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HARMONICS REDUCTION TECHNIQUES IN ELECTRICAL POWER SYSTEM

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ABSTRACT
In the presented paper, the analysis of harmonics is done in loads particularly in non-linear loads like welding machine, induction motor, dc drives and ac drives computers, printers, TVs, servers. The harmonics reduces the power quality of the system and machine efficiency also. The harmonics are analysed by making the use of fast flourier transform technique. The harmonic analyser is used to detect the presence of harmonics in the electrical load and if detected than shows the presence of harmonics in the form of voltage and current waveform in the harmonic analyser which is capable of detecting harmonics up to ninety-nine level.

KEYWORDS- *harmonic detection, harmonic analyser, welding machine, ac drive, dc drive.*

INTRODUCTION

With the growing application of instrument such as power electronic equipment in the large manufacturing industries has led to very serious problems like generation of harmonic distortion, poor power factor and low voltage profile in the transmission and distribution side of the power system [12]–[4]. Among all the power electronic devices, power converter is the main electronic device that is responsible of injecting harmonics in the power system [14], [6].

Besides power electronic devices, the application of non-linear load also plays a crucial role in generating harmonics in the electrical power system. The injection of capacitor banks in the distribution system is also responsible for generating harmonics in the system. These harmonics not only reduce the voltage profile of the distribution line but also reduce the life of the electrical apparatus or appliances. Various type of loads like welding machine, induction motor etc are greatly responsible for producing harmonic current and voltages in the system. Therefore, it is very important to eliminate or mitigate such disturbing harmonics distortion from the system. In present several types of active filters are introduced for eliminating harmonics from the system so that the overall power quality can be improved of the power system [7]–[9].

WHAT IS HARMONIC DISTORTION?

We can understand the word harmonic like the integer which multiplies fundamental frequencies is known as "Harmonics". Here, harmonic is a type of signal whose frequency is an integral multiple of the reference signal. In another way, it can be defined as the ratio between the frequency of the signal and the frequency of the reference signal.

EXPERIMENTAL SETUP OF PROPOSED SYSTEM

The system comprises of an analyzing unit preferably a harmonic analyzer installed in the system for analyzing the presence of harmonic disturbance in the electrical load, wherein the analyzing unit comprising an LCD screen that displays harmonics up to 99th order and the harmonics are analyzed by using Fast Fourier Transform (FFT) technique [10], [11]. Fig.1 shows the schematic diagram of harmonic analyzer. When harmonics are generated in the nonlinear electrical load, the analyzing unit analyzes the presence of harmonic disturbance by implementing Fast Fourier Transformation (FFT) technique.

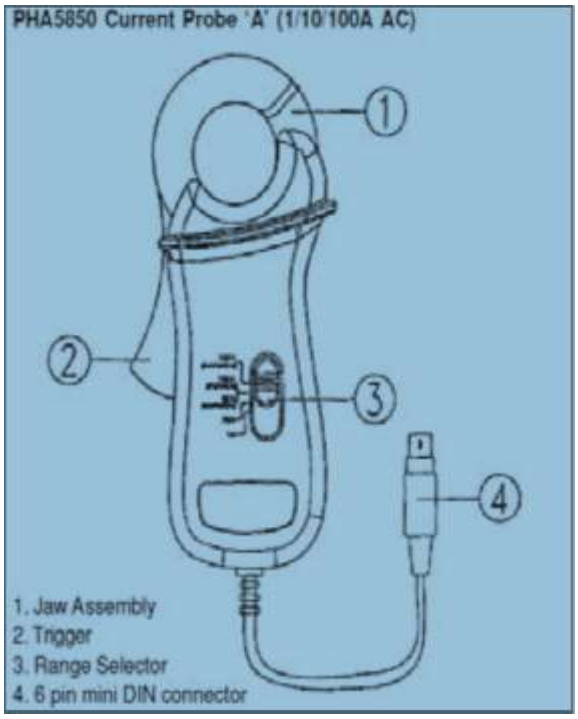

Fig.1 Harmonic Analyser

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The main advantage of using FFT technique over Discrete Fourier Transform (DFT) technique is that the Fast Fourier Transform (FFT) has high accuracy rate and is very fast in response. The FFT plays important roles in the analysis, design, and implementation of discrete signal processing.

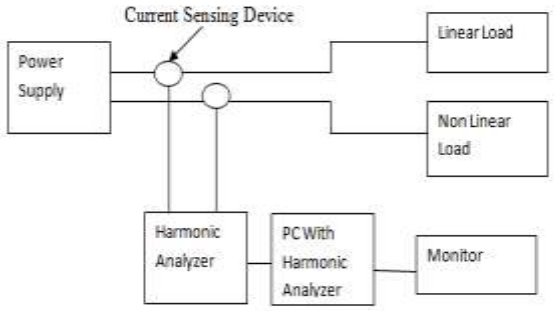

Fig.2 Block diagram of proposed system

FOURIER ANALYSIS

The analysis of harmonics is the process of calculating the magnitudes and phases of the fundamental and high order harmonics of the periodic waveforms. The resulting series is known as Fourier series. It establishes a relation between a function in the domain of time and a function in the domain of frequency.

The Fourier's theorem states that every no sinusoidal periodic wave can be decomposed as the sum of sine waves through the application of the Fourier series, given the following conditions:

1. The integral over one period of the function is a finite value.
2. The function possesses a finite number of discontinuities in a period.
3. The function possesses a finite number of maxima and minima in a period.

HARMONIC SOURCES

Harmonics are the result of nonlinear loads which give a non sinusoidal response to a sinusoidal signal. The main sources of harmonics are:

- Arc furnaces and other elements of arc discharge, such as fluorescent lamps. Arc furnaces are considered as voltage harmonic generators more than current generators. Typically all harmonics (2nd, 3rd, 4th, 5th,…) appear but the odd harmonics are predominant with typical values with regard to the fundamental harmonic:
- The third harmonic represents 20%, and the fifth harmonic represents 10%.
- The seventh harmonic represents 6%, and the ninth harmonic represents 3%.
- Magnetic cores in transformers and rotating machines require third harmonic current to excite the iron.
- The inrush current of transformers produces second and fourth harmonics.
- Adjustable speed controllers used in fans, pumps, and process controllers.
- Solid-state switches which modulate control currents, light intensity, heat, etc.
- Controlled sources for electronic equipment.
- Rectifiers based on diodes and thrusters for welding equipment, battery chargers, etc.
- Static reactive power compensators.
- DC high voltage transmission stations.
- AC to DC converters (inverters).

RESULT AND CONCLUSION

Fig.2 shows the block diagram of proposed system. During the supply of electrical power when linear or non-linear load is connected to the system, the system undergoes with the low voltage profile due to presence of harmonic current on the load side. the harmonic analyzer is connect in parallel to the line of the load for sensing the abnormal current and harmonics. After detecting various types of harmonics produced by non-linear loads, the pc is connected to the harmonic analyser to insert fast Fourier transform technique for further analyses and monitor is used to display the number of harmonics at a time. Fig.3 shows the output waveform obtains by harmonic analyzer after implementing fast Fourier transform techniques. This proposed system is very helpful in detecting the order of harmonics in the power system.

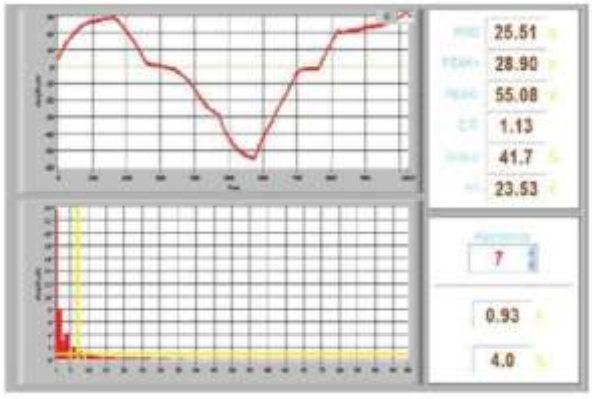

Fig.3 Output waveform of harmonic analyser

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