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UPS with Dual Power Supply for Household Loads' Energy Conservation

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Abstract – *The amount of electrical load for the household consumers is increasing day by day. Thus the cost for the energy consumed also increasing making the electrical energy more costlier. Also by consuming more power from the main grid, the household consumers are although indirectly, reducing the amount of power available for the industries, thus increasing the generation cost of electrical energy. In this scenario standalone PV systems has proved to be better solution where it supplies a load individualy. The solar panels, being not very effeicient, is not a suitable option to supply to the grid or the industries. But, if used in the proposed scheme, it can lessen the amount of power drawn from the grid by the household consumers and thus reducing the monthly electricity bill for the same. Also it will improve the power scenario where more power will be available in the grid for large consumers like industries, hospitals and offiices. The paper suggests a scheme where a UPS (Uniterrupted Power Supply) is implemented to supply the most part of a household load. Some of the heavy loads like air conditioner, refrigerator are kept out of this scheme for better running environment of the UPS and they can be supplied from the AC mains individualy. All other essential loads are connected and supplied by the UPS. If implemented for a large scale of houses, this can save a great amount of power.*

Key Words: Uninterrupted Power Supply, Photovoltaic system, Solar Panel, Charge Controller, Inverter, Household Load.

1.INTRODUCTION

India, being a country of northern hemisphere of earth, receives a huge amount of solar energy equivalent to nearly 5,000 trillion kWh/year which is equivalent to almost 600 GW. This exceeds total energy requirement of the country with a large margin. If this amount of energy can be utilised, use of the conventional energy sources would reduce drastically, making the environment more clean, the cost of energy generation less. It will also reduce the fear of running out of fossil fuel in the near future. Solar PV installation in a country like India has the potential to save the lives of 134 crore people, both ideally and financially, by decreasing the monetary expense and increasing the available amount of fossil fuel. Still now majority of the loads has to rely on fossil fuel which is highly subsidized to make available for all. Use of solar energy would therefore decrease the demand thus making the economy more stronger.[1]

Although India utilises only a very small amount of the solar energy it receives, the number of solar panels are increasing by day. Although the applications are limited only to some of the areas where mainline power is not available easily. Which means, solar power is still in a form of backup power rather than a parllel one. If this scenario can be improved, solar power can prove to play a major role in the power industry. The following scheme is such one to implement solar power in houses in order to utilise the solar energy and reduce the energy cost. It will also be beneficial for the as the power supply is uninterrupted. If used in proper way, this can also be implemented for the emergency sectors like hospitals, offices etc.

2. PROPOSED SCHEME

The proposed scheme can generate roughly about 500Watts which should be sufficient to to supply most of the household loads. It also has a vast area of application in lighting in emergency sectors. The scheme consist of the following blocks/systems.

I. Solar panel
II. Solar Charge Controller
III. AC Charge Controller
IV. LDR Circuit to switch between suplly for the UPS
V. Inverter circuit
VI. Loads

All these blocks are connected with each other to form the whole system. Alll the simulations are done in Proteus 8 and simulations were run over and over to make it more closer to real conditions.

2.1 Solar Panel

The solar panels has the ability to generate electricity in a clean, green and and reliable way. Photovoltaic systems consists of photovoltaic cells connected in series and parallel. Solar cells are semiconductor devices that convert light energy directly into electricity. As sun is the usual source of light, they are often called solar cells. The term photovoltaic comes from "photo" i.e. light and "voltaic" means related to producing electricity. So,

the term photovoltaic essentially means producing electricity from sunlight. A solar cell is essentially a photodiode. When sunlight falls upon it, the holoes and electrons present in it starts to flow with the help of photons . This generates an electrical current. It also introduces a voltage across the cell. To increase the amount aof voltage and current received, more number of cells can be connected in series and parallel connection. Series connection will increase the amount of voltage produced while parallel connection would increase current. In this thesis, the panel is simulated to have an output of 12V. In reality, a 12V panel may generate more or less than that depending on the irradiation level. To regulate the supply a charging circuit will be used.

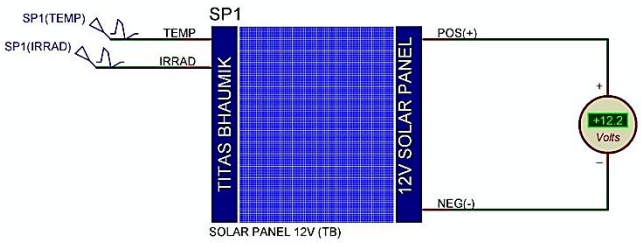
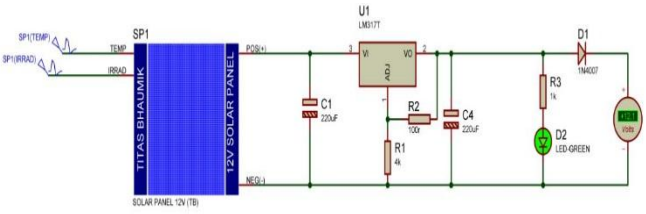


Fig-1: Solar Panel model in Proteus

2.2 Solar Charge Controller

A simple charging circuit using LM317 is used to charge the battery which can an input of upto 50V and in turn gives output accordingly. The main advantage of this charging circuit is that the output stays constant after a certain point. This makes this circuit one of the best for constant charging current supply. The main element of the circuit is adjustable voltage regulator IC LM 317 . It has three pins, pin 1 is the control pin used to control the output voltage.



Output is taken from pin 2 and the DC supply is given to pin 3. This gives out a constant current inthe pin no 2 *i.e.* the output pin.

Fig-2: Solar Charge Controller using LM317

2.3 AC Charge Controller

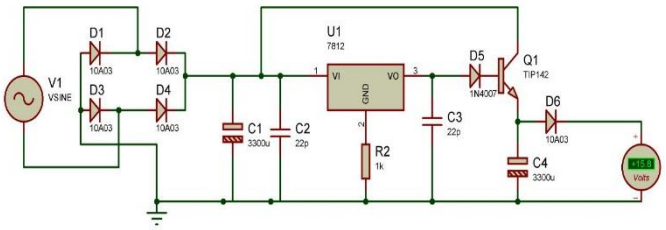


Fig-3: AC Charging Circuit using LM7812

When solar power is not available like in the night time or in a cloudy day, the battery can also be charged from mainline AC power. For this purpose a charging circuit has been used which implements LM7812 IC to provide a regulated voltage at the output. 7812 is widely used in 12V voltage regulator circuits. This IC is a complete standalone voltage regulator and can be used in anywhere to control the output voltage of any circuit. To get clean output voltage, two capacitors are used at the input and output. The power supply from the mainline is first volatage stpped down using a 220V/12V transformer and then it is rectified by using a diode bridge rectifier. The rectified Dc is then supplied to the input pin *i.e.* pin 1 of the IC. The IC has the output pin as pin no 3. Through this pin the ouotput power is received and supplied to the battery for charging purpose. An NPN transistor, TIP142 is also used for controlling the charging and it will autocut the circuit, *i.e.* stop charging once the battery is fully charged. Note that this circuit only gets activated when battery output is low and there is no solar power present. This circuit is controlled by an LDR circuit which is discussed later.[2]

2.4 Inverter

To supply the household load, the output from the bvattery need to be inverted, *i.e.* converted to AC. An inverter is used for this purpose. The inverter implements CD40474 IC which is essentially a square wave genrator.

CD4047 is a low power multivibrator IC capable of operating in monostable or astable mode. It charges a capacitor (C_1) through a resistor (R_3) like every other 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), and they are complementary to each other. These square wave pulses are pre amplified by two IRFZ44N transistors. When this amplified current passes through the transformer winding, it produces AC voltage as per laws of electromagnetic induction across the secondary winding of the transformer.

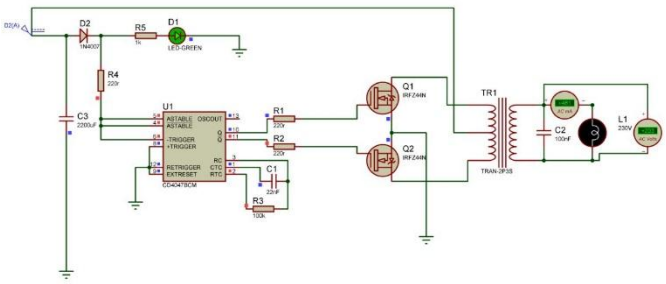


Fig-4: Inverter using CD4047

The transformer used is a 220/12 V unit where the 12V winding is center tapped as 12-0-12 V. The transformer is used in inverted mode *i.e.* the primary winding is the 12V winding, and the 220V winding is used as the secondary winding and output is received across this winding.

When the output at pin 11 is low, pin 10 will be high which is connected to gate of Q1. Current flows through the upper winding of the transformer and positive half cycle output is received across the secondary winding. When the output at pin 11 is high, pin 10 will be low. This time Q2, whose gate is connected with pin 11 will be turned on and current will flow through the lower winding of the transformer and negative half cycle output will be received in secondary. This in turn will result in a alternating current through the secondary winding of the transformer. The output power is hence received across the secondary 220V winding.

2.5 LDR Circuit

LDR is Light Dependent Resistor means its resistance depends on light falling upon it. It is an element made up of semiconductor materials which, when light falls on it, reduces its resistance. Basically the photons (which are

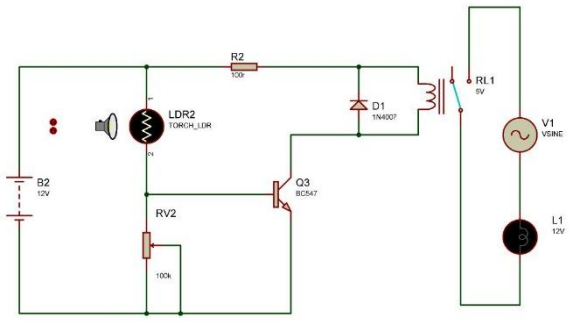


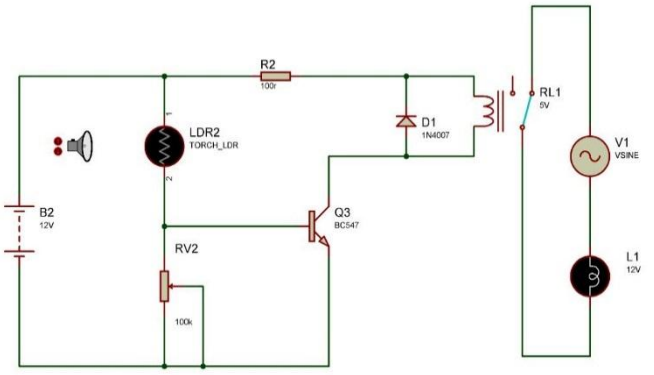
Fig – 5 : LDR Circuit (not activated)

nothing but energy packets) present in light excites the electrons in the LDR. This causes the electrons to move from valence band to conduction band. Thus when light falls on LDR, number of electrons in the conduction band increases. Hence the conductivity of the LDR increases while reducing its resistance.

This principle is widely used in automatic street light control. The same principle can be implemented to control a relay which will connect the Ac mains to the charging circuit of the battery. During the daytime, when sunlight falls on the LDR, the circuit provides energizing current for the relay coil. Then the relay works to connect the supply from the solar panel to the battery charging circuit and the battery is charged by the solar panel. But during night time or in cloudy days, amount of light falling on the LDR is less and the circuit sends very little amount of current through the relay coil which is not sufficient to energise the coil. This makes the relay disconnect the supply from the panel and connects the charging circuit to the Ac main. The battery is then charged by AC main through the charging circuit which is discussed before.

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 a relay. The combination is formed in such a way that during daytime, the LDR circuit drives the relay to make the battery connected with the charging circuit output which is driven by the solar panel. During night time or cloudy hours, the relay works to connect the battery with the charging circuit which is powered by the AC mains.

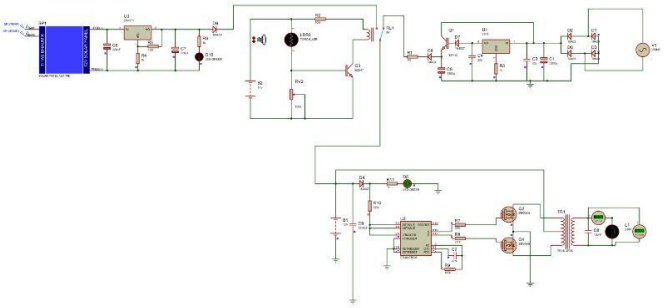


Fig – 7 : Combined Circuit

This scheme keeps the battery charging constant so that the battery is never out of charge. Also as the load is supplied by the inverter from the battery, power cut does not affect the supply. Also any kind of fault in the supply lines does not reach the load or the consumer, amking it a safe process. The scheme has another benefit in terms of speed. As the load is supplied from the battery, during power cut, the changeover moment is nil. Therefore unlike backup inverters, there is no time gap in between.

4. Conclusion

This scheme provides a way to reduce the main line energy cosumption for the household consumers. As the battery gets charged mainly by the solar power, and the load is supplied from the battery, it works almost as a standalone solar system. However, mainline AC is also present to compensate for any abrupt conditions such as cloudy days. It greatly reduces the amount of power consumed from grid by the household loads, therefore reducing the electricity bill. It also increases the amount of power available in the grid which can be used for loads with high capacity like loads in the industry or in large offices etc.

The scheme has some drawbacks. The main being, as the battery is constantly charging and discharging, the battery life is greatly affected. However, by using lead-acid battery the lifetime can be improved. Also the electrical elements present in the circuit goes through wear and tear due to constant use. The maintenance cost, although pretty low, but has to be maintained. Also, this system has very low running cost, the initial cost for situating the scheme is a bit on the higher side.

In spite of all the difficulties, this scheme is very benefitiary and profitable one which wil not only save money for the households, may also prove to be benefitiary for the country's economy.

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