International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 4, Issue 2, February 2015

REDUCED COMMON MODE NOISE AND LOWER ORDER HARMONIC IN PUSH PULL CONVERTER BY ACTIVE FILTER

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ABSTRACT

Power quality problems are major concern in the power systems. Harmonic and common mode noise are produced by the fast switching in power converters, EMI are produced by the electromagnetic induction or electromagnetic radiation emission from an external source. In recent, years active filter have become popular because of their excellent current harmonic and reactive power mitigation ability. In this paper reduced the common mode EMI noises and lower order harmonic in push pull converter by using active filter and PI controller used. Reduced the harmonic and common mode Electromagnetic Interference (EMI) noises in the source side of the push pull converter by Line Impedance Stabilization Network (LISN) and Active filter is implemented in the MATLAB/simulink model for verified the result of filter circuit. It is used for power factor correction, reactive power compensation to maintain constant current and mitigate harmonic in the source side of the power converter. Thus, the requirements of the current harmonic limits specified in IEEE std. 519-1992 are always satisfied under different load conditions.

Index Terms—**Active filter, EMI, LINS and PI controller.**

1. INTRODUCTION

The need for effectual control and efficient use of electric power has resulted in immense propagation of power semiconductor converters almost [1] all areas of electric power such as in utility, industry and other commercial applications. This has resulted in severe power quality problems, since most of these nonlinear converters contribute to harmonic injection into the power system, reduced power factor, unhinge, reactive power load [2] etc. The weakness of equipments in mechanical processing industry to poor power quality leads to heavy losses. Conventionally, passive L-C filters were used to reduce line harmonics [5]. However, the passive filters have the disadvantage of fixed compensation, large size, and occurrence of resonance with other elements. The new advances in power semiconductor devices have resulted in the development of Active Power Filters (APF) for harmonic control [7]. Different topologies of active power filters have been proposed for EMI and lower harmonic mitigation. The shunt Active Power Filter based on voltage source inverter (VSI) structure is an eye-catching solution to harmonic current problems.
The shunt Active Power Filter is a pulse width modulated (PWM) voltage source inverter that is connected in parallel [3] with the load. It has the capability to add harmonic current into the ac system with the same amplitude but in differing phase of the load [4]. The principle function of shunt active filter is compensation of source harmonic current i.e. it confines [8] the source harmonic current at the load terminals, hindering its diffusion into power system. The principal components of the Active Power Filter are VSI, a DC energy device that in this case is capacitor [9] and the connected control circuits. The performance of a shunt active filter depends mainly on the method used to compute the reference current and control method used to inject the preferred compensation current into the line [6].

2. CONFIGURATION AND PRINCIPLE OF ACTIVE FILTER

The proposed method contains [10] the three phase source connected to the diode bridge rectifier.

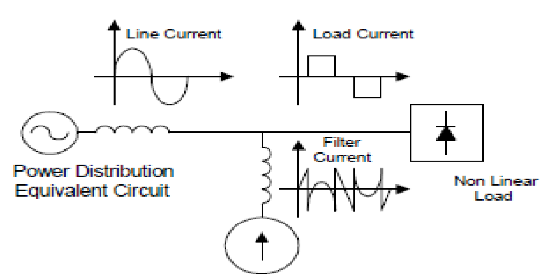

FIGURE .1.SINGLE LINE DIAGRAM OF ACTIVE FILTER

ISSN: 2278 – 909X

The active filter is connected in parallel to load. The Shunt Active Power Filter contains VSI connected in series with an inductor which acts as filter. The inverter [15] uses MOSFET because of its high switching frequency.

Inverter itself produces frequency current with low state loss. The structure of Shunt Active Power Filter for three phase three wire system is shown in Fig.1.The inverter [13] circuit triggering depends on the control path. The future system use PWM control to generate the pulse to trigger gate of MOSFET.

3. FILTER DESIGN

3.1. PUSH PULL CONVERTER WITHOUT FILTER CIRCUIT

Push pull converter is used to converter dc to dc power conversion. Power converter are normally produced the harmonic and EMI it reduced the power quality and reduced the goodness of the power in source side it causes many problems and power losses. Circuit diagram of push pull converter are shown in figure.2.

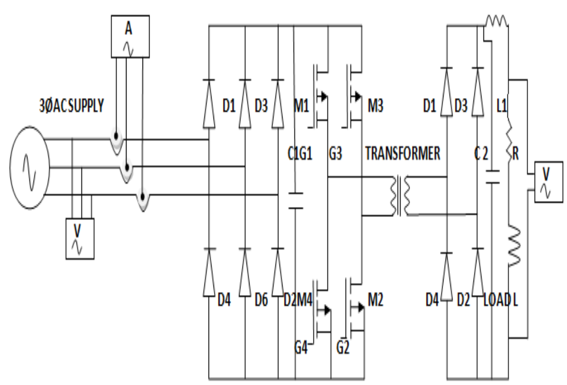

FIGURE.2. PUSH PULL CONVERTER WITHOUT FILTER CIRCUIT

Push pull converter are used as the dc to dc converter increased or decreased the output based on the inductor and capacitor selection in the secondary side of the transformer the out will be changed.

Using the buck converter formulas to calculated the values of the l and c output voltage is reduced or using the boost converter formulas to calculated the values of the l and c output voltage is increased these two methods are used to design the push pull converter.

3.2. LISN DESIGN

The common mode noise and differential mode noises are separated by power combiners for EMI filter design [15]. The power combiners have two types; they are 0^o and 180^o, and frequency response. Principle is to combine two power inputs.

The power of the input from the line (L) and the neutral (N) wire is denoted as PL and P respectively then the output power.

$$V_{CM}=\frac{LINE\ VOLTAGE + NEUTRAL\ VOLTAGE}{2}$$

$$V_{DM}=\frac{LINE\ VOLTAGE - NEUTRAL\ VOLTAGE}{2}$$

Line voltage = $V_{CM}+V_{DM}$

Neutral voltage = $V_{CM}-V_{DM}$

$$P_O= (PL + PN)/2 + \sqrt{(PL.PN.COS\theta)}$$

$$P0° = (PL + PN)/2 + \sqrt{(PL.PN})$$

$$P180° = (PL + PN)/2 + \sqrt{(PL.PN})$$

$$P_L= (V_{\ LINE})^2/R$$

$$P_N= (V_{\ NEUTRAL})^2/R$$

$$P_L= (V_{CM}+V_{DC})^2/R$$

$$P_N= (V_{CM}-V_{DC})^2/R$$

$$P_O(0^0)=2V^2_{CM}/R\ –1`$$

$$P_O(180^0)=2V^2_{DM}/R\text{--}2$$

Calculate the voltage common-mode noise VCM and voltage differential–mode noise VDM as the above equation R is the impedance for power combiner. We can measure the V_{CM} and V_{DM} by spectrum analyzer.

For conducted EMI measurement, the micro-voltage is commonly used as the reference unit From equation (1) and (2) the output noise voltage from the noise separator will be measured by the spectrum analyzer in relative units of dB μv, with constant input impedance R and it is "+3dB" above from the measured data in the design calculations [15].these are the calculating formulas used to calculate the EMI filter.

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3.3 PI CONTROLLER DESIGN

It is evident from the above discussions that the P-I action provides the dual advantages of fast response due to P-action and the zero steady state error due to I-action. The error transfer function of the above system can be expressed as:

$$\frac{e(s)}{r(s)} = 1 + \frac{\frac{1}{(kk_p(1+\tau_i s))}}{(\tau_i s(1+\tau_i s))}$$

$$= \frac{\tau_i\,(1+\tau_s)}{s^2\,\tau\tau_i\ + (1+kk_p)\tau_i\,s + kk_p}$$

In the same way as in integral control, we can close that the steady state error would be zero for P-I action. Besides, the closed loop characteristic equation for P-I action is:

$$s^2\tau\tau_i + (1+kk_p) + \tau_i s + kk_p = 0$$

From which we can obtain, the damping constant use:

$$\varepsilon = \frac{1+kk_p}{2}\sqrt{\frac{\tau_i}{kk_p\tau}}$$

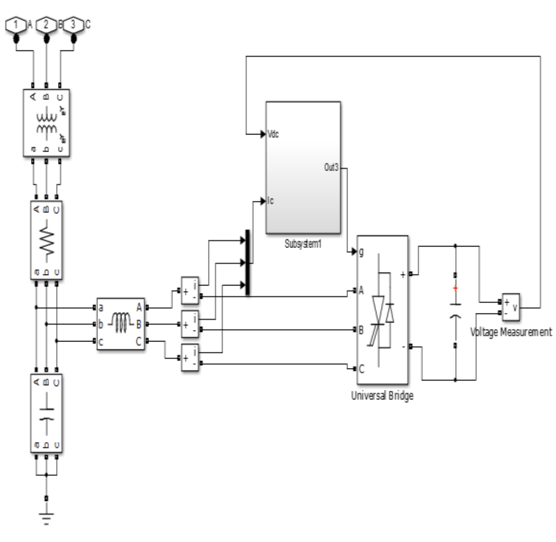

FIGURE.4.SHUNT ACTIVE FILTER SIMULATION DIAGRAM

Whereas, for simple integral control the damping constant is:

$$\varepsilon = \left(\frac{1}{2}\right)\sqrt{\frac{\tau_i}{k_\tau}}$$

Comparing these two, one can easily observe that, by varying the term K_P, the damping constants be increased. So we can conclude that by using P-I control, the steady state error can be brought behind to zero, and simultaneously, the transient response can be improved by this method.

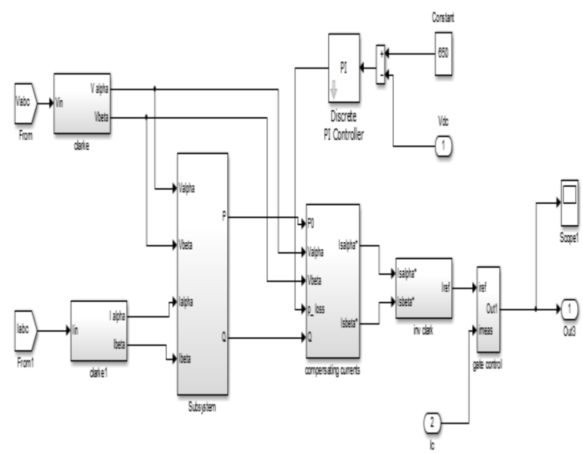

FIGURE.5. SUBSYSTEM SIMULINK DIAGRAM

Simulink diagrams of the shunt active filter are shown in above diagrams these are the basic blocks used to develop the PI controller in the MATLAB/simulink.

The above Line Impedance Stabilization Network and PI controller are designed and implementation in the push pull converter shown in section 4 given below.

4. IMPLEMENTATION OF LISN AND SHUNT ACTIVE FILTER IN PUSH PULL CONVERTER

Shunt active filter is placed parallel to the Main circuit and LISN also introduced in front side of the converter shown in the figure.6. This method is mainly used to reduce the EMI in source side and harmonic reduction.

Shunt active filter are connected parallel to the line terminals.

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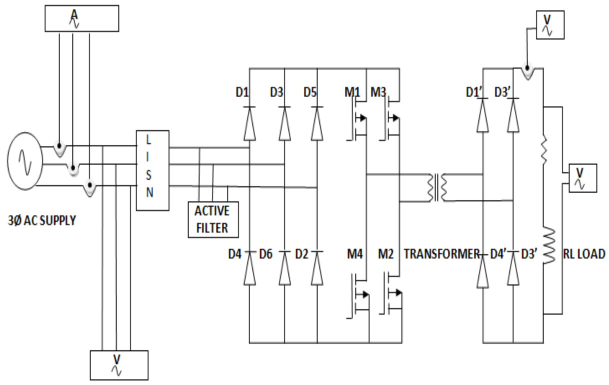

FIGURE.6. PUSH PULL CONVERTER WITH FILTER CIRCUIT

Calculated the total harmonic distortion by the help of the FFT analysis. EMI value also analysis to design the LISN values.

4. RESULT DISCUSSION

4.1. WITHOUT FILTER CIRCUIT

Source side noise reduction is main aim of this project compared the source side voltage and current with and without filter shown below. Using the FFT analysis harmonic are analysis and the wave form with and without filter circuit are shown, FFT analysis report also shown in below diagrams.

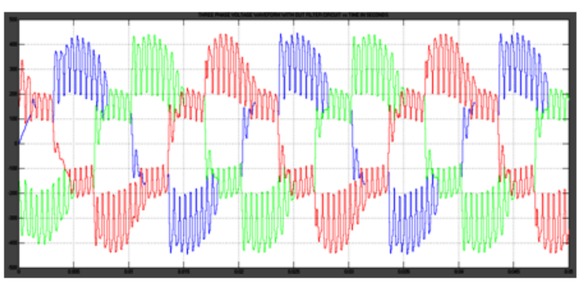

FIGURE.6. VOLTAGE WAVEFORM WITHOUT FILTER CIRCUIT

Source side voltage profile of without active filter is shown in the Fig.6.the simulation period is set for 0.1sec.

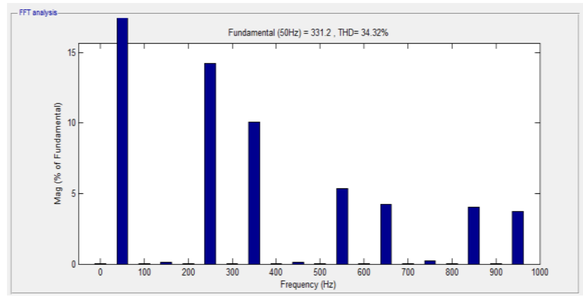

FIGURE.7. FFT ANALYSIS FOR VOLTAGE WAVEFORM WITHOUT FILTER CIRCUIT

The FFT analysis of source side voltage without filter circuit is shown in the Fig.7.the 3rd order harmonic is 6.27%, the 5th order harmonic is 1.3%, the 7th order harmonic is 4.31% and 9th order harmonic is 4.31% for the fundamental frequency of 50Hz, the THD of source voltage without filter is 34.4%. The THD analysis for the simulation period is 0.1second.

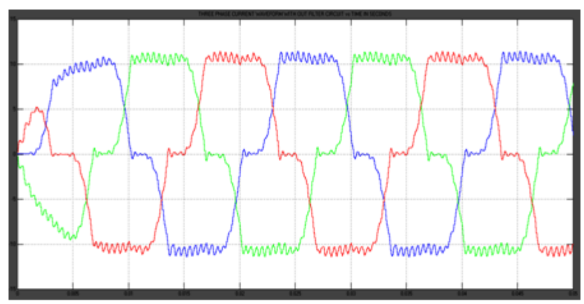

FIGURE.8. CURRENT WAVEFORM WITHOUT FILTER CIRCUIT

Source side current profile of without active filter is shown in the Fig.8.the simulation period is set for 0.1sec

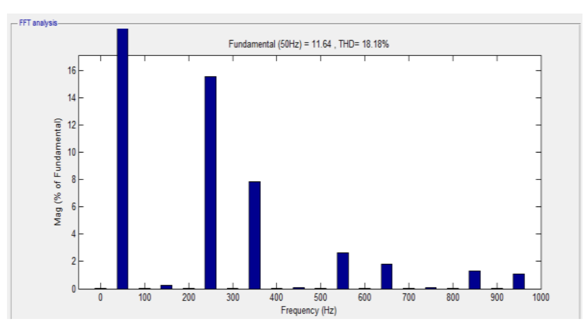

FIGURE.9. FFT ANALYSIS FOR CURRENT WAVEFORM WITHOUT FILTER CIRCUIT

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Without filter circuit the total harmonic distortion are analysis by the FFT filter and lower order harmonic percentage are showed and total harmonic of the source current and voltage for the simulink period is set for 0.1 seconds.

4.2. WITH FILTER CIRCUIT.

In the push pull converter implementation the LISN and active filter reduced the total harmonic distortion and common mode noises .the results are shown below diagrams and FFT analysis.

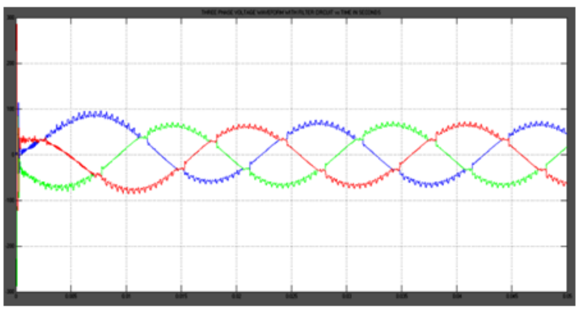

FIGURE.10.VOLTAGE WAVEFORM WITH FILTER CIRCUIT

Source side voltage profile of with active filter is shown in the Fig.10. The simulation period is set for 0.1sec.Voltage waveform

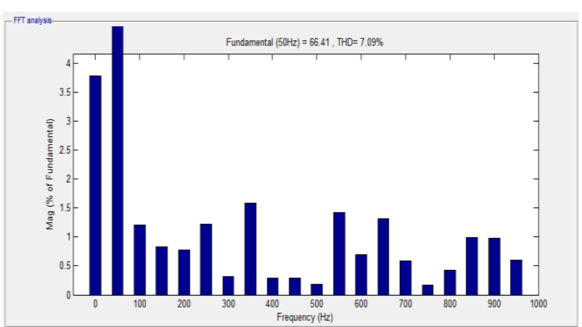

FIGURE.11. FFT ANALYSIS FOR VOLTAGE WAVEFORM WITH FILTER CIRCUIT

The FFT analysis of source side voltage with filter circuit is shown in the Fig.11.the 3rd order harmonic is 0.15%, the 5th order harmonic is 2.93%, the 7th order harmonic is 1.64% and 9th order harmonic is 0.27% for the fundamental frequency of 50Hz, the THD of source voltage without filter is 7.09%. The THD analysis for the simulation period is 0.1 sec.

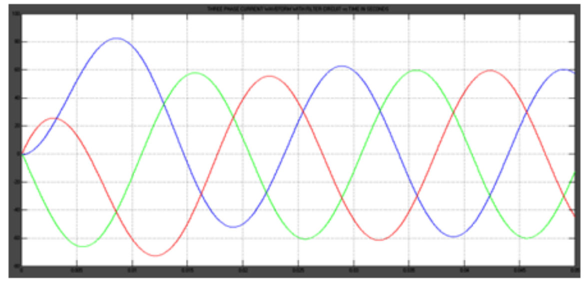

FIGURE.12. CURRENT WAVEFORM WITH FILTER CIRCUIT

Source side current profile of with active filter is shown in the Fig.12.the simulation period is set for 0.1sec

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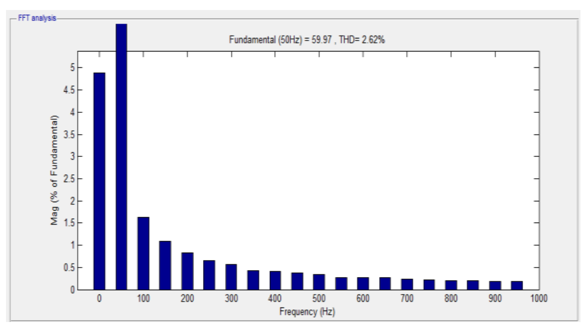

FIGURE.13. FFT ANALYSIS FOR CURRENT WAVEFORM WITH FILTER CIRCUIT

The FFT analysis of source side current with filter circuit is shown in the Fig.13.the 3rd order harmonic is, the 7th order harmonic is and 9th order harmonic is for the fundamental frequency of50Hz, the THD of source voltage without filter is 2.6%. The THD analysis for the simulation period is 0.1second.

4.3 COMPARASION OF VOLTAGE AND CURRENT WITH AND WITHOUT FILTER CIRCUIT

The below tabulation shown the comparison of the voltage and current total harmonic distortion with filter circuit and without filter circuit shown. The harmonic and noise are reduced by the filter circuit are clearly shown.

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TABLE.1. COMPARISON BETWEEN WITH AND WITHOUT FILTER

SNO	PARAMETERS	WITHFILTER THD	WITHOUT FILTER THD
1	VOLTAGE	34.3%	7.09%
2	CURRENT	18.18%	2.6%

Voltage and current parameters are compared in table reduced the current harmonic and voltage harmonic

5. Conclusion.

In this paper reduced the lower order harmonic, EMI in source side, losses and improved the power quality. PI controller are used in this paper used many mathematic calculation to improved the power quality. Active power filters are modern day devices which are capable of compensating to a very large expand. Usually when passive filters where used, there were many problem associated with it. So, active filters were used excessively because of its innate advantages. In the paper present, the two cases with and without filter were analyzed through MAT LAB/Simulink model. Then after calculating the in both cases the results showed that by shunt active power filer compensates harmonics by reducing the below the IEEE norms.

6. References

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ISSN: 2278 – 909X