thermo sensors corporation

Address: P.O. Box 461947 Garland, TX 75046
Phone: 972-494-1566 **Toll Free:** 1-800-889-5478
Website: www.thermosensors.com

Resistance Temperature Detectors (RTDs)

Resistance Temperature Detectors (RTD's). These detectors are frequently used in the plastics industries and many others. Care must be taken to eliminate moisture and vibration effects can be troublesome as well. Thermo Sensors provides the utmost in current state of the art in materials, techniques and research.

Thermo Sensors offers the Reliatemp RTD. This RTD features lifetime moisture free use as well as excellent vibration resistance.

Please refer to our order guide to assist in determining your needs. We can also provide technical design assistance and application suggestions. Give us a call.

Reliatemp RTD

Advantages of Thermo Sensors' new "RELIATEMP" RTD

- Great insulation resistance due to highly compacted Mgo along with proprietary techniques performed during manufacturing. Thermo Sensors standard IR test is 100 volts input with a pass being greater than 2000 megohms.
- Wide span of temperature, (-200¬† to +400¬† c) with optional I-600 sheath (-200¬† to +660¬† c).
- Vibration resistant due to encapsulation method of element.
- Improved time response due to moisture free Mgo compaction.
- Less drift due to Mgo compaction and iron-free backing powder in RTD tip.

Reliatemp RTD Specs

Ice Point Resistance:	100 ohm ± .10 ohm
Temperature Range:	-200¬† TO +660¬†c
Insulation Resistance:	>2000 megaohms (waterproof)
Time Response:	2.1 seconds
Thermal Shock:	450¬†c plunged into room temperature water at 3 fps, five times
Thermal Cycling:	284 cycles between 26¬† and 480¬†c (62 min. intervals)
Self Heating:	7.8 ohm/watt with 60 mw/1.2¬†c
Vibration:	Three axes with 3 g's acceleration (5 to 500 Hz) at room temperature
High Temp Vibration:	One axis with 20 g's acceleration (30 to 550 Hz) at 540¬†c

**RTD'S fabricated per ASTM E1137

**RTD'S tested per ASTM E644 & beyond

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Reliatemp RTD Warranty

Thermo Sensors warrants all RTD's to be free from defects in workmanship for a three year period. This warranty is limited to workmanship in the encapsulation process. RTD's which fail within the three year period due to vibration, physical abuse or process, will not be covered under warranty.

Thermo Sensor's Reliatemp RTD is completely waterproof. Therefore, insulation resistance is guaranteed for a lifetime to be moisture free, greater than 2000 megohms.

Rtd's which "fall within" the warranty conditions will be replaced at no charge, after the Thermo Sensors evaluation.

Introduction

For years Thermo Sensors Corporation has been furnishing quality RTD's used to control industrial processes worldwide. Being genuinely dedicated to furnishing materials to current state-of-the-art techniques; Thermo Sensors Corporation is constantly striving for innovation and improvement in all its products. An example is our development of Reliatemp, industries only lifetime moisture free RTD along with excellent vibration resistance, solving industries two main problems. We are dedicated to continue furnishing industry with precision high quality products.

The information in this section is designed to help you better understand RTD's and give ordering information in a clear and concise way.

Application and Technical Data

Linearity

Linearity is defined as the maximum deviation of the calibration curve (an average of the upscale and downscale readings) from a straight line so positioned as to minimize the maximum deviation.

Platinum resistance elements have a nearly linear output while nickel and nickel-iron (Balco) sensors are quite curved. Copper elements are also nearly linear over their narrow temperature range.

Stability

Stability is the relationship of a sensor's original resistance curve to its curve after being in service. Drift rates published by a manufacturer must be assumed to be applicable to high purity laboratory environment probes. The published drift rates of 0.0°C are to be considered general and not necessarily quantitative.

Several parameters affect stability in a platinum sensor used in industrial processes. Thermal and mechanical treatment cause physical changes in the crystalline structure of the platinum causing different resistances at different temperatures. Chemical reactions involving platinum and impurities as well as migration of internal materials can affect a sensor output. A shunting effect due to insulation resistance deterioration is another influencing occurrence.

The drift caused by these conditions is not normally catastrophic except in rare instances. Attempts to establish a statement of stability in industrial applications would result in an ambiguous approximation at best.

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Self-Heating

Since an RTD measures temperature by passing a current through a resistor (the RTD), the error known as self-heating occurs.

Primarily the sensor's mass, its internal construction, the measurement current and to a large degree environmental conditions determine the magnitude of this error. Normally a very small current, usually 1-5 milliamps is used in the excitation circuit to minimize this joule heating of the sensor. Thermo Sensors' internal construction technique maximizes heat transfer quality to further reduce the effect.

An installation condition requiring large mass hardware such as thermowells or protective tubes coupled with an environment of still or slow moving air is going to experience a great deal more self-heating than the next example. a small diameter (.250" O.D.) direct immersion probe mounted in an environment of flowing water (min. 3 ft./sec) could totally dissipate the error.

Fortunately if a small measuring current (1-2 ma) is used, selfheating errors will be well within acceptable levels for industrial applications.

To approximate the amount of error; consider that normally the dissipation constant will be of the magnitude of 20-100 mw/0°C, and use the following formula.

$$\text{Self-heating error} = \frac{\text{Power}}{\text{Dissipation constant}}$$

Example: Measurement current - 2 ma
Resistance of sensor - 140 ohms
dissipation constant - 50 mw/0°C

$\text{Power} = 1^2 R$
$= (.002)^2 (140) = 0.56 \text{ MW}$

$$\text{Error} = \frac{.56 \text{ mw}}{50 \text{ mw/0°C}} \quad .011°C$$

Time Constant

Time constants are values used to indicate the time it takes a sensor to read 63.2% of a step change in temperature. This test is conducted in water flowing at 3 ft/sec or 20 ft/sec in air. Typically this measurement is made by plunging a sensor at room temperature into a bath at 80°C and noting the time required to reach 63.2% of that step change. Generally speaking, it takes approximately five (5) time constants before 100% of the step change is realized.

Several variables affect the response time of sensors. Diameter of the sheath, material of the sheath and internal construction for different temperature ranges are the most variable. It is possible, however, to approximate the time constant for a particular group of sensors based on diameter and assuming the sheath material is a 300 series stainless steel.

These approximations are:
.125" 1.1sec.
.188" 1.7sec.
.250" 2.2sec.

Note: elements capable of a lower range of -250°C (to +600°C) have similar time constants.

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These time constants should serve only as a general approximation for direct immersion sensors. Sensors installed in thermowells, protection tubes or that are mounted in conditions allowing appreciable stem losses are not subject to even these general constants.

In the rare instance where the response time absolute needs to be known; response time testing must be conducted to provide a time constant.

Insulation Resistance

To prevent an unacceptable shunting effect between the sensing element and the probe sheath, care must be taken to assure good insulation quality.

In all sensors and particularly those in industrial service, high temperature operation, contamination and moisture absorption are potential problems.

To eliminate the effects of these occurrences, Thermo Sensors adheres to stringent manufacturing procedures. Reliatemp's Insulation Resistance will always be > 2000 megaHMS at or below 100°C.

Repeatability

By definition repeatability of a sensor is the relationship of the original resistance at 0°C and any different resistance at 0°C after being subjected to the following test.

The sensor shall be brought slowly to the upper limits of its temperature range and then exposed to air at room temperature. It shall then be brought slowly to its lower limit, and exposed to air at room temperature.

This procedure is repeated ten times. The resistance of 0°C is then measured and the difference from the pre-testing resistance is 0°C is noted.

For a typical platinum probe, the resistance should not change more than 0.3°C for a 0.12% sensor or 0.15°C for a 0.06% sensor. The 0.12% and 0.06% are original resistance tolerances at 0°C of the element.

Temperature Coefficient (Alpha)

Temperature coefficient, or Alpha, is the term given to the average resistance/temperature relationship of an RTD over the temperature span of 0-100°C and is expressed as ohm/ohm/0°C. The formula for determining Alpha is:

$$A = \frac{R(100°C) - R(0°C)}{100R\ (0°C)}$$

Typical Temperature Coefficients are:

.003926	(99.999% Pure Plat. - Laboratory Grade)
.00320	(MIL-T-24388)
.00391 .003915 .003902	Sometimes referred to as American standards, although no standards exist.

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.003850	Din Standard 43760-widely used in industrial applications. B.S. 1904:1964

Note: SAMA Standard RC21-4-1966, has a temperature coefficient of .003923. The SAMA 100 ohm (Nominal) element only has a resistance of 98.129 ohms at 0°C. This element is in common use and should not be confused with the more commonly used elements having a 100 ohm resistance at 0°C.

Nickel	Copper	Nickel/Iron
.00672	.00427	(Balco)
.00618		.00519

Platinum is by far the most commonly used material in RTD probes. The other materials are used where the higher resistance change or the non-linearity of their curves are advantageous.

It becomes obvious that since Alpha is a value developed using the variables of R(0°C) & R(100°C) that the Alphas noted above are not absolutes.They do however commonly serve as adequate specifications for the standard elements.

Alpha serves as an integral component in developing resistance versus temperature tables. The R/T table for platinum sensors published at the back of this catalog were developed using the Callendar-Van Dusen equation which corrects for the departure from linearity at temperatures other than 0-100°C which is stated by Alpha.

Callendar-Van Dusen Equation

$$\frac{R}{R_0} = 1+\alpha \left[T-\delta\left(\frac{T}{100}-1\right)\left(\frac{T}{100}\right)-\beta\left(\frac{T}{100}-1\right)\left(\frac{T}{100}\right)^3\right]$$

Where:
T = Temperature (°C)
R = Resistance at temperature T
R_0 = Resistance at 0°C

α = Constant (see formula above)
δ = Constant (typical value 1.5)
β = Constant (typical value 0.11 for temperatures less than 0°C; value is zero for temperatures over 0°C)
a useful form of this equation to calculate the resistance at a given temperature at and above 0°C is:

$R_T = R_O (1 + AT + BT^2)$

$$A=\alpha\left(1+\frac{\delta}{100}\right) \quad B=-\frac{a\delta}{10^4}$$

R_T = Resistance at temperature T
R_O, T, a and d are defined in the first equation.

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Accuracy - Interchangeability

The terms accuracy and interchangeability are used jointly when considering the accuracy of an RTD. The factors affecting the accuracy of an RTD measurement excluding the accuracy of the readout instrument, is the relationship of the "as built" sensor to the resistance vs. temperature curve when compared to the assumed curve (the resistance vs. temperature table), and any aging or other environment effects on the sensor.

It is impossible to manufacture on a production basis sensors that will adhere to the calculated value of their resistance vs. temperature tables. There are three terms to be considered to understand why. They are:

Temp	Tolerance	
C	± 0° C	± OHMS
-.200	1.3	0.56
-100	0.8	0.32
0	0.3	0.12
100	0.8	0.30
200	1.3	0.48
300	1.8	0.64
400	2.3	0.79
500	2.8	0.93
600	3.3	1.06
700	3.8	1.17
100 ohm ± .12% @ 0°C Element		

Proportional Error -
The error caused by the deviation of the sensor's actual temperature coefficient (Alpha) from the reference value. This error exists because of normal manufacturing tolerances in the alloying of the sensor material.

Adjustment Error -
The error caused by deviations of resistance at 0°C from the reference values. For example - a standard tolerance at 0°C for a 100 ohm platinum element is ± 0.12%. a wider tolerance of ±0.5% and tighter tolerance of ± 0.06% and ± 0.03% are available but are somewhat less expensive and appreciably higher in cost respectively.

Intrinsic Error -
Simply the sums of the proportional and adjustment errors. The intrinsic error of an element will influence its relationship to the published resistance/temperature table. Deviations are a function of temperature and accuracy statements cannot be given that will cover the entire useful range of a sensor. Therefore, an "interchangeability factor" is stated for cardinal temperatures throughout the range. The interchangeability tolerance for a 100 ohm platinum element (± 0.12%) is shown in the table below.

Note: Not all sensors are usable at all the temperatures shown. The tolerances are applicable up to the maximum temperature of a given sensor.

Calibration

Occasionally, the interchangeability tolerance listed for a sensor is unacceptable for an application. On those occasions there are three types of calibrations available. Thermo Sensors maintains a laboratory with equipment traceable to the National Bureau of Standards to furnish these calibrations.

1. If there is only one temperature of interest, or the interest is over a narrow range, elements can be selected by calibration to have a closer interchangeability tolerance of no more than .25% of the temperature. This selection calibration makes field adjustment of the measurement instrument unnecessary when elements are changed in critical applications.

2. Elements can be calibrated at a particular temperature of interest. Also if there are temperatures of interest over a narrow range, a two or three point calibration will provide the user with information for interpolation within that range so that the measurement instrument can be adjusted.

3. a complete computer generated resistance/temperature table can be provided for a platinum sensor over the range of 0°C to its maximum useful temperature. These tables can be provided in °F or °C with temperature increments from .01° to 1° as specified by the customer.

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Matched Pairs
When using two platinum sensors to measure the differential temperature of chilled water, standard ± 0.12% elements can produce an error as much as 0.6°C. Usually this is unacceptable in critical applications. In those cases, sensors having a differential of down to ± 0.6°C at 0°C or .25% of a selected temperature can be furnished by calibration at additional cost.

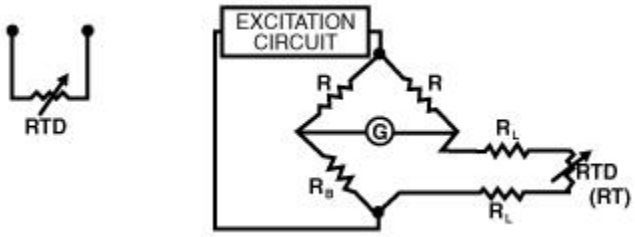
Lead Wire Compensation

Since the readout instrumentation for sensors is normally remoted considerable distances from the sensors themselves, it is important to consider and usually eliminate additional resistance imposed by the connecting wires. It is important that only the resistance change of the sensor be measured. To eliminate any change in lead resistance due to ambient changes, either a three or four wire connection should be used.

Most industrial applications are served well by using a three wire system while the four wire is common in laboratory environments.

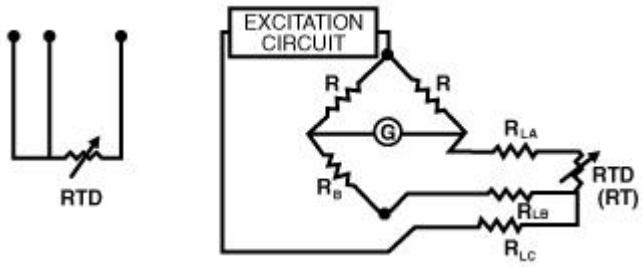
Diagrams and comments relating to the four commonly used wiring systems are shown below.

2-Wire System



At balance RB will equal RT + 2RL giving an error equal to the two leads of the sensor connection. Depending on lead length and wire size the error may be negligible or profound.

3-Wire System



Industrial sensors commonly use this three wire connection system. For this system to be effective, all the leads (R_{LA}, B, C) should be very near the same length and of the same gauge.

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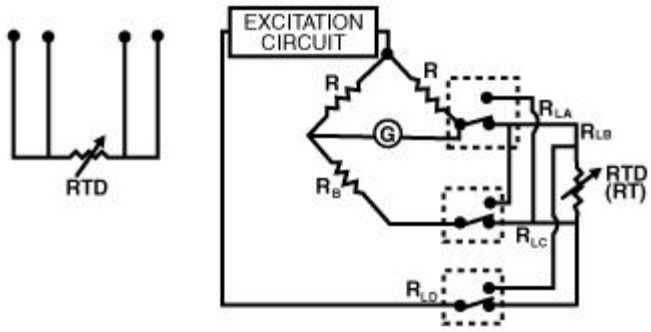
Phone: 972-494-1566 **Toll Free:** 1-800-889-5478
Website: www.thermosensors.com

At balance:
$R_B = R_{LB} = R_T + R_{LA}$
$R_T = R_B + R_{LB} - R_{LA}$

Any error would be to the magnitude of the difference in resistance of R_{LA} and R_{LB} which should be negligible assuming the leads are the same length and gauge.

4-Wire System



This system provides precision measurements. By switching the pairs of leads and averaging, you arrive at a value from which the lead resistance, thermal emf's in the leads and resistance changes in the leads due to ambient variation has been eliminated.

Switch Position a At balance:
$R_B + R_{LC} = R_T + R_{LA}$
$R_T = R_B + R_{LC} - R_{LA}$

Switch Position B
At balance:
$R_B + R_{LA} = R_T + R_{LC}$
$R_T = R_B + R_{LA} = R_{LC}$

Resistance vs. Temperature Tables

The condensed Resistance VS Temperature Tables on the following pages are provided to aid in the proper RTD element selection.

Notice that the tables for the various platinum curves are for the standard 100 ohm @ 0°C sensor.

To calculate the resistance of:

50 ohm, multiply the values by .5;
200 ohm, multiply the values by 2;
500 ohm, multiply the values by 5;
1000 ohm, multiply the values by 10.

Table C100 for the 100 ohm @ 25°C Copper (90.35 ohms @ 0°C) is published. To calculate the resistance of the 10 ohm at 25°C (9.035 ohms @ 0°C) multiply the value shown by .1.

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100 Ω Platinum (.00385 Ω/Ω/°C) @ 0° C (DIN 43760)										
Temp. °C	-100	-0	Temp. °C	0	100	200	300	400	500	600
-0	60.25	100.00	0	100	138.50	175.84	212.03	247.06	280.90	313.59
-10	56.19	96.09	10	103.90	142.29	179.51	215.58	250.50	284.22	316.80
-20	52.11	92.16	20	107.79	146.06	183.17	219.13	253.93	287.53	319.99
-30	48.00	88.22	30	111.67	149.82	186.82	222.66	257.32	290.83	323.18
-40	43.67	84.27	40	115.54	153.58	190.46	226.18	260.72	294.11	326.35
-50	39.71	80.31	50	119.40	157.32	194.08	229.69	264.11	297.39	329.51
-60	35.53	76.33	60	123.24	161.04	197.69	233.19	267.49	300.65	332.66
-70	31.32	72.33	70	127.07	164.76	201.30	236.67	270.86	303.91	335.79
-80	27.08	68.33	80	130.89	168.47	204.88	240.15	274.22	307.15	338.92
-90	22.80	64.30	90	134.70	172.16	288.46	243.61	277.56	310.38	342.13
-100	18.49	60.25	100	138.50	175.84	212.03	247.06	280.90	313.59	345.13

Interchangeability Tolerance ± (0.12% Element)								
Temp. °C	Tolerance		Temp. °C	Tolerance		Temp. °C	Tolerance	
	-0	-0		±°C	±ohm		±°C	±ohm
-200	1.3	.56	100	.08	.30	400	2.3	.79
-100	0.8	.32	200	1.3	.48	500	2.8	.93
0	0.3	.12	300	1.8	.64	600	3.3	1.06

100 Ω Platinum (.003916 Ω/Ω/°C) @ 0°C										
Temp. °C	-100	-0	Temp. °C	0	100	200	300	400	500	600
-0	57.57	100.00	0	100.00	139.16	177.13	213.93	249.56	284.02	317.28
-10	55.44	96.09	10	103.97	143.01	180.86	217.54	253.06	287.40	320.54
-20	51.29	92.02	20	107.93	146.85	184.58	221.15	256.55	290.77	323.78
-30	47.11	88.01	30	111.88	150.67	188.29	224.74	260.02	294.12	327.02
-40	42.91	83.99	40	115.81	154.49	191.99	228.32	263.49	297.47	-
-50	38.68	79.96	50	119.73	158.29	195.67	231.89	266.94	300.80	-
-60	34.42	75.91	60	123.64	162.08	199.35	235.45	270.38	304.12	-
-70	30.12	71.85	70	127.54	165.86	203.01	238.99	273.80	307.43	-

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-80	25.80	67.77	80	131.42	169.63	206.66	242.53	277.22	310.72	-
-90	21.46	63.68	90	135.30	173.38	210.30	246.05	280.63	314.01	-
-100	17.14	59.57	100	139.16	177.13	213.93	249.56	284.02	317.28	-

Interchangeability Tolerance ± (0.12% Element)								
Temp. °C	Tolerance		Temp. °C	Tolerance		Temp. °C	Tolerance	
	-0	-0		±°C	±ohm		±°C	±ohm
-200	1.3	.56	100	0.8	.30	400	2.3	.79
-100	0.8	.32	200	1.3	.48	500	2.8	.93
0	0.3	.12	300	1.8	.64	600	3.3	1.06

100 Ω Platinum (.003902 Ω/Ω/°C) @ 0°C										
Temp. °C	-100	-0	Temp. °C	0	100	200	300	400	500	600
-0	59.39	100.00	0	100.00	139.02	176.85	213.52	249.03	283.36	316.50
-10	55.55	96.03	10	103.96	142.86	180.57	217.12	252.51	286.73	316.75
-20	51.40	92.05	20	107.90	146.68	184.28	220.71	255.99	290.09	322.99
-30	47.22	88.06	30	111.83	150.49	187.98	224.29	259.45	293.43	326.21
-40	43.01	84.05	40	115.75	154.29	191.66	227.89	262.90	296.76	329.42
-50	38.77	80.03	50	119.66	158.08	195.33	231.42	266.34	300.08	332.62
-60	34.49	75.99	60	123.55	161.63	198.99	234.96	269.77	303.39	-
-70	30.17	71.94	70	127.44	165.63	202.64	238.50	273.19	306.69	-
-80	25.82	67.87	80	131.31	169.38	206.28	242.02	276.59	309.97	-
-90	21.44	63.79	90	135.17	173.12	209.91	245.53	279.98	313.24	-
-100	17.07	59.68	100	139.02	176.85	213.52	249.03	283.36	316.50	-

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Interchangeability Tolerance ± (0.12% Element)								
Temp. °C	Tolerance		Temp. °C	Tolerance		Temp. °C	Tolerance	
	-0	-0		±°C	±ohm		±°C	±ohm
-200	1.2	.50	100	0.7	.27	400	2.5	.88
-100	0.7	.30	200	1.2	.45	500	3.0	1.01
0	0.3	.10	300	1.8	.65	600	3.7	1.21

100 Ω (Nominal) Platinum (SAMA Std. RC21-4-1966) (98.129 Ω/Ω/°C) @ 0°C										
Temp. °C	-100	-0	Temp. °C	0	100	200	300	400	500	600
-0	59.399	98.129	0	136.129	136.625	173.972	210.171	245.221	279.122	311.875
-10	54.337	94.216	10	102.030	140.412	177.644	213.728	248.663	282.449	315.086
-20	50.255	90.292	20	105.920	144.187	181.304	217.273	252.093	285.764	318.287
-30	46.151	86.355	30	109.799	147.950	184.953	220.807	255.512	289.068	321.476
-40	42.023	82.405	40	113.665	151.702	188.581	224.329	258.919	292.361	324.654
-50	37.871	78.442	50	117.521	155.442	192.215	227.840	262.315	295.642	327.820
-60	33.691	74.465	60	121.365	159.171	195.829	231.339	265.699	298.911	-
-70	29.483	70.474	70	125.197	162.889	199.432	234.827	269.072	302.169	-
-80	25.244	66.466	80	129.018	166.595	203.023	238.303	272.434	305.416	-
-90	20.972	62.441	90	132.827	170.289	206.603	241.768	275.784	308.651	-
-100	16.665	58.399	100	136.625	173.972	210.171	245.221	279.122	311.875	-

Interchangeability Tolerance ± (0.12% Element)								
Temp. °C	Tolerance		Temp. °C	Tolerance		Temp. °C	Tolerance	
	-0	-0		±°C	±ohm		±°C	±ohm
-200	1.2	.50	100	100	.7	400	2.5	.85
-100	0.7	.30	200	200	1.2	500	3.0	1.0
0	0.3	.10	300	300	1.8	600	3.7	1.2

Address: P.O. Box 461947 Garland, TX 75046
Phone: 972-494-1566 **Toll Free:** 1-800-889-5478
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120 Ω Nickel (.00672 Ω/Ω/) @0°C							
Temp. °C	-100	-0	Temp. °C	0	100	200	300
-0		120.00	0	120.00	200.64	303.46	439.44
-10		113.00	10	127.17	209.85	315.31	455.20
-20		106.15	20	134.52	219.29	327.53	471.20
-30		99.41	30	142.06	228.96	340.14	-
-40		92.46	40	149.79	238.85	353.14	-
-50		86.17	50	157.74	248.95	366.53	-
-60		79.62	60	165.90	259.30	380.31	-
-70		73.10	70	174.25	269.91	394.49	-
-80		66.60	80	182.84	280.77	409.07	-
			90	191.64	291.96	424.05	-
			100	200.64	303.46	439.44	-

Interchangeability Tolerance ± (0.12% Element)								
Temp. °C	Tolerance		Temp. °C	Tolerance		Temp. °C	Tolerance	
	-0	-0		±°C	±ohm		±°C	±ohm
-200	1.3	.56	100	.08	.30	400	2.3	.79
-100	0.8	.32	200	1.3	.48	500	2.8	.93
0	0.3	.12	300	1.8	.64	600	3.3	1.06

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100 Ω Platinum (.003916 Ω/Ω/°C) @ 0°C										
Temp. °C	-100	-0	Temp. °C	0	100	200	300	400	500	600
-0	57.57	100.00	0	100.00	139.16	177.13	213.93	249.56	284.02	317.28
-10	55.44	96.09	10	103.97	143.01	180.86	217.54	253.06	287.40	320.54
-20	51.29	92.02	20	107.93	146.85	184.58	221.15	256.55	290.77	323.78
-30	47.11	88.01	30	111.88	150.67	188.29	224.74	260.02	294.12	327.02
-40	42.91	83.99	40	115.81	154.49	191.99	228.32	263.49	297.47	-
-50	38.68	79.96	50	119.73	158.29	195.67	231.89	266.94	300.80	-
-60	34.42	75.91	60	123.64	162.08	199.35	235.45	270.38	304.12	-
-70	30.12	71.85	70	127.54	165.86	203.01	238.99	273.80	307.43	-
-80	25.80	67.77	80	131.42	169.63	206.66	242.53	277.22	310.72	-
-90	21.46	63.68	90	135.30	173.38	210.30	246.05	280.63	314.01	-
-100	17.14	59.57	100	139.16	177.13	213.93	249.56	284.02	317.28	-

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Detector Tolerance Chart

Table 3

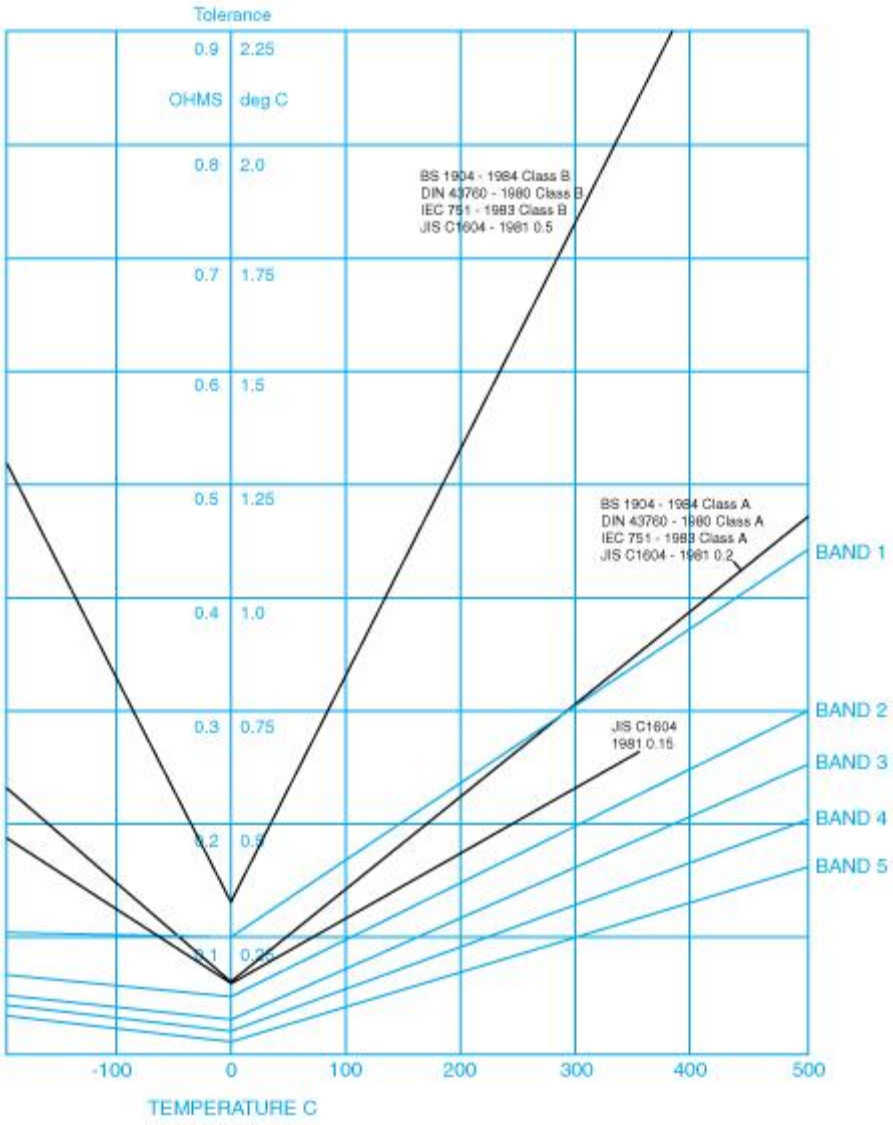

Table 3 illustrates the tolerances applicable for specifications DIN 43760 - 1980, BS 1904 : 1984, IEC 751 : 1983 and JIS C1604 - 1981, together with the Thermo Sensors Bands 1 to 5.

At the higher temperatures it should be appreciated that the tolerance deviation is most affected by variation of Alpha values, rather than R0 accuracy.

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Terminal Head Connected RTD Assemblies

Table A

Figure 1	RTD Assembly without Process Fitting	**Figure 4**	Spring-Loaded RTD Assembly with 1/2" NPT Pipe Nipple Extension

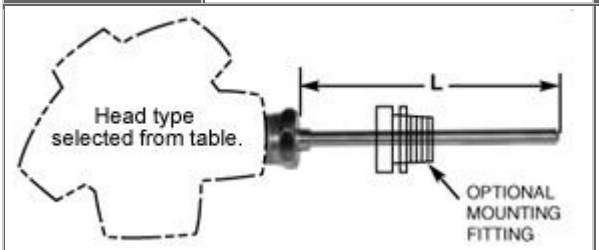
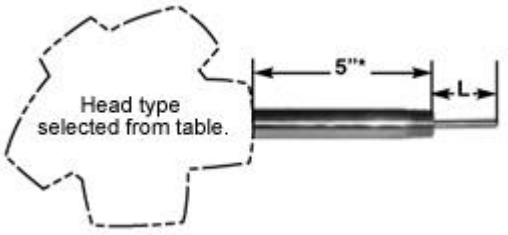

		

Figure 2	RTD Assembly with 1/2" NPT Process Fitting	**Figure 5**	Spring-Loaded RTD Assembly with 1/2" NPT Hex Fitting/Union Nipple Extension

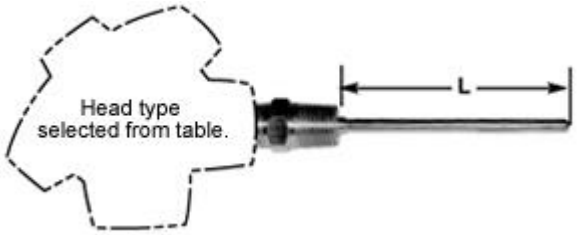
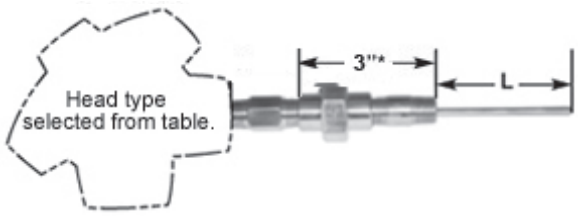
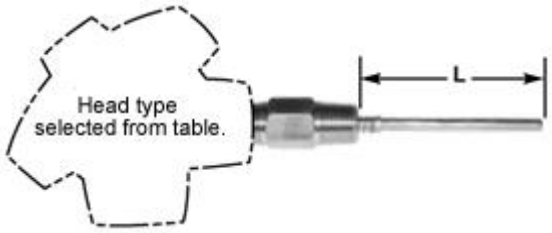
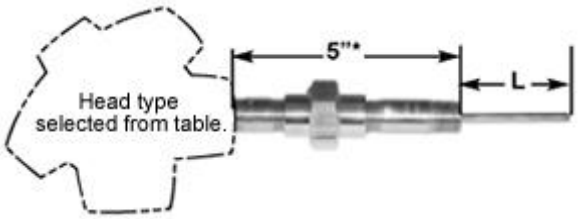

		

Figure 3	Spring-Loaded RTD Assembly with 1/2" NPT Process Fitting	**Figure 6**	Spring-Loaded RTD Assembly with 1/2" NPT Nipple/Union/Nipple Extension
			

* For custom extension length, add desired length as suffix to basic order code. Variable lengths only available in figure 4, 5 and 6
Example: 5046, for 6" long extension.

** Fitting/Extension shown in figures 1, 2, 3, & 5 only available in stainless steel.

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*** Hockey puck transmitter will fit these heads (see accessories section)

**** For corrosion resistance, epoxy coating can be ordered on there head option, Add "EC" as suffix to basic order code. Example: 300EC.

- If connection head is not required, simply insert figure number as basic order code Example:

How to Order:

Pgs. 6-8	-	Page 9						-		-	Page 10	-	TW Section
Basic Order Code		Sensor Diameter	Element	Tolerance	Temp. Range	Sheath Mate	Lead Conn.		"L" Length		Options		Order Code for Thermowell
104		4	A	1	B	1	C		12		2AS		If required (see Thermowell section)
Table A		Table B	Table C	Table D	Table E	Table F	Table G		Table H		Table I		

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Table 4 continued

Type of Head	Head Material	Basic Order Code					
		Figure 1	Figure 2	Figure 3	Figure 4	Figure 5	Figure 6
 Industrial Weatherproof Screw Cover Head	Cast Aluminum	100	200	300	400	500	600
 Epoxy Coated Weatherproof Screw Cover Head	Cast Iron	102	202	302	402	502	602
 General Purpose Weatherproof Screw Cover Head For Flip Top Style, add sufix "F" to basic order code	Cast Aluminum	104	204	304	404	504	604
 Corrosion Resistant Weatherproof Screw Cover Head For Flip Top Style, add sufix "F" to basic order code	Nylon	106	206	306	406	506	606
 CSA / ATEX / FM Approved Explosion Proof Head meets NEC Class I Div I Groups B, C, D Class II Div I, Groups E, F, G NEMA 4X, 7, 9, II2G, Ex d, IIC, Gb, II2 D, Ex tb, IIIC Db, IECEx	Cast Aluminum	108	208	308	408	508	608
	316 Stainless Steel	110	210	310	410	510	610

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RTD Assembly Specifications

Table B (sensor diameter)

Sensor Diameter		Order Code
1/8"	(.125")	2
3/16"	(.188")	3
1/4"	(.250")STD	4
5/16"	(.312")	5
3/8"	(.375")	6

Table C (element)

Resistance 0°C	Material	Temperature Coefficient/Alpha (a)	Order Code	
			Single Element	Dual Element
100Ω	Platinum	.00385Ω/Ω°C	A	2A
100Ω	Platinum	.003916Ω/Ω°C	B	2B
100Ω	Platinum	.003902Ω/Ω°C	C	2C
98.129Ω (100Ωnom-)	Platinum Sama Standard RC21-4-1966	.00392Ω/Ω°C	D	2D
120Ω	Nickel	.00672Ω/Ω°C	E	2E
9.035Ω	Copper	.00427Ω/Ω°C	F	2F

Table D (tolerance)

Accuracy at 0°C		Order Code
± .12%	Class B	1
± .06%	Class A	2
± .03%	Lab Grade	3
± .02%	Lab Grade	4
± .01%	Lab Grade	5

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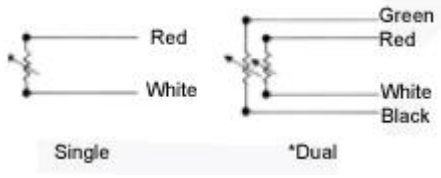
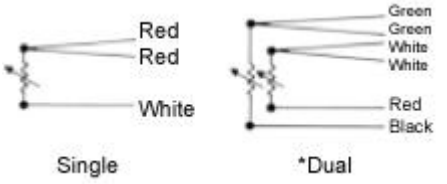
Table E (temperature range)

Temperature Range	Order Code
-200 to +250 Deg. C -328 to +482 Deg. F	A
-200 to +400 Deg. C -328 to +752 Deg. F	B
-200 to +660 Deg. C -328 to +1220 Deg. F	C

Table F (sheath material)

Sheath Material	Order Code
316 SS	1
Alloy 600	2
Alloy C-276	3

Table G (lead connection)

2-Wire	Order Code A
	
3-Wire	**Order Code B**
	
4-Wire	**Order Code C**

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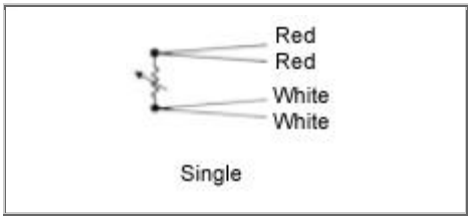


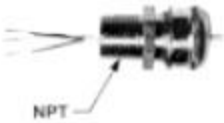
Table H (length)

Specify "L" in Inches Length Not required when Thermowell is used.

Optional Connections

(For extended lead types)

Table I (options)

	Description		Order Code
	Spade Lugs for #8 Screw		L
	Male Plug		M
	The connectors shown are for 3-wire single element assemblies. Two - 2 Pin connectors mounted in tandem will be furnished for both styles of 4-wire single element assemblies. Dual element assemblies will have the same connector arrangements except Doubled.		
	Female Jack		F
	Watertight connector	1/2" NPT	W1
		3/4" NPT	W3

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Phone: 972-494-1566 **Toll Free:** 1-800-889-5478
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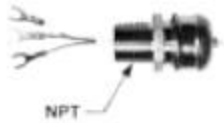
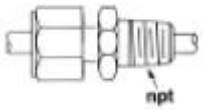
	Watertight connector with lugs for #8 screws	1/2" NPT	WL1
		3/4" NPT	WL3

Optional Mounting Fittings		
Description	**NPT**	**Order Code**
	1/8"	1AS
	1/4"	2AS
	3/8"	3AS
	1/2"	4AS
	3/4"	6AS
For Teflon readjustable insert, replace "A" with "R" Example: 4RS		

Optional Spring-Loaded Devices	
Description	**Order Code**
 Adjustable Spring	FP 275
 1/2" NPT Double threaded adjustable hex bushing	FP 240
 1/2" NPT single threaded adjustable hex bushing	

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Extended Lead RTD Assemblies

Table A (cont.)

Figure 7

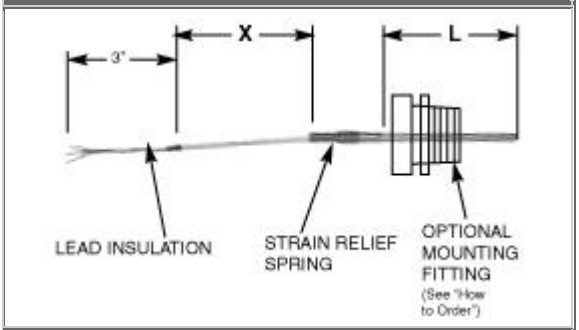

Figure 8

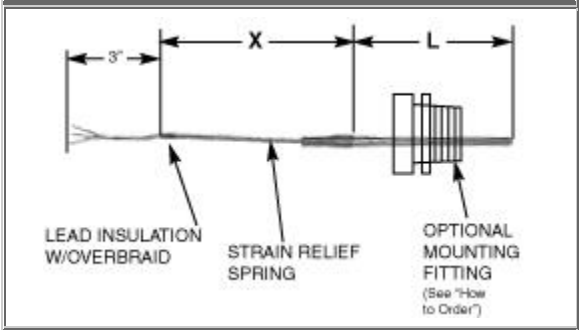

Figure 9

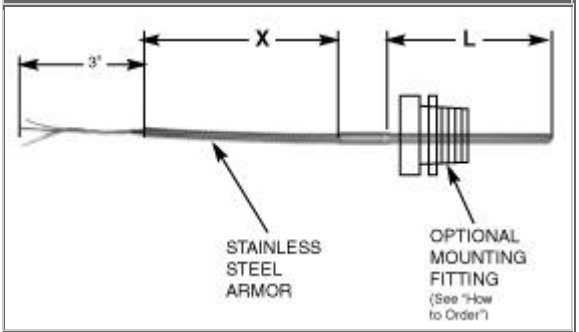

Figure 10

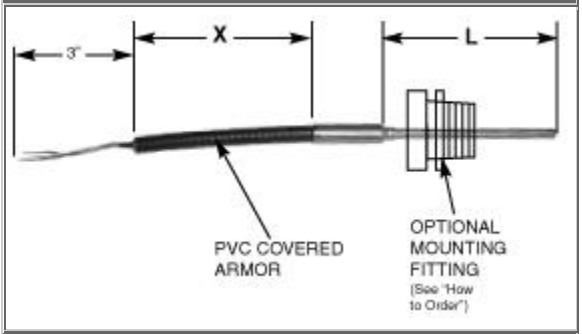

Figure 11

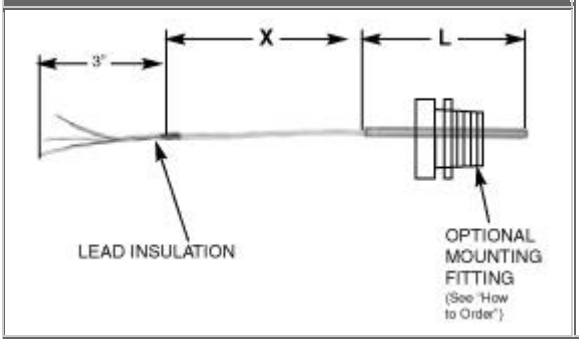

Figure 12

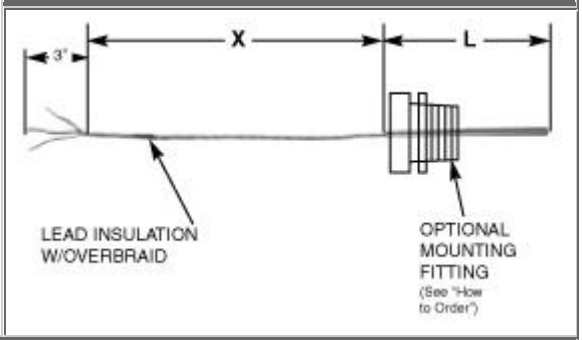

Figure 13

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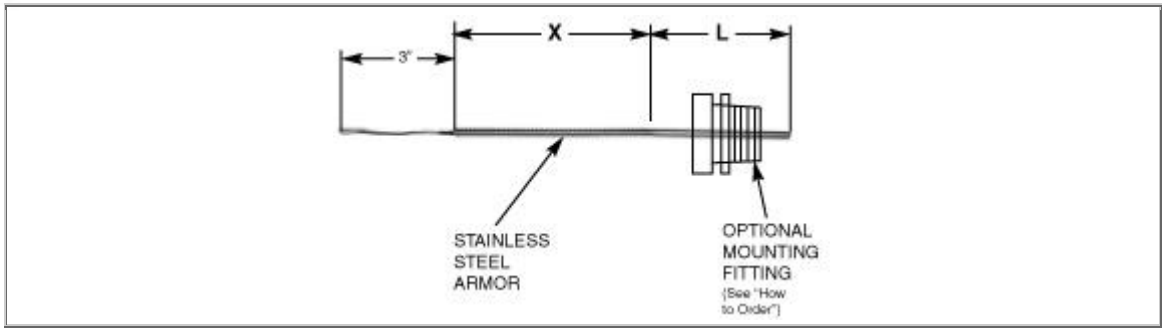

Lead Insulation	Basic Order Code						
	Figure 7	Figure 8	Figure 9	Figure 10	Figure 11	Figure 12	Figure 13
Teflon	TT (X)	TTS (X)	TTA (X)	TTP (X)	T (X)	TS (X)	TA (X)
Kapton	TK (X)	TKS (X)	TKA (X)	TKP (X)	K (X)	KS (X)	KA (X)
Polyvinyl	TP (X)	TPS (X)	TPA (X)	TPP (X)	P (X)	PS (X)	PA (X)
Fiberglass	TG (X)	TGS (X)	TGA (X)	TGP (X)	G (X)	GS (X)	GA (X)

How to Order:

Replace the "X" in "Basic" order code with desired lead extension Length in inches.

Example: TT48 for 48" Lead Length

RTD Assembly Specifications

Table B (sensor diameter)

Sensor Diameter		Order Code
1/8"	(.125")	2
3/16"	(.188")	3
1/4"	(.250")STD	4
5/16"	(.312")	5
3/8"	(.375")	6

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Table C (element)

Resistance 0°C	Material	Temperature Coefficient/Alpha (a)	Order Code	
			Single Element	Dual Element
100Ω	Platinum	.00385Ω/Ω°C	A	2A
100Ω	Platinum	.003916Ω/Ω°C	B	2B
100Ω	Platinum	.003902Ω/Ω°C	C	2C
98.129Ω (100Ωnom-)	Platinum Sama Standard RC21-4-1966	.00392Ω/Ω°C	D	2D
120Ω	Nickel	.00672Ω/Ω°C	E	2E
9.035Ω	Copper	.00427Ω/Ω°C	F	2F

Table D (tolerance)

Accuracy at 0°C		Order Code
± .12%	Class B	1
± .06%	Class A	2
± .03%	Lab Grade	3
± .02%	Lab Grade	4
± .01%	Lab Grade	5

Table E (temperature range)

Temperature Range	Order Code
-200 to +250 Deg. C -328 to +482 Deg. F	A
-200 to +400 Deg. C -328 to +752 Deg. F	B
-200 to +660 Deg. C -328 to +1220 Deg. F	C

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Table F (sheath material)

Sheath Material	Order Code
316 SS	1
Alloy 600	2
Alloy C-276	3

Table G (lead connection)

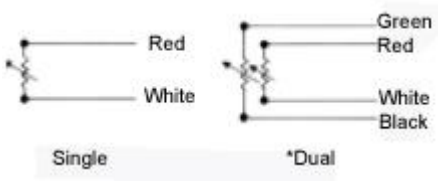
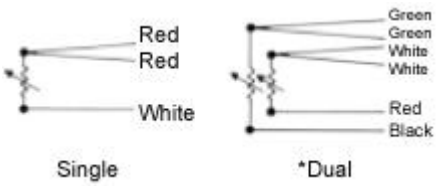
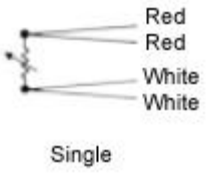
2-Wire	Order Code A
	
3-Wire	**Order Code B**
	
4-Wire	**Order Code C**
	

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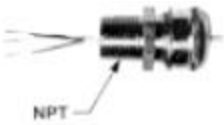
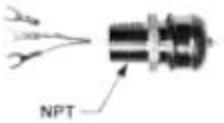
Table H (length)

Specify "L" in Inches Length Not required when Thermowell is used.

Optional Connections

(For extended lead types)

Table I (options)

	Description		Order Code
	Spade Lugs for #8 Screw		L
	Male Plug		M
	The connectors shown are for 3-wire single element assemblies. Two - 2 Pin connectors mounted in tandem will be furnished for both styles of 4-wire single element assemblies. Dual element assemblies will have the same connector arrangements except Doubled.		
	Female Jack		F
	Watertight connector	1/2" NPT	W1
		3/4" NPT	W3
	Watertight connector with lugs for #8 screws	1/2" NPT	WL1
		3/4" NPT	WL3

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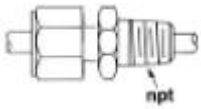
Optional Mounting Fittings		
Description	**NPT**	**Order Code**
	1/8"	1AS
	1/4"	2AS
	3/8"	3AS
	1/2"	4AS
	3/4"	6AS
For Teflon readjustable insert, replace "A" with "R" Example: 4RS		

Optional Spring-Loaded Devices	
Description	**Order Code**
 Adjustable Spring	FP 275
 1/2" NPT Double threaded adjustable hex bushing	FP 240
 1/2" NPT single threaded adjustable hex bushing	SSL

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Direct Immersion/Replacement RTD Assemblies

Table A (cont.)

Figure 14

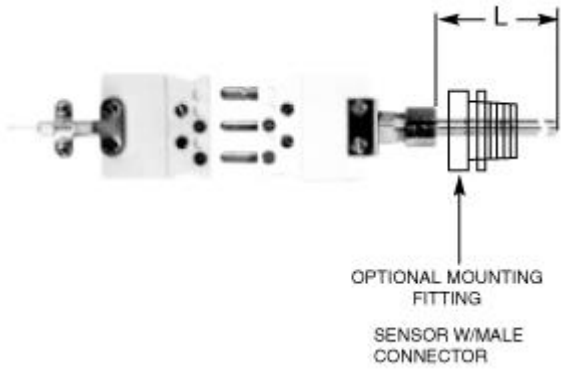


Figure 15

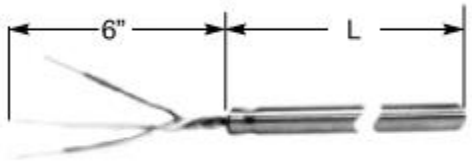


Figure 16

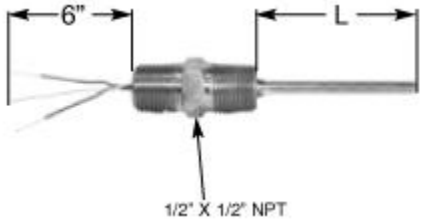


Figure 17

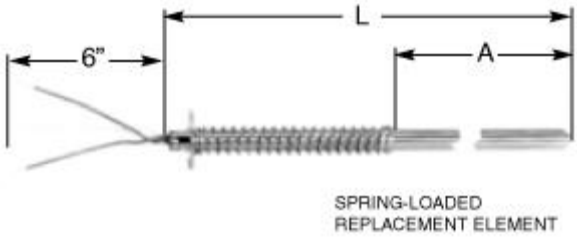
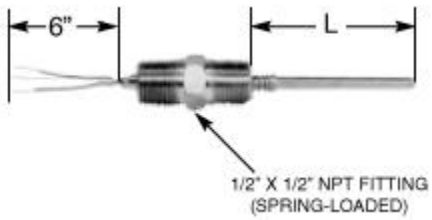


Figure 18



Basic Order Code				
Fig. 14	Fig. 15	Fig. 16	Fig. 17	Fig. 18
M w/o mating female MF w/ mating female	B	SB	BS(A)	SBS

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How to Order:

Pgs. 6-8	-	Page 9						-		-	Page 10
Basic Order Code		Sensor Diameter	Element	Tolerance	Temp. Range	Sheath Material	Lead Conn.		"L" Length		Options
SB		4	A	1	A	1	B		6		L
Table A		Table B	Table C	Table D	Table E	Table F	Table G		Table H		Table I

RTD Assembly Specifications

Table B (sensor diameter)

Sensor Diameter		Order Code
1/8"	(.125")	2
3/16"	(.188")	3
1/4"	(.250")STD	4
5/16"	(.312")	5
3/8"	(.375")	6

Table C (element)

Resistance 0°C	Material	Temperature Coefficient/Alpha (a)	Order Code	
			Single Element	Dual Element
100Ω	Platinum	.00385Ω/Ω°C	A	2A
100Ω	Platinum	.003916Ω/Ω°C	B	2B
100Ω	Platinum	.003902Ω/Ω°C	C	2C
98.129Ω (100Ωnom-)	Platinum Sama Standard RC21-4-1966	.00392Ω/Ω°C	D	2D
120Ω	Nickel	.00672Ω/Ω°C	E	2E
9.035Ω	Copper	.00427Ω/Ω°C	F	2F

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Table D (tolerance)

Accuracy at 0°C		Order Code
± .12%	Class B	1
± .06%	Class A	2
± .03%	Lab Grade	3
± .02%	Lab Grade	4
± .01%	Lab Grade	5

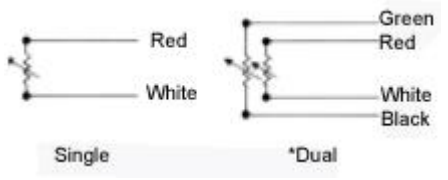
Table E (temperature range)

Temperature Range	Order Code
-200 to +250 Deg. C -328 to +482 Deg. F	A
-200 to +400 Deg. C -328 to +752 Deg. F	B
-200 to +660 Deg. C -328 to +1220 Deg. F	C

Table F (sheath material)

Sheath Material	Order Code
316 SS	1
Alloy 600	2
Alloy C-276	3

Table G (lead connection)

2-Wire	Order Code A
	
3-Wire	**Order Code B**

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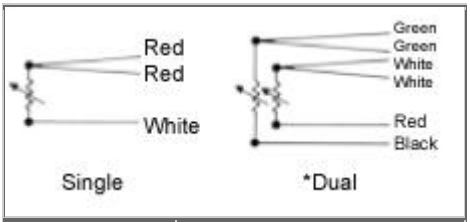


4-Wire	Order Code C

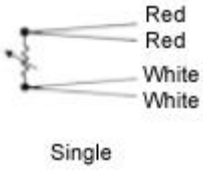


Table H (length)

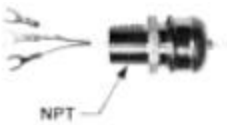
Specify "L" in Inches Length Not required when Thermowell is used.

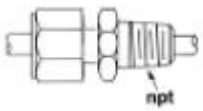
Optional Connections

(For extended lead types)

Table I (options)

	Description	Order Code
	Spade Lugs for #8 Screw	L
	Male Plug	M
	The connectors shown are for 3-wire single element assemblies. Two - 2 Pin connectors mounted in tandem will be furnished for both styles of 4-wire single element assemblies. Dual element assemblies will have the same connector	

	arrangements except Doubled.		
	Female Jack		F
	Watertight connector	1/2" NPT	W1
		3/4" NPT	W3
	Watertight connector with lugs for #8 screws	1/2" NPT	WL1
		3/4" NPT	WL3

Optional Mounting Fittings		
Description	**NPT**	**Order Code**
	1/8"	1AS
	1/4"	2AS
	3/8"	3AS
	1/2"	4AS
	3/4"	6AS
For Teflon readjustable insert, replace "A" with "R" Example: 4RS		

Optional Spring-Loaded Devices	
Description	**Order Code**
 Adjustable Spring	FP 275
 1/2" NPT Double threaded adjustable hex bushing	FP 240
 1/2" NPT single threaded adjustable hex bushing	SSL

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RTD's for the Plastics Industry

The RTD's (resistance temperature detectors) listed in this section are those most commonly used in the plastics industry. They are also suitable for other applications requiring the convenience of bayonet connection or simplification of installation as with the rigid tube design.

For other designs and materials, please consult the factory.

Specifications

Sensing Element:
Platinum sensors with a tolerance of ± 0.12% at 0°C and temperature ranges of -50 to + 400°C (-58 to + 752°F) are catalogued. Assemblies are available in two temperature coefficients (Alpha) of .03385 W/W/°C (Din 43760) and .003916Ω/Ω/°C. The Din curve is the most commonly used sensor.

Lead Materials:
Leads for the 260°C (482°F) range assemblies are silver plated copper insulation with teflon.

Leads for the 400 °C (752°F) range assemblies are nickel plated copper insulated with fiberglass.

Sheath Material:
3/16" O.D. (.188") 304 stainless steel

Bayonet Assemblies

Table 1 (style)

Figure 1	Bayonet with stainless steel armor

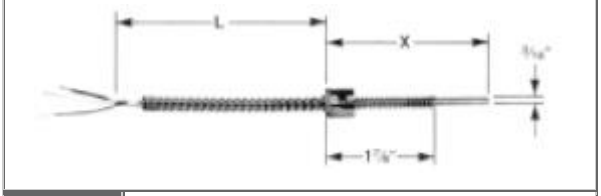
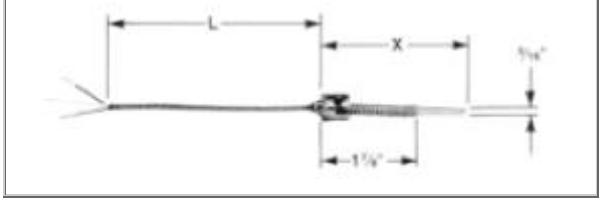
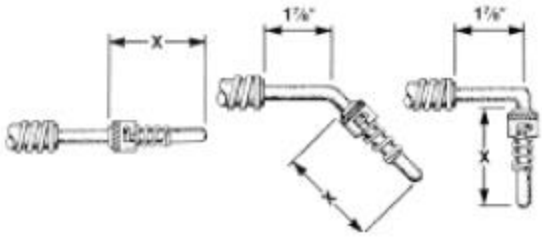


Figure 2	Bayonet with stainless steel overbraid



Straight



Assemblies in figures 1-5 are available with straight, 45° or 90° angle configuration. Select in Table 1.

Order	Configuration

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Figure 3	Rigid tube with stainless steel armor

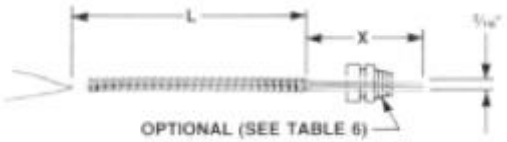

Figure 4	Rigid tube with stainless steel overbraid

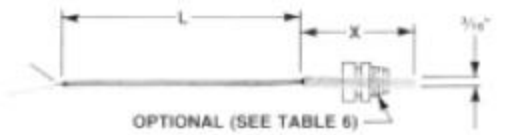

Figure 5	Rigid tube bayonet with male plug (only option "M" in Table 5 may be specified

Code	Straight	45°	90°
Figure 1	R111	R145	R190
Figure 2	R211	R245	R290
Figure 3	R311	R345	R390
Figure 4	R411	R445	R490
Figure 5	R511	R545	R590

Table 2 (sensing element options)

Sensor Type	Order Code	
	2-Wire*	3-Wire*
100ohm Platinum .00385 T.C. (DIN 43760) (Most commonly used)	A2	A3
Notes:	For dual element insert a "2" in front of order Code. Example: 2A3	

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Bayonet and Rigid Assemblies

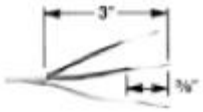
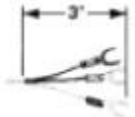
Table 3
Temperature Range Options

Temperature Range	Order Code
-50 to +260°C -50 to +500°F	L
-50 to +400°C -50 to +750°F	S

Table 4
Dimension Option

"X" and "L" Lengths	Order Code
Refer to Figures 1-7 and specify the lengths of "X" and "L" in inches. Insert in ordering sequence. See "How To Order"	

Table 5
End Terminations

 Insulated Leads-Striped	B
 No. 8 Spade Lugs	L
 Male Plug	M Required for Figure 5. Optional for others.

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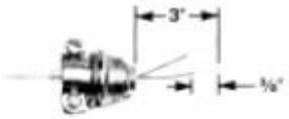
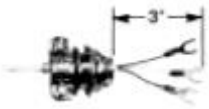
 1/2" BX Connector	BX
 1/2" BX Connector w/ #8 Lugs	BXL

Table 6
Options

Style	Order Code
1/8" npt brass compression fitting for Figures 3 and 4	B
1/8" npt stainless steel compression for Figures 3 and 4.	S
Mating female connector for end termination "M" in Table 5	F

How to Order:

Make a selection from each table and specify "X" and "L" dimensions as shown below. Insert hyphens only where indicated.

Style	-	Sensing Element	-	Temp. Range	-	Dimensions			-	Terminations	-	Options
R111		A3		L		(X)	Specify in Inches	(L)		M		F
Table 1		Table 2		Table 3		Table 4				Table 5		Table 6 (optional)

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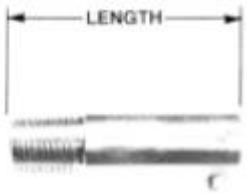
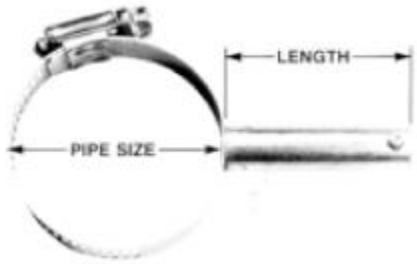
Bayonet Adapters

Table 13



Thread	Length	Part Number
1/8NPT	7/8"	3001-1
1/8NPT	1-3/8"	3001-2
1/8NPT	2-1/2"	3001-3
3/8-24	7/8"	3001-4
3/8-24	1-3/8"	3001-5
3/8-24	2-1/2"	3001-6



Part Numbers									
Adapter Lengths	Pipe Clamp Sizes (IPS)								
	1/2"	3/4"	1-1/2"	2"	2-1/2"	3"	3-1/2" - 4"	5"	6"
1.875" Standard	3002-1	3002-2	3002-3	3002-4	3002-5	3002-6	3002-7	3002-8	3002-9
2-1/2"	3003-1	3003-2	3003-3	3003-4	3003-5	3003-6	3003-7	3003-8	3003-9
3"	3004-1	3004-2	3004-3	3004-4	3004-5	3004-6	3004-7	3004-8	3004-9
3-1/2"	3005-1	3005-2	3005-3	3005-4	3005-5	3005-6	3005-7	3005-8	3005-9
4"	3006-1	3006-2	3006-3	3006-4	3006-5	3006-6	3006-7	3006-8	3006-9
5-1/4"	3007-1	3007-2	3007-3	3007-4	3007-5	3007-6	3007-7	3007-8	3007-9

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For New Installations:
The following formula may be used to determine the "X" dimensions of bayonet RTD.

For Threaded Adapters:
X = Depth of hole + adapter length + 1/2".

For Pipe Clamp Adapters:
X = Adapter length + 3/4"
(This formula assumes the sensor is in surface contact with the pipe.)

Nozzle and Immersion Bolt Assemblies

Table 7

Figure 1 Immersion Bolt with Armor Extension

"X"	"U"	Order Code	"X"	"U"	Order Code
3"	***	R350-(U)***	6"	***	R350-(U)***
	Flush	R351		Flush	R351
	1/2"	R352		1/2"	R352
	1"	R353		1"	R353
4"	***	R354-(U)***	***	***	R354-(X)-U)***
	Flush	R355		Flush	R355
	1/2"	R356		1/2"	R356
	1"	R357		1"	R357
***Insert desired length of "U" in inches and/or "X" in inches. Example: R350-1/4; R3512-8-1/4					

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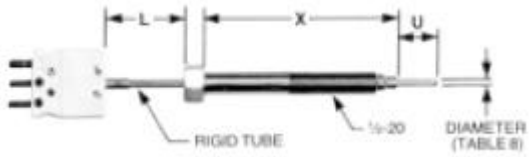
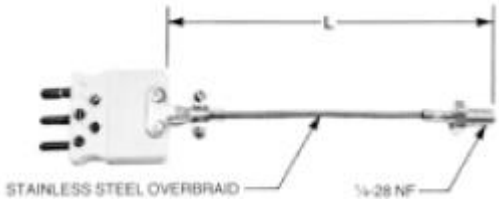
Figure 2 Immersion Bolt with Rigid Tube Extension



"X"	"U"	Order Code	"X"	"U"	Order Code
3"	***	R390-(U)***	6"	***	R398-(U)***
	Flush	R391		Flush	R399
	1/2"	R392		1/2"	R3910
	1"	R393		1"	R3911
4"	***	R394-(U)***	***	***	R3912-(X)-U)***
	Flush	R395		Flush	R3913-(X)
	1/2"	R396		1/2"	R3914-(X)
	1"	R397		1"	R3915-(X)
***Insert desired length of "U" in inches and/or "X" in inches. Example: R350-1/4; R3512-8-1/4					

Figure 3 Nozzle Bolt with Stainless Steel Overbraided Extension



Description	Fig. 3 (as shown)	Fig. 3 w/o. Male Plug
Description	R500	R501
Mating Female Connectors Order Mating Female Connectors as a Separate Item		

Sensing Element	Order Part Number

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2-Wire	6000-U
3-Wire	6009-U

Table 8
Sensor Diameter

Diameter	Order Code
1/8" (.125")	2
3/16" (.188) Standard	3
Do not use this table for "R500", "R501"	

Table 9
Sensing Element

Sensor Type	Order Code	
	2-Wire*	3-Wire*
100 OHM Platinum .00385 T. C. (DIN43760) (Most commonly used)	A2	A3
Note: All sensor are ± 0.12% @ °C Dual Elements are not available.		

Table 10
Temperature Range

Temperature Range	Order Code
-50 to + 260°C -58 to + 500°F	L
-50 to + 260°C -58 to + 500°F	S

Table 11
"L" Dimension

"L" Dimension	Order Code
Refer to Figures 1-3 and Specify "L" in inches and insert in ordering sequence. See "How to Order"	

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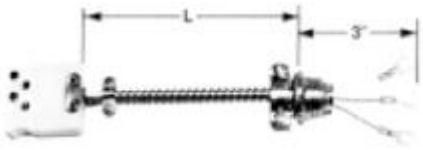
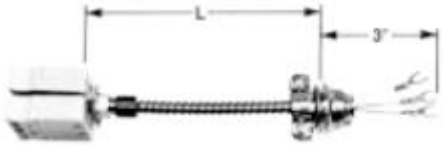
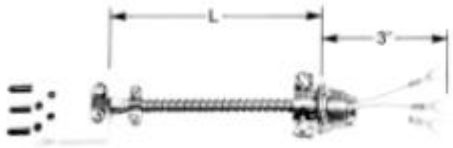
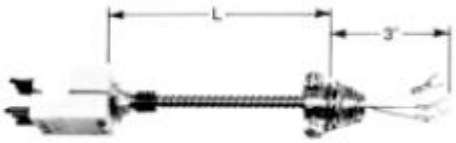
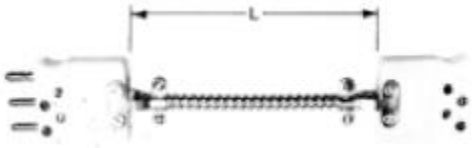
How to Order:

Style	-	Sheath Diameter	-	Sensing Element	-	Temp. Range	-	Length		
R353		3		A3		L		(X)	Specify "L" in Inches	(L)
Table 7		Table 8		Table 9		Table 10		Table 11		

Extension Assemblies

Table 12

Figure 1	Jack and BX Connector	**Figure 4**	Jack and BX Connector -Dual
 Part Number: 5010-(L) RTD		 Part Number: 5013-(L) RTD	
Figure 2	Plug and BX Connector	**Figure 5**	Plug and BX Connector - Dual
 Part Number: 5011-(L) RTD		 Part Number: 5014-(L) RTD	
Figure 3	Plug and Jack	**Figure 6**	Plug and Jack - Dual
 Part Number: 5012-(L) RTD		 Part Number: 5015-(L) RTD	

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How to Order:

Select the desired part number and specify "L" in inches.
Example: 5010-48