Department of Electrical Engineering

Instrumentation Lab EE-702

Experiment No.-5: Instrumentation of Temperature.

Objective: Study of Thermocouple and Thermistor as temperature transducer with an instrumentation trainer. Obtain the operational and calibration characteristics and time response of both.

Equipment / Apparatus required : Temperature instrumentation tutor, multi meter, Thermometer, electric kettle, stop watch.

Theory :

(a): Thermocouple

Thermocouple works on principle of Seeback effect. It states that when two wires of dissimilar metals are joined together and the junctions are kept at different temperature. A voltage is generated called thermo-electric emf. (refer to figure:1). Therefore it is called active transducer. The voltage created is of the order of several microvolts per degree of temperature difference. The emf is given by:

$$E = a + b\,\Delta T$$

where a & b are constant and ΔT is the temperature difference between the two junctions.

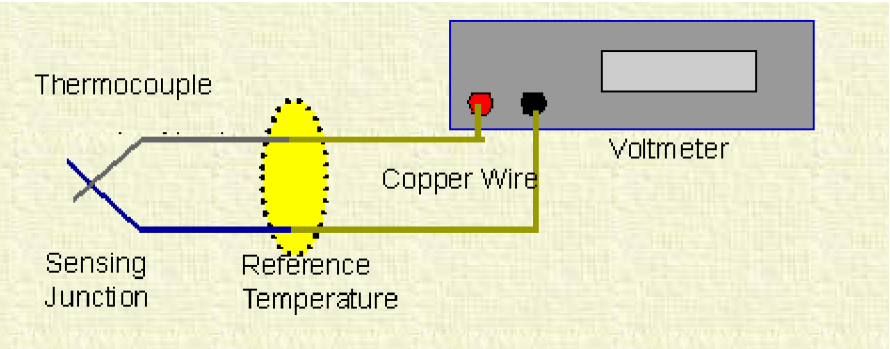

Figure:1

(b): Thermistor

Thermistor as temperature sensors are constructed from sintered metal oxide in a ceramic matrix whose electrical resistance varies with temperature. They are sensitive but highly non-linear. Thermistor are commonly used with bridge circuits as signal conditioner and therefore referred to as passive transducers.

Thermistor resistance is a function of absolute temperature with the following relationship:

$$R = R_0 * e^{\beta (1/T - 1/T0)}$$

Here R_0, R are the respective resistance values when the surrounding temperature is T0, T (K). β is the Thermistor constant.

Specifications:

Range of Thermocouple	: 0-100^0 C
Resolution	: 0.1^0 C
Range of Thermistor	: 0-100^0 C
Resolution	: 0.1^0 C
Display	: 3 ½ digit
Adjustments	: Zero adjust, Span calibration

Diagram:

Identify the various stages of functional block diagram (figure2(a,b)) from input to output from the panel diagram and circuit diagram attached (figure 3) for both the transducer and report.

Procedure:

1. Thermistor and Thermo-couple can be connected to the measuring unit by a 9 pin connector and can be used one at a time by selection with a toggle switch .
2. Switch on the unit, check : red LED
3. Toggle the switch at 1 for Thermistor.
4. Measure the initial water temperature by thermometer and adjust the display reading by zero adjustment pot.
5. Boil the water up to 100^0 C and set the span for full scale deflection.
6. Take the fresh water.
7. Start again from minimum temperature and take the reading in steps of analog voltage output, digital readout of temperature in steps of 10^0 C and note corresponding time with help of watch. Record in the table of observations.
8. Toggle the switch at 2 for Thermocouple and repeat steps from 4 to 7.

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Observations:

1. Thermistor:

S.No.	Temperature(^{0}C)	Analog output,(mV)	Digital reading(^{0}C)	Time
1	Room temperature			0.0
2	Increment of 10 ^{0}C from room temp			
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11	100			

2. Thermocouple:

S.No.	Temperature(^{0}C)	Analog output,(mV)	Digital reading(^{0}C)	Time
1	Room temperature			0.0
2	Increment of 10 ^{0}C from room temp			
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11	100			

Results :

Plot the following set of graphs for both Thermistor and Thermocouple sensors :

1. Temperature vs. analog output,
2. Temperature vs. time,
3. Analog output vs. time
4. Calibration graph : Thermometer reading vs. Display

Discussion:

1. What is the typical nature of temperature-Resistance characteristic of Thermistor? Draw.
2. What are the Peltier and Thomson effects? How do they affect TC output?
3. What are the different types of Thermocouple? Draw characteristics.
4. What is the difference between PTC Thermistor and NTC Thermistor? Draw characteristics.
5. What could be industrial applications of each?

6. Compare the application potential of Thermistor and thermocouple in term of characteristics and features.
7. What is reference junction compensation, what are the different techniques?
8. What is Steinhart-Hart equation?

References :

1. Principle of Industrial instrumentation- Patranabis,D.
2. Instrumentation-Devices & Systems- Rangan, Sarma, Mani

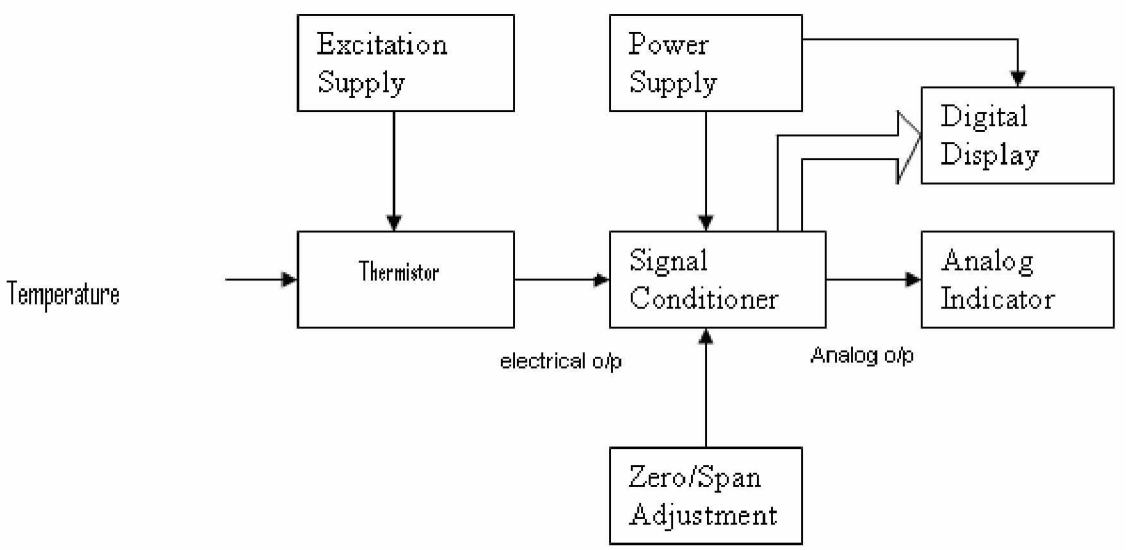

Figure 2a. Functional block diagram of Temperature tutor

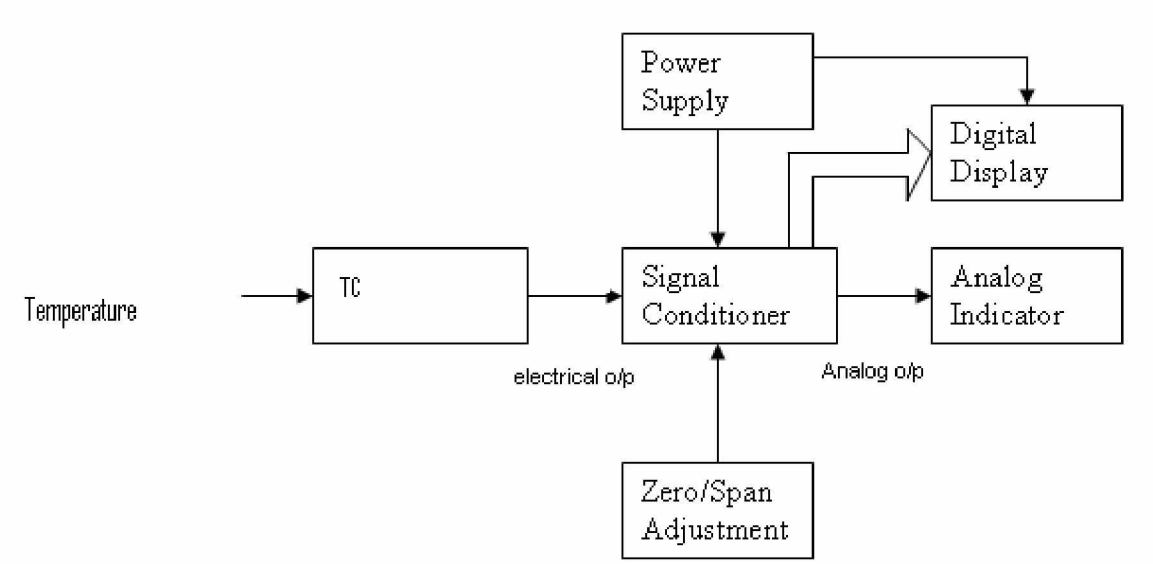

Figure 2b. Functional block diagram of Temperature tutor