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Comparative Study of Different Types of Asymmetrical Multi-Level Inverter

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***Abstract*—In this paper a comparative study of different types of asymmetrical multi-level inverter is carried out. The inverters are designed to produce 31 levels from four independent different constant voltage level dc sources (asymmetrical sources). The paper focuses on asymmetric 31-level inverter, in general any number of levels can be obtained. A sine pulse width modulation (SPWM) technique is used for switching operation. The converters are simulated using MABLAB/Simulink software and the number of switches required, output voltage/current and the total harmonic distortion (THD) are compared.**

Keywords—Asymmetrical multi-level inverter (AMLI); Sine pulse width modulation (SPWM); Total harmonic distortion (THD)

I. INTRODUCTION

There are lot of research is going on in the field of converter design. This is mainly due to the increase in energy demand and a suitable device (converter) is required to convert the available energy in to useful electrical energy in order to fill the gap between demand and supply. The converters are classified depending upon various factors. Depending up on number of levels converters are classified as; two-level converter or rectangular converter and a multi-level converter.
Cascaded converter is one of the type of multi-level converter, in which number of converters are cascaded to obtain multi-levels. Multi-levels can also be obtained by other methods like using multiple sources together with few switches and diodes. If the multiple sources used are all have same voltage then it is called symmetrical sources and if the voltage values of all the input sources have different values then it is called asymmetrical sources.

Symmetrical sources produces less number of levels when compared with the asymmetrical sources both using same number components [1]. As the number of voltage levels increases there is will be an efficient amount reduction of THD in the output. Use of asymmetrical sources has more advantage comparing to symmetrical sources and the asymmetry selected among the sources should be optimal [2].

In this paper a comparative study is made between cascaded asymmetrical multi-level inverter asymmetrical multi-level inverter. Both the converting systems are taking input from same number of asymmetrical sources. The explanation of these converting systems is explained in section II. Simulation of the converters are carried using MATLAB/Simulink which is explained in section III. In section IV results and discussion is made supplementing the comparison of the two converts. Conclusion is made in the succeeding section.

II. ASYMMETRICAL MULTI-LEVEL INVERTER (AMLI)

A. *Type - 1: Cascaded AMLI*

The Fig.1 shows the block diagram of cascaded AMLI which takes input from number of symmetrical dc sources. Each dc input source is provided with an inverter to invert the input dc voltage. These inverters are connected in cascade form and their duty cycle is controlled to obtain output voltage/current having multi-levels.

Fig.1: Block diagram of Cascaded AMLI (Type-1)

The Fig.2 shows the circuit diagram of the Cascaded AMLI (Type-1), that has 16 switches.

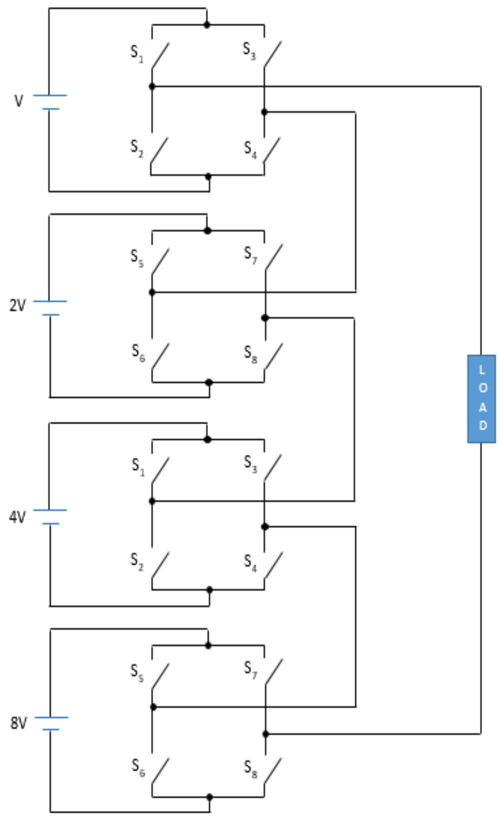

Fig.2: Circuit diagram of Cascaded AMLI (Type-1)

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B. Type -2: AMLI

The Fig.3 shows the block diagram of AMLI which takes input from number of asymmetrical dc sources. Each dc input source is provided with additional switches to obtain desired number of levels in output voltage/current. By controlling the switching frequency of these additional switches maximum number of output levels can be achieved. The output of asymmetrical converter will be of the form of output of half bridge rectifier, this is then inverted in an unfolding inverter to obtain ac output voltage/current which is having multi-levels.

The Fig.4 shows the circuit diagram of the AMLI (Type-2), that has 8 switches and four diodes.

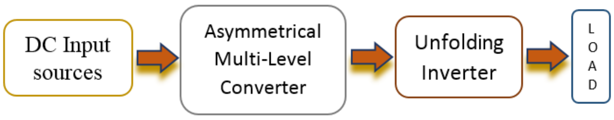

Fig.3: Block diagram of AMLI (Type-2)

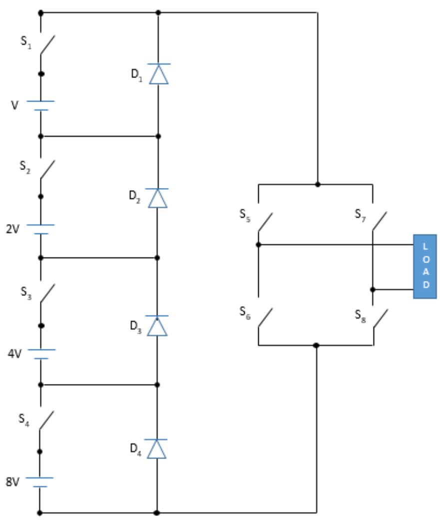

Fig.4: Circuit diagram of AMLI (Type-2)

III. SIMULATION OF AMLI

There are two types of AMLIs are simulated and studied in this paper. The simulation of both the converters are done in MATLAB/Simulink software. The simulation of those converters are explained in detail later in this section.

A. Type – 1

The converter takes input from four asymmetrical sources of voltages, 10V, 20V, 40V, and 80V. Each of these sources are provided with an inverter and these inverters are connected in cascade. Each of these inverter has four switches, in total there are 4 inverters and 16 switches. The Fig.5 shows the simulation model of cascaded AMLI (type-1).

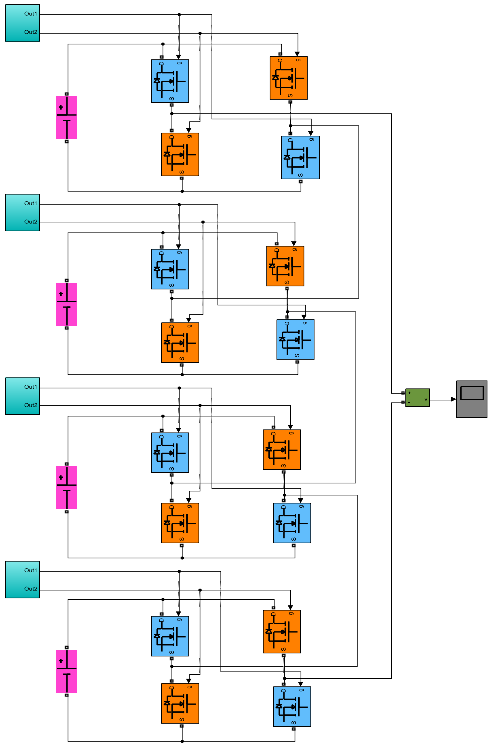

Fig.5: Simulation model of cascaded AMLI (Type-1)

Inverter one has switches S1, S2, S3, and S4, second inverter switches are S5, S6, S7, and S8, third inverter switches S9, S10, S11, and S12, and fourth inverter switches S13, S14, S15, and S16 respectively. The duty cycle of these switches are controlled to get the multi-levels at the load side. The gate pulses of these switches are shown from Fig.6 to Fig.13.

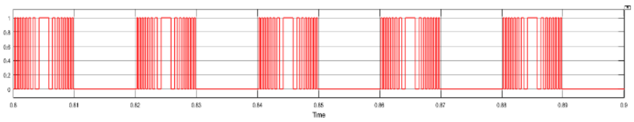

Fig.6: Gate pulses of switches S_1 and S_4 (type-1)

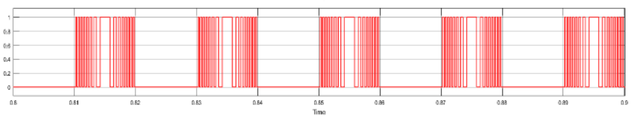

Fig.7: Gate pulses of switches S_2 and S_3 (type-1)

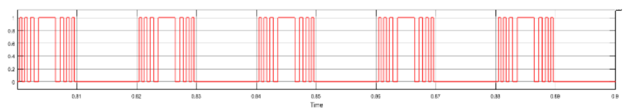

Fig.8: Gate pulses of switches S_5 and S_8 (type-1)

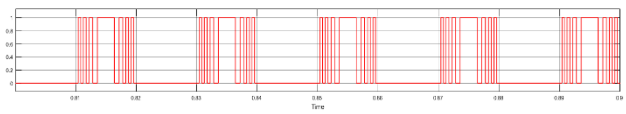

Fig.9: Gate pulses of switches S_6 and S_7 (type-1)

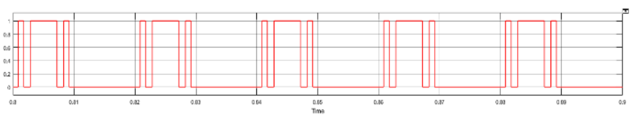

Fig.10: Gate pulses of switches S_9 and S_{12} (type-1)

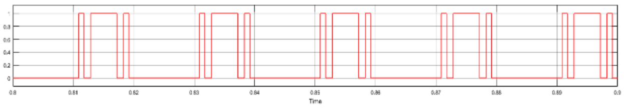

Fig.11: Gate pulses of switches S_{10} and S_{11} (type-1)

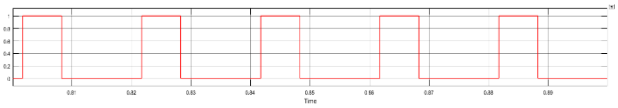

Fig.12: Gate pulses of switches S_{13} and S_{16} (type-1)

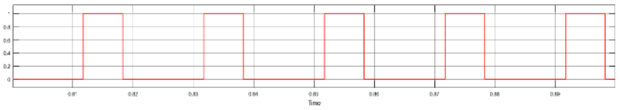

Fig.13: Gate pulses of switches S_{14} and S_{15} (type-1)

The Fig.4 shows the waveform of 31-level output voltage and output current of the cascaded AMLI (type-1). The waveform of output voltage and voltage THD is shown in Fig.15 and the waveform of output current and current THD is shown in Fig.16.

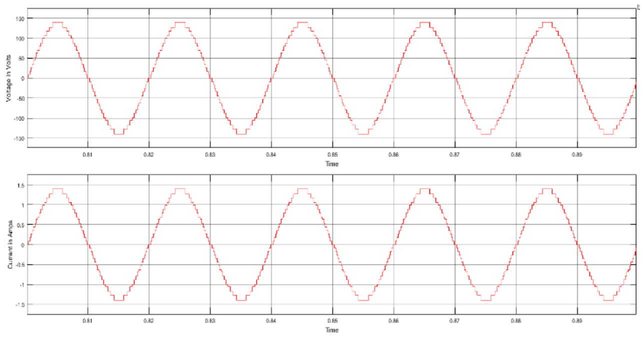

Fig.14: Output voltage and current waveform of cascaded AMLI (type-1)

B. Type – 2

This converter is taking input from four asymmetrical source voltages of 10V, 20V, 40V, and 80V. Each of these source is provided with a switch (S1, S2, S3, and S4) in series to connect and disconnect the supply. An additional diode is provided across each of these combination of source and a switch as a parallel path for the flow of current. This complete network is then connected to an inverter to unfold the waveform to get a full wave form. This type-2 converter has 8 switches in total including four switches of inverter (S5, S6, S7, and S8). Fig.17 shows the simulation model of AMLI (type-2).

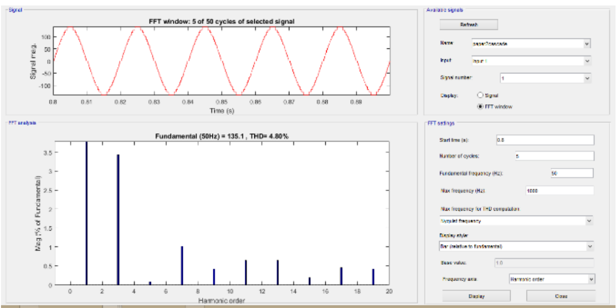

Fig.15: Output voltage waveform and THD of cascaded AMLI (type-1)

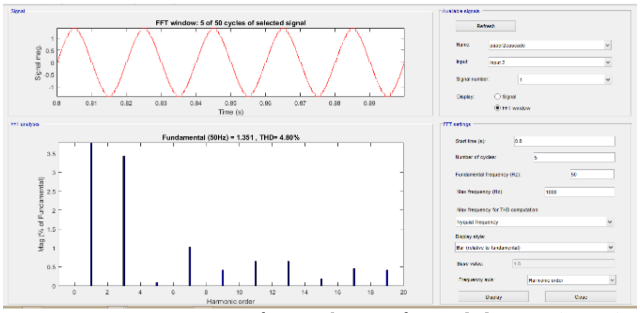

Fig.16: Output current waveform and THD of cascaded AMLI (type-1)

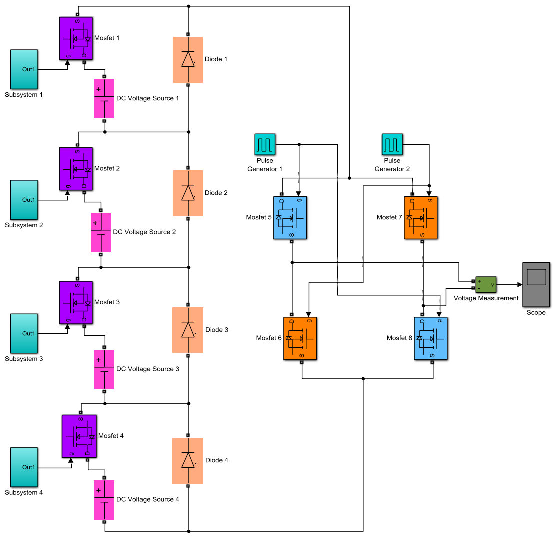

Fig.17: Simulation model of AMLI (Type-2)

Operation of the converter is like this, when all the switches (S1, S2, S3, and S4) are off there will not be any voltage at the output terminals. When only switch S1 is on and all other switches are off then 10V appears across the output. Similarly when only switch S2 is on and all other switches are off then 20V appears at the output. In the same way for switches S3, and S4 the voltages of 40V and 80V appears at the output respectively. When the combination of switches are operated the voltages also gets combined and appears at the output terminals. For example, if the switches S1, S2, and S4 are on then the combined voltage at the load (output) is 10 + 20 + 80 = 110V. This is same for all other combinations also. The gate pulses of all the switches used in type-2 converter are shown in Fig.18, 19, 20, and 21.

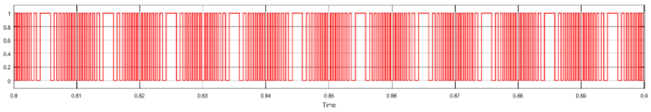

Fig.18: Gate pulse of switches S_1 (type-2)

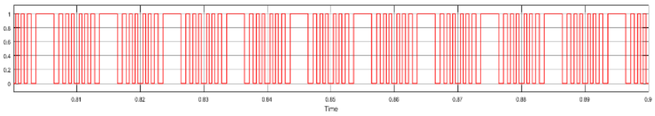

Fig.19: Gate pulse of switches S_2 (type-2)

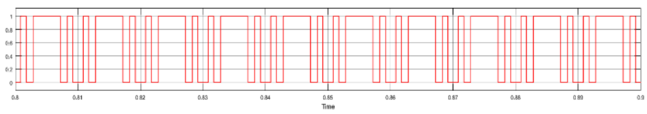

Fig.20: Gate pulse of switches S_3 (type-2)

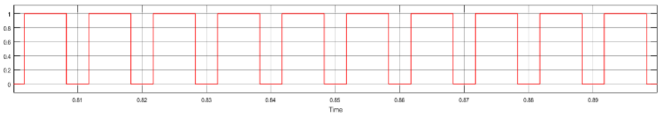

Fig.21: Gate pulse of switches S_4 (type-2)

The Fig.22 shows the waveform of 31-level output voltage and output current of the AMLI (type-2). The waveform of output voltage and voltage THD is shown in Fig.23 and the waveform of output current and current THD is shown in Fig.24.

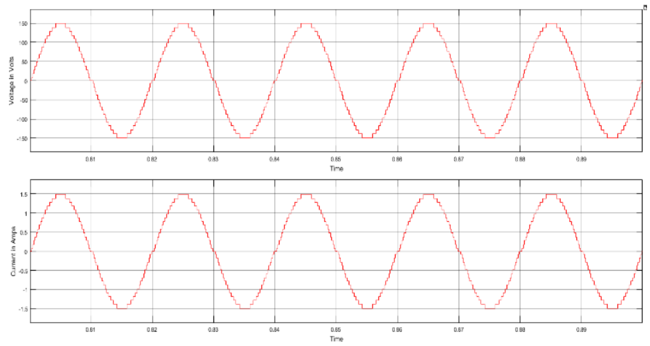

Fig.22: Output voltage and current waveform of AMLI (type-2)

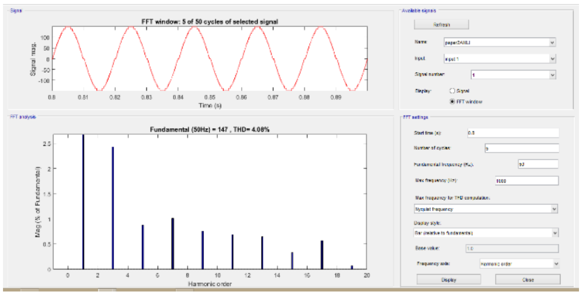

Fig.23: Output voltage and voltage THD waveform of AMLI (type-2)

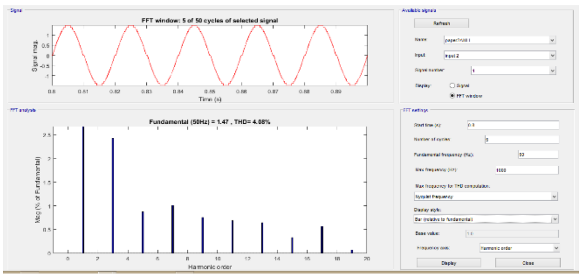

Fig.24: Output current and current THD waveform of AMLI (type-2)

IV. RESULTS AND DISCUSSION

The two types of AMLIs are simulated in the previous section. Both the converters producing same number of levels i.e., 31 levels in the output voltage/current. The type-1 converter uses 16 switches whereas type-2 converter uses 8 switches and 4 diodes. The voltage and current THDs of type-1 and type-2 converters are 4.80% and 4.08% respectively. The results of both the converters are tabulated in the Table.1.

TABLE I. RESULTS AND DISCUSSION

Parameter	Type – 1	Type – 2
Number of levels	31	31
Number of inverter bridges	4	1
Number of switches	16	8
Number of diodes	-	4
Voltage and current THD	4.80 %	4.08 %

V. CONCLUSION AND FUTURE SCOPE

In the paper the study of two different types of asymmetrical multi-level inverter (AMLI) is carried out. Both of these converters are producing same number of levels (31 levels) in the output voltage/current from four asymmetrical input dc voltage sources. A sine pulse width modulation (SPWM) technique is incorporated for switching of switches. In the type-2 converter the number of switches used are half (8 switches) of the number of switches used in type-1 converter (16 switches). THD decreases with the reduction of number of switches. The THD is found to be reduced by 0.72% in the type-2 converter compared to type-1 converter. So the type-2 converter can be considered for the conversion of voltage from dc to ac.

REFERENCES

[1] J Gowri Shankar, Dr. J Belwin Edward, “A 15-Level Asymmetric Cascaded H Bridge Multilevel Inverter with Less Number of Switches For Photo Voltaic System” IEEE International Conference on Circuit, Power and Computing Technologies [ICCPCT], 2016.

[2] Javier pereda, and Juan dixon, “Cascaded Multilevel Converters: Optimal Asymmetries and Floating Capacitor Control” IEEE Transactions on Industrial Electronics, Vol. 60, No. 11, November 2013.

[3] Sérgio Daher, Jürgen Schmid, and Fernando L. M. Antunes, “Multilevel Inverter Topologies for Stand-Alone PV Systems” IEEE Transactions on Industrial Electronics, VOL. 55, NO. 7, July 2008.

[4] Bhuvaneswari.V, HariKumar.M.E, “Analysis of Asymmetrical and Symmetrical Three Phase Cascaded Multilevel Inverter Using Multicarrier SPWM Techniques” IEEE International Conference on Green Computing Communication and Electrical Engineering (ICGCCEE), 2014.

[5] Jose Rodriguez, Jih-Sheng Lai, and Fang Zheng Peng, “Multi-Level Inverter: A Survey of Topologies, Control, and Applications”, IEEE Transactions on Industrial Electronics, Vol. 49, No. 4, August 2002.