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Sixty pulse AC-DC Controlled Multipulse Converter for Total Harmonic Reduction

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***Abstract*: - This paper deals with Multi-pulse AC to DC sixty pulse converters for total harmonic reduction. Harmonic voltages and currents in an electric power system are a result of non-linear electric loads. Harmonic frequencies in the power grid are a frequent cause of power quality problems. Harmonics in power systems result in increased heating in the equipment and conductors, misfiring in variable speed drives, and torque pulsations in motors. Reduction of harmonics is considered desirable. Thus for producing sixty pulse set of six pulse are required. All the simulations have been done on MATLAB platform for similar ratings for same configuration. The results are obtained for controlled converters for R Load.**

Index Terms-*Multi-pulse, Harmonics, Total Harmonic Distortion, Form factor, Ripple Content*

I. Introduction

Power electronic devices are non-linear loads that create harmonic distortion and can be susceptible to voltage dips if not adequately protected. This paper deals with multi-pulse converter for high voltage & high power application for example as in HVDC. The technique shown is based on dc current reinjection. Moreover, a control strategy over the whole range of phase delay angle is obtained along with complicated input current and output voltage study. Due to power electronics device various harmonics are encountered and thus it subject to voltage dip [1, 7]. Devices such as adjustable speed drive, HVDC system, uninterruptible power supplies etc are employed with three phase ac-dc conversion. AC-DC converters also known as rectifiers are developed by using thyristors and diodes which provides controlled and uncontrolled dc power [5, 3]. In this paper we discussed sixty pulse multipulse converters. The present work analyzes the sixty pulse AC-DC converters in solving harmonic problem in the three phase system. It is also analyzed the performance of increasing the number of pulses on AC to DC converter [5, 6]. The performance enhancement of multi-pulse converter is achieved for total harmonics distortion (THD) in supply current, DC voltage ripples and form factor [6].

II. Harmonics

Harmonics were non sinusoidal component present in sine waveform. Harmonics would cause serious problems in the power system. Harmonic distortion is not a new phenomenon on power system.

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The impact of harmonics on the quality of electrical power continues to be a critical concern
.

III. Types of Harmonics:

There are mainly two types of harmonics occurs in system:

A. Current Harmonics

In a normal alternating current power system, the current varies sinusoidal at a specific frequency, usually 50 or 60 hertz. When a linear electrical load is connected to the system, it draws a sinusoidal current at the same frequency as the voltage (though usually not in phase with the voltage).Current harmonics are caused by non-linear loads. When a non-linear load, such as a rectifier, is connected to the system, it draws a current that is not necessarily sinusoidal. The current waveform can become quite complex, depending on the type of load and its interaction with other components of the system. Regardless of how complex the current waveform becomes, as described through Fourier series analysis, it is possible to decompose it into a series of simple sinusoids, which start at the power system fundamental frequency and occur at integer multiples of the fundamental frequency. Further examples of non-linear loads include common office equipment such as computers and printers, Fluorescent lighting, battery chargers and also variable-speed drives.

B. Voltage Harmonics

Voltage harmonics are mostly caused by current harmonics. The voltage provided by the voltage source will be distorted by current harmonics due to source impedance. If the source impedance of the voltage source is small, current harmonics will cause only small voltage harmonics.

IV. Harmonics Fundamentals

Harmonics provides a mathematical analysis of distortions to a current or voltage waveform. Based on Fourier series harmonics can describe any periodic wave as summation of simple sinusoidal waves which are integer multiples of the fundamental frequency. Harmonics are steady-state distortions to current and voltage waves and repeat every cycle. They are different from transient distortions to power systems such as spikes, dips and impulses. with IEEE guide for Harmonic Control [2].

V. Total Harmonic Distortion

Total harmonic distortion or THD is a common measurement of the level of harmonic distortion present in power systems. THD is defined as the ratio of total harmonics to the value at fundamental frequency.

$$\mathrm{THD} = \frac{\sqrt{V_2^2 + V_3^2 + V_4^2 + \cdots + V_n^2}}{V_1}$$

Where V_n is the RMS voltage of nth harmonic and $n = 1$ is the fundamental frequency.

Advantages of Multipulse AC-DC Converters:

1. The performance parameters such as total harmonic distortion (THD) of AC mains current and ripple factor of output DC voltage improve simultaneously.

2. The improvement is independent of supply frequency variation, unlike passive filters.

3. Minimal or no control required as Diodes and / or Thyristors are mainly used.

4. Economic, Maintenance Free and Efficient.

5. Phase shifting transformers are used to derive multiple phase supply from three phase AC mains using different combination of transformer windings such as star, delta, zigzag, fork, polygon etc.

VI Simulation of Controlled Multi-Pulse Converter

A. Sixty Pulse Converters

In this configuration of 60 pulse operation, 10 six-pulse converters phase shifted from each other by 6 degrees. All 10 transformer primaries are to be connected in series. Figure 4 shows the arrangement of 60 pulse controlled converter in which there are two groups positive and negative. Positive group contain 5 six pulse converter and similarly negative group contain another 5 six pulse converter. In figure 1 positive group 5 six pulse converters is shown. [17]

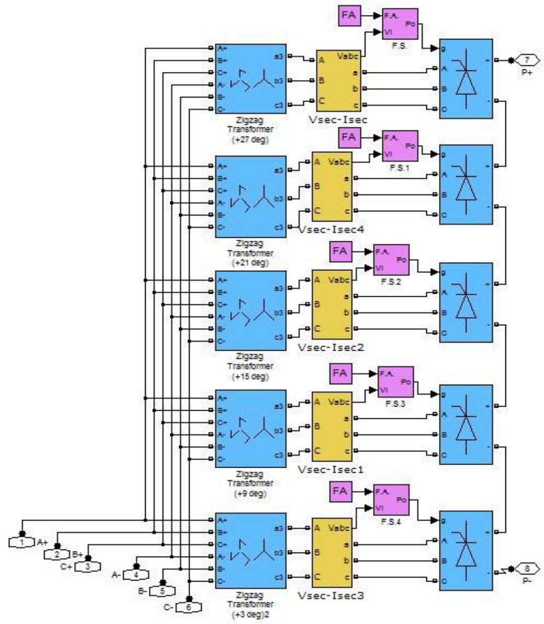

Fig 1. Controlled sixty pulse converter (positive group)

The ripple content and the form factor blocks are shown below in fig

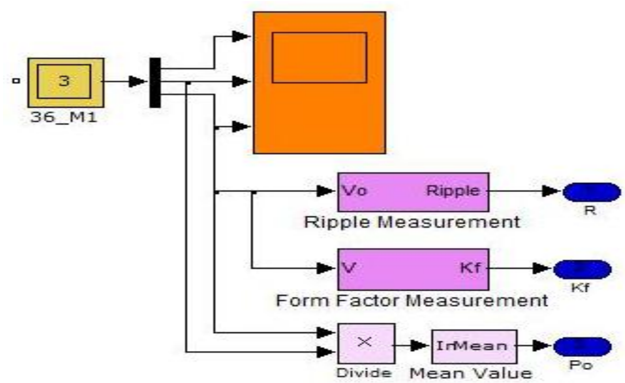

Fig.2 Modeling for ripple content

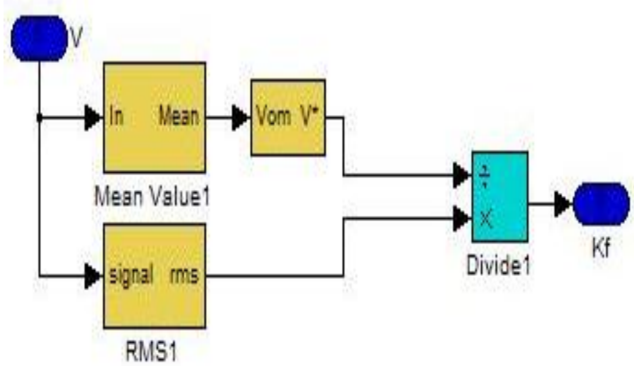

Fig 3.Modeling for form factor

VII Out-Put of Simulation Results

The figure in the following are given in three section (4, 5, 6) first is source current (SC), second is Load current or output current (LC), third is D.C output voltage (OV)

A. Sixty Pulse Converter

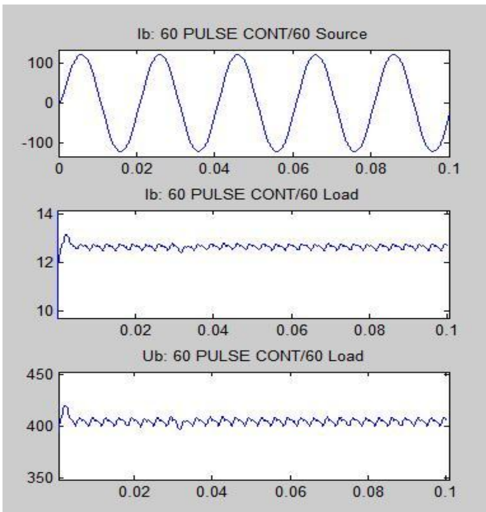

Fig. 4 Output for SC, LC, and OV for 60 pulses

B. Voltage /Firing angle output

60 pulse

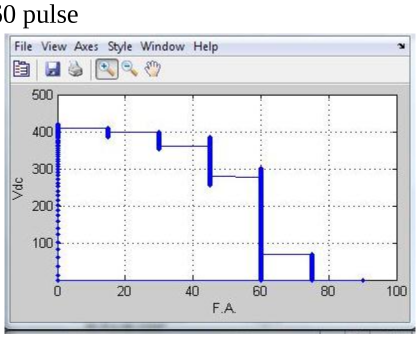

Fig. 5 Output for voltage vs. firing angle for 60 pulses

C. Ripple/Firing angle outputs

60 pulse

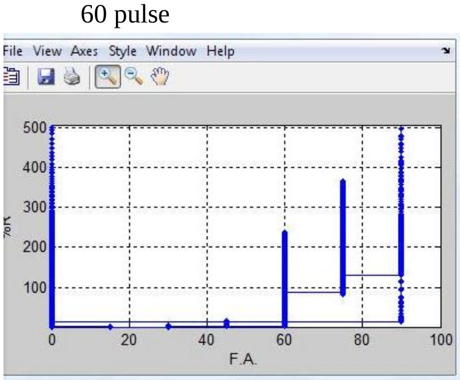

Fig. 6 Output for Ripple vs. firing angle for 60 pulse

VII Conclusion

A. Simulation:

The various multi-pulse configurations were simulated using the software MATLAB/ SIMULINK [5]. The effect of pulse variation on different multi-pulse converters reveals that with R load, there is smoothing effect on current and thus current THD decreases. The effect is similar for different multi-pulse converters.

B. Performance Analysis and Comparison

All the data obtained after simulation of models using MATLAB/SIMULINK has been collected here so as to ease the comparison factors accounted for i.e. THD, Form Factor, Ripple Content..

C. Result of Simulation

It is concluded therefore that in general with increase in number of pulses in multi-pulse case the performance parameters of these converters have remarkably improved. The THD for controlled converters has reduced than for the consecutive uncontrolled converters. The results are also compared and found effective

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Bibliography

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