Design of One-Phase Inverter Using EGS002 with SPWM

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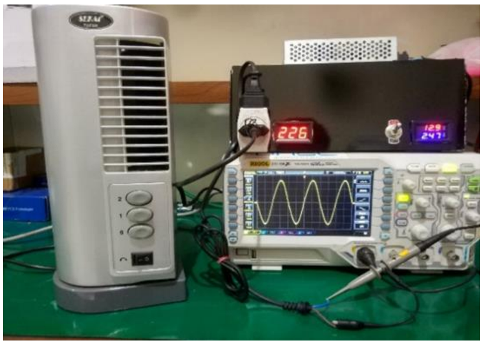
ABSTRACT



The more advanced the development of the technological world in Indonesia, the needs of the community in the use of electrical energy are also higher so that an alternative tool is needed that can produce a voltage source such as PLN. In this thesis, a 1-phase inverter will be designed that can produce output in the form of an AC voltage of 220 volts with a frequency of 50 Hz and has a good feedback voltage so that the inverter output voltage can be stable at an AC voltage value of 220 volts. The 1-phase inverter is made using a full bridge inverter circuit, the SPWM (sinusoidal pulse width modulation) signal is generated using EGS002 by ASIC (Application Specific Integreted Circuit), and the voltage correction transformer used has a maximum working power of 600 watts. According to the results of the no-load test the 1-phase inverter can produce an AC voltage on the output side of 220 to 230 volts with 50 Hz frequencys and the results of the load test show that the inverter has a good feedback voltage so that even when the input voltage drops, the inverter output voltage value is still above 220 volts.

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1. INTRODUCTION

The more advanced the development of the world of technology in Indonesia, the needs of the community in the use of electrical energy are also getting higher, in general, many people in Indonesia still rely on PLN as the main source of electricity produced by generators [1][2]. However, if the cost of electricity is expensive, an alternative tool is needed that can replace PLN's role as a source of AC electricity provider [4]. Power inverter or commonly [5] referred to as inverter is a power electronic device that can convert DC voltage into AC voltage with a controllable frequency [6][7]. Based on the type of inverter output waveform there are 3 types, namely, squarewave inverter, modified squarewave inverter, and pure sinewave inverter [3][8][9]. Squarewave inverter is an inverter with a box wave output [10], a modified squarewave inverter is an inverter with a box wave output modified into a three-level pattern so that it approaches the sine signal pattern [11], while the pure sinewave inverter is an inverter with a pure sine wave output [12]. Each inverter has its own advantages, but at the output of all types of inverters produce a lot of harmonic values [13]. This harmonic value greatly affects the performance of the inverter when supplying voltage to an electrical load, the greater the harmonic value, the less load that can be supplied while the smaller the harmonic value, the more load that can be supplied by the inverter [14]. When compared to the three types of inverters, the least harmonic value is pure sinus inverters [15]. To reduce harmonic values, usually use filters or it can be with the PWM (Pulse Width Modulation) technique [16]. Pure sinewave inverter is able to operate the AC load safely because it has a very small harmonic value so that it does not harm or damage the AC electrical equipment that is often used in everyday life [17].

Design an inverter that is expected to be used in everyday life as a substitute for AC power providers when there is a power outage by PLN. The DC source voltage used is 24 V_{DC} and the AC voltage generated in the test is 220 V_{AC} with a maximum working power of about 905 W. 1 phase inverter using a 24 V_{DC} source with current strength capable of producing power up to 905 W while in the research in this article using a DC PSU source 12V with a current capacity of 10A so that the maximum power that the inverter can produce is about 120W [18].

A 1-phase 400 W inverter with a frequency of 50 Hz. Value achievements in the expected research are 2, namely, the success of producing AC voltage such as PLN and can be used for selected loads such as incandescent lamps, solders, and fans. The test results showed that the 1-phase inverter is capable of producing pure sine waves with an AC voltage of 220 V with a frequency of 50 Hz. The 1-phase inverter uses 2 combinations of methods, namely switching high frequency (SHF) and sinusoidal pulse width modulation (SPWM) while in the research in this article only uses 1 method i.e. sinusoidal pulse width modulation (SPWM) [19].

Designed a 1-phase inverter that is expected to produce an AC voltage of 220 V, the test results show that a 1-phase inverter can produce an AC voltage output of 220 V. Inverter 1 the phase created is a box wave inverter modified using IC SG3525A as a PWM generator while in this article's research 1 phase inverter what is created is a sine wave inverter by utilizing EGS002 as an SPWM signal generator [20]. The research in this article will be in Design of One-Phase Inverter Using EGS002 with SPWM which can produce output in the form of 220 V AC voltage with a frequency of 50 Hz and has a good feedback voltage so that the inverter output can be stable at 220 V AC voltage.

2. METHODS

The method used is the experiment method, the 1-phase Inverter will be tested to supply AC voltage to the AC load such as 8W LED lamp, 25W fan, 40W electric solder, 60W incandescent lamp, and 135W electric drill. The overall schematic of the 1-phase inverter is shown in Figure 1, the inverter full-bridge circuit with a configuration of 12 MOSFETs shown in Figure 2, and the designed 1-phase inverter system is shown in Figure 3. Based on the 1-phase inverter system, the process carried out by the tool is that the tool will carry out the process of converting voltage from DC to AC through the scavenging process on the MOSFET then raised the AC voltage level of the MOSFET output will be increased to a voltage that higher using a step-up transformer. Then the AC voltage results on the output side of the transformer will be used to supply the load being tested.

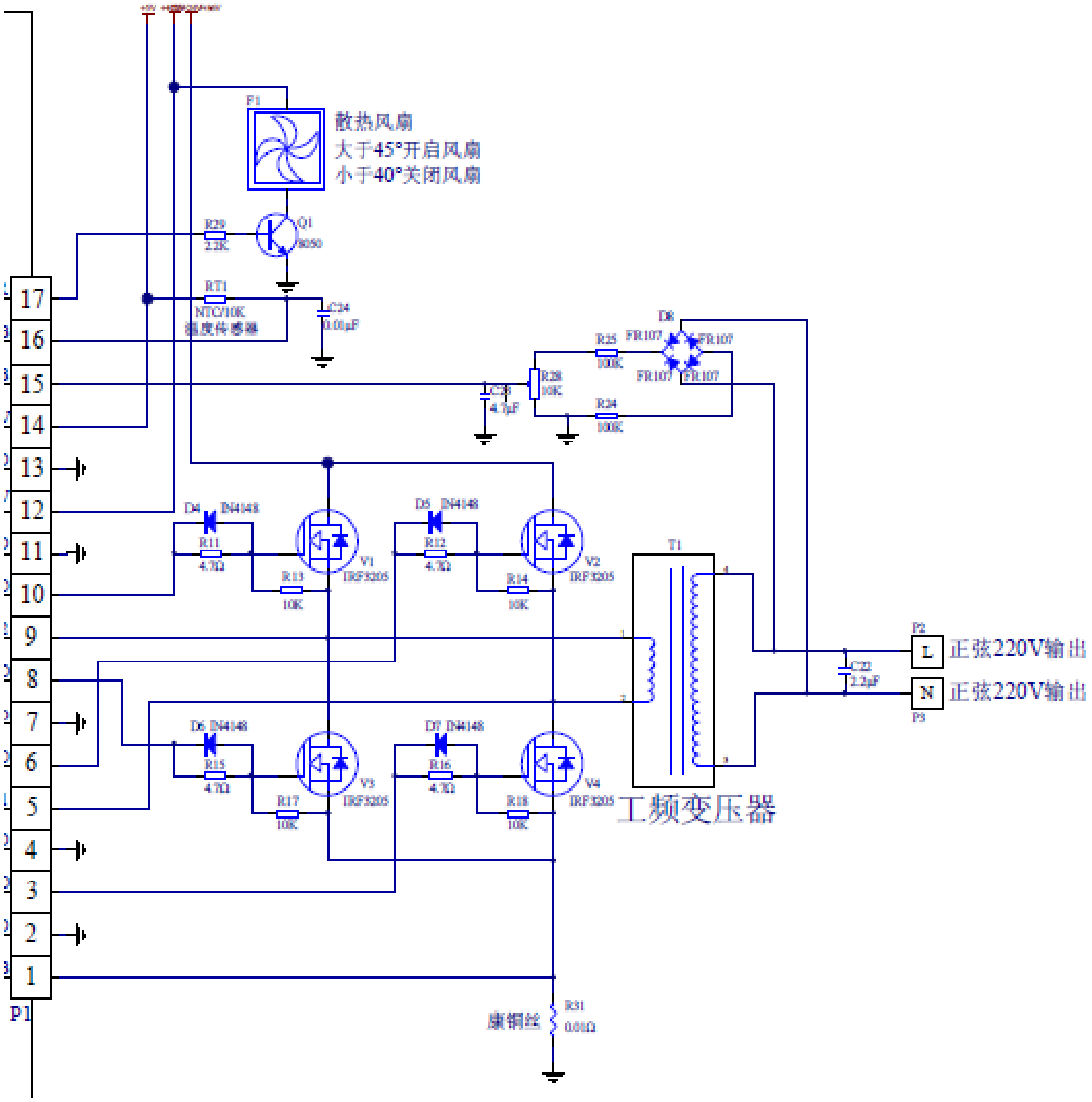

Figure 1. Schematic of the Whole Set

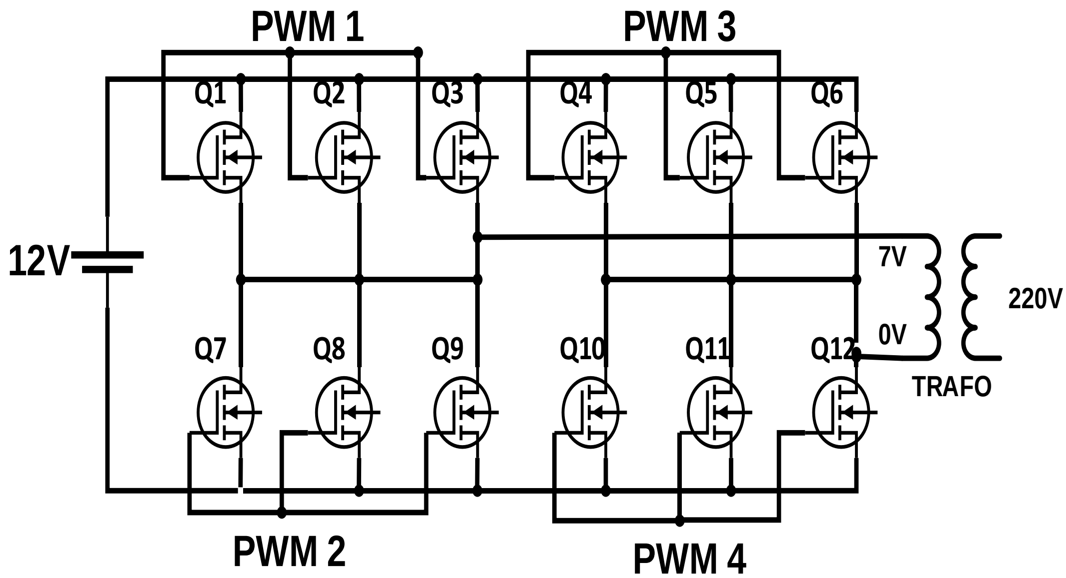

Figure 2. 1 Phase Inverter Configuration with 12 MOSFETs

2.1. 1-Phase Inverter System Design

Based on the block diagram of the 1-phase inverter working system shown in Figure 3, the 1-phase inverter working system to be made its working principle is that PSU 12V/10A will be used as a DC voltage source which will be supply voltage $12V_{DC}$ for voltage regulator, EGS002 circuit and 1 phase inverter. The voltage regulator serves as the source of the DC voltage for the EGS002 circuit. The 1-phase inverter block serves to convert 12V DC voltage into 7V AC voltage then the AC voltage will be increased to $220V_{Ac}$ using a step-up transformer. The filter block functions as an AC voltage filter after passing through the transformer, while the AC load block is the AC loads that will be used to test the 1-phase inverter.

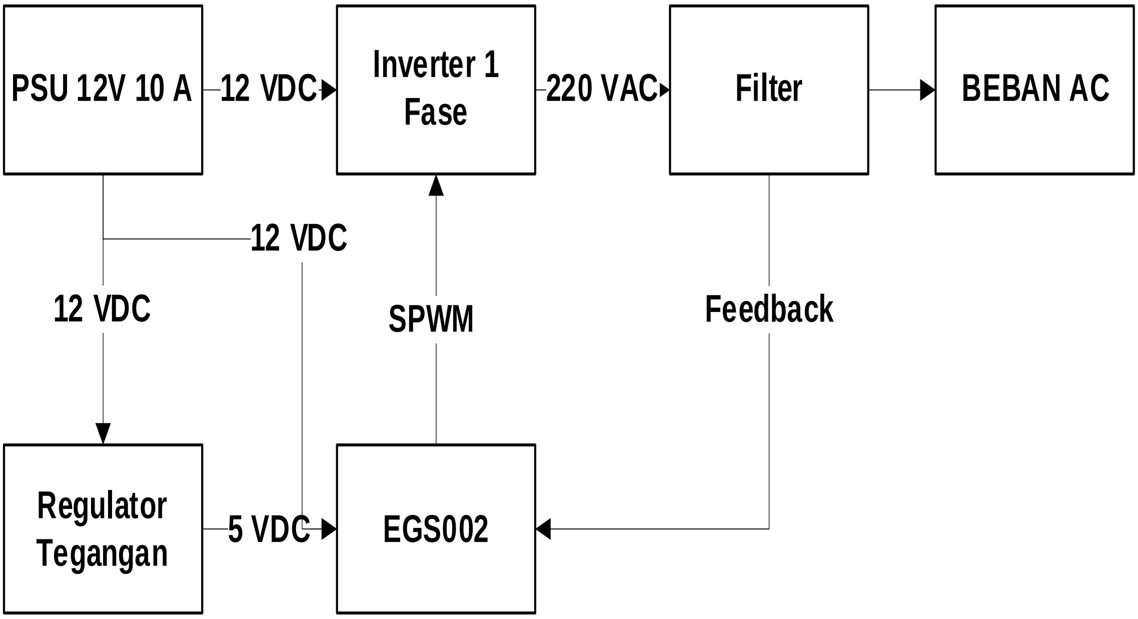

Figure 3. Block Diagram of 1 Phase Inverter Working System

Based on the results of the analysis and design of the 1-phase inverter system, the inverter specifications that will be made look like in Table 1, where the transformer power capability and DC source power greatly affects the working power of the inverter, because the PSU used has a maximum working current of 10A and a voltage of 12V, the maximum power that can be generated by inverter 1 phase is 120W.

Table 1. Tool Specifications

Parameters	Information
Input Voltage	12 Vdc
Output Voltage	220 Vac
Frequency	50 Hz
Power	120 Watts

3. RESULTS AND DISCUSSION

The analysis and discussion will be explained based on data from the 1-phase inverter test results. In this study, the parts to be tested are the EGS002 circuit, a 1-phase inverter when without load, and when the inverter is used to turn on LED lamps (8W), fans (25W), electric solder (40W), incandescent lamps (60W), and electric drills (135W).

EGS002 testing was performed to find out whether EGS002 can generate an SPWM signal or not. The results of the EGS002 test are shown in Figure 4, where the pink ch-3 signal is the base signal with a square waveform and the pink ch-4 signal is a unipolar modulation signal after passing through the RC filter. The R value on the RC filter is 680ohm while the C value is 1 uf.

At the time of application the use of the EGS002 SPWM signal will be charged to 12 MOSFETs IRF3205 which are the components of the switching. The theory should be that when EGS002 is used to activate the switch on the MOSFET IRF3205 on the 1-phase inverter circuit, the signal that is read is the SPWM signal as shown in Figure 5.

Figure 4. CH-1 Pink (Basic Signal) and CH-2 Blue (Modulation Signal)

Figure 5. SPWM EGS002 Signal

a. 1 Phase Inverter Testing

1-phase inverter testing will be carried out with two stages of testing, namely the first test is carried out when the inverter has not been loaded and the second test is carried out when the inverter has been loaded. The loads used when testing the inverter are LED lamps (8W), fans (37W), electric solder (40 W), incandescent lamps (60 W) and electric drills (137 W). The measuring instruments used for data retrieval are digital wattmeters and rigol oscilloscopes.

1) No-load inverter testing

Testing of no-load inverters is carried out with the aim of knowing whether the 1-phase inverter made is capable of producing an output voltage of 220 V_{AC} with a frequency of 50 Hz as well as producing a pure sine waveform on the output side of the inverter. The results of the test there Figure 6 can be said that the inverter is able to produce an output in the form of a pure sine signal with a rated AC voltage of 234 V_{AC} and a frequency of 50 Hz.

Figure 6. No-Load Test Results

2) Inverter testing with loads

Inverter testing with loads will be carried out by overloading a 1-phase inverter with 8 W LED lights, a 25 W fan, a 40 W electric solder, a 60 W incandescent lamp, and a 135 W electric drill. Figure 7, it can be said that when testing using an 8W LED lamp the rated output voltage value is 228 V_{AC} with an input current of 1.35 A while the sine signal form experiences a slight clipping at the peak of the wave, this is due to harmonic distortion that occurs because the LED lamp is a non-linear load type that uses rectifier components in it. To overcome this, you can use an additional filter on the output side of the inverter. Figure 8 it can be said that at the time of testing the 25W fan 1 phase inverter was able to operate normally with an output voltage value of 226 V_{AC} and an input current of 2.47 A. In Figure 9 it can be said that at the time of testing the 40W electric solder 1-phase inverter was able to operate normally with an output voltage value of 227 V_{AC} and an input current of 3.17 A.

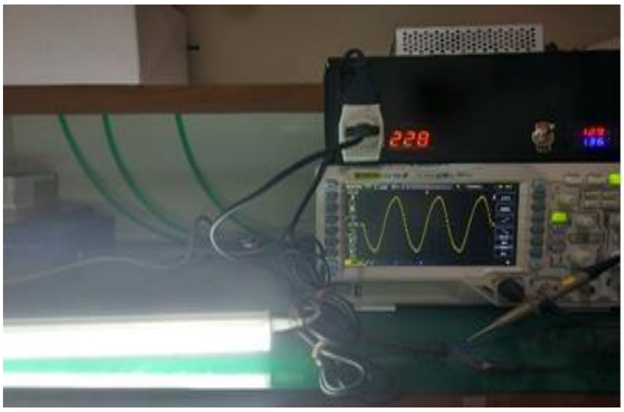

Figure 7. 8W LED Light Testing

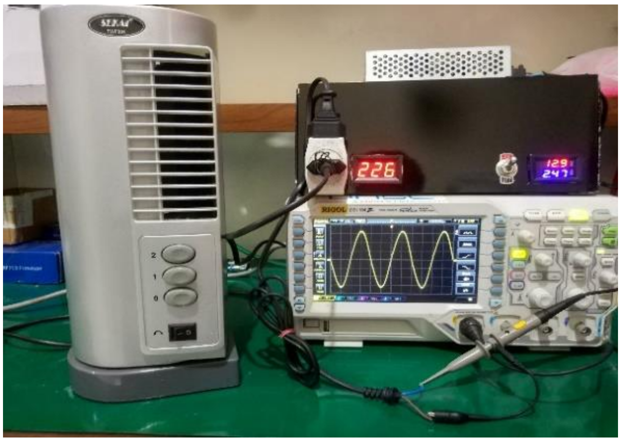

Figure 8. 25W Fan Testing

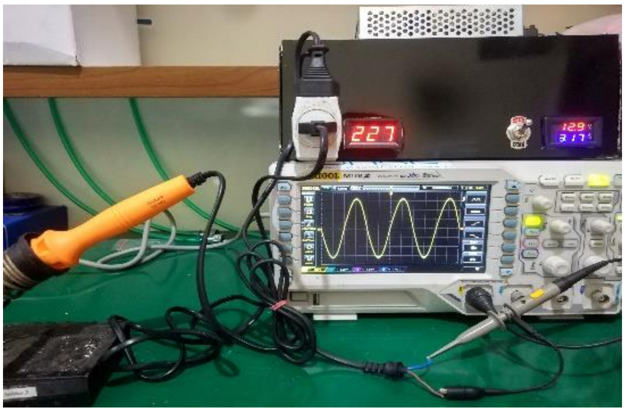

Figure 9. 40W Electric Soldering Testing

In Figure 10 it can be said that at the time of testing the 60W incandescent lamp 1 phase inverter was able to operate normally with an output voltage value of 227 V_{AC} and an input current of 5.44 A.

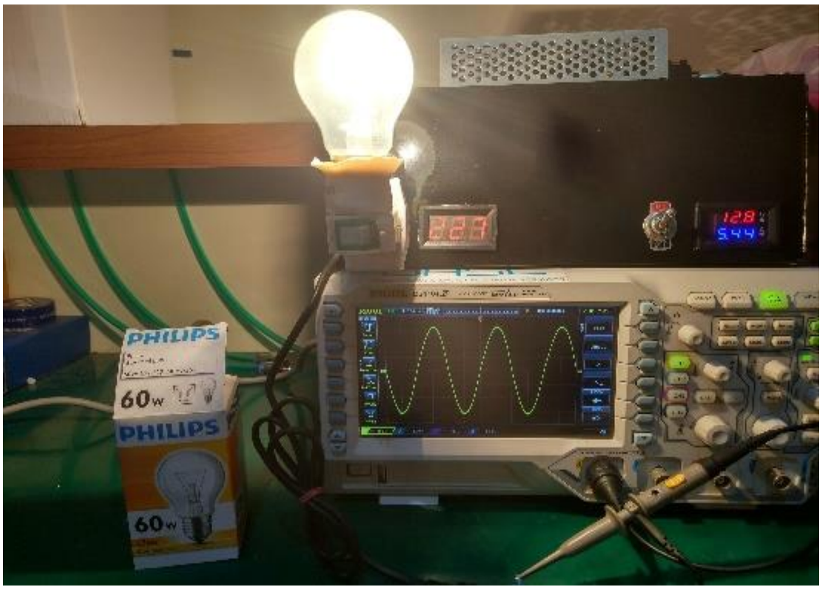

Figure 10. 60W Incandescent Lamp Testing

Data in Figure 11, it can be said that the 1-phase inverter can operate normally with an output voltage of 227 V_{AC} and an input current of 5.46 A. From the test results of the 5 loads, it can be said that in addition to non-linear loads, the test results show that the sine wave is still in the form of pure sine even though it is given a load with great power. The data obtained during load testing can be seen in Table 2 which shows the changes that occur in the input and output voltages based on load power. From the data shown in Table 2, it can be plotted into the figures shown in Figure 12, Figure 13, and Figure 14.

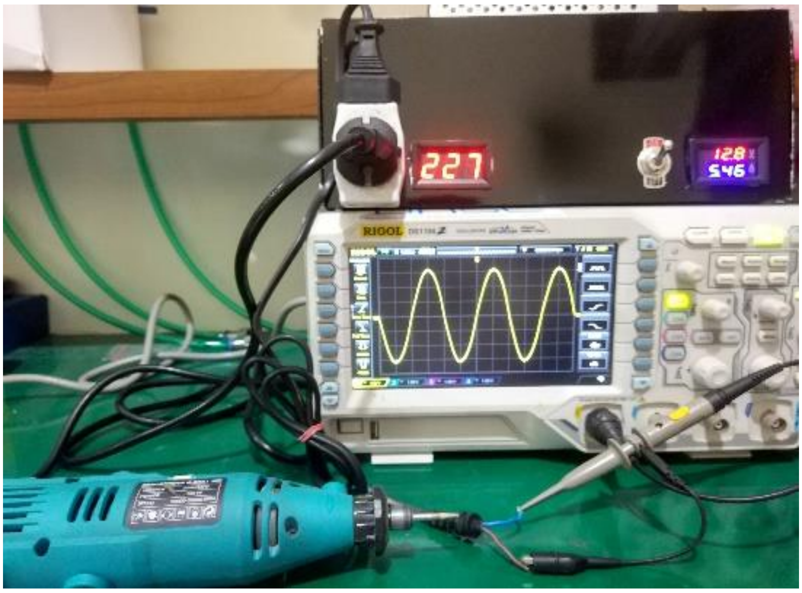

Figure 11. 135W Electric Drill Testing

Table 2. Load Test Results

Load Power (W)	V Input (V_{DC})	I Input (A)	V Output (V_{AC})	I Output (A)	P Output (W)
8	12.9	1.36	228	0.033	7
25	12.9	2.47	226	0.219	24.1
40	12.9	3.17	227	0.142	32.5
60	12.8	5.44	227	0.259	60.4
135	12.8	5.46	227	0.292	65

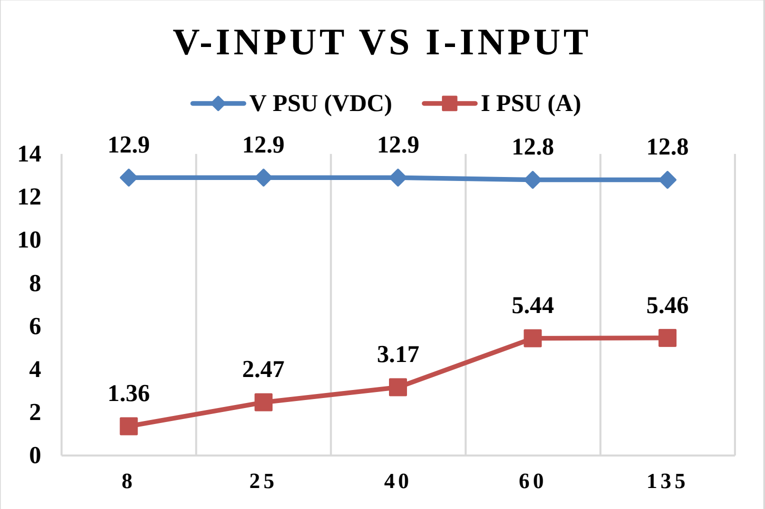

Figure 12. Graph of Input Voltage and Input Current

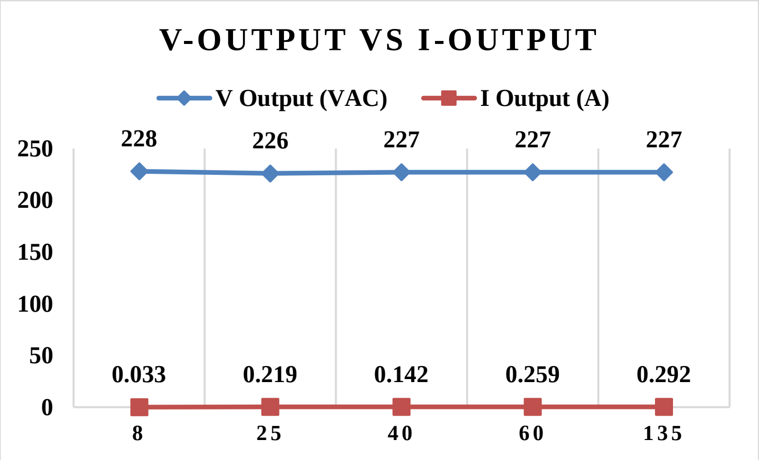

Figure 13. Graph of Output Voltage and Output Current

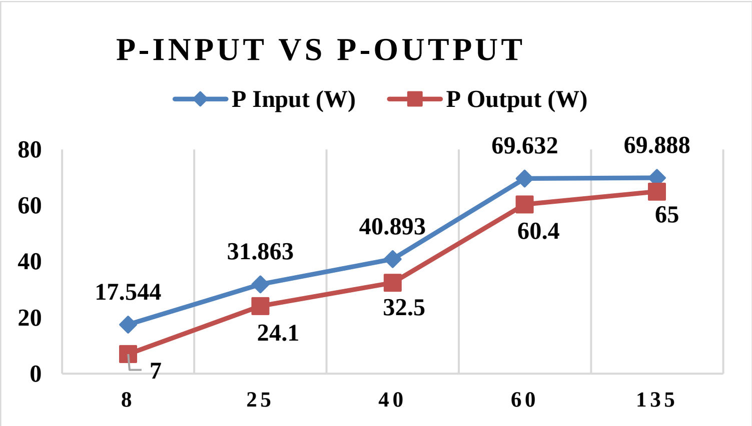

Figure 14. Graph of Output Voltage and Output Current

4. CONCLUSION

From the results of tool design, tool testing, and tool discussion, it can be concluded that the designed 1-phase Inverter has successfully worked according to its theory because, when testing a 1-phase inverter is able to produce an AC voltage of 220 V_{AC} and a frequency of 50 Hz. The 1-phase inverter also has a very good feedback voltage so that the inverter output is always stable at values above 220V_{AC} during load testing. Based on the test results, the inverter is able to operate well with the average efficiency of load testing is 81%.

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