

DC Choppers



Introduction

- Chopper is a static device.
- A variable dc voltage is obtained from a constant dc voltage source.
- Also known as dc-to-dc converter.
- Widely used for motor control.
- Also used in regenerative braking.
- Thyristor converter offers greater efficiency, faster response, lower maintenance, smaller size and smooth control.

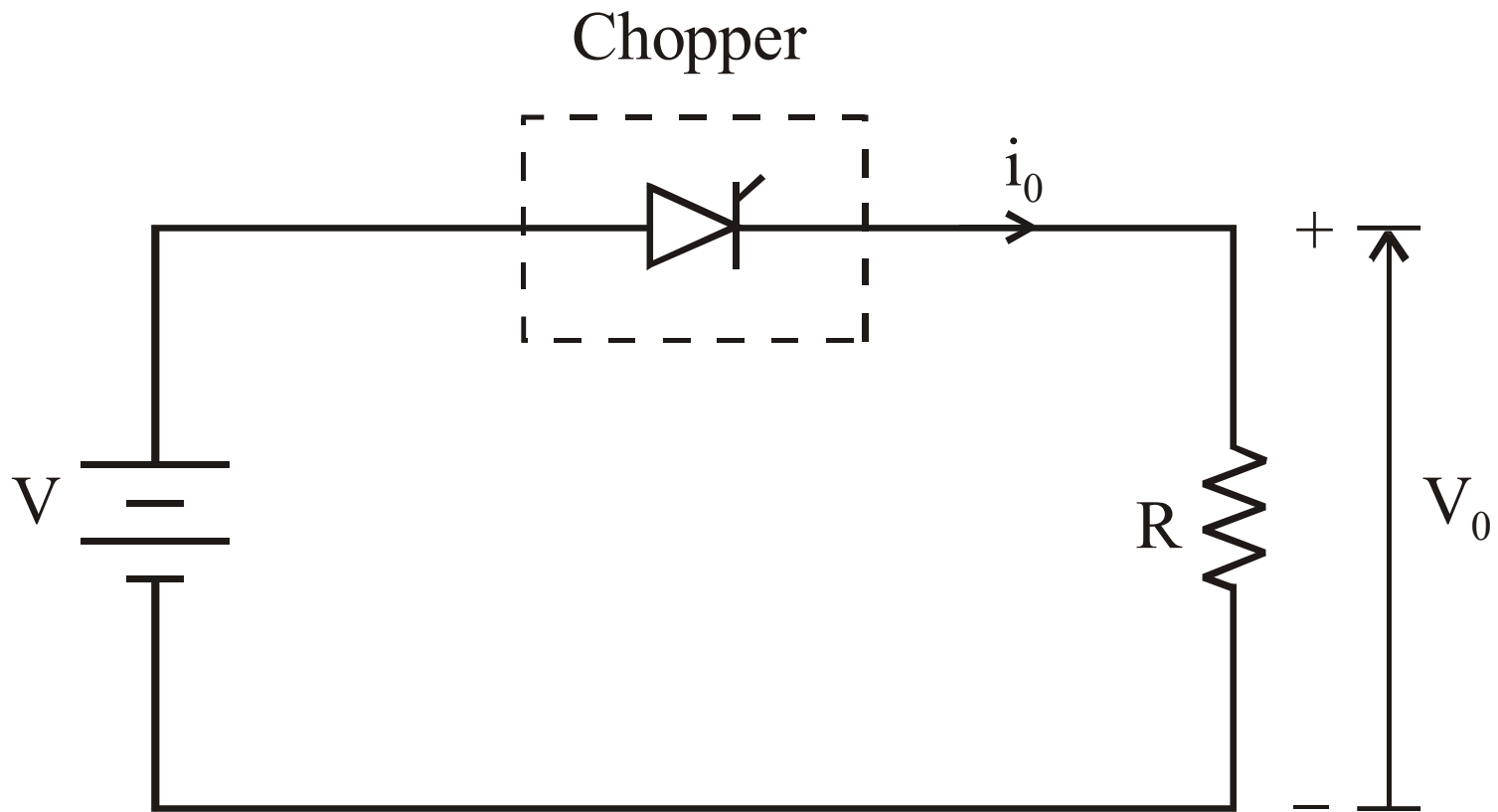


Choppers are of Two Types

- Step-down choppers.
- Step-up choppers.
 - In step down chopper output voltage is less than input voltage.
 - In step up chopper output voltage is more than input voltage.

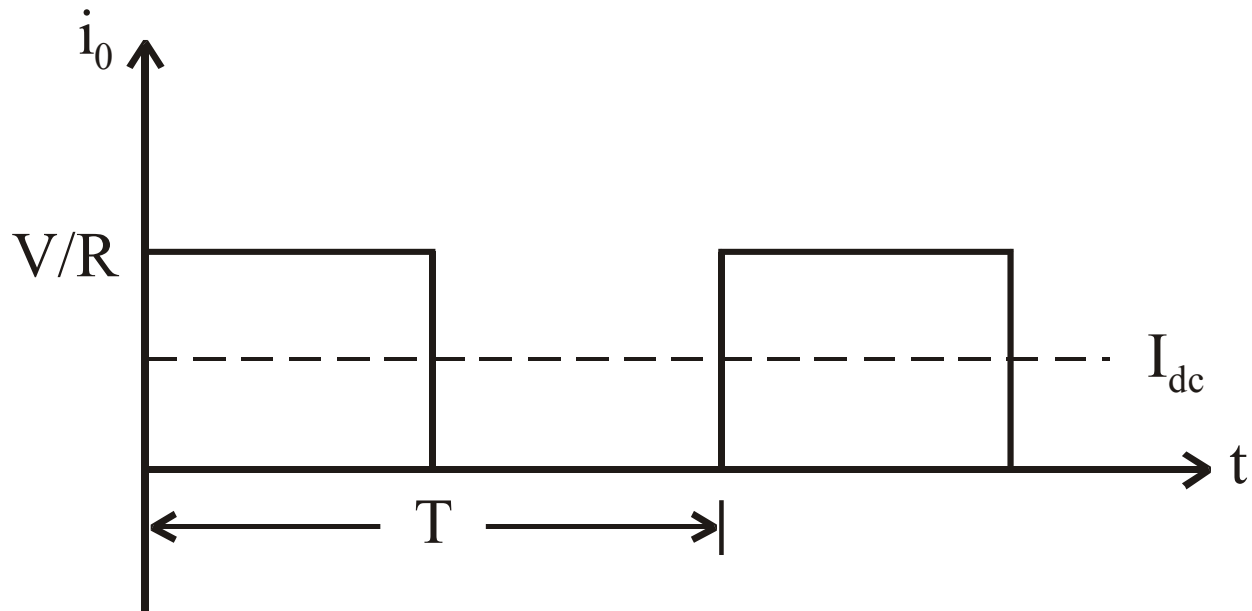
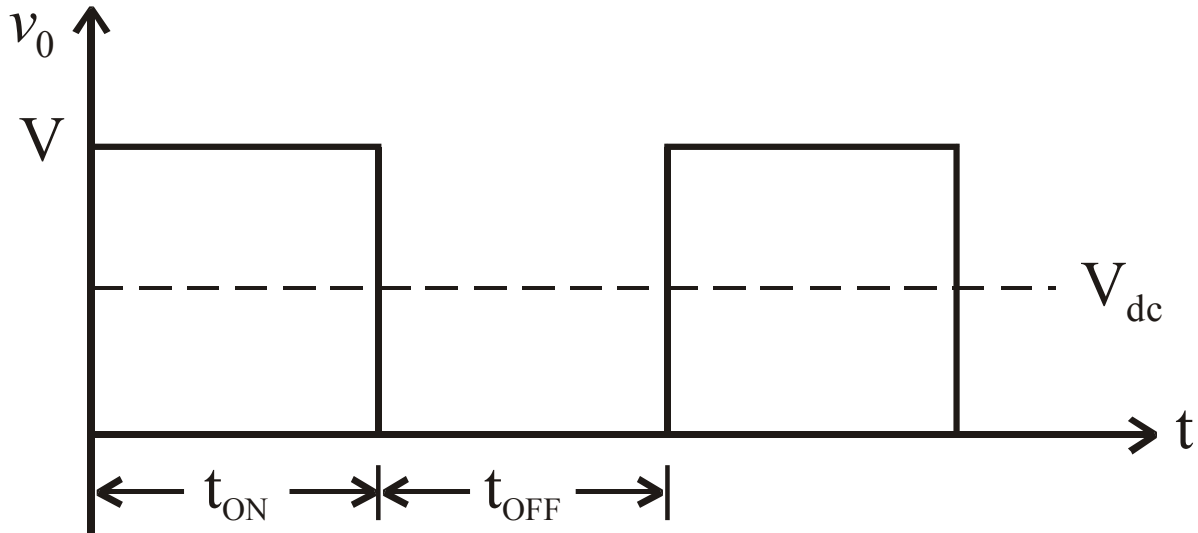


Principle Of Step-down Chopper



- A step-down chopper with resistive load.
- The thyristor in the circuit acts as a switch.
- When thyristor is ON, supply voltage appears across the load
- When thyristor is OFF, the voltage across the load will be zero.





Average Output Voltage

$$V_{dc} = V \left(\frac{t_{ON}}{t_{ON} + t_{OFF}} \right)$$

$$V_{dc} = V \left(\frac{t_{ON}}{T} \right) = V \cdot d$$

but $\left(\frac{t_{ON}}{t} \right) = d = \text{duty cycle}$



Average Output Current

$$I_{dc} = \frac{V_{dc}}{R}$$

$$I_{dc} = \frac{V}{R} \left(\frac{t_{ON}}{T} \right) = \frac{V}{R} d$$

RMS value of output voltage

$$V_o = \sqrt{\frac{1}{T} \int_0^{t_{ON}} v_o^2 dt}$$



But during t_{ON} , $v_o = V$

Therefore RMS output voltage

$$V_o = \sqrt{\frac{1}{T} \int_0^{t_{ON}} V^2 dt}$$

$$V_o = \sqrt{\frac{V^2}{T} t_{ON}} = \sqrt{\frac{t_{ON}}{T}} \cdot V$$

$$V_o = \sqrt{d} \cdot V$$



Output power $P_o = V_o I_o$

But $I_o = \frac{V_o}{R}$

\therefore Output power

$$P_o = \frac{V_o^2}{R}$$

$$P_o = \frac{dV^2}{R}$$



Effective input resistance of chopper

$$R_i = \frac{V}{I_{dc}}$$

$$R_i = \frac{R}{d}$$

The output voltage can be varied by varying the duty cycle.



Methods Of Control

- The output dc voltage can be varied by the following methods.
 - Pulse width modulation control or constant frequency operation.
 - Variable frequency control.



Pulse Width Modulation

- t_{ON} is varied keeping chopping frequency ' f ' & chopping period ' T ' constant.
- Output voltage is varied by varying the ON time t_{ON}



