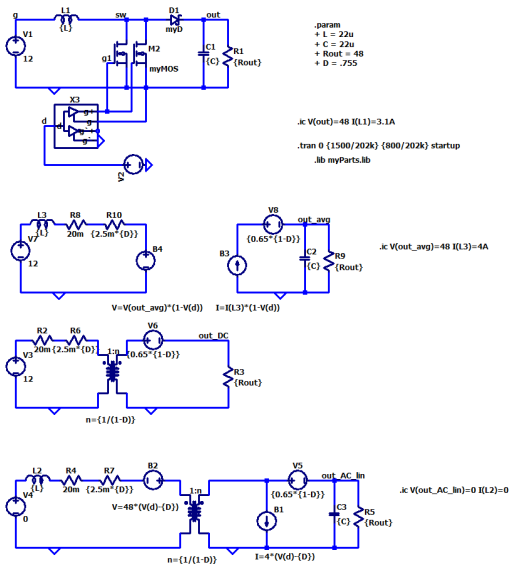
Model Simulation



① Averaging:

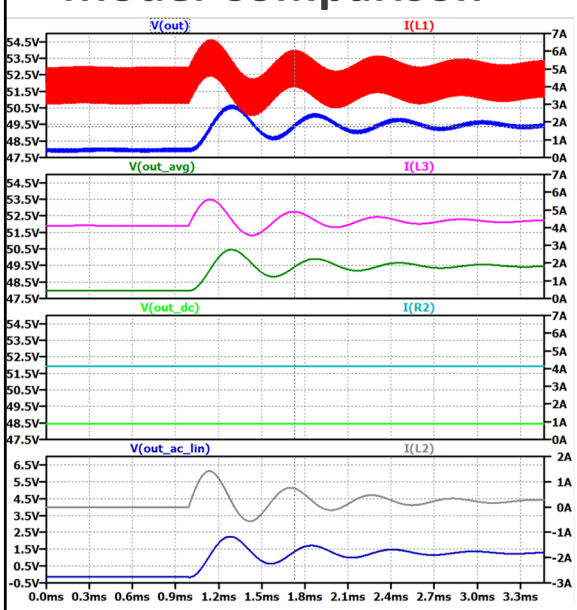
$$\langle v_L \rangle_{T_s} = \langle v_g \rangle_{T_s} - d'(t) \langle v \rangle_{T_s}$$

$$\langle i_C \rangle_{T_s} = -\frac{\langle v \rangle_{T_s}}{R} + d'(t) \langle i_L \rangle_{T_s}$$

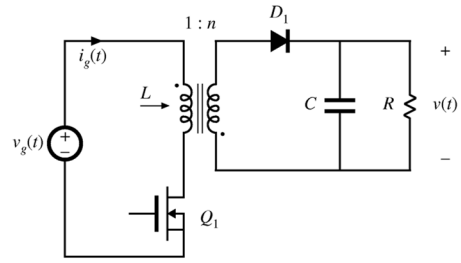
$$L \frac{d\hat{i}_L}{dt} = \hat{v}_g - D'\hat{v} + V\hat{d}$$

$$C \frac{d\hat{v}}{dt} = \hat{v}\left(\frac{-1}{R}\right) + \hat{i}_L (D') + \hat{d}(-I_L)$$

Model Comparison

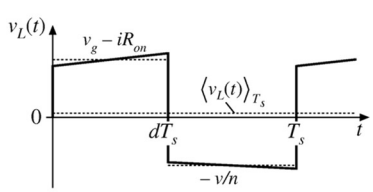


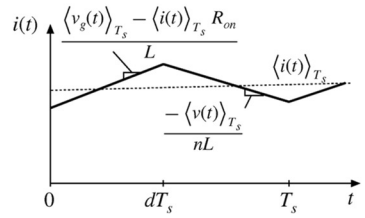
7.2.9: Nonideal Flyback Modeling



- MOSFET has on-resistance R_{on}
- Flyback transformer has magnetizing inductance L, referred to primary

Inductor Waveforms





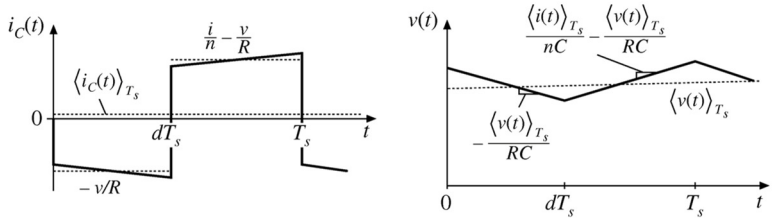
Average inductor voltage:

$$\langle v_L(t) \rangle_{T_s} = d(t) \left(\langle v_g(t) \rangle_{T_s} - \langle i(t) \rangle_{T_s} R_{on} \right) + d'(t) \left(\frac{-\langle v(t) \rangle_{T_s}}{n} \right)$$

Hence, we can write:

$$L \frac{d \langle i(t) \rangle_{T_s}}{dt} = d(t) \langle v_g(t) \rangle_{T_s} - d(t) \langle i(t) \rangle_{T_s} R_{on} - d'(t) \frac{\langle v(t) \rangle_{T_s}}{n}$$

Capacitor Waveforms



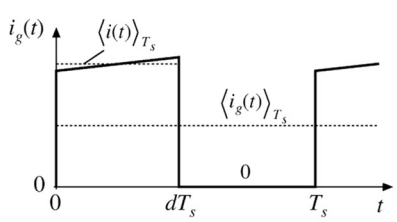
Average capacitor current:

$$\langle i_C(t) \rangle_{T_s} = d(t) \left(\frac{-\langle v(t) \rangle_{T_s}}{R} \right) + d'(t) \left(\frac{\langle i(t) \rangle_{T_s}}{n} - \frac{\langle v(t) \rangle_{T_s}}{R} \right)$$

Hence, we can write:

$$C \frac{d \langle v(t) \rangle_{T_s}}{dt} = d'(t) \frac{\langle i(t) \rangle_{T_s}}{n} - \frac{\langle v(t) \rangle_{T_s}}{R}$$

Input Current Waveform



Average input current:

$$\langle i_g(t) \rangle_{T_s} = d(t) \langle i(t) \rangle_{T_s}$$

Flyback Linearization

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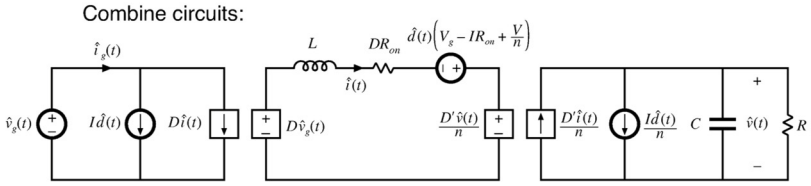
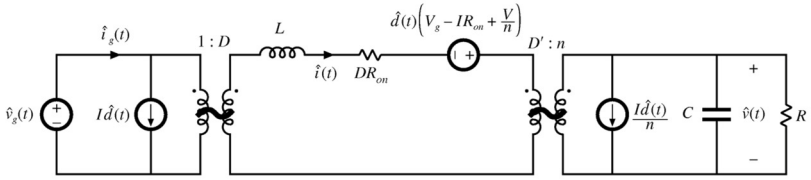
Flyback Equivalent Circuit Model

Flyback AC Model

Combine circuits:



Replace dependent sources with ideal transformers:



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Remainder of Chapter 7