# PV ARRAY BASEDBLDC MOTOR DRIVEN WATER PUMP USING SOLAR TECHNOLOGY

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***Abstract*- The main objective of this paper is the utilization of solar photovoltaic (SPV) energy in the brushless DC (BLDC) motor driven water pump. Here DC-DC boost converter, used as an intermediate power conditioning unit. It plays a vital role in efficiency enhancement of SPV array and soft starting of the BLDC motor with proper control. The speed control of BLDC motor is performed by PWM (Pulse Width Modulation). The control of the voltage source inverter (VSI) using DC link voltage regulator. Here there is no additional control or current sensing element is required for speed control. The behavior of proposed pumping system is demonstrated by evaluating its various performances through MATLAB/simulink based simulation study. The purposes for selecting this converter are its innate properties of least conceivable exchanging pressure, high change productivity due to less number of parts, great switch usage and disposal of info swell channel since the information inductor itself goes about as a swell channel. But three traditional DC-DC converters viz. buck, lift and buck-help converter, all other created topologies have higher number of segments bringing about the productivity decay, expanded cost, weight and size. Likewise, these converters, including the established buck-help converter, experience the ill effects of higher weight on their capacity gadgets and exceptionally poor switch use**

***Keywords:*BLDC Motor, Solar Technology, PWM, SPV Array**

## 1. Introduction

In this paper we are going to explain some previous existing systems related to brushless dc motor in section I, in section II we explained about overview of proposed in system. Section III contains and design of proposed system. Section IV contains simulation results and performance analysis of PV array based BLDC motor driven water pump using solar technology

### 1.1 Overview of Previous Existing Systems

Design of Solar Powered BLDC Motor Driven Electric Vehicle **[1].** By using solar power the project was successfully tested**. T**he BLDC motor mounted upon the frame realized the prototype of the vehicle which was tested at different load condition.

BLDC Motor Driven Solar PV Array Fed Water Pumping System Employing Zeta Converter [2]. In this paper they used IGBT. It reduces switching losses. By continuous conduction mode of the Zeta converter it improves power levels. Hence this system operated under a maximum power output levels under minimum solar irradiance. So by using these types of power generation, we can produce a electrical power with lower production cost and low energy consumption for pump motor with a high speed and smooth response of the system

Brushless DC (BLDC) motor drive for solar photovoltaic (SPV) array fed water pumping system by using Fuzzy Logic controller [3]. In this paper the water pumping has been achieved indeed, even at the base sunlight based insulation level and the beginning current of the motor has been controlled inside the passable run. In addition, key recurrence exchanging of the VSI has stayed away from the high recurrence exchanging misfortunes

Design and implementation of solar PV fed BLDC motor driven water pump using MPPTV [4]. The Design and implementation of solar PV fed BLDC motor driven water pumping system validated under static and dynamic performance in various practical operating conditions

Simulation andAnalysis Of Solar Powered Brushless Dc Motor [5]. BLDC motor driven by solar energy and hence can be used in solar water pumping, E-BIKE also compressor. Closed loop Speed control Inverter fed BLDC Motor using PWM we can discuss in this paper.

**2. Proposed system**

Configuration of PV array fed BLDC motor-pump demonstrates an itemized schematic of proposed PV cluster encouraged BLDC engine driven water pump. This framework constitutes a SPV exhibit; help DC-DC converter, VSI, BLDC engine and water pump. An incremental conductance (INC) MPPT strategy is connected for effectiveness improvement of PV exhibit through lift converter activity. Then again, the speed control of BLDC engine and electronic recompense is performed by PWM control of the VSI. The below fig.1 shows that Block diagram ofPV Array Based BLDC Motor Driven Water Pump Using Solar Technology

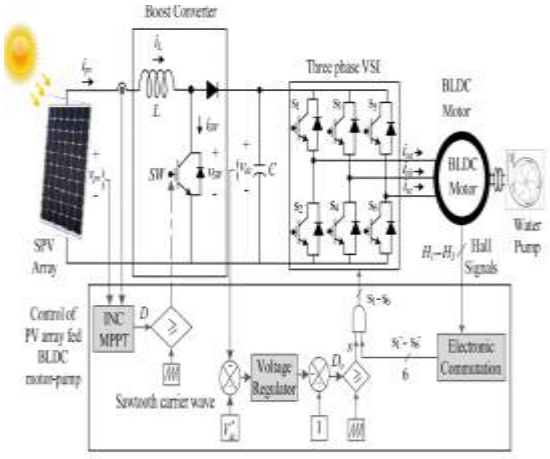


Fig.1Block diagram ofPV Array Based BLDC Motor Driven Water Pump Using Solar Technology

An inbuilt encoder, mounted on the BLDC engine itself, gives three Hall signals following the rotor position which is additionally changed over into six heartbeats. Following areas expound outline and control procedures of proposed framework.

**3. Proposed System Design**

The plan of proposed water pumping framework depends on the choice of BLDC engine and pump. A BLDC engine with 1.8 kW control rating is chosen, as showed in Table I, and alternate stages viz. PV cluster, support DC-DC converter and water pump are likewise outlined. The estimation of different parameters are expounded in following segments

**3.1Design of SPV Array**

The SPV cluster of 2.24 kW most extreme power rating is chosen to nourish the BLDC engine - pump of 1.8 kW control rating. The surplus power from SPV cluster is required to remunerate the misfortunes of converters and engine pump. To appraise alternate parameters, SPV exhibit voltage is first thought to be as per the evaluated DC voltage of BLDC engine and ideal plan of lift converter. It is chosen with the end

goal that the ideal obligation proportion at MPP is at its base conceivable esteem, which results in a decent switch usage, decreased voltage and current weight on control gadgets, and diminished current rating of the inductor. Table 1shows Design of SPV array A PV module HB-1280, made by HBL Power System Ltd. [12] with crest intensity of 80 W at standard isolation level of 1000 W/m2 is considered to outline a SPV exhibit of required limit. Table II depicts the estimation of its parameters.

**Table:1 Design of SPV array**

| Solar PV Module | |
|---|---|
| Cells | 36 |
| Module voltage | 21 V |
| Module current | 5.6 A |
| Module MPP voltage, $V_m$ | 17 V |
| Module MPP current, $I_m$ | 4.75 A |
| **Solar PV array** | |
| MPP voltage, $V_{mpp} = v_{pv}$ | 238 V |
| Power at MPP, $P_{mpp} = p_{pv}$ | 2240 W |
| Current at MPP, $I_{mpp} = i_{pv}$ | $P_{mpp}/V_{mpp} = 2240/238 = 9.4$ A |
| Numbers of modules in series, $N_s$ | $V_{mpp}/V_m = 238/17 = 14$ |
| Numbers of modules in parallel, $N_p$ | $I_{mpp}/I_m = 9.4/4.75 = 1.98 \approx 2$ |

**3.2Design of Boost DC-DC Converter**

The MPP voltage of SPV cluster, Vpv = Vmpp = 238 V is supported to the DC transport voltage of VSI, Vdc = 310 V. This offers a base obligation proportion, D, bringing about the benefits specified in past area. Table III outlines the estimation of inductor, L [4] and capacitor, C [1], where fsw is the exchanging recurrence of lift converter; IL is the normal inductor current; ΔIL is swell substance in the inductor current. Table 2 shows that Design of boost DC-DC converter

**Table.2 Design of boost DC-DC converter**

| Parameter | Expression | Data | Value | Selected value |
|---|---|---|---|---|
| $D$ | $\frac{V_{dc} - v_{pv}}{V_{dc}}$ | $v_{pv} = 238$ V<br>$V_{dc} = 310$ V | 0.23 | 0.23 |
| $L$ | $I_L = N_p * I_m$<br>$L = \frac{D * v_{pv}}{f_{sw} \Delta I_L}$ | $D = 0.23$<br>$v_{pv} = 238$ V<br>$f_{sw} = 20$ kHz<br>$N_p = 2$<br>$I_m = 4.75$ A<br>$\Delta I_L = 10\%$ of $I_L$ | 2.88 mH | 3 mH |
| $C$ | $\omega = 2 * \pi * f = \frac{2 * \pi * N_r * P}{120}$<br>$I_{dc} = P_{mpp}/V_{dc}$<br>$C = \frac{I_{dc}}{6 * \omega * \Delta V_{dc}}$ | $P = 4$<br>$N_r = 3000$ rpm<br>$V_{dc} = 310$ V<br>$P_{mpp} = 2240$ W<br>$\Delta V_{dc} = 2\%$of $V_{dc}$ | 309 μF | 500 μF |

DC transport of VSI contains the 6th symphonious segment of VSI yield voltage ΔVdc is swell substance in the capacitor voltage; Idc is normal current coursing through the DC transport of VSI; f and ω are the info voltage frequencies of BLDC engine in Hz and rad/sec. separately. The shafts of BLDC engine are indicated by P, and speed of the BLDC engine is meant by Nr. The estimations of converter parameters are chosen with the end goal that the proposed framework performs palatably even at the awful climate condition moreover.

**3.3Design of Pump**

The water pump is composed based on its power speed qualities [1, 13] as,

W/(rad/sec)3 .....(1)

Where Kp is proportionality steady and ωr means the BLDC engine speed in rad/sec.Table.3 shows that Specifications of BLDC motor

**Table.3 Specifications of BLDC motor**

| | |
|---|---|
| Power, $P$ | 1.8 kW |
| Speed, $N_r$ | 3000 rpm |
| DC voltage, $V_{dc}$ | 310 V |
| Poles, $P$ | 4 |
| Inertia, $J$ | 3.5 kg.cm$^2$ |
| Current, $I_s$ | 5.64 A |
| Voltage constant, $K_v$ | 78 V/krpm |
| Torque constant, $K_t$ | 0.74 Nm/A |
| Phase resistance, $R_s$ | 2.3 Ω |
| Phase inductance, $L_s$ | 7.68 mH |

**4. Simulation Results and Performance Analysis**

In this section we discuss about results by using MALTLAB. The below fig 2: shows that Simulation Circuitof PV Array Based BLDC Motor Driven Water Pump Using Solar Technology.Fig. 3 shows that Output Wave Form of Rotor Speed. Fig.4 shows that Output Wave Form of stator current ia.. Fig 5 shows that Output Wave Form of line – line voltage vab. Fig.6 shows that Output Wave Forms of Vs, Is, Vdc, N, Te, Ia

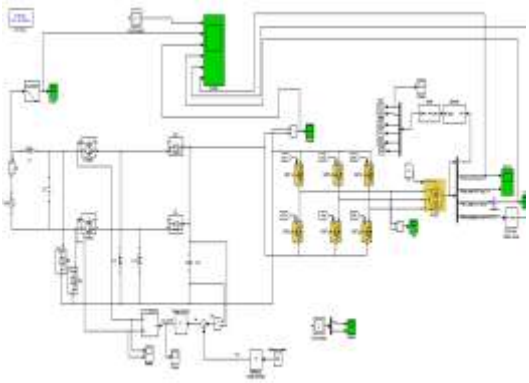

Fig. 2: Simulation Circuit of PV Array Based BLDC Motor Driven Water Pump Using Solar Technology

**6.2 Output Waveforms**

Fig. 3 Output Wave Form of Rotor Speed

Fig.4 Output Wave Form of stator current ia

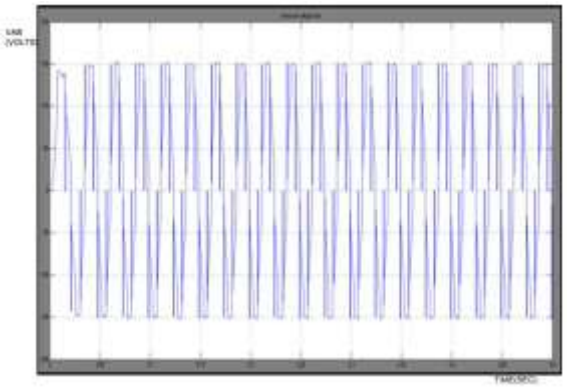

Fig 5 Output Wave Form of line – line voltage vab

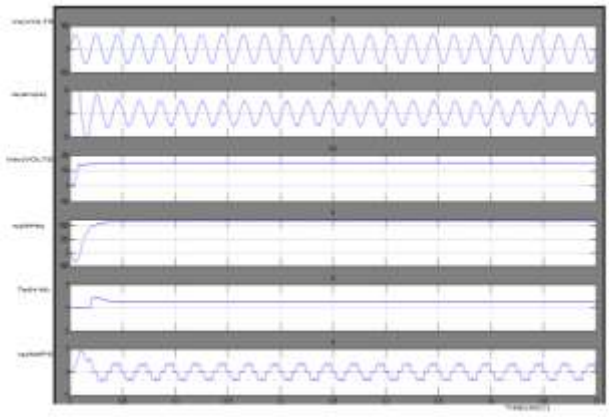

Fig.6 Output Wave Forms of Vs, Is, Vdc, N, Te, Ia

## 5. Conclusion

The SPV Array sustained lift converter based BLDC engine driven water pump has been proposed and its reasonableness has been shown by breaking down its different execution records utilizing MATLAB based reproduction contemplate. A basic, effective and conservative strategy for speed control of BLDC engine has been recommended, which has offered outright disposal of current detecting components. The best possible determination of SPV cluster has made the lift converter fit for following MPP regardless of climate conditions. An ideal plan of the lift converter has been exhibited. The protected beginning of brushless DC engine has been accomplished with no extra control. The coveted execution of proposed framework even at 20% of standard sun oriented irradiance has legitimized its appropriateness for sun based PV based water pumping.

## 6. Future Scope

Designing PV cells with some electrical appliances like DC – DC boosters are very useful in boosting up the voltage wherever it is necessary and also for suppressing the ripples…etc. DC – DC choppers with variable duty cycle can be used along with filters. For direct application of DC that kind of system can be designed. Intelligent devices like microprocessors, PLC (programmable logic controller) may be added to the system to keep the operating point (maximum power point) for maximum efficiency. A detailed performance analysis of the present system can be carried out to show its reliability as a future work. Solar PV is a technology that offers a solution for a number of problems associated with fossil fuels. It is clean decentralized, indigenous and does not need continuous import of a resource. On the above of that, India has among the highest solar irradiance in the world which makes Solar PV all the more attractive for India.

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