DESIGN AND CONSTRUCTION OF A 500VA INVERTER

BY
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2004/18761EE

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DECEMBER, 2010.

DECLARATION

I, Abdulrahman Aliyu wish to declare that this project work titled "Design and Construction of a 500VA inverter" was carried out by me and has never been presented elsewhere for the award of a Bachelor of Engineering degree.

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Abdulrahman Aliyu   Date

silicon controlled rectifiers (SCRs) inverters are essential. For very low voltage and high current requirements, tunnel diodes are used [2].

Inverters are commonly used to supply AC power from DC sources such as solar panels or batteries. The electrical inverter is a high-power electronic oscillator which is so named because of early mechanical AC to DC converters which were made to work in reverse and thus, were "inverted" to convert DC to AC. The inverter performs the opposite function of a rectifier by converting DC electricity from sources such as battery to AC electricity. The electricity can be at any required voltage, in particular it can operate AC equipments designed for mains operation or rectified to produce DC at any desired voltage [1].

1.2 AIMS AND OBJECTIVE

The main aim of this project is to design and construct a 500VA inverter capable of achieving the following objectives:-

- To produce an alternating current (AC) from a direct current (DC) source such as car battery, modular panel (solar cell)
- To ensure the protection of the backup source, consumer equipments and supply.
- To design a 500VA inverter which can power domestic appliances at that rating since most voltage regulators used for electronic appliances are rated at 500VA.

1.3 MOTIVATION

I was motivated to design an inverter considering the deplorable state of the power sector in the country. The inverter which is commonly used to supply AC power from DC sources becomes necessary since the electrical energy needed for the rectification process is unstable or completely unavailable. The inverter is therefore an option that helps to supplement the electrical energy by converting the direct current (DC) to alternating current (AC), thereby ensuring security of equipments, efficiency and storage of information.

1.4 SCOPE OF WORK

This project is written in five chapters. Chapter one contains the introduction, aims and objectives, motivation and scope of work. In chapter two, the literature review is discussed. Chapter three highlights the methodology which includes the relevant information about the design and the calculations carried out while chapter four contains information on the results obtained, and the discussions of those results. Finally, chapter five discusses the conclusions and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 History of Inverters

From the late 19th century, through the middle of the 20th century, direct current (DC) to alternating current (AC) power conversion was accomplished using rotary converters or motor generator sets (M-G sets). In the early 20th century, vacuum tubes and gas filled tubes began to be used as switches in inverter circuits. The most widely used type of tube was the thyratron [1].

The origins of the electromechanical inverters explained the source of the term inverter. Early AC to DC converters used an induction or synchronous AC motor directly connected to a generator (dynamo) so that the generator commutator reversed its connections at exactly the right moments to produce DC. A later development is the synchronous converter, in which the motor and generator windings are combined into one armature, with slip rings at one end and a commutator at the other and only one field frame. The result with either is AC-in, DC-out. With an M-G set, the DC can be considered to be "mechanically rectified AC". Given the right auxiliary and control equipment, an M-G set or rotary converter can be "run backwards", converting DC to AC. Hence, an inverter is an inverted converter [1].

2.2 Controlled Rectifier Inverters

Since early transistors were not available with sufficient voltage and current rating for most inverter application, it was the 1957 introduction of the thyristor or silicon controlled rectifier (SCR) that initiated the transition to solid state inverter circuits. The commutation requirements of SCRs are a key consideration in SCR circuit designs. SCRs do not turn OFF or commutate automatically when the gate control signal is shut off. They only turn off when the forward current is reduced to below the minimum holding current, which varies with each kind

CERTIFICATION

This is to certify that the project work titled "Design and Construction of a 500VA Inverter" was carried out by Abdulrahman Aliyu with the Registration Number 2004/18761EE, under the supervision of Engr. (Dr.) M.N. Nwohu and submitted to the Electrical and Computer Engineering Department, Federal University of Technology, Minna.

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ACKNOWLEDGEMENT

All thanks go to Almighty Allah for sparing my life up to this time. My profound gratitude goes to my parents, Alhaji Jibril and Hajiya Khadijat Aliyu for their care, love and support throughout my stay in school. May Almighty Allah reward them abundantly.

I am highly indebted to my supervisor, Engr. Dr. M.N. Nwohu for his devoted supervision and direction throughout the period of this project work. My sincere appreciation goes to my sisters Fatima, Halima, Maryam, Farida and Nana Aisha for their support, understanding and encouragement towards the successful completion of this project.

I am also grateful to all members and staffs of the department of Electrical and Computer Engineering, Federal University of Technology, Minna, for their various contributions throughout my period of study.

ABSTRACT

In this project, the inverter requires a fully charged 12 volt DC battery whose negative terminal is connected to the drain of the power mosfet. This is achieved using the power mosfet as the main switching component in this project. The pulses generated was gotten from oscillator that is capable of converting DC to AC which is the pulse width modulator and is used to pass signals via 1K resistor to the isolated gates of the mosfet. A centre tapped step up transformier is used to change the voltage profile from 12 volt to the desired 220 volt from which the output of the inverter is gotten and is connected to the load.

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CHAPTER ONE

GENERAL INTRODUCTION

1.1 INTRODUCTION

The field of power electronics has experienced rapid advancement. Power electronics have wide applications in power systems, communications and computer engineering. The versatility of power electronics has improved the high performance of most of the equipments used in the afore-mentioned field of studies. However, these equipments have been short-lived by the insufficient supply of electrical energy or power failure.

The distributions of electrical energy to consumer has not been satisfactory as most of the consumer equipments malfunction or even get damaged because of continuous power failure. Very often, this scenario has led to loss of information during data processing in computer especially where no time or warning is given to ensure proper shutdown of the system.

The design and construction of an inverter cannot be over-emphasized as the need for constant power supply is essential in our daily lives. An inverter is an electrical device that converts direct current (DC) to alternating current (AC) in which the resulting AC can be at any required voltage and frequency with the use of appropriate transformers, switching and control circuits [1].

The inverter is just the opposite of a converter in which the inversion process can be achieved with the help of transistors, silicon controlled rectifiers (SCRs) and tunnel diodes. For low and medium outputs, transistorized inverters are suitable while for high power outputs, of SCR, through some external process. For SCRs connected to an AC power source, commutation occurs naturally every time the polarity of the source voltage reverses. SCRs connected to a DC power source usually require a means of forced commutation that forces the current to zero when commutation is required. The least complicated SCRs circuits employ natural commutation rather than forced commutation.

In applications where inverters transfer power from a DC power source, it is possible to use AC-DC controlled rectifier circuits operating in the inversion mode. In the inversion mode, a controlled rectifier circuit operates as a line commutated inverter. This type of operation can be used in high voltage DC power transmission systems and in regenerative braking operation of motor control systems. Another type of SCR inverter circuit is the current source input (CSI) inverter. A CSI inverter is the dual of a six-step voltage source inverter. With a current source inverter, the DC power supply is configured as a current source rather than a voltage source. The inverter SCRs are switched in a six-step sequence to direct the current to a three phase AC load as a stepped current waveform.CSI inverter commutation methods include load commutation and parallel capacitor commutation. The load is a synchronous motor operated at a leading power factor. As they become available in higher voltage and current ratings, semiconductors such as transistors or insulated gate bipolar transistors (IGBTs) that can be turned off by means of control signals have become the preferred switching components for use in inverter circuits.

2.3 Rectifier and Inverter Pulse Numbers

Rectifier circuits are often classified by the number of current pulses that flow to the DC side of the rectifier per cycle of AC input voltage. A single-phase half-wave rectifier is a one- pulse circuit and a single-phase full-wave rectifier is a two-pulse circuit. A three-phase half-wave rectifier is a three-pulse circuit and a three-phase full-wave rectifier is a six-pulse circuit.

With three-phase rectifiers, two or more rectifiers are sometimes connected in series or parallel to obtain higher voltage or current ratings. The rectifier inputs are supplied from special transformers that provide phase shifted outputs. This has the effect of phase multiplication. Six phases are obtained from two transformers, twelve phases from three transformer and so on. The associated rectifier circuits are 12-pulse rectifiers, 18 pulse rectifiers and so on.

When controlled rectifier circuits are operated in the inversion mode, they would be classified by pulse number also. Rectifier circuits that have a higher pulse number have reduced harmonic content in the AC input current and reduced ripple in the DC output voltage. In the inversion mode, circuits that have a higher pulse number have lower harmonic content in the AC output voltage waveform [1].

2.4 Applications of inverters.

Inverters convert low frequency AC mains to a higher frequency for use in induction heating by rectification to provide DC power. The inverter then changes the DC power to high frequency AC power. In HVDC power transmissions, AC power is rectified and high voltage DC power is transmitted to another location. At the receiving location, an inverter in a static inverter plant converts the power back to AC.

A variable-frequency drive controls the operating speed of an AC motor by controlling the frequency and voltage of the power supplied to the motor. An inverter provides the controlled power. In most cases, the variable-frequency drive includes a rectifier so that the DC power for the inverter can be provided from AC mains. Since an inverter is the key component, variable-frequency drives are sometimes called inverter drives or just inverters. In electric vehicle drives, adjustable speed motor control inverters are currently being used to power the traction motor in some electric locomotives and diesel-electric locomotives as well as some battery electric vehicles and hybrid electric highway vehicle such as the Toyota prius. Various improvements in inverter technology are being made, especially, in electric vehicle applications. In vehicles with regenerative braking, the inverter also takes power from the motor (now acting as a generator) and stores it in the batteries. An air conditioner bearing the inverter tag uses a variable-frequency drive to control the speed of the motor and thus the compressor.

CHAPTER THREE

METHODOLOGY

3.1 Analysis of the block diagram

The circuit design of an inverter can be represented by the block diagram in Figure 1

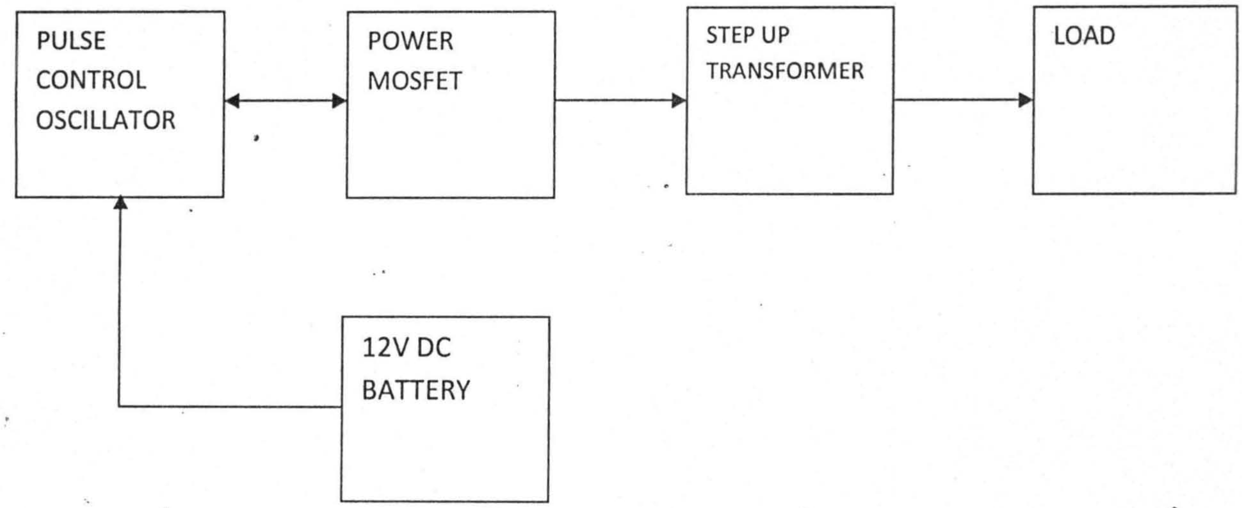


Figure 1: Block diagram of an inverter

The block diagram above displays a stage by stage breakdown of the major components required for the inverter design which are as follows:-

- Pulse control oscillator
- Power MOSFET which serves as a commutator
- A 12V DC battery cell
- A center tapped step up transformer
- External load

3.2 The Oscillator (SG3524)

An Oscillator is a circuit that creates an AC signal. Oscillators signals can be designed to produce many kinds of waveforms such as sine, rectangular, triangular or saw tooth. The range of frequencies that oscillators can generate is from less than 1 Hz to well over 10 gigahertz ($10GHz = 1 \times 10^{10} Hz$). Depending on the waveform and frequency requirements, oscillators are designed in different ways [8].

In this design, the SG3524 serves as an oscillator that is programmed by one timing resistor $RT = 100K$ and one timing capacitor $CT = 0.001\mu F$. It controls the frequency of the output signal according to the formulae below:-

$f = 1.18RTCT$

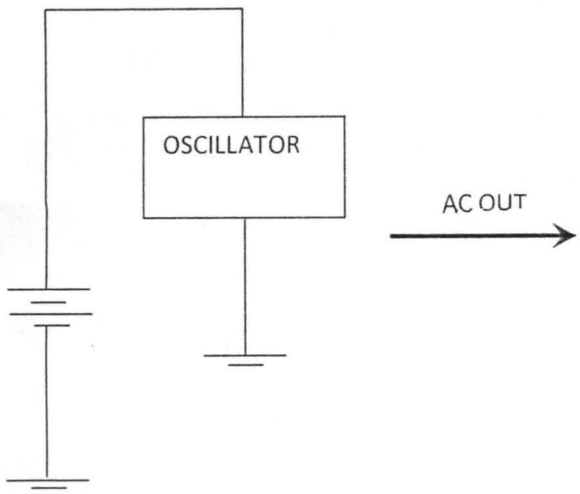
Where $RT = 100K, CT = 0.001\mu F$

$f = 1.18 \times 100 \times 0.001$

$= 0.118Hz$

The advantage of using this device is that the inverter gives a low harmonic content of the frequency which is suitable for inductive loads. The RT establishes a constant charging current for CT, which is fed to the comparator providing linear control of the output pulse width by the error amplifier. It contains an on-board 5V regulator that serves as a reference as well as powering the SG3524's internal control circuitry. It also comprises a single monolithic chip having all the functions required for the construction of regulating power supplies, inverters or switching regulators [3].

The Oscillator is considered the 'heart' of the inverter because it is a circuit that converts DC to AC and the only input to the oscillator is a DC power supply while the output is AC [8]. This is shown in figure 2 and 3 below:-



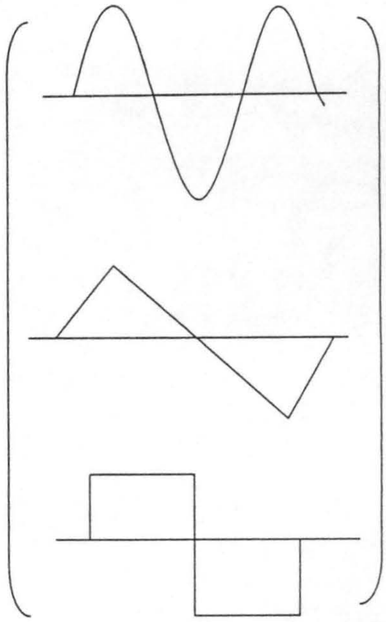


Figure 2: Oscillator Circuit

Figure 3: Resultant AC Outputs

The circuit diagram of the oscillator is represented in figure 4 where the resultant output pulses from the oscillator are passed through pins 14 and 12 via 1K resistors to the isolated gates of the power Mosfets.

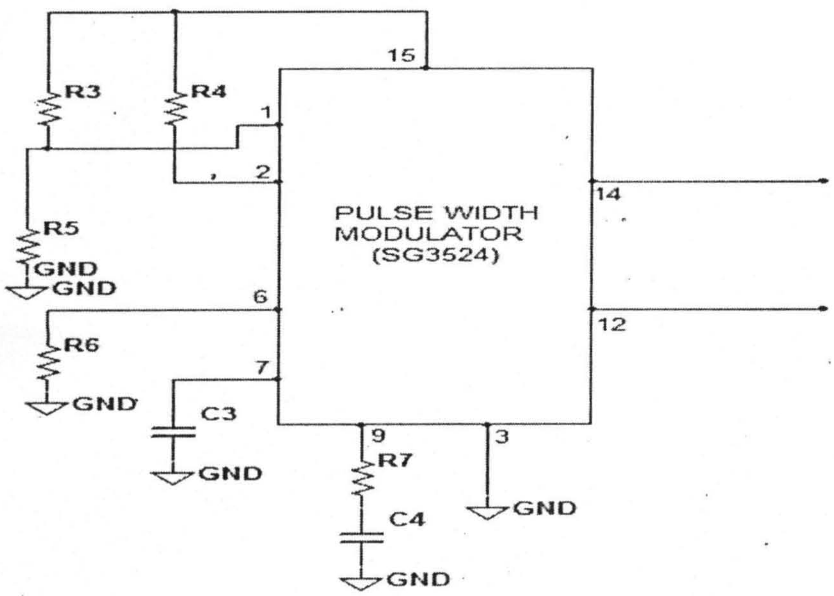


Figure 4: Pulse width modulator

3.3 The Power Mosfet (IRF3205)

IRF3205 is a specific type of metal oxide semi conductor field-effect transistor (MOSFET) designed to handle large amount of power compared to the other power semi-conductor devices like insulated gate bipolar transistor (IGBT) thyristors. Its main advantages are high commutation speed and good efficiency at low voltages. It shares with the IGBT an isolated gate that makes it easy to drive. It was made possible by the evolution of common metal oxide semiconductor (CMOS) technology developed for manufacturing integrated circuits in the late 1970s.The power MOSFET shares it's operating principles with its low-power counterpart, the lateral MOSFET. The power MOSFET is the most widely used low voltage switch found in most power supplies [4].

When the device is fully ON, the switch is almost closed at sufficiently large gate source voltage. It turns OFF when the gate source voltage is below the threshold value. They require continuous application of a gate source voltage of appropriate magnitude in order to be in the

ON state. No gate current flows except during the transitions from ON to OFF or vice-versa when the gate capacitance is being charged or discharged.

Because of their unipolar nature, the power MOSFETs can switch at very high speeds in which the only intrinsic limitation in commutation speed is due to the internal capacitance of the MOSFET. This capacitance must be charged or discharged when the transistor switches. This can be a relatively slow process because the current that flows through the gate capacitance is limited by the external device. The circuit will actually dictate the commutation speed of the transistor [4]. The circuit symbol of the power MOSFET is represented in figures 5 and 6 below:-

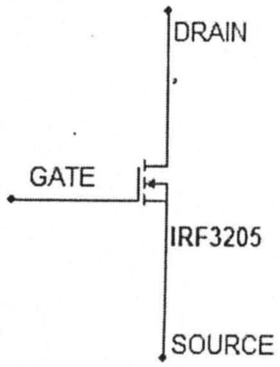


Figure 5: Circuit symbol of Mosfet

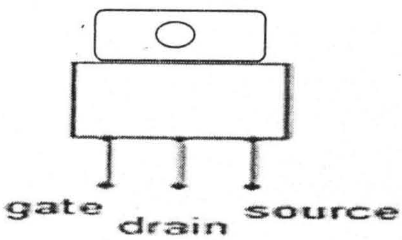


Figure 6: Component Symbol of Mosfet

In this design, the output pulse from the oscillator is passed through a 1K resistor to the isolated gates of the power MOSFETS.

The source of the MOSFET is connected to the negative terminal of the 12V battery source while the drain of the MOSFET is connected to the negative terminal of the transformer via the heat sink which is screwed to the drains of the power MOSFET.

This process enables the maximum voltage of the battery to flow to the primary windings of the power transformer. The circuit diagram below shows a parallel connections of four power MOSFETS in figure 7:-

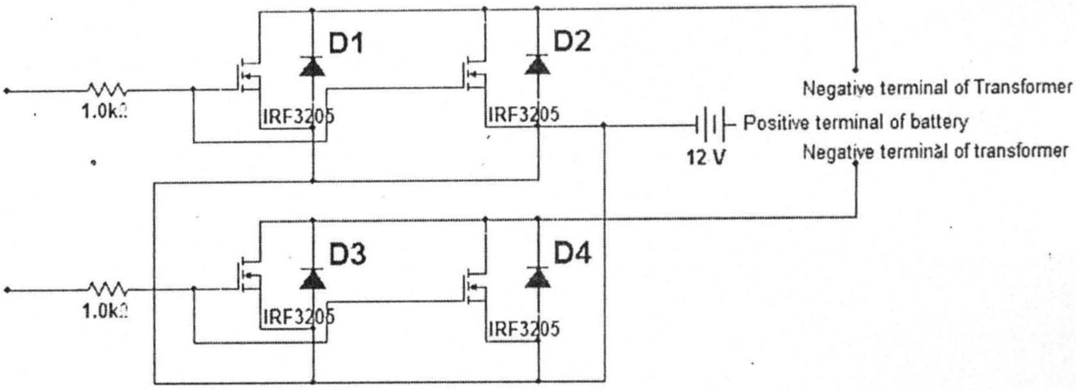


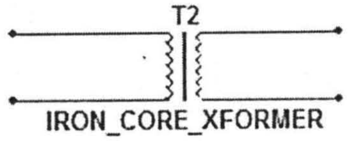
Figure 7: Circuit representation of the power Mosfet (IRF3205)

3.4 The Power Transformer

A transformer is a device that transfers electrical energy from one circuit to another purely by magnetic coupling. The relative motion of the parts of the transformer is not required for the transfer of energy. The energy transfer allows AC power to be converted to any desired voltage but at the same frequency. Since a transformer works on the principle of electromagnetic induction, it must be used with an input source voltage that varies in amplitude (AC voltage source).

A transformer consists of two or more coils of wire placed near each other so that most of the magnetic field generated by one coil passes through the other coil. The transformer may have an air core or a metallic core of some nature. The coils may be tightly coupled together or loosely coupled.

The schematic symbols of a transformer are given in figures 8 and 9:-



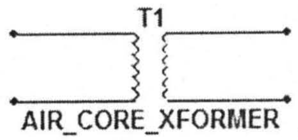


Figure 8: Iron core transformer

Figure 9: Air core transformer

A transformer is basically an electromagnetic static equipment based on the principle of Faraday's law of electromagnetic induction. A transformer essentially consists of a magnetic core, build-up of insulated silicon steel laminations, upon which are wound sets of coils suitably located with respect to each other and termed as primary and secondary windings. Such a combination may be used to derive a voltage higher or lower than what is immediately available. In the former case, the transformer is termed as a 'step-up' transformer, while in the latter case, it is known as a 'step-down' transformer. The primary winding is that winding to which the supply voltage is applied, irrespective of whether it is a higher or lower voltage winding, the other winding to which the load is connected is termed as secondary winding.

If an alternating voltage is applied to the terminals of the primary windings of the transformer, with the secondary winding open circuited, a very small current will flow in the primary circuit only, which serves to magnetize the core and to supply the iron losses of the transformer. Thus, an alternating magnetic flux is established in the core which induces an emf in both primary and secondary windings. As primary and secondary windings are wound on the same core and as the magnetic flux is common to both windings, obviously, the voltage induced in the primary and secondary windings are, therefore, in direct proportion to the number of turns in these windings [9].

The formular connecting induced voltage, flux and number of turns is:-

$$\frac{V}{N} = \frac{B_m \times A_n \times f}{22.51 \times 10^2} \quad \text{------(2)}$$

Where $\frac{V}{N} =$ Volts per turn, which is the same for both windings

$B_m =$ Maximum flux density in the core in tesla.

$A_n =$ Net cross section area of core in sq cm.

$f =$ Supply frequency in Hz.

The power transformer is not an energy conversion or energy source device and therefore cannot convert DC to AC. AC circuits are commonly connected to each other by means of transformers. A transformer couples two AC circuits magnetically rather than through any direct conductive connections and permits a "transformation" of the voltage and current between one circuit and the other i.e by matching a high-voltage low-current AC output to a circuit requiring a low-voltage high-current source [7].

The transformer used in this design is a step-up transformer (center-tapped) which changes the voltage profile of the system from 12V to the desired 220V. The voltage output of the transformer is gotten across the secondary terminal. Figure 10 shows the internal structure of the power transformer while Figure 11 shows the sinusoidal waveform that is the usual waveform of an AC power supply.

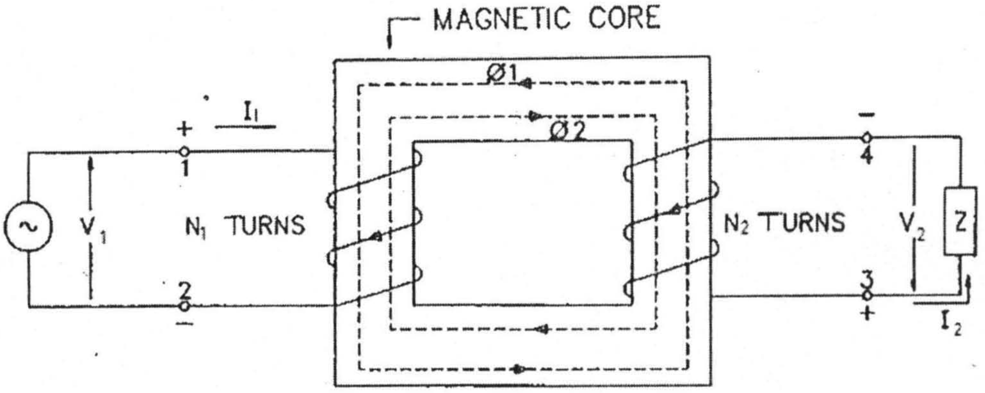


Figure 10: Internal structure of a transformer

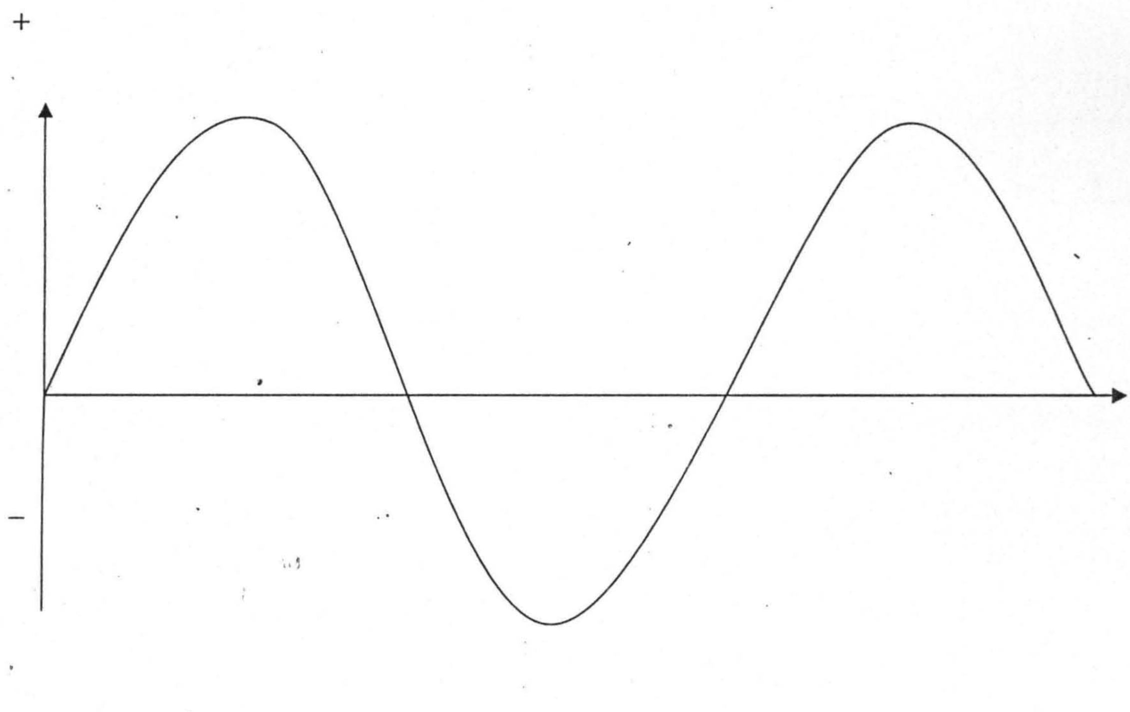


Figure 11: Output waveform of the power transformer

The alternation of the direction of current in the primary winding of the transformer produces alternating current (AC) in the secondary circuit [1].

The ideal power transformer is represented with the equations shown below:-

$$V_1 I_1 = V_2 I_2 \quad \text{------------------------------------} (3)$$

$$\frac{V_1}{V_2} = \frac{N_1}{N_2} \quad \text{------------------------------------} (4)$$

$$\frac{I_1}{I_2} = \frac{N_2}{N_1} \quad \text{------------------------------------} (5)$$

where,

V_1 = voltage in the primary

V_2 = voltage in the secondary

I_1 = current in the primary

I_2 = current in the secondary

N_1 = turns in the primary

N_2 = turns in the secondary

3.5 Timer Unit

The following components make up the timer unit:-

- 555 timer,
- 6V DC relay,
- NPN transistor (C1815),
- BCD counter (4026),
- Battery monitor unit,
- Diodes.

3.5.1 The 555 Timer

Integrated timer circuits represent one of the interesting developments in IC design. The circuit consists of a number of high quality functional blocks that are combined in one IC but are interconnected externally. Thus one IC can be used for many different functions. The 555 timer can be used as a monostable multivibrator (one-shot) or as an astable multivibrator (an oscillator) [7]. The diagram in figure 12 below shows the 555 timer wired in astable mode where the external capacitor charges through resistors R_a and R_b.

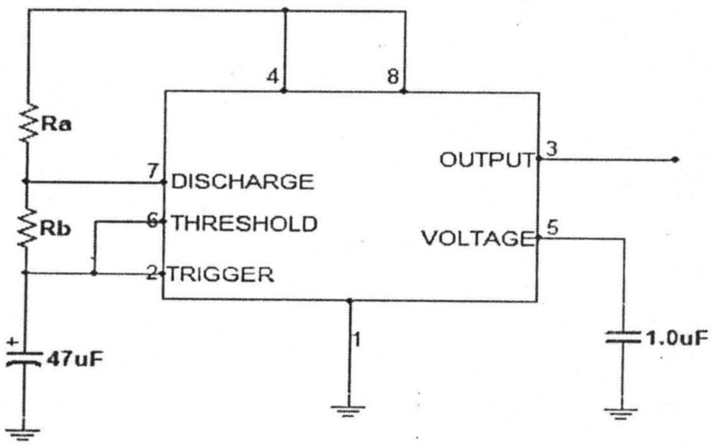


Figure 12: 555 Timer in Astable mode

The charging time (output high) is given by:-

$$t_1 = 0.695(R_a + R_b)C \text{ ------------------------------ } (6)$$

The discharging time (output low) is given by

$$t_2 = 0.695R_bC \text{ ------------------------------ } (7)$$

The total period T is given by the sum of the two equations (6) and (7)

$$T = t_1 + t_2 = 0.695(R_a + 2R_b)C \text{ ------------------------------ } (8)$$

The duty cycle $= \dfrac{R_b}{R_a + 2R_b}$ -- (9)

The LM555 is a highly stable device for generating accurate time delays or oscillations. The emanation of the IC timers eliminated a wide range of mechanical and electromechanical timing devices. It also helped in the generation of clock and oscillator circuits.

Timing circuits are those which will provide an output change after a pre-determined time interval. This is, of course, the action of the mono-stable multivibrator which will give time delay after a fraction of a second to several minutes quite accurately. The time delay mode is precisely controlled by one external resistor and capacitor [5]. The diagram in Figure 13 shows a schematic diagram of a 555 timer:-

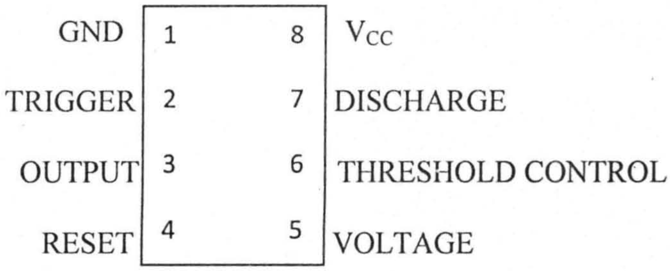


Figure 13: External circuitry of a 555 timer

The details regarding connections to be made to pins are as follows:-

Pin 1: This is the ground pin and should be connected to the negative side of the supply voltage.

Pin 2: This is the trigger input. A negative voltage pulse applied to this pin when falling below $\frac{1}{3}$ V_{cc} causes the comparator output to change state. The output level then switches from LOW to HIGH. The trigger pulse must be of shorter duration than the time interval set by the external RC networks, otherwise the output remains HIGH until the trigger input is driven HIGH again.

Pin 3: This is the output pin and is capable of sinking or sourcing a load requiring up to 200mA and can drive TTL circuits. The output voltage available is approximately –1.7V.

Pin 4: This is the reset pin. It is not required in this design hence, it is connected to the same point as pin 8 to prevent accidental resetting.

Pin 6: This is the threshold input. It resets the flip flop and hence drives the output low if the applied voltage rises above $\frac{2}{3}$ of the voltage applied to pin 8. A current of minimum value of 0.1A must be supplied to the pin since this determines the maximum value of resistance that can be connected between the positive side of the supply and this pin.

Pin 7: This is the discharge pin. Usually, the external timing capacitor is connected between pin 7 and ground and is thus discharged when the transistor turns on.

Pin 8: This is the power supply pin and is connected to the positive side of the supply. The voltage applied may vary from +5 to +18V.

This design consists of two 555 timer wired in astable and mono-stable mode. For the astable operation, the free running frequency at 1Hz and duty cycle are accurately controlled with two external resistors and a capacitor. It generates pulses used by the decade counter (4026). In the mono-stable operation, the timer is used to energize or de-energize the 6V relay responsible for the shutdown of the inverter.

3.5.2 Relays

A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be ON or OFF. The relay has two switch positions which are double throw (change-over) switches.

Relay allows one circuit to switch a second circuit which can be completely separated from the first. In this design, the effect of a low voltage battery (less than 10V) is used to trigger the first 6V DC relay which consequently switches on the 555 timer. The timer de-energizes the second relay which is responsible for subsequent shutting down of the inverter. There is no electrical connection inside the relay between the circuits, the link is magnetic and mechanical. Relay is useful if we want a small current in one circuit to control another circuit or device such as lamp or electric motor which requires a large current or if there are different switch contacts to be operated simultaneously. Figure 14 shows the symbol of a relay. The current needed to operate a relay is called PULL-IN current and the drop-out current which is the current in the coil when relay just stops working. If the coil resistance of a relay is R and it's operating voltage is V then the PULL-IN current is represented as:-

$$I = \frac{V}{R} \qquad (10)$$

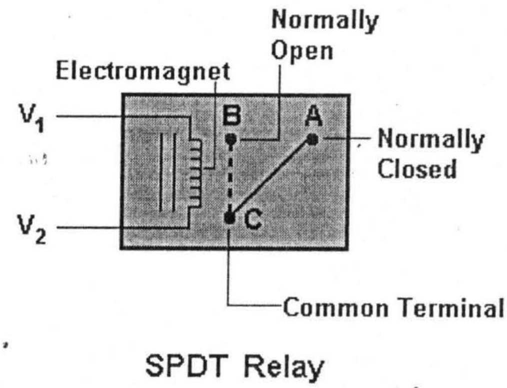


Figure 14: Circuit symbol of a relay

3.5.3 Transistors (C1815)

Transistors are active components used basically as amplifiers and switches. Transistor provides the power gain that is needed for most electronic applications. They can also provide voltage gain and current gain. The transistor regions are named emitter, base and collector. The simplest transistor structure is shown in figure 15.

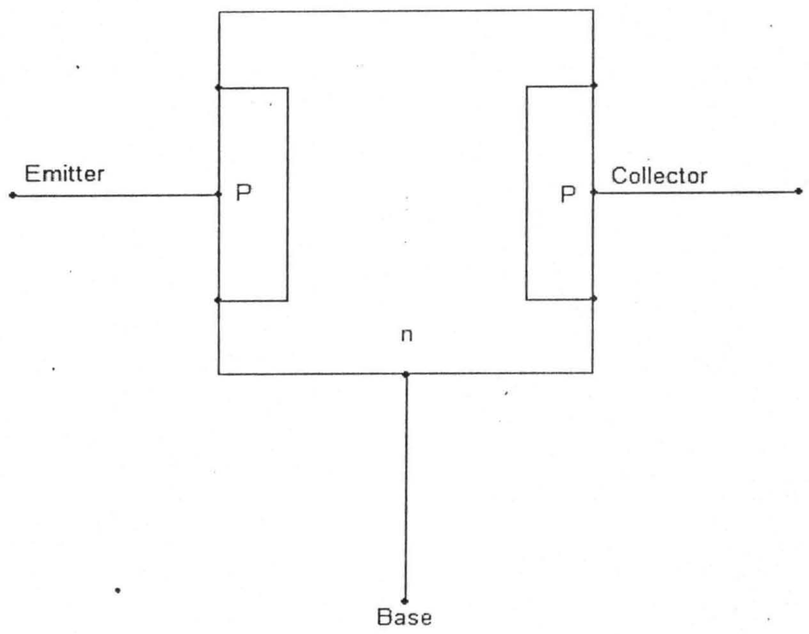


Figure 15: Simple transistor structure

In this design an n-p-n transistor is used as a switch which has an n-type emitter, a p-type base and an n-type collector otherwise, it is exactly the same as the p-n-p transistor. Since the currents in these transistors are carried by both polarities of carriers (holes and electrons),they are often called bipolar transistors, in contrast to the field effect transistors [8].

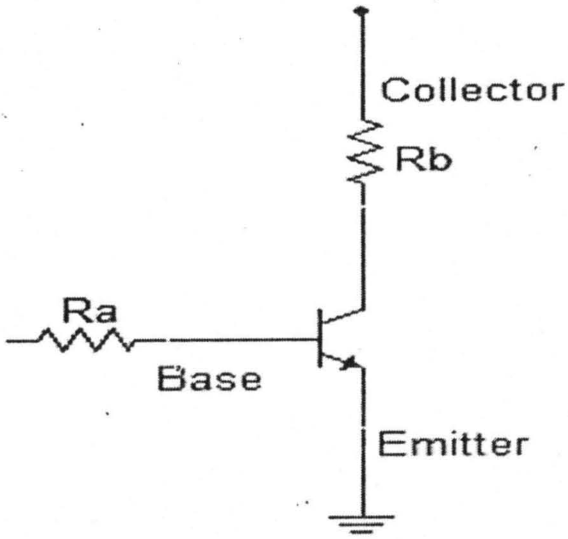


Figure 16: Diagram of an n-p-n transistor

A simple symbol diagram of an n-p-n transistor is represented in figure 16, the transistor C1815 was used in this design to trigger the 6V DC relays in the battery monitor unit.

3.5.4 Battery Monitor Unit

In this design, a 12 volt DC rechargeable lead acid battery was used having a minimum capacity of 45 Ah. A 10K variable resistor was also used to preset the shutdown voltage when battery voltage falls below 10 volt. If battery voltage is at 12 volt, the zener diode conducts by triggering the 6 volt DC relay through the base of the C1815 transistor. This occurs without interrupting the inversion process. If voltage level falls below 10 volt, the zener diode stops conducting thereby de-energizing the relay. The de-energizing of this relay leads to the shutdown of the inverter.

This can be represented using the simple circuit diagram in Figure 17.

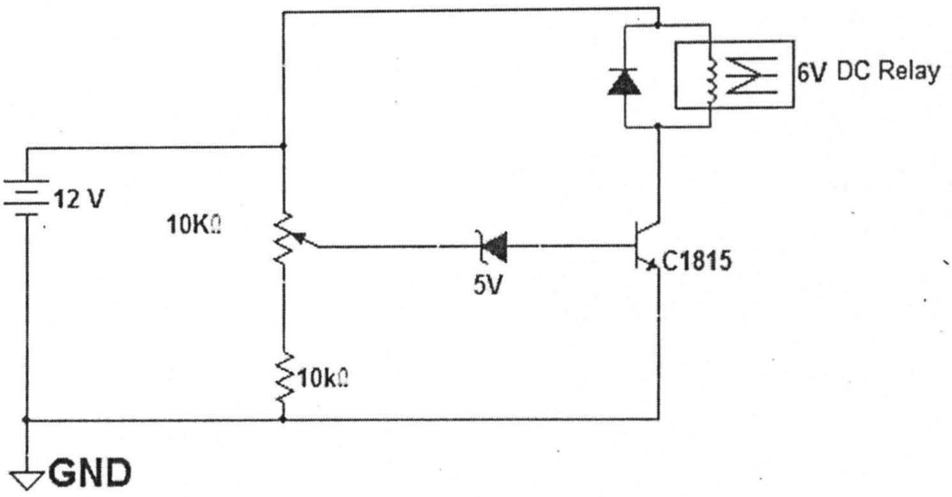


Figure 17: Battery monitor unit

3.5.5 Diodes

The diodes used in this design are:-

- The Pn junction diode.
- The Zener diode.

Figure 18 and 19 shows a symbol representation of a Pn junction diode and a zener diode:-

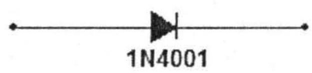


Figure 18: Symbol of a Pn junction diode

Figure 19: Symbol of a Zener diode

An ideal diode has zero resistance for current flowing one way through it and infinite resistance for current flowing the other way. From another point of view, it allows current to flow through itself in only one direction. The direction in which the current may flow is called the forward direction, whereas the way in which current may not flow is called the backward direction [7].

3.5.5.1 The Pn junction diode

The Pn junction allows current to flow relatively easily in one direction while strongly resisting the flow of the current in the other direction. Thus, the Pn junction is a reasonable approximation of an ideal diode [7].

The schematic symbol in Figure 18 designates the p-type semiconductor material, and the bar in the symbol designates the n-type material. The arrow points in the forward direction. Thus, conventional current will flow through the diode in the direction the arrow points, but current will not flow in the opposite direction.

3.5.5.2 Zener diode

A normal diode will breakdown if a sufficiently high reverse bias is applied. Breakdown in a normal diode is usually accompanied by the destruction of the Pn junction. Thus, in a normal operation, breakdown is the same as burn out which is not desirable. However, it is possible to construct a diode that will have a non destructive reverse bias breakdown at a well defined voltage. Such a diode is called a zener diode [7]. The symbol representation of a zener diode is shown in figure 19.

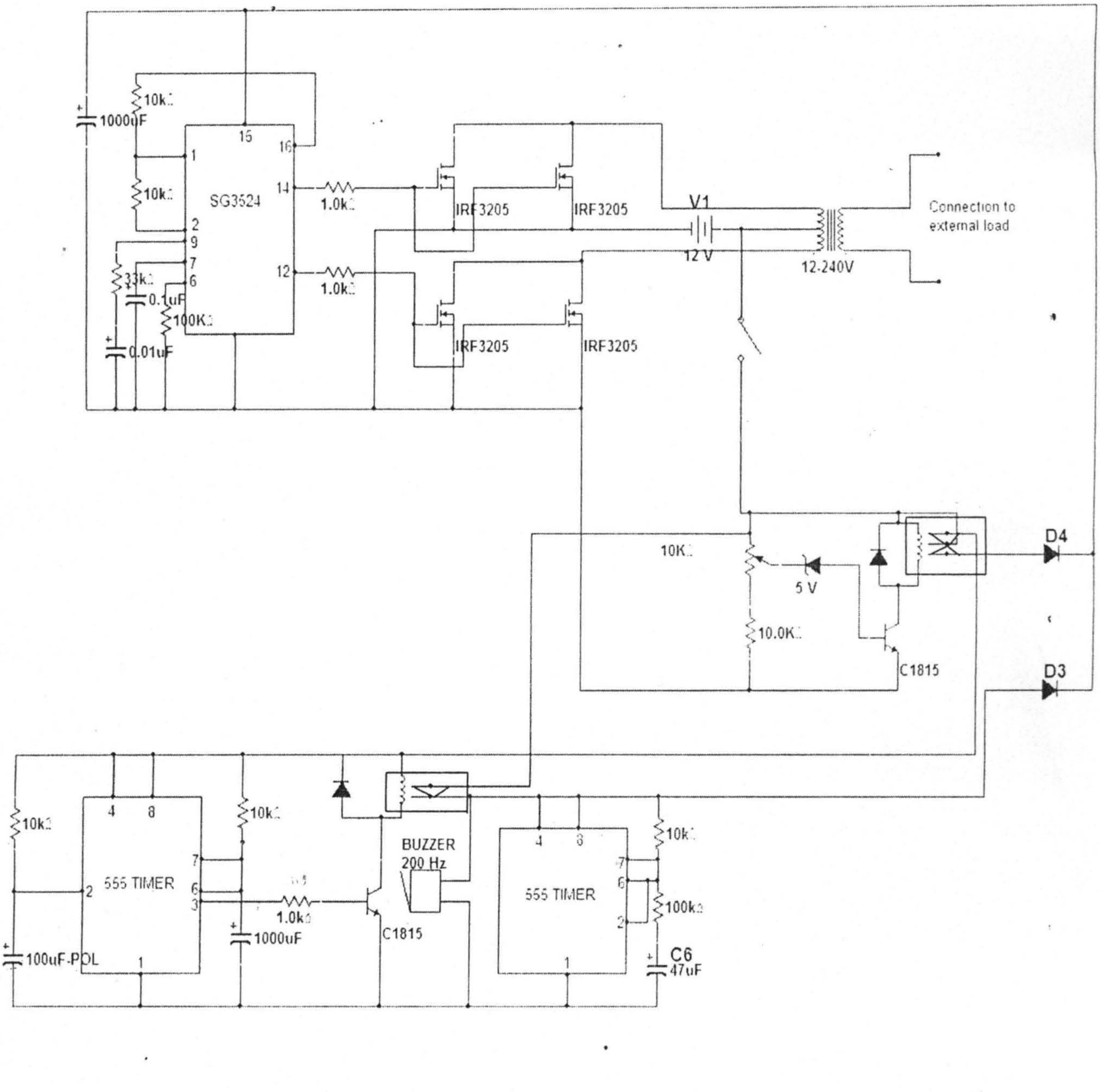


Figure 20: complete circuit diagram of an inverter

CHAPTER 4

CONSTRUCTION, TESTING AND RESULTS

4.1 Circuit Construction

The construction of this project (500VA Inverter) was done in three different stages which are as follows:-

- The testing of part of the construction on the breadboard.
- The soldering of the component on the Vero-board.
- The coupling of the entire project to the casing.

4.2 Testing and Results

Series of problems were encountered during the implementation, testing and construction of this project which are as follows:-

1. After carrying out the paper design and analysis, the project was implemented and tested to ensure it's working.

2. During the first connection of a fully charged 12 volt car battery, arcing of the terminal contact was experienced. A spanner of required size was used to screw the bolt firmly.

3. The output frequency from the oscillator was gotten to be 0.118Hz which is suitable for inductive loads.

4. The output voltage gotten from the power mosfet was equal to the battery voltage.

5. The output voltage of the transformer was measured to be 187.5 volt which can be used by domestic appliances. The expected voltage (220V) was not obtained due to losses incurred by the power transformer.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The pulse width modulator is the 'heart' of the inverter design. The advantage of using this device is that the inverter gives a low harmonic content of the frequency which is suitable for inductive loads.

A 12 volt DC supply is fed to the oscillator where-by the realized pulses is passed to the gate of each channels of the power MOSFET via 1K resistor which is used to limit the gate current flowing through it. At the output of the inverter is a step up transformer (center tapped) where the output voltage is tapped to supply the load.

5.2 Recommendations

1. To improve on this design, an AC source can be used to feed the bridge rectifier which convert AC to DC. This process is used to charge the 12 volt battery.

2. To improve on this design, a transformer with a higher VA rating can be used with a DC battery of higher voltage to increase the inverters VA rating.

3. Electrical Engineering students on students' work experience programme (SWEP) can be actively engaged on inverter projects as it practically exposes them to designs.

5.3 Precautions

1. To prevent the power MOSFETs from overheating, heat sinks was attached to quickly dissipate the heat generated in them.
2. It was ensured that when soldering, the soldering iron was not placed on the components for a long time to avoid over-heating of the components.

3. It was ensured that the voltage rating of the components was not exceeded.
4. It was ensured that all connections made and the casing was neatly done.

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