AC-DC Bidirectional Microgrid System for PV System Application

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ABSTRACT ***For boost operation, the majority of power supplies use two-stage converters. However, they have significant issues with size, losses, and cost that lower the converter's and the system's overall efficiency. Single-stage resonant converters have been created with the goal of lowering component count, size, and cost. However, because of the Electromagnetic Induction (EMI) issue and the Discontinuous Conduction Mode (DCM) boost operation, switches experience high voltage stress. Harmonics can be recovered at the device, building, and distribution levels and then reinjected into the system to correct distorted wave patterns in order to enhance the quality of the power. Nonlinear loads and switching devices, which account for 40% of utility loads in most cases, produce harmonics. When managing high voltage and power, a typical two-level inverter reaches its limit and produces higher-order harmonics. This restriction is starting to emerge as the primary disadvantage of the two-level inverter. The limitations of the two-level inverter are lessened by a multilevel inverter.***

Key Words: Solar System, MPPT, MATLAB,

1. INTRODUCTION

Improving the power quality in photovoltaic systems for solar energy storage is one of the challenging issues. Deviations in current, voltage, and frequency are indicative of it, and they might result in equipment failure or malfunction. Furthermore, the solar PV conversion system's value is in giving customers pure power. The enhancement of power quality should be taken into consideration together with power availability. Given these issues, a solar-fed seven-level QZS-CMI inverter requires a well-developed control algorithm to improve the system's power quality. Additionally, a simplified MPPT algorithm is needed to maximize the power from the PV panel.

TCT arrangement is the most popular connector configuration for achieving increased output power and a significant reduction in mismatch power loss in partial shadow conditions. Here, partial shading (PS) refers to the phenomenon when passing clouds, building shadow, bird droppings, etc., significantly impair photovoltaic cell performance. Multiple peaks partially shade one another, causing hotspots and making it harder to track maximum power. However, as it seeks to obtain the global maximum power under partial shade conditions, the use of Maximum Power Point (MPP) tracking minimizes the issue of multiple peaks. But they are unable to reduce the number of power peaks; as a result, the issue brought on by partial shade continues to exist. However, the cause of the multiple peak issue is essentially the variation in row current flowing within the photovoltaic array. When the shade on the PV panel is distributed equally, the row current differential that causes multiple power peak issues can be reduced. Consequently, shadow dispersion lowers the number of peaks by minimizing the row current differential. On the other hand, shade dispersion in PV arrays can be accomplished electrically or physically.

Electrical array reconfiguration is employed for dynamic shade dispersion, while physical displacement comes after a single rearrangement.

2. Photovoltaic modules' outputs of current and power are roughly related to the amount of solar energy and the surrounding temperature. The parameters of the load dictate the operating voltages and output current of a module at a particular intensity. The construction of the Power vs. Voltage (P-V) and Current vs. Voltage (I-V) curves is necessary to ascertain the PV module's properties. The PV characteristics of solar PV modules are predicted using three parameters provided by the PV module manufacturer: Open Circuit voltage (Voc), Short circuit current (Isc), and Maximum Power Point (Vmp, Imp). The Closed Loop Boost Converter Simulation Model is displayed in Figure 1.

3. EVOLUTION OF PWM STRATEGIES

In order to generate the PWM switching edges, the most common and extensively used PWM approach, known as SPWM, simply compares a sinusoidal modulating signal with a triangular carrier. Natural Sampled PWM (NSPWM) is a technology that compares these two signals instantaneously to calculate the PWM switching instants through a natural sampling procedure. The breadth of carrier and reference adjustments for NSPWM performance enhancement is broad. These are the attempts to improve performance by using alternative carrier functions (other than triangular) and reference functions (other than sine).

4. IMPLEMENTATION

In the current trend, renewable energy sources are appealing options for supplying electricity in locations where connecting to the utility network is either impractical or prohibitively expensive. As electric distribution technology advances into the twenty-first century, a number of changes are emerging that will alter the requirements for energy supply. Interest in green power production systems has increased due to factors such as the world's deteriorating environment, rising energy use, and the finite nature of fossil fuels. Worldwide interest in renewable sources has increased due to the rapid depletion of fossil fuels and the rise in energy use. Large numbers of micro sources are integrated into the microgrid idea without interfering with the main utility grid's ability to function. PV and wind energy sources power the DC and AC networks of this hybrid microgrid, respectively. Micrograds with AC or DC power sources can be linked to energy storage devices. The suggested

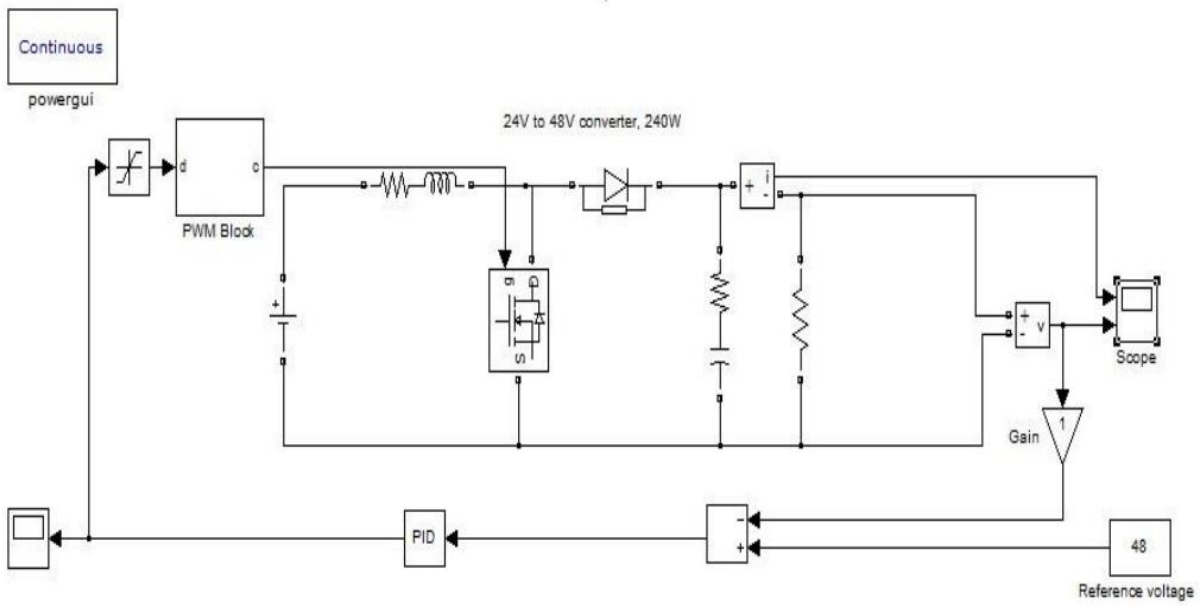

Figure 1 System Model

hybrid Microgrid can function in either independent or grid-tied mode. Sources and loads for AC are linked to the AC network, whereas sources and loads for DC are linked to the DC network. The system model and operation also take into account the uncertain and sporadic characteristics of wind speed, solar irradiation level, ambient temperature, and load. Figure 2 depicts a microgrid system representation. A grid-connected photovoltaic application system uses a DC-DC boost converter to maintain a consistent output voltage. The purpose of the boost converter is to increase the DC voltage from a solar panel that is erratic to a greater, steady value.

5. DC-DC BOOST CONVERT WITH MPPT TRACKING

Constant output voltage is achieved with a DC-DC boost converter in grid-connected photovoltaic application systems. The purpose of the boost converter is to increase a solar panel's erratic voltage to a greater, steady DC value.

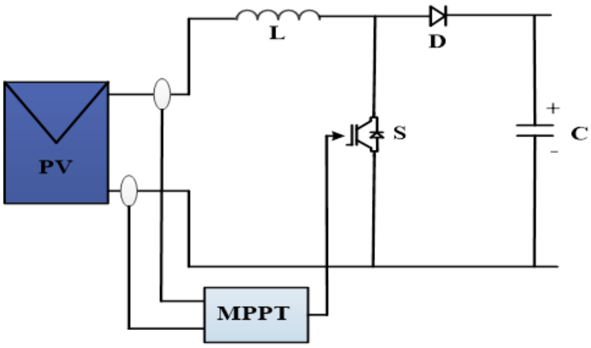

Figure 3 DC-DC boost converter with MPPT tracking

It uses voltage feedback to keep the output voltage constant. To do this, the core of the control system is a microcontroller, which tracks and provides a pulse-width-modulation signal to adjust the power of the electronic component in the boost converter. The boost converter can couple directly with the grid-tied inverter in solar systems that are linked to the grid.

GRID SYNCHRONISATION

PV system installations are skyrocketing, mainly because governments and utility companies are sponsoring grid-connected PV system-focused initiatives.

In a distributed system with a generic structure, the power conversion unit transforms the input power into electricity. Its design is directly related to the type of input power. The generated power can be sent to the local loads or the utility network, contingent upon the location of the producing equipment's connection.

One of the most important parts of the distributed system is control. The control duties consist of two primary parts:

- Input-side controller: Its main feature is its capacity to extract as much power as possible from the input source. Of course, one also needs to consider the protection provided by the input-side converter.
- Grid-side controller: It carries out the subsequent tasks:

It assures excellent quality of the injected power in the following ways:

(a) it regulates the active power generated;

(b) it controls the reactive power transfer between the PV and the grid;

(c) the grid-side controller controls the dc-link voltage.

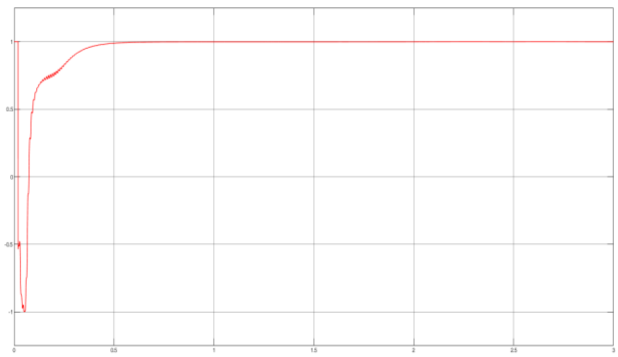

Figure 4 Unity power factor at the grid side

Figure 4 illustrates the UPF (unity power factor) that this grid-connected system achieves at the grid side.

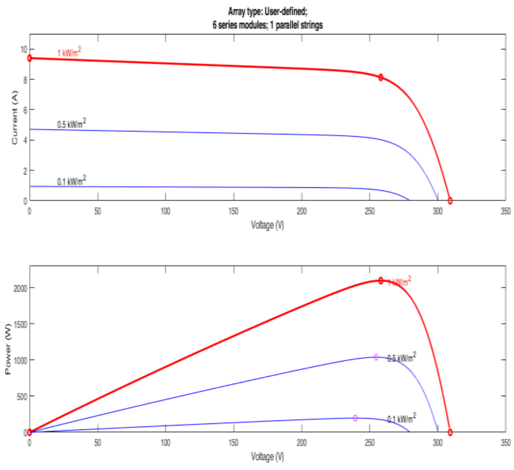

Figure 5 PV power and current with respect to voltage

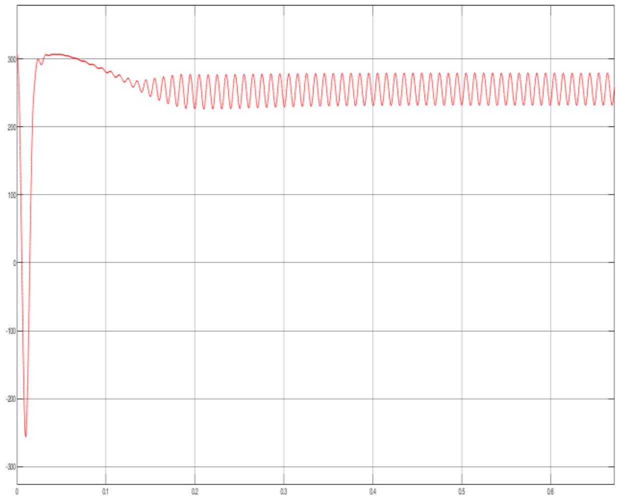

Figure 6 PV output DC voltage with 50V ripple

A DC-DC boost converter is needed to raise the DC voltage and reduce this ripple. With the use of an inverter, the DC-DC boost converter's output voltage can be readily linked to a single-phase grid due to its high voltage and ripple-free output of 400V. Additionally helpful for MPPT (Maximum Power point tracking), which is done using the perturb and observe method, is this DC-DC boost converter. This converter operated on a 5KHz switching frequency as the initial stage of our system.

CONCLUSION

This work develops a maximum power point controller and five-level inverter research of a photovoltaic system integrated with the grid. Using the MATLAB Simulink model, a photovoltaic array is created. Simulink MATLAB has been used to build and simulate the solar system with DC-DC boost converter, maximum power point controller, and multilayer inverter. configuration and comparison of a few multilayer inverters, with an emphasis on five-level inverters.

The AC/DC hybrid microgrid optimizes the topology of conventional distribution networks by taking into consideration the access requirements of both AC and DC sources and loads. The microgrid can achieve a more flexible and reliable transmission mode through the employment of power electronic transformers as the core of its energy management, electrical isolation, and precise control of the voltage, current, and power flow by the control system. The electromagnetic transient simulation takes too long because of the power electronic transformer's frequent switching, which combines the power electronic device with the high-frequency transformer. Large numbers of micro sources are integrated into the microgrid idea without interfering with the main utility grid's ability to function. PV and wind energy sources power the DC and AC networks of this hybrid microgrid, respectively. Microgrids with AC or DC power sources can be linked to energy storage devices. The suggested hybrid Microgrid can function in either independent or grid-tied mode. Sources and loads for AC are linked to the AC network, whereas sources and loads for DC are linked to the DC network. The system model and operation also take into account the uncertain and sporadic characteristics of wind speed, solar irradiation level, ambient temperature, and load. The PV module sets the maximum PV output voltage at 290, with a ripple of about 50V from peak to peak. This large voltage ripple can harm a system, lower its efficiency, and increase its losses. PV output's DC voltage. A DC-DC boost converter is needed to raise the DC voltage and reduce this ripple. With the use of an inverter, the DC-DC boost converter's output voltage can be readily linked to a single-phase grid due to its high voltage and ripple-free output of 400V. Additionally helpful for MPPT (Maximum Power point tracking), which is done using the perturb and observe method, is this DC-DC boost converter. This converter operated on a 5KHz switching frequency as the initial stage of our system.

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