AC-DC BIDIRECTIONAL MICROGRID SYSTEM FOR PV SYSTEM APPLICATION

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Abstract: Most of the power supplies practice two-stage converter for boost operation. But, they have serious problems like size, losses and cost that reduce the efficiency of the converter and the whole system. With the intention of reducing the component count, size and cost, single-stage resonant converter has been developed. However, it has high voltage stress in switches by the Discontinuous Conduction Mode (DCM) boost operation and Electromagnetic Induction (EMI) problem. To improve the power quality, harmonics can be harvested at device, building and distribution levels and then injected back to the system to repair distorted wave shapes. Harmonics are created by nonlinear loads and switching devices that are usually 40% of utility load. A normal two-level inverter gets its limitation when handling high voltage and power thus, producing a higher-order harmonics. This limitation is becoming the main drawback, when using the two-level inverter. A multilevel inverter reduces the limitation of the two-level inverter.

Key Words: Solar System, MPPT, MATLAB.

1. INTRODUCTION

In solar energy storage PV system, enhancing the power quality is one of the perplexing problems. It is exhibited in current, voltage and frequency deviations and they lead to consequential in failure or malfunction of equipment. Moreover, the solar PV conversion system lies in providing a pure form of power to the consumers. The power availability should also be accounted in addition to the power quality improvement. In view of these problems, a well-developed control algorithm is needed for a solar fed seven level QZS-CMI inverter to enhance the power quality of the system and in addition, a simplified MPPT algorithm is required to extract maximum power from PV panel. Among all, the widely used interconnection arrangement for obtaining enhanced output power along with the considerable mismatch power loss reduction under partial shade condition is TCT arrangement. Partial Shading (PS) here, is the phenomenon that majorly affects the performance of a PV cell due to passing clouds, shade of the buildings and bird drops etc., Due to partial shading multiple peaks, hotspot occur and difficulty in tracking maximum power arises. However, application of Maximum Power Point (MPP) tracking minimizes the problem of multiple peaks as it attempts to reach the global maximum power under partial shade condition. However, fail to alleviate multiple power peaks; hence, the problem that arises due to partial shading still persists. On the other hand, the problem of multiple peaks actually arises due to difference in row current flowing in the PV array. This row current difference that introduces multiple power peak problems can be minimized when the shade occurring on the PV panel is equally disbursed. Therefore, shade dispersion minimizes the row current difference, in consequence reduces the number of peaks. However, shade dispersion in PV array is achieved either physically or electrically. For dynamic shade dispersion, electrical array reconfiguration is used; while, physical relocation follows one-time rearrangement.

The current and power outputs of photovoltaic modules are approximately proportional to solar irradiation and the ambient temperature. At a given intensity, a module's output current and operating voltages are determined by the characteristics of the load. In order to determine the characteristics of the PV module, the Power vs. Voltage (P-V) and Current vs. Voltage (I-V) curves must be constructed. Three parameters, namely, Open Circuit voltage (V_{oc}), Short circuit current (I_{sc}), and Maximum Power Point (V_{mp}, I_{mp}), given by the manufacturer of the PV module, are used for the prediction of the PV characteristics of solar PV module. Figure 1 shows Simulation Model of Closed Loop Boost Converter

2. EVOLUTION OF PWM STRATEGIES

The most popular and widely used PWM technique, SPWM involves the simple direct comparison of a sinusoidal modulating signal with a triangular carrier to produce the PWM switching edges. The instantaneous comparison of these two signals

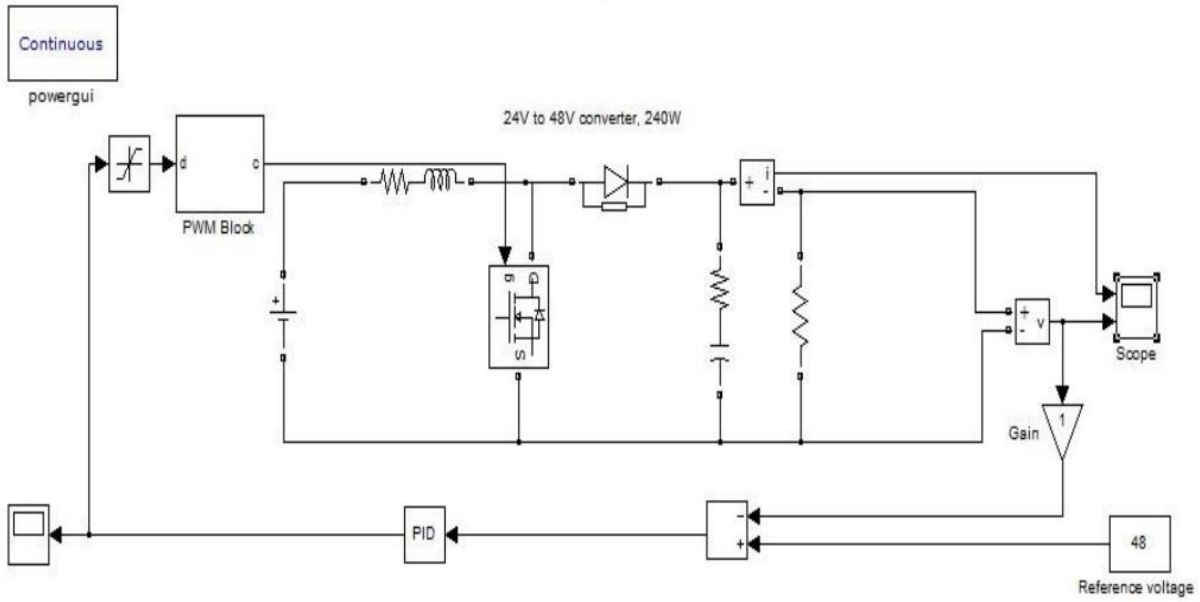

Figure 1 System Model

determines the PWM switching instants by a process of natural sampling and the technique is called as Natural Sampled PWM (NSPWM). The performance enhancement in NSPWM has a wide scope through carrier and reference modifications. These are the attempts to use different functions for reference (other than sine) and carrier (other than triangular) towards improving the performance.

3. IMPLEMENTATION

In the present trend, Renewable energy sources are attractive choices for providing power in the places where an association to the utility network is either not possible or unduly costly. As electric distribution technology steps into next century, several trends have become noticeable which will modify the necessities of energy delivery. The ever-increasing energy consumption, soaring value and exhaustible nature of fossil fuels, and also the worsening international environment have created enhanced interest in green power generation systems. Renewable sources have gained worldwide attention because of quick depletion of fossil fuels in conjunction with growing energy demand. Microgrid concept integrates large amounts of micro sources without disrupting the operation of main utility grid. This hybrid Microgrid consists of PV/wind energy sources for DC and AC networks respectively. Energy storage systems may be connected to either AC or DC Microgrids. The proposed hybrid Microgrid operates in grid-tied or isolated mode. AC sources and loads are connected to AC network, whereas DC sources and loads are connected to DC network. Uncertainty and intermittent characteristics of wind speed, solar irradiation level, ambient temperature and load are additionally considered in the system model and operation. Representation of microgrid system shown in Figure 2. DC-DC boost converter used for constant output voltage for grid connected photovoltaic application system. The boost converter is designed to step up a fluctuating solar panel voltage to a higher constant DC voltage.

4. DC-DC BOOST CONVERT WITH MPPT TRACKING

DC-DC boost converter used for constant output voltage for grid connected photovoltaic application system. The boost converter is designed to step up a fluctuating solar panel voltage to a higher constant DC voltage.

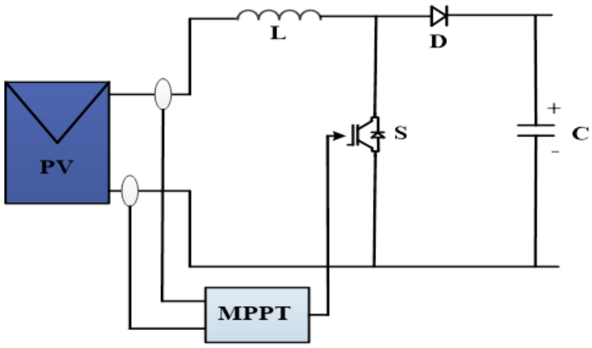

Figure 3 DC-DC boost converter with MPPT tracking

It uses voltage feedback to keep the output voltage constant. To do so, a microcontroller is used as the heart of the control system which it tracks and provides pulse-width-modulation signal to control power electronic device in boost converter. The boost converter will be able to direct couple with grid-tied inverter for grid connected photovoltaic system.

5. GRID SYNCHRONISATION

The number of PV installations has an exponential growth, mainly due to the governments and utility companies that support programs that focus on grid-connected PV systems.

In a general structure distributed system, the input power is transformed into electricity by means of a power conversion unit whose configuration is closely related to the input power nature. The electricity produced can be delivered to the local loads or to the utility network, depending where the generation system is connected.

One important part of the distributed system is its control. The control tasks can be divided into two major parts:

(1) Input-side controller: Its main property is that it can extract the maximum power from the input source. Naturally, protection of the input-side converter is also important to be considered.

(2) Grid – side controller: It performs the following:

(a) It controls the active power generated
(b) It controls the reactive power transfer between the PV and the grid
(c) Control of the dc-link voltage is done by the grid-side controller
(d) It ensures high quality of the injected power

Figure 4 Unity power factor at the grid side

This grid connected system also achieve a UPF (unity power factor) at the grid side which is shown in Figure 4.

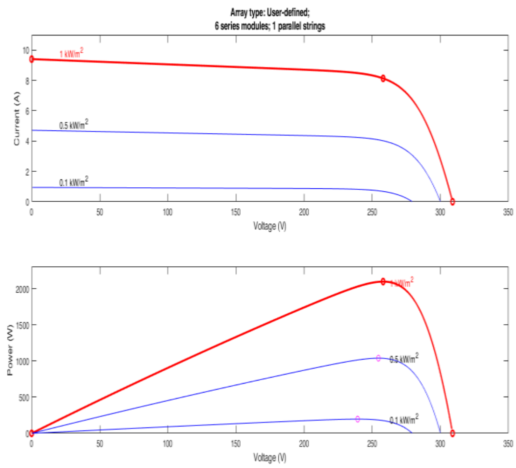

Figure 5 PV power and current with respect to voltage

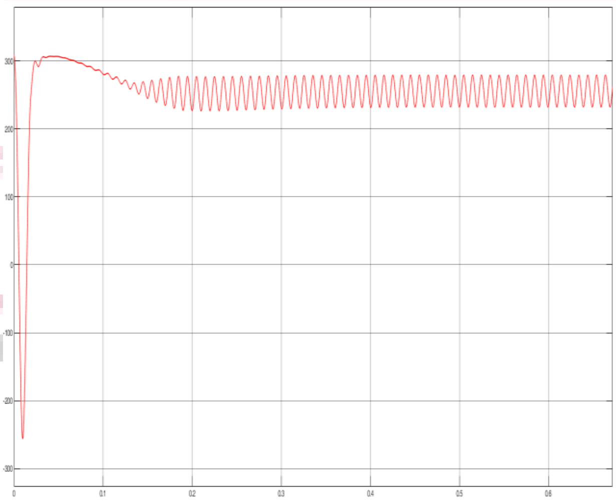

Figure 6 PV output DC voltage with 50V ripple

For reduction of this ripple and increase the dc voltage required a DC-DC boost converter. Output voltage of DC-DC boost converter is ripple free and high voltage as 400V so it can be easily connected to the single-phase grid by using inverter. This DC-DC boost converter also useful for MPPT (Maximum Power point tracking) which is performed by perturb and observe method. This converter worked as a first stage of our system and work on a 5KHz Switching frequency.

CONCLUSION

In this work, the study of the photovoltaic system integrated with grid has been developed with maximum power point controller and five-level inverter. A Photovoltaic array is developed in MATLAB Simulink model. The photovoltaic system with DC-DC boost converter, maximum power point controller and multilevel inverter has been designed and simulated with Simulink MATLAB. Configuration as well as comparison between some multilevel inverters focusing on five-level inverter. The AC/DC hybrid microgrid, which takes into account the access requirements of AC and DC sources and loads, optimizes the structure of traditional distribution networks. The application of power electronic transformers as the core of its energy management, with electrical isolation and accurate control of the voltage, current and power flow by the control system, enables the microgrid to achieve a more flexible and stable transmission mode. Because the power electronic transformer combines the power electronic device and the high-frequency transformer, its frequent switching causes the electromagnetic transient simulation to take too long. Microgrid concept integrates large amounts of micro sources without disrupting the operation of main utility grid. This hybrid Microgrid consists of PV/wind energy sources for DC and AC networks respectively. Energy storage systems may be connected to either AC or DC Microgrids. The proposed hybrid Microgrid operates in grid-tied or isolated mode. AC sources and loads are connected to AC network, whereas DC sources and loads are connected to DC network. Uncertainty and intermittent characteristics of wind speed, solar irradiation level, ambient temperature and load are additionally considered in the system model and operation. Maximum PV output voltage is set to 290 according to the PV module and this voltage has approximately 50V peak to peak ripple. This high voltage ripple can damage a system and reduces the efficiency also increases the losses of the system. DC voltage of the PV output. For reduction of this ripple and increase the dc voltage required a DC-DC boost converter. Output voltage of DC-DC boost converter is ripple free and high voltage as 400V so it can be easily connected to the single-phase grid by using inverter. This DC-DC boost converter also useful for MPPT (Maximum Power point tracking) which is performed by perturb and observe method. This converter worked as a first stage of our system and work on a 5KHz Switching frequency.

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