NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Electrical and Electronic Engineering

MAGNETIC FIELD DETECTOR

Graduation Project
EE – 400

Student: Ahmad Ibrahim (20021837)

Supervisor: Assis. Prof. Dr. Özgür C. Özerdem

Nicosia - 2006

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ACKNOWLEDGEMENTS

First of all I am happy to complete the task which I had given with blessing of God and also I am grateful to all the people in my life who have, supported me, advised me. Taught me and who have always encouraged me to follow my dreams and ambitions. My dearest parents, my brothers and sisters, my friends and my tutors. They have taught me that no dream is unachievable. As in the words of Walt Disney "If you can dream it, you can do it."

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ABSTRACT

The earliest magnetic field detectors allowed navigation over trackless oceans by sensing the Earth's magnetic poles. Magnetic field sensing has vastly expanded as industry has adapted a variety of magnetic sensors to detect the presence, strength, or direction of magnetic fields not only from the Earth, but also from permanent magnets, magnetized soft magnets, vehicle disturbances, brain wave activity, and fields generated from electric currents. Magnetic sensors can measure these properties without physical contact and have become the eyes of many industrial and navigation control systems.

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INTRODUCTION

Humans have long known of the existence of magnetic forces. Compasses relying on the magnetic field of the earth have been used for centuries as navigational aids. Until the nineteenth century, however, the cause and source of magnetic fields remained a mystery. Even after scientists began to learn about magnetism, the field remained complete separate from the study of electricity; at the time, it seemed inconceivable that the two could be related in any way.

In this project we are going to design, build and test a magnetic field detector. How to turn the switches on and off, Suggestion into where these switches can be used will be made.

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

The second chapter we have discussed magnetic field definition and properties, and many applications that demonstrate the use of magnetic field detectors.

The third chapter is the most important chapter, which explains the hardware project in details, how we built it, How it work, what its input and output? With the circuit diagrams of magnetic field detector, the diagram of the first and second and stage circuits also will be shown. And the components for all of them were listed.

The aims of this project are:

- To design and build a magnetic field detector.
- To gain hands-on experience in electronic hardware project.
- To modify the original circuit where possible.
- To suggest potential real-life use of magnetic field detector.

CHAPTER ONE

ELECTRONIC COMPONENTS

1.1 Overview

This chapter presents an introduction to electronic components that are commonly used in hardware projects. Safety guidelines for electronic projects will also be described.

1.2 1ntroduction to Electronic Components

Electronics gets its name from the electron, a tiny particle which forms part of all atoms, which, as everybody knows, make up everything in the world. Atoms contain other types of particles - protons and neutrons - but it is the electrons which will be interesting us here.

Electrons and protons have the electrical property of charge. Protons have positive charge and electrons have negative charge and they normally balance each other out. We don't really need to know what charge is. It's just a property like weight or color, but it is this property which makes the whole of electronics happens. But keep in mind the fact that opposite charges attract and similar charges repel.

When electrons move together in a unified way we say there is a current flowing. Electrons are actually moving all the time in materials like metals but moving in a random disordered way. A current is when they all move together in one particular direction.

When you touch a lift button having walked across a synthetic carpet and you feel a shock that is electrons flowing through you to the ground. That's all a current is, simply the movement of electrons in a particular direction.

Electrons can't flow through every material. Materials that allow a current to flow easily are called conductors. Materials that don't allow a current to flow are called non-conductors or insulators. Metals are the most common conductors, plastics are typical insulators.

Conductor's	**non-conductors**
Gold	plastic
Copper	wood
Carbon	air

Copper is a good conductor. Copper tracks are used on the printed circuit boards to connect the components together. Solder is another good conductor. The solder makes the actual join between the leg of the component and the track.

The plastic that a printed circuit board is made of is an insulator. Currents can only flow up and down the copper tracks and not jump from one to another. For the same reason wires are surrounded by plastic coatings to stop them conducting where they shouldn't.

There are certain materials that are between the two extremes of conductor and non-conductor; we will come to them later.

A battery supplies the 'force' that makes the electrons move. This force is called the voltage. The bigger the voltage the more force. Mains electricity which is 240 volts is more powerful than an ordinary 9 volt battery.

Currents are measured in amps, and voltages are measured in volts (after the scientists Ampere and Volta). Voltages are sometimes called potential differences, or electromotive forces, but we won't use these terms here.

There is a big confusion for many people as to the difference between voltage and current. They talk about so many volts going through something when they really mean amps. So let's think about things in a different way.

Imagine water flowing through a pipe filling up a pond. The water represents the electrons and the pipe represents the wire. A pump provides the pressure to force the water through the pipe. The pump is the battery. How much water flows out the end of the pipe each second is the current. How hard the water is being pumped is the voltage.

A narrow pipe will take a long time to fill the pond, whereas a broad pipe will do it much faster using the same pump. Clearly the rate of flow depends on the thickness of the pipe. So we have the situation where the same voltage (pump pressure) can give rise to different currents (flow rate) depending on the pipe. Try to guess what the thickness of the pipe represents in this model of things (answer later).

An electric current requires a complete path - a circuit - before it can flow. In a circuit with a battery, the battery is both the starting flag and the finishing line for the electrons. A chemical reaction in the battery releases electrons which flow around the circuit and then back into the battery. The battery keeps the current flowing, feeding electrons in at one end and collecting them at the other. It takes energy to do this and so after a while the battery wears out.

Current flows into a component and the same amount of current always flows out of the component. It is not 'used up' in any way. As the current passes through components things happen (an LED lights up for instance).

1.2.1 Resistors

Electrons move more easily through some materials than others when a voltage is applied. In metals the electrons are held so loosely that they move almost without any hindrance. We measure how much opposition there is to an electric current as resistance.

Resistors come somewhere between conductors, which conduct easily, and insulators, which don't conduct at all. Resistance is measured in ohms after the discoverer of a law relating voltage to current. Ohms are represented by the Greek letter omega.

Think back to the model of water flowing in a pipe. The thickness of the pipe must represent the resistance. The narrower the pipe the harder it is for the water to get through and hence the greater the resistance. For a particular pump the time taken to fill the pond is directly related to the pipe thickness. Make the pipe twice the size and the flow rate doubles, and the pond fills in half the time.

The resistors used in the kits are made of a thin film of carbon deposited on a ceramic rod. The less carbon the higher the resistance. They are then given a tough outer coating and some colored bands are painted on.

The main function of resistors in a circuit is to control the flow of current to other components. Take an LED (light) for example. If too much current flows through an LED it is destroyed. So a resistor is used to limit the current.

When a current flows through a resistor energy is wasted and the resistor heats up. The greater the resistance the hotter it gets. The battery has to do work to force the electrons through the resistor and this work ends up as heat energy in the resistor.

An important property to know about a resistor is how much heat energy it can withstand before it's damaged. Resistors can dissipate about a 1/4 Watt of heat (compare this with a domestic kettle which uses up to 3 000 Watts to boil water).

It's difficult to make a resistor to an exact value (and in most circuits it is not critical anyway). Resistances are given with a certain accuracy or tolerance. This is expressed as being plus or minus so much of a percentage. A 10% resistor with a stated value of 100 ohms could have a resistance anywhere between 90 ohms and 110 ohms. The resistors are 5% (that's what the gold band means) which is more than enough accuracy.

Real resistances vary over an enormous range. In the *Lie Detector* there is a 1 000 000 ohms resistor alongside a 470 ohms resistor. In circuit diagrams you will often see an 'R' instead of omega to represent ohms. This is a convention that dates from before the days of computers and laser printers when Greek letters were rarely found on typewriters. The letter 'k' means a thousand and its position shows the position of the decimal point.

Here are some examples:

10R = 10 ohms

10k = 10 kilohms = 10 000 ohms

4k7 = 4.7 kilohms = 4 700 ohm

1.2.1.1 Fixed value resistors

During manufacture, a thin film of carbon is deposited onto a small ceramic rod. The resistive coating is spiraled away in an automatic machine until the resistance between the two ends of the rod is as close as possible to the correct value. Metal leads and end caps are added; the resistor is covered with an insulating coating and finally painted with colored bands to indicate the resistor value

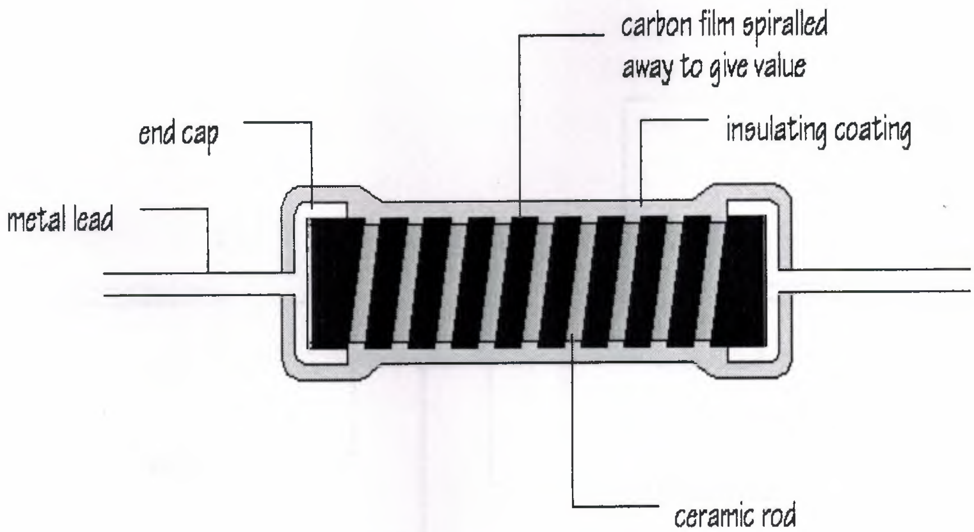


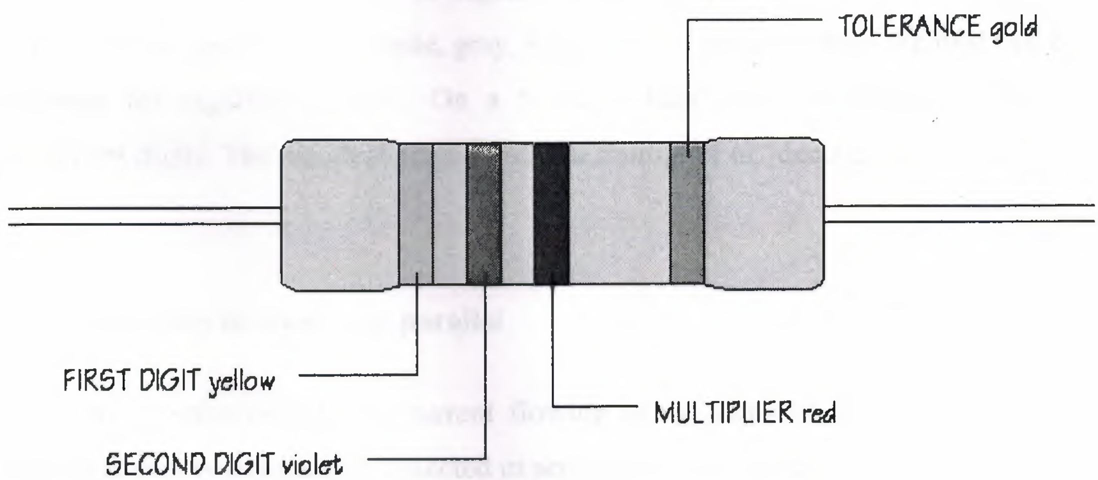
Figure 1.1: The diagram shows the construction of a carbon film resistor

Carbon film resistors are cheap and easily available, with values within ±10% or ±5% of their marked or 'nominal' value. Metal film and metal oxide resistors are made in a similar way, but can be made more accurately to within ±2% or ±1% of their nominal value. There are some differences in performance between these resistor types, but none which affect their use in simple circuits.

Wire wound resistors are made by winding thin wire onto a ceramic rod. They can be made extremely accurately for use in multi-meters, oscilloscopes and other measuring equipment. Some types of wire wound resistors can pass large currents without overheating and are used in power supplies and other high current circuits.

1.2.1.2 Resistor Color Code

The resistor color code is a way of showing the value of a resistor. Instead of writing the resistance on its body, which would often be too small to read, a color code is used. Ten different colors represent the numbers 0 to 9. The first two colored bands on the body are the first two digits of the resistance, and the third band is the 'multiplier'. Multiplier just means the number of zeroes to add after the first two digits. Red represents the number 2, so a resistor with red, red, red bands has a resistance of 2 followed by 2 followed by 2 zeroes, which is 2 200 Ohms or 2.2 kilo Ohms.



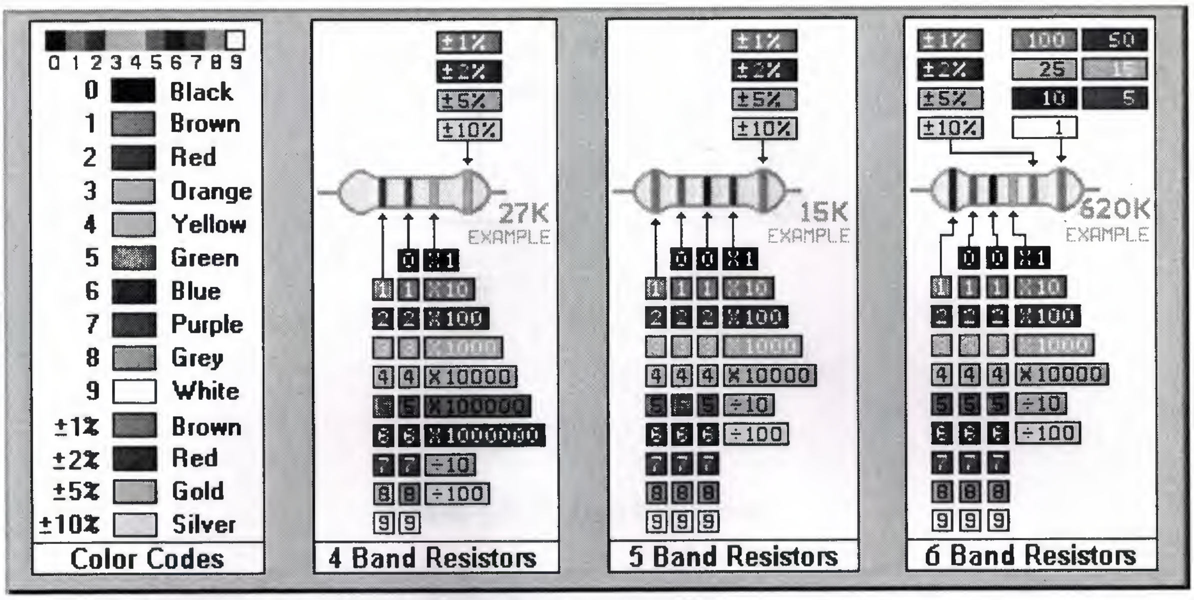


Figure 1.2: Color code identification

While these codes are most often associated with resistors, and then can also apply to capacitors and other components. The standard color coding method for resistors uses a different color to represent each number 0 to 9: black, brown, red, orange, yellow, green, blue, purple, grey, white. On a 4 band resistor, the first two bands represent the significant digits. On a 5 and 6 band, the first three bands are the significant digits. The next band represents the multiplier or "decade".

1.2.1.3 Resistors in series and parallel

In a series circuit, the current flowing is the same at all points. The circuit diagram shows two resistors connected in series with a 6 V battery:

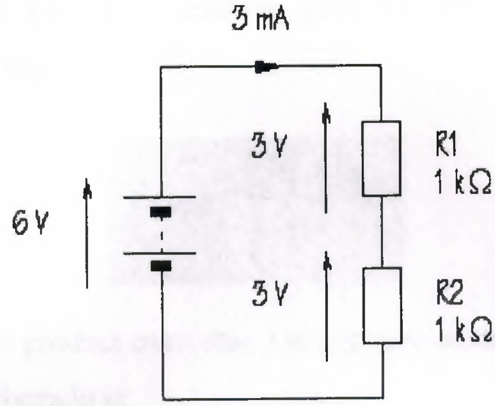


Figure 1.3: Resistors in series.

It doesn't matter where in the circuit the current is measured; the result will be the same. The total resistance is given by:

$$R_{\mathbf{total}} = R_1 + R_2$$

The next circuit shows two resistors connected in parallel to a 6 V battery:

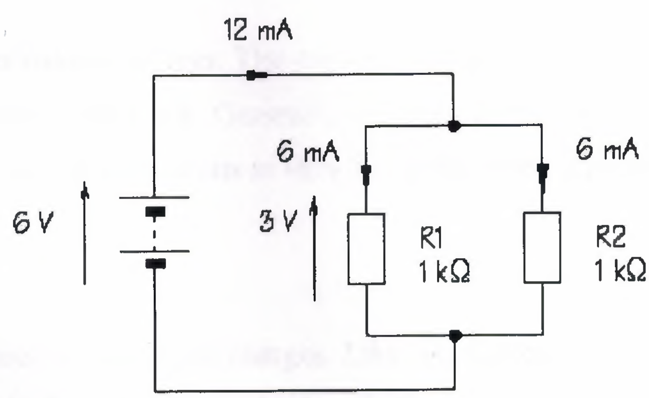


Figure 1.4: Resistors in parallel.

Parallel circuits always provide alternative pathways for current flow. The total resistance is calculated from:

$$R_{total} = \frac{R_1 \times R_2}{R_1 + R_2}$$

This is called the product over sum formula and works for any *two* resistors in parallel. An alternative formula is:

$$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2}$$

This formula can be extended to work for more than two resistors in parallel, but lends itself less easily to mental arithmetic. Both formulae are correct.

1.2.1.4 Variable Resistors

Unsurprisingly, variable resistors are resistors whose resistance can be varied. The variable resistors (called presets) have a metal wiper resting on a circular track of carbon. The wiper moves along the track as the preset is turned. The current flow through the wiper; and then; through part of the carbon track. The more of the track it has to go through the greater the resistance.

The presets have three legs. The top leg connects to the wiper and the other two legs to the two ends of the track. Generally only one of the track legs is actually used. Variable resistors are used in circuits to vary things that need changing, like volume etc.

1.2.2 Capacitors

Capacitors are stores for electrical charges. Like tiny batteries they can cause a current to flow in a circuit. But they can only do this for a short time; they cannot deliver a sustained current. They can be charged up with energy from a battery, then return that energy back later. The capacitance of a capacitor is a measure of how much energy or charge it can hold.

In its simplest form a capacitor consists of two metal plates separated by a small gap. Air or another non-conductor fills the gap. The bigger plates have bigger capacitance. To stop capacitors becoming impractically large however they are often rolled up like Swiss rolls.

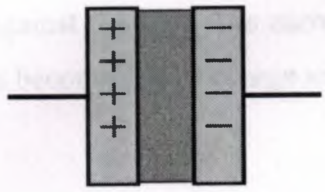


Figure 1.5: Capacitor contains

Another way of increasing the capacitance is to put some non-conducting material between the plates. This is called a dielectric. When the capacitor charges up the protons and electrons in the dielectric separate out a little which allows more charge to be stored on the plates than usual. Dielectrics are made of various materials. Ceramic dielectrics are common and are used in the capacitors.

Capacitance is measured in Farads after the scientist Michael Faraday. A Farad is quite a big unit. The capacitors in a *Flashing Lights* have capacitances of about 50 millionths of a Farad (and they're quite powerful capacitors). The symbol for a millionth is the Greek letter "μ" which you will often see represented as a 'u' (the closest to the Greek letter on an ordinary typewriter).

Capacitors come in two flavors, electrolytic and non-electrolytic. Electrolytic capacitors use a special liquid or paste which is formed into a very thin dielectric in the factory. Non-electrolytic capacitors have ordinary dielectrics.

Electrolytic capacitors can store more charge than non-electrolytic capacitors but there are a couple of problems. They must be connected the right way around in a circuit or they won't work (anyone who has soldered a capacitor in a *Flashing Lights* backwards will know this). They also slowly leak their charge, and they have quite large tolerances. A 47uF capacitor might actually be as high as 80uF or as low as 10uF. In the *Flashing Lights* kit the capacitors control how fast the lights flash. You might have noticed that the rate can vary quite a lot from board to board and this is the reason.

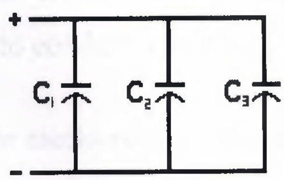
When a capacitor is connected to a battery it begins to charge. The current flows rapidly at first. Charge builds up on the two plates, negative charge on one plate and the same amount of positive charge on the other. The positive charge results from electrons leaving one of the plates and leaving positively-charged protons behind. But as the capacitor fills with charge it starts to oppose the current flowing in the circuit. It is as if another battery were working against the first. The current decreases and the capacitor charges more slowly. The plates become full of charge and it takes practically forever to squeeze the last drop in.

If a capacitor is shorted then it discharges. Charge flows out of the capacitor rapidly at first, then progressively more slowly. The last little drop just trickles out. The speed at which the capacitor empties depends on the resistance that connects across it. If a simple wire shorts out a capacitor then it empties in a flash, often with a spark if it's a big capacitor.

We've seen that when a capacitor is fully charged the current stops. In other words a continuous current cannot flow for ever through a capacitor. A continuous current is called a direct current or D.C.

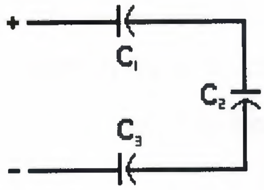
An alternating current (A.C.) however can flow through a capacitor. An alternating current is one which is continually changing its direction. Mains are A.C. and change its direction 50 times a second. An alternating current continually charges and discharges a capacitor and hence is able to keep flowing.

Here are some basic formulas for wiring capacitors in series or parallel. These are useful when you cannot find a component with the exact value that you are looking for.



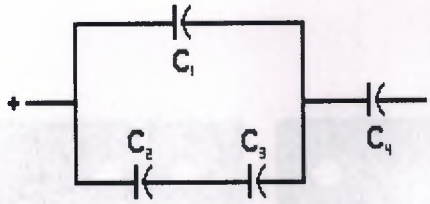
$$C = C_1 + C_2 + C_3$$

Capacitors in parallel



$$C = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}}$$

Capacitors in series



$$C = \frac{1}{\frac{1}{C_1 + \frac{1}{\frac{1}{C_2} + \frac{1}{C_3}}} + \frac{1}{C_4}}$$

Capacitors in series and parallel

Figure 1.6: Capacitors wiring.

1.2.3 Semiconductors

Now we come to what is probably the most important discovery in electronics this century. Without this discovery we wouldn't have televisions, computers, space rockets or transistor radios. Unfortunately it's also one of the hardest areas to understand in electronics. But don't lose heart, read the section through a few times until you've grasped the ideas.

Recall that the reason that metals are such good conductors is that they have lots of electrons which are so loosely held that they're easily able to move when a voltage is applied. Insulators have fixed electrons and so are not able to conduct. Certain materials, called semiconductors, are insulators that have a few loose electrons. They are partly able to conduct a current.

The free electrons in semiconductors leave behind a fixed positive charge when they move about (the protons in the atoms they come from). Charged atoms are called ions. The positive ions in semiconductors are able to capture electrons from nearby atoms. When an electron is captured another atom in the semiconductor becomes a positive ion.

These behaviors can be thought of as a 'hole' moving about the material, moving in just the same way that electrons move. So now there are two ways of conducting a current through a semiconductor, electrons moving in one direction and holes in the other. There are two kinds of current carriers.

The holes don't really move of course. It is just fixed positive ions grabbing neighboring electrons, but it appears as if holes are moving.

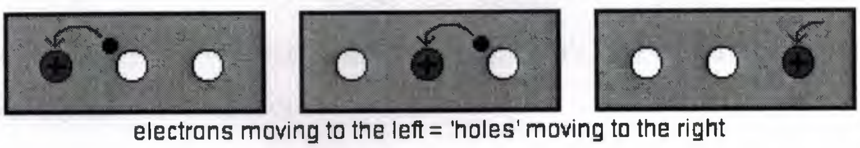


Figure 1.7: Moving of electrons.

In a pure semiconductor there are not enough free electrons and holes to be of much use. Their number can be greatly increased however by adding an impurity, called a donor. If the donor gives up some extra free electrons we get an n-type semiconductor (n for negative). If the donor soaks up some of the free electrons we get a p-type semiconductor (p for positive). In both cases the impurity donates extra current carriers to the semiconductor.

In n-type semiconductors there are more electrons than holes and they are the main current carriers. In p-type semiconductors there are more holes than electrons and they are the main current carriers. The donor atoms become either positive ions (n-type) or negative ions (p-type).

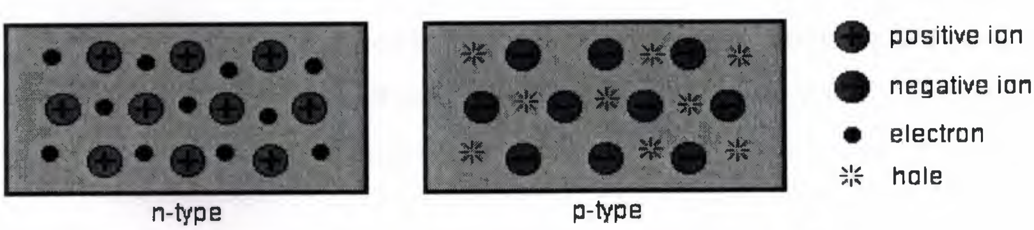


Figure 1.8: The tow types of semiconductors.

The most common semiconductors are silicon (basically sand) and germanium. Common donors are arsenic and phosphorus.

When we combine n-type and p-type semiconductors together we make useful devices, like transistors and diodes and silicon chips.

1.2.3.1 Transistors

Transistors underpin the whole of modern electronics. They are found everywhere - in watches, calculators, microwaves, hi-fi's. A Pentium(tm) computer chip contains over a million transistors.

Transistors work in two ways. They can work as switches (turning currents on and off) and as amplifiers (making currents bigger). We'll only be looking at them as switches here. To understand them as amplifiers would involve a little mathematics.

Transistors are sandwiches of three pieces of semiconductor material. A thin slice of n-type or p-type semiconductor is sandwiched between two layers of the opposite type. This gives two junctions rather than the one found in a diode. If the thin slice is n-type the transistor is called a p-n-p transistor, and if the thin slice is p-type it is called an n-p-n transistor. The middle layer is always called the base, and the outer two layers are called the collector and the emitter.

We will consider the (more common) n-p-n transistor here, as used in the circuits. In an n-p-n transistor electrons are the main current carriers (because n-type material predominates).

When no voltage is connected to the base then the transistor is equivalent to two diodes connected back to back. Recall that current can only flow one way through a diode. A pair of back-to-back diodes can't conduct at all.

If a small voltage is applied to the base (enough to remove the depletion layer in the lower junction), current flows from emitter to base like a normal diode. Once current is flowing however it is able to sweep straight through the very thin base region and into the collector. Only a small part of the current flows out of the base. The transistor is now conducting through both junctions. A few of the electrons are consumed by the holes in the p-type region of the base, but most of them go straight through.

Electrons enter the emitter from the battery and come out of the collector. (Isn't that rather illogical you might say, electrons emitted from the collector? Yes it is, but the parts of a transistor are named with respect to conventional current, an imaginary current which flows in the opposite direction to real electron current.)

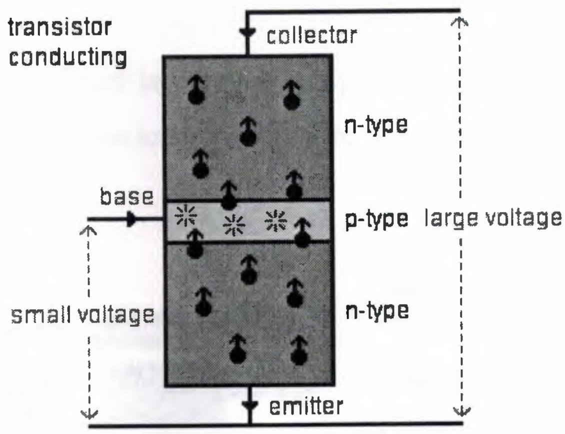
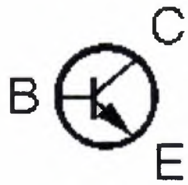


Figure1.9: Transistor conducting.

The difference between PNP and NPN transistors is that NPN use electrons as carriers of current and PNP use a lack of electrons (known as "holes"). Basically, nothing moves very far at a time. One atom simply robs an electron from an adjacent atom so you get the impression of "flow". It's a bit like "light pipes". In the case of "N" material, there are lots of spare electrons. In the case of "P" there aren't. In fact "P" is gasping for electrons.

Now we can see how a transistor acts as a switch. A small voltage applied to the base switches the transistor on, allowing a current to flow in the rest of the transistor.



This is the symbol used to represent an "NPN" transistor.

You can distinguish this from a "PNP" transistor (right) by the arrow which indicates current flow direction.

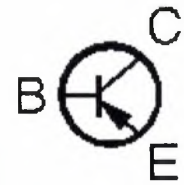


Figure 1.10: The difference between PNP and NPN transistors.

1.2.3.2 Diodes

A diode allows current to flow in only ONE direction. If the cathode end (marked with a stripe) is connected so it is more negative than the anode end, current will flow.

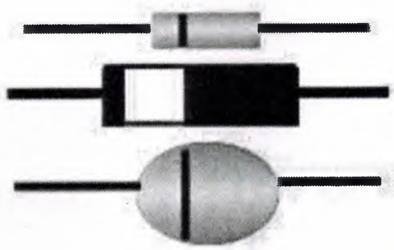


Figure 1.11: The picture shows three types of diodes

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

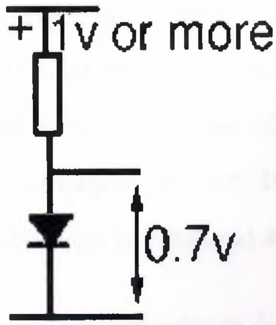


Figure 1.12: A diode forward voltage drop.

Silicone	diode	=	0.7v
Schottky	diode	=	0.3v
Germanium	diode	=	0.2v

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

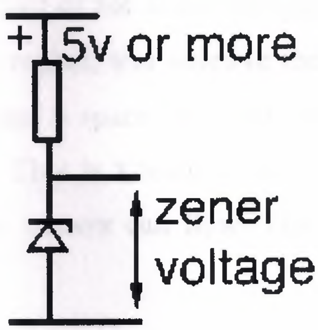


Figure 1.13: Zener diode

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

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

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

1.2.3.2.1 Light Emitting Diodes (LEDs)

A diode consists of a piece of n-type and a piece of p-type semiconductor joined together to form a junction.

Electrons in the n-type half of the diode are repelled away from the junction by the negative ions in the p-type region, and holes in the p-type half are repelled by the positive ions in the n-type region. A space on either side of the junction is left without either kind of current carriers. This is known as the depletion layer. As there are no current carriers in this layer no current can flow. The depletion layer is, in effect, an insulator.

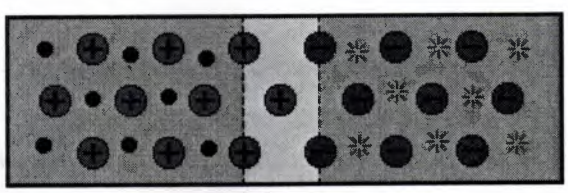


Figure 1.14: Depletion layer.

Now consider what would happen if we connected a small voltage to the diode. Connected one way it would attract the current carriers away from the junction and make the depletion layer wider. Connected the other way it would repel the carriers and drive them towards the junction, so reducing the depletion layer. In neither case would any current flow because there would always be some of the depletion layer left.

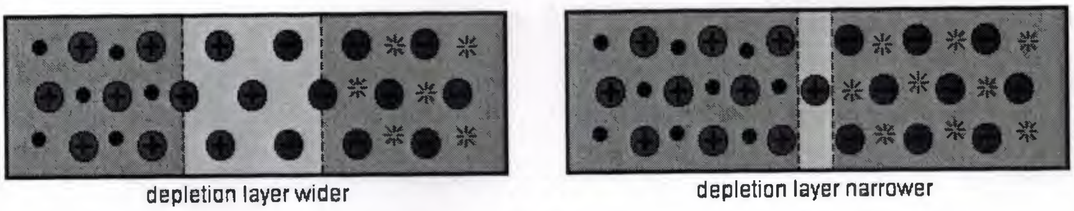


Figure 1.15: Reducing the depletion layer.

Now consider increasing the voltage. In one direction there is still no current because the depletion layer is even wider, but in the other direction the layer disappears completely and current can flow. Above a certain voltage the diode acts like a conductor. As electrons and holes meet each other at the junction they combine and disappear. The battery keeps the diode supplied with current carriers.

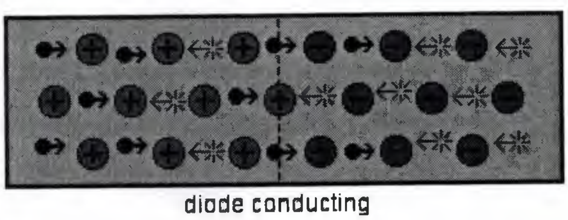


Figure 1.16: Diode conducting.

Thus a diode is a device which is an insulator in one direction and a conductor in the other. Diodes are extremely useful components. We can stop currents going where we don't want them to go. For example we can protect a circuit against the battery being connected backwards which might otherwise damage it.

Light emitting diodes (LEDs) are special diodes that give out light when they conduct. The fact that they only conduct in one direction is often incidental to their use in a circuit. They are usually just being used as lights. They are small and cheap and they last practically forever, unlike traditional light bulbs which can burn out.

The light comes from the energy given up when electrons combine with holes at the junction. The color of the light depends on the impurity in the semiconductor. It is easy to make bright red, green and yellow LEDs but technology has not cracked the problem of making cheap blue LEDs yet.

1.2.3.3 LM339

The LM3339 is a power audio amplifier for consumer applications. In order to hold system cost to a minimum, gain is internally fixed at 34 dB. A unique input stage allows ground referenced input signals. The output automatically self-centers to one-half the supply voltage.

The output is short circuit proof with internal thermal limiting. The package outline is standard dual-in-line. The LM339N uses a copper lead frame. The center three pins on either side comprise a heat sink. This makes the device easy to use in standard PC layouts.

Uses include simple phonograph amplifiers, intercoms, line drivers, teaching machine outputs, alarms, ultrasonic drivers, TV sound systems, AM-FM radio, small servo drivers, power converters, etc. The figure 1.10 shows the LM339N construction.

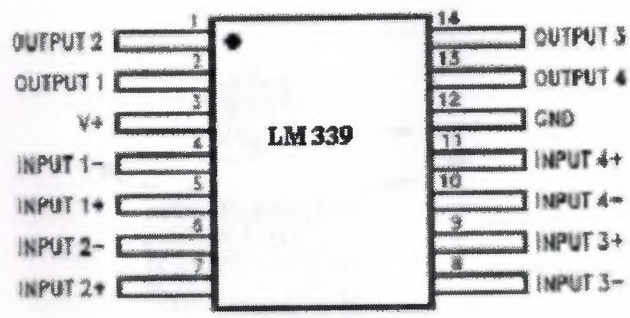


Figure 1.17: The LM339N construction

1.2.4 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.

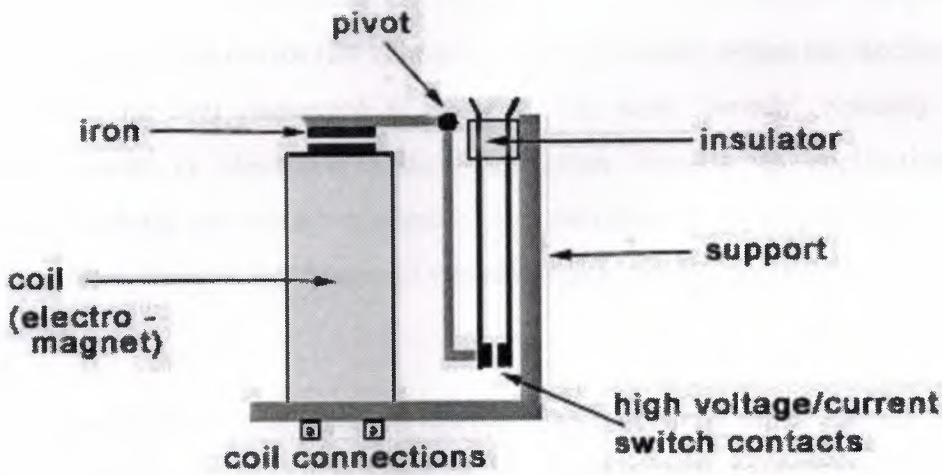


Figure1.18: A typical relay (with "normally-open" contacts).

1.2.5 Batteries

Batteries provide the power for the circuits. The source of this power is a chemical reaction. Chemicals within the battery react with each other and release electrons. These electrons flow around the circuit connected to the battery and make things happen. Electrons flow out of the negative terminal of the battery, through the wires and components of the circuit, and then back into the positive battery terminal.

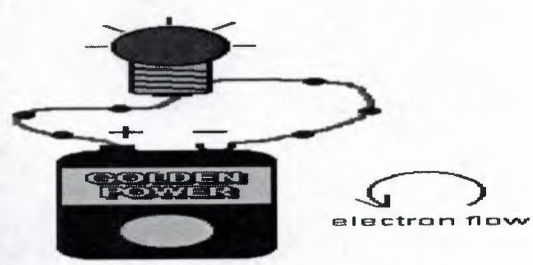


Figure 1.19: Battery

It takes energy to do this and so eventually all the energy in the battery is used up. Occasionally the acid in the battery messily leaks out before it has been used and the battery has to be discarded.

1.2.6 Switches

switch is a device for changing the course (or flow) of a circuit. The prototypical model is a mechanical device (for example a railroad switch) which can be disconnected from one course and connected to another. The term "switch" typically refers to electrical power or electronic telecommunication circuits. In applications where multiple switching options are required, (i.e. a telephone service) mechanical switches have long been replaced by electronic variants which can be intelligently controlled and automated.

In the simplest case, a switch has two pieces of metal called contacts that touch to make a circuit, and separate to break the circuit. The contact material is chosen for its resistance to corrosion, because most metals form insulating oxides that would prevent the switch from working. Sometimes the contacts are plated with noble metals. They may be designed to wipe against each other to clean off any contamination. Nonmetallic conductors, such as conductive plastic, are sometimes used. The moving part that applies the operating force to the contacts is called the actuator, and may be a toggle or dolly, a rocker, a push-button or any type of mechanical linkage. Figure 1.20 shows some types of switches.

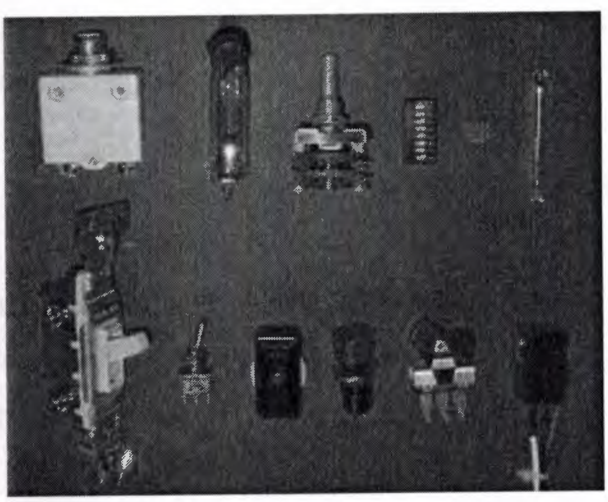


Figure 1.20 Switch

It is not important to use a specific type of switches due to the similarity of creating a circuit. In this section the switch type which is used in the project is cleared as type and general information, MINIATURE TOGGLE SWITCH, a range of low coast panel mounting miniature toggle switches providing exceptional value available in single pole and double pole options including momentary biased options, as shown in figure 1.21.

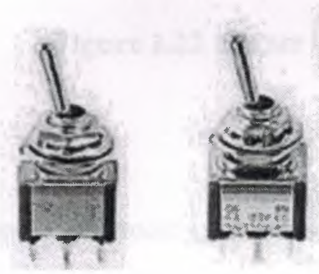


Figure 1.21 Miniature toggle switches.

1.2.7 Buzzers

An electronic buzzer is compact and produces high sound pressure levels with minimal power consumption. Operating voltages typically range from 1 to 30 V while sound output can be as high as 75 dB at 1 m. Most buzzers operate at low frequencies, typically 300500 Hz, and use an oscillating hammer to resonate a membrane. An electromagnetic assembly controls the hammer, which vibrates once current flows through a coil within the buzzer. A second coil detects the vibration and provides feedback to a transistor so that the oscillator becomes synchronized with the vibrating hammer. The result is a designated tone.

Tone output can be selected using two methods. The first is simply to listen to the tone. A second method, called fast Fourier transform (FFT) analysis, is perhaps more accurate because it visually collects a body of frequencies rather than just one. Such analysis can determine the tone's effectiveness compared to other sounds. Figure 1.22 shows one type of a buzzer.

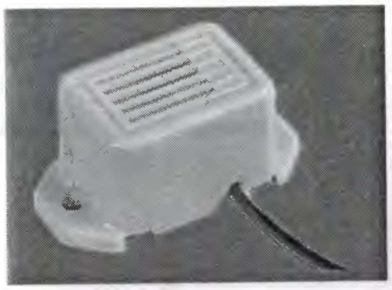
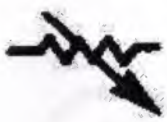
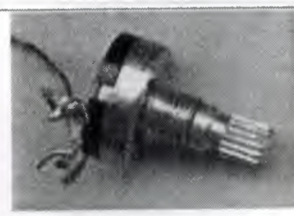
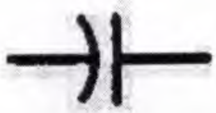
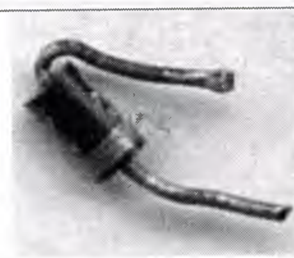
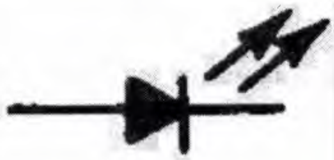
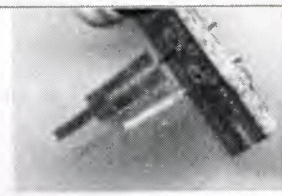


Figure 1.22 Buzzer

Table 1.1 Description of some of the most common components and their schematic symbols.

Component	**Schematic Symbol**	**Actual appearance**
Resister		
Variable Resister		
Capacitor		
Diode		

Light emitting diode (LED)		
Chassis Ground		This is just a connection to ground.
Earth Ground		This is just a connection to ground.
NPN Bipolar Transistor		
PNP Bipolar Transistor		

1.3 Safety Guidelines

1. We have taken care about chip pins when we plant it in the board to not be broken.
2. Be aware while soldering to not heat up the chip by the soldering iron long time on the pins.
3. While soldering be aware not be let to pins to be soldering together and check after soldering the pins in between space.
4. Be aware of the soldering iron position while stand by.
5. Be aware when turns up side down the board after the chip plant that the pins arrangement will be different.
6. The glass will have to be removed from lamp without breaking the filament. Wrap the glass in masking tape and it in a vise. Slowly crank down until the glass breaks, then remove the bulb and carefully peel back the tape. If the filament has broken, you will need another lamp.

1.4 Summary

This chapter presented an introduction to electronic components that are commonly used in hardware projects and how they function, how they must be connected. By applying the safety guidelines, the circuit should work smoothly.

CHAPTER TWO

MAGNETIC FIELD DETECTOR APPLICATIONS

2.1 Overview

In physics, a magnetic field is the relativistic part of an electric field (as explained by Einstein in 1905). When an electric charge is moving from the perspective of an observer, the electric field of this charge due to space contraction is no longer seen by the observer as spherically symmetric (and due to time dilation not radial) and must be computed using the Lorentz transformations. One of the products of these transformations is the part of electric field which only acts on moving charges and we call it "magnetic field".

The quantum-mechanical motion of electrons in atoms produces magnetic fields of permanent ferromagnets. Spinning charged particles also have magnetic moment. Some electrically neutral particles (like neutron) with non-zero spin also have magnetic moment due to charge distribution in their inner structure. Spin-zero particles never have magnetic moment.

A magnetic field is a vector field, it associates with every point in space a vector that may vary in time. The direction of the field is the equilibrium direction of a magnetic dipole (like a compass needle) placed in the field.

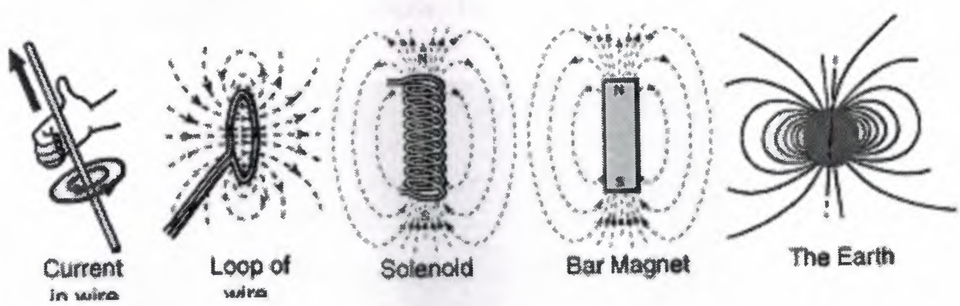


Figure 2.1 Magnetic Sources

2.2 Magnetic Field Properties

Maxwell did much to unify static electricity and magnetism, producing a set of four equations relating the two fields. However, under Maxwell's formulation, there were still two distinct fields describing different phenomena. It was Albert Einstein who showed, using special relativity, that electric and magnetic fields are two aspects of the same thing (a rank-2 tensor), and that one observer may perceive a magnetic force where a moving observer perceives only an electrostatic force. Thus, using special relativity, magnetic forces are a manifestation of electrostatic forces of charges in motion and may be predicted from knowledge of the electrostatic forces and the velocity of movement (relative to some observer) of the charges.

Changing magnetic field is mathematically the same as moving magnetic field, thus according to Einstein's field transformation equations (= Lorentz transformation of field from proper reference frame to non-moving reference frame) part of it appears as electric field component, this is known as Faraday's law of induction and is the principle behind electric generators and electric motors.

2.2.1 Magnetic Field Lines

The direction of the magnetic field vector follows from the definition. It coincides with the direction of orientation of magnetic dipole like a small magnet or a small loop of current in the magnetic field, or a bunch of small particles of ferromagnetic material. Figure 2.2 shows the magnetic field lines.

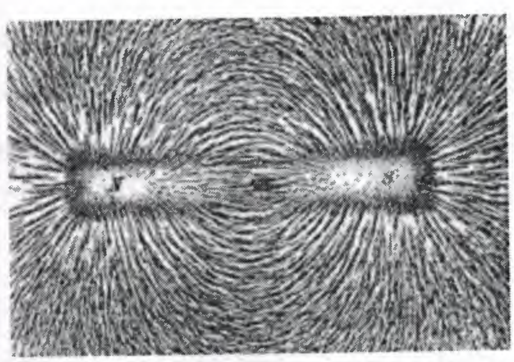


Figure 2.2 Magnetic Field Lines

2.2.2 Pole labelling confusions

Because the end of compass needle pointing north was historically called the north magnetic pole of the needle, and because dipoles (being vectors) align "head to tail" versus each other, the north pole of a compass needle actually points toward Earth's south magnetic pole (which is located in northern Canada).

The "north" and "south" poles of a magnet or a magnetic dipole are labelled similar to north and south poles of a compass needle. Near the north pole of a bar or a cylinder magnet, the magnetic field vector is directed out of the magnet; near the south pole, into the magnet. This magnetic field continues inside of magnet (so there are no actual "poles" anywhere inside or outside of a magnet). Breaking a magnet in half does not separate the poles but produces two magnets with two "poles" each. Earth's magnetic field is produced by electric currents in its liquid core.

2.3 Rotating magnetic fields

A rotating magnetic field is a magnetic field which periodically changes direction. This is a key principle to the operation of alternating-current motor. A permanent magnet in such a field will rotate so as to maintain its alignment with the external field. This effect was utilised in early alternating current electric motors. A rotating magnetic field can be constructed using two orthogonal coils with 90 degrees phase difference in their AC currents. However, in practice such a system would be supplied through a three-wire arrangement with unequal currents. This inequality would cause serious problems in standardization of the conductor size and in order to overcome it, three-phase systems are used where the three currents are equal in magnitude and have 120 degrees phase difference. Three similar coils having mutual geometrical angles of 120 degrees will create the rotating magnetic field in this case.The ability of the three phase system to create a rotating field utilized in electric motors is one of the main reasons why three phase systems dominated in the world electric power supply systems. Because magnets degrade with time, synchronous motors and induction motors use short-circuited rotors (instead of a magnet) following rotating magnetic field of multicoiled stator. (Short circuited turns of rotor develop eddy currents in rotating field of stator which (currents) in turn move the rotor by Lorentz force).

In 1882, Nikola Tesla identified the concept of the rotating magnetic field. In 1885, Galileo Ferraris independently researched the concept. In 1888, Tesla gained U.S. Patent 381968 for his work. Also in 1888, Ferraris published his research in a paper to the Royal Academy of Sciences in Turin.

2.4 Hall effect

Because Lorentz force is charge sign dependent, it results in a charges separation, when a conductor with current is placed in transverse magnetic field with a buildup of opposite charges on two opposite sides of conductor (in the direction normal to the magnetic field direction)—and the potential difference between these sides can be measured.

Hall effect is often used to measure the magnitude of magetic field as well as to find the sign of dominant charge carriers in semiconductors (negative electrons or positive holes).

2.5 Magnetic field of celestial bodies

A rotating body of conductive gas or liquid develops self amplifying electric currents (thus self generates magnetic field) due to combination of differential rotation (different angular velocity of different parts of body), Coriolis force and induction. Distribution of currents can be quite complicated, with numerous open and closed loops - thus the magnetic field of these currents in their immediate vicinity is also quite multitwisted. At large distance, however, magnetic field of currents flowing in opposite direction cancels out and only a major dipole field survives (diminishes with distance most slow). Because major currents flow in the direction of conductive mass motion (equatorial currents) then the major component of generated magnetic field is the dipole field of equatorial current loop, thus producing magnetic poles near geographic poles of a rotating body.

Magnetic fields of all celestial bodies are more or less aligned with the direction of rotation. Another feature of this dynamo model is that the currents are AC rather than DC - their direction (thus the direction of the magnetic field they generate) periodically (more or less) alternates, changing amplitude and reversing direction (which is still more or less aligned with the axis of rotation).

The sun's major component of magnetic field reverses direction every 11 years (so the period is about 22 years), resulting in diminished magnitude of magnetic field near reversal time. During this dormancy time the sunspots activity is maximized (because of lack of magnetic braking on plasma) and as a result - massive ejection of high energy plasma into solar corona and interplanetary space takes place. Collision of neighboring sunspots with oppositely directed magnetic field results in generation of strong electric field near rapidly disappearing magnetic field regions. This electric field accelerates electrons and protons to high energies (kiloelectron volts) which results in jets of extremely hot plasma leaving Sun's surface and heating coronal plasma to high temperatures (millions K).

Compact and fast rotating astronomical objects (white dwarfs, neutron stars and black holes) have extremely strong magnetic fields. The magnetic field of a newly born fast spinning neutron star is so strong (up to 10^8 Teslas) that it electromagnetically radiates enough energy to quickly (in a matter of few million years) damp down the star rotation 100-1000 times. Matter falling onto neutron star also has to follow magnetic field lines, resulting in two hot spots on the surface where it can reach and impact star's surface. These spots are literally few feet across but tremendously bright. Their periodic eclipsing during star rotation is believed to be the source of pulsating radiation.

Jets of relativistic plasma are often observed along the direction of magnetic poles of active black holes in centers of young galaxies.

If the gas or liquid is very viscosious (resulting in turbulent differential motion) then the reversal of magnetic field may not be very periodic. This is the case of Earth's magnetic field which is generated by turbulent currents in viscosious outer core.

2.6 Magnetic Field Sensors and Applications

Magnetic sensors have been in use for well over 2,000 years. Early applications were for direction finding, or navigation. Today, magnetic sensors are still a primary means of navigation but many more uses have evolved. The technology for sensing magnetic fields has also evolved driven by the need for improved sensitivity, smaller size, and compatibility with electronic systems.

2.6.1 Low Field Sensors

The low field sensors are used for medical applications and military surveillance. They generally tend to be bulky and costly compared to other magnetic field sensors. Care must be taken to account for the effects of the Earth's field since daily variations in the Earth's field may exceed the measurement range of a low field sensor.

2.6.1.1 SQUID

The most sensitive low field sensor is the Superconducting QUantum Interference Device (SQUID). Developed around 1962 with the help of Brian J. Josephson's work that developed the point-contact junction to measure extremely low current. The SQUID magnetometer has the capability to sense field in the range of several fempto-teslas (fT) up to 9 tesla. That is a range of over 15 orders of magnitude! This is the key for medical use since the neuromagnetic field of the human brain is only a few tenths of a fempto-tesla.

2.6.1.2 Search-Coil

Another common low field sensor is the basic search-coil magnetometer based on Faraday's law of induction which states that the voltage induced in a coil is proportional to the changing magnetic field in the coil. This induced voltage creates a current that is proportional to the rate of change of the field. The sensitivity of the search-coil is dependent on the permeability of the core, and the area and number of turns of the coil.

In order for the search-coil to work, the coil must either be in a varying magnetic field or moving through a magnetic field. This restricts the search-coil from detecting static, or slowly changing, fields. These sensors are commonly found in the road at traffic control signals. They are low cost and easily manufactured.

2.6.1.3 Other Low Field Sensors

Other low field sensor technologies include nuclear precession, optically pumped, and fiber-optic magnetometers. These are precision level instruments used for laboratory research and medical applications. For instance, the long-term stability of the nuclear procession magnetometer can be as low as 50pT/year.

2.6.2 Earth's Field Sensors

The magnetic range for the medium field sensors lends itself well to using the Earth's magnetic field. Several ways to use the Earth's field are to determine compass headings for navigation, detect anomalies in it for vehicle detection, and measure the derivative of the change in field to determine yaw rate.

2.6.2.1 Fluxgate

Fluxgate magnetometers are the most widely used sensor for compass navigation systems. They were developed around 1928 and later refined by the military for detecting submarines. Fluxgate sensors have also been used for geophysical prospecting and airborne magnetic field mapping. The most common type of fluxgate magnetometer is called the second harmonic device.

2.6.2.2 Magnetoinductive

Magnetoinductive magnetometers are relatively new with the first patent issued in 1989. The sensor is simply a single winding coil on a ferromagnetic core that changes permeability within the Earth's field. The sense coil is the inductance element in a L/R relaxation oscillator. The frequency of the oscillator is proportional to the field being measured. A static dc current is used to bias the coil in a linear region of operation as shown in figure 2.3. The observed frequency shift can be as much as 100% as the sensor is rotated 90 degrees from the applied magnetic field. The oscillator frequency can be monitored by a microprocessor's capture/compare port to determine field values. These magnetometers are simple in design, low cost, and low power. They are available from Precision Navigation, Inc. and used in compass applications.

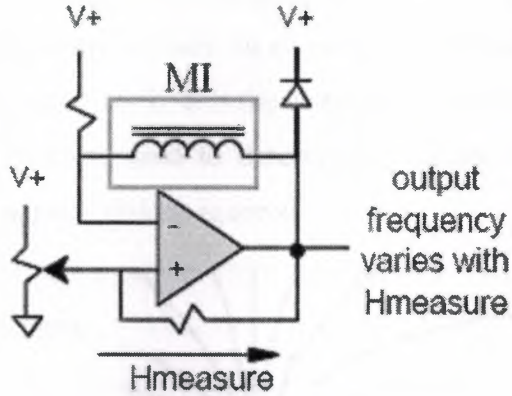


Figure 2.3 Magnetoinductive (MI) Sensor Circuit

2.6.2.3 Anisotropic Magnetoresistive (AMR)

The anisotropic magnetoresistive (AMR) sensor is one type that lends itself well to the Earth's field sensing range. AMR sensors can sense dc static fields as well as the strength and direction of the field this sensor is made of a nickel-iron (Permalloy) thin film deposited on a silicon wafer and is patterned as a resistive strip. The properties of the AMR thin film cause it to change resistance by 2-3% in the presence of a magnetic field.

AMR sensors available today do an excellent job of sensing magnetic fields within the Earth's field below 1 gauss. These sensors are used in applications for detecting ferrous objects such as planes, train, and automobiles that disturb the Earth's field. Other applications include magnetic compassing, rotational sensing, current sensing, underground drilling navigation, linear position sensing, yaw rate sensors, and head tracking for virtual reality.

- **Electronic Compass Using AMR Sensors**

The Earth's magnetic field intensity is about 0.5 to 0.6 gauss and has a component parallel to the Earth's surface that always point toward magnetic north. This is the basis for all magnetic compasses. AMR sensors are best suited for electronic compasses since their range of sensitivity is centered within the earth's field.

The Earth's magnetic field can be approximated with the dipole model shown in Figure 2.4. This figure illustrates that the Earth's field points down toward north in the northern hemisphere, is horizontal and pointing north at the equator, and point up toward north in the southern hemisphere. In all cases, the direction of the Earth's field is always pointing to magnetic north. It is the components of this field that are parallel to the Earth's surface that are used to determine compass direction. The vertical portion of the Earth's magnetic field is ignored.

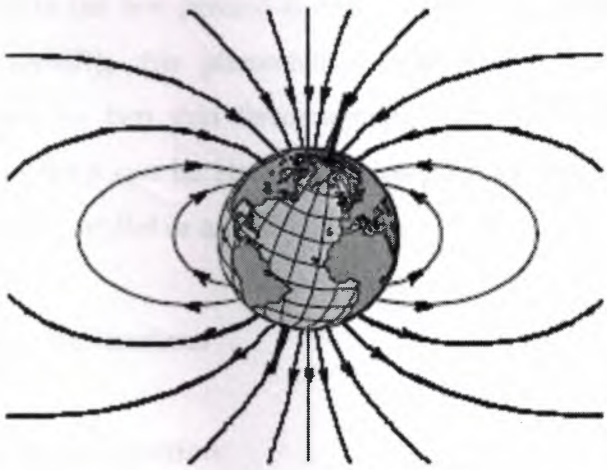


Figure 2.4 Earth Dipole Model

2.6.3 Bias Magnet Field Sensors

Most industrial sensors use permanent magnets as a source of the detected magnetic field. These permanent magnets magnetize, or bias, ferromagnetic objects close to the sensor. The sensor then detects the change in the total field at the sensor. Bias field sensors not only must detect fields which are typically larger than the Earth's field, but they also must not be permanently affected or temporarily upset by a large field.

2.6.3.1 Reed Switches

Possibly the simplest magnetic sensor which produces a useable output for industrial control is the reed switch. Low cost, simplicity, reliability, and zero power consumption make reed switches popular in many applications. A reed switch together with a separate small permanent magnet make a simple proximity switch often used in security systems to monitor the opening of doors or windows. The magnet, affixed to the moveable part, activates the reed switch when it comes close enough. The desire to sense almost everything in cars is increasing number of reed switch sensing applications in the automotive industry.

2.6.3.2 Giant Magnetoresistive (GMR) Devices

Large magnetic field dependent changes in resistance are possible in thin-film ferromagnet/non-magnetic metallic multilayer. This phenomenon was first observed in France in 1988. Changes in resistance with magnetic field of up to 70% were observed. Compared to the few percent change in resistance observed in anisotropic magnetoresistance (AMR), this phenomenon was truly giant magnetoresistance (GMR) the resistance of two thin ferromagnetic layers separated by a thin non-magnetic conducting layer can be altered by changing whether the moments of the ferromagnetic ayers are parallel or antiparallel

- **GMR Sensor Applications**

1. **Proximity Detection**

A magnetic field sensor can directly sense a magnetic field from a permanent magnetic, an electromagnet, or a current. In sensing the presence of a ferrous object, a biasing magnet is often used. The biasing magnet magnetizes the ferromagnetic object such as a gear tooth, and the sensor detects the combined magnetic fields from the magnetized object and the biasing magnet. A biasing magnet is affixed to the sensor in a position such that its direct influence on the sensor is minimal. Usually the biasing magnet is mounted on the top of the sensor with its magnetic axis perpendicular to the sensitive axis of the sensor. The biasing magnet can be centered such that there is little or no field in the sensitive direction of the sensor. In this way a reasonable large biasing magnet can be used. Occasionally a spacer is used between the sensor and the magnet to reduce the field at the sensor and, therefore, reduce how critically the magnet must be positioned.

2. **Displacement Sensing**

GMR bridge sensors can be effectively employed to provide position information from small displacements associated with actuating components in machinery, proximity detectors, and linear position transducers.

Due to the nonlinear characteristic of dipole magnetic fields produced by permanent magnets, the range of linear output may be limited. Figure 26 shows the position and motion of two sensors with differing sensitive axis directions relative to a cylindrical permanent magnet.

The sensitive axis of the sensor is indicated by the double headed arrow on each sensor. The rate of change of the component of the magnetic field along the sensitive axis for each sensor is shown superimposed on the line of motion. Note that the field for the lower sensor changes direction and is negative in the center and positive at both ends.

3. Rotational Reference Detection

GMR sensors offer a rugged, low cost solution to rotational reference detection. High sensitivity and dc operation afford the GMR bridge sensor an advantage over inductive sensors which have very low outputs at low frequencies and can generate large noise signals when subjected to high frequency vibrations. GMR sensors are field sensors and does not measure the induced signal from the time rate of change of fields, as do variable reluctance sensors. The output from a GMR bridge sensor will have a minimum when the sensor is centered over a tooth.

4. Current Sensing

Currents in wires create magnetic fields surrounding the wires or traces on printed wiring boards. The field decreases as the reciprocal of the distance from the wire. GMR bridge sensors can be effectively employed to sense this magnetic field. Both dc and ac currents can be detected in this manner. Bipolar ac current will be rectified by the sensors omnipolar sensitivity unless a method is used to bias the sensor away from zero. Unipolar and pulsed currents can be measured with good reproduction of fast rise time components due to the excellent high frequency response of the sensors.

Since the films are extremely thin, response to frequencies up to 100 megahertz is possible. The sensor can also be mounted immediately over a current carrying trace on a circuit board. High currents may require more separation between the sensor and the wire to keep the field within the sensor's range.

CHAPTER THREE
MAGNETIC FIELD DETECTOR CIRCUIT

3.1 Overview

In this chapter we will explain the design of magnetic field detector circuit, its functions and the use of it. This chapter also contains a brief explanation about the circuit and the components to be used.

3.2 Introduction

The circuit uses an incandescent lamp to detect a magnetic field. With the magnetic source exposed to air, a constant current source is used to slightly heat the filament. As it is heated, the resistance increases. As magnetic field over the filament it cools down, thus lowering its resistance. A comparator is used to detect this difference and light an LED.

3.3 Schematic

The schematic shown below shows the magnetic field detector.

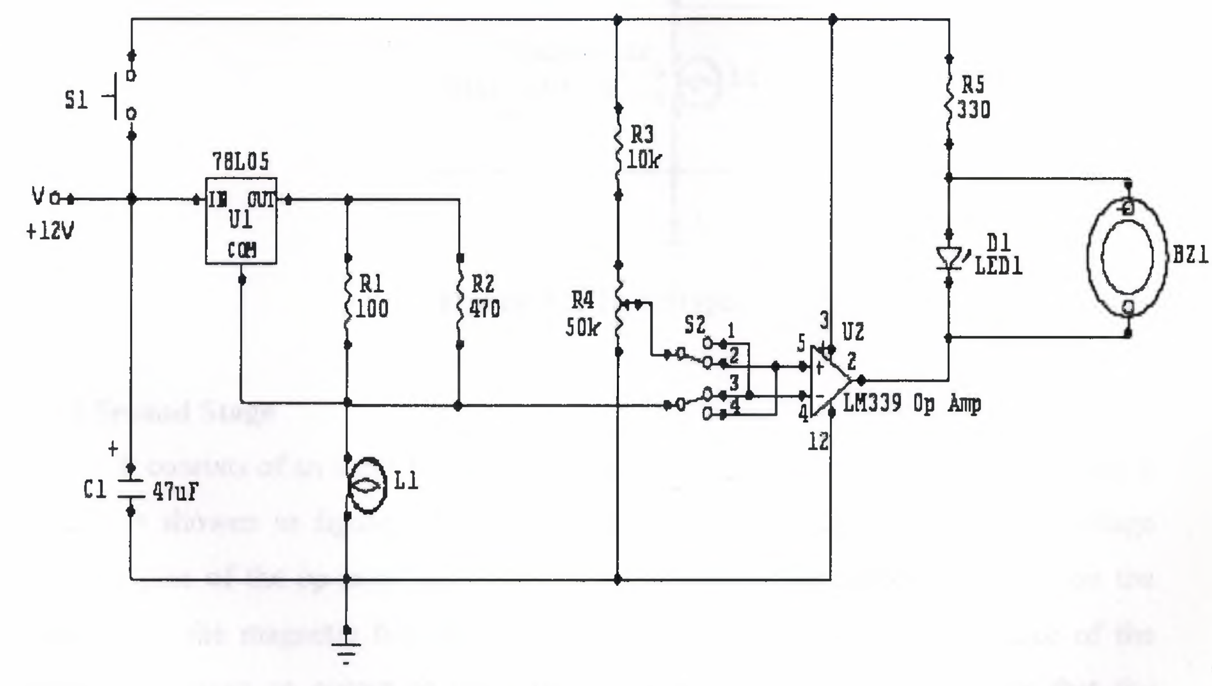


Figure 3.1: Magnetic field detector.

3.4 Working principles and the description of the stages used.

We divide the circuit into two stages:

3.4.1 First Stage

The first stage contains a fixed current supply that is composed of 78L05 voltage regulator and 2 resistance to heat the filament and increase its resistance.

The regulator supplies approximately 54.1 mA. This current keeps the filament hot to keep the resistance increased and fixed to the desired value.

The open circuit resistance of the filament without any magnetic field is approximately 11.4 Ohm. When the current is applied, the resistance increases to 24 ohm and oscillates between these values depending on the magnetic field.

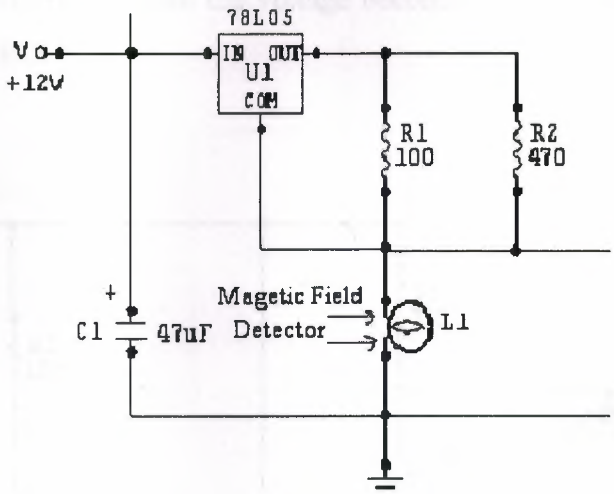


Figure 3.2: First Stage.

3.4.2 Second Stage

It consists of an amplifier, a potentiometer, two resistors 1 LED, 1 buzzer and 1 switch as showen in figure 3.3. The potentiometer allows us to change the voltage between pins of the op-amp (pin4-5), so we can change the output depending on the intensity of the magnetic field.When the magnetic field changes this balance of the comparator gives an output to drive the led and the buzzer and indicates that the magnetic field has increased or decreased.

The switch S2 is used to change inputs of pins 4-5 (inverting – non inverting) of the op-amp U2. This reverses the output, i.e. we get output when there is no magnetic field.

Shortly if pins 2-3 of S2 are connected to pins 5(+), 4(-) of U2 we get output when there is magnetic field. If we connect pins 1-4 of S2 to pins 4(+), 5(-) of U2 we get output when there is no magnetic field. This is caused by the voltage difference between pins 4-5 of U2.The measurements shows that.

At the steady state:

Approximately -0.350 and 0.350 the circuit can response to normal breath of a human being (pins 2-3 of S2 are connected to pins 5(+), 4(-) of U2 or 0.350 when pins 1-4 of S2 to pins 4(+), 5(-) of U2). (This can be adjusted to higher intensity of magnetic field by R4).In the first state the applied magnetic field can cause a difference that changes it to a maximum value 0.350 depending on the intensity. In the second state it oscillates between 0.350,-0.350.Briefly when the voltage becomes 0V the circuit begins to drive the buzzer and the LED.

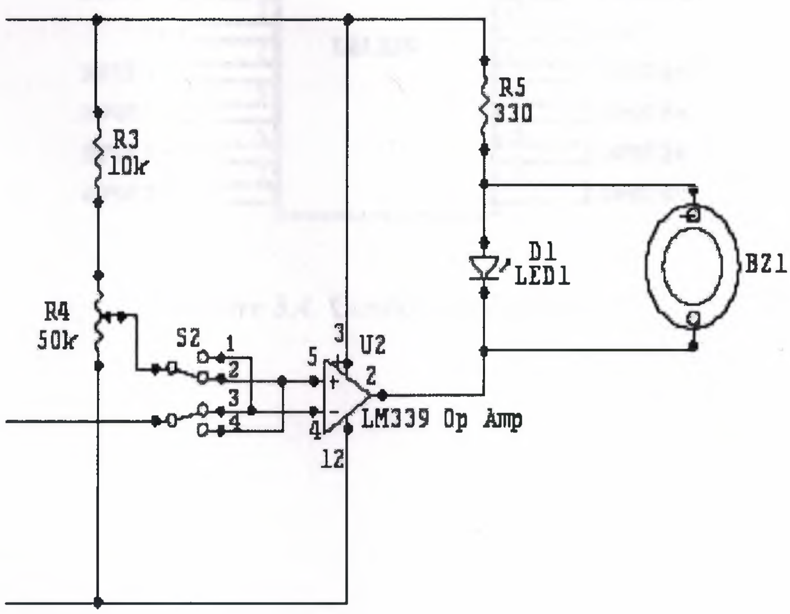


Figure 3.3: Second Stage.

3.5 Low Power Quad Voltage Comparators (LM339)

The LM339 device is a monolithic quad of independently functioning comparator designed to meet the needs for a medium speed, TTL compatible comparator for industrial applications. Since no antisaturation clamps are used on the output such as a Baker clamp or other active circuitry, the output leakage current in the OFF state is typically 0.5 nA. This makes the device ideal for system applications where it is desired to switch a node to ground while leaving it totally unaffected in the OFF state. Other features include single supply, low voltage operation with an input common mode range from ground up to approximately one volt below VCC. The output is an uncommitted collector so it may be used with a pull-up resistor and a separate output supply to give switching levels from any voltage up to 36V down to a VCE SAT above ground (approx. 100 mV), sinking currents up to 15 mA. In addition it may be used as a single pole switch to ground, leaving the switched node unaffected while in the OFF state. Power dissipation with all four comparators in the OFF state is typically 4 Mw from a single 5V supply (1 mW/comparator) [6].

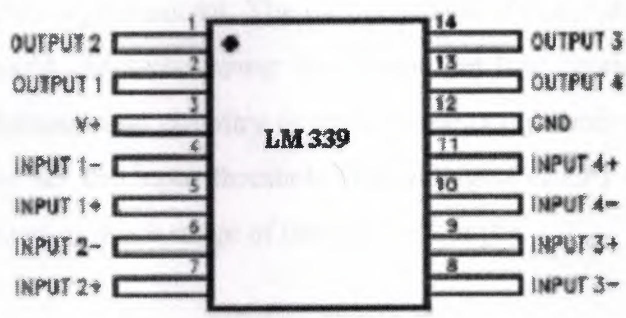


Figure 3.4: Connection diagram .

The amplifier is an op-amp and a part of the IC LM339 shown in figure 3.5. It is used as a comparator.

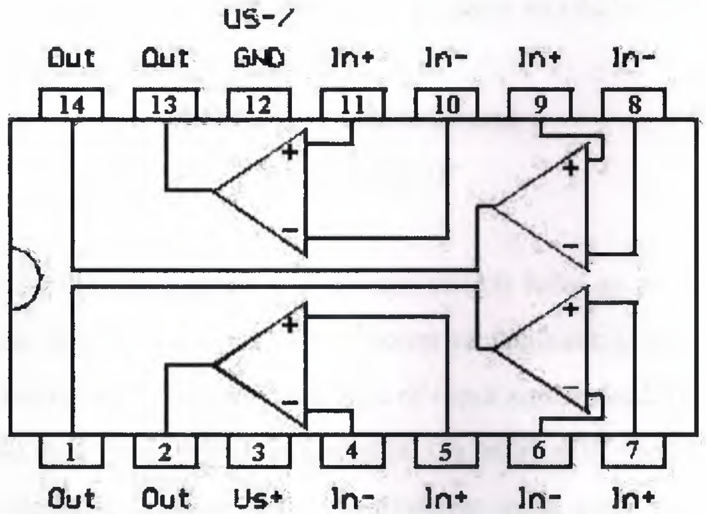


Figure 3.5: The IC LM339[6].

3.5.1 Comparator Circuits

Figure 3.6 shows a basic comparator circuit for converting low level analog signals to a high level digital output. The output pull-up resistor should be chosen high enough so as to avoid excessive power dissipation yet low enough to supply enough drive to switch whatever load circuitry is used on the comparator output. Resistors R1 and R2 are used to set the input threshold trip voltage (VREF) at any value desired within the input common mode range of the comparator [6].

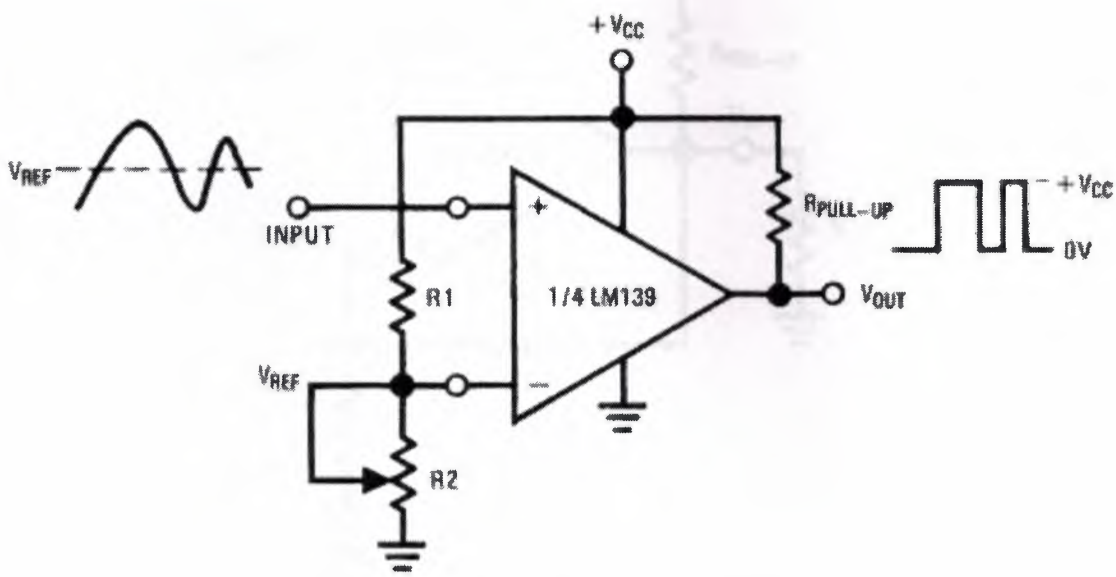


Figure 3.6: Basic comparator circuit [6].

3.5.2 Comparators with Hysteresis

Figure 3.7 shows a comparator with a small amount of positive feedback. In order to insure proper comparator action, the components should be chosen as follows:

$$RPULL\text{-}UP < RLOAD \text{ and}$$
$$R1 > RPULL\text{-}UP$$

This will insure that the comparator will always switch fully up to +VCC and not be pulled down by the load or feedback. The amount of feedback is chosen arbitrarily to insure proper switching with the particular type of input signal used. If the output swing is 5V, for example, and it is desired to feedback 1% or 50 mV, then R1 ≈ 100 R2. To describe circuit operation, assume that the inverting input goes above the reference input (VIN > VREF). This will drive the output, VO, towards ground which in turn pulls VREF down through R1. Since VREF is actually the non-inverting input to the comparator; it too will drive the output towards ground insuring the fastest possible switching time regardless of how slow the input moves. If the input then travels down to VREF, the same procedure will occur only in the opposite direction insuring that the output will be driven hard towards +VCC [6].

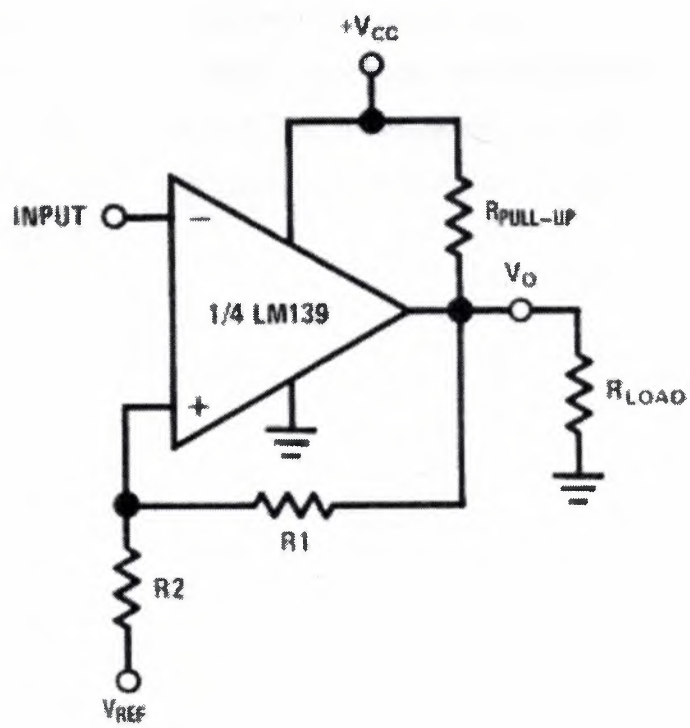


Figure 3.7: Comparator with hysteresis [6].

3.6 IC Voltage Regulators (78L05)

Voltage regulators comprise a class of widely used ICs. Regulators IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in single IC. Although the internal construction of the IC is somewhat different from that described for discrete voltage regulator circuit, the external operation is much the same. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage.

A power supply can be build using a transformer connected to the ac supply line to step the ac voltage to desired amplitude, then rectifying that ac voltage, filtering with a capacitor and RC filter, if desired, and finally regulating the dc voltage using an IC regulator. The regulators can be selected for operation with load currents from hundreds of milliamperes to tens of amperes, corresponding to power ratings from milliwatts to tens of watts.

3.6.1 Three-Terminal Voltage Regulators

Figure 3.8 shows the basic connection of a three – terminal voltage regulator IC to a load. The fixed voltage regulator has an unregulated dc input voltage, Vi, applied to one input terminal, a regulated output dc voltage, Vo, from a second terminal, with the third terminal connected to ground. For a selected regulator, IC device specifications list a voltage range over which the input voltage can vary to maintain a regulated output voltage over a range of load current. The specifications also list the amount of output voltage change resulting from a change in load current (load regulation) or in input voltage (line regulation).

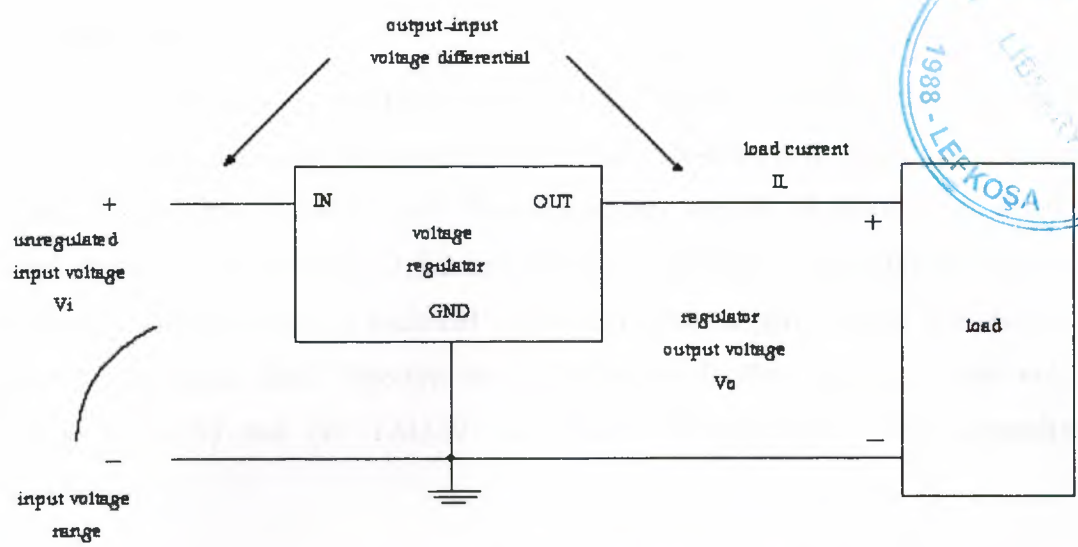


Figure 3.8: Block representation of three-terminal voltage regulator [7].

3.7 Components Used in Magnetic Field Detector

The components used in the magnetic field detector circuit are listed below:

Table 3.1: Components list.

Symbol of the component	Value and description
R1	100 Ohm 1/4W Resistor.
R2	470 Ohm 1/4W Resistor.
R3	10k 1/4W Resistor.
R4	50K 1/4W Resistor.
R5	330 1/4W Resistor.
C1	47uF Electro lytic Capacitor.
U1	78L05 Voltage Regulator (Used as a fixed current source)
U2	LM339 Op Amp (Used as a comparator).
L1	Magnetic switch (Rood relay).
D1	LED.
BZ1	Buzzer.
S2	S2 SPST miniature toggle type switch.
S1	Pushbutton switch.
Battery	8×1.5 V AA size battery.
Miscellaneous	Board, Wire, Sockets for ICs.

3.8 Summary

In this chapter the magnetic field Detector circuit was presented. Also in this chapter we have explained the two stages of the circuit and the diagram of the first and second circuits also showed. And the components for all of them were listed on Table1.Working principles of U2, S2 and behavior of the circuit are explained in details. Some experimental data are included in the explanation part. Figure 3.9 shows the design of magnetic field Detector circuit on a board. Data sheets for the voltage regulator (78L05) and (IC LM339) are shown in appendix 1 and appendix 2 respectively.

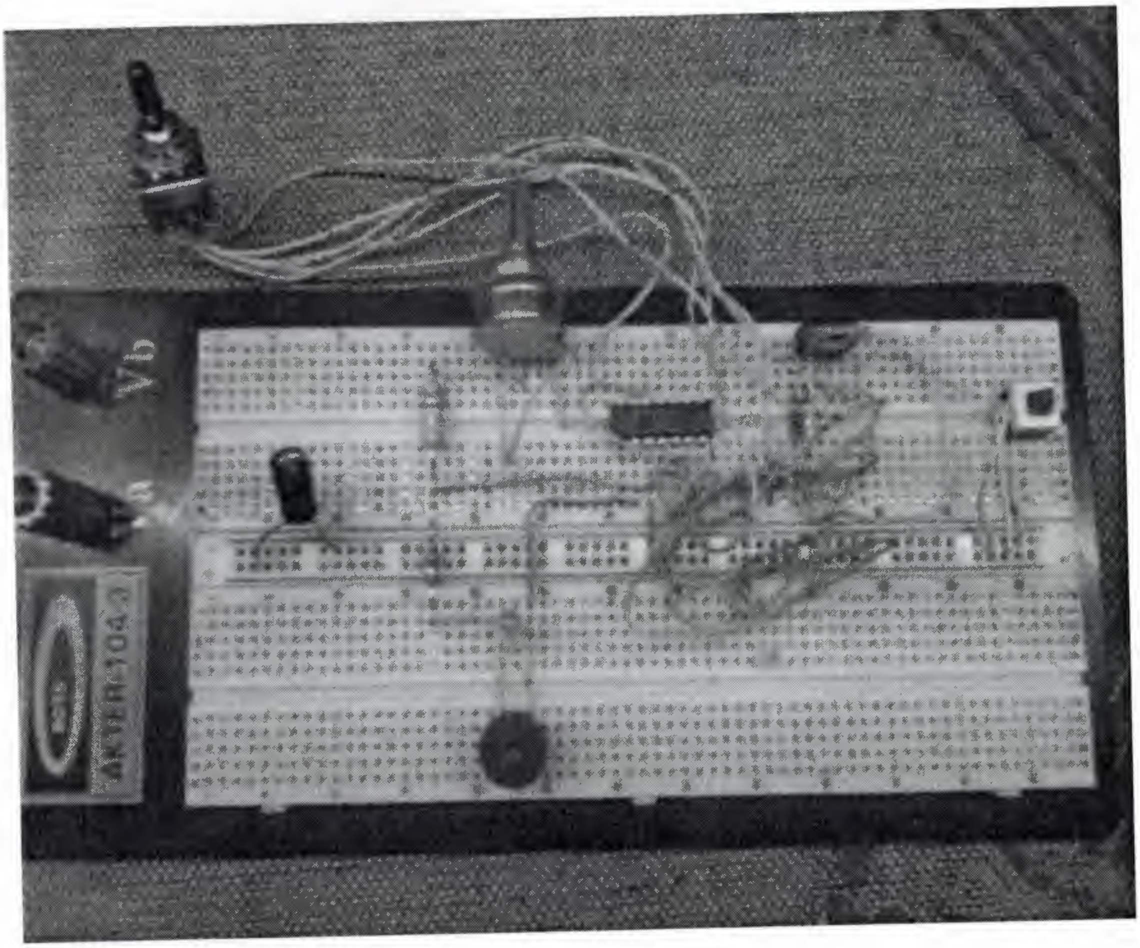


Figure 3.9: Magnetic Field Detector project photograph.

CONCLUSION

We could build the magnetic field Detector circuit combining the analog components, analog components such as resistors, capacitors and voltage regulator, also, we used an IC like the operational amplifier used as a comparator and the circuit uses an incandescent lamp to detect airflow in the input and a Buzzer on the output stage.

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

- To design and build a magnetic field detector.
- To gain hands on experience in electronic hardware project
- To suggest potential real-life use of magnetic field sensors.
- How to use the electronic parts description book

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