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International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

ENERGY MANAGEMENT AND CONTROL OF SINGLE-STAGE GRID CONNECTED SOLAR PV AND BATTERY SYSTEM

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ABSTRACT:

In general, Solar Photovoltaic (SPV) is integrated to grid through a DC-DC converter and Voltage Source Converter (VSC) for real power injection (called two-stage conversion).In view of efficiency point, the single-stage conversion becomes popular and in which Maximum Power Point Tracking (MPPT) of SPV and real power injection are achieved with VSC alone.But, if Battery Energy Storage (BES) supported by bidirectional DC-DC converter is presented in the single-stage conversion system, then co-ordination between DC-DC converter and VSC is required to achieve simultaneous operation of MPPT and real power injection. a coordinated control of singlestage grid connected SPV and BES system is proposed along with energy management. In which, the algorithm coordinates VSC and bidirectional DC-DC converter based on the State of Charge (SoC) of the battery such that MPPT and power injection is achieved simultaneously.

Keywords: Solar Photovoltaic (SPV) , Voltage Source Converter (VSC) , Battery Energy Storage (BES.

Introduction:

Solar Panels are a form of active solar power, a term that describes how solar panels make use of the sun's energy: solar panels harvest sunlight and actively convert it to electricity. Solar Cells, or photovoltaic cells, are arranged in a grid-like pattern on the surface of the solar panel. Solar panels are typically constructed with crystalline silicon, which is used in other industries (such as the microprocessor industry), and the more expensive gallium arsenide, which is produced exclusively for use in photovoltaic (solar) cells.

Solar panels collect solar radiation from the sun and actively convert that energy to electricity. Solar panels are comprised of several individual solar cells. These solar cells function similarly to large semiconductors and utilize a large-area p-n junction diode. When the solar cells are exposed to sunlight, the p-n junction diodes convert the energy from sunlight into usable electrical energy. The energy generated from photons striking the surface of the solar panel allows electrons to be knocked out of their orbits and released, and electric fields in the solar cells pull these free electrons in a directional current, from which metal contacts in the solar cell can generate electricity. The more solar cells in a solar panel and the higher the quality of the solar cells, the more total electrical output the solar panel can produce. The conversion of sunlight to usable electrical energy has been dubbed the Photovoltaic Effect.

LITERATURE REVIEW

Sid-Ali Amamra[1],Estimation of Amplitude, instantaneous phase and frequency of single-phase grid voltage signal have been studied in this paper. The proposed approach uses a novel circular limit cycle oscillator (CLO) coupled with frequency-locked loop (FLL). Due to the nonlinear structure of the CLO, the proposed frequency adaptive CLO technique is robust against various perturbations faced in the practical settings e.g. discontinuous jump of phase, frequency and amplitude. Global stability analysis of the CLO and local stability analysis of the frequency adaptive CLO has been performed. Experimental results demonstrate the effectiveness of the proposed technique over a very recent technique proposed in the literature.

Shanghai Jiao Tong[2] Currently, residential photovoltaic power generation system is increasingly used worldwide. In this paper, an optimized structure of residential photovoltaic (PV) power generation system with 1500V DC bus is proposed. It includes PV panels, a three-level boost converter, a high efficiency isolated bidirectional DC-DC converter, battery and three-phase five-level DC-AC converter that can work under islanding mode or grid-connected mode. The higher DC bus voltage greatly reduces line loss and improves efficiency of the system. An energy management scheme used for the system is proposed in this paper to guarantee the stability of the system and to increase its economic benefits. The optimized designed method of bidirectional LLC is proposed. Finally, experiments are carried out to verify the performance of the optimized converters and the system.

AquibJahangir[3],The increasing demand for ac and dc loads has emphasized the need for effective control and energy management scheme of a hybrid AC-DC microgrid. The control of Hybrid Energy Storage System (HESS) maintains a constant DC bus voltage with required power sharing among

different sources and loads. The ac/dc microgrid comprises of a PV array,Battery storage system, supercapacitors and VSC (Voltage Source Converter) feeding DC and AC loads. The supercapacitor having high power density responds to the transients due to a sudden change in load or source power. The aim of the paper is to purge the switching of control to incur minimal transients in the microgrid. Its control hardware implementation is carried out on an FPGA based NI LabView PXI with SbRio interface to obtain the experimental results validating the proposed hybrid energy management control scheme.

PROPOSED SYSTEM

In proposed method, battery energy storage is connected to dc-link of VSC through a bi-directional DC-DC converter to meet the requisite of power management in the grid and load environment. In single-stage SPV-battery grid connected system, both VSC and bi-directional DC-DC converter are responsible for MPP tracking and real power injection to grid. For that, co-ordination between VSC and bi-directional DC-DC converter is required for MPP tracking. In grid connected SPV system battery storage supported by DC-DC converter on dc-side of VSC, the MPPT is achieved by co-ordinate control of VSC and DC-DC converter. The cost of the proposed method is less when compared to other battery supported PV systems , because of less number of devices in the proposed method. The active rectification of power and reactive power compensation during non-SPV hours improves the utilization of converters in the proposed method when compared to existing methods.

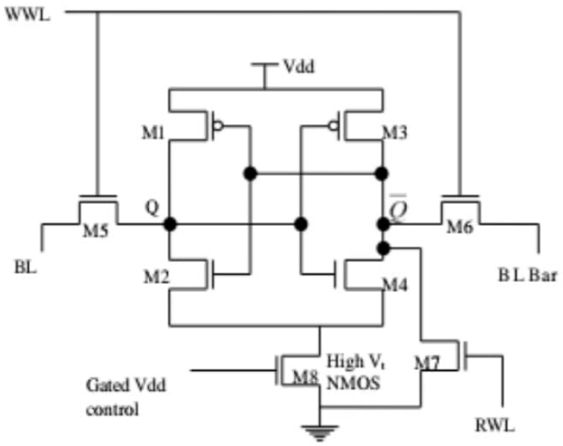
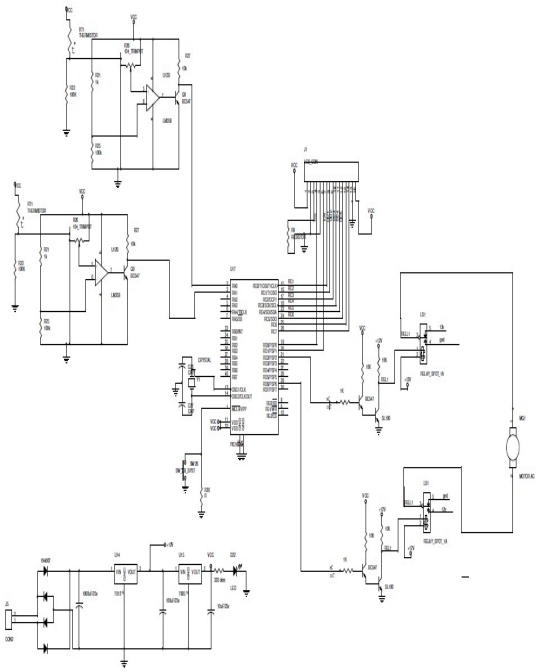


FIG 1:SCHEMATIC SRAM CELL

WORKING OF PRINCIPLE

The system comprises of solar panel which will absorb sunlight and generate an electric current, 12V battery where the current from solar panel is stored, Ardino which will measure the voltage available in the battery, Bidirectional DC-DC convertor, voltage regulator, LCD display, lamp.Solar panel: A solar panel is a collection of interconnected silicon solar cells that form a circuit. They are also known as photovoltaic solar modules, solar plates, solar PV modules, and solar power panels, etc. Solar panels absorb sunlight and generate an electric current, which travels to your home appliances via DC wires. On the front of the panel, there is a glass layer, followed by an insulating layer and a protective back sheet. A single solar panel can generate a certain amount of electricity. Solar panels produce direct or DC current, meaning the solar electricity generated by the photovoltaic panels flows in only one direction only. So in order to charge a battery, a solar panel must be at a higher voltage than the battery being charged. In other words, the voltage of the panel must be greater than the opposing voltage of the battery under charge, in order to produce a positive current flow into the battery.A Bidirectional DC-DC convertor is used as a battery voltage regulator, which is an electronic device used in off-grid



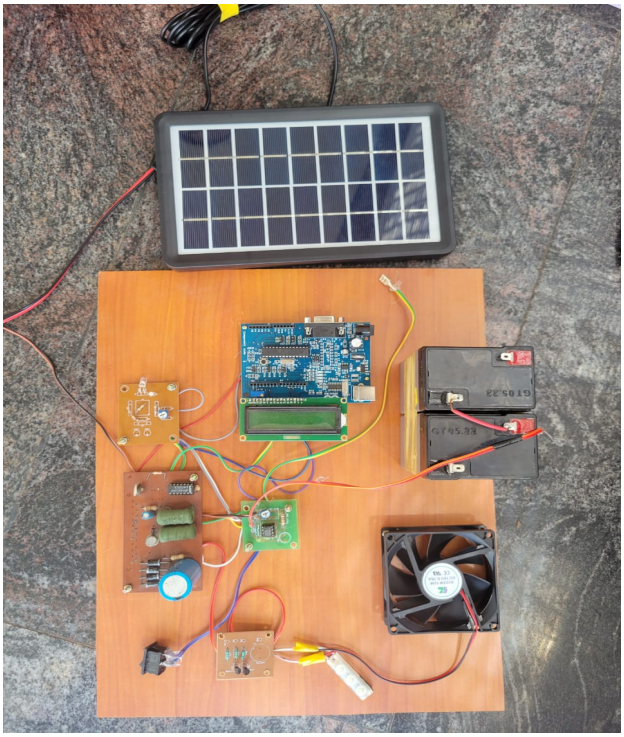
systems and grid-tie systems with battery backup.

FIG 1:CIRCUIT DIAGRAM

The convertor regulates the constantly changing output voltage and current from a solar panel due the angle of the sun and matches it too the needs of the batteries being charged.The charge controller does this by controlling the flow of electrical power from the charging source to the battery at a relatively constant and controlled value.Thus maintaining the battery at its highest possible state of charge while protecting it from being overcharged by the source and from becoming over-discharged by the connected load. Since batteries like a steady charge within a relatively narrow range, the fluctuations in output voltage and current must be tightly controlled.The Bidirectional DC-DC convertor turns-off the circuit current when the batteries are fully charged and their terminal voltage is above a certain value, usually about 14.2 Volts for a 12 volt battery.

This protects the batteries from damage because it doesn't allow them to become over-charged which would lower the life of expensive batteries. To ensure proper charging of the battery, the regulator maintains knowledge of the state of charge (SoC) of the battery. This state of charge is estimated based on the actual voltage of the battery.When the load flows in the circuit, Bidirectional DC-DC convertor boost up both the positive and negative cycle to the battery to maintain constant current.

OUTPUT SCREEN



CONCLUSION:

Single-stage SPV-DSTATCOM with coordinated control algorithm is proposed for MPPT tracking with VSC and DC-DC converter. The performance of the proposed method is demonstrated through simulation and experimental studies by operating at three different modes of operation (SPM, DPM and BPM). The advantages of the proposed method are, 1) During SPV hours, in addition to compensation of reactive power, real power injection to grid is possible along with charging/discharging of battery. 2) During non-SPV hours, rectification action is discussed for better zutilization of VSC capacity. 3) Reliability of system increases with energy storage device (i:e:; Battery)

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