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Design of Grid Tie Inverter Fed With Renewable Energy Sources

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Abstract: Solar power generation studies are extensively increasing, because it is considered as an essentially inexhaustible, largely available and pollution free energy resource. Solar energy source that convert Solar energy into Electrical Energy. That Electrical Energy are further divided into two main categories. They are stand-alone (or) off line and grid-connected. The standalone system is isolated from the electric distribution grid. This system actually one of the most complex and includes all the elements necessary to serve AC applications in common household or commercial applications. The number of system will depend on the type of load that is being served. A good example is water pumping applications. The Grid connected system is directly couped to the electric distribution network and do not require battery storage. Electric energy is either sold or bought from the local energy load patterns and the solar resource variation during the day, this operation mode requires an inverter to convert DC currents to AC currents. Electric grid is parallel to the renewable system by use of the inverter. This project presents the New Design and performance of the Grid Tie Inverter and results prove that the system will reduce the energy consumption and optimum use of the renewable energy use can be utilized.

Keywords: Grid Connected Inverter, Grid Tied PV System, Conservation of Energy

I. INTRODUCTION

Energy is one of the important inputs of any country for economic development. Fossil fuels are produced environmental problems so only renewable energy sources are used. Renewable energy sources are PV sources and wind generators are mostly used.

PV sources are used in many applications they are satellite power systems, house hold applications, battery charging, pumping water, water heating etc. The main advantage are being maintenance and pollution free. But installation cost is high.

Mostly they require inverter (dc/ac) for load interface. Cost can be reduced by using high efficiency power converters since PV system have low conversion efficiency.

Application of photovoltaic system include domestic lighting, street lighting, electric vehicles, military application, space application, hybrid systems, power plant etc.

Grid connected PV systems is constantly growing energy demand are more popular, and encouraged in many countries. The PV technology is most important for research and development for large scale uses such as fabrication of less costly photovoltaic systems. Many countries are even funded for distributed power system. Here Grid Tie Inverter is discussed in detail.

II. GRID TIE INVERTER

A. Objectives

Electrical energy generation from renewable energy sources such as sun, wind etc., are widely adopted due to the increase in electricity consumption.

The present grid tie inverters available are imported and their capacity ranges from 5 KW to M Watts scale but the micro inverters are need of the hour.

By using the micro inverters we can convert the power as AC syncronized with Grid and the line loss and the size of the power cable can be reduced. The above will reduce the cost of the inverter.

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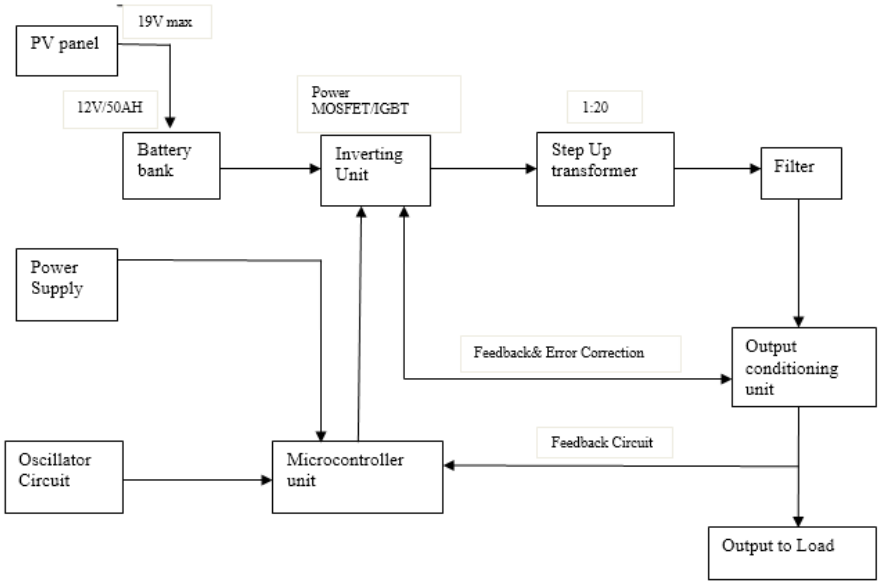
B. Block Diagram



C. Solar PV Array

Fig 1 Solar PV Array

Solar panels collect clean renewable energy in the form of sunlight and convert that light into electricity which can then be used to provide power for electrical loads. Solar panels are comprised of several individual solar cells which are themselves composed of layers of silicon, phosphorous (which provides the negative charge), and boron (which provides the positive charge). Solar panels absorb the photons and in doing so initiate an electric current.

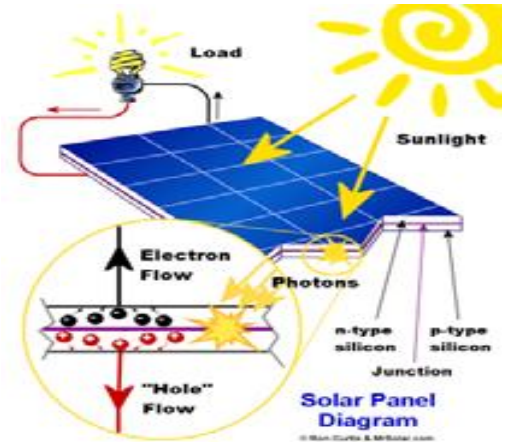


Fig. 2 Photovoltaic Principle

The resulting energy generated from photons striking the surface of the solar panel allows electrons to be knocked out of their atomic orbits and released into the electric field generated by the solar cells which then pull these free electrons into a directional current. This entire process is known as the Photovoltaic Effect and clearly displayed in the Fig.2. The Performance Analysis of the GTI was verified in our Electrical Machines Lab through proper experimental setup. The PV Source for this Experiment was chosen with a Capacity of 100W

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D. Battery
12V Batteries connected in series are used to store the energy obtained from PV panels.

Type: Lead Acid Rechargeable Battery Rating & Connection: 12V , 50AH connected in series Charging

Current: 3A Max. The GTI is connected at the output terminals of the Battery. The main aim of having the battery storage in our system is in the event of out of synchronization; still it is possible that the critical loads can be operated. Even our Inverter can work efficiently during the day with higher sun shine without battery storage. In such a case it is advantage that the battery storage system is eliminated and gives higher savings in the Installation. Battery set used for storage purpose with Instrumentation system which helps the measurement of battery voltage & charging current.

E. Description
The inverter is the heart of the PV system and is the focus of all utility-interconnection. An inverter is a device that converts direct current to alternating current. The PV Inverters are classified into following categories,

a. Stand Alone Type - Standalone inverter is like ordinary inverter which is having battery backup. These inverter ranges from 100W to 1000W.Low watt standalone inverter are used in power laptop computers.

b. Synchronous Grid Tie Type - Synchronous inverter is a special type of inverter which is specially designed for solar panel. This inverter is used to synchronous the output of PV panel and the utility. This type of Inverter can be connected with Battery Backup also. It is possible to install a medium to large-sized PV array and remain hooked up to the utility Power Grid. The overall system consists of up to four main sections as described below:

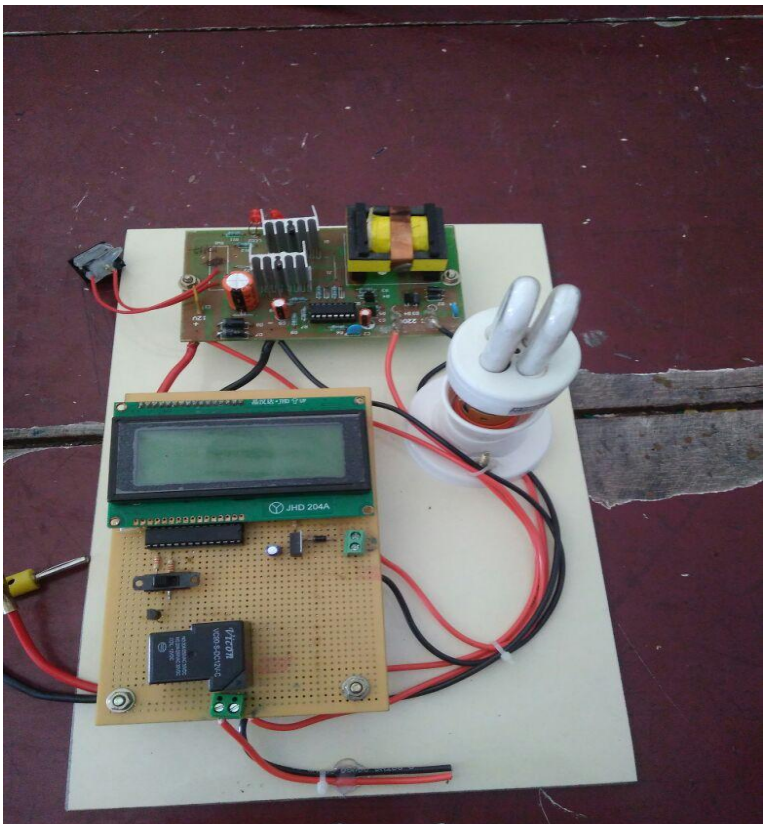

Fig.3. Hardware Description of Grid Tie Inverter

1. Sinusoidal PWM
This circuit consists of Comparator, Buffer Amplifier, ZCD and Logic Gates. The comparator compares the reference sine wave and high frequency carrier wave. The reference sine wave is taken from the utility through a step down transformer. The buffer amplifier consists of op-amp and it is having unity gain. Hence it is called as unity gain non –inverting amplifier. ZCD is also made of op-amp. The inverting terminal is grounded and the reference sine wave is given to non –inverting terminal. Here 2 ZCD's of 0 degree and 180 degree phase shift is used. In this circuit we use NAND gate as logic gate. Once the Carrier signal and the Sine wave signal are modulated in this circuit, which can develop the PWM pulses. These pulses are essential for the ON / OFF control of the Switching Devices.

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2. MOSFET Driver

The driver circuit contains IRFZ44IC. This IC is high voltage, high speed power MOSFET and IGBT driver with independent high and low side reference output. The output driver feature a high pulse current buffer stage designed for minimum driver cross conduction. Propagation delay is matched to simplify using high frequency application. The floating channel can be used to drive an N-channel power MOSFET or IGBT in the high side configuration which operated up to 500V or 600V.

3. Power Circuit

The Power circuit consists of 2 MOSFET. Here IRF 44 MOSFET is used. The 2 MOSFET are in bridge connection. The input is 12V DC which is taken from solar panel through battery. To protect this circuitsnubber circuit is used. The output of the bridge is connected to the 12V/230V step up transformer. The Sine Wave can be obtained after passing the signal through LC Circuit. The Frequency of this output signal is same as that of the Grid Frequency. Hence after verifying the Phase and Voltage level, the GTI Output can be synchronized with the Grid.

4. Transformer

To obtain 230V output the step up transformer is used. Here Transformer ratio is 1:20.12V AC from the power circuit is fed into the primary of the transformer and hence it is step up into 230V in the secondary of the transformer.

Fig.4. Transformer

F. Microcontroller Unit

In this microcontroller unit we used Atmega328. It is high performance Microchip 8bir AVR RISC based microcontroller. It has high balancing power consumption and processing speed.

G. Methodology

Energy is vital for the progress of a nation and it has to be conserved in a most efficient manner. Among Non-conventional energy sources, India has made notable progress in utilizing wind energy. However, solar-based Energy, the other potential and abundantly available resource, is yet to take off in the country. The solar photo voltaic energy is of the most decentralized nature among all the sources of energy in the world and harnessing power from solar energy is solely pollution free. India receives about 300 clear sunny days in a year. This is equal to over 5000 trillion kWh/year, which is far more than the total energy consumption of the country in a year. The daily average solar energy incident over India varies from 4-7kWh/ m2, depending upon location.

The inverter operates in parallel with the grid supply with the power to the local load supplied from the solar input via the inverter. Any excess Renewable energy will be exported into the grid. In the event when sufficient renewable energy is not available to meet the local load the grid will make up the shortfall. Provided the local load is not greater than the capacity of the grid, battery charging will automatically occur from the Solar PV Panel to maintain the battery bank at its float voltage. In the event that the grid voltage or frequency moves out of its operating range, the grid will be disconnected and the load is supplied directly from the inverter / battery with no interruption to the power fed to the load.

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H. Innovation

- The existing inverters require power converters for switching purpose which are more expensive but this grid tie inverter is designed with micro inverters with an advantage of low cost.
- Since the micro inverters require less space, the size of the inverter is reduced.
- By inverting the dc power to ac in inverter which is placed next to the solar panel, will reduce transmission losses in the present system.
- In earlier inverters, PCB board is used. If any fault occurs in the system, the board gets damaged which leads to the replacement of the entire system but we use Jumper board in grid tie inverter in which only the damaged part can be replaced without affecting the other parts.
- Due to the usage of jumper board in this system, only the damaged part can be replaced in the board. Therefore, the service for damaged part is easy.

III. CONCLUSION

In the grid interactive system, the solar power which may be available in excess of the demand during period of high sunshine is fed to the grid and is utilized elsewhere. This also improves the grid voltage and power factor. The grid interactive system having some storage for the energy, obtained from PV, can compensate the voltage of a pure, grid connected system. The system has been designed to supply continuous power to a dedicated local load with the power to the load carrying from the solar array, grid, or battery bank in the order of preference. It is capable of operation in a grid interactive mode and will automatically change over to the stand alone operation without break in power in the event of the grid drifting out. It can be summarized from the analysis that grid-interactive photovoltaic power system could play a vital role to mitigate power shortage problem of the region and can enhance reliability of quality power supply which is essential for critical loads. Performance of a grid-interactive PV system installed in the location under investigation will most likely be similar for all parts of Southern India as geographical and climatic conditions are almost same in this entire region. Satisfactory steady state performance experienced from the system in terms of energy conservation indicates that the grid interactive PV system is Economically Viable and Technically Feasible for Grid Interaction of Solar PV Generation. This is an innovative and a promising option for large scale penetration of this technology will be helpful to alleviate the dependence on grid.

Fig.3.Test Setup of Grid Tie Inverter(a)

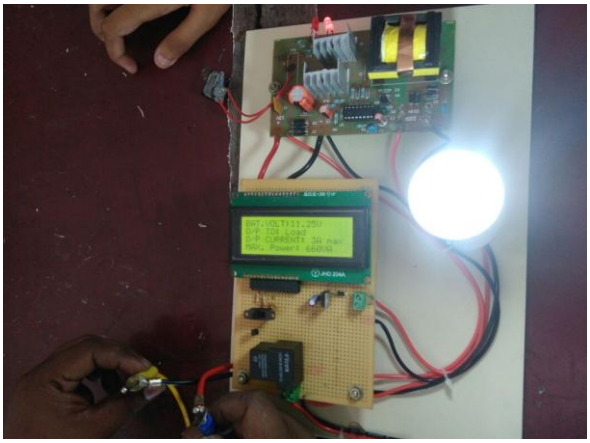

Fig.4.Test Setup of Grid Tie Inverter(b)

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BIOGRAPHIES

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