NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Electrical & Electronic Engineering

HOME AUTOMATION

Graduation Project
EE-400

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Nicosia - 2008

Acknowledgement

I want to thank my Instructor Asst. Prof Dr. Cemal Özgür ÖZERDEM. With his guidance I learned lots of systems, equipments and their applications in theorically. Also he answered all my questions in my project every time patiently. His experiences, working and problem solving style lighted my way to engineering gate.

Thanks to all my other Instructors in the Engineering Faculty, with their experiences I had good plans about my engineering future.

Finally, lots of thanks to my family for their priceless efforts, since they gave me the opportunity to be here as an electrical & electronic engineer candidate.

Abstract

Year after year more and more devices are entering modern households. Different types of devices with different and multiple purposes. More often these devices are not just being acquired but interconnected to produce new, small and intelligent home networks. The particular research covers particular aspects of these networks and attempts to analyze users'requirements and expectations of such networking environments.It also attempts to present existing home networking challenges and to provide possible solutions.

The final aim of the procejt is to bring up particular issues that concern developing of the intelligent home network that would satisfy most of users' needs without complicating their everyday life. It also deals with social impacts of these Networks and focuses on their smooth integration into people life.

CONTENTS

Introduction

Home intelligent networks provide the members of the families with all kind of necessary services participating in their daily life. However, adopting networking technologies to interconnect devices within the home environment is not yet a widespread technique and only a few things about it are well defined so far: neither the way for a successful setting up and maintaining these complex networks nor the consequences of living with them. More precisely, the aim of this particular research is to determine what users anticipate from such networked environments examining their basic requirements. Referring to related work, the research tries to expose existing difficulties and implications and to suggest what researchers should take into account while modeling products and services for intelligent home networks.

Intelligent home is an environment where people are supported and assisted in their everyday activities by information technology that is very different from the computer as we knew it so far. These environments integrate information, communication and sensing technologies into everyday objects.

Intelligent home is considered also to be a domestic environment in which people are surrounded by interconnected technologies that are responsive to people's presence and actions . In fact, people are surrounded by computational devices that varyingly respond, predict, and monitor their activities., intelligent home is the one that adjusts its functions to the inhabitants' needs based on the information it collects from the inhabitants, the computational system, and the context. In this kind of environment, information processing and networking technology is hidden away, and interaction between the home and its devices is achieved through advanced user interaction techniques.

1.LED

LED's are special diodes that emit light when connected in a circuit. They are frequently used as "pilot" lights in electronic appliances to indicate whether the circuit is closed or not. A a clear (or often colored) epoxy case enclosed the heart of an LED, the semi-conductor chip.

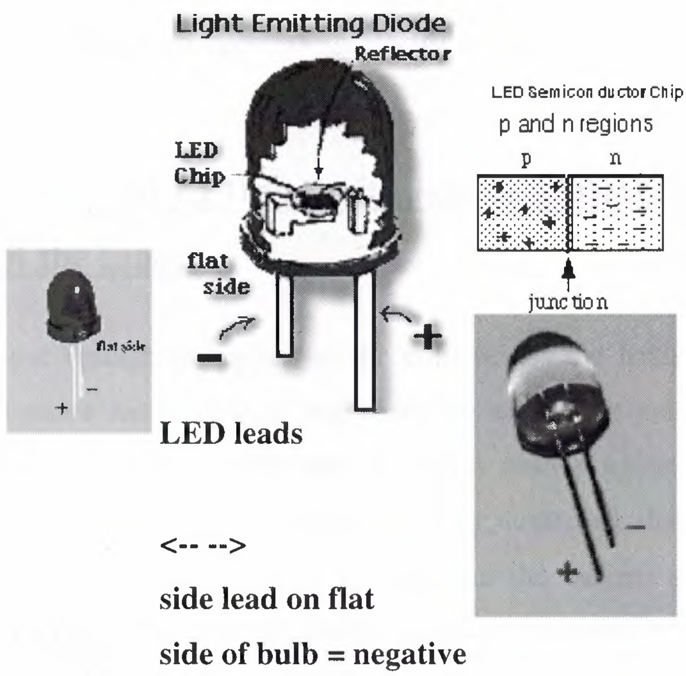


Figure-1

The two wires extending below the LED epoxy enclosure, or the "bulb"indicate how the LED should be connected into a circuit. The negative side of an LEDlead is indicated in two ways: 1) by the flat side of the bulb, and 2) by the shorter of the two wires extending from the LED. The negative lead should be connected to the negative terminal of a battery. LED's operate at relative low voltages between about 1 and 4 volts, and draw currents between about 10 and 40 milliamperes. Voltages and currents substantially above these values can melt a LED chip.

The most important part of a light emitting diode (LED) is the semi-conductor chip located in the center of the bulb as shown at the right. The chip has two regions separated by a junction. The p region is dominated by positive electric charges, and the n region is dominated by negative electric charges. The junction acts as a barrier to the flow of electrons between the p and the n regions. Only when sufficient voltage is applied to the semi-conductor chip, can the current flow, and the electrons cross the junction into the p region.

In the absence of a large enough electric potential difference (voltage) across the LED leads, the junction presents an electric potential barrier to the flow of electrons.

1.1 What Causes the LED to Emit Light and What Determines the Color of the Light?

When sufficient voltage is applied to the chip across the leads of the LED, electrons can move easily in only one direction across the junction between thep and n regions. In the p region there are many more positive than negative charges. In the n region the electrons are more numerous than the positive electric charges. When a voltage is applied and the current starts to flow, electrons in the n region have sufficient energy to move across the junction into the p region. Once in the p region the electrons are immediately attracted to the positive charges due to the mutual Coulomb forces of attraction between opposite electric charges. When an electron moves sufficiently close to a positive charge in the p region, the two charges "re-combine".

Each time an electron recombines with a positive charge, electric potential energy is converted into electromagnetic energy. For each recombination of a negative and a positive charge, a quantum of electromagnetic energy is emitted in the form of a photon of light with a frequency characteristic of the semi-conductor material (usually a combination of the chemical elements gallium, arsenic and phosphorus). Only photons in a very narrow frequency range can be emitted by any material. LED's that emit different colors are made of different semi-conductor materials, and require different energies to light them.

1.2 How Much Energy Does an LED Emit?

The electric energy is proportional to the voltage needed to cause electrons to flow across the p-n junction. The different colored LED's emit predominantly light of a single color. The energy (E) of the light emitted by an LED is related to the electric charge (q) of an electron and the voltage (V) required to light the LED by the expression: $E = qV$ Joules. This expression simply says that the voltage is proportional to the electric energy, and is a general statement which applies to any circuit, as well as to LED's. The constant q is the electric charge of a single electron, -1.6×10^{-19} Coulomb.

1.3 Finding the Energy from the Voltage

Suppose you measured the voltage across the leads of an LED, and you wished to find the corresponding energy required to light the LED. Let us say that you have a red LED, and the voltage measured between the leads of is 1.71 Volts. So the Energy required to light the LED is $E = qV$ or $E = -1.6 \times 10^{-19}$ (1.71) Joule, since a Coulomb-Volt is a Joule. Multiplication of these numbers then gives $E = 2.74 \times 10^{-19}$ Joule.

1.4 Finding The Frequency From The Wavelength Of Light

The frequency of light is related to the wavelength of light in a very simple way. The spectrometer can be used to examine the light from the LED, and to estimate the peak wavelength of the light emitted by the LED. But we prefer to have the frequency of the peak intensity of the light emitted by the LED. The wavelength is related to the frequency of light by $f = \frac{c}{\lambda}$, where c is the speed of light (3×10^{8} m/s) and λ is the wavelength of light read from the spectrometer (in units of nanometers or 10^{-9} meters). Suppose you observed the red LED through the spectrometer, and found that the LED emits a range in colors with maximum intensity corresponding to a wavelength as read from the spectrometer of λ= 660 nm or 660 x 10^{-9} m. The corresponding frequency at which the red LED emits most of its light is $f = \frac{3 \times 10^8}{660 \times 10^{-9}} \frac{ms^{-1}}{m}$ or 4.55 x 10^{14} Hertz. The unit for one cycle of a wave each second (cycle per second) is a Hertz.

2.Resistors

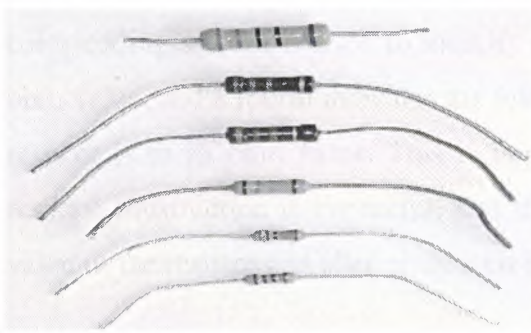


Figure-2

A resistor is a component of an electrical circuit that resists the flow of electrical current. A resistor has two terminals across which electricity must pass, and is designed to drop the voltage of the current as it flows from one terminal to the next. A resistor is primarily used to create and maintain a known safe current within an electrical component.

Resistance is measured in ohms, after Ohm's law. This rule states that electrical resistance is equal to the drop in voltage across the terminals of the resistor divided by the current being applied to the resistor. A high ohm rating indicates a high resistance to current. This rating can be written in a number of different ways depending on the ohm rating. For example, 81R represents 81 ohms, while 81K represents 81,000 ohms.

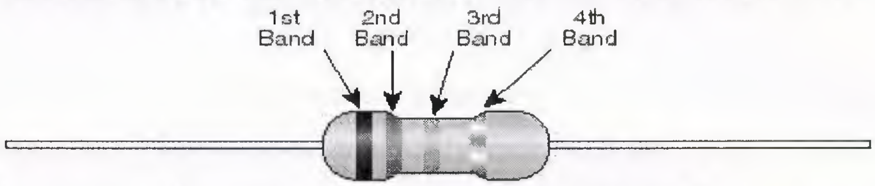
The amount of resistance offered by a resistor is determined by its physical construction. A carbon composition resistor has resistive carbon packed into a ceramic cylinder, while a carbon film resistor consists of a similar ceramic tube, but has conductive carbon film wrapped around the outside. Metal film or metal oxide resistors are made much the same way, but with metal instead of carbon. A wirewound resistor, made with metal wire wrapped around clay, plastic, or fiberglass tubing, offers resistance at higher power levels. For applications that must withstand high temperatures, materials such as cermet, a ceramic-metal composite, or tantalum, a rare metal, are used to build a resistor that can endure heat.

A resistor is coated with paint or enamel, or covered in molded plastic to protect it. Because resistors are often too small to be written on, a standardized color-coding system is used to identify them. The first three colors represent ohm value, and a fourth indicates the tolerance, or how close by percentage the resistor is to its ohm value. This is important for two reasons: the nature of resistor construction is imprecise, and if used above its maximum current, the value of the resistor can alter or the unit itself can burn up.

Every resistor falls into one of two categories: fixed or variable. A fixed resistor has a predetermined amount of resistance to current, while a variable resistor can be adjusted to give different levels of resistance. Variable resistors are also called potentiometers and are commonly used as volume controls on audio devices. A rheostat is a variable resistor made specifically for use with high currents. There are also metal-oxide varistors, which change their resistance in response to a rise in voltage; thermistors, which either raise or lower resistance when temperature rises or drops; and light-sensitive resistors.

2.1 Code Of Resistors

Standard EIA Color Code Table **4 Band:** ±2%, ±5%, and ±10%



Color	1st Band (1st figure)	2nd Band (2nd figure)	3rd Band (multiplier)	4th Band (tolerance)
Black	0	0	10^{0}	
Brown	1	1	10^{1}	
Red	2	2	10^{2}	±2%
Orange	3	3	10^{3}	
Yellow	4	4	10^{4}	
Green	5	5	10^{5}	
Blue	6	6	10^{6}	
Violet	7	7	10^{7}	
Gray	8	8	10^{8}	
White	9	9	10^{9}	
Gold			10^{-1}	±5%
Silver			10^{-2}	±10%

Figure-2.1

2.2 A Few Type Of Resistors

2.2.1Termistors

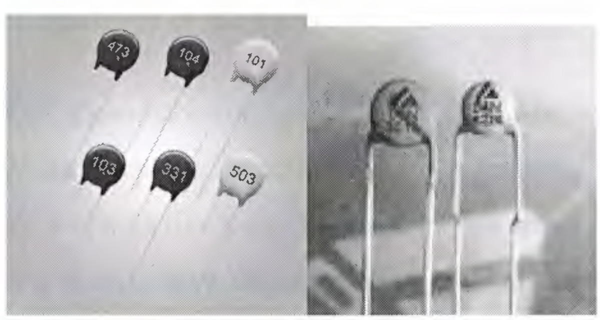


Figure-2.2 NTC-PTC

Thermistor, a word formed by combining thermal with resistor, refers to a device whose electrical resistance, or ability to conduct electricity, is controlled by temperature. Thermistors come in two varieties; NTC, negative thermal coefficient, and PTC, positive thermal coefficient, sometimes called posisitors.

The resistance of NTC thermistors decreases proportionally with increases in temperature. They are most commonly made from the oxides of metals such as manganese, cobalt, nickel and copper. The metals are oxidized through a chemical reaction, ground to a fine powder, then compressed and subject to very high heat. Some NTC thermistors are crystallized from semiconducting material such as silicon and germanium.

Electrical circuitry is colder at startup than after running for a length of time. NTC thermistors are used to take advantage of this to protect the circuitry from the surge in electrical flow that accompanies startup. Because the resistance of NTC thermistors varies gradually with temperature, they are also used as temperature measuring devices.

PTC thermistors have increasing resistance with increasing temperature. They are generally made by introducing small quantities of semiconducting material into a polycrystalline ceramic. When temperature reaches a critical point, the semiconducting material forms a barrier to the flow of electricity and resistance climbs very quickly. Unlike the gradual changes in NTC thermistors, PTCs act more like on-off switches. The temperature at which this occurs can be varied by adjusting the composition of the thermistor.

Another type of PTC thermistor consists of a slice of plastic with carbon grains embedded in it. When the plastic is cool, the carbon grains are close enough to each other to form a conductive path. Plastic expands when as it warms; at a certain temperature, it will have expanded enough to push the carbon grains apart and break the conductive path.

This on-off behavior of PTC thermistors is useful in situations where equipment can be damaged by easily definable events. For example, they can be used to protect the windings in transformers and electrical motors from excessive heat.

Caracteristik of NTC

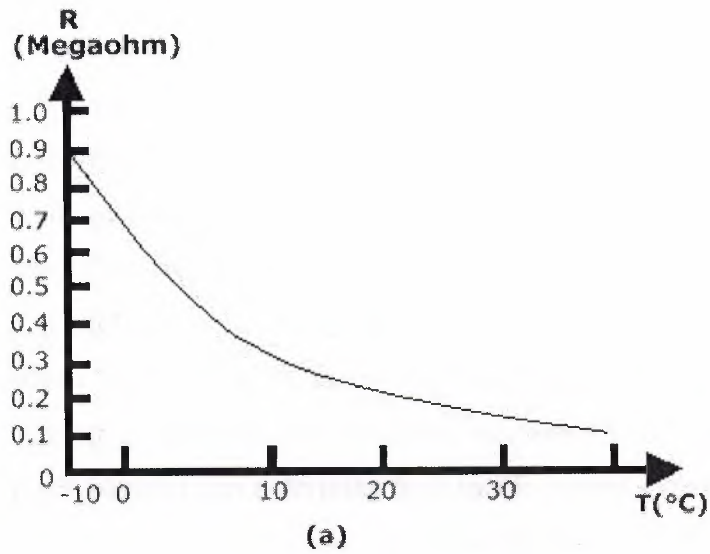


Figure-2.3

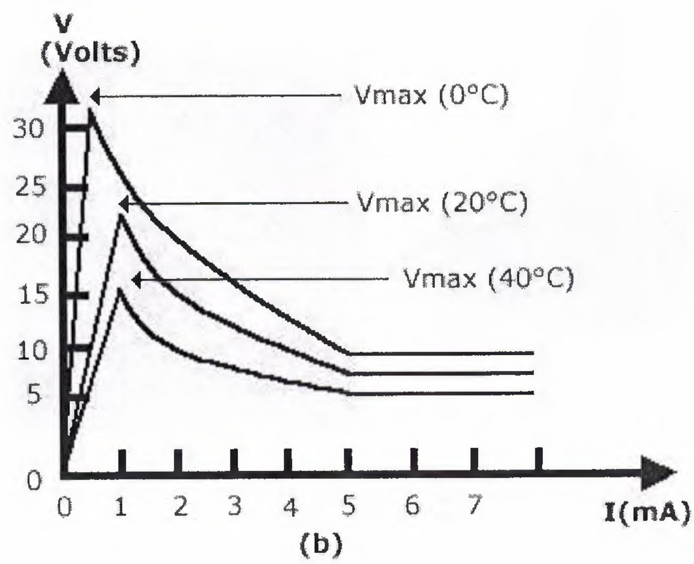


Figure-2.4

2.2.2 Potentiometer

A potentiometer is a manually adjustable resistor.A few potentiometer are shown above figure-1 The way this device works is relatively simple. One terminal of the potentiometer is connected to a power source. Another is hooked up to ground (a point with no voltage or resistance and which serves as a neutral reference point), while the third terminal runs across a strip of resistive material. This resistive strip generally has a low resistance at one end; its resistance gradually increases to a maximum resistance at the other end. The third terminal serves as the connection between the power source and ground, and is usually interfaced to the user by means of a knob or lever. The user can adjust the position of the third terminal along the resistive strip in order to manually increase or decrease resistance. By controlling resistance, a potentiometer can determine how much current flows through a circuit. When used to regulate current, the potentiometer is limited by the maximum resistivity of the strip.

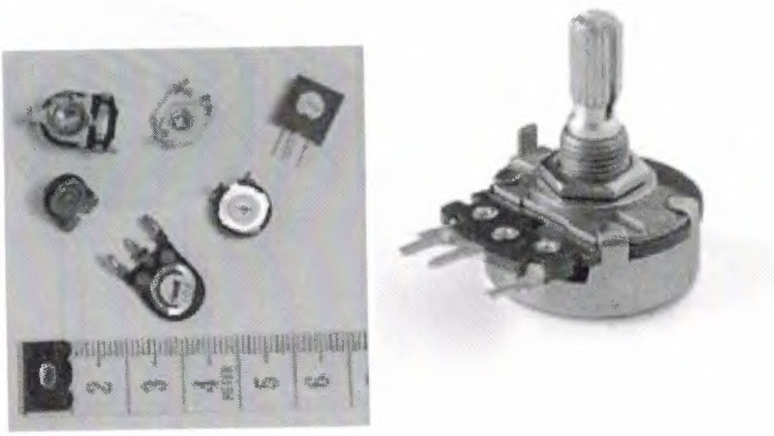


Figure-2.5

The power of this simple device is not to be underestimated. In most analog devices, a potentiometer is what establishes the levels of output. In a loud speaker, for example, a potentiometer directly adjusts volume; in a television monitor, it controls brightness.

A potentiometer can also be used to control the potential difference, or voltage, across a circuit. The setup involved in utilizing a potentiometer for this purpose is a little bit more complicated. It involves two circuits: the first circuit consists of a cell and a resistor. At one end, the cell is connected in series to the second circuit, and at the other end it is connected to a potentiometer in parallel with the second circuit. The potentiometer in this arrangement drops the voltage by an amount equal to the ratio between the resistance allowed by the position of the third terminal and the highest possible resistivity of the strip. In other words, if the knob controlling the resistance is positioned at the exact halfway point on the resistive strip, then the output voltage will drop by exactly fifty percent, no matter how high the potentiometer's input voltage. Unlike with current regulation, voltage regulation is not limited by the maximum resistivity of the strip.

2.2.3 Ligth Dependent Resistors

A Light Dependent Resistor (aka LDR, photoconductor, or photocell) is a device which has a resistance which varies according to the amount of light falling on its surface.

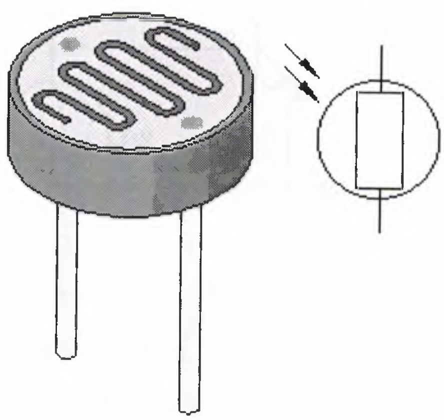


Figure-2.6

A typical light dependent resistor is pictured above together with (on the right hand side) its circuit diagram symbol. Different LDR's have different specifications.

2.2.3.1 Uses For Light Dependent Resistors

Light dependent resistors are a vital component in any electric circuit which is to be turned on and off automatically according to the level of ambient light - for example, solar powered garden lights, and night security lighting. An LDR can even be used in a simple remote control circuit using the backlight of a mobile phone to turn on a device - call the mobile from anywhere in the world, it lights up the LDR, and lighting (or a garden sprinkler) can be turned on remotely!

2.2.3.2 Light Dependent Resistor Circuits

There are two basic circuits using light dependent resistors - the first is activated by darkness, the second is activated by light. The two circuits are very similar and just require an LDR, some standard resistors, a variable resistor (aka potentiometer), and any small signal transistor

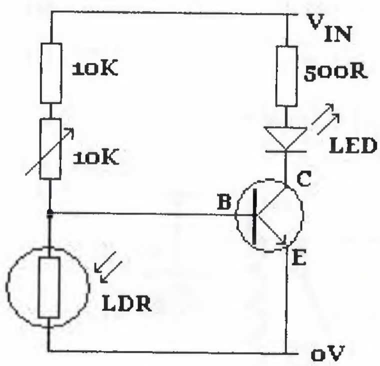


Figure-2.7

In the circuit diagram above, the LED lights up whenever the LDR is in darkness. The 10K variable resistor is used to fine-tune the level of darkness required before the LED lights up. The 10K standard resistor can be changed as required to achieve the desired effect, although any replacement must be at least 1K to protect the transistor from being damaged by excessive current.

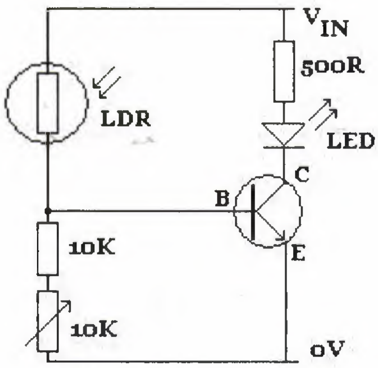


Figure-2.8

By swapping the LDR over with the 10K and 10K variable resistors (as shown above), the circuit will be activated instead by light. Whenever sufficient light falls on the LDR (manually fine-tuned using the 10K variable resistor), the LED will light up.

2.2.3.3 Using An LDR in The Real World

The circuits shown above are not practically useful. In a real world circuit, the LED (and resistor) between the positive voltage input (Vin) and the collector (C) of the transistor would be replaced with the device to be powered.

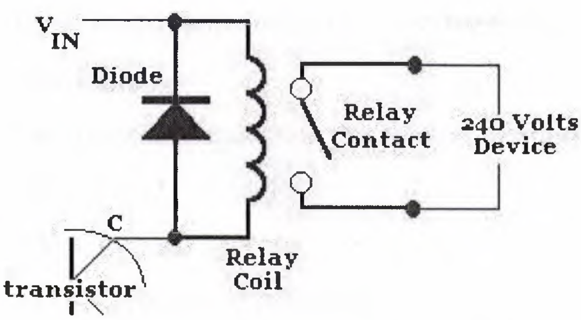


Figure-2.9

Typically a relay is used - particularly when the low voltage light detecting circuit is used to switch on (or off) a 240V mains powered device. A diagram of that part of the circuit is shown above. When darkness falls (if the LDR circuit is configured that way around), the relay is triggered and the 240V device - for example a security light - switches on.

3. Capacitor

A capacitor is a device that stores an electrical charge or energy on it's plates. These plates (see Fig. 1), a positive and a negative plate, are placed very close together with an insulator in between to prevent the plates from touching each other. A capacitor can carry a voltage equal to the battery or input voltage. Usually a capacitor has more than two plates depending on the capacitance or dielectric type.

The 'Charge' is called the amount of stored electricity on the plates, or actually the electric field between theses plates, and is proportional to the applied voltage and capacitor's 'capacitance'.
'capacitance'.
The Formula to calculate the amount of capacitance is $Q = C * V$ where:
- Q = Charge in Coulombs
- C = Capacitance in Farads
- V = Voltage in Volts

There is also something else involved when there is 'charge', something stored called 'Energy'.
The formula to calculate the amount of energy is: $W = V^2 * C / 2$ where:
- W = Energy in Joules
- V = Voltage in Volts
- C = Capacitance in Farads

3.1 Capacitor Codes

Except for the electrolytic and large types of capacitors, which usually have the value printed on them like 470uF 25V or something, most of the smaller caps have two or three numbers printed on them, some with one or two letters added to that value. Check out the little table below.

As you can see it all looks very simple. If a capacitor is marked like this 105, it just means 10+5zeros = 10 + 00000 = 1.000.000pF = 1000 nF = 1 uF. And that's exactly the way you write it too. Value is in pF (PicoFarads). The letters added to the value is the tolerance and in some cases a second letter is the temperature coefficient mostly only used in military applications, so basically industrial stuff.

So, for example, it you have a ceramic capacitor with 474J printed on it it means: 47+4zeros = 470000 = 470.000pF, J=5% tolerance. (470.000pF = 470nF = 0.47uF) Pretty simple, huh? The only major thing to get used to is to recognize if the code is uF nF, or pF.

Other capacitors may just have 0.1 or 0.01 printed on them. If so, this means a value in uF. Thus 0.1 means just 0.1 uF. If you want this value in nanoFarads just move the comma three places to the right which makes it 100nF. "NPO" is standard for temperature stability and 'low-noise', it does *not* mean non-polarized even though you might think so because the abbreviation looks similar. Polarized ceramic capacitors do not exist. The abreviation "NPO" stands for "Negative-Positive-Zero" (what is read as an 'O' is actually zero), and means that the negative and positive temperature coefficients of the device are zero--that is the capacitance does not vary with temperature. ONLY the black top indicates NPO qualification and the values are in the range from 1.8pF to 120pF, unless manufactured with different values for Military and/or industrial purposes on special request. They feature 2% tolerance which comes down to about 0.25pF variation, and all are 100V types. You may sometimes find NPO-type caps marked witht he EIA (Electronic Industrial Association) code "COG". The EIA has an established set of specifications for capacitor temperature characteristics (EIC 384/class 1B). Thus, a capacitor labeled "Y5P" would exhibit a plus/minus tolerance of 10% variation in capacitance over a temperature range of -30°C. to +85°C. Or it may say N12 which translates to 120pF. Or 2P2 (2.2pF).But the average hobbyist uses only a couple types like the common electrolytic and general purpose ceramic capacitors and depending on the ap plication, a more temperature stable type like metal-film or polypropylene.

The larger the plate area and the smaller the area between the plates, the larger the capacitance. Which also depends on the type of insulating material between the plates which is the smallest with air. (You see this type of capacitor sometimes in high-voltage circuits and are called 'spark-caps'.) Replacing the air space with an insulator will increase the capacitance many times over. The capacitance ratio using an insulator material is called Dielectric Constant while the insulator material itself is called just Dielectric. Using the table in Fig. 4, if a Polystyrene dielectric is used instead of air, the capacitance will be increased 2.60 times.

3.2 <u>Type Of Capasitors</u>

3.2.1 <u>Electrolytic</u> - Made of electrolyte, basically conductive salt in solvent. Aluminum electrodes are used by using a thin oxidation membrane. Most common type, polarized capacitor. Applications: Ripple filters, timing circuits. Cheap, readily available, good for storage of charge (energy). Not very accurate, marginal electrical properties, leakage, drifting, not suitable for use in hf circuits, available in very small or very large values in uF. They WILL explode if the rated working voltage is exceeded or polarity is reversed, so be careful. When you use this type capacitor in one of your projects, the rule-of-thumb is to choose one which is twice the supply voltage. Example, if your supply power is 12 volt you would choose a 24volt (25V) type. This type has come a long way and characteristics have constantly improved over the years. It is and always will be an all-time favorite; unless something better comes along to replace it. But I don't think so for this decade; polarized capacitors are heavily used in almost every kind of equipment and consumer electronics.

3.2.2 Tantalum - Made of Tantalum Pentoxide. They are electrolytic capacitors but used with a material called tantalum for the electrodes. Superior to electrolytic capacitors, excellent temperature and frequency characteristics. When tantalum powder is baked in order to solidify it, a crack forms inside. An electric charge can be stored on this crack. Like electrolytics, tantalums are polarized so watch the '+' and '-' indicators. Mostly used in analog signal systems because of the lack of current-spike-noise. Small size fits anywhere, reliable, most common values readily available. Expensive, easily damaged by spikes, large values exists but may be hard to obtain. Largest in my own collection is 220uF/35V, beige color.

3.2.3 Super Capacitors - The Electric Double Layer capacitor is a real miracle piece of work. Capacitance is 0.47 Farad (470,000 uF). Despite the large capacitance value, its physical dimensions are relatively small. It has a diameter of 21 mm (almost an inch) and a height of 11 mm (1/2 inch). Like other electrolytics the super capacitor is also polarized so exercise caution in regards to the break-down voltage. Care must be taken when using this capacitor. It has such large capacitance that, without precautions, it would destroy part of a powersupply such as the bridge rectifier, volt regulators, or whatever because of the huge inrush current at charge. For a brief moment, this capacitor acts like a short circuit when the capacitor is charged. Protection circuitry is a must for this type.

3.2.4 Polyester Film - This capacitor uses a thin polyester film as a dielectric. Not as high a tolerance as polypropylene, but cheap, temperature stable, readily available, widely used. Tolerance is approx 5% to 10%. Can be quite large depending on capacity or rated voltage and so may not be suitable for all applications.

3.2.5 Polypropylene - Mainly used when a higher tolerance is needed then polyester caps can offer. This polypropylene film is the dielectric.Very little change in capacitance when these capacitors are used in applications within frequency range 100KHz. Tolerance is about 1%.Very small values are available.

3.2.6 Polystyrene - Is used as a dielectric. Constructed like a coil inside so not suitable for high frequency applications. Well used in filter circuits or timing applications using a couple hundred KHz or less. Electrodes may be reddish of color because of copper leaf used or silver when aluminum foil is used for electrodes.

3.2.7 Metalized Polyester Film - Dielectric made of Polyester or DuPont trade name "Mylar". Good quality, low drift, temperature stable. Because the electrodes are thin they can be made very very small. Good all-round capacitor.

3.2.8 Epoxy - Manufactured using an epoxy dipped polymers as a protective coating. Widely available, stable, cheap. Can be quite large depending on capacity or rated voltage and so may not be suitable for all applications.

3.2.9 Ceramic - Constructed with materials such as titanium acid barium for dielectric. Internally these capacitors are not constructed as a coil, so they are well suited for use in high frequency applications. Typically used to by-pass high frequency signals to ground. They are shaped like a disk, available in very small capacitance values and very small sizes. Together with the electrolytics the most widely available and used capacitor around. Comes in very small size and value, very cheap, reliable. Subject to drifting depending on ambient temperature. NPO types are the temperature stable types. They are identified by a black stripe on top.

3.2.10 Multilayer Ceramic - Dielectric is made up of many layers. Small in size, very good temperature stability, excellent frequency stable characteristics. Used in applications to filter or bypass the high frequency to ground. They don't have a polarity. *Multilayer caps suffer from high-Q internal (parallel) resonances - generally in the VHF range. The CK05 style 0.1uF/50V caps for example resonate around 30MHz. The effect of this resonance is effectively no apparent capacitance near the resonant frequency.As with all ceramic capacitors, be careful bending the legs or spreading them apart to close to the disc body or they may get damaged.

3.2.11 Silver-Mica - Mica is used as a dielectric. Used in resonance circuits, frequency filters, and military RF applications. Highly stable, good temperature coefficient, excellent for endurance because of their frequency characteristics, no large values, high voltage types available, can be expensive but worth the extra dimes.

3.2.12 Adjustable Capacitors - Also called trimmer capacitors or variable capacitors. It uses ceramic or plastic as a dielectric.Most of them are color coded to easily recognize their tunable size. The ceramic type has the value printed on them. Colors are: yellow (5pF), blue (7pF), white (10pF), green (30pF), brown (60pf). There are a couple more colors like red, beige, and purple which are not listed here.

3.3 Tuning or 'air-core' Capacitors

They use the surrounding air as a dielectric. I have seen these variable capacitor types of incredible dimensions, especially the older ones. Amazing it all worked. Mostly used in radio and radar equipment. This type usually have more (air) capacitors combined (ganged) and so when the adjustment axel is turned, the capacitance of all of them changes simultaneously. The one on the right has a polyester film as a dielectric constant and combines two independent capacitors plus included is a trimmer cap, one for each side.

3.4 Capacitors in Schematics

Capacitors in schematics are represented as a pair of plates. Sometimes the plates are drawn as straight lines (a), sometimes as curved ones (d), and sometimes as a combination of the two. Electrolytic capacitors are frequently indicated by a symbol with one straight and one curved line (d) or the european way of drawing this symbol in (e). A '+' sign is placed at the straight line to indicate the anode. Occasionally an electrolytic is drawn as two straight lines, but the plus sign is always included to indicate its polarity.

3.4 The Farad, MicroFarad and PicoFarad

Capacitors have always had farad as the unit of measure, abbreviated "F". Since this is a very large unit of measure for most practical capacitors or for most uses of capacitance, you'll find that a millionth of a farad or a million-millionth of a farad are the more common units found on capacitors. Yes, these days we can find capacitors with ratings in the tens and hundreds of farads, but those are usually reserved for extremely high-current, low-voltage switching supplies or for a more frivolous use as energy-storage tanks for use with high-power automotive audio power amplifiers. This treatise is for "normal" capacitors.

In scientific notation, we would write 1 millionth of a farad as 1 x 10-6 farad. In electronics, since we deal with so many component values and circuit values on even the smallest schematic or product, the metric prefix form is used for an electronic shorthand to keep the scribbling to a minimum. That prefix form uses letter symbols to take the place of the scientific notation--or more accurately, the engineering notation--that would otherwise accompany a unit of measure. The metric prefix form replaces the engineering notation that would otherwise be used in front of the unit of measure. That list follows.

microFarads (μF)		nanoFarads (nF)		picoFarads (pF)
0.000001μF	=	0.001nF	=	1pF
0.00001μF	=	0.01nF	=	10pF
0.0001μF	=	0.1nF	=	100pF
0.001μF	=	1nF	=	1000pF
0.01μF	=	10nF	=	10,000pF
0.1μF	=	100nF	=	100,000pF
1μF	=	1000nF	=	1,000,000pF
10μF	=	10,000nF	=	10,000,000pF
100μF	=	100,000nF	=	100,000,000pF

Table 1. Capacitance Conversion

Metric Prefix	Symbol	Power of 10 (multiplier)
giga [Note 2]	G	x 10^9
mega	M	x 10^6
kilo	K	x 10^3
(none)		x 10^0 (same as 1 or unity)
milli	m	x 10^-3
micro	f	x 10^-6
nano	n	x 10^-9
pico	p	x 10^-12

This list does extend farther in either direction, but those larger and smaller multipliers are not as commonly used in electronics. But using this list, you'll find that the common capacitor multipliers in the United States will be f (micro) and p (pico). A capacitor with a value of 3.3fF is the same as a capacitor with a value of 3.3 x 10^-6 farads or 0.0000033 farads. "f", by the way, is the lower-case Greek letter "mu", properly written as our Roman lower case "u" with a leading descender much as a "y" has a trailing descender.

3.5Voltage Ratings

In addition to value and tolerance, a capacitor is often marked with a voltage rating. These may simply be noted as "50V" or "50VDC" or some such other voltage as appropriate. Voltage ratings are sometimes incorporated into a capacitors "coded description". For instance, the value code "2A104K" has a "2A" prefix which translates to a voltage rating of 100V. The "104K" part, as you now know, translates to 100,000pF or 0.1fF or 100nF with a tolerance of 10%. Voltage prefixes include:

1E 25V

1H 50V

2A 100V

Since this seems to be European in nature, these voltage markings are new territory for me. I would appreciate more information on this so that I can flesh out this article and make it more accurate. My e-mail address appears in the "Wrapup" section following in case you would like to contact me with some of this information. I try to be accurate, so please make sure that you include source material rather than depending upon hand-me-down folklore.

3.6 Temperature Coefficient

Capacitors, most notably ceramic capacitors, have temperature coefficients ("tempco" or TC). That is, their value will change with a change in temperature. Some "bulk" ceramic capacitors (those "M" tolerance things) can change over 10 or 20 percent with a 20 degree shift in temperature, so are unsuitable for use in circuits that are frequency-dependent, such as oscillators or filters. Capacitance changes are not necessarily linear or even directly proportional at all times for a particular type of capacitor.

4. Diodes

Diodes allow electricity to flow in only one direction. The arrow of the circuit symbol shows the direction in which the current can flow. Diodes are the electrical version of a valve and early diodes were actually called valves.

Circuit symbol:

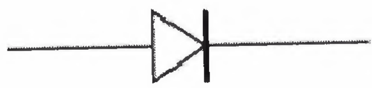
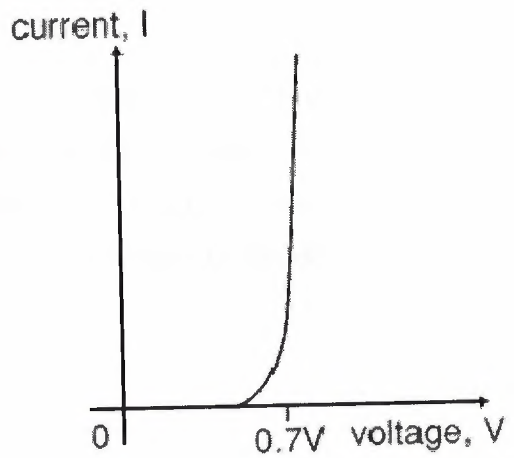


Figure-4

4.1 Forward Voltage Drop

Electricity uses up a little energy pushing its way through the diode, rather like a person pushing through a door with a spring. This means that there is a small voltage across a conducting diode, it is called the forward voltage drop and is about 0.7V for all normal diodes which are made from silicon. The forward voltage drop of a diode is almost constant whatever the current passing through the diode so they have a very steep characteristic (current-voltage graph).



Characteristic of a Silicon Diode

Figure-4.1

4.2 Reverse Voltage

When a reverse voltage is applied a perfect diode does not conduct, but all real diodes leak a very tiny current of a few μA or less. This can be ignored in most circuits because it will be very much smaller than the current flowing in the forward direction. However, all diodes have a maximum reverse voltage (usually 50V or more) and if this is exceeded the diode will fail and pass a large current in the reverse direction, this is called breakdown.

4.3 Connecting And Soldering

Diodes must be connected the correct way round, the diagram may be labelled a or + for anode and k or - for cathode (yes, it really is k, not c, for cathode!). The cathode is marked by a line painted on the body. Diodes are labelled with their code in small print, you may need a magnifying glass to read this on small signal diodes!

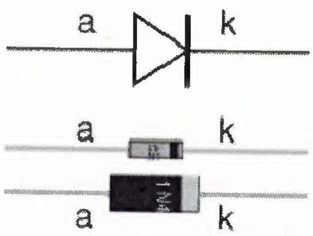


Figure-4.2

4.4 Testing Diodes

You can use a multimeter or a simple tester (battery, resistor and LED) to check that a diode conducts in one direction but not the other. A lamp may be used to test a rectifier diode, but do NOT use a lamp to test a signal diode because the large current passed by the lamp will destroy the diode!

4.5 Signal diodes (small current)

Signal diodes are used to process information (electrical signals) in circuits, so they are only required to pass small currents of up to 100mA. For general use, where the size of the forward voltage drop is less important, silicon diodes are better because they are less easily damaged by heat when soldering, they have a lower resistance when conducting, and they have very low leakage currents when a reverse voltage is applied.

Signal diodes are also used to protect transistors and ICs from the brief high voltage produced when a relay coil is switched off. The diagram shows how a protection diode is connected 'backwards' across the relay coil.

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.

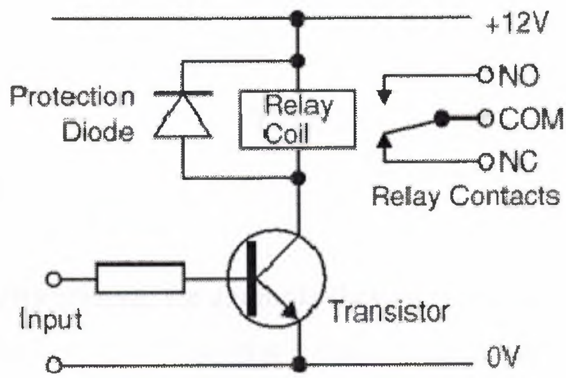


Figure-4.3

4.6 Rectifier Diodes (Large Current)

Rectifier diodes are used in power supplies to convert alternating current (AC) to direct current (DC), a process called rectification. They are also used elsewhere in circuits where a large current must pass through the diode.

All rectifier diodes are made from silicon and therefore have a forward voltage drop of 0.7V. The table shows maximum current and maximum reverse voltage for some popular rectifier diodes. The 1N4001 is suitable for most low voltage circuits with a current of less than 1A.

Diode	Maximum Current	Maximum Reverse Voltage
1N4001	1A	50V
1N4002	1A	100V
1N4007	1A	1000V
1N5401	3A	100V
1N5408	3A	1000V

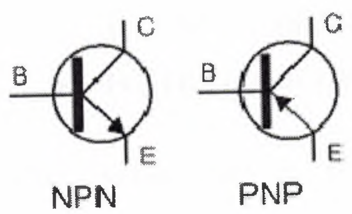
Table-2

5. Transistor

Transistors amplify current, for example they can be used to amplify the small output current from a logic IC so that it can operate a lamp, relay or other high current device. In many circuits a resistor is used to convert the changing current to a changing voltage, so the transistor is being used to amplify voltage. A transistor may be used a s a switch (either fully on with maximum current, or fully off with no current) and as an amplifier (always partly on). The amount of current amplification is called the current gain, symbol h_{FE}.

5.1 Types Of Transistor

There are two types of standard transistors, NPN and PNP, with different circuit symbols. The letters refer to the layers of semiconductor material used to make the transistor. Most transistors used today are NPN because this is the easiest type to make from silicon. If you are new to electronics it is best to start by learning how to use NPN transistors.



Transistor circuit symbol

The leads are labelled base (B), collector (C) and emitter (E). These terms refer to the internal operation of a transistor but they are not much help in understanding how a transistor is used, so just treat them as labels! A Darlington pair is two transistors connected together to give a very high current gain.

5.2 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.

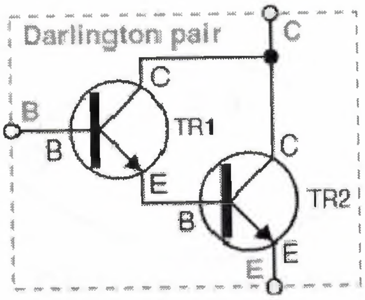


Figure-5.2

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 $h_{FE2} = 40$.

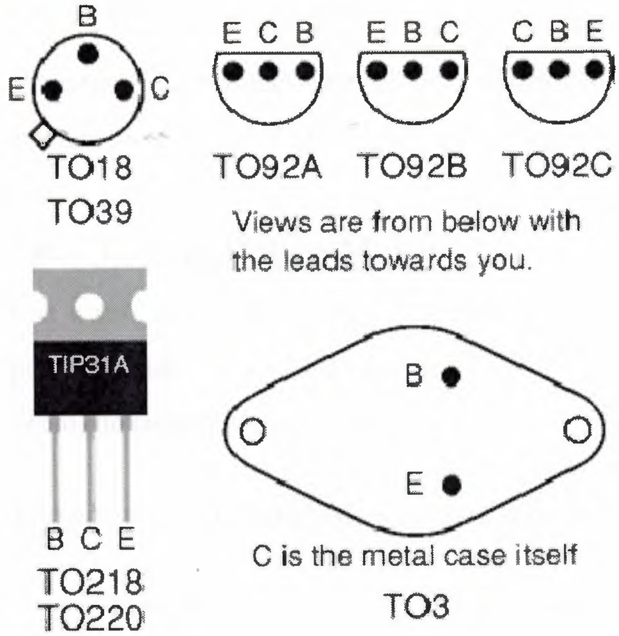
The overall gain of this pair is $h_{FE1} \times h_{FE2} = 220 \times 40 = 8800$. The pair's maximum collector current $I_C(max)$ is the same as TR2.

5.3 Connecting

Transistors have three leads which must be connected the correct way round. Please take care with this because a wrongly connected transistor may be damaged instantly when you switch on.

If you are lucky the orientation of the transistor will be clear from the PCB or stripboard layout diagram, otherwise you will need to refer to a supplier's catalogue to identify the leads.

The drawings on the right show the leads for some of the most common case styles.



Transistor leads for some common case styles.

Figure-5.3

Please note that transistor lead diagrams show the view from below with the leads towards you. This is the opposite of IC (chip) pin diagrams which show the view from above.

5.4 Soldering

Transistors can be damaged by heat when soldering so if you are not an expert it is wise to use a heat sink clipped to the lead between the joint and the transistor body. A standard crocodile clip can be used as a heat sink.

5.5 Heat sinks

Waste heat is produced in transistors due to the current flowing through them. Heat sinks are needed for power transistors because they pass large currents. If you find that a transistor is becoming too hot to touch it certainly needs a heat sink! The heat sink helps to dissipate (remove) the heat by transferring it to the surrounding air.

5.6 Testing a 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:

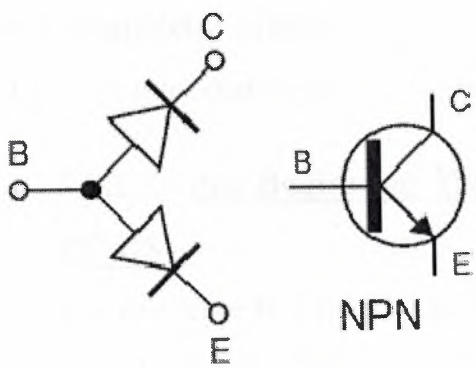
5.6.1 Testing With a Multimeter

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 multimeter 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.



Testing an NPN transistor

5.6.2 Testing in a Simple Switching Circuit

Connect the transistor into the circuit shown on the right which uses the transistor as a switch. The supply voltage is not critical, anything between 5 and 12V is suitable. This circuit can be quickly built on breadboard for example. Take care to include the 10kΩ resistor in the base connection or you will destroy the transistor as you test it!

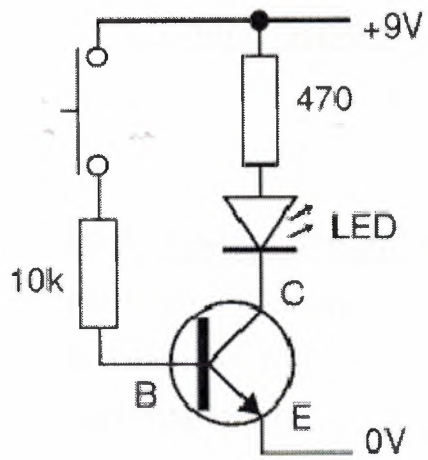


Figure-5.4

A simple switching circuit to test an NPN transistor If the transistor is OK the LED should light when the switch is pressed and not light when the switch is released. To test a PNP transistor use the same circuit but reverse the LED and the supply voltage. Some multimeters have a 'transistor test' function which provides a known base current and measures the collector current so as to display the transistor's DC current gain h_{FE}.

5.7 Transistor codes

There are three main series of transistor codes used in the UK:

5.7.1 Codes Beginning With B (or A), for Example BC108, BC478

The first letter B is for silicon, A is for germanium (rarely used now). The second letter indicates the type; for example C means low power audio frequency; D means high power audio frequency; F means low power high frequency. The rest of the code identifies the particular transistor. There is no obvious logic to the numbering system. Sometimes a letter is added to the end (eg BC108C) to identify a special version of the main type, for example a higher current gain or a different case style. If a project specifies a higher gain version (BC108C) it must be used, but if the general code is given (BC108) any transistor with that code is suitable.

5.7.2 Codes beginning With TIP, For Example TIP31A

TIP refers to the manufacturer: Texas Instruments Power transistor. The letter at the end identifies versions with different voltage ratings.

5.7.3 Codes Beginning With 2N, For Example 2N3053

The initial '2N' identifies the part as a transistor and the rest of the code identifies the particular transistor. There is no obvious logic to the numbering system.

5.8 Choosing a Transistor

Most projects will specify a particular transistor, but if necessary you can usually substitute an equivalent transistor from the wide range available. The most important properties to look for are the maximum collector current I_C and the current gain h_{FE}. To make selection easier most suppliers group their transistors in categories determined either by their typical use or maximum power rating.

NPN transistors								
Code	Structure	Case style	I_C max.	V_{CE} max.	h_{FE} min.	P_{tot} max.	Category (typical use)	Possible substitutes
BC107	NPN	TO18	100mA	45V	110	300mW	Audio, low power	BC182 BC547
BC108	NPN	TO18	100mA	20V	110	300mW	General purpose, low power	BC108C BC183 BC548
BC108C	NPN	TO18	100mA	20V	420	600mW	General	

							purpose, low power	
BC109	NPN	TO18	200mA	20V	200	300mW	Audio (low noise), low power	BC184 BC549
BC182	NPN	TO92C	100mA	50V	100	350mW	General purpose, low power	BC107 BC182L
BC182L	NPN	TO92A	100mA	50V	100	350mW	General purpose, low power	BC107 BC182
BC547B	NPN	TO92C	100mA	45V	200	500mW	Audio, low power	BC107B
BC548B	NPN	TO92C	100mA	30V	220	500mW	General purpose, low power	BC108B
BC549B	NPN	TO92C	100mA	30V	240	625mW	Audio (low noise), low power	BC109
2N3053	NPN	TO39	700mA	40V	50	500mW	General purpose, low power	BFY51

BFY51	NPN	TO39	1A	30V	40	800mW	General purpose, medium power	BC639
BC639	NPN	TO92A	1A	80V	40	800mW	General purpose, medium power	BFY51
TIP29A	NPN	TO220	1A	60V	40	30W	General purpose, high power	
TIP31A	NPN	TO220	3A	60V	10	40W	General purpose, high power	TIP31C TIP41A
TIP31C	NPN	TO220	3A	100V	10	40W	General purpose, high power	TIP31A TIP41A
TIP41A	NPN	TO220	6A	60V	15	65W	General purpose, high power	
2N3055	NPN	TO3	15A	60V	20	117W	General purpose,	
PNP transistors								
Code	Structure	Case style	I_C max.	V_{CE} max.	h_{FE} min.	P_{tot} max.	Category (typical use)	Possible substitutes
BC177	PNP	TO18	100mA	45V	125	300mW	Audio,	BC477

							low power	
BC178	PNP	TO18	200mA	25V	120	600mW	General purpose, low power	BC478
BC179	PNP	TO18	200mA	20V	180	600mW	Audio (low noise), low power	
BC477	PNP	TO18	150mA	80V	125	360mW	Audio, low power	BC177
BC478	PNP	TO18	150mA	40V	125	360mW	General purpose, low power	BC178
TIP32A	PNP	TO220	3A	60V	25	40W	General purpose, high power	TIP32C
TIP32C	PNP	TO220	3A	100V	10	40W	General purpose,	TIP32A

Table-3

6. LM311 - Voltage Comparator

6.1 General Description

The LM111, LM211 and LM311 are voltage comparators that have input currents nearly a thousand times lower than devices like the LM106 or LM710. They are also designed to operate over a wider range of supply voltages: from standard ±15V op amp supplies down to the single 5V supply used for IC logic. Their output is compatible with RTL, DTL and TTL as well as MOS circuits. Further, they can drive lamps or relays, switching voltages up to 50V at currents as high as 50 mA.

Both the inputs and the outputs of the LM111, LM211 or the LM311 can be isolated from system ground, and the output can drive loads referred to ground, the positive supply or the negative supply. Offset balancing and strobe capability are provided and outputs can be wire OR'ed. Although slower than the LM106 and LM710 (200 ns response time vs 40 ns) the devices are also much less prone to spurious oscillations. The LM111 has the same pin configuration as the LM106 and LM710.

The LM211 is identical to the LM111, except that its performance is specified over a -25°C to +85°C temperature range instead of -55°C to +125°C. The LM311 has a temperature range of 0°C to +70°C.

6.2 Features

- Operates from single 5V supply
- Input current: 150 nA max. over temperature
- Offset current: 20 nA max. over temperature
- Differential input voltage range: ±30V
- Power consumption: 135 mW at ±15V

6.3 Connection Diagram

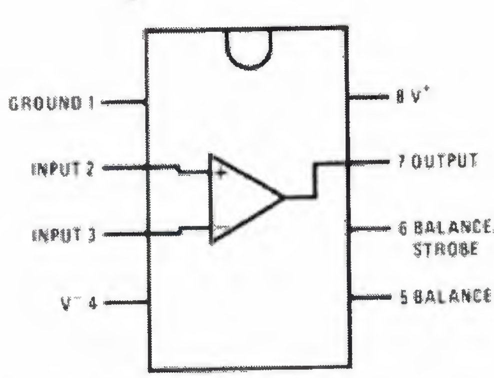


Figure-6.3 Typical Application

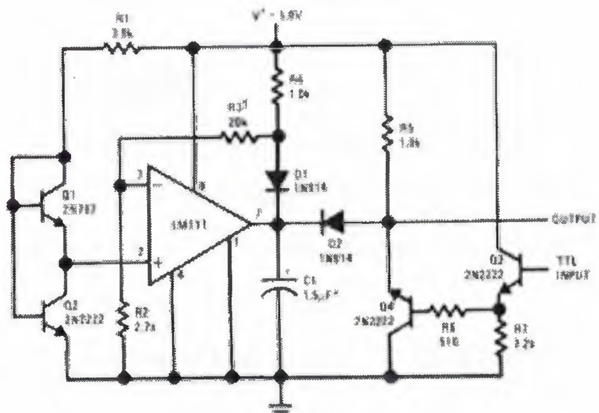
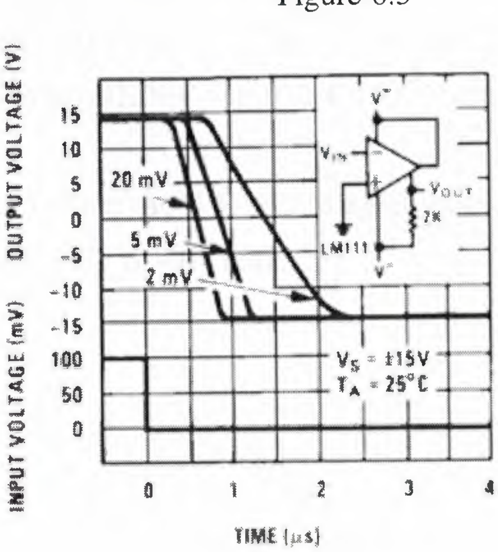


Figure-6.4

Figure-6.5



7. CD4027BC Flip-Flop with Set and Reset

The CD4027BC dual J-K flip-flops are monolithic complementary MOS (CMOS) integrated circuits constructed with N- and P-channel enhancement mode transistors. Each flip-flop has independent J, K, set, reset, and clock inputs and buffered Q and Q outputs. These flip-flops are edge sensitive to the clock input and change state on the positive- going transition of the clock pulses. Set or reset is independent of the clock and is accomplished by a high level on the respective input. All inputs are protected against damage due to static discharge by diode clamps to VDD and VSS.

7.1 Features

_ Wide supply voltage range: 3.0V to 15V

_ High noise immunity: 0.45 VDD (typ.)

_ Low power TTL compatibility: Fan out of 2 driving 74L or 1 driving 74LS

_ Low power: 50 nW (typ.)

_ Medium speed operation: 12 MHz (typ.) with 10V Supply

7.2 Ordering Code

Order Number Package Number Package Description

*CD4027BCM M16A 16-Lead Small Outline Integrated Circuit (SOIC),JEDEC MS-012, 0.150" Narrow

* CD4027BCN N16E 16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide

7.3 Connection Diagram

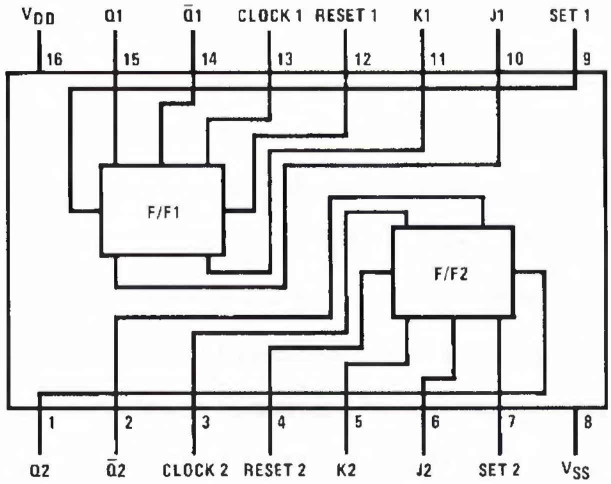


Figure-7.3

8.Motion Sensors

TYPICAL MOTION SENSOR

Motion sensors are used to detect movement in order toswitch equipment on and off, usually outdoor or indoorlighting. They generally employ an infra-red detector and often include a photoelectric cell which prevents operation during daylight hours. Most units also incorporate an adjustable timer to switch off equipment after a pre-set time has elapsed. Figure 1 depicts a typical motion sensor.

Motions sensors are often packaged with lamp fittings and sold as 'sensor lights'. These are usually a single unit complete with sensor, lamp(s) and lamp holder(s). Typically sensor lights are placed in outdoor areas where illumination is required for short periods - for example in driveways or pathways. They provide night access lighting and also serve as a deterrent for intruders. For both motion sensors and sensor lights, it is the detector unit which continually consumes standby power in order to sense motion. When the sensor detects infra-red radiation, it produces an electric signal. A rapid change iradiation levels (generated by movement) energises the relay switch within the unit. If the unit incorporates a light level sensor, the relay can only be energised at night. If the unit incorporates a timer, then the relay will de-energise after a pre-set period of time.

Motion sensors typically used to switch 240V loads. It does not cover sensors used in alarm system applications, which do not switch loads and typically require 12 volts DC power. These are dealt with in a separate standby profile for security systems.

CONCLUSION

The current research included the study of intelligent home networks.It presented basic user requirements as well as what has been done so far in the still infant field of intelligent home networks. It also came up with existing difficulties and challenges in the way towards smart homes as well as with few suggestions and ideas.

In particular, the aim of the research is to find out what do users anticipate from intelligent home networks and to suggest what researchers should take into account while modeling infrastructure for such environments. According to the research, users demand features like compatibility of home devices, easy-to-use user interfaces and customizable products and services. They are absolutely concerned about security, safety and privacy. Users also envision a smooth integration of intelligent homes into their life. Referring to three different projects, the research shows that intelligent networks are evolving stepwise and gain inhabitants trust incrementally.

In an experimental Project of couple leaving for a period of time in an home, it was inferred that the subjects welcomed the smartness of the new networked environment.However, there are still some challenges that have to be overcome in order to make intelligent environments widely available. Lack of administration makes smart home appliances as well as the whole network difficult to be managed by the inhabitants. Another rising issue is the social implication of such environments. Are users ready to accept something like that? How it will affect their everyday life? Despite however, all the seemingly insuperable obstacles, the work towards intelligent home networks moves quite fast. Lots of households nowadays, interconnect their appliances creating small networks. These networks vary from simple ones with just few computers to more complicated where the networks include almost every electronic device of the house.

The impacts of living in such environment are not yet well known. However, if the smart networks are built in smart way, they could provide countless solutions simplifying users' life.

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