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# A study on DC to DC converters in solar PV system

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**Abstract**
The solar energy is one of the renewable energy source that is utilized to meet the electricity demand. The major DC to DC converters namely buck, boost, buck-boost, SEPIC, Zeta and Cuk converters are utilized in SPV power generation. Boost converters are used to boost up the voltages. Initially we gave the dc supply. To boost that low voltage to high voltage we are using boost converters. The SEPIC and CUK converters have input current continuous and helps in getting accurate maximum power point tracking of solar cell. The Zeta converter is capable of operating in both Boost and Buck converters. The Zeta converter is cascaded between the Solar Photovoltaic panel and Load. In this paper, we described about the operation of DC to DC converters that are used in solar photovoltaic (SPV) power generation.

**Keywords:** DC chopper, DC to DC converters, buck boost converters

## 1. Introduction

Now a day's world is moving towards the usage of the renewable energy. So to reduce the environmental pollution the electrical system is using photo voltaic cells. Because photo voltaic reduces the environmental impacts such as greenhouse effect and air pollution. The main purpose of renewable energy is to meet the electrical demand in the present generation. In the renewable energy the main source of that is solar energy. Now in the present paper we will discuss about the Working of different DC- DC Converters used in Solar PV system [1].
Here we will discuss about some DC to DC converters.
Boost Converter is used to rise the voltage and Buck converter is used to decrease the voltage. The combination of Buck and Boost converter is Cuk converter. Sepic converter is the reverse of Cuk converter. These Converters are used to keep the continuous constant output voltage of PV panel as in any weather conditions. In DC- DC Converters we are getting a constant output voltage but we are giving a variable input voltage. To meet the demands of electricity by using Solar PV system we are using converters for getting output voltage. In the DC-DC converters the main important factor is duty cycle. For getting Maximum Power Point tracking (MPPT) duty cycle plays important role converters.
The basic block diagram of Solar PV System is shown in the fig 1. Here the major components are Solar panel, dc to dc converter with MPPT, battery-operated, 1- phase inverter with SPWM and transformer, load. DC-DC converters are used as a cascade of Buck converter and Boost converter. Depend on the ratio of duty cycle we are classifying the converters. When duty cycle ratio is more than 0.5 then it operates as Boost converter and when duty cycle ratio is less than 0.5. Then it operates as Buck converter. When ac voltage is greater than the input dc voltage then the chopper will generate output ac waveform. The polarity to the output voltage is given by the inverter at the line frequency which gives the sinusoidal output voltage [6]. In this paper our main focus is on DC to DC converters. Working of DC - DC converters and operation of each converter and compare the all converters.

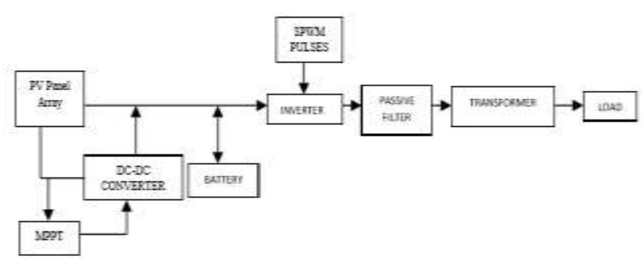


**Fig 1:** Basic block diagram of Solar PV system [6]

## 2. Converter Topology

### 2.1 Buck Converter

Buck Converter is used to step down the voltages. The Basic operation is reducing the output voltage suitable to load. In this converter input voltage is always greater than the output voltage. In the below Fig. 2, Initially when switch is open the current flows through circuit is zero. When switch is closed the current will start to increase. And inductor will yield an opposite voltage across it's terminals due to change in current. If switch is opened still current will change and there will always voltage drop in the inductor. Here in Buck Converter the first we are placing switch and we are placing filter cascade to it. It is basically a Voltage to Current Converter. Here we are giving Pulsed input current. We are getting a continuous output current and due to this continuous output current we can lower output voltage ripples. The output voltage Buck Converter is $v_o = Dv_{in}$ [4].

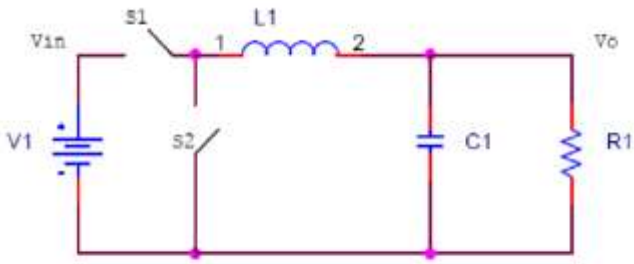


**Fig 2:** Schematic circuit diagram of a Buck Converter [4]

### 2.2 Boost Converter

In the Boost Converter the input voltage is less than the output voltage. So it is called step-up converter also known as voltage - current converter. Boost converters are used for grid integrated connection of low voltage DC sources such as photo voltaic and fuel cells [3]. In the boost Converter the $R_{in}$ value varies from $R_0$ to 0 and duty cycle varies from 0 to 1. In this maximum power point system will adapt the values of $R_{in}$ value equal to $R_{MPP}$. But it is not possible if the set values of $R_{in}$ not equal to $R_{MPP}$. So the input impedance is less than or equal to 1 of the impedance connected to its output $R_L$ Therefore the MPPT region is possible only if $R_L \geq R_{MPP}$. The output voltage expression of the Boost Converter is $v_o = \frac{v_{in}}{1-D}$ [4]. In this converter once the switch is off then the energy kept in the inductor will flows through capacitor. In CCM the current will not reach to zero but in DCM current will falls to zero [5].

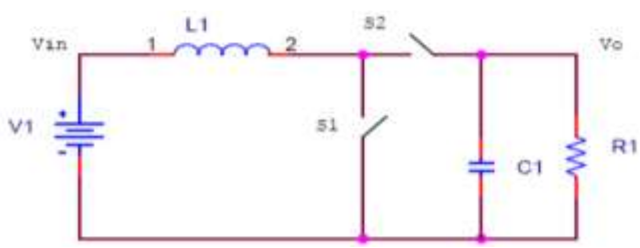


**Fig 3:** Schematic diagram of Boost converter [4]

### 2.3 Buck-Boost Converter

The Buck-Boost Converter is a combination of Buck and Boost Converters. This converter is implemented in different applications like standalone/grid connected photo-voltaic system and motor drives. This Converter is under research to rise efficiency of solar PV-based applications [1]. Buck-Boost converter can produce output greater than or fewer than the input voltage. Switching power control circuit will give a signal to the MOSFET. When MOSFET is OFF current will flows over the inductor and energy kept in the inductor will be rise. When the MOSFET is ON energy stored in the inductor will be decrease and current will flows through the Load [2]. In this converter the output voltage depends upon the duty cycle (D) of the converter. It is also known as voltage to current voltage converter [3]. The output voltage expression for the Buck-Boost Converter is $v_o = D\frac{v_{in}}{1-D}$ [4]. Here Based on the construction the switch is placed after the inductor.

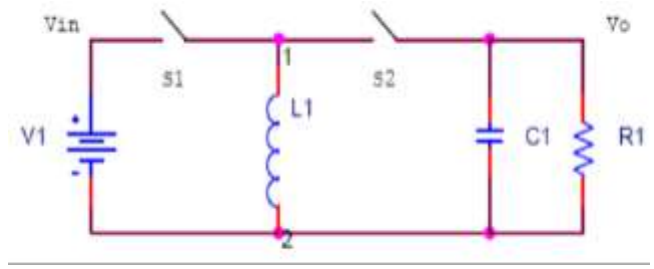


**Fig 4:** Circuit Diagram of Buck-Boost Converter [4]

### 2.4 Cuk Converter

Cuk Converter is combination of boost and buck converters. It is a negative output capacitive energy fly back. In this converter we are using capacitor rather inductor for storing energy and transferring power. In this converter we are getting a ripple free output [1]. The input characteristics are same as Buck converter and output characteristics are same as Boost converter [8]. The output vo0ltage of the Cuk Converter is $v_o = D\frac{v_{in}}{1-D}$ [8]

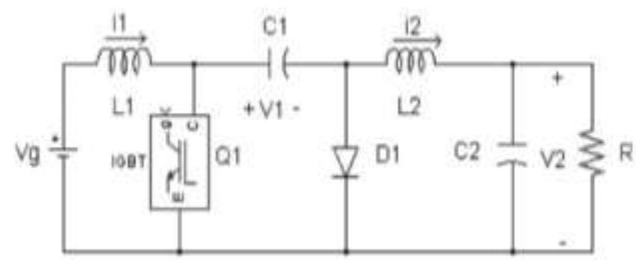


**Fig 5:** Schematic diagram of CUK converter [7]

**Table 1:** Analysis of DC-DC Converters

| Type of Converter | $K_{crit}$ | $R_{in}$(CCM) | $R_{in}$ (DCM) | Efficiency |
|---|---|---|---|---|
| Buck | 1-D | $\frac{R_L}{D}$ | $\frac{R_L}{4}\left(1+\sqrt{1+\frac{4K}{D^2}}\right)$ | High |
| Boost | $D(1-D)$ | $R_L(1-D)$ | $\frac{4R_L}{\left(1+\sqrt{1+\frac{D^2}{K}}\right)^2}$ | Low |
| Buck-Boost | $(1-D)$ | $\frac{R_L(1-D)^2}{D^2}$ | $\frac{KR_L}{D^2}$ DCM happens for K $\leq Kcrit$ | High |

Table 1 & 2 gives the comparison of $R_{in}$ values in continuous as well as discontinuous mode and performance of DC to DC converters respectively [4]. From the above table we can conclude that if the value of K is less than or equal to the Kcrit value then the operation of converter is in DCM and if the K value is greater than Kcrit value then the operation of converter is in CCM. We can know the ratio of input resistance to the load resistance [4].

In Comparison of Different DC-DC Converters for MPPT Application of Photovoltaic System Tadipathi Ramki gives the comparison about the Computational Performance and Efficiency of DC-DC Converters [3].

**Table 2:** Performance of DC to DC converters

| Type of Converter | Computational Performance | Efficiency R<Rmpp |
|---|---|---|
| Buck | Better | High |
| Boost | Poor | Low |
| Buck-Boost | Better | Medium |
| Cuk | Average | Medium |

From the above table we can conclude that DC - DC Converter under small resistance value that is less than the load resistance the performance of Buck converter is better among all the converters [3].

## Conclusion

Buck-Boost and Cuk are getting high efficiency when compared to other two converters. The efficiency of buck converter is high when $R<R_{mpp.}$ The output voltage of the converters depends on their duty cycle. The Cuk has an output voltage magnitude that is either greater than or less than the input voltage magnitude. The Cuk converter is similar to the buck boost converter that provides a negative polarity regulated output voltage with respect to a common terminal. Depending upon the solar irradiance conditions the performance of the converters differ.

## References


1. Baharudin NH, Mansur TMNT, Hamid FA, Ali R, Misrun MI. Topologies of DC-DC converter in solar PV applications. Indonesian Journal of Electrical Engineering and Computer Science. 2017; 8(2):368-374.
2. Sivakumar S, Jagabar Sathik M, Manoj PS, Sundararajan G. "An assessment on performance of DC–DC converters for renewable energy applications." Renewable and Sustainable Energy Reviews. 2016; 58:1475-1485.
3. Amri B, Ashari M. The comparative study of Buck-boost, Cuk, Sepic and Zeta converters for maximum power point tracking photovoltaic using P&O method. In 2015 2nd International Conference on Information Technology, Computer, and Electrical Engineering (ICITACEE), 2015, 327-332.
4. Ramki T, Tripathy LN. Comparison of different DC-DC converter for MPPT application of photovoltaic system. In International Conference on Electrical, Electronics, Signals, Communication and Optimization (EESCO), 2015, 1-6.
5. Kotak VC, Tyagi P. DC to DC Converter in maximum power point tracker. International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering. 2013; 2(12):6115-6125.
6. Mageshwari S, Kanagalakshmi S, Rao H. Design and Implementation of Buck-Boost Converter for Residential PV Application. International Journal on Electrical Engineering and Informatics. 2017; 9(4):834-849.
7. Safari A, Mekhilef S. Simulation and hardware implementation of incremental conductance MPPT with direct control method using cuk converter. IEEE transactions on industrial electronics. 2010; 58(4):1154-1161.
8. Devi RD, Deepa K. Comparative analysis of MPPT methods for cuk converter based Solar PV system. International Journal of Pure and Applied Mathematics. 2018; 118(22):1555-1561.
9. Coelho Roberto F, Filipe Concer, Denizar C. Martins. "A study of the basic DC-DC converters applied in maximum power point tracking." In 2009 Brazilian Power Electronics Conference, IEEE, 2009, pp. 673-678.