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Advanced MPPT Algorithm with Hybrid PV/Wind Power Management System

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Abstract: When more than one source is available for a given load, the sources may be utilized in a better manner to supply power efficiently to the load. In this project we consider two sources such as solar panel and wind energy. Both these are renewable energy sources and the production capacity of these depends upon a large number of external features. The project houses a DC bus in which both the powers generated by wind and solar are given to the load. Depending upon the load requirement only solar or the wind can be made to supply power. Using low voltage DC for the NANO grid provides various advantages such as easier integration with renewable sources and battery banks, increased savings, etc.Future systems would use renewable sources and storage devices to become self-sufficient in generation with bare minimum consumption from the grid. The project houses current and voltage sensors for measuring the power output of the solar panel and the wind energy. As the whole process takes place automatically there is a very lesser need for human interference and the electricity losses during the distribution can be saved on a huge scale.

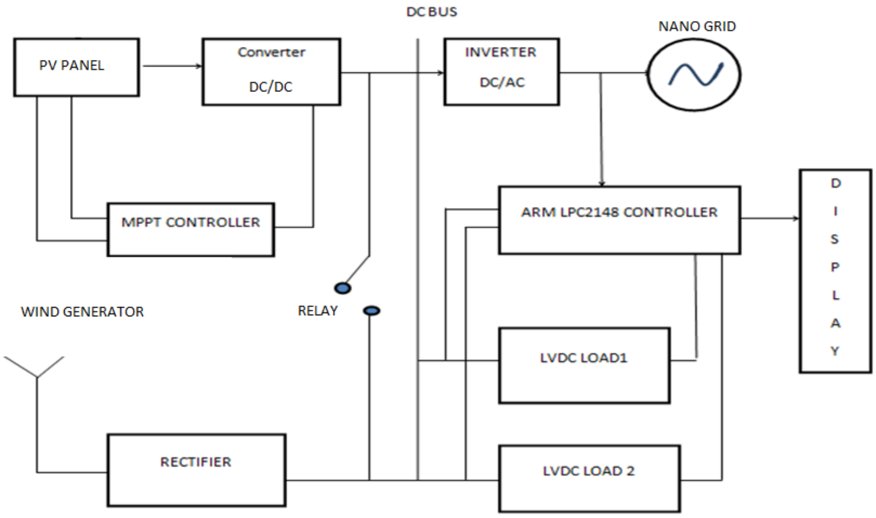
Keywords: Power supply, NANO grid, solar panel, battery

I. INTRODUCTION

The utilization of dc for distribution systems was not popular until recent times. The rising concern for energy savings has led to the evolution of dc systems being used in distribution. Renewable sources like solar PV and wind turbines that are dc in nature could be directly coupled to the dc bus thereby avoiding a dc-ac conversion stage. The evolution of dc NANO grid has facilitated the process of energy management for commercial buildings. Batteries form the backbone of the NANO grid providing uninterrupted power to critical loads even in case of a grid failure. DC distribution systems with various DC voltage levels are compared with the conventional 230V AC distribution network and the results are presented in literature .However, only low DC voltage levels can be directly supplied to household/critical appliances and among these, it has been found that a 48V DC Distribution system with its cable area optimized has minimum losses and maximum energy savings .Further, battery banks can be directly connected to such a lv dc bus, thus obviating an additional conversion stage. Hence the 48V system is adopted in this work. The main objective of this work is to achieve effective energy management in the DC NANO grid while providing uninterrupted power supply to the DC loads and minimizing grid utilization. Most of the existing grid connected PV systems with energy storage/energy management systems use batteries primarily as a source of backup [18], [19]. However, this work aims at achieving self sufficiency in energy consumption; the power generated by renewable sources is used to meet the load demand along with the help of a storage element. The EMS is implemented through the proposed control algorithm for the two stage cascaded converter topology.

II. PROPOSED SYSTEM

The existing distribution system is AC in nature and hence the DC allocation must be derived at the dispersion level. This local DC allocation system within inhabitancy and financial structures is called a DC NANO grid [1]. All DC and electronic loads, energy storage devices and sustainable sources can be coupled to the NANO grid. Since DC is used, integration complexities, reactive power problems and power factor correction circuits in appliances can be avoided [2]. The enlargement of the DC NANO grid has also promoted the process of energy management. Future commercial and residential buildings will be self-sufficient by generating the necessary power through sustainable sources, with minimized consumption from the AC grid. Batteries form the backbone of the NANO grid, providing steady power to particular load seven in case of a grid failure.



III. WORKING

The DC NANO grid requires a power converter, which can transfer power between the LVDC distribution network and the AC transmission network. The converter must possess bidirectional power flow capability to evacuate excess power to utility or to supply the loads during power deficit. Another requirement is the Voltage matching between the DC and AC nodes. A common solution is to use an inverter followed by a line frequency transformer. Current and voltage sensors are used for measuring the power output of the solar panel and the wind energy. It also measures the power required by the load.Relay circuitry is used to switch multiple energy sources to the DC bus, thereby giving an uninterrupted power supply. The proposed system, a DC-DC conversion stage is essential to match the voltage levels. A bidirectional DC-DC converter with an intermediate High Frequency (HF) Transformer facilitates efficient operation at high power densities and hence is adopted in this system. The most common topology for this conversion stage is the Dual Active Bridge (DAB) converter which consists of voltage source inverters (active-bridges) on either side of a HF transformer .The proposed scheme, the bidirectional converter operates in three modes namely, power surplus mode, power deficit mode, and idle mode. The transition between various modes is determined by a four level control scheme based on battery voltage. The proposed converter contains a buck-boost bidirectional converter blended with a isolated boost dual half-bride converter. Due to diminished number of power conversion stages and less component count, the proposed converter configuration has higher efficiency on comparing with existing topologies. The configuration is reliable and needs only six switches. Hence the switching losses will be very less. The input of the half-bridge converter is formed by connecting the PV array in series with the battery, thereby incorporating an inherent boosting stage for the scheme. Batteries are the energy storage devices. Since the charging and discharging modes affects on battery life span, the battery input voltage and current should be ripple free. By using a high efficiency bidirectional converter with higher switching frequency it can achieve. The bidirectional converter assures buck and boost modes of operation for getting power flow in both directions. This converter interfaces the PV and energy storage device such as high voltage battery. The boosting capability of bidirectional converter is further enhanced by a high frequency step-up transformer. The transformer also ensures galvanic isolation to the load from the sources and the battery. A bidirectional buck–boost converter is used to harness power from PV along with battery charging/discharging control. The unique feature of this converter is that MPP tracking, battery charge control, and voltage boosting are accomplished through a single converter. A isolated boost half-bridge converter is used for harnessing power from wind, and a single-phase full-bridge bidirectional converter is used for feeding ac loads.

IV.SIMULATION RESULT

Simulation studies are done on the MATLAB/Simulink platform, and the simulation results obtained are presented in this section. The output voltage of the PV is DC. The pulse generated by P & O technique provides gate pulses to the bidirectional converter. The PMSG of wind system generates three phase AC voltage which is converted to DC by using a full bridge rectifier. The power outputs wind and solar energies are enhanced by an isolated dual half bridge converter.

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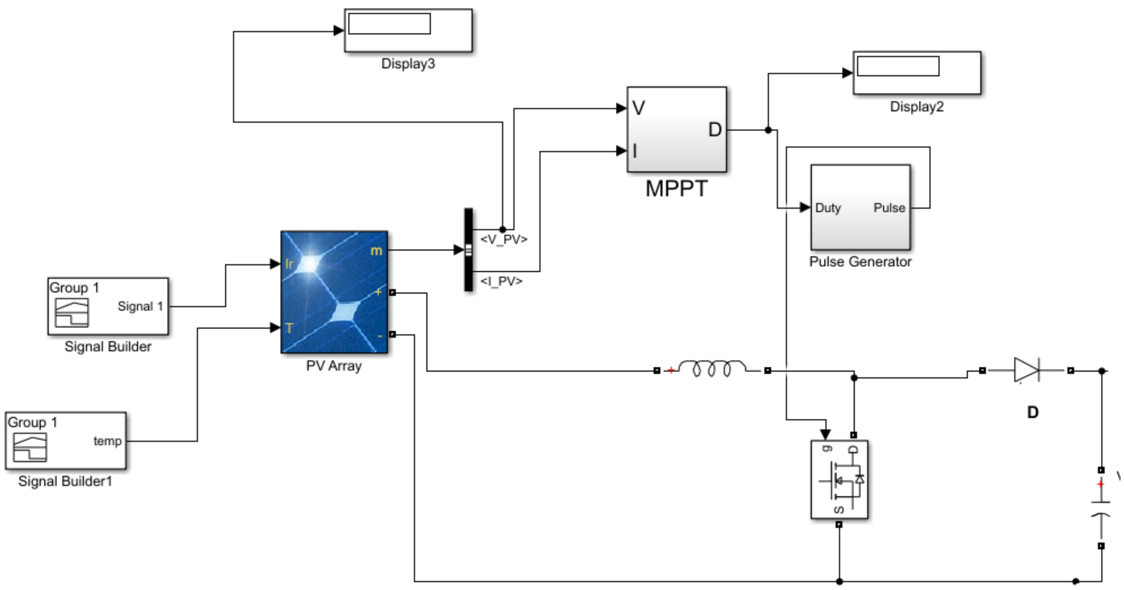

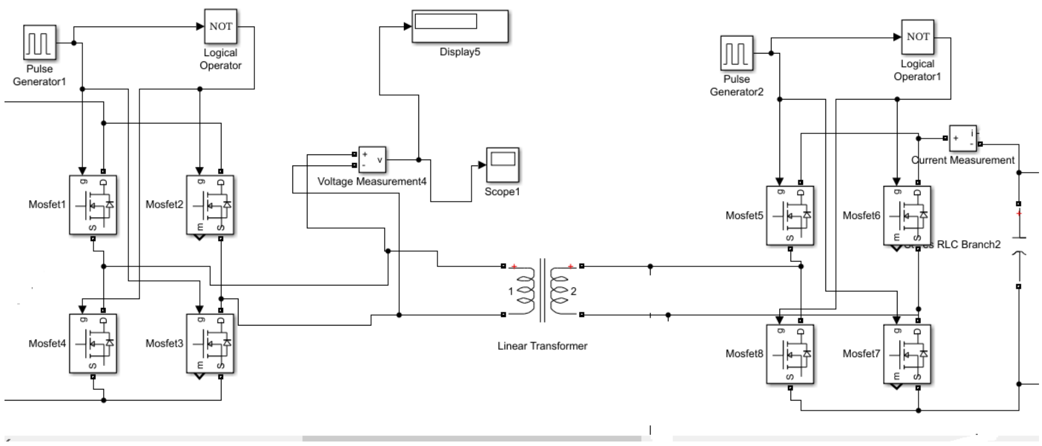

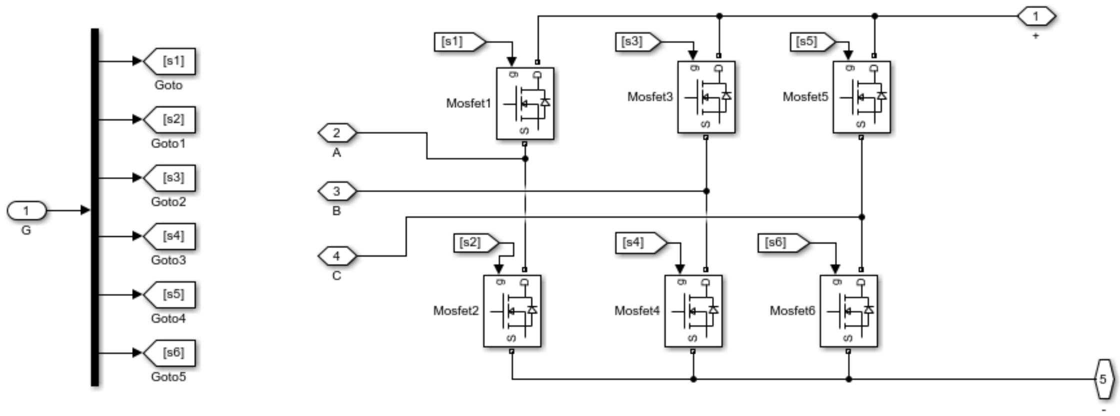

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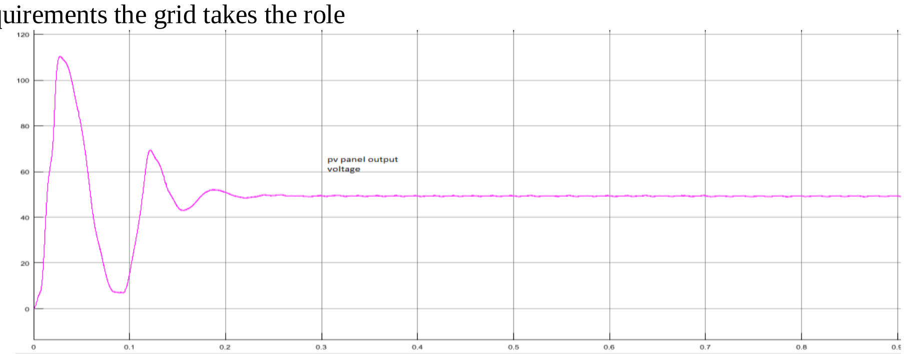
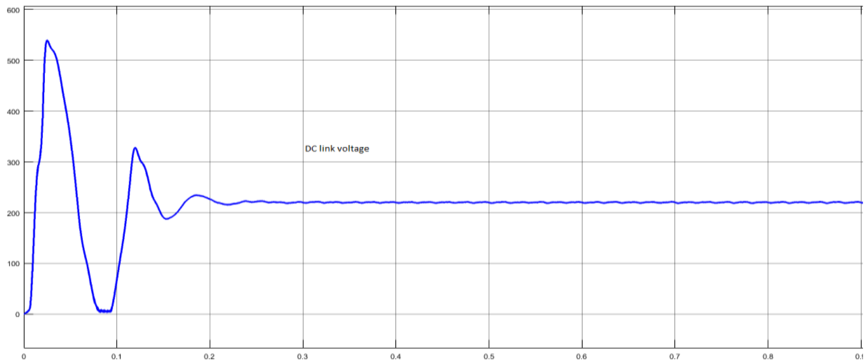
Simulation done in MATLAB

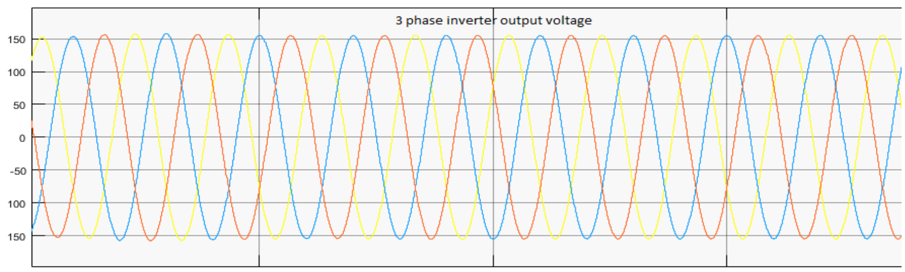
The three phase inverter can deliver power to the loads. The grid of 230v is associated with the system. Due to the bidirectional power flow, the excess power from PV and wind can give to the grid side. The intermittence nature of renewable energy sources is avoided by delivering power from battery. If the battery voltage may not be sufficient to meet the load requirements the grid takes the role



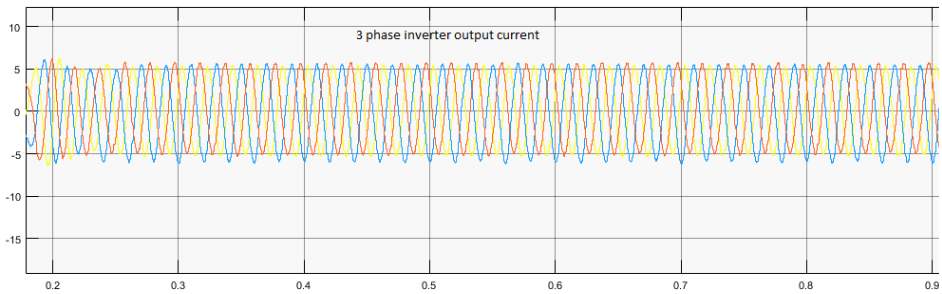
PV panel output voltage



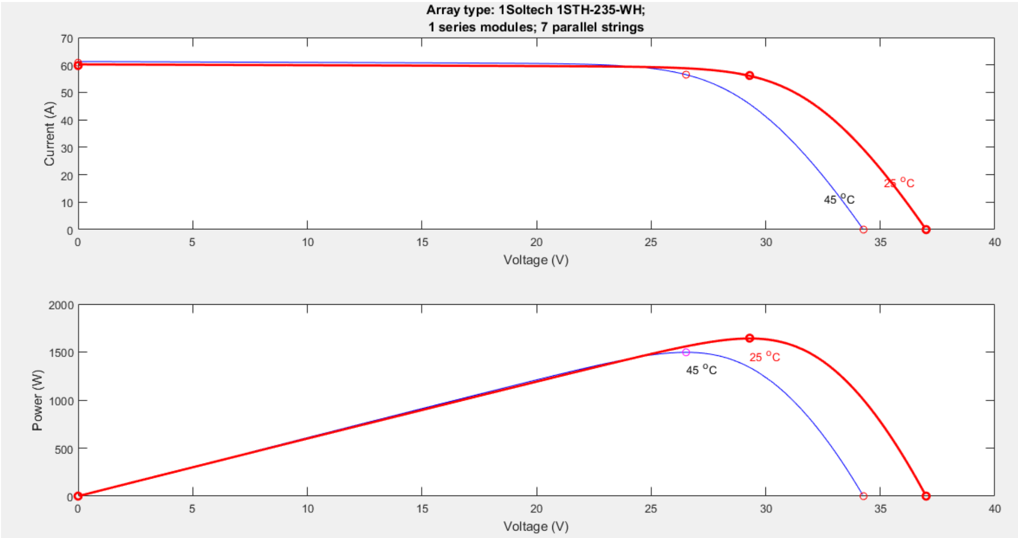
DC link voltage



3 Phase inverter output voltage



3 Phase inverter output current



V. ADVANTAGES

- As the whole process takes place automatically there is a very lesser need for human interference.
- Also the electricity losses during the distribution can be saved on a huge scale.
- In the Proposed system more than one renewable resource can be used to generate power.
- The energy which is abundant can be used when the other is low.

VI. CONCLUSION

A bidirectional converter interface for a low voltage DC NANO grid has been presented. The two stage converter facilitates power transfer between the 48V DC NANO grid and AC distribution network.The control strategy is implemented in a custom made FPGA board.'the energy management scheme ensures effective utilization of energy in the DC NANO grid thereby achieving the control objective: supplying uninterrupted power to the DC loads while minimizing grid utilization.

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