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Performance of PV system Using SSIB Converter

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ABSTRACT: The number of large-scale solar photovoltaic (PV)systems continues to increase, while the size of the largest systemshas already reached several hundred megawatts. This trend willchallenge existing PV system architectures and will require newPV system architectures with higher power ratings and highervoltage levels at the point of common coupling (PCC). This paperreports a medium-voltage (MV) dc-bus PV system architecturebased on a high-gain soft-switched interleaved boost (SSIB) dc–dcconverter. The interleaved characteristic increases the flexibilityof the converter, allowing for either a higher voltage and/or currentrating, thus increasing the power rating of the converter. Thehigh-gain capability of the SSIB converter allows it to be connecteddirectly to an MV dc bus. This will facilitate direct connection of aPV system to an MV ac grid (i.e., 20 kV) using only one step-uptransformer. Simulation and experimental results are presentedto verify the operation of the SSIB converter and to confirm thesteady-state and dynamic performance of the proposed PV systemarchitecture.

KEYWORDS: DC–DC power converters, large-scale systems,photovoltaic (PV) systems, power conversion.

I. INTRODUCTION

With the global environmental pollution and energy crisis, distributed power generation system (DPGS) based on renewable energy, such as photovoltaic (PV) and wind power generation (WPG), is playing a more and more important role in energy production. However, the output power of PV and WPG are usually strongly fluctuant due to the randomness and intermittence of solar and wind energy, which requires a large capacity of energy storage to satisfy the load demand when the system works in stand-alone mode, and results in a strong impact on the utility grid when the system works in grid-connected mode. This problem can be partially overcome by utilizing the hybrid wind-solar power system thanks to the complementary characteristics of wind and solar energy. A reasonable size of PV/WPG/battery can not only improve the power supply reliability, but also reduce the cost of the system.

II. BLOCK DIAGRAM

SSIB Converter

SSIB Converter for PV Application When connecting a large-scale PV system (MW level orhigher) to the MV or HV electricity grid, multiple transformer stages are usually required. This is because the maximum allowed dc output voltage of a PV string is 1000 V (600 V in North America) [33], and the voltage at the PCC has to be 20 kV or above. Consequently, most MV or HV grid-connected large-scale PV systems have two transformer stages, as shown in Fig. 1(a) and (b). To connect a large PV system to an MV grid through only one step-up transformer, the SSIB converter needs to provide a voltage gain that can boost the minimumMPP voltage to the voltage of the MV dc bus, in this case 7.5 kV.

Converter Configuration: Greater values of N allow the converter to operate with a lower duty cycle. At the same time, the input current ripple is reduced by a factor of 1/N, and can be reduced further depending on the duty cycle. The reduced input current ripple results in better MPPT performance. However, N is limited due to the voltage rating of the auxiliary capacitor. As described in (5), the voltage rating of the uppermost auxiliary capacitor increases with increasing N. Therefore, N should be properly chosen considering a trade-off between converter operating duty cycle, input current ripple, and voltage rating of the auxiliary capacitor.

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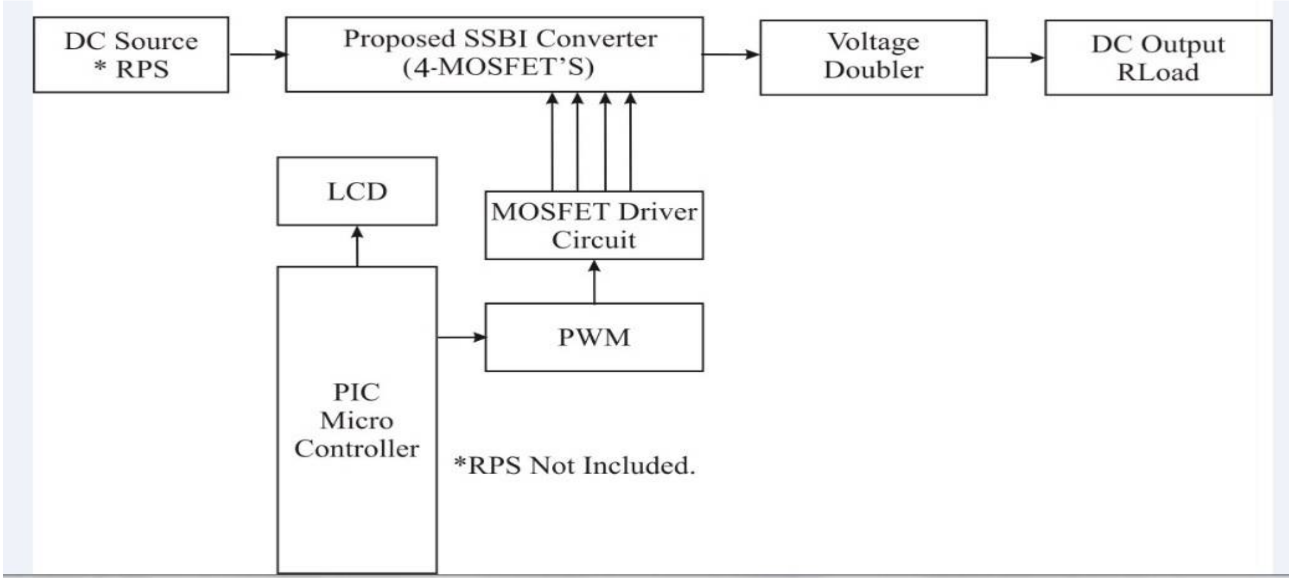

Fig. 1 Block Diagram of PV system Using SSIB Converter

MPPT

Maximum power point tracking (MPPT) is a technique that charge controllers use for wind turbines and PV solar systems to employ and maximize power output. PV solar comes in different configurations. The most basic version is one where power goes from collector panels to the inverter (often via a controller) and from there directly onto the grid. A second version might split the power at the inverter. This is called a hybrid inverter. The apportionment of how much power goes to each at any given moment varies continuously. Part of the power goes to the grid and part of it to a battery bank. The third version is not connected at all to the grid but still employs a dedicated PV inverter that features MPPT. In this configuration power goes from the solar panels to the inverter and from there to a battery bank. A variation on these configurations is that instead of only one single inverter, micro inverters are deployed, one for each PV panel. This allegedly increases PV solar efficiency by up to 20%. For the sake of completeness it should be mentioned that there are now MPPT equipped specialty inverters (mostly from China) that are designed to serve three functions. They grid-connect wind power as well as PV solar power and branch off power for battery charging.

This article about the application of MPPT concerns itself only with PV solar. Solar cells have a complex relationship between temperature and total resistance that produces a non-linear output efficiency which can be analysed based on the I-V curve. It is the purpose of the MPPT system to sample the output of the PV cells and apply the proper resistance (load) to obtain maximum power for any given environmental conditions. MPPT devices are typically integrated into an electric power converter system that provides voltage or current conversion, filtering, and regulation for driving various loads, including power grids, batteries, or motors.

- Solar inverters convert the DC power to AC power and may incorporate MPPT: such inverters sample the output power (I-V curve) from the solar modules and apply the proper resistance (load) so as to obtain maximum power.
- MPP(Maximum power point) is the product of the MPP voltage(Vmpp) and MPP current(Impp).

PV SYSTEM

A photovoltaic system, also solar PV power system, or PV system, is a power system designed to supply usable solar power by means of photovoltaic. It consists of an arrangement of several components, including solar panels to

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absorb and convert sunlight into electricity, a solar inverter to change the electric current from DC to AC, as well as mounting, cabling and other electrical accessories to set up a working system. It may also use a solar tracking system to improve the system's overall performance and include an integrated battery solution, as prices for storage devices are expected to decline. Strictly speaking, a solar array only encompasses the ensemble of solar panels, the visible part of the PV system, and does not include all the other hardware, often summarized as balance of system (BOS). Moreover, PV systems convert light directly into electricity and shouldn't be confused with other technologies, such as power or solar thermal, used for heating and cooling.

PV systems range from small, roof-top mounted or building-integrated systems with capacities from a few to several tens of kilowatts, to large utility-scale power stations of hundreds of megawatts. Nowadays, most PV systems are grid-connected, while off-grid or stand-alone systems only account for a small portion of the market.Operating silently and without any moving parts or environmental emissions, PV systems have developed from being niche market applications into a mature technology used for mainstream electricity generation. A roof-top system recoups the invested energy for its manufacturing and installation within 0.7 to 2 years and produces about 95 percent of net clean renewable over a 30-year service lifetime.
A photovoltaic system converts the sun's radiation into usable electricity. It comprises the solar array and the balance of system components. PV systems can be categorized by various aspects, such as, grid-connected vs. standalone systems, building-integrated vs. rack-mounted systems, residential vs. utility systems, distributed vs. centralized systems, roof-top vs. ground-mounted systems, tracking vs. fixed-tilt systems, and new constructed vs. retrofitted systems. Other distinctions may include, systems with micro inverters vs. central inverter, systems using crystalline silicon vs. thin-film technology, and systems with modules from Chinese vs. European and U.S.-manufacturers.

III. RESULT AND DISCUSSION

The proposed control methodology to achieve a various functions for Solar interfaced Gridsystems connected at a 3-phase 3-wire distribution network is verified through an MATLAB/Simulink. A 3-phase 4-leg current controlled voltage source inverter is actively controlled to achieve balanced sinusoidal grid currents.

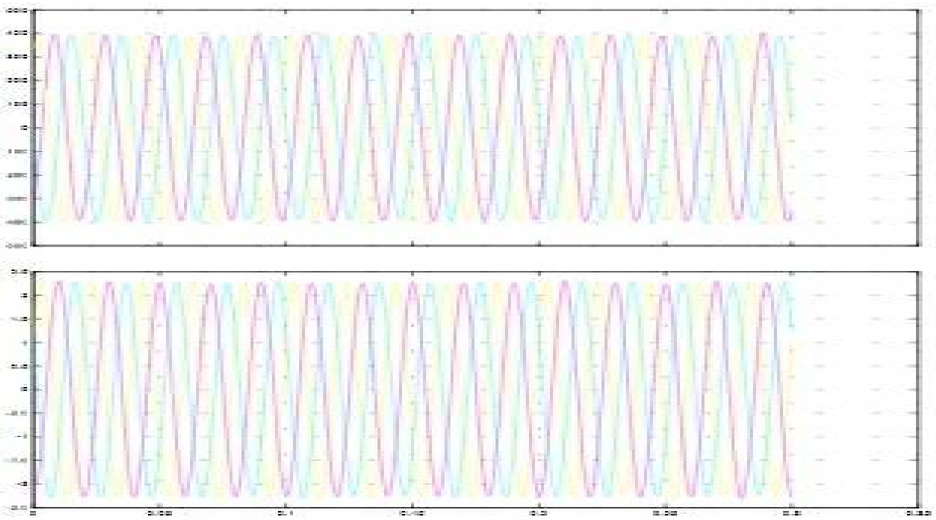

Fig. 2 AC Load Output

A variable output power from the solar is connected on the dc-link of grid-interfacing inverter.

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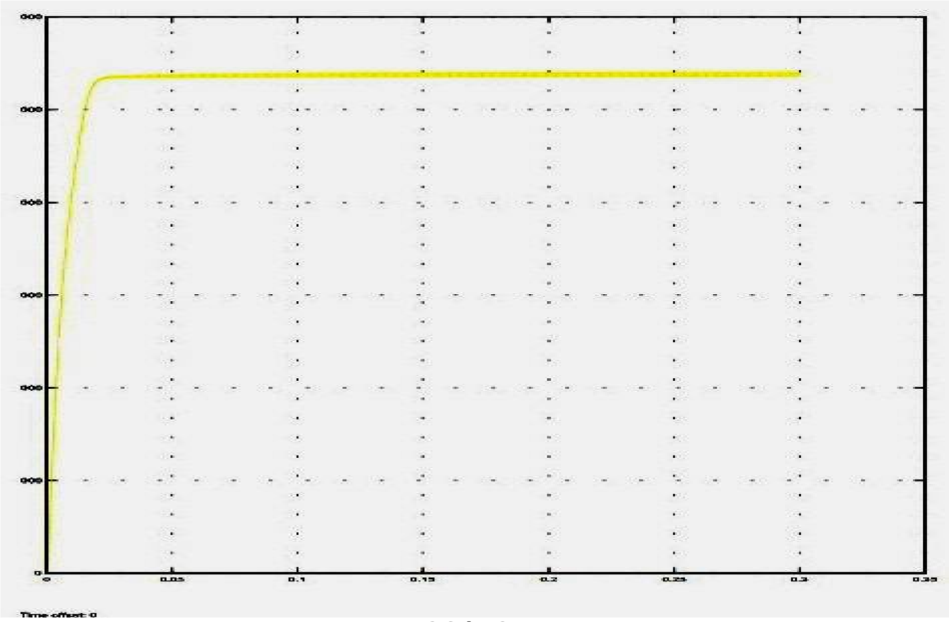

Fig.3 Solar Output

The power quality problems for a 3-phase 3 wire nonlinear load connected system whose unbalance, harmonics, and reactive power demand to be compensated, where inverter is connected on PCC.

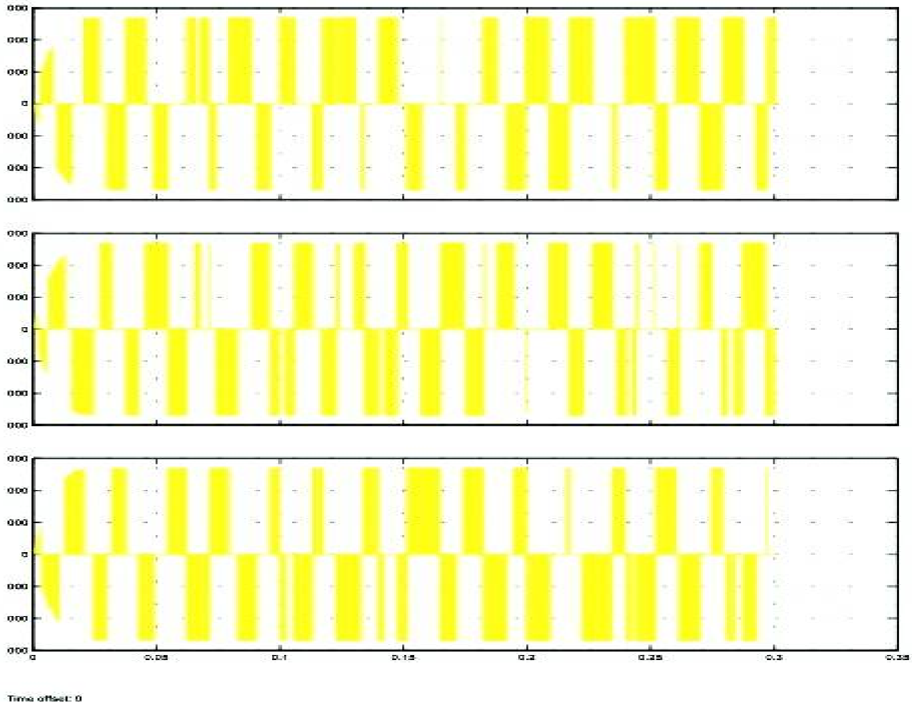

Fig. 4 Inverter Output

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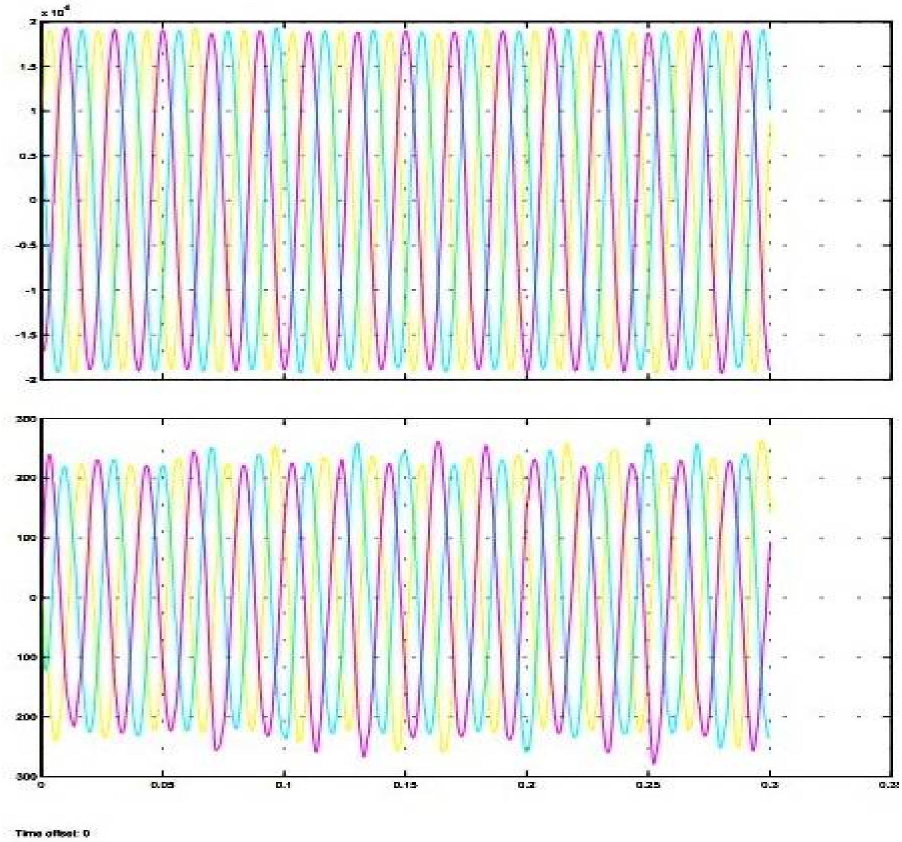

Fig. 5 3-Phase Load Output

The solar power 6000v (DC Voltage) is converted by 3 phase AC voltage Inverter. Thus the Inverter connected to the Grid. At last the Grid source is connected to the 3 phase AC load.

IV. CONCLUSION

An MV dc-bus PV system architecture based on a high-gain SSIB dc–dc converter has been reported in this paper. The MV ac grid connection of a PV system using only one step-up transformer has been achieved by introducing the SSIB converter. Simulation and experimental results verified both the steady state and dynamic performance of the PV system architecture. The performance of the MPPT controller under rapidly changing solar irradiation conditions and the operation of the SSIB converter were confirmed. The N = 2, P = 1 SSIB converter achieved a voltage gain of 9.3 for a duty ratio of 0.71, thus proving that a PV system can achieve medium-voltage grid connection using only one step-up transformer.

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