NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Electrical and Electronic Engineering

Water Activated Alarm

Graduation Project
EE 400

Student: Mohammed Fadhle Hassan (20033312)

Supervisor: Assist. Prof. Dr. Kadri Bürüncük

Nicosia - 2007

ACKNOWLEDGEMENT

First of all, I would like to extend my sincere and humble gratitude to Almighty Allah who endowed me potential and ability to make solid contribution to the already existing ocean of knowledge.

I wish to express my gratitude and sincere appreciation to my supervisor Assist. Prof. Dr. Kadri Bürüncük for his kind patronage, guidance and concern during this project. I am really thankful to him for being there whenever I needed his advice, and I felt my quick progress from his advises.

My special thanks to all my housemates, Majid Wazir Abbasi and Mobin Wazir Abbasi, also my special thanks to all my friends, Khalid Mohammed, Ahmed Ammar, Yusuf Ammar, Usama Wadeya, Fadi Safi, Saad Allah Matar, Adam Sevim and Mustafa Saeed Al-Hashemi. I am really thankful to them for bearing with me and my moods during my studies. Also, special thanks to my uncle for his support and my cousin Khalid Hassan.

Finally, I want to thank my family especially my parents, no words could express the love and understanding my parents have extended to me during the whole period of my education and through my life. Without their endless support and love for me, I would never achieve my current position. I wish my mother and my father live happily always and being proud of me.

ABSTRACT

As can be seen nowadays developing technologies are going so fast where manufacturing companies and high buildings have been built to prevent any losses from floods.

Water Activated Alarms are used as Flood Warning Systems mostly; water activated alarms or flood warning systems have been designed to give forewarning to the likelihood of flooding in order to save lives and properties. The flood warning systems or water activated alarms ensure that the end users of the forecast receive appropriate warnings in time to take effective action to save lives and minimize damage to properties.

Water activated alarm (Flood warning system) is an equipment which gives alarm (sound) whenever the flood exceeds its acceptable level by using sensor (probe) and a warning light will be activated when the alarm activates.

This project presents the design and construction of water activated alarm circuit. The system indicates flood or water by sounding an alarm and warning light.

TABLE OF CONTENTS

INTRODUCTION

The idea of the water activated alarm is used as a flood warning system in most of the countries. Flood warning systems are recognized in the entire world as important systems to provide the public with better information in order to save lives, properties and to minimize the flood losses as well. Because floods are disseminated to the public very quickly, a warning system has been made to prevent any of these losses.

The aim of this project is to design a water activated alarm, a water activated alarm circuit is giving an alarm (sound) whenever the flood or the water exceeds its acceptable level and at the same time a warning light will be activated.

This project consists of the introduction and four chapters, which are:

Chapter 1 will represent an introduction and detailed information about the field of Electronics and its developments. Also, it will represent the beginning of the integrated circuits, how did they develop and what are their characteristics.

Chapter 2 will represent the components that have been used to construct the water activated alarm circuit; moreover it describes in details each component with its properties and characteristics. Also, this chapter contains some safety guidelines to prevent any losses of the components.

Chapter 3 will represent general information about alarm systems and especially water detectors. Also, contains some similar circuits with their general process of working.

Chapter 4 will be concerned on the process of the water activated alarm circuit which has been divided into four stages and each one of these four stages is described step by step since the probe detect the flood or the water until the last process which is sound and light.

Conclusion will represent some results and future investigation for the water activated alarms or flood warning systems.

1- ELECTRONICS AND INTEGRATED CIRCUITS

1.1 Overview

This chapter presents a general explanation to electronics and integrated circuits and their definitions, classifications and developments.

1.2 Electronics

Electronics is the study of electron mechanics. Or the study of mechanism of flow of charge in various materials like semiconductors, resistors, nanostructures, vacuums etc.

The field of electronics comprises the study and use of systems that operate by controlling the flow of electrons (or other charge carriers) in devices such as thermionic valves (vacuum tubes) and semiconductors. The design and construction of electronic circuits to solve practical problems is an integral technique in the field of electronics engineering and is equally important in hardware design for computer engineering. All applications of electronics involve the transmission of either information or power. Most deal only with information.

The study of new semiconductor devices and surrounding technology is sometimes considered a branch of physics. This article focuses on engineering aspects of electronics. Other important topics include electronic waste and occupational health impacts of semiconductor manufacturing.

1.3Electronic Systems and Circuits

Electronic systems are used to perform a wide variety of tasks. The main uses of electronic circuits are:

- The controlling and processing of data.
- The conversion to/from distribution of electric power.

Both these applications involve the creation and/or detection of electromagnetic fields and electric currents. While electrical energy had been used for some time prior to the late 19th century to transmit data over telegraph and telephone lines, development in electronics grew exponentially after the advent of radio.

One way of looking at an electronic system is to divide it into three parts:

- **Inputs:** Electronic or mechanical sensors (or transducers). These devices take signals/information from external sources in the physical world (such as antennas or technology networks) and convert those signals/information into current/voltage or digital (high/low) signals within the system.

- **Signal Processors:** These circuits serve to manipulate, interpret and transform inputted signals in order to make them useful for a desired application. Recently, complex signal processing has been accomplished with the use of Digital Signal Processors.

- **Outputs:** Actuators or other devices (such as transducers) that transform current/voltage signals back into useful physical form (e.g., by accomplishing a physical task such as rotating an electric motor).

For example, a television set contains these 3 parts. The television's input transforms a broadcast signal (received by an antenna or fed in through a cable) into a current/voltage signal that can be used by the device. Signal processing circuits inside the television extract information from this signal that dictates brightness, color and sound level. Output devices then convert this information back into physical form. A cathode ray tube transforms electronic signals into a visible image on the screen. Magnet-driven speakers convert signals into audible sound.

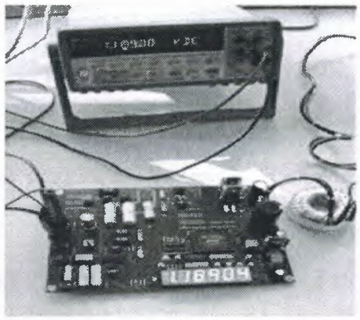


Figure 1.1: A Commercial digital voltmeter checking a prototype

1.4 Electronic Devices and Components

An electronic component is any indivisible electronic building block packaged in a discrete form with two or more connecting leads or metallic pads. Components are intended to be connected together, usually by soldering to a printed circuit board, to create an electronic circuit with a particular function (for example an amplifier, radio receiver, or oscillator). Components may be packaged singly (resistor, capacitor, transistor, diode etc.) or in more or less complex groups as integrated circuits (operational amplifier, resistor array, logic gate etc). Active components are sometimes called devices rather than components. Different electronic components will be shown in the next chapter.

1.5 Types of Circuits

There are three types of circuits which they are, analog circuits, digital circuits and mixed-signal circuits. The following paragraphs are explaining the three types of circuits at a side.

1.5.1 Analog Circuits

Most analog electronic appliances, such as radio receivers, are constructed from combinations of a few types of basic circuits. Analog circuits use a continuous range of voltage as opposed to discrete levels as in digital circuits. The number of different analog circuits so far devised is huge, especially because a 'circuit' can be defined as anything from a single component, to systems containing thousands of components.

Analog circuits are sometimes called linear circuits although many non-linear effects are used in analog circuits such as mixers, modulators, etc. Good examples of analog circuits include vacuum tube and transistor amplifiers, operational amplifiers and oscillators.

Some analog circuitry these days may use digital or even microprocessor techniques to improve upon the basic performance of the circuit. This type of circuit is usually called 'mixed signal'.

Sometimes it may be difficult to differentiate between analog and digital circuits as they have elements of both linear and non-linear operation. An example is the comparator which takes in a continuous range of voltage but puts out only one of two levels as in a digital circuit. Similarly, an overdriven transistor amplifier can take on the characteristics of a controlled switch having essentially two levels of output.

1.5.2 Digital Circuits

Digital circuits are electric circuits based on a number of discrete voltage levels. Digital circuits are the most common physical representation of Boolean algebra and are the basis of all digital computers. To most engineers, the terms "digital circuit", "digital system" and "logic" are interchangeable in the context of digital circuits. In most cases the number of different states of a node is two, represented by two voltage levels labeled "Low" and "High". Often "Low" will be near zero volts and "High" will be at a higher level depending on the supply voltage in use.

Computers, electronic clocks, and programmable logic controllers (used to control industrial processes) are constructed of digital circuits. Digital Signal Processors are another example.

1.5.3 Mixed Signal Circuits

Mixed-signal circuits refers to integrated circuits (ICs) which have both analog circuits and digital circuits combined on a single semiconductor die or on the same circuit board. Mixed-signal circuits are becoming increasingly common. Mixed circuits contain both analog and digital components. Analog to digital converters and digital to analog converters are the primary examples. Other examples are transmission gates and buffers.

1.6 Integrated Circuits

Integrated circuits were made possible by experimental discoveries which showed that semiconductor devices could perform the functions of vacuum tubes, and by mid-20th-century technology advancements in semiconductor device fabrication. The integration of large numbers of tiny transistors into a small chip was an enormous improvement over the manual assembly of circuits using discrete electronic components. The integrated circuit's mass production capability, reliability, and building-block approach to circuit design ensured the rapid adoption of standardized ICs in place of designs using discrete transistors.

There are two main advantages of ICs over discrete circuits:

1- Cost.

2- Performance.

Cost is low because the chips, with all their components, are printed as a unit by photolithography and not constructed a transistor at a time.

Performance is high since the components switch quickly and consume little power, because the components are small and close together. As of 2006, chip areas range from a few square mm to around 350 mm^2, with up to 1 million transistors per mm^2.

1.6.1 Advances in Integrated Circuits

Among the most advanced integrated circuits are the microprocessors or "**cores**", which control everything from computers to cellular phones to digital microwave ovens. Digital memory chips and ASICs (Application Specific Integrated Circuits) are examples of other families of integrated circuits that are important to the modern information society. While the cost of designing and developing a complex integrated circuit is quite high, when spread across typically millions of production units the individual IC cost is minimized. The performance of ICs is high because the small size allows short traces which in turn allows low power logic (such as CMOS) to be used at fast switching speeds.

ICs have consistently migrated to smaller feature sizes over the years, allowing more circuitry to be packed on each chip. This increased capacity per unit area can be used to decrease cost and/or increase functionality.

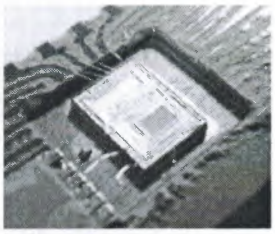


Figure1.2: The integrated circuit from an Intel 8742, an 8-bit microcontroller that includes a CPU running at 12 MHz, 128 bytes of RAM, 2048 bytes of EPROM, and I/O in the same chip.

1.6.2 Popularity of ICs

Only a half century after their development was initiated, integrated circuits have become ubiquitous. Computers, cellular phones, and other digital appliances are now inextricable parts of the structure of modern societies. That is, modern computing, communications, manufacturing and transport systems, including the Internet, all depend on the existence of integrated circuits. Indeed, many scholars believe that the digital revolution brought about by integrated circuits was one of the most significant occurrences in the history of mankind.

1.6.3 Classification

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

Digital integrated circuits can contain anything from a few thousand to millions of logic gates, flip-flops, multiplexers, and other circuits in a few square millimeters. The small size of these circuits allows high speed, low power dissipation, and reduced manufacturing cost compared with board-level integration. These digital ICs, typically microprocessors, DSPs, and micro controllers work using binary mathematics to process "one" and "zero" signals.

Analog ICs, such as sensors, power management circuits, and operational amplifiers, work by processing continuous signals. They perform functions like amplification, active filtering, demodulation, mixing, etc. Analog ICs ease the burden on circuit designers by having expertly designed analog circuits available instead of designing a difficult analog circuit from scratch.

ICs can also combine analog and digital circuits on a single chip to create functions such as A/D converters and D/A converters. Such circuits offer smaller size and lower cost, but must carefully account for signal interference.

1.6.4 Manufacture

In manufacturing an IC, two operations are done which they are, Fabrication and Packaging. The following paragraphs are explaining the two operations at a side.

1.6.4.1 Fabrication

The semiconductors of the periodic table of the chemical elements were identified as the most likely materials for a solid state vacuum tube by researchers like William Shockley at Bell Laboratories starting in the 1930s. Starting with copper oxide, proceeding to germanium, then silicon, the materials were systematically studied in the 1940s and 1950s. Today, silicon mono-crystals are the main substrate used for integrated circuits (ICs) although some III-V compounds of the periodic table such as gallium arsenide are used for specialized applications like LEDs, lasers, solar cells and the highest-speed integrated circuits. It took decades to perfect methods of creating crystals without defects in the crystalline structure of the semiconducting material.

Semiconductor ICs are fabricated in a layer process which includes these key process steps:

Imaging

Deposition

Etching

The main process steps are supplemented by doping, cleaning and planarization steps.

Mono-crystal silicon wafers (or for special applications, silicon on sapphire or gallium arsenide wafers) are used as the substrate. Photolithography is used to mark different areas of the substrate to be doped or to have poly-silicon, insulators or metal (typically aluminum) tracks deposited on them.

Integrated circuits are composed of many overlapping layers, each defined by photolithography, and normally shown in different colors. Some layers mark where various dopants are diffused into the substrate (called diffusion layers), some define where additional ions are implanted (implant layers), some define the conductors (poly-silicon or metal layers), and some define the connections between the conducting layers (via or contact layers). All components are constructed from a specific combination of these layers.

In a self-aligned CMOS process, a transistor is formed wherever the gate layer (poly-silicon or metal) crosses a diffusion layer.

Resistive structures, meandering stripes of varying lengths, form the loads on the circuit. The ratio of the length of the resistive structure to its width, combined with its sheet resistivity determines the resistance.

Capacitive structures, in form very much like the parallel conducting plates of a traditional electrical capacitor, are formed according to the area of the "plates", with insulating material between the plates. Owing to limitations in size, only very small capacitances can be created on an IC.

More rarely, inductive structures can be built as tiny on-chip coils, or simulated by gyrators.

Since a CMOS device only draws current on the transition between logic states, CMOS devices consume much less current than bipolar devices.

A random access memory is the most regular type of integrated circuit; the highest density devices are thus memories; but even a microprocessor will have memory on the chip. Although the structures are intricate with widths which have been shrinking for decades, the layers remain much thinner than the device widths. The layers of material are fabricated much like a photographic process, although light waves in the visible spectrum cannot be used to "expose" a layer of material, as they would be too large for the features. Thus photons of higher frequencies (typically ultraviolet) are used to create the patterns for each layer. Because each feature is so small, electron microscopes are essential tools for a process engineer who might be debugging a fabrication process.

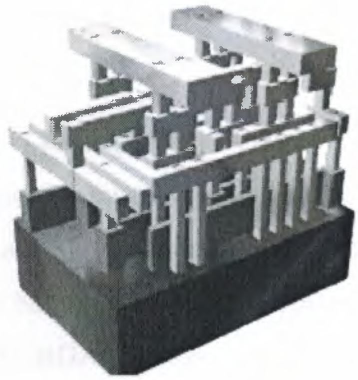


Figure 1.3: Rendering of a small standard cell with three metal layers (dielectric has been removed). Starting from up, the sand-colored structures are metal interconnect, with the vertical pillars being contacts, typically plugs of tungsten. The reddish structures are poly-silicon gates, and the solid at the bottom is the crystalline silicon bulk.

1.6.4.2 Packaging

The earliest integrated circuits were packaged in ceramic flat packs, which continued to be used by the military for their reliability and small size for many years. Commercial circuit packaging quickly moved to the dual in-line package (DIP), first in ceramic and later in plastic. In the 1980s pin counts of VLSI circuits exceeded the practical limit for DIP packaging, leading to pin grid array (PGA) and leadless chip carrier (LCC) packages. Surface mount packaging appeared in the early 1980s and became popular in the late 1980s, using finer lead pitch with leads formed as either gull-wing or J-lead, as exemplified by Small-Outline Integrated Circuit. A carrier which occupies an area about 30 – 50% less than an equivalent DIP, with a typical thickness that is 70% less. This package has "gull wing" leads protruding from the two long sides and a lead spacing of 0.050 inches.

Small-Outline Integrated Circuit (SOIC) and PLCC packages. In the late 1990s, PQFP and TSOP packages became the most common for high pin count devices, though PGA packages are still often used for high-end microprocessors. Intel and AMD are currently transitioning from PGA packages on high-end microprocessors to land grid array (LGA) packages.

Ball grid array (BGA) packages have existed since the 1970s. Flip-chip Ball Grid Array packages, which allow for much higher pin count than other package types, were developed in the 1990s. In an FCBGA package the die is mounted upside-down (flipped) and connects to the package balls via a package substrate that is similar to a printed-circuit board rather than by wires. FCBGA packages allow an array of input-output signals (called Area-I/O) to be distributed over the entire die rather than being confined to the die periphery.

Traces out of the die, through the package, and into the printed circuit board have very different electrical properties, compared to on-chip signals. They require special design techniques and need much more electric power than signals confined to the chip itself.

When multiple dies are put in one package, it is called SIP, for *System In Package*. When multiple dies are combined on a small substrate, often ceramic, it's called a MCM, or Multi-Chip Module. The boundary between a big MCM and a small printed circuit board is sometimes fuzzy.

1.7 Other Developments

In the 1980s programmable integrated circuits were developed. These devices contain circuits whose logical function and connectivity can be programmed by the user, rather than being fixed by the integrated circuit manufacturer. This allows a single chip to be programmed to implement different LSI-type functions such as logic gates, adders, and registers. Current devices named FPGAs (Field Programmable Gate Arrays) can now implement tens of thousands of LSI circuits in parallel and operate up to 400 MHz.

The techniques perfected by the integrated circuits industry over the last three decades have been used to create microscopic machines, known as MEMS. These devices are used in a variety of commercial and military applications. Example commercial applications include DLP projectors, inkjet printers, and accelerometers used to deploy automobile airbags.

In the past, radios could not be fabricated in the same low-cost processes as microprocessors. But since 1998, a large number of radio chips have been developed using CMOS processes. Examples include Intel's DECT cordless phone, or Atheros's 802.11 card.

Future developments seem to follow the multi-microprocessor paradigm, already used by the Intel and AMD dual-core processors. Intel recently unveiled a prototype, "not for commercial sale" chip that bears a staggering 80 microprocessors. Each core is capable of handling its own task independently of the others. This is in response to the heat versus speed limit that is about to be reached using existing transistor technology. This design provides a new challenge to chip programming. X10 is the new open-source programming language designed to assist with this task.

1.8 Summary

This chapter presented detailed information about electronics and integrated circuits (ICs). In electronics part, we have included general information about the electronic devices and components, and the three types of circuits in detailed information. In integrated circuits part, we have included classifications, manufacturing and some other developments in ICs.

2- BASIC ELECTRONIC COMPONENTS

2.1 Overview

This chapter includes the basic electronic components that are commonly used in projects like some semiconductors, capacitors and resistors. Also, presents safety guidelines for electronic projects.

2.2 Resistors

These are small cylindrical components having a lead-out protruding from each end. The value is not marked in numbers and letters, but is indicated by four colored bands around the body of the component. the value in the units called "ohms", and resistors often have values of many thousands of using vary large numbers it is common for resistance to be specified in kilo ohms (K) and mega ohms (M). These are equal to a thousand ohms and million ohms respectively. Thus a resistor having a value of 33000 ohms would normally be said to have a value of 33 k ohms, and a resistor having a value of 2700000 ohms would normally have its value given as 2.7 M ohms. It is common these days for the unit's symbol to be used to indicate the decimal point as well. This sometimes further shortens a value in its written form, and there is no danger of decimal point being overlooked due to poor quality printing or something of this nature. In out two examples given above the value of 33k ohms would not be altered sine the K already indicates the position of the decimal point, but 2.7 M would be altered to 2M7.

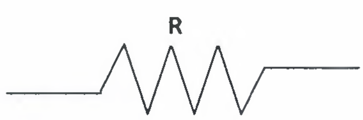


Figure 2.1: Resistor Symbol.

Table 2.1: Color codes are often used to indicate the value of the resistors in the electronic equipment and this is a detail of the resistor color codes.

Color	**1st / 2nd Band**	**3rd Band**	**4th Band**	***Color***
Gold	Not used	0.1	5%	
Black	0	0	Not used	
Brown	1	10	1%	
Red	2	100	2%	
Orange	3	1000	Not used	
Yellow	4	10000	Not used	
Green	5	100000	Not used	
Blue	6	1000000	Not used	
Violet	7	Not used	Not used	
Grey	8	Not used	Not used	
White	9	Not used	Not used	
Silver	Not used	0.1	10 %	
No Band	*Not used*	*Not used*	*20 %*	

The resistor color code is very straightforward, with the first two bands (color) giving the first two digits of the value, the third band giving a multiplier (i.e. the first two digits are multiplied by this third band in order to give the value of the component in ohms), and the fourth band showing the tolerance of the component. The resistor color is detailed in table 2.1 above.

Thus in the example shown in figure 1.1 below the first two digits of the value are 2 (red) and 7 (violet), given 27 which must be multiplied by 100000 (green), giving a value of 2700000 ohms. This would normally be written at 2.7M or 2M7. The fourth band is silver which indicates that the value of the component is within 10% of its marked value. Note that it is perfectly all right to use a component having a closer tolerance than is specified in a components list (a 5 % type can be used in place of a 10 % type for example), but a component having a higher tolerance than the specified (such as a 20 % type instead of a 10% type) is not acceptable.

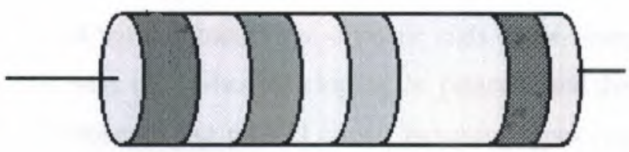


Figure 2.2: Shows the resistor configuration.

Resistors also have a power rating, and this is not usually marked on the component (except in the case of high power types where the value and wattage may both be written on the component, no color codes being used). For the circuits in this project ordinary miniature 1/8, 1/4, or 1/3 watt resistors are satisfactory since the power levels involved are very low. Higher power resistors are not really suitable, and this is due to their physical rather than electrical characteristics. Higher wattage resistors are physically quit large and would be difficult to fit into the available space, and some have very thick lead-out wires which will not fit easily into solder less breadboards.

Incidentally, in order to aid the selection of a resistor of the correct value, all components lists in this project have the color code for each resistor alongside value. Thus, even if you do not understand the resistor color coding system you should still is able to pick out the appropriate resistors with the aid of the components lists.

2.3 Capacitors

A capacitor is a device that stores energy in an electric field, by accumulating an internal imbalance of electric charge and the value of the units called “farad”. Most capacitors used to look much the same as resistors but were normally a little larger and had the value written on their body rather than marked using a color code. Modern capacitors are still generally some what larger than resistors, but they often have both lead-out wires coming from the same end of the component as this makes them more convenient for use with printed circuit boards. Also, they often have rectangular rather than tubular bodies.

The project use’s several types of capacitor, including electrolytic types. These are available as axial (with the lead-out wires coming from opposite ends of the component) and printed circuit types. Axial electrolytic were used when developing the projects, and the layout drawings show the electrolytic as axial components, but printed circuit mounting types can be fitted into the layouts with no difficult.

An important point to bear in mind with electrolytic capacitors is that they are polarized, and most be connected to the circuit the right way around (resistors, and most other types of capacitor can be connected either way round). In the component layouts given in this project the lead-out wires are identified by (+) and (-) signs, and the lead-out wires of the actual components are identified (+) and (-) signs on the bodies of the components. Additionally, axial types usually have an indentation around one end of the components body, and this indicates the end of the component from which the positive (+) lead-out wire emerges and these is shown in figure 2.3 below.

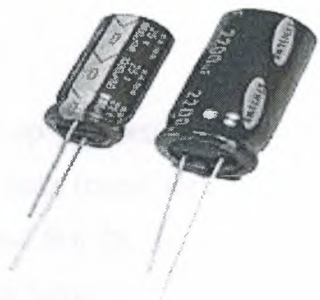


Figure 2.3: This image shows a pair of radial electrolytic capacitors with leads. The industry standard, as shown, is that the positive lead is longer than the negative lead. The arrows on the minus sign stripe are pointing to the left end of the cap, which means that the left end is the negative lead-out.

One of the capacitor will be used in this project is a tantalum bead type, and like an electrolytic capacitor this is a polarized component. Tantalum capacitors are normally small (see figure 2.4), bead shaped components (which are sometimes called tantalum bead capacitors) which have both lead-out wires coming from the same end of the body. The positive lead-out wire should be identified by the appropriate sign marked on the body of the component. Be careful to connect the tantalum capacitor the right way round as capacitor of this type are easily damaged by a voltage of the wrong polarity.

Figure 2.4: This is a radial tantalum capacitor.

2.3.1 Capacity

This analogy should help you better understand capacity. In the following diagram (Figure 2.5), you can see 2 tanks (capacitors) of different diameter (different capacitance). You should readily understand that the larger tank can hold more water [if they're filling to the same level (voltage)]. The larger capacitor has more area in which to store water. Just as the larger capacitor's, larger plate area would be able to hold more electrons.

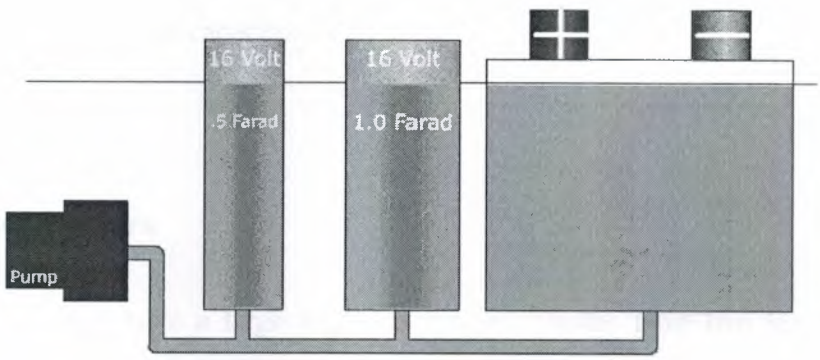


Figure 2.5: Capacities.

2.3.2 Capacitors and DC voltage

When a DC voltage source is applied to a capacitor there is an initial surge of current, when the voltage across the terminals of the capacitor is equal to the applied voltage, the current flow stops. When the current stops flowing from the power supply to the capacitor, the capacitor is 'charged'. If the DC source is removed from the capacitor, the capacitor will retain a voltage across its terminals (it will remain charged). The capacitor can be discharged by touching the capacitor's external leads together. When using very large capacitors (1/2 farad or more) in your car, the capacitor partially discharges into the amplifier's power supply when the voltage from the alternator or battery starts to fall. Keep in mind that the discharge is only for a fraction of a second. The capacitor can not act like a battery. It only serves to fill in what would otherwise be very small dips in the supply voltage.

2.3.3 Capacitors and AC voltage

Generally, if an AC voltage source is connected to a capacitor, the current will flow through the capacitor until the source is removed. There are exceptions to this situation and the AC current flow through any capacitor is dependent on the frequency of the applied AC signal and the value of the capacitor.

2.4 Semiconductors

Semiconductors have a large amount of types. Diodes have two lead-out wires are called anode (A) and cathode (K). Transistors have three lead-out wires are called the base, emitter and collector. It is essential that these are connected correctly, as there is no chance of project working if they are not. Fortunately modern transistors are not easily damaged, and incorrect connection is not likely to damage a device (or other components in the circuit), two transistors are used in this project and they will be mentioned ahead.

2.4.1 Diodes

Diodes are non-linear circuit elements. They are made of two different types of semiconductors right next to each other. Qualitatively we can just think of an ideal diode have two regions: a conduction region of zero resistance and an infinite resistance non-conduction region. For many circuit applications, the behavior of a (junction) diode depends on its polarity in the circuit. If the diode is reverse biased (positive potential on N-type material) the current through the diode is very small. The following figure is shown the characteristic of diode.

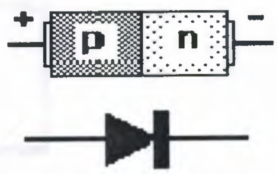


Figure 2.6: Diode.

- Forward Biased P-N Junction: forward biasing the p-n junction drives holes to the junction from the p-type material and electrons to the junction from the n-type material. At the junction the electrons and holes combine so that a continuous current can be maintained.

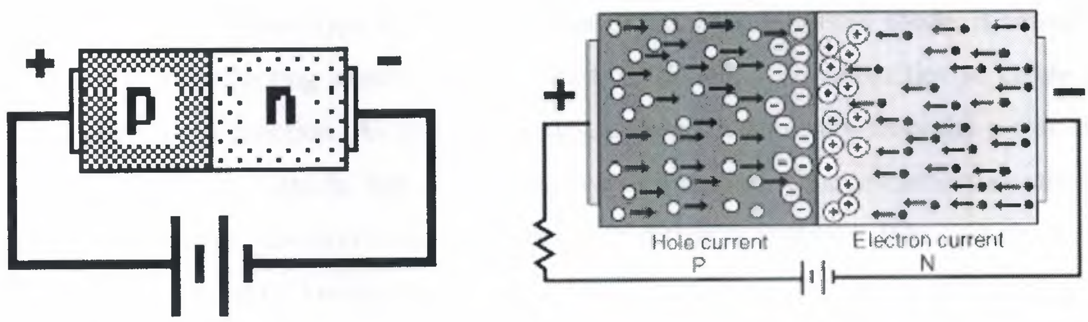


Figure 2.7: Forward Biased P-N Junction

- Reverse Biased P-N Junction: the application of a reverse voltage to the p-n junction will cause a transient current to flow as both electrons and holes are pulled away from the junction. When the potential formed by the widened depletion layer equals the applied voltage, the current will cease except for the small thermal current.

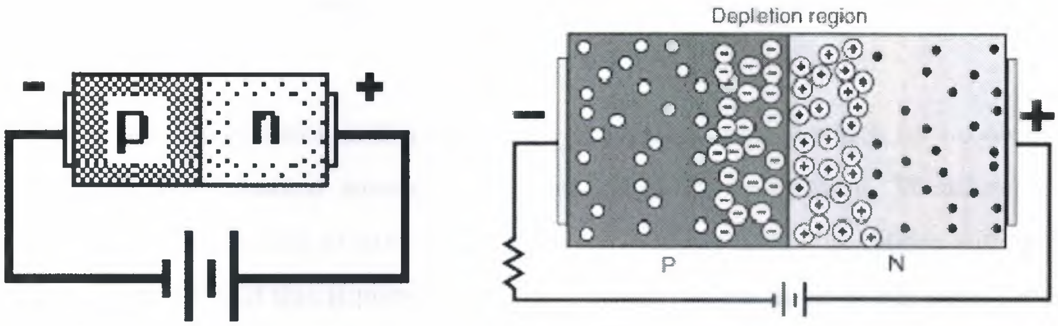


Figure 2.8: Reverse Biased P-N Junction

2.4.1.1 Light Emitting Diode (LED)

An LED is a special type of semiconductor diode. Like a normal diode, it consists of a chip of semiconducting material impregnated, or doped, with impurities to create a structure called a p-n junction. As in other diodes, current flows easily from the p-side or anode to the n-side, or cathode, but not in the reverse direction. Charge-carriers-electrons and holes flow into the junction from electrodes with different voltages. When an electron meets a hole, it falls into a lower energy level, and releases energy in the form of a photon as it does so.

The wavelength of the light emitted, and therefore its color, depends on the bandgap energy of the materials forming the p-n junction. In silicon or germanium diodes, the electrons and holes recombine by a non-radiative transition which produces no optical emission, because these are indirect bandgap materials. The materials used for an LED have a direct bandgap with energies corresponding to near-infrared, visible or near-ultraviolet light.

The main point to note about diodes is that they are polarized components and must be connected into circuit the write way round if the circuit is to function properly. The cathode (+) lead of a diode is normally marked by a band around the appropriate end of the component's body, and this band is shown on the component layout diagrams in order to indicate diode polarity.

One minor complication is that there are a few diodes around which for no obvious reason, have the band marked around the wrong end of the component. Therefore, if a circuit which uses diodes fails to work it would be advisable to check the diodes with some sort of component tester if this is possible. Another minor complication is that some diodes a number of bands marked around their body, and in such cases the manufacturer uses these bands to indicate the diodes type number rather than simply marking the type number on the component. In such cases the bands are normally offset towards the end of the component form which the cathode (+) lead-out wire emanates. Figure 2.9 below should help to clarify this point.

Figure 2.9: Typical LED.

2.4.2 Transistors

A transistor is a semiconductor device, commonly used as an amplifier. The transistor is the fundamental building block of the circuitry that governs the operation of computers, cellular phones, and all other modern electronics.

Because of its fast response and accuracy, the transistor may be used in a wide variety of digital and analog functions, including amplification, switching, voltage regulation, signal modulation, and oscillators. Transistors may be packaged individually or as part of an integrated circuit chip, which may hold thousands of transistors in a very small area.

Modern transistors are divided into two main categories:

- Bipolar Junction Transistors (BJTs).
- Field Effect Transistors (FETs).

Application of current in BJTs and voltage in FETs between the input and common terminals increases the conductivity between the common and output terminals, thereby controlling current flow between them. The transistor characteristics depend on their type.

2.4.2.1 Bipolar Junction Transistors (BJTs)

The Bipolar Junction Transistor (BJT) was the first type of transistor to be mass-produced. Bipolar transistors are so named because they conduct by using both majority and minority carriers. The three terminals of the BJT are named emitter, base and collector. Two p-n junctions exist inside a BJT: the base/emitter junction and base/collector junction. The BJT is commonly described as a current-operated device because the collector/emitter current is controlled by the current flowing between base and emitter terminals. Unlike the FET, the BJT is a low input-impedance device, as the base/emitter voltage (V_{be}) is increased the base/emitter current and hence the collector/emitter current (I_{ce}) increase exponentially ($I_{ce} \propto K^{V_{be}}$ where K is a constant). Because of this exponential relationship the BJT has a higher transconductance than the FET.

Bipolar transistors can be made to conduct by light, since absorption of photons in the base region generates a photocurrent that acts as a base current; the collector current is approximately beta times the photocurrent. Devices designed for this purpose have a transparent window in the package and are called phototransistors.

2.4.2.2 Field Effect Transistors (FETs)

The Field-Effect Transistor (FET), sometimes called a unipolar transistor, uses either electrons (N-channel FET) or holes (P-channel FET) for conduction. The four terminals of the FET are named source, gate, drain, and body (substrate). On most FETs the body is connected to the source inside the package and this will be assumed for the following description.

A voltage applied between the gate and source (body) controls the current flowing between the drain and source, as the gate/source voltage (V_{gs}) is increased the drain/source current (I_{ds}) increases roughly parabolically ($I_{ds} \propto V_{gs}{}^2$). In FETs the drain/source current flows through a conducting channel near the gate. This channel connects the drain region to the source region. The channel conductivity is varied by the electric field generated by the voltage applied between the gate/source terminals. In this way the current flowing between the drain and source is controlled.

FETs are divided into two families:

- Junction Field Effect Transistors (JFETs).
- Insulated Gate Field Effect Transistors (IGFETs).

2.4.2.2.1 Junction FETs

All field-effect transistors are unipolar rather than bipolar devices. That is, the main current through them is comprised either of electrons through an N-type semiconductor or holes through a P-type semiconductor. In a junction field-effect transistor, or JFET, the controlled current passes from source to drain or from drain to source as the case may be. The controlling voltage is applied between the gate and source. Note how the current does not have to cross through a PN junction on its way between source and drain: the path (called a channel) is an uninterrupted block of semiconductor material.

2.4.2.2.2 Insulated Gate FETs

Insulated gate field-effect transistors are unipolar devices just like JFETs that are; the controlled current does not have to cross a PN junction. There is a PN junction inside the transistor, but its only purpose is to provide that non-conducting depletion region which is used to restrict current through the channel. IGFET exploits a similar principle of a depletion region controlling conductivity through a semiconductor channel, but it differs primarily from the JFET in that there is no direct connection between the gate lead and the semiconductor material itself. Rather, the gate lead is insulated from the transistor body by a thin barrier, hence the term insulated gate. This insulating barrier acts like the dielectric layer of a capacitor, and allows gate-to-source voltage to influence the depletion region electro-statically rather than by direct connection.

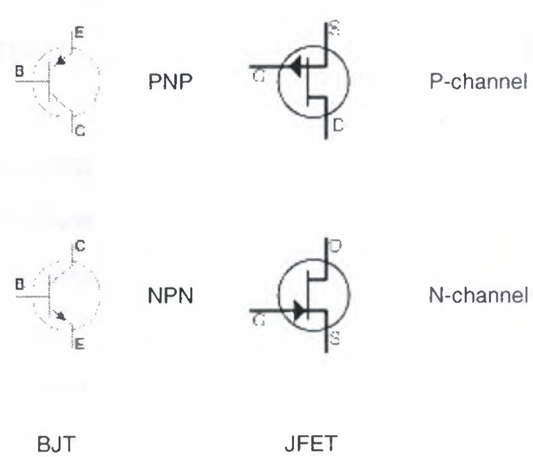
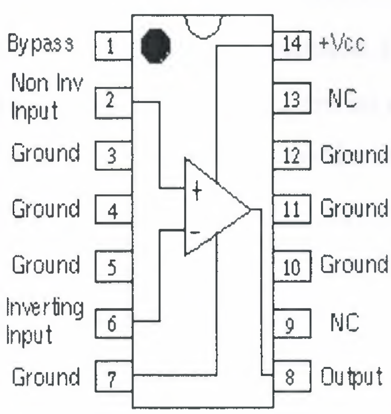


Figure 2.10: BJT and JFET Symbols.

2.5 Integrated circuits

Integrated circuits have a wide variety of packages, but here we are only concerned with two types of integrated circuits, the TLO81CP operation amplifier has another version of 14 pin DIL which is TLO84CP. The TLO84CP has a 14 pin DIL (Dual in Line) plastic package, and the LM380N has a 14pin DIL plastic package. As can be seen from the pin out diagram of figure 2.11 below, the two packages are essentially the same, the 14 pin version simply being an extended version of the 8pin one as can be seen from the pin out diagram of figure 2.12 below. Note that integrated circuit pin out diagrams are top views, and not base views like transistor lead out diagrams. In other words, the device is pictured looking at the side that carries the type number and with the pins pointing away from the viewer.

The only point to watch when connecting one of the integrated circuits is to make sure that it is not plugged in upside down. Check that the independent on the top of the package and at one end of the device corresponds properly with the component layout diagram (where this indentation will always be clearly shown).



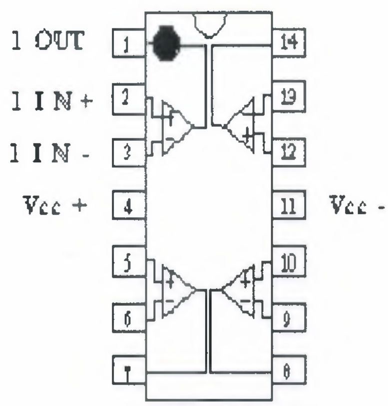


Figure 2.11: Shows 14 pin DIL integrated circuit top views of the LM380 and TL084CN from left to right.

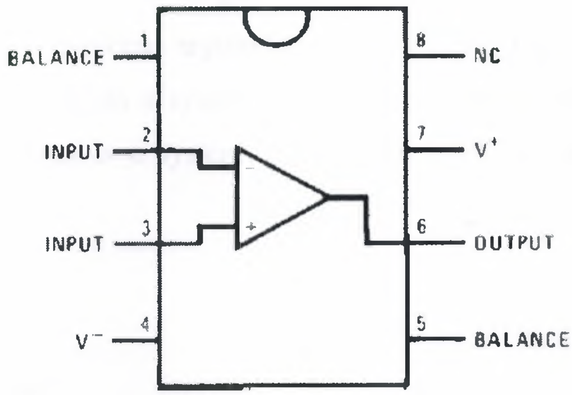


Figure 2.12: Shows the 8 pin out version of TLO81CP.

There are alternative operational amplifier integrated circuits that can be used instead of the TLO81CP device incidentally, but only internally compensated BIFET types are suitable as it will not function properly in some of the project. Alternative operational amplifier integrated circuits that are suitable are the LF351, TLO71CP and TLO84CN devices. Although some FET (Field Effect Transistors) operational amplifier devices require special handling precautions, these are the types which have MOSFET (Metal-Oxide Semiconductor Field-Effect) input stages, and not the BIFET devices mentioned above which can be handled like any normal semiconductor component without risk of damage. Note that there are no common alternatives to LM380N device and that the 14 pin version of this device must be used.

2.6 Switches

A 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 (e.g., a telephone service), mechanical switches have long been replaced by electronic variants which can be intelligently controlled and automated.

The switch is referred to as a "gate" when abstracted to mathematical form. In the philosophy of logic, operational arguments are represented as logic gates. The use of electronic gates to function as a system of logical gates is the fundamental basis for the computer (i.e. a computer is a system of electronic switches which function as logical gates).

2.6.1 Types of Switches

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

Figure 2.13: Toggle Switch Symbol.

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

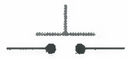


Figure 2.14: Push Button Switch Symbol.

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

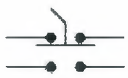


Figure 2.15: Selector Switch Symbol.

2.7 Batteries

A devices which are storing charge, the capacity of a battery to store charge is often expressed in ampere hours (1 A·h = 3600 coulombs). If a battery can provide one ampere (1 A) of current (flow) for one hour, it has a real-world capacity of 1 A·h. If it can provide 1 A for 100 hours, its capacity is 100 A·h. Because of the chemical reactions within the cells, the capacity of a battery depends on the discharge conditions such as the magnitude of the current, the duration of the current, the allowable terminal voltage of the battery, temperature, and other factors.

The cells in a battery can be connected in parallel, series, or in both (see figure 2.16 below which shows a 1.5 volt cell). A parallel combination of cells has the same voltage as a single cell, but can supply a higher current (the sum of the currents from all the cells). A series combination has the same current rating as a single cell but its voltage is the sum of the voltages of all the cells. Most practical electrochemical batteries, such as 9 volt flashlight (torch) batteries and 12 V automobile (car) batteries, have a series structure. Parallel arrangements suffer from the problem that, if one cell discharges faster than its neighbor, current will flow from the full cell to the empty cell, wasting power and possibly causing overheating. Even worse, if one cell becomes short-circuited due to an internal fault, its neighbor will be forced to discharge its maximum current into the faulty cell, leading to overheating and possibly explosion. Cells in parallel are therefore usually fitted with an electronic circuit to protect them against these problems. In both series and parallel types, the energy stored in the battery is equal to the sum of the energies stored in all the cells.

Figure 2.16: Shows a battery cell.

A battery can be simply modeled as a perfect voltage source (i.e. one with zero internal resistance) in series with a resistor. The voltage source depends mainly on the chemistry of the battery, not on whether it is empty or full. When a battery runs down, its internal resistance increases. When the battery is connected to a load (e.g. a light bulb), which has its own resistance, the resulting voltage across the load depends on the ratio of the battery's internal resistance to the resistance of the load. When the battery is fresh, its internal resistance is low, so the voltage across the load is almost equal to that of the battery's internal voltage source. As the battery runs down and its internal resistance increases, the proportion of its internal voltage that gets through the internal resistance to appear at the load gets smaller, so the battery's ability to deliver power to the load decreases.

Generally batteries can be divided into two main types: Non-rechargeable (disposable) and Rechargeable.

2.7.1 Non-rechargeable Batteries

Disposable batteries, also called primary cells, are intended to be used once, until the chemical changes that induce the electrical current supply are complete, at which point the battery is discarded. These are most commonly used in smaller, portable devices with either low current drain, only used intermittently, or used well away from an alternative power source. Primary cells can be recharged with varying degrees of success using a specialized charging technique called periodic current reversal which is a form of biased AC (i.e. alternating current with a DC offset).

Figure 2.17: Various batteries(clockwise from bottom left): two 9-volt, two "AA", one "D", a cordless phone battery, a camcorder battery, a 2-meter handheld ham radio battery and a button battery, one "C" and two "AAA" plus.

2.7.2 Rechargeable Batteries

By contrast, rechargeable batteries or secondary cells can be re-charged after they have been drained. This is done by applying externally supplied electrical current which causes the chemical changes that occur in use to be reversed. Devices to supply the appropriate current are called chargers or rechargers.

The oldest form of rechargeable battery still in modern usage is the "wet cell" lead-acid battery (see figure 2.17 which shows several types of batteries). This battery is notable in that it contains a liquid in an unsealed container, requiring that the battery be kept upright and the area is well-ventilated to deal with the explosive hydrogen gas which is vented by these batteries during overcharging. The lead-acid battery is also very heavy for the amount of electrical energy it can supply. Despite this, it's low manufacturing cost and its high surge current levels make its use common where the weight and ease of handling are not concerns.

2.8 Loudspeakers

A *loudspeaker*, or *speaker*, is an electromechanical transducer which converts an electrical signal into sound. The term loudspeaker is used to refer to both the device itself, and a complete system consisting of one or more loudspeaker *drivers* (as the individual units are often called) in an enclosure. The loudspeaker is the most variable element in an audio system, and is responsible for marked audible differences between systems.

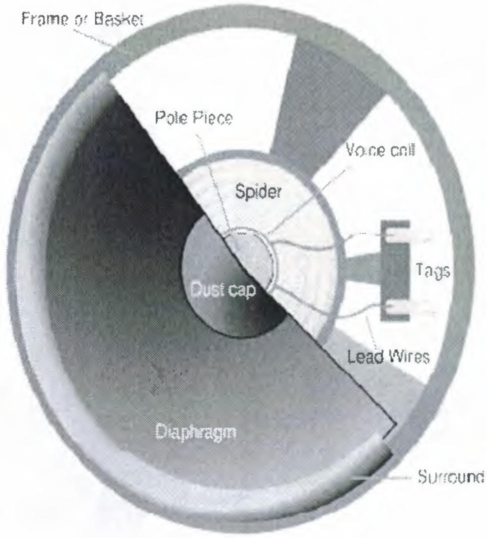


Figure 2.18: Close up of a loudspeaker driver.

Figure 2.18 shows a cut-away view of a dynamic loudspeaker. The lead wires as shown are for illustration purposes. Commonly the voice coil wires are soldered to the lead wires and the soldered joints are glued to the diaphragm, close to the dust-cap periphery.

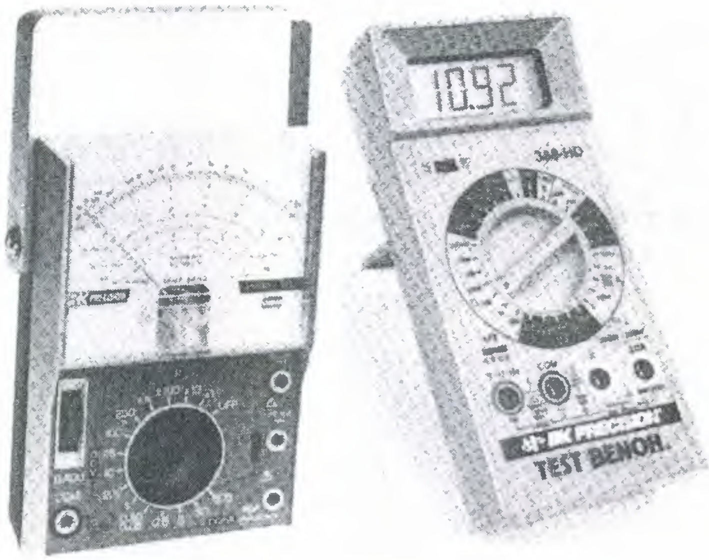
2.9 Basic Circuit Measurements

Voltage, current, and resistance measurements are commonly required in electronics work. Special types of instruments are used to measure these basic electrical quantities.

The instrument used to measure voltage is a voltmeter, the instrument used to measure current is an ammeter, and the instrument are combined into a signal instrument known as a multimeter, or VOM (volt-ohm-millimeter), in which you can choose what specific quantity to measure by selecting the switch setting.

Typical multimeters are shown in figure 2.19. Part (a) shows an analog meter, that is, with a needle pointer, and part (b) shows a digital multimeter (DMM), which provides a digital readout of the measured quantity.

An electronics technician cannot function without knowing how to measure current, and resistance.



(a) (b)

Figure 2.19: Typical Multimeters. (a) Analog, (b) Digital

2.9.1 Meter symbols

Throughout this course, certain symbols will be used in circuits to represents the different meters, as shown in figure 2.20. You may see any of three types of symbols for voltmeters, ammeters, and ohmmeters, depending on which symbol most effectively conveys the information required. Although the digital meter is much more widely used than the analog meter in industry, we will use the analog meter symbol in certain situations to illustrate the better operation of a circuit when relative measurements or changes in quantities need to be depicted by the position or movement of the needle. The digital meter symbol is used when fixed values are indicated in a circuit. The general schematic symbol is used to indicate placement of meters in a circuit when no values or value changes need to be shown.

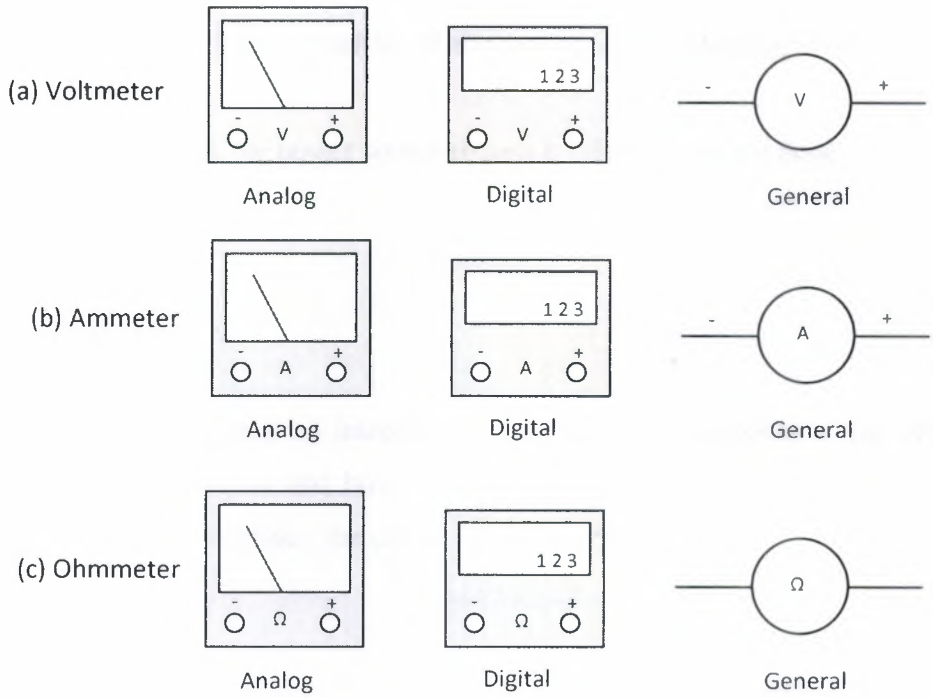


Figure 2.20: Meter Symbols used in this Course

2.10 Safety Guidelines

1. Read the data sheet of any electrical instrument before using it in the circuit.
2. Be careful with chips pins when we plant them in the board not to break them.
3. Be careful while connecting the ground and voltage supply because mixing them will cause the burning of the chips.
4. Be careful with the arrangement of the transistor pins (base, emitter, and collector) not to mix them, which lead to short cut and sometimes to be burned.
5. Be careful when shifting probes in a live/active circuit; be sure to shift using only one hand. It is better to keep the other hand off other surfaces and behind your back.
6. After finishing the connection of the circuit try to check that there is no short cut between the electric components

7. Be careful with the polarities of the power source (battery) when we connect it in any circuit.
8. Be careful with the power source to turn it off after you are done.

2.11 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.

3- ALARM SYSTEMS AND WATER DETECTORS

3.1 Overview

This chapter will introduce general information about alarm systems and different types of alarm systems and specially flood warning systems.

3.2 Alarm System Categories

The Alarm System is a detection signal system that is considered to be the combination of interrelated signal initiating devices, signal indicating devices, control equipment, and interconnecting wiring installed for a particular application monitored Alarm System.

An alarm system which reports detected conditions to a monitoring facility, monitoring facilities are usually located off-site from the protected premises. When a monitoring facility is located within the building or complex that includes the protected premises, the alarm system is called a Proprietary system.

3.3 Types of Alarm Systems

Alarm systems are divided into several broad categories, as listed below. The terms used to identify each type may vary, depending on who is using the term.

3.3.1 Fire Alarm

A system that detects and reports a fire in the protected premises, detects and reports water flowing in a sprinkler system, or detects and reports dangerous conditions such as smoke or overheated materials that may combust spontaneously.

3.3.2 Hold-Up Alarm

A system that reports the presence of one or more criminals attempting to take goods or funds with implied or actual threat of force.

3.3.3 Duress Alarm

A system that reports the presence of one or more persons trying to force an individual to enter, or re-enter, a facility against the individual's will. Note: Although the triggering devices for hold-up, duress, and panic alarms are often the same or similar, police response may differ. A duress alarm, for example, may be designed to detect and silently report an employee being forced back into a protected facility to provide access to a safe, vault, drug storage area, or area containing confidential records. The intent is generally not to make the criminal aware that a call for help is being triggered to the monitoring facility. In a residential environment, a duress alarm could signal an abduction or rape attempt.

3.3.4 Panic Alarm

A system that reports a more general type of perceived emergency, including the presence of one or more unruly or inebriated individuals, unwanted persons trying to gain entry, observed intruders in a private yard or garden area, or a medical emergency. Provides police with little specific information, but is often the only way that a user can call for assistance under abnormal conditions.

3.3.5 Single Sensor Alarm

A sensor detects the emergency condition and causes an alarm to be transmitted to the monitoring facility or to be indicated audibly or visually. Some sensors use single switches to trigger the alarm; other sensors require that two switches activate before the alarm is triggered. Some sensors use two or more detection technologies and require that two or more technologies sense the emergency condition before the alarm is triggered. All of these are single sensors.

3.3.6 Multiple Sensor Alarm

An alarm generated when at least two separate sensors detect the condition before the alarm is triggered. In some instances, redundant sensors in different system zones must trip before the alarm is triggered. However, activation of one sensor may trigger a trouble or pre-alarm signal. For example: Smoke detectors that is cross-zone-wired so that two or more zones must detect the smoke before an alarm condition creates Public emergency response.

3.3.7 Sequential Alarm

When two or more sensors sequentially detect a condition and each triggers an alarm. When this happens, there is a high probability that a real emergency exists.

3.3.8 Industrial Process Alarm

A system that provides supervision for a wide variety of commercial and industrial processes, including sump-pump operations, water levels, pressures temperatures, chemical processes and special furnace operations. Normally, users (employees or sub-contractors) are notified when these systems report problems.

3.4 Users of Alarm Systems

- **User:** The person responsible for the correct operation of the alarm system (the boss, the buyer). Not necessarily the person who actually operates the alarm system.

- **System Operator:** A person who operates an alarm system. Such person is assumed to be taught how to arm, or how to arm and disarm the system, and how to prevent alarm signals from being transmitted to the monitoring facility unnecessarily or by mistake. A system operator may, or may not, be an authorized user agent.

3.5 Control Equipment at Protected Location

Equipment and devices that make the system at the user location function properly. We will explain about control equipment start by keypad.

- **Keypad:** The portion of the arming station containing numbered push buttons similar to those on telephones or calculators. These buttons control the arming or disarming of the system.

- **Signal Indicating Device:** A device that provides an audible or visual indication that an emergency condition has been detected. Audible devices include electronic sounders, bells, horns, and sirens. Visual devices include incandescent or strobe lights. Signal indicating devices also include panels that provide lamps or schematic building diagrams to identify the specific location of the sensor or sensors that have detected an emergency.

- **Delay Zone:** One or more sensors in an alarm circuit, when triggered, a specific time delay results before an alarm condition is generated. Delay zones are often created for the most frequently used exit and entry doors to allow for sufficient time for normal entry and exit without causing alarm conditions.

3.6 Sensors (In Alarm Systems)

- **Double-Action Trigger:** A sensor that requires separate simultaneous actions, or closely-spaced sequential actions before an alarm is transmitted to the monitoring facility. If only one action is taken, a trouble signal may be transmitted or logged and annunciated.

- **Dual-Technology Trigger:** A sensor that uses two or more separate technologies, two of which must sense the designated condition before the device triggers an alarm signal. If only one technology senses the condition, a trouble signal may be transmitted or logged and annunciated.

- **Multiple-Activation Trigger:** This is not really a special type of sensor. Rather it is a system-designed feature that requires two or more sequential activations of the sensor before an alarm signal is transmitted to the monitoring facility.

- **The mercury Switch:** A set of electrical contacts that are opened or closed as a sphere of liquid mercury encompasses them or is re-moved from them inside a hermetically sealed enclosure. Usually the enclosure is tilted in one direction to close the switch and in the opposite direction to open it.

- **The Capacity Sensor:** A sensor that detects a change in capacitance when a person touches or comes in close proximity to an object, such as a safe or file cabinet, insulated from electrical ground potential.

- **Vibration Sensor**: A sensor that detects vibrations generated during forced entry or an attempted forced entry.

- **Sprinkler System Water Flow Sensor:** A sensor that detects the flow of water in a sprinkler system.

- **The Wet-Pipe Flow Sensor:** A sensor that detects the flow of water in a wet-pipe sprinkler system.

- **Dry-Pipe Flow Sensor:** A sensor that detects the flow of water in a dry-pipe sprinkler system.

- **Open-Pipe (Deluge) Flow Sensor**: A sensor that detects the flow of water in an open-pipe sprinkler system.

3.7 Flood Warning Systems

A flood (in Old English flod, a word common to Teutonic languages) is an overflow of water, an expanse of water submerging land, a deluge. In the sense of "flowing water", the word is applied to the inflow of the tide, as opposed to the outflow or ebb.

Flood warning systems are systems designed to give forewarning of the likelihood of flooding in order to save lives and property. The flood warning systems ensures that the end users of the forecast receive appropriate warnings in time to take effective action to save lives and minimize damage to property.

3.8 Operation of the Flood

Flood depending on water, at any one time, this volume of water is in many different forms. It can be liquid, as in oceans, rivers and rain; solid, as in the glaciers of the north and south poles; or gaseous, as in the invisible water vapor in the air. Water changes from state to state as it is moved around the planet by wind currents. Wind currents are generated by the heating activity of the sun. The sun shines more on the area around earth's equator than it does on areas farther north and south, causing a heat discrepancy over the surface of the globe. In warmer regions, hot air rises up into the atmosphere, pulling cooler air into the vacated space. In cooler regions, cold air sinks, pulling warmer air into the vacated space. The rotation of the earth breaks this cycle up, so there are several, smaller air-current cycles all along the globe. Driving by these air current cycles, earth's water supply moves in a cycle of its own. When the sun heats the oceans, liquid water from the ocean's surface evaporates into water vapor in the air. The sun heats this air (water vapor and all) so that it rises through the atmosphere and is carried along by wind currents. As this water vapor rises, it cools down again, condensing into droplets of liquid water (or crystals of solid ice). Collections of these droplets are called clouds. If a cloud moves into a cooler environment, more water may condense onto these droplets. If enough water accumulates in this way, the droplets become heavy enough that they fall through the air as precipitation (rain, snow, sleet or hail). Some of this water collects in large, underground reservoirs, but most of it forms rivers and streams that flow into the oceans, bringing the water back to its starting point and this can be seen in figure 3.1 below.

Overall, wind currents in the atmosphere are fairly consistent. At any particular time of year, currents tend to move in a certain way across the globe. Consequently, specific locations generally experience the same sort of weather conditions year to year. But on a day-to-day basis, the weather is not so predictable. Wind currents and precipitation are affected by many factors, chiefly geography and neighboring weather conditions. A huge number of factors combine in an infinite variety of ways, producing all sorts of weather. Occasionally, these factors interact in such a way that a typical volume of liquid water collects in one area. For example, conditions occasionally cause the formation of a hurricane, which dumps a large quantity of rain wherever it goes. If a hurricane lingers over a region, or multiple hurricanes happen to move through the area, the land receives much more precipitation than normal.

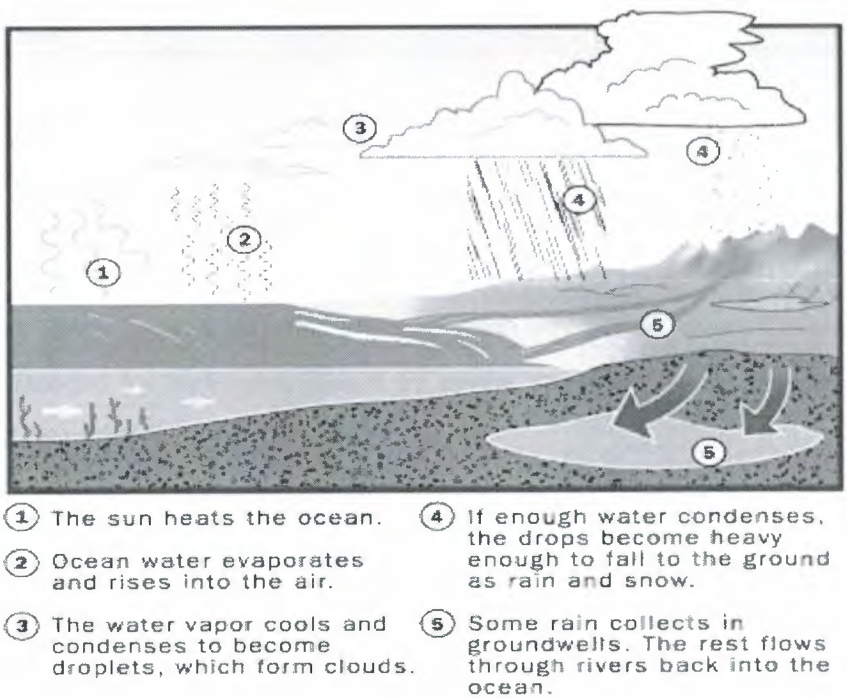


Figure 3.1: Shows how flood created.

Since waterways are formed slowly over time, their size is proportionate to the amount of water that normally accumulates in that area. When there is suddenly a much greater volume of water, the normal waterways overflow, and the water spreads out over the surrounding land. At its most basic level, this is what a flood is an anomalous accumulation of water in an area of land.

A series of storms bringing massive amounts of rain is the most common cause of flooding, but there are others.

3.9 Types of Flood

These statistics are restricted to floods which occur in stream and river systems and are divided into several categories:

3.9.1 Flash Floods

These kinds of periodic floods occur naturally on many rivers, forming an area known as the flood plain. These river floods usually result from heavy rain, sometimes combined with melting snow, which causes the rivers to overflow their banks. A flood that rises and falls rapidly with little or no advance warning that is why called flash flood. Flash floods usually result from intense rainfall over a relatively small area. Coastal areas are occasionally flooded by high tides caused by severe winds on ocean surfaces, or by tidal waves caused by undersea earthquakes.

Common source of flooding is unusual tidal activity that extends the reach of the ocean farther inland than normal. This might be caused by particular wind patterns that push the ocean water in an unusual direction. It can also be caused by tsunamis, large waves in the ocean triggered by a shift in the earth's crust.

3.9.2 River Floods

Flooding along rivers is a natural and inevitable part of life. Some floods occur seasonally when winter or spring rains, coupled with melting snows, fill river basins with too much water, too quickly. Torrential rains from decaying hurricanes or tropical systems can also produce river flooding.

3.9.3 Coastal Floods

Winds generated from tropical storms and hurricanes or intense offshore low pressure systems can drive ocean water inland and cause significant flooding. Escape routes can be cut off and blocked by high water. Coastal flooding can also be produced by sea waves called tsunamis, sometimes referred to as tidal waves. These waves are produced by earthquakes or volcanic activity.

3.9.4 Urban Floods

As land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb rainfall. Urbanization increases runoff 2 to 6 times over what would occur on natural terrain. During periods of urban flooding, streets can become swift moving rivers, while basements can become death traps as they fill with water.

3.9.5 Ice Jam floods

Floating ice can accumulate at a natural or man-made obstruction and stop the flow of water.

Although computerization of data collection and analysis has been a huge help, the task of flood prediction is still not an easy one. Before an estimate of flood height and arrival can be made, estimates have to be made of three major components of a flood, which are:

- **Base Flow:** Is the amount of water already in the stream, usually contributed by the natural release of ground water?

- **Runoff:** This can be determined by the amount of rain or melt water, ground and soil saturation, and the effect of any dams or diversions.

- **Routed Flow:** This is amount of water moving down from upstream. By using all this information needs to be compared to history of previous floods to arrive at a best estimate for the height and duration of the flood. Once compiled, the information it may incorporate in flood watches or warnings broadcast on weather radio and relevant websites as it have been done in the modern countries which help people to save them self.

3.10 Main Causes of Floods

Floods from the sea can cause overflow or overtopping of flood-defenses like dikes as well as flattening of dunes or buffs. Land behind the coastal defense may be inundated or experience damage. Floods from sea may be caused by heavy storm (storm surge), high tide, a tsunami or a combination thereof.

Many rivers that flow over relatively flat land border on broad flood plains. When heavy rainfall or melting snow causes the river's depth to increase and the river to overflow its banks, a vast expanse of shallow water can rapidly cover the adjacent flood plain.

Monsoon rainfalls can cause disastrous flooding in some equatorial countries, such as Bangladesh, due to their extended periods of rainfall. Heavy rain caused substantial damage across Eastern Europe in the summers of 2003 and 2005. Normally river floods occur only in winter as a result of heavy rain in combination with melting of snow and glaciers in spring.

Although nature is normally blamed for the damage, the people are at least partly responsible for the presence of human activities in areas prone to the hazard of floods. Prevention is often aimed at containing floods with defenses, often increasing the potential damage in the long run. Nowadays, strategies to deal with floods more and more include evacuation strategies to avert damage.

3.11 Similar Systems

Here are some circuits which have been used to detect the water, which are:

3.11.1 Water Activated Alarm with 555 Timer

Hear a similar circuit which it can be used to give alarm (Sound) whenever water (Flood) exceeds its desired place. The circuit uses a 555 timer wired as a stable oscillator and powered by the emitter current of the BC109C, as it can be seen clearly in figure 3.2 below. Under dry conditions, the transistor will have no bias current and be fully off. As the probes (Contact) get wet, a small current flow between base and emitter and the transistor switches on. A larger current flows in the collector circuit enabling the 555 oscillator to sound. An On/Off switch is provided, and a non-reactive metal for the probe contacts should be used. Gold or silver plated contacts from an old relay may be used, however a cheap alternative is to wire alternate copper strips from a piece of Vero board. These will eventually oxidize over but as very little current is flowing in the base circuit, the higher impedance caused by oxidization is not important. No base resistor is necessary as the transistor is in emitter follower, current limit being the impedance at the emitter.

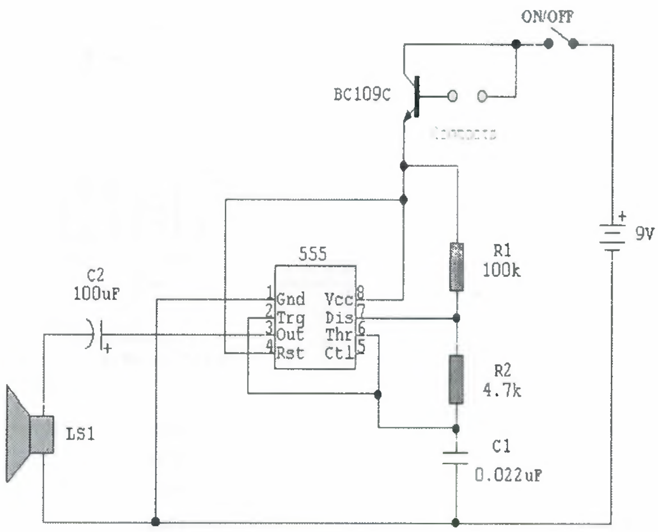


Figure 3.2: Shows a water activated alarm.

3.11.2 Water Level Indicator with alarm

This circuit not only indicates the amount of water present in the overhead tank but also gives an alarm when the tank is full. The circuit uses the widely available CD4066, bilateral switch CMOS IC to indicate the water level through LEDs. When the water is empty the wires in the tank are open circuited and the 180K resistors pulls the switch low, hence opening the switch and LEDs are OFF. As the water starts filling up, first the wire in the tank connected to S1 and the + supply are shorted by water. This closes the switch S1 and turns the LED1 ON, as the water continues to fill the tank, the LEDs 2, 3, and 4 lights up gradually, and this can be seen in figure 3.3 below. The numbers of levels of indication can be increased to 8 if 2 CD4066 ICs are used in a similar fashion.

When the water is full, the base of the transistor BC148 is pulled high by the water and this saturates the transistor, turning the buzzer ON.

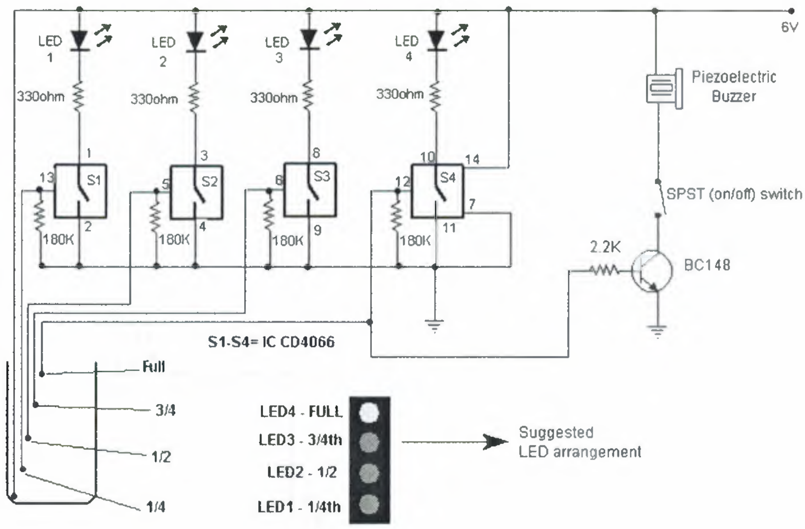


Figure 3.3: Shows the flow diagram illustrates how the system works.

3.11.3 Water Leak Detection Systems

Water damage can occur almost anywhere home, office, etc. Water using appliances and fixtures, such as refrigerators with icemakers, dishwashers and water heaters are common locations of leaks.

Unfortunately, slow leaks at these appliances and fixtures are often times impossible to see until it is too late. If it goes undetected, a slow leak can lead to rotting house framing and sub-floors, and can be a precursor to a catastrophic leak that can release several gallons of water per minute, causing extensive water damage. A water leak detection system may help prevent these problems. The circuit shown in figure 3.4 is an example for water seepage alarm. When a sensor probes bridge by water, circuit current will triggers alarm beeper.

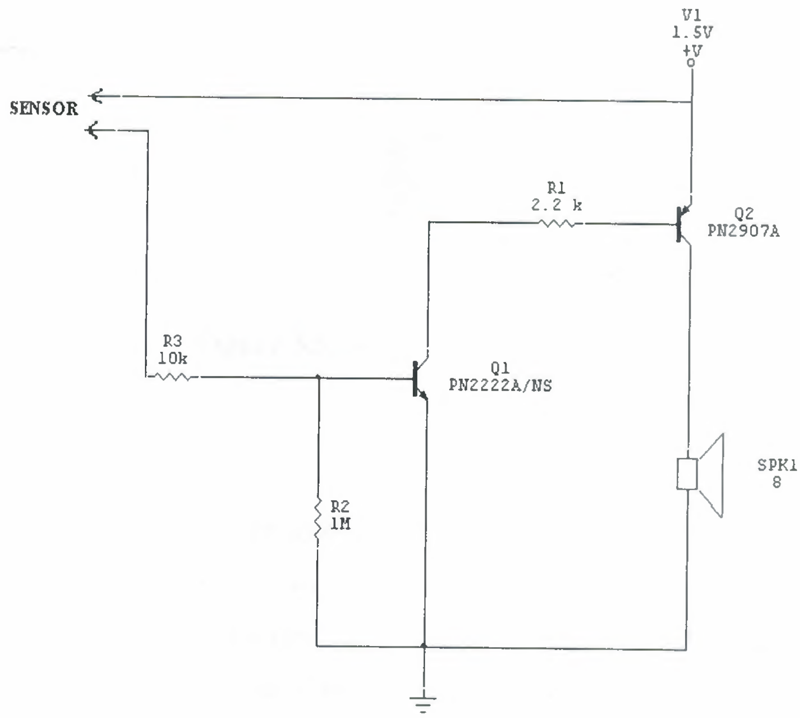


Figure 3.4: Shows the flow diagram illustrates how the system works.

3.11.3.1 Types of water leak detection

- **Passive leak detection systems:** Are intended to alert when there is leak. They generally sound an audible alarm tone, flashing light, and some may also send a signal. Passive systems are frequently battery-operated, stand-alone units. An example of moisture sensor can be located on the floor and activates the alarm when it becomes wet; figure 3.5 below shows passive water leak detection.

Figure 3.5: A Passive water leak detection.

- **Active leak detection systems:** Usually generate some type of alarm, but also perform a function that will stop the water flow. They feature a shut-off valve and some means to determine that a leak is occurring. Most devices use moisture sensors to detect a leak. Other systems use a flow sensor and a timer to determine that something is leaking and the water needs to be turned off.

An active leak detection system can either operate at an individual appliance or it can operate and control. Individual Appliance systems are designed to detect a leak from an appliance, such as a washing machine or water heater. When a leak is detected, an alarm is activated and the water supply to the appliance is automatically shut off, figure 3.6 shows an example of these devices.

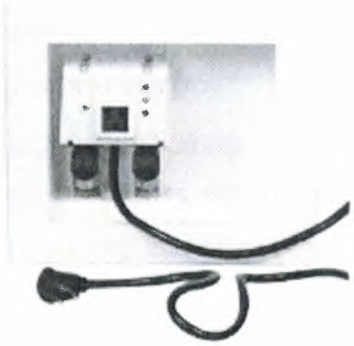


Figure 3.6: Individual appliance water leak sensing device.

Figure 3.7: Whole house water leak detection system using remote water sensors.

Remote water sensors can either be wired to the control panel or the remote water sensors can be wireless and "communicate" with control panel by radio signals, and figure 3.7 shows one of these devices.

3.12 Importance of Water Detectors

1. Helps prevent costly water damage which may not be covered by insurance.
2. Warns of leaks and overflows in bath, kitchen, laundry, furnace, computer rooms or anywhere there is a potential for leaks.
3. Low battery signal tells user when it's time to replace the battery.
4. Circuit test bar ensures system is working.
5. Alerts user within hearing range that water has reached desired level when used to monitor the filling of pools, tubs, sinks, aquariums and more.
6. An ideal backup system for sump and bilge pumps in residential, commercial and marine applications.

3.13 Summary

This chapter presented some information about alarm systems and other types of alarm systems and how we can use the alarm systems in general. Also we have seen the using of alarm systems specially the flood warning systems.

4- WATER ACTIVATED ALARM

4.1 Overview

This chapter will present an explanation for the water activated alarm circuit, and components which have been used in the circuit. The water activated alarm circuit has been divided into four stages. These stages are explaining clearly since input (sensor) sense the water until the output (sound and light) of the circuit.

4.2 Components of Water Activated Alarm

Here are the components which have been used to construct the circuit of flood warning system. There are eight resistors have been used in the circuit, which are:

- R1 100K (Brown, Black, Yellow, Gold).
- R2 100K (Brown, Black, Yellow, Gold).
- R3 33K (Orange, Orange, Orange, Gold).
- R4 33K (Orange, Orange, Orange, Gold).
- R5 2.7M (Red, Violet, Green, Silver).
- R6 1K (Brown, Black, Red, Gold).
- R7 10K (Brown, Grey, Orange, Gold).
- R8 18K (Brown, Grey, Orange, Gold).

There are four capacitors have been used while constructing the circuit, these capacitors were connected in different place on the circuit, which are:

- C1 100 ɳF Polyester (Brown, Black, Yellow, Black, Red).
- C2 33 µF 10 V Tantalum.
- C3 10 ɳF Polyester (Brown, Black, Yellow, Black, Red).
- C4 10 µF 25V Electrolytic.

There are four semiconductors have been used, two are integrated circuits (IC), and two are transistors (TR):

- IC1 TL 081 CP.
- IC2 LM 380N.
- Tr1 BC 109 C.
- Tr2 BC 179.

There is switch that has been used in the circuit, which is:

- S1 (SPST) Miniature toggle type.

There is also a loud speaker, which is:

- LS1 The value between (40 – 80 ohms).

The power supply for the circuit in a 9_volt battery:

- B1 PP6 Size 9 volt and connector to suit.

The circuit which is shown in figure 4.1 has been divided into fours stages in state to its operation, these stages are going to describe when sensor detects the flood until it gives the alarm.

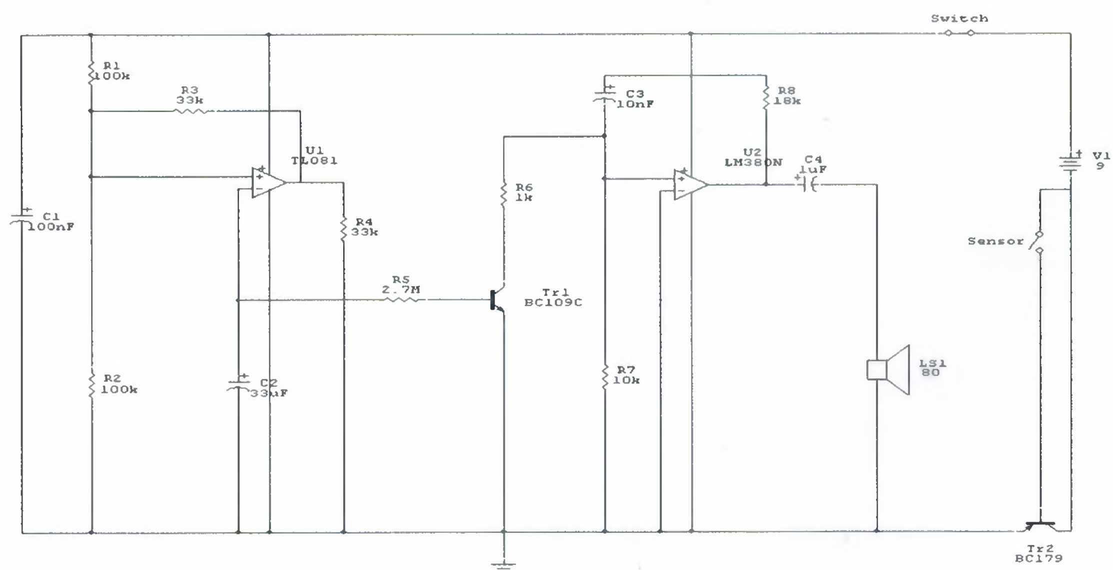


Figure 4.1: A complete circuit of water activated alarm.

4.3 First Stage

Stage one is explaining when sensor detect the water. The input (sensor) which is made by using two non-insulated wires placed on an insulated base, these wires are placed close to each other in order to be bridge by water whenever there is flood, as it's seen in figure 4.2 below.

Transistor 2 (TR2) is normally cut off and passes only minute leakage currents, but if the sensor is activated, TR2 is biased hard into conduction and supplies virtually the full supply voltage to the alarm generator circuit which is based on IC1 and IC2.

- **TR2 (BC179)**

BC179 are epitaxial PNP silicon transistors in TO 18 case (18 A 3 DIN 41876). The collector is electrically connected to the case. The transistors are particularly suitable for use in AF input and driver stages. Check the appendix for more characteristics.

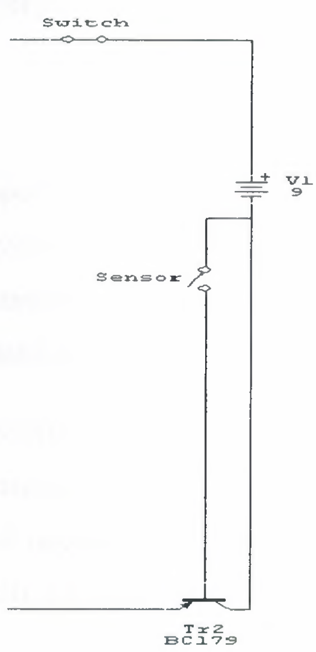


Figure 4.2: When sensor detect water transistor will be activated.

4.4 Second Stage

The output of integrated circuit 1 (IC1) simply switches from the high state to the low one and back again, producing a square wave output. This is not suitable as the modulation signal as it would simply switch the tone between the frequencies, rather than giving the smooth variation in pitch which is require. The signal across C3 is a form of saw tooth waveform which steadily rises as C2 charges, and falls as C2 discharges. It is not actually a linear, because there is some variation in the rate at which the voltage rises and falls but this is of no consequence here, and it is this signal that is used to modulate the tone generator. The required loose coupling to the base of transistor 1 is providing by R5.

As it can be seen in figure 4.3 below, IC TLO81CP has been used in the circuit. The schematic circuit diagram inside the IC contain an operation amplifier which some times called deferential amplifier because it has inverting and non-inverting inputs, and the figure 4.4 below shows an schematic circuit diagram of the operation amplifier (Op-Amp), operation amplifier is an integrated circuit, is microcircuit in which all the component have been integrated (combined) on a single chip.

- **IC1 (TL081CP)**

The TL08_JFET-input operational amplifier family is designed to offer a wider selection than any previously developed operational amplifier family. Each of these JFET-input operational amplifiers incorporates well-matched, high voltage JFET and bipolar transistors in a monolithic integrated circuit.

Device types with a C suffix are characterized for operation from 0°C to 70°C, those with an I suffix are characterized for operation from –40°C to 85°C, and those with an M suffix are characterized for operation over the full military temperature range of –55°C to 125°C. Check the appendix for more characteristics.

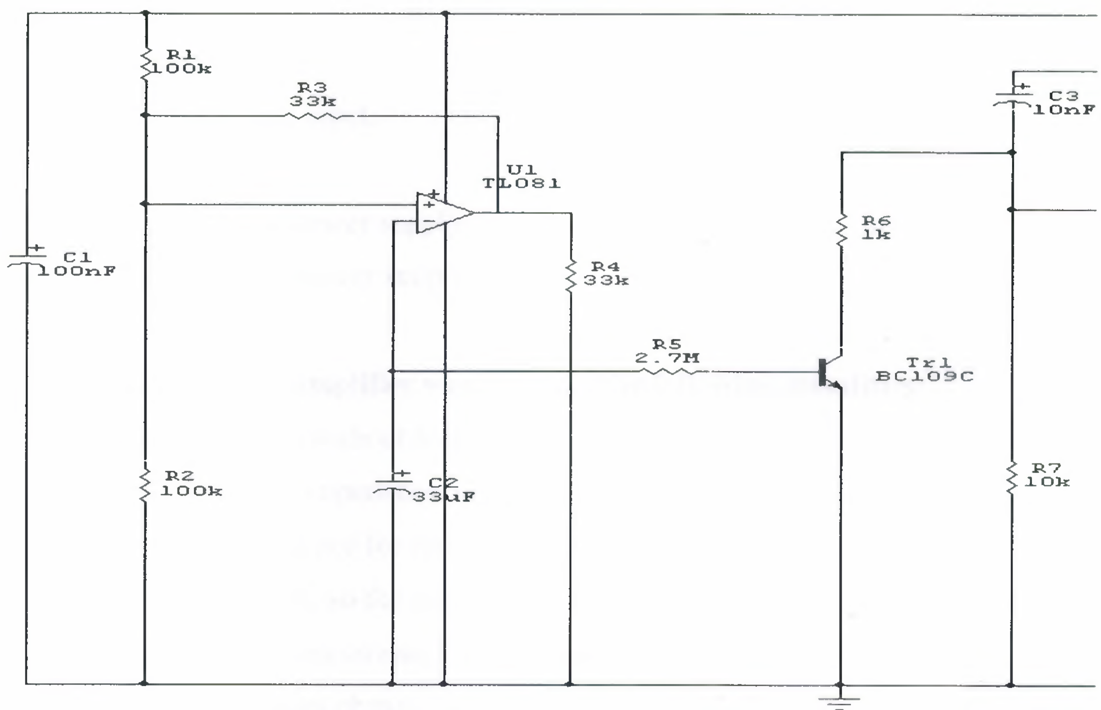


Figure 4.3: Switching the input from high to low state, and then squire the signal.

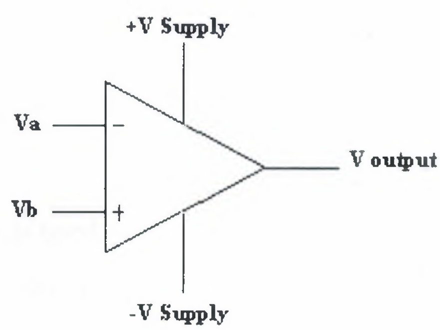


Figure 4.4: Op-amps in schematic circuit diagram.

Where:

- V_a: Inverting input.
- V_b: Non-inverting input.
- V_{output}: Output.
- $+V_{Supply}$: Positive power supply.
- $-V_{Supply}$: Negative power supply.

An ideal voltage amplifier would posses the following quantities:

- Infinite open loop (without feedback) gain.
- Infinite high input impedance, so it would not require any current.
- Zero output impedance for efficient transfer its output voltage.
- Infinite band width, so the output would not be drift with temperature changes, and it would be free from unwanted oscillations.
- Instantaneous output change.

In the figure 4.3 above, op-amp IC using feed back connected to non-inverting input through R3 so that to convert signal values to their squires.

The op-amp is provided by two power supplied of equal and opposite polarities (+V, -V).

4.5 Third Stage

Integrated circuit 2 (IC2) is used as the tone generator and its output is coupled to LS1 (Load Speaker 1) by C4, as it can be seen in figure 4.5 below. The operating frequency of IC2 can be varied up and down by increasing and decreasing the base current fed to TR1. This modulation is provided by IC1 which is used as a simple very low frequency oscillator having an operating frequency of only about 0.5 Hertz.

The IC2 which is LM 380 is a power audio amplifier, and the internal gain is fixed at 34dB. The output automatically self-centers to one-half the supply voltage. The output is short circuit proof with internal thermal limiting.

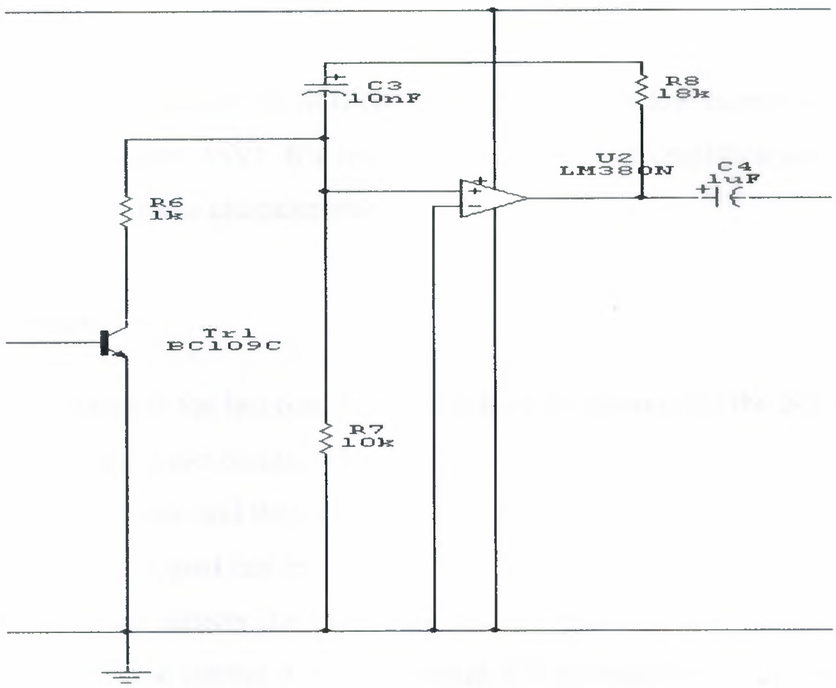


Figure 4.5: Generating the output tone.

- **IC2 (LM380)**

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, power converters.........etc. Check the appendix for more characteristics.

- **TR1 (BC109C)**

NPN transistor in a TO-18; SOT18 metal package, has low current (max. 100mA) and has low voltage (max. 45V). It's used for switching and amplification applications. Check the appendix for more characteristics.

4.6 Fourth Stage

In this stage which is the last one, when switching the power ON the IC1 will amplify the signal to its square wave output. The output of IC1 will be an input to IC2 which is generating the toning signal and then send it to the output (Loud Speaker), as it can be seen in figure 4.6, the output signal can be controlled by Tr1 which is controlling signal coming from IC1. When sensor detects the flood Tr2 will be activated and then circuit will be completely closed because current will pass through Tr2 to negative side of the battery, and IC2 will send the signal to loud speaker through C4.

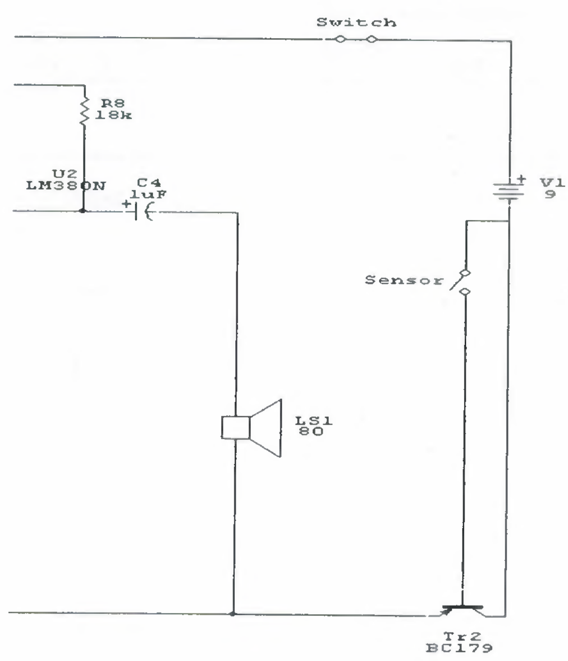


Figure 4.6: Generating the output tone.

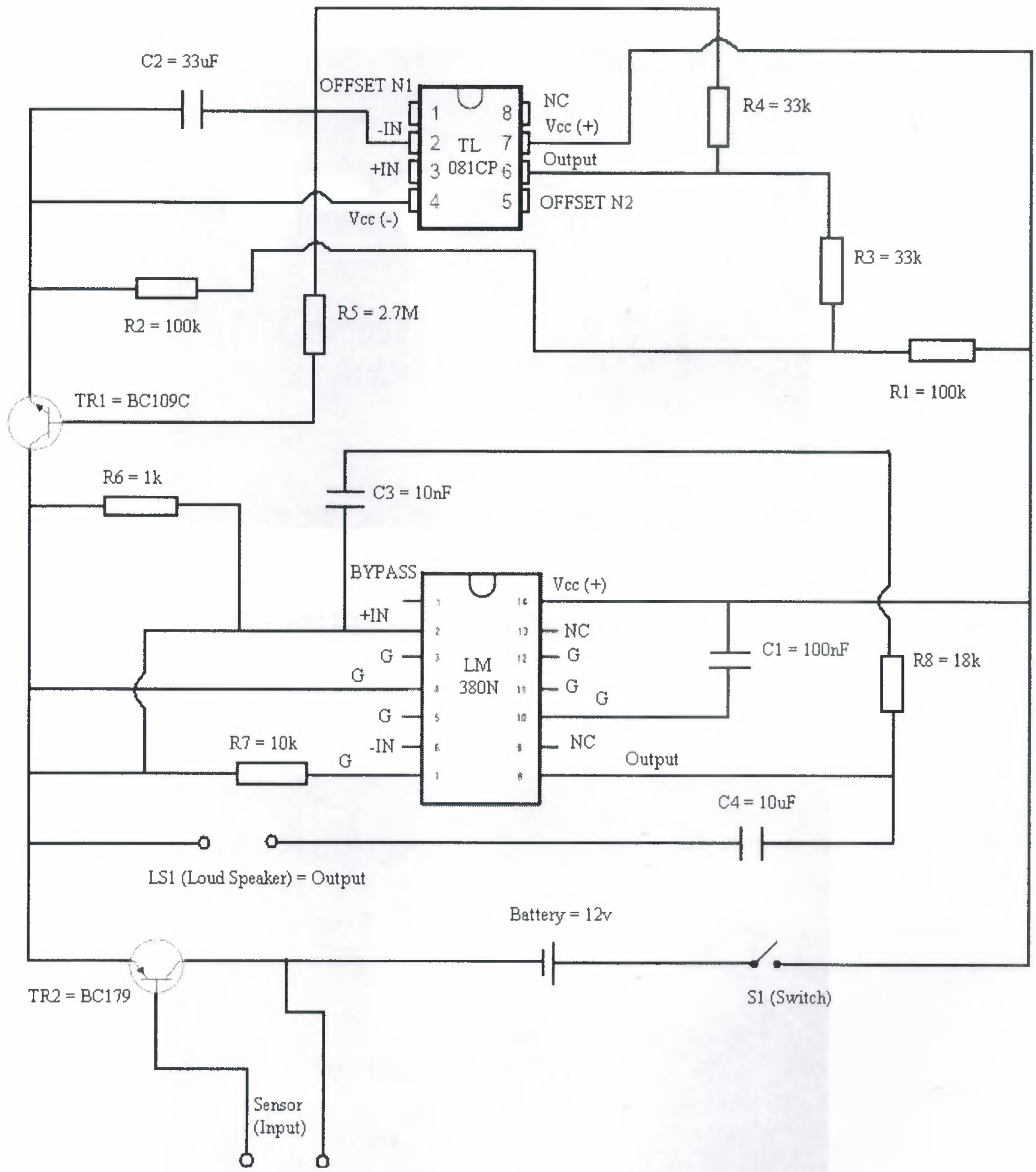


Figure 4.7: Constructional details of the water activated alarm circuit.

Figure 4.8: External view of the water activated alarm.

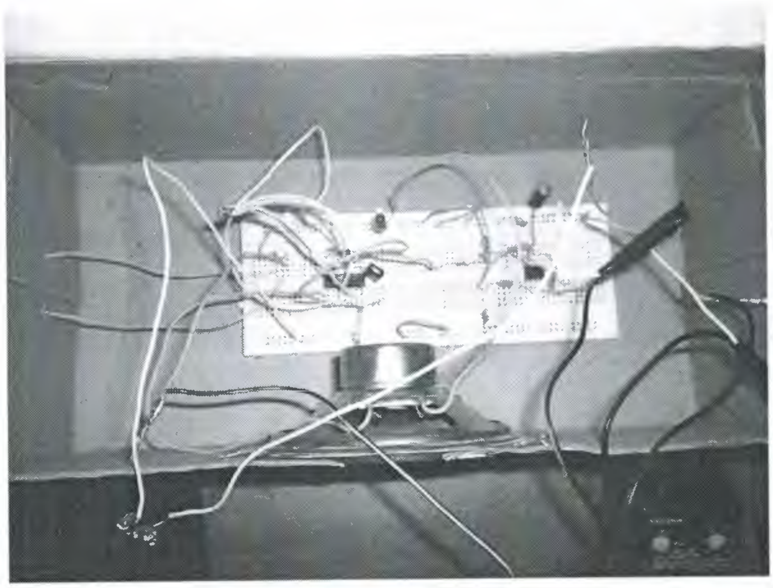


Figure 4.9: Internal view of the water activated alarm circuit.

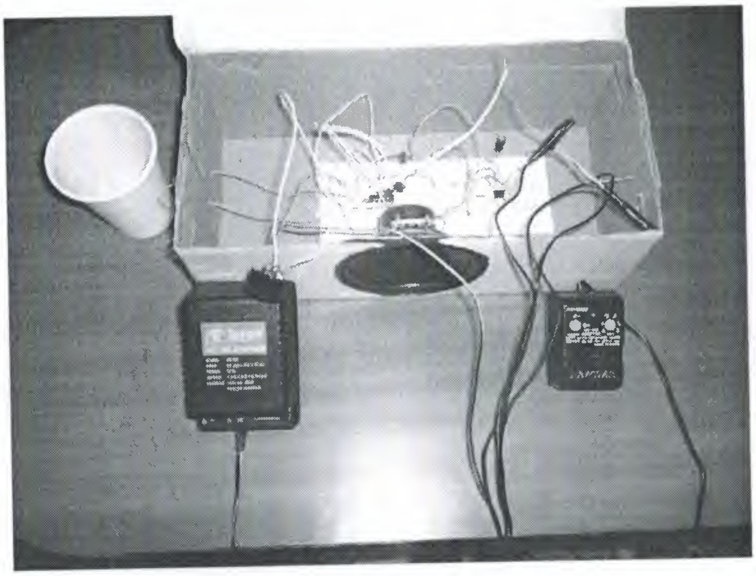


Figure 4.10: Overall view of the water activated alarm circuit.

4.7 Simple Changes in the Circuit

There are simple changes I've made in my project like replacing TL081CP with UA741 which is a single operational amplifier because of low sound obtained by the loud speaker. Replacing the TL081CP with UA741 gave me the chance to have a very loud voice from the speaker. Activating the single operational amplifier UA741 needs an input voltage of 12v, that's why I used another AC-DC adapter with an output voltage of 12v.

The other change I've made in the circuit is placing a LED in parallel with the loud speaker. So, as an output a red light will be activated when the loud speaker activates.

- **UA741CN**

The UA741 is a high performance monolithic operational amplifier constructed on a single silicon chip. It is invented for a wide range of analog applications. The high gain and wide range of operating voltages provide superior performances in integrator, summing amplifier and general feedback applications. The internal compensation network (6dB/ octave) insures stability in closed loop circuits. Check the appendix for more characteristics.

4.8 Summary

This chapter represents the operation of water activated alarm circuit, and describes in details the specific work for each stage.

CONCLUSION

This project presented the design and construction of water activated alarm, in such a way the system indicates water by sounding an alarm in order to save lives, properties and minimize damage as much as possible.

The water activated alarm has been constructed in such a way that the system will activate when the water exceeds its acceptable level and the water level can be sensed by two pieces of metal, in other words, two wires very close to each other. At the moment when the water level exceeds the two wires an alarm (sound) will be activated followed by a warning light.

As a developing idea, a water pump (motor) can be added to the circuit and pumps out the water away from its original position.

In the future, proposed approach can be developed to make a network connection for the water activated alarm by using SCADA (Supervisory Control And Data Acquisition), so that it can be automated and controlled from far, moreover using wireless connection in order to send a warning signal to control center which it might be controlled by SCADA.

REFERENCES

[1] http://en.wikipedia.org/wiki/resistors.

[2] http://www.hobbyprojects.com/components/images/colors.gif.

[3] http://www.futurlec.com/pictures/capacitorelectrolytic.jpg.

[4] http://stairwaytokevin.com.au/product.asp?prodid=186109.

[5] http://bocasemiconductor.com/product/items.asp?productid=bc179.

[6] http://www.talkingelectronics.com/chipdataebook-1d/html/lm380.html.

[7] http://www.alldatasheet.com.

[8] http://en.wikipedia.org/wiki/led.

[9] http://www.howstuffworks.com/battery.htm/printable.

[10] http://en.wikipedia.org/wiki/battery_%28electricity%29.

[11] http://www.howstuffworks.com/flood.htm/printable.

[12] http://en.wikipedia.org/wiki/flood.

[13] http://www.umich.edu/~gs265/society/floods.htm.

[14] http://www.zen22142.zen.co.uk/circuits/alarm/walarm.htm.

[15] http://www.ewc2.org/upload/downloads/errol_douglas.doc.

[16] http://www.electronic-circuits-diagrams.com/alarmsimages/alarmsckt6.shtml.

[17] http://www.discovercircuits.com/pdf-files/h2oalm.pdf.

[18] Lessons in Electric Circuits, Volume III Semiconductors by Tony R. Kuphaldt Fourth Edition, last update January 1, 2004.

APPENDIX 1

JFET-INPUT OPERATIONAL AMPLIFIER (TL081CN)

1.1 General Description

The TL08_JFET-input operational amplifier family is designed to offer a wider selection than any previously developed operational amplifier family. Each of these JFET-input operational amplifiers incorporates well-matched, high voltage JFET and bipolar transistors in a monolithic integrated circuit.

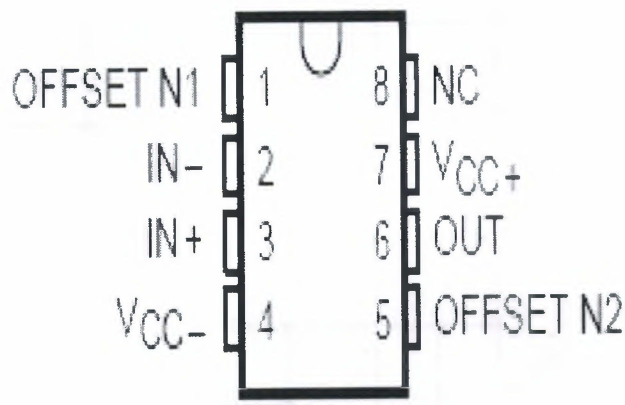
Device types with a C suffix are characterized for operation from 0°C to 70°C, those with an I suffix are characterized for operation from –40°C to 85°C, and those with an M suffix are characterized for operation over the full military temperature range of –55°C to 125°C.

1.2 Features

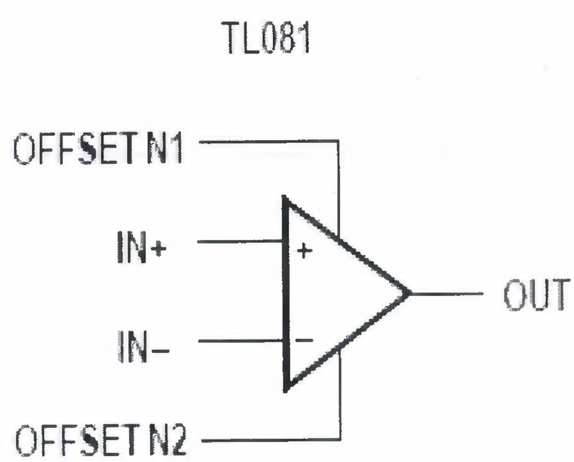
- Low power consumption.
- Wide common mode and differential voltage ratings.
- Low input bias and offset currents.
- Output short circuit protection.
- Low total harmonic distortion.
- High input impedance.
- Internal frequency compensation.
- Latch up free operation.
- High slew rate.
- Common mode input voltage range.

1.3 Diagrams

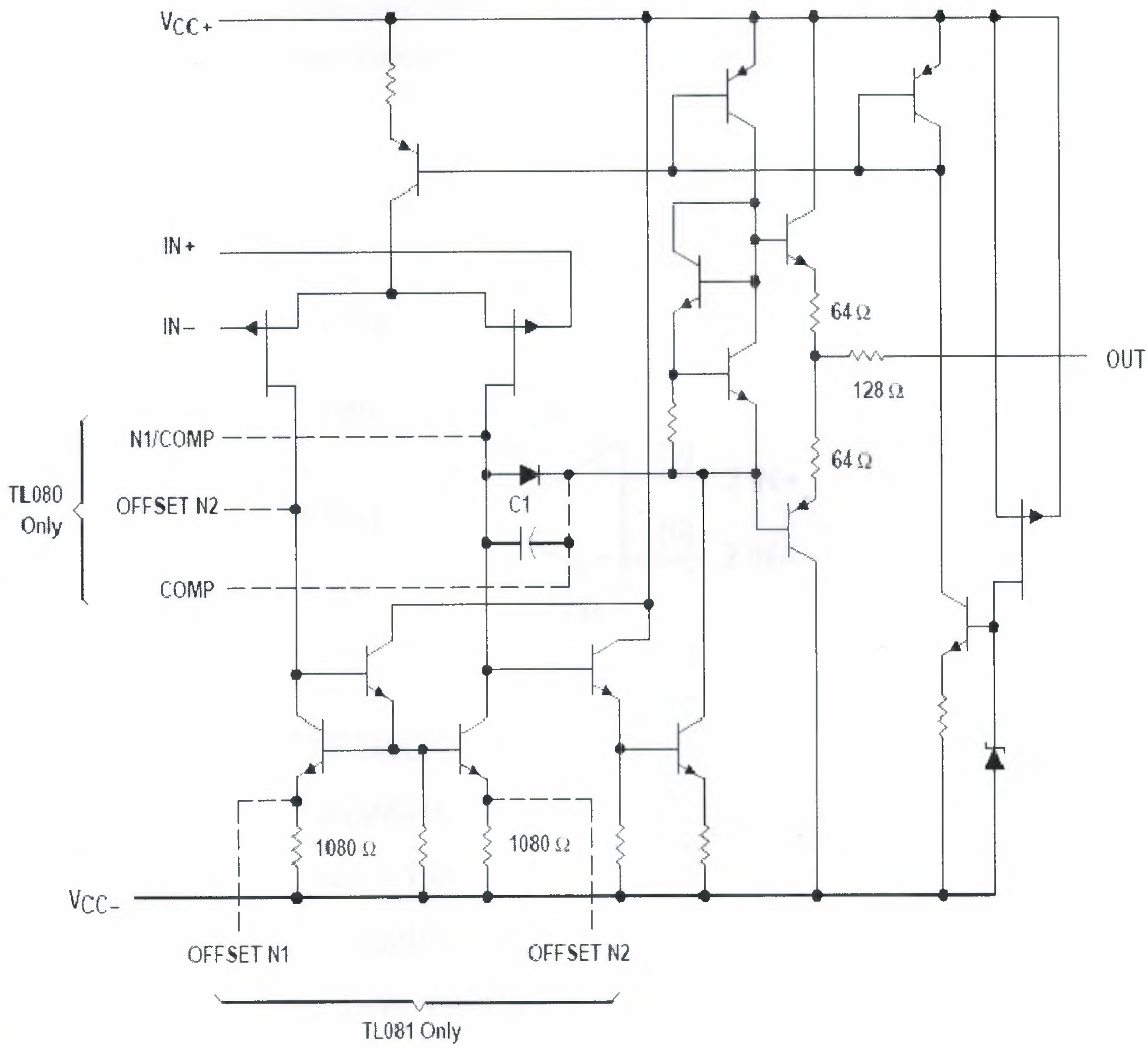
1.3.1 Connection Diagram (Top View)



1.3.2 Block Diagram (Symbol)



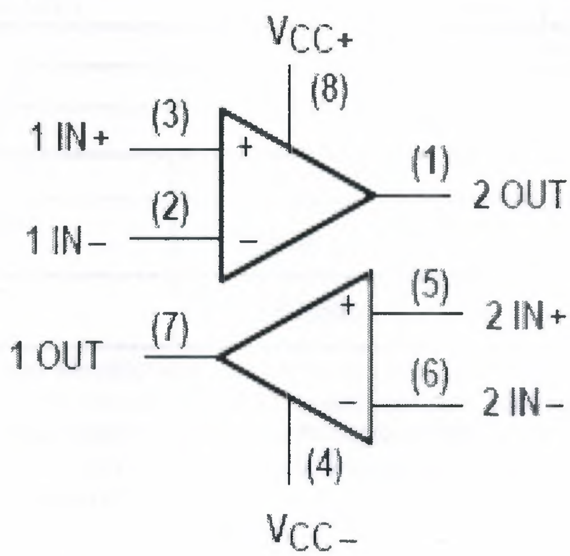
1.3.3 Schematic Diagram



C1 = 18 pF on TL081, TL082, and TL084 only (including their suffix versions).
Component values shown are nominal.

1.4 Chip Information (TL081CN)

This chip, when properly assembled, displays characteristics similar to the TL082. Thermal compression or ultrasonic bonding may be used on the doped aluminum bonding pads. Chips may be mounted with conductive epoxy a gold-silicon performs.



CHIP THICKNESS: 15 TYPICAL

BONDING PADS: 4 × 4 MINIMUM

$T_J$max = 150°C

TOLERANCES ARE ±10%

ALL DIMENSIONS ARE IN MILS

PIN (4) INTERNALLY CONNECTED TO BACKSIDE OF CHIP

1.5 Absolute Maximum Ratings

		TL08_C TL08_AC TL08_BC	TL08_I	TL08_M	UNIT
Supply voltage, V_{CC+} (see Note 1)		18	18	18	V
Supply voltage V_{CC-} (see Note 1)		−18	−18	−18	V
Differential input voltage (see Note 2)		±30	±30	±30	V
Input voltage (see Notes 1 and 3)		±15	±15	±15	V
Duration of output short circuit (see Note 4)		unlimited	unlimited	unlimited	
Continuous total dissipation		See Dissipation Rating Table			
Operating free-air temperature range		0 to 70	−40 to 85	−55 to 125	°C
Storage temperature range		−65 to 150	−65 to 150	−65 to 150	°C
Case temperature for 60 seconds	FK package			260	°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds	J or JG package			300	°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	D, N, P, or PW package	260	260		°C

NOTES: 1. All voltage values, except differential voltages, are with respect to the midpoint between V_{CC+} and V_{CC-}.
2. Differential voltages are at the noninverting input terminal with respect to the inverting input terminal.
3. The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 V, whichever is less.
4. The output may be shorted to ground or to either supply. Temperature and/or supply voltages must be limited to ensure that the dissipation rating is not exceeded.

1.6 Dissipation Rating Table and the Electrical Characteristics Table

PACKAGE	$T_A \leq 25°C$ POWER RATING	DERATING FACTOR	DERATE ABOVE T_A	$T_A = 70°C$ POWER RATING	$T_A = 85°C$ POWER RATING	$T_A = 125°C$ POWER RATING
D (8 Pin)	680 mW	5.8 mW/°C	32°C	464 mW	377 mW	N/A
D (14 Pin)	680 mW	7.6 mW/°C	60°C	608 mW	494 mW	N/A
FK	680 mW	11.0 mW/°C	88°C	680 mW	680 mW	275 mW
J	680 mW	11.0 mW/°C	88°C	680 mW	680 mW	275 mW
JG	680 mW	8.4 mW/°C	69°C	672 mW	546 mW	210 mW
N	680 mW	9.2 mW/°C	76°C	680 mW	598 mW	N/A
P	680 mW	8.0 mW/°C	65°C	640 mW	520 mW	N/A
PW (8 Pin)	525 mW	4.2 mW/°C	25°C	336 mW	N/A	N/A
PW (14 Pin)	700 mW	5.6 mW/°C	25°C	448 mW	N/A	N/A

electrical characteristics, $V_{CC\pm}$ = ±15 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS†		TL080C TL081C TL082C TL084C			TL081AC TL082AC TL084AC			TL081BC TL082BC TL084BC			TL081I TL082I TL084I			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_O = 0, R_S = 50 Ω	T_A = 25°C		3	15		3	6		2	3		3	6	mV
			T_A = full range			20			7.5			5			9	
α_{VIO}	Temperature coefficient of input offset voltage	V_O = 0, T_A = full range	R_S = 50 Ω		18			18			18			18		µV/°C
I_{IO}	Input offset current ‡	V_O = 0	T_A = 25°C		5	200		5	100		5	100		5	100	pA
			T_A = full range			2			2			2			10	nA
I_{IB}	Input bias current ‡	V_O = 0	T_A = 25°C		30	400		30	200		30	200		30	200	pA
			T_A = full range			10			7			7			20	nA
V_{ICR}	Common-mode input voltage range	T_A = 25°C		±11	−12 to 15		±11	−12 to 15		±11	−12 to 15		±11	−12 to 15		V
V_{OM}	Maximum peak output voltage swing	T_A = 25°C	R_L = 10 kΩ	±12	±13.5		±12	±13.5		±12	±13.5		±12	±13.5		V
		T_A = full range	R_L ≥ 10 kΩ	±12			±12			±12			±12			
			R_L ≥ 2 kΩ	±10	±12		±10	±12		±10	±12		±10	±12		
A_{VD}	Large-signal differential voltage amplification	V_O = ±10 V, T_A = 25°C	R_L ≥ 2 kΩ	25	200		50	200		50	200		50	200		V/mV
		V_O = ±10 V, T_A = full range	R_L ≥ 2 kΩ	15			25			25			25			
B_1	Unity-gain bandwidth	T_A = 25°C			3			3			3			3		MHz
r_i	Input resistance	T_A = 25°C			10^{12}			10^{12}			10^{12}			10^{12}		Ω
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR} min, R_S = 50 Ω	V_O = 0, T_A = 25°C	70	86		80	86		80	86		80	86		dB
k_{SVR}	Supply voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	V_{CC} = ±15 V to ±9 V, R_S = 50 Ω	V_O = 0, T_A = 25°C	70	86		80	86		80	86		80	86		dB
I_{CC}	Supply current (per amplifier)	No load, T_A = 25°C	V_O = 0,		1.4	2.8		1.4	2.8		1.4	2.8		1.4	2.8	mA
V_{O1}/V_{O2}	Crosstalk attenuation	A_{VD} = 100,	T_A = 25°C		120			120			120			120		dB

† All characteristics are measured under open-loop conditions with zero common-mode voltage unless otherwise specified. Full range for T_A is 0°C to 70°C for TL08_C, TL08_AC, TL08_BC and −40°C to 85°C for TL08_I.

‡ Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive as shown in Figure 18. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as possible.

APPENDIX 2

SINGLE OPERATIONAL AMPLIFIER (UA741CN)

2.1 Description

The UA741 is a high performance monolithic operational amplifier constructed on a single silicon chip. It is invented for a wide range of analog applications. The high gain and wide range of operating voltages provide superior performances in integrator, summing amplifier and general feedback applications. The internal compensation network (6dB/ octave) insures stability in closed loop circuits.

2.2 Features

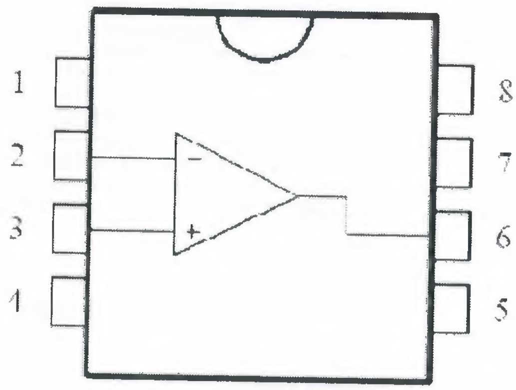
- Large Input Voltage Range.
- No Latch-Up.
- High Gain.
- Short-Circuit Protection.
- No Frequency Compensation.
- Required.

2.3 Applications

- Summing Amplifier.
- Voltage Follower.
- Integrator.
- Active Filter.
- Function Generator.

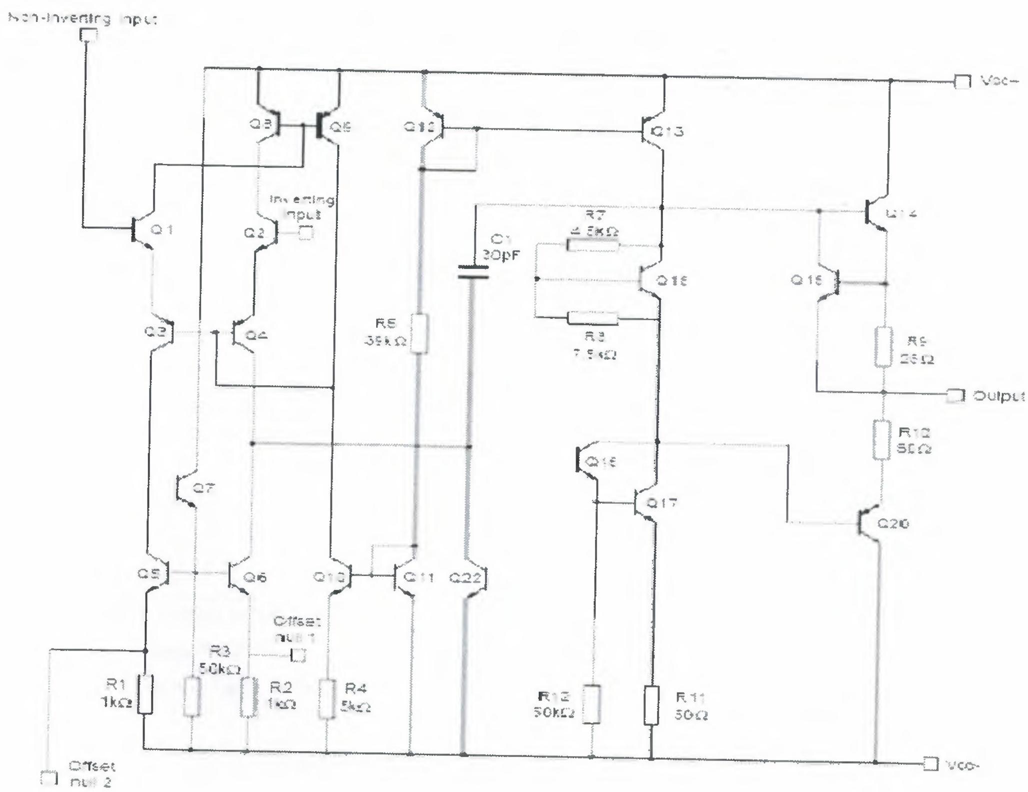
2.4 Diagrams

2.4.1 Pin Connections (Top View)



1 - Offset null 1
2 - Inverting input
3 - Non-inverting input
4 - V_{CC}^{-}
5 - Offset null 2
6 - Output
7 - V_{CC}^{+}
8 - N.C.

2.4.2 Schematic Diagram



2.5 Absolute Maximum Ratings

Symbol	Parameter	UA741M	UA741I	UA741C	Unit
V_{CC}	Supply voltage	±22			V
V_{id}	Differential Input Voltage	±30			V
V_i	Input Voltage	±15			V
P_{tot}	Power Dissipation [1]	500			mW
	Output Short-circuit Duration	Infinite			
T_{oper}	Operating Free-air Temperature Range	-55 to +125	-40 to +105	0 to +70	°C
T_{stg}	Storage Temperature Range	-65 to +150			°C

1. Power dissipation must be considered to ensure maximum junction temperature (Tj) is not exceeded.

2.6 Electrical Characteristics

$V_{CC} = \pm 15V$, $T_{amb} = +25°C$ (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input Offset Voltage ($R_s \leq 10k\Omega$) $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max}$		1	5 6	mV
I_{io}	Input Offset Current $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max}$		2	30 70	nA
I_{ib}	Input Bias Current $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max}$		10	100 200	nA
A_{vd}	Large Signal Voltage Gain ($V_o = \pm 10V$, $R_L = 2k\Omega$) $T_{amb} = +25°C$ $T_{min} < T_{amb} < T_{max}$	50 25	200		V/mV
SVR	Supply Voltage Rejection Ratio ($R_s \leq 10k\Omega$) $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max}$	77 77	90		dB
I_{CC}	Supply Current, no load $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max}$		1.7	2.8 3.3	mA
V_{icm}	Input Common Mode Voltage Range $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max}$	±12 ±12			V

CMR	Common Mode Rejection Ratio ($R_S \le 10k\Omega$) $T_{amb} = +25°C$ $T_{min} \le T_{amb} \le T_{max}$	 70 70	 90		dB
I_{OS}	Output short Circuit Current	10	25	40	mA
$\pm V_{opp}$	Output Voltage Swing $T_{amb} = +25°C$ $R_L = 10k\Omega$ $R_L = 2k\Omega$ $T_{min} \le T_{amb} \le T_{max}$ $R_L = 10k\Omega$ $R_L = 2k\Omega$	 12 10 12 10	 14 13		V
SR	Slew Rate $V_i = \pm 10V$, $R_L = 2k\Omega$, $C_L = 100pF$, unity Gain	0.25	0.5		V/μs
t_r	Rise Time $V_i = \pm 20mV$, $R_L = 2k\Omega$, $C_L = 100pF$, unity Gain		0.3		μs
K_{ov}	Overshoot $V_i = 20mV$, $R_L = 2k\Omega$, $C_L = 100pF$, unity Gain		5		%
R_i	Input Resistance	0.3	2		MΩ
GBP	Gain Bandwith Product $V_i = 10mV$, $R_L = 2k\Omega$, $C_L = 100pF$, f =100kHz	0.7	1		MHz
THD	Total Harmonic Distortion f = 1kHz, $A_v = 20dB$, $R_L = 2k\Omega$, $V_o = 2V_{pp}$, $C_L = 100pF$, $T_{amb} = +25°C$		0.06		%
e_n	Equivalent Input Noise Voltage f = 1kHz, $R_s = 100\Omega$		23		$\frac{nV}{\sqrt{Hz}}$
∅m	Phase Margin		50		Degrees

APPENDIX 3

NPN GENERAL PURPOSE TRANSISTOR (BC109C)

3.1 Description

NPN transistor in a TO-18; SOT18 metal package.

PNP complement: BC177.

3.2 Features

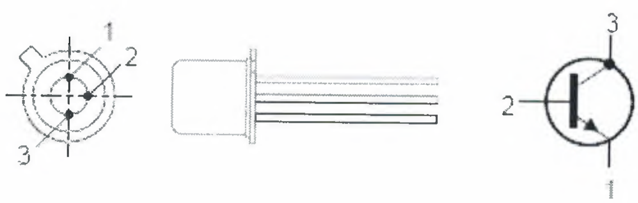
- Low current (max. 100mA).
- Low voltage (max. 45V).

3.3 Applications

- General purpose switching and amplification.

3.4 Pining

PIN	DESCRIPTION
1	emitter
2	base
3	collector, connected to the case



Simplified outline (TO-18; SOT18) and symbol.

3.5 Quick Reference Data

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CBO}	collector-base voltage	open emitter			
	BC107		–	50	V
	BC108; BC109		–	30	V
V_{CEO}	collector-emitter voltage	open base			
	BC107		–	45	V
	BC108; BC109		–	20	V
I_{CM}	peak collector current		–	200	mA
P_{tot}	total power dissipation	$T_{amb} \leq 25$ °C	–	300	mW
h_{FE}	DC current gain	$I_C = 2$ mA; $V_{CE} = 5$ V			
	BC107		110	450	
	BC108		110	800	
	BC109		200	800	
f_T	transition frequency	$I_C = 10$ mA; $V_{CE} = 5$ V; f = 100 MHz	100	–	MHz

3.6 Limiting Values

In accordance with the Absolute Maximum Rating System.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CBO}	collector-base voltage	open emitter			
	BC107		–	50	V
	BC108; BC109		–	30	V
V_{CEO}	collector-emitter voltage	open base			
	BC107		–	45	V
	BC108; BC109		–	20	V
V_{EBO}	emitter-base voltage	open collector			
	BC107		–	6	V
	BC108; BC109		–	5	V
I_C	collector current (DC)		–	100	mA
I_{CM}	peak collector current		–	200	mA
I_{BM}	peak base current		–	200	mA
P_{tot}	total power dissipation	$T_{amb} \leq 25$ °C	–	300	mW
T_{stg}	storage temperature		−65	+150	°C
T_j	junction temperature		–	175	°C
T_{amb}	operating ambient temperature		−65	+150	°C

3.7 Thermal Characteristics

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th\,j\text{-}a}$	thermal resistance from junction to ambient	note 1	0.5	K/mW
$R_{th\,j\text{-}c}$	thermal resistance from junction to case		0.2	K/mW

Note 1: Transistor mounted on an FR4 printed circuit board.

3.8 Electrical Characteristics

Tj = 25 °C unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{CBO}	collector cut-off current	$I_E = 0$; $V_{CB} = 20$ V	–	–	15	nA
		$I_E = 0$; $V_{CB} = 20$ V; $T_j = 150$ °C	–	–	15	µA
I_{EBO}	emitter cut-off current	$I_C = 0$; $V_{EB} = 5$ V	–	–	50	nA
h_{FE}	DC current gain	$I_C = 10$ µA; $V_{CE} = 5$ V				
	BC107A; BC108A		–	90	–	
	BC107B; BC108B; BC109B		40	150	–	
	BC108C; BC109C		100	270	–	
h_{FE}	DC current gain	$I_C = 2$ mA; $V_{CE} = 5$ V				
	BC107A; BC108A		110	180	220	
	BC107B; BC108B; BC109B		200	290	450	
	BC108C; BC109C		420	520	800	
V_{CEsat}	collector-emitter saturation voltage	$I_C = 10$ mA; $I_B = 0.5$ mA	–	90	250	mV
		$I_C = 100$ mA; $I_B = 5$ mA	–	200	600	mV
V_{BEsat}	base-emitter saturation voltage	$I_C = 10$ mA; $I_B = 0.5$ mA; note 1	–	700	–	mV
		$I_C = 100$ mA; $I_B = 5$ mA; note 1	–	900	–	mV
V_{BE}	base-emitter voltage	$I_C = 2$ mA; $V_{CE} = 5$ V; note 2	550	620	700	mV
		$I_C = 10$ mA; $V_{CE} = 5$ V; note 2	–	–	770	mV
C_c	collector capacitance	$I_E = i_e = 0$; $V_{CB} = 10$ V; f = 1 MHz	–	2.5	6	pF
C_e	emitter capacitance	$I_C = i_c = 0$; $V_{EB} = 0.5$ V; f = 1 MHz	–	9	–	pF
f_T	transition frequency	$I_C = 10$ mA; $V_{CE} = 5$ V; f = 100 MHz	100	–	–	MHz
F	noise figure BC109B; BC109C	$I_C = 200$ µA; $V_{CE} = 5$ V; $R_S = 2$ kΩ; f = 30 Hz to 15.7 kHz	–	–	4	dB
F	noise figure BC107A; BC108A BC107B; BC108B; BC108C	$I_C = 200$ µA; $V_{CE} = 5$ V; $R_S = 2$ kΩ; f = 1 kHz; B = 200 Hz	–	–	10	dB
	BC109B; BC109C		–	–	4	dB

Note 1: V_{BEsat} decreases by about 1.7 mV/K with increasing temperature.
Note 2: V_{BE} decreases by about 2 mV/K with increasing temperature.

APPENDIX 4

AUDIO POWER AMPLIFIER (LM380N)

4.1 General Description

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.

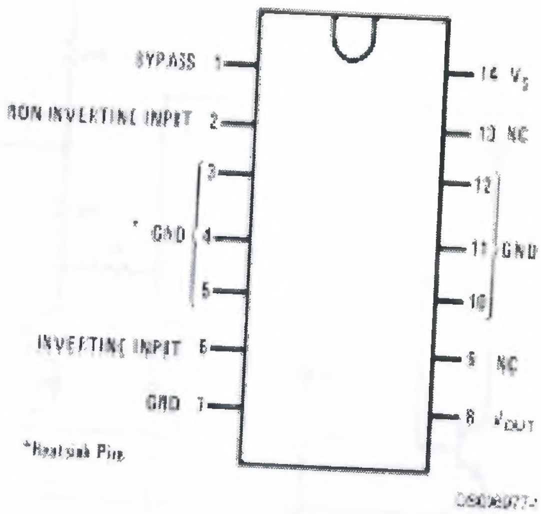
Uses include simple phonograph amplifiers, intercoms, line drivers, teaching machine outputs, alarms, ultrasonic drivers, TV sound systems, AM-FM radio, small servo drivers, power converters.........etc.

4.2 Features

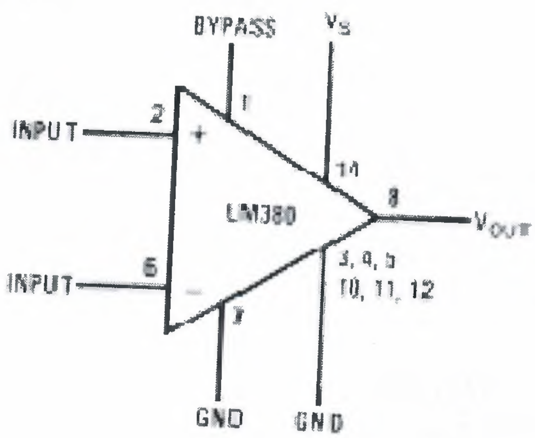
- Wide supply voltage range.
- Low quiescent power drain.
- Voltage gain fixed at 50.
- High peak current capability.
- Input referenced to GND.
- High input impedance.
- Low distortion.
- Quiescent output voltage is at one-half of the supply voltage.
- Standard dual-in-line package.

4.3 Diagrams

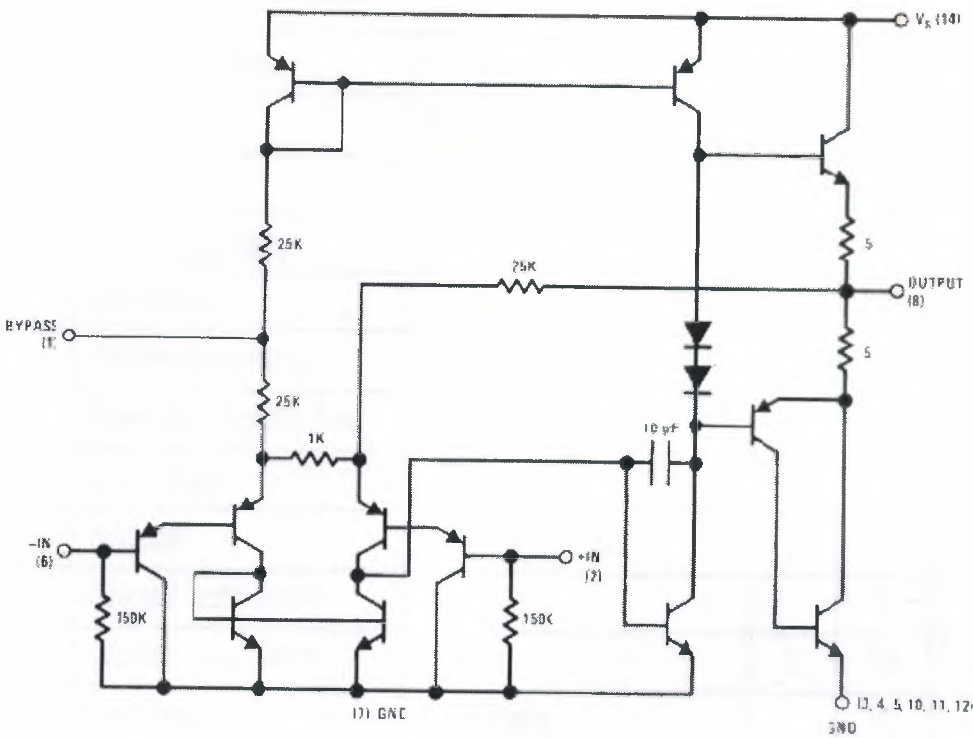
4.3.1 Connection Diagram (Top View)



4.3.2 Block Diagram (Symbol)



4.3.3 Schematic Diagram



4.4 Absolute Maximum Ratings (Note 1)

Parameter	Rating
Supply Voltage	22V
Peak Current	1.3A
Package Dissipation 14-Pin DIP (Note 7)	8.3W
Package Dissipation 8-Pin DIP (Note 7)	1.67W
Input Voltage	minus or plus 0.5V
Storage Temperature	minus 65°C to plus150°C
Operating Temperature	0°C to plus 70°C
Junction Temperature	plus 150°C
Lead Temperature	plus 260°C

4.5 Electrical Characteristics (Note 2)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$P_{OUT(RMS)}$	Output Power	R_L = 8Ω, THD = 3% (Notes 4, 5)	2.5			W
A_V	Gain		40	50	60	V/V
V_{OUT}	Output Voltage Swing	R_L = 8Ω		14		V_{p-p}
Z_{IN}	Input Resistance			150k		Ω
THD	Total Harmonic Distortion	(Notes 5, 6)		0.2		%
PSRR	Power Supply Rejection Ratio	(Note 3)		38		dB
V_S	Supply Voltage		10		22	V
BW	Bandwidth	P_{OUT} = 2W, R_L = 8Ω		100k		Hz
I_Q	Quiescent Supply Current			7	25	mA
V_{OUTQ}	Quiescent Output Voltage		8	9.0	10	V
I_{BIAS}	Bias Current	Inputs Floating		100		nA
I_{SC}	Short Circuit Current			1.3		A

Note 1: "Absolute Maximum Ratings" indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits.

Note 2: V_S = 18V and T_A = 25°C unless otherwise specified.

Note 3: Rejection ratio referred to the output with C_{BYPASS} = 5 µF.

Note 4: With device Pins 3, 4, 5, 10, 11, 12 soldered into a 1/16" epoxy glass board with 2 ounce copper foil with a minimum surface of 6 square inches.

Note 5: C_{BYPASS} = 0.47 µfd on Pin 1.

Note 6: The maximum junction temperature of the LM380 is 150°C.

Note 7: The package is to be derated at 15°C/W junction to heat sink pins for 14-pin pkg; 75°C/W for 8-pin.

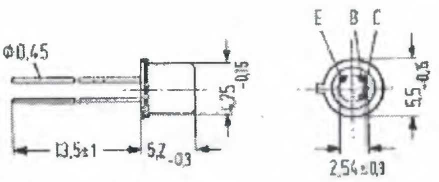
APPENDIX 5

PNP SILICON TRANSISTOR (BC179)

5.1 Description

BC177, BC178 and BC179 are epitaxial PNP silicon transistors in TO 18 case (18 A 3 DIN 41876). The collector is electrically connected to the case. The transistors are particularly suitable for use in AF input and driver stages.

Type	Ordering code
BC 177[1]	Q62702-C684
BC 177 A	Q62702-C141
BC 177 B	Q62702-C142
BC 178[1]	Q62702-C685
BC 178 A	Q62702-C153
BC 178 B	Q62702-C154
BC 178 C	Q62702-C155
BC 179[1]	Q62702-C686
BC 179 B	Q62702-C303
BC 179 C	Q62702-C145



Approx. weight 0.33 g Dimension in mm

5.2 Maximum Ratings and Thermal Resistance

Maximum ratings (T_{amb} = 25 °C)		BC 177	BC 178	BC 179	
Collector-emitter voltage	$-V_{CES}$	50	30	25	V
Collector-emitter voltage	$-V_{CEO}$	45	25	20	V
Emitter-base voltage	$-V_{EBO}$	5	5	5	V
Collector current	$-I_C$	100	100	50	mA
Collector peak current	$-I_{CM}$	200	200	–	mA
Base current	$-I_B$	50	50	5	mA
Base peak current	$-I_{BM}$	100	100	–	mA
Junction temperature	T_j	175	175	175	°C
Storage temperature range	T_{stg}		–55 to +125		°C
Total power dissipation	P_{tot}	300	300	300	mW
Thermal resistance					
Junction to ambient air	R_{thJA}	≤500	≤500	≤500	K/W
Junction to case	R_{thJC}	≤200	≤200	≤200	K/W

5.3 Static Characteristics (Temp. = 25°C)

The transistors are grouped according to the DC current gain h_{FE} and are marked with A, B, C. At $-V_{CE}$ = 5 V and the collector currents indicated below, the following static characteristics apply:

h_{FE} group	A	B	C
Type	BC 177 BC 178 –	BC 177 BC 178 BC 179	– BC 178 BC 179
$-I_C$ mA	h_{FE} I_C/I_B	h_{FE} I_C/I_B	h_{FE} I_C/I_B
0.01	90	150	270
2	170 (120 to 220)	290 (180 to 460)	500 (380 to 800)
100[1]	120[3]	200[3]	400[3]

Type	BC 177, BC 178, BC 179				
V_{CE} V	$-I_C$ mA	$-I_B$ mA	$-V_{BE}$ V	$-V_{CEsat}$ V	$-V_{BEsat}$ V
5	0.1	–	0.57	–	–
5	2	–	0.62 (0.55 to 0.7)	–	–
5	100	–	0.8	–	–
–	10	0.5	–	0.1 (<0.2)[1]	0.7 (<0.8)
–	100[3]	5	–	0.2 (<0.6)[1][3]	0.85 (<1)[3]
5	10	–	–	0.2 (<0.6)[2]	–

		BC 177	BC 178	BC 179	
Collector cutoff current ($-V_{CES}$ = 20 V)	$-I_{CES}$	2 (<100)	2 (<100)	2 (<100)	nA
Collector cutoff current ($-V_{CES}$ = 20 V; T_{amb} = 125°C)	$-I_{CES}$	<4	<4	<4	µA
Emitter-base breakdown voltage ($-I_{EB}$ = 10 µA)	$-V_{(BR)EBO}$	>5	>5	>5	V
Collector-emitter breakdown voltage ($-I_{CE}$ = 2 mA)	$-V_{(BR)CEO}$	>45	>25	>20	V
Collector-emitter breakdown voltage ($-I_{CE}$ = 10 µA)	$-V_{(BR)CES}$	>50	>30	>25	V

1) The transistor is overloaded to such an extent that the DC current gain decreases to h_{FE} = 20.
2) I_C = 10 mA for the characteristics, which passes at constant base current the point I_C = 11 mA; V_{CE} = 1 V.
3) These values do not apply to BC 179.

5.4 Dynamic Characteristics

Dynamic characteristics (T_{amb} = 25 °C)		BC 177	BC 178	BC 179	
Transition frequency ($-I_C$ = 10 mA; $-V_{CE}$ = 5 V; f = 50 MHz)	f_T	130	130	130	MHz
Collector-base capacitance ($-V_{CBO}$ = 10 V; f = 1 MHz)	C_{CBO}	4.5 (< 7)	4.5 (< 7)	4.5 (< 7)	pF
Noise figure ($-I_C$ = 0.2 mA; $-V_{CE}$ = 5 V) R_g = 2 kΩ; Δf = 200 Hz; f = 1 kHz	NF	< 10	< 10	< 4	dB
f = 30 to 15 000 Hz	NF	–	–	2 (< 4)	dB

I_C = 2 mA; V_{CB} = 5 V; f = 1 kHz

h_{FE} group	A	B	C	
Type	**BC 177** **BC 178** –	**BC 177** **BC 178** **BC 179**	– **BC 178** **BC 179**	
h_{11e}	2.7 (1.6 to 4.5)	4.5 (3.2 to 8.5)	8.7 (6 to 15)	kΩ
h_{12e}	1.5	2	3	10^{-4}
h_{21e}	220	330	600	–
h_{22e}	18 (< 30)	35 (< 60)	60 (< 110)	μS