# Chapter 15

# Synchronous Motor Drives



- A large variety of applications – higher efficiency

# Rotor Structure

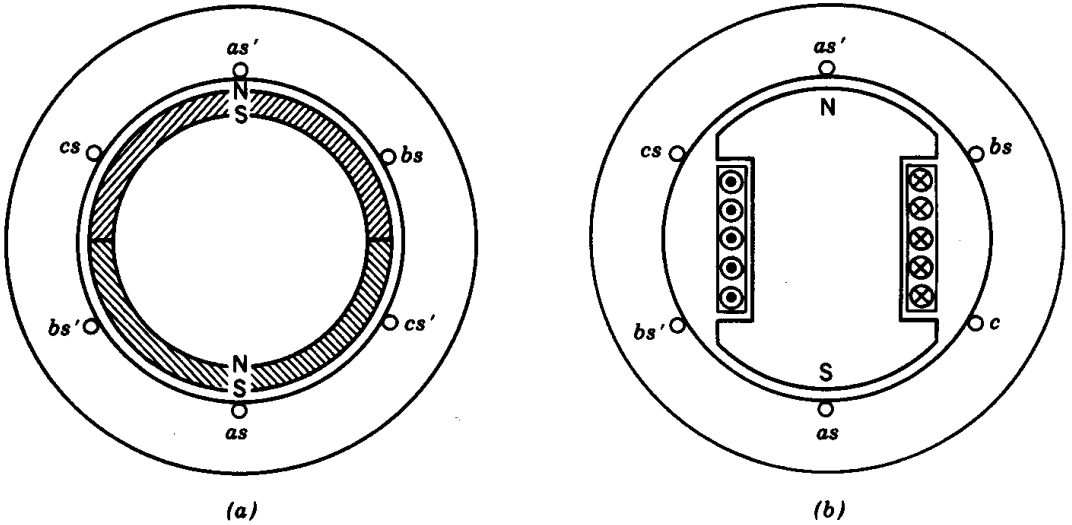


**Figure 15-1** Structure of synchronous motors: (*a*) permanent-magnet rotor (two-pole); (*b*) salient-pole wound rotor (two-pole).

- Permanent-magnet or wound with a field winding

# Per-Phase Representation

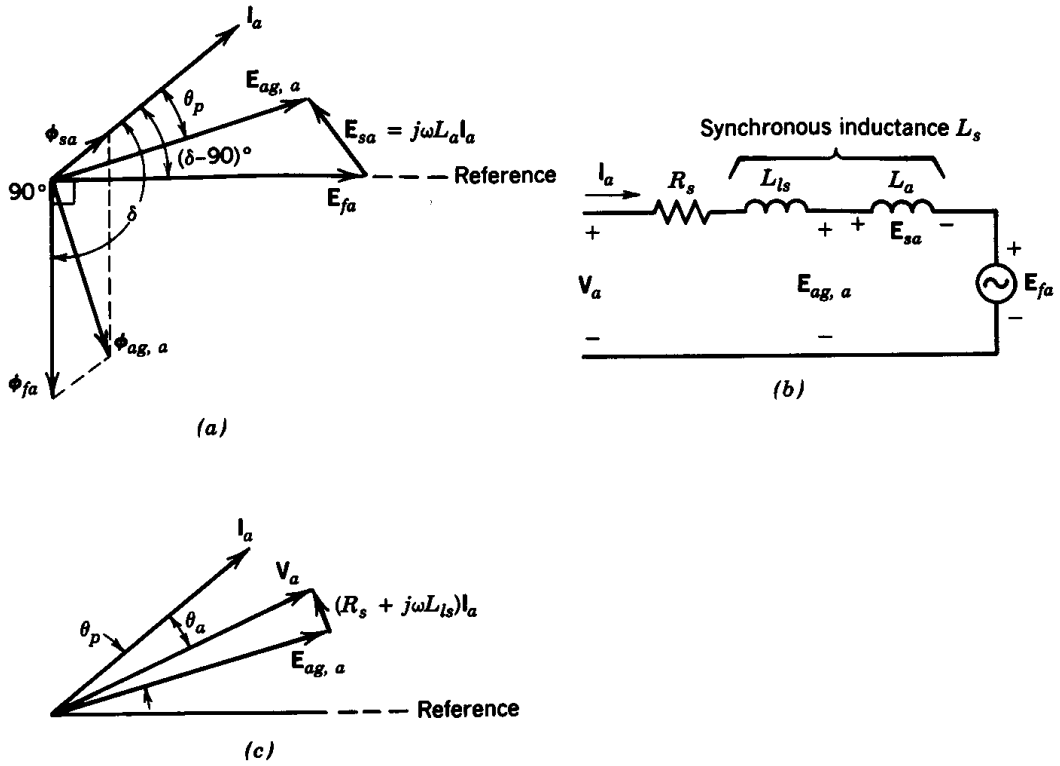


**Figure 15-2** Per-phase representation: (*a*) phasor diagram; (*b*) equivalent circuit; (*c*) terminal voltage.

- In sinusoidal steady state

# Phasor Diagram

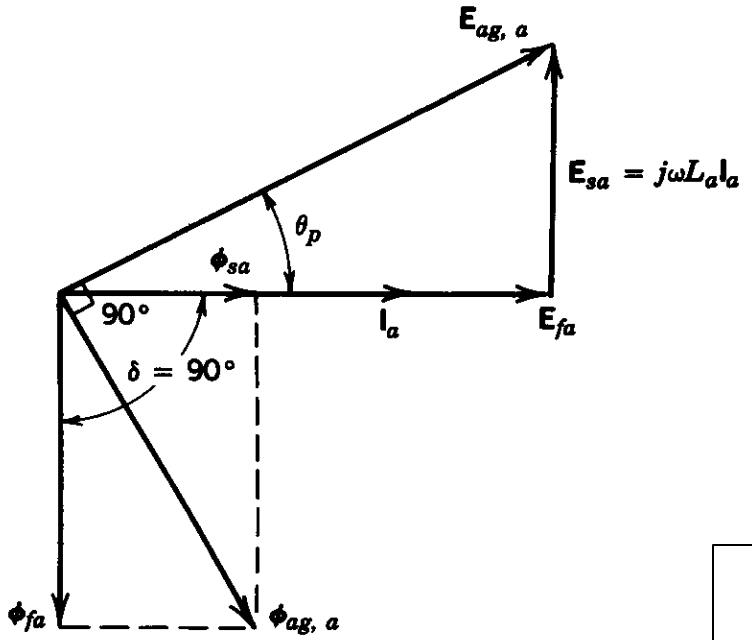


**Figure 15-3** Phasor diagram with $\delta = 90°$.

- Optimum operation

# Rotor Position

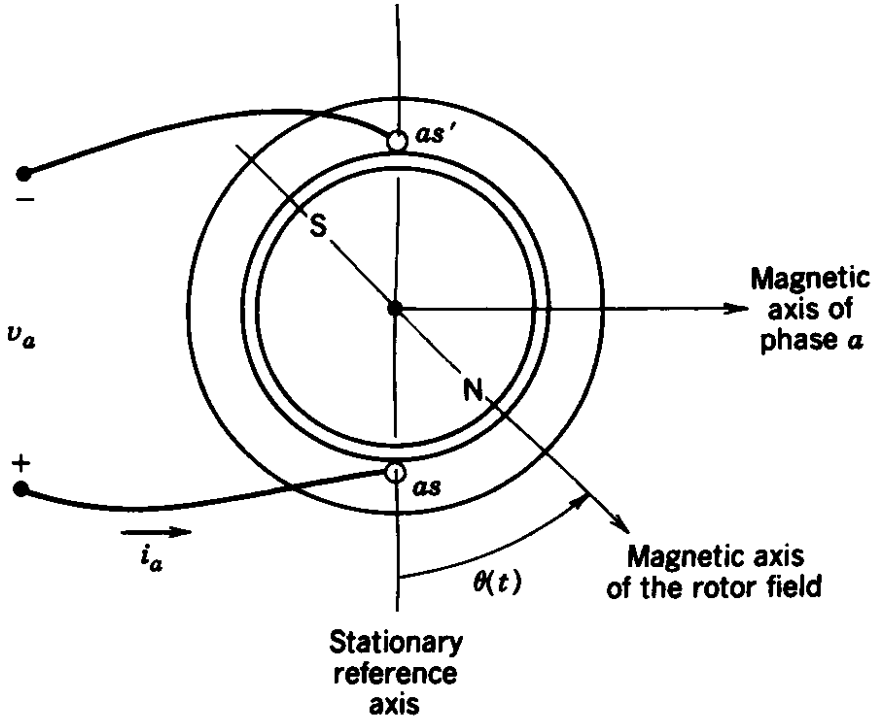


**Figure 15-4** Measured rotor position θ at time $t$.

- Needs closed-loop operation knowing the rotor position

# Synchronous Motor Drive

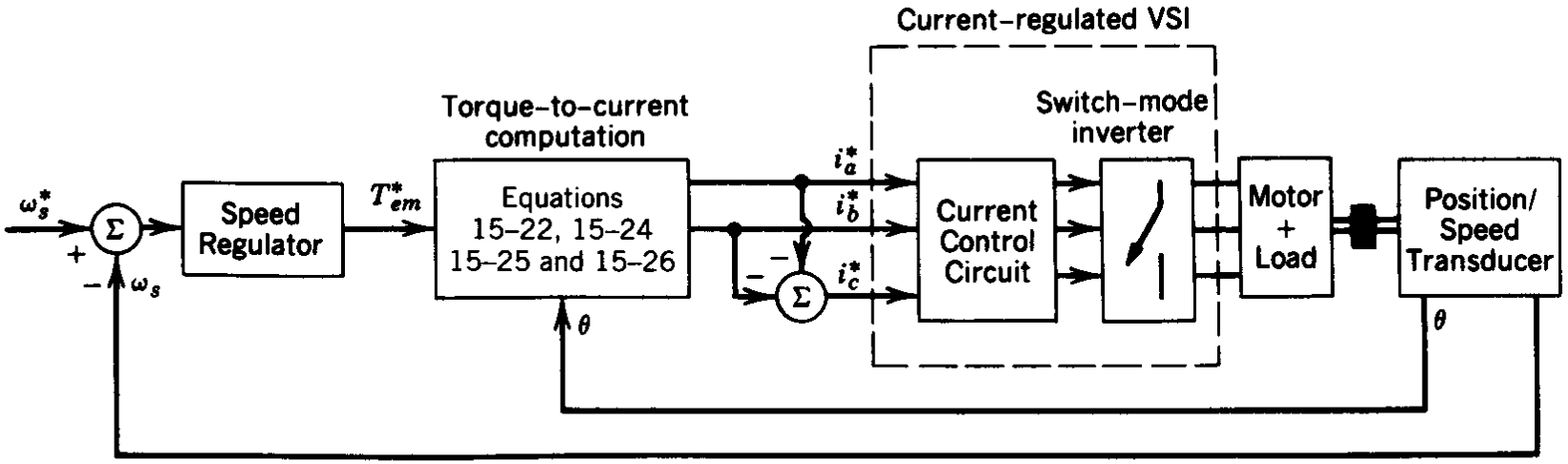


**Figure 15-5** Synchronous motor servo drive.

- Controller based on steady state operation

# Trapezoidal Waveform Synchronous Motor

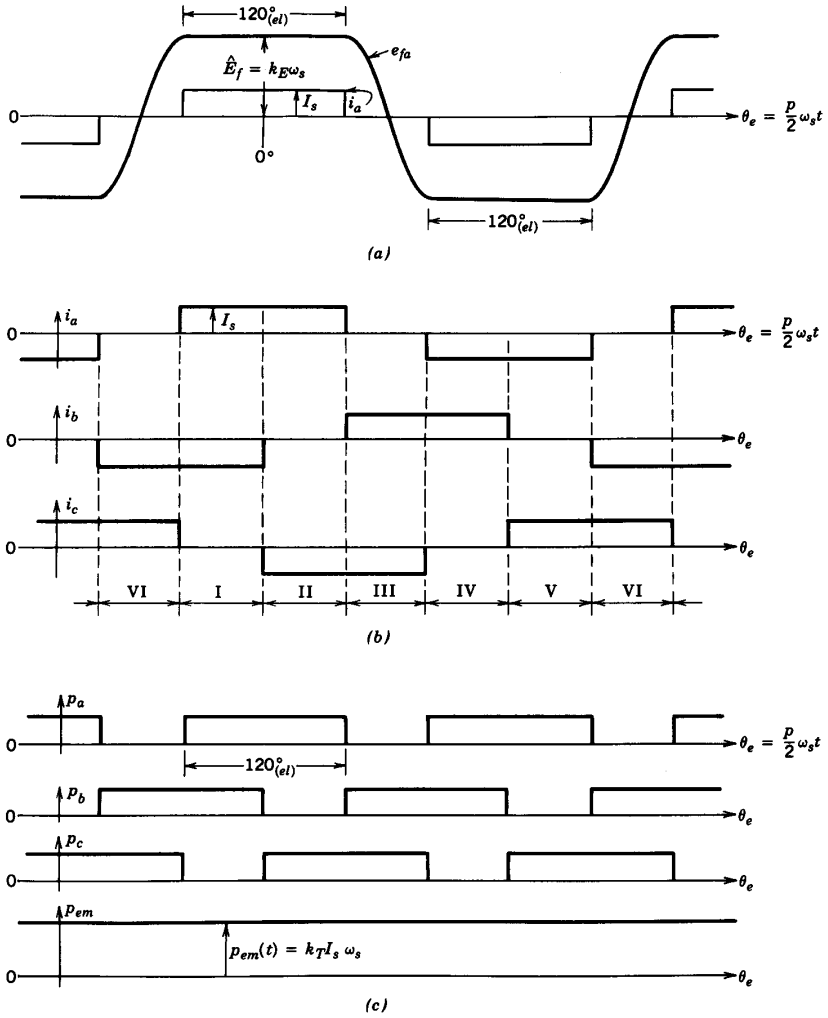


**Figure 15-6** Trapezoidal-waveform synchronous motor drive.

- used in applications where speed of response not critical

# Load-Commutated Inverter (LCI) Drive

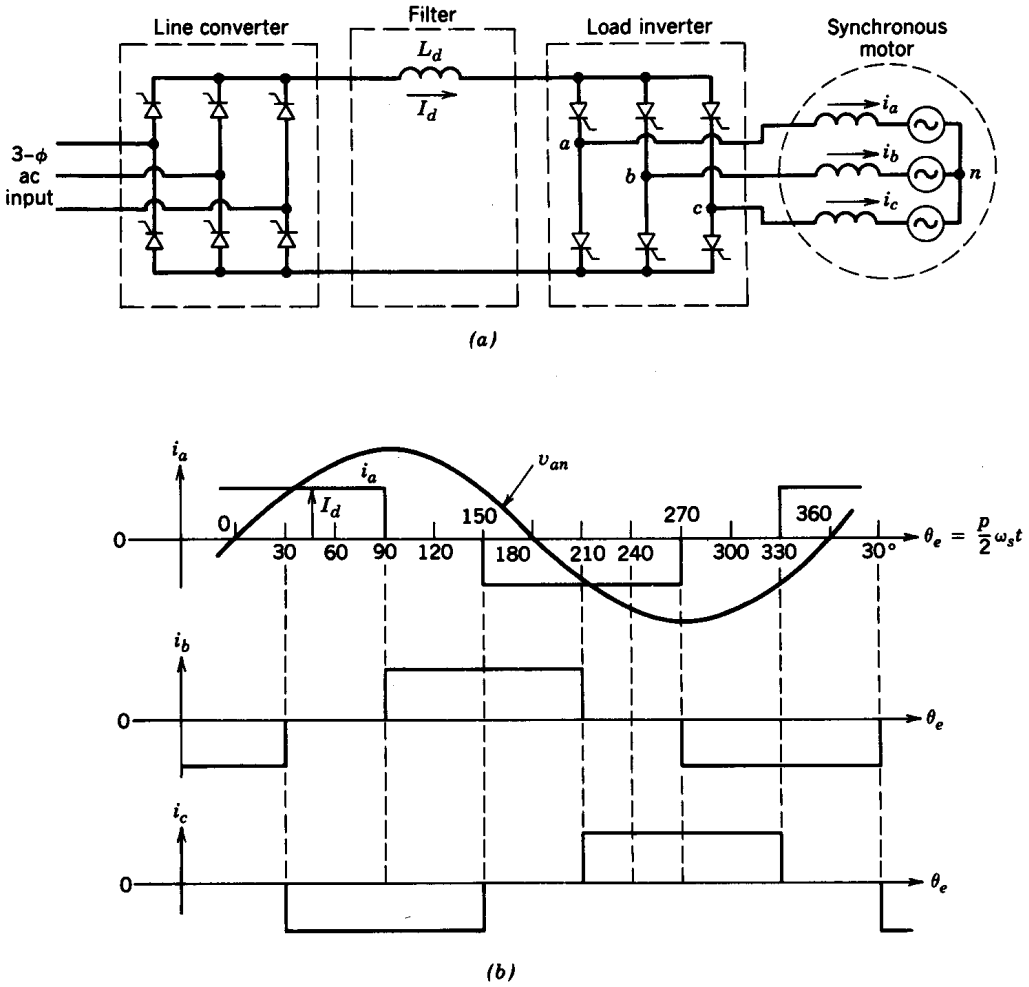


**Figure 15-7** An LCI drive: (*a*) circuit; (*b*) idealized waveforms.

- Used in very large power ratings

# LCI Drive Controller

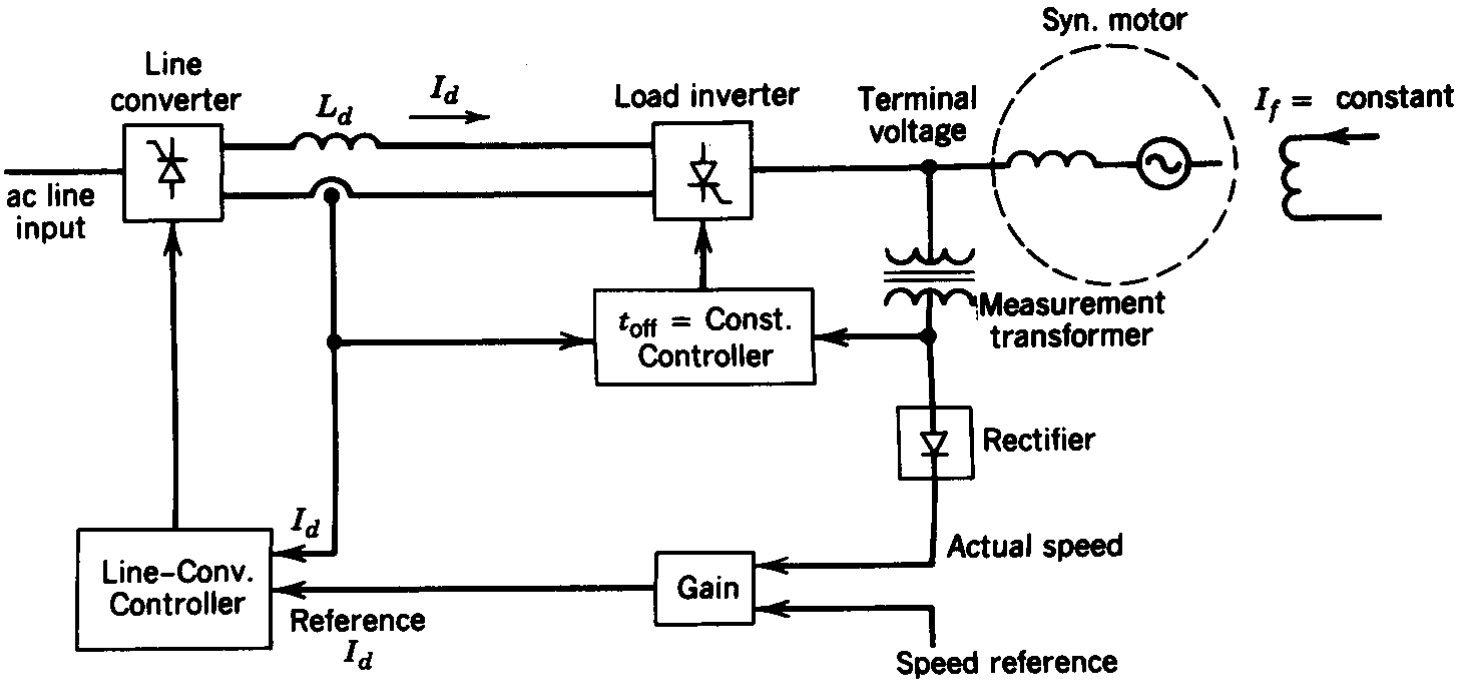


**Figure 15-8** An LCI drive controller.

- Line converter controls the dc-link current

# Three-Phase Cycloconverter

- Low-frequency ac output is synthesized

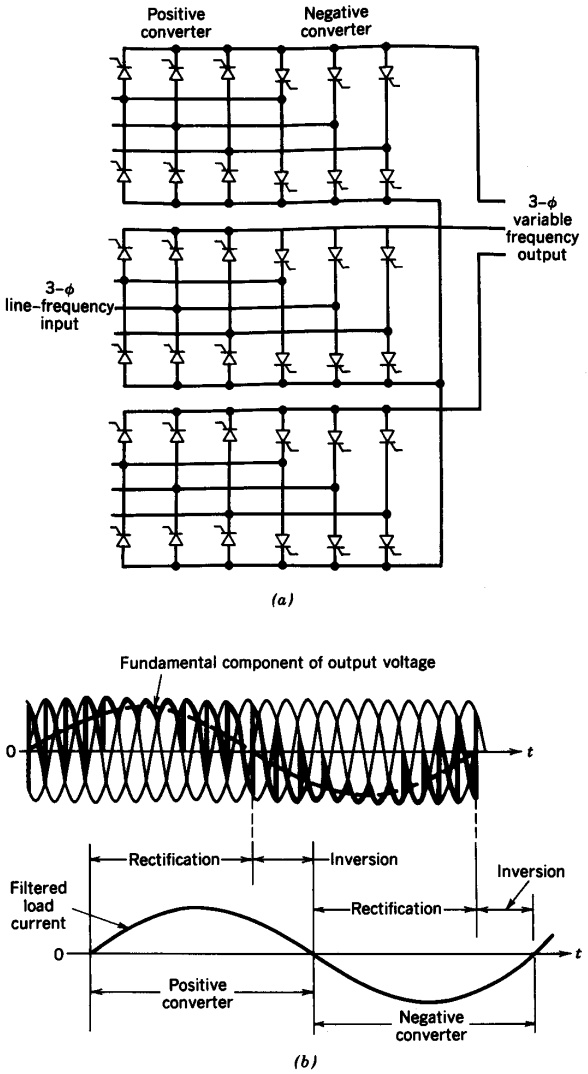


**Figure 15-9** Three-phase cycloconverter.