Principle of chopper Operation.

Science a chopper is a high speed ON/OFF semiconductor switch. It connects source to load and disconnects the load from source at fast speed. By doing this, a chopped load voltage is obtained from a constant DC supply of magnitude V_s. The below figure shows the basic circuit for the operation of chopper.

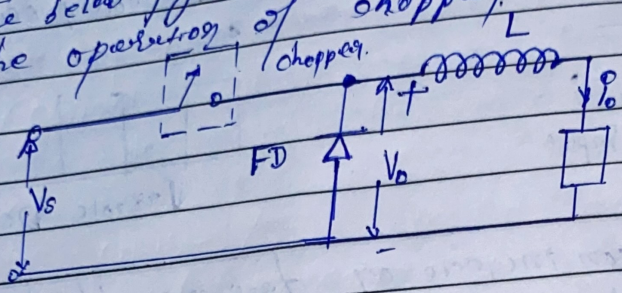


Fig: chopper circuit

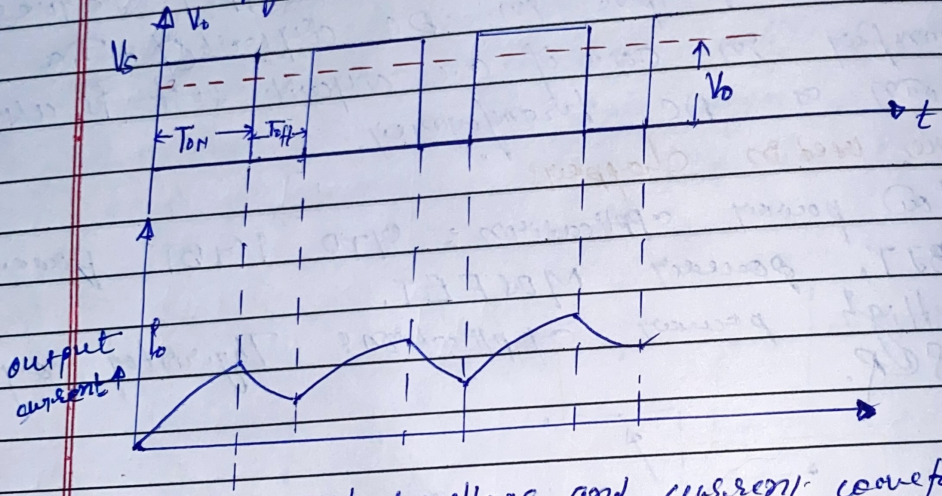


Fig: output voltage and current waveform.

Here for the sake of highlighting the principle of chopper operation, the circuitry used for controlling the on, off period of the switch is not shown.

During the period T_{ON}, the chopper is ON and the load voltage is equal to source voltage V_s. During the interval 'Toff' chopper is off

the load current flows through the free-wheeling diode FD & a result of the load terminals are short circuited by FD and load voltage is 0. In this manner, a chopped dc voltage is produced at the load terminals.

The load current varies as shown in figure where during Ton, the load current rises whereas during Toff, the load current decays.

So,

The average load voltage is given by

$$V_o = \frac{T_{on}}{T_{on} + T_{off}} * V_s$$

$$V_o = \frac{T_{on}}{T} V_s$$

where
T_{on} = ON time
T_{off} = off time
T = time period.

$\therefore \frac{T_{on}}{T} = \alpha$ (duty cycle)

$\therefore$ $\boxed{V_o = \alpha V_s}$

or

$\boxed{V_o = T_{on} f V_s}$

$\therefore \boxed{f = \frac{1}{T}}$

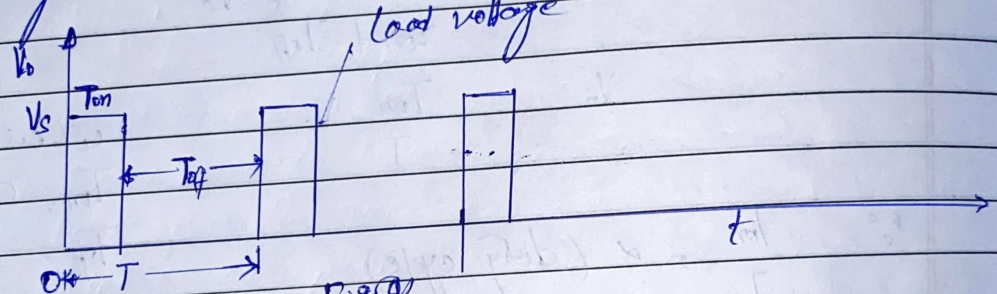
So, by changing the value of α we can change the load voltage.

Control strategies

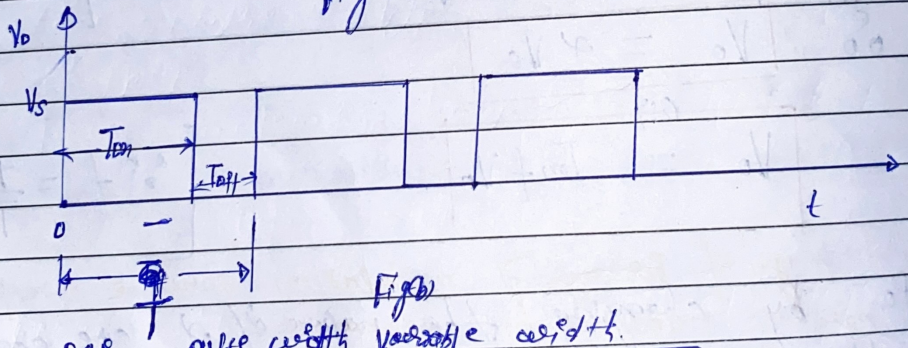
The operation of chopper is controlled by
1) Time Ratio control (TRC)
2) Current limit control.

Time Ratio control (TRC): In this scheme the on time ratio Ton/T is varied. In this method two methods are used. strategies are
1) Constant frequency system.
2) Variable frequency system.

Constant frequency system: In this scheme the ON time is varied but chopping frequency (f) remains the same. This is achieved by PWM technique schemes shown below:



Fig(a)



Fig(b)

fig: pulse width variable width.

In fig(a) $\alpha = 0.5$

Then $T_{ON} = \frac{1}{2}T$

In fig(b) $\alpha = 75\%$

$\therefore T_{on} = \frac{3}{4}T$.

Ideally α can varies from 0 to unity. Therefore output voltage can vary from 0 to V_s.

Variable frequency system: In this technique (scheme) chopping frequency f is varied and either i) On-time Ton is kept constant or ii) Toff time is kept constant. This scheme is shown below.

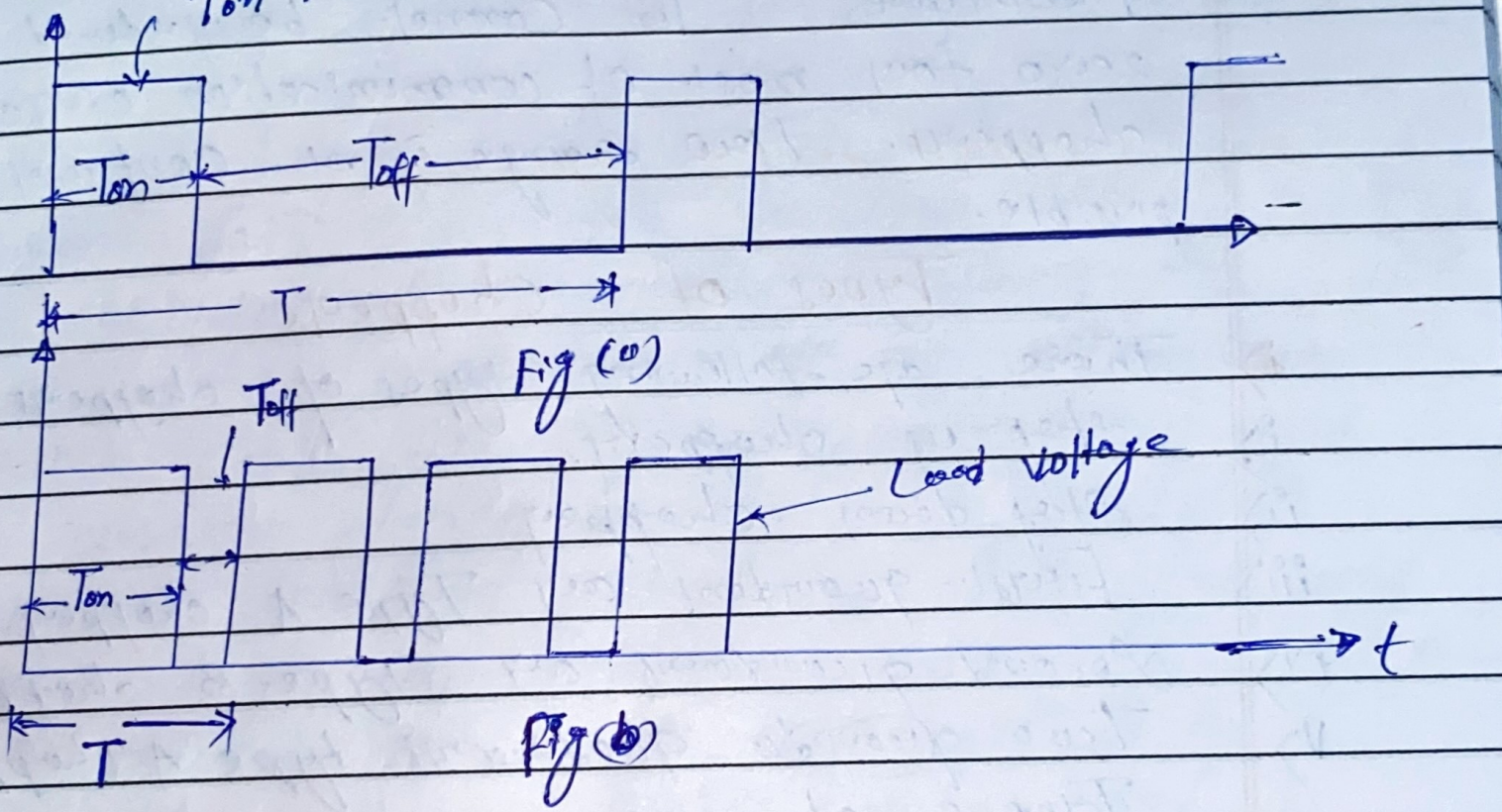


Fig: Variable frequency system waveform.

In the above figure the ON time (Ton) is kept fixed while Toff is varied and hence α changes.