Principles of Measurement & Instrumentation I

Laboratory

PHYS417

Laboratory Report

Abdullah Burkan BEREKETOĞLU

Experiment 5- Characterization of a Thermistor

Submitted By: Abdullah Burkan BEREKETOĞLU

Submitted to: Deniz Orhun BOZTEMUR & Enver BULUR

Student Id: 2355170

Experiment Date: 24.12.2021

Submission Date: 24.12.2021

Question 1: Explain briefly what a thermistor is:

An electrical resistor that is strongly dependent on temperature, and its resistance can be greatly reduced by heating, it is used for measurement and control.

Question 2: Explain what β is:

An indicator of the shape of the curve that represents the relation between resistance and temperature of NTC (Negative Temperature Coefficient) thermistor.

$$\beta = \frac{\ln(\frac{R_{T1}}{R_{T2}})}{(\frac{1}{T_1} - \frac{1}{T_2})}$$

Question 3: Explain the difference between NTC and PTC thermistors:

An NTC thermistor, or negative temperature coefficient thermistor's resistance value decreases as the temperature increases; On the other hand, A PTC (Positive temperature coefficient) thermistor's resistance increases with the increase in temperature. PTC's are commonly used as inline resettable fuses. Its quick spike in resistance is good for combatting overcurrent scenarios.

Question 4: Explain the Steinhart and Hart equation:

Steinhart and Hart Equation can be said as an empirical expression that determined to be the best mathematical expression for resistance temperature relationship of NTC thermistors and NTC probe assemblies.

Question 5: Explain what an energy gap is:

In semi-conductors, there are valence and conduction bands, and between those filled - valence and the empty conduction band, what we call as energy gap is at. At zero temperature, no

charges are in the conduction band and the resistance should be infinite as the system behaves as an insulator, so with temperature conduction band gets filled and resistance lowers.

Question 6: Explain what "Sensitivity" is:

The sensitivity of a thermistor is dependent on the temperature since thermistors have thermally changing resistances its sensitivity solely depends on that. Alpha = -B/T^2 for the NTC thermistors, and alpha represents the sensitivity.

Question 7: Examples of locations where thermistors can be used at:

They can be used at Temperature sensors, being non-linear variable resistive devices they can measure temperatures of both liquids and ambient air. Used in Automotive applications with similar reasoning, to measure the oil and coolant temperatures, also in Household appliances such as microwave ovens, fridges and so.

Also as mentioned above in PTC part can be used for circuit protection (surge protection), rechargeable batteries to maintain the temperature at a certain level. Measuring thermal conductivity of electrical materials. In wheatstone bridge circuitry.

Code

```
/thermocouples/

#include "max6675.h"

int ktcSO = 8;

int ktcCS = 9;

int ktcCLK = 10;

MAX6675 ktc(ktcCLK, ktcCS, ktcSO);

Void setup() {

        Serial.begin(9600);

        // give the Max a little time to settle

        delay(500);

}

Void loop() {

float sensorValue = analogRead(A0);

float kelvin = (ktc.readCelcius() +273.15);

        Serial.print("T(kelvin) = ");

        Serial.print(kelvin);

        Serial.print("\t");

        Serial.print("Thermistor Value = ");

        Serial.println(sensorValue);

        delay(500);

}
```

References

Oxford Languages and Google - English | Oxford Languages (oup.com)

NTC Thermistors - Calculate Beta Values | Ametherm

Basics of NTC and PTC Thermistors | DigiKey

What is the thermistor sensitivity? - Electrical Engineering Stack Exchange

NTC Thermistor - Steinhart and Hart Equation | Ametherm

Steinhart-Hart-Eqn-for-10k-Thermistors.pdf (skyeinstruments.com)

What is a Thermistor Used For & How Do They Work? (pyrosales.com.au)

Thermistor Applications and Characteristics | PTC and NTC Thermistors (electronicshub.org)

Thermistor: Definition, Uses & How They Work | Electrical4U