A project report on

ARDUINO BASED SOLAR POWER INVERTER WITH BATTERY CHARGER CONTROLLER WITH MOBILE INTERFACE.

Submitted in partial fulfillment of the requirements of,
Bachelor of Engineering in
Electrical Engineering.

Submitted by

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CERTIFICATE

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During the academic year **2018-19** in partial fulfilment of the requirements for the award of degree of **Bachelor of Engineering in Electrical Engineering** from

Date-

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The foregoing dissertation entitled **"Arduino Based Solar Power Inverter"** is hereby approved as a creditable study of Electrical Engineering presented by

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DECLARATION

We declare that this written submission represents my ideas in my own words and where others ideas or words have been included; We have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not represented or fabricated or falsified any idea/data/fact/source in my submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission have not been taken when needed.

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ACKNOWLEDGEMENT

It gives me immense pleasure to present this project on "**Arduino Based Solar Power Inverter**" carried out at AIKTC, New Panvel in accordance with prescribed syllabus of University of Mumbai for Electrical Engineering. We express our heartfelt gratitude to those who directly and indirectly contributed towards the completion of this project. We would like to thanks Dr Abdul Razzak Principal, AIKTC, Sayeed Kaleem HOD for allowing me to undertake his guidance for continuous support. We would like to thanks all the faculty members, non-teaching staffs of Electrical Engineering of our College for their direct and indirect support and suggestion for performing the project.

ABSTRACT

Solar System is now widely used for green energy generation. However there arises a problem in voltage levels which affects the system stability. As the solar cell generates fewer amounts of charges we have to use a controller to maximize the efficiency. In this project Inverter Circuit is used. The results are taken and a display panel interfacing with Arduino. This system protects the battery from over charging and deep discharging to increase battery life.

CONTENTS

CHAPTER 1

INTRODUCTION

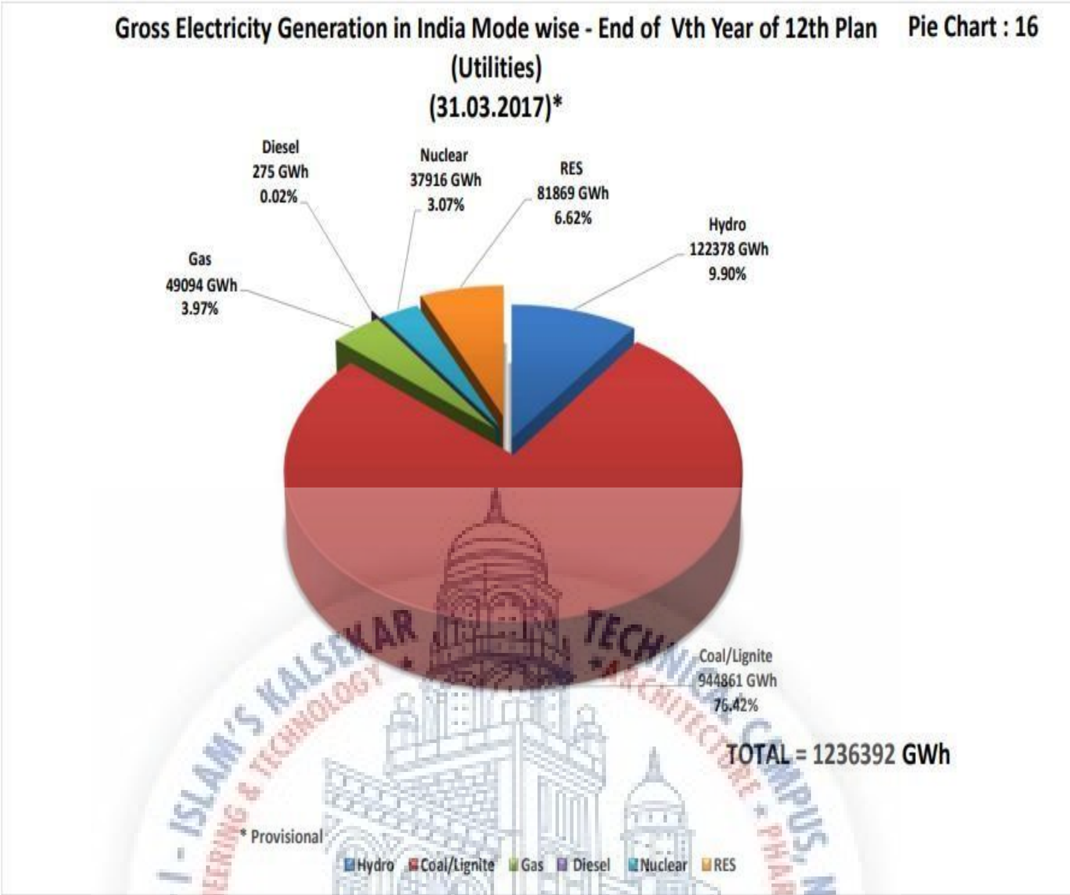
Solar energy is the energy provided by the sun. It is the radiant light and heat from the Sun, harnessed using technologies such as solar heaters, solar photovoltaic, and solar thermal electricity. Energy is produced in Sun by nuclear fusion during a series of steps proton-proton (P-P) chain reaction, I this process hydrogen is converted to helium. The core is the only part of the Sun that produces heat through fusion about 99%. Hydrogen nuclei in Sun's core fuse together to form helium nuclei and release energy, this process is called nuclear fusion. In this state, some 120 million tons of matter--mostly hydrogen converts into helium on the sun every minute, with some of the mass being converted into energy. Electromagnetic energy from the sun comes to Earth in the form of radiation. The sun radiates energy equally in all directions, and the Earth intercepts and receives part of this energy. The power flux reaching the top of the Earth's atmosphere is about 1400 Watts/m2. This simply means on an average, one square meter on the side of the Earth facing the sun receives energy from the sun equal to that from fourteen 100 Watt light bulbs every second. The Earth receives 174petawatt of incoming solar radiation at the upper atmosphere. Approximately 30% is reflected back to the space while the rest is absorbed by the clouds, oceans and land masses. The spectrum of solar light at the earth's surface is mostly spread across the visible and near-infrared ranges with a small part in the near-ultraviolet.

SOLAR POTENTIAL

Most people around the world live in areas with insolation levels of 150 to 300 watts per square meter or 3.5 to 7.0 kWh/m2 per day. The total solar energy absorbed by Earth's atmosphere, oceans and land masses is approximately 3,850,000 exajoules (EJ) per year. The amount of solar energy reaching the surface of the planet is so vast that in one year it is about twice as much as will ever be obtained from all of the Earth's non-renewable resources of coal, oil, natural gas, and mined uranium combined. Geography effects solar energy potential because areas that are closer to the equator have a greater amount of solar radiation.However, the use of photovoltaics that can follow the position of the sun can significantly increase the solar energy potential in areas that are farther from the equator. Time variation effects the potential of solar energy because during the nighttime there is little solar radiation on the surface of the Earth for solar panels to absorb. This limits the amount of energy that solar panels can absorb in one day. Cloud cover can effect the potential of solar panels because clouds block incoming light from the sun and reduce the light available for solar cells.In addition, land availability has a large effect on the available solar energy because solar panels can only be set up on land that is unowned and suitable for solar panels. Roofs have been found to be a suitable place for solar cells, as many people have discovered that they can collect energy directly from their homes this way. Other areas that are suitable for solar cells are lands that are unowned by businesses where solar plants can be established. Solar technologies are broadly characterized as either passive or active depending on the way they capture, convert and distribute sunlight and enable solar energy to be harnessed at different levels around the world, mostly depending on distance from the equator.

Although solar energy refers primarily to the use of solar radiation for practical ends, all renewable energies, other than geothermal and tidal, derive their energy from the Sun in a direct or indirect way. Active solar techniques use photovoltaics, concentrated solar power, solar thermal collectors, pumps, and fans to convert sunlight into useful outputs. Passive solar techniques include selecting materials with favorable thermal properties, designing spaces that naturally circulate air, and referencing the position of a building to the Sun. Active solar technologies increase the supply of energy and are considered supply side technologies, while passive solar technologies reduce the need for alternate resources and are generally considered demand side technologies.

In 2000, the United Nations Development Programme, UN Department of Economic and Social Affairs, and World Energy Council published an estimate of the potential solar energy that could be used by humans each year that took into account factors such as insolation, cloud cover, and the land that is usable by humans. The estimate found that solar energy has a global potential of 1,575–49,837 EJ per year.


Gross Electricity Generation in India Mode wise - End of Vth Year of 12th Plan (Utilities) (31.03.2017)*
Pie Chart : 16
Diesel 275 GWh 0.02%
Nuclear 37916 GWh 3.07%
RES 81869 GWh 6.62%
Hydro 122378 GWh 9.90%
Gas 49094 GWh 3.97%
Coal/Lignite 944861 GWh 76.42%
TOTAL = 1236392 GWh
* Provisional
Hydro
Coal/Lignite
Gas
Diesel
Nuclear
RES

CHAPTER 2

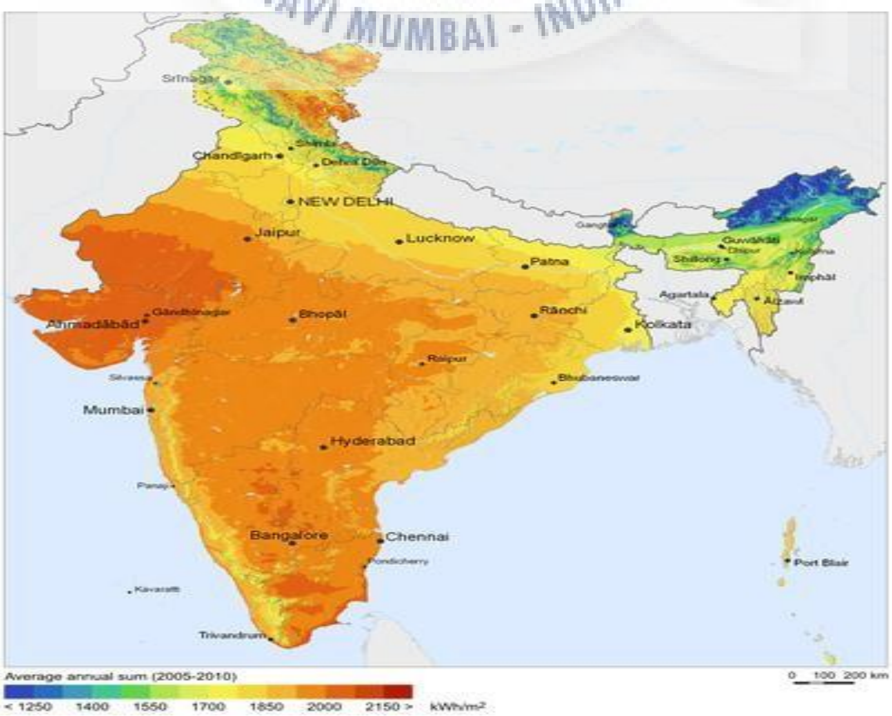
HISTORY

Solar power in India is a fast developing industry. As of September, 2017 the country's solar grid had a cumulative capacity of 16.20 GW. India quadrupled its solar-generation capacity from 2,650 MW on 26 May 2014 to 12,289 MW on 31 March 2017. The country added 3.01 GW of solar capacity in 2015-2016 and 5.525 GW in 2016-2017, the highest of any year, with the average current price of solar electricity dropping to 18% below the average price of its coal-fired counterpart. In January 2015 the Indian government expanded its solar plans, targeting US$100 billion in investment and 100 GW of solar capacity (including 40 GW from rooftop solar) by 2022.. India's initiative of 100 GW of solar energy by 2022 is an ambitious target, since the world's installed solar-power capacity in 2014 was 181 GW.

The improvements in solar thermal storage power technology in recent years has made this task achievable as the cheaper solar power need not depend on costly and polluting coal/gas/nuclear based power generation for ensuring stable grid operation In addition to its large-scale grid-connected solar PV initiative, India is developing off-grid solar power for local energy needs.

The country has a poor rural electrification rate; in 2015 only 55 percent of all rural households had access to electricity, and 85 percent of rural households depended on solid fuel for cooking Solar products have increasingly helped to meet rural needs; by the end of 2015 just under one million solar lanterns were sold in the country, reducing the need for kerosene.

That year, 118,700 solar home lighting systems were installed and 46,655 solar street lighting installations were provided under a national program; just over 1.4 million solar cookers were distributed in India.



OBJECTIVE:

In recent years, the interest in solar energy has risen due to surging oil prices and environmental concern. In many remote or underdeveloped areas, direct access to an electric grid is impossible and a photovoltaic inverter system would make life much simpler and more convenient. With this in mind, this paper aims to design, build, and test a solar panel inverter. This inverter system could be used as backup power during outages, battery charging, or for typical household applications. The key features of the system are a true 50Hz, 230Vrms sinusoidal voltage output, a wide input range, and maximum power-point tracking (MPPT), and a power output of up to 300W. The overall goal is to design this system while minimizing component costs. Although systems with similar features already exist, many are prohibitively expensive for those people who stand to benefit the most. In addition, inverters in the lower price range typically lack the features mentioned above.

STATEMENT OF PROBLEMS:

Electricity is the major source of power for country's most of the economic activities. But in our country Kenya, we have been suffering due to electricity crisis for a long time. To reduce this problem, there are some alternative ways which can help in this purpose. But among all of the methods solar system may be an easy and effective one especially in the rural areas where the electricity has not reached yet.

This solar energy is a renewable energy which is inefficiently exploited. The importance of solar energy is that it’s free, clean and with very high potentials in the future [2]. Photovoltaic systems (PV) are used to convert the solar energy into electrical energy using photovoltaic panels which can then be used into domestic electrical applications.

An important piece of solar power supply is the DC to AC inverter which converts the DC voltage from a battery to an AC voltage that is necessary to operate electronic components. Due to the delicate nature of this equipment, an inverter which is capable of producing a pure sine wave is necessary to avoid noise and wear on delicate and expensive gear. Many of these devices are very expensive so it is the goal of this project to design a DC/AC inverter capable of producing a pure sine wave for use with domestic equipment. In this project, an inverter circuit was designed that can supply an electrical load of up to 600 watts, but due to the high ratings of the 600 watts load, the unavailability and high cost of the components, and for safety reasons, a 125 watts application system was implemented and realized.

CHAPTER 3

ARDUINO UNO

Nearly 7, 00,000 numbers of arduinos are present in the market. Of these, Arduino ATMEGA-328 microcontroller consist of 14 input and output analog and digital pins (from this 6 pins are considered to be a PWM pins), 6 analog inputs and remaining digital inputs. Power jack cable is used to connect arduino board with the computer. Externally battery is connected with the arduino microcontroller for the power supply. Arduino is an open source microcontroller from which there is no feedback present in the microcontroller. This arduino board consist of I2C bus, that can be able to transfer the data from arduino board to the output devices. These arduino boards are programmed over RS232 serial interface connections with atmega arduino microcontrollers. The operating volt ranges from 5v. The input voltage recommended for arduino microcontroller is from 7v and the maximum of 12v. The DC input current given to the arduino board is in the range of 40mA.

It consists of different types of memories such as flash memory, EEPROM, SRAM. The length of the arduino board is nearly about 68.64mm and the width of the microcontroller is about 53.4mm. The weight of the arduino microcontroller is about 20g. We can use various types of microcontroller such as 8 bit AVL Atmel microcontroller and 32 bit Atmel arm microprocessor. From these different kinds of processors, we can use those processors for various engineering projects as well as industrial applications. Some of the examples of using the arduino in the industrial applications are controlling the actuators and sensors. Some of the examples of arduino microcontrollers are Arduino Duemilanove, Arduino UNO, Arduino Leonardo, Arduino Mega, Arduino MEGA 2560 R3, Arduino MEGA 2560 R3, Arduino Nano, Arduino Due, LilyPad Arduino, micro arduino. We have already mentioned, arduino has been programmed by using c and c++ programming language. These c and c++ are high level languages. Normally it has 18 numbers of input and output pins.

Among those 6 pins are considered to be an analog inputs. From these analog inputs, we can be able to work the arduino microcontroller using analog inputs supply. Normally analog inputs can be in the range of 0-5V. Similar to that digital inputs are present in the microcontroller which can act the use of microcontroller using digital inputs. Digital inputs can be in the range of 5V.

ATMEGA 328 microcontroller, which acts as a processor for the arduino board. Nearly it consists of 28 pins. From these 28 pins, the inputs can be controlled by transmitting and receiving the inputs to the external device. It also consists of pulse width modulation (PWM). These PWM are used to transmit the entire signal in a pulse modulation. Input power supply such as Vcc and Gnd are used. These IC mainly consists of analog and digital inputs. These analog and digital inputs are used for the process of certain applications.

- **DESCRIPTION**

ANALOG INPUT:

Arduino atmega-328 microcontroller board consist of 6 analog inputs pins. These analog inputs can be named from A0 to A5. From these 6 analog inputs pins, we can do the process by using analog inputs. Analog inputs can be used in the operating range of 0 to 5V Analog signal is considered as the continuous time signal, from which these analog signal can be used for certain applications. These are also called as non discrete time signal.

Inputs such as voltage, current etc.., are considered to be either analog signal or digital signal only by analysing the time signal properties. Various applications of arduino microcontroller can use only an analog input instead of digital inputs. For these applications, analog input ports or pins can be used.

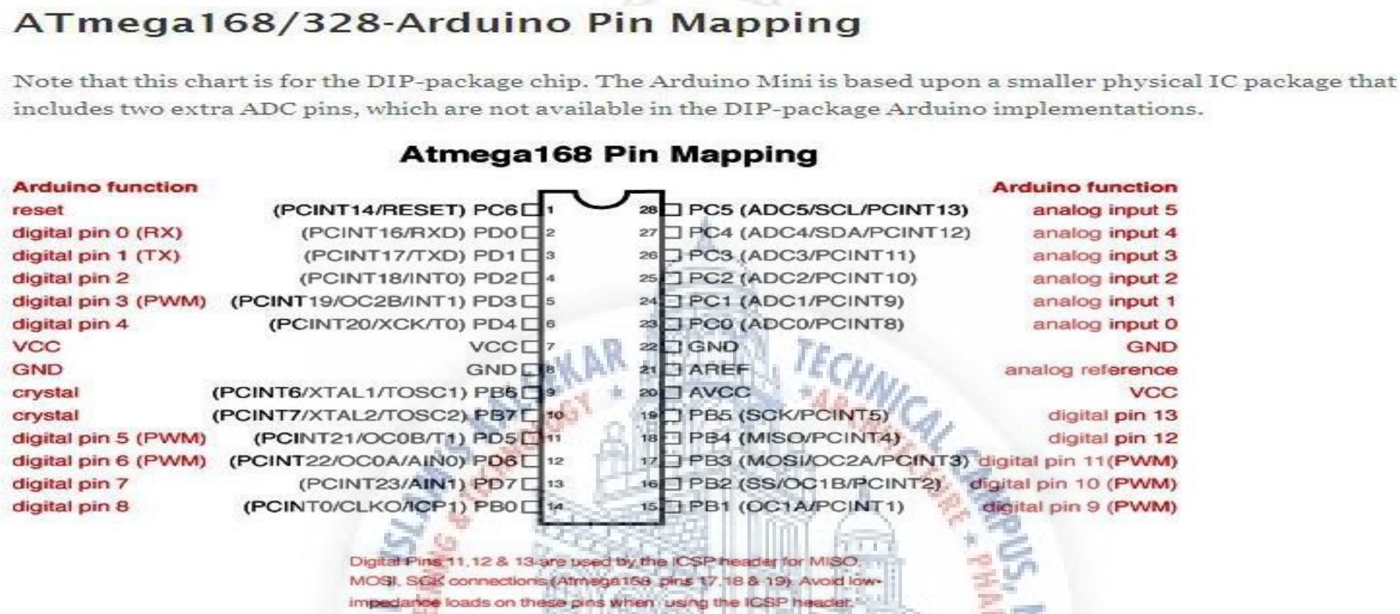
DIGITAL INPUT:

Digital inputs can be defined as the non continuous time signal with discrete input pulses. It can be represented as 0's and 1's. These digital inputs can be either on state or in off state. Arduino atmega328 microcontroller also consists of 12 digital input pins. It can be stated as D0 to D11. Nearly 12 inputs can be used for digital input/output applications. The working of the digital input ports is where the discrete input pulses can be triggered and supplied to the ports. These ports receive the input and therefore the port can be used for both input and output process. These digital pins can access only the digital inputs.

ATMEGA-328 IC:

This ATMEGA-328 integrated chip consists of 28 pins. It consists of 6 analog inputs that are shown in the pin diagram. Analog inputs can be represented as PC0 to PC5. These analog input pins posses the continuous time signal which acts as an analog input for the system. Further it also consists of 12 digital inputs. It can be represented as PD1 to PD11 which act as an digital input ports based on pulse width modulation (PWM). These PWM, which transmits the signal in the form of discredited form. Both analog and digital input ports can be used for various applications for the input power supply, VCC and GND pins are used. Pins PB6 and PB7, which acts as a crystal to generate a clock signal. By using these crystal, we can generate the clock signals and by these clock signals, we can use this clock signals for input sources. PC6 pin are the one where it can be used for the reset option. Resetting the program can be done by using this PC6 pin.

The pin diagram of atmega-328 microcontroller can be shown below.



JACK CABLE / USB PORT:

This Arduino atmega-328 microcontroller can be interfaced with the other electronic devices such as computer by using USB port or power jack cable from these power jack cable, we can upload the program of Arduino for their applications. At first, the program can be initialised or can be edited by using Arduino software tools. Then these programs can be transferred through arduino microcontroller board by using usb cable or power jack cable.

POWER SUPPLY:

There is an additional power supply source present in Arduino microcontroller. Power supply port is present at the corner of the arduino microcontroller. Either we can use this power supply port by connecting with external power supply.(ie, ac power supply), or by connecting an dc power supply through input pins. These power supplies produce an active form to the arduino microcontroller. These arduino microcontrollers can accept a range of power supply. When the power supply voltage range exceeds, the microcontroller gets damaged. Hence, only the particular range of power supply should be given to the arduino microcontroller.

- **WORKING PRINCIPLE**

The working of arduino microcontroller is where the proper connection is made. Checking all the input ports as well as the power supply connection. The output of the pins can be connected with the external devices according to their applications. The program to be executed for the applications can be done by using arduino software. From this arduino software, we can edit according to the applications. This software can works on c and c++ programming language. It is fully a high level language. By using the conditions of working, we can create a program to proceed for the applications.

Then after, these programs can be uploaded through the arduino microcontroller by using the power jack cable. The program can be uploaded to the microcontroller and ready for further process. ATMEGA-328 microcontroller can saves a program and these IC can acts as a processor to do the process without any error. After by giving an analog or digital input to the system, we can do the process according to the applications. We can control the process of the application by editing the program in the arduino software and again can be uploaded to the arduino microcontroller via power jack cable. There is an option of reset button.

The purpose of reset button is to reset the program which means the previous programs are deleted and we can use the arduino for the other application purposes. Likewise, these arduino ATMEGA-328 microcontrollers can be used for n number of applications. These arduino microcontrollers are widely used in automation industries for controlling the process and to work the system in an automation mode.Here, I have provided a simple arduino program to do the process of rotating a stepper motor for one revolution. There are many number of example programs that are present in the arduino software. We can edit these programs for our applications purposes.

CHAPTER 4

SOLAR PANEL

SOLAR PANEL:

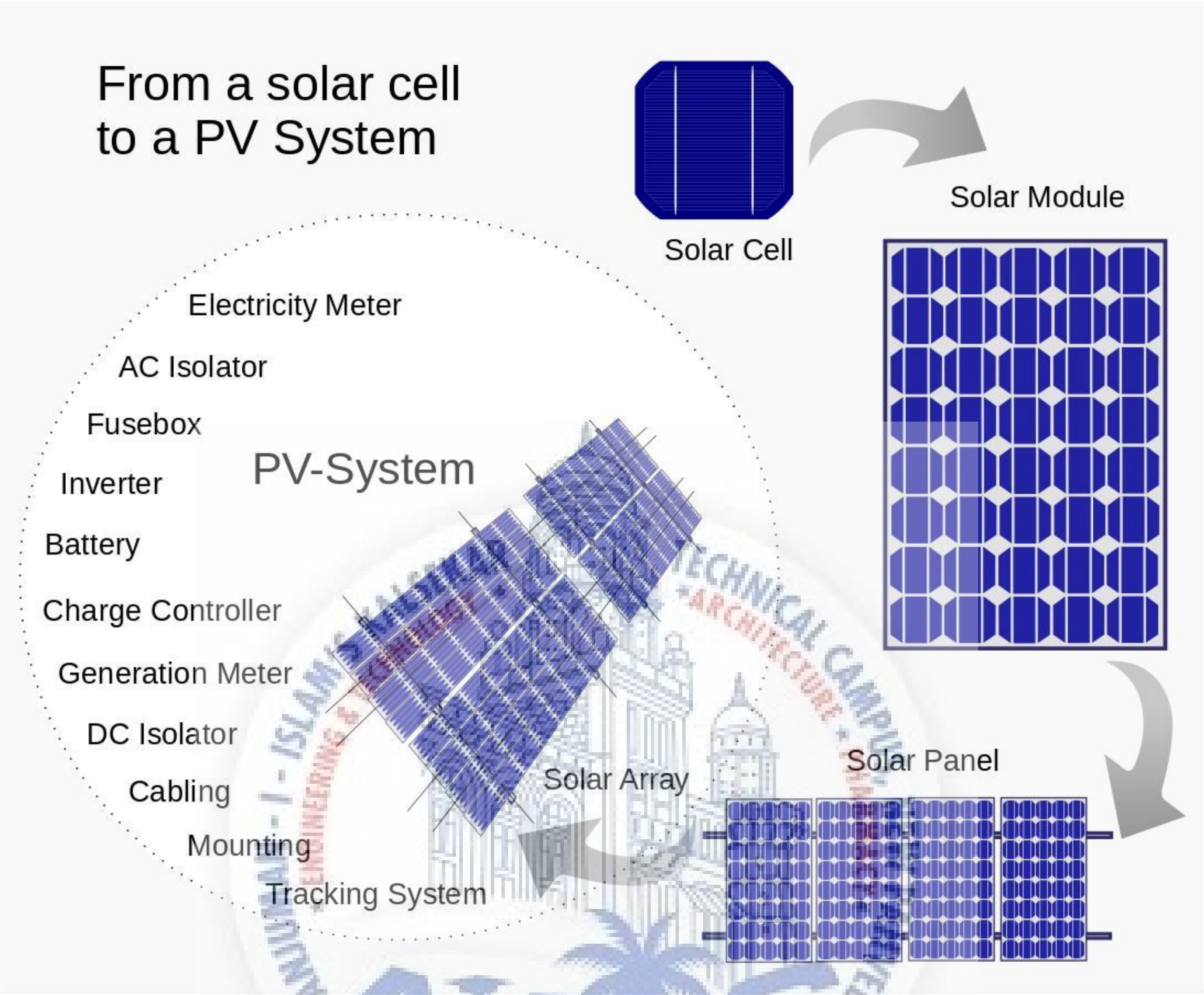
Solar panels absorb the sunlight as a source of energy to generate electricity or heat.A photovoltaic (PV) module is a packaged, connect assembly of typically 6x10 photovoltaic solar cells. Photovoltaic modules constitute the photovoltaic array of a photovoltaic system that generates and supplies solar electricity in commercial and residential applications. Each module is rated by its DC output power under standard test conditions (STC), and typically ranges from 100 to 365 Watts (W).

The efficiency of a module determines the area of a module given the same rated output – an 8% efficient 230 W module will have twice the area of a 16% efficient 230 W module. There are a few commercially available solar modules that exceed efficiency of 22% and reportedly also exceeding 24%. A single solar module can produce only a limited amount of power; most installations contain multiple modules. A photovoltaic system typically includes an array of photovoltaic modules, an inverter, a battery pack for storage, interconnection wiring, and optionally a solar tracking mechanism. The most common application of solar panels is solar water heating systems.

THEORY

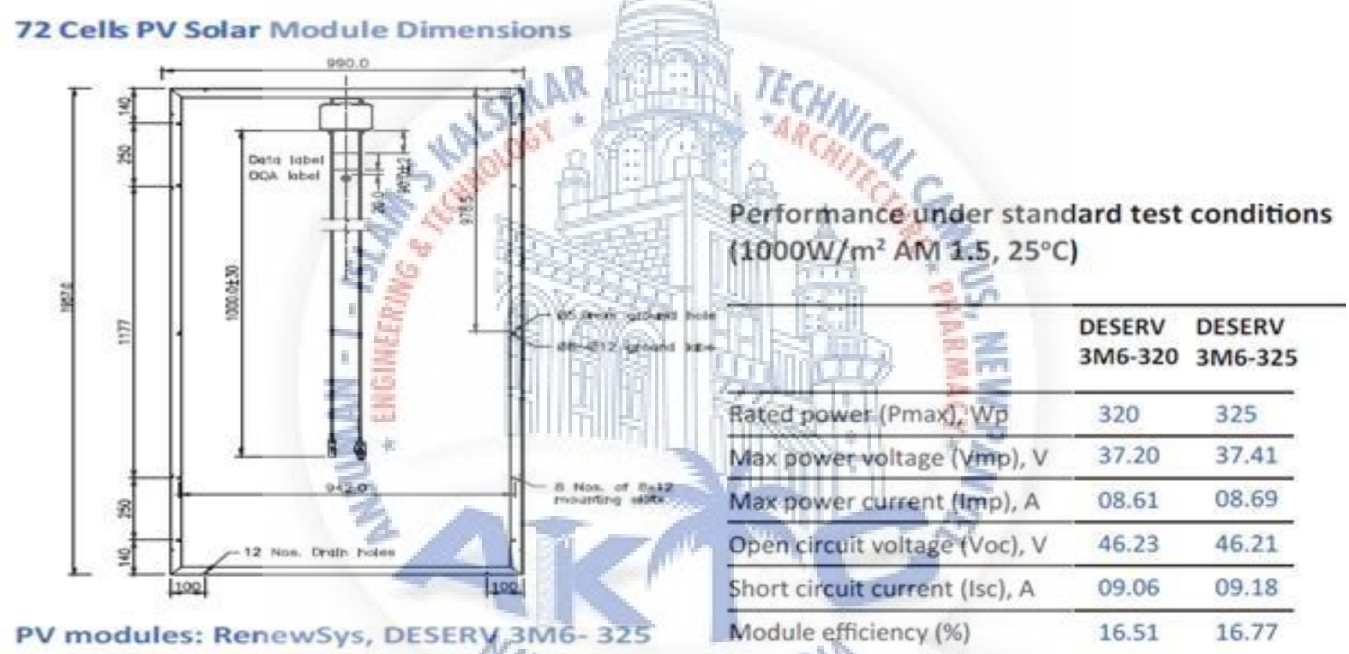
Photovoltaic modules use light energy (photons) from the Sun to generate electricity through the photovoltaic effect. The majority of modules use wafer-based crystalline silicon cells or thin-film cells. The structural (load carrying) member of a module can either be the top layer or the back layer. Cells must also be protected from mechanical damage and moisture. Most modules are rigid, but semi-flexible ones are available, based on thin-film cells. The cells must be connected electrically in series, one to another. Externally, most of photovoltaic modules use MC4 connectors type to facilitate easy weatherproof connections to the rest of the system. Modules electrical connections are made in series to achieve a desired output voltage or in parallel to provide a desired current capability. The conducting wires that take the current off the modules may contain silver, copper or other non-magnetic conductive transition metals. Bypass diodes may be incorporated or used externally, in case of partial module shading, to maximize the output of module sections still illuminated.

Some special solar PV modules include concentrators in which light is focused by lenses or mirrors onto smaller cells. This enables the use of cells with a high cost per unit area (such as gallium arsenide) in a cost-effective way.



MAINTENANCE

Solar panel conversion efficiency, typically in the 20% range, is reduced by dust, grime, pollen, and other particulates that accumulate on the solar panel. "A dirty solar panel can reduce its power capabilities by up to 30% in high dust/pollen or desert areas", says Seamus Curran, associate professor of physics at the University of Houston and director of the Institute for NanoEnergy, which specializes in the design, engineering, and assembly of nanostructures. Paying to have solar panels cleaned is often not a good investment; researchers found panels that had not been cleaned, or rained on, for 145 days during a summer drought in California, lost only 7.4% of their efficiency. Overall, for a typical residential solar system of 5 kW,



	DESERV 3M6-320	DESERV 3M6-325
Rated power (Pmax), Wp	320	325
Max power voltage (Vmp), V	37.20	37.41
Max power current (Imp), A	08.61	08.69
Open circuit voltage (Voc), V	46.23	46.21
Short circuit current (Isc), A	09.06	09.18
Module efficiency (%)	16.51	16.77

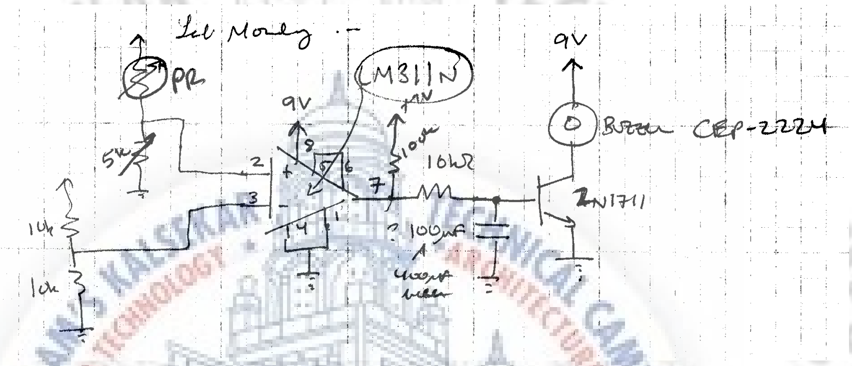
Fig 3.2 PV module with specification(STD condition)

washing panels halfway through the summer would translate into a mere $20 gain in electricity production until the summer drought ends—in about 2 ½ months. For larger commercial rooftop systems, the financial losses are bigger but still rarely enough to warrant the cost of washing the panels. On average, panels lost a little less than 0.05% of their overall efficiency per day.

CHAPTER 5

DESIGNING OF PCB AND CIRCUIT

This tutorial leads you through the design of a PCB using layout software from Express PCB, which is freeware available at www.expresspcb.com. Before beginning you should make sure your computer has both Express PCB and Express SCH, if not than you should download the software. **Before beginning the PCB process**, you should come up with the initial design, build it and test it on a breadboard, fix any errors, and determine specific components. It is also useful to have datasheets and dimensions for all of the "special" components such as transistors, ICs, sensors, actuators, etc., on hand. For this tutorial, we will use a drawer burglar alarm circuit, which had the following form after testing on a breadboard:



There are two stages remaining in the process to creating the circuit board. In the first stage, you build the schematic using the ExpressPCB schematic editor. In the second stage you layout the circuit board. It is possible to skip directly to the layout editor. However, doing the schematic first will allow you to link the schematic into the layout editor reducing the probability of error.

EXPRESS PCB SOFTWARE:-

1. Open Express SCH to create a fresh schematic. The first time you start Express SCH you will get a dialog box with a link to a quick start guide for Express SCH. This can be useful if you want to get a general overview for the tool. Once you are ready to start, close the dialog box to view the empty schematic.

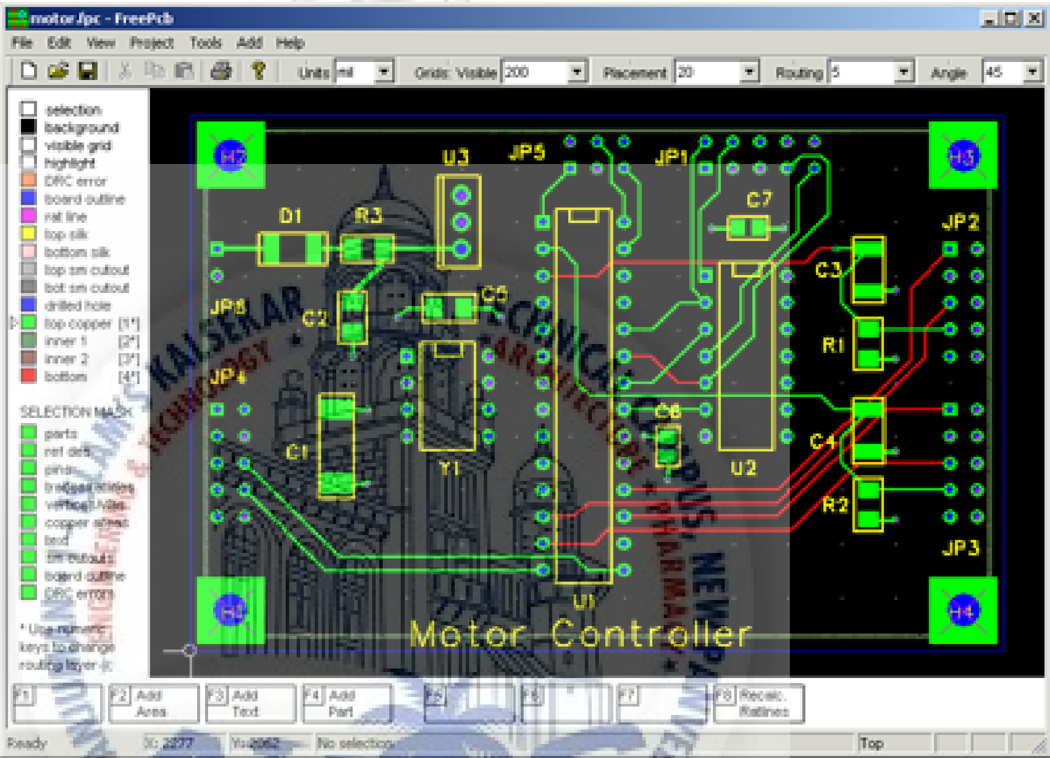
2. Click on Op-Amp-like symbol to place components. To place the resistors, select "Passive-Resistor" in the text box in the upper right corner.

3. Then click on the schematic for the 4 resistors (not including the photoresistor or potentiometer) in roughly the location you want them to display. Then zoom in using the magnifying glass tool (or the wheel on the mouse) and pan the display (using the sliding bars) to improve your view.

4. Now you need to give each of the resistors unique identifiers. Right click on a resistor and choose "Set component properties." In the Component Properties box, under

"Component ID," select "Auto assign Part ID." The program should assign this resistor to be R1. Set its value 10k in the "Part Name" field and hit OK. Repeat this process to identify and label R2 (10k), R3 (100k), and R4 (10k)

5. Now add the capacitor, potentiometer, comparator, and transistor to the circuit by first clicking back on the component placement tool (the red op-amp symbol) and using the component names "Passive-Capacitor polarized," "Passive- Potentiometer," "IC – National - LM311 – Comparator – DIP-8," and "Semiconductor – Transistor NPN." Use "set component properties" to assign all of these parts Part IDs, label them and position them (using the arrow tool) in a logical manner.



6. For future use, save this as a custom component by selecting "Component" -> "Save custom component" and then in the dialog box that appears give the component a name such as "photoresistor." (If someone else has already completed the tutorial on this computer, the part may already exist, in that case you should either save this component with a unique name, or save your component on top of the one already existing)

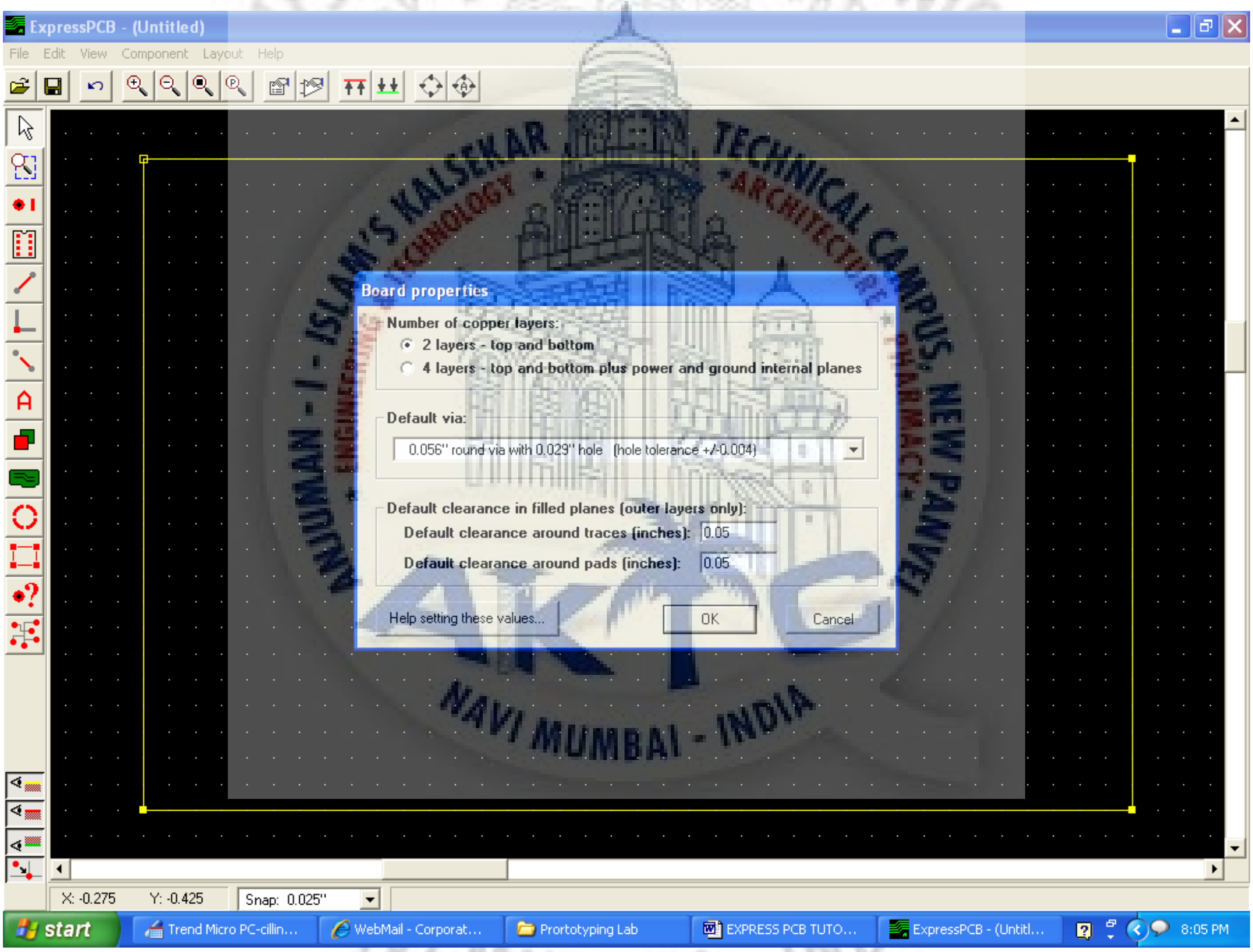
7. For future use, save this as a custom component by selecting "Component" -> "Save custom component" and then in the dialog box that appears give the component a name such as "photoresistor." (If someone else has already completed the tutorial on this computer, the part may already exist, in that case you should either save this component with a unique name, or save your component on top of the one already existing)

DESIGNING OF PCB LAYOUT:

When doing the layout, it is particularly useful to have the actual components and/or in front of you, along with a ruler or set of calipers (the ruler and calipers are unnecessary for this tutorial).

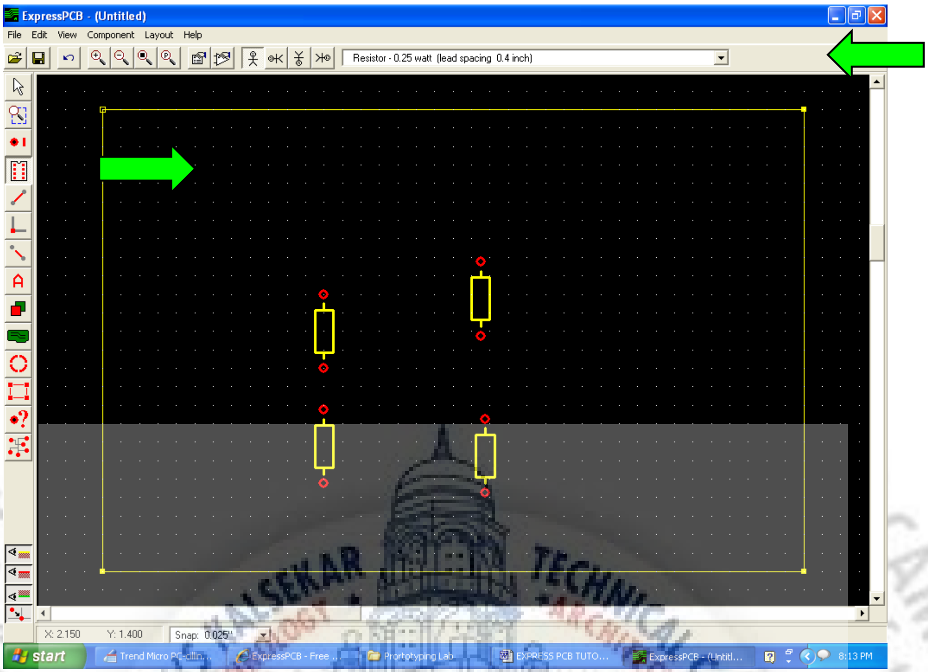
1. Open ExpressPCB. When you first open the program, a dialog box appears with links to the Quick Start Guide and a PCB Design Tips file. If you have time, both of these links can be instructive. Once you're ready to continue, hit OK to go to a new file.

2. Under "File" select "New file." Choose the 2-layer board, with Default via '0.056" round via with 0.029" hole'. Change both default clearances for the filled planes to 0.05 (the maximum allowed). Hit OK and again OK on the warning that appears in the next window.

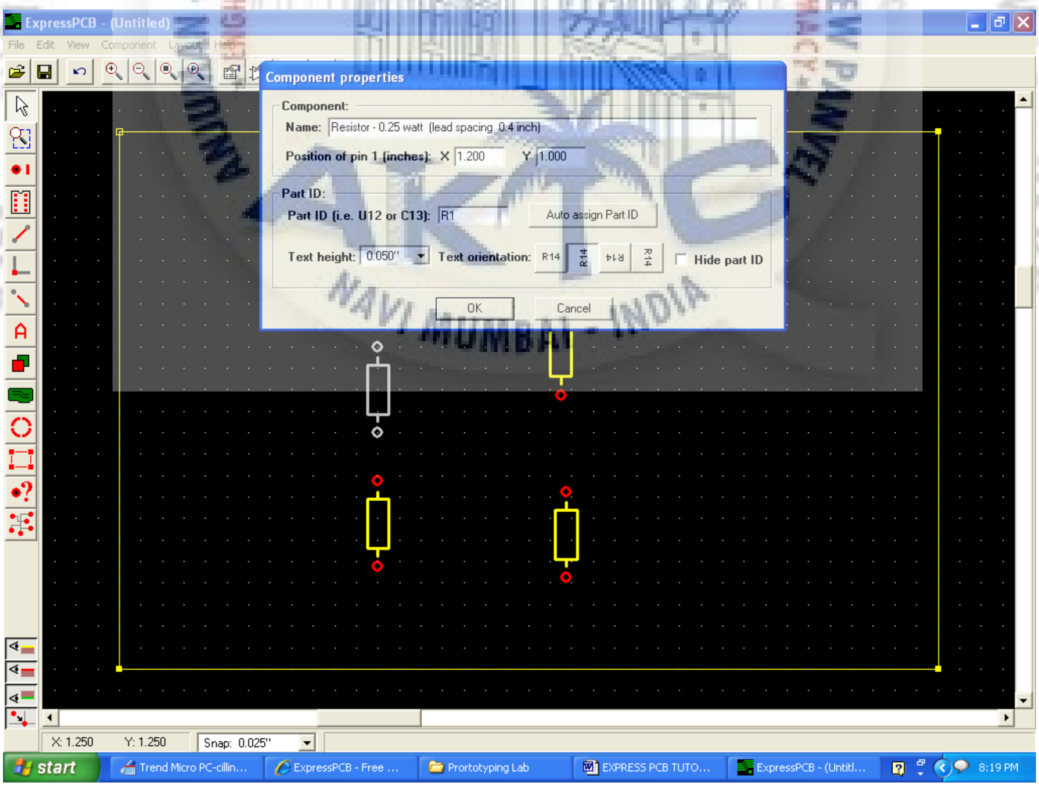


The yellow line on the screen shows the boundary for the PCB. The default boundary is 3.8 x 2.5 inches, which matches the express PCB miniboard service. This demo will use the entire board—**however for our class project you should only use half the board (1.9" x 2.5") so that we can double up designs**. Also, be aware that no copper (pads or traces) can be placed closer than 0.025" to the perimeter of the board.

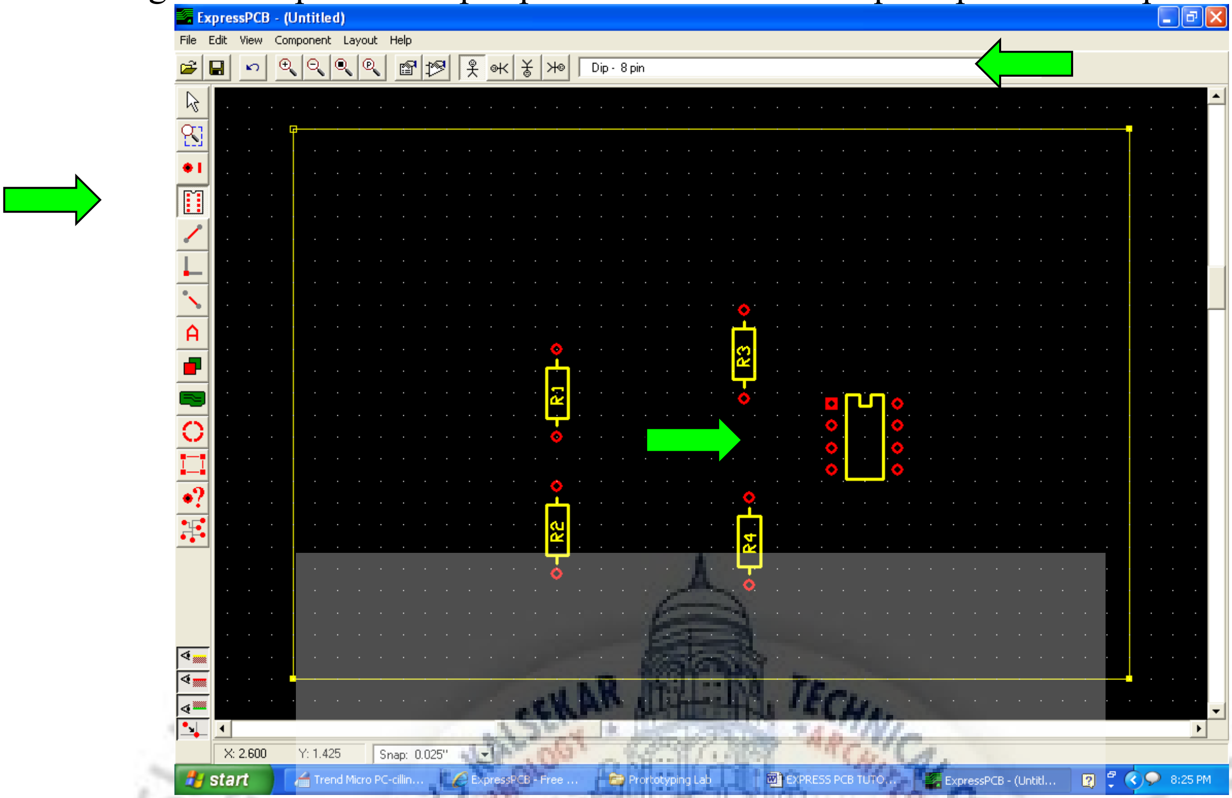
3. The first thing you need to do is to place all of your components onto the layout. Let's start with the resistors. Select the component placing tool, which looks like a little IC, and from the pull-down menu on the upper right choose "Resistor-0.25 watt (lead spacing 0.4 inch)." (This description matches the small resistors in Ri-024). Put 4 resistors on the schematic.



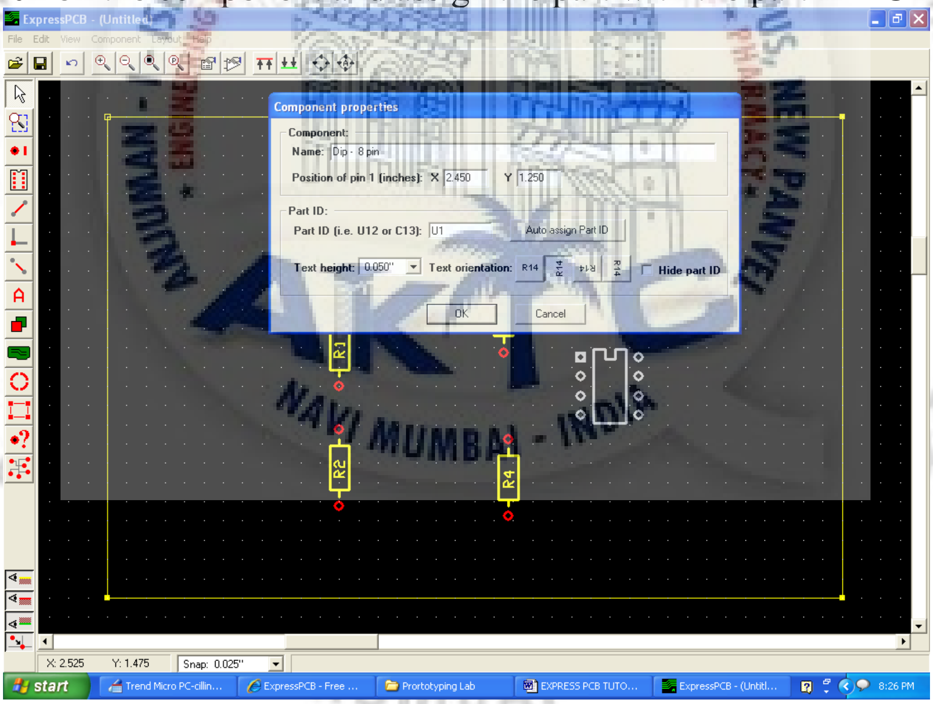
4. Now double click on each of the resistors to bring up the component properties box, and assign the resistors with part IDs R1, R2, R3, and R4.



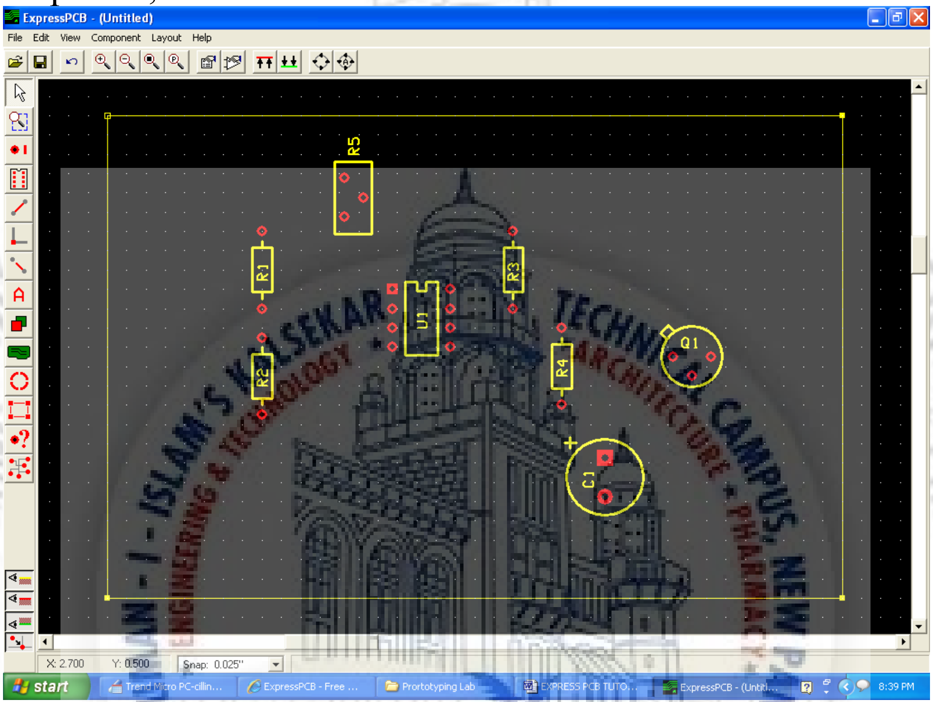
5. The LM311 for this example is in an 8-pin DIP package, so you place the comparator using the component "Dip 8-pin." Notice how the square pad denotes pin 1.



6. Double-click on the component and assign the part with the part ID "U1"



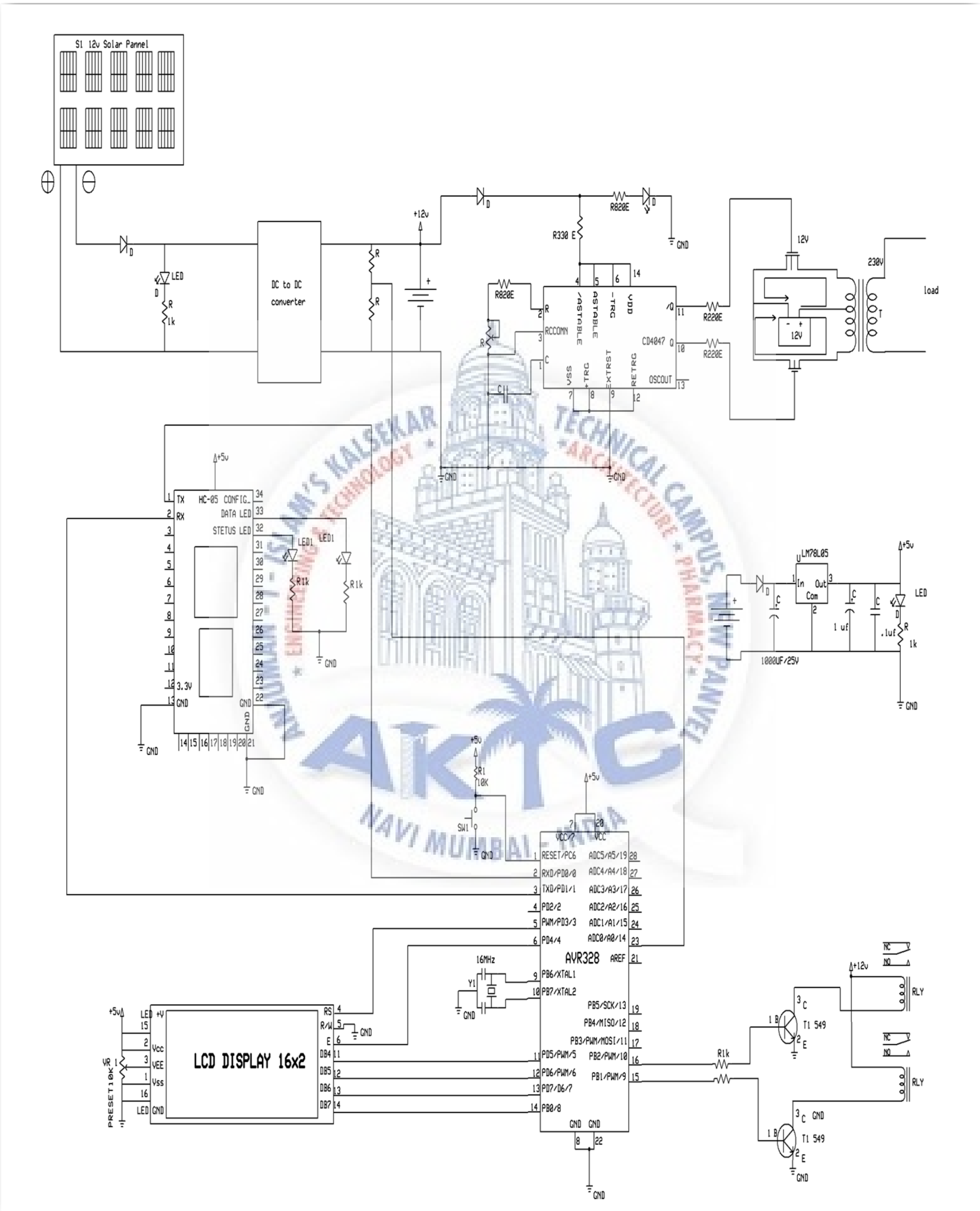
7. Now add the following components (this assumes that each of these component descriptions match the components in the circuit—it's good to confirm this with a ruler when you go to build your own circuit—matching lead spacings are particularly important):
    a. A capacitor with the description "Cap – radial electrolytic – Lead spacing 0.2 inch" and give it part ID, "C1" (notice how the square pad denotes the positive lead)
    b. A transistor with the description "Semiconductor – TO-39" and give it part ID, "Q1"
    c. A potentiometer with the description "Potentiometer – Bourns series 3386H" and give it partID, "R5"



8. Save your work.

CHAPTER 6

BLOCK DIAGRAM AND LIST OF COMPONENTS



LIST OF COMPONENTS:

1. Solar Panel Single Screen(12V, 15W)
2. DC to DC Buck Boost Converter
3. Battery 12 V, 4.5Ah SMF Lead acid
4. CD4047
5. Single Phase Stepdown Transformer 230V/12v with Tapping
6. Voltage Regulator 7805 12V/5V inbuilt oscillator
7. Arduino UNO AT-Mega 328
8. LCD 16*2 (7 channels,RW,En,RS,5V) 4 bit Mode
9. Relays 12 V DC
10. Bluetooth Devices HC-05 2.4GHz, 10mtrs range
11. Different Range of Resistor and Capacitor

CHAPTER 7

DC-DC BUCK BOOST CONVERTER

The general configuration of Buck-Boost converter is shown Figure.

A buck-boost Converter can be obtained by cascade connection of the two basic converters:

- the step down converter
- the step up converter

The circuit operation can be divided into two modes:

- During mode 1 (Figure a), the switch S_1 is turned on and the diode D is reversed biased. In mode 1 the input current, which rises, flows through inductor L and switch S_1 .
- In mode 2 (Figure b), the switch S_1 is off and the current, which was flowing through the inductor, would flow through L, C, D and load. In this mode the energy stored in the inductor (L) is transferred to the load and the inductor current (i_L) falls until the switch S_1 is turned on again in the next cycle.

The waveforms for the steady-state voltage and current are shown in Figure.

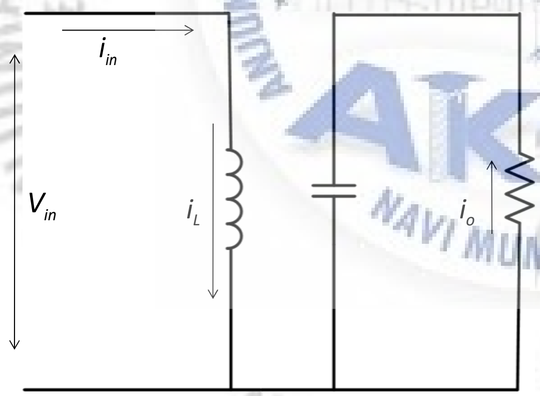


Figure 8a: Buck Boost Converter in mode 1

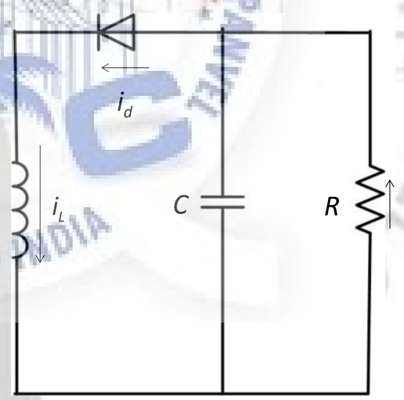


Figure 8b: Buck Boost Converter in mode 2

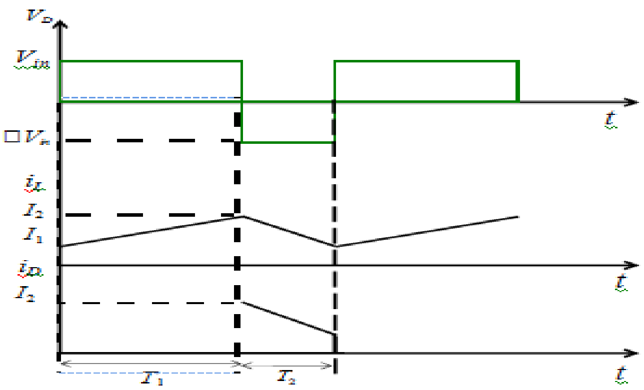


Figure 9: Current and voltage waveforms of Buck Boost Converter

Buck-Boost Converter Continuous Mode of Operation

Since the switching frequency is considered to be very high, it is assumed that the current through the inductor (L) rises linearly. Hence, the relation of the voltage and current in ***mode 1*** is given by

$$V_{in} = L\frac{I_2 - I_1}{T_1} = L\frac{\Delta I}{T_1}$$
$$\Rightarrow T_1 = L\frac{\Delta I}{V_{in}} \quad (29)$$

The inductor current falls linearly from I_2 to I_1 in ***mode 2*** time T_2 and is given by

$$V_o = -L\frac{\Delta I}{T_2}$$
$$\Rightarrow T_2 = -L\frac{\Delta I}{V_o} \quad (30)$$

The term $\Delta I (= I_2 - I_1)$, in ***mode 1*** and ***mode 2***, is the peak to peak ripple current through the inductor L. From **equation 29** and **equation 30** the relation between the input and output voltage is obtained as

$$\Delta I = \frac{V_{in}T_1}{L} = -\frac{V_o T_2}{L} \quad (31)$$

The relation between the ***on*** and off time, of the switch S_1, and the total time duration is given in terms of duty ratio (D) as:

$$T_1 = DT \quad (32a)$$

$$T_2 = (1-D)T \quad (32b)$$

Substituting the values of T_1 and T_2 from **equation 32a** and **equation 32b** into **equation 31** gives:

$$V_o = -\frac{V_{in}D}{1-D} \tag{33}$$

If the converter is assumed to be lossless, then

$$V_{in}I_{in} = -V_oI_o$$
$$V_{in}I_{in} = \frac{V_{in}D}{1-D}I_o \Rightarrow I_{in} = \frac{I_oD}{1-D} \tag{34}$$

The switching period T obtained from **equation 29** and **equation 30** as:

$$T = T_1 + T_2 = L\frac{\Delta I}{V_o} - L\frac{\Delta I}{V_{in}} = L\Delta I\frac{(V_{in}-V_o)}{V_{in}V_o} \tag{35}$$

The peak to peak ripple current ΔI is obtained from **equation 35** as

$$\Delta I = \frac{TV_{in}V_o}{L(V_o - V_{in})} = \frac{DT}{L}V_{in} = \frac{V_{in}D}{fL}$$

where (36)

f = switching frequency

When the switch S_1 is turned ***on***, the filter capacitor supplies the load current for the time duration T_1. The average discharge current of the capacitor $I_{cap} = I_{out}$ and the peak to peak ripple current of the capacitor are:

$$\Delta V_{cap} = \frac{1}{C}\int_0^{T_1} I_{cap}dt = \frac{1}{C}\int_0^{T_1} I_o dt = \frac{I_oT_1}{C} = \frac{I_oD}{fC} \tag{37}$$

Buck-Boost Converter Boundary between Continuous and Discontinuous Conduction

In **Figure 10** the voltage and load current waveforms of at the edge of continuous conduction is shown. In this mode of operation, the inductor current (i_L) goes to zero at the end of the ***off interval*** (T_2). From **Figure 10**, it can be seen that the average value of the inductor current is given by

$$I_{LB} = \frac{1}{2}I_2 = \frac{1}{2}\Delta I \tag{38}$$

Substituting the value of ΔI from **equation 36** into **equation 38** gives:

$$I_{LB} = \frac{1}{2}\frac{DT}{L}V_{in} \tag{39}$$

In terms of output voltage, **equation 39** can be written as

The average value of the output current is obained substituting the value of input current from **equation 34** into **equation 40** as:

$$I_{OB} = \frac{1}{2}\frac{T}{L}V_o(1-D)^2 \quad (41)$$

Most applications in which a buck-boost converter may be used require that V_{out} be kept constant. From **equation 40** and **equation 41** it can be seen that I_{LB} and I_{OB} result in their maximum values at $D=0$ as

$$I_{LB,\max} = \frac{TV_{out}}{2L}$$
$$I_{OB,\max} = \frac{TV_{out}}{2L} \quad (42)$$

From **equation 38** it can be seen that peak-to-peak ripple current is given by

$$\Delta I = 2I_{LB} \quad (43)$$

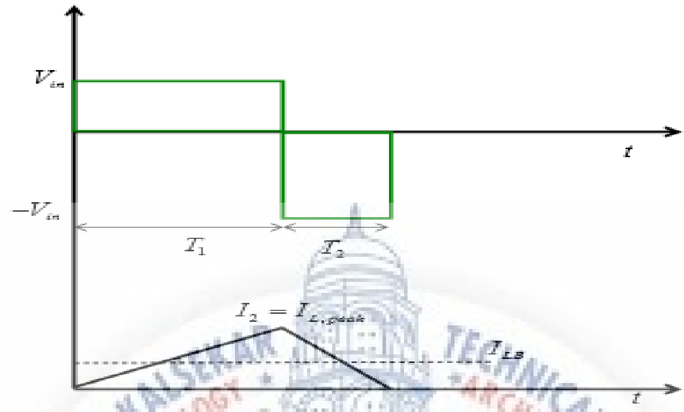


Figure 10: Current and voltage waveforms of Buck Boost Converter in boundary between continuous **and discontinuous mode**

CHAPTER 8

BATTERY CP1245

CP1245 12V 4.5Ah(20hr)

The rechargeable batteries are lead-lead dioxide systems. The dilute sulfuric acid electrolyte is absorbed by separators and plates and thus immobilized. Should the battery be accidentally overcharged producing hydrogen and oxygen, special one-way valves allow the gases to escape thus avoiding excessive pressure build-up. Otherwise, the battery is completely sealed and is, therefore, maintenance-free, leak proof and usable in any position.

Battery Construction

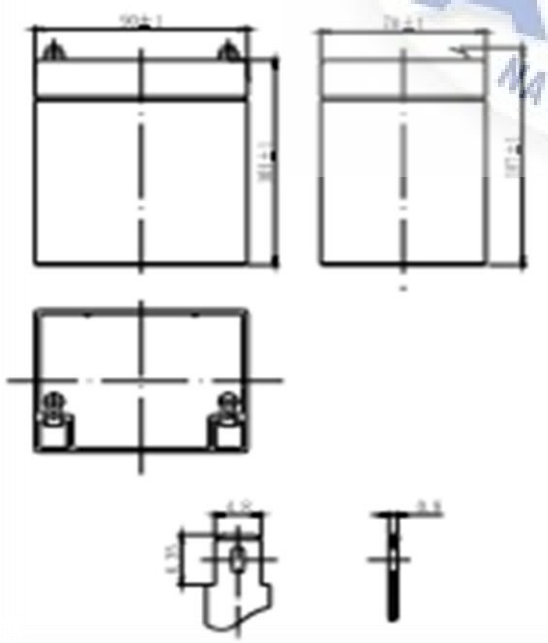
Component	Positive plate	Negative plate	Container	Cover	Safety valve	Terminal	Separator	Electrolyte
Raw material	Lead dioxide	Lead	ABS	ABS	Rubber	Copper	Fiberglass	Sulfuric acid

General Features

- Absorbent Glass Mat (AGM) technology for efficient gas recombination of up to 99% and freedom from electrolyte maintenance or water adding.
- Not restricted for air transport-complies with IATA/ICAO Special Provision A67.
- UL-recognized component.
- Can be mounted in any orientation.
- Computer designed lead, calcium tin alloy grid for high power density.
- Long service life, float or cyclic applications.
- Maintenance-free operation.
- Low self discharge.

Dimensions and Weight

Length(mm / inch)	90 / 3.54
Width(mm / inch)	70 / 2.76
Height(mm / inch)	101 / 3.98
Total Height(mm / inch)	107 / 4.21
Approx. Weight(Kg / lbs)	1.55 / 3.41



Performance Characteristics

Nominal Voltage	12V
Number of cell	6
Design Life	5 years
Nominal Capacity 77°F(25°C)	
20 hour rate (0.225A, 10.5V)	4.5Ah
10 hour rate (0.43A, 10.5V)	4.3Ah
5 hour rate (0.69A, 10.5V)	3.45Ah
1 hour rate (2.96A, 9.6V)	2.96Ah
Internal Resistance	
Fully Charged battery 77°F(25°C)	41.5mOhms
Self-Discharge	
3% of capacity declined per month at 20°C(average)	
Operating Temperature Range	
Discharge	-20~60°C
Charge	-10~60°C
Storage	-20~60°C
Max. Discharge Current 77°F(25°C)	67.5A(5s)
Short Circuit Current	225A
Charge Methods: Constant Voltage Charge 77°F(25°C)	
Cycle use	2.30-2.35VPC
Maximum charging current	1.8A
Temperature compensation	-30mV/°C
Standby use	2.23-2.27VPC
Temperature compensation	-20mV/°C

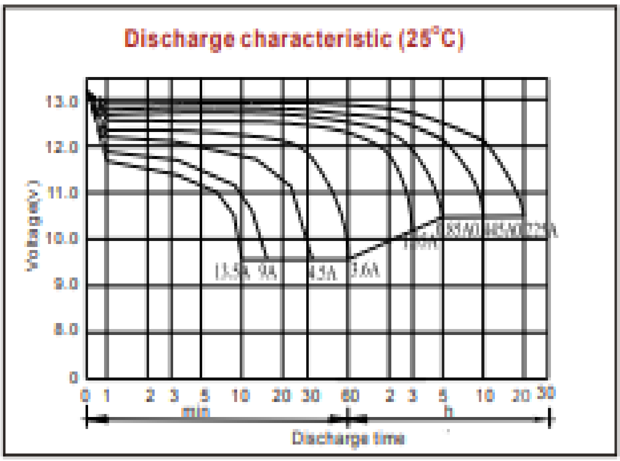
Discharge Constant Current (Amperes at 77°F25°C)

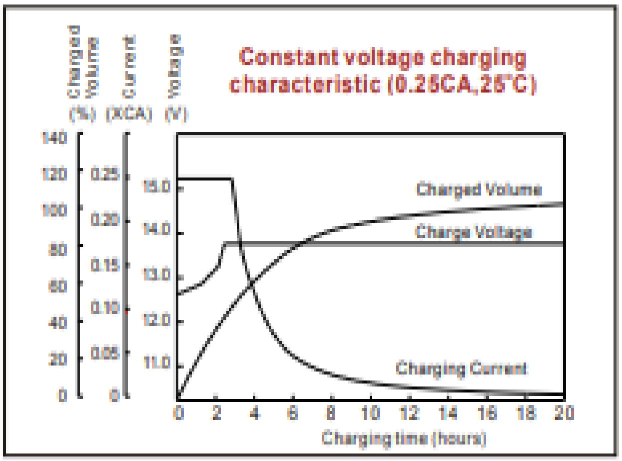
End Point Volts/Cell	5min	10min	15min	30min	1h	3h	5h	10h	20h
1.60V	15.3	12.4	8.64	4.63	2.96	1.20	0.76	0.46	0.230
1.65V	14.5	11.8	8.26	4.48	2.86	1.16	0.74	0.45	0.230
1.70V	13.6	11.2	7.97	4.25	2.74	1.12	0.71	0.44	0.228
1.75V	12.8	10.6	7.65	4.06	2.62	1.07	0.69	0.43	0.225
1.80V	11.9	9.98	7.03	3.83	2.50	1.00	0.67	0.42	0.221

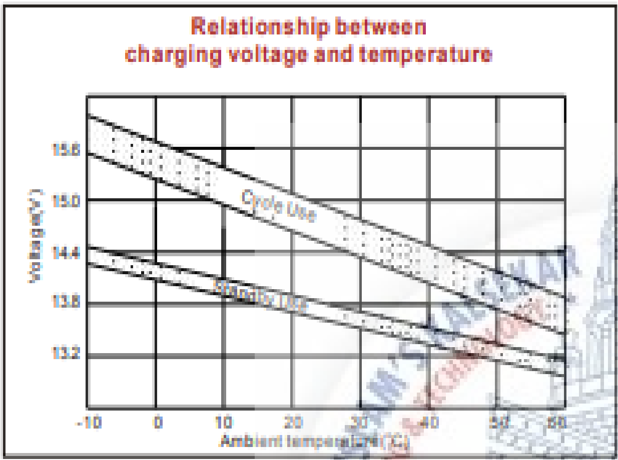
Discharge Constant Power (Watts at 77°F25°C)

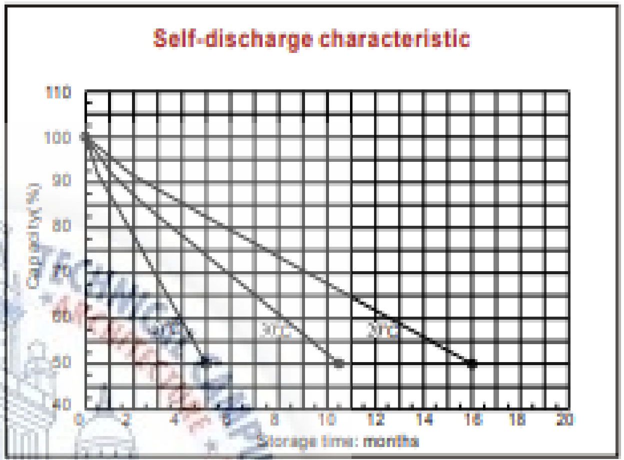
End Point Volts/Cell	5min	10min	15min	30min	45min	1h	2h	3h	5h
1.60V	30.4	21.3	16.98	9.22	7.44	5.22	3.35	2.43	1.56
1.65V	28.5	20.1	16.02	8.76	7.10	5.01	3.24	2.37	1.54
1.70V	26.6	18.8	15.15	8.28	6.75	4.77	3.13	2.31	1.51
1.75V	24.8	17.6	14.19	7.80	6.38	4.54	3.01	2.26	1.47
1.80V	22.9	16.42	13.22	7.31	6.01	4.29	2.89	2.16	1.44

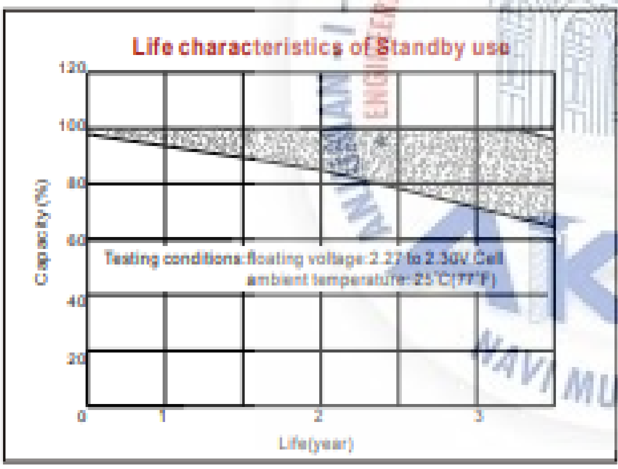
(Note)The above characteristics data are average values obtained within three charge/discharge cycles not the mimimum values.

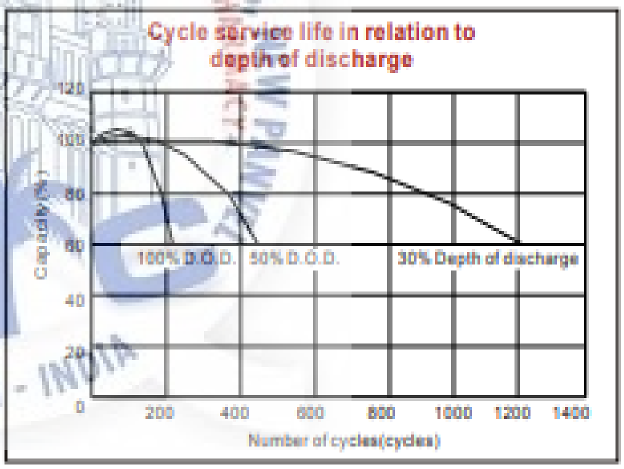

Discharge characteristic (25°C)
Voltage(V)
Discharge time
min
h

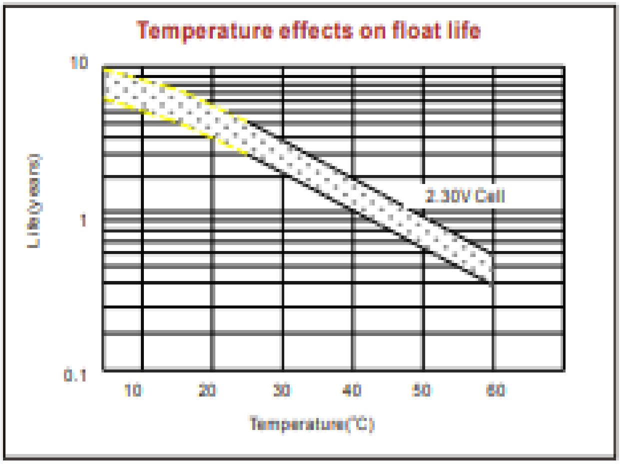

Constant voltage charging characteristic (0.25CA,25°C)
Charged Volume
Charge Voltage
Charging Current
Charging time (hours)

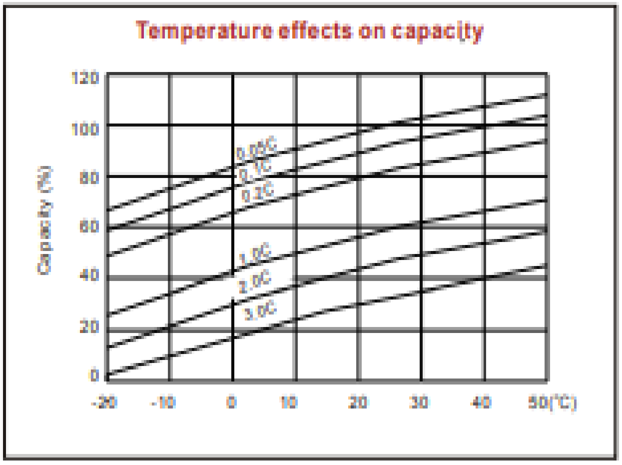

Relationship between charging voltage and temperature
Cycle Use
Standby Use
Voltage(V)


Self-discharge characteristic
Storage time: months


Life characteristics of Standby use
Capacity(%)
Life(year)

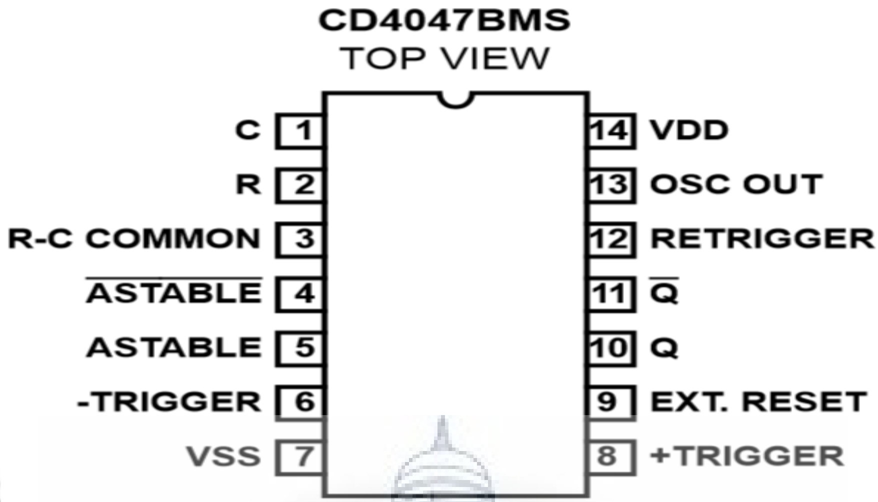

Cycle service life in relation to depth of discharge
100% D.O.D.
50% D.O.D.
30% Depth of discharge
Number of cycles(cycles)


Temperature effects on float life
2.30V Cell
Life(years)
Temperature(°C)


Temperature effects on capacity
Capacity (%)

CHAPTER 9

CD4047 CMOS LOW-POWER MONOSTABLE/ASTABLE MULTIVIBRATOR



DESCRIPTION

CD4047BMS consists of astable multivibrator with logic tech- niques incorporated to permit positive or negative edge triggered monostable multivibrator action with retriggering and external counting options.

Inputs include +TRIGGER, -TRIGGER, ASTABLE, ASTABLE, RETRIGGER, and EXTERNAL RESET. Buffered outputs are Q, Q, and OSCILLATOR. In all modes of operation, an external capacitor must be connected between C-Timing and RC-Common terminals, and an external resistor must be connected between the R-Timing and RC- Common terminals.

Astable operation is enabled by a high level on the ASTABLE input or a low level on the ASTABLE input, or both. The period of the square wave at the Q and Q Outputs in this mode of operation is a function of the external components employed. "True" input pulses on the ASTABLE input or "Complement" pulses on the ASTABLE input allow the circuit to be used as a gatable multivibrator. The OSCILLATOR output period will be half of the Q terminal output in the astable mode. However, a 50% duty cycle is not guaranteed at this output.

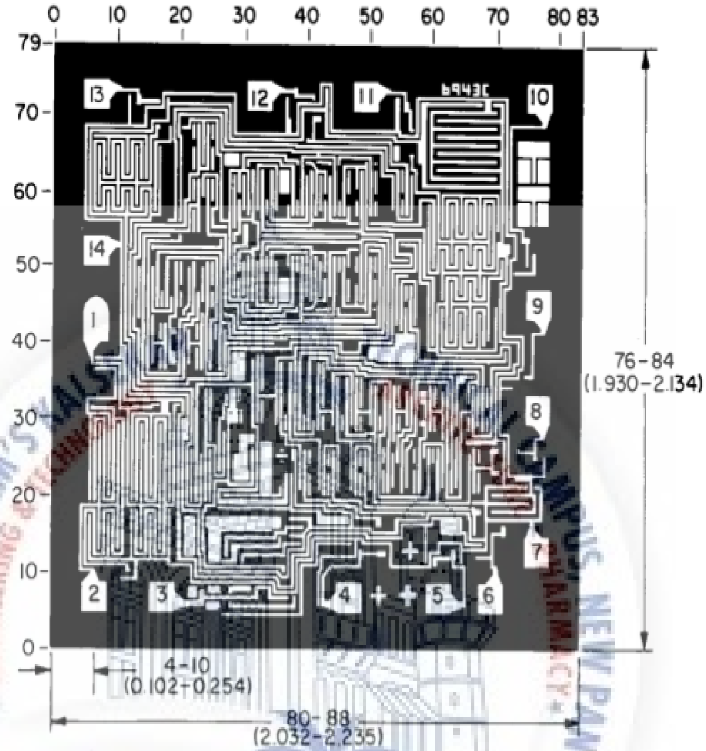
The CD4047BMS triggers in the monostable mode when a positive going edge occurs on the +TRIGGER input while the -TRIGGER is held low. Input pulses may be of any duration relative to the output pulse.

If retrigger capability is desired, the RETRIGGER input is pulsed. The retriggerable mode of operation is limited to positive going edge. The CD4047BMS will retrigger as long as the RETRIGGER input is high, with or without transitions (See Figure 31)

An external countdown option can be implemented by coupling "Q" to an external "N" counter and resetting the counter with trigger pulse. The counter output pulse is fed back to the ASTABLE input and has a dura- tion equal to N times the period of the multivibrator.

A high level on the EXTERNAL RESET input assures no output pulse during an "ON" power condition. This input can also be activated to ter- minate the output pulse at any time. For monostable operation, when- ever VDD is applied, an internal power on reset circuit will clock the Q output low within one output period (tM).

Chip Dimensions and Pad Layout



Dimensions in parenthesis are in millimeters and are derived from the basic inch dimensions as indicated. Grid graduations are in mils (10^{-3} inch).

METALLIZATION: Thickness: 11kÅ – 14kÅ, AL.

PASSIVATION: 10.4kÅ - 15.6kÅ, Silane

BOND PADS: 0.004 inches X 0.004 inches MIN

DIE THICKNESS: 0.0198 inches - 0.0218 inches

Retrigger Mode Operation

The CD4047BMS can be used in the retrigger mode to extend the output pulse duration, or to compare the frequency of an input signal with that of the internal oscillator. In the retrigger mode the input pulse is applied to terminal 12, and the output is taken from terminal 10 or 11. As shown in Figure 31 normal monostable action is obtained when one retrigger pulse is applied. Extended pulse duration is obtained when more than one pulse is applied.

For two input pulses, $t_{RE} = t_1' + t_1 + 2t_2$. For more than two pulses, the output pulse width is an integral number of time periods, with the first time period being $t_1' + t_2$, typically, 2.48RC, and all subsequent time periods being $t_1 + t_2$, typically, 2.2RC.

External Counter Option

Time t_M can be extended by any amount with the use of external counting circuitry. Advantages include digitally controlled pulse duration, small timing capacitors for long time periods, and extremely fast recovery time. A typical implementation is shown in Figure 32. The pulse duration at the output is

$$t_{ext} = (N - 1)(t_A) + (t_M + t_A/2)$$

where t_{ext} = pulse duration of the circuitry, and N is the number of counts used.

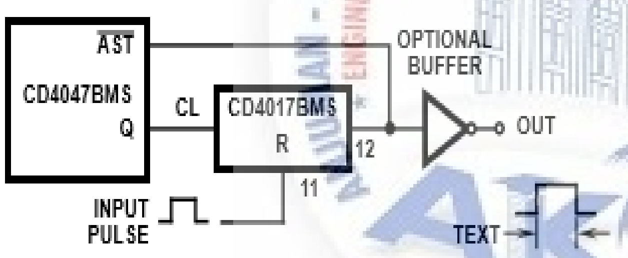


FIGURE 32. IMPLEMENTATION OF EXTERNAL COUNTER OPTION

Timing Component Limitations

The capacitor used in the circuit should be non polarized and have low leakage (i.e. the parallel resistance of the capacitor should be at least an order of magnitude greater than the external resistor used). There is no upper or lower limit for either R or C value to maintain oscillation.

However, in consideration of accuracy, C must be much larger than the inherent stray capacitance in the system (unless this capacitance can be measured and taken into account). R must be much larger than the CMOS "ON" resistance in series with it, which typically is hundreds of Ω. In addition, with very large values of R, some short term instability with respect to time may be noted.

The recommended values for these components to maintain agreement with previously calculated formulas without trimming should be:

$C \geq 100pF$, up to any practical value, for astable modes;

$C \geq 1000pF$, up to any practical value for monostable modes.

$10k\Omega \leq R \leq 1M\Omega$

Power Consumption

In the standby mode (Monostable or Astable), power dissipation will be a function of leakage current in the circuit, as shown in the static electrical characteristics. For dynamic operation, the power needed to charge the external timing capacitor C is given by the following formula:

Astable Mode:

$$P = 2CV^2f. \text{ (Output at terminal No. 13)}$$

$$P = 4CV^2f. \text{ (Output at terminal Nos. 10 and 11)}$$

Monostable Mode:

$$P = \frac{(2.9CV^2)\text{ (Duty Cycle)}}{T}$$

(Output at terminal Nos. 10 to 11)

The circuit is designed so that most of the total power is consumed in the external components. In practice, the lower the values of frequency and voltage used, the closer the actual power dissipation will be to the calculated value.

Because the power dissipation does not depend on R, a design for minimum power dissipation would be a small value of C. The value of R would depend on the desired period (within the limitations discussed above). See Figures 26, 27, and 28 for typical power consumption in astable mode.

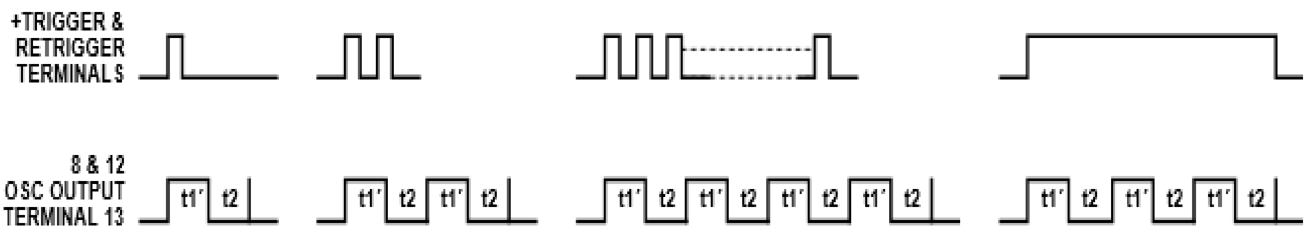


TABLE 9. FUNCTIONAL TERMINAL CONNECTIONS

In all cases External resistor between terminals 2 and 3 (Note 1)
External capacitor between terminals 1 and 3 (Note 1)

FUNCTION	TERMINAL CONNECTIONS			OUTPUT PULSE FROM	OUTPUT PERIOD OR PULSE WIDTH
	TO VDD	TO VSS	INPUT TO		
ASTABLE MULTIVIBRATOR					
Free Running	4, 5, 6, 14	7, 8, 9, 12	-	10, 11, 13	T_A (10, 11) = 4.40 RC
True Gating	4, 6, 14	7, 8, 9, 12	5	10, 11, 13	T_A (13) = 2.20 RC (Note 2)
Complement Gating	6, 14	5, 7, 8, 9, 12	4	10, 11, 13	
MONOSTABLE MULTIVIBRATOR					
Positive Edge Trigger	4, 14	5, 6, 7, 9, 12	8	10, 11	tM (10, 11) = 2.48 RC
Negative Edge Trigger	4, 8, 14	5, 7, 9, 12	6	10, 11	
Retriggerable	4, 14	5, 6, 7, 9	8, 12	10, 11	
External Countdown (Note 3)	14	5, 6, 7, 8, 9, 12	-	10, 11	

NOTES:

1. See text.
2. First positive $^1/_2$ cycle pulse width = 2.48 RC. See note follow Monostable Mode Design Information.
3. Input Pulse to Reset of External Counting Chip External Counting Chip Output to Terminal 4.

Logic Diagrams

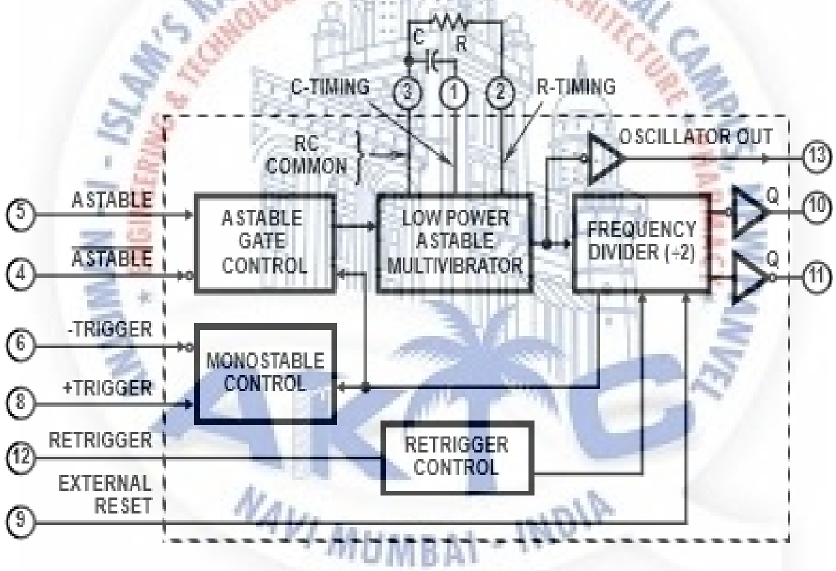


FIGURE 1. CD4047BMS LOGIC BLOCK DIAGRAM

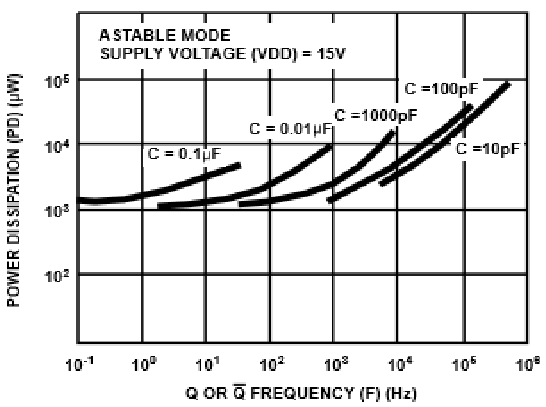


FIGURE 28. TYPICAL POWER DISSIPATION vs OUTPUT FREQUENCY (VDD = 15V)

Logic Diagrams (Continued)

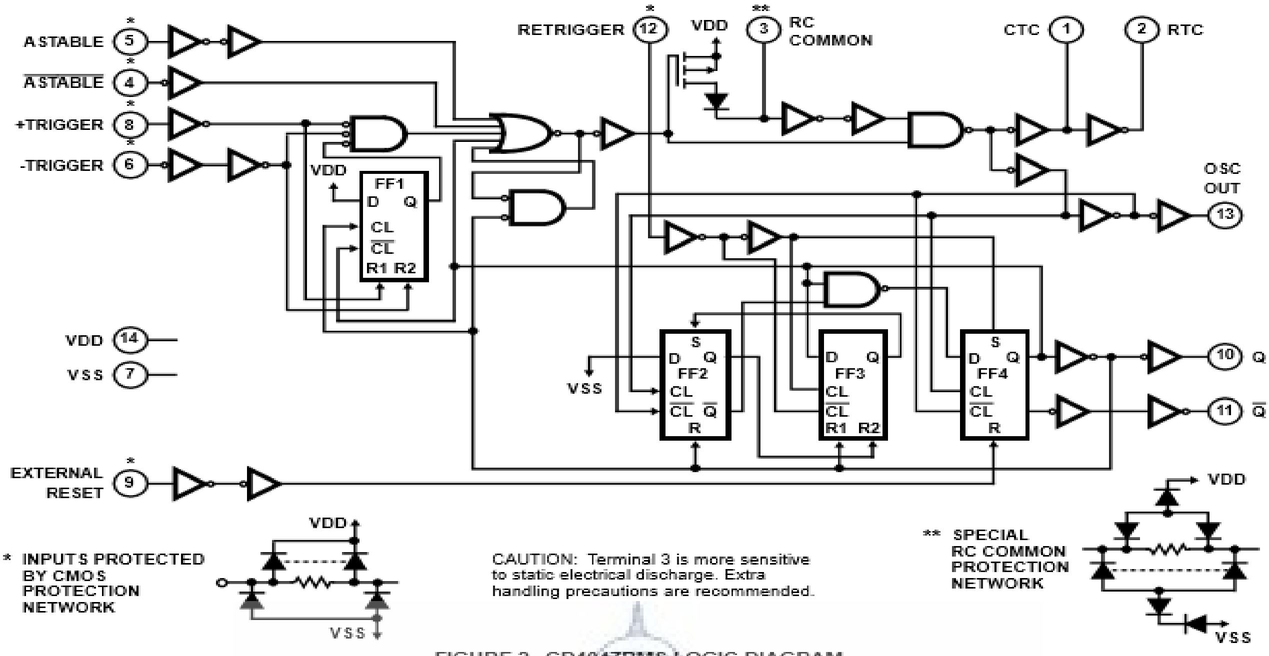
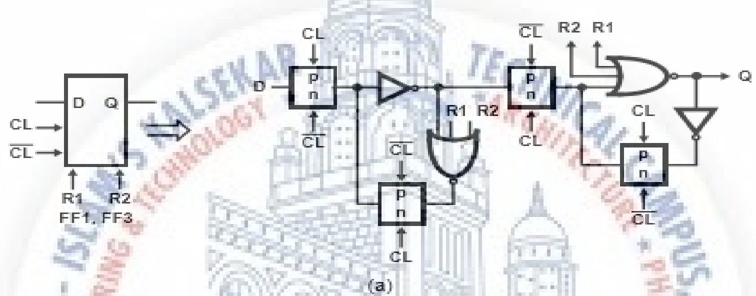


FIGURE 2. CD4047BMS LOGIC DIAGRAM



Typical Performance Characteristics

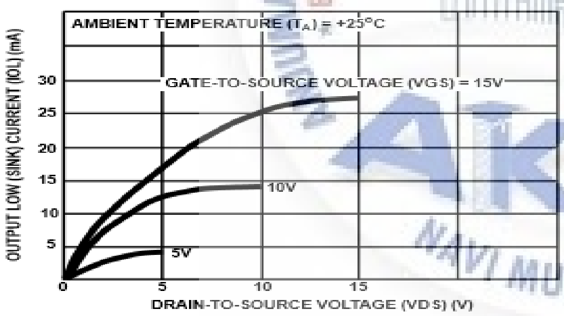


FIGURE 4. TYPICAL OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

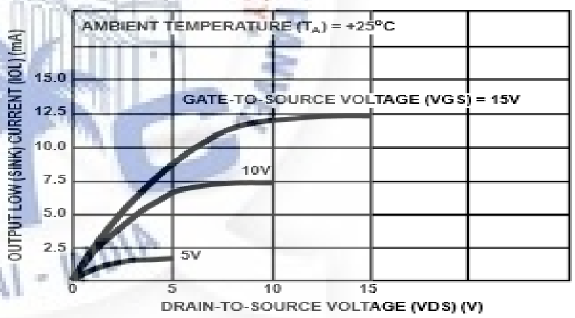


FIGURE 5. MINIMUM OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

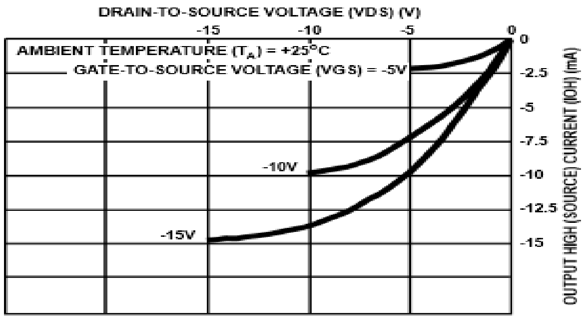


FIGURE 6. TYP. OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

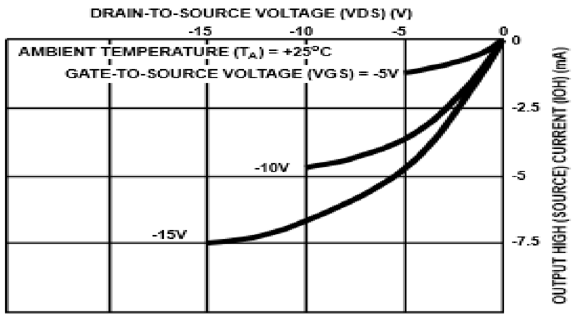


FIGURE 7. MINIMUM OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

Astable Mode Design Information

Unit-to-Unit Transfer Voltage Variations

The following analysis presents variations from unit to unit as a function of transfer voltage (VTR) shift (33%-67% VDD) for free running (astable) operation.

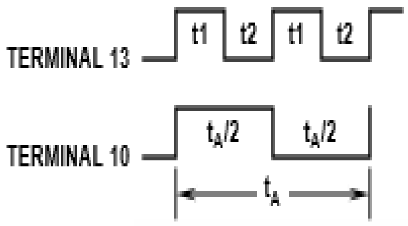


FIGURE 29. ASTABLE MODE WAVEFORMS

$$t1 = -RC \ln \frac{VTR}{VDD + VTR};$$

typically, t1 = 1.1RC

$$t2 = -RC \ln \frac{VDD - VTR}{2VDD - VTR};$$

typically, t2 = 1.1RC

$$t_A = 2(t1 + t2)$$

$$= -2RC \ln \frac{(VTR)(VDD - VTR)}{(VDD + VTR)(2VDD - VTR)}$$

Typ:	VTR = 0.5VDD	t_A = 4.40RC
Min:	VTR = 0.33VDD	t_A = 4.62RC
Max:	VTR = 0.67VDD	t_A = 4.62RC

thus if t_A = 4.40RC is used, the variation will be +5%, -0% due to variations in transfer voltage.

Variations Due to VDD and Temperature Changes

In addition to variations from unit to unit, the astable period varies with VDD and temperature, Typical variations are presented in graphical form in Figures 11 to 18 with 10V as reference for voltage variations curves and +25°C as reference for temperature variations curves.

Monostable Mode Design Information

The following analysis presents variations from unit to unit as a function of transfer voltage (VTR) shift (33% - 67% VDD) for one shot (monostable) operation.

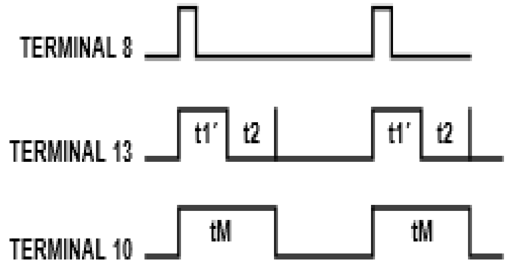


FIGURE 30. MONOSTABLE WAVEFORMS

$$t1' = -RC \ln \frac{VTR}{2VDD};$$

typically, t1′ = 1.38RC

$$tM = (t1' + t2)$$

$$tM = -RC \ln \frac{(VTR)(VDD - VTR)}{(2VDD - VTR)(2VDD)}$$

where tM = Monostable mode pulse width.
Values for tM are as follows:

Typ:	VTR = 0.5VDD	tM = 2.48RC
Min:	VTR = 0.33VDD	tM = 2.71RC
Max:	VTR = 0.67VDD	tM = 2.48RC

thus if tM = 2.48RC is used, the variation will be +9.3%, -0% due to variations in transfer voltage.

NOTES:

1. In the astable mode, the first positive half cycle has a duration of tM; succeeding durations are t_A/s.
2. In addition to variations from unit to unit, the monostable pulse width varies with VDD and temperature. These variations are presented in graphical form in Figures 19 to 26 with 10V as reference for voltage variation curves and +25°C as reference for temperature variation curves.

CHAPTER 10

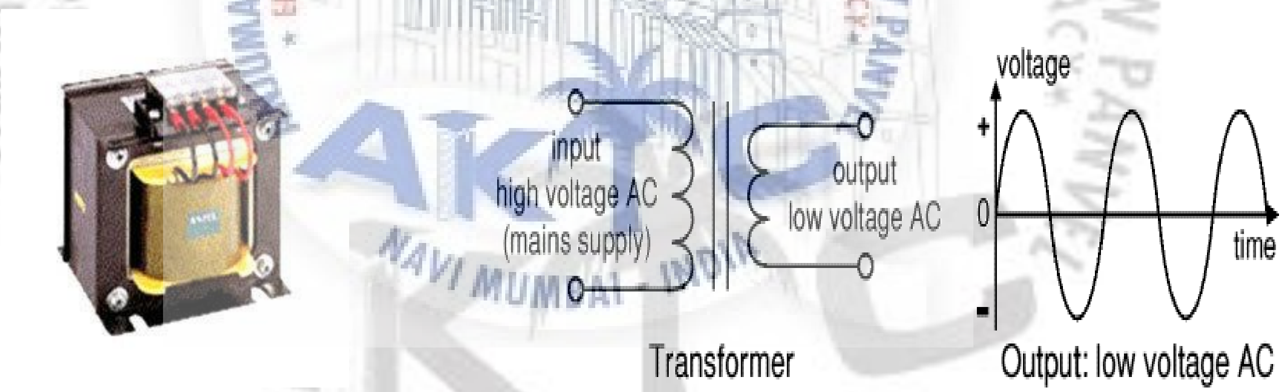
STEP DOWN TRANSFORMER

TRANSFORMER

STEPDOWN TRANSFORMER :-

Step down transformer is the first part of regulated power supply. To step down the mains 230V A.C. we require step down transformer. Following are the main characteristic of electronic transformer.

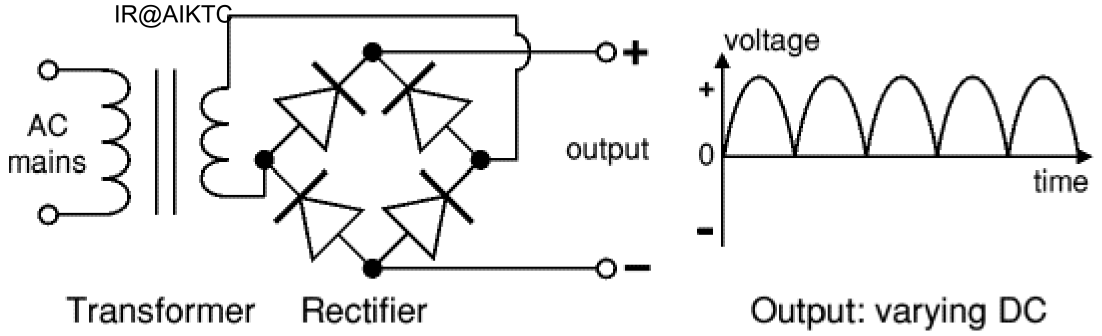
1) Power transformers are usually designed to operate from source of low impedance at a single freq.
2) It is required to construct with sufficient insulation of necessary dielectric strength.
3) Transformer ratings are expressed in volt–amp. The volt-amp of each secondary winding or windings are added for the total secondary VA. To this are added the load losses.
4) Temperature rise of a transformer is decided on two well-known factors i.e. losses on transformer and heat dissipating or cooling facility provided unit.



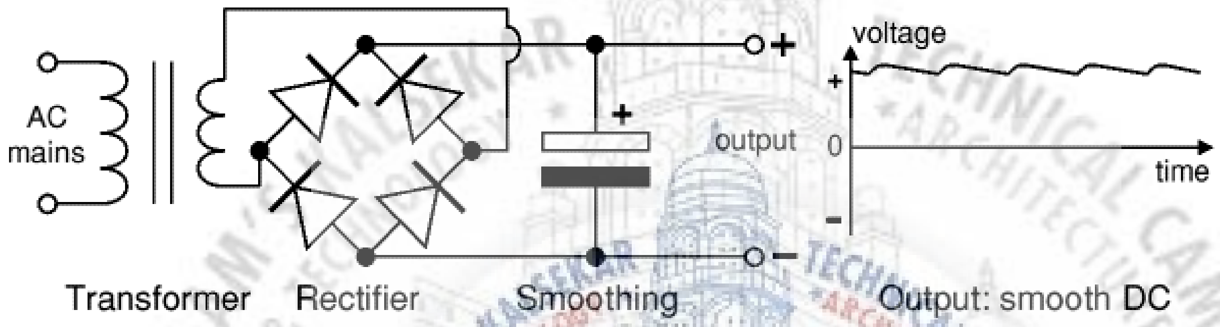
The **low voltage AC** output is suitable for lamps, heaters and special AC motors. It is **not** suitable for electronic circuits unless they include a rectifier and a smoothing capacitor.

- **Transformer + Rectifier**

- The **varying DC** output is suitable for lamps, heaters and standard motors. It is **not** suitable for electronic circuits unless they include a smoothing capacitor.

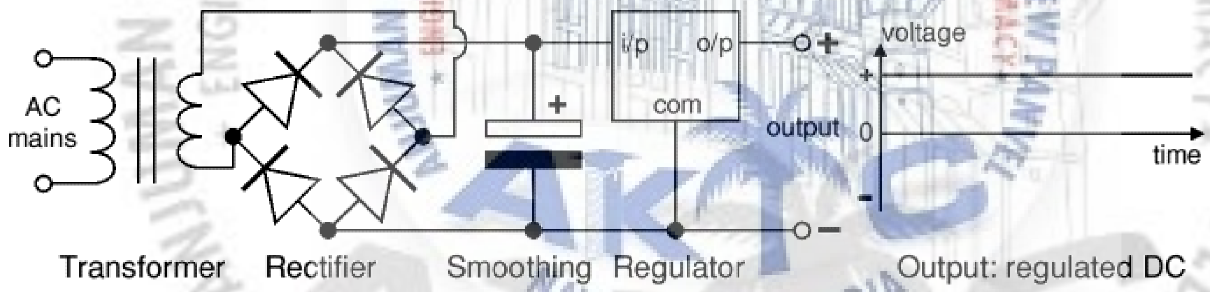


- **Transformer + Rectifier + Smoothing**



The **smooth DC** output has a small ripple. It is suitable for most electronic circuits.

- **Transformer + Rectifier + Smoothing + Regulator**



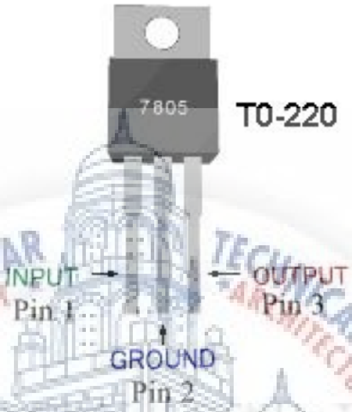
The **regulated DC** output is very smooth with no ripple. It is suitable for all electronic circuits. The fig. above shows the circuit diagram of the power supply unit. This block mainly consists of a two regulating IC 7805 and a bridge rectified and it provides a regulated supply approximately 5V.

The transformer used in this circuit has secondary rating of 7.5V. The main function of the transformer is to step down the AC voltage available from the main. The main connections are given to its primary winding through a switch connected to a phase line. The transformer provides a 7.5V AC output at its secondary terminals and the maximum current that can be drawn form the transformer is 1 Amp which is well abo ve the required level for the circuit

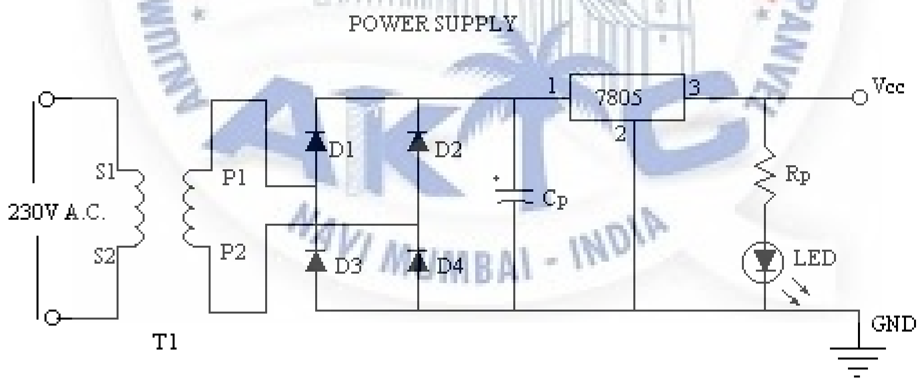
CHAPTER 11

VOLTAGE REGULATOR 7805

A voltage regulator is a circuit. That supplies constant voltage regardless of change in load current. IC voltage regulators are versatile and relatively cheaper. The 7800 series consists of three terminal positive voltage regulators. These ICs are designed as fixed voltage regulator and with adequate heat sink, can deliver o/p current in excess of 1A. These devices do not require external component.



This IC also has internal thermal overload protection and internal short circuit and current limiting protection. For our project we use 7805 voltage regulator IC.



78xx ICs are easy to use and handle but these cannot give an altering voltage required so Lm317 series of ICs are available to obtain a voltage output from 1.25 volts to 37 volts. 7805 is a voltage regulator integrated circuit. It is a member of 78xx series of fixed linear voltage regulator ICs. The voltage source in a circuit may have fluctuations and would not give the fixed voltage output. The voltage regulator IC maintains the output voltage at a constant value. The xx in 78xx indicates the fixed output voltage it is designed to provide. 7805 provides +5V regulated power supply. Capacitors of suitable values can be connected at input and output pins depending upon the respective voltage levels.

ADVANTAGES

1. 78xx series ICs do not require additional components to provide a constant, regulated source of power, making them easy to use, as well as economical and efficient uses of space. Other voltage regulators may require additional components to set the output voltage level, or to assist in the regulation process. Some other designs (such as a switched-mode power supply) may need substantial engineering expertise to implement.

2. 78xx series ICs have built-in protection against a circuit drawing too much power. They have protection against overheating and short-circuits, making them quite robust in most applications. In some cases, the current-limiting features of the 78xx devices can provide protection not only for the 78xx itself, but also for other parts of the circuit.

SPECIFICATIONS:

Available o/p D.C. Voltage = + 5V.

Line Regulation = 0.03

Load Regulation = 0.5

V_{in} maximum = 35 V

Ripple Rejection = 66-80 (db)

CHAPTER 12

RELAYS

RELAYS

ELECTROMAGNETIC RELAYS

A **relay** is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism, but other operating principles are also used. Relays find applications where it is necessary to control a circuit by a low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits, repeating the signal coming in from one circuit and re-transmitting it to another. Relays found extensive use in telephone exchanges and early computers to perform logical operations. A type of relay that can handle the high power required to directly drive an electric motor is called a contactor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protection relays

A simple electromagnetic relay consists of a coil of wire surrounding a soft iron core, an iron yoke, which provides a low reluctance path for magnetic flux, a movable iron armature, and a set, or sets, of contacts; two in the relay pictured. The armature is hinged to the yoke and mechanically linked to a moving contact or contacts. It is held in place by a spring so that when the relay is de-energized there is an air gap in the magnetic circuit. In this condition, one of the two sets of contacts in the relay pictured is closed, and the other set is open. Other relays may have more or fewer sets of contacts depending on their function. The relay in the picture also has a wire connecting the armature to the yoke. This ensures continuity of the circuit between the moving contacts on the armature, and the circuit track on the printed circuit board (PCB) via the yoke, which is soldered to the PCB.

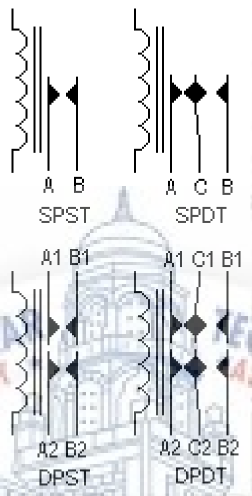
When an electric current is passed through the coil, the resulting magnetic field attracts the armature, and the consequent movement of the movable contact or contacts either makes or breaks a connection with a fixed contact. If the set of contacts was closed when the relay was de-energized, then the movement opens the contacts and breaks the connection, and vice versa if the contacts were open. When the current to the coil is switched off, the armature is returned by a force, approximately half as strong as the magnetic force, to its relaxed position. Usually this force is provided by a spring, but gravity is also used commonly in industrial motor starters. Most relays are manufactured to operate quickly. In a low voltage application, this is to reduce noise. In a high voltage or high current application, this is to reduce arcing.

When the coil is energized with direct current, a diode is often placed across the coil to dissipate the energy from the collapsing magnetic field at deactivation, which would otherwise generate a voltage spike dangerous to circuit components. Some automotive relays already include a diode inside the relay case. Alternatively a contact protection network, consisting of a capacitor and resistor in series, may absorb the surge. If the coil is designed to be energized with alternating current (AC), a small copper ring can be crimped to the end of the solenoid.

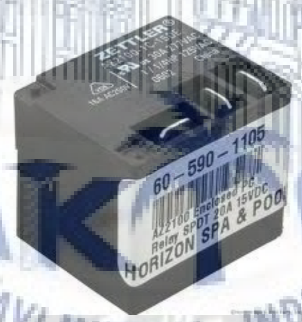
This "shading ring" creates a small out-of-phase current, which increases the minimum pull on the armature during the AC cycle.[1]

By analogy with functions of the original electromagnetic device, a solid-state relay is made with a thyristor or other solid-state switching device. To achieve electrical isolation an optocoupler can be used which is a light-emitting diode (LED) coupled with a photo transistor.

POLE AND THROW RELAY



Circuit symbols of relays. "C" denotes the common terminal in SPDT and DPDT types.



The diagram on the package of a DPDT AC coil relay

Since relays are switches, the terminology applied to switches is also applied to relays. A relay will switch one or more *poles*, each of whose contacts can be *thrown* by energizing the coil in one of three ways:

- Normally-open (**NO**) contacts connect the circuit when the relay is activated; the circuit is disconnected when the relay is inactive. It is also called a **Form A** contact or "make" contact.
- Normally-closed (**NC**) contacts disconnect the circuit when the relay is activated; the circuit is connected when the relay is inactive. It is also called a **Form B** contact or "break" contact.
- Change-over (**CO**), or double-throw (**DT**), contacts control two circuits: one normally-open contact and one normally-closed contact with a common terminal. It is also called

a **Form C** contact or "transfer" contact ("break before make"). If this type of contact utilizes"make before break" functionality, then it is called a **Form D** contact.

The following designations are commonly encountered:

- **SPST** – Single Pole Single Throw. These have two terminals which can be connected or disconnected. Including two for the coil, such a relay has four terminals in total. It is ambiguous whether the pole is normally open or normally closed. The terminology "SPNO" and "SPNC" is sometimes used to resolve the ambiguity.
- **SPDT** – Single Pole Double Throw. A common terminal connects to either of two others. Including two for the coil, such a relay has five terminals in total.
- **DPST** – Double Pole Single Throw. These have two pairs of terminals. Equivalent to two SPST switches or relays actuated by a single coil. Including two for the coil, such a relay has six terminals in total. The poles may be Form A or Form B (or one of each).
- **DPDT** – Double Pole Double Throw. These have two rows of change-over terminals. Equivalent to two SPDT switches or relays actuated by a single coil. Such a relay has eight terminals, including the coil.

The "S" or "D" may be replaced with a number, indicating multiple switches connected to a single actuator. For example 4 PDT indicates a four pole double throw relay (with 14 terminals).

EN 50005 are among applicable standards for relay terminal numbering; a typical EN 50005-compliant SPDT relay's terminals would be numbered 11, 12, 14, A1 and A2 for the C, NC, NO, and coil connections, respectively.

APPLICATIONS

Relays are used to and for:

- Control a high-voltage circuit with a low-voltage signal, as in some types of modems or audio amplifiers,
- Control a high-current circuit with a low-current signal, as in the starter solenoid of an automobile,

Detect and isolate faults on transmission and distribution lines by opening and closing circuit breakers (protection relays),

CHAPTER 13

BLUETOOTH DEVICE

HC-05

-Bluetooth to Serial Port Module

Overview

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup.

Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Bluecore 04-External single chip Bluetooth system with CMOS technology and with AFH(Adaptive Frequency Hopping Feature). It has the footprint as small as 12.7mmx27mm. Hope it will simplify your overall design/development cycle.

Specifications

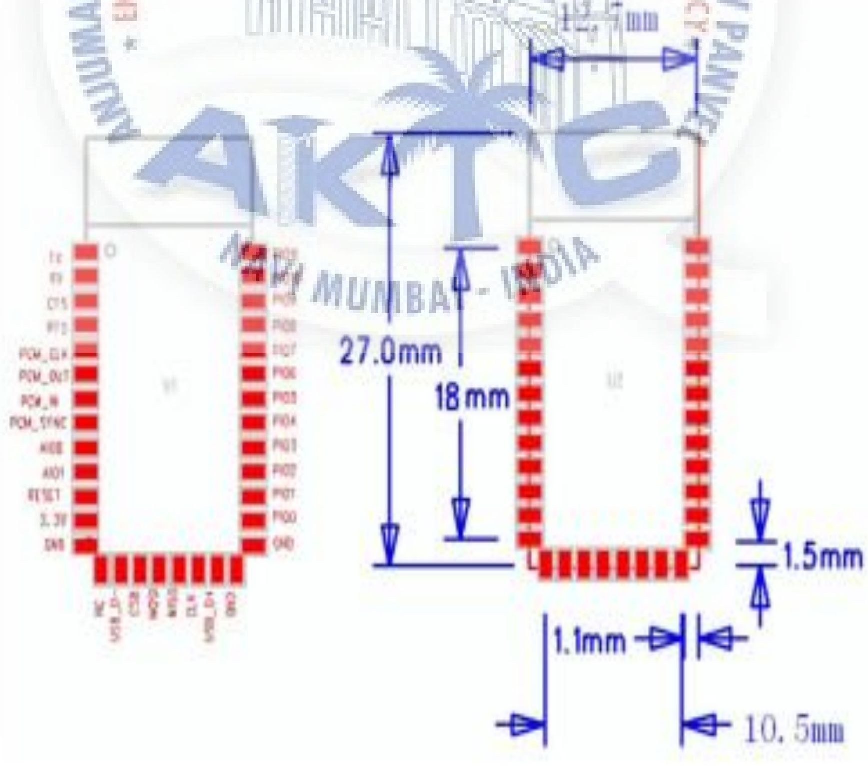
Hardware features

- Typical -80dBm sensitivity
- Up to +4dBm RF transmit power
- Low Power 1.8V Operation ,1.8 to 3.6V I/O
- PIO control
- UART interface with programmable baud rate
- With integrated antenna
- With edge connector

Software features

- Default Baud rate: 38400, Data bits:8, Stop bit:1,Parity:No parity, Data control: has. Supported baud rate: 9600,19200,38400,57600,115200,230400,460800.
- Given a rising pulse in PIO0, device will be disconnected.
- Status instruction port PIO1: low-disconnected, high-connected;
- PIO10 and PIO11 can be connected to red and blue led separately. When master and slave are paired, red and blue led blinks 1time/2s in interval, while disconnected only blue led blinks 2times/s.
- Auto-connect to the last device on power as default.
- Permit pairing device to connect as default.
- Auto-pairing PINCODE:"0000" as default
- Auto-reconnect in 30 min when disconnected as a result of beyond the range of connection.

Hardware



PIN Name	PIN #	Pad type	Description	Note
GND	13 21 22	VSS	Ground pot	
3.3 VCC	12	3.3V	Integrated 3.3V (+) supply with On-chip linear regulator output within 3.15-3.3V	
AIO0	9	Bi-Directional	Programmable input/output line	
AIO1	10	Bi-Directional	Programmable input/output line	
PIO0	23	Bi-Directional RX EN	Programmable input/output line, control output for LNA(if fitted)	
PIO1	24	Bi-Directional TX EN	Programmable input/output line, control output for PA(if fitted)	
PIO2	25	Bi-Directional	Programmable input/output line	
PIO3	26	Bi-Directional	Programmable input/output line	
PIO4	27	Bi-Directional	Programmable input/output line	
PIO5	28	Bi-Directional	Programmable input/output line	
PIO6	29	Bi-Directional	Programmable input/output line	
PIO7	30	Bi-Directional	Programmable input/output line	
PIO8	31	Bi-Directional	Programmable input/output line	
PIO9	32	Bi-Directional	Programmable input/output line	
PIO10	33	Bi-Directional	Programmable input/output line	
PIO11	34	Bi-Directional	Programmable input/output line	
USB_+	20	Bi-Directional		
NC	14			
PCM_CLK	5	Bi-Directional	Synchronous PCM data clock	
PCM_OUT	6	CMOS output	Synchronous PCM data output	
PCM_IN	7	CMOS Input	Synchronous PCM data input	
PCM_SYNC	8	Bi-Directional	Synchronous PCM data strobe	

RESETB	11	CMOS input with weak internal pull-up	Reset if low.input debouncde so must be low for >5MS to cause a reset	
UART_RTS	4	CMOS output, tri-stable with weak internal pull-up	UART request to send, active low	
UART_CTS	3	CMOS input with weak internal pull-down	UART clear to send, active low	
UART_RX	2	CMOS input with weak internal pull-down	UART Data input	
UART_TX	1	CMOS output, Tri-stable with weak internal pull-up	UART Data output	
SPI_MOSI	17	CMOS input with weak internal pull-down	Serial peripheral interface data input	
SPI_CSB	16	CMOS input with weak internal pull-up	Chip select for serial peripheral interface, active low	
SPI_CLK	19	CMOS input with weak internal pull-down	Serial peripheral interface clock	
SPI_MISO	18	CMOS input with weak internal pull-down	Serial peripheral interface data Output	
USB_-	15	Bi-Directional		

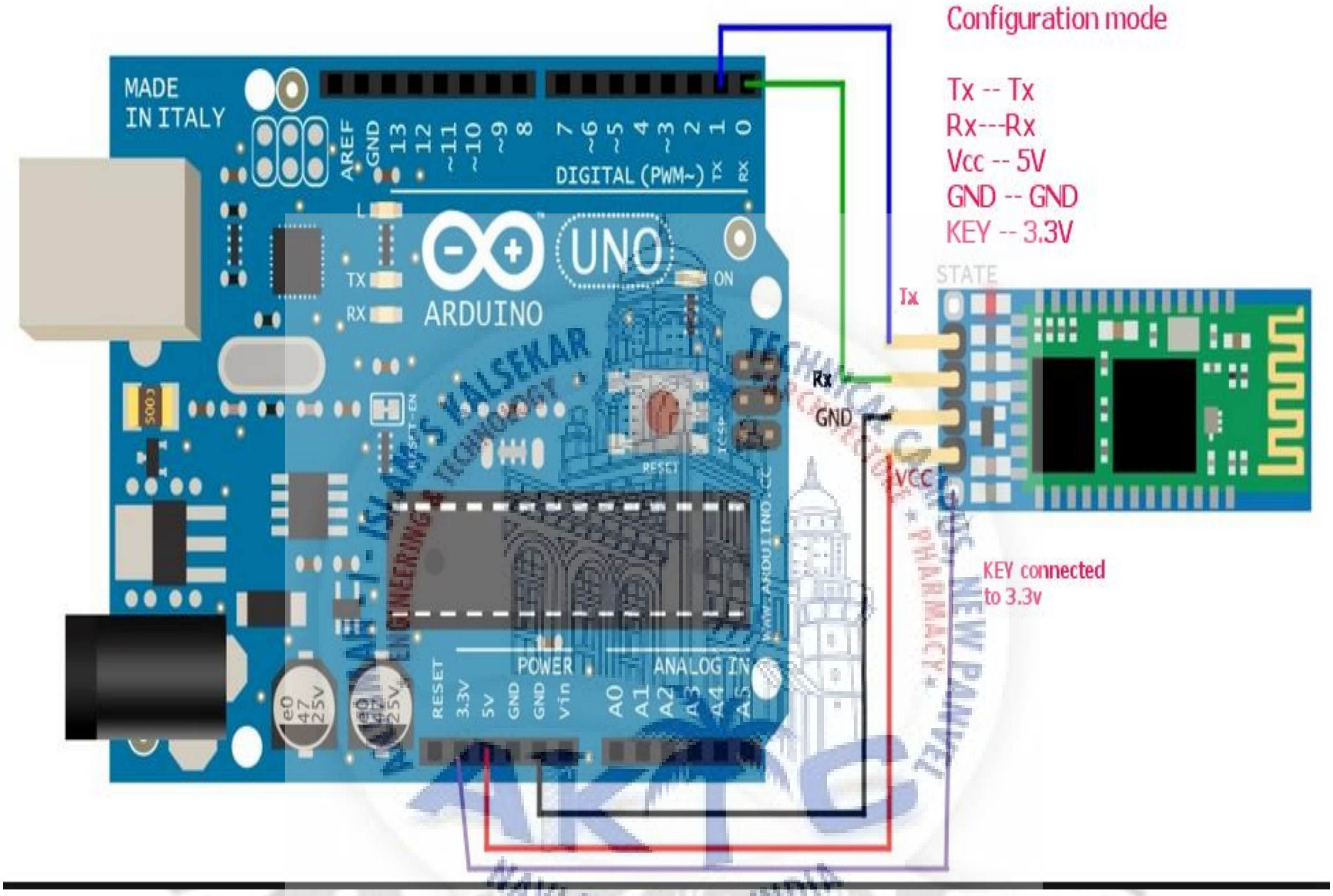


FIG CONNECTION OF ARDUINO UNO AND BLUETOOTH DEVICE HC-05

CHAPTER 14

GENERAL COMPONENTS

There are Different types of Components or Devices are used in Project which are listed below:

1. LCD 16x2
2. Different Range of Resistor
3. Capacitor
4. Others

1. LCD 16 X 2

Liquid crystal Display (LCD) displays temperature of the measured element, which is calculated by the microcontroller. CMOS technology makes the device ideal for application in hand held, portable and other battery instruction with low power consumption.

GENERAL SPECIFICATION:

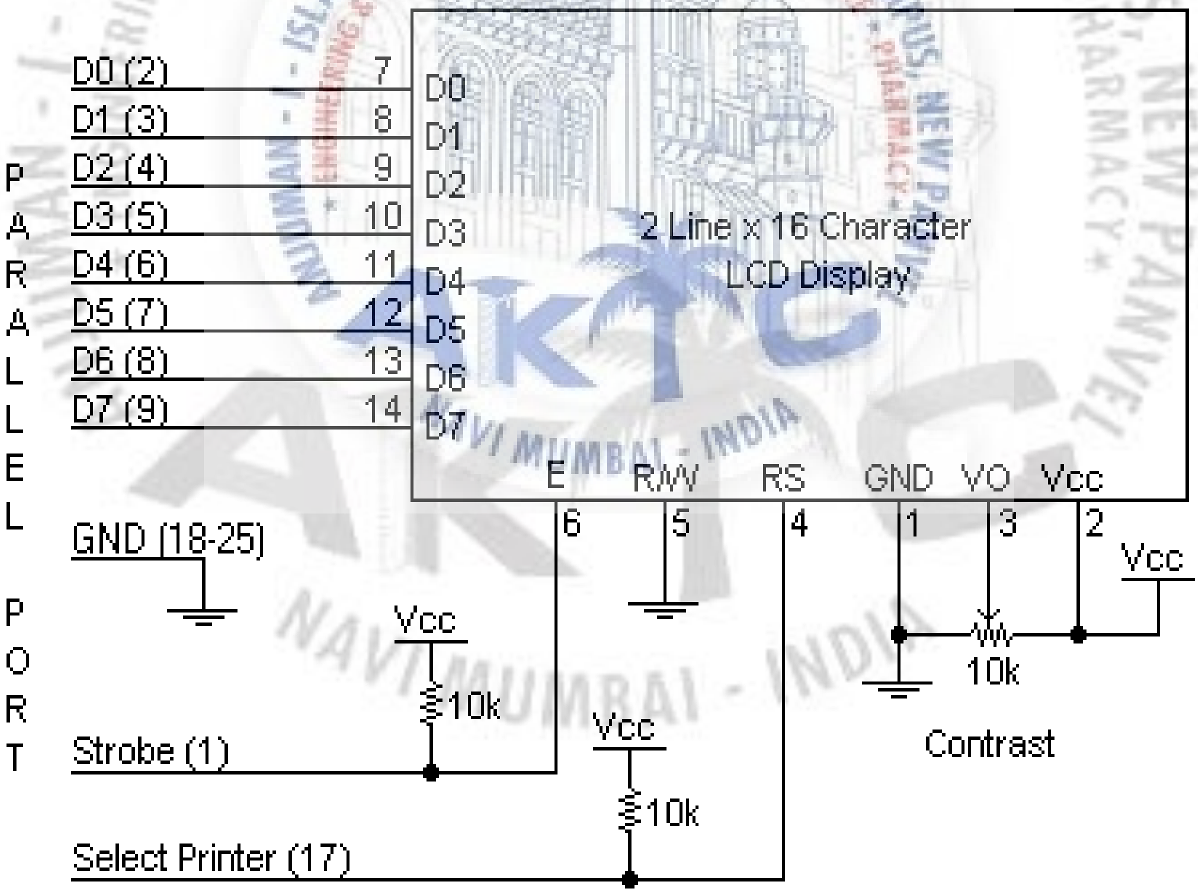
- Drive method: 1/16 duty cycle
- Display size: 16 character * 2 lines
- Character structure: 5*8 dots.
- Display data RAM: 80 characters (80*8 bits)
- Character generate ROM: 192 characters
- Character generate RAM: 8 characters (64*8 bits)
- Both display data and character generator RAMs can be read from MPU.
- Internal automatic reset circuit at power ON.
- Built in oscillator circuit.

Net Media 2x16 Serial LCD Display Module

PIN Configuration

JP1/JP14 Pins 1 – 8	Description	JP1/JP14 Pins 9 -16	Description
Pin1	Ground	Pin9	D2 (Not Used)
Pin2	VCC (+5)	Pin10	D3 (Not Used)
Pin3	Contrast	Pin11	D4
Pin4	Data/Command (R/S)	Pin12	D5
Pin5	Read/Write (W)	Pin13	D6
Pin6	Enable (E1)	Pin14	D7
Pin7	D0 (Not Used)	Pin15	VCC (LEDSV+)
Pin8	D1 (Not Used)	Pin16	Ground

CIRCUIT DIAGRAM OF LCD 16X2



2. Diodes

Diodes are components that allow current to flow in only one direction. They have a positive side (leg) and a negative side. When the voltage on the positive leg is higher than on the negative leg then current flows through the diode (the resistance is very low). When the voltage is lower on the positive leg than on the negative leg then the current does not flow (the resistance is very high). The negative leg of a diode is the one with the line closest to it. It is called the cathode. The postive end is called the anode.

3. LED

Light Emitting Diodes are great for projects because they provide visual entertainment. LEDs use a special material which emits light when current flows through it. Unlike light bulbs, LEDs never burn out unless their current limit is passed. A current of 0.02 Amps (20 mA) to 0.04 Amps (40 mA) is a good range for LEDs. They have a positive leg and a negative leg just like regular diodes. To find the positive side of an LED, look for a line in the metal inside the LED. It may be difficult to see the line. This line is closest to the positive side of the LED. Another way of finding the positive side is to find a flat spot on the edge of the LED. This flat spot is on the negative side.

When current is flowing through an LED the voltage on the positive leg is about 1.4 volts higher than the voltage on the negative side. Remember that there is no resistance to limit the current so a resistor must be used in series with the LED to avoid destroying it.

4. Resistors

Resistors are components that have a predetermined resistance. Resistance determines how much current will flow through a component. Resistors are used to control voltages and currents. A very high resistance allows very little current to flow. Air has very high resistance. Current almost never flows through air. (Sparks and lightning are brief displays of current flow through air. The light is created as the current burns parts of the air.) A low resistance allows a large amount of current to flow. Metals have very low resistance. That is why wires are made of metal. They allow current to flow from one point to another point without any resistance. Wires are usually covered with rubber or plastic. This keeps the wires from coming in contact with other wires and creating short circuits. High voltage power lines are covered with thick layers of plastic to make them safe, but they become very dangerous when the line breaks and the wire is exposed and is no longer separated from other things by insulation.

Resistance is given in units of ohms. (Ohms are named after Mho Ohms who played with electricity as a young boy in Germany.) Common resistor values are from 100 ohms to 100,000 ohms. Each resistor is marked with colored stripes to indicate it's resistance. To learn how to calculate the value of a resistor by looking at the stripes on the resistor, go to Resistor Values which includes more information about resistors.

5. Variable Resistors

Variable resistors are also common components. They have a dial or a knob that allows you to change the resistance. This is very useful for many situations. Volume controls are variable resistors. When you change the volume you are changing the resistance which changes the current. Making the resistance higher will let less current flow so the volume goes down. Making the resistance lower will let more current flow so the volume goes up. The value of a variable resistor is given as it's highest resistance value. For example, a 500 ohm variable resistor can have a resistance of anywhere between 0 ohms and 500 ohms. A variable resistor may also be called a potentiometer (pot for short).

6. Switches

Switches are devices that create a short circuit or an open circuit depending on the position of the switch. For a light switch, ON means short circuit (current flows through the switch, lights light up and people dance.) When the switch is OFF, that means there is an open circuit (no current flows, lights go out and people settle down. This effect on people is used by some teachers to gain control of loud classes.)

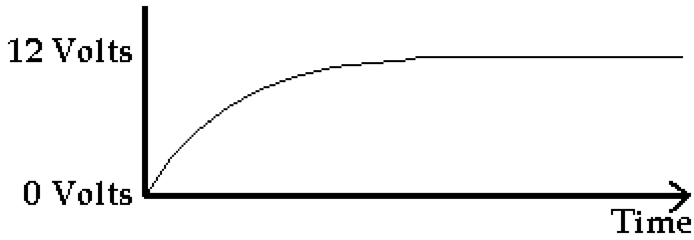
When the switch is ON it looks and acts like a wire. When the switch is OFF there is no connection.

7. The Capacitor

If you already understand capacitors you can skip this part.

The picture above on the left shows two typical capacitors. Capacitors usually have two legs. One leg is the positive leg and the other is the negative leg. The positive leg is the one that is longer. The picture on the right is the symbol used for capacitors in circuit drawings (schematics). When you put one in a circuit, you must make sure the positive leg and the negative leg go in the right place. Capacitors do not always have a positive leg and a negative leg. The smallest capacitors in this kit do not. It does not matter which way you put them in a circuit.

A capacitor is similar to a rechargable battery in the way it works. The difference is that a capacitor can only hold a small fraction of the energy that a battery can. (Except for really big capacitors like the ones found in old TVs. These can hold a lot of charge. Even if a TV has been disconnected from the wall for a long time, these capacitors can still make lots of sparks and hurt people.) As with a rechargable battery, it takes a while for the capacitor to charge. So if we have a 12 volt supply and start charging the capacitor, it will start with 0 volts and go from 0 volts to 12 volts. Below is a graph of the voltage in the capacitor while it is charging.



The same idea is true when the capacitor is discharging. If the capacitor has been charged to 12 volts and then we connect both legs to ground, the capacitor will start discharging but it will take some time for the voltage to go to 0 volts. Below is a graph of what the voltage is in the capacitor while it is discharging.

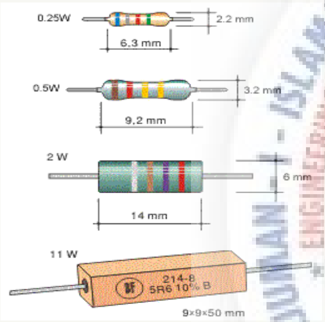
We can control the speed of the capacitor's charging and discharging using resistors.Capacitors are given values based on how much electricity they can store. Larger capacitors can store more energy and take more time to charge and discharge. The values are given in Farads but a Farad is a really large unit of measure for common capacitors. In this kit we have 2 33pf capacitors, 2 10uf capacitors and 2 220uF capacitors. Pf means picofarad and uf means microfarad. A picofarad is 0.000000000001 Farads. So the 33pf capacitor has a value of 33 picofarads or 0.000000000033 Farads. A microfarad is 0.000001 Farads. So the 10uf capacitor is 0.00001 Farads and the 220uF capacitor is 0.000220 Farads. If you do any calculations using the value of the capacitor you have to use the Farad value rather than the picofarad or microfarad value.

Capacitors are also rated by the maximum voltage they can take. This value is always written on the larger can shaped capacitors. For example, the 220uF capacitors in this kit have a maximum voltage rating of 25 volts. If you apply more than 25 volts to them they will die. We don’t have to worry about that with this kit because our power supply can only put out 12 volts.

CHAPTER 15

PRICE LIST OF COMPONENTS

Resistor

product Image	Item Name-	Price
	**Resistor network 1k - 10K 9Pin** This is a 10K resistor array in 9Pin package. useful for pull up.	Price - Rs.5.00
	**Plastic Preset 1k to 1m**	Price - Rs.20.00
	**1R to 1M Resistor 1/4 W (10Pcs)** **1R to 1M Resistor 0.5 to 11 W (10Pcs)**	Price - Rs.10.00 Price - Rs.50.00

Diodes

Product Image	Item Name-	Price
	**1N4007** 1N4007 is a 1.0A general purpose rectifier diode.	Price - Rs.2.00
	**1N5819** 1A 40V Schottky Barrier rectifier.	Price - Rs.3.00

Capacitor

Product Image	Item Name-	Price
	33pf ceramic disk capacitor	Price - Rs.1.00
	1uf electrolytic capacitor	Price - Rs.2.00
	10uf electrolytic capacitor	Price - Rs.2.00
	100 to 1000 uf electrolytic capacitor	Price - Rs.8.00

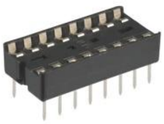
Voltage Regulator

Product Image	Item Name-	Price
	7805 - 5V voltage regulator This is an positive 5V - 500mA to 1.5A regulator	Price - Rs.15.00

LED Diodes AND LCD

Product Image	Item Name-	Price
 **LED RED - 3mm** **Price - Rs.2.00**	 **LED GREEN - 3mm** **Price - Rs.2.00**	 **LED YELLOW - 3mm** **Price - Rs.2.00**
 **LED Red 5mm** **Price - Rs.2.00**	 **LED Green 5mm** **Price - Rs.2.00**	 **LED Yellow - 5mm** **Price - Rs.2.00**
 **LED-RGB diffused Common Cathode** **Price - Rs.20.00**	 **16x2 LCD with green Backlight** **Price - Rs.240.00**	
	**Crystal 4 to 20 MHz** This is an 4 MHz quartz crystal in HC49U casing.	**Price - Rs.20.00**

IC Base

Product Image	Item Name-	Price
	8 pin to 16 Pin IC Base	Price - Rs.8.00
	20 Pin IC Base	Price - Rs.10.00
	40 Pin IC Base	Price - Rs.20.00

SOLAR PANEL

	Solar panel 12v, 21 W with Positive and Negative terminal	Price- Rs 4225.00

MODULES

Product Image	**Item Name-**	**Price**
	**230v/3-0-3 step down Transformer PT voltage sensor**	**Price - Rs.65.00**
	**CT sensor current sensor**	**Price - Rs.95.00**
	**12v SPDT 25 amp Relay**	**Price - Rs.45.00**
	**230v 2 pin power cord**	**Price - Rs.20.00**
	**Copper clad PCB General Dot PCB**	**Price - Rs.50.00**

ARDUINO UNO

Product Image	Item Name-	Price
	arduino uno at mega with USB Cable	Price – Rs. 525.00

BLUETOOTH HC-05

	Bluetooth HC-05 Device	Price – Rs. 375.00

BBATTERY KEAD ACID 12V

	SMF 12V LEAD ACID BATTERY	PRICE – RS. 990

CHAPTER 16

ARDUINO PROGRAMMING

PROGRAMMING OF ARDUINO ATMEGA UNO

```
#include <LiquidCrystal.h>
LiquidCrystal lcd(3,4,5,6,7,8);
float battValue = 0;
void setup()
{ pinMode(9, OUTPUT);
  pinMode(10, OUTPUT);
  lcd.begin(16, 2);
  lcd.print(" Solar Based ");
  lcd.setCursor(0,1);
  lcd.print("  Inverter");
  delay(2000);
  lcd.clear();
  lcd.print("  A.I.K.T.C");
  lcd.setCursor(0,1);
  lcd.print("");
  delay(2000);
  lcd.clear();
  lcd.print("  Guided By:");
  lcd.setCursor(0,1);
  lcd.print(" Prof.M.K.Alam");
  //delay(2000);
  lcd.clear();
  Serial.begin(9600);
}
void loop()
{
  battValue = analogRead(A0);
```

```
battValue=battValue*0.0049;
battValue=battValue*7;
 lcd.clear();
 lcd.print("Batt:");
 lcd.print(battValue);
 lcd.print("(V)    ");
 if(battValue>=13)
 {
 digitalWrite(9,HIGH);
 lcd.setCursor(0,1);
 lcd.print("Batt.Full Charge");
 }
else
 {
 digitalWrite(9,LOW);
 }
 if(battValue<=10)
 {
 digitalWrite(10,HIGH);
 lcd.setCursor(0,1);
 lcd.print("Batt. Discharged");
 else
 {
 digitalWrite(10,LOW);
 }
 Serial.print("V");
 Serial.println(battValue);
 delay(250);
}}
```

CHAPTER 17

PAYBACK PERIOD

Payback period in capital budgeting refers to the period of time required to recoup the funds expended in an investment, or to reach the break-even point. For example, a $1000 investment made at the start of year 1 which returned $500 at the end of year 1 and year 2 respectively would have a two-year payback period. Payback period is usually expressed in years. Starting from investment year by calculating Net Cash Flow for each year: Net Cash Flow Year 1 = Cash Inflow Year 1 - Cash Outflow Year 1. Then Cumulative Cash Flow = (Net Cash Flow Year 1 + Net Cash Flow Year 2 + Net Cash Flow Year 3, etc.) Accumulate by year until Cumulative Cash Flow is a positive number: that year is the payback year.

The time value of money is not taken into account. Payback period intuitively measures how long something takes to "pay for itself." All else being equal, shorter payback periods are preferable to longer payback periods. Payback period is popular due to its ease of use despite the recognized limitations described below.

Plant	Solar System Size	400	KW
	Rate of Interest	0.12	Flat Rate
	Plant Cost	2.6 Cr.	INR
	IRR	18.53 %	
Annual Generation	Annual Generation per KW	600,000	Units
	Generation to reduce	2.50%	First Year
	Generation to reduce	0.70%	Per year
Warranty	Panels	25	Years
	Inverters	5	Years
Accelerated Depreciation	Year 1	40	Percentage per FY
	Year 2	40	Percentage per FY
	Year 3	20	Percentage per FY
Operating Costs	Plant maintenance etc	14,952,671	Annual cost per year towards Asset Replacement, Repairs and Maintenance over 25 Years
	Inverter Replacement and allied spares in year 12		
	Plant Capital Cost	2,579,144	

Cost computation	Maintance+spares	26,000,000	
		17,531,816	
	Total Costs of D + M		
	Total Generation in 25 Years	43,531,816	
		13,565,724	kWh
Unit cost	Average Per unit costs	2.58	

CONCLUSION

In this project we have shown the factors required for the installation of solar PV plant. With an approx simulation of the yeld which is provided by it to the user. In this project Simulink based model of solar cell and solar array is developed. Modelling of solar array is much easier than its modelling in real environment and testing it. Boost converter is used to boost and regulate the output voltage of solar array. Duty cycle of boost converter is controlled through ARDUINO and Mobile Device to track the maximum power from solar. Simulink based models and their outputs of solar cell and array are shown clearly for different stages to understand the use of physical modelling using Simulink. Payback period and commercial gain and benefit is also measured by this method of management and potential time for investment return and profit thereafter for a predefined period of 25 years solar life time of operation is also given.

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