Fabrication of a MOSFET-based low-cost inverter for domestic purposes

Madhubala Baruah, Kishore Dutta#

Department of Physics, Handique Girls' Guwahati, Assam, India

*Corresponding author’s e-mail address: kdkishore77@gmail.com

Abstract

We design a low-cost inverter circuit using transistor and MOSFETs motivated by the growing demand due to frequent power shortages. As an undergraduate laboratory experiment, the circuit constructed from transistors, capacitors, resistors, and n-channel enhancement MOSFETs works in three stages: astable multivibrator, oscillatory circuit, and step-up of the voltage. It produces a 50 Hz AC signal which is then fed into a step-up transformer. We find that the circuit transforms a 12 Volt DC input to a 160 Volt AC output. Higher voltage rating can be achieved by enhancing the stage of oscillation.

1. Introduction:

In today’s technological world, the demand in energy consumption, energy saving, explorations of alternative energy sources are growing day by day. Search for alternating energy source now-a-days is an open challenging problem. Apart from this, due to lack of sufficient electric power generation, inverter has become a highly demanding equipment used in every residential and commercial places [1, 2]. An inverter drives the power from DC power banks, like lead acid battery pack. The most common type of inverter we see in everyday life is uninterruptible power supply (UPS) that are used to keep personal computers running in the event of power cuts. Designing a low cost inverter is therefore a highly demanding challenge which can mitigate the needs of power for economically weak people during the time of load shedding. Keeping this in mind, an attempt has been made in this project to design a low cost inverter circuit which can generate a sufficient amount of AC voltage for domestic purpose. The branded inverters available in the market comprises of ICs, Op-Amps, and 555 timer, making it very expensive. However, without using ICs, a low-cost DC to AC inverter can be designed as done in this project. It comprises only low-cost transistors, n-channel enhancement MOSFETs, and a step-up transformer [3, 4].

2. Experimental Details:

The basic idea behind a working inverter circuit is to convert a DC signal to a constant oscillation and apply these oscillatory signals across the primary of a suitable step-up transformer to obtain the desired AC voltage. The circuit that is designed for this purpose thus works in three successive steps: (a) astable multivibrator (b) MOSFET-based oscillator circuit and (c) Stepped up the voltage using transformer. The circuit designed in this project work...
is shown schematically in Fig. 1, showing clearly the various components used in the circuit. It requires (a) a

![Figure 1: Schematic circuit diagram of the inverter](image)

12V DC Battery (b) a center-tapped 2 Amp step-up transformer (c) two IRF 630 n-MOSFET (d) two 2N2222 transistors (e) two 2.2 µF Capacitors (f) two 680 Ω resistors and (g) two 12 KΩ resistors.

2.1. Working Principle behind the circuit

![Figure 2: Circuit diagram of astable multivibrator](image)

In the first step of the functioning, there is an astable multivibrator, also known as a free running multivibrator that possesses no stable states. This is constructed using the transistors, capacitors, and resistors, as shown separately in Fig. 2. Its output oscillates continuously between its two unstable states without the aid of external triggering. The time period of each states are determined by the values of the resistors and capacitors used in the circuit. As shown in Fig. 2, the two transistors are working together as a switch. When one of the transistors is ON, its collector and emitter act as a short circuit while in the OFF mode, they act as an open circuit. In the OFF state, the collector of the transistor possesses a voltage $V_c$ while in the ON state, the collector turns out to have zero voltage (grounded). When the circuit is switched ON, one of the transistors will be conducting more than the other due to imbalance in the circuit or difference in the parameters of the transistor. Finally, depending on the time constant, it will be driven to saturation (ON) and the less conducting transistor will be driven to cutoff (OFF). Lets assume that the transistor $Q_1$ is in ON state and $Q_2$ is in OFF state. During this time capacitor $C_2$ is charging to $V_c$ through resistor $R$. During this time, $Q_2$ remains OFF due to the negative voltage from the discharging capacitor $C_1$ which is charged during the previous cycle. Thus, the OFF time of $Q_2$ is determined by time constant $T_1 = R_1 C_1$. After this time period, the capacitor $C_1$ discharges completely and starts charging in reverse direction through $R_1$. The negative voltage from the capacitor $C_1$ turns OFF the transistor $Q_1$ and the capacitor $C_1$ starts charging from $V_c$ through resistor $R$ and base emitter of transistor $Q_2$. Thus the transistor $Q_2$ remains in ON state. As in the previous state, when the capacitor $C_2$ discharges completely, it starts charging towards opposite direction through $R_2$. When the voltage across the capacitor $C_2$ is sufficient to turn ON transistor $Q_1$, it will turn ON and the capacitor $C_1$ starts discharging. This process continues and produces rectangular waves at the collector of each transistor.

![Figure 3: Circuit diagram of MOSFET based oscillatory circuit](image)

In the second step, the signal from the astable multivibrator needs to be fed into a circuit that can generates a constant desired oscillation. We use MOSFET-
based oscillator circuit, as shown in Fig. 3. It comprises two IRF 630 n-MOS. Each n-MOS has three terminals: Gate, Drain, and Source. The Gate terminals of the MOSFETs are connected to a 12 KΩ resistors through a 2.2 µF capacitor as shown in the diagram. It is also fed by the collector of each transistors used in the astable multivibrator circuit. The Source terminals of each MOSFET are connected to the Emitter of the transistors to enhance the frequency produced by the astable multivibrator. Finally, the oscillatory signal generated by the n-MOS is used as an input to the step-up transformer by connecting the Drain terminals of each MOSFETs to the primary coil of a step-up transformer. The center-tapped step-up transformer has a three terminal input with two extreme terminals connected to the Drains and the center one is connected to the positive terminal of the supply voltage (12 Volt DC battery). In fact, it is also connected to the collector terminals of the transistors. This way the n-MOS based oscillatory circuit is able to generate a high AC voltage having frequency ~50Hz.

3. Results and Discussions:
As shown in Fig. 1, the circuit for the inverter is assembled by connecting the circuits for astable multivibrator, n-MOS oscillator circuit and the step-up transformer as discussed above. With this circuitry, the output terminal of the step-up transformer with its center-tap connected to 12V DC, is connected to a 220 Volt 60 Watt bulb. When the circuit is switched on, the bulb glows and we measure the output AC voltage by using an AC voltmeter and its frequency by a digital multimeter. We find that the frequency of the AC signal is \( f \approx 50\text{Hz} \) and the output AC voltage is 160 Volt. The frequency of the oscillator circuit can further be enhanced by using a series of MOSFETs in succession. Further, the output AC voltage can be increased by using a step-up transformer with more turn’s ratio.

4. Conclusions
The circuit designed here is an initial attempt to develop a low-cost domestic purpose inverter that generates a desired amount of AC voltage for emergency. Although in our experiment we obtain a 50Hz, 160 Volt AC output, the circuit can easily be reconfigured by using more numbers of MOSFETs and a step-up transformer having high turn’s ratio so that desired output can be achieved. Since 160 Volt is sufficient to glow a number of 20-30 Watt Compact fluorescent lamp (CFL), it can be used effectively in domestic purpose in emergency.

5. Acknowledgement:
The authors would like to acknowledge the Department of Physics, Handique Girls’ College for providing scopes for smooth performance of the entire project work within stipulated time.

6. References