Energoelektronika
3. Prostowniki Niesterowane

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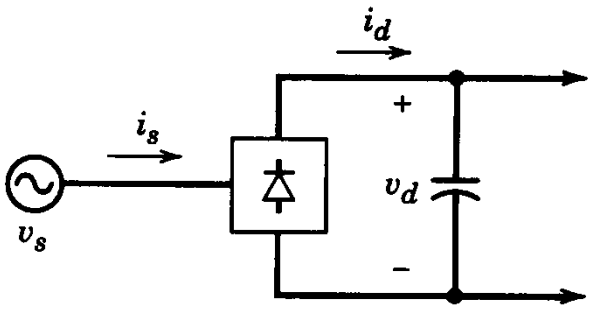
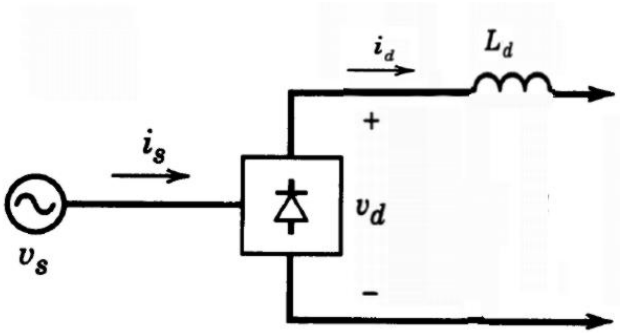
Prostowniki niesterowane

- Wprowadzenie do koncepcji prostowania
- Jednofazowy prostownik diodowy
- Jednofazowy prostownik mostkowy
- Podwajacz napięcia
- Prostowniki trójfazowe

Diode Rectifier Block Diagram

- Uncontrolled utility interface (ac to dc)





A Simple Circuit

- Resistive load

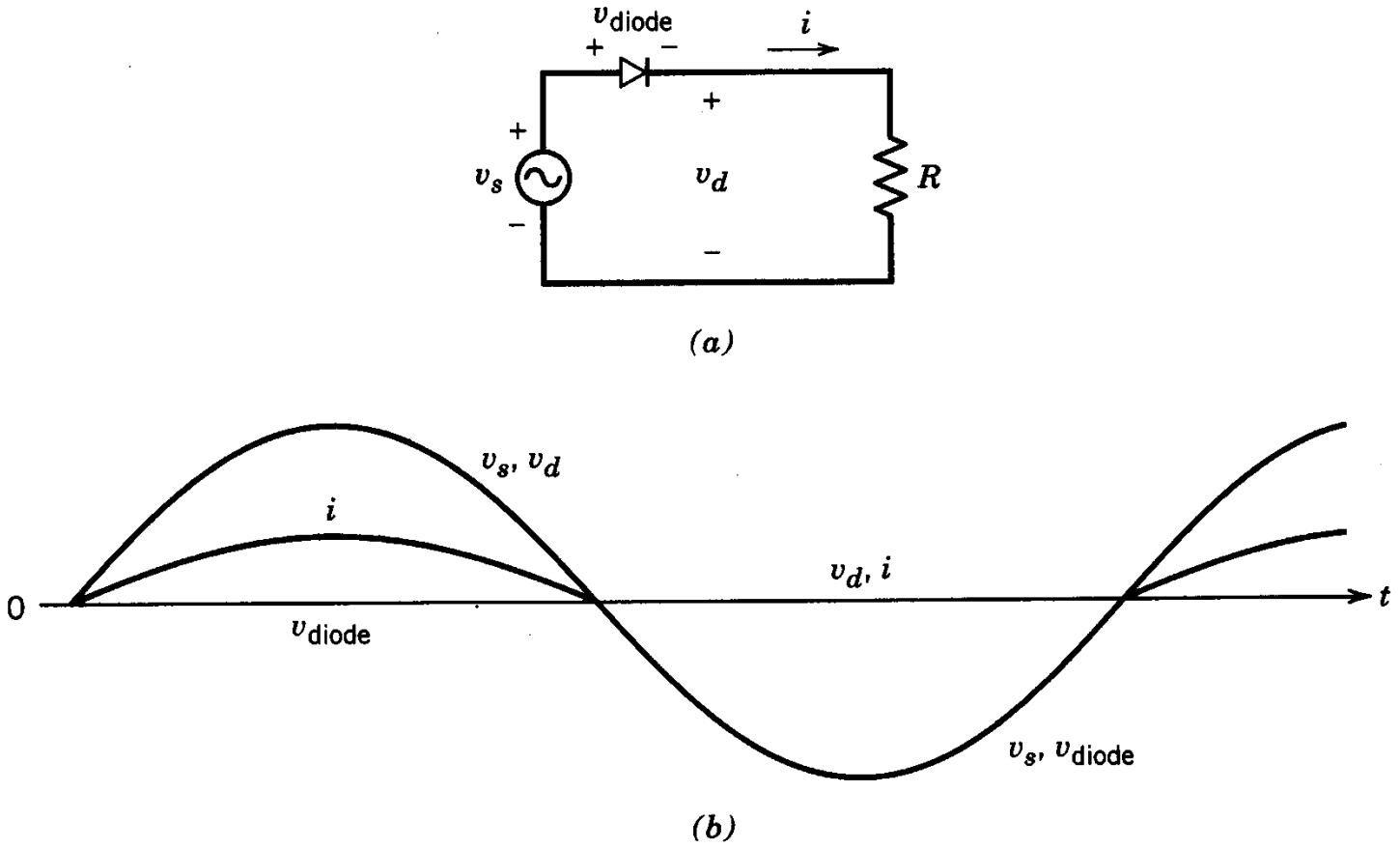


Figure 5-2 Basic rectifier with a load resistance.

A Simple Circuit (*R-L* Load)

- Current continues to flows for a while even after the input voltage has gone negative

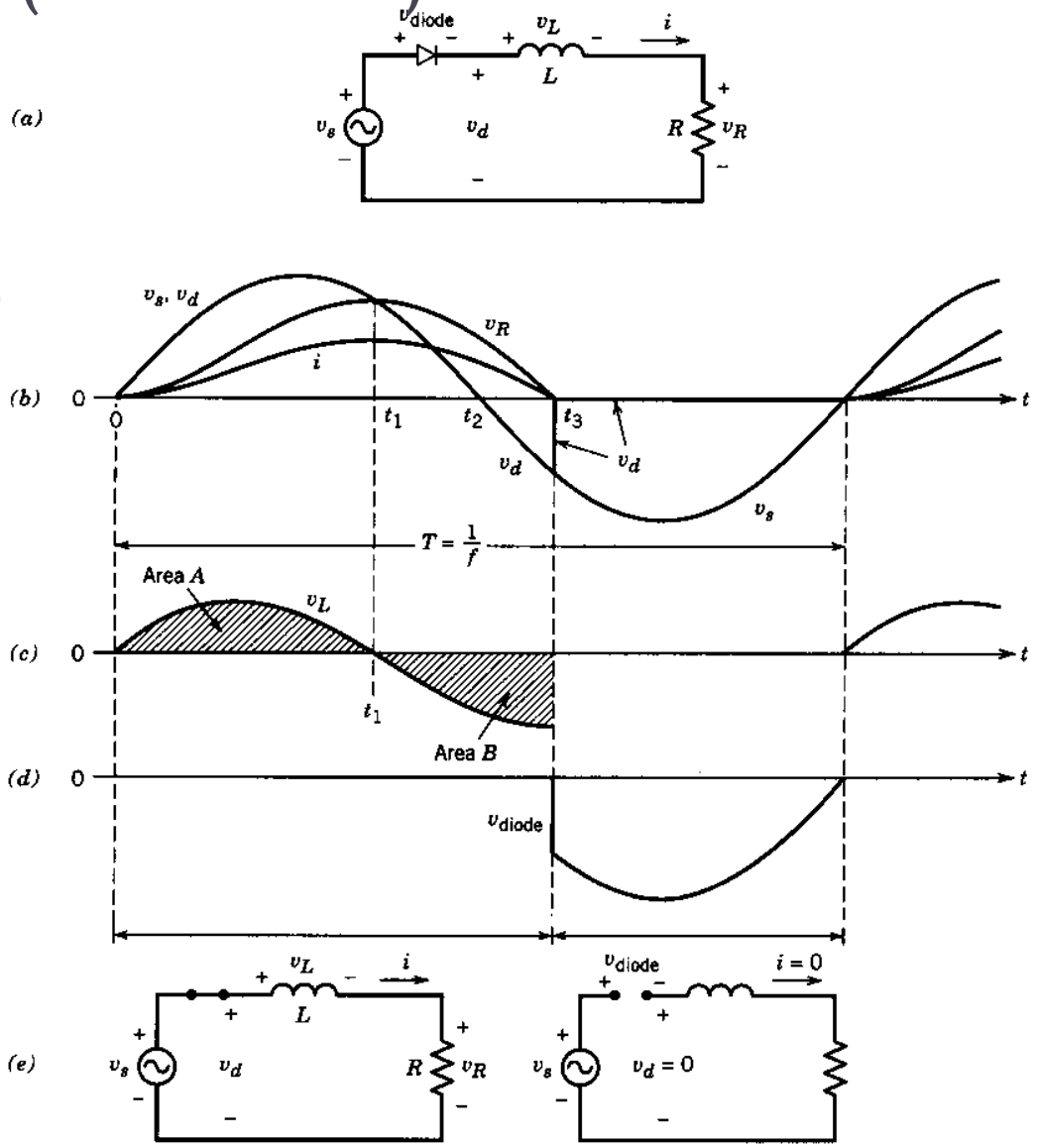


Figure 5-3 Basic rectifier with an inductive load.

A Simple Circuit (Load has a dc back-emf)

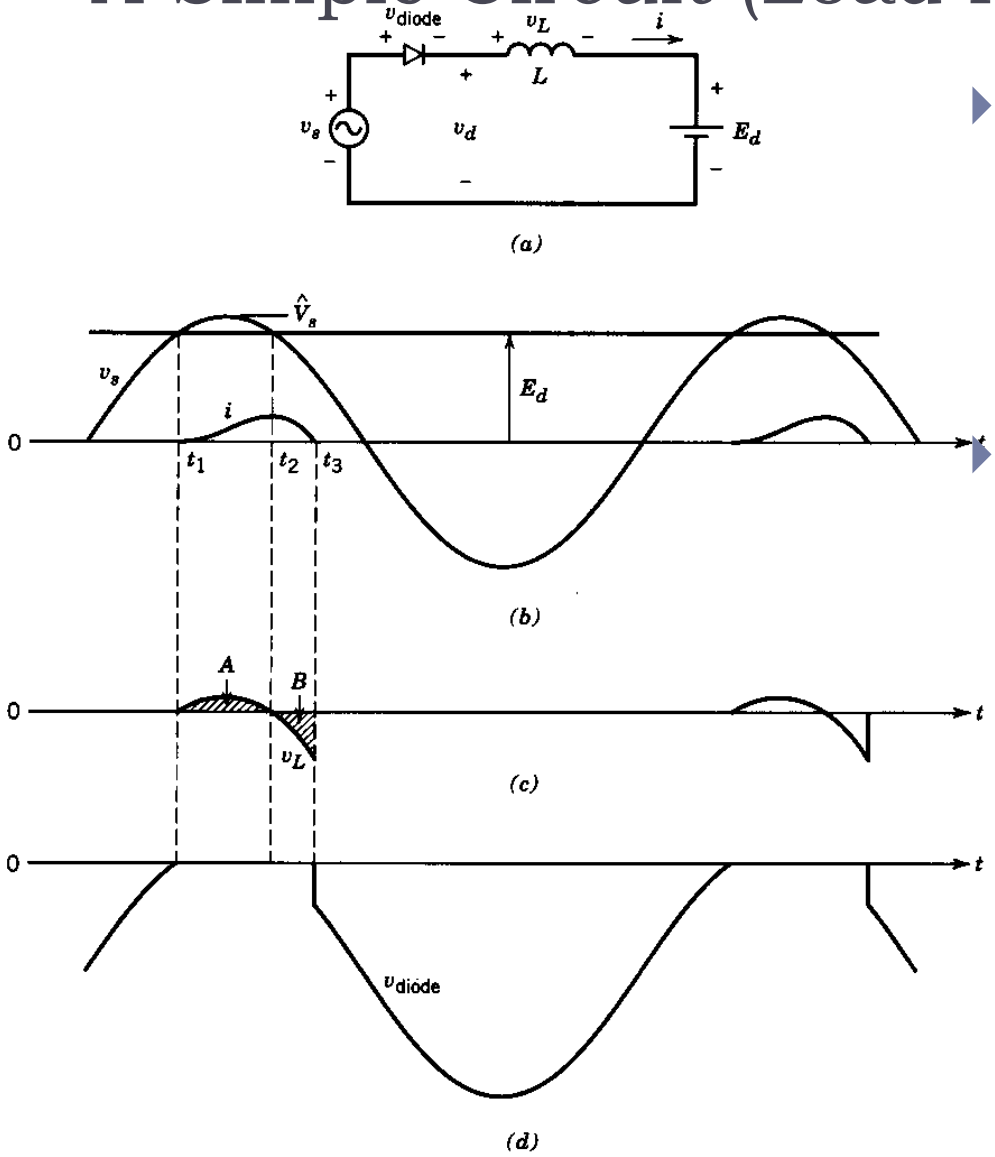
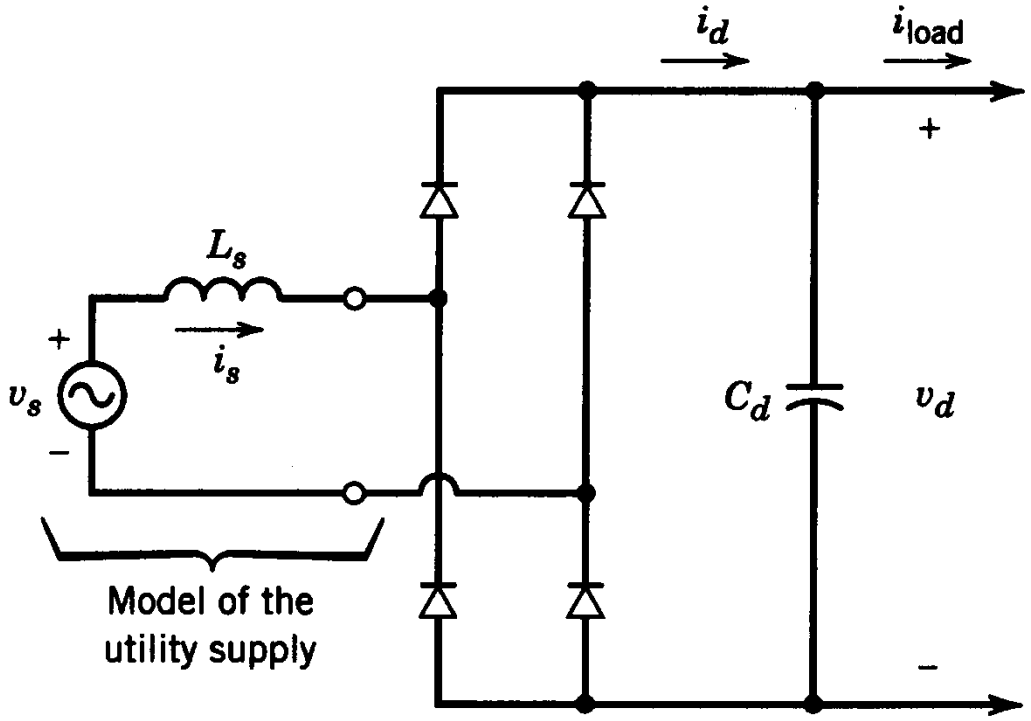


Figure 5-4 Basic rectifier with an internal dc voltage.

- Current begins to flow when the input voltage exceeds the dc back-emf
- Current continues to flows for a while even after the input voltage has gone below the dc back-emf

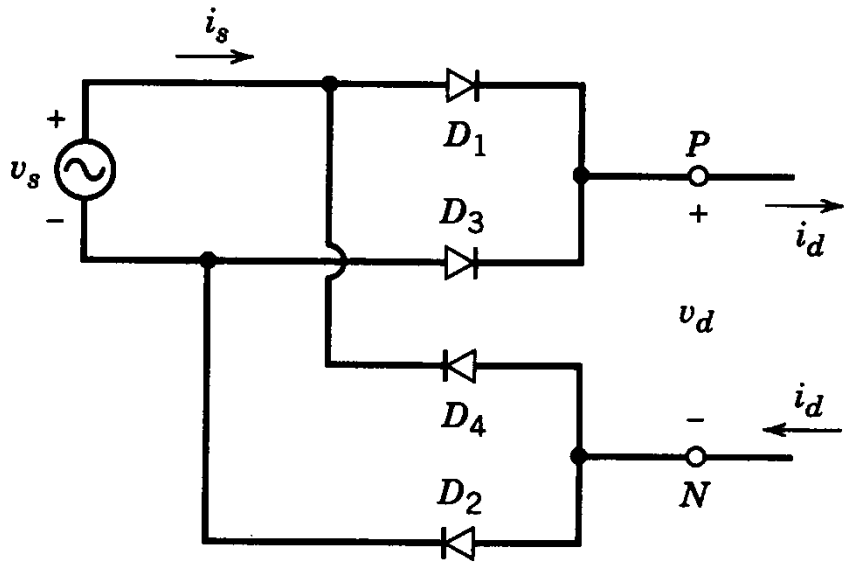
Single-Phase Diode Rectifier Bridge

- Large capacitor at the dc output for filtering and energy storage



Redrawing Diode-Rectifier Bridge

- Two groups, each with two diodes



Diode-Rectifier Bridge Analysis

- Two simple (idealized) cases to begin with

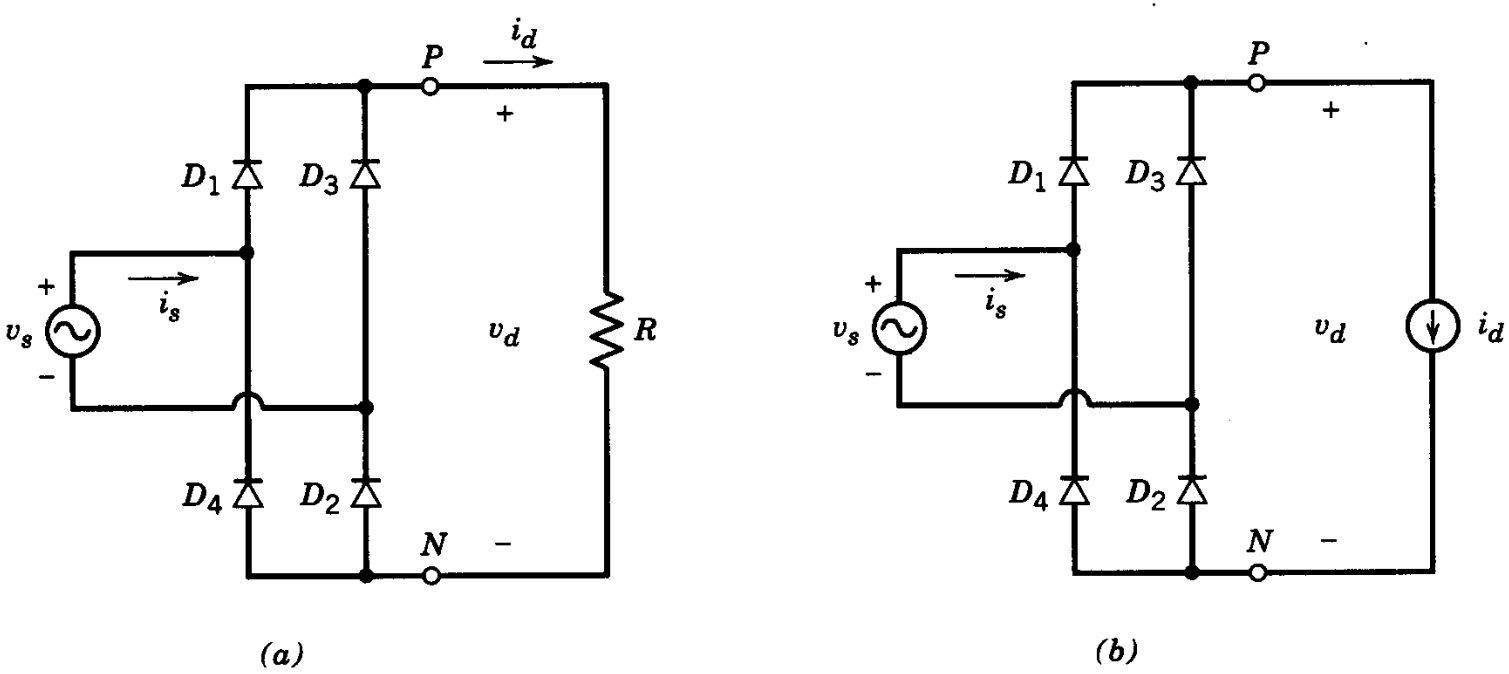
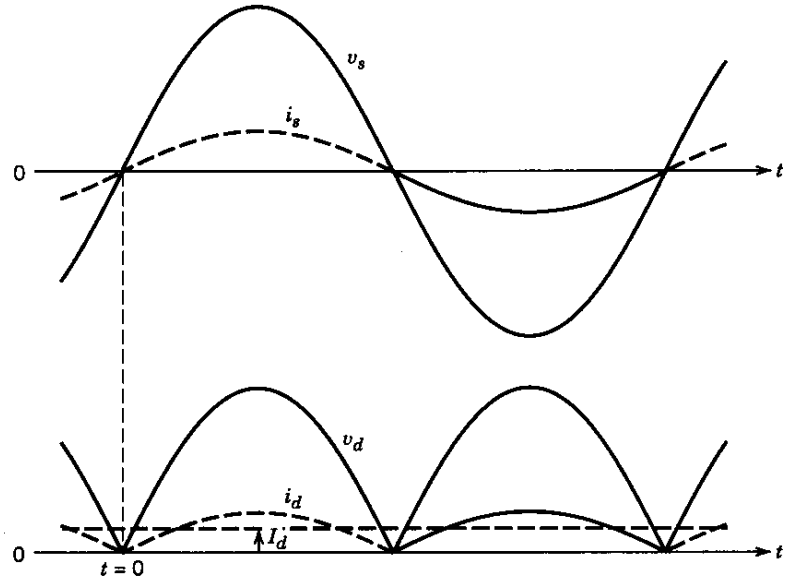
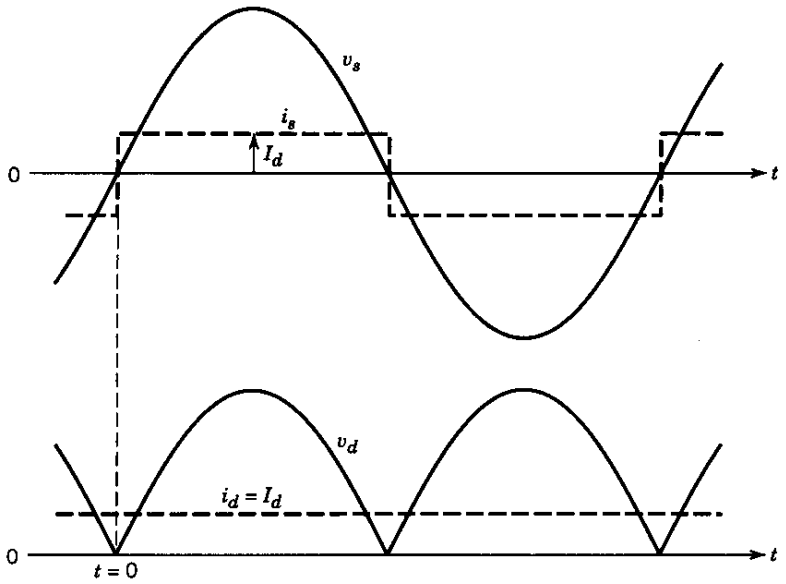


Figure 5-6 Idealized diode bridge rectifiers with $L_s = 0$.

Waveforms with a purely resistive load and a purely dc current at the output

- In both cases, the dc-side voltage waveform is the same





Diode-Rectifier Bridge Input Current

- Idealized case with a purely dc output current

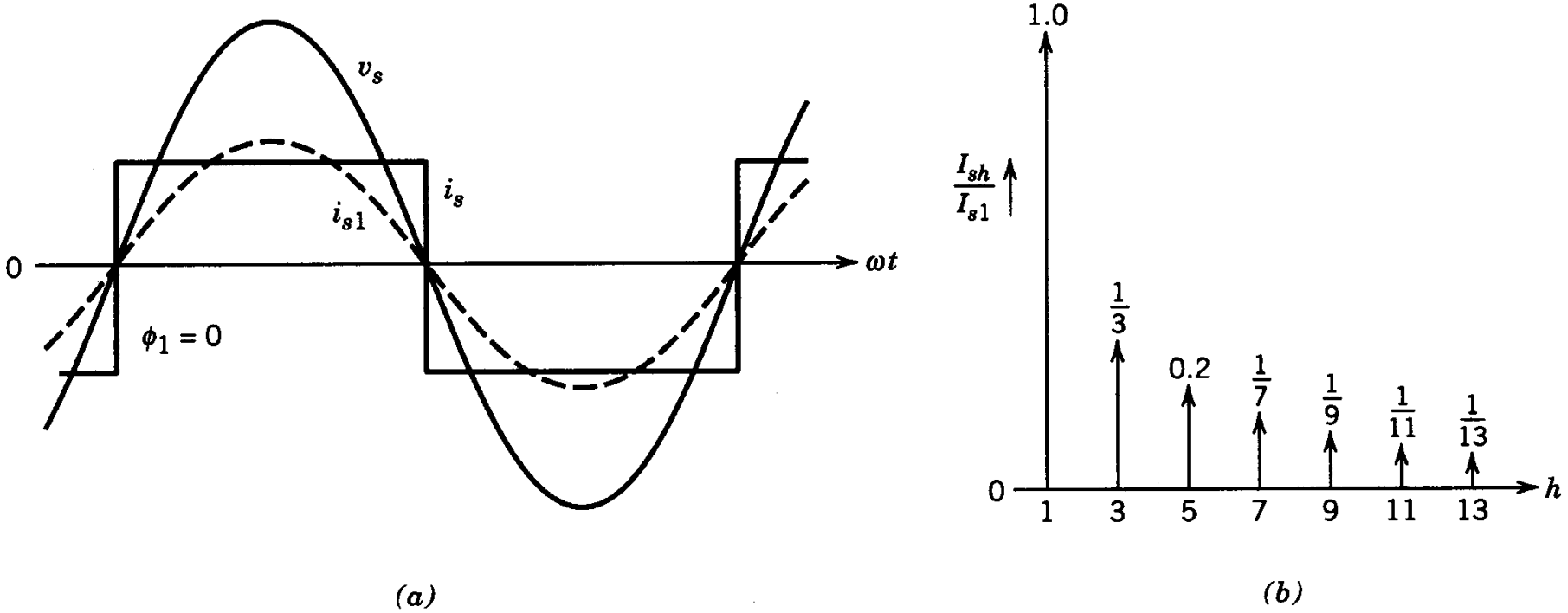
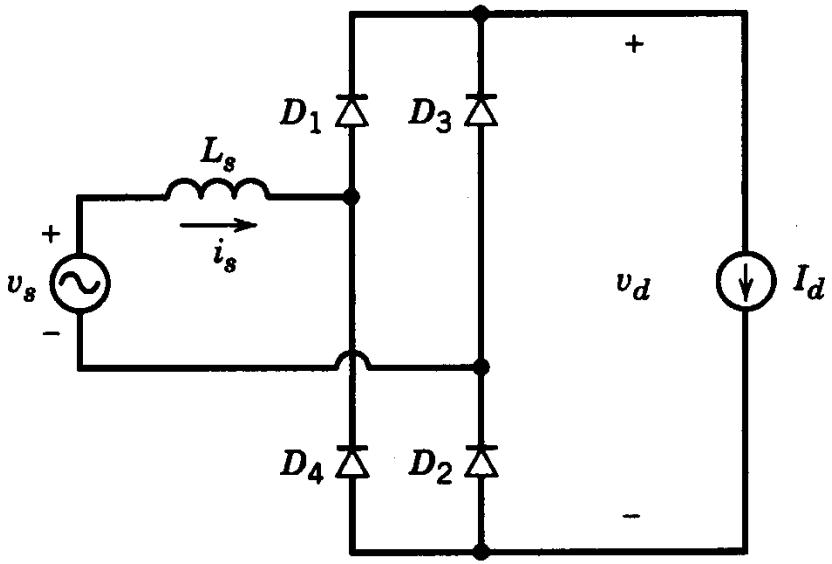


Figure 5-9 Line current i_s in the idealized case.

Diode-Rectifier Bridge Analysis with AC-Side Inductance

- Output current is assumed to be purely dc



Understanding Current Commutation

- Assuming inductance in this circuit to be zero

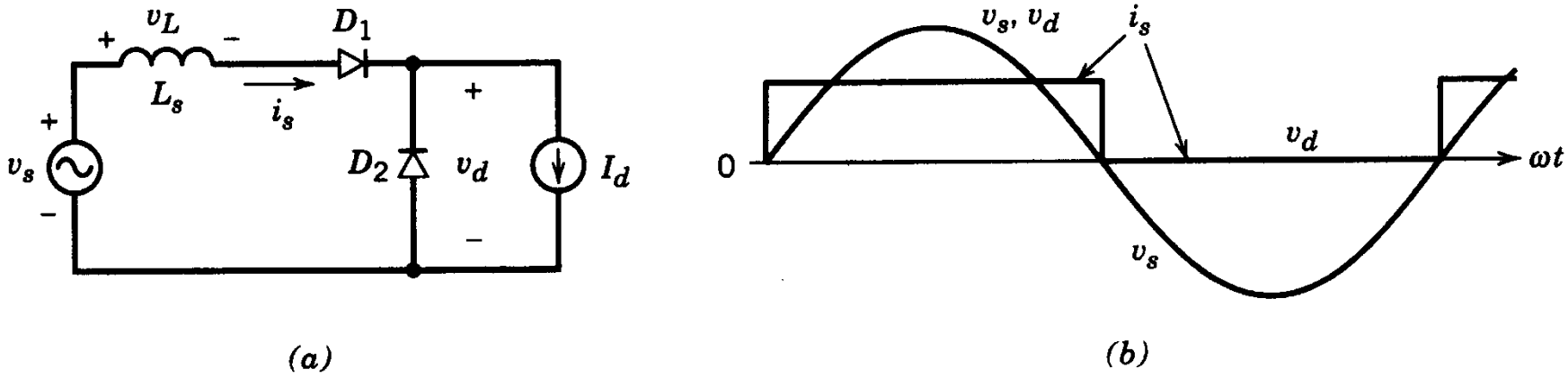
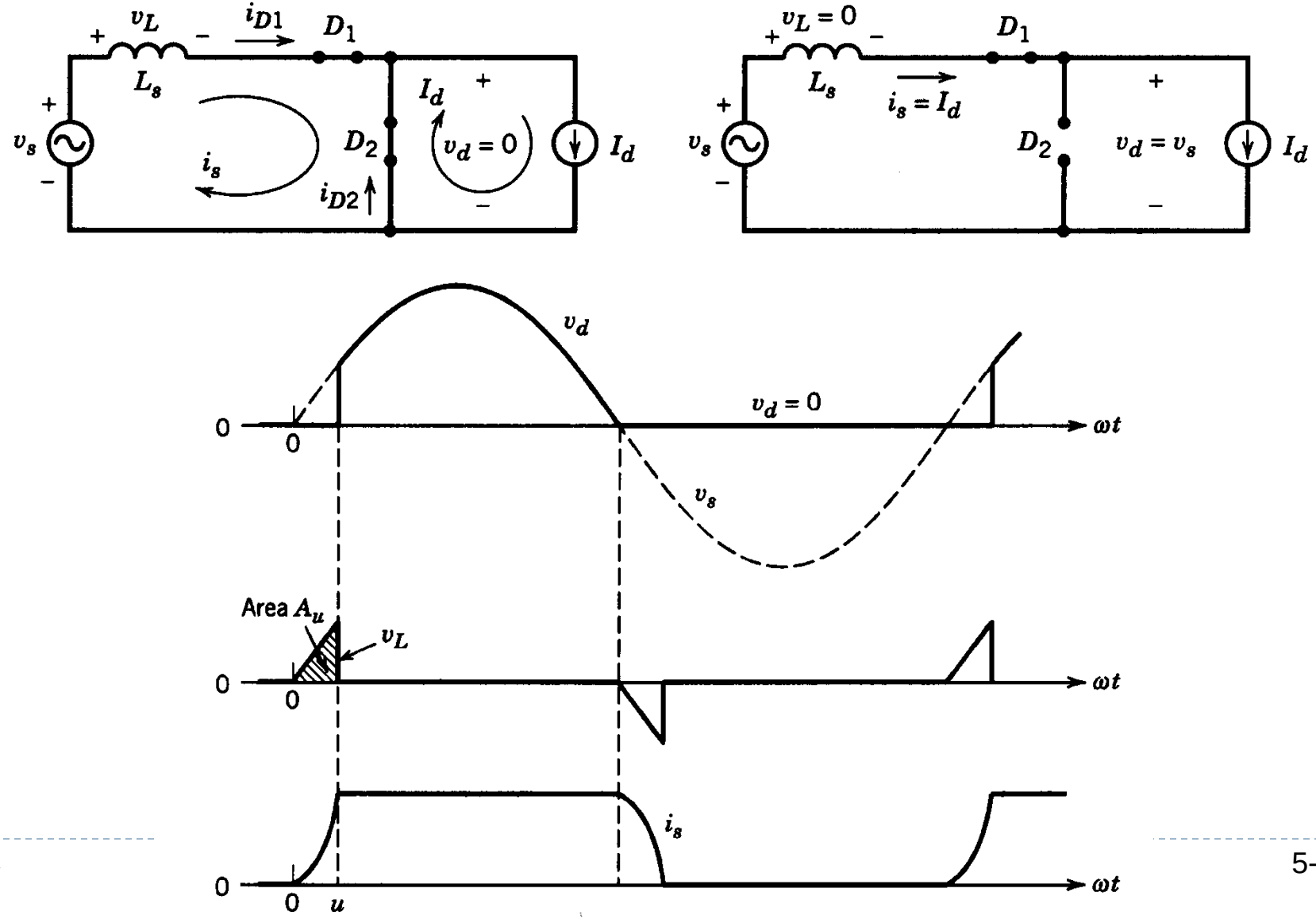


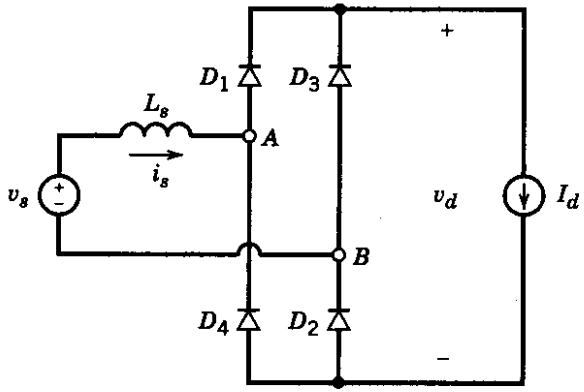
Figure 5-11 Basic circuit to illustrate current commutation. Waveforms assume $L_s = 0$.

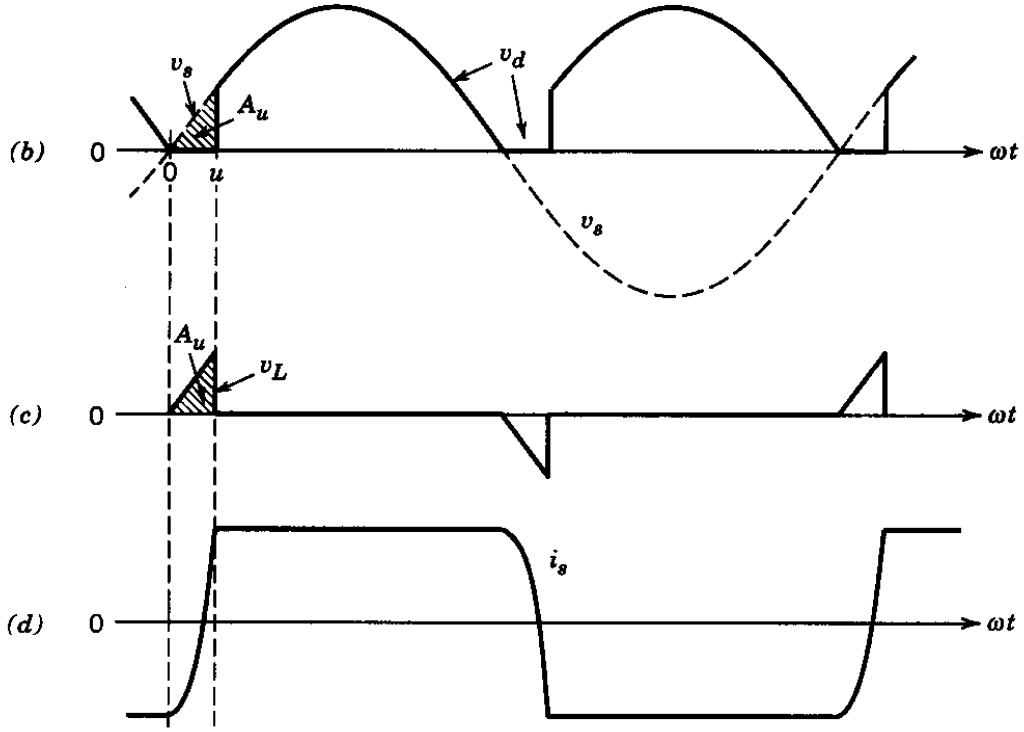
Understanding Current Commutation (cont.) – inductance is included



Current Commutation in Full-Bridge Rectifier

- Shows the necessary volt-seconds





Understanding Current Commutation

- Note the current loops for analysis

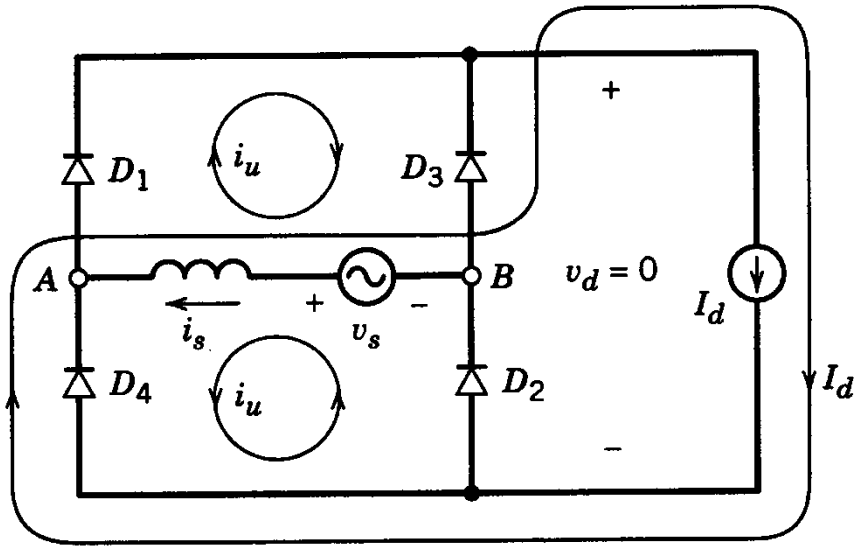
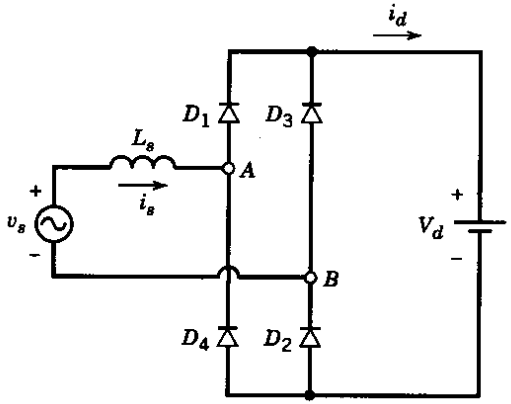
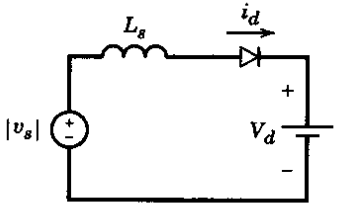
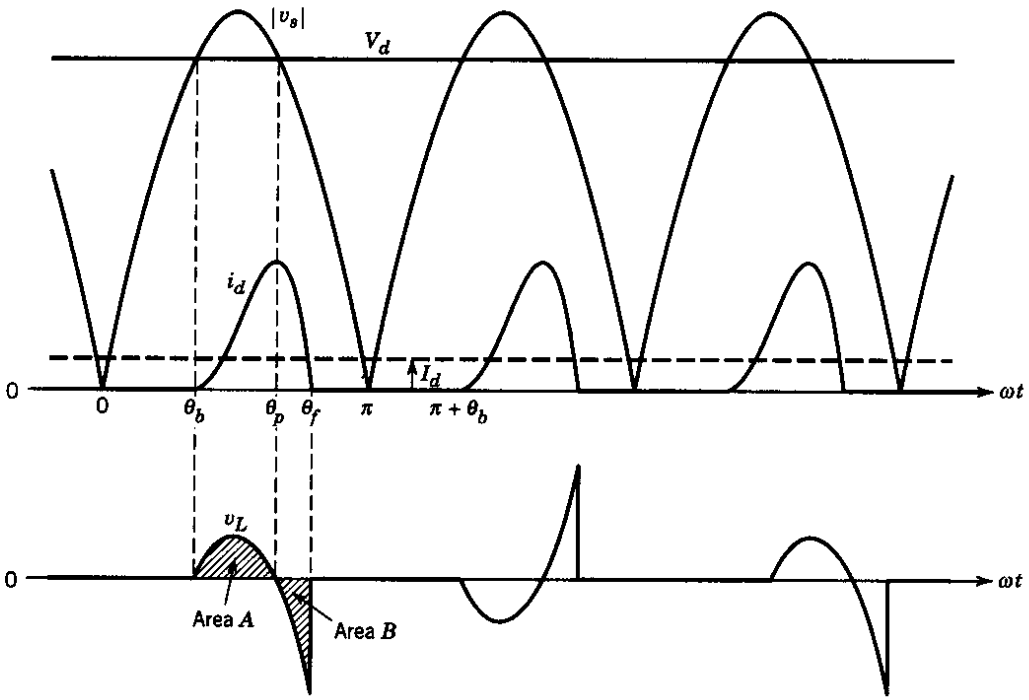


Figure 5-15 Redrawn circuit of Fig. 5-14*a* during current commutation.

Rectifier with a dc-side voltage







DC-Side Voltage and Current Relationship

- Zero current corresponds to dc voltage equal to the peak of the input ac voltage

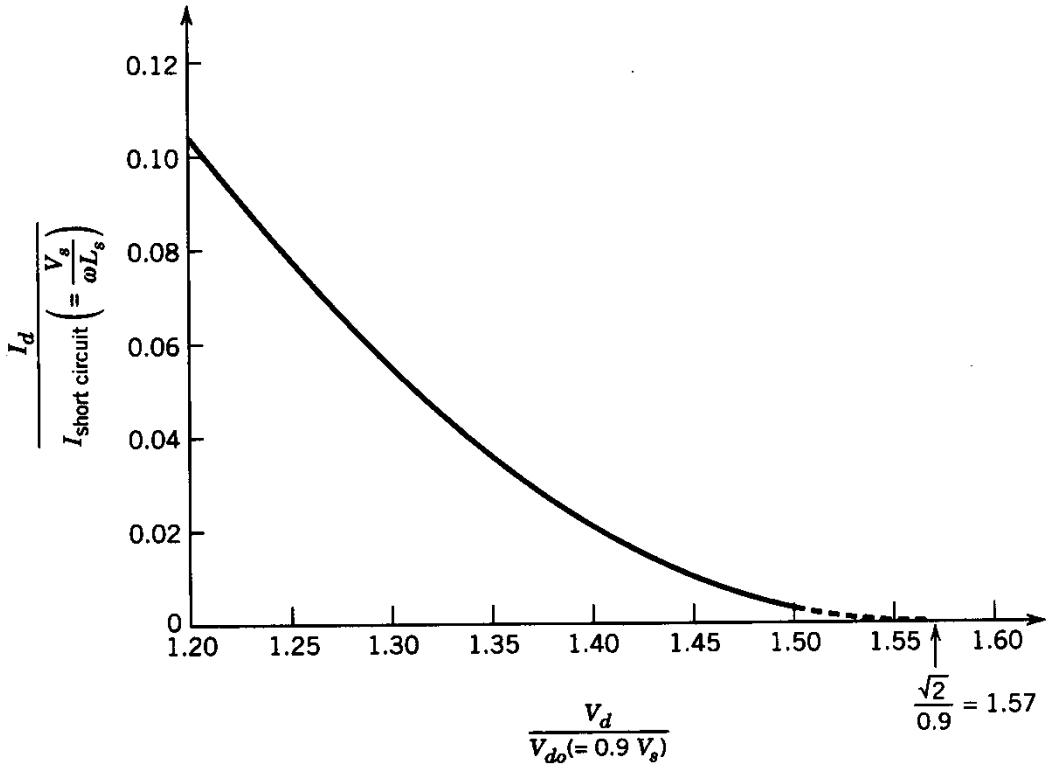
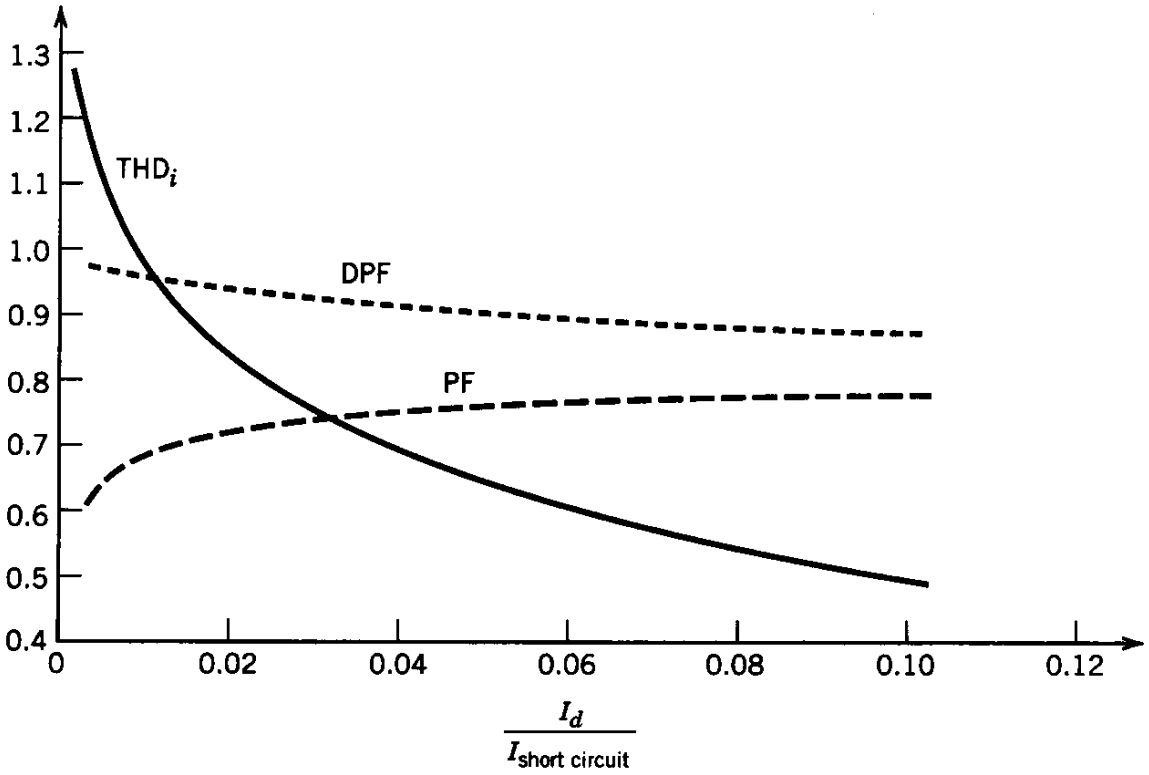


Figure 5-17 Normalized I_d versus V_d in the rectifier of Fig. 5-16*a* with a constant dc-side voltage.

Effect of DC-Side Current on THD, PF and DPF

- Total Harmonic Distortion (very high at small currents)
- Power Factor ($cos\vartheta$)
- Displacement Power Factor



Crest Factor versus the Current Loading

- The Crest Factor is very high at low values of current

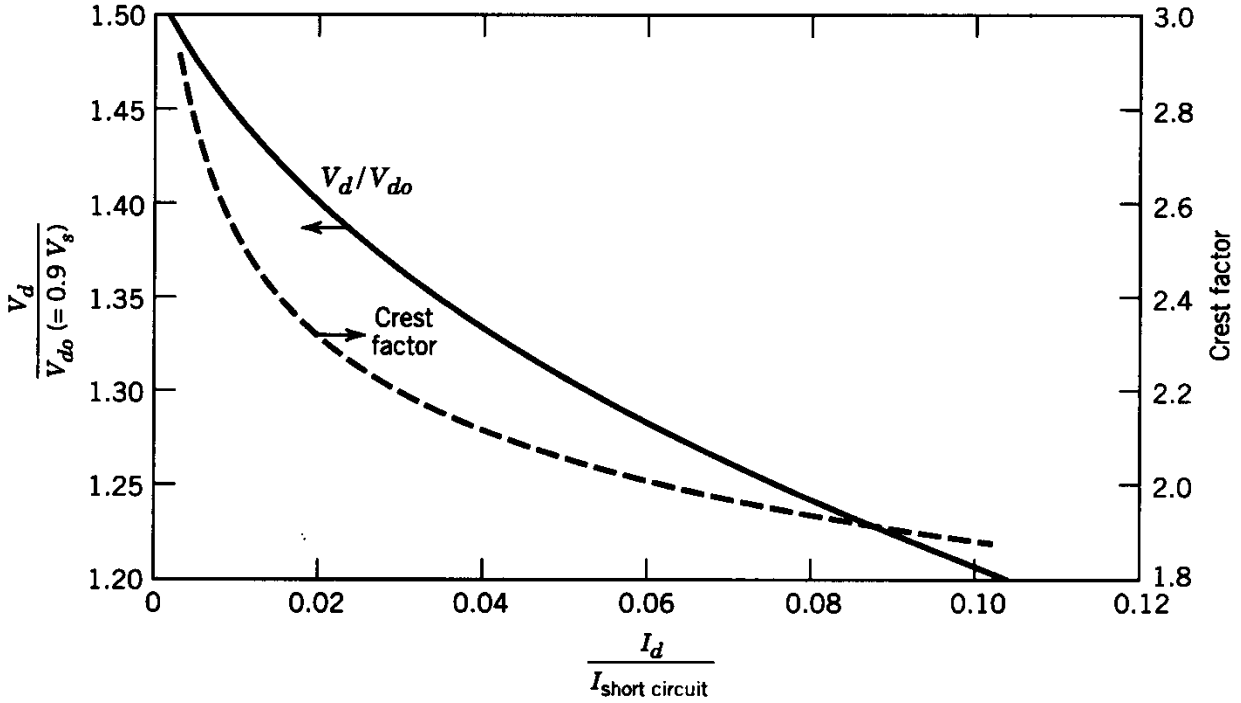


Figure 5-19 Normalized V_d and the crest factor in the rectifier of Fig. 5-16*a* with a constant dc-side voltage.

Diode-Rectifier with a Capacitor Filter

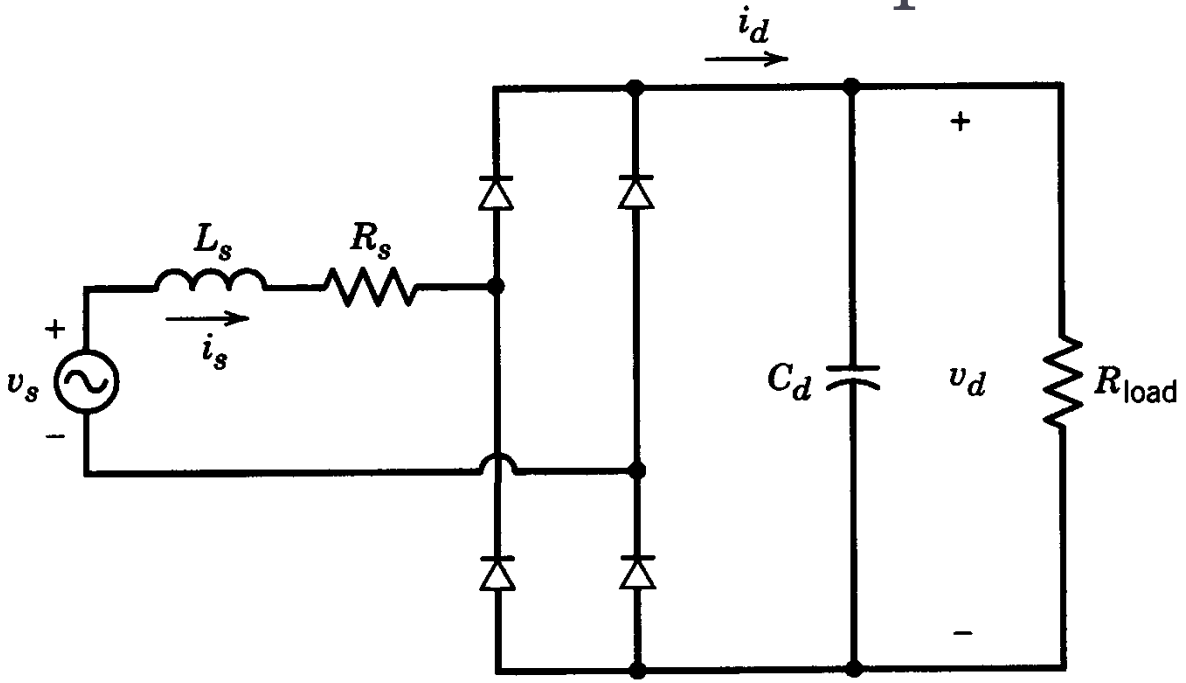
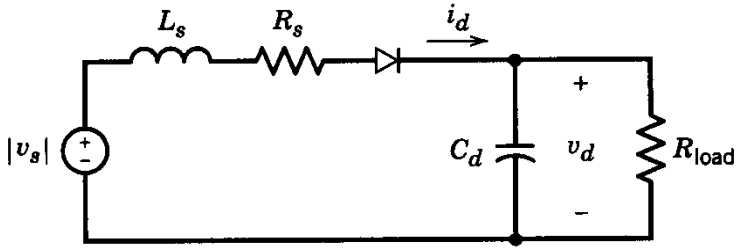
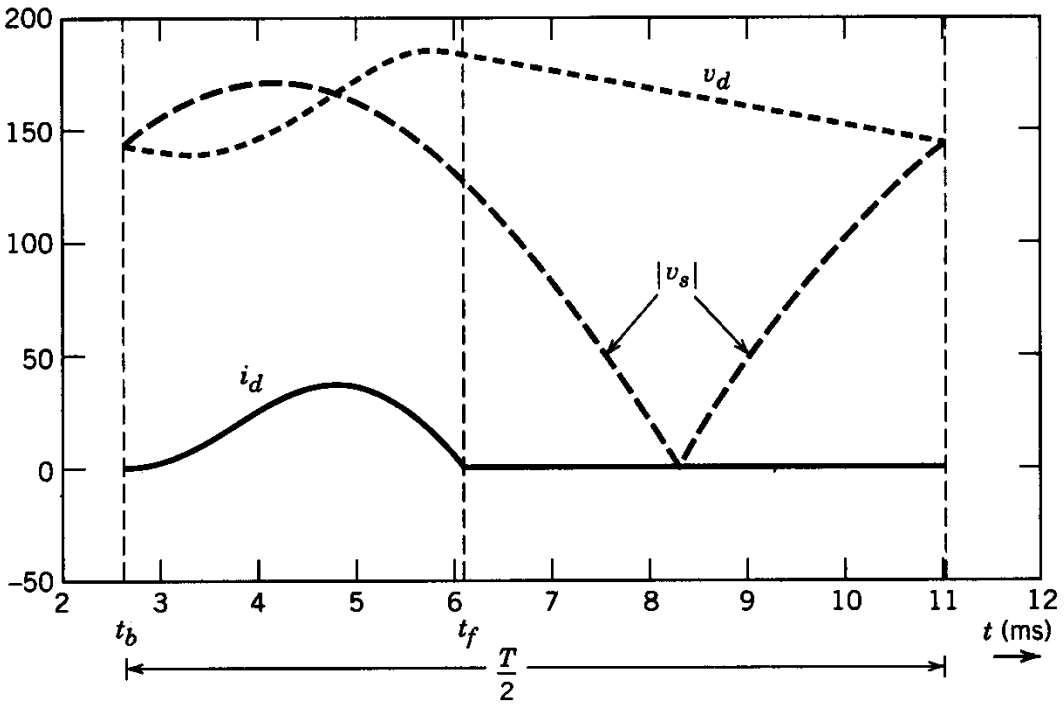


Figure 5-20 Practical diode–bridge rectifier with a filter capacitor.

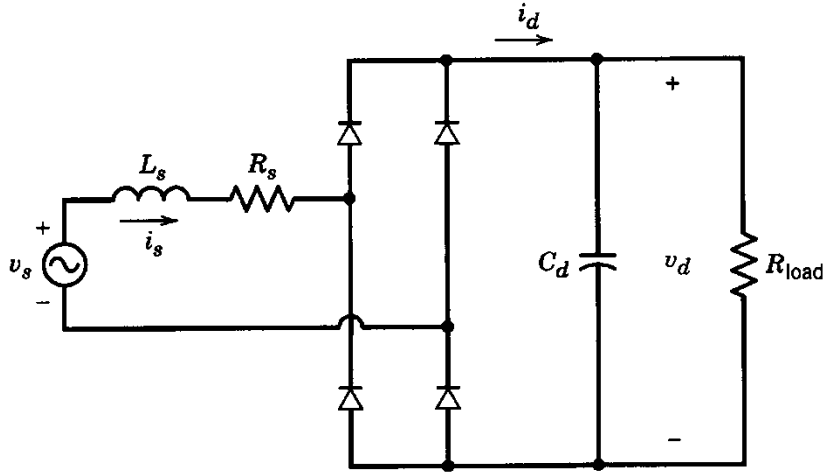
Diode Rectifier Bridge

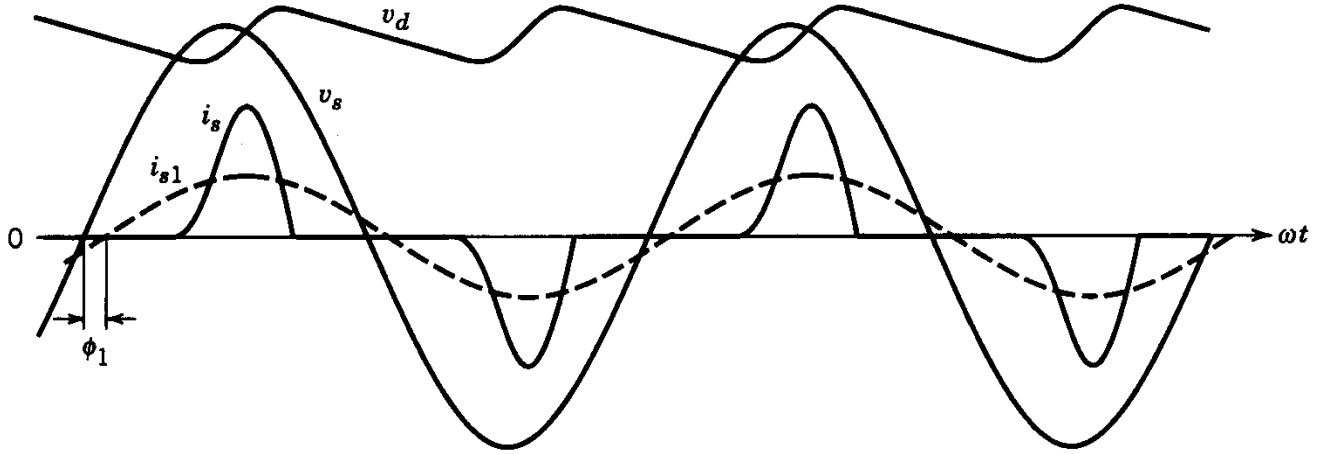
- Equivalent circuit for analysis on one-half cycle basis





Diode-Bridge Rectifier: Waveforms





Input Line-Current Distortion – harmonics analysis

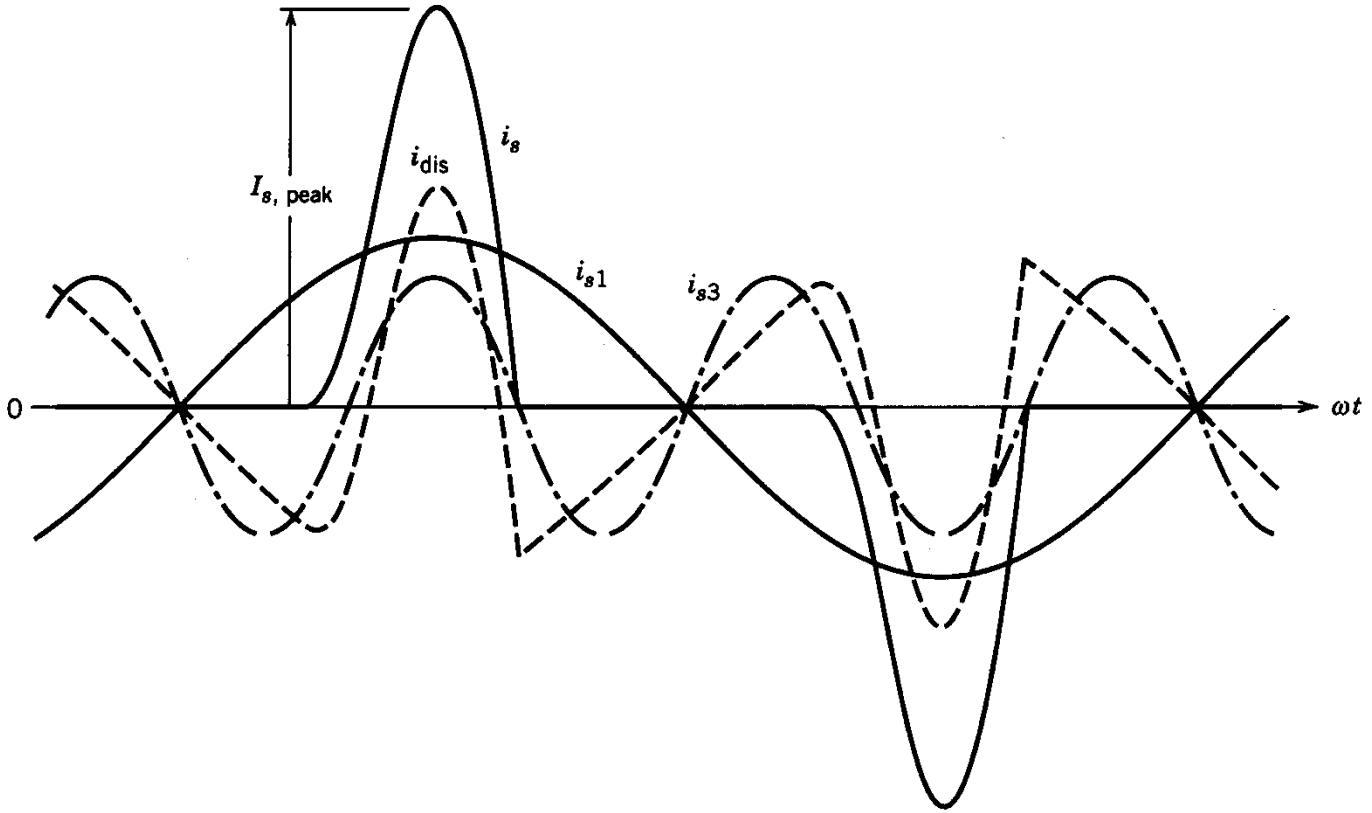
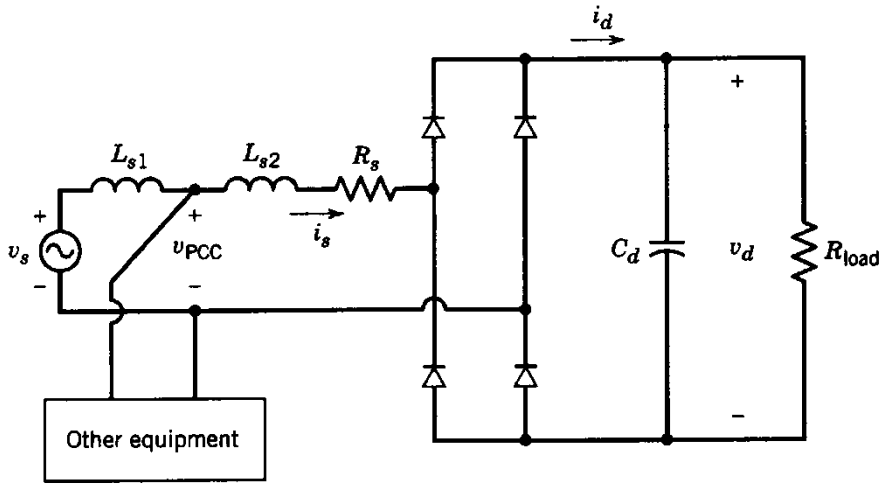
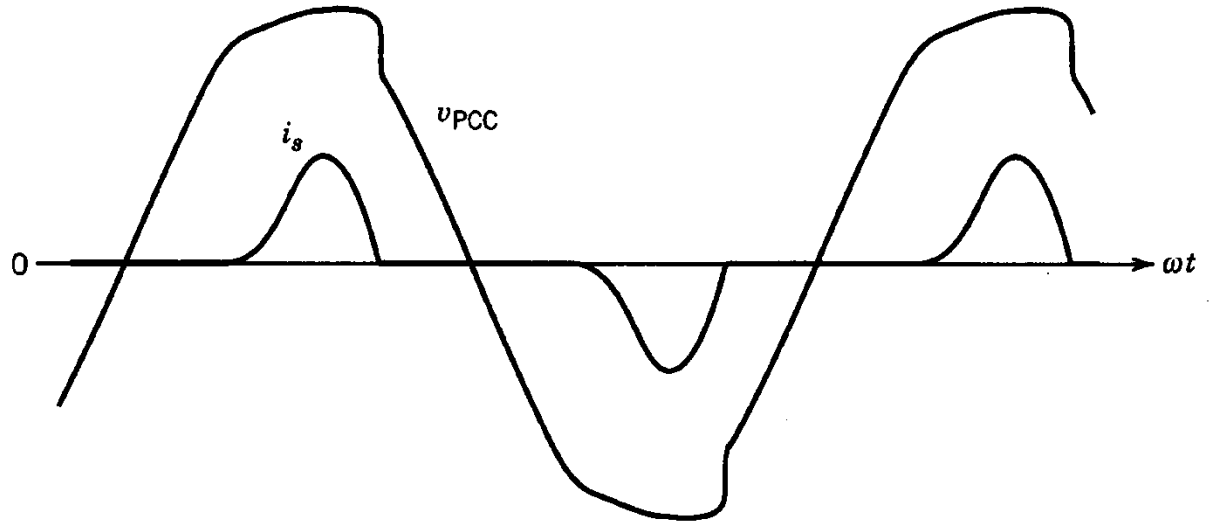


Figure 5-24 Distorted line current in the rectifier of Fig. 5-20.

Line-Voltage Distortion

- PCC is the point of common coupling





Voltage Doubler Rectifier

- In 115-V position, one capacitor at-a-time is charged from the input.

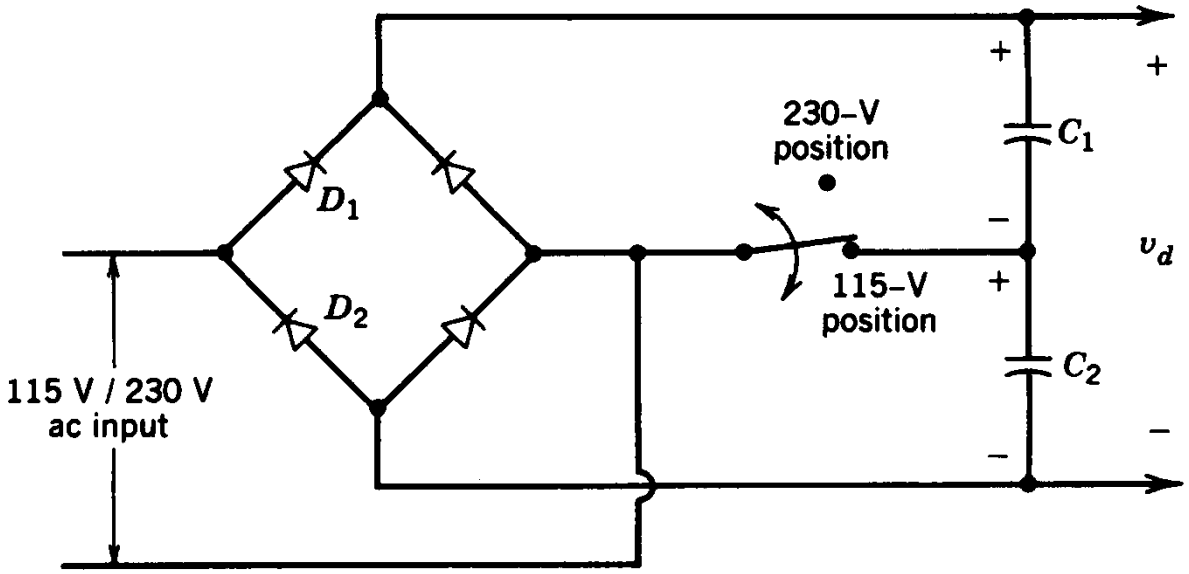
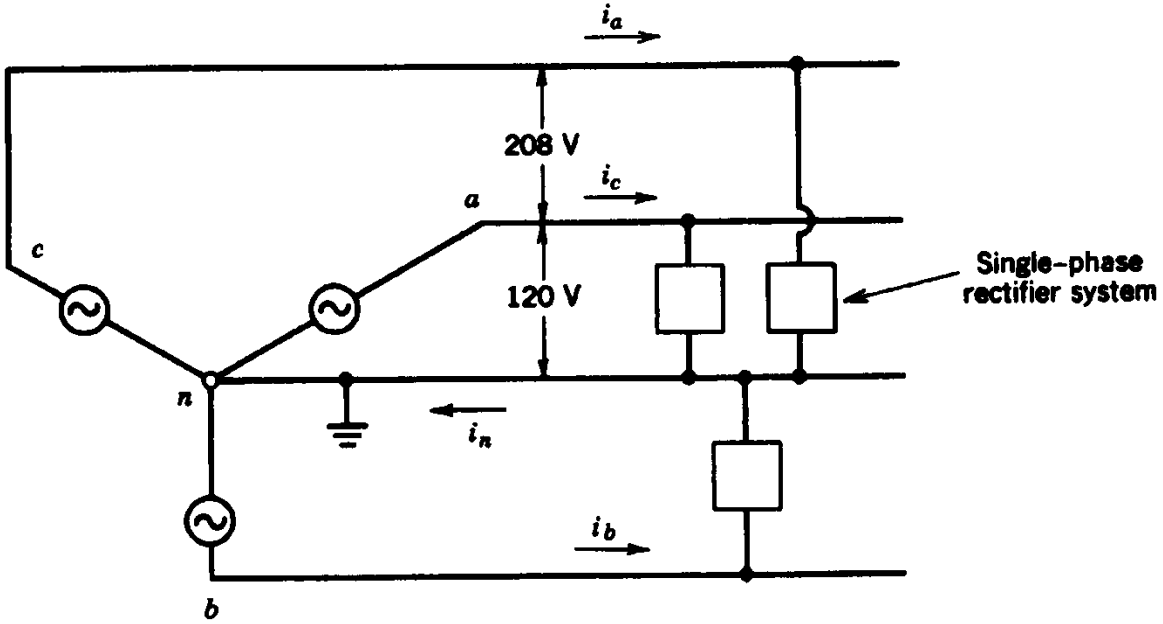
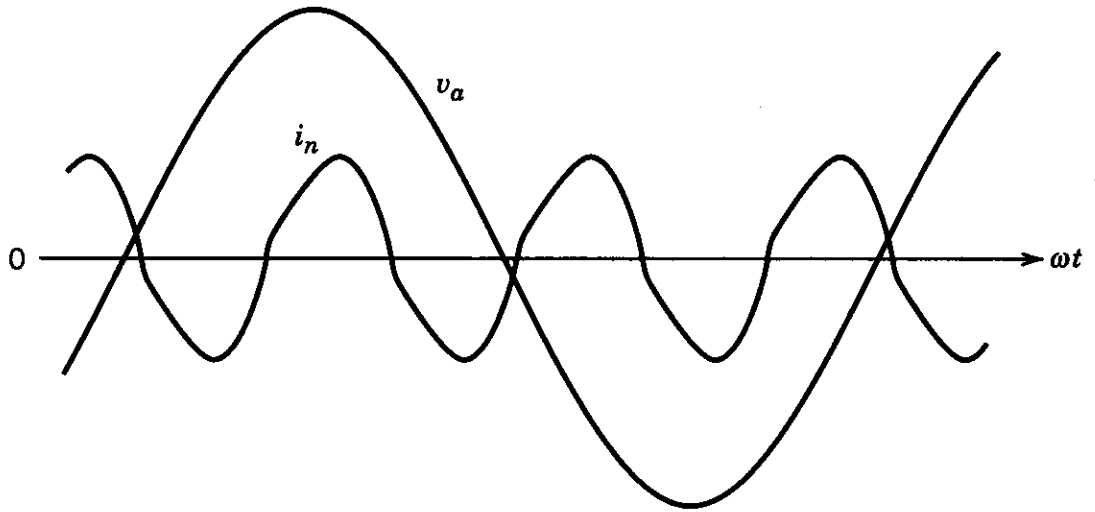


Figure 5-27 Voltage-doubler rectifier.

A Three-Phase, Four-Wire System

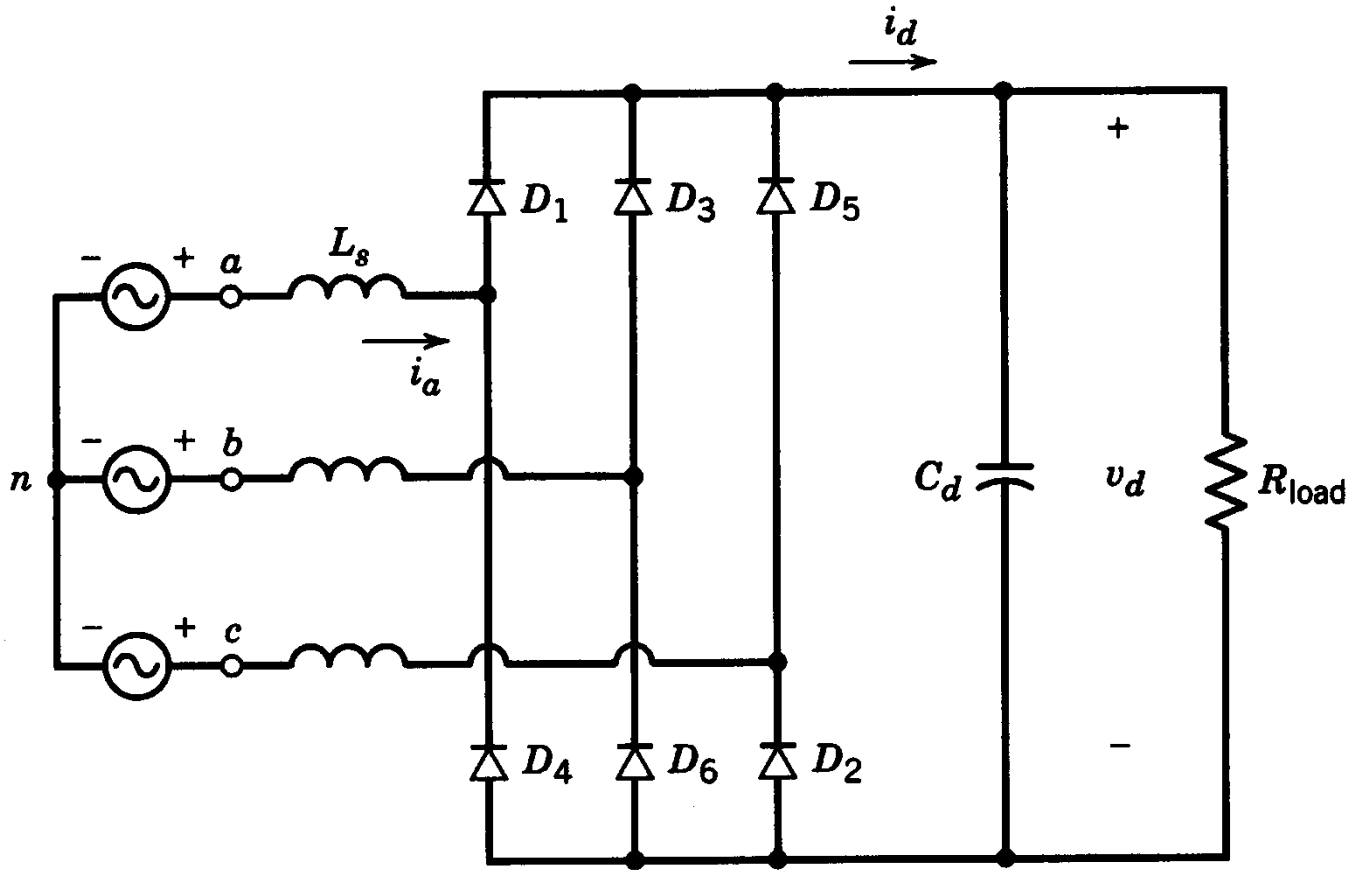


- A common neutral wire is assumed



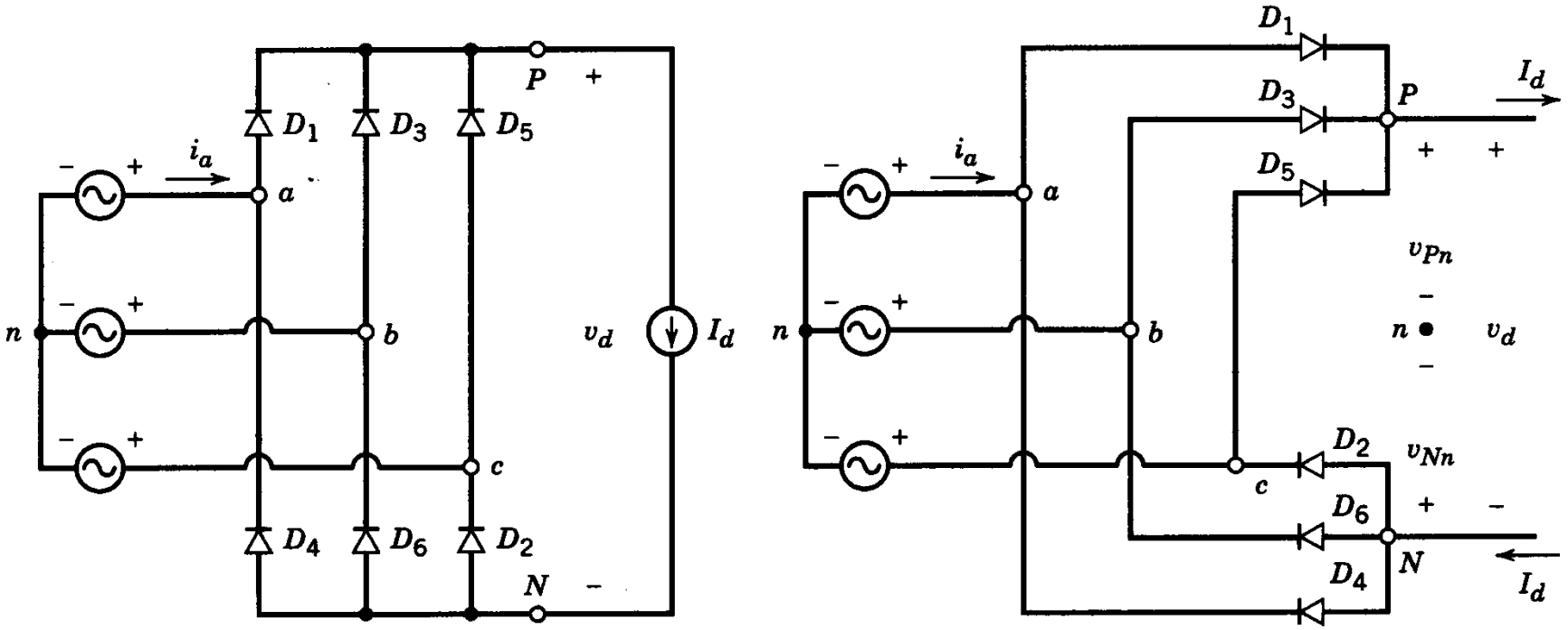
Three-Phase, Full-Bridge Rectifier

- Commonly used

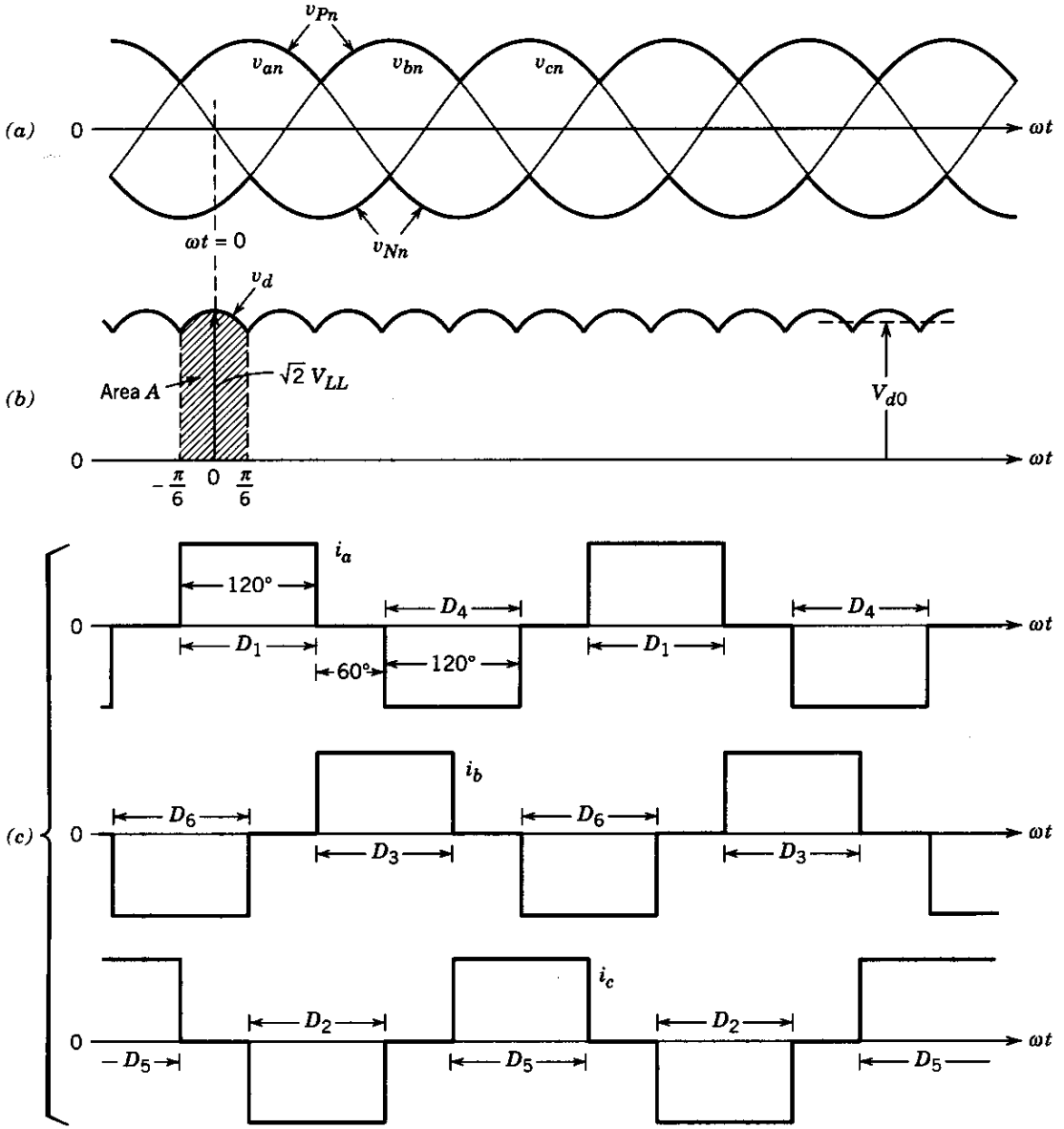


Three-Phase, Full-Bridge Rectifier: Redrawn

- Two groups with three diodes each



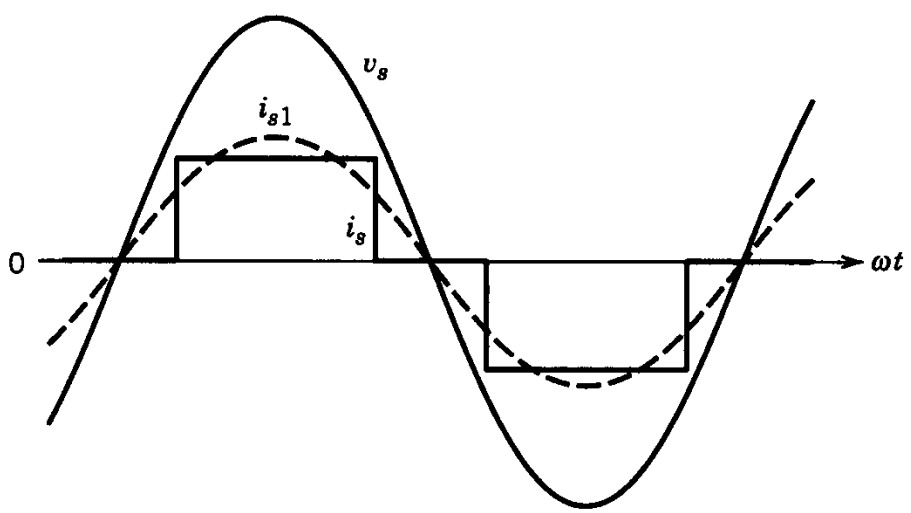
Three-Phase, Full-Bridge Rectifier Waveforms

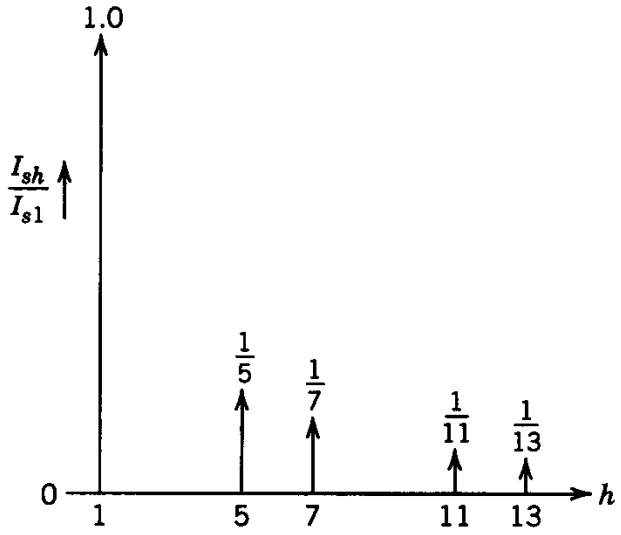


- Output current is assumed to be dc

Three-Phase, Full-Bridge Rectifier: Input Line-Current

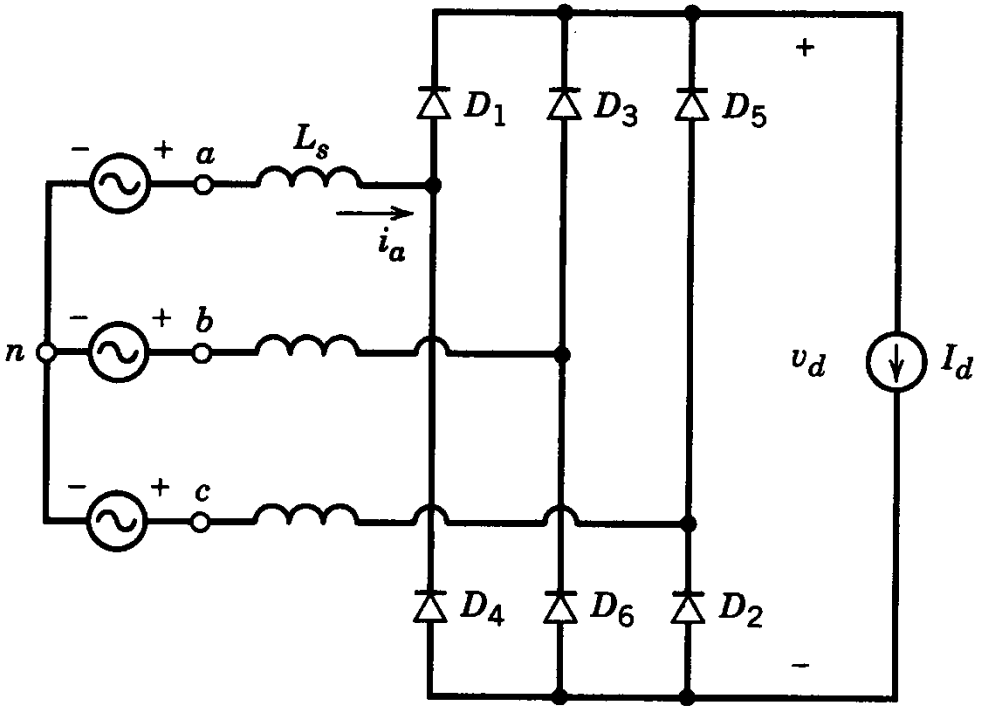
- Assuming output current to be purely dc and zero ac-side inductance





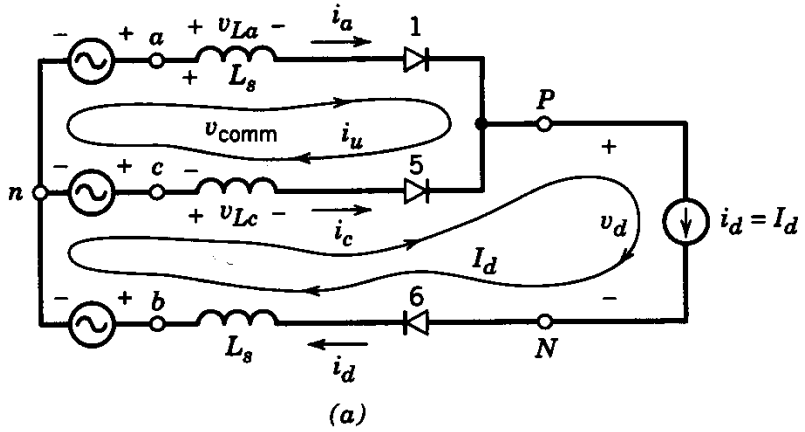
Three-Phase, Full-Bridge Rectifier

- Including the ac-side inductance

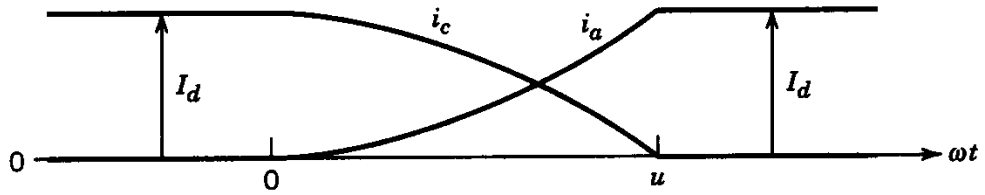


3-Phase Rectifier: Current Commutation

- output current is assumed to be purely dc



(a)



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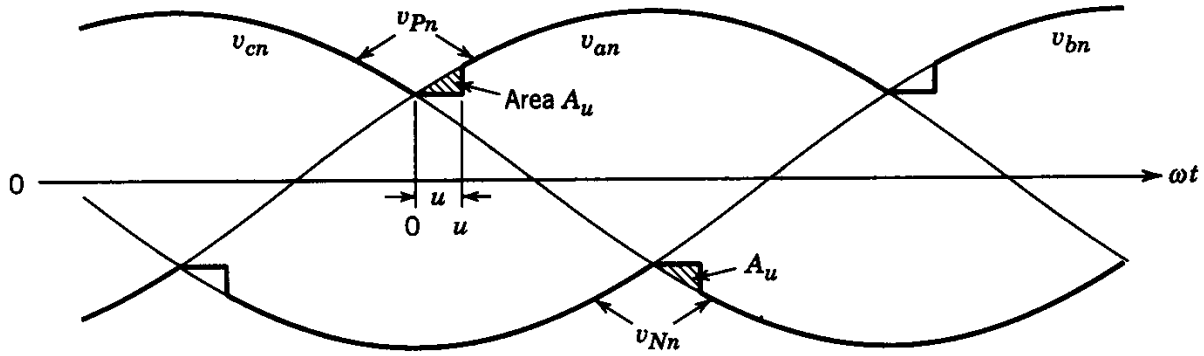
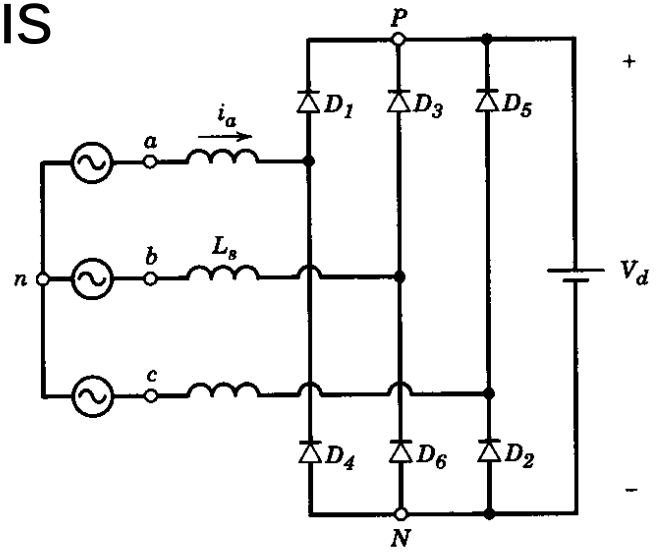


(c)

Rectifier with a Large Filter Capacitor

- Output voltage is assumed to be purely dc



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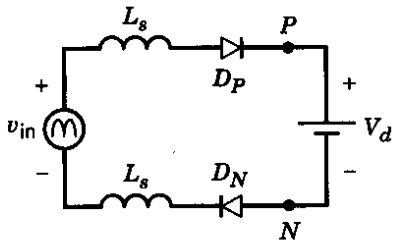

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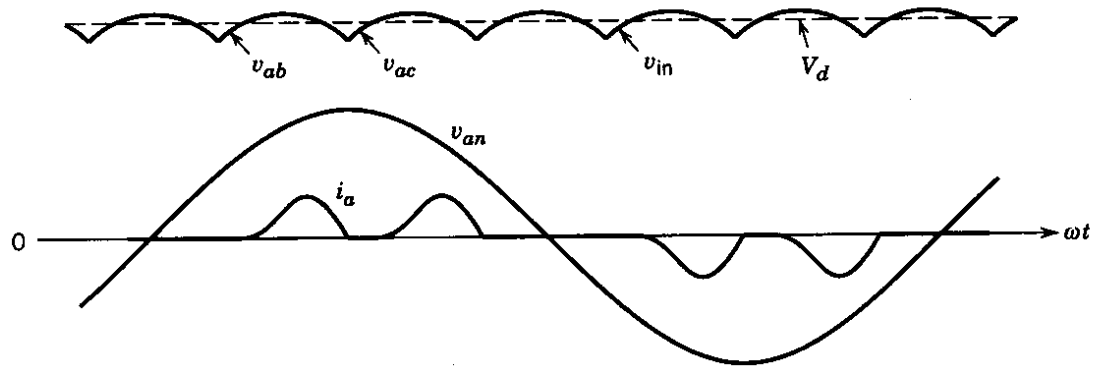
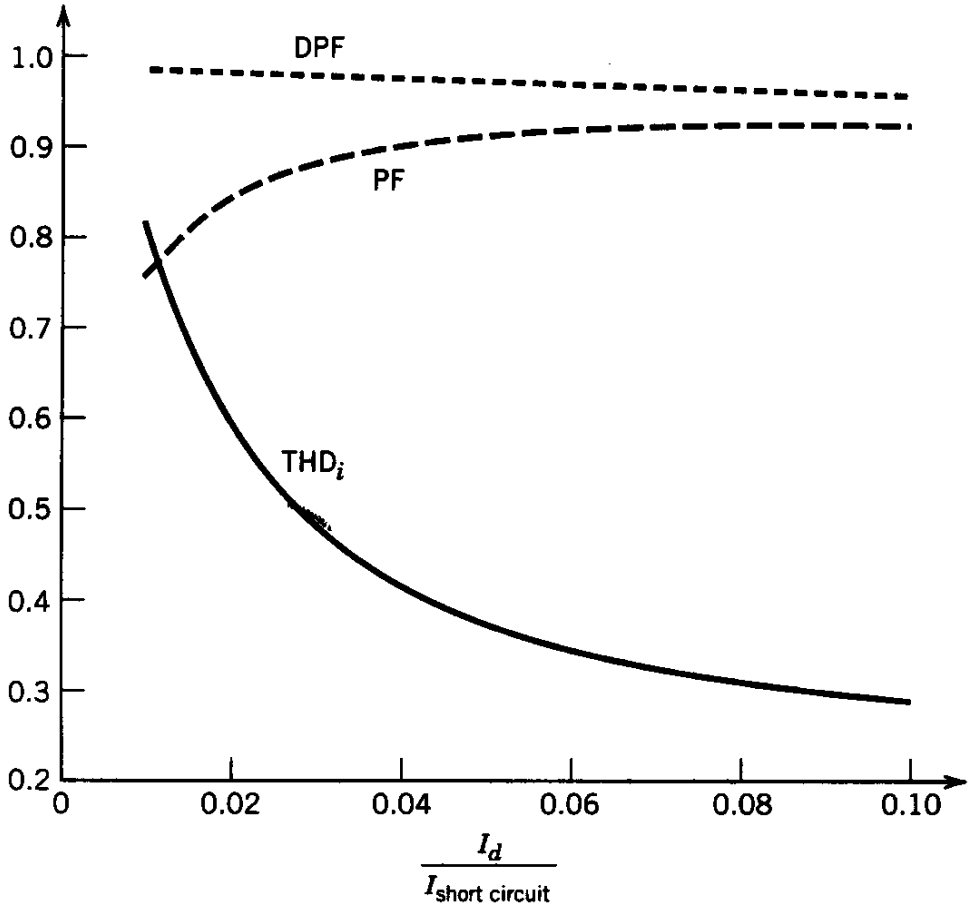


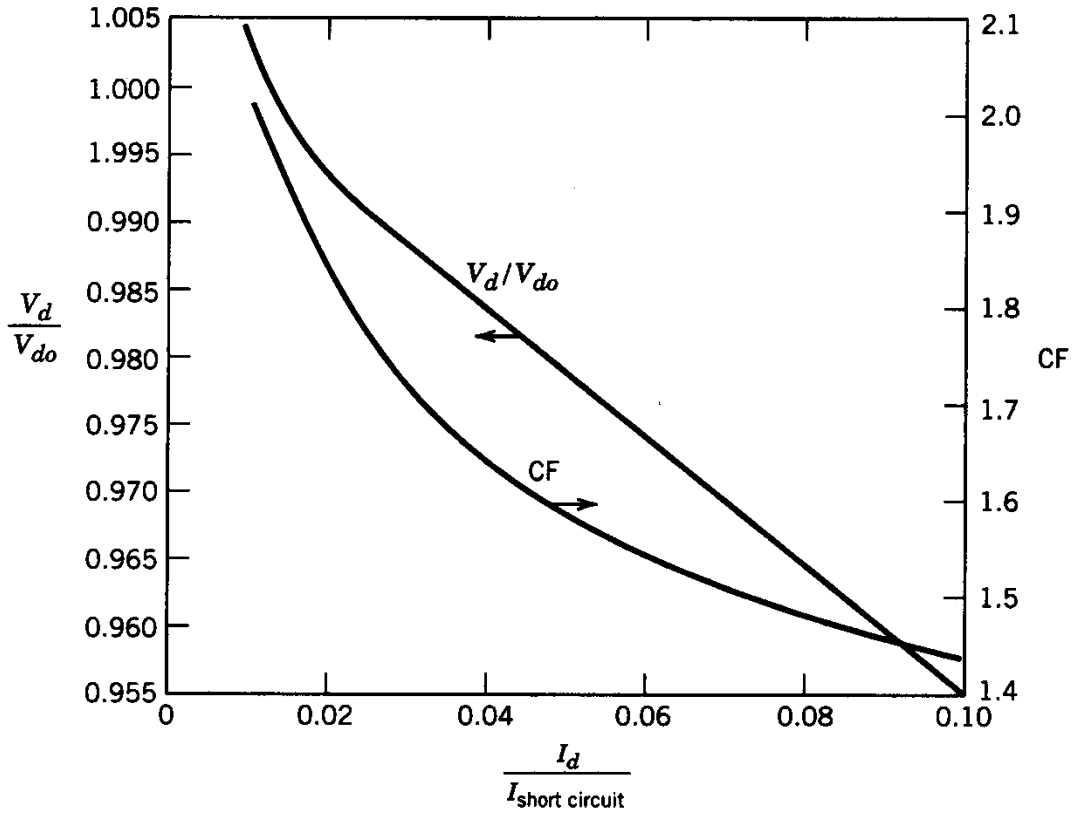
Three-Phase, Full-Bridge Rectifier

- THD, PF and DPF as functions of load current



Crest Factor versus the Current Loading

- The Crest Factor is very high at low values of current



Three-Phase Rectifier Waveforms

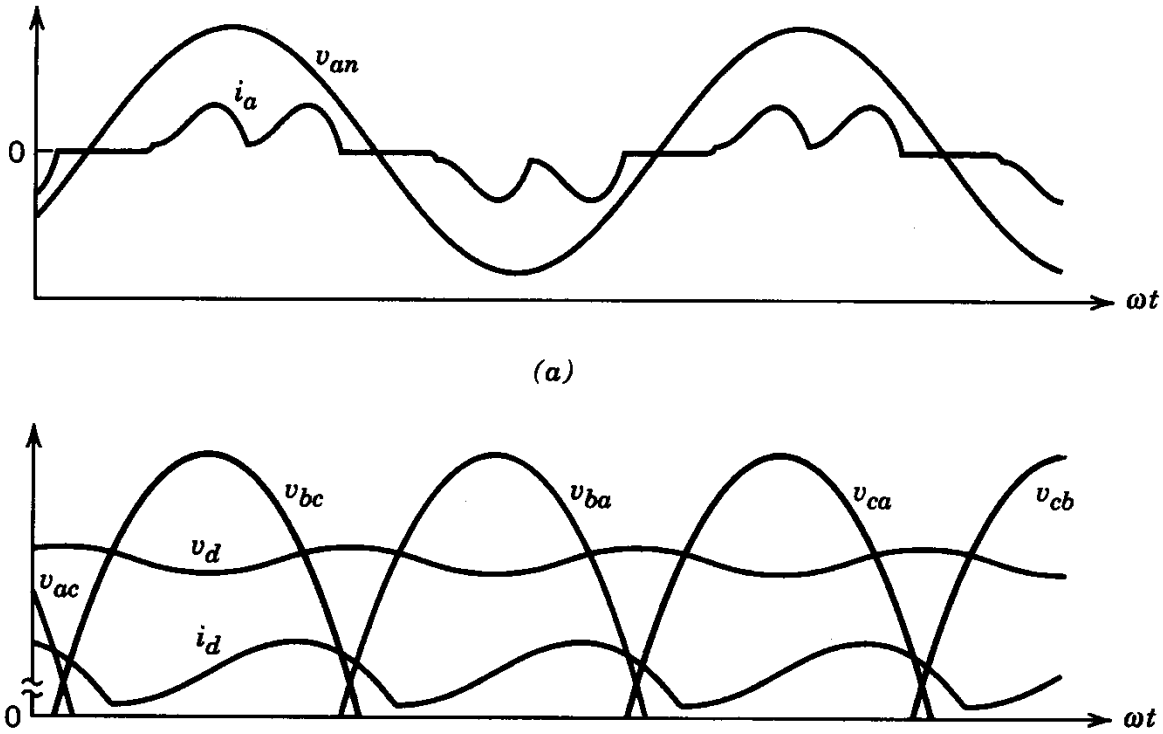


Figure 5-39 Waveforms in the rectifier of Fig. 5-30, obtained in Example 5-7.