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SOLAR POWERED BATTERY CHARGING WITH REVERSE CURRENT PROTECTION

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Abstract - Solar energy is a very efficient source of green energy that is available for free. But it needs to be coupled with proper storage for best use. Also, to store it we need to use charge controlling circuitry to protect panel from reverse currents as well as to charge the battery efficiently. So, we demonstrate this concept by using a mini solar panel to charge a rechargeable lead acid battery. Also, we use a charge control circuit designed to stop reverse current flow and charge the battery effectively using the solar panel. Thus, this allows us to effectively provide solar battery charging with reverse current protection. It acts as a control circuit to monitor and regulate the process of charging several batteries ranging from 4 volts to 12 volts (we can increase a capacity as required), using a photovoltaic (PV) solar panel as the input source for the battery charging process with that additional future of reversal current protection.

Key Words: Solar energy, Solar panel, Battery, Charger

1.INTRODUCTION

Background Crisis of electricity is a major problem in the present era. This problem is even more critical for a densely populated poverty corrupted developing third world country like ours. Many of our people live here without the basic facility of electricity. Day by day crisis of electricity is increasing whereas no other solution is left for us without using the solar power or wind turbine to generate electricity.

To meet the above crisis, we can't go with the fossil fuels because its increase the overall cost to generate the power Thereby such a system that can not only reduce the electricity crisis but also the crisis of petroleum or other natural resources for driving vehicles is desirable. Motivation Ours is a tropical country where the amount of sunlight is mostly available to meet up the demand of producing electricity. This type of project is not new but for our country of this can be implemented successfully for commercial purpose, it can bring a revolutionary change in the lifestyle and the economical prospectus.

The idea to harness the power of the sun to charge batteries has been known since France decided it needed an alternative source of energy in the 70"s, [1]. Satellite technology has given clear pictures to designers about solar energy intensity exploration and distribution worldwide [2] [3]. Solar energy research emphasis over the past three decades has concentrated on solar energy direct heat production and solar energy electricity production. In 19th century, scientists discovered that the silicon crystal is very good semiconductor that can be fabricated into solar cells and panels to produce electricity when placed in sunlight. [4] Analyses the technical progress of photovoltaic cells thereby predicting its future trend. The goal of our research is to design: (13) a universal battery charger that can use electric power supply as well as solar energy as its input source; [14] a system capable of charging varying voltages of batteries (small and large voltages) and [15] a system that is able to control the state of the charging to avoid overheating.

2.DESIGN CONTRAINTS:

This paper will be required to take energy from the sun generated by solar panels and convert the energy to AC voltage, which will be able to power most electronic devices. The project must have a system to keep trac k of voltage levels and be able to protect the system from being overused or overcharged.[5] It must also be able to keep track of its solar efficiency and be able to maintain the maximum amount of solar energy possible with the given environmental and weather conditions. The biggest constraint to this project will be to maximize the solar efficiency to provide the most power to the system that can be generated by the solar panels. Weather and solar patterns must be accounted for when making all of the calculations for the efficiency and output of the solar panels. Climate factors, such as clouds, moisture, ha ze, dust, and smog will have a degrading effect on the output power of the station's panel array.[12]

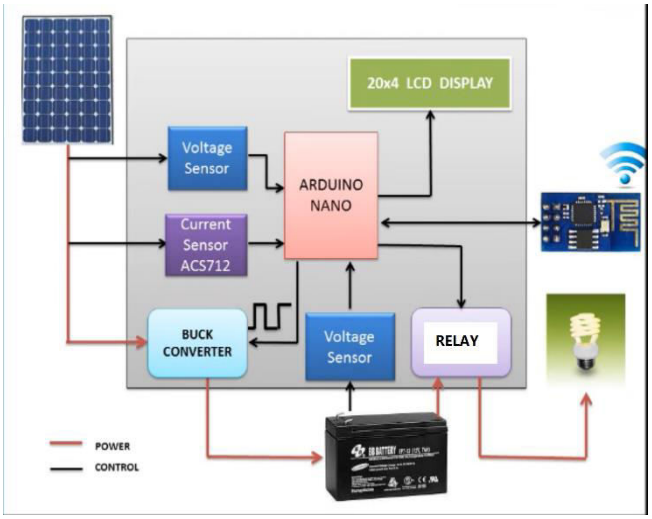

Fig.1 Block Diagram

System Design :

We determined that this paper would need to follow the example of any electrical system. It must have a source, a function, and an output. For our source,[6] we will be using solar panels optimized with solar trac king. The system will contain the microcontroller to act as a charge controller and an inverter to convert from 12 Volt DC stored in the batteries to 110 Volt AC as the output. Figure 1 above shows a block diagram of the system. The solar tracker would be affixed to the solar panel and would relay information to the microcontroller.[7]

3.SOLAR PANEL TECHNOLOGY:

The term solar panel is used colloquially for a photo-voltaic (PV) module. A PV module is an assembly of photo-voltaic cells mounted in a framework for installation. Photo-voltaic cells use sunlight as a source of energy and generate direct current electricity. A collection of PV modules is called a PV Panel, and a system of Panels is an Array. Arrays of a photovoltaic system supply solar electricity to electrical equipment. photovoltaic modules use light energy (photons) from the Sun to generate electricity through the photovoltaic effect. Most modules use wafer-based crystalline silicon cells or thin-film cells. The structural (load carrying) member of a module can be either the top layer or the back layer. Cells must be protected from mechanical damage and moisture. Most modules are rigid, but semi-flexible ones based on thin-film cells are also available. The cells are connected electrically in series, one to another to the desired voltage, and then in parallel to increase amperage. The wattage of the module is the mathematical product of the voltage and the amperage of the module. The manufacture specifications on solar panels are obtained under standard condition which is not the real operating condition the solar panels are exposed to on the installation site[2]

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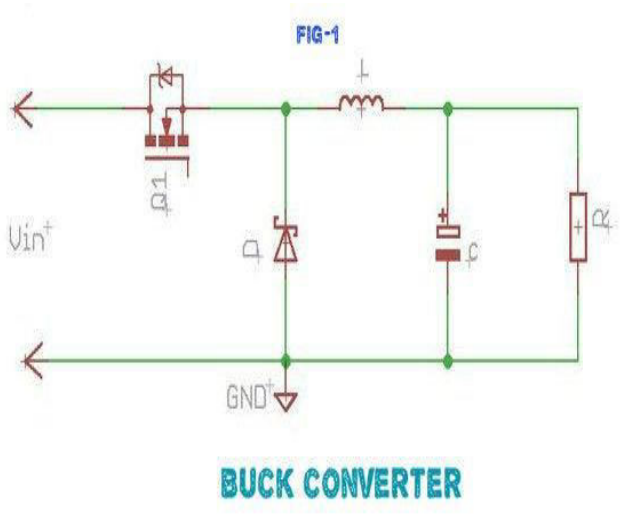
4.Working Principle:

When the MOSFET is ON, current flows through the inductor (L), load (R) and the output capacitor (C) as shown in fig-2. In this condition, the diode is reverse biased. So no current flows through it. During the ON state magnetic energy is stored in the inductor and electrical energy is stored in the output capacitor.
When the MOSFET is off, stored Energy in the Inductor is collapsed and current complete its path through the diode (forward-biased) as shown in fig-3. When stored energy in the inductor vanishes, the stored energy in the capacitor is supplied to load to maintain the current.
What is Synchronous Buck Converter?
In the above topology, the diode used to have a considerable amount of voltage drop which reduced the efficiency of the Converter. To improve the efficiency a Power electronics switch is used in its place. Thus a synchronous buck converter is a modified version of the basic buck converter circuit topology in which the diode, D, is replaced by an electronics switch like MOSFET(Q2). It is shown in fig-4.
I would like to give special credit to coder-tonics from which I have taken this explanation part of the buck converter.

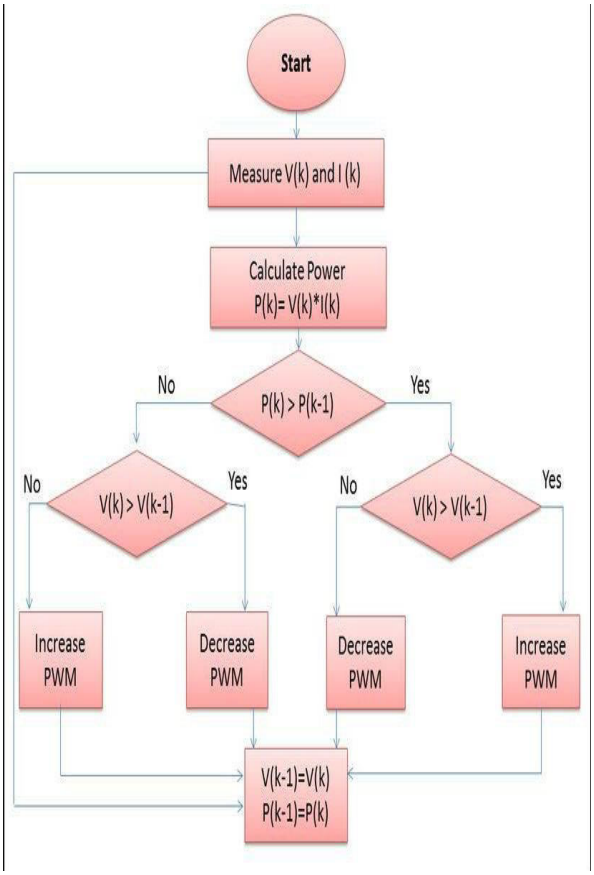
5.BUCK CONVERTER DESIGN



In our case, the input source is a 50W solar panel and load is a 12V lead-acid battery. From the earlier discussion, we have concluded that a buck converter consists of 1.Inductor 2.Capacitor 3.MOSFETS

Selecting the frequency: The switching frequency is inversely proportional to the size of the inductor and capacitor and directly proportional to the switching losses in MOSFETs. So higher the frequency, lower the size of the inductor and capacitor but higher switching losses. So a mutual trade-off between the cost of the components and efficiency is needed to select the appropriate switching frequency.

Keeping these constraints into consideration the selected frequency is 50KHz.



Program flow chart :

The Maximum Power Tracker uses an iterative approach to finding this constantly changing MPP. This iterative method is called Perturb and Observe or hill climbing algorithm. To achieve MPPT, the controller adjusts the voltage by a small amount from the solar panel and measures power, if the power increases, further adjustments in the direction are tried until power no longer increases.

6.Testing:

UNIT TESTING

Unit testing is a first level of software testing where each component of software are tested to validate that each component performs as designed can be done by having one or a few inputs and usually a single output.

FUNCTIONAL TESTING

Functional Testing is a next level in testing methods that is used to test the functionality of the system. In our project, testing of RFID reader and Zigbee module is done by connecting both to the computer separately using USB to UART port converter.

SYSTEM TESTING

System testing of software or hardware is the testing that is conducted on a complete integrated system to validate the system's compliance whether it meets it's specified requirements.

PERFORMANCE TESTING

Performance testing is a kind of non-functional testing that is carried out to examine the proposed system parameters in terms of its stability and responsiveness and also it is used to measure the quality attributes of the system.

ACCEPTANCE TESTING

Acceptance testing is also a kind of testing technique used to check whether the software has met the desired and required specifications. The main purpose of this test is to verify that if it has met the required criteria so that it can be implemented and delivered to its end users

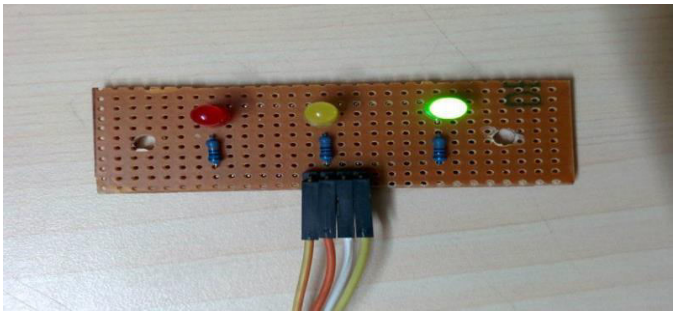
7.RESULTS :

The below fig shows the lcd display with battery parameters indication .

Fig.01 LCD Display With battery parameters indication

In above fig its shows the battery parameters like voltage receiving from the solar panel, Battery charging level, current, and its also shows whether the load is connected or not . It also has the feature of indication of pulse width modulation.

Fig.02 LED Lights for battery charge level Indication



Above fig shows that this project also contains the LED charging level indications of the battery, With the help of led's we can see the battery charging level indication.

State of Charge	12 Volt battery	Volts per Cell
100%	12.7	2.12
90%	12.5	2.08
80%	12.42	2.07
70%	12.32	2.05
60%	12.2	2.03
50%	12.06	2.01
40%	11.9	1.98
30%	11.75	1.96
20%	11.58	1.93
10%	11.31	1.89
0	10.5	1.75

data from http://www.windsun.com

In above chart shows the different battery charging level corresponding to battery voltage and voltage per cell received from the windsun.com website.

The above fig shows the data chart uploaded to the thingspeak.com voltage vs time. With the help of this we can track the solar voltage remotely from anywhere.

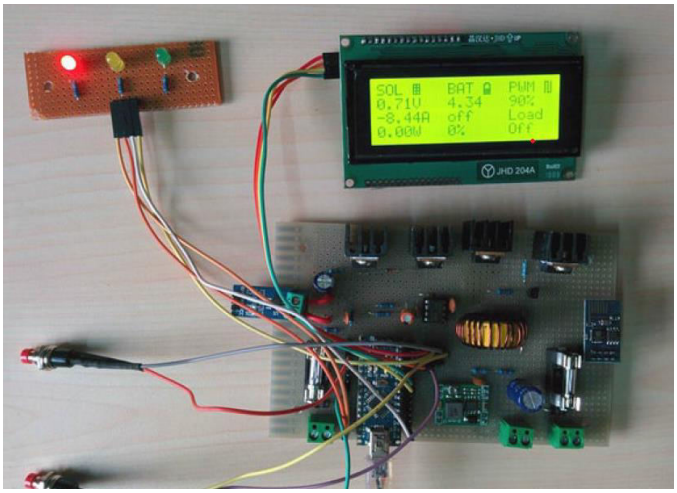


Fig 03. The above fig shows the complete charging system its also provided with reset button in case of program structed we can use of it.

ADVANTAGES:

- It has several advantages like overcurrent protection, overvoltage protection and reverse current protection.
- It is equipped with LED's and LCD display for battery charge and battery parameters indication.
- Its also equipped with WIFI logger so the system data can be upload to the web.

- Cost effective.
- High efficiency.

APPLICATIONS:

- Laptop chargers, some versions are fitted to the laptop carrying case.
- PDA, iPod, mobile phone charger.
- AA or AAA battery size chargers for rechargeable batteries (to fit 1, 2, 4 or even 8 batteries).
- 12V charger for car, RV, etc. to supply relatively small appliances on the move.

CONCLUSION:

We conclude that making use of solar energy for charging of battery saves the wastage of fossil fuel which were used for charging of battery and since we have used microcontroller Arduino nano in our project it provides overvoltage and overcurrent protection for the battery, so life of battery will be more and reverse current protection will provide protection for battery against reverse currents. The solar battery charge is a flow of the best in the future life. This System provides portable, reliable power anywhere it is needed from off-grid construction sites, to remote locations where power is not accessible or affordable, and without the associated with traditional fuel-driven generators.

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