DEVELOPMENT AND COMMERCIALIZATION OF 2.5KVA SOLAR POWER GENERATOR

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APPROVAL

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A project submitted to the Department of Production Engineering, University of Benin, in partial fulfillment of the requirement for the award of B.Eng. in Production Engineering Department of the University of Benin, Benin City, Nigeria.

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CERTIFICATION

This is to certify that the project work was carried out by **AIGBE CALEB EFE** with the Matriculation Number: **ENGI604376** of the Department of Production Engineering in the Faculty of Engineering, University of Benin, Edo State. In partial fulfillment of the requirement for the award of Bachelor of Engineering (B. Eng).

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DEDICATION

This Project is dedicated to Almighty God and My Family for the strength and encouragement to finish this milestone.

ACKNOWLEDGEMENT

I would like to express my sincere thankfulness to God Almighty for his mercy, safeguarding and his faithfulness. Additionally, I want to utilize this opportunity to thank my departmental lecturers for having such a positive influence on my life and guiding me through my engineering journey.

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LISTS OF ABBREVIATIONS

MEANING	ABBREVIATION
Voltage	V
Alternating Current	AC
Direct Current	DC
Ampere	A
Ampere-hour	AH
Kilo-volts ampere	KVA
Wattage	W
Watt-Hour	WH
Days of Autonomy	DOA
Depth of discharge	DOD
Effective load demand	ELD
Peak sun hour	PSH
Pulse width modulation	PWM
Open circuit voltage	Voc
Open circuit current	Ioc
Short circuit current	Isc
Maximum power voltage	Vmp
Maximum system current	ImP

ABSTRACT

This work is on the design and construction of a 2.5KVA solar inverter. Solar inverter converts the variable direct current (DC) output of a photovoltaic (PV) solar panel into a utility frequency alternating current (AC) that can be fed into a commercial electrical grid or used by a local, off-grid electrical network. It is a critical component in a photovoltaic system, allowing the use of ordinary AC-powered equipment. In solar inverters, Solar panels produce direct electricity with the help of electrons that are moving from a negative to a positive direction. Most of the appliances that we use at home work on alternative current. This AC is created by the constant back and forth of the electrons from negative to positive. In AC power, the voltage can be changed depending on how the equipment will be used. Solar inverters are used to convert DC to AC because solar panels can only produce Direct Current.

A 2.5KVA electrical inverter was designed for this project. The inverting circuitry assembly's architecture has two 200Ah dry cell batteries, a 240v/24-0-24v center-tapped transformer, and electrical and electronic components. A refrigerator (1200 watts), four high-energy lights (40 watts each), a standing fan (60 watts), a television (200 watts), a DVD player (240 watts), and a 60-watt tungsten lamp were all powered by the design electric inverter. At the stated load of 1940 watts, the inverter lasted for roughly five hours.

CHAPTER ONE

1.1 BACKGROUND OF PROJECT

The Nigerian power sector has been plagued with challenges for many years, resulting in frequent power failures and inadequate electricity supply. The issues range from inadequate generation capacity to transmission and distribution challenges as well as financial constraints, governmental policy, and regulatory issues. To solve these problems, several strategies have been proposed and some implemented.

Over the years, Nigeria has struggled with insufficient power generation capacity, leading to power shortages. To address this, the government has focused on diversifying the energy mix by promoting renewable energy sources such as solar and wind power. The Renewable Energy Master Plan aims to increase renewable energy contributions to the power grid.

The commonly used alternative power source by individuals as well as small and medium scale industries is the petrol/gasoline power generators which are bedeviled with perennial cases of scarcity of Premium Motor Spirit (PMS). Besides it has been reported that petrol power generators emit quantifiable volumes of carbon monoxide gas (CO) which is a major component of greenhouse gases known to deplete the ozone (O_3) layer of the earth's crust/atmosphere and also for the level of noise pollution associated with it.

Due to the limitations in the use of gas generators, there is a need for solar power generators. A solar power generator works when sunlight strikes photovoltaic solar panels and this energy goes through the generator's charge controller to its battery bank (for power storage, which allows the power to be used now or later) through the generator's inverter and (if you use a power transfer kit) directly to your home's electric panel. This is the process a solar generator uses to convert sunlight into AC (alternate current) electricity that can be used in your home.

The need for backup power systems can never be over-emphasized especially in this technological age. Almost every sector or organization makes use of electrical energy for the smooth running of its operation e.g., medical equipment is considered sensitive because a power failure of whatever duration can result in either loss of lives or an impediment in the person's health, hence the need for backup systems. No country in the world can boast of 100% power reliability, thus solar power generators and other alternative power sources are needed in electrical engineering especially when noise, maintenance, and other factors make the use of the conventional generator undesirable.

1.2 STATEMENT OF PROBLEM

A 2.5KVA Solar power generator has been developed to solve the power need of an individual for a bedroom flat. This is because of its low operating cost and eco-friendliness compared to other power generators such as gasoline.

1.3 AIM AND OBJECTIVES OF PROJECT

This project aims to develop and commercialize a 2.5KVA solar power generator, capable of powering a one-bedroom flat.

The objectives of this project are:

1. To develop a solar power generator as an alternative source of power.
2. To develop a solar power generator that is eco-friendly and noise-free.
3. To develop a solar power generator that is easy to install and use.
4. To develop a source of power that has low operating cost since it does not require fueling.
5. To develop a product that is cost-effective and has a -large profit margin.
6. To carry out feasibility studies of the developed solar generator.

1.4 RELEVANCE OF PROJECT

The relevance of the project is to show that an alternative power source specifically for the need of a one-bedroom flat requirement may be obtained by the use of a solar power generator, which is very environmentally friendly.

1.5 SCOPE OF THE PROJECT

The scope of this project is limited to the design construction, and commercialization of a 2.5KVA solar power generator.

1.6 LIMITATIONS OF THE PROJECT

The limitations of the project are stated as follows;

a. The solar power generator will not produce the desired result if overloaded or powered above its rated power (2.5KVA)
b. Solar panels depend on sunlight to generate electricity, which means they will be inefficient on stormy and gloomy days.
c. Solar power generator still requires AC power to initially charge the batteries before the DC power from the batteries can be inverted to AC power. This implies that if batteries are not charged, then the inverter will not produce the required output.

1.7 COMMERCIALIZATION OF A 2.5KVA SOLAR POWER GENERATOR

There are several procedures and factors to take into account while commercializing a 2.5KVA solar power generator. Here is a general description of the procedure:

1. Market Research;

- Define your target demographic. Who could be interested in your solar power generator? Are residential, commercial, or industrial clients your target market?

- Research your rivals. What items that are similar to these are already on the market? What makes your product unique?

2. Product Development

- Create the 2.5KVA solar power generator. Make sure everything complies with safety requirements and is simple to install and use.

- Take into account supplementary functions like remote monitoring, battery storage, or compatibility with current solar installations.

3. Prototyping and Testing

- Create a working prototype of your solar power generator and put it to the test to make sure it works as it should and is dependable.

4. **Certifications and Compliance**

- Obtain the accreditation and permits required for your product. This could involve having the appropriate safety certificates and abiding by local electrical codes.

5. Manufacturing

- Establish a manufacturing procedure so you can mass produce your solar power generators. Think about elements like cost-effectiveness, quality assurance, and scalability.

6. Distribution

- Create a distribution plan. Do you intend to offer your goods directly to consumers or through merchants and distributors?

- If required, form alliances with distributors or retailers.

7. Marketing and Branding

- Develop a marketing plan to advertise your solar generator. Online promotion, social media marketing, and attendance at trade exhibits and business gatherings are a few examples of this.

- Create a powerful brand identity that conveys the advantages of your product.

8. Sales and Customer Support

- Teach your sales staff how to persuade potential buyers of your product's advantages.

- Deliver first-rate customer service to respond to questions, resolve problems, and win over customers.

9. **Financing**

– Get your company some financing. This could entail looking for funding from venture capitalists, angel investors, or borrowing money.

10. Warranty and Service

- Provide a warranty for your product to reassure customers.

- Create a service network to offer upkeep and repairs as required.

11. Price Strategy

- Choose your product's price approach. Take into account elements like market demand, competitiveness, and production costs.

12. Sustainability and Environmental Impact

- Emphasize how your solar power generator saves the environment by reducing carbon emissions and electricity costs.

13. Regulatory Compliance

- Make sure your product remains compliant by staying up to date on changing laws governing the production of solar power.

14. Feedback and Iteration

- Constantly acquire client input and apply it to your product.

- To stay competitive, be willing to make the necessary changes and improvements.

15. Scaling

- As your company expands, think about pursuing new markets or providing more solar-related goods and services.

Keep in mind that bringing a product like a solar power generator to market needs meticulous preparation, money, and commitment. It's critical to comprehend the particular requirements and tastes of your target market and to modify your plan as necessary. Additionally, keeping up with developments in solar technology and renewable energy regulations will help your company succeed in the dynamic energy market.

CHAPTER TWO

LITERATURE REVIEW

Solar energy is a renewable source of power that has gained significant attention in recent years due to its potential to address the growing concerns about climate change and environmental degradation (Smith, 2022). The process of harnessing solar energy involves converting sunlight into electricity through the use of photovoltaic (PV) cells or concentrating solar power (CSP) systems.

Solar energy is known to have tremendous environmental benefits, as it produces no greenhouse gas emissions during operation. According to Wang, Lu, and Yue (2021), solar energy systems "do not release any air pollutants, and their carbon footprint is significantly lower compared to conventional energy sources such as fossil fuels." This attribute contributes to mitigating climate change and improving air quality.

Greater energy independence is possible thanks to solar energy. Both individuals and groups can produce their electricity by mounting solar panels on their rooftops. According to the U.S. Department of Energy (2021), solar energy production can be decentralized, reducing dependency on centralized power networks. In remote places or during natural disasters, this independence promotes energy security and resilience.

Long-term cost savings for consumers from solar energy are possible. Although the initial cost of installing solar panels may appear high, over time they can lower electricity bills and need little upkeep. It is an affordable way to supply electricity to the electronic equipment and appliances in your home. Unlike gas generators, which need to be regularly refueled, there are no further costs after the generator and solar panels are purchased and installed.

Solar power generators, also known as solar photovoltaic systems or solar panels, have gained significant attention as a viable renewable energy source in recent years. These systems harness the power of sunlight and convert it into electricity, offering a sustainable alternative to traditional fossil fuel-based power generation.

2.1 COMPONENTS OF A SOLAR POWER GENERATOR

Solar power generators consist of several key components that work together to capture and convert solar energy. These components include;

a. Solar panels
b. Inverter
c. Battery
d. Charge controller
e. Enclosure case
f. Wire
g. Fuse

2.1.1 Solar Panels

Solar panels, commonly referred to as photovoltaic (PV) panels, are apparatuses that use the photovoltaic effect to transform sunlight into electricity. They are made up of a network of connected solar cells composed of silicon or another semiconducting material. Electricity is produced when sunlight strikes solar cells and excites the material's electrons. Simply put, a solar panel works by allowing photons, or particles of light, to knock electrons free from atoms, generating a flow of electricity, according to the University of Minnesota Duluth. Solar panels comprise many, smaller units called photovoltaic cells — this means they convert sunlight into electricity.

There are many different applications and uses for solar panels. The production of electricity for residential and commercial buildings is one of the most popular uses. Rooftop installations or building-integrated photovoltaic (BIPV) are also options for their use. This makes it possible for solar-generated electricity to be used directly or to be integrated into the electrical grid. The installation of solar panels on buildings can dramatically lower the greenhouse gas emissions linked to the generation of energy, according to a study by Fthenakis, Kim, and Alsema (2008).

In places with limited access to a dependable energy grid, such as isolated areas or off-grid locales, solar panels are also used. In these circumstances, solar power systems with energy storage devices, such as batteries, can offer a reliable and independent source of electricity. This method is particularly applicable to emergency response and rural electrification circumstances. Solar panels provide a decentralized and ecologically beneficial option for electrification in poor locations, as stated by Bazilian et al. (2015).

Solar panels are also used for a variety of different purposes, such as to power satellites, spacecraft, and other automobiles. They are also used in agricultural contexts for irrigation systems, farm machine power, and water pumping. Solar panels can also be used to power outdoor activities like camping and offer electricity for charging portable electronics.

2.1.2 Inverter

Direct current (DC) is converted to alternating current (AC) using electrical equipment known as an inverter. It is necessary for various applications, including solar power systems, uninterruptible power supplies (UPS), home appliances, electric cars, and home appliances. Two common inverter types can be adjusted to use with solar power systems. Inverter for a modified and pure sine wave.

(1). Modified sine wave inverter: A modified sine wave inverter is a type of power inverter that produces an AC output waveform that approximates a sine wave but with some distortions. It is commonly used in powering basic household appliances, power tools, and certain electronics.

The phrase "modified sine wave" describes a waveform that has undergone certain modifications from a pure sine wave. A stepped waveform is produced by a modified sine wave inverter. It consists of several steps that resemble a sine wave in shape but with sharp changes in voltage levels. Certain sensitive electronics, including audio equipment and some medical instruments, may experience problems as a result of harmonic distortion brought on by these transitions.

As compared to pure sine wave inverters, which provide a cleaner and more stable waveform output, modified sine wave inverters are frequently more economical and accessible. Modified sine wave inverters, however, may result in increased heat and noise in some appliances as well as decreased performance or efficiency because of the waveform distortions.

(2). Pure sine wave inverter: A pure sine wave inverter converts direct current (DC) into high-quality alternating current (AC) suitable for powering a wide range of sensitive electronic devices. It is a kind of power inverter that generates an uninterrupted, smooth sinusoidal waveform, just like the waveform of the utility grid. Smooth oscillation, the absence of harmonic distortions, and low total harmonic distortion (THD) values define this waveform. Pure sine wave inverters are created to deliver premium power, guaranteeing the best performance and dependability of delicate equipment.

In situations where power quality is important, such as when powering computers, telecommunications systems, audio and video equipment, or medical equipment, pure sine wave inverters are frequently employed. In comparison to modified inverters, they have several benefits, such as a larger variety of device compatibility, increased efficiency, less audible and electrical noise, and longer equipment lifespan.

2.1.2.1 Components of An Inverter

An inverter requires various components for its proper operation. Some of these components are:

a. Transformer
b. MOSFETs
c. Microcontroller
d. Battery
e. Capacitors
f. Resistors
g. Transistors

Transformer

A transformer is an electrical component that is essential in converting direct current (DC) to alternating current (AC) when discussing inverters. Depending on the demands of the AC output, the transformer in an inverter is in charge of stepping up or stepping down the voltage levels.

Transformers are commonly employed in inverters to achieve galvanic isolation, which is the electrical separation of the input and output circuits. This isolation offers safety by shielding the equipment and people from potential electrical risks. Furthermore, transformers aid in voltage management and impedance matching.

Here is a brief description of how a transformer functions within an inverter:

Step-up Transformers: A step-up transformer is used in an inverter that is intended to change low DC voltage (such as that from a battery) into a greater AC voltage. For the intended AC output, the transformer raises the voltage to the required level.

Step-down Transformers: On the other hand, a step-down transformer is used in an inverter that transforms a high DC voltage (such as from a solar panel array) into a lower AC voltage. The voltage is decreased by the transformer to the proper level for the AC output.

Two or more wire coils (winding) are twisted around a magnetic core to make the transformer. The primary winding is coupled with the DC input, and the secondary winding is coupled with the AC output. A magnetic field is produced in the core when the DC input current passes through the primary winding. The secondary winding experiences a voltage due to the magnetic field, which produces an AC output.

MOSFET

A common form of field-effect transistor used in electronic devices and integrated circuits is the MOSFET (Metal-Oxide-Semiconductor Field-Effect Transistor). By altering the voltage applied to its gate terminal, it may regulate the flow of electric current. They are frequently utilized in inverters for many different purposes, such as power electronics and motor drives. MOSFETs are used in inverters to change DC (direct current) power into AC (alternating current).

A source, a drain, and a gate are the three primary parts that make up a MOSFET's construction. A channel that the current travels through connects the source and drain. A thin coating of silicon dioxide or another type of oxide serves as an insulator between the gate terminal and the channel.

Based on the predominant charge carriers (holes or electrons) that carry the current across the channel, MOSFETs can be classified as either n-channel or p-channel. The majority of the charge carriers are electrons in n-channel MOSFETs and holes in p-channel MOSFETs.

The conductivity of the channel is modulated in a MOSFET operation by altering the voltage applied to the gate terminal. A conductive channel between the source and drain is formed when a voltage is supplied to the gate, which induces an electric field across the insulating oxide layer. When a voltage is put between the source and drain, this channel permits the flow of current.

Cutoff, saturation, and linear (sometimes referred to as triode) regions are the three operating modes for MOSFETs. The MOSFET is off in the cutoff area, and there is no discernible current flowing between the source and drain. The MOSFET is completely on and the current flowing between the source and drain is at its maximum in the saturation region. The MOSFET functions as an amplifier in the linear area, where the current flow is proportional to the gate-source voltage.

MOSFETs are employed in a variety of electronic circuits, including digital and analog ones, power amplifiers, voltage and switching regulators, motor control, and many more. They are a vital component of contemporary electronic gadgets due to their fast switching rates, low power consumption, and small size.

A unique class of MOSFET created to manage high power levels is known as a power MOSFET. They are utilized in applications including power supply, motor drives, and power converters and have a lower on-resistance.

Microcontroller

An inverter's main and essential component is a microcontroller. It is a small computer that has a wide range of capabilities, including generating switching PWM signals, controlling safety systems, and adjusting the frequency and voltage of inverter outputs. C, assembly, micro/C, MPLAB, and other programming languages and software can all be used to program a microcontroller. After stepping down and rectifying the AC voltage, a voltage regulator provides a microcontroller with a voltage of 5 volts direct current (dc). A microcontroller creates a variable frequency pulse width modulation (PWM) signal to control the applied voltage on the gate drive, which in turn regulates the switching of the power devices like MOSFETs or IGBTs in the H-bridge circuit. The PWM signal controls the output waveform's output frequency, voltage, and harmonic composition.

Battery

An inverter is used with a rechargeable energy storage device known as a battery to supply backup power during power outages or as a standalone power source in off-grid situations.

Storage for electrical energy generated by the grid or renewable energy sources like solar panels and wind turbines is provided by the battery in an inverter system. When it is accessible during regular operation, grid electricity can be used to charge the battery. When there is a power outage or the system is operating off-grid, the inverter absorbs energy from the battery and transforms it into AC power to give to the connected devices.

Capacitors

A capacitor is an electronic component that stores electrical energy in an electric field. A DC link capacitor is connected in parallel with an inverter's input to lessen the impact of voltage variations brought on by changes in the load. The DC link capacitor also provides low-impedance channels for ripple currents generated by power-switching circuits.

Bus link capacitors are used in DC-to-AC inverters to isolate the effects of the inductance from the DC voltage source to the power bridge.

Resistors

A resistor is a part of an electrical circuit that restricts the passage of current. Resistors are used in inverters to limit the amount of current that flows through the circuit and to create a voltage drop across the load.

Resistors are used in resistive load inverters to supply a load for the inverter's output. The relationship between the output voltage and load resistance is linear.

Transistors

Transistors are semiconductor devices that can switch or amplify electronic impulses and electrical power. Inverters use transistors to regulate current flow, allowing the conversion of DC to AC.

The number of transistors an inverter employs depends on its complexity, power rating, and design. Simple inverters may just require a few transistors, whereas high-power industrial inverters may utilize hundreds or even thousands.

2.1.3 Battery

In solar power generators, batteries are necessary for storing the energy generated by the solar panels. The stored energy can be used when sunlight is not present, such as at night or when it is cloudy. It's critical to consider battery capacity, kind, and efficiency when selecting the ideal battery for a solar power generator.

The two battery types that are most typically used in solar generators are lead-acid and lithium-ion.

Lead-Acid Batteries: Lead-acid batteries have long been used in solar power systems due to their availability and durability (Mishra & Biswas, 2021). They are available in several formats, such as sealed lead-acid batteries and flooded lead-acid batteries, to satisfy the various needs for solar energy storage (Maneze et al., 2021).

Regular maintenance on FLA batteries is required, and this includes checking the electrolyte levels and ensuring there is enough ventilation. SLA batteries are maintenance-free; however, they typically have a shorter lifespan than FLA batteries.

Lithium-Ion Batteries: Lithium-ion batteries are growing in popularity as a result of their better energy density, longer lifespan, and lighter weight as compared to other battery types. These batteries are capable of reliably storing solar energy as well as acting as an off-grid power source (Salahuddin et al., 2021). They require less maintenance and are more efficient in charging and discharging batteries. However, they are usually more expensive upfront.

2.1.4 Charge Controller

A crucial part of solar energy producers is the charge controller, which controls the electrical flow between the solar panels and the batteries. By making ensuring the batteries are charged correctly and shielding them from extreme overcharging or discharge, it increases their useful life. Its main objective is to regulate charging to avoid batteries from being overcharged. Solar energy generators employ several different charge controller types, such as:

PWM (Pulse Width Modulation) Charge Controllers: PWM charge controllers are one of the most prevalent types. They work by swiftly turning the voltage provided to the battery on and off while changing the current passing through the solar panel. PWM controllers are less sophisticated and expensive than other varieties, but they are also less efficient. They perform effectively with smaller systems that employ panels of lower voltage.

MPPT (Maximum Power Point Tracking) Charge Controllers: PWM controllers perform less well and with less sophistication than MPPT controllers. They use a more complex algorithm to keep track of the solar panels' peak output and boost energy conversion. MPPT controllers can boost the effectiveness of the system by converting extra voltage into higher charging current. They are perfect for larger systems and panels with higher voltage.

Solar Hybrid Charge Controllers: Charge controller hybrids combine the capabilities of an inverter and a charge controller. They can oversee the battery bank, charging, and power distribution all at once. Because they can effectively manage the power flow and incorporate renewable energy sources (such as solar panels and wind turbines), hybrid controllers are extensively utilized in off-grid solar systems with battery storage.

Diversion Charge Controllers: Diversion charge controllers are frequently used in off-grid systems with additional power generation. To avoid battery overcharging, they redirect extra energy to auxiliary loads like air conditioners or water heaters. These controls guarantee efficient energy use and lessen the chance of energy waste.

MPPT Boost Charge Controllers: For systems in colder climates or with lower panel voltages, MPPT boost charge controllers were developed specifically. To effectively charge batteries, they can "boost" the panel voltage to a greater level. These settings are beneficial in areas with poor lighting.

The chosen charge controller depends on the system's size, voltage requirements, efficiency goals, and budgetary restrictions. Selecting a charge controller that is compatible with the solar panels, battery bank, and overall system design is essential for achieving the best performance and battery longevity.

2.1.5 Enclosure Case

In solar power generation systems, the enclosing shell is crucial for protecting the generator's fragile parts from external factors including weather, dust, and vandalism. The enclosure case's design and construction should ensure adequate ventilation, heat dissipation, and durability to maintain the solar power generator's peak performance and longevity.

To achieve these ends, manufacturers commonly make enclosure cases out of high-end materials like aluminum, stainless steel, or weather-resistant polymer. Aluminum's excellent thermal conductivity makes it possible for heat to be effectively dissipated from the generator's components. Because stainless steel is more durable and resists corrosion, it guarantees the enclosure case's lifetime even in bad weather.

Effective sealing techniques are also incorporated into the enclosing case's construction to prevent the introduction of dust and water. Proper sealing is essential for maintaining the generator's integrity and protecting it from damage caused by moisture and dirt.

In addition to providing protection, the enclosing case design should allow for adequate ventilation to allow heat generated by the solar power generator's components to be released. This can be done by using ventilation fans or natural convection designs, which permit the free movement of air while maintaining the necessary level of protection.

Strong locking components may also be included in the enclosing case to restrict access and prevent theft or damage. Strong latches, tamper-evident screws, or complex security systems are a few examples of these locking mechanisms.

Overall, the enclosing casing in solar power generators is a crucial component that ensures the safety, durability, and best performance of the generator. Through the use of premium materials, proper sealing techniques, ventilation systems, and secure locking mechanisms, the enclosure case provides a dependable solution for guarding fragile solar power-generating components.

2.1.6 Wire

Installing and wiring a battery, charge controller, inverter, trickle charger, and fuses inside a waterproof casing constitutes wiring a solar power generator. The appropriate input and output sockets are then wired and mounted on the case's outside, where they are conveniently accessible.

Pre-install wires at the solar panel modules can be used to connect them. The proper wire must be chosen, nevertheless, to extend the wiring to the inverter or service panel. You can utilize PV wire, also known as TUV PV Wire or EN 50618 solar cable standard, for rooftop PV installations.

PV module wiring is available in three different configurations: series, parallel, and series-parallel.

2.1.6.1 Series Connection

Solar panels have both positive and negative terminals. The positive terminal of one module is linked to the negative of the next, and so on, throughout the entire string, when connecting solar panels in series. This type of wiring increases the output voltage, which may be measured at the available terminals.

2.1.6.2 Parallel Connection

Solar panel parallel wiring increases the output current while preserving constant voltage. The sum of all currents generated by the string's modules is the output current.

In addition, the National Electrical Code (NEC) requirements must be followed when wiring solar panels in parallel. Conductor size and over-current protection are included. According to NEC 690.8(A)(1) and NEC 690.8(A)(2), this is determined by 125% oversizing the Short Circuit Current (Isc), taking into account the number of modules in the system.

2.1.6.3 Series-Parallel Connection

Solar panel wiring that mixes parallel and series connections is known as series-parallel wiring. This connection connects solar panels in series by connecting positive and negative terminals to increase voltage and by connecting these strings in parallel. Each string of parallel-connected solar panels must have the same voltage and adhere to NEC 690.7, 690.8(A)(1), and 690.8(A)(2). Modules must consistently be of the same model to give the system its best performance.

2.1.7 Fuse

An essential part of a solar power system is fuses. They guard against overloading and short-circuiting the system. We advise adding fuses or circuit breakers at three distinct points: between the charge controller and the battery bank, between the charge controller and the solar panels, and between the battery bank and the inverter.

Fuses and circuit breakers are used to prevent the wiring from overheating and to prevent any connected equipment from catching fire or suffering damage in the event of a short circuit.

The National Electrical Code (NEC) can be applied to the following techniques to size fuses for solar systems:

1) Establish the highest circuit current.

2) Calculate the nominal fuse's ampere rating.

3) If necessary, DE-rate fuse owing to anomalous ambient temperature

4) Determine the ampere rating on the fuse nameplate.

CHAPTER THREE

METHODOLOGY

(DESIGN, CONSTRUCTION AND ASSEMBLY)

3.1 COMPONENTS OF THE INVERTER

To function properly, an inverter needs several components. Among them are the following:

a) Transformer;

b) Integrated Circuits (ICs);

c) Relay;

d) Battery;

e) Fuse/Circuit Breaker;

f) Switches.

(g) Panel Indicator (Light Emitting Diode)

(h) Output display meter

(I) MOSFETs, Voltage Regulators, and Transistors

3.1.1 TRANSFORMER

One of the most crucial parts of an inverter is the transformer. It is a center-tapped transformer that changes the 24V battery supply to 240V. The transformer, which is a step-up transformer, has a secondary winding of 240 volts and a primary winding of 24 volts.

3.1.2 INTEGRATED CIRCUITS:

Different ICs are used by inverters in each of their sections. Among the ICs utilized are the following:

1. PWM controller/oscillator

2. a working amplifier

3. IC regulators

3.1.3 RELAY:

An electromagnetic switch is a relay. Relays turn on and off depending on the flow of current via their coils. Relays are used to turn on and off different high-voltage circuits. Relays are used in inverters for several cut-off circuits and to switch the output between the AC mains supply and the supply produced by the inverter.

3.1.4 BATTERY

When the AC mains fail, a deep cycle lead accumulator (battery) supplies DC power to the inverter section. At the inverter output socket, this supply is changed into a 240v AC supply.

3.1.5 FUSE/CIRCUIT BREAKERS

These self-destructing devices guard the circuit from high Current flow. 3.1.6 CHANNELS Inverters frequently employ reset switches and on/off switches. The supply can be turned off and restarted using the reset switch.

3.1.7 PANEL INDICATOR (LED):

Light-emitting diodes are small semiconductor devices that emit light when a small forward current is applied to them.

3.1.8 OUTPUT DISPLAY METER (VOLT/AMPERE):

A voltmeter is used in inverters to indicate output voltage values.

3.1.9 TRANSISTORS:

In the inverter circuit, transistors are used to produce oscillation signals, amplify signals, and turn various circuits on and off.

3.1.10 MOSFET

A semiconductor die is covered with a layer of silicon dioxide (SiO), followed by a layer of metal (really, poly-crystalline silicon is used in place of metal), to create a metal-oxide-semiconductor (MOS) structure. Since silicon dioxide is a dielectric, its construction is similar to a planar capacitor with a semiconductor in place of one of the electrodes. The distribution of charges in the semiconductor is altered when a voltage is applied across a MOS arrangement. Power Due to their voltage control and extremely low instantaneous input current, MOSFETs simplify circuits. When there is a power outage, the circuit's alternating output is handy. Due to the absence of the secondary breakdown phenomenon exclusive to the bipolar transistor, they are exceedingly resilient. Because they are not subject to tiny carrier delays and storage duration, power MOSFETs are substantially faster than comparable-sized bipolar transistors. The MOSFET, which has a positive temperature coefficient, defends itself by distributing 18 currents evenly throughout the silicon chip. A bipolar transistor's base experiences a current concentration that results in hot spots, especially when the collector-emitter voltage is high.

MOSFET STRUCTURE

The modification of charge concentration brought on by a MOS capacitance is the foundation of a metal-oxide-semiconductor field effect transistor. It has two terminals (the source and drain), each of which is coupled to a different highly doped area. These regions may be P or N types, but they both fall under the same type category. The regions that have been heavily doped are often identified by a "+" after the type of doping. A doped zone of the opposite type, known as the body, divides these two sections. The absence of a "+" symbol indicates that this area is not heavily doped. A third electrode, the gate, which is positioned above the body and is isolated from every other zone by an oxide, makes up the active region, which is a MOS capacitance. The source and drain are in the N+ area and the body is in the P region if the MOSFET has an N-channel. A positive gate-source voltage produces an N channel at the p region's surface, just below the oxide, when it is applied. The transistor's conductivity is provided by this channel, which extends from the source to the drain.

3.1.11 REGULATORS:

The regulator is a part that has an internal standard voltage with which it continuously checks the supply's actual output. It then electronically controls the resistor in the circuit to make the necessary modifications. Because many electronic circuits place a variable load on their power supplies, the regulator is important because many circuits will not operate as intended if the supply voltage changes. Internal short circuit current limiting and thermal overload protection are provided by the regulator IC. Input, ground, and output are its three terminals. The last two digits of the IC part number indicate the voltage. This inverter uses the IC 7812 regulator, which provides l2Vdc.

3.2 BASIC WORKING PRINCIPLE OF THE INVERTER

The AC mains supply goes to the mains sensor, which then notifies the relay of the availability of the AC mains through a signal from the AC mains sensor. The relay then transfers the AC mains signals directly to the inverter output socket. This AC mains supply is transformed into a DC supply at the battery charging stage. The needed voltage and current to charge the inverter battery are then provided by regulating the DC supply. A 50Hz frequency MOS drive signal is produced by an oscillator section inside the inverter when the AC mains supply is unavailable. The output portion receives an amplified version of this MOS drive signal. MOSFET devices are used in the output portion to switch electrical current. These MOSFETs are linked to the inverter transformer's primary winding. 20 These MOSFETs begin to turn on and off at a frequency of 50Hz as soon as they receive the MOS driving signal from the driver section. An alternating current with a 501-Iz frequency is started at the primary winding of the inverter transformer as a result of the MOSFET turning on and off. As a result, a changeover relay sends a 240V AC supply (with a 50Hz frequency) from the secondary winding to the inverter's output socket.

3.3 CIRCUIT DESCRIPTION OF PWM-BASED 24V MOSFET INVERTER

PWM, also known as pulse width modulation, is utilized to maintain a steady 240V for the inverter's AC supply output. When the value of the load attached to the inverter output varies, the inverter output of a typical inverter also changes. Based on the value of the load connected to the inverter output socket, the PWM-based inverter adjusts the output value. This is accomplished by adjusting the oscillator's switching frequency's breadth. The AC supply at the inverter output of a PWM-based inverter depends on the oscillator frequency generated by the oscillator section's width. In this inverter, the PWM controller IC provides a small portion of the inverter output as a reference voltage. The PWM portion will alter the oscillation pulse width produced by the oscillator section based on this reference voltage. The inverter output will always remain constant even if the load on the inverter output changes since this change in width will compensate for any change in the inverter output.

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3.4 TO OBTAIN 50Hz FREQUENCY BY THE OSCILLATION SECTION

This inverter's oscillation component makes use of a PWIVI controller IC (SG3525). This IC is used to create the 50Hz frequency needed for the inverter's AC supply. Through the inverter on/off switch and diodes, battery power is delivered to the IC's pin 15 to initiate this operation. 21 The negative terminal of the battery is linked to Pin-8 of the IC. The 24V supply from the battery is regulated by a voltage regulator. Pins 6 and 7 are found in the oscillation section. The value of the capacitor and resistance at these pins determine the frequency that the IC1 generates. The capacitors control the IC's output frequency, which is 50 Hz. The timing resistance pin is Pin 6. At this stage, a resistance maintains the oscillator frequency. The flip-flop section of the integrated circuit receives the signal produced by the oscillator section. The received signal is changed into a signal with changing polarity in this section. When there are two polarity-changing signals, the first signal will be positive when the second signal is negative, and vice versa when the second signal turns positive. This happens 50 times per second, or 50Hz, creating an alternating signal inside the flip-flop part of the IC. The MOS Drive Signal is the term for this alternating signal.

3.5 OUTPUT SECTION

Each MOSFET channel receives the 501-Iz alternating MOS drive signal independently. As a result, the MOSFET channels turn on and off alternately. The procedure of turning on and off is done 50 times every second. The heat sink, which absorbs and dissipates heat in the circuit, is linked to the drains (middle pins) of all the MOSFETs in a single channel. The input signal is connected to the gates of the MOSFETs in one channel via resistors, which also serve to limit the pulses entering the gates. The ground is made up of a group of connections between the sources of the MOSFETs. Only one channel from the output remains on at a time, the other channel being kept off, due to the differing polarities of the 50Hz MOS driving signals at pin-i I and pin-14. The first half of the inverter transformer's center-tapped winding receives current when the 22nd MOSFET channel is turned on. Current travels through the second half of the inverter transformer's winding when the second MOSFET channel switches on. An alternating current will commence in the inverter transformer's winding as a result of the MOSFET channels being turned on and off.

3.6 DRIVER SECTION

The MOS Drive signal from pin-il and 14 of IC is given to the base of the MOS driver Ti and T2. This results in the MOS drive signal getting separated into two different channels. Transistors Ti and T2 amplify the 50Hz MOS drive signal at their base to a sufficient level and output them from the emitter. The 50Hz signal from the emitter of Ti is given to the gate G of the first MOSFET channel through a resistance. Likewise, the 50Hz signal from the emitter of T2 is given to the gate G of the second MOSFET channel via resistance.

But,

$$N_s/N_p \; V_s/V_p \; \text{‘r’}Ts = n$$

Where n = transformer turns ratio

If Vp = 24V; V 240V; N5 = 600 turns

Therefore, Vs/Vp = 240/24 =10

Andn=Ns/Np

NP = 600/10 = 60 turns 23

The transformer is a center tap at its primary, with the number of turns (N_p) 60 in each winding.

3.7 CHARGING SECTION FOR BATTERIES

The inverter component stops operating when it receives AC mains power, however, the charger section in the inverter begins operating and begins charging the battery.

3.8 A DESIGN ANALYSIS OF THE DRIVER CIRCUIT

$$V_{/N} — V_{BE} = I_{BRB}$$

$$H_{fe} = I\ C/IB$$

From Above,

$$RB = (V/_{IN'}— V_{BE.})\ /1_B$$

Were,

Ic = collector current

I_B = base current

V_{IN} = input voltage

V_{BE}= Base-Emitter voltage

H_{FE} = current gain

From the datasheet,

$$1c=100 \text{ mA}$$

$$hfe = 700$$

$$V_{BE}= 0.7 \text{ v}$$

Therefore,

$$I_B \ 100\text{mA}/700$$

$$I_B = 0.1429 \text{ mA}$$

$V_{IN}= 7.5$ v

$$R_B = (7.5- 0.7)10.1429 \text{ x}103$$

$$= 47{,}585.72\Omega$$

$$= 47.59\text{k } \Omega$$

The nearest preferred value to 47.59k1 was chosen, therefore 50k was used in the design of the inverter for the base resistors of the NPN transistors of the driver stage.

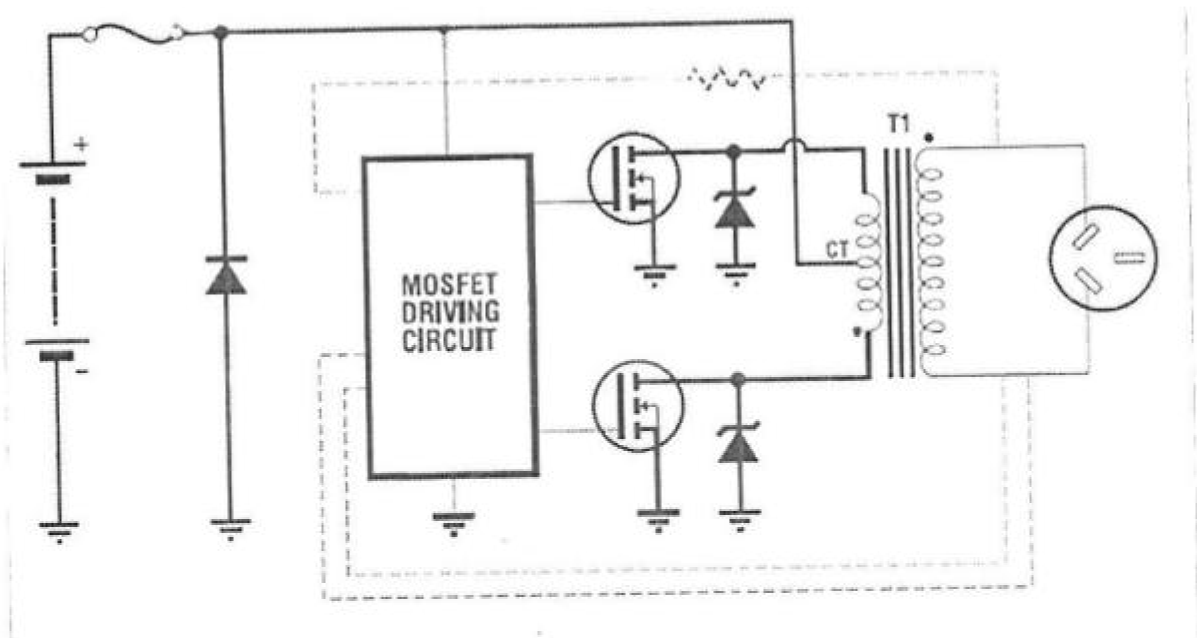


Fig 1: The fundamental design for DC-AC Inverters

3.9 THE TRANSFORMER

This is a static piece of machinery or apparatus that converts electrical power from one circuit into electrical power from another circuit without changing the frequency. With a corresponding drop or increase in current, it can raise or lower the voltage in a circuit.

A transformer's operation relies on mutual induction between two circuits connected by a shared magnetic flux, or two coils that are electrically distinct but magnetically connected by a low-reluctance route. A component like a transformer is required for the inverter to be effective in managing appliances that consume alternating current with a greater power rating than what is available in the circuit.

3.10 CENTRE TAP TRANFORMER

A center tap in electronics refers to a connection made at a point midway along the winding of an inductor or transformer, the element of a resistor, or the potentiometer. On inductors, taps are occasionally employed to couple signals; they may not always be at the halfway point, but rather, closer to one end. This is frequently used in the Hartley oscillator. Because there is only one winding, inductors with taps also allow the transformation of the amplitude of alternating current (AC) voltages for power conversion. In this scenario, they are known as auto-transformers. An illustration of an auto-transformer is an ignition coil for a car. Along with the customary connections at each of the device's two ends and the slider connection, potentiometer tapping offers one or more connections along the element of the device.

Circuit functionalities that would not be possible with the standard setup of simply the two-end connections and one slider connection are now possible thanks to potentiometer taps. The voltage output of a center-tapped transformer is known as volts center-tapped (VCT). A 24 VCT transformer, for instance, will measure 12 VAC from each outer tap to the center tap (half winding) and 24 VAC across the outer two taps (winding as a whole). Due to the 180-degree phase difference between these two 12 VAC supplies, it is simple to create positive and negative 12-volt DC power supplies from them.

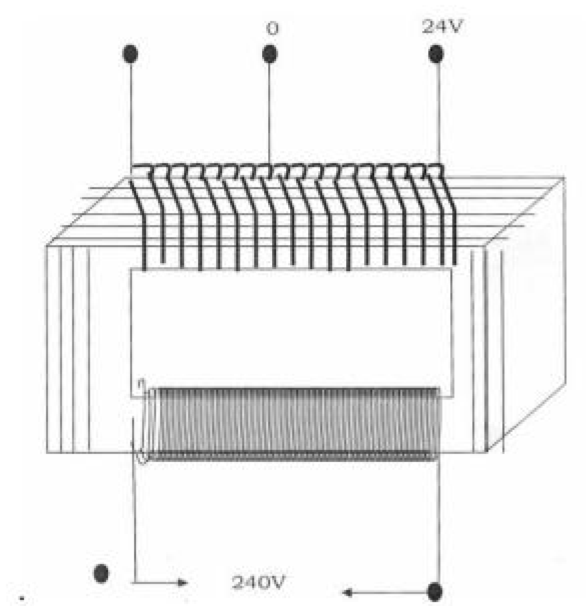


Fig 2: A Centre tapped Transformer

3.11 HOW TO CHOOSE THE RIGHT INVERTER AND BATTERY

An electronic power generator known as an inverter transforms low-voltage direct current (DC) from a battery to high-voltage alternating current (AC). Sometimes, especially at night, power outages can be frustrating. Inverters will assist you in overcoming the blackout and solving your issues. It's not always simple to choose the correct inverter and battery.

Load Calculation: To start, figure out your power use. The Watts (W) of all loads that will be powered by the inverter, such as CFLs, TVs, etc., can be added to determine this. For instance, 20+60 = 80W for a 20W CFL and a 60W TV.

Inverter Capacity: Never select the Volt-Ampere (VA) rating of the Inverter. VA=Watts x Power Factor. The power factor value varies from 0.6 to 0.8. Note that a 600VA-rated inverter (with a power factor of 0.8) delivers approximately 480 Watts only!

Inverter Type: Square wave, Quasi-Sine wave, and Pure Sine wave inverters are now available. In practice, a sine wave is the correct waveform on which all electronic equipment, including televisions and computers, are designed to run.

Battery Selection: The battery is the backbone of any inverter. Usually, a 12V battery is used with home inverters. Tubular-type storage batteries are recommended for inverters because they are capable of long hours of guaranteed backup time. Backup time is simply the number of hours for which an inverter will be able to run the output electric load during power failure. Batteries are available in different voltage and Ampere-Hour (Ah) ratings. Backup time is mainly determined by the Ah rating of the battery. Tubular batteries have a higher capacity-to-size ratio. These types can be recharged faster and are energized to deliver increased power and higher efficiency.

Backup Time: The formula to Calculate the backup time of the Inverter is Ahx12V x PFx0.9/Load VA hours. Where Ah is the ampere-hour capacity of the battery, PF stands for the power factor of the inverter and load is the sum of VA ratings of the electrical loads connected to the inverter.

Quick Selection: 800VA sine wave inverter with a 130 Ah tubular battery for a maximum backup of nearly 3 hours @600Watts.

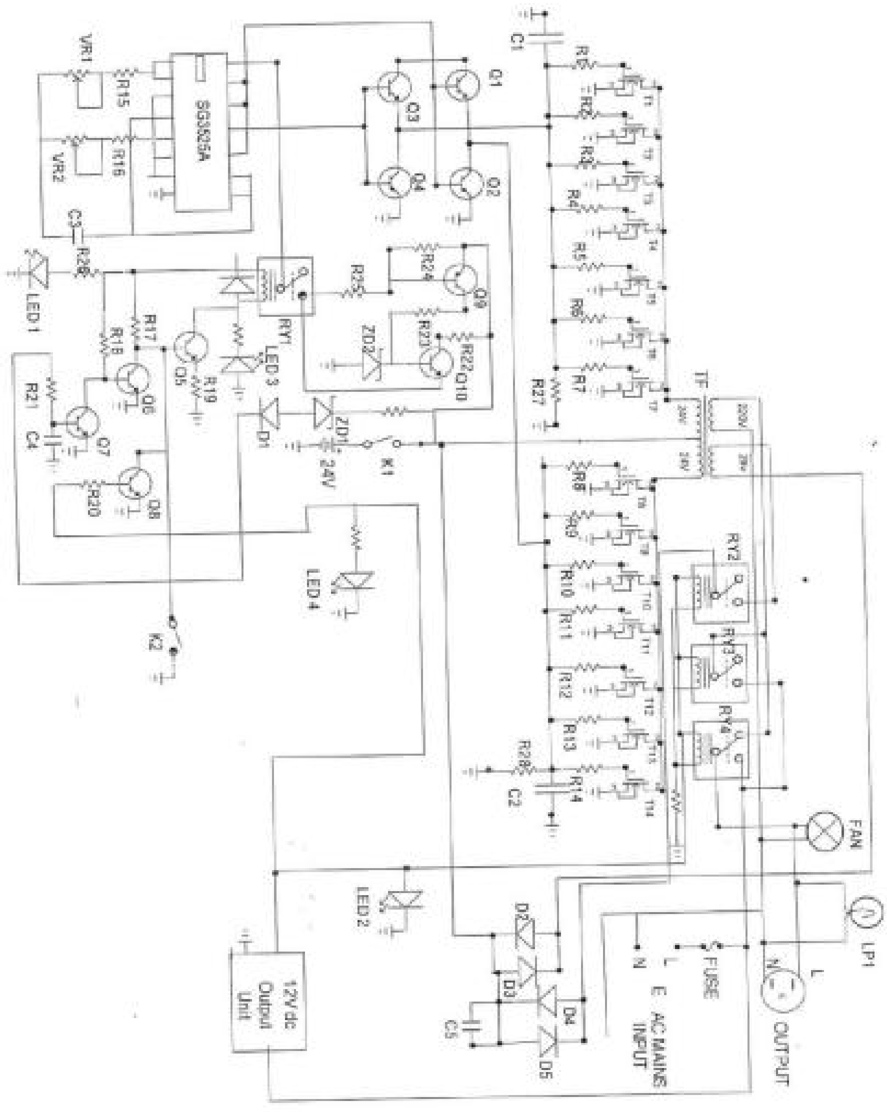


Fig 3: CIRCUIT DIAGRAM OF INVERTER

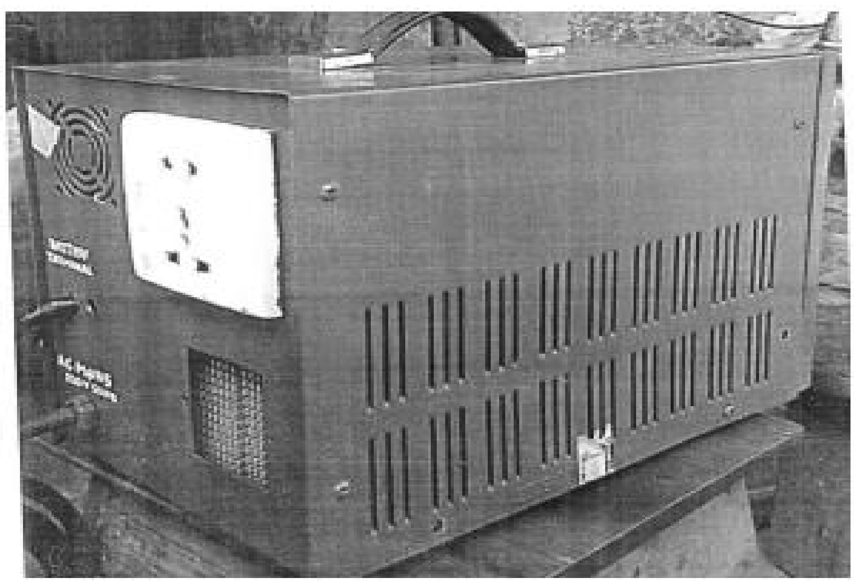
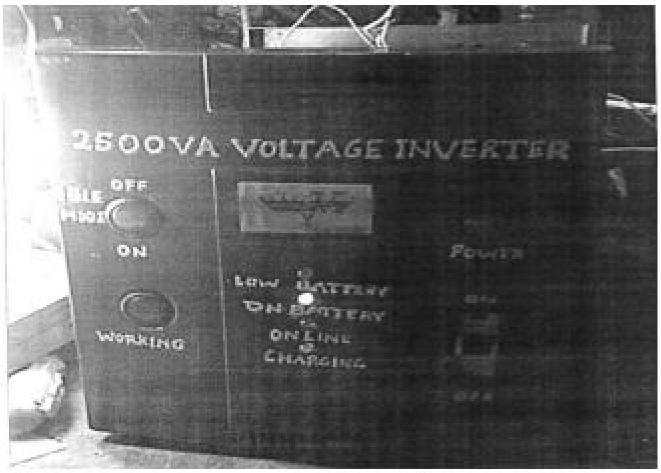
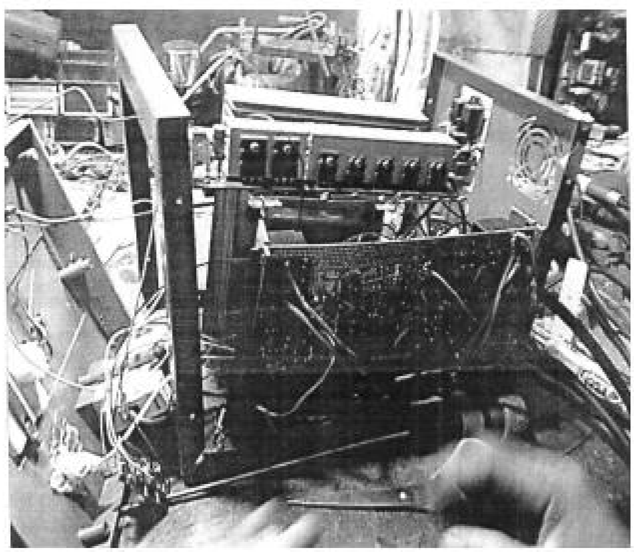


Plate 1: PHOTOGRAPHS OF THE PROJECT (Showing Front, Back and Internal View)





3.12 FABRICATION PROCESSES

The fabrication processes involved in the development of a 2.5KVA solar power generator are Bench fitting operation, welding operation, material selection, and Bill of Engineering Materials and Evaluation.

1. Bench Fitting Operation: Bench fitting operation is a process of assembling and finishing metal parts by hand using various tools and techniques. It is a common practice in engineering workshops to produce components that require high accuracy and precision. Some of the tools and techniques used in bench fitting operations are:

- Holding tools: These are tools that are used to hold the workpiece firmly and securely while performing other operations. Some examples of holding tools are vices, clamps, pliers, etc.
- Striking tools: These are tools that are used to apply force or impact on the workpiece or other tools. Some examples of striking tools are hammers, mallets, punches, etc.
- Cutting tools: These are tools that are used to remove excess or unwanted material from the workpiece by cutting, sawing, filing, chiseling, etc. Some examples of cutting tools are hacksaws, files, chisels, drills, etc.
- Marking, measuring, and testing tools: These are tools that are used to mark, measure, and test the dimensions, shape, and quality of the workpiece. Some examples of marking, measuring, and testing tools are rulers, calipers, dividers, scribes, gauges, etc.

2. Welding Operation: Welding is a process of joining two or more metal parts by melting and fusing them. Welding is used in the fabrication of solar power generators to connect the solar panels, the frames, the batteries, and the inverters. Welding can be done by using different methods, such as arc welding, gas welding, resistance welding, etc. Each method has its advantages and disadvantages, depending on the type, thickness, and shape of the metal parts.

3. Material Selection: The materials involved in the fabrication processes are: Mild steel, angle bars, and rollers.

I. Mild Steel: Mild steel is a type of steel that has a low carbon content, usually less than 0.25%. It is one of the most common and widely used forms of steel, because it is cheap, easy to form, and has adequate strength for many applications. Mild steel is also known as low-carbon steel or plain-carbon steel.

Mild steel has various properties that make it suitable for different purposes. Some of these properties are:

- Density: Mild steel has a density of about 7850 kg/m3, which means it is relatively heavy compared to other metals.
- Strength: Mild steel has a moderate tensile strength, ranging from 400 to 550 MPa, depending on the grade and composition. It also has a good yield strength, which is the stress at which it begins to deform permanently.
- Hardness: Mild steel has a low hardness, measured by the Brinell scale, of about 120 BHN. This means it is soft and easy to cut, drill, or file.
- Melting point: Mild steel has a high melting point of about 1450 °C, which means it can withstand high temperatures without losing its shape or properties.
- Weld-ability: Mild steel has excellent weldability, which means it can be joined with other metal parts by melting and fusing them. Welding is a common method of fabricating mild steel products.
- Machinability: Mild steel has excellent machinability, which means it can be shaped and finished by using various tools and techniques, such as turning, milling, grinding, etc. Machining is another common method of fabricating mild steel products.
- Ductility: Mild steel has high ductility, which means it can be stretched or bent without breaking or cracking. Ductility is an important property for forming and shaping mild steel products.
- Magnetic: Mild steel has good magnetic properties due to its high iron content. It can be attracted by magnets or magnetized by electric currents. Magnetic properties are useful for some applications, such as motors, generators, or transformers.

II. Angle Bar: Angle bar is a material that is commonly used in construction, engineering, and fabrication. It is also known as angle iron, L-bracket, or steel angle. It is a metal bar that has an L-shaped cross-section, with two sides perpendicular to each other. Angle bars can be made of different types of metal, such as carbon steel, stainless steel, aluminum, or brass. Angle bars can have equal or unequal legs, depending on the intended use and design.

Angle bar has various properties and advantages that make it suitable for different purposes. Some of these are:

- Strength: The angle bar has a moderate tensile strength and yield strength, which means it can resist stretching and bending forces without breaking or deforming. Angle bars can also support heavy loads and withstand high temperatures.
- Durability: The angle bar has a high resistance to corrosion and rust, especially if it is galvanized or coated with protective materials. Angle bars can also last for a long time without wearing out or losing their shape.
- Versatility: Angle bars can be cut, drilled, welded, or bent into various shapes and sizes to fit different needs and specifications. Angle bars can also be joined with other metal parts by using different techniques, such as riveting, bolting, or soldering.
- Cost-effectiveness: Angle bar is relatively cheap and easy to produce compared to other metal materials. Angle bars can also reduce the cost of construction and fabrication by saving time and labor.

CHAPTER FOUR

RESULT ANALYSIS

4.0 CONSTRUCTION PROCEDURE AND TESTING

The following processes were appropriately taken into account when creating this project,

i. Determine the intended use of all materials and components;

ii. Use an ohmmeter to test the resistance of newly purchased components before connecting them to other components as needed.

iii. Making a schematic diagram or planning the placement of the materials or components.

iv. Testing the finished system to see if the design works, and

v. Finally, project implementation.

After obtaining all the necessary equipment, I proceeded to arrange the components on the Vero board. We were unable to place the MOSFETs on the breadboard due to the heat they produced when loaded, so proper soldering of the components was done next. After each component was soldered onto the board, the completion was properly verified. The construction procedures are as below:

1. Assemble the oscillator section, which is made up of small components and an integrated circuit, first, following the instructions on the circuit diagram. By connecting the part leads themselves and fusing the joints, it is finely finished.

2. Next, put the power transistors into the aluminum heat sinks with acute piercings. This is made by bending the sides of aluminum sheets that have been cut into the required sizes so that they may be held securely.

3. To avoid short circuits and direct contact between the transistors and the ground, use a mica isolation kit to mount the transistors to an aluminum heat sink.

4. Secure the heat sink assembly to the bottom of a robust, thick-gauge metal enclosure that is properly vented.

5. Use screws and bolts to secure the power transformer next to the aluminum heat sinks.

6. Attach the constructed circuit board's proper points and the power transistors to the aluminum heat sinks.

7. Lastly, connect the power transistor's outputs to the second winding of the power transformer.

8. Finish the assembly by tightening and interlocking all of the external electrical fittings, including the battery inputs, fuses, sockets, and mains cord.

9. To recharge the battery as needed, a transformer and an optional solar power supply circuit may be placed inside.

4.1 PACKAGING AND CASE-MAKING

The Vero Board was assembled using solder for every component. The entire circuit was installed in a case after which other external parts, including indicators, battery connectors, and switches, were added.

4.2 NO-LOAD TEST

The inverter circuit was wired using two 12-V sealed rechargeable batteries connected in series with one another. While the battery's negative terminal was linked to the general ground of the inverter circuit, the battery's positive terminal was connected to the center tap of the 32-inverter transformer. The transformer made a loud buzzing noise when the inverter was turned on, indicating that the output voltage was excessive. Using a screwdriver, the variable resistor in the control circuit Figure 6 was turned to alter the pulse width output. The terminals of a digital multi-meter were inserted into the socket to ascertain the precise output voltage value. The output voltage was lowered to 240V in this manner.

4.3 LOAD TEST

The 2,500-watt inverter was put to the test with a load of 1940 watts, which included a refrigerator (1200 watts), four high-energy lights (40 watts each), a standing fan (60 watts), a television (200 watts), a DVD player (240 watts), and a 60-watt tungsten lamp. It lasted for almost five hours under the stated load of 1940 watts. The transformer's hum might be tolerated

Refrigerator	1200W,
4 High energy bulbs (40W each),	160W
Standing Fan	60W
Television	200W
DVD player	240W
Tungsten lamp	60W
Total power	1940W

The calculation is stated below; 33

Battery rating = 200AH; 1 2V

However, there are two batteries, hence when connected in series to have the 24V supply, the battery rating will be 400AH; 24V. The power rating of the battery in VAhr

= 400AH x 24V

=9600VAHr

Total Load for testing 1 940W 1 940VA

Time required for the battery to discharge,

= 9600/1940

=4.94845HRS

= 5Hrs Approximately

4.4 ASSEMBLING OF SECTIONS

After providing the casing and completing the fabrication of the system's sections, the assembly into the casing came next. The sections were correctly arranged and put together into the casing, which served as the location for general coupling and linkages to the external equipment.

Finally, the indication that shows when the system is powered was brought out. The system's power switch and the battery contacts that link the batteries were both hauled out. The solar panel was finally hung.

4.5 TESTING OF SYSTEM OPERATION

The system needed to be tested and put to use at this point. The system's functionality was tested to ensure that it maintained all of the necessary performance.

The system was powered by the switch after the batteries were connected, and an ON LED was displayed. After the system was powered on, a load of more than 500W was placed on it and allowed to remain there for more than 20 minutes to track the amount of heat the MOSFETs would release and determine whether the system could support such a load.

4.6 SAFETY OF A SOLAR INVERTER

Only fully charged, in good condition batteries should be utilized with power inverters. If demand is excessively strong, a weak battery will be quickly discharged.

Working with large batteries can be risky, and improper handling might cause significant damage. A power inverter used improperly can even cause electrocution. To ensure their safety, anyone attempting to connect a solar inverter directly to a battery should read and abide by all safety instructions provided in the inverter's instruction manual.

People should make sure to utilize power inverters that have a high enough rating for the equipment they need to operate at all times. For instance, if a powerful power saw is connected to a cigarette lighter, the small inverter could overheat and catch fire inside the dashboard. Avoid using adapters that provide more outlets than the device is made to support, and ensure that the area around the inverter has adequate airflow to prevent overheating.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 DESIGN PROBLEMS

The following issues in this design project were found:

i. The difficulty in achieving the intended output frequency of 50 Hz, as components had to be chosen, tested, and then re-chosen because the initial frequency was between 45 and 48 Hz.

ii. Replacing some integrated circuits (ICs) that were harmed by too much current during soldering.

iii. Due to heat during soldering, some transistors were damaged and conducted in reverse.

iv. Equipment construction and testing with a power outage

v. Component values that deviate from their rated values for a variety of reasons, such as environmental conditions or manufacturing mistakes.

vi. When picking inverter ratings, take into account how big the electrical loads the inverter will be running.

5.2 RECOMMENDATION

The design and installation of three-phase inverters should be encouraged for industrial applications since this project can be used as an alternative power source for household and medical gadgets. It is highly advised to use it in remote locations without power, where solar energy can be used. Future inverter designs should incorporate faster switching devices, improved overload, over-current protection, and more efficient charging circuits

5.3 CONCLUSION

The primary goals of this project, which included the creation of a 2500-watt inverter capable of ensuring supply during PHCN power outages, the abolition of power spikes, energy management, and a decrease in the amount of money spent on fuel and generator maintenance, were achieved. The inverter, which is more ecologically friendly, simpler to use, and needs less maintenance than a generator, can assist in resolving the energy problem in a studio apartment or small apartment.

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