International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 04 | Apr 2019 www.irjet.net p-ISSN: 2395-0072

Standalone Photovoltaic System with Household Load: Online and Offline

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Abstract - *The demand for solar energy is increasing rapidly in all over the world. The main reason behind the trend is cheaper solar cells, making it economically very much profitable for a larger range of applications. However, solar power has yet to accomplish a higher level to be connected with grid ,owing to unstable voltage output and non-reliable service frame. So it is important to find a solution in between while anticipating towards energy saving. This thesis discusses about a system with photovoltaic panel to charge a battery which will in turn supply the load when needed. Although in the daytime, while the battery is charging, mains ac line will supply the load, the battery will supply the load only in two caes, either the main ac line is cut off, or in the nighttime, when for household loads, the load demand is usually the maximum. The system utilizes a 12V battery coupled with an inverter circuit to supply the load in need. It also has a charging circuit to charge the battery at a finite voltage level. Also to reduce the initial cost, 12V solar panel is used to supply the battery charging current, thus a dc voltage booster circuit is also used to smoothen the charging circuit input. This system not only provides a way to provide backup power to the households, it also saves money for the households by sharing the load between mains ac and solar powered battery.*

Key Words: Photovoltaic system, Solar Panel, Charge Controller, DC Voltage Booster, Charge Controller, Inverter, Household Load.

1.INTRODUCTION

India, owing to its geographical location, receives solar energy equivalent to nearly 5,000 trillion kWh/year which is equivalent to 600 GW. This is more than enough from the total energy requirement of the country. Solar PV solution has the potential to supply the demands for the entire country, saving the lives of 134 crore people, who has to rely on highly subsidized fossil fuels, to supply their various kinds of loads.

But India utilises a very little amount of alternative energy it receives, solar power being one of the most available among them. A mere 0.3 percent of all the energy received in the form of sunlight. A Solar PV Power plant is a concept to generate electricity directly from the daylight then changing it to the AC electricity which might be employed in any electrically powered sector. PV panels are placed on metallic brackets support structures and then they are electrically connected on series and/or parallel connection to produce the specified voltage and/or current. The received power is then transferred to batteries by means of charge controller which basically maintains a constant charging current, therefore making the battery safe. And in time, the batteries provide to electrical converter, that produces AC from DC then the Ac power received at the output is equipped to the load(s). Standalone alternative energy Systems are fully independent from any electrical utility grid. they're most often utilized in remote areas where electricity is not out there or where the association fees of the grid are higher than the price of another energy system. Standalone star systems put together stated as autonomous, or off grid systems are to collect and store alternative energy to be utilized by house appliances.

2. PROPOSED SCHEME

The proposed scheme would generate roughly about 500Watts which can be used to drive small loads. It has a broad area of application in emergency lighting. The system consist of the following blocks/systems.

I. Solar panel
II. DC voltage booster
III. Charge controller for the battery
IV. Inverter circuit
V. LDR Circuit
VI. Loads

2.1 Solar Panel

The photo volatic's offer consumers the ability to generate electricity in a clean, quiet and reliable way. Photovoltaic systems comprises of photovoltaic cells. They are devices that convert light energy directly into electricity. As the source of light is generally the sun, they are often called solar cells. The term photovoltaic comes from "photo" i.e. light and "voltaic" means related producing electricity. So, the photovoltaic process is "producing electricity from sunlight. Finally, It is a device that produces an electric current to light. They do not use the sun‟s heat to produce electricity. Rather, they produce electricity directly when sunlight interacts with semiconductor materials present in them. In this thesis, the panel is simulated to have an output of 12V constant. The simulation is done in Proteus 8. It

gives out the values in real time from which the hardware can be assumed.

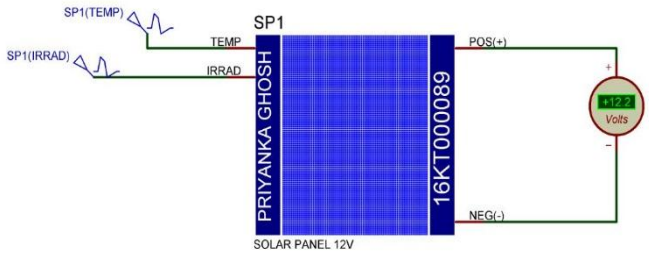
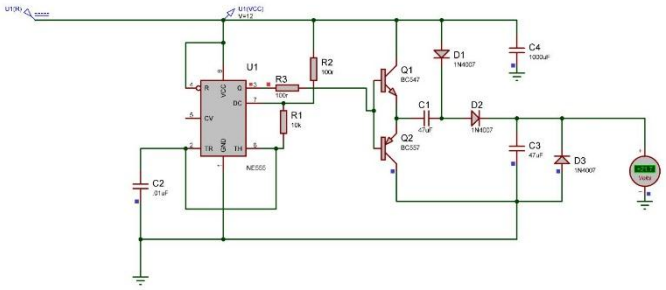


Fig.- 1 : Solar Panel Proteus model

2.2 DC Voltage Booster

A boost converter is a DC-to-DC power converter that increases voltage while decreasing current from input to its output. As the panel being used is 12V, 10W, it is harder to maintain a constant charging voltage across the battery. The panel is taken at such a low rating considering the economic aspects of the consumers who will use the circuitry ion real life. Thus using a dc voltage booster is required to supply the power from the panel to the input of the charging circuit at a higher voltage.

The electronic circuit is essentially a sq. wave generator which uses NE555 timer IC. It is followed by transistors T1 and T2. This is basically a voltage doubler circuit, from voltage 10VDC to 20VDC. It can give current of about 50mA which is convenient for the circuit. The principle of the circuit is when a voltage input of



about

Fig – 2 : DC Voltage Booster using NE555

10V is given to the circuit, the timer IC works to generate the square wave, which in turn drives the transistors in a push-pull technique. This generates a voltage almost double the input, while decreasing the current at the output.

The actual output voltage is around 18 volts giving considering the losses. On lower current ratings, the voltage is higher.

2.3 Charging Circuit

A simple charging circuit using LM317 is used to charge the battery which takes an input of about 18V and in turn gives output of about 16V. The actual voltage output is about 14V though, owing to the losses. The main element of the circuit is IC LM 317 ,which is an adjustable voltage regulator IC. The pin 1 of the IC is the control pin used to control the voltage at the output.The pin 2 is the output pin at which the voltage appears which is used as the charging voltage. The regulated DC supply is given as the input to the pin 3, *i.e.* the input pin.

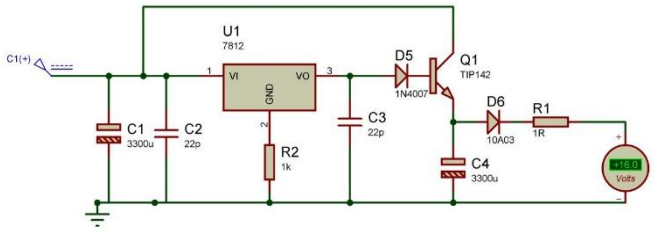


Fig – 3 : Charge Controller using LM317

The charging voltage and current is controlled by the Transistor Q1,resistor R2. When the battery is first connected to the charging terminals ,the current through R2 increases. This increases voltage output from LM 317.When the battery is fully charged the charger reduces the charging current and the battery stops charging.

2.4 Inverter

CD4047 is a low power IC capable of operating as a monostable or astable multivibrator. It charges a capacitor (C_1) through a resistor (R_3) as in every astable multivibrators. Resistor (R_3) is provided for adjusting the output frequency to exact 50Hz.

The time period of the oscillation is given by the T = 4.40*R*C. CD4047 has two outputs (pins 10 and 11), complementary to each other. These square wave pulses are pre amplified by two IRFZ44N transistors. This amplified current as passes through the transformer winding, it produces AC current across the secondary winding of the transformer.

The transformer is a 220/12 V unit where the 12V winding is center tapped as 12-0-12 V. The primary winding is the 12V winding, and the 220V winding is used as the secondary winding and through this winding the load is fed.

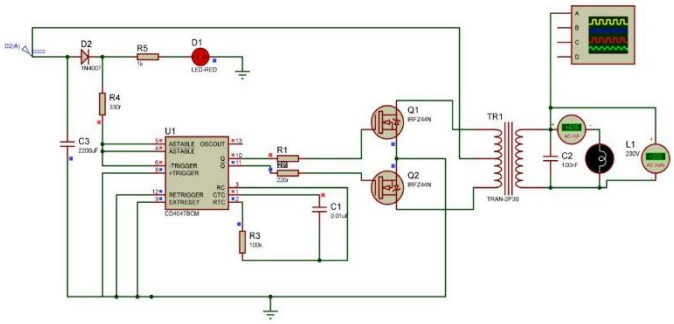


Fig – 4 : Inverter using CD4047

When the output at pin 11 is low, pin 10 will be high Q1, current flows through the upper winding of the transformer and we will get positive half cycle output. When the output at pin 11 is high, pin 10 will be low and, current flows through the lower winding of the transformer and negative half cycle output is received. This in turn will result in a current through the secondary winding of the transformer which changes its direction every alternate time. So an AC is produced across the transformer secondary winding.

2.5 LDR Circuit

LDR is the element made up of semiconductor materials which, when light falls on it, reduces its resistance. Basically the photons present in light excites the electrons in the LDR to move from valence band to conduction band. Thus when light falls on LDR, more number of electrons are available for conduction. Thus the conductivity of the LDR increases reducing its resistance.

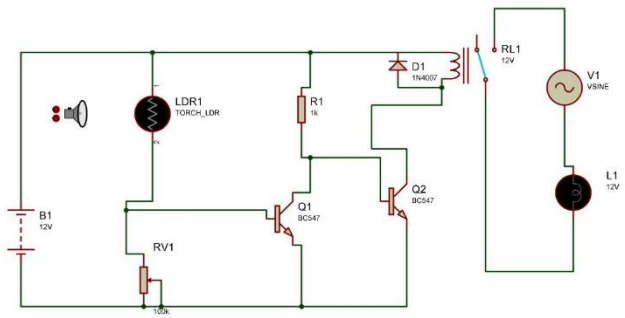


Fig – 5 : LDR Circuit (not activated)

This principle is widely used in street light control. Here also the same principle is used to control the relay which connect the Ac mains to the load. The circuitry is made in such a way that, when light falls on the LDR during the daytime, the circuit provides energizing current for the relay coil. Thus the relay works to connect the load to the AC mains. But during night time or when there is darkness around the LDR, the circuit blocks the current through the relay coil, hence making the load disconnected from AC mains. Then the load is supplied from the inverter.

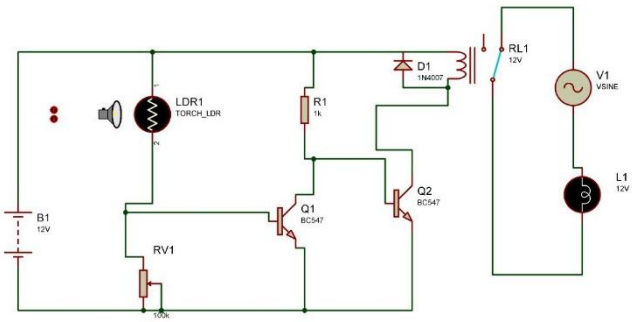


Fig – 6 : LDR Circuit (activated)

2.6 Loads

Household loads can be driven by using this circuit which generally consumes less power. The circuit is best suited for resistive loads such as bulbs, chargers etc. The loads also should be under 500W for proper running of the scheme.

3. COMBINED CRCUIT OPERATION

All the circuits are combined using relays. The combination is formed in such a way that during daytime, the LDR circuit drives a relay to make the load connected with AC mains.

But when powercut appears, the inverter circuit starts to operate and supply the loads. So the load is never out of supply.

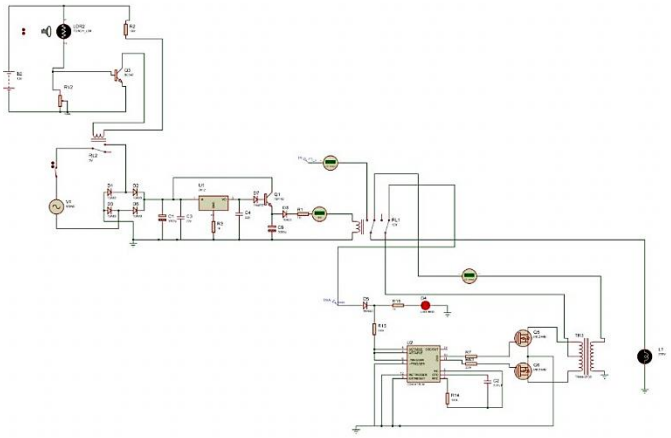


Fig – 7 : Combined Circuit

During nighttime, the LDR circuit stops current through the relay coil which in turn disconnects the load from the AC mains supply. This in turn activates the inverter circuit to operate and the load is supplied from the battery through the inverter. In this way not only a backup power

source is provided for the load, but during the nighgt time energy consumption from the grid is also reduced. Therefore, the electricity bill for the household is also reduced. This leads to two basic advantages, monetary saving for the household, and more available power for the industries. If used in large scale, it can also reduce the fuel consumption in the power plants thereby reducing the pollution and cost of electricity generation.

4. Conclusion

This paper provides a way to reduce the main line energy consumption for the household consumers. It presents a way to use solar photovoltaic panels to be used in a standalone way (*i.e.* not connected to the grid) for household loads. It also presents way to make the supply to load uninterrupted. The loads can operate from grid(online load) as well as off the grid(offline load, works by using only the supply from battery which is charged by the solar panel).

The scheme has drawbacks too. One of the main disadvantage being that, if during night time, the battery discharges, AC power is not available for the load as it is cut off by the LDR circuit. This disadvantage can be removed by manually operating the LDR circuit when in need. Also the circuitry being little complex, may require expert help in case of a fault.

REFERENCES

[1] Nayna P. Lokhande, Nilima G. Maraskolhe, Shubham S. Lokhande and Prof. Bhushan S. Rakhonde, "*Solar Energy Conversion And Its Utilization*," International Research Journal of Engineering and Technology (IRJET), Volume: 04 Issue: 01 | Jan -2017.

[2] Datasheet of LM7812

[3] Bindhiya Manger, Deepak Rasaily, Tashi Rapden Bhutia , Mingma Lepcha and Reepika Gurung, "*Design of Inverter with Solar Charge*", International Journal of Engineering Trends and Technology (IJETT) – Volume 33 Number 8- March 2016

[4] *Automatic Street Light Control System using LDR & Transistor BC 547K*, retrieved April 22, 2019, from https://www.electricaltechnology.org/2013/04/automatic-street-light-control.html

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