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ANALYSIS OF SHUNT ACTIVE FILTER WITH REFERENCE CURRENT GENERATION BASED ON LMS ALGORITHM

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Abstract

Power Quality improvement is the major area of research in the last few years due to the extreme use of semiconductor and non-linear loads. For the reduction of carbon emission and to improve the efficiency of electrical network and loads. The harmonics present in the system are responsible for the deficiency of the system and load efficiency. These harmonics interruption into the grid can be prevented by the use of shunt active power filter. The least mean square method is used for implementing the hysteresis current control. The dc bus voltage is regulated by using PI controller. The control methods are responsible for generation of reference currents, the compensation of harmonics depends upon the algorithm used. The performance of shunt active filter with the proposed algorithm for the filter has been analysed in different operating condition. The Shunt active filter with DC bus voltage control is analysed by the Matlab Simulink.
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Index Terms: *SAPF Shunt Active Power Filter, Non Linear Loads, Current Harmonics, Least Mean Square LMS*

1. INTRODUCTION

Broad utilizations of nonlinear loads have caused alarming power quality issues, notably current harmonic contamination to the electrical power system. Generally, the injected harmonic currents deteriorate power quality by increasing total harmonic distortion (THD) of a power system. Moreover, they are also the main culprit to reduction of overall power system efficiency (indicated by low power factor), overheating of equipment, failure of sensitive devices, and even blown capacitor [1,2,3]. As a result, it is obligatory to limit harmonic contents in power system and maintain it within an acceptable level.

In conjunction with the mitigation efforts, IEEE standard 512-1992 has been formulated (presently revised as IEEE standard 519-2014 [4]) to strictly limit level of harmonic distortion within 5% THD and also harmonic filters are installed in the polluted power system to minimize power quality issues due to harmonic currents. Conventionally, the harmonic filters are developed based on passive elements such as inductors and capacitors to deal with specific harmonic issues (i.e., they only have fixed mitigation ability) [5]. However, due to their inherent weaknesses of inflexibility, instability, and large size, they are soon replaced by active power filters (APFs) which offer versatile solution to harmonic problems [6,7,8].

The Shunt active power filter is one of the power filter that has a dynamic performance and this needs a better control methodology to provide a better overall performance of the power system. This control techniques are responsible for the generation of reference currents used to trigger the voltage source inverter.

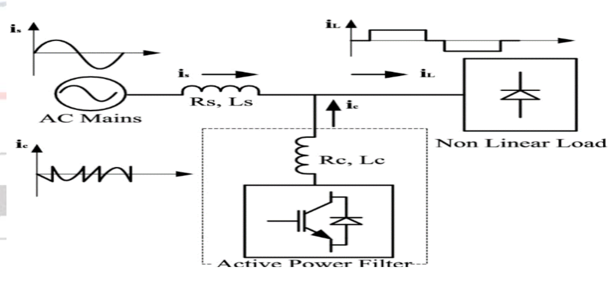

Fig. 1: Shunt Active Power Filter.

1.1 Working

The shunt active filter generates the harmonic currents that is equal and opposite in phase with the reactive current which is involved from the load end. Harmonics current and reactive current components cancelled at the source end and the result is distortion less sinusoidal waveform. The active filters overcome the problems of passive filters. Main advantage of active filters to

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compensate for the harmonics value lower than 5% at the point of common coupling. Active filters provides compensation voltages and currents.

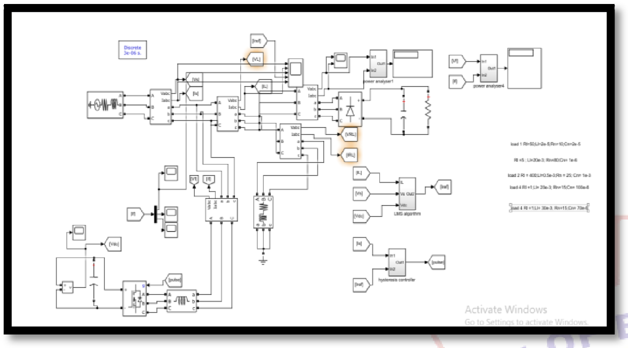

Fig. 2: Proposed Model.

1.2 Mathematical Modelling

Non Linear Load- The three phase full bridge rectifier with RL load acts as a non-linear load which distorts line current, source voltage is given by

$$V_{in} = V_m Sinwt$$

$$I_{st} = \sum_{h=1}^{\infty} I_h Sin\,(h_{wt} + \emptyset_h)$$

$$I_{st} = I_1 Sin(\omega_{st} + \emptyset_1) + \sum_{k=2}^{\infty} I_k Sin\,(h_{wt} + \emptyset_k)$$

Where $I_1$is the fundamental current and $I_k$is the harmonic current, V_{in} is the peak supply voltage, ω_{st} is the fundamental frequency, $\emptyset_k$ is the phase angle between supply voltage and current of the kth harmonic component.

The shunt active passive filter is tuned for the harmonic frequency of line current and this filter will provide reactive power compensation.

The distorted current is given by

$$I_l(t) = I_f(t) + I_h(t)$$

For proper compensation of harmonics and power factor improvement the supply current should have fundamental component and in phase with the supply mains.

$$I_s(t) = I_m Sin(\omega_{st}) = I_f(t)$$

Where Im is the maximum fundamental component of current and w is the supply frequency.

1.3 Least Mean Square Algorithm

The least mean algorithm uses a gradient based method. This algorithm uses the estimates of the gradient vector from the available data. This method includes an iterative procedure that makes successive corrections to the weight vector in the direction of the negative of the gradient vector which leads to the minimum mean square error.

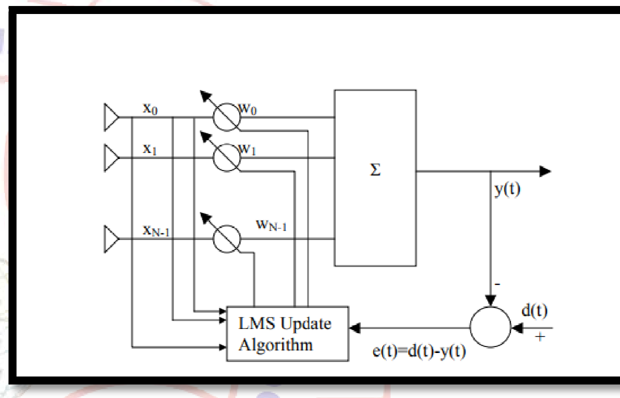

Fig.3: LMS adaptive beam forming network.

From the method of steepest descent, the weight vector equation is given by

$$\omega\,(n+1) = \omega(n) + \frac{1}{2}\,\mu\,[\,-\nabla(\,E\{e^2(n)\})]$$

Where $\mu$the step is is size parameter and controls the convergence characteristics of the LMS algorithm, $e^2(n)$ is the mean square error between the beam former output y (n) and the reference signal which is given by

$$e^2(n) = [d^*(n) - w^h x(n)]2$$

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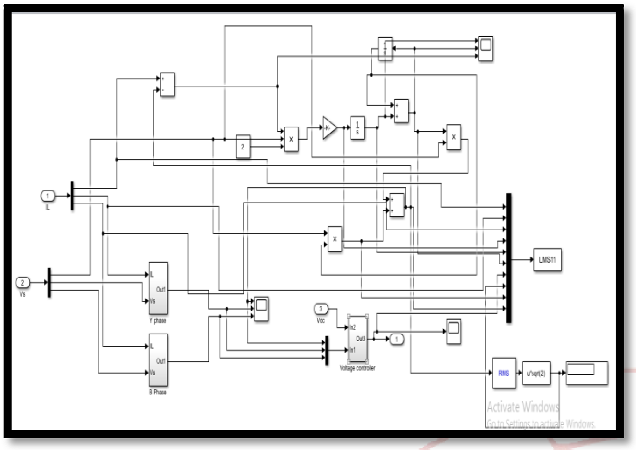

Fig. 4: Simulink model of LMS algorithm.

Table 1: List of Parameters.

Parameters	Values
Three Phase Source	415 V , 50 Hz
Load 1	Rl=50 , L= 2e-5 , Rn = 10, Cn= 2e-5
Load 2	Rl = 400, Ll = 0.5e-3, Rn =25 , Cn = 1e-3
Load 3	Rl =1, Ll = 20e-3, Rn = 15, Cn = 100e-6

2. RESULT

The simulation of shunt active power filter and its control algorithm has been implemented in the model with the Matlab/ Simulink power system block set. The linear and nonlinear loads has been implemented in the system. Supply voltage waveform and supply current waveform without filter is shown in the graph below, after the implementation of filter the changes in the waveform can be seen clearly and the current waveform becomes sinusoidal with the less amount of harmonic distortion. Various analysis can also be done by using FFT analysis for the harmonics analysis and found to be in the value of permissible limits.

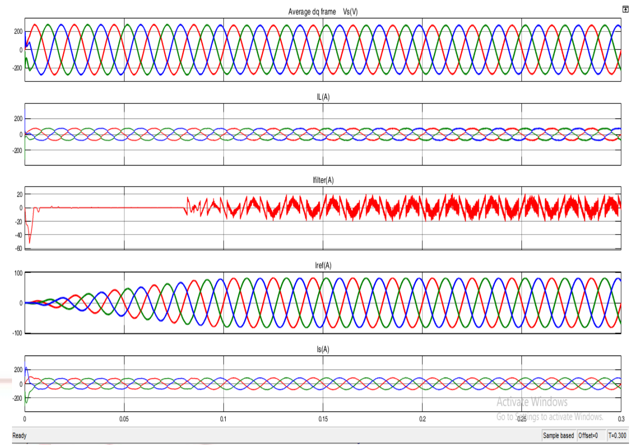

Fig-5: Output Voltage and current waveforms with and without filter implementation

3. CONCLUSION

Non Linear and linear loads are connected are connected to the three phase supply and the supply current is non sinusoidal. Shunt active filter is switched at 0.08 seconds. After simulation it is observed from the results that the supply current is now sinusoidal and in phase with the supply voltage, power factor is near about unity and the total harmonic distortion reduced to 5% the IEEE limits.

REFERENCES

[1]. Kale, M.; Ozdemir, E. An adaptive hysteresis band current controller for shunt active power filter. Electro. Power Syst. Res. 2005, 73, 113–119.
[2]. Soni, M.K.; Soni, N. Review of causes and effect of harmonics on power system. Int. J. Sci. Eng. Technol. Res. 2014, 3, 214–220.
[3] Henderson, R.D.; Rose, P.J. Harmonics: The effects on power quality and transformers. IEEE Trans. Ind. Appl. 1994, 30, 528–532.
[4] IEEE Standard 519. IEEE recommended practice and requirement for harmonic control in electric power systems. In IEEE Std 519-2014 (Revision of IEEE Std 519-1992);
[5] Das, J.C. Passive filters—Potentialities and limitations. IEEE Trans. Ind. Appl. 2004, 40, 232–241.
[6] Akagi, H. Active harmonic filters. Proc. IEEE 2005, 93, 2128–2141.

[7] B. Singh, S.K. Dube, S.R. Arya, Hyperbolic tangent function-based least mean-square control algorithm for distribution static
compensator, IET Gener Transm Distrib 8 (2014) 2102–2113.
[8] S. Haykin, B. Widrow, Least-mean-square adaptive filters, John Wiley & Sons, 2003.

[9] S.K. Patel, S.R. Arya, R. Maurya, Optimal step LMS-based control algorithm for DSTATCOM in distribution system, Electro Power
Compo Syst 47 (2019) 704 – 720.
[10] R. Rajagopal, K. Palanisamy, S. Paramasivam, Comparative performance of normalized LMS and variable step size LMS based control
for shunt active filtering, in: 2019 9th int. conf. adv. computer. Commun, IEEE, 2019, pp. 136 – 141.
[11] D. He, M. Wang, Y. Han, S. Hui, Variable step size LMS adaptive algorithm based on exponential function, in: 2019 2nd IEEE int.
conf. inf. commun. signal process, in: ICICSP 2019, 2019, pp. 473 – 477.
[12] S.K. Sahoo, S. Kumar, B. Singh, VSSMLMS-based control of multifunctional PV-DSTATCOM system in the distribution network,
IET Gener Transm Distrib 14 (2020) 2100 – 2110.
[13] C.M. Hackl, M. Landerer, modified second-order generalized integrators with modified frequency locked loop for fast harmonics
estimation of distorted single-phase signals, IEEE Trans Power Electron 35 (2019) 3298 – 3309.
[14] P. Rodriguez, A. Luna, I. Etxeberria, J.R. Hermoso, R. Teodorescu, Multiple second order generalized integrators for harmonic synchronization of power converters, in: 2009 IEEE energy convers. congr. expo., IEEE, 2009, pp. 2239 – 2246.