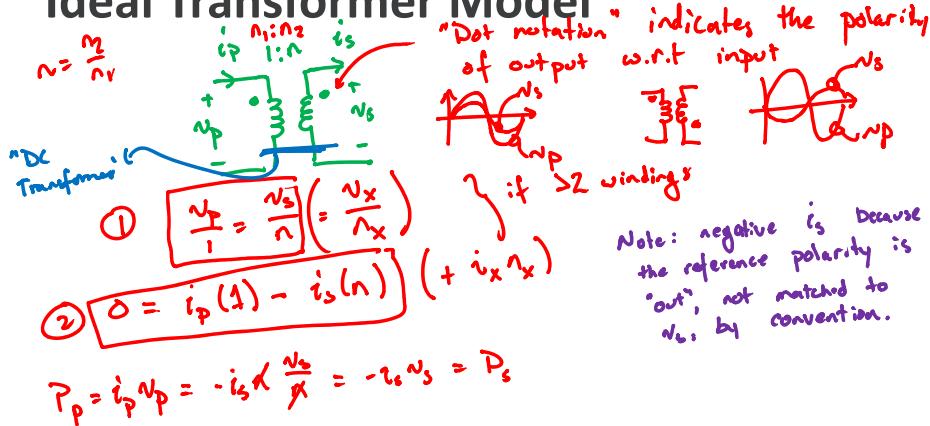


Steady-State Equivalent Circuit Modeling

- 3.1. The dc transformer model
- 3.2. Inclusion of inductor copper loss
- 3.3. Construction of equivalent circuit model
- 3.4. How to obtain the input port of the model
- 3.5. Example: inclusion of semiconductor conduction losses in the boost converter model
- 3.6. Summary of key points

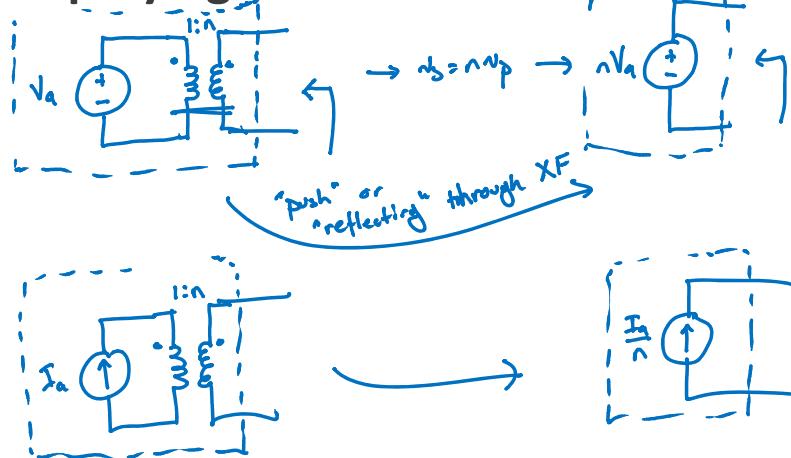
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Ideal Transformer Model



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Simplifying Circuits with Ideal XF



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Simplifying Circuits with Ideal XF

The diagram shows a detailed circuit analysis for simplifying with ideal XF.

Circuit Components: A source V_a is connected to a load Z through a transformer with turns ratio $n = n_p/n_s$. The primary side has a voltage nV_a and current i_p . The secondary side has a voltage V_a and current i_s . A test voltage V_{test} is applied across the load Z , and a test current i_{test} flows through it.

Equations:

$$Z_{eq} = \frac{V_{test}}{i_{test}}$$

$$n_s > V_{test}$$

$$n_p = \frac{n_s}{n} = \frac{V_{test}}{n}$$

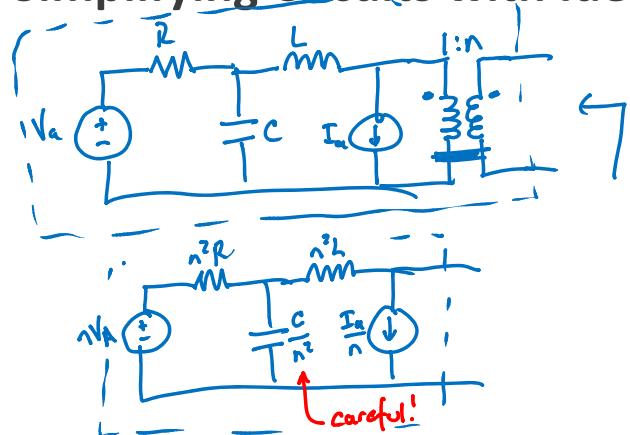
$$i_p = -\frac{n_p}{Z} = -\frac{V_{test}}{nZ}$$

$$i_s = +i_p \frac{1}{n} = -\frac{V_{test}}{n^2 Z} = -i_{test}$$

$$Z_{eq} = \frac{V_{test}}{i_{test}} = n^2 Z$$

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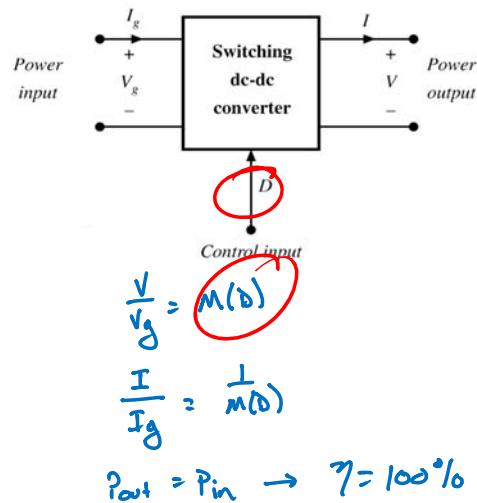
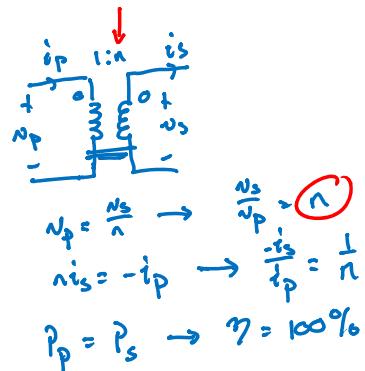
Simplifying Circuits with Ideal XF



$$\frac{1}{T_C} \rightarrow \frac{1}{T_{SC}} = Z_C \quad n^2 Z_C = \frac{n^2}{Z_C}$$

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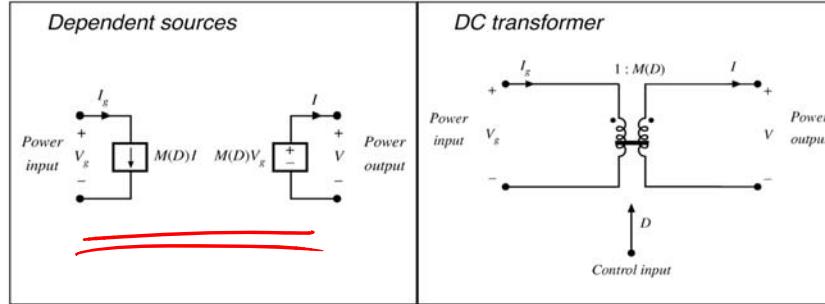
The DC Transformer Model



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DC-DC Converter Equivalent Circuit

$$P_{in} = P_{out} \quad V_g I_g = VI \quad V = M(D) V_g \quad I_g = M(D) I$$



Fundamentals of Power Electronics

Chapter 2: Principles of steady-state converter analysis



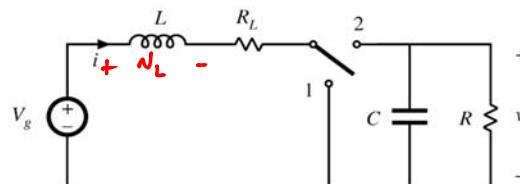
Inclusion of Copper Loss

Dc transformer model can be extended, to include converter nonidealities.

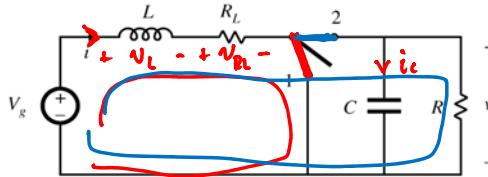
Example: inductor copper loss (resistance of winding):



Insert this inductor model into boost converter circuit:



Nonideal Boost Converter



$$\begin{aligned} \textcircled{1} \quad v_L(t) &= V_g - v_{R_L}(t) \\ &= V_g - i_L(t) R_L \\ &= V_g - I_L R_L \end{aligned}$$

S.R.A

$$\begin{aligned} \textcircled{2} \quad v_L(t) &= V_g - i_L(t) R_L - v(t) \\ v(t) &= V_g - I_L R_L - v \end{aligned}$$

S.R.A

Volt-second balance:

$$\langle v_L \rangle = \phi = \underbrace{V_g - I_L R_L}_{(D+D')} - D'V$$

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