A

MINI PROJECT REPORT ON

TRIAC POWER CONTROL MODEL

SUBMITTED TO SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE

IN THE PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE COMPLTION OF MINI PROJECT

OF

THIRD YEAR ENGINEERING

IN

ELECTRONICS & TELECOMMUNICATION

BY

KEDAR PRABHAKAR DHERE	**T120233061**
PRATIK AVINASH JOSHI	**T120233111**

UNDER THE GUIDANCE OF

PROF. R. S. GUTTE

Sinhgad Institutes

DEPARTMENT OF ELECTRONICS & TELECOMMUNICATION ENGINEERING,

SINHGAD COLLEGE OF ENGINEERING,

S. No. 44/1, OFF SINHGAD ROAD,

VADGAON (BK), PUNE – 411041

APRIL 2016

CERTIFICATE

This is to certify that the Mini Project entitled

TRIAC POWER CONTROL MODEL

submitted by

KEDAR PRABHAKAR DHERE	**T120233061**
PRATIK AVINASH JOSHI	**T120233111**

This is a bonafide work carried out by us under the supervision of **Prof. R. S. GUTTE** and it is approved for the partial fulfillment of the requirements of T.E. Engineering submitted to Savitribai Phule Pune University, Pune.

The Mini Project work has not been earlier submitted to any other institute or university for the award of degree or diploma.

Prof. R. S. Gutte	**Dr. M. B. Mali**	**Dr. S. D. Lokhande**
Guide	Head	Principal
Department of E&TC	Department of E&TC	SCOE, Pune

Place: PUNE

Date:

ACKNOWLEDGEMENT

We are feeling very humble in expressing our gratitude. It will be unfair to bind the precious help and support which we got from many people in few words. It would be our pride to take this opportunity to express our gratitude.

First of all, we would thank our beloved guide **Prof. R. S. Gutte** for his valuable guidance, patience and support. He has constantly helped us with his technical expertise and we were lucky to be backed with his continuous motivation. He has always given us freedom to do mini project work and the chance to work under his supervision.

We would like to thanks **Dr. M. B. Mali, Head, Department of E&TC,** for his constant encouragement and valuable suggestions. He always remains a source of inspiration for us to work hard and with full dedication. We would like to express our sincere gratitude to **Dr. S. D. Lokhande, Principal**, for his guidance and support.

We are thankful to all teacher fraternity of SCOE, E&TC Department. We are also helpful to lab assistants for helping us entire during project work.

Finally, it is the love, blessings and support of our family members and friends which drove us to complete this mini project work.

Thank you all!

KEDAR PRABHAKAR DHERE

PRATIK AVINASH JOSHI

Table of Contents

CHAPTER 1 – INTRODUCTION 1

1.1 Background 2

1.2 Brief about this Mini Project 5

1.3 Block Diagram 5

1.4 Basic Principle 6

1.5 Software used for this Mini Project 6

1.6 Hardware used for this Mini Project 7

1.7 Organization of this Mini Project Report 7

CHAPTER 2 – LITERATURE REVIEW 8

CHAPTER 3 – DESIGN AND DEVELOPMENT 11

3.1 Interfacing Diagram 12

3.2 Pin Description 12

3.3 Circuit Diagram 13

3.4 Brief Description and Working 14

3.5 Component Description 15

3.5.1 PIC16F877A (Microcontroller) 15

3.5.2 IC 4N25 (Phototransistor Coupler) 16

3.5.3 IC MOC3021 (Optoisolator) 16

3.5.4 BT139 (TRIAC) 17

CHAPTER 4 – RESULTS 18

4.1 Algorithm 19

4.2 Flowchart 20

4.3 Simulation Results 21

4.4 Hardware Testing 23

4.5 PCB Layout 25
CHAPTER 5 – CONCLUSION AND FUTURE SCOPE 26
5.1 Advantages 27
5.2 Disadvantages 27
5.3 Applications 27
5.4 Conclusion 28
5.5 Future Scope 28
REFERENCES 29
APPENDIX (DATA SHEETS) 30

List of Figures

Figure 1.1: Block Diagram of Overall System 5
Figure 3.1: Interfacing Diagram 12
Figure 3.2: Circuit Diagram of Mini Project Circuit 13
Figure 3.5.1: PIC16F877A Microcontroller IC 15
Figure 3.5.2: Pin Configuration of IC 4N25 16
Figure 3.5.3: Pin Configuration of IC MOC3021 16
Figure 3.5.4: Pin Configuration of BT139 TRIAC 17
Figure 4.2: Flowchart 20
Figure 4.3.1: Circuit Diagram (Proteus Simulation) 21
Figure 4.3.2: Simulation Result (Condition – 1) 22
Figure 4.3.3: Simulation Result (Condition – 2) 22
Figure 4.5: PCB Layout 25

List of Table

Table 3.1: Pin Sescription 12

List of Photographs

Photograph 4.4.1: Hardware Testing Setup 23
Photograph 4.4.2: Hardware Testing - 1 24
Photograph 4.4.3: Hardware Testing - 2 24

CHAPTER 1 – INTRODUCTION

1.1 Background

1.1.1 TRIAC

TRIAC (triode for alternating current) is a generic trademark for a three terminal electronic component that conducts current in either direction when triggered. Its formal name is bidirectional triode thyristor or bilateral triode thyristor. A thyristor is analogous to a relay in that a small voltage and current can control a much larger voltage and current.

TRIACs are a subset of thyristors and are related to silicon controlled rectifiers (SCRs). TRIACs are bidirectional and conduct current in both directions. Another difference is that SCRs can only be triggered by a positive current at their gate, but, in general, TRIACs can be triggered by either a positive or negative current at their gate, although some special types cannot be triggered by one of the combinations. To create a triggering current for an SCR a positive voltage has to be applied to the gate but for a TRIAC either a positive or negative voltage can be applied to the gate. In all three cases the voltage and current are with respect to one main terminal. Once triggered, SCRs and thyristors continue to conduct, even if the gate current ceases, until the main current drops below a certain level called the holding current. Firing angle of any thyristor is simply the reference to the voltage level at which the SCR is turned on. This can be done by sending a precisely timed pulse into SCR Gate to begin conduction at the desired voltage level.

TRIACs bidirectionality makes them convenient switches for alternating-current (AC). In addition, applying a trigger at a controlled phase angle of the AC in the main circuit allows control of the average current flowing into a load (phase control). This is commonly used for controlling the speed of induction motors, dimming lamps, and controlling electric heaters.

1.1.2 Application of TRIAC

Low-power TRIACs are used in many applications such as light dimmers, speed controls for electric fans and other electric motors, and in the modern computerized control circuits of many household small and major appliances.

When mains voltage TRIACs are triggered by microcontrollers, optoisolators are frequently used; for example opto-TRIACs can be used to control the gate current. Alternatively, where safety allows and electrical isolation of the controller isn't necessary, one of the microcontroller's power rails may be connected one of the mains supply. In these situations it is normal to connect the neutral terminal to the positive rail of the microcontroller's power supply, together with A1 of the TRIAC, with A2 connected to the live. The TRIAC's gate can be connected through a resistor, and sometimes a transistor to the microcontroller, so that bringing the voltage down to the microcontroller's logic zero pulls enough current through the TRIAC's gate to trigger it. This ensures that the TRIAC is triggered in quadrants II and III and avoids quadrant IV where TRIACs are typically insensitive.

1.1.3 Switches

In electrical engineering, a switch is an electrical component that can break an electrical circuit, interrupting the current or diverting it from one conductor to another. The mechanism of a switch may be operated directly by a human operator to control a circuit (for example, a light switch or a keyboard button), may be operated by a moving object such as a door-operated switch, or may be operated by some sensing element for pressure, temperature or flow. A relay is a switch that is operated by electricity. Switches are made to handle a wide range of voltages and currents; very large switches may be used to isolate high-voltage circuits in electrical substations.

1.1.4 Electronic Switches

A relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching-often a silicon-controlled rectifier or TRIAC.

The analogue switch uses two MOSFET transistors in a transmission gate arrangement as a switch that works much like a relay, with some advantages and several limitations compared to an electromechanical relay.

The power transistor(s) in a switching voltage regulator, such as a power supply unit, are used like a switch to alternately let power flow and block power from flowing.

Many people use metonymy to call a variety of devices "switches" that conceptually connect or disconnect signals and communication paths between electrical devices, analogous to the way mechanical switches connect and disconnect paths for electrons to flow between two conductors. Early telephone systems used an automatically operated Strowger switch to connect telephone callers; telephone exchanges contain one or more crossbar switches today.

Since the advent of digital logic in the 1950s, the term *switch* has spread to a variety of digital active devices such as transistors and logic gates whose function is to change their output state between two logic levels or connect different signal lines, and even computers, network switches, whose function is to provide connections between different ports in a computer network. The term 'switched' is also applied to telecommunications networks, and signifies a network that is circuit switched, providing dedicated circuits for communication between end nodes, such as the public switched telephone network. The common feature of all these usages is they refer to devices that control a binary state: they are either on or off, closed or open, connected or not connected.

Today, electronics is used in home appliances for wide purposes including the motor regulation of a washing machine, the control of a vacuum cleaner, the light dimming of a lamp or the eating in a coffee machine etc. This pervasion increases rapidly because appliances require enhanced features, easy to build and modify as electronics based solutions become cheaper and more sophisticated. Within this evolution, the microcontrollers (MCU) progressively replace analog controllers and discrete solutions even in low cost applications. They are more flexible, often need less components and provide faster time to market. With an analog IC, the designer is limited to a fixed function frozen inside the device. Remote control facilitates variety of operation around the home or office from a distance such as fan regulators and mains power supply. It provides a system that is easy to understand and also to operate, a system that would be cheap and affordable, reliable and easy to maintain the system of remote control and offers long durability. It adds more comfort to everyday living by removing the inconvenience of having to move around to operate a fan regulator.

1.2 Brief about this Mini Project

Today, to turn on/off various electrical appliances, different types of mechanical switches are used. We have to press, push or apply certain amount of pressure to turn them on/off. This process can be done wirelessly by using remote control i.e. with a wireless module. This will help to eliminate mechanical switchboards and to avoid wiring & other related disadvantages. This will also reduce human efforts and will provide one of the cheapest way to wirelessly control the appliances. The proposed model in this mini project aims to achieve wireless switching (turning on & off) of electrical appliances by using suitable control signal (IR, RF, etc.).

1.3 Block Diagram

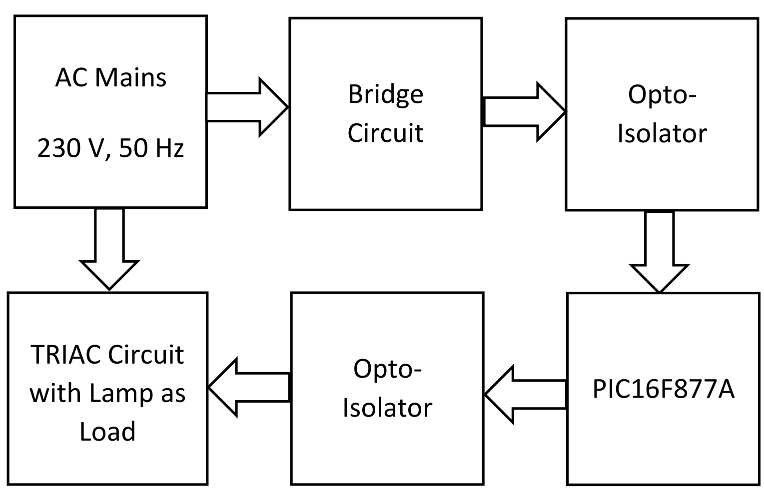


Figure 1.1: Block Diagram of Overall System

1.4 Basic Principle

Input to the module will be the 230 V, 50 Hz AC Mains supply. This will be applied to the step down transformer to step down the voltage level. Then this stepped down signal is applied to the bridge rectifier circuit. Bridge rectifier will convert the ac signal into pulsating dc signal. Here center tapped full wave rectifier is avoided so as to avoid its further disadvantages. Also the diodes in center tapped rectifier require more PIV (Peak Inverse Voltage) rating as compared to the bridge rectifier and the cost of center tapped transformer is also high. Thus here in this circuit bridge rectifier is used. Now this pulsating dc signal is applied to voltage regulator block. Voltage regulator IC is used so that stable dc supply is available at its output. This dc supply will be used for microcontroller as supply voltage.

Now power circuit is comprised of ac mains supply, bulb as load, and the TRIAC. The control circuit consists of micro controller and optoisolators. Here two opto-isolators are used. First one is used to check zero crossing signal from bridge rectifier output thus it will isolate high voltage pulsating dc circuit from microcontroller circuit. The second isolator is used to electrically isolate control circuit from actual power circuit in which load connected in series with ac mains and TRIAC. This isolator will accept control signal from microcontroller depending on zero crossing signal and other designed parameters and will supply gate pules to gate of TRIAC. When TRIAC receives gate pulse it will be triggered and will act as a closed circuit with minimal resistance. Thus load circuit gets completed and bulb glows according to the firing angle of gate pulses. This firing angle i.e. the time delay from which TRIAC receives forward biasing and the instant at which it receives or it is provided with gate pulses, can be varied by varying delay between zero crossing signal and control signal from microcontroller.

1.5 Software used for the Mini Project

1. MPLAB IDE for programming of PIC-16F877A
2. XC-8 Compiler
3. PIC kit 3 programmer for dumping code into microcontroller.

4. Proteus for simulation
5. Eagle for PCB Design

1.6 Hardware used for the Mini Project

1. PIC16F877A Microcontroller
2. 4N25 and MOC3021 Opto-isolators
3. BT139 TRIAC
4. 1N4007 diodes, resistors
5. Breadboard (for hardware testing)
6. Personal computer / laptop and PIC programmer kit (for dumping the code into PIC Microcontroller)

1.7 Organization of the Mini Project Report

This report of mini project consists of total six chapters. They are as follows:

Chapter 1 gives introduction, block diagram and basic principle of the mini project.

Chapter 2 comprises of the literature survey.

Chapter 3 gives the details about the design, development and implementation of the project

Chapter 4 consists of the results obtained after simulation and actual implementation.

Chapter 5 gives the conclusion of the mini project and also gives brief information regarding future scope for this concept and overall project model.

Finally references, appendix (data sheets of the components used in this mini project module) are given.

CHAPTER 2 – LITERATURE REVIEW

The literature review for this mini project is based on assessment and study of following key research papers published earlier.

In in the research project ‘Control of Electrical Lights and Fans using TV Remote’ conducted at IIT Bombay, the objective of design project is to build a system for controlling light intensity of an electrical bulb or speed of fan using a TV remote or using serial port interface. Intensity/speed of the load is controlled by changing the RMS voltage across the load using TRIAC circuitry that is by changing the corresponding firing angle at the gate of the TRIAC. [1]

The authors concluded that intensity of a bulb and speed of the fan can be controlled in 8 different levels including ON and OFF using a TV Remote or a Serial port interface. The level at which different loads are operating is displayed on a LCD.

According to the research paper ‘Low-Cost Electric Range Control Using a TRIAC’, Microchip Technology Inc., a low-cost microcontroller-based replacement for the mechanical thermostat which eliminates certain drawbacks. [2]

The conclusion of the research paper is as follows:

The PIC10F204 thermostat implemented in this application note has many benefits over the adjustable mechanical thermostat it is designed to replace. These benefits include:

1. Better reliability due to minimal mechanical components.

2. Built in safety features like automatic shutdown.

3. Built in visual feedback to let the user know when the unit is on.

4. Flexible design and programmability via In-Circuit Serial Programming™ (ICSP™) (i.e., the same switch can be used in multiple applications).

5. Increased accuracy and good simmer performance.

The research paper ‘Microcontroller Based IR Remote Control Signal Decoder for Home Application’, Pelagia Research Library Advances in Applied Science Research, describes a design and implementation of an infrared (IR) remote control signal decoder which can be used for various home control applications. For a demonstration they have designed remote controlled fan regulator and ON-OFF power supply switch. The entire system is based on microcontroller that makes the control system smarter and easy to modify for other applications. [3]

The authors conclude as, IR remote control signal decoder is implemented using microcontroller and its application is successfully demonstrated for home applications. The system is quite cheap, reliable and easy to operate.

CHAPTER 3 – DESIGN AND DEVELOPMENT

The design process of this module started from conceptualizing the main idea behind the project. This project aims to achieve power control at the output of the TRIAC by controlling the gate supply of it.

3.1 Interfacing Diagram

Following figure shows interfacing diagram of the project module. The inevitable connections such as Vcc, Vss, ground, crystal, etc. are not shown in this diagram.

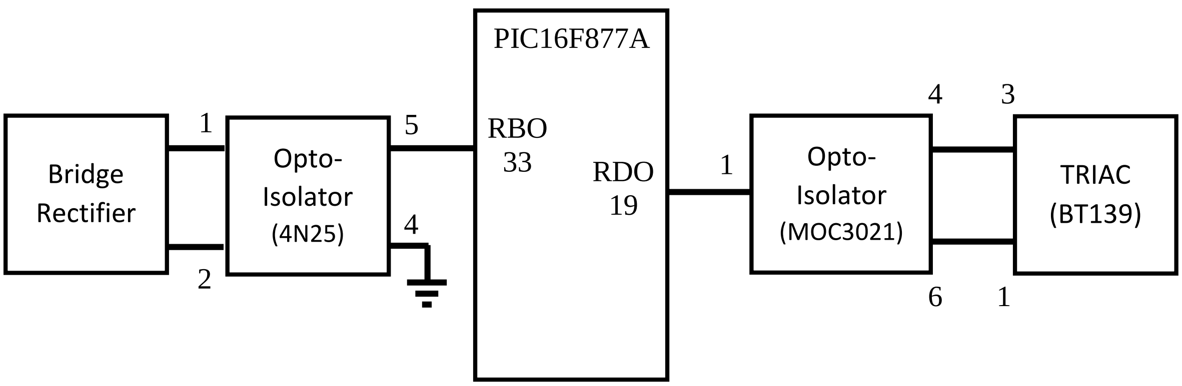


Figure 3.1: Interfacing Diagram

3.2 Pin Description

Table 3.1: Pin description

Pin Details / Pin Number	**Description**
1. Optoisolator (4N25)	
1	Anode (A)
2	Cathode (C)
4	Emitter (E)
5	Collector (C)

2. Microcontroller (PIC16F877A)	
33	PORTB.0
19	PORTD.0
3. Optoisolator (MOC3021)	
1	Anode
4	Main Terminal
6	Main Terminal
4. TRIAC (BT139)	
1	Main Terminal 1
3	Gate

3.3 Circuit Diagram

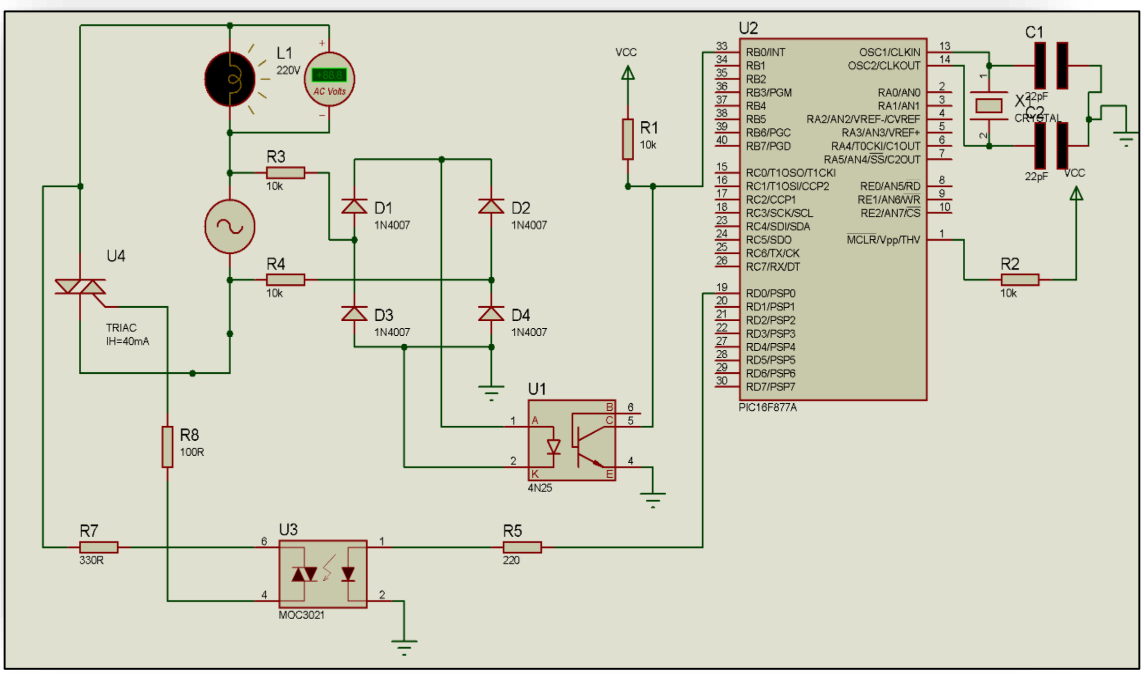


Figure 3.2: Circuit Diagram of the Mini Project Circuit

3.4 Brief Description and Working

The above circuit consist of two pats, control circuit and power circuit.

Initially zero crossing of the output of the bridge rectifier is to be sensed and further it should be given to microcontroller. Hence to isolate high voltage rectifier circuit from low power microcontroller circuit the opto-isolator U1 (4N25) is used as shown in the circuit diagram. When rectifier signal crosses zero value then diode in 4N25 is forward biased which provides positive base signal to the transistor. Thus transistor acts as closed switch and current flows across it. Now initially as this transistor is off the voltage at pin RB0 of microcontroller is high, but as soon as it starts acting like a closed switch the voltage at this pin falls. Microcontroller is programmed to sense this falling edge on pin RB0 as it is the external interrupt pin to PIC16 microcontroller. Then specific amount of delay is set in the microcontroller. After this specified delay microcontroller gives a pulse on pin RD0. This pulse is then provided to second opto-isolator MOC3021. This isolator accepts the pulse from microcontroller and isolates the gate circuitry of TRIAC from microcontroller control circuitry. In this way the control signal is provided to gate of the TRIAC from the microcontroller.

When module is on the ac mains supply is provided across the TRIAC. Thus TRIAC is given required biasing voltage as soon as the circuit is powered on. According to working principle of TRIAC it waits for the gate pulse which fires i.e. turns on the TRIAC. As explained in above paragraph MOC3021 provides positive gate supply to TRIAC and then TRIAC is fired. It starts conducting as soon as it receives the gate supply and acts as a short circuit with very minimum resistance. Thus the circuit between the bulb, which is connected as a load, and mains supply gets completed. So the bulb glows according to the level of power delivered to it.

This power level is dependent on the firing angle of the TRIAC which is ultimately decided by microcontroller after receiving external interrupt signal from zero crossing detector.

In this way the overall working of the circuit diagram can be explained.

3.5 Component description:

3.5.1 PIC16F877A (Microcontroller)

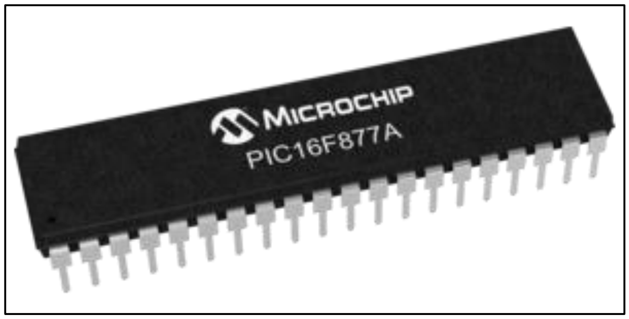


Figure 3.5.1: PIC16F877A Microcontroller IC

PIC16F877 is a powerful (200 nanosecond instruction execution) microcontroller. It is easy-to-program (only 35 single word instructions) CMOS FLASH-based 8-bit microcontroller which packs Microchip's powerful PIC® architecture into 40- or 44-pin package. The PIC16F877A features 256 bytes of EEPROM data memory, self-programming, an ICD, 2 Comparators, 8 channels of 10-bit Analog-to-Digital (A/D) converter, 2 capture/compare/PWM functions, the synchronous serial port can be configured as either 3-wire Serial Peripheral Interface (SPI™) or the 2-wire Inter-Integrated Circuit (I^2C™) bus and a Universal Asynchronous Receiver Transmitter (USART). All of these features make it ideal for more advanced level A/D applications in automotive, industrial, appliances and consumer applications.

Features of PIC16F877A which are used in this project in some way or the other are:

i. High-performance RISC CPU: Operating speed is 20Mhz. Operating voltage is 4.0-5.5 Volts. Its industrial temperature range is -40 to +85 degrees. It has 35 single word instructions

ii. Special Microcontroller Features: It has flash memory of 14.3 KB (8192 words). It has data SRAM of 368 bytes. It is available with data EEPROM of 256 bytes. It is also provided with selectable oscillator options.

iii. Peripheral Features: PIC16F877A has 33 I/O pins and 5 I/O ports

3.5.2 IC 4N25 (Phototransistor Coupler)

The 4N25 family is an industry standard single channel phototransistor coupler. Each opto-coupler consists of gallium arsenide infrared LED and a silicon NPN phototransistor.

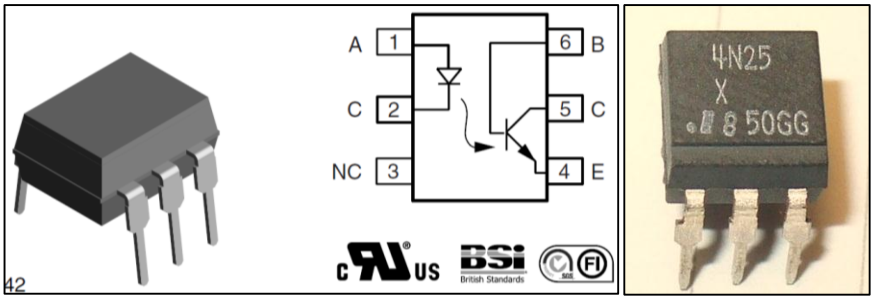


Figure 3.5.2: Pin Configuration of IC 4N25

Features of 4N25 opto-coupler are: its isolation test voltage is 5000 VRMS, it can be interfaced with common logic families, it is available in industry standard dual-in-line 6 pin package. Applications of this IC includes AC mains detection, Reed relay driving, Switch mode power supply feedback, Telephone ring detection, Logic ground isolation, Logic coupling with high frequency noise rejection

3.5.3 IC MOC3021 (Optoisolator)

MOC3021 is an opto-coupler designed for triggering TRIACS. By using this we can trigger anywhere in the cycle, so can call them as non-zero opto-coupler. It comes in 6-pin DIP shown in figure.

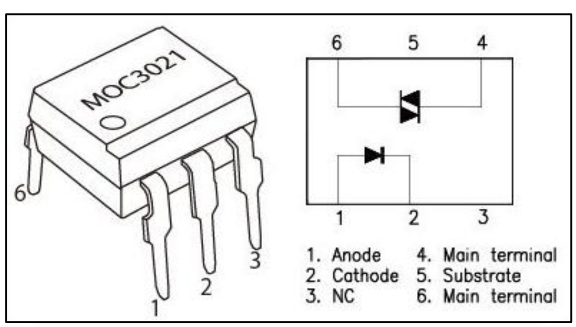


Figure 3.5.3: Pin Configuration of IC MOC3021

Features of MOC3021 are as follows.

- Peak blocking voltage - 400 V
- Gallium-Arsenide-Diode Infrared Source and Optically-Coupled Silicon TRIAC Driver (Bilateral Switch)
- Standard 6-Terminal Plastic DIP

Some of the applications of MOC3021 are solenoid / valve controls, static AC sower switch, lamp ballasts, solid state relays, incandescent lamp dimmers, motor controls, etc.

3.5.4 BT139 (TRIAC)

Planar passivated sensitive gate four quadrant TRIAC in a SOT78 (TO-220AB) plastic package intended for use in applications requiring high bidirectional transient and blocking voltage capability and high thermal cycling performance. Typical applications include motor control, industrial and domestic lighting, heating and static switching. This sensitive gate "series E" TRIAC is intended to be interfaced directly to microcontrollers, logic integrated circuits and other low power gate trigger circuits.

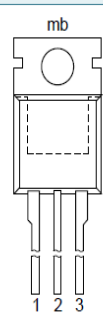
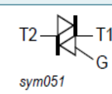
Pin	Symbol	Description	Simplified outline	Graphic symbol
1	T1	main terminal 1	 TO-220AB (SOT78)	
2	T2	main terminal 2		
3	G	gate		
mb	T2	mounting base; main terminal 2		

Figure 3.5.4: Pin Configuration of BT139 TRIAC

Features and benefits of BT139 TRIAC are: it can be direct triggered from low power drivers and logic ICs, it has high blocking voltage capability, and it is planar passivated for voltage ruggedness and reliability.

CHAPTER 4 – RESULTS

Turning on of the TRIAC can be controlled by controlling the gate drive provided to it. In this project we have tried to fulfill our set objectives. When module is given ac supply, first zero crossing signal generated external interrupt for microcontroller and then we have set particular delay so that after that set amounts of delay microcontroller will provide output pulse.

The delay for the above purpose is provided via programming microcontroller using inbuilt delay function. Here we have tried hard to get accurate delay and so the firing of the TRIAC. Thus TRIAC turns on accordingly and provides corresponding power to load.

For experimentation process of the project we have followed certain steps. Initially we decided the flow of program, flow of control and power signal. Then we defined the algorithm for the program and according to it the flowchart for the process was drawn.

4.1 Algorithm

The algorithm involved with this mini project module is as follows.

1. Set the direction of pin RB0 as input and pin RD0 as output
2. Set global interrupt enable and external interrupt enable bits
3. Select falling edge for interrupt
4. Wait for falling edge signal on pin RB0
5. After getting falling edge set interrupt flag and wait for set delay
6. Send a short finite duration pulse on pin RD0
7. Clear interrupt flag
8. Go to step 4.

4.2 Flowchart

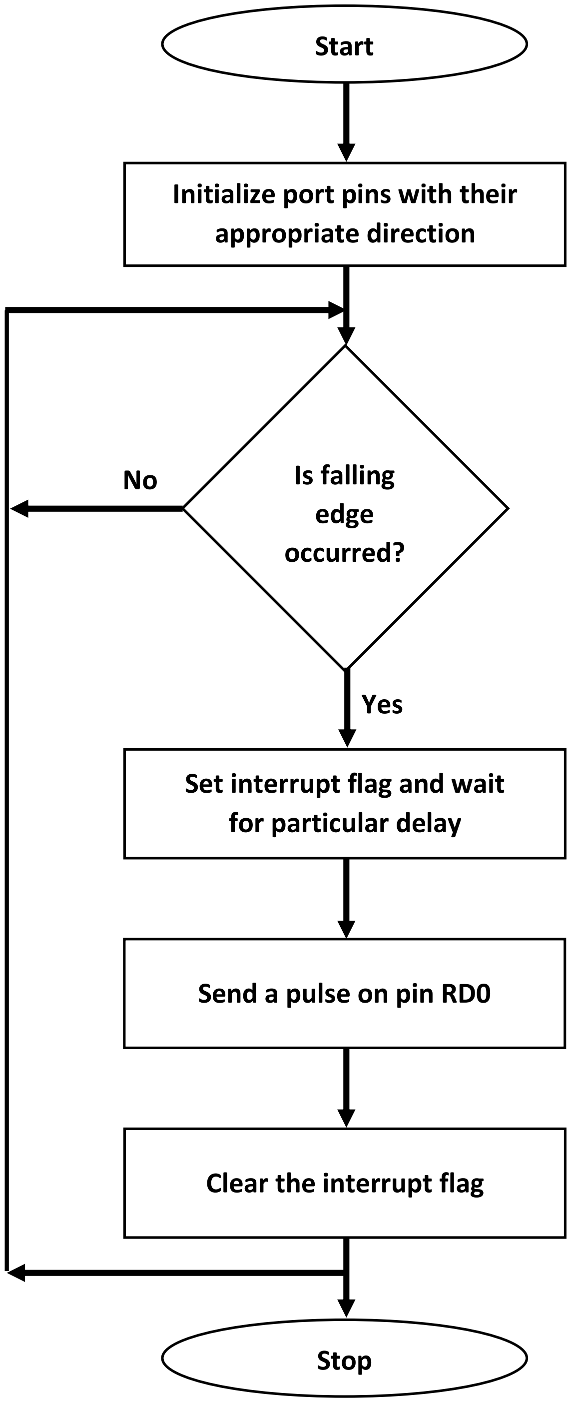


Figure 4.2: Flowchart of the Mini Project

4.3 Simulation Results

First step followed in the experimentation was to implement the proposed circuit model in the simulation software. Here we have used the Proteus Design Suite 8.3 to simulate this project. We have used MPLAB IDE v2.00 and XC8 Compiler to write our program and compile or build the written code respectively.

Following are the screenshots taken while simulating the circuit proposed under this mini project.

Condition 1 is considered for maximum delay and minimum output of around 42 V across bulb. Condition 2 is considered for minimum delay therefore maximum output of around 111V across und bulb.

The circuit diagram for simulation for is as follows.

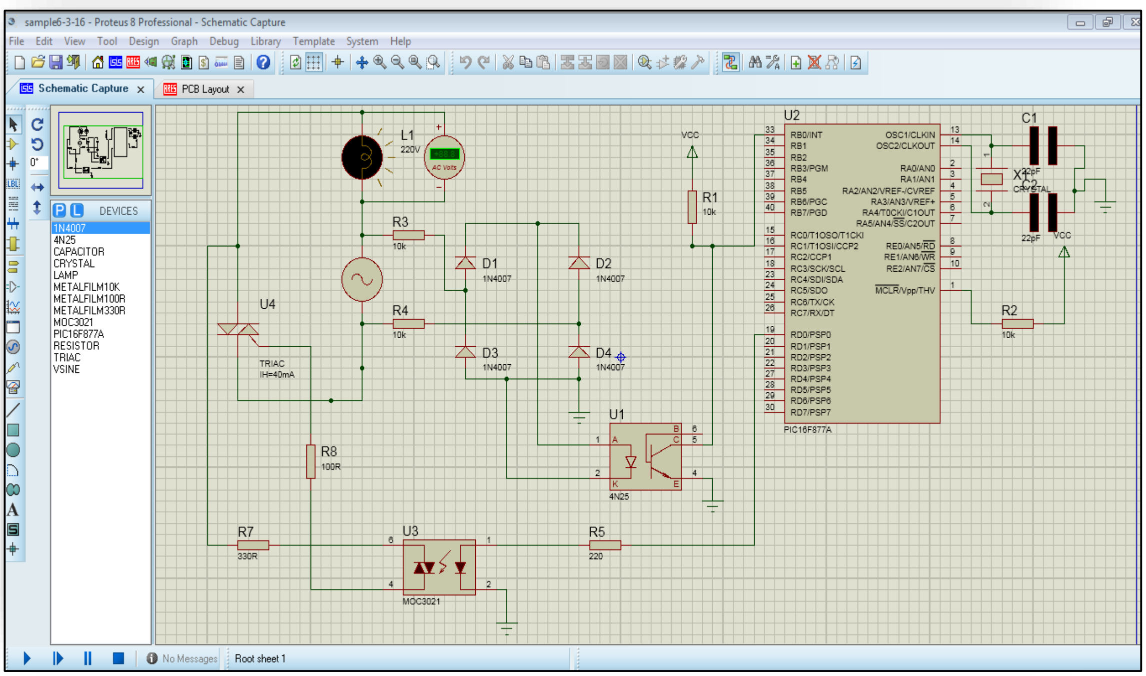


Figure 4.3.1: Circuit Diagram (Proteus Simulation)

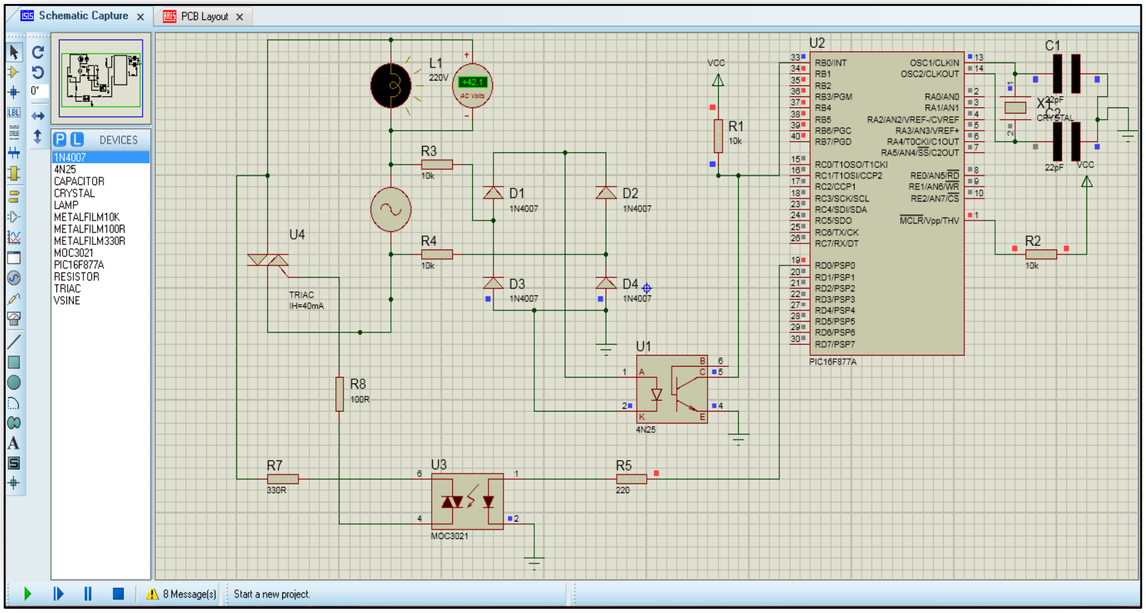


Figure 4.3.2: Simulation Result (Condition – 1)

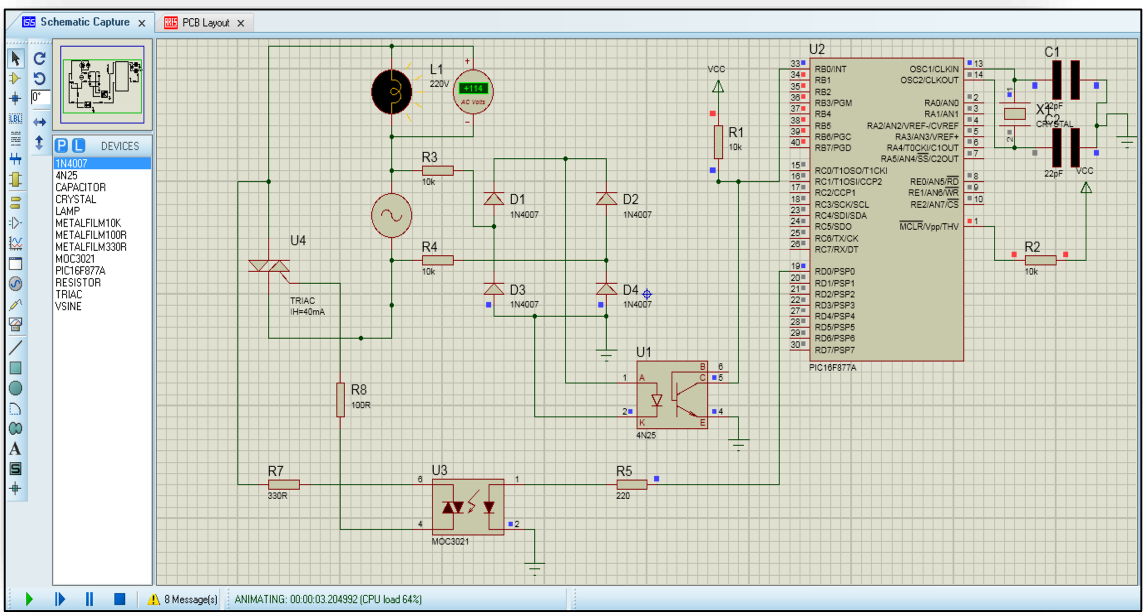


Figure 4.3.3: Simulation Result (Condition – 2)

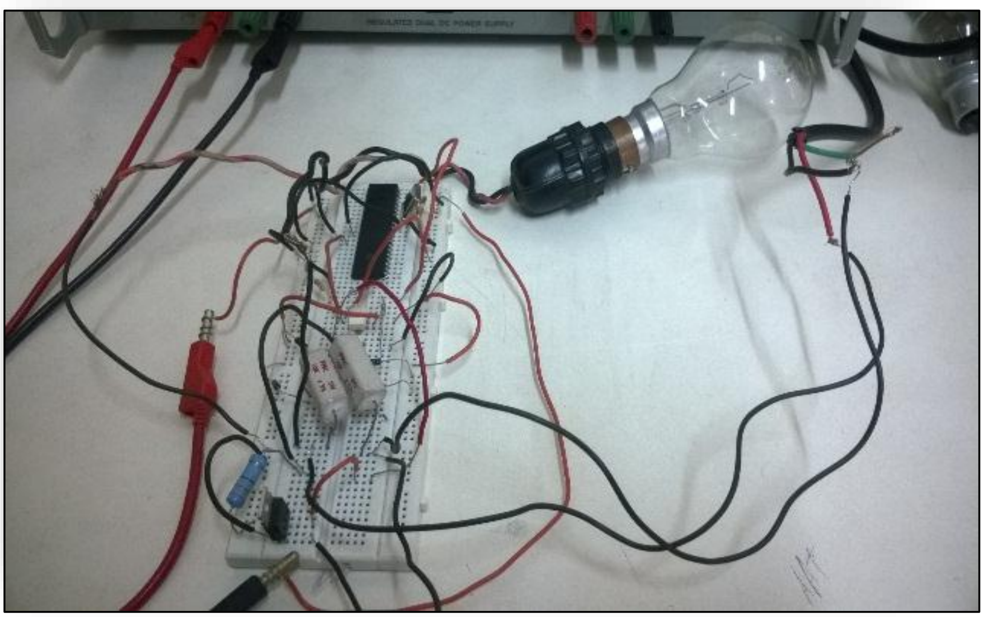
4.4 Hardware Testing

After observing satisfactory results in the simulation step, we moved ahead with the concept to test it on breadboard. Breadboard was selected for hardware testing step based on its simplicity, ease of constructing the circuit on it and moreover all the components are so that they can be mounted on breadboard. All the required components were bought. Here we have used DC Power Supply for providing +5V to microcontroller and ac mains to provide 230V, 50 Hz AC supply for power circuit. Load Used in the testing was 60W bulb.

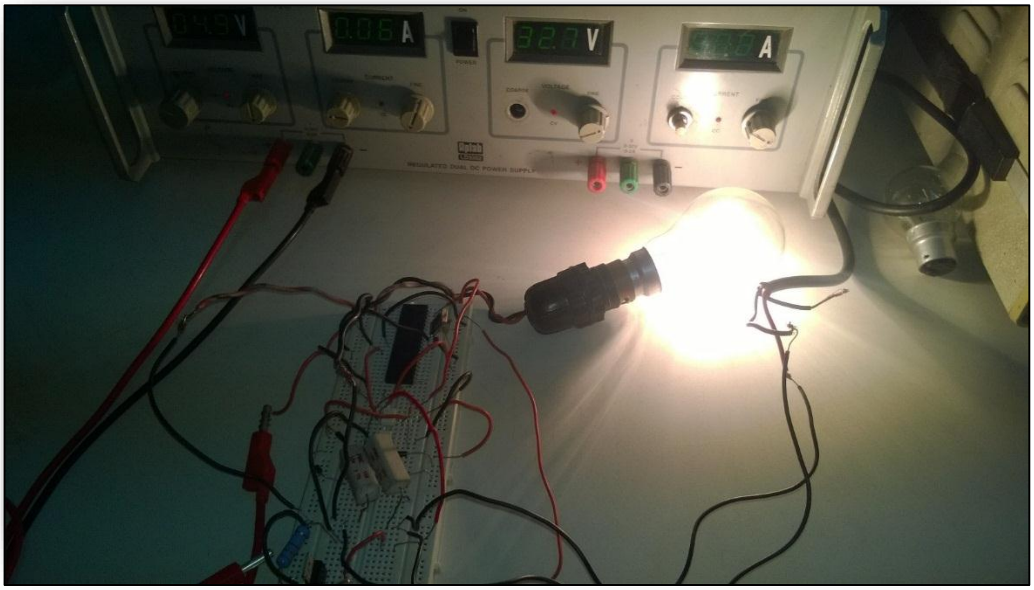
Here power resistors are used (10KΩ, 5W). If normal 1/8W resistors are used excessive current flowing through them. This damages them and makes the circuit unable to work as desired.

While performing hardware testing proper care was taken as far as high voltage power circuit is concerned. While measuring ac voltages across components we took due care about short-circuit and proper mode selection of multi-meters.

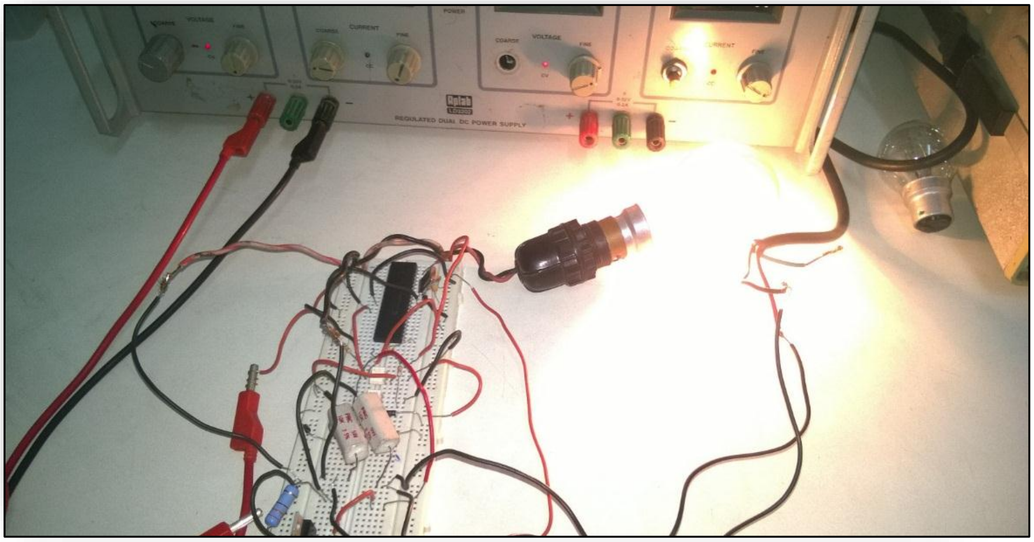
Following photographs show the hardware testing of the project module.



Photograph 4.4.1: Hardware Testing Setup



Photograph 4.4.2: Hardware testing for one delay



Photograph 4.4.3: Hardware testing for the other delay value

The circuit constructed in the designing in this mini project module was implemented successfully with some minor modifications.

4.4 PCB Layout

After successful hardware testing we proceeded towards the building Printed Circuit Board (PCB) layout. Here we have used Eagle software to build PCB Layout.

Eagle's UI is designed with what is called a modal interface. That is, you select one mode, perform it a bunch of times, as opposed to selecting an object and applying a single operation at a time. When used properly, this allows you to work very rapidly, but it can also be a major source of aggravation if you are used to the Windows-y way of doing things.

Eagle has four basic views: Library, Schematic, Board, and Control Panel. Control Panel is the main window, it launches everything else and when you close it, and all subordinate windows get closed. Library allows to manage and edit parts. Schematic is where the schematic for project is drawn. It defines the parts in project, and which pins on the parts should be connected. Board is where layout of the pieces of project is done and the correct pins are physically connected as defined in the Schematic.

The PCB layout of the PCB in this mini project is as shown in following figure.

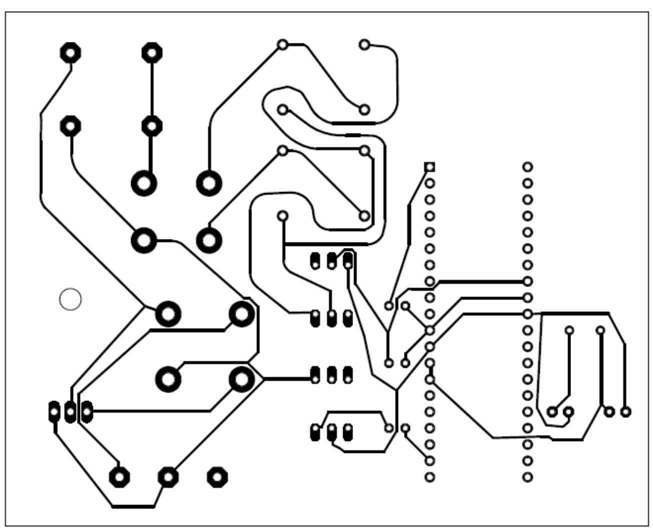


Figure 4.5: PCB Layout

CHAPTER 5 – CONCLUSION AND FUTURE SCOPE

This chapter deals with the advantages and disadvantages related to the model proposed under this mini project title. It also gives brief attention towards the other applications of the main idea behind this mini project. Further, we have concluded all the observations, findings and results into the conclusion point. Finally, this topic gives scope of the mini project and future extension that may be made in this mini project.

5.1 Advantages

The advantages of this project model are as follows:

1. The circuit can be effectively used to control the power delivered to the load by controlling firing angle of TRIAC. Thus controlled rectifier application of TRIAC can be easily achieved using this module.
2. Any type of load can be driven either ac or dc after doing small modifications (if necessary).
3. Automation in power variation is possible using programmable microcontroller. This is the major advantage of using microcontroller in this mini project than using other circuits like IC555, IC784, etc.
4. By using the opto-isolators we have eliminated all the disadvantages of the transformers which are used for isolation of power circuits and control circuits.

5.2 Disadvantages

Some disadvantages of the project model are as follows:

1. If the load changes some modifications are vital.
2. Here we have not been able to dynamically control delay value for firing pulse for TRIAC.
3. Accurate triggering can only be achieved after high precision programming of the microcontroller.

5.3 Applications

1. Controlled Rectifier for driving loads such as light bulb, motors, etc.
2. The module can also be used to step down ac supply in some cases and so for some applications like above, the need of step down transformer can be eliminated.
3. In industry motor control and other heavy ac loads can be controlled wirelessly and efficiently using some modifications in this circuit.

5.4 Conclusion

In this project module we have studied in detail the working of TRIAC. We also studied deeply how gate triggering of TRIAC can be controlled using different values of firing angle. The working of opto-isolators were studied. The need of isolation between power and control circuits and how opto-isolators can be used more efficiently and effectively are also understood.

Thus from this mini project module it can be concluded that TRIAC triggering can be controlled by controlling its firing angle. The required gate pulses can be easily provided by microcontroller and so we can achieve different load powers, according to firing angle values, at the load connected in the TRIAC circuit. It is also observed and concluded that more work needs to be done for precise operation of this mini project model.

5.5 Future Scope

The current scope of this mini project is limited due to certain limitations. It is observed that more efforts can to be taken for further precise operation of this mini project model. More accurate circuit can be constructed for precise control of firing angle thereby more accurate control of load power. The idea can be extended to the module which can be useful to control to any type of load (for e.g. R, R-L Load, etc.). The research is going on industry to control the home appliances based on the similar concept using wireless control. The module can be extended for wireless control using IR Remote, RF signals. Further, modifications can be done so as to control the module remotely by using GSM module.

References

1. Anshu Jain, Sandeep Gupta, Durga Prasad, “Control of Electrical Lights and Fans using TV Remote”, EE 318 Electronic Design Lab -I, Project Report, EE Dept., IIT Bombay, April 2006
2. Reston Condit, “Low-Cost Electric Range Control Using a TRIAC”, AN958, Microchip Technology Inc., 2004, DS00958A - page 1
3. Nhivekar G.S. and Mudholkar R.R., “Microcontroller Based IR Remote Control Signal Decoder for Home Application”, Pelagia Research Library, Advances in Applied Science Research, 2 (4):410-416, 2011, p410
4. Md. Shahadat, Hossain, K. M. A. Salam, “Embedded System Design Based on Infrared Technology by Using Microcontroller”, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 3, Issue 10, October 2014, p12296
5. Muhammad Ali Mazidi, “PIC Microcontroller and Embedded System”, 3rd Edition, Pearson, 2008
6. P. S. Bimbhra, “Power Electronics”, Khanna Publisher, 1 January 2012
7. N. N. Bhargava, D. C. Kulshreshtha, S. C. Gupta, “Basic Electronics and Linear Circuits”, Tata McGraw Hill Education Private Limited, 2010
8. http://www.microchip.com/wwwproducts/en/PIC16F877A
9. https://www.fairchildsemi.com/products/optoelectronics/TRIAC-driver-optocouplers/random-phase-TRIAC-driver/MOC3021M.html
10. http://www.vishay.com/docs/83725/4n25.pdf
11. https://en.wikipedia.org/wiki/TRIAC
12. https://en.wikipedia.org/wiki/Opto-isolator

APPENDIX

(DATA SHEETS)