♦ PRECISION INSTRUMENTS FOR TEST AND MEASUREMENT ♦

RTD Series

Precision Resistance Temperature Detector (RTD) Simulator

User and Service Manual

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RTD Series-im November 2014

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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.

Contents

Figures and Tables

Chapter 1
INTRODUCTION

1.1 Introduction

The RTD Series Precision RTD (Resistance Temperature Detector) Simulator provides a very broad-range of absolute resistance values that replace RTD's,thermocouples. Thermocouples present a resistance that depends on the temperature. The RTD simulator effectively replaces an RTD to test, analyze, and calibrate RTD measuring systems.

The RTD Series simulator 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. The special design of the RTD Series provides absolute accuracy, and requires no zero resistance subtraction from any setting.

Wirewound resistors are used for 1 Ω steps and over. The wirewound resistors exhibit stability of better than 10 ppm/year, improving as they age. The low-resistance resistors are constructed with resistance wire. There is a minimum of copper resistance in series to limit temperature coefficient effects.

The RTD 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 mΩ per decade, and more importantly, keep switch contact resistance reproducible, insuring repeatable instrument performance.

High-quality, low resistance, heavy duty 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 RTD Series is designed to allow very convenient maintenance of calibration over time. The decades for the 0.001 Ω through 0.1 Ω steps are adjusted with convenient potentiometers. Trimming of the higher decades is also possible.

With a resolution as low as 1 mΩ and a maximum available resistance of over 1111.11 Ω, the RTD 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, and as well as RTD simulators.

Figure 1-1: RTD Series Precision RTD Simulator

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.

SPECIFICATIONS

Model	RTD-Z-6-.001	RTD-X-6-.001	RTD-Z-6-.01	RTD-X-6-.01
Minimum resistance (Ω)	10.000	10.000	10.00	10.00
Maximum resistance (Ω)	1,111.110	1,111.110	11,111.10	11,111.10
Resolution (mΩ)	1	1	10	10
Number of decades	6	6	6	6
Absolute accuracy (ppm)	50	100	50	100
Tempco max. (ppm/°C)	5	5	5	5
Tempco typical (ppm/°C)	3	3	3	3
Stability (ppm/24hrs)	2	2	2	2
Stability (ppm/year)	10	10	10	10
Dimensions				
W cm (in)	43.9(17.3)	43.9(17.3)	43.9(17.3)	43.9(17.3)
H cm (in)	8.9(3.5)	8.9(3.5)	8.9(3.5)	8.9(3.5)
D cm (in)	10.2(4)	10.2(4)	10.2(4)	10.2(4)

**At 23°C "true ohm" measurement, 30-70% RH, absolute reading, SI traceable; no zero subtraction required*

Switch Setting:

The 10 Ω switch has two stops at positions 1 and 10. Absolute accuracy, *without* zero subtraction, is accomplished by having a minimum settable resistance, *which includes all contact and wiring resistances.* Absolute accuracy applies for every setting. See **table above** for the minimum settable resistance for any model. Minimum settable resistance is implemented by a mechanical stop in one of the decades.

Maximum Power for rated accuracy:

100 mW or 100 mA for 10.000 to 10.999 Ω;
100 mW per step for the highest decade in use for 11 Ω and over.

Maximum Current: 200 mA.

Breakdown Voltage: 1000 V.

Connection to Terminals:

2 terminal devices: use **H** and **L CURRENT** terminals
3 terminal devices: use **H CURRENT - L CURRENT** and **G** terminals;
4 terminal devices: use all **CURRENT** and **SENSE** terminals. (Note: Ground Strap is the only connection between **CURRENT** and **SENSE** terminals.)

Environmental conditions:

Operating temperature: 0ºC to 55ºC.
Storage temperature: -40ºC to 70ºC.
Humidity: <80% RH.

Switch type:

Multiple solid silver contacts; dust-tight diallyl-phthalate body.
To allow continuous rotation, a blank position is added on all decades except the 10 Ω decade.

SPECIFICATIONS CONTINUED

Resistor type:

Wirewound, hermetically sealed, low-inductance

Terminals:

Four, 5-way, gold-plated, tellutium-copper binding posts with low thermal emf and low resistance, for four-terminal Kelvin measurements, plus one binding post connected to case for shielding.

Options:

-RH Rear output is available as an option.

RTD-Z SERIES RESISTANCE TEMPERATURE DETECTOR (RTD) SIMULATOR

Resistor Type: Wirewound, hermetically sealed, low inductance.
Accuracy: 50 ppm absolute accuracy without "zero" setting subtraction; true-ohm measurement at CURRENT terminals at 23°C; NIST traceable.
Resistance Range: 10.000 Ω to 1,111.110 Ω., with 1 mΩ resolution.
Minimum Setting: 10 Ω.
Temperature Coefficient: <±5 ppm/°C, 3 ppm/°C typical.
Stability: 10 ppm/year.
Maximum Power for rated accuracy:
100 mW or 100 mA for 10.000 to 10.999 Ω;
100 mW per step for the highest decade in use for 11 Ω and over.
Maximum Current: 200 mA.
Breakdown Voltage: 1000 V.

Switch Setting: The 10 Ω switch has two stops at positions 1 and 10. Use caution so as not to damage the switch.
To set values requiring a 0 in the 10 Ω position, follow this example: for a 205 Ω setting, set the dials to 1-10-5-0-0-0.
Connection to Terminals:
2 terminal devices: use H and L CURRENT terminals;
3 terminal devices: use H CURRENT - L CURRENT and G terminals;
4 terminal devices: use all CURRENT and SENSE terminals.
Switch Break-in: Whenever the unit has been idle, turn each switch 7-10 times both ways before using. This switch "break-in" procedure is standard metrology procedure required for best accuracy to remove any silver oxide film on the contact surfaces, typically <1 mΩ.

MODEL: RTD-Z-6-0.001 SN: G2-1444653

WARNING

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

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RTD lbls/RTD-Z-6-.001/p1/cat09/04-13;55%

Figure 2-2: Typical Operating Guide Affixed to Unit (See label on your specific unit for actual specifications)

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 23ºC.

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

Four high performance, low resistance, heavy duty 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.

These terminals are labeled **CURRENT H**, **CURRENT L**, **SENSE H**, and **SENSE L** provide two current and two potential terminals, respectively. In accordance with industry standards, the two **SENSE** terminals are internally connected to the RTD circuit, and the external shorting links must be connected for 4-terminal measurement, as this is the only connection between **CURRENT** and **SENSE** terminals. A fifth metal binding post labeled **GND** (Ground) is connected to the case and may be used as a guard or shield terminal.

When 4-terminal measurements are used, it is best to use banana plugs rather than lugs, because the center conductor of a banana plug is closer to the center of the banana jack. Lugs may result is small differences from the calibrated values - of the order of 5 ppm.

4.2.1 Thermal emf Considerations

The highest quality low emf components are used in the RTD Series 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 RTD Series binding posts. This will depend on the test lead material. Whenever this is critical, brass and iron materials should be avoided.

This emf will be virtually 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.

4.3 Dial Setting

The l0 Ω decade does not go below the "1" position in order to maintain a precise and constant minimum resistance of 10 Ω, so that no subtraction of zero resistance is required. Excise caution so as not force 10 Ω decade dial below 1 position. To set values requiring a 0 in the 10 Ω position, follow this example: for a 205 Ω setting, set the dials to 1-10-5-0-0-0.

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

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

To determine the resistance obtained when one or more "10" settings are used, simply add "1" to the next higher decade. For example, and a setting of 10-10-l0-10.10-10 Ω becomes:

10	1 0 0 0 0.0
10	1 0 0 0.0
10	1 0 0.0
10	1 0.0
.10	1.0
.01	0.1
TOT	**1 1 1 1 1.1**

Use caution so as not to damage the switch.
To set values requiring a 0 in the 10 Ω position, follow this example: for a 205 Ω setting, set the dials to 1-10-5-0-0-0.

4.4 Power Considerations

To maintain the maximum possible accuracy and precision, power applied to the RTD Series should be kept as low as possible, preferably below 0.1 W. For best protection of the instrument, it is advisable to limit the input power to 0.5 W. This may be implemented with a series resistor or fuse.

4.5 Environmental Conditions

For optimal accuracy, the decade box should be used in an environment of 23ºC. It should be allowed to stabilize at that temperature for at least four hours after any significant temperature variation.

Humidity should be maintained at laboratory conditions of <80% RH.

4.6 Switch Conditioning

The switch wipers employed in this unit are self cleaning. They have solid silver alloy contacts. After being left idle, the wipers and contacts must be conditioned or "broken in" again to remove the film of silver oxide that develops over time. This is standard metrology practice when high accuracy is required. This effect is of the order of less than 1 mΩ, So it may be ignored whenever measurements of that magnitude are not important.

To perform this "breaking in," simply rotate each switch seven to ten times in each direction with the exception of the 10 Ω decade switch which should not be rotated beyond the stops.

4.7 PT 100 Temperature Charts

One of the primary applications of the RTD Series is as calibration of temperature equipment that uses PT-100 Thermocouples. Temperature conversion charts are show on the next two pages.

Platinum Resistance (-200^{O}C to 239^{O}C)

Temperature Coefficient - 0.00385 Ohms/Ohm/^{O}C

°C	Ohms	°C	Ohms	C	Ohms	°C	Ohms	°C	Ohms	°C	Ohms	°C	Ohms
-200	18.49	-137	45.11	-74	70.73	-11	95.69	51	119.78	114	143.80	177	167.35
-199	18.93	-136	45.52	-73	71.13			52	120.16	115	144.17	178	167.72
-198	19.36	-135	45.94	-72	71.53	-10	96.09	53	120.55	116	144.55	179	168.09
-197	19.79	-134	46.35	-71	71.93	-9	96.48	54	120.93	117	144.93		
-196	20.22	-133	46.76			-8	96.87	55	121.32	118	145.31	180	168.46
-195	20.65	-132	47.18	-70	72.33	-7	97.26	56	121.70	119	145.68	181	168.83
-194	21.08	-131	47.59	-69	72.73	-6	97.65	57	122.09			182	169.20
-193	21.51			-68	73.13	-5	98.04	58	122.47	120	146.06	183	169.57
-192	21.94	-130	48.00	-67	73.53	-4	98.44	59	122.86	121	146.44	184	169.94
-191	22.37	-129	48.41	-66	73.93	-3	98.83			122	146.81	185	170.31
		-128	48.82	-65	74.33	-2	99.22	60	123.24	123	147.19	186	170.68
-190	22.80	-127	49.23	-64	74.73	-1	99.61	61	123.62	124	147.57	187	171.05
-189	23.23	-126	49.64	-63	75.13			62	124.01	125	147.94	188	171.42
-188	23.66	-125	50.06	-62	75.53	0	100.00	63	124.39	126	148.32	189	171.79
-187	24.09	-124	50.47	-61	75.93	1	100.39	64	124.77	127	148.70		
-186	24.52	-123	50.88			2	100.78	65	125.16	128	149.07	190	172.16
-185	24.94	-122	51.29	-60	76.33	3	101.17	66	125.54	129	149.45	191	172.53
-184	25.37	-121	51.70	-59	76.73	4	101.56	67	125.92			192	172.90
-183	25.80			-58	77.13	5	101.95	68	126.31	130	149.82	193	173.26
-182	26.23	-120	52.11	-57	77.52	6	102.34	69	126.69	131	150.20	194	173.63
-181	26.65	-119	52.52	-56	77.92	7	102.73			132	150.57	195	174.00
		-118	52.92	-55	78.32	8	103.12	70	127.07	133	150.95	196	174.37
-180	27.08	-117	53.33	-54	78.72	9	103.51	71	127.45	134	151.33	197	174.74
-179	27.50	-116	53.74	-53	79.11			72	127.84	135	151.70	198	175.10
-178	27.93	-115	54.15	-52	79.51	10	103.90	73	128.22	136	152.08	199	175.47
-177	28.35	-114	54.56	-51	79.91	11	104.29	74	128.60	137	152.45		
-176	28.78	-113	54.97			12	104.68	75	128.98	138	152.83	200	175.84
-175	29.20	-112	55.38	-50	80.31	13	105.07	76	129.37	139	153.20	201	176.21
-174	29.63	-111	55.78	-49	80.70	14	105.46	77	129.75			202	176.57
-173	30.05			-48	81.10	15	105.85	78	130.13	140	153.58	203	176.94
-172	30.47	-110	56.19	-47	81.50	16	106.24	79	130.51	141	153.95	204	177.31
-171	30.90	-109	56.60	-46	81.89	17	106.63			142	154.32	205	177.68
		-108	57.00	-45	82.29	18	107.02	80	130.89	143	154.70	206	178.04
-170	31.32	-107	57.41	-44	82.69	19	107.40	81	131.27	144	155.07	207	178.41
-169	31.74	-106	57.82	-43	83.08			82	131.66	145	155.45	208	178.78
-168	32.16	-105	58.22	-42	83.48	20	107.79	83	132.04	146	155.82	209	179.14
-167	32.59	-104	58.63	-41	83.88	21	108.18	84	132.42	147	156.19		
-166	33.01	-103	59.04			22	108.57	85	132.80	148	156.57	210	179.51
-165	33.43	-102	59.44	-40	84.27	23	108.96	86	133.18	149	156.94	211	179.88
-164	33.85	-101	59.85	-39	84.67	24	109.35	87	133.56			212	180.24
-163	34.27			-38	85.06	25	109.73	88	133.94	150	157.31	213	180.61
-162	34.69	-100	60.25	-37	85.46	26	110.12	89	134.32	151	157.69	214	180.97
-161	35.11	-99	60.66	-36	85.85	27	110.51			152	158.06	215	181.34
		-98	61.06	-35	86.25	28	110.90	90	134.70	153	158.43	216	181.71
-160	35.53	-97	61.47	-34	86.64	29	111.28	91	135.08	154	158.81	217	182.07
-159	35.95	-96	61.87	-33	87.04			92	135.46	155	159.18	218	182.44
-158	36.37	-95	62.28	-32	87.43	30	111.67	93	135.84	156	159.55	219	182.80
-157	36.79	-94	62.68	-31	87.83	31	112.06	94	136.22	157	159.93		
-156	37.21	-93	63.09			32	112.45	95	136.60	158	160.30	220	183.17
-155	37.63	-92	63.49	-30	88.22	33	112.83	96	136.98	159	160.67	221	183.53
-154	38.04	-91	63.90	-29	88.62	34	113.22	97	137.36			222	183.90
-153	38.46			-28	89.01	35	113.61	98	137.74	160	161.04	223	184.26
-152	38.88	90	64.30	-27	89.40	36	113.99	99	138.12	161	161.42	224	184.63
-151	39.30	-89	64.70	-26	89.80	37	114.38			162	161.79	225	184.99
		-88	65.11	-25	90.19	38	114.77	100	138.50	163	162.16	226	185.36
-150	39.71	-87	65.51	-24	90.59	39	115.15	101	138.88	164	162.53	227	185.72
-149	40.13	-86	65.91	-23	90.98			102	139.26	165	162.90	228	186.09
-148	40.55	-85	66.31	-22	91.37	40	115.54	103	139.64	166	163.27	229	186.45
-147	40.96	-84	66.72	-21	91.77	41	115.93	104	140.02	167	163.65		
-146	41.38	-83	67.12			42	116.31	105	140.39	168	164.02	230	186.82
-145	41.79	-82	67.52	-20	92.16	43	116.70	106	140.77	169	164.39	231	187.18
-144	42.21	-81	67.92	-19	92.55	44	117.08	107	141.15			232	187.54
-143	42.63			-18	92.95	45	117.47	108	141.53	170	164.76	233	187.91
-142	43.04	-80	68.33	-17	93.34	46	117.85	109	141.91	171	165.13	234	188.27
-141	43.45	-79	68.73	-16	93.73	47	118.24			172	165.50	235	188.63
		-78	69.13	-15	94.12	48	118.62	110	142.29	173	165.87	236	189.00
-140	43.87	-77	69.53	-14	94.52	49	119.01	111	142.66	174	166.24	237	189.36
-139	44.28	-76	69.93	-13	94.91			112	143.04	175	166.61	238	189.72
-138	44.70	-75	70.33	-12	95.30	50	119.40	113	143.42	176	166.98	239	190.09

Platinum Resistance (240°C to 629°C)

Temperature Coefficient - 0.00385 Ohms/Ohm/°C

°C	Ohms	°C	Ohms	C	Ohms	°C	Ohms	°C	Ohms	°C	Ohms	°C	Ohms
240	190.45	301	212.37	362	233.87	423	254.93	484	275.56	545	295.75	606	315.52
241	190.81	302	212.73	363	234.22	424	255.27	485	275.89	546	296.08	607	315.84
242	191.18	303	213.09	364	234.56	425	255.61	486	276.23	547	296.41	608	316.16
243	191.54	304	213.44	365	234.91	426	255.95	487	276.56	548	296.74	609	316.48
244	191.90	305	213.80	366	235.26	427	256.29	488	276.89	549	297.06		
245	192.26	306	214.15	367	235.61	428	256.63	489	277.23			610	316.80
246	192.63	307	214.51	368	235.96	429	258.98			550	297.39	611	317.12
247	192.99	308	214.86	369	236.31			490	277.56	551	297.72	612	317.44
248	193.35	309	215.22			430	257.32	491	277.90	552	298.04	613	317.76
249	193.71			370	236.65	431	257.66	492	278.23	553	298.37	614	318.08
		310	215.57	371	237.00	432	258.00	493	278.56	554	298.70	615	318.40
250	194.07	311	215.93	372	237.35	433	258.34	494	278.90	555	299.02	616	318.72
251	194.44	312	216.28	373	237.70	434	258.68	495	279.23	556	299.35	617	319.04
252	194.80	313	216.64	374	238.04	435	259.02	496	279.56	557	299.68	618	319.36
253	195.16	314	216.99	375	238.39	436	259.36	497	279.90	558	300.00	619	319.68
254	195.52	315	217.35	376	238.74	437	259.70	498	280.23	559	300.33		
255	195.88	316	217.70	377	239.09	438	260.04	499	280.56			620	319.99
256	196.24	317	218.05	378	239.43	439	260.38			560	300.65	621	320.31
257	196.60	318	218.41	379	239.78			500	280.90	561	300.98	622	320.63
258	196.96	319	218.76			440	260.72	501	281.23	562	301.31	623	320.95
259	197.33			380	240.13	441	261.06	502	281.56	563	301.63	624	321.27
		320	219.12	381	240.47	442	261.40	503	281.89	564	301.96	625	321.59
260	197.69	321	219.47	382	240.82	443	261.74	504	282.23	565	302.28	626	321.91
261	198.05	322	219.82	383	241.17	444	262.08	505	282.56	566	302.61	627	322.22
262	198.41	323	220.18	384	241.51	445	262.42	506	282.89	567	302.93	628	322.54
263	198.77	324	220.53	385	241.86	446	262.76	507	283.22	568	303.26	629	322.86
264	199.13	325	220.88	386	242.20	447	263.10	508	283.55	569	303.58		
265	199.49	326	221.24	387	242.55	448	263.43	509	283.89				
266	199.85	327	221.59	388	242.90	449	236.77			570	303.91		
267	200.21	328	221.94	389	243.24			510	284.22	571	304.23		
268	200.57	329	222.29			450	264.11	511	284.55	572	304.56		
269	200.93			390	243.59	451	264.45	512	284.88	573	304.88		
		330	222.65	391	243.93	452	264.79	513	285.21	574	305.20		
270	201.29	331	223.00	392	244.28	453	265.13	514	285.54	575	305.53		
271	201.65	332	223.35	393	244.62	454	265.46	515	285.87	576	305.85		
272	202.01	333	223.70	394	244.97	455	265.80	516	286.21	577	306.18		
273	202.36	334	224.06	395	245.31	456	266.14	517	286.54	578	306.50		
274	202.72	335	224.41	396	245.66	457	266.48	518	286.87	579	306.82		
275	203.08	336	224.76	397	246.00	458	266.82	519	287.20				
276	203.44	337	225.11	398	246.35	459	267.15			580	307.15		
277	203.80	338	225.46	399	246.69			520	287.53	581	307.47		
278	204.16	339	225.81			460	267.49	521	287.86	582	307.79		
279	204.52			400	247.04	461	267.83	522	288.19	583	308.12		
		340	226.17	401	247.38	462	268.17	523	288.52	584	308.44		
280	204.88	341	226.52	402	247.72	463	268.50	524	288.85	585	308.76		
281	205.23	342	226.87	403	248.07	464	268.84	525	289.18	586	309.09		
282	205.59	343	227.22	404	248.41	465	269.18	526	289.51	587	309.41		
283	205.95	344	227.57	405	248.76	466	269.51	527	289.84	588	309.73		
284	206.31	345	227.92	406	249.10	467	269.85	528	290.17	589	310.05		
285	206.67	346	228.27	407	249.45	468	270.19	529	290.50				
286	207.02	347	228.62	408	249.79	469	270.52			590	310.38		
287	207.38	348	228.97	409	250.13			530	290.83	591	310.70		
288	207.74	349	229.32			470	270.86	531	291.16	592	311.02		
289	208.10			410	250.48	471	271.20	532	291.49	593	311.34		
		350	229.67	411	250.82	472	271.53	533	291.81	594	311.66		
290	208.45	351	230.02	412	251.16	473	271.87	534	292.14	595	311.99		
291	208.81	352	230.37	413	251.50	474	272.20	535	292.47	596	312.31		
292	209.17	353	230.72	414	251.85	475	272.54	536	292.80	597	312.63		
293	209.52	354	231.07	415	252.19	476	272.88	537	293.13	598	312.95		
294	209.88	355	231.42	416	252.53	477	273.21	538	293.46	599	313.27		
295	210.24	356	231.77	417	252.87	478	273.55	539	293.79				
296	210.59	357	232.12	418	253.22	479	273.88			600	313.59		
297	210.95	358	232.47	419	253.56			540	294.11	601	313.91		
298	211.31	359	232.82			480	274.22	541	294.44	602	314.24		
299	211.66			420	253.90	481	274.55	542	294.77	603	314.56		
		360	233.17	421	254.24	482	274.89	543	295.10	604	314.88		
300	212.02	361	233.52	422	254.59	483	275.22	544	295.43	605	315.20		

Chapter 5
MAINTENANCE

5.1 Maintainability and Reliability

It is possible to maintain Model RTD Series 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 adjustable decades for 1 Ω decades and above and resistance wire for lower decades which can be trimmed. 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 RTD Series 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 RTD Series 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 RTD Series 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 RTD 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 RTD Series 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 RTD Series 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 adjustability of these two decades
- Precision resistance measurement bridge or multimeter, with a transfer accuracy of ±l ppm. Options include:
  - Guildline Model 9975
  - Measurements International Model 6000A
- IET/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 RTD Series 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 RTD being tested.
5. Confirm that the resistances fall within these limits.
6. If any resistances fall outside these limits, the associated switch assembly may require adjustment or replacement.

5.4 Adjustments

If one or more resistances fall outside the limits, the associated resistor should be adjusted. 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.

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^{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 adjusted, that all the resistances of that decade be tested and adjusted as required.

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

- Adjustment considerations
- Adjustment procedure

5.4.1 Adjustment Considerations

Before adjusting or trimming any resistances, observe the following:

> ⚠ **CAUTION** ⚠
>
> **The RTD Series front panel GND binding post should be connected to the test instrument's ground point.**

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

5.4.2 Adjustment/Trimming Procedure

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

1. Stabilize RTD Series 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 RTD Series to a resistance meter.
4. Rotate all knobs approximately 10 times and be careful not to rotate the minimum setting decade beyond the stops.
   Breaking in the switches helps eliminate any residual contact corrosion resistance.
5. Set all dials to zero, except the 10 ohm decade which has a minimum stop at position 1.
6. Measure the 10 Ω setting. It should be a 10 Ω ± 2 ppm; if an adjustment is needed, proceed as follows:
7. Turn the potentiometer T0 on the lowest decade board either 0.001 Ω or 0.01 Ω board fully clockwise and record the reading.
8. Turn the potentiometer T0 on the lowest decade board either 0.001 Ω or 0.01 Ω fully counter-clockwise and record the reading.
9. Set the potentiometer to obtain the midpoint resistance reading between maximum and minimum.
10. Repeat the same process for the 0.01 ohms and 0.1 ohms decades as applicable.
11. Setting these T0 potentiometers to their midpoints will bring the fixed 10 ohms very close to its nominal.
12. Re-measure 10 Ω minimum. The number should be very close to its nominal. If any adjustments are necessary, Locate a piece of manganin resistance wire l T-11, on the lowest decade 0.001 Ω or 0.01 Ω board.
13. Trim the wire as follows. If the 10 Ω resistance is high, reduce it by adding a small bit of solder to an exposed portion of the wire. If the 10 Ω resistance is low, gently file the wire in one spot. Make these steps carefully and slowly, allowing the wire to cool down and re-measuring.

14. Once the 10 Ω adjustment is completed, follow the Table 5-1 below for each decade less than 0.1 Ω.
15. Use Fig 5-1 to locate the potentiometers on the decades, 0.001 Ω, 0.01 Ω, and 0.1 Ω
16. Replace the housing and reinstall the 4 housing screws.

Setting on the RTD-Z	Potentiometer on RTD-Z PCBoard
1	T1
2	T2
3	T3
4	T4
5	T5
6	T6
7	T7
8	T8
9	T9
10	T10

Table 5-1: Trimming Potentiometers

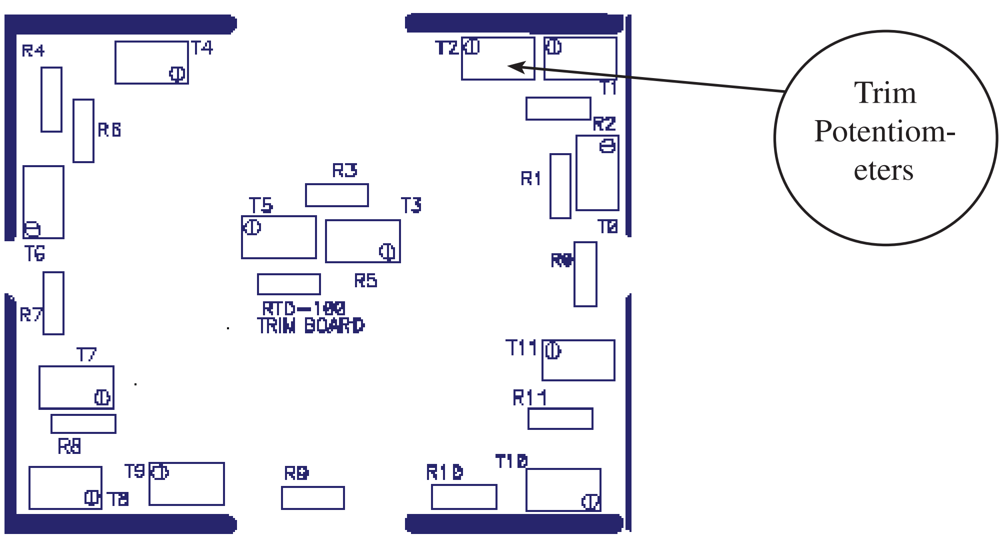

Figure 5-1: Typical Trimmer Board

5.5 Replaceable Parts List

Model Ref	IET Pt No	Description
1	BP-1000-RD	Binding Post, Red
2	BP-1000-BK	Binding Post, Black
3	BP-1000-GN	Binding Post, Green
4	RTD Series-4300-KNB	Knob Assembly
Not Shown	RTD Series-3100	Foot
Not Shown	RTD-4000-.001	1 mΩ/step Decade Switch Assembly
Not Shown	RTD-4000-0.01	10 mΩ/step Decade Switch Assembly
Not Shown	RTD-4000-LX-0.1	100 mΩ/step Decade Switch Assembly
Not Shown	RTD-4000-1	1 Ω/step Decade Switch Assembly
Not Shown	RTD-4000-10	10 Ω/step Decade Switch Assembly
Not Shown	RTD-4000-100	100 Ω/step Decade Switch Assembly

Table 5-2: Replaceable Parts List

Figure 5-2: RTD Series Replaceable Parts