DESIGN AND CONSTRUCTION OF 500WATT UNINTERUPTIBLE POWER SUPPLY (UPS)

BY

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96/5153EE

OF

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SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, NIGERIA.

FEBRUARY, 2002

DECLARATION

I hereby declare that this project is the result of my own handwork and research, which has never been presented anywhere by anybody. It was conducted under the supervision of MR. JONATHAN G. KOLO, in the Department of Electrical and Computer Engineering of Federal University of Technology, Minna-Niger State.

..... 6-3-2002

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CERTIFICATION

This is to certify that this project titled "Un-interruptible Power Supply (UPS)" was carried out by GANA SAMUEL PETER under the supervision of MR. JONATHAN G. KOLO and submitted to Electrical and Computer Engineering Department, Federal University of Technology, Minna in partial fulfillment of the requirements for the award of Bachelor of Engineering (B. Eng.) Degree in Electrical and Computer Engineering.

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Sign and Date

Dr. Y.A. ADEDIRAN
Head of Department

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Sign and Date

Dr. T. A. AKINBULIRE
External Examiner

.....
Sign and Date

DEDICATION

This work is dedicated to my creator, Lord and Personal Saviour, Jesus Christ, to my indispensable parents, Mr. & Mrs. Samuel Gana, to my beloved sister Mrs. Lade Umaru and Miss Elizabeth N. Daniel.

ACKNOWLEDGMENT

To God be the glory, great thing he has done, he gave the breath that kept me alive. He gave the wisdom, knowledge and understanding that proved me worthy of university education, to him be honour, power and majesty forever and ever. Amen.

I am indebted to my parents, Mr. Zacheas B. Gana and Mrs. Rhoda Nnasha Gana for their tireless support, encouragement and prayers and provision throughout my academic pursuit. I want you to know that I'm the fertile seed that you have planted and out of me the God of Heaven in whom I live shall cause you to reap in hundred folds.

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TABLE OF CONTENT

CHAPTER TWO:- SYSTEM DESIGN

CHAPTER THREE CONSTRUCTION, TESTING AND RESULT

CHAPTER FOUR

ABSTRACT

Certain types of electrical equipment such as computer and communication devices are very critical when it comes to the quality of their power supply. Harmful influences like voltage fluctuations, vastation in frequencies, electrical surges and power outage can be ver disturbing.

Hence the needs for a UPS cannot be over-emphasised, the UPS must provide AC output such that means of failure is undetected by the load. This project highlights the design and construction of an uninterruptible power supply.

This made possibly by use of high current semiconductor FET (BIPOLAR) switches that convert AC voltage to an equipment by changing over to an inverted backup D.C voltage in the event of mains failure or other irregularities in the mains supply.

During the process of the circuit designed for the UPS, various factor such as change over speed, power quality and efficiency were amongst the various components employed. The pulse obtained from 555 timers IC in which the output signal is divided into two by the help of J.k. Flip-flop. This two signal were used to drive the switching circuit in the inverter unit.

The (UPS) units was designed to convert a 12 v d.c 30a max supply to feed a 500watts 240 vac load at 50Hz.

CHAPTER ONE

1.10 GENERAL INTRODUCTION

When electric power is generate, it is both clean and stable, but during transmission and distribution, it is subjected to a variety of harmful influences like electrical storms, noise, large variations in loads and accident resulting in blackouts, over voltages, under voltage and voltage spills. All these power supply disturbances may cause some of the sensitive equipment to strip out. The supply problems can be overcome by connecting an uninterrupted power supply (UPS) between AC input power supply and sensitive load equipment, where it will not only clean up any supply aberrations, but will also maintain the critical load during a complete outage.

Uninterruptible power supply provides both power conditioning and back ups. Basically, UPS consist of battery charge, the inverter, and filter and battery bank. The filter and charger convert the AC power source to DC. The battery bank is the source of DC supply to the inverter, when there is main power outage or failure it will be converted to AC to feed the load through static by – pass switch.

This project is reducing size and weight, because of the use of power BIPOLAR transistor with high – frequency pulse – modulation.

Uninterrupted power supply is used to supply computer, industry and air traffic control system where power failure can cause damages to the loads. UPS systems achieve this by rectifying the standard mains supply, using the direct current to

charge the stand by battery and to produce "clean" alternating current by passing through an inverter and filter system.

1.1.2 AIMS AND OBJECTIVES

The uninterrupted power supply is designed to have output of 500VA that can carry a maximum load of 500 watts with a voltage output of 220 volts for duration of one (1) hour maximum.

1.20 BASIC STRUCTURE OF UPS

The uninterruptible power supply is made up of inverter, charging unit, filter, overloading protection, low battery detector and charge over switch.

1.2.1 BATTERY CHARGER

A battery charger is an electrical device that is used for putting energy into a battery. The battery charger changes the AC from the power line into DC suitable for charger. The charging unit also includes rectifier, which can be full, or half wave.

1.2.2 INVERTER

An inverter is a device that changes d.c power into a.c power (just the opposite of converter). Thus providing precisely regulated output voltage and frequency to the load when there is power outage.

1.2.3 FILTER UNIT

The output of inverter from transformer is a square – wave known to sine-wave super imposed on several harmonics, it is the filter unit that will filter the transformer output signal to prevent damages to inductive loads.

1.2.4 CHANGE OVER SWITCH

Relay is use in this unit, which acts as by-pass switch by connecting the loads to the inverter the type of relay used in this project is electro magnetic.

1.2.5 OVER LOADING PROTECTION

The overloading protection is made up of fuse to protect the system from overloading. The fuse is perhaps the cheapest simplest form of protection and is used to protect low voltage equipment against overloads and short circuit. The maximum value of current that fuse will conduct without melting in this project is 2 amps, which is known as the fuse current rating.

1.3.0 TYPES OF UPS

UPS can be classified into the following categories depending on the way it was design to operate. Each of the categories has it's own advantages and disadvantages.

1.3.1 DUAL TRACK UPS

This is a system that contains a stable by – pass a alternative power path. The native power path is switched on when the inverter is faulty. The advantage of this dual track is that when the inverter fails and raw power present, there is still supply to the load.

The disadvantage of this system is that there is always a delay of microsecond in the switching over from inverter to main supply see fig 1.1 for dual tracks diagram.

.2 SINGLE TRACT UPS

The single tracks UPS is a system in which the inverter is always at work henever the system is under operation. It is a two block system which features a ctified power applied to the battery and simultaneously been sent to the inverter r AC conversion. No switching take, thus no system disruption. More so the ttery must keep charged at the rate equal to the rate at which power is consumed.

The load is protected from raw AC detrimental influence. The disadvantage f this single charge will lead to complete breakdown of the system. Also this type f UPS is bulky, this is due to the large transformer that will be used at both the harger and output

.3.3 DOUBLE CONVERSION UPS

The double conversation UPS has a large charger and inverter. It is basically a different form of single – track system.

The charger converts the raw AC line to DC and sends it to the inverter and the inverter reconverted the DC to AC and supplies the loads through static by-pass switch.

The charger is large enough so it charges up a stand by battery. On detecting a mains failure, the static by pass switch needs the inverter from the battery and power supply to the load is recorded uninterrupted.

The disadvantages are that any fault with the inverter leads to the failure of the whole system. See the block diagram in fig 1.3

4 FORRORESONAT UPS

The forresonant UPS is made - up of small charger battery, an inverter and a roresonant.

The forroresonant transformer supply to the load when the main power is ailable.

The forro-create pure sine wave from the battery via inverter when main wer is in acceptable.

The main disadvantage is that it use forroresonant transformer, which has e unique characteristics of providing, the level of power protection needed in PS. It alternates spikes of high voltages and surges in the mains are absorbed by . It also stores electrical energy (fly wheel effect), which aids in filling micro reak up to 20 ms in duration. See the block diagram in fig 1.4.

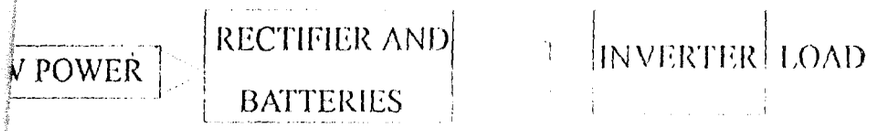


Fig 1.1 SINGLE TRACK UPS

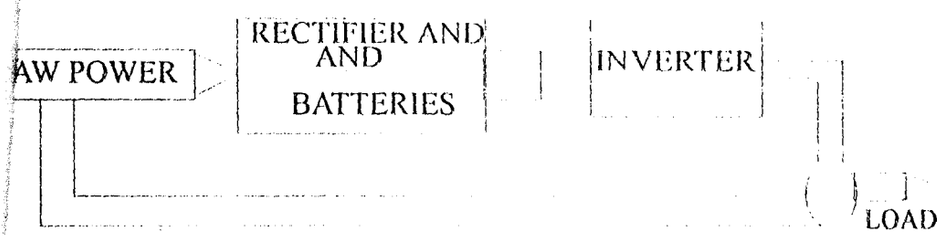


Fig 1.2 DUAL TRACK UPS

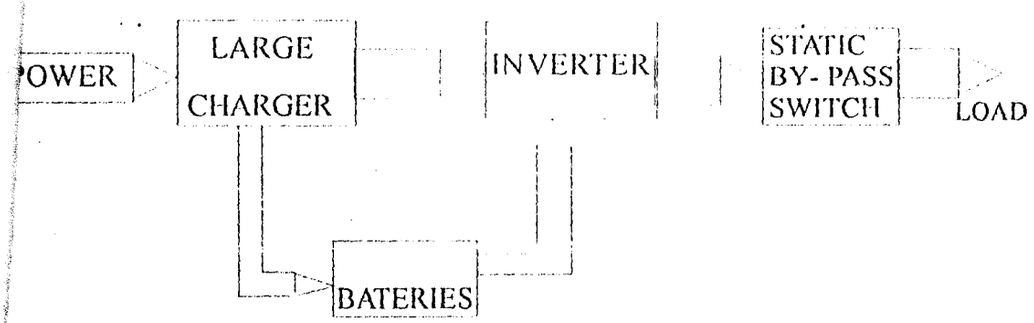


Fig 1.3 DOUBLE CONVERSION UPS

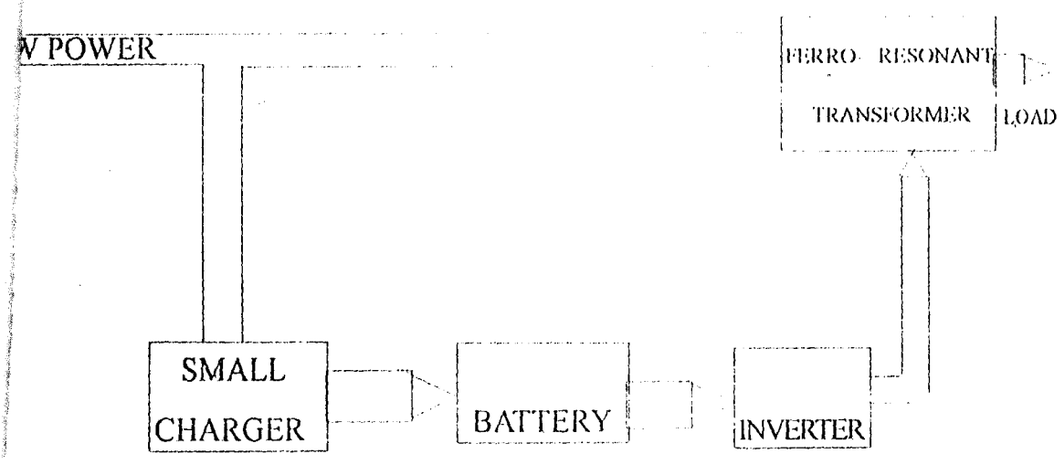


Fig 1.4 FERRO RESONANT UPS

1.4.0 METHODOLOGY AND THEORY OF DESIGN

1.4.1 RELAY:

A relay is a device used to control a large flow of current by means of a low voltage, low current circuit. It is a magnetic switch. A flash light cell is used to energize the electromagnet. This circuit is controlled by the switch. When the coil is magnetized, its attractive force pulls the lever arm called an ARMATURE towards the coil. The contact points on the armature will open or close depending upon the arrangement and control the larger high voltage circuits.

Relays are in varieties of forms and play important role in electrical engineering for example telecommunication and automatic control e.t.c

The internal diagram of a typical relay of electromagnetic material is shown in fig. 1.5 The relay has a coil of wire an iron core and an iron yoke which serves an easy path for flux, imparts the polarity of the rear end of the armature which is thus powerful attracted by the opposite polarity of the front and of the core.

1.4.2 TRANSFORMER

A transformer is a static (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. It can raise or lower the voltage in a circuit but with a corresponding decrease or increase in current. The physical basis of a transformer is mutual induction between two circuits linked by a common magnetic flux.

A transformer consists of two or more coils of wire wind round a common laminated iron core. A key advantage of transformer is that they can be used to increase or decrease voltage depending on the number of turns on the secondary

winding. On a secondary having less turn than primary voltage is decrease and in this case it is called steps down transformer. On a secondary having more turns than the primary voltage is increases. It is called step up transformer.

The principal components of transformer are:-

(1) **Core**:-This is laminated iron sheet, which is insulated to reduce iron loss

(2) **Winding**:- This is the number of turn of wire on the secondary and primary, the ratio depends on the application.

The following are important formula for transformer design.

(3) Transformer ratio

$$\frac{E_2}{E1} = \frac{N_2}{N1} = K$$

This constant K is known as voltage transformation ratio.

(i) If $N_2 > N_1$ i.e $K > 1$, them transformer is called setup transformer.

(ii) If $N_2 < N_1$ i.e $K < 1$, them transformer is called step down transformer

(4) Induce emf

$E=4.44\ FT\ \emptyset\ X\ 10\ E\text{-}8V$

$\emptyset = B \times A$

F=Frequency

T=Number of turns per winding

$\emptyset$=Flux

B=Flux density

A=Cross sectional area of the core.

(5) Primary equivalent resistance

$$R_1 + (T1/T2)^2 R_2$$

(6) Primary equivalent reactance

$$X=X_1 + (T1/T2)^2 X_2$$

1.4.3 FUSE

A fuse is a small piece of wire connected in between two terminals mounted on insulated base and is connected in series with the circuit. The use is perhaps the cheapest and simplest form of protection and is used or protecting low voltage equipments against overloading and short circuits.

The fuse is expressed to carry the normal working current safely without over heating and during overloads or short circuits it heated up to melting point rapidly. The materials used normally are tin, lead, sliver, zinc aluminum, copper etc.

1.4.4 LITERATURE REVIEW

Theoretical and experimental studies of electricity during the 18th and 19th century led to the development of the first electrical machines and the beginning of the wide spread used of electricity. The history of electronics began to evolve separately from that of electricity late in the 19th century with the identification of electronics by the English physicist J.J Thompson and the measurement of its electric charge by the American physicist R.A. Milkman in 1909.

With the breakdown in integrated circuit and semiconductor microprocessor chips haven been design and used as electronics components. The need for

constant electricity supply all around the world is in high demand. In this part of the world (Africa), often regular power failure is experienced and the need to shield or protect valuable information from the computer. This lead to the invention of UPS.

UPS provides a source of power or an electronic device in the event of power outage. It allows the users to the critical load to safely shut down their devices.

Though, the project have been work upon with ranges from 250 VA to 400VA. The scope of this project is to improve on the work done in terms of power out put to 500 VA, less failure rate, longer time of operation, trickle charging current efficiency etc.

1.4.5 PROJECT OUT LINE

The scope of this project is subdivided into four chapters. Chapter one of this project covers aims and objective of the project. It also contains the literature review, methodology, and various types of UPS available right from conception up till date and general introduction about the project.

Chapter two which includes the system design given vivid exposition of power supply, general concept of power supply and the conversion of DC to AC (Inverter Section) the battery charges circuit unit. This chapter also explains analysis of components used in design and principle of operation.

Chapter three deals with various stages undergone during the construction process, testing of the project work (system testing) and discussion of results.

Chapter four gives recommendation with respect to the result achieved and state possible future improvement of the project. It also include conclusion based on the result achieved during the project work.

2.5 ON – LINE AND OFF-LINE CONCEPT

UPS can be categories into on line and off-line concepts based on the mode of operation.

1.5.1 ON – LINE CONCEPT

The on line UPS is a system in which the inverter is always at work whenever the system is under operation whether the main power is on or off.

It takes in raw power AC input and converts it to Dc and the to AC via the inverter and supplies the load.

The load is essentially isolated from the raw power supply input the back up is provided by an internal battery, which is connected to the inverter of the UPS when the input power fails. The battery can maintain the fully rated load for ten minutes, but the period can be more than ten minutes if lighter load is connected.

The advantage of the design is that the load is constantly protected from direct mains Ac detrimental influence.

The disadvantage of On – Line design is that the components are over stressed since the inverter and charger are constantly at work whenever the system is use.

The block diagram is shown above in fig 15.

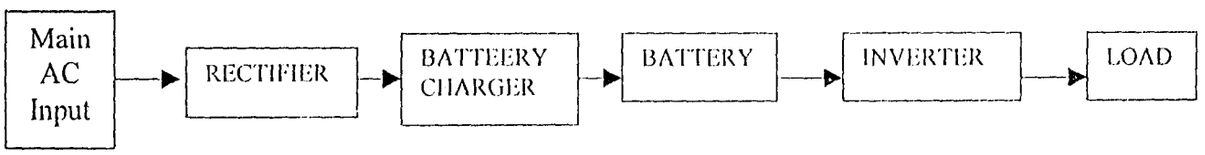


Fig 1.5

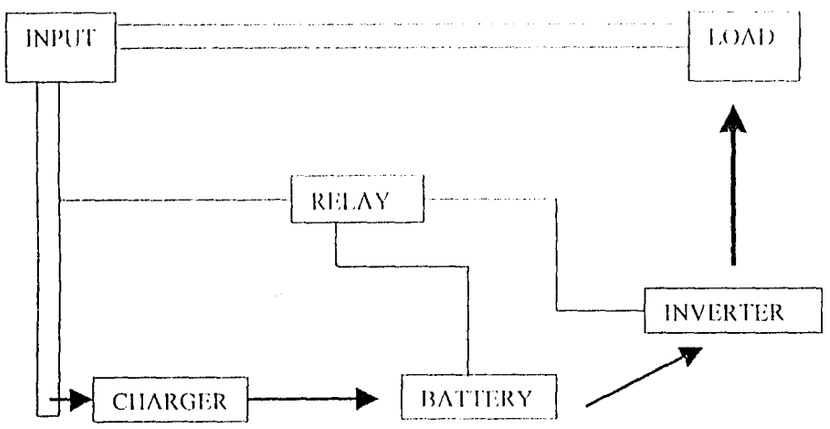
1.5.2 OFF - LINE CONCEPT

The off – line is a system in which during mains AC inputs power feeds the load directly via the filter and when the mains AC inputs fails the unit switches to inverter mode which convert DC from battery to AC and use it to feed the load. The off – line design is one use in the project.

When normal mains input supply is back, the UPS automatically starts up with aid of a relay switch and the battery starts charging up immediately for further use. The off line design has great advantages, over the on-line.

The advantage of this off-line concept is that it has the ability of supplying power to the load. Also the components is not over stressed as that of on –line is that raw mains supply with detrimental influences is supply to the loads, which can cause damages to the load.

The diagram is shown below – in fig 1.6



CHAPTER TWO

SYSTEM DESIGN

2.1 VOLTAGE REGULATOR

This is positive voltage regulator that maintaining a regular voltage at its output, the fixed voltage regulator has an unregulated DC input voltage applied to one unit terminal or regulated output DC voltage from a second terminal, with the third terminal connected to ground. This type of voltage regulator allows 1.5 fit load current if adequate heat sink is provide. The purposed of the heat sink is to absorbed heat generated due to the internal power dissipation's; current drawn by the power supply load may have a wide range of values. In addition, the temperature may change. These effects tend to change the output voltage. A regulator is normally connected between the filter and the load, designed to maintain a nearly constant out put voltage for anticipated various in the input voltage, the load current and temperature.

An important figure of merit is the voltage regulation. It is defined as the percentage change in the output voltage resulting from a specified change in either the input voltage or the load current.

2.13 DARLINGTON PAIR TRANSISTOR

It is the name given to a pair of similar transistors so connected that emitter of one is directly joined to the base of the other as shown in fig 2.1 (a) obviously, the emitter current of Q1 becomes the base current of Q2,

Darlington pairs are commercially mounted in a single package that has only these lead: base, collector and emitter as shown in fig 2. 1 (b). It often forms a

double CC stage in multistage amplifiers. It is so because a Darlington connection can be considered equivalent to two-cascade emitter follower.

MAIN CHARACTERISTIC

(i) Current gain

It can be proved that current gain of Darlington pair is $(1+\beta 1)+(1+\beta 2) = (1+\beta)^2 \simeq \beta^2$

If the transistors are identical

$$\beta_1 = \beta_2$$

Proof

$I\beta_2 = IE_1 = (1+\beta 1)\ I\beta_1 \sim \beta_1\ I\beta_1$

$IE_2 \sim \beta_2\ I\beta_2\ \beta 1\ \beta\ IB_1$

$$Ai = \frac{IE_2}{I_{\beta 1}} = \beta 1\ \beta_2 = \beta_2$$

It means that a Darlington pair behaves like a single transistor having a beta of β^2

ii. INPUT IMPEDANCE

In fig 2.1 (a). The input impedance seen from the base of Q2 is $ri.2 = \beta 2$ $(re.2 + RE) \simeq \beta_2 RE$

Input impedance as seen from the bases of Q_2 is $ri.1 = \beta 1\ (re.1 + ri.2) = \beta 1$ re. $1 + \beta 1$ ri.$2 = \beta 1$ re. $1 + \beta_2\ R_E \simeq \beta_1\ \beta_2\ R_E$ or r_{in} (base of Q1 $= \beta_2 RE$

NOTE: If there is a load resistance RL couples to the emitter of Q2, then

$ri.1 = \beta^2\ (RE\ //\ RL) = \beta^2 rE$

As seen, lod impedance RE has been transformed into β^2 RE. Obviously, a Darlington Pair is capable of high input impedance. In fact, whenever a load cause severe loss in voltage gain (loading effect), It is usual to step up load impedance via a FET stage, a single cc stage or Darlington Pair when much greater impedance transformation is required.

(ii) Voltage gain

$$A = \frac{RE}{Re + RE} \quad \left| \quad \right| \quad \left| \quad \right|$$

$$\left| \right| re$$

$$RE$$

Advantages of Darlington Pair

1. It has normous impedance transformation capability i.e. it can transform a low-impedance load into a high impedance load. Hence, it is used in a high-gain operational amplifier which depends on very high input inpendance for its operation as an integrator:
2. It uses very few component
3. It provides very high B-value.

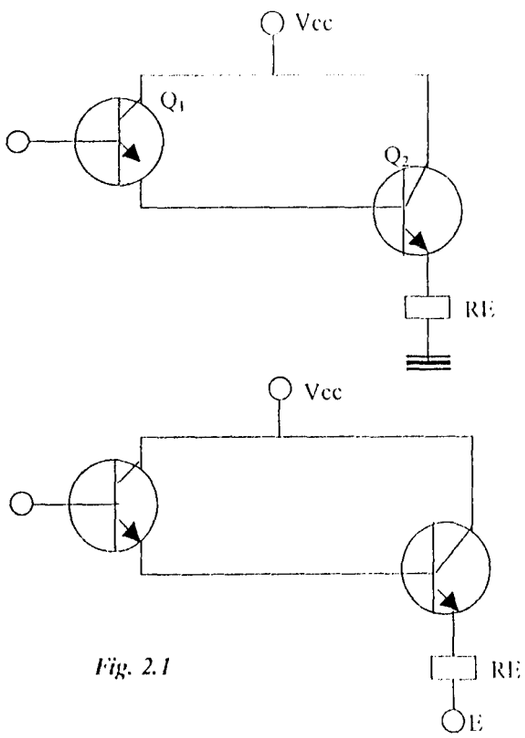


Fig. 2.1

2.1.4 TLC 555 TIMER

As the name implies, TLC 555 timer arce use as a timer in various electronic instruments. TLC 555 timer fabricated through complementary meta-oxide semiconductor (CMOS) process. It is capable of producing accurate time delay and oscillation due to its high input impedance.

TLC 555 timer can be used as monostable or bistable in any circuit depends on the ways the resistor and capacitors are connected to it. It can be monostable one resistor and one capacitor whole astable more than two resistor and capacitor.

The CMOS process allows the TLC 555 operated at the frequently up to 2 MHZ. It also consume very low power typically 1MW at VCC = 5v over a wide range of supply voltage ranging from 2vRE 18v. this is how the output pulse is been generated TLC 555 timer.

2.1.5 CONTROL SIGNAL GENERATION

The driver switching signal was generated using TLC 555 timer as an astable mutivibrator.

At the time interval when the capacitor C charges from 1/3vcc the output is high, the time interval is given by.

T high = 0.695 (RA + RB) C

The output is low when capacitor discharges from 2/3vcc and the time interval is given by T low = 0.695 RB. C

Therefore, the oscillation period 'T' is given by

T = T high + T low

= 0.695 (RA = RB) C + 0.695 RB C

The frequency of the oscillation F is given by F = 1/T

$$\frac{1.44}{(RA + 2RB)\,C}$$

To obtain the frequency of 100 HZ at output, the flip – flop divided by two (2) help us to divided the frequency by 2 to obtain 50 HZ at the first half cycle, equal to second half cycle.

The value of the RA is chosen to be 1K while RB the value is chosen to 14kohm. The capacitance of the capacitor C are as follows:-

$$F = \frac{1.44}{(RA + 2R_B)\,C}$$

$$50 = \frac{1.44}{(1,000 + 2 \times 14,00)\,C}$$

$$50 = \frac{1.44}{29,000\,c}$$

$$C = \frac{1.44}{50 \times 29,000}$$

$$C = \frac{1.44}{145,000}$$

C = 0.000000993F

C = 0.993 μF

2.1.6 INVERTER SWITCHING

This is important part of inverter where the battery D.C voltage is being chopped to obtain AC equivalent voltage. To accomplish, this the use of flip – flops is employed. The flip – flops has two output also clock, the two input signal are J, K and also two output are Q, $\overline{Q}$. The source is connected to the Darlington Pair – transistor where the emitter of one is directly joined to the other. To obtain balance circuit the source have been return to ground and via is connected to the center tap of the primary transformer.

Since the two deferent pulses generated are alternating, it means that when Q is ON $\overline{Q}$ is OFF the Q pulls the battery potential connected to the transformer center – tap to earth, resulting in an upward swing. As soon as the first pulse goes to zero the second pulse goes high triggering on $\overline{Q}$ and turn off Q. $\overline{Q}$ is also pull the battery voltage down to earth to obtain a second downward swing. This two swing on getting to the transformer are coupled together to obtain a square wave whose peak to peak voltage is twice the battery's potential.

2.1.7 PUSH AND PULL SWITCH

Push and pull switch is use to switch ON and OFF the circuit. If it is push i.e. ON the cct will start working, but if it is pull i.e. off the circuit will stop working but the battery will continue charging, it doesn't affect the charging of the battery.

2.2.0 TRANSFORMER DESIGN

The transformer is responsible for coupling the swings for the switching transistor together to get a low voltage AC at the transformer. It also steps the low voltage up to 230v at the transformer secondary. The size and the coil gang of the transformer suggest its power handling capability.

In this project, the transformer is designed to power load of 500VA successfully.

Battery voltage = 12v

Peak to peak value at the primary coil is 24v

Vrms = 0.707 x 24 = 16.68v

At the secondary winding

= 500/240 = 2.08A

Thus, the wire gauge that can stand this current from magnetic wire specifications ANG of. This gauge will support maximum current of 2.08A

Therefore, gauge ANG 17 was used on secondary winding.

E2 = 220v, E1 = 16v

Number of turn per volt = 8 turn/volt

$$\frac{N2}{N1} = \frac{E2}{E1} = \frac{I_1}{I_2}$$

Where N1 = Primary turns

N2 = Secondary turns

E2 = Secondary voltage

E1 = Primary voltage

I2 = Secondary current

I1 = Primary current.

2.2.1 CALCULATION OF POWER

P out = Power 500W

V out = Voltage at output = 240

V in = Input voltage = 12v

Conversion efficiency = 0.8

Power (out) = power (in) (1)

P = IV (2)

From egun (2)

P out = I out V out

$$I\ out = \frac{P\ out}{V\ out}$$

$$= \frac{500}{240} = 2.0A$$

$$I\ in = \frac{P\ in}{V\ in}$$

$$= \frac{500}{12} = 41.67$$

Taking the conversion efficiency into consideration

$$I\ in = \frac{P\ in}{Efficiency}$$

$$I\ in = \frac{41.67}{0.8} = 52.08A$$

Using two Darlington transistors configuration, the current to be switched by each one is given by: -

$$I = \frac{I\,in}{2} = \frac{52.08}{2}$$

$$I\,in = 26.04A$$

This each of the main transistor must be capable of switching current in excess of 26.04A

$$Ib = Ic / B$$

$$Ic = I = 26.04A$$

$$B = B_1 B_2 ; B1 = 100, B_2 = 30$$

$$Ib > 26.04A = 8.68 \times 10^{-3}$$

$$100 \times 30$$

$$Ib > 8.68mA$$

Ib is chosen as 9mA

$$IB = 2 \times 9mA = 18mA$$

For transistor chosen as Bu 208/2N3 772

$$IB = Ic$$

$$= B\,I_{B1}$$

$$V\,in = I_{B1}\,R + V_{BE}$$

$$R = \frac{V_{in} - V_{BE}}{I_{B1}}$$

$$R = \frac{V_{in} - V_{BE}}{I_B / B}$$

For silicon transistor $V_{BE} = 0.7V$

$$B = 25$$

$$R = 12 - 0.7$$

$$18 \times 10^{-3}/25$$

$$R = 15694.44$$

$$R = 15.69\ K$$

The nearest preferred valued of r2 is chosen as 15 k

OFFLINE TYPE OF U.P.S.

BLOCK DIAGRAM OF AN UNINTERRUPTED POWER SUPPLY

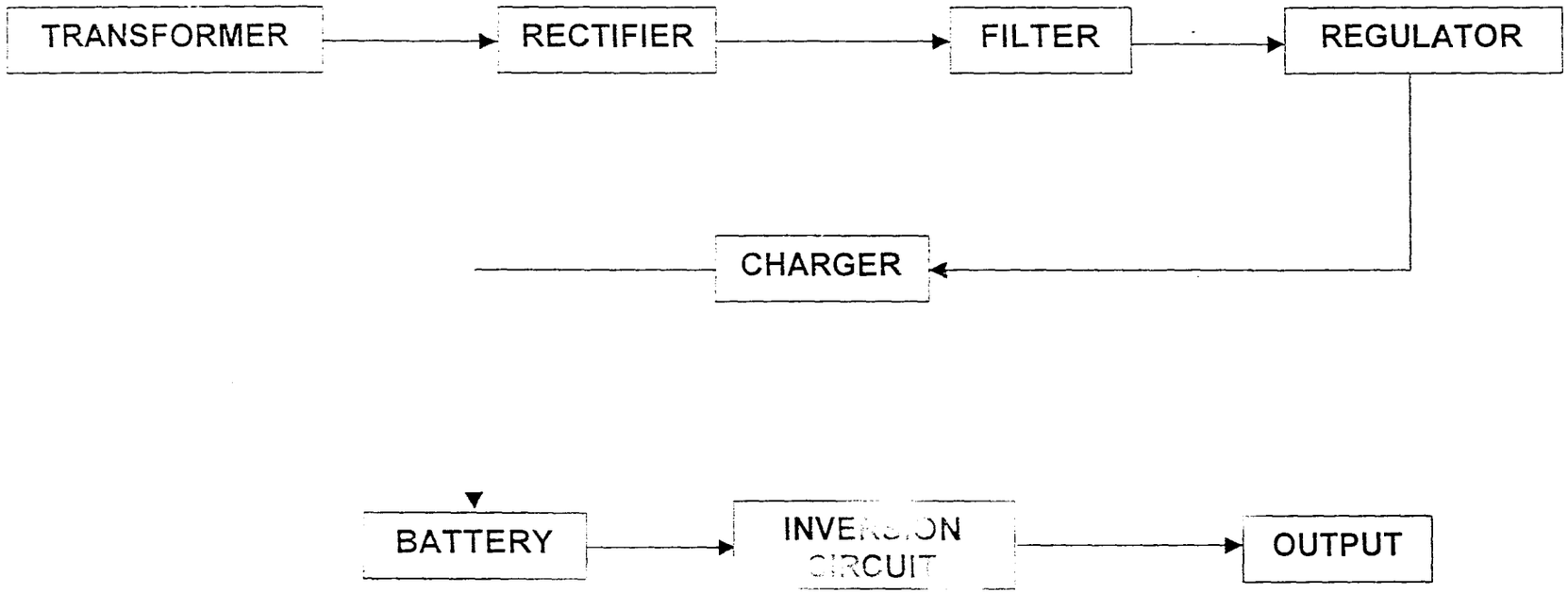
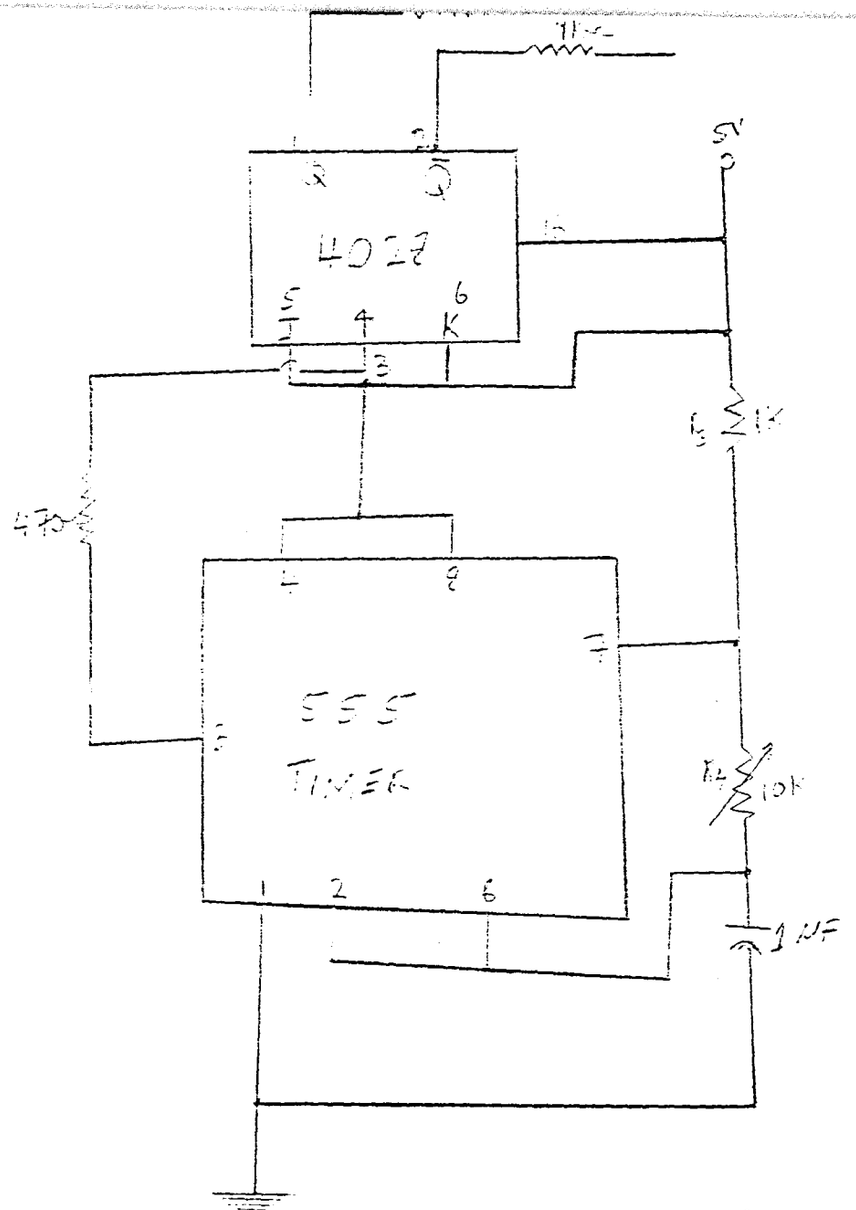


Fig. 2.1



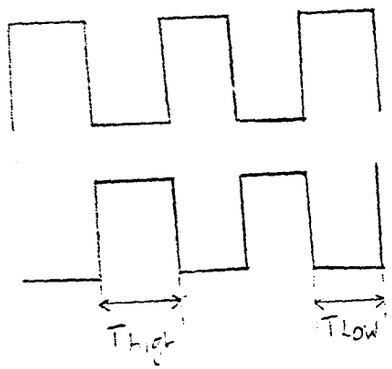


Fig 2.2 PULSE GENERATOR

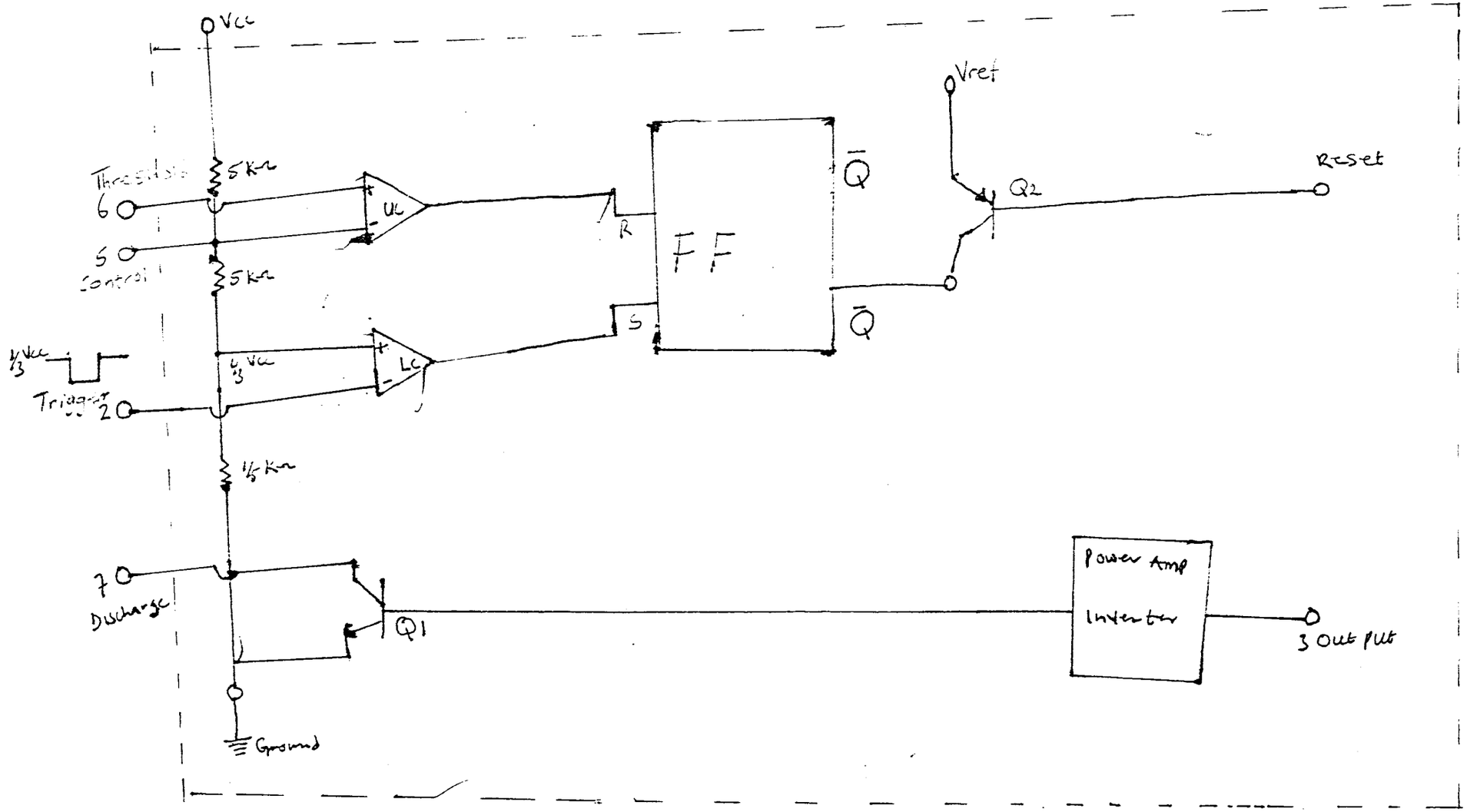


fig 2.3 INTERNAL CIRCUIT OF 555 TIMER.

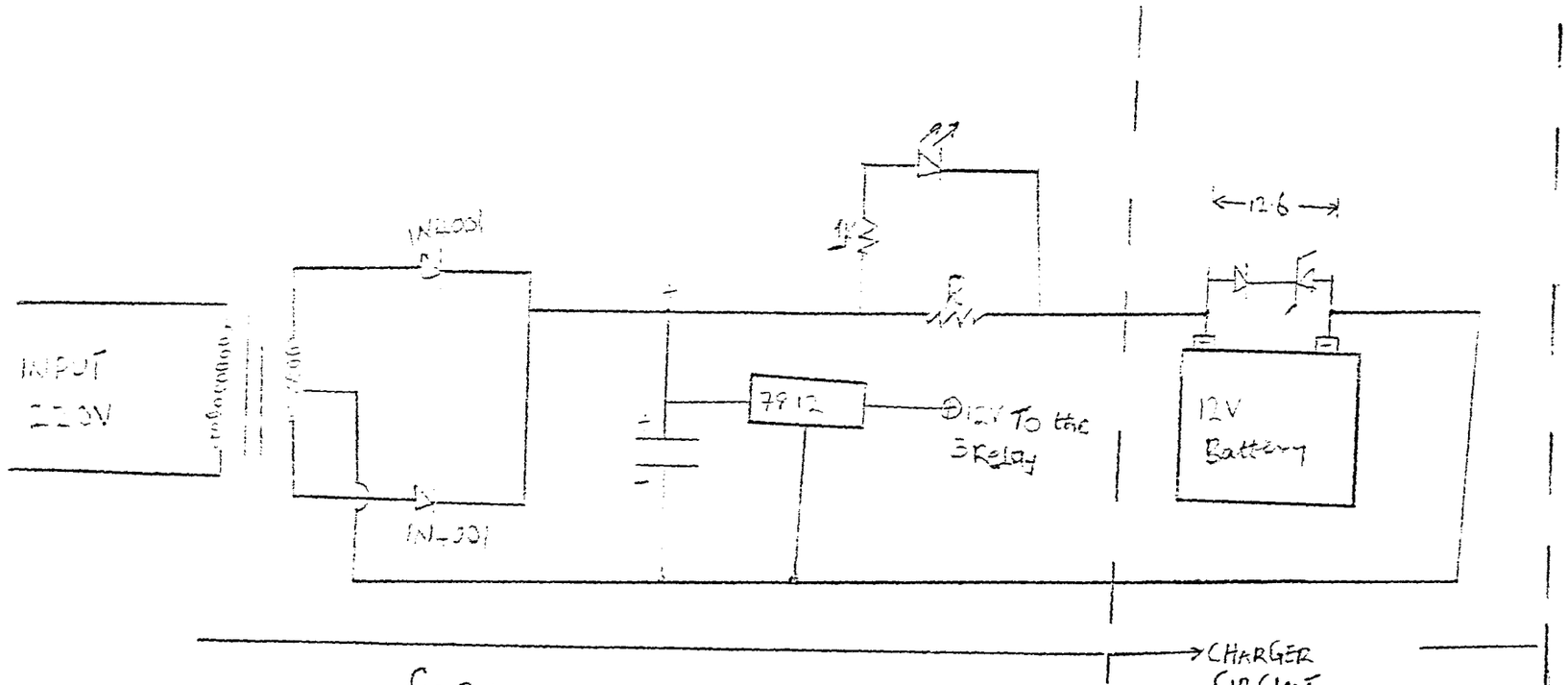


fig 2.4 Power Supply CIRCUIT

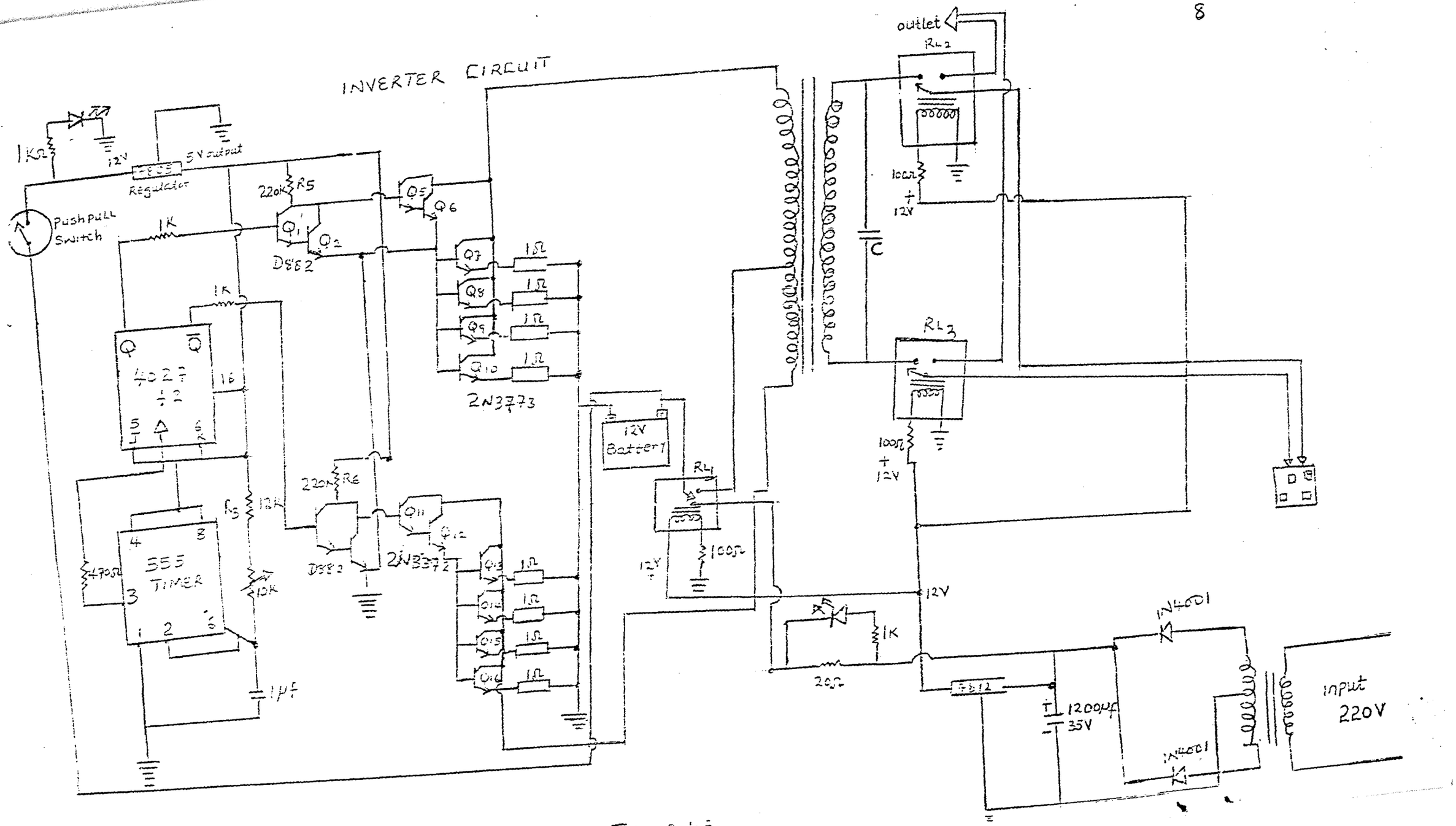

INVERTER CIRCUIT
1KΩ
12V
5V output
Regulator
Push pull Switch
1K
220K R5
Q1
Q2
D882
Q5
Q6
Q7
Q8
Q9
Q10
1Ω
2N3773
4027
÷2
16
5
6
220K R6
R5 12K
555 TIMER
4700Ω
10K
1µf
Q11
Q12
D882
2N3772
Q13
Q14
Q15
Q16
12V Battery
RL1
100Ω
12V
1K
20Ω
outlet
RL2
100Ω
12V
C
RL3
100Ω
12V
12V
1N4001
1200µf
35V
1N4001
input
220V

Figure 1-3

2.2.2 FILTER

A filter consist of inductor and a capacity is used for this project. This scheme accomplishes the important goal of making voltage sinusoid out of rectangular output voltage of the transformer. The inductor value of 460MH and capacitor value of 22μF were arrived from the calculations done below.

For an inductor = capacitor filter

Frequency of operation is given by.

$$Fo = \frac{1}{22VLC}$$

$$Lc = \frac{1}{(22\ fo)^2}$$

Where frequency = 50Hz

$$Lc = \frac{1}{(2 \times 2 \times 50)^2}$$

Lc = 0.0000101032

Given the value of L = 22μF

$$L = \frac{0.0000101032}{22 \times 10\text{-}6} = 0.460H$$

L = 460MH

The value of L = 460MH

A filter circuit is necessary to provide s steadier dc voltage, this is achieved by connecting the capacitor across the output.

2.2.3 THE BATTERY

The storage battery is a chemical device reversible in its action, which stores energy at one time for use at another time. The energy is chemical not electrical.

Electrical energy in the form of direct current electricity is applied to the battery during the operation term charging. The electric current brings about chemical charges in the battery and the chemical energy when cell is discharging.

There are different types of batteries like acid battery, alkaline battery, nickel-iron battery and nickel cadmium battery.

For this project lead-acid was chosen for the following reasons.

i. It can operate satisfactory over wide range of temperature

ii. Its voltage on discharge is the highest of all others.

iii. The complete reversible chemical reaction produces little physical charge in the plates.

2.2.4 BATTERY CAPACITY

The capacity of a battery is its ability to produce a current over a certain period of time. It is equal to the product of amperes supplied by the battery and the time. Capacity is measured in amper-hours (AH). The capacity of this one is 7AH.

2.2.5 CELL ON CHARGE

To reverse the chemical charges take place in the cell during discharge it is necessary to pass a current into cell in the opposite direction to that of discharge.

The charging sources must therefore have a voltage greater than that of the cell to be charged. The charging source connected across the cell supplies an excess of negative charge electrons to the negative place and create a storage positive plate.

2.2.6 THE CHARGER

The charger is partially as elf-regulating type for use with 24v batteries. The system charges the battery at a rate of 1.5A when the battery is flat but thus automatically reduces the charger to a trickle rate when battery reaches the fully charged level.

Zener Diode is been connected across the positive and negative terminal of the battery to avoid over charging of battery. So if the battery is fully charged, the Zener Diode across it will stop the battery been charged.

The transformer that can step the mains voltage to 15VAC and also a full wave rectifier consist of two diodes is used to convert the mains AC to DC.

CHAPTER THREE

CONSTRUCTION, TESTING AND RESULT

3.1 CONSTRUCTION AND TESTING

The construction and testing stage involve three stages; they are design stage, pre-construction on the breadboard and construction on vero board.

3.1.1 BREAD - BOARD

A bread board was used in this project to do the pre-construction of each of the units before transferred to the permanent board and soldered. Each unit constructed on the bread board was tested and re-adjusted where necessary before transferred to the vero-board for final soldering. By doing so the error of fault was greatly reduced.

3.1.2 VERO - BOARD

This is the final stage of construction as each unit constructed and tested on the bread-board before soldering it together. IC socket were used for each IC use in this project to prevent soldering heat which damage IC and also to make the replacement of any faulty IC easy.

The power transistor i.e. Darlington pair transistor were mounted on heat sink to absorb heat generated by transistor due to internal energy dissipation so as to prevent the effect of thermal run away.

This project was divided into units: - Inverter, filter section, battery chargers and light emitting diode. (LED).

The output of each stages were tested to see that they meet the target before coupling them together. Also, the soldering of the component was done with much caution as to avoid damage to the components as a result of heat.

3.2 SYSTEM TESTING

At every stage of construction, each component were check to see that they are in good working condition and also each stage output were tested before transferring them to Vero-board.

To test for NPN transistor, Ohmmeter was used. The negative terminal of the Ohmmeter was use to touch the emitter and collector terminal to measure the forward resistance of the both junctions. A resistance about 760 Ohms is a normal value. The Ohmmeter of R x 100 range are employed in this test.

The TLC 555 timer output wave form was tested and pin 3 was connected to JK flip – flop, to make sure that the two out is alternating, the oscilloscope with two channel was used and the signal were clearly seen on the screen to be alternating.

In the charging circuit, the transformer output was measured to in AC before rectifying and filter off ripple. The light emitter diode (LED) was used to unsure that the charger is properly connected.

The resistance of the resistor were also verifying by using ohmmeter.

Capacitor can also be verified using a meter that is design and to carry out the test, this is only way to get the best result. An ohm-meter lead was place across

the capacitor were prolarised ones. A low resistance above reaching (zero ohms to few hundred ohms) indicates a detective capacitor.

Finally, the output of the inverter circuit with the relay network was tested on no load and then output measured to be 230v.

3.3 DISCUSSION OF RESULT

The aim or target of the project was to design and construct a UPS with output power of 500watt at the output voltage of 240v.

After construction and test the result obtained show some little difference to the target. The output is 230v.

The output current is 2.19A

Therefore, the output is equal to output current (VA) multiply by output voltage (V)

P = I (VA) x v.

P = 230 x 2.19A

P = 503.7VA

The trickle charging current was calculated to be between 12Ma (Max) AND 10mA (min). However, the battery recharge up to 12.6v with the help of zener diode. The reasons for the difference between the expected value and the value obtained at output are as follows:

i. Using of component with close value substitute for the real value when the real value is not available.

ii. Voltage drops across the passive component in the circuit also result in output difference.

iii. Winding of the transformer and energy loss by the transformer also affect the output.

In conclusion, the goal of the project can be concluded to be achieved, since the approximate value of output power is obtained.

CHAPTER FOUR

4.1 CONCLUSION

The target of this project which is the design and construction of a 500W capacity UPS for critical load application was achieved as demonstrated by the results obtained from the test carried as explained in chapter three.

However, a number of difficulties were encountered at the initial stages of the design and construction. This was because very little was known about the project, but constant research into books, electronics journals, operational manuals of commercial UPS and professional suggestions from senior friends and the project supervisor. I was able to get through.

4.2 IMPROVEMENT

For future work improvement on this project, some steps was be taken into consideration to make it more effective.

i. If the raw power can be stabilized before passing into the load will save the load from power fluctuating problem.

ii. To minimized time delay by switching from inverter to main supply or vise-versa through the action of relay can be done by using fast acting solid faster relay instead of electro-mechanical type that was used in this project.

4.3 RECOMMENDATION

Most of the project designs implemented so far in this topic are mainly of the off-line operating mode type. Therefore, I recommend that the next project on this subject be on the ON-LINE operating mode type.

I want to recommend that a higher capacity inverter circuit capable of handling battery voltage of about 48 voltage instead of normal 12v be designed.

Since the over all project is costly, it is recommended that the electrical department, make available some of the basic components for the project in order to create a harmonized working condition for the student and also to relied student of financial stress.

4.4 COST ANALYSIS

The cost analysis is a very important aspect in engineering project management. Since this particular project is a prototype model the cost analysis is importantly so that anybody that wants to do the mass production will know how it can cost him to make the production.

ITEMS	QUANTITY	UNITY PRICE COST (₦)
Casing	1	600
Vero board	1	140
Transformer	1	200
Transformer step down	1	3, 000
Heat sink	2	100
Connecting wire	1	100
Voltage regulator	2	1, 000
Switch	1	40
Rectifier	1	50
Capacitor	1	50
Bolt and Nut	6	60
Transistor	16	1, 500
555 timer	1	50
JK Flip-Flop	1	100
Soldering Iron	1	150
Resistor	1	65
TOTAL	**=38**	**7, 205**

4.5 REFERENCES

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