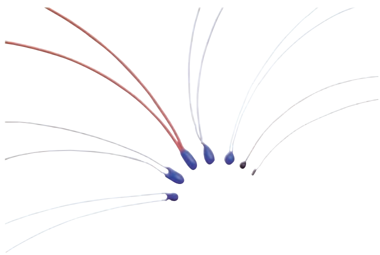
THERMOMETRICS
A COMMITMENT TO EXCELLENCE

Application Spotlight

Thermistors FAQ



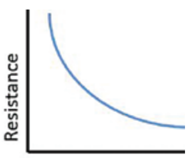
What is a Thermistor?

A thermistor is an electronic component that exhibits a large change in resistance with a change in its body temperature. The word “thermistor” is a construction of the words “thermal resistor.” There are two types of Thermistors - NTC and PTC.

What are NTC Thermistors?

NTC Thermistors are thermistors with a negative temperature coefficient, that is, where resistance drops with increases in temperature, as shown in Figure 1.

Figure 1



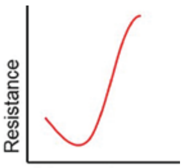
What are some NTC Thermistor applications?

- **Temperature Measurements**
  The high sensitivity of a thermistor makes it an ideal candidate for low cost temperature measurement applications.
- **Temperature Control**
  NTC thermistors can be used for temperature control (on/off) using a minimum amount of circuitry.
- **Temperature Compensation**
  In many cases, circuit precision requires that there is some sort of temperature compensation. Oscillators, LCD displays, a battery under charge and some amplifiers are examples of circuits that may require temperature compensation.
- **Inrush Current Limiter**
  An NTC disc thermistor subjected to a change in power will experience a time lag before reaching a lower resistance. This time lag can be utilized to limit the inrush surge current (the larger the part, the greater the lag).
- **Fluid Level Applications**
  NTC thermistors can be used to sense the presence or absence of a liquid by using the difference in dissipation constants between a liquid and a gas.

What are PTC Thermistors?

PTC Thermistors are thermistors with a positive temperature coefficient, that is, where resistance increases with increases in temperature,as shown in Figure 2.

Figure 2



What are some PTC Thermistor applications?

- **Overcurrent Protection**
  When a fault condition occurs, the PTC thermistor will heat up causing it to switch from a low to a very high resistance.
- **Electronic Ballast Design**
  PTC thermistors are used in electronic ballast systems as a time delay element when the circuit is energized.
- **Motor Starting**
  With a PTC thermistor in series with the starting windings in a single phase electronic motor, the PTC acts as a time delay.
- **Battery Management**
  As a rechargeable battery becomes fully charged, its temperature increases and the PTC resistance increases rapidly reducing the charge to a very low level.
- **Self Regulating Heater**
  The PTC thermistor can provide a combination of heater and thermostat in one device. As ambient temperature increases, the PTC resistance also rises, so that the effect is a power reduction to the circuit.

Thermistors FAQ

What are the Individual Parameters of a Thermistor?

Parameters include Zero-load Resistance Value, Beta (β) Constant, Ratio, Alpha (α), Thermal Time Constant (τ), Dissipation Constant (δ).

What is the Zero-load Resistance Value?

Zero-load Resistance Value is the resistance value of a thermistor measured at a prescribed temperature, also called no-load resistance value. The value is normally measured at a standard temperature of 25°C (R25). The measurement is conducted at a power level such that the influences of spontaneous heat generation can be negligible.

What is Beta (β) Constant?

The Beta Constant, shown in Figure 3, is the slope of the NTC thermistors resistance to temperature characteristic (in kelvins) over a specified temperature range according to the formula:

$$\beta = \left[\frac{T \times T_0}{T_0 - T}\right] \times ln\left[\frac{R_T}{R_{T0}}\right]$$

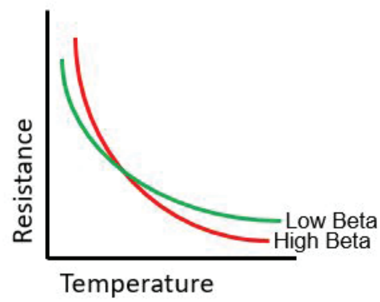


Figure 3

What is the Ratio?

The Ratio is the ratio of the resistance of a thermistor at two different temperature points.

What is the Alpha (α)?

The Alpha is the zero-power temperature coefficient of resistance, which is the ratio at a specified temperature, of the rate of change of zero-power resistance with temperature to the zero-power resistance of the thermistor. Put simply, it is the % change in resistance per degree C change in temperature at a specified temperature.

What is the Thermal Time Constant (τ)?

Thermal Time Constant, as shown in Figure 4, is the time required for a thermistor to change 63.2% of the total difference between its initial and final body temperature when subjected to a step function change in temperature under zero-power conditions.

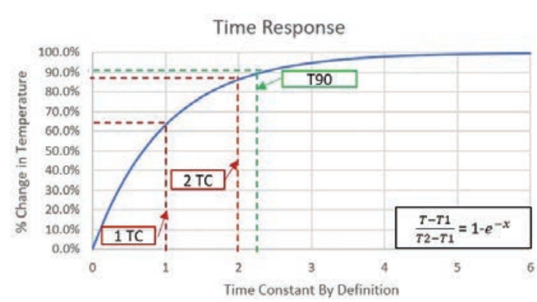


Figure 4

What is the Dissipation Constant (δ)?

Dissipation Constant is the ratio, (in milliwatts per degree C) at a specified ambient temperature, of a change in power dissipation in a thermistor to the resultant body temperature change. Simply, it is the power required to change the thermistor by 1°C through self-heating.

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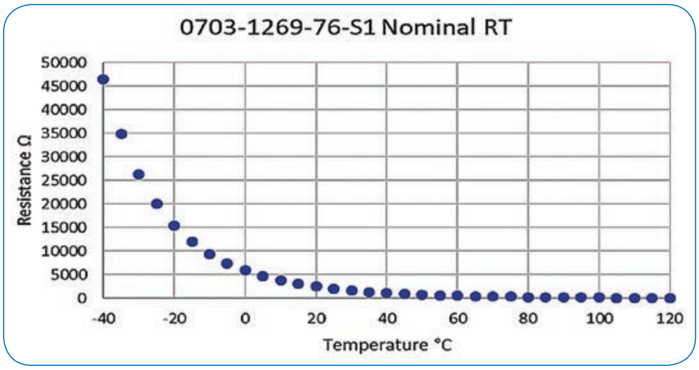
NTC Sensor Linearization

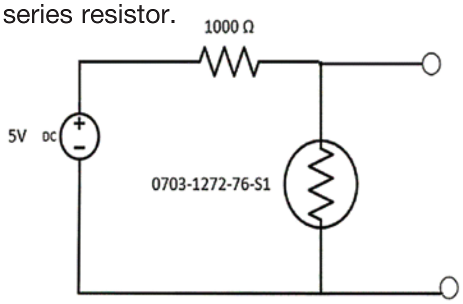
Resistance / Temperature

The resistance / temperature characteristics of an NTC based temperature sensor generally are defined by a 4th order polynomial equation and represented by a typical R/T curve. A general R/T is shown for the 0703-1272-76-S1 thermistor as a response to temperature.



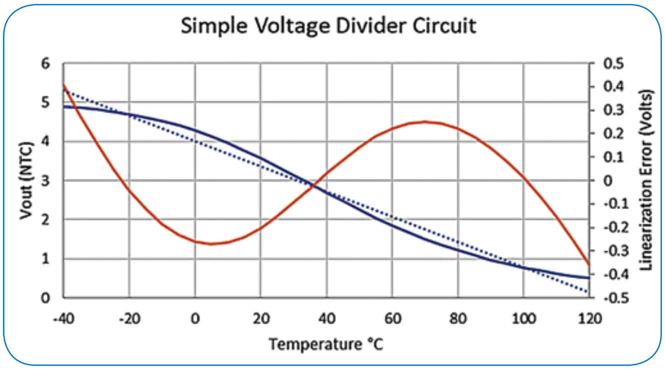
Sensing Circuit

In many instances the sensing circuit is a simple voltage divider network with a source voltage and series resistor.



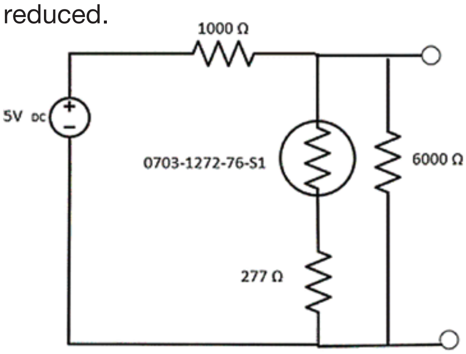
Linearization Errors

Over an extended temperature range, linearization errors will occur in the voltage output with respect to temperature as shown by the orange line on the graph.



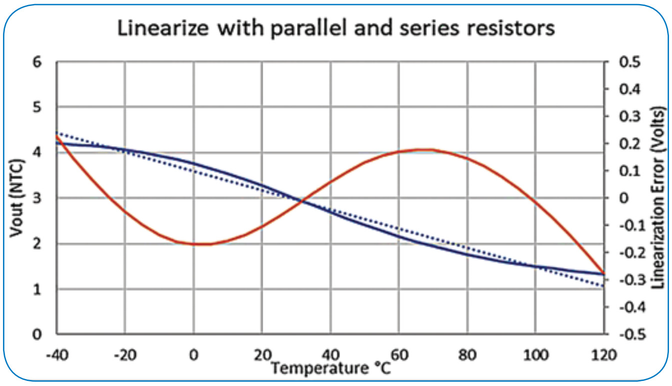
Reduced Errors

By adding simple passive components in parallel and series with the NTC, these linearization errors can be reduced.



Voltage Divider

This arrangement reduces linearization error by 32% over a simple voltage divider.



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