SUPERIOR PERFORMANCES OF DIFFERENT NEW MULTILEVEL INVERTER TOPOLOGY WITH DISPARATE PULSE TECHNIQUES

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ABSTRACT

This paper establish the Analysis& designing of a new multilevel inverter topology with reduced number of DC source and power switches and further comparing using PWM technique. Through various PWM techniques like NLT, PD, POD and APOD, Comparison is 31 level multilevel inverter using various PWM technique to analysis there characteristics. The analysis PWM technical configured with V_{rms} , I_{rms} with high efficient, less THD harmonic profile and cost efficient. The nearest level modulation technique is introduced with different DC offset value to evaluate the voltage harmonic at the load. The validation is done for presented PWM technique by using simulation software MATLAB/Simulink and laboratory based experimental test.

Key words: NLT, PD, POD and APOD.

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1. INTRODUCTION

Now a days the energy requirement is increasing due to the industry and consumer requirement as increased because of that energy generation as start to move towards the renewable energy like wind, solar etc this is the reason inverter and converter as been playing a big role in converting DC into AC current With the expansion independency on sustainable power source, there is a tremendous increment in the accessibility of segregated DC power sources. This DC power sources can be associated in arrangement or corresponding to expand the voltage level or current ability. The DC power created is to be changed over to AC source because of the transcendence of AC hotspot for transmission and family application .Through using MLI asymmetrical function we can able to reduce the switches and sources by designing the new switching positions and source arrangements by using this method various level can achieve like 7,9,15 and 31-level through various pwm topology like NLT,PD,POD

and APOD through using the novel multilevel inverter method high THD, low efficiency as been overcome easily and help to achieve high efficiency. In phase disposition the carrier wave as the same path and in same direction, phase opposite disposition the carrier wave as change the path after each 180 degree , In alternative phase opposite disposition as change the carrier signal path in each cycle. The supply voltage as been given to the multi level inverter (MLI) as been control through this above PWM techniques.

2. EXISTING TOPOLOGY

2.1. Seven Level Inverter

The seven level inverter shown in Fig 1 and the existing topology with various asymmetric PWM technique for this nearest level technique is used it as work using different DC offset value by changing the DC value by comparing with the reference value with two different DC source as 100v and 200v and six switches as been used S1,S2,S3,S4,Sa and Sb where the switching operation as been given clearly in table and the load resistor as been connected parallel to the switches.

Figure 1 Circuit diagram of 7- level inverter

The switching topology of several level inverter as been shows the function which the operation of each switches in both ON and OFF for both positive and negative switching operation given in table 1.& Fig 2.

Table 1 for 7- level switching operation

S1	S2	S3	S4	Sa	Sb	Digital
1	0	0	1	0	1	100
0	1	1	0	0	1	110
1	0	1	0	0	1	111
0	1	1	0	1	0	100
1	0	0	1	1	0	110
0	1	0	1	1	0	111

The seven level simulation waveform for the final AC output voltage with the peak voltage of 300v in the time period of 0.1sec where time in sec as X-axis and voltage (V) as Y-axis.

Figure 2 level output waveform

The testing for THD represented in fig 3 is done by selected signal of generated 5 cycle this FFT analysis is done for 3 cycle seven level switching waveform with the frequency of 305.8 to the THD =12.31% based on the frequency of 50Hz to the maximum frequency of 2500Hz range the peak voltage of 300v in positive half and -300v in negative half cycle where the 0 is the start time point. This is 7-level in using the nearest level technique through the various dc offset value of 0.5 to 3.5 in positive and -0.5 to -3.5 in negative cycle.

Figure 3 THD for 7-level inverter using NLT

2.2. 9 - Level Inverter

The nine level inverter as been used existing topology with various asymmetric pwm technique for this nearest level technique is used it as work using different DC offset value by changing the DC value by comparing with the sin wave value with three different DC source as 100v,100v and 200v and eight switches as been used S1,S2,S3,S4,S5,S6,Sa and Sb where the switching operation as been given clearly in table and the load resistor as been connected parallel to the switches through the nine level inverter we can reduce the THD total harmonic distortion is improve and reduce the THD this circuit as extra two then the 7-level this switches are represented S5 and S6 this as connected in between the dc source V1 and V3 this as the voltage of 100v and 200v respectively.

Figure 4 Circuit diagram of 9-level inverter using NLT

The Ac output voltage for the 9-level inverter (shown in fig 4) is 400v in the positive half cycle and -400v in the negative half cycle this as the dc offset of 0.5 with the 100% modulation index this as each pulse stand for 100 volt each cycle complete in the time period of 0.02. This as voltage (V) as a X-axis then time(sec) as a Y-axis.

Figure 5 9-Level output waveform

The testing for THD is done by selected signal of generated 5 cycle this FFT analysis is done for 4 cycle nine level as shown in the fig 5 & switching waveform with the frequency of 378.1 to the THD =9.90% based on the frequency of 50Hz to the maximum frequency of 1000Hz range the peak voltage of 400v in positive half and -400v in negative half cycle where the 0 is the start time point represented in the fig 6. This is 9-level in using the nearest level technique through the various dc offset value of 0.5 to 4.5 in positive and -0.5 to -4.5 in negative cycle.

Figure 6 THD for 9- level inverter using NLT

2.3. Fifteen Level Inverter

The 15-level inverter as been used existing topology with various asymmetric PWM technique for this nearest level technique is used it as work using different DC offset value by changing the DC value by comparing with the sin wave value with three different DC source as 100v, 200v and 400v and eight switches as shown in the fig 7 and it has been used S1, S2, S3, S4, S5, S6, S7, S8, Sa and Sb where the switching operation as been given clearly in table and the load resistor as been connected parallel to the switches S1, S2, S3 and S4 through the fifteen level inverter we can reduce the THD total harmonic distortion is improve and reduce the THD this circuit as extra two then the 9-level this switches are represented S7 and S8 this as connected in between the dc source V1 and V3 this as the voltage of 100v and 400v respectively. This circuit diagram as shown in the fig 7 the voltage V2 is connect in the negative side with the S3 and S4 in the positive side. This IGBT switches are H- bridge connect with the load resistor.

Figure 7 Circuit diagram of 15-level inverter using NLT

In ac output voltage for the 15-level inverter this as a peak value of 700v in the positive half cycle and -700v in the negative half cycle and one zero pulse this as the dc offset of 0.5 with the 100% modulation index this as each pulse stand for 100 volt each cycle complete in the time period of 0.02 sec. This as voltage(V) as a X-axis then time(sec) as a Y-axis. This waveform as seven positive level and seven negative level is represented in fig 8.

Figure 8 15- level output waveform

The testing for THD is done by selected signal of generated 5 cycle this FFT analysis is done for 4 cycle fifteen level switching waveform as shown in the fig 9 with the frequency of 707.8 to the THD =5.39% based on the frequency of 50Hz to the maximum frequency of 1000Hz range.

Figure 9 THD for 15 - level inverter using NLT

2.4. Comparison the Resulted Value with Existing Value

Through the above techniques the nearest level technique is been compare with the existing topology result from the basic paper by comparing the THD, Irms and Vrms value through this function various value are take from Bhogeswara RaoAngara, M.M.Tripathi “Novel design of cascaded multilevel inverter with reduced number of components”978-1-4673-6540-6/15/31.00 ©2015IEEE . this value are taken for 0.5,0.45,0.4,0.35 etc with the dc offset value this as clearly shows the better result compare with the base paper shown below in the table 2 & 3.

Table 2 & 3 Shows the comparison of RMS value & THD with the existing topology

Value	Vrms(new)	Irms(new)	Vrms	Irms
0.5	227.7	227.7	217.7	217.7
0.45	227.9	227.9	217.9	217.9
0.40	228.3	228.3	218.1	218.1
0.35	228.6	228.6	218.3	218.3

Level	THD	THD(new)
7-Level	11.86	11.65
9-Level	10.13	10.08
15-Level	8.18	5.39

The THD value for different level is also calculated with the existed only there show the better result in higher level like 15,9 and 7 levels respectively there result are given above which as been compare with the existing topology.

3. PROPOSED TOPOLOGY

3.1. 31- Level Inverter Using Different PWM Techniques

The 31- level inverter as used to reduce the harmonics which as eight switches where four switches are connected series with the four source next to each switches the basic H-bridge as four switches the load resistor as connected with parallel there are four diode connected in series which is help to current flow without any short circuit between the switches there are four DC source DC 1,2,3 and 4 it as the voltage of 24,48,96 and 192 volt. This circuiting is same for PD, POD and APOD used in different PWM techniques mentioned as fig 10 respectively.

Figure 10 Circuit diagram for 31- level inverter

3.2. Various PWM Techniques

PD -This is the one of the method and the techniques and the working principle are shown in the fig 11 in pulse width modulation techniques' which as been comes under the asymmetric PWM signal. Here the carrier signal as above zero they are in the same path.

POD -This is the one of the method in pulse width modulation techniques' which as been comes under the asymmetric pwm signal. Here the phase as been changes after 180° degree.

APOD -This is the one of the method in pulse width modulation techniques' which as been comes under the asymmetric pwm signal, The carrier signal change in both positive and negative stages.

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Figure 11 Circuit diagram of 31- level MLI using various PWM

This table 4 shows the digital function of each switches both on and off by denote with the binary digit 0 and 1 switches as some specific function S1,S2,S3 and S4 as continues switching operation but switches H1,H2,H3 and H4 are used from the current flow path during the positive cycle the H1 and H2 are in ON but H3 and H4 are in OFF but in negative H3 and H4 are in ON and the corresponding PD output waveforms are described in the fig 12 & 13 respectively.

Table 4 -31 level inverter switching operator positive cycle

S4	S3	S2	S1	H1	H2	H3	H4
0	0	0	0	1	1	0	0
0	0	0	1	1	1	0	0
0	0	1	0	1	1	0	0
0	0	1	1	1	1	0	0
0	1	0	0	1	1	0	0
0	1	0	1	1	1	0	0
0	1	1	0	1	1	0	0
0	1	1	1	1	1	0	0
1	0	0	0	1	1	0	0
1	0	0	1	1	1	0	0
1	0	1	0	1	1	0	0
1	0	1	1	1	1	0	0
1	1	0	0	1	1	0	0
1	1	0	1	1	1	0	0
1	1	1	0	1	1	0	0
1	1	1	1	1	1	0	0

3.3. PD Output Waveforms

Figure 12 & 13 Shows the ac output voltage & current waveform using PD

3.4. FFT Analysis of PD

Figure 14 THD analysis for ac output voltage

Figure 15 THD analysis for ac output current

The FFT analysis of output voltage and current for the 31 level inverter as been below where the THD of output voltage is 3.99% at the frequency of 352.8HZ in the range of 1000HZ as maximum frequency during the starting period the FFT analysis is maximum

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same for current as the frequency 7.063HZ as the THD of 3.99% the peak value as 7 in positive and -7 in negative and the analysis reports are represented in the above fig 14 & 15

3.5. POD Output Waveform

Figure 16 & 17 Shows AC output current & voltage waveform using POD

The current output waveform with X-axis as current (A) and Y-axis as time (sec) which as the peak current of 7A in positive and negative peak current as -7A for a cycle as the time period of 0.02sec as shown in the fig 16 & 17 respectively.

3.6. FFT Analysis of POD

Figure 18 THD analysis for Ac output voltage

Figure 19 THD analysis for Ac output current

The FFT analysis of output voltage and current for the 31-level inverter as been below in the fig 18 & 19 where the THD of output voltage is 3.99% at the frequency of 352.8HZ in the range of 1000HZ as maximum frequency during the starting period the FFT analysis is maximum same for current as the frequency 7.063HZ as the THD of 3.99% the peak value as 7 in positive and -7 in negative respectively.

3.7. APOD Output Waveform

AC Output Current & Voltage

Figure 20 & 21 Shows AC output current & voltage waveform

This waveform as output waveform in the fig 20 for the alternative current X-axis as output voltage and Y-axis as time with the peak voltage 360v at the time duration of 0.1sec for a complete cycle each cycle as the time duration of 0.02sec for negative half the peak value is -360v.

The current output waveform in fig 21 with X-axis as current (A) and Y-axis as time (sec) which as the peak current of 7A in positive and negative peak current as -7A for a cycle as the time period of 0.02sec.

3.8. FFT Analysis of POD

Figure 22 THD analysis of Ac output voltage

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Figure 23 THD analysis of Ac output current

The FFT analysis in fig 22 & 23 of output voltage and current for the 31- level inverter has been shown below where the THD of output voltage is 3.99% at the frequency of 352.8HZ in the range of 1000HZ as maximum frequency during the starting period the FFT analysis is maximum same for current as the frequency 7.063HZ as the THD of 3.99% the peak value as 7 in positive and -7 in negative and the analysis reports represented and the table 5 shows the comparison of existing topology levels.

Table 5 Comparison with the existing topology

NAME	THD	THD(EX)	SWITCHES	SWITCHES(EX)	SOURCE	SOURCE(EX)
PD	3.99	4.05	8	10	4	5
POD	3.99	4.15	8	10	4	5
APOD	3.93	4.17	8	10	4	5

3.9. Comparison with the Existing Topology Result

At the modulation index 100% this paper has been compared and also having better results with the various level like 7, 9 and 15 is also as better THD with the 31 level and it has a better value than PD, POD and NLT. The alternative phase opposite disposition is used for hardware implementation due to it as the THD 3.93% which has been improved for the existing basic paper Shubham Kumar Gupta(1), Kuldeep Rathore(2) and Praveen Bansal(3) "Design and Analysis of a New 31-Level Asymmetrical Inverter Topology with Different PWM Techniques" 978-1-5386-6472-8/18/31.00 ©2018 IEEE.

4. HARDWARE RESULT

4.1. Hardware Implementation

Table 6 Hardware components details

NAME	DETAILS	RANGE
MOSFET	IRF250	12V-15V
MICROPROCESSOR	DSPIC30F2010	5V
IC(PHOTODIODE IC)	TLP250	5V-15V(AC)
VOLTAGE REGULATOR	IC7805	5V
CRYSTAL OSCILLATOR	PLL	10mH-20Mh
TRANSFORMER	Transformer	230V/12V

This hardware has been implemented and the details are shown in table 6. Using alternative phase opposite disposition which as three multi tapped transformer with 7 tapping which is help to converter 230v into 12v this switches are operate at the range of 12 to 15 volt which as the micro controller to implement the switching operation and it as different voltage 6,12,24 and 48 volts for the four dc source to convert the ac source into dc source four diodes are connected in series ask as power source for the MLI the switch as been connected with heat sink to reduce the switching loss and the hardware design for 31–level is shown in the fig 24.

Figure 24 Hardware design for 31-level MLI using APOD **Figure 25** Output waveform for ac output voltage and current

4.2. AC Output Waveform

This both output waveform of voltage and current with the peak voltage of 46v and -46v in negative it as the better results in fig 25

5. CONCLUSION

Here various novel topology has been analysed with different PWM techniques like PD,POD & APOD and the results are tabulated with various parameters like RMS voltage, current & THD and its found that new PWM techniques gives better results compared with earlier PWM techniques imposed on the topologies. From this results this PD,POD & APOD PWM techniques are tested on new design 31- level novel multilevel inverter topology which has advantages' like low power components and enhanced performances like least THD value and better RMS voltage and current at APOD PWM techniques ,compare to existing topologies and the results are evident using matlab simulation and validated using hardware output.

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