Linear Power Supplies

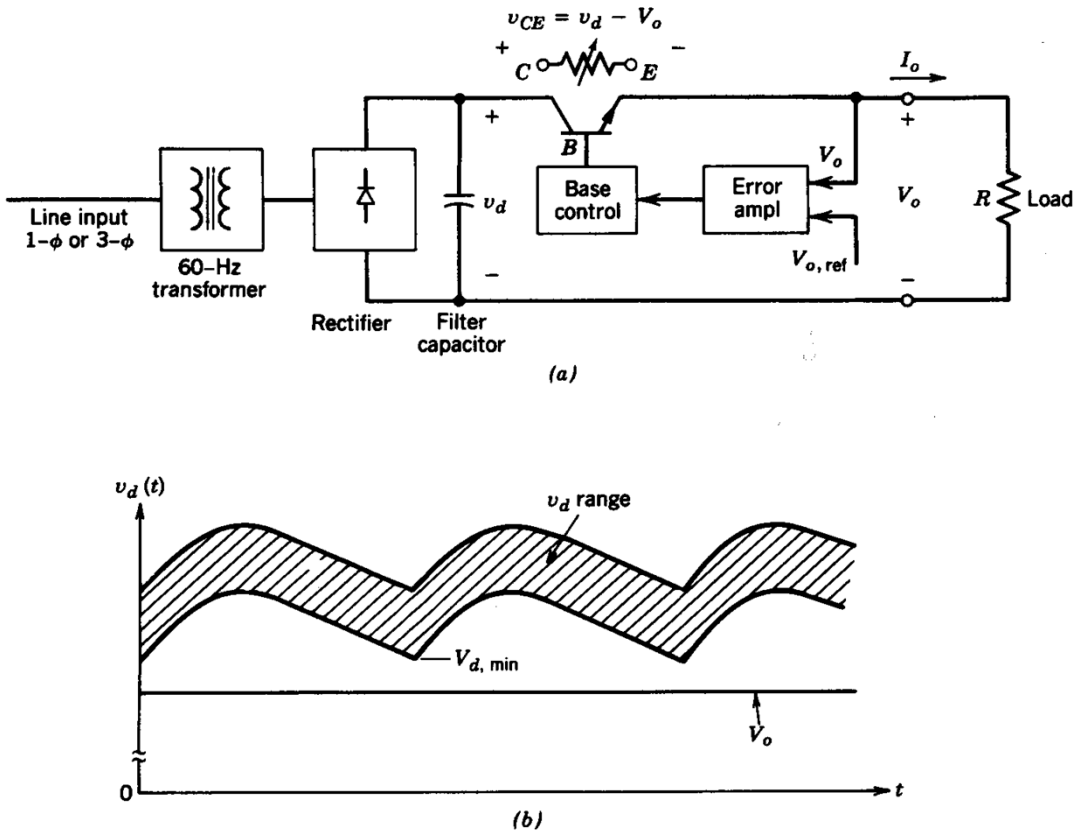

Figure 10-1 Linear power supply: (*a*) schematic; (*b*) selection of transformer turns ratio so that $V_{d,\text{min}} > V_o$ by a small margin.

- Very poor efficiency and large weight and size

Switching DC Power Supply: Block Diagram

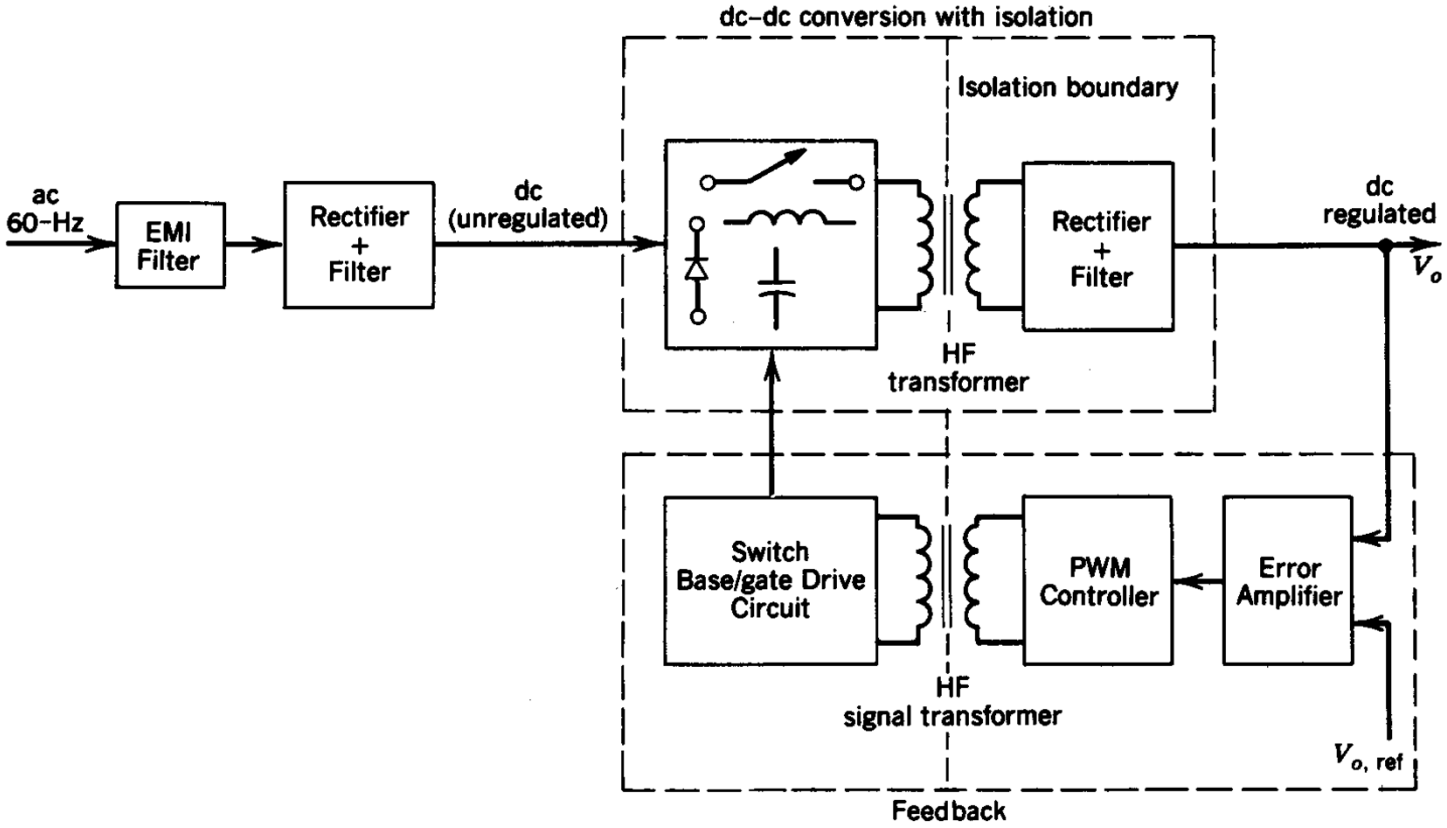

Figure 10-2 Schematic of a switch-mode dc power supply.

- High efficiency and small weight and size

Ferrite Core Material

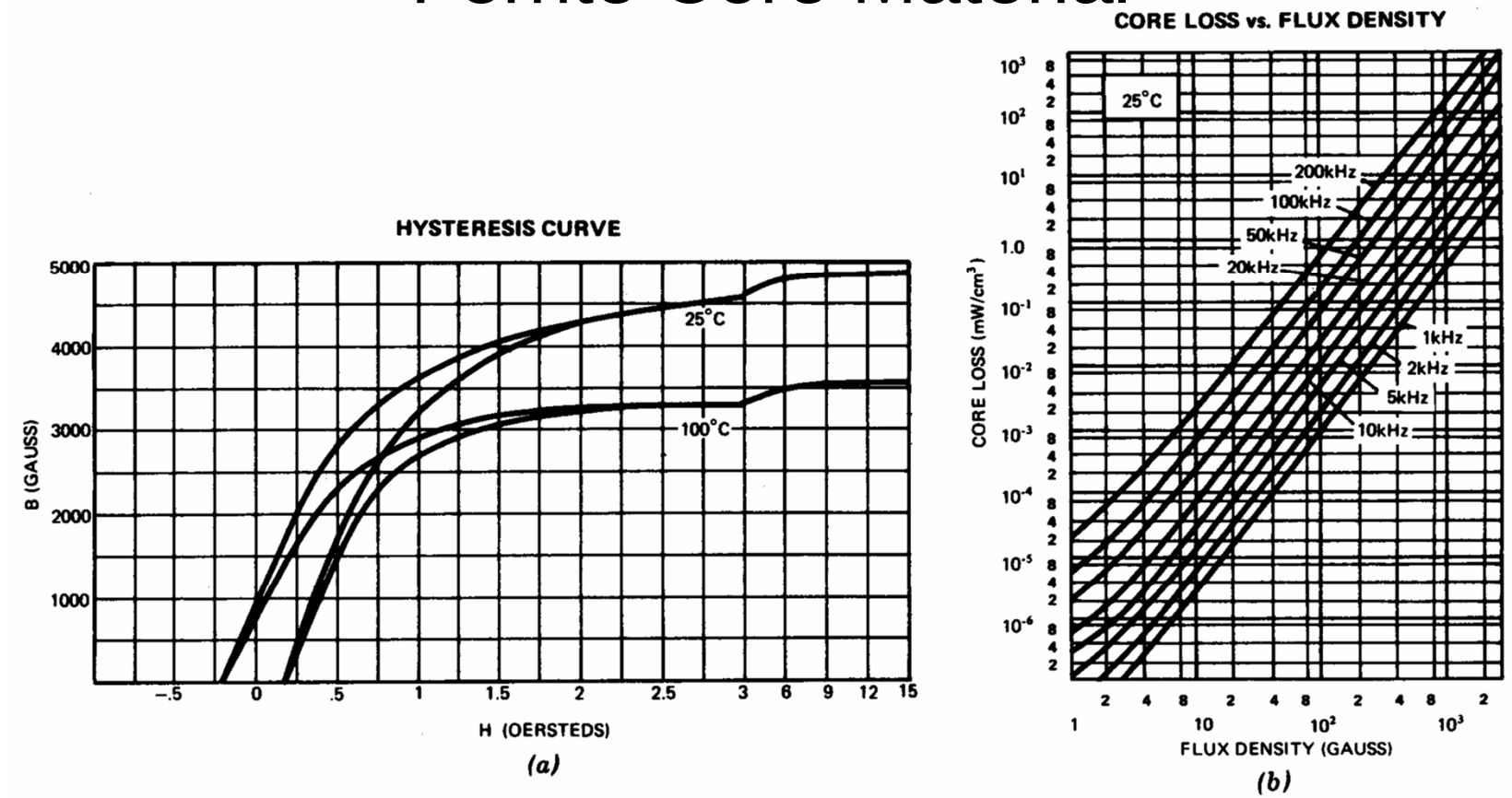

Figure 10-17 3C8 ferrite characteristic curves: (*a*) B–H loop; (*b*) core loss curves. (*Courtesy of Ferroxcube Division of Amperex Electronic Corporation.*)

- Several materials to choose from based on applications

Flyback Converter

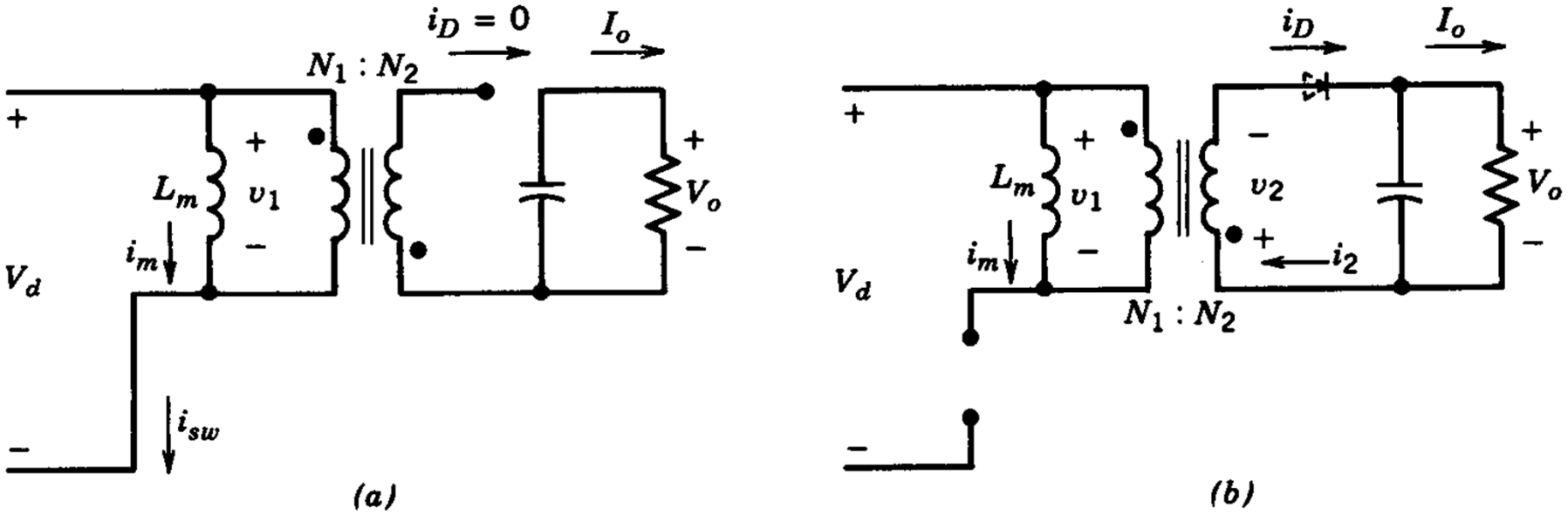

Figure 10-7 Flyback converter circuit states: (*a*) switch on; (*b*) switch off.

- Switch on and off states (assuming incomplete core demagnetization)

Flyback Converter

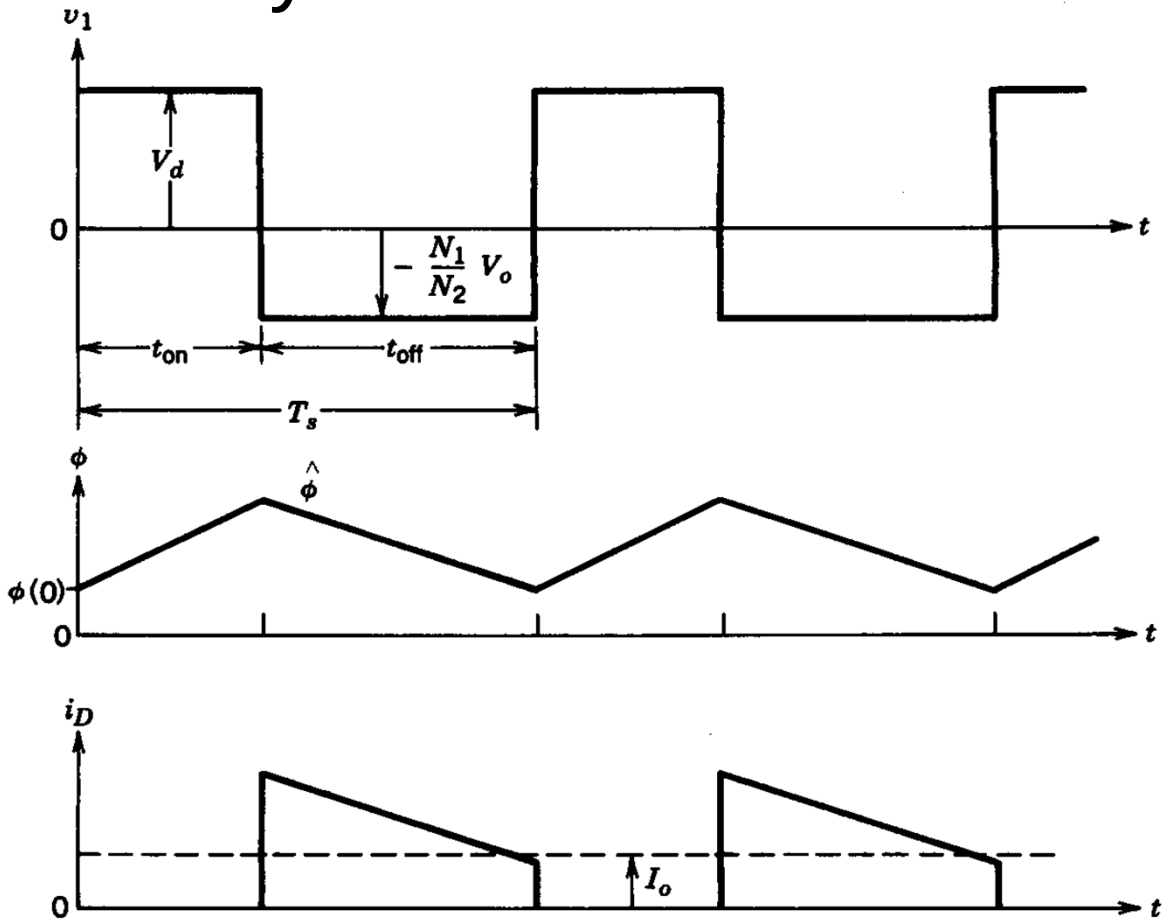

Figure 10-8 Flyback converter waveforms.

- Switching waveforms (assuming incomplete core demagnetization)

Forward Converter: in Practice

- Switching waveforms (assuming incomplete core demagnetization)

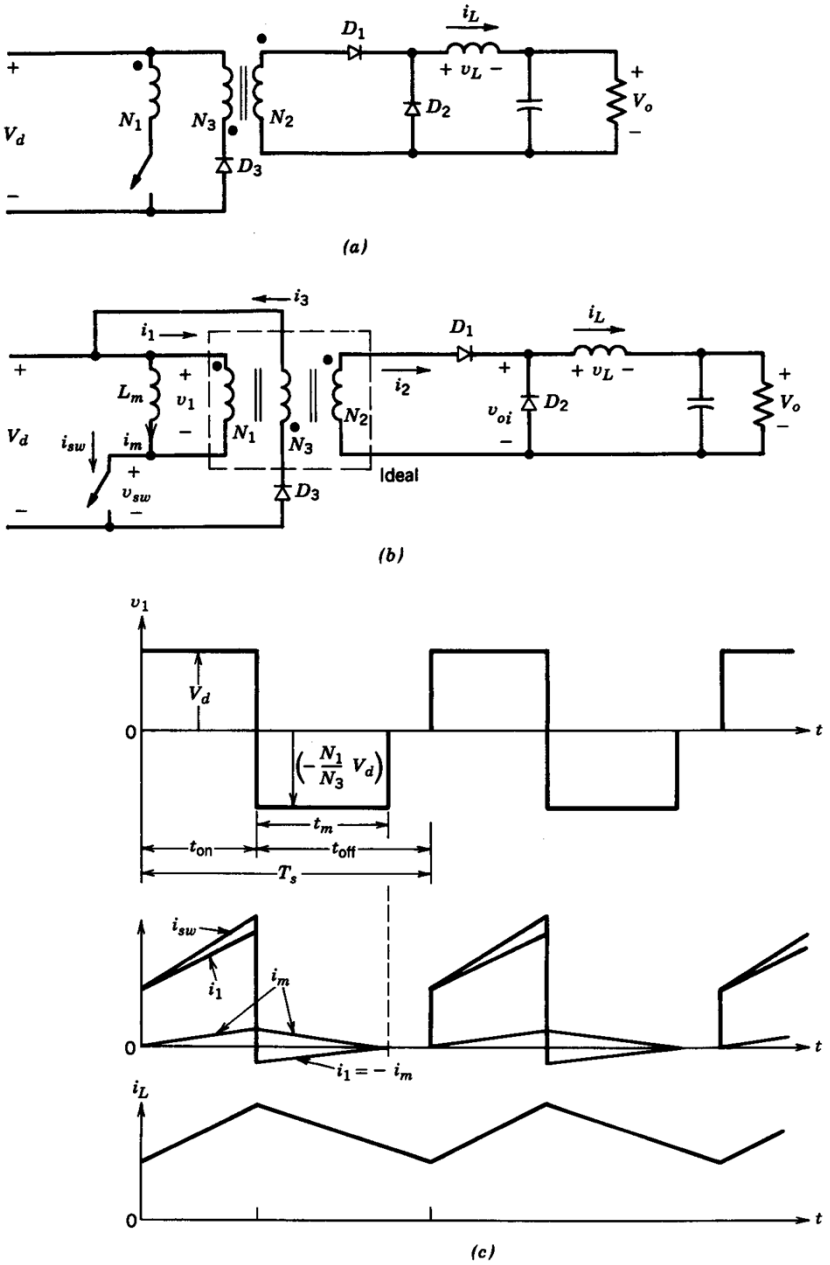

Figure 10-11 Practical forward converter.

Control to Regulate Voltage Output

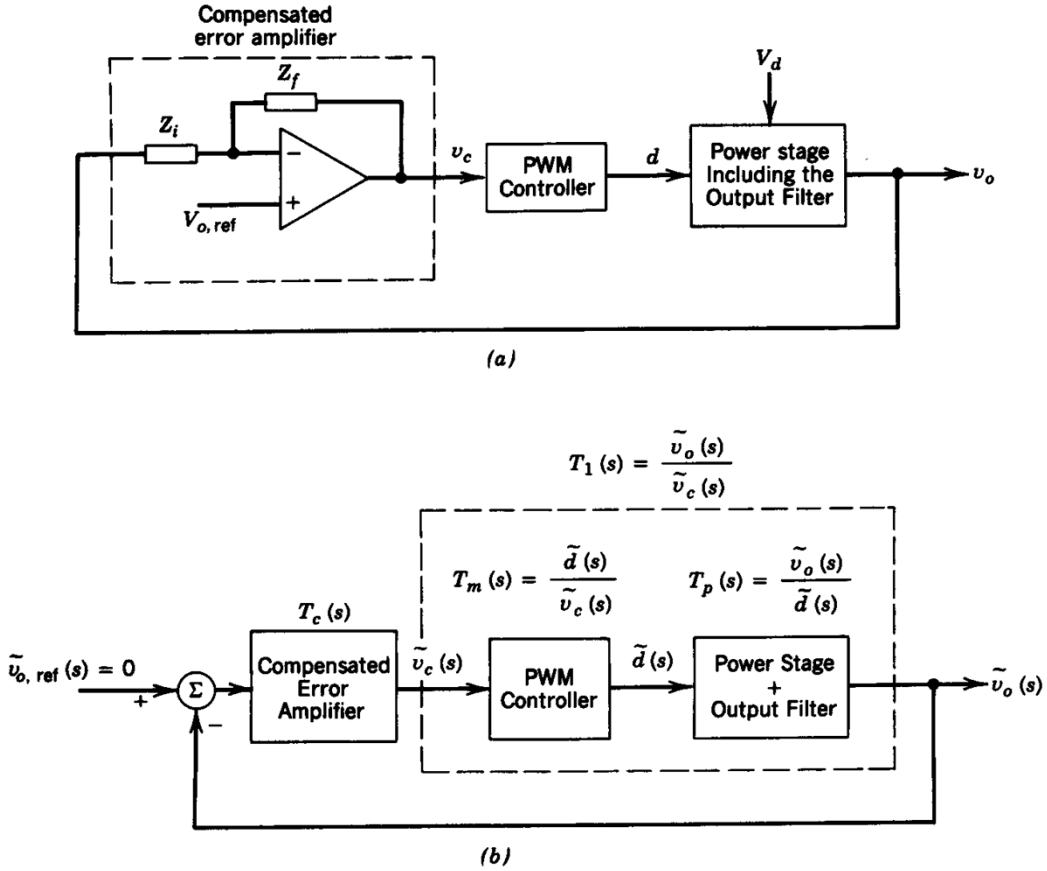

Figure 10-19 Voltage regulation: (*a*) feedback control system; (*b*) linearized feedback control system.

- Linearized representation of the feedback control system

State-space averaging description

State-space model

$$\dot{x} = Ax + Bu$$
$$y = Cx(+Du)$$
$$x = \{\text{e.g.}\} = \begin{bmatrix} v_c \\ i_L \end{bmatrix}$$

Averaging

$$\dot{x} = A_1 x + B_1 v_d \quad \text{during } t_{on}$$
$$\dot{x} = A_2 x + B_2 v_d \quad \text{during } t_{off}$$

Weighted sum

$$\dot{x} = \left[A_1 d + A_2 \left(1 - d\right) \right] x + \left[B_1 d + B_2 \left(1 - d\right) \right] v_d$$

Small perturburations

$$x = X + \tilde{x}, \quad d = D + \tilde{d}, \quad v_d = V_d$$

Simplify

$$\dot{\tilde{x}} = A\tilde{x} + \left[\left(A_1 - A_2 \right) X + \left(B_1 - B_2 \right) V_d \right] \tilde{d}$$

$$A = A_1 D + A_2 \left(1 - D\right)$$

Transfer function

Laplace domain $$\tilde{x} = \left[sI - A \right]^{-1} \left[\left(A_1 - A_2 \right) X + \left(B_1 - B_2 \right) V_d \right] \tilde{d}$$

Transfer function $$T_p(s) = \frac{\tilde{v}_o(s)}{\tilde{d}(s)}$$