Step-Up Chopper

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The chopper configuration of figure is capable of giving a maximum voltage that is slightly smaller than the input DC voltage (i.e, $E_0 < E_{dc}$).Therefore, the chopper configuration of figure is called as Step-Up Chopper. However, the chopper can also be used to produce higher voltage at the load than the input voltage (i.e., $E_0 > E_{dc}$). This is called as Step-Up Chopper and is illustrated in figure1.

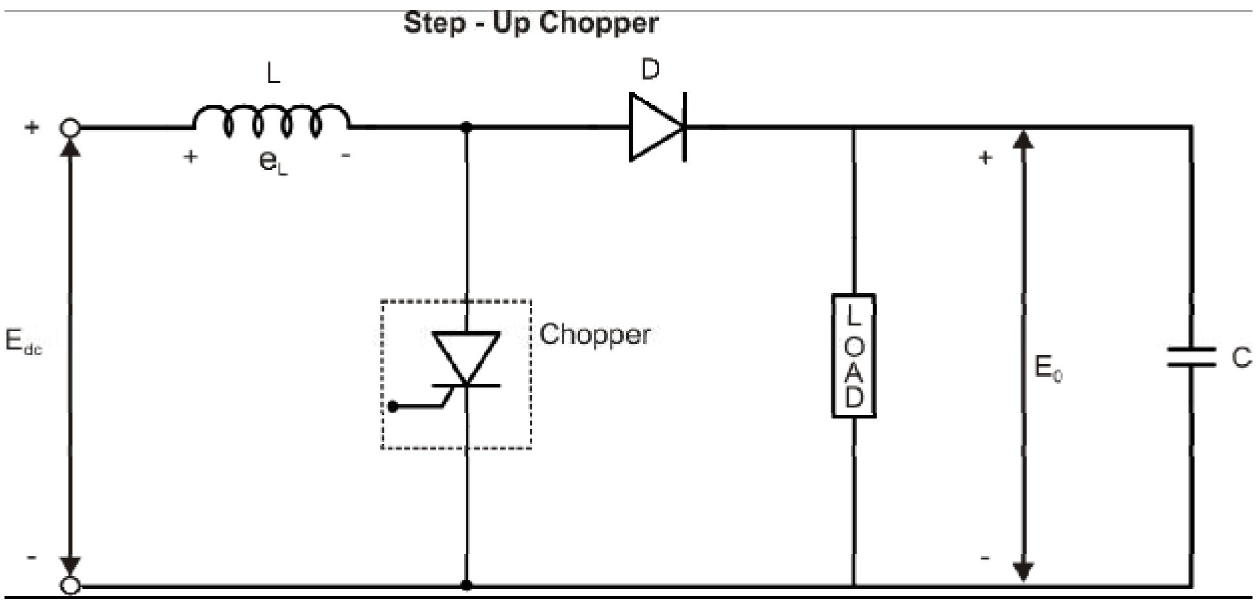

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Figure 1

From the above figure it is clear that the SCR is triggered periodically and is kept conducting for a period T_{on} & is blocked for a period T_{off}. The chopped load voltage waveform is as shown in figure no. 2.

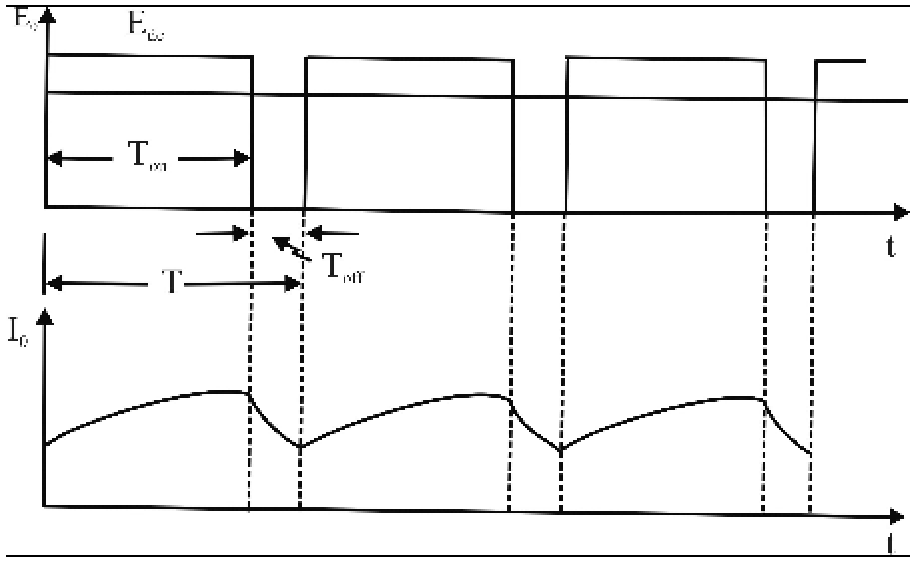

Figure 2

During the period T_{on}, when the chopper is on, the supply terminals are connected to the load terminals. & during the period T_{off}, when the chopper is 'Off". In this manner, a chopped DC voltage is produced at the load terminals.

When the chopper is "On", the inductor L is connected to the supply E_{dc}, and inductor stores energy during on-period, T_{on}.

When the chopper is "Off", the inductor current is forced to flow through the diode and load for a period T_{off}. As the current tends to decrease, polarity of the emf induced in the inductor L is reversed to that of shown in figure and as a result voltage across the load

E_0 becomes

$E_o = E_{dc} + Ldis\backslash dt$

that is, the inductor voltage adds to the source voltage to force the inductor current into the load. In this manner, the energy stored in the inductor is released to the load. Here, higher value of inductance L is preferred for getting lesser ripple in the output.

During the time T_{on} , when the chopper is "On", the energy input to the inductor from the source is given by

$$Wi = E_{dc} \times Is \times T_{on}$$

Equation is based on the assumption that the source current is free from ripples.

Now, during the time T_{off}, when chopper is "Off", energy released by the inductor to the load is given by

$$Wi = (E_0 - E_{dc}) \times Is \times T_{off}$$

Considering the system to be lossless, and, in the steady-state, these two energies will be equal.

$$E_{dc} \times Is \times T_{on} = (E_0 - E_{dc}) \times Is \times T_{off}$$

or

$$E_0 = E_{dc} (T_{on} + T_{off} / T_{off})$$

or

$$E_0 = E_{dc} (T / T - T_{on})$$

or

$$E_0 = E_{dc} [1 / (T/T – T_{on} /T)]$$

But, $T_{on} / T = \alpha$

$E_0 = E_{dc} / (1 - \alpha)$ Where

T_{on} = ‘On’ time of the chopper.

T_{off} = ‘Off’ time of the chopper.

T ($T_{on}+T_{off}$) = Chopping period

If $\alpha = T_{on}/T$ be the duty cycle

Thus the load voltage can be controlled by varying the duty cycle of the chopper.

For $\alpha = 0$, $E_0 = E_{dc}$; and $\alpha = 1$, $E_0 = \infty$.

Hence, for variation of a duty cycle α in the range $0 < \alpha < 1$, the output voltage E_0 will vary in the range $E_{dc} < E_0 < \infty$.