BFF3302 SENSOR AND INSTRUMENTATION SYSTEM

Temperature Transducer

By

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Chapter Description

- Aims
  - Obtain basic knowledge about temperature transducer.
- Expected Outcomes
  - Able to explain and describe about characteristics and properties of temperature transducer.
- References

  - B.C.Nakra and K.K. Chaudhry, 2012. Instrumentation measurement and analysis, 3rd ed., Tata-McGraw-Hill.
  - Introduction to signal processing, instrumentation, and control : an integrative approach / Joseph Bentsman Hackensack, NJ : World Scientific Pub., 2016
  - Transducers for instrumentation / M. G. Joshi, New Delhi, India : Infinity, 2017
  - Instrumentation and measurement in electrical engineering / editor : Harinirina Randrianarisoa, New York : Arcler Press, 2017

Temperature Ranges for Various Application

APPLICATIONS	TEMP RANGES
General purpose for textile, printing, food, rubber, thick plastics, paints, laminating, maintenance	-50 to 1000°C -58 to 1832°F
Life sciences, biology, zoology, botany, veterinary medicine, heat loss and research	0 to 500°C 32 to 932°F
Thin film plastic, polyester, fluorocarbons, low temperature glass	50 to 600°C 122 to 1112°F
Glass and ceramic surfaces, tempering,annealing, sealing, bending and laminating	300 to 1500°C 572 to 2732°F
See-through clean combustion flames and hot gases. Furnace tubes	500 to 1500°C 932 to 2732°F
Medium to high temperature ferrous and non-ferrous metals. See-through glass	250 to 2000°C 482 to 3632°F
Hot and molten metals, foundries, hardening, forging, annealing, induction heating	600 to 3000°C 1112 to 5432°F

Contact vs Non-Contact

	Contact Methods	Non-contact method
Measuring conditions	▪measuring head contacts the measuring objects. ▪No changes should be introduced in the temperature of the measured object when it is brought into contact with the measuring head.	▪Contact with the measuring object is indirect. Thus, the measuring object must be observable.
Measuring range	▪Measurement made above 1200° C are difficult, but measurement below 1000° C are easily made.	▪Large errors tend to occur when measurements are made below 1000° C. Measurements above 1000°C are easily made.
Measuring accuracy	▪Generally, 0.5 to 1 % ▪0.01% is possible, depending on the measuring conditions.	▪Generally, around 20°C ▪5 to 10°C at best
Speed of response	▪Generally slow,1 to 2 minutes. ▪May take more than 1 hour in unfavorable conditions.	▪Generally,2 to 3 s . ▪Less than 10 s in the worst case.

Temperature Selection Guides

(http://www.thermometricscorp.com/temsensel.html)

- **Temperature Range**
- **Accuracy**
- **Repeatability / Stability**
- **Response Time**
- **Sensitivity**
- **Life Expectancy / Replacement Cost**
- **Cost**

Common Temperature Sensors

- IC Temperature Transducer *
- Thermocouples *
- Thermistors *
- Resistance Temperature Detectors (RTDs) *
- Infrared (IR)

IC temperature transducer

- Describe:
  - Working principle
  - Characteristics
  - Properties of the transducer/sensor
  - Construction of the sensor/transducer

Pros and Cons of IC temperature transducer

Disadvantages

- Temp < 200°C
- Power supplied required
- Slow
- Self heating
- Limited configurations

Advantages

- Most linear
- Highest output
- Directly calibrated in °Kelvin
- 1°C initial accuracy available
- Operates from 400 µA to 5 mA.
- Less than 1Ohm dynamic impedance
- Easily calibrated
- Wide operating temperature range
- Low cost

Thermocouple

Chapter Outline:

- The Thermocouple
- Discussion of fundamentals. Thermocouple characteristics (voltage-temperature). Thermocouple circuits.
- Temperature measurement and output voltage.
- Calibration.

Thermocouple Application

- **Copper-Constantan (T) :**
- **Iron-Constantan (J) :**
- **Chromel-Alumel (K) :**

Thermistor

Chapter Outline:

- Discussion of fundamentals thermistor characteristics.
- The effects of self-heating on the thermistor's resistance.
- Temperature measurement circuit.
- Instrumentation amplifier and thermistor bridge circuit.

RESISTANCE TEMPERATURE DETECTOR (RTD)

Chapter Outline:

- Discussion of fundamentals of RTD characteristics.
- RTD principles and construction.
- Temperature measurement circuit.
- RTD response: resistance vs. temperature.