DESIGN AND CONSTRUCTION OF AN AUTOMATIC ROOMLIGHT CONTROLLER WITH VISITOR COUNTING CAPABILITY

BY

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(EE/08/1724)

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DECEMBER 2012

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A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING, SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY, MODIBBO ADAMA UNIVERSITY OF TECHNOLOGY, YOLA, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF BACHELOR OF ENGINEERING.

DECEMBER, 2012

DECLARATION

I hereby declare that this project constructed and the report written by me and it is a record of my own research work. It has not been presented before in any previous application for a bachelor's degree. References also made to published literature have been duly acknowledged.

.... Date: ....

Nwachukwu, Emmanuel Prince
(EE/08/1724)

The above declaration is confirmed by

.... Date.....................................

Engr. Mrs. Zara Oriolowo
(Supervisor)

CERTIFICATION

This project entitled **"Design and Construction of an Automatic Roomlight Controller with Visitor Counting Capability"** by **Nwachukwu Emmanuel Prince (EE/08/1724)** meets the regulations governing the award of the bachelor's degree of the Modibbo Adama University of Technology, Yola and is approved for its contribution to knowledge and literary presentation

.... Date: ....

Mrs. Zara Oriolowo
(Supervisor)

.... Date: ....

Engr I. M. Visa
(Head of Department)

.... Date.......................................

Prof. E. E. Omizegba
(External Examiner)

DEDICATION

This project report is dedicated to my parents, Mr/Mrs Eze Nwachukwu, my brothers, Nwachukwu Victor, Nwachukwu Christian, Nwachukwu Joseph and my sisters, Nwachukwu Eunice, Nwachukwu Elizabeth, Nwachukwu Esther, Nwachukwu Ruth, Nwachukwu Grace and Nwachukwu Abigail.

ACKNOWLEDGEMENTS

My profound gratitude goes to God Almighty the one who was, who is and will forever be for his protection and kindness over me throughout course of my degree program. A million thanks goes to Engr A.S Kadalla for his willingness to teach and support during the course of this design and construction

I sincerely appreciate my parents for their support all through the days. My sincere gratitude also go to my brothers and sisters Nwachukwu Eunice, Nwachukwu Victor, Nwachukwu Elizabeth, Nwachukwu Esther, Nwachukwu Ruth, Nwachukwu Christian, Nwachukwu Grace, Nwachukwu Abigail and Nwachukwu Joseph for their love, care and support, you are all inevitable.

I want to say a very big thank you to my uncle and his family, Pastor Gabriel Nwachukwu for his concern during this challenging period.

I sincerely appreciate all my lecturers for equipping us with the necessary skills to face any challenge today, tomorrow and forever. My love goes out to my very special friends Francis Chukwuemeka Agwu, Owuama Chinemerem, Chike Echebiri and Owuama Ihuoma. Not forgetting my very special friends, all the students of Electrical/Electronics engineering especially the present 500L students of **MAUTECH**, you" guys" have been a special set of people.

ABSTRACT

This Project **"Automatic Room Light Controller with Visitor counting capability"** presents a reliable circuit that takes over the task of controlling the room lights as well as counting number of persons/ visitors in the room very accurately. The above job is done by a microcontroller which in this context is a reliable switch control device. Review of room lighting control and other devices used in effectively switching room lights on and off was reviewed. Finally the results obtained from this circuit are as follows, properly controlled room light and counting system.

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CHAPTER ONE: INTRODUCTION

This chapter will discuss on the background, problem statement, objective, significance and the scope of this project

1.0 BACKGROUND

The advent of technology has made several tasks very easy to carry out. Such tasks include switching and counting amongst others.

A switch is an electrical component that can break an electrical circuit, interrupting current from one conductor to another. The most familiar form of switch is the light switch, with one or more electrical contacts which are connected to external circuit. Each set of contacts can be in two states; either ‘closed’ or ‘open’ meaning the contacts are touching and electricity can flow between them or the contacts are separated and the switch is non-conducting respectively. A light switch can be operated by a human, but the room light controller is designed to effectively light up an ac bulb in a room without necessarily walking up to a light up switch mounted on the wall or somewhere. In this project, a reliable circuit is designed and constructed to take over the task of counting the number of persons in a room and controlling the lights in a room accurately, the room could be an office, library depending on where it is preferably installed. When someone enters the room, the counter is incremented by one and the light in the room will be switched ON and when any one leaves the room then the counter is decremented by one. The light will be only switched OFF when everyone in the room is out. The total number of people in the room would be displayed on an L.C.D. a microchip is used to do the above job. It receives signal from an infrared sensor, this signal is operated upon by a program in the ROM of the microcontroller and necessary action is being taken accordingly.

1.1 PROBLEM STATEMENT

People often forget to turn off their room light or office light before leaving, this brings about increase in electric bills to pay and decrease in the life span of the bulbs (especially incandescent lamps), but with an effective light controlling circuit such as to be designed in this project, money would be saved and the efficiency of the lighting bulbs moderated

1.2 OBJECTIVES

The objective of this project is to make use of the versatile capabilities of a microcontroller to design a circuit that would count the number of persons visiting a particular room and accordingly light up the room. Other integrated circuits like the timer circuit will be incorporated to achieve this project.

1.3 SIGNIFICANCE OF THE STUDY

Light control systems are great additions to security systems as they are programmed to turn on all the lights when someone enters a restricted area, implying with such circuits, one cannot enter his room or his office dark. Light control systems provide additional benefits including increased flexibility in where and sensors can be placed. The number of useful applications of light control systems is infinite.

1.4 SCOPE OF STUDY

There would be some certain tasks this project would not be able to carry out, it does not take control of all the electrical appliances in the home (if installed at home), or in the office. It would only be able to switch ON a room light depending on if a person is in the room or not. However, this project can be specifically set up for other home appliances such as a fan, television, radio depending on the choice of an individual.

CHAPTER TWO: LITERATURE REVIEW

2.0 ROOM LIGHT EVOLUTION

Room lighting has evolved over the last couple of hundred years. The lighting sources we are accustomed to today come about as a result of hundreds of years of innovation. Although the method of home lighting has changed over time, the overall purpose remained the same, attractive lighting that lets you see inside your home when sunlight is not available.

2.1 HISTORY OF ARTIFICIAL LIGHTING

The history of room light can be dated back to the 15^{th} century and the categories of lights used then can be subdivided into the following

2.1.1 CANDLES

Although candles are still used today to create a soft mood, they were used from 1620-1850 as a primary source of room lighting. Until the 19th century, candles were made of the solid part of animal fat called tallow. Tallow was very cheap, but it had an unpleasant odour and produced a lot of smoke when burned.

2.1.2 OIL LAMPS

Oil lamps were used as a primary source of illumination in many rooms during the late nineteenth century. Oil lamps were safer than candles because the flame is surrounded by a hurricane glass cover. Oil lamps produced smoke and soot; therefore they were not a clean light source. Room owners had to constantly trim back the wick of oil lamps so that the flame would not get out of control. Kerosene was used in many oil lamps until the development of lamp oil, which produced less soot.

2.1.3 GAS LAMPS

Gas lamps came along during the nineteenth century and offered a few benefits over oil lamps and candles. Room owners did not have to continually trim the wick of gas lamps as they did for oil lamps. Furthermore, gas lamps did not produce messy wax spills characteristic of candles. The downside to using a gas lamp was that it made a room feel hot and stuffy because the lamp used some of a home’s air source.

2.1.4 INVENTION OF ELECTRICITY

Candles, oil and gas were all inconvenient ways to light the room. Fumes and wax drippings were a constant nuisance to room owners. Electricity showed a promise of mess-free lighting, although finding an affordable electric source was a big problem. The earliest electric lighting produced was the arc light, which was used outdoors. Practical incandescent lamps suitable for indoor use were not invented until 1870.

2.1.5 ELECTRICAL ROOM LIGHTING GAINS POPULARITY

Metal filament lamps were perfected in 1911. Electrical lighting for the room was limited to wealthy individuals. It was only after the Electricity Supply Act in 1926 that electrical lighting was available on a widespread basis. Although you might think that electrical lighting was popular from the start, it took a considerable amount of advertising to get consumers to see the benefit of using electrical lighting in their homes. Women were a crucial force behind the success of electrical lighting. The Electrical Association for Women put out a vast array of literature and advertisements explaining how a housewife’s life could be simplified through electrical appliances. [1]

2.2 REVIEW OF ROOM LIGHT CONTROL

In early lighting, control was limited to the time of day that a play was presented and the angle towards the sun at which the stage was set. There was little or no artificial lighting for these early theatres such as the Theatre of Dionysus (Athens, circa 330 BC) or the theatre at Epidaurus (Circa 340 BC).

Over hundreds of years many types of artificial lighting were used, everything from the sun, candles, torches, oil lamps, gas lamps, lime lighting and electric arc. Many of these early methods were cumbersome, dangerous, and often with little or no control whatsoever even over the simplest of functions such as the brightness of the light, but these early methods did allow some experimentation in lighting design, and many of the lighting techniques and principals used today were developed during this era. As new lighting technologies emerged, those in the lighting fields already had ideas about what they wanted to do with light, just as soon as it became possible.

The late 1800s brought about the incandescent lamp as well as technology to remotely control the light levels of these lamps through an electrical system. In 1881 London's Savoy Theatre installed the world's first electric lighting system, utilizing over 1150 lights to illuminate the stage and auditorium. Then in 1903 the Kliegl Brothers installed an electrical lighting system in the Metropolitan Opera House in New York City featuring 96 resistance dimmers for the stage lighting. These were the first controllers: large and bulky complicated systems which provided little control (dimming only) and required real-time manual operation often from several crew members, sometimes as many as half a dozen. Over the next 75 years the dimmers evolved, through many different incarnations, into electronic dimmers using small control voltages sent from a controller. At first, these controllers still had no memory, therefore no way to store "scenes" or "looks" and therefore these controls still had to be operated manually, though advancements in electronics now allowed users to assign control to groups of lights in any combination, thus allowing a single operator to effectively and efficiently control an entire show. This approach was still vastly limited by the fact that all the control had to be done in real-time.

Finally, came the first basic computerized consoles. These consoles had simple scene storage and offered many great new improvements, but their limitations were many. Most of these consoles used a simple low-voltage signal to control dimmers. Many different methods emerged but the 0-10Volt method was the most popular, however even amongst those using 0-10V, there was no standard. For some consoles 10V corresponded to full intensity, for others, the opposite, and there were other problems as well. The early consoles primarily stored a simple "scene." This was analogous to one frame of a movie. One "scene" would consist of a single, static level of light for every light fixture. For example "scene 1" might set lights 1-10 to full on, lights 2-20 to 50%, and so on. When this "scene" was called up on the controller, it would set each light to that level, all at the push of one button. Eventually consoles could be programmed with "wait" and "fade" times so that when a new scene was called, the console could be programmed to fade between scenes at a given rate, or to have fixtures wait for a set amount of time before then transitioning at the set fade time. The only way to create dynamic lighting effects was to program chases – combinations of different scenes and fade times programmed to run in sequence, or , in the earlier days, to be called in sequence manually. Through the years different manufacturers developed different types of solutions and improvements for more and more different types of controllers, and with each advancement, the various manufacturers moved further and further away from each other and deeper into proprietary protocols which only worked with lighting fixtures of their own manufacture. The result was unacceptable, one must either use multiple lighting desks or only use lighting from the same manufacturer. The need for a standard form of communication became clear.

In 1986 the U.S. Institute of Theatre Technology (USITT) first developed the DMX 512 protocol as a standard interface between consoles and dimmers. DMX 512 (DMX stands for Digital Multiplex, 512 refers to the standard number of "channels" of data that are transmitted) is a simple and robust standard, and the wiring and transmission of data (voltages and cabling) are based on the already proven RS-485 standard, therefore the new standard was immediately adopted by most and has since all but eliminated proprietary protocols. Over the years various improvements have been made to the standard, while retaining its backwards compatibility. In 1990 the USITT updated the standard now as DMX512 (1990), and then in 1998 the standard was taken over by the Entertainment Services and Technology Association (ESTA), and more revisions to the standard were made, leading to the new official designation of DMX512-A. DMX would continue to evolve, gaining separate cabling standards (2004) for portable and permanent installations, and new add-ons such as the Remote Device Management (RDM) extension to the standard which allows a controller to "tell" a device that the information being sent is for addressing, not lighting control. And so DMX has become the universal means for controlling all programmable lighting, to understand how to control any intelligent light fixture you must simply know the attributes of the light and understand how DMX works.[2]

Modern technology increased and light control systems were introduced. A light control system is a device that can control any and all lights throughout a building, With the touch of a button, you can turn lights on or off, dim lights, power fans and more from anywhere in the building. There are many applications of light control systems, and they have a lot to offer in terms of ease and convenience.

Light control systems used to be mainly for commercial use, but there are now a wide variety of residential options as well. The complexity of the light control system can range from simplistic to intricate depending on your needs. On the simple end, you might want to get a light system designed to only control your exterior lights according to time of day or light level. Alternatively, you might want to get a “whole-house” light control system that operates from a central command centre. On the other hand, perhaps you just want something in between. You can opt for individual light control systems just for the main rooms in your house as well. No matter what type of light control system meets your needs, you will find that you have a lot of options available to you. One of the biggest benefits derived from light control systems is their programmability. You can design how you want your lights to behave based on time of day, motion, and many other factors. For example, with a light control system you can program your lights to automatically turn on when you enter the house or turn off when you leave. You can program a lighting design consistent with something you can think of. Of course, you could adjust the lighting levels in each room manually, but that takes time. With a light control system, you can pre-design as series of lighting concepts and toggle between them in seconds.

Light control systems are great additions to security systems as they can be programmed to turn on all of your lights when someone enters a restricted area or breaks into your home. Motion detectors can also trigger lights so you do not have to walk into a dark room or up to a dark house at night. The number of useful applications for light control systems is infinite.[3]

One very important component now used in the controlling of behaviours of the lighting systems in the room is the **MICROCONTROLLER**.

2.3 THE FIRST MICROCONTROLLER

In 1971, the first microcontroller was invented by two engineers at Texas Instruments, according to the Smithsonian Institution. Gary Boone and Michael Cochran created the TMS 1000, which was a 4-bit microcontroller with built-in ROM and RAM. The microcontroller was used internally at TI in its calculator products from 1972 until 1974, and was refined over the years. In 1974, TI offered the TMS 1000 for sale to the electronics industry. The TMS 1000 was available in various configurations of RAM and ROM sizes. As of 1983, about 100 million TMS 1000 devices had been sold.

2.3.1 INTEL MICROCONTROLLERS

In addition to producing the first microprocessor, Intel also developed many important microcontrollers, two of which are the 8048 and 8051. Introduced in 1976, the 8048 was one of Intel's first microcontrollers and was used as the processor in the IBM personal computer keyboard. It is estimated that over one billion 8048 devices were sold. The 8051 followed in 1980 and became one of the most popular microcontroller families. Variations of the 8051 architecture are still being produced today, making the 8051 one of the most long-lived electronic designs in history.

2.3.2 ELECTRICALLY ERASABLE MEMORIES

During the 1990s, microcontrollers with electrically erasable and programmable ROM (EEPROM) memories, such as flash memory, became available. These microcontrollers could be programmed, erased and reprogrammed using only electrical signals. Prior to the electrically reprogrammable devices, microcontrollers often required specialized programming and erasing hardware, which required that the device be removed from its circuit, slowing software development and making the effort more expensive. With this limitation removed, microcontrollers were able to be programmed and reprogrammed while in a circuit so devices with microcontrollers could be upgraded with new software without having to be returned to the manufacturer. Many current microcontrollers, such as those available from Microchip and Atmel, incorporate flash memory technology.

2.3.3 MODERN MICROCONTROLLERS

In addition to general purpose devices, specialized microcontrollers are being produced for areas such as automotive, lighting, communications and low-power consumer devices. Microcontrollers have also become smaller and more powerful. For example, in 2010, Atmel announced a flash microcontroller in a package measuring 2 mm by 2 mm. These tiny microcontrollers are small enough and cheap enough to be used in products such as toys and toothbrushes. [4]

Amongst the works which a microcontroller can be used to carry out is the simulation, design, implementation and control of a welding process using a microcontroller, this work was carried out by students in the Indian Institute of Technology Bombay, Powai, Mumbai, where The user inputs the welding current, no. of cycles required for squeeze, weld and hold cycles and the job count. The microcontroller reads this data and calculates the approximate firing angle required to obtain the desired welding current. A control voltage corresponding to this firing angle is applied to the TCA785 phase control IC through a DAC. The phase control IC is used to trigger the high power anti-parallel thyristors in the main welding transformer. This IC recognizes the zero crossing of the AC line voltage through a stepped down transformer and this zero crossing is indicated to the micro-controller through a port line. The micro-controller synchronizes the firing of the thyristors with the zero crossing in every half cycle. The firing of the thyristors takes place for the number of cycles that the user has the input. During this time, the micro-controller receives feedback about the actual welding current that is being made available through an ADC. Appropriate action is taken to ensure that the actual welding current is very close to the desired welding current. Once a particular job has been welded, the microcontroller has to display the relevant information, which is required by the user. This includes the actual welding current and the number of jobs completed. If during the welding process, errors occur, provision is made to indicate the occurrence of the error. A 12 V power supply for the phase control IC and DAC, a 15V supply for the DAC and a 5V power supply for the rest of the circuit is designed and incorporated in the overall system design. The design also includes provisions to store an entire schedule for later use. This helps in avoiding mistakes from occurring and eliminates the need to re-enter all the data. [5].

CHAPTER THREE: DESIGN AND CONSTRUCTION PROCEDURE

3.0 SYSTEM DESCRIPTION

The design consideration for this project is illustrated with the block diagram below:

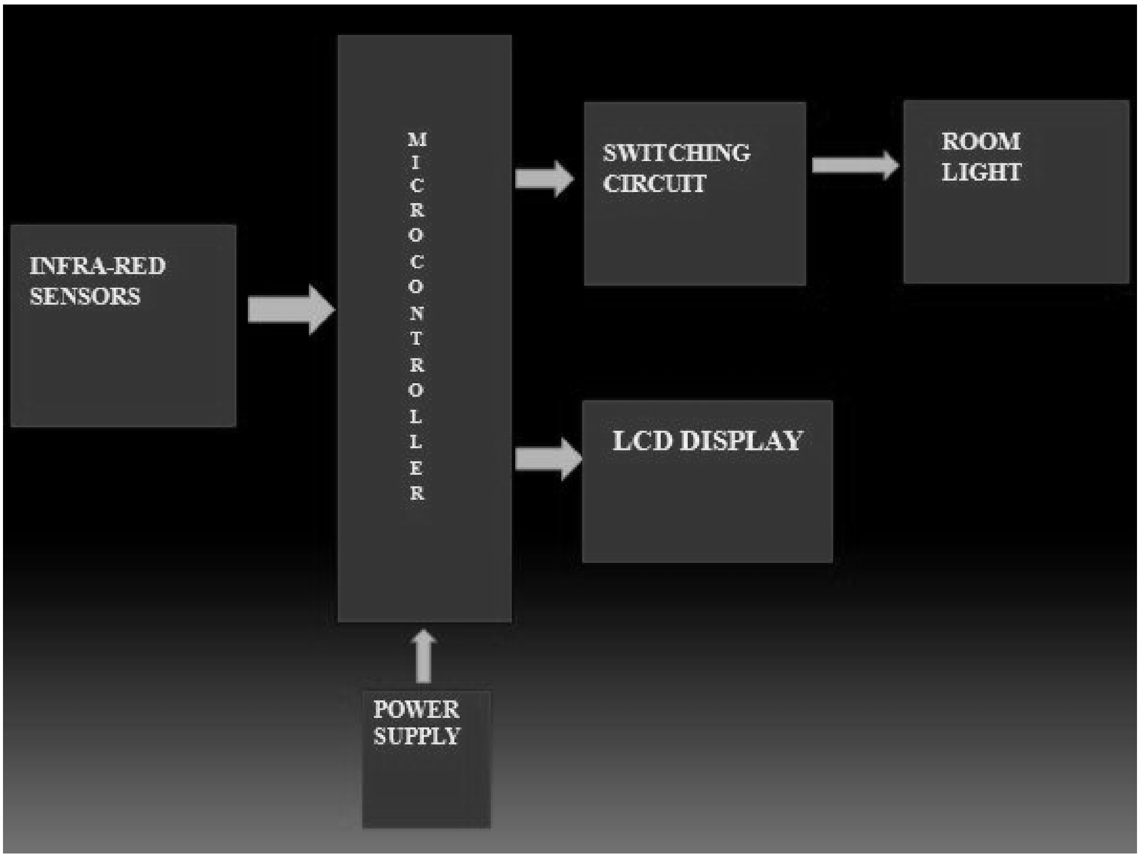


Figure 3.0 Block diagram for Automatic Roomlight controller

3.1 POWER SUPPLY UNIT

Electronic circuits need energy to work. In most cases the energy is provided by a circuit called the regulated power supply. A failure in this circuit would affect all other parts of the circuit and it is the most important part of any electronic system. The function of this unit is to convert AC voltages to DC in order to remove voltage fluctuations with line voltage and load variation. The process of conversion can be illustrated below

Figure 3.1: Block Diagram for Power Rectification

3.2 TRANSFORMER

The function of the transformer in this project is to step-down the AC voltage from the mains to a suitable value required by the electronic components of this circuit. The transformer used in this project was selected based on the maximum current and the maximum voltage required by the regulator and taking in consideration the rectifiers. Its design analysis is as follows:

$$Np = Number\ of\ primary\ turns$$

$$Ns = Number\ of\ secondary\ turns$$

$$\emptyset m = Maximum\ flux\ in\ the\ core\ in\ Webers\ (Wb)$$

$$F = frequency\ of\ the\ A.C\ voltage\ in\ Hertz$$

$$Vp = Applied\ voltage\ at\ primary$$

$$Vs = Supply\ voltage\ at\ secondary$$

From the transformer equation,

Induced e.m.f in the primary turns is given by

$$Ep = 4.44fNp\emptyset m \ldots\ldots\ldots..(i)$$

Also, Induced e.m.f in the secondary turns is given by

$$Es = 4.44fNs\emptyset m \ldots\ldots\ldots..(ii)$$

From equations (i) and (ii)

It can be deduced that

$$\frac{Es}{Ep} = \frac{Ns}{Np} \ldots\ldots..(iii)$$

But primary ampere turns = secondary ampere turns

$$IpNp = IsNs \ldots\ldots\ldots..(iv)$$

Therefore

$$\frac{Is}{Ip} = \frac{Ns}{Np} = \frac{Es}{Ep} \ldots\ldots\ldots..(v)$$

Hence,

$$\frac{Vs}{Vp} = \frac{Ip}{Is} \ldots\ldots\ldots..(vi)$$

$$\frac{Vs}{Vp} = \frac{Ip}{Is} \ \therefore Ip = \frac{Vs \times Is}{Vp} = \frac{12 \times 1000 \times 10^{-3}}{240} = 0.05A$$

Input impedance of the transformer $Z_1 = \frac{V_p}{I_p} = \frac{240}{0.05}$ $Z_1 = 4800\Omega \approx 4.8K\Omega$

Output impedance of the transformer $Z_o = \frac{V_s}{I_s} = \frac{12}{1000 \times 10^{-3}} = 12\Omega$

Input power $P_1 = V_pI_p = 240 \times 0.05 = 12W$

Output power $P_0 = V_sI_s = 12 \times 1000 \times 10^{-3}$ 12W which implies that the input power equals the output power.

Therefore, the centre tap transformer with the rating of 12V, 1000mA was selected for this project.

3.3 THE RECTIFIER

The rectifier employs one or more diodes to convert AC voltage into pulsating DC voltage. The rectifier used in this project was a single phase full wave rectifier as shown:

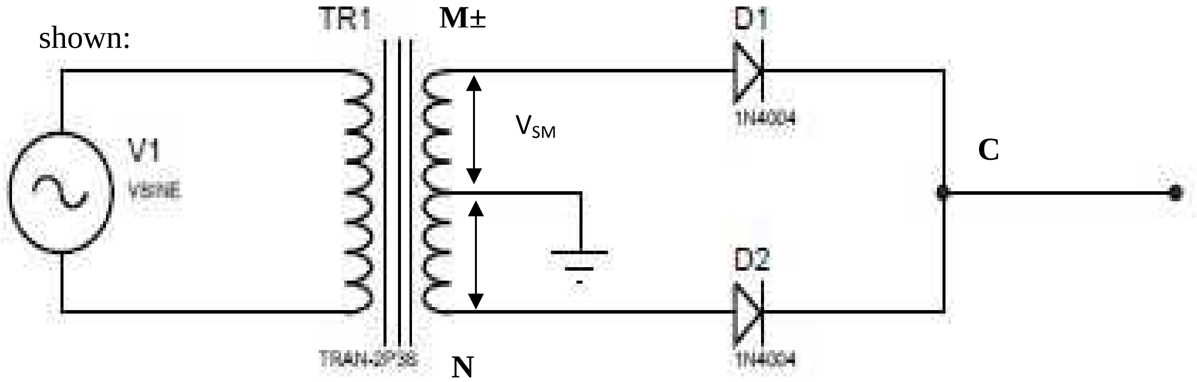
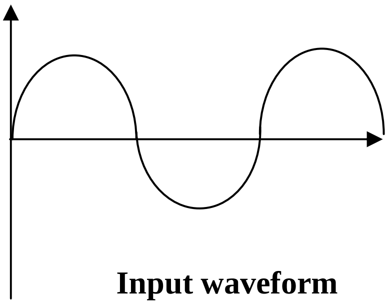


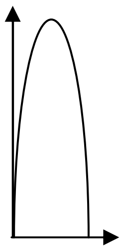
Figure 3.2a: Full Wave Rectifier

When the circuit was connected as shown above, point M and N where positive and negative respectively, hence during the positive half cycle, Diode D_1 is forward biased while D_2 is reversed biased, and d1 conducts causing current to flow at point C towards the load. During the negative half cycle, terminal N is positive, hence diode D_2 is forward biased and conducts, while D_1 is reversed biased and current flows at point C, implying both half cycles were utilized as shown below:



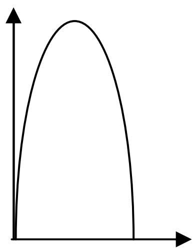
Input waveform

Figure 3.2b



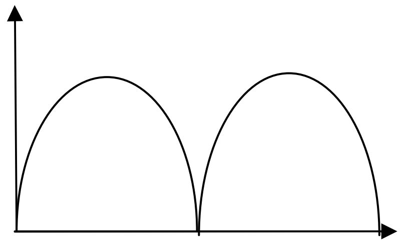
Output of D_2

Figure 3.2c



Output of D_1

Figure 3.2d



Total Output of D_1 and D_2

Figure 3.2e

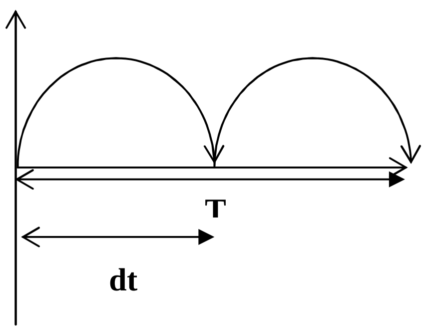
Hence from the output wave form there were still ripples so a smoothing/filtering circuit was needed.

3.4 FILTERING CIRCUIT

3.4 FILTERING CIRCUIT: the function of this circuit element is to remove fluctuations (ripples) present in the output voltage supplied by the rectifier

Note: no filter can produce a ripple free output voltage as that of a dc battery but it approaches it so closely that the power supply performs well. The analysis of the filtering circuit element is as follows

The output wave form from the rectifier is given below



Where T is the period for a complete AC voltage cycle given by

$$T = \frac{1}{F} \dots \dots \dots (vii)$$

But dt is the period for a complete half dc cycle given by

$$dt = \frac{1}{2f} \dots \dots .. (viii)$$

also

$$I_c = \frac{d_q}{dt} \dots \dots .. (ix)$$

$$\frac{dq}{dt} = C\frac{dv}{dt} \dots \dots .. (x)$$

Equating equations (ix) and (x)

$$I_c = C\frac{dv}{dt} \dots \dots .. (xi)$$

Making c the subject of the formula $C = I\frac{dt}{dv} \dots \dots .. (xii)$ but in equation (vii) $dt = \frac{1}{2f}$, substituting equation (viii) in equation (xii) $C = \frac{i}{2fd_v} \dots \dots .. (xiii)$

Where

C = capacitance

I = Maximum current required by the circuit

Dv = ripple factor

F = frequency component in the dc voltage

The maximum current was taken to be 1A because the total current requirement is not up to 1A but for a conducive environment for the project to perform, also the ripple factor is 10% of the filtered voltage

$$\frac{10}{100} \times 1.414 \times 12 = 1.6\,, F = 50Hz$$

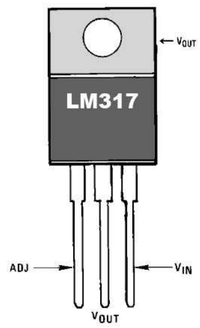
$$\therefore C = \frac{1}{2 \times 50 \times 1.6} = \frac{1}{160} = 6.25 \times 10^{-3}F \cong 6250F$$

And since capacitors are rated in capacitance and working voltage, the capacitor rated 6800µF was selected for filtering the circuit.

3.4 VOLTAGE REGULATORS

These are control devices designed to maintain the value of some quantity substantially constant. Thus it keeps the terminal voltage of the dc supply constant even when the AC input to the transformer varies or the load varies. The voltage regulator used here is the LM317 and it is a 3-terminal

adjustable positive voltage regulator capable of supplying in excess of 1.5A over a 1.2V to 37V voltage output range. The LM317 is shown below with its pin labels pin 1,2 and 3being adjustable, output and input respectively.



The circuit diagram is shown below

Figure 3.4a LM317

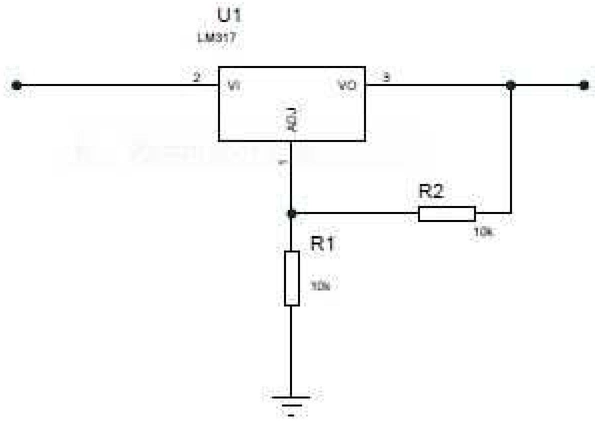


Figure 3.4b: Connection for the LM317

The analysis for the resistors to obtain an output voltage of 5V for the microcontroller was as follows:

From the datasheet,

$$V_{out} = V_{ref}\left[1 + \frac{R_2}{R_1}\right] + I_{adj}(R_2)$$

$$V_{out} = 5V$$

$V_{ref} = 1.25V$

$I_{adj} = 100\mu A$

$$V_{out} = VR_1 + VR_2 = 5V$$

$$VR_1 = I_1 R_1$$

$$VR_2 = (I_1 + I_{adj})R_2$$

But I_{adj} is very small when compared with I1, hence it is negligible and

$V_{out} = I_1(R_1 + R_2) = 5$ but $I_1 = \frac{V_{ref}}{R_1}$ $and\ V_{ref} = 1.25V$ $\therefore \frac{V_{ref}}{R_1}(R_1 + R_2) =$

$V_{ref}\left(1 + \frac{R_1}{R_2}\right) = V_{ref}\left(1 + {R_1}/{R_2}\right) = 5, 5 = 1.25\left(1 + {R_2}/{R_1}\right)$

$\frac{5}{1.25} = 1 + \frac{R_2}{R_1} = 4 - 1 = {R_2}/{R_1}$ $\therefore R_2 = 3R_1$ Let R_1= 1KΩ, then R_2 = 3KΩ. Hence the resistors R_1 and R_2 are 1000Ω and 3000Ω respectively. Thus the power circuit can be shown below.

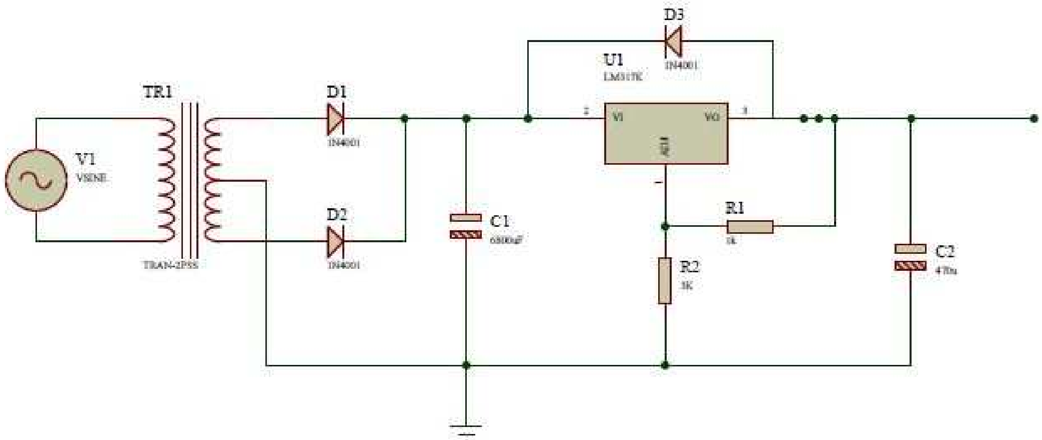


Figure 3.4c: Power Supply Unit

3.5 INFRARED SENSORS

The sensor circuit comprises a transmitting circuit and a receiving circuit. A sensor is a device which measures a physical quantity and converts it into a signal which can read or interpreted by an electronic instrument. The circuit is an infrared, 940nm emitting diode in GaAIAs/GaAS technology with a high radiant power moulded in a blue-gray package. It is commonly known as the TSAL6200 and more features can be seen in the datasheet.

Figure 3.5a: The TSAL6200 Infrared Emitter

Applications of this emitting diode are in the following:

- Infrared remote control unites with higher power requirements.
- Free air transmission systems
- Infrared source for optical counters and card readers

The design of the infrared emitter is as follows, a program was written to the microcontroller generating a frequency of 40 KHz and the connections is shown below

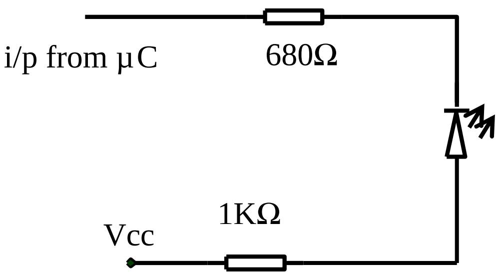


Figure 3.5.1: Infrared emitting Diode

3.5.1 THE RECEIVING CIRCUIT

The TSOP1756 was used for the receiving circuit, it is a miniaturized receiver for infrared remote control system, pin diode and preamplifier are assembled on lead frame, the epoxy package is designed as an IR filter, and the demodulated output signal can directly be decoded by a microprocessor. The TSOP1756 is the standard IR remote control receiver series, supporting all major transmission codes. The features of this receiver used in this project can be seen in its datasheet but the most important is that it has low power consumption.

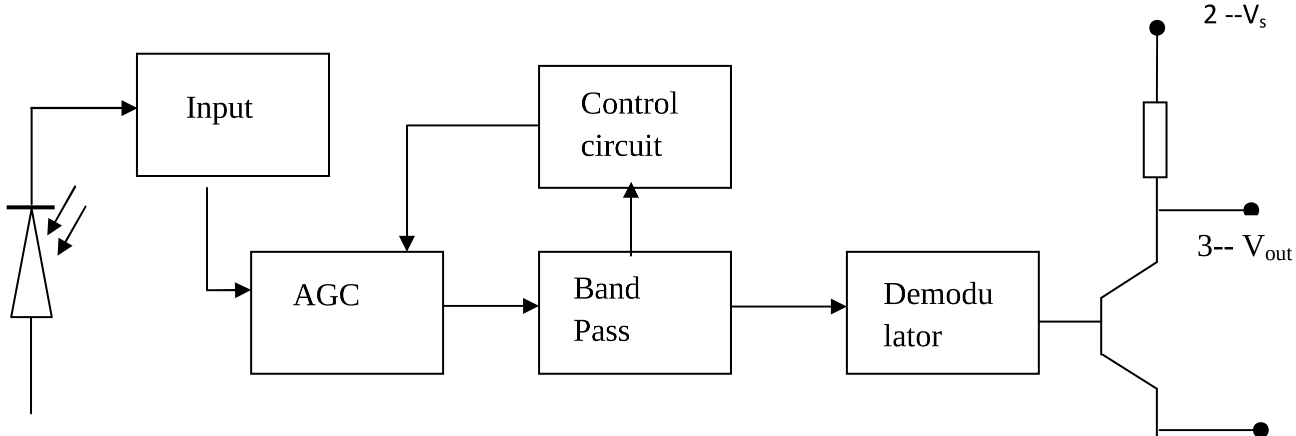


Figure 3.5.1a: Block Diagram of the Infrared Receiver

The circuit diagram for the receiver is shown below

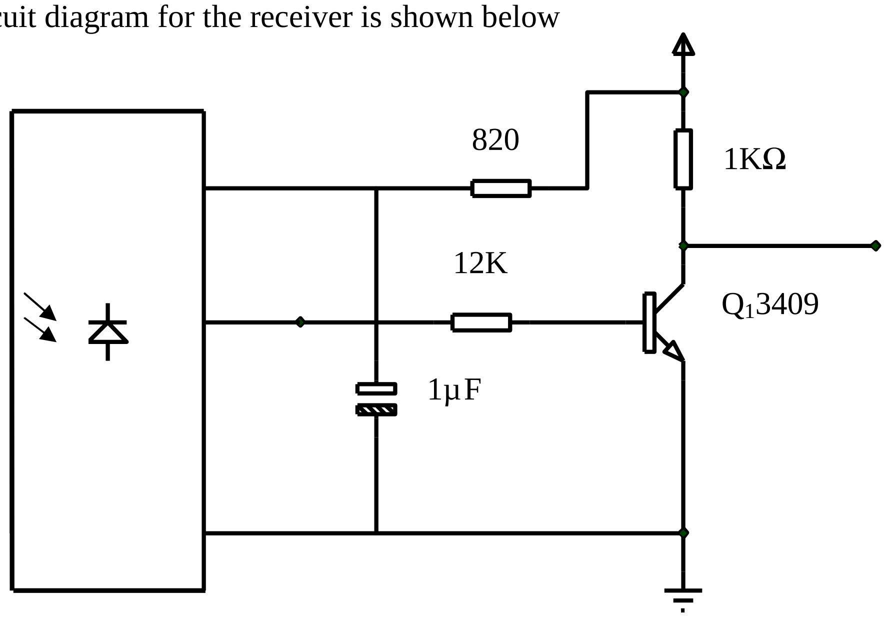


Figure 3.5.1b: Circuit Diagram for the Receiver

The complete circuit for the Infrared sensor circuit is shown in the diagram below

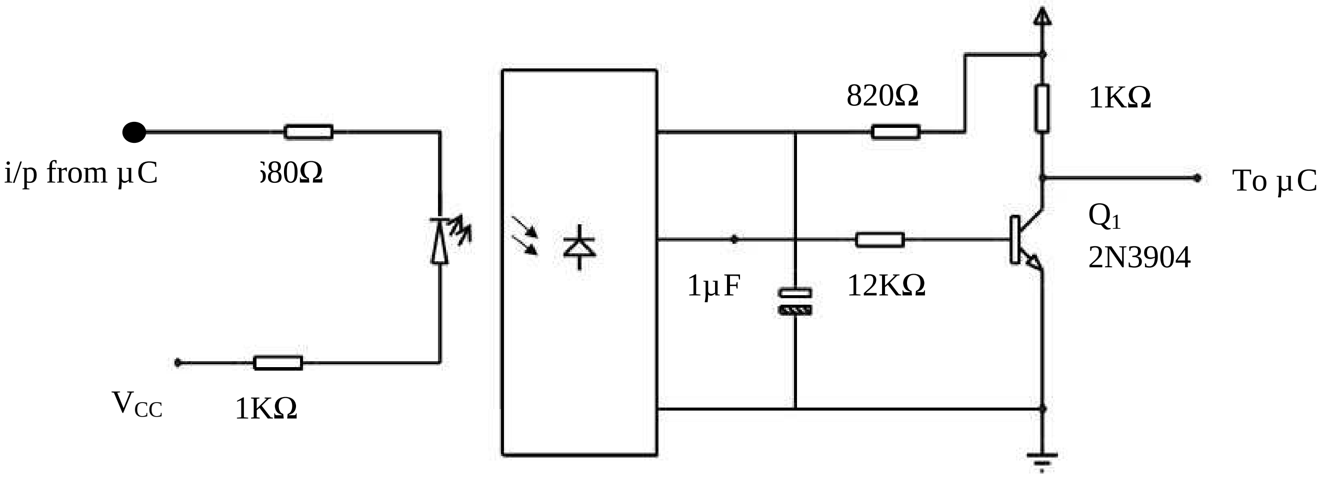


Figure 3.5.1c: Circuit Diagram for Infrared sensor circuit

3.6 LCD DISPLAY

This component is also known as the liquid crystal display. It is a flat panel display, electronic visual display that used the light modulating properties of liquid crystals. The LCD used in this project is a 16 × 2 LCD display with 16-pin connections. The pin description is shown the table below

Table 3-1: LCD pin Descriptions

PIN	SYMBOL	DESCRIPTION
1	Vss	Ground
2	Vcc	+5V power supply
3	V_{DD}	Power supply to control contrast
4	RS	RS=0 to select command register RS=1 to data

		register
5	R/W	R/W = 0 for write, R/W =1 for read
6	E	Enable
7	DB0	8-bit data bus
8	DB1	8-bit data bus
9	DB2	8-bit data bus
10	DB3	8-bit data bus
11	DB4	8-bit data bus
12	DB5	8-bit data bus
13	DB6	8-bit data bus
14	DB7	8-bit data bus
15	+	Anode
16	-	Cathode

The anode and cathode power on the LCD. The characters displayed by the LCD consist of $5 \times 8 \, or \, 5 \times 7$ dot matrix. The display contrast depends on the supply voltage. For this reason, V_{DD} is connected to a 10K potentiometer which when varied gives the actual contrast which can be comfortably visible. Some LCDs have in-built backlight (blue or green), blue was chosen for this project. The LCD was initialized through a set of program shown below

After the initialization, when the circuit is switched on, when no action is going on the display can be seen as shown in the picture below

Figure 3.6: LCD after Initialization

3.7 THE MICROCONTROLLER

A microcontroller (sometimes abbreviated µC, uC or MCU) is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Program memory in the form of NOR flash or OTP ROM is also often included on chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications.

Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analogue components needed to control non-digital electronic systems.

The microcontroller has multiple functions but one of the property used in the design of this project is the Interrupt property. Microcontrollers must provide real time (predictable) response to events in the embedded system they are controlling. When certain events occur, an interrupt system can signal the processor to suspend processing the current instruction sequence and to begin an interrupt service routine (ISR, or "interrupt handler"). The ISR will perform any processing required based on the source of the interrupt before returning to the original instruction sequence. Possible interrupt sources are device dependent, and often include events such as an internal timer overflow, completing an analog to digital conversion, a logic level change on an input such as from a button being pressed, and data received on a communication link. Where power consumption is important as in battery operated devices, interrupts may also wake a microcontroller from a low power sleep state where the processor is halted until required to do something by a peripheral event.

In this project, a square wave frequency of 40KHz was generated which was transmitted by the infrared emitter, which when cut, the receiver sends a boosted signal through the transistor Q_1 to the interrupt pins of the microcontroller and the program embedded in the chip acts on the signal and necessary action is taken.

The embedded program used in this project was written with a compiler called ***READS51***. Reads51 is "**R**igel's **E**mbedded **A**pplications **D**evelopment **S**ystem for the 80**51**." It is an Integrated Development Environment (IDE). Reads51 is an integrated applications software development system, which runs on an IBM PC or compatible host. Reads51 allows writing, compiling, assembling, debugging, downloading, and running applications software in the MCS-51 language.

Reads51 contains a C compiler, relative assembler, linker/locator, editor, chip simulator, assembly language debugger, and host-to-board communications in a user-friendly, menu-driven environment. The microcontroller used in this project is the AT89S52 which can be shown in the picture below;

Figure 3.7a; The AT89S52 Microcontroller

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard 80C51 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. More features of this Microcontroller and its pin labels can be seen in its datasheet.

The microcontroller performs the intended action with the set of instructions written to which can be seen in appendix 1

The subroutine 'main' is the program that initializes the microcontroller pins in such a way that they behave as intended

3.8 CRYSTAL OSCILLATOR

Crystal is a circuit element commonly used in clock, full name is called the crystal oscillator, in the microcontroller, the role of the system is very large, is a combination of the MCU's internal circuitry, resulting in the need for microcontroller clock frequency, single chip implementation of all directives are built on this basis. The crystal oscillator used in this project is the 12MHz Oscillator and the connection as directed by the datasheet is as shown below

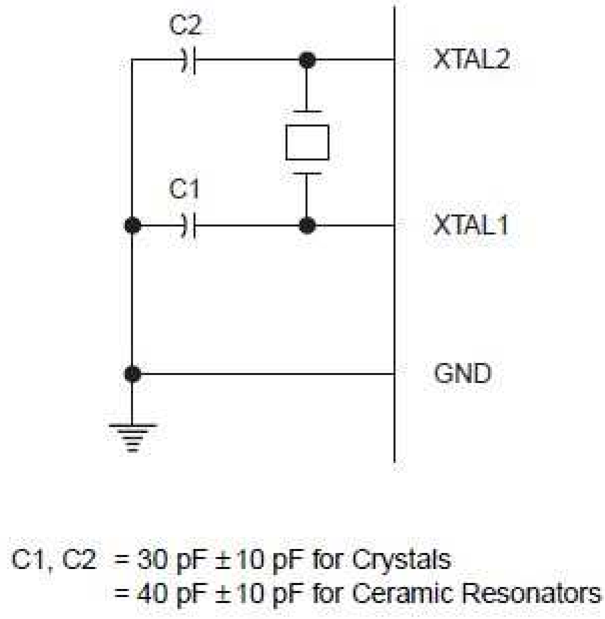


Figure 3.8a: Circuit Connection for the Crystal Oscillator

30pF was specifically selected for the purpose of this project. And the crystal oscillator is thus shown

Figure 3.8b: Crystal Oscillator

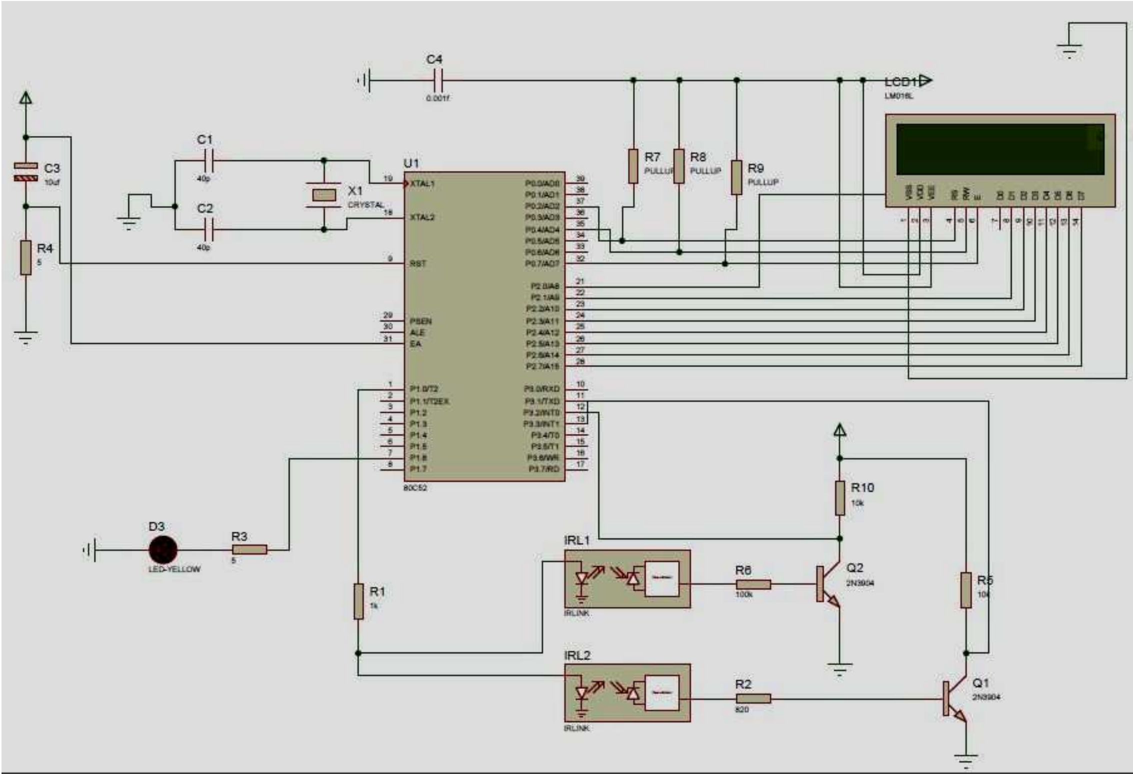


Figure 3.9b: Circuit Diagram for the Roomlight Controller

3.9 CASING:

The whole system is cased in a plastic-like material. Which was designed after the construction was carried out. It has dimensions of $8 \times 3.5\,inches$ and a height of 2.5 inches. The case also provided a space the LCD and infrared sensors.

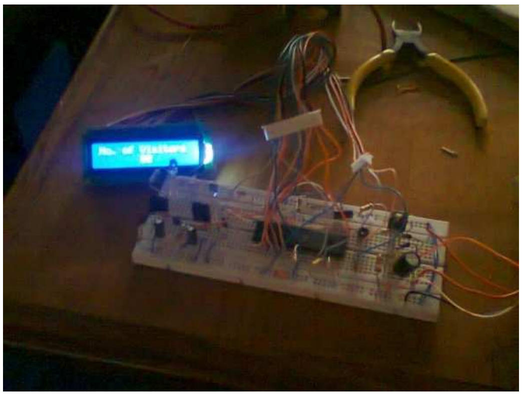


Figure 3.9.1a: The Automatic Room Light Controller during Construction

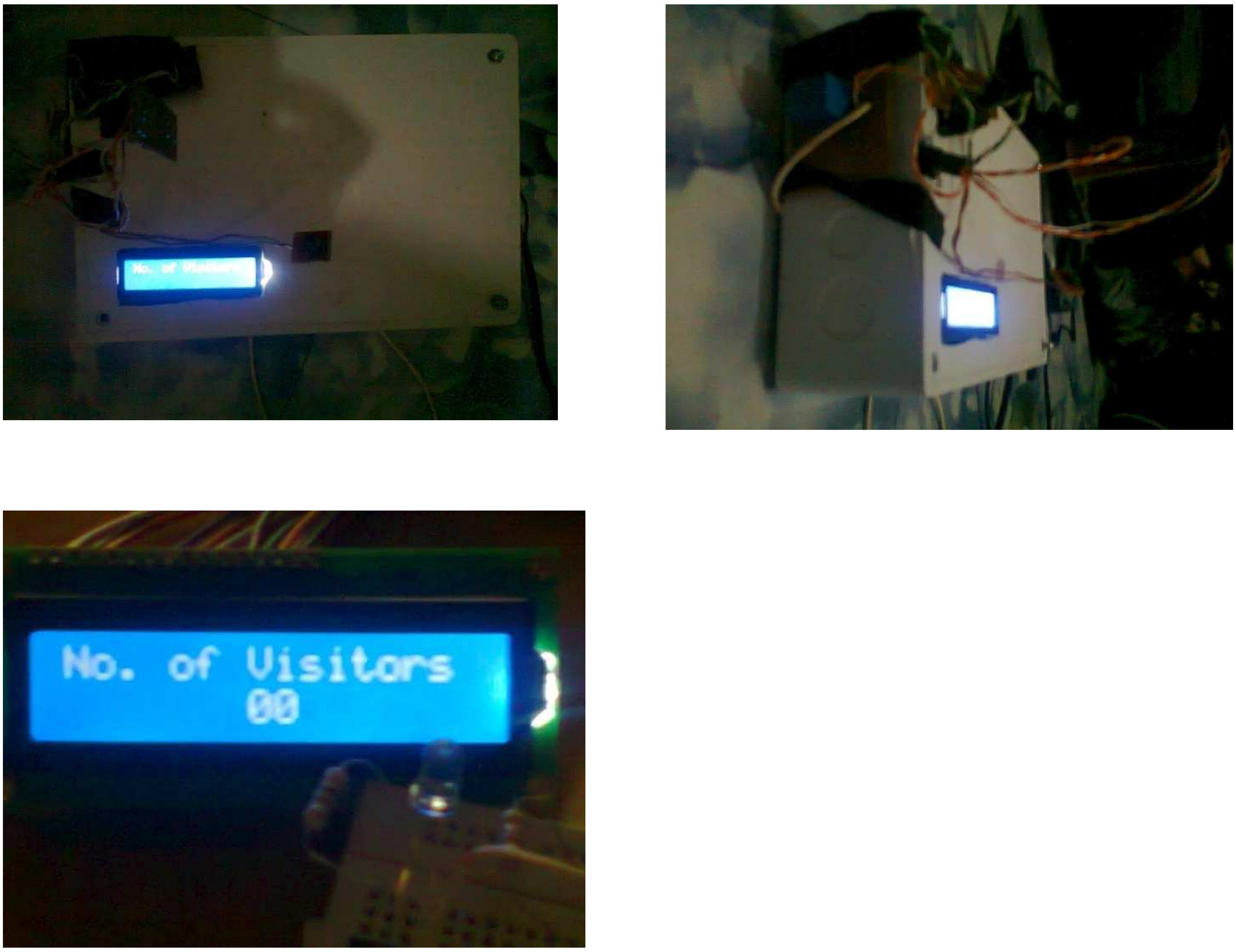


Figure 3.91b: the Automatic roomlight controller after construction

CHAPTER FOUR: PERFORMANCE AND COST EVALUATION

4.0 INTRODUCTION

This chapter is based on testing, performance evaluation and assembling of components on Vero board in relation to the designed circuit. An individual component was tested and each of the subunits was built on a bread board and monitored before transferring it to the veroboard. Proteus 7.8 was also used for simulating the design before building to bread board and finally to Printed Veroboard. The simulation output can be thus shown

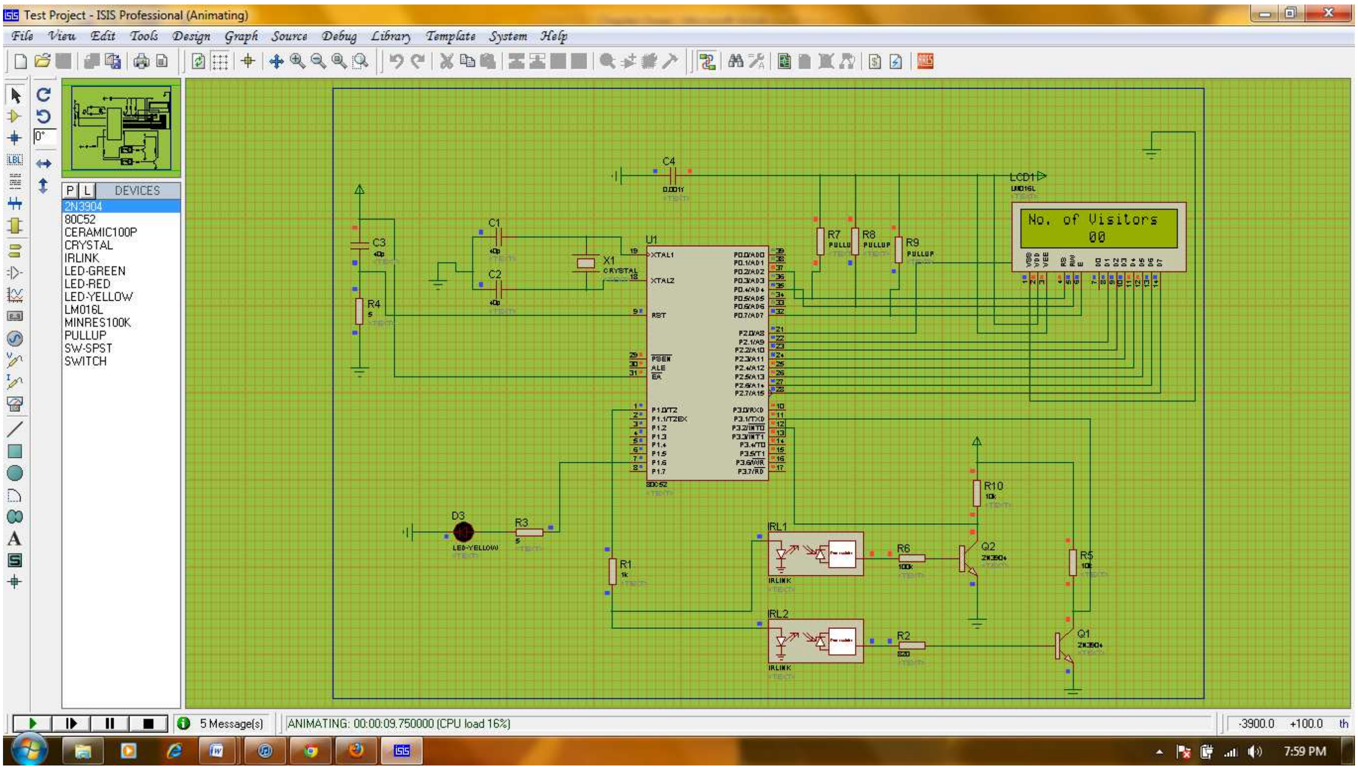


Figure 4.0 Result for Simulation of the Roomlight Controller

4.0 PERFORMANCE

The system was first built on bread board. This was done to ascertain its workability and to logically arrange the entire circuit according to the design specification. The construction followed a sequence ranging from the power supply to the final output. The sensors from the doors served as inputs to microcontroller as well. The output of the microcontroller was used (through programming) to control the switching on and off of the room light and counting number of entries into the room. In this project we interfaced ***AT89S52*** microcontroller with an LCD display to enable see the counting process.

The entire system has one input which is the input from the sensors attached to the doors and one power source – regulated AC power supply source. The integrated circuits (IC's) used was fixed on IC socket so as to ensure easy replacement. The individual components were held firm on the veroboard with the aid of soldering lead and iron.

After the construction of the entire system, the program was written and burned into the microcontroller chip. It was tested working as it performed the objective of the design. Satisfaction was gotten from the moment the system was activated, the LCD initialized displaying the numbers '00' and when the Infrared was bridged, the LED connected to pin 1.6 light on and the LCD displayed '001' the system kept counting till number 15 and counted down and finally the light was switched off. The mission of the design was hence accomplished.

4.1 TESTING

Various test was carried out before, during and after the construction has been completed. The multi-meter was extensively used for carrying out most of these tests. Each subunit was tested and confirmed efficient.

4.2 CONTINUITY TEST

The multi-meter was used to check open circuit in the circuit, as part of this test; short circuit test was also conducted. Partial contact was thoroughly checked and corrected.

4.3 COMPONENT STATUS TEST

The theoretical specification of components and their appropriate characteristics was tested and was observed efficient. Data sheet's was also used as a component guide to ascertain its specifications.

4.4 COST EVALUATION

Table 4.1: Cost Evaluation of Materials

S/N	DESCRIPTION	QUANTITY	UNIT PRICE (N)	AMOUNT
1	AT89S52µC 44 PIN IC SOCKET	2 1	500 50	1000 50
2	LCD DISPLAY	1	1500	1500

3	LCD DATA CABLE	1 PAIRS	200	200
4	CAPACITORS (30pF) (1µF) (10µF) (6800µF) (470µF)	2 7 1 1 1	10 10 10 100 50	20 70 10 100 50
5	LM317	1	50	50
6	TRANSISTOR (2N3904)	2	50	100
7	RESISTORS (1K) (3K) (10K) (820Ω) (68Ω) (12K)	4 1 2 3 2 2	10 10 10 10 10 10	40 10 20 30 20 20
8	CRYSTAL	1	50	50

	OSCILLATOR (12.000MHz)			
9	DIODE(1N4004)	3	10	30
10	IR RECEIVER (TSOP1756)	2	50	100
11	IR TRANSMITTER (TSAL6200)	2	50	100
12	TRANSFORMER (CENTER TAPPED)	1	500	500
13	CASING	1	1100	1100
14	GLUE	2	100	100
15	VERO BOARD	1	100	100
				TOTAL= 5370

CHAPTER FIVE: CONCLUSIONS

5.0 SUMMARY

Basically this project was aimed at designing and constructing, using a microcontroller a circuit which would be able to do the following:

- Switch a roomlight on and off depending on the number of people in the room.
- Count the number of people entering the room and display

Using this project, any roomlight can be controlled and the number of entry into the room can be instantaneously noted. Hence the most notable thing is that the microcontroller has the ability to execute several instructions as long as there is power supply and the necessary interfaced circuitries are functional.

5.1 CONCLUSIONS

The microcontroller is the mother chip of this project; it has useful applications and has been used in the design of much more advanced circuits than this. And one factor which would enable our effective use of this chip is studying its datasheet rigorously and understanding it, then designing any circuit will not be difficult.

5.2 RECOMMENDATIONS

The project has been designed and constructed but there is still room for improvement, it can be extended by incorporating another mini circuit which stores the number of entries in a particular room, and also a buzzer which signals delay at the door when entering.

Also following the difficulties experienced in this project, the microcontroller and a programming language such as C++ should be very well treated in the school curriculum.

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4) B.L Theraja and A.K. Theraja. (2000), **A Textbook of Electrical Technology.** S.Chand & company (IND) Ltd. Pp. 2167-2186.
5) Engr. A. S. Kadalla **"Power Electronics –EE516, Electronics Circuit Techniques-EE503 and Electronics Circuit I EE305"** Lecture Notes, department of Electrical and Electronics Engineering, Modibbo Adama University of Technology Yola.
6) Muhammad Ali Mazidi and Janice Gillispie Mazidi, (www. Asadali.tk) **"The 8051 Microcontroller and Embedded Systems";** Department of Computer Science and Information Engineering National Cheng Kung University, Taiwan
7) AT89S52 Microcontroller datasheet.

APPENDIX 1

Program Listing

```
#include <sfr52.inc>

   cseg at 0
   AJMP MAIN:                      jumps to 'main' program subroutine
   CSEG AT 0003H
   AJMP OUT_SIDE_SENSOR
   CSEG AT 0013H
   AJMP IN_SIDE_SENSOR:            jumps to in_side_sensor program subroutine

MAIN:
        MOV IE,#85H:               Enables Interrupt
        MOV IP,#05H:               Sets Interrupt Priority
        MOV P1,#00H                : initializes port 1
        MOV TCON,#05H              : sets timer control to enable
        MOV T2MOD,#02H             : Enable Timer 2 output
        MOV R0,#00H                : initializes Register 0 to zero
        MOV R1,#00H                : initializes Register 1 to zero
        MOV R2,#00H                : initializes Register 2 to zero
        MOV R3,#00H                : initializes Register 3 to zero
        MOV T2CON,#00H
        ; Configure Timer 2 in Auto-Reload Mode.
        ; Timer Clk = (12 * 1)/12 = 1MHz
        Mov TL2, #B1h               ; Lower Byte
        Mov TH2, #FFh               ; Upper Byte
        Mov RCAP2L, #B1h                ; Lower Byte
        Mov RCAP2H, #FFh                ; Upper Byte
```

```
Setb TR2                    ; Run Timer
MOV A,#38H
ACALL COMMAND
MOV A,#0CH
ACALL COMMAND
MOV A,#01H
ACALL COMMAND
MOV A,#06H
ACALL COMMAND
MOV A,#80H
ACALL COMMAND
MOV A,#'N'
ACALL DATA_DISPLAY
MOV A,#'o'
ACALL DATA_DISPLAY
MOV A,#'.'
ACALL DATA_DISPLAY
MOV A,#' '
ACALL DATA_DISPLAY
MOV A,#'o'
ACALL DATA_DISPLAY
MOV A,#'f'
ACALL DATA_DISPLAY
MOV A,#' '
ACALL DATA_DISPLAY
MOV A,#'V'
ACALL DATA_DISPLAY
```

```
        MOV A,#'i'
        ACALL DATA_DISPLAY
        MOV A,#'s'
        ACALL DATA_DISPLAY
        MOV A,#'i'
        ACALL DATA_DISPLAY
        MOV A,#'t'
        ACALL DATA_DISPLAY
        MOV A,#'o'
        ACALL DATA_DISPLAY
        MOV A,#'r'
        ACALL DATA_DISPLAY
        MOV A,#'s'
        ACALL DATA_DISPLAY
        MOV A,#C7H
        ACALL COMMAND
        MOV A,#'0'
        ACALL DATA_DISPLAY
        MOV A,#'0'
        ACALL DATA_DISPLAY
WAIT:
        AJMP WAIT

OUT_SIDE_SENSOR:
        SETB P1.1
        JB P1.3, GOING_OUT
        RETI
```

```
IN_SIDE_SENSOR:
        SETB P1.3
        JB P1.1, COMING_IN
        RETI

GOING_OUT:
       CLR P1.1
       CLR P1.3
       DJNZ R0,INTRT                    : decrements Register 0
       ACALL BCDCONV
       ACALL DATA_WRT
       CLR P1.6:                        switches off the roomlight
INTRT:   RETI

COMING_IN:
       CLR P1.1
       CLR P1.3
       INC R0                           : increments Register 0
       ACALL BCDCONV
       ACALL DATA_WRT
       JB P1.6, INTRT
       SETB P1.6                        :  turns on the roomlight
       RETI

BCDCONV:
      MOV B,#10
```

```
    MOV A,R0
    DIV AB
    MOV R1,B
    MOV B,#10
    DIV AB
    MOV R2,B
    MOV B,#10
    DIV AB
    MOV R3,B
    RET
COMMAND:
    MOV P2,A
    CLR P0.2
    CLR P0.4
    SETB P0.7
    CLR P0.7
    ACALL DELAY
    RET
DATA_DISPLAY:
    MOV P2,A
    SETB P0.2
    CLR P0.4
    SETB P0.7
    CLR P0.7
    ACALL DELAY
    RET
DELAY:
```

```
        MOV R3,#50
HERE2:
        MOV R4,#255
HERE:
        DJNZ R4,HERE
        DJNZ R3,HERE2
        RET

DATA_WRT:
        MOV A,#C7H
        ACALL COMMAND
        MOV A,R3
        ADD A,#30H
        ACALL DATA_DISPLAY
        MOV A,R2
        ADD A,#30H
        ACALL DATA_DISPLAY
        MOV A,R1
        ADD A,#30H
        ACALL DATA_DISPLAY
        RET
END
```

The subroutine ‘main’ is the program that initializes the microcontroller pins in such a way that they behave as intended