

A Project Report
On
PRE-PAID ENERGY METER USING IR SENSOR

Submitted for partial fulfillment of award of
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By
VIKRANT BHATI

Mrs. Veena Verma
(Project Guide)



**Department Of Electronics & Communication
Engineering KIET GROUP OF INSTITUTIONS,
GHAZIABAD, UP, INDIA
(APRIL, 2017)**

Certificate

Certified that **VIKRANT BHATI** have carried out the project work presented in this project report entitled “**PREPAID ENERGY METER**” for the award of **Bachelor of Technology in Electronics & Communication Engineering** from **KIET GROUP OF INSTITUTIONS, GHAZIBAD, UP (Dr. A. P. J. Abdul Kalam Technical University, Lucknow)** under my supervision. The project report embodies result of original work and studies carried out by Student himself and the contents of the report do not form the basis for the award of any other degree to the candidate or to anybody else.

Mrs. Veena Verma
Asst. Professor(ECE)

Dr. Sanjay Sharma
HoD (ECE)

Date:7th April 2017

ABSTRACT

In this project, the idea of a Prepaid energy meter using a IR SENSOR and an ATMEGA16 microcontroller has been introduced. This concept provides a cost efficient manner of electricity billing system. The present energy billing systems are discrete, inaccurate, costly and slow. They are also time and labor consuming. The major drawback of traditional billing system is power and energy theft. This drawback is reduced by using a prepaid energy meter which is based on the concept “Pay first and then use it”. Prepaid energy meter also reduces the error made by humans while taking readings to a large extent and there’s is no need to take reading in it.

The recharge is done by providing the input using an IR SENSOR and the meter is charged with the amount. According to the time of power consumption, the amount of readings will be reduced. A in built counter, counts the amount of energy consumed and displays the remaining amount of readings on the LCD. A relay system has been used which shut down or disconnect the energy meter and load through supply mains when the recharge amount is depleted. A buzzer is used as an alarm which starts before the recharge amount reaches a minimum value.

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CHAPTER-1

1.1 INTRODUCTION:

The Electrical metering instrument technology has come a long way from what it was more than 100 years ago. From the original bulky meters with heavy magnets and coils, there have been many innovations that have resulted in size & weight reduction in addition to improvement in features and specifications. Resolution and accuracy of the meter have seen substantial improvements over the years. Introduction of the digital meter in the later part of last century has completely changed the way Electrical parameters are measured. Starting with Voltmeters & Ammeters, the digital meter has conquered the entire spectrum of measuring instruments due to their advantages like ease of reading, better resolution and rugged construction. Of particular significance is the introduction of the Electronic Energy Meter in the mid eighties. Now a days, the energy consumption and energy distribution has become a big subject for discussion because of huge difference in energy production and consumption. In this regard, energy consumers are facing so many problems due to the frequent power failures; another important reason for power cuts is due to the un-limited energy consumption of rich people. In this aspect, to minimize the power cuts and to distribute the energy equally to all areas, some restriction should have over the power consumption of each and every energy consumer, and according to that the Government should implement a policy, by introducing Autonomous Energy Meters everywhere in domestic sector. Hence, the need has come to think on this line and a solution has to be emerged out.

Today the metering instrument technology grown up significantly, such that the Consumed energy can be calculated mathematically, displayed, data can be stored, data can be transmitted, etc. Presently the microcontrollers are playing major role in metering instrument technology. The present project work is designed to collect the consumed energy data of a particular energy consumer through wireless communication system (without going to consumer house), the system can be called as automatic meter reading (AMR) system. The Automatic Meter reading system is intended to remotely collect the meter readings of a locality using a communication system, without persons physically going and reading the meters visually.

The following are the advantages of electronic energy meter:

1. Accuracy

While electromechanical meters are normally available with Class 2 accuracy, Electronic meters of Class 1 accuracy are very common.

2. Low Current Performance

Most of the electromechanical meters tend to run slow after a few years and stop recording at low loads typically below 40% of their basic current. This is due to increased friction at their bearings. This results in large losses in revenue since most of the residential consumers will be running at very low loads for almost 20 hours in a day. Electronic meters record consistently and accurately even at 5% of their basic current. Also they are guaranteed to start recording energy at 0.4% of their basic current.

3. Low Voltage Performance

Most of the mechanical meters become inaccurate at voltages below 75% of rated voltage whereas electronic meters record accurately even at 50% of rated voltage. This is a major advantage where low voltage problem is very common.

4. Installation

The mechanical meter is very sensitive to the position in which it is installed. If it is not mounted vertically, it will run slow, resulting in revenue loss. Electronic meters are not sensitive

5. Tamper

The mechanical meters can be tampered very easily even without disturbing the Wiring either by using an external magnet or by inserting a thin film into the meter to touch the rotating disc. In addition to these methods, in the case of a single-phase meter, there are more than 20 conditions of external wiring that can make the meter record less. In the case of 3 Phase meter, external wiring can be manipulated in 4 ways to make it slow. Hence, any of these methods cannot tamper electronic meters. Moreover they can detect the tampering of meter by using LED.

New Features

Electronic meters provide many new features like prepaid metering and remote Metering that can improve the efficiency of the utility.

PREPAYMENT METERING

Yet another advantage of the electronic meter is the possibility of introducing Prepaid metering system. Prepaid metering system is the one in which the consumer pays money in advance to the utility and then feeds this information into his meter. The meter then updates the credit available to the consumer and starts deducting his consumption from available credit. Once the credit reaches a

minimum specified value, meter raises an alarm. If the credit is completely exhausted, the meter switches off the loads of the consumer.

Main advantage of this system is that the utility can eliminate meter readers. Another benefit is that they get paid in advance. The consumer benefits due to elimination of penalty for late payment. Also it enables him to plan his electricity bill expenses in a better manner. Due to the intelligence built in into the electronic meters, introduction of prepaid metering becomes much easier than in the case of electromechanical meters.

Prepaid Energy Metering

Energy meters, the only direct revenue interface between utilities and the consumers, have undergone several advancements in the last decade. The conventional electro-mechanical meters are being replaced with electronic meters to improve accuracy in meter reading. Asian countries are currently looking to introduce prepaid electricity meters across their distribution network, buoyed up by the success of this novel methodology in South Africa. The existing inherent problems with the post-paid system and privatization of state held power distribution companies are the major driving factors for this market in Asia.

Over 40 countries have implemented prepaid meters in their markets In United Kingdom the system, has been in use for well over 70 years with about 3.5 million consumers. The prepaid program in South Africa was started in 1992 since then they have installed over 6 million meters. Other African counties such as Sudan, Madagascar are following the South African success. The concept has found ground in Argentina and New Zealand with few thousands of installations. The prepaid meters in the market today are coming up with smart cards to hold information on units consumed or equivalent money value. When the card is inserted, the energy meter reads it, connects the supply to the consumer loads, and debits the value. The meters are equipped with light emitting diodes (LED) to inform consumers when 75 percent of the credit energy has been consumed. The consumer then recharges the prepaid card from a sales terminal or distribution point, and during this process any changes in the tariff can also be loaded in the smart card.

CHAPTER 2

HARDWARE DESCRIPTION

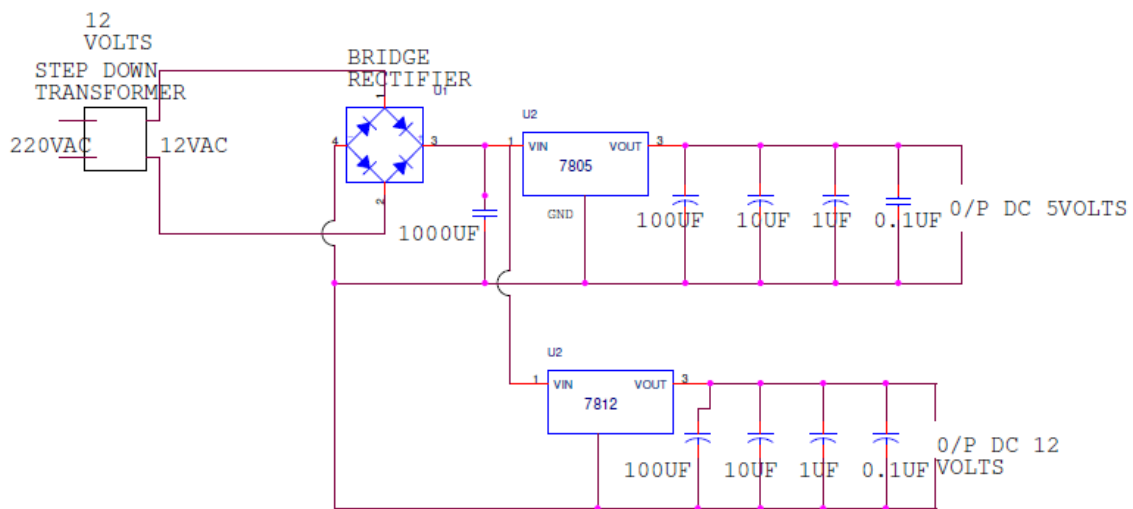
COMPONENTS USED IN OUR PROJECT ARE AS FOLLOWS:

2.1 Power Supply:

Power supply is a reference to a source of electrical power. A device or system that supplies electrical or other types of energy to an output load or group of loads is called a power supply unit or PSU. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others

This power supply section is required to convert AC signal to DC signal and also to reduce the amplitude of the signal. The available voltage signal from the mains is 230V/50Hz which is an AC voltage, but the required is DC voltage (no frequency) with the amplitude of +5V and +12V for various applications.

In this section we have Transformer, Bridge rectifier, are connected serially and voltage regulators for +5V and +12V (7805 and 7812) via a capacitor (1000 μ F) in parallel are connected parallel as shown in the circuit diagram below. Each voltage regulator output is again is connected to the capacitors of values (100 μ F, 10 μ F, 1 μ F, 0.1 μ F) are connected parallel through which the corresponding output (+5V or +12V) are taken into consideration.



Circuit Explanation

2.1.1 Transformer

A transformer is a device that transfers electrical energy from one circuit to another through inductively coupled electrical conductors. A changing current in the first circuit (the primary) creates a changing magnetic field; in turn, this magnetic field induces a changing voltage in the second circuit (the secondary). By adding a load to the secondary circuit, one can make current flow in the transformer, thus transferring energy from one circuit to the other.

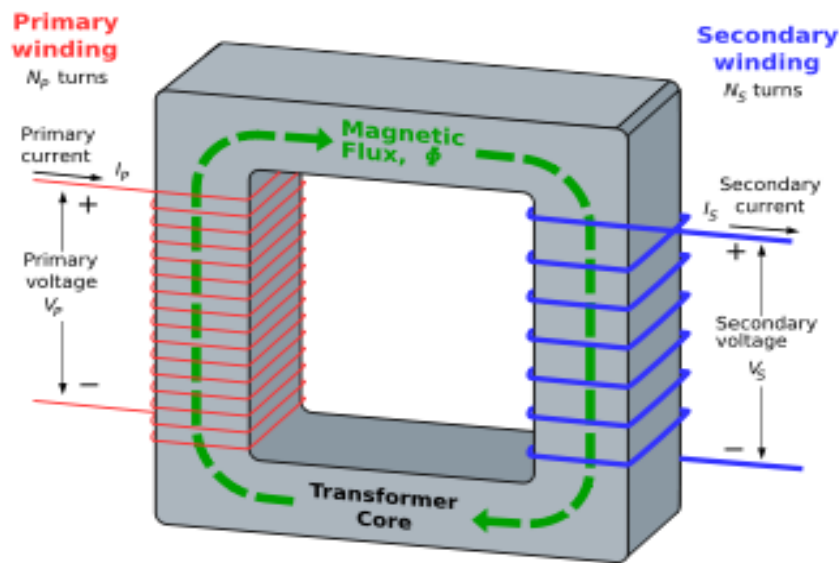
The secondary induced voltage V_S , of an ideal transformer, is scaled from the primary V_P by a factor equal to the ratio of the number of turns of wire in their respective windings:

$$\frac{V_S}{V_P} = \frac{N_S}{N_P}$$

Basic principle

The transformer is based on two principles: firstly, that an electric current can produce a magnetic field (electromagnetism) and secondly that a changing magnetic field within a coil of wire induces a voltage across the ends of the coil (electromagnetic induction). By changing the current in the primary coil, it changes the strength of its magnetic field; since the changing magnetic field extends into the secondary coil, a voltage is induced across the secondary. A simplified transformer design is shown below. A current passing through the primary coil creates a magnetic field. The primary and secondary coils are wrapped around a core of very high magnetic permeability, such as iron; this

ensures that most of the magnetic field lines produced by the primary current are within the iron and pass through the secondary coil as well as the primary coil.



An ideal step-down transformer showing magnetic flux in the core

Induction law

The voltage induced across the secondary coil may be calculated from Faraday's law of induction, which states that:

$$V_S = N_S \frac{d\Phi}{dt}$$

Where V_S is the instantaneous voltage, N_S is the number of turns in the secondary coil and Φ equals the magnetic flux through one turn of the coil. If the turns of the coil are oriented perpendicular to the magnetic field lines, the flux is the product of the magnetic field strength B and the area A through which it cuts. The area is constant, being equal to the cross-sectional area of the transformer core, whereas the magnetic field varies with time according to the excitation of the primary. Since the same magnetic flux passes through both the primary and secondary coils in an ideal transformer, the instantaneous voltage across the primary winding equals

$$V_P = N_P \frac{d\Phi}{dt}$$

Taking the ratio of the two equations for V_S and V_P gives the basic equation for stepping up or stepping down the voltage

$$\frac{V_S}{V_P} = \frac{N_S}{N_P}$$

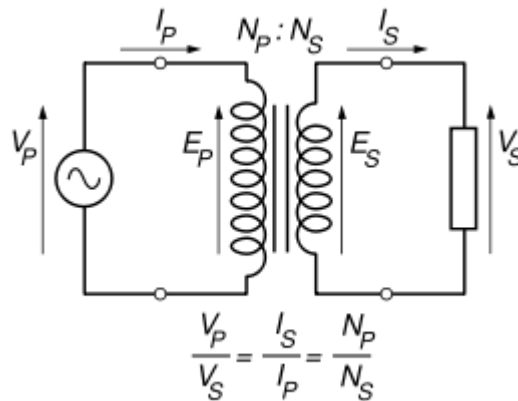
Ideal power equation

If the secondary coil is attached to a load that allows current to flow, electrical power is transmitted from the primary circuit to the secondary circuit. Ideally, the transformer is perfectly efficient; all the incoming energy is transformed from the primary circuit to the magnetic field and into the secondary circuit. If this condition is met, the incoming electric power must equal the outgoing power.

$$P_{\text{incoming}} = I_P V_P = P_{\text{outgoing}} = I_S V_S$$

Giving the ideal transformer equation

$$\frac{V_S}{V_P} = \frac{N_S}{N_P} = \frac{I_P}{I_S}$$



$$P_{\text{in-coming}} = I_P V_P = P_{\text{out-going}} = I_S V_S$$

Giving the ideal transformer equation

$$\frac{V_S}{V_P} = \frac{N_S}{N_P} = \frac{I_P}{I_S}$$

If the voltage is increased (stepped up) ($V_S > V_P$), then the current is decreased (stepped down) ($I_S < I_P$) by the same factor. Transformers are efficient so this formula is a reasonable approximation.

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The impedance in one circuit is transformed by the *square* of the turns ratio. For example, if an impedance Z_S is attached across the terminals of the secondary coil, it appears to the primary circuit to have an impedance of

$$Z_S \left(\frac{N_P}{N_S} \right)^2$$

This relationship is reciprocal, so that the impedance Z_P of the primary circuit appears to the secondary to be

$$Z_P \left(\frac{N_S}{N_P} \right)^2$$

Detailed operation:

The simplified description above neglects several practical factors, in particular the primary current required to establish a magnetic field in the core, and the contribution to the field due to current in the secondary circuit.

Models of an ideal transformer typically assume a core of negligible reluctance with two windings of zero resistance. When a voltage is applied to the primary winding, a small current flows, driving flux around the magnetic circuit of the core. The current required to create the flux is termed the magnetizing current; since the ideal core has been assumed to have near-zero reluctance, the magnetizing current is negligible, although still required to create the magnetic field.

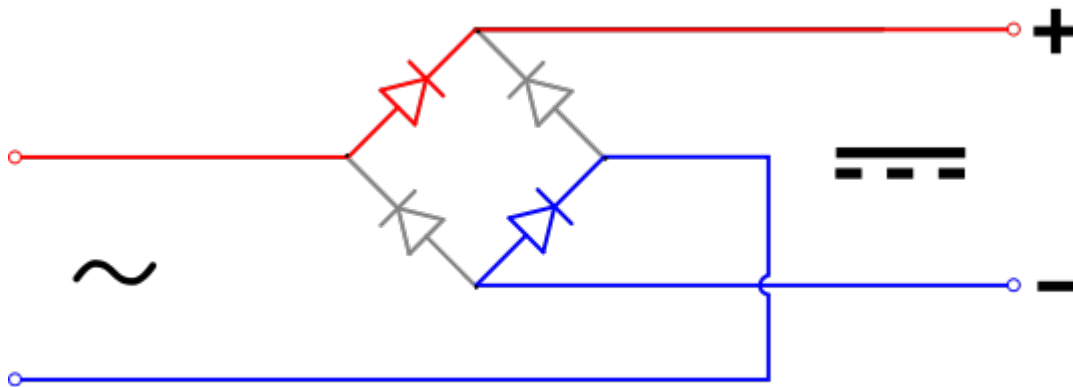
The changing magnetic field induces an electromotive force (EMF) across each winding. Since the ideal windings have no impedance, they have no associated voltage drop, and so the voltages V_P and V_S measured at the terminals of the transformer, are equal to the corresponding EMFs. The primary EMF, acting as it does in opposition to the primary voltage, is sometimes termed the "back EMF". This is due to Lenz's law which states that the induction of EMF would always be such that it will oppose development of any such change in magnetic field.

2.1.2 Bridge Rectifier

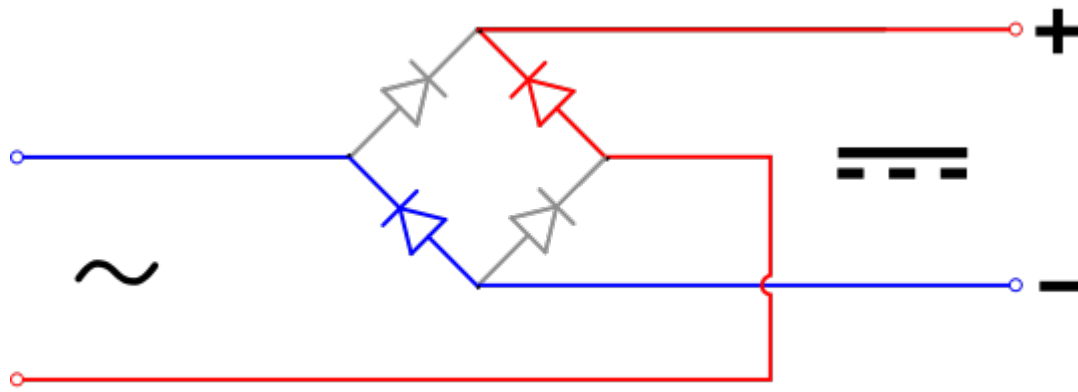
A diode bridge or bridge rectifier is an arrangement of four diodes in a bridge configuration that provides the same polarity of output voltage for any polarity of input voltage. When used in its most common application, for conversion of alternating current (AC) input into direct current (DC) output, it is known as a bridge rectifier. A bridge rectifier provides full-wave rectification from a two-wire AC input, resulting in lower cost and weight as compared to a center-tapped transformer design, but has two diode drops rather than one, thus exhibiting reduced efficiency over a center-tapped design for the same output voltage.

Basic Operation

When the input connected at the left corner of the diamond is positive with respect to the one connected at the right hand corner, current flows to the right along the upper colored path to the output, and returns to the input supply via the lower one.

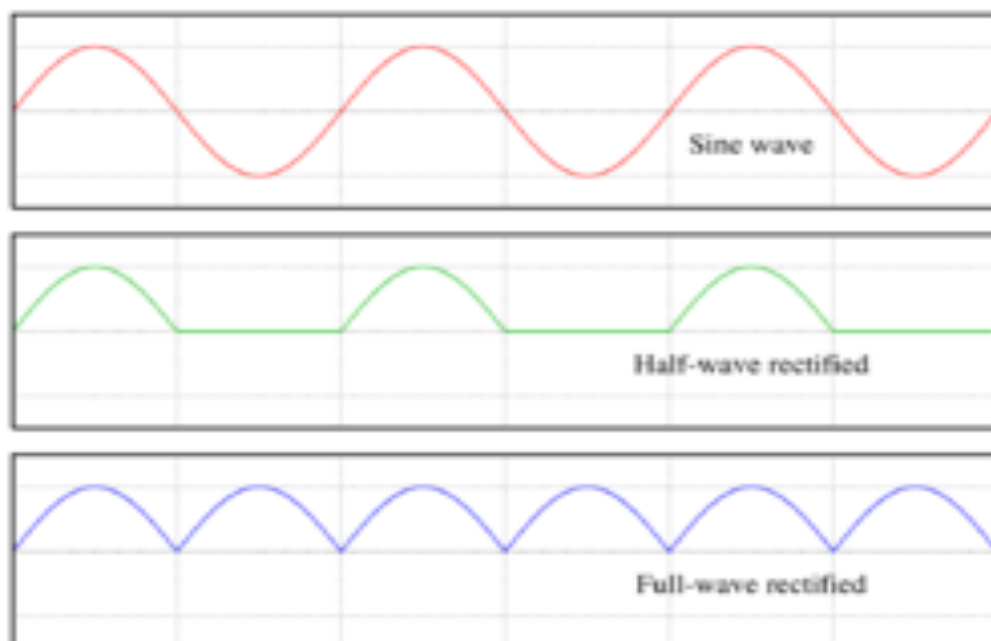


When the right hand corner is positive relative to the left hand corner, current flows along the upper colored path and returns to the supply via the lower colored path.



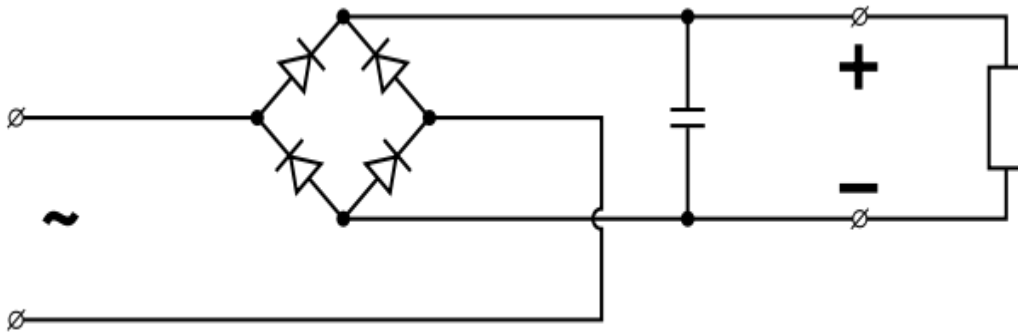
In each case, the upper right output remains positive with respect to the lower right one. Since this is true whether the input is AC or DC, this circuit not only produces DC power when supplied with AC power: it also can provide what is sometimes called "reverse polarity protection". That is, it permits normal functioning when batteries are installed backwards or DC input-power supply wiring "has its wires crossed" (and protects the circuitry it powers against damage that might occur without this circuit in place).

Prior to availability of integrated electronics, such a bridge rectifier was always constructed from discrete components. Since about 1950, a single four-terminal component containing the four diodes connected in the bridge configuration became a standard commercial component and is now available with various voltage and current ratings.



Output smoothing (Using Capacitor):

For many applications, especially with single phase AC where the full-wave bridge serves to convert an AC input into a DC output, the addition of a capacitor may be important because the bridge alone supplies an output voltage of fixed polarity but pulsating magnitude (see diagram above).



The function of this capacitor, known as a reservoir capacitor (aka smoothing capacitor) is to lessen the variation in (or 'smooth') the rectified AC output voltage waveform from the bridge. One explanation of 'smoothing' is that the capacitor provides a low impedance path to the AC component of the output, reducing the AC voltage across, and AC current through, the resistive load. In less technical terms, any drop in the output voltage and current of the bridge tends to be cancelled by loss of charge in the capacitor.

This charge flows out as additional current through the load. Thus the change of load current and voltage is reduced relative to what would occur without the capacitor. Increases of voltage correspondingly store excess charge in the capacitor, thus moderating the change in output voltage / current. Also see rectifier output smoothing.

The simplified circuit shown has a well deserved reputation for being dangerous, because, in some applications, the capacitor can retain a *lethal* charge after the AC power source is removed. If supplying a dangerous voltage, a practical circuit should include a reliable way to safely discharge the capacitor. If the normal load can not be guaranteed to perform this function, perhaps because it can be disconnected, the circuit should include a bleeder resistor connected as close as practical across the capacitor. This resistor should consume a current large enough to discharge the capacitor in a reasonable time, but small enough to avoid unnecessary power waste.

Because a bleeder sets a minimum current drain, the regulation of the circuit, defined as percentage voltage change from minimum to maximum load, is improved. However in many cases the improvement is of insignificant magnitude.

The capacitor and the load resistance have a typical time constant $\tau = RC$ where C and R are the capacitance and load resistance respectively. As long as the load resistor is large enough so that this time constant is much longer than the time of one ripple cycle, the above configuration will produce a smoothed DC voltage across the load.

In some designs, a series resistor at the load side of the capacitor is added. The smoothing can then be improved by adding additional stages of capacitor-resistor pairs, often done only for sub-supplies to critical high-gain circuits that tend to be sensitive to supply voltage noise.

The idealized waveforms shown above are seen for both voltage and current when the load on the bridge is resistive. When the load includes a smoothing capacitor, both the voltage and the current waveforms will be greatly changed. While the voltage is smoothed, as described above, current will flow through the bridge only during the time when the input voltage is greater than the capacitor voltage. For example, if the load draws an average current of n Amps, and the diodes conduct for 10% of the time, the average diode current during conduction must be $10n$ Amps. This non-sinusoidal current leads to harmonic distortion and a poor power factor in the AC supply.

In a practical circuit, when a capacitor is directly connected to the output of a bridge, the bridge diodes must be sized to withstand the current surge that occurs when the power is turned on at the peak of the AC voltage and the capacitor is fully discharged. Sometimes a small series resistor is included before the capacitor to limit this current, though in most applications the power supply transformer's resistance is already sufficient.

Output can also be smoothed using a choke and second capacitor. The choke tends to keep the current (rather than the voltage) more constant. Due to the relatively high cost of an effective choke compared to a resistor and capacitor this is not employed in modern equipment.

Some early console radios created the speaker's constant field with the current from the high voltage ("B +") power supply, which was then routed to the consuming circuits, (permanent magnets were considered too weak for good performance) to create the speaker's constant magnetic field. The speaker field coil thus performed 2 jobs in one: it acted as a choke, filtering the power supply, and it produced the magnetic field to operate the speaker.

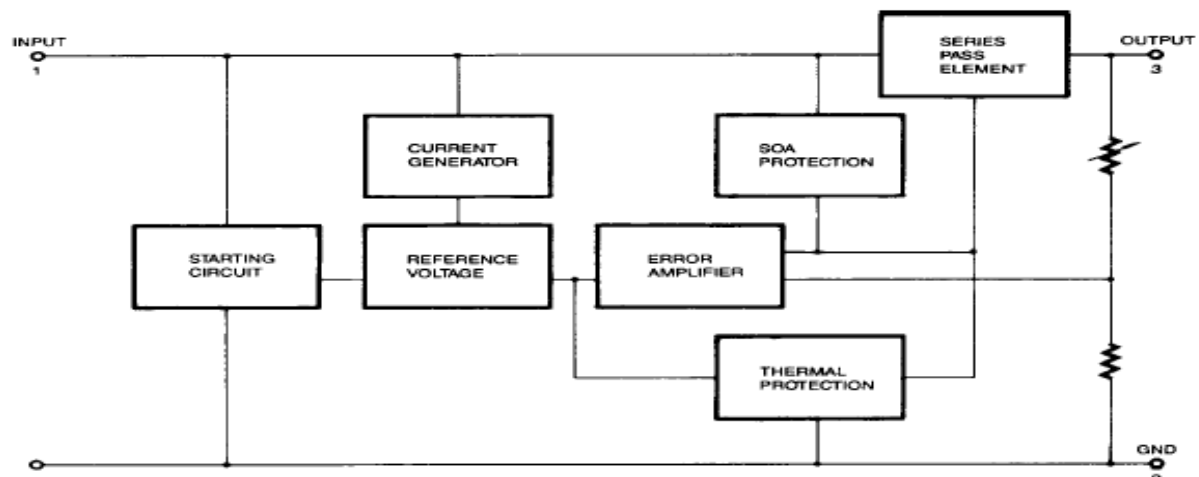
2.1.3 Voltage Regulator

A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level.

The 78xx (also sometimes known as LM78xx) series of devices is a family of self-contained fixed linear voltage regulator integrated circuits. The 78xx family is a very popular choice for many electronic circuits which require a regulated power supply, due to their ease of use and relative cheapness. When specifying individual ICs within this family, the xx is replaced with a two-digit number, which indicates the output voltage the particular device is designed to provide (for example, the 7805 has a 5 volt output, while the 7812 produces 12 volts). The 78xx line is positive voltage regulators, meaning that they are designed to produce a voltage that is positive relative to a common ground. There is a related line of 79xx devices which are complementary negative voltage regulators. 78xx and 79xx ICs can be used in combination to provide both positive and negative supply voltages in the same circuit, if necessary.

78xx ICs have three terminals and are most commonly found in the TO220 form factor, although smaller surface-mount and larger TrO3 packages are also available from some manufacturers. These devices typically support an input voltage which can be anywhere from a couple of volts over the intended output voltage, up to a maximum of 35 or 40 volts, and can typically provide up to around 1 or 1.5 amps of current (though smaller or larger packages may have a lower or higher current rating).

Internal Block Diagram



2.2 IR SENSOR:

Introduction

Infrared technology addresses a wide variety of wireless applications. The main areas are sensing and remote controls. In the electromagnetic spectrum, the infrared portion is divided into three regions: near infrared region, mid infrared region and far infrared region.

The wavelengths of these regions and their applications are shown below.

- Near infrared region — 700 nm to 1400 nm — IR sensors, fiber optic
- Mid infrared region — 1400 nm to 3000 nm — Heat sensing
- Far infrared region — 3000 nm to 1 mm — Thermal imaging

The frequency range of infrared is higher than microwave and lesser than visible light.

For optical sensing and optical communication, photo optics technologies are used in the near infrared region as the light is less complex than RF when implemented as a source of signal. Optical wireless communication is done with IR data transmission for short range applications.

An infrared sensor emits and/or detects infrared radiation to sense its surroundings.

The working of any Infrared sensor is governed by three laws: Planck's Radiation law, Stephen – Boltzmann law and Wien's Displacement law.

Planck's law states that "every object emits radiation at a temperature not equal to 0⁰K". Stephen – Boltzmann law states that "at all wavelengths, the total energy emitted by a black body is proportional to the fourth power of the absolute temperature". According to Wien's Displacement law, "the radiation curve of a black body for different temperatures will reach its peak at a wavelength inversely proportional to the temperature".

The basic concept of an Infrared Sensor which is used as Obstacle detector is to transmit an infrared signal, this infrared signal bounces from the surface of an object and the signal is received at the infrared receiver.

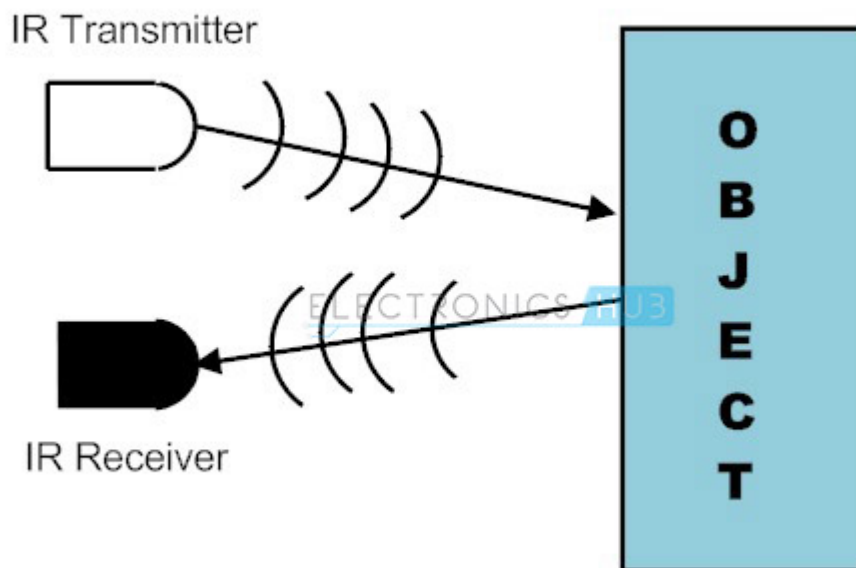
There are five basic elements used in a typical infrared detection system: an infrared source, a transmission medium, optical component, infrared detectors or receivers and signal processing. Infrared lasers and Infrared LED's of specific wavelength can be used as infrared sources. The three main types of media used for infrared transmission are vacuum, atmosphere and optical fibers. Optical components are used to focus the infrared radiation or to limit the spectral response. Optical lenses made of Quartz, Germanium and Silicon are used to focus the infrared radiation. Infrared receivers can be photodiodes, phototransistors etc. some important specifications of infrared receivers are photosensitivity, detectivity and noise equivalent power. Signal processing is done by amplifiers as the output of infrared detector is very small.

2.2.1 Types of IR Sensors

Infrared sensors can be passive or active. Passive infrared sensors are basically Infrared detectors. Passive infrared sensors do not use any infrared source and detects energy emitted by obstacles in the field of view. They are of two types: quantum and thermal. Thermal infrared sensors use infrared energy as the source of heat and are independent of wavelength. Thermocouples, pyroelectric detectors and bolometers are the common types of thermal infrared detectors.

Quantum type infrared detectors offer higher detection performance and are faster than thermal type infrared detectors. The photosensitivity of quantum type detectors is wavelength dependent. Quantum type detectors are further classified into two types: intrinsic and extrinsic types. Intrinsic type quantum detectors are photoconductive cells and photovoltaic cells.

Active infrared sensors consist of two elements: infrared source and infrared detector. Infrared sources include an LED or infrared laser diode. Infrared detectors include photodiodes or phototransistors. The energy emitted by the infrared source is reflected by an object and falls on the infrared detector.



IR Transmitter

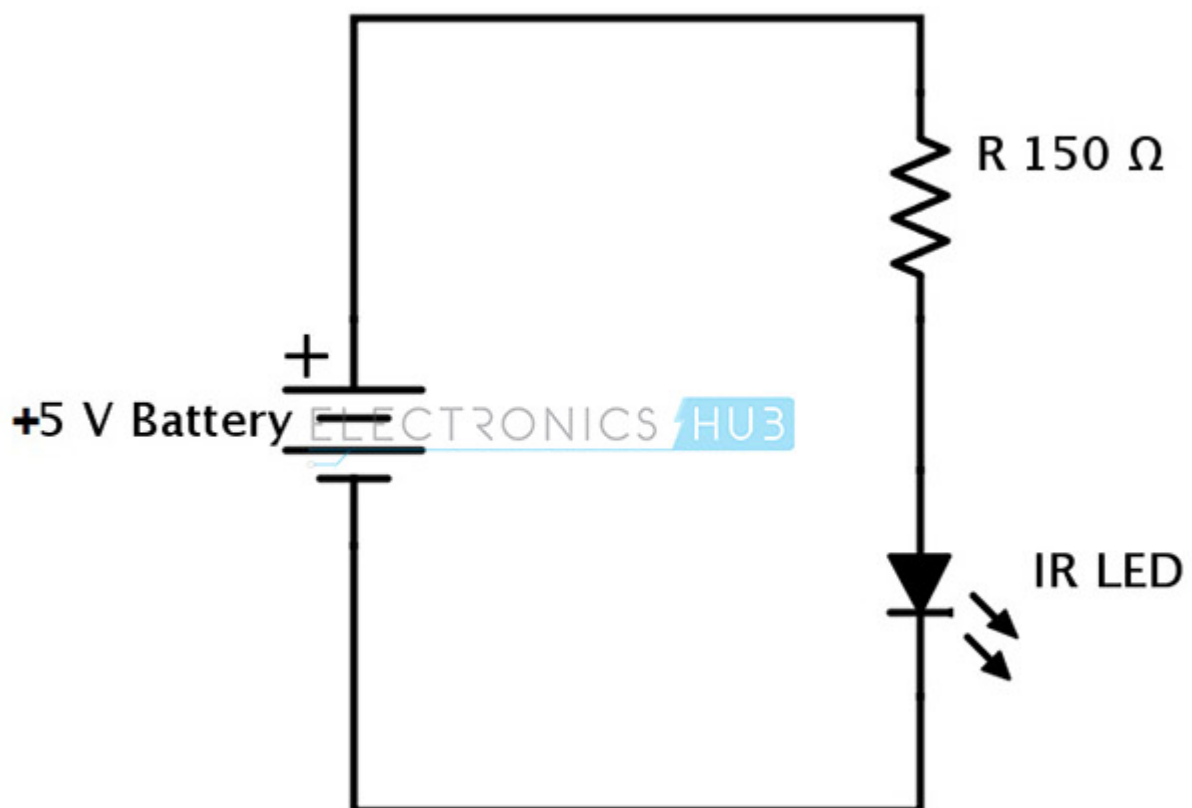
Infrared Transmitter is a light emitting diode (LED) which emits infrared radiations. Hence, they are called IR LED's. Even though an IR LED looks like a normal LED, the radiation emitted by it is invisible to the human eye.

The picture of a typical Infrared LED is shown below.



There are different types of infrared transmitters depending on their wavelengths, output power and response time.

A simple infrared transmitter can be constructed using an infrared LED, a current limiting resistor and a power supply. The schematic of a typical IR transmitter is shown below.



When operated at a supply of 5V, the IR transmitter consumes about 3 to 5 mA of current. Infrared transmitters can be modulated to produce a particular frequency of infrared light. The most commonly used modulation is OOK (ON – OFF – KEYING) modulation.

IR transmitters can be found in several applications. Some applications require infrared heat and the best infrared source is infrared transmitter. When infrared emitters are used with Quartz, solar cells can be made.

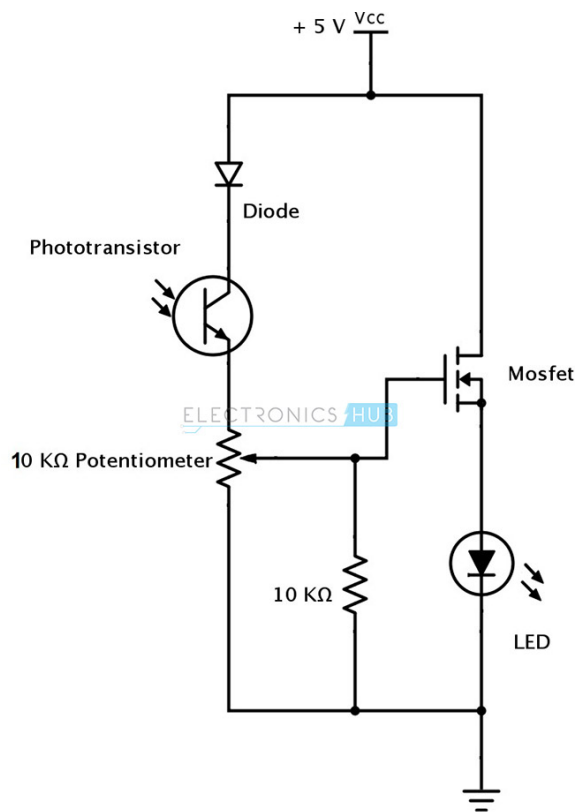
IR Receiver

Infrared receivers are also called as infrared sensors as they detect the radiation from an IR transmitter. IR receivers come in the form of photodiodes and phototransistors. Infrared Photodiodes are different from normal photo diodes as they detect only infrared radiation. The picture of a typical IR receiver or a photodiode is shown below.



Different types of IR receivers exist based on the wavelength, voltage, package, etc. When used in an infrared transmitter – receiver combination, the wavelength of the receiver should match with that of the transmitter.

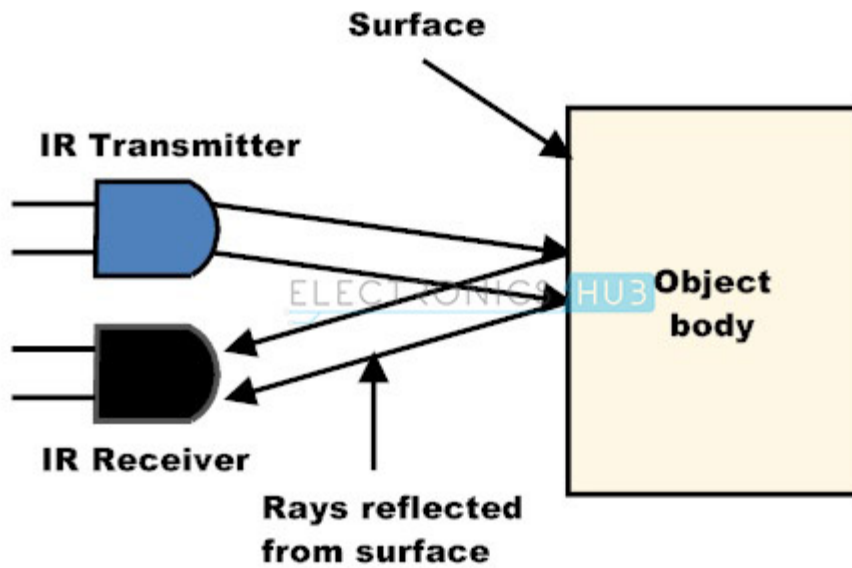
A typical infrared receiver circuit using a phototransistor is shown below.



It consists of an IR phototransistor, a diode, a MOSFET, a potentiometer and an LED. When the phototransistor receives any infrared radiation, current flows through it and MOSFET turns on. This in turn lights up the LED which acts as a load. The potentiometer is used to control the sensitivity of the phototransistor.

Principle of Working

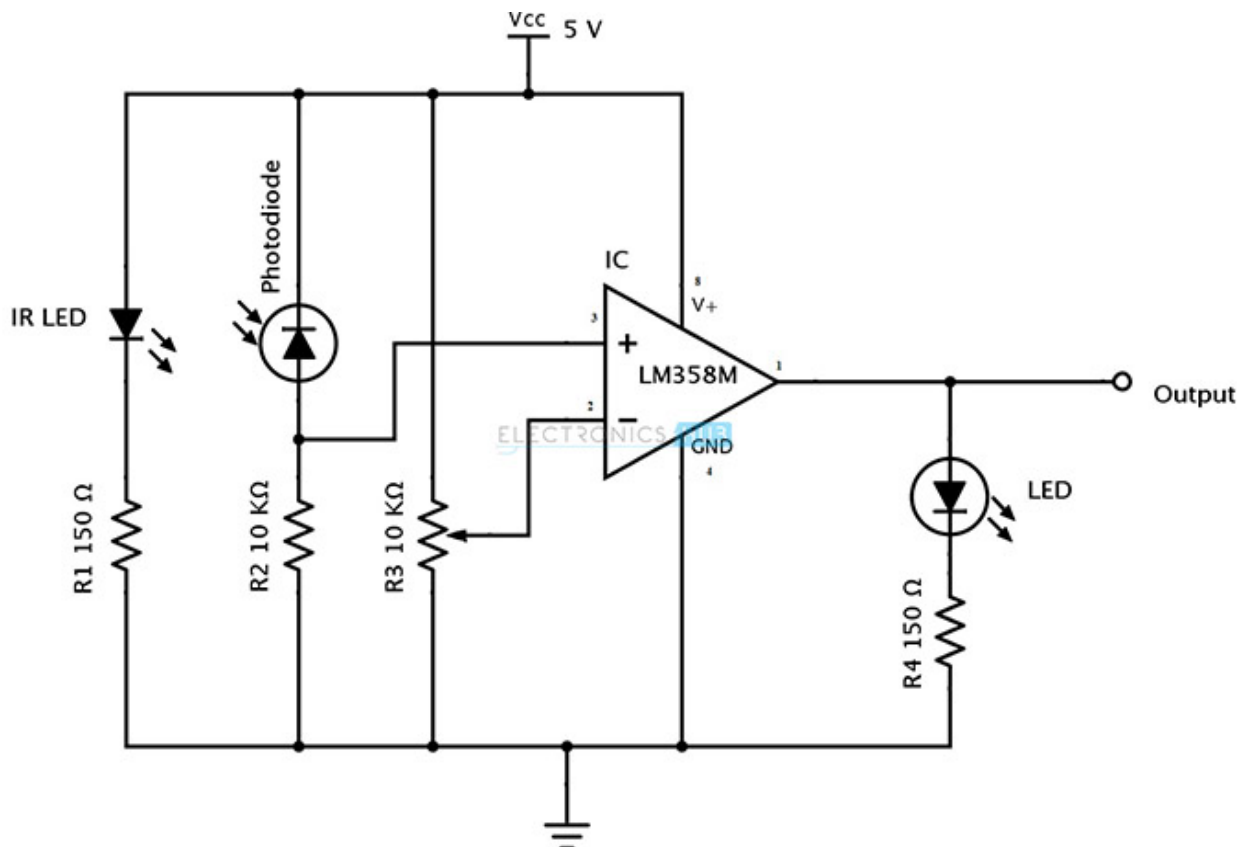
The principle of an IR sensor working as an Object Detection Sensor can be explained using the following figure. An IR sensor consists of an IR LED and an IR Photodiode; together they are called as Photo – Coupler or Opto – Coupler.



When the IR transmitter emits radiation, it reaches the object and some of the radiation reflects back to the IR receiver. Based on the intensity of the reception by the IR receiver, the output of the sensor is defined.

Obstacle Sensing Circuit or IR Sensor Circuit

A typical IR sensing circuit is shown below.



It consists of an IR LED, a photodiode, a potentiometer, an IC Operational amplifier and an LED.

IR LED emits infrared light. The Photodiode detects the infrared light. An IC Op – Amp is used as a voltage comparator. The potentiometer is used to calibrate the output of the sensor according to the requirement.

When the light emitted by the IR LED is incident on the photodiode after hitting an object, the resistance of the photodiode falls down from a huge value. One of the input of the op – amp is at threshold value set by the potentiometer. The other input to the op-amp is from the photodiode's series resistor. When the incident radiation is more on the photodiode, the voltage drop across the series resistor will be high. In the IC, both the threshold voltage and the voltage across the series resistor are compared. If the voltage across the resistor series to photodiode is greater than that of the threshold voltage, the output of the IC Op – Amp is high. As the output of the IC is connected to an LED, it lightens up. The threshold voltage can be adjusted by adjusting the potentiometer depending on the environmental conditions.

The positioning of the IR LED and the IR Receiver is an important factor. When the IR LED is held directly in front of the IR receiver, this setup is called Direct Incidence. In this case, almost the entire radiation from the IR LED will fall on the IR receiver. Hence there is a line of sight communication between the infrared transmitter and the receiver. If an object falls in this line, it obstructs the radiation from reaching the receiver either by reflecting the radiation or absorbing the radiation.

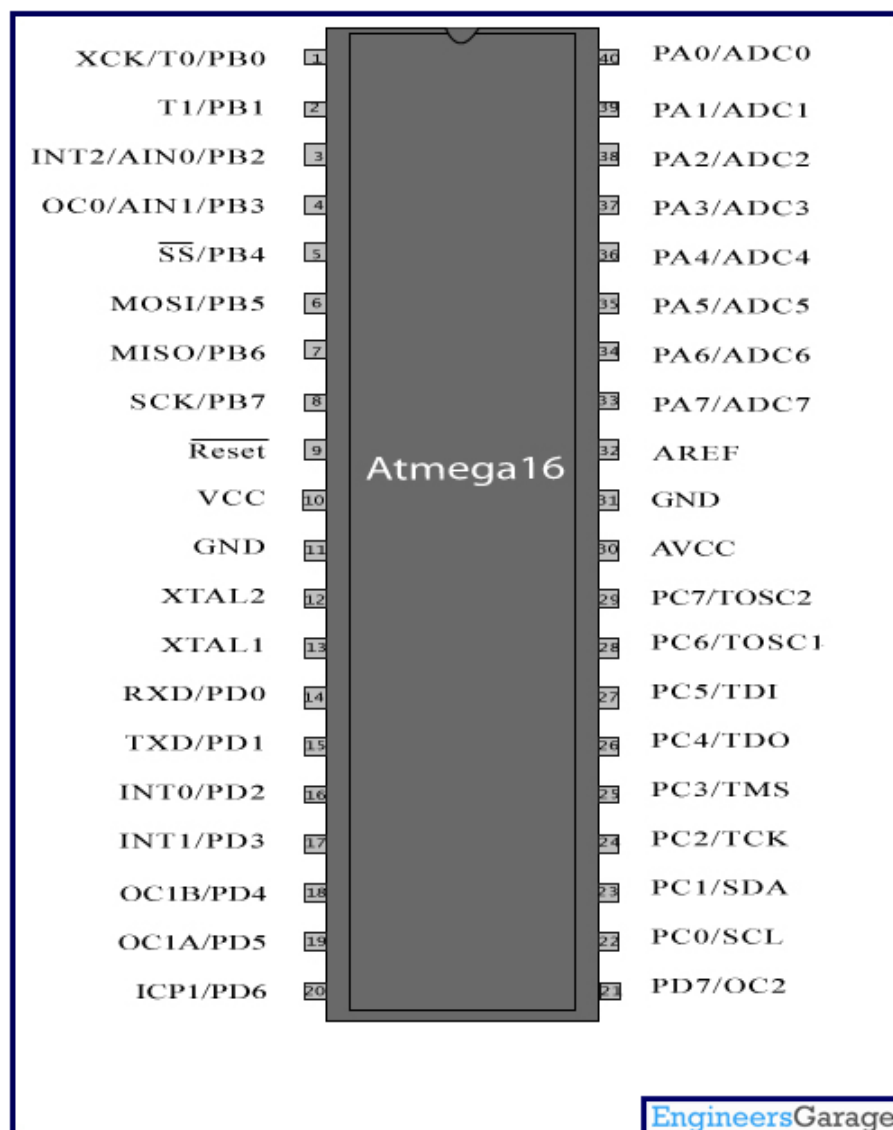
2.3 ATMEGA16 :

ATmega16 is an 8-bit high performance microcontroller of Atmel's Mega AVR family with low power consumption. ATmega16 is based on enhanced RISC (Reduced Instruction Set Computing, Know more about RISC and CISC Architecture) architecture with 131 powerful instructions. Most of the instructions execute in one machine cycle. ATmega16 can work on a maximum frequency of 16MHz.

ATmega16 has 16 KB programmable flash memory, static RAM of 1 KB and EEPROM of 512 Bytes. The endurance cycle of flash memory and EEPROM is 10,000 and 100,000, respectively.

ATmega16 is a 40 pin microcontroller. There are 32 I/O (input/output) lines which are divided into four 8-bit ports designated as PORTA, PORTB, PORTC and PORTD.

ATmega16 has various in-built peripherals like USART, ADC, Analog Comparator, SPI, JTAG etc. Each I/O pin has an alternative task related to in-built peripherals. The following table shows the pin description of ATmega16.



Pin Description:

Pin No.	Pin name	Description	Alternate Function
1	(XCK/T0) PB0	I/O PORTB, Pin 0	T0: Timer0 External Counter Input. XCK : USART External Clock I/O
2	(T1) PB1	I/O PORTB, Pin 1	T1:Timer1 External Counter Input
3	(INT2/AIN0) PB2	I/O PORTB, Pin 2	AIN0: Analog Comparator Positive I/P INT2: External Interrupt 2 Input
4	(OC0/AIN1) PB3	I/O PORTB, Pin 3	AIN1: Analog Comparator Negative I/P OC0 : Timer0 Output Compare Match Output
5	(SS) PB4	I/O PORTB, Pin 4	In System Programmer (ISP) Serial Peripheral Interface (SPI)
6	(MOSI) PB5	I/O PORTB, Pin 5	
7	(MISO) PB6	I/O PORTB, Pin 6	
8	(SCK) PB7	I/O PORTB, Pin 7	
9	RESET	Reset Pin, Active Low Reset	
10	Vcc	Vcc = +5V	
11	GND	GROUND	
12	XTAL2	Output to Inverting Oscillator Amplifier	
13	XTAL1	Input to Inverting Oscillator Amplifier	
14	(RXD) PD0	I/O PORTD, Pin 0	USART Serial Communication Interface
15	(TXD) PD1	I/O PORTD, Pin 1	
16	(INT0) PD2	I/O PORTD, Pin 2	External Interrupt INT0
17	(INT1) PD3	I/O PORTD, Pin 3	External Interrupt INT1
18	(OC1B) PD4	I/O PORTD, Pin 4	PWM Channel Outputs
19	(OC1A) PD5	I/O PORTD, Pin 5	
20	(ICP) PD6	I/O PORTD, Pin 6	Timer/Counter1 Input Capture Pin
21	PD7 (OC2)	I/O PORTD, Pin 7	Timer/Counter2 Output Compare Match Output
22	PC0 (SCL)	I/O PORTC, Pin 0	TWI Interface
23	PC1 (SDA)	I/O PORTC, Pin 1	
24	PC2 (TCK)	I/O PORTC, Pin 2	JTAG Interface
25	PC3 (TMS)	I/O PORTC, Pin 3	
26	PC4 (TDO)	I/O PORTC, Pin 4	
27	PC5 (TDI)	I/O PORTC, Pin 5	

28	PC6 (TOSC1)	I/O PORTC, Pin 6	Timer Oscillator Pin 1
29	PC7 (TOSC2)	I/O PORTC, Pin 7	Timer Oscillator Pin 2
30	AVcc	Voltage Supply = Vcc for ADC	
31	GND	GROUND	
32	AREF	Analog Reference Pin for ADC	
33	PA7 (ADC7)	I/O PORTA, Pin 7	ADC Channel 7
34	PA6 (ADC6)	I/O PORTA, Pin 6	ADC Channel 6
35	PA5 (ADC5)	I/O PORTA, Pin 5	ADC Channel 5
36	PA4 (ADC4)	I/O PORTA, Pin 4	ADC Channel 4
37	PA3 (ADC3)	I/O PORTA, Pin 3	ADC Channel 3
38	PA2 (ADC2)	I/O PORTA, Pin 2	ADC Channel 2
39	PA1 (ADC1)	I/O PORTA, Pin 1	ADC Channel 1
40	PA0 (ADC0)	I/O PORTA, Pin 0	ADC Channel 0

Features:

- High-performance, Low-power Atmel AVR 8-bit Microcontroller
- Advanced RISC Architecture 131

- Powerful Instructions – Most Single-clock Cycle Execution 32 x 8
- General Purpose Working Registers–Fully Static Operation–Up to 16MIPS
- Throughput at 16MHz–On-chip 2-cycle
- Multiplier High Endurance
- Non-volatile Memory segments
- 16KBytes of In-System Self-programmable Flash program memory–512Bytes EEPROM–1KByte Internal SRAM–
- Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
- Data retention: 20 years at 85°C/100 years at 25°C(1)
- Optional Boot Code Section with Independent Lock Bits z
- System Programming by On-chip Boot Program True Read-While-Write Operation
- Programming Lock for Software Security JTAG (IEEE std. 1149.1 Compliant) Interface–Boundary-scan Capabilities
- According to the JTAG Standard–Extensive On-chip Debug Support–Programming of Flash, EEPROM, Fuses, and Lock Bits through the JTAG Interface Peripheral Features
- Two 8-bit Timer/Counters with Separate Prescalers and Compare Modes–One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
- Real Time Counter with Separate Oscillator–Four PWM Channels–8-channel, 10-bit ADC z 8 Single-ended Channels z 7 Differential Channels in TQFP Package
- Only z 2 Differential Channels with Programmable Gain at 1x, 10x, or 200x
- It has 32 I/O (Input/output) pins grouped as A, B, C & D with 8 pins in each group.
- This group is called as PORT.
- PA0 - PA7 (PORTA)
- PB0 - PB7 (PORTB)
- PC0 - PC7 (PORTC)
- PD0 - PD7 (PORTD)

Port A (PA7 - PA0):

Port A serves as the analog inputs to the A/D Converter. Port A also serves as an 8-bit bi-directional I/O port, if the A/D Converter is not used. When pins PA0 to PA7 are used as inputs and are externally pulled low, they will source current if the internal pull-up resistors are activated. The Port A pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port B (PB7 - PB0):

Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). Port B also serves the functions of various special features of the ATmega16 as listed on page 58 of datasheet.

Port C (PC7 - PC0):

Port C is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). Port C also serves the functions of the JTAG interface and other special features of the ATmega16 as listed on page 61 of datasheet. If the JTAG interface is enabled, the pull-up resistors on pins PC5(TDI), PC3(TMS) and PC2(TCK) will be activated even if a reset occurs.

Port D (PD7 - PD0):

Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). Port D also serves the functions of various special features of the ATmega16 as listed on page 63 of datasheet.

RESET: Reset Input. A low level on this pin for longer than the minimum pulse length will generate a reset, even if the clock is not running.

XTAL1: External oscillator pin 1

XTAL2: External oscillator pin 2

AVCC: AVCC is the supply voltage pin for Port A and the A/D Converter. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter.

AREF: AREF is the analog reference pin for the A/D Converter.

All these pins have some function written in bracket. These are additional function that pin can perform other than I/O. Some of them are.

- ADC (ADC0 - ADC7 on PORTA)
- UART (Rx,Tx on PORTD)
- TIMERS (OC0 - OC2)
- SPI (MISO, MOSI, SCK on PORTB)
- External Interrupts (INT0 - INT2)

Memory: It has 8 Kb of Flash program memory (10,000 Write/Erase cycles durability), 512 Bytes of EEPROM (100,000 Write/Erase Cycles).
1Kbyte Internal SRAM

I/O Ports: 23 I/ line can be obtained from three ports; namely Port B, Port C and Port D.

Interrupts: Two External Interrupt source, located at port D. 19 different interrupt vectors supporting 19 events generated by internal peripherals.

Timer/Counter: Three Internal Timers are available, two 8 bit, one 16 bit, offering various operating modes and supporting internal or external clocking.

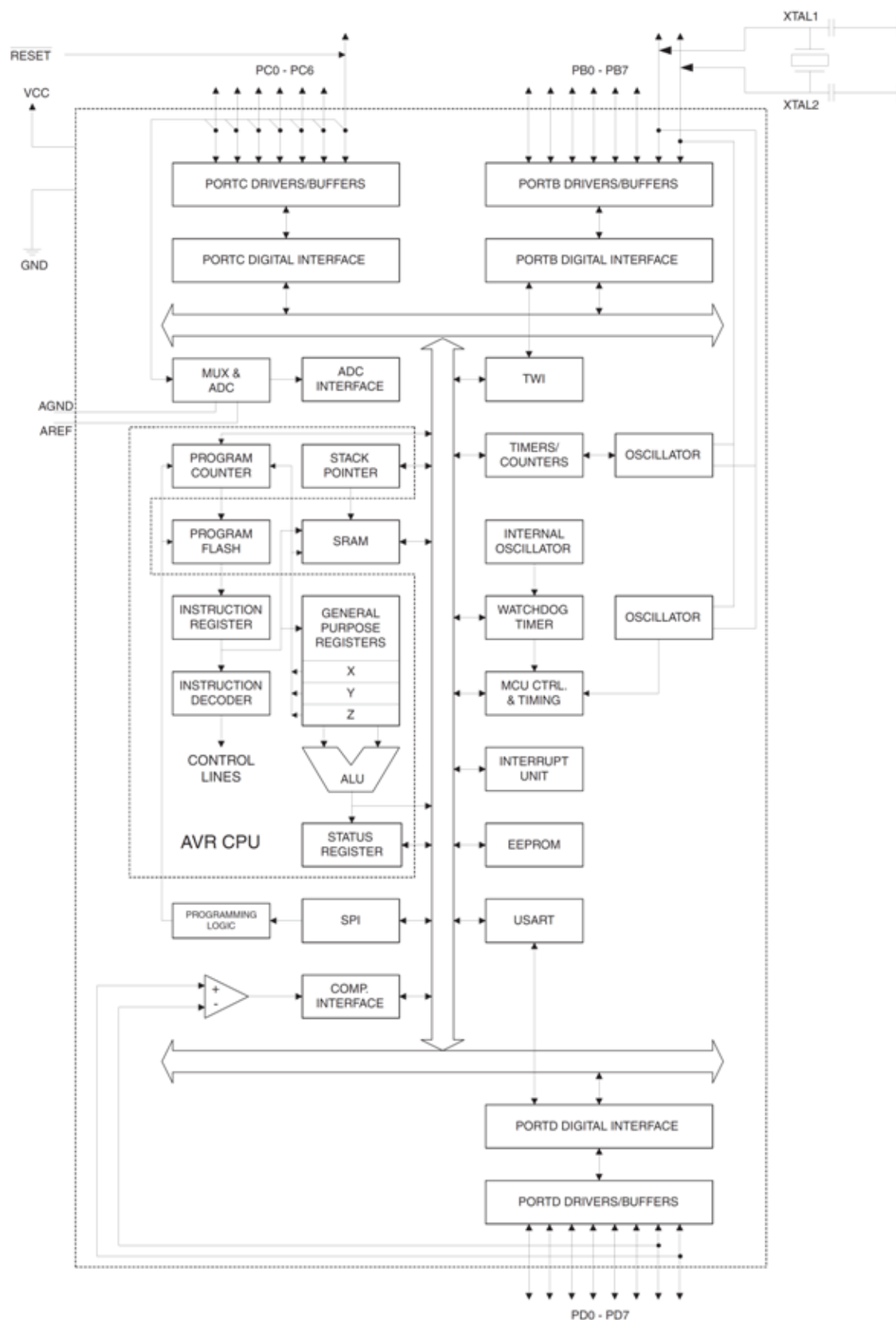
SPI (Serial Peripheral interface): ATmega8 holds three communication devices integrated. One of them is Serial Peripheral Interface. Four pins are assigned to Atmega8 to implement this scheme of communication.

USART: One of the most powerful communication solutions is USART and ATmega8 supports both synchronous and asynchronous data transfer schemes. It has three pins assigned for that. In many projects, this module is extensively used for PC-Micro controller communication.

TWI (Two Wire Interface): Another communication device that is present in ATmega8 is Two Wire Interface. It allows designers to set up a commutation between two devices using just two wires along with a common ground connection, As the TWI output is made by means of open collector outputs, thus external pull up resistors are required to make the circuit.

Analog Comparator: A comparator module is integrated in the IC that provides comparison facility between two voltages connected to the two inputs of the Analog comparator via External pins attached to the micro controller.

Analog to Digital Converter: Inbuilt analog to digital converter can convert an analog input signal into digital data of 10bit resolution.

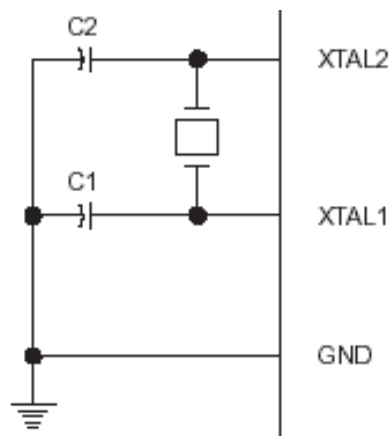


XTAL1: Input to the inverting oscillator amplifier and input to the internal clock operating circuit.

XTAL2: Output from the inverting oscillator amplifier.

Oscillator Characteristics:

XTAL1 and XTAL2 are the input and output, respectively, of an inverting amplifier that can be configured for use as an on-chip oscillator, as shown in Figure 1. Either a quartz crystal or ceramic resonator may be used. To drive the device from an External clock source, XTAL2 should be left unconnected while XTAL1 is driven, as shown in Figure 2.



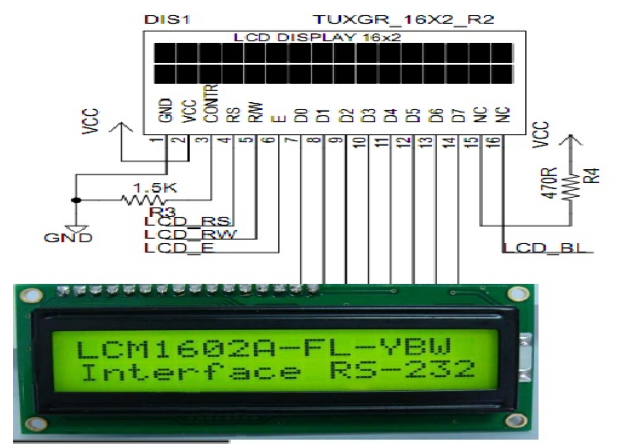
Note: C1, C2 = 30 pF \pm 10 pF for Crystals
= 40 pF \pm 10 pF for Ceramic Resonators

Oscillator Connections

2.3 LCD (Liquid Cristal Display)

Introduction:

A liquid crystal display (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. Each pixel consists of a column of liquid crystal molecules suspended between two transparent electrodes, and two polarizing filters, the axes of polarity of which are perpendicular to each other. Without the liquid crystals between them, light passing through one would be blocked by the other. The liquid crystal twists the polarization of light entering one filter to allow it to pass through the other.



A program must interact with the outside world using input and output devices that communicate directly with a human being. One of the most common devices attached to an controller is an LCD display. Some of the most common LCDs connected to the controllers are 16X1, 16x2 and 20x2 displays. This means 16 characters per line by 1 line 16 characters per line by 2 lines and 20 characters per line by 2 lines, respectively.

Many microcontroller devices use 'smart LCD' displays to output visual information. LCD displays designed around LCD NT-C1611 module, are inexpensive, easy to use, and it is even possible to produce a readout using the 5X7 dots plus cursor of the display. They have a standard ASCII set of characters and mathematical symbols. For an 8-bit data bus, the display requires a +5V supply plus 10 I/O lines (RS RW D7 D6 D5 D4 D3 D2 D1 D0). For a 4-bit data bus it only requires the supply lines

plus 6 extra lines (RS RW D7 D6 D5 D4). When the LCD display is not enabled, data lines are tri-state and they do not interfere with the operation of the microcontroller.

Features:

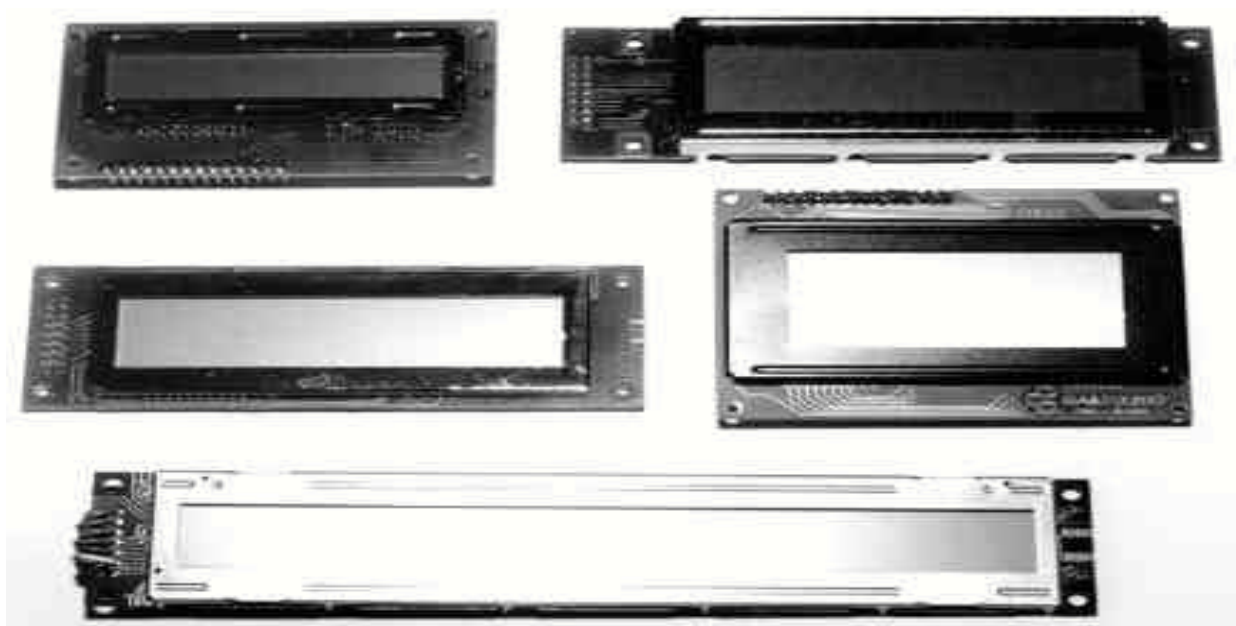
- (1) Interface with either 4-bit or 8-bit microprocessor.
- (2) Display data RAM
- (3) 80x8 bits (80 characters).
- (4) Character generator ROM
- (5) 160 different 57 dot-matrix character patterns.
- (6) Character generator RAM
- (7) 8 different user programmed 57 dot-matrix patterns.
- (8) Display data RAM and character generator RAM may be accessed by the microprocessor.
- (9) Numerous instructions
- (10) Clear Display, Cursor Home, Display ON/OFF, Cursor ON/OFF, Blink Character, Cursor Shift, Display Shift.
- (11). Built-in reset circuit is triggered at power ON.
- (12). Built-in oscillator.

Data can be placed at any location on the LCD. For 16×1 LCD, the address locations are:

POSITION		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
ADDRESS	LINE1	00	01	02	03	04	05	06	07	40	41	42	43	44	45	46	47

Fig: Address locations for a 1x16 line LCD

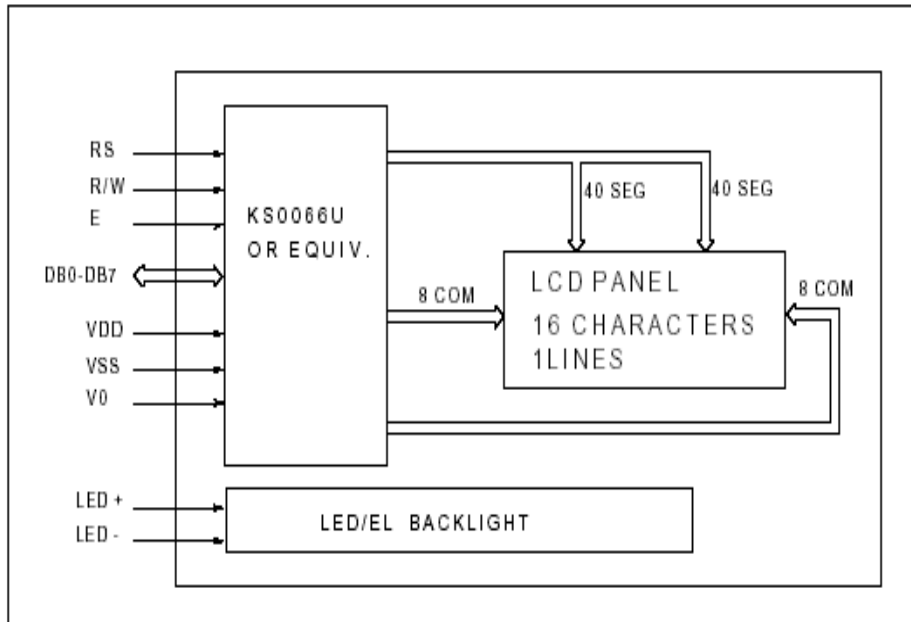
Shapes and sizes:



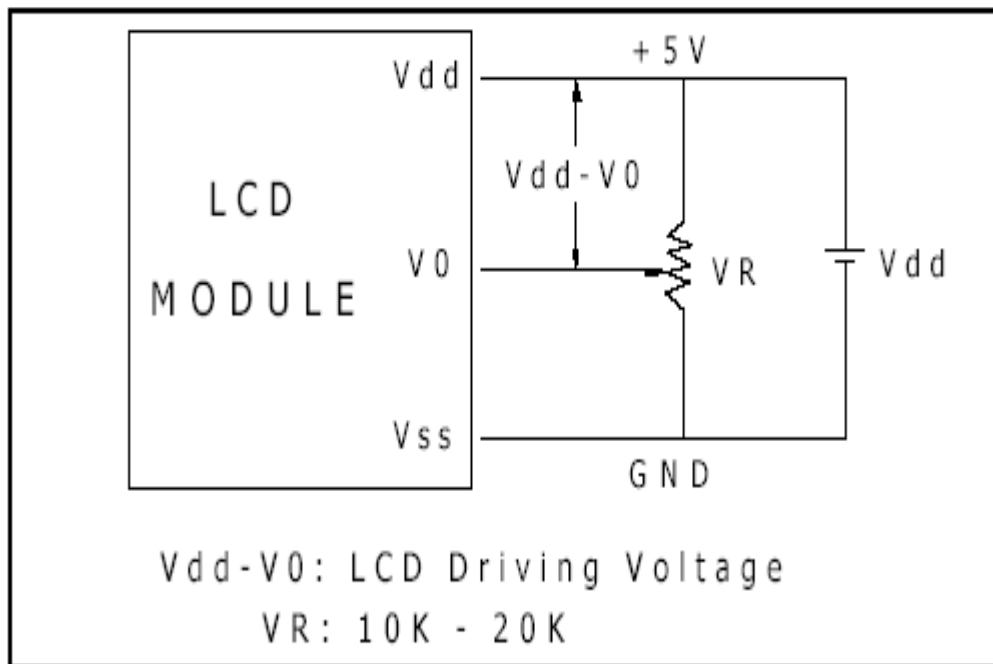
Even limited to character based modules, there is still a wide variety of shapes and sizes available. Line lengths of 8, 16,20,24,32 and 40 characters are all standard, in one, two and four line versions.

Several different LC technologies exist. “Supertwist” types, for example, offer improved contrast and viewing angle over the older “twisted nematic” types. Some modules are available with back lighting, so that they can be viewed in dimly-lit conditions. The back lighting may be either “electro-luminescent”, requiring a high voltage inverter circuit, or simple LED illumination.

ELECTRICAL BLOCK DIAGRAM:



Power supply for LCD driving



PIN DESCRIPTION:

Most LCDs with 1 controller has 14 Pins and LCDs with 2 controller has 16 Pins (two pins are extra in both for back-light LED connections).

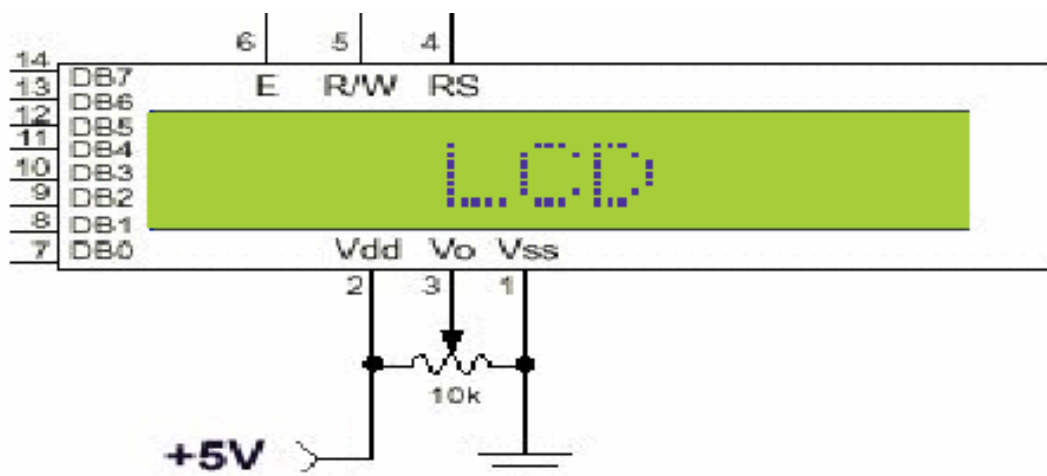


Fig: pin diagram of 1x16 lines LCD

PIN	SYMBOL	FUNCTION
1	Vss	Power Supply(GND)
2	Vdd	Power Supply(+5V)
3	Vo	Contrast Adjust
4	RS	Instruction/Data Register Select
5	R/W	Data Bus Line
6	E	Enable Signal
7-14	DB0-DB7	Data Bus Line
15	A	Power Supply for LED B/L(+)
16	K	Power Supply for LED B/L(-)

CONTROL LINES:

EN:

Line is called "Enable." This control line is used to tell the LCD that you are sending it data. To send data to the LCD, your program should make sure this line is low (0) and then set the other two control lines and/or put data on the data bus. When the other lines are completely ready, bring EN high (1) and wait for the minimum amount of time required by the LCD datasheet (this varies from LCD to LCD), and end by bringing it low (0) again.

RS:

Line is the "Register Select" line. When RS is low (0), the data is to be treated as a command or special instruction (such as clear screen, position cursor, etc.). When RS is high (1), the data being sent is text data which could be displayed on the screen. For example, to display the letter "T" on the screen you would set RS high.

RW:

Line is the "Read/Write" control line. When RW is low (0), the information on the data bus is being written to the LCD. When RW is high (1), the program is effectively querying (or reading) the LCD.

Only one instruction ("Get LCD status") is a read command. All others are write commands, so RW will almost always be low.

Finally, the data bus consists of 4 or 8 lines (depending on the mode of operation selected by the user). In the case of an 8-bit data bus, the lines are referred to as DB0, DB1, DB2, DB3, DB4, DB5, DB6, and DB7.

Logic status on control lines:

- E - 0: Access to LCD disabled
 - 1: Access to LCD enabled
- R/W - 0: Writing data to LCD
 - 1: Reading data from LCD
- RS - 0: Instructions
 - 1: Character

Writing data to the LCD:

- 1) Set R/W bit to low
- 2) Set RS bit to logic 0 or 1 (instruction or character)
- 3) Set data to data lines (if it is writing)
- 4) Set E line to high
- 5) Set E line to low

Read data from data lines (if it is reading) on LCD:

- 1) Set R/W bit to high
- 2) Set RS bit to logic 0 or 1 (instruction or character)
- 3) Set data to data lines (if it is writing)

4) Set E line to high

5) Set E line to low

Entering Text:

First, a little tip: it is manually a lot easier to enter characters and commands in hexadecimal rather than binary (although, of course, you will need to translate commands from binary couple of sub-miniature hexadecimal rotary switches is a simple matter, although a little bit into hex so that you know which bits you are setting). Replacing the d.i.l. switch pack with a of re-wiring is necessary.

The switches must be the type where On = 0, so that when they are turned to the zero position, all four outputs are shorted to the common pin, and in position “F”, all four outputs are open circuit.

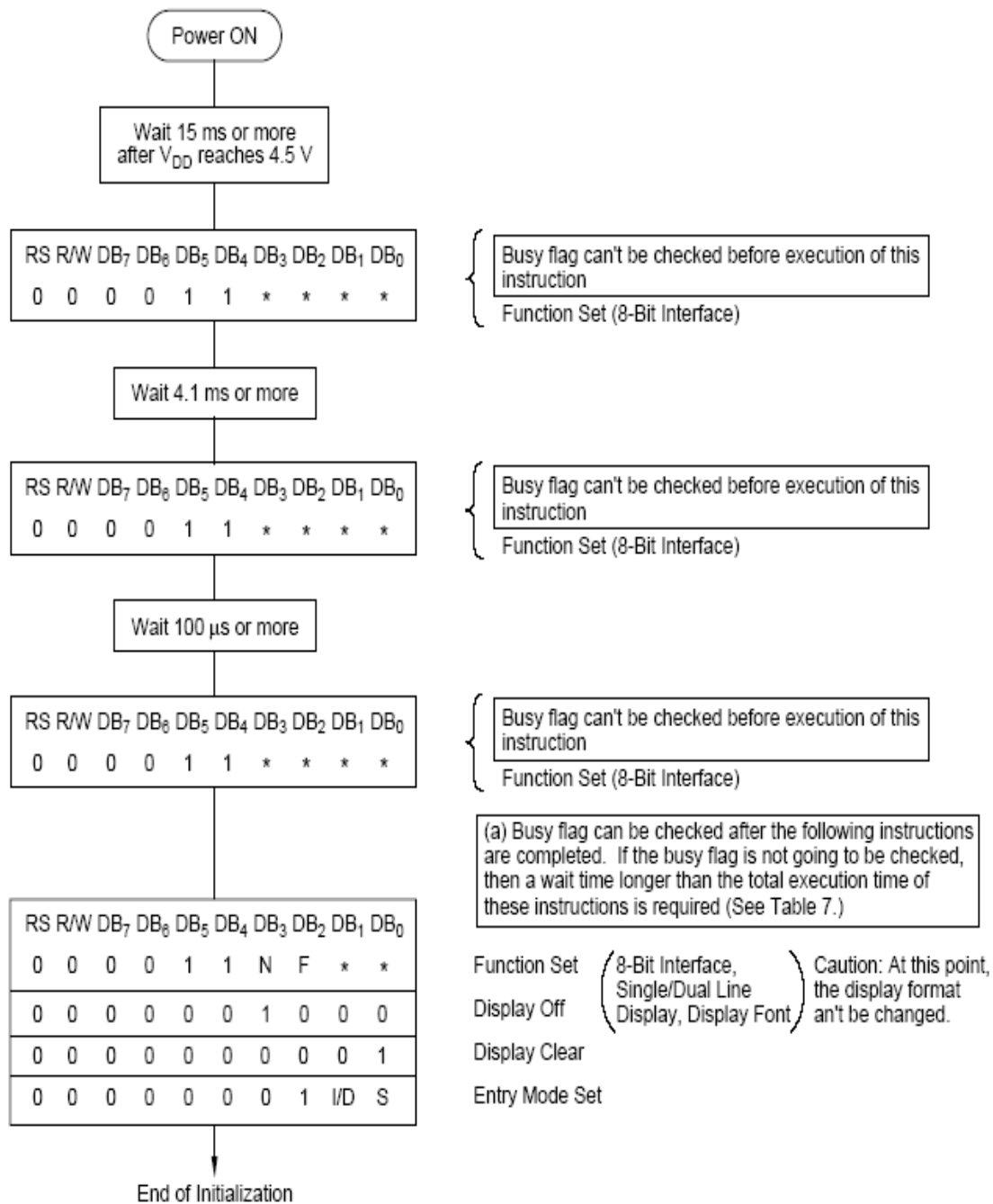
All the available characters that are built into the module are shown in Table 3. Studying the table, you will see that codes associated with the characters are quoted in binary and hexadecimal, most significant bits (“left-hand” four bits) across the top, and least significant bits (“right-hand” four bits) down the left.

Most of the characters conform to the ASCII standard, although the Japanese and Greek characters (and a few other things) are obvious exceptions. Since these intelligent modules were designed in the “Land of the Rising Sun,” it seems only fair that their Katakana phonetic symbols should also be incorporated. The more extensive Kanji character set, which the Japanese share with the Chinese, consisting of several thousand different characters, is not included!

Using the switches, of whatever type, and referring to Table 3, enter a few characters onto the display, both letters and numbers. The RS switch (S10) must be “up” (logic 1) when sending the characters, and switch E (S9) must be pressed for each of them. Thus the operational order is: set RS high, enter character, trigger E, leave RS high, enter another character, trigger E, and so on.

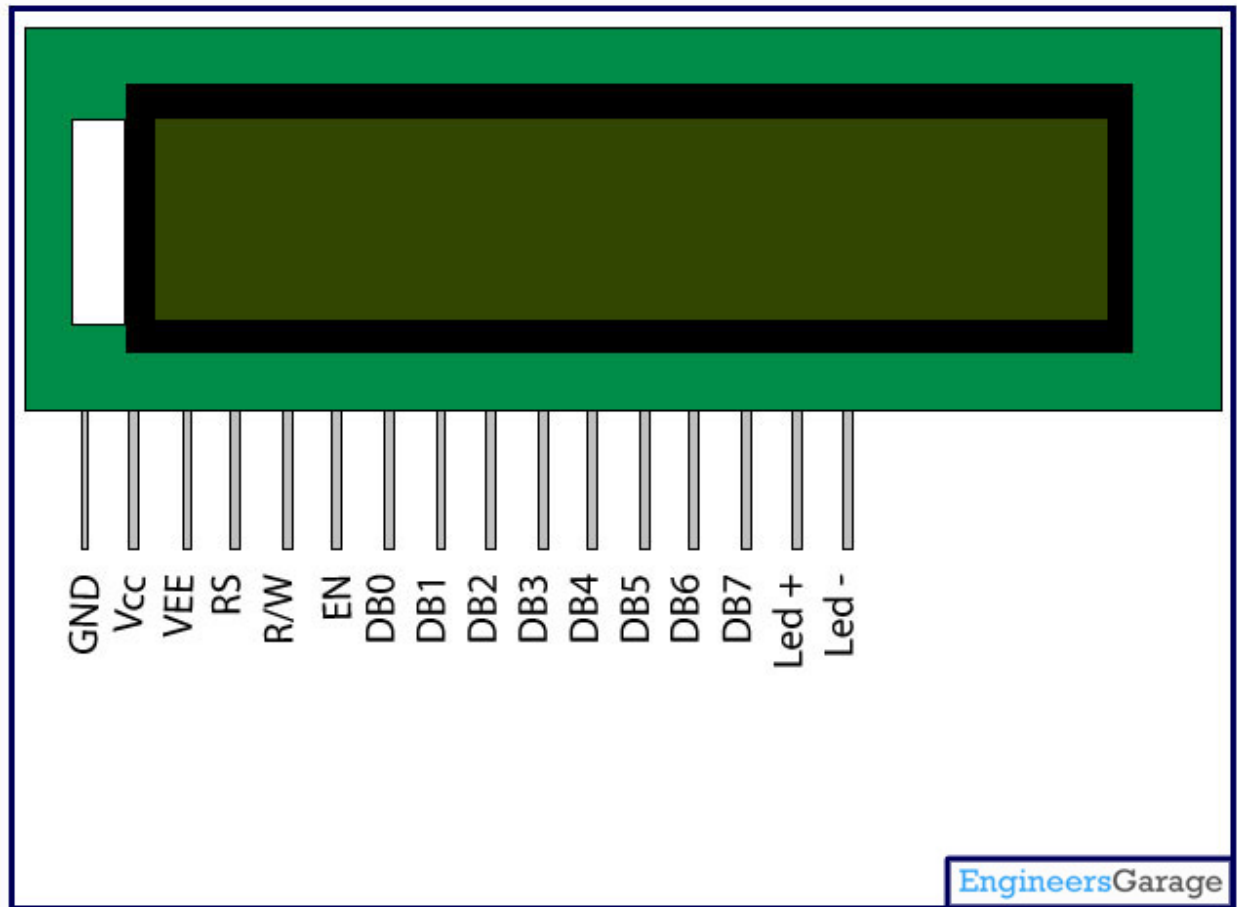
The first 16 codes in Table 3, 00000000 to 00001111, (\$00 to \$0F) refer to the CGRAM. This is the Character Generator RAM (random access memory), which can be used to hold user-defined graphics characters. This is where these modules really start to show their potential, offering such capabilities as bar graphs, flashing symbols, even animated characters. Before the user-defined characters are set up, these codes will just bring up strange looking symbols.

Initialization by Instructions:



LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

A **16x2 LCD** means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.



Pin No	Function	Name
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	V _{CC}
3	Contrast adjustment; through a variable resistor	V _{EE}
4	Selects command register when low; and data register when high	Register Select
5	Low to write to the register; High to read from the register	Read/write
6	Sends data to data pins when a high to low pulse is given	Enable
7	8-bit data pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Backlight V _{CC} (5V)	Led+
16	Backlight Ground (0V)	Led-

Working

We always use devices made up of Liquid Crystal Displays (LCDs) like computers, digital watches and also DVD and CD players. They have become very common and have taken a giant leap in the screen industry by clearly replacing the use of Cathode Ray Tubes (CRT). CRT draws more power than LCD and are also bigger and heavier. All of us have seen an LCD, but no one knows the exact working of it. Let us take a look at the working of an LCD.



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The article below is developed as two sections:-

1. Basics of LCD Displays
2. Working Principle of LCD

Invention History of Liquid Crystal Display (LCD)

We get the definition of LCD from the name “Liquid Crystal” itself. It is actually a combination of two states of matter – the solid and the liquid. They have both the properties of solids and liquids and maintain their respective states with respect to another. Solids usually maintain their state unlike liquids who change their orientation and move everywhere in the particular liquid. Further studies have showed that liquid crystal materials show more of a liquid state than that of a solid. It must also be noted that liquid crystals are more heat sensitive than usual liquids. A little amount of heat can easily turn the liquid crystal into a liquid. This is the reason why they are also used to make thermometers.

The liquid-crystal display has the distinct advantage of having low power consumption than the LED. It is typically of the order of microwatts for the display in comparison to the some order of mill watts for LEDs. Low power consumption requirement has made it compatible with MOS integrated logic circuit. Its other advantages are its low cost, and good contrast. The main drawbacks of LCDs are additional requirement of light source, a limited temperature range of operation (between 0 and 60° C), low reliability, short operating life, poor visibility in low ambient lighting, slow speed and the need for an ac drive.

Basic structure of an LCD

A liquid crystal cell consists of a thin layer (about 10 μm) of a liquid crystal sandwiched between two glass sheets with transparent electrodes deposited on their inside faces. With both glass sheets transparent, the cell is known as transitive type cell. When one glass is transparent and the other has a reflective coating, the cell is called reflective type. The LCD does not produce any illumination of its own. It, in fact, depends entirely on illumination falling on it from an external source for its visual effect

Types of LCD/Liquid Crystal Displays

Two types of display available are dynamic scattering display and field effect display.

When dynamic scattering display is energized, the molecules of energized area of the display become turbulent and scatter light in all directions. Consequently, the activated areas take on a frosted glass appearance resulting in a silver display. Of course, the unenergized areas remain translucent.

Field effect LCD contains front and back polarizers at right angles to each other. Without electrical excitation, the light coming through the front polarizer is rotated 90° in the fluid.

Now, let us take a look at the different varieties of liquid crystals that are available for industrial purposes. The most usable liquid crystal among all the others is the nematic phase liquid crystals.

Nematic Phase LCD

The greatest advantage of a nematic phase liquid crystal substance is that it can bring about predictable controlled changes according to the electric current passed through them. All the liquid crystals are according to their reaction on temperature difference and also the nature of the substance.

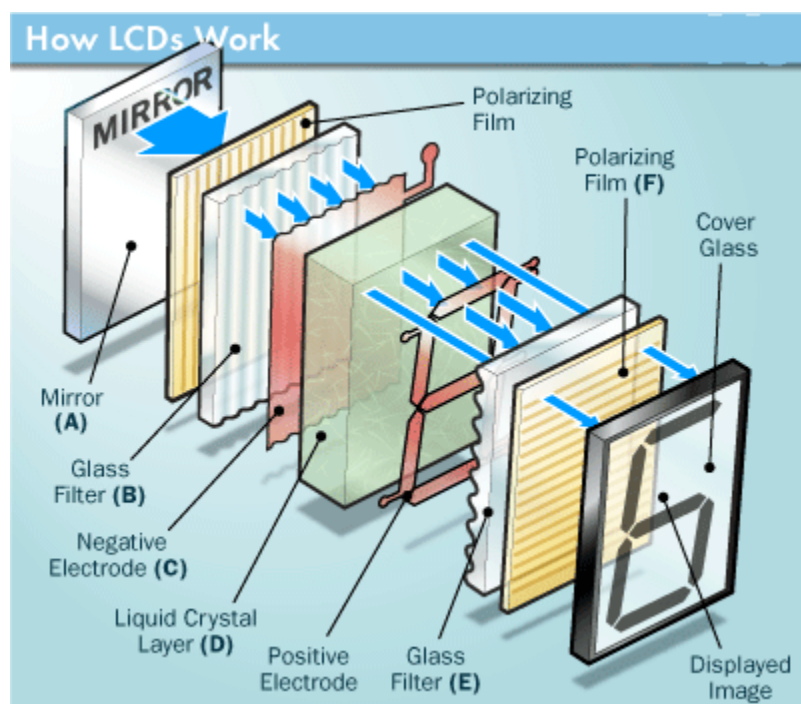
Twisted Nematics, a particular nematic substance is twisted naturally. When a known voltage is applied to the substance, it gets untwisted in varying degrees according to our requirement. This in turn is useful in controlling the passage of light. A nematic phase liquid crystal can be again classified on the basis in which the molecules orient themselves in respect to each other. This change in orientation mainly depends on the director, which can be anything ranging from a magnetic field to a surface with microscopic grooves. Classification includes Smectic and also cholesteric. Smectic can be again classified as smectic C, in which the molecules in each layer tilt at an angle from the previous layer. Cholesteric, on the other hand has molecules that twist slightly from one layer to the next, causing a spiral like design. There are also combinations of these two called Ferro-electric liquid crystals (FLC), which include cholesteric molecules in a smectic C type molecule so that the spiral nature of these molecules allows the microsecond switching response time. This makes FLCs to be of good use in advanced displays.

Liquid crystal molecules are further classified into thermotropic and lyotropic crystals. The former changes proportionally with respect to changes in pressure and temperature. They are further divided into nematic and isotropic. Nematic liquid crystals have a fixed order of pattern while isotropic liquid crystals are distributed randomly. The lyotropic crystal depends on the type of solvent they are mixed with. They are therefore useful in making detergents and soaps.

Making of LCD

- Though the making of LCD is rather simple there are certain facts that should be noted while making it.
- The basic structure of an LCD should be controllably changed with respect to the applied electric current.
- The light that is used on the LCD can be polarized.
- Liquid crystals should be able to both transmit and change polarized light.
- There are transparent substances that can conduct electricity.

To make an LCD, you need to take two polarized glass pieces. The glass which does not have a polarized film on it must be rubbed with a special polymer which creates microscopic grooves in the surface. It must also be noted that the grooves are on the same direction as the polarizing film. Then, all you need to do is to add a coating of nematic liquid crystals to one of the filters. The grooves will cause the first layer of molecules to align with the filter's orientation. At right angle to the first piece, you must then add a second piece of glass along with the polarizing film. Till the uppermost layer is at a 90-degree angle to the bottom, each successive layer of TN molecules will keep on twisting. The first filter will naturally be polarized as the light strikes it at the beginning. Thus the light passes through each layer and is guided on to the next with the help of molecules. When this happens, the molecules tend to change the plane of vibration of the light to match their own angle. When the light reaches the far side of the liquid crystal substance, it vibrates at the same angle as the final layer of molecules. The light is only allowed an entrance if the second polarized glass filter is same as the final layer. Take a look at the figure below.



working of LCD

The main principle behind liquid crystal molecules is that when an electric current is applied to them, they tend to untwist. This causes a change in the light angle passing through them. This causes a change in the angle of the top polarizing filter with respect to it. So little light is allowed to pass through that particular area of LCD. Thus that area becomes darker comparing to others.

For making an LCD screen, a reflective mirror has to be setup in the back. An electrode plane made of indium-tin oxide is kept on top and a glass with a polarizing film is also added on the bottom side. The entire area of the LCD has to be covered by a common electrode and above it should be the liquid crystal substance. Next comes another piece of glass with an electrode in the shape of the rectangle on the bottom and, on top, another polarizing film. It must be noted that both of them are kept at right angles. When there is no current, the light passes through the front of the LCD it will be reflected by the mirror and bounced back. As the electrode is connected to a temporary battery the current from it will cause the liquid crystals between the common-plane electrode and the electrode shaped like a rectangle to untwist. Thus the light is blocked from passing through. Thus that particular rectangular area appears blank.

Colour Liquid Crystal Display

Colour LCDs are those that can display pictures in colours. For this to be possible there must be three sub-pixels with red, green and blue colour filters to create each colour pixel. For combining these sub-pixels these LCDs should be connected to a large number of transistors. If any problem occurs to these transistors, it will cause a bad pixel.

One of the main disadvantages of these types of LCDs is the size. Most manufacturers try to reduce the height than gain it. This is because more transistors and greater pixels will be needed to increase the length. This will increase the probability of bad pixels. It is very difficult or also impossible to repair a LCD with bad pixels. This will highly affect the sale of LCDs.

Advantages of an LCD's:

- LCD's consumes less amount of power compared to CRT and LED
- LCD's are consist of some microwatts for display in comparison to some mill watts for LED's
- LCDs are of low cost
- Provides excellent contrast
- LCD's are thinner and lighter when compared to cathode ray tube and LED

Disadvantages of an LCD's:

- Require additional light sources
- Range of temperature is limited for operation
- Low reliability
- Speed is very low
- LCD's need an AC drive

Applications of Liquid Crystal Display

Liquid crystal technology has major applications in the field of science and engineering as well on electronic devices.

- Liquid crystal thermometer
- Optical imaging
- The liquid crystal display technique is also applicable in visualization of the radio frequency waves in the waveguide
- Used in the medical applications

2.5 LED (LIGHT EMITTING DIODE)

Introduction:

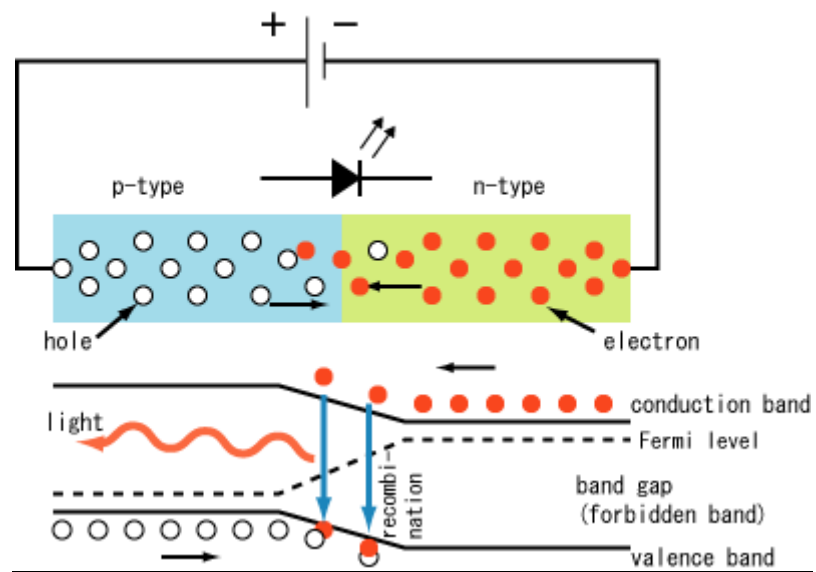
A light-emitting diode (LED) is a semiconductor diode that emits light when an electrical current is applied in the forward direction of the device, as in the simple LED circuit. The effect is a form of electroluminescence. where incoherent and narrow-spectrum light is emitted from the p-n junction..

LEDs are widely used as indicator lights on electronic devices and increasingly in higher power applications such as flashlights and area lighting. An LED is usually a small area (less than 1 mm²) light source, often with optics added to the chip to shape its radiation pattern and assist in reflection. The color of the emitted light depends on the composition and condition of the semi conducting material used, and can be infrared, visible, or ultraviolet. Besides lighting, interesting applications include using UV-LEDs for sterilization of water and disinfection of devices, and as a grow light to enhance photosynthesis in plants.

Basic principle:

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

The wavelength of the light emitted, and therefore its color, depends on the band gap energy of the materials forming the *p-n junction*. In silicon or germanium diodes, the electrons and holes recombine by a *non-radiative transition* which produces no optical emission, because these are indirect band gap materials. The materials used for the LED have a direct band gap with energies corresponding to near-infrared, visible or near-ultraviolet light. LED development began with infrared and red devices made with gallium arsenide. Advances in materials science have made possible the production of devices with ever-shorter wavelengths, producing light in a variety of colors. LEDs are usually built on an n-type substrate, with an electrode attached to the p-type layer deposited on its surface. P-type substrates, while less common, occur as well. Many commercial LEDs, especially GaN/InGaN, also use sapphire substrate.



LED Display types:

- Bar graph
- Seven segment
- Star burst
- Dot matrix

Basic LED types:

Miniature LEDs



Different sized LEDs. 8 mm, 5mm and 3 mm

These are mostly single-die LEDs used as indicators, and they come in various-size packages:

- surface mount
- 2 mm
- 3 mm (T1)
- 5 mm (T1 $\frac{3}{4}$)
- 10 mm
- Other sizes are also available, but less common.

Common package shapes:

- Round, dome top
- Round, flat top
- Rectangular, flat top (often seen in LED bar-graph displays)
- Triangular or square, flat top

The encapsulation may also be clear or semi opaque to improve contrast and viewing angle.

There are three main categories of miniature single die LEDs:

- Low current — typically rated for 2 mA at around 2 V (approximately 4 mW consumption).

- Standard — 20 mA LEDs at around 2 V (approximately 40 mW) for red, orange, yellow & green, and 20 mA at 4–5 V (approximately 100 mW) for blue, violet and white.
- Ultra-high output — 20 mA at approximately 2 V or 4–5 V, designed for viewing in direct sunlight.

Five- and twelve-volt LEDs

These are miniature LEDs incorporating a series resistor, and may be connected directly to a 5 V or 12 V supply.

Applications:

Automotive applications with LEDs

Instrument Panels & Switches, Courtesy Lighting, CHMSL, Rear Stop/Turn/Tail, Retrofits, New Turn/Tail/Marker Lights.

Consumer electronics & general indication

Household appliances, VCR/ DVD/ Stereo/Audio/Video devices, Toys/Games Instrumentation, Security Equipment, Switches.

Illumination with LEDs

Architectural Lighting, Signage (Channel Letters), Machine Vision, Retail Displays, Emergency Lighting (Exit Signs), Neon and bulb Replacement, Flashlights, Accent Lighting - Pathways, Marker Lights.

Sign applications with LEDs

Full Color Video, Monochrome Message Boards, Traffic/VMS, Transportation – Passenger Information.

Signal application with LEDs

Traffic, Rail, Aviation, Tower Lights, Runway Lights, Emergency/Police Vehicle Lighting.

Mobile applications with LEDs

Mobile Phone, PDA's, Digital Cameras, Lap Tops, General Backlighting.

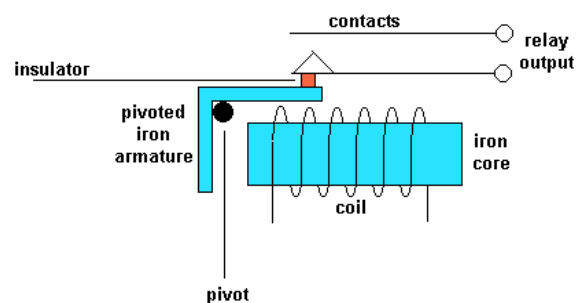
Photo sensor applications with LEDs

Medical Instrumentation, Bar Code Readers, Color & Money Sensors, Encoders, Optical Switches, Fiber Optic Communication.

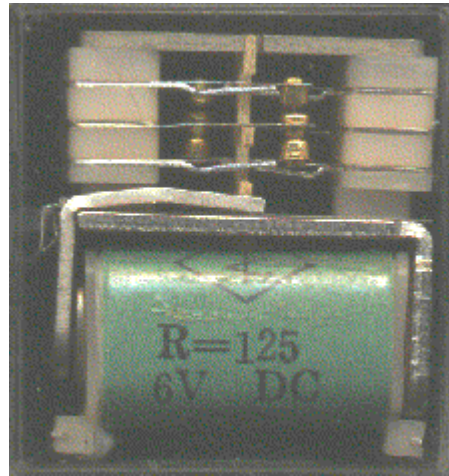
2.6 RELAYS

Introduction:

A relay is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. A relay is able to control an output circuit of higher power than the input circuit, it can be considered to be, in a broad sense, a form of an electrical amplifier.

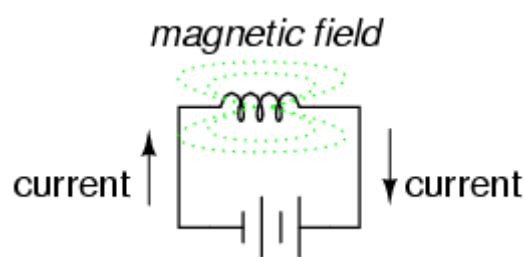


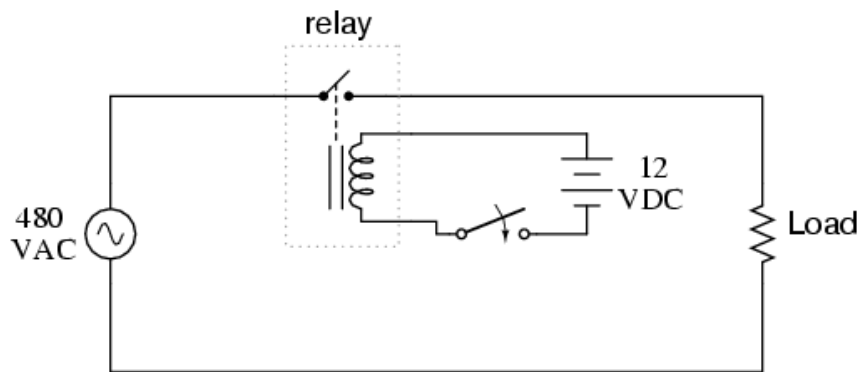
Relays are usually SPDT (single pole double through switch) or DPDT (double pole double through switch) but they can have many more sets of switch contacts, for example relays with 4 sets of changeover contacts are readily available.



Basic operation of a relay:

An electric current through a conductor will produce a magnetic field at right angles to the direction of electron flow. If that conductor is wrapped into a coil shape, the magnetic field produced will be oriented along the length of the coil. The greater the current, the greater the strength of the magnetic field, all other factors being equal.





Inductors react against changes in current because of the energy stored in this magnetic field. When we construct a transformer from two inductor coils around a common iron core, we use this field to transfer energy from one coil to the other. However, there are simpler and more direct uses for electromagnetic fields than the applications we've seen with inductors and transformers. The magnetic field produced by a coil of current-carrying wire can be used to exert a mechanical force on any magnetic object, just as we can use a permanent magnet to attract magnetic objects, except that this magnet (formed by the coil) can be turned on or off by switching the current on or off through the coil.

If we place a magnetic object near such a coil for the purpose of making that object move when we energize the coil with electric current, we have what is called a *solenoid*. The movable magnetic object is called an *armature*, and most armatures can be moved with either direct current (DC) or alternating current (AC) energizing the coil. The polarity of the magnetic field is irrelevant for the purpose of attracting an iron armature. Solenoids can be used to electrically open door latches, open or shut valves, move robotic limbs, and even actuate electric switch mechanisms and is used to actuate a set of switch contacts

Applications:

- To control a high-voltage circuit with a low-voltage signal, as in some types of modems or audio amplifiers,
- To control a high-current circuit with a low-current signal, as in the starter solenoid of an automobile,
- To detect and isolate faults on transmission and distribution lines by opening and closing circuit breakers (protection relays),
- To isolate the controlling circuit from the controlled circuit when the two are at different potentials, for example when controlling a mains-powered device from a low-voltage switch. The latter is often applied to control office lighting as the low voltage wires are easily installed in partitions, which may be

often moved as needs change. They may also be controlled by room occupancy detectors in an effort to conserve energy,

- To perform logic functions. For example, the Boolean AND function is realized by connecting NO relay contacts in series, the OR function by connecting NO contacts in parallel. The change-over or Form C contacts perform the XOR (exclusive or) function. Similar functions for NAND and NOR are accomplished using NC contacts. The Ladder programming language is often used for designing relay logic networks.

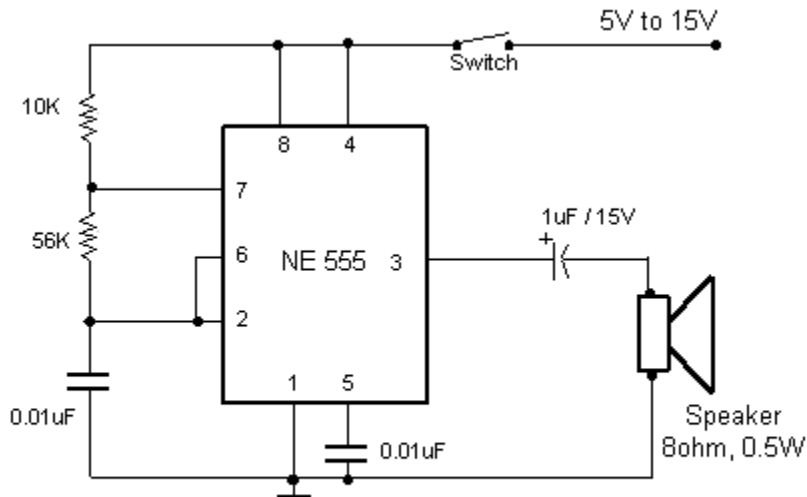
- Early computing. Before vacuum tubes and transistors, relays were used as logical elements in digital computers. See ARRA (computer), Harvard Mark II, Zuse Z2, and Zuse Z3.

2.7 BUZZER:

Simple electronic buzzer

This very simple circuit just uses a couple of resistors, a capacitor and the easily available 555 timer IC.

The 555 is setup as an astable multivibrator operating at a frequency of about 1kHz that produces a shrill noise when switched on. The frequency can be changed by varying the 10K resistor.



Buzzers working:

According to British Telephones, a magnetic effect is produced when a battery is connected to a buzzer's circuitry and the button is pressed. This causes electricity to flow through the coils, which attracts the armature and produces a sound. The current breaks at the device's contact screw, thereby collapsing the magnetic field until the buzzer's button is pressed.

Buzzers are available in a variety of styles. Magnetic buzzers emit audio via a coil, while electromechanical buzzers may use a bell in their design.

Mechanical buzzers do not operate with electricity. Instead, they rely on a tightly wound spring. Hand buzzers and alarm clocks that are manually wound are mechanical in design. Piezo buzzers can emit a variety of beeps and buzzes and are often used on car doors and to indicate computer errors.

Buzzers are employed for use on microwave ovens and conventional ovens as well. Timing devices depend on buzzers, as do alarms for seat belts and dashboard warning lights. Buzzers are also used during recreational activities. Most game shows require players to hit a buzzer when they are ready to answer a question or want to signal the host. At college and professional basketball games, buzzers sound when the clock runs out of time.

Type of buzzers

Electromechanical

Early devices were based on an electromechanical system identical to an electric bell without the metal gong. Similarly, a relay may be connected to interrupt its own actuating current, causing the contacts to buzz. Often these units were anchored to a wall or ceiling to use it as a sounding board. The word "buzzer" comes from the rasping noise that electromechanical buzzers made.

Mechanical

A joy buzzer is an example of a purely mechanical buzzer. They require drivers.

Piezoelectric[edit]



Piezoelectric disk beeper

A piezoelectric element may be driven by an oscillating electronic circuit or other audio signal source, driven with a piezoelectric audio amplifier. Sounds commonly used to indicate that a button has been pressed are a click, a ring or a beep.

Buzzers and it's function

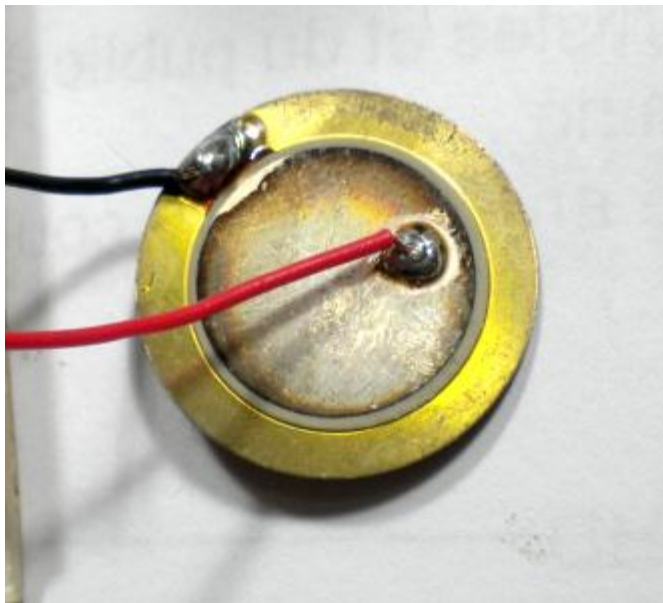
Electro-mechanical buzzer

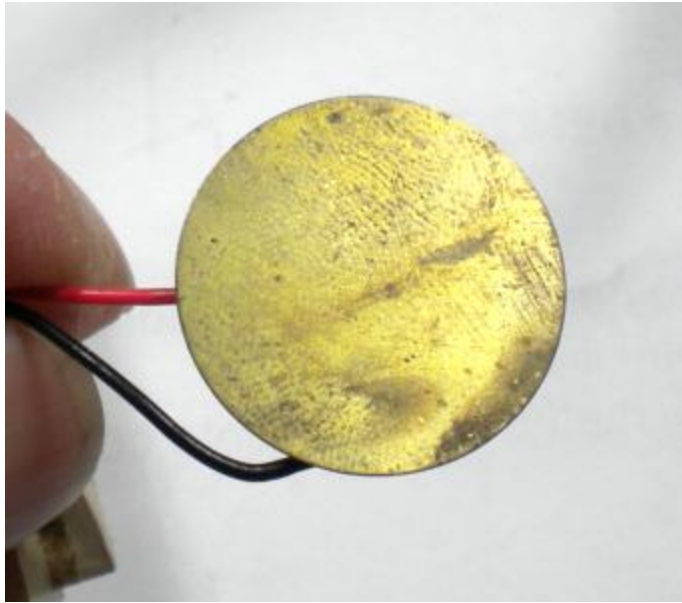
A buzzer is in the mechanical form of a small rectangular or cylindrical housing, with electrical connection for direct mounting on rigid printed circuit, or with electrical connection consisting of flexible electrical son. In the latter case, the buzzer has two small brackets. The loudness of such a component is about 85 dB / cm (note that it does not specify the sound level meter - as for HP, as a business perspective, it would seem probably too little power. As for sweets which are given the price per 100g and not for one kilogram).



It requires a DC voltage to operate, it should generally be between 3 V and 28 V, depending on the model. A buzzer designed to operate at 6 V generally works very well for any supply voltage between 4 V and 8 V, and a buzzer designed to operate at 12 V can work perfectly at a voltage between 6 V and 28 V (see characteristics given by the manufacturer for not making stupidity). There are also buzzers that work directly on the AC mains 230 V. This type of buzzer is convenient to use, because unlike piezoelectric buzzers simple (simple piezoelectric transducers without associated electronics), it has no work, except of course the eventual control stage which will enable it. He provides a simple DC voltage and presto, it sounds.

Simple Piezo-electric:- A buzzer (transducer) piezoelectric requires an AC voltage to operate, a few volts to several tens of volts (3V to 30V for example). It presents an optimal resonance frequency a few kHz (between 1 kHz and 5 kHz in general, eg, 2 kHz, 2.8 kHz or 3 kHz). It is this type of transducer that can be found on the back of the watch with an alarm function.





Unlike the electro-mechanical buzzer seen before, this component requires some electronics to generate the AC signal it needs to function. So use an oscillator responsible for generating a square wave signal whose frequency is matched to the resonant frequency of the transducer, oscillator can easily be built with logic gates or transistors. If we apply the piezoelectric transducer a signal on one of its terminals, and the same signal but out of phase on its other terminal, it will be able to deliver a power quad, with a supply voltage identical (mounting bridge, same principle as that adopted for certain audio amplifiers power).

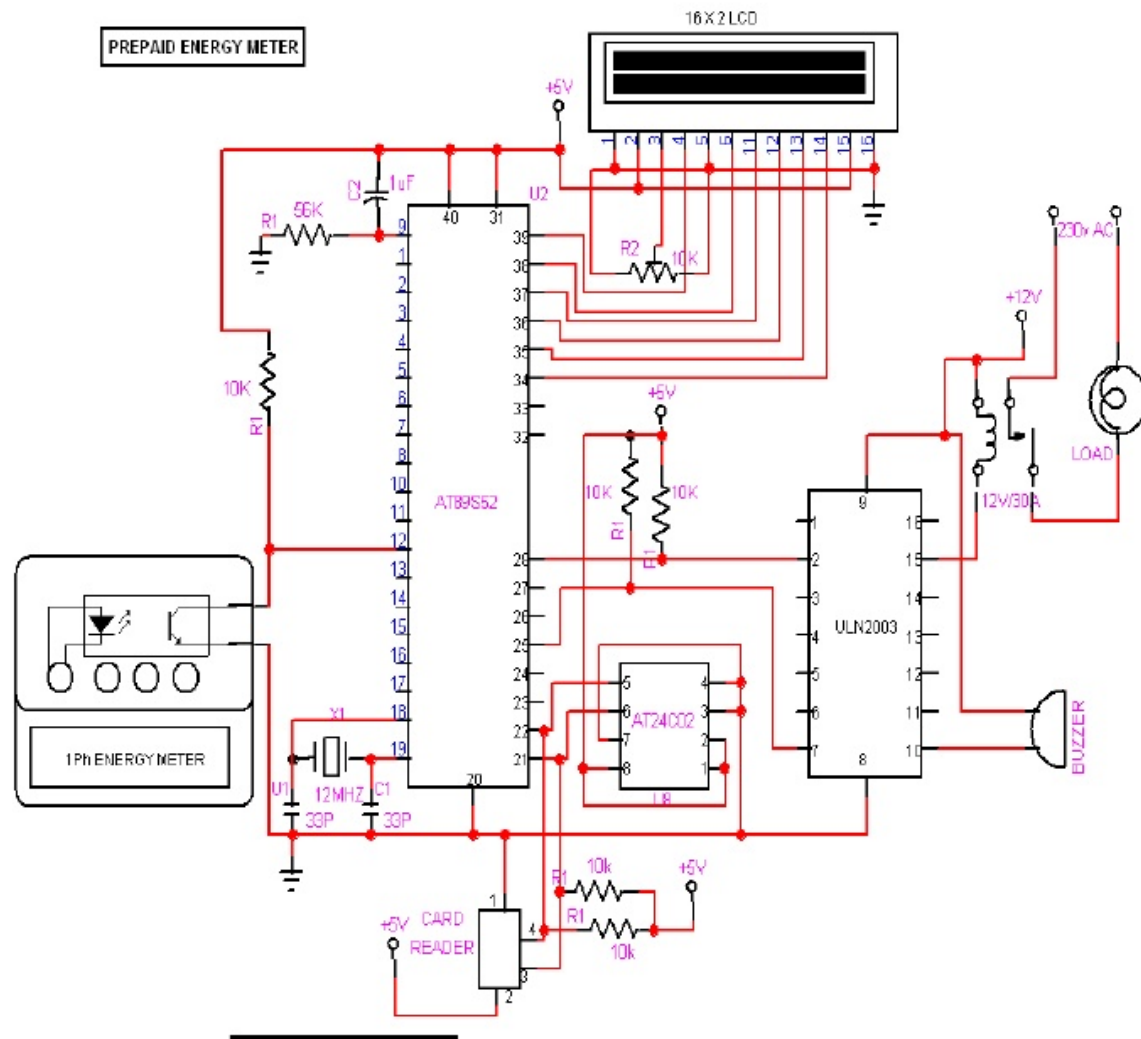
Warning

A piezoelectric transducer is reversible: it produces a sound when one applies an alternating voltage, and outputs a voltage periodic damped when tapped. The second feature is useful to use as a vibration sensor (placed on an acoustic drum, it helps with some additional electronics, trigger another sound), but can be dangerous to the electronics that control because the tension he is capable of delivering upon impact may amount to several tens of volts. It is therefore imperative not to "rush" when used as a sound generator, if one wants his control stage live long. You can always try to "capture" the energy that provides the transducer when struck, this is what I tried - without much convincing results it must be admitted.

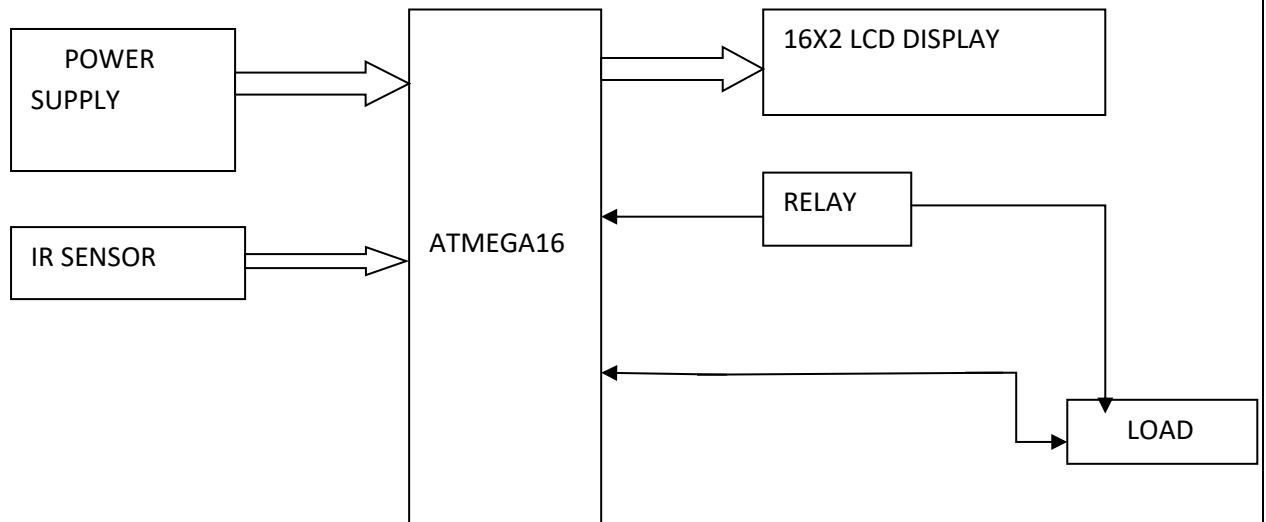
CHAPTER-3

CIRCUIT DIAGRAM AND BLOCK DIAGRAM

Circuit diagram



Block diagram:



CHAPTER-4

BENEFITS OF PREPAID ENERGY METER

Improved operational efficiencies:

The prepaid meters are likely to cut the cost of meter reading as no meter readers are required. In addition, they eliminate administrative hassles associated with disconnection and reconnection. Besides, going by South Africa's experience, prepaid meters could help control appropriation of electricity in a better way than conventional meters.

Benefits of Reduced financial risks:

Since the payment is up-front reduces the financial risk by improving the cash flows and necessitates an improved revenue management system.

Better customer service:

The system eliminates billing delay, removes cost involved in disconnection/reconnection, enables controlled use of energy, and helps customers to save money through better energy management.

Market Drivers

Power sector reforms:

The upcoming competitive and customer focused deregulated power distribution market will force the market participants to make the existing metering and billing process more competent. This is likely to drive the prepaid market.

Increasing non-technical losses:

Metering errors, tampering with meters leading to low registration and calibration related frauds are some of the key components of non-technical losses. India reports greater than 10 percent of non-technical losses. It has been reported that prepaid meters control non-technical losses better than conventional ones

Opportunities in the emerging electrifying markets:

Most of the Asian countries do not have 100 percent electrification; hence new markets are being created by the increasing generating capacity. Prepaid systems can be more easily introduced in such new markets rather than the existing ones.

4.1 Market Restraints**Consumer behavior:**

Consumers have not had any major problems with the existing post-paid system, and hence it is likely to be difficult to convince them to change over to prepaid system. Consumers might not appreciate the concept of "pay and use" as far as electricity is concerned because it might be perceived as an instrument to control common man's life style.

Initial investment:

Utilities might be discouraged by the huge initial investment, which includes the cost of instrument, marketing campaign, establishing distribution channel, and other management costs.

Rapid technology changes:

The rapid technology changes happening in the metering market are expected to delay the decision to go for prepaid system.

Uncertainty over the success:

Prepaid system is not as proven a concept in all the markets as South Africa; hence there is bound to be uncertainty over its success, if implemented. The success of the system depends on the commitment by utilized for this they need to get convinced on the real benefits of prepaid meters

4.2 Recent Initiatives

The Sabah Electricity Sdn Bhd (SESB), Malaysia, has awarded a contract to a local manufacturer to supply 1,080 prepaid meters

Countries such as Thailand, Bangladesh, Singapore, and Iran have been showing increased interest in adopting prepaid system

In India, the State of West Bengal has decided to introduce the smart card operated prepaid energy meters in remote islands of Sunder bans. In Mumbai, pre-paid power is provided by the Brihanmumbai Electricity Supply and Transport (BEST) Undertaking. Tata Power plans to introduce pre-paid electricity in Delhi.

CHAPTER-5

ADVANTAGES OF PREPAID ENERGY METER

ADVANTAGES

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CHAPTER-6

FUTURE SCOPE

FUTURE SCOPE:

In the present time of 21st century we have no space for errors or faults either in any technical system or in general applications. Prepaid energy meter is an advantages concept for the further. It's facilitates the exemption from electricity bills. Electricity coupons will be available at nearby shops. The word prepaid means "pay before use" one of the advantageous feature of this concept prepaid energy meter is used to prepaid the ongoing supply of electricity to homes, offices etc.

CONCLUSION

The monopolistic power distribution market in asia is gradually transforming into a competitive marketplace. Differentiation in service is going to be the key competitive factor to the improve market share in the deregulated power markets prepaid meters with their advantages over conventional ones are likely to help power distributors to differentiate and offer value –added services to consumers. Encourage consumers to opt for prepaid meters on a voluntary basis and offering tariff or non-tariff incentives to those consumers who prepaid their power changes would help the utilities to implement this system

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