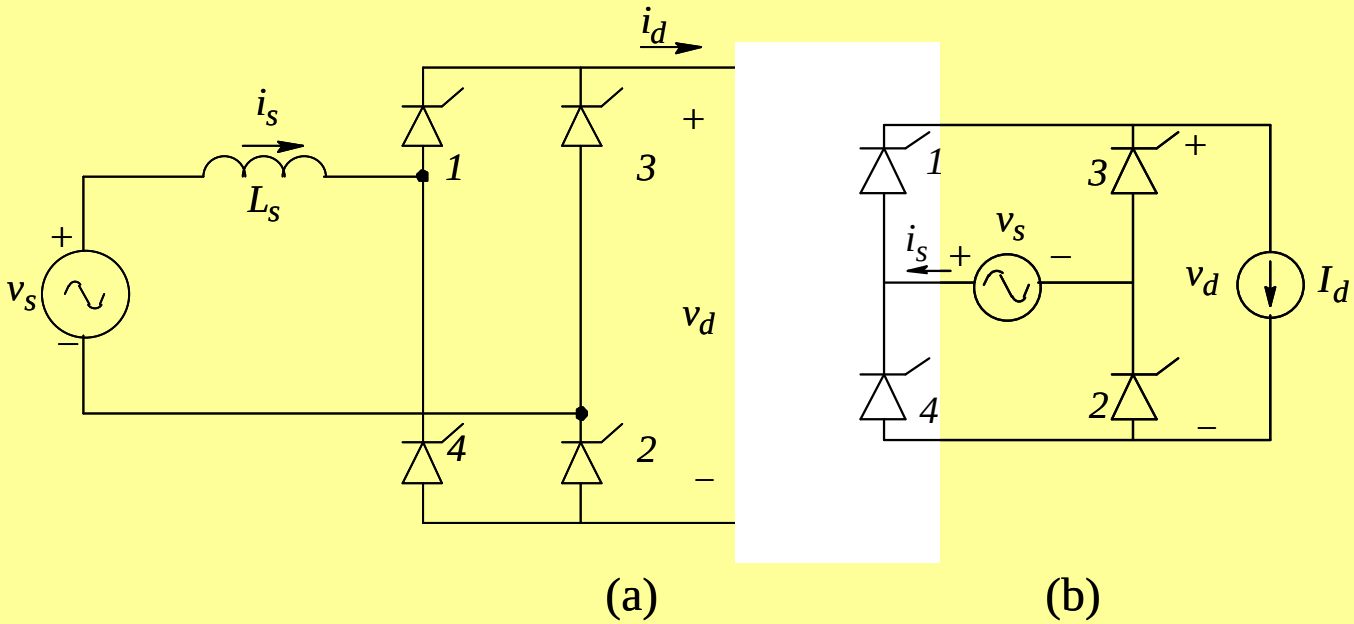
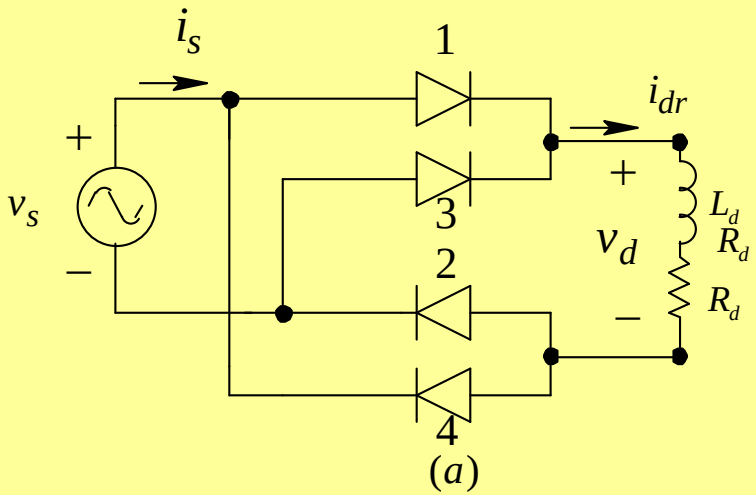
Thyristor Converters

- Single-Phase Thyristor Inverter Operation

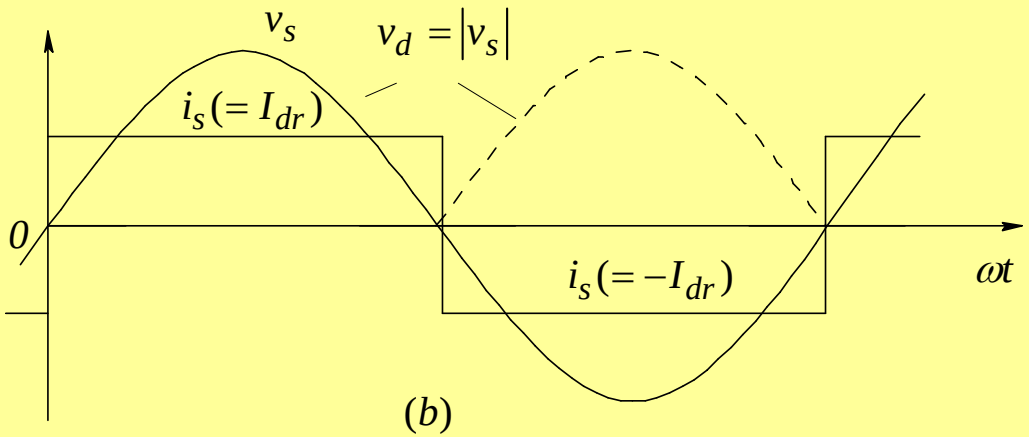
Single-Phase, Phase-Controlled Thyristor Converters



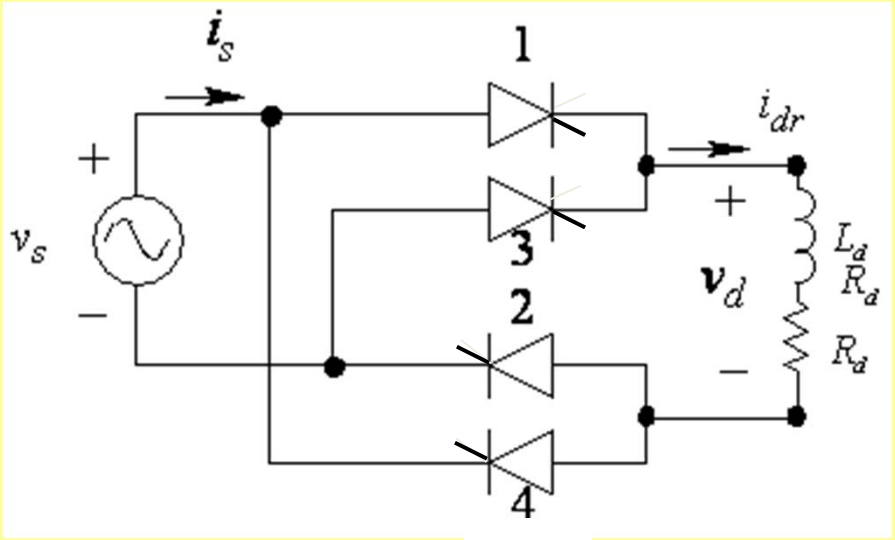
Review: Diode Rectifiers

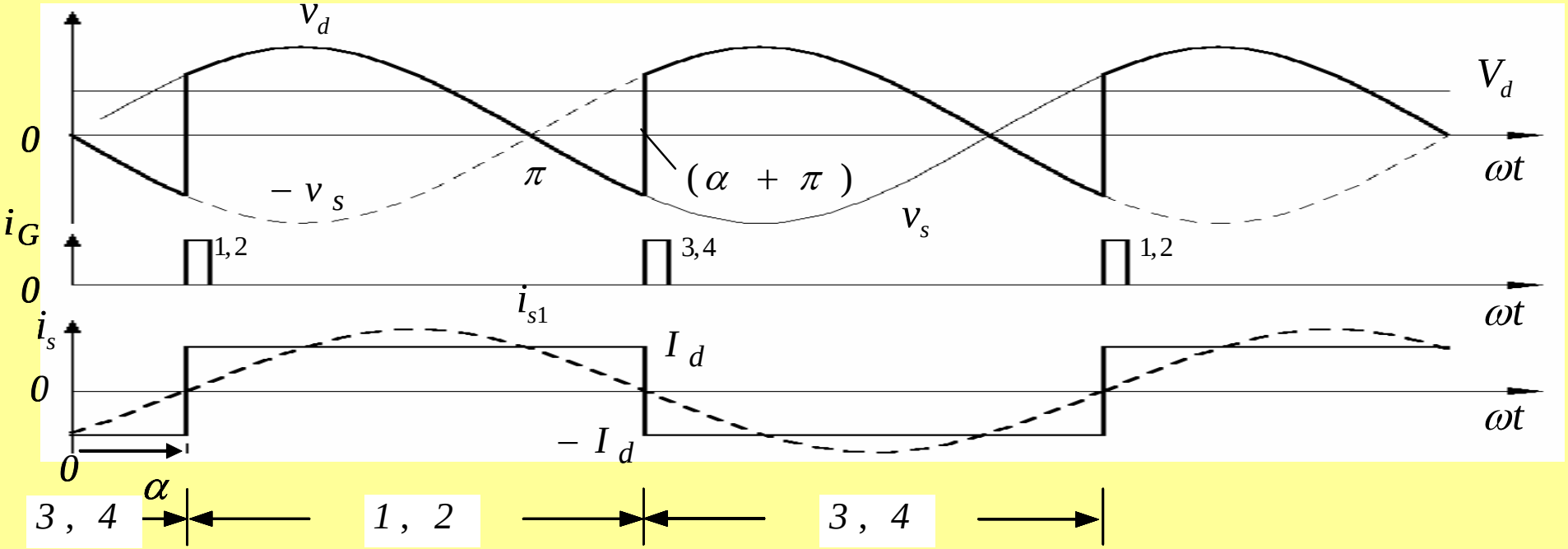


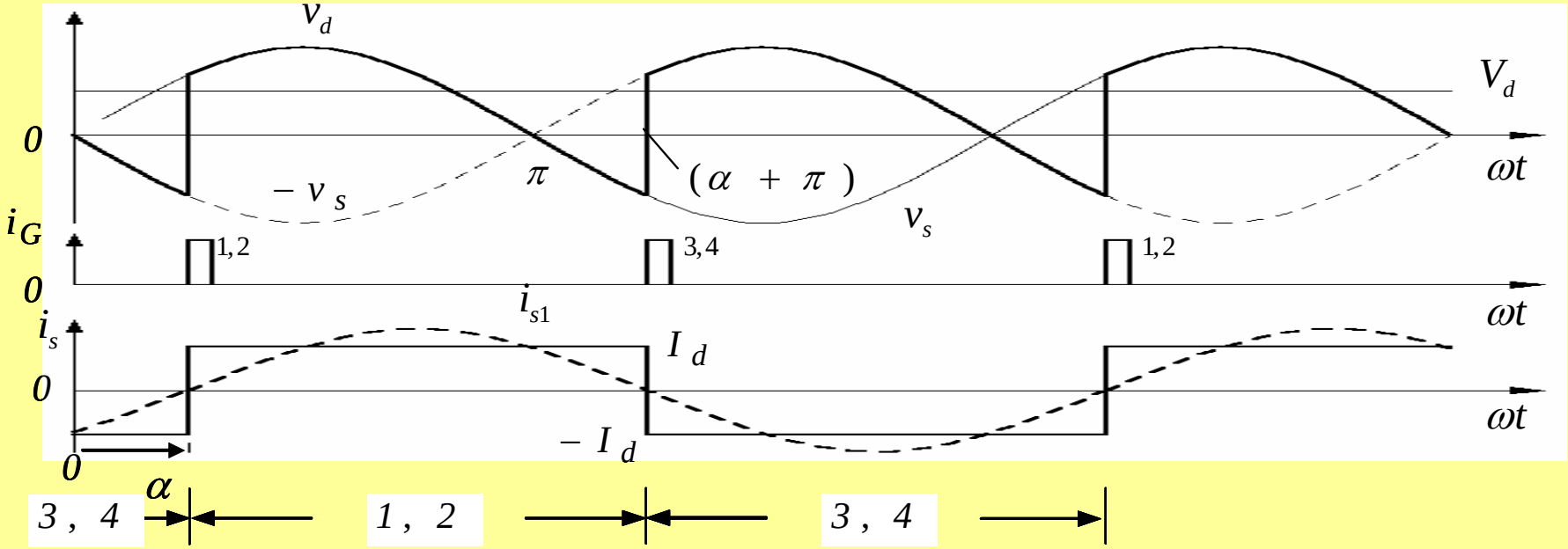
(a)



(b)







$$v_d(t) = v_s(t) \quad \text{and} \quad i_s(t) = I_d \qquad \alpha < \omega t \le \alpha + \pi$$

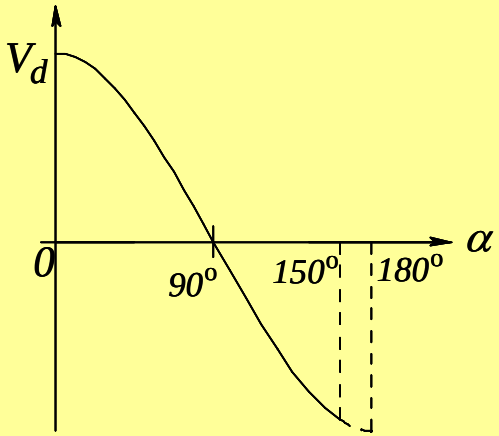
$$v_d(t) = -v_s(t) \quad \text{and} \quad i_s(t) = -I_d \qquad \alpha + \pi < \omega t \le \alpha + 2\pi$$

$$V_d = \frac{1}{\pi}\int_{\alpha}^{\alpha+\pi} \hat{V}_s \sin\omega t \cdot d(\omega t) = \frac{2}{\pi}\hat{V}_s \cos\alpha$$

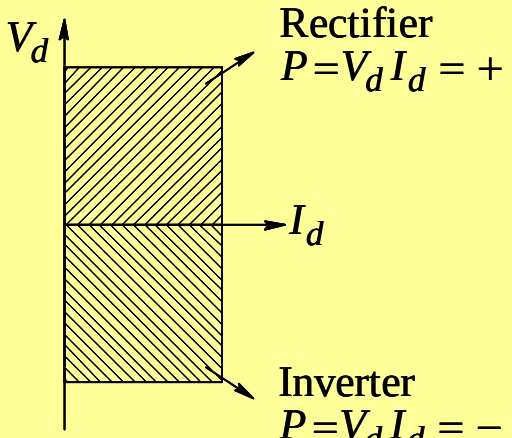
$$\hat{I}_{s1} = \frac{4}{\pi} I_d$$

$$P = \frac{1}{2}\hat{V}_s \hat{I}_{s1}\cos\alpha = V_d I_d$$

Effect of Delay Angle:

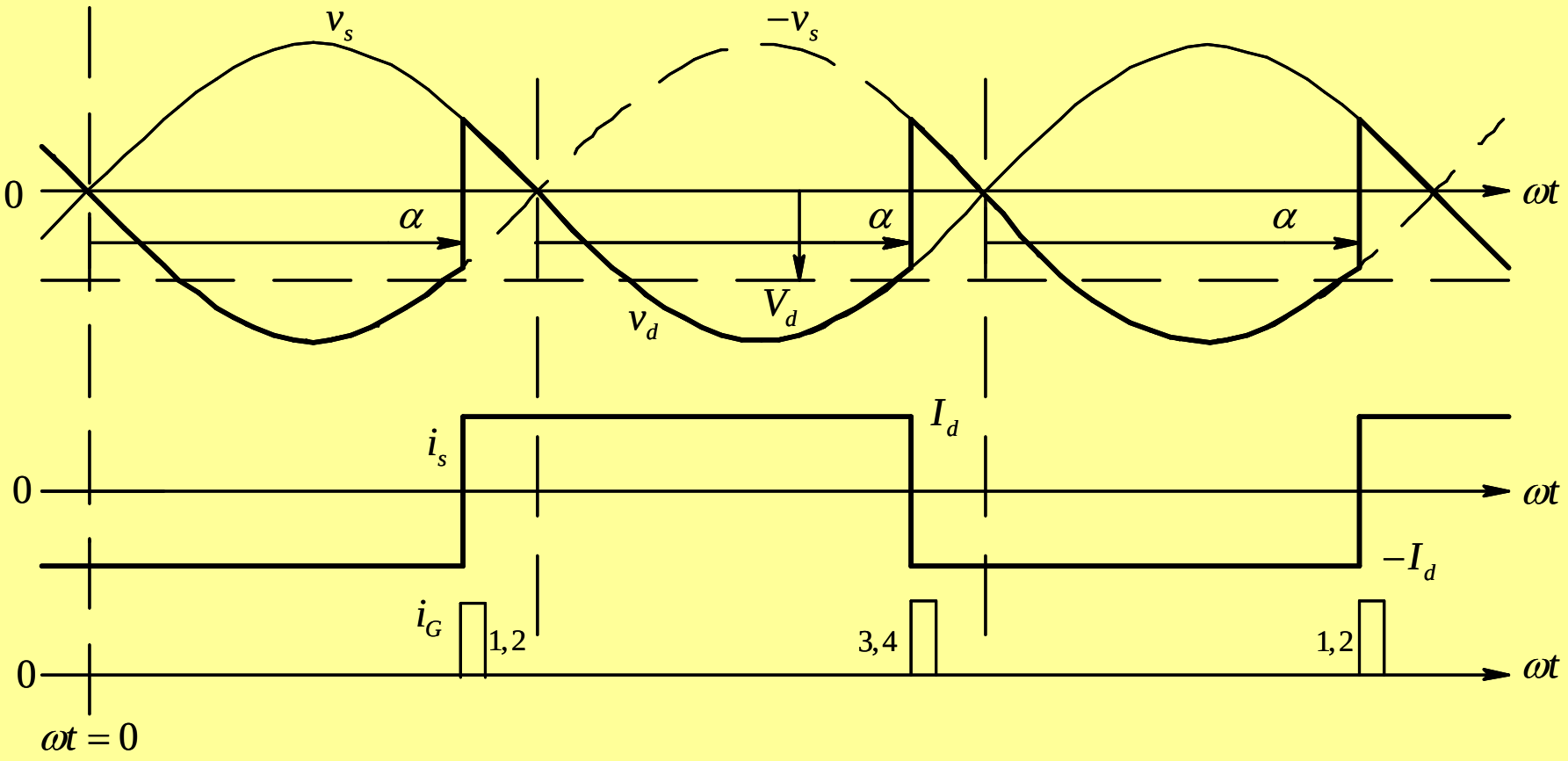


(a)



(b)

$$V_d = \frac{1}{\pi}\int_{\alpha}^{\alpha+\pi} \hat{V}_s \sin\omega t \cdot d(\omega t) = \frac{2}{\pi}\hat{V}_s \cos\alpha$$

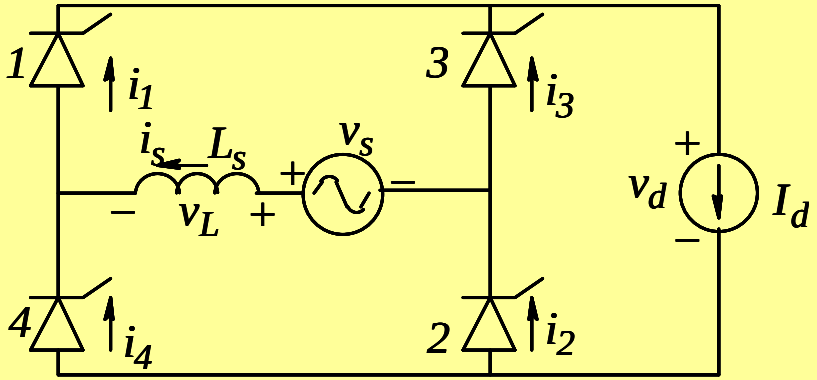


Current Harmonics and the Reactive Power:

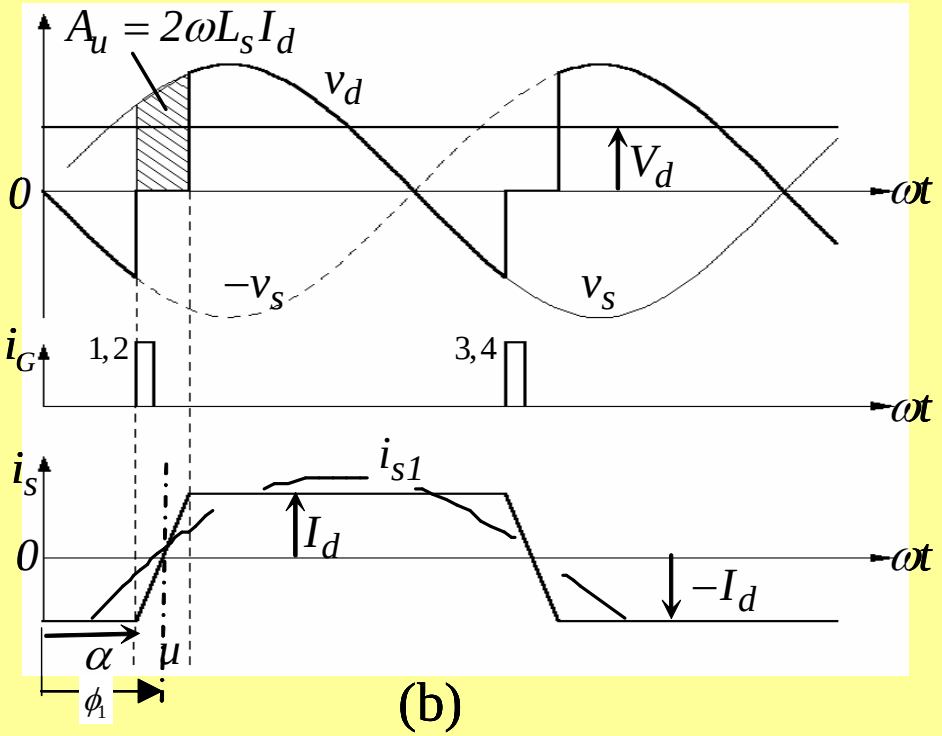
$$\hat{I}_{sh} = \frac{\hat{I}_{s1}}{h}$$

$$Q = \frac{1}{2}\hat{V}_s \hat{I}_{s1} \sin\alpha$$

The Effect of L_s on Current Commutation



(a)



(b)

$$\int_{\alpha}^{\alpha+u} v_L \, d(\omega t) = L_s \int_{\alpha}^{\alpha+u} \frac{di_s}{dt} d(\omega t) = \omega L_s \int_{-I_d}^{I_d} di_s = \omega L_s (2I_d)$$

$$\Delta V_d = \frac{2}{\pi} \omega L_s I_d \qquad V_d = \frac{2}{\pi} V_s \cos\alpha - \frac{2}{\pi} \omega L_s I_d$$

$$\phi_1 = \alpha + \frac{u}{2} \qquad Q = \frac{1}{2} \hat{V}_s \hat{I}_{s1} \sin(\alpha + \frac{u}{2})$$

Summary

- Single-Phase Thyristor Converters
  - Inverter Mode of Operation
  - Current Commutation