Practical Model for Solar AC Generation

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Abstract: ***This paper presents the experimental model of Solar AC Generation system. This project has opted a way to generate AC power directly from a solar panel. Why is this so important? This makes it possible to simply hook the solar panels directly into the power grid without the need for expensive DC to AC power conversion equipment. This invention, when commercialized, will make the cost of solar power more practical and affordable. We have heard about the promise of cheap solar energy now for decades. It was expected that at least in the world's sunniest areas, all the cities would be supplementing their power with clean renewable solar power. Sadly this is not the case. Here is the problem. Solar panels today produce DC power which has to be converted to AC to be used by most homes and businesses. The price of solar panels combined with the price of inverters, phase synchronizers, installation and maintenance has made the price of solar prohibitive. Add to that the loss of power from the different components used in the DC to AC conversion process and it becomes even more unattractive. But what if there was a better way to make power available as required by the consumers. The proposed hardware is able for Directly Generating Alternating Current Electricity from Photovoltaic Cells.***

Keywords: PCC, PWM, PVC, MPPT, Solar A.C

1. Introduction

Solar energy is radiant light and heat from the sun harnessed using a range of ever-evolving technologies such as solar heating, solar photovoltaic's, solar thermal energy, solar architecture and artificial photosynthesis. It is an important source of renewable energy and their technologies are broadly characterized as either passive solar or active solar depending on the way they capture and distribute solar energy or convert it into solar power. The array of a photovoltaic power system which is active solar technique produces direct current (DC) power which fluctuates with the sunlight's intensity. For practical use this usually requires conversion to certain desired voltages or alternating current (AC), through the use of inverters. Multiple solar cells are connected inside modules. Modules are wired together to form arrays, and then tied to an inverter, which produces power at the desired voltage, and for AC, the desired frequency or phase. The AC solar generation has the potential to reduce the use of fossil fuels tremendously if you just imagine them, installing photovoltaic solar power centres around the country generating supplemental power for the grid. Existing technology requires solar energy to be converted from direct current (DC) to alternating current (AC) before it is compatible with the nation's power grid. The AC Solar Generation seeks to achieve the same result at a lower cost and with less energy loss by producing alternating current directly instead of relying on additional equipment. Above the solar cells is a spinning disc with slots which controls each cell's exposure to light and darkness. The resulting voltage is AC that can be configured to three-phase power usable with the national power grid. Mounted above the solar cells is a spinning disk powered by a DC electric motor. The DC motor gets its power from four small DC solar cells mounted in the corners of the base. The disk has portals cut into it allowing light to pass through to every other solar cell below it. As the disk spins each of the banks of solar cells is alternately exposed to light and alternately produce power. When the portal is half way between the two cells the voltage cancels and drops to zero. The resulting voltage is sinusoidal or AC.

2. Background Information

The demand and need for clean and renewable energy is becoming more urgent as earth undergoes global climate changes. Generation of electricity from coal produces over 50% of the carbon dioxide released into the atmosphere each year. Coal and other fossil fuels will also eventually run out. The hydroelectric power generation of electricity is limited to places where there is an adequate water source. Nuclear energy for the creation of electricity has the drawback of creating nuclear waste. However, one type of clean renewable energy is solar energy or sunlight. Solar energy is a constant source of clean energy that can shine on all areas of the surface of the planet. Solar energy or sunlight can be converted into electricity by a photovoltaic cell. A photovoltaic cell known as a solar cell captures and converts sunlight into electricity. A solar cell is made from a semi conducting material (a semiconductor) such as silicon that absorbs the sunlight which generates a flow of electricity through the solar cell. Because of the properties of semiconductors, positive and negative terminals of the solar cell are static and electron flow from a solar cell is unidirectional (i.e. the electricity can only flow in one direction). Thus, as with all photovoltaic cells, the solar cell produces only direct current (DC) electricity. The problem with direct current electricity is that direct current electricity is difficult to transmit any appreciable distance, which limits their use. Thus, alternating current electricity is more usable than direct current electricity. Moreover, most electrical devices utilize alternating current (AC) electricity. Atlanta, Indiana – A Process to generate AC power directly from a solar cell without using converter equipment is a candidate for General Electric's Eco imagination Challenge, a competition that awards funding to projects designed to improve energy use. Existing technology requires solar energy to be converted from direct current (DC) to alternating current (AC) before it is compatible with the national power grid. The AC Solar Generation seeks to achieve the same result at a lower cost and with less energy loss by producing alternating current directly instead of relying on additional equipment.

3. Literature Survey

The present invention is a system, device and method for directly generating alternating current electricity from photovoltaic cells. The system, device and method mechanically gradually exposes and shades photovoltaic cell pairs connected in anti parallel to sunlight to generate alternating current electricity at an AC junction of the solar cell pairs. Gradually and alternately exposing and shading the two anti-parallel connected solar cells of each solar cell pair causes the amplitude and polarity of the electricity at the AC junction to gradually rise and fall to produce alternating current electricity. The gradual, alternating exposure and shading of the two anti-parallel solar cells is accomplished by mechanically covering and exposing the solar cell pairs. In particular, while one solar cell of an anti-parallel connected solar cell pair undergoes gradual exposure to sunlight from 0% exposure (100% shaded) of the solar cell electricity generating area to 100% exposure (0% shaded) of the solar cell electricity generating area, the other solar cell of the solar cell pair undergoes gradual shading from sunlight from 0% shaded (100% exposure) to 100% shaded (0% exposure). Such gradual, alternating exposure and covering of each solar cell of each anti-parallel connected solar cell pair is periodic. The rate of exposure and shading determines frequency. In one form, a rotating disc situated over the solar cell pairs has spaced apart openings forming coverings between each opening to alternately expose and shade the solar cell pairs during rotation. A direct current motor is utilized to rotate the segmented disc. The motor is preferably powered by separate solar cells. The present invention also provides a phase synchronizer for maintaining a desired alternating current frequency. The phase synchronizer controls the motor to control rotation of the segmented disc.

The present invention makes solar energy a viable, cost effective, environmentally friendly option for residential and/or commercial use. The present invention is capable of being used on a minute, small or large scale through appropriate scaling the solar cell ac electricity generating and/or the use of a plurality thereof. Solar cell AC electricity generation arrays can easily produce the power equivalent to an average power plant today, while being environmentally friendly enough to be located proximate a playground, school or in any urban environment. Large scale solar cell AC electricity generating arrays can be easily set up even in the most remote places in the world.

4. System Development

4.1 Solar panel (A)

Solar panels (A) produce the DC power to drive the DC motor and it acts as source to speed control circuit.

4.2 Speed control Circuit

Speed control circuit consisting of different electronics components such as Transistor TIP122 for switching purpose, Regulator IC 7805 for constant voltage regulation, Op-amp IC LM358.

4.3 DC Motor and spinning disc

The permanent magnet dc motor is used for the rotation of disc. Which is mounted above the solar panels is a spinning disc. The dc motor gets its power from three solar panels mounted in the corner on the based. The disc has the three portals cut into it allowing light to passing through to every other solar panels below it.As the disc spins each of the banks of solar panel half way between the two panels, the voltage cancel and drop to zero, the resulting voltage is sinusoidal or AC.

4.4 Solar panels (B):

The six solar panels (B) are installed on the based and arranged in a circular shape, below the above disc. Each of three solar panels are connected in parallel with an angle of 120 degree. These two parallel pair of solar panels are connected in Anti-parallel. So that these anti-parallel connection of solar panels produces the resulting voltage is in the form of sinusoidal or AC.

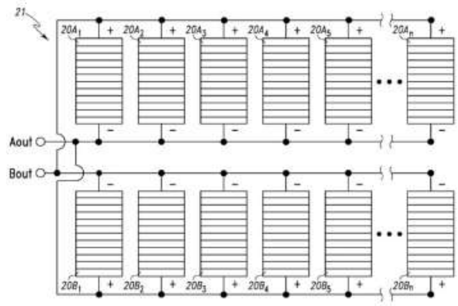


Figure 4.4.1: Block diagram of solar ac generation

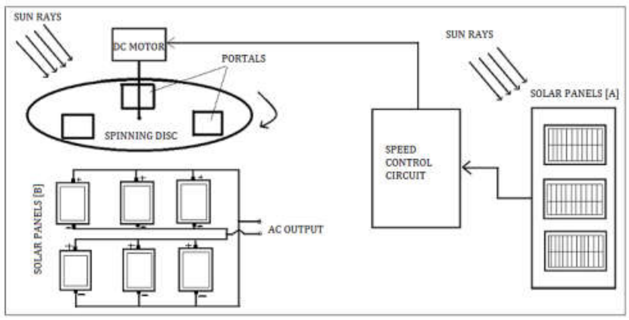
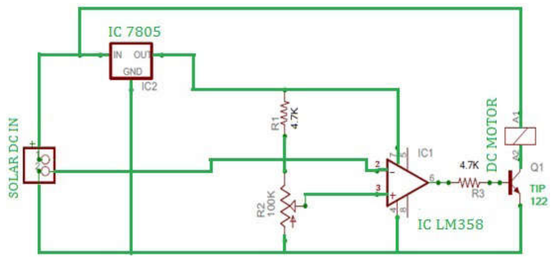


Figure 4.4.2: Block diagram of solar ac generation

5. Circuit Diagram and Description

The circuit actually utilizes the power from the solar panel (A). The main working of circuit is to control the speed of DC motor. This can be achieved by operating op-amp IC LM358 in an inverting mode and variable resistor from non inverting terminal is such set to make the speed constant at variable intensity of light. The transistor TIP122 conducts more when the intensity of light is lower and vice versa. The circuit operates through constant regulation provided by regulator IC 7805 as well as it provides constant voltage to the DC motor.



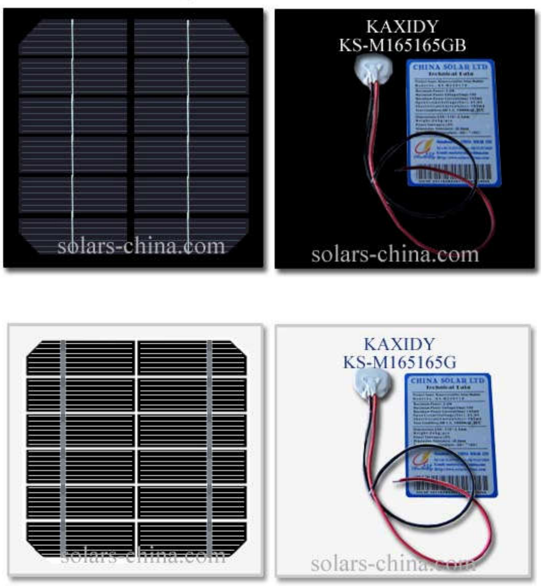
5.1 Circuit Component Description

Components Values
OP-AMP (IC1) LM358
Regulator (IC2) 7805
Transistor (Q1) TIP122
Resistor (R1) 4.7kΩ
Resistor (R2) 100kΩ (variable)
Resistor (R3) 4.7kΩ

5.2 Hardware Description

5.2.1 Photovoltaic Cells

Maximum Power (Pm) :3.6W
Operating Voltage (Vmp):5V
Operating Current (Imp) : 600mA
Power Tolerance:-5% to +5%



5.2.3 Description

A solar cell, or photovoltaic cell, is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect. It is a form of photoelectric cell, defined as a device whose electrical characteristics, such as current, voltage, or resistance, vary when exposed to light. Solar cells are the building blocks of photovoltaic.

5.2.3 Description

A solar cell, or photovoltaic cell, is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect. It is a form of photoelectric cell, defined as a device whose electrical characteristics, such as current, voltage, or resistance, vary when exposed to light. Solar cells are the building blocks of photovoltaic modules, otherwise known as solar panels. Solar cells are described as being photovoltaic irrespective of whether the source is sunlight or an artificial light. They are used as a photodetector (for example infrared detectors), detecting light or other electromagnetic radiation near the visible range, or measuring light intensity. The operation of a photovoltaic (PV) cell requires 3 basic attributes:

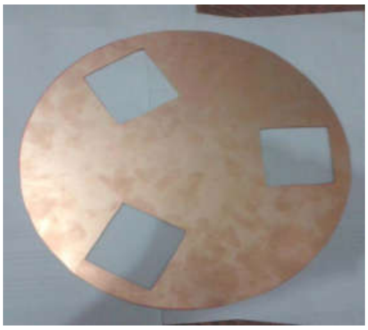
- The absorption of light, generating either electron-hole pairs or exactions.
- The separation of charge carriers of opposite types.
- The separate extraction of those carriers to an external circuit

5.2.4 DC Motor

A DC motor relies on the fact that, like magnet poles repel and unlike magnetic poles attract each other. A coil of wire with a current running through it generates an electromagnetic field aligned with the centre of the coil. By switching the current on or off in a coil its magnet field can be switched on or off or by switching the direction of the current in the coil the direction of the generated magnetic field can be switched 180°. A simple DC motor typically has a stationary set of magnets in the stator and an armature with a series of two or more windings of wire wrapped in insulated stack slots around iron pole pieces (called stack teeth) with the ends of the wires terminating on a commutator. The armature includes the mounting bearings that keep it in the center of the motor and the power shaft of the motor and the commutator connections. The winding in the armature continues to loop all the way around the armature and uses either single or parallel conductors (wires) and can circle several times around the stack teeth. The total amount of current sent to the coil, the coil's size and what it is wrapped around dictate the strength of the electromagnetic field created. The sequence of turning a particular coil on or off dictates what direction the effective electromagnetic fields are pointed. By turning on and off coils in sequence a rotating magnetic field can be created. These rotating magnetic fields interact with the magnetic fields of the magnets (permanent or electromagnets) in the stationary part of the motor (stator) to create a force on the armature which causes it to rotate. In some DC motor designs the stator fields use electromagnets to create their magnetic fields which allow greater control over the motor. At high power level, DC motors are almost always cooled using forced air. The commutator allows each armature coil to be activated in turn. The current in the coil is typically supplied via two brushes that make moving contact with the commutator. Now, some brushless DC motors have electronics that switch the DC current to each coil on and off and have no brushes to wear out or create sparks.

5.2.5 Spinning Disc

The spinning disc has three portals each 120 degree apart from each other. This disc is coupled to the Dc motor shaft and mounted over the solar panel [B]. When disc rotates, its portal cuts the sun rays allowing light to pass through it and follow onto the every other solar panels. As the disc spins each of the solar panels are alternately exposed to light and alternately produce power. When the portal is half way between the two cells the voltage cancels and drops to zero. The resulting voltage is sinusoidal or AC.



6. Result Analysis

6.1 Stepwise Experimental Analysis on CRO:

In the first diagram, a sequence of representative diagrams illustrating the manner of generating AC electricity from a photovoltaic cell pair of a photovoltaic cell pair array of the photovoltaic AC electricity generation as shown in Figure 5.1

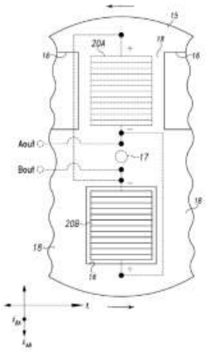


Figure 6.1.1: Output generation step 1

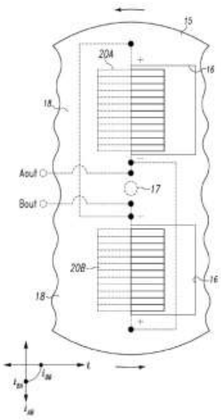


Figure 6.1.2: Step 2

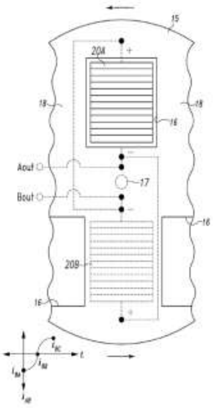


Figure 6.1.3: Output generation step 3

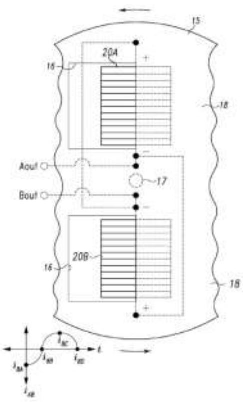


Figure 6.1.4: Step 4

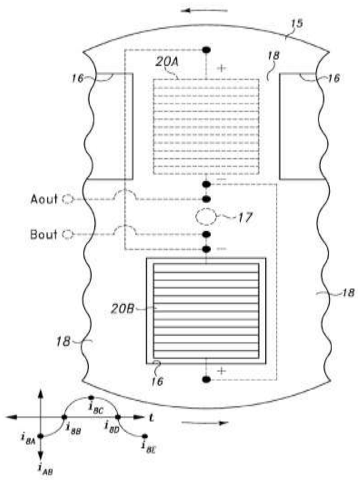


Figure 6.1.5: Output generation step 5

In the second diagram, the sequence of representative diagrams illustrating the manner of generating AC electricity from a photovoltaic cell pair of a photovoltaic cell pair array of the photovoltaic AC electricity generation, as shown in Figure 6.2. In the third diagram, the sequence of representative diagrams illustrating the manner of generating AC electricity from a photovoltaic cell pair of a photovoltaic cell pair array of the photovoltaic AC electricity generation as shown in Figure 6.3 In the fourth diagram, the sequence of representative diagrams illustrating the manner of generating AC electricity from a photovoltaic cell pair of a photovoltaic cell pair array of the photovoltaic AC electricity generation as shown in Figure 6.4

In the fifth diagram, the sequence of representative diagrams illustrating the manner of generating AC electricity from a photovoltaic cell pair of a photovoltaic cell pair array of the photovoltaic AC electricity generation as shown in Figure 6.1.5.

6.2 Experimental output

6.2.1 Observation table:

Instrument used: Digital Multimeter and CRO

Day hours
Output Voltage (AC)
Output Current (AC)
Output Power (Watt)
09:00 – 11:59 3.8V (average) 370mA (average) 1.41 W
12:00 – 14:59 5.8V (average) 600mA (average) 3.48 W
15:00 – 17:00 5.9V (average) 620mA (average) 3.66 W

6.2.2 Waveform obtained

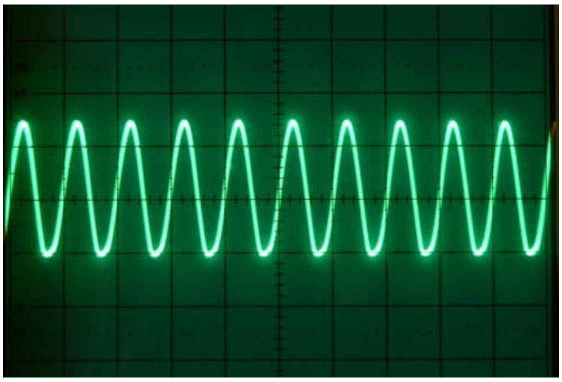


Figure 6.2.2: Practically observed output waveform on CRO

7. Conclusion

This is truly a transforming technology. The AC solar generation has the potential to reduce the use of fossil fuels tremendously by installing photovoltaic solar power centers around the country generating supplemental power for the grid. By use of this technique, the use of fossil fuels will be reduced as they are limited sources of energy and could not recover. So it is important to redevelop such project that generates power using renewable energy sources. Existing technology requires solar energy to be converted from direct current (DC) to alternating current (AC) before it is compatible with the nation's power grid. The AC Solar Generation seeks to achieve the same result at a lower cost and with less energy loss by producing alternating current directly instead of relying on additional equipment. This invention, when commercialized, will make the cost of solar power more practical and affordable. We have heard about the promise of cheap solar energy now for decades. We would think by now that at least in the world's sunniest areas all the cities would be supplementing their power with clean renewable solar power. In this project a modification in the existing photovoltaic set up is suggested that generates AC power without DC-AC conversion. The losses that take place in this conversion may be reduced by using this technique.

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