Design of Cascade 11 Level Inverter With Fewest Power Electronics Switches

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Abstract- *In this paper, a new single-phase wind energy inverter (WEI) with flexible AC transmission system (FACTS) capability is presented. The proposed inverter is placed between the wind turbine and the grid, same as a regular WEI, and is able to regulate active and reactive power transferred to the grid. This inverter is equipped with distribution static synchronous compensators option in order to control the power factor (PF) of the local feeder lines. Using the proposed inverter for small-tomedium-size wind applications will eliminate the use of capacitor banks as well as FACTS devices to control the PF of the distribution lines. The goal of this paper is to introduce new ways to increase the penetration of renewable energy systems into the distribution systems. This will encourage the utilities and customers to act not only as a consumer, but also as a supplier of energy. Moreover, using the new types of converters with FACTS capabilities will significantly reduce the total cost of the renewable energy application.*

Keywords- Modular multilevel converter (MMC), multilevel inverter (MLI), wind energy inverter (WEI, flexible AC transmission system (FACTS)).

I. INTRODUCTION

The ROLE of power electronics in distribution systems has greatly increased recently. The power electronic devices are usually used to convert the nonconventional forms of energy to the suitable energy for power grids, in terms of voltage and frequency. In permanent magnet (PM) wind applications, a back-to-back converter is normally utilized to connect the generator to the grid. A rectifier equipped with a maximum power point tracker (MPPT), converts the output power of the wind turbine to a dc power. The dc power is then converted to the desired ac power for power lines using an inverter and a transformer. Withrecent developments in wind energy, utilizing smarter wind energy inverters (WEIs) has become an important issue. There are a lot of single-phase lines in the United States, which power small farms or remote houses . Such customers have the potential to produce their required energy using a small-to-medium-size wind turbine. Increasing the number of small-to-medium wind turbines will make several troubles for local utilities such as harmonics or power factor (PF) issues. A high PF is generally desirable in a power system to decrease power losses and improve voltage regulation at the load. It is often desirable to adjust the PF of a system to near 1.0. When reactive elements supply or absorb reactive power near the load, the apparent power is reduced. In other words, the current drawn by the load is reduced, which decreases the power losses.

II. LITERATURE SURVEY

1. NEW MULTILEVEL INVERTER TOPOLOGY WITH REDUCED NUMBER OF SWITCHES

The multi-level inverter system is very promising in ac drives, when both reduced harmonic contents and high power are required. In this paper, a new topology for symmetrical and asymmetrical multilevel inverter is introduced. Both types have many steps with fewer power electronic switches, which results in reduction of installation area and cost and have simplicity of control system. Firstly, we describe briefly the structural parts of the inverter then switching strategy and operational principles of the proposed inverter are explained and operational topologies are given. A new algorithm for determination of dc voltage sources' magnitudes has also been presented. Finally, the simulation results verify the effectiveness of the both topology in multilevel inverter configuration and validate the proposed theory

2 DESIGN OF NEW CASCADED MULTILEVEL INVERTER WITH SYMMETRICAL DC-VOLTAGE SOURCE

In this paper, a new cascaded module of multilevel inverter is proposed. The proposed topology produces a large number of levels with reduced total harmonic distortion (THD). This module consists of less number of MOSFETs and gate drivers which optimize the design of MLI in term of complexity, cost, control and installation. The performance analysis of proposed module is done by using a modulation technique. Simulation results for 17-level are evaluated on MATLAB/SIMULINK

Renewable energy resource (RES) has become more attractive and fascinating due to the advancement of technology. RES like solar energy, wind energy, biomass, hydropower and geothermal etc are attractive in meeting the demands of consumer than the conventional sources. By economic point of view these RESs are contributing much well due to priceless quality of solar energy. The implementation of RESs in hybrid system gives rise a tremendous regime in the domain of energy . The collective advantage of maximum efficiency and minimum losses is achieved by photovoltaic, wind turbine and fuel cell. Power electronic devices MLI, converter, chopper etc play an important role with the collaboration of these RESs and distributed grid system. The concept of optimization of micro grids with distributed system is a good opportunity in gaining flexibility, reliability, control mechanism and efficient quality of power. DC to AC power conversion is a key technology in the modern set-up of generation,transmission, distribution, and utilization of electric power. With the advent of recent power electronics devices, digital controllers, and sensors, the role of power inverters is also envisaged and acknowledged in frontiers such as futuristic smart grids and greater penetration of renewable energy sources-based power generation. Conventional two level inverters have been used.

3 DESIGN AND IMPLEMENTATION OF NINE LEVEL MULTILEVEL INVERTER

In this paper the solar based boost converter integrated Nine level multilevel inverter presented. It uses 7 switches to produce nine level output stepped waveform. The aim of the work to produce 9 level wave form using solar and boost converter. The conventional inverter has multiple sources and has 16 switches are required and also more number of voltage sources required. The proposed inverter required single solar panel and reduced number of switches and integrated boost converter which increase the input voltage of the inverter. The proposed inverter simulated and compared with R load using Mat lab and prototype model experimentally verified .The proposed inverter can be used in n number of solar applications.

Multilevel inverters are utilized generally in the regular applications due to the high voltage capacity and it delivers the multilevel with low composition with least concern in the exchanging gadgets.

1.4 OBJECTIVES

The main objectives of this system are as follows:

- The output of 11 - Level will give a staircase waveform that is close to sine wave.
- Switching frequency must be low enough to get low switching losses.
- They can draw current without disturbing the source.
- They can operate at high and low frequency but low frequency gives minimum losses.

III. EXISTING SYSTEM

Multilevel inverter had been paid a lot of attention from the academia and research community in recent times due to its role in high and medium power applications. In this paper, a detailed survey is made on the recently designed multilevel inverter to find the suitability of the inverters for particular applications. Research is performed on various types of multilevel inverters such as: Symmetric, asymmetric, hybrid and modularized multilevel inverter in order to identify the issues in generating more levels at the output. A summary of various issues in multilevel inverter with reduced switch count is provided, so that a novel topology of multilevel inverter can be designed in future. Further, an 81-level switched ladder multilevel inverter using unidirectional and bidirectional switches is designed

Existing Block Diagram

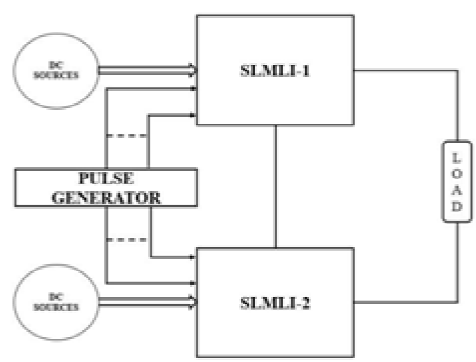


Fig 1.1 Existing Block Diagram

IV. PROPOSED SYSTEM

A hybrid system comprise of Photovoltaic (PV), Battery, Ultra capacitor (UC), Fuel Cell (FC) to meet isolated DC load demand. The PV is the primary energy source, whereas battery and SC both are considered for their different power density to supply transient and steady loadrespectively. To increase the reliability of the systemsource FC has been chosen to keep the battery fully charged. The battery sources are connected to DC bus by DC-DC converters. A power flow control strategy adapts their variable DC voltage to Bus voltage by means of these converters.

Proposed Block Diagram

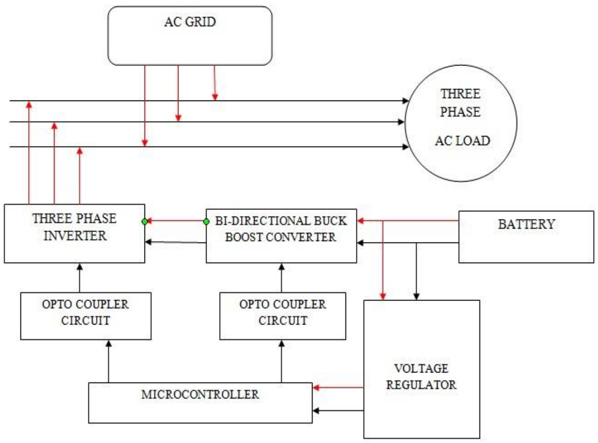


FIG 1.2 Proposed Block Diagram

EXPERIMENTAL RESULT

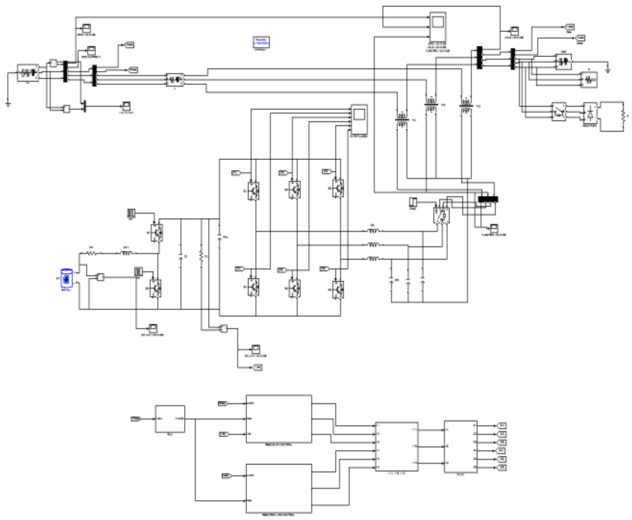
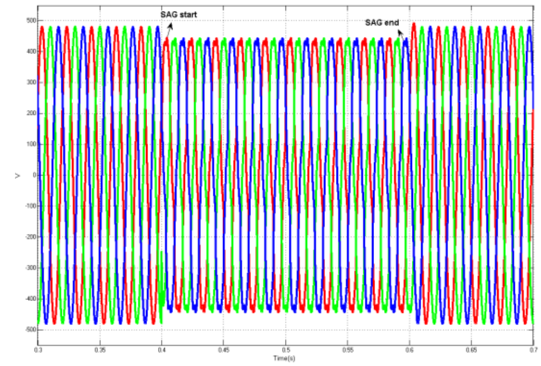


FIG 1.3 Simulation of PV sysytem

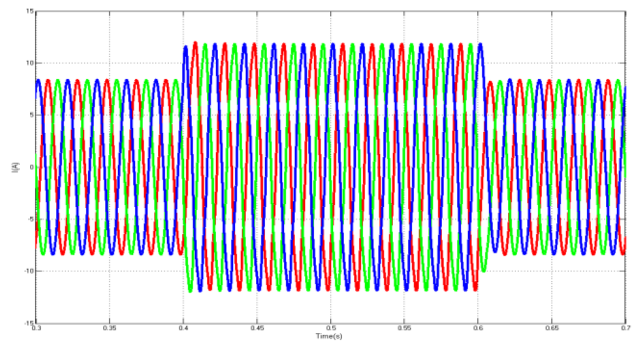
The aim of the designed inverter is to transfer active power coming from the wind turbine as well as to provide utilities with distributive control of volt-ampere reactive (VAR) compensation and PF correction of feeder lines. The application of the proposed inverter requires active and reactive power to be controlled fully independent, so that if wind is blowing, the device should be working as a normal inverter plus being able to fix the PF of the local grid at a target PF (D-STATCOM option), and if there is no wind, the device should be only operating as a D-STATCOM (or capacitor bank) to regulate PF of the local grid. This translates to two modes of operation

GRID VOLTAGE



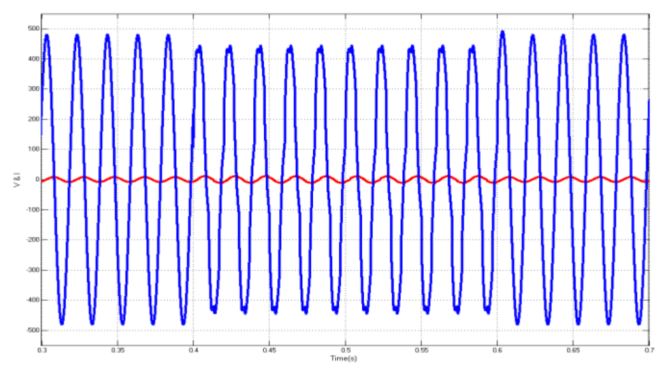
Three phase Grid voltage is above 400v

GRID CURRENT



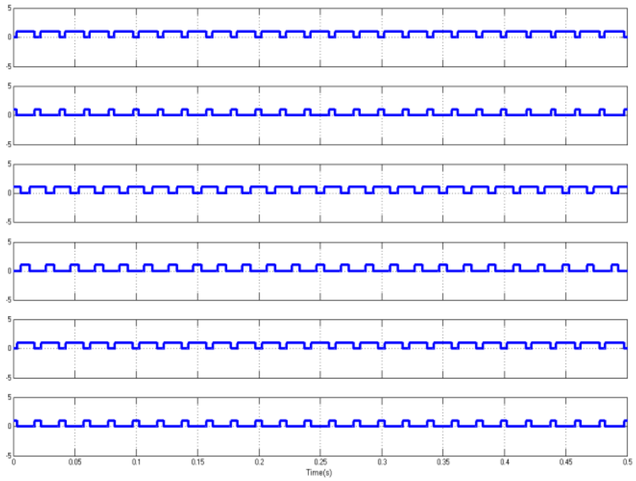
Three phase Grid Current is 8 Amps

VOLTAGE & CURRENT IN MUX



The Voltage In MUX is Above 440v and The Current In MUX is 8 Amps

GATE PULSES



The second function of the controller systems is to keep the capacitors' voltages balanced. In order to do this, a carrier based pulse width modulation (CPWM) method is used. The top graph is reference signal and the carrier waveforms for an 11-level MMC inverter

V. CONCLUSION

In this paper, the concept of a new multilevel inverter with FACTS capability for small-to-mid-size wind installations is presented. The proposed system demonstrates the application of a new inverter with FACTS capability in a single unit without any additional cost. Replacing the traditional renewable energy inverters with the proposed inverter will eliminate the need of any external STATCOM devices to regulate the PF of the grid. Clearly, depending on the size of the compensation, multiple inverters may be needed to reach the desired PF.

This shows a new way in which distributed renewable sources can be used to provide control and support in distribution systems. The proposed controller system adjusts the active power by changing the power angle (delta) and the reactive power is controllable by the modulation index m. The simulation results for an 11-level inverter are presented in MATLAB/Simulink. To validate the simulation results, a scaled prototype of the proposed 11-level inverter with D-STATCOM capability is built and tested. Practical results show good performance of the proposed control strategy even in severe conditions.

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