NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Electrical and Electronic Engineering

Moisture Detector

Graduation Project
EE400

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ABSTRACT

As can be seen nowadays developing technologies are going so fast and as it can be seen every home has a garden so it should have a system that detects the humidity level of the soil of the garden, such system called moisture detector.

Moisture Detectors are used as Automatic Irrigation Systems mostly; moisture detectors or automatic irrigation systems have been designed to give an alarm to the mankind of humidity in a soil in order to remind the mankind that the soil is wet enough.

Moisture detector (Automatic irrigation system) is equipment which gives alarm (sound) whenever the humidity level in a soil is dry or less..

This project presents the design and construction of moisture detector circuit. The system indicates the humidity level in a soil by sounding an alarm if the soil is dried.

INTRODUCTION

Moisture detectors are considered essential in numerous fields. In this project we are going to design, build, test and demonstrate moisture detector. We will go on starting with explaining how it works, where it can be used and develop to get the best results.

The first chapter of this project is the equipments chapter which include electronic components that are used in this project with some explanation about there functionality and characteristic. Safety guideline will be introduced specially when dealing with electronic parts to avoid any accidents such as burning or breaking components.

The second chapter will discuss moisture detectors, the principle behind their operation, and many applications that demonstrate the main idea of moisture detectors.

The third chapter is basically the core of the project and the most important chapter, which explains the hardware part of the project in details, how to develop it, how does it work and even what are the input and output voltage values. The chapter also includes the circuit diagrams of moisture detector, the diagram of the first and second part of the circuit will also be shown.

The fourth chapter is the last chapter which will mainly contains the modifications that will be done in the circuit to make it more reliable and handy, the problems that we would have and the solutions that will accomplished.

The aim of this project is to design and build moister detector and to gain enough experience with electrical components while working in this project, also to get innovative by modifying the circuit.

CHAPTER ONE

ELECTRONIC COMPONENTS

1.1 Overview

This chapter includes an introduction to electronic components that are commonly used in hardware projects such as resistors, capacitors and semiconductors. Also this chapter includes some safety guidelines for electronic projects.

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 such as protons and neutrons, but it is the electrons which will be interested in.

Electrons and protons have electrical property of charge. Protons have positive charges and electrons have negative charges and they normally balance each other out. It is 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 occurs when they all move together in one particular direction.

Electrons cannot flow through every material. Materials that allow current to flow easily are called conductors. Materials that do not 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. Solder makes the actual join between the leg of the component and the track.

The material the PCB (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 should not.

A battery supplies the 'force' that makes the electrons move. This force is called the voltage. The bigger the voltage the more force there are.

Currents are measured in Amps, and voltages are measured in Volts, (which named after the scientists Ampere and Volta). Voltages are sometimes called potential differences, or electromotive forces, but we will not 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.

Imagining 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.

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 [1].

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 do not 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 (Ω).

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 coloured 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 is damaged. Resistors can dissipate about a 1/4 Watt of heat .It is 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 [1].

Real resistances vary over an enormous range. For example, in 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:

20R = 20 ohms
20k = 20 kilo ohms = 20,000 ohms
5k5 = 5.5 kilo ohms = 5,500 ohms

1.2.1.1 Fixed Value Resistors

During manufacturing, 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.

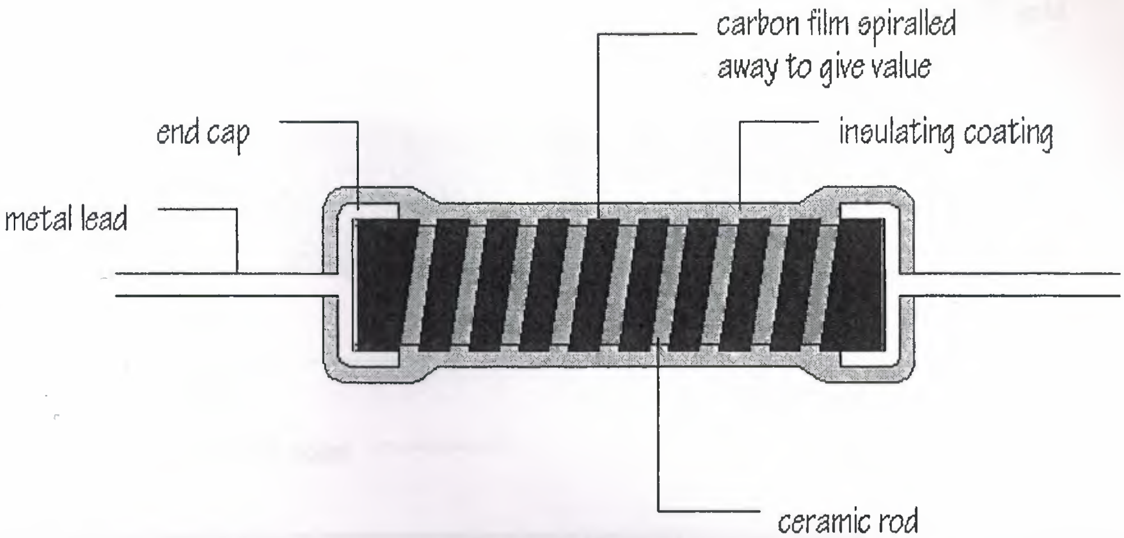


Figure 1.1: The diagram shows the construction of a carbon film resistor [1].

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 MultiMate's, 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.

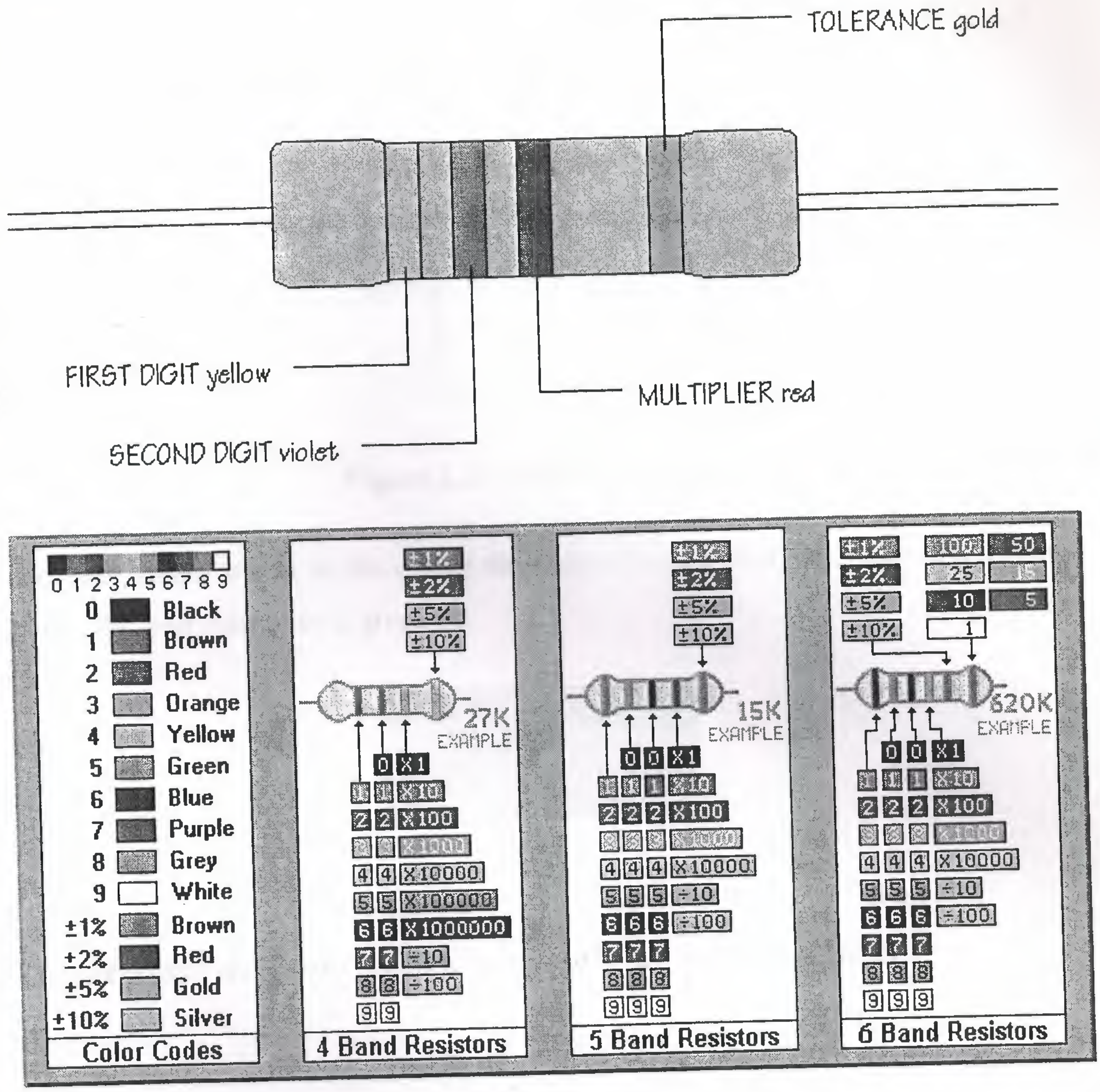


Figure 1.2: Color code identification [1].

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, and 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].

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:

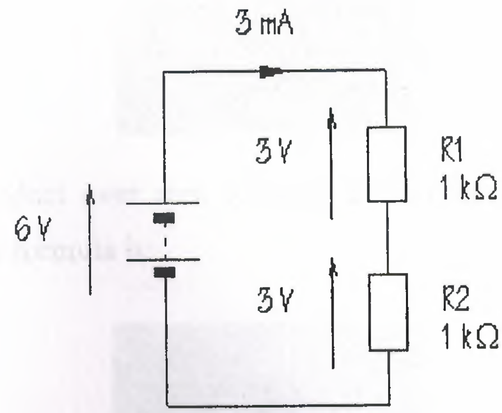


Figure 1.3: Resistors in series.

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

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

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

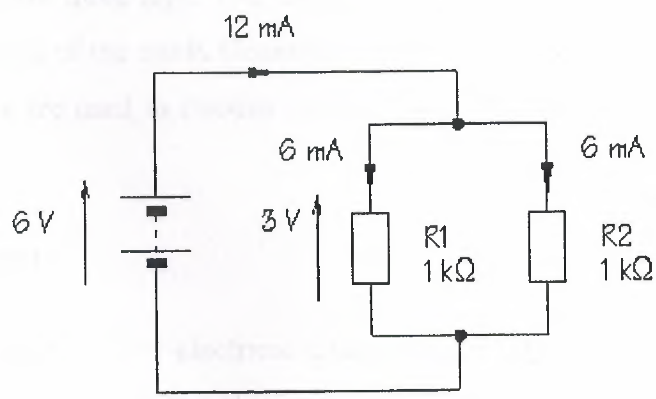


Figure 1.4: Resistors in parallel.

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].

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.

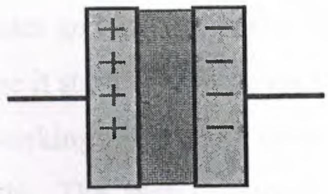


Figure 1.5: Capacitor contains

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) [1].

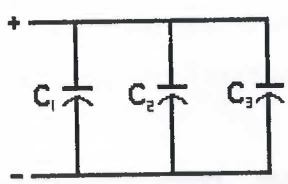
Capacitors come in two types, electrolytic and non-electrolytic. Electrolytic capacitors use a special liquid or paste which is formed into a very thin dielectric in the factory. Non-electrolytic capacitors have ordinary dielectrics.

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 will not 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. For Example, 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.

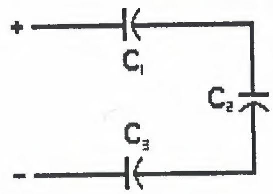
If a capacitor is shorted then it discharges. Charge flows out of the capacitor rapidly at first, then progressively more slowly. The last little drop just trickles out. The speed at which the capacitor empties depends on the resistance that connects across it. If a simple wire shorts out a capacitor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



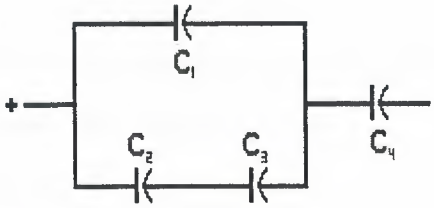
$$C = C_1 + C_2 + C_3$$

Capacitors in parallel



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

Capacitors in series



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

Capacitors in series and parallel

Figure 1.6: Capacitors wiring [2].

1.2.3 Semiconductors

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 behaviours 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 neighbouring electrons, but it appears as if holes are moving.

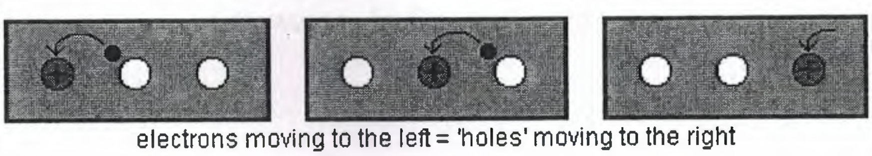


Figure 1.7: Moving of electrons.

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).

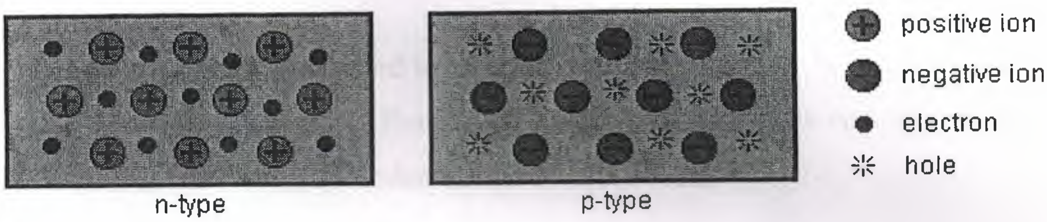


Figure 1.8: The tow types of semiconductors.

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 [8].

Transistors work in two ways. They can work as switches (turning currents on and off) and as amplifiers (making currents bigger). We will 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 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 cannot 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 we 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.)

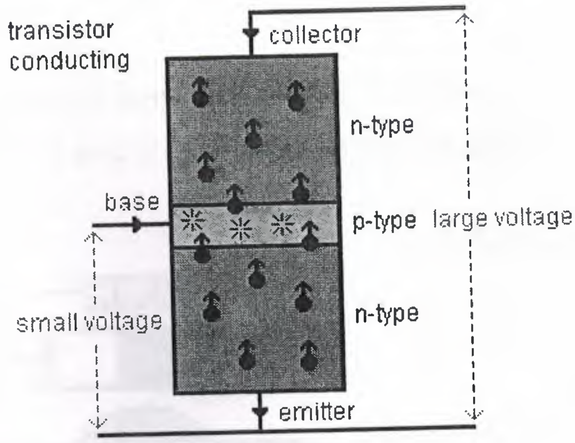
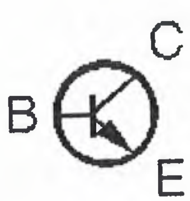


Figure1.9: Transistor conducting.

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.

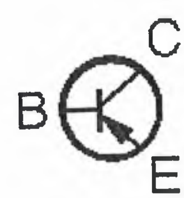


Figure 1.10: The difference between PNP and NPN transistors.

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.

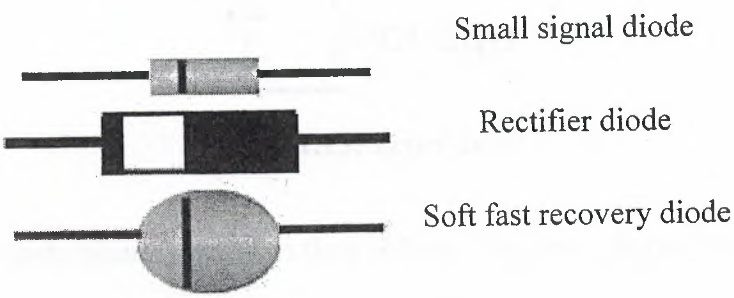


Figure 1.11: The picture shows three types of diodes [4].

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:

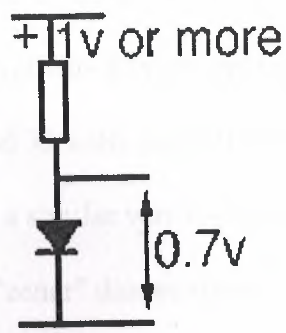


Figure 1.12: A diode forward voltage drop.

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.

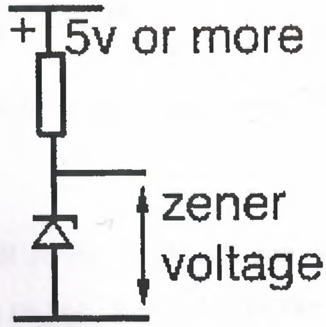


Figure 1.13: Zener diode

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.

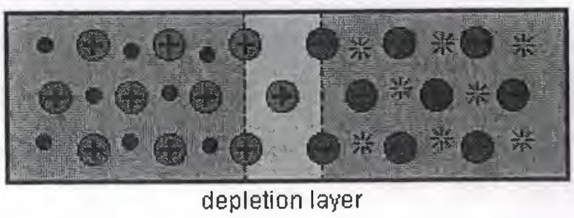


Figure 1.14: Depletion layer.

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.

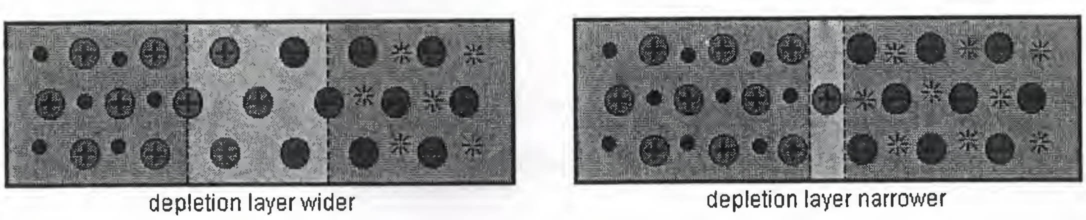


Figure 1.15: Reducing the depletion layer.

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.

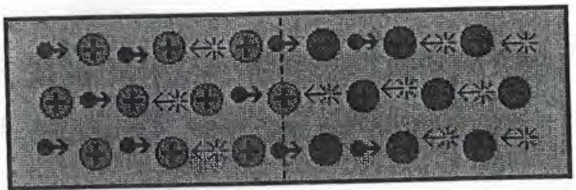


Figure 1.16: Diode conducting.

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 colour 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 LM380N

The LM380N is a power audio amplifier for consumer application, in order to hold system cost to a minimum, gain is internally fixed at 34 dB.

A unique input stage allows inputs to be ground referenced. The output is automatically self centering to one half the supply voltages; the output is short circuit proof with internal thermal limiting.

The package outline is standard dual-in-line. A copper lead frame is used with the center three pins on either side comprising a heat sink. This makes the device easy to use in standard p-c layout.

Uses include simple phonograph amplifiers, intercoms, line drivers, teaching machine outputs, alarms, ultrasonic drivers, TV sound systems, AM-FM radio, small servo drivers, and power converters.

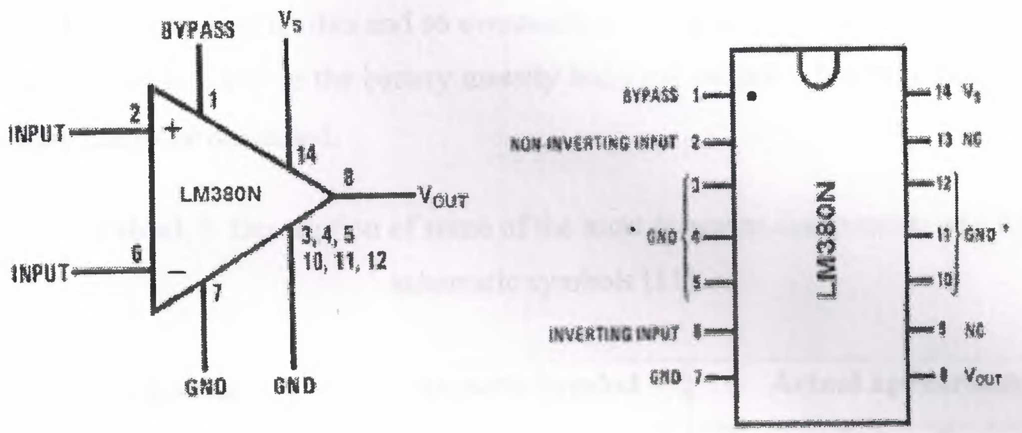


Figure 1.17: IC_LM380N form

1.2.4 Batteries

Battery is electric device that converts chemical energy into electrical energy, consisting of a group of electric cells that are connected to act as a source of direct current.

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.

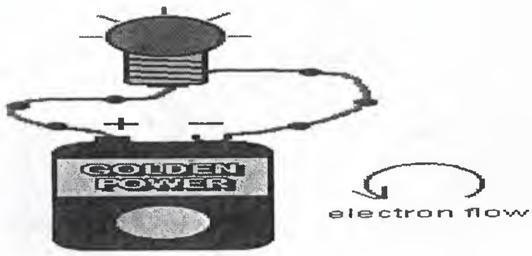
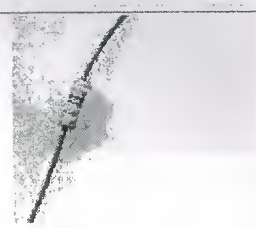
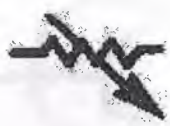
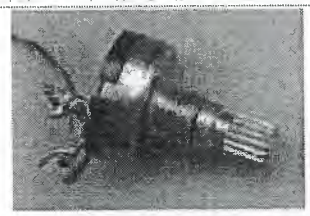
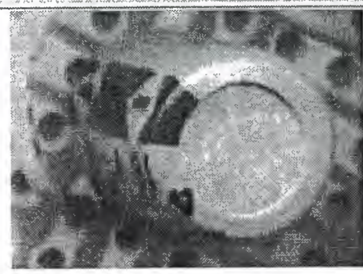
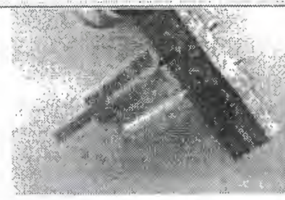
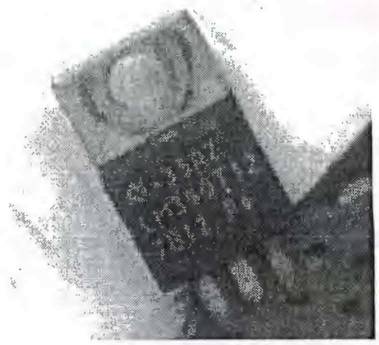


Figure 1.18: Battery

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.

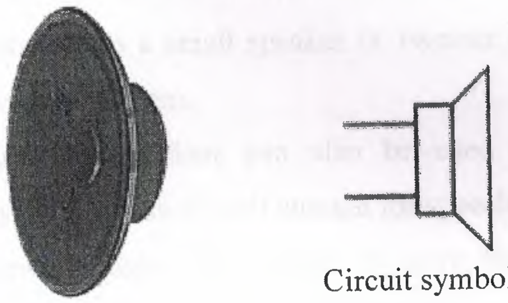
Table1.1: Description of some of the most common components and their schematic symbols [11].

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		

1.2.5 Loudspeakers

Loudspeakers are output transducers which convert an electrical signal to sound. Usually they are called 'speakers'. They require a driver circuit, such as a 555 stable or an audio amplifier, to provide a signal. There is a wide range available, but for many electronics projects a 300mW miniature loudspeaker is ideal. This type is about 70mm diameter and it is usually available with resistances of 8Ω and 64Ω. If a project specifies a 64Ω speaker you must use this higher resistance to prevent damage to the driving circuit, a circuit symbol, and a photograph are shown in Figure 1.13.



Circuit symbol

Photograph of a loudspeaker

Figure 1.13

Most circuits used to drive loudspeakers produce an audio (AC) signal which is combined with a constant DC signal. The DC will make a large current flow through the speaker due to its low resistance, possibly damaging both the speaker and the driving circuit.

To prevent this happening a large value electrolytic capacitor is connected in series with the speaker, this blocks DC but passes audio (AC) signals. See capacitor coupling shown in Figure 1.14.

Loudspeakers may be connected either way round except in stereo circuits when the (+) and (-) markings on their terminals must be observed to ensure the two speakers are in phase.

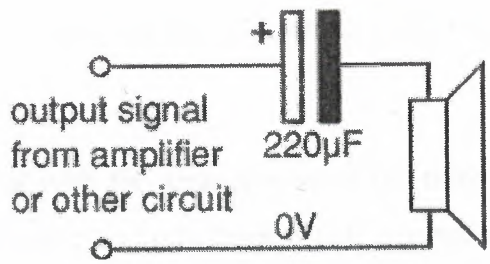


Figure 1.14 Capacitor in series to block DC

Correct polarity must always be observed for large speakers in cabinets because the cabinet may contain a small circuit (a 'crossover network') which diverts the high frequency signals to a small speaker (a 'tweeter') because the large main speaker is poor at reproducing them.

Miniature loudspeakers can also be used as a microphone and they work surprisingly well, certainly well enough for speech in an intercom system for example

A somewhat higher impedance of more than 80 ohms does not seem to be available. Except where noted otherwise, the use of the low impedance loud speaker such as 8 ohms type is not recommended.

Loudspeakers should be treated carefully since the diaphragm is easily damaged, and you should always hold a loudspeaker by magnet housing at the rear of the component.

1.3 Safety Guidelines

1-We have to be careful with the polarities of the power source (battery) when we connect it in any circuit.

2- We have to read and apply the data sheet of any electrical instrument before use it in the circuit.

3-We have to be careful with electrical components (capacitors, resistors and lads) not to be broken them.

4- We have to be careful with chip pins (IC380N) when we plant them in the board not to be broken them.

5- We have to be careful with the arrangement of the transistor pins (base, emitter, and collector) not to be broken and mix them which cause damage the transistor.

6- We have to discharge capacitors in equipment before working on the circuits, because large capacitors found in many laser flash lamps and other systems are capable of storing lethal amounts of electrical energy and pose a serious danger even if the power source has been disconnected.

7- We have to be careful when shifting probes in a live/active circuit, be sure to shift using only one hand: It is best to keep the other hand off other surfaces and behind your back.

8- If you are working on a design project and you plan to work with voltages equal to or above 50 volts, notify your instructor and obtain their approval before proceeding.

9- We have to be careful with the power source to turn it off after we finished using it.

1.4 Summary

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

CHAPTER TWO

MOISTURE DETECTOR APPLICATIONS

2.1 Overview

This chapter gives an introductory to moister detectors and principle behind their operation, also provides some applications showing moister detectors being used in soil and building using deferent techniques.

2.2 Introduction to Moisture Detector

Moisture detector has many applications in our daily live also in our homes, when moisture enters our home, it causes many problems on our health and huge defects on the home's walls, to detect the moisture in walls we can use wall moisture detector which is a electronic meter measure, the moisture content via an electrical resistance test in the wall.

One important application of moisture detector is to detect the moisture in the soil which is very essential application to farmers, because they can know by soil moisture detector if the plants need watering or not. In other words it can help them obtain economically irrigation system.

Tensiometer is one of the most famous soil moisture detectors; tensiometer is a water filled plastic tube with hollow ceramic tips attached on one end and a vacuum gauge and airtight seal on the other.

This device should be installed at the desired depth in the soil with the ceramic tip in good contact with soil particles to detect the moisture in the soil or to know whether the soil is moisten or dry.

2.3 Moisture Definition

Moisture has several definitions from different points that define and give a general description to it. Some of those definitions are:

- Water or other liquid causing a slight wetness or dampness.
- The amount of water held in soil against the pull of gravity.
- Wetness caused by water.
- Small amount of liquid that causes wetness.
- Water in the liquid or vapor phase.

2.4 Moisture Detector Applications

2.4.1 Soil Moisture

Soil moisture is difficult to define because it means different things in different disciplines. For example, a farmer's concept of soil moisture is different from that of a water resource manager or a weather forecaster. Generally, however, soil moisture is the water that is held in the spaces between soil particles.

Surface soil moisture is the water that is in the upper 10 cm of soil, whereas root zone soil moisture is the water that is available to plants, which is generally considered to be in the upper 200 cm of soil [5].

Figure 2.1: Soil Sample [5]

2.4.1.1 Importance of Soil Moisture

Compared to other components of the hydrologic cycle, the volume of soil moisture is small; nonetheless, it's of fundamental importance to many hydrological, biological and biogeochemical processes.

Soil moisture information is valuable to a wide range of government agencies and private companies concerned with weather and climate, runoff potential and flood control, soil erosion and slope failure, reservoir management, geotechnical engineering, and water quality.

Soil moisture is a key variable in controlling the exchange of water and heat energy between the land surface and the atmosphere through evaporation and plant transpiration.

As a result, soil moisture plays an important role in the development of weather patterns and the production of precipitation.

Simulations with numerical weather prediction models have shown that improved characterization of surface soil moisture, vegetation, and temperature can lead to significant forecast improvements.

Soil moisture also strongly affects the amount of precipitation that runs off into nearby streams and rivers.

Large-scale dry or wet surface regions have been observed to impart positive feedback on subsequent precipitation patterns, such as in the extreme conditions over the central U.S. during the 1988 drought and the 1993 floods.

Soil moisture information can be used for reservoir management, early warning of droughts, irrigation scheduling, and crop yield forecasting [5].

2.4.1.2 Soil Moisture Methods and its Detectors

Soil moisture measured in two very distinctly different methods-quantitatively, which means by amount, and qualitatively, which is an indication of how tightly the water is held by the soil particles.

A- Quantitative Methods

- Gravimetric soil sampling
- Neutron scatter
- Di-electric constant

Each of these methods can provide the user a quantitative soil moisture value usually in inches of water per foot of soil. Multiple measurements can be made in the root zone, typically in one-foot increment.

Adding up each individual depth readings will provide the total moisture content of the root zone. By comparing the total root zone content of data one to that of a subsequent date, the amount of moisture depletion or recharge in inches can be determined.

I- Gravimetric Soil Sampling

The gravimetric method is a direct absolute technique for estimating the total (both available and unavailable) water content of soil. The method involves drying a soil sample in an oven (150C) to determine the amount of water in the soil (by subtracting the oven-dry weight from the initial field soil weight). The weight of the water is then divided by the oven-dry soil weight to obtain the water content by weight (g/g),if a specific volume of soil is used, the volumetric water content can be determined.

This method is time consuming, labor-intensive, and requires sampling equipment, weighing scale and an oven. A large number of samples must be taken to overcome the inherent spatial variability of soils and water content, since this method is destructive, samples cannot be taken from exactly the same point on subsequent sampling dates. This method is commonly used to calibrate indirect methods such as neutron probe or di-electric constant methods [6].

II- Neutron Scatter

The neutron scatter device, often referred to as neutron probe, measures total soil water content if properly calibrated by gravimetric sample. This method estimates the amount of water in a volume of soil by measuring the amount of hydrogen in the measurement area, by far the largest hydrogen-containing compound in soils is water.

The probe supplies a source of fast, high-energy neutrons and a detector housed in a unit, which is lowered into an access tube installed in the soil. The probe is to make readings throughout the root zone.

Fast neutrons emitted from the source pass through the access tube into the surrounding soil gradually lose energy through collisions with other atoms. Hydrogen molecules in the soil are most effective in slowing the fast neutrons since they are nearly equal in mass. As a result of the collisions, a cloud of slow or thermolized neutrons is produced. The detector contained in the probe unit measures this cloud. The size and density of the cloud depends mainly on soil type, access tube material and soil water content.

Generally the measurement size is a 6 to 12 –inch spherical shape. The number of slow neutrons counted in a specific interval of time is linearly related to the total volumetric soil water content.

Calibration or the relationship of the neutron count to volumetric water content is necessary when using different access tube materials. Steel electrical metal conduit, PVC and aluminum are the most common materials used. Calibration should also be developed for soils high in organic matter and some ions such as boron.

The neutron probe allows a rapid and repeatable measurement of soil water content to be made at several depths and locations within a field. The ability to repeat measurement at the same location minimizes the effects of soil variability. When calibrated, neutron probe are considered among the most accurate methods for measuring total soil water content.

Neutron probe access wells should be installed at least to the vine rooting depth. The neutron probe is inaccurate when measuring the top 8 inches of soil because portions of the neutrons escape.

III- Di-electric Constant Methods

The di-electric constant methods seek to measure the capacity of a nonconductor (soil) to transmit high frequency electro-magnetic waves or pulses when inserted into the soil, the resultant values are related through calibration to soil moisture content.

The basis for use of this instrument is that dry soil has di-electric values is near 2 to 5 and that of water is 80 when measured between 30 MHz and 1 GHz.

Two approaches have been developed for measuring the di-electric constant of the soil water media and estimating the soil volumetric water constant [6].

- Time domain reflectometry (TDR)

- Frequency domain reflectometry (FDR)

Both TDR and FDR do not use a radioactive source reducing cost of licensing, training, monitoring when compared to neutron probe.

I- Time Domain Reflectometry (TDR)

The TDR device propagates a high–frequency transverse electromagnetic wave along a cable attached to parallel conducting probe inserted into the soil. The signal is reflected from one probe to the other, then back to the meter, which measures the time between sending the pulse and receiving can be computed. The faster the propagation velocity, the lower the di-electric constant, and thus lower soil moisture.

Waveguides are usually a pair of stainless steel rods, which are inserted into the soil a few inches apart. The measurement is the average volumetric water content along the length of the waveguide if so calibrated.

Waveguides are installed from the surface to a maximum depth of usually 18-24 inches. Pairs of rods can be permanently installed to provide water constant at different depths. If deeper measurements are needed, a pit is usually dug which the waveguides are inserted into the undisturbed pit wall. The soil disruption can change water movement and water extraction patterns, resulting in erroneous data.

The TDR technique is highly accurate. Since surface measurements can be made easily and in multiple sites, it works well for shallow rooted crops.

II- Frequency Domain Reflectometry (FDR)

This approach uses radio frequency waves (RF) to measure soil capacitance. The soil acts as the di-electric completing a capacitance circuit, which is part of a feedback loop of a high frequency transistor oscillator. The frequency varies between manufacturers but is generally near 150 MHz.

The soil capacitance is related to the di-electric constant by the geometry of the electric field content as discussed in the TDR method. Two distinct types of instruments use the FDR techniques, an access tube method and a hand-held push probe.

An access tube of PVC material is used similar to the neutron probe in that the electrodes are lowered into the access well and measurements are taken at various depths, it is necessary to ensure a very close fit between the walls of the access tube and the soil to ensure reliable values, air gaps affect the travel of the signal into the soil. Calibration to soil volumetric water content is required (especially in clayey soils and those with high bulk densities) to ensure accurate values, if properly calibrated and installed, the probe `s accuracy can be good.

Many of the same advantages of the neutron probe are available with this system including rapid measurements at the same locations and depths over time.

Another variant of this technology is the use of a permanent installation, which reads multiple depths. These are in conjunction with electronics to make frequent cost low for an array of four sites in a field.

The other type of capacitance device is a hand-push probe, which allows rapid, easy and near surface readings, These probe provide a qualitative measurement of soil water content on a scale from 1-100 with high readings equaling higher soil moisture content.

Probe use in drier soils and those containing stones or hard pans is difficult, deeper measurements are possible using a soil auger to gain access to deeper parts of the root zone; the probe is best used in shallow rooted crops.

B- Qualitative Methods

- tensiometer
- porous blocks

These methods measure how tightly (measured in tension units) the soil moisture is held by soil particles.

Soil water tension, soil water suction or soil water potential is all terms describing the energy status of soil water.

As the tension increases water extraction becomes more difficult for the plant, the relationship between soil tension and soil moisture content is not linear and is often different in each soil and can vary by depth. Therefore, these qualitative methods are used to determine the status of plant water availability not a quantity of water contained in the soil.

Qualitative measurement of soil moisture have often been called a measurement of soil moisture have often been called a measurement that indicates when irrigate rather that how much to irrigate.

Since each of these device measure only a single point measurement and are generally not portable, an array of measurements is necessary to represent the moisture content in the root zone, typical depth locations are ¼, ½, and ¾ of the root zone.

The number of sites in a field is determined by field size and soil variability, typically, a minimum of three sites is necessary to characterize even the most uniform field.

I- Tensiometers

Tensiometers are water filled plastic tubes with hollow ceramic tips attached on one end and a vacuum gauge and airtight seal on the other.

These devices should be installed at the desired depth in the soil with the ceramic tip in good contact with soil particles.

The water in the tensiometer eventually comes to pressure equilibrium with the surrounding soil through the ceramic tip. When soil dries soil water is pulled out through the tip into the soil creating a tension or vacuum in the tube, as the soil is re-wetted, the tension in the tube is reduced, causing water to re-enter the tip, reducing the vacuum.

Most tensiometers have a scale from 0-100 centibars. The practical operating range is from 0-75 centibars. A lower (near 0centibars) reading indicates saturated soil conditions, readings of near 6-10centibars indicate in fine textured soils, while reading of around 25-30 centibars is about field capacity in fine textured soils, at near 75 centibars, coarse textured soils will be nearly 100 percent depleted of available water but is only about 35 for fine textured soils.

Tensiometers require careful installation and maintenance are to insure reliable results installations should be protected from field hazards and have good soil contact with the ceramic tip, after extreme drying/wetting cycles, refilling may be necessary to replenish water and remove entrapped air. Tensiometers that use a portable pressure transducer to measure tension are available resulting in less cost for each tub and more cost for the portable meter.

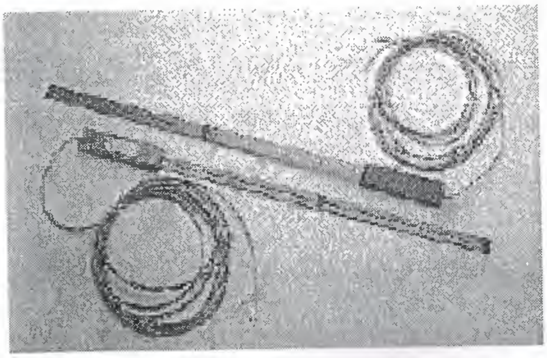
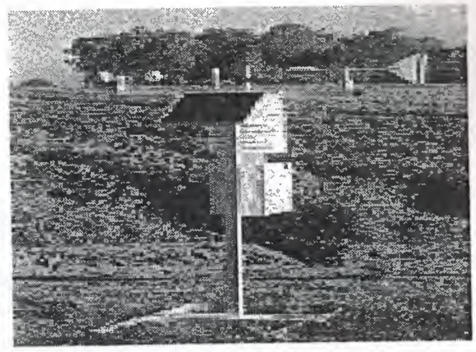
 

Figure 2.2: Tensiometers

II-Porous Blocks

Porous blocks are made of gypsum, glass/gypsum matrix, ceramic, nylon, and Fiberglas; they are buried at the depth of measurement desired.

The blocks come to equilibrium with the moisture content in the depth of measurement id related to soil water tension.

- **Electrical Resistance Blocks**

Two electrodes are buried inside the block with a cable extending to the surface.

The electrical resistance is measured between the two electrodes using a meter attached to the cable, higher resistance reading mean lower block water content (and higher soil water tension).

Porous blocks require the same careful installation as tensiometers; good soil contact is important, maintenance required is much less than tensiometers.

Gypsum blocks are proven to breakdown in alkaline soils and will eventually dissolve, necessitating an abandonment or replacement, soil high in soluble salts may cause erroneous readings, since salts influence soil conductivity and resistance.

Gypsum blocks are best suited for finer textured soils since they are not generally sensitive below 100 cinnabars, or most sandy soils, this would be outside the level of available water.

A newer type of gypsum block consists of a fine granular matrix with gypsum compressed into a block containing electrodes, the outside surface of the matrix is incased in a synthetic membrane and placed in a perforated PVC or stainless steel protective cover.

The construction materials enhance water movement to and from block, making it more responsive to soil water tensions in 30-200centibars range. This makes them more adaptable to a wider range of soil textures.

- **Thermal Dissipation Blocks**

Thermal dissipation blocks are made of a porous, ceramic material, embedded inside a porous block is a small heater and temperature sensor attached by cable to a surface meter.

A measurement is made applying voltage to an internal heater and measuring the rate heat is conduct away from the heater (heat dissipation), the rate of heat dissipation is related to moisture content and, therefore, soil tension.

Thermal dissipation sensors are sensitive to soil water across a wide range of soil water content; however, to yield water content they must be individually calibrated.

2.4.2 Moisture in the Materials

Moisture in the materials is one of the most severe problems which face some companies such as tobacco companies and pimples companies because it may cause a damage to there products.

2.4.2.1 Microwaves Moisture Detector for Materials

Microwaves moisture detector is a control station running at high frequency that emits a signal intercepted by an aerial acting as a sensor. The signal broadcast by the aerial travels through the material, comes out at the other end and is picked up again by the aerial, which takes it back to the same electronic checkpoint, the signal interacts with the material, and is altered in the process, by measuring this variation on the microwave, one can trace it back to the dielectric constant, which represents the materials fingerprints.

Water has a very high dielectric constant, whereas other materials such as tobacco and pimples have extremely low dielectric constants, therefore, the higher the dielectric constant measured, the higher the moisture content of the material.

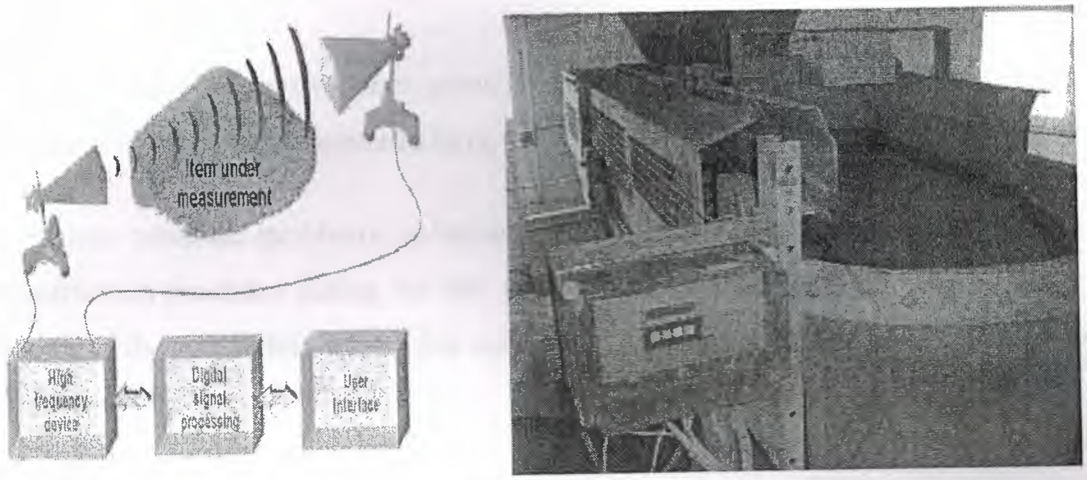


Figure 2.3: Microwaves moisture detector

2.4.3 Moisture in the Buildings

Moisture in the parts of the buildings is one of most problem face civil engineers and builders because its may be responsible about falling some buildings and may be responsible for a significant number of health problems in the buildings.

2.4.3.1 Moisture Problems in the Buildings

Moisture problems in the building concern about indoor exposure to mold has been increasing as the public becomes aware that exposure to mold can cause a variety of health effects like an allergic reactions.

Molds can be found almost anywhere; they can grow on virtually any organic substance, as long as moisture and oxygen are present.

There are molds that can grow on wood, paper, carpet, foods, and insulations because the moisture and oxygen can enter them.

When excessive moisture accumulates in buildings or on building materials, mold growth will often occur, particularly if the moisture problem remains undiscovered or unaddressed, it is impossible to eliminate all molds and mold spores in the indoor environment. However, mold growth can be controlled indoors by controlling moisture indoors.

Since mold requires water to grow, it is important to prevent moisture problems in buildings, moisture problems can have many causes, including uncontrolled humidity.

Some moisture problems in buildings have been linked to changes in building construction practices during the last years, some of these changes have resulted in buildings that are tightly sealed, but may lack adequate ventilation, potentially leading to moisture build-up.

Building materials, such as drywall, may not allow moisture to escape easily, moisture problems may include roof leaks, landscaping or gutters that direct water into or under the building, and invented combustion appliances. Delayed maintenance or insufficient maintenance is also associated with moisture problems in schools and large buildings, moisture problems in portable classrooms and other temporary structures have frequently been associated with mold problems.

Analysis of these moisture problems has recently been supported by a number of models and theories that predict moisture movement in walls, experimental measurement technology, however, currently lags behind the modelling expertise, making model validation difficult.

Improved sensors for detecting the moisture levels in building envelopes would greatly aid in the validation of such theories and could assist in assessing the effectiveness of moisture abatement techniques that are used in existing homes.

An appropriate moisture sensor could conceivably be incorporated as part of a “smart” home that could help occupants detect problems before they become a serious hazard.

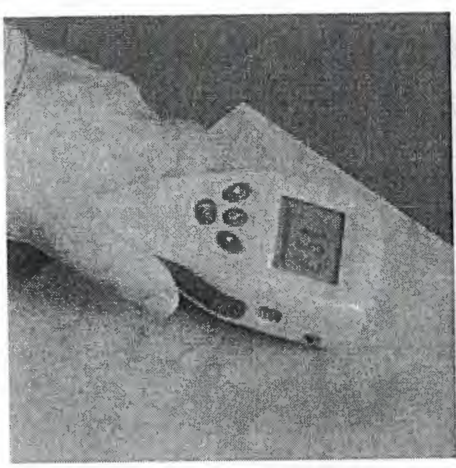
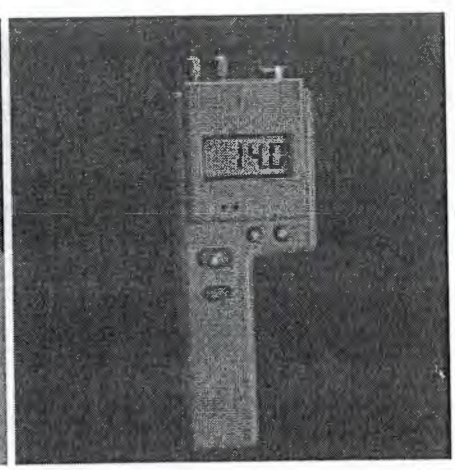
Moisture detection is a problem faced by many industries, but the building science community has not adopted many of the advanced techniques used by these industries to make a sensor.

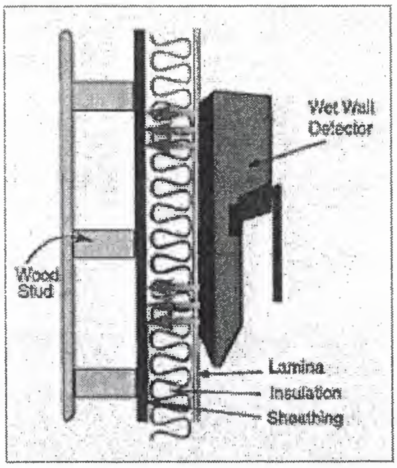
Such techniques include infrared reflectance, nuclear magnetic resonance, and microwave attenuation, and microelectronic sensors.

The challenge in adopting these techniques lies in the packaging of the sensor so that it has a low profile within a wall cavity, an alternative to placing sensors in a wall is to place a sensing unit on one side of a wall, in this situation, the unit must have the capability of detecting moisture at specific locations within the construction.

- **Walls Moisture Detector**

Walls Moisture Detector is an electronic meters measure the moisture content via an electrical resistance test in the wall. A pin-type meter is inserted in the concrete by drilling holes or driving two concrete nails into the concrete. These holes are used as the contact point for the two pins of the instrument. The procedure is a conductivity test; and the more moisture, is the better conductivity, which results in higher readings.



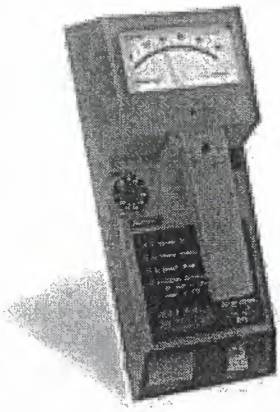


Figure 2.4: Walls moisture detectors forms

2.5 Summary

This chapter demonstrated moisture definition, principles and some applications and methods on where and how moisture detectors could be used. We discussed some moisture detectors that are used at homes and companies such as wall moisture detectors. We also went through design specifications and explaining how do they operate. We have mentioned some methods that we can use to detect the moisture in the soil. Now, after reviewing techniques of moisture detectors and explanation of the essential components that I will use in my moisture detector circuit which I will illustrate in the next chapter.

CHAPTER THREE

MOISTURE DETECTOR

3.1 Overview

This chapter is an illustration of the circuit and explanation of the project. The detector verifies if moisture exists in the mediums (sand) or not, this is identified by triggering a low frequency alarm, this operation can be obtained by inserting the two probes in the material medium. This circuit normally produces a low frequency audio output having a fundamental frequency of only few Hertz, but the operating frequency rises considerably if a couple of probes are placed in water. A more modest increase in pitch is produced if the probes are placed in some thing wet, such as moist soil.

One of the most practical applications for this circuit that it can act as a soil moisture indicator to show whether a plant needs watering by giving an indication of moisture at root level.

3.2 Hardware Representation

The circuit that is shown in figure 3.1 is little more than a low frequency oscillator based on IC1 and driving a loudspeaker LS1 via C2. The frequency at which IC1 oscillates can be considerably boosted by switching on Tr1 so the R3 is effectively connected from the input of IC1 to the negative supply rail. As the circuit stands though, Tr1 is cut off and passes no significant current.

With probes placed on water there will be low resistance between them and heavy base current will flow into Tr1 so that this device is biased hard into conduction and the frequency IC1 is taken to its maximum figure. It should perhaps be pointed out that pure water does in fact have a very high resistance, but most source of water (rain, tap water, etc.) contain significant amount of purities which produces a much lower resistance.

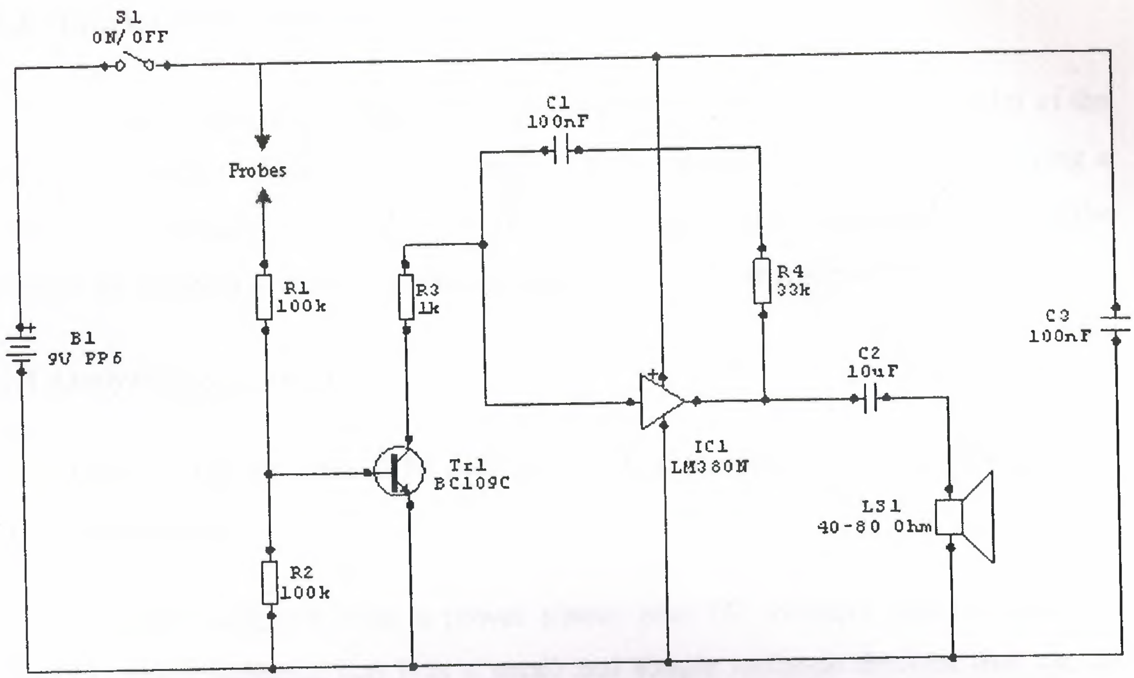


Figure 3.1: Circuit diagram [8]

If the probes are placed in some thing that has only modest moisture content there, will be a much higher resistance between them, but Tr1 will still be biased into conduction to certain extent and there will be a significant increase in the operating frequency of the unit. Thus, Tr1 is not simply switched fully on or fully off, and intermediate states (and output frequencies from the unit) can be produced.

The probes can simply consist of two-piece of a single strand PVC-insulated wire with a small length of insulation (about 5 mm) removed from the ends. If the unit is to be used as a soil moisture indicator, the two probes must be mounted together so that they are a fixed distance apart. A spacing of about 200 mm is suitable. The spacing is important as it affects the sensitivity of the unit. If the unit seems to be oversensitive, incidentally, removing some of the exposed at the end of each probe is the easiest way of correcting this. Similarly, a lack of sensitivity can be corrected by removing some of the insulation at the end of each probe to leave a greater length of exposed wire.

3.3 The Aim of the Circuit

Before starting analyzes the circuit of the project we have to know the aim of the circuit, the aim of the circuit is to produce a low frequency audio output having a fundamental frequency of only few Hertz alarm from the loud speaker when the probes are inserted in moist material medium (the sample that we want to test it).

3.4 Analyzing the Circuit

Analyzing the circuit will be done by dividing the circuit to two parts and then follow the current.

The circuit supplied from a power source nine DC voltages using Adapter or Battery, which indicates that it is a small and simple moisture detector that can be used in a small and simple plant's watering system in a small garden.

The current of this battery will go from plus pole (+) to the minus pole (-) through the ON case of the switch, which connect series with the plus pole (+) of the battery, the ON case of the switch will act as a short circuit and the OFF case of the switch will act as open circuit, this is the current direction through the circuit, but the current direction inside the battery is from minus pole (-) to the plus pole (+).

After crossing the current through the ON case of the switch it will divide to two current values with certain factor one of them will go through the above wire and the second current will cross the probes if the material medium (the sample that we want to test it) has enough conductivity by having the available moisture in its particles because its known that the moisture is water or other liquid diffused in a small quantity as vapors, and water has chemical composite that allow to the electrical current to pass through it with certain conductivity.

After that, the current will go to the parallel resistor R1 (100KΩ) after current crossing the resistor the value of this current will be decrease by the relation of the Ohms low.

$$I = V / R \qquad (1)$$

Where:

- V: is the voltage across the resistor terminals and the unit is volts.

- I: is the current passing through the resistor and the unit is amperes.

- R: is the resistance and the unit is ohms.

Not just the value the current will decrease and the power will decrease since the resistor will absorb some power from the current and it will dissipate it as heat energy through their bodies and this loss power can be calculated by the three power loss equations.

$$P=V*I \qquad (2)$$

$$P = I^2 * R \qquad (3)$$

$$P=V^2/R \qquad (4)$$

Where:

- P: is the power loss and the unit is watts.

- I: is the current passing through the resistor and the unit is amperes.

- R: is the resistance and the unit is ohms.

After crossing the current resistor R1, part of this current will go through the second resistor R2 (100KΩ), where the process that happened in the first resistor will happen in this resistor and then the current will go to the ground as shown in figure 3.2 which is the first part of the circuit, and then the other part of the current will go to the base of the transistor Tr1 (BC109C) which is NBN transistor(not pointing in) since the base of this transistor is connected to the cross section point between the first resistor (R1) and the second resistor (R2) and the emitter of Tr1 is connected directly to the ground and the collector of the transistor is connected to the third resistor R3 (1KΩ).

The function of this transistor is to make the current control to the forward devices in the circuit, which mean if the current returned to the first part of the circuit the transistor will avoid it, and the emitter will take it to the ground and the other function of the transistor to make amplification of the forward current.

And then this current will passing though R3 (1 KΩ), where the process that will happen in this resistor will be the same as the first two parallel resistors R1 and R2 as shown in the first part of the circuit which is Figure 3.2.

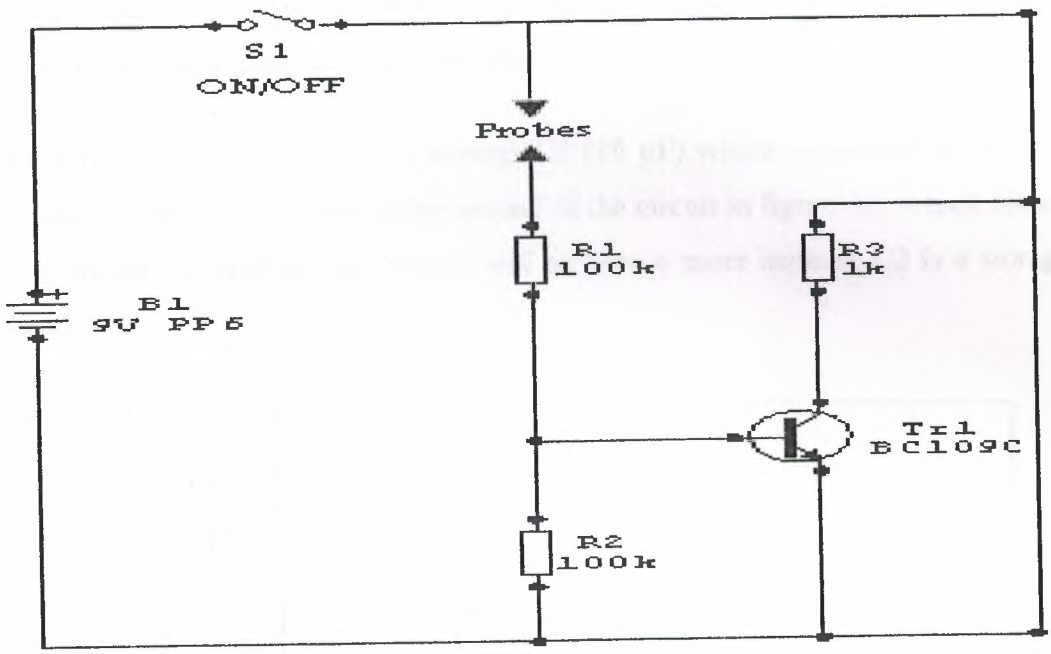


Figure 3.2: First part of the circuit

After crossing the current resistor R3, the current will divide to tow currents let us call them I1 and I2 because this currents now are passing through the branch of C1 (100 nF), IC1 (LM380N) and R4 (33 KΩ), since this branch has two wires, the upper wire has capacitor1 (C1 100 nF) and R4 (33 KΩ). The lower wire has integrated circuit1 (IC1-LM380N). firstly,I1 will pass through C1, this capacitor will be charged with voltage since it a storing device, thus the voltage entering to this branch will be decreased with certain factor as some of it will be absorbed by the capacitor then I1 will pass through R4(33 KΩ) which will decrease the current as well.

I2 will pass in the lower branch, so it will pass through the integrated circuit (LM380N) this current will connect to the second pin of the IC or chip, this chip has 14 pins. The connection of the IC is as follows, the first pin is an input and the fourteenth pin is Vcc, input voltage. The 3rd, 4th, 5th, 7th, 10th, 11th, and the12th pins are grounded. This work of this IC integrated circuit upon the logic functions mainly (AND, OR, and NOT) because these pins are connected together by this logic gates (AND, OR, and NOT).

The output pin of this integrated circuit is the eighth pin, now the output current of this integrated circuit will connect to the output current of the upper wire after crossing the mentioned capacitor and resistor

After that the current will pass through C2 (10 μF) which connected series with the mentioned branch as shown in the second of the circuit in figure 3.3, which means that the output's voltage of that branch will be reduce more because C2 is a storage device as well.

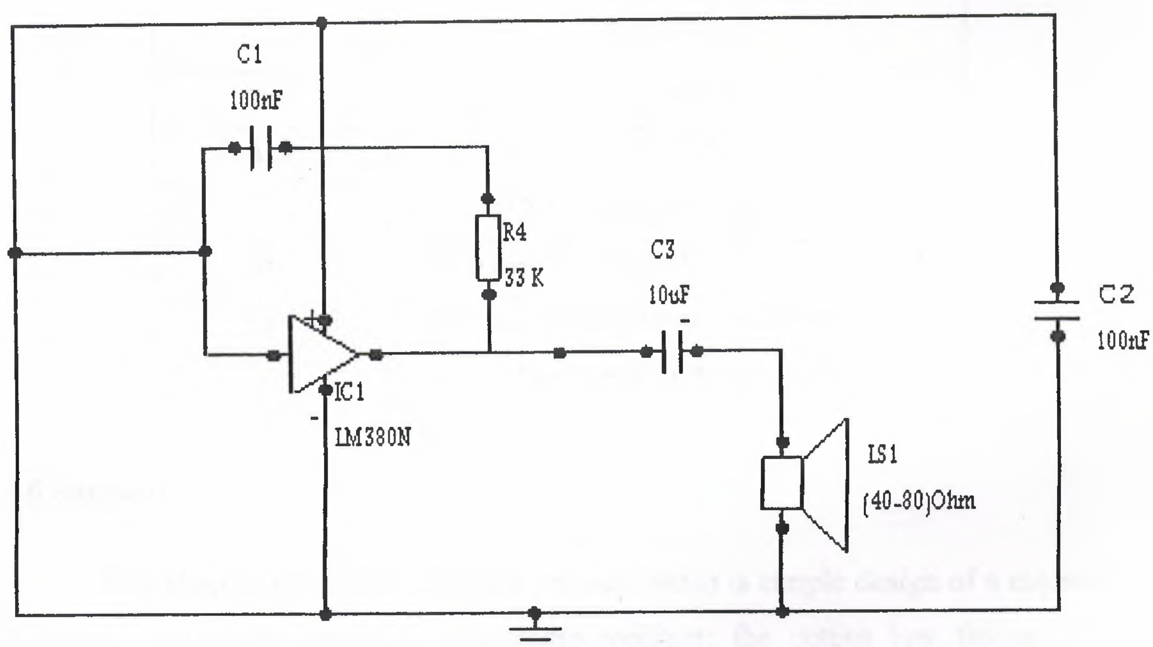


Figure 3.3: Second part of the circuit

Finally, this current enters the loudspeaker LS1 of a resistance range of (40 – 80) ohms, where here an important process occurs which it is the current transformation from its time domain to its frequency domain takes place hence a low frequency alarm is being come out. The whole circuit is connected in parallel with third capacitor C3 (100 nF).

3.5 Part List

List of the used components shown in Table 3.1

Table 3.1: Part list

Part Label	Part Description
R1	100 K (Brown, Black, Yellow, Gold)
R2	100 K (Brown, Black, Yellow, Gold)
R3	1 K (Brown, Black, Red, Gold)
R4	33 K (Orange, Orenge, Orenge, Gold)
C1	100 nF Polyester (Brown, Black, Yellow, Black, red)
C2	10 µF 25V electrolytic
C3	100 nF Polyester (Brown, Black, Yellow, Black, red)
IC1	LM380N
Tr1	BC109C
S1	SPST Miniature Toggle Type
B1	PP6 Sise 9 Volt and Connector to Suit
LS1	Miniature Type Having an Impedance in the Range 40 to 80 ohms

3.6 Summary

This chapter presented hardware project, which is simple design of a moisture detector, which can operate in any damp medium; the output low frequency is alternated depending on moisture level in a certain medium that is connected to the detector. This chapter also provided a detailed explanation on how the detector circuit works from input (the power source) to output (a low frequency audio).

Next chapter will be implementation of the project, the results and modifications described in details for the circuit components that make vital changes to the output.

CHAPTER FOUR

MODIFICATION OF THE MOISTURE DETECTOR

4.1 Overview

This chapter contains the specifications of the project, which has been analyzed in chapter three. The modifications and the Results are described as well, such as adjusting the volume (the low frequency audio output) of the loudspeaker to lower or higher level, and decreasing the noise,

4.2 Modifications

This section presents the modifications that were added to the project as follows:

4.2.1 Reduction of Noise

This section explains how we could reduce noise in the electronic circuit, for that purpose capacitors are used, capacitor can be connected in parallel with some other capacitors as shown in Figure 4.1.

In such a way the output low frequency will be limited to the best output that is needed. That value of the capacitor was reached using a variable capacitor and adjusting it to the best value, which is 100nf because this value gives us the best low frequency audio output.

This Modification of the circuit is shown in Figure 4.1, as mentioned before the capacitors are storage devices so the voltage in that branch will decrease and filtered because we can use the capacitors as filters for the voltage as we use them for signals in communication systems as well, that is why noise is eliminated and much more sensitive output is reached.

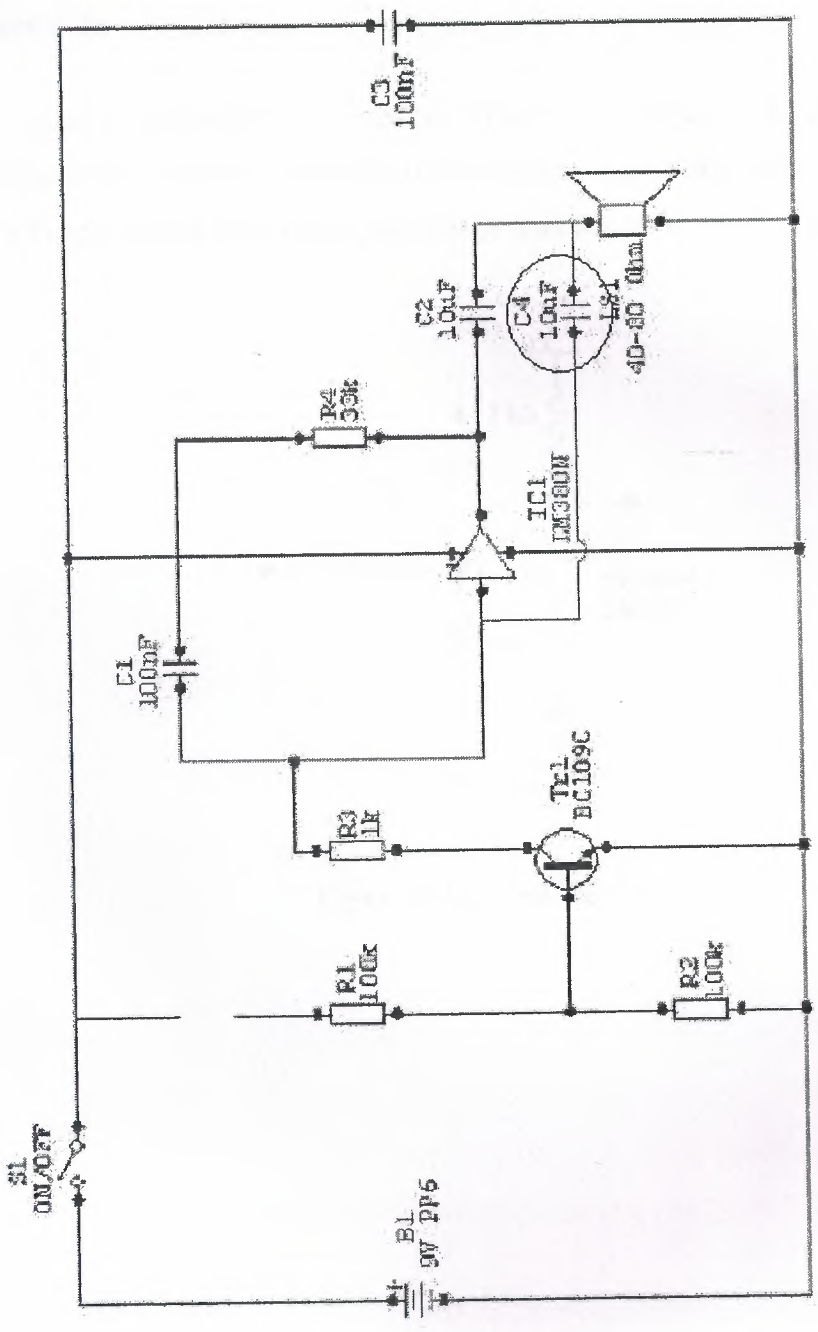


Figure 4.1: Modified part of the circuit

4.2.2 Inverting the Output

The idea of the circuit is to detect moist in the ground using two probes. When switching on the circuit the speaker should make a sound indicating that the soil is dry and needs watering, the moment the soil is watered and the two probes are connected the sound should stop indicating soil is wet enough.

In this case we needed an inverter circuit which is shown in figure 4.2. we used NPN transistor 2N3904 and other three resistors connected as in the figure with values in accordance with our input voltage which is 9V.

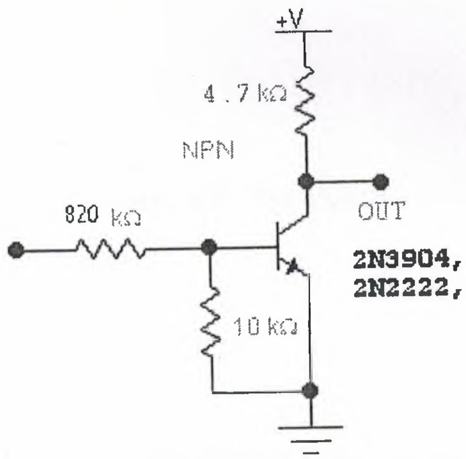


Figure 4.2: Inverter circuit

4.3The Circuit Picture

The circuit is in figure 4.3 as shown below:

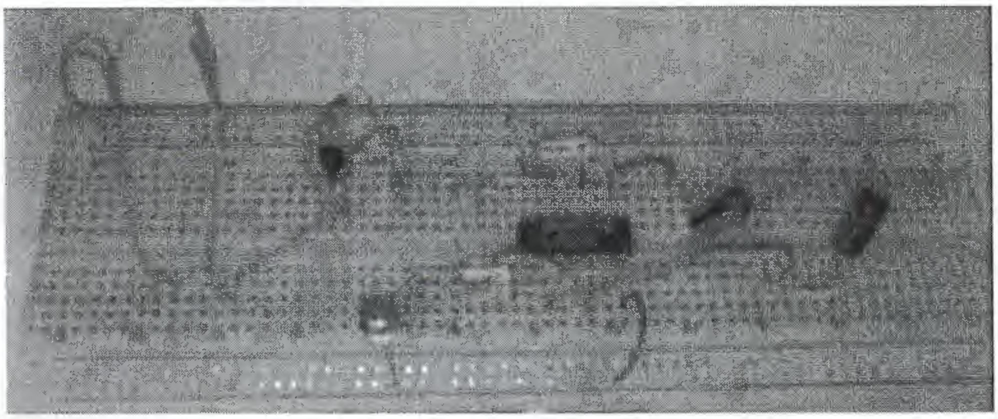


Figure 4.3: The Circuit

4.4 Results

This section describes the moist mediums that are used in testing part of the circuit, those were two moist mediums and the third one was dry medium, the mediums were planting soil, the first medium was very moist medium and the moisture in the second one was less than the moisture in the first medium.

The result of this test as it recognized the highest alarm sound was for the first medium because it has the highest level of moisture between its particles and the less alarm sounds for the second medium because it has lower moisture than the first medium and for dry medium was not any alarm sound.

Here in this section there are very important notices that have been reached during the modification's part of the project. Starting with filtering and volume adjusting results, these are considered as important results for electronic engineer.

4.4.1 Filtering and Volume Adjusting

As results of the experiments during the modification part, it is being recognized that a capacitor can be use for filtering purpose since the output frequency can be limited to a desired level. Resistors can be used for adjusting the output volume, by increasing the resistance value, volume is decreased frequently, and vice versa.

4.5 Specification

Actually, the moisture detector acts as automatic irrigation system since it operates when the moisture (water or other liquid diffused in a small quantity as vapor, or within a solid, or condensed on a surface) is exist in the soil or in any other medium.

4.6 Summary

This chapter provided the main modifications added to the project and the results that have been made on the moisture detector circuit in details. The specifications of the project have been viewed as well.

CONCLUSION

Electronic fields are considered as a real revolution in the world. Utilizing electronic components we can design equipments that benefit us in loads of ways. As we have seen in this project, we can create impressive practical tool and essential to our life using simple electronic components.

Moisture detectors are considered one of those important devices that make a significant key role to people's life. These detectors can economize human's time and resources due to its automatic functionality mentioned in the project.

The aim of this project was to have a hand-on experience with electronic components and use them to make projects; this was accomplished by the exploring the project and gathering information about components functionality. Another aim was to design, build and implement a device that acts as moisture detector, and it was accomplished by troubleshooting and attempting to implement moisture detectors.

The first chapter of this project was about electronic components that are used in this project with some explanation about there functionality and characteristic.

The second chapter went through moisture detectors, the principle behind their operation, and many applications that demonstrate the main idea of moisture detectors.

The third chapter was described as the most important chapter, because what it contains of detailed information about the circuit.

The final chapter contained the modifications that have been done in the circuit.

In conclusion, we can say that moister detectors have load of application such as wet wall moister detector, wood moister detectors that can be used at homes and most importantly is soil moister detector which is easily can be connected to motors to form complete self-independent economically automatic irrigation system that we need severely in a world were water is the key element.

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