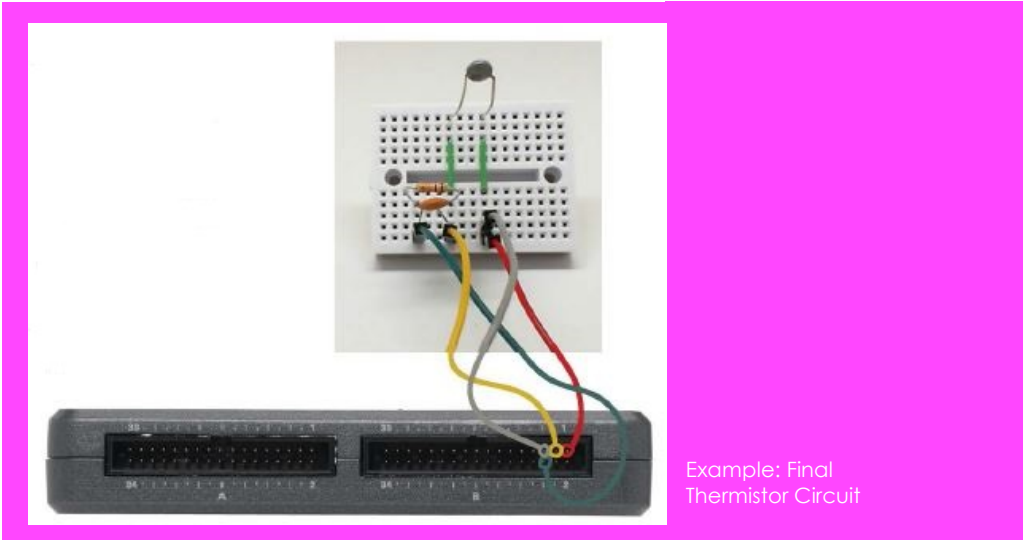
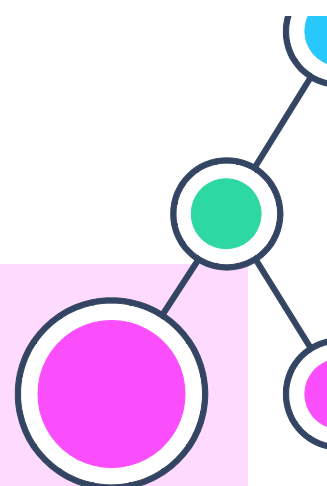


# Thermistor

## Core Concept Instructor Set



Example: Final Thermistor Circuit

**Materials:**  
myRIO  
Thermistor

**“...because of their extreme accuracy they can be used for complex hardware control.”**

## Learn It!

A thermistor is a temperature measuring device that varies its resistance as a function of temperature. The term “thermistor” is actually a combination of the words “thermal” and “resistor”. A thermistor’s data is read by wiring it in series with a fixed resistor. The voltage drop across the thermistor is read as an analog signal. When the temperature changes the resistance of the thermistor changes and this results in a change in the voltage drop read. Thermistors are used in a variety of temperature

control applications, and because of their extreme accuracy they can be used for complex hardware control.

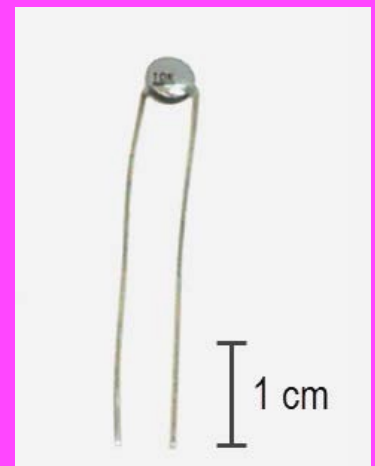
In this exercise you will connect a thermistor circuit to your myRIO device. You will use the thermistor to read the ambient temperatures, and vary the temperature to see changes in voltage and the displayed temperature value.

## Build It!

Thermistor signals are simple analog signals, with a change in voltage corresponding to a change in data. Let’s explore how to change this voltage signal by changing the temperature around the thermistor

### Creating a thermistor Circuit

**Step 1:** Connect the thermistor as indicated in the circuit diagrams. The circuit should contain a fixed resistor ( $10k\Omega$ ) wired in series with the thermistor, along with a capacitor in parallel with the fixed resistor. One end of the circuit should be connected to the +5V pin and the other to ground. The analog signal is read between the two components. Connect the end of the circuit containing the thermistor to the +5V connection to place it in the top branch of the circuit. Doing so means that the voltage measured across the thermistor increases as the temperature increases.



## Thermistor demo

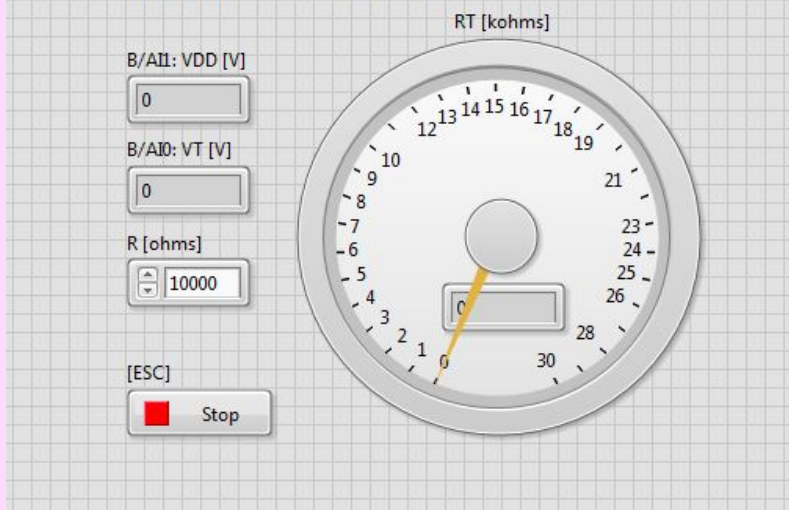


Figure 1: Thermistor Demo Front Panel

### Running the VI

Step 2: Open the file titled "Thermistor Demo". Open the thermistor demo labview project (Thermistor demo.lvproj) and the VI titled "Main.vi"

On the front panel there should be three numeric indicators. One will be a large dial, indicating the resistance value produced by the thermistor. The other two indicate the voltage drops across the individual components, being the fixed resistor and thermistor. There is also a control for setting the value of the fixed resistor, which allows for accurate temperature measurements to be taken (Figure 1).

Step 3: Enter 10,000 as the value of your fixed resistor. Run the VI. Observe the value of "RT" as displayed on the dial on the front panel. Try pinching the thermistor between two fingers or exposing it to warm air from a blow dryer or other device. Watch as the resistance of the thermistor changes.

### Guiding Questions:

- How does the resistance "RT" vary as temperature changes? What about "VT"?
- How do you think wiring a different series resistor into the circuit might affect the readings?

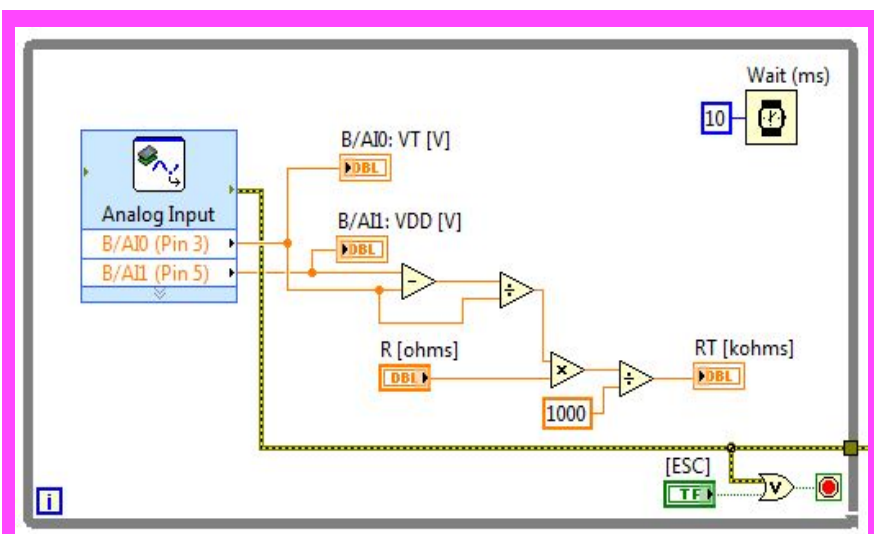
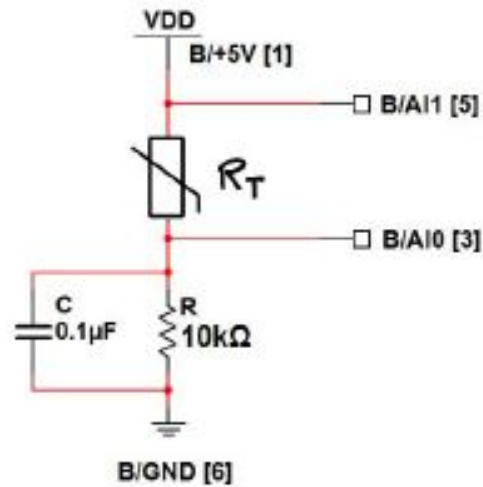


Figure 2: Thermistor Block Diagram

Step 4: Explore how the code works. Open the block diagram of the Main VI. The main body of the code runs within a while loop, which allows it to run continuously while the temperature is read by the thermistor (Figure 2).

Data is taken from the thermistor in the form of two analog signal values. These are the voltage drop across the resistor, and the net supplied voltage.

Current is the same through each component of a system like this. By using this fact, along with the equation  $V=IR$ , a voltage drop across the fixed resistor can be determined, as well as the resistance offered by the thermistor.



Thermistor Circuit Diagram

### Expand it!

- Add the necessary computation to convert the measured resistance to temperature in degrees Celsius; display the temperature on the large front-panel dial indicator. Use the built-in VIs Mathematics/Elementary/Natural Logarithm and Mathematics/Polynomial/Polynomial Evaluation. Use the polynomial coefficients presented in the resources section.
- Modify your temperature display to display in degrees Fahrenheit.
- Create a Boolean indicator to indicate when the measured temperature exceeds (or falls below) a preset threshold.

### Research it!

Study the video Thermistor Characteristics ([youtu.be/US406sjBUxY](https://youtu.be/US406sjBUxY), 4:54) to learn more about thermistor characteristics and the Steinhart-Hart thermistor equation that converts measured thermistor resistance to temperature in degrees Kelvin.

Study Thermistor Resistance Measurement ([youtu.be/PhZ2QlCrwuQ](https://youtu.be/PhZ2QlCrwuQ), 6:10) to learn how to measure the thermistor resistance with a voltage divider, and also how to size the resistor R for best measurement sensitivity and range.

Take a look at Measure Resistance with a Voltage Divider ([youtu.be/9KUVD7RkxNI](https://youtu.be/9KUVD7RkxNI), 9:44) for a more complete treatment of voltage dividers as a measurement technique.

Study the video Analog Input Express VI ([youtu.be/N6Mi-VjBlmc](https://youtu.be/N6Mi-VjBlmc), 2:00) to learn how to use the Analog Input Express VI to measure the voltage divider's primary output as well as the voltage divider supply voltage.

Thermistor Specs:

[http://www.epcos.com/inf/50/db/ntc\\_09/LeadedDisks\\_\\_B57164\\_\\_K164.pdf](http://www.epcos.com/inf/50/db/ntc_09/LeadedDisks__B57164__K164.pdf)

Capacitor Specs:

<http://www.avx.com/docs/Catalogs/class3-sc.pdf>

Thermistors by National Instruments ~ thermistor characteristics and the Steinhart-Hart thermistor equation:

<http://zone.ni.com/reference/en-XX/help/370466V-01/measfunds/thermistors>

NTC Thermistors by Vishay ~ Learn about thermistor principles of operation, selection criteria, design equations, and example circuits and applications:

<http://www.vishay.com/docs/29053/ntcintro.pdf>

<http://www.vishay.com/docs/29053/ntcintro.pdf>