

## Design Of Dc -Dc Boost Converter for PV System

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**Abstract** - Out of all types of energies electrical energy has high demand universally. So, technologies are developed to convert other forms of energy into electrical energy. Depletion in fossil fuels forces the world to derive energy from renewable energy sources like solar, wind, biomass, etc., .out of all renewable energy sources solar energy has more advantages. As long as the sun is present, we can derive electrical energy. So, PV technologies are developed to convert solar energy directly into electrical energy. A PV system converts solar energy directly into electrical energy and various components of the solar system are PV system, DC-DC converter, Maximum power point technique controllers. In PV systems generated voltage is at a very low level. To enhance this low voltage level to required voltage level boost converters are introduces in PV systems.in addition to boost up the generated voltage level to required level, boost converters can also be used in a tracking maximum power along with MPPT technique. NOT all boost converter work for all systems .so for constructing a PV system we have to design a suitable boost converter .in the present work we studied design aspects of dc-dc boost converter, and we designed dc-dc boost converter for a PV system.

**Key Words:** Photovoltaic system Photovoltaic cell modelling Design DC-DC boost Converter

### 1.INTRODUCTION

These days, using renewable energy sources helps lessen pollution in the environment and green house impact in particular. It is evident that installed power has grown quickly, particularly to keep up with the raising demand for energy. In the global energy pool, biogas production systems are among the most significant clean and renewable energy sources, along with solar and wind power producing facilities. Because photovoltaic systems have the potential to produce electricity, they are clean, renewable energy sources with many benefits. Additionally, because they do not affect the environment or living things, their use is growing daily. They are also modular and offer the option to feed any extra energy generated back into the grid. These factors have also led to a rise in photovoltaic system research, analysis, and experimentation. For solar systems to be used correctly and efficiently, the energy produced must be optimized through the use of power electronics conversion circuits. The purpose of the DC-DC

converters in this instance is to enhance efficiency of the electricity produced by RES. Low voltage level is provided by fuel cells and photovoltaic cells in comparison to what the inverter stage needs for input. Here are a few of the most popular circuits for DC-DC converters. These are minimal input/output current fluctuation, high efficiency, and high voltage gain. Adopting such topologies enables decreased size and cheap cost for the converters to be used in the installation. The installation of photovoltaic systems, their cost and efficiency, the impact of sunlight and ambient temperature on the cells, the features of a building that must be connected to a network-connected photovoltaic system, connection topologies, the annual energy amount of the system connected to the grid, the computation of the annual performance ratio, and topics like inverters were all covered in the studies design, modeling of solar cells, and maximum efficiency.

### 2.Photovoltaic systems

A solar power generation system is made up of several parts, including assemblies, mechanical parts, electrical connections, and photovoltaic cells. They can supply AC loads connected to the system via an inverter or DC loads with a converter used to control output.

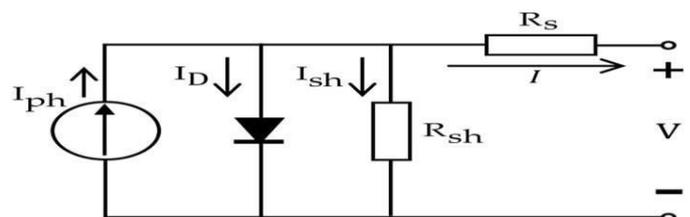


Fig 1. Equivalent circuit diagram of PV cell

- I: PV cell output current (A)
- $I_p$ : function of light level and P-N joint temperature photoelectric(A)
- $I_o$ : inverted saturation current of diode D(A)
- V: V cell output voltage (V)
- $R_s$ : The analogous circuit's series resistance (Ohm)
- $R_{sh}$ : The analogous circuit's parallel resistance (Ohm)
- $e$  = Electron constant ( $1.6021917 \times 10^{-9}$  C)
- k: Boltzmann constant ( $1380622 \times 10^{-23}$  J/°K)
- T: Reference operating temperature (° K)

The mathematical representation of the circuit model shown in the diagram is provided by Equation 1. The  $I_D$  current is an internal current that flows through the P-junction of the

semiconductor materials that make up a photovoltaic battery. It is dependent on the terminal voltage and the current drawn by the load to alter the battery's absolute temperature. This current is expressed in Equation 2.

$$I = I_L - I_0 \left[ \exp\left(\frac{e}{A.k.T_{bat}}(v + R_s x I)\right) \right] \quad (1)$$

$$I_D = I_0 \left[ \exp\left(\frac{e}{A.k.T_{bat}}(v + R_s x I)\right) \right] \quad (2)$$

### 2.1 Characteristic Current-Voltage Curve of PV Cell

The elimination of the  $I_L$  current, which is generated under radiation from the cell's current-voltage curve in the dark, can be understood as the current-voltage characteristic of the radiation under irradiation. The power that can be extracted from the photovoltaic diode can be computed using these curves. The maximum power point (MPP), the filling factor (FF), the open-circuit voltage (V), and the short circuit current (ISC) all contribute to the explanation of the solar cell's performance. The homogeneity of the current characteristic is measured by FF. A solar cell's current characteristics are depicted in Figure 2.

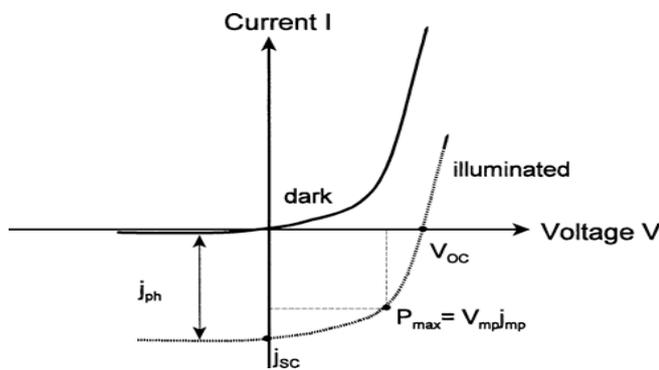


Fig.2. Current-Voltage characteristics of solar cell.

The maximum power point is the location on the curve shown in Figure 2 where a solar cell's output reaches its maximum value. This is the point on the current-voltage curve where the maximum value is given by the operating voltage  $V = V_{mp}$  and the operating current

$I = I_{mp}$  corresponding to this voltage. To calculate power, the following computations should be performed in addition to equation 1 and 2. Factor of filling (FF): It is defined as the ratio of  $V_{mp} \times I_{mp}$  to  $V_{oc} \times I_{sc}$  in the current under radiation. In the area where voltages are positive and currents are negative, this computation represents the greatest  $V_{mp} \times I_{mp}$  value.

$$FF = \frac{P_m}{V_{oc} \times I_{oc}} = \frac{V_{mP} \times I_{mP}}{V_{oc} \times I_{oc}} \quad (3)$$

Thus, these variables can be used to express the solar cell's output power.

$$P_m = V_{mp} \times I_{mp} = FF \times (V_{oc} \times I_{oc}) \quad (4)$$

The efficiency of a solar cell can be calculated  $\eta$  as in the following equation

$$\eta = V_{oc} \times I_{sc} \times FF \quad (5)$$

### 3. DC-DC BOOST CONVERTER

By raising the proper voltage at the converter's input, a boost converter raises the output voltage. to a higher voltage level. Fig3 displays a basic circuit diagram. The semiconductor switch is made up of capacity elements and diodes, as seen in Figure 3. The source voltage completes the circuit. through the switch when it is sent. The diode is polarity-reversed, some energy is stored on the casing, and the load of the output feeds into the capacitor. The capacitor is drawing a lot of current.

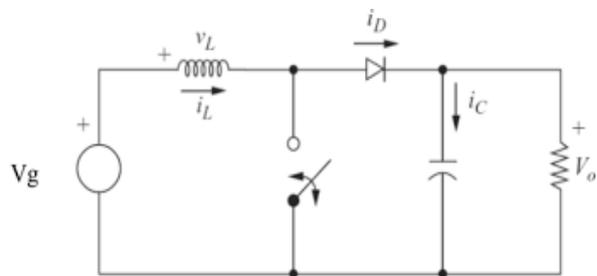


Fig 3. Basic boost converter circuit diagram

The charging current flowing through the inductor and through the diode toward the condenser and the load begins as soon as the switch is turned off. The inductor releases its energy, and the diode connects it to the load. The polarity of the voltage on the inductor is the same as the polarity of the voltage source. The result is a higher output voltage. As seen in Figure 4, the circuit is split into two sections and the diode is connected to the cut off in this manner. When the RC circuit's time constant is significantly larger than the switching period, the output voltage stays constant.

#### 3.1 current passing through the inductor while the switch is in transmission.

When the switch is in transmission, the equivalent circuit is as shown in Figure 4. The source  $V_s$ 's Value based on L and I.

$$V_s(t) = L \frac{di_L}{dt} \quad (6)$$

. The inductor current will rise at a steady pace if the voltage source remains constant. Thus, there is no saturation of the inductor.

$$\frac{\Delta I_L}{\Delta t} = \frac{V_s}{L} \tag{7}$$

Over the DT range, the switch continues to be in transmission. The DT range can be shown as Δt switch is in the transmission state, the net increase in the inductor current is as follows.

$$\Delta I_L = \frac{V_s}{L} (DT) \tag{8}$$

### 3.2 current passing through the inductor while the switch is in the cut off.

The analogous circuit is shown in Figure 5 when the switch is in the cut off position. In this instance, the inductor's voltage

$$V_L = V_s - V_o \tag{9}$$

In case of  $V_o > V_s$ , the voltage on the inductor and the direction of the flowing current are negative.

$$\frac{di_L}{dt} = \frac{V_s - V_o}{L} \tag{10}$$

The interval value when the switch is turned off is (1-D) T. In this instance, the inductor's current

$$\Delta I_L = \frac{V_s - V_o}{L} (1 - D) \tag{11}$$

In a single period, the net change in current is zero. Thus,

$$\frac{V_s}{L} DT + \Delta I_L = 0 \tag{12}$$

Simplifying the equation when the net change in current over a period of time is zero yields. The output voltage.

$$V_o = \frac{V_s}{1 - D} \tag{13}$$

From  $0 < D < 1$ , the D value is changed. Consequently, the output voltage exceeds the input voltage. The amplifier type converter is the name given to this circuit.

### 3.3 DC / DC Boost Converter Modelling and Simulation

In below Figure boost converter, which is made up of an inductor, diode, mosfet, pulse generator, resistor, and capacitor, it is used at the DC/AC inverter input at the module output to raise. The DC voltage at the output of the photovoltaic module in the grid-connected photovoltaic system simulation. The time-dependent variation curve of the DC signal at the boost converter output obtained. in the MATLAB/Simulink simulation, i.e. the inv shown in Figure 5. The voltage at the

output of the photovoltaic module is 22.83V, which is increased to 220.6 V using a boost converter.

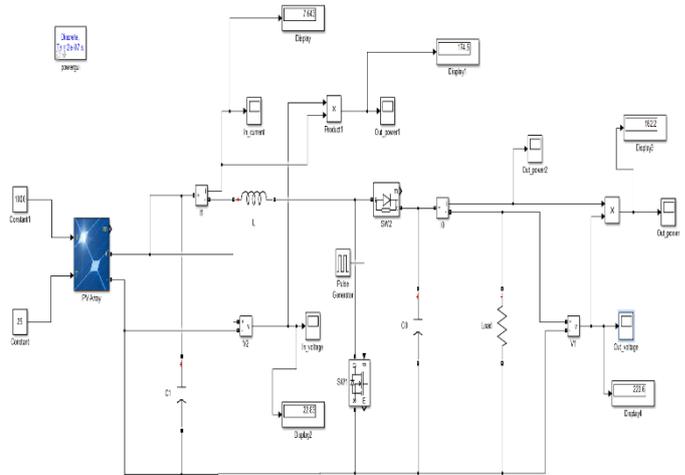


Fig 4. Simulated model

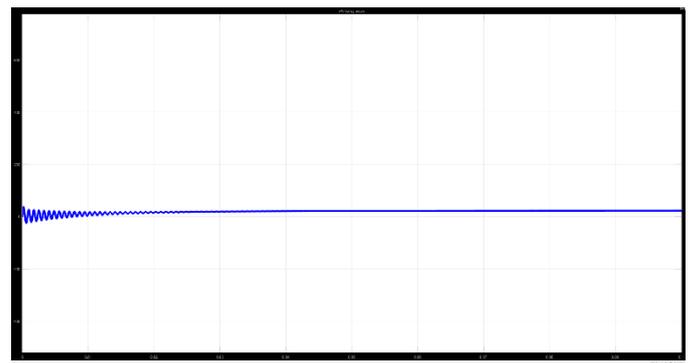


Fig 5. Time dependent variation of DC voltage at the input of the PV panel.

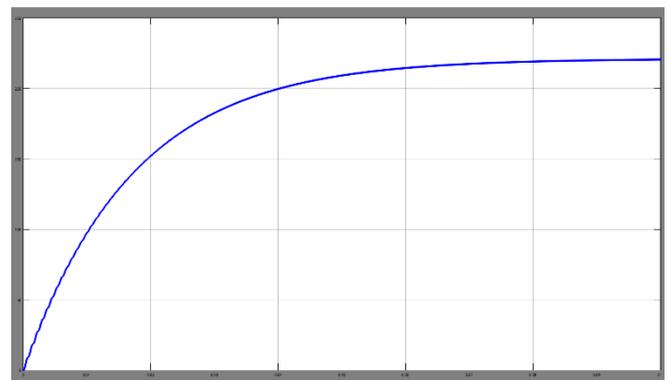


Fig 6. Time dependent variation of DC voltage at the output of the Boost converter.

The boost converter circuit's component values, the values of the selected inductor and capacitor, the value of the chosen capacitor, and the value of the chosen inductor are all explained

in detail below. Additionally, Figure 8 displays the value of the current at the boost converter's output, and Figure 6 displays the time-dependent variation of DC voltage at the sensor's input.

### 3.3.1 Determination of inductor in DC/DC Boost Converter

Equation 16 determines the inductor's value. This equation is derived from the equation 14 and 15, which compute the average inductor current and the current flowing through the load, respectively.

$$I_{ort} = \frac{D \cdot V_{input}}{2Lf} + I_{min} \tag{14}$$

$$I_o = \frac{D \cdot (1-D) \cdot V_{input}}{2Lf} + (1 - D) \cdot I_{min} \tag{15}$$

The minimum L value for  $I_{min} = 0$  in equation 15, which computes the over current, is determined as follows.

$$I_o = \frac{D \cdot (1-D) \cdot V_{input}}{2 \cdot f \cdot V_o} \tag{16}$$

In the simulation, the used inductor value is  $607.696 \cdot 10^{-6}H$ . The values of the parameters used in the simulation are given in table 1.

System parameters	Parameters Value
Output voltage (Vo)	220.6
Input voltage (Input )	22.83
Switching period(T)	0.00001
High voltage residence time(D)	0.9088
Load Resistance(R)	300
Load current (Io)	0.7354

**Table 1.** Values of parameters used in the simulation

### 3.3.2 Capacitor Selection in DC / DC Boost Converter

Equation 21 is the formula used to determine the minimum capacitor (C min) value. The formula for the minimal capacitor was derived using equations 19 and 20. Equation 17 and 18 provide the formula used to calculate the frequency of the higher voltage (Duty cycle).

$$D = 1 - \left(\frac{V_i}{V_o}\right) \tag{17}$$

$$T_a = T_i - T_k = 1/f \tag{18}$$

As seen in fig, the output voltage is also the capacitors voltage, which varies. The AQ load areas above and below the average diode current are equivalent in fig Equation 21 provides. Calculation of the capacitor va

$$\Delta Q = T_i - I_c = D \cdot T_a \cdot I_c \tag{19}$$

$$\Delta V_o = \frac{1}{c} (iDiyot - I_c)dt = \frac{\Delta Q}{c} = \frac{D \cdot T_a \cdot I_c}{c} = \frac{DT_a V_o}{Ry \cdot c} \tag{20}$$

$$C_{min} = \frac{D \cdot V_o}{Ry \Delta V_o \cdot fs} \tag{21}$$

In the simulation, a capacitor of  $60.5861 \cdot 10^{-6}$

### 3.3.3 Modelling and simulation of pulse generator

The boost converter's mosfet switch is provide by the pulse generator, which also periodically generates square waves. The pulse generator's parameters and their respective values are displayed below.

Pulse Type: Time Axis

Pulse Time: Simulated Time

Amplitude:1

Period:1/100000

Pulse Width:90

Phase Delay:0

and the settings were used to run the simulation.

## 4.CONCLUSION

In conclusion, careful consideration of a number of criteria is necessary to ensure optimal performance and efficiency when constructing a DC-DC boost converter for a photovoltaic (PV) system. The main procedures involve figuring out what the system needs, picking the best converter architecture, deciding on parts such switches, inductors, diodes, and capacitors, and building control circuitry for regulation. Verifying the design and maximizing efficiency require simulation and testing. These procedures can be used to effectively collect solar energy and power different loads in a photovoltaic system using a well-designed boost converter. A boost converter raises the voltage from the photovoltaic module's 20-volt output to 220 volts.

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