NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Electrical and Electronic Engineering

INFRARED ALARM SECURETY SYSTEM

GRADUATION PROJECT
EE400

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ABSTRACT

As the life is getting more complicated, many people try to make their environment more safe and more comfortable, that leads to design some protection and luxury systems such as alarm systems. One of these alarm systems is infrared security alarm activated alarm which considered as an "intelligent" alarm can make our life more easy and safety.

Infrared security alarm system activated system depends on a sensitive element acts as the input of the alarm, which is the photodiode, photodiode designed to have high response time that what we need in security systems. If any objects is pass between the transmitter and the receiver infrared, that will make an different of the amplifier input depend on what value we put as reference or the range that we fix it to covered by the system.

Sensor systems that include information processing for making decisions or eliciting actions on a local and autonomous basis is quite large. It extends to surveillance, industrial control, robotics, environmental control, the automotive sector, consumer electronics and multimedia applications.

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Chapter 1

ELECTRONIC COMPONENTS

1.1 Introduction

In the early 20th century, Henry Round of Marconi Labs first noted that a semiconductor junction would produce light. Russian Oleg Vladimirovich Losev independently created the first LED in the mid 1920s; his research, though distributed in Russian, German and British scientific journals, was ignored. Rubin Braunstein of the Radio Corporation of America reported on infrared emission from gallium arsenide (GaAs) and other semiconductor alloys in 1955.Experimenters at Texas Instruments, Bob Biard and Gary Pittman, found in 1961 that gallium arsenide gave off infrared radiation when electric current was applied. Biard and Pittman were able to establish the priority of their work and received the patent for the infrared light-emitting diode. Nick Holonyak Jr., then of the General Electric Company and later with the University of Illinois at Urbana-Champaign, developed the first practical visible-spectrum LED in 1962and is seen as the "father of the light-emitting diode". Holonyak's former graduate student, M. George Craford, invented in 1972 the first yellow LED and 10x brighter red and red-orange LEDs.The first known report of a light-emitting solid-state diode was made in 1907 by the British experimenter H. J. Round. However, no practical use was made of the discovery for several decades. Independently, Oleg Vladimirovich Losev published "Luminous carborundum [silicon carbide] detector and detection with crystals" in the Russian journal Telegraphy i Telephony bez Provodov (Wireless Telegraphy and Telephony). Losev's work languished for decades. The first practical LED was invented by Nick Holonyak, Jr., in 1962 while he was at General Electric Company. The first LEDs became commercially available in late 1960s, and were red.They were commonly used as replacements for incandescent indicators, and in seven-segment displays, first in expensive equipment such as laboratory and electronics test equipment, then later in such appliances as TVs, radios, telephones, calculators, and even watches. These red LEDs were bright enough only for use as indicators, as the light output was not enough to illuminate an area. Later, other colors became widely available and also appeared in appliances and equipment as the LED materials technology became more advanced, the light output was increased, and LEDs became bright enough to be used for illumination. Most LEDs were made in the very common 5 mm T1-3/4 and 3 mm T1 packages, but with higher power, it has become increasingly necessary to get rid of the heat, so the packages have become more complex and adapted for heat dissipation As next-generation electronic information systems evolve, it is critical that all people have access to the information available via these systems. Examples of developing and future information systems include interactive television, touch screen-based information kiosks, and advanced Internet programs. Infrared technology, increasingly present in mainstream applications, holds great potential for enabling people with a variety of disabilities to access a growing list of information resources. Already commonly used in remote control of TVs, VCRs and CD players, infrared technology is also being used and developed for remote control of environmental control systems, personal computers, and talking signs. For individuals with mobility impairments, the use of infrared or other wireless technology can facilitate the operation of information kiosks, environmental control systems, personal computers and associated peripheral devices. For individuals with visual impairments, infrared or other wireless communication technology can enable users to locate and access talking building directories, street signs, or other assistive navigation devices. For individuals using augmentative and alternative communication (AAC) devices, infrared or other wireless technology can provide an alternate, more portable, more independent means of accessing computers and other electronic information systems [2]. Generally, IR links consist of a modulation source driving a light emitting diode that radiates at a wavelength of 850 to 970nm. This light is detected by a photodiode, and the resulting signal is amplified and decoded to recover the transmitted information. Since IR light is used, licensing is not required; the radiation is easily confined to a single room since walls and doors block these wavelengths, and electrical interference is easily rejected. Also, multipath interference does not significantly degrade the signal, and there are few domestic light sources emitting IR that flicker at a frequency high enough to corrupt a modulated signal. (Compact Fluorescent or "energy saving" lamps are a possible problem, though manufacturers do try to avoid common IR data transmission frequencies).

The main limitations of an optical system result from the low power output available from an IR light emitting diode (LED) combined with noise generated in the photodiode by current flowing in the device due to ambient lighting and leakage. These factors control the operational range of a system and the ambient light levels it can tolerate [3].

In chapter one we will explain the most commonly used electronic circuit's components such as (Resistors, Capacitors, Semiconductors, Integrated circuits, and Diodes), and some other devices, where each of the mentioned components has its own properties (shapes, colors, values, units).

In chapter two, we have subjected the types of sensors and their principles work, and the illustration of their characteristics.

In chapter three, we have stated the circuit diagram of infrared alarm system followed by how it does work, and described how each component of the circuit does work?, and the applications of the system. We will also state the problems that had faced us in the practical design applying, which will be following by the conclusion.

1.2 Resistors

The resistor is the simplest, most basic electronic component. In an electronic circuit, the resistor opposes the flow of electrical current through itself. It accomplishes this by absorbing some of the electrical energy applied to it, and then dissipating that energy as heat. By doing this, the resistor provides a means of limiting or controlling the amount of electrical current that can pass through a given circuit.

Resistors, such as the Figure 1.1, have two ratings, or values, associated with them. First, of course is the resistance value itself. This is measured in units called ohms and symbolized by the Greek letter Omega (Ω).

The second rating is the amount of power the resistor can dissipate as heat without itself overheating and burning up. Typical power ratings for modern resistors in most applications are ½ watt and ¼ watt, which are the two sizes shown in Figure 1.1. High-power applications can require high-power resistors of 1, 2, 5, or 10 watts, or even higher.

Figure 1.1 Resistors

A general rule of thumb is to always select a resistor whose power rating is at least double the amount of power it will be expected to handle. That way, it will be able to dissipate any heat it generates very quickly, and will operate at normal temperatures. For purposes of physical comparison, the larger resistor in Figure 1.1 is rated at ½ watt; its body is a cylinder 3/8" long and 1/8" in diameter. The smaller resistor, rated at ¼ watt, is of the same shape but is only 1/4" long and 1/16" in diameter.

The traditional construction of ordinary, low-power resistors is as a solid cylinder of a carbon composition material. This material is of an easily controlled content, and has a well-known resistance to the flow of electrical current. The carbon cylinder is molded around a pair of wire leads at either end to provide electrical connections. The length and diameter of the cylinder are controlled in order to define the resistance value of the resistor the longer the cylinder, the greater the resistance; the greater the diameter, the less the resistance. At the same time, the larger the cylinder, the more power it can dissipate as heat. Thus, the combination of the two determines both the final resistance and the power rating.

A newer, more precise method is shown Figure 1.2. The manufacturer coats a cylindrical ceramic core with a uniform layer of resistance material, with a ring or cap of conducting material over each end. Instead of varying the thickness or length of the resistance material along the middle of the ceramic core, the manufacturer cuts a spiral groove around the resistor body. By changing the angle of the spiral cut, the manufacturer can very accurately adjust the length and width of the spiral stripe, and therefore the resistance of the unit[4].

The wire leads are formed with small end cups that just fit over the end caps of the resistor, and can be bonded to the end caps. With either construction method, the new resistor is coated with an insulating material such as phenol or ceramic, and is marked to indicate the value of the newly finished resistor.

High-power resistors are typically constructed of a resistance wire (made of nichrome or some similar material) that offers resistance to the flow of electricity, but

Figure 1.2 Precise resistor's picture

Can still handle large currents and can withstand high temperatures. The resistance wire is wrapped around a ceramic core and is simply bonded to the external connection points. These resistors are physically large so they can dissipate significant amounts of heat, and they are designed to be able to continue operating at high temperatures[4].

These resistors do not fall under the rule of selecting a power rating of double the expected power dissipation. That is not practical with power dissipations of 20 or 50 watts or more. Therefore, these resistors are built to withstand the high temperatures that they will produce in normal operation, and are always given plenty of physical distance from other components so they can still dissipate all that heat harmlessly. Regardless of power rating, all resistors are represented by the schematic symbol shown in the Figure 1.3. It can be drawn either horizontally or vertically, according to how it best fits in the overall diagram.

1.2.1 Reading the Color Cods of a Resistor

In Figure 1.4 is an image of a ½-watt resistor. Due to variations in monitor resolution, it may not be precisely to scale, but it is close enough to make the point. You can see that there are four colored stripes painted around the body of this resistor, and that they *are grouped closer to one end (the top) than to the other.*

to someone who knows the color code, these stripes are enough to identify this as a 470Ω, 5% resistor. Imagine putting all of that in numbers on something that small. Or worse on a ¼- watt resistor, which is even smaller. The use of colored stripes, or bands, allows small components to be accurately marked in a way that can be read at a glance, without difficulty or any great possibility of error. In addition, the stripes are easy to paint onto the body of the resistor, and so do not add unreasonably to the cost of manufacturing the resistors.

Figure 1.3 Schematic symbol

Figure 1.4 ½-Watt resistors

The resistor, the bands have the following significance. The first two bands give the two significant digits of the resistance value. The third gives a decimal multiplier, which is some power of 10, and generally simply defines how many zeroes to add after the significant digits. The fourth band identifies the tolerance rating of the resistor.
If the fourth band is missing, it indicates the original default tolerance of 20%. The bands may take on colors according to the following Figure 1.5 and Table 1.1.

1.3 Capacitors

It is known that an electrical current can only flow through a closed circuit. Thus, if we break or cut a wire in a circuit, that circuit is opened up and can no longer carry a current. But we know that there will be a small electrical field between the broken ends. The Figure 1.6 shows two metal plates, placed close to each other but not touching.

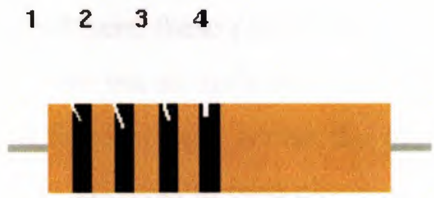

Figure 1.5 reading digits of resisters

Table 1.1 Resistor's colors values

Color	Significant Digits (1 and 2)	Multiplier (3)	Tolerance (4)
Black	0	1	
Brown	1	10	
Red	2	100	
Orange	3	1000	
Yellow	4	10,000	
Green	5	100,000	
Blue	6	1,000,000	
Violet	7		
Grey	8		
White	9		
Gold		0.1	5%
Silver		0.01	10%
(None)			20%

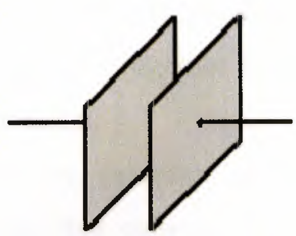

Figure 1.6 Metal plates

A wire is connected to each plate as shown, so that this construction may be made part of an electrical circuit. As shown here, these plates still represent nothing more than an open circuit. A wide one to be sure, but an open circuit nevertheless.

Now suppose we apply a fixed voltage across the plates of our construction, as shown in Figure 1.7. The battery attempts to push electrons onto the negative plate, and pull electrons from the positive plate. Because of the large surface area between the two plates, the battery is actually able to do this. This action in turn produces an electric field between the two plates, and actually distorts the motions of the electrons in the molecules of air in between the two plates.

Our construction has been given an electric charge, such that it now holds a voltage equal to the battery voltage. If we were to disconnect the battery, we would find that this structure continues to hold its charge until something comes along to connect the two plates directly together and allow the structure to discharge itself. Because this structure has the capacity to hold an electrical charge, it is known as a capacitor. How

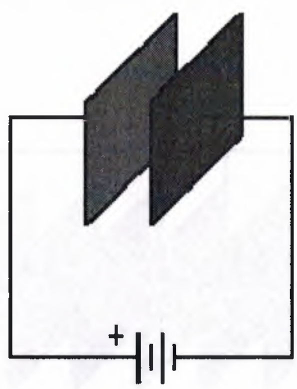

Figure 1.7 Fixed voltage applied to the plates

much of a charge it can hold is determined by the area of the two plates and the distance between them. Large plates close together show a high capacity; smaller plates kept further apart show a lower capacity.

Even the cut ends of the wire we described at the top of this page show some capacity to hold a charge, although that capacity is so small as to be negligible for practical purposes[4].

The electric field between capacitor plates gives this component an interesting and useful property: it resists any change in voltage applied across its terminals. It will draw or release energy in the form of an electric current, thus storing energy in its electric field, in its effort to oppose any change. As a result, the voltage across a capacitor cannot change instantaneously; it must change gradually as it overcomes this property of the capacitor.

A practical capacitor is not limited to two plates. As shown the Figure 1.8, it is quite possible to place a number of plates in parallel and then connect alternate plates together. In addition, it is not necessary for the insulating material between plates to be air.

Any insulating material will work, and some insulators have the effect of massively increasing the capacity of the resulting device to hold an electric charge. This ability is known generally as capacitance, and capacitors are rated according to their capacitance.

It is also unnecessary for the capacitor plates to be flat. Consider Figure 1.9, which shows two "plates" of metal foil, interleaved with pieces of waxed paper. This assembly can be rolled up to form a cylinder, with the edges of the foil extending from

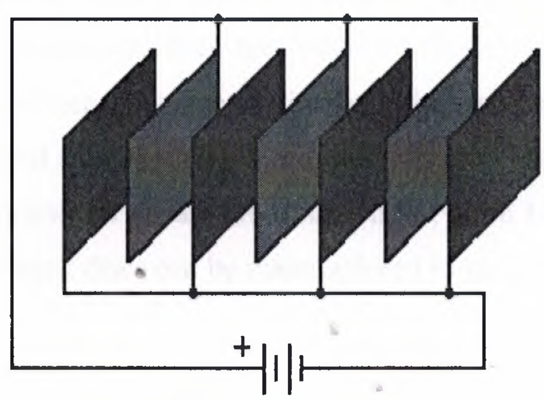

Figure 1.8 Multi-plates capacitor

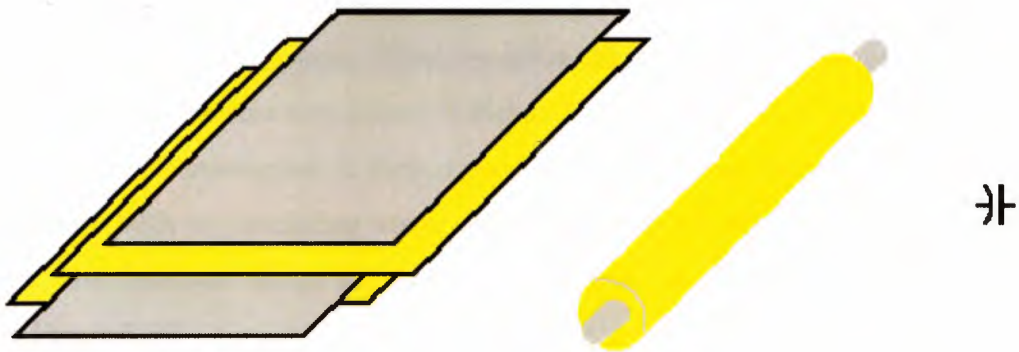

Figure 1.9 Plates of metal foil

either ends so they can be connected to the actual capacitor leads. The resulting package is small, light, rugged, and easy to use. It is also typically large enough to have its capacitance value printed on it numerically, although some small ones do still use color codes.

The schematic symbol for a capacitor, shown in Figure 1.9 to the right of the rolled foil illustration represents the two plates. The curved line specifically represents the outer foil when the capacitor is rolled into a cylinder as most of them are. This can become important when we start dealing with stray signals which might interfere with the desired behavior of a circuit (such as the "buzz" or "hum" you often hear in an AM radio when it is placed near fluorescent lighting). In these cases, the outer foil can sometimes act as a shield against such interference.

An alternate construction for capacitors is shown in Figure 1.10. We start with a disc of a ceramic material. Such discs can be manufactured to very accurate thickness

Figure 1.10 Alternate constructions for capacitors

And diameter, for easily controlled results. Both sides of the disc are coated with solder, which is compounded of tin and lead.

These coatings form the plates of the capacitor. Then, wire leads are bonded to the solder plates to form the structure shown in Figure 1.10.

The completed construction is then dipped into another ceramic bath, to coat the entire structure with an insulating cover and to provide some additional mechanical protection. The capacitor ratings are then printed on one side of the ceramic coating, as shown in Figure 1.10.

Modern construction methods allow these capacitors to be made with accurate values and well-known characteristics. Also, different types of ceramic can be used in order to control such factors as how the capacitor behaves as the temperature and applied voltage change. This can be very important in critical circuits.

1.3.1 Reading the Values of a Capacitor

The basic unit of capacitance is the farad, named after British physics and chemist Michael Faraday (1791 - 1867) For you physics types [1]., the basic equation for capacitance shown below.

$$C = q/V$$

Where:

- C is the capacitance in farads.
- Q is the accumulated charge in coulombs.
- V is the voltage difference between the capacitor plates.

Verbally, a capacitance of one farad will exhibit a voltage difference of one volt when an electrical charge of one coulomb is moved from one plate to the other through capacitance. To help put this in perspective; one ampere of current represents one coulomb of charge passing a given point in an electrical circuit in one second.

In practical terms, the farad (f) represents an extremely large amount of capacitance. Real-world circuits require capacitance values very much smaller.

Therefore, we use Microfarads (μf) and Pico-farads (pf) to represent practical capacitance values. The use of the micro- and Pico- prefixes is standard. One $\mu f = 1 \times 10^{-6}$ f and one $pf = 1 \times 10^{-6}$ μf. Sometimes you will see the designation μμf in place of pf; they have the same meaning.

Like resistors, capacitors are generally manufactured with values to two significant digits. Also, small capacitors for general purposes have practical values greater than one pf and less than one μf. As a result, a useful convention has developed in reading capacitance values. If a capacitor is marked "47," its value is 47 pf. If it is marked .047, its value is .047 μf. Thus, whole numbers express capacitance values in Pico-farads while decimal fractions express values in microfarads. Any capacitor manufactured with a value of one μf or greater is physically large enough to be clearly marked with its actual value.

A newer nomenclature has developed, where three numbers are printed on the body of the capacitor. The third digit in this case works like the multiplier band on a resistor; it tells the number of zeros to tack onto the end of the two significant digits. Thus, if you see a capacitor marked "151," it is not a precision component. Rather, it is an ordinary capacitor with a capacitance of 150 pf. In this nomenclature, all values are given in Pico-farads.

Therefore, you might well see a capacitor marked 684, which would mean 680000 pf, or 0.68 μf.

1.4 Semiconductors

Metal conducts electricity; rubber does not. Gold conducts electricity; Styrofoam does not. Most materials fall easily into one category or the other. Everyone knows, for example, that if you want a good wire you are going to make it out of copper, not plastic. But there is a whole group of materials that fall in between. Their conductivity is in between metals and insulators. And their conductivity can be modified transiently, by shining a light on them or injecting charges. They are known as semiconductors, and they first became interesting to physicists in the late 1920s . At first, no one could figure out how they worked. Scientists once thought that certain atoms simply held onto their electrons more strongly than others. But as physicists got a better understanding of what an atom looked like, they understood what was really going on. Different kinds of atoms have different numbers of electrons swarming around them[2].

These electrons can only sit in specific places around the atom. It is sort of like rows of seats in a theater-in-the-round, a few electrons get to sit in the first row around the stage, and when that is filled the next electrons sit in the next row and so on. Electrons in a filled row stay put just as in a theater it is harder to get out when you have people sitting on each side of you. In an insulator, every row is completely filled. Consequently the electrons rarely move. No moving electrons mean no electricity can pass through.

But if you are sitting in the back row of a movie theater and the seats are not full, you could easily get up, switch seats, may be even decide to check out a different movie in the next theater. In a metal, the last row is not filled with electrons. The outer electrons have little loyalty to the atom they are with and readily wander off in search of other atoms. This translates too many moving electrons, which means metals can easily conduct electricity.

They reside somewhere in the middle. They are mostly made of atoms that do not conduct electricity, but they have a handful of atoms with loose electrons. Under certain circumstances by changing things like temperature or how much energy is injected these loose electrons will start a flowing current.

That means that depending on what you do, semiconductors can transiently conduct more or less electricity. It is just that property that transistors exploit .

1.4.1 Intrinsic and Extrinsic Semiconductors

An intrinsic semiconductor is one, which is pure enough that impurities do not appreciably affect its electrical behavior. In this case, all carriers are created by thermally or optically exciting electrons from the full valence band into the empty conduction band. Thus equal numbers of electrons and holes are present in an intrinsic semiconductor. Electrons and holes flow in opposite directions in an electric field, though they contribute to current in the same direction since they are oppositely charged. Hole current and electron current are not necessarily equal in an intrinsic semiconductor, however, because electrons and holes have different effective masses (crystalline analogues to free inertial masses).

The concentration of carriers is strongly dependent on the temperature. At low temperatures, the valence band is completely full, making the material an insulator. Increasing the temperature leads to an increase in the number of carriers and a corresponding increase in conductivity. This principle is used in thermistor. This behavior contrasts sharply with that of most metals, which tend to become less conductive at higher temperatures due to increased phonon scattering. An extrinsic semiconductor is one that has been doped with impurities to modify the number and type of free charge carriers[3].

1.4.2 Purity and Perfection of a Semiconductor Materials

Semiconductors with predictable, reliable electronic properties are difficult to mass-produce because of the required chemical purity, and the perfection of the crystal structure, which are needed to make devices. Because the presence of impurities in very small proportions can have such big effects on the properties of the material, the level of chemical purity needed is extremely high. Techniques for achieving such high purity include zone refining, in which part of a solid crystal is melted. Impurities tend to concentrate in the melted region, leaving the solid material more pure. A high degree of crystalline perfection is also required, since faults in crystal structure such as dislocations, twins, and stacking faults, create energy levels in the band gap, interfering with the electronic properties of the material. Faults like these are a major cause of defective devices in production processes. The larger the crystal, the harder it is to achieve the necessary purity and perfection; current mass production processes use six-inch diameter crystals which are grown as cylinders and sliced into wafers.

1.5 Integrated Circuits

Another name for a chip, an integrated circuit (IC) is a small electronic device made out of a semiconductors material. The first integrated circuit was developed in the 1950s by Jack Kilby of Texas instrument and Robert Noyce of Fairchild Semiconductor [3]. Integrated circuits are used for a variety of devices, including microprocessors, audio and video equipment, and automobiles. Integrated circuits are often classified by the number of transistors and other electronic components.

An integrated circuit (IC) is a thin chip consisting of thousands or millions of interconnected semiconductor devices, mainly transistors, as well as passive components like resistors. As of present days, typical chips are of size 1 cm^2 or smaller, but larger ones exist as well. Among the most advanced integrated circuits are the microprocessors, which drive everything from computers to cellular phones to digital microwave ovens. Digital memory chips are another family of integrated circuits that are crucially important in modern society. The integrated circuit was made possible by mid-20th-century [4], technology advancements in semiconductor device fabrication and experimental discoveries that showed that semiconductor devices could perform the functions performed by vacuum tubes at the time. The integration of large numbers of tiny transistors onto a small chip was an enormous improvement to the manual assembly of finger-sized vacuum tubes. The integrated circuit's small size, reliability, fast switching speeds, low power consumption, mass production capability, and ease of adding complexity quickly pushed vacuum tubes into obsolescence. Only a half century after their development was initiated, integrated circuits have become ubiquitous. Computers, cellular phones, and other digital appliances are now inextricable parts of the structure of modern societies. Indeed, many scholars believe that the digital revolution brought about by integrated circuits was one of the most significant occurrences in the history of mankind.

1.5.1 Significance

Integrated circuits can be classified into analog, digital and mixed signal (both analog and digital on the same chip).

Digital integrated circuits can contain anything from one to millions of logic gates, flip-flops, multiplexers, etc. in a few square millimeters. The small size of these circuits allows high speed, low power dissipation, and reduced manufacturing cost compared with board-level integration.

The growth of complexity of integrated circuits follows a trend called "Moore's Law", first observed by Gordon Moore of Intel. Moore's Law in its modern interpretation states that the number of transistors in an integrated circuit doubles every two years. By the year 2000 the largest integrated circuits contained hundreds of millions of transistors , and the trend shows no sign of slowing down.

The integrated circuit is one of the most important inventions of the 20th century. Modern computing, communications, manufacturing, and transportation systems, including the Internet, all depend on its existence.

1.6 Diodes

A diode, or "rectifier," is any device through which electricity can flow in only one direction. The first diodes were crystals used as rectifiers in home radio kits. A weak radio signal was fed into the crystal through a very fine wire called a cat's whisker. The crystal removed the high frequency radio carrier signal, allowing the part of the signal with the audio information to come through loud and clear. The crystal was filled with impurities, making some sections more resistant to electrical flow than others. Using the radio required positioning the cat's whiskers over the right kind of impurity to get electricity to flow through the crystal to the output below it.

At the time, though, no one really understood about the impurities -- then in 1939, Russell Ohl accidentally discovered that it was the boundary between sections of different purity that made the crystal work [3]. Now that the way they work is understood, manufacturers make crystal diodes that work much more consistently than the ones in those original radio kits.

A crystal diode is made of two different types of semiconductors right next to each other. One side is easy for electrons to travel through; one side is much tougher. It is something like trying to swim through a pool filled with water and then a pool filled with mud: swimming through water is easy; swimming through mud is next to impossible. To an electron, some semiconductors seem like water, some like mud.

One side of the semiconductor boundary is like mud, one like water. If you try to get electricity to move from the mud side to the waterside, there is no problem. The electrons just jump across the boundary, forming a current. But try to make electricity go the other way and nothing will happen. Electrons that did not have to work hard to travel around the waterside just do not have enough energy to make it into the mud side. (In real life, there are always a few electrons that can trickle in the wrong direction, but not enough to make a big difference.)

This boundary has turned out to be crucial for our daily lives. Diodes change the alternating current that comes from your wall outlet into the direct current that most appliances need. And transistors need two such boundaries to work.

1.7 Potentiometer

These are available in a number of different types, but the circuit in the book requires carbon type that is available from virtually any electronic component retailer. Wire wound type are electrically suitable, but are often physically rather large and more expensive and are not recommended. Rotary types are preferable to slider types as the latter are usually much more difficult to mount. It is important to connect the potentiometer correctly in most cases as otherwise, for example, advancing a volume control might give a decrease in volume rather than increase. Potentiometer are available with a linear law (Lin = linear abbreviated type) or with a logarithmic law (log. Type), and circuit will work if the wrong type is used (provided it has the right value of course). However, if we take a volume control as a simple example, a logarithmic type would normally be utilized in this application, and using this type of potentiometer gives an apparently smooth and easily controlled increase in volume as the control is advanced. If a linear type is used, there is an apparent sudden increase in volume as control is advanced from zero, with very little apparent change in volume over the major part of the control's adjustment range. It is possible to set the volume at desired level, but the volume-level is comparatively difficult to control accurately. Thus, it is advisable to use potentiometer of the type specified in the appropriate component list.

1.8 Light Emitting Diodes

Two light-emitting diodes (LEDs) are employed in the project, and these are both small types (3 mm or 0.125 in), but the TIL209 is a red device and the TIL211 is a green device. Many component suppliers do not use type numbers for the LEDs and simply describe them as LED of a certain color, diameter, and shape (the TIL209 and TIL211 are both type incidentally).

With most LED circuits, including those described here, from the electrical viewpoint the size, color, and shape of the LED is not important and with exception of a few special types such as infra-red and multi-color type types any LED can be used. For circuit that use both types it is not even essential to use LEDs of different colors, but a two- current display will probably be clearer than one having LEDs of the same color.

There are various way used to show which LED lead-out wire is the anode (+) and which is the cathode (-), one of the most common being to have one lead-out wire shorter than shorter than the other, usually the shorter lead-out wire is cathode one (-), but unfortunately this is not always the case, and sometimes different method of identification is used. With some LEDs there is no obvious way of telling which lead-out wire is which as they seem to be symmetrical if the manufacturer's or retailer's data is not available, or does not make it clear lead-out wire is which, you can simply try each LED either way round.

If the device is wrongly connected it will fail to light but is unlikely to sustain any damage, and it will merely be necessary to reverse the polarity of the device in order to make the circuit function correctly.

And now viewing some general detailed information about light emitting diodes,

1.8.1 Function

LEDs emit light when an electric current passes through them an example of a light emitting diode and its circuit symbol are shown Figure 1.11.

1.8.2 Connecting and Soldering

LEDs must be connected the correct way round, the diagram shown in Figure 1.12 *may be labeled* **(a)** *or (+) for anode and* **(k)** *or (-) for cathode (it really is k, not c, for* cathode). The cathode is the short lead and there may be a slight flat on the body of round LEDs. If you can see inside the LED the cathode is the larger electrode (but this is not an official identification method).

LEDs can be damaged by heat when soldering, but the risk is small unless you are very slow. No special precautions are needed for soldering most LEDs.

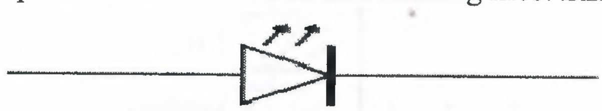

Figure 1.11 A circuit symbol of a light emitting diode

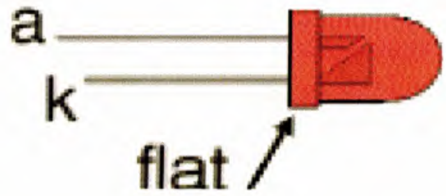

Figure 1.12 Light emitting diode diagram

1.8.3 Connecting LEDs in Series

If it is desired to have several LEDs on at the same time it may be possible to connect them in series. This prolongs battery life by lighting several LEDs with the same current as just one LED.

All the LEDs connected in series pass the same current so it is best if they are all the same type. The power supply must have sufficient voltage to provide about 2V for each LED (4V for blue and white) plus at least another 2V for the resistor. To work out a value for the resistor you must add up all the LED voltages and use this for V_L circuit diagram shown in Figure 1.13.

1.8.4 Sizes, Shapes, and Viewing Angles of LEDs

LEDs are available in a wide variety of sizes and shapes. The 'standard' LED has a round cross-section of 5mm diameter and this is probably the best type for general use, but 3mm round LEDs are also popular as mentioned in.

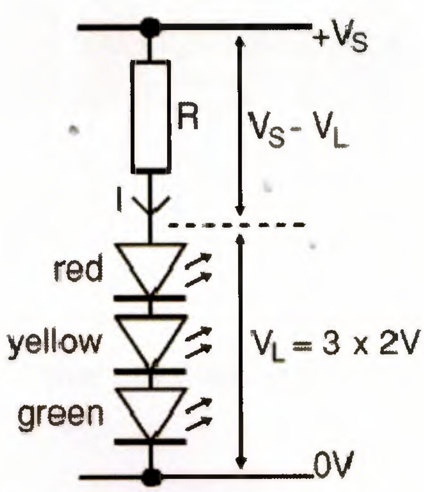

Figure 1.13Circuit diagram

Round cross-section LEDs are frequently used and they are very easy to install on boxes by drilling a hole of the LED diameter, adding a spot of glue will help to hold the LED

if necessary. LED clips are also available to secure LEDs in holes shown in Figure 4.4.
Other
Cross-section shapes include square, rectangular and triangular.

As well as a variety of colors, sizes and shapes, LEDs also vary in their viewing angle. This tells you how much the beam of light spreads out. Standard LEDs have a viewing angle of 60° but others have a narrow beam of 30° or less.

1.8.5 Color of LEDs

LEDs are available in red, orange, amber, yellow, green, blue, and white. Blue and white
LEDs are much more expensive than the other colors as show in Figure 1.14.
The color of an LED is determined by the semiconductor material not by the coloring of the 'package' (the plastic body)[4].

LEDs of all colors are available in uncolored packages which may be diffused (milky) or clear (often described as 'water clear'). The colored packages are also available as diffused (the standard type) or transparent.

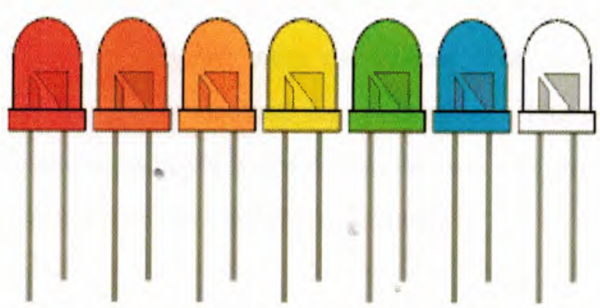

Figure 1.14 Colors of LEDs

CHAPTER 2

SENSORS

2.1 THERMAL SENSORS

2.1.1Definition

Process control is a term used to describe any condition, by which a physical quantity is regulated. There is no more widespread evidence of such control than that associated with temperature and other thermal phenomena. In our natural surrounding, some of the most remarkable techniques of temperature regulation are found in the bodily functions of living creatures. On the artificial side, humans have been vitally concerned with temperature control since the first fires waves struck for warmth. Industrial temperature regulation has always been of paramount important and becomes even more so the advance of technology. In this chapter we shall be concerned first with developing an understanding of the principles of the thermal, mechanical and optical sensors [6].

2.1.2 Temperature

If we are to measure the thermal energy, we must have some sort of units by which to classify the measurement. The original units used were "hot" and "cold". These were satisfactory for their time but are inadequate for modern use. The proper unit for energy measurement is the Joules of the sample in the SI system, but this would depend on the size of the material so it would indicate the total thermal energy.

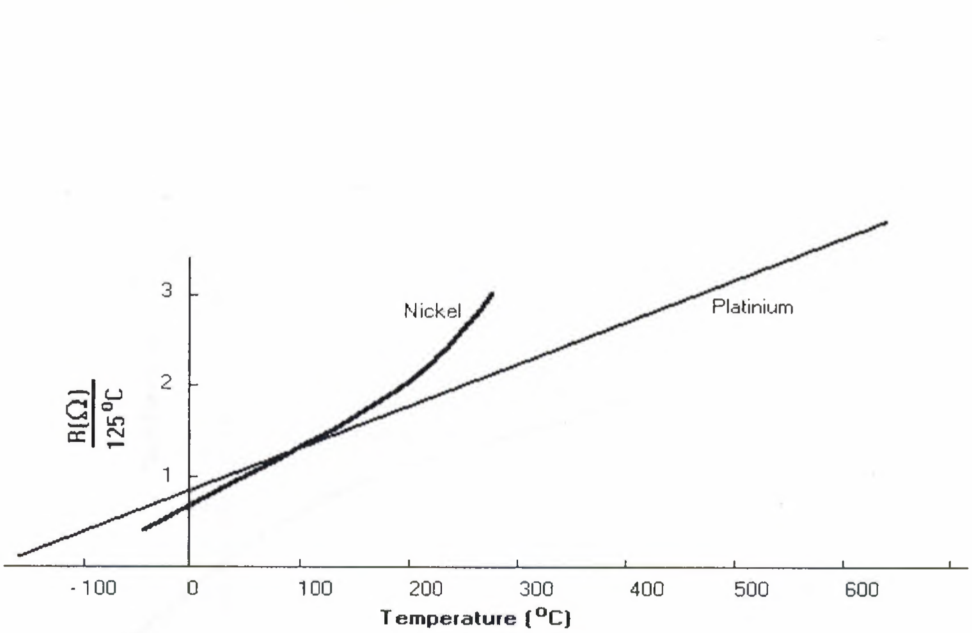

Figure 2.1 Metal resistance increases almost linearly with temperature but the slope is very small.

2.1.3 Resistance Versus Temperature Approximation

An approximation of the resistance versus temperature curves of figure 2.1 shows that the curves are very nearly linear, that is, a straight line. In fact, when only short temperature spans are considered, the linearity is even evident. This fact is employed to develop approximate analytical equation for the resistance versus temperature of a particular metal.

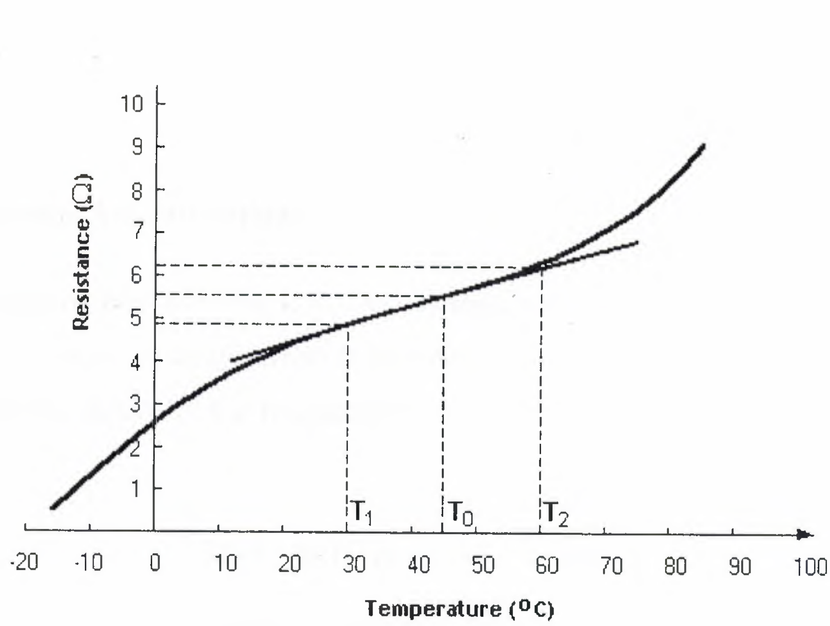

Figure 2.2 Line L represents a linear approximation of resistance versus temperature between T_1 and T_2.

2.1.3.1 Linear Approximation

A linear approximation means that we may develop an equation for a straight line that approximates the resistance versus temperature (R-T) curve over some specified span. In the figure 2.2, we see a typical R-T curve of some material that represent temperature T_1 and T_2 as shown, and T_0 represents the midpoint temperature. The equation of this straight line is the linear approximation to the curve over a span T_1 to T_2 is written as:

$$R(T) = R(T_0)[1+\alpha_0 \Delta T] \qquad T_1 < T < T_2$$

Where, $R(T)$ = Approximation of the resistance at temperature T

$R(T_0)$ = Resistance at temperature T_0

$\Delta T = T - T_0$

α_0 = Fractional change in resistance per degree of temperature at T_0

$$\alpha_0 = \frac{1}{R(T)} \text{(slope at } T_0\text{)}$$

2.1.3.2 Quadratic Approximation

A quadratic approximation to the R-T curve is more nearly accurate representation of R-T curve over some span of temperature. It includes both a linear term, as before, and a term that varies as the square of the temperature. Such an analytical approximation is usually written as

$$R(T) = R(T_0)\,[1+\alpha_1\,\Delta T + \alpha_2\,(\Delta T)^2]$$

Where, α_1 = Linear fractional change in resistance with temperature

α_2 = Quadratic fractional change in resistance with temperature

2.1.3.3 Resistance-Temperature Detectors

A resistance temperature detector (RTD) is a temperature sensor that is based on the principle that is, Metal resistance increases with temperature. Metals used in these devices vary from Platinum, which is very repeatable, quite sensitive and very expensive, to Nickel, which is not quite as repeatable, more sensitive and less expensive.

2.1.3.4 Sensitivity

An estimate of RTD sensitivity can be noted from typical values of α_0. For Platinum, this number is typically on the order of 0.004/ ^{0}C, and for Nickel a typical value is 0.005/ ^{0}C. Thus with platinum, for example, a change of 0.4Ω would be expressed for a 100Ω RTD if the temperature is changed by 1 ^{0}C. Usually a specification will provide the calibration information either as a graph of resistance versus temperature or as a table of values from which the sensitivity can be determined.

2.1.3.5 Response Time

In general, RTD has a response time of 0.5 to 5 seconds or more. The slowness of response is due principally to the slowness of thermal conductivity in bringing the devices into thermal equilibrium with its environment. Generally, time constants are specified either for a "free air" condition (or its equivalent) or an "oil bath" condition (or its equivalent). In the former case, there is poor thermal contact and hence slow response, and in the latter, good thermal contact and fast response. These numbers yield a range of response times depending on the application.

2.1.3.6 Construction

An RTD, of course, is simply a length of wire whose resistance is to be monitored as a function of temperature. The construction is typically such that the wire is wound on a form (in a coil) to achieve small size and improve thermal conductivity to decrease response time. In many cases, the coil is protected from the environment by the sheath or protective tube that inevitably increases response time but may be necessary in the hostile environments. A loosely applied standard sets the resistance at multiples of 100Ω for the temperature of 0 ^{0}C.

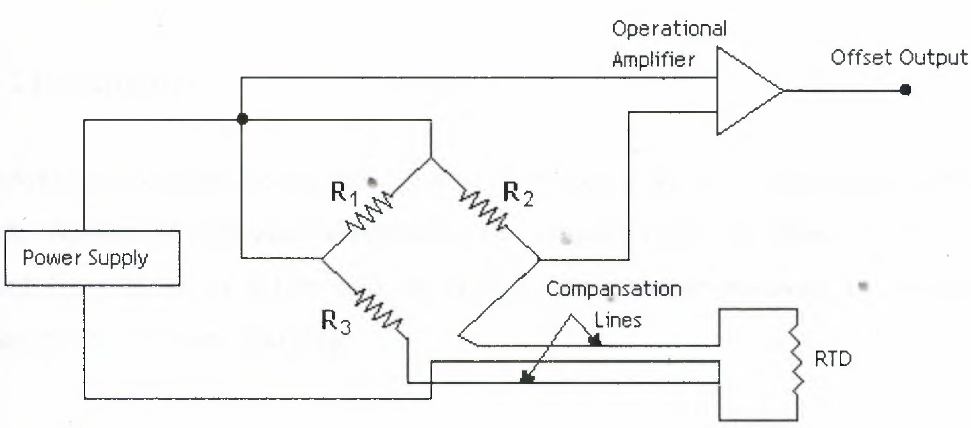

Figure 2.3: Note the compensation lines in this typical RTD signal conditioning circuit

2.1.3.7 Signal Conditioning

In view of the very small fractional changes of resistance with temperature (0.4%), the RTD is generally used in a bridge circuit. Figure 2.3 illustrates the essential features of such a system. The compensation line in the R_3 leg of the bridge is required when lead lengths are so long that thermal gradients along the RTD leg may cause changes in line resistance. These changes show up as false information, suggesting changes in RTD resistance. By using the compensation line, the same resistance changes also appear on the R_3 side of the bridge and cause no net shift in the bridge null.

2.1.3.8 Dissipation Constant

Because the RTD is a resistance, there is an I^2R power dissipated by the device itself that causes a slight heating effect, self-heating. This may also cause am erroneous reading or even upset the environment in delicate measurement conditions. Thus the current though the RTD must be kept sufficiently low and constant to avoid self-heating. Typically, dissipation constant is provided in RTD specifications. This number relates the power required to raise the RTD temperature by one degree of temperature. Thus, 25mW / ^{0}C dissipation constant shows that if I^2R power losses in the RTD equal to 25mW, then the RTD will be heated by 1^{0}C.

2.1.4 Thermistors

The thermistor represents to another class of temperature sensors that measures temperature through changes of material resistances. The characteristics of these devices are very different from those of RTDs and depend on the peculiar behavior of semiconductor resistances versus temperature[6].

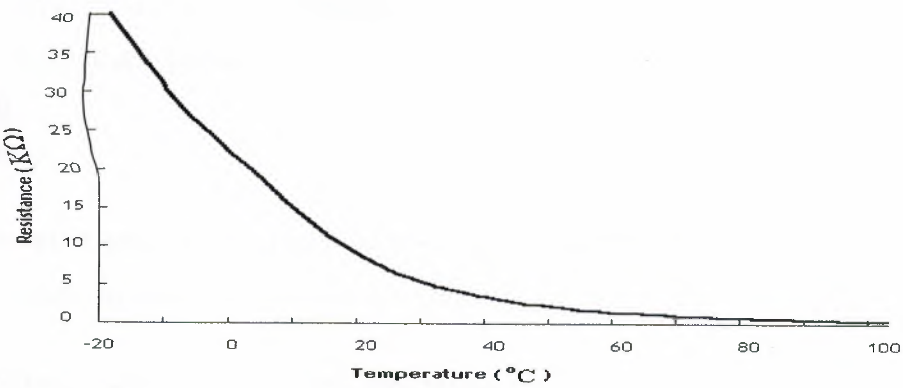

Figure 2.4 Thermistor resistance versus temperature is highly nonlinear and usually has a negative slope

2.1.4.1Thermistor Characteristics

A Thermistor is a temperature sensor that has been developed from the principles of semiconductor resistance change with temperature. The particular semiconductor material used varies widely to accommodate temperature ranges, sensitivity, resistance ranges and other factors. The devises are usually mass produced for a particular configuration and tables or graphs of resistance versus temperature are provided for calibration.

2.1.4.2 Thermistor Characteristics Sensitivity

The sensitivity of the thermistor is a significant factor in the in application. Changes in resistance of 10% per ^{0}C are not uncommon. Thus, a thermistor with a nominal resistance of 10 KΩ at some temperature may change by 1 KΩ for a 1^0C change in temperature.

2.1.4.3 Construction

Because the thermistor is a bulk semiconductor, it can be fabricated in many forms. Thus, common forms include discs, beads and rods, varying in size from a bead of 1mm to a disc of several centimeters in diameter and several centimeters thick. By variation of doping and use of different semiconductor material, a manufacturer can provide a wide range of resistance values at any particular temperature.

2.1.4.4 Range

The temperature range of thermistor depends on the material used to construct the sensor. In general, there are three range limitation effects:

1. Melting or deterioration of the semiconductor
2. Deterioration of encapsulation material
3. Insensitivity at higher temperatures

The semiconductor material melts or deteriorates as the temperature is raised. This condition generally limits the upper temperature to less than 300 ^{0}C. At the low end, the principle limitation is that the thermistor resistance becomes very high, into the MΩs, making practical applications difficult. For thermistor shown in figure 2.4, if extended, the lower limit is about -80^{0}C, where its resistance has risen to over 3MΩ! Generally the lower limit is -50^{0}C to -100^{0}C.

2.1.4.5 Response Time

The response time of the thermistor depends principally on the quantity of material present and the environment. Thus, for the smallest bead thermistor in an oil bath (good thermal contact), a response of ½ second is typical. The same thermistor in still air will respond with typical response of 10seconds.

2.1.4.6 Signal Conditioning

Because a thermistor exhibits such a large change in resistance in with temperature, there are many circuit applications. In many cases, however, a bridge circuit is used because the nonlinear features of the thermistors make it difficult as an actual measurement device. Because these devices are resistances, care must be taken to ensure that power dissipation in the thermistor does not exceed limits specified or even interfere with the environment for which the temperature is being measured. Dissipation constants are quoted for thermistors as the power in mill-watts required to raise a thermistor's temperature 1^0C above its environment.

2.1.5 Thermocouples

we have considered the change in material resistance as a function of temperature. Such a resistance change is considered a variable parameter property in the sense that the measurement of resistance, and thereby temperature, requires external power resources. There exists another dependence of electrical behavior of materials on temperature that forms the basis of a large percentage of all temperature measurements.This effect is characterized by a voltage-generating sensor in which an electromotive force (emf) is produced that is proportional to temperature. Such an emf is found to be almost linear with temperature and very repeatable for constant materials. Devices that measure temperature based on this thermoelectric principle are called thermocouples (TCs)[7].

2.1.6 Vapor-pressure Thermometers

A vapor pressure thermometer converts temperature information into pressure as does the gas thermometer, but it operates by the different process. If a closed vessel is partially filled with liquid, then the space above the liquid will consist of evaporated vapor of the liquid at a pressure that depends on the temperature. If the temperature is raised, more liquid will vaporize and the pressure will increase. A decrease in temperature will result in condensation of some of the vapor, and the pressure will decrease. Thus, vapor pressure depends on temperature. Different materials have different curves of pressure versus temperature, and there is no simple equation like that for a gas thermometer. Figure 2.5 shows a curve a curve of vapor pressure versus temperature for methyl chloride, which is often employed in these sensors. The pressure available is substantial as the temperature rises. As in case of gas thermometers, the range is not great and response time is slow (20 seconds or more) because the liquid and vessel must be heated.

2.1.7 Liquid Expansion Thermometers

Just as a solid experiences an expansion in dimension with temperature, a liquid also shows an expansion in volume with temperature. This effect forms the basis for the traditional liquid-in-glass thermometers that are so common in temperature measurement. The relationship that governs the operation of this device is

$$V(T) = V(T_0)[1 + \beta \Delta T]$$

Where, V(T) = volume at temperature T

$V(T_0)$ = volume at temperature T_0

β = volume thermal expansion constant

In actual practice, the expansion effects of the glass container must be accounted for to obtain high accuracy I temperature indications. This type of temperature sensor is not commonly used in process control work because further transduction is necessary to convert the indicated temperature into an electrical signal.

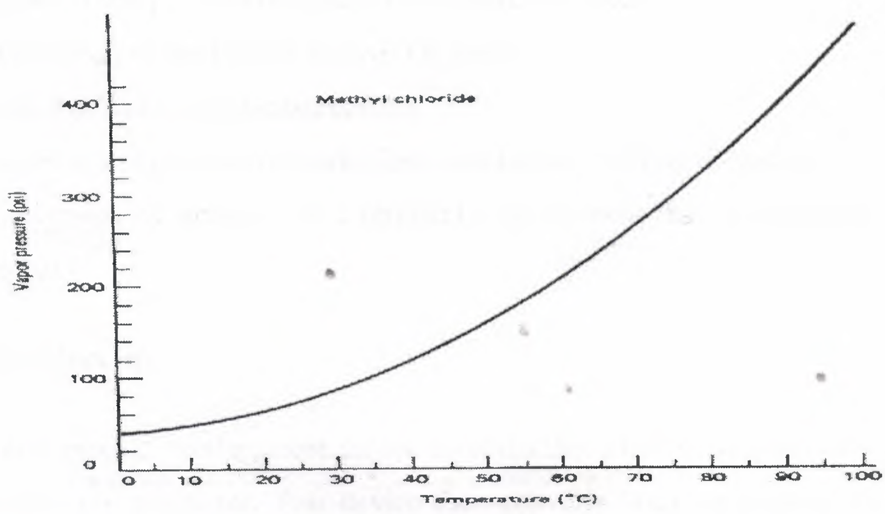

Figure 2.5 Vapor pressure curve for Methyl chloride

2.2 Mechanical Sensors

2.2.1 Definition

The class of sensors used for the measurement of mechanical phenomena is of special significance because of the extensive use of these devices through out the process control industry. In many instances, an interrelation exists by which a sensor designed to measure some mechanical variable is used to measure another variable. To learn to use the mechanical sensors, it is important to understand the mechanical phenomena themselves and the operating principles and application details of the sensor [8].

2.2.2 Displacement, Location or Position Sensors

The measurement of displacement, position or location is an important topic in the process industries. Examples of industrial requirements to measure these variables are many and varied and the required sensors are also of greatly varied designs. To give a few examples of measurement needs:

1. Location and position of objects on a conveyer system
2. Orientation of steel plates in a rolling mill
3. Liquid or solid level measurements
4. Location and position of work piece in automatic milling operation
5. Conversion of pressure to a physical displacement that is measured to indicate pressure.

2.2.2.1 Potentiometric

The simplest type of displacement sensor involves the action of displacement in moving the wiper of a potentiometer. This device then converts linear or angular motion into a changing resistance that may be converted directly to voltage and/or current signals. Such potentiometric device often suffer from the obvious problems of mechanical wear, friction in wiper action, limited resolution in wire-wound units and high electronic noise.

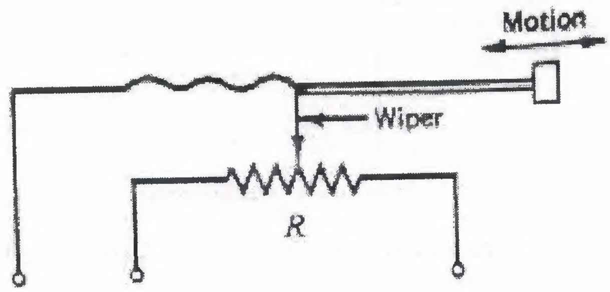

Figure 2.6 Potentiometric displacement sensor

2.2.2.2 Capacitive and Inductive

The second class of sensors for displacement measurement involves changes in capacity and inductance.

2.2.2.3 Capacitive

The basic operation of a capacitive sensor can be seen from the familiar equation for a parallel-plate capacitor.

$$C = K\varepsilon_o \frac{A}{d}$$

Where, K= The dielectric constant

ε_o= Permittivity = 8.85 pF/m

A= Plate common area

d= Plate separation

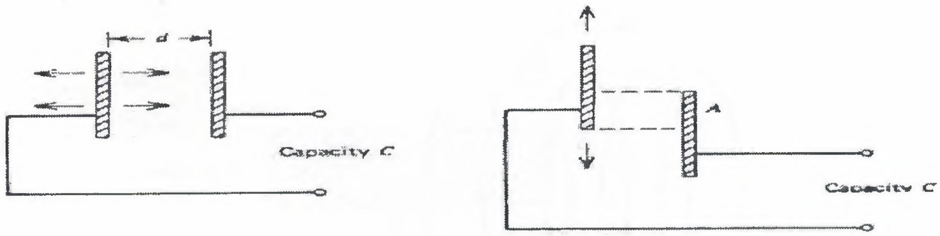

Figure 2.7 Capacity varies with distance between plates and common area. Both are used in sensors.

There are three ways to change the capacity

- Variation of distance between the plates (d)
- Variation of shared area of the plates (A)
- Variation of the dielectric constant (K)

2.2.2.4 Inductive

If a permeable core is inserted into an inductor as shown in figure 2.8, the net inductance is increased. Every new position of the core produces a different inductance. In this fashion, the inductor and movable core assembly may be used as a displacement sensor. An AC bridge or other active electronic circuit sensitive to inductance then may be employed for signal conditioning.

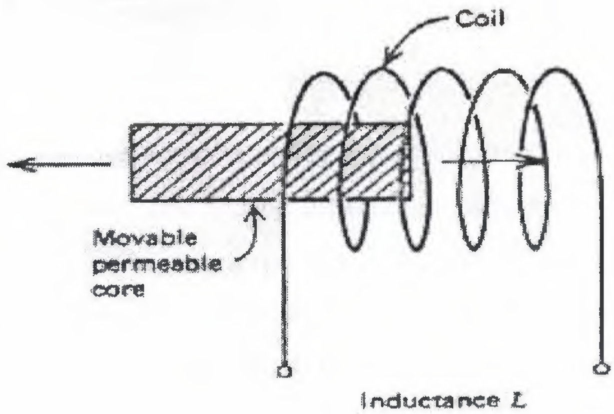

Figure 2.8 The variable reluctance displacement sensor changes the inductance in coil in response to core motion.

2.2.2.5 Variable Reluctance

The class of variable-reluctance displacement sensors differs from the inductive in that moving core is used to vary the magnetic flux coupling between two or more coils, rather than changing am individual inductance. Such devices find application in many circumstances for the measure of both translational and angular displacements. Many configurations of these devices exist, but the most common and extensively used is called a linear variable differential transformer (LVDT).

2.2.2.6 LVDT

The LVDT is an important and common sensor for displacement in the industrial environment. Figure 2.9 shows that an LVDT consists of three coils of wire wounded on a hollow form. A core of permeable material can slide freely through the centre of the form. Flux formed by the primary, which is excited by some AC source as shown. Flux formed by the primary is linked to the two secondary coils, inducing an AC voltage in each coil.

When the core is centrally located in assembly, the voltage induces in each primary is equal. If the core moves to one slide or the other, a larger AC voltage will be induced in one coil and a smaller AC voltage in the other because of changes in the flux linkage associated with the core.

If the two secondary coils are wired in series opposition, as shown in figure 2.9, then the two voltages will be subtract; that is, the differential voltage is formed. When the core centrally located, the net voltage is zero. When the core is moved to one side, the net voltage amplitude will increase. In addition, there is a change in phase with respect to the source when the core is moved to one side or the other.

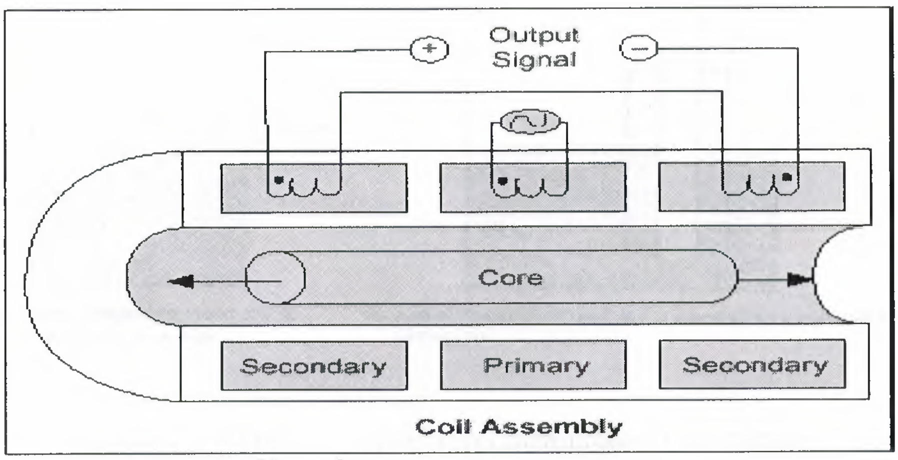

Figure 2.9 The LVDT has a movable core with three coils

2.2.3 Level Sensors

The measurement of solid or liquid level calls for a special class of displacement sensor. The level measured is most commonly associated with material in a tank or hopper. A great variety of measurement techniques exists, as the following representative examples show.

2.2.3.1 Mechanical

One of the most common techniques for level measurement, particularly for liquids, is a float that is allowed to ride up and down with level changes. This float, as shown in figure 2.10, is connected by linkage to a secondary displacement measuring system such as potentiometric device or an LVDT core.

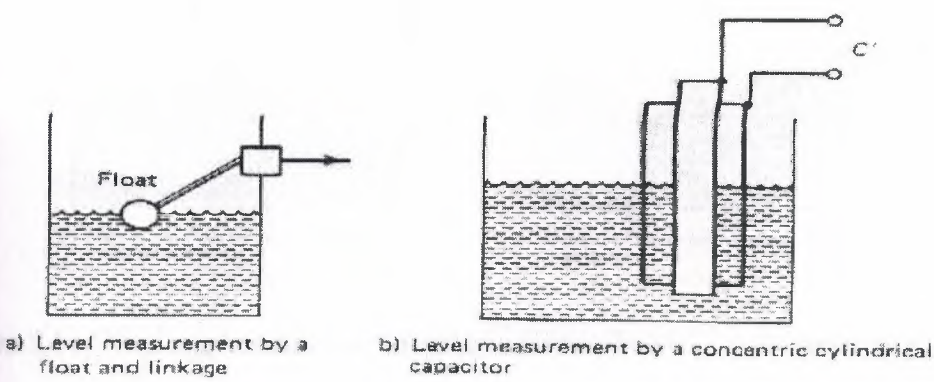

Figure 2.10 There are many level measurement techniques.

2.2.3.2 Electrical

They are several purely electrical methods of measuring level. For example, one may use the inherent conductivity of a liquid or solid to vary the resistance seen by the probes inserted into the material. Another common technique is illustrated in figure 3.5b. In this case, two concentric cylinders are contained in a liquid tank. The level of the liquid partially occupies the space between the parallel, one with the dielectric constant of air (≈ 1) and the other with that of the liquid. Thus, variation of liquid level causes variation of the electrical capacity measured between the cylinders[7].

2.2.3.3 Ultrasonic

The use of the ultrasonic reflection to measure level is favored because it is a non-sensitive technique; that is, it does not involve placing anything in the material. Figure 2.11 shows the external and internal techniques.

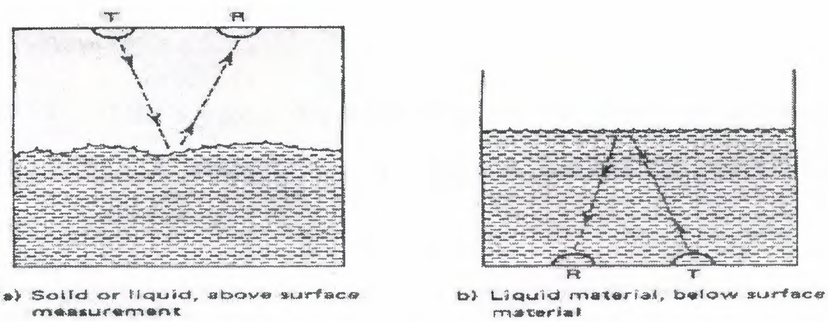

Figure 2.11 Ultrasonic measurement needs no physical contact with material, just and transmitter T and receiver R.

Obviously, the external technique is better suited to solid material level material. In both cases the measurement depends on the length of time taken for reflections of an ultrasonic pulse from the surface of the material. Ultrasonic techniques based on reflection time also have become popular for ranging measurements.

2.2.3.4 Pressure

For liquid measurement, it is also possible to make a no contact measurement of level if the density of the liquid is known. This method based on the well-known relationship between pressure at the bottom of a tank and the height and density of the liquid.

2.2.4 Motion sensors

Motion sensors are designed to measure the rate of change of position, location or displacement of an object that is occurring. If the position of an object as a function of time is x(t), then the first derivative gives the speed of the object, v(t), which is called the velocity if a direction is also specified. If the speed of the object is also changing, then the first derivative of the speed gives the acceleration. This is also the second derivative of the position.

The primary form of the sensor is the accelerometer. This device measures the acceleration a(t) of an object. Thus, in accelerometer we have a sensor that can provide the acceleration, speed or position information.

2.2.4.1 Types of motion

The design of a sensor to measure the motion is often tailored to the type of motion that is to be measured. It will help us to understand these sensors if we have a clear understanding of these type of motions.

The proper unit of acceleration is meter per second squared (m/s^2). Then speed will be in mete per second (m/s) and position of course in meters (m). Often, acceleration is expressed by comparison with the acceleration due to gravity at the earth's surface. This amount of acceleration, which is approximately 9.8 m/s^2, is called a "gee", which is given as a bold **g** in the text.

2.2.4.2 Rectilinear

This type of motion is characterized by velocity and acceleration which is composed of straight-line segments. Thus, objects may accelerate forward to a certain velocity, decelerator to a stop, reverse, and so on. There are many types of sensors designed to handle this type of motion. Typically, maximum acceleration is less than few **g**s, and a little angular motion is allowed. If there is angular motion, then several rectilinear sensors must be used, each sensitive to one line of motion. Thus, is vehicle is to be measured, two transducers may be used, one to measure motion in forward direction of vehicle motion and the other perpendicular to the forward axis of the vehicle[6].

2.2.4.3 Angular

Some sensors are designed to measure only relations about some axis, such as the angular motion of the shaft of a motor. Such devices can not be used to measure the physical displacement of the whole shaft, but only its rotation.

2.2.4.4 Vibration

In normal experiences of daily living, a person rarely experiences accelerations that vary from I **g** by more than a few percent. Even the severe environments of a rocket launching involve accelerations of only 1**g** to 10**g**. On the other hand, if an object is placed in periodic motion about some equilibrium position, very large peak accelerations may result that reach to 100**g** or more. This motion is called vibration. Clearly, the measurement of acceleration of this magnitude is very important to industrial environments, where vibrations are often encountered from machinery operations. Often, vibrations are somewhat random is both the frequency of periodic motion and the magnitude of displacements from equilibrium. For analytical treatments, vibration is defined in terms of a regular periodic motion.

2.2.4.5 Shock

A special type of acceleration occurs when an object that may be in uniform motion or modestly accelerating is suddenly brought to rest, as in a collision. Such phenomena are the result of very large accelerations, or actually decelerations, as when an object is dropped from some height onto a hard surface. The name shock is given to decelerations that are characterized by very short times, typically in the order of milliseconds, with peak accelerations over 500**g**.

2.2.4.6 Accelerometer

These several physical processes can be used to develop a sensor to measure acceleration. In applications that involve flight, such as aircraft and satellite, accelerometers are based on properties of rotating masses. In industrial world, however, the most common design is based on combination of Newton's law of mass acceleration and Hook's law of spring action.

2.2.4.7 Spring Mass System

Newton's law simply states that if a mass (m) is undergoing an acceleration (a) then there must be a force (F) acting on the mass and given by F=ma. Hook's law states that if a spring constant (k) is stretched (extended) from its equilibrium position for a distance Δx, then there must be a force acting on the spring given by $F=k\,\Delta x$.

In figure 2.12a, we have a mass that is free to slide on a base. The mass is connected to the base by a spring that is in its un-extended state and exerts no force on the mass. In figure 2.12b, the whole assembly is accelerated to the left, as shown. Now the spring extends in order to provide the force necessary to accelerate the mass. This condition is described by equation Newton's and Hook's law:

$$ma = k\,\Delta x$$

Where, k= Spring constant in N/m

Δx= Spring extension in m

m= mass in Kg

a= acceleration in m/s^2

This equation allows the measurement to be reduced to a measurement of spring extension (linear displacement) because

$$a = \frac{k}{m} \Delta x$$

If the acceleration is reversed, the same physical argument would apply, except that the spring is compressed instead of extended. Above equation still describes the relationship between spring displacement and acceleration.

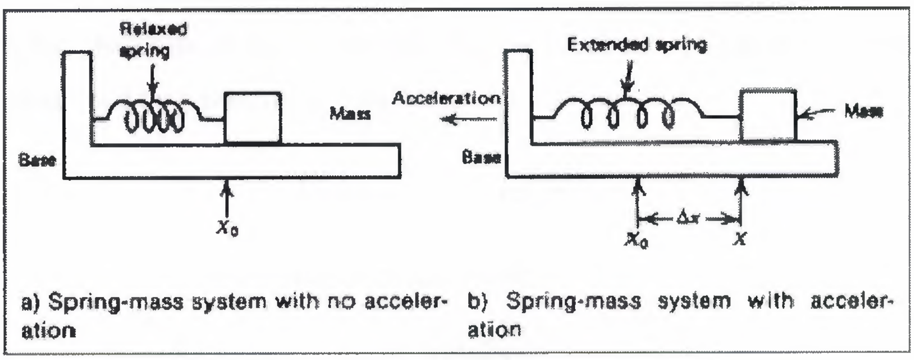

Figure 2.12 The basic spring mass accelerometer

The spring-mass principle applies to many common accelerometer designs. The mass that converts the acceleration to spring displacement is referred to as the test mass or seismic mass. We see then that acceleration measurement reduces to linear displacement measurement; most designs differ in how this displacement measurement is made .

2.2.4.8 Natural frequency and Damping

On close examination of the simple principle just described, we find another characteristic of spring-mass system that complicates the analysis. In particular, a system consisting of a spring and attached mass always exhibits oscillations at some characteristic natural frequency. Experiments tell us that if we pull a mass back and then release it (in the absence of acceleration), it will be pulled back by the spring, overshoot the equilibrium and oscillate back and forth. Only friction associated with the mass and base eventually brings the mass to rest. Any displacement measuring system will respond to this oscillation as if an actual acceleration occurs. This natural frequency is given by

$$f_N = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

Where, f_N is natural frequency in Hz

The friction that eventually brings the mass to the rest is defined by a damping coefficient (α), which has the units of S^{-1}. In general, the effect of the oscillation is called transient response, described by a periodic damped signal whose equation is

$$X_T(t) = X_o e^{-\alpha t} \sin(2\pi f_N t)$$

Where, $X_T(t)$ = Transient mass position

X_o = peak position, initially

α = damping coefficient

2.2.5 Pressure Sensors

The measurement and control of fluid (liquid and gas) pressure has to be one of the most common in all the process industries. Because of the great variety of conditions, ranges and materials for which pressure must be measured. There are many different types of pressure sensors designs. In the following paragraphs, the basic concepts of pressure are presented, and a brief description is given of the most common types of pressure sensors. We shall see that pressure measurement is often accomplished by conversion of the pressure information to some intermediate form, such as displacement, which is then measured by a sensor to determine the pressure.

2.2.5.1 Pressure Principles

Pressure is simply the force per unit area that a fluid exerts on its surroundings. If it is a gas, then the pressure of the gas is the force pre unit area that the gas exerts on the walls of the container that holds it. If the fluid is a liquid, then the pressure is the force per unit area that the liquid exerts on the container in which it is contained. Obviously, the pressure of the gas will be uniform on the walls that must enclose the gas completely. In a liquid, the pressure will vary being greatest on the bottom of the vessel and zero on the top surface, which not be enclosed.

2.2.5.2 Static Pressure

The statements made in the previous paragraph are explicitly true for a liquid that is not *moving in space, that is not being pumped through pipes or flowing through the channel.* The pressure incases where no motion is occurring is referred to as static pressure.

2.2.5.3 Dynamic Pressure

It is a fluid in motion; the pressure that it exerts on its surroundings depends on the motion. Thus, if measure the pressure the pressure of the water in a hose with the nozzle closed, we find a pressure of, say, 40 pounds per square inch (note: force per unit area). If the nozzle is opened the pressure is the hose will drop to a different value, say, 30 pounds per square inch. For this reason, a through description of pressure must note the circumstances under which it is measured. Pressure can depend on flow, compressibility of the fluid, external forces and numerous other factors.

2.3 Optical Sensors

2.3.1 Definition

A desirable characteristic of sensors is that they have negligible effect on the measured environment, that is, the process. Thus, if a resistance-temperature detector (RTD) heats up its own temperature environment there is less confidence that the RTD resistance truly represents the environmental temperature. Much effort is made in sensor and transducer design to reduce backlash from the measuring instrument on its environment.

When electromagnetic (EM) radiation is used to perform process variable measurements transducers that do not affect the system measured emerge. Such systems of measurements are called nonlinear or non-contact because no physical contact is made with the environment of the variable. Non-contact characteristic measurements often can be made from a distance.

In process control, EM radiation is either the visible or infrared light band is frequently use in measurement applications. The techniques of such applications are called optical because such radiation is close to visible light. A common example of optical transduction is measurement of an object's temperature by its emitted EM radiation. Another example involves radiation reflected off the surface to yield a level or displacement measurement.

Optical technology is a vast subject covering a span from geometrical optics, including lenses, prisms, gratings and the like to physical optics with lasers, parametric frequency conversion and nonlinear phenomena. These subjects are all interesting but all that is required for our purposes is a familiar with optical principles and knowledge of specific transduction and measurement methods.

2.3.2 Fundamentals of EM radiation

We are familiar with EM radiation as visible light. Visible light is all around us. EM radiation is also familiar in other forms, such as radio or TV signals and ultraviolet or infrared light.

This section covers a general method of characterizing EM radiation. Although much of what follows is valid for the complete range of radiation, particular attention is given to the infrared, visible and ultraviolet, because most sensor applications are concerned with these ranges.

2.3.2.1 Nature of EM Radiation

Em radiation is a form of energy that is always in motion, that is, it propagates through space. An object that releases or emits such radiation loses energy. One that absorbs radiation gains energy.

2.3.2.2 EM Radiation Spectrum

The oscillating nature of this radiation gives rise to a different interpretation of this relation in relation to our environment. In categorizing radiation by wavelength or frequency, we are describing its position in the spectrum of radiation. Figure 2.13 sows the range of EM radiation from very low frequency to very high frequency, together with the associated wavelength in meters and how the bands of frequency relate to our world. This one type of energy ranges from radio signals and visible light X rays and penetrating cosmic rays and all through the smooth variation of frequency. Even though figure 2.13 presents distinct boundaries EM radiation descriptions, in reality the boundaries are quite indistinct. Thus, the transition between microwave and infrared, for example, is gradual, so that over a considerable band the radiation could be described by either term.

2.3.3 Visible Light

The small band of radiation between approximately 400nm and 760nm represents visible light. This radiation band covers those wavelengths to which our eyes (or radiation detectors in our heads) are sensitive.

2.3.3.1 Infrared light

Infrared light contains the least amount of energy per photon of any other band. Because of this, an infrared photon often lacks the energy required to pass the detection threshold of a quantum detector. Infrared is usually measured using a thermal detector such as a thermopile, which measures temperature change due to absorbed energy.

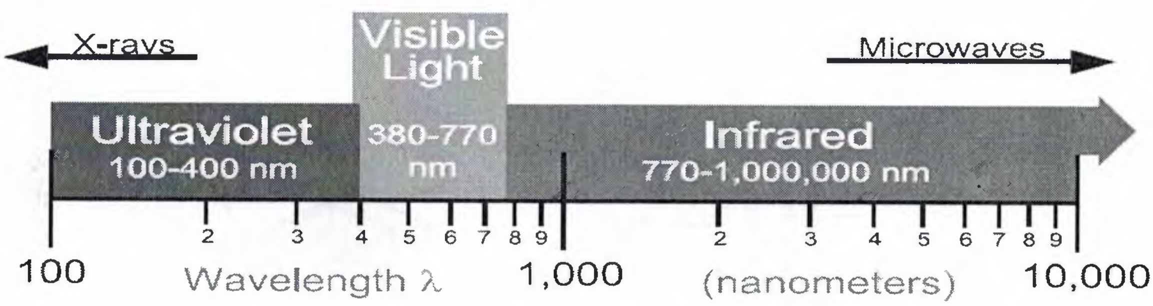

Figure 2.13 electromagnetic radiation spectrums

2.3.3.2 Photo-detectors

An important part of any application of light to an instrumentation problem is how to measure or detect radiation. In most process control related applications, the radiation lies in the range from IR through visible and sometimes UV bands. The measurement sensors generally used are called photo-detectors to distinguish them from other spectral ranges of radiation such as RF detectors in radio frequency (RF) applications.

2.3.3.3 Photo-detector Characteristics

The particular characteristic related to EM radiation detection is the spectral sensitivity. This is given as graph of sensor response relative to the maximum as a function of radiation *wavelength. Obviously, it is important to match the spectral response of the sensor to the* environment in which it is to be used.

2.3.3.4 Photo-conductive Detectors

One of the most common detectors is based on the change in conductivity of a semiconductor material with radiation intensity. The change in conductivity appears as a change in resistance, so that these devices also are called photo-resistive cells.

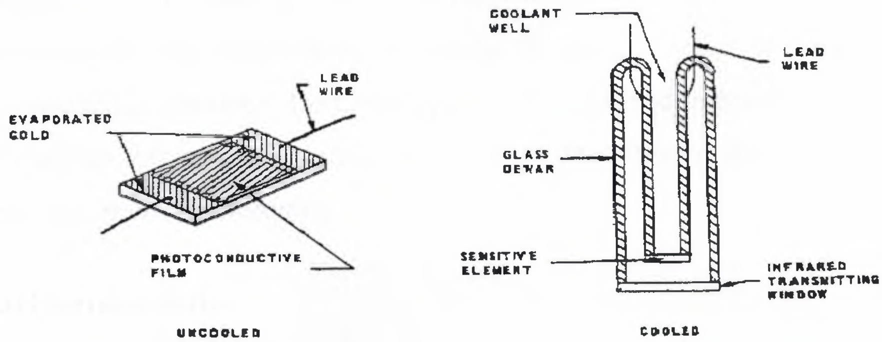

Figure 2.14 Photoconductive cell has a structure to maximize exposure and minimize resistance.

2.3.3.5 Principle

In a semiconductor photo-detector, a photon is absorbed and thereby excited into the conduction band, the semiconductor resistance decreases, making the resistance an inverse function of radiation intensity. For the photon to provide such an excitation it must carry at least as much energy as the gap. Following equation shows the maximum wavelength as

$$E_p = \frac{hc}{\lambda_{\max}} = \Delta W_g$$

$$\lambda_{\max} = \frac{hc}{\Delta W_g}$$

Where, h= Plank's constant

ΔW_g= Semiconductor energy gap (J)

$\lambda_{\max}$ = Maximum detectable radiation wavelength (m)

Any radiation with a wavelength greater than that predicted by the equation cannot cause any resistance change in the semiconductor. It is important to note that the operation of a thermistor involves thermal energy excitation electrons in the conduction band. To prevent the photoconductor from showing similar thermal effects, it is necessary either to operate the devices at a controlled temperature or to make the gap too large for the thermal effects to produce conduction electrons. Both approaches are employed in practice. The upper limit of the cell spectral response is determined by many other factors, such as reflectivity and transparency to certain wavelengths.

2.3.3.6 Cell Characteristics

Two common photo-conductive semiconductor materials are cadmium sulfide (CdS) and cadmium selenide (SdSe). The characteristics of photo-conductive detectors vary considerably when different semiconductor materials are used as the active element.

2.3.3.7 Signal Conditioning

Like the thermistor, a photoconductive cell exhibits a resistance that decreases non-linearly with the dynamic variable, in this case, radiation intensity. Generally, the change in resistance is pronounced where a resistance can change by several hundred orders of magnitude from dark to normal daylight In an absolute intensity measurement is desired, calibration data are use in conjunction with any accurate resistance measurement method. Sensitive control about some ambient radiation intensity is obtained using the cell in the bridge circuit adjusted for a null at the ambient level. various Op. Amp. Circuits using the photoconductor as a circuit element are used to convert the resistance change to a current or voltage change. It is important to note that the cell is a variable sensor, and therefore has some maximum power dissipation that cannot be exceeded. Most cells have dissipation from 50 to 500 mW, depending on size and construction.

2.3.4 Photovoltaic Detectors

Another important class of photo-detectors generates a voltage that is proportional to incident EM radiation intensity. These devices are called photovoltaic cells because of their voltage generating characteristics. They actually convert the EM energy into electrical energy. Applications are found as both EM radiation detectors and power sources converting solar radiation into electrical power. The emphasis of our consideration is on instrumentation type applications.

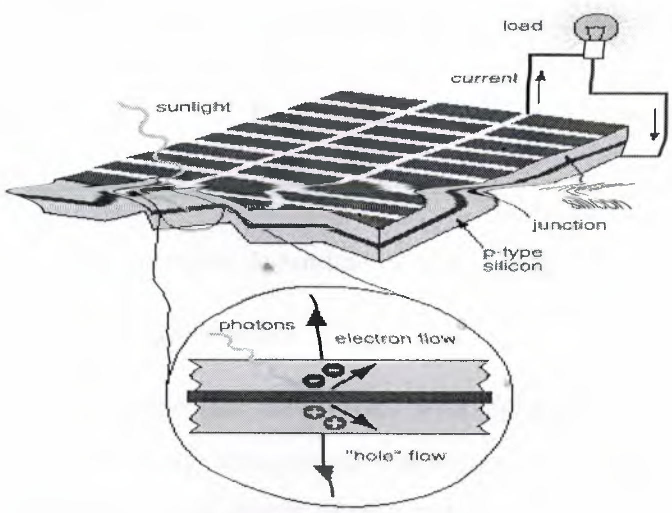

Figure 2.15 A photovoltaic solar cell is a giant pn junction diode.

2.3.4.1 Principle

Operating principles of the photovoltaic cell are best described by figure 2.15. We see that the cell is actually a giant diode that is constructed using a pn junction between appropriately doped semiconductors. Photons, striking the cell, pass through the thin p-diode upper layer and are absorbed by electrons in the n-layer, which case formation of conduction electrons and holes. The depletion-zone potential of the pn junction then separates these conduction electrons and holes, which causes a difference of potential to develop across the junction. The upper terminal is positive and the lower negative. It is also possible to build a cell with a thin n-doped layer on top so that all polarities are opposite. Photovoltaic cells also have a range of spectral response within which a voltage will be produced. Clearly, if the frequency is too small, the individual photons will have insufficient energy to create an electron-hole pair and no voltage will be produced. There is also upper limit to the frequency because of the optical effects such as radiation penetration through the cell.

Since the photovoltaic cell is a battery, it can be modeled as an ideal voltage source, Vc, in series with an internal resistance Rc as shown in figure 2.16. It turns out that the voltage source varies with light intensity in an approximately logarithmic fashion[8].

$$V_c = \mathrm{V_o} \log_e(1 + I_R)$$

Where, Vc= Open-circuit cell voltage

Vo= Constant, dependant on cell material

I_R= light intensity

The internal resistance of the cell also varies with light intensity. At low intensity the resistance may be thousands of ohms, whereas at higher intensities it may drop to less than fifty ohms. This complicates the design of system to derive maximum power from the cell, since the optimum load is equal to the internal resistance. Fortunately, at higher intensities the internal resistance is nearly constant.

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2.3.4.2 Signal Conditioning

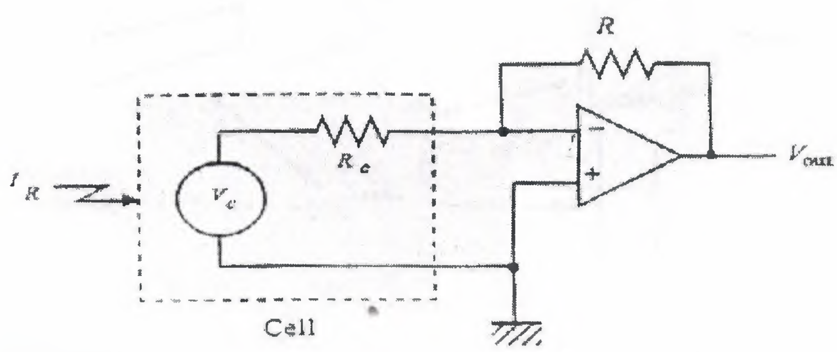

Figure 2.16 circuit allows conversion of the cell short circuit current into a proportional voltage.

2.3.4.4 Photodiode Detectors

The previous part showed one way that the pn junction of a diode is sensitive to EM radiation, the photovoltaic effect. A pn diode is sensitive to EM radiation in another way as well, which gives rise to the fact that photodiodes as sensors.

The photodiode effect refers to the fact that photon impinging on the pn junction also alter the reverse current-versus-voltage characteristics of the diode. In particular, the reverse current will be increased almost linearly with light intensity. Thus, the photodiode is operated in the reverse-bias mode.

One of the primary advantages of the photodiode is the photodiode is its fast response, which can be in the nanosecond range. Generally, photodiodes are very small, like regular diodes, so that a lens must be used to focus light on the pn junction. Often, the lens is built into photodiode casing, as shown in the figure 2.17.

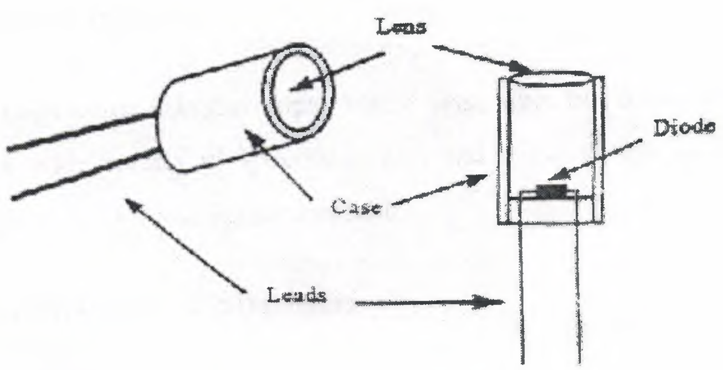

Figure 2.17 Photodiodes are very small and often use an internal lens to focus light on the junction.

Spectral response of photodiode is typically peaked in the infrared, but with usable response in the visible radiation in a broad range of visible to infrared and far-infrared radiation. In some cases a photodiode is operated in the photovoltaic mode, since the output will then be zero when the voltage is zero. In this mode the speed is slower, however, and the short-circuit currents are very small.

2.3.4.5 Phototransistor

An extension of the photodiode concept is the phototransistor. In this sensor, the intensity of EM radiation impinging on the collector-base junction of the transistor acts much like a base current in producing an amplified collector-emitter current.

The phototransistor is not as fast as the photodiode, but still offers response times in microseconds. As usual, there is a limit to the spectral response, with maximum response in the infrared but usable range in the visible band. This device can be used much like a transistor, except that no base current is required. A load line using the collector resistor and supply voltage will show response as a function of light intensity. Often, the transistor has a built-in lens, like that in figure 2.17, to concentrate radiation on the junction.

2.3.4.6 Photo-emissive Detectors

This type of photo-detector was developed many years ago, but it is still one of the most sensitive types. A wide variety of spectral ranges and sensitive can be selected from the many types of photo-emissive detectors available.

2.3.4.7 Principles Photo-emissive Detectors

To understand the basic operational mechanism of photo-emissive devices, let us consider the two-element vacuum photo-tube Such photo-detectors have been largely replaced by the other detectors in modern measurements.

Chapter 3

INFRARED ALARM SECURITY

3.1 Objectives of the Project

The objectives of the security system are to:

- Monitor the perimeter of a factory or military installation.
- Achieve high system efficiency.
- Achieve a competitive and low system cost.
- Produce a prototyped product that is durable and can withstand harsh environmental conditions such as excessive heat, fog and humidity.
- To integrate special casing into the system to protect the receiver, detector and their associated circuitry, from these harsh elements.
- Ensure that the monitoring beam can not be seen by the naked eye; thus, the source must generate an infrared wave.
- Alert the intruder that the alarm has activated when the beam is broken.

3.2 Operational Characteristics

The alarm by infrared makes it attractive for security applications.

Features include:

- a high intruder detection accuracy *the probability of triggering a false alarm is small.*
- high system durability to withstand harsh temperature.
- a choice between a fixed or portable security systems.

3.3Technical Characteristics

The technical characteristics of the alarm system are outlined in Table 3.1.

Table 3.1: Technical Characteristics of the alarm system

Parameter	Value
Pulse Frequency	120Hz
Power	6-24VDC
Current requirement	200mA
Operating Temperature	30 C to +60 C

3.4 Indoor and Outdoor Applications

Infrared security systems designed for indoor and outdoor applications monitor:

- entrances and exits
- corridors
- staircase
- Industrial controls and monitors
- Museum audio; walking tours, talking homes
- Garage door openers
- Lighting controls
- Driveway annunciators
- Intrusion alarms
- Weather monitors; fog, snow, rain using light back-scatter
- Traffic counting and monitoring
- Animal controls and monitors; cattle guards, electronic scarecrow
- Electronic distance measurements; hand held units out to 50 cm an it can be increased.

3.5 Transmission Characteristics and Requirements

If the security system were to be upgraded for commercial purposes, it would have a continuous and periodic transmission between the supervised premises and the central station. Figure 3.1 illustrates how the supervised premises would be networked to the central station.

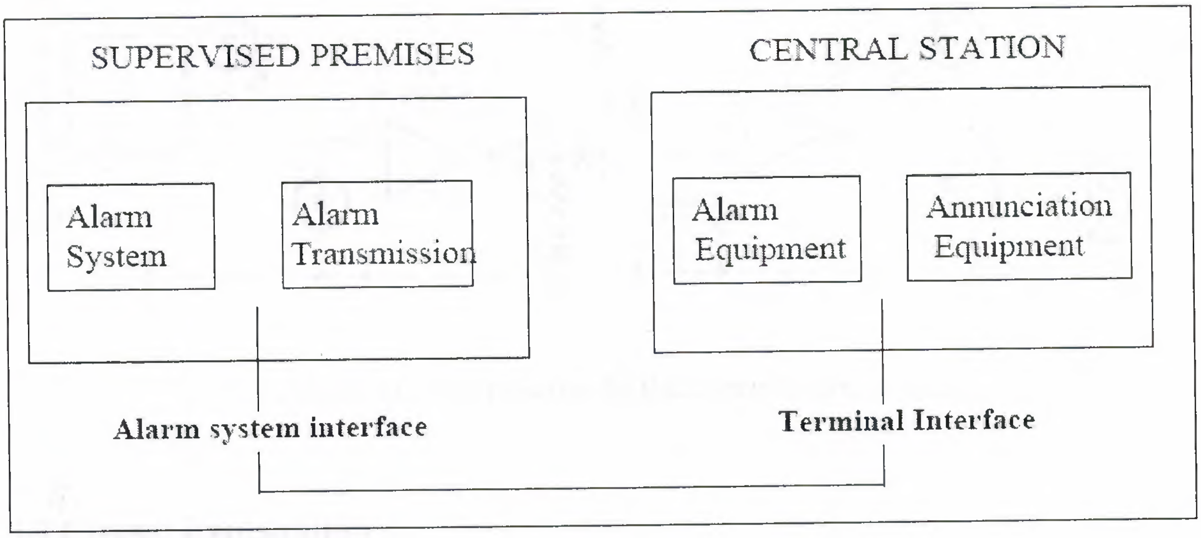

Figure 3.1: Alarm Transmission System

It is required that the transmission system shall communicate information about the state of the alarm system to the designated central station. The transmission system response delay is defined as the time taken for a signal to be sent from the supervised premises to the monitoring station this time delay it can be added to the circuit by timer gate .

3.6 Electric Design

Explain the electrical components of the active infrared alarm security System discuss the circuit in figure3.2.

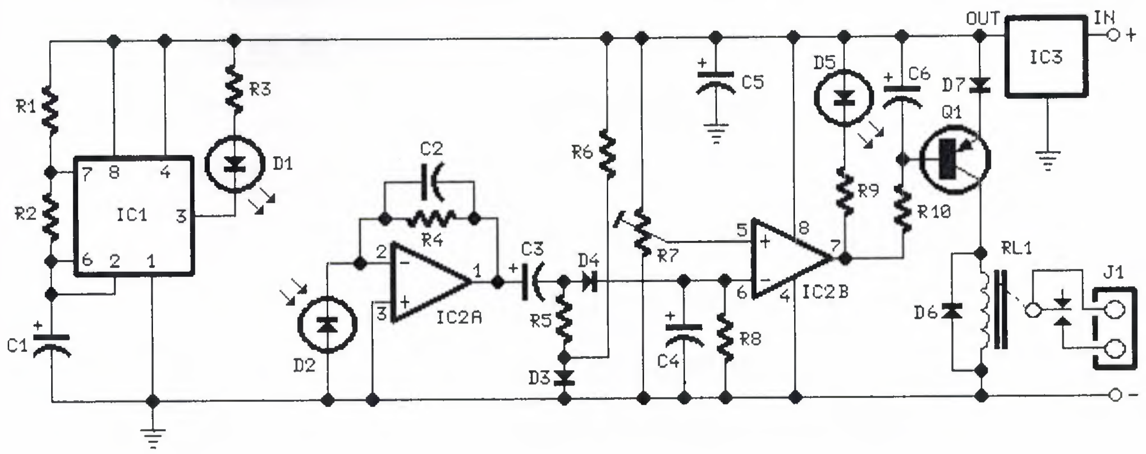

Figure 3.2 Circuit drawing for the infrared alarm system

3.7 Circuit Explanation

IC1 forms an oscillator driving the infrared LED by means of 0.8mSec. Pulses at 120Hz frequency and about 300mA peak current D1 and D2 are placed facing the target on the same line, a couple of centimeters apart, on a short breadboard strip. D2 picks-up the infrared beam generated by D1 and reflected by the surface placed in front of it. The signal is amplified by IC2A and peak detected by D4 & C4. Diode D3, with R5 & R6, compensates for the forward diode drop of D4. A DC voltage proportional to the distance of the reflecting object and D1 & D2 feeds the inverting input of the voltage comparator IC2B. This comparator switches on and off the LED and the optional relay via Q1, comparing its input voltage to the reference voltage at its non-inverting input set by the Trimmer R7 [9].

3.8 System Components

Table 3.2 parts of circuit

R1	10K 1/4W Resistor
R2, R5, R6 &R9	1K 1/4W Resistors
R3	33R 1/4W Resistor
R4,R8	1M 1/4W Resistors
R7	10K Trimmer Cermet
R10	22K 1/4W Resistor
C1,C4	1μF 63V Capacitors
C2	47pF 63V Ceramic Capacitor
C3, C5 & C6	100μF 25V Electrolytic Capacitors
D1	Infra-red LED
D2	Infra-red Photo Diode
D3,D4	1N4148 75V 150mA Diode
D5	LED (Any color and size)
D6, D7	1N4002 100V 1A Diodes
Q1	BC327 45V 800mA PNP Transistor
IC1	555 Timer IC
IC2	LM358 Low Power Op-amp
IC3	7812 12V 1A Positive voltage regulator IC
RL1	Relay Coil Voltage 12V

3.9 Electronics Part Description

3.9.1 Timer Chip

The timer is a TLC555 CMOS chip that modulates the VCSEL's output current at 1kHz and 50% duty-cycle. The oscillation frequency and duty-cycle are found by:

i- Specifying a capacitor value, C

ii- Solving the following two equations:

$$F = \frac{1.44}{(R_1 + 2R_2)C} \quad , \quad D = \frac{R_2}{R_1 + 2R_2}$$

Where: D is the duty cycle (%)

F is the oscillation frequency (Hz).

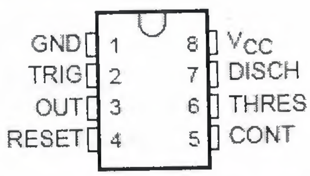

Figure 3.3 Timer chip 555

3.9.2 Operational Amplifier (LM358)

These devices consist of two independent, high-gain, frequency-compensated operational amplifiers designed to operate from a single supply over a wide range of voltages. Operation from split supplies also is possible if the difference between the two supplies is 3 V to 32 V (3 V to 26 V for the LM2904), and VCC is at least 1.5 V more positive than the input common-mode voltage. The low supply-current drain is independent of the magnitude of the supply voltage.

Applications include transducer amplifiers, dc amplification blocks, and all the conventional operational amplifier circuits that now can be implemented more easily in single-supply-voltage systems. For example, these devices can be operated directly from the standard 5-V supply used in digital systems and easily can provide the required interface electronics without additional 5-V supplies as its in figure 3.4.

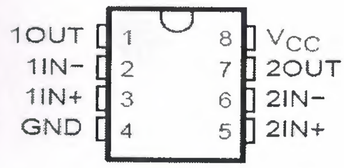

Figure 3.4 operational amplifier

3.9.3 Positive Voltage Regulators

These voltage regulators are monolithic integrated circuits designed as fixed-voltage regulators for a wide variety of applications including local, on-card regulation. These regulators employ internal current limiting, thermal shutdown, and safe-area compensation. With adequate heat sinking they can deliver output currents in excess of 1.0 A. Although designed primarily as a fixed voltage regulator, these devices can be used with external components to obtain adjustable voltages and currents [10].

- Output Current in Excess of 1.0 A
- No External Components Required
- Internal Thermal Overload Protection
- Internal Short Circuit Current Limiting
- Output Transistor Safe-Area Compensation
- Output Voltage Offered in 1.5%, 2% and 4% Tolerance
- Available in Surface Mount D2PAK-3, DPAK-3 and Standard
- Pin 1 Input , 2 Ground, 3 Output .

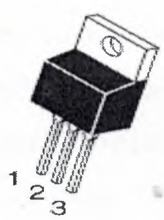

Figure 3.5 voltage regulator

3.9.4 Small Signal PNP Transistor

This is the transistor with the general PNP type for the small signal amplification. It is used for the drive circuit of the relay. Well suitable for TV and home appliance equipment and small load switch transistors with high and low saturation voltage .

Figure 3.7 Transistor

3.9.5 High Speed Infrared Emitting Diode

TSHF5210 is a high speed infrared emitting diode in GaAlAs double hetero (DH) technology, molded in a clear, untainted plastic package. TSHF5210 combines high speed with high radiant power at wavelength of 890 nm.

Figure 3.8 infrared photodiode

3.9.6 The Silicon PIN Photodiode

Although you may be aware of many kinds of light detectors, such as a "photo transistor", "photo cells" and "photo resistors", there are only a few devices that are practical for through-the-air optical communications. Many circuits that have been published in various magazines, have specified "photo transistors" as the main light detector. Although these circuits worked after a fashion, they could have functioned much better if the design had used a different detector. From the list of likely detectors, only the silicon "PIN" photodiode has the speed, sensitivity and low cost to be a practical detector.

As the letters PNP and NPN designate the kind of semiconductor materials used to form transistors, the "I" in the "PIN" photodiode indicates that the device is made from "P" and "N" semiconductor layers with a middle intrinsic or insulator layer.

Most PIN photodiodes are made from silicon and as shown on Figure 3.9 most IR light emitting diodes (LEDs) and infrared lasers do indeed emit light at or near the 900nm peak, making the
ideal optical transmitters of information.

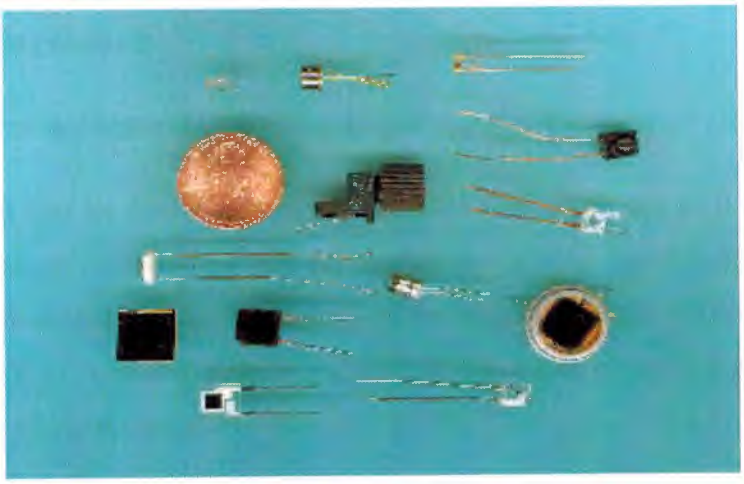

Figure 3.9 samples of detectors

3.9.7 Relay Driver

A relay is an electro-magnetic switch, which is useful if you want to use a low voltage circuit to switch on and off a light bulb (or anything else) connected to the 220v mains supply [10].

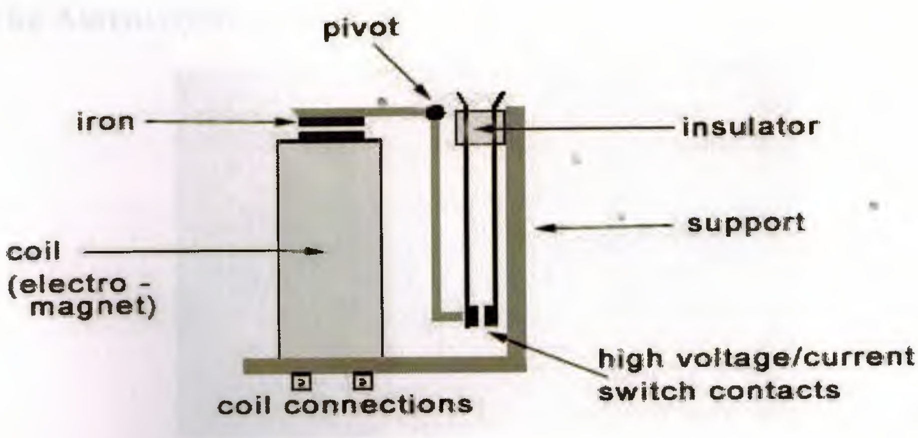

Figure 3.10 A typical relay (with "normally-open" contacts).

3.10 Operation Confirmation of the Detector

adjusts the potentiometer to control the reference voltage of the IC3 to the right and the output circuit always works. Turn on the power. Move your hand in front of the infrared sensor and confirm whether the LED lights up. If the LED disappears 1 second later, the detector is working normally.

3.11 Operation Adjustment by the Light Around

This option part that we find out if we add variable resistor instead of R3 and adjusts the operation according to the light around with the variable resistor for the operation adjustment of the output circuit. When turning the variable resistor clockwise, in the light place, the output of transmitter infrared diode (D1) it can controlled and that give us additional range of our project.

3.12 Power supply

The power supply must be regulated we used in the circuit for this voltage regulator for reference voltages the circuit can be fed by a commercial wall plug in power supply having a DC output voltage in the range 6-24 V. The current drawing of circuit diagram give us at less than of 40 mA the leds not work an on over 70 mA .

3.13 The Alarm System Picture

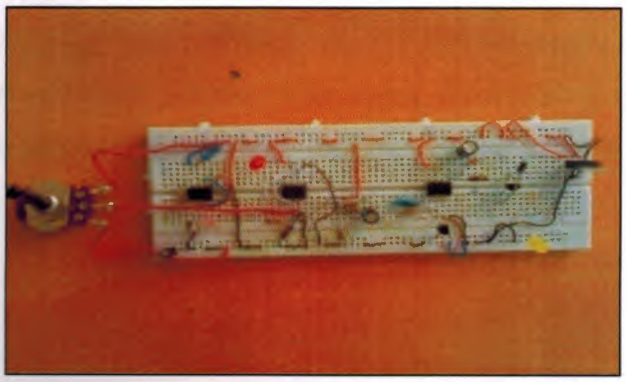

Figure 3.11: Circuit Layout.

3.14 Problems solved

1) Power supply

We face first problem in the design at the power supply .its not easy to work with electronics components the power supply should supply the circuit by 9V and 0.2 mA at the scale 9V but after we measure the supply by the DDM it was 12V .that error its normal but we have to consider it in our design . The design we have was made to work at range of 12-24V and after some changes it can work with same effects and same response at 6-24V.

2) Transmitter part

the circuit have the resistor R3 this resistor value can control the input of the infrared diode. Therefore, it gives us another range to control the output of the system. We change this resistor to minimum value we can have but we didn't cancel it from the circuit because its work as safety part at the same time as controller resistor.

3) Load effect

this was the main problem we face in many place of the circuit. First we separate the circuit to four stages ,transmitter ,receiver and amplifying ,voltage comparator and relay controlling .

First stage The transmitter part its completely separated from others stages. No electric connection between them .Second stage the receiver and amplifying , this stage is effected by the third stage by the load so we find to add voltage follower between them .Third stage the comparator part we find the value of the minimum reference voltage is 2.5 V , less than 2.5V the system not work it will give off output all the time .also reverse current comes from the least stage it effect the output we add diode between this stages .Fourth stage relay controlling this stage need high accuracy to work so we but high impedances transistor to insure that will not work under low deferent changes on the base of transistor.

CONCLUSION

The objective of the sensing activity in microelectronics is the search for new engineering solutions for industrial applications inspired by principles, functions, mechanisms and architectures found in living organisms. Currently the focus is on sensor systems featuring an efficient implementation of signal and information processing tasks in Analog and mixed circuitry.

The application scope for sensor systems that include information processing for making decisions or eliciting actions on a local and autonomous basis is quite large. It extends to surveillance, industrial control, robotics, environmental control, the automotive sector, consumer electronics and multimedia applications. Typical requirements for sensor systems in these domains are reliability, real-time processing, compactness, low power consumption (portable, battery operated systems) and finally low-cost.

That useful alarm can be created, to be practical and useful to the people life, infrared alarm security system is actually circuit acting as a switch depends on reflected amount of infrared light and control many devices, but since this project is intended for undergraduate electrical and electronic engineering level, the electronic device that will be controlled is a LED diode .

Two important aims accomplished were:-

- To modify the original circuit where possible
- This aim is accomplished by simple circuit connected to the output of the basic circuit to show a kind of applications to the system. Two LEDs are added to make the use of the device easier, a red diode to show that our system is active and ready to detect the infrared reflected or cutting it , and a yellow diode to show that the alarm is turned ON.

Referances

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