



Fly back Converter Using PV Source with Modified MPPT Techniques for AC Load Applications

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ABSTRACT: Photovoltaic (PV) vitality presents awesome potential for applications in conveyed power frameworks. On the other hand, despite everything it exhibits a low vitality transformation rate even at the Maximum Power Point (MPP). The normal effectiveness can be even lower if the working point is permitted to float as indicated by uncontrolled burden and barometrical conditions varieties. Keeping in mind the end goal to boost the vitality change, power hardware converters controlled with Maximum Power Point Tracking (MPPT) calculations are utilized. Different sorts of MPPT calculations have been proposed in the writing. In PV creating frameworks, bother and perception (P&O) MPPT calculations are generally utilized. This framework depends on change of P&O strategy through a settled step prescient control by utilizing Model Predictive Control (MPC) under measured quick sunlight based radiation variety. The proposed prescient control to accomplish MPP speeds up the control circle since it predicts mistake before the exchanging sign is connected to the fly back DC/DC converter. This undertaking proposes the configuration of a battery which stores vitality and conveys to the heap when the PV source can't supply the ability to the heap. On account of the huge utilization of air conditioning stacks, a PWM inverter is associated at burden side to give air conditioning supply. It is relied upon to diminish the motions created. MATLAB/SIMULINK is utilized to recreate the model.

KEYWORDS: Maximum Point Tracking, Battery, Photovoltaic Array, Flyback converter DC-DC converter, Model prescient control, Voltage source inverter.

I. INTRODUCTION

Because of World vitality emergency and developing interest for vitality as ordinary vitality sources can't take care of the expanding demand for vitality around the world. So renewable vitality sources have turned into a vital benefactor to the aggregate vitality expended on the planet. Sun oriented photovoltaic framework (SPV) is a force framework intended to supply usable sunlight based force by method for photo voltaics. The decrease in the expense of photovoltaic cells has further expanded enthusiasm for renewable vitality source, which keeps on picking up ubiquity with 60% yearly development in the introduced limit of photovoltaic (PV) frameworks [1]. It comprises of a plan of a few segments, including sun based boards to assimilate and specifically change over daylight into power, a sunlight based inverter to change the electrical current from DC to AC. A few methodologies have been proposed to enhance productivity of SPV framework and to give the best possible air conditioning voltage required by private clients. For this reason, dc-dc converters have been investigated widely to meet the required electric vitality requests by these frameworks utilizing a battery move down [2]. A solitary switch fly back converter is outlined with transformer detachment to charge the battery. The battery voltage is changed over into air conditioning supply utilizing a voltage source inverter (VSI) and a channel.

Various techniques for how to track the most extreme force purpose of a PV module have been expected to unwind

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the issue of effectiveness and items utilizing these systems have been made and are currently economically accessible for purchasers [3]. Most extreme Power Point Trackers (MPPTs) assume a critical part in photovoltaic (PV) power frameworks in light of the fact that they augment the force yield from a PV framework for a given arrangement of conditions, and accordingly expand the cluster proficiency. Along these lines, a MPPT can minimize the general framework cost. MPPTs find and keep up operation at the greatest force point, utilizing a MPPT calculation. In the course of recent decades, numerous MPPT strategies have been proposed; the relative benefits of these different techniques are examined in [4]. The basic working administration is low insolation. Amid low insolation periods, catching the majority of the accessible sunlight based force can generously enhance framework execution. A viable MPPT controller and converter can utilize accessible vitality to essentially lessen the measure of introduced PV.

Considering the MPPT routines talked about in [4], strategies considered incorporate Incremental Conductance (INC), Perturb-and-Observe (P&O), fragmentary Open-Circuit Voltage (Voc), and Best Fixed Voltage.

The P&O system, asserted by numerous in the writing to be mediocre compared to others, keeps on being by a long shot the most broadly utilized technique as a part of suitable MPPTs. P&O is a surely understood system with moderately great execution; on the other hand, P&O technique can't generally focalize to the genuine most extreme force point. Additionally, P&O is moderately moderate, which restricts its capacity to track transient isolation conditions [1]. The primary commitment of this paper is to enhance the P&O strategy execution by anticipating the mistake one stage ahead in skyline through model prescient control method [10]. This proposes another usage of a P&O calculation that mitigates the primary disadvantages generally identified with the P&O system.

II. PROPOSED SYSTEM CONFIGURATION

Figure 1 shows a block diagram of the solar PV energy conversion system with a dc-dc fly back converter, a battery, a VSI and an output filter.

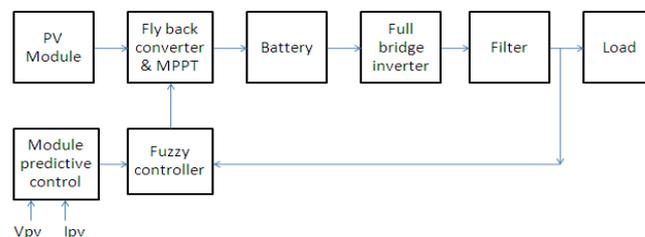


Fig. 1. Block diagram of system configuration

Flyback converter is the most generally utilized SMPS circuit for low output power applications where the output voltage needs to be isolated from the input main supply. V_{pv} and I_{pv} are the output voltage and output current of the PV module. These values are given as the inputs to model predictive control. Solar-PV array characteristics are varying with natural conditions and to capture the most energy, an MPPT controller is used with a flyback converter. The MPPT algorithm P&O functions with the help of model predictive control [2]. The perturbation and observation method is used for MPPT of PV panel. A feedback controller is connected to VSI under varying loads for regulating output voltage. Figure 2 shows the detailed circuit of proposed system.

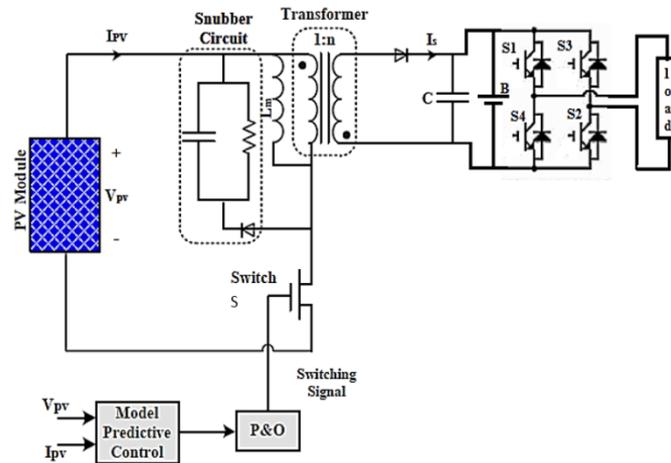


Fig. 2. Proposed arrangement of solar PV energy system with a flyback converter and a solitary-stage voltage source inverter

A. Battery System and Inverter

The battery plays an important role in case of the solar power system. The battery stores part of the energy generated by the solar PV power source and delivers to the load during the periods when the solar power source is unable to supply the power to the load due to any reason. The capacity of the battery depends on the daily load and days of autonomy. A full-bridge voltage source inverter (VSI) is utilized here which consists of four switches. PWM pulses are generated by the sinusoidal PWM controller. The output signal from this full-bridge VSI is a pulse waveform which contains the desired YIELD waveform along with frequency components at or around harmonics of the switching frequency. A filter is here utilized to extract the desired output voltage by separating it from the switching frequency.

III. PRINCIPLE OF MODEL PREDICTIVE CONTROL

By development technology of computer and digital signal processing, modern techniques have been developed for power converter controlled such as model predictive control (MPC) [5]. This control appears during 80s as an attractive alternative for the control power converter due to its quick dynamic response. The main characteristic of predictive control is use the model of system for prediction of controlled variables and selects the most appropriate control set based on optimality criterion. The different approach called Model predictive control.

MPC has capable of predicting future yield signals based on future input signals and initial values. A model of the system is considered in order to predict the future behavior of the variables over a period. These predictions are evaluated based on the characteristic of model and cost function, and then the sequence that reduces the cost function is selected to predict the future control signal.

In the general scheme of MPC for power electronics inverters measured variables $X(K)$, are used in the model to calculate predictions, $\hat{X}_1(K+1)$ of the controlled variables for each one of the n possible actuations, that is, switching states, voltages, or currents [1]. Then these predictions are evaluated using a cost function which considers the reference values, $X_1^*(K+1)$, design constraints, and the optimal actuation, S , is selected and applied in the converter. The normal form of the cost function, g , subject to minimization can be formulated as

$$g = [\hat{X}_1(K+1) - X_1^*(K+1)] + \lambda_1 [\hat{X}_2(K+1) - X_2^*(K+1)] + \dots + \lambda_n [\hat{X}_n(K+1) - X_n^*(K+1)] \quad (1)$$

where λ is the weighting factor for each objective. To select the switching state which minimizes the cost function g , every possible states are evaluated and the optimal value is stored to be applied next.



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IV. MPPT USING MODEL PREDICTIVE CONTROL

The technique Maximum Power Point Tracking (MPPT) is used in power electronic circuits to extract maximum energy from the Photovoltaic (PV) Systems [6]. In the recent decades, photovoltaic power generation has become more important due its numerous advantages such as needs a few maintenance and environmental advantages and fuel free. However, there are two major barriers for the utilization of PV systems, low energy conversion efficiency and high initial cost. To enhance the energy efficiency, it is important to work PV system always at its maximum power point.

A. Perturb and Observe Algorithm

In proposed sunlight PV energy conversion system, the perturbation and observation method is applied in order to track maximum power point [2]. It is an iterative method of obtaining maximum power point on operating curve of PV array. This calculation works by occasionally measuring array terminal voltage and current and increments or decrements them after comparing it to the change in output power [7]. Here operating voltage of PV array is perturbed by a finite increment value and due to this, the change in yield power is observed. If this change is positive then it shows that operating point is moving closer to the greatest power point (GPP) else it moving away. This determines the direction of next perturbation [8]. The maximum power point can be determined when $dP/dV = 0$, where P is the output power and V is the output voltage of PV array. As the force-voltage relationship of a typical PV module is not linear, the maximum power point can be tracked using this calculation when condition $dP/dV = 0$ is true for any value of solar radiation and temperature units.

B. Model Predictive Control Procedure

Figure 3 shows the operating flowchart of P&O algorithm, V_{pv} and I_{pv} are output voltage and current of PV array and k is the value of variation in voltage to compute next perturbation. For a given perturbation on the voltage of the panel leads to an increase or decrease the output power of the PV, then the subsequent perturbation is generated in the same or opposite direction [1-2].

```
function D = mppt(V, I)

Di = .5;
Dm = .9;
Dn = .1;
dd = .001; %

persistent Vk Pk Do;

dataType = 'double';

if isempty(Vk)
    Vk=0;
    Pk=0;
    Do=Di;
end
P= V*I;
dV= V - Vk;
dP= P - Pk;

if dP ~= 0
    if dP < 0
        if dV < 0
            D = Do - dd;
        else
            D = Do + dd;
        end
    end
end
```

Fig. 3. MPC procedure using P&O to determine reference current

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```

Pk=0;
Do=Di;
end
P= V*I;
dV= V - Vk;
dP= P - Pk;

if dP ~= 0
    if dP < 0
        if dV < 0
            D = Do - dd;
        else
            D = Do + dd;
        end
    else
        if dV < 0
            D = Do + dd;
        else
            D = Do - dd;
        end
    end
else D=Do;
end

if D >= Dm || D<= Dn
    D=Do;
end

Do=D;
Vk=V;
Pk=P;

```

Fig. 4. MPC-MPPT procedure

As a consequence of the P&O algorithm, when the MPP is reached, the system may oscillate around it and this problem is overcome by reducing the perturbation step size. The discrete time set of equations of the flyback converter shown in Figure 2 is given by Equations 2 and 3 when switch is “ON” and Equations 4 and 5 when switch is “OFF” [1]:

$$i_{pv}(k+1) = \frac{T_s}{L} V_{pv}(k) + i_{pv}(k) \quad (2)$$

$$V_c(k+1) = \left(1 - \frac{T_s}{RC}\right) V_c(k) \quad (3)$$

$$i_{pv}(k+1) = i_{pv}(k) - \frac{T_s}{Ln} V_c(k) \quad (4)$$

$$V_c(k+1) = \frac{T_s}{nC} i_{pv}(k) + \left(1 - \frac{T_s}{RC}\right) V_c(k) \quad (5)$$

After determining the reference current, cost function can be obtained as in Equation 6 using the procedure shown in Figure 4.

$$g_{s=0,1} = |i_{pv_{s=0,1}}(k+1) - i_{ref}| \quad (6)$$

The objective of the paper is to minimize the cost function g . Using procedure illustrated in Figure 4 the final switching state for MPPT can be determined.

V. SIMULATION

Solar PV energy conversion system with a flyback converter is modeled in MATLAB platform with maximum power tracking controller for extracting maximum power from PV array and a PWM generated VSI for load variation in output. For greatest force point tracking, a perturbation and observation algorithm with model predictive control is used [9].

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Then the value of voltage starts increasing linearly. This increase shows that the battery starts charging and it took 0.62 second.

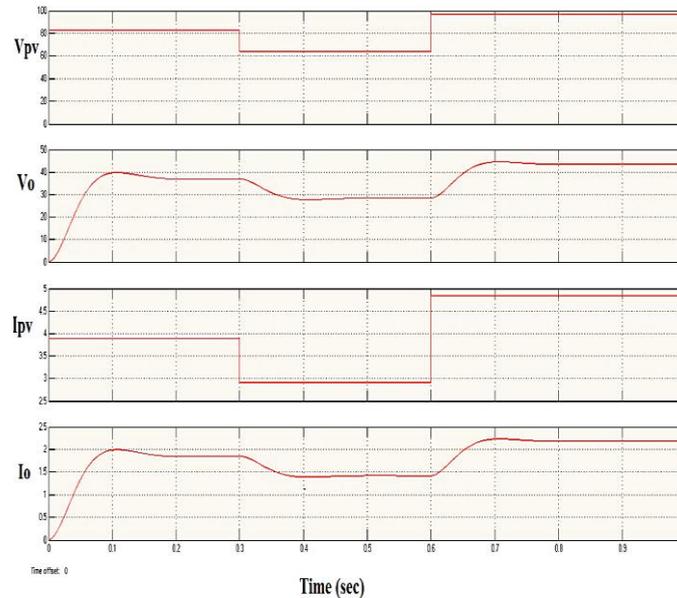


Fig. 5. Output of PV panel and Flyback converter

Figure 5 shows the output voltage of PV (V_{pv}), flyback converter (V_o), output current of PV (I_{pv}) and flyback converter (I_o) respectively. It is clear that oscillations in the outputs of flyback converter are low with MPC-P&O.

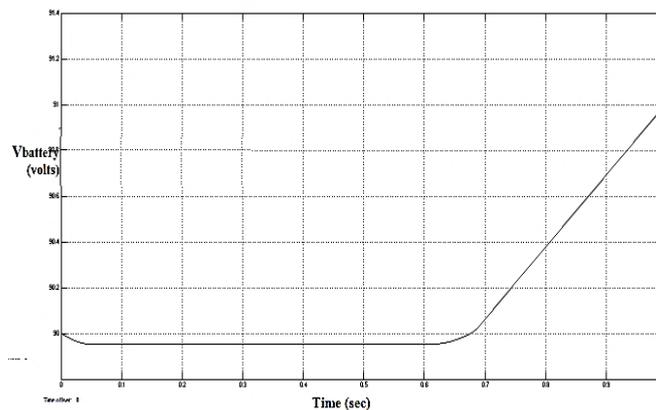


Fig. 6. Charging of Battery

Figure 6 shows the charging of battery connected at inverter input side. Initially the value of voltage is constant. It shows that till 0.62 seconds the voltage is constant.

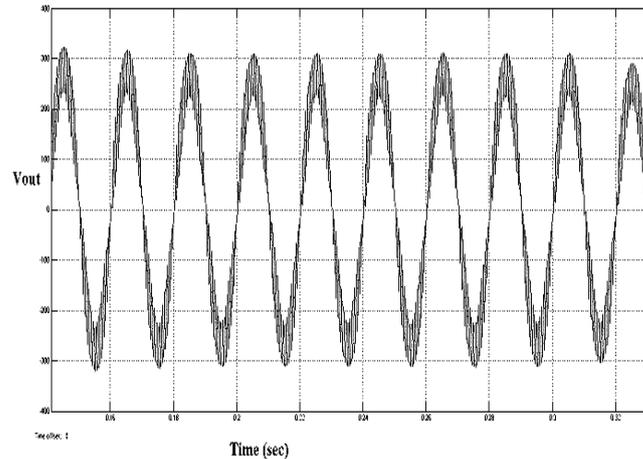


Fig. 7. Output voltage

Figure 7 and 8 shows the output voltage and current of the MPC-P&O with single phase full bridge inverter.

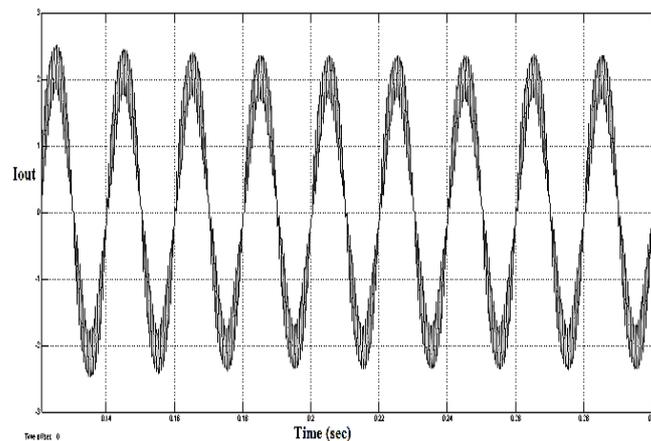


Fig. 8. Output current

VI. CONCLUSION

The model was simulated using SIMULINK and MATLAB. The study of a standalone solar PV energy system have been carried out using a flyback converter, battery and a single phase voltage source inverter. The P&O with model predictive controller performance has been investigated and it has given required response. The battery charging has been achieved through maximum power point tracking which gives sufficient backup. Thus it provided energy storage and can be applied to AC loads. So depending on the requirement one can choose it for low power application.

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