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Solar Operated Battery Management System

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Abstract: *This paper focuses on the hardware aspects of battery management systems (BMS) for electric vehicle and stationary applications. The purpose is giving an overview on existing concepts in state-of-the-art systems and enabling the reader to estimate what has to be considered when designing a BMS for a given application. After a short analysis of general requirements, several possible topologies for battery packs and their consequences for the BMS' complexity are examined. Four battery packs that were taken from commercially available electric vehicles are shown as examples. Later, implementation aspects regarding measurement of needed physical variables (voltage, current, temperature, etc.) are discussed, as well as balancing issues and strategies. Finally, safety considerations and reliability aspects are investigated..*

Keywords: Solar

I. INTRODUCTION

BMS means different things to different people. To some it is simply Battery Monitoring, keeping a check on the key operational parameters during charging and discharging such as voltages and currents and the battery internal and ambient temperature. The monitoring circuits would normally provide inputs to protection devices which would generate alarms or disconnect the battery from the load or charger should any of the parameters become out of limits.

For the power or plant engineer responsible for standby power who's battery is the last line of defence against a power blackout or a telecommunications network outage BMS means Battery Management Systems. Such systems encompass not only the monitoring and protection of the battery but also methods for keeping it ready to deliver full power when called upon and methods for prolonging its life. This includes everything from controlling the charging regime to planned maintenance.

For the automotive engineer the Battery Management System is a component of a much more complex fast acting Energy Management System and must interface with other on board systems such as engine management, climate controls, and communications and safety systems.

There are thus many varieties of BMS.

The battery fuel status indicator is a common feature of the battery supported handheld devices The battery fuel measurement is achieved by measuring the discharging and charging currents in real time. The discharging current is the current coming out from the battery and the charging current is the current flowing into the battery. The fuel used (mAH) and the fuel remaining (mAH) are calculated by tracking the discharging and charging currents over time. The fuel used is the total discharged current over time and the remaining fuel is simply the subtraction of the fuel used from the fully charged fuel.

1.1 Need of project

- The behaviour of the battery fuel is greatly affected by temperature and the battery aging. A true battery management needs to consider these effects by measuring current, voltage, and temperatures with a function of time.
- Battery management system needs to be enhanced in order to provide a better performance.
- Battery monitoring system is also part of BMS that is required in order to monitor operational system, performance and battery life such as charge and discharge process.
- Provide battery safety and longevity, a must-have for Li-ion.
- Reveal state-of-function in the form of state-of-charge and state-of-health (capacity)
- The BMS also needs to provides protection when charging and discharging; it disconnects the battery if set limits are exceeded or if a failure occurs

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1.2 Objectives of Project

- Protect the cells or the battery from damage
- Prolong the life of the battery
- Maintain the battery in a state in which it can fulfil the functional requirements of the application for which it was specified.
- Cell protection
- Charge control AND Digital display of all parameters

II. LITERATURE SURVEY

2.1 Paper Survey

Many Researches has been done on Battery Management System (BMS) and Battery Monitoring System. Compared to Battery Management System Battery Monitoring System is software design based on BMS. Rahimi-Eichi and Habiballah[1] in their paper gave a brief introduction to the composition of the battery management system (BMS).They says BMS in vehicles is comprised of kinds of sensors, actuators, controllers which have various algorithms and signal wires. Their main task is to protect the cells and battery packs from being damaged and to make the batteries operate within the proper voltage and temperature, but here the key issue is battery cell voltage measurement. Small drop in each cell voltage gives larger voltage drop in the entire battery pack, so accurate values of battery parameters cannot be obtained by this method hence this method is not appropriate one. Karmore, Swapnili P, A.R.Mahajan[2] proposed battery monitoring system which is capable of sensing and monitoring capability of battery of mobile phone, which is used to indicate the battery conditions in any numbers of standby powers. The main aim behind the research work is the design and development of Power saver. It consists of two modules that is Start profiler and Installed application list. Start profiler starts the application and gives the Stat, pie, chart view of the battery voltage and installed application gives the list of all the applications in the device with percentage battery usage. Powers aver is used for calculation of battery consumption. Luo,Min,et al[3] Proposed a novel online battery monitoring system based on GPRS for electric vehicles. It divided the traditional battery management system into two parts. One part is the online monitoring terminal with GPRS date transmitter unit settled in the EVs to measure the voltage, current and temperature, and the other one is an upper computer with a battery online monitoring system software but in this system, the monitoring software is designed on a fixed PC, which restricts applied range of monitoring system. Besides, the batteries information is transmitted to an upper computer through the GPRS communication in a slow rate.
The increasing sales of electric and hybrid electric cars in urban areas, in conjunction with the large assortment of consumer electronics are fueling demand for a portable, low-cost, environmentally friendly and reliable energy storage devices. Lithium-ion batteries currently provide one of the best solutions when considering cost, energy density and safety. This chapter presents an overview on the current state of lithium-ion battery technology in the automotive field.

2.2 Current Energy Situation Presently, fossil fuels supply 80% and renewable resources supply only 13 % of the total global energy demand. There are several concerns with the ongoing trend, mainly the limited sources of fossil fuels. Several studies suggest that the reserves of oil, coal and natural gas could be exhausted within the next 200 years . Another issue worth addressing is the impact of emissions from burning fossil fuels on the environment. The presence of excess carbon dioxide in the atmosphere has been attributed to a rise in global temperatures, rise in sea levels, negative impacts on natural ecosystems and a rise in catastrophic weather events. given no change to the current trend, is demonstrated in .It is apparent that a change from the current trend of energy use is necessary in order to sustain the needs of the future generations and avoid global climate

2.3. Energy Storage Candidates In the context of global warming, electrical energy storage devices and batteries are critically important and can be used in applications ranging from transportation to localized urban electrical power generation and distribution. Batteries are able to store energy that is produced at times of either low requirement, low cost or from irregular sources. The stored energy can then be used at times of peak demand, high production cost or when there are no other viable generations means present. A brief description of some of these energy storage devices is presented below:

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2.4. Lead acid battery*:* Lead acid batteries are one the oldest and most popular energy storage devices due to their high reliability and low cost. However Low energy density, short cycle life and inability to work in low temperatures make lead acid batteries unsuitable for long term energy storage.

2.5. Nickel cadmium batteries: Nickel cadmium batteries are also popular due to their reliability and minimal need for care.

2.6 Lithium-*ion batteries:* Lithium-ion batteries first produced by Sony in 1990 have drastically improved over the last few decades. Energy density, cycle life and efficiency. Lithium-ion batteries have largely replaced bulkier less energy absorbing nickel cadmium batteries in electronic devices such as cellular phones and computers. Furthermore lithium-ion batteries are now used in electrical and hybrid electrical vehicles such as the Nissan Leaf. **2.7 *Fuel Cells****:* Some examples of current fuel cell technology include hydrogen fuel cells, direct-methanol fuel cells and molten carbonate fuel cells. Most fuel cell technologies are excellent at storing energy. Unfortunately, fuel cells suffer from high cost and low efficiency.

2.8. Ultra-capacitors: Ultra-capacitors are an excellent candidate for producing short term instantaneous power. In comparison to batteries, ultra-capacitors have much lower energy densities and much greater power densities. This relationship has encouraged further exploration into producing a battery/ultra-capacitor hybrid energy storage unit

III. SYSTEM DEVELOPEMENT

While developing any microcontroller based electronic system, there are some steps which must be followed. These steps are:

1. Deciding system specifications i.e. Block diagram
2. Selection of system components
3. Design of circuit diagram
4. Design of PCB layout
5. Manufacturing of PCB layout
6. Component mounting & soldering
7. Testing and troubleshooting of hardware
8. Design of enclosure or structure if any

3.1 Block Diagram

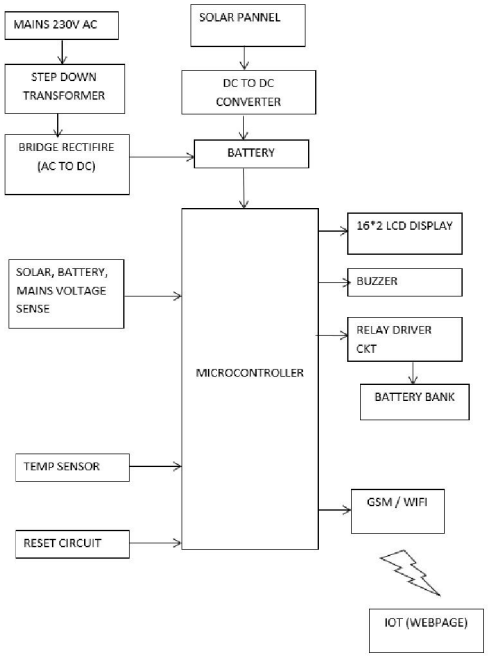

Figure 3.1.System Block Diagram

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3.2 Description of Blocks

3.2.1 Microcontroller PIC18F4520

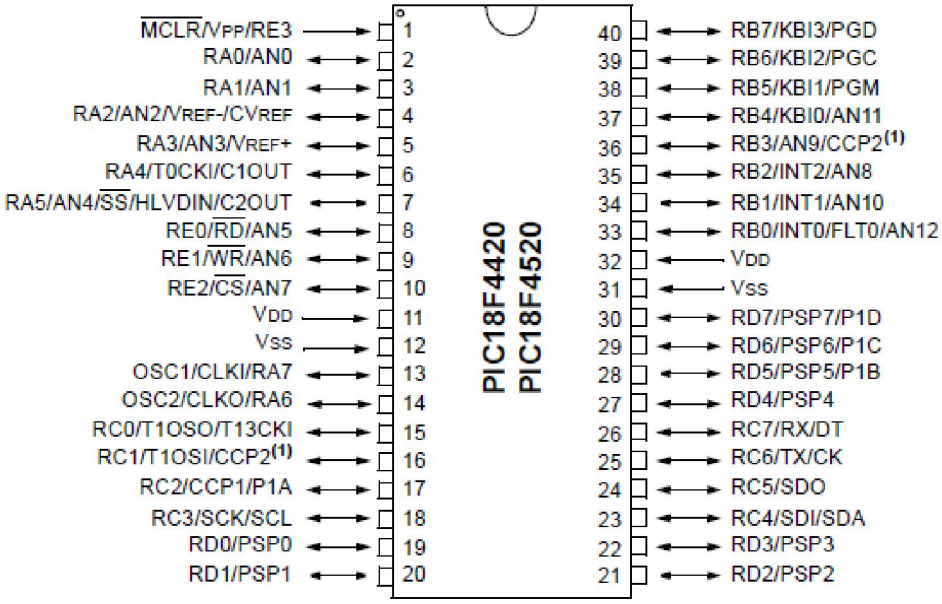

Figure 3.2.1 Pin diagram of PIC18F4520 microcontroller.

Features:

Data Memory up to 4k bytesn Data register map - with 12-bit address bus 000-FFF

o Divided into 256-byte banks

o There are total of F banks

o Half of bank 0 and half ofbank 15 form a virtual (oraccess) bank that is accessibleno matter which bank isselected – this selection isdone via 8-bits

Program memory is 16-bits wide accessed through a separate program data bus and address bus inside the PIC18.

o Program memory stores the program and also static data in the system.

On-chip External

On-chip program memory is either PROM or EEPROM.

n The PROM version is called OTP (one-time programmable) (PIC18C) The EEPROM version is called Flash memory (PIC18F).

o Maximum size for program memory is 2M n Program memory addresses are 21-bit address starting at location 0x000000

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Features	PIC18F4520
Operating Frequency	DC – 40 MHz
Program Memory (Bytes)	32768
Program Memory (Instructions)	16384
Data Memory (Bytes)	1536
Data EEPROM Memory (Bytes)	256
Interrupt Sources	20
I/O Ports	Ports A, B, C, D, E
Timers	4
Capture/Compare/PWM Modules	1
Enhanced Capture/Compare/PWM Modules	1
Serial Communications	MSSP, Enhanced USART
Parallel Communications (PSP)	Yes
10-Bit Analog-to-Digital Module	13 Input Channels
Resets (and Delays)	POR, BOR, RESET Instruction, Stack Full, Stack Underflow (PWRT, OST), MCLR (optional), WDT
Programmable High/Low-Voltage Detect	Yes
Programmable Brown-out Reset	Yes
Instruction Set	75 Instructions; 83 with Extended Instruction Set Enabled
Packages	40-Pin PDIP 44-Pin QFN 44-Pin TQFP

Table 3.2.1 **Features of pic18f4520**

3.2.2 Lead Acid Battery

The battery which uses sponge lead and lead peroxide for the conversion of the chemical energy into electrical power, such type of battery is called a lead acid battery. The lead acid battery is most commonly used in the power stations and substations because it has higher cell voltage and lower cost. The various parts of the lead acid battery are shown

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below. The container and the plates are the main part of the lead acid battery. The container stores chemical energy which is converted into electrical energy by the help of the plates.

Working Principle of Lead Acid Battery

When the sulphuric acid dissolves, its molecules break up into positive hydrogen ions ($2H^+$) and sulphate negative ions (SO_4^{--}) and move freely. If the two electrodes are immersed in solutions and connected to DC supply then the hydrogen ions being positively charged and moved towards the electrodes and connected to the negative terminal of the supply. The SO_4^{--} ions being negatively charged moved towards the electrodes connected to the positive terminal of the supply main (i.e., anode).

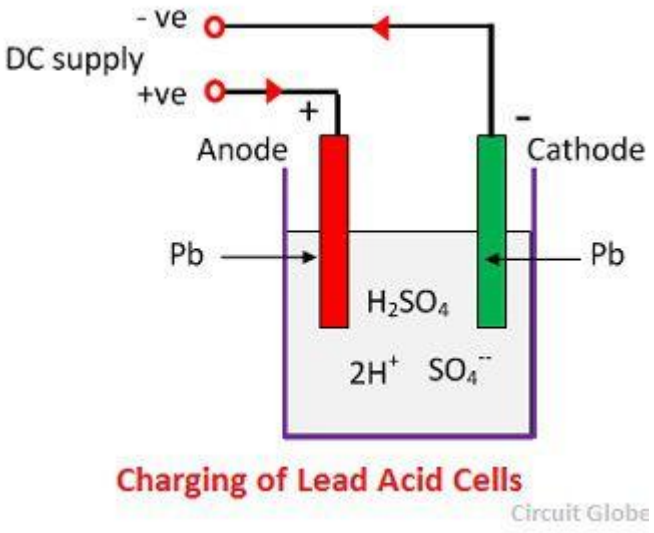

Figure 3.2.2.a Working Principle of Lead Acid Battery

Each hydrogen ion takes one electron from the cathode, and each sulphates ions takes the two negative ions from the anodes and react with water and form sulfuric and hydrogen acid.

The oxygen, which produced from the above equation react with lead oxide and form lead peroxide (PbO_2.) Thus, during charging the lead cathode remain as lead, but lead anode gets converted into lead peroxide, chocolate in colour.

If the DC source of supply is disconnected and if the voltmeter connects between the electrodes, it will show the potential difference between them. If wire connects the electrodes, then current will flow from the positive plate to the negative plate through external circuit i.e. the cell is capable of supplying electrical energy

Chemical Action during Discharging

When the cell is full discharge, then the anode is of lead peroxide (PbO_2) and a cathode is of metallic sponge lead (Pb). When the electrodes are connected through a resistance, the cell discharge and electrons flow in a direction opposite to that during charging.

The hydrogen ions move to the anode and reaching the anodes receive one electron from the anode and become hydrogen atom. The hydrogen atom comes in contacts with a PbO_2, so it attacks and forms lead sulphate ($PbSO_4$), whitish in colour and water according to the chemical equation.

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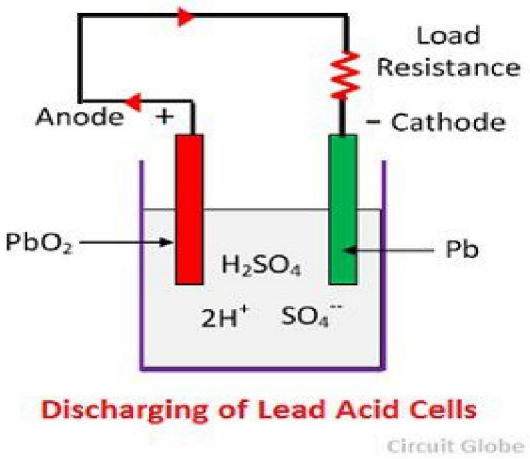
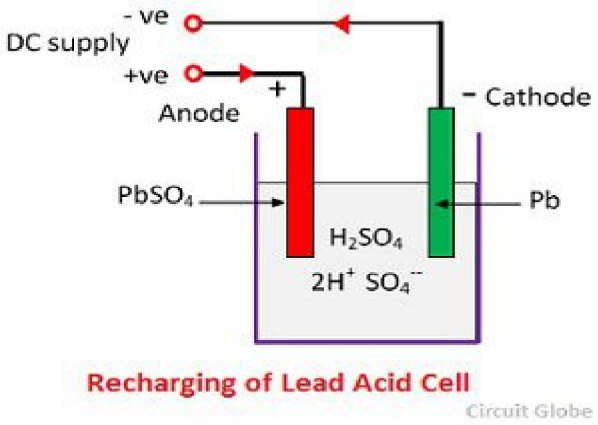


Figure 3.2.2.a Chemical Action during Discharging

Chemical Action During Recharging

For recharging, the anode and cathode are connected to the positive and the negative terminal of the DC supply mains. The molecules of the sulfuric acid break up into ions of $2H^+$ and SO_4^{--}. The hydrogen ions being positively charged moved towards the cathodes and receive two electrons from there and form a hydrogen atom. The hydrogen atom reacts with lead sulphate cathode forming lead and sulfuric acid according to the chemical equation.



$$PbSO_4 + 2H_2O + 2H = PbSO_4 + 2H_2SO_4$$

1) Figure 3.2.2.a Chemical Action during recharging

3.2.3 16*2 LCD DISPLAY:

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.

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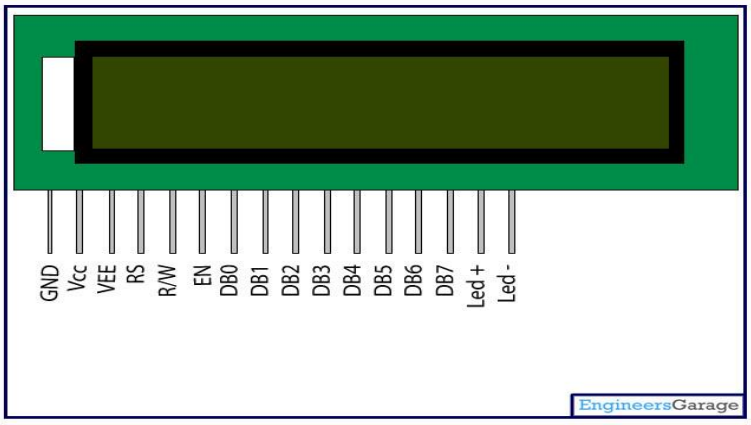

Figure 3.2.3LCD display

6. Interface pin description

Pin no.	Symbol	External connection	Function
1	Vss	Power supply	Signal ground for LCM
2	V_{DD}		Power supply for logic for LCM
3	V_0		Contrast adjust
4	RS	MPU	Register select signal
5	R/W	MPU	Read/write select signal
6	E	MPU	Operation (data read/write) enable signal
7~10	DB0~DB3	MPU	Four low order bi-directional three-state data bus lines. Used for data transfer between the MPU and the LCM. These four are not used during 4-bit operation.
11~14	DB4~DB7	MPU	Four high order bi-directional three-state data bus lines. Used for data transfer between the MPU
15	LED+	LED BKL power supply	Power supply for BKL
16	LED-		Power supply for BKL

table 3.2.3interface pin description

3.2.4.SOLAR PANEL:

Photovoltaic solar panels absorb sunlight as a source of energy to generate direct current electricity. A photovoltaic (PV) module is a packaged, connected assembly of photovoltaic solar cells available in different voltages and wattages. Photovoltaic modules constitute the photovoltaic array of a photovoltaic system that generates and supplies solar electricity in commercial and residential applications.

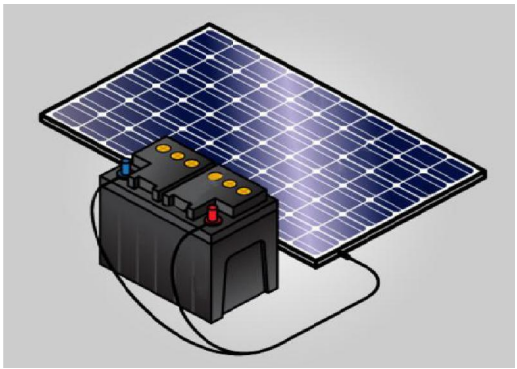

Figure 3.2.4solar panel

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One of the essential components of the solar charging system is the solar panel. A solar panel is a device that is designed to absorb sunlight to generate electricity or heating power. It is the component that helps collect energy from direct sunlight and then converts it into electricity.

There are several types of solar panels. The three most common types are Monocrystalline cells, polycrystalline cells and amorphous or thin-film solar cell. It is essential to understand the basic features including the watts, cost and space you require before you decide the one to pick.

Solar charge controllers' primary function is to manage power, but it may offer additional capabilities including load control and lighting. Thus, when the solar charge controller receives the solar supply, it then regulates the electricity and current directed to the batteries to ensure proper battery charging occurs.

3.2.5 TEMPERATURE SENSORS:-

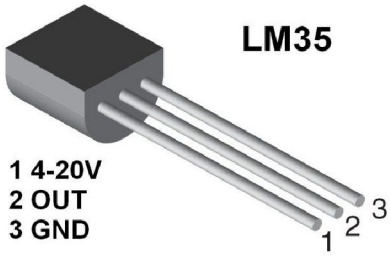


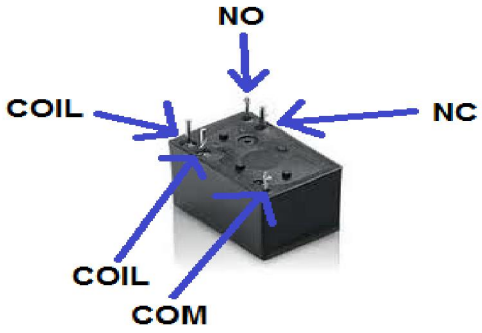
Figure 3.2.5LM35

The LM35 is one kind of commonly used temperature sensor that can be used to measure temperature with an electrical o/p comparative to the temperature (in °C). It can measure temperature more correctly compare with a thermistor. This sensor generates a high output voltage than thermocouples and may not need that the output voltage is amplified. The LM35 has an output voltage that is proportional to the Celsius temperature. The scale factor is .01V/°C.

The LM35-series devices are precision integrated-circuit temperature sensors, with an output voltage linearly proportional to the Centigrade temperature. The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The LM35 devicedoes not require any external calibration or trimming to provide typical accuracies of ± ¼ °C at room temperature and ± ¾ °C over a full −55°C to 150°C temperature range.

3.2.6 RELAY:

Relays are electromechanical switches. They have very high current rating and both AC and DC motors can be controlled through them because motor will be completely isolated from the remaining circuit. Relays are used as driving circuit for motor.



3.2.7 BUZZER:

A buzzer or beeper is an audio signaling device. Which may be mechanical, electromechanical, or piezoelectric (*piezo* for short). Typical uses of buzzers and beepers include alarm device, timers, and confirmation of user input such as a mouse click or keystroke.

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Figure 3.2.7buzzer

Features

- sealed: yes
- operating power: 3-6V DC / 25mA
- extremely compact, ultrathin construction
- no electrical noise
- low current consumption yet high sound pressure level

Specifications

- tone type: single
- operating voltage: 3-6V DC
- rated voltage: 5V DC
- current consumption: 25mA
- osc. frequency: 3.2kHz
- sound level: 87dB
- connector type: pcb

3.2.8 LED'S. (light emitting diode).

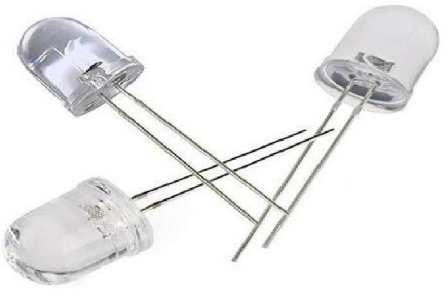

Figure 3.2.8 LED'S.

Working Principle:

A light-emitting diode is a two-lead semiconductor light source. It is a p–n junction diode that emits light when activated. When a suitable voltage is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the colour of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor.

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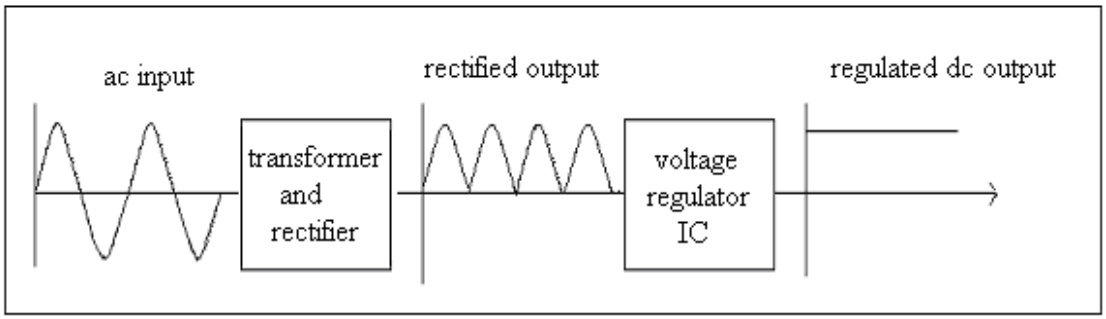
3.3 Working of block Diagram:-

3.3.1 POWER SUPPLY:

All electronic circuits use DC power supply of adequate voltage for their operation.To obtain this DC voltage from 230V AC mains, we need to use a 'rectifier'. The rectified DC voltage is 'pulsating ' in nature. We know that a combination of rectifier & filter can produce a dc voltage which is almost pure i.e. ripple free.However, the problem with such a power supply is that its output voltage will not remain constant in the event of fluctuations in ac input voltage or changes in load current. This type of power supply is called as unregulated power supply.The power supply, which provides a constant output voltage irrespective of everything is called, regulated power supply. So we have to design a regulated power supply using series voltage regulator IC 7805.

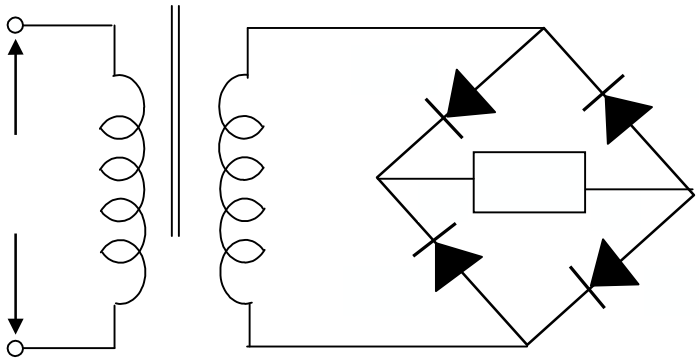
Following figure shows general block diagram of regulated power supply.



1) Figure 3.3.1.aregulated power supply

BRIDGERECTIFIER

Bridge rectifier circuit consists of four diodes arranged in the form of a bridge as shown in figure.



OPERATION

During the positive half cycle of the input supply, the upper end A of the transformer secondary becomes positive with respect to its lower point B. This makes Point1 of bridge Positive with respect to point 2. The diode D1 & D2 become forward biased & D3 & D4 become reverse biased. As a result a current starts flowing from point1, through D1 the load & D2 to the negative end.During negative half cycle, the point2 becomes positive with respect to point1. Diodes 63D1 & D2 now become reverse biased. Thus a current flow from point 2 to point1.

TRANSFORMER

Transformer is a major class of coils having two or more windings usually wrapped around a common core made from laminated iron sheets. It has two cols named primary and secondary. If the current flowing through primary is fluctuating, then a current will be inducted into the secondary winding. A steady current will not be transferred from one coil to other coil.

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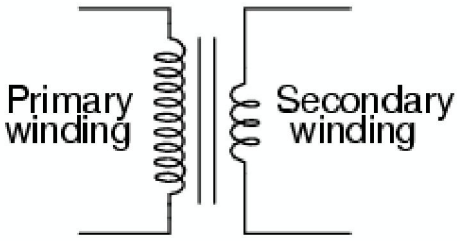

Design of C1:

The maximum current that can be drawn from this IC is 1A.But our circuit requires maximum current of Imax, which is summation of all the current required to drive individual IC,s.

Im = 100 mA

For safety purpose, we consider the maximum current limit exactly double of the circuit requirement

Imax=2Im.

Therefore, Imax = 200 mA.

We know that,

$$Q = CV \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where,

Q = charge on capacitor.

C = capacitance.

V = voltage applied to capacitor.

Also,

$$Q = I\,t. \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where,

I = Imax.

t = period of output voltage of rectifier.

Equating equations (1) & (2), we get

$$CV = Imax\ t. \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

Now, at input of transformer, applied voltage frequency is 50 Hz.

As we have used step down transformer of 9-0-9 V, we get output voltage having same frequency of 50 Hz but amplitude step down to 9V (rms).

After rectification, frequency doubles & amplitude becomes Vpeak, as shown in figure.

Vin(rms) = 230 v.

Vsec(rms)= 9v.

Therefore, Vpeak = Vp = Vsec / 0.707.

Vp = 12 v.

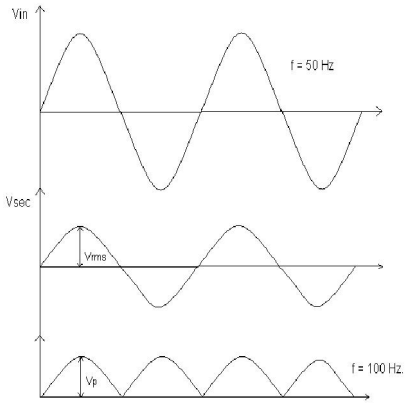

Figure 3.3.1.dwaveform

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And, t = 1 / 2f.
= 1 / 100.
= 0.01 sec.
From equation (3),
CV = I t.
Therefore,
C = Imax t / V.
= 200 * 0.01 / 12
= 166.66 uF.
Select, C1= 470 uF.

Design of C2:
We know that, due to internal circuitry of IC 7805 and load connected at the output of power supply; various types of noises are generated at its output, such as thermal noise, flicker noise, shot noise, white noise etc. Hence in order to bypass all these noises, we have to connect a capacitor C2.
It can take value between 0.1uF to 100uF.
Here we have connected C2 = 100 uF.

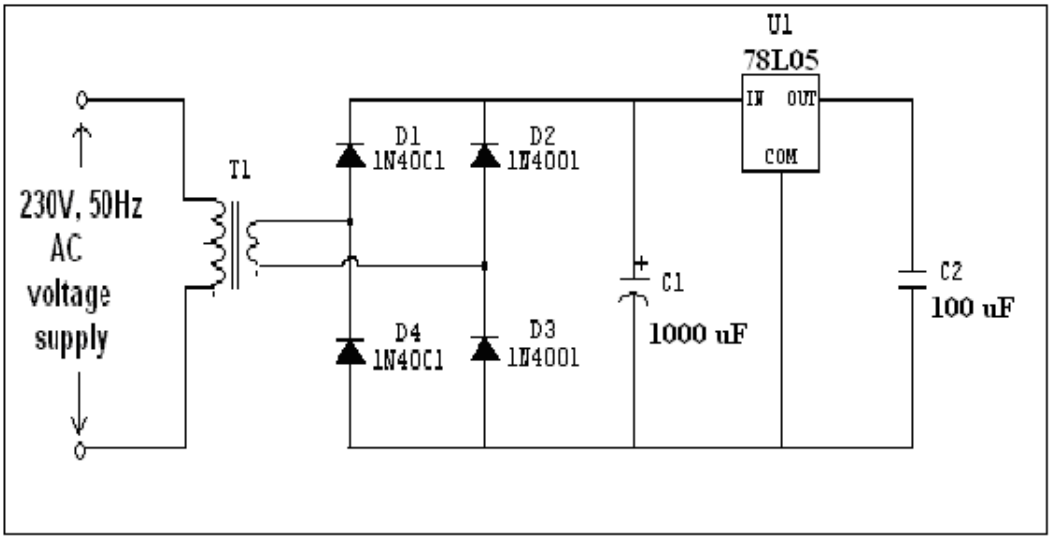

Figure 3.3.1.d regulated power supply

3.3.2 SOLAR BATTERY CHAEGING CIRCUIT:

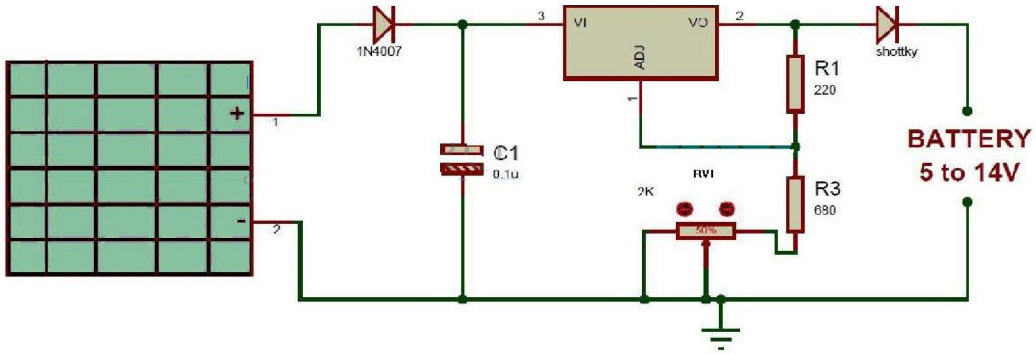

Figure 3.3.2solar battery charger circuit

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One of the essential components of the solar charging system is the solar panel. A solar panel is a device that is designed to absorb sunlight to generate electricity or heating power. It is the component that helps collect energy from direct sunlight and then converts it into electricity.

There are several types of solar panels. The three most common types are Monocrystalline cells, polycrystalline cells and amorphous or thin-film solar cell. It is essential to understand the basic features including the watts, cost and space you require before you decide the one to pick.

Solar charge controllers' primary function is to manage power, but it may offer additional capabilities including load control and lighting. Thus, when the solar charge controller receives the solar supply, it then regulates the electricity and current directed to the batteries to ensure proper battery charging occurs.

3.3.4 BUZZER:-

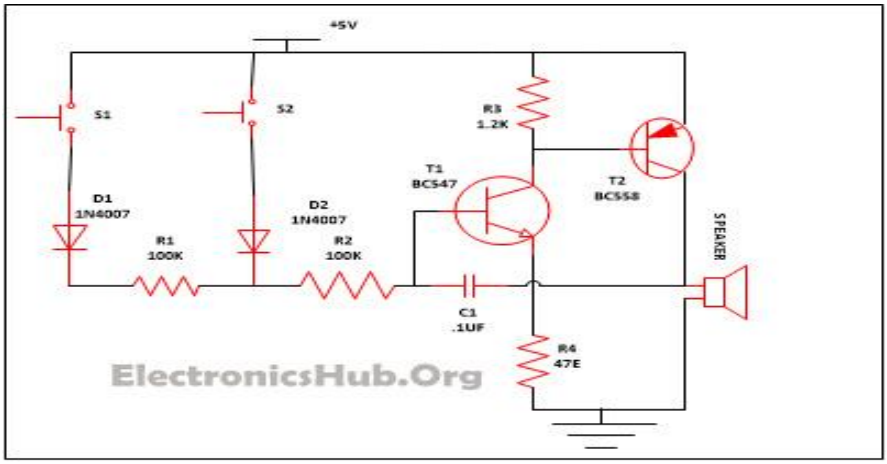

Figure 3.3.1.c Buzzer circuit diagram

Working Principle:

The vibrating disk in a magnetic**buzzer** is attracted to the pole by the magnetic field. When an oscillating signal is moved through the coil, it produces a fluctuating magnetic field which vibrates the disk at a frequency equal to that of the drive signal.

When A voltage is applied to the electrodes of the piezo element, they produces flex in either way. This flex force bends the ground plate up and down.

The exact opposite thing happens too, when a a piezoelectric element is subjected to varying pressure, it produces voltage.

As you've seen before, self drive piezo buzzers are constructed with an extra electrically isolated feedback electrode. The voltage created by the flex force is available in the feedback terminal.

The piezo buzzer is placed in a resonant cavity, there is a hole in the opposite side of the resonant cavity from where the buzzing sound comes out.

The driver circuit and piezo buzzer co-operates soon between themselves and they starts oscillating on the resonant frequency of the piezo buzzer. So that's it, construction of a simple *piezo buzzer circuit*,

I could write more about it's operating principle, but that's not necessary her Need a buzzer that sounds good ? Here is the more pleasant sounding **piezoelectric buzzer circuit**Piezo buzzers are one of the most common buzzers available around, they got their name from the piezoelectric material used as the active element.

These buzzers are usually driven at a relatively higher voltage but low current, consumes a little power, but still capable of producing very high sound.

So, here we're going to build and test a simple piezoelectric buzzer circuit Component list

You're going to need few very basic components for this *simple piezo buzzer circuit*.

One BC548 transistor, or other similar NPN transistor.

One 10kΩ resistor.

One 100kΩ resistor.

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One self drive 3 terminal piezoelectric buzzer.
One 1-10mH inductor coil, details below.
A power source of course, 6V to 24V

3.3.5 REALY DRIVER CIRCUIT:

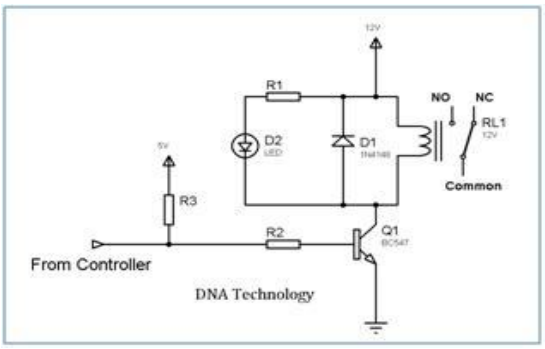

Figure 3.3.1.relay circuit diagram

shows the basic relay driver circuit. As you can see an NPN transistor BC547 is being used to control the relay. The transistor is driven into saturation (turned ON) when a LOGIC 1 is written on the PORT PIN thus turning ON the relay. The relay is turned OFF by writing LOGIC 0 on the port pin. A diode (1N4007/1N4148) is connected across the relay coil; this is done so as to protect the transistor from damage due to the BACK EMF generated in the relay's inductive coil when the transistor is turned OFF. When the transistor is switched OFF the energy stored in the inductor is dissipated through the diode & the internal resistance of the relay coil. Normally 1N4148 diode can be used as it is fast switching diode with a maximum forward current of 300ma. This diode is also called as free-wheeling diode. The LED is used to indicate that the RELAY has been turned ON.The resistor R1 defines the current flowing through the LED thereby defining the LED's intensity. Resistor R2 is used as a Series Base Resistor to set the base current. When working with 8051 controllers I have noted that it's not compulsory to use this resistor as the controller has internal 10k resistor which acts as a base resistor.

3.4 Material costing Sr.No.	COMPONENT	NOBs	PRICE/PC	TOTAL
1	ATMEGA328P micro-controller	1	400	400
2	Pushbutton switch	12	25	300
3	Bi colour leds	36	7	250
4	5V buzzer	1	35	35
5	12V, 1Amp Step down Transformer	1	280	280
6	1000uF, 25V capacitors	5	12	60
7	28 Pin IC base	1	85	85
8	74hc595 SHIFT REGISTER	9	64	572
9	IC base 16 pin	9	20	178
10	Multi stand wire	4M	38	150
11	TTL to serial converter	1	245	245
12	USB cord	1	85	85
13	Crystal 16MHz	1	28	28

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14	Resistor	80	1.5	120
15	Capacitor-CIRAMIC DISC 104	15	2	30
16	P-N junction diode	4	4	16
17	Copper Clad	1	240	240
18	FeCl3 powder	1	180	180
19	Solder metal	1	235	235
20	Panel board	1	1000	1000
22	AC Supply wire	1	30	30
TOTAL			4519	

Figure 3.3.1.c Basic Transformer

IV. SOFTWARE DEVELOPMENT

4.1 Selection of Microcontroller Programming Tool.

Once microcontroller is selected, selecting a perfect development tools is most important. For develop every microcontroller based system, a set of software and hardware tools are required. Software tools for editing and debugging and troubleshooting the microcontroller program. While hardware tools for burning computer code into microcontroller and testing microcontroller hardware. A good development tools must have following properties:

1. Simple to use.
2. Not many steps execution.
3. Inexpensive.
4. Must include basic functions like editor, debugger, compiler.
5. Must include power supply and basic hardware required and I/O pins connector facility.
6. Cross-platform development.
7. Must support different programming language and computer operating system.

4.1.1 Embedded C

Embedded C is a set of language extensions for the C Programming language by the C Standards committee to address commonality issues that exist between C extensions for different embedded systems. Historically, embedded C programming requires nonstandard extensions to the C language in order to support exotic features such as fixed-point arithmetic, multiple distinct memory banks, and basic I/O operations. Embedded C uses most of the syntax and semantics of standard C, e.g., main() function, variable definition, datatype declaration, conditional statements (if, switch, case), loops (while, for), functions, arrays and strings, structures and union, bit operations, macros, etc.

Features:-

1) It is small and simpler to learn, understand, program and debug.
2) Compared to assembly language, C code written is more reliable and scalable, more portable between different platforms.
3) C compilers are available for almost all embedded devices in use today, and there is a large pool of experienced C programmers.
4) C has advantage of processor-independence and is not specific to any particular microprocessor/microcontroller or any system.
5) As C combines functionality of assembly language and features of high level languages.
6) It is fairly efficient.
7) It supports access to I/O and provides ease of management of large embedded projects.

4.1.2 PIC Microcontroller

PIC is a family of microcontrollers manufactured by Microchip Technology Inc. PIC stands for **Peripheral Interface Controller**. It is also referred to as **Programmable Interface Controller** or **Programmable Intelligent Computer**.

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Figure 3.3.1.cpic microcontroller

As all other microcontrollers PIC Microcontroller can be programmed using Assembly Language. As it is little bit difficult we prefer High Level Languages. Many high level language compilers are available for programming a PIC Microcontroller like MikroC, MPLAB XC8, Hi-Tech C, CCS C etc. In this tutorial we will use CCS C Compiler. CCS stands for Custom Computer Services, a Microchip PIC Microcontroller Tool Solutions company.
MikroC and CCS C are the best compilers for beginners as they includes a lot of built in libraries which enable us to program a PIC Microcontroller without the deep knowledge of its internal architecture. I think CCS C is the best High Level Language Compiler for PIC Microcontroller as it is almost hardware independent.

4.2 MPLAB X IDESoftware.

MPLAB X IDE is a software program that runs on a PC (Windows®, Mac OS®, Linux®) to develop applications for Microchip microcontrollers and digital signal controllers. It is called an Integrated Development Environment (IDE), because it provides a single integrated "environment" to develop code for embedded microcontrollers.
MPLAB X Integrated Development Environment brings many changes to the PIC® microcontroller development tool chain. Unlike previous versions of the MPLAB IDE which were developed completely in-house, MPLAB X IDE is based on the open source NetBeans IDE from Oracle. Taking this path has allowed us to add many frequently requested features very quickly and easily, while also providing us with a much more extensible architecture to bring you even more new features in the future.

1. Open MPLAB IDE v8.56
2. From the 'Projects' tab, select the first option 'Project Wizard'
3. Click on 'Next' in the welcome window that appears.
4. Select the desired PIC which you need to program or build your project on and click on 'Next'
5. Select the active tool suite you require; among the list of tool suites given (Usually the HI-TECH Universal tool suite is preferred,if installed)
6. Check if the ToolSuite contents listed contains a compiler suiting your programming needs("HI-TECH ANSI C Compiler" in the case of a HI-TECH Universal toolsuite) and click 'Next'
7. Create a new project file at your desired location in the desired name.
8. Take care that the project file is saved in the '*.mcp' format and click 'Next'
9. In the next window , add any files you desire to add to your new project,if required. else just skip this step by clicking 'Next'.
10. Now click 'finish' and your new project is created.
11. Now select the 'New' option from the 'File' tab.v

Select 'Save as' option from the 'File' tab and save the new file in the same folder in which you have created the project by selecting a suitable option from 'save as type'(depending on which type of program you're doing)

12. Go to the 'Project' tab and select the option 'Add Files To The Project' and add the file saved in the previous step you're doing programming in C

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13. Assembly Source Files if you're doing programming in ASSEMBLY language etc...

Begin programming in the file

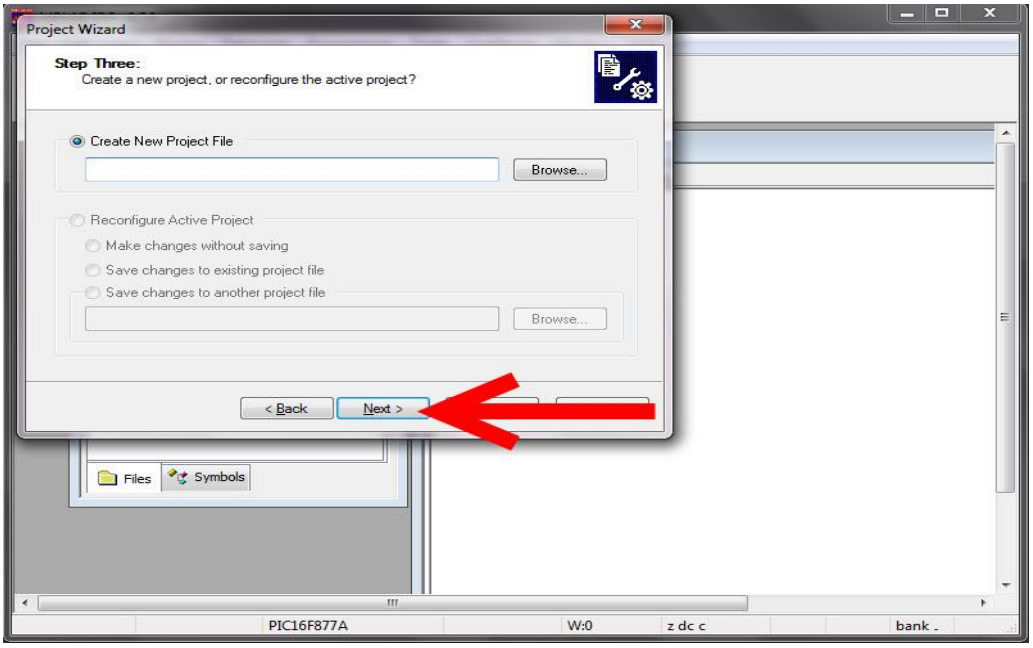

Figure 4.2.apcb wizard software

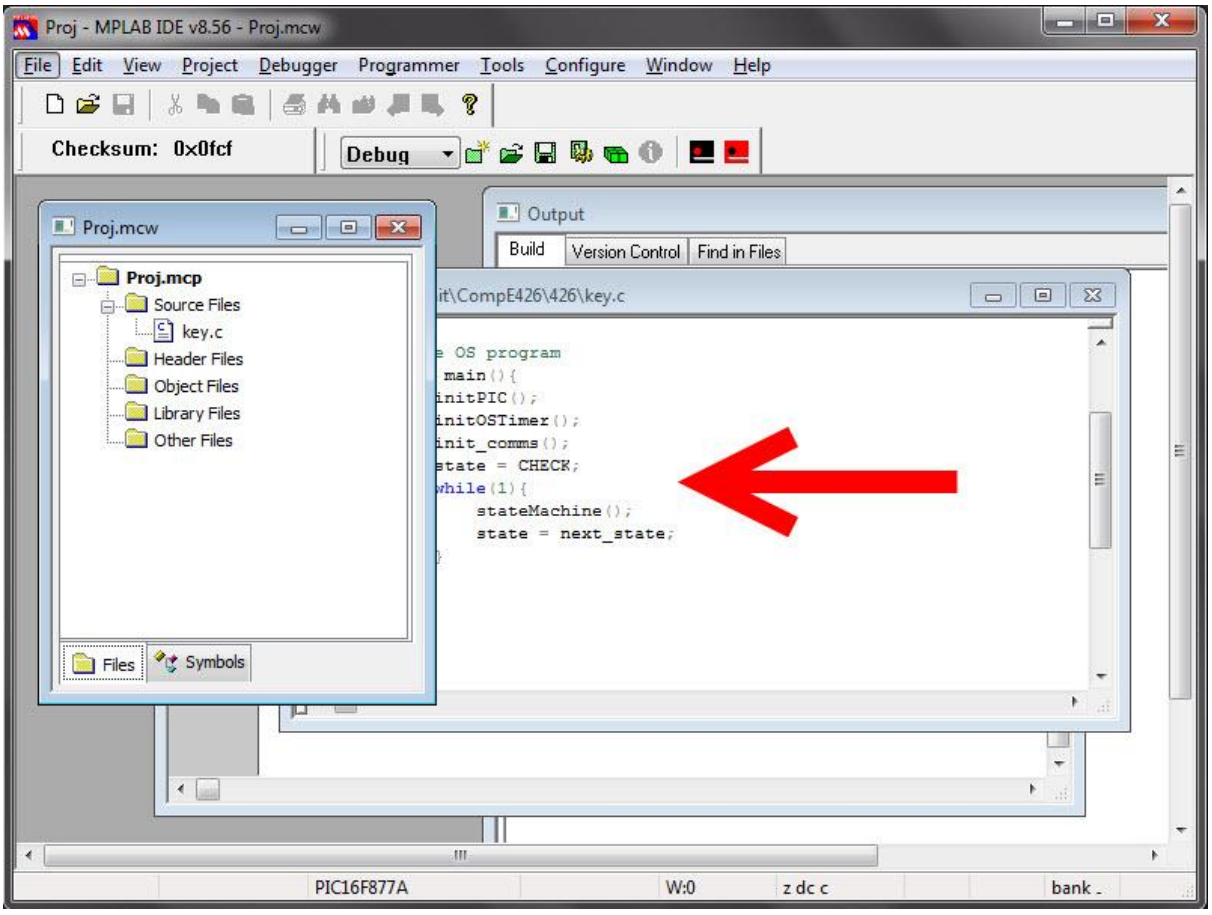

Figure 4.2.cMPLAB IDE SOFTWARE

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4.3Programmer:

Pic kit 3

The MPLAB PICkit 3 allows debugging and programming of PIC® and dsPIC® Flash microcontrollers at a most affordable price point using the powerful graphical user interface of the MPLAB Integrated Development Environment (IDE). The MPLAB PICkit 3 is connected to the design engineer's PC using a full speed USB interface and can be connected to the target via an Microchip debug (RJ-11) connector (compatible with MPLAB ICD 2, MPLAB ICD 3 and MPLAB REAL ICE).HID interface, say no more driver againSupport windows 7 systemUSB (Full speed 12 Mbits/s interface to host PC)Real-time execution MPLAB IDE compatible (free copy included)Built-in over-voltage/short circuit monitor

Firmware upgradeable from PC/web downloadTotally enclosedSupports low voltage to 2.0 volts (2.0v to 6.0v range)Diagnostic LEDs (power, busy, error)Read/write program and data memory of microcontrollerErase of program memory space with verificationFreeze-peripherals at breakpointProgram up to 512K byte flash with the Programmer-to-Go

MaterialPlastic HousingDimensions 95 x 40 x 13 mm / 3.74 x 1.57 x 0.51 inch

Figure 4.3PIC KIT3

4.4 CCS COMPILER

The CCS C Compiler for PIC10, PIC12, PIC14, PIC16, and PIC18 microcontrollers has 307 Built-in Functions to access PIC® MCU hardware is easy and produces efficient and highly optimized code. Functions such as timers, A/D, EEPROM, SSP, PSP, USB, I^2C and more:

- Built-in libraries that work with all chips for RS-232 serial I/O, I^2C, discrete I/O and precision delays.
- Serial I/O functions allow standard functions such as GETC() and PRINTF() to be used for RS-232 like I/O.
- Formatted printf allows easy formatting and display in HEX or decimal.
- Multiple I^2C and RS232 ports may be easily defined.
- #use rs232() offers options to specify a maximum wait time for getc.
- Hardware tranceiver used when possible, but for all other occasions the compiler generates a software serial transceiver.

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- Microcontroller clock speed may be specified in a PRAGMA to permit built-in functions to delay for a given number of microseconds or milliseconds.
- Functions such as INPUT() and OUTPUT_HIGH() properly maintain the tri-state registers.
- Compiler directives determine if tri-state registers are refreshed on every I/O or if the I/O is as fast as possible.
- **#USE SPI ()**
- Simple functions like READ_ADC() to read a value from A/D converter.
- Source code drivers included for LCD modules, keypads, 24xx and 94xx serial EEPROM, X10, DS1302 and NJU6355 real time clocks, Dallas touch memory devices, DS2223 and PCF8570, LTC1298 and PCF8591 A/D converters, temperature sensors, digital pots, I/O expander and much more.
- 133 ready-to-run programs included.

4.5 **PCB Design and Manufacturing.**

4.5.1 INTRODUCTION OF PCB

PCB means printed circuit board. PCB is one of the most important element in any electronics system. They accomplish the interconnection between the components mounted on them in a particular manner. PCB consist of conductive circuit pattern which is applied to one or both sides of an insulating base copper which is most widely used as a conductor material. Aluminum nickel, silver, brass is used for same special application. The thickness of conducting material depends upon the current carrying capacity of the circuit. Thus, a thicker conductor layer will have more current carrying capacity once the PCB is manufactured the current carrying capacity depends on the conductor track.

4.5.2 FUNCTION:

The printed circuit board usually serves there distinct function as follows:

- It provides mechanical support to the component mounted on it.
- It provides necessary electrical interconnection.
- It acts as a heat sink i.e. it provides a conduction path leading to removal of most of

the heat generated in the circuit.

4.5.3 Advantages of PCB:

- Over the conventional wire method
- PCB's have controllable and predictable electrical mechanical properties.
- Rapid production is possible.
- Time is saved since it avoids wiring connection production to another.
- Reduce size and weight.
- Soldering is done in one operation instead of individual connection between component and wire.
- Cost is less.
- Efficient routines conductor.
- Simple troubleshooting.
- Reduce wiring error.
- General flexibility in circuit packaging.

4.5.4 TYPES OF PCB'S:

- Single sided PCB
- Double sided PCB

a) Single sided PCB:

This type of PCB consists of natural coil of copper on only one side of the base material. This type of PCB is frequently used when the manufacturing cost has to kept at minimum.

b) Double sided PCB:

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Double sided PCB is used when there is more number of jumpers. This type of PCB has copper foil on both side of the base material. Double sided PCB's are used when insulation of PCB is very complicated. i.e. if jumpers are more in numbers and when it is difficult to fabricate the PCB on a single sided PCB.

4.5.5 DESIGNING OF PCB'S

The designing of PCB's consist of the designing of layout followed by preparation of artwork. The layout should include all relevant aspects and detail of PCB, while the artwork preparation bring it to from required for production process

4.5.6 Making of PCB's

The simplest process on PCB fabrication involves following steps:-

1. Layout
2. Artwork
3. Etching
4. Screen printing
5. Drilling
6. Mounting of components
7. Soldering
8. Lead cutting
9. Testing And Debugging

1. Layout:

Layout designing with pencil sketch of component of conductors drawing which contain all relevant information for preparation of artwork layout is designing by taking paper for better accuracy. For placing the components on layout all the information about circuit is needed for the artwork preparation. The layout should be prepared from the component size. Layout planning means planning fir the placing of the component and input output connection of the given circuit.

Rules for the layout:

1) First rule s to prepare each and every PLB layout as view from the component side or top side.
2) Another important rule is not to start the designing of layout unless clear circuit diagram is available.
3) Develop the layout in the direction of signal flow and between the smaller components larger size component are to be placed.
4) Among the components larger size component should be placed first and then smaller component should be placed, and then all the component should be placed in such manner that the dishoarding of the other component will not occur.
5) In designing of PCB layout it is very important to divide the circuit into functional subunit which help in testing.
6) Masks the input, in output and power connection to appropriate point.
7) Use two different colors for drawing a layout of double sided PCB.
8) The rule for the width of conductor is as follows width of ground > width of supply> of the signal.

2. Artwork:

Artwork is accurately scaled configuration of the printed circuit from which the master pattern is made photographically. It is the process to carry out the layout of design on the copper clad sode of PCB'S. we use photogenic for artwork on copper clad side, first cover the layout with pencil on copper clad and then tracing copied using photogenic. The artwork is complicated with good drawing scale or firstly we decided the component plan on greed sheet then frill point of the remark double state and lastly trace it with pencil as per circuit diagram. The tracked doubled scale layout than reduced to single scale (i.e actual size) and then down on copper plate by using screen printing.

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- The generation of pcb artwork is consider as the most important step of the PCB manufacturing process. The art designers have skills patience. The artwork design should consider the following facts
- Start PCB design in rough using ruled with squares(graph paper). The process can be carried out at actual size using one inch graph paper or suitable enlarge means of appropriate choice of paper.
- Using the square grid as guide, try to arrange all components so that they are mounted on a standard 0.1inch matrix. This grid system give more convenience in placement of the components and conductors. Less accuracy in drawing the hole locations in early rectified at the artwork preparation stage where pads are placed exactly Incentre of grid intersection.
- For single sided pcb's the conductor path is always on opposite size of component side. The copper of PCB called foil side. The components are always placed.

3. SCREEN PRINTING:-

The Process of screen printing is suitable for large scale production. This process uses resist ink applied through a stencil or mask to the surface of blank circuit board. The stencil is produced and attached to a fine mesh, metal, nylon, polyester or silk screen. The resist ink is forced through openings in the stencil onto the surface of the blank board. This process produces positive of the copper foil. When it dries, the board is ready for etching. Etching of PCB: - The process of removing the unprotected or unprinted area of Copper from the board is called 'Etching'. The solution or the chemical used for etching is called as 'etching solution'. Any one of the following, solution is used to each the PCB. • Ammonium Parasulphate. • Chromic Acid. • Cupric Chloride. • Ferric Chloride The most common etching used in industries is Ferric Chloride (FeC13). It is a cheap chemical and least dangerous and easily available in the market. In this process the PCB is dipped in the etching solution. After few hours we get only the conducting patterns because the unprotected Copper is dissolved in the etching.

4. ETCHING:

Etching is the most important step in which unwanted copper is removed by preserving required copper pattern, unwanted copper is removed by means of chemical reactions. The two chemicals used as enchants hobby and prototype PCN'S are

- Ammonium per sulphate.
- Ferric chloride.

General ferric chloride is used in laboratories. It is an acid solution used for dissolving copper. It has faster etched time and is more toxic than ammonium per sulphate.

➢ **Tank or double etching:**

In which plate is kept in a tank lower and fully emerged into the etching solution which has almost disappeared tank etching could not provide the fast, precious and uniform etching which is design today in electronic equipment.

➢ **Etching solution:**

The solution is used for removal of copper during removal process is known as etching solution. Example.Ferric chloride, cupric chloride, chromic acid, alkaline ammonia.

5. Drilling:

Drilling of component mounting holes into PCB'S operating in PCB production, PCB holes are made by drill, wherever the superior hole finished fir the plated through hole process is required and where the tooling constant for punching tool can be justified therefore drilling is applied.

This is a process of placement of component at proper place. The components are mounted on the opposite side if cu track by checking polarities i.e +ve or –ve. Before mounting the components lead so component should be staggered with pliers and clean with blade.

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6. Mounting of components:

Mounting is the technique of fixing the components over the PCB. For example, if we want to mount the resistor on the PCB then there is two way of mounting; one is horizontally and another is vertically. In the horizontal vertical fixing of resistor, the leads of both sides are bended according to the distance between the drilled holes. So as per the resistors there are many components are technically mounted. Following points should be considered while mounting the components on the PCB.

7. Soldering:

Soldering Is the process between two metals, in its molten state solder, disorder some of the metal with which it comes in contact to be soldered are more often than not converted, cannot dissolve a flux is remained. This exited film from the areas to be soldered. The following process is involved in soldering.

- Melting of flux that in terms removes the film metal to be soldered.
- Melting of soldier which makes the higher flux and impurity suspended in the surface.
- The soldier above partially some of the metal in the connected.

➢ **Soldering Gun:**

Soldering gun is usually heavier and more heat than of average pencil soldering and heavy duty conductor or connector required, the use of the gun because it can generate enough heat to quickly being a heavy metal joint up to proper soldering tool is called gun.

➢ **Soldering techniques:**

- The soldering forms a film joint.
- The soldering should be with all elements joint.
- The shape of the element is obscured,
- Place the soldier near iron tip and let the flow pass if rounded joint till it comes back near the joint.
- Remove the iron and let the soldered flow into the areas from where iron has been removed.
- All the elements for the joint should be getting connected with soldered.

8. Lead cutting:

After the whole developing of PCB, the leads of the components must be removed with the help of cutter. Because of the lead, the circuit mat sorted. So it will affect on proper result of circuit.

9. Testing And Debugging:

➢ **Testing:**

None of the electronic circuit functions satisfactory unless it is tested systematically. During the completion of the project, we have to follow some rules and regulations for testing. Some of these guidelines are given as under:

1. Check whether the component agree with the parts list, if any doubt persists then double click the value and rating of the capacitors, transistors, resistors and diodes for polarity.
2. Check the continuity of all the tracks on the printed circuit board.
3. Make sure that the drilling, fitting and any other fitting work is done before soldering any component on PCB.
4. Id any mixing is there, keep it away from other component and keep it well ventilated.
5. Make the wiring diagram if the layout involves a lot of wires.
6. Use good quality wires only.
7. Inspect the soldier joints by eye check or check them with the help of continuity tester. Make sure that there are no soldier joints that are dry and also no tracks are sorted due to poor soldering.
8. Ensure that the position of all components agree with the circuit diagram.
9. Check whether all the components are fitted according to their polarity.
10. Check whether all the earthen connection are there and they are of good quality.

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- **Debugging:**

While implementing our ideas in the project we face many difficulties. The significant once have been discussed briefly in the following section along with the procedure employed to solve the problems.

VI. ADVANTAGE, DISADVANTAGES& APPLICATION

6.1 Advantages:

1. Improved life span of the battery
2. Reduced maintenance and replacement cost
3. Enhanced visibility into historic records
4. Continuous battery monitoring to avoid expensive downtime and protects business.
5. Proactive maintenance – data is available remotely and can be used to enable early fault detection
6. Capability to make informed decisions by using the data generated by the battery monitoring system.

6.2 Disadvantages of System:

1. Some toxic chemicals, like cadmium and arsenic, are used in the PV production process. These environmental impacts are minor and can be easily controlled through recycling and proper disposal.
2. Solar energy is somewhat more expensive to produce than conventional sources of energy due in part to the cost of manufacturing PV devices as the conversion efficiencies continue to increase and the manufacturing costs continue to come down, PV will become increasingly cost competitive with conventional fuels.
3. Solar power is a variable energy source, with energy production dependent on the sun. Solar facilities may produce no power at all some of the time, which could lead to an energy shortage if too much of a region's power come from solar power.

Application

1. Electrical vehicle.
2. Smart Grid.
3. Industrial area.

VII. CONCLUSION

Many battery models do not simulate of the discharging behaviour of actual batteries. When batteries are nearly fully discharged, and the load is removed from the battery, the voltage of the battery will increase; when the load is connected to the battery, and the current resumes, the voltage of the battery will drop to the nominal value. Such discharging behaviour should be simulated in future battery models. In addition, the performance of battery models could be further improved. To improve BMS hardware systems, a method could be created to allow the BMS to communicate with vehicle controllers and other sub-systems in the vehicle, such as the motor controller. In addition, a protection device could be added to the system to switch off the battery pack when it operates out of its SOA. Furthermore, the cell-balancing function could be improved. A BMS could then be developed for use in electric vehicles.

VIII. FUTURE SCOPE

Many battery models do not simulate of the discharging behaviour of actual batteries. When batteries are nearly fully discharged, and the load is removed from the battery, the voltage of the battery will increase; when the load is connected to the battery, and the current resumes, the voltage of the battery will drop to the nominal value. Such discharging behaviour should be simulated in future battery models. In addition, the performance of battery models could be further improved. To improve BMS hardware systems, a method could be created to allow the BMS to communicate with vehicle controllers and other sub-systems in the vehicle, such as the motor controller. In addition, a protection device could be added to the system to switch off the battery pack when it operates out of its SOA. Furthermore, the cell-balancing function could be improved. A BMS could then be developed for use in electric vehicles

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