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Design and Implementation of a Three-Phase Converter in A Solar PV System Using MMC

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ABSTRACT -

A model of a solar panel array with variable irradiance and temperature is included in the study described here. Because each array receives a different amount of irradiation, the output varies. The system's output power has shifted as a result of this fluctuation. The work done here is done to adapt temperature and irradiance fluctuations in the solar panels and to increase the power output produced by the renewable energy source. With the suggested modulation technique, which has a simplified computational methodology, the levels of a multilevel inverter can be any number. This approach would be preferable for a solar system with variable input variables that generates consistent and effective output power.

Keywords –MLI, PV, Module material, mismatch loses, etc

INTRODUCTION

A PV module consists of several interconnected solar cells encapsulated into a single, long-lasting, stable unit. The primary purpose of encapsulating a group of electrically connected solar cells is to protect them and their interconnecting wires from the typically harsh environment in which they are used. Solar cells, for example, are susceptible to mechanical damage due to their thinness. Water or water vapour may also corrode the metal grid on the top surface of the solar cell as well as the wires that connect the individual solar cells.The two primary functions of encapsulation are to protect the solar cells from mechanical damage and to prevent water or water vapour from corroding the electrical contacts. PV modules come in a variety of shapes and sizes, and the structure of the module varies depending on the type of solar cell or application.

A transparent top surface, an encapsulant, a rear layer, and a frame around the outer edge characterize the majority of PV bulk silicon PV modules. The top surface of most modules is glass, the encapsulant is EVA (ethyl vinyl acetate), and the rear layer is Tedlar, as shown below.

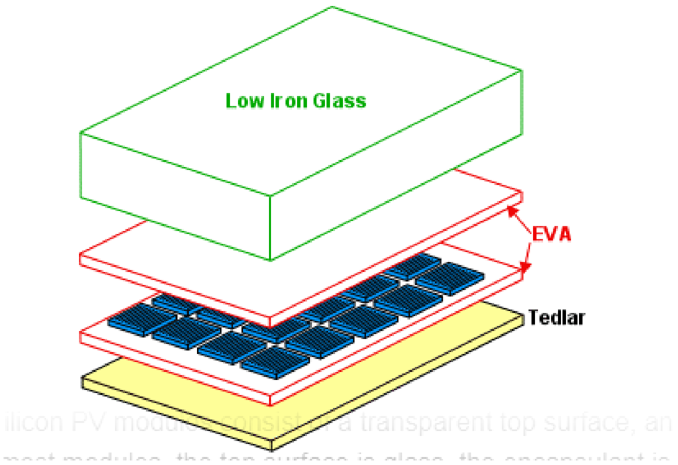

Figure 1 Typical bulk silicon module materials.

Mismatch losses are caused by the interconnection of solar cells or modules with different properties or that have been subjected to different conditions. Under certain conditions, mismatch losses are a serious problem in PV modules and arrays because the output of the entire PV module is determined by the solar cell with the lowest output under worst-case conditions. When one solar cell in a module is shaded while the others are not, the power generated by the good solar cells can be dissipated rather than powering the load. As a result, highly localized power dissipation and local heating can occur, causing irreversible damage to the module.

Mismatch loss is defined as a fixed percentage decrease in the DC power output of the system caused by minor differences in the electrical characteristics of the installed modules. These losses will be greater in systems with a wider rated power error range. Mismatch values range from 0.01% to 3%, according to industry research, depending on system configuration and string length. In some PV modelling tools, mismatch loss includes differences in string lengths, cloud shading, and edge effects, as well as module electrical characteristics

II. MODULAR MULTILEVEL INVERTERS (MMIS)

Multilevel inverters are used in efficient power-conversion systems for applications requiring high power and power quality. They have been selected as the best option in the power industry, reactive power compensation, and interfacing with renewable energy sources such as wind, fuel, and photovoltaic cells. In industrial applications, three major topologies are used: cascaded H-bridge inverter, flying capacitor, and diode clamped multilevel inverter. Electric motor drives, electric vehicle drives, power factor compensators, active filters, DC power source utilization, and back to back frequency link systems all benefit from a multilevel inverter. The harmonic content of the output waveform can be reduced by a multilevel inverter without causing a drop in the inverter output power.

III.METHODOLOGY

To model HRES components, researchers have developed a number of modelling techniques. Individual component performance is modelled either deterministically or probabilistically. DC-AC converters are required when the generated power is transmitted to the grid or used by AC loads (inverters). There are single phase and three phase output inverters available. There are four types of grid integrated inverters for photovoltaic systems: central plant inverter systems, string inverter systems, multi-string inverter systems, and micro grid inverter (AC modules) systems

The previous technology, central plant inverters, used centralized inverters to connect a large number of PV modules to the grid. The PV modules are connected in series (called a string). These strings are connected in parallel with string diodes to achieve high power levels.

The previously mentioned triangular waveform amplitude and frequency parameters determine the exact design of the controller. The proposed controller's goal is to force the inverter to switch at a fixed frequency.

Table 1 : Inverter Parameters

Power electronic device	IGBT/Diodes
Snubber resistance	5000 ohms
Forward voltages	0
Ron	$1x10^{-3}$ ohms

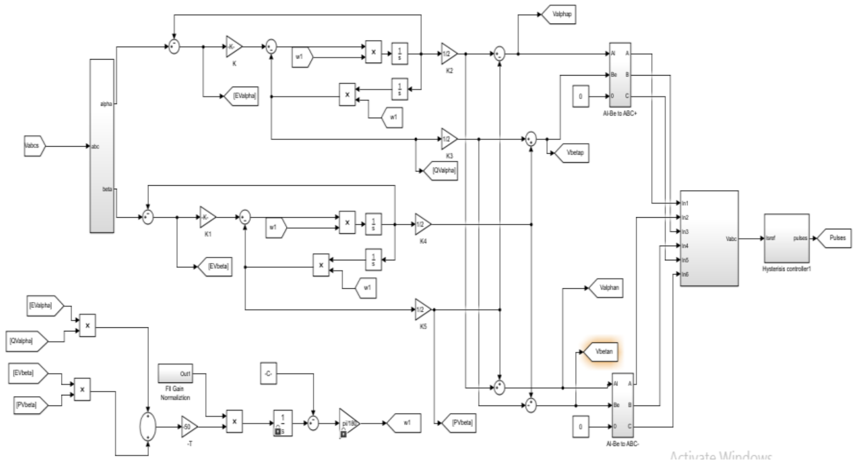

Figure 2 Extension of the proposed work

The PI controller is used in conjunction with the classical hysteresis current controller to overcome its drawbacks. The PI controller's input for each phase is an error in the current between the reference current and the solar system's output current. The advantages of this controller include its easy implementation, fast transient response, direct limiting of device peak current and practical insensitivity to voltage ripple.

IV.RESULT ANALYSIS

The work presented here includes a solar panel array model with variable irradiation and temperature fed to each module. Each array is subjected to varying irradiation, resulting in varying output; this variation has resulted in variation in the system's output power. The work done here is done to accommodate temperature and irradiation variations in the solar panels, as well as to improve the power output generated by the renewable energy resource.

CASE 1: Solar system with having variable radiation and basic regulation inverter control

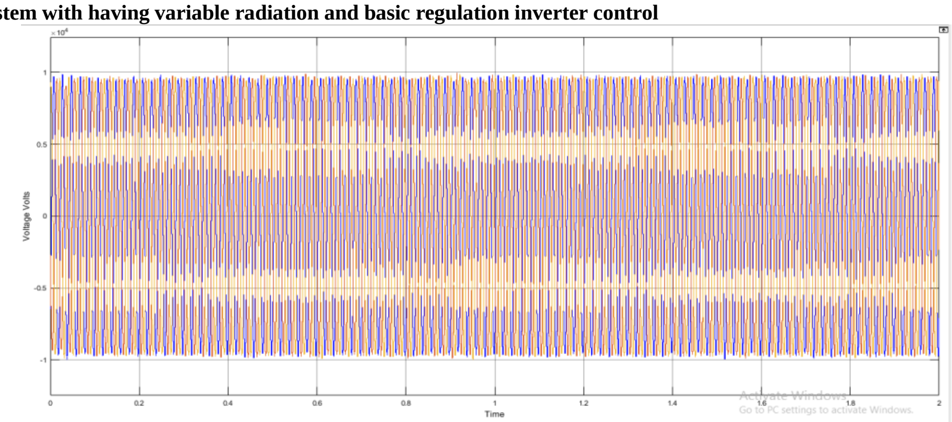

Figure 3 Voltage output from the system with basic inverter control

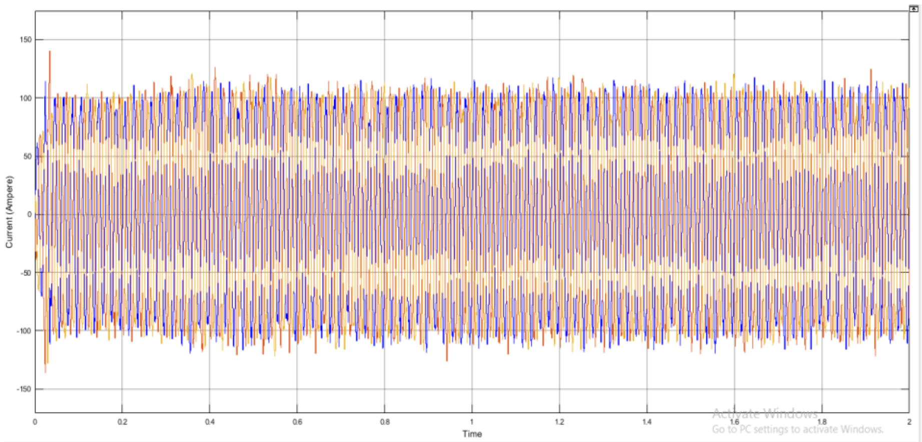

Figure 4 Current outputs from the system with basic inverter control

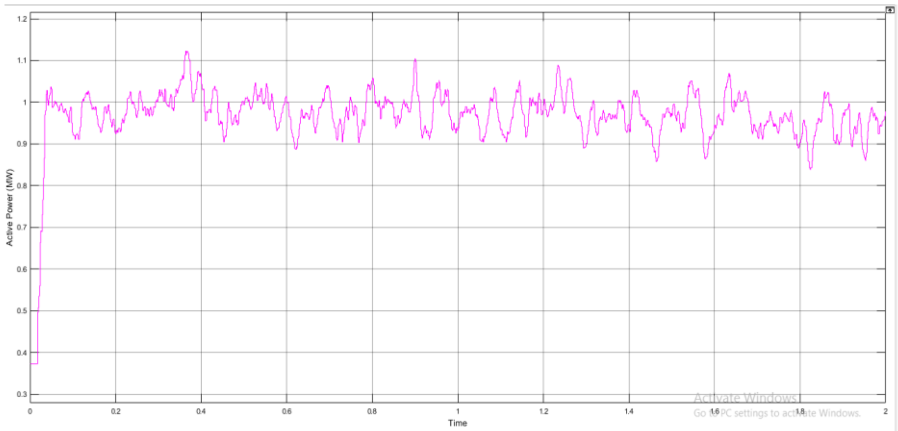

Figure 5 Active Power output from the system with basic inverter control

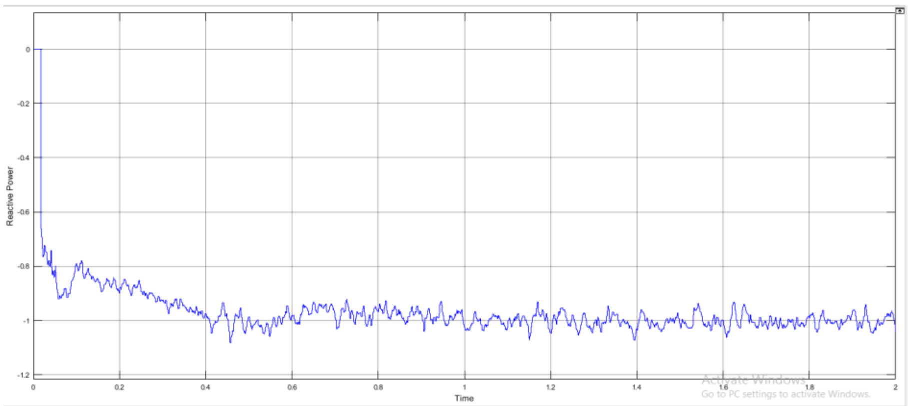

Figure 6 Reactive Power output from the system with basic inverter control

CASE 2: Proposed 7Solar PV system with Power normalizing hysteresis controller

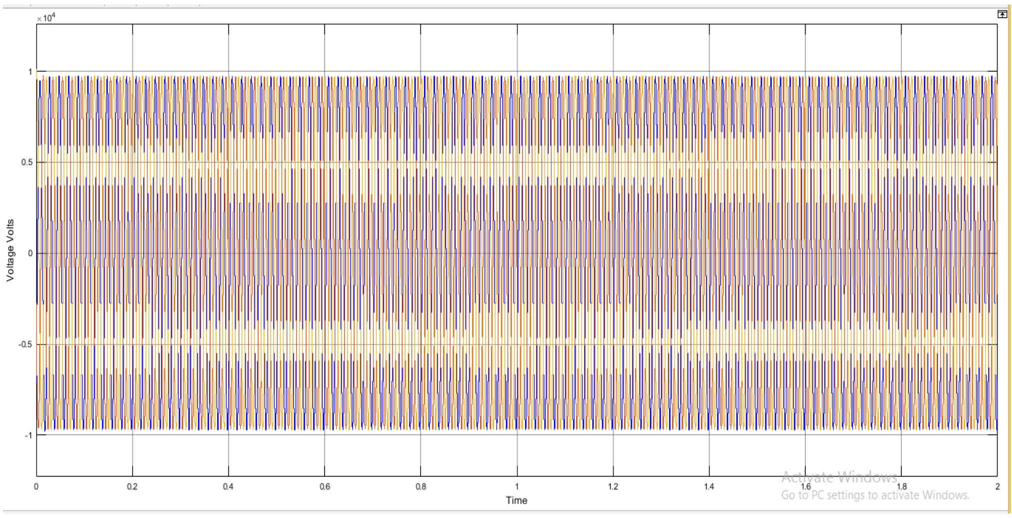

Figure 7 Voltage Output from the system having Power Normalizing hysteresis controller

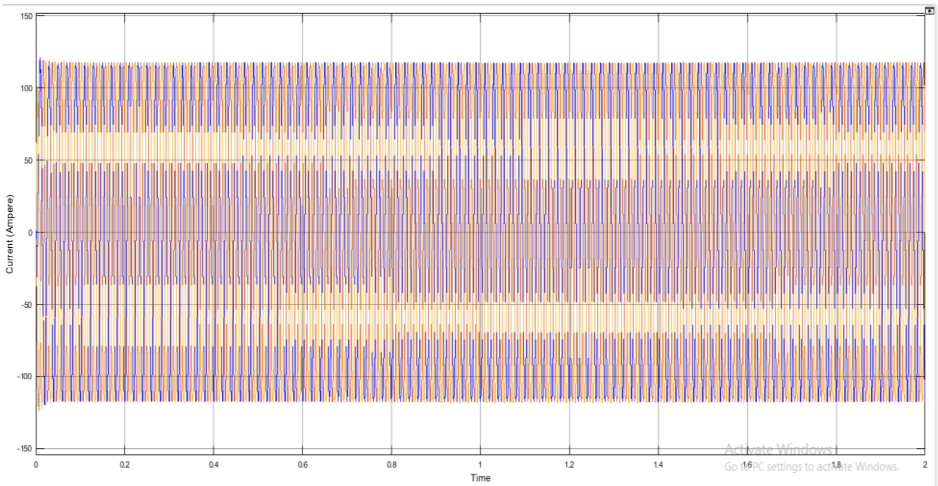

Figure 8 Current Output from the system having Power Normalizing hysteresis controller

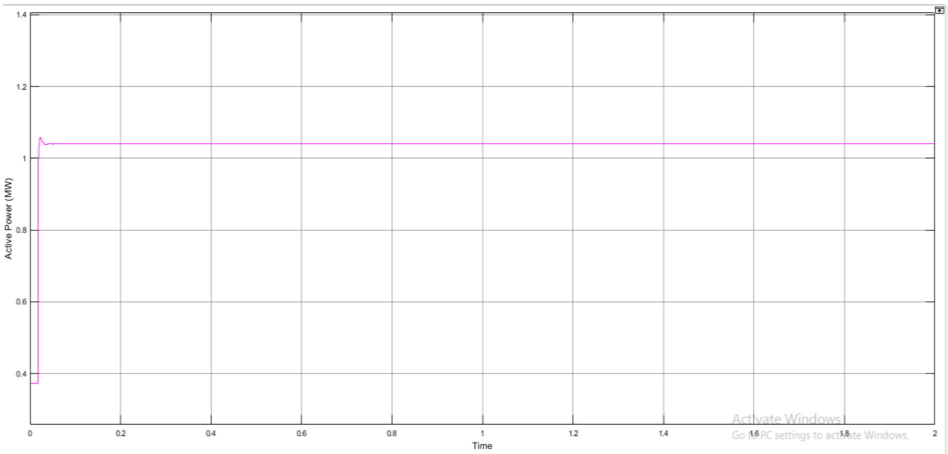

Figure.9 Active Power Output from the system having Power normalizing hysteresis controller

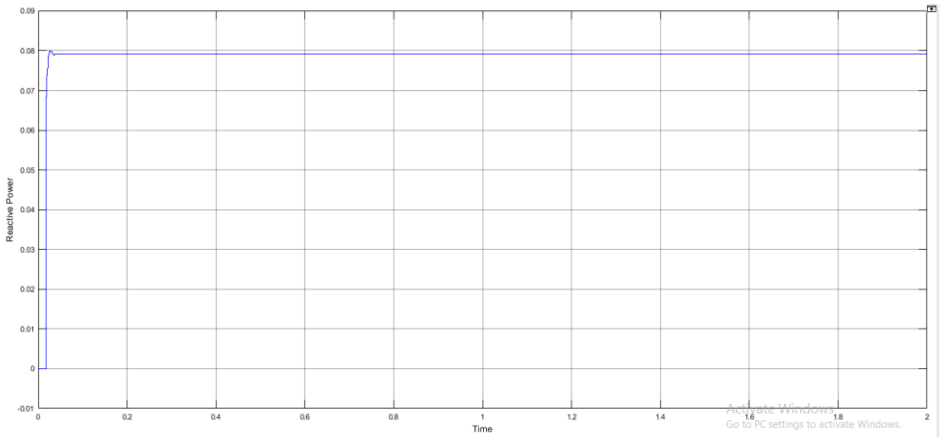

Figure 10 Reactive Power Output from the system having Power normalizing hysteresis controller

V. VALIDATION

The active power output of the two systems is compared in this section. The graph compares the active power output of the two systems. The green graph depicts the active power output of the proposed power normalizing hysteresis loop controller for the inverter, whereas the graph depicts the active power output of the system with basic inverter control.

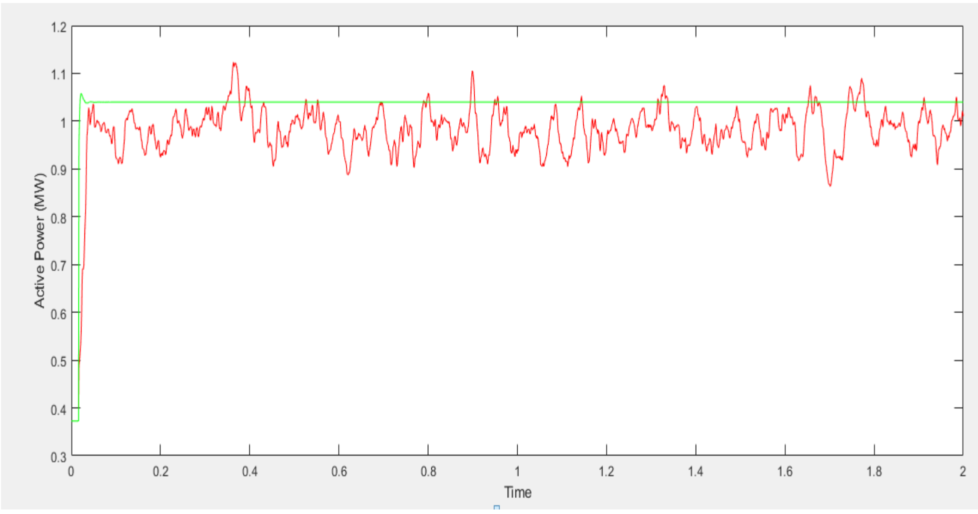

Figure 11 Comparative analyses of active power outputs

When the voltage was held constant at 10KV, active power output increased from approximately 1 MW to 1.03 MW. The proposed controller, which included an inverter with power normalizing hysteresis loop control, was used to keep the active power output stable and balanced.

VI. CONCLUSION

This paper describes the detailed design and implementation of a three-phase converter in a solar PV system made up of various cell array models fed by varying irradiation and temperature. Power normalising hysteresis control has been proposed while integrating the inverter with the grid.

Variations in irradiation and temperature input to each array of solar modules can cause a disruption in the system's active power output, according to the research. With this goal in mind, a controller that will both stabilize and increase active power output was developed. The proposed technique's effectiveness and efficiency for grid integrated inverter operation is demonstrated by a comparative analysis in a solar PV with dynamic input parameters based model.

Table 2 : Comparative outcomes form the solar system

Parameters/ Model	**Active Power**	**Voltage**	**Current**
Model 1	1MW	10 KV	100 Ampere
Model 2	1.03MW	10 KV	120 Ampere

The following main conclusive points were drawn during the system analysis in the MATLAB/SIMULINK environment.

- In the system with power normalizing hysteresis control, the magnitude of active power output is greater than in the system with basic voltage current regulation control. The active power was calculated to be approximately 1.03 Watts and less pulsing than the power output from the inverter with basic voltage current regulation Control.
- The increase in efficiency of the system to about 3%.
- Furthermore, the magnitude and stability of reactive power in the proposed controller outperform reactive power in the basic voltage current regulation system.

The voltage output of the modelled solar system with varying irradiation and temperature control is fed to the inverter for DC to AC conversion. The voltage is then returned to the power grid. The grid voltage is held constant at 10KV in both systems.

The proposed modulation technique is easy to implement and can be applied to any number of levels in a multilevel inverter. In a solar system with varying input parameters that still produces stable and efficient output power, this implementation would be preferable.

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