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Automatic Reduction of THD for Non-Linear Load by Using Microcontroller

Rajat Paunikar[1], Suraj Gaygowad[2], Amit Ghushey[3], Krishnakant Bhonde[4], Shreyash Gedam[5], Pranit Padole[6], Nikhil Honshette[7], Abhay Halmare[8]

[1, 2, 3, 4, 5, 6]*Student, Electrical Engineering, Karmaveer Dadasaheb Kannamwar College of Engineering, Nagpur, Maharashtra, India,*
[8]*Assistant Professor Electrical Engineering, Karmaveer Dadasaheb Kannamwar College of Engineering, Nagpur, Maharashtra, India*

Abstract: ***In a perfect world, the term harmonics used to describe power quality would refer to how pure the voltage and current waveforms are when they take the shape of sinusoidal. Power quality is veritably important to commercial and industrial power system designs. ideally, the electrical supply should be a perfect sinusoidal waveform without any kind of distortion or disruption. If the current or voltage waveforms are distorted from its ideal form it'll be nominated as harmonic distortion. This harmonic distortion could affect because of numerous reasons.***

In present's world, high significance is given by the engineers to decide a system to reduce the harmonic distortion. While power system designs were simple and cautious in the past, harmonic distortion was undeniably lower. But, currently due to complex design is being used in the industry harmonic distortion has increased as well. This design explains the effects of Harmonics in the Power System and way to reduce the effects of Harmonics. Also, this design will illustrate how harmonic distortion, one of the most significant issues with power quality, generates a number of interruptions to the power system. It includes the Harmonic reduction ways to enhance the power quality.

Keywords: Total Harmonic Distortion, Power quality, Harmonics reduction, Waveform, Sinusoidal, Enhance.

I. INTRODUCTION

As always, the main aim of the power system would be generation of electrical energy to the end user. Also, power system generation is associated with the term power quality. So much importance has been given to power quality that it's considered as a separate area of power engineering. Electric powers is the main power sources use in our current industries. Disturbance in Power quality occurs because of changes in the magnitude of voltages and frequency. Power quality problem comes with the wide operation of nonlinear loads.

During normal operation, the major cause of power quality disturbance and harmonics distortion are generally nonlinear loads. Harmonics develop in the power system for a brief period of time when faults are established, and voltage instability is seen. It alters the voltage quality, causes some harmonic distortion in the system, and results in power losses. It's necessary to distinguish Power quality disorder and to enhance power quality.

This study work purposes to reduce the harmonics distortion using PWM (Pulse Width Modulation) inverter. There are various harmonic minimization techniques that can improve power quality and have research behind them. In order to reduce the harmonics distortion, several controls method similar as, PWM(Pulse Width Modulation) Inverter, active filter, passive filter, p- q system, Diode switch and harmonics filter with thyristor device are used. This study further explains how harmonic distortion is reduced with the help of PWM Inverter. Results show that the PWM (Pulse Width Modulation) Inverter give the bettered results of power quality by reducing harmonics.

II. AIM OF THE PROJECT

This project's major goal is to outline the impacts of harmonics in the power system and how to minimize those effects. Also, this project will detail how harmonic distortion, one of the most significant issues with power quality, causes a number of disruptions to the power system.

It comprises simulation for the same as well as harmonic reduction techniques to enhance power quality. An inverter converts DC voltage into an AC output. Harmonics have a significant impact on the power quality during the conversion from DC to AC. A thorough explanation of how harmonic reduction would enhance power quality is provided.

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III. BACKGROUND STUDY

The presence of harmonics in electrical systems causes distortion and deviation from sinusoidal waveforms in current and voltage. A power network's primary problem is harmonics. Users' equipment may fail or operate incorrectly due to power problems caused by voltage, current, or frequency variations. Because non-sinusoidal current is used by non-linear loads, the increased usage of automation equipment causes a lot of harmonics in the sharing network. Along to increasing demand for better power quality i.e. generally defined any change to the voltage, current, or frequency they affects with the regular operation of electrical equipment.

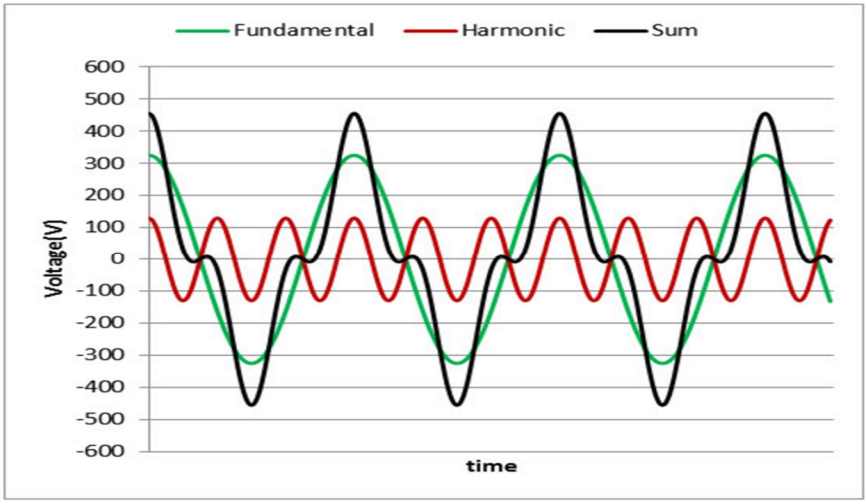


Fig.2.1. Harmonic Current and Voltage Distortion

The most used harmonic indicator in a power system network is total harmonic distortion. The most dominant factor which is responsible for poor power quality is Total Harmonic Distortion . The Total Harmonic Distortion may be calculated in either voltage or current profile. Equations (1) and (2) are used to determine the Total Harmonic Distortion in voltage and current profiles, respectively.

$$THD_V = \frac{\sqrt{\sum_{h=2}^{\infty} V_h^2}}{V_1} = \frac{\sqrt{V_2^2 + V_3^2 + V_4^2 + \ldots}}{V_1} \quad (1)$$

$$THD_I = \frac{\sqrt{\sum_{h=2}^{\infty} I_h^2}}{I_1} = \frac{\sqrt{I_2^2 + I_3^2 + I_4^2 + \ldots}}{I_1} \quad (2)$$

THD is defined as the ratio of the root mean square value of the harmonic component to the root mean square value of fundamental component and is generally expressed in percentage. This indicator is used to find out the variation of a periodic non-sinusoidal waveform with respect to perfect sine wave. An perfect sine wave has zero THD. Similar to this, voltage and current at the hth order are given as Vh/V1 and Ih/I1 for each individual harmonic distortion. The THD factor pertaining to the RMS value of the current waveform is given by equation (3).

RMS Value = $\sqrt{\sum}\infty$ I2 = I1$\sqrt{1}$ + THD2 (3)

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IV. BLOCK DIAGRAM

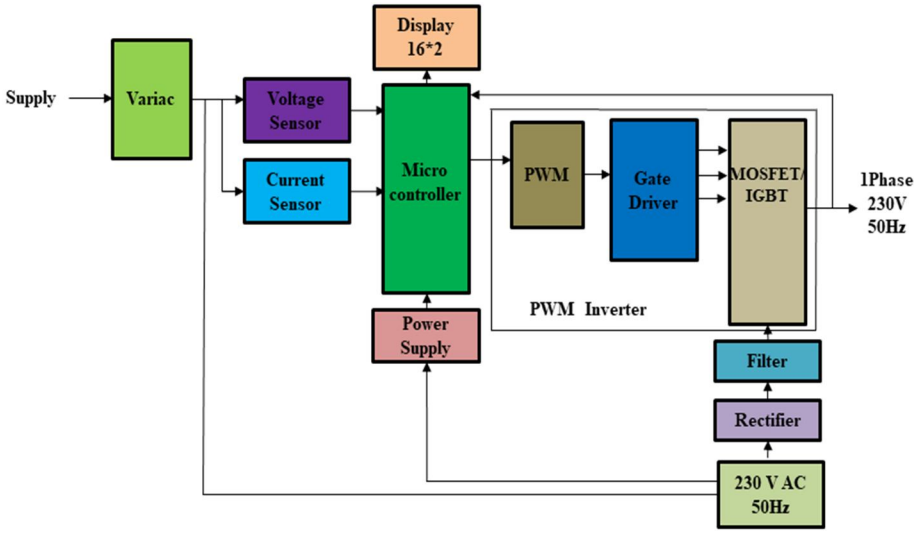


Fig.4.1. Block diagram of Automatic Reduction of THD for Non Linear Load by using Microcontroller

Reduction of Total Harmonic Distortion (THD) in non linear load by using non linear load. Thus the Schematic Block diagram is shown in figure. It consists of microcontroller , filters , rectifiers, MOSFET, inverters etc. Nowadays consumption of Electrical energy is increases day by day and we have to use the non linear load. Such a load work or consume a fundamental waveform that type of load is used discrete form of supply. That's why they creates harmonics and distort the current and voltage waveform. Therefore energy bill cost is increases due to lagging power factor and our appliances are based on non linear load.

V. METHODOLOGY

Here, our project has to reduce the harmonics in a non-linear load by using a microcontroller. In a power system, there is a very small amount of harmonics, but in a power system, the load used is mainly a non-linear load, which is why harmonics will be created. So we are using a rectifier and filter (the supply will be 230 volts, 50 Hz, and 1 phase) to convert the AC supply into a DC supply, and the filter circuit removes the ac component present in the rectified output. As we know, there are no frequencies present in the DC supply, so the harmonics will not be present in the DC supply. Voltage and current sensors(according to the Block Diagram) are used to measure the fluctuation of voltage and current. Then, with the help of a microcontroller, the voltage and current are shown on the display.

A PWM inverter, which converts DC to AC, is mainly made up of PWM, a gate driver, and a MOSFET. An inverter's internal control can be used to alter the output voltage of the device. Using an inverter's pulse width modulation control is the most efficient way to accomplish this. In this arrangement, the inverter receives a set DC input voltage, and the AC output voltage is regulated by varying the on and off times of the inverter's individual components. This method of adjusting the output voltage is known as pulse width modulation control, and it is the most widely used method. To minimize harmonics, the pulse width is altered in PWM technology. A microcontroller is then used to deliver the harmonic-free voltage to the load in accordance with the demands of the load.

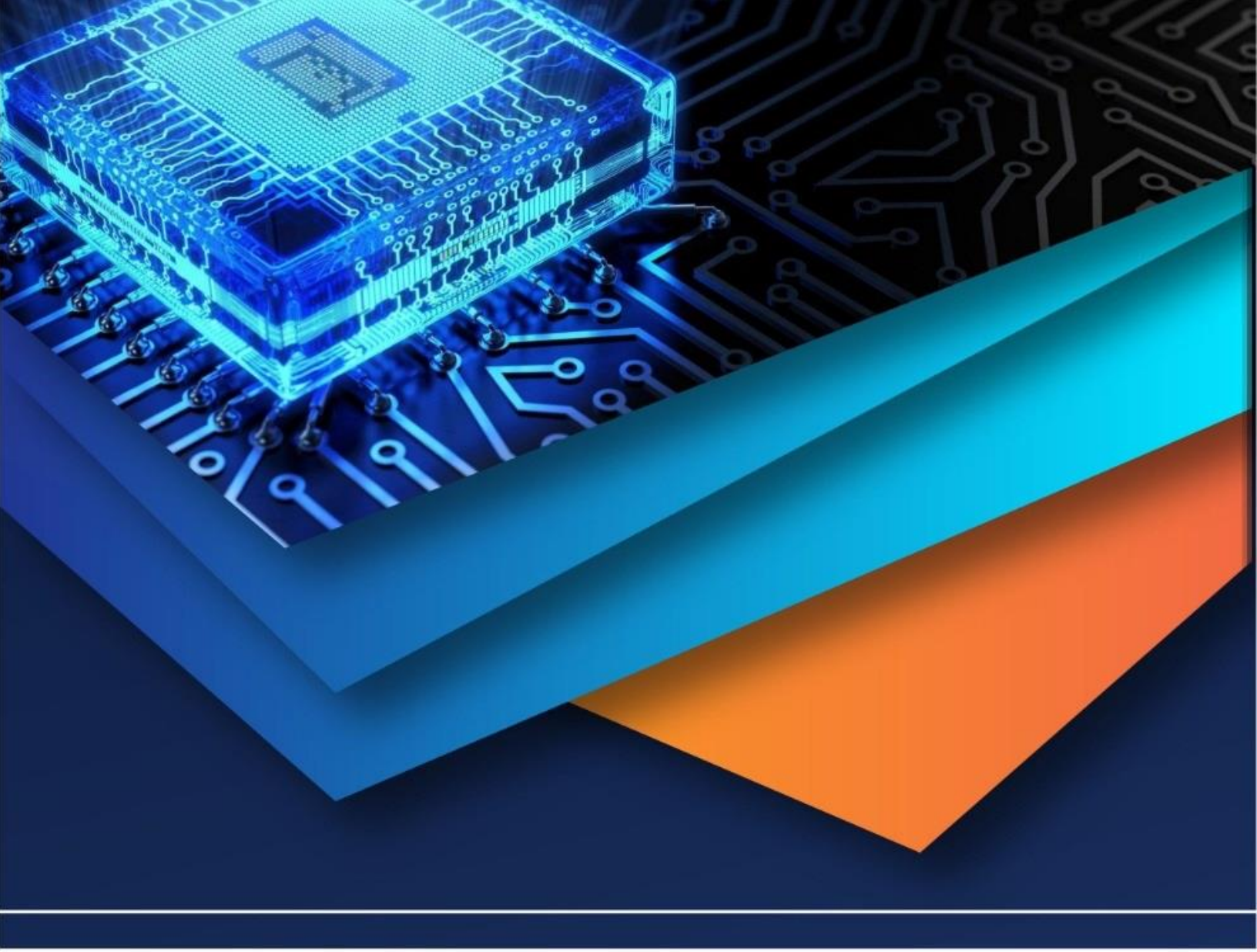
VI. CONCLUSION

While considering system additions or modifications, take the impact of harmonics into account as one of the key power quality issues. Every maintenance, troubleshooting, and repair program should also include determining the magnitude and position of non-linear loads in order to remove THD (total harmonic distortion) with the use of PWM (pulse width modulation). This article was written with the goal of identifying the harmonics that different nonlinear loads deliver into the system and to assist in determining the levels of harmonic voltages and currents that may be present. The amounts and orders of harmonic currents that are present in such non-linear loads are also identified in this article. The use of these non-linear loads and other electronic equipment in both the home and industrial sectors is observed to cause significant current distortion.

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