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Grid-Integrated Industrial Motors-Driven Solar Water Pump with Power Flow Management

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Abstract: This work presents a unidirectional power flow control for a solar-assisted water supply system with grid support. The solar photovoltaic (PV) array acts as a primary source whereas the grid is operated as a reserve supply to ensure an uninterruptable water supply irrespective of working conditions. The present system has a reduced payback period and an efficient solution of water pumping in the present energy scenario. A fundamental switching operation of brushless DC motor (BLDC) drive is employed in this work. Additionally, this controller also offers the PV array power optimization and voltage balancing across split dc-link capacitors at all situations. The developed system is tested for both volumetric and centrifugal pumps. A unique way of emulating the power factor correction of landsman converter is also discussed in this work. The authenticity of this system with developed unidirectional grid control is examined through both MATLAB-based simulation and experimental responses. Overall, the developed system provides a cost-effective, efficient, and maintenance free PV array energized water pumping system with the grid support.

Key words— Renewable energy sources, landsman Converter, BLDC, Split Capacitor Converter, Total harmonic distortion (THD), water pump.

I. INTRODUCTION

The air-conditioning is energy intensive application which normally uses single phase induction motors for driving its compressor and fans. The efficiency of these motors is between 70-80%. More over the on-off control employed for the temperature control is not energy efficient and introduces many disturbances in the distribution system along with increased wear and tear of the motor and reduce power factor. The use of PMBLDCM for driving the compressor results in energy efficiency improvement of the Air-Con. Moreover, the temperature in the air-conditioned zone can be maintained at these reference smoothly while operating the Air-Conunder speed control. This paper presents to improve the power factor using Landsman Converterfor PMBLDC motor application. Mainly in air conditioning systems to achieve the below, which is difficult in conventional system. Smooth start-up of air conditioning systems without fluctuations in input voltage .Achieve the study and smooth speed control to maintain the constant Room temperature. Avoid the Harmonics in the power system due to the continuous switching millions of Air conditioners and main higher efficiency.

Irrigation is a well-established procedure on many farms and is practiced on various levels around the world. The continuously increasing carbon emission and diminishing of fossil fuels encourage the instant consumers to adopt the renewable energy. A solar photovoltaic (PV) generation is emerging as the best alternative of conventional sources for various appliances. With reference to this, the water pumping has gained a broad attention in last few decades as a crucial application of PV energy. The DC motors have been used initially to pump the water followed by an AC induction motor. An innumerable research has been carried out on electric motor drives to improve the performance and efficiency of PV fed pumping systems with cost benefit. A permanent magnet brushless DC (BLDC) motor, due to its high efficiency, high power density, no maintenance, long service life, low electromagnetic interference (EMI) issues and small size, is being opted from last decade. It has been determined that introducing this motor reduces the cost and size of PV panels in addition to improved performance and maintenance free operation.

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II. BOOST PFC CONVERTER

For the active Power Factor Correction in we mostly use dc-dc converter. Among all converters, the boost converter is more effective PFC applications. Mostly we use dc-dc boost he output of ac-dc converter to get power factor. This process also has simplicity, inefficiency and lower harmonic distortion as other converters. The dc-dc converter which voltage is known as boost dc-dc convert converters requires some energy storage inductors, along with switching element transistors. Most of the times the boost PFC type ac not require much filtering because it gets conform the ac source. Only a simple filter capacitor can full fill the requirement of converter. However, higher level of filtering other converters such as buck and buck-boost their input current is pulsating type. In this PFC technique bridge rectifier I Boost converter. We can control the output DC power factor by controlling this boost convert can operate in different regions that are define inductors current behaviour. The regions in converter can operate are the continuous (CCM) and discontinuous conduction mode (the inductor current ripples are very high due losses are high so the DCM operation restrict applications. Moreover, in case of boost PFC converter there is low requirement of filtering because of continuous line current, whereas other dc-dc converters such as buck, buck-boost, and flyback have higher requirement of filtering because of pulsating line current.

III. EXISTING SYSTEM

The utility grid power is provided using a single-phase rectifier and a PFC boost converter. The elimination of the maximum power point tracking (MPPT) converter has significantly enhanced the dynamic performance and efficiency of the developed system. The carrier-based high-frequency switching (CBHFS) current controller is developed to achieve both the desired nature of power quality indices like the grid current, the voltage, and the distortion in grid parameters as well as to optimize the solar power under all working modes. Besides, this controller also helps to maintain the zero asymmetries in voltage across dc-link capacitors. The second-ordered generalized integrator (SOGI) filter used to extract the fundamental component of the grid voltage in a developed carrier-based pulse width modulation (CBPWM) controller offers resilience to the abnormal grid conditions.

Demerits

- High harmonics distortions
- Cuk and SEPIC converters is high, degrading the power density. Furthermore, these topologies have high quantity of passive parts, increasing cost and lowering density of power.

IV. PROPOSED SYSTEM

Proposed system consists of majorly a PV array, landsman PFC converter, Split capacitor converter, and the pump set comprising BLDC drive. The dc–dc conversion state used in a double stage system is eliminated in this configuration. A PV array capable to provide a sufficient power to drive a BLDC is used through a midpoint converter. The grid-side PFC converter is responsible for both MPPT as well as unidirectional power flow control. The present configuration needs only one voltage sensor at the dc link for implementing the voltage balancing control. However, when the grid is absent, a high-frequency switching control for a BLDC drive is applied to achieve the MPPT as well as to run the drive efficiently.

V. BLOCK DIAGRAM

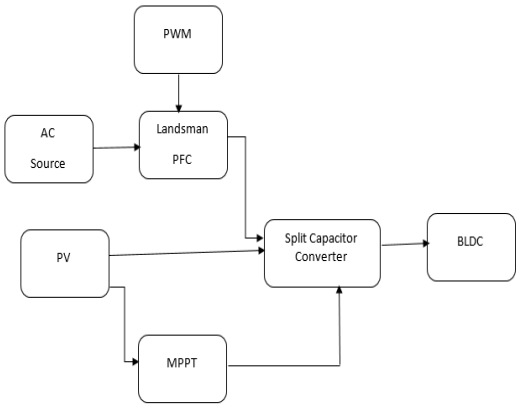

Fig: Block Diagram of Proposed System

The utility grid power is provided using a single-phase rectifier and a PFC landsman converter. Sin pulse width modulation technique applied to landsman converter to improve PFC. The output of converter given to split capacitor converter. Brushless DC in most commonly used

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motors in small scale applications like exhaust fans, Toys etc. The motor is supply by split capacitor converter with a dc-dc converter power factor correction circuit (PFC). The Landsman Converter performs power factor correction and DC voltage control both are in a single controller. PFC converter improve the power quality in AC mains in wide range of speed and input AC voltage. If the any failure in utility grid the BLDC motor run with the help of PV source. At this power flow MPPT switching pulses apply to split capacitor converter.

VI. CIRCUIT DIAGRAM

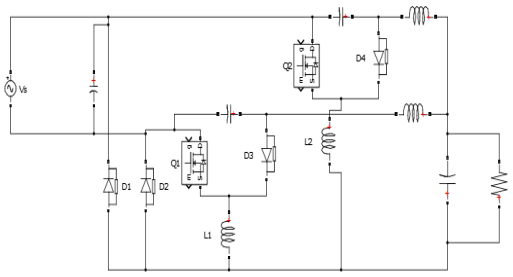


Fig: Proposed landsman Converter

Power Factor Correction (PFC) system increases the efficiency of power supply, delivering cost savings on electricity Exchanging power supplies without PFC attract current short, high greatness beats. The beats can be smoothed out utilizing dynamic or inactive PFC procedures. This improves the power factor. A Landsman converter is used for power factor correction in Brushless DC Motor (BLDC) drive.

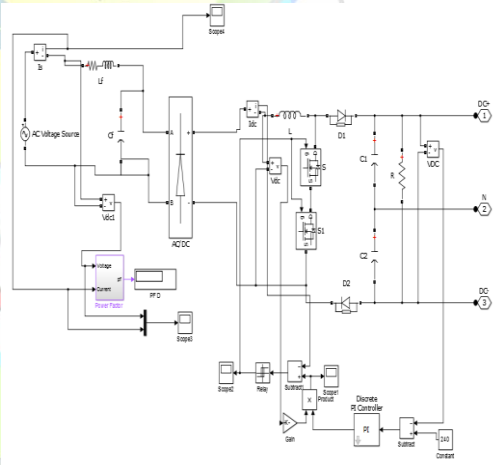
Fig: shows the proposed BL-Landsman converter based BLDC drive. In this the DBR is eliminated at the front end of converter, so it reduces switching losses associated with it. This bridgeless converter is designed between the two switches operate for positive and negative half cycles of supply voltage. During the positive half cycle of the supply voltage, the input current flows through switch Sw1, inductor Li1, $L_0$1 and a diode Dp. Similarly, switch Sw2, inductors Li2, $L_0$2 and a diode Dn conduct for a negative half cycle of supply voltage. The current flowing through the input inductors Li1 and Li2 are discontinuous and Li1 Li2 the current of output inductors $L_{01}$and L_{02} and voltage of intermediary capacitors (V_{c1} and V_{c2} remain continuous during switching cycle.

VII. MPPT

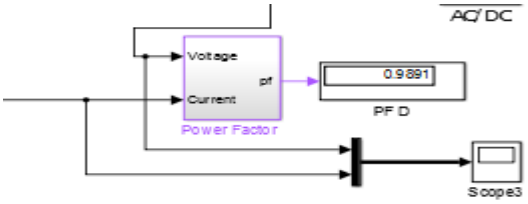
A Maximum power point where its principle to obtain the extreme power point extraction under every condition. It's basically used in wind turbine and PV panel. The major aim of MPPT is to extraction of the maximum power from a PV model by working them operate at desired voltage (maximum power point). MPPT verifies out the output of PV model, with the help of battery that can be the most suitable for PV. The supply power to a load, where the battery can be connected directly to PV model and MPPT .It is mainly used for power extraction in renewable energy MPPT is most effective under these conditions: It can be worked in all the weather condition and it is easier to operate and control. PV model generally used at cold temperature and MPPT is used to extract the maximum power available from sunlight or PV rays. When battery is completely discharged: MPPT can extracted more current and charge the battery if the state of charge in the battery is lowers. MPPT technique is used in this project is pertub and observe method. MPPT are generally used in typically is an electronic power converters.

VIII. SIMULATION RESULTS

Conventional Boost PFC Circuit



Boost PFC



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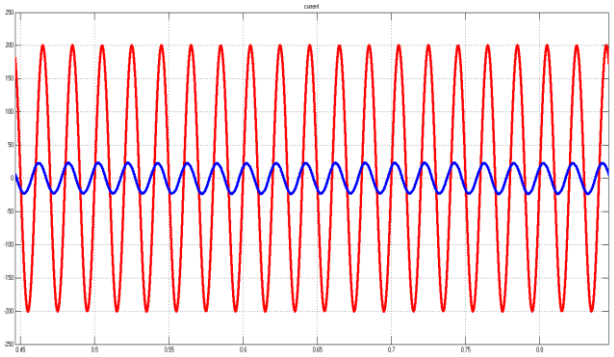
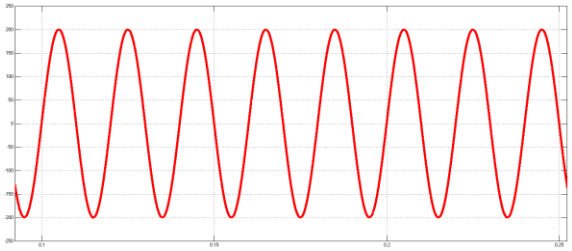
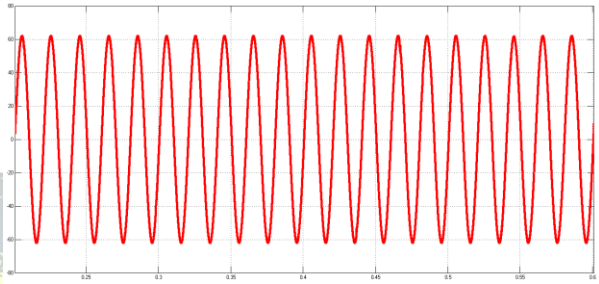
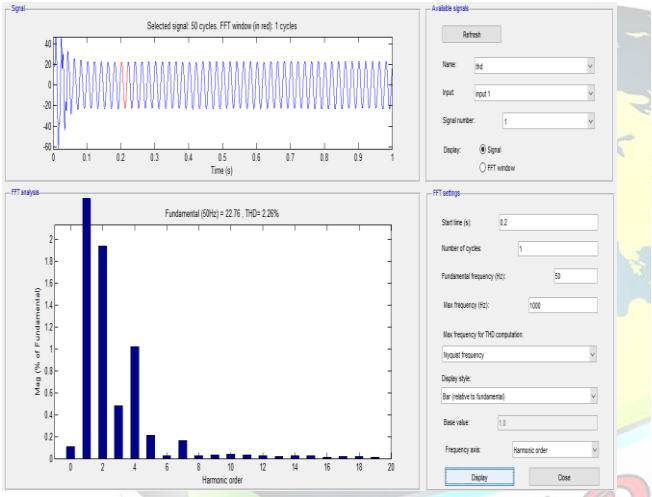




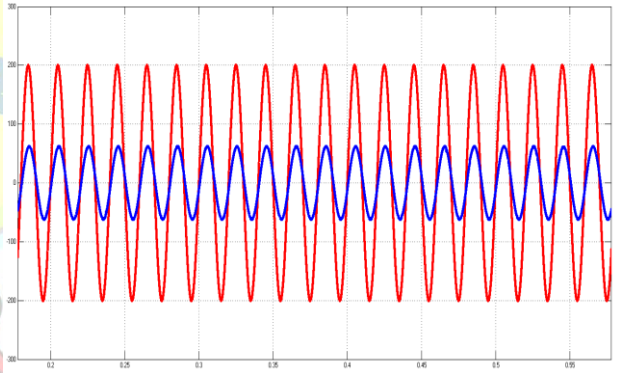
Grid Current



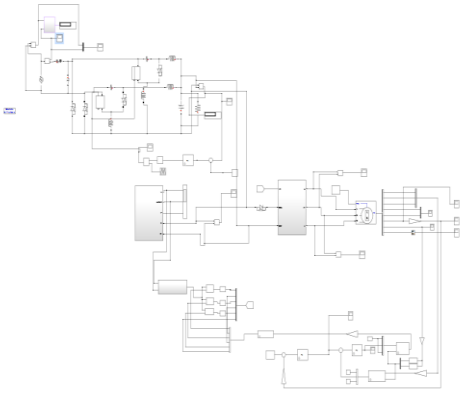
THD

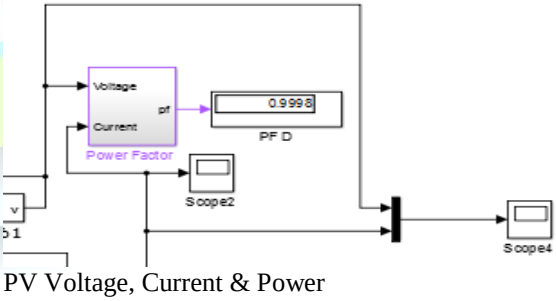


Landsman Converter PFC



Proposed Simulation Circuit





PV Voltage, Current & Power

Grid Voltage

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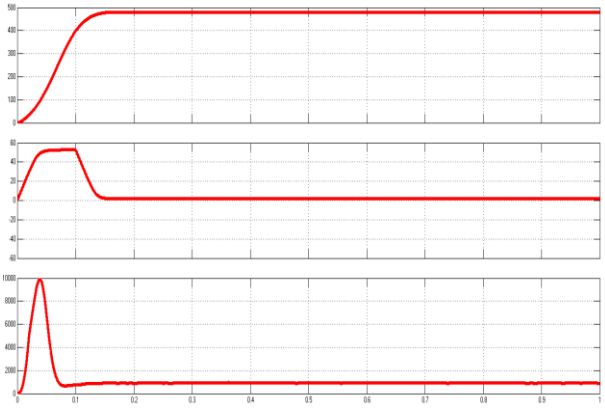
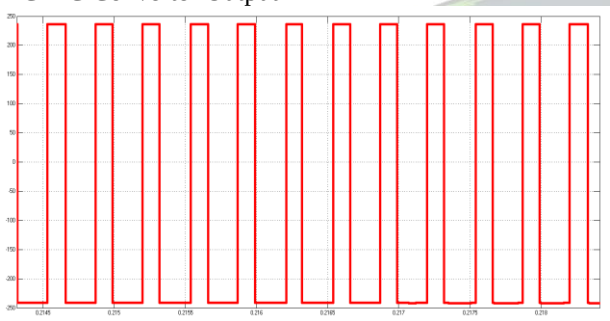
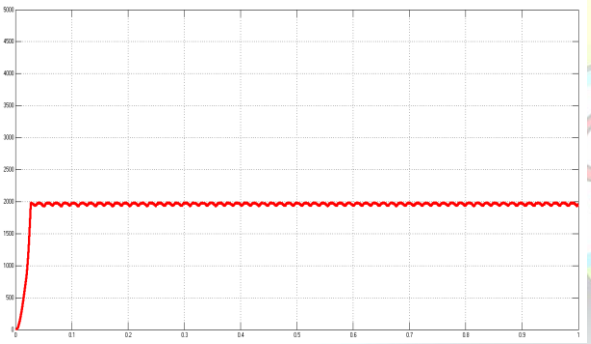


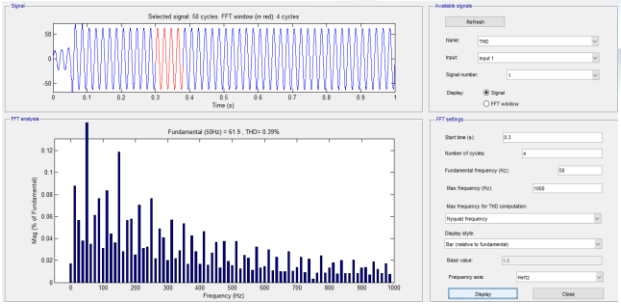
DC-AC Converter Output



BLDC Motor Speed



THD



IX. Conclusion

Grid interfaced solar-powered BLDC-driven water pumping with unidirectional power flow control has been presented in this work. The applicability of the system has been demonstrated by utilizing a MATLAB platform. Moreover, the results obtained through MATLAB for both Conventional and proposed system .We obtained good power factor with low THD using landsman converter. The developed multiintended unidirectional power flow control has performed very well and all desired objectives are achieved successfully.

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