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# VIRTUALIZATION AND SIMULATION OF INCREMENTAL CONDUCTANCE MPPT BASED TWO PHASE INTERLEAVED BOOST CONVERTER USING SIMULINK IN MATLAB

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***Abstract:*** ***The Photovoltaic power generation systems are made connected to the load via DC-DC converters. There the DC-DC converter circuits are then controlled by Maximum Power Point Tracking (MPPT) controllers to extract maximum power from the source. And the Modeling and simulation of Interleaved Boost converter (IBC) with Incremental Conductance (InC) MPPT algorithm for PV application is discussed in this dissertation. The mathematical model of PV module, interleaved boost Converter and MPPT controller are simulated using MATLAB/Simulink. The PV system is simulated for various temperature and irradiation level and the results are obtained.***

***Keywords:*** ***Maximum Power Point Tracking (MPPT),Incremental Conductance (InC) algorithm, Interleaved Boost Converter (IBC), MATLAB/Simulink, solar power***

## I. INTRODUCTION

The DC-DC support converters are associated between the PV Modules and load in order to manage and help the output voltage of the PV. The DC-DC support converters creates high ripple in info current and output voltage [5]. These issues with the conventional DC-DC support converters are overcome by interleaved help converters because of current sharing between the components. Contrasted with the conventional converter the cost of TEC is high because of paralleling of numerous converters. However, then again the current sharing technique brings about use of low power segments and switches for the converter [6]. The MPPT algorithms are utilized to control the duty cycle of the converter or power conditioning circuit associated in the middle of the PV and load to extricate the maximum power from the source and to sustain it into the load. The MPPT algorithms proposed in the literature are Perturb and Observe (P&O) , Incremental conductance (InC); Constant voltage and parasitic capacitance algorithm are discussed in [7]. Alternate algorithms are, for example, short current heartbeat [8], open circuit voltage [9] and short circuit current [9] algorithm. Maximum power point tracking (MPPT or here and there just PPT) is a technique utilized regularly with wind turbines and photovoltaic (PV) solar systems to amplify power extraction under all conditions. Albeit solar power is chiefly secured, the principle applies for the most part to sources with variable power: for instance, optical power transmission and thermo photovoltaics. PV solar systems exist in a wide range of configurations concerning their relationship to inverter systems, outside grids, battery banks, or other electrical loads. Despite a definitive goal of the solar power, however, the focal issue tended to by MPPT is that the efficiency of power transfer from the solar cell relies on upon both the measure of daylight falling on the solar panels and the electrical characteristics of the load. As the measure of daylight shifts, the load characteristic that gives the highest power transfer efficiency changes, so that the efficiency of the system is upgraded when the load characteristic changes to keep the power transfer at highest efficiency. This load characteristic is known as the maximum power point and MPPT is the way toward discovering this point and keeping the load characteristic there. Electrical circuits can be intended to introduce self-assertive loads to the photovoltaic cells and then change over the voltage, current, or frequency to suit different devices or systems, and MPPT tackles the issue of picking the best load to be exhibited to the cells in order to get the most usable power out.

## II. ALGORITHMS OF MPPT

Perturbation and observation (P&O): This algorithm perturbs the operating voltage to ensure maximum power. While there are several advanced and more optimized variants of this algorithm, a basic P&O MPPT algorithm is shown below.

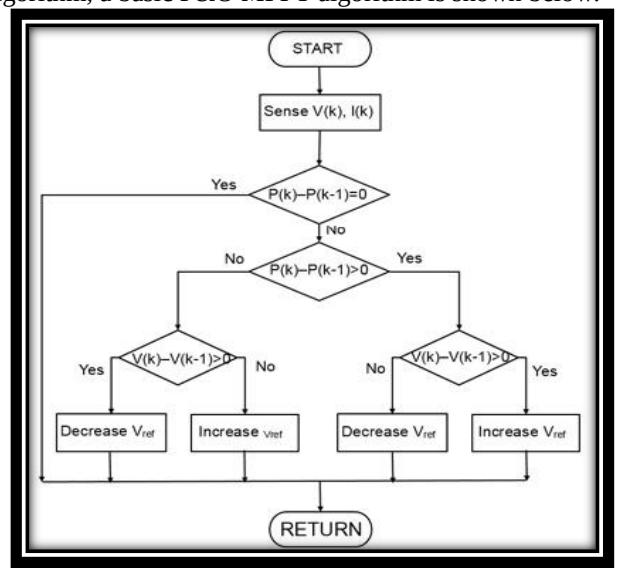


Fig 1 Basic P&O algorithm.

Incremental conductance: This algorithm, shown below, compares the incremental conductance to the instantaneous conductance in a PV system. Depending on the result, it increases or decreases the voltage until the maximum power point (MPP) is reached. Unlike with the P&O algorithm, the voltage remains constant once MPP is reached.

  

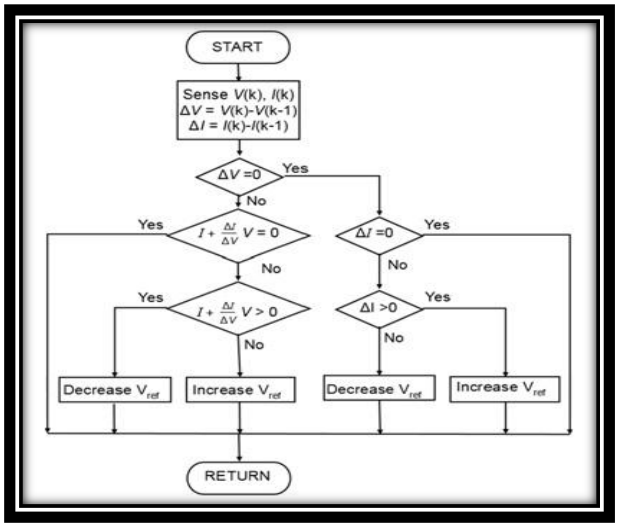


Fig 2 Incremental conductance algorithm.

Fractional open-circuit voltage: This algorithm depends on the principle that the maximum power point voltage is dependably a constant portion of the open circuit voltage. The open circuit voltage of the cells in the photovoltaic array is measured and utilized as in contribution to the controller.

## III. RELATED WORK

S. Sheik Mohammed D. Devaraj[1] recommended that the Photovoltaic power generation systems are associated with the load by means of DC-DC converters. The DC-DC converter circuits are controlled by Maximum Power Point Tracking (MPPT) controllers to concentrate maximum power from the source. Displaying and reproduction of Interleaved Boost converter (IBC) with Incremental Conductance (InC) MPPT algorithm for PV application is discussed in this paper. The scientific model of PV module, interleaved support Converter and MPPT controller are reproduced utilizing MATLAB/Simulink. The PV system is reproduced for different temperature and irradiation level and the outcomes are acquired.

P.Abishri, Umashankar S, Sudha Ramasamy [2] recommended that the power level of a power electronic converter is constrained because of a few factors, increment in current causes an expansion in the weight on exchanging devices. Also, the diode turn around recuperation current and parasitic reverberation current end up noticeably more noteworthy than the principle switch can handle. Subsequently, the span of the lift inductor ought to be expanded to stay away from saturation and overheating issues. In order to propel the power level fundamentally the strategies, including gadget paralleling, module paralleling and interleaving are generally utilized. For a few applications, help stages are outlined separately with the end goal that the converter stages can be associated in parallel to meet the expanding power necessity. This technique is ideal as it is anything but difficult to build the power rating by essentially stacking converters with expanded repetition. The disadvantages of the strategy are it's moderately high cost, huge volume secured, and cooling troubles. Furthermore, to give break even with sharing of information current among the converters, extra circuitry ought to be utilized and the currents of individual converters don't return legitimately, current of one module can flow through other module and some startling disappointments may happen. This paper surveys the swell info current and output voltage of two and three stage Interleaved Boost Converter (IBC) and examines the performance of four stage IBC for sustainable applications.

K. Sivakumar [3] proposes interleaved help converter utilizing SIC diodes for PV applications is proposed. The converter consists of two exchanging cells sharing the PV panel output current. Their exchanging examples are synchronized with 180◦ stage move. Each exchanging cell has a SIC Schottky diode and a Cool MOS exchanging gadget. The SIC diodes gives little switch recuperation current and voltage drop is additionally significantly diminished .Such leverage from the SIC diodes empowers higher efficiency and higher power thickness of the converter system by lessening the prerequisite of the cooling system. Also the MPPT controller is utilized as a part of our proposed system to productively draw the power from the solar panel. Reenactment and exploratory outcomes are introduced to confirm the proposed system. This paper shows a handy outline and execution system for an interleaved help converter (IBC) utilizing SIC Schottky diodes in a private PV pre regulator application. It must be noticed this speaks to a case of the utilization of the strategy and system. It can be stretched out to streamline the dc–ac inverter. The plan objective is to amplify the efficiency in the system and the outline criteria with the ordinary determination of single-stage PV inverters.

D.Umarani [4] In this paper, reenactment of PV based two stage interleaved help converter has been discussed. Interleaved Boost Converter (IBC) serves a few applications which require support in output voltage, for example, energy units, photovoltaic cells and batteries and so forth., since it has a few focal points over conventional DC-DC converters. The configuration of IBC comprises parallel mix of various lift converters with same stage move and exchanging frequency. This paper manages the plan of two-stage IBC for a five level fell multilevel inverter (MLI). The hotspot for each extension of the MLI has been demonstrated as PV. The reenactment has been done utilizing MATLAB/SIMULINK.

M.S.Sivagamasundari [5] Energy , particularly elective wellspring of vitality is indispensable for the improvement of a nation. In future, the world expects to grow more of its solar asset potential as an option vitality source to defeat the persistent shortages and instability of power supply. In order to boost the power output the system segments of the photovoltaic system ought to be enhanced. For the advancement maximum power point tracking (MPPT) is a promising technique that network tie inverters , solar battery chargers and comparable devices use to get the maximum conceivable power from one or more solar panels. Among the diverse techniques used to track the maximum power point, Perturb and Observe technique is a kind of system to advance the power output of an array. In this strategy, the controller changes the voltage by a little sum from the array and measures power, if the power increments, facilitate alterations toward that path are attempted until power at no

  

time in the future increments. In this research paper the system performance is upgraded by bother and observe strategy utilizing buck help converter. By changing the duty cycle of the buck support converter, the source impedance can be coordinated to alter the load impedance to enhance the efficiency of the system. The Performance has been examined by the MATLAB/Simulink.

## IV. PROPOSED WORK

The MPPT algorithms are utilized to control the duty cycle of the converter or power conditioning circuit associated in the middle of the PV and load to separate the maximum power from the source and to nourish it into the load. The MPPT algorithms proposed in the literature are Perturb and Observe (P&O), Incremental conductance (InC); Constant voltage and parasitic capacitance algorithm are discussed in [7]. Alternate algorithms are short current heartbeat, open circuit voltage and short circuit current algorithm. The P&O and InC algorithm are generally utilized algorithms among the MPPT algorithms. The P&O algorithm is straightforward and simple to execute. Be that as it may, the algorithm sways around the maximum power point (MPP) at unfaltering state. Change of algorithm results in slower reaction i.e., tracking is ill-advised under quickly changing weather conditions and drags efficiency of algorithm down amid cloudy days . The InC MPPT algorithm tracks speedier than the P&O algorithm and likewise it has better precision. InC MPPT based PV system with two stage interleaved support converter is introduced and discussed in this paper. The entire PV system is reenacted in MATLAB/Simulink.

*Mathematical Model of PV Module*

The equivalent circuit for simplified model of PV cell consists of a current source ($I_{pv}$), a diode(D), and series resistor ($R_s$) connected as shown in Fig. 4.1.

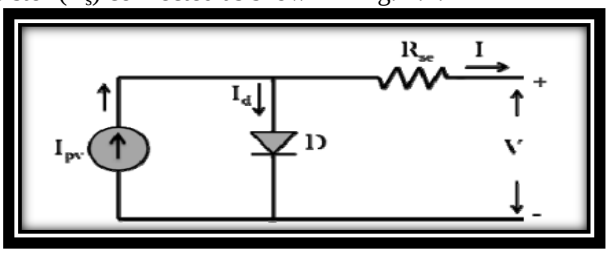


Fig.3. Equivalent Circuit of PV Cell

The output current (I) equation is derived by applying Kirchhoff's law in the equivalent circuit.

The equation for output current is as follows

$$I = I_{pv} - I_d \quad (1)$$

Equation 1 can re-written as

$$I = I_{pv} - I_s\left\{\exp\left(\frac{q}{AkT_cN_s}V + IR_{se}\right) - 1\right\} \quad (2)$$

where,

$$I_{pv} = [I_{sc} + K_I(T_c - T_r)]\cdot G \quad (3)$$

$$I_s = I_{rs}\left(\frac{T_c}{T_r}\right)^3 \exp\left[\frac{qE_g}{A_k}\left(\frac{1}{T_c} - \frac{1}{T_r}\right)\right] \quad (4)$$

$$I_{rs} = \frac{I_{sc}}{\exp\left(\frac{q}{AkT_{c(n)}N_s}V_{oc}\right) - 1} \quad (5)$$

The general model of the PV cell has a parallel resistor (Rp) in the circuit which is connected across the diode. The estimation of parallel resistance is high and along these lines it is by and large dismissed in demonstrating the PV cell. Displaying and recreation of The PV depends on the scientific conditions is introduced in numerous literatures [12-17]. Displaying and reenactment of PV module utilizing basic pieces is exhibited in [15]. This model is extremely primitive, and the client needs to change to parameters inside the pieces of the model in order to investigate distinctive PV modules. Therefore, the conceivable outcomes of error in encouraging the information are high. The PV module display with the veiled subsystem and an exchange box is discussed in [17].

This model provides the user with front end dialog box which makes the model more user-friendly to analyze any commercial PV modules.

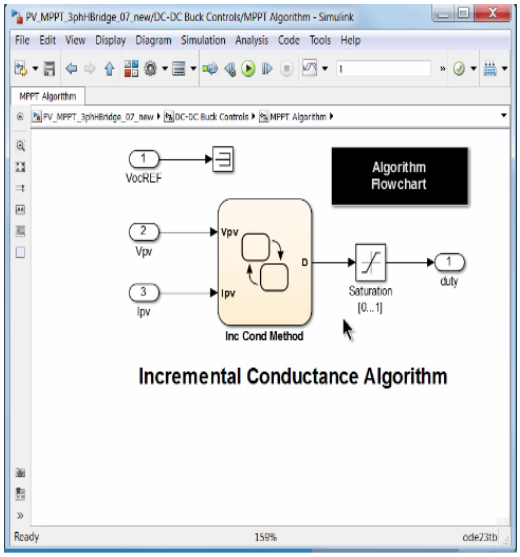


Fig. 3. InC MPPT Algorithm in Matlab

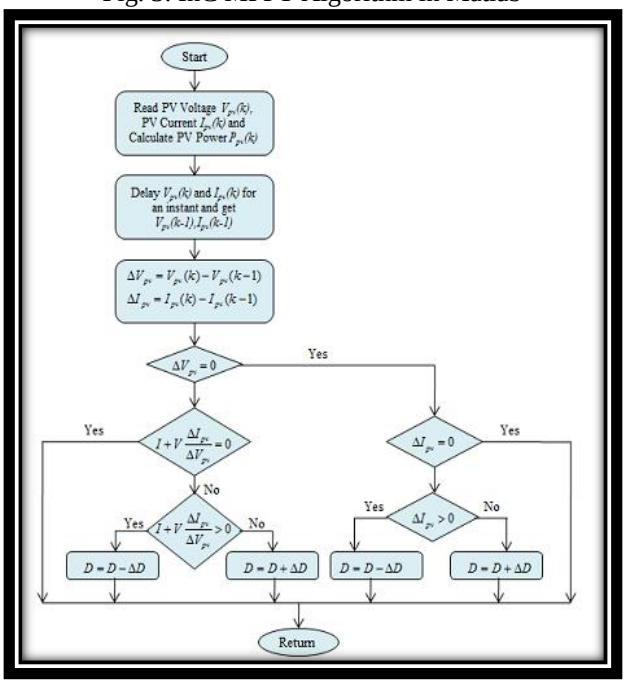


Fig. 4. Flowchart of InC MPPT Algorithm

  

## V. SIMULATION

The subsystem of InC MPPT is shown in Fig. 6.1 The InC MPPT controller with the PWM pulse generator is shown in Fig. 6.2. Fig. 6.3 shows the interconnection of PV Module and the mc. The circuit of 2 phase mc shown in Fig. 6.1 is implemented and it is simplified as a subsystem for illustrative purpose.

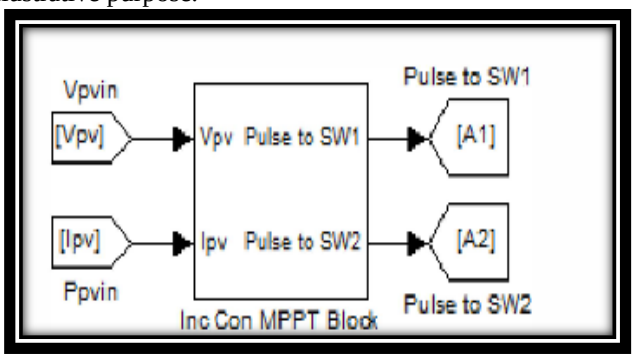


Fig. 6.1 InC MPPT Controller subsystem

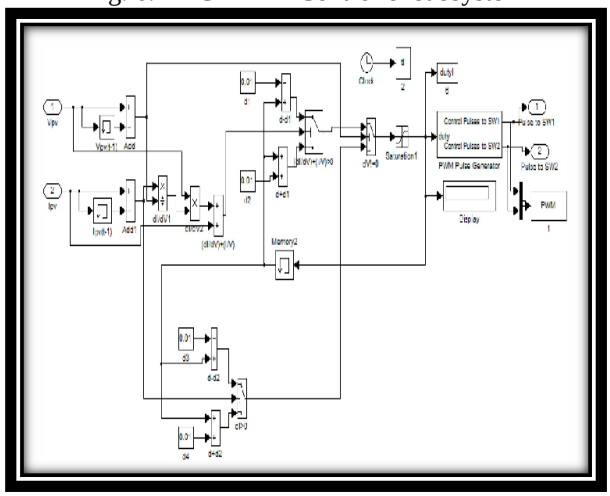

Fig.6.2. InC MPPT Controller with PWM

The model is simulated for various conditions and the results obtained from the simulation are presented and discussed in this section. In case 1, the temperature (Tc) and irradiation level(G) of the PV module are given as $T_c = 40^{\circ}C$, G=800 W/m$^2$ from 0 to 100 msec. Then, in case 2, from 100 ms to 200 ms the values are changed as which is the standard test condition (STC) of PV wherein the output power of the PV would be the rated maximum power given in the data sheet.

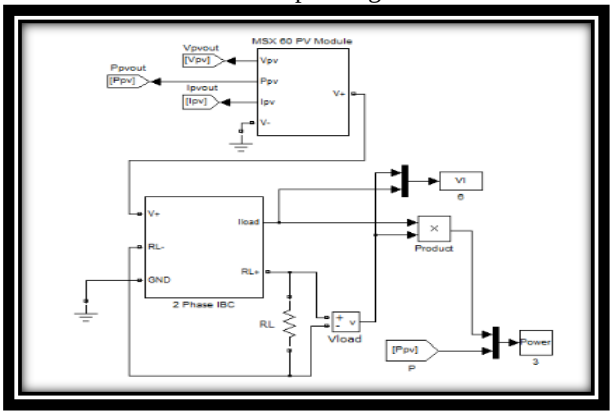


Fig. 6.3 . Subsystem for PV Module and 2 phase IBC

Advance, on the off chance that 3, at 200 msec the qualities are changed to Tc=750C, G=600 W/m2 and proceeds until 300 msec. The scopes of qualities are chosen as offered just to recreate the model under various irradiation and temperature levels. The V-P characteristics and V-I characteristics of Solarex MSX60 PV module for the given conditions are shown in Fig. 6.4 and 6.5

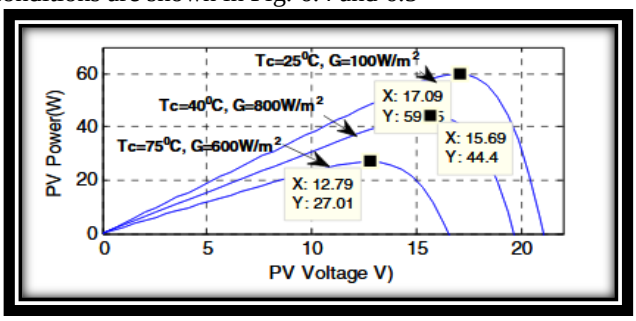


Fig. 6.4 V-P Characteristics of Solarex MSX60 PV

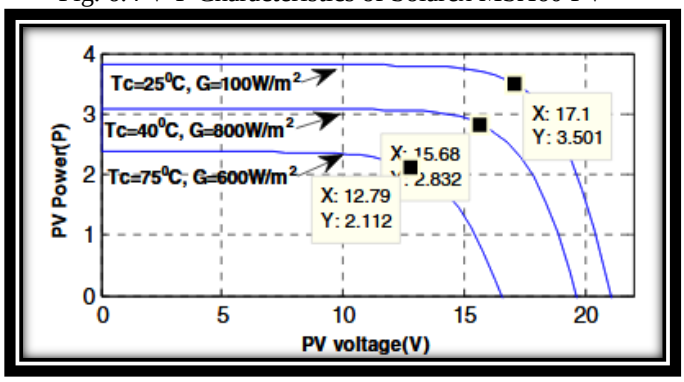


Fig. 6.5 V-I Characteristics of Solarex MSX60 PV

The duty cycle of the converter generated by the InC MPPT block under different conditions is shown in Fig.6.6.

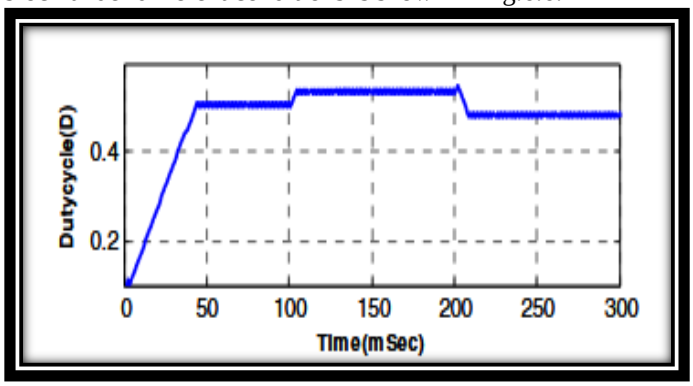


Fig. 6.6 Dutycycle of Two phase IBC under different cases

## VI. CONCLUSION

Reenactment of Incremental Conductance MPPT based Two stage Interleaved Boost converter with PV is exhibited in this diss. The model is recreated for different conditions and the outcomes are gotten. The info current ripple and output voltage ripple of the IBC are close zero at half duty cycle. The converter circuit works at the duty cycle near half for all the chose conditions. The ripple of info current and output voltage are additionally analyzed and discovered less. The general efficiency of the system is around 95%..

  

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