American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-5, Issue-5, pp-217-220
www.ajer.org
Research Paper Open Access

Harmonic Reduction System Using Active Filter

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ABSTRACT : *This paper presents the harmonics analysis and compensation which occurred in the electrical system. We use the electrical signal analysis based on FFT technique in order to calculate harmonics that occurred in the electrical system. The harmonics are compensated by using active harmonic filters. This system consists of a computer which works as controller, processor, analysis, monitor and database unit together with a microcontroller which has A/D converter is used for sampling the electrical signals via a parallel port of the computer. The active harmonic filters (IGBT Module) are controlled by PWM (Pulse Width Modulation) signal from the microcontroller. The PWM data (Switching angle) is programmed by computer. The data such as voltages, currents, the total harmonic distortion etc., can be saved as database for analysis. The harmonics compensation increase high efficiency of the electrical system and decrease the damage and incorrect operation that may happen with electrical devices.*

Keywords : *Harmonic compensation, Pulse width modulation (PWM), single phase full bridge inverter, Active Power Filter (APF)*

I. INTRODUCTION

At present users have realized the importance of the electrical quality and electrical works. The process of production of industries, which use high technology devices or electrical power systems are facing several problems of high reactive power burden as well as high harmonic currents, unbalanced load and excessive neutral currents etc. which is reported as high as 32.53%. The characteristic of these devices is sensitive to the changes of current and voltage. If the size and shape of signals are distorted, it may damage the devices and makes functional failure. These problems affect the performance of today's high–tech industrial equipment connected to the system; also it may cause huge energy losses in the distribution system. The main reason of signal distortion is the harmonics of electrical systems. Most of them are due to nonlinear device which oscillate harmonics such as converter, power rectifier, adjustable-speed drive. Using non-linear devices, harmonic current is applied to the electrical system itself but if non-linear devices have wide range, harmonic current may leak into adjacent electrical system.

Harmonics are undesirable components in the sinusoidal waveform of the AC Power supply. Harmonics occur as integral multiples of the fundamental frequency. That is, the third order harmonic will have a frequency of 3 times the fundamental frequency; 150 Hz which is 3 times the fundamental 50 Hz frequency. Harmonics affect power quality and efficiency.

It is therefore necessary that harmonics in any power system be monitored. Should harmonics be present, they can be minimized by using suitable methods such as filters. Using a mathematical technique known as Fast Fourier Transforms, the distorted AC waveform can be resolved into its component waveforms. Out of the measured harmonics, the even harmonics(harmonics whose frequency are the fundamental frequency multiplied by even numbers such as 100Hz(2 *50) or 200Hz(4*50) get cancelled out and have no effect. For the study and management of harmonics, only the odd harmonics are considered.

II. LITERATURE SURVEY

The literature survey is conducted for dissertation in all possible means through media of textbooks, reference books, data books, technical magazines, research papers and the powerful information media of internet. For this project, information are collected from all above sources and compared the same with each other and also with our developed system and found that the developed system will have more advantages over other existing systems.

The studies required broad knowledge of the issues regarding harmonics in power system, the standard limit and requirements, modeling and simulation, issues related to utility and consumers especially at an industrial area, and result from studies by other researchers. All this information is necessary to address the changes and dynamic of harmonics voltage at an industrial area. The following sections include brief knowledge of harmonics and reviews on papers related to relevant harmonic standards and requirements, mitigation, probabilistic aspects, cost of mitigation and effect of harmonic impedance variability. The review focus on studies related to harmonic in power system with regards to relation between utility and consumers. The reviews also pointed out the differences and similarities between previous studies and this research.

III. BASIC ON HARMONICS

The basic harmonic theory which according to Fourier theorem, periodic non-sinusoidal or complex voltage (Fig. 3.1) or current waveforms can be represented by the sum of a series of multiple frequency terms of varying magnitudes and phases as shown in equation (1);

$$F(t)=a_0+\sum[a_n\cos(nwt+q_n)] \quad (1)$$

Where: a_n is the magnitude of the nth harmonic frequency
a_0 is the d. c. component
q_n is the phase angle of the nth harmonic frequency
ω is the fundamental frequency
n =1,2,3,…

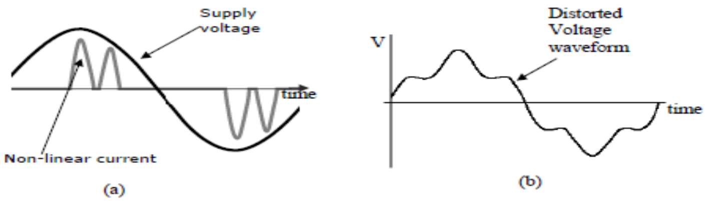

Figure 3.1 Harmonic Current and Voltage Distortion:

a) Non-linear load draws non-sinusoidal current from the system.
b) Resulting voltage distortion due to non-sinusoidal current

Harmonic is measured using total harmonic distortion (THD) which is also known as distortion factor and can be applied to current and voltage. It is a square-root of sum of all harmonic magnitudes over the fundamental. Equation (2) shows the calculation for voltage total harmonic distortion (THDv).

$$THD_V = \frac{\sqrt{\sum_{n=2}^{\infty} V_n^2}}{V_1} \quad (2)$$

Where: V_1 is the magnitude of fundamental frequency voltage
V_n is the magnitude of nth harmonic frequency voltage

IV. HARDWARE SYSTEM DEVELOPMENT

The system is used to develop active filter based harmonics reduction technique for electrical systems. This system uses bridge rectifier as non linear load. Because of non linear load harmonics are introduced in the system. To eliminate effect of these harmonics Active Filter is connected in parallel with the load. Harmonic reduction technique can be used to evaluate the occurring harmonics in the system. System uses Active Filter consisting of MOSFETs, controlling of MOSFET is done with the help of PWM signal from controller. Controller will generate PWM signal with switching frequency of 20 KHz to control active devices.
Active Filter introduces current which is 180^0 out of phase as that of current introduced because of non linear load. Active filter is connected in parallel with nonlinear load, hence harmonics get eliminated.

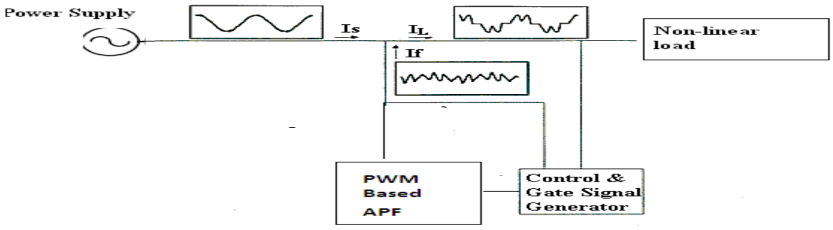

Fig. 4.1: generalized block diagram

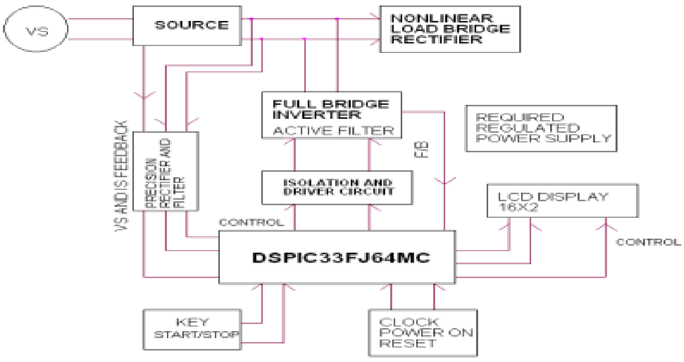

Fig.4.2: detail block diagram

The base unit basically consists of following Sections

- Controller dsPIC33FJ64MC802
- Isolation and Driver Circuit
- Active Filter
- LCD Display
- Bridge Rectifier as Non linear load.

V. SOFTWARE IMPLEMENTATION

Fig 5.1shows system flowchart of harmonics reduction system .Initially we are sampling data from signal of system and then monitoring signal on computer. We analyze the harmonics. The next, we calculate PWM data from program PWM. Finally, we sent PWM signal to control filter.

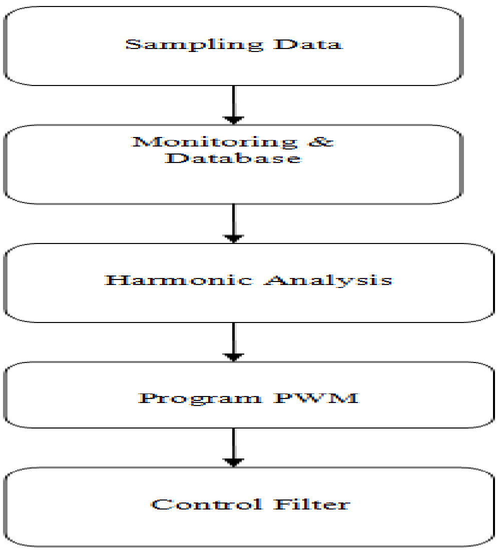

Fig5.1: complete system flowchart

5.1 Overall control system

The "Overall Control System" block of the proposed scheme is presented in Figure 5.2. The task of the control system is to produce appropriate gating signals for the switching transistors (MOSFET). It consists of four blocks namely "P-I controller Reference current generator, hysteresis current controller active filter Controller".

To make system real time, data required for PWM calculation i.e. active filter current value taken from microcontroller transfer to hysteresis controller with the help of embedded system block of MATLAB that gives gating pulses to active filter.

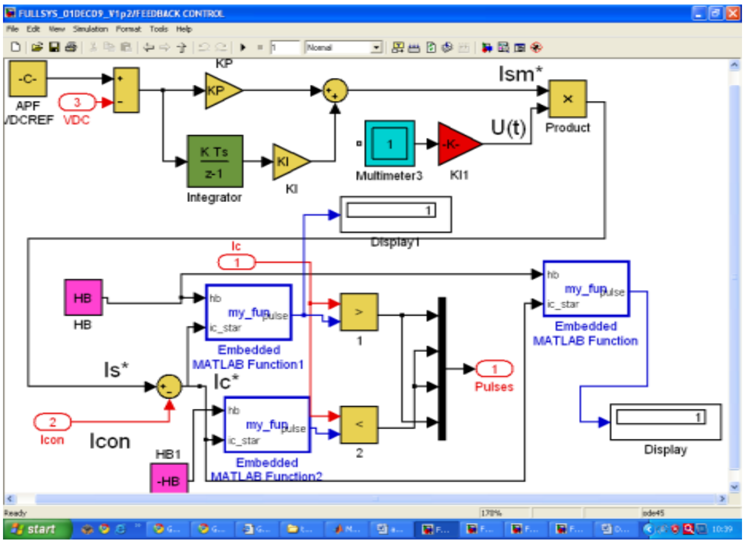

Fig.5.2: control system

VI. CONCLUSION

In this paper I present the harmonic reduction system using active filter to reduction total harmonics distortion value by the computers which work with microcontroller and active power filter. The harmonic reduction system program PWM and control active power filter by analyze signal in system. The computer shows electric signal, harmonic analysis, function direct and automatic filter control. Harmonic reduction that increases the efficiency of electric system and can improve in the real system (in the future)

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