“Control Electrical Appliances”

Abstract:

The computer had seen a lot of evolution both in hardware and software Sides, yet there are some features which remain unbeatable and one among them is the structure oriented programming language or **C**. Apart from computer Programming they are fused in circuit boards, microcontrollers.., etc to carry out Specified functions. The reason is the elegance and simplicity of the keywords used in c.

This paper is about **Controlling Home/Industrial Appliance with computer using C**. This idea is evolved from the in-out features of microcontroller. The same can be extended to a PC where the output from PC is a pulse which will activate a relay and hence controlling electrical/electronic appliance. This is possible in all PCs having printer port.

CONTENTS

UNIT 1 –INTRODUCTION TO COMPONENTS USED

UNIT 2- BREADBOARD

UNIT 3 – SOLDERING

UNIT 4- To Control Electrical Appliances using computer

ϖ **UNIT 1 –INTRODUCTION TO COMPONENTS USED**

1. RESISTOR

A resistor is a two-terminal electronic component that produces a voltage across its terminals that is proportional to the electric current through it in accordance with Ohm's law:

$V = IR$

Resistors are elements of electrical networks and electronic circuits and are ubiquitous in most electronic equipment. Practical resistors can be made of various compounds and films, as well as resistance wire (wire made of a high-resistivity alloy, such as nickel/chrome). The primary characteristics of a resistor are the resistance, the tolerance, maximum working voltage and the power rating. Other characteristics include temperature coefficient, noise, and inductance. Resistors can be integrated into hybrid and printed circuits, as well as integrated circuits. Size, and position of leads (or terminals) are relevant to equipment designers; resistors must be physically large enough not to overheat when dissipating their power.

Units: The ohm (symbol: Ω) is a SI-driven unit of electrical resistance, named after Georg Simon Ohm. Commonly used multiples and submultiples in electrical and electronic usage are the milliohm ($1x10^{-3}$), kilohm ($1x10^{3}$), and megohm ($1x10^{6}$).

- **Carbon film resistor**

- **Color coding of resistors**

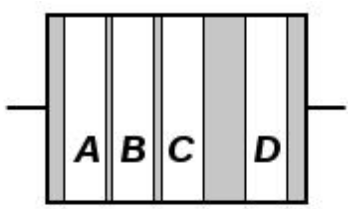
Resistor values are always coded in ohms.

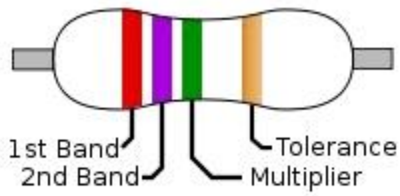
♣ band **A** is first significant figure of component value

♣ band **B** is the second significant figure

♣ band **C** is the decimal multiplier

- band **D** if present, indicates tolerance of value in percent (no color means 20%)





• COLOR CODING TABLE

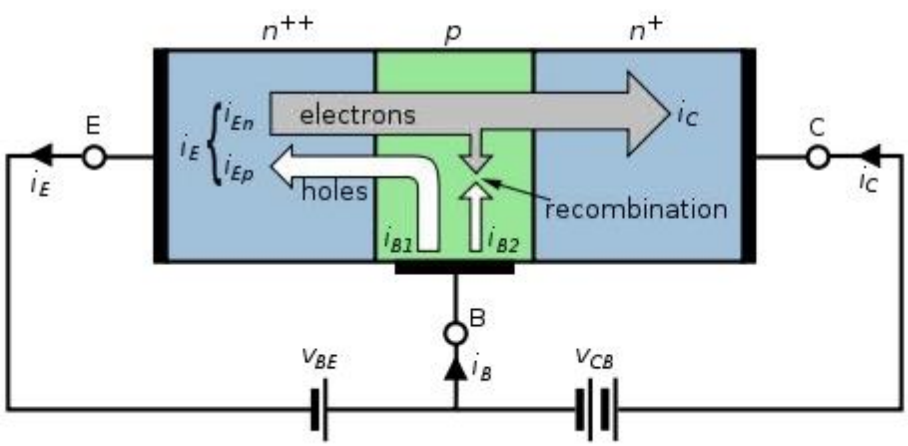
Color	Significant figures	Multiplier	Tolerance		Temp. Coefficient (ppm/K)	
Black	0	$\times 10^{0}$	–		250	U
Brown	1	$\times 10^{1}$	±1%	F	100	S
Red	2	$\times 10^{2}$	±2%	G	50	R
Orange	3	$\times 10^{3}$	–		15	P
Yellow	4	$\times 10^{4}$	–		25	Q
Green	5	$\times 10^{5}$	±0.5%	D	20	Z
Blue	6	$\times 10^{6}$	±0.25%	C	10	Z
Violet	7	$\times 10^{7}$	±0.1%	B	5	M
Gray	8	$\times 10^{8}$	±0.05%	A	1	K
White	9	$\times 10^{9}$	–		–	
Gold	–	$\times 10^{-1}$	±5%	J	–	
Silver	–	$\times 10^{-2}$	±10%	K	–	
None	–	–	±20%	M	–	

2. BIPOLAR JUNCTION TRANSISTOR

A bipolar (junction) transistor (BJT) is a three-terminal electronic device constructed of doped semiconductor material and may be used in amplifying or switching applications. *Bipolar* transistors are so named because their operation involves both electrons and holes. Charge flow in a BJT is due to bidirectional diffusion of charge carriers across a junction between two regions of different charge concentrations. This mode of operation is contrasted with *unipolar transistors,* such as field-effect transistors, in which only one carrier type is involved in charge flow due to drift. By design, most of the BJT collector current is due to the flow of charges injected from a high-concentration emitter into the base where they are minority carriers that diffuse toward the collector, and so BJTs are classified as *minority-carrier* devices.

- **WORKING OF TRANSISTOR**

An NPN transistor can be considered as two diodes with a shared anode. In typical operation, the emitter–base junction is forward biased and the base–collector junction is reverse biased. In an NPN transistor, for example, when a positive voltage is applied to the base–emitter junction, the equilibrium between thermally generated carriers and the repelling electric field of the depletion becomes unbalanced, allowing thermally excited electrons to inject into the base region. These electrons wander (or "diffuse") through the base from the region of high concentration near the emitter towards the region of low concentration near the collector. The electrons in the base are called *minority carriers* because the base is doped p-type which would make holes the *majority carrier* in the base.

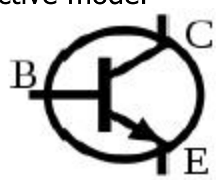


To minimize the percentage of carriers that recombine before reaching the collector–base junction, the transistor's base region must be thin enough that carriers can diffuse across it in much less time than the semiconductor's minority carrier lifetime. In particular, the thickness of the base must be much less than the diffusion length of the electrons. The collector–base junction is reverse-biased, and so little electron injection occurs from the collector to the base, but electrons that diffuse through the base towards the collector are swept into the collector by the electric field in the depletion region of the collector–base junction. The thin *shared* base and asymmetric collector–emitter doping is what differentiates a bipolar transistor from two *separate* and oppositely biased diodes connected in series.

- **NPN**

NPN is one of the two types of bipolar transistors, in which the letters "N" and "P" refer to the majority charge carriers inside the different regions of the transistor. Most bipolar transistors used today are NPN, because electron mobility is higher than hole mobility in semiconductors, allowing greater currents and faster operation.

NPN transistors consist of a layer of P-doped semiconductor (the "base") between two N-doped layers. A small current entering the base in common-emitter mode is amplified in the collector output. In other terms, an NPN transistor is "on" when its base is pulled high relative to the emitter. The arrow in the NPN transistor symbol is on the emitter leg and points in the direction of the conventional current flow when the device is in forward active mode.



- **Regions of operation**

Bipolar transistors have five distinct regions of operation, defined mostly by applied bias:

- **Forward-active** (or simply, **active**): The emitter–base junction is forward biased and the base–collector junction is reverse biased. Most bipolar transistors are designed to afford the greatest common-emitter current gain, β_F, in forward-active mode. If this is the case, the collector–emitter current is approximately proportional to the base current, but many times larger, for small base current variations.
- **Reverse-active** (or **inverse-active** or **inverted**): By reversing the biasing conditions of the forward-active region, a bipolar transistor goes into reverse-active mode. In this mode, the emitter and collector regions switch roles. Because most BJTs are designed to maximize current gain in forward-active mode, the β_F in inverted mode is several (2–3 for the ordinary germanium transistor) times smaller. This transistor mode is seldom used, usually being considered only for failsafe conditions and some types of bipolar logic. The reverse bias breakdown voltage to the base may be an order of magnitude lower in this region.

- **Saturation**: With both junctions forward-biased, a BJT is in saturation mode and facilitates high current conduction from the emitter to the collector. This mode corresponds to a logical "on", or a closed switch.
- **Cutoff**: In cutoff, biasing conditions opposite of saturation (both junctions reverse biased) are present. There is very little current flow, which corresponds to a logical "off", or an open switch.

- **<u>Transistor 'alpha' and 'beta'</u>**

The proportion of electrons able to cross the base and reach the collector is a measure of the BJT efficiency. The heavy doping of the emitter region and light doping of the base region cause many more electrons to be injected from the emitter into the base than holes to be injected from the base into the emitter. The *common-emitter current gain* is represented by β_F; it is approximately the ratio of the DC collector current to the DC base current in forward-active region. It is typically greater than 100 for small-signal transistors but can be smaller in transistors designed for high-power applications. Another important parameter is the common-base current gain, α_F. The common-base current gain is approximately the gain of current from emitter to collector in the forward-active region. Alpha and beta are more precisely related by the following identities (NPN transistor):

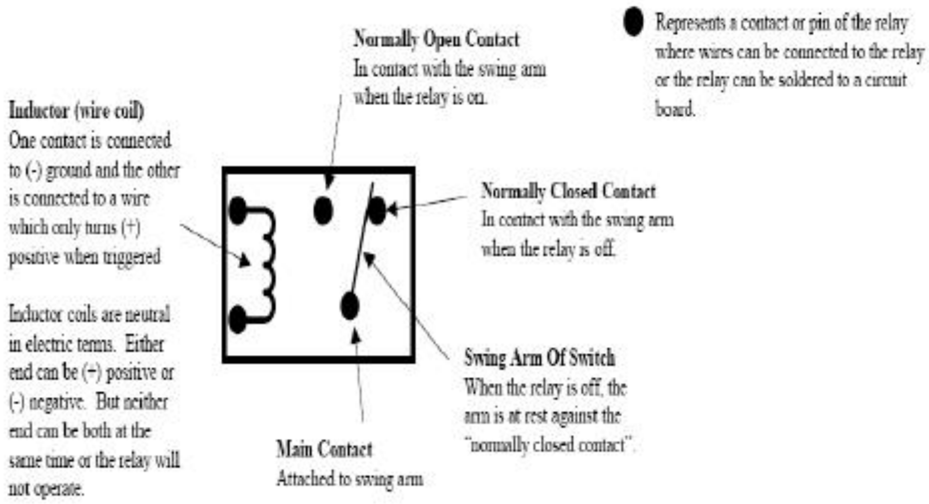
$$\alpha_T = \frac{I_\mathrm{C}}{I_\mathrm{E}} \qquad \beta_F = \frac{I_\mathrm{C}}{I_\mathrm{B}} \qquad \beta_F = \frac{\alpha_T}{1-\alpha_T} \iff \alpha_T = \frac{\beta_F}{\beta_F+1}$$

3. SPDT RELAY:

A relay is an electromechanical switch. More importantly, relays are used in virtually every type of electronic device to switch voltages and electronic signals.

A relay operates based on the principals of electromagnetic. Inside a relay is an inductor (a wire coil) that, when energized with an electric pulse, will generate a magnetic field. The second part of a relay is a system of metallic arms which make up the physical contacts of the switch. When the relay is off, or no electric pulse is given to the relay, the arm of the switch is in one position. When the relay is on, or an electric pulse is sent to the relay, the swing or switching arm of the switch moves to another contact of the switch. The arm moves as the generated magnetic field pulls the swinging arm toward the inductor (or wire coil). There are many different configurations of relays but this is the simplest form of the internal switching. Relays can have as few as 1 moving arm up to many inside of a single relay box.

- **A Look At A Relay**



When the relay is in the "off" position, the swing arm is in contact with the normally closed contact. This means that when the relay is in the "off" position, the normally closed contact is also conducting to the main contact. When the relay is activated, the magnetic field created by the inductor coil pulls the swing arm until it makes contact with the normally open contact connecting the circuit connected to the normally open contact to the circuit connected to the main contact.

- **<u>Relay Terms:</u>**

¬ **Inductor Coil:** generates a magnetic field inside the relay housing when voltage is applied.

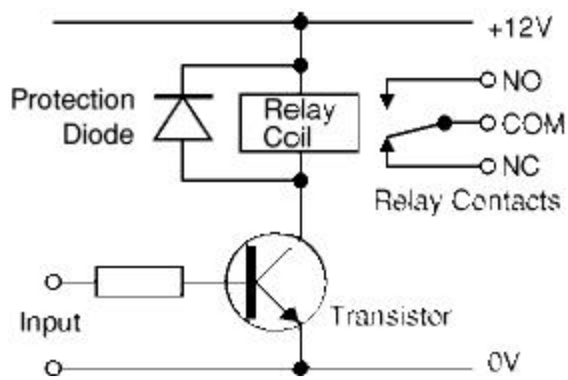
¬ **Swing Arm:** the only moving part of a relay. Switches between contacts of the relay when pulled by the magnetic field generated the inductor coil.

¬ **Normally Open Contact:** the contact or pin that is NOT in contact with the swing arm when the relay is in the off position but is the contact the swing arm switches to when the relay is activated.

¬ **Normally Close Contact:** the contact or pin that IS in contact with the swing arm when the relay is in the off position but is the contact the swing arm switches away from when the relay is activated.

¬ **Main Contact:** connected to the swing arm. The primary purpose of the switching of the relay allows the primary contact to jump or switch between the circuits attached to the normally open and normally closed contacts when the relay is turn on and off.

Protection diodes for relays:



Transistors and ICs must be protected from the brief high voltage produced when a relay coil is switched off. The diagram shows how a signal diode (eg 1N4148) is connected 'backwards' across the relay coil to provide this protection.

Current flowing through a relay coil creates a magnetic field which collapses suddenly when the current is switched off. The sudden collapse of the magnetic field induces a brief high voltage across the relay coil which is very likely to damage transistors and ICs. The protection diode allows the induced voltage to drive a brief current through the coil (and diode) so the magnetic field dies away quickly rather than instantly. This prevents the induced voltage becoming high enough to cause damage to transistors and ICs.

Relays and transistors compared

Like relays, transistors can be used as an electrically operated switch. For switching small DC currents (< 1A) at low voltage they are usually a better choice than a relay. However, transistors cannot switch AC (such as mains electricity) and in simple circuits they are not usually a good choice for switching large currents (> 5A). In these cases a relay will be needed, but note that a low power transistor may still be needed to switch the current for the relay's coil!

Diode

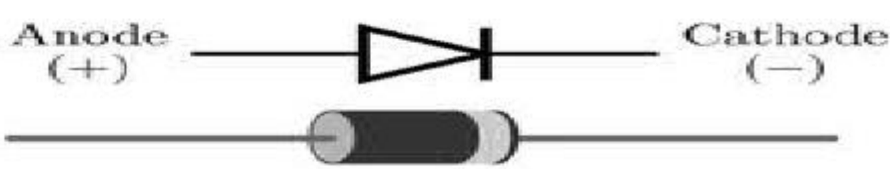


Figure 7: Typical diode packages in same alignment as diode symbol. Thin bar depicts the cathode.

In electronics, a **diode** is a two-terminal electronic component that conducts electric current in only one direction. The term usually refers to a **semiconductor diode**, the most common type today, which is a crystal of semiconductor connected to two electrical terminals, a P-N junction. A **vacuum tube diode**, now little used, is a vacuum tube with two electrodes; a plate and a cathode. The most common function of a diode is to allow an electric current in one direction (called the diode's *forward* direction) while blocking current in the opposite direction (the *reverse* direction). Thus, the diode can be thought of as an electronic version of a check valve. This unidirectional behavior is called rectification, and is used to convert alternating current to direct current, and extract modulation from radio signals in radio receivers.

Current–voltage characteristic

A semiconductor diode's behavior in a circuit is given by its current–voltage characteristic, or I–V graph (see graph at right). The shape of the curve is determined by the transport of charge carriers through the so-called *depletion layer* or *depletion region* that exists at the p-n junction between differing semiconductors. When a p-n junction is first created, conduction band (mobile) electrons from the N-doped region diffuse into the P-doped region where there is a large population of holes (vacant places for electrons) with which the electrons "recombine". When a mobile electron recombines with a hole, both hole and electron vanish, leaving behind an immobile positively charged donor (dopant) on the N-side and negatively charged acceptor (dopant) on the P-side. The region around the p-n junction becomes depleted of charge carriers and thus behaves as an insulator.

However, the width of the depletion region (called the depletion width) cannot grow without limit. For each electron-hole pair that recombines, a positively-charged dopant ion is left behind in the N-doped region, and a negatively charged dopant ion is left behind in the P-doped region. As recombination proceeds more ions are created, an increasing electric field develops through the depletion zone which acts to slow and then finally stop recombination. At this point, there is a "built-in" potential across the depletion zone.

If an external voltage is placed across the diode with the same polarity as the built-in potential, the depletion zone continues to act as an insulator, preventing any significant electric current flow (unless electron/hole pairs are actively being created in the junction by, for instance, light. see photodiode). This is the *reverse bias* phenomenon. However, if the polarity of the external voltage opposes the built-in potential, recombination can once again proceed, resulting in substantial electric current through the p-n junction (i.e. substantial numbers of electrons and holes recombine at the junction).. For silicon diodes, the built-in potential is approximately 0.6 V. Thus, if an external current is passed through the diode, about 0.6 V will be developed across the diode such that the P-doped region is positive with respect to the N-doped region and the diode is said to be "turned on" as it has a *forward bias*.

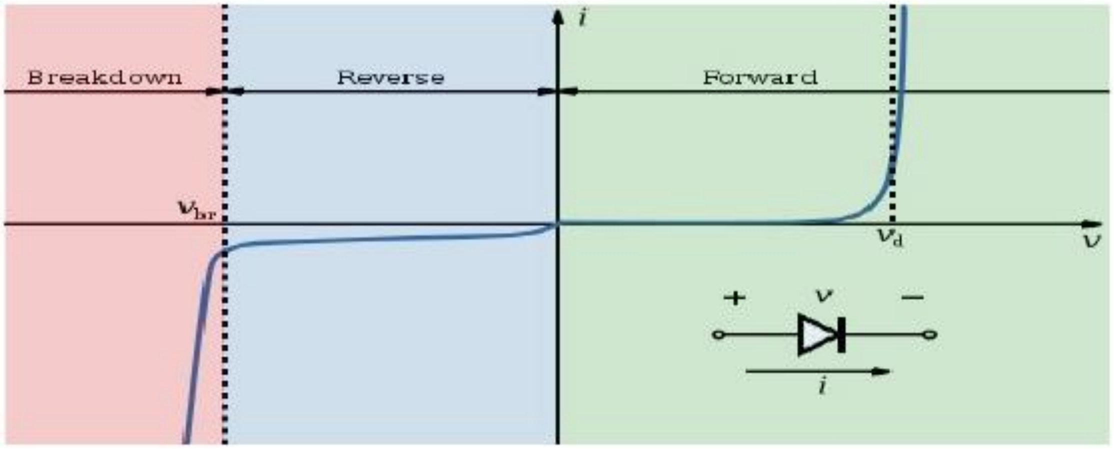


Figure 5: I–V characteristics of a P-N junction diode (not to scale).

A diode's '***I–V characteristic'*** can be approximated by four regions of operation (see the figure at right). At very large reverse bias, beyond the peak inverse voltage or PIV, a process called reverse breakdown occurs which causes a large increase in current (i.e. a large number of electrons and holes are created at, and move away from the pn junction) that usually damages the device permanently. The avalanche diode is deliberately designed for use in the avalanche region. In the zener diode, the concept of PIV is not applicable. A zener diode contains a heavily doped p-n junction allowing electrons to tunnel from the valence band of the p-type material to the conduction band of the n-type material, such that the reverse voltage is "clamped" to a known value (called the *zener voltage*), and avalanche does not occur. Both devices, however, do have a limit to the maximum current and power in the clamped reverse voltage region. Also, following the end of forward conduction in any diode, there is reverse current for a short time. The device does not attain its full blocking capability until the reverse current ceases.

The second region, at reverse biases more positive than the PIV, has only a very small reverse saturation current. In the reverse bias region for a normal P-N rectifier diode, the current through the device is very low (in the µA range). However, this is temperature dependent, and at suffiently high temperatures, a substantial amount of reverse current can be observed (mA or more).

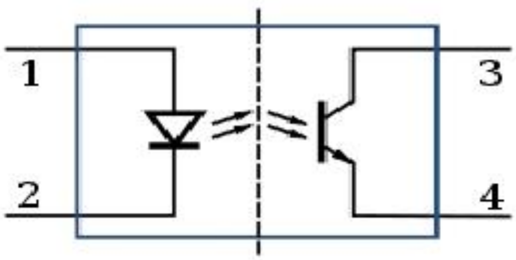
The third region is forward but small bias, where only a small forward current is conducted. As the potential difference is increased above an arbitrarily defined "cut-in voltage" or "on-voltage" or "diode forward voltage drop (V_d)", the diode current becomes appreciable (the level of current considered "appreciable" and the value of cut-in voltage depends on the application), and the diode presents a very low resistance. The current–voltage curve is exponential. In a normal silicon diode at rated currents, the arbitrary "cut-in" voltage is defined as 0.6 to 0.7 volts. The value is different for other diode types — Schottky diodes can be rated as low as 0.2 V and red or blue light-emitting diodes (LEDs) can have values of 1.4 V and 4.0 V respectively. At higher currents the forward voltage drop of the diode increases. A drop of 1 V to 1.5 V is typical at full rated current for power diodes.

Opto-coupler:

In electronics, an **opto-isolator** (or **optical isolator**, **optical coupling device**, **optocoupler**, **photocoupler**, or **photoMOS**) is a device that uses a short optical transmission path to transfer an electronic signal between elements of a circuit, typically a transmitter and a receiver, while keeping them electrically isolated—since the electrical signal is converted to a light beam, transferred, then converted back to an electrical signal, there is no need for electrical connection between the source and destination circuits. Isolation between input and output is rated at 7500 Volt peak for 1 second for a typical component costing less than 1 US$ in small quantities.

The opto-isolator is simply a package that contains both an infrared light-emitting diode (LED) and a photodetector such as a photosensitive silicon diode, transistor Darlington pair, or silicon controlled rectifier (SCR). The wave-length responses of the two devices are tailored to be as identical as possible to permit the highest measure of coupling possible. Other circuitry—for example an output amplifier—may be integrated into the package. An opto-isolator is usually thought of as a single integrated package, but opto-isolation can also be achieved by using separate devices.

Configurations



Schematic diagram of a very simple opto-isolator with an LED and phototransistor. The dashed line represents the isolation barrier, over which there is no electrical contact.

A common implementation is a LED and a phototransistor in a light-tight housing to exclude ambient light and without common electrical connection, positioned so that light from the LED will impinge on the photodetector. When an electrical signal is applied to the input of the opto-isolator, its LED lights and illuminates the photodetector, producing a corresponding electrical signal in the output circuit. Unlike a transformer the opto-isolator allows DC coupling and can provide any desired degree of electrical isolation and protection from serious overvoltage conditions in one circuit affecting the other. A higher transmission ratio can be obtained by using a Darlington instead of a simple phototransistor, at the cost of reduced noise immunity and higher delay.

With a photodiode as the detector, the output current is proportional to the intensity of incident light supplied by the emitter. The diode can be used in a photovoltaic mode or a photoconductive mode. In photovoltaic mode, the diode acts as a current source in parallel with a forward-biased diode. The output current and voltage are dependent on the load impedance and light intensity. In photoconductive mode, the diode is connected to a supply voltage, and the magnitude of the current conducted is directly proportional to the intensity of light. This optocoupler type is significantly faster than photo transistor type, but the transmission ratio is very low; it is common to integrate an output amplifier circuit into the same package.

The optical path may be air or a dielectric waveguide. When high noise immunity is required an optical conductive shield can be integrated into the optical path. The transmitting and receiving elements of an optical isolator may be contained within a single compact module, for mounting, for example, on a circuit board; in this case, the module is often called an **optoisolator** or **opto-isolator**. The photosensor may be a photocell, phototransistor, or an optically triggered SCR or TRIAC. This device may in turn operate a power relay or contactor. Analog optoisolators often have two independent, closely matched output phototransistors, one of which is used to linearize the response using negative feedback.

D-subminiature

DB25 Female

DB25 Male

The **D-subminiature** or **D-sub** is a common type of electrical connector used particularly in computers. A D-sub contains two or more parallel rows of pins or sockets usually surrounded by a D-shaped metal shield that provides mechanical support, some screening against electromagnetic interference, and ensures correct orientation. The part containing pin contacts is called the *male connector* or *plug*, while that containing socket contacts is called the *female connector* or *socket*. The socket's shield fits tightly inside the plug's shield. The shields are connected to the overall screens of the cables (when screened cables are used), creating an electrically continuous screen covering the whole cable and connector system.

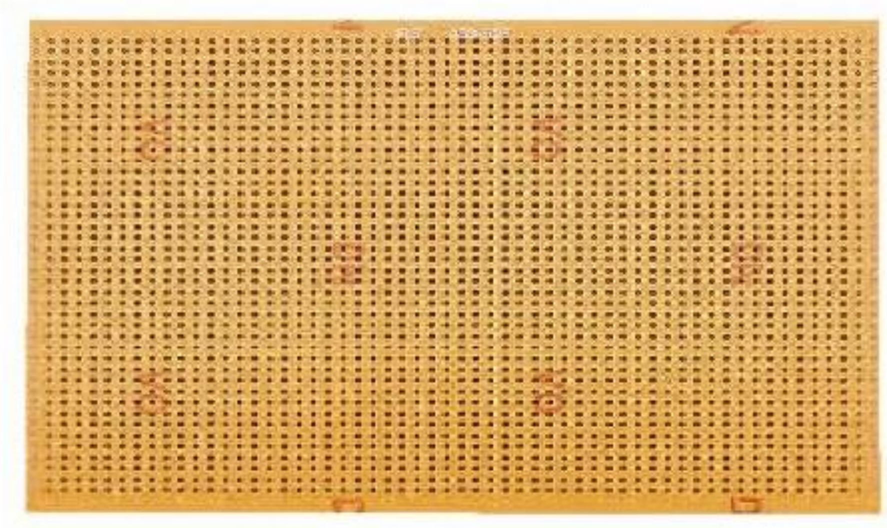
DB25 female connector & Cable

Pin No (DB25)	Signal name	Direction	Register - bit	Inverted
1	nStrobe	Out	Control-0	Yes
2	Data0	In/Out	Data-0	No
3	Data1	In/Out	Data-1	No
4	Data2	In/Out	Data-2	No
5	Data3	In/Out	Data-3	No
6	Data4	In/Out	Data-4	No
7	Data5	In/Out	Data-5	No
8	Data6	In/Out	Data-6	No
9	Data7	In/Out	Data-7	No
10	nAck	In	Status-6	No
11	Busy	In	Status-7	Yes
12	Paper-Out	In	Status-5	No
13	Select	In	Status-4	No
14	Linefeed	Out	Control-1	Yes

15	nError	In	Status-3	No
16	nInitialize	Out	Control-2	No
17	nSelect-Printer	Out	Control-3	Yes
18-25	Ground	-	-	-

4. PRINTED CIRCUIT BOARD

A **printed circuit board**, or **PCB**, is used to mechanically support and electrically connect electronic components using conductive pathways, tracks, or traces, etched from copper sheets laminated onto a non-conductive *substrate*. It is also referred to as **printed wiring board** (**PWB**) or **etched wiring board**. A PCB populated with electronic components is a **printed circuit assembly** (**PCA**), also known as a **printed circuit board assembly** (**PCBA**). PCBs are inexpensive, and can be highly reliable. They require much more layout effort and higher initial cost than either wire-wrapped or point-to-point constructed circuits, but are much cheaper and faster for high-volume production. Much of the electronics industry's PCB design, assembly, and quality control needs are set by standards that are published by the IPC organization.



Conducting layers are typically made of thin copper foil. Insulating layers dielectric are typically laminated together with epoxy resin prepreg. The board is typically coated with a solder mask that is green in color. Other colors that are normally available are blue and red. There are quite a few different dielectrics that can be chosen to provide different insulating values depending on the requirements of the circuit. Some of these dielectrics are polytetrafluoroethylene (Teflon), FR-4, FR-1, CEM-1 or CEM-3. Well known prepreg materials used in the PCB industry are FR-2 (Phenolic cotton paper), FR-3 (Cotton paper and epoxy), FR-4 (Woven glass and epoxy), FR-5 (Woven glass and epoxy), FR-6 (Matte glass and polyester), G-10 (Woven glass and epoxy), CEM-1 (Cotton paper and epoxy), CEM-2 (Cotton paper and epoxy), CEM-3 (Woven glass and epoxy), CEM-4 (Woven glass and epoxy), CEM-5 (Woven glass and polyester).

ϖ UNIT 2- BREADBOARD

1. BREADBOARD:

A breadboard (protoboard) is a construction base for a one-of-a-kind electronic circuit, a prototype. In modern times the term is commonly used to refer to a particular type of breadboard, the solder less breadboard (plug board).

Because the solder less breadboard does not require soldering, it is reusable, and thus can be used for temporary prototypes and experimenting with circuit design more easily. Other, often historic, breadboard types don't have this property. This is also in contrast to strip board (veroboard) and similar prototyping printed circuit boards, which are used to build more permanent soldered prototypes or one-offs, and cannot easily be reused.

- **Typical specifications**

A modern solder less breadboard consists of a perforated block of plastic with numerous tin plated phosphor bronze or nickel silver alloy spring clips under the perforations. The spacing between the clips (lead pitch) is typically 0.1" (2.54 mm). Integrated circuits (ICs) in dual in-line packages (DIPs) can be inserted to straddle the centreline of the block. Interconnecting wires and the leads of discrete components (such as capacitors, resistors, inductors, *etc.*) can be inserted into the remaining free holes to complete the circuit. Where ICs are not used, discrete components and connecting wires may use any of the holes.

- **BUS AND TERMINAL STRIPS**

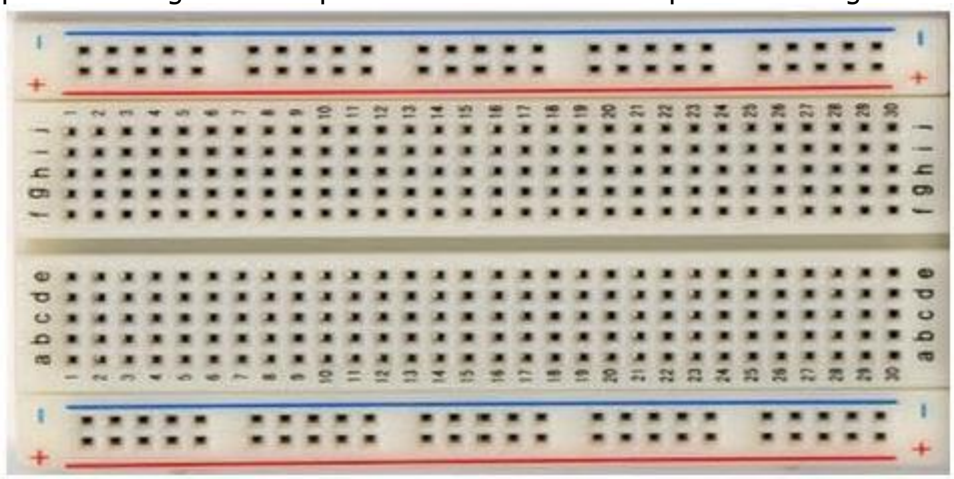
Solder less breadboards are available from several different manufacturers, but most share a similar layout. The layout of a typical solder less breadboard is made up from two types of areas, called strips. Strips consist of interconnected electrical terminals.

¬ **Terminal strips**

The main area to hold most of the electronic components. In the middle of a terminal strip of a breadboard, one typically finds a notch running in parallel to the long side. The notch is to mark the centreline of the terminal strip and provides limited airflow (cooling) to DIP ICs straddling the centreline. The clips on the right and left of the notch are each connected in a radial way; typically five clips (i.e., beneath five holes) in a row on each side of the notch are electrically connected. The five clip columns on the left of the notch are often marked as A, B, C, D, and E, while the ones on the right are marked F, G, H, I and J.

¬ **BUS STRIPS**

To provide power to the electronic components. A bus strip usually contains two columns, one for ground, and one for a supply voltage. But some breadboards only provide a single-column power distributions bus strip on each long side.



- **Diagram**

A "full size" terminal breadboard strip typically consists of around 56 to 65 rows of connectors, each row containing the above mentioned two sets of connected clips (A to E and F to J). "Small size" strips typically come with around 30 rows.

- **Terminal Strip:**

```
   A B C D E  F G H I J
 1 o-o-o-o-o v o-o-o-o-o
 2 o-o-o-o-o o-o-o-o-o
 3 o-o-o-o-o o-o-o-o-o
 ~
 ~
61 o-o-o-o-o o-o-o-o-o
62 o-o-o-o-o o-o-o-o-o
63 o-o-o-o-o ^ o-o-o-o-o
```

- **Bus Strip:**

```
V G
o o
| |
o o
| |
o o
| |
o o
| |
o o
```

- **<u>Jump wires</u>**

The jump wires for solder less bread boarding can be obtained in ready-to-use jump wire sets or can be manually manufactured. The latter can become tedious work for larger circuits. Shorter stripped wires might result in bad contact with the board's spring clips (insulation being caught in the springs). Longer stripped wires increase the likelihood of short-circuits on the board. Needle-nose pliers and tweezers are helpful when inserting or removing wires, particularly on crowded boards.

- **<u>Limitations</u>**

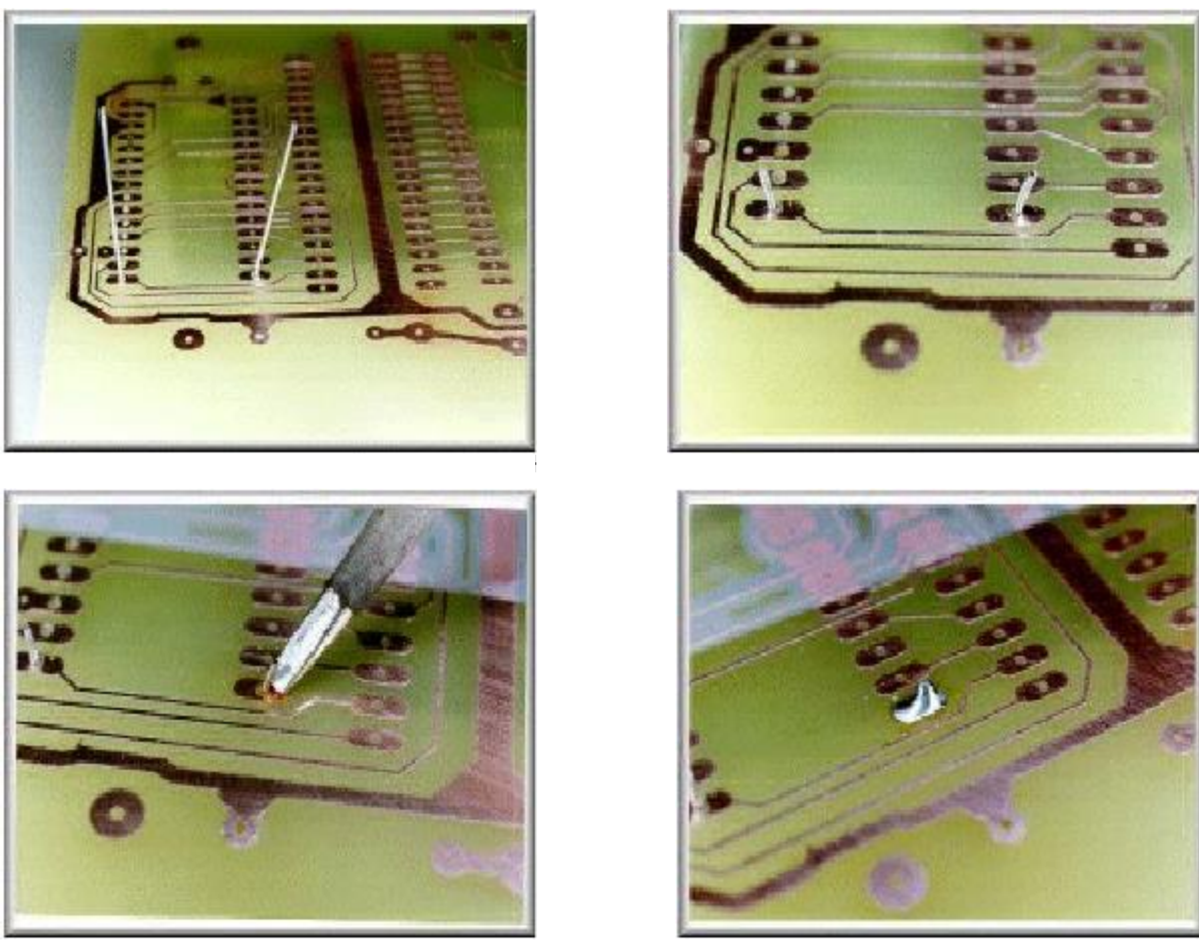
Solder less breadboards usually cannot accommodate Surface mount technology devices (SMD) or non 0.1" (2.54 mm) grid spaced components, like for example those with 2 mm spacing. Due to large stray capacitance (from 2-25pF per contact point), high inductance of some connections and a relatively high and not very reproducible contact resistance, solder less breadboards are limited to operate at relatively low frequencies, usually less than 10 MHz, depending on the nature of the circuit. The relative high contact resistance can already be a problem for DC and very low frequency circuits. Solder less breadboards are further limited by their voltage and current ratings. Complex circuits can become unmanageable on a breadboard due to the large amount of wiring necessary.

ϖ **UNIT 3 – SOLDERING**

1. SOLDERING

Soldering is a process in which two or more metal items are joined together by melting and flowing a filler metal into the joint, the filler metal having a relatively low melting point. Soft soldering is characterized by the melting point of the filler metal, which is below 400 °C (752 °F). The filler metal used in the process is called solder.

Soldering is distinguished from brazing by use of a lower melting-temperature filler metal; it is distinguished from welding by the base metals not being melted during the joining process. In a soldering process, heat is applied to the parts to be joined, causing the solder to melt and be drawn into the joint by capillary action and to bond to the materials to be joined by wetting action. After the metal cools, the resulting joints are not as strong as the base metal, but have adequate strength, electrical conductivity, and water-tightness for many uses.



+

=

- **Applications**

One of the most frequent applications of soldering is assembling electronic components to printed circuit boards (PCBs). Another common application is making permanent but reversible connections between copper pipes in plumbing systems. Joints in sheet metal objects such as food cans, roof flashing, rain gutters and automobile radiators have also historically been soldered, and occasionally still are.

- **Solders**

Soldering filler materials are available in many different alloys for differing applications. In electronics assembly, the eutectic alloy of 63% tin and 37% lead (or 60/40, which is almost identical in performance to the eutectic) has been the alloy of choice. A eutectic formulation has several advantages for soldering; chief among these is the coincidence of the liquidus and solidus temperatures, i.e. the absence of a plastic phase. This allows for quicker wetting out as the solder heats up, and quicker setup as the solder cools. A non-eutectic formulation must remain still as the temperature drops through the liquidus and solidus temperatures. Any differential movement during the plastic phase may result in cracks, giving an unreliable joint. Additionally, a eutectic formulation has the lowest possible melting point, which minimizes heat stress on electronic components during soldering.

Lead-free solders are suggested anywhere children may come into contact with (since children are likely to place things into their mouths), or for outdoor use where rain and other precipitation may wash the lead into the groundwater. Some examples of solder types and their applications are tin-lead (general purpose), tin-zinc for joining aluminium, lead-silver for strength at higher than room temperature, cadmium-silver for strength at high temperatures, zinc-aluminium for aluminium and corrosion resistance, and tin-silver and tin-bismuth for electronics. Specialty alloys are available with properties such as higher strength, better electrical conductivity and higher corrosion resistance.

- **Flux**

In high-temperature metal joining processes (welding, brazing and soldering), the primary purpose of flux is to prevent oxidation of the base and filler materials. Tin-lead solder, for example, attaches very well to copper, but poorly to the various oxides of copper, which form quickly at soldering temperatures. Flux is a substance which is nearly inert at room temperature, but which becomes strongly reducing at elevated temperatures, preventing the formation of metal oxides. Secondarily, flux acts as a wetting agent in the soldering process, reducing the surface of the molten solder and causing it to better wet out the parts to be joined.

- **Soldering defects**

The most common defect when hand-soldering results from the parts being joined not exceeding the solder's liquidus temperature, resulting in a "cold solder" joint. This is usually the result of the soldering iron being used to heat the solder directly, rather than the parts themselves. Properly done, the iron heats the parts to be connected, which in turn melt the solder, guaranteeing adequate heat in the joined parts for thorough wetting. In 'electronic' hand soldering solder the flux is *embedded* in the solder. Therefore heating the solder *first* may cause the flux to evaporate before it cleans the surfaces (pcb pad and component connection) being soldered.

In electronics non-corrosive fluxes are often used. Therefore cleaning flux off may merely be a matter of aesthetics or to make visual inspection of joints easier in specialised 'mission critical' applications such as medical devices, military and aerospace i.e. satellites . For satellites also to reduce weight slightly but usefully. In some conditions i.e. high humidity, even non-corrosive flux might remain slightly active, therefore the flux may be removed to absolutely negate the possibility of corrosion over time. In some applications, the PCB might also be coated in some form of protective material such as a lacquer to protect it and/or exposed solder joints from the environment.

Movement of metals being soldered before the solder has cooled will cause a highly unreliable cracked joint. In electronics' soldering terminology this is known as a 'dry' joint. It has a characteristically dull or grainy appearance immediately after the joint is made, rather than being smooth, bright and shiny. This appearance is caused by crystallization of the liquid solder. A dry joint is weak mechanically and a poor conductor electrically. In general a good looking soldered joint *is* a good joint. As mentioned it should be smooth, bright and shiny. If not smooth i.e. lumps or balls of otherwise shiny solder the metal has not 'wetted' properly. Not being bright and shiny suggests a weak 'dry' joint. In electronics a 'concave' fillet is ideal. This indicates good wetting and minimal use of solder (therefore minimal *heating* of heat sensitive components). A joint may be good, but if a large amount of unnecessary solder is used then more heating is obviously required. Excessive heating of a PCB may result in 'delamination', the copper track may actually lift off the board, particularly on single sided PCBs without 'through hole' plating.

- **Tools**

Hand-soldering tools include the electric soldering iron, which has a variety of tips available ranging from blunt to very fine to chisel heads for hot-cutting plastics, and the soldering gun, which typically provides more power, giving faster heat-up and allowing larger parts to be soldered. Hot-air guns and pencils allow rework of component packages which cannot easily be performed with electric irons and guns.

ϖ **UNIT 4- To Control Electrical Appliances using computer**

1. Introduction

Here is a circuit diagram for using the printer port of a PC, for control application using software and some interface hardware. The interface circuit along with the given software can be used with the printer port of any PC for controlling up to eight equipments. The interface circuit shown in is drawn for only two device, being controlled by D0 and D1 bit at pin 2 and pin 3 of the 25-pin parallel port. Identical circuits for the remaining data bits D2 through D7 (available at pins 4 through 9) have to be similarly wired. The use of opto-coupler ensures complete isolation of the PC from the relay driver circuitry.

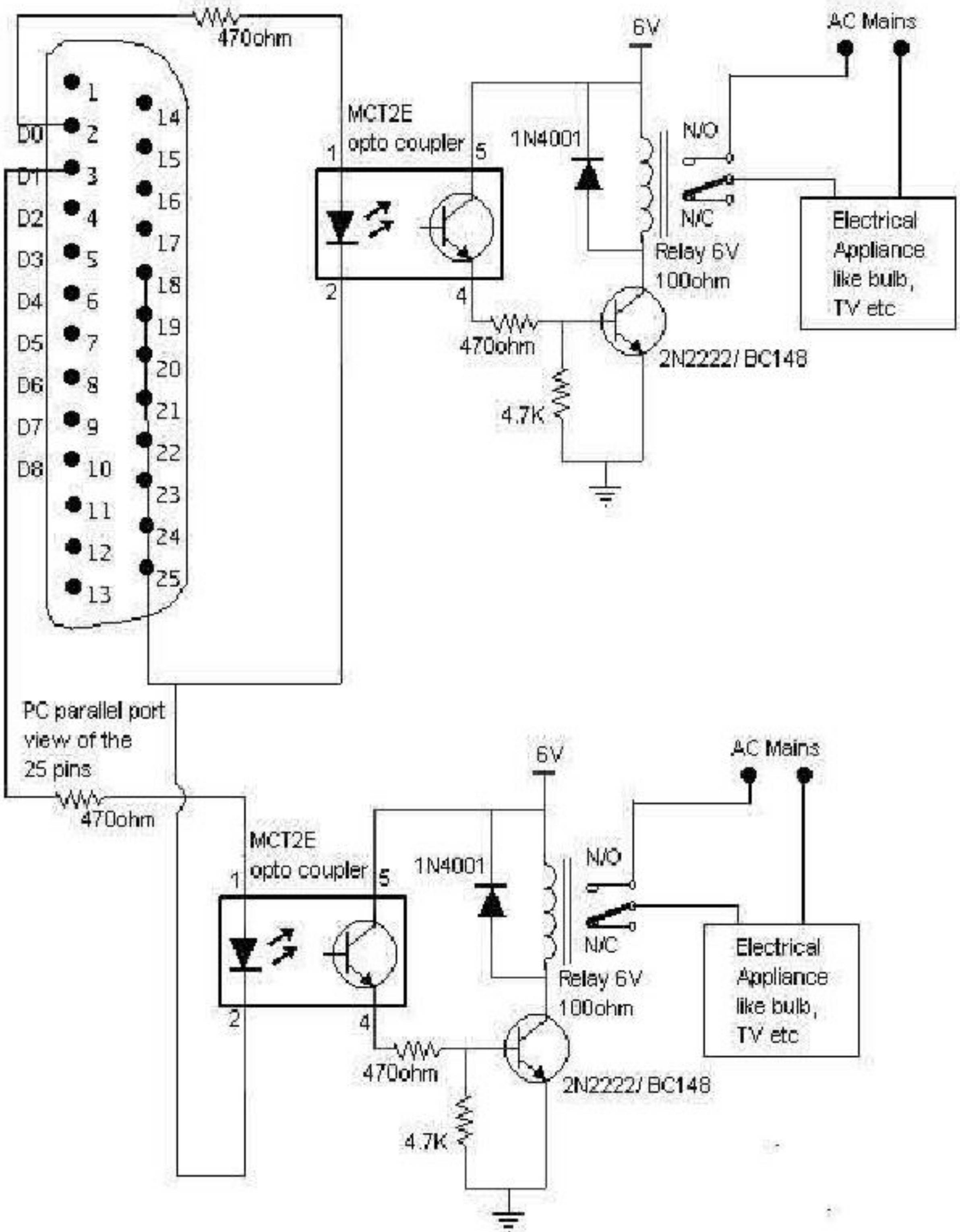
Lots of ways to control the hardware can be implemented using software. In C/C++ one can use the outportb (portno,value) function where portno is the parallel port address (usually 378hex for LPT1) and 'value' is the data that is to be sent to the port. For a value=0 all the outputs (D0-D7) are off. For value=1 D0 is ON, value=2 D1 is ON, value=4, D2 is ON and so on. e.g. If value=29(decimal) = 00011101(binary) ->D0, D2, D3, D4 are ON and the rest are OFF.

- **WORKING:**

First of all, connect the DB25 cable to the parallel port of computer as well as DB25 female connector on the circuit board. Now open the software "Portctrl" which is written in "c" and is very easy to understand. The screen in the software shows the status of the Data pins of the computer's parallel port.

Initially, All the pins are in the off state i.e. 0. Now Press the appropriate numeric key to turn on/off pins of the computer's port. This in turn sends either 3.5-5v signal(on state) if the key is pressed once and if it is pressed again then it sends 0-1.5v(off state) signal. The software converts the number pressed in to hex code which is also shown on the screen and then sends the value to parallel port address (usually 378hex for LPT1). Maximum up to 8 appliances can be controlled by pressing appropriate keys.

When any of the port is in "on" state then the voltage forward biases the LED in the Optocoupler and sends the light to a phototransistor. The Optocoupler provides complete isolation from the computer's port. The phototransistor in turn activates the transistor BC148 used to energize relay. Inside a relay is an inductor (a wire coil) that, when energized with an electric pulse, will generate a magnetic field. The second part of a relay is a system of metallic arms which make up the physical contacts of the switch. When the relay is off, or no electric pulse is given to the relay, the arm of the switch is in one position. When the relay is on, or an electric pulse is sent to the relay, the swing or switching arm of the switch moves to another contact of the switch. The arm moves as the generated magnetic field pulls the swinging arm toward the inductor (or wire coil). And hence the AC circuit is completed and the electrical appliance is turned on.


470ohm
6V
AC Mains
1
14
D0
2
15
D1
3
16
D2
4
17
D3
5
18
D4
6
19
D5
7
20
D6
8
21
D7
9
22
D8
10
23
11
24
12
25
13
MCT2E
opto coupler
1
5
2
4
1N4001
N/O
N/C
Relay 6V
100ohm
Electrical
Appliance
like bulb,
TV etc
470ohm
2N2222/ BC148
4.7K
PC parallel port
view of the
25 pins
470ohm
6V
AC Mains
MCT2E
opto coupler
1
5
2
4
1N4001
N/O
N/C
Relay 6V
100ohm
Electrical
Appliance
like bulb,
TV etc
470ohm
2N2222/ BC148
4.7K

However, Transistors and ICs must be protected from the brief high voltage produced when a relay coil is switched off. The protection diode allows the induced voltage to drive a brief current through the coil (and diode) so the magnetic field dies away quickly rather than instantly. This prevents the induced voltage becoming high enough to cause damage to transistors and ICs.

2. Background:

Parallel port is a simple and inexpensive tool for building computer controlled devices and projects. The simplicity and ease of programming makes parallel port popular in electronics hobbyist world. The parallel port is often used in computer controlled robots, home automation, etc. Here is a simple tutorial on parallel port interfacing and programming, with some examples. The primary use of parallel port is to connect printers to the computer and is specifically designed for this purpose. Thus it is often called as printer Port or Centronics port (this name came from a popular printer manufacturing company 'Centronics' which devised some standards for parallel port). You can see the parallel port connector in the rear panel of your PC. It is a 25 pin female (DB25) connector (to which printer is connected). On almost all the PCs only one parallel port is present, but you can add more by buying and inserting ISA/PCI parallel port cards.

• Parallel port modes

The IEEE 1284 Standard which has been published in 1994 defines five modes of data transfer for parallel port. They are:

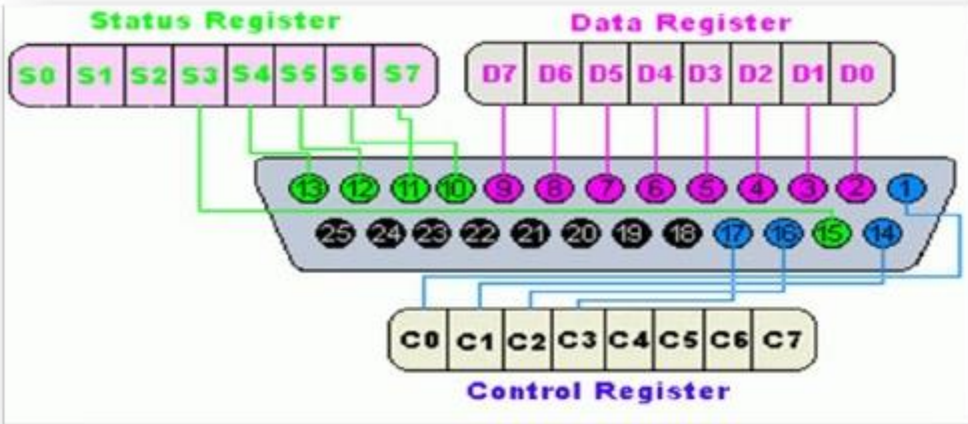
1. Compatibility Mode
2. Nibble Mode
3. Byte Mode
4. EPP
5. ECP

The programs, circuits, and other information found in this tutorial are compatible to almost all types of parallel ports and can be used without any problems.

• Hardware

The pin outs of DB25 connector is shown in the picture below: The lines in DB25 connector are divided into three groups, they are:

1. Data lines (data bus)
2. Control lines
3. Status lines



As the name refers, data is transferred over data lines. Control lines are used to control the peripheral, and of course, the peripheral returns status signals back to the computer through Status lines. These lines are connected to Data, Control And Status registers internally. The details of parallel port signal lines are given below:

Pin No (DB25)	Signal name	Direction	Register - bit	Inverted
1	nStrobe	Out	Control-0	Yes
2	Data0	In/Out	Data-0	No
3	Data1	In/Out	Data-1	No
4	Data2	In/Out	Data-2	No
5	Data3	In/Out	Data-3	No
6	Data4	In/Out	Data-4	No
7	Data5	In/Out	Data-5	No
8	Data6	In/Out	Data-6	No
9	Data7	In/Out	Data-7	No
10	nAck	In	Status-6	No
11	Busy	In	Status-7	Yes
12	Paper-Out	In	Status-5	No
13	Select	In	Status-4	No
14	Linefeed	Out	Control-1	Yes
15	nError	In	Status-3	No
16	nInitialize	Out	Control-2	No
17	nSelect-Printer	Out	Control-3	Yes
18-25	Ground	-	-	-

- **<u>Parallel port registers:</u>**

As you know, the Data, Control and Status lines are connected to there corresponding registers inside the computer. So, by manipulating these registers in program, one can easily read or write to parallel port with programming languages like 'C' and BASIC. The registers found in a standard parallel port are:

1. Data register
2. Status register
3. Control register

As their names specify, Data register is connected to Data lines, Control register is connected to Control lines and Status register is connected to Status lines. (Here the word connection does not mean that there is some physical connection between data/control/status lines. The registers are virtually connected to the corresponding lines.) So, whatever you write to these registers will appear in the corresponding lines as voltages. Of course, you can measure it with a multimeter. And whatever you give to Parallel port as voltages can be read from these registers (with some restrictions). For example, if we write '1' to Data register, the line Data0 will be driven to +5v. Just like this, we can programmatically turn on and off any of the Data lines and Control lines.

- **<u>Where these registers are?</u>**

In an IBM PC, these registers are IO mapped and will have an unique address. We have to find these addresses to work with the parallel port. For a typical PC, the base address of LPT1 is 0x378 and of LPT2 is 0x278. The Data register resides at this base address, Status register at base address + 1 and the control register is at base address + 2. So, once we have the base address, we can calculate the address of each register in this manner. The table below shows the register addresses of LPT1 and LPT2.

Register	LPT1	LPT2
Data register (baseaddress + 0)	0x378	0x278
Status register (baseaddress + 1)	0x379	0x279
Control register (baseaddress + 2)	0x37a	0x27a

3. LIST OF COMPONENTS USED:

1. 25 pin connector (DB25 male) and DB25 cable.
2. Two 470ohm resistors.
3. 4n35 optocoupler.
4. 4.7Kohm resistor.
5. 2N2222/BC148.
6. Relay 6v/100ohm.
7. 1N4001Diode.
8. 6v battery.
9. One 3 pin plug and socket.
10. One LED.
11. Connecting wires.
12. 230 v A.C. main supply.
13. Printed Circuit Board.

4. Applications:

The project can be used for various applications wherever you require control using pc.

a) Hotel power management.

b) Street light management.

c) Home automation.

d) High voltage grid control.

e) Industrial automation and many more.

ϖ **UNIT 5 –DATASHEETS**

- **TRANSISTOR BC148**

Electrical Characteristics T_a=25°C unless otherwise noted

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Units
I_{CBO}	Collector Cut-off Current	V_{CB}=30V, I_E=0			15	nA
h_{FE}	DC Current Gain	V_{CE}=5V, I_C=2mA	110		800	
V_{CE} (sat)	Collector-Emitter Saturation Voltage	I_C=10mA, I_B=0.5mA I_C=100mA, I_B=5mA		90 200	250 600	mV mV
V_{BE} (sat)	Base-Emitter Saturation Voltage	I_C=10mA, I_B=0.5mA I_C=100mA, I_B=5mA		700 900		mV mV
V_{BE} (on)	Base-Emitter On Voltage	V_{CE}=5V, I_C=2mA V_{CE}=5V, I_C=10mA	580	660	700 720	mV mV
f_T	Current Gain Bandwidth Product	V_{CE}=5V, I_C=10mA, f=100MHz		300		MHz
C_{ob}	Output Capacitance	V_{CB}=10V, I_E=0, f=1MHz		3.5	6	pF
C_{ib}	Input Capacitance	V_{EB}=0.5V, I_C=0, f=1MHz		9		pF
NF	Noise Figure : BC146/147/148 : BC549/550 : BC549 : BC550	V_{CE}=5V, I_C=200µA f=1KHz, R_G=2KΩ V_{CE}=5V, I_C=200µA R_G=2KΩ, f=30~15000MHz		2 1.2 1.4 1.4	10 4 4 3	dB dB dB dB

Typical Characteristics

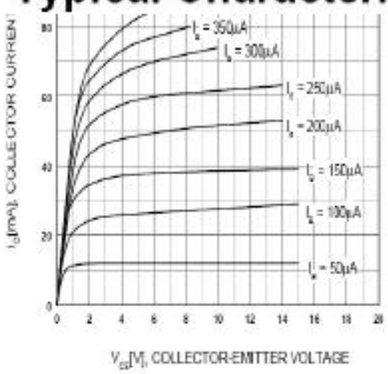


Figure 1. Static Characteristic

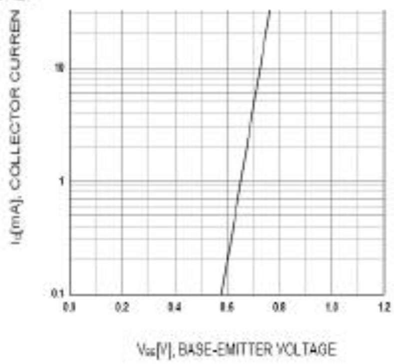


Figure 2. Transfer Characteristic

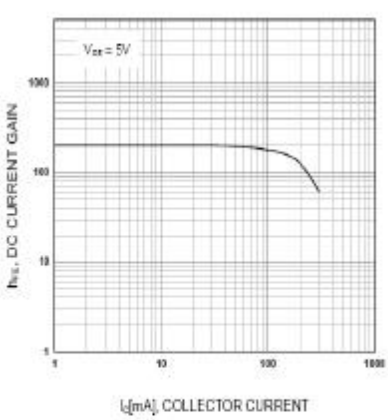


Figure 3. DC current Gain

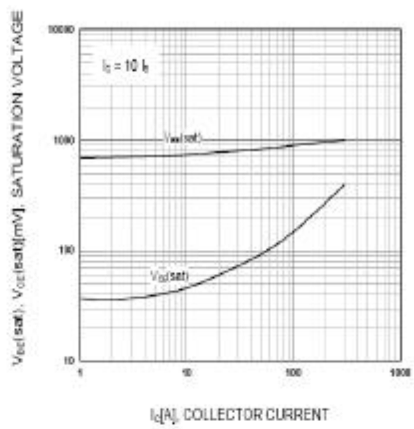


Figure 4. Base-Emitter Saturation Voltage
Collector-Emitter Saturation Voltage

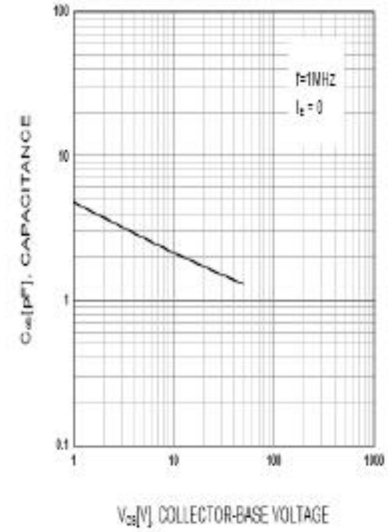


Figure 5. Output Capacitance

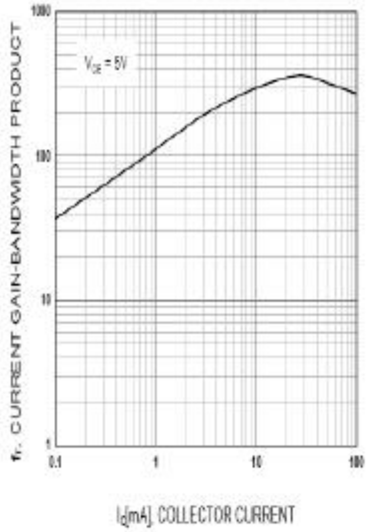


Figure 6. Current Gain Bandwidth Product

- **Optocoupler(4n35)**

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C unless otherwise specified)			
Parameter	**Symbol**	**Value**	**Units**
TOTAL DEVICE			
Storage Temperature	T_{STG}	-55 to +150	°C
Operating Temperature	T_{OPR}	-55 to +100	°C
Lead Solder Temperature	T_{SOL}	260 for 10 sec	°C
Total Device Power Dissipation @ T_A = 25°C	P_D	250	mW
Derate above 25°C		3.3 (non-M), 2.94 (-M)	
EMITTER			
DC/Average Forward Input Current	I_F	100 (non-M), 60 (-M)	mA
Reverse Input Voltage	V_R	6	V
Forward Current - Peak (300µs, 2% Duty Cycle)	I_F(pk)	3	A
LED Power Dissipation @ T_A = 25°C	P_D	150 (non-M), 120 (-M)	mW
Derate above 25°C		2.0 (non-M), 1.41 (-M)	mW/°C
DETECTOR			
Collector-Emitter Voltage	V_{CEO}	30	V
Collector-Base Voltage	V_{CBO}	70	V
Emitter-Collector Voltage	V_{ECO}	7	V
Detector Power Dissipation @ T_A = 25°C	P_D	150	mW
Derate above 25°C		2.0 (non-M), 1.76 (-M)	mW/°C

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

Parameter	Test Conditions	Symbol	Min	Typ*	Max	Unit
EMITTER						
Input Forward Voltage	(I_F = 10 mA)	V_F		1.18	1.50	V
Reverse Leakage Current	(V_R = 6.0 V)	I_R		0.001	10	µA
DETECTOR						
Collector-Emitter Breakdown Voltage	(I_C = 1.0 mA, I_F = 0)	BV_{CEO}	30	100		V
Collector-Base Breakdown Voltage	(I_C = 100 µA, I_F = 0)	BV_{CBO}	70	120		V
Emitter-Collector Breakdown Voltage	(I_E = 100 µA, I_F = 0)	BV_{ECO}	7	10		V
Collector-Emitter Dark Current	(V_{CE} = 10 V, I_F = 0)	I_{CEO}		1	50	nA
Collector-Base Dark Current	(V_{CB} = 10 V)	I_{CBO}			20	nA
Capacitance	(V_{CE} = 0 V, f = 1 MHz)	C_{CE}		8		pF

ISOLATION CHARACTERISTICS

Characteristic	Test Conditions	Symbol	Min	Typ*	Max	Units
Input-Output Isolation Voltage	(Non '-M', Black Package) (f = 60 Hz, t = 1 min)	V_{ISO}	5300			Vac(rms)
	('-M', White Package) (f = 60 Hz, t = 1 sec)		7500			Vac(pk)
Isolation Resistance	(V_{I-O} = 500 VDC)	R_{ISO}	10^{11}			Ω
Isolation Capacitance	(V_{I-O} = &, f = 1 MHz)	C_{ISO}		0.5		pF
	('-M' White Package)			0.2	2	pF

Note

* Typical values at $T_A = 25°C$

TRANSFER CHARACTERISTICS (T_A = 25°C Unless otherwise specified.)

DC Characteristic	Test Conditions	Symbol	Device	Min	Typ*	Max	Unit
Current Transfer Ratio, Collector to Emitter	(I_F = 10 mA, V_{CE} = 10 V)	CTR	4N35 4N36 4N37	100			%
			H11A1	50			
			H11A5	30			
			4N25 4N26 H11A2 H11A3	20			
			4N27 4N28 H11A4	10			
	(I_F = 10 mA, V_{CE} = 10 V, T_A = -55°C)		4N35 4N36 4N37	40			
	(I_F = 10 mA, V_{CE} = 10 V, T_A = +100°C)		4N35 4N36 4N37	40			
Collector-Emitter Saturation Voltage	(I_C = 2 mA, I_F = 50 mA)	$V_{CE\ (SAT)}$	4N25 4N26 4N27 4N28			0.5	V
	(I_C = 0.5 mA, I_F = 10 mA)		4N35 4N36 4N37			0.3	
			H11A1 H11A2 H11A3 H11A4 H11A5			0.4	
AC Characteristic Non-Saturated Turn-on Time	(I_F = 10 mA, V_{CC} = 10 V, R_L = 100Ω) (Fig.20)	T_{ON}	4N25 4N26 4N27 4N28 H11A1 H11A2 H11A3 H11A4 H11A5		2		μs
Non Saturated Turn-on Time	(I_C = 2 mA, V_{CC} = 10 V, R_L = 100Ω) (Fig.20)	T_{ON}	4N35 4N36 4N37		2	10	μs

TRANSFER CHARACTERISTICS (T_A = 25°C Unless otherwise specified.) (Continued)							
AC Characteristic	**Test Conditions**	**Symbol**	**Device**	**Min**	**Typ***	**Max**	**Unit**
Turn-off Time	(I_F = 10 mA, V_{CC} = 10 V, R_L = 100Ω) (Fig.20)	T_{OFF}	4N25 4N26 4N27 4N28 H11A1 H11A2 H11A3 H11A4 H11A5		2		µs
	(I_C = 2 mA, V_{CC} = 10 V, R_L = 100Ω) (Fig.20)		4N35 4N36 4N37		2	10	

* Typical values at T_A = 25°C

Fig. 13 Switching Speed vs. Load Resistor (Black Package)

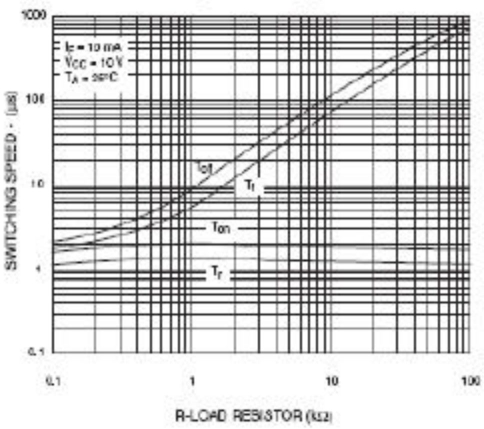
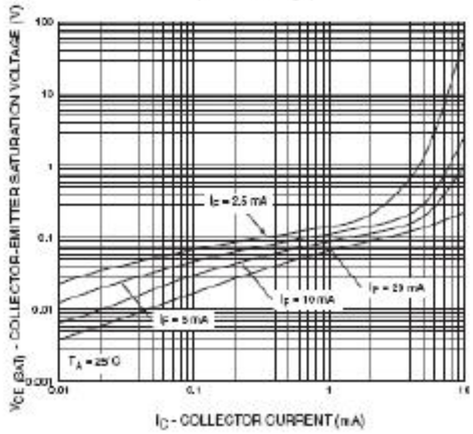


Fig. 11 Collector-Emitter Saturation Voltage vs Collector Current (Black Package)



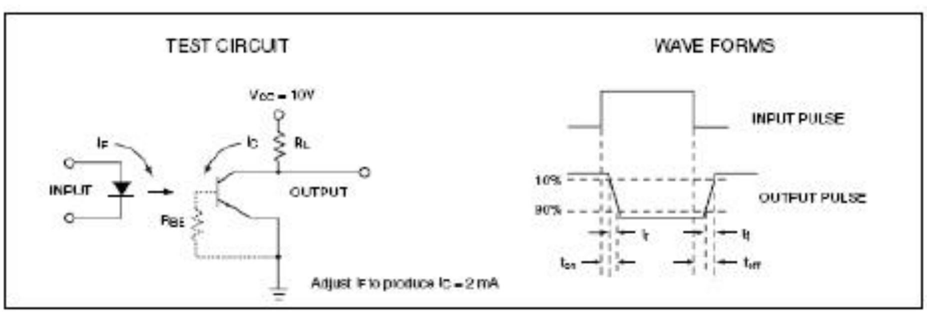


Figure 20. Switching Time Test Circuit and Waveforms

UNIT 6 – Software:

- **program written in C**

```
/*program to control devices using PC parallel port
The devices are controlled by pressing the keys 1-8
that corresponds to each of the 8 possible devices
*/
 #include<dos.h>
#include<stdio.h>
#include<conio.h>
#define PORT 0x378 /* This is the parallel port address */
main()
{
char val=0,key=0;
char str1[]="ON ";
char str2[]="OFF";
char *str;
clrscr();
printf("Press the approriate number key to turn on/off devices:\n\n");
printf("Here Device1 is connected to D0 of parallel port and so on\n\n");
printf("Press \"x\" to quit\n\n");
gotoxy(1,8);
printf("Device1:OFF Device2:OFF Device3:OFF Device4:OFF\n");
printf("Device5:OFF Device6:OFF Device7:OFF Device8:OFF");
while(key!='x' && key!='X')
{
gotoxy(1,12);
printf("Value in hex sent to the port:");
key=getch();
switch(key){
```

```
case '1':
gotoxy(9,8);
val=(val&0x01)?(val&(~0x01)):val|0x01;
str=(val&0x01)?str1:str2;
printf("%s",str);
outportb(PORT,val);
gotoxy(1,13);
printf("%x",val);
break;
case '2':
gotoxy(21,8);
val=(val&0x02)?(val&(~0x02)):val|0x02;
str=(val&0x02)?str1:str2;
printf("%s",str);
outportb(PORT,val);
gotoxy(1,13);
printf("%x",val);
break;
case '3':
gotoxy(33,8);
val=(val&0x04)?(val&(~0x04)):val|0x04;
str=(val&0x04)?str1:str2;
printf("%s",str);
outportb(PORT,val);
gotoxy(1,13);
printf("%x",val);
break;
case '4':
gotoxy(45,8);
val=(val&0x08)?(val&(~0x08)):val|0x08;
str=(val&0x08)?str1:str2;
```

```
printf("%s",str);
outportb(PORT,val);
gotoxy(1,13);
printf("%x",val);
break;
case '5':
gotoxy(9,9);
val=(val&0x10)?(val&(~0x10)):val|0x10;
str=(val&0x10)?str1:str2;
printf("%s",str);
outportb(PORT,val);
gotoxy(1,13);
printf("%x",val);
break;
case '6':
gotoxy(21,9);
val=(val&0x20)?(val&(~0x20)):val|0x20;
str=(val&0x20)?str1:str2;
printf("%s",str);
outportb(PORT,val);
gotoxy(1,13);
printf("%x",val);
break;
case '7':
gotoxy(33,9);
val=(val&0x40)?(val&(~0x40)):val|0x40;
str=(val&0x40)?str1:str2;
printf("%s",str);
outportb(PORT,val);
gotoxy(1,13);
printf("%x",val);
```

```
break;
case '8':
gotoxy(45,9);
val=(val&0x80)?(val&(~0x80)):val|0x80;
str=(val&0x80)?str1:str2;
printf("%s",str);
outportb(PORT,val);
gotoxy(1,13);
printf("%x",(unsigned char)val);
break;
}
}
}
```

UNIT 7 – CONCLUSION

• CONCLUSION

The conclusion of the project is that whenever the voltage or a digital signal '1' is applied on the parallel port of the computer using the software which is written in "c" then the voltage on the corresponding pin drives the optocoupler.
When the voltage is applied, then the optocoupler activates the transistor inside the optocoupler which drives the transistor BC 148. The transition in the resistance of the circuit due to variation in voltages across the optocoupler makes the transistor BC 148 ON. The transistor in turn energizes the coil in the relay .The energized coil makes connection between the two terminals of the other circuit in which the electrical appliance is connected. And hence the AC circuit is completed.
Another very interesting conclusion of this project is use of the relay whose connection is to be made very carefully otherwise the circuit will not work. Precautions must be taken under every step of soldering the circuit.

• SCOPE OF THE PROJECT

The project helps in understanding the working of the 25 pin parallel port of the computer, SPDT Relay and Optocoupler. The scope of this project is huge with the modernization and advancement in computer fields.
The project can be used for various applications wherever you require control using pc.

a) Hotel power management.

b) Street light management.

c) Home automation.

d) High voltage grid control.

e) Industrial automation and many more.