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Development of Hardware in Loop Simulation of Grid Connected Photovoltaic System

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Abstract

This paper describes an ideal topology for inverters in a grid connected photovoltaic (PV) system. The Multistring inverter topology will improve the reliable operation of the Photovoltaic (PV) system because of independent control of each string will enhance the efficiency of the system. An efficient voltage control scheme is presented to control the Maximum Power Point Tracking (MPPT) and the inverter. The three phase two level voltage source inverter (VSI) has been used to validate the concept of Multistring. The simulation results have been presented to verify the proposed topology. An experimental prototype has been developed in the laboratory and dSPACE DS1103 is used to generate the signals for real time implementation.

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1. Introduction

During the last few years the installed capacity of grid connected photovoltaic systems have been drastically increased all over the world because of the increase in cost of energy generated by the conventional power plant and at the same time cost of photovoltaic modules has been reduced to generate the clean energy [1]. Grid Connected Systems have been classified into small scale (upto 2 kW), medium scale (2 – 500 kW) and large scale systems

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(more than 500 kW) based on power ratings. Medium Scale grid connected systems have three different inverters they are Central, String and Multistring Inverters [2]-[4].

Central Inverter consists of enormous number of solar panels coupled in series or parallel to the one single inverter. The drawbacks of this type of inverters are if they are any mismatches in PV panels the entire system will get affected and also the installation cost of the system is very high. String Inverters are better when compared to Central Inverter because of one inverter is connected to each string and the separate MPPT Algorithms in order to surge the capacity of the system [5]-[7]. The drawbacks of String Converters are which can be applicable to certain kilowatts level because the cost of the system is very high due to the large number of inverters. Multistring Inverters are the ones which is capable of combining the advantages of both the Central and String Inverters it has the advantage of having separate DC-DC converter intended for each string which will leads to generate extreme power and it can be applicable for Megawatt system because of the flexibility provided by the system one can easily increase the capacity of the system by connecting one additional string without making too many changes and the cost of this type of inverter is high but the amount of energy generated will compromise the cost [8].

One of the most consistent topology in use for numerous purposes is the three phase 2-level VSI arrangement. Due to its easiness, dependability and lustiness it has been used over the years in the area of electrical drives and in the industrial zone this topology is very popular. In general, most of the VSI topologies are used in medium scale systems based on MOSFETs and IGBTs. But in VSI there is a possibility of having expensive filters because the switching frequency has been limited [9]-[10].

In this paper the multistring topology has been described based on two level VSI the parameters of the systems are analysed with the help of simulations and the experimental prototype has been developed in the laboratory in order to validate the system. The proposed topology can be used for a medium capacity load, while improving power quality and efficiency. As the converter structure is very flexible and modular, it allows independent control goals.

The following section describes the complete system description and the control strategy adopted and the simulation and the experimental results and finally discussion has been made based on the results.

2. System Description

The block diagram of the projected system is shown in Fig.1. It comprises of two PV strings which have the capacity of 10kW. One string has 20 panels 4 panels are connected in series and 5 modules are connected in parallel to get the capacity of 5 kW and it is linked to the boost converter through the capacitors. Then the two boost converters are coupled in sequence to increase the DC link voltage. The conventional three phase two level voltage source inverter (VSI) is used for connecting to the grid. In most of the industries still they have used the two level VSI because it provides the greater flexibility for reliable operation of the system.

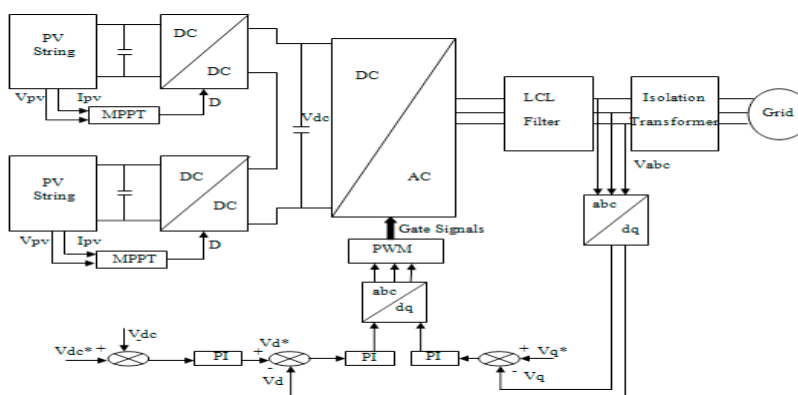


Fig. 1. Block Diagram of Multistring Inverter for Medium Scale Grid Connected System.

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