IJAREEIE

e-ISSN: 2278-8875
p-ISSN: 2320-3765

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

Volume 10, Issue 7, July 2021

ISSN INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.282

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.282|

|| Volume 10, Issue 7, July 2021 ||

| DOI:10.15662/IJAREEIE.2021.1007045 |

Design of Single Phase Multilevel Inverter

Rohan Kadu, Sudhanshu Deshpande, Yukta Shingade

Department of School of Electrical Engineering, Dr Vishwanath Karad's MIT World Peace University, Pune, India

ABSTRACT- Harmonic content is one of the most important aspects of these inverters. The amount of harmonics introduced to the system is lesser as compared with those of common inverters because of the staircase waveform of multilevel inverters. Total harmonic distortion (THD) is directly proportional to the no. of switches used to convert DC to AC and is inversely proportional to no. of levels. In this paper we propose a system in which we are using only 10 switches to generate 15 levels for getting less distorted and smooth waveform, thus reducing cost and complexity, also less switches leads to less switching time and improved system. After doing permutation and combinations on 3 DC voltages (4V, 8V and 12V), we are able to produce 15 output levels.

I. INTRODUCTION

In the last few decades, multilevel voltage-source inverters have emerged as a viable solution for high-power dc-to ac conversion applications. A multilevel inverter(MLI) is a linkage structure of multiple input dc levels(obtained from dc sources and/or capacitors) and power semiconductor devices to synthesize a staircase waveform. Multilevel inverters (MLIs) have been innovated as necessary cost-benefit devices with a wide range of applications. They have been in the focus for decades because of interesting features, such as high-quality output voltage, operation in high voltage/power, low stress on switches, etc [1]. Voltage stresses experienced by the power switches are lower as compared to the overall operating voltage level. In addition, the multilevel waveform has a better harmonic profile as compared to a two-level waveform obtained from conventional inverters. Other advantages of MLIs are reduced dv/dt stress on the load and possibility of fault-tolerant operation [7]. Researchers are also exploring avenues to employ MLIs for low-power applications. Multilevel inverters (MLIs) continue to extend the performance credentials to use as power converter interface and support for high power quality demanding applications. MLIs enjoy savvy to incarnate possible turn around and foster structural modifications to leave way for an enhancement in the utility value. The MLIs can be composed in an array of power switches and capacitive voltage sources coiled through the switching devices to serve and translate the dc voltage into a multiple-stepped ac voltage waveform with variable amplitude and frequency [9]. The MLIs are destined with lower voltage distortion, common-mode voltage ratio, reduced dv/dt and even abolish the output filters. The quality of multilevel inverter output voltage waveform increases as the number of levels increases as compared to two level output voltage waveforms produced by conventional inverters [10].

II. LITERATURE REVIEW

Sr. no.	Title	Author	Publications	Remark
[1]	An Envelope Type (E-Type) Module: Asymmetric Multilevel Inverters With Reduced Components	EmadSamadaei, SayyedAsgharGholamian	IEEE	It uses 4 unequal DC sources and 10 switches to produce 13 levels whereas our system uses only 3 DC sources to produce 15 levels
[2]	A Novel Multilevel Inverter Based on Switched DC Sources	Krishna Kumar Gupta and Shailendra Jain	IEEE	This system uses 2 unequal sources, 3 switches to produce 7 levels, reduce component count
[7]	A Novel Multilevel Inverter with Reduced DC Sources	Ambili R, Fareeda A Kareem	IJIREEIE	This system reduces DC sources. In this to obtain 9 levels of voltages only 2 DC sources are required (4 switches)

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.282|

|| Volume 10, Issue 7, July 2021 ||

| DOI:10.15662/IJAREEIE.2021.1007045 |

[8]	A Novel Topology of Multilevel Inverter with Reduced Number of Switches and DC Sources	NakulThombre, RatikasinghRawat, PriyankaRana	IJPEDS	The proposed topology is based on asymmetrical multilevel inverter which produces 21 levels of output with the use of 11 unidirectional switches, 3 diodes and 4 DC voltage sources
[9]	Novel Multilevel Inverter Topologies for Cascaded Voltage Source Architectures	Subramanian Annamalai, JaisivaSelvaraj	IJRASET	this paper proposes two new single phase multilevel inverter (mli) topologies configured with reduced switches suitable for cascaded structure on extracting various levels of ac output voltages
[10]	Comparison of Performances of Switched DC Sources Inverter and Cascaded H-bridge Inverter	MithunKuriakose, Anooja V S	IJSETR	The system produces 5 levels with reduced THD from 2 equal DC sources (12V) and 8 switches.
[5]	A Novel DC Link Coupled Vl QZ Source Based Reduced Switch Multilevel Inverter	G.LourdsSajitha, C.R.Balamurugan	IJPAM	Reduced switch MLI proposed based on DC link coupled VL quasi Z source
[6]	A New Multilevel Inverter Topology Based on Switched Capacitor for Power Quality Improvement	G BhaskarRao, G V Ram Mohan, D B Chowdary	IJSEAT	A novel switched capacitor-based fell multilevel inverter is proposed in this venture, which is developed by an exchanged capacitor frontend and H-Bridge backend.
[4]	Hybrid multilevel DC link inverter with reduced power electronic switches	Durga Prasad G, Jegathesan V, P V V Rama Rao	PECCON	To decrease the number of switches and THD, a polarity generation module is introduced for multilevel inverters.

III. PROPOSED SYSTEM

This paper introduces a new topology of asymmetric multilevel modular with a new component arrangement including 10 switches, 10 diodes and 4 unequal DC sources (two $2VDC$, two $1VDC$) named as Envelope type (E-Type).

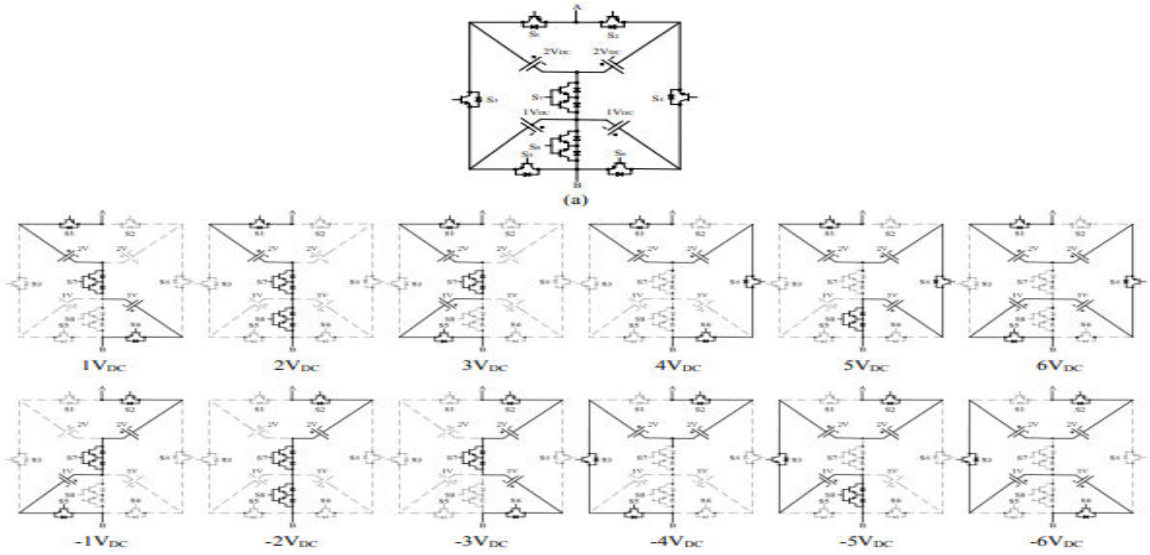


Fig.1. proposed system

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.282|

|| Volume 10, Issue 7, July 2021 ||

| DOI:10.15662/IJAREEIE.2021.1007045 |

This arrangement synthesizes voltage sources and produces 13 levels (6 positive level, 6 negative level and zero level) without any additional circuit. The main concept of this circuit is to create different paths from different sides of a DC source to be connected to other sources. Fig.3 shows the configuration of the E-Type asymmetrical module in which DC sources are located in the middle of the circuit and are connected together to form different voltage levels via the surrounding switch (S1-S6). A bidirectional switch (S7) is required to avoid short circuits of DC sources on the left or right sides of the module. Another bidirectional switch (S8) is also needed to achieve voltage levels of $\pm 5VDC$. Different switching conditions of this structure are shown in Fig 5.1.

Block Diagram

A multilevel inverter has several advantages over a conventional two-level inverter that uses high switching frequency pulse width modulation (PWM).

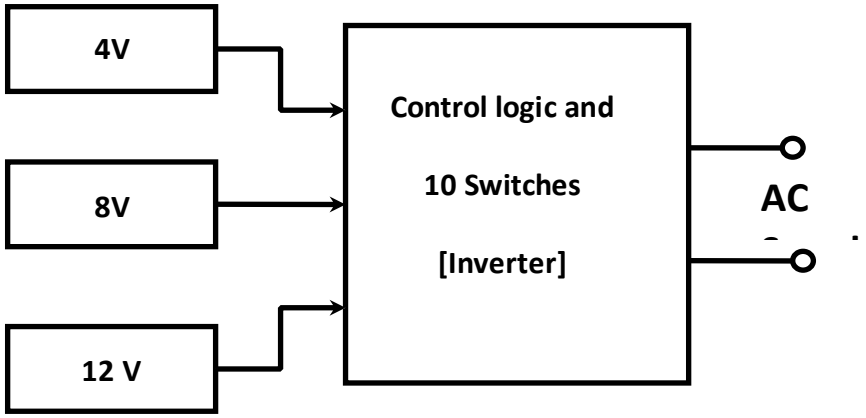


Fig.2. block diagram of proposed system

4V, 8V and 12V are separate DC sources used in this system. This is fed to the control logic and a series of switches which comprises the inverter. The output is 15 different levels of AC output. Inverter consists of

1. Switches: there are 10 switches present in this system. The MOSFET switches are used in this system since they can handle large power and are more accurate than any other type like IGBT or conventional transistor type (NPN or PNP).
2. Control logic: control logic is used to control the state of the switch.

This output is then given to the oscilloscope as shown in fig 2 below.

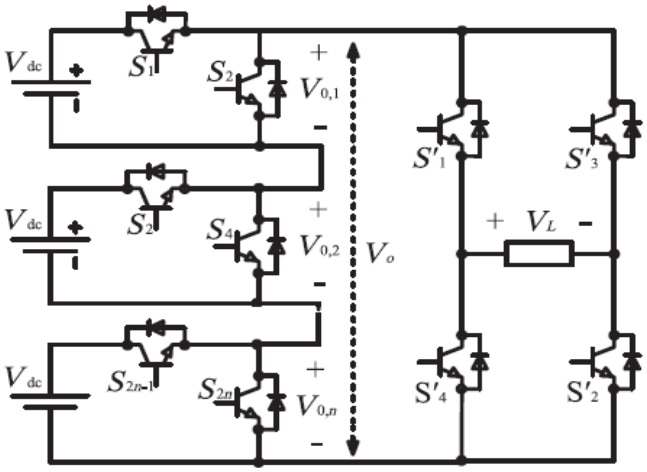


Fig.3 circuit diagram of proposed system

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.282|

|| Volume 10, Issue 7, July 2021 ||

| DOI:10.15662/IJAREEIE.2021.1007045 |

Fig.3 shows the circuit diagram of An Envelope Type (E-Type) Module: Asymmetric Multilevel Inverters with Reduced Components. The circuit diagram includes 10 Switches namely Mosfet1, Mosfet2 ... Mosfet10. The switches are made up of Mosfet (metal oxide semiconductor field effect transistor), we are using these switches to convert input to 15 levels AC output. Letters DC represents DC power supply in the proposed circuit diagram where DC=4 Volt, DC1=8 Volt and DC2=12 Volt. The 10 subsystems represented as Dut1 are used to feed as logic to switch i.e. to control switch.

Control Circuit:

We have used Arduino Uno for controlling purposes. The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. In the circuit diagram there are 10 switches. For switching purpose we have used MOSFET IRF540., who has Dynamic dV/dt Rating, Repetitive Avalanche Rated, 175 °C Operating Temperature, Fast Switching, Ease of Paralleling, Simple Drive Requirements, Compliant to RoHS Directive 2002/95/EC. After that circuit we have attached on Transformer:

Specifications:

- input voltage = 20V
- Output voltage = 230V
- Power = 500W
- Winding ration = 2:23

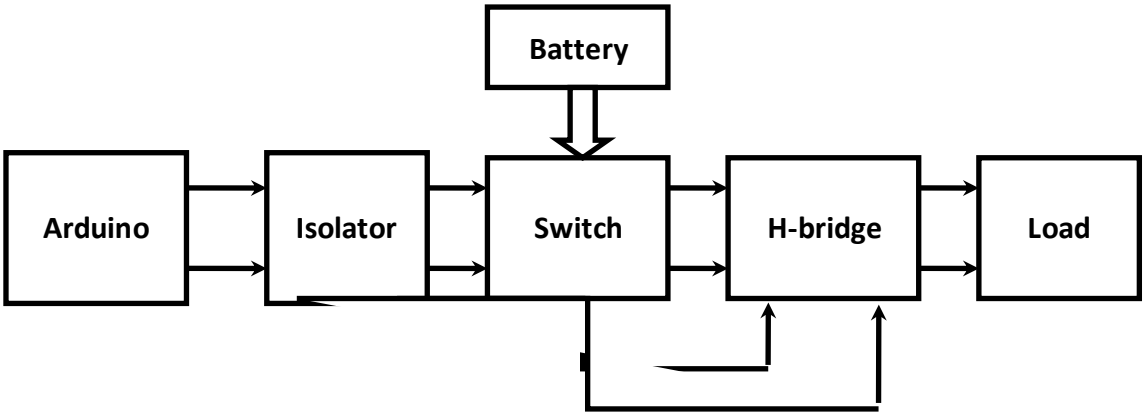


Fig.4 control circuit of proposed system

Gate Circuit

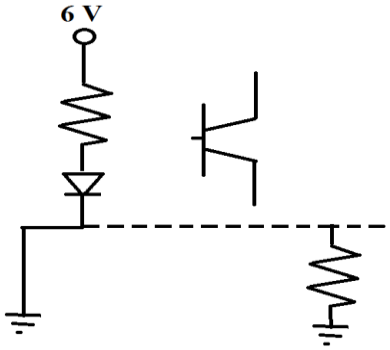


Fig.5.gate circuit

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.282|

|| Volume 10, Issue 7, July 2021 ||

| DOI:10.15662/IJAREEIE.2021.1007045 |

The dotted line is an opto-coupler which separates switches from load and source.

Switching Sequence

Table.1. switching sequence of proposed system

Volt	S1	B1	S2	B2	S3	B3
0	0	1	0	1	0	1
4	0	1	0	1	1	0
8	0	1	1	0	0	1
20	0	1	1	0	1	0
16	1	0	0	1	0	1
20	1	0	0	1	1	0
24	1	0	1	0	0	1
24	1	0	1	0	1	0

IV. RESULT

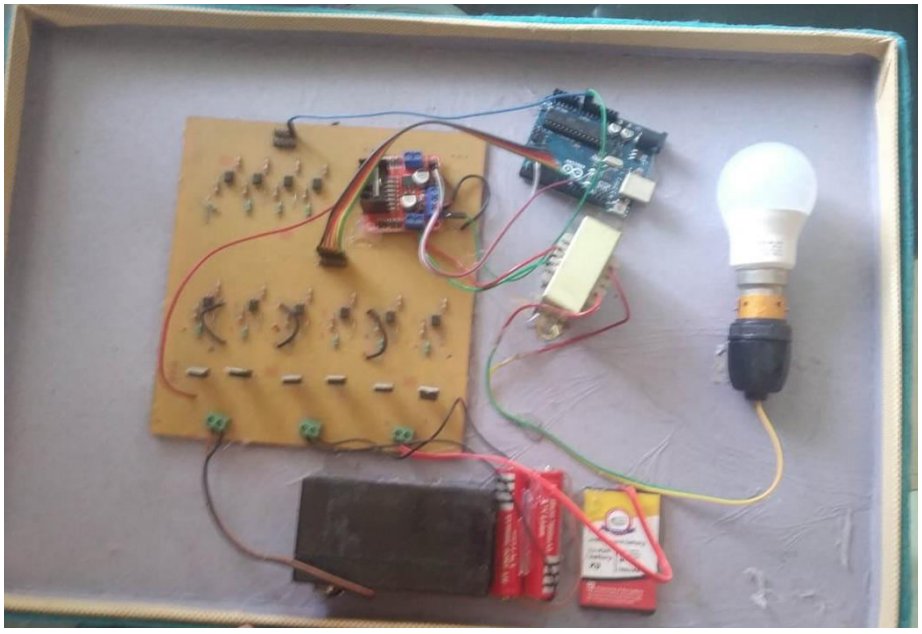


Fig.6. Hardware

V. CONCLUSION

This paper presented a new MLI topology that can generate 15 levels with reduced components. It can be used in high-voltage high-power applications with unequal dc sources. It uses 3 unequal DC sources to generate 15 levels. It uses

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.282|

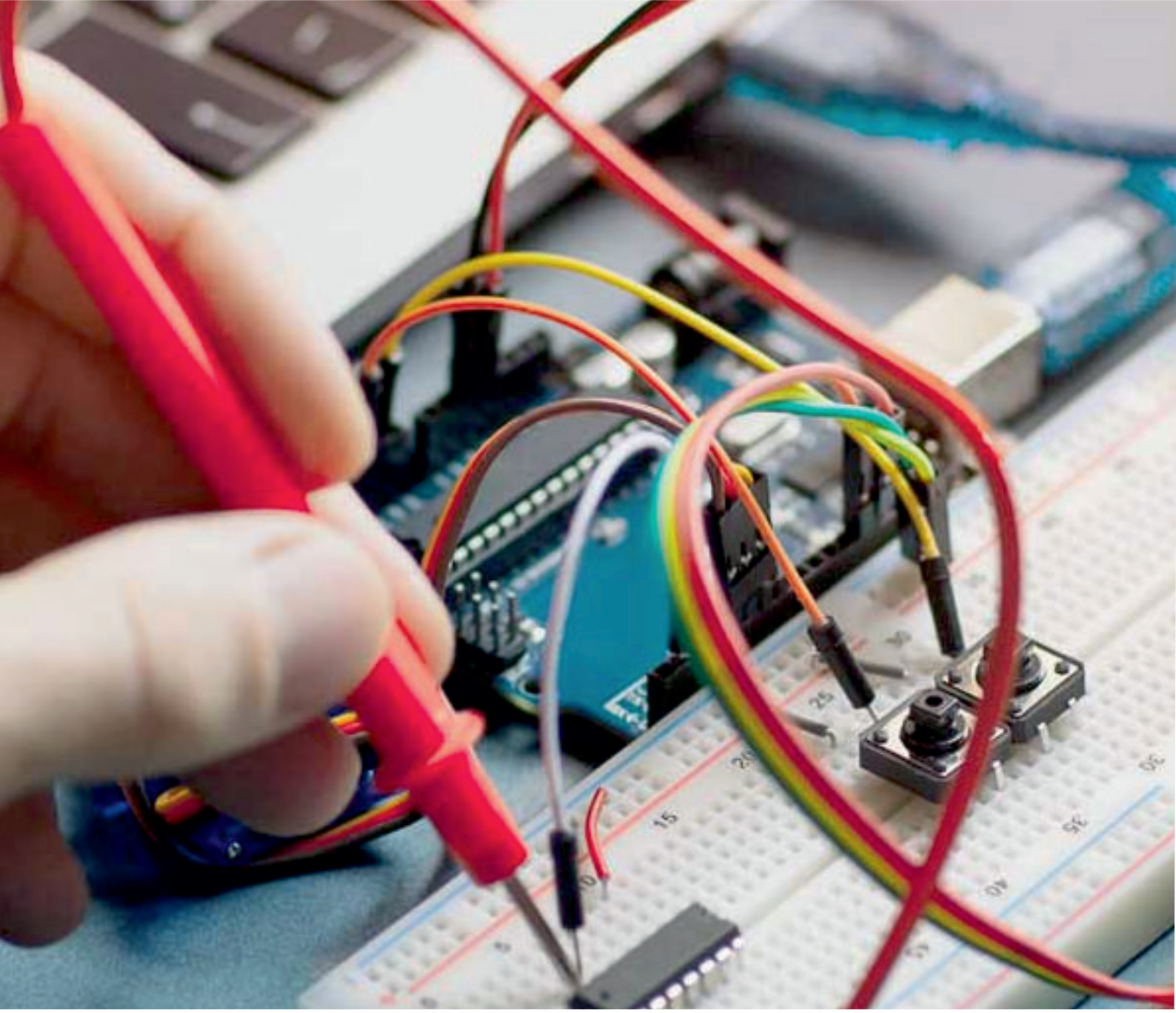
|| Volume 10, Issue 7, July 2021 ||

| DOI:10.15662/IJAREEIE.2021.1007045 |

only 10 switches to obtain this many output levels hence reduces components. As this module can be easily modularized, it can be used in cascade arrangements to form high-voltage outputs with low stress on semiconductors and lowering the number of devices. Modular connection of these modules leads to achieving more voltage levels with different possible paths. It causes an improvement in the reliability of the modular inverter that enables it to use different paths in case of malfunction for a switch or a driver. The main advantage of the proposed module is its ability to generate both positive and negative output voltages without any H-bridge circuit at the output of the inverter. THD % is 4% in experimental results that satisfy harmonics standard (IEEE519). The system is applicable in applications like Dynamic Voltage Restorer, Static VAR compensator, active power filters and high-power motor drives.

REFERENCES

1. EmadSamadaei, SayyedAsgharGholamian, AbdolrezaSheikholeslami, and JafarAdabi, “An Envelope Type (E-Type) Module: Asymmetric Multilevel Inverters with Reduced Components”, IEEE Transactions On Industrial Electronics, Vol. 63, No. 11, November 2016
2. Krishna Kumar Gupta, Shailendra Jain, “A Novel Multilevel Inverter Based onSwitched DC Sources”, IEEE Transactions On Industrial Electronics, Vol. 61, No. 7, July 2014
3. Swapna God, ShakiraPathan, SonaliWagaskar, RupaliParabhane, “Quasi Z-Source Network Based Control Scheme For Fstp BLDC Motor”, NovateurPublicationsInternational Journal of Research Publications in Engineering and Technology [IJRPET]ISSN: 2454-7875Volume 3, Issue 6, Jun.-2017
4. Durga Prasad G, Jegathesan V, P V V Rama Rao, “Hybrid multilevel DC link inverter with reduced power electronic switches”, 1st International Conference on Power Engineering, Computing and CONtrol, PECCON-2017, 2-4 March 2017, VIT University, Chennai Campus
5. G.LourdsSajitha, 2C.R.Balamurugan, “A Novel DC Link Coupled Vl QZ Source Based Reduced Switch Multilevel Inverter”, International Journal of Pure and Applied MathematicsVolume 118 No. 20 2018, 53-59
6. G BhaskarRao, G V Ram Mohan,D B Chowdary, “A New Multilevel Inverter Topology Based on SwitchedCapacitor for Power Quality Improvement”, International Journal of Science Engineering and Advance Technology, IJSEAT, Vol.5, Issue 1 January -2017
7. Ambili R, Fareeda A Kareem, “A Novel Multilevel Inverter with ReducedDC Sources” International Journal Of Innovative Research In Electrical, Electronics, Instrumentation And Control Engineering Vol. 3, Issue 9, September 2015
8. NakulThombre, RatikasinghRawat, PriyankaRana, Umashankar S, “A Novel Topology of Multilevel Inverter with ReducedNumber of Switches and DC Sources”, International Journal of Power Electronics and Drive System (IJPEDS)Vol. 5, No. 1, July 2014, pp. 56~62
9. Subramanian Annamalai1, JaisivaSelvaraj, “Novel Multilevel Inverter Topologies for Cascaded Voltage Source Architectures”, Volume 5 Issue VI, June 2017 IC Value: 45.98 ISSN: 2321-9653, International Journal for Research in Applied Science &EngineeringTechnology (IJRASET)
10. MithunKuriakose, Anooja V S, “Comparison of Performances of Switched DC Sources Inverter and Cascaded H-bridge Inverter”, International Journal of Science, Engineering and Technology Research, Volume 3, Issue 9, September2014
11. https://www.autodesk.com/products/eagle/blog/how-an-optocoupler-works/#eagle-navigation
12. https://www.theengineeringprojects.com/2018/06/introduction-to-arduino-uno.html
13. https://www.theengineeringprojects.com/2017/09/introduction-to-irfz44n.html
14. https://www.petervis.com/electronics/IRFZ44N/IRFZ44N.html
15. International Journal of Industrial Electronics and Electrical Engineering, ISSN: 2347-6982, 2349-204X Volume-5, Issue-11, Nov.-2017 http://iraj.in Diode Clamped Multilevel Inverter Switching Topology 31 DIODE CLAMPED MULTILEVEL INVERTER SWITCHING TOPOLOGY VARSHA SHARNA.



INNO SPACE
SJIF Scientific Journal Impact Factor

Impact Factor: 7.282

doi cross ref

ISSN INTERNATIONAL STANDARD SERIAL NUMBER INDIA

निस्केयर NISCAIR

International Journal of Advanced Research

in Electrical, Electronics and Instrumentation Engineering

9940 572 462 6381 907 438 ijareeie@gmail.com

www.ijareeie.com

Scan to save the contact details