Power System Integration of Photovoltaic and Energy Storage

[1]Balamurugan.R, [2]Vanisha.B, [3]Manimekalai.A, [4]Kavitha.N, [5]Iyappan.S
[1]AP/EEE, [2,3,4,5]Final Year Department Of EEE
Karur College Of Engineering, Karur

Abstract

This project is a compact topology for an integrated PV and energy storage system based on three quadratic boost converters and one bidirectional buck-boost converter. One of the quadratic boost converters is used for DMPPT control, and the other two quadratic boost converters are used to implement a boost inverter that can generate sinusoidal waveform. A bidirectional buck-boost converter, to charge and discharge the energy storage system to balance the power gap between the PV panels and the load, is also integrated in the topology. A control strategy is developed to balance the supply and load demand. improve the voltage gain and reduce the voltage stress.

INTRODUCTION

Solar energy can be utilized in two major ways. Firstly, the captured heat can be used as solar thermal energy, with applications in space heating. Another alternative is the conversion of incident solar radiation to electrical energy, which is the most usable form of energy. This can be achieved with the help of solar photovoltaic cells or with concentrating solar power plants. As the Photovoltaic module exhibits non-linear V-I Characteristics, which are dependent on solar in solution and environment factors, the development of an accurate power electronic circuit oriented model, is essential to simulate and design the photovoltaic integrated system. A compact topology for an integrated PV and energy storage system based on three boost converters and one bidirectional buck-boost converter. One of the boost converters is used for MPPT control, and the other two boost converters are used to implement a boost inverter that can generate sinusoidal waveform.[1] A differential boost inverter (DBI) is a boost-based topology that is used to generate a sinusoidal output. In DBI, the instantaneous output can be higher or lower than the dc-input voltage. DBI exhibits nonlinear control to-output behaviour in large-signal dynamic sense. Therefore, generating a high-frequency sinusoidal output using this topology is a challenge.[2] System efficiency and cost effectiveness are of critical importance for photovoltaic (PV) systems. This paper addresses the two issues by developing a novel three-port DC-DC converter for stand-alone PV systems, based on an improved Fly back-Forward topology. It provides a compact single-unit solution with a combined feature of optimized maximum power point tracking (MPPT), high step-up ratio[3] The converter consists of two basic Boost cells and some diode–capacitor multiplier (DCM) cells as needed. Because of the DCM cells, the voltage conversion ratio is enlarged and the extreme large duty ratio can be avoided in the high step-up applications[4] The adaptor output port is designed to behave as a power source/sink, thus enabling its hot-swap parallel connection to renewable power sources without modifying their Maximum Power Point. Moreover, the adaptor device features a power characteristic with a single controllable MPP and allows the control of the injected power within the operating range of the DC-AC grid-connected inverter[5]

PROPOSED SYSTEM

In recent years for a great number of appliances DC-DC converter topology is employed. Normally in renewable energy system, the system having a low output characteristics to recover this demand DC-DC converter topology is implemented. maintaining the dc output voltage range in PV array and a fuel cells, converter can used to improve the output voltage. But during the switching operation this voltage stress will be raised. While choosing the converter the concentrating features are when switch is turn on it must attain the zero voltage crossing, when Photovoltaic arrays is connected to the grid the converter should provide the high terminal voltage is low input range. The converter which gives the high output range at low voltage stress is more efficient. Voltage gain generally based on the duty ratio hence by choosing the passive components the duty cycle ratio is limited. DC-DC converters are considered to be of great economic importance in today and are widely used at home solar systems to produce the desired output power. DC Nano grid is a low-power dc distribution system suitable for residential power applications. The average load demand in the Nano grid is generally met by the local renewable energy sources like solar, wind, etc. An energy storage unit is also required in the Nano grid to ensure uninterruptible power supply to the critical loads and to maintain power balance in the system. The diode D in figure is associated as a series blocking diode in order to avoid reverse power flow Electronic converters, solar panel as an energy source, a storage unit and some dc and local ac loads. This project analyse and implement a new double stage boost converter with single switch is developed which has the same voltage gain as the series connection of two boost converters and termed as quadratic boost converter (QBC).Quadratic boost based dc Nano grid, where there is no need to incorporate step up transformers and conversion range is large compared to conventional boost converters.

In PWM (square-wave) dc-to-dc converter topologies, dc conversion ratio M is a function of duty ratio D of the active (transistor) switch. Both minimum and maximum attainable conversion ratios are limited in practical converters. M_{max} is limited by the degradation in efficiency as duty ratio D approaches 1. On the lower end, minimum ON-time of the transistor switch results in a minimum attainable duty ratio and, consequently, in a minimum conversion ratio M_{min}. Conversion range can be extended significantly if conversion ratio M has a quadratic dependence on duty-cycle. Quadratic boost converter (QBC) is a modified step up converter with single switch and better conversion ratio.

BLOCK DIAGRAM

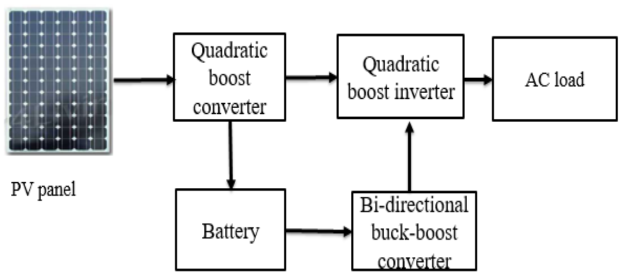

Figure:1 Block Diagram of Proposed System

The block diagram of proposed system is shown in figure:1 is contained solar panel in 12V and this first quadratic boost converter is DMPP tracking the maximum power of the panel then it is boost up the voltage this energy is stored in battery , the bi-directional buck boost converter as depends on the AC load increase it act as boost mode, if load demand decrease in this bidirectional buck boost converter act as buck converter . Another quadratic boost converter is act as inverter that is converted DC to AC it is finally connected into AC load. As this gives as efficient of the output depends on the load and this project is used quadratic boost converter is reduced the voltage stress. This operate at efficiently. In input of PV panel is 12V is boost up and to finally gets in 85.43V in DC voltage is converted in AC voltage using quadraticboost inverter this connected into AC load .

OUTPUT

The simulation output result of the proposed system boost converter output is shown in this figure:2 this gives as boosted voltage at 19V. Buck converter t is reduced in 12V into 9V .the proposed result it is s at 85.43V.

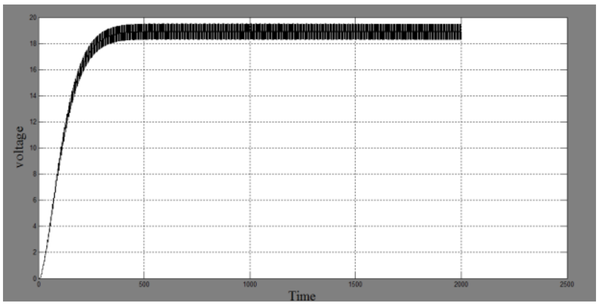

Figure : 2 boost converter

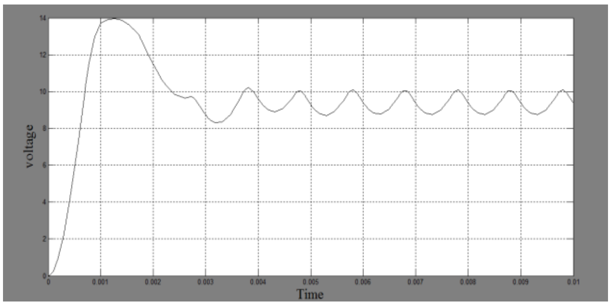

Figure :3 buck converter

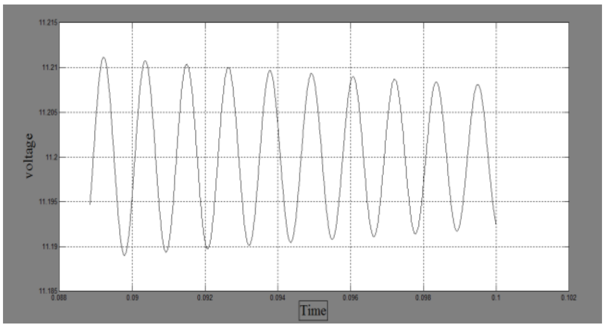

Figure : 4 buck boost converter

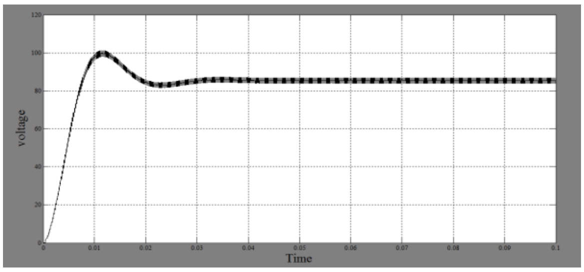

Figure : 5 proposed system output

CONCLUSION

A compact topology of a integrated PV and the energy storage system based on three quadratic boost converters and one bidirectional buck boost converter with their associated controllers it is presented in this paper. The proposed topology includes an energy storage system to allow the solar PV system to operate under varying irradiation and various load conditions. Additionally, the proposed topology can operate as well with a large range of load demand including some extremely conditions such transient short-circuit situations and Simulation results verify the effectiveness of the proposed topology. And it is implemented in hardware in this efficiently gives at output 93%. Reduseed the voltage stress in each electrical components in quadratic boost converter and bi directional buck boost converter this operate at simply and effectively.

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