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ENHANCMENT OF GRID-CONNECTED SOLAR PV SYSTEM POWER QUALITY USING ADAPTIVE NOISE REDUCTION MANAGEMENT AND FREQUENCY CONTROL LOOP

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ABSTRACT
In this project, a two-stage, three-phase PV-grid interfaced system with a three-phase VSC that has been used as a multipurpose device is implemented. Multifunctional VSC, which transmits active power from PV systems to the grid and also serves as an active power filter (APF) to enhance power quality at AC mains, is controlled using an adaptive noise reduction method. The management method described here responds dynamically with speed and accuracy. With linear and non-linear loads, the suggested SPV energy system has been put into practise to demonstrate harmonic elimination, load balancing, and power factor adjustment. A complex dc voltage control loop with fuzzy logic and a frequency loop are used to reduce disruptions at the load and grid side. An adaptive noise reduction technique is used to regulate multifunctional VSC, which transfers active power from PV systems to the grid and also functions as an active power filter (APF) to improve power quality at AC mains. The managerial approach outlined here reacts quickly and precisely to changes in the environment. The proposed SPV energy system has been implemented with linear and non-linear loads to show noise elimination, load balancing, and power factor correction.

INTRODUCTION

Grid connected solar photovoltaic (PV) systems are now a significant field of study due to the rise in demand for renewable energy sources. Moreover, the grid-connected PV system is becoming far more alluring due to the steep decline in cost and rise in efficiency of PV panels, as well as the appearance of less expensive and creative inverter designs. Achieving maximum power point tracking (MPPT), load control, and power quality at the interaction of PV with the grid, such as harmonics elimination, load balancing, etc., are some of the difficulties that come with integrating PV into the grid.

Several of them talk about the system's power quality improvement, but their discussion is confined to simulation studies with no mention of the hardware. In this paper, we provide a control that aims to accomplish the following To take advantage of the inverter's capabilities to compensate for reactive power loss while also transferring solar energy in a grid-integrated solar PV system. To improve the system's power quality at the AC mains. When there is no solar power generation, the inverter

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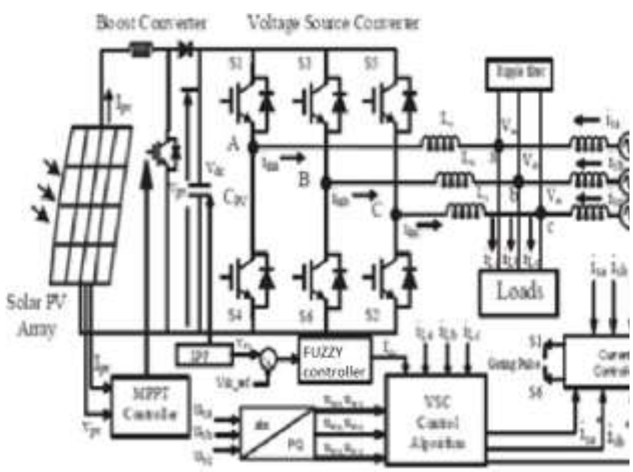
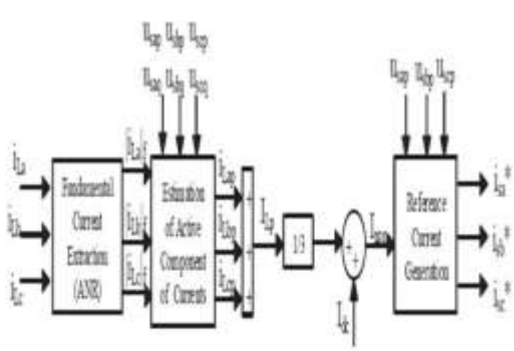
typically sits idle, but a smart inverter with reactive power capabilities can be used constantly. The overall cost of installing solar PV will be lower thanks to such a multi-functional inverter. The proposed system can perform a variety of tasks in addition to the inverter's multifunctionality, including solar power transfer. to the grid and loads, including load balancing with both linear and non-linear loads, harmonic compensation at the AC mains, power factor correction, and MPPT tracking. A rapid and accurate dynamic response is also provided by the control mechanism discussed here, which is also very robust and simple to implement in both software and hardware.

Proposed SYSTEM CONFIGURATION





A complete schematic diagram of the proposed system in which a grid is interfaced with a solar PV generating system using a three-leg VSC. The configuration consists of SPV panels, a DC-DC boost converter, interfacing inductors, a ripple filter and a VSC with a two stage control system MPPT control and inverter control.

Two stage control algorithms are used in the proposed system. First stage is maximum power point tracking (MPPT) which is used to control DC-DC boost converter whereas the second stage is to control VSC switching. For VSC control, a new control algorithm called adaptive noise reduction (ANR) has been used in this work.

In order to minimize disturbances at the load and grid side, a sophisticated dc voltage control loop with fuzzy logic and a frequency loop are employed. Multifunctional VSC, which transmits active power from PV systems to the grid and also serves as an active power filter (APF) to enhance power quality at AC mains, is controlled using an adaptive noise reduction method. The management method described here responds dynamically with speed and accuracy. With linear and non-linear loads, the suggested SPV energy system has been put into practice to demonstrate harmonic removal, load balancing, and power factor adjustment. An inverter is an electrical device that converts direct current (DC) to alternating current (AC); the converted AC can be at any required voltage and frequency with the use of appropriate transformers, switching, and control circuits. Solid-state inverters have no moving parts and are used in a wide range of applications, from small switching power supplies in computers, to large electric utility high- voltage direct current applications that transport bulk power. Inverters are commonly used to supply AC power from DC sources such as solar panels or batteries.

There are two main types of inverter. The output of a modified sine wave inverter is similar to a square wave output except that the output goes to zero volts for a time before switching positive or negative. It is simple and low cost (~$0.10USD/Watt) and is compatible with most electronic devices, except for sensitive or specialized equipment, for example certain laser printers. A pure sine wave inverter produces a nearly perfect sine wave output (<3% total harmonic distortion) that is essentially the same as utility-supplied grid power. Thus it is compatible with all AC electronic devices. This is the type used in grid-tie inverters. Its design is more complex, and costs 5 or 10 times more per unit power (~$0.50 to $1.00USD/Watt). The electrical inverter is a high-power electronic oscillator. It is so named because early mechanical AC to DC converters was made to work in reverse, and thus was "inverted", to convert DC to AC. The inverter performs the opposite function of a rectifier.

This inverter is similar to the half-bridge inverter; however, a second leg provides the neutral point to the load. As expected, both switches S1 and S1ÿ (or S2. and S2ÿ) cannot be on simultaneously because a short circuit across the dc link voltage source VI would be produced. There are four defined and one undefined

The undefined condition should be avoided so as to be always capable of defining the ac output voltage. In order to avoid the short circuit across the dc bus and the undefined ac output voltage condition, the modulating technique should ensure that either the top or the bottom switch of each leg is on at any instant. It can be observed that the ac output voltage can take values up to the dc link value vi, which is twice that obtained with half-bridge VSI topologies. Several modulating techniques have been developed that are applicable to full- bridge VSIs. Among them are the PWM (bipolar and unipolar) techniques.

The conversion of solar radiation occurs by the photovoltaic effect which was first observed by Becquerel. It is quite generally defined as the emergence of an electric voltage between two electrodes attached to a solid or liquid system upon shining light onto this system. Energy conversion devices which are used to convert sunlight to electricity by the use of the photo-voltaic effect are called solar cells. Single converter cell is called a solar cell or more generally photovoltaic cell and combination of such cells designed to increase the electric power output is called a solar module or solar array and hence the name ‘Photovoltaic Arrays’. Solar cells can be arranged into large groupings called arrays. These arrays, composed of many thousands of individual cells, can function as central electric power stations, converting sunlight into electrical energy for distribution to industrial, commercial and residential users. Solar cells in much smaller configurations are commonly referred to as solar cell panels or simply panels.

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Practically, all photovoltaic devices incorporate a P-N junction in a semiconductor across which the photo voltage is developed. The solar panels consist mainly of semiconductor material, with Silicon being most commonly used.

Current-type converters have advantages of excellent current controllability, easy protection and high reliability over Voltage source APF. More over CSI topology has superior characteristics compared to VSI topology in terms of direct injected current, which result in a faster response in time varying load environment and lower dc energy storage requirement. The drawback of the current source APF is larger power losses of the dc-link inductor. However, the current-type active power filter will become more attractive when the super conducting coils are available in the future. Losses are less important in low- power applications but very important in high power applications.

Since they are easily expandable, voltage type APF's are likely to be used for network wide compensation. Current type APF's will continue to popular for single-node distortion problems. In other words, electric utility interest will likely to be focused on voltage type converters, while industrial users likely to use both type of converters.

SIMULATION RESULTS

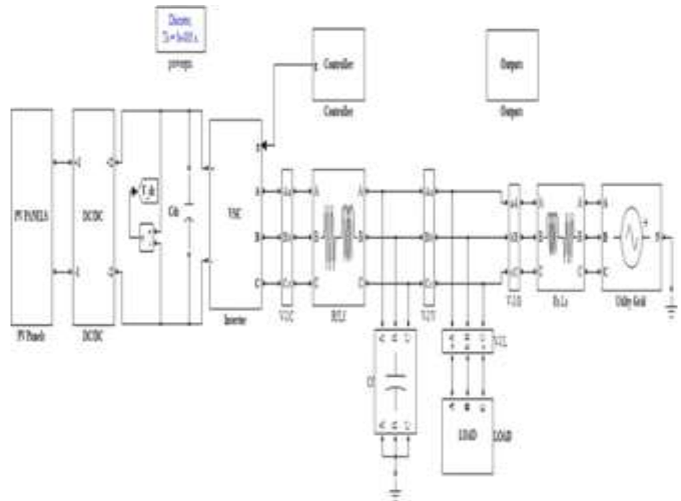

Fig 1 simulation circuit

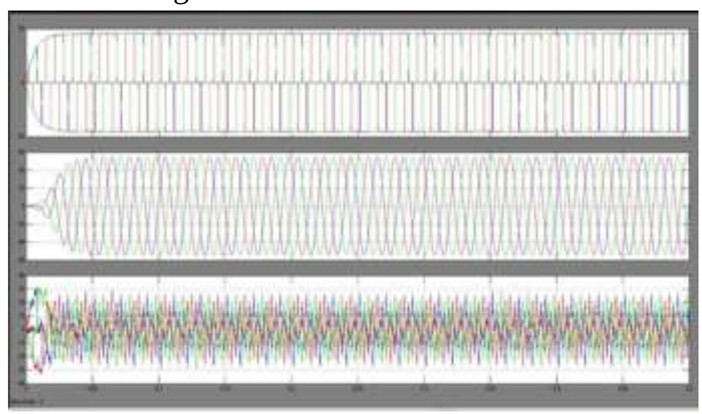

Fig 2. Converter voltage and current, filter currents

Fig3. Load voltage and load current, grid voltage

CONCLUSION

A three-phase two stage SPV energy conversion system has been implemented on hardware. A new ANR control technique has been proposed and implemented for estimation of reference supply current to generate the switching pulses for VSC. The implemented control algorithm has been found to provide acceptable characteristics in all the situations. The performance of the multifunctional VSC has been demonstrated for harmonic elimination, power factor correction, load balancing, reactive power compensation and transfer of solar power under balanced and unbalanced load condition for both linear and non-linear loads. Solar power from the solar simulator has been successfully fed to the grid and overall performance of the proposed grid interfaced SPV energy system has been found satisfactory under different operating conditions. The reactive power compensation capability of the inverter has been demonstrated in addition to solar power transfer. This makes it possible to utilize inverter at night time when there is no solar power generation. This will definitely result in improved efficiency and reduced cost of solar PV system.

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