1.4 BOOST CONVERTER

- Boost converter which increases the input DC voltage to a specified DC output voltage. A typical Boost converter is shown below.
- Step-up chopper works as a step-up transformer on DC current.
- The working principle of a step up chopper can be explained from the above diagram. In the circuit, a large inductor L is connected in series to the supply voltage. Capacitor maintains the continuous output voltage to the load. The diode prevents the flow of current from load to source.

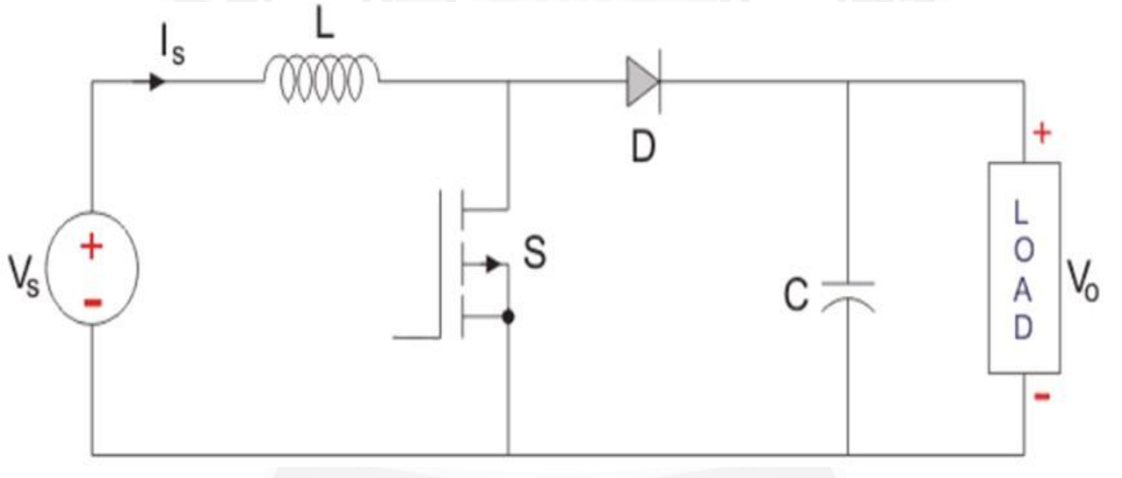

Figure 1.4.1 Block diagram of Boost converter

[Source: "Power Electronics" *by* P.S.Bimbra, Khanna Publishers *Page: 279]*

- The input voltage source is connected to an inductor. The solid-state device which operates as a switch is connected across the source. The second switch used is a diode. The diode is connected to a capacitor, and the load and the two are connected in parallel as shown in the figure above.

- The inductor connected to input source leads to a constant input current, and thus the Boost converter is seen as the constant current input source. And the load can be seen as a constant voltage source. The controlled switch is turned on and off by using Pulse Width Modulation(PWM). PWM can be time-based or frequency based. Frequency-based modulation has disadvantages like a wide range of frequencies to achieve the desired control of the switch which in turn will give the desired output voltage. Time-based Modulation is mostly used for DC-DC converters. It is simple to construct and use. The frequency remains constant in this type of PWM modulation.

The Boost converter has two modes of operation.

The first mode is when the switch is on and conducting.

MODE I : SWITCH IS ON, DIODE IS OFF

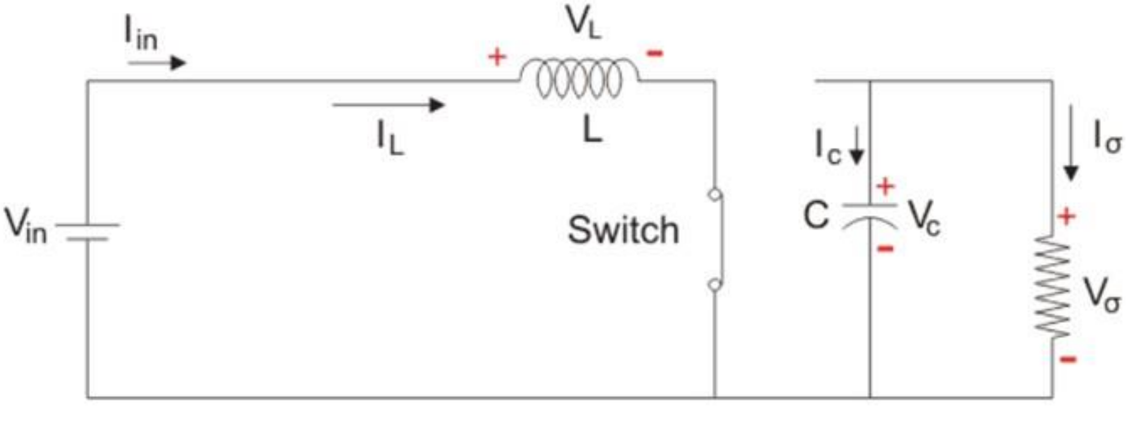

Figure 1.4.2 Boost converter- Mode I circuit diagram

[Source: "Power Electronics" *by* P.S.Bimbra, Khanna Publishers *Page: 280]*

- The Switch is ON and therefore represents a short circuit ideally offering zero resistance to the flow of current so when the switch is ON all the current will flow through the switch and back to the DC input source. Let us say the switch is on for a time T_{ON} and is off for a time T_{OFF}. We define the time period, T, as T=Ton + Toff.
- When the chopper is turned ON the current through the inductance L will increase from I_1 to I_2. As the chopper is on the source voltage is applied to L that is $v_L = V_S$.

MODE II : SWITCH IS OFF, DIODE IS ON

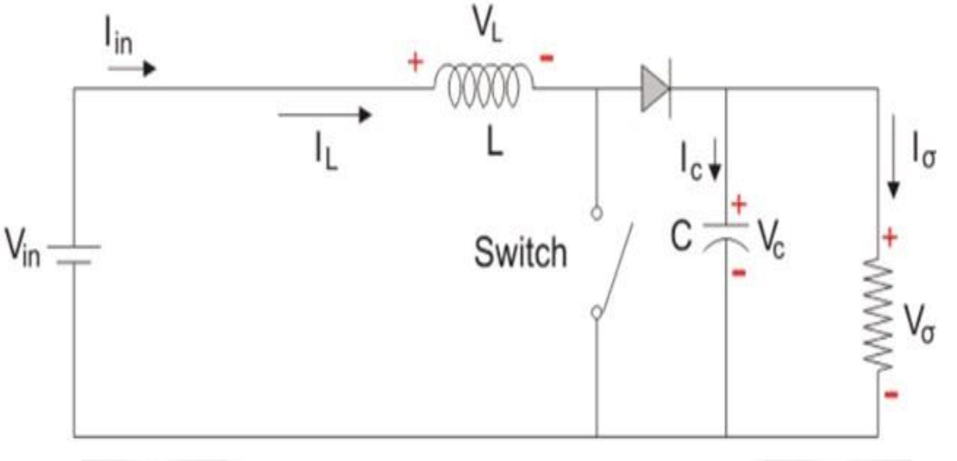

Figure 1.4.3 Boost converter- Mode II circuit diagram

[Source: "Power Electronics" *by* P.S.Bimbra, Khanna Publishers *Page: 280]*

When the chopper is OFF, the KVL can be written as $v_L - V_0 + V_s = 0$ or $v_L = V_0 - V_s$

where v_L is the voltage across L. Variation of source voltage v_S, source current I_S, load voltage v_0 and load current i_O is sketched in the fig .

Let us assume that the variation of output current is linear, the energy input to inductor from the source, during the time period T_{on}, is

$$W_{in}= V_s (I_1+I_2/2) T_{on}$$

During the time T_{off} the chopper is off, so the energy released by the inductor to the load is

$$W_{off} = (V_0-V_s)(I_1+I_2/2).T_{off}$$

Let us assume that the system is lossless, then the two energies say W_{in} and W_{off} are equal.

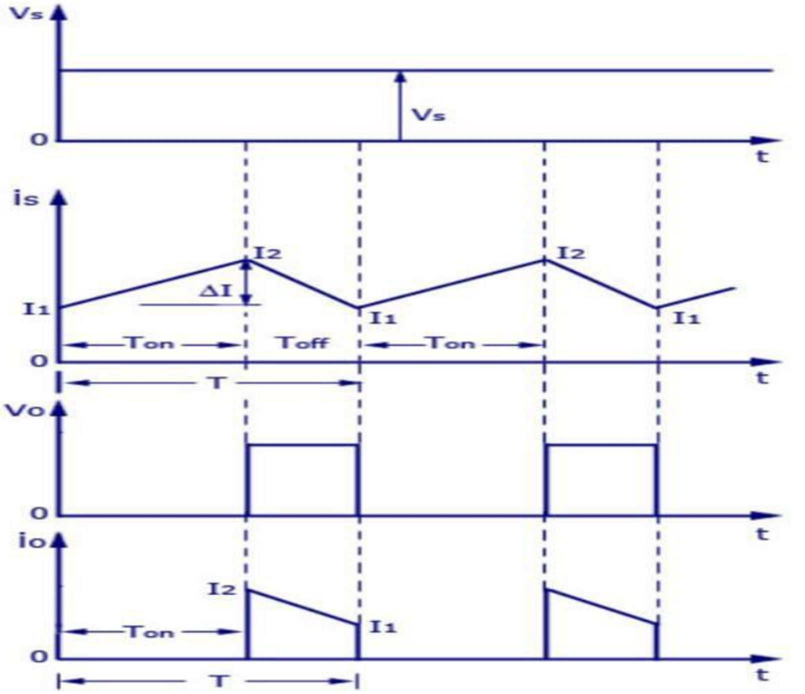

Figure 1.4.4 Boost converter Waveforms

[Source: "Power Electronics" *by* P.S.Bimbra, Khanna Publishers *Page: 281]*

Boost converter Output Voltage

So equating these two we will get

$$V_S (I_1+I_2/2)\, T_{on} = (V_0-V_S)(I_1+I_2/2).T_{off}$$

$$V_S\, T_{on} = (V_0-V_S)\, T_{off}$$

$$V_0 T_{off} = V_S\, (T_{off} + T_{on}) = V_S\, .T$$

$$V_0 = V_S\, (T/T_{off}) = V_S \; (T/T-T_{on}) = V_S\, (1/(1-D)$$

From the above equation , we can see that the average voltage across the load can be stepped up by varying the duty cycle.

We know that D varies between 0 and 1. But as we can see from the equation above that if D = 1 then the ratio of output voltage to input voltage at steady state goes to infinity.