PORTABLE SOLAR POWER INVERTER

[1]Dhananjay Kande [2]Dhage Ganesh, [3]Balaji Kolape, [4]Dhiraj Ghote [5]Prof.Mrityunjaya Patted
[1234]Student, [5]Assistant Professor
[12345]Department of Electrical Engineering
[12345]JSPM's Bhivarabai Sawant Institute of Technology And Research, Wagholi, Pune 412207

***Abstract*:** This paper will discuss an alternative energy device, the Portable Solar Power Supply. Solar power is considered one the most environmentally friendly and abundantly available alternative source of energy. The Portable Solar Power Supply is designed to optimize capturing solar energy, storing it into a battery, and providing both standard household alternating current (AC) and most common direct current (DC) power. While this device is designed to optimize capturing solar energy and storing it into a battery, this device was designed to have its weight and size minimized.

Index Terms — Solar Panel, Battery, Rectifier, Inverter Circuit, MPPT, LDR.

I. INTRODUCTION

Due to the more apparent limitations of fossil fuels, solar energy is becoming more popular as the renewable energy source that could change the future. It is available in abundance and its usage does not harm the environment with greenhouse gas emissions.
Developing a portable device that could capture this solar energy and supply it when needed is an invaluable solution to keeping up with the demand of portable devices. Also, a portable device that could provide power for non-portable devices that could be handy when used outdoors is of great significance. Examples of non-portable devices that can be handy when used outdoors are an electric fan, a projector to watch movies, a computer printer, and a microwave oven for people who want to heat up their food quickly. The applications of a portable solar power supply is very broad. It can be used to supplement a mobile home's fuel powered portable generator. It can be used to provide power to devices while camping outdoors. Examples of devices used while camping outdoors that will utilize a portable solar charger are: a flashlight light with a rechargeable battery, a radio, a television, and also the battery of the vehicle that is used for transportation.

II. LITERATURE SURVEY

For environmental concern and due to peak power demand solar photovoltaic cell has become an alternative energy source for power generation. This is low power project, is designed for standalone application which ensures increased efficiency, minimal cost and overall reduction in the system size. The aim of this work is to design and simulate low cost, portable efficient solar power inverter for standalone applications using 8051 Microcontroller. The designed expected output is 230V pure sine wave signal for load. The incremental conductance based Maximum Power Point Technique (MPPT) algorithm has been implemented using light dependent resistors LDR and aurdino. [1]
For power generation on smaller scale the renewable energy sources are preferred due to various advantages offered by them like modularity, nonpolluting nature, localized generation and distribution. With the level of solar insolation available in India there is good scope for power generation at micro and small scale level. With advancement in area of PV systems, the prices of PV module going down and tariff rates with PV generation coming in par with conventional sources of energy, there is boost for solar power due to government policies in India.[2]
MOSFETs are used instead of IGBTs because of a couple of reasons. MOSFETs are used because of their high frequency applications and we are using high switching frequency so it is very important that we use a transistor that can withstand such high frequency switching. It is also preferred for wide line and load variations, long duty cycles, low voltage applications like in our project 220 volts and also for low powered applications as for our project 15 watts. The main reason we are using MOSFETs in this project is its cost effectiveness. Under average typical conditions, a MOSFET provides the longest battery life while meeting all peak-performance levels and usually at a lower cost.[3]

III. PRPOSED SYSTEM

As mentioned earlier in the abstract of this paper, the Portable Solar Power supply is supposed to capture solar energy, store it into a 12 volt lead-acid battery, and then provide useful power for a broad range of devices that operation on both AC and DC power. To gain a better understanding of how this project will function as single unit, a basic block diagram illustrating the functionality of this project is illustrated below in Figure 1.

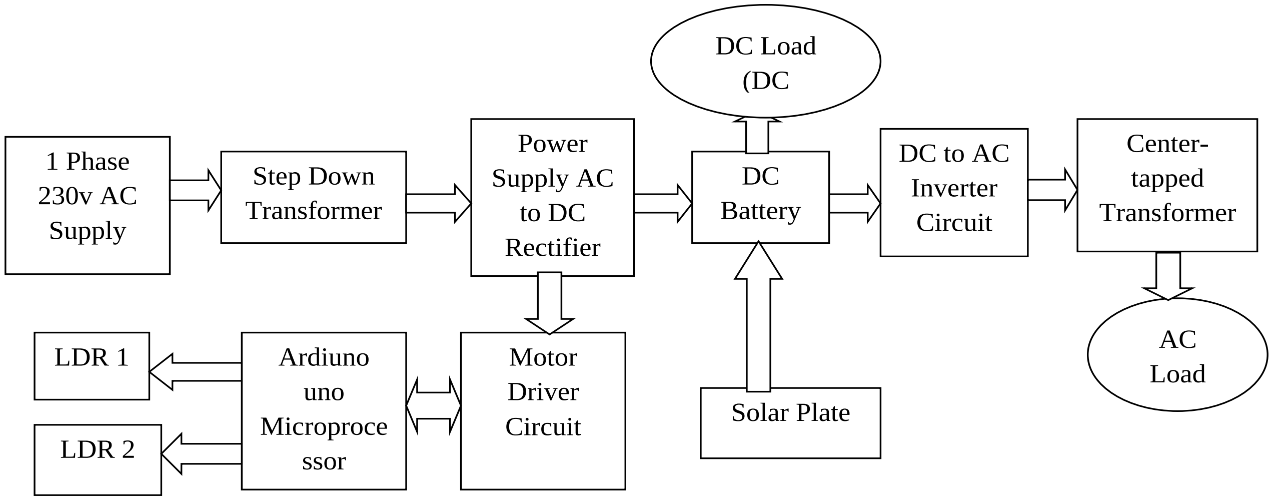


Fig.1: Block Diagram of the Proposed System

Single phase 230v, 50Hz AC supply is given to step down transformer, it converts 230v AC supply into 15v AC supply and then given to power supply AC to DC rectifier circuit. This rectifier circuit converts 15v AC supply into 12v DC supply. This 12v DC supply is then given to DC battery. DC battery is lead acid battery. Battery charge by supply and output of battery is given to DC motor which acts as a DC load. Then 12v DC supply is also given to DC to AC inverter circuit by battery.

This inverter circuit converts 12v DC supply into 5v AC supply and given to center tapped transformer. This transformer converts 5v AC supply into 230v AC supply and given to bulb which acts as an AC load.

Microcontroller microprocessor is use to control DC motor driver circuit and light dependent resistors (LDR1 & LDR2). DC motor driver circuit is use to drive the DC motor connected to solar plate for its move. As per input signal from microprocessor the motor driver circuit drives the motor and solar plate is move. Same process happen with LDR2 as light falls on it. This process is known as Maximum Power Point Tracking (MPPT). Because of this process solar plate absorb more sun light as per light intensity by using LDRs.

IV. COMPONENTS SELECTIONS

SOLAR PLATE

A 10 Watt 12V nominal output Mono-crystalline solar panel was chosen for this project. The Mono-crystalline panel was chosen because it has the higher efficiency, high power per area, high stability and high liability. It has a max power of 10W, a weight of only 8.8 pounds, max current of 2.92 Amps, and maximum operating voltage of 12 Volts (seen in Figure below). The solar panel we have chosen for the project was a good choice in order to have solar tracking functionality. Solar tracking is one of the goals in our project, which will essentially keep the greatest amount of panel surface area perpendicular to the feeding light source at all times. Below in Figure 3 is an illustration of this solar panel.

Fig.3: Solar plate

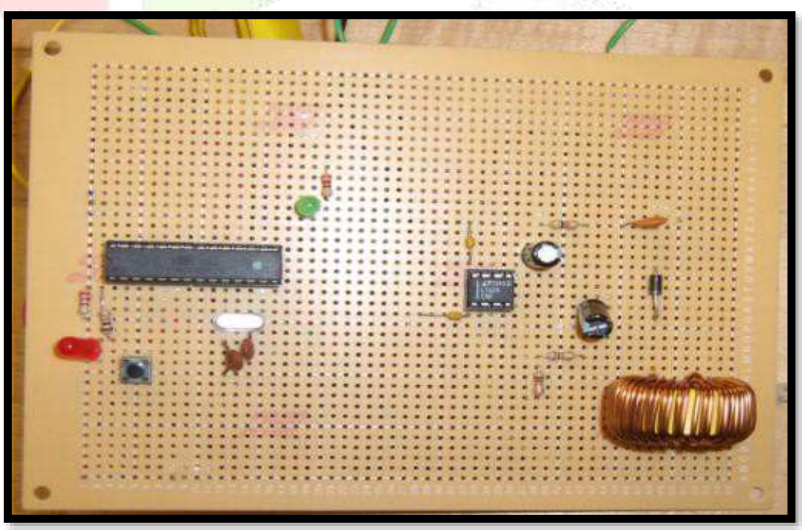
BATTERY

Batteries operate by converting chemical energy into electrical energy through electrochemical discharge reactions. Batteries are composed of one or more cells, each containing a positive electrode, negative electrode, separator, and electrolyte. Cells can be divided into two major classes: primary and secondary. Primary cells are not rechargeable and must be replaced once the reactants are depleted. Secondary cells are rechargeable and require a DC charging source to restore reactants to their fully charged state The maximum power available from a battery depends on its internal construction. The battery chosen for this project is a 12 V Sealed Lead Acid battery with 6 cells and 35Ah, which is manufactured by Battery Mart. The battery has an approximate battery life of over 100,000 operating hours and 450A max discharge surge current and minimum charge current of 1 Amp. The battery's dimension is 7.65' x 5.25' x 7.18' and weighing 29 pounds, which was a good size in comparison to other batteries found while doing research. The battery is the heaviest part of the project, therefore, finding a battery at a good size and weight was a key factor for our project. The advantages of this battery are it has no memory effect, recyclable, and has long service life. The battery can also operate in wide temperatures ranging from -40 degrees to 60 degrees Celsius. The battery used in the project is shown in Figure 4 below

Battery model

MICROCONTROLLER

The simple 8051 Microcontroller has 40digital input/output pins. It contains everything needed to support the requirements; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.
The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.



With Switching Voltage Regulator Microcontroller Microcontroller

INVERTER

Converts DC to AC power by switching the DC input voltage (or current) in a pre-determined sequence so as to generate AC voltage (or current) output. Both capacitors have the same value. Thus the DC link is equally spilt into two. The top and bottom switch has to be complementary. Meaning, if the top switch is closed (ON), the bottom must be OFF, and vice-versa.

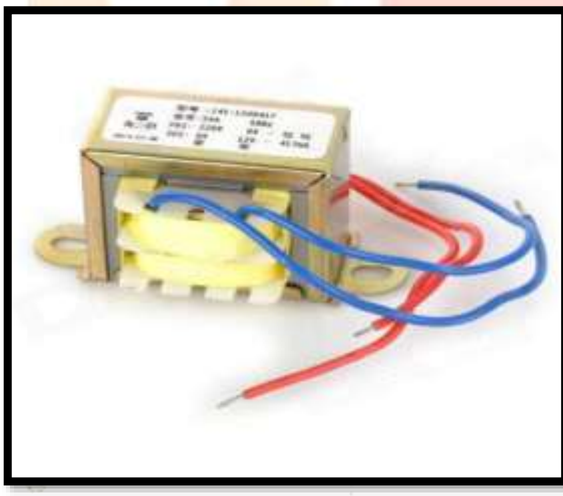
Output of the inverter is "chopped AC voltage with zero DC components". It contains harmonics**.** An LC section low-pass filter is normally fitted at the inverter output to reduce the high frequency harmonics. In some applications such as UPS, "high purity" sine wave output is required. Good filtering is a must. In some applications such as AC motor drive, filtering may not require.

The switching frequency used in this project is 50Hz. It is desired to control the inverter with proper switching signals. The turn on and turn off time of the switches is determined by this PWM control signal generated by the 3525A IC controller. Before this control signal is being generated, proper calculation is done to determine the suitable switching pulses conditions (frequency) for the switches.

TRANSFORMER

A transformer is an electrical device and it consists of 2 coils that are joined by an iron core. It offers the much required capability of changing the current and voltage levels simply. The main function of the transformer is that to increase (step-up) or decrease (step-down) AC voltages. The transformer works on the principle of Faraday's law of electromagnetic induction, that is, mutual inductance between 2 circuits that is linked by a common magnetic flux. Transformer converts an electrical energy from one circuit to another circuit with the help of mutual induction between the 2 windings without electrical connection between them, and also converts power from one circuit to another circuit without changing the frequency however with a different voltage level.

In a step up transformer, secondary winding contains a lot of winding than the first coil. Returning to a transformer, it has more windings in the primary than the secondary winding. These are one of the main reasons we use AC current in our homes and not DC. DC voltages can't be modified using transformers



Transformer Model

V. SOLAR TRACKING

During the research process, the group learnt that if solar tracking was implemented into the project, it can increase the amount of energy delivered into the battery of the Portable Solar Power Supply. The group decided to implement a single axis tracking system that follows the azimuth of the sun. Based on research, the group decided to only incorporate a horizontal axis tracking system because it is expected to increase the efficiency of the portable Solar Power Supply by 26 percent, while a two-axis tracking system that can track the elevation of the sun along with the azimuth, is expected to increase the efficiency of a solar system up to 32 percent. A two-axis tracking system will only yield a 5 percent increase in efficiency when compared to a single axis tracking system that will follow the azimuth of the sun. Maximum power point tracking (MPPT) was one of the critical features of the battery charging process of this project. It increases the efficiency of charging the battery from the solar panel. The maximum power point occurs where the current and voltage at which a solar module can generate the maximum power. The maximum power point location is not known in advance. To gain a better understanding of how MPPT increases the efficiency of the charging process for the Portable Solar Power Supply, a close examination of the electrical characteristics of a solar panel will be discussed for

any solar panel, the MPPT is not fixed. The IV curves change with the amount of light, the temperature of the panel, and also for each individual solar panel. As the curves change, the MPPT also changes.
The charge controller for the Portable Solar Power Supply uses an iterative approach to finding this constantly changing MPP [2]. This iterative approach is called the Hill Climbing Algorithm. This Hill Climbing Algorithm is implemented on a Microcontroller. The software that implements the Hill Climbing Algorithm is described below:

- Increase the conversion ratio of DC/DC/Converter.
- Measure the solar panel Watt.
- If the solar panel watts are greater than the last measurement,
- Then it is climbing the front of the hill, loop back and do it again.
- Else if Watts are less than the last time measurements,
- Then it is on the back side of the hill, decrease the conversion ratio and loop back to try again.

This Hill Climbing Algorithm occurs about once a second in the charge controller and performs a good job of keeping the solar panel operating at its maximum power point.

VI. HARDWARE SETUP AND OUTPUT

Some calculations are needed to be carried out before proceeding to hardware design stage. According to Ohm's Law, the current flowing across an electronic component inside a circuit should be directly proportional to amount of voltage applied, while keeping the resistance constant. Using the properties of Ohm's law, we can now calculate the capacity needed to operate some low wattage appliances running at 230V AC supply.
The fluorescent lights are rated at 15W, so we based on operating units to achieve 35W. For the size of battery bank in ampere hours will be using is 12V, 4.5Ah. The last step is determining the rating of the solar panel needed. Since we are considering this design to be portable, we will limit the design to use of just 1 solar panel OF 10W. With the consistent improvement in technology and research development, there are many solar panels readily available on the market. It is important to choose a solar panel which is able to meet the objectives and goals of this project. For the selection of solar panel, we look at the three important factors which are: Cost, Open Circuit Voltage, and Size. For the charge controller and solar tracking, the group decided to build Microcontroller to perform these tasks. The group decided to build the Microcontroller with a switching voltage regulator as opposed to a linear voltage regulator due to the fact that switching voltage regulators are more efficient than linear voltage regulators. This buck converter will take the output of the charge controller and step it down to 5V and a current of 500mA. The entire setup is arranged as shown below.

Hardware setup of the proposed system

VII. CONCLUSION

Photovoltaic power production is gaining more significance as a renewable energy source due to its many advantages. These advantages include everlasting pollution free energy production scheme, ease of maintenance, and direct sunbeam to electricity conversion. However the high cost of PV installations still forms an obstacle for this technology. Moreover the PV panel output power fluctuates as the weather conditions, such as the insolation level, and cell temperature. The described design of the system will produce the desired output of the project. The inverter will supply an AC source from a DC source.

The proposed system described is valuable for the promising potentials it holds within, ranging from the long run economic benefits to the important environmental advantages. This work will mark one of the few attempts and contributions in the Arab world, in the field of renewable energy; where such projects could be implemented extensively. With the increasing improvements in solar cell technologies and power electronics, such projects would have more value added and should receive more attention and support.

REFERENCES

[1]. Roopa Gangeputra, Nikhil Seshasayee Usha A Joshi, “design, analysis and simulation of portable solar power inveter”, Department of E & E Engg, BMSCE, Bangalore. ushaajoshi@yahoo.com

[2]. Jayesh Priolkar, Anita Anvekar ‘Implementation of Solar PV Based Micro Inverter’ 2016 Biennial International Conference on Power and Energy Systems, Ponda, Goa, India. jayeshpriolkar@gmail.com

[3]. Luo-Qi Soh, Chee-Chiang Derrick Tiew ‘Building of A Portable Solar AC & DC Power Supply 2014 Fifth International Conference on Intelligent Systems, Modelling and Simulation’, Singapore, e-mail: lqsoh001@unisim.edu.sg

[4]. J.M.EnriqueJ, M.Andújar, M.A.Bohórquez “A reliable, fast and low cost maximum power point tracker for photovoltaic applications” Volume 84, Issue 1, January 2010.