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PV Fed Seven-Level Inverter using Fuzzy Control Technique

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Abstract: ***In recent decades, multi level inverter has been playing important role to lessen the total harmonic distortion in the power electronic converters. The number of switches and and its losses have been the critical factor in multi-level inverters. In this Proposed technique, photo-voltaic based seven level inverter has been proposed to adjust the harmonics in the multi-level inverter. This proposed circuit consists of DC to DC converter and capacitor selection circuit. The number of switches utilized is very less and switching loss also less. A part from simulation study, the hardware proves the advantages of proposed system.***

Keywords: Multi-Level Inverter(MLI); Photo-Voltaic(PV); Optimization; Direct Current(DC).

I.INTRODUCTION

To increase the power output the system components of the PV system should be optimized. Maximum power point tracking is the simplest way to get high power from solar panels. P&O and MPPT are widely used due to its ease of implementation [1].This paper publishes a seven level MLI [2].This system evolves two asymmetrically distributed switches; system common-mode voltage is maintained constant with a simple modulation scheme [3].This article explains about recent trending on modelling and control of grid connected photovoltaic energy conversion system [4]. The response of semiconductor switches to perform holding action is the major role [5]. A grid connected photovoltaic system is represented in this paper. This inverter technique holds two single-phase VSI. A PV system is built upon multi-string technology [6].Generation of power by PV panel is ease to fix in residential building and deliver low-voltage grid power flow bidirectional. Manufacturer looks upon PV and grid side to maintain the efficiency and low distortion & academic proposing new ideas soon become state of the art [7].

II.EXISTING SYSTEM

Fig 1 represents DC HFL inverter. In input voltage two level DC-DC converter performs high-frequency chopping to implement electrical isolation and generates an output of high frequency modulation wave uA. The output isw converted into the unipolar modulation wave uB through cycloconverter.

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An isolated dc-dc converter generates three-level modulation wave; the generation of uA through gate pulse and it's switches varies the turns ratio ofdc choper, thefive-level modulation wave uB is produced by uA; uO occurs through filtering.

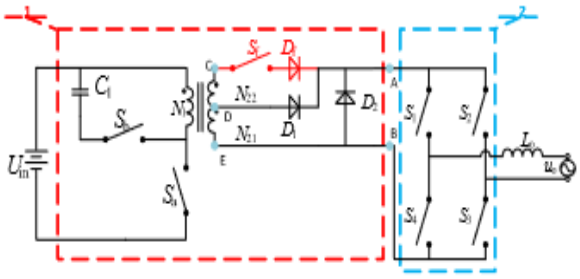


Fig.1 Conventional diagram of DC HFL inverter

By varying conduction state of Sf, the turns ratio of another side also varied dynamically. Now, multi level output is obtained.In the above circuit, the red dotted line indicates an active clamping forward converter and blue dotted line is composed of a full-bridge converter and an output filter inductor.D1 and Df perfom rectification; D2 is the freewheeling diode.

The main drawback of the existing system is core losses become high. The step-up transformer is used in the ratio of 1:10. Input source is battery and it need an additional charge controller to charge the battery.So, the overall cost is too high. In this conventional technique PWM technique is not enough for the future generation. Voltage stress of the switch is to be high. So switching losses is high and collapse the output.

III.FUZZY LOGIC CONTROLLER

The control action and modifications are performed using fuzzy logic control. It response more faster than con ventional method. A simple mathematical model is enough to present this control strategy. A schematic diagram of fuzzy controller is displayed below:

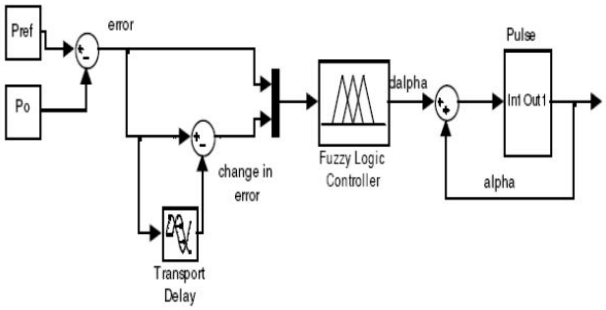


Fig.2Denotes Fuzzy Controller

It does not perform control control action within a single cycle. An adequate number of ways to achieve control are to be less. they are:

- Fuzzification
- Inference engine
- Defuzzification

Fuzzification

Fuzzy variable error signal is translated and some changes done in error signal are assigned with seven fuzzy variables is said to be as negative big (nb), negative medium (nm), negative small (ns), zero (zr), positive small (ps),positive medium (pm) and positive big (pb).Also changes alpha value assigned with seven fuzzy variable. Using sampling interval to calculate changes in error signal.

e = Pref-Pout

Where,

e is the error signal.

Error and changes in error signal are taken as input source. Changes in alpha is same as that of fuzzy controller output.

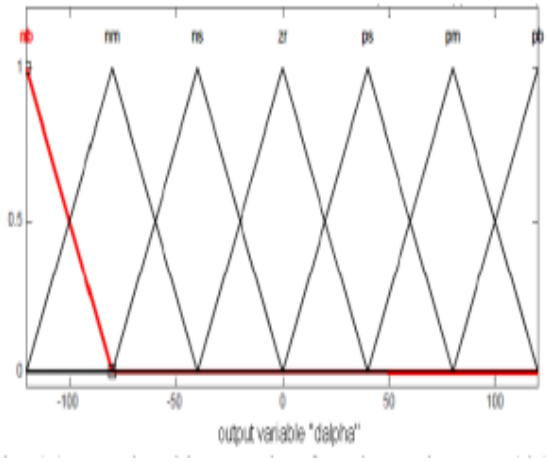


Fig. 3 Changes In Error Signal

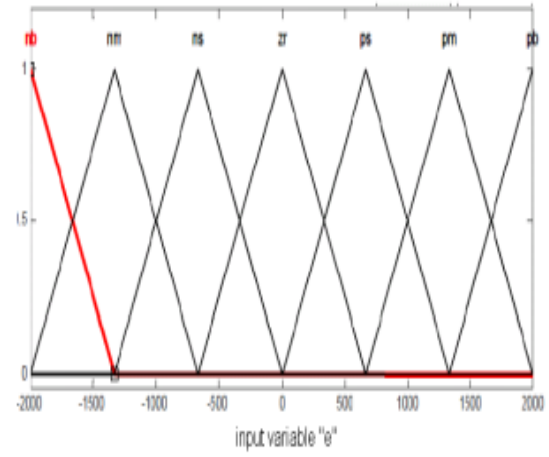


Fig. 4 Changes In Firing Angle

Interference Engine

It involves two steps: fuzzy rule base, fuzzy implication**.** This section performs three functions namely applying fuzzy operator, applying fuzzy implication and aggregating all outputs.In interface engine the rule base is apllied on fuzzified input and its output is identified by fuzzy implication.

Defuzzification

It generates a single numbered output.

IV.PROPOSED TOPOLOGY

The proposed system comprised of a cascaded connection of capacitor selection circuit and a full-bridge power converter. Its operation is broadly classified into two categories: positive half cycle and negative half cycle. For analytic purpose, we assumes that diode is said to be ideal and energy storage element stores energy as 2Vdc/3, Vdc/3. The output of pv panel is contolled in sinusoidal way and maintains it in phase with the utility voltage. In positive half cycle the output current of the seven-level inverter tends to be positive and it's opeartion is divided into four modes respectively.

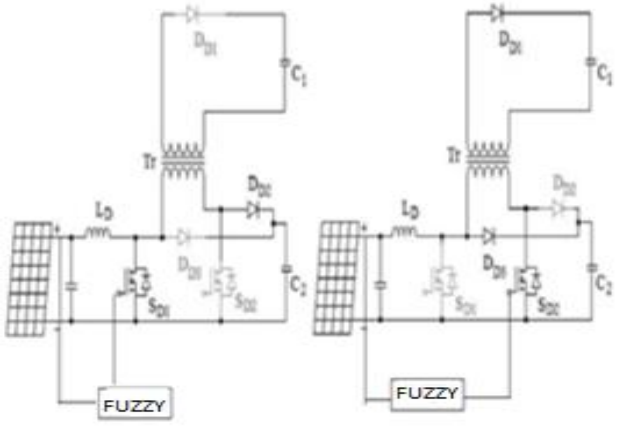


Fig. 2 Operation of dc–dc power converter: (a)SD1 switched on and (b) SD1 switched off

Both inductor and LD are energised by switching action of SD1 as shown in fig.2(a) . Fig.2(b) show off condition of SD1. Both capacitors are connected in parallel by transformer. During off condition of SD1, LD and pv panel energise C2 via DD3; C1 energised via transformer and DD1. By charging both capacitor at same instant, voltage ratio is same as that of turns ratio.

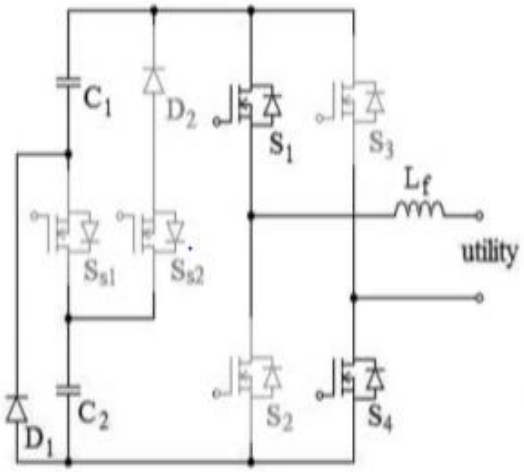


Fig. 3 (a) Mode 1

Mode 1: Both S1 & S4 are switched on. Now SS1 and SS2 are switched off. These conditions makes diode is to conduct and C1 starts to discharge. Both capacitor selection circuit and MLI experiences an voltage magnitude of Vdc/3.

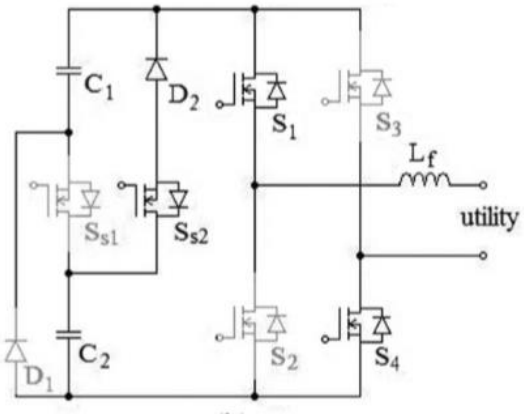


Fig. 3 (b) Mode 2

Mode 2: both S1 and S4 are switcched on. SS2 is able to conduct and SS1 is turned off. In this condition C2 starts to discharge through D and SS2.The total amount of output voltage at capacitor selection circuit is 2Vdc/3 and also the output voltage of MLI also equivalent to that capacitor selection output voltage.

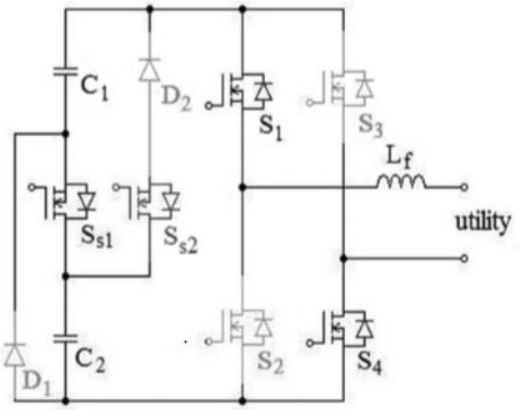


Fig. 3 (c) Mode 3

Mode3:The switches S1 & S4 are turned on and D become reverse biased. SS1 is switched on and SS2 IS either switched on or off. Capacitance C1 & C2 disharge at same time and the voltage magnitude of capacitor become V_{dc}. The output of MLI turns to be Vdc.

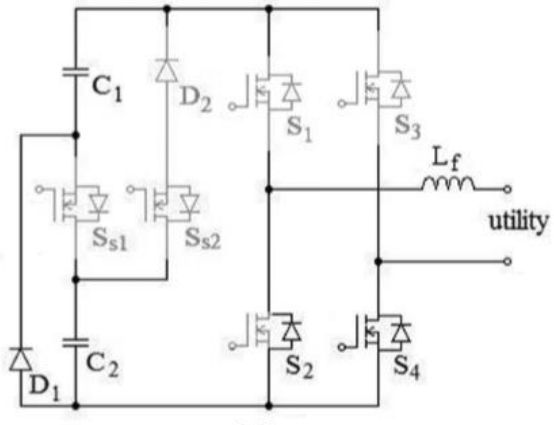


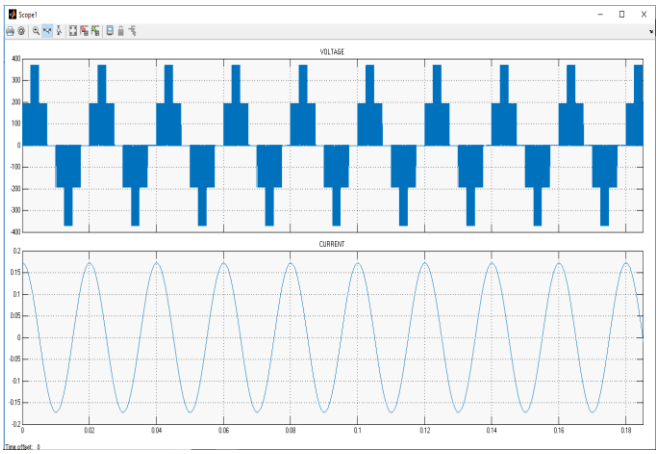
Fig. 3 (d) Mode 4

Mode 4: The capacitor selection circuit exzperiences Vdc/3, when SS1 & SS2 are switched off. Only S4 is ON ; after thatthe inverter stimulates an positive output current in nature.it flows hrough the filter inductor and enables the S2 to turn on continuous conduction of the filter inductor current.Now inverter output voltage tends to zero.

According to various modes of operation the output voltage of positive half cycle turns to be Vdc/3, 2Vdc/3, Vdc, 0.

V.RESULT AND DISCUSSION

The output voltage and current wavform of the five level inverter has been depicted in the figure 1. The 400V five level voltage is produced in the existing system with the help of DC-DC Converter.The dc chopper rise and low the input. produced from photo-voltaic array. The 0.18A current has been produced from this circuit. In the negative half cycle, it offers negative current. It's performance is divided into four different modes. Figure 3 visualizes apppearance of capacitor selection in postive and negative half cycle capacitor is more or less same.



The FFT Analysis for the output current has been done in the Matlab. This existing system has produced 1.72% total harmonic distortion. The analysis has been done from 0.15s to 0.168s for one cycle with 50Hz. The amount of THD in existing system is depicted in figure 4

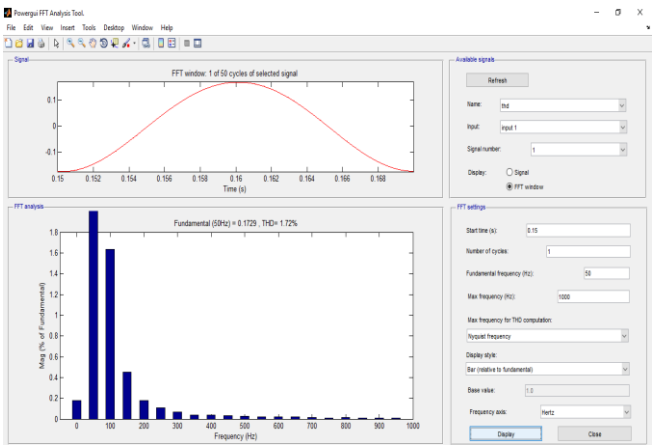


Fig. 4 Visualize THD Analysis

The simulation configuration is depicted in the figure 5. This circuit has been designed using simulink and simscape toolboxes in the Matlab Software.

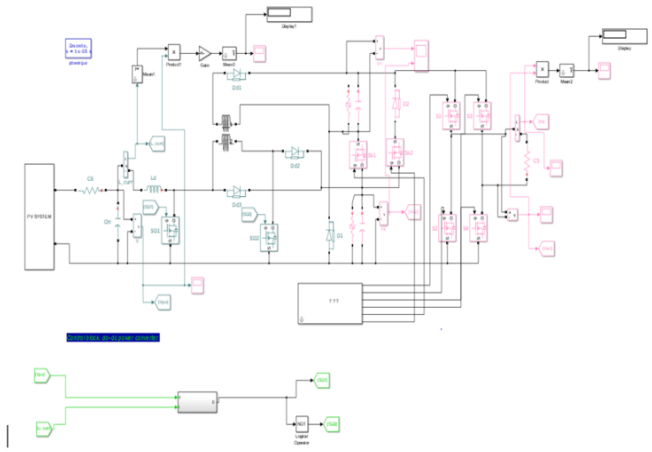
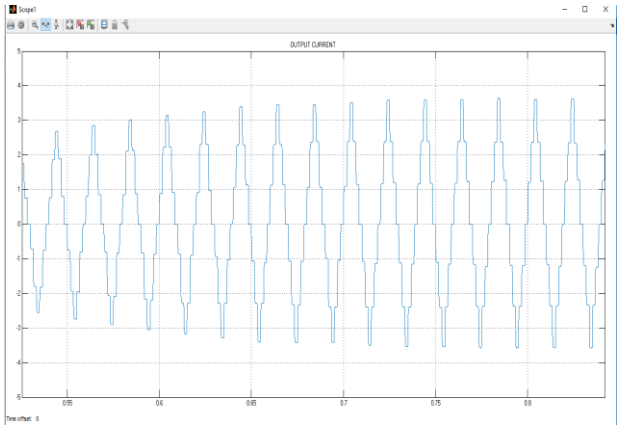


Fig. 5 Shows Simulation Circuit Diagram

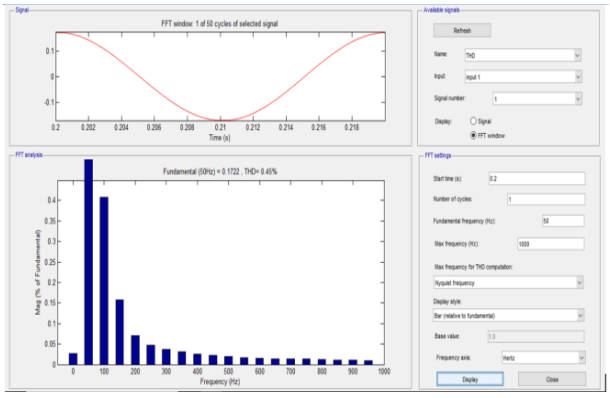
Current Waveform



The above waveform explains about current waveform of an proposed system. An output voltage is always be in a stepped structure.

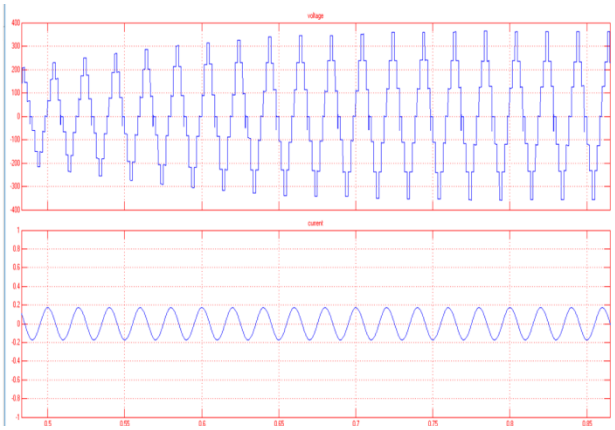
THD Analysis

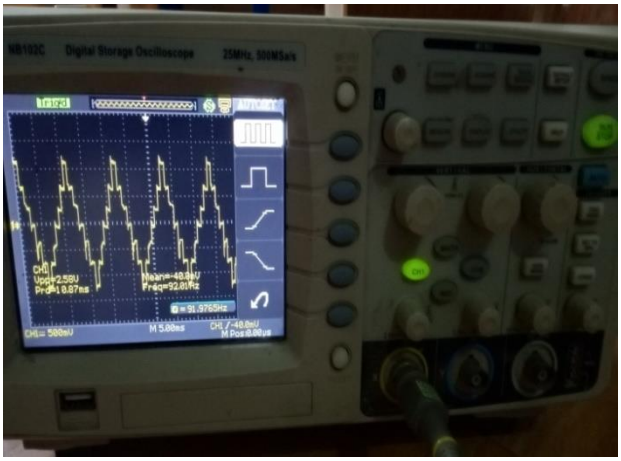
The following figure represents the total harmonics distortion waveform. The harmonics content become in proposed system and it is said to be 0.5 in nature.



Voltage Waveform

In this below picture, the output voltage waveform of 7-level MLI is shown.





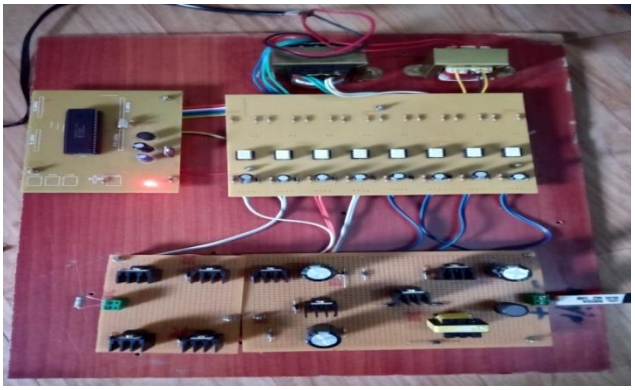
The ouput waveform of hardware is determined or observed from Cathode ray oscilloscope(CRO).

SL.NO	PARAMETERS	EXISTINGSYSTEM	PROPOSED SYSTEM
1	Input Voltage	400W	160V
2	Output Voltage	385v	285v
3	Number Of Levels	5	7
4	THD	1.74%	0.45%
5	No Of Switches	7	8
6	Efficiency	76%	88%

The efficiency, THD, No. of semiconductor devices and are details are seen from the above table.

Hardware Picture

The below picture briefly explains about seven level multilevel inverter. it comprised of bidirectional switch, energy storage device, PN junction diode. A diode can allow current to flow only in forward conduction mode in this case, we use diode IN4007. Capacitor act as a filter and it removes harmonics and distortion. MOSFET plays a vital role in MLI operation.



VI.CONCLUSION

In our system Total Harmonic Distortion (THD)was efficiently reduced using seven level MLI with less number of power electronic switches, simple structure, and lower switching losses. The FUZZY optimization has been applied to optimize specific parameters in the power electronic converter. In MATLAB/SIMULINK software, we done simulation of proposed system. The performance of the proposed circuit has been validated with the help of hardware results and comparison table.

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