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# Low Voltage Ride Through Using Boost Converter Topology Powered by MPPT Algorithm for Solar PV System

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***Abstract:***
The importance of a step-up converter (boost converter) and the low voltage ride through methodology is discussed. The antiphon of the solar PV system is analyzed through the MATLAB software. The interpretation of the Maximum Power Point Tracking (MPPT) algorithm facilitates the solar PV module to track the Maximum Power Point area and to implement the low voltage ride through methodology using a boost converter. The MPPT algorithm was developed using the Petrub and observation method. The necessary simulation was done through the MATLAB software.

***Keywords****: Renewable Energy, Solar Energy, Low Voltage Ride Through , MPPT, P&O , PV Module, Solar power*

## Introduction:

The availability and utilization of solar energy is most important to the present scenario to overcome the huge environmental pollution through the exhaustion of fossil fuel. The usage of natural renewable energy sources will create an eco-friendly atmosphere. To satisfy the demand for electricity, solar energy may be used to overcome global warming and to relegate the huge environmental pollution due to the exhaust of fossil fuels. The thrust needs of the new, cheaper and sustainable alternative solar energy shall be taken into consideration. [1]. In the future most efficient way of producing the energy will be of through photovoltaic (PV). The availability of solar power is collected and utilized through solar Photo voltaic panel which is associated with the boost converter. The green energy through photovoltaic (PV) provides the visionary of the future with satisfying living environmental conditions. Here, the research focuses on the area of utilization of maximum solar PV power through the Maximum Power Point Tracking methodology associated with boost converter. The low voltage ride through is achieved by functioning the boost converter through MPPT algorithm. So that the maximum production of solar power was extracted from the photovoltaic renewable energy system and the boosted power with required magnitude is injected to the load .The photovoltaic system is powered through MPPT algorithm to frequently regulate Z identified by solar to maintain

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the PV system accomplishing the solar array under fluctuating situations changing irradiance, load and temperature. Therefore to achieve the maximum power the several MPPT techniques are implemented and the solar PV operates at the condition based on MPPT [2]. There are many MPPT algorithms that are there to facilitate the operation of solar PV to trap he maximum power.
Due to the smooth execution and authenticity, perturb and observe (P&O) or hill climbing method is used.

## II. BLOCK DIAGRAM

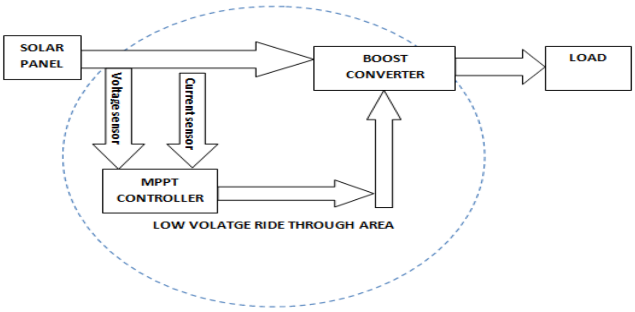


Figure 1 Block Diagram of a Low Voltage Ride Through Methodology

The block diagram shown above is constructed with a Solar PV panel[3], Boost converter, Maximum PowerPoint Tracking (MPPT) controller, Load, current and voltage sensor are channelized to MPPT controller. Its measured values are processed by the MPPT controller and this will facilitate apprehend the MPPT of the solar panel. [4].

## III. MODELLING OF SOLAR PHOTO VOLTAIC

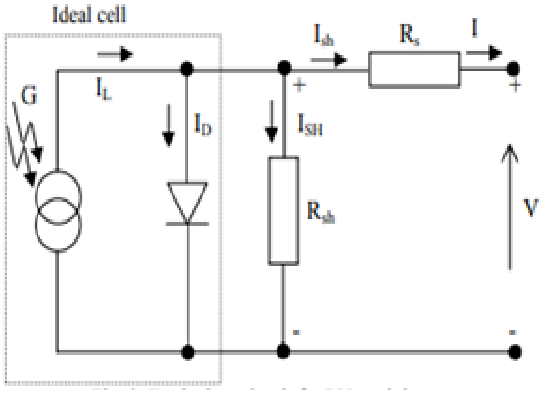


*Figure 2 Modelling of Solar PV*

Based on the following equations (i) , (ii) , (iii), the solar PV modeling process can be done

$$I_D = I_0\left[ e^{\frac{V_c q}{ak T_{ck}}} - 1 \right] \qquad (i)$$

Where,
* $I_D$ = Dark current (A),
* $I_O$ = Diode saturation current (A),
* $V_c$ = Cell Voltage (V)
* q = Electron Charge , equal to $1'.6.10^{-19}$ (Coul).
* a = Ideality constant of diode,
* K = Boltzan's man constant , $1'38 . 10^{-23}$ (j/k),
* $T_{ck}$ = Cell temperature .

The total current of PV Cell, the difference of the photocurrent IL and ID as given in equation
*IL = Current generated by the incident light
*$I_D$ = General diode current

$$I = I_L – I_D \qquad (ii)$$

It is necessary to determine [5]optimal solar cell is designed as a current source connected in anti-parallel with diode as shown in the figure (2).

## IV. BOOST CONVERTER

Below-shown figure (3) is called as Boost converter. The optimal deliver is sequentially higher than the opted input.

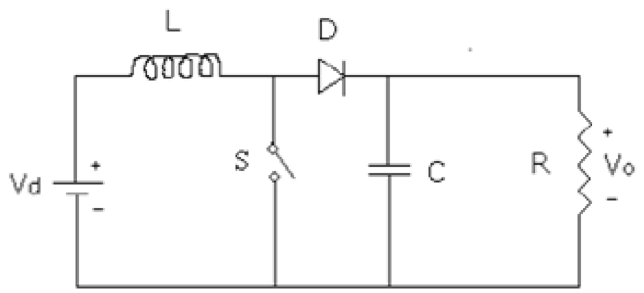


*Figure 3diagram of the step-up converter / Boost converter*

The input DC voltage source of Boost converter is referred as "Vd" which is coming from the solar panel and it consists of switch "s", inductor "L", capacitor "C" and "$R_L$" . Depends upon the requirement of output the switch "S" may be open or closed. [6]. The output voltage changes when the duty cycle "D" changes but the input current are continuous. The inductor value will be greater than the input current of a factor (1-D) and the capacitor filter circuit carries more RMS current.[7].

**1) The maximal switch current can be calculated by**

$$D = \frac{V_{IN(min)} \times \eta}{V_{out}} \qquad \text{(iii)}$$

* $V_{IN(min)}$ = Minimal input
* $V_{OUT}$ = Desired output
* η = Converter Efficiency

**2) To calculate maximal switching current is to find the current.**

$$\Delta I = \frac{V_{IN(min)} \times D}{f_s \times L} \qquad \text{(iv)}$$

* $V_{IN(min)}$ = Minimal input voltage
* fS = Minimum switching frequency
* L = Specified inductor

**3 ) Find $I_{max}$**

$$I_{MAXOUT} = \left[I_{LIM}(min) - \frac{\Delta I_L}{2}\right] \times (1 - D) \qquad \text{(v)}$$

* $I_{LIM(min)}$ = Minimal value of switch current
* $\Delta_{IL}$ = Inductor ripple current

**4) Inductor Selection**

The inductance decreases when current increases.

$$L = \frac{V_{IN} \times (V_{OUT} - V_{IN})}{\Delta I_L \times f_s \times V_{OUT}} \qquad \text{(vi)}$$

During the extended conduction mode of Boost converter, the value of inductance L is

* $L_{min}$ = (1-D) 2 * D * R/2 *f

**5) Output Capacitor Selection**

$$C_{OUT(min)} = \frac{I_{OUT}(max) \times D}{f_s \times \Delta V_{OUT}} \qquad \text{(vii)}$$

* $C_{OUT\ (min)}$ = Minimal output
* $I_{OUT\ (max)}$ = Application of maximum output current

**6) Voltage ripple of minimum value of filter circuit**

* Vr = ΔVo / Vo (viii)

* Cmin = D/ R * f *Vr

## V. PERTURB & OBSERVE TECHNIQUE

To improve the utilization of solar panel and to implement the low voltage ride through developing newer techniques[8] MPPT is used. Using MPPT the extended power is transferred to the load during the uncertainty condition also. By varying D of the boost converter the source Z is matched with respect to the load Z for extracting $P_{max}$ from solar PV. The impedance matching is given by the below-given equation .

Ref = Vin Iin = (1−D 2 )×Vdc Idc = (1 − D 2 )× Rload (ix)

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P&O method is consider for its simple implementation and high reliability. The algorithm is created ed by perturbing (increment/decrement) of voltage. A small improvement in voltage is agreed for PV and observe the consequentialtransform in power. The working point has enthused away from maximum point if ΔP is negative and the perturbation lead towards Pmax point if ΔP is positive. The method oscillates around the peak point when the steady-state is reached. The flow chart of the P&O technique as has been shown in the below Fig. The perturbation size is kept very small because of maintaining the small power variation. It improving the performance of the system[9]

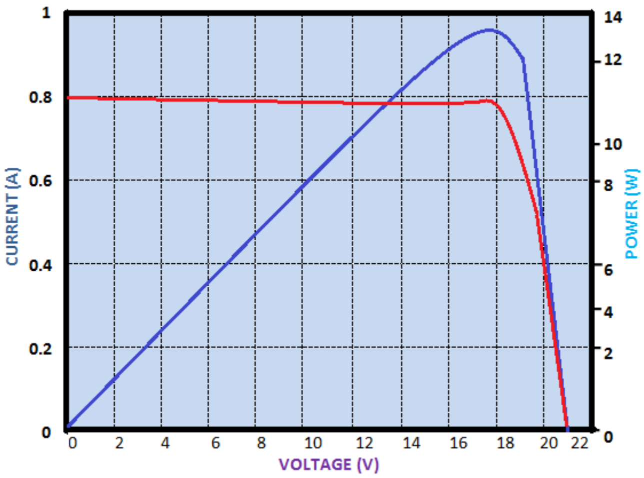


*Figure 4Perturb and Observe Algorithm P-V characteristics*

Figure 4 explains clearly about logic of the P&O algorithm. By applying a small increment (perturbed) ΔV of the operating voltage of PV system this will be resulting in a change of ΔP. If Δp is positive then there will be an increment of conductance.

So, the operating voltage of the perturbation needs to be in similar direction. If the operating voltages move in reverse direction of the incremental conductance the operating point will be negative (Δp) then the MPPT moves away .

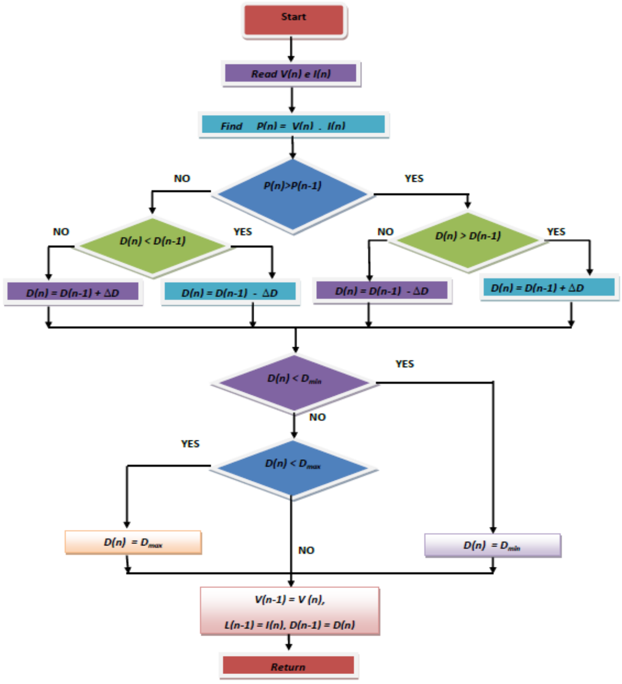


*Figure 5Proposed P&O Algorithm*

## VI. SIMULATION MODEL IN SIMULINK

The simulation model in the Simulink of solar PV is shown in fig 6. Here the PV is divided into two parts Power limited electrical driver and Behavioural PV modeling. The same is proposed and Current source is stable at a constant value of radiation.

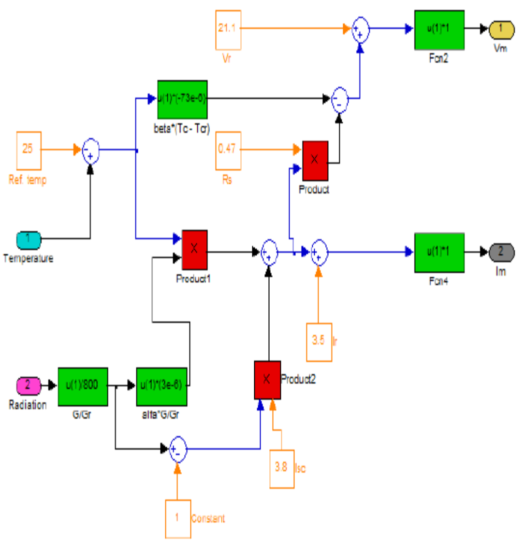


*Figure 6 Behavioral Model of PV*

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Here electrical driver component is utilized to exhibit the V-I
characteristics of the response from the PV panel. The behavioral model values of voltage and current are calculated as stated in fig 7.

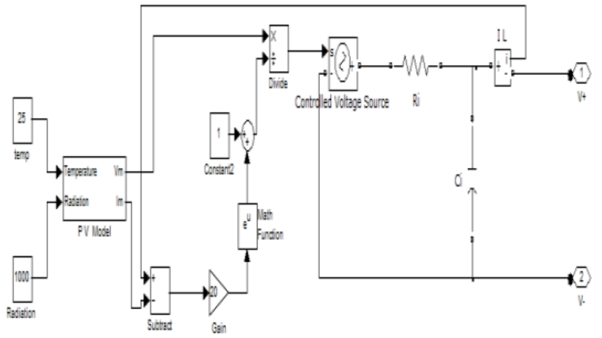


*Figure 7Power limited driver*

Using SIMULINK software the MPPT algorithm is developed as shown in figure 8. Followed to that the proposed work of Low Voltage Ride Through methodology was simulated in the SIMULINK model and should be stated in figure 9 [10].

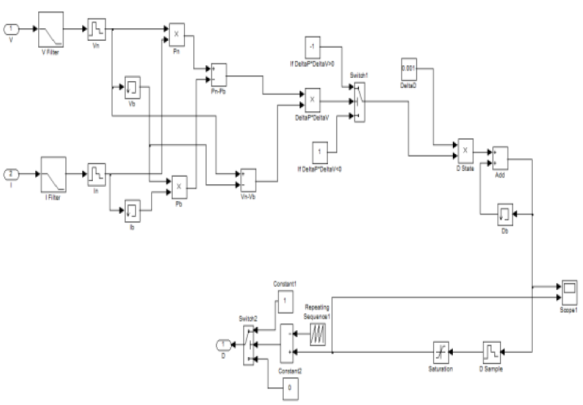

*Figure 8SIMULINK Model of P& O - MPPT Algorithm*

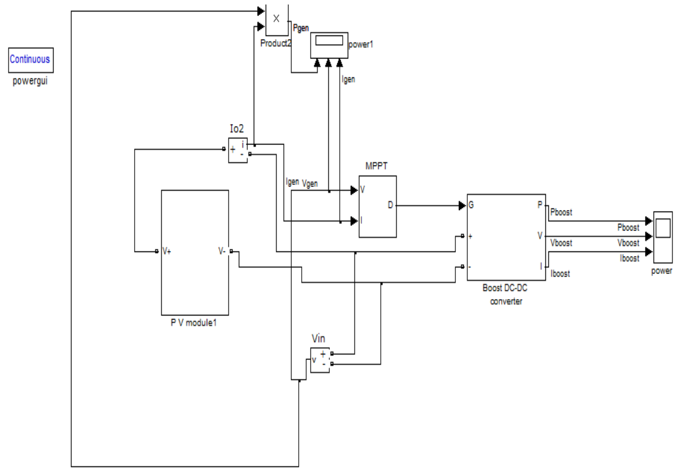


*Figure 9Proposed work SIMULINK model*

similar direction. If the operating voltages move in reverse direction of the incremental conductance the operating point will be negative (Δp) then the MPPT moves away.

## VII. SIMULATION MODEL IN SIMULINK

The obtain waveform as shown below determines the conditions of presence and absence of MPPT block as stated in figure 10 and figure 11. During the absence of MPPT block and Boost converter, solar irradiance level varies the response of solar PV panel and output power varies at the normal operating condition. It is clearly defined that during the irradiance condition of sun, after by including the MPPT and Step-up converter the output power stable at the maximum power point area .

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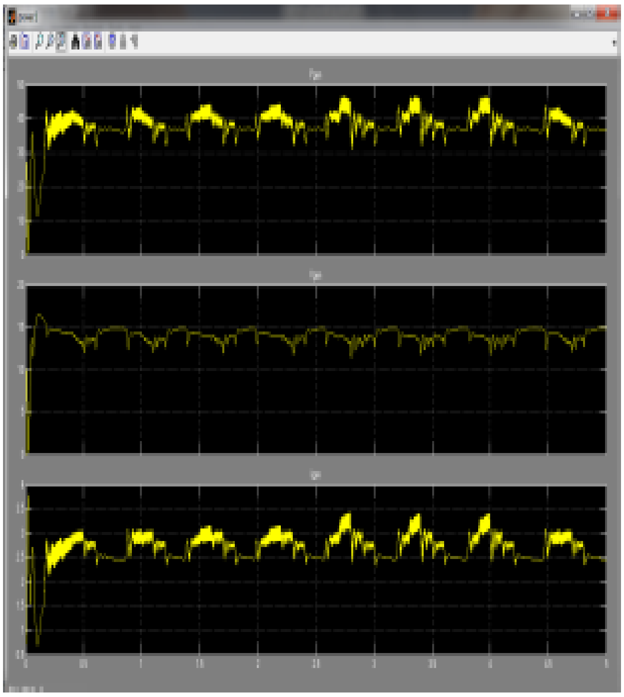

*Figure 10Simulation results of without MPPT block*

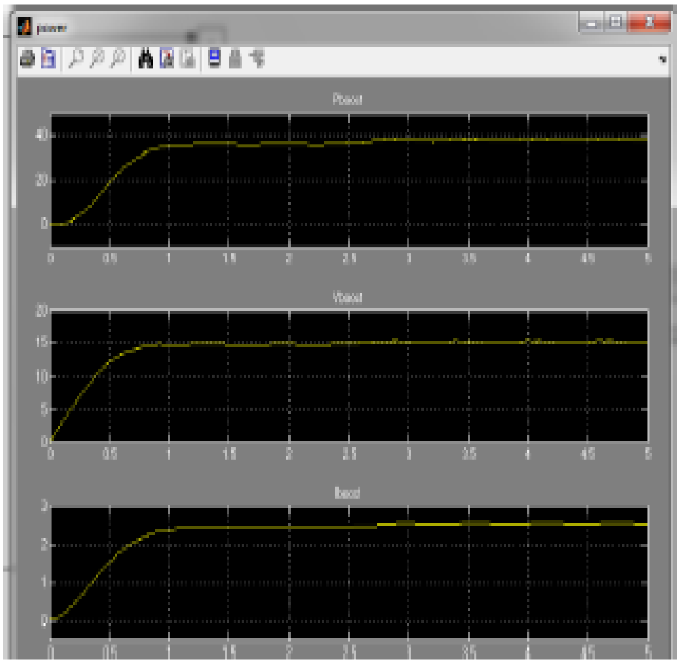

Figure 11Simulation results of with MPPT block

## CONCLUSION

The Low Voltage Ride Through methodology was defined to achieve the Maximum Power Point Tracking through the solar Photovoltaic array. Here boost converter plays a decisive role to emerge the output personality of Solar PV panel. The peak point trapping is done with the help of the MPPT algorithm and the necessary gate signal is applied to energize the boost converter . The PV behavioral model was simulated and the necessary simulation was done with and without MPPT block. The response was obtained from simulation and it was found as satisfactory. It was observed that by implementing MPPT block the solar PV panel was efficiently used by achieving the low voltage ride through methodology.

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