DESIGN AND CONSTRUCTION OF A 1000VA SOLAR POWER INVERTER.

BY

OLANIYAN OLADIRAN I.

(2005/22077EE)

DEPARTMENT OF ELECTRICAL/COMPUTER ENGINEERING, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.

NOVEMBER, 2010

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A FINAL YEAR PROJECT SUBMITTED TO THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, IN PARTIAL FULFILMENT OF THE REQUIREMENTS OF THE AWARD OF THE BACHELOR OF ENGINEERING (B. ENG.) DEGREE IN ELECTRICAL AND COMPUTER ENGINEERING.

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DEDICATION

This project is dedicated to Almighty Allah the most beneficent the merciful in which the successful completion of the program is due to His mercy. To my late daddy Prince Olaniyan Hassan A. (may Allah grant him Aljanna firdaous). To my respected mum Princess Olaniyan Khadijat and to my able brother Prince Hassan B Olalekan. May Almighty Allah let them reap the fruit of their labour (Amin)

Declaration

I, OLANIYAN OLADIRAN I., declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquish the copyright to the Federal University of Technology, Minna.

Olaniyan Oladiran I. ....

(Name of student)

10/11/5 ....

(Signature and Date)

ENGR A.G. RAJI ....

(Name of H.O.D)

(Jan. 11, 2011) ....

(Signature and Date)

Michael David ....

(Name of Supervisor)

10/11/5 ....

(Signature and Date)

Engr Dr. G. I. Ighalo ....

(Name of External Examiner)

1/12/10 ....

(Signature and Date)

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I give my humblest gratitude to Almighty Allah, the most merciful and most beneficent for the privileged, grace and strength which He has afforded me to partake of this great experience.

To my parent, late Prince Olaniyan Hassan A. and the Princess Olaniyan Khadijat through whom it has been possible for one to experience this life and have seen to my well being this far.

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Finally, I will like to thank my friends and all other well-wishers who have contributed on their own way to this my success, may Almighty Allah bless every one "Amen"

ABSTRACT

The project involved the design and construction of a 1KVA solar power inverter that is supplies by 12V d.c from a car battery and produces an output of 220AC, 50HZ frequency. The battery is being charge from either the solar module or power mains.

The project comprises three major units namely: the power supply unit, the inverter unit and the battery charger unit. The inverter unit comprises of oscillator using SG3524, which generate pulse width signal that switches ON and OFF a set of power MOSFETs, thus producing a square wave at the output. The output of the inverter unit amplified with the aid of a center-tapped power transformer. The inverter was design in such a way as to switch between the mains power and the battery.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the study

This project is an analysis, design and construction of a 1000VA power inverter, which was embark upon due to inadequate supply of electricity for domestic and commercial use from the primary source (power holding company of Nigeria). It is crucial to produce an alternative secondary source of power generation that is completely independent of Power Company (primary source). Power failure has become a disturbing and common problem in the society. Its unexpected occurrence has given rise to damages to domestic and industrial appliance, loss of lives and increase in the tariff charge by telecommunication operators in the country, who claims that they waste more money in fuel to power their power generating set.

The above mentioned problems from the PHCN have actually led to the development of solar power inverter designed to handle electric power.

This device gets its DC charging current via solar panel, which induces voltage during the day light. This makes it totally independent on primary source of electrical energy. The device will serve as a secondary power supply in remote areas where the facility of PHCN is not available. In addition, it can serve as a back up in some places where the utility is present but always fluctuating.

To this end, the inverter was designed to have two inputs, one from the solar panel and the other one is from the battery. In addition, it was designed to suit wide range of electronics.

1.2 DEFINITION OF DC INVERTER

An inverter is an electronic device that consist electronic circuits that is capable of converting direct current DC to alternating current AC.

The name solar inverter shows that the inverter derives its primary input, from the solar source, which charges the battery that gives secondary DC source to the inverter.

1.3 AIMS/OBJECTIVES

The major aims of this solar power inverter are listed as follow:

- To provides an alternative power supply through the utilization of natural resources.
- To maximizes the efficiency and reliability of earlier power inverter.
- To makes it completely independent from the primary source of power.

This serves as alternative source of power, which could fill in the gap and cover the lapses of inadequate power supply in the country.

1.4 METHODOLOGY

The 1000VA DC to AC inverter was designed and constructed after the consultation with individual and experts in the electronics and electrical field. The theoretically and analysis of the device in test books and website was done.

In designing this inverter, a modular method adopted. Each module were independently designed on the breadboard, tested with relevant measuring devices to compare and contrast with expected result, before finally assembled on a breadboard.

The respective modules were tested and found okay on the breadboard and it was permanently soldered on a Vero board.

The entire circuits i.e. transformer, the main circuit board and the relays were arranged and assembled in the casing and the complete system was tested and found okay.

1.5 SCOPE OF THE PROJECT

The project is design and construction of a 1KVA solar power inverter that charges from either solar panel or a main source (PHCN) and produces an output of 220V A.C to supply the load.

1.6 ADVANTAGES OF SOLAR CELLS

(i) Solar cells convert sunlight directly to electricity with no requirement for a thermal or mechanical step in conversion process

(ii) Once installed, solar cells require little maintenance and have a long span of life.

(iii) Solar cells produce electricity with little or no adverse environmental effects.

(iv) Solar cells can be located where the power is needed thus no distribution network is required.

(v) It contains no fuel or gas.

(vi) It consumes no fuel and does not produce any pollution

(vii) It is serves as an alternative means for power generation.

(viii) It is economical as it does not require many expenses after installation.

1.7 ADVANTAGES OF POWER INVERTER

1. It is reliable
2. It is potable and easy to maintain
3. It is cost effective
4. Availability of component in the market

CHAPTER TWO

2.0 LITERATURE REVIEW/THEORETICAL BACKGROUND

2.1 Historical Background

Since its early times, man has seen the great potential in the sun as an enormous source of power and energy. In addition, overtime man has devised means to tap into this great energy source in the atmosphere. Indeed, the sun is an ideal power source. The solar energy is ever flowing inexhaustible and free from pollution [1].

The term photovoltaic has been used in English since 1849 and it was derived from the Greek word "phos" meaning "light" and "voltaic", means electrical. This last term is derived directly for the name of Italian physicist Volta, after whom the volt, the unit of electrical potential is named [2].

The harnessing of solar energy is not new. In fact, the development of solar energy dates back more than 100 years, to the middle of the industrial revolution. Several pioneering solar power plants were constructed to produce steam from the heat of the sun, which was used to drive the machinery of the time. At the same time, Henri Bacquerei discovered the photovoltaic effect in 1839[2].

The first solar cell was not built until 1883, when Charles Fritts Coated semiconductor selenium with an extremely thin layer of gold to form the PN junction [5].

The modern age of solar technology arrived 1954, when Bell laboratories in United States accidentally found that silicon doped with certain impurities was very sensitive to light. This resulted in the production of the first practical solar cells, with a sunlight energy conversion efficiency of around 6%. But due to a lot of researches and development of technology, the efficiency increases gradually to 22%, 24%, 28% up to date which has efficiency of around 30 – 60% using Gallium Arsenide (GaAs) with multi-junction photovoltaic cell[11].

2.2 Brief Historical Background of Inverter

The first generation inverters used meteoroid Darlington technology. This special circuit produces current to power transistor proportional to load. Second generation inverter used FET (Field Effect Transistor), since FET has relatively no switching losses efficiency was markedly improved. In 1990, integrated circuit allowed the creation of energy management systems. In 1993, the first processors controlled inverter/charger was introduced. The advantages of modified sine wave technology are efficient and relatively economical [4].

Trace engineering developed an improvement to the modified sine wave technology in their sine wave sine's inverter, while not a true wave; the output is a multi-step approximation that results in fewer load incompatibility [6].

Star power technology in 1995 introduces a pure sine wave inverter/charger using frequency switching techniques; they were successful in producing a high output charger with a power factor approaching "1". There is negligible distortion at the past in both inverter and charger, which is viewed as a technology milestone [6].

Mainly inverters perform two functions; first, they convert incoming DC into AC and then step up the resulting AC into main voltage level using a step-up transformer.

Earlier inverters made use of tunnel diodes; SCR (Silicon Control Rectifier) and transistor in the inversion process but modern ones use SG3524IC.

2.3 PRINCIPLE OF OPERATION OF SOME BASIC COMPONENTS USED

2.3.1 Transistor

The first silicon transistor was produced by Texas Instruments in 1954. This was the work of Gordon Teal an expert in growing crystals of high purity, who had previously worked at Bell lab. The first MOS (Metal Oxide Silicon) transistor actually built was by Kahng and Atalla at Bell Lab in 1960[1].

The transistor is the key active component in practically all modern electronics, and considered by many to be one of the greatest inventions of the 20th century.

A transistor is a semiconductor device used to amplify or switch electronic signals. It is made of a solid piece of semiconductor material, with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals changes the current flowing through another pair of terminals. Because the controlled (output) power can be much more than the controlling (input) power, the transistor provides amplification of a signal. Some transistors are packaged separately but many more are found embedded in integrated circuits [7].

2.3.1.1 Simplified Operation

The essential usefulness of a transistor comes from its ability to use a small signal applied between one pair of its terminals to control a much larger signal at another pair of terminals. This property is called gain. A transistor can control its output in proportion to the input signal, that is, can act as an amplifier or to turn current on or off in a circuit as an electrically controlled switch, where the amount of current is determined by other circuit elements.

The two types of transistors have slight differences in how they are used in a circuit. A Bipolar Junction Transistor has terminal labeled base, collector and emitter. A small current at the base terminal (that is, flowing from the base to the emitter) can control or switch a much larger current between the collector and emitter terminals. For a Field Effect Transistor, the terminals are labeled gate, source and drain and a voltage at the gate can control a current between source and drain [3].

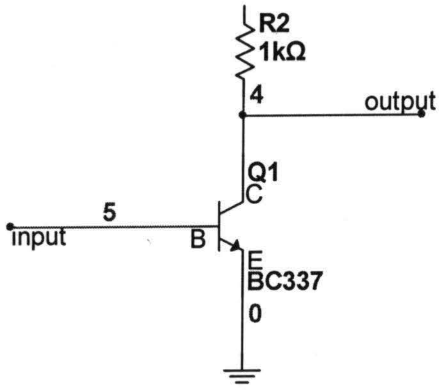


Fig. 2.0 **Simple circuit to show parts of a BJT**

In the circuit, charges will flow between emitter and collector terminals depending on the current in the base. Since internally the base and emitter connections behave like a semiconductor diode, a voltage drop develops between base and emitter while the base current exists.

2.3.2 Relays

Relays are electromechanical devices that open and close an electrical circuit in response to a signal that may be voltage, current, power, frequency, speed, temperature, pressure, flow, level or any other physical phenomenon.

Electromagnetic relays operate by the force due to magnetic field on an armature. Electromagnetic relays consist of an open coil located on an electromagnet in which an armature is free to slide. When current circulated in the coil, a magnetic field is produced in the core of electromagnet. The action of magnetic field on the armature causes the armature to slide is called the actuation. This makes the relay contact to close the NO (Normally Open) and Open NC (Normally Close).

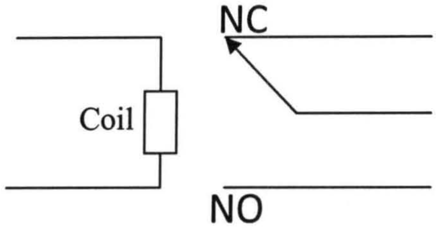


Fig. 2.1 **Schematic Diagram of Typical Relay**

2.3.2.1 Selection of Relay

Selection of a right relay depends on application and it is a huge subject but at least requires the evaluations for some factors such as cost, reliability, redundancy, number and type of contact, contact rating, voltage ratings, coil voltage, coil current, cost of assembly mounting structure and more.

2.3.3 Battery

This is an essential component that energies the inverter circuit with DC 12V, which will later invert to almost AC 12V before its step up to desired output of 220V.

Selection of a good and appropriate battery for the inverter requires a lot of technical considerations.

For proper selection and maintenance of the battery to take place, the factors affecting battery reliability include:

1. Temperature: The natural problem that causes battery ageing are strongly affected by temperature. Manufacturing data indicates that the battery life reduced by 10% of every additional 10^0F. For this reason it is not only necessary that the inverter design should be

such that the batteries are kept as cool as possible at all time, but also that a battery with wide operating temperature range should be selected.

2. Battery Voltage: Batteries are made of individual cells. To make up a battery of voltage higher than that of a cell, individual cell must be connected in series. When batteries are kept on constant charge as they are in inverter system, the individual cells are charged in series. Slight manufacturing variation in battery cells causes some cell to take a larger percentage of charging voltage than the others. This causes premature aging of those cells. The series connected group of cells is only as strong as its weakest link, so when any individual cell becomes weak the whole battery is weakened. It has been proved that the magnitude of this ageing problem is directly related to the number of cell in the string and therefore increases as the battery voltage increases.
3. Battery charger: The charging condition of a battery has a major effect on the battery life span. The battery's life span maximized, if the battery is always powered from a constant voltage. This is because maintaining the battery under a continuous charge arrests some of the battery's natural ageing processes.

Another important aspect of the battery is the battery type. For use in electronic equipment, the possible choices are:

a) Nickel-Cadmium (Wet cell rechargeable battery)
b) Sealed lead-acid battery

Due to obvious fewer advantages of lead-acid batteries over the nickels in terms of ampere-hour rating, life expectance, charge retention, operating temperature and number of cells in series for a given voltage, the sealed lead acid battery is often recommended for battery performance.

2.3.3.1 Care and Maintenance of Batteries

For maximum performance to be achieved the battery have to be serviced from time to time. Servicing the battery involves:

a) Checking and topping of the acid level.

b) Cleaning of corroded terminals to ensure proper contact

c) Discharge of acid when concentration falls bellow average level.

d) Ensure that the battery voltage is appropriate to prevent over charging of the battery.

2.3.3.2 Choice of Battery

The choice of battery depends on intended time duration for a given output of inverters and the charging capability of the charger inside the inverter. For a 1000VA inverter to operate for one hour at maximum load, the required current is given by

I = 1000/12 (since the battery is 12V)

I = 83.3A

Hence, using a battery of 200AH, the time duration will be 200/83.3 x 1hr

= 2.4 hours (approximately)

Using 2 batteries will give an output time of approximately 5 hours on full load.

Hence, on maximum load and full charge on batteries, the operation time of the inverter will not exceed 5 hours. The period can however be increased if the load on the inverter is reduced to about half or if more batteries are used.

CHAPTER THREE

3.0 DESIGN AND CONSTRUCTION

The functional block diagram that represents the stages of the 1KVA inverter is shown below:

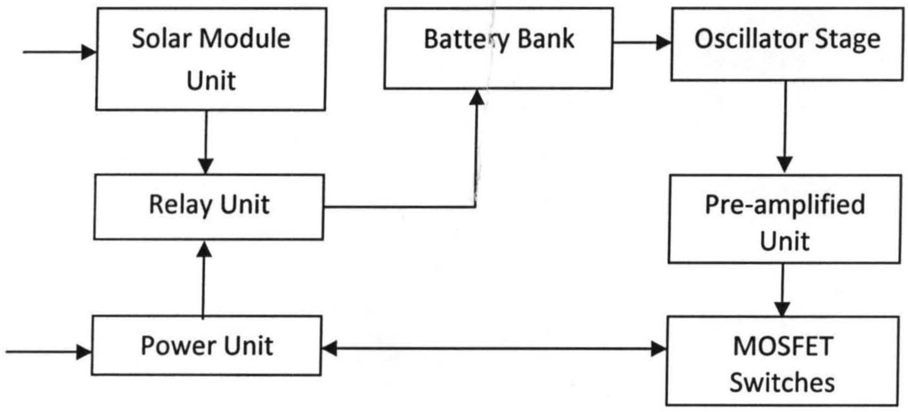


Fig. 3.0 Functional Block Diagram of 1KVA Solar Inverter

3.1 DESIGN SPECIFICATIONS

- Output power 1kVA
- Output waveform = pulse width modulation
- Output frequency = 50Hz
- Output voltage = 220 volts AC
- Charging type = constant voltage

The capacity of an inverter is a function of

- The type and number of power MOSFETS used
- The size and capacity of the power transformer

3.2 POWER UNIT

The power unit consists:

- Input transformer
- Bridge rectifier
- Filtering Capacitor
- Fuses and Voltage Regulators

The transformer used is a step-down transformer with rating of 220/12V.

The input of the transformer fed with voltage from the mains and the output connected to the bridge rectifier junction of opposite polarity.

3.3 THE RELAY CIRCUITS ARRANGEMENT

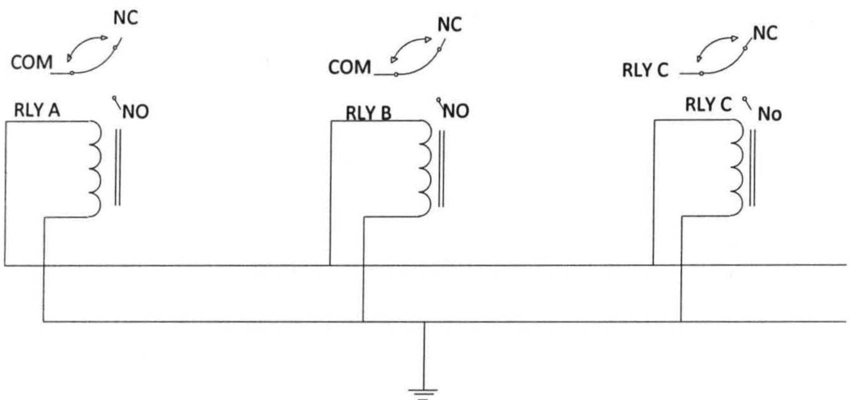


Fig. 3.1

Three relays were used: relay A, B and C for switching the device. The relays were connected in parallel and controls by a rectified voltage from the mains. All the relays are normally close mode relay. Relay A is normally close at the inverter ON i.e. it used to supply source to the inverter through the battery when the mains AC supply is OFF. On the application of power from the mains, it switches OFF the inverter.

Relay B is use to control the charging circuit and AC output voltage. On the application of the voltage from the mains, the normally closed relay B energizes and switches ON the output socket. At the same time it make the circuit with the output transformer winding which now turn to be the primary coil through transformation, drop the voltage to 12v at the secondary (centre tap/primary coil when AC is not used). The 12v a.c. is then supply to the MOSFET and MOSFET serves as the rectifier that charges the battery.

Relay C: is used to switch OFF the source from solar when AC main is available. The relay is normally closed at the positive battery terminal. The supply from solar module can also be switch OFF through the manual switch.

3.3.1 The relay as switching circuit

The 12V step down transformer is used to step-down 220V through the mains. The bridge rectifier connected to the secondary coil of the transformer. The rectifier converts AC 12V into DC equivalent to 24V. The diode type of rectifier used is 1N4007, which takes 0.7V to conduct.

The output from the rectifier were passed into the smoothing capacitor of 100µf, 50v polarized and the output from smoothing capacity were regulated to 12V, using L7812CF regulator.

The relays A, B, and C are fed from the 12v output of the L7812 CT regulator.

3.4 BATTERY CHARGING UNIT

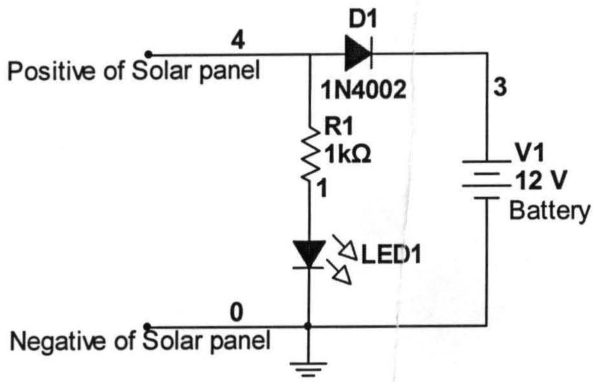


Fig. 3.2

3.4.1 Design specification:

Rating of the battery = 40Ah

Voltage rating = 12V

Given that the solar panel DC output voltage (V_{out}) =15V

Considering the diode which stops the flow of current in the opposite direction from the battery:

V_D = voltage drop across the diode = 0.7V

$V_{out} = 15V - 0.7V$

$V_{out} = 14.3V$

Given that V_C = battery charging voltage

V_F = rated voltage of the battery = 12V

$V_C = V_{out} - V_F$

$V_C = 14.3V - 12V$

$V_C = 2.3V$

Charging voltage = 2.3V

3.5 OSCILLATOR STAGE

The conversion of DC energy from the battery to AC energy of a specified frequency is been done in this stage. It is an electronic source of alternating current or voltage having sine, square, saw tooth or pulse width.

According to the definition/explanation above, it can be deduces that the oscillating stage is where the name inverter was found.

The oscillator used in this design was pulse width modulation regulator control (SG3524). This was chosen because of some reliability and availability of some essential components in its circuitry to implement single ended or push-pull switching regulator. Included on the circuit is oscillator, voltage reference, a pulse width modulator, error amplifier, overload protection circuitry and output drivers.

The SG3524 IC has 16pin dual-in-line-dip, dual alternating out-put switches, current limiting and shut down circuitry, voltage stability.

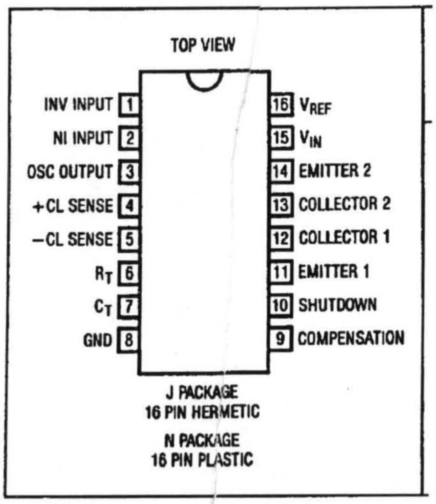


Fig. 3.3 SG3524 IC

In the design, the IC is supplied with 12V DC at pin 15. However, the internal circuitry of the device required 5V DC. The excess voltage is being fed to both inverting and non-inverting pins 1 and 2 error amplifier respectively via pin 16 voltage reference pin. The voltage output of the comparator sunk to the ground through pin 4 and pin 5 which are clock sense pin[13].

The major functional unit of the IC (SG3524) is oscillator circuitry. The oscillating frequency is varied through the resistor and capacitor connected to pin 6 and pin 7 respectively. The output of oscillator is pin 3 which is a single ended pulse fed directly into a flip flop.

The flip flop divides the single ended output into two and fed to NOR gate, then to transistors each attached to a NOR gate at pin 12, 11, 13 and 14, pin 14 and 11 of each transistor is grounded (emitter) while pin 12 and 13 are the output pin used for push pull application and fed to the preamplifier circuit using 2SC956.

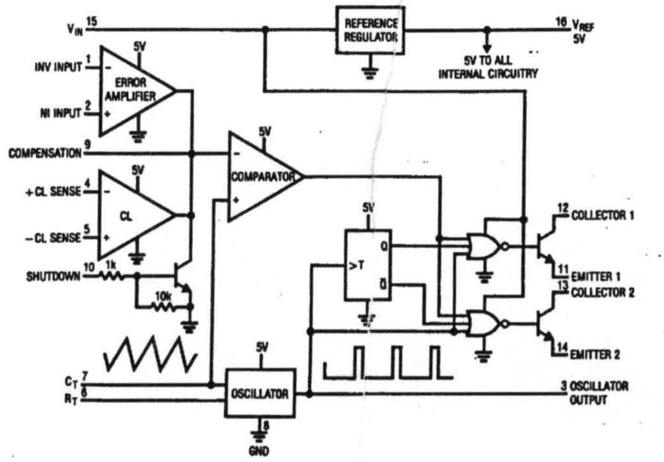


Fig. 3.4 Internal Circuitry of SG3524 IC

3.5.1 Frequency Configuration of the Oscillator

As stated above, SG3524 requires external synchronization for the designer to vary the pulse duration derived and consequently the frequency. The formula generated from the manufacturer of SG3524 for pulse duration (t) = R_tC_t where t is in microsecond.

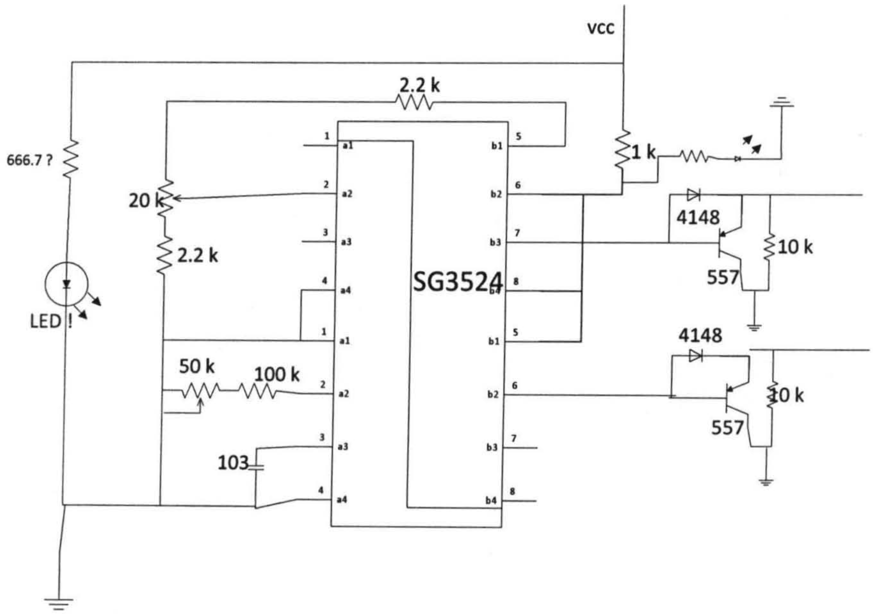


Fig. 3.5 circuit diagram of the oscillator

Thus $T = R_tC_t$ R_t is chosen to be 100kΩ

C_t also chosen to be 200nF

Therefore $T = 100 \times 10^3 \times 200 \times 10^{-9}$

$T = 0.02$secs.

However, frequency (f) = 1/T

$F = 1/0.02$

$= 50$Hz.

The flip-flop divides the frequency into two i.e. F = 50Hz = 25Hz (half cycle) which will later summed at the output transformer.

Resistor 10kΩ was used to drop voltage that feeds the inverting and non-inverting error amplifier at pin 1 and 2 and finally sink into the ground via pin 4 and pin 5. Pin 9 is a compensation pin and function in the case where there is error amplification.

The voltage is sinks through 100kΩ in series with 22nF charging current

$$= \frac{3.6}{100 \times 10^3} = 3.6 \times 10^{-5}$$

$$= 36 \times 10^{-6}$$

$$= 36\mu A$$

3.5.2 Preamplifier

The output signal from the oscillator needs to be boosts to achieve the required current and voltage, which is to be drive by power MOSFET to the output step-up transformer.

Transistors 2SC945 were used. It is an NPN silicon transistor with excellent signal amplification.

The current output I_{out} of oscillator = 36μA. However, the current of the base of 2SC945 transistor was calculated using current divider theorem, the current that flow through 2.2kΩ resistor to the base as shown in the diagram below:

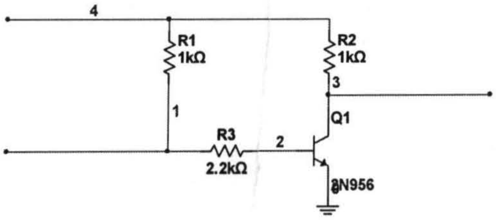


Fig. 3.6 Preamplifier Circuit Diagram

$$I_b = I_1 + I_2 = 36\mu A + \frac{12}{1000} = 0.012036A = 12.036mA$$

3.6 POWER SWITCHING MOSFET

MOSFETs are metallic oxide semi conductors in which the gate is completely insulated from the channel by a thin (about 1dm) layer of silicon oxide. This permit operation with gate source or gate channel voltage above and below zero [9]. The insulated gate of the MOSFET further reduces substantially the gate current, in which the gate current is less than one Pico ampere (pA).

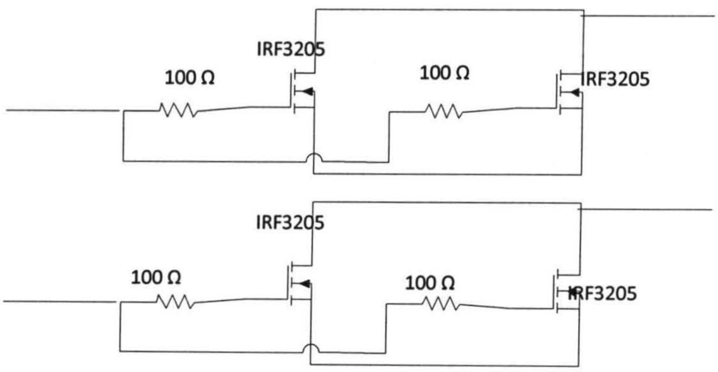


Fig 3.7 circuit configuration of the MOSFET

On the design, the MOSFET received 5V alternating voltage. Therefore, to completely OFF the MOSFET gate was negatively biased to avoid the damage of the component, because without the negative bias, the MOSFET will not completely OFF before the arrival of the other pulses which might damage the MOSFET.

In addition, 22KΩ resistor connected between the gate and the source to be completely turned OFF the MOSFET. In addition, diodes were connected across the drain of the MOSFET to avoid surge at reverse direction, which might also damage the MOSFET.

3.6.1 Design Calculation

5V was fed from preamplifier to the switching MOSFET that makes $V_{GS} = 0$ at self bias.

$$I_G = \frac{V_H - V_{GS}}{R_b}$$

$$I_G = \frac{5-0}{100} = \frac{5}{100}$$

$$= 0.05Amp$$

If $V_G = 5V$ at V_H

Therefore: Drain Current = D_i

Since drain current = $\frac{V_{DD}}{R_D}$

R_D = the reactance of the coil of the transformer. Therefore, the reactance of the coil must be known.

Since L (inductance) is not noted

:. $X_L = \frac{V}{I}$, V = 12 and I =?

Targeted power rating = 1KW = P = IV

1000 = 12 x I

$I = \frac{1000}{12} = 83.30Amp$

The IRF3205 has capacity of 100Amp, therefore the MOSFET should be arranged parallel to compensate for the current.

$$\text{If } X_L = \frac{V}{I} = \frac{12}{83} = 0.144\Omega$$

At 50Hz the reactance of the coil was noted to be 0.148Ω . Hence, $R_D = 0.144\Omega$

$$\text{Drain current} = \text{Di} = \frac{V_{DD}}{R_D} = \frac{12}{0.144} = 83.3Amps$$

3.7 TRANSFORMER

A transformer is a static (stationary) piece of apparatus by means of which electric power in one circuit transformed into electric power of the same frequency in another circuit [14]. It can raise or low the voltage in a circuit in response to ratio of the coil at the primary and secondary winding but with a corresponding decrease or increase in current.

The physical basis of a transformer is mutual induction between two circuit linked by a common magnetic flux generated corresponding to the input power to the transformer.

The bidirectional transformer was used at the output stage of the entire design of 1KVA inverter, to be able to realized 220V from the input of transformer of 12V AC signal at the MOSFET end.

This step-up center tapped transformer steps up 12v ac from the output of the inverter unit to the desired 220v ac.

3.7.1 Design Calculation

Let input power = output power

Given that input current = 83.3A

Let E_s = Emf of secondary side of the transformer = 220V

E_p = Emf of primary side of the transformer = 12V

N_s = number of turns in secondary side of the transformer = 580turns

N_p = number of turns in primary side of the transformer =?

K = transformer ratio $= \frac{Es}{Ep} = \frac{Ns}{Np}$

$\frac{230}{12} = 19.2 = K$

Given that the number of turns of the secondary side (N_S) =580 turns

To find N_p i.e. number of turns in primary side

Given $E_p = 12V$, $E_s = 220V$

$$\frac{Ep}{Es} = \frac{Np}{Ns}$$

$$N_p = \frac{Ep}{Es} \times N_s = \frac{12}{220} \times 580 = 30 \text{ turns}$$

To achieve the impedance of the coil the parameters are noted:

Secondary coil turns	=	580 turns
Primary coil turns	=	30 turns
Secondary Voltage	=	220V
Primary Voltage	=	12V
Secondary current	=	?
Primary current	=	83.3A

The secondary current obtained by the current that runs through the source to the drain of the MOSFET. This help in powering the transformer, because the transformer is the R_L (Load resistor of the MOSFET).

:. I_s (primary current) is given by transformer ratio:

$$\frac{I_p}{I_s} = \frac{V_s}{V_p} = I_p = \frac{12 \times 83.3}{220} = 4.15A$$

:. Secondary current = 4.15A

Power efficiency = power input = power output

Power efficiency = 12 x 83 = 240 x 4.15

= 996W

If primary reactance $X_{sr} = \frac{V}{I} = \frac{12}{83}$

= 0.1446

:. Inductance of the primary coil

X_L = $2\pi fL$

= 0.1446

= 2 x 3.142 x 50 x L

L = $\frac{X_L}{2\pi f} = \frac{0.1446}{2\times3.142\times50}$

L = $0.4 \times 10^{-3}H$

Inductance of the primary coil

X_L = $\frac{220}{4.15} = 57.8\Omega$

X_L = $2\pi fL$

X_L = 2 x 3.142 x 50 x L

L = $\frac{57.8}{2\times3.142\times50}$

L = 0.18H

Therefore, the resonant factor (Q) = $\frac{\omega L}{R_{dc}}$

Where R_{dc} = dc pure resistivity

DC resistivity for secondary coil is 1.6Ω

DC resistivity for primary coil = 2.5Ω

$$\frac{2\pi f L}{R_{dc}} = \; Q - \text{for primary coil}$$

$$\frac{2 \times 3.142 \times 50 \times 0.4 \times 10^{-3}}{1.6}$$

$$= \quad 0.12$$

Q factor for secondary coil

$$\frac{2 \times 3.142 \times 0.18 \times 50}{2.5}$$

$$= \quad 21.8$$

Hence, impedance for secondary coils,

R = $Q \times X_L$

R = 0.12 x 0.144

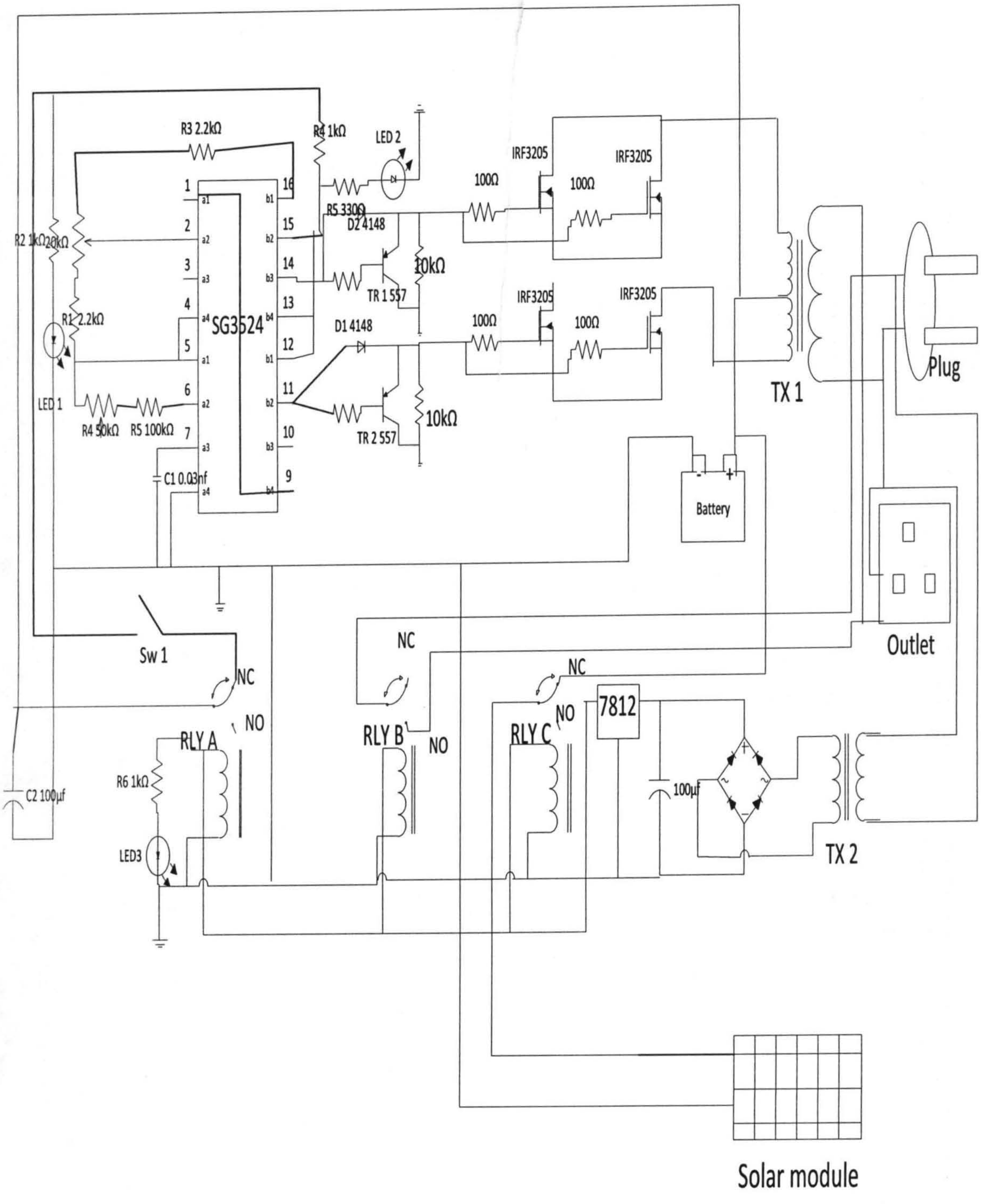
R = 0.0174Ω

Impedance for secondary coil

= $Q \times X_L$

= 0.18 x 57.8

= 10.404 Ω



COMPLETE CIRCUIT DIAGRAM OF 1KVA SOLAR POWER INVERTER

CHAPTER FOUR

4.0 CONSTRUCTION, TESTING, RESULTS AND DISCUSSION OF RESULT

4.1 CONSTRUCTION AND TESTING

The realization of this project involved theoretical and practical exercise of converting the designed circuit diagram on the paper into a real, workable electrical device. The modular methods of construction were introduced to verifying the workability of each stage of the design on breadboard, which is the temporary circuit connection and to be able to determine the stage(s) that required some amendment.

The final construction was implements on a Vero board. All the involved electronic components were carefully studied, connected together under the guide of the circuit diagram and datasheet that provides detailed information on the connection of each component. The design analysis of the whole circuit diagram in previous chapter was of great benefit in the construction, because it predicted the expected output of each stage.

Each unit circuit was executed one after the other. After which all the units were joined together as a single working hardware.

The circuit's construction involves the following materials and tools:

- Jumper wires
- Integrated circuit sockets
- Razor blade
- Cutting knife
- Soldering iron
- Soldering lead

- Vero board
- Pliers
- Digital multimeter

4.2 CASING CONSTRUCTION

The casing was made of rugged metal. The metal material is wrought metal designed with special perforation to serve as vent and sprayed to ensure insulation, and aesthetic value also to avoid corrosion.

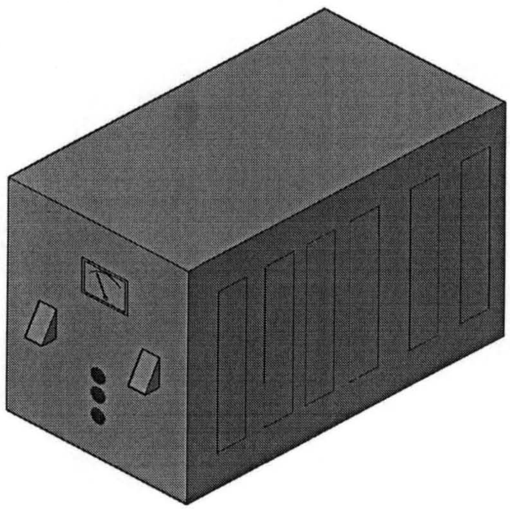


Fig. 3.12 **Casing**

4.3 TESTING

The work at this stage is not just on paper, but also as a finished hardware system (product). After carrying out all paper design and analysis, the design was implemented and tested to sure of its workability.

Finally, it was constructed to meet the desired specification. The test was carryout as follow:

- Oscilloscope: The oscilloscope was use to observe the ripple in the power supply waveform also to check the oscillator waveform as well as the oscillator frequency.
- Multimeter: The specified and expected input and output of the device found correct. Continuity, resistance, voltage and current of components were also tested and found to comply with the calculations in chapter three.
- The entire system output test, carried out on no load and on load.

4.4 RESULT

While carrying out the test as discussed above, the resulted output shown below:

- Output power 1kVA
- Output waveform = sinusoidal
- Output frequency = 50Hz
- Output voltage = 220 volts AC

4.4.1 DISCUSSION OF RESULT

The result obtained from the project is very satisfactory. The primary aim of obtaining a 1kVA output from the inverter was achieve and the uninterrupted constant supply of power achieved. 220VAC from 12VDC battery also achieved.

4.5 PROBLEMS ENCOUNTERED

1. The MOSFET were overheating, hence, the idea of heat sink to reduce the heating.
2. There was noise in the output transformer, so vanish was applied to hold the coils more compact together to clear the noise.
3. It was difficult getting some components over the shelf. Hence, equivalents were used after consulting the data sheet.
4. It was difficult at first to design and construct the changeover system.

CHAPTER FIVE

5.0 CONCLUSION

This project was designed and constructed to provide an alternative means of power supply for domestic and commercial use. In addition, it aimed to provide solution to the erratic nature of power supply in this country.

This inverter can supply power to most household appliances for a period of time that is directly proportional to the ampere-hour rating of the battery. Finally, to achieve a longer time of power supply, battery banks and wider solar modules are recommends.

5.1 RECOMMENDATIONS

1. The inverter should be design to use more than one battery at a time.
2. The charging unit should be designed to be able to deliver a high charging current, so that batteries could be charged on time.
3. The device should be incorporated with alarm, to call the attention of the user when battery discharged.
4. The device should be design to automatically switch OFF when battery charges are below the useable capacity.

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APPENDIX

R_1, R_2, R_3..Voltage control

LED_1..Inverter indicator

LED_2..Power supply indicator

LED_3..Solar module connection indicator

R_4, R_5, and C_1..Frequency adjuster

D_1, D_2..Reverse current limiter

R_5..Biasing resistor for sg3524

R_6..Biasing resistor for LED_3

R_7, R_8, R_9, and R_{10}..Biasing resistor for MOSFET gate

C_2..Current supper

C_3..Filtering capacitor

Sw_1..Inverter ON and OFF switch

7812..Voltage regulator

TR_1 and TR_2..Preamplifier

Tx_1..Bidirectional output transformer

Tx_2..Input transformer to rectifier