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## PORTABLE SOLAR DESALINATION SYSTEM

S.S.Revathi<sup>1</sup>S. Karthikeyan,K.Gowtham Raj,D.JohnBritto<sup>2</sup>

Assistant Professor, Karpaga Vinayaga College of Engineering & Technology<sup>1</sup>

UG Scholar, Karpaga Vinayaga College of Engineering & Technology<sup>2</sup>

ssr68.elam@gmail.com<sup>1</sup>, karthiks.karthiks04@gmail.com<sup>2</sup>

*ABSTRACT* - Clean water and reliable energy can be difficult to obtain in remote locations such as desert villages, secluded islands, and other places where no fresh water can be found. The primary goal for this project is address these problems by implementing a portable desalination plant system that is to be powered by solar energy PV system as the main energy source.

*Keywords:* PV Cell,Z-SourceInverter,PWM technique.

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### I. INTRODUCTON PHOTOVOLTAIC ARRAY

PV cells are made of semiconductor materials, such as silicon. For solar cells, a thin semiconductor wafer is specially treated to form an electric field, positive on one side and negative on the other. When light energy strikes the solar cells, electrons are knocked loose from the atoms in the semiconductor material. If electrical conductors are attached to the positive and negative sides, forming an electrical circuit, the electrons can be captured in the form an electric current that is, electricity. This electricity can then be used to power a load. A PV cell can either be circular or square in construction.

Due to the low voltage generated in a PV cell (around 0.5V), several PV cells are connected in series (for high voltage) and in parallel (for high current) to form a PV module for desired output. Separate diodes may be needed to

avoid reverse currents, in case of partial or total shading, and at night. The p-n junction of mono-crystalline silicon cells may have adequate reverse current characteristics and these are not necessary. Reverse currents waste power and can also lead to overheating of shaded cells. Solar cells become less efficient at higher temperatures and installers try to provide good ventilation behind solar panels.

Photovoltaic array consists of more solar panels to convert solar energy into electricity. It consists of multiple components, including the photovoltaic modules, mechanical and electrical connections and mountings and means of regulating and/or modifying the electrical output.

The materials used in PV cells are as follows:

1. single-crystal silicon
2. poly-crystalline silicon
3. Gallium Arsenide (GA As)
4. Cadmium Telluride (CdTe)
5. Copper Indium Diselenide

(CuInSe<sub>2</sub>)

Due to the low voltage generated in a PV cell (around 0.5V), several PV cells are connected in series (for high voltage) and in parallel (for high current) to form a PV module for desired output.

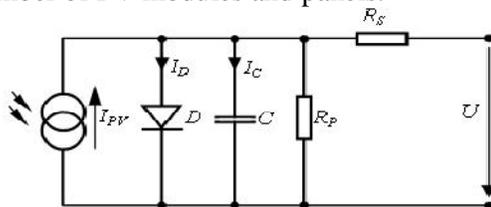
The power that one module can produce is not sufficient to meet the requirements of home or business. The modules in a PV array are usually first connected in series to obtain the desired voltages; the individual modules are then connected in parallel to allow the system to produce more current.

**PHOTOVOLTAIC STRUCTURE:**

A photovoltaic system is a system which uses one or more solar panels to convert solar energy into electricity. It consists of multiple components, including the photovoltaic module, mechanical and electrical connections and mounting for regulating and/or modifying the electrical output.

**PV CELL-PANEL**

PV cells are connected electrically in series and/or parallel circuits to produce higher voltages, currents and power levels. Photovoltaic modules consist of PV cell circuits sealed in an environmentally protective laminate, and are the fundamental building blocks of PV systems. Photovoltaic panels include one or more PV modules assembled as a pre-wired, field-installable unit. A photovoltaic array is the complete power-generating unit, consisting of any number of PV modules and panels.



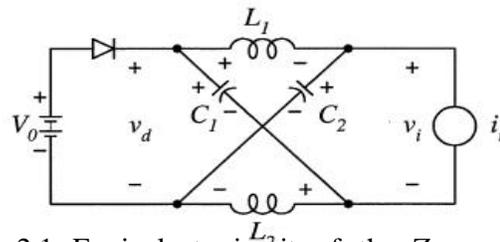
**Fig. 1.1** Equivalent Circuit Diagram Of a Solar Cell

The P-N junction has a certain depletion layer capacitance, which is typically

neglected for modeling solar cells .At increased inverse voltage the depletion layer becomes wider so that the capacitance is reduced similar to stretching the electrodes of a plate capacitor. Thus solar cells represent variable capacitance whose magnitude depends on the present voltage. This effect is considered by the capacitor C located in parallel to the diode.

**II. MODES OF OPERATION**

There are two modes of operation of Z source inverter. The One is shoot through state and another one is non-shoot through state.



**Fig 2.1** Equivalent circuit of the Z-source inverter viewed from the dc link

The Z-source inverter is a buck–boost inverter that has a wide range of obtainable voltage. The traditional V- and I-source inverters cannot provide such feature. The three-phase Z-source inverter bridge has one extra zero state (or vector) when the load terminals are shorted through both the upper and lower devices of any one phase leg (i.e., both devices are gated on), any two phase legs, or all three phase legs. This shoot-through zero state (or vector) is forbidden in the traditional V-source inverter, because it would cause a shoot-through in Fig . We call this third zero state (vector) the shoot-through zero state (or vector), which can be generated by seven different ways: shoot-through via any one phase leg, combinations of any two phase legs, and all three phase legs. The Z-source network makes the shoot-through zero state possible. This shoot-through zero state provides the unique buck–boost feature to the inverter.

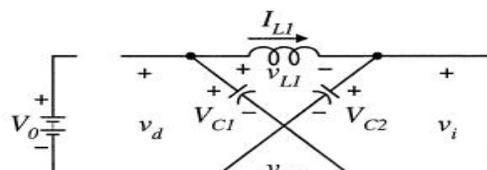


Fig 2.2 Equivalent circuit of the Z-source inverter viewed from the dc link when the inverter bridge is in the shoot-through zero state.

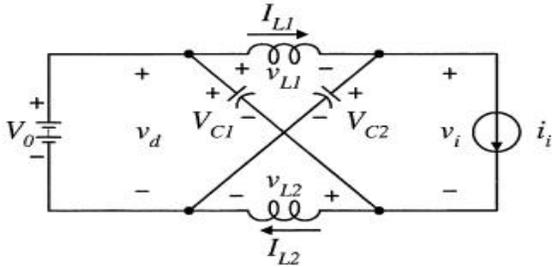


Fig 2.3 Equivalent circuit of the Z-source inverter viewed from the dc link when the inverter bridge is in one of the eight non shoot-through switching states.

In our design we are going to utilize the energy from the sun to create electric current. The current we obtain is to be inverted to an AC current from its original DC state the system first starts by collecting energy from the sun. The energy received is directly converted to a high frequency AC signal. In turn, this high frequency ac signal is being used to create heat through the coils. This method is known as inductive heating, which is a commonly used technique to generate heat.

The heat produced by this inductive heating is then utilized to boil the water in a tank placed in close vicinity of the coil. Eventually, the boiled water changes its physical state into water vapor, which will then process into vapor distillation from which clean water is acquired.

### III. PWM CONTROLLER

There are two controllers for this application: output voltage Controller and dc bus voltage controller. The output voltage can be controlled by adjusting modulation index (Ma). Together with the dc bus voltage can be maintained by changing zero switching periods (T<sub>0</sub>)

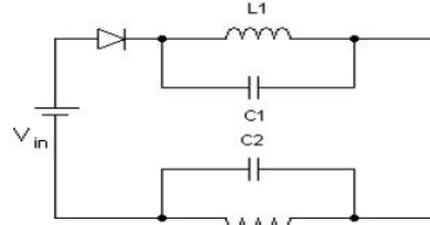


Fig2.4 Equivalent circuit of Z-source network during the shoot through state

During the shoot through state,

$$V_1 = V_c$$

And during the nonshoot though state,

$$V_1 = V_{in} - V_c$$

Where,  $V_1$  is the inductor voltage,  $V_c$  is the capacitor voltage of the Z-network,  $V_{in}$  is the input DC voltage. The average voltage of Inductor over one switching period is zero, which is Given by

$$V_1 = (T_0 V_c + T_1 (V_{in} - V_c) / T) = 0$$

$$V_c (T_0 - T_1) + T_1 V_{in} = 0$$

$$V_c (T_1 - T_0) = T_1 V_{in}$$

Based on  $V_c / V_{in}$  we get,

$$V_c / V_{in} = T_1 / (T_1 - T_0)$$

Where  $T_1$  is the time period of non-shoot through state and  $T_0$  is the time period of shoot through state. The capacitor voltage of the Z-network is expressed by

$$V_c = (T - T_0) V_{in} / (T - T_0 - T_0)$$

$$V_c = (1 - (T_0 / T)) V_{in} / (1 - (2T_0 / T))$$

where  $T$  denotes the total time period.

The peak DC link voltage  $V_0$  appearing across the inverter bridge shown is derived as follows

Where  $B$  is the boost factor of the inverter, which is Given by,

$$V_0 = V_0 - V_1$$

$$= 2V_c - V_{in}$$

$$= (2T_1 V_{in} - V_{in}) / (T_1 - T_0)$$

$$= T V_{in} / (T_1 - T_0)$$

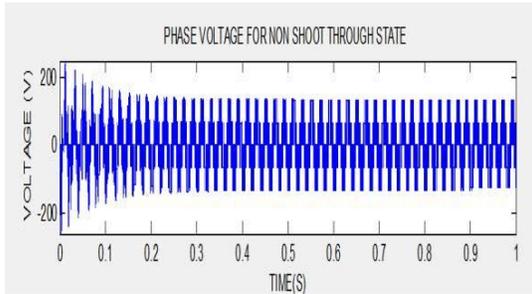
The output peak phase voltage obtained from

the Z-source inverter is expressed as

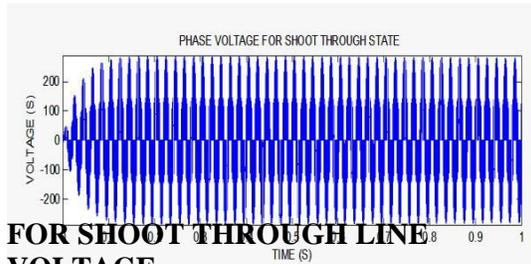
$$V_{ac} = MV_{in}/2$$

$$V_{ac} = MBV_{in}/2$$

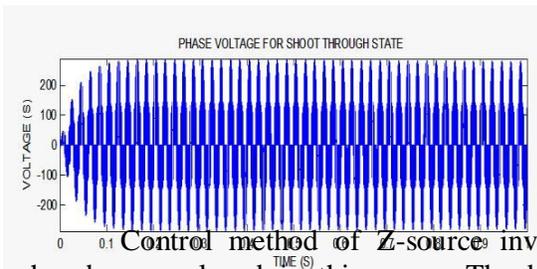
**FOR NON SHOOT PHASE VOLTAGE**



**FOR SHOOT THROUGH PHASE VOLTAGE**



**FOR SHOOT THROUGH LINE VOLTAGE**



**Control method of Z-source inverter** has been analyzed in this paper. The boost factor, voltage gain across the switches has been analyzed in detail. Simulation of Z-source inverter under simple boost control method using straight lines with the value different from the peak value of the sinusoidal reference has also been presented, showing that better performance would be obtained if modulation index (M) and shoot-through duty ratio (D0) for shoot were set to a high value. The simulation results suggest that the z-source technique can be applied to an inverter to solve the shading problems. In future we can increase the voltage with voltage by using some advanced techniques.

**IV. SIMULATION RESULT**

Simulink circuit of Z-source inverter with solar energy system is shown in fig.4.1

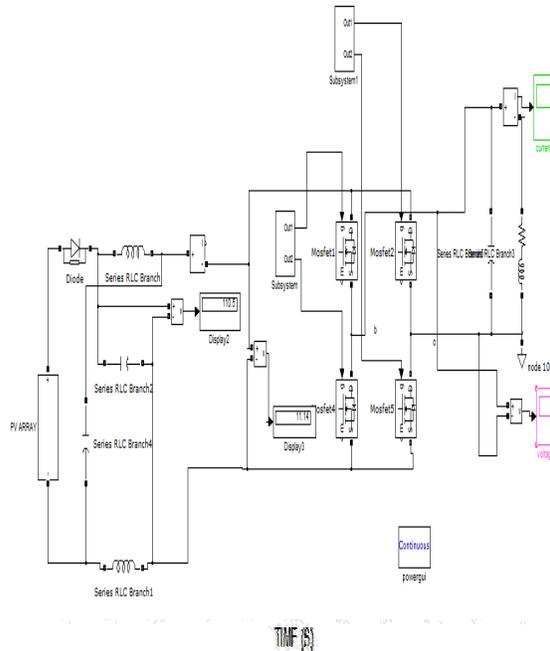


Fig4.1 Simulink circuit of Z-source inverter with solar energy system

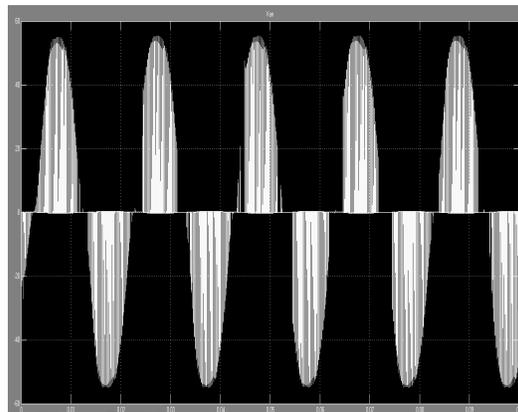


Fig 4.2 Voltage across the load

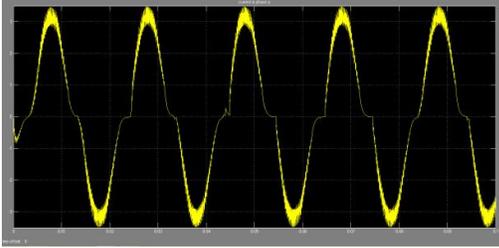


Fig 4.3 Current through the load

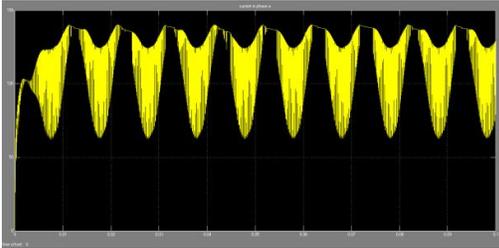


Fig 4.4 Voltage across the capacitor C1

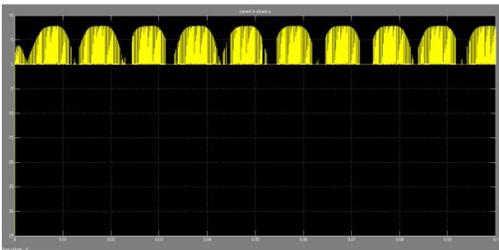


Fig 4.5 Current through the inductor L1

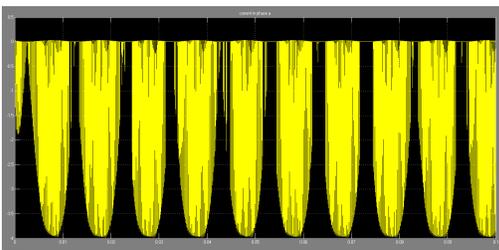


Fig 4.6 Current through the inductor L2

like aluminum, Iron etc. Although this project has come to an end, improvements could still be made by varying the pulse width modulation. We feel good knowing that our project can grow into something very useful for people who struggle to get clean drinking water.

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## V. CONCLUSION

Our objective for this project was a proof of concept: that we could make a portable solar desalination unit using solar panels, a Z-bridge inverter, a work coil with a core inside, and vapor distillation. The use of an inductor coil to generate heat with flux makes gives us the energy we need for vapor distillation. We may use efficient materials