DESIGN AND CONSTRUCTION OF AN AUTOMATIC GARAGE LIGHT

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A THESIS SUBMITTED TO THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

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DEDICATION

This project is dedicated first to God Almighty, the family of Mr. and Mrs. L.C. Okolo, my Aunt Margret, my siblings Sophie, Leonard, Joan, Patrick, Crystal and William and not forgetting my beloved Grandmother, love you all This is also dedicated to the Electrical/Computer Engineering Department and staff therein of the Federal University of Technology, Minna.

DECLARATION

I, Gregory Okolo Nnamdi, declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquish the copyright to the Federal University of Technology, Minna.

Gregory Okolo N.	Engineer Y.A Adediran
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Signature and Date	Signature and Date

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My first and sincere gratitude goes to God Almighty without whom everything concerning my life and this project would have resulted in a fiasco.

I would love to use this medium to express my sincere gratitude to my beloved parents

Mr. and Mrs. L.C.Okolo and my siblings for their moral, material and spiritual support and also my dear Grandmother for the disciplinary training she gave me, I love you all.

I would also like to use this medium to appreciate my beloved friends who have always stood by me both in the smooth and rough times. I would like to appreciate my project supervisor Engineer. Adediran who has been of great assistance throughout the period I was carrying out the project. I would also like to appreciate the HOD, Engineer. Musa Abdullahi who has been like a Father to me and has inspired in so many ways.

ABSTRACT

This project deals with the design and construction of an Automatic Garage Light system. It is aimed at overcoming darkness when parking a car in the garage at night. This was achieved by techniques employed using a Light Detecting Unit – consisting of a Light Dependent Resistor, Power supply from a 12V/0.5A step-down transformer, a Relay, NPN transistors, Variable resistors among other equipment. The headlights trigger the garage light for a preset time period-daytime override included.

The project was carried out using commonly available and inexpensive components and the results obtained were quite satisfactory.

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CHAPTER ONE

Introduction

1.0 Introduction

The 20th century has come and gone, luckily for us it was a century engulfed in massive technological `research and development which are now used to make our way of life a lot easier.

Most of such technological breakthroughs were finalized with the use of electrical power, electric circuits and devices. With the discovery of electricity, man expanded his frontiers into a world of unending possibilities. Our cars, trains, ships all changed from locomotive engines to engines using electric current devices. With these changes movement of people and goods were made easier and faster and life was now simpler.

Integrated circuits were later discovered after previous devices were either bulky or overheating after a long duration of operating. Most devices now have in-built integrated circuits, with these small devices, functions and task were done faster and lasted longer than their predecessors and the devices with such were now portable ,sophisticated and easier to carry around eg calculator, wireless remote control etc.

These devices are found everywhere either at home or at work and are used for either security purposes or for the purpose of comfort.

The project Automatic Garage Light is one of such devices and its aim is for the comfort of its user.

1.1 History

The Automatic Garage light has no definite date or day of invention but ever since the discovery of integrated circuits and their importance in most electronic devices, more ideas and inventions were thought about and later designed.

For this project though the areas of light bulbs and sensory devices are very important. The electric light is an illumination that is produced by means of a number of devices that convert electrical energy into light.

Light (Electric light) was discovered after scientists began to understand electricity in the 1700s, with the success for the test of electricity with the use of a kite by Benjamin Franklin, the electric light finally became an important source of comfort and security.
It was first invented by Thomas Alva Edison and Thomas Swan by 1879, yet it was an improved project that was 50 years old, at the end of Thomas Edison's research and construction, he was able to produce a reliable, long lasting source of light.

The history of the light bulb dates back to 1809 and between 1809-1878, 8 scientists had started the research on the light bulb with Humphrey Davey starting in 1809 and Sir Joseph Wilson Swan ending in 1878, Sir Swan invented a practical and long lasting electric bulb of 13 and a half hours using a carbon fiber filament from cotton.
After them, Thomas Alva Edison and he invented a carbon filament that burned for 40hour and later improved on it by 1880 using a bamboo-derived filament that made it last for 1200hours.

After his discovery between 1903-1991,other scientists and researchers continued at creating a light bulb that could last long enough and by 1991,Phillips invented a light bulb that could last 60,000 hours with a bulb using magnetic induction.

The types of electric lightning devices now today include the fluorescent lamp, Incandescent lamp, light bulb etc.

The sensory devices are devices that measure electrical quantities as well as chemical and mechanical quantities. It is responsive to change in quantity to measurement example of such include temperature, position, concentration etc. some of the devices act as both sensors and transducers and example of such devices include the photo electric cells. The photoelectric cells operate in burglar alarms, traffic light controls and door openers. A phototube and a beam of light form an essential part of such an electric circuit.

The light produced by a bulb at one end of the circuit falls on the phototube located some distance away and interruption in the beam of light breaks the circuit and causes a relay to close which then energizes the device being used. The Automatic Garage Light is connected with a bulb at its end to produce its required output at the given time,

This device is used mainly in the garage of any public or private building and it helps its owner clear his things form his car under a particular time.

1.2 Aim of the project

For the comfort of its user after a hard day's work, the project will ease the user the stress of switching on the garage light for his own purpose.

1.3 Objective of the project

1. To provide a simpler, cost effective device aimed at preventing darkness at anytime within its environment when needed.

2. To demonstrate effectively how important constant research for improvement can help save time and energy.

1.4 Project Requirements

1. A variable resistor which regulates the voltage to correspond with the light intensity based on the sensor.
2. An NE555 timer
3. Power supply unit needed for powering the circuit.
4. Photo electric cells needed for powering/triggering the device
5. Relay
6. Light emitting diode used for indicating which photocell is functioning.

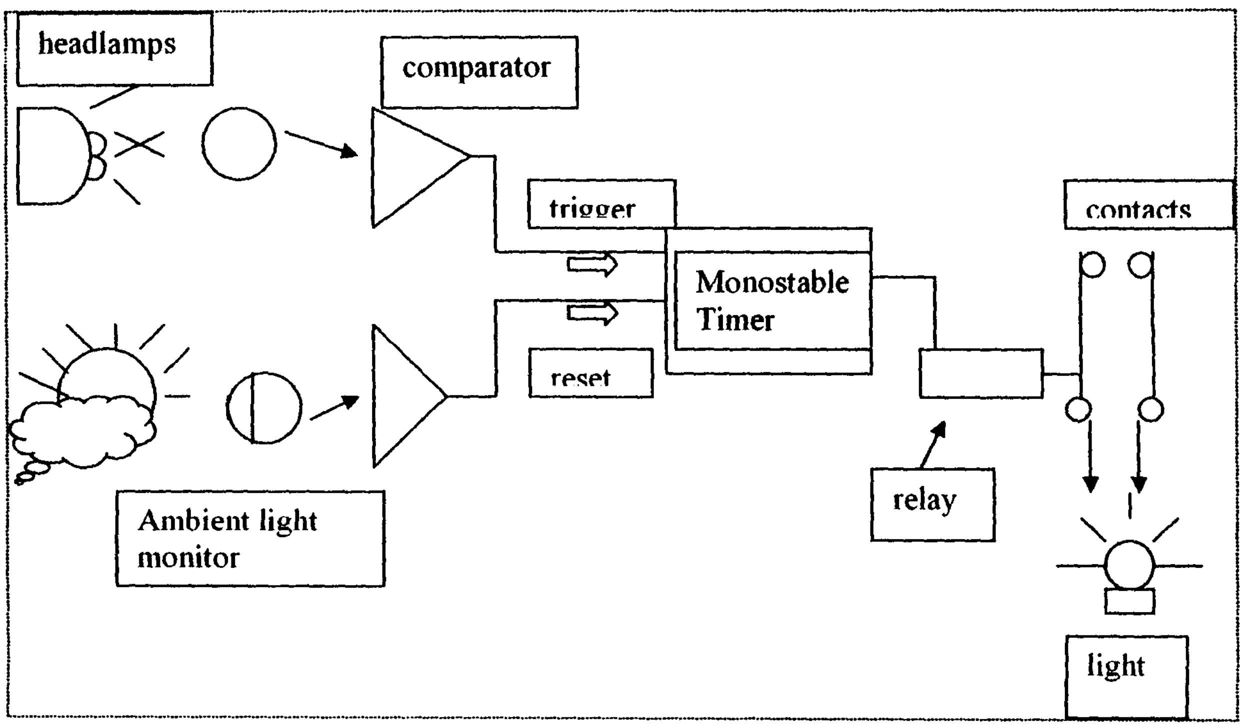


Figure 1.1 BLOCK DIAGRAM OF THE AUTOMATIC GARAGE LIGHT

CHAPTER TWO

Literature review

2.1 Theoretical background

The garage is a building for parking or storing one or more motor vehicles, the garage could be either for public or private use and its operational both at day and at night. At anytime the garage is visible for its user to gain access into it and perform his final duties before leaving the premises, it's a lot easier at day time but at night, the lights in the garage must be illuminated properly so as to allow a better visibility of the garage as a whole.

Illumination which is the provision of light to make something visible or bright, or the fact of being lit up in a particular place is an important aspect of this project and can be controlled in many ways as well.

The Garage light could be operated manually or automatically depending on the user's style and financial base. This project meanwhile is on the basis of an automatic garage light whose control unit automatically operates the garage's light for a pre-determined period of time and is activated by the car's headlamps as the vehicle is driven into the garage. It is also automatic in the sense that, it will only switch on the garage electric light during night-time hours once the ambient light levels have fallen below a pre-determined level. The intensity of the light being received can be varied with the use of a potentiometer.

The project hasn't really been constructed for the garage itself but in other areas of interest. One already made project is the INSTEON SwitchLinc Relay Countdown Timer. Its aim is to control the use of light in the home by preventing the wastage of current from a light bulb been left on. It replaces the usual wall switch and acts as a standalone wall switch timer. Once you press the paddle top to turn on the switch, its activates the built-in timer as well and will automatically turn the lights off in 15 minutes.

Tapping the paddle again will keep the light on for an hour and each additional tap will add another hour to the timer; the highest you can go is up to 24 hours maximum. The device all has timer settings stored in a non-volatile memory and are not lost during power failures. If such power outage occurs, the timer will return to its last on/off state when power is restored.

The device can control up to a 480-watt incandescent or 13A resistive load and has supply voltage of 120 volts AC. When it comes to heat the device uses a hard-contact relay to control the load, this makes it run cooler and full voltage gets to the load as well.

2.2 Difficulties limiting performance

Even though a product like the INSTEON SwitchLinc Relay Countdown Timer is a simple project for comfort, constructing the project had created some difficulties.

- The use of Incandescent Light bulb could be change to fluorescent bulbs since it consumes much more power, generate a great deal of heat, and relies on a filament that deteriorates with use.

2.3 Brief history of lights and lamps

Pre-electrical Lamps

The first lamp was invented around 70,000 BC. A hollow rock, shell or other natural found object was filled with moss or a similar material that was soaked with animal fat and ignited. Humans began imitating the natural shapes with manmade pottery, alabaster, and metal lamps. Wicks were later added to control the rate of burning. Around the 7th century BC, the Greeks began making terra cotta lamps to replace handheld torches. The word lamp is derived from the Greek word lampas, meaning torch.

Oil Lamps

In the 18th century, the central burner was invented, a major improvement in lamp design. The fuel source was now tightly enclosed in metal, and an adjustable metal tube was used to control the intensity of the fuel burning and intensity of the light. Around the same time, small glass chimneys were added to lamps to both protect the flame and control the flow of air to the flame. Ami Argand, a Swiss chemist is credited with first developing the principal of using an oil lamp with a hollow circular wick surrounded by a glass chimney in 1783.

Lighting Fuels

Early lighting fuels consisted of olive oil, beeswax, fish oil, whale oil, sesame oil, nut oil, and similar substances. These were the most commonly used fuels until the late 18th century. However, the ancient Chinese collected natural gas in skins that was used for illumination.

In 1859, drilling for petroleum oil began and the kerosene (a petroleum derivative) lamp grew popular, first introduced in 1853 in Germany. Coal and natural gas lamps were also becoming wide-spread. Coal gas was first used as a lighting fuel as early as 1784.

Gas Lights

In 1792, the first commercial use of gas lighting began when William Murdoch used coal gas for lighting his house in Redruth, Cornwall. German inventor Freidrich Winzer (Winsor) was the first person to patent coal gas lighting in 1804 and a "thermolampe" using gas distilled from wood was patented in 1799. David Melville received the first U.S. gas light patent in 1810.

Early in the 19th century, most cities in the United States and Europe had streets that were gaslight. Gas lighting for streets gave way to low pressure sodium and high pressure mercury lighting in the 1930s and the development of the electric lighting at the turn of the 19th century replaced gas lighting in homes.

Electrical Lighting

Sir Joseph Swann of England and Thomas Edison both invented the first electric incandescent lamps around the 1870s. Incandescent lightbulbs work in this way: electricity flows through the filament that is inside the bulb; the filament has resistance to the electricity; the resistance makes the filament heat to a high temperature; the heated filament then radiates light. All incandescent lamps work by using a physical filament.

Thomas A. Edison of the United States invented the first commercially successful incandescent lamp around 1879. Incandescent lamps are what we regularly use in our homes.

2.4 Types of lights

2.4.1 The Incandescent Light bulb

The incandescent light bulb (also spelled light bulb) or incandescent lamp is a source of artificial light that works by incandescence.

Incandescent bulbs are also called electric lamps, a term originally applied to the original arc lamps. Incandescent bulbs are made in a wide range of sizes and voltages, from 1.5 volts to about 300 volts. They require no external regulating equipment and have a low manufacturing cost, and work well on either alternating current or direct current. As a result the incandescent lamp is widely used in household and commercial lighting, for portable lighting, such as table lamps, some car headlamps and electric flashlights, and for decorative and advertising lighting.

2.4.2 Light emitting diodes

Light emitting diodes (LED) are PN junction devices that give off light radiation when biased in the forward direction. Most light emitting diodes function in the near infrared and visible ranges, though there are now UV LEDs. Light emitting diodes are a reliable means of indication compared to light sources such as incandescent and neon lamps.

LEDs are solid-state devices requiring little power and generating little heat. Because their heat generation is low and because they do not rely on a deteriorating material to generate light, LEDs have long operating lifetimes. One of the alternatives, incandescent bulbs, consumes much more power, generate a great deal of heat, and rely on a filament that deteriorates with use. Neon bulbs, on the other hand, rely on excited plasma, which, along with its electrodes, can deteriorate over time.

Common features of light emitting diodes include lens type choices, bipolar construction, dual LEDs, and arrays. Lens type choices include flat lenses and domed lenses. Bipolar LEDs work even if voltage is reversed. Select models change color on reverse voltage. Dual LEDs are two LED lamps in the same housing. In an LED array the LEDs are packaged as multiples. LED arrays will contain a certain number of elements (LEDs).

2.4.3 Fluorescent Lights

Another type of electric lamp containing a low pressure vapour, usually mercury, in a glass tube. Passing an electric through it produces ultraviolet radiation that is converted into visible light by a coating inside the tube. Fluorescent lamps are cooler and more efficient than incandescent lamps, which produce light by heating a filament to high temperatures. A fluorescent lamp consists of a glass tube filled with a mixture of argon and mercury vapor and coated with phosphors on the inside surface. Each end of the tube is fitted with metal electrodes coated with a compound of an alkaline earth metal and oxygen, called an alkaline earth oxide that produces electrons when connected to a power source. A device called a starter sends extra voltage to ionize, or give a net electric charge to, the gas in the tube. When current flows through the ionized gas between the electrodes, it emits ultraviolet radiation. The phosphor coating inside the tube absorbs this ultraviolet radiation and re-emits the energy as visible light.

Since the discovery of fluorescence in the 1600s, scientists have synthesized hundreds of thousands of phosphors. Each phosphor has a characteristic color of emission and duration of luminescence. Some phosphors, such as zinc sulfide and cadmium sulfide, are easily excited by a beam of electrons. As a result, these phosphors are used in the production of radar and television screens.

American engineer Peter Hewitt created the first mercury vapor lamp in 1901, which functions like a modern fluorescent lamp without the phosphor coating. The mercury vapor lamp emitted much of its radiation in the ultraviolet region of the electromagnetic spectrum. Engineers at General Electric Company were the first to combine phosphors with mercury vapor lamps to produce the first practical fluorescent lamp in 1934. Fluorescent lamps rapidly replaced incandescent lamps in industrial use and have also grown in popularity for home lighting.

CHAPTER THREE

Design and Implementation

3.1 Power Supply

The main input voltage of 240volts a.c is applied to the three way terminal block TB2, via the protective fuse FSI and is stepped down by transformer T1 to 9v a.c. This is then rectified by the bridge rectifier, this is smoothened by the reservoir capacitor C1.To help decouple any noise and spikes, capacitor C2 is connected across capacitor C1.The result is a D.C unregulated supply of approximately 11v which is the main supply for the circuit.Generally, the main supply is usually an alternating current a.c and can be varied after rectification.

Rectification is the conversion of an alternating current (a.c) to direct current (d.c) in power supply circuits for electronic systems. The mains are stepped down to the required d.c voltage. The rectifier circuits make use of the following:

a. Half-wave Rectifier

b. Full-wave Rectifier

c. Bridge Rectifier

3.1.1 Half-wave Rectifier

This uses a single rectifier diode. A diode conducts only in one direction i.e. unidirectional, conducting in the forward-bias direction and non-conducting in the reverse bias direction.

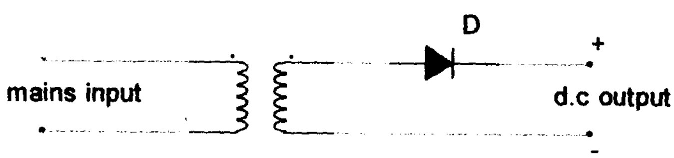


figure 3.1 half wave rectifier

3.1.2 Full-wave Rectifier

This uses a transformer with a center-tapped coil and two rectifier diode. On the first half-cycle, diode D1 conducts and diode D2 conducts and D1 is non-conducting. Hence, full-wave rectifier provides a much smoother flow of current than the half-wave rectifier.

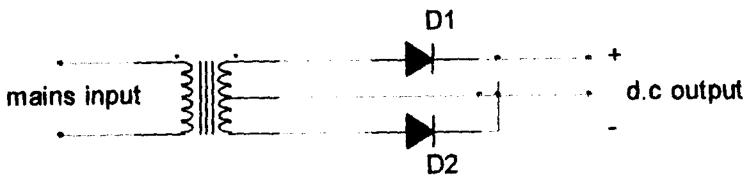


figure 3.2 full-wave rectifier

3.1.3 Bridge Rectifier

This is another full-wave rectifier which uses a bridge of four diode. Two diode D1 and D2 conducts simultaneously on the first half cycle and diode D3 and D4 are non-conducting.However,on the second half-cycle, diode D3 and D2 conduct and diode D1 and D2 are non-conducting. The wave form is shown below on the full-wave using two diodes.

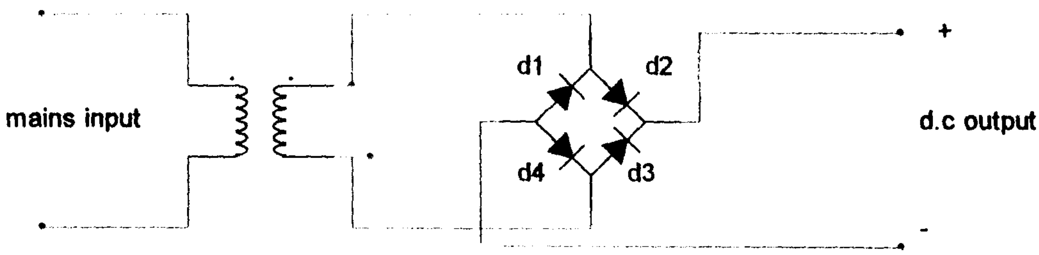


figure 3.3 bridge rectifier

3.1.4 Filtering/Smothering

In order to achieve constant or smooth e.m.f at some fixed value, a reservoir capacitor is connected across the d.c output. The current from the rectifying circuit charges the capacitor and it is later discharged steadily as current flows through the load. If the average charging current equals the steady discharging current, the capacitor remains charged. The potential difference between its plates is not absolutely steady but varies regularly, the smoothed electromotive force (e.m.f) flows a ripple voltage.

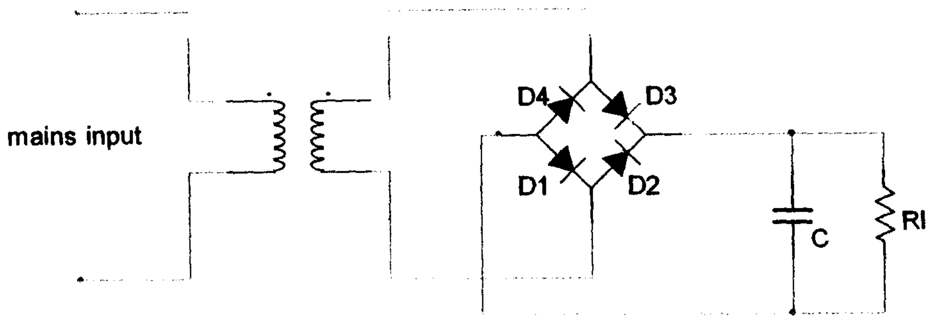


figure 3.4 filtering

Ripple voltage Vr is the deviation of the load voltage from its average voltage or d.c value. The diode current is the boundary of the shaded portions and is assumed triangular.

3.2 MAINS SWITCHING

For the mains switching, a relay rated, 12v 200ohms coil (with 240v 5A a.c).The relay has two sets of change over contacts, of which the normally-open contacts are employed to switch the electric light. This circuit is so versatile that it will permit not only an existing lamp to be operated, but also enables us to connect a light to the unit if the garage does not already have lighting installed.

The electric light is connected to the four-way terminal block TB2.To automate an existing lamp/light, we simply connected terminals TBB2/2 and TB/3 in parallel across the light switch. Contacts RLA2 will then close when IC2 (NE555) is timing and this will in effect short out the light switch to illuminate the electric light.

In a garage where there was no light or light switch, we then linked terminals TB2/1 and TB2/2 with a link wire which connects the live (L) supply to terminal 2 of the relay RLA2. The live output was taken from terminal TB2/3 to a new light output which we can install in the garage. The circuit returns to the terminal TB2/4 where it is connected to neutral (N) through relay contact RLA1.

The mains supply was taken from a fused 13A outlet via a 240v supply existing already in the garage.

3.3 Timers:

Astable and monostable multivibrators are used for timing operations in many electronic systems. The popular eight pin NE555 timer integrated circuit IC can either be used as a square-wave oscillator. i.e. an astable or as a single pulse generator i.e monostable. It works on d.c supply from 3 to 15v and can source or sink current up to 200Ma at its output. Basically, it consists of an R-S flip-flop whose reset and set are each controlled by an operational amplifier (OPAMP)

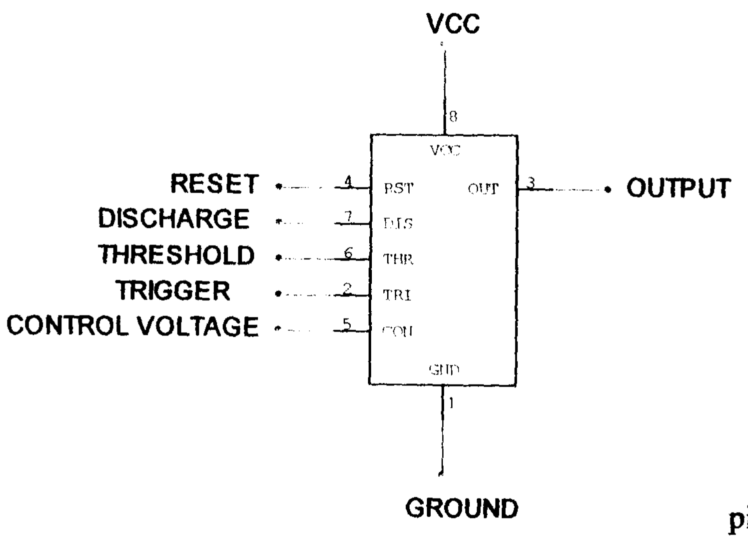
3.4 NE555 TIMER

For this project, we would use the monostable operation of the NE555. The external resistor, RA and the threshold (pin 6) is joined to discharge (pin 7).The time delay is provided by one resistor and a capacitor. One rectangular pulse is produced when the circuit is triggered by the falling edge of an external pulse applied to trigger pin 2.it then returns to its once table state (low output) to await the next trigger pulse.

The trigger pulse can be obtained for example by switching S1 to X (+Vcc) to Y (0v) and back to X again. The operation is completed in a time which is less than the output pulse time and is given by the delay time TD

TD=1.1RC

Below are is pin diagram and internal block diagram of the NE555 timer.



pin configuration

Figure 3.5 NE555 timer

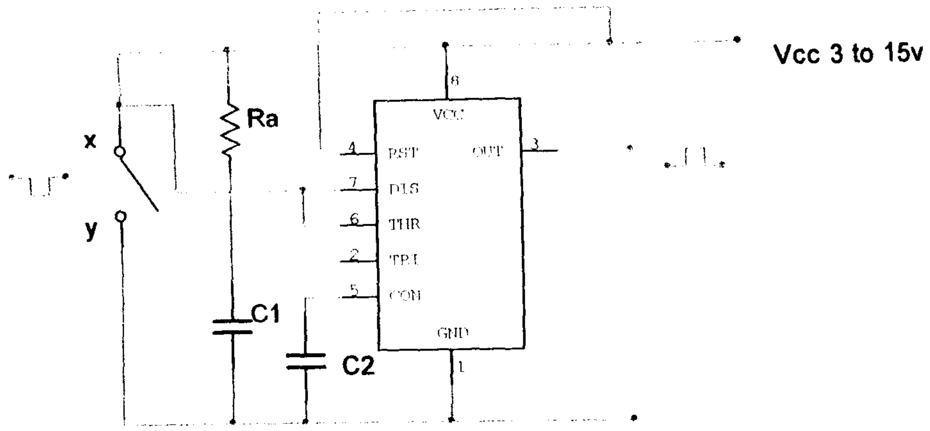


Figure 3.6 Internal block diagram of the NE555 timer

3.41 THE NE555 TIMER IN MONOSTABLE OPERATION

The pin-out and the internal block diagram are shown below as in monostable operation.In the standby state, the control flip-flop holds Q1 ON thus clamping the timing capacitor C to ground. The output pin 3 during this time is at ground potential or low. The 5K internal resistor act as voltage dividers providing bias voltage of 2/3V cc and 1/3V cc respectively. Since these two voltages fix the necessary comparator threshold voltages, they also aid in determining the timing interval.

Since the lower comparator is biased at 1/3Vcc, it remains in the standby state so long as the trigger input, pin 2 is held above 1/3Vcc.When triggered by a negative going pulse, the lower comparator sets the internal flip-flop which releases the short circuit across the timing capacitor, thus Q1 is OFF and the output goes high approximately Vcc. Since the timing capacitor is now unclamped, the voltage across it now rises exponentially through Ra towards Vcc with a time constant of RaC.After a period of time, the capacitor rapidly to ground potential, turning Q1 ON. Consequently the output now returns to the standby state or ground.

The circuit is triggered only by a negative going pulse, when the level is less than 1/3Vcc.Once triggered, the output will remain HIGH until the set time has elapsed, even if it is triggered again during this\time interval. since the external charges exponentially from 0 to 1/3 Vcc.

Therefore t = 1.1 Ra C

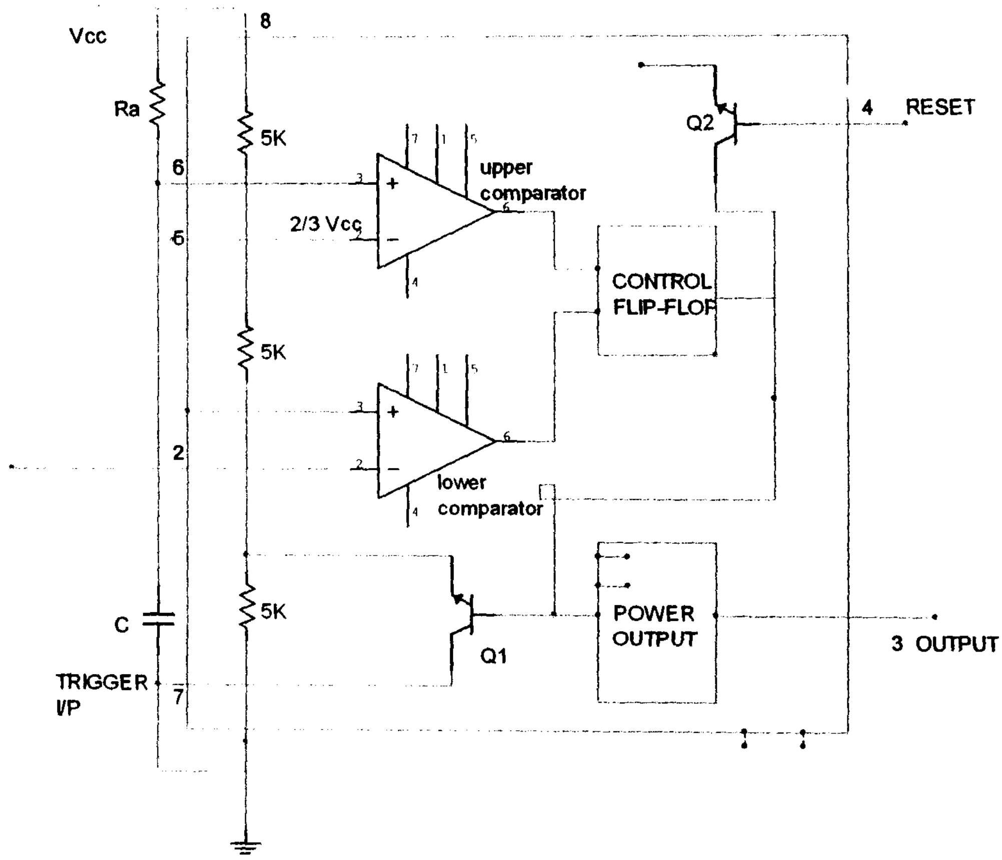


Figure 3.7 Monostable operational diagram of the NE555 timer

3.5 PHOTO CELLS

Photocells change light (also infrared and ultraviolet radiation) into electrical signals and are useful in burglary and fire alarms as well as in counting and automatic control systems. There are three types namely

1. Photo emissive
2. Photo voltaic
3. Photo conductive

PHOTO EMMISIVE

This is a diode whose cathode is coated with potassium selsium oxide. As light strikes the cathode, electrons are emitted from the surface and are collected by the positive plate. The amount of electrons emitted is proportional to the intensity of light falling in the cathode.

PHOTO VOLTAIC CELL

When illuminated, a photo voltaic cell produces voltage, i.e. it is a true cell. It consists of a pin semi-conductor junction with the p-layer being thin enough to allow the incident light to reach the junction. The source of energy is the incident light.

The voltage available depends on the junction materials, the intensity of the light and the current taken. For a silicon cell in full sunlight, the voltage on open is 0.45v approximately with a maximum current of about 35mA for each square centimeter of cell and an efficiency of about 10% i.e. only 10% of the light is charged to electrical energy. For gallium arsenide the efficiency is nearer 20%.

PHOTO CONDUCTIVE CELL OR LIGHT DEPENDENT RESISTOR

The resistance of certain semiconductors such as cadmium sulphide decreases as the intensity of the light falling on them increases. The effect is due to the energy of the light setting free electrons from donor atoms in the semi-conductor, so increasing its conductor, i.e. reducing its resistance. During the day,light resistance is low, a negative potential is therefore applied to the use of the transistor.

Consequently, there's no collector current. The relay is opened and the light is turned off. At night, the dark resistance is greater thereby making a positive voltage to be applied to the base of the transistor and the relay is closed turning the light on.

3.6 Operational Amplifier

An operational amplifier is an integrated circuit amplifier with a very large voltage gain, high input impedance and low output impedance.

They are available in hundreds of different types, the most general group being the d.c-coupled differential voltage amplifiers, inverting and non-inverting inputs and a single-ended output. The symbolic diagram is shown below

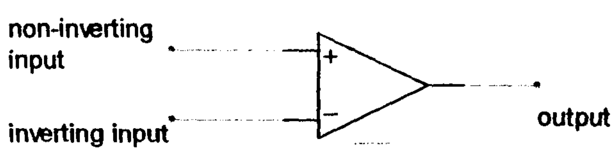


Figure 3.8 Operational amplifier

The output is an amplified version of the difference between the two inputs (the output goes to positive when the non-inverting input is greater than the inverting input). Only a very small difference in potential is required between the two inputs to cause a large output-voltage swing. The voltage gain is large and unpredictable, and the device is never used as an amplifier without negative feedback being applied. They are designed in such a way that can open-loop gain of several million to be reduced to one-tenth of the gain by the application of negative feedback.

The voltage gain, Av of the amplifier is the ratio of the output voltage to input voltage with understated conditions for source resistance and load resistance. The ideal op-amp has infinite input impedance, zero output impedance , infinite voltage gain, infinite bandwidth and zero output voltage when the two input voltages are equal.Unfortunantely, this device would also have infinite cost. The basic inverting and non-inverting amplifier circuits are shown below.

Inverting amplifiers

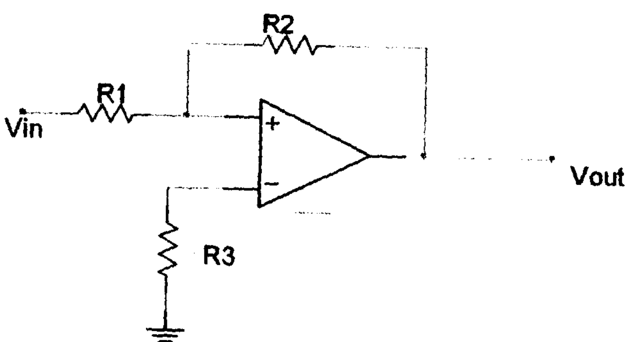


Figure 3.9 inverting amplifier

Av = Vout/Vin = -R2/R1

Zin= R1 ; Zout = fraction of an ohm

R3=R1//R2

Non-inverting amplifier

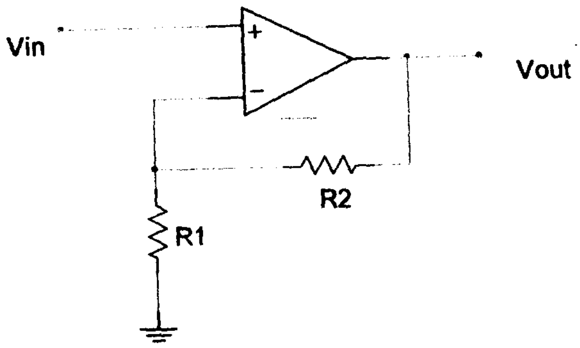


Figure 3.1.1 non-inverting amplifier

Av=Vout/Vin = 1+ R2/R1

Zout = fraction of an ohm

In the construction of this project we decided to use the LM358N, a bipolar op-amp. This is a dual low-power op-amp designed specifically to operate from a single supply rail of 3 to 30 v dc with a quiescent current of 500A.

The 741 features an input common mode that includes ground and an output voltage that can swing to ground. This op-amp is ideally suited for direct operation from a standard +Vdc supply and is compatible with all forms of logic.

3.7 Circuit design

The circuit diagram of the AUTOMATIC GARAGE LIGHT is centered around a twin operational amplifier chip, LM741.As indicated earlier, this circuit uses two photoconductive cells or light dependent resistors (l.d.r) of which ORP12 was chosen. The first l.d.r, R3 can be taken as the daylight/night time detector and is connected to form a potential divider with preset resistor VR1.It is located in a position where it can monitor ambient light levels.

The Day/Night sensor which detects when dusk is approaching is formed by ICIa and associated components and will activate the Automatic Garage Light circuit when the light has fallen to a predetermined level. As the ambient light increases, the unit is de-activated, the circuit then prevents the electric light from being unnecessarily triggered during daytime. The output from the potential divider network was taken from the wiper of VR1 and connected to the inverting input pin 2 of ICIa; a simple fixed divider comprising of resistors R1 and R2 provides a reference voltage of 50% of the supply rail to the non-inverting input pin 3.The supply voltage is about 10v and thus pin 3 is held at about 5v.

When pin 3 is more positive than pin 2, then the output (pin 7) swings high to almost the supply rail voltage. Conversely, should the potential at pin 2 exceed that at pin 3, then the output will sing low to about 1 volt or so. Since the resistance of l.d.r R3 changes inversely to the incident light levels, the voltage at pin 2 will fall when the ambient light level increases, and rise when the light upon it reduces. Thus, the output of ICIa can be made to switch high or low by the change of light level which is monitored by l.d.r R3, such that in darkness (R3 resistance high) pin 7 is low and vice versa.

The exact point at which the switch-over from high to low takes place can be determined by the setting of preset VR1.This can be trimmed so that each installation can be individually tuned to prevailing conditions.

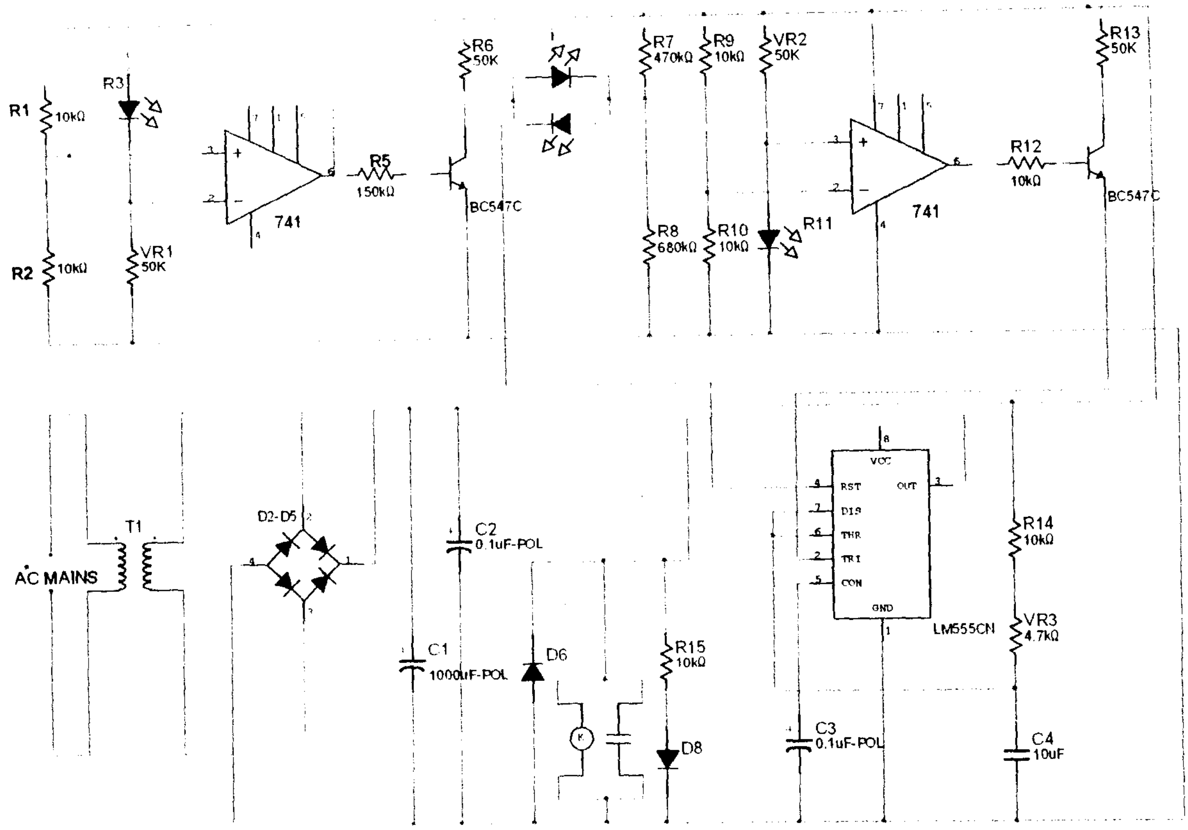


Figure 3.1.2 circuit diagram of the automatic garage light

Of course, the gradual onset of darkness is a very slow change over several hours. The gain of the op-amp is so light that in a comparator mode, only a tiny fraction of a voltage difference needs to exist between the non-inverting and inverting inputs of ICla and the device will amplify this and switch over the state of the output. Without any feedback between the input and output, the amplification factor or "open-loop gain" of LM741 is up to 100,000 and so the IC will multiply the difference between the two inputs by this factor thereby making the circuit very sensitive to differences between the inputs.

When pin 3 is more positive than pin 2, then the output (pin 7) swings "high" to almost the supply rail voltage. Conversely should the potential at pin 2 exceed that at pin 3, and then the output will swing "low" to about 1 volt or so.

3.8 Headlights Detector

The other op-amp, ICIb was also connected as a comparator circuit but this time,R11 is another photoconductive cell (l.d.r) which was mounted in the garage at the spot where the car's headlamps on it. This time when light falls upon the photo resistor, the inverting input (pin 2) will be fed towards the positive supply rail and the output will swing low.

Resistors R9 and R10 set up a reference voltage at pin 3 (the non-inverting input) and VR2 is another pre set which controls the sensitivity of the circuit. i.e. how brightly R11 must be illuminated by the car's headlamps before the comparator switches over. The output from ICIb (headlights detect) drives the trigger terminal (pin 2) of the timer chip, IC2.The timer requires a voltage of two-thirds of the supply rail or less in order to commence timing and so the timer is triggered when l.d.r R11 detects the car headlights, the trigger terminal being driven low by ICIb.

Unlike the trigger input, the reset terminal (pin 4) of IC2 needs a voltage of 0.7 maximum for the device to reset. The output of ICIa can be well over one volt when "low" and so a transistor switch TR1 was included which also inverts the output signal from pin 7.

Therefore, when ICIa output goes high (under daytime conditions), transistor TR1 saturates and the collector falls to about 100mV or so. This provides a suitable reset signal for the timer chip, with the result that during daylight hours, the timer is disabled and cannot operate; this will override any signal present at the timer's trigger terminal.

The timer itself is a standard monostable arrangement which will generate a fixed period delay when triggered at pins 2, unless the reset pin 4 is low. The period is determined by resistor R14, preset V3 and capacitor C4 and is about eight minutes maximum.VR3 can be trimmed to change the period as required.

The output of the timer, pin3 goes high during timing and this will illuminate l.e.d D8.The relay is also energized during timing, diode D6 preventing latching current or relay coil when it de-energizes. Resistor R4 introduces an additional side-effect in the operation if the Schmitt trigger. When the output switches either high or low, this effectively places R4 parallel with resistors R1 or R2 respectively.

This can be considered as altering the values of R1 and R2 and has important effect upon the reference voltage at pin 5.When ICIa output is low, resistor R4 can be considered being parallel with R2. and the reference voltage is

Vref = combined value of R2 and R4 /Total resistance of voltage divider x supply voltage

= 7.6 x 10^3/ (10 +7.6) x 10

= 4.32 v

Alternatively, when pin 7 is high, R4 is now in parallel with R1 and the reference voltage becomes Vref = R2 / R2R1//R4 x supply voltage

= R2 x 10(10 + 7.67) x 10

= 5.66v

There is now a difference between the point at which the circuit can be switched high and the point when it must low because the reference voltage at pin 2 is changed by the inclusion of R4.The difference in switching points is called "hysteresis" and is a fundamental characteristic of the Schmitt trigger.

In practice the circuit will trigger where the ambient light level has fallen to a certain level but the light must increase back beyond that level before the circuit switches back again.Connected to the output of ICla is a bi-colour L.D.R (red and green).This will glow red when the op-amp output is high (daylight) and green when the op-amp output is low (circuit operational).Resistor R1 and R3 provide a voltage drop for each l.e.d chip.

3.9 Construction and Assembly

The whole of the circuit for the Automatic Garage Light was constructed on a circuit board measuring 100 x 110 cm approximately. Assembly started with the soldering of the smallest components first. We made sure that the transistors, electrolytic capacitors, bridge rectifier and diodes were correctly polarized also noted two link wires which need soldering into place. After mounting all the components on the circuit board, the board was then installed into the box-measuring 160mm x 110mm x 50mm approximately. The flying leads for the l.d.r photocells and light-emitting diodes were soldered directly to the circuit board.

3.10 Light Sensors

The l.d.r.R3 (daylight detector) was mounted on top of a small container and was located to flush against the garage window; it was connected by a length of flexible cables. We made sure that this photocell R3 has an unobstructed view of ambient light levels. On the other hand, l.d.r R11 was mounted in the garage in the location where light from the car's headlamps would fall on it. The photocell was glued on top of a small container .Both photocells were positioned where light from the electric light does not fall onto them to avoid feedback as this will cause oscillation.

CHAPTER FOUR

Test, Results and Discussion

4.1 Installation

The diagrams below shows how the unit can be connected to an existing electric light and how to install a full-controlled electric light if one does not exist already.

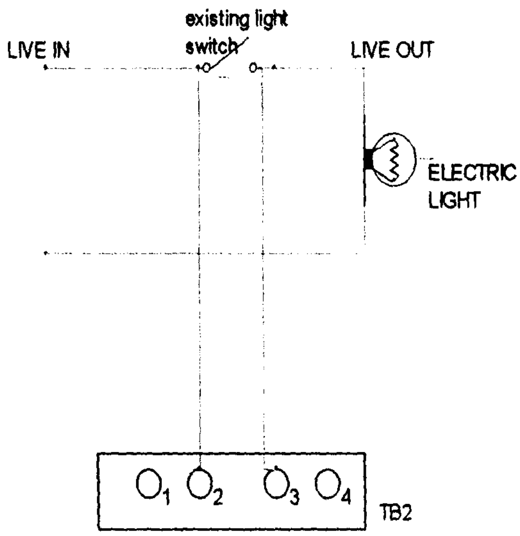


Figure 4.1 Connection for existing electric light

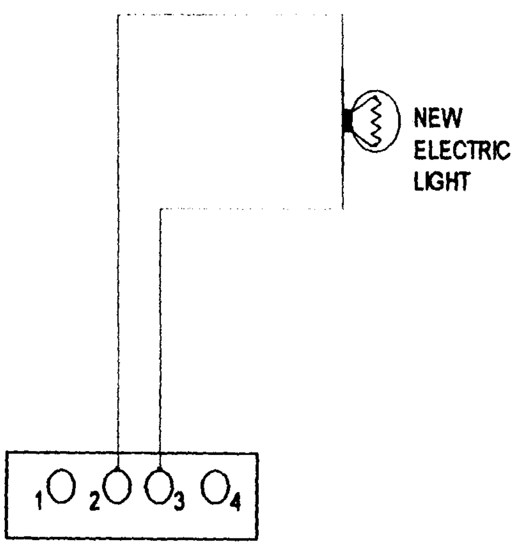


figure 4.2 Installation of a new electric light

This is necessary to ascertain the working conditions of the unit before placing it on its finals stages to been a finished product. A lot of attention was placed on the polarity of the bridge rectifier and smoothing capacitor C1. We kept the photocells handy before housing them permanently. We set the preset VR1 and VR2 to mid way and VR3 to nearly fully anticlockwise before the graduation. We clipped a 12v d.c across capacitor C1.

The bi-colour l.e.d D1 turned red (indicating day time) than we simulated night-time by covering photocell R3 and l.e.d D1 turned green, we temporarily exposed R11 to light simulating car headlamps and the relay wins heard clicked into operation with the yellow l.e.d D8 illuminating. After some period determined by VR3, the relay switched out again.

Of course, if D1 is red it should not be possible to activate the relay and D8 because the timer should be in a disable state due to the resetting action of transistor TR1 upon ICla.

4.2 Results and Discussion

- **For a one shot monostable**

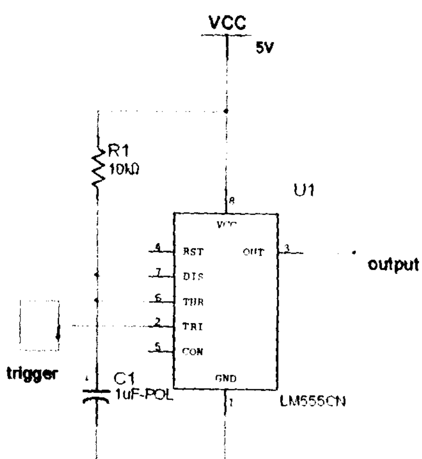


figure 4.3 one shot monostable timer

When choosing you must know the value of the transistor depends on the type of formular you use.

Rl = Load resistor

Rb = Base resistor

When choosing a transistor conditions must be followed,

1. Load current should be less than the maximum IC current of the transistor
2. The hfe must be greater than 5 x load current / maximum output current

For condition 1

Load = 50k

Supply voltage = 12v

Load current will then be $I = V/R = \frac{12}{50000} = 2.4 * 10^{-3} = 2.4mA$

For condition 2

Hfe > 5 x load current / maximum output current

$= \frac{5 \times 2.4 \times 10^{-3}}{3.3\ mA} = 3.64$

Cross checking the values of transistors 2N222, BC547C from the TTL-Data book gives

ma = 0.8 A

Hfe = 300

So any transistor picked must be greater than 2.4

When the trigger goes on, a low voltage occurs and the result at the output is oscillated between been stable (off) and unstable (on),a time duration occurs when the output results of the monostable IC is at an unstable state (on).The time here is a function of the resistor and capacitor being connected to the IC.

The formular for time can be gotten at T = 1.1RiCi

= 1.1 * (10k + 4m7) * 10^f

The time can't be constant and so it varies within a range of 0 to 4.7, so at maximum and minimum values the time will be

At maximum T = 1.1 * (10k + 4.7) * 10^f

At minimum T = 1.1 * (10k + 0) * 10^f

Therefore the time for the monostable IC to function under an unstable state will be

T = 1.1 * (Ri) * 10^f

Therefore T = 1.1 x 4.7 x 10^-6 = 5.17 x 10^-5

- **For the switch**

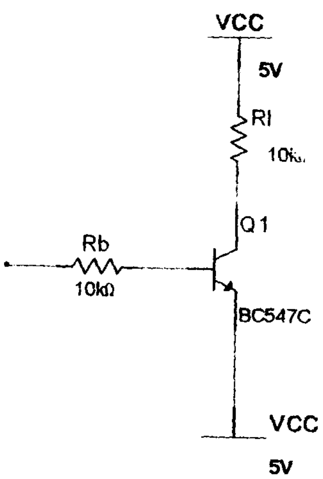


figure 4.4 switch

- **For the base resistance**

When choosing the base resistance ,note first that the Rb is a resistor that limits the current from the transistor and the transistor connected to Rb isn't voltage controlled but a current controlled component.

So for $Rb = \frac{\text{chipvoltage x hfe}}{\text{5 x max collector current}}$

$= \frac{12 \times 300}{5 \times 0.8}$ = 900ohms therefore Rb > 900ohms

CHAPTER FIVE

Conclusion

5.1 Conclusion

The aim of this project right from its conception stage was to produce an automatic garage lightning device using an NE555 timer, comparators, light dependent resistors etc. The availability of electrical components and research materials, economy and durability were considered during the implementation of the project. Its performance finally met design specifications and after considerable time spent on analysis, design, and construction, a final product was reached.

From the results gotten, it can be concluded that the entire project was a huge success.

5.2 Problems encountered

In the course of this project, the following setbacks or problems were encountered:

1. The L.E.D in the garage had to be placed in front of the garage light so as to avoid light errors with the light placed in the garage.
2. Unavailability of components at close proximity.
3. Constant power failure, which considerably slowed down the pace at which the work was carried out.
4. Due to time and financial constraint, some attractive features could not be added to the project. (eg construction of a car for the project)

5.3 Recommendation

I would recommend that further work be done on the following areas to improve the efficiency of the project.

1. A backup power supply should be designed since the system cannot work without constant power supply just like any other automatic system.
2. Exposure to electronic appliances by students should occur at an earlier stage in their academic tenure so that they can be familiar with various forms of electronic and electrical equipments and their functions.
3. Excursions, workshop seminars should be done so that the students can appreciate their respective courses and have an idea of the challenges that await them.

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[5] INTERNET www.globalspec.com light sensors

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[7] The TTL-Data Book for Design Engineer

[8] The TTL-74 Series Pin Connection Data Sheet

OPERATION MANUAL FOR AN AUTOMATIC GARAGE LIGHT

OKOLO GREGGORY.N
2000/9897EE

Below are the necessary steps taken to achieve full operation of the Automatic Garage Light system:

Step 1: Plug the device via an A.C power or Battery power supply.

Step 2: In the day-time, the presence of sunlight is detected via the Light Dependent Resistor on the roof and the system is switch off.

Step 3: As the light intensity from the sun reduces, darkness approaches, this turns on the device to night-time operation mode.

Step 4: In the night-time, the user's car light (as the user drives into the garage) triggers the light dependent resistor in the garage and this automatically triggers the system to switch on the garage light.

Step 5: The light stays on for a particular [illegible]n before switching off.