International Journal of Future Generation Communication and Networking
Vol. 13, No. 4, (2020), pp. 954 – 963

An Efficient MPPT Controller for Variable Frequency Drives in Water Pumping System

Ms. Lalitha B[1], Nidyadarsanaa S[2], Pavithra N[3], Shalini K[4] & Shanmati V S[5]

[1]*Assistant Professor, Department of Electrical and Electronics Engineering, KPR Institute of Engineering and Technology, Coimbatore, Tamilnadu, India.*
[2-5]*Student, Department of Electrical and Electronics Engineering, KPR Institute of Engineering and Technology, Coimbatore, Tamilnadu, India.*

Abstract

The fundamental point of this venture is to plan an ease and profoundly proficient "MPPT Controller for VFD" for water siphoning applications. The converter circuits particularly DC-DC converters are constrained by Maximum Power Point Tracking (MPPT) regulators to extricate most extreme force from the source. This paper talks about a plan and recreation of a proficient Interleaved Boost Converter (IBC) with Perturb and Observe (P&O) calculation for water siphoning applications. The principle preferred position of proposed Interleaved Boost Converter(IBC)is that the voltage worry over all the dynamic switches is half of the information voltage before turn on and additionally after mood killer when the working obligation beneath half. The exchanging misfortunes are limited as capacitor charging and releasing relies upon the turn upon and turn off activity of the switches. This makes the proposed IBC to work with higher effectiveness and higher exchanging recurrence. Since the IBC works with higher exchanging recurrence, the proposed IBC has a higher advance down transformation proportion, lower exchanging misfortunes and littler yield current wave contrasted and the traditional IBC. This model converters works at an information voltage scope of 38-45V which produces yield of 12V/1.9A.Since Variable recurrence Drives (VFD) is utilized in this application for speed alteration, it can modify the speed of the air conditioner engine to a suitable level by changing the recurrence utilizing VFD.

Keywords*: Maximum Power Point Tracking (MPPT), Interleaved Boost converter (IBC), Variable Frequency Drives (VFD) and Perturb and Observe (P&O).*

1. Introduction

The interest for sustainable power sources has expanded these days since the expense of petroleum derivatives increments because of its consumption. This powers people in each area to move towards sustainable power sources, for example, sun based, wind, hydro and different wellsprings of sustainable power source. The interest for sun oriented force is expanding a ton these days as it has numerous favorable circumstances, for example, no mileage, less support and no waste delivered during age and it is totally natural inviting. The DC-DC converters are associated between the PV Modules and burden so as to control the yield voltage of the PV modules. The customary DC-DC converter creates high wave in input current and yield voltage [2]. These issues with the traditional DC-DC help converters are overwhelmed by interleaved support converters because of current sharing between the components. The expense of TEC is high due to resembling of numerous converters when contrasted with customary sort converters. The current sharing procedure is more profitable as it brings about usage of low force parts and switches for the converter [1].

The MPPT calculations converter or force molding circuit associated in the middle of the PV and burden are utilized to remove the most extreme force from the source by controlling obligation pattern of the converter. The most regularly utilized MPPT calculations are Perturb and Observe (P&O), Incremental conductance (Inc) calculations. Different MPPT calculations are Constant voltage and parasitic capacitance calculation, open circuit voltage and short out current calculation. Nitty gritty correlations of different MPPT strategies are discussed [5].

ISSN: 2233-7857 IJFGCN

The Constant Voltage and parasitic capacitance calculation is most normally utilized and it is easy to actualize. Yet, the calculation sways around the most extreme force point (MPP) at consistent state. Improvement of calculation results in more slow reaction i.e., following is ill-advised under quickly changing climate conditions and hauls productivity of calculation down during overcast days. The Perturb and Observe (P&O) MPPT calculation has better precision as it tracks quicker than the consistent voltage calculation, P&O MPPT with two stage interleaved support converter is introduced and examined in this paper [3]. The total PV framework is recreated in MATLAB/Simulink with its nitty gritty execution in a brief manner [4],[6].

2. Related Work

A) Comparative Analysis of Developed Fractional open circuit voltage algorithm and Perturb & Observe (P&O) MPPT Algorithm for Photovoltaic Applications

These days sun oriented energy is the most normally utilized sustainable power sources and thus the photovoltaic module turns out to be more well-known because of its focal points, for example, ease, no contamination and exceptionally proficient technique to remove power. A portion of the basic issues related with photovoltaic framework is that, it is hard to get greatest and stable force. Consequently, Maximum Power Point Tracking calculations are utilized to remove steady and greatest force from the source. While utilizing a photovoltaic framework it is important to decide the kind of converter to be utilized to build the force yield of the photovoltaic. The plan of MPPT utilizing Perturb and Observe (P&O) calculation will follow the yield power rapidly and diminish the swaying in photovoltaic framework. The aftereffect of the greatest force tracker utilizing the Perturb and Observe (P&O) calculation is superior to the Fractional Open Circuit voltage calculation. Converters, for example, Interleaved Boost converter is utilized to defeat the force misfortunes that regularly emerge in PV frameworks. The consequence of intensity yield utilizing interleaved support converter is more prominent than utilizing buck converter. The effectiveness of photovoltaic framework increments while utilizing Interleaved Boost converter with Perturb and Observe calculation.

3. Proposed System

The ordinary plan of MPPT based variable recurrence drives in different applications utilizes just regular converters, for example, buck and lift converters which has lower effectiveness and higher exchanging misfortunes. The equipment usage of MPPT configuration utilizing traditional converters is extremely confounded as size of the circuit increments with higher yield and improved effectiveness. The proposed plan includes utilizing an Interleaved Boost Converter (IBC) which creates high effectiveness with basic equipment plan. To beat the downsides of traditional framework, the proposed framework with numerous points of interest, for example, low exchanging misfortunes, improves venture down change proportion, straightforward equipment plan and minimal effort, low current wave, higher exchanging recurrence is planned and executed in this paper.

4. Methodology

The detailed working of the project is given in the block diagram as shown below.

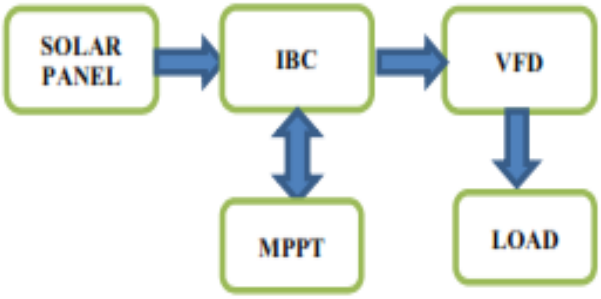


Fig.1 Hardware Architecture

ISSN: 2233-7857 IJFGCN

The block diagram of the proposed system is shown in Figure 1.

5. Design Procedure

5.1 Solar Panel or PV module

The primary working of sun based cell is that it legitimately retains energy from daylight to get sunlight based force. The motivation behind photovoltaic module is that it changes over sun powered energy into power. for example dc power. Photovoltaic module works under the marvel of photoelectric impact. As a rule, the PV cells are associated in arrangement and corresponding to frame a sun based cluster. It extricates energy from sun to deliver dc power dependent on shifting temperature and irradiance levels.

Fig.2 shows the system configuration of solar cell module. It extracts energy from sun to produce dc power based upon varying temperature and irradiance stages.

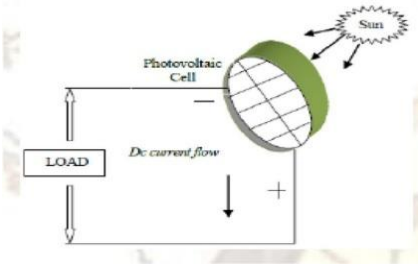


Fig.2 PV Module

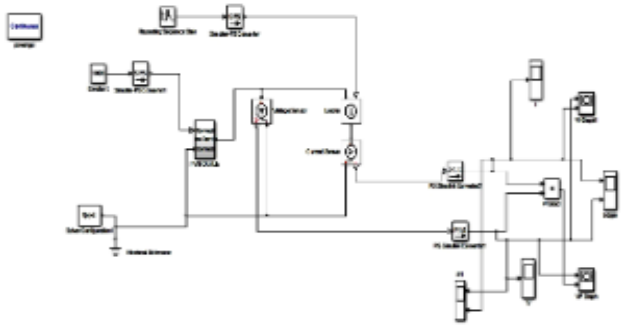
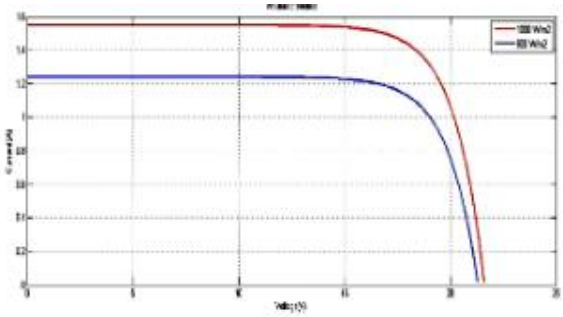


Fig.3 Simulink model of Solar Panel

Figure 3 shows the Simulink diagram of solar array using MATLAB.



ISSN: 2233-7857 IJFGCN

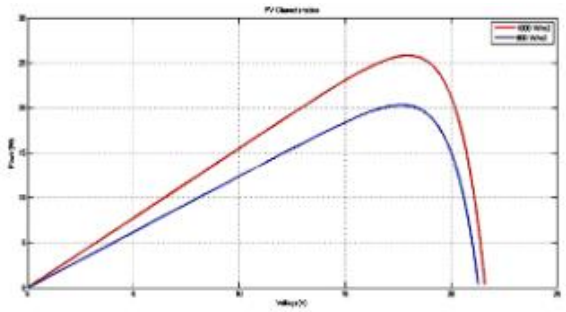


Fig.4 P-V and V-I characteristics of PV panel

Figure 4 shows the P-V and V-I characteristics of solar panel with its maximum operating point is obtained using Simulink.

5.2 Maximum Power Point Tracking (MPPT)

The function of Maximum Power Point Tracking (MPPT) in Photovoltaic System (PV) is that it is important to remove most extreme force from the hotspot for better execution of PV frameworks. However, it is difficult to remove steady and most extreme force from the source consistently. Thus, Maximum Power Point Tracking calculation is utilized by the photovoltaic framework to separate most extreme force ceaselessly. When all is said in done, there are different MPPT calculations utilized while most usually utilized calculations are Perturb and Observe (P&O) and Incremental conductance (Inc) calculations.

Fig.5 MPPT Controller

Figure 5 shows the hardware model of MPPT controller which is used to track maximum output power.

i) Perturb and Observe (P&O) Algorithm

It is the most widely recognized and least difficult type of calculation for following the greatest sun oriented force. All in all, Perturb and Observe (P&O) calculation sways around the most extreme working point (MPP). This calculation works on the premise that the subordinate of intensity under the capacity of voltage is zero at Maximum Power Point (MPP).

ISSN: 2233-7857 IJFGCN

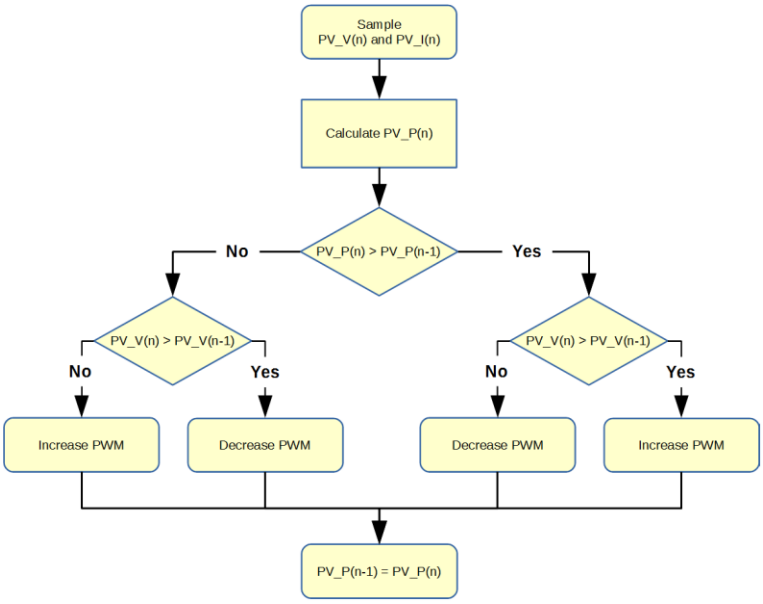


Fig.6 Flowchart of P&O algorithm

Figure 6 shows the definite flowchart of P&O calculation. By and large, the irritation of PV cluster happens in two ways.

Perturbation of PV cluster move towards MPP. In the event that the working voltage annoys in a provided guidance when dP>0, at that point the irritation of PV voltage is moved around the MPP.

Perturbation of PV cluster moves from MPP. In the event that dP<0, at that point the working point moves from MPP. During this time, the bearing of annoyance is turned around.

dP/dV = 0 | at MPP. _____ (1)

In view of the worth dP/dV, the P&O calculation chooses the bearing of irritation.

5.3 Interleaved Boost Converter (IBC)

The PV modules connect the DC-DC converters to the heap to manage the yield voltage of the PV modules. The present day DC-DC converters make huge information current and yield voltage ripples. Such issues with customary DC-DC support converters are fathomed by interleaved help converters because of current perspective sharing. Two stage interleaved DC-DC support converters are solely used for applications where lower current wave, higher effectiveness yield, snappy elements with more force thickness are required.

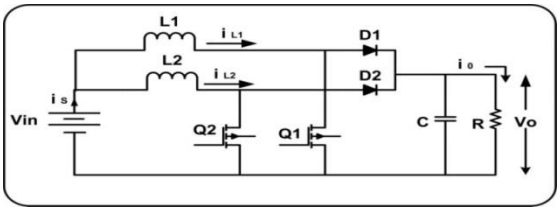


Fig.7 Circuit diagram of 2 phase interleaved boost converter

Figure 7 portrays the circuit outline of two stage interleaved support converter. The estimation of TEC is high because of the equal activity of multi-converters comparative with customary sort. The current sharing strategy is more profitable as it brings about the utilization of low force exchanging parts.

ISSN: 2233-7857 IJFGCN

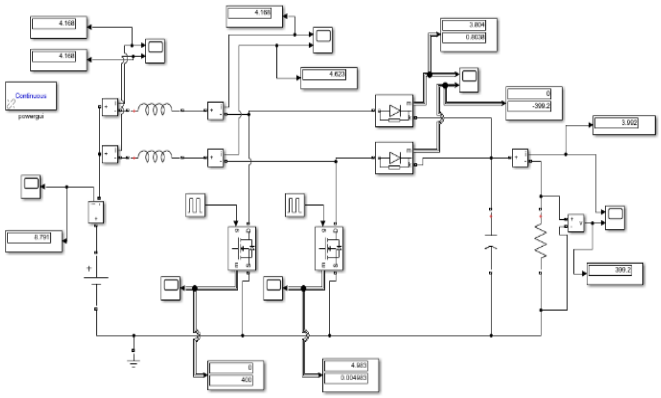


Fig.8 Simulink model of IBC

Figure 8 shows the simulation diagram of IBC.

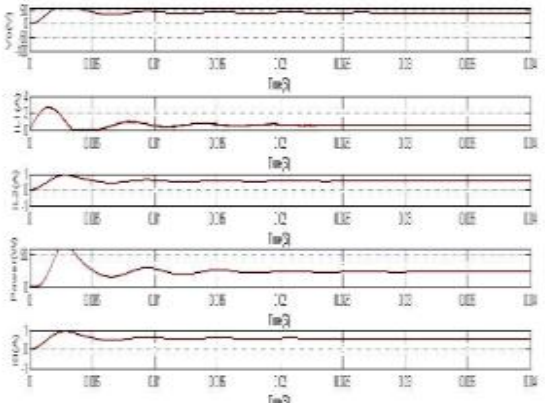


Fig.9 Simulation output of IBC

Figure 9 shows the Output voltage, current, power and frequency waves of Interleaved boost converter.

5.4 Variable Frequency Drive (VFD)

Differential-recurrence drive is the sort of flexible speed control utilized in electro-mechanical drive frameworks to oversee Induction engines speed and force by adjusting motor info voltage. As the VFD changes both the recurrence and the rpm of the generator, it regularly keeps changing the voltage to hold the volt/hertz proportion consistent. Force esteem continues as before, for example T=1, yet HP is diminished in direct extent to the speed increment.

The activity of a cutting edge VFD can be part into three significant areas:

- The power move activity
- The control segment that incorporates CPU and the outside switches alongside signs to control VFD activity.
- The power section where AC/DC and the other way around activity is performed.

ISSN: 2233-7857 IJFGCN

Fig.10 Variable Frequency Drive

Figure 10 portrays the standard variable recurrence drive. VFDs deal with the recurrence of their yield by fluctuating the info AC current to DC, and by utilizing voltage beat width tweak to recover the AC current and voltage yield waveform.

5.5 Motor

The motor changes the electrical energy into mechanical energy. It worked as per the rule of the Flemings left hand rule. It is utilized for mechanical activities, for example, water siphoning.

Fig.11 AC motor

At the point when the Variable Frequency drive is associated with air conditioning engine, the VFD changes voltage and recurrence relatively so as to look after voltage/recurrence proportion consistent. This causes the VFD to change recurrence as needs be all through the activity which likewise helps in altering the speed of the engine. Figure 11 shows the 5 Volt AC drive.

6. Workflow

Figure 12 shows the detailed workflow the proposed system in the step by step manner.

ISSN: 2233-7857 IJFGCN

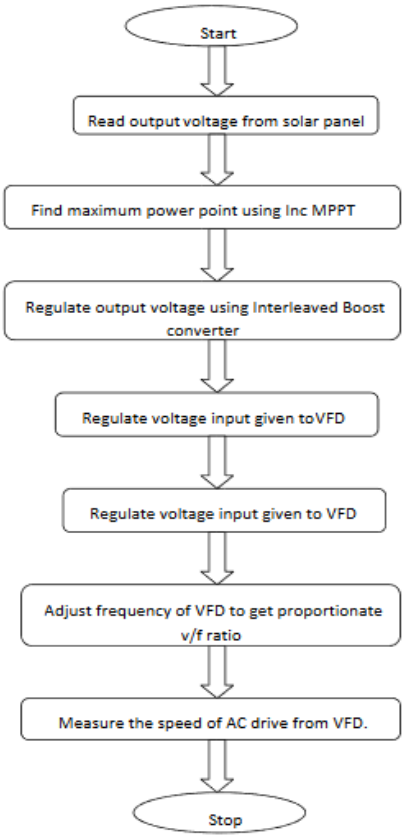


Fig.12 Workflow of the project

ISSN: 2233-7857 IJFGCN

7. Output Model

7.1 Simulation Diagram

Figure 13 shows the simulation diagram of Interleaved Boost Converter with P&O algorithm.

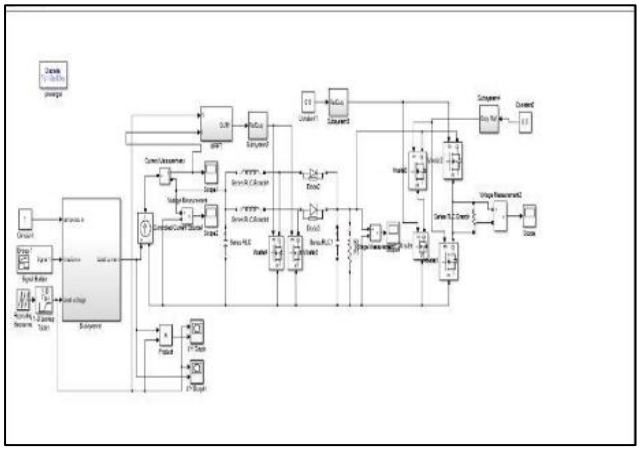


Fig.13 Simulation model of IBC with P&O algorithm

7.2 Hardware Model

Figure 14 shows the hardware model of the proposed system.

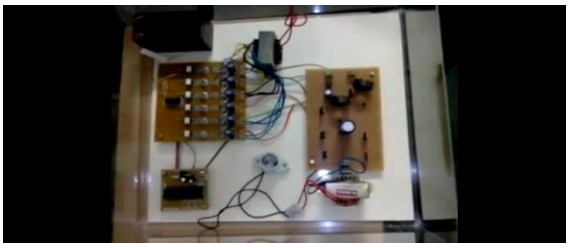


Fig.14 Hardware model

8. Simulation Result and Discussion

Figure 15 shows the simulation result with output voltage, current and output power of IBC with P&O algorithm.

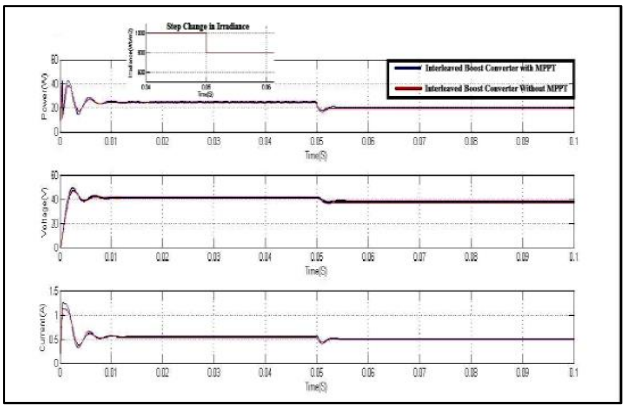


Fig.15 Simulation result using Simulink

The plan of Interleaved support converter with P&O calculation for water siphoning applications is introduced in this paper. The reenactment consequence of the proposed framework portrays that with the utilization of Interleaved Boost Converter (IBC) , the waves delivered at the yield is diminished to the greatest worth.

Table 1 Parameter comparison between IBC and boost converter.

Parameters	IBC	Boost converter
Voltage ripple	0.013mV	0.009mA
Current ripple	2.16 V	0.0926A
Required output power	20 W	20 W
Actual output power	19.68 W	19.656 W

The above table shows the variety in the estimations of various boundaries in IBC and lift converter. This table obviously clarifies the variety in IBC and lift converter as the wave esteems at the yield is diminished to 95% when contrasted with customary lift converter. This has the preferred position that the yield power is delivered with high exactness since its wave esteems are diminished.

9. Conclusion

Plan and examination of Interleaved Boost converter for sustainable power source applications is done in this paper. The information voltage of 100V is supported to 400V yield utilizing this interleaving method. The activity is performed under open circle condition. The framework is equipped for providing capacity to the heap with the higher productivity of 98%. The Interleaved help converter can be associated with a network associated framework with the inverter circuit for changing over DC to AC. The changed over AC voltage is then given to Variable recurrence drives (Vfd) for voltage control with the assistance of recurrence alteration. Since the Variable recurrence drive (Vfd) is utilized in this application for control of voltage by methods for altering the recurrence., for example volt/hertz. It is then associated with AC engine for water siphoning applications which is really introduced in this paper.

It has favorable circumstances, for example, low wave, more yield power, high precision and effectiveness. Since the wave content is low in the yield waveform, the force misfortune is relatively low and greatest influence is gotten at the yield.

The proposed interleaved Boost Converters are additionally utilized in the uses of high effectiveness converters, power factor rectification circuit and battery chargers.

References

[1] H.M. Swamy, K.P. Guruswamy and S.P. Singh, “Design, Modeling and analysis of Two level Interleaved Boost Converter” IEEE International Conference on Machine Intelligence and Research Advancement (ICMIRA), pp.509514, December, 2013.

[2] A. Ghosh, S. Banerjee, M. K. Sarkar and P. Dutta, “Design and Implementation of Type-II and Type-III controller for DC-DC switched mode boost converter by using K-factor approach and Optimization Techniques,” IET Power Electronics, vol.9, no.5. pp. 938-950, 2016.

[3] S. Joseph Sam Immanuel, N. Booma “Design of Interleaved Boost Converter based PV Systems with Maximum Power Point Tracking” International Journal of Innovation in information Embedded and Communication Systems, Vol 13, 2016.

[4] Sadegh Hesari, “Design and Implementation of Maximum Power Tracking Systems using Photovoltaic Applications”, International Journal of Renewable Energy Research, June 2016.

[5] J.Surya Kumari, Ch. Sai Babu “Comparison of Maximum Power Point Tracking Algorithms for Photovoltaic systems” International Journal of Advances in Engineering and Technology, Nov 2011.

[6] S. Sheik Mohammed, “Modeling and Simulation of Photovoltaic module using Matlab/Simulink” International Journal of Chemical and Environmental Engineering, 2011.