Profile Analysis of Isolated and Grid Connected Photovoltaic System Using Three Phase 9Level CHB Multilevel Inverter

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Abstract: This research paper aims to support the 9-level Cascaded hybrid bride based Multilevel configuration that is connected to a photovoltaic system. The term multi-level implies that an n-level inverter is capable of manufacturing an-voltage level instead of producing 2 levels as within the convention two-level inverter. the multilevel electrical converter configurations may draw an input current with low distortion, operate at the upper switch frequency and lower switch frequency with lower switch loss and achieving higher potency and ensuing lower total harmonic distortion within the output wave while not victimization any filter circuit. This is the main concept implies in the multilevel inverter by using several semiconductors switches to produces several voltage levels. The symmetric configuration is introduced to scale back the amount of a full of active switching component that is cost-efficient. The concept of Grid-connected PV system is highly popular and preferable for both medium and high power demands. The Simulation strategies of voltage responses and THD responses for asymmetric and symmetric photovoltaic array associated with the 3 phase 9-level CMLI(cascaded Multilevel Inverters) are being carried under the MATLAB environment.

Keywords: Photovoltaic, *Cascaded Hybrid multilevel inverter, FFT, THD, MATLAB/Simulink*

1. Introduction

A multilevel inverter wont to convert the DC energy to AC energy which can be connected to the electricity grid. The electrical transmission systems are in A.C. and not all of the loads (appliances/machines) are using the direct current (D.C.) power supply as their sources since most of them need an A-C power as their main source. this is often wherever the electrical converter is required to convert DC energy to AC energy. within the early decade, the electrical converter was restricted to a two-level inverter that implements some semiconductors switch, these standard two-level electrical converter were isn't capable of handling high power application. that's why the necessity for introducing high-level electrical converter (multilevel inverter) becomes essential to beat the shortage of standard two-level inverter and expeditiously high power loads. Besides these reasons, the multilevel inverter is aimed to exchange the conventional two-level inverter to realize sensible power quality, low switch losses, and high voltage capability.

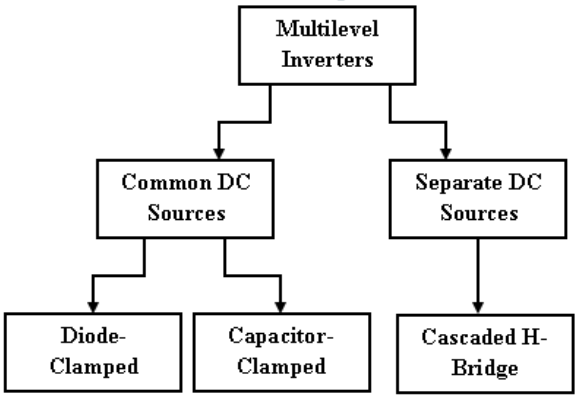

Fig.: 1 Block Diagram of Multilevel Inverter Topologies

Several researchers have been operated thus on various MLI topologies to offer their best to develop higher electric cell materials and economical management mechanisms for a grid-connected PV system. during this paper, we have a

tendency to discuss the newest electrical converter schemes to reinforce the general energy production that's quite compatible with the grid system. The cascaded H-bridge inverter is today highly regarded because of the bigger demand for medium-voltage dynamical inverters(high power inverters). Therefore for this research, we have considered for cascaded hybrid bridge multilevel inverter(CHB) topology. The main concept implies in the 9Level cascaded multilevel inverter is to use several semiconductors switches to produces several voltage levels. The only disadvantage for cascaded multilevel H-bridge inverter is the need to separate DC sources. The approach of the paper tends to prove that higher levels of cascaded H-bridge based multilevel inverters provide higher power efficiency along with the overall efficiency of the system. Thus this kind of configurations is high on demand that can hold efficient power Quality, low switching losses along with high voltage capabilities. In addition, MLI's provides less power switching losses and very low harmonic distortion that maintains system stability to constant.

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(a) The cascaded series structure allows a scalable, modularized circuit layout and packaging due to the identical structure of each H-bridge.

(b) No extra clamping diodes or voltage balancing capacitors are necessary.

(c) Switching redundancy for inner voltage levels is possible because the phase voltage is the sum of the output of each bridge.

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2. Methodology and Basic Principle

The proposed 9level Cascaded H Bridge Inverter with the lesser number of switches are such that it has a lower total harmonic distortion and minimal THD ratio. The CMLI uses a string of series connected single-phase full-bridge inverters to construct three leg parts of three phase 9-level MLI along with separate dc sources. The output of every Hybrid-bridge provides a stairs wave that's nearly sinusoidal and every single-phase full-bridge inverter generates 3 voltages at the output: zero, dc V and -dc V. The four switches S_1, S_2, S_3, and S_4 are controlled to get 3 separate outputs Vout Switch pairs S_1 and $S_3$and $S_2$and S_4 that are complementary to every alternative. the various voltage levels that may be obtained at the output terminals are +2Vdc, +Vdc, 0, -Vdc, and -2Vdc. The no. of levels within the o/p voltage is augmented or increased by 2 by adding a consistent inverter asynchronous(in series). one H-bridge is shown in Figure below.

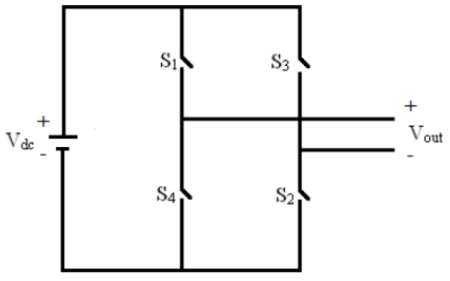

Fig.:2 Single H-Bridge Topology

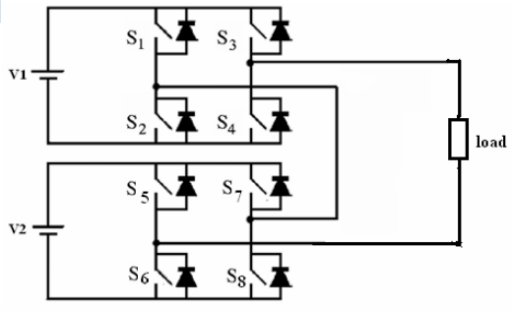

Fig:3 Single Phase of Cascaded H-bridge Multilevel Inverter

Likewise, two single H-brides combine to form a single cascaded multilevel inverter. In the given figure3 four switches S_1, S_2, S_3, and S_4 of first H-bridge is connected with four other alternative switches named S_5,S_6,S_7 and S_8 respectively. Therefore arrangement of various H bridges in this fashion tends to form a cascaded arrangement of various semiconductor switches. The AC o/p of each H-bridge is made to connect in series and the o/p voltage obtained is such that the addition of all H-bridge's individual output voltages. So, by victimizing this topology, we'll acquire n level victimization (n-1) H-bridges, and with each of bridge there are four switches like *MOSFET, IGBT,*

etc. we have got used *VSI* here. Using VSI, we'll acquire an sq. wave output of 1 level or we'll acquire Associate in Nursing output of up to 2 levels by making the changes in switch firing delay. The step voltage waveforms throughout the simulation results. Each H-bridge has its own DC input voltage that can be connected to a single or separate PV array. Likewise every bridge holds its own DC current which is offered by PV array. Switching states of single phase two H-bridge Cascaded MLI can be shown in Table-1.

Table :1 Switching States of Single Phase Cascaded Multilevel Inverter.

V0	S1	S2	S3	S4	S5	S6	S7	S8
V1	0	0	0	0	0	0	0	0
V2	0	1	0	0	0	1	1	0
V3	0	1	1	0	0	1	1	0
-V2	1	0	0	0	0	0	0	1
-V3	1	0	0	0	1	0	0	1

By varied the change timing within the 'pulse generator' block, thus on acquire nine levels or steps within the output. The waveform obtained during Simulation result of Cascaded H-bridge MLI can be seen below.

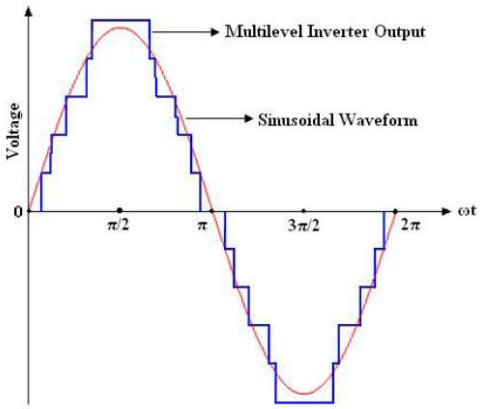

Fig.: 4 A Typical Staircase Sinusoidal Waveform Generated By Cascaded H-Bridge Multilevel Inverter

The input voltage of H-brides is based on the Irradiance level and temperature status of each PV array. Then this input voltage(DC) is reffered to MLI that enhance the voltage level to 485V(AC) which is further boosted upto 11kV. The MLI output is stepped up by Three-phase transformer. The output of every inverter exhibits their harmonic profile in form of steps. To enhance harmonics to exact level, inductance of transformer is adjusted.The RMS value of voltage obtained Vrms is found to be 492 volts during simulation response. Therefore this 9-level CHB multilevel inverter harvest approximately 495.4 Vrms for Rphase, 490 Vrms for Y phase and 496Vrms for B-phase respectively that to be fed to the grid system. This voltage value is enhanced by using a step-up transformer linked to it further of rating 200kVA that maintains voltage compatibility on the three-phase grid.Below showing the single ph of 9level ML inverter topology together with voltage waveform and THD response of voltage.

3. Simulation Results and FFT/THD Analysis

To synthesize 9-level ph voltage, 3 firing angles are required. The same 3 switching angles can be used in all the three phases with delaying viz., 00, 120 and 240 electrical degrees for phases A, B, and C respectively. The three-phase nine-level cascaded H-bridge MLI o/p voltage response are discussed later.THD response of the proposed three-phase 9level Multi-Level Inverter can also be seen in below figure.

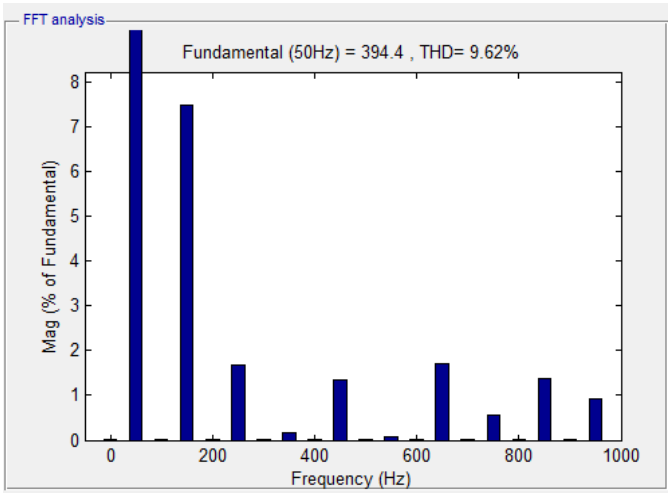

Fig.: 5 THD Response of Phase Voltages For 9level Three Phase Multilevel Inverter

So the above figures provide THD analysis of output voltages of three phases R, Y and B of nine level symmetrical cascaded multilevel inverter. *THD* of the output waveform is found for 9level multilevel CHB inverter for grid-connected PV system is 12.46% that can be seen in the diagrams below.

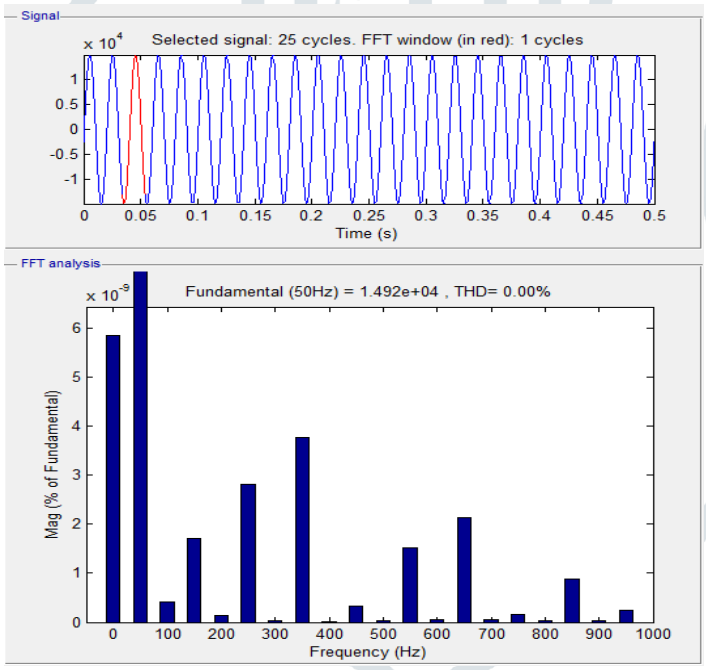

Fig.: 6 THD Analysis of Grid Connected System

The fundamental frequency is taken into account as 50*Hz* for *THD*. Since there's fewer harmonic within the voltage wave form, the MLI will be used directly for the combination of the three-phase grid system. This topology is often applied to high voltage applications by increasing the input DC voltage values.

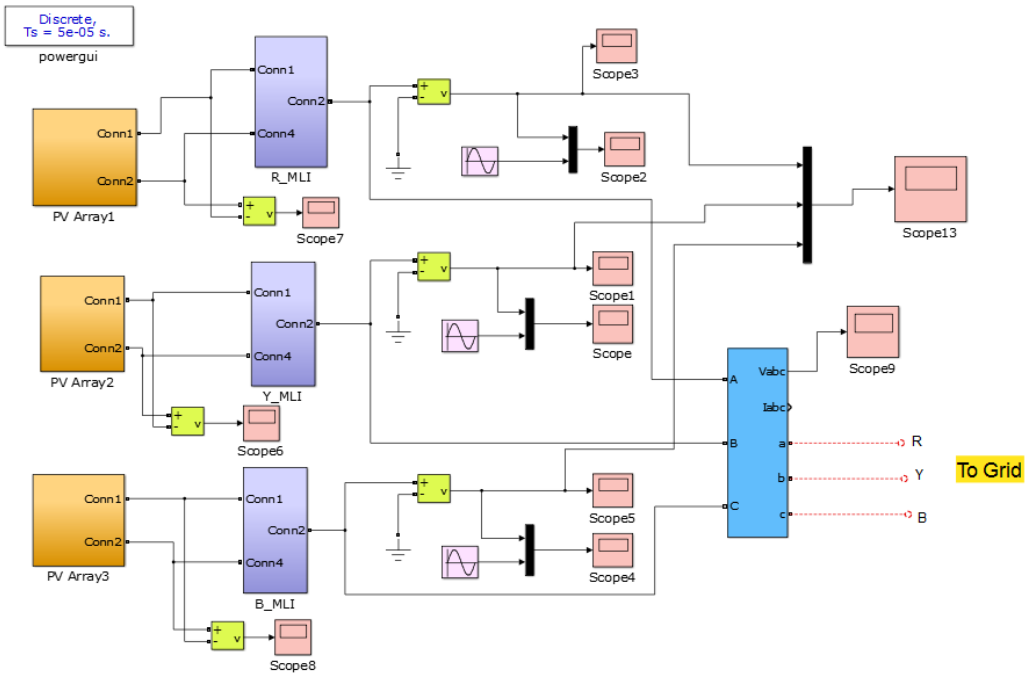

Fig.: 7 Showing Three Phase 9level Multilevel Inverter Topology isolated to Grid

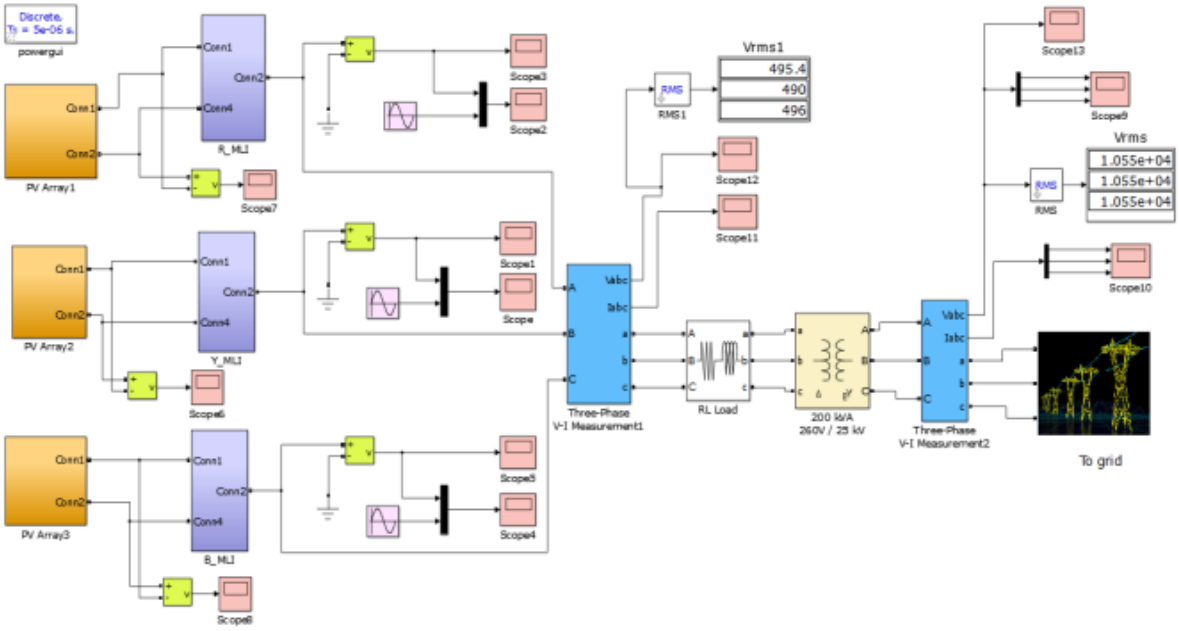

Fig.: 8 Simulation Diagram of Three Phase Grid Connected 9level Multilevel Grid Connected Topology

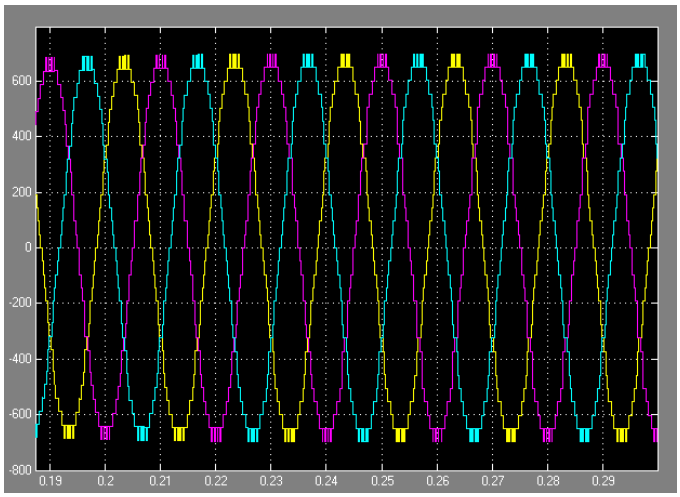

Fig.: 9 Voltage Response of Three Phase Symmetric 9level CHB MLI Connected to PV Arrays

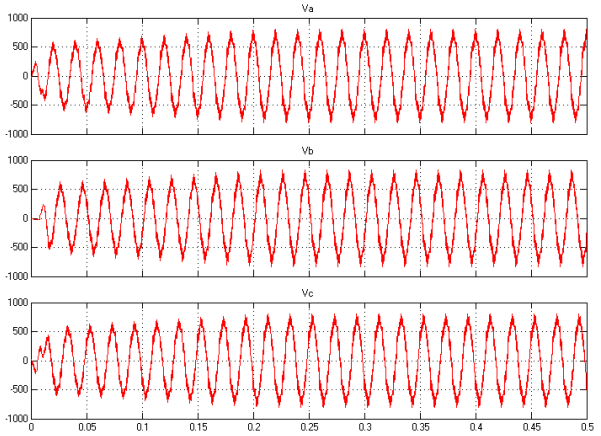

Fig.: 10 Voltage Level of Three Phase 9level Multilevel Grid Connected Topology of V-I Measurement Block1

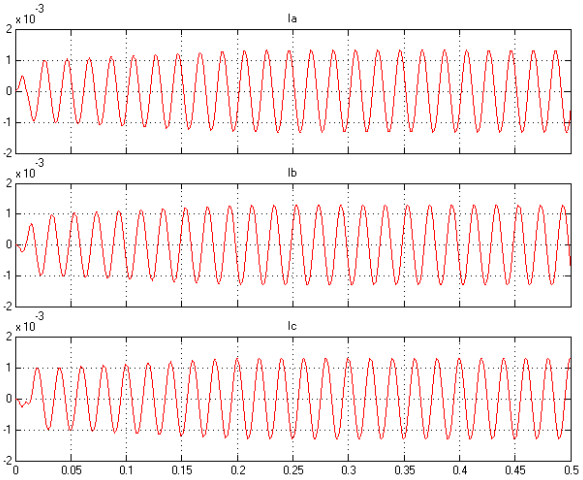

Fig.: 11 Current Level of V-I Measurement Block1 for Three Phase 9level Multilevel Grid Connected System

4. Conclusions

The areas with higher grid access to utilize grid connectivity and the places wherever utility power is deficient more or less a lot of overpriced to bring the ability, don't have any alternative however to prefer their own generation. They may generate power from various sources including the native or local generators by victimizing kind of fossil fuels (diesel, gas) and domestically obtainable renewable energy technologies (solar PV, wind, small hydro plants, biomass, etc.) with or without its own battery storage. this can be referred to as off-grid electricity. Remote power

systems are put in for the subsequent reasons:

i. proper harvest of Renewable i.e., environmentally safe, pollution free.

ii. so as to Combine numerous generating sources available like hybrid power generation.

iii. so to eradicate the unreliable, fault-prone and interrupted grid affiliation.

iv. so as to obtaine storage and back-ups in a proper manner.

v. so as to reduce transmission loss by reducing overhead lines.

vi. so as to enhance the applications and products in the field of power system such as Lighting, Communication Systems, Cooking, Heating, Pumping, Small-scale business utilization etc.

vii. Also, so as to Captivate the power generation is finished primarily considering the replacement of diesel with solar.

To illustrate to the effectiveness of the proposed scheme, various simulation cases have been generated with different combinations and system conditions. Later the proposed scheme was connected to grid and different simulation cases were generated and the optimized combination was selected. So, it has been observed from the study that working performance of CHB MLI scheme and Battery less grid photovoltaic system is best and would be proved to be a better option as compared to isolated hybrid systems in future. Furthermore, considering different sizes of components, it has been found that the addition of PV in the proposed scheme increases the renewable energy penetration and reduces the effect of green house gases. Hence, the size of PV shall be effectively optimized for better system performance. The application of proposed algorithm is further extended for variations in different parameters like temperature, solar radiation and load demands etc.

Additionally, the cascaded inverter provides better response when compared to other multilevel topologies because of absence of the input voltage unbalance and freewheeling diodes. In the cascaded multilevel inverter configuration the output percentage THD we get is very low but not exactly zero because due to this , the level of the inverter reaches infinity which is not a feasible solution for practical realization and hence the level of inverter is made limited to 9levels and the output percentage THD is controlled with the implementation of the proposed PWM technique in 9level CHB multilevel inverter, sinusoidal PWM is a novel modulation technique that is being proposed in the thesis for 9level multilevel voltage source based inverter and simulation is done in the MATLAB/SIMULINK and its working & performance status are analyzed for different levels of multilevel inverter. The output parameters like output percentage THD, Voltage/Current level are analyzed. This modulation techniques tends to provide higher modulation indexes, thus the % THD levels are low so its highly preferable for the practical applications. Switching losses or voltage drop across the switches is controlled by PWM modulation; by the way of switching angle control harmonics is eliminated. The %THD data we obtained was 13.72%for Single phase cascaded MLI and 9.62% for three phase grid connected 9level Cascaded Hybrid MLI respectively.

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