LabVIEW Based Water Temperature Measurement & Control

A Project report submitted in partial fulfilment
of the requirements for the degree of B. Tech in Electrical Engineering

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CERTIFICATE

To whom it may concern

This is to certify that the project work entitled "**LabView Based Water Temperture Measurement & Control"** is the bona fide work carried out by **Dayanidhi Yadav (11701614017),Ranjeet Kumar(11701614034),Pankaj Kumar(11701614030)** ,a student of B.Tech in the Dept. of Electrical Engineering, RCC Institute of Information Technology (RCCIIT), Canal South Road, Beliaghata, Kolkata-700015, affiliated to Maulana Abul Kalam Azad University of Technology (MAKAUT), West Bengal, India, during the academic year 2017-18, in partial fulfillment of the requirements for the degree of Bachelor of Technology in Electrical Engineering and that this project has not submitted previously for the award of any other degree, diploma and fellowship.

_____ _____

Signature of the Guide **Signature of the HOD**

Name: **Name:**

Designation **Designation**

_____

Signature of the External Examiner

Name:

Designation:

ACKNOWLEDGEMENT

It is our great fortune that We have got opportunity to carry out this project work under the supervision of ***Dr. Debasish Mondal*** in the Department of Electrical Engineering, RCC Institute of Information Technology (RCCIIT), Canal South Road, Beliaghata, Kolkata-700015, affiliated to Maulana Abul Kalam Azad University of Technology (MAKAUT), West Bengal, India. we express our sincere thanks and deepest sense of gratitude to our guide for his constant support, unparalleled guidance and limitless encouragement.

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Name and Signature of the Student

Place:
Date:

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ABSTRACT

With the development and popularization of computer technology, digital technology ,digital equipments are replacing analog device gradually. The measurement and control technology plays an important role in the process of production and scientific research. As the time advancing the conventional instruments are emerging shortage .It becomes necessary to improve & modernize conventional instruments are emerging shortage. It becomes necessary to Improve &modernize conventional instruments .In this project work ,the conception of virtual instrument and control of temperature for specific set temperature is introduced .The program system and programming environment of virtual instrument, LabVIEW will be mentioned as well. Around the anticipant target which the PC-based virtual instrument in this thesis is expected to achieve, the design thoughts and the whole structure on which the virtual instrument was built are described in details thouhts.Following these thougghts as principles, a temperature control system will be designed.Based on Virtual instrument(LabVIEW), the temperature control system will be designed to relize the data of the temperature of the objects . The sample input signals were analysed and disposed to determine the output signal at given set point with specific delay time using by using the LabVIEW based program.

1. Introduction

In this project work we will design a LabVIEW VI(virtual instrument) based temperature

Measurement and control system. The LM-35 will be taken as temperature sensor.

The amplified output of the LM-35 is given in to the analog input card (AI0) of the compact RI0

Chasis.when the measured temperature is above or below the desired temperature set in the

LabVIEW relay controller will be closed or open depending on the requirement. The output from the digital output card(DI 0) actuate the relay. The voltage generated by the relay

Contact makes ON/OFF the heater. The temperature of the water is sensed by the LM-35.

Such closed loop ON/OFF temperature control system is similar to the one used in heating and cooling of our homes with a thermostat.

2. OVERVIEW OF LABVIEW

2.1 What is LabVIEW?

LabVIEW is a **"program development application"**. LabVIEW is a **graphical programming language**, as opposed to a text-based language, used to create programs in a block diagram form.

LabVIEW is a "general-purpose programming system." The LabVIEW program contains the following:

- extensive library of functions
- library for data acquisition
- data presentation
- data storage

The above is a simple summary of what LabVIEW can do. For a more detailed explanation of LabView, check out the National Instruments official web site.

2.2 Learning Labview Basics

In this section, the user will learn about the four basic operations of labview. The four basics are: **virtual instruments**, **front panel**, **block diagram**, and **icon and connector**.

- **Virtual Instruments**

LabVIEW is defined as a **general-purpose programming system**. A LabVIEW program is also referred as **virtual instruments**. Virtual instruments means that the operations and appearance can imitate actual instruments.

Virtual instruments are structured as follows:

1. The control or user interface of virtual instruments is known as the **front panel**. The front panel simulates the panel of a physical instrument.
2. Instructions that are given to the virtual instrument are in the form of a **block diagram**.
3. Virtual instruments can be used as a "top-level program", or as a subprogram of another program.

Front Panel

The "user interface" of VI looks like that of an instrument (check the illustration below). This "user interface" is known as the **front panel.**

Block Diagram

With the **block diagram**, you can construct a block diagram that wires together objects that send or receive data, perform specific functions, and control the flow of execution.

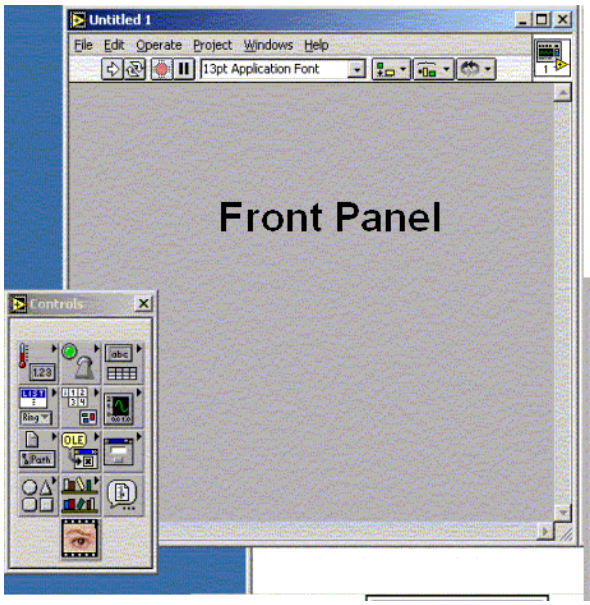


Fig.1:Front Panel

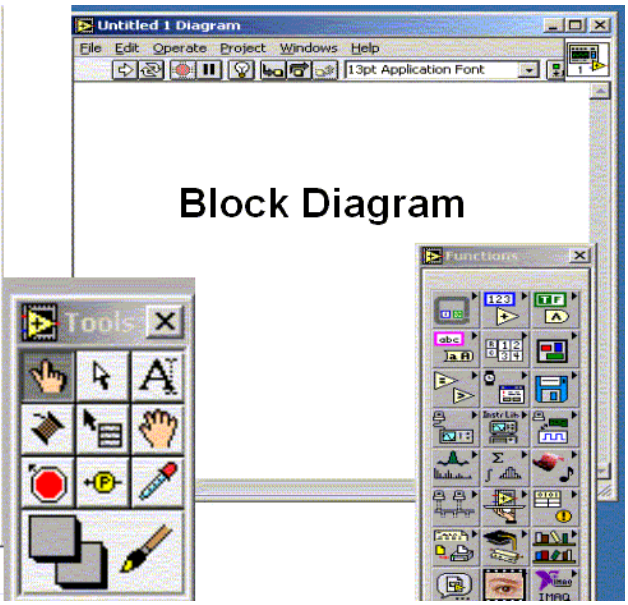


Fig.2: Block Diagram

2.3 VI DIAGRAM IN LABVIEW:

This diagram has been constructed using LabVIEW software for temperature measurement and control. The hardware circuit is connected to the software via RIO cards NI 9203 (Analog Input card)and NI 9472(Digital output card) for Analog to Digital conversion.

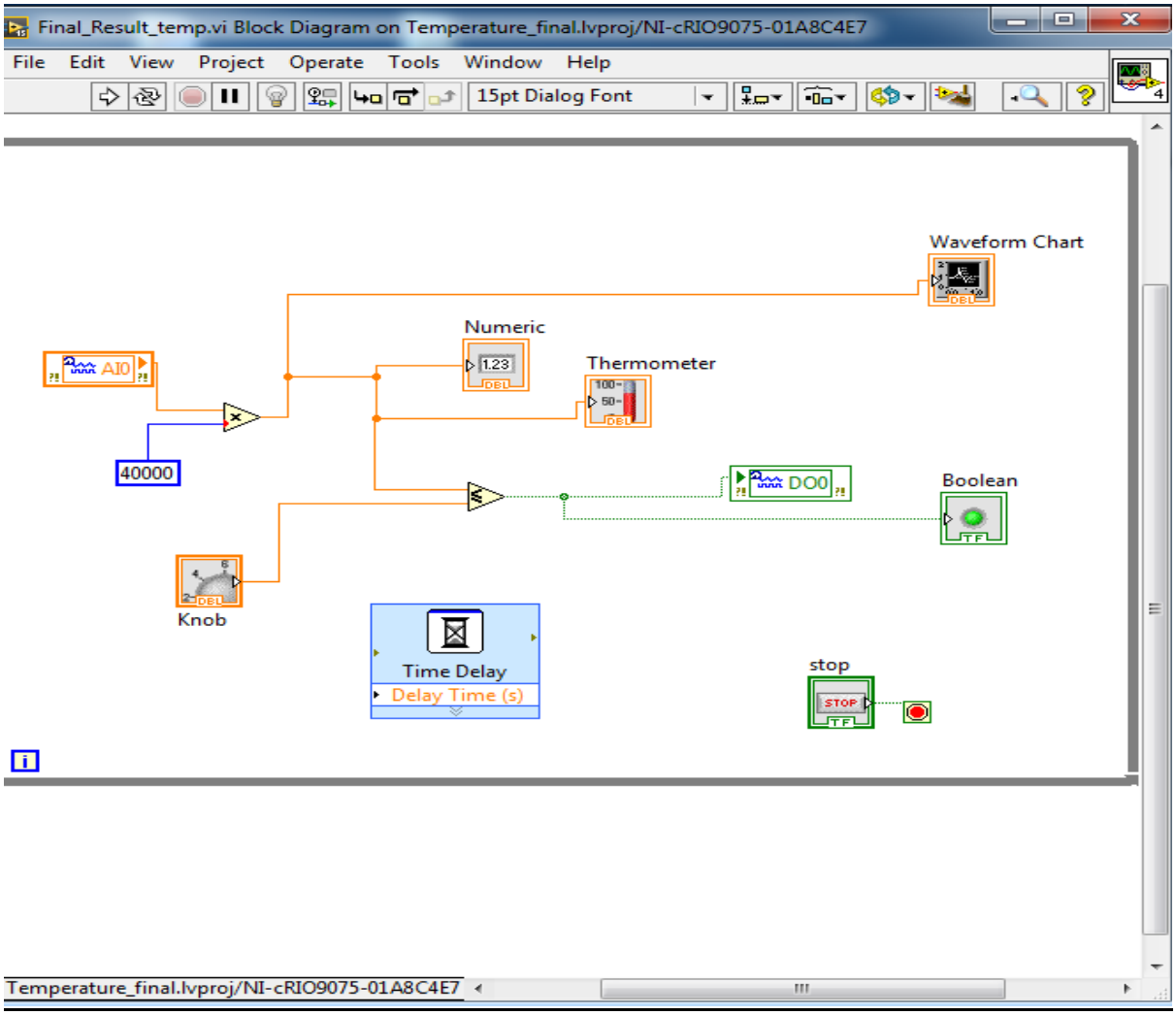
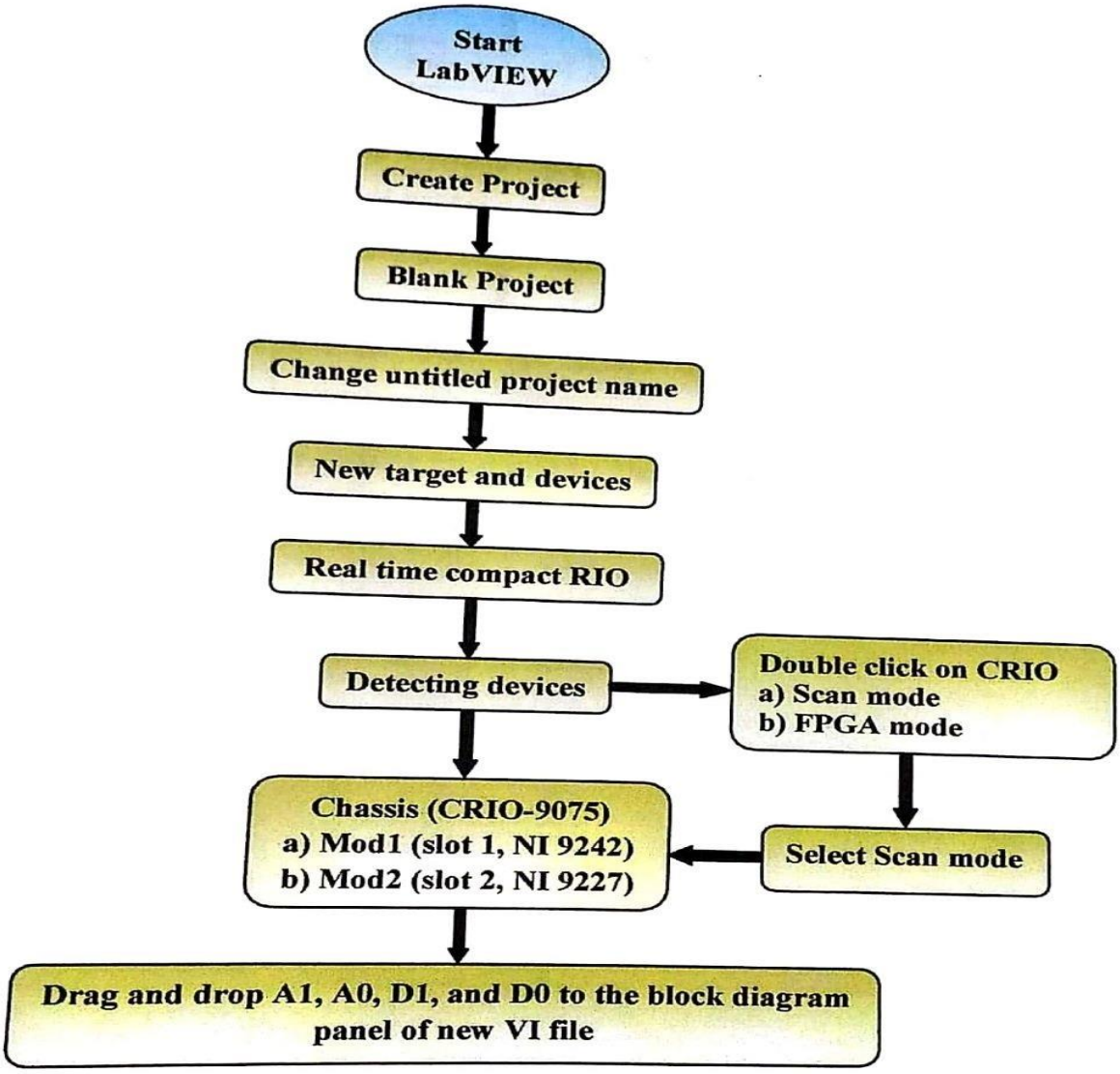


Fig 3: LabVIEW VI diagram

2.4 : Flow chart of Lab VIEW



To create new VI file under the new project:

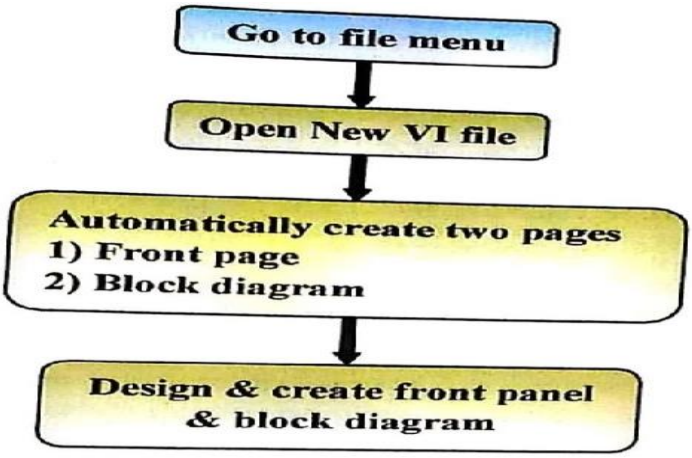


Fig.4: Flow chart

3.*METHODS OF TEMPERATURE MEASUREMENT*

3.1

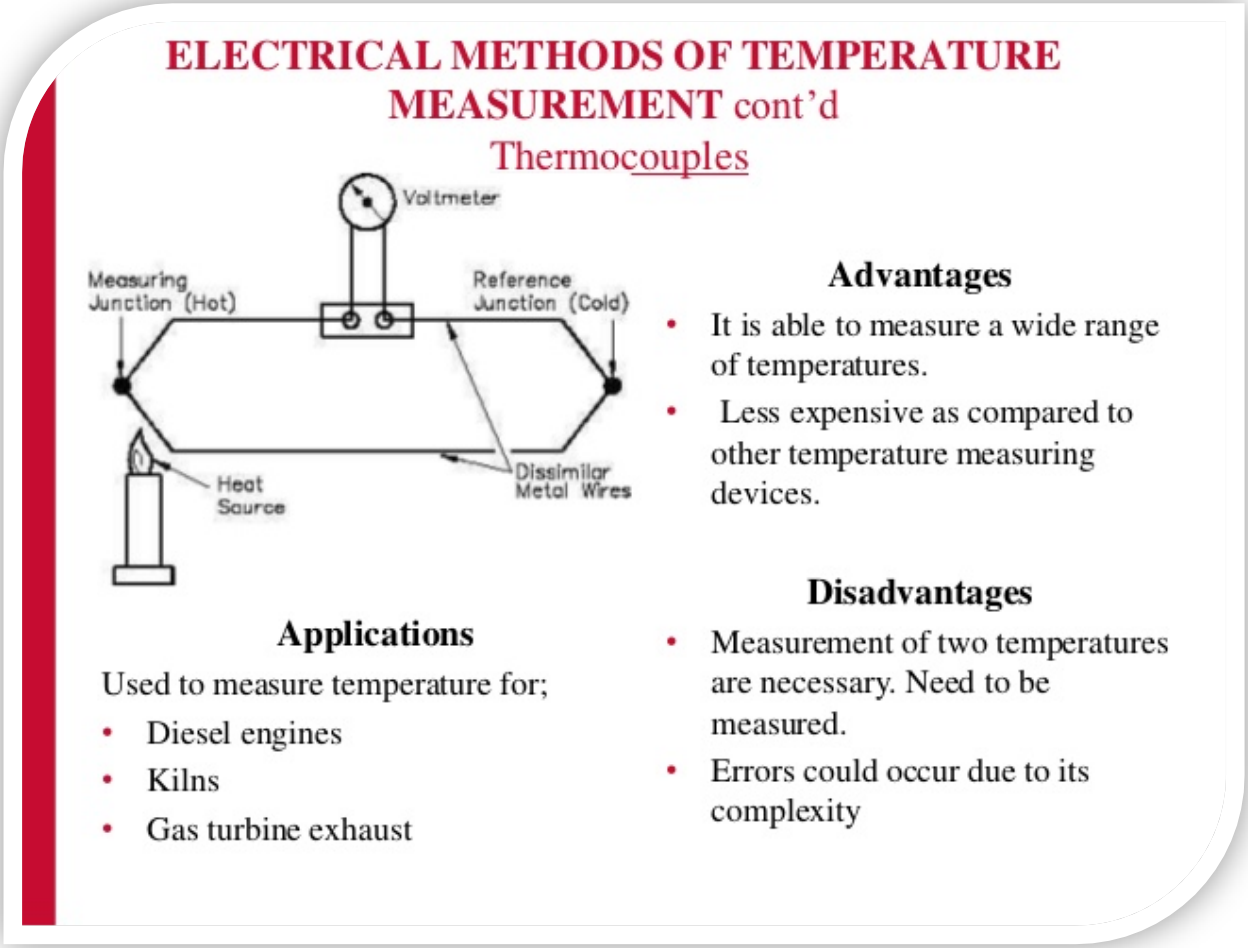


Fig.5: thermocouple

3.2

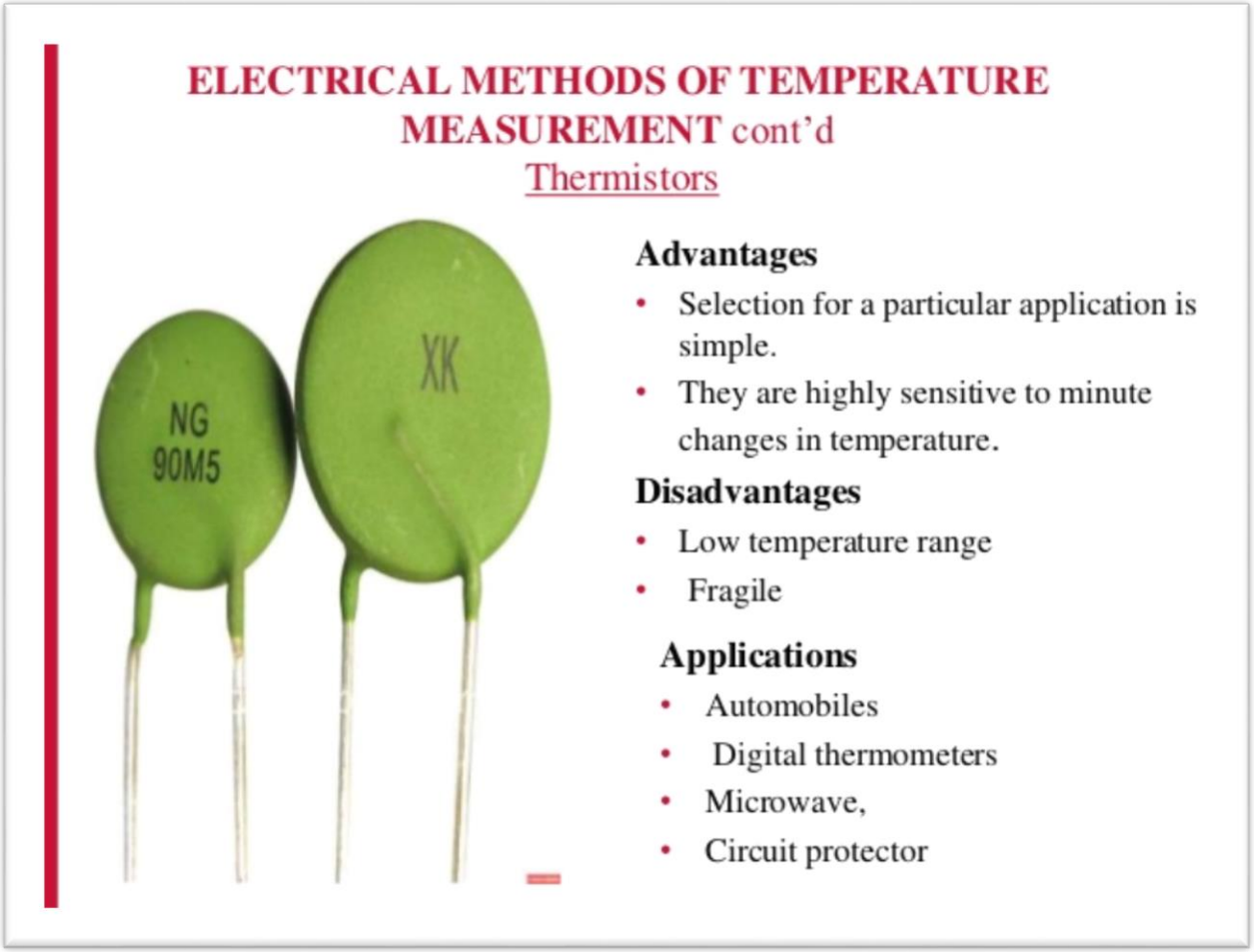


Fig. 6: thermistor

3.3

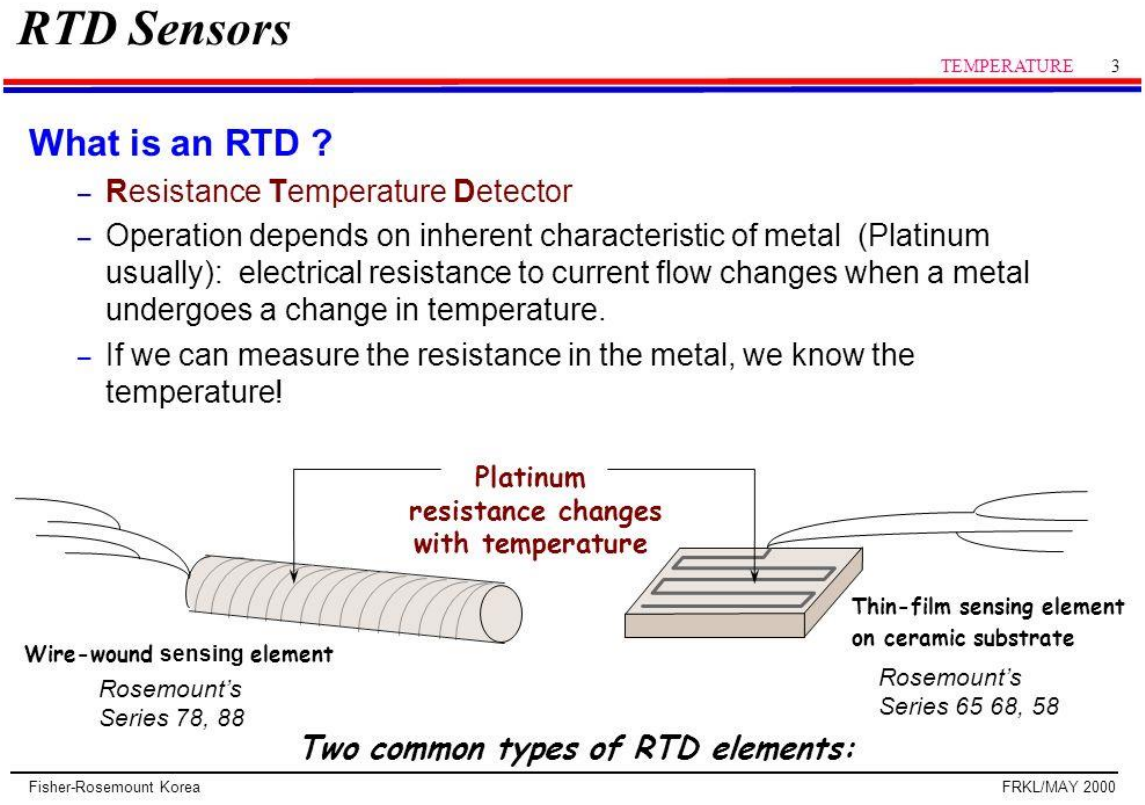
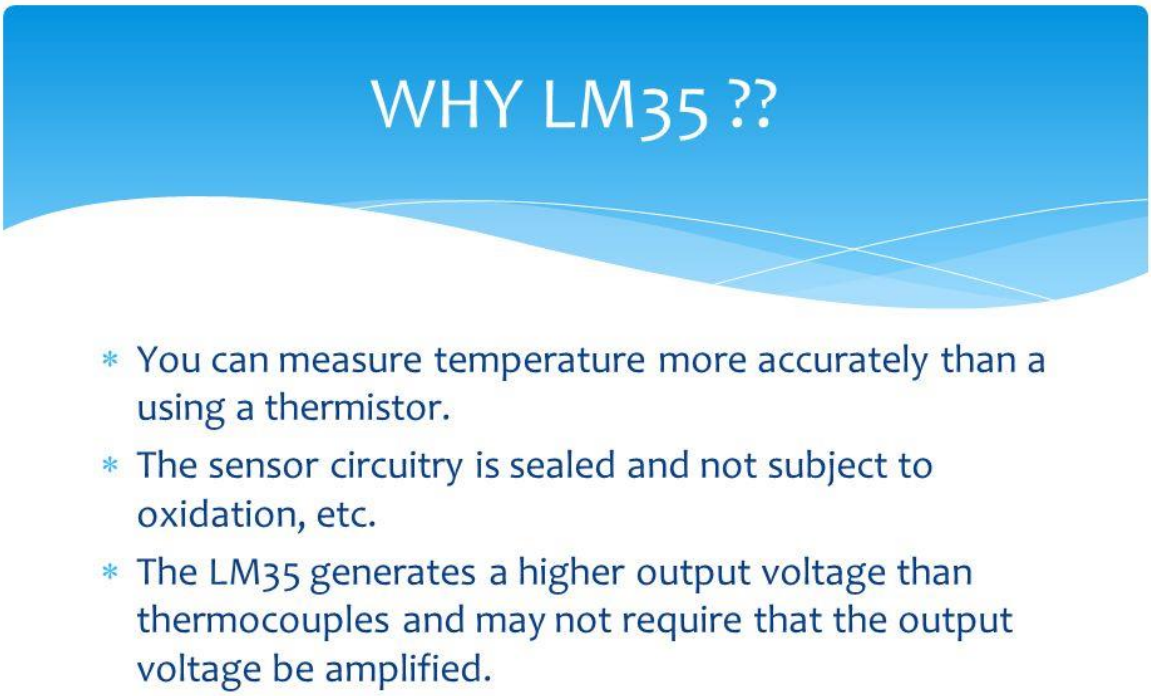


Fig.7: RTD figure

3.4



3.4.1

LM35 Temperature Sensor

The LM35 is one kind of commonly used temperature sensor that can be used to measure temperature with an electrical o/p comparative to the temperature (in °C). It can measure temperature more correctly compare with a thermistor. This sensor generates a high output voltage than thermocouples and may not need that the output voltage is amplified. The LM35 has an output voltage that is proportional to the Celsius temperature. The scale factor is .01V/°C.

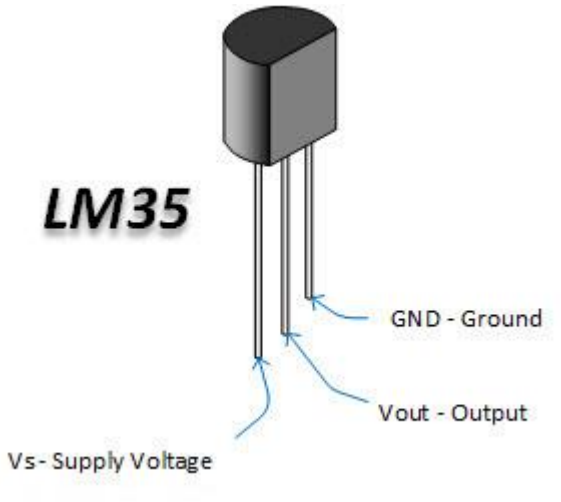


Fig. 8: LM 35 sensor

LM35 Temperature Sensor

The LM35 does not need any exterior calibration and maintains an exactness of +/-0.4°C at room temperature and +/-0.8°C over a range of 0°C to +100°C.One more significant characteristic of this sensor is that it draws just 60 microamps from its supply and acquires a low self-heating capacity. The LM35 temperature sensor available in many different packages like T0-46 metal can transistor-like package, TO-92 plastic transistor-like package, 8-lead surface mount SO-8 small outline package.

3.4.2 Configuration

1	Vcc	Input voltage is +5V for typical applications
2	Analog Out	There will be the increase in 10mV for raise of every 1°C. Can r from -1V(-55°C) to 6V(150°C)
3	Ground	Connected to ground terminal of the circuit

3.4.3 Applications of LM35 Temperature Sensor

The applications of LM35 temperature sensor include the following

- Measuring temperature of a particular environment and HVAC applications
- Providing thermal shutdown for a component/ circuit
- Checking Battery Temperature
-

4. *Circuit Diagram of the Project*

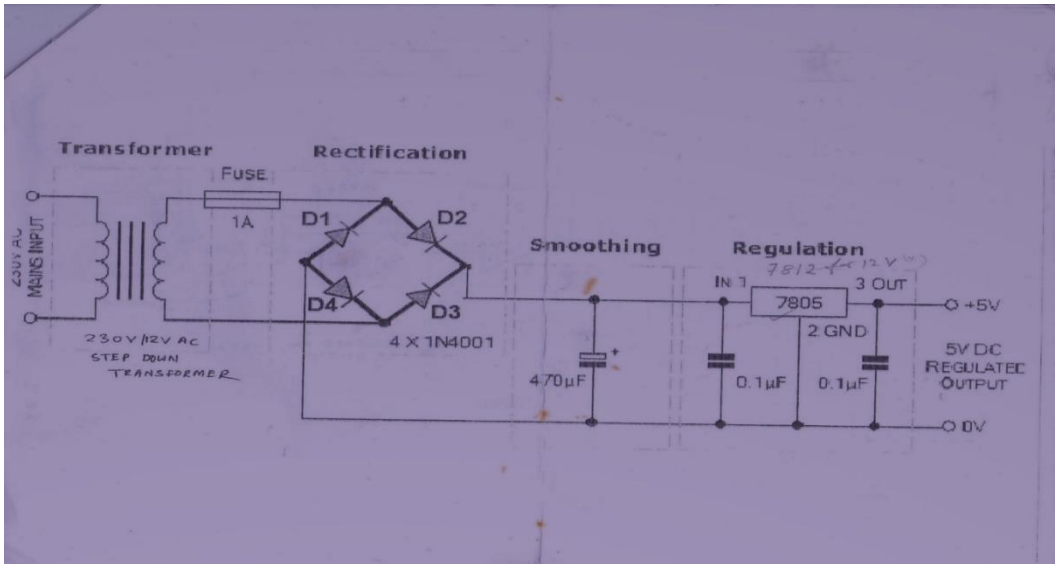


Fig. 9: **Conversion of 230v ac to 5v or 12v dc**

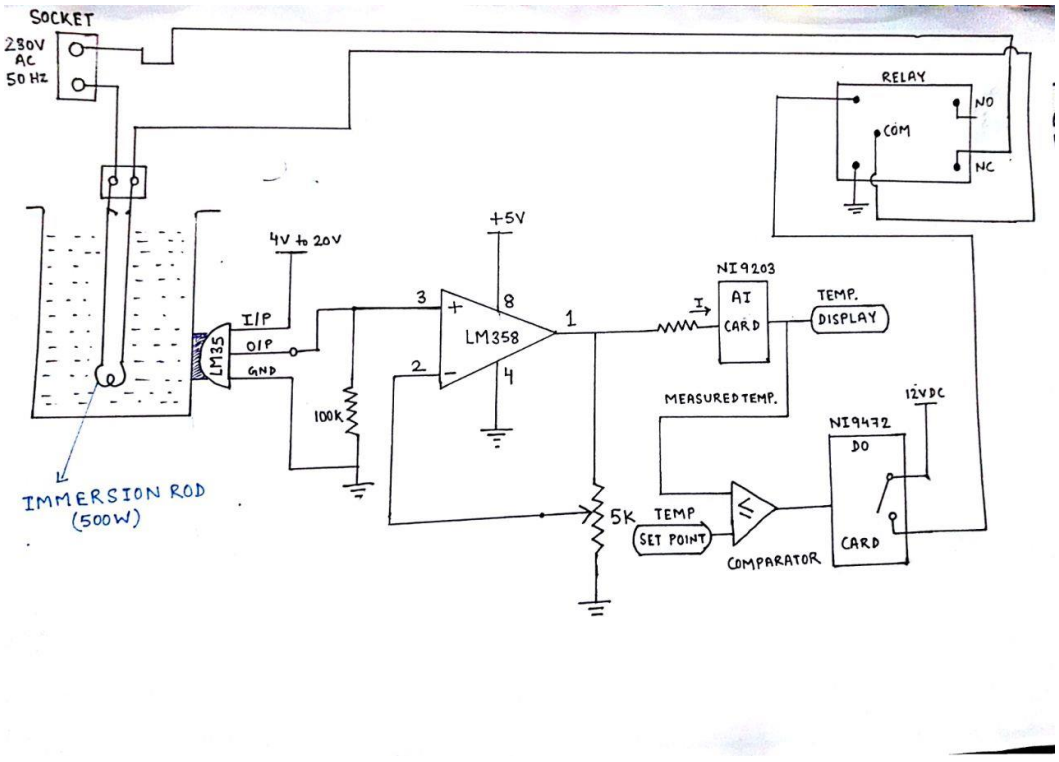


Fig 10:full circuit explationation

5. Working principle:

LM35 is a precision Fahrenheit temperature sensor. This is 3-pin device that outputs a DC voltage proportional to the measured temperature . The output of the sensor is calibrated (10mV/C).

The RELAY (JQC-3FC/T73) (i.e electromagnetic relay) will control the current (+12V supply) to the water container the is used as a heating element. The relay cannot be connected to the output terminals of the DI card directly as the outputs of the card are not capable of sourcing enough current to energize the relay coil. An IC-Lm358 opamp used as a amplifier voltage will work very well in switching the relay.

We need approximately 250W of power to be dissipated from the heating of the immersion rod dipped in water container. Calculated the value of the water temperature from the known values of voltage applied and the power dissipation desired (250W).

Position the water container and the temperature sensor very close to each other. This will allow efficient thermal contact between the temperature sensor and the water container.

5.1HARDWARE DIAGRAM OF FULL CIRCUIT:

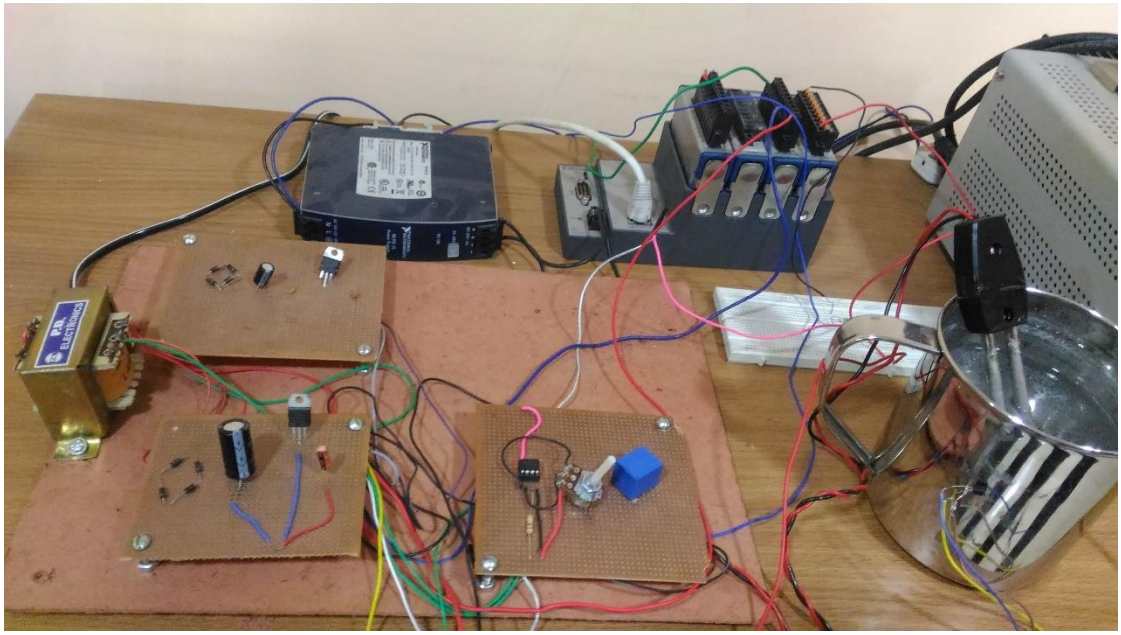


Fig.11: Hardware diagram

5.2 CIRCUIT EXPLANATION

In this project our main objective is to measure and control the temperature of water based on labview. In this circuit at first we have built one source containing 230/12v stepdown transformer,four diodes, one 1000 micro farad 25v capacitor and 1 uf,one IC-7812 for 12v DC source.

Four diodes,one 470uf,one 0.1uf, one IC-7805 for +5v DC source. At the secondary side of transformer we have build full wave rectifier to convert the AC voltage to dc voltage.

For temperature measurement sensor LM-35 , +5v dc is needed for vcc pin.This LM-35

only can generates voltage in terms of mV range(10mV/c).LM358 100k and 5k resistor is

Used for the amplification purpose.After amplification the voltage signal is fed to AI card(from 9 to 0) through resistor 1k.

From the AI card the signal goes to comparator where we can set the temperature for control

the Water temperature.Now from the output of the do card the signal is fed to

the relay JQC-3FC-T73. One external dc source is connected where we set a voltage at 12 to the coil pin of relay.when temperature is above the comparator set point, the D0 card passes the signal

To the relay coil goes actuate. Then the relay switch go to NO to NC and that external 12V gets path for pin 9 to 8 of DO card. In this way Water temperature goes heated up and the temperature sensor will able to sense the temperature and the process continues

6. HARDWARE COMPONENTS AND THEIR DESCRIPATIONS

The following components are used in our project:

1. *Relay(*(JQC-3FC/T73)
2. *LM-35(Temperature Sensor)*
3. *Op Amp IC- LM 358*
4. *Single Phase Transformer(AC230V/12-0-12V)*
5. *Regulators(IC-7805,IC-7812)*
6. *Heater(500w)*
7. *Resistors(1k,100k,5k)*
8. *Capacitors(1000uf,470uf,1uf,0.1uf)*
9. *Diodes*

6.1 OPERATION OF THE RELAY

- Single pole double throw (SPDT) - Such relay has 5 terminal pins which consists of a pair of coil pins , a common pin, a normally open (NO) pin and a normally close (NC) Pin. When the relay is not activated , the common pin is in contact with the NC pin and when it is activated, the common pin will break away from contact with the NC pin and subsequently makes contact with the NO pin. Also, when the relay is deactivated (from activated state) , the common pin will conversely break away from contact with the NO pin and return back in contact with the NC pin.

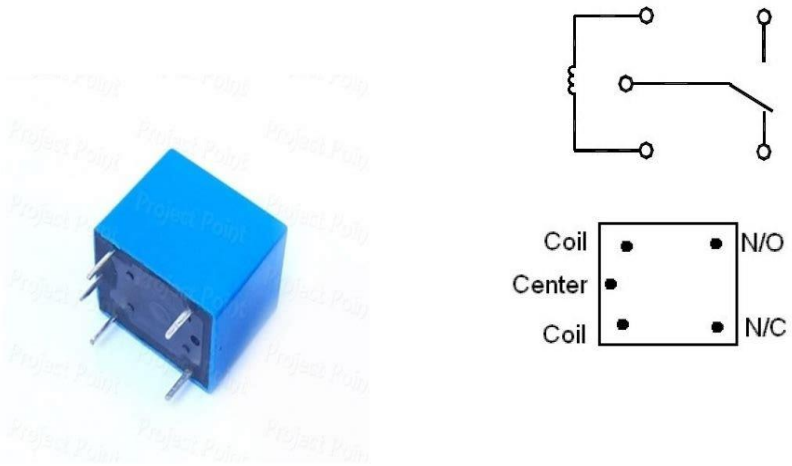
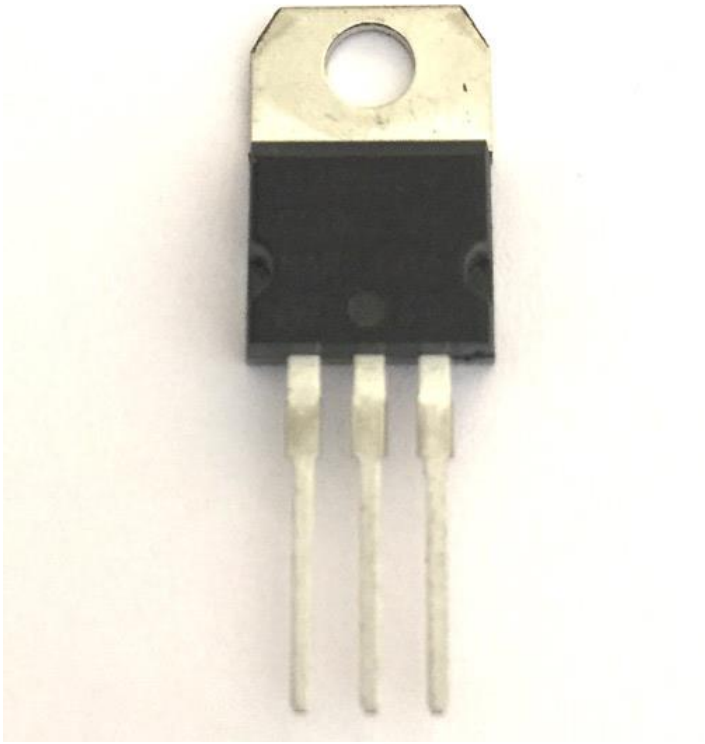
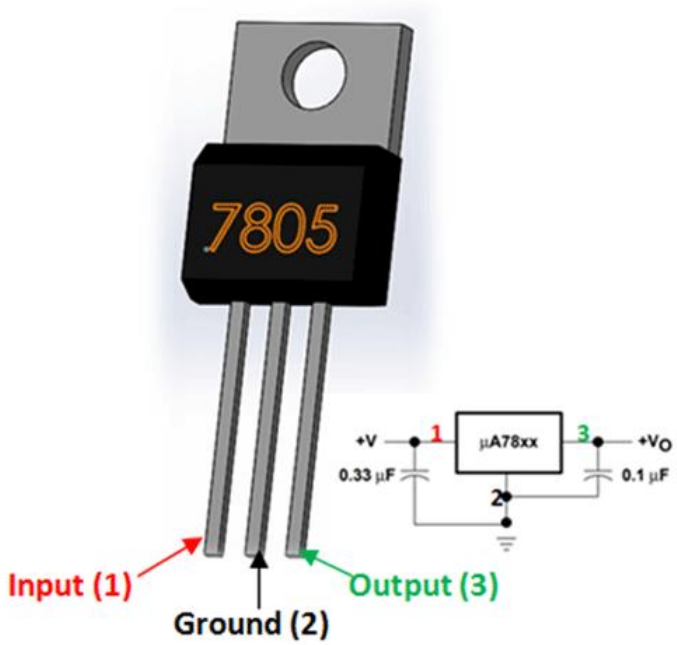


Fig. 12: Diagram of used relay in our project

6.2 7805 Voltage Regulator IC





LM7805 Voltage Regulator IC
7805 Voltage Regulator Pinout

Fig.13: IC 7805 Voltage Regulator

6.2.1 Pin configuration

Pin Number	Pin Name	Description
1	Input (V+)	Unregulated Input Voltage
2	Ground (Gnd)	Connected to Ground
3	Output (Vo)	Outputs Regulated +5V

6.2.2 7805 Regulator Features

- 5V Positive Voltage Regulator
- Minimum Input Voltage is 7V
- Maximum Input Voltage is 25V
- Operating current(I_Q) is 5mA
- Internal Thermal Overload and Short circuit current limiting protection is available.
- Junction Temperature maximum 125 degree Celsius
- Available in TO-220 and KTE package

Note: ***Complete Technical Details can be found at the datasheet give at the end of this page.***

6.2.3 7805 Voltage Regulator Equivalent

LM7806, LM7809, LM7812, LM317, LM7905, LM7912, LM117V33, XC6206P332MR.

6.2.4 Brief Description on 7805 Voltage Regulator IC

Voltage regulators are very common in electronic circuits. They provide a constant output voltage for a varied input voltage. In our case the 7805 IC is an iconic regulator IC that finds its application in most of the projects. The name 7805 signifies two meaning, “78” means that it is a positive voltage regulator and “05” means that it provides 5V as output. So our 7805 will provide a +5V output voltage.The output current of this IC can go up to 1.5A. But, the IC suffers from heavy heat loss hence a Heat sink is recommended for projects that consume more current. For example if the input voltage is 12V and you are consuming 1A, then (12-5) * 1 = 7W. This 7 Watts will be dissipated as heat.

6.3 7812 Voltage Regulator IC

7812 is a 12V Voltage Regulator that restricts the voltage output to 12V and draws 12V regulated power supply. The 7812 is the most common, as its regulated 12-volt supply provides a convenient power source for most TTL components.

7812 is a series of 78XX voltage regulators. For ICs within the family, the xx is replaced with two digits, indicating the output voltage (for example, the 7805 has a 5-volt output, while the 7812 produces 12 volts).

Applications

- *Circuits requiring steady 12v supply*
- *Protection for devices having specific voltage sensitivity*
- *DIY projects requiring specific voltage from an existing higher/ varying voltage supply*

6.3.1 Features

- *Fixed 12V voltage regulators*

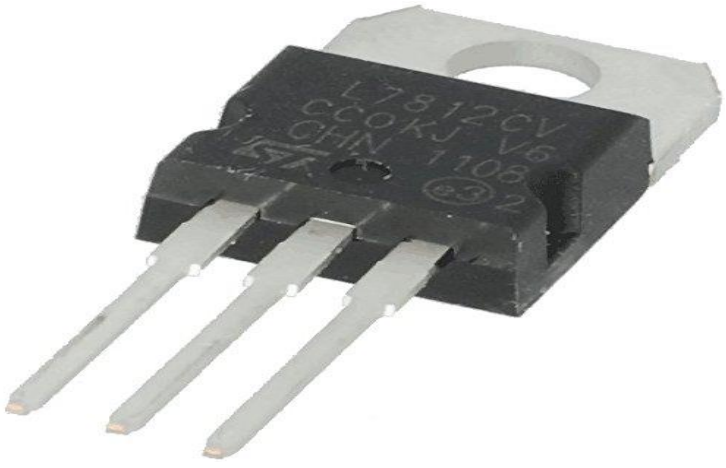


Fig. 14: IC 7812

- *Thermal overload protection*
- *Short circuit protection*

- *Output transition SOA protection*
- *Heatsink is required*

6.3.2 Specifications

- *Output Type: Fixed*
- *Output Voltage: +12V DC*
- *Current Output: up to 1.5A*
- *Input Voltage: 14.6 - 35VDC*
- *Quiescent (standby) current: 8mA*
- *Dropout Voltage (Max): 2V @ 1A*
- *Category: Linear Voltage Regulators - Standard*
- *Polarity: Positive*
- *Operating Temperature: 0 to +125°C*
- *Mounting Style: Through Hole*
- *Pin Spacing Pitch: 2.54mm*
- *Hole Diameter: 3.8mm*
- *Dimensions: 10.4 x 4.6 x 9.15mm*

Linear regulator like 7812 has performance issues with respect to battery life and Power loss. If you are looking for an alternative for 7812 with better efficiency and less power loss, then we would recommend a DC Buck Switching voltage regulator. Buck converters may be preferred over 78xx regulators because they are more efficient and do not require heat sinks, but they are more expensive.

6.4 Single phase 230/12-0-12V Transformer

6.4.1 Features

. Low Temperature Rise

. High accuracy

.Small Size

. Low loss

. Made of excellent raw materials

6.4.2 Specifications

.Input voltage 230V

.Output voltage 16V

.Output current 550mA

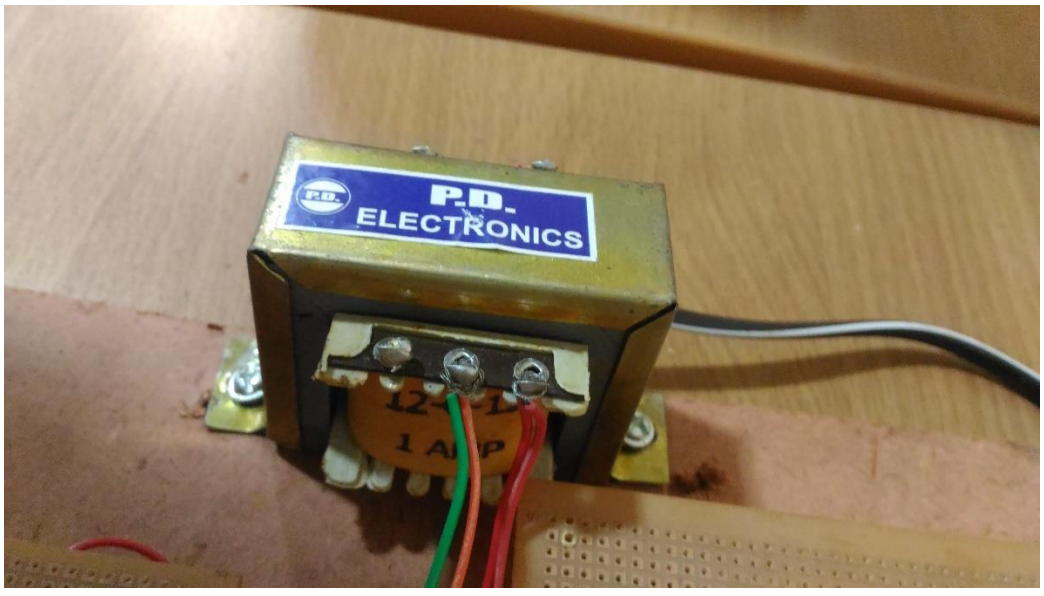


Fig. 15: Single phase 230/12-0-12 V transformer

6.4.3 Working Principle

Transformer is a static device which transform the power or energy from one circuit to Another circuit without change of frequency. The operation of transformer occurs in two Domains one electrical another magnetic frequency. Transformer has primary winding , Secondary windings and magnetic core. The primary winding is connected to the supply Voltage(alternating voltage) secondary winding is connected to the load and both windings Are magnetically coupled through magnetic core.

Due to the alternating voltage the alternating current flow through the primary winding And produce the alternating flux and primary emf is developed (according to faraday's Law of electromagnetic induction). According to this principle the primary winding is Experienced the magneto motive force(mmf) and the alternating flux is linked with the Secondary winding. Due to this alternating flux secondary induced emf is produced and if Load is connected to the secondary terminal the secondary current will flow through the Secondary winding. In this reason the secondary magneto motive force is developed and Which is equal to the primary magneto motive force.

V1=primary supply voltage, V2=secondary terminal voltage

E1=primary induced voltage, E2=secondary induced voltage

N1=number of primary turn, N2=number of secondary turn

Emf(E)=4.44φfN

E1/E2=V1/V2=N1/N2=I2/I1=a(a=turn ratio)

6.5 CAPACITORS

Capacitance is defined as the ratio of the electric charge on each conductor to the potential Difference between them.the unit of capacitance in the international system of units(SI) is The farad(F). defined as one column per volt91C/V).capacitance value of typical capacitor For use in general electronics range from about 1pf to about 1mf.

The capacitance of capacitor is proportional to the surface area of the plates (conductor) All inversely realted to the gapbetween them. In practice, the dielectric between the plates Passes a small amount of leakage current. It has an electric field strength limit,know as The breakdown voltage. The conductors and leads introduce an undesired inductance And resistance.

Capacitor is widely used in electric circuit for blocking direct current while Allowing alternating current pass. In analog filter network, they smooth the output Of power supply. In resonant circuit they tuned radio to particular frequencies. In electric Power transmission system, they stabilize voltage and power flow. The property of energy Storage in capacitor was exploited as dynamic memory in early digital computers.

In this project one 1000 micro farad,1 micro farad,0.1micro farad,470 micro farad electrolytic capacitor are used to design DC=12v and DC=5v power supply

Fig.16 : capacitors

Defination of electric resistance is the measure of the degree to which a conductor opposes

An electric current through the conductor. Resistivity is the main property of electrical

Resistance. Electrical resistivity is an intrinsic property that quantifies how strongly a given material opposes the flow of electric current. Alow resistivity indicates a material that readily

Allows the flow of electric current.

6.6 USED RESISTANCES:-

In this project we have used under mentioned resistor for different purpose. They are:-

1k ohm resistor:-It is used for getting the analog input and then applying it to the AI card. It convert the voltage to corresponding current(mA) signal.

100k ohm and 5k ohm(potentiometer) resistor combination:-they are used in combination for amplification purpose.

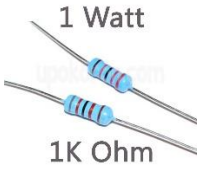


Fig.17: Resistors & potentiometer

6.7 DIODES

A diode is a two terminal electronic components that conducts primarily in one direction

(asymmetric conductance), it has low (ideally zero) resistance to the current in one direction

And high (ideally infinite) resistance in the other. A semiconductor diode the most common type today is a crystalline piece of semiconductor material with a p-n junction connected to

Two electrical terminals. A vaccum tube diode has two electrodes a plate and a heated cathode.

The must common function of a diode is to allow an electric current to pass in one direction (forward direction) while blocking current in opposite direction(reverse direction).

Fig. 18: Diodes

Fig. 19: Heater

6.8 Electric Heater

Electric heaters have been around for decades as a source of heat in homes to provide warmth to us. One of the reason for their popularity is because of lower cost to purchase and easy maintenance compared to other sources of heat. They are usually powered by electricity though a small percentage are still using propane or kerosene as fuel.They work by converting electricity into heat using metals as heating elements. The metals have high resistance that permit a certain amount of current to flow though them to provide the required heat. Electrical energy is changed into heat energy and the the relationship between the wattage and Btu/hr is:**1 Watt = 3.415 Btu/hr.**

7. *TEMPERATURE MEASUREMENT DATA*

Observation for temperature indication in LabVIEW:

SL NO	***VOLTAGE(V)***	***TEMPERATURE (°C)***
1	1.05	38.72
2	1.16	40.77
3	1.33	46.74
4	1.41	50.16
5	1.58	55.62
6	1.64	58.10
7	1.73	60

8 *HARDWARE MODAL OF LABVIEW*

8.1 Interface of hardware with Labview

- From the of LM358 (pin-1) the wire is connected in series with 1k ohm resistor to transform the voltage into current (mA range) because the NI-9203 analog input card can only detect the signal within this current range. After that from the other side of the 1k ohm resistor the wire is connected at pin-0 of NI 9203.
- At DO9472 i.e the digital output card the pin 9 is the voltage source common card also for relay common. The pin 8 is for voltage supply. One external DC voltage source is used where we set the voltage at 12V and fed to the pin 8 of Digital output card.
- The earth terminal is connected to the common terminal of that card. The output of the digital output card i.e DO 0 of the DO card is fed to the relay coil of JQC-3FC(T73) (pin 1) and the common part is connect to the earth terminal of external DC source. When the relay coil is energized the 12V gets the output at pin 9 and process continouse in this way.
- When the measured temperature is above the set point relay JQC-3FC(T73) IS de energize, no voltage passes to the 9. The relay has NC contact between pin13 and pin 9 which is now NO position.
- Again when temperature is below the set point relay is energized. The 12V sopply passes through the pin 9 to the immersion rod dip in water container. The contact between pin13 pin9 is now NC position. Imersion rod is now heated by the flow of current.

8.2 SPECIFICATION OF NI9203 CARD:

8-Channel, 20mA, 16-Bit Analog input module

- 8 channels, 200kS/s current input
- 20Ma, 0 mA to 20mA programmable input ranges, 16-Bit resolution
- NIST- traceable calibration
- Screw- terminal or spring- terminals connectively
- 250Vrms, CAT II bank isolation
- -40C to 70C Operating Range, 5g Vibration, 50 g Shock

Fig.20: NI 9203 Card

8.2.1 INTERNAL CIRCUIT OF NI9203:

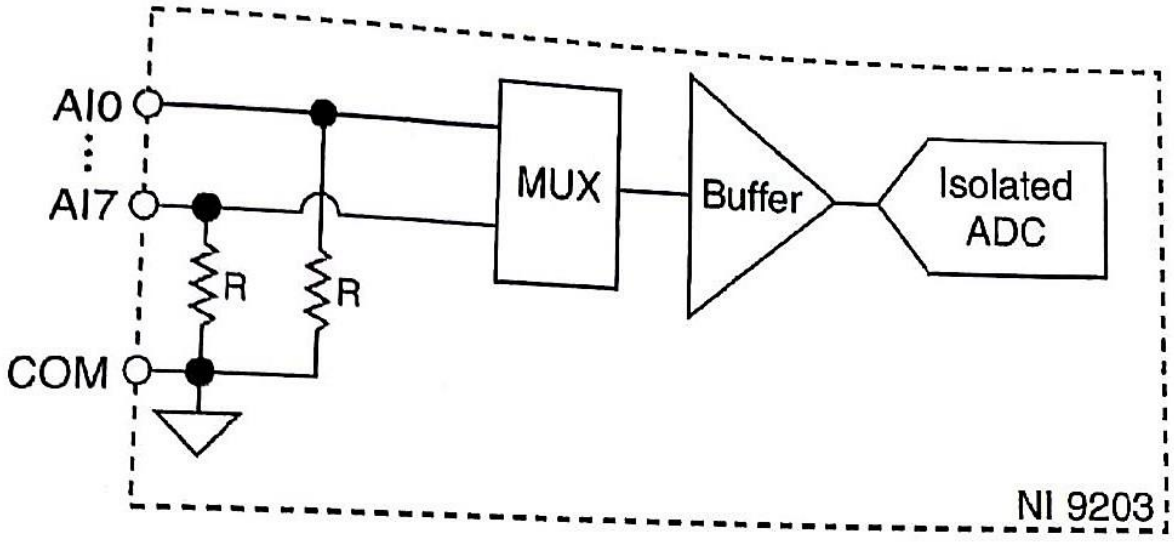


Fig.21 :circuitry of NI 9203

8.3 SPECIFICATION OF NI 9472:

- ***DSUB, screw-terminal, or spring-terminal connectivity***
- ***CompactDAQ counter compatibility***
- ***250 Vrms, CAT II, channel-to-earth isolation (screw and spring terminal); 60 VDC, CAT I, channel-to-earth isolation (DSUB)***

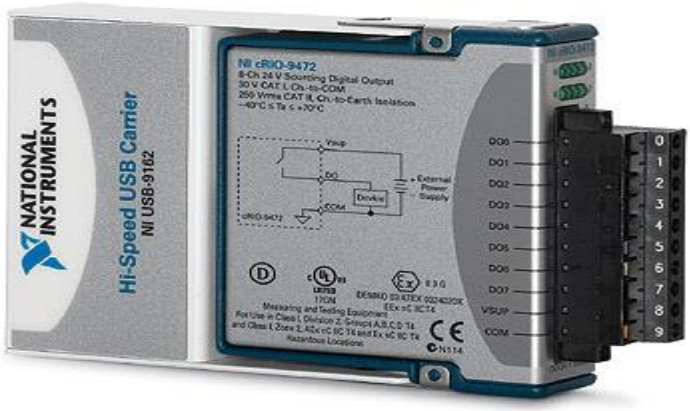


Fig.22: NI 9472

9.GRAPHICAL DISPLAY FOR TEMPERATURE CONTROL

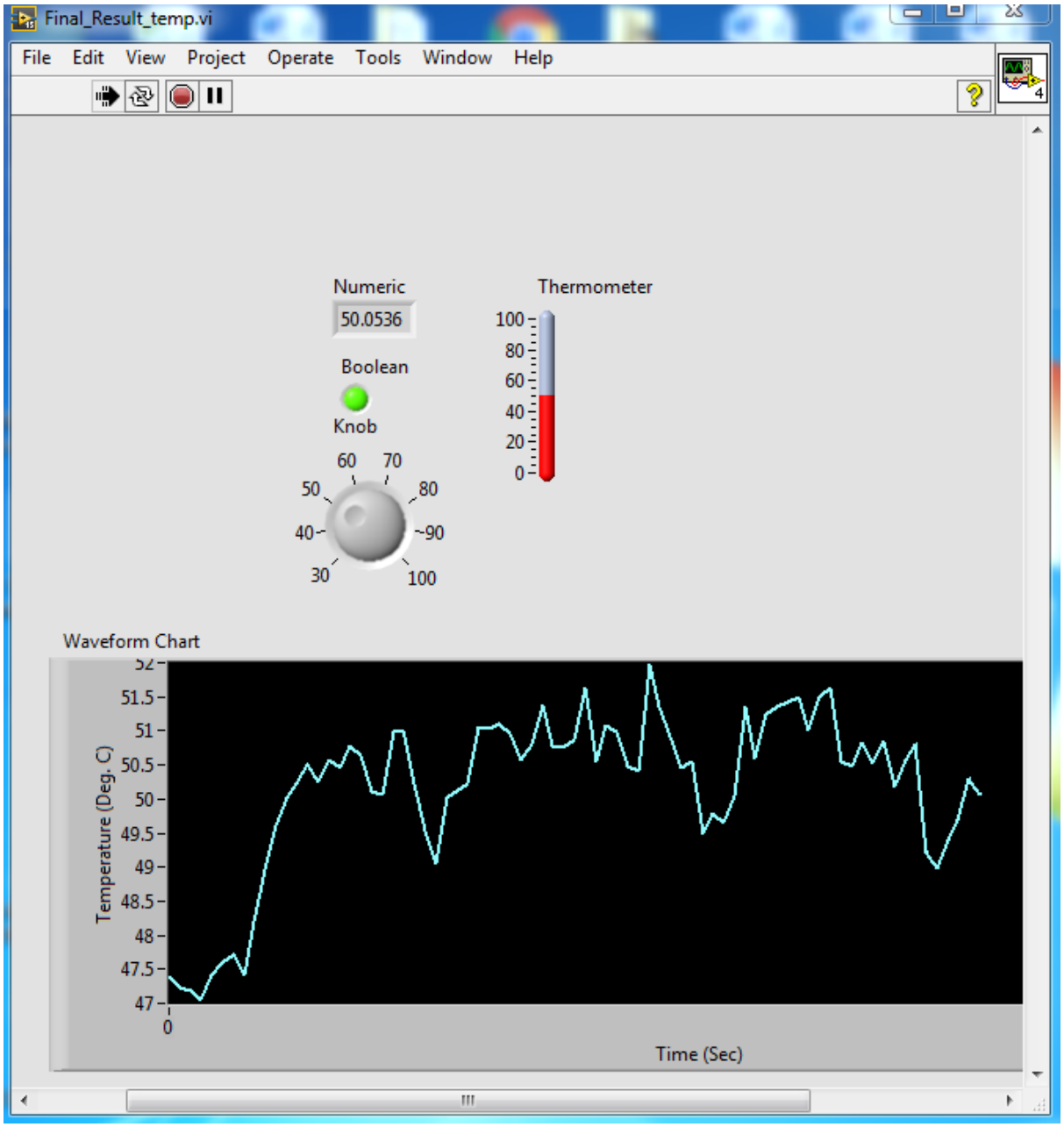


Fig. 23:Output waveform of operation of relay at 50.08°**C** temperature set point

In this case ,we take set point temperature as 50.08°**C**. This means as soon as the temperature rises above 50.08°**C**,the relay goes to OFF position and the water does not get supply.Again, when the temperature falls below 50.08°**C**,the relay goes to ON position and the temperature vs Time characteristics are shown above as the relay operates continuously and various temperature points are recorded .the last recorded temperature is 50.0536°**C**(ON position) as shown above.

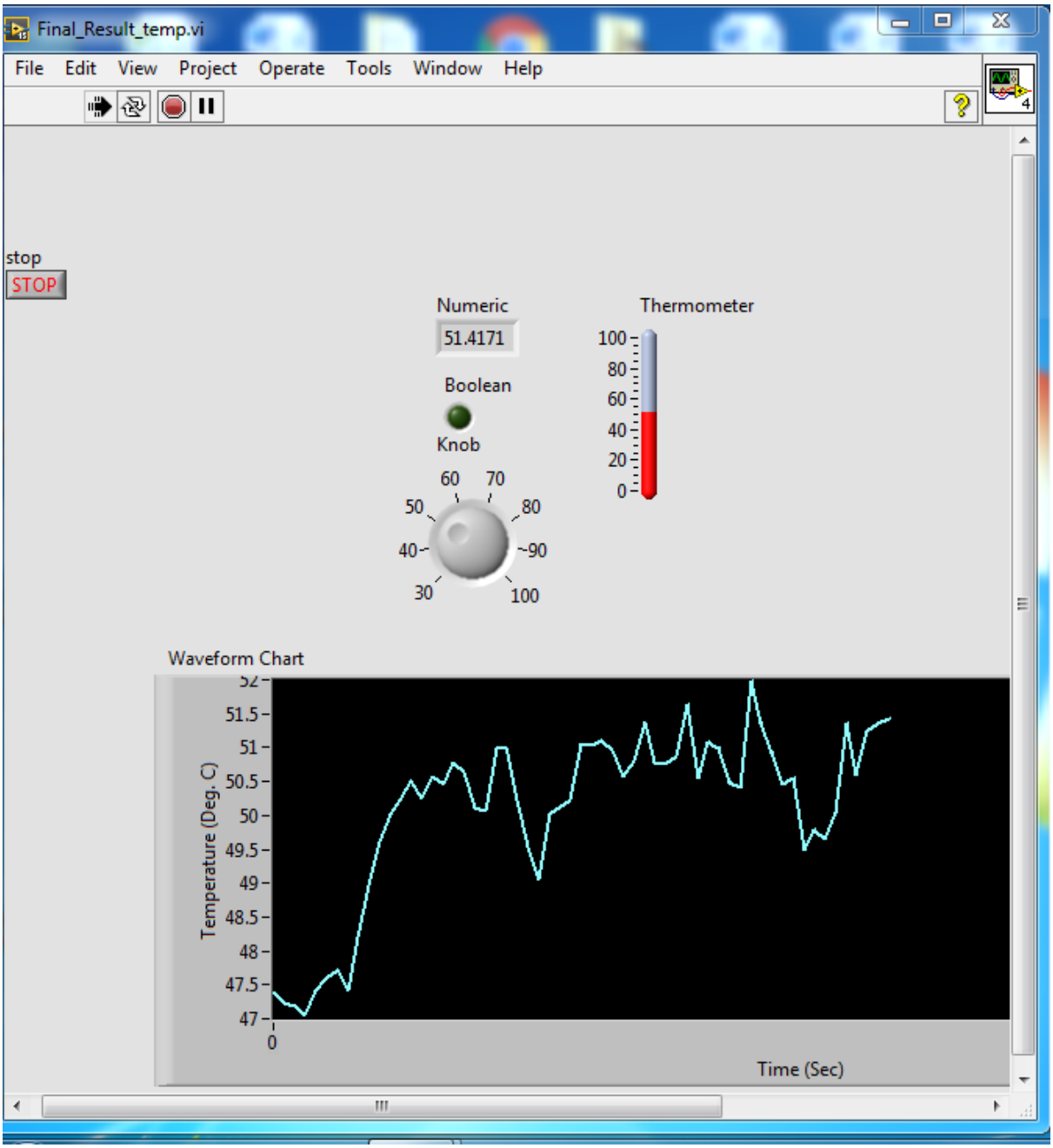


Fig.24:Output waveform of operation of relay at 50.08°**C** temperature set point

In this case ,we take set point temperature as 50.08°**C**. This means as soon as the temperature rises above 50.08°**C**,the relay goes to OFF position and the water does not get supply.Again, when the temperature falls below 50.08°**C**,the relay goes to ON position and the temperature vs Time characteristics are shown above as the relay operates continuously and various temperature points are recorded .the last recorded temperature is 51.4171°**C**(OFFposition) as shown above.

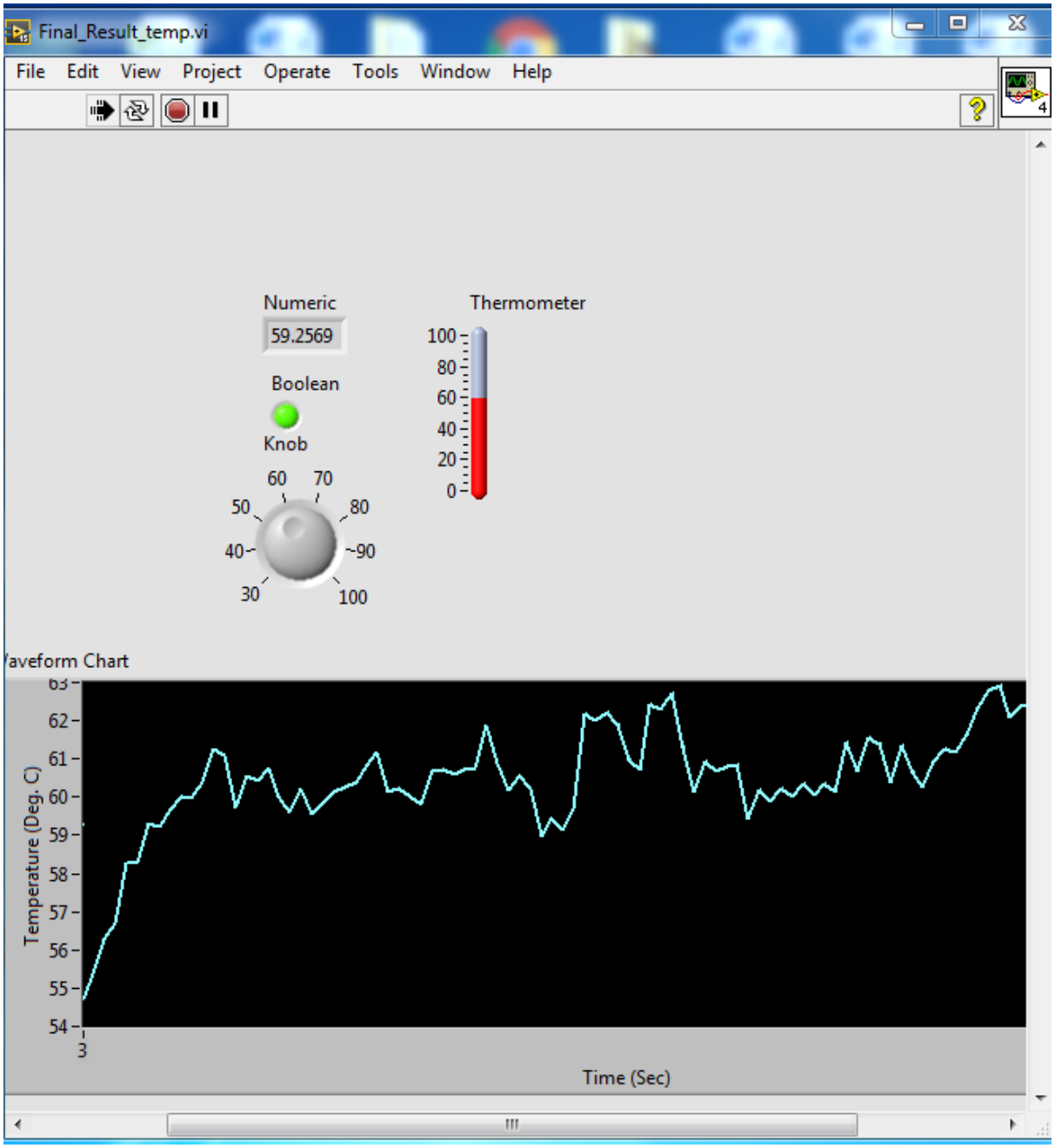


Fig.25:Output waveform of operation of relay at 60.17°**C** temperature set point

In this case ,we take set point temperature as 60.17°**C**. This means as soon as the temperature rises above 60.17°**C**,the relay goes to OFF position and the water does not get supply.Again, when the temperature falls below 60.17°**C**,the relay goes to ON position and the temperature vs Time characteristics are shown above as the relay operates continuously and various temperature points are recorded .the last recorded temperature is 59.2569°**C**(ON position) as shown above.

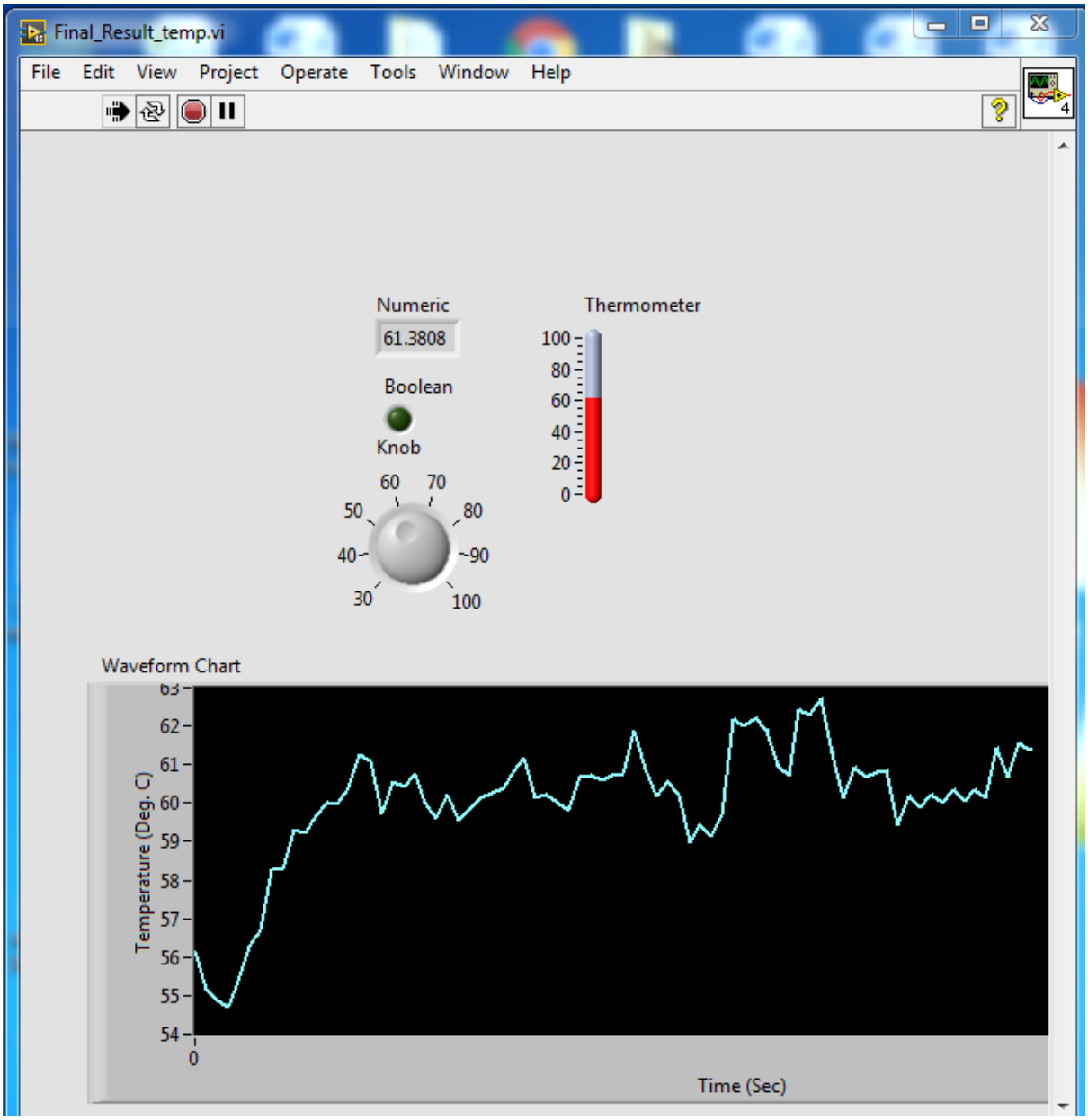


Fig.26:Output waveform of operation of relay at 60.17°**C** temperature set point

In this case ,we take set point temperature as 60.17°**C**. This means as soon as the temperature rises above 60.17°**C**,the relay goes to OFF position and the water does not get supply.Again, when the temperature falls below 60.17°**C**,the relay goes to ON position and the temperature vs Time characteristics are shown above as the relay operates continuously and various temperature points are recorded .the last recorded temperature is 61.3808°**C**(OFF position) as shown above.

10.*CONCLUSION*

With virtual instrument being the platform & the shortcoming of traditional temperature

Control system, this thesis combines graphical programming language LabVIEW & the basic

Principles of auctioneering control to conduct temperature control.

Heater is used and the temperature of water is controlled by ON and OFF the heater using relay.

The IC based temperature sensor LM-35 is employed to measure the temperature of the water. The LabVIEW is used to show the indication of the temperature reading and Its graphical display. For multiple set point temperature the ON-OFF control action has been

Observed and displayed in LabVIEW. It has been found that the temperature of the heating

Substance is controlled successfully but with high differential gap.This project can be employed for domestic water heating system.

11. *FUTURE SCOPE AND LIMITATIONS*

.It has been observed that the ON-OFF control of temperature against a set point is Not a fine control. The differential gap is high. To reduce this differential gap continuous Mode of control, PID controller can be designed.

.Instead of using LabVIEW VI the whole project can be implemented with hardware Components as the cost of the equipments for LabVIEW is very high.

*12. **APPENDIX A***

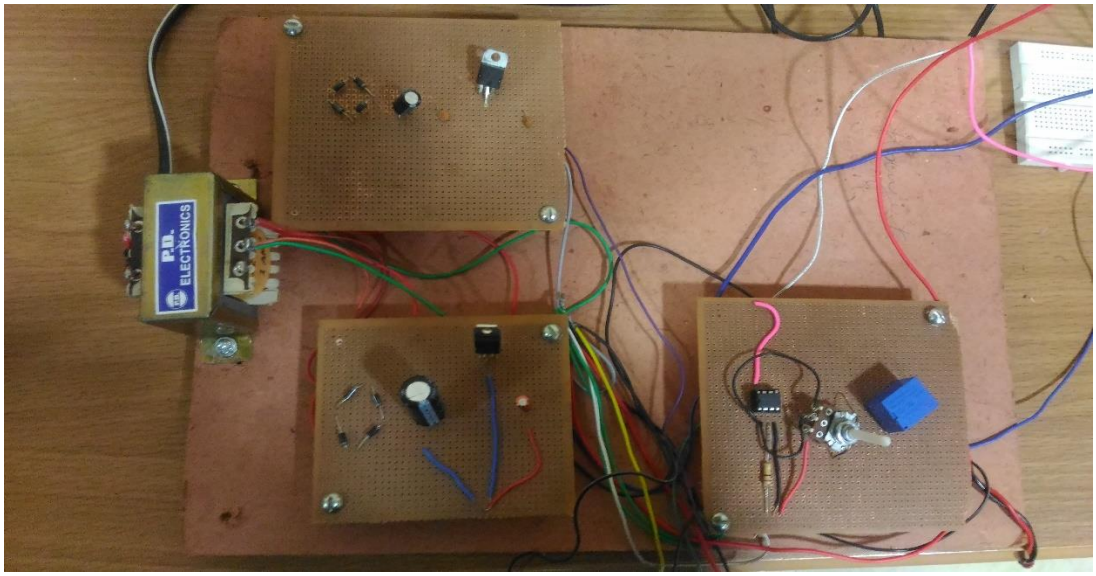


Fig.27:Hardware representation of LabVIEW based circuit

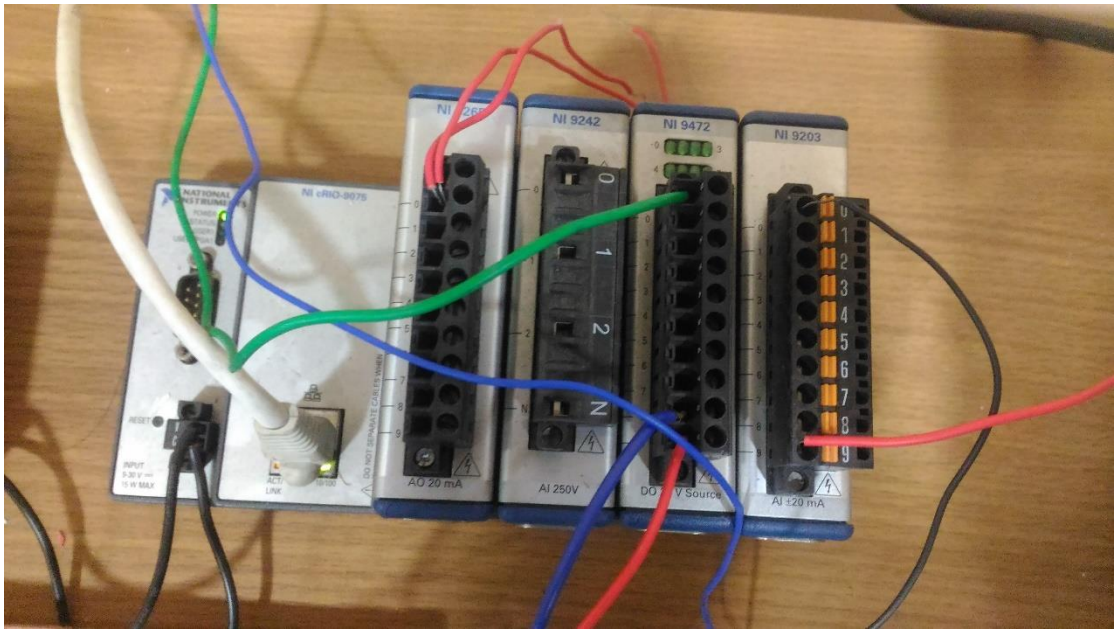


Fig. 28:NI 9203 (Analog input card) & NI 9472 (Output digital card)

13. ***REFERENCE***

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