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Isolated Bidirectional Battery Converter Control for Standalone Solar PV Applications

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ABSTRACT: This method focuses on the efficient use of battery storage system for overcoming the intermittency conditions in the standalone solar PV applications.MPPT algorithm is proposed to perform dual active bridge control. The generates the desired phase shift in the extract either maximum power or reduced power. A dual-active bridge (DAB) based isolated DC-DC converter has been used for the high-power transfer efficiency. Bidirectional power flow, fast dynamic control, and smaller size. In the method two input PV and battery are bi-directional connected the switching frequency high power dual active bridge (DAB) DC-DC converter is used. Being using an isolated converter topology, the dual active bridge employs a transformer to provide step-up/step-down functionality and isolation for the converter. Transformers, as well as other passive components such as inductors and capacitors may be reduced in size when higher switching frequencies are employed. However for energy storage applications, the circulating power of the DAB based DC-DC converter at the input and output ends are the major concern. In this method uses a modified phase-shift control algorithm for DAB converter in order to reduce the back power flow/ circulating power and improve the battery performance over long time.

I. INTRODUCTION

Electric energy systems were proved to be most efficient way of transmitting and distributing power until recent past. Maximum Power Point Tracking (MPPT) control is a technique to vary the terminal voltage of PV panels to extract the maximum power out of them. Among various MPPT algorithms is simple and cost effective to implement. The advent of various distributed energy sources, especially renewable energy generation whose output is DC power, demand DC grids for efficient operation. Moreover, user end power requirement in the terminal end for most of the present day devices such as battery chargers, led lights, electronic gadgets, etc. boils down to DC voltage, where conversion elements are added in AC grids to make the voltage level suitable for end equipment connected. This needs further demands use of DC for power distribution. Use of small-scale isolated DC grids (DC micro grids) in remote areas, with solar PV as the source, was proved to be economically beneficial than extending AC grids to that location. Different economic issues and advantages of DC solar micro-grids were summarized. Different challenges involved in the formation of such micro grids is discussed, which also presents various aspects of the micro grid such as distribution levels, local, central power management units, and their functions. Performance improvement technique of a micro grid is discussed. The detailed modelling of a control strategy for interconnected micro grids The DC bus is the crucial component of the DC micro grid. Maintaining constant the voltage on the DC bus is of paramount importance in the micro grid because it is the main factor deciding the performance of the system. The bus voltage varies because of the variations in input power from sources like Solar Photovoltaic (PV) modules. It varies in relation to the amount of power injected into the bus. Similar to this, the voltage on the bus varies with the change in the load power requirement. Strict monitoring and control of bus voltage are required to supply the loads at rated voltage. In this method discusses different topologies of bidirectional DC-DC converters such as a bidirectional buck-boost converter, bidirectional full-bridge converter, multi-phase interleaved converter and floating interleaved converter.

Different control strategies for the control of these converters like current mode control. An islanded DC micro grid system is considered for this investigation. Practically, the micro grid consists a DC bus which runs for a length along with various power sourcing units and loads connected at point of common coupling. The DC bus is sourced from various solar PV sources, wind based sources and other renewable based power supplying unit and the loads are distributed throughout the length of the grid. All the solar PV sources are considered to be operating in MPPT mode and the control of each solar PV source is independent of each other. Practically any number of sources or the loads can be present. The variation in the load and the change in irradiation levels at each solar PV panel is unpredictable. This may result in deviation of DC bus voltage from a nominal value leading to voltage stability issues.

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This problem must be addressed in real time to prevent of the system. This is achieved by controlling a battery storage interfaced to DC bus through a bi-directional power converter.

II. PROPOSED SYSTEM

Battery storage system and its power electronics based control plays a crucial role in a standalone PV system compared to the grid connected PV systems. MPPT control of ML-DAB is by controlling the phase shift(∅) between the two active bridges. Active bridge control will be triggered when a signal is received to limit the PV output generation. Voltage and current sensors are used to sense the slope of PV power curve. The control voltage from the PI controller will vary the phase shift of ϕ.Hence, a good power management strategy is required to use available resources efficiently, maintain stiff dc-bus voltage at all the times and efficient battery energy storage system with uninterruptable supply to the loads depicts the standalone.Solar PV battery hybrid system enabled with the modified control method based DAB converter.

Where, the solar PV is integrated with the dc bus through the uni-directional dc-dc boost converter and the battery is interfaced through the isolated bidirectional DC-DC DAB converter and loads are fed through the three-phase inverter

.The operation of the standalone solar PV system with energy storage support has been determined by the condition of the available energy sources and loads in the system. The solar PV acts as source and consumer demand acts a load whereas the electrical energy storage devices namely battery and super capacitor acts as both source and load based on the operation

III. BLOCK DIAGRAM

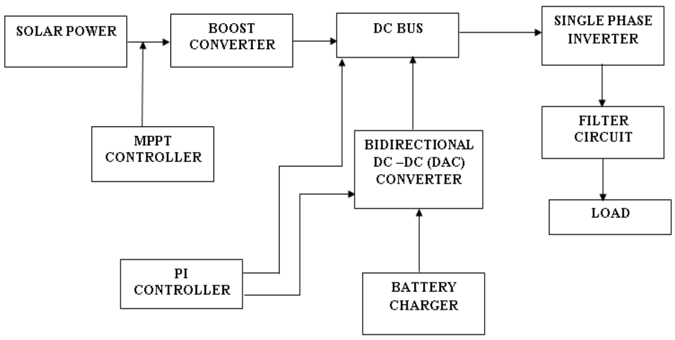

Figure: Proposed system block diagram

BLOCK DIAGRAM EXPLANATION:

DC-DCboost converter is incorporated in the system to obtain the maximum available power from the solar PV system with one of the available maximum powers tracking control algorithm. Among those maximum power harvesting methods.DC-DC boost converter and the battery is interfaced through the isolated bidirectional DC-DC DAB converter and loads are fed through the three-phase inverter. Battery have been used as energy storage device in order to use solar PV more efficiently and to increase the reliability of the system by supporting as back up source to fill the energy gap or to store the excess available power.

Efficient power flow controller need to be designed to control and balance the power in all modes of operation. The possible operational modes in solar PV system enabled with the battery storage system are depicted

DUAL ACTIVE BRIDGE CONTROL MPPT ALGORITHM

Various advanced control strategies are proposed in the literature that enables the high

penetration of PV system into the grid. One of these methods is control of active power for frequency regulation. Energy storage is typically used to perform this control. However, cost and lifetime of the energy storage elements do not make this option effective. For grid stability during grid frequency oscillations, the PV plant can run at and below the MPP point to control its power output. This idea is implemented in many ways, but modifying the MPPT tracking control algorithm will result in fast and efficient results.

When the grid meets its maximum demand, it can send a signal to the PV plants to enable them to operate below the

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MPP points, instead of shutting down the plants completely. Once the PV control system receives a signal, it alters its MPPT algorithm to operate below the maximum point.

$$Po = \frac{v_p v_s}{n\omega l} . (\emptyset - \frac{\emptyset^2}{\pi} - \frac{\alpha^2}{2\pi} - \frac{\beta^2}{2\pi}) \text{ ..... (1)}$$

Where, Po is the average power measured at the output of the converter, with the variables defined as, ω=2πwhere fs is the switching frequency, n is the transformer turns ratio and L is the primary referred inductance (LLK) used at the highfrequencylink.The power flow is controlled by ϕ. Thus, by varying ϕ, the desired maximum power from the solar module can be obtained.

ADVANTAGES

- Photovoltaic systems are quiet and visually unobtrusive.
- PV cells were originally developed for use in space, where repair is extremely expensive, if not impossible. PV still powers nearly every satellite circling the earth because it operates reliably for long periods of time with virtually no maintenance.
- Solar energy is a locally available renewable resource. It does not need to be imported from other regions of the country or across the world. This reduces

  environmental impacts associated with transportation and also reduces

- A PV system can be constructed to any size based on energy requirements
- PV system can enlarge or move it if his or her energy needs change.

APPLICATIONS

- Stand along and battery backup grid connected PV system require a single battery.
- The photovoltaic charge these deep cycle batteries during the daylight hours so that you can have electricity at night or on cloudy days

IV. SIMULATION DIAGRAM

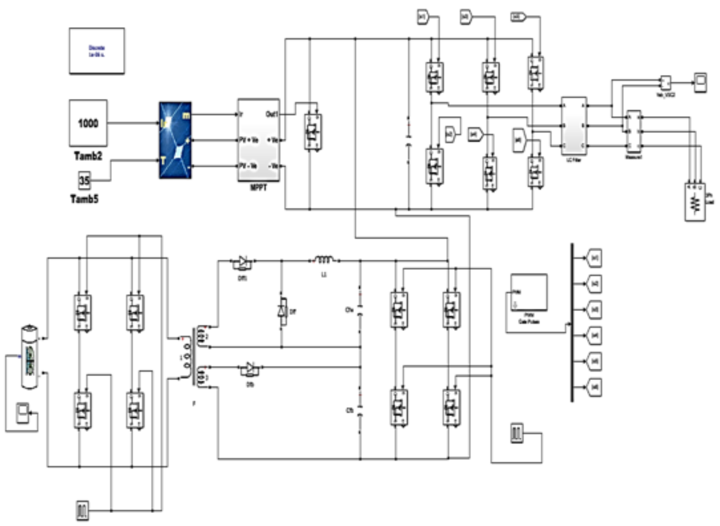

Figure :Simulation circuit diagram

The result of PV based dual active bridge DC-DC (DAB) converter. The simulation circuit and its corresponding waveforms are as followsThe improvement of efficiency is determined by the proper selection of operating modes and phase-shift group and Experimental results

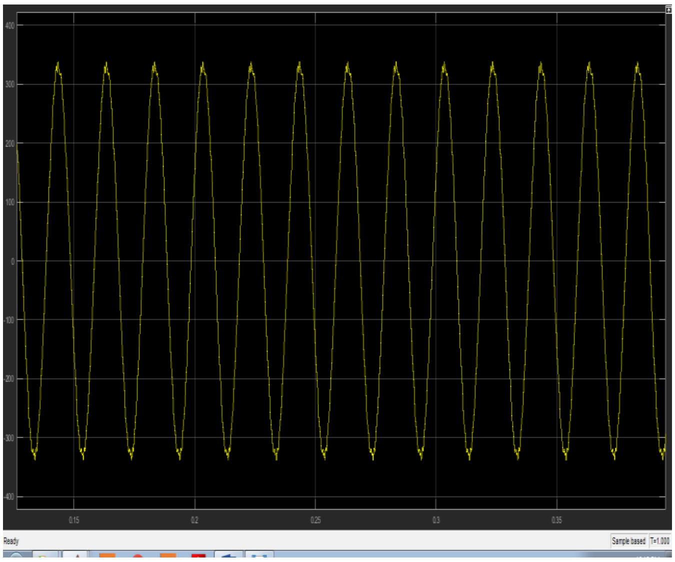

Figure :Output waveform

The peak Power and gain is in the storage unit can in the time in seconds, the clock pulse can continue device to discharge all its energy. The y-axis denotes the power value in the source side.The x-axis denote the time duration in the load side

HARDWARE OUTPUTTABULATION:

Hardware	Specification	Input Ranges	Output Ranges
Generating power	Input source	0-230V	230V
Microcontroller	PIC (16f877a)	5V DC	5V DC
Rectifier	Input power	230V AC	12V DC
Boost converter	Converting the input supply	12VDC	24VDC
Inverter	Output power	24V DC	24V AC
Transformer	Output power	24v AC	230V AC
AC lamp	Output load	230V DC	4A

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V. CONCLUSION

This method proposes the use of the extended phase shift (EPS) control scheme over the conventional phase shift modulation, for standalone solar PV application. Dual Active Bridge control MPPT algorithm for frequency regulation for a two-stage PV converter. With the proposed control algorithm, Dual active bridge control can be achieved by modifying the MPPT controls. The battery circulating power flow and peak current are reduced using the EPS control

leading to a better dynamic system response.The effect of phase shift ratio and modulation index on DAB power transfer and circulating power flow is evaluated in the current study. The closed loop simulations shows the automatic power transfer control for the proposed system operating in power surplus and deficiency conditions. The proposed control strategy enables the automatic power transfer in both power surplus and deficiency conditions and it also results in the stable dc link voltage.

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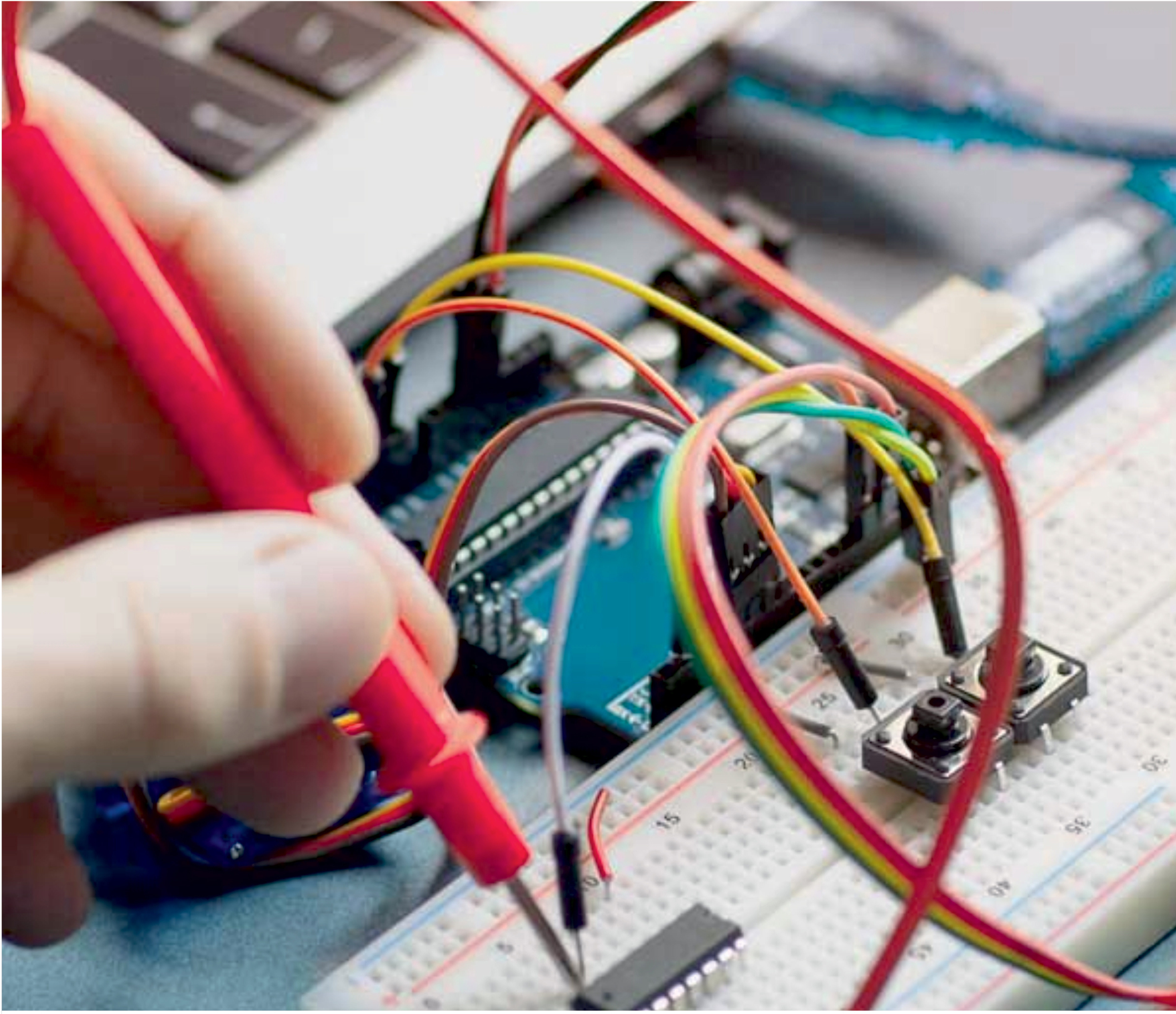

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