IJESRT: 8(9), September, 2019 ISSN: 2277-9655

International Journal of Engineering Sciences &Research Technology

(A Peer Reviewed Online Journal)
Impact Factor: 5.164

IJESRT

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

SINGLE PHASE AC to AC CONVERSION WITHOUT FREQUENCY RESTRICTIONS

Taniya Manzoor
Electrical Engineering, GNDEC, Ludhaina, India

DOI: 10.5281/zenodo.3407070

ABSTRACT

Single Phase AC to AC conversion finds various applications in domestic drive systems, street- light dimmers and fan regulators. Conventionally, this conversion is done by using thyristor based power electronic circuits such as AC Voltage Controllers and Cyclo-Converters. However, these devices provide either no frequency control as in AC Voltage Controllers or limited frequency control as in cyclo-converters. For unrestricted frequency control AC-DC-AC conversion is usually undertaken. It is proposed to use fully controlled devices such as IGBT's (insulated gate bipolar transistor) in direct single phase AC to AC power conversion. Matrix Converters are power electronic converters that facilitate direct AC-AC conversion without any intermediate DC stage. Matrix converters make use of self-commutating devices like IGBTs thus eliminating the frequency constraints of cyclo-converters. The additional attractive features include sinusoidal input and output current, improved power factor and regeneration capabilities.

KEYWORDS: Matrix Converters, Thyristors, IGBT's, Regeneration.

1. INTRODUCTION

Rapid developments in the field of power electronics has led to the availability of a wide range of inverter circuits, varying in output frequency and voltage. The origin of such circuits is the single phase bridge inverter circuit, but its output is not sinusoidal and contains harmonics[7]. Hence, resonant inverters are used where the frequency is much higher, at around 100KHz, with high efficiency but since the switch carries the load current for a longer period, the device rating has to be higher. Variable voltage and variable frequency ac motor drives have come to increased use in various industrial applications. These new approaches need a simple method of control foracmotors.

A cyclo inverter is a type of power control in which an alternating voltage at supply frequency is converted directly to an alternating voltage at load frequency without any intermediate d.c stage. The cyclo inverter is controlled by controlling the firing pulses so that it produces an alternating output voltage. By controlling the frequency and depth of phase modulation of the firing angles of the converters, it is possible to control the frequency and amplitude of the output voltage[5]. Thus, a cyclo-inverter has the facility for continuous and independent control over both its output frequency and voltage. The quality of output voltage wave and its harmonic distortion also impose the restriction on this frequency. The distortion is very low at low output frequency. Here, a cyclo-inverter is suggested where the IGBT switch is self commutated and hence eliminates the need for a commutation circuit.

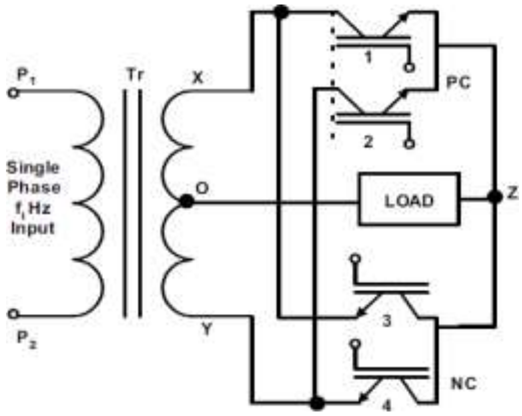
2. VARIOUS TOPOLOGIES

Half-Bridge Topology

The figure shows the detailed circuit topology of a half bridge IGBT based cyclo-converter.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Figure.1:



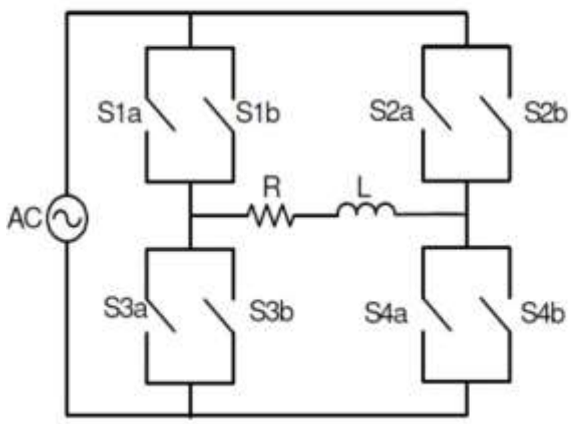
Schematic diagram of an IGBT based cyclo-converter

It consists of a single phase transformer with mid tap on the secondary winding and four thyristors, without any flow of circulating current two of these thyristors P1, P2 are for positive group and the other two are for negative group. Load is connected between secondary winding and terminal A as shown. Output is obtained through proper conduction of IGBTs in the two input cycles. The IGBTs are fired according to a cycle depending on the integer multiple with which the supply frequency is to be multiplied. Thus, the output of converter will have a frequency, fo= fi .Nr where Nr is an integer and fi is the source frequency.

Full-BridgeTopology

The matrix converter has several advantages over traditional rectifier-inverter type power frequency converters. It provides sinusoidal input and output waveforms, with minimal higher order harmonics and no subharmonics; it has inherent bi- directional energy flow capability; the input power factor can be fully controlled.

Figure.2:



Schematic diagram of a single phase AC to single phase AC converter

The Single-Phase Matrix Converter consists of a matrix of input and output lines with four bi- directional switches connecting the single-phase input to the single-phase output at the intersection.. It comprises of four ideal switches S1, S2, S3, and S4 capable of blocking forward and reverse voltages (symmetrical devices).The Single phase matrix converter circuit as shown in Figure uses four bi-directional switches for the Cyclo- converter implementation. It requires the use of bi-directional switches capable of blocking volt- age and conducting current in both directions[5]. Unfortunately there is no discrete semiconductor device currently that could be fulfilling the needs and hence the use of common-emitter anti-parallel IGBT, diode pair

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

as shown in Figure. Diodes are in place to provide reverse blocking capability to the switching module. The IGBT were used due to its high switching capabilities and high current carrying capabilities desirable amongst researchers for high power applications.

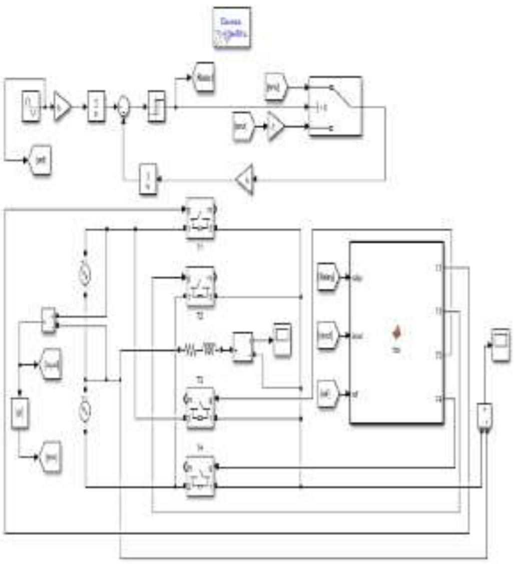
This topology promises minimal energy storage requirements, which allows to get rid of bulky and lifetime-limited energy-storing capacitors. But the matrix converter has also some disadvantages. First of all it has a maximum input- output voltage transfer ratio limited to = 87 % for sinusoidal input and output waveforms[3]. It requires more semiconductor devices than a conventional AC- AC indirect power frequency converter, since no monolithic bi-directional switches exist and consequently discrete unidirectional devices, variously arranged, have to be used for each bi-directional switch.

3. RESULTS AND DISCUSSION

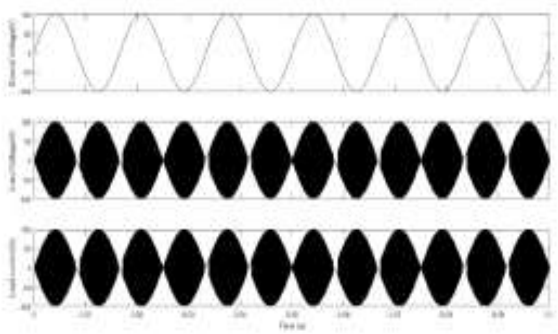
Simulation Results for Half-Bridge Topology

The Simulink model is shown in Fig.3. The objective of this work is to analyze the output voltage and current waveforms for R and RL load.

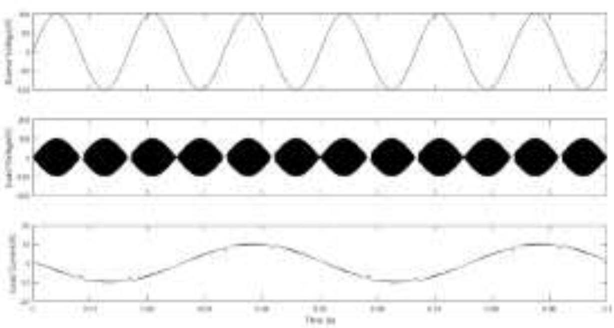
Figure.3:



MATLAB Simulink model for Half-Bridge Topology



Output voltage and current waveforms for R load



Output voltage and current waveforms for RL load

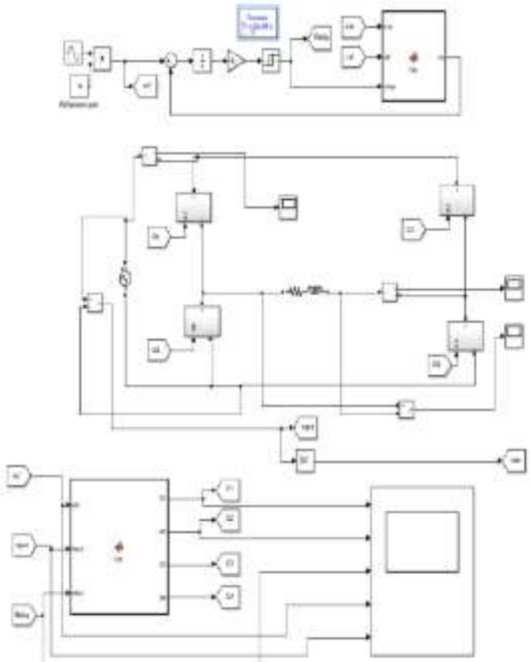
ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Simulation Results for Full-Bridge Topology

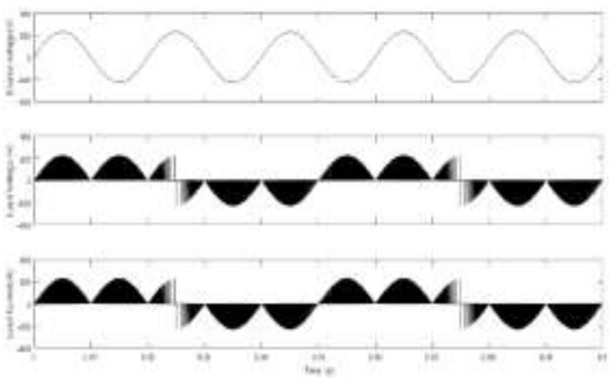
The Simulink model is shown in Fig.4 The objective of this work is to analyze the output voltage and current waveforms for R and RL load

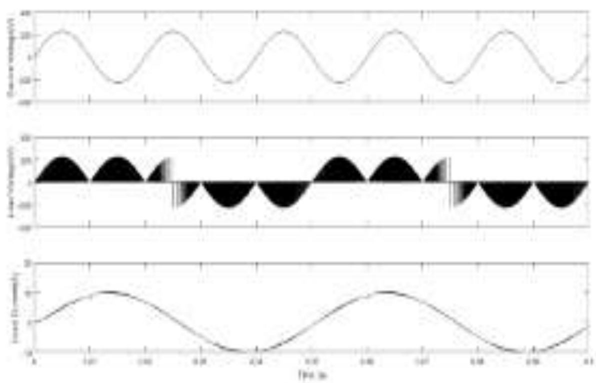
.

Figure.4:



MATLAB Simulink model for Full-Bridge Topology





Output voltage and current waveform for RL load

Output voltage and current waveforms for R load

4. CONCLUSION

Deduced from three phase matrix converters, the above mentioned matrix converter topology is able to carry out Single Phase AC to AC conversion without frequency restrictions successfully. The simulation results have been supported by experimental results. It is also found that the quality of output as well as input current improved by making use of self-commutating devices like IGBT's, besides ensuring unity power factor operation.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

REFERENCES

[1] Lee Empringham, Johann W Kolar, Jose Rodriguez, Pat W Wheeler, and Jon C Clare. *Technological issues and industrial application of matrix converters: A review IEEE Transactions Industrial Electronics,* 60(10):42604271,2013.

[2] SH Hosseini and E Babaei. *A new generalized direct matrix converter. In Industrial Electronics, 2001. Pro- ceedings. ISIE 2001. IEEE International Symposium* ,volume2,pages10711076.IEEE,2001.

[3] Zahiruddin Idris, SZ Mohammad Noor, and Mustafar Kamal Hamzah. *Safe commutation strategy insin- gle phase matrix converter. In Power Electronics and Drives Systems, 2005. PEDS 2005. International Conference*, volume2, pages886891.IEEE,2005.

[4] .B H Kwon, B-D Min, and J-H Kim. *Novel commu- tation technique of acac converters. IEE Proceedings- Electric Power Applications*, 145(4):295300,1998.

[5] Jose Rodriguez, Marco Rivera, Johan W Kolar,and Patrick W Wheeler. *A review of control and modulation methods for matrix converters. IEEE transactions on industrial electronics,* 59(1):5870,2012.

[6] LixiangWei, Thomas A Lipo, and Ho Chan. *Matrix converter topologies with reduced number of switches. In Power Electronics Specialists Conference, 2002. pesc 02. 2002 IEEE 33rd Annual, volume 1,* pages 5763. IEEE,2002.

[7] Adrian zuckerberger , D Weinstock and Abraham Alexandrovitz. *Single-phase matrix converter. IEEE Proceedings-Electric Power Applications,* 144(4):235240, 1997.