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# Simulation Of Photovoltaic Cell With Push Pull Buck DC-DC Converter

Patel Jaydeep Khanbubhai Patel Pratik b
*Electrical Engineering.MGITER Navsari,*
*Electrical Engineering.MGITER Navsari,*

***Abstract***— *Renewable energy sources have become a popular alternative electrical energy source where power generation in conventional ways is not practical. In the last few years the photovoltaic and wind power generation have been increased significantly. The paper proposes a method of modeling and simulation of Solar Photovoltaic (SPV) arrays, interface between two dissimilar toolboxes in MATLAB and different control schemes for the converter control. This paper also shows the simulation of the SPV . The main obj ective is to find the non-linear I-V equation by obtaining the curve at three points, open circuit, maximum power and short circuit. The method finds the I-V equation for the single diode photovoltaic model including the effect of the series and parallel resistances. Simulation of the standalone system has been carried out using DC-DC converters full bridge push pull converter topology.*

***Keywords***- *Voltage Source Converters, Solar Photovoltaic Arrays, DC-DC Converters, Maximum power point tracking. Current source converter*

## I. INTRODUCTION

Due to the critical condition of industrial fuels which include oil, gas and others, the development of renewable energy sources is continuously improving. This is the reason why renewable energy sources have become more important these days. Few other reasons include advantages like abundant availability in nature, eco-friendly and recyclable. Many renewable energy sources like solar, wind, hydel and tidal are there. Among these renewable sources solar energy are the world's fastest growing energy resources. With no emission of pollutants, energy conversion is done through PV cells.
In this thesis, a photovoltaic generation system model is studied and simulated. When any one of the system is shutdown the other can supply power.

A 7.2kW solar array has been built in MATLAB using Simscape toolbox. The I-V curves are generated for variations cell temperatures and solar irradiance level. The output of the SPY is then fed to the DC-DC converter. As the voltage generated by the SPY is more, buck topology is used for the converter. The converter has been designed in methodologies, Push pull full bridge. For modeling the SPY MATLAB/Simscape has been used and in order to model the converter-inverter part MATLAB/Sim Power Systems toolbox have been used. This paper also presents the interface between these two toolboxes which makes the task easier for analysis and for the simulation environment.

## II. METHOD

The PV model has been developed as per the requirement. The variations in isolation and cell temperature are considered in simulation. Modeling of the converter has been done by considering the voltage and current ripples. The output of the converter is designed to obtain a constant 380V DC output. The solar photovoltaic system which has been designed in MATLAB/Simscape toolbox. The output of the SPY is the input to DC-DC Converter. In this paper DC-DC converter models are used for the buck mode of applications, Push-Pull Full Bridge converters. The design methodology has been done as per the theoretical calculations. The needs for these converters are analyzed and the brief study has been carried out in choosing the converter topologies.

## III. MODELING OF PV CELL

The photovoltaic system converts sunlight directly to electricity without having any disastrous effect on our environment. The basic segment of PV array is PV cell, which is just a simple p-n junction device. The manifests the equivalent circuit of PV cell. Equivalent circuit has a current source (photocurrent), a diode parallel to it, a resistor in series describing an internal resistance to the flow of current and a shunt resistance which expresses a leakage current. The current supplied to the load can be given as.

$$I = I_{PV} - I_O\left[exp\left(\frac{V+IR_s}{aV_T}\right) - 1\right]\text{-}\left(\frac{V+IR_S}{R_P}\right)$$

Where,
$I_{PV}$-Photocurrent current,
$I_O$-diode's Reverse saturation current,
V-Voltage across the diode,
α-Ideality factor

$V_T$-Thermal voltage
$R_S$-Series resistance
$R_P$-Shunt resistance

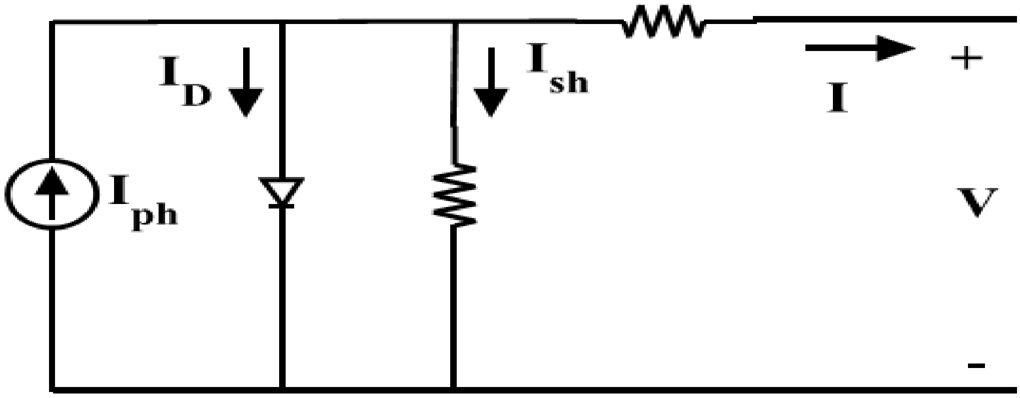


***Fig. 1. Equivalent circuit of Single diode modal of a solar cell***

PV cell photocurrent, which depends on the radiation and temperature, can be expressed as.

$$I_{PV} = \left(I_{PV\_STC} + K_I\ \Delta T\right)\frac{G}{G_{STC}}$$

Where,
$K_I$-cell's short circuit current temperature coefficient
G-solar irradiation in W/m2
$G_{STC}$-nominal solar irradiation in W/m2
$I_{PV\_STC}$-Light generated current under standard test condition
The reverse saturation current varies as a cubic function of temperature, which is represented as

$$I_o = I_{o\_STC}\left(\frac{T_{STC}}{T}\right) exp\left[\frac{qE_g}{aK}\left(\frac{1}{T_{STC}} - \frac{1}{T}\right)\right]$$

Where,
$I_{o\_STC}$-Nominal saturation current
$E_g$-Energy band gap of semiconductor
$T_{STC}$-temperature at standard test condition
q-charge of electrons
The reverse saturation current can be further improved as a function of temperature as follows

$$I_o = \frac{I_{SC\_STC} + K_I \Delta T}{exp\left[\left(\frac{V_{OC\_STC} + K_v \Delta T}{a V_T}\right)\right] - 1}$$

Where ,
$I_{SC\_STC}$-short circuit current at standard test condition
$V_{OC\_STC}$-short circuit voltage at standard test condition
$K_V$-temperature coefficient of open circuit voltage

Efficiency of a PV cell does not depend on the variation in the shunt resistance Rp of the cell but efficiency of a PV cell greatly depends on the variation in series resistance Rs .
As Rp of the cell is inversely proportional to the shunt leakage current to ground so it can be assumed to be very large value for a very small leakage current to ground. As the total power generated by a single PV cell is very low, we used a combination of PV cells to fulfill our desired requirement. This grid of PV cells is knows as PV array. The equations of the PV array can be represented as.

$$I = I_{PV}N_P - I_O N_P\left[exp\left(\frac{V + IR_S\left(\frac{N_S}{N_P}\right)}{aV_T N_S}\right) - 1\right]$$

Where,
$N_S$-Number of series cells
$N_P$-Number of parallel cells
The two key parameters which are used to relate the electrical performance are the open-circuit voltage of the cell VOC and short-circuit current of the cell Isc.

The maximum power can be stated as

$$P_{max} = V_{max} I_{max}$$

## IV. SIMULATION AND RESULT

The simulation results are analyzed at different instances. The I-Y curves of the SPY are furnished in where we can observe the solar irradiance level at 1000wb/m$^2$ and the cell temperature at 50$^0$ c.

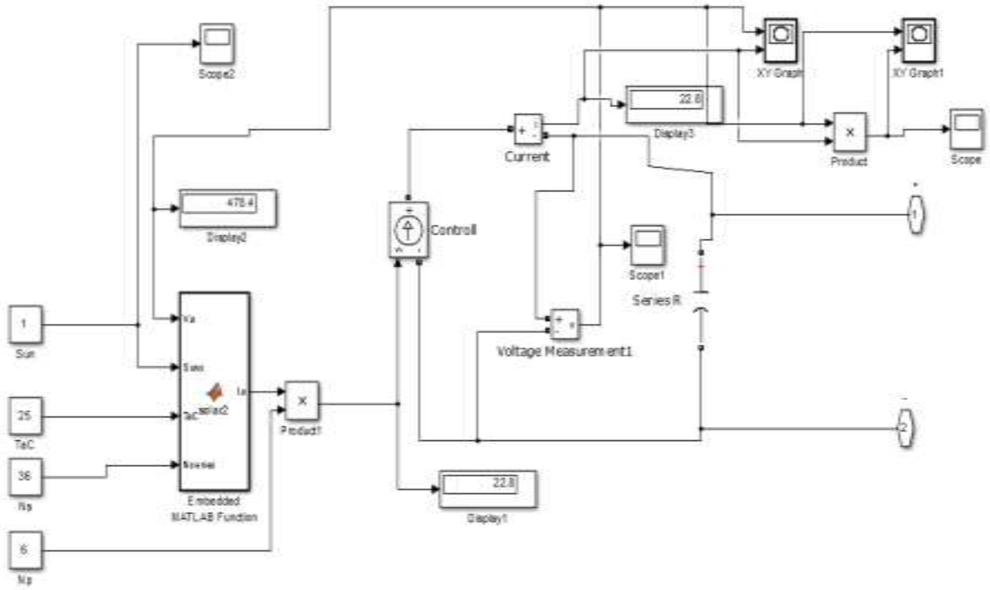


*Fig 2.Simulation Model of PV cell at 25$^0$ c and 1000wb/m$^2$*

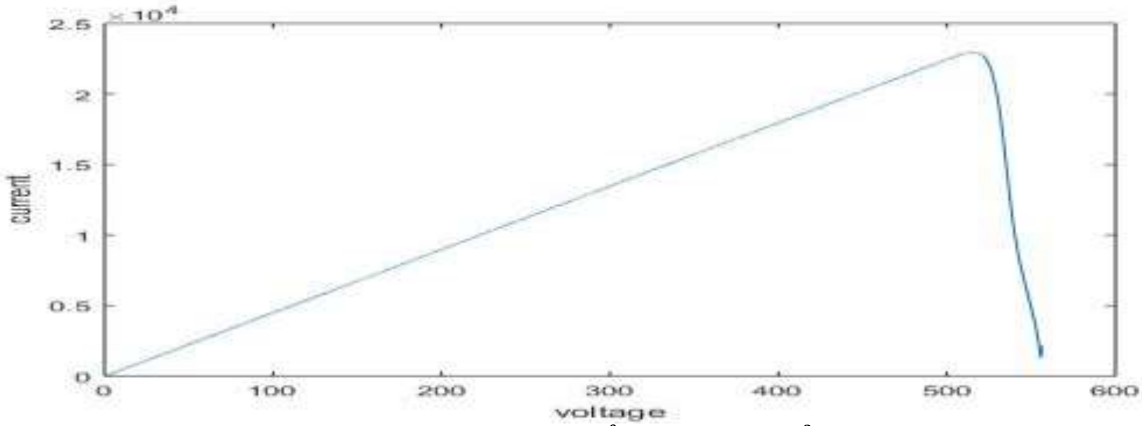


*Fig 3. P-V Curve at 25$^0$ c and 1000wb/m$^2$*

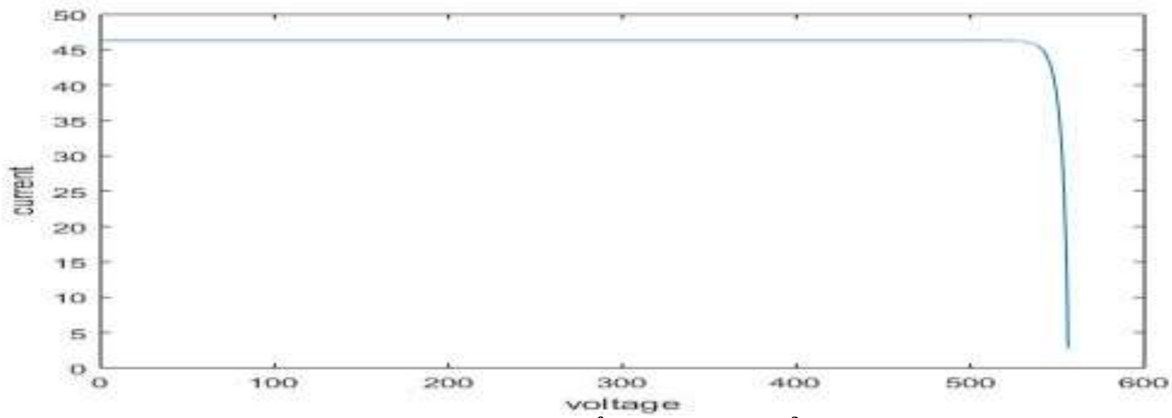


*Fig 4. I-V Curve at 25$^0$ c and 1000wb/m$^2$*

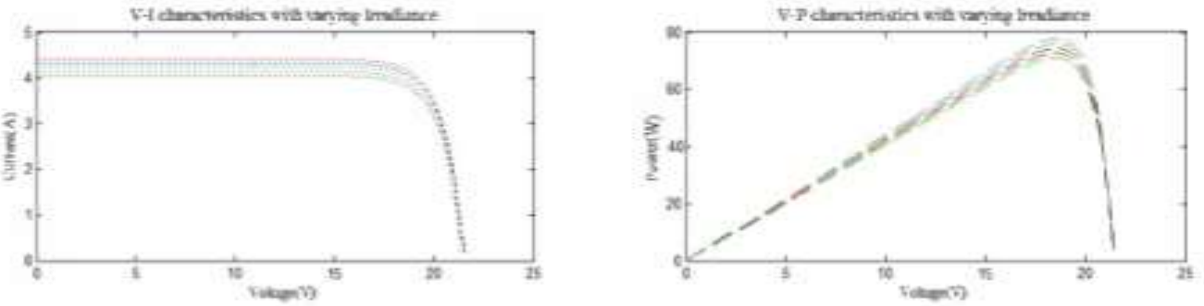


*Fig 5. P-V and I-V curve at varing solar irradiance level*

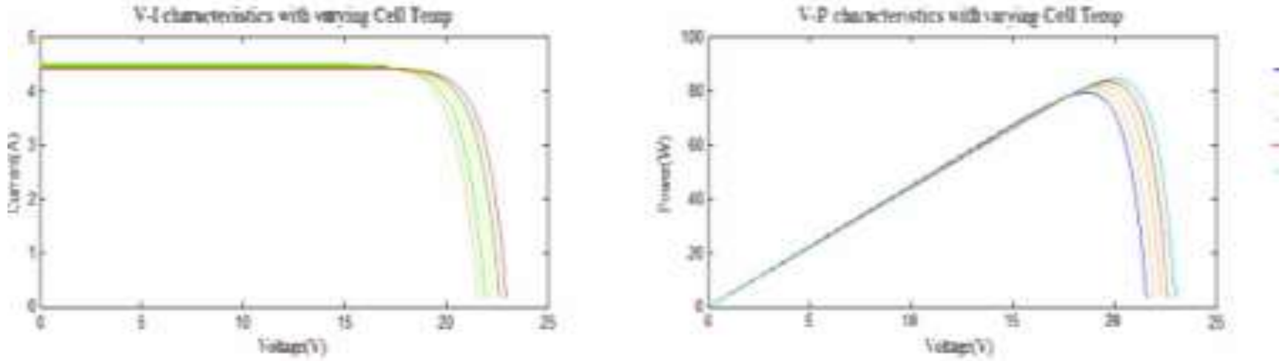


*Fig 6. P-V and I-V curve at different tempter*

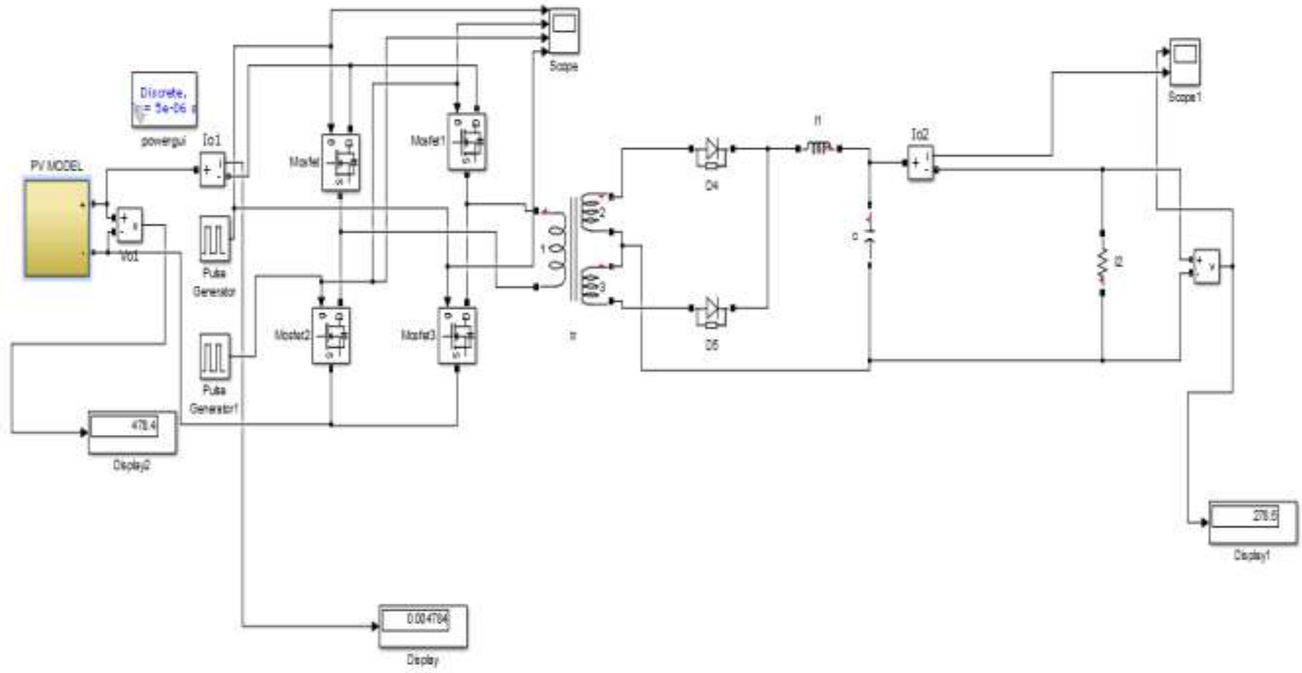


*Fig 7. Simulation Model PV cell with push pull DC-DC converter*

A.Open Loop Push Pull DC-DC Converter Output Voltage and Current in MATLAB:

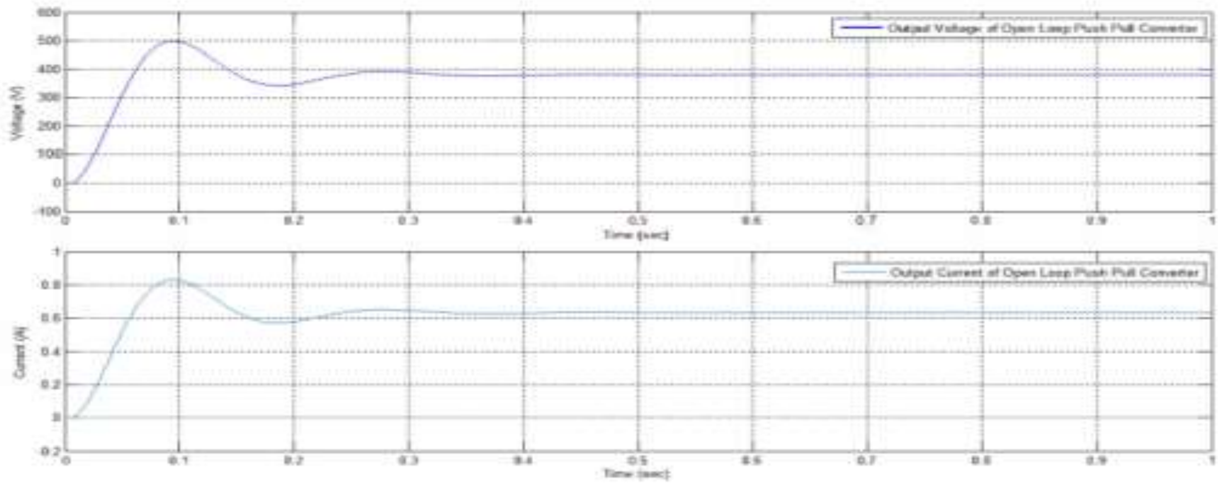


***Fig 8. Output Voltage and Current of Push Pull DC-DC converter***

Open loop voltage and current see in fig 8 voltage and current also see the settling time, percentage peak overshootand the damping of the system.

## V. CONCLUSION

PV cell, module and array are simulated and effect of environmental conditions on their characteristics is studied. Finally the Solar Photovoltaic System simulation in MATLAB with DC-DC converter topologies are shown in this the paper.

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