DESIGN AND CONSTRUCTION OF 1000WATTS INVERTER

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H/EEET/09/3415

BEING PROJECT SUBMITED TO THE DEPARTMENT OF ELECTRICAL/ELECTRONICS ENGINEERING TECHNOLOGY NUHU BAMALLI POLYTECHNIC ZARIA KADUNA STATE,

IN PARTIAL FULFILMENT FOR THE REQUIREMENTS OF THE AWARD OF HIGHER NATIONAL DIPLOMA IN ELECTRICAL AND ELECTRONICS ENGINEERING TECHNOLOGY

NOVEMBER, 2011

DECLARATION

I hereby declare that this project was designed and constructed solemnly by me under the guidance of Mallam Rabiu Al-Tanko Umaisha of the department of Electrical Electronics Engineering technology Nuhu Bamalli Polytechnic, Zaria.

And I have neither copied someone's work nor has someone done it for me. All authors referred to in this work have been dully acknowledged.

Kefas Didam Usman
NBPTZ/H/EET/09/3415

5/1/2012
Date

APPROVAL

This project report, carried out by Kefas Didam Usman, with Reg. No. HND/EEET/09/3415 meets the partial requirements for the award of Higher National Diploma in Electrical and Electronics engineering Technology, Nuhu bamalli Polytechnic, Zaria and is hereby approved.

Mallam Rabiu Al-Tanko Umaisha
(Project Supervisor)

20/1/2012
Date

Engr. Mamud Abubakar Panti
(Project Co-ordinator)

Date

Engr. Mohammed A. Garba
(Head of Department)

Date

DEDICATION

This project is dedicated to my beloved Late Mother Mrs. Laraba Usman.

ACKNOWLEDGEMENTS

I must express my gratitude to Almighty God for his Grace and Mercy. All Glory be to Him, who has given me the health and the capacity to complete my studies successfully.

My special gratitude goes to my loving and caring late parents Mr. and Mrs. Yunana Usman, for their tireless struggle throughout my studies.

My special thanks also to my supervisor Mal. Rabiu Al-Tanko Umaisha for his caring and supportive advice and for taking much of his time to read through my work and make the necessary corrections. There is no amount of words that can express my gratitude over the substantial contribution made by them.

I also wish to express my appreciation to my uncles, brothers and sisters for their support, Mr. Renben Usman, Mr. RSM Ali Musa (Rtd), Mr. Josiah Usman and Miss Jenchat, Ali Musa.

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ABSTRACT

It is very difficult to convince a country like Nigeria that there would be no more power failure because we are still developing our economy, technology and national strength which form basic prerequisite to a nation with uninterrupted power assessment. It is a lot easier to educate Nigerians on the effectiveness and performance of the inverter. This is a part of what is intended to do in the course of this project by designing and constructing high efficiency, low power dissipation and maximum power output of 1000 watts (inverter) that is good, reliable, portable and affordable.

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CHAPTER ONE
INTRODUCTION

1.1 INTRODUCTION

From experience continuous electric power supply is not guaranteed in Nigeria as such rendering industries that need constant and uninterrupted power supply less operational. Industries that have little or no tolerance to power interruption cannot survive under these conditions, as such an alternative means of generating electric power has to be developed. The inverter is one of such alternative power generating devices. The fundamental configurations of the inverters are:

1. The battery which is the source of direct current
2. A changing mechanism which employs the step down characteristics of a transformer (step down) and a rectifier to remove ripples from the generated d.c.
3. A voltage amplifier which is usually a transformer that converts d.c. power to a,c power.
4. Systems that have high tolerance of power interruption like lighting circuits, electric home appliances etc. can use standby supply systems like generators when there is power interruption. On the other hand, systems that have a low tolerance to power interruption like computers, automatic teller machines, medical equipments, communication equipments etc. must require inverter power supply system to ensure there is no breakdown of normal process in the event of a power cut.

In standby supply systems, the load receives electric power when adequate change over process has been effected in the cause of power failure.

Inverter as the name implies, is an electronic circuit for converting direct current (DC) to alternating current (AC). Inverters are used in a wide range of applications from small switched power supplier for a computer to a large electric utility application to transport bulk power.

1.2 AIM AND OBJECTIVES OF THE PROJECT

The aim of this project is to design and construct a 1000W DC to AC inverter, which can operate equipments with a power consumption of 1000 watts or less using a high current D.C. power source from a low battery and also capable of charging the battery. When there is a power cut,

The objectives of this project are:

1. To construct a standby power supply with well filtered output AC.
2. To produced a full automatic alternative source of electrical power supply at a cheaper cost.

1.3 HISTORICAL BACKGROUND OF THE PROJECT

In the early inverter, from the late nineteenth century through the middle of twentieth century, DC-to-AC power converters, were accomplished using rotary converters of motor generator sets.

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

1.4 PROJECT MOTIVATION

In a developing country like Nigeria, certain factors will make it impossible to have a constant power supply from its utility companies like PHCN (power holding company of Nigeria). Some of these factors include political, economical, ecological and socio-cultural reasons. As such there must be a means of providing alternative power to enable the industries in the country operate normally with uninterrupted power supply. Hence the design of this project.

1.5 SIGNIFICANCE OF THE PROJECT

The significance of this project includes

1. Continuous electric power supply even in of power failure
2. Protection of electronic equipments from sudden incapacitation due to commercial power cut.

1.6 METHODOLOGY

The earlier inverter as mentioned earlier under literature review are not common. The method we adopted in the design and construction of the inverter is the use of SG 3524 with other passive and active components. The circuits are interconnected as shown in the diagram Fig. 3.4.

The circuit is designed to oscillate at 50Hz. This is normally determined by the values of resistance and capacitance connected to pin terminals 9 and 16. The operational amplifiers are utilized to boost the voltage level within the circuit. The MOSFETS serve as switching circuit. The number of MOSFETS required for the operation is determined by the size of the load. Eight numbers of MOSFETS are installed to serve a load of 1000W. The MOSFETS are distributed evenly as shown in fig. 3.4.

A changing unit is equally constructed within the circuit to charge the battery when there is alternative supply. The diode IN5400 is connected to allowed flow of current to the battery when there is alternative supply.

7805 which is a voltage regulator is installed to give the SG3524 the voltage requirement.

1.7 SCOPE AND LIMINATIONS OF THE PROJECT

1. This inverter is used for domestic purpose for the operations of lamp, fan, television, computer etc. but it is not recommended for industrial purposes where high voltage is needed for operation of heavy duty motors etc.
2. For the sake of this project, the (inverter) constructed has a constant output voltage of 220V and a frequency of 50Hz with a minimum power output of 1000watts.

1.8 PROJECT LAYOUT

This project is divided into five chapters. Chapter one (1) deals with introduction of the inverter, aim and objective Historical background, significance, methodology, scope and limitations and project layouts, the second chapter of the project deals with the literature review, where explanation is given on related work.

Chapter three (3) explains the design procedure of the project work. It includes the block diagram, the design of the transformer of and complete circuit diagram. Chapter four (4) result analysis and chapter five (5) deals with conclusion.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

In the early days of electricity theory, AC and DC were directly competing technologies, rather than the complementary role they play today. DC was the first type of electricity invented, dating as far back as 200BC; more conservative estimates place these ancient batteries at roughly 225AD. Inverters however, were not invented until the early 1900s. Nikola Tesla invented the series of technologies that lead to the modern inverter, according to the United States Patent Office.

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

The origins of electromechanical inverters explain the source of the term inverter. Early AC to DC converters used as induction or synchronous AC motor direct-connected to a generator (dynamo) so that the generator's commutator reversed its connections at exactly the right moments to produce DC. A later development is the synchronous converter, in which the motor and generator windings are combined into one armature, with slip rings at one end and a commutator at the other and only one field frame. The result with either is AC-in, DC-out. With an M-G set, the DC can be considered to be separately generated from the AC; with a synchronous converter, in a certain sense it can be considered to be "mechanically rectified AC". Given the right auxiliary and control equipment, an m-G set or rotary converter can be "run backwards", converting DC to AC. Hence an inverter is an inverted converter. [2]

Power inverters are usually described as having either a high or low switching frequency. Switching frequency refers to the rate at which the input DC voltage is oscillated to create an AC output. Low frequency inverters oscillate a DC voltage at 60 Hz. Then they step that voltage up to the desired amplitude using a bulky and a heavy transformer. High frequency inverters, on the other hand, use a small and lightweight transformer. A high frequency inverter will produce many harmonics near the range of the switching frequency. However, most of the harmonics are relatively higher in order than the 60Hz fundamental frequency. These harmonics can be isolated using a small low-pass filter. In turn. isolation of harmonics will result in less buzzing in audio equipment and less reference in other electronic equipment such as radios and televisions. When you think mobility, a unit that's the size of a laptop doesn't seem awfully large. But consider the trend in electronics these days, a laptop seems gigantic as compared to some of the microscopic devices and apertures that are being massed produced. Therefore a trend in electronics, as is has been in the past decades, is miniaturization. Size and buld determines mobility. And for a unit as useful as a power inverter, smallness should be one of the top priorities in designing this unit. In order to create a more compact until, it requires the use of as many devices of negligible size as possible. These devices, or integrated circuits, must also be able to accomplish as many feats as possible within there small stature. Multiple functions in these integrated circuits are a property that should be examined first. The increase in demand for mobile AC power sources has led to an increase in market supply. However these inverters that use the "modified sine wave" technology tend to produce a lot of heat do to power loss. Their efficiency is also less than proficient. The price of an inverter like this is considerably less than one with a pure sine wave output, but it is also reflected in their operational efficiency. The design that we will implement will solve the problem associated with "modified sine wave" inverters by using microprocessor to obtain a more efficient and smooth means of switching the inverter's transistors. This will reflect, in the overall design, comparable to other sine wave inverters on the market. Protection of the user is also of the utmost importance. There will be thermal and short circuit protection offered on this inverter. Thermal protection will be implemented through the microprocessor. Short-circuit protection will reduce the risk of electrical shock or fire due to bare or unprotected wires or implements. Other protection will be offered to protect the user's voltage supply or battery from damage. A low voltage alarm will be used to alert the user of a low supply voltage at about 10.7 VDC. If the decrease in voltage still remains the unit will shut down at a supply voltage of 10 VDC. For practical use, a cigarette lighter adapter will be used to connect the inverter to the 12 VDC system of an automobile. Appropriate gauge wire will connect the cigarette lighter adapter to the inverter. A blade style fuse will protect the3 inverter form over-current conditions. The output will be provided using a single output receptacle to deliver the 120 VAC. For mobility sake the whole inverter will be no longer than 8" long, 4.75" wide, and 2.5" high. [3]

CHAPTER THREE

DESIGN ANALYSIS

3.1 INTRODUCTION

This chapter explains the design procedure of the project work. It includes the block diagram and the design of the transformers and the complete circuit diagram.

3.2 THE TRANSFORMER

The design of transformer in inverter requires care and ascension since the transformer must operate continuously during failover and restoration the transformer has the following range of operating parameters.

The operational duration of the inverter is variable dependent on two factors. The load connected and the ampere hour AH of the battery used.

Since the maximum possible load that the inverter can handle is 100 VA. then the operating duration of the inverter will be $\frac{1000}{\text{Battery AH}}$

Input and output operating voltage during main supply is 12AC/220VAC output voltage supply is 12VDC/220VAC.

Frequency is = 50Hz

Power = 1000VA

Then the maximum output load current of the transformer is

$P \quad = I \times V \times P.F$

$I \quad = \frac{P}{V \times P.F}$

= 4.45 amps maximum output load current then the total number of turns both in the primary and secondary voltage is driven as

$$\frac{ES}{NS} = \frac{EP}{NP}$$

ES = Secondary EMF

Ns = Secondary no. of Turns

Ep = Primary no. of Turns

As shown in the schematics below

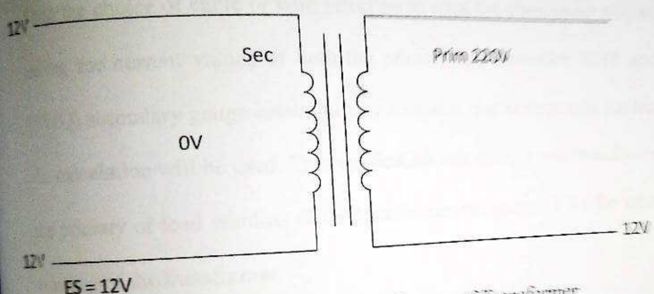


Fig. 3.1: Schematic Diagram of Transformer

NS = Unknown

EP = 220VAC

NP = 500 turns

Then $Ns = \frac{ES}{NSS} = \frac{EP}{NP} = \frac{120}{NS} = \frac{220V}{500T}$

$Ns = \frac{12 \times 500}{200}$

Ns = 27 turns

Then the transformer voltage and turns ratio is equal to

$$\frac{Emf\ in\ Prm}{Emf\ in\ sec} = \frac{No.in\ Prm}{No.in\ sec}$$

$$\frac{220VACV}{12VAC} = \frac{500T}{27T}$$

18.3 or $^{1}/_{18.5} = 18.5$

Then the secondary current of the transformer can be deducted as secondary current = primary amps x winding ratio.

= 4.354 amps x 18.5 = 84.0amps

Then the choice of cable or wire selection to wind the transformer will be determined by taking the current values of both the primary and secondary AMP and compete with (SWQ) secondary gauge catalogue any wire size that corresponds the amperage value of the calculation will be used. This verification was done, it was found to be gauging 19 for the primary or load winding of the transformer the gauge 12 for the secondary of battery winding of the transformer.

3.3 BLOCK DIAGRAM OF THE INVERTER

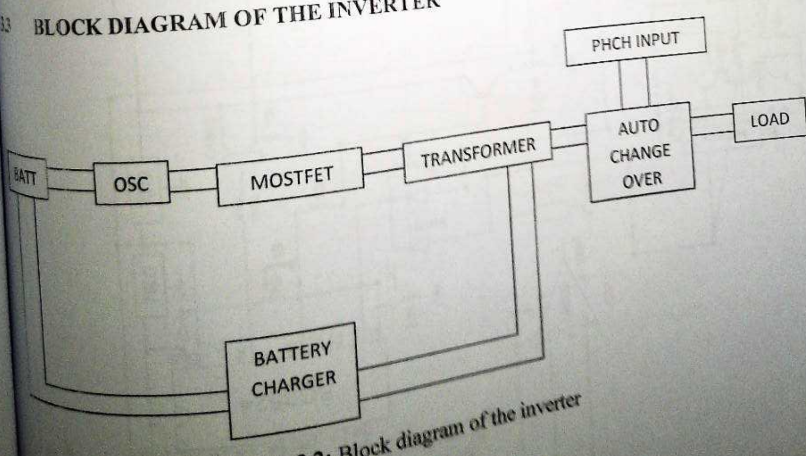
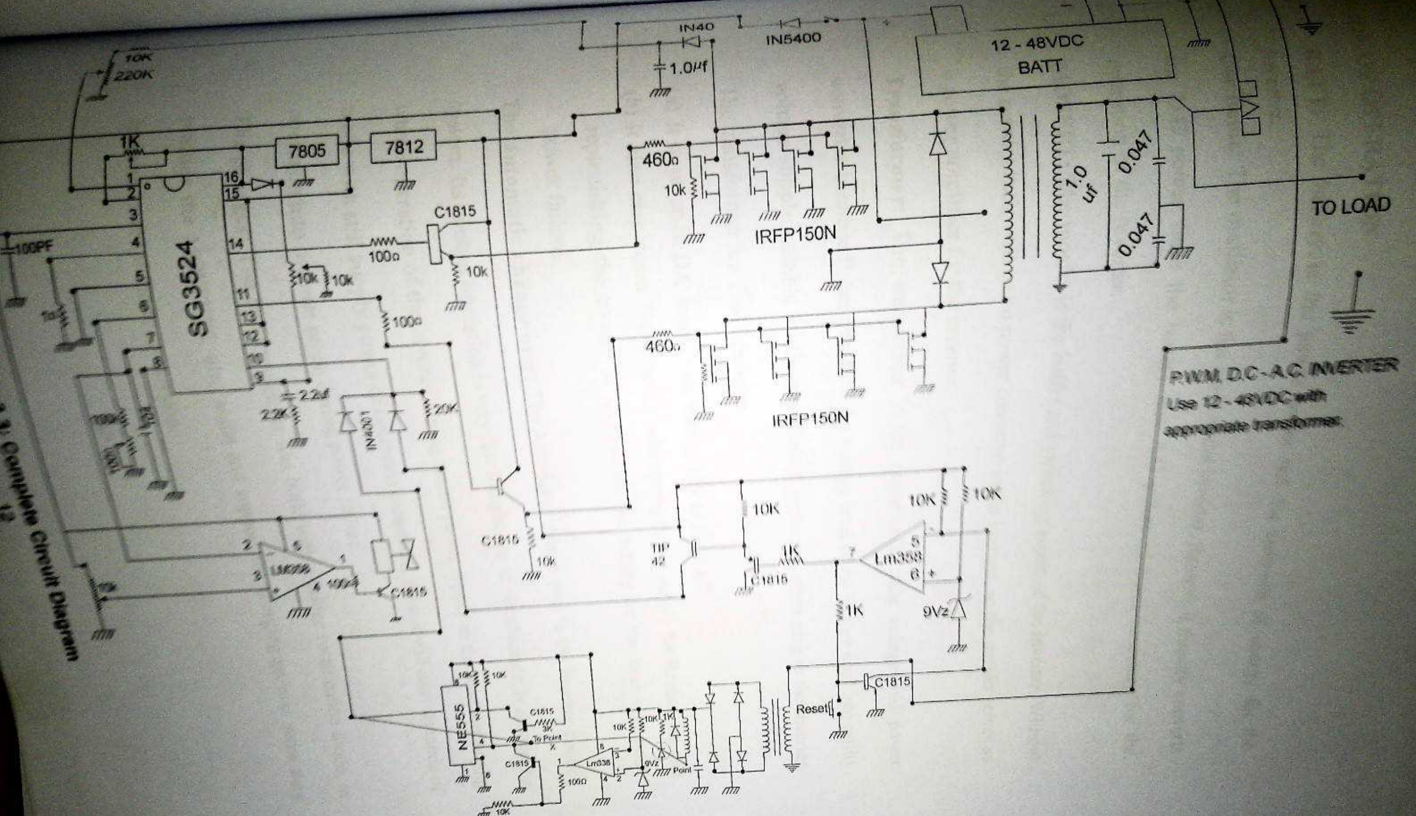


Fig. 3.2: Block diagram of the inverter



3.1: Complete Circuit Diagram

MODE OF OPERATION

1. **BATT:** The battery is the power banks and the reservoir of energy for the inverter.

2. **Oscillator:** The oscillator is the heart of the inverter. Because it directly converts the D.C power from the battery into A.C pulses of 50Hz necessary for the operation of the inverter.

3. **MOSFET:** The mosfet is the buffer and switching aspect of the inverter. Without the mosfet their will be no power converter in the inverert, so the mosfet serves as a power amplifier for the inverter.

4. **Transformer:** The transformer is the major solid state voltage and power converter because it can transform the voltage level of the battery used into utility voltage supply suitable for the operation of appliances when plug to the inverter. The transformer has dual operation.

   (a) It steps up in D.C level of the battery 12V to 220VAC

   (b) It also step down PHNC to 12 volts during power supply for Recharging and replenishing the battery so as to repair the battery for the next emergency power failure.

5. **The automatic change over:** The Automatic change over is the inverter control system. Its control operation is very fast Roughly up to 10millicesec. It change the whole operation of the inverter during mains power supply to the load recharging mode with still supply power of operation connected. Also it will alter its mode of operation into inverter mode during power failure.

6. **The charger:** The battery charger was build with a bridge rectification diode, in practice the MOSFETS, also assist and support the charging process some they have an internal diode connection.

CHAPTER FOUR

RESULT ANALYSIS

INTRODUCTION

In the particular aspect of the project great care was taken bearing in mind that any wrong placement of components could lead to the malfunction of the device this project was assembled temporary on bread board to test how the circuit will operate with the design layout.

CONSTRUCTION

This project was initially arranged or assembled on the bread board (i.e. all the stage one after the other) to test it conformity with the circuit diagram which was okey.

After that all components were removed from the bread board and finally soldered on Vero board neatly. The MOSFETS were attached to heat sinks for heat dissipation and placed some distance away from other components to prevent heat from damaging the integrated circuit (IC). During the soldering, care was taken to prevent dry joint continuity and insulating test was performed on the completed project using multi-meter.

TESTING

Firstly, the frequency was adjusted to normal frequency of 50Hz through variable resistor and was confirmed by the frequency meter. Secondly, the circuit was then connected to the transformer and tested to see that the result obtained met the expected performance. The battery used has the timing capacity of 45AH. This means that the battery can run for one hour if a current of 45A is drawn from it and it was tested by different load and it gives different time which the battery takes before running down.

Table 4.1: Result for Testing wattage bulb and current

NO.	WATTAGE BULB (W)	CURRENT I (A)
	18.00	0.075
	30	0.125
	40	0.167
	60	0.250
	100	0.417
6.	200	0.833

At the end of the construction, a digital multi-meter was used to test peak point in the circuit and the result tabulated in table 4.1 other tests carried out were for continuity and that of the output voltage.

Table 4.2: Result of Testing input and output voltage at peak point.

S/NO.	TEST POINT	INPUT VOLTAGE (VOLS)	OUTPUT VOLTAGE
1.	12 V regulator	24V(dc)	12V (dc)
2.	SG 3524	12V (ac)	12V (dc)
3.	Mosfet gate	12V (ac)	12V (dc)
4.	Inverter system	12V (ac)	240V(dc)

PACKAGING

The whole circuit was housed in a metallic box with enough provision for ventilation for cooling the transformer. The transformer is screwed to the base of the casing while the MOSFETS were place a distance from the transformer because of the heat product by the transformer.

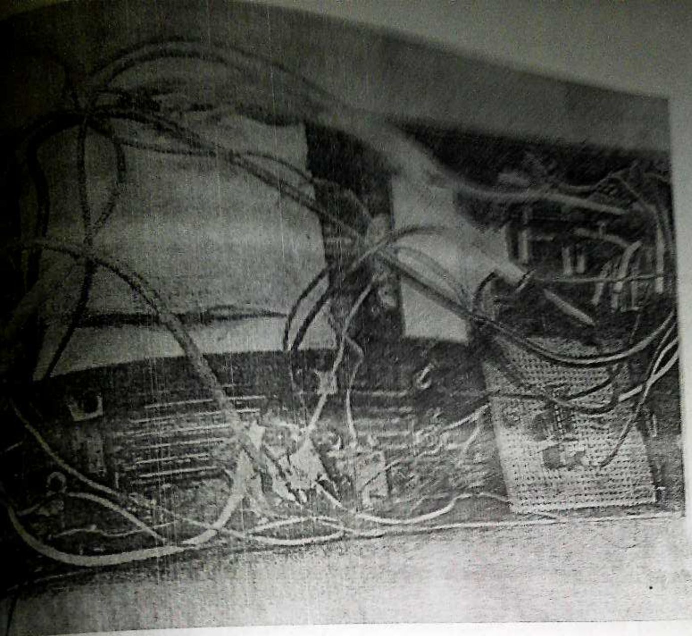


Fig. 4.1: Casing of the Project

CHAPTER FIVE

CONCLUSION

ODUCTION

hapter explains the conclusion, problems faced and recommendation of the project. the initial stage of the project we checked the circuit diagram to verify any fault e going for the components in the market which are all available.

NCLUSION

battery – to – mains 220V, 50Hz inverter was designed and constructed with the able specifications of components and materials to provide electrical power in case of wer failure. The main purpose of the project was achieved when the design was done, nstructed and tested. The battery – to – main 220V, 50Hz inverter powered some ectric bulbs, radio cassette player, computer when there was no power.

ROBLEMS FACED

ome of the problems encountered during this work were as follows:

1. Inadequate equipment
2. Inadequate power supply for the soldering work
3. Lack of technical know-how

ECOMMENDATIONS

ecommended that:

(i) The project work should be modified or improved
(ii) It should be modified and increased from 1000 watts to higher watts
(iii) Due to problems faced, I call for more practical to be conducted.

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