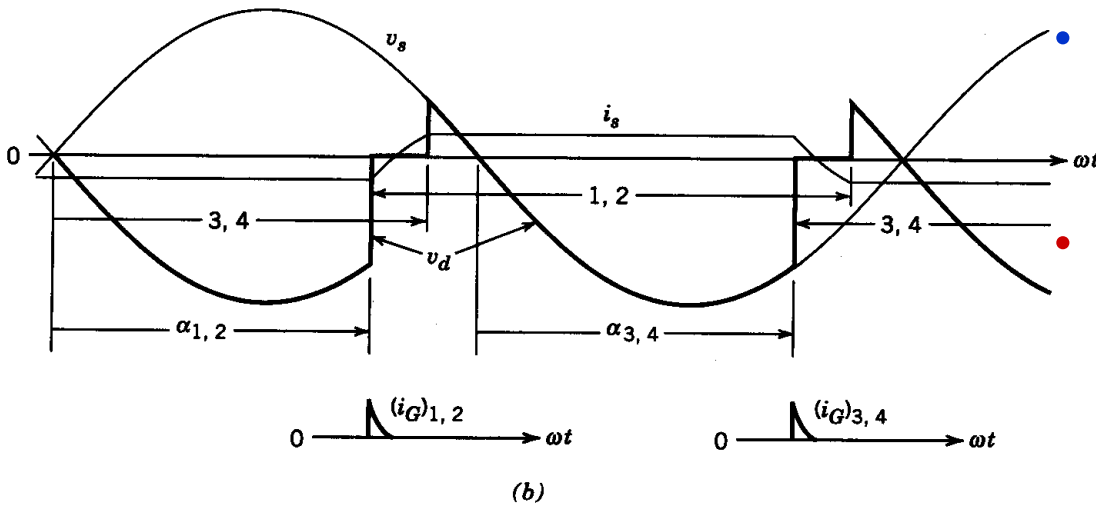
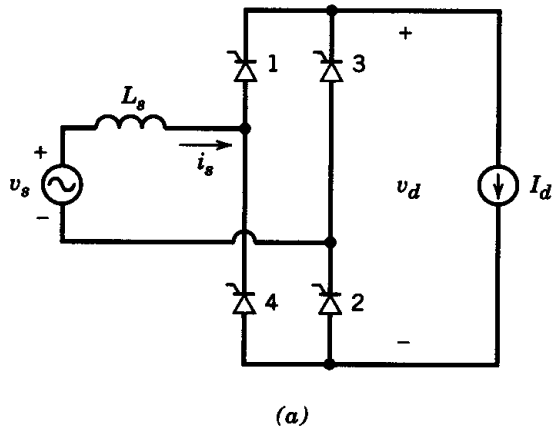


Thyristor Converters: Inverter Mode (V_d is negative)



- Average value of v_d is negative for $90^\circ < \alpha < 180^\circ$. Average power P_d is negative ($P_d = V_d I_d$) and thus power flows from the dc to the ac side
- On the ac side, $P_{ac} = V_s I_s \cos \phi_1$ is also negative because $\phi_1 > 90^\circ$
- Inverter mode of operation is possible because there is a source of energy on the dc side
- ac side voltage source provides commutation of current from one pair of thyristors to the others

Figure 6-15 (a) Inverter, assuming a constant dc current. (b) Waveforms.

3-Phase Thyristor Converters

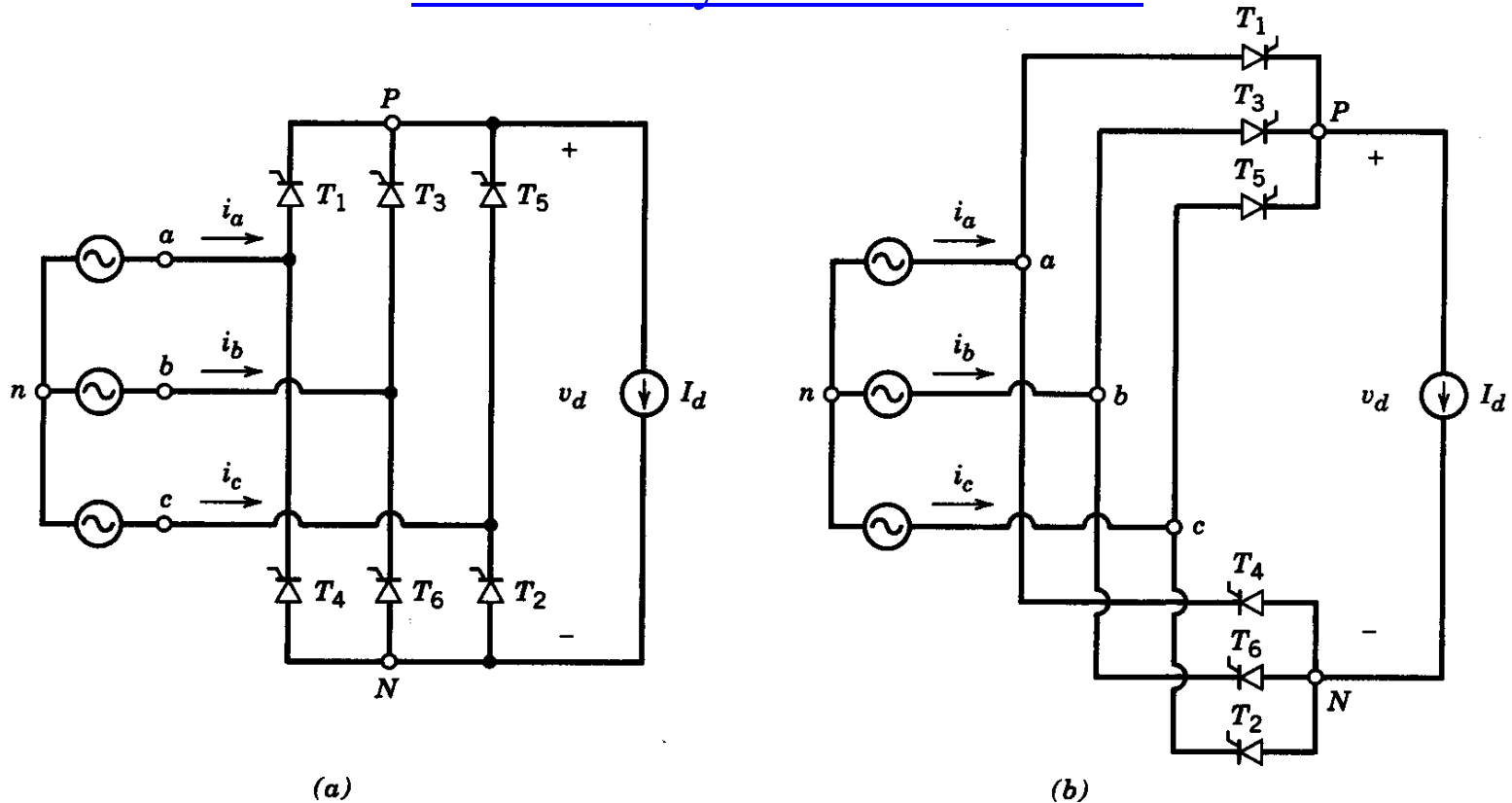


Figure 6-19 Three-phase thyristor converter with $L_s = 0$ and a constant dc current.

- Current I_d flows through the one thyristor of the top group and one of the bottom group
- If a continuous gate pulse is applied then this circuit will act like a three-phase full bridge diode rectifier and, as a result,

$$V_{d0} = 1.35 V_{LL}$$

3-Phase Thyristor Converter Waveforms

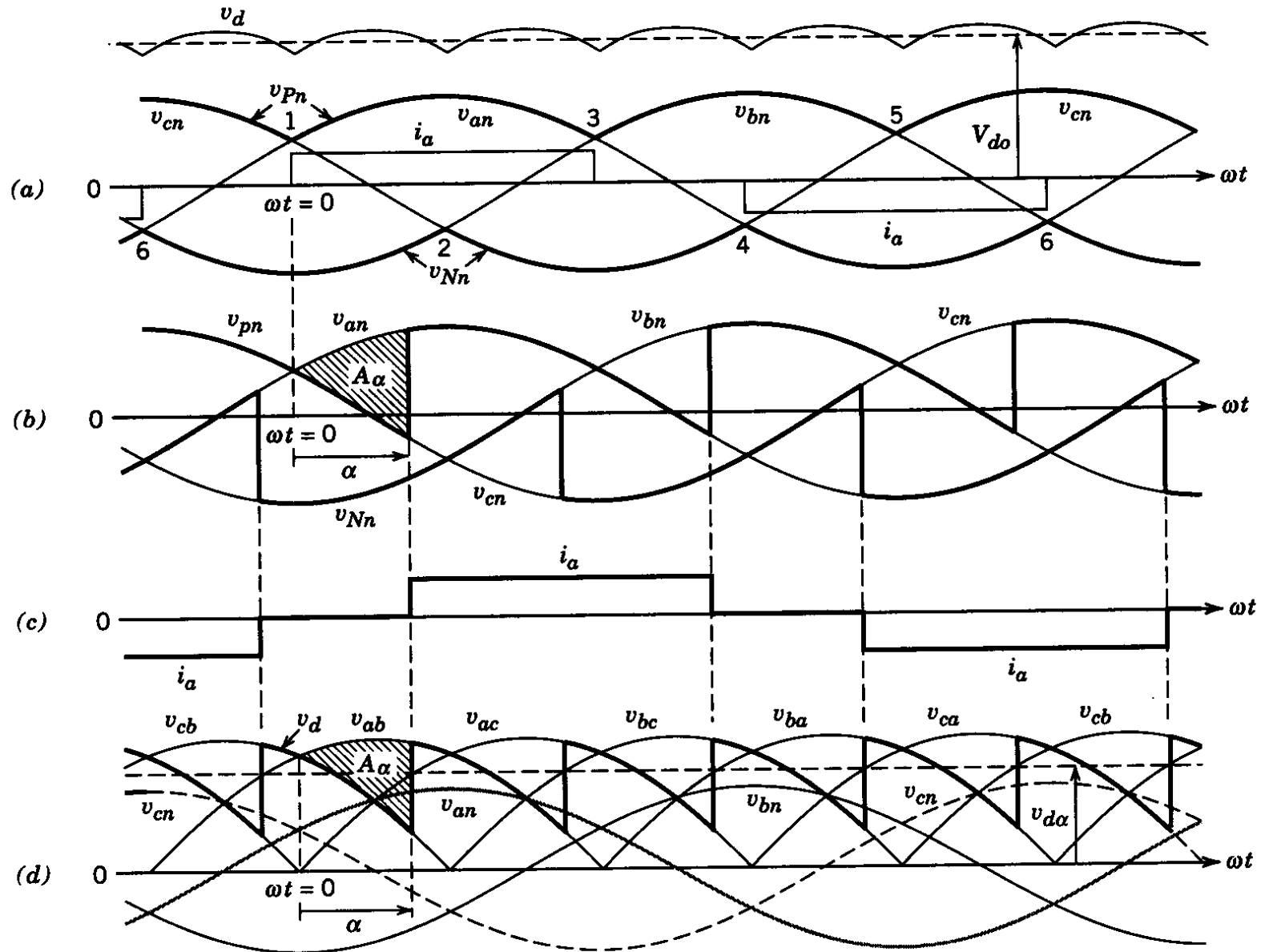


Figure 6-20 Waveforms in the converter of Fig. 6-19.

Average Output DC Voltage

$$V_{d\alpha} = V_{d0} - \frac{A_{\mu}}{\pi/3}$$

$$V_{ac} = \sqrt{2}V_{LL} \sin(\omega t)$$

The reduction in the average dc voltage due to the delay angle α

$$A_{\mu} = \int_0^{\alpha} \sqrt{2}V_{LL} \sin(\omega t) d(\omega t) = \sqrt{2}V_{LL} (1 - \cos \alpha)$$

$$\begin{aligned} \therefore V_{d\alpha} &= V_{d0} - \frac{A_{\mu}}{\pi/3} = 1.35V_{LL} - \frac{\sqrt{2}V_{LL} (1 - \cos \alpha)}{\pi/3} \\ &= 1.35V_{LL} \cos \alpha = 1.35V_{d0} \end{aligned}$$

Average Power

$$P_{d\alpha} = V_{d\alpha} I_d = 1.35V_{LL} I_d \cos \alpha$$

❖ dc-side voltage waveforms as a function of α

❖ V_d repeats at six times the line frequency

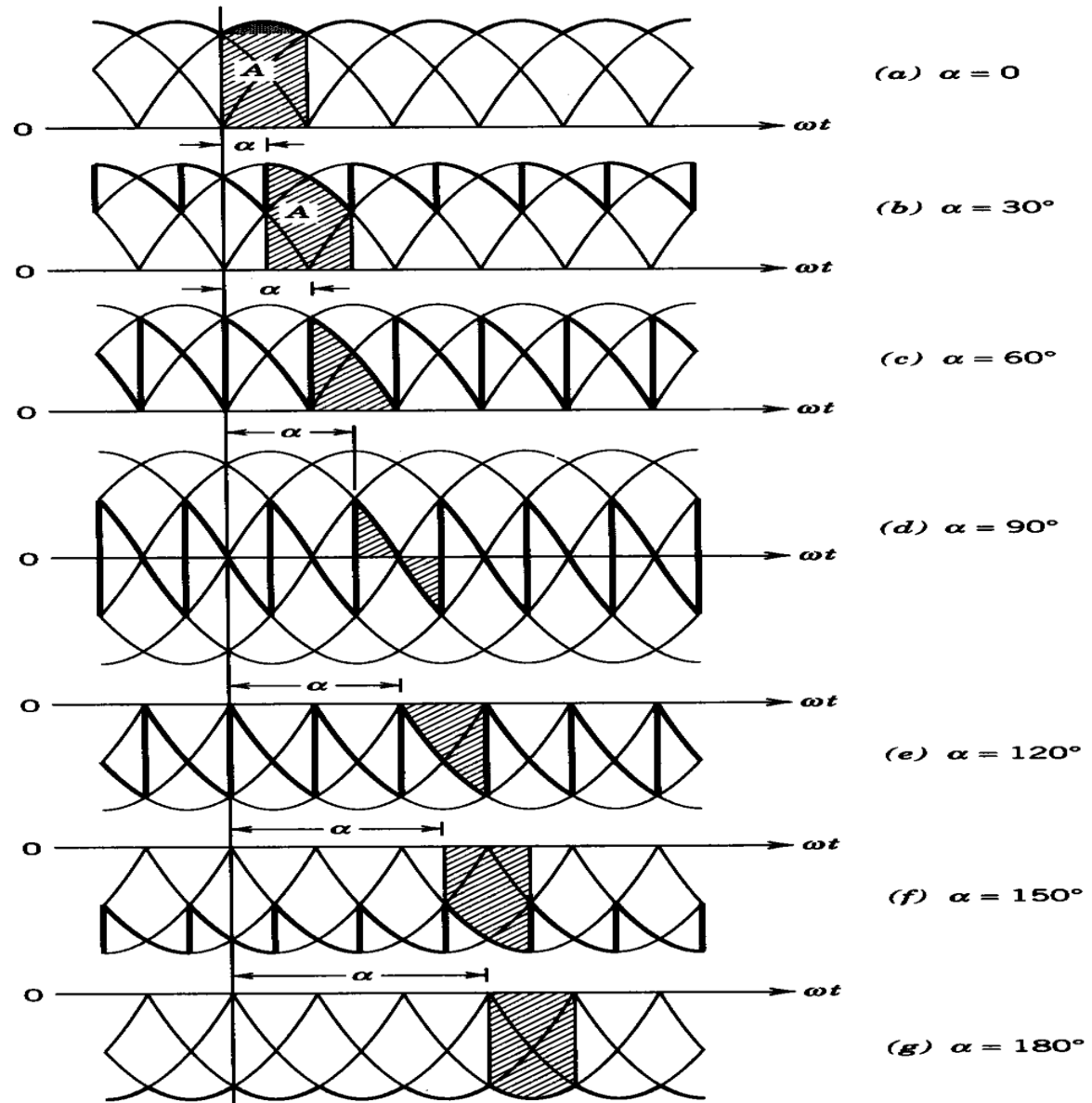


Figure 6-21 The dc-side voltage waveforms as a function of α where $V_{d\alpha} = A/(\pi/3)$. (From ref. 2 with permission.)

Conclusions

- Thyristor converters provides controlled transfer of power between the line frequency ac and adjustable-magnitude dc
- By controlling α , transition from rectifier to inverter mode of operation can be made and vice versa
- Thyristor converters are mostly used at high-power levels
- Thyristor converters inject large harmonics into the utility system