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Simulation and Analysis of Triggering Based Single Phase Bridge Type Cycloconverter

Shashank Mishra [*1], ***Mirza Mohammad Shadab*** [2], ***Isarar Ahmad*** [3]
Department of Electrical Engineering, Integral University, Lucknow (U.P.) INDIA
Email: ***shashanksmart300@gmail.com***

Abstract

Power electronics converters, especially cycloconverter & IGBT have been extending their range of use in industry because they provide reduced energy consumption, better system efficiency, improved quality of product and good maintenance. The cycloconverter has been traditionally used only in very high power drives, usually above one megawatt where no other type of drives can be used. The traditional cycloconverter requires a large number of thyristors with a very complex control circuit. But here simple triggering pulse generator based cycloconverter has developed with the help of IGBT. The cycloconverter has four IGBT comprises of a positive and negative bank. When positive current flows in the load, the output voltage is controlled by phase control of the two positive bank IGBT while the negative bank IGBT are kept off and vice versa when negative current flows in the load. In this paper the simulink model of single phase bridge types cycloconverter has simulated and analyzed that the output response of cycloconverter is two and four times to input response of cycloconverter.

Keywords *: 1-phase Cycloconverter, IGBT.*

INTRODUCTION

In industrial applications two forms of electrical energy direct current (DC) and alternate current (AC) are used. Constant voltage and constant current AC is directly available. However, for different applications different forms, different voltages and/or different currents are needed. Converters are needed to achieve different forms. These converters are classified as rectifiers, choppers, inverters and cycloconverters. Basically, cyclo converters are AC to AC converters and are used to vary the frequency of a supply to a desired load frequency. Those are clearly commutated, direct frequency converters that use obviously commutated thyristors. Those are in particular used in excessive strength programs as much as tens of megawatts for frequency reduction. Some of the packages of cycloconverter encompass excessive strength AC drives, propulsion systems, excessive frequency induction heating, synchronous vehicles in sea and undersea vehicles, electromagnetic launchers, and so for[1]. A cycloconverter refers to a frequency changer that could to change AC strength from one frequency to AC energy at another frequency. This process is known as AC-AC conversion. It is mainly used in electric traction, AC motors having variable speed and induction heating. A cycloconverter can gain frequency conversion in a single degree and guarantees that voltage and the frequencies are controllable. In addition, the want to use commutation circuits isn't always essential as it makes use of herbal commutation. Electricity transfer within a cycloconverter takes place in two guidelines (bidirectional)[2]. Moreover, operations are only smooth at frequencies that aren't equal half frequency enter values. This is genuine due to the fact a cycloconverter is an AC-AC converter this is section managed. Harmonics in a cycloconverter are specially laid low with techniques of manipulate, overlap impact, the wide variety of pulses in a given cycle, operation mode and mode of conduction.

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After that the simulation and analysis of the idea of single phase to single phase cycloconverter are mentioned.[3].

SINGLE PHASE CYCLOCONVERTER

A cycloconverter is a device that converts AC power at one frequency into AC power of an adjustable but lower frequency without any direct current or DC stage in between. A cycloconverter can achieve frequency conversion in one stage and ensures that voltage and the frequencies are controllable. In addition, the need to use commutation circuits is not necessary because it utilizes natural commutation. A major problem with cycloconverters is that when it is operating at small currents, there are inefficiencies created with firing delay[7 9]. There are two types of cycloconverters−

- **Step up Cycloconverter**

These types use natural commutation and give an output at higher frequency than that of the input.

- **Step Down Cycloconverter**

This type uses forced commutation and results in an output with a frequency lower than that of the input. Cycloconverters are further classified into three categories –

- **Single-Phase to Single-Phase**

This type of cycloconverter has two full wave converters connected back to back. If one converter is operating the other one is disabled, no current passes through it.

- **Three-Phase to Single-Phase**

This cycloconverter operates in four quadrants that is (+V, +I) and (−V, −I) being the rectification modes and (+V, −I) and (−V, +I) being the inversion modes.

- **Three-Phase to Three-Phase**

This type of cycloconverter is majorly used in AC machine systems that are operating on three phase induction and synchronous machines.

A device which converts input at one frequency to output power at a different frequency with one-stage conversion is called a cycloconverter. In this section basic principle of operation of step up as well as step down cycloconverter is presented. For understanding the principle of step down cycloconverter requires force commutation. It consists of eight thyristors P1 to P4 and N1 to N4, P for positive group and N for negative group as shown in figure 1. During the positive half cycle of a supply voltage thyristors P1 & P2 and N1 & N2 are forward biased. The forward baised thristors P1 & P2 are turned on together at wt = 0 and N1 & N2 are turned on together at 3π for 2 times output response to input response and 4π for 4 times output response to input response. During negative half cycle thyristors pair P3, P4 and N3, N4 are forward baised. The forward baised thyristors P3, P4 are turned on together at wt = π and N3 & N4 are turned on together at 4π for 2 times output response to input response and 5π for 4 times output response to input response as shown in fig. 2[4]

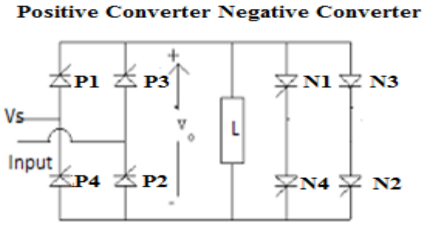


Fig 1: *Single Phase bridge type Cycloconverter*

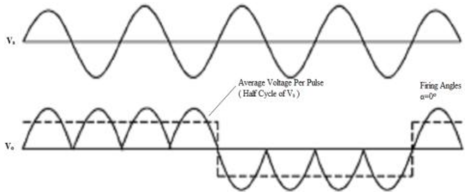


Fig 2: *Input Voltage and Output Voltage Waveform of Cycloconverter*

The rms value of output voltage of cycloconverter is given by:
$V_{or} = [\frac{1}{\pi}\int_{\alpha}^{\pi} Vm^2 \sin^2 \acute{\omega}t \; d(\acute{\omega}t)]^{1/2}$, α is s firing angle, V_m is a maximum voltage of input supply and here firing angle (α) is 0^o[4].

SIMULINK MODEL OF CYCLOCONVERTER

This is a simulink model of single phase to single phase bridge type cycloconverter at resistive load. IGBT used in behalf of the thyristors as shown in figure 3, IGBT will work when external pulse applied to the IGBT. The IGBT P1 & P2 are triggered by pulse generator 1, IGBT P3 & P4 are triggered by pulse generator 2, IGBT N1 & N2 are triggered by pulse generator 3, IGBT N3 & N4 are triggered by pulse generator 4. The P groups IGBT is used for positive waveform and N groups IGBT is used for negative waveform. By this simulink model of cycloconverter at resistive load 2 & 4 times output response to input response have obtained as shown in fig. 4 & 5 according to time duration of pulse generator[5]. Here all IGBT are fired at angle 0^o it means IGBT acts like a diode. In this simulink model 50 hz and 230 V AC voltage supply is used as input signal in the paper and also 8 IGBT and 4 different types pulse generator is used. This paper is analyzed that triggering based cycloconverter at resistive load and output response two & four times to input response have obtained as shown in figure 4 & 5. Here simulink model of single phase bridge types cycloconverter have designed and analyzed as shown in fig. 3.

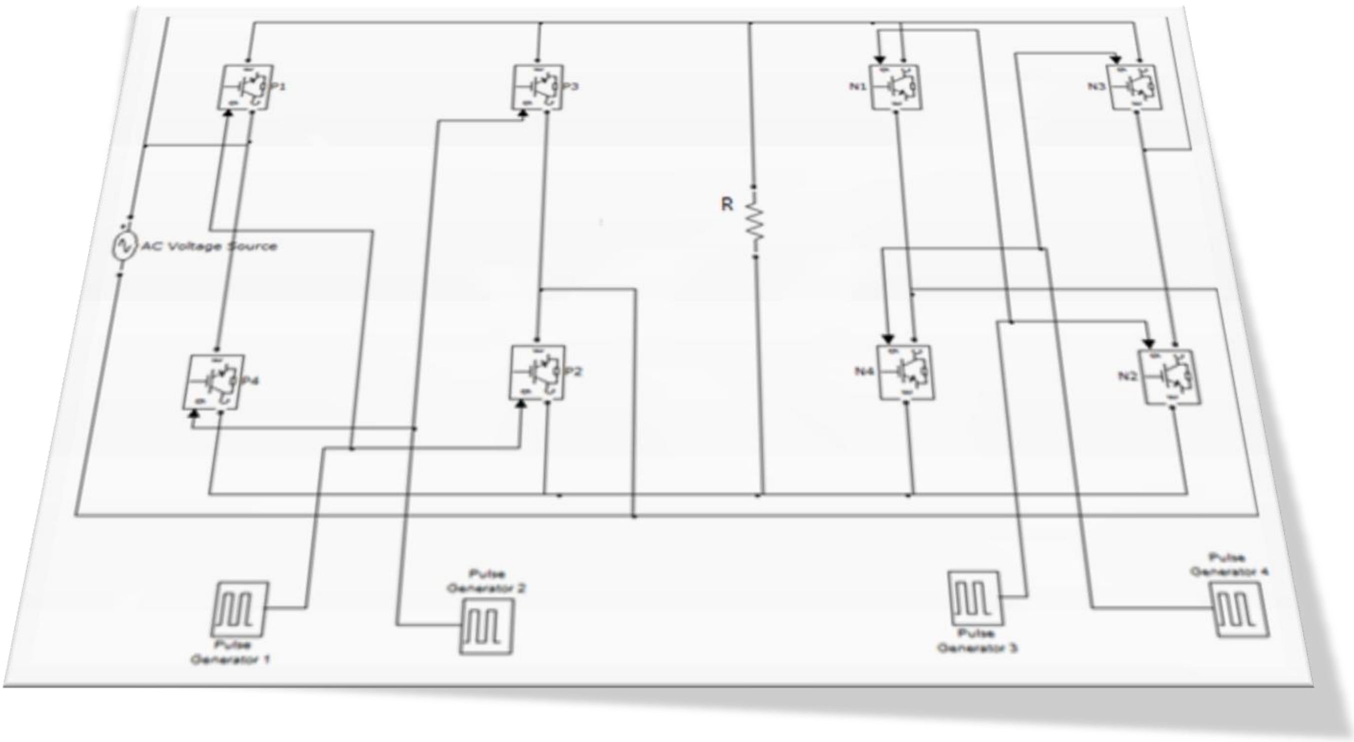
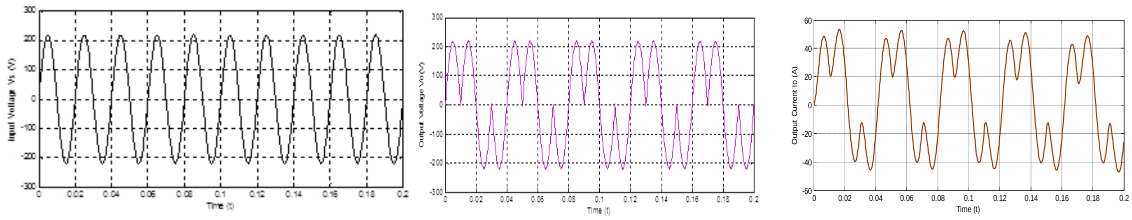
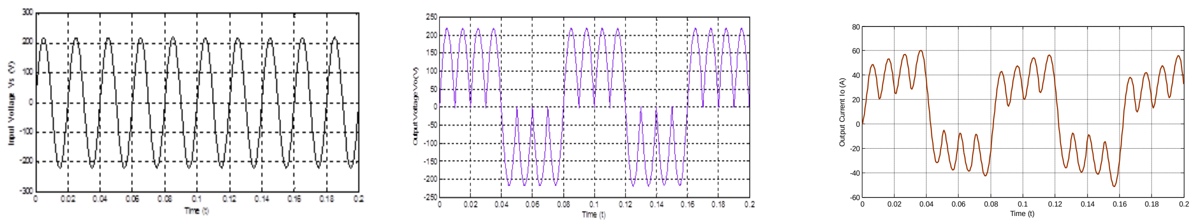


Fig 3: *Simulink Model of Single Phase to Single Phase Bridge Type Cycloconverter*



(a) (b) (c)

Fig 4: *(a) Input Voltage Waveform of Cycloconverter (b) Output Voltage Waveform of Cycloconverter (c) Output Current Waveform of Cycloconverter, When Input Frequency is Two Times Output Frequency*



(a) (b) (c)

Fig 5: *(a) Input Voltage Waveform of Cycloconverter (b) Output Voltage Waveform of Cycloconverter (c) Output Current Waveform of Cycloconverter, When Input Frequency is Four Times Output Frequency*

CONCLUSION

The triggering based controlled single phase cycloconverter circuit is designed, simulated and desired above results are obtained. Single phase to single phase bridge cycloconverter at resistive load are developed and obtained output response two and four times to input response which is used for the different motors and machine. This different frequency of cycloconverter is also useful to replace flywheel from the operating machine which reduces the cause of torsional vibration and fatigue damage of machine.

FUTURE APPLICATIONS

Cycloconverter have produced harmonics in output voltages, here only lower order have removed and higher order harmonics will removes from external aided cicuits. When cycloconverters are using for a running AC machine, the leakage inductance of the machine filters most of the high frequency harmonics and reducing voltage of the lower order harmonics. A speed controller of three phase motor on cycloconverter is proposed in future. It is very possible that there will soon be a possible combination of higher frequency generators and cycloconverter. The cycloconverter may be connected to different motors and observed the output responses. In the future cycloconverter will perform with the higher frequency.

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Biography

Shashank Mishra
(Author)

Mirza Mohammad Shadab
(Co – Author)

Isarar Ahmad
(Co – Author)

1. **Corresponding Author : Shashank Mishra** is the student of M-Tech final year (Electrical Engineering) in Integral University , Lucknow (U.P.) INDIA. He has received his B-Tech Degree in Electrical & Electronics Engineering from IIMT Institute of Engineering and Technology, Meerut affiliated to UPTU Lucknow in 2012.
2. **Co- Author : Mr. Mirza Mohammad Shadab** was born in Lucknow, Uttar Pradesh, India. He received B.Tech degree in Electrical & Electronics Engineering from Integral University, Lucknow, U.P in 2008, M.Tech degree in Electrical Engineering from Aligarh Muslim University, Aligarh, U.P, in 2011. He is pursuing PhD in electrical engineering from Integral University, Lucknow. He is working as an Assistant Professor in the Department of Electrical Engineering, Integral University, Lucknow, India. His research interests include renewable energy systems, multilevel inverters, power system and drives.
3. **Co- Author : Mr. Isarar Ahmad** was born in Balia, Uttar Pradesh, India. He received B.Tech degree in Electrical & Electronics Engineering from UCER Allahabad U.P in 2009, M.Tech degree in Electrical Engineering from NIT Hamirpur in 2011. He is pursuing PhD in electrical engineering from Integral University, Lucknow. He is working as an Assistant Professor in the Department of Electrical Engineering, Integral University, Lucknow, India. His research interests power system and power electronics.

