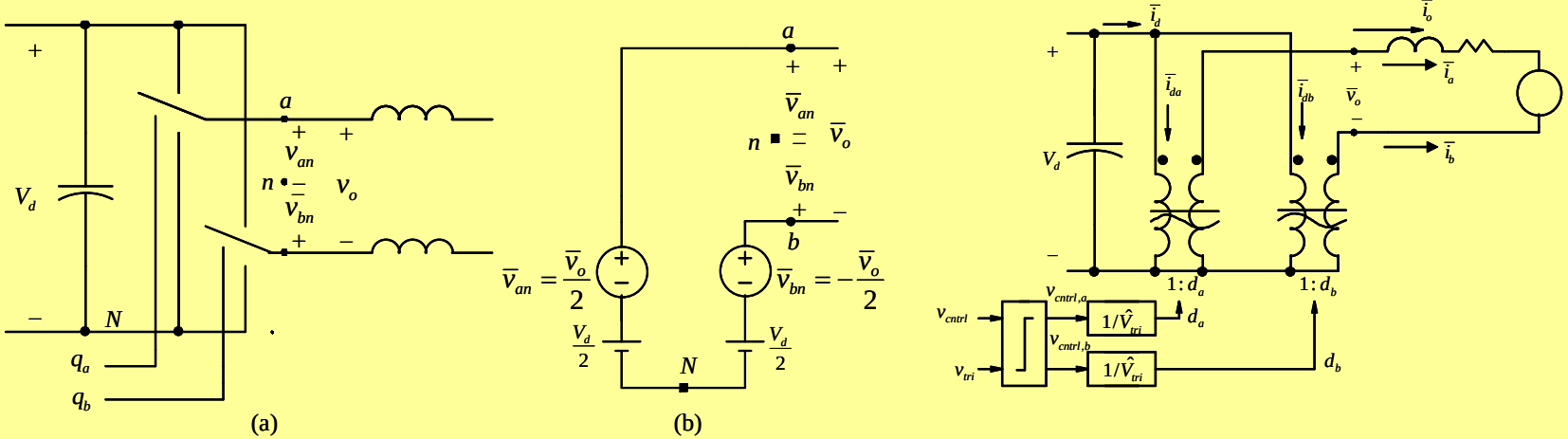
Converters for DC and AC Motor Drives

- Converters for DC-Motor Drives
- Converters for Three-Phase AC Motor Drives
- Semiconductors

Switch-Mode Converters for DC-Motor Drives



$$\bar{v}_{an} = \frac{\bar{v}_o}{2} \qquad \bar{v}_{bn} = -\frac{\bar{v}_o}{2} \qquad \bar{v}_{com} = \frac{V_d}{2} \qquad \bar{v}_{aN} = \frac{V_d}{2} + \frac{\bar{v}_o}{2} \qquad \bar{v}_{bN} = \frac{V_d}{2} - \frac{\bar{v}_o}{2}$$

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

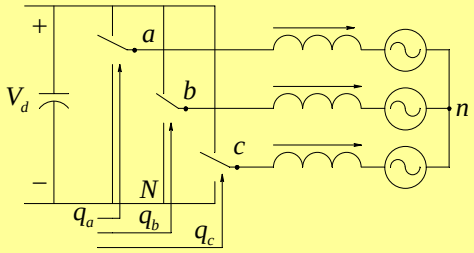
$$\bar{v}_{bN} = \bar{v}_{com} + \bar{v}_{bn}$$

$$\bar{v}_o = (d_a - d_b)V_d$$

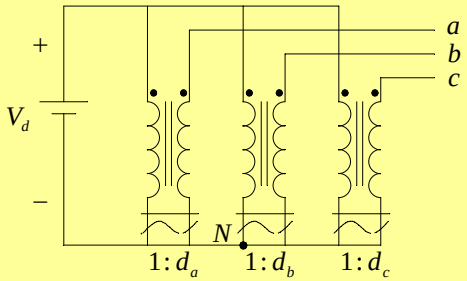
$$d_a = \frac{1}{2} + \frac{1}{2}\frac{\bar{v}_o}{V_d} \qquad d_b = \frac{1}{2} - \frac{1}{2}\frac{\bar{v}_o}{V_d}$$

- Output voltage can be positive or negative

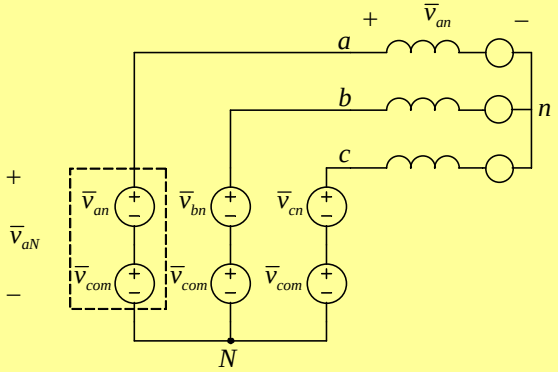
Three Phase Inverter AC-Motor Drives



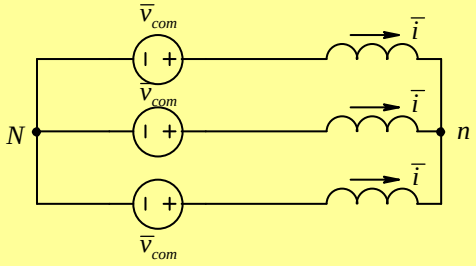
(a)



(b)



(a)



(b)

$$\bar{v}_{aN} = \frac{V_d}{2} + \bar{v}_{an} \qquad \bar{v}_{bN} = \frac{V_d}{2} + \bar{v}_{bn} \qquad \bar{v}_{cN} = \frac{V_d}{2} + \bar{v}_{cn}$$

$$d_a = \frac{1}{2} + \frac{\bar{v}_{an}}{V_d} \qquad d_b = \frac{1}{2} + \frac{\bar{v}_{bn}}{V_d} \qquad d_c = \frac{1}{2} + \frac{\bar{v}_{cn}}{V_d}$$

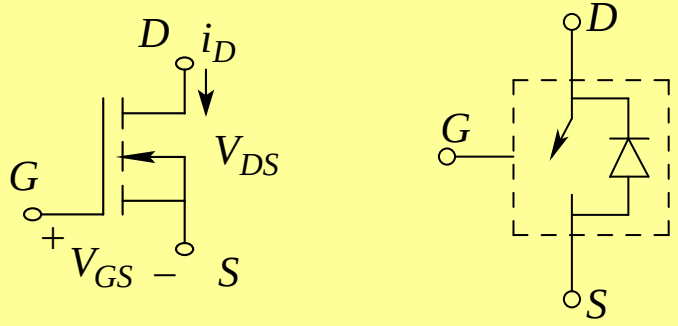
$$(\hat{V}_{ph})_{\max} = \frac{V_d}{2} \qquad (\hat{V}_{LL})_{\max} = \sqrt{3}(\hat{V}_{ph})_{\max} = \frac{\sqrt{3}}{2}V_d \simeq 0.867V_d \qquad (\hat{V}_{LL})_{\max} = V_d$$

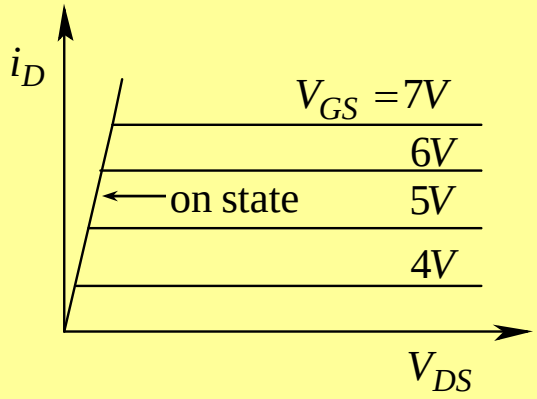
Power Devices

- ☐ Voltage rating — up to 9kV
- ☐ Current rating — ~ kA
- ☐ Switching items — ~ 0.1μs
- ☐ On-State voltage drop — 1V to 3V
- ☐ Cost

Controlled Switches

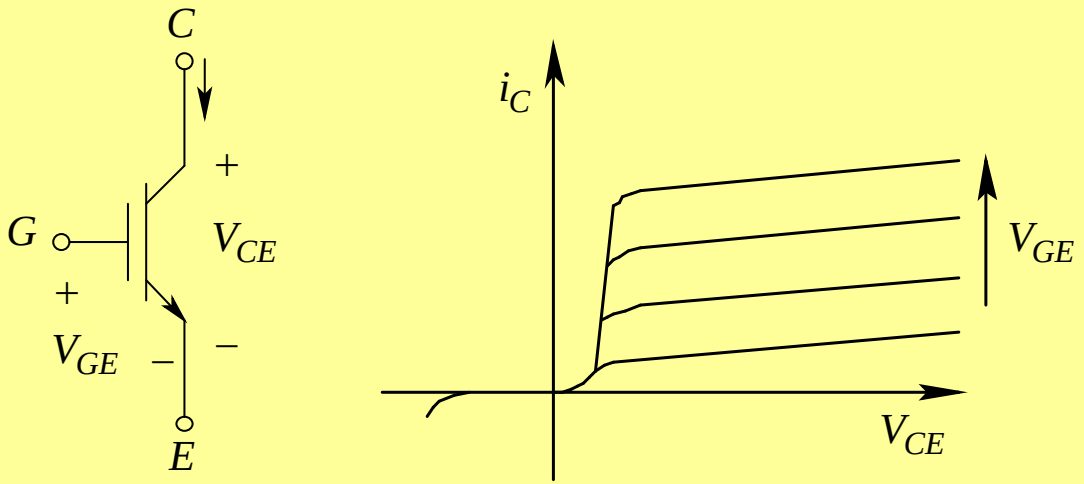
☐ MOSFET





- Insulated gate for low gate requirements
- Built-in diode
- r_{ds} increases exponentially with voltage rating
- Good for low voltage, high frequency

IGBT - Insulated Gate Bipolar Transistor



- Insulated Gate for low drive requirements
- Moderately high switching frequency
- Lower conduction losses than MOSFETs in high voltage devices
- Higher voltage (up to 3.3 kV) and current rating (up to 1200A)

☐ Smart Power Modules

- Gate Driver ICs
- Power Modules with Gate drivers

Summary

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