SECTION 6
Technical Information

Thermistor Theory

NTC thermistor materials are prepared by heating mixtures of metal oxides to high temperatures so that the oxides combine chemically to form the spinel crystallographic structure. The name derives from the mineral spinel, $MgAl2O_4$, which has this structure. In this structure Mg occupies tetrahedral, or A sites, in the crystal lattice and Al occupies octahedral, or B sites. This is a normal spinel, with one 2+ metal ion on the A site, two 3+ metal ions on the B sites and four oxygens. This is commonly written $Mg[Al2]O_4$, where the elements in the bracket represent the B sites.

An inverse spinel has half the trivalent ion on the A sites and the divalent ion on the B sites, such as nickel ferrite, $Fe[NiFe]O_4$. Various degrees of inversion can occur depending on the metal ions, the temperature of reaction, and any annealing cycles to which the material is subjected. A common thermistor material is nickel manganite, a partially inverse spinel with manganese present on the B sites in 3+ and 4+ states.

These types of materials are referred to as valence-controlled semiconductors. Conduction occurs when ions having multiple valence states occupy equivalent crystallographic sites. They must be the same element and differ in valence by one unit and occupy B sites. The conduction mechanism is a thermally activated electron hopping process, in which the electrons hop from one cation (Mn^{3+}) to another (Mn^{4+}) in the B lattice sites under the influence of a potential gradient across the material.

The conductivity is a product of charge density and mobility. Charge density is determined by the number of charge carries, the density of B sites and the probability of a B site being active. The mobility is determined by the distance between the nearest neighbor B sites, the activation energy (needed for the electron to move from one site to another) and a frequency factor (how often it tries to jump). Charge carries are also produced by other defects such as non-stoichiometry and grain boundaries.

By considering the effects of all the above factors, an expression for conductivity can be derived:

$$\sigma = \sigma_{\infty}^{(-q/kT)}$$

where s` is the infinite temperature conductivity (which includes consideration of charge density and mobility), -q is the activation energy, k is Boltzmann's constant, and T the absolute temperature. For thermistors, the resistivity s (and hence resistance) is of more interest and the above becomes

$$\sigma = \sigma_{\infty}^{(q/kT)}$$

Beta Constant

By replacing resistivity with resistance values and combining the activation energy and Boltzmann's constant terms, the familiar thermistor expression is obtained

$$R = A^{(ß/T)}$$

where A includes dimensional factors and infinite temperature resistance, ß is the material constant beta and T is the absolute temperature.

One can determine the beta constant by measuring the resistance at two temperatures and using the above equation,

$$R_1/R_2 = e^{(ß/T_1 - ß/T_2)}$$

$$\ln(R_1/R_2) = ß(1/T_1 - 1/T_2)$$

$$ß = \ln(R_1/R_2) / (1/T_1 - 1/T_2)$$

Alpha Temperature Coefficient of Resistance

The temperature coefficient of resistance a is determined by

$$a = 1/R \cdot dR/dT$$

and is usually expressed in terms of % change in resistance per degree.

The coefficient of resistance and the material constant ß are related to each other by

$$a = (-ß/T^2)$$

Beta and a are two different ways of expressing the same property.

R versus T Approximation Methods

Although the expression $R = A^{(ß/T)}$ gives good agreement with empirical data over short temperature spans, a better method of interpolation over larger temperature ranges is necessary for accurate temperature measurements.

Thermistor accuracy depends on the precision and uncertainty of the calibration system used. The precision of the measurement statement, however, is in large part due to the method of approximation and interpolation. The approximation methods outlined below provide several choices for maximum simplicity while allowing for precise interpolation.

Narrow Range Approximation Methods

The following table shows two approximation methods, the applicable temperature range and range of deviation from nominal resistance.

Equation	Temperature Range	Deviation
$Ln(R_T) = \frac{A}{T}$	very small	–
$R_T = A^{(B/T)}$	-20 to +120°C	+0.94, -0.82°C

Steinhart and Hart

The Steinhart and Hart equation is an empirical expression that has been determined to be the best mathematical expression for the resistance-temperature relationship of a negative temperature coefficient thermistor. It is usually found explicit in T:

$$1/T = a + b\,(\mathrm{Ln}\,R) + c\,(\mathrm{Ln}\,R)^3 \qquad (1)$$

where: T = Kelvin units (°C + 273.15)
a,b,c = coefficients derived from measurement
Ln R = natural logarithm of resistance in ohms

To find a, b and c, measure a thermistor at three temperatures. The temperatures should be evenly spaced, and at least 10°C apart. Use the three temperatures and resistances to solve three simultaneous equations.

$$1/T_1 = a + b\,(\mathrm{Ln}\,R_1) + c\,(\mathrm{Ln}\,R_1)^3$$

$$1/T_2 = a + b\,(\mathrm{Ln}\,R_2) + c\,(\mathrm{Ln}\,R_2)^3$$

$$1/T_3 = a + b\,(\mathrm{Ln}\,R_3) + c\,(\mathrm{Ln}R_3)^3$$

The equations allow you to derive a, b and c for any temperature range. We have calculated these coefficients for the range 0 to 100°C with 50°C as the intermediate point. These are listed below for your use.

Coefficients derived from 0, 50 and 100°C catalog resistance

Thermistor type	25°C resistance	a	b	c
001A	100 Ω	0.0017709	0.0003406	1.479E-07
002A	300 Ω	0.0015632	0.0003108	9.747E-08
003A	1 KΩ	0.001313	0.0002906	1.023E-07
004	2252 Ω	0.0014733	0.0002372	1.074E-07
005	3 KΩ	0.0014051	0.0002369	1.019E-07
007	5 KΩ	0.001262	0.0002359	9.411E-08
017	6 KΩ	0.0012473	0.000235	9.439E-08
016	10 KΩ	0.0011303	0.0002339	8.863E-08
006	10 KΩ	0.0010295	0.0002391	1.568E-07
008	30 KΩ	0.0009354	0.0002211	1.275E-07
011	100 KΩ	0.0008253	0.0002045	1.144E-07
014	300 KΩ	0.0008207	0.0001848	1.014E-07
015	1 MEGΩ	0.0008142	0.000167	8.819E-08

Knowing a, b and c for the thermistor allows you to use the Steinhart and Hart equation in two ways. If resistance is known and temperature is desired, use equation (1) above. If the temperature is known and expected resistance is desired, use equation (2) below. Remember that T is in Kelvin units.

$$R = e^{\left[\left(\beta - (\alpha/2)\right)^{1/3} - \left(\beta + (\alpha/2)\right)^{1/3}\right]} \qquad (2)$$

where

$$\alpha = \left(a - (1/T)\right)/c \text{ and } \beta = \left[\left(\frac{b}{3c}\right)^3 + \frac{\alpha^2}{4}\right]^{1/2}$$

It should be noted that these values of alpha and beta are not related to the alpha and beta used with single term exponential equations.

The ability to precisely interpolate for a given temperature from measurements at known fixed-points depends in part on the closeness of those points. Fixed-points such as the water triple point, mercury triple point, gallium melting point and indium freezing point provide a solid basis for the interpolation.

For practical reasons some of the R vs. T tables have small interpolation differences when random values from the tables are used in the above equations, particularly over large temperature spans.

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Spreadsheet Program

The following spreadsheet program (Lotus 123) allows calculation of the Steinhart and Hart coefficients, using three resistances at three temperatures. It calculates resistance, dR/dT or determines the temperature for a known resistance.

Labels start with an apostrophe ('). Brackets indicate data you must enter. Other cells are formulas.

B1: 'Temp.(C)

C1: 'Resistance

D1: 'T (K)

E1: 'ln(R)

A2: 'Low

B2: [Input low temperature in °C]

C2: [Input low temp. resistance in ohms]

D2: +B2+273.15

E2: @LN(C2)

A3: 'Mid

B3: [Input mid temperature in °C]

C3: [Input mid temp. resistance in ohms]

D3: +B3+273.15

E3: @LN(C3)

A4: 'High

B4: [Input high temperature in °C]

C4: [Input high temp. resistance in ohms]

D4: +B4+273.15

E4: @LN(C4)

A6: 'ln(R1)-ln(R2)

B6: +E2-E3

A7: 'ln(R1)-ln(R3)

B7: +E2-E4

A8: '(1/T1)-(1/T2)

B8: 1/D2-1/D3

A9: '(1/T1)-(1/T3)

B9: 1/D2-1/D4

A11: 'Coefficients: a=

B11: 1/D2-B13*E2^3-B12*E2

A12: 'b=

B12: (B8-B13*(E2^3-E3^3))/B6

A13: 'c=

B13: (B8-B6*B9/B7)/((E2^3-E3^3)-B6*(E2^3-E4^3)/B7)

A15: 'Solving for R, given T:

A16: 'Degrees C=

B16: [Input known temperature in °C]

C16: +B16+273.15

D16: (B11-(1/C16))/B13

E16: '=A

D17: @SQRT((B12/(3*B13))^3+(D16^2)/4)

E17: '=B

A18: 'Resistance (Ohm)=

B18: @EXP((D17-(D16/2))^(1/3)-(D17+(D16/2))^(1/3))

A19: 'dR/dT=

B19: -1*B18/(C16^2*(B12+3*B13*(@LN(B18))^2))

A20: '%dR/dT=

B20: +B19/B18*100

A23: 'Solving for T, given R:

A24: 'Ohms=

B24: [Input known resistance in ohms]

A26: 'Temperature (C)=

B26: 1/(B11+B12*@LN(B24)+B13*(@LN(B24))^3)-273.15

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How to Use Thermilinears

We present a general description of Thermilinear Networks in the Thermilinear Component Section of the catalog. The examples below describe general circuit development that may be used with YSI Thermilinear Networks.

Voltage Mode

You can develop a thermometer circuit without active circuitry using the voltage mode. The voltage mode configuration is based on a voltage divider (figure 1) or Wheatstone bridge (figure 2). We consider both circuits together in the following example since the bridge is an extension of the voltage divider.

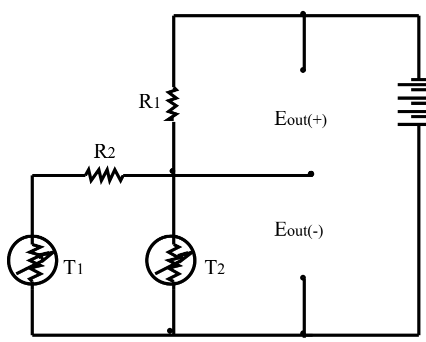

Figure 1

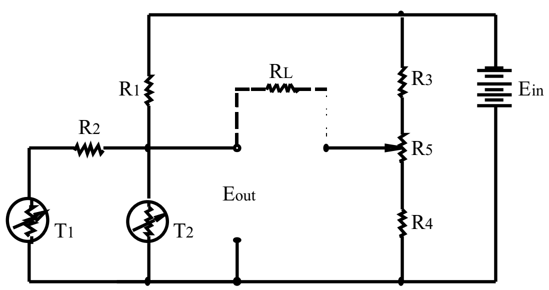

Figure 2

Voltage Mode Circuit Design Example

The range and output slope must be established first. The signs and units must be known. The example will be:
range: 0 to 100°C
output slope: -10 mv/°C (negative slope)

We use the YSI 44201 network in the example. This network has a temperature range of 0 to 100°C, includes the YSI 44018 Thermilinear composite and the YSI 44301 resistor set. We've taken design data from the YSI Thermilinear Network Specification pages.

$R_1 = 3200\ \Omega$
$R_2 = 6250\ \Omega$

$E_o = (-0.0053483E_{in})t + 0.86507E_{in}$

sensitivity constant
$= (\delta/\delta)/E_{in}$
$= -0.0053483$

output voltage at 0°C per volt in
$= E_{o0°C}/\delta E_{in}$
$= +0.86507$

$R_t = (-17.115)t + 2768.23$

$-\delta R$

R_t @ 0°C

1. Determine input voltage that results in the desired voltage sensitivity (-10mV/°C in this example). This is equal to the voltage sensitivity per degree divided by the sensitivity constant.

$E_{in} = (\delta E/\delta t)\ (\delta/\delta)/E_{in})$
$= -.01$ V/°C 4 -0.0053483/°C
$= 1.869753$ V

2. Determine output voltage (E_{out}). The general equation is given with the temperature as the variable.

$E_{out} = [((\delta/\delta T)/E_{in}) \times E_{in}] \times t + (\delta E_{o0°C}/ E_{in} \times E_{in})$

@ 0°C = -0.0053483/°C x 1.869753 V x 0°C + 0.86507 x 1.869753 V = 1.617467 V

3. Power dissipation. Calculate self-heat to evaluate the effect of power on measurement accuracy. Self-heat is most severe for the higher resistance thermistor (T_2) at high temperature. A 30K Ω @ 25°C thermistor has a resistance of 2069 Ω at 100°C.

$P = E^2$ 4 R

Where:

P = power dissipation in watts

E = voltage at the maximum temperature

R = resistance of the higher resistance thermistor at the maximum temperature

$P = 0.617467^2$ V 4 2069 Ω = 0.000184 Watts

The dissipation constant is used to turn this into a temperature unit. We will assume for the example that the component is immersed in flowing water. The dissipation constant for a YSI 44018 is 8 mW/°C (0.008W/°C) in flowing water.

Self-heat error = 0.000184 W 4 0.008W/°C
= 0.023°C

The resistors R_3, R_4 and R_5 are selected next. The goal is to pick these resistors to achieve 0 V out at 0°C. The first thing that must be done is to determine the resistance of T_1, R_2 and T_2 at 0°C. The total of these resistances will be called R_{cal} R_{cal} will be calculated by first calculating the total resistance for the left half of the bridge, R_t and then subtracting the effect of R_1. For this example, the equation for R_t is found in the data table for the YSI 44201 network.

R_t = (17.115 Ω/°C) x t°C + 2768.23 Ω

@ 0°C = (-17.115 Ω/°C) x 0°C + 2768.23 Ω
= 2768.23

@ 100°C = (-17.115 Ω/°C) x 100°C + 2768.23 Ω
= 1056.73

@ 100°C = -0.0053483/°C x 1.869753 V x 100°C + 0.86507 x 1.869753 V = 0.617467 V

Now R_{cal} is calculated with the following formula:

$$\frac{1}{R_{cal}} = \frac{1}{R_t} - \frac{1}{R_1}$$

$$\frac{1}{R_{cal@0°C}} = \frac{1}{R_{t@0°C}} - \frac{1}{R_1}$$

$$\frac{1}{R_{cal@0°C}} = \frac{1}{R_{t@0°C}} - \frac{1}{R_1}$$

For the example:

$$\frac{1}{R_{cal@0°C}} = \frac{1}{2768.23\ \Omega} \quad \frac{1}{3200\ \Omega} = 0.000048742$$

$R_{cal@0°C}$ = 1 / 0.000048742 = 20516.3 Ω

A ratio calculation is done to determine the values for R_3 and R_4.

$$\frac{R_1}{R_{cal@0°C}} = \frac{R_3}{R_4}$$

Another resistor, R_5, is introduced at this time. This is the zero control. The total resistance of this resistor is to be equal to two times the tolerance of the larger of R_3 and R_4. When making circuit calculations, it is assumed that half of R_5's resistance is included with R_3 and the other half with R_4.

R_4 is chosen by the designer and R_3 is calculated based on the selection of R_4. For the example:

choose R_4 = 4990 ±1% (approximately ±50 Ω)

R_5 = 2 x 50 = 100

$R_3 + R_5/2$ is substituted for R_3 in the ratio equation above.

$R_4 + R_5/2$ is substituted for R_4 in the ratio equation above.

Solve the ratio equation:

$R_3 = R_5/2 = [R_1 \text{ x } (R_4 + R_5/2)] / R_{cal0°C}$

$R_3 = [(R_1 \text{ x } (R_4 + R_5/2)) / R_{cal0°C}] - R_5/2$

= [(3200 Ω x (4990 Ω + 50 Ω))/20516.3 Ω] -100/2 = 736.1 Ω

A standard resistor value is selected that is near to this calculated value. 732 Ω is selected for the example. The last step is to ascertain that the null value of the circuit falls within the adjustment range of the control.

$R_x = ((R_3 + R_4 + R_5) \times E_{out@0°}) - R_4$

Where:

R_x = the part of the control added to R_4. This is not to exceed $R_5/2$.

For the example:

$R_x = ((732 + 4990 + 100) \times 0.86507) - 4990$

$= 46.44\ \Omega$

Since $R_x < R_5/2$, the resistor selections are acceptable.

Resistive Mode Operations

Using the Thermilinear Network in the resistive mode requires energizing the network with a constant current. This can be done by connecting the network in the feedback loop of an operational amplifier (below).

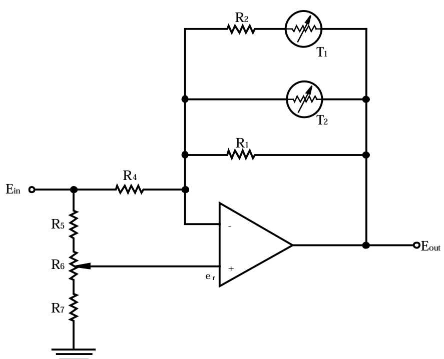

Figure 3

The general transfer function for this circuit is:

$$E_{out} = [1 + \frac{R_t}{R_4}]\, e_r - \frac{R_t}{R_4} E_{in}$$

Where: R_t = Resistance of the network in the resistive mode

(feedback resistance)

e_r = voltage at the positive input

As in the voltage mode, the range and output slope must be established. The signs and units must be known.

range: 30 to 100°F

output slope: -10mV/°C (negative slope)

We use the YSI 44204 Network in the example. This network has a temperature range of 30 to 100°F, includes the YSI 44018 Thermilinear composite and the YSI 44304 resistor set. We've taken design data from YSI Thermilinear Network Specification pages.

R_4 must be calculated for this circuit. As seen in the equation above, zero output occurs when $R_t = R_4$ and $E_{in} = 2e_r$. Zero degrees can be placed at any reasonable point, either inside or outside the intended range of the circuit.

This example sets $R_4 = R_t$ at 0°F, which is outside the range. This means that the equation above may not be used, and the R_t equation must be used. The equation for the YSI 44204 Network is:

$$R_t = \underbrace{(-17.834)}_{-dR}t + \underbrace{5173.7}_{R_t\ @\ 0°F}$$

since t = 0°F, $R_t = 5173.7\ \Omega = R_4$

R_5, R_6 and R_7 are selected to achieve a voltage divider so that e_r can be set at one half of E_{in}.

The value of E_{in} is given by:

$$E_{in} = \frac{2dE(R_t @ 0°F)}{dR}$$

Where: dE = The change in E_o per degree

dR = The change in network resistance per degree

substituting numbers from the example:

$$E_{in} = \frac{2 \times 0.01 \times 5173.7}{17.834}$$

$= 5.802$

Power Dissipation

A method to determine power dissipation is described in the voltage mode circuit design example.

The excitation voltage (E_{in}) must be stable for supply and temperature variations because the current requirement is constant in this example. A series variable resistance can be used for setting E_{in} to produce the correct full scale output.

Two-Wire System

A 3-wire sensor can be reduced to a 2-wire sensor (below) if R_2 is connected at the sensor end of the cable in either the voltage or resistive mode. Note R_1 is connected to the other end of the cable. Resistance errors due to very long leads may then be subtracted from R_1.

Multiplexing

One resistor set may serve any number of Thermilinear Composites for monitoring at several locations as shown below.

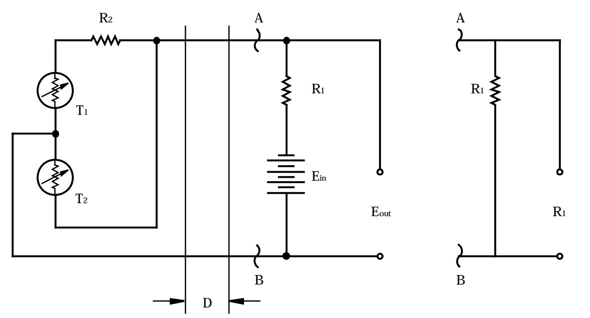

Figure 4

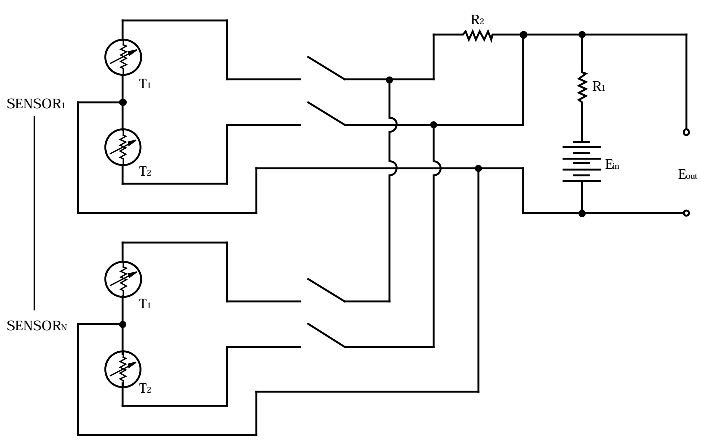

Figure 5

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Technical Publications

Technical Manuals/Documents

TD001 Thermistor Probes for Severe Moisture Environments
TD002 Measurement Science Conference Tutorial
TD003 Temperature Compensation Using Thermistor Networks
TD004 Goddard Specification S-311-P-18
TD005 Reproducibility, Stability and Linearization of Thermistor Resistance Thermometers
TD006 YSI 46000 and YSI 47000 Series Thermistors
TD007 Aging Phenomena in Nickel-Manganese Oxide Thermistors
TD008 Practical Design Techniques Tame Thermistor Design
TD009 Thermistor Aging Phenomenon Due to Temperature Cycling
TD010 All About Thermistors
TD011 Long-Term Thermistor Stability at an Elevated Temperature
TD012 Glass Thermistor Notebook
TD013 Thermistors Compensate Gain TC

Technical Notes

TN001 Statement of Qualification Requirements Based on Similarity to YSI 44900 Series Parts
TN004 Thermistor-Specific Heat
TN005 Glass Thermistor Leads
TN006 Humidity Resistance of Oxycast Epoxy Compared to EC210
TN007 Material Recommendation for Potting Thermistors
TN008 Materials for MSFC-SPEC-1443 Outgas Testing
TN009 Outgas Testing on Oxycast 6850FTLV TN010 EC210 Replacement
TN011 YSI 44018 Special Range Values
TN012 Thermistor Test Data Life Tests
TN013 Thermistor Reliability and Accuracy at High Pressure
TN014 NBS Study on YSI 403 Probe with YSI 44012 Thermistor TN015 CE Mark and YSI Thermistors
TN015 CE Mark and YSI Thermistors

Technical Applications

TA001 Thermistor Self-Heat Mode
TA003 YSI 4600 Serial Interface
TA004 Thermistor A/D Converter Circuit

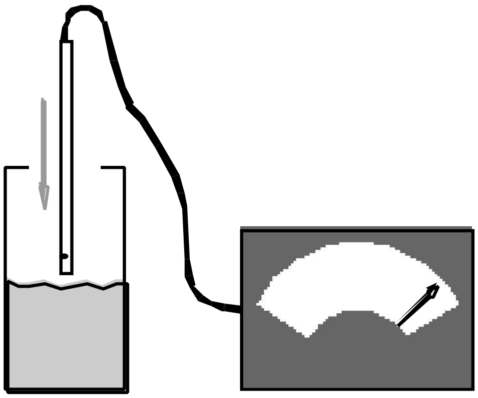
Assuring Accurate Measurement

You can ensure the accuracy of your measurement by avoiding the common errors explained below.

Immersion Stem Effect

An error source frequently ignored is stem effect. It can be the source of very large errors. Stem effect occurs when a portion of the probe is at a temperature other than the temperature of the sample.

Here's a simple method for determining stem effect. Slowly insert the probe into a sample at approximately the test temperature while observing the readout to determine when there's no further change with further insertion. When no further change is observed, stem effect error is eliminated.



How to Eliminate Immersion Stem Effect

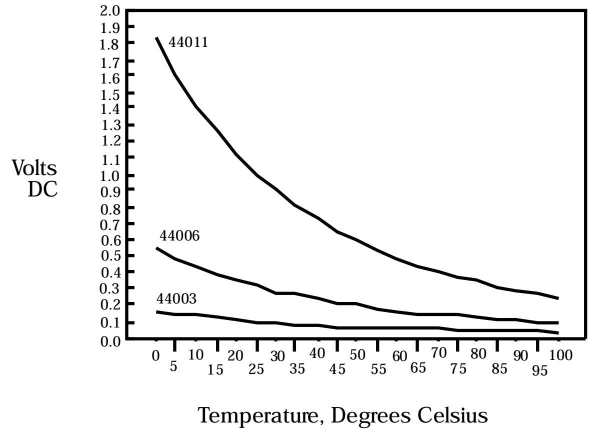
1. Immersion should be at least 10 times the diameter of the probe.

2. The sample volume should be no less than 1,000 times the mass of the sensor.

Dissipation Error (Self-Heat)

Power application to a thermistor may induce a temperature change in the sensor. This change is called dissipation or self-heat error. You may reduce dissipation error by limiting the power applied to a thermistor during a measurement.

The graph curves represent 10 mk (0.010ºC) of self-heat for a 1kΩ (YSI 44003A), 10kΩ (YSI 44006) and 100kΩ (YSI 44011) thermistor at a specific temperature when a specific voltage is applied. The dissipation constant is 1mW/ºC in still air.



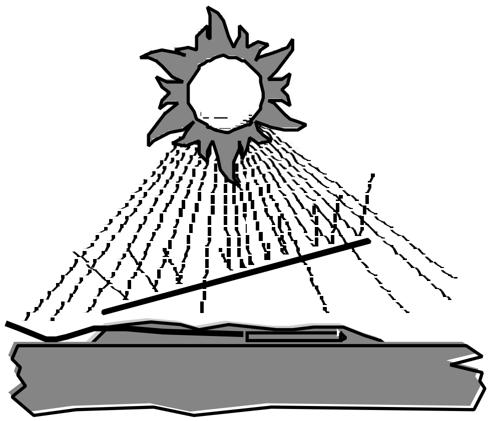
Gas Stream Error

A major source of error in the measurement of low-flow gas streams is another sort of stem effect. In this case, the leads conduct better than the sample and transfer heat to the thermistor. Mounting the thermistor on its own leads and having as much of the leads exposed to the sample as possible will improve the accuracy of the measurement. A very low mass form for lead support exposes a greater length of lead to the sample.

In still air, self-heat from over application of power to the thermistor can contribute significantly to the error. If the thermistor is self-heated, any change in air flow will change its resistance and its apparent temperature.

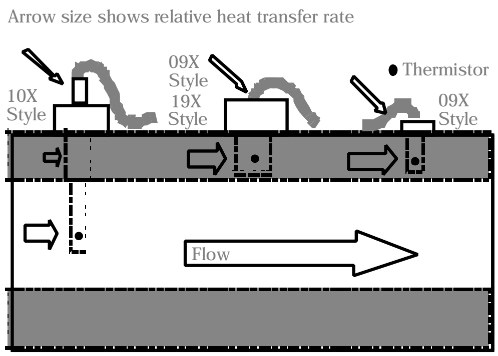
Radiant Error

Radiant energy directed on the sensor may cause radiant error. This error, similar to stem effect, is common and significant when measuring in direct sunlight or other radiant source. Inserting a reflective surface between the radiant source and the sensor-lead combination reduces error.



Pipe Error

Pipe error may occur if a significant temperature differential exists between the pipe wall and the fluid or gas. Flow rate and immersion depth of the probe will significantly affect the accuracy of the measurement. The drawing below illustrates this effect. The two probes on the right are measuring pipe temperature; the probe on the left is measuring the temperature of the flow.



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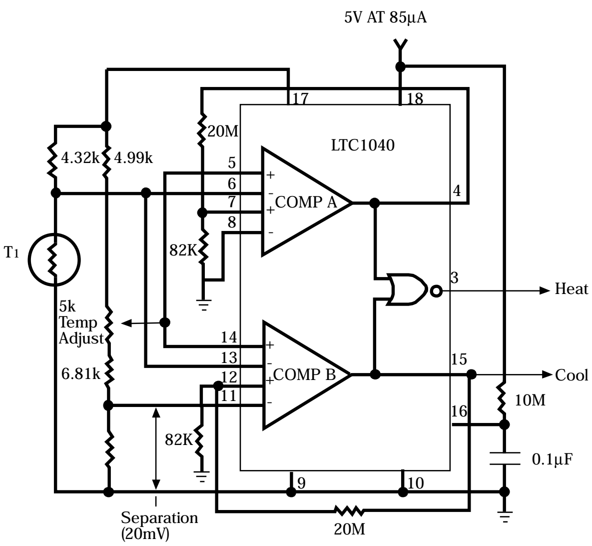
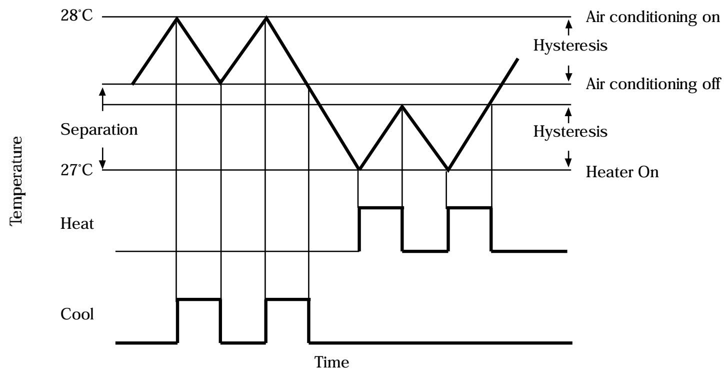
Thermistor Applications

Complete Heating & Cooling Automatic Thermostat



T1 Thermistor #44007
Yellow Springs Instrument Co., Inc.
Hysteresis = 5Vx82k = 20mV
20M



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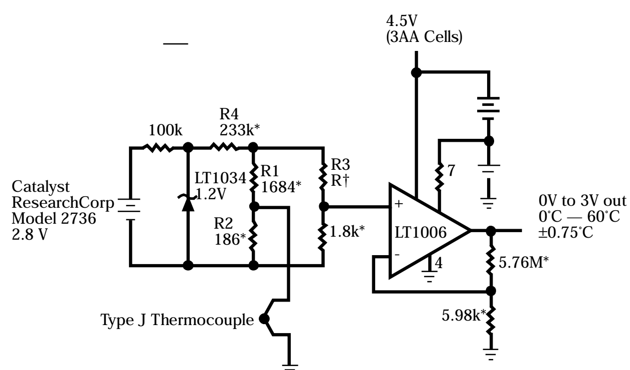
Micropower Thermocouple Signal Conditioner with Cold Junction Compensation



Total Power Consumption ≤500µW
*=TRW MAR-60.1%
R† = Yellow Springs Inst. Co
Model 44007 5k @25°C

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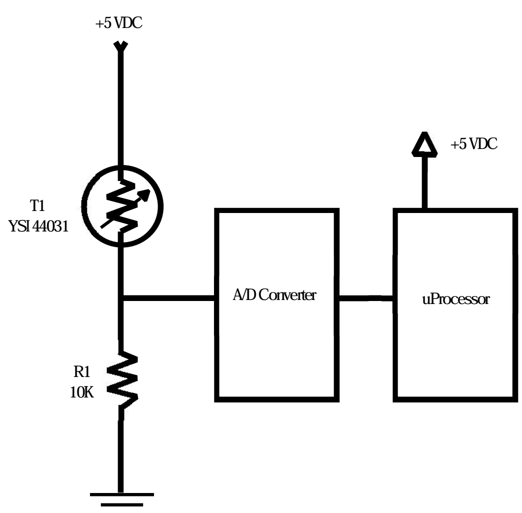
Half Bridge with A/D Converter



This circuit provides a low cost method of achieving precise temperature measurements when a microprocessor and A/D convertor are available. The half bridge interface provides a voltage which the A/D converts to counts. The microprocessor uses a lookup table which quickly converts the A/D counts to a temperature value. This eliminates the need to implement thermistor equations in code or use a floating point library.

Custom Thermilinear Ranges

This page lists Thermilinear ranges developed for custom applications. Below are ranges developed for applications in °C. Please note that the user supplies the range resistors.

YSI 44018 Custom Thermilinear Ranges in °C

No.	Temperature Range °C	Linearity Deviation °C	R_1	R_2	R_t Variables Slope (m)	Intercept (b)	E_{out} Variables Slope (m)	Intercept (b)
1	-40 to +70	1.20	17290	35250	-112.6240	11457.50	-0.0065138	0.662664
2	-30 to +50	0.16	18700	35250	-127.0960	12175.00	-0.0067965	0.651070
3	-30 to +55	0.31	18900	37000	-128.3340	12326.50	-0.0067902	0.651290
4	-30 to +60	0.37	14000	25500	-91.2740	9626.57	-0.0065196	0.687610
5	-30 to +70	0.96	14500	30000	-94.4784	10013.90	-0.0065158	0.690610
6	-25 to +55	0.20	16000	31000	-106.6430	10786.10	-0.0066652	0.674130
7	-5 to +45	0.06	5700	12000	-32.4020	4593.39	-0.0056846	0.805858
8	-5 to +50	0.08	5690	11600	-32.6089	4577.55	-0.0057309	0.804490
9	-5 to +125	1.11	2610	5230	-13.3552	2304.34	-0.0051169	0.882889
10	-2 to +38	0.03	5700	12400	-32.1012	4603.11	-0.0056318	0.807563
11	0 to 10	0.00	42000	67900	-310.7530	21849.50	-0.0073988	0.520226
12	0 to 30	0.04	11680	22960	-73.8485	8358.02	-0.0063226	0.715584
13	0 to 40	0.27	5900	12400	-28.5226	4442.72	-0.0048347	0.753067
14	0 to 60	0.14	7775	14800	-47.0450	5938.37	-0.0060508	0.763770
15	0 to 100	0.22	3200	6250	-17.1150	2768.23	-0.0053483	0.865070
16	0 to 120	0.81	2610	5230	-13.3552	2304.34	-0.0051169	0.882889
17	5 to 130	0.88	2130	4635	-10.6233	1936.67	-0.0049874	0.909235
18	15 to 35	0.01	4400	10100	-23.5611	3687.77	-0.0053547	0.838130
19	15 to 45	0.03	4380	9450	-23.8370	3660.60	-0.0054422	0.835753
20	15 to 65	0.07	6739	12252	-39.8117	5225.63	-0.0059080	0.775471
21	20 to 32	0.00	4400	10100	-23.5181	3686.65	-0.0053450	0.837875
22	20 to 65	0.06	2500	5360	-12.6473	2234.19	-0.0050589	0.893676
23	20 to 120	0.23	1696	3383	-8.2913	1577.55	-0.0048887	0.930159
24	22 to 42	0.02	5445	10800	-30.8702	4388.70	-0.0056694	0.806006
25	28 to 64	0.04	1900	4300	-9.1144	1750.58	-0.0047970	0.921358
26	35 to 135	0.27	1175	2375	-5.4353	1133.10	-0.0046257	0.964340
27	45 to 75	0.04	2000	3900	-9.8670	1816.00	-0.0049335	0.908000
28	45 to 125	0.19	1030	2050	-4.6619	1002.50	-0.0045261	0.973301
29	50 to 100	0.05	2500	4530	-12.8234	2202.82	-0.0051294	0.881120
30	55 to 65	0.00	2000	3900	-9.8319	1813.85	-0.0049159	0.906924

For more information,
contact us at **800 747-5367** or
937 427-1231•Fax 937 427-1640
Info@YSI.com• **www.YSI.com**

Resistance versus Temperature -80 to -11°C

Thermistor Mix		L Mix	L Mix	L Mix	B Mix	B Mix	B Mix	B Mix	B Mix	H Mix	H Mix	H Mix	H Mix	H Mix
Ω at 25°C		100	300	1000	2252	3000	5000	6000	10,000	10,000	30,000	100,000	300,000	1 MEG
ºF	ºC													
-112.0	-80	14.47K	67.66K	278.8K	1660K	2211K	3685K	4423K	7371K	3558K				
110.2	79	13.51K	62.78K	258.1K	1518K	2022K	3371K	4044K	6741K	3296K				
108.4	78	12.62K	58.29K	239.1K	1390K	1851K	3086K	3703K	6172K	3055K				
106.6	77	11.80K	54.15K	221.7K	1273K	1696K	2827K	3392K	5653K	2833K				
104.8	76	11.04K	50.34K	205.6K	1167K	1555K	2592K	3109K	5182K	2629K				
103.0	75	10.33K	46.83K	190.8K	1071K	1426K	2378K	2853K	4756K	2440K				
101.2	74	9672	43.58K	177.2K	982.8K	1309K	2182K	2618K	4364K	2266K				
99.4	73	9061	40.59K	164.7K	902.7K	1202K	2005K	2405K	4008K	2106K				
97.6	72	8494	37.82K	153.1K	829.7K	1105K	1843K	2211K	3684K	1957K				
95.8	71	7966	35.26K	142.5K	763.1K	1016K	1695K	2033K	3389K	1821K				
-94.0	-70	7475	32.9K	132.6K	702.3K	935.4K	1560K	1871K	3119K	1694K				
92.2	69	7018	30.71K	123.5K	646.7K	861.4K	1436K	1723K	2872K	1577K				
90.4	68	6592	28.68K	115.1K	595.9K	793.7K	1323K	1588K	2646K	1469K				
88.6	67	6195	26.8K	107.3K	549.4K	731.8K	1220K	1464K	2440K	1369K				
86.8	66	5825	25.06K	100.1K	506.9K	675.2K	1126K	1351K	2251K	1276K				
85.0	65	5479	23.45K	93.48K	467.9K	623.3K	1039K	1247K	2078K	1190K				
83.2	64	5157	21.95K	87.3K	432.2K	575.7K	959.9K	1152K	1919K	1111K				
81.4	63	4856	20.55K	81.58K	399.5K	532.1K	887.2K	1064K	1774K	1037K				
79.6	62	4575	19.26K	76.28K	369.4K	492.1K	820.5K	984.2K	1640K	968.4K				
77.8	61	4312	18.05K	71.35K	341.8K	455.3K	759.2K	910.7K	1518K	904.9K				
-76.0	-60	4066	16.93K	66.78K	316.5K	421.5K	702.9K	843.3K	1405K	845.9K				
74.2	59	3835	15.89K	62.53K	293.2K	390.5K	651.1K	781.2K	1302K	791.1K				
72.4	58	3620	14.92K	58.59K	271.7K	361.9K	603.5K	723.9K	1206K	740.2K				
70.6	57	3418	14.02K	54.92K	252K	335.7K	559.7K	671.4K	1119K	692.8K				
68.8	56	3229	13.17K	51.5K	233.8K	311.5K	519.4K	622.9K	1038K	648.8K				
67.0	55	3051	12.39K	48.32K	217.1K	289.2K	482.2K	578.4K	964K	607.8K				
65.2	54	2885	11.65K	45.36K	201.7K	268.6K	447.9K	537.4K	895.6K	569.6K				
63.4	53	2729	10.97K	42.6K	187.4K	249.7K	416.3K	499.3K	832.1K	534.1K				
61.6	52	2582	10.33K	40.03K	174.3K	232.2K	387.1K	464.4K	774K	501K				
59.8	51	2445	9730	37.63K	162.2K	216K	360.2K	432.1K	720.2K	470.1K				
-58.0	-50	2315	9171	35.39K	151K	201.1K	335.3K	402.3K	670.5K	441.3K				
56.2	49	2194	8647	33.3K	140.6K	187.3K	312.3K	374.6K	624.3K	414.5K				
54.4	48	2079	8158	31.35K	131K	174.5K	291K	349K	581.7K	389.4K				
52.6	47	1972	7699	29.52K	122.1K	162.7K	271.3K	325.3K	542.2K	366K				
50.8	46	1870	7270	27.81K	113.9K	151.7K	253K	303.5K	505.8K	344.1K				
49.0	45	1775	6867	26.22K	106.3K	141.6K	236.2K	283.2K	472.0K	323.7K				
47.2	44	1685	6489	24.72K	99.26K	132.2K	220.5K	264.5K	440.8K	304.6K				
45.4	43	1600	6135	23.32K	92.72K	123.5K	205.9K	247K	411.7K	286.7K				
43.6	42	1521	5803	22.01K	86.65K	115.4K	192.5K	230.9K	384.8K	270K				
41.8	41	1445	5491	20.79K	81.02K	107.9K	180K	215.9K	359.8K	254.4K				
-40.0	-40	1374	5198	19.64K	75.79K	101K	168.3K	201.9K	336.5K	239.8K	884.6K	3356K		
38.2	39	1307	4922	18.56K	70.93K	94.48K	157.5K	189K	315K	226K	830.9K	3147K		
36.4	38	1244	4663	17.54K	66.41K	88.46K	147.5K	176.9K	294.9K	213.2K	780.8K	2951K		
34.6	37	1184	4420	16.59K	62.21K	82.87K	138.2K	165.7K	276.2K	201.1K	733.9K	2769K		
32.8	36	1127	4191	15.7K	58.3K	77.66K	129.5K	155.3K	258.9K	189.8K	690.2K	2599K		
31.0	35	1073	3975	14.86K	54.66K	72.81K	121.4K	145.6K	242.7K	179.2K	649.3K	2440K		
29.2	34	1023	3772	14.07K	51.27K	68.3K	113.9K	136.6K	227.7K	169.3K	611K	2292K		
27.4	33	974.9	3580	13.33K	48.11K	64.09K	106.9K	128.2K	213.6K	160K	575.2K	2154K		
25.6	32	929.6	3400	12.63K	45.17K	60.17K	100.3K	120.3K	200.6K	151.2K	541.7K	2025K		
23.8	31	886.6	3230	11.97K	42.42K	56.51K	94.22K	113K	188.4K	143K	510.4K	1904K		
-22.0	-30	846.0	3069	11.35K	39.86K	53.1K	88.53K	106.2K	177K	135.2K	481K	1791K		
20.2	29	807.5	2918	10.77K	37.47K	49.91K	83.22K	99.83K	166.4K	127.9K	453.5K	1685K		
18.4	28	771.0	2775	10.22K	35.24K	46.94K	78.26K	93.89K	156.5K	121.1K	427.7K	1586K		
16.6	27	736.4	2640	9705	33.15K	44.16K	73.62K	88.32K	147.2K	114.6K	403.5K	1494K		
14.8	26	703.6	2512	9218	31.2K	41.56K	69.29K	83.13K	138.5K	108.6K	380.9K	1407K		
13.0	25	672.5	2392	8758	29.38K	39.13K	65.24K	78.28K	130.5K	102.9K	359.6K	1326K		
11.2	24	643.0	2278	8323	27.67K	36.86K	61.45K	73.72K	122.9K	97.49K	339.6K	1250K		
9.4	23	614.9	2170	7914	26.07K	34.73K	57.9K	69.46K	115.8K	92.43K	320.9K	1178K		
7.6	22	588.3	2068	7527	24.58K	32.74K	54.58K	65.49K	109.1K	87.66K	303.3K	1111K		
5.8	21	563.0	1972	7161	23.18K	30.87K	51.47K	61.76K	102.9K	83.16K	286.7K	1049K		
-4.0	-20	538.9	1880	6815	21.87K	29.13K	48.56K	58.27K	97.11K	78.91K	271.2K	989.8K		
2.2	19	516.1	1794	6489	20.64K	27.49K	45.83K	54.99K	91.65K	74.91K	256.5K	934.6K		
0.4	18	494.3	1712	6180	19.48K	25.95K	43.27K	51.9K	86.5K	71.13K	242.8K	882.7K		
1.4	17	473.6	1634	5887	18.4K	24.51K	40.86K	49.02K	81.71K	67.57K	229.8K	834K		
3.2	16	454.0	1561	5611	17.39K	23.16K	38.61K	46.33K	77.22K	64.2K	217.6K	788.2K		
5.0	15	435.2	1491	5349	16.43K	21.89K	36.49K	43.77K	72.96K	61.02K	206.2K	745.2K		
6.8	14	417.4	1424	5101	15.54K	20.7K	34.5K	41.4K	69.01K	58.01K	195.4K	704.7K		
8.6	13	400.4	1361	4866	14.7K	19.58K	32.63K	39.17K	65.28K	55.17K	185.2K	666.7K		
10.4	12	384.2	1302	4643	13.91K	18.52K	30.88K	37.06K	61.77K	52.48K	175.6K	630.9K		
12.2	11	368.8	1245	4432	13.16K	17.53K	29.23K	35.06K	58.44K	49.94K	166.6K	597.2K		

Resistance versus Temperature -10 to +59°C

Thermistor Mix		L Mix	L Mix	L Mix	B Mix	B Mix	B Mix	B Mix	B Mix	H Mix	H Mix	H Mix	H Mix	H Mix
Ω at 25°C		**100**	**300**	**1000**	**2252**	**3000**	**5000**	**6000**	**10,000**	**10,000**	**30,000**	**100,000**	**300,000**	**1 MEG**
°F	**°C**													
+14.0	**-10**	354.1	1191	4232	12.46K	16.60K	27.67K	33.20K	55.33K	47.54K	158K	565.5K		
15.8	**9**	340.0	1140	4042	11.81K	15.72K	26.21K	31.47K	52.44K	45.27K	150K	535.6K		
17.6	**8**	326.7	1091	3862	11.19K	14.90K	24.83K	29.81K	49.69K	43.11K	142.4K	507.5K		
19.4	**7**	313.9	1045	3691	10.60K	14.12K	23.54K	28.24K	47.07K	41.07K	135.2K	481K		
21.2	**6**	301.7	1001	3529	10.05K	13.39K	22.32K	26.78K	44.63K	39.14K	128.5K	456K		
23.0	**5**	290.1	958.9	3374	9.530K	12.70K	21.17K	25.40K	42.34K	37.31K	122.1K	432.4K		
24.8	**4**	278.9	919.0	3228	9.050K	12.05K	20.08K	24.10K	40.17K	35.57K	116K	410.2K		
26.6	**3**	268.3	881.0	3088	8.590K	11.44K	19.06K	22.88K	38.13K	33.93K	110.3K	389.2K		
28.4	**2**	258.2	844.8	2956	8.150K	10.86K	18.10K	21.72K	36.19K	32.37K	104.9K	369.4K		
+30.2	**-1**	248.5	810.3	2830	7.741K	10.31K	17.19K	20.62K	34.37K	30.89K	99.80K	350.7K		
32.0	**0**	239.2	777.5	2710	7355	9796	16.33K	19.60K	32.66K	29.49K	94.98K	333.1K	1088K	3966K
+33.8	**+1**	230.3	746.2	2596	6989	9310	15.52K	18.62K	31.03K	28.15K	90.41K	316.4K	1030K	3740K
35.6	**2**	221.9	716.3	2487	6644	8851	14.75K	17.70K	29.50K	26.89K	86.09K	300.6K	975.3K	3529K
37.4	**3**	213.8	687.8	2384	6319	8417	14.03K	16.84K	28.06K	25.69K	81.99K	285.7K	923.8K	3330K
39.2	**4**	206.0	660.6	2286	6011	8006	13.34K	16.02K	26.69K	24.55K	78.11K	271.6K	875.2K	3144K
41.0	**5**	198.6	634.6	2192	5719	7618	12.70K	15.24K	25.40K	23.46K	74.44K	258.3K	829.5K	2969K
42.8	**6**	191.5	609.9	2102	5444	7252	12.09K	14.50K	24.17K	22.43K	70.96K	245.7K	786.3K	2804K
44.6	**7**	184.6	586.2	2017	5183	6905	11.51K	13.81K	23.02K	21.45K	67.66K	233.8K	745.6K	2649K
46.4	**8**	178.1	563.6	1936	4937	6576	10.96K	13.15K	21.92K	20.52K	64.53K	222.5K	707.2K	2504K
48.2	**9**	171.9	542.1	1859	4703	6265	10.44K	12.53K	20.88K	19.63K	61.56K	211.9K	671K	2367K
50.0	**10**	165.9	521.5	1785	4482	5971	9951	11.94K	19.90 K	18.79K	58.75K	201.7K	636.8K	2238K
51.8	**11**	160.1	501.7	1714	4273	5692	9486	11.38K	18.97K	17.98K	56.07K	192.2K	604.5K	2117K
53.6	**12**	154.6	482.9	1647	4074	5427	9046	10.85K	18.09K	17.22K	53.54K	183.1K	574K	2003K
55.4	**13**	149.3	464.9	1582	3886	5177	8628	10.35K	17.26K	16.49K	51.13K	174.5K	545.2K	1896K
57.2	**14**	144.2	447.6	1521	3708	4939	8232	9879	16.47K	15.79K	48.84K	166.3K	518K	1795K
59.0	**15**	139.4	431.2	1462	3539	4714	7857	9429	15.71K	15.13K	46.67K	158.6K	492.3K	1700K
60.8	**16**	134.7	415.4	1406	3378	4500	7500	9000	15K	14.50K	44.60K	151.3K	468K	1610K
62.6	**17**	130.2	400.2	1353	3226	4297	7162	8595	14.33K	13.90K	42.64K	144.3K	444.9K	1525K
64.4	**18**	125.9	385.8	1302	3081	4105	6841	8209	13.68K	13.33K	40.77K	137.7K	423.2K	1446K
66.2	**19**	121.7	371.9	1253	2944	3922	6536	7844	13.07K	12.79K	38.99K	131.4K	402.6K	1370K
68.0	**20**	117.7	358.6	1206	2814	3748	6247	7497	12.50K	12.26K	37.30K	125.5K	383.1K	1299K
69.8	**21**	113.9	345.9	1161	2690	3583	5972	7167	11.94K	11.77K	35.70K	119.8K	364.6K	1232K
71.6	**22**	110.2	333.7	1118	2572	3426	5710	6853	11.42K	11.29K	34.17K	114.5K	347.1K	1169K
73.4	**23**	106.7	322.0	1077	2460	3277	5462	6554	10.92K	10.84K	32.71K	109.4K	330.6K	1110K
75.2	**24**	103.3	310.8	1038	2354	3135	5225	6272	10.45K	10.41K	31.32K	104.5K	314.9K	1053K
77.0	**25**	100.0	300.0	1000	2252	3000	5000	6000	10.00K	10.00K	30.00K	100.0K	300.0K	1000K
78.8	**26**	96.9	289.7	963.9	2156	2872	4787	5744	9574	9605	28.74K	95.51K	285.9K	949.7K
80.6	**27**	93.8	279.8	929.4	2064	2750	4583	5499	9165	9227	27.54K	91.34K	272.5K	902.2K
82.4	**28**	90.9	270.3	896.3	1977	2633	4389	5267	8779	8867	26.4K	87.38K	259.8K	857.2K
84.2	**29**	88.1	261.1	864.5	1894	2523	4204	5046	8410	8523	25.31K	83.6K	247.8K	814.7K
86.0	**30**	85.4	252.4	834.0	1815	2417	4029	4836	8060	8194	24.27K	80.00K	236.4K	774.5K
87.8	**31**	82.8	243.9	804.8	1739	2317	3861	4633	7722	7880	23.28K	76.58K	225.6K	736.5K
89.6	**32**	80.3	235.9	776.8	1667	2221	3702	4441	7402	7579	22.33K	73.32K	215.3K	700.5K
91.4	**33**	77.8	228.1	749.9	1599	2130	3549	4260	7100	7291	21.43K	70.22K	205.5K	666.4K
93.2	**34**	75.5	220.6	724.1	1533	2042	3404	4084	6807	7016	20.57K	67.26K	196.2K	634.1K
95.0	**35**	73.2	213.4	699.4	1471	1959	3266	3919	6532	6752	19.74K	64.44K	187.4K	603.6K
96.8	**36**	71.1	206.5	675.6	1412	1880	3134	3762	6270	6500	18.96K	61.75K	179K	574.6K
98.6	**37**	69.0	199.8	652.7	1355	1805	3008	3610	6017	6258	18.21K	59.19K	171K	547.2K
100.4	**38**	67.0	193.4	630.8	1301	1733	2888	3466	5777	6026	17.49K	56.75K	163.5K	521.2K
102.2	**39**	65.0	187.3	609.7	1249	1664	2773	3328	5546	5805	16.8K	54.42K	156.3K	496.6K
104.0	**40**	63.1	181.4	589.5	1200	1598	2663	3197	5329	5592	16.15K	52.19K	149.4K	473.2K
105.8	**41**	61.3	175.7	570.0	1152	1535	2559	3069	5116	5389	15.52K	50.07K	142.9K	451K
107.6	**42**	59.6	170.2	551.2	1107	1475	2459	2949	4916	5193	14.92K	48.04K	136.7K	430K
109.4	**43**	57.9	164.9	533.2	1064	1418	2363	2835	4725	5006	14.35K	46.11K	130.8K	410K
111.2	**44**	56.2	159.8	515.9	1023	1363	2272	2726	4543	4827	13.8K	44.26K	125.1K	391.1K
113.0	**45**	54.7	154.9	499.2	983.8	1310	2184	2621	4369	4655	13.28K	42.5K	119.8K	373.1K
114.8	**46**	53.1	150.1	483.2	946.2	1260	2101	2521	4202	4489	12.77K	40.81K	114.7K	356.1K
116.6	**47**	51.7	145.6	467.8	910.2	1212	2021	2425	4042	4331	12.29K	39.2K	109.8K	339.8K
118.4	**48**	50.2	141.2	452.9	875.8	1167	1944	2333	3889	4179	11.83K	37.66K	105.2K	324.4K
120.2	**49**	48.9	137.0	438.6	842.8	1123	1871	2246	3743	4033	11.39K	36.19K	100.8K	309.8K
122.0	**50**	47.5	132.9	424.8	811.3	1081	1801	2162	3603	3893	10.97K	34.78K	96.54K	295.9K
123.8	**51**	46.2	128.9	411.6	781.1	1040	1734	2081	3469	3758	10.57K	33.44K	92.52K	282.7K
125.6	**52**	45.0	125.1	398.8	752.2	1002	1670	2004	3340	3629	10.18	32.15K	88.69K	270.1K
127.4	**53**	43.8	121.5	386.5	724.5	965.0	1608	1930	3217	3504	9807	30.92K	85.04K	258.1K
129.2	**54**	42.6	117.9	374.7	697.9	929.6	1549	1859	3099	3385	9450	29.74K	81.55K	246.7K
131.0	**55**	41.5	114.5	363.2	672.5	895.8	1493	1792	2986	3270	9109	28.61K	78.22K	235.9K
132.8	**56**	40.4	111.2	352.2	648.1	863.3	1439	1727	2878	3160	8781	27.53K	75.04K	225.6K
134.6	**57**	39.3	108.0	341.6	624.8	832.2	1387	1665	2774	3054	8467	26.5K	72.01K	215.8K
136.4	**58**	38.3	105.0	331.3	602.4	802.3	1337	1605	2675	2952	8166	25.5K	69.11K	206.4K
138.2	**59**	37.3	102.0	321.5	580.9	773.7	1290	1548	2580	2854	7876	24.56K	66.34K	197.5K

Resistance versus Temperature 60 to 129°C

Thermistor Mix		L Mix	L Mix	L Mix	B Mix	B Mix	B Mix	B Mix	B Mix	H Mix	H Mix	H Mix	H Mix	H Mix
Ω at 25°C		100	300	1000	2252	3000	5000	6000	10,000	10,000	30,000	100,000	300,000	1 MEG
°F	°C													
140.0	60	36.4	99.1	311.9	560.3	746.3	1244	1493	2488	2760	7599	23.65K	63.7K	189.1K
141.8	61	35.4	96.3	302.7	540.5	719.9	1200	1440	2400	2669	7332	22.77K	61.17K	181K
143.6	62	34.5	93.7	293.9	521.5	694.7	1158	1389	2316	2582	7076	21.94K	58.75K	173.3K
145.4	63	33.7	91.1	285.3	503.3	670.4	1117	1341	2235	2497	6830	21.14K	56.44K	166K
147.2	64	32.8	88.6	277.0	485.8	647.1	1079	1294	2157	2417	6594	20.37K	54.23K	159K
149.0	65	32.0	86.1	269.0	469.0	624.7	1041	1250	2083	2339	6367	19.63K	52.12K	152.3K
150.8	66	31.2	83.8	261.3	452.9	603.3	1006.0	1207	2011	2264	6149	18.93K	50.1K	146K
152.6	67	30.4	81.5	253.9	437.4	582.6	971.1	1165	1942	2191	5940	18.25K	48.17K	139.9K
154.4	68	29.7	79.3	246.7	422.5	562.8	938.0	1126	1876	2122	5738	17.6K	46.32K	134.1K
156.2	69	29.0	77.2	239.7	408.2	543.7	906.3	1088	1813	2055	5545	16.97K	44.54K	128.6K
158.0	70	28.3	75.2	233.0	394.5	525.4	875.7	1051	1752	1990	5359	16.37K	42.85K	123.3K
159.8	71	27.6	73.2	226.5	381.2	507.8	846.4	1016	1693	1928	5180	15.8K	41.23K	118.3K
161.6	72	26.9	71.3	220.2	368.5	490.9	818.3	981.8	1636	1868	5007	15.25K	39.67K	113.5K
163.4	73	26.3	69.4	214.1	356.2	474.7	791.2	949.0	1582	1810	4842	14.72K	38.18K	108.9K
165.2	74	25.6	67.6	208.3	344.5	459.0	765.1	917.9	1530	1754	4682	14.21K	36.75K	104.5K
167.0	75	25.0	65.9	202.6	333.1	444.0	740.0	887.5	1479	1700	4529	13.72K	35.39K	100.3K
168.8	76	24.5	64.2	197.1	322.3	429.5	715.9	858.7	1431	1648	4381	13.25K	34.08K	96.31K
170.6	77	23.9	62.5	191.8	311.8	415.6	692.7	830.7	1385	1598	4239	12.79K	32.82K	92.48K
172.4	78	23.3	60.9	186.7	301.7	402.2	670.3	803.8	1340	1549	4102	12.36K	31.62K	88.82K
174.2	79	22.8	59.4	181.7	292.0	389.3	648.8	778.0	1297	1503	3970	11.94K	30.46K	85.32K
176.0	80	22.3	57.9	176.9	282.7	376.9	628.1	753.2	1255	1458	3843	11.54K	29.35K	81.98K
177.8	81	21.8	56.5	172.2	273.7	364.9	608.2	729.2	1215	1414	3720	11.15K	28.29K	78.78K
179.6	82	21.3	55.1	167.7	265.0	353.4	588.9	706.0	1177	1372	3602	10.78K	27.27K	75.71K
181.4	83	20.8	53.7	163.3	256.7	342.2	570.4	683.9	1140	1332	3489	10.42K	26.29K	72.78K
183.2	84	20.3	52.4	159.1	248.6	331.5	552.6	662.3	1104	1293	3379	10.08K	25.35K	69.98K
185.0	85	19.9	51.1	154.9	240.9	321.2	535.4	641.8	1070	1255	3273	9744	24.45K	67.29K
186.8	86	19.4	49.9	151.0	233.4	311.3	518.8	621.8	1036	1218	3172	9424	23.59K	64.72K
188.6	87	19.0	48.7	147.1	226.2	301.7	502.8	602.7	1004	1183	3073	9117	22.76K	62.26K
190.4	88	18.6	47.5	143.4	219.3	292.4	487.4	584.3	973.8	1149	2979	8821	21.96K	59.91K
192.2	89	18.2	46.4	139.8	212.6	283.5	472.6	566.4	944.1	1116	2887	8536	21.19K	57.65K
194.0	90	17.8	45.3	136.2	206.1	274.9	458.2	549.1	915.2	1084	2799	8261	20.45K	55.48K
195.8	91	17.4	44.2	132.8	199.9	266.6	444.4	532.6	887.7	1053	2714	7996	19.75K	53.41K
197.6	92	17.0	43.2	129.5	193.9	258.6	431.0	516.6	861.0	1023	2632	7741	19.07K	51.42K
199.4	93	16.6	42.1	126.3	188.1	250.9	418.2	501.2	835.3	994.2	2552	7496	18.41K	49.52K
201.2	94	16.3	41.2	123.2	182.5	243.4	405.7	486.2	810.4	966.3	2476	7259	17.78K	47.69K
203.0	95	15.9	40.2	120.2	177.1	236.2	393.7	471.8	786.4	939.3	2402	7030	17.18K	45.94K
204.8	96	15.6	39.3	117.3	171.9	229.3	382.1	458.0	763.3	913.2	2331	6810	16.6K	44.26K
206.6	97	15.3	38.4	114.4	166.9	222.6	370.9	444.7	741.1	887.9	2262	6598	16.04K	42.65K
208.4	98	15.0	37.5	111.7	162.0	216.1	360.1	431.6	719.4	863.4	2195	6393	15.5K	41.1K
210.2	99	14.6	36.7	109.0	157.3	209.8	349.7	419.1	698.5	839.7	2131	6195	14.98K	39.62K
212.0	100	14.3	35.8	106.4	152.8	203.8	339.6	407.1	678.5	816.8	2069	6005	14.48K	38.2K
213.8	101				148.4	197.9	329.8	395.4	659.0	794.6	2009	5821	14K	36.84K
215.6	102				144.2	192.2	320.4	384.2	640.3	773.1	1950	5643	13.54K	35.53K
217.4	103				140.1	186.8	311.3	373.3	622.1	752.3	1894	5472	13.09K	34.27K
219.2	104				136.1	181.5	302.5	362.6	604.4	732.1	1840	5307	12.66K	33.06K
221.0	105				132.3	176.4	294.0	352.5	587.5	712.6	1788	5147	12.25K	31.91K
222.8	106				128.6	171.4	285.7	342.6	571.0	693.6	1737	4993	11.86K	30.79K
224.6	107				125.0	166.7	277.8	333.0	555.1	675.3	1688	4844	11.47K	29.72K
226.4	108				121.6	162.0	270.1	324.0	540.0	657.5	1640	4700	11.11K	28.69K
228.2	109				118.2	157.6	262.6	314.9	524.9	640.3	1594	4561	10.75K	27.71K
230.0	110				115.0	153.2	255.4	306.4	510.7	623.5	1550	4427	10.41K	26.76K
231.8	111				111.8	149.0	248.4	297.9	496.4	607.3	1507	4297	10.08K	25.84K
233.6	112				108.8	145.0	241.6	289.9	483.1	591.6	1465	4172	9763	24.96K
235.4	113				105.8	141.1	235.1	281.9	469.8	576.4	1425	4051	9456	24.12K
237.2	114				103.0	137.2	228.7	274.4	457.4	561.6	1386	3933	9161	23.31K
239.0	115				100.2	133.6	222.6	267.0	444.9	547.3	1348	3820	8876	22.52K
240.8	116				97.6	130.0	216.7	260.0	433.4	533.4	1311	3711	8601	21.77K
242.6	117				95.0	126.5	210.9	253.1	421.8	519.9	1276	3605	8336	21.05K
244.4	118				92.5	123.2	205.3	246.4	410.7	506.8	1241	3502	8080	20.35K
246.2	119				90.0	119.9	199.9	239.8	399.6	494.1	1208	3403	7832	19.68K
248.0	120				87.7	116.8	194.7	233.7	389.4	481.8	1176	3307	7594	19.03K
249.8	121				85.4	113.8	189.6	227.5	379.2	469.8	1145	3214	7364	18.41K
251.6	122				83.2	110.8	184.7	221.7	369.4	458.2	1114	3124	7142	17.81K
253.4	123				81.1	107.9	179.9	216.1	360.1	446.9	1085	3038	6927	17.23K
255.2	124				79.0	105.2	175.3	210.5	350.8	435.9	1057	2953	6720	16.68K
257.0	125				77.0	102.5	170.8	205.2	341.9	425.3	1029	2872	6519	16.14K
258.8	126				75.0	99.9	166.4	199.8	333.0	414.9	1002	2793	6326	15.62K
260.6	127				73.1	97.3	162.2	194.8	324.6	404.9	976.3	2717	6139	15.12K
262.4	128				71.3	94.9	158.1	190.0	316.6	395.1	951.1	2643	5958	14.64K
264.2	129				69.5	92.5	154.1	185.2	308.6	385.6	926.7	2571	5784	14.18K

6

Resistance versus Temperature 130 to 199°C

Thermistor Mix		L Mix	L Mix	L Mix	B Mix	B Mix	B Mix	B Mix	B Mix	H Mix	H Mix	H Mix	H Mix	H Mix
Ω at 25°C		100	300	1000	2252	3000	5000	6000	10,000	10,000	30,000	100,000	300,000	1 MEG
°F	°C													
266.0	130				67.8	90.2	150.3	180.6	301.1	376.4	903.0	2501	5615	13.74K
267.8	131				66.1	87.9	146.5	176.1	293.5	367.4	880.0	2434	5452	13.31K
269.6	132				64.4	85.7	142.9	171.6	286.0	358.7	857.7	2369	5294	12.89K
271.4	133				62.9	83.6	139.4	167.6	279.3	350.3	836.1	2306	5141	12.49K
273.2	134				61.3	81.6	136.0	163.3	272.2	342.0	815.0	2244	4994	12.1K
275.0	135				59.8	79.6	132.6	159.3	265.5	334.0	794.6	2185	4851	11.73K
276.8	136				58.4	77.6	129.4	155.6	259.3	326.3	774.8	2128	4713	11.37K
278.6	137				57.0	75.8	126.3	151.9	253.1	318.7	755.6	2072	4580	11.02K
280.4	138				55.6	73.9	123.2	148.1	246.9	311.3	736.9	2018	4450	10.69K
282.2	139				54.3	72.2	120.3	144.7	241.1	304.2	718.8	1965	4325	10.36K
284.0	140				53.0	70.4	117.4	141.2	235.3	297.2	701.2	1914	4204	10.05K
285.8	141				51.7	68.8	114.6	137.7	229.6	290.4	684.1	1865	4087	9746
287.6	142				50.5	67.1	111.9	134.5	224.2	283.8	667.5	1817	3974	9455
289.4	143				49.3	65.5	109.2	131.3	218.9	277.4	651.3	1770	3864	9173
291.2	144				48.2	64.0	106.7	128.4	214.0	271.2	635.6	1725	3757	8901
293.0	145				47.0	62.5	104.2	125.2	208.7	265.1	620.3	1681	3654	8637
294.8	146				45.9	61.1	101.8	122.3	203.8	259.2	605.5	1639	3555	8383
296.6	147				44.9	59.6	99.4	119.6	199.4	253.4	591.1	1598	3458	8137
298.4	148				43.8	58.3	97.1	116.7	194.5	247.8	577.1	1558	3364	7899
300.2	149				42.8	56.9	94.9	114.0	190.1	242.3	563.5	1519	3274	7669
302.0	150				41.8	55.6	92.7	111.5	185.9	237.0	550.2	1481	3186	7447
303.8	151				40.9	54.5	90.8	109.0	181.7	231.7	537.7			
305.6	152				40.0	53.3	88.8	106.5	177.5	226.6	525.1			
307.4	153				39.1	52.1	86.8	104.1	173.5	221.7	512.9			
309.2	154				38.2	50.9	84.9	101.8	169.6	216.9	501.0			
311.0	155				37.3	49.7	82.9	99.4	165.7	212.2	489.3			
312.8	156				36.5	48.7	81.1	97.3	162.1	207.6	478.1			
314.6	157				35.7	47.6	79.3	95.1	158.5	203.2	467.2			
316.4	158				34.9	46.5	77.6	93.0	155.0	198.8	456.6			
318.2	159				34.1	45.5	75.9	91.0	151.6	194.6	446.2			
320.0	160				33.4	44.5	74.2	89.0	148.3	190.5	436.1			
321.8	161				32.7	43.5	72.6	87.1	145.1	186.5	426.3			
323.6	162				32.0	42.6	71.0	85.2	141.9	182.6	416.7			
325.4	163				31.3	41.7	69.5	83.3	138.4	178.7	407.4			
327.2	164				30.6	40.8	68.0	81.5	135.8	175.0	398.3			
329.0	165				29.9	39.9	66.4	79.7	132.8	171.4	389.5			
330.8	166				29.3	39.0	65.1	78.1	130.1	167.8	380.8			
332.6	167				28.7	38.2	63.7	76.4	127.3	164.4	372.4			
334.4	168				28.1	37.4	62.3	74.8	124.6	161.0	364.3			
336.2	169				27.5	36.6	61.0	73.2	122.0	157.7	356.3			
338.0	170				26.9	35.8	59.7	71.7	119.4	154.5	348.6			
339.8	171				26.3	35.1	58.5	70.1	116.9	151.4	341.0			
341.6	172				25.9	34.3	57.3	68.7	114.5	148.3	333.6			
343.4	173				25.2	33.6	56.1	67.3	112.1	145.3	326.4			
345.2	174				24.7	32.9	54.9	65.9	109.8	142.4	319.4			
347.0	175				24.2	32.2	53.8	64.5	107.5	139.6	312.7			
348.8	176				23.7	31.6	52.7	63.2	105.3	136.8	305.9			
350.6	177				23.2	30.9	51.6	61.9	103.2	134.1	299.4			
352.4	178				22.8	30.3	50.5	60.7	101.1	131.5	293.1			
354.2	179				22.3	29.7	49.5	59.4	99.0	128.9	286.9			
356.0	180				21.9	29.1	48.6	58.2	97.1	126.3	281.0			
357.8	181				21.4	28.5	47.5	57.1	95.1	123.9	275.0			
359.6	182				21.0	27.9	46.6	55.9	93.2	121.5	269.3			
361.4	183				20.6	27.4	45.6	54.8	91.3	119.1	263.7			
363.2	184				20.2	26.8	44.7	53.7	89.5	116.8	258.3			
365.0	185				19.8	26.3	43.8	52.7	87.8	114.6	253.0			
366.8	186				19.4	25.8	43.0	51.6	86.0	112.4	247.7			
368.6	187				19.0	25.3	42.1	50.6	84.3	110.2	242.7			
370.4	188				18.6	24.8	41.3	49.6	82.7	108.1	237.7			
372.2	189				18.3	24.3	40.5	48.6	81.1	106.1	232.9			
374.0	190				17.9	23.8	39.7	47.7	79.5	104.1	228.2			
375.8	191				17.6	23.4	39.0	46.8	78.0	102.2	223.6			
377.6	192				17.2	22.9	38.2	45.9	76.5	100.2	219.1			
379.4	193				16.9	22.5	37.5	45.0	75.1	98.4	214.7			
381.2	194				16.6	22.1	36.8	44.2	73.7	96.6	210.4			
383.0	195				16.3	21.7	36.1	43.4	72.3	94.8	206.2			
384.8	196				16.0	21.3	35.5	42.6	70.9	93.0	202.1			
386.6	197				15.7	20.9	34.8	41.8	69.6	91.3	198.2			
388.4	198				15.4	20.5	34.2	41.0	68.3	89.7	194.2			
390.2	199				15.1	20.2	33.5	40.2	67.1	88.0	190.4			

Resistance versus Temperature 200 to 250°C

Thermistor Mix		L Mix	L Mix	L Mix	B Mix	B Mix	B Mix	B Mix	B Mix	H Mix	H Mix	H Mix	H Mix	H Mix
Ω at 25°C		100	300	1000	2252	3000	5000	6000	10,000	10,000	30,000	100,000	300,000	1 MEG
°F	°C													
392.0	200				14.9	19.8	32.9	39.6	65.9	86.5	186.7			
393.8	201						32.3	38.8	64.7	84.9	183.1			
395.6	202						31.7	38.1	63.5	83.3	179.5			
397.4	203						31.2	37.4	62.3	81.9	176.0			
399.2	204						30.6	36.7	61.2	80.4	172.6			
401.0	205						30.0	36.0	60.1	79.0	169.3			
402.8	206						29.5	35.4	59.0	77.6	166.1			
404.6	207						29.0	34.8	58.0	76.2	162.9			
406.4	208						28.5	34.2	57.0	74.9	159.8			
408.2	209						28.0	33.6	56.0	73.6	156.8			
410.0	210						27.5	33.0	55.0	72.3	153.8			
411.8	211						27.0	32.4	54.0	71.0	150.9			
413.6	212						26.5	31.8	53.1	69.8	148.1			
415.4	213						26.1	31.3	52.1	68.6	145.3			
417.2	214						25.6	30.7	51.2	67.4	142.6			
419.0	215						25.1	30.2	50.3	66.2	139.9			
420.8	216						24.7	29.7	49.5	65.1	137.3			
422.6	217						24.3	29.2	48.6	64.0	134.8			
424.4	218						23.9	28.7	47.8	62.9	132.3			
426.2	219						23.5	28.2	47.0	61.8	129.9			
428.0	220						23.1	27.7	46.2	60.8	127.5			
429.8	221						22.7	27.2	45.4	59.8	125.2			
431.6	222						22.3	26.8	44.7	58.8	122.9			
433.4	223						22.0	26.3	43.9	57.8	120.7			
435.2	224						21.6	25.9	43.2	56.8	118.5			
437.0	225						21.3	25.5	42.5	55.9	116.3			
438.8	226						20.9	25.0	41.8	55.0	114.3			
440.6	227						20.5	24.6	41.1	54.1	112.2			
442.4	228						20.2	24.2	40.4	53.2	110.2			
444.2	229						19.9	23.8	39.7	52.3	108.3			
446.0	230						19.5	23.4	39.1	51.5	106.4			
447.8	231						19.2	23.1	38.5	50.6	104.5			
449.6	232						18.9	22.7	37.8	49.9	102.6			
451.4	233						18.6	22.3	37.2	49.0	100.8			
453.2	234						18.3	22.0	36.6	48.2	99.1			
455.0	235						18.0	21.6	36.0	47.4	97.3			
456.8	236						17.7	21.3	35.5	46.7	95.7			
458.6	237						17.4	20.9	34.9	46.0	94.0			
460.4	238						17.1	20.6	34.4	45.2	92.4			
462.2	239						16.9	20.3	33.8	44.5	90.8			
464.0	240						16.6	20.0	33.3	43.8	89.2			
465.8	241						16.3	19.6	32.8	43.1	87.7			
467.6	242						16.1	19.3	32.2	42.4	86.2			
469.4	243						15.8	19.0	31.7	41.8	84.8			
471.2	244						15.6	18.7	31.3	41.1	83.3			
473.0	245						15.3	18.5	30.8	40.5	81.9			
474.8	246						15.1	18.2	30.3	39.9	80.5			
476.6	247						14.9	17.9	29.8	39.3	79.2			
478.4	248						14.6	17.6	29.4	38.7	77.9			
480.2	249						14.4	17.4	28.9	38.1	76.6			
482.0	250						14.2	17.1	28.5	37.5	75.3			

For more information,
contact us at **800 747-5367** or
937 767-7241 • Fax 937 767-9353
Info@YSI.com • **www.YSI.com**

Glossary

316SS A stainless steel containing approximately 2% Mn, 2% Mo,12% Ni and 17% Cr, with the balance Fe and trace C, S, P and Si.

Absolute zero The lowest possible temperature; the temperature at which thermal energy is at a minimum. Defined as 0 Kelvin or -273.15°C.

Accuracy Measure of the closeness of a reading to the actual value.

Ambient range In general, the human environmental range, -20 to +50°C. The industrial application ambient range is 0 to 70°C, the military range is -55 to +125°C.

Ambient temperature Temperature of the background or surrounding environment.

Ampere (A) SI unit of electric current.

AWG American Wire Gauge.

Beta value An indicator of the shape of the resistance vs temperature curve.
$\beta = \ln (R_T/R_{To})/(1/T-1/T_o)$

Calibration Documenting a sensor's value as determined by a precise measurement.

Celsius (Centigrade,°C) A temperature scale defined by setting the ice point of water at 0°C and the boiling point of water at 100°C.

CE Mark Signifies product acceptance by the European Community. The Joint European Standards Institution.

Control point The temperature at which the controlled system is to be maintained.

Current (I) The rate of flow of an electric charge, usually expressed in amperes.

Current proportioning A type of temperature controller which provides a control current proportional to the difference between the measured temperature and the control point.

Direct current (dc) Current that flows in one direction only. The type of current that is supplied by batteries.

Degree (°) An increment of a temperature scale. The size of a degree is different in different temperature scales; for example, 1°C = 1.8°F

De-rated A deliberate reduction in the rating of a component to improve reliability.

Deviation The difference between an observed and a fixed value; the difference between the observed temperature and the set point of the controller.

Dielectric Any material capable of sustaining a steady electric field; an insulator.

Differential The difference between the temperature at which a controller turns heat off and the temperature at which the heat is turned on, in degrees.

Dissipation constant The ratio of power dissipation to temperature rise induced when current is applied to a thermistor (e.g. 8mW˚/C represents a 1˚C temperature rise for every 8 mW of power dissipated).

Drift A slow variation of any performance characteristic of a device or circuit.

Dumet A copper-clad, nickel-iron alloy with a thermal expansion closely matching that of glass. Provides hermetic seals in soft glasses.

emf Electromotive force. Difference of electrical potential that drives currents through circuits. Unit is the volt.

Epoxy A flexible resin used in coatings and adhesives. Also called epoxy resin.

Error The difference between the correct or desired value and the actual reading.

Fahrenheit A temperature scale defined by setting the freezing point of water at 32°C and the boiling point of water at 212°C.

Galvanometer An instrument that measures small electrical currents by means of deflecting magnetic coils.

Ground A conducting path between an electrical circuit and the earth or some conductor serving in its place.

GSFC S-311-P-18 A specification issued by the Goddard Space Flight Center covering thermistors for use in space flight.

Heat Energy in the process of transferring between a system and its surroundings as a result of temperature differences.

Heat transfer The process whereby thermal energy flows from a high energy body to a low energy body via conduction, convection or radiation.

Hermetic Airtight

Hysteresis The retardation or lagging of an effect behind the cause of the effect.

ID Inside diameter.

Input impedance The small signal impedance measured between the input terminals of a network.

Insulation resistance The resistance between two conductors, or between a conductor and ground, when they are separated only by insulating material.

Interchangeable Able to substitute one sensor for another while maintaining consistent readings.

Interchangeability error A measurement error that can occur if two or more probes are used to make the same measurement. It is caused by a slight variation in characteristics of different probes.

Isothermal Occurring at constant temperature.

ITS-90 International Temperature Scale of 1990.

Kelvin (K) An absolute temperature scale based on the Celcius scale; the thermodynamic temperature scale. One kelvin is the same temperature interval as one degree Celcius, and 0K = -273.15°C.

Linearity deviation The difference between the actual response of a device and its theoretical straight-line approximation.

Maximum operating temperature The temperature above which a device will not safely operate.

Maximum power rating The maximum power that a device can safely handle.

Metrology The science of measuring.

Mica A transparent mineral used to make the cross supporting the platinum wire windings in an SPRT. One of the best electrical insulators.

Microamp (µA) One millionth of an ampere, 10^{-6} A.

MIL-R-23648 The US Department of Defense general specification for thermistors.

Milliamp (mA) One thousandth of an ampere, 10^{-3} A.

Millivolt (mV) One thousandth of a volt, 10^{-3} V.

Negative temperature coefficient (NTC) Decreasing resistance with increasing temperature.

NIST National Institute of Standards and Technology. The US government agency that defines measurement standards in the United States.

NPT National Pipe Thread.

OD Outer diameter.

Offset The difference in temperature between the set point and the actual process temperature.

Ohms (Ω) SI unit of electrical resistance.

Ohm's law A relationship between voltage (emf), current and resistance in an electrical component carrying direct current. E = IR.

On/Off controller A temperature controller that turns a heater fully on or fully off.

Operating Range The specified range over which a device is expected to operate.

Platinum resistance element An element made of platinum whose resistance varies with temperature.

Positive temperature coefficient (PTC) Increasing resistance with increasing temperature.

Power (p) Rate of doing work, in Watts (W).

Probe Usually refers to a sensing element built into a housing that is physically suitable for insertion into the environment or substance to be measured.

PVC Polyvinyl chloride.

Range An area between two limits within which a sensor or instrument is operational; the extent of the sensor's or instrument's capabilities.

Rankine (°R) An absolute temperature scale based on the Fahrenheit scale, where one degree Rankine is the same temperature interval as one degree Fahrenheit, and 0°R = -459.67°F.

Repeatability The ability of a sensor or instrument to give the same reading or output under repeated identical conditions.

Resistance (R) The resistance to the flow of electric current measured in ohms (Ω).

Resistance ratio The ratio of the resistance of a thermistor at two different temperatures, usually resistance at 25°C to resistance at 125°C (R_{25}/R_{125}).

Resistor An electrical component designed to provide a known resistance.

Response time The time required to change the output of an electronic circuit after a sudden change in input. Used by YSI as the time required to sense 90% of a temperature change. See Time Constant.

Selection The examination of a device for compliance to a specific characteristic, usually associated with size or measurement tolerance.

Self-heating The effect of driving, usually resistive devices, at a level which induces a bias in the measured value.

Sensitivity The minimum change in temperature to which the instrument or sensor will respond.

Set point The temperature which a controller is set to maintain.

SI System Internationale. The standard metric system of units.

Sinter To form small particles into larger particles, cakes or masses by heating without liquifying.

SMD Surface-mount device.

SMT Surface-mount thermistor.

Solid wire A wire with no stranding.

Span The difference between the upper and lower limits of a range.

SPRT Standard Platinum Resistance Thermometer. A primary temperature standard calibrated to fixed-points of nature such as the triple-point of water.

Stability The ability of an instrument or sensor to maintain a constant output given a constant input.

Steinhart & Hart equation An equation which calculates resistance as a function of temperature for negative temperature coefficient thermistors.

Stranded wire Wire whose conductor is woven from individual wires or strands.

Teflon DuPont trademark name for polytetrafluoroethene. Used to insulate electrical conductors. Noted for its chemical inertness and heat resistance.

Temperature A measure of the degree of hotness or coolness of some sample. Temperature is to heat, what voltage is to power.

Temperature scale The scale assigned to allow determination of temperature. The International Practical Temperature Scale is reviewed for fit to the thermodynamic scale at approximately 20-year intervals. There are four practical scales, Celsius °C, Kelvin K, Fahrenheit °F, Rankine °R, and one theoretical scale, the Thermodynamic Temperature Scale. The scales differ in end points and value of divisions.

Thermal conductivity The ability of a material to conduct thermal energy.

Thermal expansion An increase in size due to an increase in temperature.

Thermal gradient The distribution of a differential temperature through a body or across a surface.

Thermal shock The shock which results when a body is subject to sudden changes in temperature.

Thermilinear component Two or three thermistor disks built into one bead which, when used in a network, provides a linear resistance vs temperature curve.

Thermilinear network One Thermilinear component and two or three resistors that can be wired to provide linear resistance response to temperature.

Thermistor A temperature-sensitive resistor made of metal oxides sintered into a disk which exhibits a large change in resistance for a small change in temperature.

Time constant The time required for a sensor to register 63.3% of a change in temperature.

Tolerance The range between allowable maximum and minimum values.

UL Underwriters Laboratories, Inc. An independent laboratory that establishes standards for commercial and industrial products.

Volt (E) SI unit of electrical potential difference.

Voltage An electrical potential measured in volts.

Voltage divider Usually a series of resistors used to divide the supply voltage in proportion to the value of each resistor in the string.

Watt SI unit of power.

Wheatstone bridge A network of four resistances, an emf source and a galvanometer connected so that when the four resistances are matched, the galvanometer will show a zero deflection or null reading.

Zero power resistance The resistance of a thermistor with no power being dissipated.

Sales Policy

New Accounts

To quickly qualify for open account status, please supply this information to our credit manager:
• Dun & Bradstreet rating or Duns number
• Two credit references from vendors
• Bank reference
• Name of chief executive officer or president
• Name of treasurer
• Name of controller
• Credit limit desired

Terms of Sale

Net 30 days from invoice date. We observe these terms rigidly. Failure to meet them may result in non-acceptance of new orders. Shipping prepaid and added, FOB Yellow Springs, Ohio.

OEM and Contract Discounts

Qualification for OEM discounts requires that these conditions be met:
• Use of YSI product in a fashion that's integral with the product–wired in.
• Description of application in the simplest non-proprietary terms.
• Expected use rate
• Permission to advertise if use is not proprietary.
• We will negotiate all agreements based on product and volume. Basically all purchases of similar products may be mixed for discount. Delivery schedules are a significant factor in developing the terms of a purchase agreement.
• Contact your local manufacturers' representative or YSI Customer Service.

Order Change and Cancellation

Our terms for order cancellation or change are:
• Any cancellation of orders for stock products after order entry must be 30 days before shipping date.
• Any cancellation after order entry of build-to-order or build-to-specification products will be subject to a minimum $50 or 15% charge, whichever is greater
• Any order for which material or labor have been expended will carry cancellation charges equal to the percentage completed or $50, whichever is greater.
• Any customer change which adds cost to the manufacture of products will be charged at normal overhead and profit.

Returned Goods

We will accept for return certain of our products.
• Cataloged thermistors
• Certain other products which have been negotiated before order placement.
Return for credit requires:
• Customer Service gives prior approval, RA number and shipping instructions
• Products are in new condition
• Products are not obsolete

Minimum Orders

Our minimum order requirements are:
• For thermistor components, 100 pieces. For smaller quantities, contact our distributors or stocking representatives.
• For all types of sensor assemblies (mixed), $75.

Exceptional Service

Expected delivery for manufactured-to-order products is normally 4 weeks. When standard delivery needs to be improved with certainty, we offer exceptional service.
A. Two-week delivery assuming material availability for all pre-engineered products.
B. Best possible delivery will include full force effort (overtime) to complete and ship the product in minimum time.

Additional charges for A service are 25% of the normal price and 50% for B service.

On occasion, because of material shortages, exceptional service will be unable to meet your needs. Call Customer Service to establish that materials are available.

Limited Warranty

We warrant our products against defects in materials and workmanship when the products are used according to their ratings and specifications. Our maximum liability is limited to repair or replacement (at our option) of defective products.

For sensors, sensor assemblies and special products, the warranty period is 1 year from shipment date. We will handle warranty repairs and replacements expeditiously. Contact Customer Service for instructions and best turn-around time.

For more information,
contact us at **800 747-5367** or
937 427-1231 • Fax 937 427-1640
Info@YSI.com • **www.YSI.com**

Contacting the YSI Precision Temperature Group

For order placement and product information:

Ph 800.747.5367 (US)
937.427.1231, Option 1
Fax: 937 427-1640
Email: bpetrus@ysis.com (Bob Petrus)
phenry@ysis.com (Phyllis Henry)

YSI Precision Temperature Group accepts purchase orders (with approved credit), payment in advance (via Visa or Mastercard) and checks. Special payment terms are available for international orders.

YSI Precision Temperature Group takes orders direct, sells through distributors, and has Manufacturer's Representatives located throughout the United States. Small quantity orders, particularly thermistors, should be forwarded to the nearest distributor. Below is a list of YSI Distributors and Manufacturer's Representatives in the United States. If you are located outside the U.S., please contact YSI Temperature Products Customer Service for your nearest Distributor or to purchase direct.

YSI Precision Temperature Group

Thermistor Distributors

YSI distributors stock YSI Precision Thermistors and Thermilinear components. Orders for less than 100 units must be directed to them.

Andruss-Peskin Corp.
P.O. Box 268
63 S. Main St.
Natick, MA 01760-0268
(508) 653-3919
800 878-3919
Fax: (508) 651-1924

RDP Corporation
5877 Huberville Avenue
Dayton, OH 45431
(937) 253-6175
Fax: (937) 254-1951

BJ Wolfe Enterprises
5321 Derry Ave., Unit E
Agoura Hills, CA 91301
818 889-8412
800 554-1224
Fax: 818 889-8417

Computer Aided Solutions
8588 Mayfield Road
Chesterland, OH 44026
(440) 729-2570
Fax: (440) 729-2257

RJM Sales
454 Park Avenue
Scotch Plains, NJ 07076
800 752-9055
(908) 322-7880
Fax: (908) 322-2160

Finnan Engineered Prod.
1149 Bellamy Rd. N., Unit 22
Scarborough, Ontario
M1H 1H7
(416) 438-6070
Fax: (416) 438-8739

Newark Electronics
4810 N. Ravenswood
Chicago, IL 60624
(800) 367-3573
Fax: (312) 275-9050

Thermx of California
31363 Medallion Drive
Hayward, CA 94544
800 300-1161
(510) 441-7566
Fax: (510) 441-2414

YSI Precision Temperature Group

Manufacturer's Representatives

Manufacturer's Representatives are available in your area for technical and purchasing support of YSI Precision Temperature Group products.

Analog Associates
Oakland, CA 94602
510 531-8896
Fax: 510 531-8897
Email: analog@ccnet.com
www.analogassociates.com

Quadra Sales Corporation
Beaverton, OR 97008
503 626-7550
Fax: 503 626-6960
Email: quadraor@aol.com
www.quadrasales.com

Sales Technology Inc.
Ft. Collins, CO 80525
303 530-9409
Fax: 970 663-0809
Email: bobshil@aol.com

Andruss-Peskin Corp.
Natick, MA 01760-0268
508 653-3919
800 878-3919
Fax: 508 651-1924
Email:
sales@andruss-peskin.com
www.andruss-peskin.com

Quantum Measurements
Hoover, AL 35226
205 824-3380
Fax: 205 824-3315
Email: qmcglenn@aol.com

Advanced Industrial Sys
Chesterfield, MO 63005
314 532-2477
Fax: 314 532-7385
Email: sales@advindsys.com
www.advindsys.com

Quantum Measurements
Lutz, FL 33549
813 909-8322
Fax: 813 909-8622
Email: qmcfl@aol.com

EQS Systems
Chesterland, OH 44026
440 729-2222
800 729-8084
Fax: 440 729-2257
Email: sales@eqssystems.com
www.eqssystems.com

Quantum Measurements
Smyrna, GA 30080
770 433-0093
Fax: 770 433-9254
Email: qmcrandy@aol.com

K-Technologies, Inc.
Minneapolis, MN 55431
612 835-7615
Fax: 612 835-0180
Email: jkresse@hotmail.com

RJM Sales
Scotch Plains, NJ 07076
908 322-7880
800 752-9055
Fax: 908 322-2160
Email: rjmnj@aol.com
www.rjmsales.com

Quadra Sales Corporation
Bothell, WA 98011
425 489-3428
Fax: 425 486-5784
Email: quadrawa@aol.com
www.quadrasales.com

RJM Sales
Chadds Ford, PA 19317
610 358-4014
Fax: 610 358-3776
Email: rjmpa@aol.com
www.rjmsales.com

Technical Component Sales of Southern California
Costa Mesa, CA 92626
714 444-2276
Fax: 714 444-2278
Email:
techcompsales@earthlink.net
www.sensortek.com

Canada -
Hoskin Scientific Ltd.
Vancouver, BC, V5T 1J7
604 872-7894
Fax: 604 872-0281
Email: salesv@hoskin.ca

Hoskin Scientific Ltd.
Burlington, Ontario, L7L 5L6
905 333-5510
Fax: 905 333-4976
Email: salesb@hoskin.ca

Hoskin Scientific Ltd.
Montreal, Quebec, H4P 2L1
514 735-5267
Fax: 514 735-3454
Email: salesm@hoskin.ca