International Journal of Current Trends in Engineering & Technology
ISSN: 2395-3152
Volume: 03, Issue: 01 (JANUARY– FEBRUARY, 2017)

Multi Pulse Converter Used For Harmonics Reduction and Improvement of Efficiency

Ranjana Singh[1], Sunita Prasad[2] and Aamir Nasir[3]
Department of Electrical and Electronics Engineering [1, 2, 3]
MIT, Bhopal[1, 2, 3]
[1]ranjanabeee@gmail.com, [2]sunita.31prasad@gmail.com, [3]aamir12889@gmail.com

***Abstract**: -* When power electronics devices used as switching harmonic are generate within the line. These harmonic brought on dangerous influence on transmission line like dipping of voltage, it additionally minimized the efficiency and lifetime of equipments. In this study offers line commutated controlled multipulse converters for fixing the harmonic problem. The outcome of increasing the quantity of pulses on the performance of AC to DC converters has been analyzed. For efficiency assessment important reasons considered are the ripple percentage, form factor and the complete harmonic distortion (THD). The consequences of load variation on multi-pulse AC to DC converters have additionally been investigated. This work shown the comparative study of 24, 36, forty eight and 60 pulse converters.

Keywords: **-** Multipulse converter, Harmonics distortion, Ripple counters.

I. INTRODUCTION

Three-segment managed rectifiers have a vast variety of applications, to tremendous high voltage direct current (HVDC) transmission systems from small rectifiers. They are used for electrochemical strategies, wide range of motor drives, controlled vigor presents, traction gear and different applications. The commutation approach can also be categorized into two major categories particularly: Line-commutated controlled rectifiers and drive-commutated pulse width modulated rectifiers. There are a couple of tactics in particular adopted for the mitigation of harmonics in a 3-section converter and multi-pulse converters fall within the same category of remedial measures. Multi pulse converters are essentially the most predominant answer for harmonic problem in a three-section converter procedure. With the advancements in technology advances these converters and different vigor electronic devices with built-in magnetic providing high enter vigor first-rate and better efficiency would be required with the aid of many industrial, business functions, energy provides. The outcome of increasing the number of pulses of AC to DC converters directly alters its efficiency parameters like ripple percentage, type element and the total harmonic distortion. Multi-pulse converters are converters delivering more than six pulses of DC voltage per cycle from AC input or the converter having extra steps in AC enter present than that of six pulse bridge rectifier supply present. Phase moving transformers are used to derive multipulse section deliver from three-segment AC mains using different combos of transformer windings such as big name, delta, zigzag, polygon, fork and so on. In this thesis we use zigzag transformer. The segment-shifting transformers play a key role in the multi-pulse rectifier's efficiency. Jiaopu et. Al [1] discussed typically used normal connections of segment-moving transformer, equivalent to Scott, polygon, megastar/delta, elevated-delta and zigzag and gave the analyses and comparisons between them. Focusing on 12-pulse segment-moving transformers, the research highlighted viable systems from basic connections to 12-pulse section-transferring transformers which illustrate the evolution and its normal standards which could also be increased to better pulse converters.

Singh ET. Al [3] analyzed the efficiency of multi-pulse electronic load controller for isolated asynchronous generator, as load controller conventional electronic situated six pulse uncontrolled rectifier contains massive content of harmonics. A comparative be trained of three phase controlled multi pulse converters was once presented by way of [4] for biomass, fuel turbine, wind method situated vigor plant, diesel, hydro, , and integrated enter current shaping of managed rectifier making use of multi-pulse current shaping proposal.

The writer Xigeng et.Al [6] introduced the cognizance of section-moving of the multi-pulse converter transformer and the method for calculating stretch section-shifting perspective, triangle voltage and the 7 number of windings and analyzed the simulation for the 30-pluse rectification process centered on this transformer. Arvindan et.Al [7] proposed two 24-pulse rectifier topologies established on section moving making use of conventional magnetic over PSCAD environment.

II. CONTROLLED RECTIFIERS

There are two types of conversion techniques , one is uncontrolled in which diodes are implemented and other is controlled in which thyristors are implemented respectively [8].The performance improvement is achieved for total harmonics distortion (THD) in input current, DC voltage ripples and form factor. Three-phase controlled rectifiers have a wide range of applications, to large high voltage direct current (HVDC) transmission systems from small rectifiers. They are used for electrochemical processes, wide range of motor drives, controlled power supplies, traction equipment and other applications.

2.1 Three-phase Half-wave Rectifier

To control the load voltage, the half-wave rectifier uses three common-cathode thyristor arrangements. The thyristor will conduct (ON state), when the anode-to-cathode voltage VAK is positive and a firing current pulse iG is applied to the gate terminal. An angle α controls the load voltage by delaying the firing pulse.

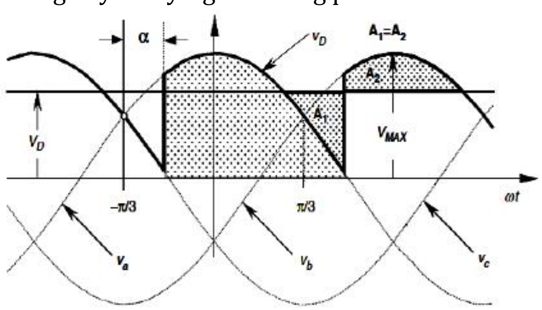


Fig 1: Instantaneous DC voltage VD, firing angle α and average dc voltage VD of half wave rectifiers.

The thyristor goes to the non-conducting condition (OFF state) when the following thyristor is switched ON, the current reached a negative value.

$$V_D = \frac{V_{Max}}{2/3\pi}\int_{-\frac{\pi}{3}+\alpha}^{\frac{\pi}{3}+\alpha} \cos\omega t.\, d(\omega t) \qquad (1)$$

2.2 Six-pulse or Double Star Rectifier

The thyristor side windings of the transformer shown in Fig.2 form a six-phase system, resulting in a six-pulse star point (midpoint connection). Disregarding commutation overlap, each valve conducts only during 60◦ per period.

$$V_D = \frac{V_{Max}}{\pi/3}\int_{-\frac{\pi}{6}+\alpha}^{\frac{\pi}{6}+\alpha} \cos\omega t.\, d(\omega t) \qquad (2)$$

2.3 Three-phase Full-wave Rectifier

Parallel connection via inter phase transformers permits the implementation of rectifiers for high current applications. For high voltage series connection is also possible, as shown in the full-wave rectifier of Fig.3. With this arrangement, it can be seen that the three common cathode valves generate a positive voltage with respect to the neutral, and a negative voltage is produced by the three common anode valves.

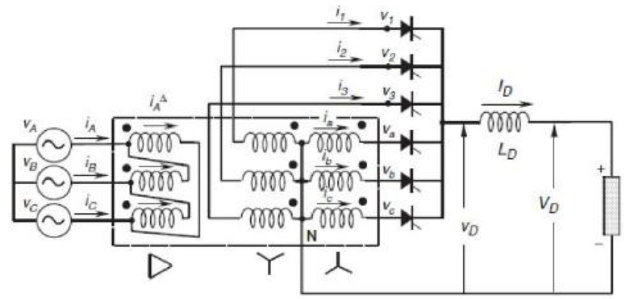


Fig 2: Six-pulse rectifier

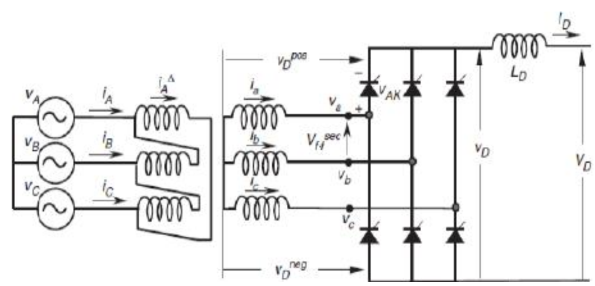


Fig 3: Three-phase full-wave rectifier

$$V_D = \frac{2V_{Max}}{2\pi/3}\int_{-\frac{\pi}{3}+\alpha}^{\frac{\pi}{3}+\alpha} \cos\omega t.\, d(\omega t) \qquad (3)$$

2.4 Harmonic Distortion

The currents of the line-commutated rectifiers are far from being sinusoidal. For example, the currents generated from the 3 phase full wave rectifier have the following harmonic content.

$$i_A = \frac{2\sqrt{3}}{\pi}\left(\cos\omega t - \frac{1}{5}\cos 5\omega t + \frac{1}{7}\cos 7\omega t - \cdots..\right) \qquad (4)$$

Some of the characteristics of the currents, obtained from Eq. (3.35) include: (i) the absence of triple harmonics; (ii) the presence of harmonics of order 6k ± 1 for integer values of k; (iii) those harmonics of orders 6k+1 are of positive sequence; (iv) those of orders 6k − 1 are of negative sequence; (v) the rms magnitude of the fundamental frequency is,

$$i_{1=\sqrt{6}/\pi}\, I_D \qquad (5)$$

and the rms magnitude of the nth harmonic is

$$I_n = i_1/n \qquad (6)$$

III. FORMULATION OF PULSE CONVERTERS

The 12-pulse rectifier was obtained with a 30◦ phase shift between the two secondary transformers. The basis for increasing pulse configurations is provided by the parallel transformers. For instance, the operation of 24 pulses is achieved by means of four transformers with 15◦ phase shift, and 48-pulse operation requires eight transformers with 7.5◦ phase shift. An ingenious and very simple way to reach high pulse operation is shown in Fig.4. This configuration is called dc ripple reinjection. It consists of two parallel converters connected to the load through a multistep reactor. The reactor uses a chain of thyristor-controlled taps, which are connected to symmetrical points of the reactor.

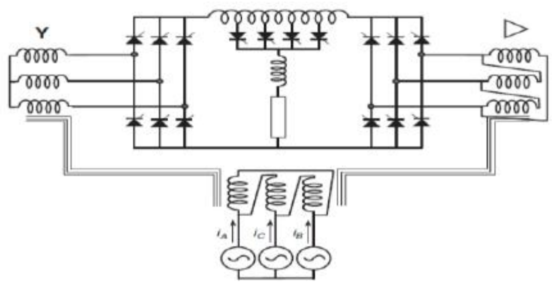


Fig 4: DC ripple reinjection technique of pulse operation

The thyristors located at the reactor is fired at the right time; high-pulse operation is reached. The pulse level operation depends on the number of thyristors connected to the reactor. The basic level of operation is multiplied to the two converters.

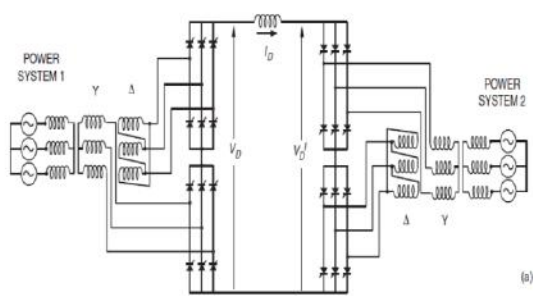


Fig 5: Typical HVDC circuit system

3.1 HVDC Power Transmission

The use of HVDC systems for interconnections of asynchronous systems is an interesting application. Some continental electric power systems consist of asynchronous networks such as those for the Texas, Quebec networks in North America, and islands loads such as that for the Island of Gotland in the Baltic Sea make good use of the HVDC interconnections.

IV. SIMULATION MODEL OF PULSE CONVERTERS

The present ac–dc converters are cost-effective for universal line and commercial voltage applications but are unreliable and fault prone for higher power applications. Thus, to lighten these problems, multi stage and multi pulse converters have been developed with the flexibility to compliment with custom power switching modes. For high and ultra high voltage levels the soft switching multi pulse converters offers attractive merits because the component count suffices with the cost of the system.

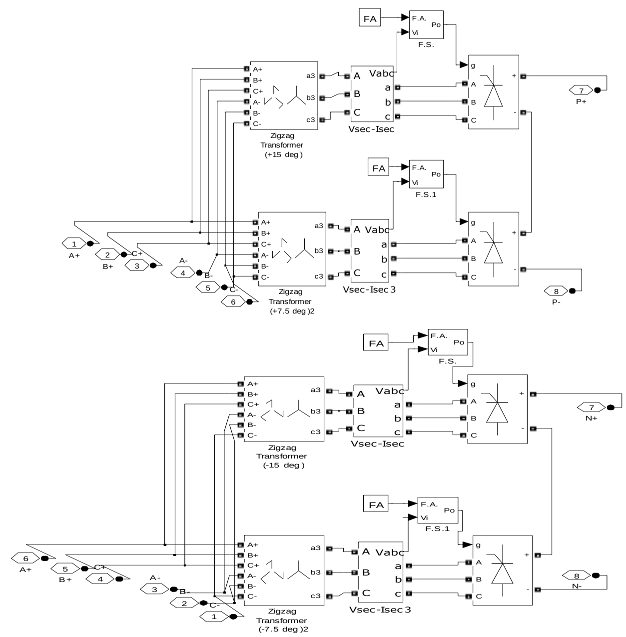


Fig. 6 Twenty Four pulse controlled converters with resistive load

4.1 Twenty Four-Pulse Converter

The below Fig 8, A which is shown below is having a twenty four pulse thyristorized converter circuits. Along with two universal bridges in each group at input side the converter requires 4 star-zigzag transformers, two on each positive phase group and negative phase group.

4.4 Thirty Six-Pulse Converter

The simulation model for thirty six pulse thyristorized converter circuit is shown in Fig.9. The converter requires 6 star-zigzag transformers at input side of the converter, 3 in positive phase group and 3 in negative phase group along with three universal bridges in each group

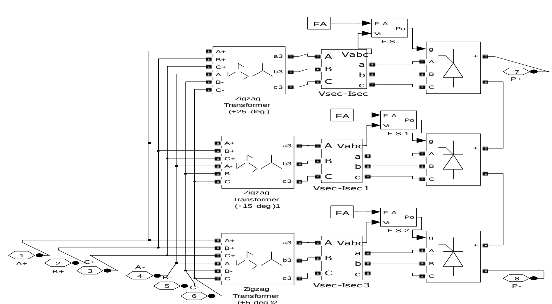


Fig. 7. Thirty six pulse controlled converters with resistive load

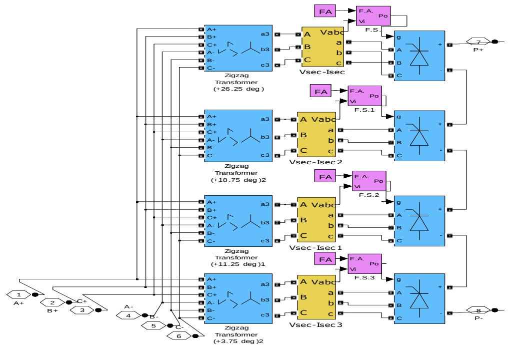


Fig. 8. Thirty six pulse controlled converters with resistive load

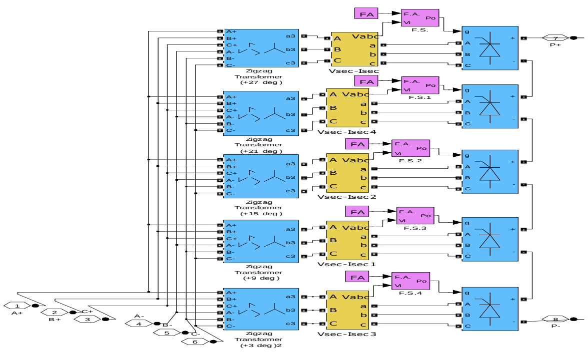
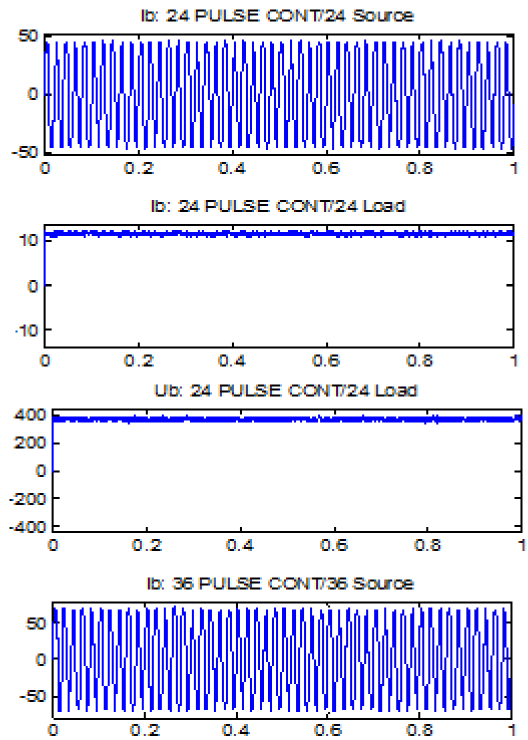


Fig. 9. Thirty six pulse controlled converters with resistive load

V. Results and Discussion



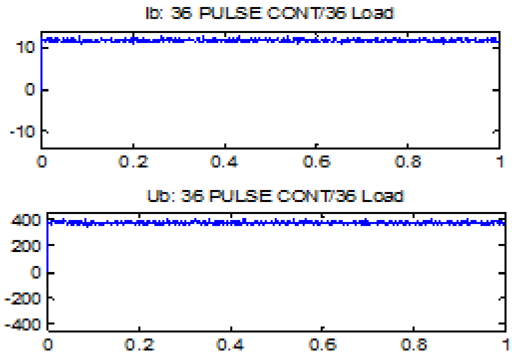


Fig.10.Ripple factor, form factor and mean value of voltage respectively of 24 and 36 pulse generator

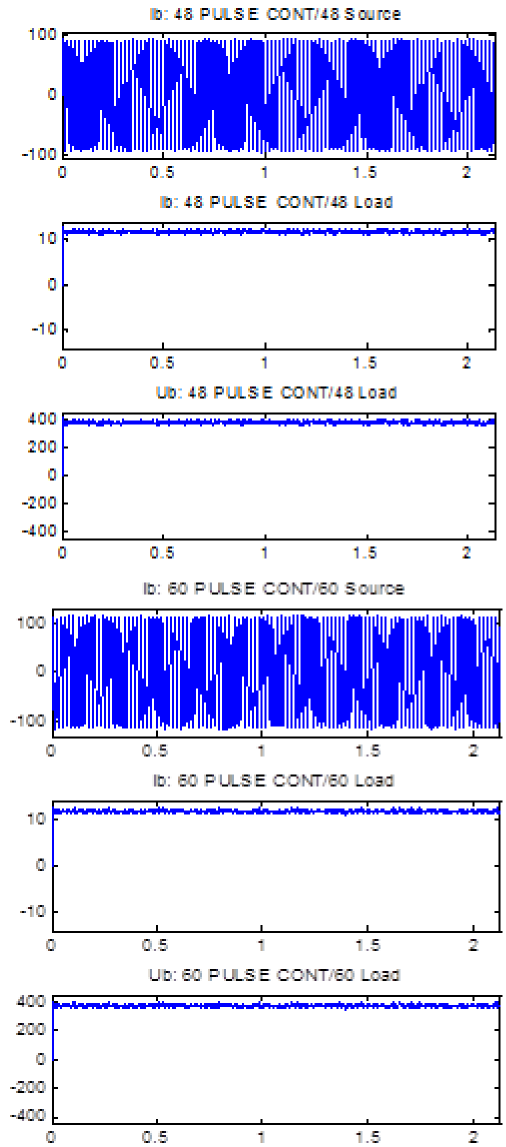


Fig.11.Ripple factor, form factor and mean value of voltage respectively of 48 and 60 pulse generator

Table 1 Comparative result of the converters

Converter pulses	Ripple %	Form Factor	THD
24	1.384	1	4.43
36	0.7016	1	1.90
48	0.7153	1	1.98
60	0.7329	1	1.16

VI. CONCLUSION

An analysis of simulation results was performed and the following conclusions can be drawn without loss of generality. Increasing the number of converter pulses reduces the voltage ripples. Form factor is also improves though insignificantly. The harmonics in the supply system are almost eliminated. The voltage ripples increase as the firing angle is increased.

REFERENCES

[1]. Wen Jiaopu; Haihong Qin; Shishan Wang; Bo Zhou, “Basic connections and strategies of isolated phase-shifting transformers for multipulse rectifiers: A review”, Asia-Pacific Symposium on Electromagnetic Compatibility (APEMC), pp 105-108, 2012.

[2]. R Maurya, P Agarwal, S.P Srivastava, “Performance investigation of Multipulse Converter for Low Voltage High Current applications”, IEEE International Conference on Computer Science and Automation Engineering (CSAE), pp-211-216, 2011.

[3]. P.K Singh, Y.K Chauhan, “Performance analysis of multi-pulse electronic load controllers for self-excited induction generator”, International Conference on Energy Efficient Technologies for Sustainability (ICEETS), pp-1299-1307, 2013.

[4]. A Chaturvedi, D Masand, Gupta, S.; Tiwari, S.; Jain, M., “Comparative analysis of three phase AC-DC controlled multi pulse converter”, IEEE Students' Conference on Electrical, Electronics and Computer Science (SCEECS), pp 1-4, 2012.

[5]. Valderra bano, A; Ramirez, J.M.; Correa, R.E., “A new 84-pulse VSC configuration using multi-level DC voltage reinjection for especial applications”, IEEE International Conference on Industrial Technology (ICIT), pp.1715-1720, 2010.

[6]. Xigeng Ma; Chao Li; Lina Bai; Ying Liu, “Analysis and Matlab Simulation of 30-Pulse Rectification System Based on Stretch Triangle Transformer”, International Conference on Electrical and Control Engineering (ICECE), pp 3312-3315, 2010.

[7]. A N Arvindan, A. Guha, “Novel topologies of 24-pulse rectifier with conventional transformers for phase shifting”, 1st International Conference on Electrical Energy Systems (ICEES), pp 108-114, 2011.

[8]. I. Sefa, Altin, N.; Colak, I; zdemir, S., “18 pulse controlled rectifier: A case study on UPS”, 13th European Conference on Power Electronics and Applications, pp 1-9, 2009.

[9]. Singh, B.; Garg, V.; Bhuvaneswari, G. , Design and Development of Autotransformer Based 24-Pulse AC-DC Converter fed Induction Motor Drive, 7th International Conference on Power Electronics and Drive Systems, 2007. PEDS '07, pp 73-80

[10]. Sahoo, AK.; Murugesan, K.; Thygarajan, T., Modeling and simulation of 48- pulse VSC based STATCOM using simulinkâ power system block set, International Conference on Power Electronics, 2006. IICPE, India, pp. 303-308, 2006.