Harmonic Distortion Analyzer Using Labview

Usha Rani Anam, P Saritha, D Uma Maheswara Reddy, K Niranjan Kumar
1, 2 Assistant Professor, Dept. of ECE, Institute of Aeronautical Engineering (IARE), Hyderabad.
3, 4 Assistant Professor, Dept. of ECE, PBR Visvodaya Institute of Technology& Sciences Kavali, SPSR Nellore(D.T), Andhra Pradesh.

Abstract

A total harmonic distortion analyzer calculates the total harmonic content of a sine wave with some distortion, expressed as total harmonic distortion (THD). A typical application is to determine the THD of an amplifier by using a very-low-distortion sine wave input and examining the output. By using a LabVIEW graphical programming environment it is creates a virtual instrument whose operation is validated in two different ways. On the one hand the input of the virtual instrument is obtained by synthesis of a periodic signal. The deformation of current signal with a set number of harmonics can be simulated for different amplitude, frequency and phase values of each harmonic number. After the synthesis of distorted signal, it can be viewed and analyzed the deforming regime characteristic parameters (the value of the total harmonic distortion factor, the fundamental frequency, the components level with the amplitudes of the measured harmonics)

1. INTRODUCTION

An instrument is a device designed to collect data from an environment, or from a unit under test, and to display information to a user based on the collected data. Such an instrument may employ a transducer to sense changes in a physical parameter, such as temperature or pressure, and to convert the sensed information into electrical signals, such as voltage or frequency variations. The term instrument may also be defined as a physical software device that performs an analysis on data acquired from another instrument and then outputs the processed data to display or recording devices. This second category of recording instruments may include oscilloscopes, spectrum analyzers, and digital millimeters. The types of source data collected and analyzed by instruments may thus vary widely, including both physical parameters such as temperature, pressure, distance, frequency and amplitudes of light and sound, and also electrical parameters including voltage, current, and frequency.

The rapid adoption of the PC in the last 20 years catalyzed a revolution in instrumentation for test, measurement, and automation. One major development resulting from the ubiquity of the PC is the concept of virtual instrumentation, which offers several benefits to engineers and scientists who require increased productivity, accuracy, and performance. A virtual instrument consists of an industry-standard computer or workstation equipped with powerful application software, cost-effective hardware such as plug-in boards, and driver software, which together perform the functions of traditional instruments. Virtual instruments represent a fundamental shift from traditional hardware-centered instrumentation systems to software-centered systems that exploit the computing power, productivity, display, and connectivity capabilities of popular desktop computers and workstations. Although the PC and integrated circuit technology have experienced significant advances in the last two decades, it is software that truly provides the leverage to build on this powerful hardware foundation to create virtual instruments, providing better ways to innovate and significantly reduce cost. With virtual instruments, engineers and scientists build measurement and automation systems that suit their needs exactly (user-defined) instead of being limited by traditional fixed-function instruments (vendor-defined).

2. HARMONIC DISTORTION

The power quality of distribution systems has a drastic effect on power regulation and consumption. Power sources act as non-linear loads, drawing a distorted waveform that contains harmonics. These harmonics can cause problems ranging from telephone transmission interference to degradation of conductors and insulating material in motors and transformers. Therefore it is important to gauge the total effect of these harmonics. The summation of all harmonics in a system is known as total harmonic distortion (THD). Total harmonic distortion is a complex and often confusing concept to grasp. However, when broken down into the basic definitions of harmonics and distortion, it becomes much easier to understand.

Now imagine that this load is going to take on one of two basic types: linear or nonlinear. The type of load is going to affect the power quality of the system. This is due

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 17
July 2018

to the current draw of each type of load. Linear loads draw current that is sinusoidal in nature so they generally do not distort the waveform (Figure 1.2). Most household appliances are categorized as linear loads. Non-linear loads, however, can draw current that is not perfectly sinusoidal (Figure 1.3). Since the current waveform deviates from a sine wave, voltage waveform distortions are created.

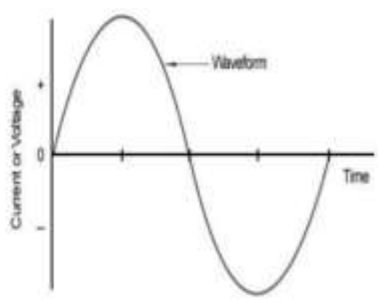

Figure 2.2: Ideal Sine wave

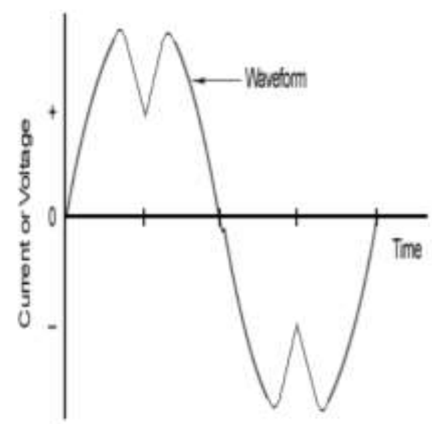

Figure 2.3: Distorted Waveform

As can be observed from the waveform in Figure 1.3, waveform distortions can drastically alter the shape of the sinusoid. However, no matter the level of complexity of the fundamental wave, it is actually just a composite of multiple waveforms called harmonics. Harmonics have frequencies that are integer multiples of the waveform's fundamental frequency. For example, given a 60Hz fundamental waveform, the 2nd, 3rd, 4th and 5th harmonic components will be at 120Hz, 180Hz, 240Hz and 300Hz respectively. Thus, harmonic distortion is the degree to which a waveform deviates

International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 17
July 2018

from its pure sinusoidal values as a result of the summation of all these harmonic elements. The ideal sine wave has zero harmonic components. In that case, there is nothing to distort this perfect wave. Total harmonic distortion, or THD, is the summation of all harmonic components of the voltage or current waveform compared against the fundamental component of the voltage or current wave:

A technical view of harmonics

Harmonics are currents or voltages with frequencies. Harmonic frequencies from the 3rd to the 25th are the most frequencies that are integer multiples of the fundamental power frequency. If the fundamental power frequency is 60 Hz, then the 2nd harmonic is 120 Hz, the 3rd is 180 Hz, etc. (see Figure 1.4). When harmonic frequencies are prevalent, electrical power panels and transformers become mechanically resonant to the magnetic fields generated by higher frequency harmonics. When this happens, the power panel or transformer vibrates and emits a buzzing sound for the different harmonic common range of frequencies measured in electrical distribution systems.

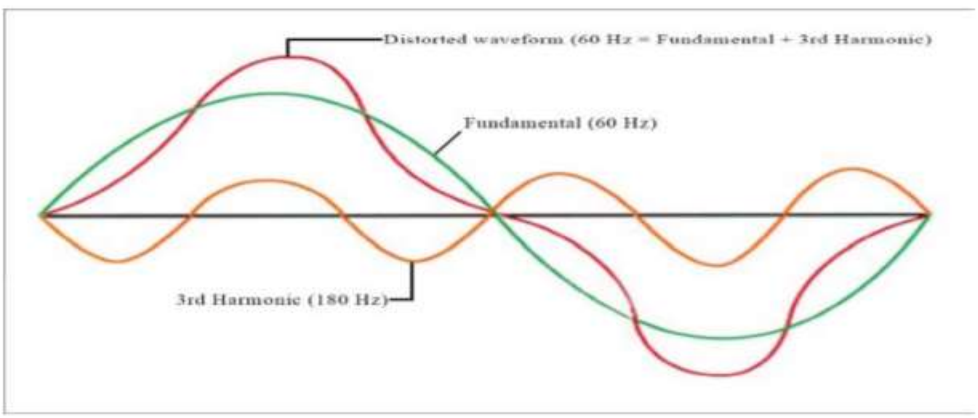

Figure 2.4: Harmonic distortion of the electrical current waveform

All periodic waves can be generated with sine waves of various frequencies. The Fourier theorem breaks down a periodic wave into its component frequencies.

International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 17
July 2018

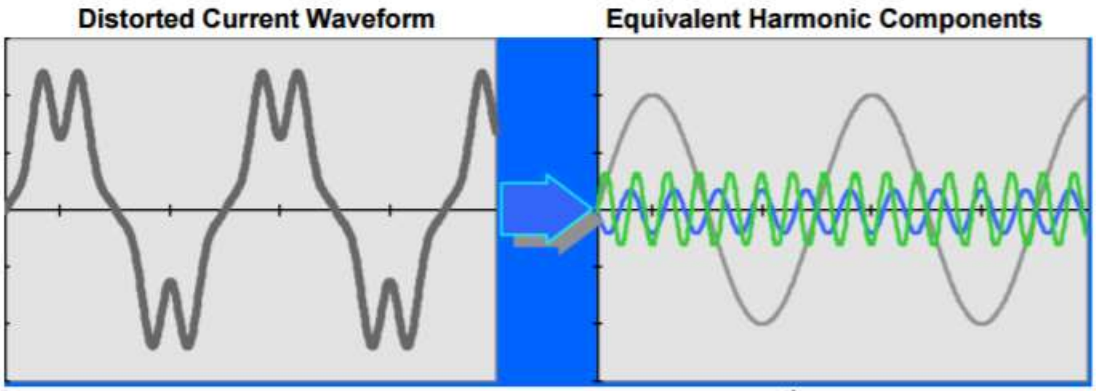

Figure 2.5: Distorted waveform composed of fundamental and 3 rd harmonic

The total harmonic distortion (THD) of a signal is a measurement of the harmonic distortion present and is defined as the ratio of the sum of the powers of all harmonic components to the power of the fundamental. It provides an indication of the degree to which a voltage or current signal is distorted

$$THD_C = Total\ Harmonic\ Current\ Distortion = \frac{\sqrt{I_2^2 + I_3^2 + I_4^2 \ldots + I_n^2}}{I_1} \, x\, 100\%$$

$$CF = Crest\ Factor = \frac{|I_{Peak}|}{I_{RMS}}$$

$$I_{RMS} = \sqrt{I_1^2 + I_2^2 + I_3^2 \ldots + I_n^2}$$

I_n = *Individual harmonic current distortion values in amps or in per unit amps.*

I_1 = *Fundamental current distortion value in amps or per unit amps.*

I_2 = *2nd harmonic current distortion values in amps or per unit amps.*

3. RESULTS

The harmonic distortion calculation using LabVIEW as shown in below Fig 4.2. The frequency spectrum contains original frequency component and integer multiplies of fundamental frequency components. These frequency components are called as harmonic components. First calculate second harmonic distortion then third

International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 17
July 2018

harmonic distortion and so finally add all harmonic distortions, we can get total harmonic distortion.

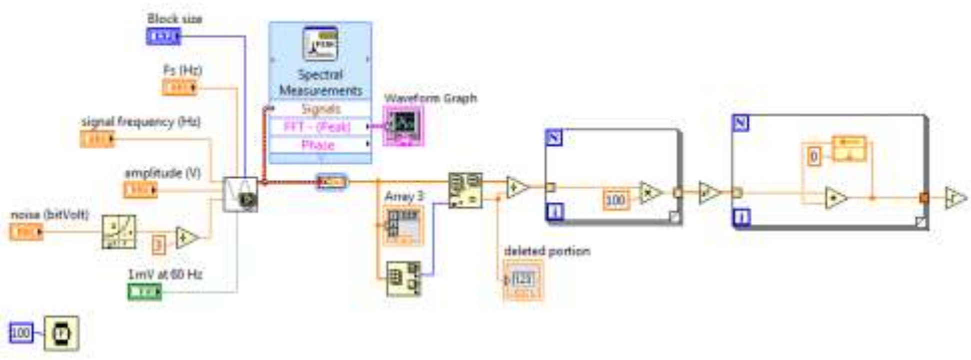

Fig 4.1: Block Diagram of Harmonic distortion calculation.

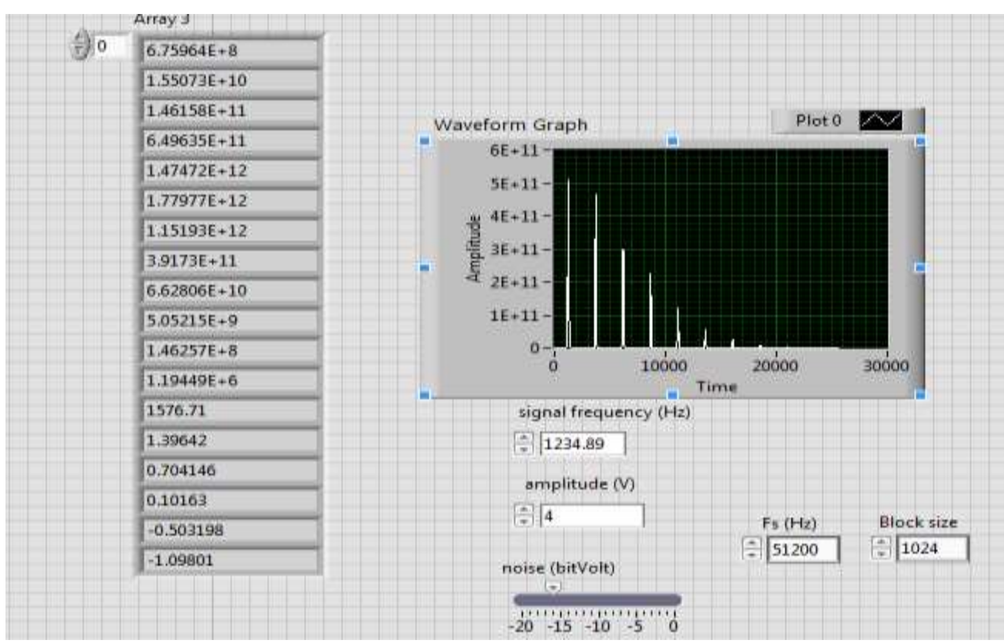

Fig 4.2: Front panel of Harmonic distortion calculation.

IV: CONCLUSION AND FUTURE SCOPE

This project provides very easy to implement harmonic distortion c analyzer by using LabVIEW. It replaces large amount of hardware. Virtual instrument offers several Benefits to engineers and scientists, who require increased productivity, accuracy and performance. The traditional hardware was replaced by virtual instruments and it also provides low cost and flexibility. This VI calculates total harmonic distortion of given signal.

Evolution and cost of measurement equipment, continuous training, and distance learning make it difficult to provide a complete set of lab equipment to every student. For a preliminary familiarization and experimentation with instrumentation and measurement procedures, the use of virtual equipment is often considered more than sufficient from the didactic point of view, while the hands-on approach with real instrumentation and measurement systems still remains necessary to complete and refine the student's practical expertise. Creation and distribution of workbenches in networked computer laboratories therefore becomes attractive and convenient.

REFERENCES

1. Brian R., Lipsman R.L., "A guide to Matlab: for beginners and experienced users",Cambridge University Press, 2001
2. Czarnecki L.S., "Harmonics and power phenomena", Wiley Encyclopedia of Electrical and Electronics Engineering, John Wiley, New York, 2000.
3. Jacobs J., Detjen D.O., De Doncker R.W., "An overview of methods to determine the harmonics in three-phase systems", IEEE Young, Researchers Symposium in Electrical Power Engineering Distributed Generation, 2002.
4. Munteanu M., Logofatu B., Lincke R., Aplicaţii de instrumentaţie

virtuală LabView, Editura Credis, Bucureşti, 2003
5. Popescu M., Bitoleanu A., Dobriceanu M., “On the AC-side interface filter in three-phase shunt active power filter systems”, World Academy of Science, Engineering and Technology, Issue 69, August 2010, pp. 516-521.
6. Selisteanu D., Petre E., ş.a., Aplicaţii LabVIEW pentru achiziţia şi generarea datelor, Editura Sitech, Craiova, 2004
7. Subtirelu G.E., “Electronica analogica asistata de calculator”, Editura Sitech, 2011, Craiova, pp. 8-18.
8. Sutherland P., “Harmonic measurements in industrial power systems”,IEEE Trans.Ind. Appl.,Vol.31, No.1,1995,pp.175-183.
9. Detection and Filtering of Harmonics, Schneider Electric, Application note, 2008.
10. Harmonics Standards for Commercial Electronic Products, dBi Corporation, 2010, http://www.dbicorporation.com/harmonic.htm.
11. Guide to Harmonics with AC Drives, ABB, Technical Guide No. 6.
12. Harmonics, E-Source Customer Direct, Platts – a Division of The McGraw Hill Companies Inc.
13. Normes CEI 61000-3-2, Limites pour les emissions de courants harmoniques.
14. LabVIEW User Guide, National Instruments, SUA, 1996