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Solar and Conventional Digital (Dual) Inverter Using Mosfet

S. Mahalingam[1], N. Kumaresan, A. Kandasamy[2]
[1,2]PG Department of Physics, L.N. Govt. College, Ponneri 601 204, Tiruvallur District, Tamilnadu, India

Abstract: The development of renewable energy such as the sun, geothermal, biomass and wind has become an important contribution to the total energy consumed in the world. This alternatives source of electrical energy can never be exhausted. They cause less emission and therefore stand out as a potentially feasible source of clean and limitless energy. These resources do not cause any significant environmental pollution or substantial health hazards and apparently available as natural abundant resources. Solar energy is amongst the highest development of renewable resources.

A solar inverter converts the variable direct current (DC) output of a photovoltaic (PV) solar panel into a utility a frequency alternating current (AC) that can be fed into a commercial electrical grid or used by local, off grid electrical network. It is a critical component in a photovoltaic system, allowing the use of ordinary commercial appliances. Solar inverter has special functions adapted for use with photovoltaic arrays, including maximum power point tracking and anti-islanding protection.

The main objective of our project is to design a construct solar and conventional digital inverter using MOSFET that produces electrical energy and operate in dual mode, supply standalone AC loads, while minimizing its cost and size they systems main property is to production of quality electricity from a renewable source to reduce dependence on fossil fuel and the associated with emission of pollutants, our goal is to develop and design an inverter that will handle the task.
Keywords: Inverter, Solar cell, Battery & Solar charge controller.

I. INTRODUCTION

An inverter is a device that changes the D.C. voltage into A.C. voltage. A direct current (D.C) is a current that flows in only one direction, while an alternating current (A.C.) is that which flows in both positive and negative directions. At the early stage, the sun was the source of energy for generating power. Due to the inadequacy of the power generated through this source, there was a need to find other ways to improve the power supply when the generating station could not meet the demand of the people. As the technology advances, the hydroelectric generation was developed, gas firing, generating station, and wired tubing methods of generating power supply were developed. In spite of all these developments, there was still a failure in electrical power generation as a result of obsolete equipment at the generating stations. There was still need to find alternative for solving the problem. As a result of this, some options like alternators, inverters and others were developed. The electrical inverter is a high power electronic oscillator. It is so named because early mechanical AC to DC converters was made to work in reverse, and thus was “inverted”, to convert DC to AC. The inverter performs the opposite function of a rectifier formed in 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 set). 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 thirteen. The origins of electromechanical inverters explain the source of the term inverter. Early A.C to D.C converters used an induction or synchronous AC motor direct – connected to a generator (dynamo) so that the generator 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 end only one field frame.

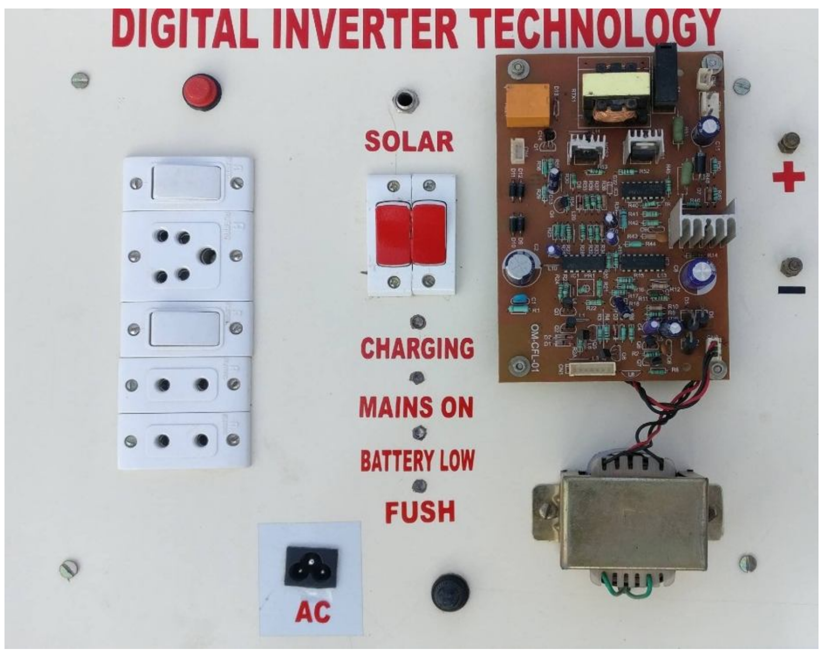
The result is either AC – in, DC – out with an M-E set, the DC can be considered to be separately generated from the AC, with a synchronous converter, in a certain sense it can be considered to be mechanically rectified AC” Given the right auxiliary and control equipment, an M-G set or rotary converter can be run “backwards”, converting DC to AC. Hence an inverter is an inverted converter. There have been a large number of articles written concerning power conversion in recent years. This can be attributed in part to the rise in popularity of high voltage DC transmission systems. And their integration with existing AC supplies grids.

Electricity generation is the first process in the delivery of electricity to consumers. The other processes are electric power transmission and electricity distribution. The importance of dependable electricity generation was revealed when it became apparent that electricity was useful for providing heat, light and power for human needs. Electricity has been generated for the purpose of powering human technologies for at least 120 years from various sources of energy. The first power plants were run on wood, while today, we rely mainly on petroleum, natural gas, coal, hydroelectric and

Nuclear power and a small amount of hydrogen, solar energy, tidal harness, wind generators and geothermal sources. In solar energy, the sun has been worshipped as life - giver to our planet since ancient times. The energy supply from the sun is truly enormous on average's the Earth's surface receives about 1.2 x 1017W of solar power. This means that in less than one hour enough energy is supplied to the Earth to satisfy the entire energy demand of the human population over the whole year. Indeed, it is the energy of sunlight assimilated by biological organisms over millions of years that has made possible the industrial growth as we know it today. Most of the other renewable means of power generation also depend on the sun as the primary source: hydroelectric, wind and wave power all have the same origin. Energy source such as photovoltaic are needed to help reduce the levels of greenhouse gases in the atmosphere and alleviate this global warming.

II. DESIGN AND CONSTRUCTION OF DUAL INVERTER

The inverter is a two operation modes device, the inverting and the charging mode. The inverting mode comprises of the oscillator, the driver, the output (MOSFET) section, the PWM section, low battery / overload protection circuit, and the transformer. The charging mode implements the transformer, the FET"s (internal diodes) and the charging control circuit. A third operation mode is the changeover modes for switching between the two aforementioned mode at times of auto-back up for power failure and power restoration for the charging process. This mode implements a delay circuit, electromagnetic relays and power supply circuit.



III. TRANSFORMER DESIGN OF AN INVERTER

A transformer is a device that couples, two AC circuits magnetically and provides electrical isolation between the circuits while allowing a transformation of voltage and current from one circuit to another, i.e. it is mainly used in voltage and current transformation and hence we made use of current voltage transformers in this project.

IV. MATERIAL AND METHODS IN AN INVERTER

A BP250/2 solar module is composed of individual solar cells. This crystalline silicon module type has an aluminium frame and glass on the front. In the field of photovoltaics, a solar module is a packaged interconnected assembly of solar cells. An installation of photovoltaic module or panels is known as a photovoltaic array PV Module generate DC electrical energy when exposed to sunlight. Although single module produce only a low voltage and current, shocks and burns are still a potential hazard. The shock hazard increases as module are connected in series producing a higher voltage and the burn hazard increases as modules are connected in parallel producing higher current. PV module can be made safe to work on by fully converting the front surface with a dense, opaque material such as the carton or placing module face down on a flat surface. A voltmeter can be used to verify that the output voltage is safe. Most frequently, cells in a solar module are interconnected in series. The 3 BP 250/2 50Watts solar module were connected in series so as to increase it output voltage and appropriate measurement were taken.

A. Construction And Mode Of Operation Of Solar Charge Controller

A solar charge controller limits the rate at which electric current is added or drawn from electric batteries. It prevents overcharging and may prevent against over voltage, which can reduce battery performance or lifespan and may pose a safety risk. It may also prevent completely draining ("deep discharging") a battery, or perform controlled discharges depending on the battery technology to protect life. The circuit shown in the Appendix A is a simple solar charge controller, which stops charging the battery when they exceed a set high voltage level, and re-enable charging when battery voltage, drops back below that level.

B. Construction of an inverter and mode of operation

This construction consists of different stages coupled together to perform a specific purpose and the circuit diagram were originally placed on a breadboard and later transferred to the ferroboard for proper construction. The circuit diagrams were shown in the Appendix B and the stages involved in the construction of the inverter include:

1) Sourcing stage
2) Regulating stage
3) Oscillating stage
4) Driving stage
5) Transformation stage
6) Output stage
7) Change-over stage
8) Battery charging stage

C. Sourcing Stage

This stage consists mainly of direct current (D.C) battery and in this case is from Solar panel. The battery provides 24V direct current (D.C) supply to the inverter system when the alternating current (A.C) from the main supply fails.

D. Regulating Stage

The regulating stage consists of an IC voltage regulator. This is a three pin 9V IC voltage regulator. It is a simple precision regulator that regulates the supplied voltage down to 9V from initial supply voltage of 24V from the battery. The regulated voltage is then used by the oscillator to come on.

E. Oscillating Stage

The oscillating stage is the heart of the inverter design. An oscillator is essentially an electronic circuit design to produce an alternating current signal of known a frequency and waveform. The inverter system needs to generate signal at a frequency of 50Hz. As a result, there has to be a kind of the oscillator circuit for this to be achieved. Here, a Pulse Width Modulation (PWM) regulator controller IC is used for the oscillator circuit. It is a common IC which has an internal RC (regulator controller) which could be made to oscillate to frequencies in excess of 1MHz depending on external component used. The IC contains various sections such as ERROR AMPLIFIER, SHUT DOWN, + 5V REGULATOR, COMPESATION and all of these are used to control the inverter. The advantage of using the PWM regulator/controller IC is that it gives a low harmonic content in a frequency which is suitable for the induction load. The PWM IC was 9V regulated supply voltage and generate signals at a frequency of 50Hz which is sent to the driver for amplification through the pin 11 and 14 of IC.

F. Driving Stage

The driving stage is required to drive the current derived from the output of the oscillator to the amplifier. The stage consists of Metallic Oxide Semiconductor Field Transistor (MOSFET) which has high impendence. The transistor user are both PNP and NPN transistor which are connected in a push-pull arrangement. The MOSFET driver stage does not match the oscillator to amplifier, but also ensures that the stages of the MOSFETs when in parallel are properly isolated from each other even if they are driven from the same source. The MOSFET is driven by the signals output of the driving stage thus controlling the voltage at the gate of the MOSFETs which result in the MOSFETs channel being alternatively switched on and off. That is, when one second MOSFET channel switches on, the first MOSFET channel switches off. The switching action of the MOSFET channel which is a crucial process in the outlet section is done repeatedly 50 turns per second, that is, at frequency of 50Hz.

G. Transformation Stage

Here, a step-up transformer is used. It is a type transformer use for increasing voltage supply to a circuit. The step up transformer consists of two coils called the primary and secondary coils, wounded round a soft iron core that is made of sheets of soft iron. The secondary coil of this type of transformer is however greater than the number of turns in the primary coil. The primary winding of this step-up transformer is 24VDV- 24V and the secondary winding is a bifilar winding of 240V. The alternating current which entered into each end of the primary winding induced a alternating current at 50Hz in the secondary winding of the transformer and the alternating current voltage is stepped up by the transformer causing it to become 240V. The output voltage of the secondary winding is transferred to the socket outlet of the output of the inverter system.

H. Output Stage

The A.C voltage produced by the inverter reaches an output socket outlet. The voltage at this point is found to be 240V alternating current and is kept constant by the action of the Pulse Width Modulation of the IC.

V. PERFORMANCE EVALUATION

The inverter was tested on a section by section basis. The output voltage of the oscillator was obtained to be 4.24volts on each side with the frequency set to approximately 50Hz. The other unit could not be tested until the final coupling had been done. The battery overcharging protection unit, low battery cut off unit, low and high voltage surge protection as well as the time delay units, feedback unit and the overload and short circuit protection unit were all tested by varying the potentiometer associated with each of them and observing the response through the displays. The list of the various settings that were made is listed overleaf;

Inverter output voltage	220volts
Inverter frequency	50Hz
Minimum battery voltage	10.0volts
Maximum loading capacity	400watts
Minimum A.C. input voltage	120V
Maximum A.C. input voltage	250V

VI. SAFETY, MAINTENANCE AND PRECAUTION

A. The following maintenance practices and safety precautions are suggested to improve the lifespan of the system and prevent hazards to the users.
B. Dead batteries should not be used in the inverter
C. The battery terminals should not be removed too often. When it is removed, replacement of correct polarity must be ensured.
D. The inverter must be put in a moderate temperature.
E. The inverter should always be shut down when not in usage.
F. The inverter should always be partially loaded.

G. The use if inductive loads like refrigerator, induction device, etc. The inverter should be avoided.
H. The input plug of the inverter should be plugged properly and earthed socked.

VII. RESULTS AND DISCUSSION

The solar panels were taken outside and aligned to receive near normal incident sunlight. The panels were connected to the charging circuit and the circuit was wired to the battery. Trickle charge was initiated and Observation was made with constant 1A throughout testing. The battery read 22.9V before connection and then read 23.5V once a connection was made. It potential the increased for the next 2 hours until the voltage stopped at 24V. AC Output voltage from the inverter is 220V, the waveform is sine wave and the frequency is 50 Hz respectively. It was observed that 2.5 % of the total output power was lost during the testing and measurement, which may due to the components used for the construction

VIII. CONCLUSION

The construction of 1kVA inverter with control circuits is a novel design for optimum performance. The overload and battery short down is another control circuit to protect the inverter system from being damaged and to extend the lifespan of the battery in use. The monitoring circuit incorporated into the inverter system is another good ideal for non-professional to know the state of the system at a glance.

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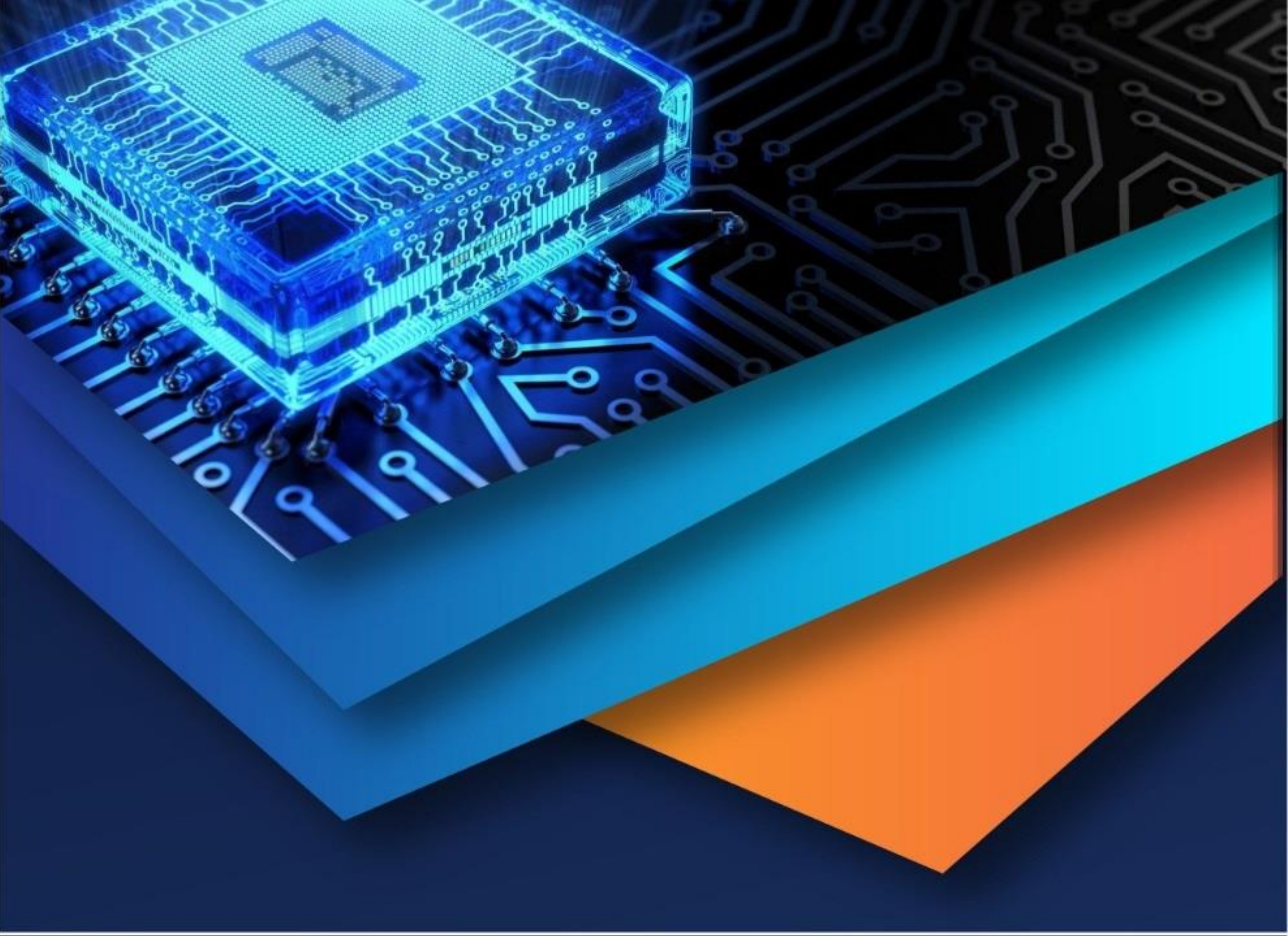

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