Single Phase Inverter using MOSFET

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ABSTRACT – The power electronics device which converts DC power to AC power at required output voltage and frequency level is known as inverter. Inverters can be broadly classified into single level inverter and multilevel inverter. Multilevel inverter as compared to single level inverters has advantages like minimum harmonic distortion and can operate on several voltage levels. Inverters are used for many applications, as in situations where low voltage DC sources such as batteries, solar panels or fuel cells must be converted so that devices can run off of AC power. One example of such a situation would be converting electrical power from a car battery to run a laptop, TV or cell phone. This report focuses on design and simulation of single phase, three phase and pulse width modulated inverter and use of pulse width modulated inverter in the speed control of Induction motor. This paper will talk about the Inverters and how they work.

***Key Words*: Inverter, MOSFET, Relays, Transformer, Diode, IC.**

1. INTRODUCTION

An Inverter is basically a converter that converts DC-AC power. Inverter circuits can be very complex so the objective of this method is to present some of the inner workings of inverters without getting lost in some of the fine details. The word „inverter‟ in the context of power electronics denotes a class of power conversion circuits that operates from a dc voltage source or a dc current source and converts it into ac voltage or current. Even though input to an inverter circuit is a dc source, it not uncommon to have this dc derived from an ac source such as utility ac supply. Thus, for example, the primary source of input power may be utility ac voltage supply that is „converted, to dc by an ac to dc converter and then „inverted‟ back to ac using an inverter. Here, the final output may be of a different frequency and magnitude than the input ac of the utility supply In our country today, this equipment is not all that in use not because it is not important but because people never give it a thought as per the construction and design. It is meant for use with a 12volts lead acid battery of it's in a car for example a suitable output voltage of 240volts AC obtainable. This output voltage of 240volts AC can be used for powering small electrical appliances such as lights, electrical tools radio, soldering iron, fan etc. However, it is with mentioning that the DC generated with this appliance is nothing comparable to the AC generated by big generation duration. This appliance is therefore suitable for short time replacement for the real AC generation especially in the remote areas and it is install where electrical appliances are sold and the need might arise for it to be tested and certified good.

Most industries in the country do not make use of DC – AC inverter because there are through to be costly with respect to the task they perform. However, putting into consideration the task, this appliance can perform. It can be concluded that it is cheaper. The construction is simple, cheaper, easy to operate and portable. The usefulness of this device and the function cannot be over emphasized especially now that our country is passing through a very sensitive era in our power generation. In these times when control and monitor of complex field operations have based in computer, a failure of AC, power supply to communication equipment means work stoppage and to some small scale industries a lot of economic and materials losses is avoidable.

1.1 Problem Statement

As a result of continuous power failure and fluctuation in power supply by Maharashtra State Electricity Board (MSEB), sensitive appliances and system are affected by interruption power supply. Then, this project is to provide a back-up and reliable power supply of 1Kva to power the sensitive appliances during power failure.

1.2 Aims and Objectives

The aim of this project is to design and construct a circuit that will take a 12V dc input from battery and provide a 1000VA output that will be able to supply a standard power to sensitive appliances.

The objective is to design a circuit that will convert dc to ac power for various appliances used in domestic home, to provide a noiseless source of electricity generation, to have a source of generating electricity that has no negative effect on the environment (i.e. no greenhouse effect) and finally to provide a source of electricity power with low maintenance cost and zero fuel cost.

1.3 Scope of the Project

The Scope of this project is to design and construct an inverter with output power rating of 1kVA, maximum output current of 22.72A, output voltage of 220V AC from a 12 V DC input. This project is basically designed for single phase domestic loads. The project is to be realized using simple and relatively cheap components available in the local markets

2. LITERATURE REVIEW

In the world today, there are currently two forms of electrical transmission, Direct Current (DC) and Alternating Current (AC), each with its own advantages and disadvantages. DC power is simply the application of a steady constant voltage across a circuit resulting in a constant current. A battery is the most common source of DC transmission as current flows from one end of a circuit to the other. Alternating current, unlike DC, oscillates between two voltage values at a specified frequency, and its ever changing current and voltage make it easy to step up or down the voltage. For high voltage and long distance transmission situations, all that is needed to step up or down the voltage is a transformer. AC current is more viable but less available. Conversion of DC current to AC is done by a device called INVERTER. A lot of engineers had earlier conceptualized what they felt inverter system should look like. The incessant power outage in Nigeria has prompted the engineers to improve the inverter power system and this project is not an exception. The power system is a very paramount constituent of technological growth. A constant supply of power improves productivity of factories and companies. Computer rooms, as well as domestic homes, require continuous supply of electricity. All this has prompted the urgency to improve on the properties of the inverter power system in quality, durability, maintainability and capacity

3. METHODOLOGY

3.1 Charging Time

The inverter input voltage is 24V direct current and for the 80% efficiently of the inverter running of equipment at 1000VA

Current drain will be

Power(volt – ampere / voltage)

1000/24 = 41.66

Since the battery specification is two of 12Volts, 60AH. Hence, it delivers for:

0.8x60/41.66 = 1.15 Hours or 69 mins

The time of charging depends on the transformer ratings, which are 12 Volts 5 Amps and the battery charging time 60AH/5 = 12 Hours

3.2 Oscillation Stage

A dual switching regulator is used here, which perform both the timing and signal generator functions. It gives a continuous signal of 50Hz and 50V at each output channels.

Frequency of oscillation: Desired frequency (f) 50Hz

Period of oscillation (T) =1/f =1/50 =0.02 sec.

A capacitor C value of 0.1 f was chosen and the value is determined from the above formulae.

R = 1/1.1fc

R = 1/2a1.1 x 50Hz x0.1 x 10

R = 181.82 kΩ

So, a 100kΩ resistor and a 100kΩ variable resistor were chosen.

3.3 Buffer Stage

In order to be able to drive the gate of power MOSFETs, gate transistor C945 were chosen. These drives were connected in a common collector arrangement, which is emitter follower arrangement. The output voltage is given below.

V1 =VB – 0.6

=5.0 – 0.6 = 4.4Volts

The output current is given as:

IE = VE/RL

IE = 4.4/22 = 200Ma

The battery consists of positive and negative plate, separators and electrolyte, all contained in the many compartments of the battery container. The battery charger is an electrical device that is used for charging the battery. It changes the alternating current from the power supply direct current suitable for charging. The use of IN4007 was encouraged because of its high wattage and internal protection device. Six pieces of this are employed at each half of the inverter

3.4 Analysis of Inverter Circuitry

The LM324 comparator and the three contact relay are the major component of the operation. At the flow of AC supply, the relay recognizes the presence of AC and the inverter section is isolated from the unit and connects the battery to the charger. The three contact relay charge and transfer the circuit from one mode to the other. At the failure of the AC supply, it transfers the circuit to the inverter. At this instance, the battery is transferred to the board, the inverter assumes a link to the socket output and the charger is disengaged. All this operations are undertaken in less than one second. The battery charger continues to charge the battery in the presence of AC supply as long as the battery is below the rated battery voltage of 12volts. The battery warning circuit and the battery protecting circuit both protect the battery from being over drained. This will occur whenever the battery voltage goes below the configured value of 5volts. Before the battery reaches the value, the protecting circuit would have started given a sign of warning to disengage the inverter which will eventually be cut off as soon as it reaches the set voltage. The capacity of the battery is basically its ability to supply given amperage for a given period of time at a given initial cell temperature while maintain voltage above a given minimum level. The ampere-hour rating is simply the product of the discharge time multiplied by a given time period. Battery has different ampere hour ratings, for example, 60Ah battery.

3.4 Why use MOSFET

The MOSFET is a three-terminal (gate, drain, and source) fully-controlled switch. The gate/control signal occurs between the gate and source, and its switch terminals are the drain and source. The gate itself is made of metal, separated from the source and drain using a metal oxide. This allows for less power consumption, and makes the transistor a great choice for use as an electronic switch or common-source amplifier.

In order to function properly, MOSFETs have to maintain a positive temperature coefficient. This means there's little-to-no chance of thermal runaway. On-state losses are lower because the transistor's on-state-resistance, theoretically speaking, has no limit. Also, because MOSFETs can operate at high frequencies, they can perform fast switching applications with little turn-off losses.

Advantages of MOSFET

- Improved switching speeds.
- Improved dynamic performance that requires even less power from the driver.
- Lower gate-to-drain feedback capacitance
- Lower thermal impedance which, in turn, has enabled much better power dissipation.
- Lower rise and fall times, which has allowed for operation at higher switching frequencies
- MOSFET is a low cost.

4. INVERTER CIRCUIT DESIGN

The Metal-oxide Semiconductor Field Effect Transistor (MOSFET) was used for the inversion process because it has negative temperature coefficient (which makes it more thermally stable), high frequency response, and high immunity to radiation than bipolar junction transistor. The approach is particularly considered with a type of multi-vibration oscillator. Multi-vibration are basically two stage amplifier with positive feedback from the output of one amplifier to the input of the other. The feedback is supplied in such a manner that one transistor is driven to saturation and the other to cut-off, it is then followed by new set of condition in which the saturated transistor driven to cut-off and the cut-off transistor is driven to saturation. Its operation is that when an alternating current is connected to the winding at the primary side of the transformer, an alternating flux is set up in the laminated core, most of which is linked with the other coil [or winding at the secondary side of the transformer] in which it produces mutually induced E.M.F in accordance to Faraday's laws of Electromagnetic induction, E = M[illegible]dt. The transformer design ratio as shown in the design equations of the transformer is a step up one, allowing the input voltage to be magnified at the output side.

The circuit design of the present inverter contains sections. The low battery section is made up of LM93 (operational amplifier, dual op - amp) and NE555 timer. The fixed reference voltage is connected to the inverting input of one of the op-amp and the output is used to trigger NE555 timer which is biased in a mono-stable configuration.

Mains from national grid is connected to A.C sensing transformers (12V step down transformer) to produce 24V D.C. Full rectifier voltage 7805 biased to produce 5V for the surge protection circuit comprising of LM324 and NE555 timer.

The relay configuration as shown in figure 1 contains three compartments. Contact one, supplies to the board switches to the normally opened terminal (NO), meaning that the output line switches to the normally opened terminal on AC (national electric) supply. That is the inverter in the next compartment is isolated as soon as there is the presence of AC (national electric) power supply, on contact 3, the terminal to the charge switches to the normally opened terminal that is on the AC (national electric) supply terminal, meaning that there is supply to the charger for it to charge the battery.

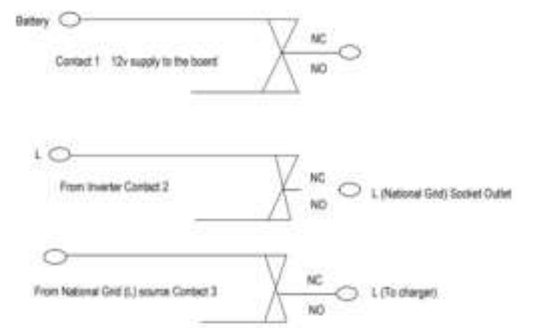

Fig1: Configuration of Three Contacts Relay

Fig 2: Actual Working Model fig 1

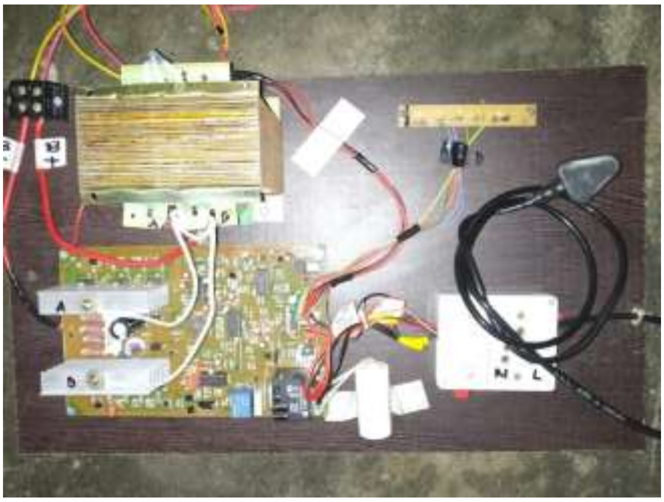

Fig 3: Actual Working Model fig 2

5. CONCLUSION

This past decade has witnessed major advances in power electronics technology for both industrial and traction drives. These advances have made it possible to significantly improve the electrical performance of these systems while simultaneously reducing their size and weight and, perhaps most importantly, reducing their cost. Improvements in all of these key metrics are expected to continue as evidenced in this paper. The future of both industrial and traction drives depends not only on advances in the underlying technologies, but the economic and regulatory climate in which they are developed. Despite the risks of predicting future trends, there are sufficient reasons to expect that increasing global concerns about efficient electrical energy utilization, transportation fuel economy, pollutant emissions levels, and electrical power quality will increase if inverters are neglected as major substitutes to electrical power supply. The developments outlined in this research work bear testimony to the major progress that has been accomplished in applying new power electronics technology to home use. Although the improvements sometimes seem painfully slow and labored, the rate of technical progress is actually very impressive.

6. RESULT

We have successfully created an Inverter using a MOSFET. The inverter when connected with dc input dives out the AC output which is sufficient to use for household purposes.

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