Inverter using Free Energy Generator

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Abstract— Power electronic systems are used widely to convert electric energy from one form to other using electronic devices. Four basic power electronics functions are AC to DC conversion, DC to AC conversion, DC to DC conversion and AC to AC conversion. These basic functions are used to build power supplies, DC transmission systems, electric drives and others. People can no longer afford to be tied down to a fixed power source location when using their equipment's. Overcoming the obstacle of fixed power has led to the invention of a DC/AC power inverter. Companies, Industries, Organizations, Homes among the others are posed with a major problem of power shortage especially here in India. Although in developing countries, shortage of power is a problem commercially and domestically. Simply stated, our ability to consume power is growing faster than our ability to supply power. Hence, there is need for the alternative source. In this paper, work has been carried out in which solar cell or module is used to power an inverter. This can also be called photovoltaic system, because it consists of solar modules, solar charge controller, 24V DC battery and an inverter. It's use is far better than generating set because it needs less maintenance, it does not use fuel, it is not heavy, it is rugged, it does not need an alternating current for its charging and it is noiseless.
Key words: Inverter, Solar Cell, Solar Charge Controller

I. Introduction

Now a days scenario of growing energy needs and pollution concern, so that alternatives to use of conventional and polluting fossil fuels have to be investigated. One such alternative is solar energy. Solar energy is quite simply the energy produced directly by the sun and can be collected elsewhere on the Earth. The sun creates its energy through a thermonuclear process that converts Millions tons of Hydrogen (H) in to Helium (He) every second. The electromagnetic radiation (visible light, infra-red, u-v radiation) streams out into space in all directions. Only small portion of the total radiation produced reaches the Earth. The radiated energy which is to the Earth is the direct source of nearly every type of energy used today. Much of the world's required energy can be supplied directly by solar power. More still can be provided indirectly. Due to the nature of solar energy, two components are required to have a functional solar energy generator. These two components are a collector and a storage unit. The collector simply collects the radiation that falls on it and converts a fraction of it to other forms of energy. The storage unit is required because of the variable nature of solar energy; sometimes only a very small amount of radiation will be received. At night or during heavy cloud cover for example, the amount of energy produced by the collector will be quite small. The storage unit can hold the excess energy produced during the period of Maximum productivity, and release it when the productivity drops. In practice, a backup power supply is usually added too, for the situations when the amount of energy required is greater than both what is being produced and what is stored in the container. [1]

II. Principle of Solar Inverter

A solar inverter, or PV inverter, converts the variable direct current (DC) output of a photovoltaic (PV) solar panel into a commercial grid or used by a local, off-grid electrical network. It is a critical component in a photovoltaic system, allowing the use of ordinary commercial appliances. Solar inverter has special functions adapted for use with photovoltaic arrays, including maximum power point tracking and anti-islanding protection.

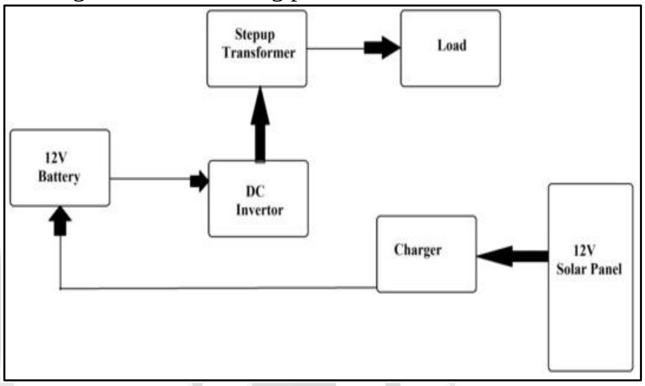

Fig. 1: Solar Inverter Schematic

III. Methodology

In this paper, we have design PV based system that produces electric energy and operates in dual mode, supplying stand-alone AC load, while minimizing its cost and size. This facilitates the production of quality electricity from a renewable source to reduce dependence on fossil fuels and the associated emissions of pollutants. Our goal is to design and develop an inverter that will handle the task described. The basic concept for PV module is to collect solar energy in space and transfer it for distribution as electric power. However this renewable source energy requires rather sophisticated conversion techniques to make them usable to the end user. The output of PV is essentially direct current (DC) form. Therefore, it needs to be converted to alternating current (AC) for it to be commercially feasible. This is necessary because the power utilization is mostly in AC form. This conversion can be done by using inverter. In any PV based system, the inverter is a critical component responsible for the control of electricity flow between the modules, battery and loads. Inverters are essentially DC-AC converter. It converts DC input in to AC output. It can be designed to be used with different voltage range and topologies for varying applications. Solar inverters are like the brains of the system. Along with inverting DC to AC power, they also provide ground fault protection and system stats including voltage and current on AC and DC circuits, energy production, and maximum power tracking. When sufficient output available from solar panels to charge the battery, solar panel charges a storage battery. In this time mains supply will not be utilized for charging purpose. A control circuit continuously monitors the battery's voltage. When the battery is fully charged, the circuit automatically turns on a power inverter and switches the appliance from running on grid power to turning on the energy stored in the battery. Then when the battery's voltage drops too low, the circuit automatically switches the appliance back to grid power until the battery is recharged. [4]

IV. DESIGN APPROACH OF SOLAR INVERTER

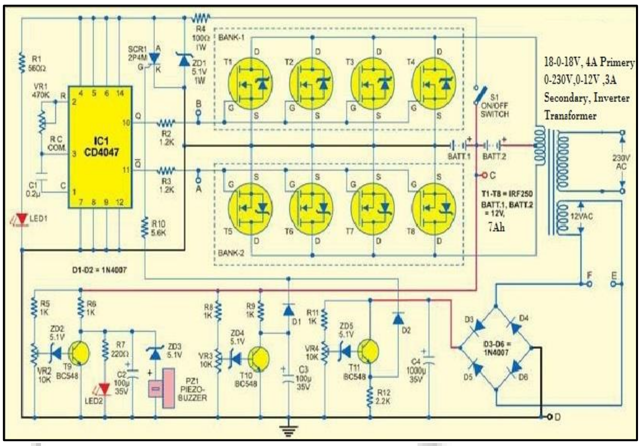

Fig. 2: Inverter circuit [courtesy of http://electronicsforu.com]

IC CD4047 has built-in facilities for astable and bistable multivibrators. The inverter application requires two outputs that are 180 degrees out of phase. Therefore IC1 is wired to produce two square-wave output signals at pins 10 and 11 with 50Hz frequency, 50 per cent duty cycle and 180-degree phase-shift. The oscillating frequency is decided by external preset VR1 and capacitor C1.These two signals drive the two MOSFET banks (bank-1 and bank-2) alternatively. When pin 10 of IC1 is high and pin 11 low, MOSFETs of bank-1 (T1 through T4) conduct, while MOSFETs of bank-2 (T5 through T8) remain in non-conducting state. Therefore a large swing of current flows through the first half of the primary winding of inverter transformer X1 and 230V AC develops across the secondary winding. During the next half cycle, the voltage at pin 10 of IC1 goes low, while the voltage at pin 11 is high. Thus MOSFETs of bank-2 conduct, while the MOSFETs of bank-1 remain non-conducting. Therefore current flows through the other half of the primary winding and 230V AC develops across the secondary winding. This way an alternating output voltage is obtained across the secondary winding. The sine wave output is obtained by forming a tank circuit with the secondary winding of the inverter transformer in parallel with capacitors C5 through C7. Two 2.2µF capacitors are connected to the gates of the MOSFETs in both the banks with respect to the ground if proper sine wave is not produced. Natural frequency of the tank circuit is adjusted to 50 Hz. Current consumption with no load is only 500 mA due to 50 per cent duty cycle of the square-wave signal. As load is increased, current consumption increases. Supply voltage to IC1 is limited to 5.1 volts by using Zener ZD1 and resistor R4 with the external battery as shown in Fig 2.[8]This circuit is applicable for only 1 KW load .If the load is below the above value then circuit will not work efficiently as per the required output.

V. MODELLING OF SOLAR INVERTER

A successful design involves accurate knowledge of daily electrical load calculation and accounts for all worst case scenarios which might possibly occur during operation.

A. *Selections of Battery Size*

Inverter should be greater 25% than the total Load

100 x (25/100) = 25

100 + 25 = 125 Watts

This is rating of the inverter.

Now the required Backup time in hours = 2 Hours

Suppose we are going to install 7Ah, batteries,

12V x 7Ah = 84Wh

Now for one battery (i.e. the Backup time of one battery)

84Wh / 125W = 0.672 Hours

But our required Backup time is 1 Hour.

1/0.672 = 2 (approx.) i.e. we will now connect two batteries each of 7Ah, 12V.

So this is a 24V inverter system, now we will install two batteries (each of 12V, 7Ah) in parallel. Because this is a 24V inverter system, so if we connected these batteries in parallel, then the voltage of batteries will become 24V and Ampere Hour rating remain same.

1) In parallel connection, voltage will be same in each wire or section, while current will be different i.e. current is additive e.g. I1+I2+I3+…+In = 7+7 = 9Ah.
2) In series circuits, current is same in each wire or section while voltage is different i.e. Voltage is additive e.g. V1+ V2+ V3…Vn. For the above system if we connect these batteries in series instead of parallel, then the rating of batteries become V1+ V2 = 24V while the current rating would be same i.e. 7Ah.

B. *Selection of Solar Panel*

We will now connect 2 batteries in series (each of 12V, 7Ah), therefore for two batteries it will be 24V, 7Ah, now required charging current for these two batteries (charging current should be 1/10 of batteries Ah) 7Ah x (1/10) = 0.7Ah

Now required No of solar panels

P = VI

P = 12V x 0.7 A

P = 8.4 Watts

This is our required watts for solar panel (only for battery charging, and then battery will supply power to the load), Now

8.4W/3W = 3 solar panels

Or 8.4W/9W = 1 solar panel.

C. *Selection of Topology*

The Push-Pull topology was the first step on electronic inverter technology. The advantage of this topology is the simplicity of overall design and cost effective in manufacturing. But major problem is the current in transformer has to suddenly reverse directions. This will cause a large reduction in efficiency. For small load application PV system, the inverter can be design by using the Push-Pull topologies. This topology is simple and easy to design. This kind of inverter can run the lamp and fan.

However some modification of the design is needed for this topology.

VI. Hardware Details

S. No	Component	Rating
1	Step-Up Transformer	18-0-18VPrimary to 0-230V 0-12V AC 4A Primary, 3A Secondary Inverter Transformer.
2	Diodes	5.1V, 1W zener diode, 5.1V zener diode, IN4007 rectifier diode.
3	Capacitors	0.2 µF, 100V ceramic disc, 100 µF, 35V electrolytic, 1000 µF, 35V electrolytic, 0.47 µF, 600V polyester.
4	IC	CD4047multivibrator.
5	SCR	2P4M
6	Transistor	BC548npn Transistor.
7	Mosfet	IRF 250
8	LED	5mm LED
9	Resistors (all ¼-watt, +5 or -5 per cent carbon)	560Ω, 1.2kΩ, 100Ω 1W, 1kΩ, 2.2kΩ, 220Ω, 5.6kΩ, 470kΩ preset, 10k Ω preset.
10	PZ	Piezobuzzer.
11	S	SPST switch.
12	Batteries	12V, 7Ah (Rechargeable).

Table 1: Component List

VII. Result & Discussions

- Battery output supply – 12V DC to the IC CD4047
- IC CD4047 gives a square wave at pin 10 and 11 of 180 Degree phase shift of 50% duty cycle.
- The output of MOSTET is 18V AC.
- Transformer takes 18V at primary side and gives 60 to 70V AC at secondary side.
- Frequency of output voltage is about 55 to 60Hz.
- Current at secondary side depends upon load. Maximum 3A

VIII. Applications of Solar Inverter

A. DC Power Source Utilization

An inverter converts the DC electricity from the source as batteries, solar panels, or fuel cells to AC electricity. The electricity can be at any required voltage; in particular it can operate AC equipment designed for mains operation, or rectified to produce DC at any desired voltage [6].

B. Uninterruptable Power Supply

An uninterruptable power supply (UPS) uses batteries and an inverter to supply AC power when main power is not available. When main power is restored, a rectifier supplies DC power to recharge the batteries.

C. HVDC Power Transmission

With HVDC power transmission, AC power is rectified and high voltage DC power is transmitted to another location. At the receiving location an inverter is a static inverter plant converts the power back to AC.

IX. 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 work done so far. The inverter will supply an AC source from a DC source. The work included in this paper is valuable for promising potential it holds within, ranging from the long run economic benefits to important environmental advantages. This work will mark one of the few attempts and contributions in the India or 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.

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