\frac{1}{10}\sum_{n=1}^{10} d_n^2 \cdots\right)$$

$$R_p = \frac{R}{10}\left(1+d_{av}^{10}-\frac{1}{10}\sum_{n=1}^{10} d_n^2 \cdots\right)$$

$$R_p \approx \frac{R}{10}\left(1+d_{av}^{10}\right)$$

The assumption being that $\frac{1}{10}\sum_{n=1}^{10} d^2$ is negligible. Since d_n maximum for the SR 1050 is less than 100 ppm d_n^2 will be less than 0.01 ppm, which can be neglected. Thus the original assumption is quite valid. A similar analysis can be made for the series-parallel connection or any other configuration in which the power divides equally among the resistors.

3.5 LINEARITY DEVIATION

To calibrate the SR 1050 as a voltage divider we need to know the difference between the actual ratio of the output to input voltages and the setting. This difference is called linearity deviation.

$$L = \frac{E_{out}}{E_{in}} - S$$

L — linearity deviation
E_{in} — actual input voltage
E_{out} — actual output voltage
S — divider setting

Since the voltage and resistance divide proportionately, the linearity deviation can be found by a precision comparison of the resistors in the divider string. By using ten resistors of the SR 1050 in the divider string, the output can be set to integral multiples of a tenth the input voltage. The linearity deviation for this divider can be written as:

$$L = \frac{\sum_{n=1}^{10S} R_n}{\sum_{n=1}^{10} R_n} - S$$

L — linearity deviation
R_n — resistance of nth resistor
$\sum_{n=1}^{10S} R_n$ — resistance from COM to OUT in ohms
$\sum_{n=1}^{10} R_n$ — total input resistance in ohms
S — divider setting

If all of the resistors in the string were equal, the voltage would divide equally. To find how far from the ideal this divider is, each resistor R_n of the string is compared to a standard resistor. To maintain the ultimate in measurement accuracy three-terminal measurements should be made. The measured resistance deviation is used to calculate the linearity deviation.

$$R_n = R_s(1 + d_n)$$

R_n — resistance of nth resistor in ohms
R_s — resistance of standard resistor in ohms
d_n — per unit deviation of R_n from R_s

This leads to the following expression for linearity deviation:

$$L = \frac{\sum_{n=1}^{10S} (1 + d_n)}{\sum_{n=1}^{10} (1 + d_n)} - S$$

The precise value of the standard resistor is unimportant since it is canceled out of this equation; thus any one of the resistors of the string can be used as the standard resistor. To simplify calculations the equation for linearity deviation can be modified by first defining the average deviation as $d_{av}^{10} = 0.1 \sum_{n=1}^{10} d_n$ and then assuming d_{av}^{10} is much smaller than one. The equation for deviation can then be expressed as follows:

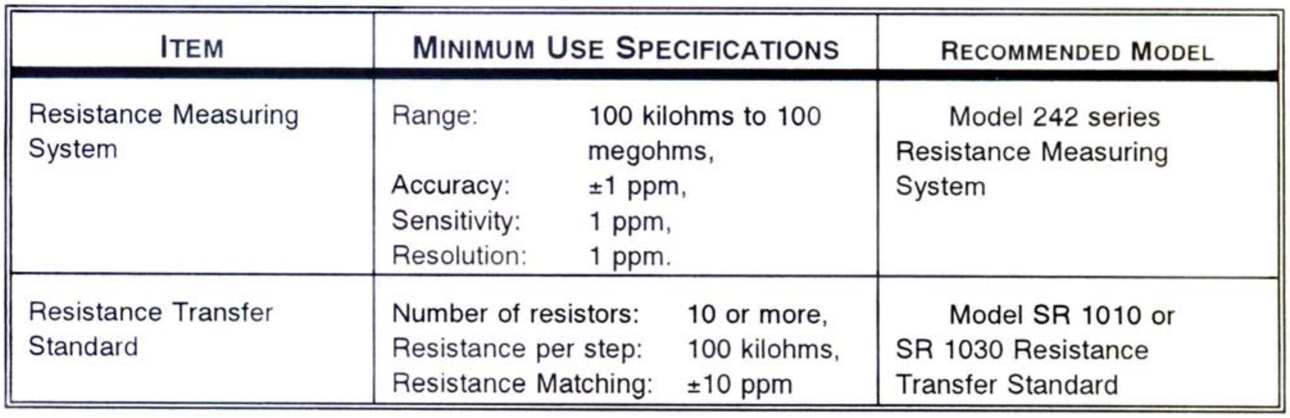
$$L = 0.1 \sum_{n=1}^{10S} \left(d_n - d_{av}^{10}\right)$$

4.1 GENERAL

Calibration of the Model SR1050 Resistance Transfer Standard consists of making traceable measurements of the resistors in the unit. The four steps involved in making such traceable measurements are: (1) traceable calibration of a resistance standard, (2) measurement of the first ten resistors of the Model SR1050 Transfer Standard connected in parallel to determine the cumulative deviation, (3) measurement of the individual resistors in the Model SR1050 Transfer Standard to determine the individual differences, and (4) computation of the individual and cumulative deviations of the resistors.

4.2 EQUIPMENT REQUIRED

The instructions in the calibration procedure pertain specifically to the Recommended Model of calibration equipment listed below. If alternate equipment is substituted, interpret the instructions accordingly. Minimum Use Specifications are the principal parameters required for performance of the calibration and are included to assist in selection of alternate equipment.



ITEM	MINIMUM USE SPECIFICATIONS	RECOMMENDED MODEL
Resistance Measuring System	Range: 100 kilohms to 100 megohms, Accuracy: ±1 ppm, Sensitivity: 1 ppm, Resolution: 1 ppm.	Model 242 series Resistance Measuring System
Resistance Transfer Standard	Number of resistors: 10 or more, Resistance per step: 100 kilohms, Resistance Matching: ±10 ppm	Model SR 1010 or SR 1030 Resistance Transfer Standard

4.3 EQUIPMENT CALIBRATION

For the highest accuracy of calibration, the calibration equipment should be calibrated immediately before the Model SR1050 Resistance Transfer Standard is calibrated.

4.4 FIRST TEN RESISTOR MEASUREMENT

1. Connect the 100 kilohm-per-step transfer standard for a resistance of one-tenth of the resistance of a step of the Model SR1050 to be calibrated. If the Model SR1050 to be calibrated is 1-megohm-per-step, connect the first nine resistors of the 100 kilohm-per-step transfer standard in series parallel for a total resistance of 100 kilohms. If the Model SR1050 Transfer Standard to be calibrated has 10 megohms per step, connect to the first ten resistors in the 100 kilohm-per-step transfer standard so that the total resistance is 1 megohm.

2. Set the deviation dial of the Model 240 series Resistance Bridge to the cumulative deviation of the resistors of the 100 kilohm-per-step transfer that are being used.

3. Measure the resistance during the dials on the Model RS 925 series Resistance Standard to balance the bridge.

4. Measure deviation of first ten resistors in Model SR1050 Transfer Standard:
   a. Set switches on Model SR1050 as follows:
      0,2,4,6,8, and 10 to A;
      1,3,5,7, and 9 to B;
      11 in center
   b. Connect Model SR1050 Transfer Standard to resistance measuring system UNKNOWN terminals.
   c. Measure resistance using deviation dial to obtain bridge balance.
   d. Note the reading of the deviation dial. This is the cumulative deviation of the first ten resistors of the Model SR1050.

4.5 INDIVIDUAL RESISTOR MEASUREMENT

1. Normalize resistance measuring system to resistance of first resistor;

   a. Connect Model SR1050 Transfer Standard to resistance measuring system UNKNOWN terminals
   b. Set deviation dial to 0 ppm.
   c. Set switches on Model SR1050 as follows:
      0 to A, 1 to B, all others in center
   d. Set Model 240 series Bridge to 10 or 100 X STANDARD as appropriate.
   e. Measure resistance using the dials on the Model RS925 series to balance the bridge.
2. Measure each of the other resistors in the Model SR1050 using the deviation dial to obtain bridge balance. The switch settings for each resistor are as follows:

RESISTOR	SWITCH											
	0	1	2	3	4	5	6	7	8	9	10	11
1	A	B	*	*	*	*	*	*	*	*	*	*
2	*	B	A	*	*	*	*	*	*	*	*	*
3	*	*	A	B	*	*	*	*	*	*	*	*
4	*	*	*	B	A	*	*	*	*	*	*	*
5	*	*	*	*	A	B	*	*	*	*	*	*
6	*	*	*	*	*	B	A	*	*	*	*	*
7	*	*	*	*	*	*	A	B	*	*	*	*
8	*	*	*	*	*	*	*	B	A	*	*	*
9	*	*	*	*	*	*	*	*	A	B	*	*
10	*	*	*	*	*	*	*	*	*	B	A	*
11	*	*	*	*	*	*	*	*	*	*	A	B

3. Note the deviation of each resistor.

4. After measuring each resistor, recheck the deviation of the first resistor; the deviation should be 0 ppm.

4.6 COMPUTATION OF DEVIATIONS

1. Compute the cumulative deviations of the resistors:
   a. For each resistor, starting with resistor 1, sum the deviations of that resistor and all preceding resistors. For example, the cumulative sum corresponding to the fourth resistor is the sum of the deviations of the first four resistors.
   b. Divide the cumulative sums by the number of deviations involved in the sum. For example, the cumulative sums corresponding to the fourth resistor is divided by 4.

2. Determine the correction factor K:
   a. Note the cumulative deviation obtained for the first ten resistors in step 1 b above. Subtract that number algebraically from the deviation of the first ten resistors measured in Paragraph 4.4, step 4.
   b. Note this number, K.

3. Add the number K to each of the deviations measured in Paragraph 4.5 and to each of the cumulative deviations computed in step 1 b above.

4. Round off the corrected sums to the nearest ppm and note these sums in the appropriate columns of the calibration card.

The following parts are listed alphabetically by description. All parts are available from TEGAM Incorporated.

TEGAM Incorporated's Cage Code number is 49374.

When ordering parts, please include the following information:

Model and Serial number of the instrument
TEGAM part number
Description of part

Description	Part No.	Qty. Used
Assy, Binding Post, Brass	53560	3
Cap, Binding Post, Black	01170	2
Cap, Binding Post, Gold Plated	01172	1
Card, Calibration	06895	1
Coax, UHF, Jack/Socket	06877	1
Connector Cover and Chain	06887	1
Cover, Dust (Enclosure)	08173	1
Foot, Adhesive	08789	4
Holder, Calibration Card, Clear	08535	6
Knob, Switch, Black	06875	6
Knob, Switch, White	06874	3
Nut, Hex, #10-32	03547	1
Washer, Shoulder	08823	3

Warranty:

TEGAM, Inc. warrants this product to be free from defects in material and workmanship for a period of insert applicable warranty years from the date of shipment. During this warranty period, if a product proves to be defective, TEGAM, Inc., at its option, will either repair the defective product without charge for parts and labor, or exchange any product that proves to be defective.

TEGAM, Inc. warrants the calibration of this product for a period of 6 months from date of shipment. During this period, TEGAM, Inc. will recalibrate any product, which does not conform to the published accuracy specifications.

In order to exercise this warranty, TEGAM, Inc., must be notified of the defective product before the expiration of the warranty period. The customer shall be responsible for packaging and shipping the product to the designated TEGAM service center with shipping charges prepaid. TEGAM Inc. shall pay for the return of the product to the customer if the shipment is to a location within the country in which the TEGAM service center is located. The customer shall be responsible for paying all shipping, duties, taxes, and additional costs if the product is transported to any other locations. Repaired products are warranted for the remaining balance of the original warranty, or 90 days, whichever period is longer.

Warranty Limitations:

The TEGAM, Inc. warranty does not apply to defects resulting from unauthorized modification or misuse of the product or any part. This warranty does not apply to fuses, batteries, or damage to the instrument caused by battery leakage.

Statement of Calibration:

This instrument has been inspected and tested in accordance with specifications published by TEGAM, Inc. The accuracy and calibration of this instrument are traceable to the National Institute of Standards and Technology through equipment, which is calibrated at planned intervals by comparison to certified standards maintained in the laboratories of TEGAM, Inc.

Contact Information:

TEGAM, INC.
10 TEGAM WAY
GENEVA, OHIO 44041
PH: 440.466.6100
FX: 440.466.6110
EMAIL: sales@tegam.com

Preparation for Repair or Calibration Service:

Once you have verified that the cause for SR1050 malfunction cannot be solved in the field and the need for repair and calibration service arises, contact TEGAM customer service to obtain an RMA, (Returned Material Authorization), number. You can contact TEGAM customer service via the TEGAM website, www.tegam.com or by calling 440.466.6100 OR 800.666.1010.

The RMA number is unique to your instrument and will help us identify your instrument and to address the particular service request by you which is assigned to that RMA number. Of even more importance is a detailed written description of the problem, which should be attached to the instrument. Many times repair turnaround is unnecessarily delayed due to a lack of repair instructions or lack of a detailed description of the problem.

The detailed problem description should include information such as measurement range, trigger mode, type of components being tested, is the problem intermittent?, when is the problem most frequent?, has anything changed since the last time the instrument was used?, etc. Any detailed information provided to our technicians will assist them in identifying and correcting the problem in the quickest possible manner. Use the Expedite Repair & Calibration form provided on the next page to provide detailed symptoms of the instrument's problem.

Once this information is prepared and sent with the instrument and RMA number to our service department, we will do our part in making sure that you receive the best possible customer service and turnaround time possible.

Expedite Repair & Calibration Form

Use this form to provide additional repair information and service instructions. The completion of this form and including it with your instrument will expedite the processing and repair process.

RMA#:		Instrument Model #:	
Serial Number:		Company:	
Technical Contact:		Phone Number:	
Additional Contact Info:			

Repair Instructions:

☐ Evaluation ☐ Calibration Only ☐ Repair Only ☐ Repair & Calibration ☐ Z540 (Extra Charge)

Detailed Symptoms:

Include information such as measurement range, instrument settings, type of components being tested, is the problem intermittent? When is the problem most frequent?, Has anything changed with the application since the last time the instrument was used?, etc.

There is no information contained in the Appendix at this time.