SIMULATION OF SOLAR BASED 5- LEVEL CASCADED H-BRIDGE INVERTER

Md. Arshiya Begum[1], Ch. Anusha[2], B. Usha Rani[3], G. Bhavani[4]
J. Srinivas Rao[5]
[1,2,3,4]UG Student, Anurag Engineering College, [5]Assistant Professor, Anurag Engineering College.

ABSTRACT
Renewable energy is a purest form of energy available on earth complete utilization of these energies leads to many advantages since it is an inexhaustible source it can be used most of the time. The different types of renewable sources are hydal wind and solar. Solar energy is the energy obtained by converting radiation from the sun to electrical energy using solar panels. The electrical energy obtained from the panel will be in DC and the voltage values will be low and for household purposes high voltage AC is required to convert DC to AC an inverter is required. Since solar energy is a variable voltage source a converter is required to control the voltage and if there is excess of energy that has to be stored in battery for back up. Here both simulation and of a seven level inverter using a simple technique of pulse generation by using MATLAB tool and is used for programming and dumped inside a Microcontroller.
Index Trems: Symmetric cascaded multilevel inverter, THD

I. INTRODUCTION

These days solar energy utilization has gained high interest has it is low cost ,high energy,[1] and a flexible kind of a source which can be installed easily wherever required. Solar energy can provide mega watts of energy when it is properly utilized. Many solar farms are installed which provide huge amount of energy so that the utilization of energy from grid or through from any non renewable energy sources can be limited. There are different types of multilevel inverters such as diode clamped , capacitor clamped and cascaded H bridge inverter[8]. Out of these Cascaded H bridge inverter is low cost, high efficient inverter .The voltage levels can be increased by increasing the level of the bridges and individual bridges will have their own protection [4]. The energy from the battery is converter from AC to DC but the inverter output will be less to boost that voltage a step up transformer has to be designed and used.

NEED AND FUTURE OF SOLAR:

The central government had launched UDAY scheme to help discoms reduce debt and improve their financial position which will ultimately help them buy power required for their customers. They were unable to buy power from generating firms despite having demand.

II. MULTI INVERTER TOPOLOGY

The cascaded H-bride multi level inverter is to use capacitors and switches and requires less number of components in each level. This topology consists of series of power conversion cells and power can be easily scaled. The combination of capacitors and switches pair is called an H-bridge and gives the separate input DC voltage for each H-bridge. It consists of H-bridge cells and each cell can provide the three different voltages like zero, positive DC and negative DC voltages. One of the advantages of this type of multi level inverter is that it needs less number of components compared with diode clamped and flying capacitor inverters. The price and weight of the inverter are less than those of the two inverters. Soft-switching is possible by the some of the new switching methods.

The current value will be less then one Amps these panels are used to capture the radiation of the sun. Since the voltage is higher the required value and is fluctuating a closed loop buck converter is designed to reduce as well as to maintain constant voltage i.e required to

charge batteries. The energy stored in the batteries are sent to the inverters. There are two types of inverter two level and multilevel. Multilevel has more advantages then two level as it mainly reduces the harmonics and provides waveform nearer to sinusoidal can be obtained[2]. There are different types of multilevel inverters such as diode clamped , capacitor clamped and cascaded H bridge inverter[8]. Out of these Cascaded H bridge inverter is low cost, high efficient inverter .The voltage levels can be increased by increasing the level of the bridges and individual bridges will have their own protection [4]. The energy from the battery is converter from AC to DC but the inverter output will be less to boost that voltage a step up transformer has to be designed and used. A single H-bridge inverter is generating three different voltage levels. CHB provides more redundancies than the previous topologies, since each single H-bridge or modular structure has one redundant switching state; the series connection itself produces more redundancies.

Since the inverter designed is a 5 level inverter the output voltage waveform will have 5 steps of different voltage levels[3] varying from ,2Vdc ,Vdc, 0, -Vdc, -2Vdc, where Vdc is the battery voltage. To turn on and off the switches a pulse has to be generated there are many pulse generation techniques such as space vector modulation and multicarrier pulse width modulation these techniques are complex and requires lot of time to generate a pulse. The technique used here is a simple and different kind of pulse generation which can be done using MATLAB and SIMULINK tool. Multilevel inverter can also be used for ac drives because of its improved low harmonic output and also the switches have less dv/dt stress[6]-[7].As the switching devices increases the control of these switches will be complicated.

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Multilevel cascade inverters are used to eliminate the bulky transformer required in case of conventional multi phase inverters, clamping diodes required in case of diode clamped inverters and flying capacitors required in case of flying capacitor inverters. But these require large number of isolated voltages to supply the each cell.It should be noted that the lower switching frequency means lower switching loss and higher efficiency is achieved. Selective harmonic elimination technique along with the multi level topology results the total harmonic distortion becomes low in the output waveform without using any filter circuit.

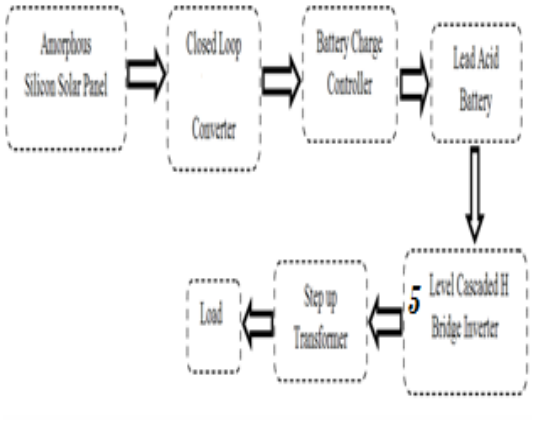
Advantages: The multilevel inverters produce common mode voltage, reducing the stress of the motor and don't damage the motor, Multilevel inverters can draw input current with low distortion **,** the multilevel inverter can operate at both fundamental switching frequencies that are higher switching frequency and lower switching frequency.

Symmetric Cascaded Multilevel Inverter :

Conventional CHBs are itself called as Symmetric Cascaded Multilevel Inverter (SCMLI). It is formed by the series connection of two or more single-phase H-bridge inverters. Each H-bridge comprises of two voltage source phase legs, where the line-line voltage is the converter output. Therefore, a single H-bridge (power cell) can generate three different voltage levels. Each leg has two possible switching states, to avoid dc-link capacitor short circuit. Since there are two legs, four different switching states are possible, out these, two outputs are redundant. When two or more H-bridge is connected in series, their outputs can be combined to generate different output levels, increasing the total inverter output voltage and also its rated power. In general terms, when k H-bridges are connected in series, 2k+1 different voltage levels are obtained (two levels per H-bridge and zero level is common to all). The symmetrical cascaded multilevel inverter which

is used here consists of two H-bridge which generates output voltage of five levels.

Figures:



Multi-level topology

BASIC CONCEPT

A power inverter, or inverter, is an electronic device or circuitry that changes direct current (DC) to alternating current (AC). The input voltage, output voltage and frequency, and overall power handling depend on the design of the specific device or circuitry. The inverter does not produce any power; the power is provided by the DC source. A power inverter can be entirely electronic or may be a combination of mechanical effects (such as a rotary apparatus) and electronic circuitry. Static inverters do not use moving parts in the conversion process.

CENTRALIZED ARCHITCHURE:

In the centralized architecture several solar panel branches of the solar array are connected in parallel. A single central inverter is used to convert the DC power generated in solar cells to AC. DC to AC conversion can be either single stage or multi stage conversion. Main advantage of this architecture is the low cost of deployment compared to other configurations. Further AC installation is much easier, since there is one AC line.

However the biggest disadvantage is the single point of failure because of the centralized operation. On the other hand maximum power point tracking cannot be done since there is a single input from all the solar panels and each single panel output is unknown. Hence the efficiency is low in this architecture.

ANALYSIS:

With the technology advancements in the semiconductor industry and introduction of smart grid, next generation solar inverters are expected to meet several requirements.

Among these requirements, the most prominent is cost reduction. Studies show that cost of the solar inverter accounts for around 10% of the overall system cost, and has significantly reduced over the years.

However, when moving from the traditional power grid to the smart grid, where sustainable resources are expected to cater power requirements by replacing fossil fuel, the cost of utility scale solar inverter, has to drop down considerably than now.

SIMULATION RESULTS:

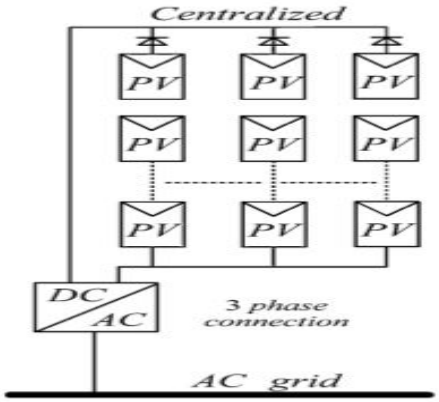
Run the simulation and observe the current into the loads and the voltage generated by the PWM inverters. Once the simulation is completed, open the Powergui and select FFT Analysis to display the 0 - 5000 Hz frequency spectrum of signals saved in the Scope Data For FFT structure. The FFT will be performed on a 2-cycle window starting at t = 0.07 - 2/60 (last 2 cycles of recording). Click on Display and observe the frequency spectrum of last 2 cycles.The half-bridge inverter generates a bipolar voltage (-200V or +200V) . Harmonics occur around the carrier frequency (1620 Hz +- k*60 Hz), with a maximum of 132% at 1620 Hz.

The full-bridge inverter generates a monopolar voltage varying between 0 and +400V for one half cycle and then between 0 and -400V for the next half cycle. For the same DC voltage and modulation index, the fundamental component magnitude is twice the value obtained with the half-bridge. Harmonics generated by the full-bridge are lower and they appear at twice the carrier frequency (maximum of 40% at 2*1620+- 60 Hz). As a result, the current obtained with the full-bridge is smoother.

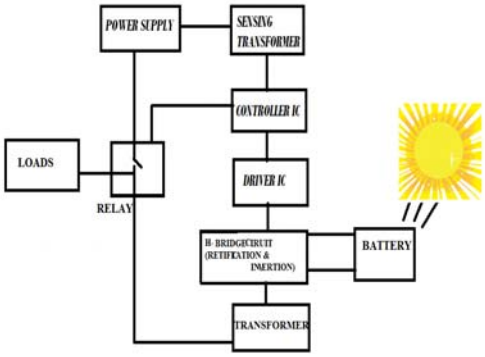
Symmetric Cascaded Multilevel inverter with 5-level is simulated using MATLAB-Simulink. Here load is taken as R load, output voltage and load current characteristics are shown in Fig.

III. HELP FUL HINTS

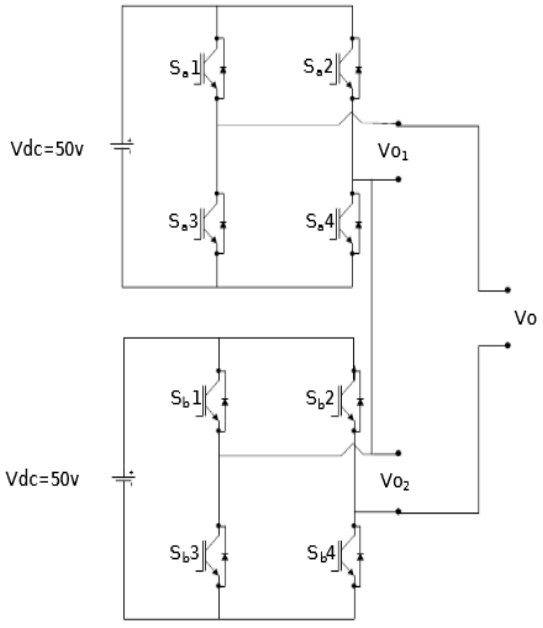
A. FIGURES:



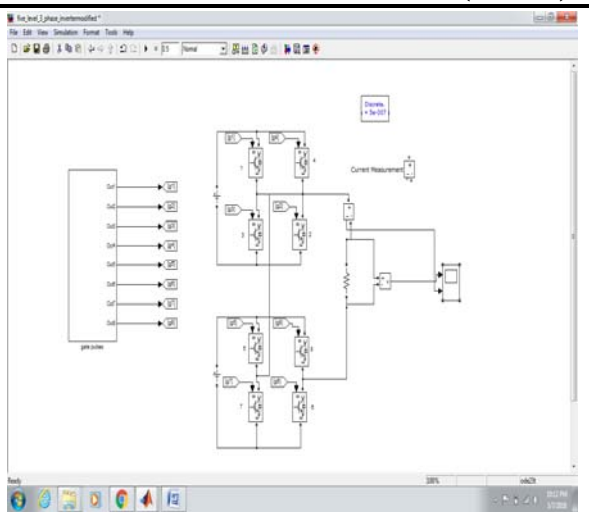
CENTRALIZED ARCHITECTURE



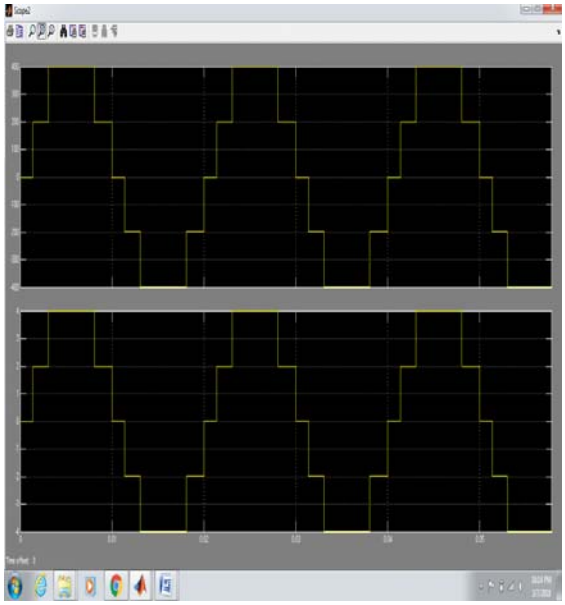
Basic blocks



H-BRIDGE CONNECTION



Simulation



Input and Output waveforms

B. References

[1] J. Rodriguez, J.-S. Lai, and F. Z. Peng, "Multilevel inverters: A survey of topologies, controls, and applications,"

[2] Multi string five-level inverter with novel PWM control scheme for pv application.

C. Abbreviations

THD- Total harmonic distortions.
PV System- Photovoltaic System
NPC- Neutral point clamped
FC- Flying capacitor

D. Equations

Two H-Bridge H1and H2 consists of a separate DC source Vdc as shown in Fig.. Let the output of H1be denoted as Vo1(t), the output of H2 be denoted as Vo2(t). Hence the total output voltage is given by

$$V(t) = Vo1(t) + Vo2(t).$$