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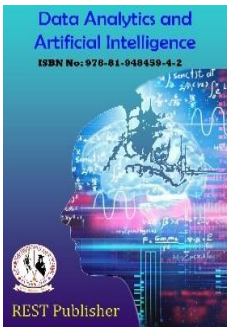

Microcontroller Based Solar Power Inverter

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Abstract. This paper presents the design and the implementation of a new microcontroller-based solarPower inverter. The aim of this paper is to design single phase inverter which can convert DC voltageto AC voltage at high efficiency and low cost. Solar and wind powered electricity generation arebeing favored nowadays as the world increasingly focuses on environmental concerns. Powerinverters, which convert solar-cell DC into domestic-use AC, are one of the key technologies fordelivering efficient AC power The hardware and software design are orientedtowards a single-chipmicrocontroller-based system, hence minimizing the size and cost. Withthis new approach themodularization of the conversion from solar power to electric power at its maximum power point canbe made more compact and more reliable.
Key words: Inverter, Microcontroller, Solar Panel, H- Bridge.

1. INTRODUCTION

Electronic devices run on AC power, however, batteries and some forms of power generation produce a DC voltage so it is necessary to convert the voltage into a source that devices can use. Hence a need for powerrating inverter to smoothly operate electrical and electronic appliances. Most of the commercially available inverters are actually square wave or quasi square wave inverters. Electronic devices run by this inverter willdamage due to harmonic contents [1]. Available sine wave inverters are expensive and their output is not so good. For getting pure sine wave we've to apply sinusoidal pulse width modulation (SPWM) technique. This technique has been the main choice in power electronics because of its simplicity and it is the mostly used method in inverter application [2]. To generate this signal, triangular wave is used as a carrier signal iscompared with sinusoidal wave at desired frequency. Advances in microcontroller technology have made it possible to perform functions that were previously done by analog electronic components. With multitasking capability, microcontrollers today are able to perform functions like comparator, analog to digital conversion (ADC), setting input/output (I/O), counters/timer, among others replacing dedicated analog components for each specified tasks, greatly reducing number of component in circuit and thus, lowering component production cost. Flexibility in the design has also been introduced by using microcontroller with capability of flash programming/reprogramming of tasks [3] The proposed approach is to replace the conventional method with the use of microcontroller. In this project PIC16F877A microcontroller was used. It has low cost and reduces the complexity of the circuit for the single phase full bridge inverter [4]. The focus of this report is on the design and prototype testing of a DC to AC inverter which efficiently transforms a DC voltage source to a high voltage AC source similar to the power delivered through an electrical outlet (240Vrms, 50Hz) with a power rating of approximately 600W. This paper investigates the application of microcontroller based solar power inverter operation during power disturbances. Also study the cost effectiveness and reduced the complexity of system of this microcontroller based inverter. This project builds upon the work of another project which mandated to buildthe DC to DC boost. In this report, it is detailed how the inverter's controls are implemented with a digitalapproach using a microprocessor for the control system and how effective and efficient a 3-level PWMinverter can be. The inverter device will be able to run more sensitive devices that a modified sine wave maycause damage to such as: laser printers, laptop computers, power tools, digital clocks and medical equipment.This form of AC power also reduces audible noise in devices such as fluorescent lights and runs inductiveloads, like motors, faster and quieter due to the low harmonic distortion.

2. PROPOSED MODEL

In this paper we have tried to reduce the cost & complexity of the conversion circuit by using a Microcontroller. It has been used to generate trigger pulses for the Mosfet so as to enable high speedswitching. Thus D.C. supply is converted into A.C.In this model there are manycomponent used are microcontroller, solar panel, timer IC555, Drivers,MOSFET, Capacitor, resistor, diode. An important piece of solar power supply is the DC to AC inverterwhich converts the DC voltage from a battery to an AC voltage that is necessaryto operate electroniccomponents. Due to the delicate nature of this equipment, an inverter which is capable of producing a puresine wave is necessary to avoid noise and wear on delicate and expensive gear. Many of these devices arevery expensive so it is the goal of this project to design a DC/ACinverter capable of producing a pure sinewave for use with domestic equipment.The Objectives of this project is to design an inverter that can be derived by 24V battery and can be usedto operate AC loads while minimizing the conventional inverter cost and complexity using Microcontroller Are,

1. Generation of pure sine wave inverter from the solar panel reducing the dependency on thefossil fuel andlimited the energy source
2. Reducing complexity by using microcontroller to generate modulation signal.

3. BLOCK DIAGRAM

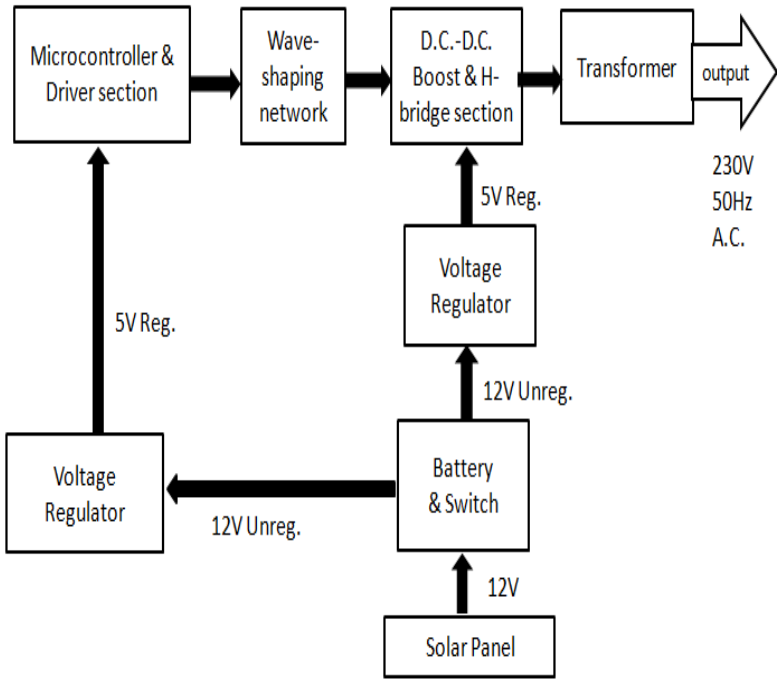
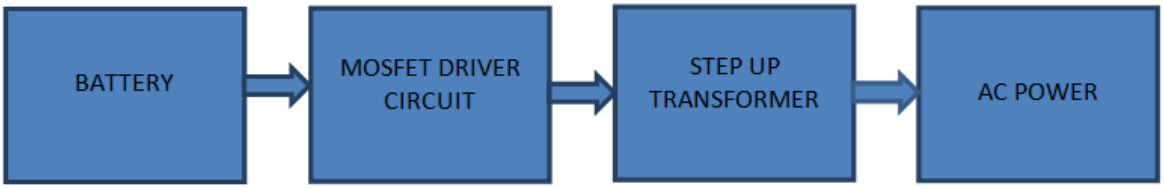


FIGURE 2. Block Diagram of Microcontroller based solar powered inverterInverter is an electronic device which is DC to ACconverter. It simply converts direct current toalternating current. Its name also indicates that it has exactly opposite operation to that of a rectifier.



BLOCK DIAGRAM OF INVERTER

FIGURE 3. Block diagram of Inverter

In this circuit DC input from battery is given to an inverter circuit and then its AC output to a transformer.When the switch is closed the current starts to rise in the circuit. This will make the transformer to generateanEMF, opposing the EMF of the battery. If we assume that the resistance of thetransformer is negligible,then the current will rise at a constant rate. This rise will depend on the inductance of the transformer; themore time will beneeded, to produce the required current to balance the EMF of the battery. Now if switchis opened before the current in the transformer grows fully, the current incircuit will start to fall. This willmake the transformer to generate reverse EMF. Now, once the circuit current reaches zero, theswitch isonce again closed and this whole process will start to repeat itself. So, by producing open, close cycle ofswitch in this circuit, we can produce ac current output from a dc current source i.e. battery. The outputfrom secondary winding oftransformer will be a square wave of frequency at which switch is opened andclosed; this is the basic working principle of inverter.Microcontroller Based Solar Power Inverter

Pulse Width Modulation: Pulse width modulation, or PWM, has become an accepted method for generating unique signals, due to theadvancement of microcontrollers and its power efficiency. To create a sinusoidal signal, PWM uses highfrequency square waves with varying duty cycles. Duty cycle is the percentage of time the signal is on relativeto the period. This means as the duty cycle increases, more power is transmitted. PWM requires rapid onand off signals, which can be achieved using high power MOSFETs. MOSFETs are ideal switches due tothe low power loss when the device is activated. It should be noted, however, that when a MOSFET is intransition between on and off, the power loss can be significant. For this reason, the transition times andfrequency should be engineered to be as short as possible. This can be achieved by minimizing theamplitudebetween the on and off stages and lowering the PWM frequency; however as the frequency decreases sodoes the signal quality.

Pulse width modulation inverter can be classified as;

1. Analog bridge PWM inverter
2. Digital bridge PWM inverter

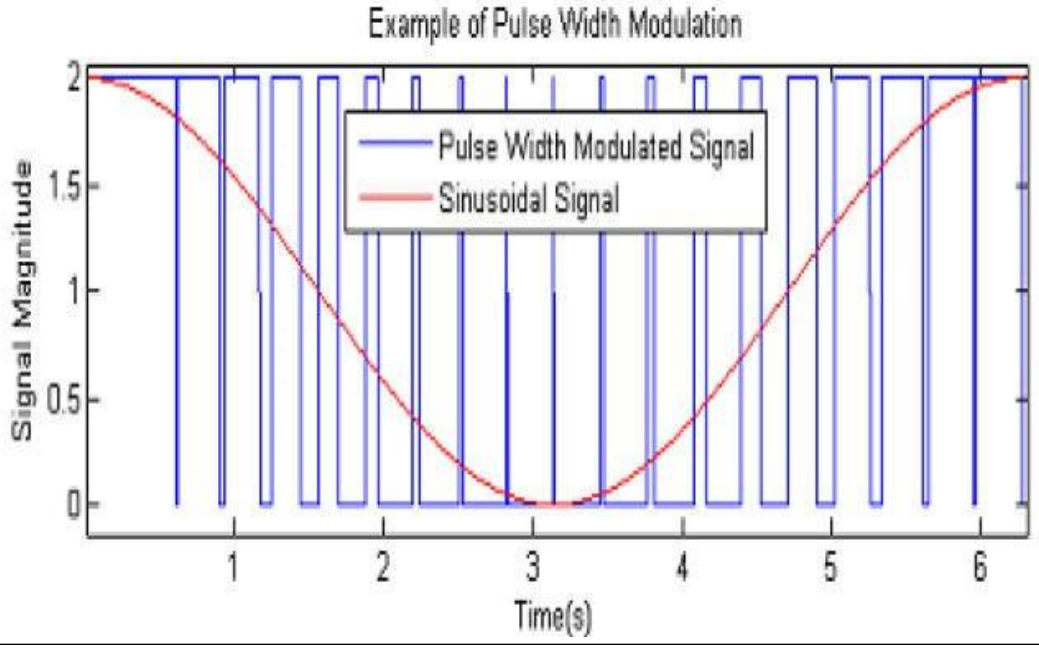


FIGURE 4. Pulse width modulations

Project Approach:While designing an inverter can be complex, it does become easier when broken down into its componentsteps. The following sections detail each component within the project, as well as how each section isconstructed and interacts with other blocks to result in the production of a 240V pure sine wave powerinverter.

Microcontroller: A microcontroller is a small computer on asingle integrated circuit containing a processor core, memory,and programmable input/output peripherals. A microcontroller can be considered a self-contained systemwith a processor, memory and peripherals and can be used as an embedded system.Why use a micro-controller**?**By reducing the size and cost compared to a design that uses a separate microprocessor, memory, andinput/output devices, microcontrollers make it economical to digitally control even more devices andprocesses. We use AT8535. It is a low-power, highperformance CMOS 8-bit microcontroller with 8K bytesof in-system programmable Flash memory. The device is manufactured using Atmel's high-densitynonvolatile memory technology and is compatible with the industry standard instruction set and pin out,memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. Bycombining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the AtmelAT8535 is a powerful microcontroller which provides a Highly-flexible and cost-effective solution toomany embedded control applications.The AT8535 provides the following standard features: 8K bytes of Flash, 256bytes of RAM, 32 I/Olines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interruptarchitecture, a full duplex serial port, on-chip oscillator and clock circuitry. In addition, the AT8535 isdesigned with static logic for operation down to zero frequency and supports two software selectable powersaving modes.

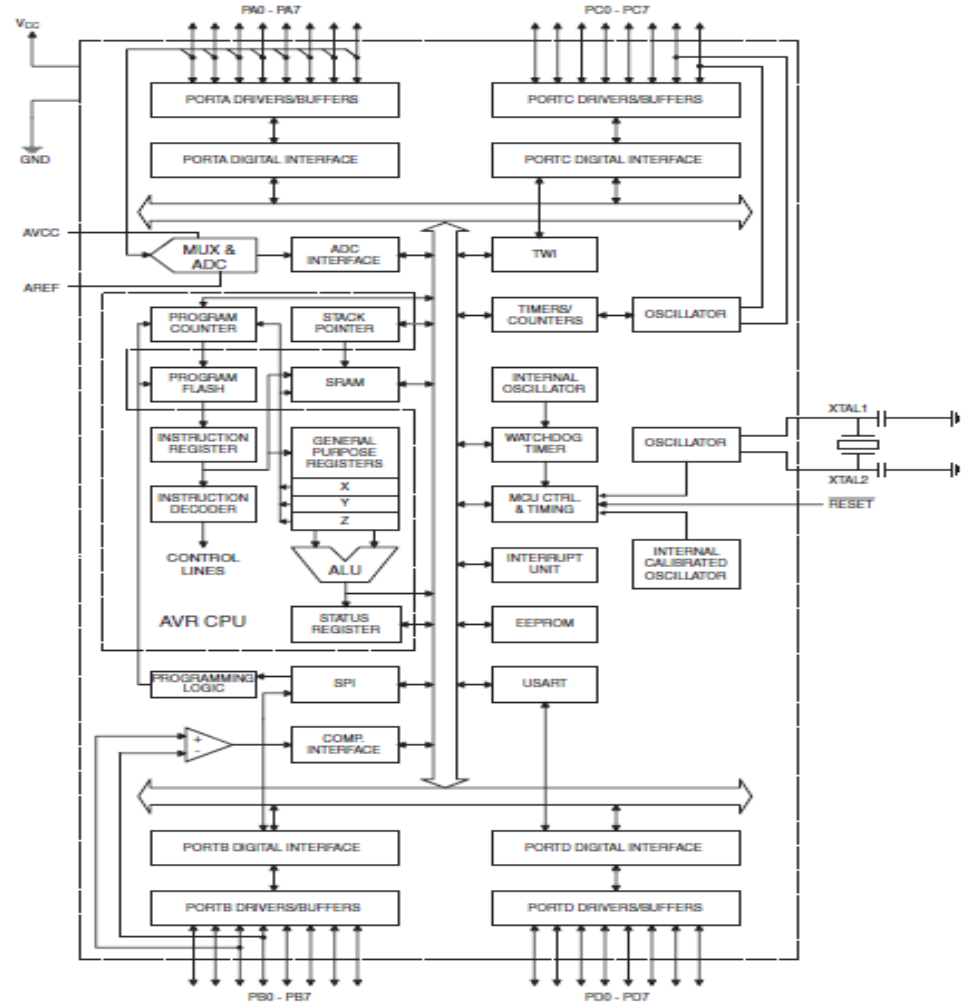


FIGURE 5. Block diagram of AT 8535

Microcontroller Based Solar Power Inverter

Pre Amplifier (Wave Shaping): It is designed by using the BC 547transistors & NE555 timer.Pre amplifier is used to amplify output, which is present at the micro controller output terminals. Byusing the pre amplifier we are converting the 5v s/g to 12v which is required to drive the powerMOSFETs. The pre-Amplifier converts the microamperes current from m/c to ma.

BC 547 Transistor:BC547 is an NPN bi-polar junction transistor. A transistor, stands for transfer of resistance, iscommonly used to amplify current. A small current at its base controls a larger current at collector & emitterterminals. BC547 is mainly used for amplification and switching purposes. It has a maximum current gain of800. Its equivalent transistors are BC548 and BC549.The transistor terminals require a fixed DC voltage to operate in the desired region of its characteristiccurves. This is known as the biasing. For amplification applications, the transistor is biased such that it ispartly on for all input conditions. The input signal at base is amplified and taken at the emitter. BC547is used in common emitter configuration foramplifiers. The voltage divider is the commonly used biasingmode. For switching applications, transistor is biased so that it remains fully on if there is a signal at itsbase. In the absence of base signal, it gets completely off.

NE 555 Timer:The 555 timer IC is an integrated circuit (chip) used in a variety of timer, pulse generation, and oscillatorapplications. The 555 can be used to provide time delays, as an oscillator, and as a flip-flop element.Derivatives provide up to four timing circuits in one package.

Power Amplifier: Power amplifier is designed by using the power MOSFETs. The MOSFET's used are IRF840 and areconnected in push pull configuration. Power amplifiers are used to improve the power handling capabilityof circuit. Power Amplifiers will convert the current in ma to the current in several amperes.

Voltage Booster: Voltage booster is consisting of the transformer it will act as step up or step down on the basis of theoperation mode of inverter. At the output of step up transformer we get the 230V acoutput. Voltage boosterwill provide the input from the power amplifiers.

Transformer: A transformer is an electrical device that transfers electrical energy between two or more circuits throughelectromagnetic induction. Electromagnetic induction produces an electromotive force within a conductorwhich is exposed to time varying magnetic fields. Transformers are used to increase or decrease thealternating voltages in electric power applications A varying current in the transformer's primary winding creates a varying magnetic flux in the transformer core and a varying fieldimpinging on the transformer'ssecondary winding. This varying magnetic field at the secondary winding induces a varying electromotiveforce (EMF) or voltage in the secondary winding due to electromagnetic induction.

MOSFET and MOSFET Driver: We are using the BT139 as Mosfet driver and IRF840 as a MOSFET. MOSFET is basically used tocontrol the charging voltage by controlling the 12VDC voltage by controlling the phase angle ofMOSFET. We control the 12VDC supply by giving appropriate gate pulses to it. It is used as the MOSFETdriver. The metal–oxide–semiconductor field-effect transistor is a type of transistor used for amplifying orswitching electronic signals.Although the MOSFET is a four-terminal device with source (S), gate (G), drain (D), and body (B)terminals, the body (or substrate) of the MOSFET is often connected to the source terminal, making it athree-terminal device like other field-effect transistors. Because these two terminals are normally connectedto each other (short- circuited) internally, only three terminals appear in electrical diagrams. The MOSFETis by far the most common transistor in both digital and analog circuits, though the bipolar junction transistorwas at one time much more common.

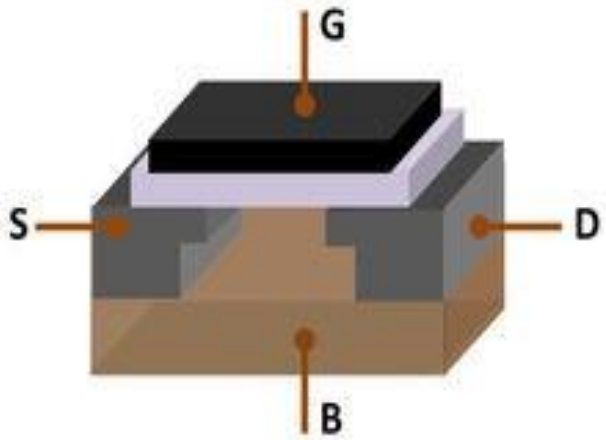


FIGURE 5. MOSFET

The main advantage of a MOSFET over a regular transistor is that it requires very little current to turnon (less than 1mA), while delivering a much higher current to a load (10 to 50 times or more).Inenhancement mode MOSFETs, a voltage drop across the oxide induce a conducting channel between thesource and drain contacts *via* the field effect. The term "enhancement mode" refers to the increase ofconductivity with increase in oxide field that adds carriers to the channel, also referred to as the *inversionlayer*. The channel can contain electrons (called an nMOSFET or nMOS), or holes. In the less common*depletion mode* MOSFET, detailed later on, the channel consists of carriers in a surface impurity layer ofopposite type to the substrate, and conductivity is decreased by application of a field that depletes carriersfrom this surface layer.

Lead Acid Battery:It has low energy-to-weight ratio and a low energy-to-volume ratio, its ability to supply high surge currentsmeans that the cells have a relatively large power-to- weight ratio. These features, along with their low cost,make it attractive for use in motor vehicles to provide the high current required by automobile starter motors.As they are inexpensive compared to newer technologies, lead–acid batteries are widely used even whensurge current is not important and other designs could provide higher energy densities. Large-format lead–
acid designs are widely used for storage in backup power supplies in cell phone towers, high-availabilitysettings like hospitals, and stand-alone power systems. For these roles, modified versions of the standard cellmay be used to improve storage times and reduce maintenance requirements. Gel-cells and absorbed glassmatbatteries are common in these roles, collectively known as VRLA (valve-regulated lead–acid) batteries.

H Bridge:An H bridge is an electronic circuit that enables a voltage to be applied across a load in either direction. Thesecircuits are often used in robotics and other applications to allow DC motors to run forwards and backwards.Most DC-to-AC converters (power inverters), most AC/AC converters, the DC-to-DC push–pullconverter, most motor controllers, and many other kinds of power electronics use H bridges. In particular,a bipolar stepper motor is almost invariably driven by a motor controller containing Two H Bridges.Microcontroller Based Solar Power Inverter

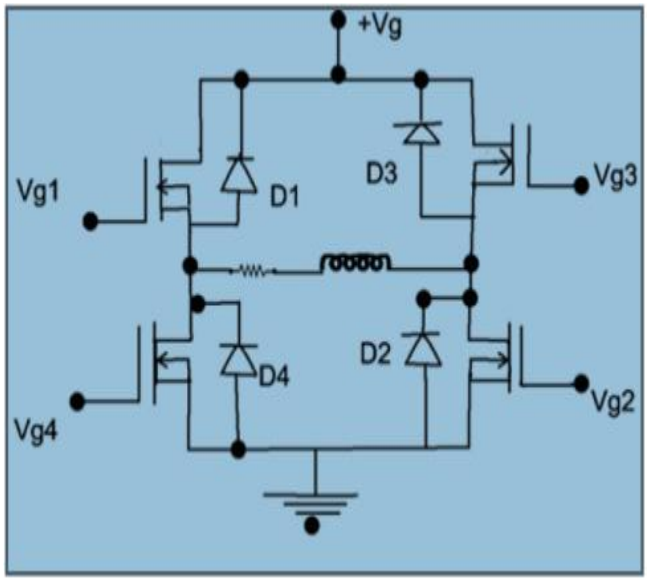


FIGURE 7. H Bridge

When switch S1 and S2 are closed and switches S3 and S4 are open, a positive voltage will be appliedacross the load. By closing S3 and S4 switches and opening S1 and S2 switches a reverse voltage will beapplied to the load.A common use of the H Bridge is an inverter. The arrangement is sometimes known as a single-phasebridge inverter. The H Bridge with a DC supply will generate a square wave voltagewaveform across theload. For a purely inductive load, the current waveform would be a triangle wave, with its peak dependingon the inductance, switching frequency, and input voltage. The H-bridge arrangement is generally used toreverse thepolarity/direction of the motor, but can also be used to 'brake' the motor, where the motor comesto a sudden stop, as the motor's terminals are shorted, or to let the motor 'free run' to a stop, as the motor iseffectively disconnected from the circuit.

4. CONCLUSION

In this work, solar power inverter is design with use of microcontroller. The objective of the circuit was toinvert power from high voltage DC sources or an output voltage of DC to DC boost into AC power similarto one available in our wall sockets for any load and of which was partially met. This inverter power outputis usable for any load although not practically tested. Almost 90% of the project was completed within timeline given and by the time this report was being submitted. The fact that I was able to integrate the wholesystem and achieve a desired output of both the frequency and voltage with reverence to rail voltage suppliedshows that much of key parts of this project is practically achievable and with required DC voltage a completeworking inverter can be achieved.There are a few changes that need to be worked on for future work. As mentioned earlier, the inductorused in the filter is a transformer coil and therefore not suitable for the amount of power required. Properinductor is recommended, iron core inductor that has small copper resistance which will increase theefficiency of the inverter. In addition, I would recommend housing even the prototype boards in enclosuresto avoid unwanted contact with the high power sources. Also hardware designed that isolates the load fromthe supply in case of over voltages, under voltages and phase outs would be of great importance if this projectis to be commercially produced in large scale.So in general we can say that by utilizing wind energy we can save Conventional sources of energy, asits cost is more and are exhaustible, weshould provide our weight age to the non-conventional energyresources, so this project of ours is future scope of power generation because the present scenario provokesus to provide our concentration on type of energy resources which is plenty and eco-friendly. So this paperof ours creates awareness to the people that do utilize alternative sources of energy, because they areinexhaustible, plenty, pollution free and very easy to recycle.

Future Scope: In this paper, we try to show the glimpse of the immense potential that Renewable energy resources hold.Some advancement which can significantly boost the practicality and effectiveness of the solution providedby our project are:

1. Research can be done to increase the power output so as to make it more useful and dependable.
2. Bulk production of the Micro-controller based solar power Inverter will further lower the cost.
3. If implemented on a bigger scale, it can become quite economical.

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