Designing A Single Phase Inverter To Calculate Public Roads Lighting Efficiency Using Sodium Lamp Types

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ABSTRACT

An inverter is a circuit which converts the AC voltage into DC voltage. Current use of inverters is very large, especially in industries, offices and housing. Even though now there are many inverter markets, but many are used for household loads, no one uses an inverter for roads lighting system namely sodium lamp because it requires a high frequency and voltage Then the surveyors placed a single phase inverter from the sodium lamp. Single phase inverter tool designed produces a voltage of 10,000 V, Amperage current of 0.20 A and 2000 w Power when tested against overloaded and not overloaded inverter, the results are quite good but in the design and manufacture of a single phase inverter is still lacking, which is only able to start the initial lighting of the sodium lamp because the current is small and the resulting voltage is unstable.

Keywords: Single phase inverter, electrical energy, public road lighting, sodium lamp.

INTRODUCTION

The comparison of electrical energy needs are not comparable with the available electrical energy, so that not all of the electricity needs are met. Based on electricity consumptions in all sectors, it tends to increase every year with a growth rate of 9% per year.

The city of Palembang is one of the major cities in the country of Indonesia, in this city there are many public roads and highways. Public roads or TOLs have lighting facilities at the night. Excellent lighting is absolutely necessary for public roads (R. Carli, dkk. 2017), for driving safety to avoid accidents due to damaged roads and poor street lighting. The Public Roads Systems actually use a type of sodium lamps (H. Zhang, dkk. 2016)

The sodium lamp itself is not capable of being rated with 220 volts of voltage, so it takes a high voltage and high frequency for a moment (A. A. Mansour, dkk. 2014), (F. S. Dos Reis, dkk. 2006). Xenon gas is ionized to initiate the release of electrons in the gas cylinder until it reaches the required working temperature. This heating period can last up to about 10 minutes because the vapor pressure of mercury-sodium is very low initially which cannot make the release of electrons in the gas cylinder. After the lamp works normally, mercury will not be achieved which makes mercury emit light. High pressure sodium type lamps require some additional circuits and components, such as ballasts to regulate the current passing through the lamp. Type of lamp most high-pressure sodium is still used conventional ballast, namely electromagnetic ballast. Ballast electromagnetic is indeed simpler inside its use, but has a weakness efficiency

Until now, many alternative energy sources have been developed to be converted into electrical energy as energy management that one of the most demanding issues within such urban centers (F. Adamo, dkk. 2013), (R. Carli, dkk. 2016). In general, the results of the conversion are still in the form of a voltage and direct current sources. So that it can be used more widely for various needs, it needs to be converted into alternating voltage and current sources namely using an inverter (K. M. Shafeeque, dkk. 2013; R. Senthilkumar, dkk. 2010; D. Istardi, dkk. 2017; S. A. Zulkifli, dkk. 2017)

Therefore, the Public roads lighting efficiency system is needed. So in this research a tool is designed, that is a high voltage single phase inverter. This tool can turn on the sodium lamps without using ballast, so the sodium lamps can be connected directly to inverter and can be used even without electricity from PLN.

METHOD

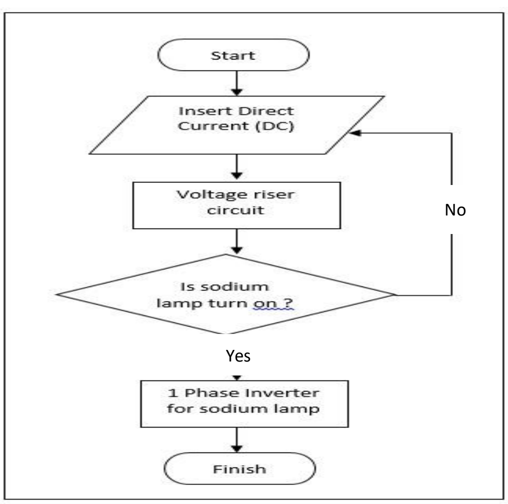

Figure 1. Flowchart of the research

The Working Principle of The First Circuit

At first, the direct current and direct voltage of the battery source of 12 V dc will supply various circuits including capacitors as a temporary storage place, then at the initial stage through a resistor that will activate the basic transistor, through the transistor, the voltage is transferred to the transformer with an output voltage of 220 Volts.

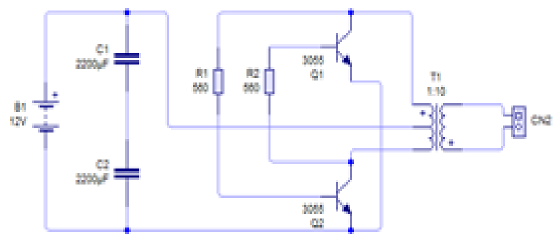

Figure 2. Single-phase inverter circuit

The Working Principle of The Voltage Riser Circuit

The 220 Volt voltage of the transformer is inserted in the multivibrator circuit, in this mutlivibrator circuit the voltage of the transformer is rectified again and raised so as to get an output voltage of up to 10 KV in order to turn on the sodium lamp.

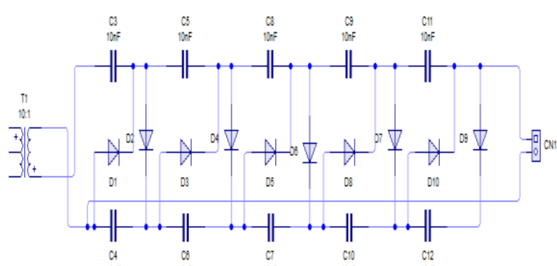

Figure 3. The voltage riser circuit

RESULT AND DISCUSSION

Non-loaded Inverter Testing

Further, the testing of single-phase inverter with input voltage and current, and voltage and no-load output current starts as shown in Table 1.

Table 1. Data Input Non-Loaded

	Input		
No.	**Voltage (V_a)**	**Current (I_a)**	**Power (P_a)**
1	11.91 V	0.83 A	9.88 Watt
2	11.89 V	0.84 A	9.98 Watt
3	11.83 V	0.84 A	9.93 Watt

The calculation of Input Power without load using by (1):

$$Pa = Va \times Ia \qquad (1)$$

Where P_a is power, V_a is voltage, and I_a is electric current.

Table 2. Data output non-load

	Input		
No.	**Voltage (V_b)**	**Current (I_b)**	**Power (P_b)**
1	10 kV	0.98 mA	9.8 Watt
2	10 kV	0.99 mA	9.9 Watt
3	10 kV	0.99 mA	9.9 Watt

The results of the high voltage above (Table 2) are obtained by calculation because it cannot be measured using multitester tools.

1) Calculation of non-loaded output current

The output current at Table 2 is obtained by using calculation system from input power (*Pin*) compared to output voltage (*Vout*), following (2):

$$Iout = Pin/Vout \qquad (2)$$

Loaded Inverter Testing

Table 3. Data input when loaded

	Input		
No.	**Voltage (V_a)**	**Current (I_a)**	**Power (P_a)**
1	11.89 V	2.41 A	28.65 Watt
2	11.79 V	2.58 A	30.41 Watt
3	11.76 V	2.27 A	26.69 Watt

Table 4. Data output when load

	Input		
No.	**Voltage (V_b)**	**Current (I_b)**	**Power (P_b)**
1	10 kV	0.18 A	1.8 kWt
2	10 kV	0.20 A	2 kW
3	10 kV	0.19 A	1.9 kW

1) Signal output of the inverter circuit

After measuring the voltage and current, then to find out the waveform that is produced, it can be seen using an oscilloscope.

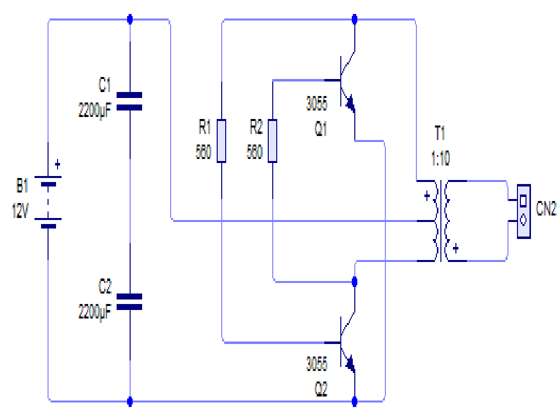

Figure 4. The main circuit inverter

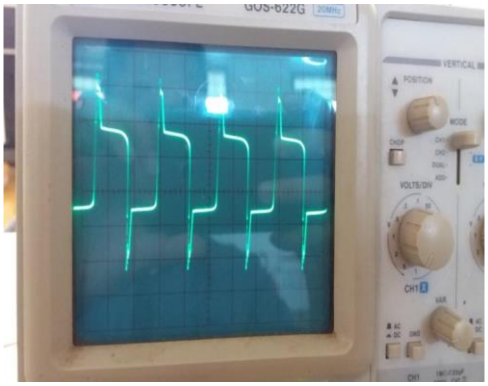

Figure 5. Input signal from the transformer

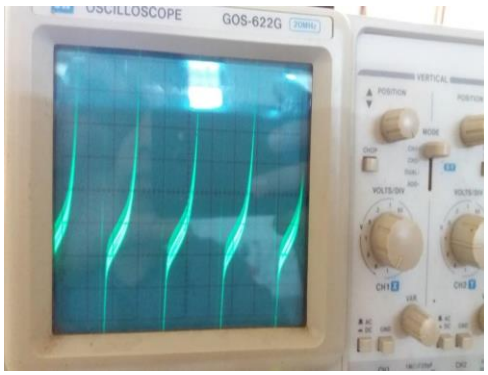

Figure 6. Signal from transformer output

From the above signal results, it can be seen that the signal changes from transformer input to transformer output, the signal output is higher. Data that is obtained from measurements through the oscilloscope are 50 µS time / div and 5 Volt / div voltage, it can know the frequency by using the calculation as follows:

Known:

Div / Time = 50 µS

The peak to peak voltage of the oscilloscope monitor is 5 boxes = 5 Div

Then the frequency :

F =1/(50µS x 5 Div)

=1/250 µS

= 4000 Hz

= 4 KHz

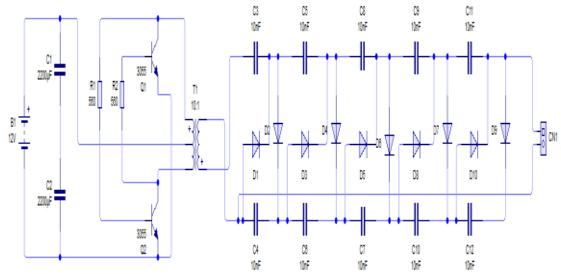

Figure 7. Voltage Multiflier circuit

Next, measure the wave as a whole by measuring the waveform output from the voltage multiplier circuit or the voltage increase circuit as can be seen in Figure 8.

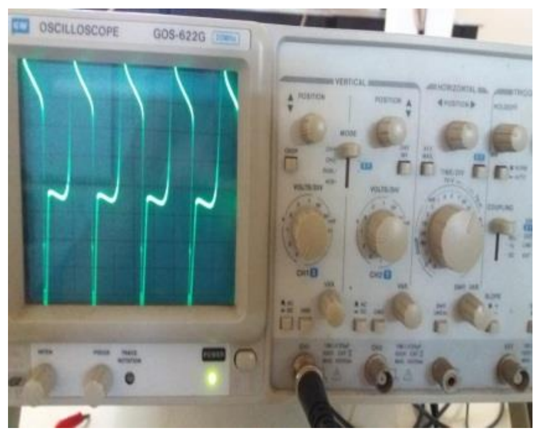

Figure 8. Output signal from Voltage

Multiflier circuit

Through measurement with an oscilloscope device, the data is 50 µS time / div and voltage is 5 Volt / div we can find out the frequency using the calculation as follows:

Known:

Time / Div = 50µS and the peak-to-peak voltage of the oscilloscope monitor is 2.5 boxes = 2.5 Div.

Then the frequency :

F = 1/(50µS x 2.5 Div)

= 1/125 µS

= 1/0.000125 S

= 8000 Hz

= 8 KHz

2) *Single phase inverter Output Wave Diagram for sodium lamps*

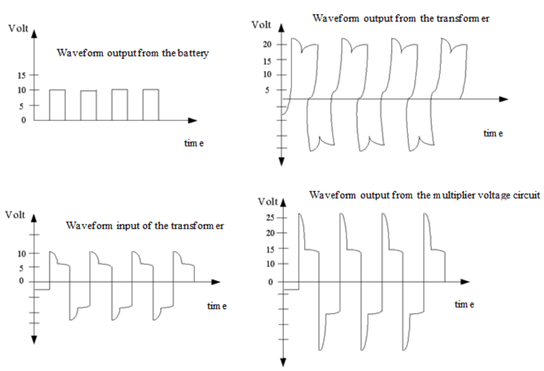

Figure 9. Inverter waveform output diagram

CONCLUSION

Single phase inverter for sodium lamps when tested many times when loaded or not loaded, the results are quite good. Single phase inverter with a voltage source of a battery of 12 Volts which is connected to a voltage riser circuit so it can be produce a high enough output voltage that is equal to 10 KV to be able to turn on the sodium lamp. The design and manufacture of a single phase inverter is only intended to be able to turn on sodium lamp with high voltage and frequency, but in this research, the inverter is only able to start the initial lighting of the sodium lamp because the current is small and the resulting voltage is unstable.

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