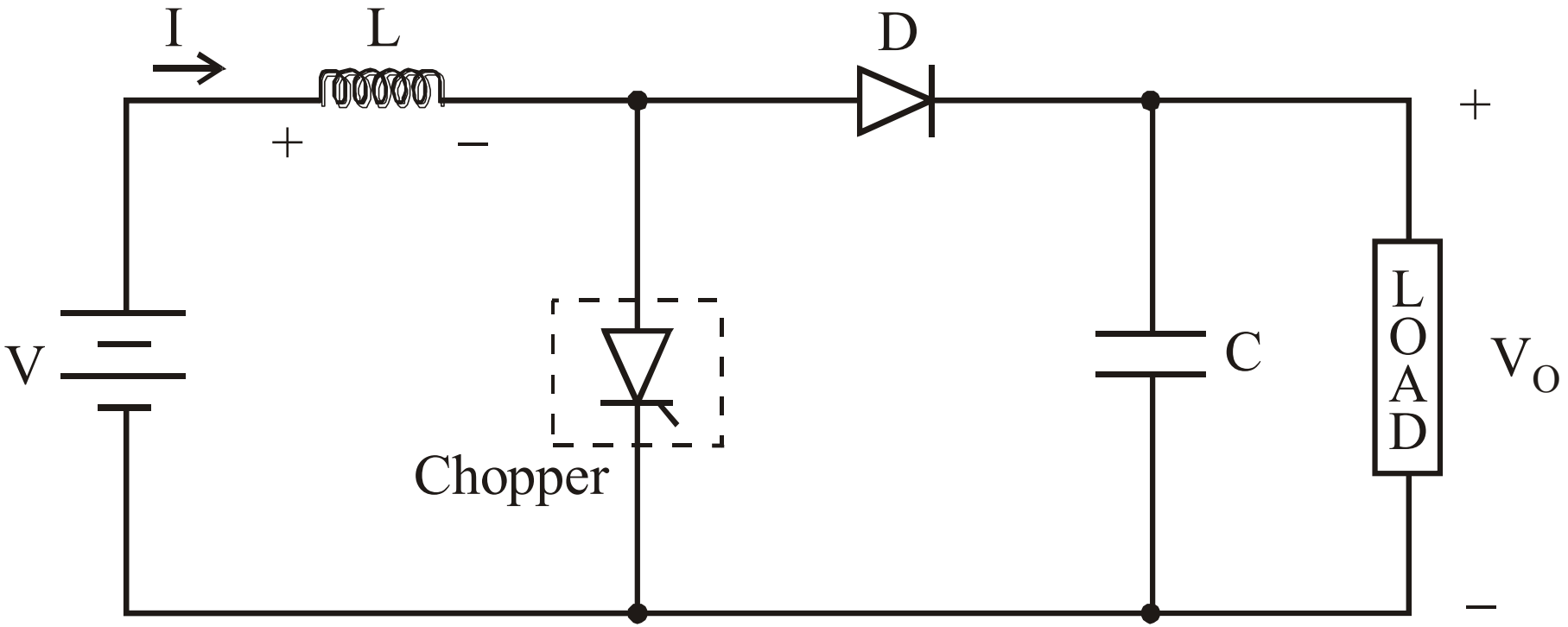
Principle Of Step-up Chopper



- Step-up chopper is used to obtain a load voltage higher than the input voltage *V*.
- The values of *L* and *C* are chosen depending upon the requirement of output voltage and current.
- When the chopper is *ON,* the inductor *L* is connected across the supply.
- The inductor current *'I'* rises and the inductor stores energy during the *ON* time of the chopper, t_{ON}.

- When the chopper is off, the inductor current *I* is forced to flow through the diode *D* and load for a period, t_{OFF}.
- The current tends to decrease resulting in reversing the polarity of induced EMF in *L*.
- Therefore voltage across load is given by

$$V_O = V + L\frac{dI}{dt} \quad i.e., \quad V_O > V$$

- A large capacitor ‘C’ connected across the load, will provide a continuous output voltage .
- Diode *D* prevents any current flow from capacitor to the source.
- Step up choppers are used for regenerative braking of dc motors.

Expression For Output Voltage

Assume the average inductor current to be I during ON and OFF time of Chopper.

When Chopper is ON

Voltage across inductor $L = V$

Therefore energy stored in inductor

$$= V.I.t_{ON}$$

Where $t_{ON} = ON$ period of chopper.

When Chopper is OFF

(energy is supplied by inductor to load)

Voltage across $L = V_O - V$

Energy supplied by inductor $L = \left(V_O - V\right) I t_{OFF}$

where $t_{OFF} = OFF$ period of Chopper.

Neglecting losses, energy stored in inductor

L = energy supplied by inductor L

$$\therefore \quad VIt_{ON} = \left(V_O - V\right) It_{OFF}$$

$$V_O = \frac{V\left[t_{ON} + t_{OFF}\right]}{t_{OFF}}$$

$$V_O = V\left(\frac{T}{T - t_{ON}}\right)$$

Where

T = Chopping period or period of switching.

$$T = t_{ON} + t_{OFF}$$

$$V_O = V\left(\frac{1}{1-\frac{t_{ON}}{T}}\right)$$

$$\therefore \qquad V_O = V\left(\frac{1}{1-d}\right)$$

Where $d = \frac{t_{ON}}{T} =$ duty cyle

For variation of duty cycle $'d'$ in the range of $0 < d < 1$ the output voltage V_O will vary in the range $V < V_O < \infty$

Performance Parameters

- The thyristor requires a certain minimum time to turn *ON* and turn *OFF*.
- Duty cycle *d* can be varied only between a min. & max. value, limiting the min. and max. value of the output voltage.
- Ripple in the load current depends inversely on the chopping frequency, *f*.
- To reduce the load ripple current, frequency should be as high as possible.

Problem

- *A Chopper circuit is operating on TRC at a frequency of 2 kHz on a 460 V supply. If the load voltage is 350 volts, calculate the conduction period of the thyristor in each cycle.*

$V = 460\ \text{V},\ V_{dc} = 350\ \text{V},\quad \text{f} = 2\ \text{kHz}$

Chopping period $T = \dfrac{1}{f}$

$$T = \frac{1}{2\times10^{-3}} = 0.5\ m\,\text{sec}$$

Output voltage $V_{dc} = \left(\dfrac{t_{ON}}{T}\right)V$

Conduction period of thyristor

$$t_{ON} = \frac{T \times V_{dc}}{V}$$

$$t_{ON} = \frac{0.5 \times 10^{-3} \times 350}{460}$$

$$t_{ON} = 0.38 \text{ msec}$$