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Study of Equipment to Measure Quantities Related to Electricity in a Three-Phase Engine

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Abstract— This study examines the WaveBook/516E device for measuring electrical energy in three-phase engines. Accurate measurement and analysis of electrical energy is critical to engine performance and efficiency. However, existing devices often lack comprehensive data analysis capabilities, which hinders researchers' understanding of engine characteristics and electrical quantities. The study focuses on the WaveBook/516E, which features data storage and customizable analysis options. The methodology involves a theoretical review, including references, data from engines, obtained using the device's standard configuration and flexible settings, underwent detailed statistical analysis. Results demonstrated consistent data for engines under different conditions, validating the device's potential for precise statistical analysis. The WaveBook/516E's data storage and customization options make it a valuable tool for research on electrical energy in three-phase engines, allowing researchers to explore various scenarios. This research helps to improve the understanding of engine behavior and promote efficient engine control practices. The device's ability to change input patterns expands its applicability to broader research in electrical energy measurement and analysis. Overall, the WaveBook/516E expands the capabilities of researchers by facilitating in-depth studies and sound engine control practices.

Keywords— Electric energy, modern engines, WaveBook/516E, validation, theoretical conceptions, experimental data.

I. INTRODUCTION

The purpose of this paper is to study and analyze the device WaveBook/516E [1] that measure quantities related to electrical energy in three-phase engines. This study focuses on a specific device that stands out for its ability to store data and enable personalized analysis according to the user's needs. The results obtained show the consistency of the stored values both with the engine off and under load, demonstrating that this device allows a detailed statistical analysis of the collected data. This discovery is of great importance as it contributes to a deeper understanding of the relationship between engine properties and measured electrical quantities. In addition, the user can customize the device's input pattern, expanding its applicability in scientific research related to measuring and analyzing electrical power problems [2, 3]. The results provide a solid basis for the development of advanced measurement and analysis techniques for three-phase engines and contribute to the development of the research field. Therefore, this paper provides a sound and validated material through experiments and theoretical models based on the scientific method, with proper statistical design and scientifically supported discussions.

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The importance of research to measure the amount of electrical energy in three-phase engines is widely recognized in the scientific community [4]. Previous studies have provided valuable information on this topic. According to a study by [5], the growing growth of the industrial, commercial, and residential sectors intensifies the demand for high-quality electricity. Power and power quality measurements are critical to delivering accurate power. This study focuses on specific devices with features that store data and allow for custom analysis. The results provide a solid basis for the development of advanced measurement and analysis techniques in three-phase engines, facilitating the development of the research field, improving energy efficiency, reducing costs, and contributing to environmental protection.

To guarantee the efficiency of a project, it is essential to have equipment that allows a safe and precise determination of the engines slip and torque. In certain situations, engines are initially built to carry out tests that evaluate their performance and validate their practical viability. To carry out these tests, there are a considerable number of companies responsible for the commercialization of measuring equipment used both in laboratories and by engineering professionals.

The WaveBook/516E has positive aspects such as the ease of inserting input and output data into the equipment, in addition to allowing a better study of the properties of waveforms from plotting the graphs. Thus making it suitable equipment for this study, as explained in Section II.

II. Methodology and Tools

The main objective of this project, described in this paper, is to carry out a detailed analysis by using the WaveBook/516E device, the experiment was performed with the WEG induction engine [6], both at no load and with a load generated by an unloaded DC generator, as shown in Fig. 1.

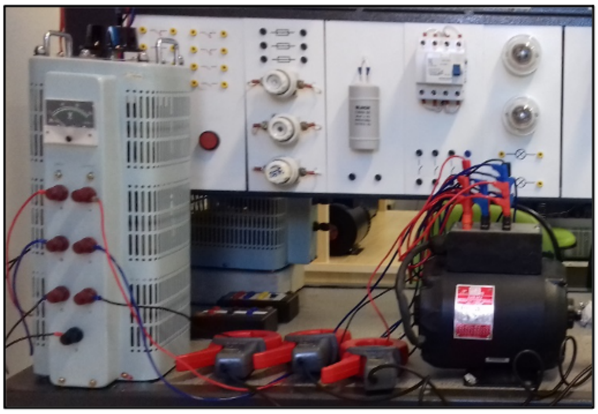

Fig. 1: Software Configuration.

In this section of the work, a theoretical study was carried out based on a bibliographical survey [1, 2, 3, 6] will be the basis of this research. In addition, other theoretical materials were also used in the bibliographic survey to clarify possible difficulties that could arise during the theoretical course. Thus, the analysis of the data obtained through the WaveBook/516E device aims at validating the theoretical basis.

III. Results

a. Initial considerations

Table 1 shows the Waveview configuration to measure the engine both at no load and at load.

Table 1: Waveview configuration with a sine wave.

Channels	Mode	Input	Level
1	On	Voltage	-10 to 10
2	On	Voltage	-10 to 10
3	On	Voltage	-10 to 10
4	Off	–	–
5	On	Current	-10 to 10
6	On	Current	-10 to 10
7	On	Current	-10 to 10
8	Off	–	–

The software offers several options to adjust the method of data acquisition by the equipment to meet the requirements of each experiment. In the present situation, it was decided to use the standard configuration of the device, as shown in Fig. 2, since it fully satisfied the needs.

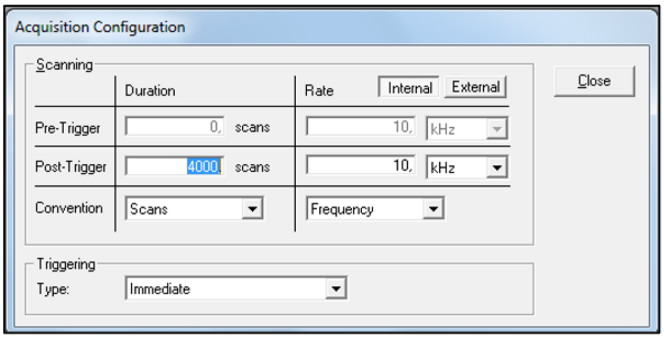

Fig. 2: Software Configuration.

The program employed also offers greater flexibility in selecting the number of waveforms to be represented simultaneously during the measurement, providing more effective monitoring of the observed data. Fig. 3 exemplifies the individual representation of the voltage waveform in channel 1, while Fig. 4 illustrates the joint representation of the waveforms of channels 1 to 3, as well as the current waveforms of channels 5 to 7.

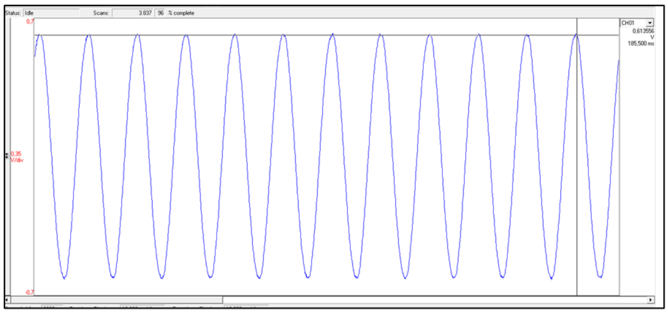

Fig. 3: Sinusoidal voltage waveform (channel 1).

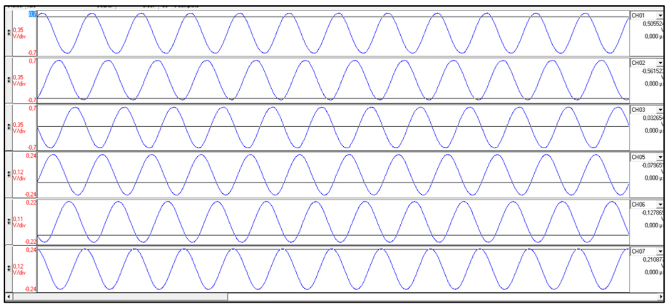

Fig. 4: Voltage (channels 1, 2, and 3) and current (channels 5, 6, and 7) waveforms.

It becomes evident that, by analyzing Fig. 4, the waveforms are extremely ideal, however, an electric engine has a considerable number of coils in its composition, so the magnetic variation rate will induce voltage and current from the stator to the rotor. Consequently, will have a reactive presence circulating in the circuit, therefore, the waveforms should not be perfectly sinusoidal.

The modifications of the operating levels in the program settings, shown in Table 2, result in the style of the waveform that will be plotted, as can be seen in Fig. 5. Since this figure presents the half-wave shape for just one channel, it should be noted that this behavior will be equivalent for all channels, considering that the user select the number of channels.

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TABLE 2: WAVEVIEW CONFIGURATION WITH HALF-WAVE GRAPH.

Channels	Mode	Input	Level
1	On	Voltage	0 to 10
2	On	Voltage	0 to 10
3	On	Voltage	0 to 10
4	Off	–	–
5	On	Current	0 to 10
6	On	Current	0 to 10
7	On	Current	0 to 10
8	Off	–	–

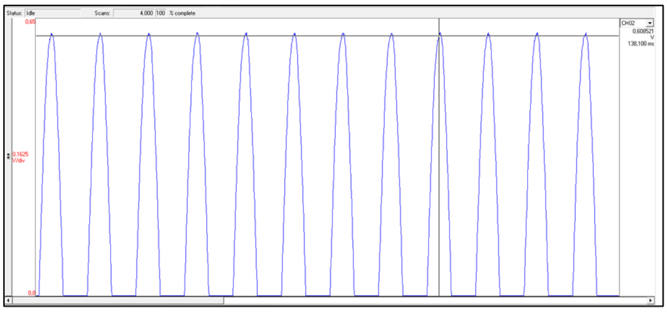

Fig. 5: Waveform with half-wave graph.

b. Comparison of the engine at no load and with load

In this subsection, the analysis of the behavior of the waveforms between the data collected from the engine with load and the data from the engine with no load will be explored. Fig. 6 depicts the six waveforms, three of which are voltage channels and three are current channels, recorded in the engine running at no load. Fig. 7 depicts the values and graphic result of the behavior of the data measured in the engine with the load.

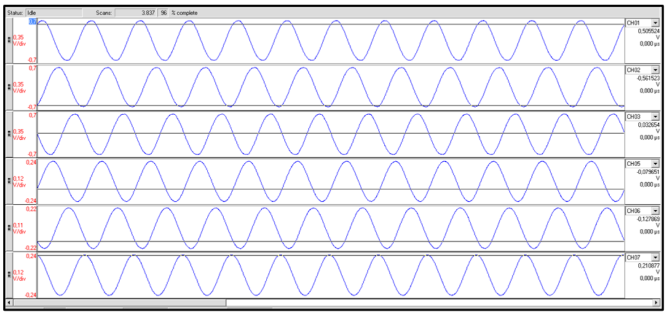

Fig. 6: Engine voltage and current waveform at no load.

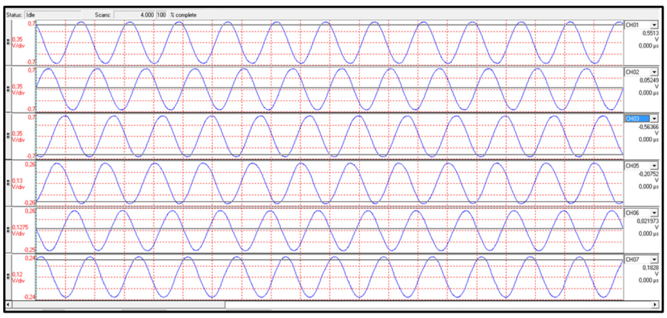

Fig. 7: Voltage and current waveforms of the engine with load.

With predefined settings, the equipment plots the waveform according to them. Therefore, the default configuration (highlighted above) is predefined with an input voltage of 150 volts. Therefore, both voltage and current behavior were analogous (Figs. 6 and 7). With this configuration, it was not possible to induce the presence of some kind of harmonic, which means that a more complex analysis of the waveforms could not be performed.

By plotting the graph on the program screen individually, in Figs. 8 and 9, one can see a flattening at the peak of the sinusoidal, so we deduce that there is some kind of harmonic present.

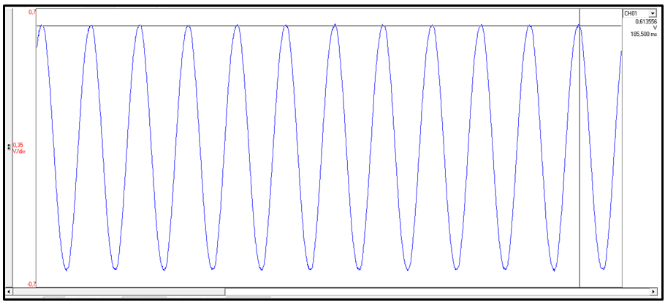

Fig. 8: Engine voltage and current waveform at no load (Channel 1).

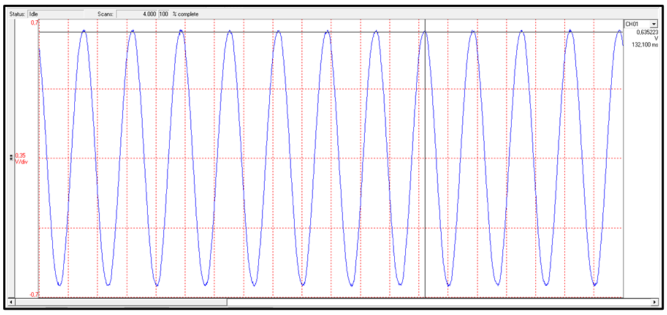

Fig. 9: Engine voltage and current waveform with load (Channel 1).

IV. CONCLUSION

This study demonstrated the importance of accurately measuring electrical energy in three-phase motors using the WaveBook/516E instrument. The results have provided valuable insight into the behavior of motors under various operating conditions and have demonstrated the data storage capability and customizable analysis features of the instrument. The results provide a solid foundation for advancing measurement and analysis techniques in the field of three-phase motors, helping to improve energy efficiency, reduce costs and protect the environment. By providing researchers with this versatile tool, further advances in motor control can be made and a deeper understanding of motor characteristics and electrical variables can be promoted. This study highlights the critical role of precision measurement devices such as the WaveBook/516E in advancing scientific research and promoting efficient energy use in various industrial, commercial, and residential applications.

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