IJERST

International Journal of Engineering Research and Science & Technology

ISSN : 2319-5991
Vol. 1, No. 2
April 2015

2nd National Conference on "Recent Advances in Science Engineering & Technologies" RASET 2015

Organized by

Department of EEE, Jay Shriram College of Technology, Tirupur, Tamil Nadu, India.

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International Journal of Engineering Research and Science & Technology

ISSN 2319-5991 www.ijerst.com
Special Issue, Vol. 1, No. 2, April 2015
2nd National Conference on "Recent Advances in Science, Engineering&Technologies" RASET-2015

Research Paper

BY TRIMING HARMONICS AND RESORTING FREQUENCY FOR EMPHASIZING POWER VIRTUE IN POWER GRID

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At present scenario energy sources such as oil, coal, and natural gas are running out and world's environment concerns on renewable energy such as wind, solar, biomass. Tomorrow's energy may come from solar because they are more preferred as renewable source of energy. With development of new functionalities solar energy based Photovoltaic cells are upcoming energy source with higher efficiency. This solar energy is typically interfaced to a power grid through Grid-tie inverters. As the penetration of renewable energy increases, the interaction issues between the sources and interfacing devices have become an important research area in order to enhance the grid stability and power quality. Frequency deviations, Harmonic regulation are solved to enhance the power quality. The existing concept used was passive filter to reduce the harmonic contents at the output voltage. The components used in the passive filters are larger in size and there is no isolation between the input and output. In the proposed idea shunt active filters are used to avoid harmonics and Frequency deviations are maintained by zero crossing detector technique and synchronization is carried out to verify whether the output of inverter is same as the grid output. This project discusses the design issues of such parameters and proposes modifications to the previously presented methods. Modeling and simulation of the entire system is carried out using MATLAB.

Keywords: PV, Synchronizing system, Grid connected system

INTRODUCTION

Today, the demand for green energy is very strong and energy source oil, coal and natural gas are running out can tomorrows energy come from wind and solar? Some think so, but others believe that the atmosphere is too vast ant that we cannot harness wind power on a major scale. Wind, blowing constantly in swift currents around the world, offers enormous energy potential. In spite of man's ability to create mighty instruments, he has not been able to harm totally this awesome power of nature.

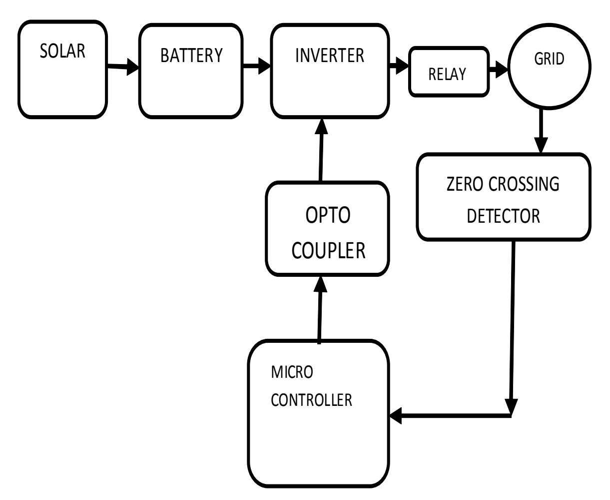
The wind remains beyond a desirable of control in spite of all our technological advances. One possible option for meeting this demand is to convert solar energy into electrical energy. This process is supported by the photovoltaic (PV) solar panel, which produces various DC output voltages and output power. In the conversion from DC to AC power, dedicated inverters maintain the right working point for the solar panel to maximize its use of solar energy.

In using solar energy as renewable energy, solar cells offer a potential attractive means for the direct conversion of sunlight into electricity with high reliability and low maintenance, as compare with solar-thermal systems. The present disadvantage is high cost to build it and the difficulty of storing large amounts of electricity for later use. The cost of solar cells is expected to be considerably reduced when cells are manufactured in large quantities using new production technique for obtaining ribbons or sheets of single crystal silicon .

WORKING PRINCIPLE

The paper discusses the detailed transient models of a grid-connected PV system. PV array is connected to the utility grid by DC/AC inverter. zero crossing detector is used to avoid deviation between inverter and grid and synchronization is carried out.

Figure 1: Block diagram using grid tie inverter



The purpose of synchronization is to verify whether the out output of inverter is same as the grid output and all simulation results have verified the validity of models and effectiveness of control methods.

PROPOSED IDEA

Harmonics mitigation passive filters were used traditionally, but due to certain drawbacks of resonance due to matching with line impedance, can compensate single harmonic at a time, bulky in weight they are not much in use. With development of semiconductor devices active harmonics filters with different current control strategies are extensively used. Shunt Active filter can be formed from topologies like CSI, VSI. There are many current control methods used in active filters.

Grid Tie Inverter

The Grid tie inverter is the heart of the PV system and is the focus of all utility- interconnection. An inverter is a device that convert direct current to alternating current. The PV inverter are classified into Stand alone type and synchronous.

METHODOLOGY

The proposed measurement methods were tested by simulations in Matlab /Simulation and Zero crossing detector technique is used to match the frequency. ETAP is the most comprehensive platform for the design, simulation, operation, and automation of generation, distribution, and industrial PS.

MODELING AND SIMULATION CIRCUIT

The proposed system consists of buck converter, pulse width modulation inverter, synchronizing circuit, as shown in the Figure 1. The buck converter operations is to regulated and maintain the voltage at certain level.

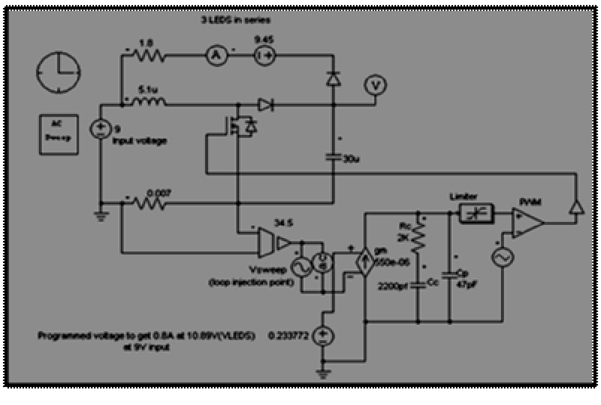
The PV array generates dc power. PV power feed to buck converter and the output of buck is insert to the inverter [4]. At the end inverter, the synchronizing circuit is used to verify the voltage, frequency and phase of the voltage.

A. Buck Converter with Hysteresis Controller

DC-DC converters are used to convert the unregulated dc input into controlled dc output at a desired voltage level. A buck converter is a step down DC to DC converter because the output voltage is less than input voltage. This converter controls the output to the specifications by comparing positive output to an internal reference. Feedback input is necessary to know positive of the voltage.

A buck converter operate in continuous mode if the current through the inductor (I_l) never falls to zero during the commutation cycle. Hysteresis comparator will change duty cycle of the signal depend of the input in order to maintain the output voltage of buck converter for certain value.

Figure 2: Simulation for Buck Converter

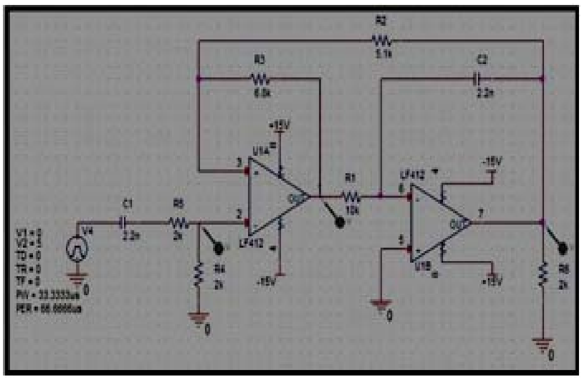


B. Three-Phase PWM Inverter

Inverters are circuits that convert dc to ac. To be more precisely, inverter transfer power from a dc source to an ac load. In PWM inverter, a control signal $v_{control}$ was compared with a repetitive switching-frequency triangular waveform in order to generate the switching signal.

In this circuit, the desired frequency output frequency is 50Hz which is also called as modulating frequency. To obtain balanced three-phase output voltage in a three-phase PWM inverter, the same triangular voltage waveforms compared with three sinusoidal control voltages that are 120^0 out of phase. The carrier frequency in this circuit is about 2 kHz. The amplitude for the modulating waves is 1.0 volt while the amplitude of carrier signal is 1.4 volt.

Figure 3: Simulation for PWM Inverter

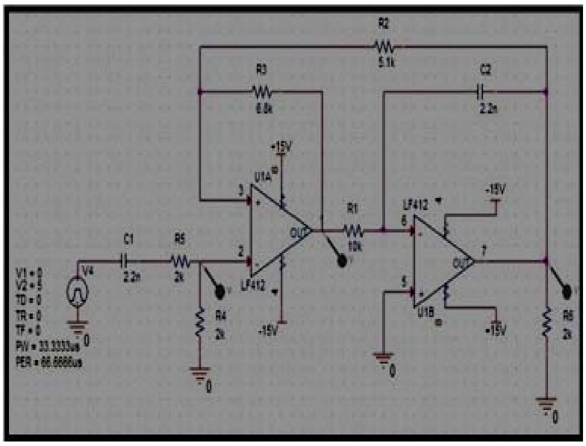


C. Voltage Comparator

The voltage comparator is inspired by using the comparator itself. The variable input voltage level is compared with a reference voltage level. The output of the PWM inverter per phase is about 240 volt AC. By using the single phase rectifier circuit, the output voltage is ripple DC voltage.

Therefore, a large capacitor is connected as filter on the dc side in order to reduce the ripple.

Figure 4: Simulation for Voltage Comparator



At the output of the capacitor, the voltage is direct current with small ripple. By using two resistors, the voltage is divided by using voltage divider and Kirchhoff voltage law. The R2 voltage is fluctuated about 7.92 to 7.98 VDC. In this current, there is upper and lower voltage level or as know as reference.

The upper voltage is 8.0volt while the lower voltage is 7.9 volt. As long as the input voltage is in the upper and lower voltage reference, the output of the comparator is almost 5VDC. If the input voltage is higher than the upper voltage reference or small than lower voltage reference, the output of the voltage comparator is slightly at 0 volt.

D. Phase Comparator

The phase comparator design is based on the logic gate Exclusive-OR. By using the characteristic of the Exclusive-OR gate, the different between the phase can be realized.

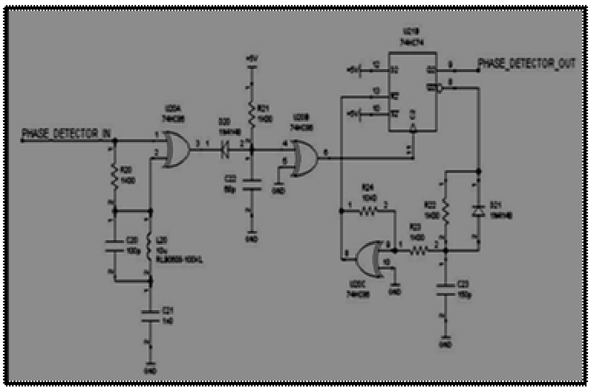
TRUTH TABLE OF EXCLUSIVE-OR LOGIC GATE

	INPUT	OUTPUT
A	B	X
0	0	0
0	1	1
1	0	1
1	1	0

Firstly, the one phase output of the inverter, which is sinusoidal wave, will be transform in pulse wave by using comparator. Thus, one phase of the line grid also is change in to pulse wave. With two pulse wave from the inverter and the line grid, the phase between them can be differentiating.

If there is no phase different, the output voltage is almost 5 volt. But, if there is a phase different between the two pulse wave, the output of the comparator is 0volt.

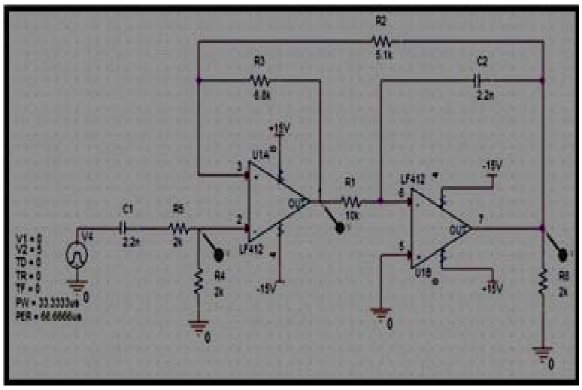
Figure 5: Simulation circuit of phase comparator



E. Frequency comparator

For the frequency comparator, it has the same topology as the phase comparator. The only different of that the Exclusive-OR gate must be simulated in its fundamental diagram which have AND, OR and NOT gate.

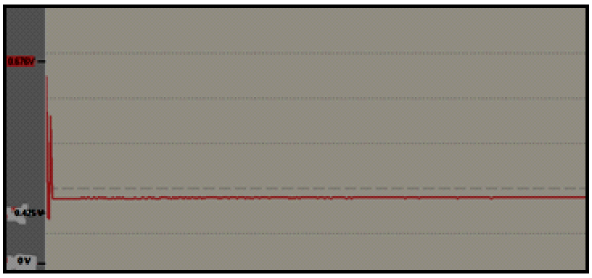
Figure 6: Simulation circuit of frequency comparator



The output of inverter is then compared with 50hertz frequency reference. If the frequency of the inverter is about 50 hertz, the output of frequency comparator is 5 volt, and if the frequency for higher or lower than 50 hertz, the output is about 0 volt.

RESULTS AND DISCUSSION

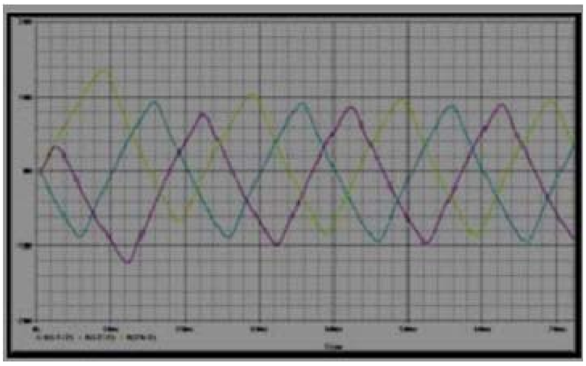
Figure 7: Output of Buck Converter



From the result of buck converter for Photovoltaic generation, the output is 10volt.The simulation result show that the output voltage of buck converter is fluctuated before it is regulated at 20 volt, the duration for the time of operation to regulate is about 1 millisecond. The switching frequency for the buck converter is 10 kH.

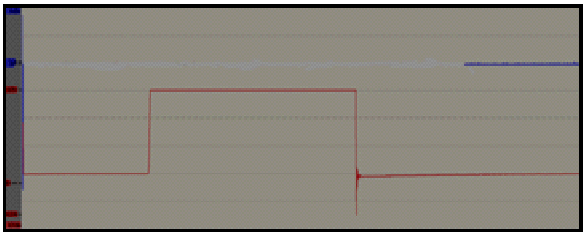
The output pf the inverter shows the 3 phase alternating voltage with amplitude of 8.93 volt. From the PWM inverter simulation, the output voltages take time about almost 40ms to get the 120º phase different between 2 phase voltages.

Figure 8: Output of PWM inverter



This may due to the time for the buck converter to regulate at 10 volt and it is affected the time process for the PWM inverter.

Figure 9: Output of Phase Comparator



From the phase comparator simulation output, the voltage is high if the per phase of inverter is same with per phase of line grid. After the delay of 40 millisecond of output inverter, the result of

Figure 10: Output of voltage comparator

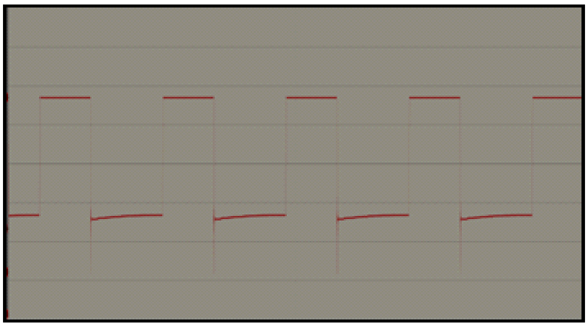
phase comparator shows that the output voltage become high(5 volt) after 42 millisecond. It means that the comparator its self only take 2 milliseconds delay to operate

The synchronizing circuit consists of voltage, frequency and phase comparator per phase. It means that for phase voltage need 3 synchronizing circuit. From the simulation of frequency comparator, after feeding the 1 phase voltage of PWM inverter with 40ms delay with the frequency of 50 Hz, the output of simulation takes about 93.7 millisecond to become high(5 volt).

If the frequency of per phase is higher of lower than 50 Hz, the output voltage from frequency comparator is low (0 volt).

From the simulation of frequency comparator, the accuracy of 100% to differentiate between allowable frequency or not.

Figure 11: Output of Frequency Comparator



For the voltage comparator circuit, the simulation shows that the comparator take about 76 millisecond to becomes high(5 volt) after being feed with 40 millisecond delay of PWM inverter output.

From this, it shows that the voltage comparator only takes time about 36 millisecond in order to complete the process. The efficiency of the voltage comparator can be vary adjust the lowet and upper voltage in the voltage comparator circuits

CONCLUSION

This system has been designed with a concept of micro photovoltaic power station. Still the solar PV system installation cost is not within an acceptable limit. Proper step should be taken to reduce the solar PV system cost. So that, the general electricity consumer can concentrate their attention in Grid-tied PV systems. We hope there will be occur a lot of activity regarding Grid-tied PV system and then our work may help to decide an optimized way.

PV panels are connected in series and parallel to match with grid voltage. Parallel connection increases current level. This DC power is converted to AC using inverter. Inverter is control to feed active power to the grid using discrete PWM signals. There is harmonics injected in the grid due to nonlinear load on utility side. To mitigate this harmonics Shunt active filter with VSI topology is used.. Synchronous reference frame for current control scheme is implemented for better results.

Active filters operation rating and control is briefly analyzed. Important terms like switching frequency, ripple suppression dc bus voltage are addressed to meet systems performance objective. Harmonic level in Supply current is improved to 3.94% with active filter implementation.

In the simulation, there are two parts of circuit, first is power conversion circuit, and second is synchronizing circuit. The power conversion circuit consists of buck converter and inverter while the synchronizing circuit consists of voltage, frequency and phase comparator. The synchronizing circuit is build for one phase only. For the voltage compactor, as long as the voltage input is in between the upper and lower level of voltage reference, the output is high. The frequency comparator have high accuracy to differ whether the frequency is the same or not.

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ISSN 2319-5991