DESIGN, CONSTRUCTION AND TESTING OF 1000VA DC-AC INVERTER

BY

Olatunde kazeem olajide

REG. NO. 95/4581

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA,

DECEMBER 2000.

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A PROJECT REPORT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING DEGREE (B.ENG.) IN ELECTRICAL AND COMPUTER ENGINEERING IN THE DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING, SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.

DECEMBER, 2000

DECLARATION

I, Olatunde Kazeem Olajide, hereby solemnly declare that this project work "**Design, construction and testing of a 100VA DC to AC inverter/changer**" is the result of my personal effort.

It has never been presented elsewhere either wholly or in part for any degree or diploma.

All information derived from published work used in this project have been duly acknowledged.

-- -----------------------------------

Signed: OLATUNDE K. O. **DATE**

CERTIFICATION

This is to certify that this project work was carried out by **Olatunde Kazeem Olajide** in department of Electrical and Computer Engineering, and it has been found to be adequate in scope and content in partial fulfilment for the award of Bachelor's degree in Electrical and Computer Engineering (B. Eng.)

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MR. KENNETH PINNIE **DATE**
(PROJECT SUPERVISOR)

-- ------------------------------

DR. Y. A. ADEDIRAN **DATE**
(HEAD OF DEPARTMENT)

-- 17/1/2001

EXTERNAL ~~SUPERVISOR~~ EXAMINER **DATE**

DEDICATION

Dedicated to Almighty Allah who in His infinite mercy made it possible for me to progress in life.

And to my late mother Mrs. Nusirat B . . Olatunde and the entire family of Alh. Y. Oyewale Olatunde.

ACKNOWLEDGEMENT

To Allah be all praises, life cannot move on smoothly without his support and guidance, and from good people around to whom I owe thanks to.

My sincere and heart felt thanks goes to my Dad Alh. Wale Olatunde for his dedication to his children's career.

I appreciate the care and love shown to me by my "MUM" Mrs. F. J. Olaosebikan, her husband Mr. Raff Olaosebikan.

A million thanks to my big brothers and sweet sister Engr. Kunle Olatunde, Arch. Habib Olatunde and Medinat Olatunde for their moral and financial support during my course of study and my younger brother Mohammed.

My appreciation also goes to my Uncle Mr. Bashir Olatunde Esq, my cousins, 'Layi, 'Shola, 'lanre, 'Tunde you are all wonderful people.

With heart felt with love I appreciate the effort of Medinat O. Umar whose interest, love and words of encouragement were source of inspiration during the course of my study.

My very special appreciation goes to all HYPIAN Club members, Esteem club members, Dr. Yinka Suleiman, Dr. Kola Adaranijo, Mr. Jire Adekeye, Alh & Mrs. Ali Afegbua and their children, Ayo Akano, Wale Suleiman, Rotimi Akano, Adeleye Johnson, Kazeem Salau, Senior Mujib Tomori, Jelil Adekilekun. So also my colleague in project work Shirawoya, Taiye Yusuf.

Appreciation also goes to my project supervisor, mr. Kenneth Pinnie, who despite his busy schedule made himself available whenever I needed his advice during the course of my project work.

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ABSTRACT

The purpose of this work is to develop a DC-AC Inverter/charger unit as an alternative to use it generating sets because of its low cost and it's maintenance free nature.

The components used in this design are locally available thereby making it possible to produce the inverter/charger unit cheaply.

The inveter/changer was designed using pulse wth momulation method of inverting and using power MOSFET as the main inverter switching component.

The control signal is generated by Astable multivibrator using Op Amp and then integrate after frequency multiplication to give the switching signal.

The inverter/charger car power load up to 1000Va from an ordinary 24volt car battery.

CHAPTER ONE

1.0 INTRODUCTION

With break through in intergrated circuit technology, electronic devices are made up of microelectronic components. These components have relatively low cost and they could be combined in some way to get very useful devices.

Due to erratic power supply of electricity in Nigeria. Coupled with exorbitant cost of procuring generating sets. It became necessary to device an alternaive source of electricity at minimal cost and which is noise free.

An inveter is a device which convert direct current voltage into an alternating current voltage. Inverters are powered bybanks of batteries which are the source of direct current voltage.

The concept of inverter is employed in uniterruptible power supplies for computer protection and in speed motor control application.

The project consist of two unit viz:

I BATTERY CHARGING UNIT

The simplest, schematic diagram of a battery charging unit is shown in Fig. 1.1. A.C. input from mains is to be stepped down by a step down transformer, it is then rectified and titltered. The tiltered output is passed through a voltage regulator and the regulated output can now be fed to the batteries for charging a battery charger level device is also incorporated.

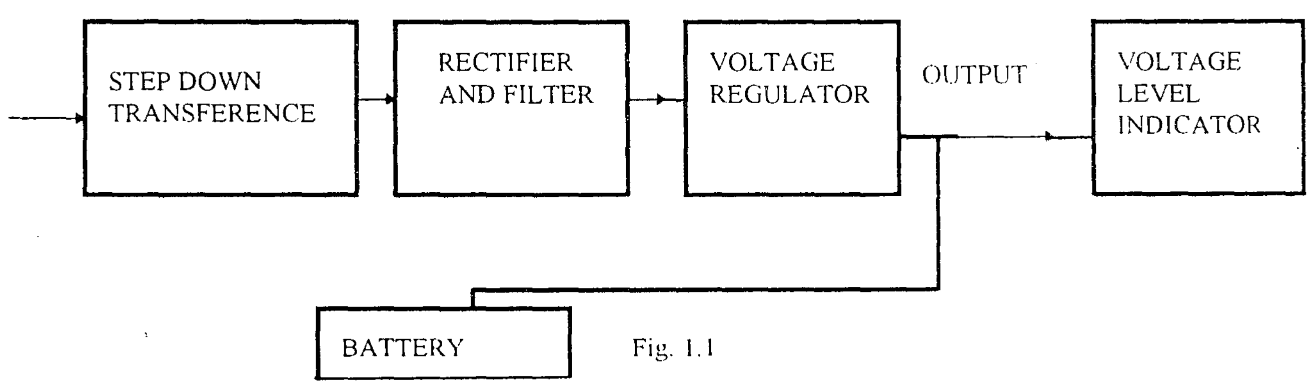


Fig. 1.1

The methods used in charging batteries is as follows:

1. Constant - voltage charging method
2. Constant - current charging method
3. Trickle or slow rate charging method
4. Floating system charging method
5. Booster/higher rate changing method

The last three methods i.e. (3,4 and 5) is a modification of 1 and 2

1) **CONSTANT VOLTAGE CHARGING**

It operates on the principle in which when the battery tends towrds it charge the terminal voltage will increase with increase in opposition to changing current where a balanced potential occurs between the battery charger and the battery.

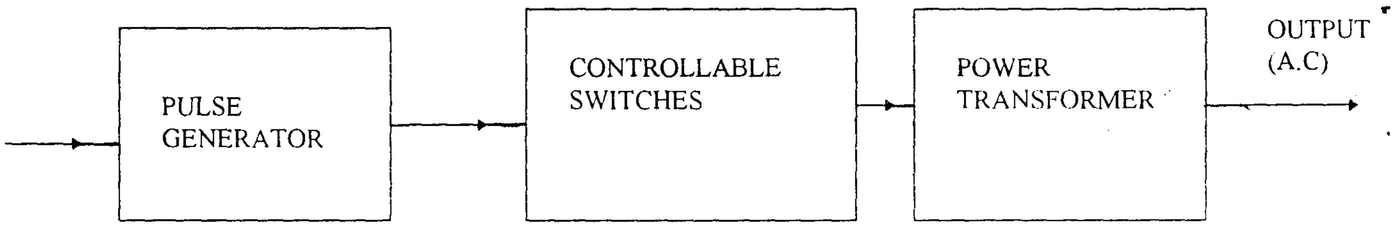
2) **CONSTANT VOLTAGE CHARGING**

The battery charging takes place at a constant rate until no futher rise in the specific gravity of the electrolyte takes place.

INVERTER UNIT

Here, the input d.c. is converted into pulses, which is a sinusoidal wave generated to be the control voltage and it also convert the saw tooth wave form which is voltage of triangular waveform. This inturn a set of power MOSFET on an off. Fig. 1.2 shows the simplest form of an inverter.

Other controllable switches that could be used are Insulated Gate Bipolar Transistor (I.G.B.T.), Bipolar Junction Transistor (B.J.T.) and Thyristor (Silicon (Silicon Controlled rectifier).



Simplest form dc-a.c. inverter

1.10 AIMS AND OBJECTIVES

The design of 1000VA inverter/battery charger takes into consideration.

* The final cost of construction of the Battery charger/inverter.
* The required power output which is up to 800W with 0.8 as power factor.
* The availability of electronic component readily I the market.
* The size and weeight of device is also considered.

The device provide the following:

* Cheap alternative to a generating set
* Standby source of electricity when there is failure from NEPA
* Abstenance from noise, vibrator, of generator because the device allows a.c. power without noise.
* Adequate power for appliance like, VCR, TV Stereo and lowly watted appliances independently of the public electricity supply in areas in which the supply is not available especially in the rural areas.

1.20 LITERATURE REVIEW

The first high performance power inverter was introduced in 1983 by Heat Interface who has been a leader in inverter/charger technology.

Before the development of the dc - ac inverter of 250VA by Heart Interface, there was no other way of obtaining AC power other than from the mains or standby generating set. The mains supply in Nigeria is quite unreliable and generating set are quite expensive to

Heat interface inverter/charger was the first reasonably priced commercially marketed inverter/charger.

In 1984 Heat Interface patented and introduced invertors utilizing first effect transistor (i.e. MOSFETS). For the main power output devices. The use of MOSFETS made the designs smaller because they are much more smaller than Bipolar junction transistors.

1.3 PROJECT OUTLINE

This project write up is dwell with the design and construction and testing of 1000VA DC-AC inverter/battery charger and it gives sequential analysis of design processes involved.

Chapter one contains concept of DC-AC inversion and battery charging and the various methods used in achieving this. The second chapter dwells with processes of designing the inverter/charger system.

Chapter three deals with the process of assembling the various component part of the inverter/charger and testing of the design and so also the analysis of the result obtained.

Chapter four outlines the conclusion, remarks, recommendation and references.

CHAPTER TWO

2.0 SYSTEM DESIGN

To facilitate easier construction of the inverter/charge system. It is necessary to split complete system into simpler functional modules.

2.1.0 COMPONENT SELECTION

The major component employed in the design of the inverter/charge include the followings: Power MOSFET, MOS PLL 4046, Voltage regulator IC, Power Transformer, counters and a number of resistors, capacitors and diode.

2.1.1 VOLTAGE REGULATOR (78XX) SERIES

This series of three terminal regulator are available with several fixed output voltages making them useful in a wide range of appliances.

The voltages available allow these to be used in logic instrumentations. This series allows 1.5A load current to be supplied with adequate heat sink provided. Current limiting is included to limit the peak output current to a safe value. Safe area protection is included to limit internal power dissipation. If internal power dissipation becomes too high for the heat sink provided, the thermal shutdown circuit takes over, preventing the IC from over heating. Common output regulator voltages are 5,6,12,15 and 24 volts.

(For 04V 13.2 V is a good charging voltage)

2.1.2 POWER MOSFET

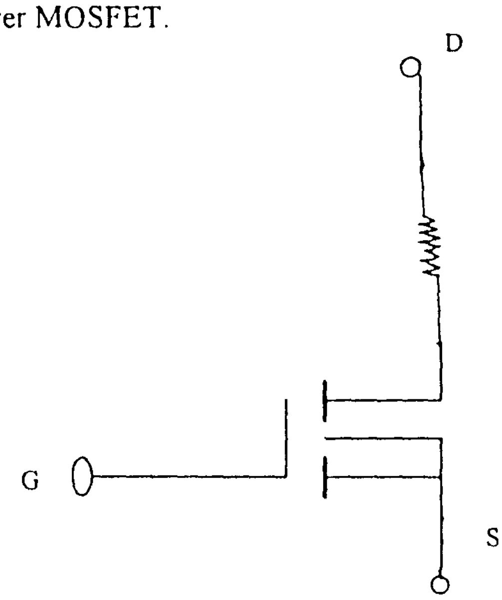
The inverter switching stage employ power MOSFET for switching purposes.

MOSFET is a majority carrier voltage controlled device i.e. a voltage of specified unit must be applied between gate and source terminals in order to produce a current flow in the drain. Fig. 2.11 shows the symbol of an N channel enhancement MOSFET switch. When the power MOSFET is used as a switch, the voltage drop between the drain and source terminal is proportional to the drain current, i.e. the power MOSFET is working in the constant resistance region and therefore it behaves essentially as a resistive element consequently the resistance of the power MOSFET is an important features of merit because of determines the power loss for a given drain current.

In effect, drain current starts to flow after a threshold gate voltage has been applied. Beyond the threshold voltage the relationship between the drain current and gate voltage is approximately equal.

In order to turn a MOSFET on a gate source voltage is needed to deliver sufficient current to charge the input capacitor in the desired time. The input capacitor is the sum of capacitors formed by the metal oxides gate structure, from gate to drain (CGD) and gate to source (CGS)

To turn off the MOSFET: Since it is a majority carrier semi conductor device it begins to turn off immediately upon the removal of conductance between drain and source, thus inhibiting any current flow Fig. 2.12 shows the terminal charaçteristics and load line of the power MOSFET.



N-CHANNEL MODE MOSFET SWITCH Fig. 2.11

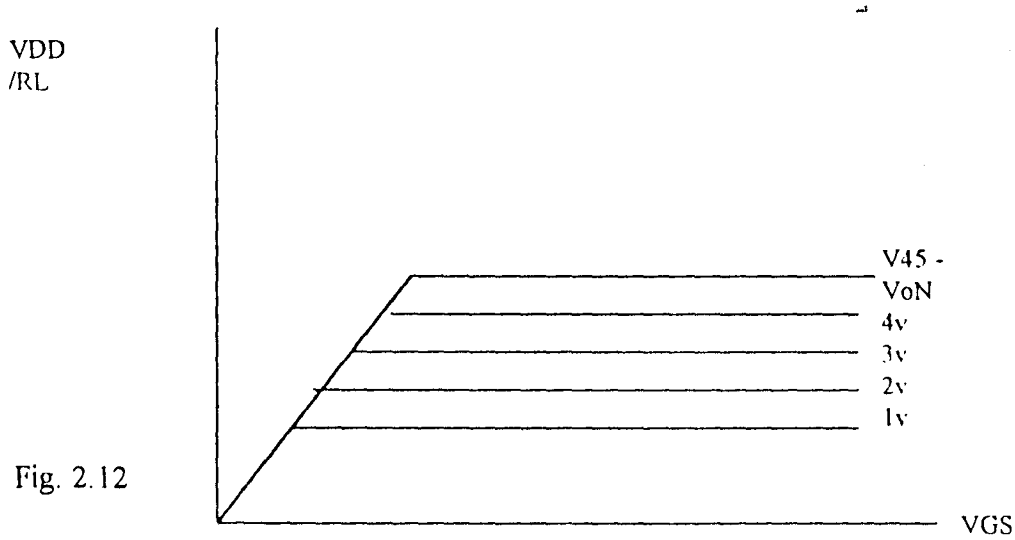


Fig. 2.12

2.1.3 DETAILED DESIGN PROCEDURE

The inverter/charger system comprises of two main parts:

(1) Battery charger module

(2) Inverter module

2.1.4 BATTERY CHARGER MODULE

The charger consists basically of a step down transformer whose output is rectified using a full wave bridge rectifier Fig 2.4 shows the circuit arrangement of a full wave bridge rectifier and its associated wave forms.

For a full wave rectifier

$$V_o = V_L = \frac{1}{\pi} \int^{\pi} V \sin wt \, d(dt)$$

$V_L = 2\ V_{sm}$

Where

V_L is the load voltage

Vsm is the maximum value of secondary volt.

$V_L = 16.5V$

$V_{sm} = V_L \sqrt{2}$

$V_{sm} = 16.5 \times \sqrt{2}$

$= 23.3V$

The output of the rectifier is filtered by 3360μF, 35V capacitor fed into a 12 volts regulator. This produced a constant output voltage of 15V. The 317IC was used as the fixed voltage rectifier.

The 317 has a maximum rating of 1.5A and it has to be mounted on heat sink to dissipate its maximum rated current. The output from the LM317 is also filtered with a 10μF capacitor.

A TIP41A transistor connected in the emitter follower mode is used to increase charging current by a voltage of 0.6V which is dropped across the base and emitter junction of the transistor. A 20Ω 10W resistor was also used as a charging resistor. A power diode is used to block the reverse bias current.

A battery voltage indicator consisting of LED which operates with the principle of comparing the battery voltage with a reference voltage of 12V., 10.5V 9V, 8V.

The charging resistance is needed in order to:-

(1) Drop excess voltage between battery level and charger voltage.

(2) To protect charger semiconductors and battery itself

CALCULATIONS

Choosing Assuming total reference resistance value = 10 K Ω Total output voltage of charger = 12.8V Scaling for 12V indicator

$\frac{12}{12.8} \times 100 = 93.75\%$ of total resistance

$\frac{93.2}{100} \times 10k\Omega = 9.32k\Omega$

$= 10k\Omega - 9.32\ k\Omega = 0.68\ k\Omega$

Scaling for 11v indicator

$\frac{11}{12.8} \times 100 = 85.9\%$ of total resistance

$\frac{85.9}{100} \times 10k\Omega = 8.59k\Omega$

$= 10k\Omega - 8.59 = 1.41k\Omega$

$= 1.41 - 0.68k\Omega = 0.73k\Omega$

Scaling for 10v indicator

$\frac{10}{12.8} \times 100 = 78.1\ \%$ of total resistance

$\frac{78.1}{} \times 10k\Omega$

100 = 10kΩ - 7.8 kΩ = 2.2 – 1.41 = 0.78kΩ

scaling for 9v indicator

$$\frac{9}{12.8} \times 100 = 70.3\% \text{ of total resistance}$$

$$\frac{70.3}{100} \times 10k\Omega = 10k\Omega - 7.03k\Omega = 2.97 - 2.2 = 0.77k\Omega$$

Therefore, ground resistor = 10kΩ - (0.68 + 0.73 + 0.78 + 0.77) kΩ

10 – 2.96 = 7.04 kΩ

2.1.5 OPERATIONAL AMPLIFIER ASTABLE MULTIVIBRATOR

In its basic form this circuit requires only an op – amp, three resistors and a capacitor. However, the approach employed in this circuit is representatively oscillators utilizing the timing circuits and components that change state (for example, comparators) at certain critical levels.

Astable multivibrator has no stable states. Consequently, it continually changes back and forth between two states at a predictable rate the figure (2.13) below shows astable multivibrator implemented with an operational amplifier with biasing resistors.

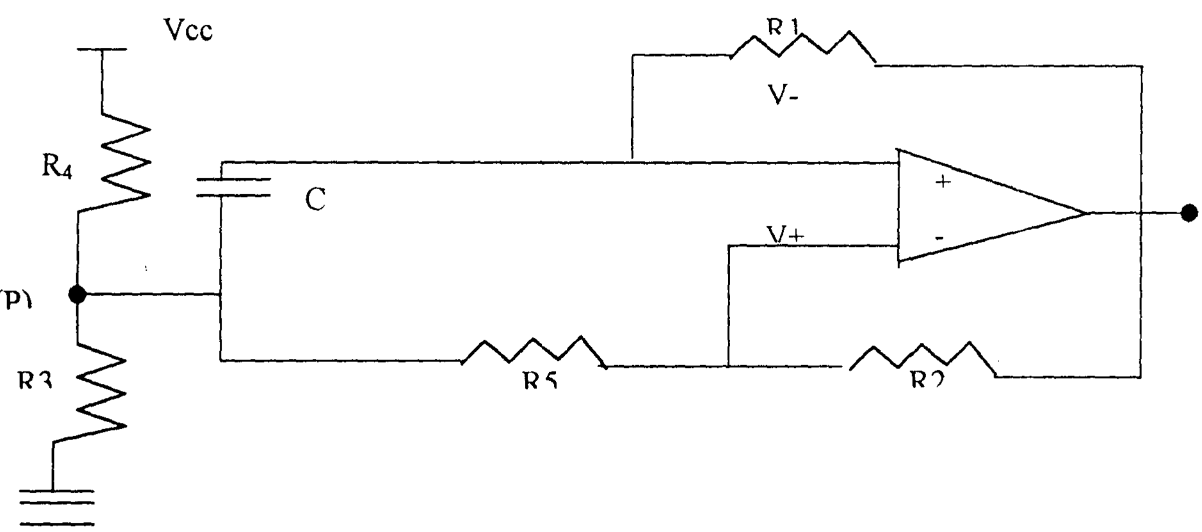


Fig 2.13

CALCULATIONS

From the figure above

$V^+ = V^-$ (1)

But

$$\frac{V_0 - V_1^-}{R_1} = \frac{V^- - (V_p)}{1/JWC}$$

$V(p) = 0$, $jwc = Sc$

$$\frac{V0 - V-}{R_1} = SCV^-$$

$V0 - V^- = ScV^-R_1$

$V0 = SCV^-R_1 + Vp$

$V_0^- = V^- (SCR_1 + 1)$

$$V- = \frac{V_0}{5CR_1 + 1} \quad ---- \quad ----- (2)$$

$$\frac{V0 - V+}{R2} \qquad \frac{V+ - V(p)}{R5}$$ at the non inverting input

Since V (p) = 0

$$\frac{V_0 - V^+}{R_2} \qquad \frac{V^+}{R_5}$$

$V+ R_2 = V0\ R_5 - VR_5$

$V+ (R_2 + R_5) = V_0R_5$

$$V+ = \frac{V_0R_5}{R_2 + R_5} \quad -- \quad -- \quad -- (3)$$

Putting equation (2) and (3) in (1)

$$\frac{V_0\,R_5}{R_2 + R_5} = \frac{V_O}{SCR_1 + 1}$$

$V_0R_5\ SCR_1 + V_0R_5 = V_0R_2 + V_0R_5$

$R_5\ SCR_1 + R_5 = R_2 + R_5$

$$S = \frac{R_2}{R_1\,R_5} = JW$$

$S = Jw = 2\pi f = 1/R_1C$

For F = 50HZ

$Jw = 2\ \pi\ 50 = 1/R_1C$

$= 100\pi = 1/R_1C$

Setting C =0.47μ f (polyester to charge in both direction)

$$R_1 = \frac{1}{100\pi \times 0.47 \times 10^{-6}}$$

$= 6.77k\Omega$

Scaling approaching

$R_1 = 6.8K + 470\Omega + 13\Omega$ (in series)

For 60 HZ

$$R_1 = \frac{1}{120\pi \times 0.47 \times 10^{-6}}$$

$= 5.643\ k\Omega$

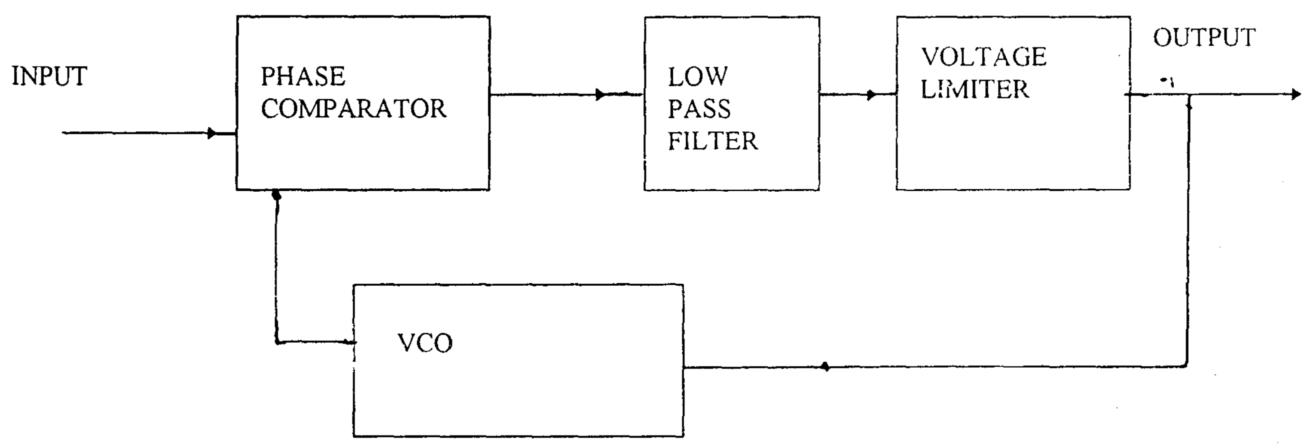
$= 5.65k\Omega$

Approximating scaling $=5.65k\Omega$

PHASE LOCKED LOOP

A phase - locked loop is a closed loop feed back circuit in which a generated signal established a synchronization on "lock" with an input signal depending on the circuit configuration and the manner in which the input and output are connected, phase-locked loops may be used in FM detection, frequency multiplication and division, tracking, establishing a noise free reference in the presence of noise.

it has a capture range which is the range of frequencies about the centre frequency at which the PLL can initially establish sychronizationand lock range which is the range or frequencies about the centre frequency at which the PLL can hold lock, once it is initialy established.The phase lock loops includes, voltage controlled oscillator VCO, phase detector, and low pass filter. The architecture of a phase locked look is shown below in Fig. 2.14



ARCHITECTURE OF PHASE LOCKED LOOK Fig 2.14

PHASE-LOCKED LOOP AS A FREQUENCY MULTIPLIER

The operation of the PLL as a frequency multiplier is illustrated in Fig.... The circuit contain a divide by 32 counter in the feedback path wither the loop. The output of the circuit is the VCO output, and no look filter is assumed for the illustration. It is also assumed that all or a portion of the look contains digital signal and components, since the frequency division circuit are most easily implemtned with such techniques.

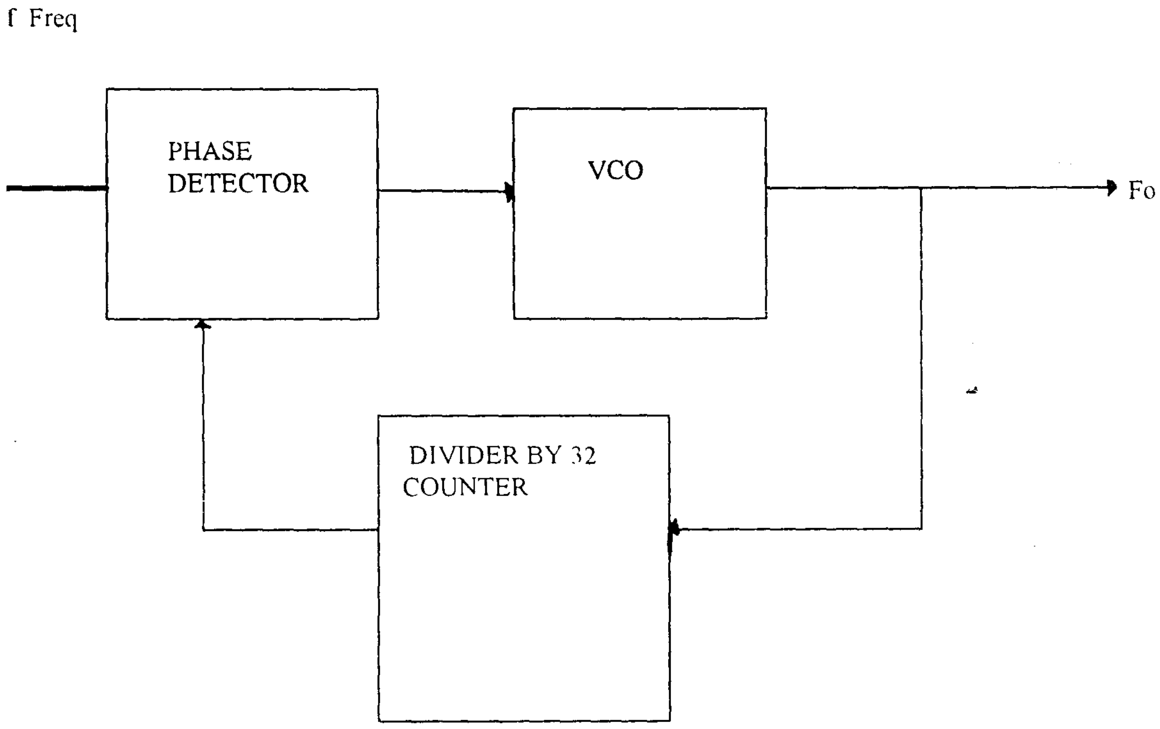


Fig. 2.15

Since reference frequency is 50Hz,

Therefore,

Output frequency is

50 X 32 = 1600Hz or 1.6khz

A divide by 32 counter is used since

reference frequency is < 9 or >21

Output frequency

For pulse with modulation

The phase-locked loop employed in this project is the CMOS 4046.

INTEGRATOR CIRCUIT

This circuit perform mathematical processes of integration. These operation arises frequently in signal-processing functions. Both differentiation and integration change the shapes of waveforms i.e. square wave to triangular, rectangular to saw tooth) involved in accordance with the associated mathematical operation. The diagram shown below in Fig. 2.16 shows an a c integration.

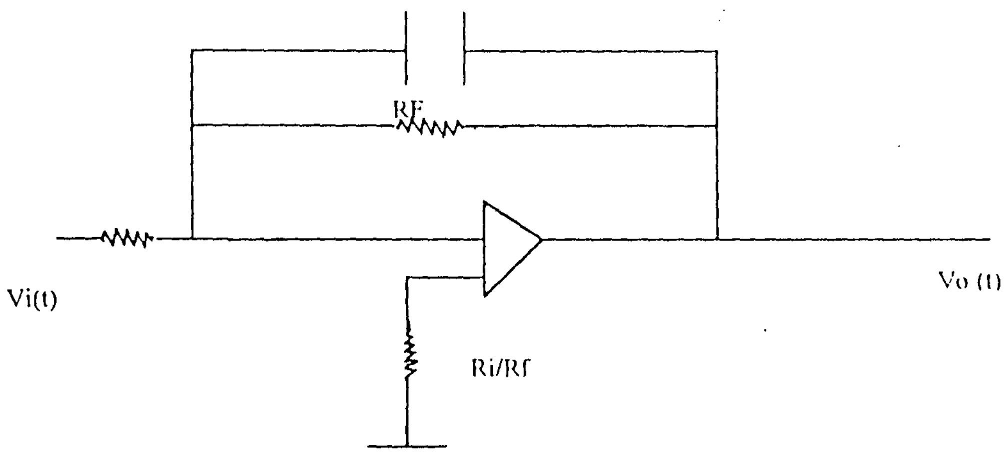


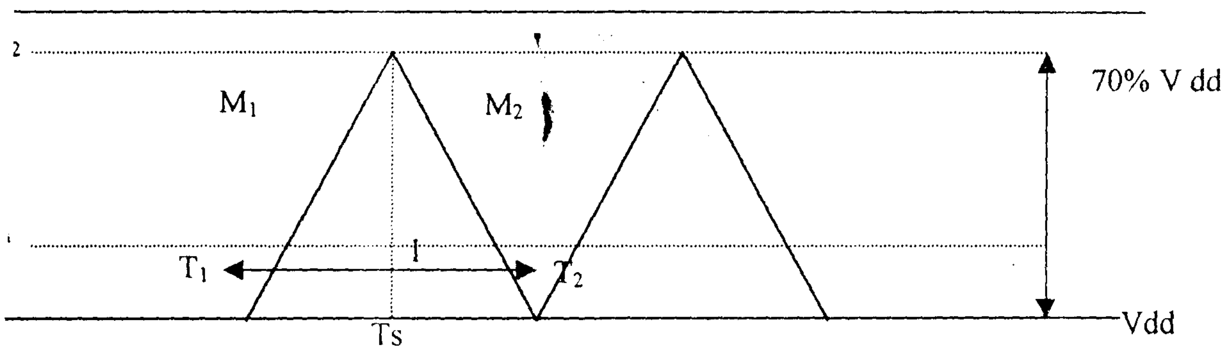
Fig. 2.16

Due to d.c. effect voltage and bias current which gives linear increase of decrease in lamp voltage which affects the output of an integrator without resistor RF (i.e. Time integrator) to slowly move toward saturation even with no signal present.

The introduction of RF will drop the gain at d.c. the input resistance is denoted as R1. Since a capacitor is an open circuit at d.c., the circuit reduces to a simple interting amplifier with gain - Rf/Ri at d.c. However, as the frequency increases, the magnitude of the capacitive reactance decreases and more of the signal current is shunted through the capacitor.

CALCULATIONS

For a triangular waveform as shown below in Fig. 2.17



Since

$$V0(t) = 1/RC \int Vi\, t + V0(t)$$

Therefore,

$$V0(t) = \frac{-Vi\,t}{R_T C_T} \times \frac{Vdd\,R_2}{(R_1 + R_2) R_T C_T} + k + \frac{Vddd\,R_2}{R_1 + R_2}$$

Where
RT = Total resistance
CT = Total capacitance

Gradient M_1 =

$$M_1 = \frac{-Vi}{R_T C_T} + \frac{Vdd\,R_2}{R_1 + R_2 R_T C_T} \quad \text{-------- (1)}$$

But for M_1 to be positive

Vi = O for equation (1)

$$M = \frac{VddR_2}{(R_1 + R_2) R_T C_T} \quad \text{-- -- -- --} \quad (2)$$

But for M_2 to be negative

- Vi >o (ie Vdd)

$$M_2 = \frac{-Vdd}{R_T C_T} + \frac{VddR_2}{(R_1 + R_2) R_T C_T} \quad \text{------ (3)}$$

Since $M_1 = -M_2$ from the wave form above

Equating (2) and (3) yields

$$\frac{R_2}{R_1 + R_2} = 1 - \frac{R_2}{R_1 + 2}$$

$$\frac{2R_2}{R_1 + R_2} = 1$$

$2R_2 = R_1 + R_2$
Therefore $R_1 = R_2 = 10k\ \Omega$ (each)

Thus, scaling R_1 and R_2 for $10k\Omega$ each

R_1 and R_2 are biasing resistors

Solving for R_T and C_T

Since $M_F = 32$

Thus, If Fo = $50H_Z$

Then fs = $1000H_Z$

T = 6,25 x164 = 62.5msec.

T = T/2 = 312.25m sec.

For safety and to accommodate different battery voltages

$(V_2) - (V_1) < V_{dd}$ i.e (voltage supply)

Let

$(V_2) - (C_1) = 70\% V_{dd}$

$V_2 = V_{dd} - 15\%\ V_{dd}$

$V_1 = O + 15\%\ V_{dd}$

$V_2 = 10.2V$

$V_1 = 1.8V$

When $V_2 = 10.2V$ t = 31.2m sec

When $V_1 = 1.8V$ t = O sec.

$$\text{Gradient} = \frac{10.2 - 1.8}{31.2x10^{-3} - 0}$$

as $M_1 = M_2$

$M_1 = 269.23$ V/sec

$M_2 = -269.23$ m V/sec

From Equation (2)

$$M_1 = \frac{V_{dd} R_2}{(R_1 + R_2) R_T C_T}$$

$$269.23 = \frac{12 R_2}{(2R_2) R_T C_T}$$

From Equation (3)

$$M_2 = -\frac{V_{dd}}{R_T C_T} + \frac{V_{dd} R2}{(R_1 + R_2) R_T C_T}$$

$$-269.23 = \frac{-12}{R_T C_T} + \frac{12 R_2}{(2R_2) \; R_T C_T}$$

From Equation (4)

$$269.23 \, R_T C_T = 6$$

$$R_T = 0.022 C_T \text{ ---------- } (6)$$

From Equation (5)

$$-269.23 = \frac{--12}{R_T C_T} + \frac{6}{R_T C_T}$$

$$-269.23 = \frac{-6}{R_T C_T} \text{ -------- } (7)$$

Putting equation (6) in (7)

$$-\ 269.23 = \frac{-6}{0.022 C^2_T}$$

$$-269.23 = -269.23 \, C^2_T$$

$$C^2_T = \frac{(-269.23)}{(-269.23)}$$

$$= 1$$

$$C_T = \sqrt{1}$$

$RT = 0.022CT$

$= 0.022 \times 1$

$= 22 \times 10^{-3}\Omega$

$RT = 22m\Omega$

POWER TRANSFORMER

A transformer is a state or stationary piece of apparatus by means of which electric power in one circuit is transformed into electric power of the same frequency in another circuit. The voltage can be raised or lowered but with a considerable drop in current.

The transformer comprises of two windings.

The primary and secondary windings.

The transformer used for the inverter/change is a step up transformer

If Volt/turns ratio = 0.284

Then $\frac{220}{N_p} = 0.284$

$N_p = 774.6$

$N_p = 775$

$X = 775$

Thus feed back ratio

Taking 12V out of 220V loading

$\frac{N_f}{N_s} = \frac{12}{220} = 0.0545$

Number of turns for feedback

$N_f = 0.0545 \times 775$

$= 43$ turns

For the secondary winding

$$\frac{18 \times 775}{200} = 63 \text{ turns}$$

$$\frac{N_s}{N_p} = \frac{63}{775}$$

Where

N_s = Number of turns in the secondary

N_p = Number of turns in the primary

To calculate for area of core used

Volt /turn

$\sqrt{KVA/Phase} = K_cFB_m \times 4$

Substituting in the value

B_m = maximum flux density in the core = IT

$K_c = 4.44$

Kva /phase = 1K watt

f = 50Hz

Volt /turns = 0.284

$$\text{Area} = \frac{0.284}{4.44 \times 1 \times \sqrt{1000} \times 50} = \frac{0.284}{7020.24}$$

$$= 0.001279$$

$$\therefore \text{Area} = 12.79 \text{ cm}^3$$

Area of core is proportional to the square of stacking length

$A \text{ core} = (cl)^2$

C = core constant = 0.45

$$L = \frac{\sqrt{Area}}{\sqrt{C}}$$

$$L = \frac{\sqrt{0.001279}}{\sqrt{0.0533m}}$$

$L = 5.33cm$

Number of lamination used,

$$= \frac{Length}{Lamination\ thickness}$$

$$= \frac{0.0533}{0.5 \times 10^{-3}}$$

= 106.64 laminations = 107 laminations

.. Number of laminator = 107

$V_1 I_1 = V_2 I_2$

Let $V_p I_p = VsIs$ If efficiency is 98%

Power out = 98%

using P.F.1 Cos 0 = 1

$V_s I_s = \frac{98}{100} VpIp$ ..... (1)

But $V_s I_s = 1000$

$1000 = 0.98 \times 24 \times Ip$

$I_p = \frac{1000}{0.98 \times 24} = 42.5A$

$I_s = \frac{1000}{220} = 4.545A$

For the guage of wire used

Output is 1000 watts

Power factor (PF) is unity at output

Choosing maximum current density (J) = 10 Amp/mm^2

Cross sectional area of coil is mm^2

Maximum Area of copper required (mm) mm^2

$= \frac{I_p}{J_{max}} = \frac{42.5}{10} = 4.25mm^2$ (for the input)

Minimum Area of copper required

$= \frac{I_s}{\sqrt{max}} = \frac{4.85}{10} = 0.485mm^2$ = for the output)

SWG 6

From the conversion table,

0.485mm^2 is approximately SWG 25

4.25mm is approximately

CHAPTER THREE

3.0 CONSTRUCTION AND TESTING

3.1 CONSTRUCTION PROCEDURE

The process involved in construction include pre-construction and bread board and then transfered on veroboard after necessary modification is completed on the prototype if needed.

According to the circuit diagram, the battery change module was first connected and the output voltage was measured. The circuit was then transferred onto the veroboard.

The inverter module was also connected on the bread-board and the output waveform oscillator and frequency multiplier is observed on the oscilloscope befor eit is transffered on to the veroboard.

The holes for transformer, battery level LEDS and other necessary preperation were made on the pre-fabricated casing. A strong case was necessary for this because of the heavy component of the inventer/changer.

The MOSFET were than mounted on an aluminium heat sink and screwed down. The connecting wires were then connected to the various points as it is in the circuit diagram. The heat sink was necessary because of the heat dissipated by the power MOSFET. The component were finally assembled together in the casing.

3.2 WINDING OF THE POWER TRANSFORMER

The shell type magnetic care was chosen. The core is made from steel lamination which have desirable property of availability, low cost low core loss, high permability and flux density.

A concentric type of winding was used in which the conductor was first wound on the plastic former and insulation was being made after each longer till the desired number of turns were obtained.

The leads were brought out after each round of desired number of turns were reached. The secondary winding were wound on top of the primary care winding. This too was done for each desired number of turns for each voltage.

Lamination were then arranged through the central hle using the C and I parts until the construction was completed. The core was laminated to reduce vibration and hence excessive noise varnish was then used to reinforce the insulation of the winding conductor to prevent contact of copper wire on iron lamination and for separation of various layer of copper windings, and insultion of any joints in the winding.

3.3 TESTING

Having ensured that all the necessary connection were fully made, the inverter/charge was connected to two 12V 60Ah car battery that is connected serially. The output voltage was then measured. Various load were applied to the output of the inverter units. Their respective power consumption over a period of time.

3.4 RESULT

Since, the inverter was powered by a bank of batteries it was necessary to consider the power consumption rate from the battery. The Tab 3.1 shows the power consumed by some appliances over a period of time.

RECOMMENDATION

The future improvement, I would recommend that the charger unit must be designed to be able to deliver up to 1000 amp or more as charging current so that large battery banks can be quickly chaged. Deep cycle battery which have relatively thick lead plates alloyed with aantomony or calcium to make them harder as better suited to deep discharge and use for inverters than engine starting batteries.

Engine starting batteries use a high number of very thin plates features like low battery shut down which prevent overcharging.

The inverter/charger cna be made to be completely independent of NEPA by attaching solar panel to make a complete installation.

REFERENCES

(1) HAROWITZ AND HILL W, 1997, THE ART OF ELECTRONICS., CAMBRIDGE UNIVERSITY PRESS, P. P. 180, 181, 182.

(2) MITCHEL F. H. 1998 INTRODUCTION TO ELECTRONICS DESIGN, PRENTICE HILL, P.87.

(3) RESHIP M. H. 1986, POWER ELECTRONICS CIRCUIT, DEVICES AND APPLICATION, LONGMAN P. 101.

(4) THERAJA B. L. AND THERAJA A. K. 1994 ELECTRICAL TECHNOLOGY, SC & COMPANY PP. 1024, 1189.