ELECTRONIC THERMOETER USING OP-AMP

A Mini Project-II Report

Submitted in Partial Fulfillment of the Requirements for the Degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS & COMMUNICATION ENGINEERING

By

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Under the Guidance of
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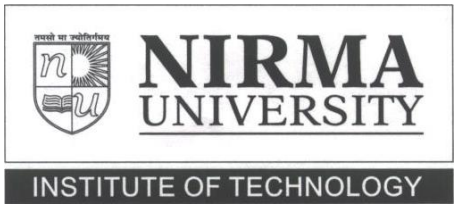

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CERTIFICATE

This is to certify that the Mini Project-II Report entitled **"Electronic thermometer using OP-AMP" s**ubmitted by **PRIYANKA GOSWAMI (13BEC031) & PRASHANT GANDHI (13BEC029)** as the partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Electronics & Communication Engineering, Institute of Technology, Nirma University is the record of work carried out by him/her under my supervision and guidance. The work submitted in our opinion has reached a level required for being accepted for the examination.

Date: 27/04/2016

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ACKNOWLEDGEMENT

I would like to show my gratitude towards our esteemed **Professor Amisha Naik**. He plays the role of boosting confidence confining to our project on. Apart I would also thank my college for helping me solving all the obstructions that I faced during making of this project. At last I would also pay my attention to all resources that I could gather on due time for doing the project under the guidance of our professor. So I thank all of them for completing the project and achieving the deadline well in advance.

ABSTRACT

As we know, a thermometer is an easy to use device and is a very handful and non-harmful device. A thermometer or rather a digital thermometer is now-a-days available at all the medical stores and is kept for safety purpose at homes too. Also digital thermometers are used in industries to check and control the temperature. We have made an electronic thermometer using a simple op-amp and calibrated it. We need an electronic thermometer to measure our body temperature or any material that requires temperature measurement. Thus, an electronic thermometer is useful for many purposes and has been a part of our day-to-day life. One such electronic thermometer has been made by us.

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LIST OF FIGURES

CHAPTER 1

1.1 Introduction

A thermometer is a device that measures temperature or a temperature gradient. A thermometer has two important elements: (1) a temperature sensor (e.g. the bulb of a mercury-in-glass thermometer) in which some physical change occurs with temperature, and (2) some means of converting this physical change into a numerical value (e.g. the visible scale that is marked on a mercury-in-glass thermometer). There are various principles by which different thermometers operate. They include the thermal expansion of solids or liquids with temperature, and the change in pressure of a gas on heating or cooling. Radiation-type thermometers measure the infrared energy emitted by an object, allowing measurement of temperature without contact. Thermometers are widely used in industry to control and regulate processes, in the study of weather, in medicine, and in scientific research. Some of the principles of the thermometer were known to Greek philosophers of two thousand years ago; by the 18th century, standardized scales had made the readings of different thermometers inter-comparable.

1.2 Development of Electronic Thermometer

Various authors have credited the invention of the thermometer to Galileo Galilei, Cornelis Drebbel, Robert Fludd, or Santorio Santorio. The thermometer was not a single invention, however, but a development. Philo of Byzantium and Hero of Alexandria knew of the principle that certain substances, notably air, expand and contract and described a demonstration in which a closed tube partially filled with air had its end in a container of water. The expansion and contraction of the air caused the position of the water/air interface to move along the tube.

1.3 Scope of the project

While an individual thermometer is able to measure degrees of hotness, the readings on two thermometers cannot be compared unless they conform to an agreed scale. Today there is an absolute thermodynamic temperature scale. We have tried to achieve a temperature measurement as low as 10°C. We have even made the necessary changes and measured the temperature with a

very accurate thermometer which goes upto 0°C. Thus, the scope of this project was to learn how a thermometer can be made using an op-amp and calibrate it using arduino.

1.4 Objective of the project

The objective of this project was to understand the basics of an electronic thermometer. Also, to be able to differentiate analog and digital thermometer. To compare them and see which one is better and implement the circuit on hardware and software too.

1.5 Contents of the report

(1) Theory on electronic thermometer
(2) Circuit diagram
(3) Equipments used
(4) Simulation results
(5) Hardware implementation
(6) Conclusion
(7) References

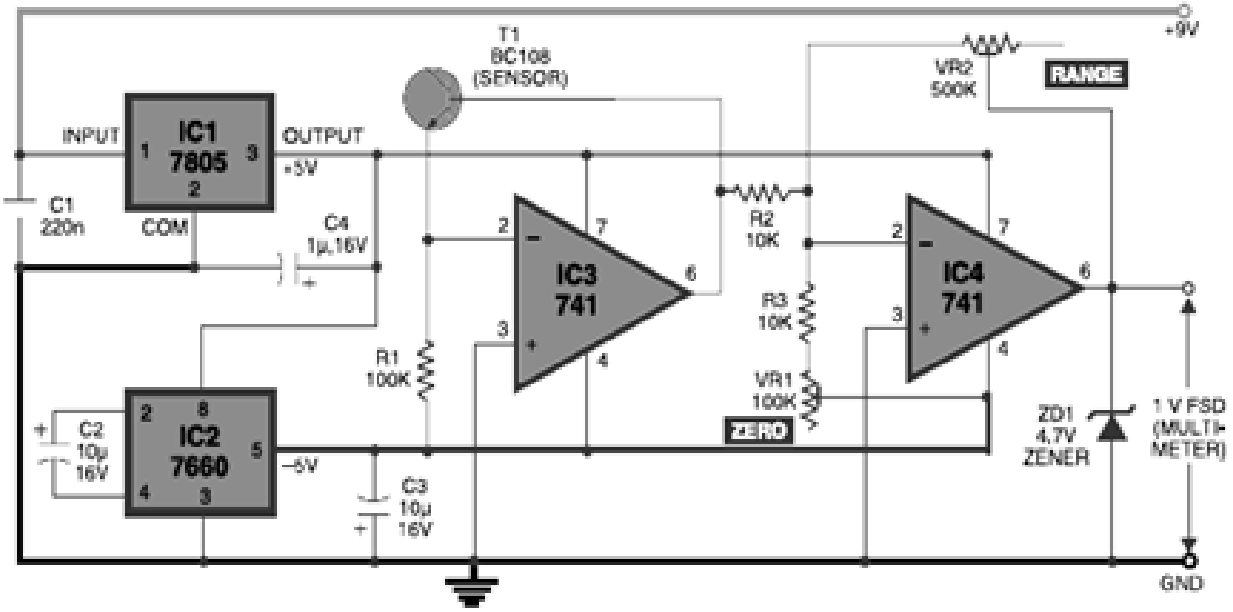
CHAPTER 2

2.1 Basics of Electronic Thermometer

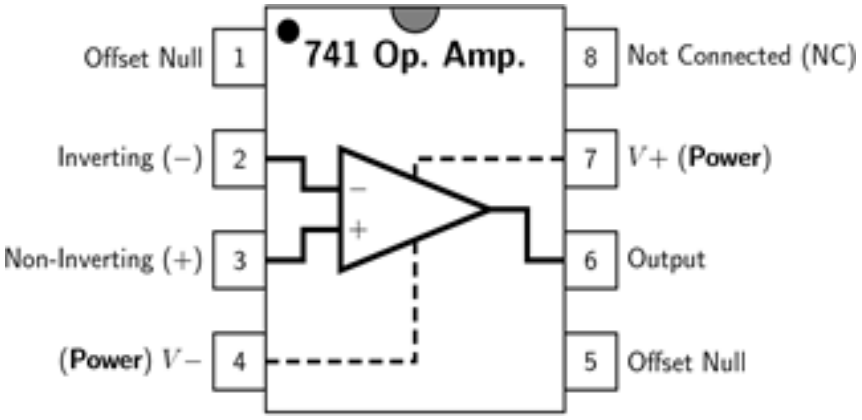
Thermometers may be described as empirical or absolute. Absolute thermometers are calibrated numerically by the thermodynamic absolute temperature scale. Empirical thermometers are not in general necessarily in exact agreement with absolute thermometers as to their numerical scale readings, but to qualify as thermometers at all they must agree with absolute thermometers and with each other in the following way: given any two bodies isolated in their separate respective thermodynamic equilibrium states, all thermometers agree as to which of the two has the higher temperature, or that the two have equal temperatures. For any two empirical thermometers, this does not require that the relation between their numerical scale readings be linear, but it does require that relation to be strictly monotonic. This is a fundamental character of temperature and thermometers. Basically, there are two types of thermometer according to the level of knowledge about the physical basis of the underlying thermodynamic laws and quantities: (1) Primary thermometer (2) Secondary thermometer.

For primary thermometers the measured property of matter is known so well that temperature can be calculated without any unknown quantities. Examples of these are thermometers based on the equation of state of a gas, on the velocity of sound in a gas, on the thermal noise, voltage or current of an electrical resistor, on blackbody radiation, and on the angular anisotropy of gamma ray emission of certain radioactive nuclei in a magnetic field. Primary thermometers are relatively complex. Secondary thermometers are most widely used because of their convenience. Also, they are often much more sensitive than primary ones. For secondary thermometers knowledge of the measured property is not sufficient to allow direct calculation of temperature. They have to be calibrated against a primary thermometer at least at one temperature or at a number of fixed temperatures. Such fixed points, for example, triple points and superconducting transitions, occur reproducibly at the same temperature.

2.2 Circuit Diagram



2.3 IC 741 OP-AMP Pin Diagram



2.4 Working Principle of the circuit

Operational amplifier IC 741 (IC3) provides a constant flow of current through the base-emitter junction of npn transistor BC108 (T1). The voltage across the base-emitter junction of the transistor is proportional to its temperature. The transistor used this way makes a low-cost sensor. You can use silicon diode instead of transistor.

The small variation in voltage across the base-emitter junction is amplified by second operational amplifier (IC4), before the temperature is displayed on the meter. Preset VR1 is used to set the zero-reading on the meter and preset VR2 is used to set the range of temperature measurement.

Operational amplifiers IC3 and IC4 operate off regulated ±5V power supply, which is derived from 3-terminal positive voltage regulator IC 7805 (IC1) and negative low-dropout regulator IC 7660 (IC2). The entire circuit works off a 9V battery.

Assemble the circuit on a general-purpose PCB and enclose in a small plastic box. Calibrate the thermometer using presets VR1 and VR2. After calibration, keep the box in the vicinity of the object whose temperature is to be measured

To convert the voltage in to temperature so that circuit can show it in degree Celsius we have used Arduino

2.5 Types of thermometer

- Alcohol thermometer
- Mercury-in-glass thermometer
- Balco alloy
- Beckmann differential thermometer
- Bi-metal mechanical thermometer
- Breguet's thermometer
- Coulomb blockade thermometer
- Cryometer
- Ear thermometer
- Fiber optical thermometer
- Forehead thermometer
- Galileo thermometer
- Gas thermometer
- Heat meter
- Indoor-outdoor thermometer
- Infrared thermometer
- Liquid crystal thermometer
- Phosphor thermometry
- Pyrometer

2.6 Applications of thermometer

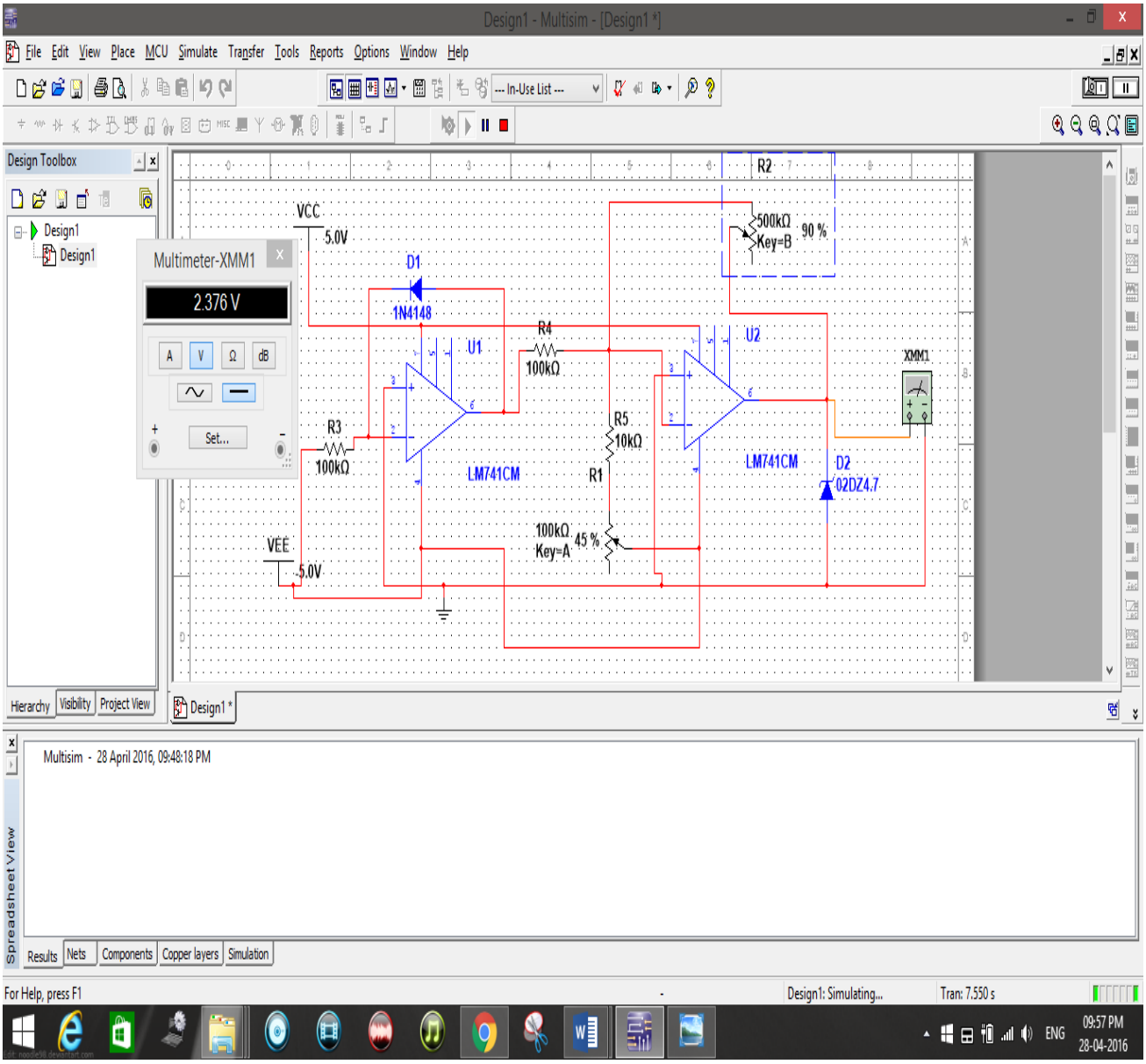
Thermometers utilize a range of physical effects to measure temperature. Temperature sensors are used in a wide variety of scientific and engineering applications, especially measurement systems. Temperature systems are primarily either electrical or mechanical, occasionally inseparable from the system which they control (as in the case of a mercury-in-glass thermometer). Thermometers are used in roadways in cold weather climates to help determine if icing conditions exist. Indoors, thermistors are used in climate control systems such as air conditioners, freezers, heaters,

refrigerators, and water heaters. Galileo thermometers are used to measure indoor air temperature, due to their limited measurement range.

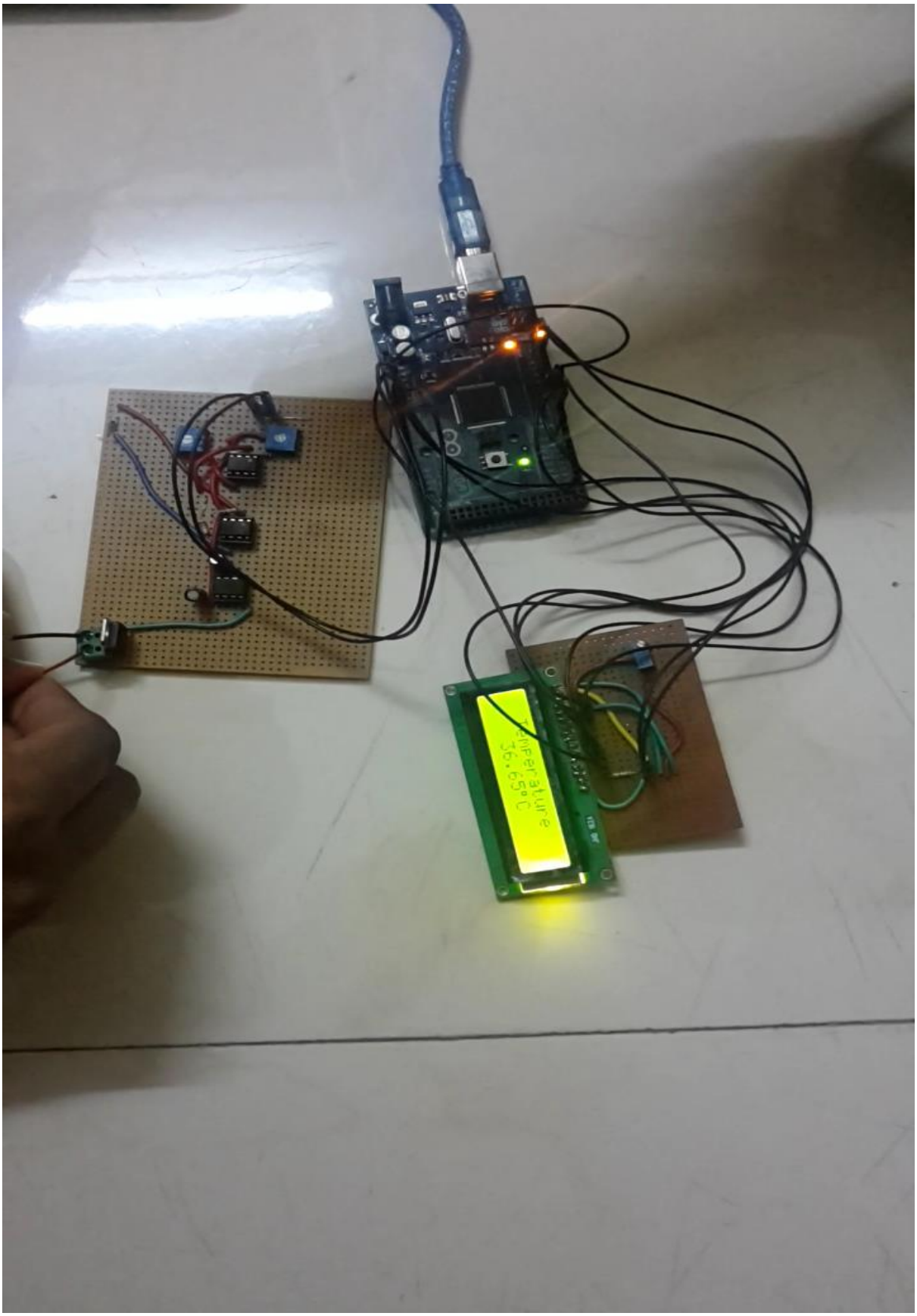
Alcohol thermometers, infrared thermometers, mercury-in-glass thermometers, recording thermometers, thermistors, and Six's thermometers are used in meteorology and climatology in various levels of the atmosphere and oceans. Aircraft use thermometers and hygrometers to determine if atmospheric icing conditions exist along their flight path. These measurements are used to initialize weather forecast models. Thermometers are used in roadways in cold weather climates to help determine if icing conditions exist and indoors in climate control systems.

CHAPTER 3

3.1 Simulation in MULTISIM



3.2 Hardware implementation


Temperature
36.65°C

Conclusion

Digital thermometer using op-amp 741 is very cost efficient temperature sensing device because it uses diode as a temperature sensor which is very cost efficient. The working principle is also very simple as the forward junction temperature of the diode increase, the voltage across the junction decreases.

References

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