iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** X **Month of publication:** October 2023

DOI: https://doi.org/10.22214/ijraset.2023.55891

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue X Oct 2023- Available at www.ijraset.com

Switched Capacitor Based Cascaded Half-Bridge Multilevel Inverter with Voltage Boosting Feature

Venkata Sowmya Balu[1], Vasavi Krishna Duda[2], Sowmya Mothukuri[3]
JNTU Hyderabad

Abstract: In many applications, cascading multilevel inverter (CMI) topologies are common. However, the biggest disadvantage of CMI is the need for many separate switches and DC sources. As a result, the CMI topology becomes more expensive, more complex, and larger, and its performance suffers. In the proposed SC-CHMI, only one DC source is used and the other DC sources are replaced by switched capacitor cells. Thanks to the self-balancing function, the capacitor charging process occurs naturally without the need for any auxiliary equipment. In the proposed SC-CHMI, the inrush current of the capacitor is attenuated using a load inductor or a front-end boost converter. To improve the performance of multi-level inverters, several types of techniques can be tested with existing multi-level inverters. Due to the modulation algorithm, modulation frequency, voltage drop on the switches and bus voltage modulation, the output voltage of the inverter has overall harmonic distortion, leading to overheating of the device and shortening the life of the device bag. In the proposed SC-CHMI, a level-shifted pulse width modulation technique is proposed to improve the output voltage quality and reduce the total harmonic distortion. This new control scheme is applicable to nine-level, eleven-level and fifteen-level SC-CHMI. The proposed topology can be used as a general-purpose inverter in renewable energy systems, due to its voltage gain characteristics, minimal number of switches, and single DC source. The effectiveness of the proposed inverter topology is confirmed by simulation results.

I. INTRODUCTION

Multi-level inverter An inverter is a power electronic circuit that converts direct current into alternating current, used as a backup power source in the home. Nowadays, multilevel inverters are used in high power switching applications. Multi-level inverters consist of several switches, used in industrial applications, railway and tram traction drives, etc.

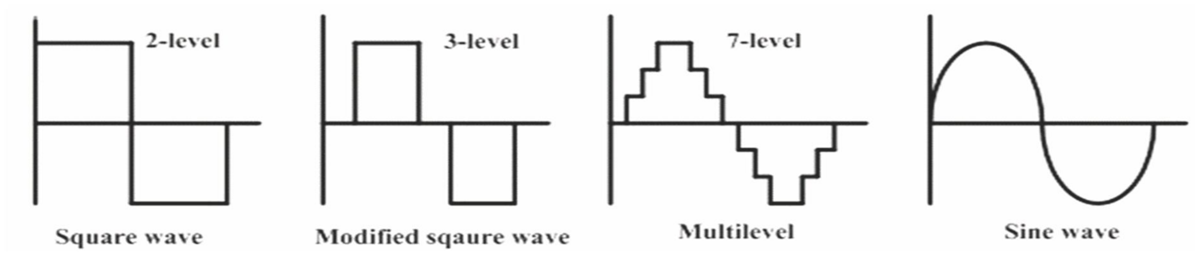

Figure 1 : Inverter Output Waveform

	Diode Clamped MLI	Flying Capacitor MLI	Cascaded H-Bridge MLI
Power Semiconductor Switches	2(m-1)	2(m-1)	2(m-1)
Clamping diodes per phase	(m-1)(m-2)	0	0
DC bus capacitors	(m-1)	(m-1)	(m-1)/2
Balancing capacitors per phase	0	(m-1)(m-2)/2	0
Voltage unbalancing	Average	High	Small
Applications	Motor Drive system: STATCOM	Motor Drive system: STATCOM	Motor Drive system: PV system,Fuel cells,Battery system

Table1:Comparison of different multilevel inverter topologies

CMI stands out for its high modularity and provides higher voltage amplitude from a given input DC voltage. Various solutions have been proposed to reduce the number of DC sources in CMI.

II. PROPOSED SWITCHING CAPACITOR BASED HALF-BRIDGE MULTILEVEL INVERTER (SC-CHMI)

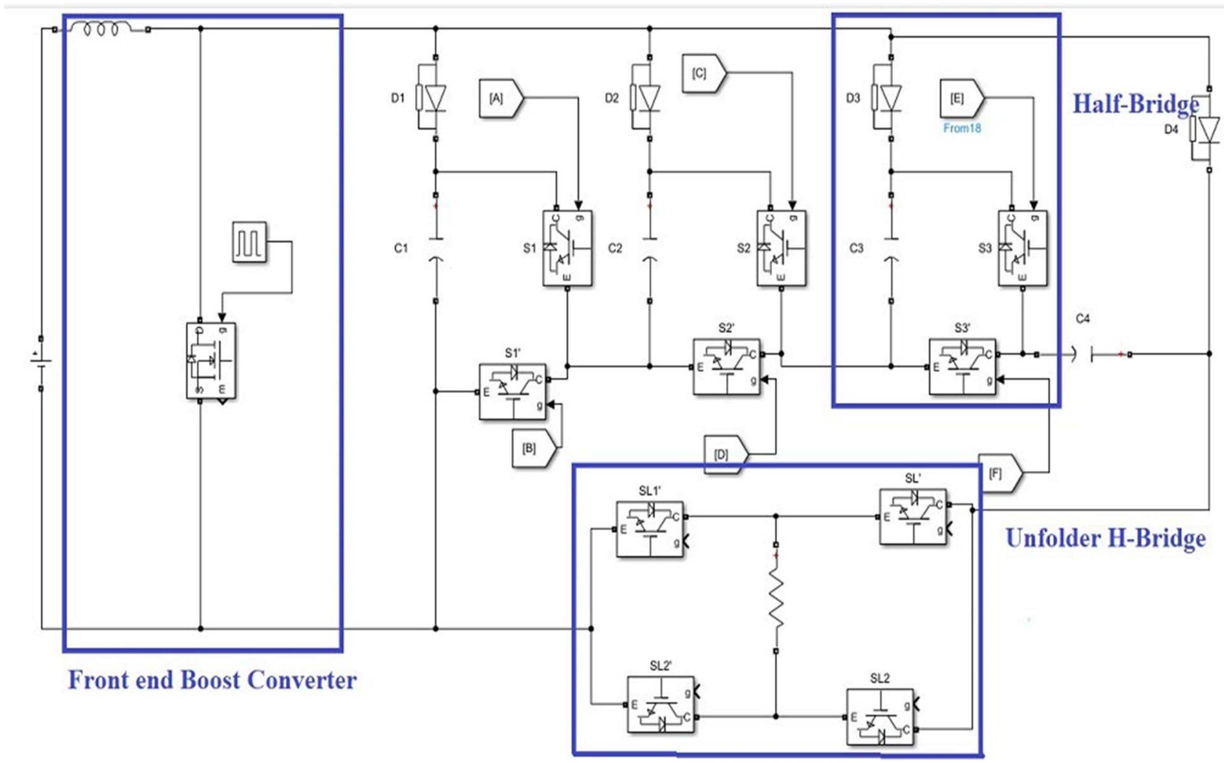

Figure 2:. Proposed SC-CHMI using an unfolder bridge and half bridge cells.

Levels	Main Switches (S1,S2,S3)	Unfolder Switches (SL1,SL2)	CHARGING Diodes (D1-D4)	Capacitors (C1-C4)	Vout
4	111	10	1000	D,D,D,D	4VDC
3	011	10	1100	C,D,D,D	3VDC
2	001	10	1110	C,C,D,D	2VDC
1	000	10	1111	C,C,C,D	1VDC
0	000	11	1111	C,C,C,C	0
-1	000	01	1111	C,C,C,D	-1VDC
-2	001	01	1110	C,C,D,D	-2VDC
-3	011	01	1100	C,D,D,D	-3VDC
-4	111	01	1000	D,D,D,D	-4VDC

Table 2:Switching status of 9-level SC-CHMI

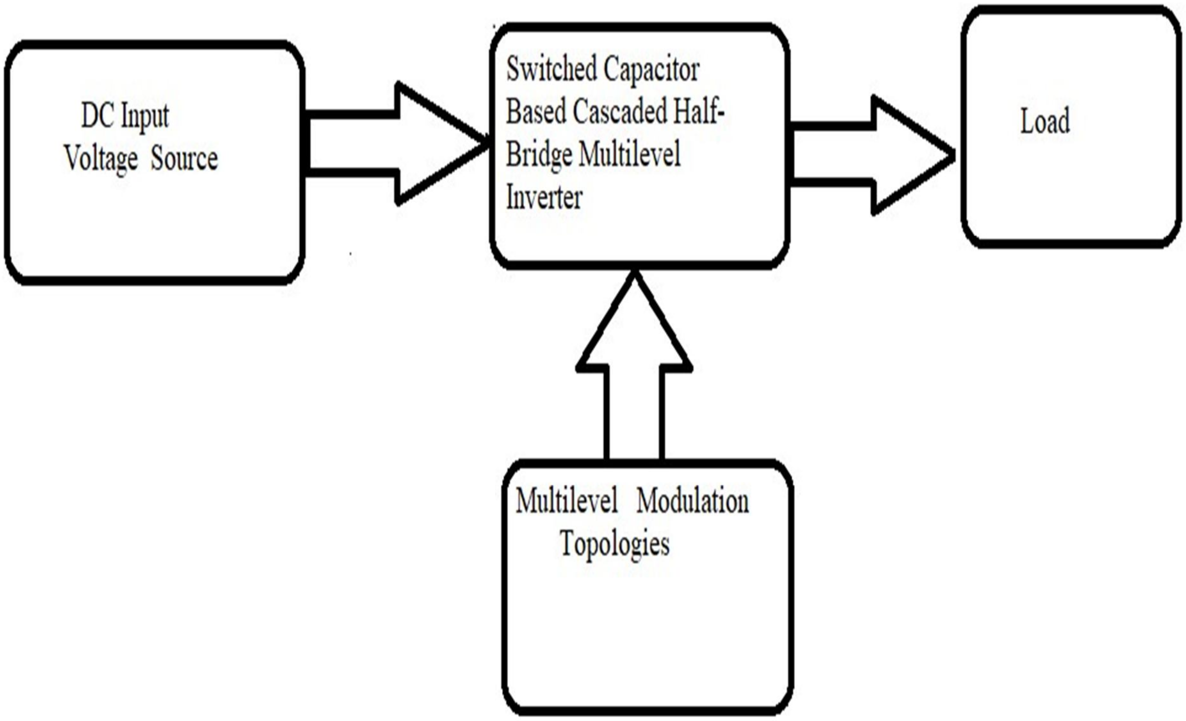

Figure 4:Block diagram of multi-level inverter

III. MODULATION TECHNIQUES

A. Phase Disposition (PD) PWM

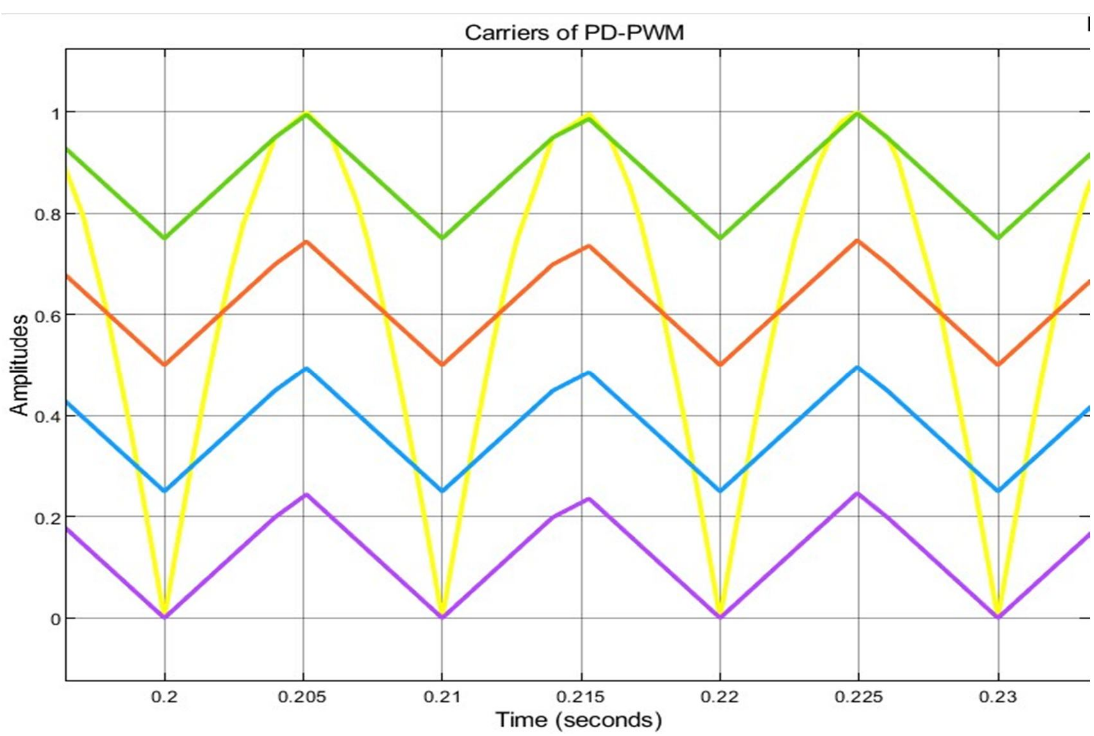

Figure 5:Multi Carrier phase disposition PWM waveform

B. *Phase Opposition Disposition (POD) PWM*

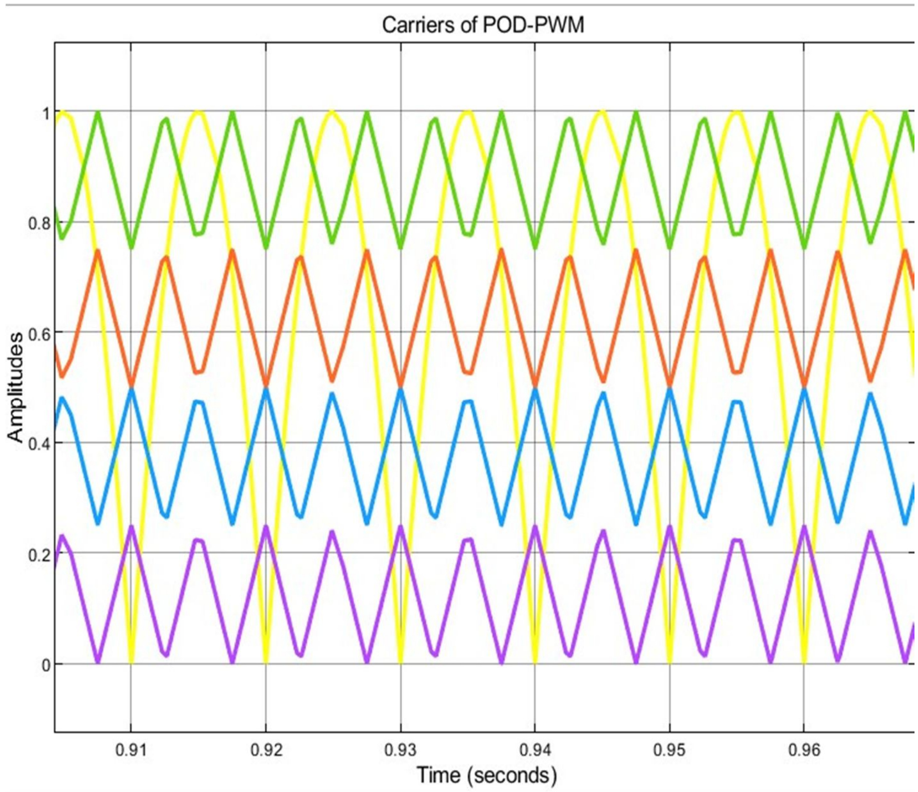

Figure 6:Multi Carrier phase opposition disposition(POD) PWM waveform

C. *Alternate Phase Opposition Disposition (APOD) PWM*

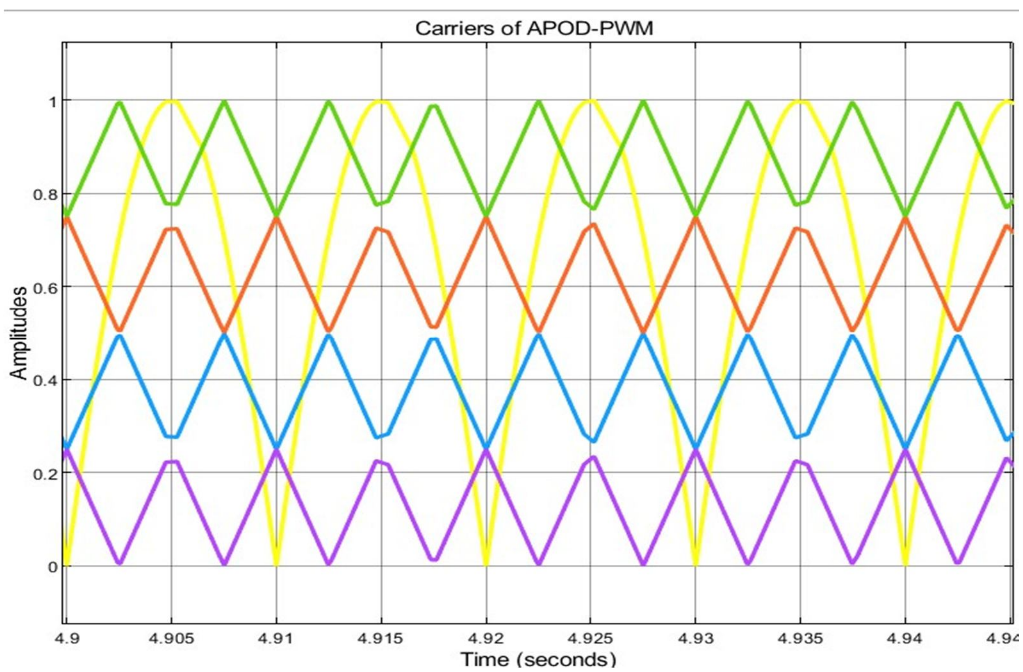

Figure 7:Multi Carrier Alternate Phase opposition disposition(APOD) PWM waveform

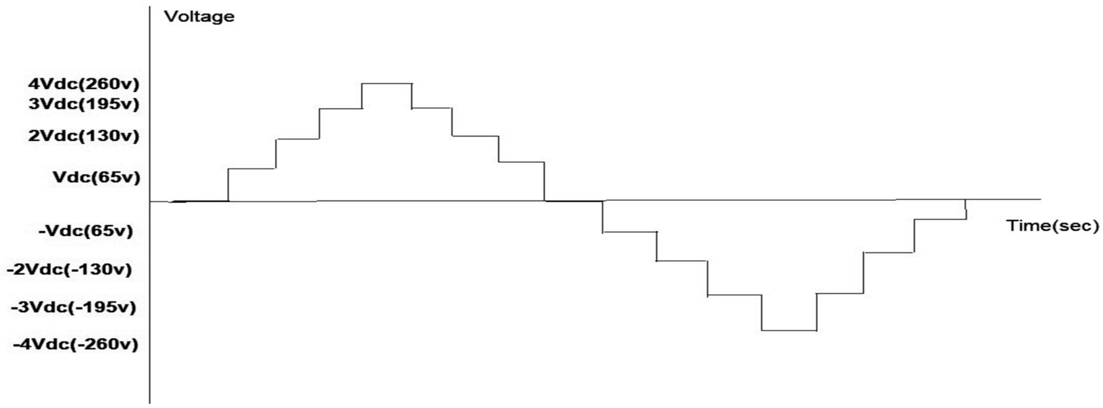

Figure 8:Output voltage waveform of 9-level SC-CHMI

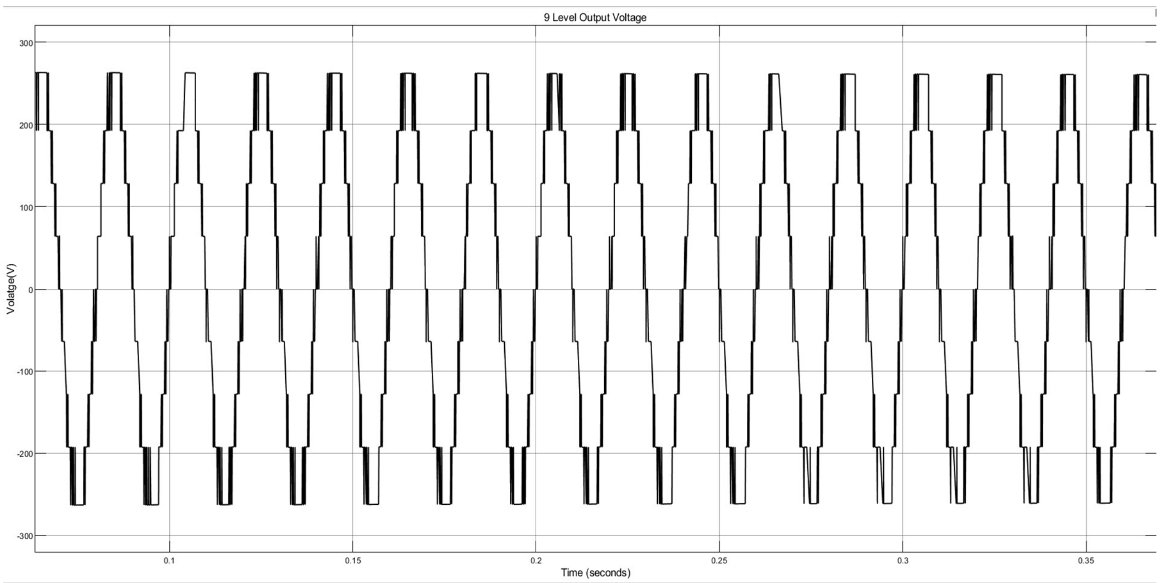

Figure 9:Output of 9-level SC-CHMI

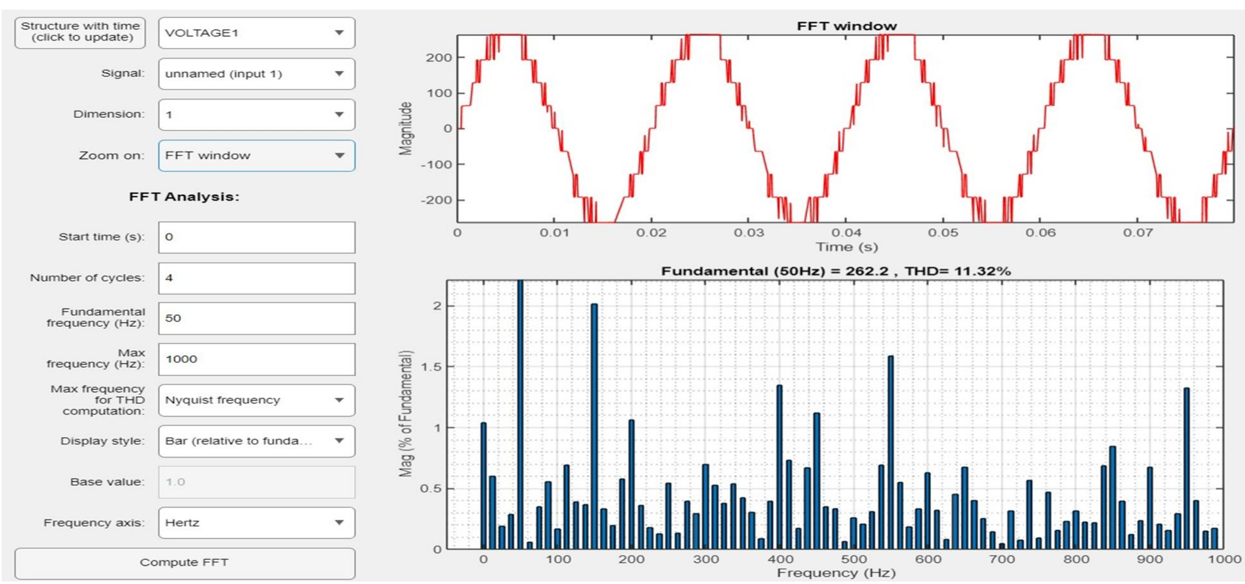

Figure 10:The fast Fourier transform (FFT) analysis of the output voltage of 9-level

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue X Oct 2023- Available at www.ijraset.com

S.NO	PWM Technique	Level	THD
1	PD	9	11.36%
2	POD	9	13.40%
3	APOD	9	13.44%
4	PD	11	10.45%
5	POD	11	11.26%
6	APOD	11	11.30%
7	PD	15	8.84%
8	POD	15	9.21%
9	APOD	15	9.26%

Tabel 3 : Comparison of different LS-PWM techniques w.r.t %THD

Input Voltage(V)	Load	Maximum Voltage(V)	%THD
65	200	+/-264	11.36%
65	120	+/-265	11.32%
65	200+j60	+/-267	11.80%
65	120+j60	+/-269	11.64%

Tabel 4:%THD and maximum voltage is observed for 9 Level SC-CHMI for R ,RL load

Input Voltage(V)	Load(Ohms)	Maximum Voltage(V)	%THD
65	200	+/-324	10.45%
65	120	+/-329	10.54%
65	200+j60	+/-328	10.57%
65	120+j60	+/-329	10.67%

Tabel 5:%THD and maximum voltage is observed for 11 Level SC-CHMI for R,RL load

Input Voltage(V)	Load(Ohms)	Maximum Voltage(V)	%THD
65	200	+/-450	8.85%
65	120	+/-454	8.90%
65	200+j60	+/-457	8.96%
65	120+j60	+/-457	8.96%

Tabel 6:%THD and maximum voltage is observed for 15 Level SC-CHMI for R,RL Load

IV. CONCLUSION

A new single-source switched-capacitor cascaded half-bridge multilevel inverter (SC-CHMI) with voltage boosting features is implemented using MATLAB software. For the intended SC-CHMI, a single DC supply and fewer switches are required. The developed configuration, constructed from 10 switches for 9 level inverter 12 switches for 11 level inverter and 16 switches for 15 level . The proposed SC-CHMI topology also features a modular architecture and may be scaled up to a desired voltage level. In the suggested topology, the capacitors are charged via a charging inductor which removes inrush currents during the charging stages.Switching states are designed to ensure sufficient charging period for the capacitor, and hence no big ripple in the capacitor voltage.To drive switches of the inverter, LS-PWM(PD,POD and APOD) is applied.The performance of proposed SC-CHMI is evaluated in purely resistive load and resistive-inductive load.

REFERENCES

[1] Rahna Rajeev,Rahul Rajesh, Savant Dev,Lakshmi Priya KJ,Amjith SUG Scholar, UG Scholar, UG Scholar, Assistant Professor, Assistant Professor Mahaguru Institute of Technology, Kattachira ‘CASCADED HALF BRIDGE MULTILEVEL INVERTER WITH FILTER FOR VOLTAGE BOOSTING APPLICATIONS’ an International open Access, Peer-reviewed, Refereed Journal Volume 11,Issue 5 May 2023 (IJCRT) www.ijcrt.org f587-f592

[2] Hossein Khoun Jahan, Amin Mohammadpour Shotorbani, Mehdi Abapour, Kazem Zare, Seyed Hosseini, Frede Blaabjerg, and Yongheng Yang ‘Switched Capacitor Based Cascaded Half-Bridge Multilevel Inverter With Voltage Boosting Feature’ VOL. 6, NO. 1, MARCH 2021c,63-73

[3] Md. Tariqul Islam,Md. Fayzur Rahman,Sourav Barua,ASM Shihavuddin,Md. Hasan Maruf,Ratil H Ashique ‘Harmonic Reduction of Cascaded H-Bridge Multilevel Inverter Using Advanced Level Shifted Pulse Width Modulation Technique’ 2021 International Conference on Electronics, Communications and Information Technology (ICECIT), 14-16 September 2021, Khulna, Bangladesh.

[4] M. Vanisri , K. Sindhu Priya , G. Chandra Shekar ‘Comparison of Level Shifting Modulation Techniques using Designed Seven Level Multilevel Inverter IJERT V10IS030236,Volume 10, Issue 03 (March 2021)

[5] M. R. Banaei, H. Khounjahan, and E. Salary, “Single-source cascaded transformers multilevel inverter with reduced number of switches,” in IET Power Electronics, vol. 5, no. 9, pp.1748–1753, Nov. 2012.