

Original Research Article

Design and Construction of 12V DC to 230V AC Power Inverter

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Abstract

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The purpose of this project is to design and construct 12V DC to 230V AC inverter with a frequency of 50Hz. The components that were used to construct the inverter consist of SG3524, MOSFET IRF3205, and a center tap transformer. Few capacitors, resistors, and variable resistor port were also used. The design and construction was done using locally sourced components. The basic principle of operation is based on an oscillator designed to produce an alternating e.m.f. of known frequency and wave form using SG3524 whose frequency is set to 50Hz and 12V DC from a regulated DC power supply to produce a 230V AC at the output of a transformer. A 4W bulb was connected as load to the inverter. A digital multi-meter was also connected at the output of the transformer and the digital multi-meter reads 230V AC. Overall, the circuit performed satisfactorily.

Keywords: Alternating, Current, Direct, Inverter, Oscillator, Power, Voltage, Waveform

INTRODUCTION

The demand of highly efficient and stable DC to AC inverters used during present day's electrical power outages is on the rise. To convert DC output from renewable energy systems, storage batteries, green and solar energy sources into purely sinusoidal unwavering AC. This process of acquiring electrical power is preferable due to its low cost energy generation, conversion, less complexity. Later this converted energy, on large scale can be fed into grid or utility supply for load sharing purpose also (can be work as Distributed Generation System (DGS)). (Banini et al., 2016). This project use a SG3524regulating pulse width modulating ic to generate 230 V AC by producing oscillator output of 12V AC. IRF3205were used as power MOSFET to amplify and switch on the power to the transformer to be step up to 230V AC. The results are shown in table 1, table 2 and table 3.

MATERIALS AND METHOD

The materials here refer to the electronics components

used for the construction of the inverter. The electronic components used are listed below in table 1.

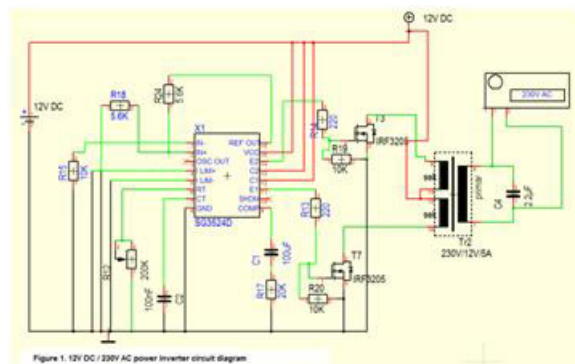
The method used to build the circuit was soldering. The circuit diagram in figure 1 was constructed using the components provided in table 1. Components were soldered on the circuit board. Wires were used to connect the transformer to the inverter and the 12V DC from the regulated DC power supply. Figure 1. Shows 12V DC/230V AC power inverter circuit diagram. Target3001! V20 was used for the inverter circuit diagram design in figure 1. (www.target3001!V20.com).

Brief Theory

An inverter is an electrical device that converts direct current (DC) to alternating current (AC).This is done by the oscillator. An oscillator is an electronic circuit designed to produce an alternating e.m.f. of known frequency and wave form. (DC Green III fifth edition chapter 7, pg 100). In this case sinusoidal AC wave form and the frequency is 50Hz produced by SG3524 pulse

Table 1. Electronic components used.

Electronic Components	Circuit designation	Quantity
1. SG3524	X1	1
2. IRF3205	T3,T7	2
3. Transformer	Tr2	1
4. 200k Ω port	R12	1
5. 10k Ω	R15,R19,R20	3
6. 100nF	C2	1
7. 5.6k Ω	R18,R24	2
8. 200 Ω	R13,R14	2
9. 2.2 μ F/400V	C4	1
10. 20k Ω	R17	1
11. 100 μ F/25V	C1	1
12. Regulated DC supply	12V DC	1

**Figure 1.** The circuit diagram for the design and construction of 12V DC to 230VAC power inverter.

width modulation ic. The oscillator output from SG3524 is taken from pin 11 and pin 14. The power transistor IRF3205 was connected to pin 11 and pin 14 as indicated in circuit diagrams in figure 1. The 100nF capacitor and 200K Ω port resistor in the circuit diagram were used to set the required frequency to 50Hz by varying the 200K Ω port. The calculation of frequency (f) is as follows:

Frequency (f) = 1/period (T)equation 1

$T=RC$ equation 2

$f=1/T$ equation 3

For $T=2CR$ equation 4

Therefore $f=1/2CR$ equation 5

$f=1/2CR$. (DC Green III fifth edition chapter 7, pg 120)

From equation 5, $f=1/2CR$

$f=1/(2 \times 100 \times 10^{-9} \times 100 \times 10^{-3})$

$f=1/(2 \times 100 \times 10^{-6} \times 100)$

$f=1/0.02$

$f=50\text{Hz}$

This 50Hz frequency in the circuit was set by Resistor, R and capacitor C. This is also known as programming the frequency.

The output of the oscillator was 12V AC. This served as the input AC voltage to the gate of the MOSFET

IRF3205, a fast switching power transistor, used to amplify the power and switch the power to the transformer to step it up to 230V AC.

The Total Power (PTOT) dissipation, for IRF3205 is 200W at $T_C = 25^\circ\text{C}$. (<http://www.irf.com>)

Therefore for a pair of transistors the power will be approximately 60Watts.

The total power produce is about 200Watts which is good for three pair of IRF3205. Further additional transistors (IRF3205) will not produce result because of saturation so in that case a bigger transformer with high current rating will be required.

The transformer used for this project has a center-tapping. The center-tapping is connected to the positive terminal of the regulated DC power supply. The outputs of the IRF3205 were connected to the input of the step up transformer as indicated in the circuit diagrams in figure 1.

Analysis of Power

The wattage of the inverter is calculated as follows:

Table 2. The test results from the digital multi-meter and oscilloscope.




No	Test	Result	Readings
1	Frequency		50.01Hz
2	Voltage		230V
3	Oscilloscope output		Square wave

Table 3. Test results using the regulated DC power supply.

No	Regulated DC power supply Voltage	AC Voltage
1	11V	220V
2	12V	230V

Power= Voltage x current. For 12V, 5A transformer, Power =12x5=60Watts.

Apparent power (s) = (Real Power)/PF(Olusegun Omitola and Taiwo Oyedare 2014).

PF = 60/ 0.8 = 75VA Therefore, the full load current flowing at the transformer primary; Real power (P) = current (I) * voltage (Olusegun Omitola and Taiwo Oyedare 2014).

$$60 = I * 12$$

$$\text{Hence, } I = 60 / 12 = 5A$$

Transformer is 12/5A

$$P = 12 \times 5$$

$$P = 60 \text{ watts}$$

Where the voltage output of the inverter, V output = 230V

Full load output current, I output =P/V

$$P = 60 / 230$$

$$I \text{ output} = 0.26A$$

Discharge duration

The duration at which the inverter discharges under load condition depends on the total power of load connected

to its output terminal and the power rating of the battery connected to its input terminal.

Duration= (Battery voltage output x current capacity)/ (Load Power Ratings). (Osaretin C. A. and Edeko F. O. 2016)

For a total load of 60Watts,

Battery power rating = 12Volts, 17Ampere per hour

Power rating= 12Vx17 Ampere

Power rating=204Watts

For a total load = 204watts

Then duration = 12x17/60

$$= 3.4 \text{ hours.}$$

TEST RESULT AND DISCUSSION

The inverter was tested by connecting the inverter to a regulated DC Power supply. Table 2showsthe practical values from the digital multi-meter readings of 50.01Hz frequency, 230V AC and square wave form from the oscilloscope output. The detailed results obtained from table 2 and the calculations as stated in equation 5 and the calculated value of 50Hz are approximately the same. The difference of 0.01 is insignificant to affect the

oscillator frequency. The results were obtained by setting the regulated DC power supply to 11V and connecting digital multi-meter connected to the output of the inverter gave 230V AC reading. The digital multi-meter with frequency detection capabilities was also connected to the inverter and the digital multi-meter reads 50.01Hz.

The output voltage of the inverter was a square wave, filtered by a 2.2 μ F/400V capacitor connected across the output terminals to remove the unwanted harmonics and leaving stable output voltage.

Testing was also done using 4 Watts bulb connected to the inverter as load. The table 3 provides the results from testing the inverter using the regulated DC power supply. Table 2 and 3

DISCUSSIONS

The results from table 1, table 2 and table 3 shows that 12V DC / 230V AC power inverters can be designed and constructed and send to developing countries that do not have hydropower generation to bridge technological gap.

CONCLUSION

The circuit designed work well as expected providing 12V DC to 230V AC inverter power output. The SG3524, MOSFET IRF3205, capacitors, resistors, variable resistor port, and a center tap transformer were used to designed and construct 12V DC / 230V AC power inverter.

RECOMMENDATIONS

The recommendation for the implementation of this project is that a car battery or sealed rechargeable battery

should be used to replace the regulated DC power supply.

ACKNOWLEDGEMENT

The authors are grateful to the members of Engineering Services Centre for their cooperation during the period this project was done.

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