AUTOMATIC REDUCTION OF THD FOR NON LINEAR LOAD BY USING PWM INVERTER WITH MICROCONTROLLER

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Abstract- *The phrase harmonics related to Power quality refers to the purity of the voltage and the sinusoidal current waveform. Power quality is crucial when designing commercial and industrial power systems. Voltage and current differences caused by harmonic distortions are frequently seen in electrical distribution networks due to frequency shifts. Particularly, there are differences from the usual sinusoidal voltage or current changes. Nonlinear loads, such as those connected to variable frequency drives (VFDs) installed for fans and pumps supplying building air conditioning systems, are the main source of harmonics. These converters specifically introduce nonlinear loads throughout the electrical distribution systems and draw a non sinusoidal current/voltage. Due to the widespread use of computers and other power devices in buildings nowadays, harmonic distortion issues are a regular occurrence. In instance, harmonic distortions can result in a number of issues and harms, such as wire overheating and power outages. This design describes the impacts of harmonics on the power system and how it can reduce those effects.*

Keywords:– Total Harmonic Distortion, Power quality, Harmonics reduction, Waveform, Sinusoidal, Voltage, Current.

I. INTRODUCTION

A voltage in a steady state that stays within a predetermined range of frequencies and voltage magnitude is said to have good power quality. To describe the quality of voltage, power, and current, the phrase power quality is appropriate. The quality of the power has a direct impact on how efficiently electronic gadgets operate. Electricity generation (AC power), transmission of electricity, and finally supply of electricity to an electricity meter situated at the location of the end consumer make up electrical power production. The widespread use of nonlinear loads has caused problems with power quality.

Harmonics are produced in the power system by nonlinear loads and cause disruptions in power quality. For power consumers at all levels of utilization, power quality has grown to be a serious issue. Harmonics are any modification to the voltage waveform or frequency waveform. The major problem with a power network is harmonics. Power problems can cause user equipment to malfunction or operate incorrectly due to variations in voltage, current, or frequency. A growing number of harmonics are produced in the sharing network by automatic equipment because to the non-sinusoidal current that is used by non-linear loads.

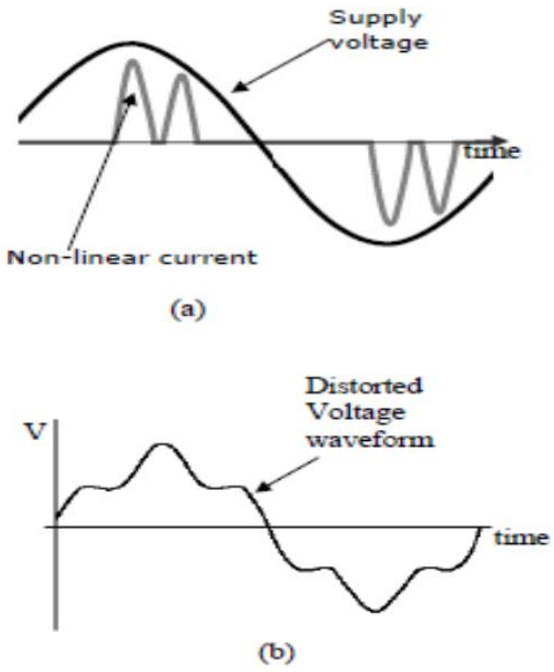

Figure 3.1 Harmonic Current and Voltage Distortion

The need for higher power quality is growing, which is commonly described as any modification to the voltage, current, or frequency that interferes with the

normal operation of electrical equipment. Harmonics alter current and voltage waveforms, which causes the power network to collapse. Nonlinear loads (AC loads where the voltage and current are not proportional.
The voltage behaviour is no longer proportional to the current under these circumstances. Computers, laser printers, converters, refrigerators, TVs, etc. are examples of nonlinear loads.) are frequently employed in the creation of energy.

The electricity network's harmonics are mostly produced by them. Heavy loads draw the current, which may be irregular. A nonlinear device cannot use continuous voltage because using it does not produce a continuous transfer supply. When a malfunction in the power system occurs, harmonic distortion in the power system disturbs the power quality and affects the system's voltage and frequency . Harmonic Distortion is increased by this disturbance.

II. AIM OF THE PROJECT

The main objective of this research is to describe the effects of harmonics on the power system and how to reduce those effects. This project will also describe the numerous disturbances to the power system that harmonic distortion, one of the most important problems with power quality, creates. It includes harmonic reduction strategies to improve power quality . An inverter transforms DC electricity into an AC output. Power quality when switching from DC to AC is significantly impacted by harmonics. It is explained in detail how harmonic reduction would improve power quality.

III. TOTAL HARMONIC DISTORTION

The most used harmonic indicator in the power system network is Total Harmonic Distortion (THD). THD is the main cause of poor power quality and the major harmonic indication of power pollution. Both the voltage profile and the current profile can be used to compute THD. Equations (1) and (2) are used, respectively, to determine the THD in voltage and current profiles.

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

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

THD is typically represented as a percentage and is defined as the ratio of the root mean square value of the harmonic component to the root mean square value of the fundamental component. With this indicator, one can determine how a periodic non-sinusoidal waveform differs from a perfect sine wave. An perfect sine wave has zero THD. Similar to this, for each individual harmonic distortion, the voltage and current at the hth order are expressed as Vh/V1 and Ih/I1.Following equation provides the THD factor for the current waveform's RMS value.

$$\text{RMS Value} = \sqrt{\sum_{h=1}^{\infty} Ih2} = I1\sqrt{1 + THDI\ 2} \quad (3)$$

IV. NON-LINEAR LOADS

Non-linear loads are ones whose impedance varies as a result of applied voltage. Current produced by the change in impedance is not sinusoidal. These non-sinusoidal currents have harmonic characteristics, which causes voltage distortion in the linked power system equipment . Certain home and industrial non-linear loads are taken into account for THD analysis in the current work. The next sections cover the home and industrial non-linear loads as well as the exact specifications.

A. Domestic Loads

Harmonics of various orders are considered for analysis in commonly used home devices with non linear voltage and current characteristics. Table 1 lists the primary non-linear residential loads along with a description of each one.

Table 1: Major Domestic Non-Liner Loads

Domestic Load	Specification
Compact Fluorescent Lamp (CFL)	200 Watts (10 lamps of 20 Watt each)
Personal Computer	2.5GHz Intel Core i5 Processor with 4GB RAM,Screen of 13.3-inch with Storing Capacity of 256GB
Uninterrupted Power Supply (UPS)	1-φ, 2KVA, 240V±10% V AC, Single phase 50±5% Hz frequency
Printer	HP Laser Jet 1020 plus with laser technology and print speed of 15 ppm.
Mobile Battery Charger	Input: 110V-250 AC, Capacity: 2600mAH, Frequency: 50Hz, Output: 5 Volts dc
Photostat Machine	Xerox Ducu Centre SC2020 with memory of 512MB

B. Industrial Loads

Because power electronic-based circuitry is so widely used in the industrial sector, harmonics are now present in most industrial loads, which causes non-sinusoidal behavior of current and voltage and harmonic distortion. Table 2 lists the various industrial loads and technical specifications that were employed for the experiment.

Table 2: Major Industrial Non-Liner Loads

Industrial Load	Specification
Rotary Converter	Voltage, Input: 210V, 230V, 460V, Output: 0-440 V (variable DC) % Regulation: 2-5% at full load & efficiency: >96% at full load
Electrical Furnance	Rated Capacity : 40-400 Tons,

	Rated Temperature : 1080 C Furnace Transformer Capacity :25-28MVA, 132KV, 50 Hz
Electric Welding Machine	Input power voltage: AC 440V (3-Phase), Rated output voltage: 20-250 V Output current range: 62A, and Efficiency: 60% .

V. BLOCK DIAGRAM

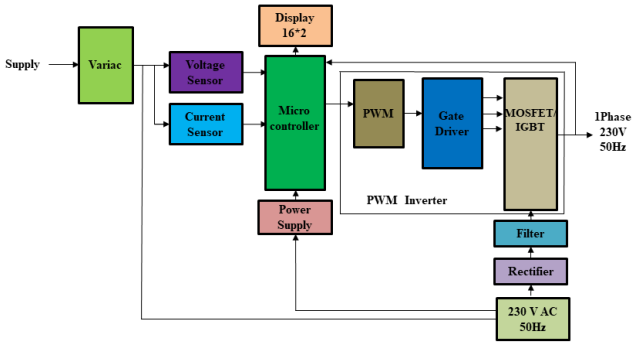

Fig.5.1. Block diagram of Automatic Reduction of THD for Non Linear Load by using PWM inverter with Microcontroller

Hence, the Schematic Block diagram is displayed in Figure. Filters, rectifiers, MOSFETs, inverters, microcontrollers, and other components are included. These days, as electrical energy consumption rises daily, we must use nonlinear loads. Such a load uses a discrete kind of supply and either works with or consumes a basic waveform. For this reason, they distort the current and voltage waveforms and produce harmonics. As a result of the lagging power factor and the non-linear load that our appliances operate under, energy bills are getting more expensive.

VI. METHODOLOGY

Here, the goal of our project is to use a microcontroller to eliminate the harmonics in a non-linear load. Although harmonics are extremely rare in power systems, they are nonetheless produced since the majority of the loads used in these systems are non-linear. Therefore, to convert the AC supply into a DC supply, we are utilizing a rectifier and filter (the supply will be 230 volts, 50 Hz, and 1 phase); the filter circuit eliminates the ac component present in the rectified output. The DC supply won't contain harmonics since, as we already know, there are no frequencies present in it. According to the Block Diagram, voltage and current sensors are employed to monitor voltage and current fluctuations. After that, the voltage and current are displayed on the display with the aid of a microcontroller.

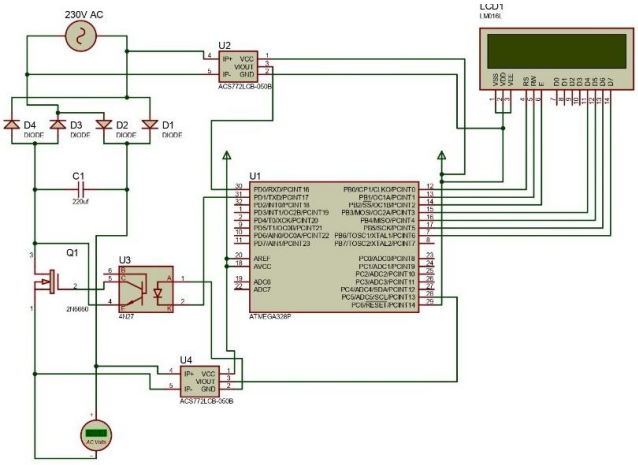

Fig.6.1. Circuit diagram of Automatic Reduction of THD for Non Linear Load by using PWM inverter with Microcontroller

PWM, a gate driver, and a MOSFET are the three basic components of a PWM inverter, which converts DC to AC. The output voltage of a device can be changed via the internal control of an inverter. The best way to do this is by controlling the pulse width modulation of an inverter. In this configuration, a fixed DC input voltage is applied to the inverter, and the AC output voltage is controlled by adjusting the on and off times of the inverter's separate components. This form of output voltage adjustment is called pulse width modulation control, and it is the most popular one. PWM technology modifies the pulse width to reduce harmonics. The harmonic-free voltage is subsequently sent to the load using a microcontroller in line with the demands of the load.

VII. CONCLUSION

Consider the effects of harmonics as one of the main power quality challenges while thinking about system additions or alterations. To reduce THD (total harmonic distortion) using PWM, every maintenance, troubleshooting, and repair program should also include figuring out the size and location of non-linear loads. In order to identify the harmonics that various nonlinear loads introduce into the system and to help determine the potential levels of harmonic voltages and currents, this article was prepared. This article also identifies the types and quantities of harmonic currents that are present in such non-linear loads.

VIII. AKNOWLEDGEMENT

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