RTD STANDARDS

Maximum Operating Range = -195°C to 660°C (-383°F to 1475°F) **Note:** RTD's are not commonly used above 900°F. However, JMS offers a special high temperature RTD which will withstand temperatures up to 1560°F.

Interchangeability = ±.25°C at 0°C

Stability = Less than .05°C shift per year.

Nominal Operating Current = 1 milliampere.

Maximum Safe Current = 20 Milliamperes.

Insulation Resistance = 100 mega ohms minimum at 50 VDC.

Probe Encapsulation = High purity alumina oxide.

Time constant for RTD element without tubing = 1 second maximum for the sensor to reach 63.2% of a step change in temperature in water at 3 feet per second.

RTD probes will usually not have a transition if the lead wires are less than 12" in length.

Accuracy

The standard accuracy of JMS Southeast's RTD is .1% of resistance at 0°C . Accuracies of .03% and .01% of resistance at 0°C are also available.

Stability

JMS Southeast bulbs are aged as part of the manufacturing process, thus ensuring high levels of stability. Generally the resistance at 0°C will hold less than a .05°C shift per year.

Vibration

JMS detectors can withstand a vibration level of 30g over the frequency range 10 Hz to 1 KHz.

Pressure

JMS RTD's are insensitive to large changes of pressure.

Response Time

Response time of JMS Southeast metal encapsulated probes is dependent on the outside diameter of the probe and the immersion media, usually matches that of the same size ungrounded thermocouple. (See page 1-13)

Self Heating

When tested in accordance with requirements of BS 1904: 1964 Section 3.16 the indicated temperature rise in the temperature detector with a power of 10.0mW dissipated in it, will not exceed +.3°C.

RESISTANCE TEMPERATURE DETECTORS

General Information

A resistance temperature detector or platinum resistance thermometer works on the principle that the electrical resistance of a metal changes in a significant and repeatable way when temperature changes. This resistance is inversely proportional to cross sectional area and proportional to length.

Platinum is the most widely used metal for resistance temperature detection due to the following characteristics:

1) chemical inertness
2) a temperature coefficient of resistance that is large enough to give readily measurable resistance changes with temperature
3) an almost strain free fabrication metal (in that resistance doesn't drastically change with strain)
4) an almost linear relation between resistance and temperature

Each resistance versus temperature relation for an RTD is qualified by a term known as "alpha". "Alpha" is the slope of the resistance between 0°C and 100°C. This is also referred to as the temperature coefficient of resistance, with the most common being 0.00385Ω/Ω/°C.

Other types of RTD's manufactured include copper, nickel and nickel alloys.

The amount of resistance of an individual RTD bulb (100Ω, 200Ω, etc.) is determined by the amount of metal between the terminal points and by the configuration of the element.

When ordering an RTD, the alpha and resistance value at 0°C (i.e.: Ro) must be specified to match the measuring instrumentation used with the RTD.

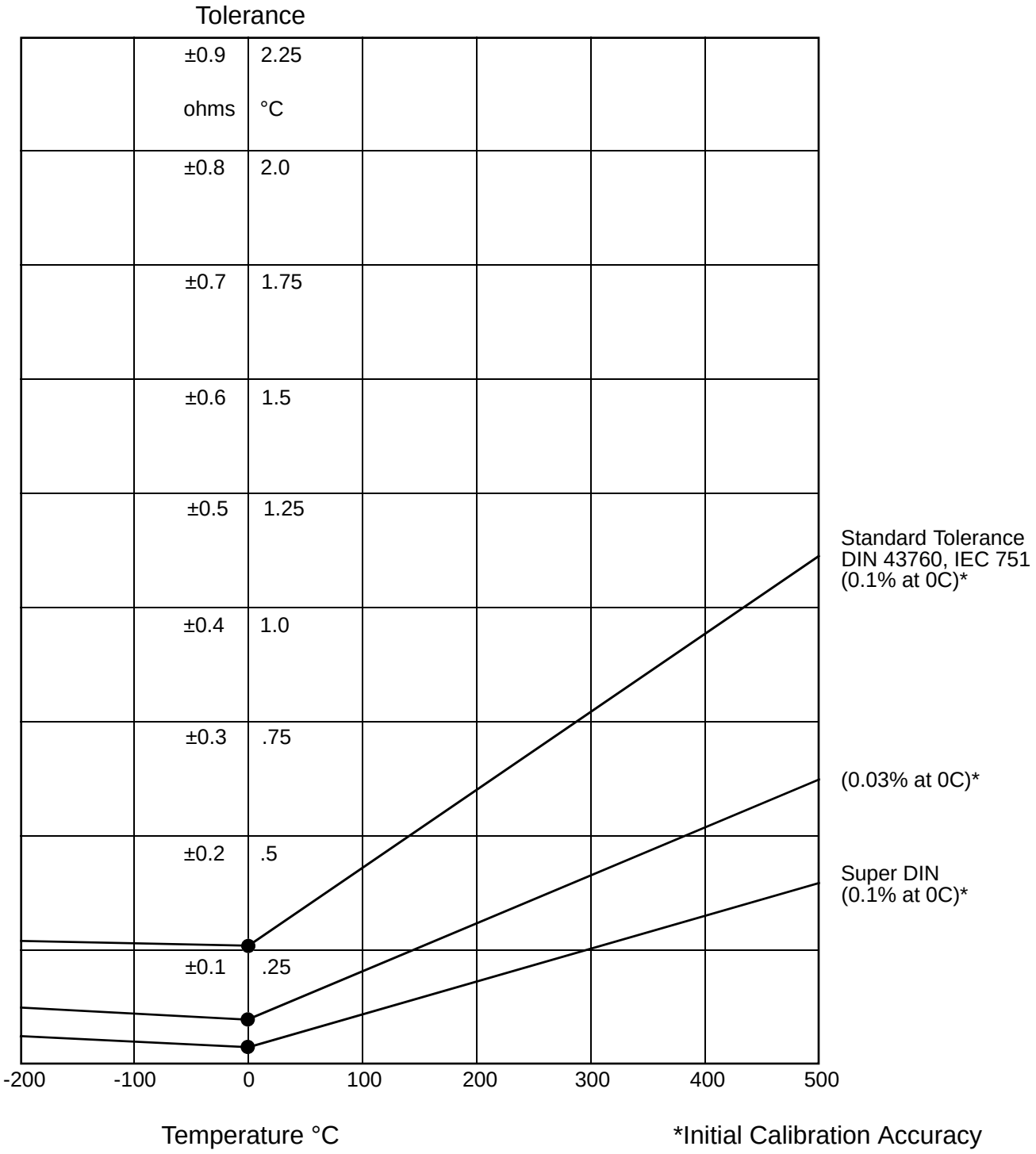
The RTD standard must also be specified. There are several RTD standards set by various organizations. These specifications are not identical and read out instrumentation must be adjusted for the specific standard of the RTD used with that equipment. Differences in the alpha values of these standards can cause errors in measurement of an RTD if one standard is connected to the instrumentation of another standard.

The following chart indicates some common RTD standards.

ORGANIZATION	STANDARD	ALPHA	NOMINAL RESISTANCE(ohms) AT 0°C
American Scientific Apparatus Makers Association (SAMA)	RC21-4-1966	0.003923	98.129
British Standards Association	B.S. 1904-1964	0.003850	100
FachnormenausschuB Elektrotchnek im Deutschen NormenausschuB	DIN 43760	0.003850	100
International Electrotechnical Commission (Supersedes BS & DIN)	IEC 751: 1983	0.003850	100
US Department of Defense	MIL-T-24388	0.00392	100

RESISTANCE TEMPERATURE DETECTORS

Super DIN
-Meets DIN 43760, I.E.C. 751 .00385 ohms/ohms/°C, to
1/10 design tolerance at initial bulb calibration
Not available in dual element swaged
-Tip sensitivity = 1 Ø + 1/2”
-Probe can be manufactured as a 3/32”, 1/8”, 1/4” or larger tube



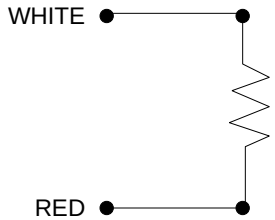
THERMOCOUPLES VS RTD'S

The following chart indicates some inherent advantages and disadvantages of RTD's or thermocouples.

	THERMOCOUPLE	RTD'S
Accuracy	Limits of error wider than RTD	Limits of error smaller than thermocouples
Ruggedness	Excellent	Sensitive to strain, shock, and pressure
Temperature	-400° to 4200°F	-200° to 1475°F
Size	Can be as small as .01" sheath material, tip sensitive	Size limited to 1/16", temperature sensitive for length of bulb
Drift	Should be checked periodically, higher than RTD's	0.01 to 0.1°C per year, less drift than thermocouple
Resolution	Must resolve millivolts per degree, lower signal to noise ratio	Ohms per degree, much higher signal to noise ratio than thermocouple
Cold Junction Reference	Required	Not required
Lead wire	Must match lead wire calibration to thermocouple calibration	Can use copper lead wire for extension wire
Response	Can be made small enough for millisecond response time	Thermal mass restricts time to seconds or more
Cost	Low	Higher than thermocouples

LEADWIRE CONFIGURATION EXPLANATION

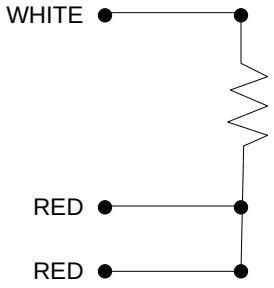
A resistance temperature detector determines the temperature by measuring resistance. The sensing element is usually a small diameter wire manufactured so that its resistance will change in a known and consistent manner. To measure the resistance accurately and consistently, other extraneous resistances must be compensated for or minimized. A major cause of extraneous resistance is leadwire in series with the RTD. The readout is the sum of the bulb resistance and the leadwire resistances. The leadwire resistance can be compensated in most applications by a three wire RTD leadwire configuration.



SYMBOL Z
2 WIRE CONFIGURATION

Figure 1

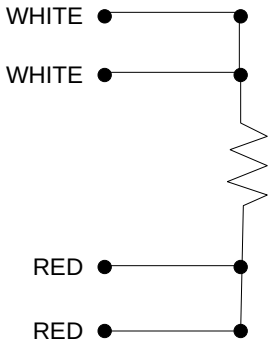
In the three wire configuration, the power supply is taken to one side of the resistance temperature detector. This puts the other two leadwires in opposite arms of the wheatstone bridge so that they cancel each other out and have little effect on the bridge output voltage. In the 3 wire configuration, the resistance of the lead wire length is compensated for in the Wheatstone bridge. This design is recommended for most industrial applications.



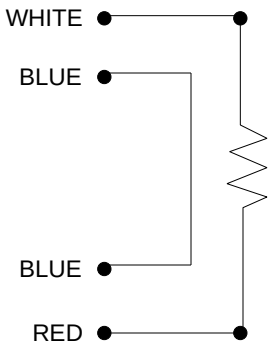
SYMBOL Y
3 WIRE CONFIGURATION

Figure 2

An even more accurate wire configuration is the 4 wire design. In this design, leadwires #1 and #2 are on one side of the power supply while leadwires #3 and #4 are on the other side of the power supply. All four leadwire resistances in this case are negated and the bulb resistance stands as the resistance input alone. We strongly recommend this design. You must have a good 4 wire input device. Call us for recommendations.



SYMBOL W
STANDARD
4 WIRE
CONFIGURATION



SYMBOL V
UNCOMMON
4 WIRE
CONFIGURATION

Figure 3

JMS RTD color codes are per ASTM E1137 and IEC 751 specifications.

RTD OPERATION AND INSTALLATION INSTRUCTIONS

RTD's are installed by means of compression fittings, welded or spring-loaded NPT fittings, or bayonet fittings.

Follow these instructions for installation of an RTD with a 1/2" x 1/2" NPT fitting:

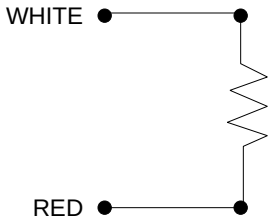
(1) Insert RTD into process hole or opening.

(2) Tighten probe into place by turning probe into threaded connection.

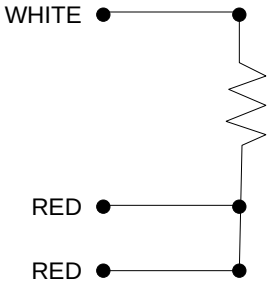
If cold-end termination of the RTD is wired into head and you have a spring loaded fitting, then the wires should be disconnected from the terminal block to prevent twisting and shorting.

ELECTRICAL:

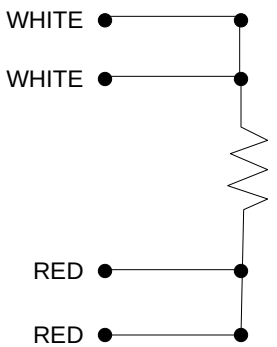
Make sure the extension wire is clean so that a good electrical connection will result at the terminal block. We recommend the use of a lacquer, cement, or other moisture proof sealing to prevent oxidation and the loosening of terminals. Connect the positive extension wire to the positive RTD wire and the negative extension wire to the negative RTD wire. Wires are color coded for identification as follows:



T**wo Wire Configuration:**
Connect the white wire to the positive connection terminal and connect the red wire to the negative connection terminal.



Three Wire Configuration:
The two red wires are common. Connect the white wire to the positive connection terminal and the two red wires to the negative connection terminals. The second red wire is the compensating lead wire.



Four Wire Configuration:
The two white wires are common and the two red wires are common. Connect the two red wires to the negative connection terminals and the two white wires to the positive connection terminals.

TEMPERATURE vs RESISTANCE TABLE

Din 43760, IEC 751 100Ω Platinum RTD
Alpha=.00385
JMS TYPE E, P, S

Temp. (degrees C)	0	(-10)	(-20)	(-30)	(-40)	(-50)	(-60)	(-70)	(-80)	(-90)
-200	18.53	14.36	10.41							
-100	60.20	56.13	52.04	47.93	43.80	39.65	35.48	31.28	27.05	22.78
0	100.00	96.07	92.13	88.17	84.21	80.25	76.28	72.29	68.28	64.25
	0	(10)	(20)	(30)	(40)	(50)	(60)	(70)	(80)	(90)
0	100.00	103.90	107.79	111.67	115.54	119.40	123.24	127.07	130.89	134.70
100	138.50	142.28	146.06	149.82	153.57	157.32	161.04	164.76	168.47	172.16
200	175.84	179.51	183.17	186.82	190.46	194.08	197.70	201.30	204.88	208.46
300	212.03	215.58	219.13	222.66	226.18	229.69	233.19	236.67	240.15	243.61
400	247.06	250.50	253.93	257.34	260.75	264.14	267.52	270.89	274.25	277.60
500	280.93	284.26	287.57	290.87	294.16	297.43	300.70	303.95	307.20	310.43
600	313.65	316.86	320.05	323.24	326.41	329.57	332.72	335.86	338.99	342.10

NOTE: Due to the interchangeability tolerance of the RTD's, the JMS type E matches both DIN 43760 / IEC 751, and British Standard BS 1904 curves.

BS 1904, 100Ω Platinum RTD
Alpha=.00385
JMS TYPE E

Temp. (degrees C)	0	(-10)	(-20)	(-30)	(-40)	(-50)	(-60)	(-70)	(-80)	(-90)
-200	18.56	14.40	10.45							
-100	60.28	56.21	52.12	48.01	43.88	39.72	35.54	31.34	27.11	22.83
0	100.00	96.09	92.16	88.23	84.29	80.32	76.34	72.35	68.34	64.32
	0	(10)	(20)	(30)	(40)	(50)	(60)	(70)	(80)	(90)
0	100.00	103.90	107.79	111.67	115.54	119.40	123.24	127.07	130.89	134.70
100	138.50	142.29	146.06	149.82	153.57	157.31	161.04	164.76	168.46	172.16
200	175.83	179.50	183.16	186.82	190.45	194.07	197.69	201.29	204.88	208.46
300	212.02	215.58	219.12	222.66	226.18	229.69	233.19	236.68	240.16	243.61
400	247.08	250.52	253.95	257.37	260.77	264.17	267.56	270.94	274.29	277.64
500	280.98	284.31	287.67	290.93	294.22	297.50	300.76	304.02	307.27	310.51
600	313.72	316.93	320.12	323.31	326.50	329.60	332.80	335.90	339.10	342.20

NOTE: Due to the interchangeability tolerance of the RTD's, the JMS type E matches both DIN 43760 / IEC 751, and British Standard BS 1904 curves.

TEMPERATURE vs RESISTANCE TABLE

SAMA RC21-4 1966, 98.13Ω Platinum RTD
Alpha=.003923
JMS TYPE F

Temp. (degrees C)	0	(-10)	(-20)	(-30)	(-40)	(-50)	(-60)	(-70)	(-80)	(-90)
-200	16.67									
-100	58.40	54.34	50.26	46.15	42.02	37.87	33.69	29.48	25.24	20.97
0	98.13	94.22	90.29	86.36	82.41	78.44	74.47	70.47	66.47	62.44
	0	(10)	(20)	(30)	(40)	(50)	(60)	(70)	(80)	(90)
0	98.13	102.03	105.92	109.80	113.67	117.52	121.37	125.20	129.02	132.83
100	136.63	140.41	144.19	147.95	151.70	155.44	159.17	162.89	166.06	170.29
200	173.97	177.64	181.30	184.95	188.58	192.22	195.83	199.43	203.02	206.60
300	210.17	213.73	217.27	220.80	224.33	227.84	231.34	234.83	238.30	241.77
400	245.22	248.66	252.09	255.51	258.92	262.32	265.70	269.07	272.43	275.78
500	279.12	282.45	285.76	289.07	292.36	295.64	298.91	302.17	305.42	308.65
600	311.88									

JISC 1604-1981, 100Ω Platinum RTD
Alpha=.003916
JMS TYPE G

Temp. (degrees C)	0	(-10)	(-20)	(-30)	(-40)	(-50)	(-60)	(-70)	(-80)	(-90)
-200	17.05									
-100	59.57	55.43	51.28	47.10	42.90	38.67	34.41	03.12	25.80	21.44
0	100.00	92.03	92.03	88.02	84.00	79.97	75.92	71.86	67.78	63.68
	0	(10)	(20)	(30)	(40)	(50)	(60)	(70)	(80)	(90)
0	100.00	103.97	107.93	111.87	115.81	119.73	123.64	127.54	131.42	135.30
100	139.16	143.01	146.85	150.68	154.49	158.30	162.09	165.87	169.64	173.40
200	177.14	180.87	184.60	188.30	192.00	195.69	199.36	203.03	206.68	210.31
300	213.94	217.56	221.16	224.75	228.33	231.90	235.46	239.00	242.53	246.05
400	249.56	253.06	256.55	260.02	263.48	266.93	270.37	273.80	277.21	280.61
500	284.00	287.38	290.75	294.11	297.45	300.78	304.10	307.41	310.71	313.99
600	317.27	320.53	323.78							

Laboratory Grade, 100Ω Platinum RTD
Alpha=.00392
JMS TYPE J

Temp. (degrees C)	0	(-10)	(-20)	(-30)	(-40)	(-50)	(-60)	(-70)	(-80)	(-90)
0	100.00	96.02	92.02	88.01	83.99	79.96	75.91			
	0	(10)	(20)	(30)	(40)	(50)	(60)	(70)	(80)	(90)
0	100.00	103.97	107.93	111.88	115.82	119.75	123.66	127.56	131.45	135.33
100	139.20	143.06	146.90	150.73	154.55	158.36	162.16	165.94	169.72	173.48
200	177.23	180.97	184.69	188.41	192.11	195.80	199.48	203.15	206.80	210.45
300	214.08	217.70	221.31	224.91	228.50	232.07	235.63	239.19	242.72	246.25
400	249.76	253.27	256.76	260.24	263.71	267.16	270.61	274.04	277.46	280.88
500	284.27	287.66	291.03	294.40	297.75	301.09	304.42	307.73	3011.04	314.33
600	317.61	320.88	324.14	327.38	330.62	333.84	337.05	340.25	343.44	346.61

NOTE: Based on NIST Supplementary ITS-90. These values were available at time if publication but subject to approval by ASTM as laboratory grade.

TEMPERATURE vs RESISTANCE TABLE

Uncommon American 100Ω Platinum RTD
Alpha=.003902
JMS TYPE H

Temp. (degrees C)	0	(-10)	(-20)	(-30)	(-40)	(-50)	(-60)	(-70)	(-80)	(-90)
-100	59.69									
0	100.00	96.03	92.06	88.06	84.06	80.04	76.01	71.96	67.89	63.80
	0	(10)	(20)	(30)	(40)	(50)	(60)	(70)	(80)	(90)
0	100.00	103.96	107.90	111.83	115.75	119.66	123.55	127.44	131.31	135.17
100	139.02	142.86	146.68	150.50	154.30	158.09	161.87	165.64	169.39	173.14
200	176.87	180.59	184.30	188.00	191.68	195.35	199.02	202.67	206.31	209.93
300	213.55	217.15	220.74	224.32	227.89	231.45	234.99	238.52	242.05	245.56
400	249.05	252.54	256.01	259.48	262.93	266.37	269.79	273.21	276.62	280.01
500	283.39	286.76	290.11	239.46	296.79	300.12	303.43	306.73	310.01	313.29
600	316.55	319.80	323.04	326.27	329.49	332.70				

ADDITIONAL RTD ELEMENT TYPES

The following are available in addition to the RTD element types listed on page 3-1.
Elements may be specified with an “X” in the part number.

ALPHA	RESISTANCE VALUE	TOLERANCE
Platinum - 0.003750	1000 ohms @ 0 deg. C	±0.2%
Platinum - 0.003850	10 ohms @ 0 deg.C	±0.2%
Platinum - 0.003850	10 ohms @ 20 deg. C	±0.2%
Platinum - 0.003850	10 ohms @ 25 deg. C	±0.2%
Platinum - 0.003850	20 ohms @ 0 deg. C	±0.2%
Platinum - 0.003850	50 ohms @ 0 deg. C	±0.2%
Platinum - 0.003850	200 ohms @ 0 deg. C	±0.1%
Platinum - 0.003850	500 ohms @ 0 deg. C	±0.1%
Platinum - 0.003850	1000 ohms @ 0 deg. C	±0.1%
Platinum - 0.003900	100 ohms @ 0 deg. C	±0.2%
Platinum - 0.003900	130 ohms @ 0 deg. C	±0.1%
Platinum - 0.003910	8 ohms @ 0 deg. C	±0.5%
Platinum - 0.003910	10 ohms @ 0 deg. C	±0.5%
Platinum - 0.003910	32 ohms @ 0 deg. C	±0.5%
Platinum - 0.003910	98.129 ohms @ 0 deg. C	±0.1%
Platinum - 0.003910	100 ohms @ 0 deg. C	±0.5%
Platinum - 0.003910	500 ohms @ deg. C	±0.5%
Platinum - 0.003920	100 ohms @ 0 deg. C	±0.1 deg. C
Platinum - 0.003920	200 ohms @ 0 deg. C	±0.1 deg. C
Platinum - 0.003920	500 ohms @ 0 deg. C	±0.1 deg. C
Platinum - 0.003926	25.5 ohms @ 0 deg. C	±0.1%
Platinum - 0.003926	100 ohms @ 0 deg. C	±0.5%
Platinum - 0.003926	200 ohms @ 0 deg. C	±0.5%
Platinum - 0.003926	470 ohms @ 0 deg. C	±0.5%
Platinum - 0.003926	500 ohms @ 0 deg. C	±0.5%
Nickel - N/A	110 ohms @ 0 deg. C	±0.5%
Ni Fe - N/A	1000 ohms deg. @ 21.1 deg. C	±0.5%
Ni Fe - N/A	2000 ohms @ 21.1 deg. C	±0.5%
Copper - N/A	100 ohms @ 25 deg.C	±0.2%

RESISTANCE / TEMPERATURE TABLE
COPPER 10Ω AT 25°C

°C	0	1	2	3	4	5	6	7	8	9
-190	1.471	1.430	1.389	1.348	1.306	1.265	1.223	1.182	1.140	1.009
-180	1.884	1.843	1.802	1.761	1.719	1.678	1.637	1.596	1.554	1.513
-170	2.295	2.254	2.213	2.172	2.131	2.090	2.049	2.008	1.967	1.925
-160	2.705	2.664	2.623	2.582	2.541	2.500	2.459	2.418	2.377	2.336
-150	3.112	3.072	3.031	2.990	2.949	2.909	2.868	2.827	2.786	2.745
-140	3.519	3.478	3.437	3.397	3.356	3.316	3.275	3.234	3.194	3.153
-130	3.923	3.883	3.842	3.802	3.762	3.721	3.681	3.640	3.600	3.559
-120	4.326	4.286	4.246	4.206	4.165	4.125	4.085	4.044	4.004	3.964
-110	4.728	4.688	4.648	4.608	4.567	4.527	4.487	4.447	4.407	4.366
-100	5.128	5.088	5.048	5.008	4.968	4.928	4.888	4.848	4.808	4.768
-90	5.526	5.486	5.446	5.407	5.367	5.327	5.287	5.247	5.208	5.168
-80	5.923	5.883	5.844	5.804	5.764	5.725	5.685	5.645	5.606	5.566
-70	6.318	6.279	6.239	6.200	6.160	6.121	6.081	6.042	6.002	5.962
-60	6.712	6.672	6.633	6.594	6.554	6.515	6.476	6.436	6.397	6.358
-50	7.104	7.064	7.025	6.986	6.947	6.908	6.869	6.830	6.790	6.751
-40	7.490	7.451	7.413	7.374	7.335	7.296	7.258	7.220	7.181	7.142
-30	7.876	7.838	7.799	7.761	7.722	7.683	7.645	7.606	7.568	7.529
-20	8.263	8.224	8.185	8.147	8.108	8.070	8.031	7.992	7.954	7.915
-10	8.649	8.610	8.572	8.533	8.494	8.456	8.417	8.378	8.340	8.301
0	9.035	9.996	9.958	8.919	8.881	8.842	8.805	8.765	8.726	8.687
0	9.035	9.074	9.112	9.151	9.189	9.228	9.267	9.305	9.344	9.383
10	9.421	9.460	9.498	9.537	9.576	9.614	9.653	9.692	9.730	9.769
20	9.807	9.846	9.885	9.923	9.962	10.000	10.039	10.078	10.116	10.155
30	10.194	10.232	10.271	10.309	10.348	10.387	10.425	10.464	10.502	10.541
40	10.580	10.618	10.657	10.696	10.734	10.773	10.811	10.850	10.889	10.927
50	10.966	11.005	11.043	11.082	11.120	11.159	11.198	11.236	11.275	11.313
60	11.352	11.391	11.429	11.468	11.507	11.545	11.584	11.622	11.661	11.700
70	11.738	11.777	11.816	11.854	11.893	11.931	11.970	12.009	12.047	12.086
80	12.124	12.163	12.202	12.240	12.279	12.318	12.356	12.395	12.433	12.472
90	12.511	12.549	12.588	12.627	12.665	12.704	12.742	12.781	12.820	12.858
100	12.897	12.935	12.974	13.013	13.051	13.090	13.129	13.167	13.206	13.244
110	13.283	13.322	13.360	13.399	13.437	13.476	13.515	13.553	13.592	13.631
120	13.669	13.708	13.746	13.785	13.824	13.862	13.901	13.940	13.978	14.017
130	14.055	14.094	14.133	14.171	14.210	14.248	14.287	14.326	14.364	14.403
140	14.442	14.480	14.519	14.557	14.596	14.635	14.673	14.712	14.751	14.789
150	14.828	14.867	14.906	14.945	14.984	15.022	15.061	15.100	15.139	15.178
160	15.217	15.256	15.295	15.334	15.373	15.412	15.451	15.490	15.529	15.568
170	15.607	15.646	15.685	15.724	15.736	15.802	15.840	15.879	15.918	15.957
180	15.996	16.035	16.074	16.113	16.152	16.191	16.230	16.269	16.308	16.347
190	16.386	16.425	16.464	16.503	16.542	16.581	16.620	16.659	16.698	16.737
200	16.776	16.815	16.854	16.893	16.932	16.971	17.010	17.049	17.088	17.127
210	17.166	17.205	17.244	17.283	17.321	17.360	17.399	17.348	17.477	17.516
220	17.555	17.594	17.633	17.672	17.711	17.750	17.789	17.828	17.867	17.906
230	17.945	17.984	18.023	18.062	18.101	18.140	18.179	18.218	18.257	18.296
240	18.335	18.374	18.413	18.452	18.491	18.530	18.569	18.608	18.648	18.687
250	18.726	18.765	18.804	18.843	18.882	18.921	18.960	18.999	18.038	18.077
260	19.116									

RESISTANCE / TEMPERATURE TABLE
NICKEL 120Ω AT 0°C

°C	0	1	2	3	4	5	6	7	8	9
-70	73.10	72.45	71.80	71.15	70.50	69.85	69.20	68.55	67.90	67.25
-60	79.62	78.97	78.31	77.66	77.01	76.36	75.71	75.06	74.40	73.75
-50	86.17	85.51	84.86	84.20	83.55	82.89	82.84	81.58	80.93	80.27
-40	92.76	92.10	91.44	90.78	90.12	89.46	88.80	88.14	87.48	86.83
-30	99.41	98.74	98.07	97.41	96.74	96.07	95.41	94.75	94.08	93.42
-20	106.15	105.47	104.79	104.11	103.44	102.77	102.09	101.42	100.75	100.08
-10	113.00	112.31	111.62	110.93	110.25	109.56	108.87	108.19	107.51	106.83
0	120.00	119.29	118.58	117.88	117.17	116.47	115.77	115.08	114.38	113.69
0	120.00	120.71	121.42	122.13	112.85	123.57	124.28	125.00	125.72	126.45
10	127.17	127.90	128.63	129.36	130.09	130.82	131.56	132.29	133.03	133.77
20	134.52	135.26	136.01	136.76	137.51	138.26	139.02	139.77	140.53	141.29
30	142.06	142.82	143.59	144.36	145.13	145.90	145.68	147.46	148.23	149.01
40	149.79	150.58	151.36	152.15	152.94	153.74	154.53	155.33	156.13	156.93
50	157.74	158.55	159.36	160.17	160.98	161.80	162.62	163.44	164.26	165.08
60	165.90	166.73	167.56	168.38	169.21	170.05	170.88	171.72	172.56	173.40
70	174.25	175.10	175.95	176.80	177.66	178.51	179.37	180.24	181.10	181.97
80	182.84	183.71	184.59	185.46	186.34	187.22	188.10	188.98	189.87	190.75
90	191.64	192.53	194.32	193.42	195.21	196.11	197.01	197.91	198.82	199.73
100	200.64	201.55	202.46	203.38	204.30	205.22	206.14	207.06	207.99	208.92
110	209.85	210.78	211.72	212.66	213.60	214.54	215.49	216.44	217.39	218.34
120	219.29	220.25	221.21	222.17	223.14	224.10	225.07	226.04	227.01	227.99
130	228.96	229.94	230.92	231.90	232.89	233.88	234.87	235.86	236.85	237.85
140	238.85	239.85	240.85	241.86	242.86	243.87	244.88	245.89	246.91	247.93
150	248.95	249.97	251.00	242.02	253.05	254.09	255.12	256.16	257.21	258.25
160	259.30	260.35	261.40	262.45	263.51	264.57	265.63	266.60	267.76	268.83
170	269.91	270.98	272.06	273.14	274.22	275.30	276.39	277.48	278.57	279.67
180	280.77	281.87	282.98	284.09	285.21	286.33	287.45	288.57	289.70	290.83
190	291.96	293.10	294.24	295.38	296.52	297.67	298.82	299.97	301.13	302.29
200	303.46	304.62	305.80	306.97	308.15	309.34	310.52	311.72	312.91	314.11
210	315.31	316.52	317.72	318.94	320.15	321.37	322.59	323.82	325.05	326.29
220	327.53	328.77	330.02	331.27	332.52	335.05	333.78	336.32	337.59	338.86
230	340.14	314.42	342.71	344.00	345.30	346.59	234.90	349.20	350.51	351.82
240	353.14	354.46	355.79	357.12	358.45	359.79	361.13	362.47	363.82	365.18
250	366.53	376.89	369.26	370.62	372.00	373.37	374.75	376.13	377.52	378.91
260	380.31	381.70	385.11	384.52	385.93	387.34	388.77	390.19	391.62	393.05
270	394.49	395.93	379.38	398.82	400.28	401.73	403.19	404.66	406.12	407.60
280	409.07	410.55	412.03	413.52	415.01	416.51	418.01	419.51	421.02	422.53
290	424.05	425.57	427.09	428.62	430.16	431.70	433.24	434.78	436.33	437.89
300	439.44	441.00	442.57	444.13	445.70	447.28	448.86	450.44	452.02	453.61
310	455.20	456.80	458.40	460.00	461.60	463.20	464.80	466.40	468.00	46.60
320	471.20									