UNESCO-NIGERIA TECHNICAL &
VOCATIONAL EDUCATION
REVITALISATION PROJECT-PHASE II

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NATIONAL DIPLOMA IN
COMPUTER TECHNOLOGY
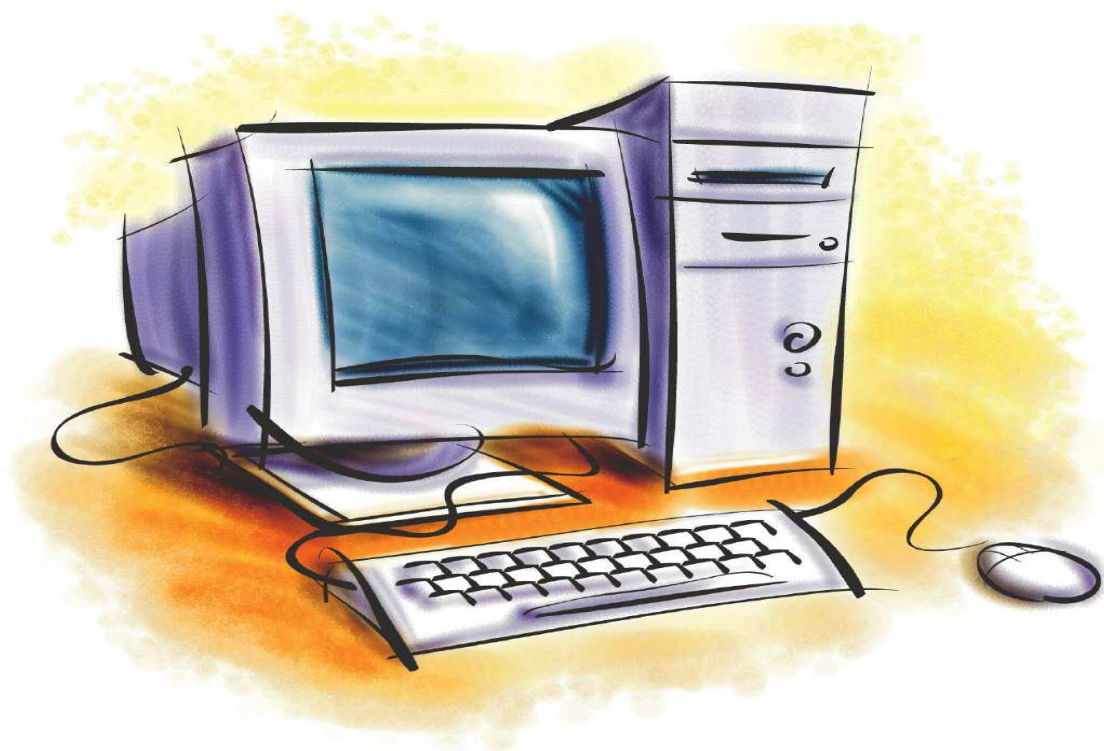
Basic Hardware Maintenance

COURSE CODE: COM 223

THEORY: YEAR2, SEMESTER2,VERSION1:DECEMBER

Table of Contents

Week1

Objective: Understanding basic Electric Theory

Introduction

A complete circuit is needed before voltage can cause the current to flow through the load to perform work. A simple electric circuit consists of .[1]

1. Voltage source (e.g. battery)
2. Load (e.g. lamp)
3. Path for the current between the power supply and the load (e.g. wire).

The following figure shows a simple electric circuit with its schematic representation. Also it can be seen from the figure (2-1) the flow of the current.

CONDUCTOR(Wire)

LOAD(Lamp)

VOLTAGE SOURCE(Battery)

Physical Representation

Schematic Representation
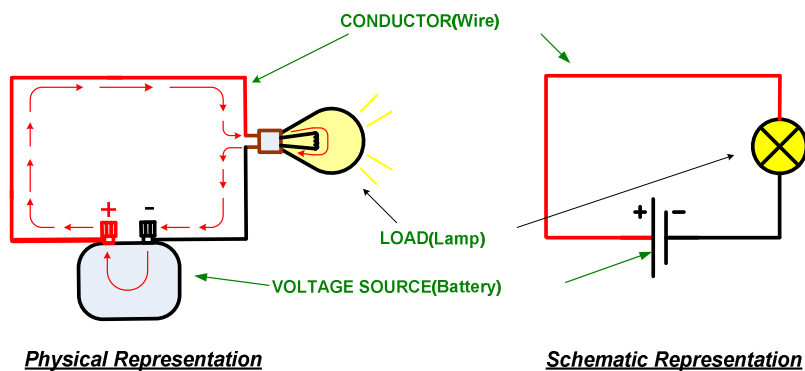
Figure(2-1) :A simple electric circuit

2.2   Basic Concepts

The three main concepts in electricity are voltage, current and resistance. Voltage or potential difference can be thought of as the driving force (although it is not really a "force") behind the electric current . In the water analogy , in figure(2-2), you can think of voltage as the pressure difference created by a pump that causes the water to flow through the pipe in the water system. Also you can think of the electrons flow in the electric circuit as equivalent to the flow of the

water in the pipes that caused by the pump. Another important concept in electricity is resistance. Its Property of a material that opposes the flow of electrons through it. Resistance in a material is a result of the collision of electrons with the atoms and with each other as they move. The collisions produce heat, increasing the temperature of the material .This can be useful in some application such as the filament lamp.
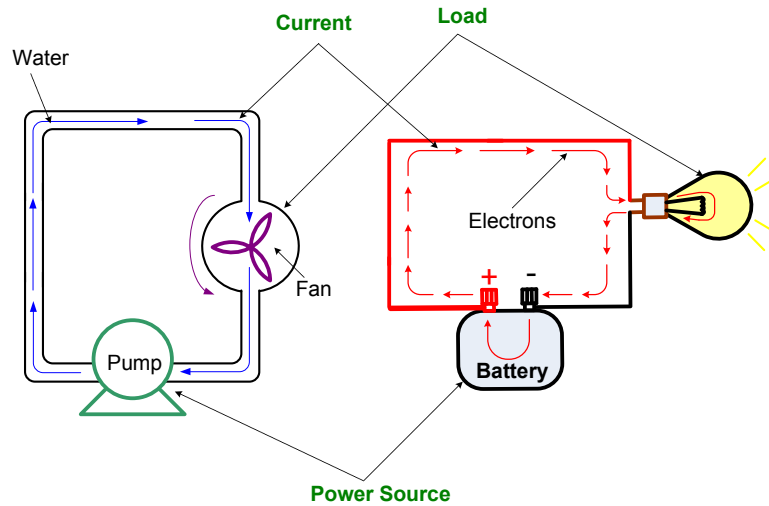
Figure (2-2) water analogy

The following table contain brief definitions to the electric concepts with their units.

The relationship between voltage, current, and resistance in an electrical circuit is fundamental to the operation of any circuit or device. It can be related mathematical in a law called Ohms law.

$$V = I \times R$$

Term	Definition	Unit
Voltage(V)	The electrical "pressure" that causes free electrons to flow through an electrical circuit.	Volt (V)

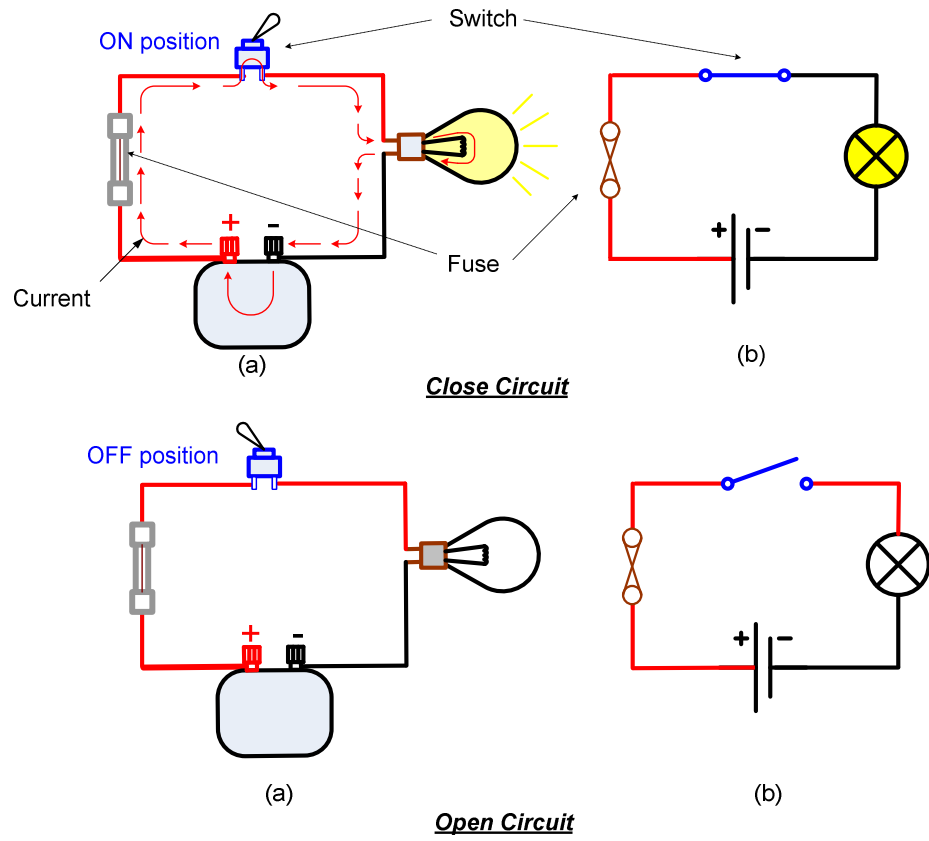| Current(I)	Flow of electrons	Ampere(A)
Resistance(R)	Opposition of the materials to the flow of the electric current through it.	Ohm(Ω)

Table (2-1): Electrical quantities definitions

To make the previous[1] circuit more practical, **a switch** and a simple **fuse** can be added as it can be seen in the following figure. The purpose of the switch is to open or close the circuit I.e. to control the circuit. Note in the next figure when the circuit is **close** the light is on, and when the circuit is **open** the light is off.

The purpose of the fuse is to open the circuit when the current exceeds the limit i.e. for protection.

2.3 Voltage Source

Voltage sources can cause two type of currents to flow in the circuit. They are Direct Current (DC) and Alternating current (AC). In DC current the current flow in one direction and in the AC current the current flows in two directions as shown in figure (2-3).

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[1] Previous : السابق

ON position

Switch

Current

Fuse

(a)

(b)

Close Circuit

OFF position

(a)

(b)

Open Circuit

Figure(2-3) :A simple electric circuit with a switch and a fuse

Example of DC voltage source is batteries and photocells. Examples of AC current are AC generators and socket outlets.

Voltage

(a)   Time   (b)
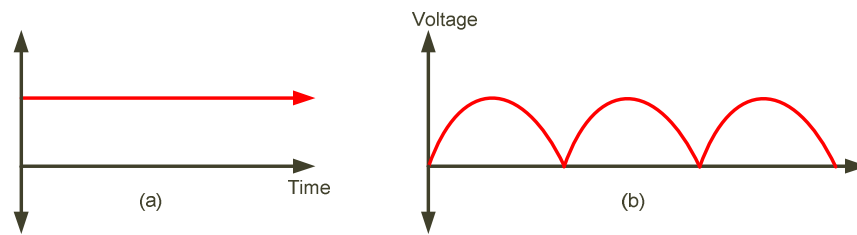
DC voltages waveforms

Voltage

(a)   Time   (b)

AC voltages waveforms

Figure(2-4):DC and AC waveforms

Week 2
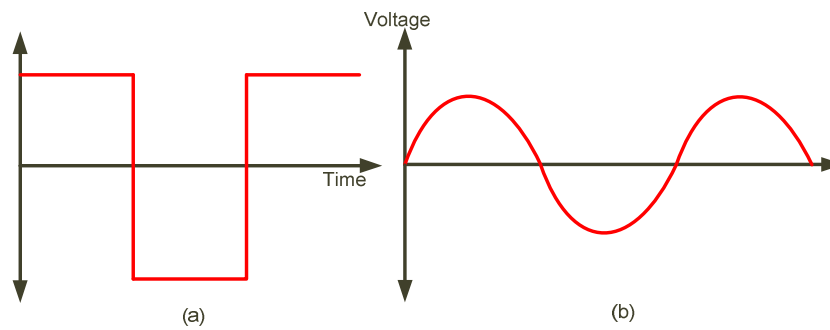This Week learning Outcome
To Understand:

Basic Electric Theory

3.1 Introduction

In 1826 George Simon Ohm found that the current, voltage, and resistance
are related in a specific way. Ohm expressed this relationship with a formula that
s law and how 's law. In this chapter, you will learn Ohm'is known today as Ohm
to used it in solving circuit problems.

Electric circuit can be of two basic forms: series and parallel. In this
s 'chapter, series, and parallel circuits are studied. you will also see how Ohm
law is used in series, and parallel circuits

3.2 Ohm's Law

s law is the most important mathematical relationship between 'Ohm
voltage, current and resistance in electricity. Ohm's Law is used in three forms
depending on which quantity voltage, current or resistance you need to
determine. In this section, you will learn each of these forms.

s Law'3.2.1 Explanation of Ohm

In the electric circuit, if the voltage across constant resistor value is
increase, the current through the resistor will also increase; and, if the voltage is
decrease, the current will decrease. For example, if voltage is double, the current
will doubled. If the voltage is halved, the current will also be halved. This
relationship is illustrated in the figure (3-1), with used voltage and current meter.
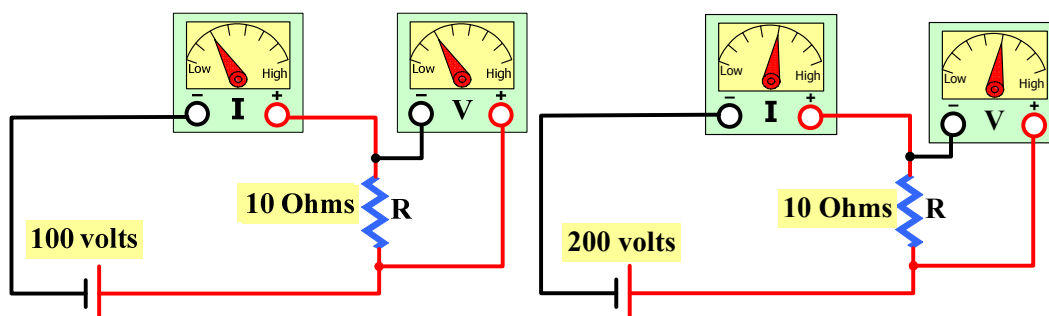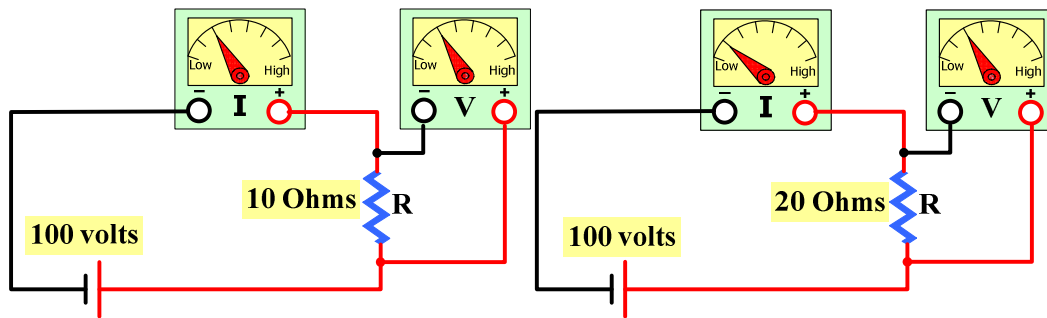
(a) Decrease V, decrease I   **(b) Increase V, increase I**
Figure (3-1): Effect of changing the voltage at constant   resistance

s law also stated that if the voltage is kept constant, less resistance 'Ohm results in more current, and, also, more resistance results in less current. For example, if resistance is halved, the current will doubled. If the resistance is doubled, the current is halved.

This relationship is illustrated by the meter indications in the figure (3-2).

Where the resistance is increase and the voltage is constant.

(a) Decrease R, increase I   **(b) Increase R, decrease I**

Figure (3-2): Effect of changing the resistance at constant   voltage

From previous illustrated,

s law states that, current and voltage are linearly 'Ohm proportional at constant resistance; current and resistance are inversely related at constant voltage.

According this law the following three equivalent formula is derived:

__Formula for current__

$$I = \frac{V}{R}$$ **Equation (3-1)**

s low is used to determine current if voltage and resistance 'This form of Ohm values are known

$$V = I\,R$$

Equation (3-2)

s low is used to determine voltage if current and resistance 'This form of Ohm
values are known

Formula for resistance

$$R = \frac{V}{I}$$

Equation (3-3)

s low is used to determine resistance if voltage and current 'This form of Ohm
values are known

3.2.2 Ohm's Law triangle

There is an easy way to remember which formula to use. By arranging
current, voltage and resistance in a triangle, one can quickly determine the
s Law triangle is shown in figure (3-3)'correct formula. Ohm
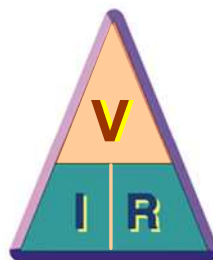
s Law triangle'   **Figure(3-3) : Ohm**

To use the triangle, cover the value you want to calculate, the remaining letters
make up the formula as shown in figure (3-4).

$$I = \frac{V}{R}$$
         $$V = I\,R$$
         $$R = \frac{V}{I}$$

<u>Remember the following three rules:</u>

s Law can only give the correct answer when the correct values are used. 'Ohm

Current is always expressed in Amperes or Amps (A)

Voltage is always expressed in Volts (V)

Resistance is always expressed in Ohms (Ω)

3.2.3 The Relationship of Current, Voltage and Resistance

s law describes how current is related to voltage and resistance. 'Ohm
current and voltage are linearly proportional at constant resistance; current and
resistance are inversely related at constant voltage.

3.2.3.1 The Linear Relationship of Current and Voltage

Current and voltage linearly proportional; that is, if one is increased by a
certain percentage, the other will increase or decrease by the same percentage,
assuming that the resistance is constant value.

s take a constant value of 'To draw a graph of current verses voltage, let
resistance. For example, R=10Ω, and calculate the current for several value of
voltage ranged from 0 to 100 V by used the formula I=V/10 where R=10 Ω. the
current values obtained are shown in the table (3-1):

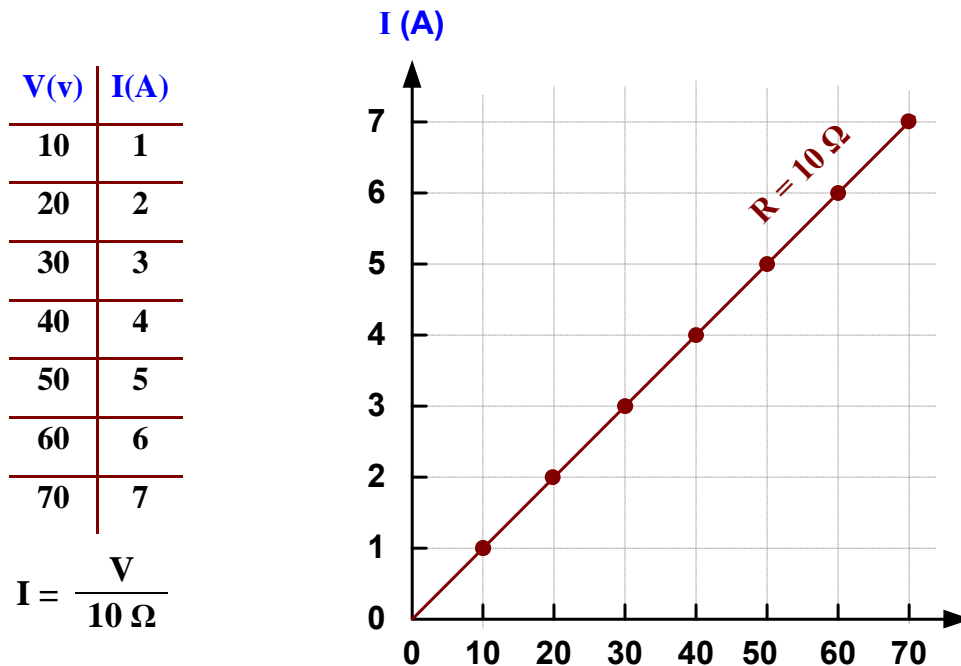| V(v)	I(A)
10	1
20	2
30	3
40	4
50	5
60	6
70	7

$$I = \dfrac{V}{10\ \Omega}$$

Table (3-1)   Figure (3-5) : Graph of current versus voltage for R= 10 Ω

The graph of the current values versus the voltage values is shown in the figure(3-5). This graph tells us that a change in voltage results in a linearly proportional change in current. From graph the change in voltage from 20 to 30 is increased by 50%   by calculation the current must be increase by the same percentages 50% $I = 2 + 2 \times 50/100 = 3A$.

3.2.3.2 Current and Resistance are Inversely Related

Current varies inversely with resistance as expressed ohms law, I=V/R.

when the resistance is decreased, the current goes up; when the resistance is s take a constant value of 'increased, the current goes down. For example, let voltage V=10volts, and calculate the current for several value of resistance ranged from 10 to 100 Ω by used the formula I=10/R. the current values obtained are shown in the next   table (3-2), The graph of the current values versus the voltage values is shown in the figure(3-6).

R (Ω)	I (A)
10	1
20	0.500
30	0.333
40	0.250
50	0.200
60	0.167
70	0.143

$$I = \frac{0 \ v}{R}$$

Table (3-2)

0Figure (3-6) : Graph of current versus resistance for V= 10 v

WEEK 3-4

1. Resistors

1.1 Resistivity

While resistance is an electrical quantity, resistivity is a physical property of materials, which is used to produce resistance.

1.1.1 Resistance of materials

Resistance or conductance depends entirely on a conductor's physical parameters:

- the type of material,
- the length l
- the cross sectional area A
- the temperature

The resistance depends on the number of valency electrons available in the material. This property of the material is called "resistivity", (or specific resistance) with the symbol " "(rho).

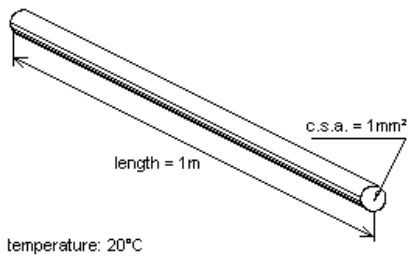The **resistivity** has the unit *mm^2/m.

Fig. 1.1.1.1:
The condition under which the resistivity ρ (rho) is defined for different conductor materials:

1m long
1mm² area
20°C temperature

The resistance increases (proportional) with increasing length and decrease (inverse proportional) with the area.

This is expressed by the formula:

$$R = \frac{\rho * l}{A}$$

Where:

R: resistance in Ω

ρ: resistivity in $\Omega*mm^2/m$

l: length in m

A: cross sectional area in mm²

The reciprocal of the resistivity ρ is the **conductivity** K (Kappa).

$$\rho = \frac{1}{K} \quad \text{or} \quad K = \frac{1}{\rho}$$

The unit of the conductivity is m/($\Omega*mm^2$)

Using K, the resistance can be calculated by the formula:

$$R = \frac{1}{K * A}$$

Example:

Copper has a ρ of 0.0178 $\Omega mm^2/m$ or a K of 57.1 m/Ωmm^2.
A copper wire is 80m long and has a c.s.a. of 1.5mm².
Calculate its resistance.
l = 80m

$A = 1.5mm^2$

$\rho = 0.0178 \, \Omega mm^2/m$

$$R = \frac{\rho * l}{A} = \frac{0.0178\,\Omega * mm^2 * 80m}{m * 1.5mm^2} = 0.949\,\Omega$$

For materials with very high resistivity (insulators), the resistivity may have different units,
for instance $\Omega * cm^2/cm = \Omega * cm$ or $\Omega * m^2/m = \Omega * m$.
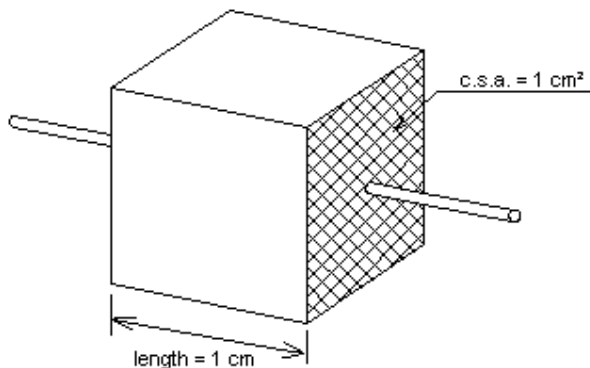

Fig. 1.1.1.2:

The values of other decades can be found by multiplying the base values by powers of ten. (e.g. $82k\,\Omega = 8.2*10^4\,\Omega$)

For general electronic applications 10% or 5% tolerance resistors are sufficient. For precision applications 2% and 1% types may be used.

1.2 The Color Code

In former times all resistors were labeled with figures indicating their values. These figures were substituted by color rings which indicate the value and the tolerance. The reasons were:

color	Value:	Multiplier	Tolerance:
black	0	$10^0 = 1$	
brown	1	$10^1 = 10$	1%
red	2	$10^2 = 100$	2%
orange	3	$10^3 = 1k$	
yellow	4	$10^4 = 10k$	
green	5	$10^5 = 100k$	
blue	6	$10^6 = 1M$	

- cheaper application of the labeling
- increasing miniaturisation left no room for figures
- figures can not be read when on the bottom side of the element.

The international color code defines the corresponding values of each color.

Color	Digit	Multiplier	Tolerance
violet	7		
grey	8		
white	9		
gold		$10^{-1} = 0.1$	5%
silver		$10^{-2} = 0.01$	10%
none			20%

Values with a tolerances between 20% and 5% can be specified by 2 significant numbers. Therefore such resistors will have

- two color rings for the value
- one color ring for the multiplier
- one color ring for the tolerance (none for 20%).

   5% and 10% tolerance resistors have 4 color rings.
   The last ring is gold or silver.

Values with smaller tolerances (2% and 1%) require three significant numbers. Therefore such resistor will have

- three color rings for the value
- one color ring for the multiplier
- one color ring for the tolerance.

   1% and 2% tolerance resistors have 5 colour rings. The last ring is brown or red.

4 colour rings for
5% and 10% tolerance resistors:

5 colour rings for
1% and 2% tolerance resistors:

	1.	2.	3.	4.	ring

	1.No	2.No	Mult	Tol
black	0	0	x1	
brown	1	1	x10	1%
red	2	2	x100	2%
orange	3	3	x1k	
yellow	4	4	x10k	
green	5	5	x100k	0.5%
blue	6	6	x1M	
violet	7	7	x10M	
grey	8	8	x100M	
white	9	9	x1G	
gold			x0.1	5%
silver			x0.01	10%

	1.	2.	3.	4.	5.	6.	ring

	1.No	2.No	3.No	Mult	Tol	Temp
black	0	0	0	x1		
brown	1	1	1	x10	1%	
red	2	2	2	x100	2%	50x1
orange	3	3	3	x1k		15x1
yellow	4	4	4	x10k		25x1
green	5	5	5	x100k	0.5%	
blue	6	6	6	x1M		
violet	7	7	7	x10M		
grey	8	8	8	x100M		
white	9	9	9	x1G		
gold				x0.1		
silver				x0.01		

1.2.3 Power rating

Resistors transform electrical energy into heat. This heat has to be transferred to the environment by any form of cooling. Cooling will be discussed in detail in chapter 7.

Different types of resistors will be able to transform different amount of electrical energy to heat without being damaged. This will depend on the construction of the resistor:

- The physical dimension (large, small)
- The maximum temperature the materials used can withstand,
- The means of cooling used.

The power rating of a resistor will give the maximum power that can be permanently applied to the resistor under normal operation conditions without causing any damage to the resistor.

The power rating given in the data sheets will only apply for normal environment temperatures. For higher temperatures the power handling capacity of the resistor will be reduced.
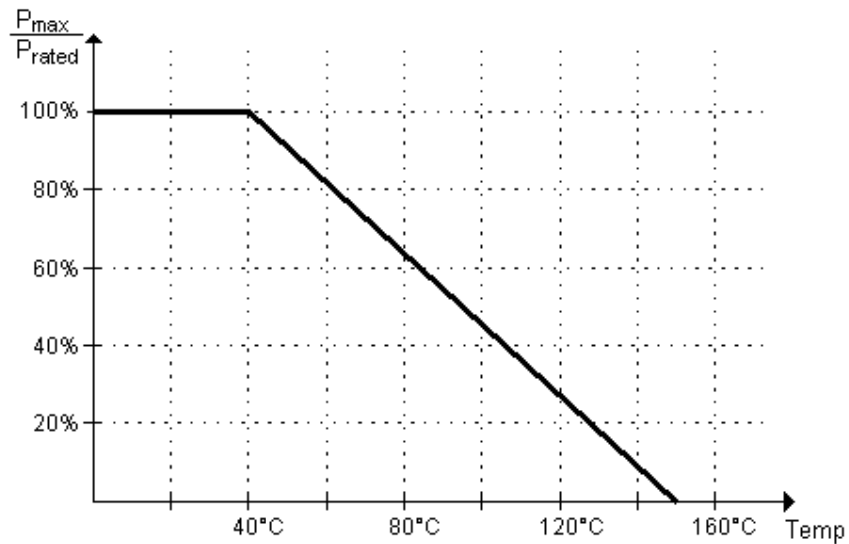

Fig. 1.2.3.1:
Typical power characteristic of a resistor versus the ambient temperature. The power handling capacity reduces at higher ambient temperatures.

Exceeding the rated power may cause damage to a resistor, mainly:

- change of nominal value,
- reduction of live time
- total failure.

Overloaded resistors will "burn". Their conductor will evaporate or oxidize and normally their resistance goes to infinite.

The power resistors can handle for short moments may be considerably higher (10 to 1000 times) than the power rating. This is because in such short moments the temperature of the resistor will not rise to excessive values.

Different types of resistors will have different pulse power ratings.

1.3 Cases and constructions

Theoretically a resistor is constructed of a resistive wire. In practice the following parts will be required in addition:

- insulating body
- contacting wires
- insulating coating

Depending on the application such resistors can be constructed in many different way. The construction will depend on the application of the resistor.

Special types of power resistors are available with metal cases which can be mounted on heat sinks for better cooling.
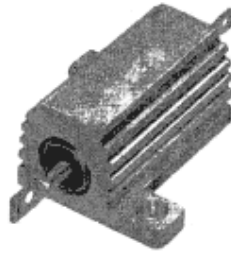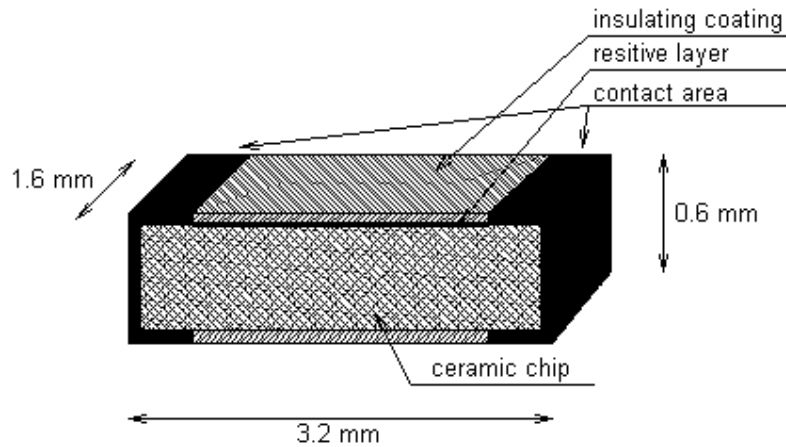

Fig. 1.2.4.2:
Example of a power resistor in metal case to be mounted on a heat sink to increase the power handling.

1.4 <u>Surface Mounted Device Resistors (SMD)</u>

For the new technology of surface mounted devices special resistors are available. They have no connector wires and will be soldered directly to the surface of the PCB. These resistors have extremely small dimensions to allow high package densities on the PCB. Normally they are of block shape rather than cylindric. The mounting and soldering can only be done with special automatic machines, as these elements are too small for manual handling.

Due to the fact that the resistive layer is on a ceramic chip, they are also called chip resistors.

Fig. 1.2.4.3:
Construction of a SMD resistor.

1.5 Resistor Arrays

In digital circuits often many resistors of similar values are required, e.g. for bus termination or as pull-up resistors. For these purposes several resistors can be integrated in one standard single-in-line (SIL) or dual-in-line (DIL) package. In many applications all of the resistors will be connected to one potential, e.g. ground. Therefore such resistor arrays will be available with one end of all resistors connected to one point. This reduces the number of required terminals and will therefore reduce the size of the package.
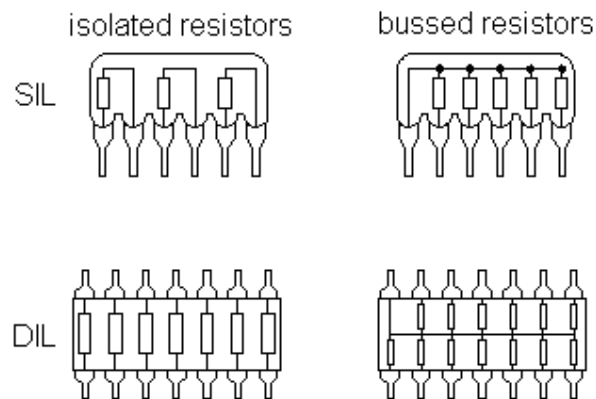
Fig. 1.2.4.4:
Packages and resistor arrangements of different resistor arrays.

All resistors of an array normally have the same values. All values of the E12 series are available from 22 Ω to 1M Ω.

High precision voltage divider resistors for voltmeters are available in one package. Typically these are 1k Ω, 9k Ω, 90k Ω and 900k Ω.

1.6 Fixed Resistor's Technologies

Fixed resistors are cheap circuit elements which normally do not produce problems. But they represent the largest group of circuit elements in electronic circuits and therefore deserve some consideration. To understand the particular properties of different types of resistors it is necessary to have a look at their construction.

1.7 Wire wound resistors

The oldest technology of resistors is based upon the resistivity of metals and certain alloy. The principle of production is still the same today. Alloy wires having a defined resistivity are coiled upon a carrier, which is equipped with suitable terminals.

1.8 Composite carbon resistors

In the history of resistors, the second to be produced were pure carbon resistors. They were, however, the first resistors to be manufactured in mass production. Essential for the development of this technology was the discovery that resistors with a large range of values up to the Megohms can be manufactured relatively easily by mixing carbon powder with resins, e.g. phenyl resin.

1.9 Carbon film resistors

The negative properties of composite carbon resistors arise mainly from the use of the composite material, the resin.

Pure carbon, on the contrary, has significantly better properties. The technology to deposit carbon from carbohydrates on ceramic carriers by pyrolysis laid the foundation for industrial manufacturing of carbon film resistors. The maximum values of resistivity of carbon film ceramic cylinders are limited by the feasible thickness of the layer. The obtainable surface resistance is smaller than 5K Ω.

1.10 Metal Film Resistors

Structurally metal film resistors are practically the same as carbon film resistors. The essential difference is the film itself: it consists of chemically pure chromium-nickel alloys, which are brought on a ceramic body by vapouring in vacuum or by a sputtering process. The metallic film on the carrier has a thickness of 10nm to 100nm and a surface resistance of up to 3k Ω.

1.11 Metal Oxide Film Resistors

Resistors with a metal oxide film are produced by hydrolysis: with hydrolysis of tin chloride, a film of about 1 μm tin oxide is deposited on the ceramic body. This film is a relatively stable resistance material, even with temperatures up to 300°C and it has clearly a higher over-loading capacity than metal film resistors of the same structure.

1.12 Metal Glaze Film Resistors

Metal glaze film resistors are occasionally grouped under the "mass resistors" - which can be explained by the relatively high thickness of the resistive film of about 20-30 μm. But technologically they are film resistors. The actual resistor film consists of a mixture of several metals, metal oxides, metal nitrates and glass. At temperatures of around 1,000°C these comp onents are melted to form a resistive film on the ceramic body. The composition of the ingredients determines the surface resistance, which is widely variable. By cutting a helix, high resistances can be obtained.
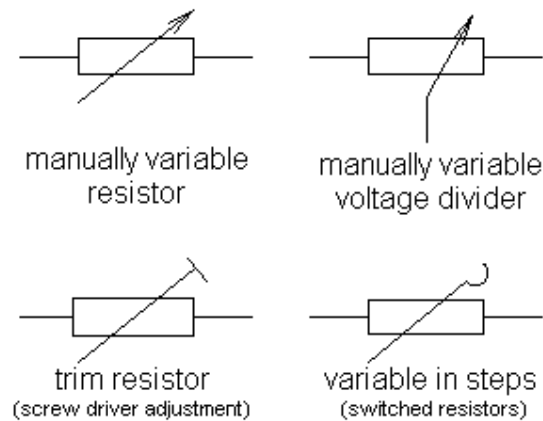

1.13 Variable Resistors

Manually variable resistors are used whenever resistance value are to be changed during operation or alignment of equipment. The resistance is varied by changing the length of the resistive path between 0 and maximum. Variable resistors are always denominated by their maximum resistance. They normally have three terminals (beginning, end, slider), so they can be used as resistor or voltage divider.

The majority of the variable resistors are rotating types with circular (approximately 270°) resistive tracks. For special applications linear variable resistors are available.

Potentiometer or **faders** we call the variable resistors which are manipulated during operation.

Trim potentiometer or **trim resistors** are variable resistors which are manipulated during alignment procedures. Often they are screw driver operated.

Fig. 1.4.1:
Circuit symbols of different types of variable resistors.

Variable resistors are produced using the same technologies as for fixed resistors. But their construction always requires some more or less complex mechanics and therefore is subject to wear.

Variable resistors are considered relatively unreliable electronic devices.
On the other hand high quality variable resistors (e.g. professional faders) will be relatively expensive.

1.14 Wire Wound Resistors

As for fixed resistors wire wound resistors are mainly used for high power applications and for low resistance values. In all constructions the wire is wound around a ceramic body. The wiper makes contact to the windings along a line across the windings. Wire wound variable resistor will vary their resistance in steps as the wiper moves along the windings.

Wire wound variable resistors are available as rotating and as linear types. Linear types are mainly used as trim resistors.
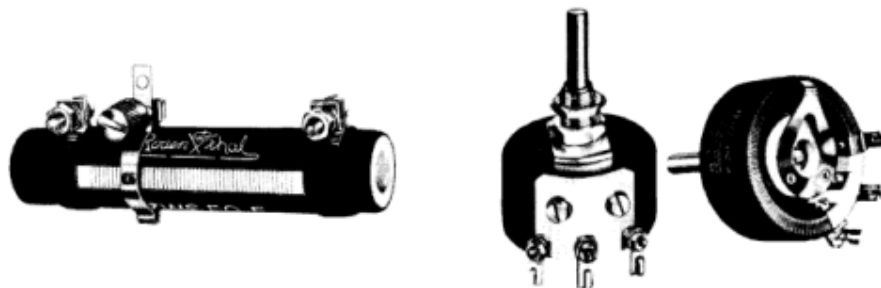
Fig. 1.4.1.1:
Construction of wire wound variable resistors.

1.15 Carbon Track Resistors

Carbon track trim resistors and potentiometer form the largest group of variable resistors in electronics. They are cheap and suitable for low power applications.

The resistive layer is made of hard carbon on a hard paper or ceramic insulating base. The wiper is of bronze, often equipped with a carbon brush. Due to the wear of the wiper and the carbon track these variable resistors have a limited life time. The reliability may be increased by equipping the slider with a double brush.

Carbon track variable resistors are mainly built as rotating types, either open or with case for dust protection and shielding.
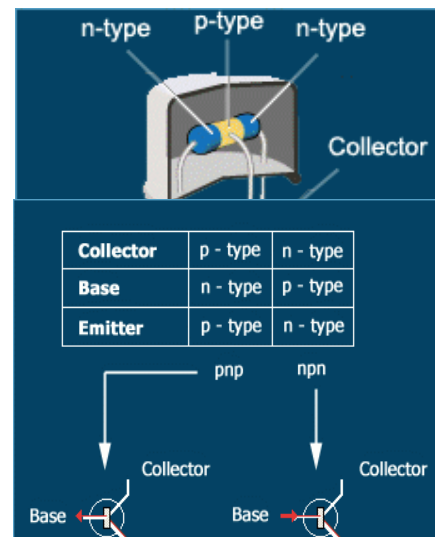
Transistor

The **transistor** is a solid state semiconductor device which can be used for amplification, switching, voltage stabilization, signal modulation and many other functions. It acts as a variable valve which, based on its input current (BJT) or input voltage (FET), *allows* a precise amount of current to flow through it from the circuit's voltage supply.
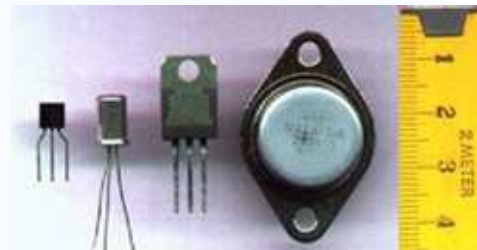
Bipolar junction transistor (BJT)

Typical Transistors

A **bipolar junction transistor** (BJT) is a type of transistor, an amplifying or switching device constructed of doped semiconductors that employs *both* types of charge carriers: electrons and holes. The BJT is a three layer sandwich of differently doped sections, either N-type|P-type|N-type (NPN transistors) or P-type|N-type|P-type (PNP transistors). The center layer is called the *base* of the transistor and is made from lightly doped, high resistivity material. By varying the current into the base terminal, the current allowed to flow between the *emitter* and a third terminal known as the *collector*(which are both heavily doped and hence low resistivity regions) can be varied. This effect can be used to amplify the input current. BJTs can be thought of as current-controlled current sources and are usually characterized as current amplifiers. Early transistors were made from

[germanium](#) but most modern BJTs are made from [silicon](#).

JUNCTION TRANSISTORS

A junction transistor consists of a thin piece of one type of semiconductor material between two thicker
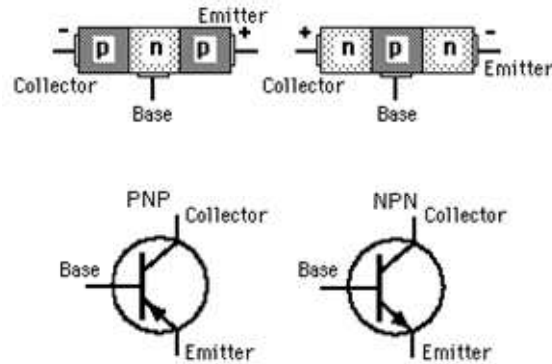
layers of the opposite type. For example, if the middle layer is p-type, the outside layers must be n-type. Such a transistor is an NPN transistor. One of the outside layers is called the emitter, and the other is known as the collector. The middle layer is the base. The places where the emitter joins the base and the base joins the collector are called junctions.

Testing a BJT transistor

Transistors can be damaged by heat when soldering or by misuse in a circuit. If you suspect that a transistor may be damaged there are two easy ways to test it:
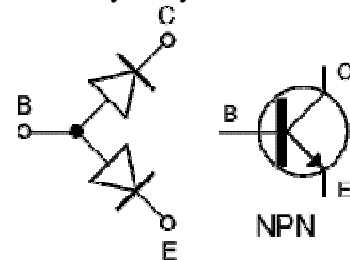
Testing with a multimeter

Use a multimeter or a simple tester (battery, resistor and LED) to check each pair of leads for conduction. Set a digital multimeter to diode test and an analogue ultimeter to a low resistance range. **Test each pair of leads both ways** (six tests in total):

- The **base-emitter (BE)** junction should behave like a diode and conduct one way only.
- The **base-collector (BC)** junction should behave like a diode and conduct one way only.
- The **collector-emitter (CE)** should not conduct either way.

The diagram shows how the junctions behave in an NPN transistor. The diodes are reversed in a PNP transistor but the same test procedure can be used.

FIELD EFFECT TRANSISTORS

A field effect transistor has only two layers of semiconductor material, one on top of the other. Electricity flows through one of the layers, called the channel. A voltage connected to the other layer, called the gate, interferes with the current flowing in the channel. Thus, the voltage connected to the gate controls the strength of the current in the channel. There are two basic varieties of field effect transistors-the junction field effect transistor(JFET) and the metal oxide semiconductor field effect transistor (MOSFET). Most of the transistors contained in today's integrated circuits are MOSFETS's
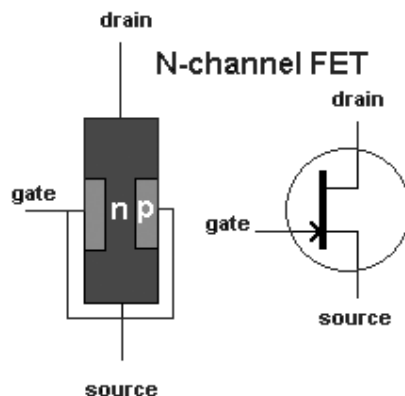
Darlington pair

This is two transistors connected together so that the amplified current from the first is amplified further by the second transistor. This gives the Darlington pair a very high current gain such as 10000. Darlington pairs are sold as complete packages containing the two transistors. They have three leads (**B**, **C** and **E**) which are equivalent to the leads of a standard individual transistor.

You can make up your own Darlington pair from two transistors. For example:
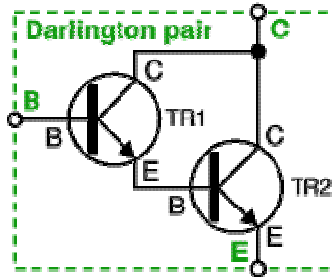
- For TR1 use BC548B with $h_{FE1} = 220$.
- For TR2 use BC639 with $h_{FE2} = 40$.

The overall gain of this pair is $h_{FE1} \times h_{FE2} = 220 \times 40 = 8800$. The pair's maximum collector current I_C(max) is the same as TR2.

Integrated circuit

Another name for a chip, an integrated circuit (IC) is a small electronic device made out of a semiconductor material. The first integrated circuit was developed in the 1950s by Jack Kilby of Texas Instruments and Robert Noyce of Fairchild Semiconductor.
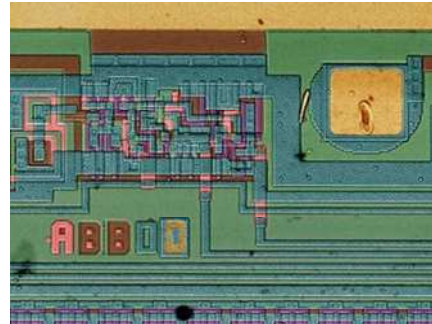

OR

An **integrated circuit (IC)** is a thin chip consisting of at least two interconnected semiconductor devices, mainly transistors, as well as passive components like resistors. As of 2004, typical chips are of size 1 cm^2 or smaller, and contain millions of interconnected devices, but larger ones exist as well. ICs categorized to two group ' **digital and linear ICs'**

What is inside the IC?

Miniaturized electronic circuit produced on a single crystal, or chip, of a semiconducting material – usually silicon. It may contain many millions of components and yet measure only 5 mm/0.2 in square and 1 mm/0.04 in thick. The IC is encapsulated within a plastic or ceramic case, and linked

via gold wires to metal pins with which it is connected to a printed circuit board and the other components that make up such electronic devices as computers and calculators.
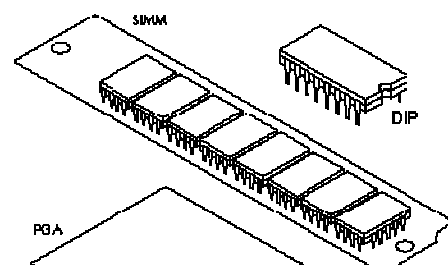

Silicon Chip

Integrated circuits are used for a variety of devices, including microprocessors, audio and video equipment, and automobiles. Integrated circuits are often classified by the number of transistors and other electronic components they contain:

☐ **SSI (small-scale integration):** Up to 100 electronic components per chip.

☐ **MSI (medium-scale integration):** From 100 to 3,000 electronic components per chip.

☐ **LSI (large-scale integration):** From 3,000 to 100,000 electronic components per chip.

☐ **VLSI (very large-scale integration):** From 100,000 to 1,000,000 electronic components per chip.

☐ **ULSI (ultra large-scale integration):** More than 1 million electronic components per chip

IC packages

Chips come in a variety of packages. The three most common are:

DIPs : Dual in-line packages are the traditional buglike chips that have anywhere

from 8 to 40 legs, evenly divided in two rows.

PGAs : Pin-grid arrays are square chips in which the pins are
arranged in concentric squares.

SIPs : Single in-line packages are chips that have just one row of
legs in a straight line like a comb.

In addition to these types of chips, there are also single in-line memory modules (SIMMs), which consist of up to nine chips packaged as a single unit.

Basic Electrical Quantities Measurement

It is necessary knowing how to measure voltage, current, and resistance. Special types of instruments are used to measure these basic electrical quantities. The instrument used to measure voltages is a **voltmeter**, the instrument used to measure current is a **ammeter,** and the instrument used to measure resistance is a o**hmmeter.**

Commonly, all three instruments are combined into a single instrument such as a **multimeter** or **AVO meter** (**A**mpere- **V**olt-**O**hmmeter), in which you can choose what specific quantity to measure by selecting the switch setting. shows typical portable multimeters, part (a) from figure shows analog multimeter with pointer, and part (b) shows a digital multimeter with digital screen.

(a) Analog multimeter   (b) Digital multimeter

Figure (3-21) Typical portable Multimeter

General scheme symbols is used to indicate placement of meters in circuit when value changes need to be shown. Figure (3-22) shows meter symbols used to present the different meters, as voltmeter, ammeter and ohmmeter.
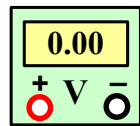
(a) Voltmeter
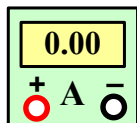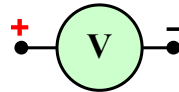
(b) Ammeter
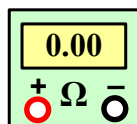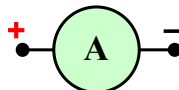
(c) Ohmmeter
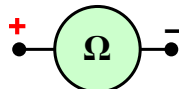
Figure (3-22) Meter symbols

3.5.1 Measuring Current with an Ammeter

It is knowing that current in the circuit is measured by ammeter, to measure the current , the circuit must be open and the ammeter is connected in the circuit.

The ammeter connection in the circuit is a series connection.

Figure (3-23) illustrates how to connect ammeter in the circuit and measure the current .
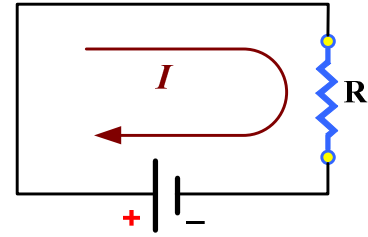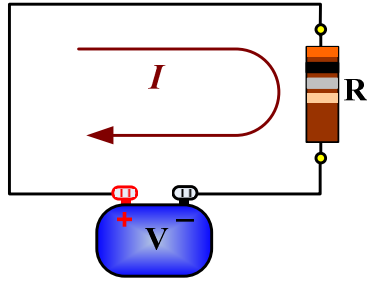
(a) Circuit in which the current is to be measured.
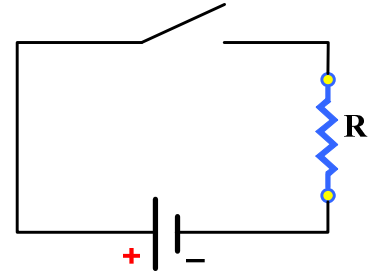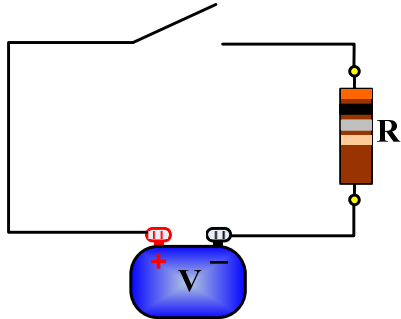
(b) Open the circuit between the resistor and the positive terminal
     of battery.
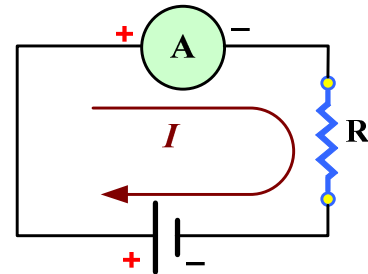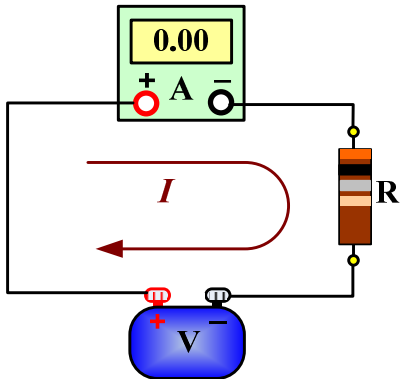
(c) Install the ammeter in the current pass with polarity as shown
    (negative to negative, positive to positive)

Figure (3-23) Example of an ammeter connection

3.5.2 Measuring Voltage with a Voltmeter

It is knowing that voltage in the circuit is measured by voltmeter, to measure the voltage, connect the voltmeter across the component which the voltage is to be measured.

Figure (3-24) illustrates how to connect voltmeter in the circuit to measure the voltage across the resistor.
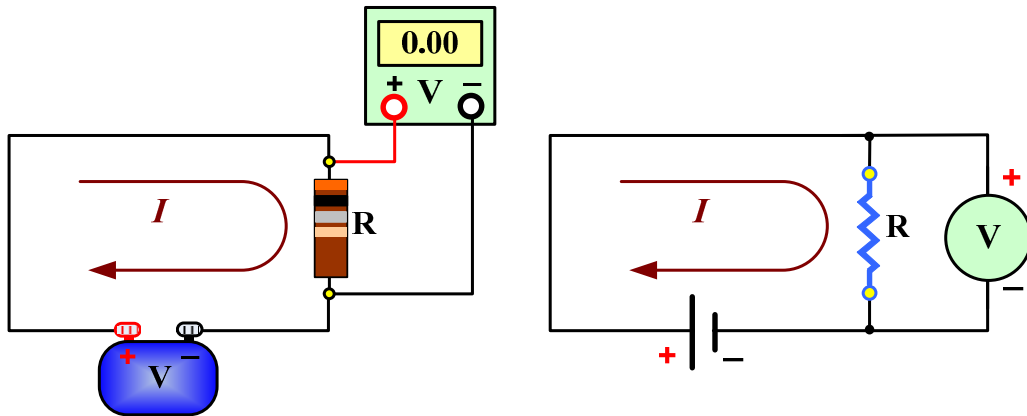
Figure (3-24) Example of a voltmeter connection

3.5.3 Measuring Resistance with Ohmmeter

To measure resistance, connect the ohmmeter across the resistor. The resistor must first removed from the circuit. This procedure is shown in figure(3-25).
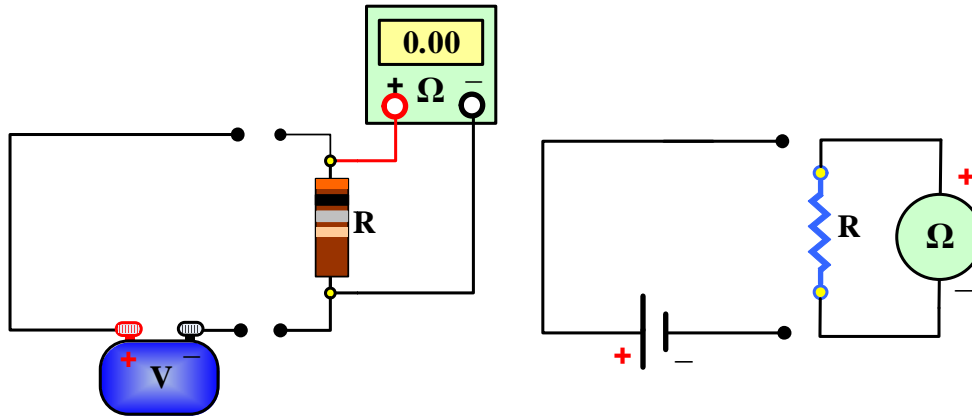
Figure (3-25) Example of using ohmmeter

1.5 Capacitors

1.5.1 Capacitor Function:-
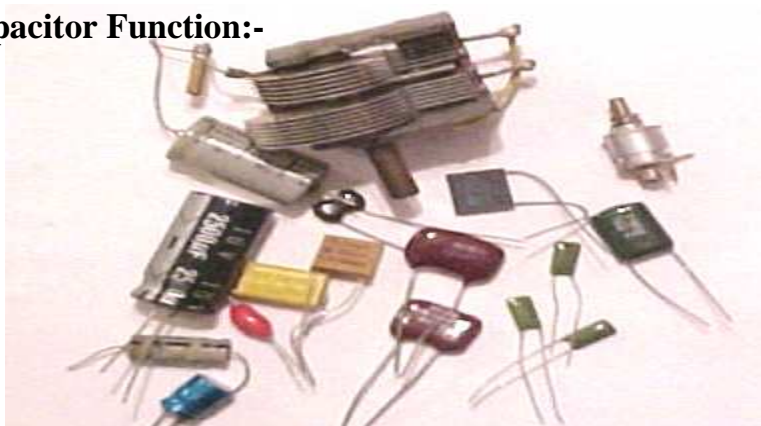
A capacitor is a device that stores energy in the electric field created between a pair of conductors on which equal but opposite electric charges have been placed. Capacitors can be used with resistors in timing circuits because it takes time for a capacitor to fill with charge. They are used to smooth varying DC supplies by acting as a reservoir of charge. They are also used in filter circuits because capacitors easily pass AC (changing) signals but they block DC (constant) signals.

1.5.2 Capacitor measuring:-

Capacitance

This is a measure of a capacitor's ability to store charge. A large capacitance means that more charge can be stored. Capacitance is measured in farads**,** symbol (F). However 1F is very large, so prefixes are used to show the smaller values.

Three prefixes (multipliers) are used, µ (micro), n (nano) and p (pico):

- µ means 10^{-6} (millionth), so $1000000\mu F = 1F$
- n means 10^{-9} (thousand-millionth), so $1000nF = 1\mu F$
- p means 10^{-12} (million-millionth), so $1000pF = 1nF$

Polarized capacitors (large values, 1µF +):

1.5.3 Capacitor types:-

Electrolytic Capacitors:

Electrolytic capacitors are polarized and they must be connected the correct way round,
At least one of their leads will be marked + or -.
They are not damaged by heat when soldering

Tantalum Bead Capacitors:

Tantalum bead capacitors are polarized and have low voltage ratings like electrolytic capacitors. They are expensive but very small, so they are used where a large capacitance is needed in a small size.
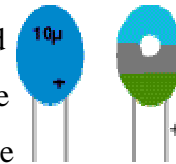
Un-polarized capacitors (small values, up to 1µF):

Small value capacitors are un-polarized and may be connected either way round. They are not damaged by heat when soldering, except for one unusual type (polystyrene). They have high voltage ratings of at least 50V, usually 250V or so. It can be difficult to find the values of these small capacitors because there are many types of them and several different labeling systems.
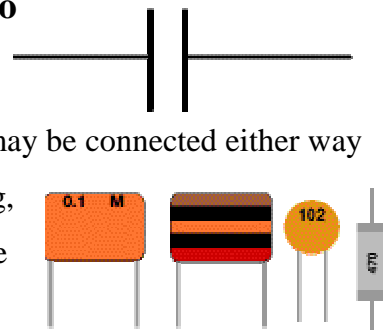
1.5.4 Capacitor Number Code:

A number code is often used on small capacitors where printing is difficult:

- The 1st number is the 1st digit,
- The 2nd number is the 2nd digit,
- The 3rd number is the number of zeros to give the capacitance in pF.
- Ignore any letters - they just indicate tolerance and voltage rating.

For example: **102**   means 1000pF = 1nF

1.5.4 Capacitor Colour Code:

The colours should be read like the resistor code, the top three colour bands giving the value in pF. Ignore the 4th band (tolerance) and 5th band (voltage rating).

Colour Code	
Colour	**Number**
Black	**0**
Brown	**1**
Red	**2**
Orange	**3**
Yellow	**4**
Green	**5**
Blue	**6**
Violet	**7**
Grey	**8**
White	**9**

For example:

Brown, black, orange   means $10000pF = 10nF = 0.01\mu F$.

Note that there are no gaps between the colours bands, so 2 identical bands actually appear as a wide band.

For example:

Wide red, yellow   means $220nF = 0.22\mu F$.

1.5.5 Capacitor connections:

Parallel connection:

Capacitors in a parallel configuration each have the same potential difference (voltage). The reason for putting capacitors in parallel is to increase the total amount of charge stored. In other words, increasing the capacitance we also increase the amount of energy that can be stored.

The total capacitance (C_{eq}) is given by:
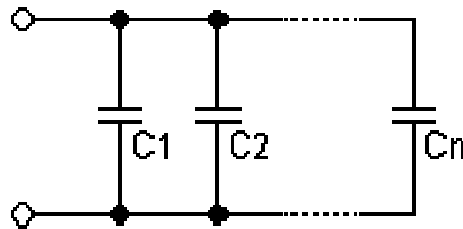
$$C_{eq} = C_1 + C_2 + \cdots + C_n$$

Series connection:

The current through capacitors in series stays the same, but the voltage across each capacitor can be different. The sum of the potential differences (voltage) is equal to the total voltage. The reason for putting capacitors in series we get less capacitance and less charge storage than with either alone (the total voltage is divided between the number of capacitors).

In parallel, the total charge stored is the sum of the charge in each capacitor. While in series, the charge on each capacitor is the same.

the total capacitance is given by:

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \cdots + \frac{1}{C_n}$$

1.2 Variable Resistors

Construction:
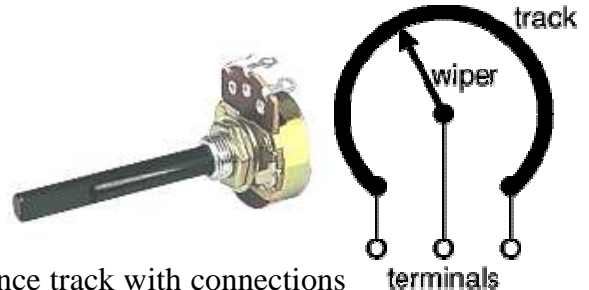
Variable resistors consist of a resistance track with connections at both ends and a wiper which moves along the track as you turn the spindle. The track may be made from carbon, cermets (ceramic and metal mixture) or a coil of wire (for low resistances).

Variable resistors are often called potentiometers in books and catalogues. They are specified by their maximum resistance, linear or logarithmic track, and their physical size. The standard spindle diameter is 6mm.

The resistance and type of track are marked on the body: 4K7 LIN means 4.7 kΩ linear track.

1M LOG means 1 MΩ logarithmic track.
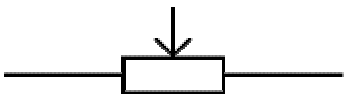
Some variable resistors are designed to be mounted directly on the circuit board, but most are for mounting through a hole drilled in the case containing the circuit with stranded wire connecting their terminals to the circuit board.

1.2.1 Linear (LIN) and Logarithmic (LOG) tracks:
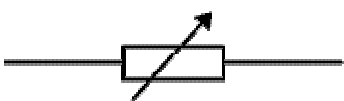
Linear (LIN) track: means that the resistance changes at a constant rate as you move the wiper. This is the standard arrangement and you should assume this type is required if a project does not specify the type of track. Presets always have linear tracks.

Logarithmic (LOG) track: means that the resistance changes slowly at one end of the track and rapidly at the other end, so halfway along the track is not half the total resistance! This arrangement is used for volume (loudness) controls because the human ear has a logarithmic response to loudness so fine control (slow change) is required at low volumes and coarser control (rapid change) at high volumes. It is important to connect the ends of the track the correct way round, if you find that turning the spindle increases the volume rapidly followed by little further change you should sop the connections to the ends of the track.

1.2.2 Potentiometer

Variable resistors used as potentiometers have all three terminals connected. This arrangement is normally used to vary voltage, for example to set the switching point of a circuit with a sensor, or control the volume (loudness) in an amplifier circuit. If the terminals at the ends of the track are connected across the power supply then the wiper terminal will provide a voltage which can be varied from zero up to the maximum of the supply.

Potentiometer   Symbol

1.2.3 Rheostat

This is the simplest way of using a variable resistor. Two terminals are used: one connected to an end of the track, the other to the moveable wiper. Turning the spindle changes the resistance between the two terminals from zero up to the maximum resistance. Rheostats are often used to vary current, for example to control the brightness of a lamp or the rate at which a capacitor charges.

Rheostat   Symbol

1.2.4 Presets

These are miniature versions of the standard variable

resistor. They are designed to be mounted directly onto the circuit board and adjusted only when the circuit is built. For example to set the frequency of an alarm tone or the sensitivity of a light-sensitive circuit. A small screwdriver or similar tool is required to adjust presets. Presets are much cheaper than standard variable resistors so they are sometimes used in projects where a standard variable resistor would normally be used.

The Basic Common Electronic Devices.

Fixed Resistor

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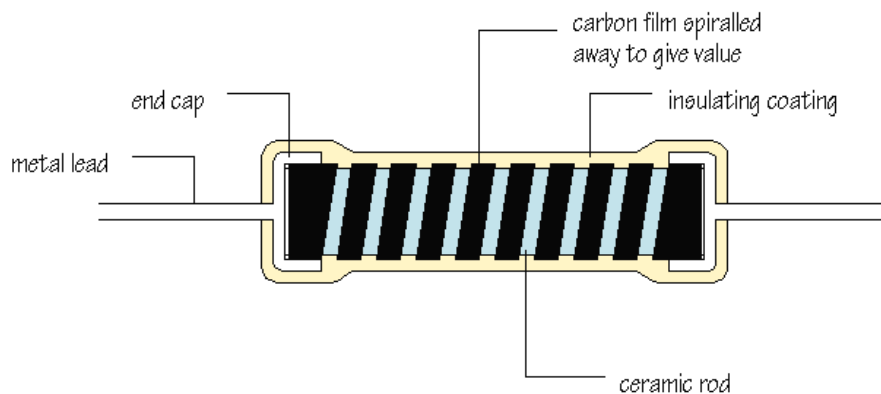
During manufacture, a thin film of carbon is deposited onto a small ceramic rod. The resistive coating is spiraled away in an automatic machine until the resistance between the two ends of the rod is as close as possible to the correct value. Metal leads and end caps are added; the resistor is covered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

Carbon film resistors are cheap and easily available, with values within ±10% or ±5% of their marked or 'nominal' value. **Metal film** and **metal oxide** resistors are made in a similar way, but can be made more accurately to within

±2% or ±1% of their nominal value. There are some differences in performance between these resistor types, but none which affect their use in simple circuits.

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

1.1.2 The Function: - Resistors limit current. In a typical application, a resistor is connected in series with an LED:
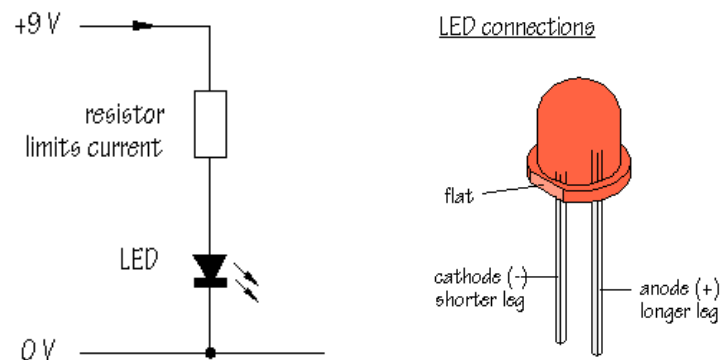
Enough current flows to make the LED light up, but not so much that the LED is damaged. The 'box' symbol for a fixed resistor is popular in the UK and Europe. A 'zigzag' symbol is used in America and Japan:

Resistors are used with **transducers** to make **sensor subsystems**. Transducers are electronic components which convert energy from one form into another, where one of the forms of energy is electrical. A **light dependent resistor**, or **LDR**, is an example of an **input transducer**. Changes in the brightness of the light shining onto the surface of the LDR result in changes in its resistance. As will be explained later, an input transducer is most often connected along with a resistor to make a circuit called a **potential divider**. In this case, the output of the potential divider will be a voltage signal which reflects changes in illumination.

Microphones and switches are input transducers. **Output transducers** include loudspeakers, filament lamps and LED's. Can you think of other examples of transducers of each type?

In other circuits, resistors are used to direct current flow to particular parts of the circuit, or may be used to determine the voltage gain of an amplifier. Resistors are used with capacitors (Chapter 4) to introduce time delays.

Most electronic circuits require resistors to make them work properly and it is obviously important to find out something about the different types of resistor available, and to be able to choose the correct resistor value, in Ω, $k\Omega$, or MΩ, for a particular application.

1.1.3 Types of resistor:

There are two classes of resistors

- Fixed resistors
- Variable resistors

They are also classified according to the material from which they are made.

- Carbon
- Film
- Wire wound
- Axial lead

There are other types as well, but these are the most common.

Colour code:-

How can the value of a resistor be worked out from the colours of the bands? Each colour represents a number according to the following scheme:

4 Band Color Code

The first band on a resistor is interpreted as the FIRST DIGIT of the resistor value. For the resistor shown below, the first band is yellow, so the first digit is 4:
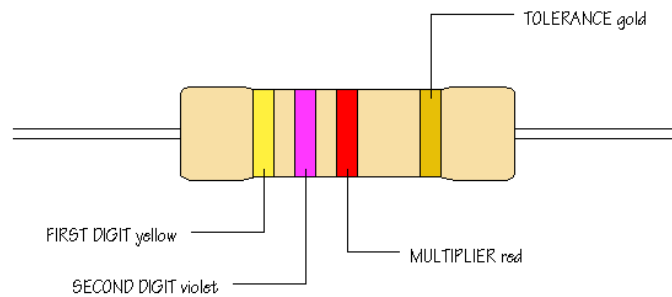
The second band gives the SECOND DIGIT. This is a violet band, making the second digit 7. The third band is called the MULTIPLIER and is not interpreted in quite the same way. The multiplier tells you how many types of nougat you should write after the digits you already have. A red band tells you to add 2 nougats. The value of this resistor is therefore 4 7 0 0 ohms, that is, 4700Ω , or
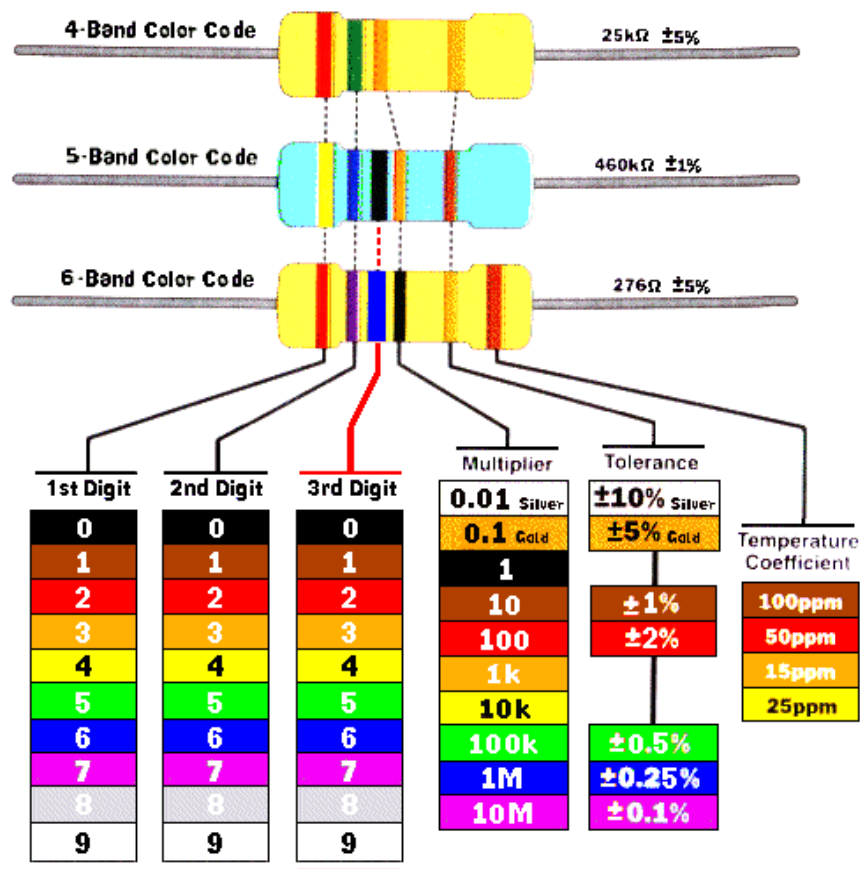
Be Careful when reading 5 and 6 Band Resistors
Note: the 3rd Digit is not used when reading the 4 band resistor

4.7 $k\Omega$. Work through this example again to confirm that you understand how to apply the colour code given by the first three bands.

The remaining band is called the TOLERANCE band. This indicates the percentage accuracy of the resistor value. Most carbon film resistors have a gold-coloured tolerance band, indicating that the actual resistance value is with + or - 5% of the nominal value. Other tolerance colours are:

When you want to read off a resistor value, look for the tolerance band, usually gold, and hold the resistor with the tolerance band at its right hand end. Reading resistor values quickly and accurately isn't difficult, but it does take practice! For example

The resistor has brown (1), black (0), red (2 zeros) and silver bond. So it value is $1000\Omega = 1k\Omega$

Resistors in series and parallel:-

Resistors

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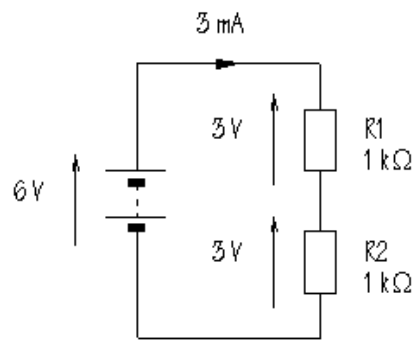
Resistors in series

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

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

In this circuit, $R_{total}=1+1=2\,k\Omega$. What will be the current flowing? The formula is:

$$I = \frac{V}{R}$$

Substituting:

$$I = \frac{6}{2\,\text{k}\Omega} = 3\,\text{mA}$$

Notice that the current value is in mA when the resistor value is substituted in $\text{k}\Omega$. The same current, 3 mA, flows through each of the two resistors. What is the voltage across R1? The formula is:

$$V = IR$$

Substituting:

$$V = 3\,\text{mA} \times 1\,\text{k}\Omega = 3\,\text{V}$$

What will be the voltage across R2? This will also be 3 V. It is important to point out that the sum of the voltages across the two resistors is equal to the power supply voltage.

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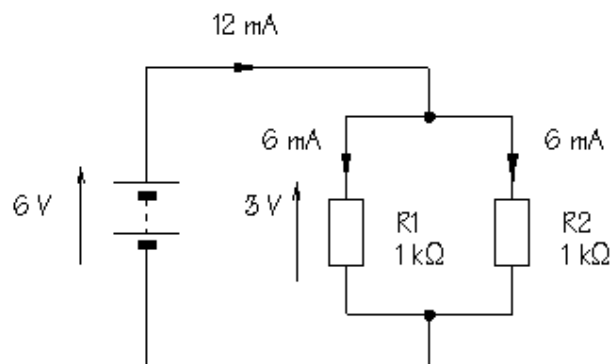
Resistors in parallel

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

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

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

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

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

What is the total resistance in this circuit?

$$R_{total} = \frac{1 \times 1}{1 + 1} = \frac{1}{2} = 0.5 \text{ k}\Omega$$

The current can be calculated from:

$$I = \frac{V}{R} = \frac{6}{0.5 \text{ k}\Omega} = 12 \text{ mA}$$

How does this current compare with the current for the series circuit? It's more. This is sensible. Connecting resistors in parallel provides alternative pathways and makes it easier for current to flow. How much current flows through each resistor? Because they have equal values, the current divides, with 6 mA flowing through R1, and 6 mA through R2.

To complete the picture, the voltage across R1 can be calculated as:

$$V = IR = 6 \text{ mA} \times 1 \text{ k}\Omega = 6 \text{ V}$$

This is the same as the power supply voltage. The top end of R1 is connected to the positive terminal of the battery, while the bottom end of R1 is connected to the negative terminal of the battery. With no other components in the way, it follows that the voltage across R1 *must* be 6 V. What is the voltage across R2? By the same reasoning, this is also 6 V.

Here is a slightly more complex circuit, with both series and parallel parts:

Circuit with series and parallel resistors

To find the overall resistance, the first step is to calculate the resistance of the parallel elements. You already know that the combined resistance of two 1 kΩ resistors in parallel is 0.5 kΩ, so the total resistance in the circuit is 1+0.5=1.5 kΩ. The power supply current is:
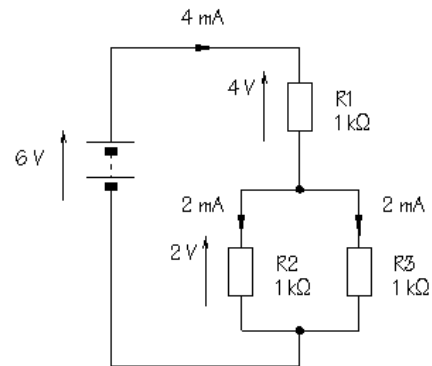
$$I = \frac{V}{R} = \frac{6}{1.5 \text{ k}\Omega} = 4 \text{ mA}$$

This is the current which flows through R1. How much current will flow through R2? Since there are two equally easy pathways, 2 mA will flow through R2, and 2 mA through R3.

The voltage across R1 is given by:

$$V = IR = 4 \text{ mA} \times 1 \text{ k}\Omega = 4 \text{ V}$$

This leaves 2 V across R2 and R3, as confirmed by the calculation for R2:

$$V = IR = 2 \text{ mA} \times 1 \text{ k}\Omega = 2 \text{ V}$$

Again, the sum of the voltages around the circuit is equal to the power supply voltage.

Check through this section carefully. A clear understanding of the concepts involved will help tremendously.

Power rating

When current flows through a resistance, electrical energy is converted into heat. This is obvious in an electric torch where the lamp filament heats up and glows white hot. Although the result may be less evident or imperceptible, exactly the same process of energy conversion goes on when current flows through *any* electronic component.

The **power** output of a lamp, resistor, or other component, is defined as the $P = VI$ rate of change of electrical energy to heat, light, or some other form of energy. Power is measured in **watts**, **W**, or **mill watts**, **mW**, and can be calculated from:

Where *P* is power.

What is the power output of a resistor when the voltage across it is 6 V, and the current flowing through it is 100 mA?

$$P = VI = 6 \times 100\,\text{mA} = 600\,\text{mW} = 0.6\,\text{W}$$

0.6 W of heat are generated in this resistor. To prevent overheating, it must be possible for heat to be lost, or **dissipated**, to the surroundings at the same rate.

A resistor's ability to lose heat depends to a large extent upon its surface area. A small resistor with a limited surface area cannot dissipate (=lose) heat quickly and is likely to overheat if large currents are passed. Larger resistors dissipate heat more effectively.

Look at the diagram below which shows resistors of different sizes:
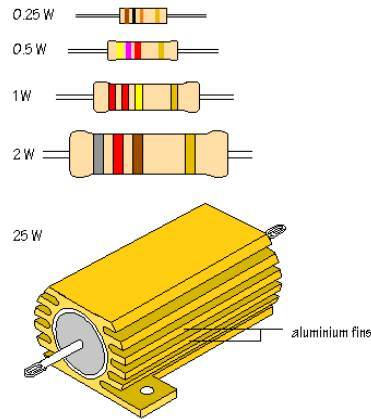
FULL-WAVE RECTIFIER

It is possible to rectify both alternations of the input voltage by using two

diodes in the circuit arrangement as shown in fig. (1).
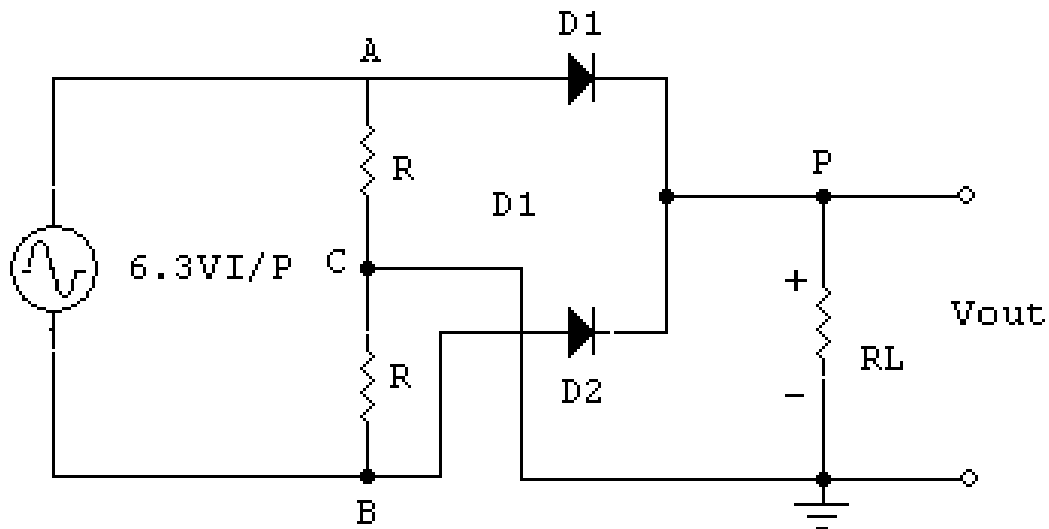
Figure (1).full-wave rectifier

Assume 6.3 V rms (18 V p-p) is applied to the circuit. Assume further that two equal valued series connected resistor R are placed in parallel with the AC source. The 18 V p-p appears across the two resistors connected between points AC and CB, and point C is the electrical midpoint between A and B.

Hence, 9 V p-p appears across each resistor. At any moment during a cycle of Van if point A is positive relative to C, point B is negative relative to C. when A is negative relative to C, point B is positive relative to C. the effective voltage in proper time phase which each diode as shown in fig.(2).the voltage applied to the anode of each diode is equal but opposite in polarity at any given instant.
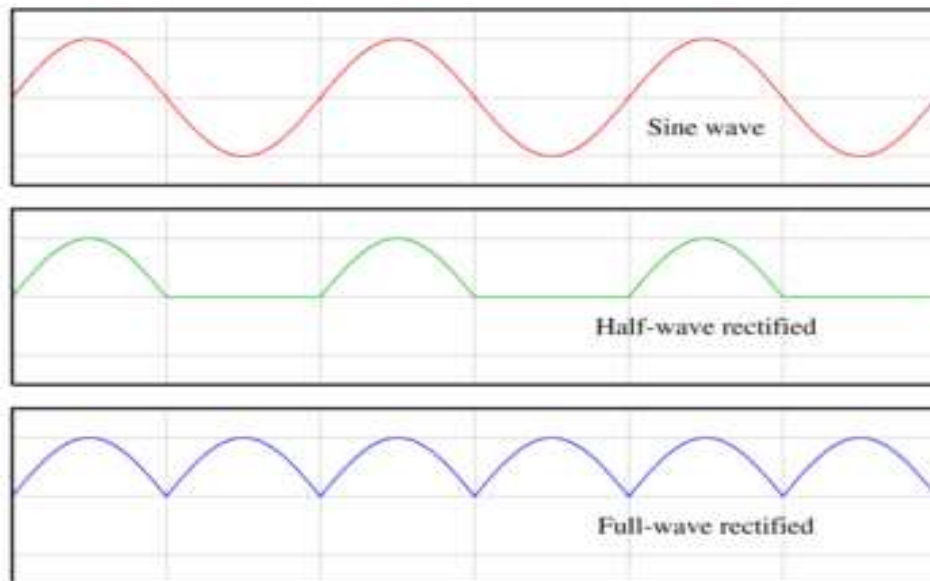
Figure (2).

When A is positive relative to C, the anode of D_1 is positive with respect to its cathode. Hence, D_1 will conduct, but D_2 will not conduct. During the second alternation, B is positive relative to C. the anode of D_2 is therefore positive with respect to its cathode and D_2 conducts while D_1 is cut off.

There is conduction then by either D_1 or D2 during the entire input voltage cycle.

Since the two diodes have a common cathode load resistor RL, the output voltage across R_L will result from the alternate conduction of D_1 and D_2. The output waveform V_{OUT} across R_L in fig. therefore has no gaps as in the case of the half-wave rectifier.

The output of a full-wave rectifier is also pulsating direct current in the diagram of figure (1) the two equal resistors R across the input voltage are necessary to provide a voltage center reference C for circuit connection and zero reference. Not that the load resistor R_L is connected from the cathodes to this center reference point C.

TRANSFORMER-FED FULL-WAVE RECTIFIER

The voltage drop across R, when its respective diode is conducting, subtracts from the voltage out and reduces the output voltage.
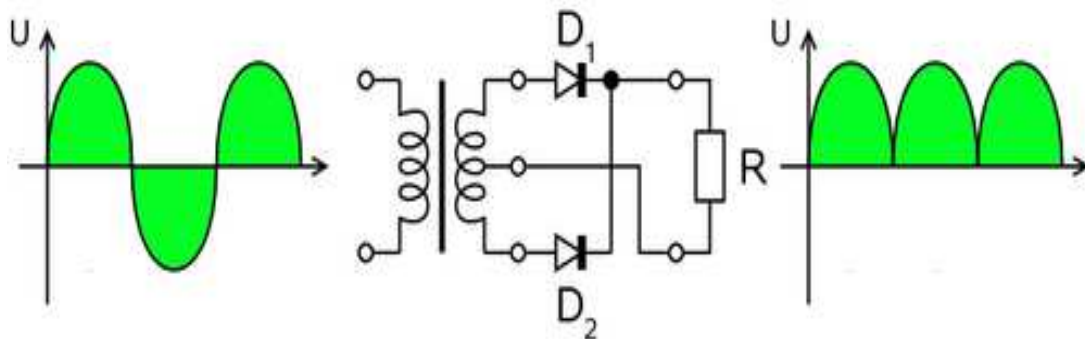
Figure (3).transformer-fed full-wave voltage rectifier.

The anodes of rectifier diodes D_1 and D_2 are fed by the secondary voltages. Since C is the center tap, each diode anode receives V rms. the load resistor RL is connected from the junction of the cathodes of D_1 and D_2, point D, to the center tap on the secondary winding, point C the output voltage appears across RL. When the power is applied to the primary of T1, D_1 and D_2 operate as a full-wave rectifier. Each diode "sees" only half the voltage appearing across the secondary and each diode conducts alternately.

D_1 acts as a half-wave rectifier, D_2 acts as a half-wave rectifier. Power rectifiers D_1 and D_2 are rated for the current they must deliver to a circuit and for the peak forward and peak inverse voltages, they can withstand. Other advantage which a transformer power supply has over a transformer less circuit is that the output voltage Out of a transformer-fed supply is line-isolated, since there is no direct connection between the primary (line) winding and the secondary winding.

Compare between half wave rectifier and full wave rectifier

A half wave rectifier, only one alternation of the AC waveform is applied to the load. When two rectifier diode are used we have full wave rectification. Here the two alternations of the input sine wave are processed alternately by diodes D_1 and D_2. The rectified output of a half wave rectifier appears as unidirectional current pulses. The rectified output of a full wave rectifier also appears as unidirectional current pulses but here we have two pulses for every sine wave of input. The rectifiers have transformed the AC waveform into pulsating DC.

Half-Wave Rectifier

The circuit we used in part 1 of the lab can be used as part of a power supply. Remember the small voltage drop.

R_{load}

This is the symbol for a transformer, which is two coils coupled by an alternating magnetic field. It is commonly used to change AC voltage, and remove the ground reference.

Figure (4a).

Full-Wave Bridge Rectifier(3)
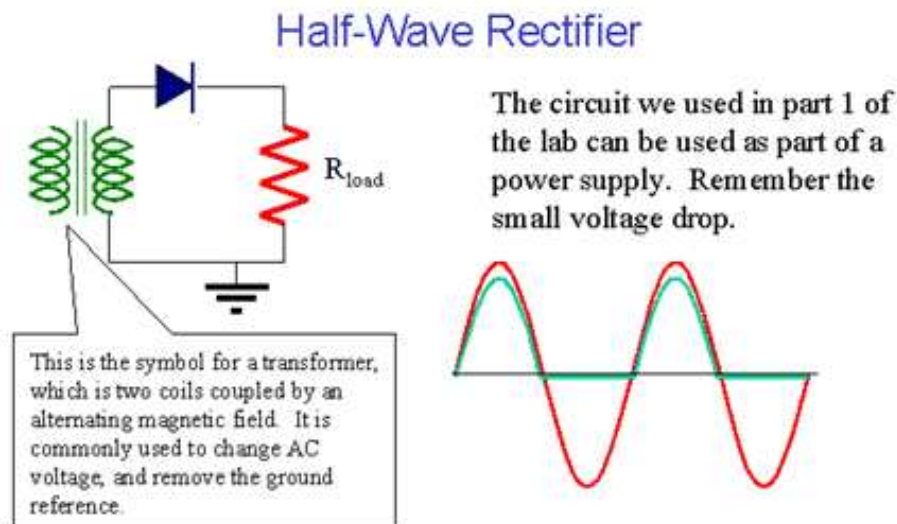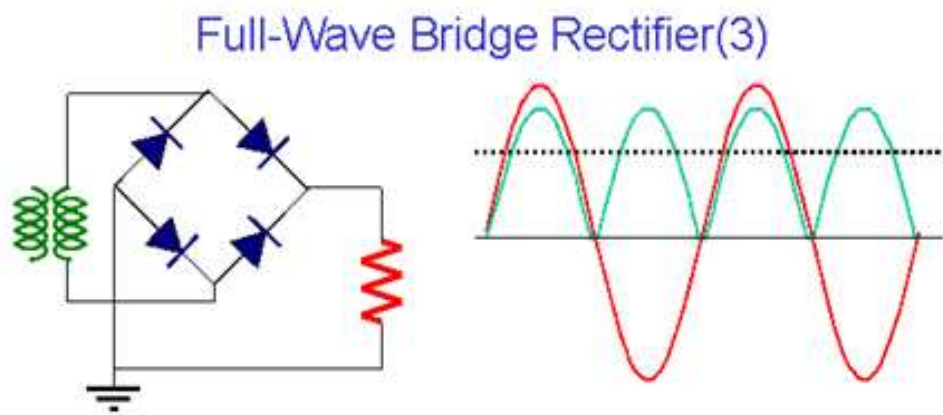
Figure (4b).

1.2 Week5

1.3 Objective: Understanding Basic measuring Equipment

1.4

Basic Electrical Quantities Measuring Equipment

It is necessary knowing how to measure voltage, current, and resistance. Special types of instruments are used to measure these basic electrical quantities. The instrument used to measure voltages is a **voltmeter**, the instrument used to measure current is a **ammeter,** and the instrument used to measure resistance is a o**hmmeter.**

Commonly, all three instruments are combined into a single instrument such as a **multimeter** or **AVO meter** (**A**mpere- **V**olt-**O**hmmeter), in which you can choose what specific quantity to measure by selecting the switch setting. Figure (1) shows typical portable multimeters, part (a) from figure shows analog multimeter with pointer, and part (b) shows a digital multimeter with digital screen.

(a) Analog multimeter   **(b) Digital multimeter**

1.5 3.2.4 Calculating Current

In this section, you will learn to determine the current values when you known the values of voltage and resistance. As examples, by using the following formula **I = V/R** . In order to get current in amperes, you must express the value of voltage in volt and the value of resistance in ohms.

Example 3-2

If the resistance in figure 3-7 is changed to 0.1 KΩ and the voltage to 50V, what is the new value of current?

Solution:

$$I = \frac{V}{R}$$

$$I = \frac{50}{100} = 0.25 \text{ A}$$

V = 500 volts

R = 0.1 KΩ

 = 0.1 X 1000 Ω

 = 100 Ω

I = ?

Solution: use the formula

$$I = \frac{V}{R}$$

$$I = \frac{10}{10} = 1 \text{ A}$$

V = 100 volts

R = 10 Ω

I = ?

1.6

1.7 3.2.5 Calculating voltage

In this section, you will learn to determine the voltage values when you known the values of voltage and current. As examples, by using the following formula V =I R.

In order to get voltage in volts, you must express the value of current in amperes and the value of resistance in ohms.

Example 3-3

In the circuit in figure (3-8), how much voltage is needed to produced 6A of current ?

I = 6 A

R
200Ω

V

+
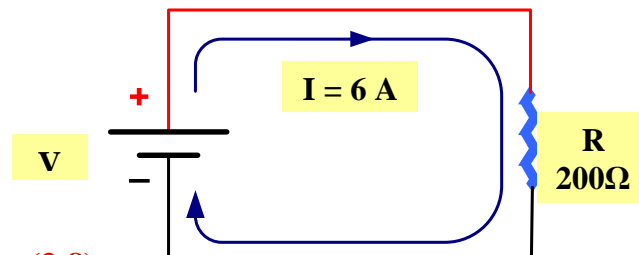
Figure (3-8)

Solution: use the formula V= I R

V = I R

V = 6 X 200   = 1200 v

If required voltage by kVolts

V = ?

R = 200 Ω

I = 6 A

Example 3-4

The circuit in figure 3-8, the current is changed to 30 mA, and the resistance is changed to 3.4 K Ω, what is the voltage

Solution:

V = ?

R = 3.4 K

V = 3400 X 0.03 = 102 v   = 3.4 X 1000 = 3400 Ω

V = I R

I = 30 mA

= 30 ÷ 1000 = 0.03 A

1.8 3.2.6 Calculating Resistance

In this section, you will learn to determine the resistance values when you

known the values of voltage and current. As examples, by using the following

formula **R = V/I**

In order to get resistance by ohms, you must express the value of voltage in

volts and the value of current in amperes.

Example 3-5

In the circuit in figure (3-9), how much resistance is needed to draw 4mA of

current ?

I = 6A

V
24 v

R

Figure (3-9)

Solution:

V = 24 v

R = ?

use the formula R= V / I

I = 6A

$$R = \frac{V}{I}$$

$$\frac{24}{6}$$

R =   = 4 Ω

1.Set the range of the desired quantity to be measured to the highest value.

2.Connect the leads to the right terminals at the meter

3.Switch on the circuit if necessary.

4.Adjust the range until you get clear readings.

5.Apply the following formula to obtain the measured quantity.

$$\text{Re}\,ading \times \frac{Range}{Full-Scale}$$

For example, referring to figure (3),the reading was 3.5 from a full-scale value of 5V, as shown in the small box.The range was set to X300V.So the measured voltage is

$$3.5 \times \frac{300}{5} = 210$$
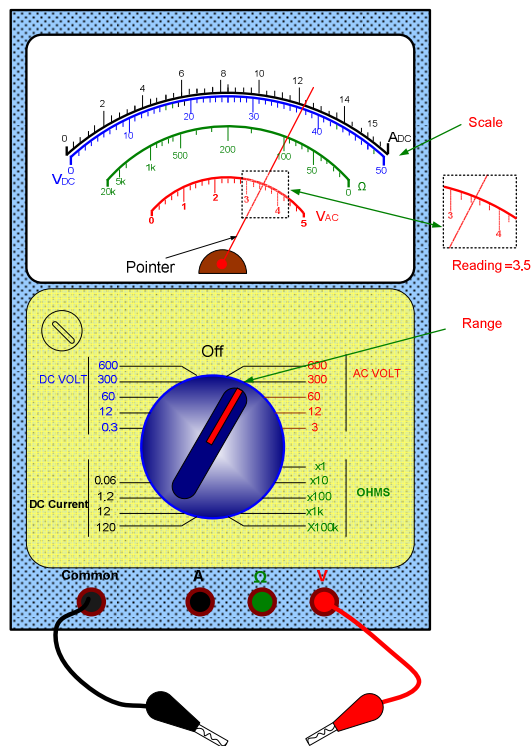
Figure(3): Multimeter

2.1.2 Measuring the Voltage

Voltage can be considered as the pressure that force the electrons to flow. The voltage is being measured by measuring the difference between the voltages at the two terminals of the device-under-test which is the (voltage drop). This can be performed using a measuring instrument called voltmeter.

Figure (1) illustrates how to connect voltmeter in the circuit to measure the voltage across the resistor.
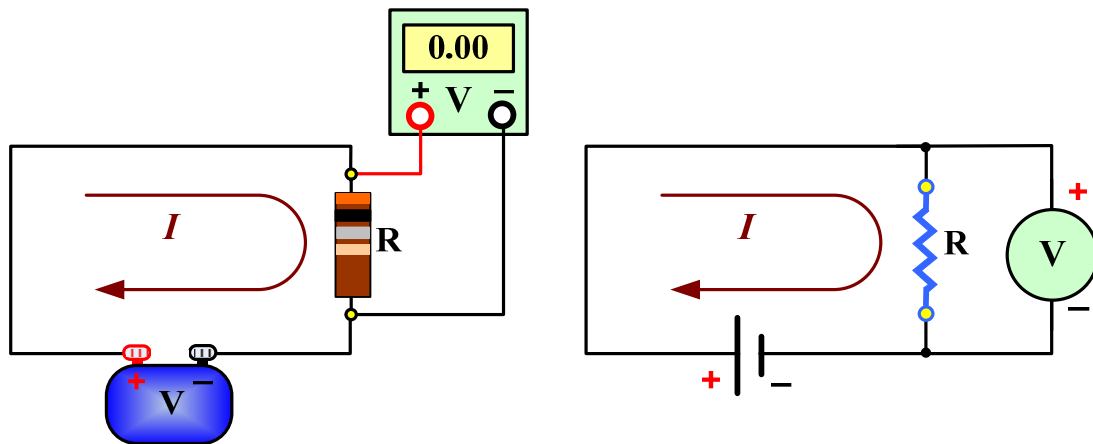
Figure (1) Example of a voltmeter connection

1.   Adjust the range of the meter

2.   Connect the leads in the true terminals of the meter

3.   Apply the other ends of the leads to the resistor under test

4.   Record the reading and apply the formula $\text{Re}\,ading \times \dfrac{Range}{full - scale}$

1.9 3.1 Ohm's law

s law is the most important mathematical relationship between voltage, 'Ohm

current and resistance in electricity.

$$V = I \ X \ R$$

It is important to know how to read the resistors' colour code and hence its ohmic value. In the following figure it shows a table of the meaning of each colour. For example, for the resistor in the figure(1),the value of the resistor is 200kΩ,since the band 1 is red i.e. equivalent to 2 in the table ,band 2 is black equivalent to zero in the table and the band 3 is yellow indicating of a multiplier of 10,000.see at the bottom of the figure.

The fourth band is the tolerance band i.e the percentage of error. It usually comes in two colors ,the silver indicates ±5% and the gold indicates ±10%.so for example, the value resistor will lie between 210kΩ and 190kΩ.

Procedure

1.   Select a number of different resistors
2.   Use the table below to determine their values
3.   Use ohmmeter to measure the same resistors you figured out
4.   Compare your calculated values with the readings you obtained

3.1.1 Resistors color code:
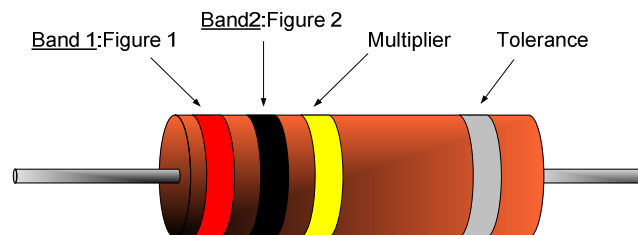
Colour		First figure value	Second figure value	Multiplier
Black		0	0	X1
Brown		1	1	X10
Red		2	2	X100
Orange		3	3	X1000
Yellow		4	4	X10,000
Green		5	5	X100,000
Blue		6	6	X1,000,000
Violet		7	7	X10,000,000
Grey		8	8	X100,000,000
White		9	9	X1,000,000,000

2   0   X10,000=200KΩ   ±5%

Figure1:Resistors colour code

1.10 Objective: Understanding Basic measuring Equipment

2.1.3 Measuring Current with Ammeter

It is well known that current in the circuit is measured by ammeter, to measure the current , the circuit must be open and the ammeter is connected in *series* the circuit.

Procedure

1. Connect the simple circuit shown in the figure below

2. Open the circuit between the source and the resistor

3. Connect the ammeter terminals to one end of the resistor and to the source

4. Switch on the power supply and record the reading.

5. Apply the formula $\mathrm{Re}\,ading \times \dfrac{Range}{full-scale}$ if necessary

Note:

If the meter did not give any movement or tried to move backward, then switch the terminal leads with each other

Figure(1) illustrates how to connect ammeter in the circuit and measure the current.
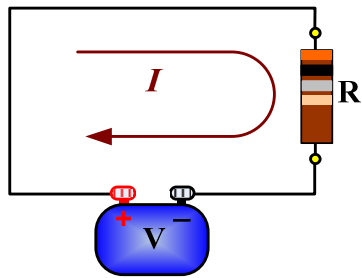
(a) Circuit in which the current is to be measured.
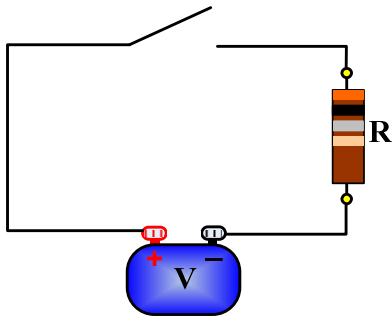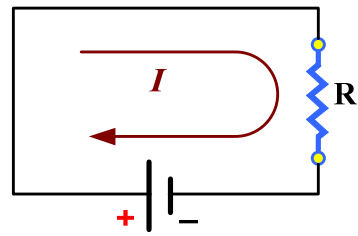
(b) Open the circuit between the resistor and the positive terminal of battery.
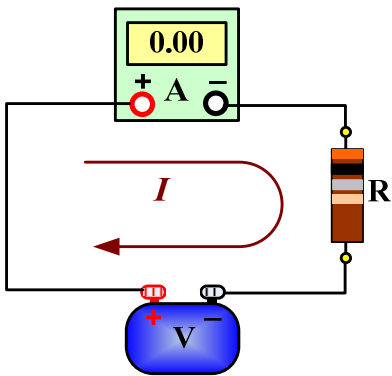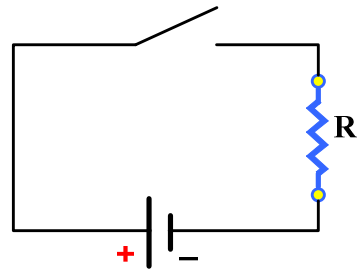
(c) Install the ammeter in the current pass with polarity as shown (negative to negative, positive to positive)
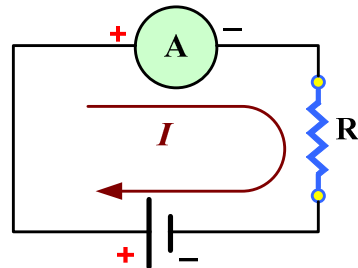
Figure 1: Example of an ammeter connection

2.1.4 Measuring Resistance with Ohmmeter

To measure resistance, connect the ohmmeter across the resistor. The resistor
   must first removed from the circuit. This procedure is shown in figure(2).
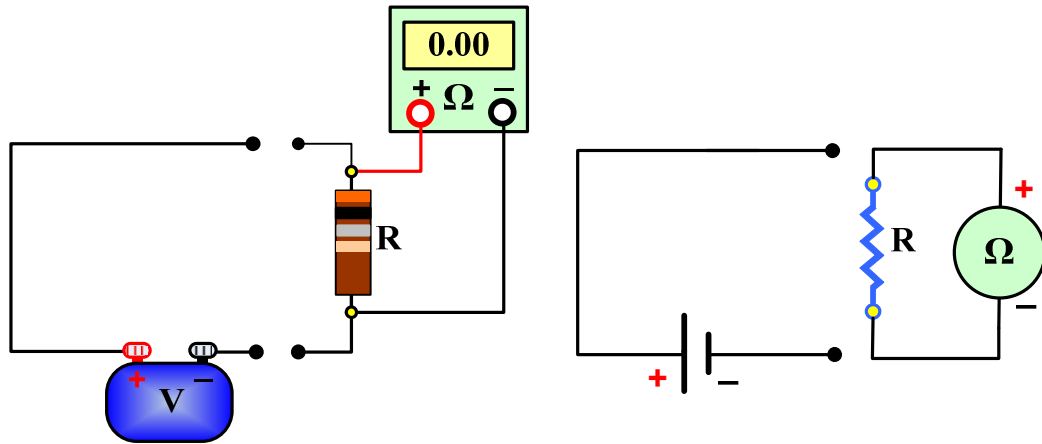
Figure (2) Example of using ohmmeter

Procedure

1.   Adjust the meter so that when the two terminals are short circuited, the

     ohmmeter reads zero

2.   Disconnect the resistor to be measured from the circuit (why?)

3.   Apply the meter leads to the resistor terminals (resistor is parallel to the meter)

4.   Record the reading and apply the formula $Re\,ading \times \dfrac{Range}{full - scale}$ if necessary

Objective: Understanding integrated circuit and terminologies

Integrated circuit

Another name for a chip, an integrated circuit (IC) is a small electronic device made out of a semiconductor material. The first integrated circuit was developed in the 1950s by Jack Kilby of Texas Instruments and Robert Noyce of Fairchild Semiconductor.

OR

An **integrated circuit (IC)** is a thin chip consisting of at least two interconnected semiconductor devices, mainly transistors, as well as passive components like resistors. As of 2004, typical chips are of size 1 cm^2 or smaller, and contain millions of interconnected devices, but larger ones exist as well. ICs categorized to two group ' **digital and linear ICs'**

Memory ROM-BIOS 1.10.1

The ROM-BIOS (Read Only Memory - Basic Input Output System) chip is a special chip held on your computer's system (mother) board. It contains software that is required to make your computer work with your operating system, for instance it is responsible for copying your operating system into RAM when you switch on your computer.

What is inside the IC?

Miniaturized electronic circuit produced on a single crystal, or chip, of a semiconducting material – usually silicon. It may contain many millions of components and yet measure only 5 mm/0.2 in square and 1 mm/0.04 in thick. The IC is encapsulated within a plastic or ceramic case, and linked via gold wires to metal pins with which it is connected to a printed circuit board and then to other components to make up such electronic ... s and calculators.

Silicon Chip

Integrated circuits are used for a variety of devices, including microprocessors, audio and video equipment, and automobiles. Integrated circuits are often classified by the number of transistors and other electronic components they contain:

SSI (small-scale integration): Up to 100 electronic components per chip.

MSI (medium-scale integration): From 100 to 3,000 electronic components per chip.

LSI (large-scale integration): From 3,000 to 100,000 electronic components per chip.

VLSI (very large-scale integration): From 100,000 to 1,000,000 electronic components per chip.

ULSI (ultra large-scale integration): More than 1 million electronic components per chip

IC packages

Chips come in a variety of packages. The three most common are:

DIPs **:** Dual in-line packages are the traditional buglike chips that have anywhere from 8 to 40 legs, evenly divided in two rows.

PGAs **:** Pin-grid arrays are square chips in which the pins are arranged in concentric squares.

SIPs **:** Single in-line packages are chips that have just one row of legs in a straight line like a comb.

In addition to these types of chips, there are also single in-line memory modules (SIMMs), which consist of up to nine chips packaged as a single unit.

Inside Logic Gates

I have received a number of requests, asking just what goes on inside logic gates to actually perform logic functions. So, by popular demand, here are the internal schematics of various gates, as implemented by several different logic families.

I won't cover the internal operation of individual semiconductor devices in these pages, except to state the basic behavior of a given device under specific conditions. More detailed coverage of semiconductor physics and internal behavior is a job for another set of pages, which will come later.

There are several different families of logic gates. Each family has its capabilities and limitations, its advantages and disadvantages. The following list describes the main logic families and their characteristics. You can follow the links to see the circuit construction of gates of each family.

Diode Logic (DL)

Diode logic gates use diodes to perform AND and OR logic functions. Diodes have the property of easily passing an electrical current in one direction, but not the other. Thus, diodes can act as a logical switch.

Diode logic gates are very simple and inexpensive, and can be used effectively in specific situations. However, they cannot be used extensively, as they tend to degrade digital signals rapidly. In addition, they cannot perform a NOT function, so their usefulness is quite limited.

Resistor-Transistor Logic (RTL)

Resistor-transistor logic gates use Transistors to combine multiple input signals, which also amplify and invert the resulting combined signal. Often an

additional transistor is included to re-invert the output signal. This combination provides clean output signals and either inversion or non-inversion as needed.

RTL gates are almost as simple as DL gates, and remain inexpensive. They also are handy because both normal and inverted signals are often available. However, they do draw a significant amount of current from the power supply for each gate. Another limitation is that RTL gates cannot switch at the high speeds used by today's computers, although they are still useful in slower applications.

Although they are not designed for linear operation, RTL integrated circuits are sometimes used as inexpensive small-signal amplifiers, or as interface devices between linear and digital circuits.

Diode-Transistor Logic (DTL)

By letting diodes perform the logical AND or OR function and then amplifying the result with a transistor, we can avoid some of the limitations of RTL. DTL takes diode logic gates and adds a transistor to the output, in order to provide logic inversion and to restore the signal to full logic levels.

Transistor-Transistor Logic (TTL)

The physical construction of integrated circuits made it more effective to replace all the input diodes in a DTL gate with a transistor, built with multiple emitters. The result is transistor-transistor logic, which became the standard logic circuit in most applications for a number of years.

As the state of the art improved, TTL integrated circuits were adapted slightly to handle a wider range of requirements, but their basic functions remained the same. These devices comprise the 7400 family of digital ICs.

Emitter-Coupled Logic (ECL)

Also known as Current Mode Logic (CML), ECL gates are specifically designed to operate at extremely high speeds, by avoiding the "lag" inherent when transistors are allowed to become saturated. Because of this, however, these gates demand substantial amounts of electrical current to operate correctly.

CMOS Logic

CMOS Logic

One factor is common to all of the logic families we have listed above:
they use significant amounts of electrical power. Many applications, especially portable, battery-powered ones, require that the use of power be absolutely minimized. To accomplish this, the CMOS (Complementary Metal-Oxide-Semiconductor) logic family was developed. This family uses enhancement-mode MOSFETs as its transistors, and is so designed that it requires almost no current to operate.

CMOS gates are, however, severely limited in their speed of operation. Nevertheless, they are highly useful and effective in a wide range of battery-powered applications.

Most logic families share a common characteristic: their inputs require a certain amount of current in order to operate correctly. CMOS gates work a bit differently, but still represent a capacitance that must be charged or discharged when the input changes state. The current required to drive any input must come from the output supplying the logic signal. Therefore, we need to know how much current an input requires, and how much current an output can reliably supply, in order to determine how many inputs may be connected to a single output.

However, making such calculations can be tedious, and can bog down logic circuit design. Therefore, we use a different technique. Rather than working constantly with actual currents, we determine the amount of current required to drive one standard input, and designate that as a standard load on any output. Now we can define the number of standard loads a given output can drive, and identify it that way. Unfortunately, some inputs for specialized circuits require more than the usual input current, and some gates, known as *buffers*, are deliberately designed to be able to drive more inputs than usual. For an easy way to define input current requirements and output drive capabilities, we define two new terms:

Fan-in

The number of standard loads drawn by an input to ensure reliable operation. Most inputs have a fan-in of 1.

The number of standard loads that can be reliably driven by an output, without causing the output voltage to shift out of its legal range of values.

Remember, fan-in and fan-out apply directly only within a given logic family. If for any reason you need to interface between two different logic families, be careful to note and meet the drive requirements and limitations of both families, within the interface circuitry

CMOS logic is a newer technology, based on the use of complementary MOS transistors to perform logic functions with almost no current required. This makes these gates very useful in battery-powered applications. The fact that they will work with supply voltages as low as 3 volts and as high as 15 volts is also very helpful.
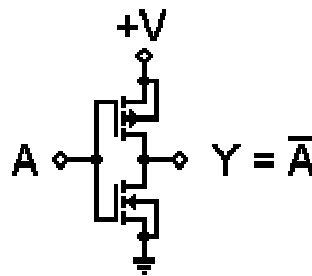
CMOS gates are all based on the fundamental inverter circuit shown to the left. Note that transistors are enhancement-mode MOSFETs; one N-channel with its source grounded, and one P-channel with its source connected to +V. Their gates are connected together to form the input, and their drains are connected together to form the output.

The two MOSFETs are designed to have matching characteristics. Thus, they are complementary to each other. When off, their resistance is effectively infinite; when on, their channel resistance is about 200Ω. Since the gate is essentially an open circuit it draws no current and the output voltage will be equal to either ground or to the power supply voltage, depending on which transistor is conducting.

When input A is grounded (logic 0), the N-channel MOSFET is unbiased, and therefore has no channel enhanced within itself. It is an open circuit, and therefore leaves the output line disconnected from ground. At the same time, the P-channel MOSFET is forward biased, so it has a channel enhanced within itself. This channel has a resistance of about 200Ω, connecting the output line to the +V supply. This pulls the output up to +V (logic 1).

When input A is at +V (logic 1), the P-channel MOSFET is off and the N-channel MOSFET is on, thus pulling the output down to ground (logic 0). Thus, this circuit correctly performs logic inversion, and at the same time provides active pull-up and pull-down, according to the output state.
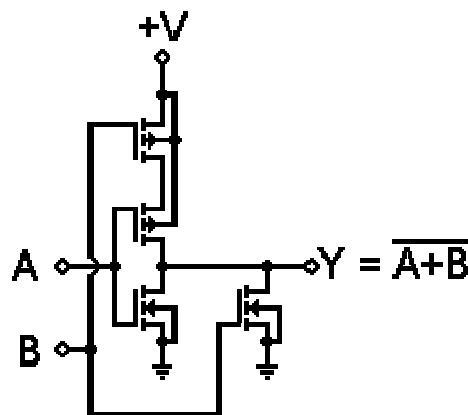
This concept can be expanded into NOR and NAND structures by combining inverters in a partially series, partially parallel structure. The circuit to the right is a practical example of a CMOS 2-input NOR gate.

In this circuit, if both inputs are low, both P-channel MOSFETs will be turned on, thus providing a connection to +V. Both N-channel MOSFETs will be off, so there will be no ground connection. However, if either input goes high, that P-channel MOSFET will turn off and disconnect the output from +V, while that N-channel MOSFET will turn on, thus grounding the output.
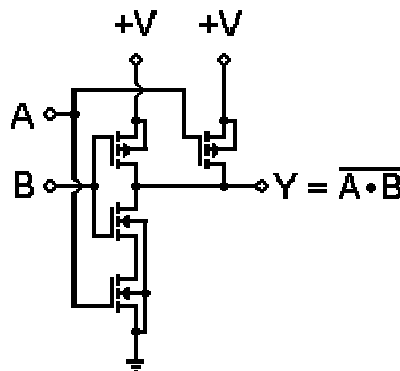
The structure can be inverted, as shown to the left. Here we have a two-input NAND gate, where a logic 0 at either input will force the output to logic 1, but it takes both inputs at logic 1 to allow the output to go to logic 0.

This structure is less limited than the bipolar equivalent would be, but there are still some practical limits. One of these is the combined resistance of the MOSFETs in series. As a result, CMOS totem poles are not made more than four inputs high. Gates with more than four inputs are built as cascading structures rather than single structures. However, the logic is still valid.

Even with this limit, the totem pole structure still causes some problems in certain applications. The pull-up and pull-down resistances at the output are never the same, and can change significantly as the inputs change state, even if the output does not change logic states. The result is uneven and unpredictable rise and fall times for the output signal. This problem was addressed, and was solved with the buffered, or B-series CMOS gates.
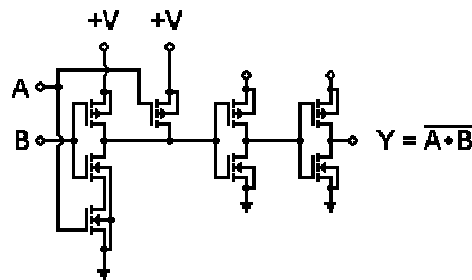
The technique here is to follow the actual NAND gate with a pair of inverters. Thus, the output will always be driven by a single transistor, either P-channel or N-channel. Since they are as closely matched as possible, the output resistance of the gate will always be the same, and signal behavior is therefore more predictable.

One of the main problems with CMOS gates is their speed. They cannot operate very quickly, because of their inherent input capacitance. B-series devices help to overcome these limitations to some extent, by providing uniform output current, and by switching output states more rapidly, even if the input signals are changing more slowly.

Note that we have not gone into all of the details of CMOS gate construction here. For example, to avoid damage caused by static electricity, different manufacturers developed a number of input protection circuits, to prevent input voltages from becoming too high. However, these protection circuits do not affect the logical behavior of the gates, so we will not go into the details here.
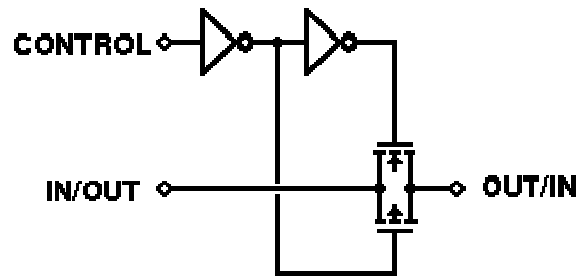
One type of gate, shown to the left, is unique to CMOS technology. This is the *bilateral switch*, or *transmission gate*. It makes full use of the fact that the individual FETs in a CMOS IC are constructed to be symmetrical. That is, the drain and source connections to any individual transistor can be interchanged without affecting the performance of either the transistor itself or the circuit as a whole.

When the N- and P-type FETs are connected as shown here and their gates are driven from complementary control signals, both transistors will be turned on or off together, rather than alternately. If they are both off, the signal path is essentially an open circuit — there is no connection between input and output.

If they are both on, there is a very low-resistance connection between input and output, and a signal will be passed through.

Transistor-Transistor Logic

Objective: Understanding integrated circuit and terminologies

What is truly interesting about this structure is that the signal being controlled in this manner does not have to be a digital signal. As long as the signal voltage does not exceed the power supply voltages, even an analog signal can be controlled by this type of gate.

$$X = \overline{A \cdot B \cdot C \cdot D}$$
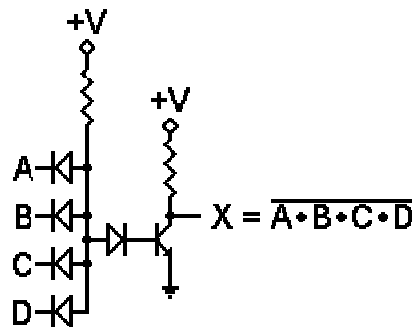
With the rapid development of integrated circuits (ICs), new problems were encountered and new solutions were developed. One of the problems with DTL circuits was that it takes as much room on the IC chip to construct a diode as it does to construct a transistor. Since "real estate" is exceedingly important in ICs, it was desirable to find a way to avoid requiring large numbers of input diodes. But what could be used to replace many diodes?

Well, looking at the DTL NAND gate to the right, we might note that the opposed diodes look pretty much like the two junctions of a transistor. In fact, if we were to have an inverter, it would have a single input diode, and we just might be able to replace the two opposed diodes with an NPN transistor to do the same job.
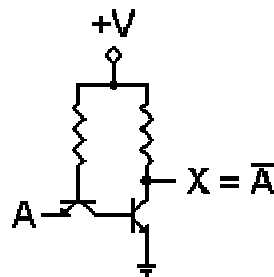
In fact, this works quite nicely. The figure to the left shows the resulting inverter.

In addition, we can add multiple emitters to the input transistor without greatly increasing the amount of space needed on the chip. This allows us to construct a multiple-input gate in almost the same space as an inverter. The resulting savings in real estate translates to a significant savings in manufacturing costs, which in turn reduces the cost to the end user of the device.
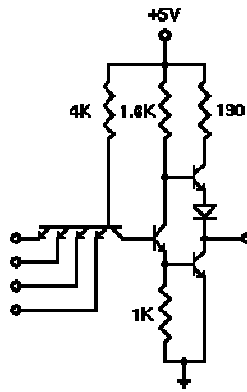
One problem shared by all logic gates with a single output transistor and a pull-up collector resistor is switching speed. The transistor actively pulls the output down to logic 0, but the resistor is not active in pulling the output up to logic 1. Due to inevitable factors such as circuit capacitances and a characteristic of bipolar transistors called "charge storage," it will take a certain amount of time for the transistor to turn completely off and the output to raise to logic 1 level. This limits the frequency at which the gate can operate.

The designers of commercial TTL IC gates reduced that problem by modifying the output circuit. The result was the "totem pole" output circuit used in most of the 7400/5400 series TTL ICs. The final circuit used in most standard commercial TTL ICs is shown to the right. The number of inputs may vary — a commercial IC package might have six inverters, four 2-input gates, three 3-input gates, or two 4-input gates. An 8-input gate in one package is also available. But in each case, the circuit structure remains the same.

Digital I/O Levels

	5.0V					5.0V
V_CC	4.5V					4.5V
V_OH	4.0V					4.0V
	3.5V					3.5V
V_IH	3.0V					3.0V
V_T	2.5V					2.5V
	2.0V					2.0V
V_IL	1.5V					1.5V
V_OL	1.0V					1.0V
GND	0.5V					0.5V

CMOS   TTL   ETL   LV   BTL   GTL

$V_{CC} = 4.5 - 5.5V$ Low Voltage levels $V_{CC} = 5V$

TTL levels

$V_{CC} = 2.7 - 3.6V$

CMOS levels

$V_{OH} = 4.9V$

$V_{IH} = 3.85V$

$V_{OH} = 2.4V$
$V_{IH} = 2.0V$
$V_{TH} = 1.5V$

$V_{OH} = 2.4V$
$V_{IH} = 2.0V$
$V_{TH} = 1.5V$

$V_{TH} = 2.5V$

$V_{IL} = 1.35V$

$V_{IL} = 0.8V$
$V_{OL} = 0.5V$

$V_{IL} = 0.8V$
$V_{OL} = 0.4V$

$V_{OL} = 0.1V$

TTL
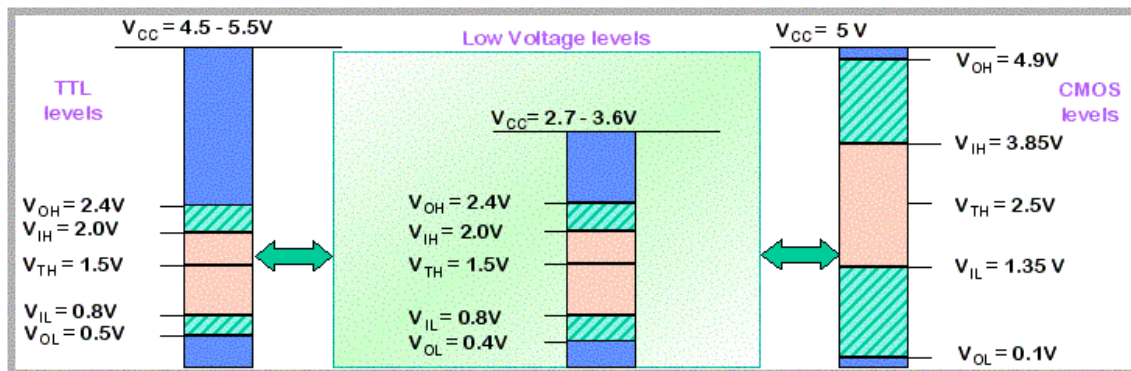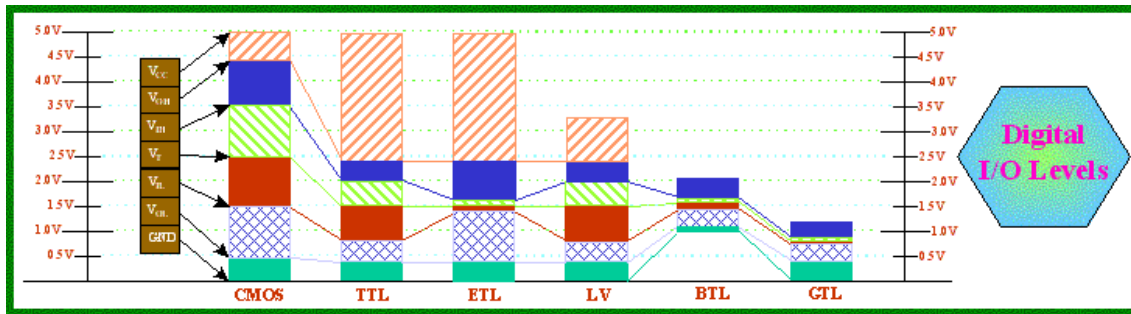
Need for Preventive Maintenance

For most end-users, the purchase of a PC is a substantial investment of both time and money. For corporations and organizations with hundreds (even thousands) of PCs, this investment is that much higher. But after the money is spent and the PC is in our home or office, few PC users ever take the time to maintain their PC. Routine maintenance is an important part of PC ownership, and can go a long way toward keeping your computer's hardware and software error-free. Proper routine maintenance can also help to avoid costly visits to the repair shop (U.S. $50 to $70/hour). Businesses can save a substantial amount of money by assigning technicians to perform regular maintenance. If you're in business for yourself, offering "preventive maintenance" services as part of a normal re-pair

or as seasonal "specials" can provide you with an added income stream. This chapter provides you with a comprehensive, step-by-step procedure for protecting and maintain-ing a personal computer investment.

It's interesting that the data recorded on our computer is often far more valuable than the actual cost of a new drive. But if the drive fails, that precious data is usually lost along with the hardware. Months (perhaps years) of records and data could be irretrievably lost. One of the first steps in any routine maintenance plan is to make regular backups of the system's contents—as well as the system's configuration. Backups ensure that you can re-cover

from any hardware glitch, accidental file erasure, or virus attack.

STEP 1: FILE BACKUPS

File backups are important for all types of PC user from major corporations to occasional home users. By creating a "copy" of your system files (or even just a part of them), you can restore the copy and continue working in the event of a disaster. Before you proceed with any type of system checks, consider performing a file backup (see Chapter 52 for more detailed information on backups).

What you need

You're going to need two items to backup your files: a "backup drive" and backup software. The actual choice of backup drive is really quite open. Tape drives, such as the Iomega Ditto drive (**http://www.iomega.co**m) or the MicroSolutions 8000t 8GB "Backpack" drive (**http://www.micro-solutions.co**m), are the traditional choice, but other high-volume removable media drives, such as Iomega's 100MB Zip drive, their 1GB Jaz drive, or the SyQuest 1.5GB SyJet drive (**http://www.syquest.co**m) are very popular. You might choose an internal or external version of a drive, but you might consider an ex-ternal

parallel-port drive because it is portable—it can be shared between any PCs. You'll also need some backup software to format the media, and handle your backup and restore operations. If you're using Windows 95, try the native Backup applet (click on

Start, Programs, Accessories, System tools, and *Backu*p).
If Backup doesn't suit your needs (or doesn't support your choice for a backup drive), many drives ship with a backup
utility on diskette. Just be sure that the backup drive and backup software are compatible with one another.
Types of backups Backups generally fall into two categories: incremental and com-plete. Both types of backups offer unique advantages and disadvantages. An incremental backup only records the "differences" from the last backup. This usually results in a faster backup procedure and uses less tape (or other media), but restores take longer because you need to walk through each "increment" in order. A complete backup records the drive's full contents. This takes much longer and uses a lot more media, but restores are easier. Many PC users use a combination of complete and incremental backups. For example, you might start with a complete backup on January 1, then make incremental backups each week until the end of February. By March 1, you'd make another complete backup, and start the incremental backup process again.
Backup frequency Perhaps the most overlooked issue with backups is the fre-quency— how often should backups be performed? The answer to that question is not al-ways simple because everyone's needs are different. Major corporations with busy order-entry systems might backup several times each day, but individual home users might not even consider backups to be necessary. The standard that I use is this: Can you afford to lose the data on this drive? If the answer is "no," it's time to back up. Table 59-1 sum-marizes
the recommended periods for preventive maintenance procedures.
File backup tips Regardless of how you choose to handle file backups, some tips will help you get the most from your backup efforts:
n Keep the backup(s) in a secure location (such as a fire-proof safe or cabinet).
n Back up consistently—backups are useless if they are out of date.
n If time is a factor, start with a complete backup, then use incremental backups.
n Use a parallel-port tape drive (or other "backup" drive) for maximum portability be-tween
PCs.

STEP 2: CMOS BACKUPS
All PCs use a sophisticated set of configuration settings (everything from "Date" and "Time" to "Video Palette Snoop" and "Memory Hole") which define how the system should be operated. These settings are stored in a small amount of very low-power mem-ory,
called *CMOS RA*M. Each time the PC starts, motherboard BIOS reads the CMOS RAM and copies the contents into low system memory (the BIOS Data Area, BDA. See Chapter 9 for more information on CMOS or Chapter 6 for more details on BIOS). While

the system power is off, CMOS RAM contents are maintained with a small battery. If this battery goes dead, CMOS contents can be lost. In most cases, this will prevent the system from even starting until you reconfigure the CMOS setup from scratch. By making a backup of the CMOS setup, you can restore lost settings in a matter of minutes. CMOS backups are simply printed screens of your CMOS setup pages.

What you need The one item that you'll need to perform a CMOS backup is a printer—it really doesn't matter what kind of printer (e.g., dot-matrix, ink jet, or laser). The printer should be attached to the PC's parallel port. After starting the CMOS setup routine, visit each page of the setup and use the <Print Screen> key to "capture" each page to the printer. Because every BIOS is written differently, be sure to check for sub-menus that might be buried under each main menu option.

CMOS backup tips CMOS backups are quick and simple, but you'll get the most ben-efit from a CMOS backup by following these pointers:

n Print out every CMOS setup page.

n Keep the printed pages taped to the PC's housing or with the system's original docu-mentation.

n You should backup the CMOS setup whenever you make a change to the system's con-figuration.

Several CMOS backup/restore tools are on the companion CD. Try CMOS.ZIP or CMOSRAM2.ZIP.

Process of Fault diagnosis

Before getting into the troubleshooting details, it is important to know about what goes on during the startup process. The reason is, there are actually quite a few steps that occur in between switching the power ON and hearing the familiar Windows 95, 98 or Windows ME./XP startup sounds and seeing the Windows desktop. In fact, there are a whole series of files that are automatically loaded one after the other when you turn your computer on. The trick with troubleshooting startup problems is trying to figure out which of those files (or what step in the process) causes a specific problem in the computer. If we know approximately where in the startup process the problem occurs (Computer gets stuck), we can diagnose the problem easily.

This chapter explains the various problems that occur in a computer and the troubleshooting procedures.

BIOS

When your computer is first turned on, it automatically loads a program called the BIOS, or Basic Input/Output System, which is stored on a special chip on your computer's motherboard. The BIOS is essentially a combination of software and hardware in that it consists of software, but the contents of that software is stored in a hardware chip.

One of the first things we should see on your computer's monitor when we start the PC is some type of message like "Hit Esc to enter Setup," although instead of Esc it may say F2 or F10 or any number of other keys and instead of Setup it may say CMOS Setup or BIOS Setup or just CMOS. Make note of the key required to enter the Setup program because we may need that later (some startup problems can only be solved by changing some BIOS/CMOS settings via the Setup program).

Power-On Self Test (POST)

The first thing that the BIOS does when it boots the PC is to perform what is called the *Power-On Self-Test*, or *POST* for short. The POST is a built-in diagnostic program that checks the hardware to ensure that everything is present and functioning properly, before the BIOS begins the actual boot. It later continues with additional tests such as the memory test and then it lists any devices that it finds attached to the computer's internal IDE controller(s). (that is seen on the screen of the monitor) as the boot process is proceeding.

The POST runs very quickly, and you will normally not even noticed that it is happening--unless it finds a problem. You may have encountered a PC that, when turned on, made beeping sounds and then stopped without booting up. That is the POST telling you something is wrong with the machine. The speaker is used because this test happens so early on, before the video is activated! These beep patterns can be used to diagnose many hardware problems with the PC. The exact patterns depend on the maker of the BIOS; the most common are Award and AMI BIOS.

BIOS Startup Screen

When the system BIOS starts up, you will see its familiar screen display, normally after the video adapter displays its information. These are the contents of a typical BIOS start up screen:

- **The BIOS Manufacturer and Version Number.**
- **The BIOS Date:** The date of the BIOS can be important in helping you determine its capabilities.
- **Setup Program Key:** The key or keys to press to enter the BIOS setup program. (This is usually {Del}, sometimes {F2}, and sometimes another key combination.
- **System Logo:** The logo of the BIOS company, or in some cases the PC maker or motherboard manufacturer.
- **The "Energy Star" Logo:** This distinctive logo is displayed if the BIOS supports the Energy Star standard, which almost all newer ones do.

The BIOS Serial Number: This is normally located at the bottom of the screen. Since BIOSes are highly customized to the particular motherboard, this serial number can be used in many cases to determine the specific motherboard and BIOS version you are using.

To Understand:
preventive Mainteance on peripherals

STEP 6: CLEAN THE KEYBOARD

Keyboards are open to the environment, so dust and debris readily settle between the keys. Over time, these accumulations can jam keys or cause repeated keystrokes. Attach the long, thin nozzle to your can of compressed air and use the air to blow through the hori-zontal gaps between key rows. Be careful. This will kick up a lot of dust, so keep the key-board away from your face. Afterward, use a clean cloth lightly dampened with ammonia solution to remove dirt or stains from the keys and keyboard housing. If any keys seem unresponsive or "sticky," you can remove the corresponding keycap (see Chapter 20) and spray a bit of good-quality electronic contact cleaner into the key assembly, then gently re-place the keycap.

STEP 7: CLEAN THE MONITOR

Several issues are important when cleaning a monitor: ventilation, case, and CRT. Moni-tors rely on vent openings for proper cooling. Use your vacuum cleaner and carefully re-move any accumulations of dust and debris from the vents underneath the case, as well as those on top of the case. Be sure that none of the vent openings are blocked by paper or other objects (this can restrict ventilation and force the monitor to run hot).
Next, use a clean cloth, lightly dampened with ammonia solution, to clean the monitor's plastic case. Active circuitry is directly under the top vents, so under no circumstances should you spray cleaner directly onto the monitor housings. Do not use ammonia or any chemicals to clean the CRT face. The CRT is often treated with anti-glare and other coat-ings, and even mild chemicals can react with some coatings. Instead, use clean tap water only to clean the CRT face. Be sure to dry the CRT face completely.

STEP 8: CLEAN THE MOUSE

Like the keyboard, a mouse is particularly susceptible to dust and debris, which are carried from the mouse pad up into the mouse ball and rollers. When enough foreign matter has accumulated, you'll find that the mouse cursor hesitates or refuses to move completely.
Loosen the retaining ring and remove the mouse ball. Clean the mouse ball using a clean cloth and an ammonia solution. Dry the mouse ball thoroughly and set it aside with the re-taining ring. Next, locate three rollers inside the mouse (an "X" roller, a "Y" roller, and a small "pressure" roller, as shown Chapter 25). Use a clean cloth, dampened with ammo-nia solution, to clean all of the rollers completely. Use your can of compressed air to blow
Do not remove the <Enter> key or <Space Bar>. These keys are held in place by metal brackets that are extremely difficult to re-attach once the key is removed. Only the most experienced technicians should work with these keys.

External Check

Now that the system is clean, it's time to perform a few practical checks of the system in-terconnections, and take care of some basic drive maintenance. Gather a small regular screwdriver (i.e., a "jewler's" screwdriver), along with a commercial floppy-drive clean-ing kit. If your system uses a tape drive, arrange to have a tape-drive cleaning kit also. If you cannot locate the appropriate cleaning kits, you can use isopropyl alcohol and long electronics-grade swabs. A hand-held degaussing coil is recommended, but might not be necessary. For this part of the chapter, you'll need to power up the PC.
These checks should be performed every four months (three times per year) or as re-quired.

If the PC is operating in dusty, industrial, or other adverse environments, you might need to check the system more frequently. Systems operating in clean office envi-ronments might only need to be checked once or twice each year.

STEP 9: CHECK EXTERNAL CABLES

A myriad of external cables interconnect the computer to its peripheral devices. You should examine each cable and verify that it is securely connected. If the cable can be se-cured to its connector with screws, be sure that the cable is secured properly. As a mini-mum, check for the following cables:

- Ac power cable for the PC
- Ac power cable for the monitor
- Ac power cable for the printer
- Ac/dc power pack for an external modem (if used)
- Keyboard cable
- Mouse cable
- Joystick cable (if used)
- Video cable to the monitor
- Speaker cable(s) from the sound board
- Microphone cable to the sound board (if used)
- Serial port cable to external modem (if used)
- Parallel-port cable to printer
- RJ11 telephone-line cable to internal or external modem (if used)

STEP 10: CLEAN THE FLOPPY DRIVE

In spite of their age, floppy disks remain a reliable and highly standardized media, and every new PC sold today still carries a 3.5" 1.44MB floppy drive. However, floppy disks are a "contact" media—the read/write heads of the floppy drive actually contact the floppy disk. This contact transfers some of the magnetic oxides from the floppy disk to the

3

Objectives: Understanding Diagnostics in Corrective Maintenance

Trouble shooting the process of searching for fault in order to correct it. It could be Hardware or software troubleshooting the following is the procedure in locating fault:

The Universal Troubleshooting Process

Regardless of how complex your particular computer or peripheral device might be, a de-pendable
troubleshooting procedure can be broken down into four basic steps (Fig. 4-1):
define your symptoms, identify and isolate the potential source (or location) of your prob-lem,
replace the suspected sub-assembly, and re-test the unit thoroughly to be sure that you
have solved the problem. If you have not solved the problem, start again from Step #1.
This is a "universal" procedure that you can apply to any sort of troubleshooting—not just
for personal computer equipment.

DEFINE YOUR SYMPTOMS

When a PC breaks down, the cause might be as simple as a loose wire or connector, or as
com-plicated
as an IC or sub-assembly failure. Before you open your tool box, you must have a
firm understanding of all the symptoms. Think about the symptoms carefully—for
example:
Is the disk or tape inserted properly?
Is the power or activity LED lit?
Does this problem occur only when the computer is tapped or moved?
By recognizing and understanding your symptoms, it can be much easier to trace a prob-lem
to the appropriate assembly or component. Take the time to write down as many
symptoms as you can. This note-taking might seem tedious now, but once you have be-gun
your repair, a written record of symptoms and circumstances will help to keep you fo-cused
on the task at hand. It will also help to jog your memory if you must explain the
symptoms to someone else at a later date. As a professional troubleshooter, you must of-ten
log problems or otherwise document your activities anyway.
IDENTIFY AND ISOLATE
Before you try to isolate a problem within a piece of computer hardware, you must first be
sure that the equipment itself is causing the problem. In many circumstances, this will be
fairly obvious, but some situations might appear ambiguous (i.e., there is no power, no
DOS prompt, etc.). Always remember that a PC works because of an intimate mingling of
hardware and software. A faulty or improperly configured piece of software can cause
confusing system errors. Chapter 3 touched on some of the problems that operating sys-tems
can encounter.

When you are confident that the failure lies in your system's hardware, you can begin to identify possible problem areas. Because this book is designed to deal with sub-assembly troubleshooting, start your diagnostics there. The troubleshooting procedures throughout this book will guide you through the major sections of today's popular PC components and peripherals, and aid you in deciding which sub-assembly might be at fault. When you have identified a potential problem area, you can begin the actual repair process and swap the suspect sub-assembly.

REPLACE

Because computers and their peripherals are designed as collections of sub-assemblies, it is almost always easier to replace a sub-assembly outright, rather than attempt to troubleshoot the sub-assembly to its component level. Even if you had the time, documenta-tion, and test equipment to isolate a defective component, many complex parts are proprietary, so it is highly unlikely that you would be able to obtain replacement compo-nents without a significant hassle. The labor and frustration factor involved in such an en-deavor is often just as expensive as replacing the entire sub-assembly to begin with (perhaps even more expensive). On the other hand, manufacturers and their distributors often stock a selection of sub-assemblies and supplies. You might need to know the man-ufacturer's part number for the sub-assembly to obtain a new one.

During a repair, you might reach a roadblock that requires you to leave your equipment for a day or two, or maybe longer. This generally happens after an order has been placed for new parts, and you are waiting for those parts to come in. Make it a point to reassemble your system as much as possible before leaving it. Gather any loose parts in plastic bags, seal them shut, and mark them clearly. If you are working with electronic circuitry, be sure to use good-quality anti-static boxes or bags for storage. Partial re-assembly (combined with careful notes) will help you remember how the unit goes together later on. Another problem with the fast technological progress we enjoy is that parts rarely stay on the shelf long. That video board you bought last year is no longer available, is it? How

Assembling and repair of computer system

Assembling the entire system might be a little tricky if you've never done it before. Some things you will want near you while doing this, is a cold drink, plenty of light, computer screws, all the manuals that came with the hardware you purchased, a screw driver and of course, your sanity.

Oh and a word about static electricity. Make sure you de-static yourself (by touching your computer's power supply or wearing a very expensive anti static bracelet), and it would be a good idea to work in a non-static area, such as on a table, or a kitchen counter, and away from carpet. Whatever you do, be very careful not to zap your components.

Configuring the motherboard jumpers.

Configuring the jumpers is the first thing that needs to be done. What you will want to do is consult your motherboard manual on how to set everything correctly. There are just to many motherboards out there that I can cover in this article. Most jumpers listed in your motherboards manual are already set up for you. The main ones you will have to configure are:

a) Power supply type. In the event that you have an AT/ATX motherboard you will need to set this one correctly.

b) CPU external bus frequency. This is where you specify what bus frequency your CPU is at.

c) CPU to bus frequency ratio. Look at the little box that contained your CPU, it will show you the exact ratio (should be a number like 2x, 3.0x, 3.5x, etc.)

d) CPU voltage. It's really important that you get this one right, or else you'll end up with a *really* hot CPU or a non-working board.

Inserting the CPU.

This one is really easy. Take the CPU, and hold it with your right hand. Look on your motherboard for the CPU socket. With your left hand hold the motherboard with a firm grip while you insert your CPU. Then connect your CPU fan. Easy isn't?

Screwing the motherboard to the computer case.

This process can be a little frustrating. A good thing to do would be to remove the piece where the motherboard screws too, which is a large panel within your computer case.

Next you should have little plastic looking screws. Use these to secure all four corners of your motherboard. Don't worry if you can't secure each corner, more often than not you will only be able to get 2 to 3 corners.

Finally, you will see holes in the middle of the motherboard. You should be able to insert two screws to secure the middle of your board. Screw these in, but make absolutely certain that you have those little red rubber looking washers. This will protect your board from damage that the metal screws can cause. Like the corner screws, it's really no big deal if you can only screw in one center support screw.

Inserting your RAM.

Once your board is securely inserted within your case, you will want to pop in the RAM. Here you will discover exactly how easy it is to perform the 40-50 dollar job that CompUSA and other stores will charge you.

Look up in your motherboard manual exactly in what sockets your RAM has to go into. Then insert your RAM slowly, but firmly into its socket. DIMMs can only be inserted in one way. Simply align the indents found on the lower part of the DIMM to the indents found in the RAM socket.

LED cords and the RESET Switch cord.

In the lower right part of your case you will see a bunch of cords ending with black heads. These black heads will be labeled HDD, RST, PWR, TURBO, etc. If they are not labeled, then good luck trying to figure out which goes where. I've actually had the chance of trying to figure that out ... it took me a few tries, but basically it's trial and error.

Anyhow, take a hold of those cords, look up in your manual where the proper connectors go to, and plug them in.

Connecting your power supply to the board.

You should refer to your computer manual as to how exactly the power supply cords should be connected to your board, but generally the black cords of the two power supply strips will be found in the center of the two connecting power supply outlets on your motherboard.

Connecting your LPT, COM1 and COM2 cables.

On the outer edge of your motherboard, usually near the keyboard connector, you will have 3 outlets. The first two will be close together and are of the same size (small). This is COM1, and COM2. Not to far from these you will see an outlet that is just a little bigger, and this is your LPT outlet. Consult your board manual to find the exact location.

So you will have to take the gray ribbons with the red dots/stripe on the side and connect them to the correct connector.

Make sure that the red stripe/dots face towards the left side of your motherboard (the side where your power supply is).

These gray ribbons then go to a little metal bracket that holds another connector that looks exactly like your printer port. You will have to screw these brackets into your case.

Installing an Operating System (OS)

Probably one of the easiest steps of all is to get your newly built computer set up with an operating system.You have a very wide choice of operating systems: Windows 95/98/NT, Linux, FBSD, OS/2 .... and the list can go on.I'll be very honest right now. I will not explain how to install any OS except the main basics of getting Windows 95/98 (they both install the same way) installed. If you want to install a UNIX OS, Win NT or OS/2, then you probably know enough about computer to do it without my guidance. First, you will need to create yourself a system disk. Grab yourself a new or used floppy disk, insert it into your current machine and format it.

To format, go to your **desktop**, open up the "My computer" **icon**, then right click on your Floppy drive **icon**. Then select format. Make sure you select "full", and the "Copy system files" option. Then hit start.

Once done, you may want to perform the following. With your floppy disk still in your drive, go to a dos prompt. If you don't know how to go to a **DOS** prompt, or if you have no clue what it is, well I'm sorry to inform you, that setting up an OS on your new computer will be nearly impossible. Take an hour or two to learn about **DOS** ... do a little research about it on the web (a great place to start is **Webfreebees.Net** of course). Anyhow, once you get to your **DOS** prompt, simply type in: SYS A: You can then exit your **DOS** prompt.Next, go to your **Start Menu**, go to FIND then FILES OR FOLDERS.

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b) FDISK.EXE Each time when the program file appears in your search window, right click on it, then select the "SEND TO" option, then "send to" your 3 1/4 floppy drive icon. Once both programs are copied, your all set to boot up your new computer again. Make sure your BIOS is set to read your floppy drive first for the boot up sequence.

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Insert your floppy and turn the power on. Once everything is done starting, you will be at a **DOS** prompt, that will look like this: A:\> What you will want to do now is type in

FDISK.EXE. This will start the software required to prepare your hard drives. The software is fairly easy to use with step-by-step instructions. If it allows it, I suggest that you enable large hard drives. This will save you the hassle of having to split up your large hard drive into smaller partitions. Once FDISK is done, you will need to reboot your computer again. Make sure you keep the system disk in your floppy drive. Once the system is done rebooting, and you find yourself to the great colorful A:\> DOS prompt. Next task is to format your hard drive(s).Simply type:FORMAT /S C

Then your hard drive will be formatted. You will then want to reboot (take the system disk out of your floppy drive). Once you reboot, if all went well, you will now see a C:\> prompt. Now the next thing you will want to do is install your CD-ROM for DOS. Refer to your CD-ROM instructions for this. You will probably have to reboot again, which is okay, since it will be one of the last times. After you reboot, and you're back to the C:\>, insert your Windows95/98 CD-ROM into the CD-ROM drive, then type in: D:\>SETUP.EXE (replace the D:\ with the appropriate drive letter of your CD-ROM). If the Windows setup starts, then you're all set, the rest is real easy stuff!

If not, you may want to load up HIMEM.SYS. Copy that file to your newly built computer's hard drive (get it from your current computer) and make a CONFIG.SYS file that will load up that memory device.

SCAN THE DISK FOR PHYSICAL DEFECTS

Compression problems can arise if the CVF tries to use sectors on the physical drive that

are defective. If this occurs, you will not be able to access the file written in the damaged

sector. To ensure that no undetected defects are in the drive, run a disk scanning utility such as ScanDisk (included with MS-DOS 6.2x and the Windows 95 Startup Disk), or use the scanning functions included with PC Tools or Norton Utilities. Any sectors that check bad will be marked in the FAT and avoided in the compression process.

DEFRAGMENT THE DISK AND CHECK FREE SPACE

Fragmentation is a common and undesirable by-product of DOS file allocation. The clusters that are used to hold a file become scattered around a disk, rather than positioned contiguously.

When clusters become scattered, the drive has to work much harder to locate and reach each part of the file. Defragmentation re-arranges the files on your disk so that the clusters associated with each file are contiguous. You should thoroughly defragment your disk prior to compression. Use DEFRAG (included with MS-DOS 6.x and the Windows 95 Startup Disk) or a third-party defragmentation utility, such as PC Tools or Nor-ton Utilities. After compressing the disk, check that at least 1.5MB of free space is on the disk—some free workspace is needed to perform the compression process.

CHECK THE DISK FOR FILE DEFECTS

It is important to detect any lost clusters or cross-linked files before installing a compression product. Use the DOS CHKDSK utility to find any disk errors. If lost clusters are re-ported, re-run CHKDSK with the /f (fix) switch to recover the lost clusters. Each lost cluster is recovered as a root directory file with a .CHK extension. You can then simply delete all .CHK files before continuing. If cross-linked files are indicated, note the names of those cross-linked files. Copy those files to new files and delete the originals—this should clear the cross-link conditions, but one or both of those files are now likely to be defective, so restore all cross-linked files from the system backup or original installation disks. If you have MS-DOS 6.2x (or a Windows 95 Startup Disk) available, you can use fix disk errors using ScanDisk instead of CHKDSK.

CHECK THE MEMORY

Remember that a compression package will need to run a TSR or device driver to achieve "on-the-fly" operation. This compression utility should be loaded into the upper memory area (if possible). Otherwise, it will consume precious conventional memory, which might prevent other memory-hungry DOS applications from running. Use the MEM function and look at the report for the "largest free upper memory block." If that number is larger than 45KB, chances are good that you can load the utility into the UMA during system initialization. If little or no upper memory is free, you will have to free sufficient memory by removing other drivers or TSRs, or seriously consider the impact of leaving the compression utility in conventional memory (this is highly undesirable).

INSTALL THE COMPRESSION UTILITY

If everything looks good up to now, you can go ahead and begin installation of the compression product. Both DoubleSpace/DriveSpace and Stacker can be started very sim-ply, and the installation process for each is very automated. For specific installationand operation information, you should refer to the detailed instructions that accompany each product.

CREATE A BOOTABLE DISK

As you will see in Chapter 17, hard disks do fail for a wide variety of reasons. Now that your drive is compressed, you will need to create bootable disks that are "compression-aware."
You could certainly boot the system from a conventional boot disk, but you would be unable to access your compressed drive(s). Fortunately, creating a compression-compatible

boot disk is a simple matter.

Week13

Objective: Understanding Installation Procedure

Computer site preparation

When computer is about to be installed the plan has to properly designed for the optimum benefit of the computers it should be located in a well ventilated area the wiring system has to be checked as a wrongly wired house may cause fire outbreak

Troubleshooting Modular Approach

The concept of modular testing is the approach which divided computer components and each it treated as an entity and one independent of the other but interrelated if make troubleshooting easier

Installation,Upgrading, and Optimizing System Performance

Most of this chapter has focused on the installation and performance of *specific* computer components. This section focuses on the performance of the computer system as a whole. In this section, you will learn how to upgrade your computer by replacing special subsystem components, such as the BIOS. You will also learn about procedures that can improve your computer's performance, such as replacing batteries, installing cache memory, and running hard drive utilities. Additionally, you will learn how to extend the abilities of your computer by installing specially designed components, such as portable system PC cards.

Desktop Computers

The procedures described here can be performed on almost all desktops. However, their relevance to portable systems is limited to the information in the "Hard Drives" and "BIOS" sections.

Memory

As you know, one function of RAM is to provide the processor with faster access to the information it needs. Within limits, the more memory a computer has, the faster it will run. One of the most common computer upgrades is the installation of more RAM.

Recall that most computers can use another type of RAM, called *cache memory*. Cache memory chips can be accessed even faster than regular RAM, so their presence can help speed up the computer. Within limits (up to 1MB), the more cache a computer has, the faster it will run. The type of cache that can be added to the

computer is called Level 2 (L2) cache, and it can be installed in available slots on the motherboard.

Cache that can be installed on the system board is called L2, Level 2, or external cache. Cache located within the processor itself is called L1, Level 1, internal, or on-board cache and cannot be added or upgraded (unless you replace the processor).

Hard Drives

Throughout the operation of the computer, the hard drive will be accessed over and over again. Information will be read from, saved to, and moved from one place to another on the drive. Its operation is critical to the perceived efficiency of the computer. However, the more the hard drive is used, the less efficient it tends to become. The next two subsections describe common hard drive problems and how to resolve them.

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System Booting

Now it's the moment of truth. Connect your monitor, mouse, keyboard and power cord to the computer. Don't screw the exterior case cover just yet, because you might have to fix something that doesn't work (let's hope not).

Now turn the power on. If you see something on your screen that matches your CPU speed, then a Memory test that matches your amount of RAM, then you got it done!

Sure you may have to fix some problems, but you can rest assured you got the core stuff done. If you don't see nothing, then you probably omitted one of the steps above, or you didn't do it right. Consult your hardware manuals! They will explain to you exactly how everything needs to be connected.

Setting up your BIOS.

Once you boot up, you will probably see a heading labeled "Press DELETE to enter setup", or maybe "Press ESC to enter setup". Whatever the key, press it to enter your BIOS.

First thing you will want to do in your BIOS is set up your hard drive. More than likely you will have an option labeled "Auto-detect IDE devices". Use this to configure your BIOS to use your hard drive(s).
You may also want to screw around with other items. I can't really help you there, but grab your motherboard manual, and read what it says about your BIOS.

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Insert your floppy and turn the power on. Once everything is done starting, you will be at a DOS prompt, that will look like this:

A:\>

What you will want to do now is type in FDISK.EXE. This will start the software required to prepare your hard drives. The software is fairly easy to use with step-by-step instructions.

If it allows it, I suggest that you enable large hard drives. This will save you the hassle of having to split up your large hard drive into smaller partitions.

Once FDISK is done, you will need to reboot your computer again. Make sure you keep the system disk in your floppy drive.

Once the system is done rebooting, and you find yourself to the great colorful A:\> DOS prompt. Next task is to format your hard drive(s).

Simply type:

FORMAT /S C

Then your hard drive will be formatted. You will then want to reboot (take the system disk out of your floppy drive).

Once you reboot, if all went well, you will now see a C:\> prompt. Now the next thing you will want to do is install your CD-ROM for DOS. Refer to your CD-ROM instructions for this.

You will probably have to reboot again, which is okay, since it will be one of the last times.

After you reboot, and you're back to the C:\>, insert your Windows95/98 CD-ROM into the CD-ROM drive, then type in:

D:\>SETUP.EXE (replace the D:\ with the appropriate drive letter of your CD-ROM).

If the Windows setup starts, then you're all set, the rest is real easy stuff!

If not, you may want to load up HIMEM.SYS. Copy that file to your newly built computer's hard drive (get it from your current computer) and make a CONFIG.SYS file that will load up that memory device.

Objective: Understanding Installation Procedure

Computer installation and Assembling

Assembling the entire system might be a little tricky if you've never done it before. Some things you will want near you while doing this, is a cold drink, plenty of light, computer screws, all the manuals that came with the hardware you purchased, a screw driver and of course, your sanity.

Oh and a word about static electricity. Make sure you de-static yourself (by touching your computer's power supply or wearing a very expensive anti static bracelet), and it would be a good idea to work in a non-static area, such as on a table, or a kitchen counter, and away from carpet. Whatever you do, be very careful not to zap your components.

Configuring the motherboard jumpers.

Configuring the jumpers is the first thing that needs to be done. What you will want to do is consult your motherboard manual on how to set everything correctly. There are just to many motherboards out there that I can cover in this article. Most jumpers listed in your motherboards manual are already set up for you. The main ones you will have to configure are:

a) Power supply type. In the event that you have an AT/ATX motherboard you will need to set this one correctly.

b) CPU external bus frequency. This is where you specify what bus frequency your CPU is at.

c) CPU to bus frequency ratio. Look at the little box that contained your CPU, it will show you the exact ratio (should be a number like 2x, 3.0x, 3.5x, etc.)

d) CPU voltage. It's really important that you get this one right, or else you'll end up with a *really* hot CPU or a non-working board.

Inserting the CPU.

This one is really easy. Take the CPU, and hold it with your right hand. Look on your motherboard for the CPU socket. With your left hand hold the motherboard with a firm grip while you insert your CPU. Then connect your CPU fan. Easy isn't?

Screwing the motherboard to the computer case.

This process can be a little frustrating. A good thing to do would be to remove the piece where the motherboard screws too, which is a large panel within your computer case.

Next you should have little plastic looking screws. Use these to secure all four corners of your motherboard. Don't worry if you can't secure each corner, more often than not you will only be able to get 2 to 3 corners.

Finally, you will see holes in the middle of the motherboard. You should be able to insert two screws to secure the middle of your board. Screw these in, but make absolutely certain that you have those little red rubber looking washers. This will protect your board from damage that the metal screws can cause. Like the corner screws, it's really no big deal if you can only screw in one center support screw.

Inserting your RAM.

Once your board is securely inserted within your case, you will want to pop in the RAM. Here you will discover exactly how easy it is to perform the 40-50 dollar job that CompUSA and other stores will charge you.

Look up in your motherboard manual exactly in what sockets your RAM has to go into. Then insert your RAM slowly, but firmly into its socket. DIMMs can only be inserted in one way. Simply align the indents found on the lower part of the DIMM to the indents found in the RAM socket.

LED cords and the RESET Switch cord.

In the lower right part of your case you will see a bunch of cords ending with black heads. These black heads will be labeled HDD, RST, PWR, TURBO, etc. If they are not labeled, then good luck trying to figure out which goes where. I've actually had the chance of trying to figure that out ... it took me a few tries, but basically it's trial and error.

Anyhow, take a hold of those cords, look up in your manual where the proper connectors go to, and plug them in.

Connecting your power supply to the board.

You should refer to your computer manual as to how exactly the power supply cords should be connected to your board, but generally the black cords of the two power supply strips will be found in the center of the two connecting power supply outlets on your motherboard.

Connecting your LPT, COM1 and COM2 cables.

On the outer edge of your motherboard, usually near the keyboard connector, you will have 3 outlets. The first two will be close together and are of the same size (small). This is COM1, and COM2. Not to far from these you will see an outlet that is just a little bigger, and this is your LPT outlet. Consult your board manual to find the exact location.

So you will have to take the gray ribbons with the red dots/stripe on the side and connect them to the correct connector.

Make sure that the red stripe/dots face towards the left side of your motherboard (the side where your power supply is).

These gray ribbons then go to a little metal bracket that holds another connector that looks exactly like your printer port. You will have to screw these brackets into your case.

Installing your floppy drive.

Next, take your floppy drive, insert it into an available bay (in the upper right hand corner of your case). Connect a power supply to the drive, which will be a thin cable coming out of your power supply. Next, take your floppy drive gray ribbon (it's the only one that will connect to the floppy drive). Connect one end to the floppy drive, and the other to the board. Look in your manual if you're not sure where this is located. Like in the above step (#6), the red stripe/dots must face towards the left part of your board.

Installing the IDE drives.

The IDE drives are the hard drives and CD-ROMs. Before putting them in their respective bays, make sure you have their jumpers set up right (consult their documentation). You will need your hard drive to be set as a master, or slave (depending on how many hard drives you have).

Then connect the IDE gray ribbon (it's the only one that will fit to the IDE drives) to the drives themselves and then to the motherboard. Like in the above step (#6), the red stripe/dots must face towards the left part of your board.

Finally, connect the power supply to the drives.

Inserting your expansion cards.

Next you will want to insert your expansion cards into your motherboard. These are the sound cards, video cards, modems, etc. Each one of these go into their correct slot (AGP, PCI or ISA) with the metal bracket facing the left part of the case so you can screw them in.

If you have an AGP card, this one will go into the AGP slot, which is brown, and there shouldn't be more than one AGP slot on your board. Slowly but firmly insert the card into the slot. You will know when it's all the way in.

PCI cards will go into the PCI slots. These slots are the smaller white ones.
The ISA cards will go into the ISA slots. These are the longer black slots.
If you got a sound card, which supports CD-ROM audio, now would be the perfect time to connect the digital audio cord to your CD-ROM.

Objective: Understanding Installation Procedure

Booting up for the first time.

Now it's the moment of truth. Connect your monitor, mouse, keyboard and power cord to the computer. Don't screw the exterior case cover just yet, because you might have to fix something that doesn't work (let's hope not).

Now turn the power on. If you see something on your screen that matches your CPU speed, then a Memory test that matches your amount of RAM, then you got it done!

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