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Characteristics of Half Wave and Full Wave Power Supply Based on Proteus Application Simulation

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Abstract: This study uses a simulation-based approach with the Proteus application to discuss the characteristics of half-wave and full-wave power supplies. Power supplies are essential components in electronic systems that convert AC voltage into DC voltage. In this study, the design and simulation of half-wave and full-wave rectifier circuits were carried out to observe the differences in performance and characteristics of each type, such as DC output voltage value, ripple, and rectification efficiency. The simulation results show that the full-wave power supply produces a more stable DC output voltage with lower ripple compared to the half-wave power supply. Additionally, the rectification efficiency in full-wave circuits is higher because rectification occurs in every AC cycle, while in half-wave circuits it only occurs in half of the cycle. This simulation provides a clear overview of the advantages and disadvantages of each type of power supply, thus serving as a useful reference in the design of power supply systems for various electronic applications.

Keywords: Power Supply, Half-Wave Rectifier, Full-Wave Rectifier, Simulation, Proteus.

Abstrak: *Penelitian ini membahas karakteristik dari power supply setengah gelombang dan gelombang penuh dengan pendekatan berbasis simulasi menggunakan aplikasi Proteus. Power supply merupakan komponen penting dalam sistem elektronika yang berfungsi mengubah tegangan AC menjadi DC. Dalam studi ini, dilakukan perancangan dan simulasi rangkaian penyearah setengah gelombang dan gelombang penuh untuk mengetahui perbedaan performa dan karakteristik masing-masing jenis penyearah, seperti nilai tegangan output DC, riak (ripple), serta efisiensi penyearahan. Hasil simulasi menunjukkan bahwa power supply gelombang penuh menghasilkan tegangan output DC yang lebih stabil dengan nilai ripple yang lebih kecil dibandingkan dengan power supply setengah gelombang. Selain itu, efisiensi penyearahan pada rangkaian gelombang penuh lebih tinggi karena proses penyearahan terjadi pada setiap siklus gelombang AC, sementara pada rangkaian setengah gelombang hanya terjadi pada setengah siklus. Simulasi ini memberikan gambaran yang jelas mengenai keunggulan dan kekurangan masing-masing jenis power supply, sehingga dapat menjadi referensi dalam perancangan sistem catu daya pada berbagai aplikasi elektronika.*

Kata kunci: *Power Supply, Penyearah Setengah Gelombang, Penyearah Gelombang Penuh, Simulasi, Proteus.*

INTRODUCTION

The development of technology in the field of electronics is increasingly rapid, along with the increasing human need for efficient and reliable electronic devices. One of the main components in an electronic system is the power supply, which functions to convert alternating current (AC) voltage from the electrical network into a stable direct current (DC) voltage that meets the needs of the device. The performance of the power supply greatly affects the quality and performance of the electronic system as a whole [1].

In the process of converting AC voltage to DC, an important component used is the rectifier circuit. Rectifiers have several types of configurations, including half-wave rectifiers and full-wave rectifiers. Each type of rectifier has different characteristics and performance, both in terms of DC output voltage, ripple level, and rectification efficiency. Therefore, it is important to understand the differences in the characteristics of the two types of rectifiers before they are applied in a power supply system [2].

As simulation software technology develops, analysis and design of electronic circuits can now be done virtually before being realized physically. One of the simulation applications that is widely used in the field of electronics is Proteus. By using Proteus, users can design, test, and analyze electronic circuits efficiently and accurately [3]. Based on the background, this study was conducted to analyze the characteristics of half-wave and full-wave power supplies based on simulation using the Proteus application. Through this simulation, it is expected to obtain a clear figure of the performance of each type of rectifier, which can be used as a reference in designing power supply systems in various electronic applications [4].

METHODS

This simulation-based study aims to analyze and compare the characteristics of half-wave and full-wave power supplies using the Proteus application [5].

Tools and Materials

1. Software: Proteus 8 Professional [6]
   The display of the simulation worksheet using the Proteus application can be seen in Figure 1 below.

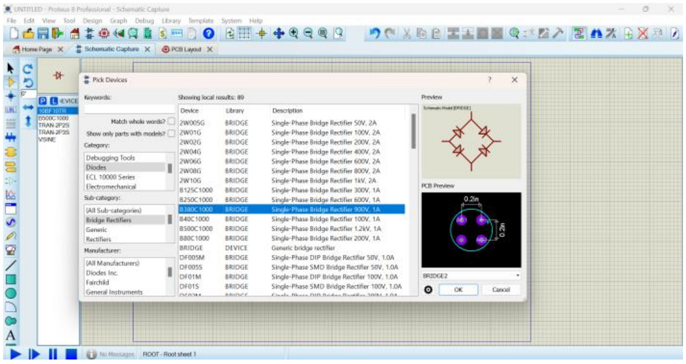


Figure 1. Proteus application worksheet

2. Circuit components (virtual in Proteus): Transformer, Rectifier diode, Load resistor, Filter capacitor, Virtual measuring instruments (oscilloscope, voltmeter, and ammeter)[7].

Research Steps

1. Block diagram design

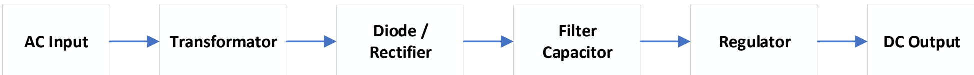


Figure 2. Power supply block diagram

2. Circuit Design
   a. Designing half-wave and full-wave power supply circuits using the Proteus application. Figure 3(a) shows the schematic diagram of a half-wave power supply circuit. Figure 3(b) displays a full-wave power supply circuit using a bridge rectifier. Meanwhile, Figure 3(c) illustrates a full-wave power supply circuit utilizing a center-tapped transformer.

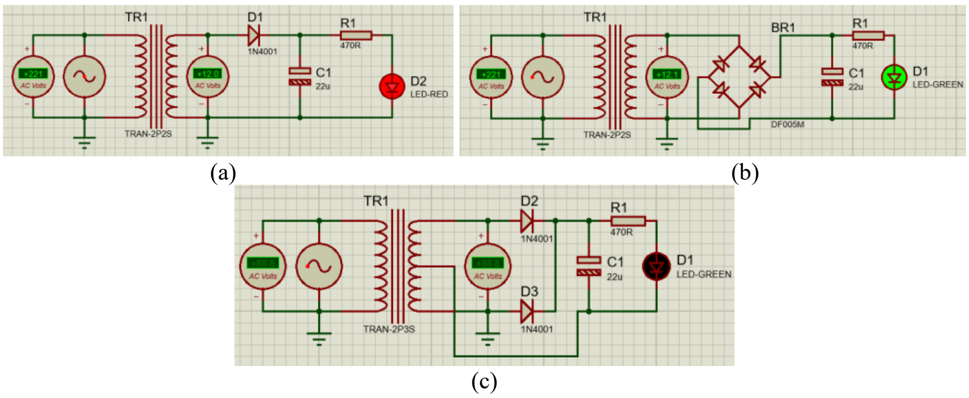


Figure 3. Power supply circuit schematics: (a) half-wave rectifier, (b) full-wave rectifier using bridge diode, (c) full-wave rectifier using center-tapped transformer

b. Using virtual components such as transformers, diodes, resistors, and capacitors. The following components use the Proteus application, such as transformers, diodes, resistors, capacitors, which can be seen in this news Figure 4.

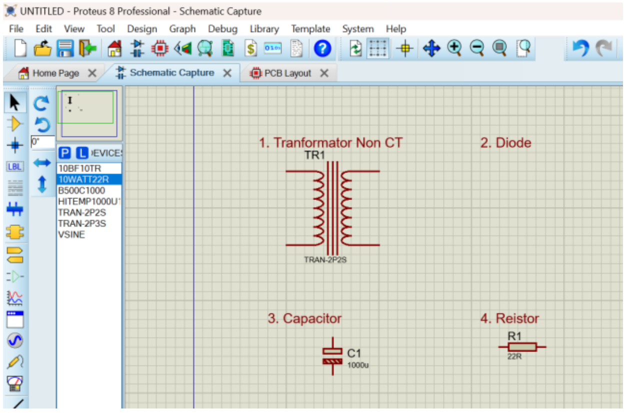


Figure 4. Transformers, diodes, resistors, and capacitors using the Proteus application

Apart from electronic circuit simulation, this Proteus application can also be used to collect data by measuring, such as using a voltmeter, ammeter, and an oscilloscope measuring instrument. Measuring tools can be shown in the following Figure 5.

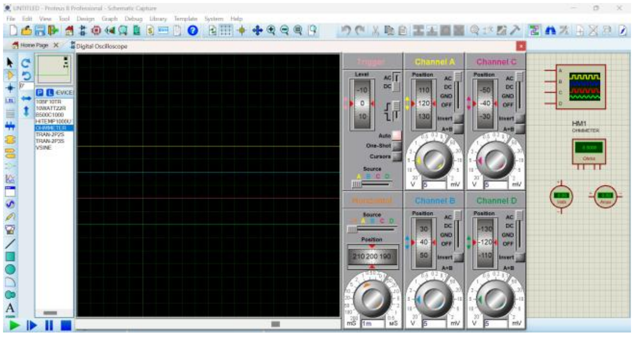


Figure 5. Transformers, diodes, resistors, and capacitors using the Proteus application

The research steps taken are as follows:

1. Circuit Simulation
   The study involves conducting simulations for each rectifier circuit to analyze their performance. During the simulations, the DC output voltage, ripple value, and output wave patterns are observed using a virtual oscilloscope. Data collection is carried out by recording the simulation results, which include the DC voltage, ripple value, and efficiency of each circuit [8].
2. Data Analysis
   The data analysis involves evaluating the simulation results to compare the performance of half-wave and full-wave power supply circuits. This includes examining key parameters such as output voltage, ripple, and efficiency. The findings are then presented in the form of tables and graphs to facilitate a clear comparison of the characteristics of each rectifier type.

RESULT AND DISCUSSION

Half Wave Power Supply Simulation

Planning of electronic circuit schematics in the form of a half-wave power supply circuit and simulated using the Proteus application [9]. This half-wave power supply uses a Non CT transformer and is rectified using 1 diode component, then filtered using an electrolytic capacitor. In the simulation process, the image is designed and created by connecting each component leg. The transformer input is given an alternating voltage of 220 volts, this voltage is taken from a generator voltage source or sinus voltage that is already available in the Proteus application. The transformer functions to reduce alternating voltage, the transformer output is still in the form of alternating current and will change to direct voltage after being rectified using a diode. According to the nature and character of silicon semiconductor diodes, which work when receiving an input voltage of 0.7 volts, this voltage is cut off by the input voltage minus 0.7 volts. The circuit figure can be seen as follows.

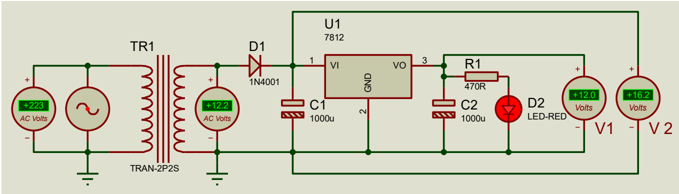


Figure 6. Half-wave power supply analysis using Proteus

In the results and discussion in Figure 6 paragraph 1 can be analyzed according to the simulation using the Proteus application, that the half-wave power supply electronic circuit, which can input 220 volts of alternating current (AC), can have its voltage reduced using a step-down transformer to 12 volts [10]. Then it is directed using an IN4001 diode with a capacity of 1 ampere and a maximum voltage of 50 volts after being directed so that the voltage is not defective and meets the capacity, it is filtered or temporarily stored using an electrolytic capacitor with a capacity of 1000 uF/16 volts. To obtain a stable voltage, a regulator is required, namely using a stabilizer IC with type 7812. Initially, the voltage produced by the rectifier and temporarily stored at 16 volts is then stabilized to 12 volts. To see whether the output voltage is there or not, an indicator is given as a load, namely a red LED diode to indicate whether the output voltage is there or not. By turning on the load indicator, the circuit can be simulated using Proteus properly and correctly.

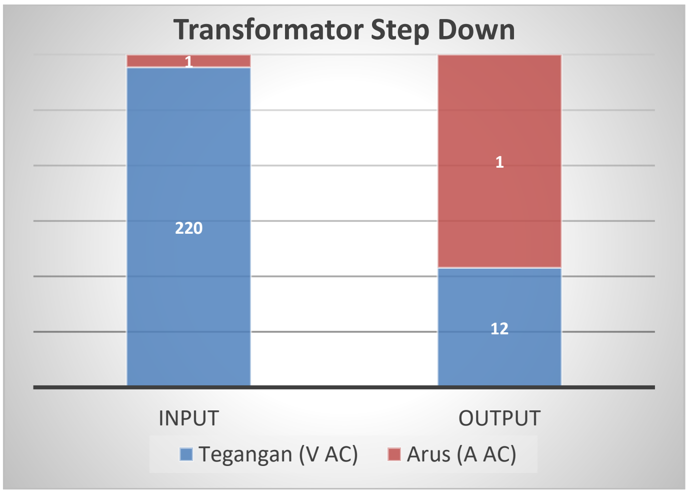


Figure 7. Graph Step Down Transformer 220 Volt to 12 Volt

In Figure 7 is proven by measurements using a voltmeter and proven in the form of a signal using an oscilloscope as in the following image [11]. Figure 9 measurement of the input voltage of 220 volts PLN and the output voltage on the transformer which is still in the form of AC voltage because it has not been rectified, if it has been rectified using a diode component, the AC voltage will become DC. and Figure 10 measurement using an oscilloscope measuring instrument. In Figure 8, the oscilloscope can show the form of the input signal and measurement. The sinus signal can be seen clearly which indicates the alternating current voltage between the input and output. The input signal is shown in the yellow wave signal, while the output voltage is shown in the blue wave signal.

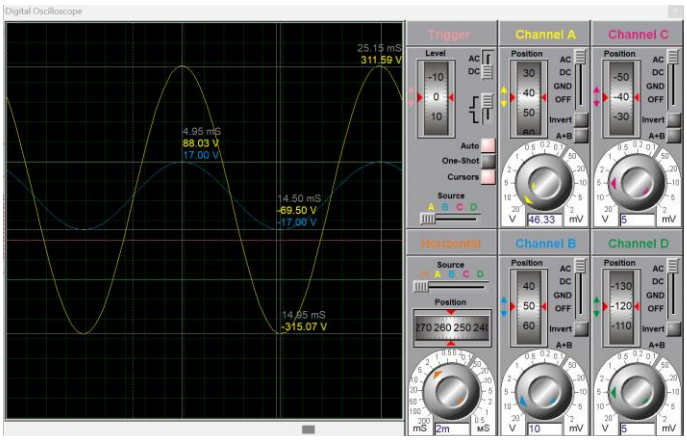


Figure 8. Display of Input and Output Voltage Measurements Using an Oscilloscope in The Proteus Application

The input voltage is measured on the oscilloscope and calculated using the following equation:

- Input Voltage on the Transformer

$V_{rms} = 0.707 \times V_m$

$= 0.707 \times 311{,}59$

$= 223{,}122\ Volt$

- Output Voltage on the Transformer

$V_{rms} = 0.707 \times V_m$

$= 0.707 \times 17$

$= 12{,}019\ Volt$

From the Proteus simulation, a half-wave rectifier can be obtained through diode 1 and can be analyzed through measurements using an oscilloscope. From the analysis through the Proteus application simulation, the voltage on the C1 filter is 16.2 volts. To obtain a stable voltage in the circuit, IC 7812 is installed so that the output voltage is stable at 12 volts. The results of measurements using an oscilloscope can be seen in the following figure. Measurements using a voltmeter, both using a voltmeter and an oscilloscope, produce good results [12].

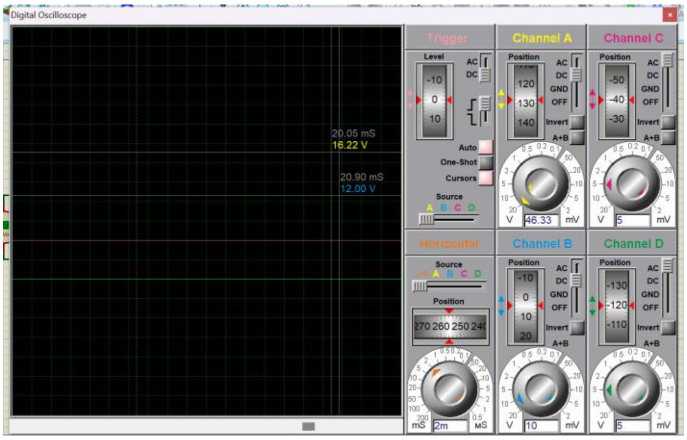


Figure 9. Output voltage measurement in the form of half-wave direct voltage

In Table 1, data is obtained from the rectifier when it is filtered and after being stabilized using the IC 7812 component. The output voltage is stable and re-filtered using capacitor C2.

Table 1. DC voltage conditions before and after stabilization

Unit	Input (V)	Output (V)
Voltage (DC)	16	12
Current (DC)	1	1

Full Wave Power Supply Simulation

Full-wave power supply is a circuit that converts AC voltage to DC using the entire AC wave cycle, both positive and negative. The full-wave power supply circuit scheme uses the proteus application, where the output from the transformer is rectified using 4 diodes. 4 diodes are arranged into a rectifier bridge (full-wave bridge rectifier), Filter capacitors to smooth the rectified DC voltage and stabilized using IC 7812 for the final 12 Volt dc output which has previously been filtered using capacitor C2. The full wave rectifier circuit schematic using Proteus simulation can be seen in the following Figure 10.

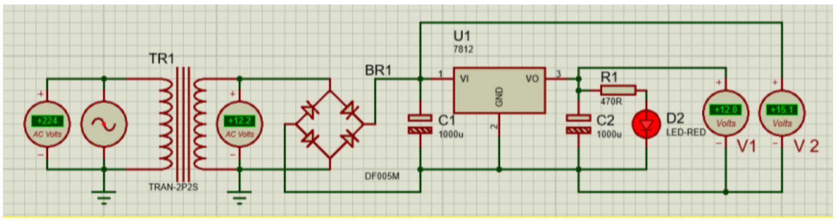


Figure 10. Full wave power supply analysis using Proteus

From Figure 13 above, the full-wave rectifier circuit can be simulated well and measured with a voltmeter before and after passing through the 12-Volt voltage stabilizer. Before stabilization, the voltage is 15.1 Volts, and after being stabilized by the IC 7812, the DC output is 12 Volts [13].

Measurement Experiment

On a real transformer, measurement on the output of a step down transformer where the output on the transformer is 12 volts AC. the measurement results are shown in the following image [14].

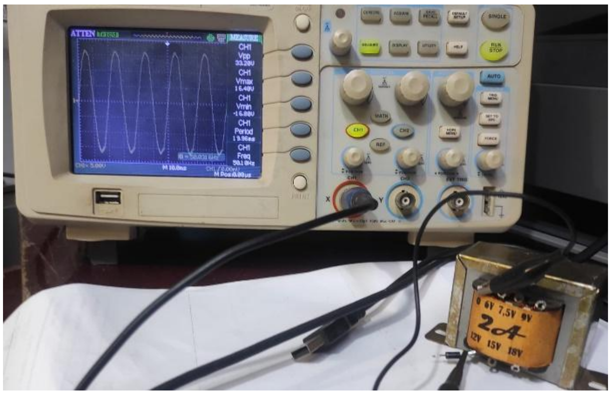


Figure 11. Measurements on the output of a 11,5 Volt AC step down transformer

Measurements on the oscilloscope obtained Vpp = 33.20 Volts, positive Vp = 16.40 Volts and negative Vp = -16.80 Volts [15]. So the effective voltage obtained is:

$V_{ef} = V_{rms}$

$V_{rms} = \frac{V_p}{\sqrt{2}}$

$V_{rms} = \frac{16{,}40}{\sqrt{2}}$

$V_{rms} = 11{,}59\ Volt = 11{,}6\ Volt$

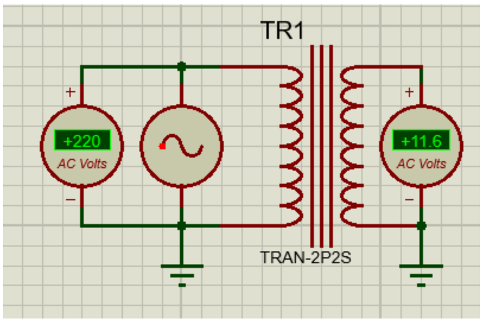
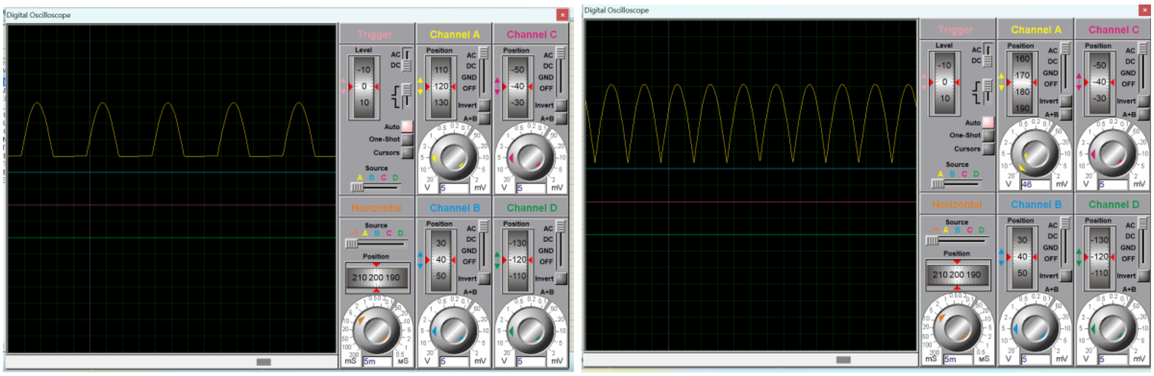


Figure 12. Measurements on the output of a 11,6 Volt AC step down transformer

For comparison of measurements to be accurate and precise between simulation and practicum, the specifications of the components used must be considered in order to obtain accurate results. in Figure 13 the practicum measurement shows a voltage of 11.6 Volts and in figure 15 the measurement in the proteus simulation shows a voltage of 11.6 Volts. in the simulation using this proteus application it is good to use as a supporting media for learning before practicum to avoid component damage if an error occurs in assembling the electronic circuit.



(a) (b)

Figure 13. Output signal measurement using an oscilloscope: (a) half-wave rectifier, (b) full-wave rectifier

Figure 13(a) shows the measurement results of a half-wave power supply where only half the wave is rectified, while Figure 13(b) shows a full wave power supply and the measurement results show that the full wave is rectified, which produces more and better ripples than a half wave power supply [16].

CONCLUSIONS

The test shows that the multihop method significantly improves the performance and range of LoRa data transmission compared to the point-to-point method. At a distance of 1.5 kilometers, the point-to-point method suffers from a high packet loss of 65%, with only 23 out of 67 packets received, indicating inadequate performance. In contrast, the multihop method successfully reduces the packet loss to only 0.8%, with 33 out of 36 packets received, indicating improved data transmission quality and reliability. This proves that the multihop method effectively enhances the performance of LoRa data transmission and meets the goal of extending the transmission range. In addition, the test also confirms that the multihop method is very efficient in increasing the range of LoRa data transmission, with evidence that the use of multiple intermediate nodes can significantly reduce packet loss and extend the transmission range. These results indicate that the multihop method is a better solution for applications that require data transmission over longer distances, offering clear advantages in data transmission quality and wider range compared to the point-to-point method.

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