"A Novel Topology for Harmonics Reduction in Photovoltaic Inverter"

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ABSTRACT : This paper analyzes and compares two approaches for dc to ac power conversion. First approach uses cascaded H-Bridge Inverter and second uses new Multi-level Scheme having Level Modules and H-Bridge. The simulation is done in SIMULINK/ MATLAB Software. The Total Harmonic Distortion in output load voltage, active Power and reactive Power produced by both the approaches are compared. It is shown that THD produced in second scheme is better upto a certain stages of the first scheme. And the available active and reactive powers are larger for the second scheme.

I. INTRODUCTION :

Rising fuel costs, increasing concerns for global climate change and a growing worldwide demand for electricity has led to global effort towards increasing use of renewable energy sources such as solar, wind, biomass etc. In case of solar PV the energy is harnessed in dc form. This dc power is converted into ac form and then fed to the grid or used in isolated load. Various methods are available for dc to ac conversion. Multilevel Inverters have gained popularity in recent times. The power quality gets increasingly better with the no. of levels in the output wave. Two approaches for dc to ac conversion are discussed..

A single stage H-Bridge Inverter is shown in Fig. 1. A cascaded multi-level inverter consists of a number of H-Bridge inverter units with separate dc source for each unit and it is connected in cascade or series as shown in Fig. 2.
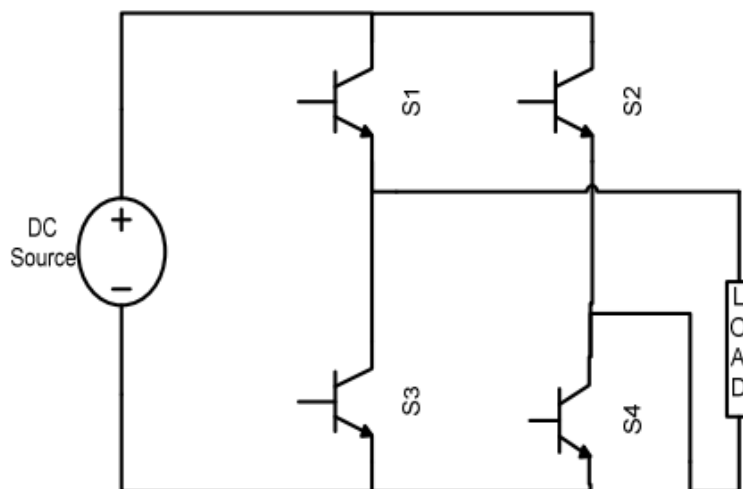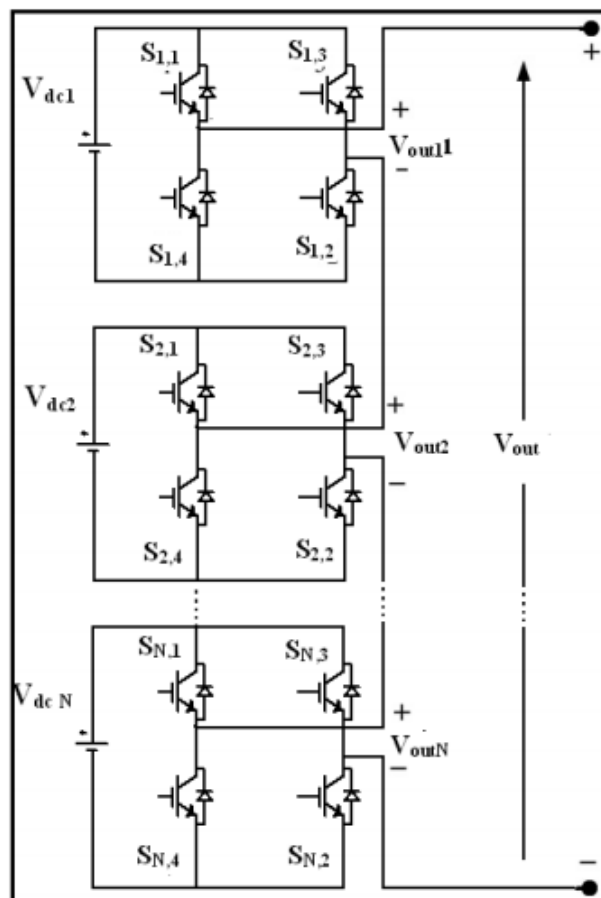

Fig:1single stage H-Bridge Inverter

fig-2 A cascaded multi-level inverter

The THD, Active Power, Reactive Power are calculated for single stage as well as multi stage H-Bridge inverter. SIMULINK/MATLAB software is used for simulation of the circuit. The variation of delay angles α result in variation of THD in load voltage. For a particular delay angle THD is found to be minimum. Further THD reduction is achieved by increasing the stages of the converter.. The simulation will be done upto 8 stages and the THD obtained in voltage is continuously decreasing with the stags.

II. LLITERATURE REVIEW:

Inordertoobtainmultileveloutputvoltage,singlephasemultilevelinverterforusingasavoltageharmonicsource,aswitchingstrategybasedoncalculatingswitchinganglesisexplained.Simulationandexperimentalresultsofmultilevelvoltagewaveformsaregivenfor15,31and127levels.TheproposedtopologyproduceoutputvoltageswithlowTHDvaluesaswellasproducetherequiredharmoniccomponentsontheoutputvoltage.Theoutputvoltageaswellastherequiredspecificharmonicscontrolledbyangles.Withtherequiredharmoniccomponents,theproposedinverterstructureissimulated

forvariousfunctions.ProposedinverterstructurerealizedsimulatedfunctionsandTHDvaluesoftheoutputvoltagewaves[1].Intheareaofhigh-powermedium-voltageenergycontrol,emergedrecentlyasaveryimportantalternativeisMultilevelinvertertechnology.Thispaperdiscussed Emergingtopologieslikeasymmetrichybridcellsandsoft-switchedmultilevelinverters[10].Themostimportanttopologieslikediode-clampedinverter(neutral-pointclamped),capacitor-clamped(flyingcapacitor),andcascadedmulticellwithseparatedcsourcesarepresentshere.MostrelevantcontrolandmodulationmethodsdevelopedforthisfamilyofconverterslikeMultilevelsinusoidalpulsewidthmodulation,multilevelselectiveharmonicelimination,andspace-vectormodulationpresentsinthispaper[2].Multilevellinecommutatedinvertersforrenewableenergysystemshavegainedpopularityinrecenttimes,especiallyinthedistributedgenerationwhereanumberofbatteries,fuelcells,solarcell,andmicro-turbinescanbeconnectedthroughaMLCtofeedthegrid[7].Multilevellinecommutatedinverterscansynthesizehigheroutputvoltagelevelsandcangeneratenearsinu

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Two approaches for dc to ac conversion
A. Cascaded H Bridge Inverter

Conventional cascaded multilevel inverter is one of the most important topologies in the family of multilevel and multi-pulse inverters. The cascade topology allows the use of several levels of DC voltages to synthesize a desired AC voltage. The DC levels are considered to be identical since all of them are fuel cells or photovoltaic, batteries, etc. H-Bridge Inverter consists of four switches, a dc source and a load (Isolated or Grid) across the two arm of H-Bridge. Each switch conducts for a period of 180°. The gate pulses for diagonal switches are identical.

A single stage H-Bridge Inverter is shown in Fig. 1. A cascaded multi-level inverter consists of a number of H-Bridge inverter units with separate dc source for each unit and it is connected in cascade or series as shown in Fig. 2.
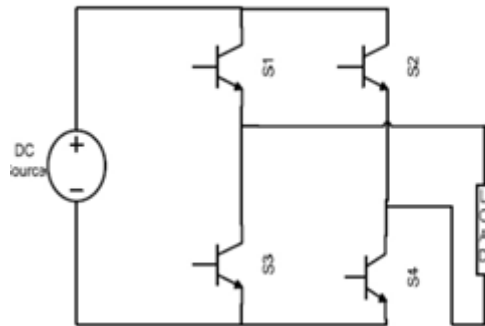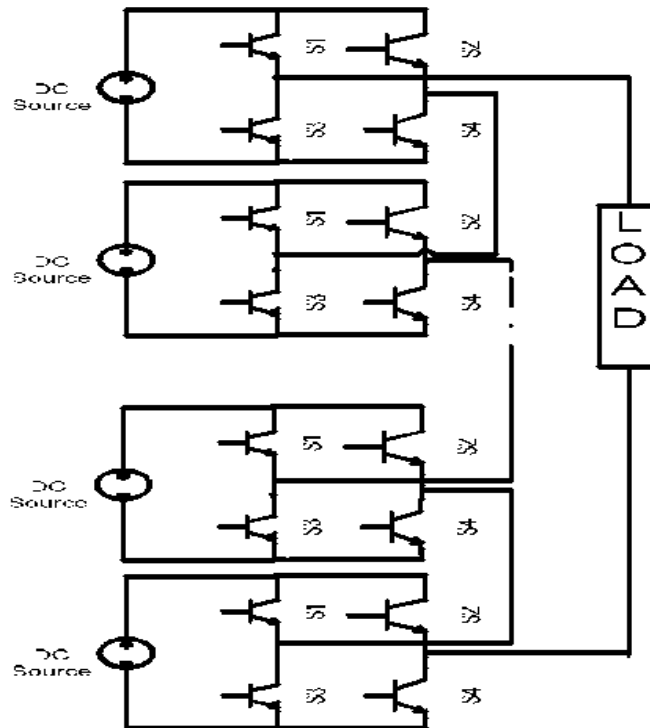

Fig. 1.Single stage H Bridge Inverter

Fig.2. Cascaded Multilevel H-Bridge Inverter

The THD, Active Power, Reactive Power are calculated for single stage as well as multi stage H-Bridge inverter. SIMULINK/MATLAB software is used for simulation of the circuit. The variation of delay angles α result in variation of THD in load voltage. For a particular delay angle THD is found to be minimum. Further THD reduction is achieved by increasing the stages of the converter. For single stage, minimum THD of 48.47% is found for α=30°. While for second stage minimum THD is 29.49% for α1=45°, α2=90°.

If the no. of stages of the converter is increased, the level of the output wave is also increased. In this case, the no. of level is one higher than the no. of stages.

For single stage, output has two levels. For two stages, output has 3 levels and so on. Fig. 3 and Fig. 4 show 3 level and 8 level output voltage waves and load currents respectively. Let the input voltage for single stage V=7 Volt, for two stage V=14 Volt and so on. The simulation is done upto 8 stages and the THD obtained in voltage is continuously decreasing with the stages

Now we have completed work upto 3 stages
Project Methodology:
The proposed multilevel inverter circuit consists of Level Module, H-Bridge inverter, Solar PV Module as dc voltage source and RL load. This load may be an isolated RL or a grid as shown in Fig. 4. The no. of levels of output voltage wave depends on the no. of level module used in the circuit.

No. of output levels

$$n = 2(m+1) - 1$$
where m is the no. of Level Module used.
The no. of switches used in the circuit

$$ns = 2m+4$$
The input dc voltage fed to kth module varies with particular
module number as:

$$Vk = 2(k-1) \cdot Vd$$
Where k =1, 2, 3 … m.
In the proposed circuit, 3 Level modules (LM), 1 HBridge inverter, and 3 Solar PV Arrays of outputvoltage V1 (Vd), V2 (2Vd) and V3 (4Vd) are used. Output wave has 15 levels and the total no. of switches used are 10. Total dc voltage used in the circuit is 7Vd. The gate pulse for first LM switch Q1 is a SPWM pulse having 7 pulses in each half cycle. To find the gate pulses for second LM switch Q2, this pulse is given to the clock of a negative edge triggered toggle flip flop. Further the pulses thus obtained are given to the clock of another toggle flip flop to get gate pulse for third LM switch Q3. The gate pulses for Q1, Q2 and Q3 are shown in Fig. 6.
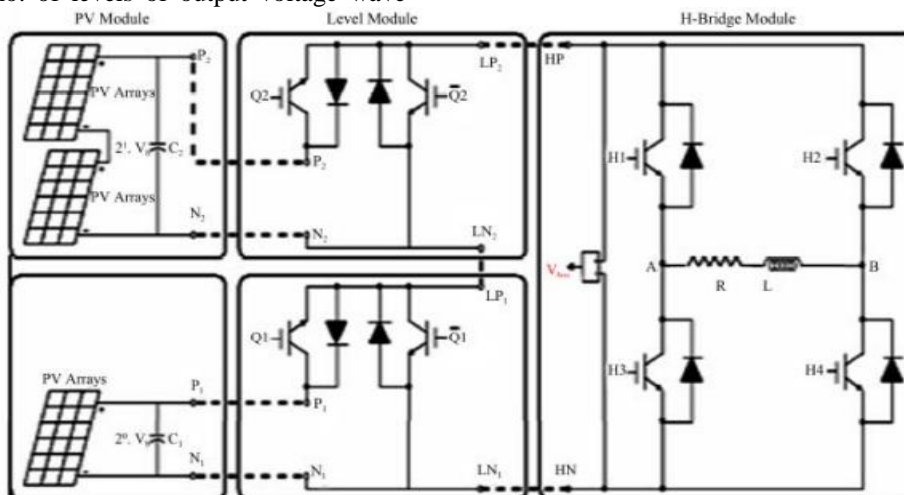

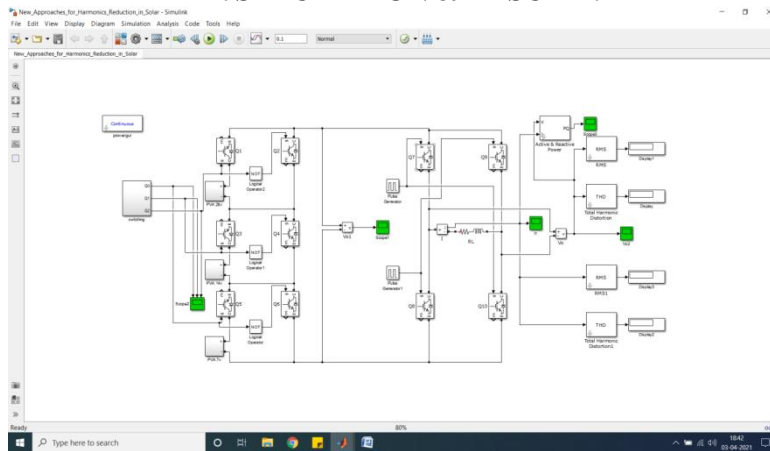Fig. 4 Proposed Multilevel circuit

III. SIMULATION & RESULT :
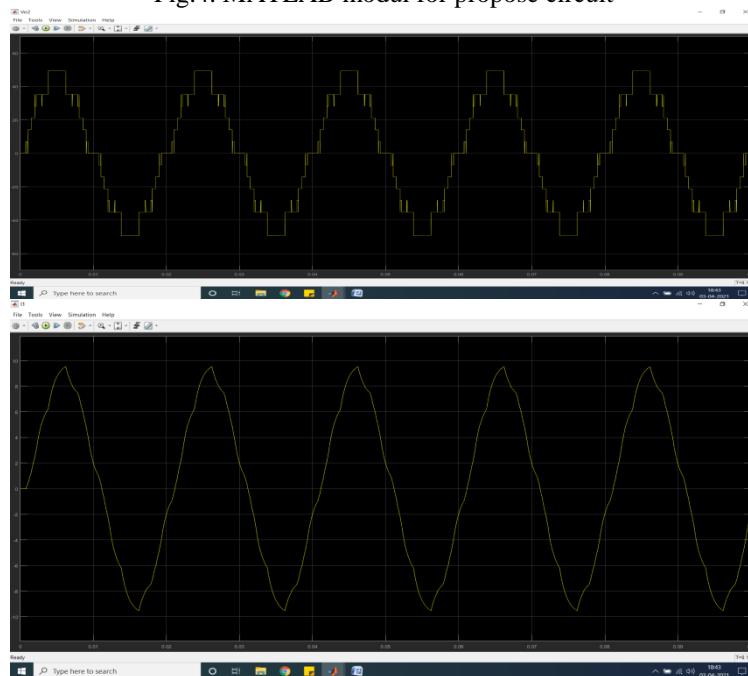

Fig.4. MATLAB modul for propose circuit

Fig5. Load Voltage & Load Current for three level in MATLAB Simulation

IV. CONCLUSIONS:
In this paper, THD in load voltage, Active Power and Re-active Power are evaluated for a proposed inverter circuit with Solar Panel as a dc Source and also a battery using SIMULINK/MATLAB software. The performances are compared for different power factor loads keeping the dc input voltage same without using the filter. In both cases, THD present in load voltage may always be reduced be-low 5% by the use of filter. The THD obtained from proposed inverter scheme is comparable to THD ob-tained from conventional inverter scheme but the no. of switches requiredis less in the proposed scheme.The overall observation is that in the range of pf from 0.8 to 0.85 the performancof PV panel connected inverter is superior to that with pure dc (battery) as input source.

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