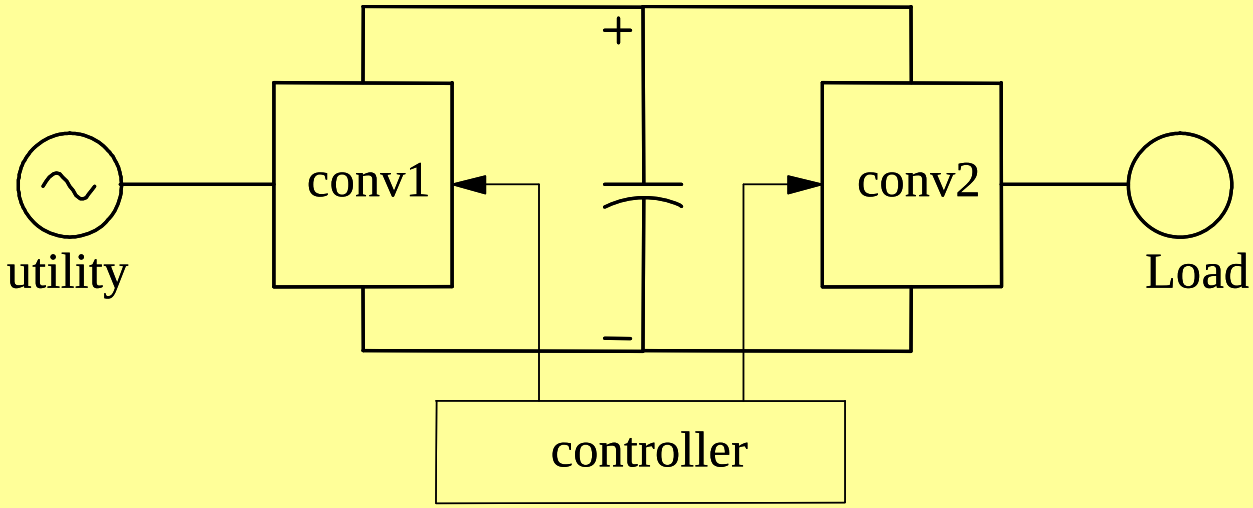
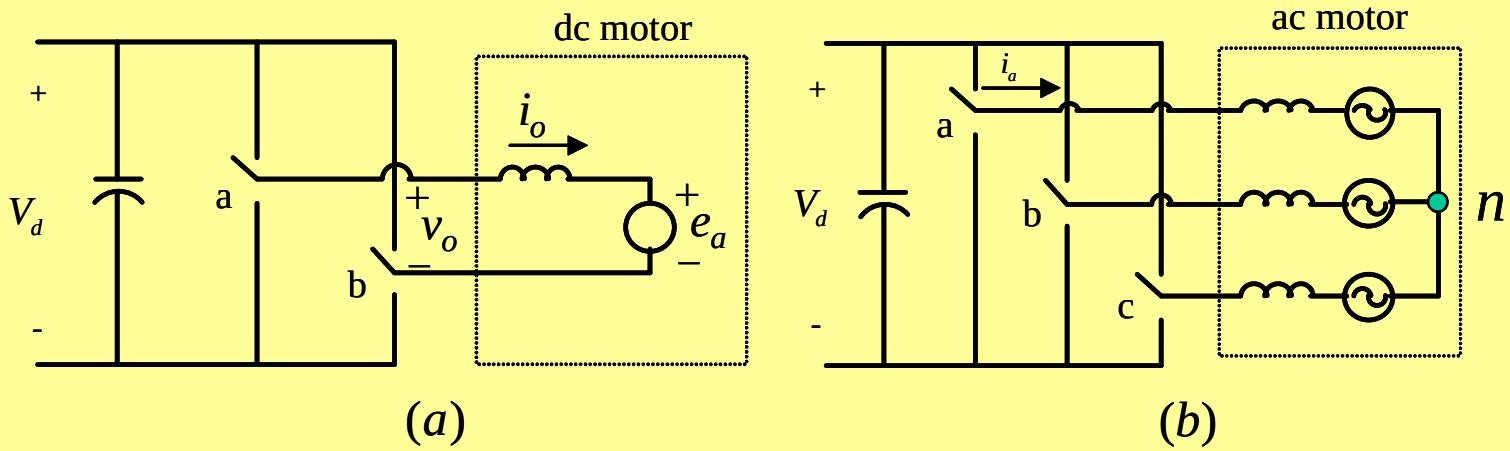
Synthesis of DC and Sinusoidal AC Voltages

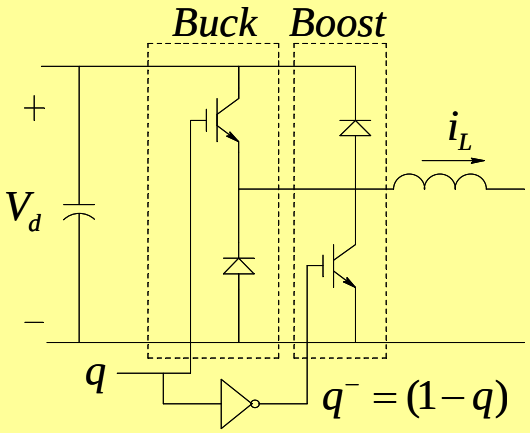
Applications in

- Electric Drives
- UPS
- Power Systems

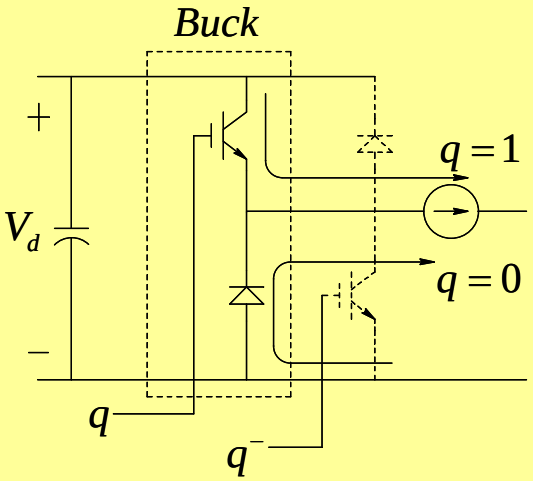




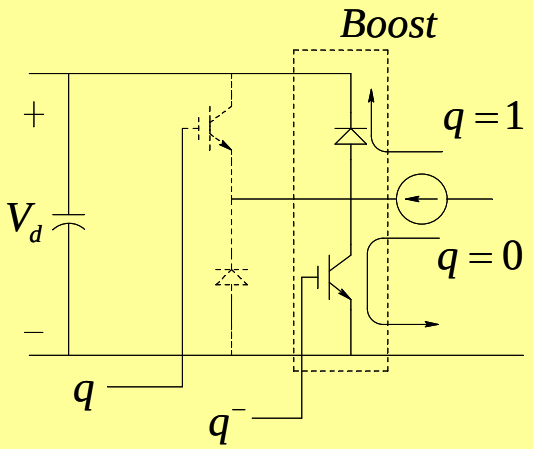
SWITCHING POWER-POLE AS THE BUILDING BLOCK



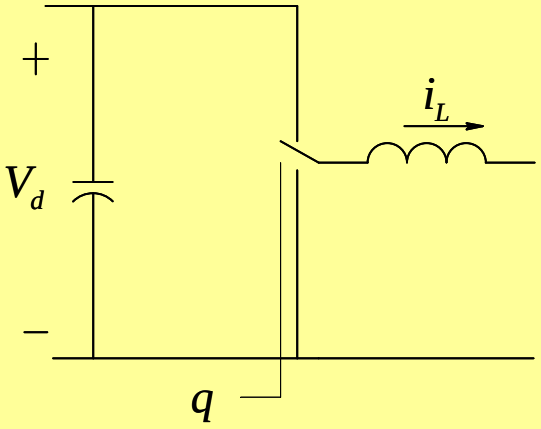
(a)



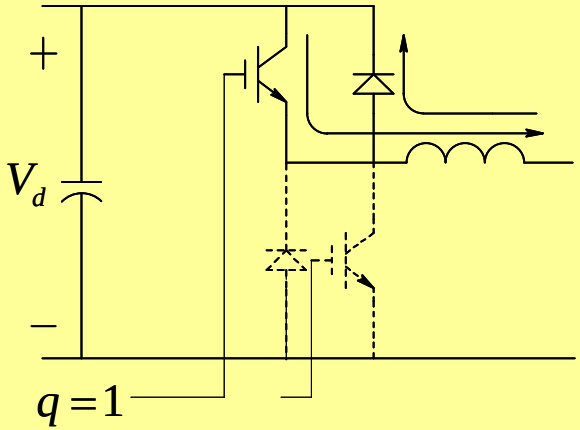
(b) i_L = positive



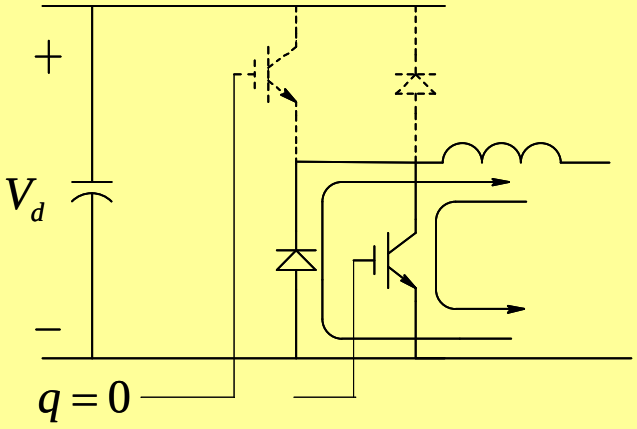
(c) i_L = negative



(a)



(b) $q=1$

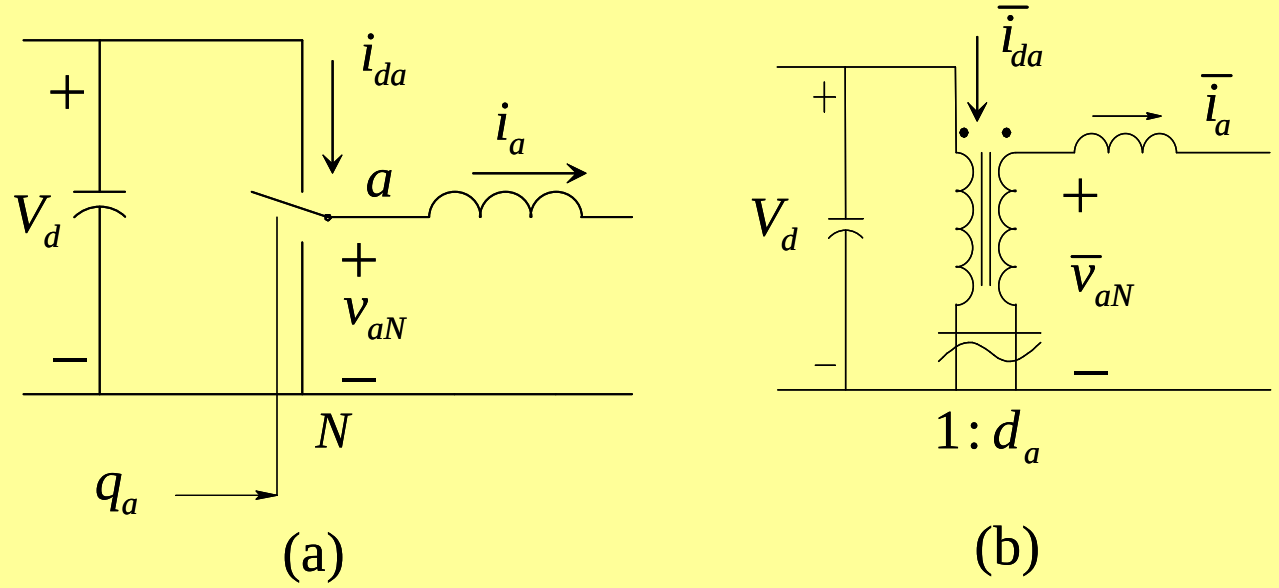


(c) $q=0$

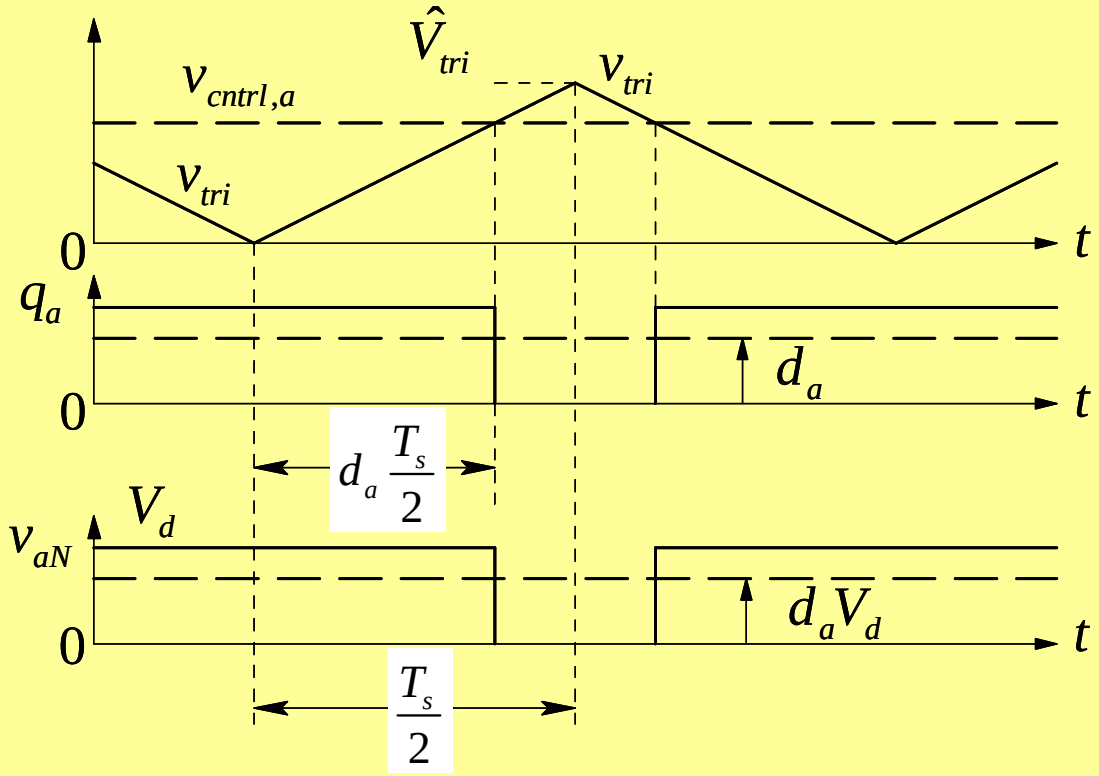
Average Representation of a Switching Power-Pole

$$\overline{v}_{aN} = d_a V_d$$

$$\overline{i}_{da} = d_a \overline{i}_a$$

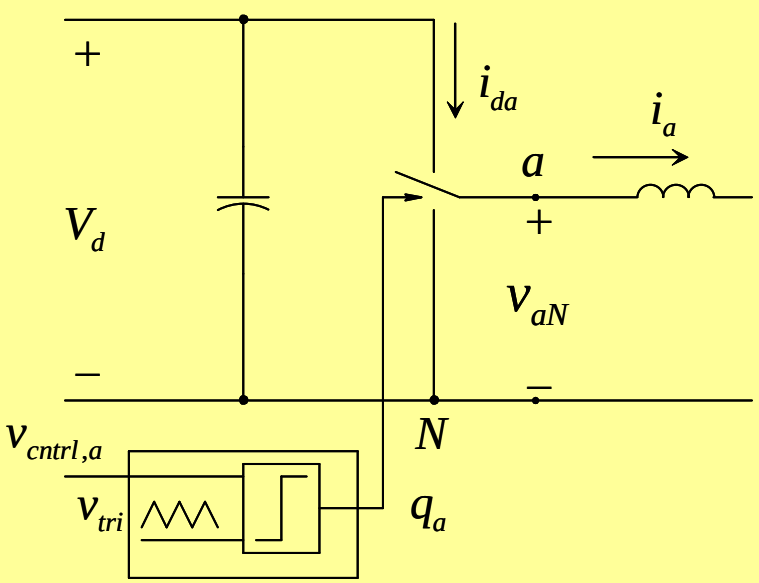


Pulse-Width-Modulation (PWM) of the Bi-Directional Switching Power-Pole

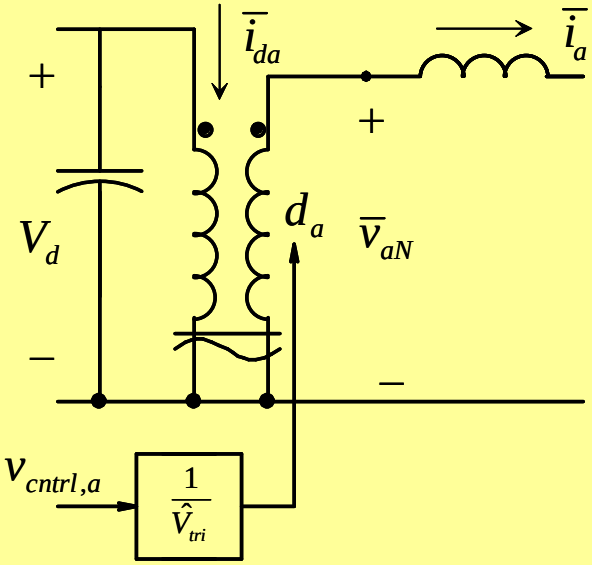


$$d_a = \frac{v_{cntrl,a}}{\hat{V}_{tri}}$$

Obtaining Pulse-Width-Modulation (PWM) Signal:



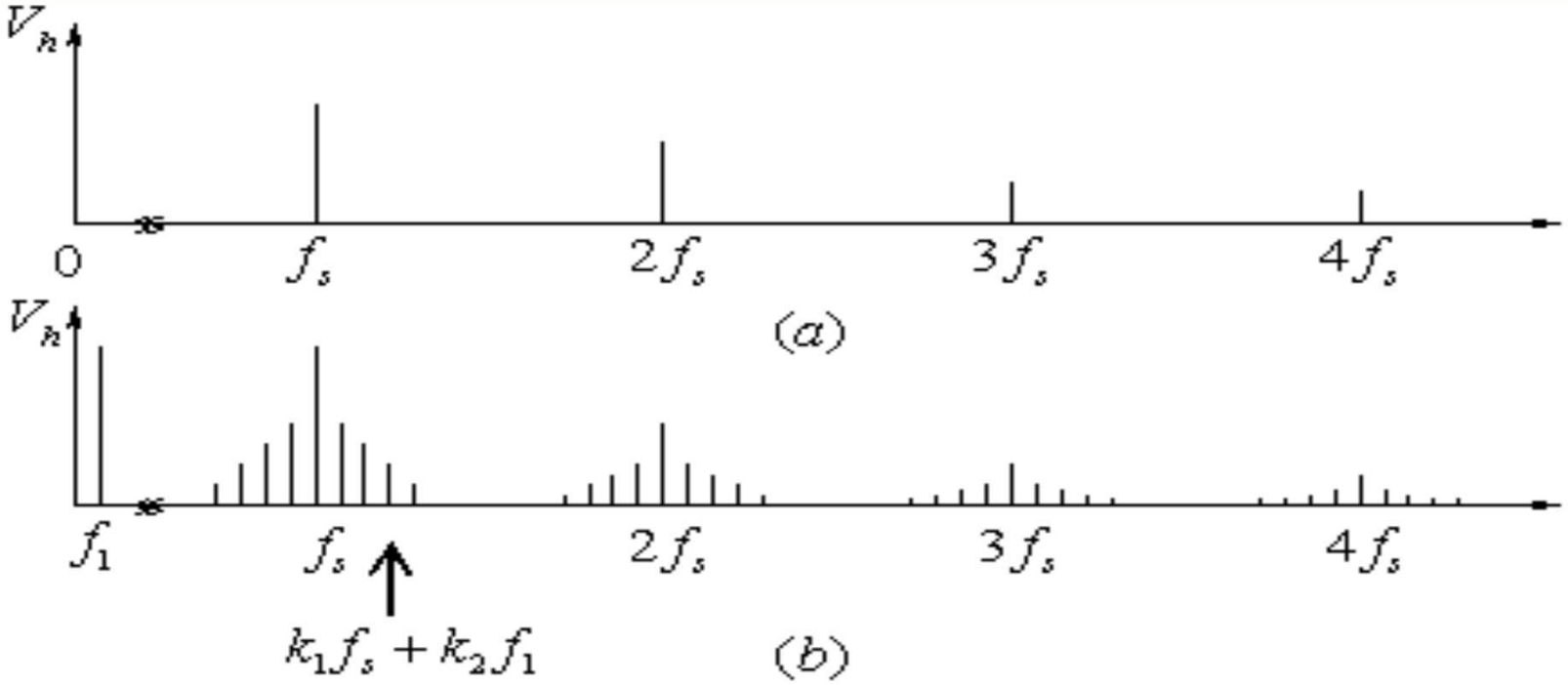
(a)



(b)

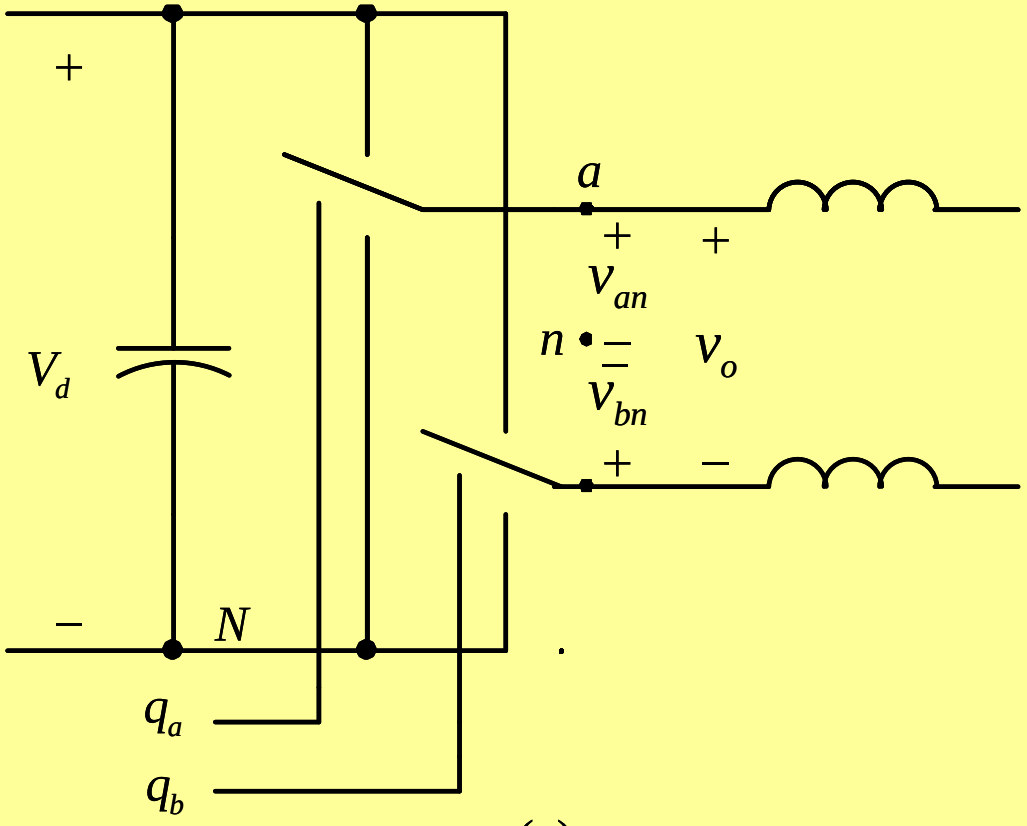
$$d_a = \frac{v_{cntrl,a}}{\hat{V}_{tri}} \qquad \bar{v}_{aN} = d_a V_d$$

Harmonics in the Output Voltage:

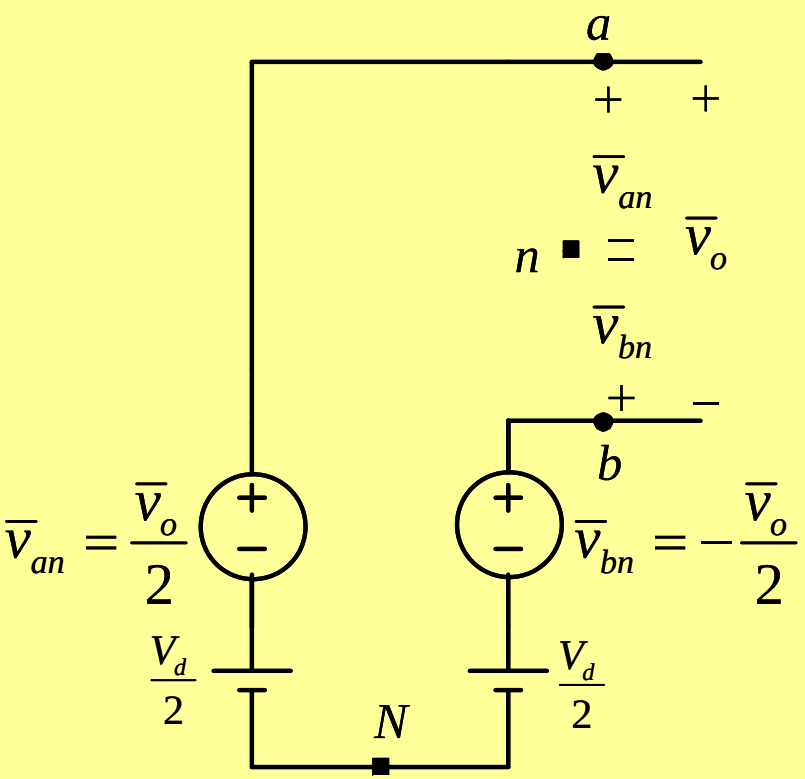


$$f_h = k_1 f_s \pm \underbrace{k_2 f_1}_{\text{sidebands}}$$

DC-MOTOR DRIVES



(a)



(b)

$$\overline{v}_{an} = \frac{\overline{v}_o}{2}$$

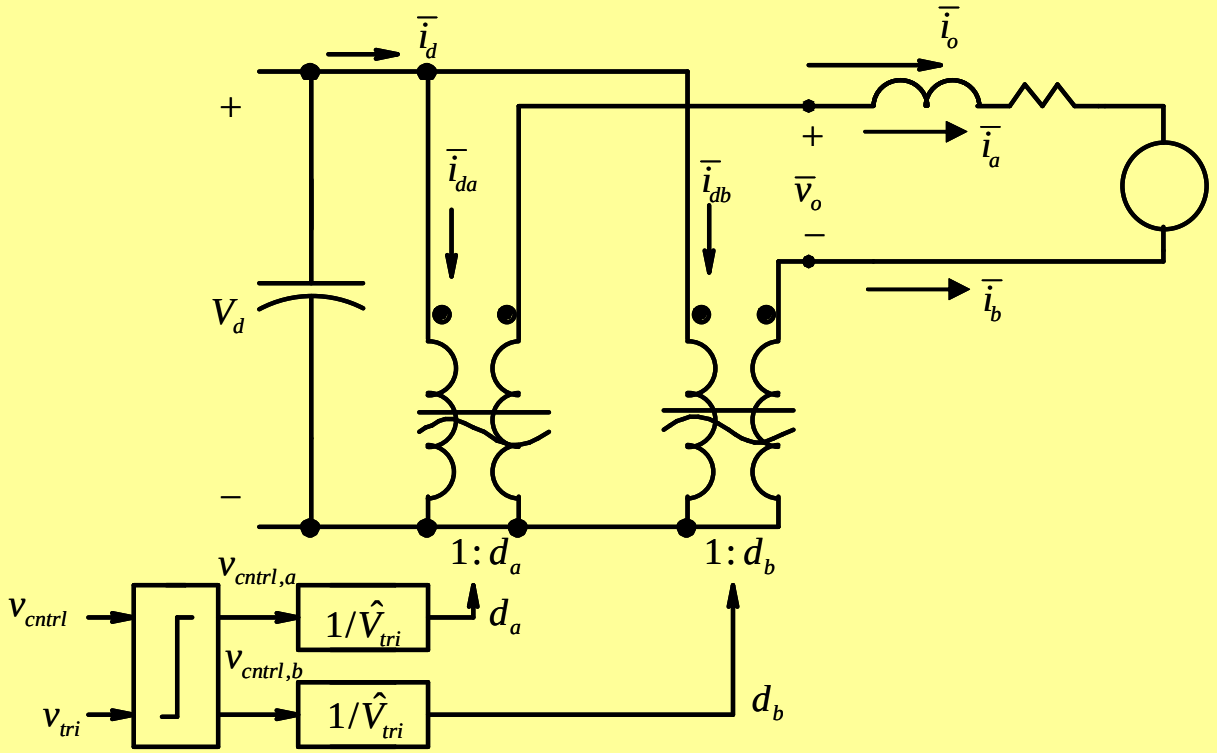
$$\overline{v}_{bn} = -\frac{\overline{v}_o}{2}$$

$$\overline{v}_{com} = \frac{V_d}{2}$$

$$\overline{v}_{aN} = \overline{v}_{com} + \overline{v}_{an}$$

$$\overline{v}_{bN} = \overline{v}_{com} + \overline{v}_{bn}$$

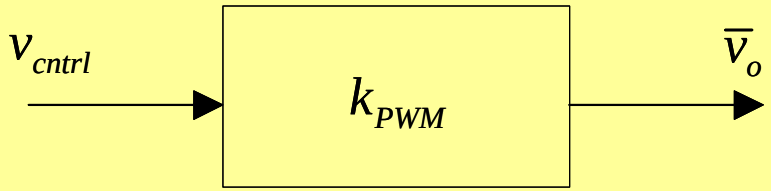
DC-MOTOR DRIVE: Average Representation:



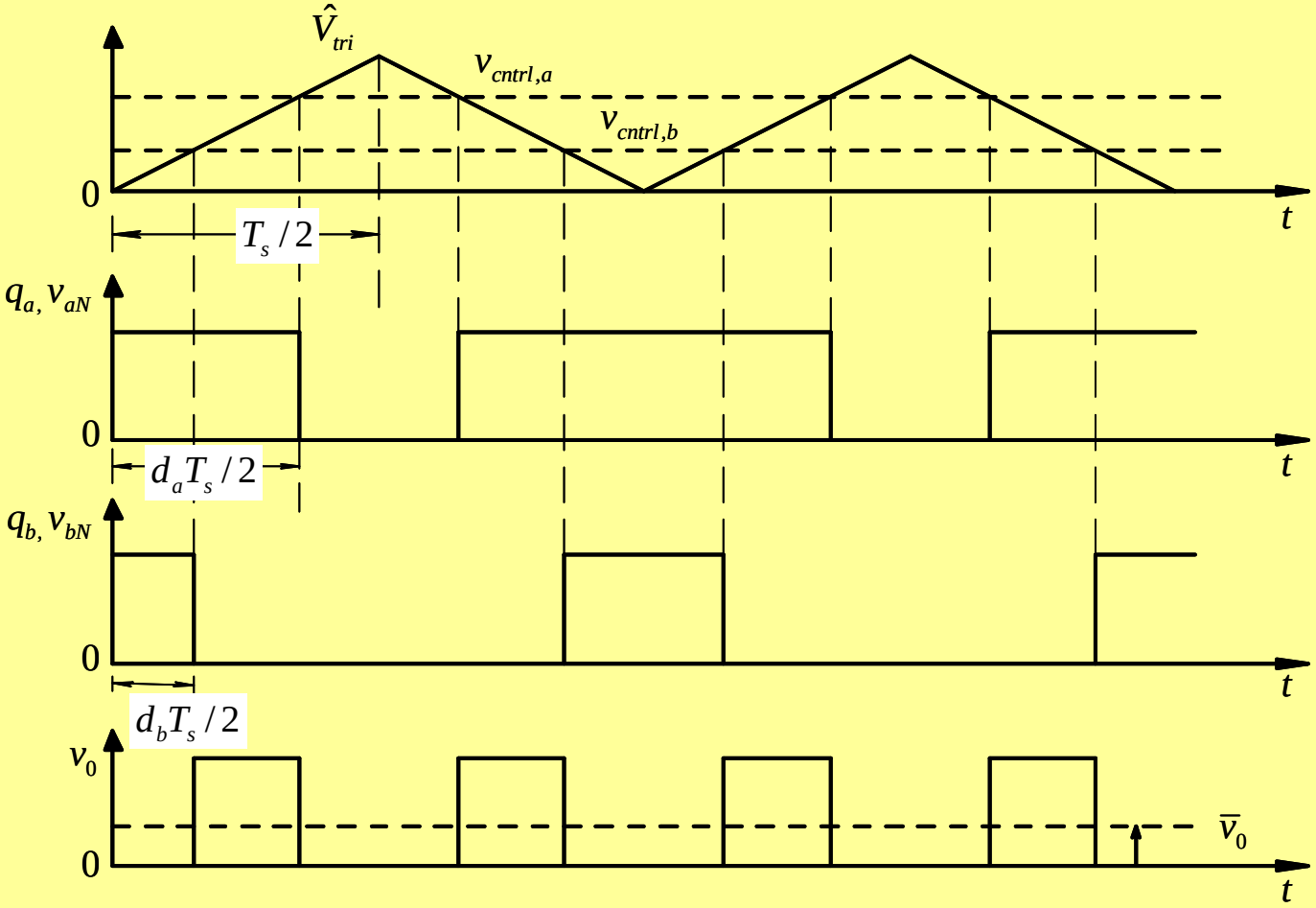
$$\bar{v}_{aN} = \frac{V_d}{2} + \frac{\bar{v}_o}{2} \qquad d_a = \frac{1}{2} + \frac{1}{2}\frac{\bar{v}_o}{V_d}$$

$$\bar{v}_{bN} = \frac{V_d}{2} - \frac{\bar{v}_o}{2} \qquad d_b = \frac{1}{2} - \frac{1}{2}\frac{\bar{v}_o}{V_d}$$

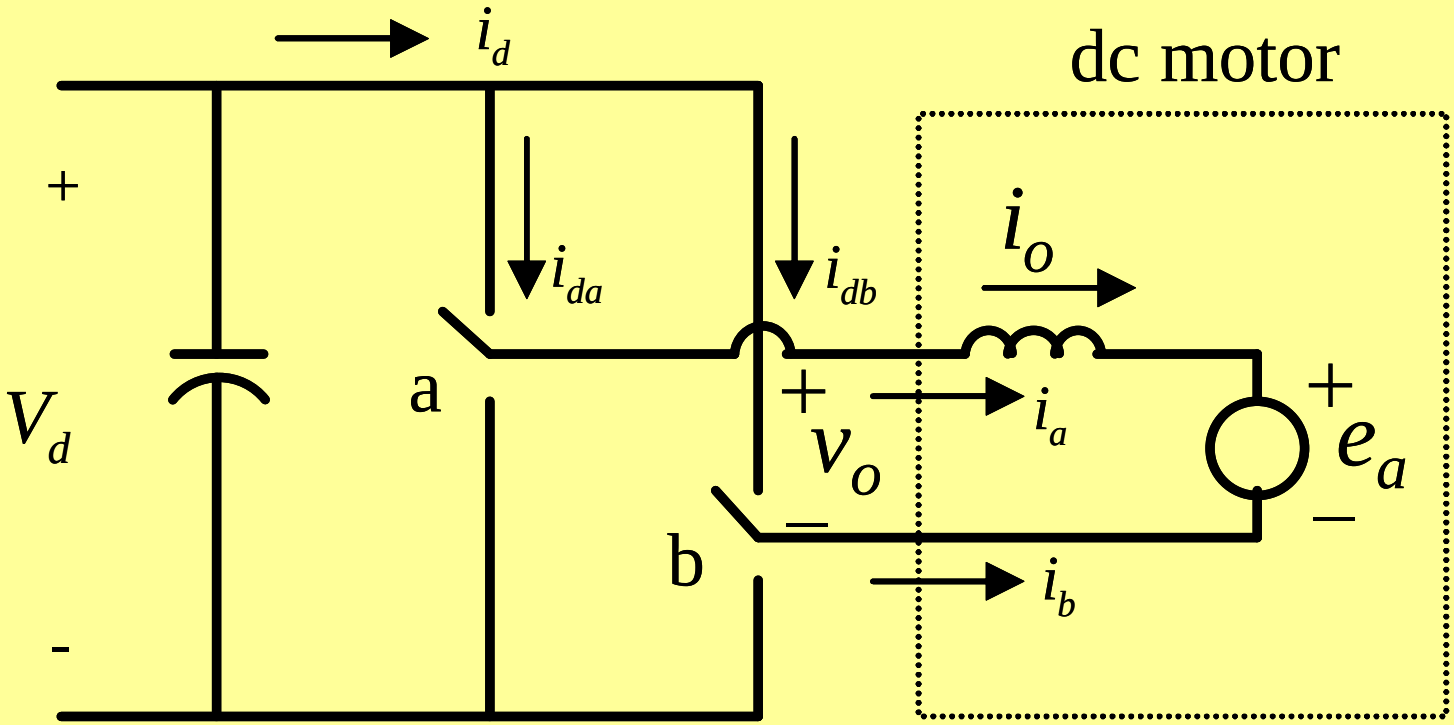
Gain of the DC-Drive Converter:

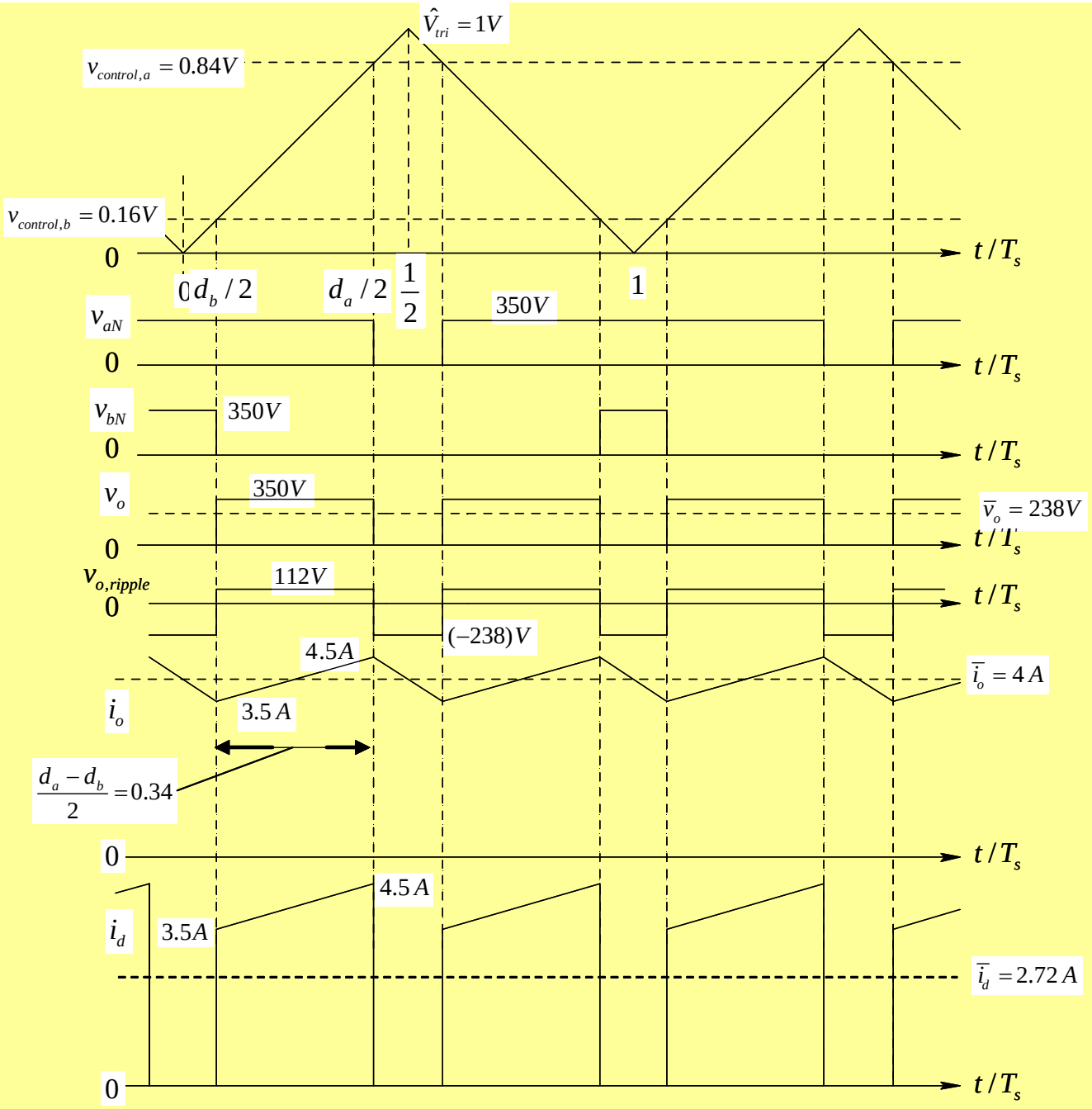


Switching Waveforms in a DC-Drive Converter:



Currents in a DC-Drive Converter:





Summary

Synthesis of DC and Sinusoidal AC Voltages

- Applications in
  - Electric Drives
  - UPS
  - Power Systems