NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Electrical and Electronic Engineering

LIGHT / DARK ACTIVATED SWITCH

Graduation Project
EE – 400

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ACKNOWLEDGMENTS

IN THE NAME OF ALLAH, MOST GRACIOUS, MOST MERCIFUL.

I wish to express my deepest appreciation to my god who stood beside me all the time,who supported me in all my achievements and who has given me the power and patience to finish my college studies successfully.

I am vary grateful to my teachers from in school and my lecturers who have brightened my mind with knowledge that i will need to have the finest life.

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Last but not least i dedicate my work and my success to my great parent, individualizing my father **FOUAD YASIN**, my whole family and my friends who provided me the encouragement and assistance that have made the completion of this work possible and I hope them success and happiness in life.

Here I would like to thank Omar Daban, Yazan Al Kilany and Mohammad Al Sharaf with their kind help, Also I will never forget my wonderful times that I spent in Cyprus and Near East University with my good friends who helped my incorporeally during my studying in college.

ABSTRACT

As the light is an important apparent in our life and it is used in a wide range of application, we are going to design and explain a light and dark activated switch circuit by using an LDR sensor.

So by this project we can control many different real life applications such as: alarm system, out door illumination, drying machine and so on. In this project we are going to make circuit that is controlling an alarm and some LEDs by giving a signal (light or dark) to the LDR sensor, assuming the system was chosen as a light activate and the room's state was dark, if the despoiler comes and turned the light switch ON or aspect a light bulb to the LDR sensor in this room, the alarm and the red lamp will be ON, because he will give a signal to the LDR sensor which will affect to the system to work and even he turned the switch OFF, the yellow lamp will tell that, there is some one came and turned the light switch ON.

Or if we assumed this system as alarm found in refrigerator and the parents don't want their child open the refrigerator and play on it, so when the child opens it, the light which is inside the refrigerator will affect to the system to work (the alarm and the red lamp will be ON) and even be closed it, the yellow lamp will tell parents that, the refrigerator has been opened.

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INTRODUCTION

The inquiry into the nature of light has lead us to recognize light as a small part of the Electro-magnetic spectrum on one hand and as the beam of photons on the other, forcing us to accept wave particle duality as the fundamental tenet of nature.

In this project we are going to design, build and test light and dark activated switches. How to turn the switches on and off, using them for alarm and LEDs will be presented. Suggestion into where these switches can be used will be made.

The first chapter of this project is the background chapter, which include electronic component especially the components were used in this project (light and dark activated switches) with some explanation and the characteristic of them. And Safety guideline when doing electronic project because of any electric component it has a guideline safety, if you do not know what is it you will burn, or break the component so that before doing any electric project you have to be care about this chapter.

Chapter two is about switches, with some information about types of switches, how they work? How we can use them? And the contact material used for making switches.

The third chapter is the most important chapter, which explains the hardware project in details, how we built it, How it work, what its input and output? With the circuit diagrams of light activated switches, dark activated switch and both of them after combining them together.

The aims of this project are:

- To design and build a light / dark activated switch.
- To gain hands-on experience in electronic hardware project.
- To modify the original circuit where possible.
- To suggest potential real-life use of switches.

CHAPTER ONE
ELECTRONIC COMPONENTS

1.1 Overview

This chapter introduces the commonly used electronic components (i.e. resisters, capacitors and diodes) characteristics, their properties generally with circuitry.
This chapter will also explain the safety guideline when doing electronic circuits, with brief explanation about light activated switch circuit, how it works.

1.2 Component Handling Precautions

Most beginners might cause damage of electrical component because they don't know that most electrical component need careful handle. Obviously one should take reasonable care in handling all components, especially nowadays when so many are of small size, as it's clear and we know that every component has a limitation of the range to stand the passed voltage and current, so in case of that voltage or current exceeds the limited range then the component will fail and it will be out of order. It is easy for these to occur without evidence of their presence, because they are generated by friction between insulating materials, and because so many different plastic materials with very low conductivity are in common everyday use. For instance, if I comb my hair with a plastic comb, I can accumulate a static charge of hundreds volt. It has been said in relation to humans that it is the current that kills, and you may have seen demonstrations in which sparks can be drawn from a person who has been charged from an electrostatic generator. However, it is the voltage that is lethal to electronic devices. Now some identifying of various components used in the electrical projects.

1.2.1 Resistors

Resistors are electronic components are usually used to limit current and attenuate signals, dissipate power (heating) or to terminate signal lines. It's measured in Ohm, Resistors are usually color coded and each color represents a specific value as well as their manufacturing tolerance. Most important characteristics of a resistor are the resistance, tolerance of resistance and the power handling capacity. Resistors are generally available from the fractions of ohms up to several mega ohms (higher value special components are also available). Most small general purpose resistors have power handling capacity of around 0.25W. Most resistors used to be this type, and most electronics designs expect this kind of resistor unless the power rating is mentions. In typical circuits, you can nowadays see resistors with power handling of 0125W up 1W. In addition, special power resistors are available, generally with power rating from few watt up to 50-100W. Highest power resistors are generally built to metal case that is designed to be connected to a heat sink.

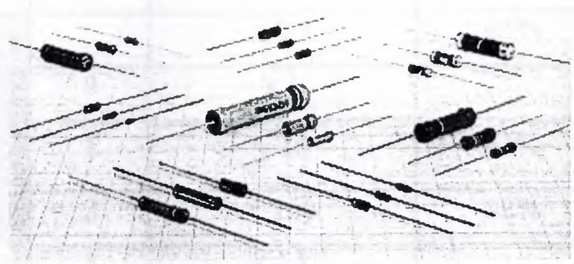


Figure 1.1 Some resistors.

The symbol for a resistor is shown in the following diagram (upper: American symbol, lower: European symbol.)

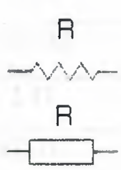


Figure 1.2 Resistor symbols.

The unit for measuring resistance is the **OHM**. (The Greek letter Ω). Higher resistance values are represented by "k" (kilo-ohms) and M (Meg ohms). For example, 120 000 Ω is represented as 120k, while 1 200 000 Ω is represented as 1M2. The dot is generally omitted as it can easily be lost in the printing process. In some circuit diagrams, a value such as 8 or 120 represents a resistance in ohms. Another common practice is to use the letter E for resistance. For example, 120E (120R) stands for 120 Ω, 1E2 stands for 1R2 etc.

1.2.1.1 Resistor Markings

Resistance value is marked on the body of the resistor. The first three bands provide the value of the resistor in ohms and the fourth band indicates the tolerance. Tolerance values of 5%, 2%, and 1% are most commonly available.

Table 1.1 The colors used to identify resistor values.

COLOR	DIGIT	MULTIPLIER	TOLERANCE	TC
Silver		x 0.01	±10%	
Gold		x 0.1	±5%	
Black	0	x 1		
Brown	1	x 10	±1%	$\pm100*10^{-6}$/K
Red	2	x 100	±2%	$\pm50*10^{-6}$/K
Orange	3	x 1 k		$\pm15*10^{-6}$/K
Yellow	4	x 10 k		$\pm25*10^{-6}$/K
Green	5	x 100 k	±0.5%	
Blue	6	x 1 M	±0.25%	$\pm10*10^{-6}$/K
Violet	7	x 10 M	±0.1%	$\pm5*10^{-6}$/K
Grey	8	x 100 M		
White	9	x 1 G		$\pm1*10^{-6}$/K

** TC - Temp. Coefficient, only for SMD d

• To find out the value of any resister we follow this equation:

Value of resistor = $(A*B*10^{c}) \pm T\ (\%)$ Ohm

Where A, B: digits C: multiplier T: tolerance

• Starting from the nearest end, identify the first baud - write down the number associated with that color.

• Second find the tolerance band, it will typically be gold *(5%)* and sometimes silver (10%) and no color (20%).

•For example we have resistor have color red, black, yellow and no color

R= (2*2*10000) ±800=4000 ±800.

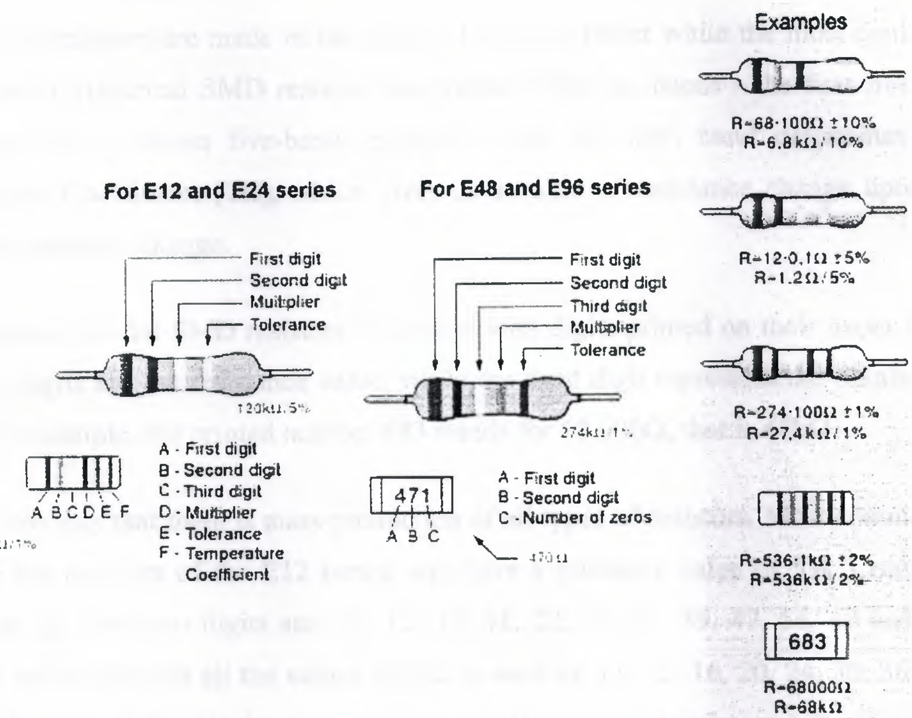


Figure 1.3 a. Four-band resistors, b. Five-band resistor, c. Cylindrical SMD resistor, d. Flat SMD resistor.

Common resistors have 4 bands. These are shown above. The first two bands indicate the first two digits of the resistance; the third band is the multiplier (the number of zeros that are to be added to the number created by the first two bands.) and fourth is the tolerance.

Marking the resistance with five bands is used for resistors with a tolerance of 2%, 1% and other high-accuracy resistors. The first three bands determine the first three digits, the fourth is the multiplier and the fifth represents the tolerance.

For SMD (Surface Mounted Device) the available space on the resistor is very small. 5% resistors use a 3 digit code, while 1% resistors use a 4 digit code.

Some SMD resistors are made in the shape of small cylinder while the most common type is flat. Cylindrical SMD resistors are marked with six bands - the first five are "read" as with common five-band resistors, while the sixth band determines the Temperature Coefficient (TC), which gives us a value of resistance change upon 1-degree temperature change.

The resistance of flat SMD resistors is marked with digits printed on their upper side. First two digits are the resistance value, while the third digit represents the number of zeros. For example, the printed number 683 stands for 68 000Ω, that is 68kΩ.

It is self-obvious that there is mass production of all types of resistors. Most commonly used are the resistors of the E12 series, and have a tolerance value of 5%. Common values for the first two digits are: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68 and 82. The E24 series includes all the values above, as well as: 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75 and 91. What do these numbers mean? It means that resistors with values for digits "39" are: 0.39Ω, 3.9Ω, 39Ω, 390Ω, 3.9kΩ, 39kΩ, etc.

For some electrical circuits, the resistor tolerance is not important and it is not specified. In that case, resistors with 5% tolerance can be used. However, devices which require resistors to have a certain amount of accuracy need a specified tolerance.

1.2.1.2 Resistor Dissipation

If the flow of current through a resistor increases, it heats up, and if the temperature exceeds a certain critical value, it can be damaged. The wattage rating of a resistor is the power it can dissipate over a long period of time. Wattage rating is not identified on small resistors. The following diagrams show the size and wattage rating. Most commonly used resistors in electronic circuits have a wattage rating of 1/2W or 1/4W. There are smaller resistors (1/8W and 1/16W) and higher (1W, 2W, 5W, etc). In place of a single resistor with specified dissipation, another one with the same resistance and higher rating may be used, but its larger dimensions increase the space taken on a printed circuit board as well as the added cost show in figure 1.4.

Where V represents resistor voltage in Volts, I is the current flowing through the resistor in Amps and R is the resistance of resistor in Ohms. For example, if the voltage across an 820□resistor is 12V, the wattage dissipated by the resistors is:

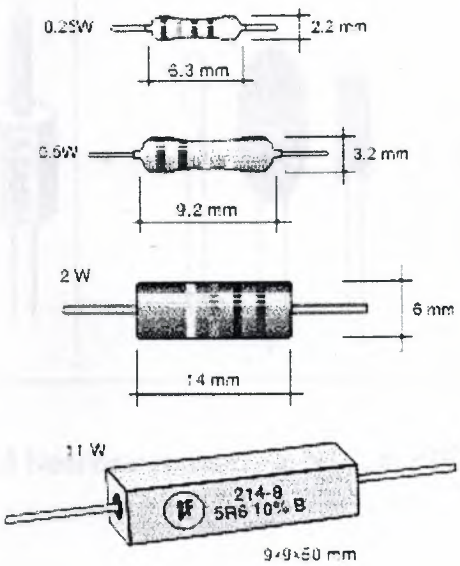


Figure 1.4 Resistor dimensions.

$$P = \frac{V^2}{R} = \frac{12^2}{820} = 0.176 \text{ W} = 176 \text{mW} \tag{1.1}$$

1.2.1.3 Nonlinear resistors

Resistance values detailed above are a constant and do not change if the voltage or current-flow alters. But there are circuits that require resistors to change value with a change in temperate or light. This function may not be linear and hence the name NON-LINEAR RESISTORS.

There are several types of nonlinear resistors, but the most commonly used include: *NTC* resistors (figure a), (Negative Temperature Co-efficient). Their resistance lowers with temperature rise, *PTC* resistors (figure b), (Positive Temperature Co-efficient). Their resistance increases with the temperature rise, *LDR* resistors (figure c), (Light Dependent Resistors). Their resistance lowers with the increase in light and *VDR* resistors, (Voltage dependent Resistors). Their resistance critically lowers as the voltage exceeds a certain value. Symbols representing these resistors are shown below in figure 1.5.

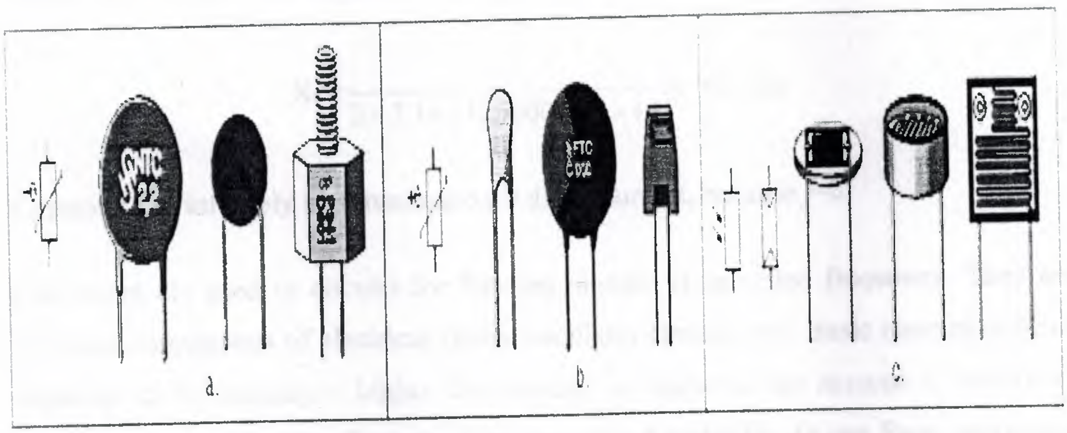


Figure 1.5 Nonlinear resistors - a. NTC, b. PTC, c. LDR.

1.2.2 Capacitors

Capacitors are common components of electronic circuits, used almost as frequently as resistors. Basic difference between the two is the fact that capacitor resistance (called reactance) depends on voltage frequency, not only on capacitors' features. Common mark for reactance is X_c and it can be calculated using the following formula:

$$X_C = \frac{1}{2\pi f C} \tag{1.2}$$

f representing the frequency in Hz and C representing the capacity in Farads.

For example, 5nF-capacitor's reactance at f=125 kHz equals:

$$Xc=\frac{1}{2\times 3.14\times 125000\times 5\times 10^{-9}}=225\Omega.$$

While, at f=1.25MHz, it equals:

$$Xc=\frac{1}{2\times 3.14\times 1250000\times 5\times 10^{-9}}=25.5\Omega.$$

Capacitor has infinitely high reactance for direct current, because f=0.

Capacitors are used in circuits for filtering signals of specified frequency. They are common components of electrical filters, oscillator circuits, etc. Basic characteristic of capacitor is its capacity - higher the capacity is, higher is the amount of electricity capacitor can accumulate. Capacity is measured in Farads (F). As one Farad represents fairly high capacity value, microfarad (µF), nanofarad (nF) and Pico farad (pF) are commonly used. As a reminder, relations between units are:

$$1F=10^{6}\mu F=10^{9}nF=10^{12}pF,$$

That is 1µF=1000nF and 1nF=1000pF. It is essential to remember this notation, as same values may be marked differently in different electrical schemes. For example, 1500pF may be used interchangeably with 1.5nF; 100nF may replace 0.1µF, etc. Bear in mind that simpler notation system is used, as with resistors. If the mark by the capacitor in the scheme reads 120 (or 120E) capacity equals 120pF, 1n2 stands for 1.2nF, n22 stands for 0.22nF, while .1µ (or .1u) stands for 0.1µF capacity and so forth.

Capacitors come in various shapes and sizes, depending on their capacity, working voltage, insulator type, temperature coefficient and other factors. All capacitors can divide in two groups: those with changeable capacity values and those with fixed capacity values. These will covered in the following chapters.

1.2.2.1 Block-capacitors

Capacitors with fixed capacity values (the so called *block-capacitors*) consist of two thin metal bands, separated by thin insulator foil. Most commonly used material for these bands is aluminum, while the common materials used for insulator foil include paper, ceramics, mica, etc after which the capacitors get named. Several models of block-capacitors as well as their symbol are represented on the picture below.

Most of the capacitors, block-capacitors included, are non-polarized components, meaning that both of their connectors are equivalent in respect of solder. Electrolytic capacitors represent the exception as their polarity is of importance, which will be covered in the following chapters.

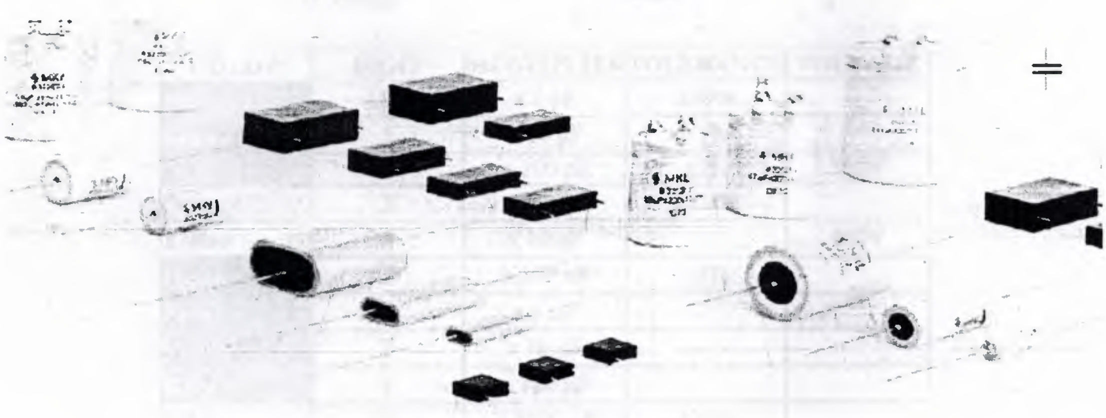


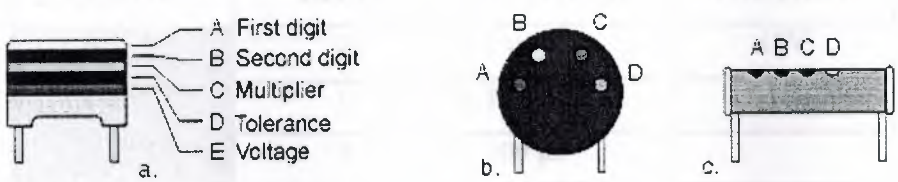
Figure 1.6 Block capacitors.

1.2.2.2 Marking the block-capacitors

Commonly, capacitors are marked by a number representing the capacity value printed on the capacitor. Beside this value, number representing the maximal capacitor working voltage is mandatory, and sometimes tolerance, temperature coefficient and some other values are printed too. If, for example, capacitor mark in the scheme reads 5nF/40V, it means that capacitor with 5nF capacity value is used and that its maximal working voltage is 40v. Any other 5nF capacitor with higher maximal working voltage can be used instead, but they are as a rule larger and more expensive.

Sometimes, especially with capacitors of low capacity values, capacity may be represented with colors, similar to four-ring system used for resistors (figure 1.7). The first two colors (A and B) represent the first two digits, third color (C) is the multiplier, fourth color (D) is the tolerance, and the fifth color (E) is the working voltage.

With disk-ceramic capacitors (figure 1.7b) and tubular capacitors (figure 1.7c) working voltage is not specified, because these are used in circuits with low or no DC voltage. If tubular capacitor does have five color rings on it, then the first color represents the temperature coefficient, while the other four specify its capacity value in the previously described way.

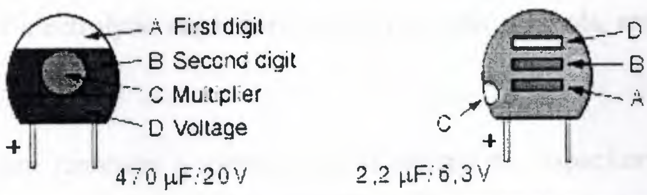


COLOR	DIGIT	MULTIPLIER	TOLERANCE	VOLTAGE
Black	0	x 1 pF	±20%	
Brown	1	x 10 pF	±1%	
Red	2	x 100 pF	±2%	250V
Orange	3	x 1 nF	±2.5%	
Yellow	4	x 10 nF		400V
Green	5	x 100 nF	±5%	
Blue	6	x 1 μF		
Violet	7	x 10 μF		
Grey	8	x 100 μF		
White	9	x 1000 μF	±10%	

Figure 1.7 Marking the capacity using color.

The figure 1.8 shows how capacity of miniature tantalum electrolytic capacitors is marked by colors. The first two colors represent the first two digits and have the same values as with resistors. The third color represents the multiplier, which the first two digits should be multiplied by, to get the capacity value expressed in µF. The fourth color represents the maximal working voltage value, shown the figure 1.8.

One important note on the working voltage: capacitor voltage mustn't exceed the maximal working voltage as capacitor may get destroyed. In case when the voltage between nodes where the capacitor is about to be connected is unknown, the "worst" case should be considered. There is the possibility that, due to malfunction of some other component, voltage on capacitor equals the power supply voltage. If, for example, the power supply is 12V battery, then the maximal working voltage of used capacitors should exceed 12V, for security's sake.



COLOR	DIGIT	MULTIPLIER	VOLTAGE
Black	0	x 1 µF	10V
Brown	1	x 10 µF	
Red	2	x 100 µF	
Orange	3		
Yellow	4		6.3V
Green	5		16V
Blue	6		20V
Violet	7		
Grey	8	x .01 µF	25V
White	9	x .1 µF	3V
Pink			35V

Figure1.8 Marking the tantalum electrolytic capacitors.

1.2.2.3 Electrolytic capacitors

Electrolytic capacitors represent the special type of capacitors with fixed capacity value. Thanks to the special construction, they can have exceptionally high capacity, ranging from one to several thousand μF. They are most frequently used in transformers for leveling the voltage, in various filters, etc.

Electrolytic capacitors are polarized components, meaning that they have positive and negative connector, which is of *outmost* importance when connecting the capacitor into a circuit. Positive connector has to be connected to the node with a high voltage than the node for connecting the negative connector. If done otherwise, electrolytic capacitor could be permanently damaged due to electrolysis and eventually destroyed.

Explosion may also occur if capacitor is connected to voltage that exceeds its working voltage. In order to prevent such instances, one of the capacitor's connectors is very clearly marked with a + or -, while working voltage is printed on capacitor body. Several models of electrolytic capacitors, as well as their symbols, are shown in figure 1.9.

Tantalum capacitors represent a special type of electrolytic capacitors. Their parasitic inductance is much lower then with standard aluminum electrolytic capacitors so that tantalum capacitor with significantly (even ten times) lower capacity can completely substitute an aluminum electrolytic capacitor.

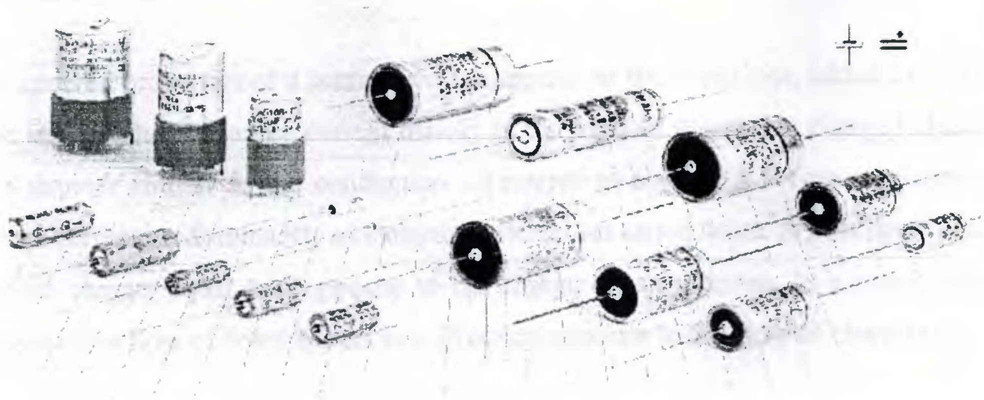


Figure 1.9 Electrolytic capacitors.

1.2.2.4 Variable capacitors

Variable capacitors are capacitors with variable capacity. Their minimal capacity ranges from 10 to 50pF, and their maximum capacity goes as high as few hundred pF (500pF tops). Variable capacitors are manufactured in various shapes and sizes, but common feature for all of them is a set of immobile, interconnected aluminum plates called stator, and another set of plates, connected to a common axis, called rotor. In axis rotating, rotor plates get in between stator plates, thus increasing capacity of the device. Naturally, these capacitors are constructed in such a way that rotor and stator plates are placed consecutively. Insulator (dielectric) between the plates is a thin layers of air, hence the name variable capacitor with air dielectric. When setting these capacitors, special attention should be paid not to band metal plates, in order to prevent short-circuiting of rotor and stator and ruining the capacitor.

1.2.3 Semiconductor

Several types of semiconductor are used in our project, and we will start with two transistor. Transistors have three lead-out wires which are called the base, emitter, and collector. It's essential that are connected correcting. A semiconductor is a substance, usually a solid chemical element or compound that can conduct electricity under some conditions but not others, making it a good medium for the control of electrical current. Its conductance varies depending on the current or voltage applied to a control electrode, or on the intensity of irradiation by infrared (IR), visible light, ultraviolet (UV), or X rays.

The specific properties of a semiconductor depend on the impurities, added to it. An N-type semiconductor carries current mainly in the form of negatively charged electrons, in a manner similar to the conduction of current in a wire. *A* P-type semiconductor carries current predominantly as electron deficiencies called holes. A hole has a positive electric charge, equal and opposite to the charge on an electron. In a semiconductor material, the flow of holes occurs in a direction opposite to the flow of electrons.

Elemental semiconductors include antimony, arsenic, boron, carbon, germanium, selenium, silicon, sulfur, and tellurium, Silicon is the best known of these, forming the basis of most integrated circuits (ICs). Common semiconductor compounds include gallium arsenide, indium antimonite, and the oxides of most metals. Of these, gallium arsenide (Ga As) is widely used in low-noise, high-gain, and weak-signal amplifying devices.

A semiconductor device can perform the function of a vacuum tube having hundreds of times its volume. A single integrated circuit (IC) such as a microprocessor chip can do the work of a set of vacuum tubes that would fill a large building and require its own electric generating plant.

1.2.3.1 Transistors

The two types of transistor shown above are called bi-polar transistors. The following circuits all use bi-polar transistors but there are many other types e.g. FET, MOS etc.

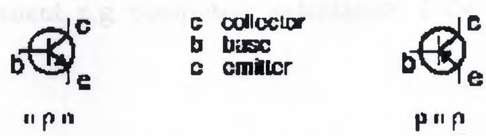


Figure 1.10 transistors types.

1.2.3.1.1 The Transistors as a Switch

In the circuit below we use a rheostat as a *variable potential divider* to apply a variable voltage across the base and emitter of the transistor to see how this affects the voltage across the collector and emitter.

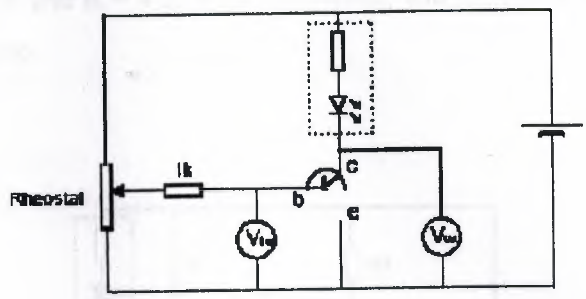


Figure 1.11 Transistors as a Switch.

Adjust the variable potential divider so that Vibe = zero.

Slowly increase Vbe. Notice that the LED lights when Vbe = (about) 0·6v and that Vbe does NOT increase much above this figure no matter what we do with the rheostat.

Conclusion

Vbe < 0·6v, transistor is OFF and Vce = the voltage of the battery

Vbe > 0·6v, transistor is ON and Vce = about 0·2v

When we say that the transistor is ON, we mean that it allows current to flow easily into its collector and out of its emitter. Transistors used as switches are found in nearly all modern electronic equipment, e.g. computers, calculators, TV's.

1.2.3.1.2 Three important transistor switching circuits

Touch the end of wire W for a fraction of a second to B1 then to B2.This type of circuit is called a bistable.

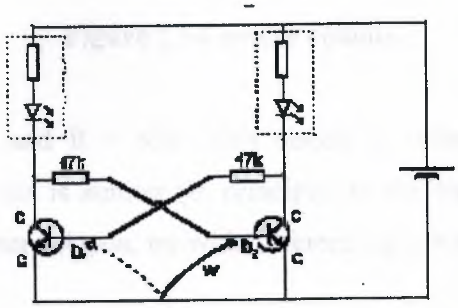


Figure 1.12 a bistable circuit.

Start with C = 470µF and R = 47k. Push the switch, and then wait. This type of circuit is called a monostable.

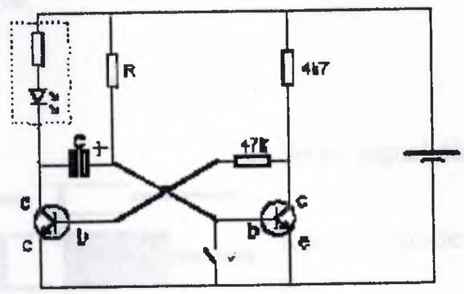


Figure 1.13 a monostable circuit.

Try the circuit with different capacitor C and resistor R.

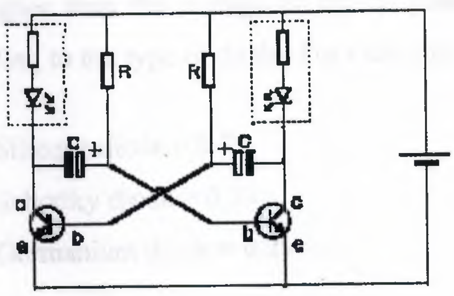


Figure 1.14 astable circuits.

Start with C = 470µF and R = 47k. This circuit is called an astable because it continually *oscillates*. This is similar (in principle) to the circuits which produce the "clock" pulses in computers. Again, try with different capacitors and resistors, R.

1.2.3.2 Diodes

A diode allows current to flow in only ONE direction.

If the cathode end (marked with a stripe) is connected so it is more negative than the anode end, current will flow.

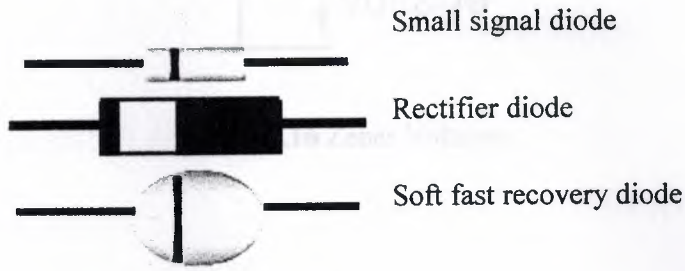
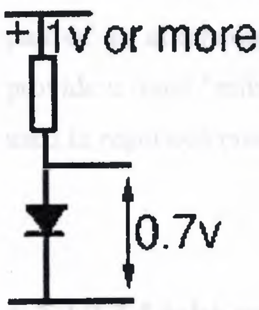


Figure 1.15 The picture shows three types of diodes.

A diode has a forward voltage drop. That is to say, when current is flowing, the voltage at the anode is always higher than the voltage at the cathode. The actual Forward Voltage Drop varies according to the type of diode. For example:



Silicone diode = 0.7v

Schottky diode = 0.3v

Germanium diode = 0.2v

In addition, the voltage drop increases slightly as the current increases so, for example, a silicon rectifier diode might have a forward voltage drop of 1 volt when 1 Amp of current is flowing through it.

A ZENER diode allows current to flow in both directions. In the "forward" direction, no current will flow until the voltage across the diode is about 0.7 volts (as with a normal diode). In the reverse direction (cathode more positive than the anode) no current will flow until the voltage approaches the "zener" voltage, after which a LOT of current can flow and must be restricted by connecting a resistor in series with the zener diode so that the diode does not melt!

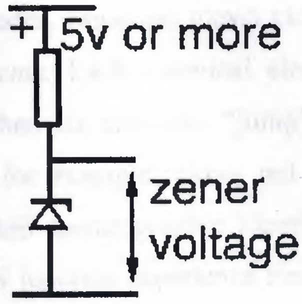


Figure 1.16 Zener Voltages.

Within a certain supply voltage range, the voltage across the zener diode will remain constant. Values of 2.4 volts to 30 volts are common. Zener diodes are not available in values above around 33 volts but a different type of diode called an AVALANCHE diode works in a similar way for voltages between 100v and 300v. (These diodes are often called "zener" diodes since their performance is so similar).

Zener diodes are used to "clamp" a voltage in order to prevent it rising higher than a certain value. This might be to protect a circuit from damage or it might be to "chop off" part of an alternating waveform for various reasons. Zener diodes are also used to provide a fixed "reference voltage" from a supply voltage that varies. They are widely used in regulated power supply circuits.

1.2.3.2.1 Light-emitting diodes

Diodes, like all semiconductor devices, are governed by the principles described in quantum physics. One of these principles is the emission of specific-frequency radiant energy whenever electrons fall from a higher energy level to a lower energy level. This is the same principle at work in a neon lamp, the characteristic pink-orange glow of ionized neon due to the specific energy transitions of its electrons in the midst of an electric current. The unique color of a neon lamp's glow is due to the fact that it's neon gas inside the tube, and not due to the particular amount of current through the tube or voltage between the two electrodes. Neon gas glows pinkish-orange over a wide range of ionizing voltages and currents. Each chemical element has its own "signature" emission of radiant energy when its electrons "jump" between deferent, quantized energy levels. Hydrogen gas, for example, glows red when ionized; mercury vapor glows blue. This is what makes spectrographic identification of elements possible. Electrons flowing through a PN junction experience similar transitions in energy level, and emit radiant energy as they do so. The frequency of this radiant energy is determined by the crystal structure of the semiconductor material, and the elements comprising it.

Some semiconductor junctions, composed of special chemical combinations, emit radiant energy within the spectrum of visible light as the electrons transition in energy levels. Simply put, these junctions glow when forward biased. A diode intentionally designed to glow like a lamp is called a light-emitting diode, or LED.

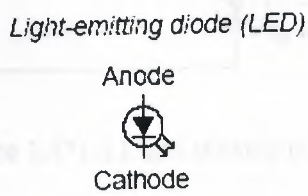


Figure 1.17(a) Light-emitting diode.

This notation of having two small arrows pointing away from the device is common to the schematic symbols of all light-emitting semiconductor devices. Conversely, if a device is light-activated (meaning that incoming light stimulates it), then the symbol will have two small arrows pointing toward it. It is interesting to note, though, that LEDs are capable of acting as light-sensing devices: they will generate a small voltage when exposed to light, much like a solar cell on a small scale.

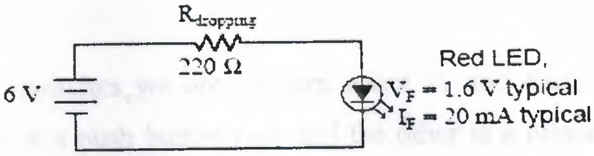


Figure 1.17(b) Light sensing circuit.

With the LED dropping 1.6 volts, there will be 4.4 volts dropped across the resistor. Sizing the resistor for an LED current of 20 mA is as simple as taking its voltage drop (4.4 volts) and dividing by circuit current (20 mA), in accordance with Ohm's Law (R=E/I). This gives us a figure of 220- ohm.

Calculating power dissipation for this resistor, we take its voltage drop and multiply by its current (P=IE), and end up with 88 mW, well within the rating of a 1/8 watt resistor. Higher battery voltages will require larger-value dropping resistors, and possibly higher-power rating resistors as well. Consider this example for a supply voltage of 24 volts.

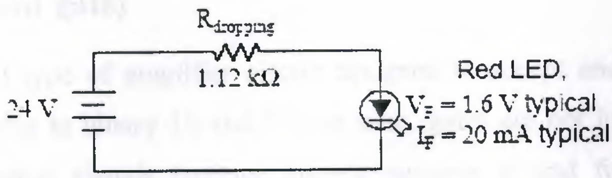


Figure 1.17(c) Light sensing circuit.

1.2.4 Battery

The word battery simply means a group of similar components. In military vocabulary, a "battery" refers to a cluster of guns. In electricity, a "battery" is a set of voltaic cells designed to provide greater voltage and/or current than is possible with one cell alone.

The symbol for a cell is very simple, consisting of one long line and one short line, parallel to each other, with connecting wires:

Figure 1.18 Battery symbol.

1.2.5 Switches

Only two types of switches we are concern about it, and there is little chance of confusing since one is a push button type and the other is a miniature toggles switch (i.e. it's operated via a small lever). The push button switch must be a push to make type and not a push to break type in other words, the two tags are connected together when the switch is operated, and disconnected when the push button is released, show in figure 1.18.

Figure 1.19 Switches.

1.2.6 Inverter (not gate)

A gate is a special type of amplifier circuit designed to accept and generate voltage signals corresponding to binary 1's and 0's. As such, gates are not intended to be used for amplifying analog signals (voltage signals between 0 and full voltage). Used together, multiple gates may be applied to the task of binary number storage (memory circuits) or manipulation (computing circuits,(each gate's output representing one bit of a multi-bit binary number. Just how this is done is a subject for a later chapter. Right now it is important to focus on the operation of individual gates. The gate shown here with the single transistor is known as an inverter, or NOT gate, because it outputs the exact opposite digital signal as what is input. For convenience, gate circuits are generally represented by their own symbols rather than by their constituent transistors and resistors. The following is the symbol for an inverter

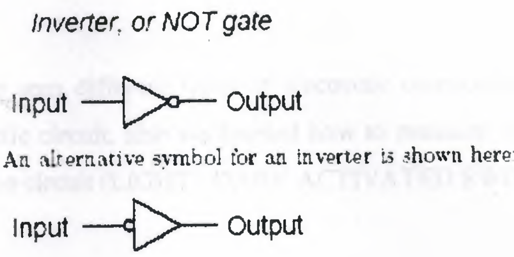
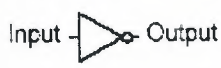


Figure 1.20 inverter.

One common way to express the particular function of a gate circuit is called a truth table. Truth tables show all combinations of input conditions in terms of logic level states (either "high" or "low", "1"or "0," for each input terminal of the gate), along with the corresponding output logic level, either "high" or "low." For the inverter, or NOT, circuit just illustrated, the truth table is very simple indeed:

Table 1.2 Truth Table.



Input	Output
0	1
1	0

1.3 Safety

1- We have taken care about chip pins when we plant it in the board to not be broken.

2- Be aware while soldering to not heat up the chip by the soldering iron long time on the pins.

3- While soldering be aware not be let to pins to be soldering together and check after soldering the pins in between space.

4- Be aware of the soldering iron position while stand by.

5- Be aware when turns up side down the board after the chip plant that the pins arrangement will be different.

1.4 Summary

In this chapter we have seen different types of electronic components and the safety way of using them in any eclectic circuit, also we learned how to measure them without expecting an error, the operation of the circuit (LIGHT / DARK ACTIVATED SWITCH) was described.

CHAPTER TWO

SWITCHES

2.1 Overview

An electrical switch is any device used to interrupt the flow of electrons in a circuit. Switches are essentially binary devices, they are either completely on ("closed") or completely off ("open"). There are many different types of switches, and we will explore some of these types in this chapter.

2.2 Switch Types

Though it may seem strange to cover this elementary electrical topic at such a late stage in this book series, I do so because the chapters that follow explore an older realm of digital technology based on mechanical switch contacts rather than solid-state gate circuits, and a thorough understanding of switch types is necessary for the under taking. Learning the function of switch-based circuits at the same time that you learn about solid-state logic gates makes both topics easier to grasp, and sets the stage for an enhanced learning experience in Boolean algebra, the mathematics behind digital logic circuits.

The simplest type of switch is one where two electrical conductors are brought in contact with each other by the motion of an actuating mechanism. Other switches are more complex, containing electronic circuits able to turn on or off depending on some physical stimulus (such as light or magnetic field) sensed. In any case, the final output of any switch will be (at least) a pair of wire-connection terminals that will either be connected together by the switch's internal contact mechanism ("closed"), or not connected together ("open").

Any switch designed to be operated by a person is generally called a hand switch, and they are manufactured in several varieties, shown in figure 2.1.

Toggle switches are actuated by a lever angled in one of two or more positions. The common light switch used in household wiring is an example of a toggle switch. Most toggle switches will come to rest in any of their lever positions, while others have an internal spring mechanism returning the lever to a certain normal position, allowing for what is called "momentary" operation, shown in figure 2.2.

Pushbutton switches are two-position devices actuated with a button that is pressed and released. Most pushbutton switches have an internal spring mechanism returning the button to its "out," or "unpressed", position, for momentary operation. Some pushbutton switches will latch alternately on or off with every push of the button. Other pushbutton switches will stay in their "in," or "pressed," position until the button is pulled back out. This last type of pushbutton switches usually has a mushroom-shaped button for easy push-pull action, shown in figure 2.3.

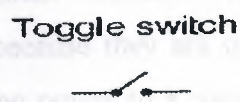


Figure 2.1 Toggle witch.

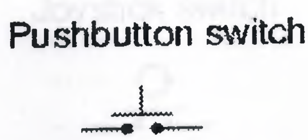


Figure 2.2 Pushbutton switch.

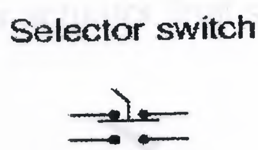


Figure 2.3 Selector switch.

Selector switches are actuated with a rotary knob or lever of some sort to select one of two or more positions. Like the toggle switch, selector switches can either rest in any of their positions or contain spring-return mechanisms for momentary operation, shown in figure 2.4.

A joystick switch is actuated by a lever free to move in more than one axis of motion. One or more of several switch contact mechanisms are actuated depending on which way the lever is pushed, and sometimes by how far it is pushed. The circle-and-dot notation on the switch symbol represents the direction of joystick lever motion required to actuate the contact. Joystick hand switches are commonly used for crane and robot control.

Some switches are specifically designed to be operated by the motion of a machine rather than by the hand of a human operator. These motion-operated switches are commonly called limit switches, because they are often used to *limit the motion of a* machine by turning off the actuating power to a component if it moves too far. As with hand switches, limit switches come in several varieties, shown in figure 2.5.

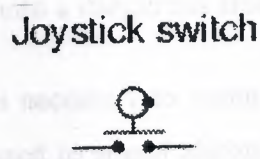


Figure 2.4 Joystick switch.

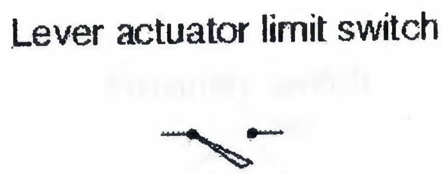


Figure 2.5 Lever actuator limit switch.

These limit switches closely resemble rugged toggle or selector hand switches fitted with a lever pushed by the machine part. Often, the levers are tipped with a small roller bearing, preventing the lever from being worn off by repeated contact with the machine part, shown in figure 2.6.

Proximity switches sense the approach of a metallic machine part either by a magnetic or high-frequency electromagnetic field. Simple proximity switches use a permanent magnet to actuate a sealed switch mechanism whenever the machine part gets close (typically 1 inch or less). More complex proximity switches work like a metal detector, energizing a coil of wire with a high-frequency current, and electronically monitoring the magnitude of that current. If a metallic part (not necessarily magnetic) gets close enough to the coil, the current will increase, and trip the monitoring circuit. The symbol shown here for the proximity switch is of the electronic variety, as indicated by the diamond-shaped box surrounding the switch. A non-electronic proximity switch would use the same symbol as the lever-actuated limit switch.

Another form of proximity switch is the optical switch, comprised of a light source and photocell. Machine position is detected by either the interruption or reflection of a light beam. Optical switches are also useful in safety applications, where beams of light can be used to detect personnel entry into a dangerous area.

In many industrial processes, it is necessary to monitor various physical quantities with switches. Such switches can be used to sound alarms, indicating that a process variable has exceeded normal parameters, or they can be used to shut down processes or equipment if those variables have reached dangerous or destructive levels. There are many different types of process switches, shown in figure 2.7.

Figure 2.6 Proximity switch.

These switches sense the rotary speed of a shaft either by a centrifugal weight mechanism mounted on the shaft, or by some kind of non-contact detection of shaft motion such as optical or magnetic, shown in figure 2.8.

Gas or liquid pressure can be used to actuate a switch mechanism if that pressure is applied to a piston, diaphragm, or bellows, which converts pressure to mechanical force, shown in figure 2.9.

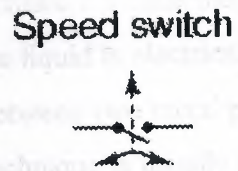


Figure 2.7 Speed switch.

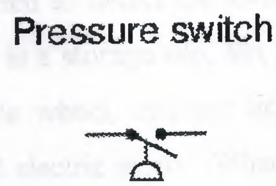


Figure 2.8 Pressure switch.

Figure 2.9 Temperature switch.

An inexpensive temperature-sensing mechanism is the "bimetallic strip:" a thin strip of two metals, joined back-to-back, each metal having a different rate of thermal expansion. When the strip heats or cools, differing rates of thermal expansion between the two metals causes it to bend. The bending of the strip can then be used to actuate a switch contact mechanism. Other temperature switches use a brass bulb filled with either a liquid or gas, with a tiny tube connecting the bulb to a pressure-sensing switch. As the bulb is heated, the gas or liquid expands, generating a pressure increase which then actuates the switch mechanism, shown in figure 2.10.

A floating object can be used to actuate a switch mechanism when the liquid level in a tank rises past a certain point. If the liquid is electrically conductive, the liquid itself can be used as a conductor to bridge between two metal probes inserted into the tank at the required depth. The conductivity technique is usually implemented with a special design of relay triggered by a small amount of current through the conductive liquid. In most cases it is impractical and dangerous to switch the full load current of the circuit through a liquid.

Level switches can also be designed to detect the level of solid materials such as wood chips, grain, coal, or animal feed in a storage silo, bin, or hopper. A common design for this application is a small paddle wheel, inserted into the bin at the desired height, which is slowly turned by a small electric motor. When the solid material fills the bin to that height, the material prevents the paddle wheel from turning. The torque response of the small motor than trips the switch mechanism. Another design uses a "tuning fork" shaped metal prong, inserted into the bin from the outside at the desired height. The fork is vibrated at its resonant frequency by an electronic circuit and magnet/electromagnet coil assembly. When the bin fills to that height, the solid material dampens the vibration of the fork, the change in vibration amplitude and/or frequency detected by the electronic circuit, shown in figure 2.11.

Inserted into a pipe, a flow switch will detect any gas or liquid flow rate in excess of a certain threshold, usually with a small paddle or vane which is pushed by the flow. Other flow switches are constructed as differential pressure switches, measuring the pressure drop across a restriction built into the pipe. ['2].

Another type of level switch, suitable for liquid or solid material detection, is the nuclear switch. Composed of a radioactive source material and a radiation detector, the two are mounted across the diameter of a storage vessel for either solid or liquid material. Any height of material beyond the level of the source/detector arrangement will attenuate the strength of radiation reaching the detector. This decrease in radiation at the detector can be used to trigger a relay mechanism to provide a switch contact for measurement, alarm point, or even control of the vessel level, show in figure 2.12.

Both source and detector are outside of the vessel, with no intrusion at all except the radiation flux itself. The radioactive sources used are fairly weak and pose no immediate health threat to operations or maintenance personnel.

As usual, there is usually more than one way to implement a switch to monitor a physical process or serve as an operator control. There is usually no single "perfect" switch for any application, although some obviously exhibit certain advantages over others. Switches must be intelligently matched to the task for efficient and reliable operation.

Liquid level switch

Figure 2.10 Liquid level switches.

Liquid flow switch

Figure 2.11 Liquid flow switches.

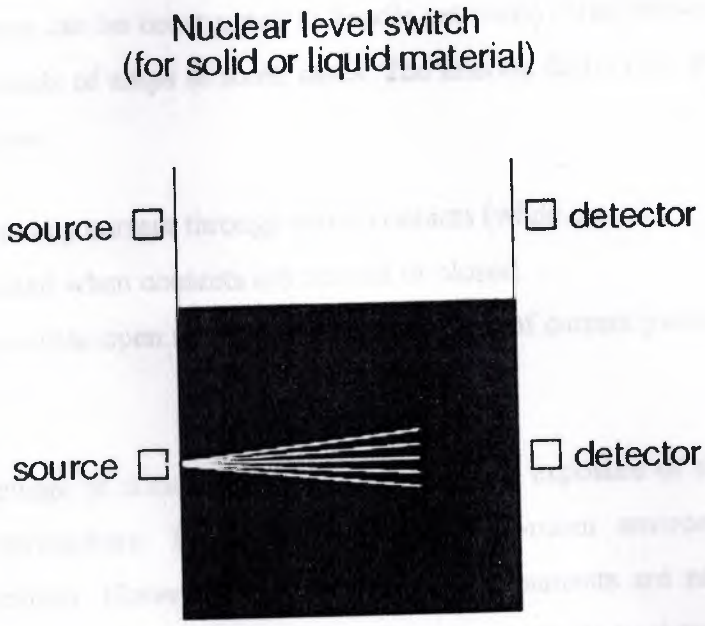


Figure 2.12 nuclear level switches.

2.2.1 Switch contact design

A switch can be constructed with any mechanism bringing two conductors into contact with each other in a controlled manner. This can be as simple as allowing two copper wires to touch each other by the motion of a lever, or by directly pushing two metal strips into contact. However, a good switch design must be rugged and reliable, and avoid presenting the operator with the possibility of electric shock. Therefore, industrial switch designs are rarely this crude.

The conductive parts in a switch used to make and break the electrical connection are called contacts. Contacts are typically made of silver or silver-cadmium alloy, whose conductive properties are not significantly compromised by surface corrosion or oxidation. Gold contacts exhibit the best corrosion resistance, but are limited in current-carrying capacity and may "cold weld" if brought together with high mechanical force. Whatever the choice of metal, the switch contacts are guided by a mechanism ensuring square and even contact, for maximum reliability and minimum resistance. ['2].

Contacts such as these can be constructed to handle extremely large amounts of electric current, up to thousands of amps in some cases. The limiting factors for switch contact amp city are as follows:

- Heat generated by current through metal contacts (while closed).
- Sparking caused when contacts are opened or closed.
- The voltage across open switch contacts (potential of current jumping across the gap).

One major disadvantage of standard switch contacts is the exposure of the contacts to the surrounding atmosphere. In a nice, clean, control-room environment, this is generally not a problem. However, most industrial environments are not this benign. The presence of corrosive chemicals in the air can cause contacts to deteriorate and fail prematurely. Even more troublesome is the possibility of regular contact sparking causing flammable or explosive chemicals to ignite.

When such environmental concerns exist, other types of contacts can be considered for small switches. These other types of contacts are sealed from contact with the outside air, and therefore do not suffer the same exposure problems that standard contacts do.

A common type of sealed-contact switch is the mercury switch. Mercury is a metallic element, liquid at room temperature. Being a metal, it possesses excellent conductive properties. Being a liquid, it can be brought into contact with metal probes (to close a circuit) inside of a sealed chamber simply by tilting the chamber so that the probes are on the bottom. Many industrial switches use small glass tubes containing mercury which are tilted one way to close the contact, and tilted another way to open. Aside from the problems of tube breakage and spilling mercury (which is a toxic material), and susceptibility to vibration, these devices are an excellent alternative to open-air switch contacts wherever environmental exposure problems are a concern.

Here, a mercury switch (often called a tilt switch) is shown in the open position, where the mercury is out of contact with the two metal contacts at the other end of the glass bulb, shown in figure 2.13.

Here, the same switch is shown in the closed position. Gravity now holds the liquid mercury in contact with the two metal contacts, providing electrical continuity from one to the other, shown in figure 2.14.

Figure 2.13 Mercury switches open position.

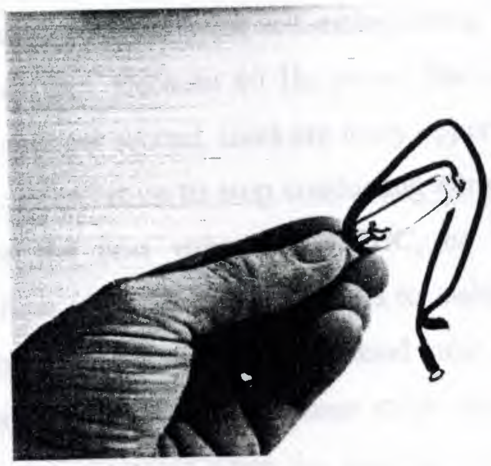


Figure 2.14 Mercury switches close position.

Mercury switch contacts are impractical to build in large sizes, and so you will typically find such contacts rated at no more than a few amps, and no more than 120 volts. There are exceptions, of course, but these are common limits.

Another sealed-contact type of switch is the magnetic reed switch. Like the mercury switch, a reed switch's contacts are located inside a sealed tube. Unlike the mercury switch which uses liquid metal as the contact medium, the reed switch is simply a pair of very thin, magnetic, metal strips (hence the name "reed") which are brought into contact with each other by applying a strong magnetic field outside the sealed tube. The source of the magnetic field in this type of switch is usually a permanent magnet, moved closer to or further away from the tube by the actuating mechanism. Due to the small size of the reeds, this type of contact is typically rated at lower currents and voltages than the average mercury switch. However, reed switches typically handle vibration better than mercury contacts, because there is no liquid inside the tube to splash around.

It is common to find general-purpose switch contact voltage and current ratings to be greater on any given switch or relay if the electric power being switched is AC instead of DC. The reason for this is the self-extinguishing tendency of an alternating-current arc across an air gap. Because 60 Hz power line current actually stops and reverses direction 120 times per second, there are many opportunities for the ionized air of an arc to lose enough temperature to stop conducting current, to the point where the arc will not re-start on the next voltage peak. DC, on the other hand, is a continuous, uninterrupted flow of electrons which tends to maintain an arc across an air gap much better. Therefore, switch contacts of any kind incur more wear when switching a given value of direct current than for the same value of alternating current. The problem of switching DC is exaggerated when the load has a significant amount of inductance, as there will be very high voltages generated across the switch's contacts when the circuit is opened (the inductor doing its best to maintain circuit current at the same magnitude as when the switch was closed).

With both AC and DC, contact arcing can be minimized with the addition of a "snubber" circuit (a capacitor and resistor wired in series) in parallel with the contact, shown in figure 2.15.

A sudden rise in voltage across the switch contact caused by the contact opening will be tempered by the capacitor's charging action (the capacitor opposing the increase in voltage by drawing current). The resistor limits the amount of current that the capacitor will discharge through the contact when it closes again. If the resistor were not there, the capacitor might actually make the arcing during contact closure worse than the arcing during contact opening without a capacitor! While these additions to the circuit helps mitigate contact arcing, it is not without disadvantage: a prime consideration is the possibility of a failed (shorted) capacitor/resistor combination providing a path for electrons to flow through the circuit at all times, even when the contact is open and current is not desired. The risk of this failure and the severity of the resulting consequences must be considered against the increased contact wear (and inevitable contact failure) without the snubber circuit.

The use of snubbers in DC switch circuits is nothing new: automobile manufacturers have been doing this for years on engine ignition systems, minimizing the arcing across the switch contact "points" in the distributor with a small capacitor called a condenser. As any mechanic can tell you, the service life of the distributor's "points" is directly related to how well the condenser is functioning.

With all this discussion concerning the reduction of switch contact arcing, one might be led to think that less current is always better for a mechanical switch. This, however, is not necessarily so. It has been found that a small amount of periodic arcing can actually be good for the switch contacts, because it keeps the contact faces free from small amounts of dirt and corrosion. If a mechanical switch contact is operated with too little current, the contacts will tend to accumulate excessive resistance and may fail prematurely! This minimum amount of electric current necessary to keep a mechanical switch contact in good health is called the wetting current.

Normally, a switch's wetting current rating is far below its maximum current rating and well below its normal operating current load in a properly designed system. However, there are applications where a mechanical switch contact may be required to routinely handle currents below normal wetting current limits (for instance, if a mechanical selector switch needs to open or close a digital logic or analog electronic circuit where the current value is extremely small). In these applications, is it highly recommended that gold-plated switch contacts be specified. Gold is a "noble" metal and does not corrode as other metals will. Such contacts have extremely low wetting current requirements as a result. Normal silver or copper alloy contacts will not provide reliable operation if used in such low-current service.

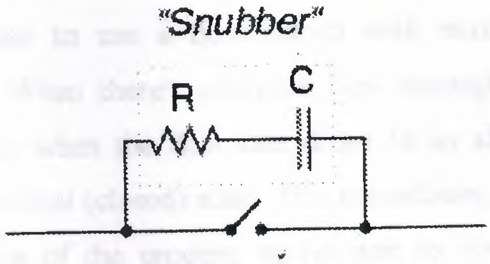


Figure 2.15 Snubber.

2.2.2Contact "normal" state and make/break sequence

Any kind of switch contact can be designed so that the contacts "close" (establish continuity) when actuated, or "open" (interrupt continuity) when actuated. For switches that have a spring-return mechanism in them, the direction that the spring returns it to with no applied force is called the normal position. Therefore, contacts that are open in this position are called normally open and contacts that are closed in this position are called normally closed.

For process switches, the normal position, or state, is that which the switch is in when there is no process influence on it. An easy way to figure out the normal condition of a process switch is to consider the state of the switch as it sits on a storage shelf, uninstalled. Here are some examples of "normal" process switch conditions:

- **Speed switch**: Shaft not turning.
- **Pressure switch**: Zero applied pressure.
- **Temperature switch**: Ambient (room) temperature.
- **Level switch**: Empty tank or bin.
- **Flow switch**: Zero liquid flow.

It is important to differentiate between a switch's "normal" condition and its "normal" use in an operating process. Consider the example of a liquid flow switch that serves as a low-flow alarm in a cooling water system. The normal, or properly-operating, condition of the cooling water system is to have fairly constant coolant flow going through this pipe. If we want the flow switch's contact to close in the event of a loss of coolant flow (to complete an electric circuit which activates an alarm siren, for example), we would want to use a flow switch with normally-closed rather than normally-open contacts. When there's adequate flow through the pipe, the switch's contacts are forced open; when the flow rate drops to an abnormally low level, the contacts return to their normal (closed) state. This is confusing if you think of "normal" as being the regular state of the process, so be sure to always think of a switch's "normal" state as that which it's in as it sits on a shelf.

The schematic symbology for switches varies according to the switch's purpose and actuation. A normally-open switch contact is drawn in such a way as to signify an open connection, ready to close when actuated. Conversely, a normally-closed switch is drawn as a closed connection which will be opened when actuated, shown in figure 2.16.

There is also a generic symbology for any switch contact, using a pair of vertical lines to represent the contact points in a switch. Normally-open contacts are designated by the lines not touching, while normally-closed contacts are designated with a diagonal line bridging between the two lines. Compare the two, shown in figure 2.17.

The switch on the left will close when actuated, and will be open while in the "normal" (unactuated) position. The switch on the right will open when actuated, and is closed in the "normal" (unactuated) position. If switches are designated with these generic symbols, the type of switch usually will be noted in text immediately beside the symbol. Please note that the symbol on the left is not to be confused with that of a capacitor. If a capacitor needs to be represented in control logic schematic, it will be shown figure 2.18.

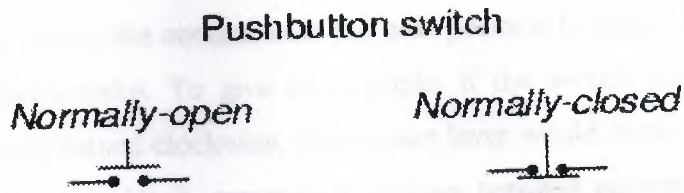


Figure 2.16 Pushbuttons switch.

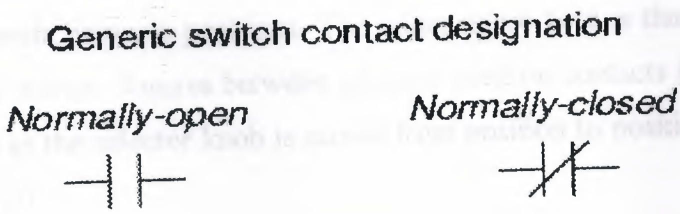


Figure 2.17 Generic switch contact designation.

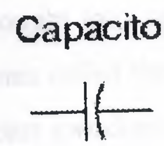


Figure 2.18 Capacitor.

In standard electronic symbology, the figure shown above is reserved for polarity sensitive capacitors. In control logic symbology, this capacitor symbol is used for any type of capacitor, even when the capacitor is not polarity sensitive, so as to clearly distinguish it from a normally-open switch contact.

With multiple-position selector switches, another design factor must be considered: that is, the sequence of breaking old connections and making new connections as the switch is moved from position to position, the moving contact touching several stationary contacts in sequence, shown in figure 2.19.

The selector switch shown above switches a common contact lever to one of five different positions, to contact wires numbered 1 through 5. The most common configuration of a multi-position switch like this is one where the contact with one position is broken before the contact with the next position is made. This configuration is called break-before-make. To give an example, if the switch were set at position number 3 and slowly turned clockwise, the contact lever would move off of the number 3 position, opening that circuit, move to a position between number 3 and number 4 (both circuit paths open), and then touch position number 4, closing that circuit.

There are applications where it is unacceptable to completely open the circuit attached to the "common" wire at any point in time. For such an application, a make-before-break switch design can be built, in which the movable contact lever actually bridges between two positions of contact (between number 3 and number 4, in the above scenario) as it travels between positions. The compromise here is that the circuit must be able to tolerate switch closures between adjacent position contacts (1 and 2, 2 and 3, 3 and 4, 4 and 5) as the selector knob is turned from position to position. Such a switch is shown figure 2.20.

When movable contact(s) can be brought into one of several positions with stationary contacts, those positions are sometimes called throws. The number of movable contacts is sometimes called poles. Both selector switches shown above with one moving contact and five stationary contacts would be designated as "single-pole, five-throw" switches.

If two identical single-poles, five-throw switches were mechanically ganged together so that they were actuated by the same mechanism, the whole assembly would be called a "double-pole, five-throw" switch, shown in figure 2.21.

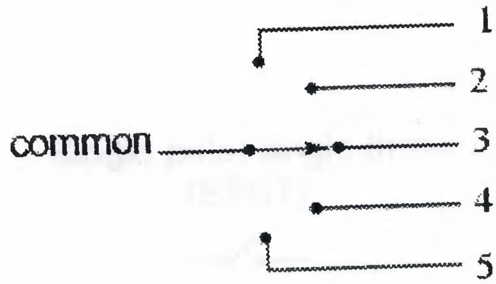


Figure 2.19 Switches a common.

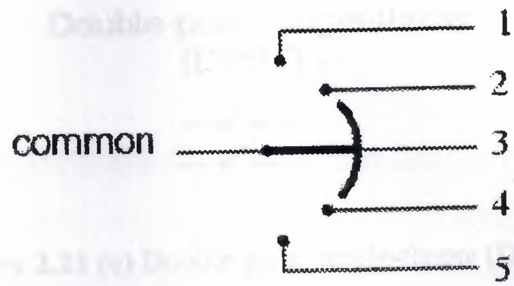


Figure 2.20 Switches a common.

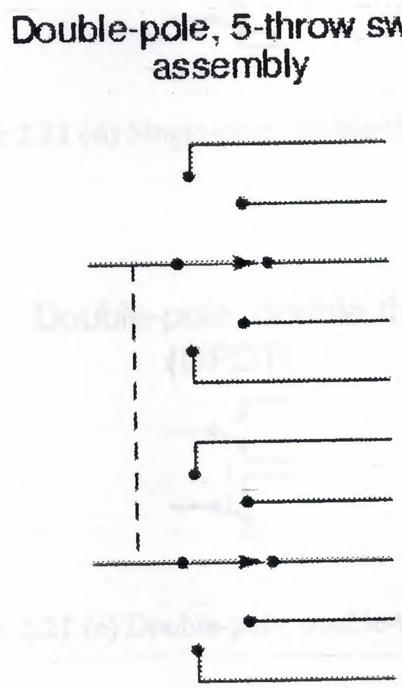


Figure 2.21 (a) Double pole.

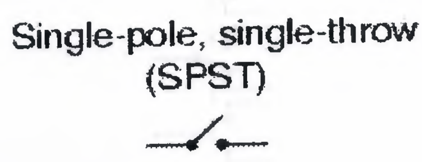


Figure 2.21 (b) Singlé-pole, single-throw (SPST).

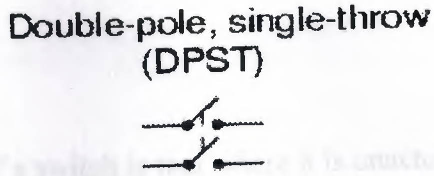


Figure 2.21 (c) Double-pole, single-throw (DPST).

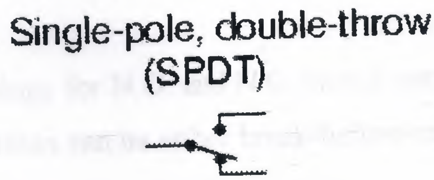


Figure 2.21 (d) Single-pole, double-throw (SPDT).

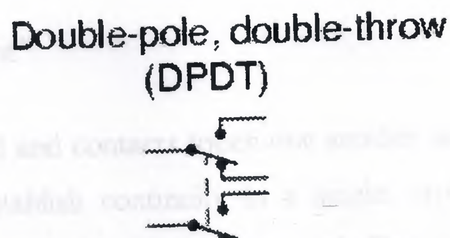


Figure 2.21 (e) Double-pole, double-throw (DPDT).

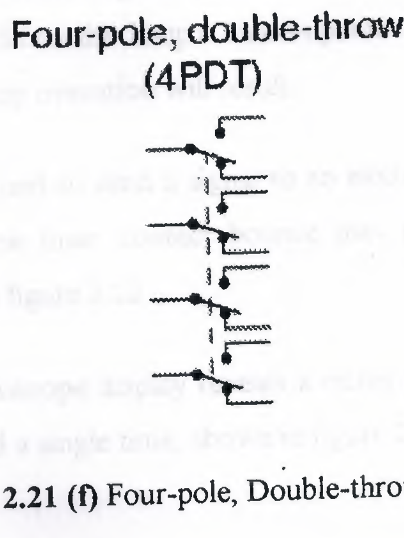


Figure 2.21 (f) Four-pole, Double-throw (4PDT).

- **REVIEW:**
- The normal state of a switch is that where it is unactuated. For process switches, this is the condition it's in when sitting on a shelf, uninstalled.
- A switch that is open when unactuated is called normally-open. A switch that is closed when unactuated is called normally-closed. Sometimes the terms "normally-open" and "normally-closed" are abbreviated N.O. and N.C., respectively.
- The generic symbology for N.O. and N.C. switch contacts is as follows.
- Multi-position switches can be either break-before-make (most common) or make-before-break.
- The "poles" of a switch refers to the number of moving contacts, while the "throws" of a switch refers to the number of stationary contacts per moving contact.

2.2.3 Contact "bounce"

When a switch is actuated and contacts touch one another under the force of actuation, they are supposed to establish continuity in a single, crisp moment. Unfortunately, though, switches do not exactly achieve this goal. Due to the mass of the moving contact and any elasticity inherent in the mechanism and/or contact materials, contacts will "bounce" upon closure for a period of milliseconds before coming to a full rest and providing unbroken contact. In many applications, switch bounce is of no consequence: it matters little if a switch controlling an incandescent lamp "bounces" for a few cycles every time it is actuated. Since the lamp's warm-up time greatly exceeds the bounce period, no irregularity in lamp operation will result.

However, if the switch is used to send a signal to an electronic amplifier or some other circuit with a fast response time, contact bounce may produce very noticeable and undesired effects, shown in figure 2.22.

A closer look at the oscilloscope display reveals a rather ugly set of makes and breaks when the switch is actuated a single time, shown in figure 2.23.

If, for example, this switch is used to provide a "clock" signal to a digital counter circuit, so that each actuation of the pushbutton switch is supposed to increment the counter by a value of 1, what will happen instead is the counter will increment by several counts each time the switch is actuated. Since mechanical switches often interface with digital electronic circuits in modern systems, switch contact bounce is a frequent design consideration. Somehow, the "chattering" produced by bouncing contacts must be eliminated so that the receiving circuit sees a clean, crisp off/on transition, shown in figure 2.24.

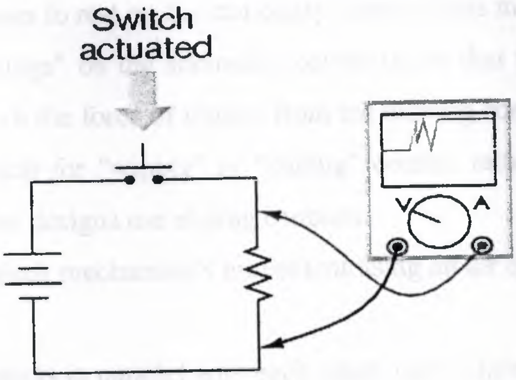


Figure 2.22 Bounce switches operations.

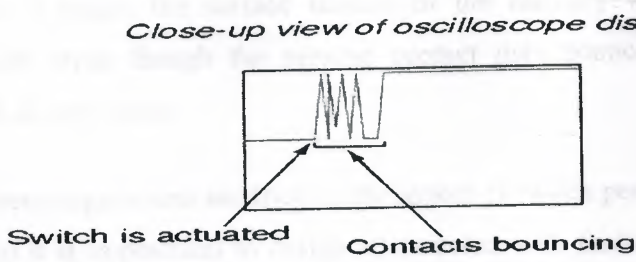


Figure 2.23 Close-up view of oscilloscope display.

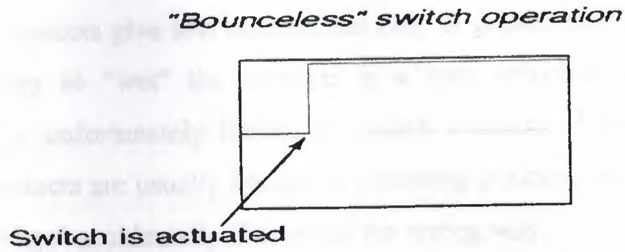


Figure 2.24 Bounceless switch operations.

Switch contacts may be debounced several different ways. The most direct means is to address the problem at its source: the switch itself. Here are some suggestions for designing switch mechanisms for minimum bounce:

- Reduce the kinetic energy of the moving contact. This will reduce the force of impact as it comes to rest on the stationary contact, thus minimizing bounce.
- Use "buffer springs" on the stationary contact(s) so that they are free to recoil and gently absorb the force of impact from the moving contact.
- Design the switch for "wiping" or "sliding" contact rather than direct impact. "Knife" switches designs use sliding contacts.
- Dampen the switch mechanism's movement using an air or oil "shock absorber" mechanism.
- Use sets of contacts in parallel with each other, each slightly different in mass or contact gap, so that when one is rebounding off the stationary contact, at least one of the others will still be in firm contact.
- "Wet" the contacts with liquid mercury in a sealed environment. After initial contact is made, the surface tension of the mercury will maintain circuit continuity even though the moving contact may bounce off the stationary contact several times.

Each one of these suggestions sacrifices some aspect of switch performance for limited bounce, and so it is impractical to design all switches with limited contact bounce in mind. Alterations made to reduce the kinetic energy of the contact may result in a small open-contact gap or a slow-moving contact, which limits the amount of voltage the switch may handle and the amount of current it may interrupt. Sliding contacts, while non-bouncing, still produce "noise" (irregular current caused by irregular contact resistance when moving), and suffer from more mechanical wear than normal contacts.

Multiple, parallel contacts give less bounce, but only at greater switch complexity and cost. Using mercury to "wet" the contacts is a very effective means of bounce mitigation, but it is unfortunately limited to switch contacts of low capacity. Also, mercury-wetted contacts are usually limited in mounting position, as gravity may cause the contacts to "bridge" accidentally if oriented the wrong way.

If re-designing the switch mechanism is not an option, mechanical switch contacts may be debounced externally, using other circuit components to condition the signal. A low-pass filter circuit attached to the output of the switch, for example, will reduce the voltage/current fluctuations generated by contact bounce, shown in figure 2.25.

Switch contacts may be debounced electronically, using hysteretic transistor circuits (circuits that "latch" in either a high or a low state) with built-in time delays (called "one-shot" circuits), or two inputs controlled by a double-throw switch. These hysteretic circuits, called multivibrators, are discussed in detail in a later chapter.

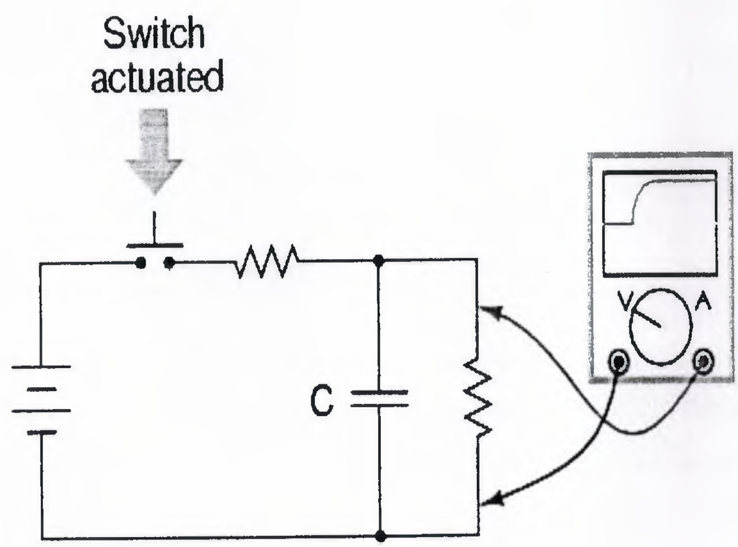


Figure 2.25 Debounced switch operations.

2.3 Summary

In this chapter we have discussed switches, the type of switches we have many types of switches, the effect of the circuit parameter on life-time of switches. Also the contact material, terminology of switches, and the bounce material, and the use of the switches in the hostile environment were been discussed.

CHAPTER THREE

LIGHT / DARK ACTIVATED SWITCH

3.1 Overview

In this chapter we will explain design a light / dark activated switch circuit, what are the input and the output of the circuit? How does it work? What is the problem are after building this circuit? The diagram of the circuit will show we can connect the circuit; also the components that are used in the circuit will be presented. And in this chapter we will combine the light activated switch circuit with the dark activated switch circuit in one circuit, with the diagrams of the modified circuit.

3.2 Introductions

There is a wide range of applications for light/ dark activated switch such as: staircase light tamers, outdoor illumination, and automatic door openers by the light beam, alarm system, solar tracking system and so on. Many of the application are familiar with the single transistor opto-switch where a photo sensor is placed between the base and either grounded depending whether normally on or normally off function is required. This simple circuit is testing how is the photo sensor is affect on the switch.

3.3 Light activated switch

3.3.1 How does it operate

The circuit diagram shown in figure (3.1) is for a switch of the type that activates a relay when the light level received by the light sensor rises above a certain threshold level and switched off again when the light level falls back below the threshold level. The relay coil is driven from collector of Tr1, and the relay will be activated if Tr1 is switched on by a suitable base current and voltage. The voltage and current available as the base of Tr1 is dependent on two main factors, the resistance provided by PCC1, and the setting of VR1. If VR1 is set at maximum value PCC1 needs to have a resistance of about 100 kilo ohm or less in order to bias TR1 conduction and activate the relay. In total darkness PCC1 has resistance of 200-kilo ohm or more, but only a very low light level is sufficient to reduce its resistance sufficiently to switch on Tr1 and the relay.

If VR1 is set for a lower resistance level, PCC1 needs to exhibit a lower resistance in the order to bias Tr1 in conduction, and the sensitivity of the circuit is reduced since PCC1 must be subjected to a higher light level in order to produce this lower resistance. If VR1 is steady adjusted lower resistance, the sensitivity of the circuit is progressively reduced. With VR1 at virtually minimum resistance even an extremely high level of light will be insufficient to operate the circuit. Thus VR1 acts as a sensitivity control, and enables the light threshold level to be varied over extremely wide limits. D1 might at the first appear to be superfluous, but it most borne in the mind that relay coil is a highly inductive component, and this can result in a high reverse voltage being generated across the relay coil as it de-energized. The purpose of D1 is to suppress this voltage pulse and prevent it from damaging Tr1.

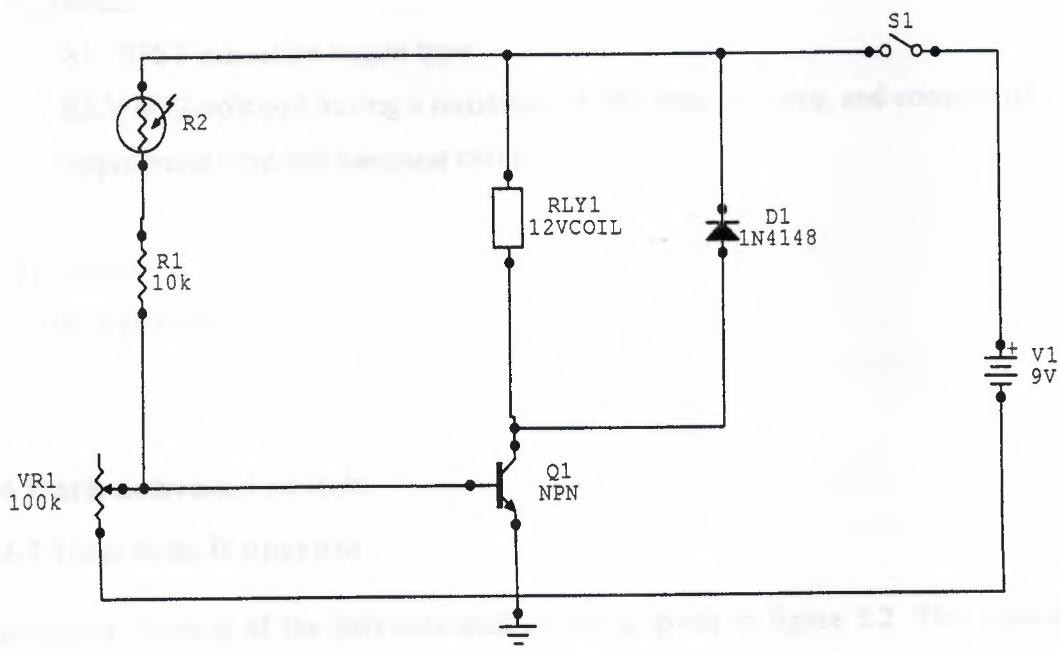


Figure 3.1 The circuit diagram of the light activated switch.

3.3.2 The components

The following components have been used in this circuit:

1) Resistor of 1/3 watt 5%

. R1 10 k ohm (brown, black, red, gold)

. VR1 100 k ohm

2) Semiconductors:

. Tr1 BC1O9C

. D1 IN4148

. LED red for the power and green for the output

3) Photocell:

. PCC1 RPY58A

4) Switch:

. S1 SPST miniature toggle type

. RLY 6/12-volt coil having a resistance of 185 ohms or more, and contacts of Appropriate type and adequate rating.

5) Battery:

. B1 size 9-volt

3.4 Dark activated switch

3.4.1 How does it operate

The circuit diagram of the dark-activated switch is given in figure 3.2. This circuit is a modified version of the previous one, and basically VR1 and PCC1 have been swooped over. Thus, in this circuit a base current is allowed to flow into Tr1 and switch the device on when PCC1 is in darkness and has a high resistance. Under bright condition PCC1 has low resistance and effectively short-circuit the base of Tr1 to earth and cuts it off. With VR1 at maximum resistance PCC1 will cut off Tr1 unless a very low level of light is present, but with VR1 at minimum resistance the light threshold is raised considerably, and VR1 acts as a sensitivity control much as it did in the circuit of Figure3.1. Also in common with the previous circuit, R1 is included to ensure that an excessive base current cannot flow into the base of Tr1.

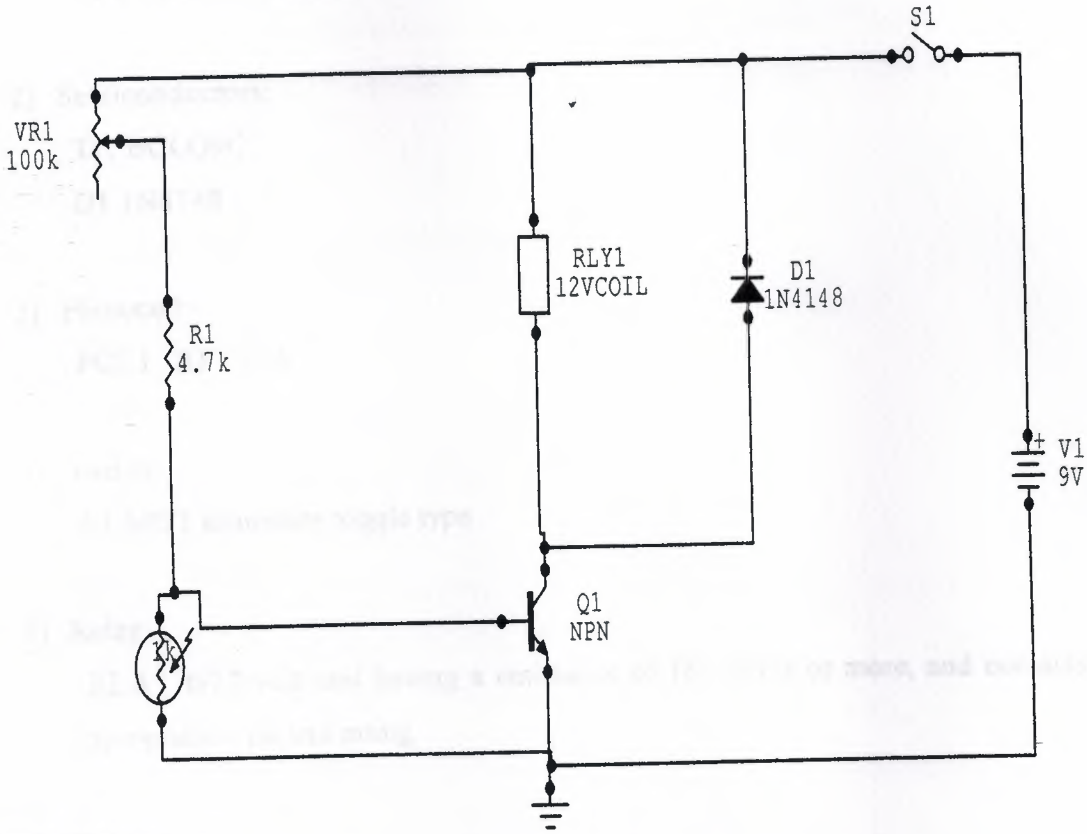


Figure 3.2 The circuit diagram of the dark activated switch.

Of course, if any of the light-sensitive circuits described in this book are constructed as permanent cased projects; the photocell must either be fitted on the exterior of the case, or it must be mounted inside the case behind a hole drilled in the case so that it can respond to the ambient light level.

3.4.2 The Components

1) Resistors of 1/3 watt 5%:

   . R1 4.7 ohm (yellow, violet, red, gold)

   . VR1 100k lin. Carbon

2) Semiconductors:

   . Trl BCLO9C

   . D1 1N4148

3) Photocell:

   . PCC1 RPY57A

4) Switch:

   . S1 SPST miniature toggle type

5) Relay:

   . RLA 6/12-volt coil having a resistance of 185 ohms or more, and contacts of appropriate type and rating.

6) Battery:

   . B1 PP6 size 9 volt and connector to suit

7) miscellaneous:

   . Vero bloc

   . Control knob

   . Wire

3.5 The circuit problems

Photo sensor is very sensitive to infrared light; that this circuit cannot be useful for some application that is dealing with infrared source. To avoid this problem special infrared shield is used for the photo sensor. And the photo sensor is sensitive to light level also, so that for each level of light we have to adjust the variable resistance.

3.6 Light and dark activated switches

3.6.1 How does it operate

Inverter gate

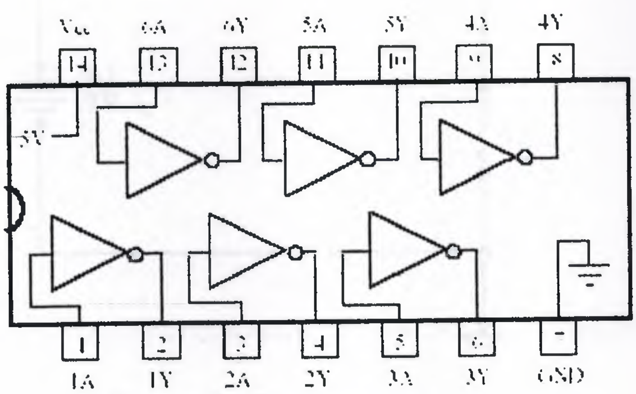


Figure 3.3 Inverter Gate.

A gate is a special type of amplifier circuit designed to accept and generate voltage signals corresponding to binary 1's and 0's. As such, gates are not intended to be used for amplifying analog signals (voltage signals between 0 and full voltage). Used together, multiple gates may be applied to the task of binary number storage (memory circuits) or manipulation (computing circuits,(each gate's output representing one bit of a multi-bit binary number. Just how this is done is a subject for a later chapter. Right now it is important to focus on the operation of individual gates. The gate shown here with the single transistor is known as an inverter, or NOT gate, because it outputs the exact opposite digital signal as what is input. For convenience, gate circuits are generally represented by their own symbols rather than by their constituent transistors and resistors. The following is the symbol for an inverter

Power supply circuit

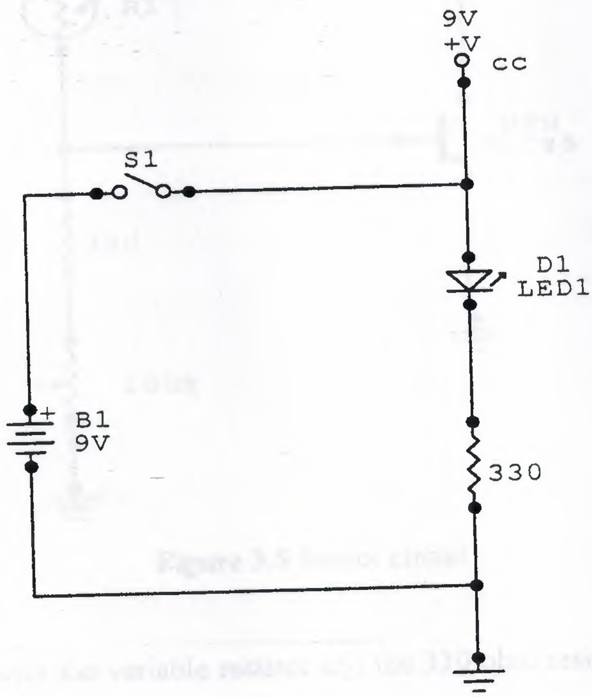


Figure 3.4 Power supply circuit.

This circuit is used to supply the circuit by the power of the buttery, the LED is used to indicate the power connection when the switch is pressed and the 330-ohm resistor is used as a voltage divider the LED.

Sensor circuit

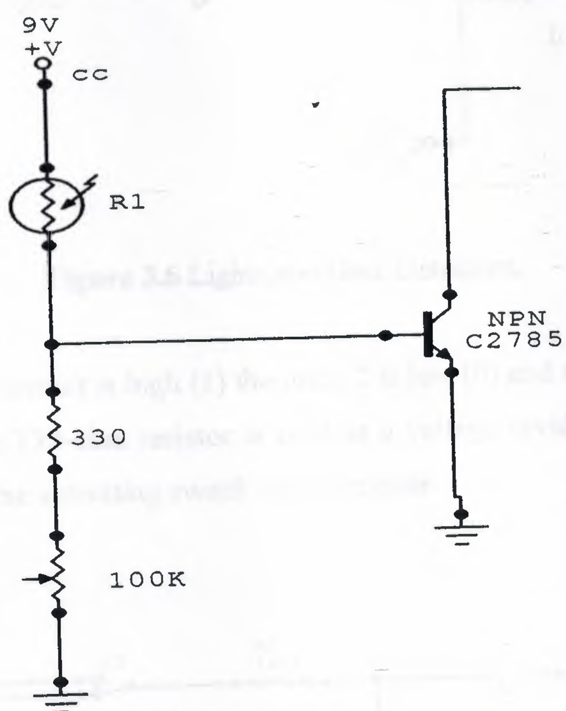


Figure 3.5 Sensor circuit.

The photo resistor with the variable resistor and the 330 ohm resistor are making biasing for the base of transistor.

When it's light the resistive of the photo resistor decreasing so, more current passing the base of the transistor and so, a high current will pass the collector through the emitter that connected to the ground, that will drop the voltage on the collector that is connected to the input of the inverter to change it to low level (0), the variable resistor to adjust the accuracy of the changing of the photo resistor. The 330 ohm resistor is used to ensure the minimum resistive between the base and ground.

Light and dark detection

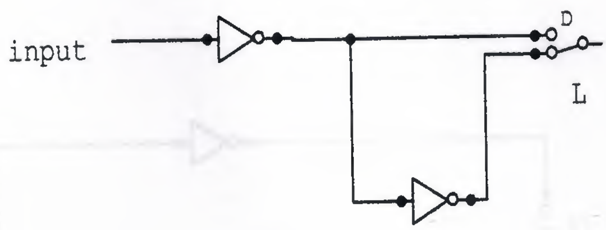


Figure 3.6 Lights and Dark Detection.

When the input of the circuit is high (1) the node 2 is low (0) and node 3 high (1), the red light will be ON. The 330-ohm resistor is used as a voltage divider for the LED so, the LED will blow when the activating switch light activates.

RC Timer

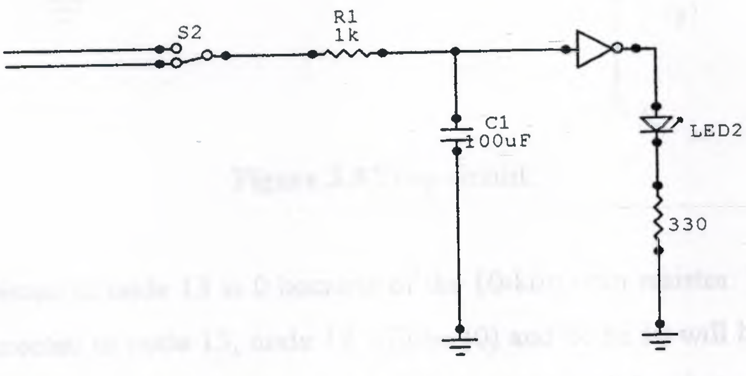


Figure 3.7 RC Timer.

The timer circuit in this project using the RC charging time principle, so the capacitor resist the raise of the voltage coming through the selector switch because it takes maximum current at the time of binary one input so voltage is zero at this time and increasing, until the voltage across the capacitor reaches the binary one voltage required for the gate to operate that is 0.7V. This circuit is used to confirm the present of the detection of the light / dark; so not operating for just a flash of light / dark.

Loop circuit

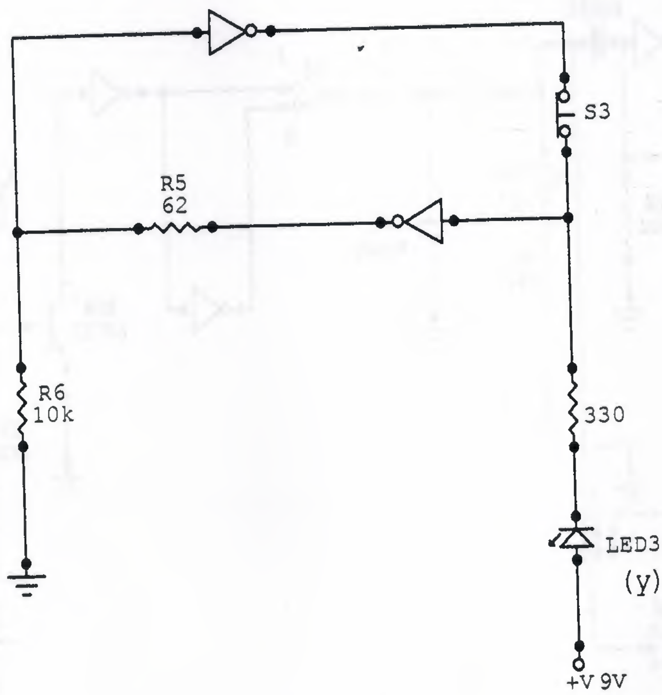


Figure 3.8 Loop circuit.

Initially, this circuit at node 13 is 0 because of the 10-kilo ohm resistor. When high light level(1) is connected to node 13, node 12 will be (0) and node 10 will be (1) and so, 62 ohm resistor will pass the high level to node 13 to hold the high level at node 13 when the external level high source is disconnected, the yellow LED will be ON. And when the push button is pressed the circuit will be return to the initially state.

The complete circuit

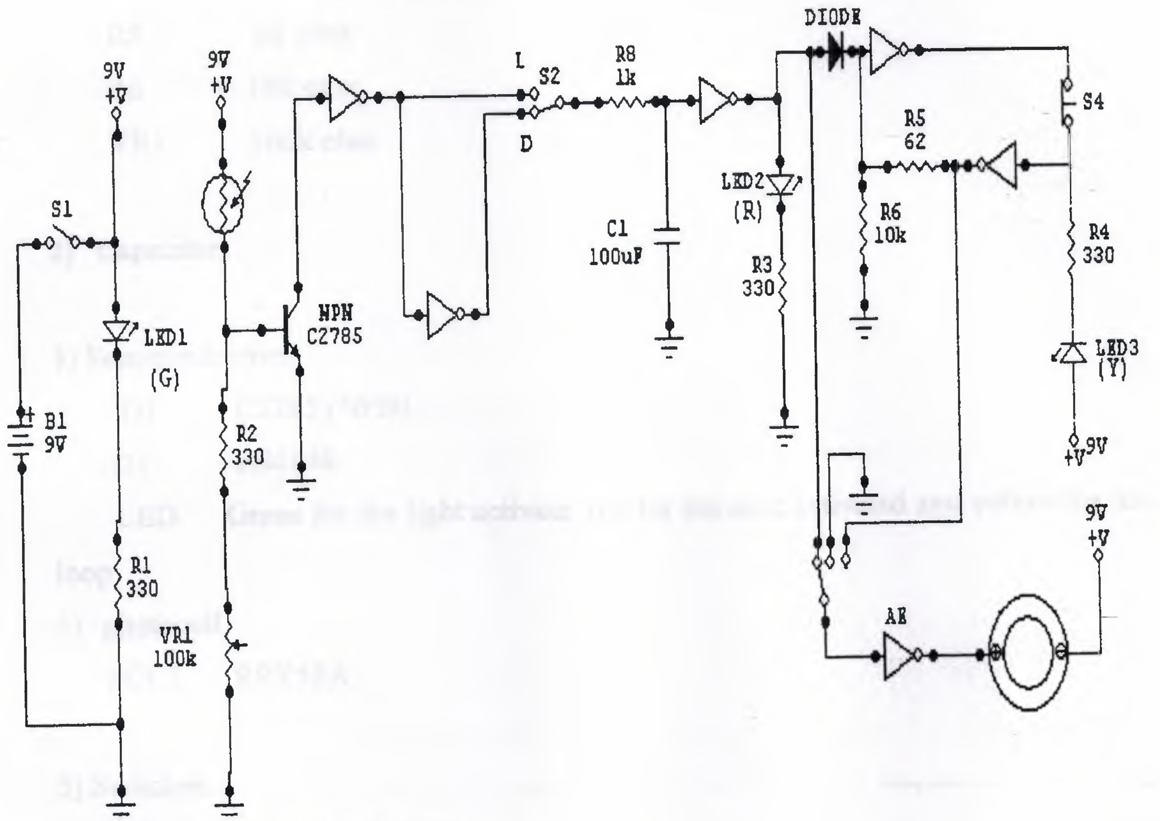


Figure 3.9 The complete circuit.

The diode in the circuit is used to pass the high level from the light and dark detection circuit and prevent passing the low level to keep the high level detection in the loop circuit. The selector switch light or dark activator is used to select the input of the loop circuit and buzzer circuit from the light LED node or the dark LED node. The selector switch of the fan circuit is used to select the input of the circuit (light or dark) or the loop detection or low (0) no alarm.

3.7 The components

1) Resistors 1/3 watt 5%:

. R1, R2, R3, R4, R8 330 ohm

. R5 62 ohm

. R6 10k ohm

. VR1 100k ohm

2) Capacitor.

3) Semiconductors:

. Tr1 C2785 (NPN)

. D1 1N4148

. LED Green for the light activate, red for the dark activated and yellow for the loop

4) photocell:

. PCC1 RPY58A

5) Switches:

S1 toggle SPDT type

S2 3-selections type

S3 push button normally close

6) Gate:

. Inventor gate 7404

7) Battery:

. B1 size

8) Fan

9) Miscellaneous:

. Vero bloc

. Control knob

. Wire

3.8 Using instructions

1- Turn ON the power switch.
2- Activating the circuit by turning the activation switch to the desired state (light, dark).
3- Adjust the sensitivity-actuating key.
4- Choosing the alarm state (loop, none or alarm).
5- When resetting the circuit press the rest button to reset the loop alarm.

3.9 Results

The circuit worked well without any fault as showing in the figure 3.8 problem in this circuit is as we mentioned before the sensitivity of an LDR sensor, but in this circuit this problem occur more than the first and second, while we are converting the effective light in dark or in dark or in light and we could detect the at least one time activation by using loop alarm. And the complete circuit was installed inside a box to make it friendlier; in addition a push button was added to reset the switch indicator (yellow LED).(e.g. as alarm system, it indicates intrusion)

Another problem is the connection of a fan to the output to be controlled, that it is not rotating when it should do and the voltage of the battery drop below it level and so affect whole the circuit this problem could be solved by replacing the one 9V battery by a six 1.5V batteries connected series to supply 9V with higher current.

3.10 Summary

In this chapter the light and dark activated circuits were presented. Also in this chapter we have explained three circuits using photo sensor (LDR), the diagram of the first second and third circuit also showed. And the components for all of them were listed.

CONCLUSION

We could build light/ dark activated switch combining the analog and digital components, analog components such as resistors, capacitors and transistors, and digital components like inverter gates.

Far from this project we have accomplished our aims that were:

- To design and build a light/ dark activated switch.
- To gain hands on experience in electronic hardware project
- To modify the original circuit where possible
- To suggest potential real-life use of switches
- To benefit how to build and use alarm system in our houses to protect our belongings and ourselves by using LDR sensor

In the first chapter we have seen different types of electronic components and the safety way of using them in any electric circuit, also we learned how to measure them without expecting an error.

In the second chapter we have discussed switches the type of switches we have seen 12 types of switch, the effect of the circuit parameter on the life time of switches. Also the contact material, terminology of switches, and the use of the switches in the hostile environment were been discussed.

The third chapter was as introduction about light and dark activated switch, where we can use it. Also in this chapter we have explained three circuits using an LDR sensor, the third circuit was a combination between the light and the dark activation switch, the diagram of the first, second and the third circuit.

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