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BLDC Motor driver solar PV array fed water pumping System Employing Zeta converter

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Abstract

This paper proposes a simple, cost effective and efficient brushless DC (BLDC) motor drive for solar photovoltaic (SPV) array fed water pumping system. A zeta converter is utilized in order to extract the maximum available power from the SPV array to run the BLDC motor .BLDC motor controlled by zeta converter using maximum power point tracking(MPPT) for soft starting of the BLDC motor i.e. the reduced current starting inhibits the harmful effect of the high starting current on the windings of the BLDC motor to drive a water pump which is attached to the shaft. The proposed control algorithm eliminates phase current sensors and adapts a fundamental frequency switching of the voltage source inverter (VSI), thus avoiding the power losses due to high Frequency switching. The project corresponding results will be plot on MATLAB using MATLAB/Simulink software .

Keywords: BLDC motor, SPV array, Water pump, Zeta converter, VSI, MPPT.

1. Introduction

Brushless dc motor are synchronous motors which are given supply with an inverter which converts the available dc into ac which is given to winding of motor with the assistance of a closed-loop system controller. Brushless dc motor is additionally referred to as electronically commutated motor. There are two ways to regulate the speed of BLDC motor, in conventional way we feed the bldc motor by boost convertor, the dc link voltage (output of boost convertor or input of VSI) is maintained constant with the assistance of boost convertor. Switches of VSI are controlled by PWM for speed control. Now this sort of configuration have drawback of high switching losses as we are using switching of VSI switches for speed control which varies consistent with PWM switching frequency. the opposite and better way is supplying a variable dc voltage to VSI at input for speed control of bldc motor; this enables VSI to work in fundamental switching frequency for achieving speed control of bldc motor. The variable dc-link voltage is achieved by employing a zeta convertor which is operated in discontinuous inductor current mode operation.

Solar photovoltaic (PV) panels use cells containing a semi-conductor material to capture the sun's energy and convert radiation into electricity. When light

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shines on the semi-conductor the electrical field across the junction between these two layers causes electricity to flow, generating DC (DC). Photovoltaic cells are connected electrically serial and/or parallel circuits to supply higher voltages, currents and power levels. A photovoltaic array is that the complete power-generating unit, consisting of any number of PV modules and panels.

The proposed converter is predicated on DC-DC Converter to take care of the constant output voltage. Hence one stage Zeta converter is proposed which is employed for DC link voltage control, power factor correction and bucking and boosting the voltage. it's a naturally isolated structure. A Zeta is analogous to a BUCK – BOOST converter but has advantages of getting non-inverted output (the output voltage is of an equivalent polarity because the input voltage). The inductors and therefore the capacitors also can have large effects on the converter efficiency and ripple voltage. This converter transfers the energy between the inductance and therefore the capacitance so as to vary from the voltage to a different . The transferred energy is controlled by switching device S(MOSFET).

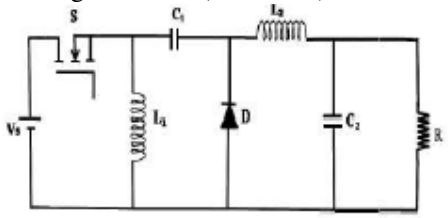

Fig.3.Schematic Diagram of Zeta Converter

The INC-MPPT algorithm uses voltage and current as feedback from SPV array and generates an optimum value of duty cycle. Further, it generates actual switching pulse by comparing the duty cycle with a high-frequency carrier. During this way, the utmost power extraction and hence the efficiency optimization of the SPV array is accomplished.

2. LITERATURE SURVEY

1.Nevertheless, a Zeta converter [5-9] based MPPT remains unexplored in any quite SPV array based applications. An incremental conductance (INC) MPPT algorithm is employed during this add order to get an optimum value of duty cycle for the IGBT(Insulated Gate Bipolar Transistor) switch of Zeta converter such the SPV array is constrained to work at its MPP. Various configuration of Zeta converters like self-lift circuit, re-lift circuit, triplelift circuit and quadruple-lift circuit using voltage lift (VL) technique are reported in aforementioned topologies have high voltage transfer gain but at the value of increased number of components and switching devices. Therefore, these topologies of Zeta converter don't suit the proposed water pumping system.

2. Ashta, one phase supply is given to the zeta converter through diode bridge converter. rather than two stage converters, one stage Zeta converter is employed for DC link voltage control and power factor correction. The controlled voltage is fed to voltage source inverter. the most objective of this paper is to regulate Output of Zeta converter to realize speed control of BLDC motor

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3. IMPLEMENTATION:

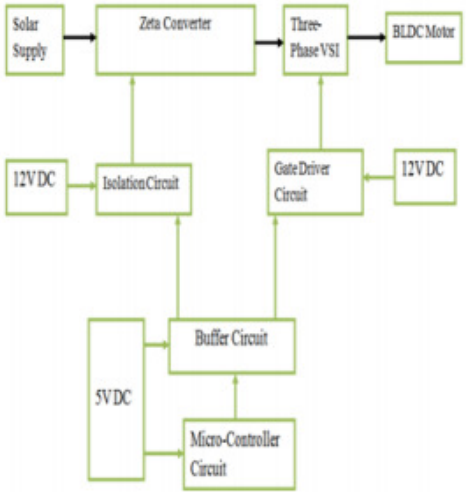

Figure 4: Block diagram of proposed SPV-Zeta converter fed BLDC motor driver for water pump

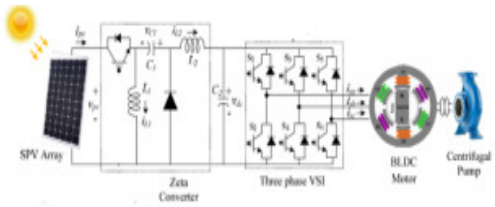

Figure 5 : circuit diagram of proposed SPV-Zeta converter fed BLDC motor driver for water pump

The SPV array generates the electric power demanded the motor-pump.

This electric power is fed to the motor-pump via a zeta converter and a VSI. The SPV array appears as an influence source for the zeta converter. Ideally, an equivalent amount of power is transferred at the output of zeta converter which appears as an input source for the VSI. In practice, thanks to the varied losses related to a DC-DC converter, slightly less amount of power is transferred to feed the VSI. the heart beat generator generates, through INCMPPT algorithm, switching pulses for IGBT (Insulated Gate Bipolar Transistor) switch of the zeta converter. The INC-MPPT algorithm uses voltage and current as feedback from SPV array and generates an optimum value of duty cycle. Further, it generates actual switching pulse by comparing the duty cycle with a high frequency carrier . during this way, the utmost power extraction and hence the efficiency The VS, converting DC output from a zeta converter into AC, feeds the BLDC motor to drive a pump coupled to its shaft. The VSI is operated in fundamental switching through an electronic commutation of BLDC motor assisted by its built-in encoder. The high frequency switching losses are thereby eliminated, contributing in an increased efficiency of proposed water pumping system.

The advantages and desirable functions of zeta converter and BLDC motor drive contribute to develop an easy , efficient, cost-effective and reliable water pumping system supported solar PV energy. Simulation results using MATLAB/Simulink and experimental performances are examined to demonstrate he starting, dynamics and steady state behavior of proposed water pumping system subjected to practical operating conditions. The SPV array and BLDC motor are designed such proposed system always

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exhibits good performance no matter solar irradiance level.

.4. RELATED WORK:

this technique consists of various modules which is employed during this project is discussed below:

a. PHOTO VOLTAIC SYSTEM:

Photovoltaic systems research seems largely to be divided into two, fairly distinct areas; namely array physics, design and optimization, and solar energy con- version systems. This paper isn't concerned with the planning of the arrays but rather with development of a model of an array that's useful for power electronics applications. Better, more efficient converter systems could also be developed by matching the control and drive requirements of the converter system to the characteristics of the array. energy specialists often appear to not have sut1icient expertise in power electronics to be ready to develop advanced converter systems, which may match the input characteristic of the facility electronic system to those of the array, so as to form best use of the array. samples of such no optimal systems are often found within the field of solar array/battery combinations for stand-alone use [2--4] and within the area of utility interactive systems.

b. BLDC MOTOR:

BLDC motors are classified into two sub categories. the primary category uses continuous rotor-position feedback for supplying sinusoidal voltages and currents to the motor. the perfect motional EMF is sinusoidal, in order that the interaction with sinusoidal currents produces constant torque with very low torque ripple. This called a static magnet electric motor (PMSM) drives, and is additionally called a PM AC drive, brushless AC drive, PM sinusoidal fed drive, sinusoidal brushless DC drive, etc. The second category of PMBL motor drives is understood because the brushless DC (BLDC) motor drive and it's also called a trapezoidal brushless DC drive, or rectangular fed drive. it's supplied by three phase rectangular current blocks of 120° duration, during which the perfect motional EMF is trapezoidal, with the constant a part of the waveform timed to coincide with the intervals of constant phase current. These machines need rotor-position information only at the commutation points, e.g., every 60°electrical in three-phase motors. The PMBLDC motor has its losses mainly within the statordue to its construction; hence the warmth can easily be dissipated into the atmosphere. because the back EMF is directly proportional to the motor speed and therefore the developed torque is nearly directly proportional to the phase current, the torque are often maintained constant by a stable stator current during a PMBLDC motor. the typical torque produced is high with fewer ripples in PMBLDC motors as compared to PMSM.

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Amongst two sorts of PMBL motors, PMSM is, therefore, preferred for applications where accuracy is desired e.g. robotics, numerical controlled machines, solar tracking etc. However, the PMBLDCM are often utilized in general and low cost applications. These motors are preferred for varied applications, thanks to their features of high efficiency, silent operation, compact in size and low maintenance.

c. Zeta Converter:

Nowadays a dc-dc converter is widely used as power supply in electronic systems. A zeta converter may be a fourth order dc-dc converter capable of amplifying and reducing the input voltage levels without inverting the polarities. the rationale being is that it includes two capacitors and two inductors as dynamic storage elements. Compared with a Cuk or Sepic converters, the Zeta converter has received the smallest amount attention.Among the renewable options, solar PV energy has been drawing increasing interest in recent years as an alternate and important source of energy for the longer term . Solar cells transform energy from an essentially unlimited source „the Sun" into useable electricity. PV systems constitute an environmentally friendly alternative way for energy production using the energy from the sun. PV system, virtually zero running cost energy is that the input source of power.

They operate quietly without emissions, albeit the load increases. With recent developments, solar power systems are easily available for industrial and domestic use with the added advantage of minimum maintenance. However, the output power induced within the photovoltaic modules depends on radiation and temperature of the solar cells. Photovoltaic modules have a really low conversion efficiency of around 15% for the manufactured ones. Besides, thanks to the temperature, radiation and cargo variations, this efficiency are often highly reduced. In fact, the efficiency of any semiconductor unit drops steeply with the temperature.

In order to make sure that the photovoltaic modules always act supplying the utmost power as possible and dictated by ambient operating conditions, a selected circuit referred to as Maximum point Tracker (MPPT) is used therefore, to maximise the efficiency of the renewable energy system, it's necessary to trace the utmost point of the PV array. In commonest applications, the MPPT may be a DC-DC converter controlled through a technique that permits imposing the photovoltaic module operation point on the utmost point (MPP) or on the brink of it. The proposed scheme consists of a solar array , a zeta dc- dc converter, and MPPT controller. during this Maximum point tracking is achieved by using Perturbation and Observation (P&O) method, also referred to as hill

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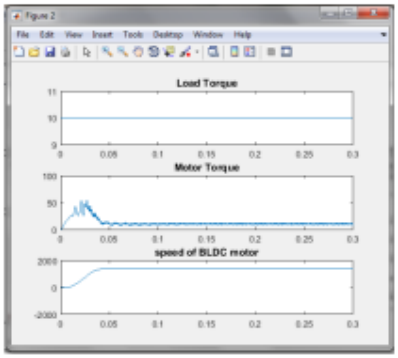
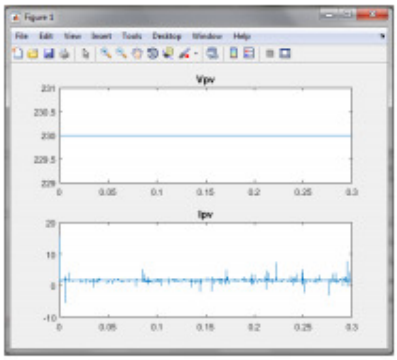
climbing method, is popular and most ordinarily utilized in practice due to its simplicity in algorithm and therefore the simple implementation.

5.Results:





6. CONCLUSION:

Mathematical analysis of ZETA converter is administered for design values of the capacitor and inductor. an easy power

electronic controller for interfacing PV array with the load has been simulated using ZETA converter. The subsystems of overall scheme like PV array model, ZETA converter model are built and tested individually before integrating to the general system. A maximum point tracking algorithm has also been incorporated. The simulation studies of the proposed scheme MPPT are administered and therefore the results are furnished. The values of parameters used for simulation are listed.

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