Component Level Laboratory

Thermistor and First Order Time Response

Objective: The objectives of this experiment are to study the thermistor as a temperature sensor and the property of the first order time response which it exhibits. Lab VIEW will be used to collect data and display the time response of the temperature sensor when the temperature is changed suddenly, i.e., step changes. This data will then be analyzed to determine the sensor time constant.

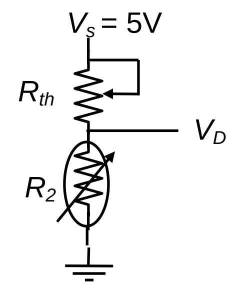
Exercise 1: Thermistor as a Temperature Sensor

A. Temperature Measurement from Resistance

We will study first order time response using a "thermistor", which resistance decreases non-linearly with increasing temperature. A voltage divider circuit can be used to convert the thermistor resistance change to voltage change.

Using 5 V as the voltage source, R_{th} (the upper resistor) as the sensor and pick R_2 (the ground resistor) so that the divider voltage is *about* 2.0 volts at room temperature. Following the steps below to see how the resistance changes due to temperature change!

(1) Measure room temperature using a lab thermometer



T_{room} =

(2) Measure the thermistor resistance with a DMM:

R_{th} =

(3) Wire the divider, apply power and notice how the voltage increases when the sensor temperature is increased by gently touching the sensor. Record the sensor's resistance:

R_{th} (1) =

(4) Build a VI in Lab VIEW to read in V_D. In the DAQ Assistant set the sampling to "Continuous" and frequency to 100 Hz. In the graph go to "properties" and cancel the

auto scale for vertical axis. Sample the reading for 10 seconds. (Copy the graph Vd versus time below.)

(5) Get a flask of hot water. Immerse the thermistor into the hot water, wait for 20 seconds, and measure the resistance of the thermistor using the DMM. Copy the graph Vd versus time below.

R_{th}^{hot} =

Post Lab Report Questions:

(1) What is the difference between the thermometers measured room temperature and that determined from the thermistor?

(2) What is the temperature of the hot water determined from the thermistor?

(3) How much temperature rise did the thermistor experience in the divider circuit due to the self-heating?

(4) Calculate the thermistor's dissipation constant in mW/^{o}C.

Exercise 2: First Order Time Response

We will study the first order time response of the thermistor. A temperature sensor can have two time constants, one for good thermal contact (GTC) (in water for example) and another for poor thermal contact (PTC) (in air for example). You will collect divider voltage values by changing the temperature measured by the thermistor and study its time constants at GTC and PTC conditions.

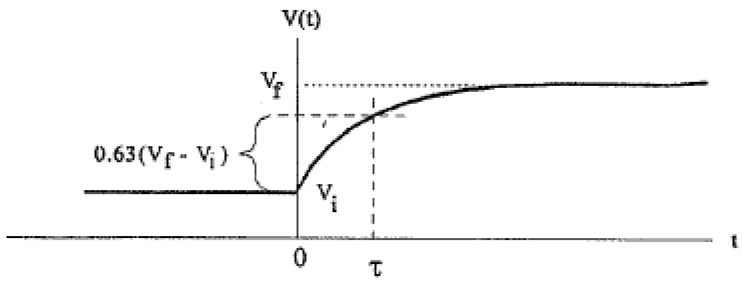
A. Use the VI built from Experiment 1.
   (1) Measure the thermistor resistance at room temperature: R_{th} =

   (2) Use the tables and interpolation to determine room temperature: T_{th} =

B. Good Thermal Contact (GTC) Time Response
   (1) Get a wok of hot water
   (2) One person starts the Lab VIEW program

(3) Another person waits 3 seconds and then put the thermistor in the water until 10 second samples were taken.
(4) Notice the first order time response curve for the sudden change in V_D due to the sudden change in the temperature (step change).

Your graph should look like this:



(5) Use the cursor to find the initial voltage and final voltage values
(6) Determine $0.6(V_f\text{-}V_i)$ then compute $Vi + 0.63(V_f\text{-}V_i)$
(7) Find the time at which this voltage occurs, this is the time constant

Tau =

(8) Now use the cursor to obtain time and voltage data at three other points along the curve.

C. Poor Thermal Contact (PTC) Time Response:
This is a continuous procedure from previous experiment using hot water.

(1) After the thermistor was immersed into the hot water for 1 minutes …
(2) Start the Lab VIEW VI program
(3) After 3 seconds, take the thermistor out of the water and hold steady in air for at least 15 second until the output is stabilized.
(4) Notice the first order time response curve for the sudden change in V_D due to the sudden change in the temperature (step change).
(5) Plot the graph, and use the cursor to find the initial and final voltage values
(6) Determine $0.6(V_f\text{-}V_i)$ then compute $Vi + 0.63(V_f\text{-}V_i)$
(7) Find the time at which this voltage occurs, this is the time constant

Tau =

(8) Now use the cursor to obtain time and voltage data at three other points along the curve.

Post Lab Report Questions:

(1) What was the percent difference between the expected divider room temperature output voltage and that actually measured?

(2) What self-heating temperature rise do you expect from the divider?

(3) What is the hot water temperature?

(4) What is the GTC time constant as determined by?

a. The 63% time?

b. The time response equation for a 50% change?

(5) What is the PTC time constant as determined by?

a. The 63% time?

b. The time response equation for a 50% change?