

Instituto Federal de Educação, Ciência e Tecnologia de Santa Catarina

Departamento Acadêmico de Eletrônica

Eletrônica de Potência



Conversor CC-CA Ponte Completa

Prof. Clovis Antonio Petry.

Florianópolis, outubro de 2025.

Eletrônica de Potência

O material do curso está disponível em:

1. Moodle para os alunos matriculados na disciplina.
2. Página do professor.
3. Canal no youtube do professor.



<https://moodle.ifsc.edu.br>



ProfessorPetry
Conhecimento para uma vida plena

PRINCIPAL PROJÉTOS PUBLICAÇÕES CONTATO

Bem vindo ao Website pessoal de Clovis Antonio Petry

O objetivo desta página é a divulgação de informações sobre eletrônica, em especial eletrônica de potência. Todos os materiais disponibilizados podem ser livremente utilizados, desde que citados os autores. As disciplinas do semestre corrente podem ser acessadas clicando na imagem da esquerda abaixo. Material didático pode ser encontrado clicando na imagem da direita abaixo.

Eventos

Outubro, 2020
SNCT 2020
Semana Nacional de Ciência e Tecnologia 2020, Florianópolis, SC.
[Acesse...](#)

Setembro, 2020
COBENGE 2020
XLVIII Congresso Brasileiro de Educação em Engenharia (COBENGE) e III Simpósio Internacional de Educação em Engenharia da ABENGE, Bento Gonçalves, RS. [Acesse...](#)

www.ProfessorPetry.com.br



<https://www.youtube.com>

Agenda

Conversores cc-ca:

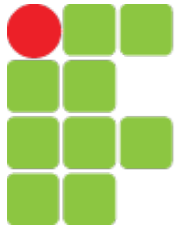
- Revisão dos conversores *CC-CA*;
- Conversores *CC-CA* Ponte Completa.



Motivação

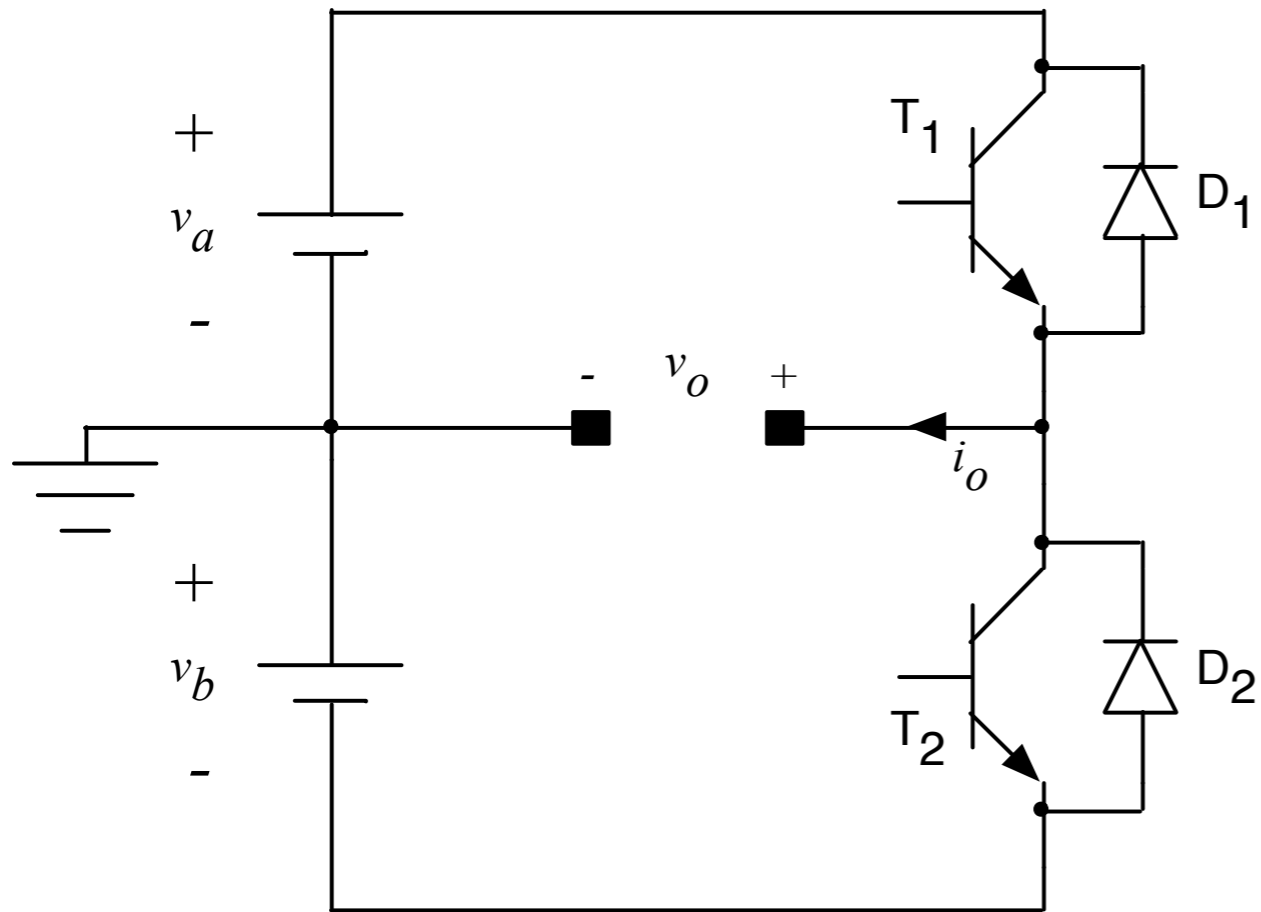
Os inversores são amplamente utilizados para acionamento de motores, inclusive em veículos elétricos.



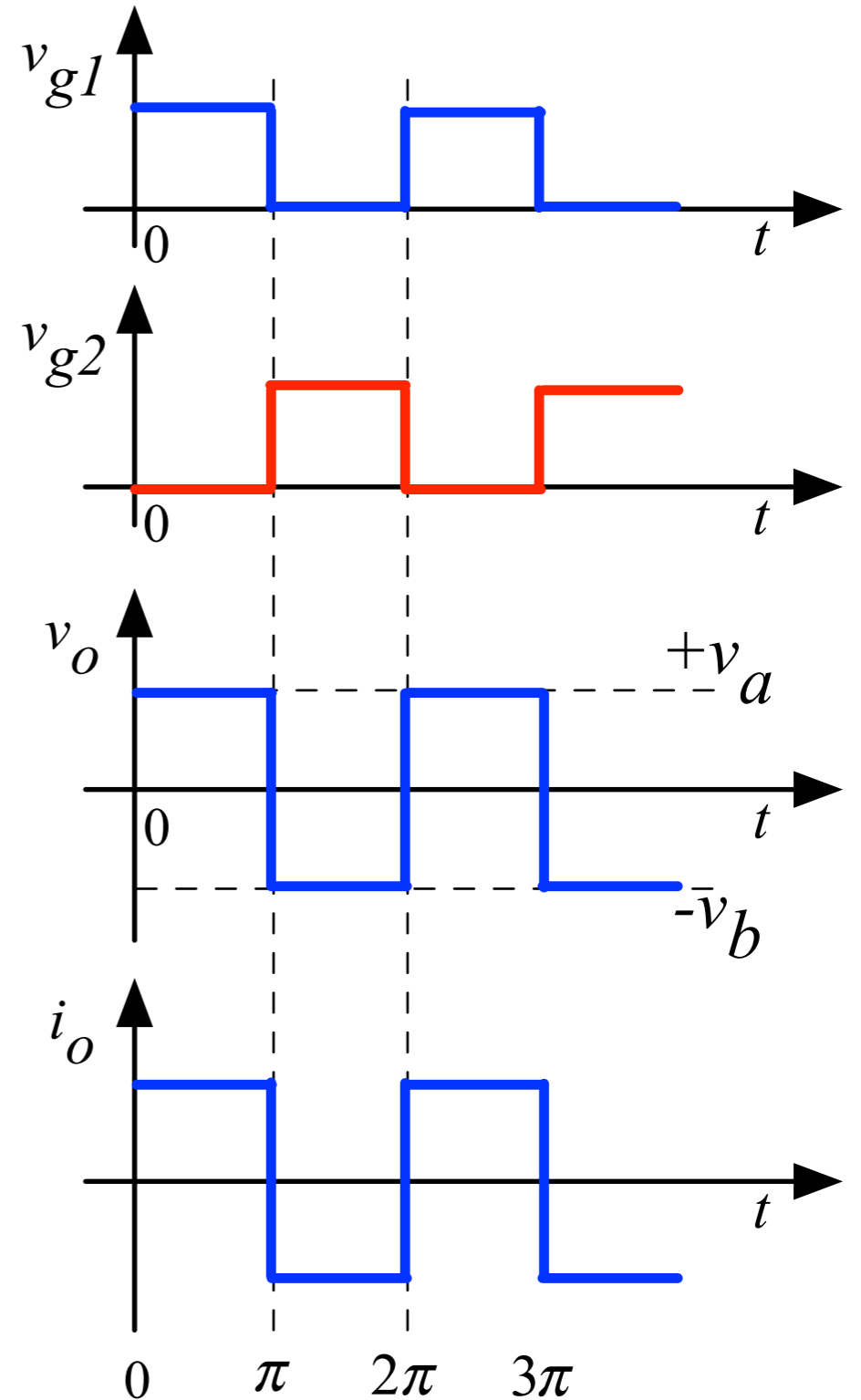


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Conversor Meia Ponte



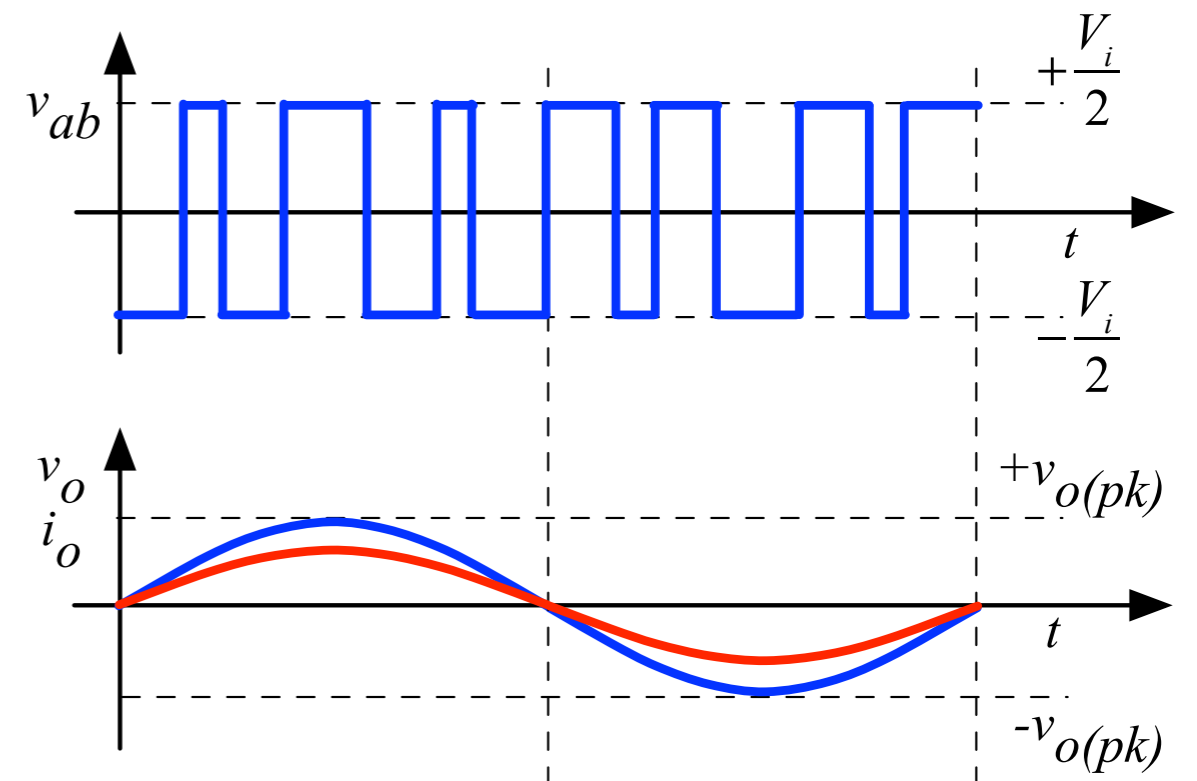
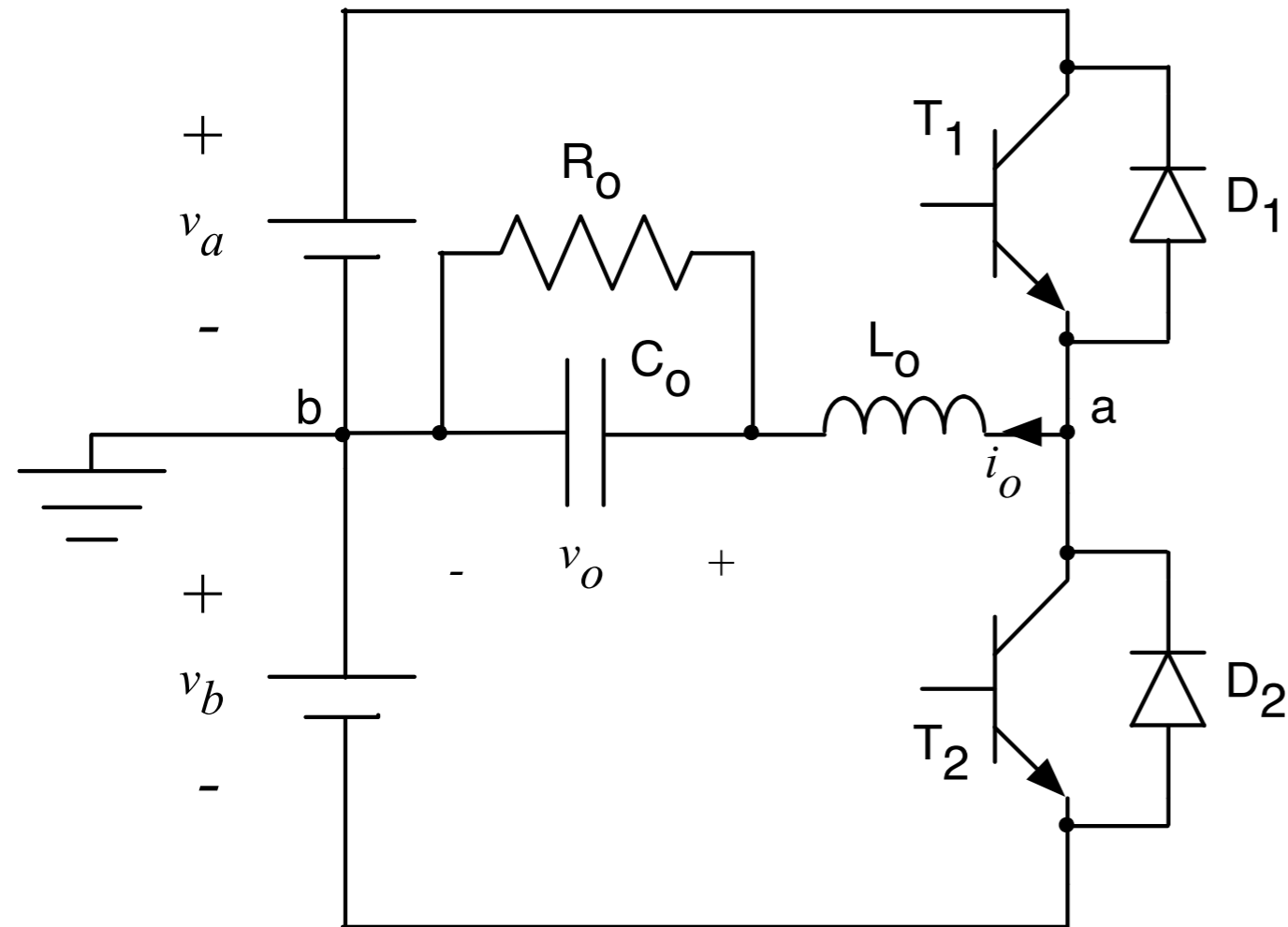
Onda Quadrada

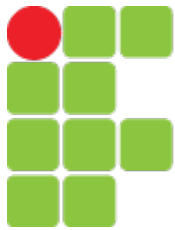


$$V_{o(ef)} = \frac{V_i}{2} \rightarrow V_a = V_b = \frac{V_i}{2}$$

Conversor Meia Ponte

PWM Senoidal

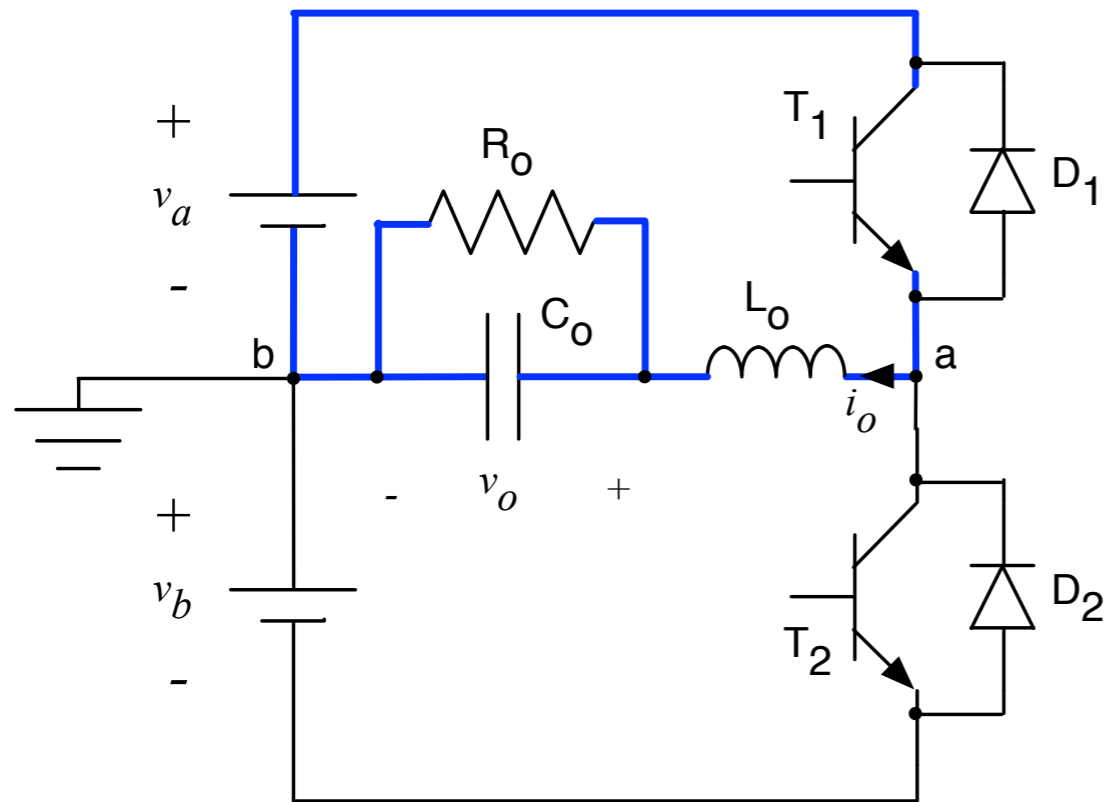




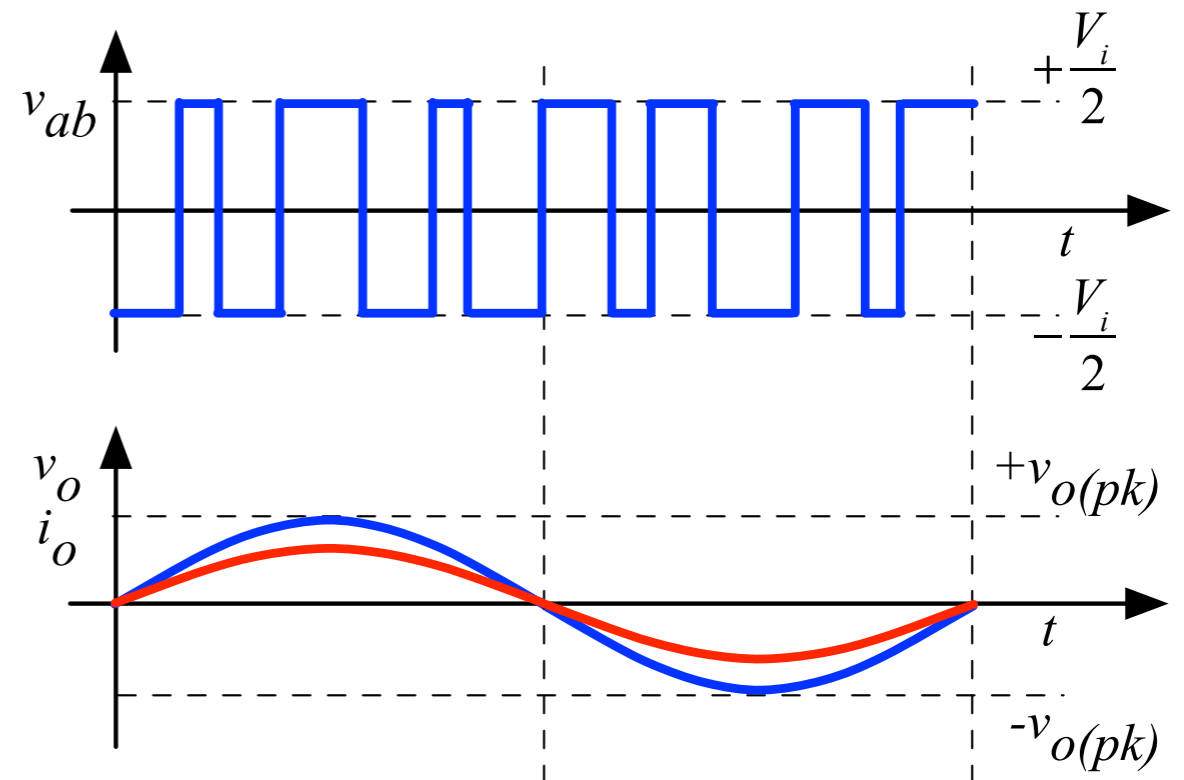
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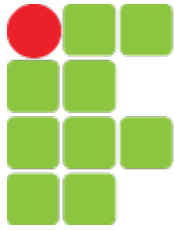
Conversor Meia Ponte

PWM Senoidal



Primeira etapa

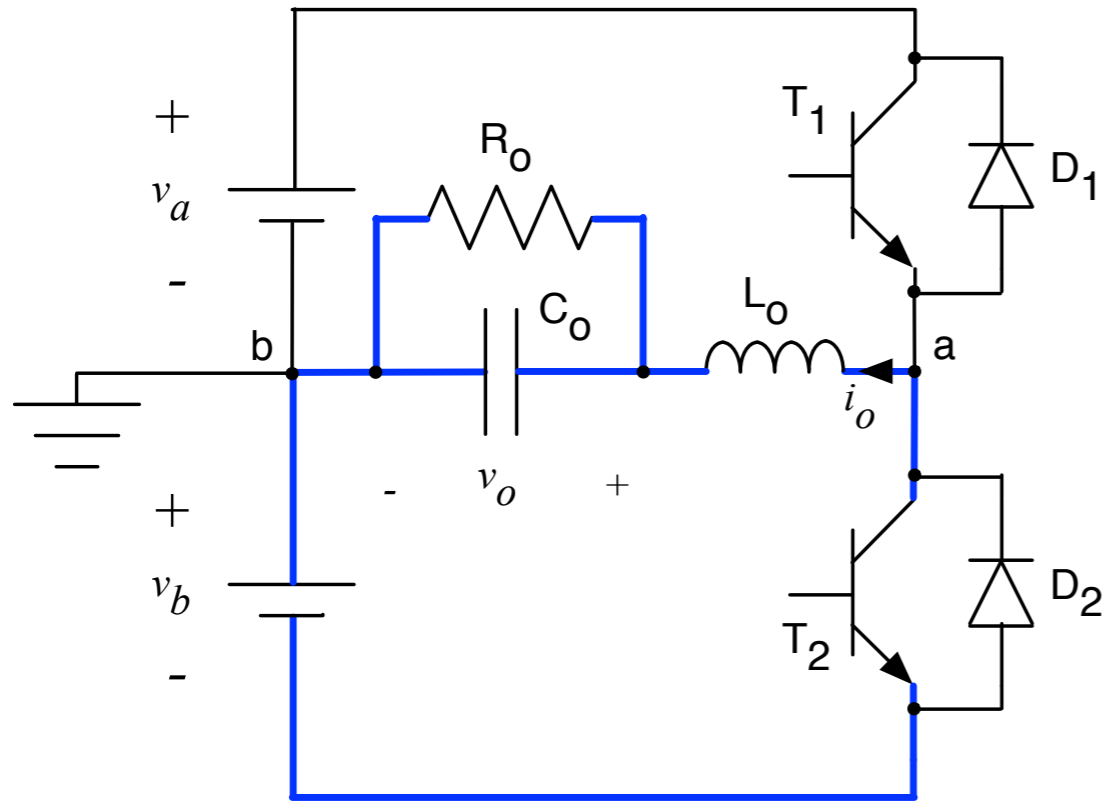




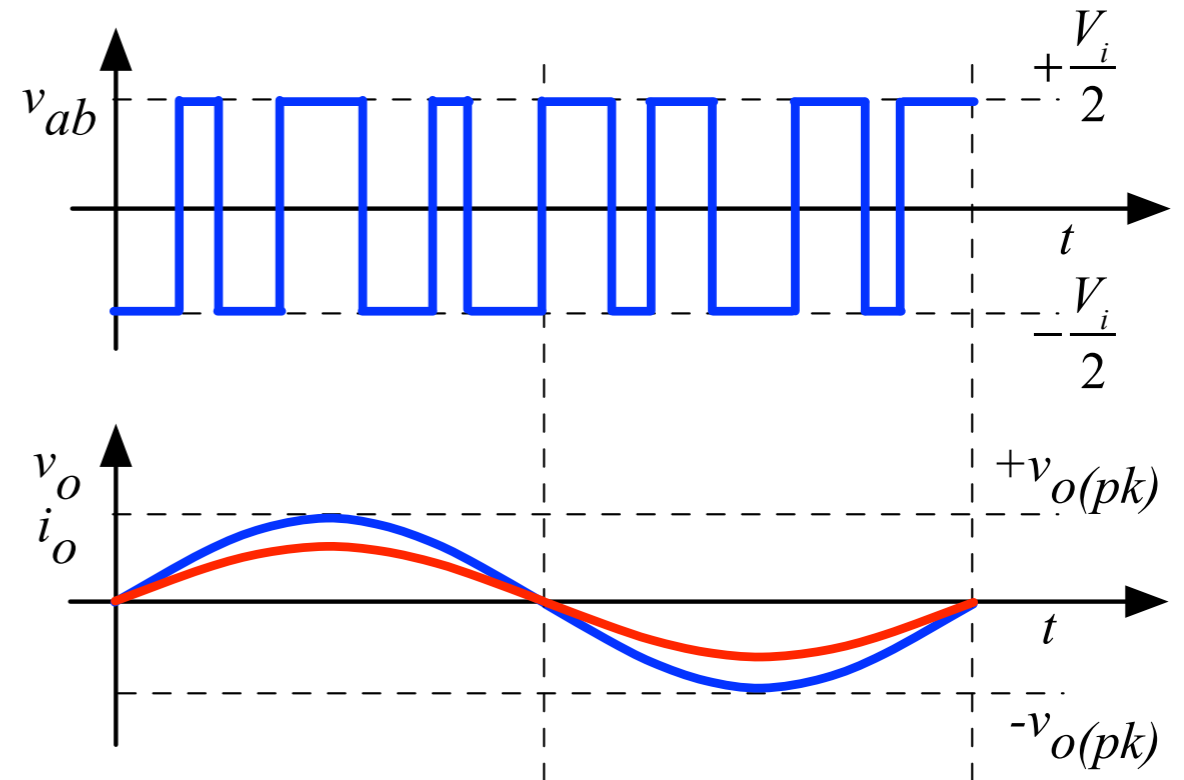
INSTITUTO FEDERAL
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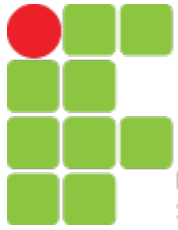
Conversor Meia Ponte

PWM Senoidal



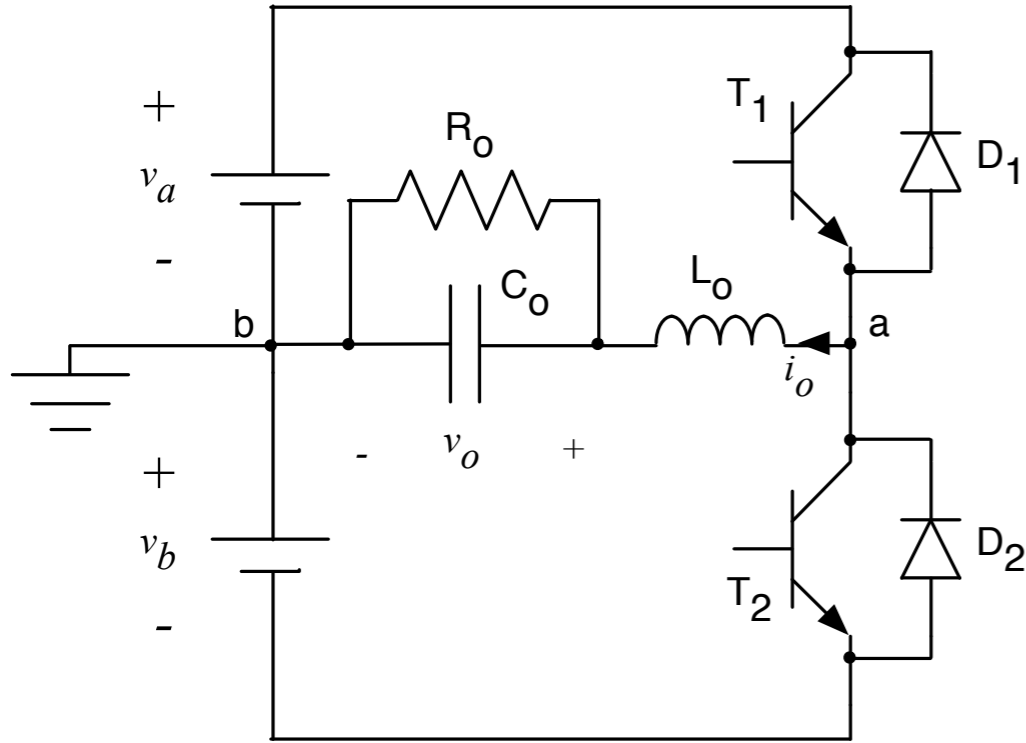
Segunda etapa





Conversor Meia Ponte

PWM Senoidal



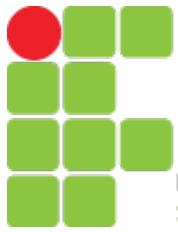
$$V_a = V_b = \frac{V_i}{2}$$

$$V_{L_o} = 0 \rightarrow V_o = V_{ab} \rightarrow V_o = \frac{V_i}{2} \cdot (2 \cdot D - 1)$$

$$v_o(t) = V_{o(pk)} \cdot \text{seno}(t)$$

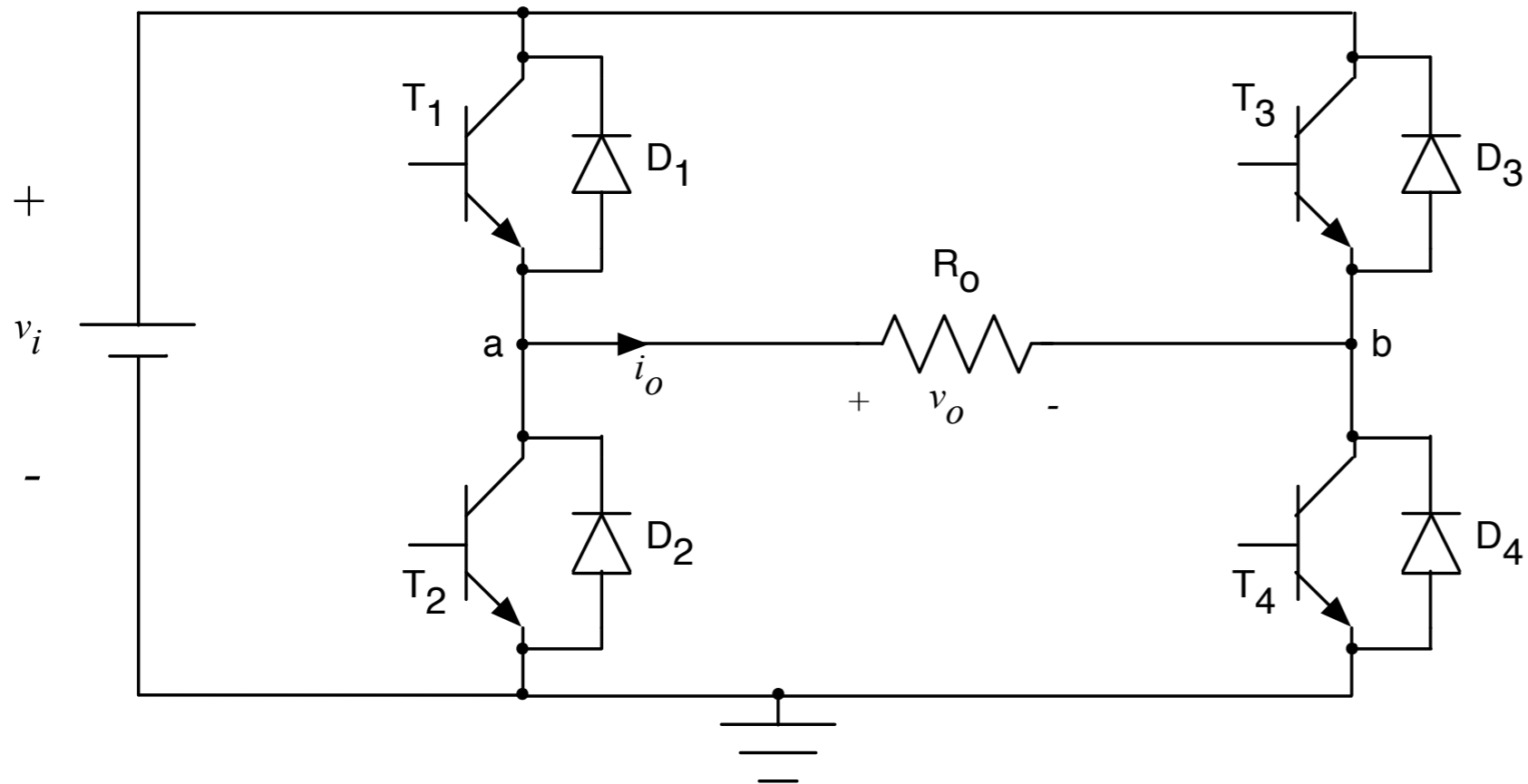
$$d(t) = \frac{1}{2} + \frac{V_{o(pk)} \cdot \text{seno}(t)}{V_i} \rightarrow d(t) = \frac{1}{2} + \frac{V_{o(pk)}}{V_i} \cdot \text{seno}(t)$$

$$IM = \frac{V_{o(pk)}}{V_i} \rightarrow d(t) = \frac{1}{2} + IM \cdot \text{seno}(t)$$

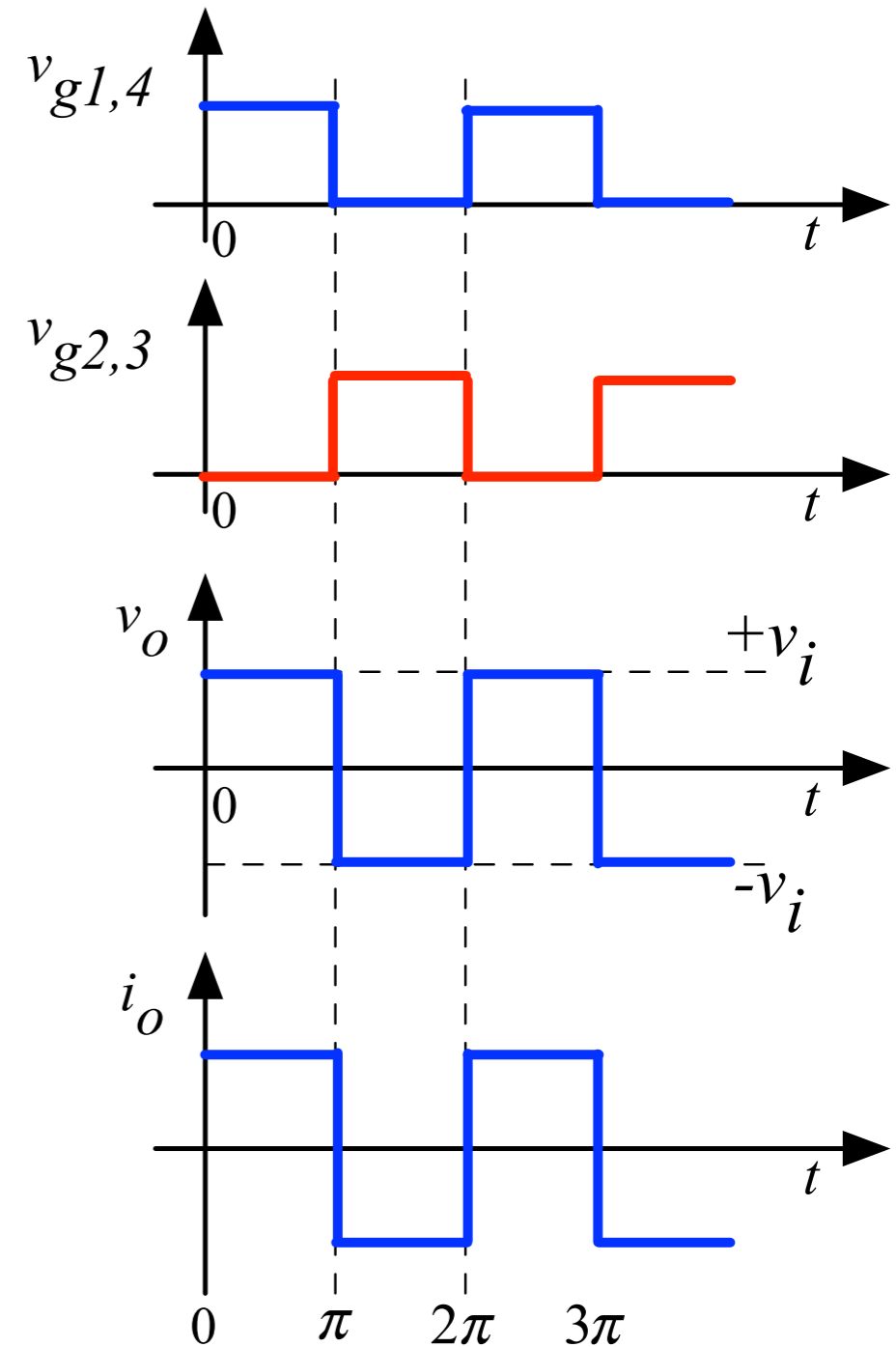


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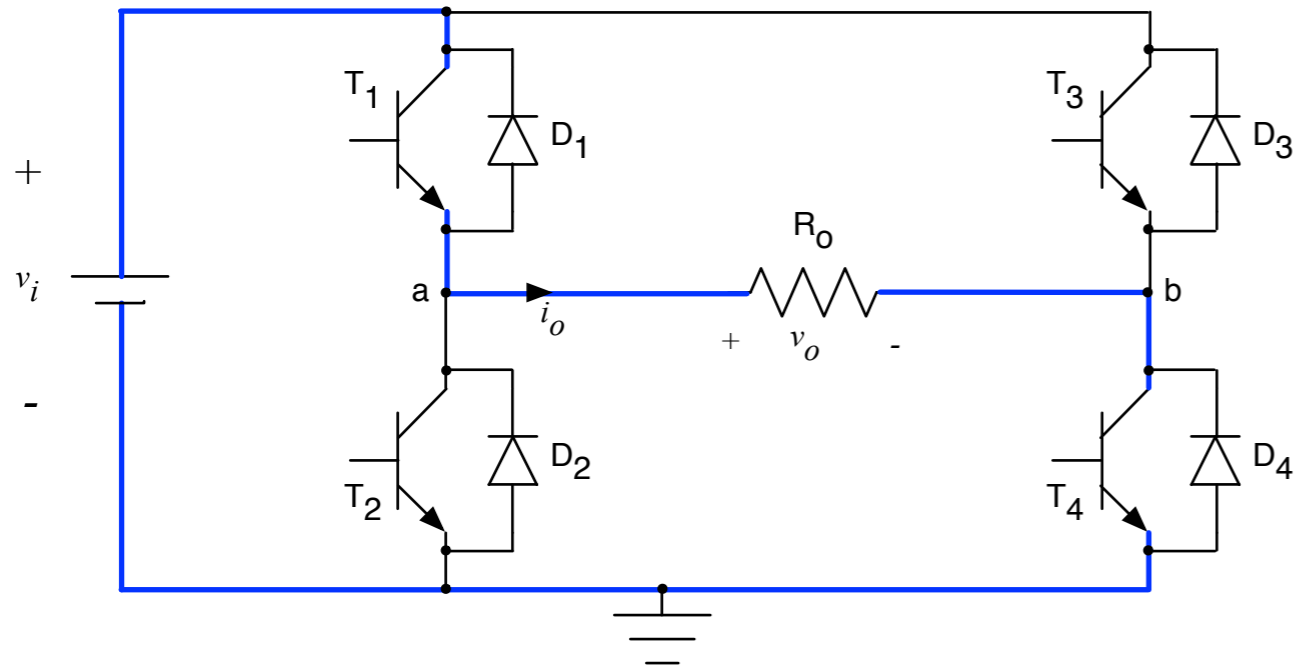
Conversor Ponte Completa



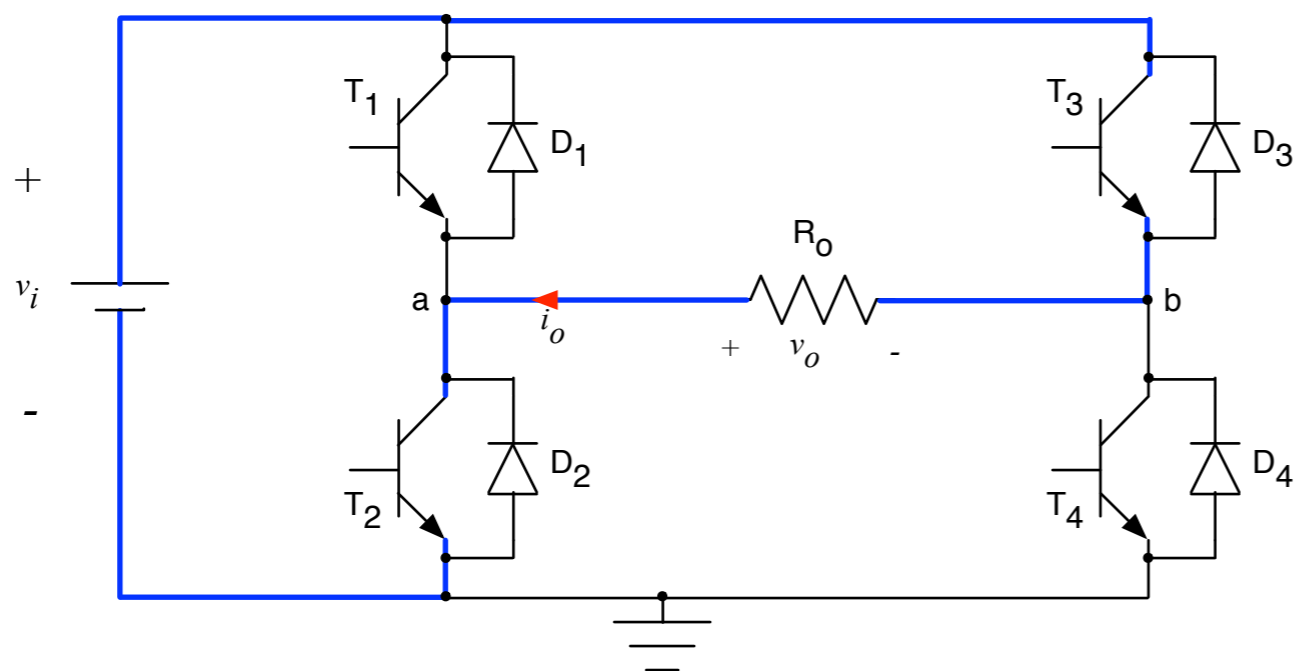
Onda Quadrada



Conversor Ponte Completa

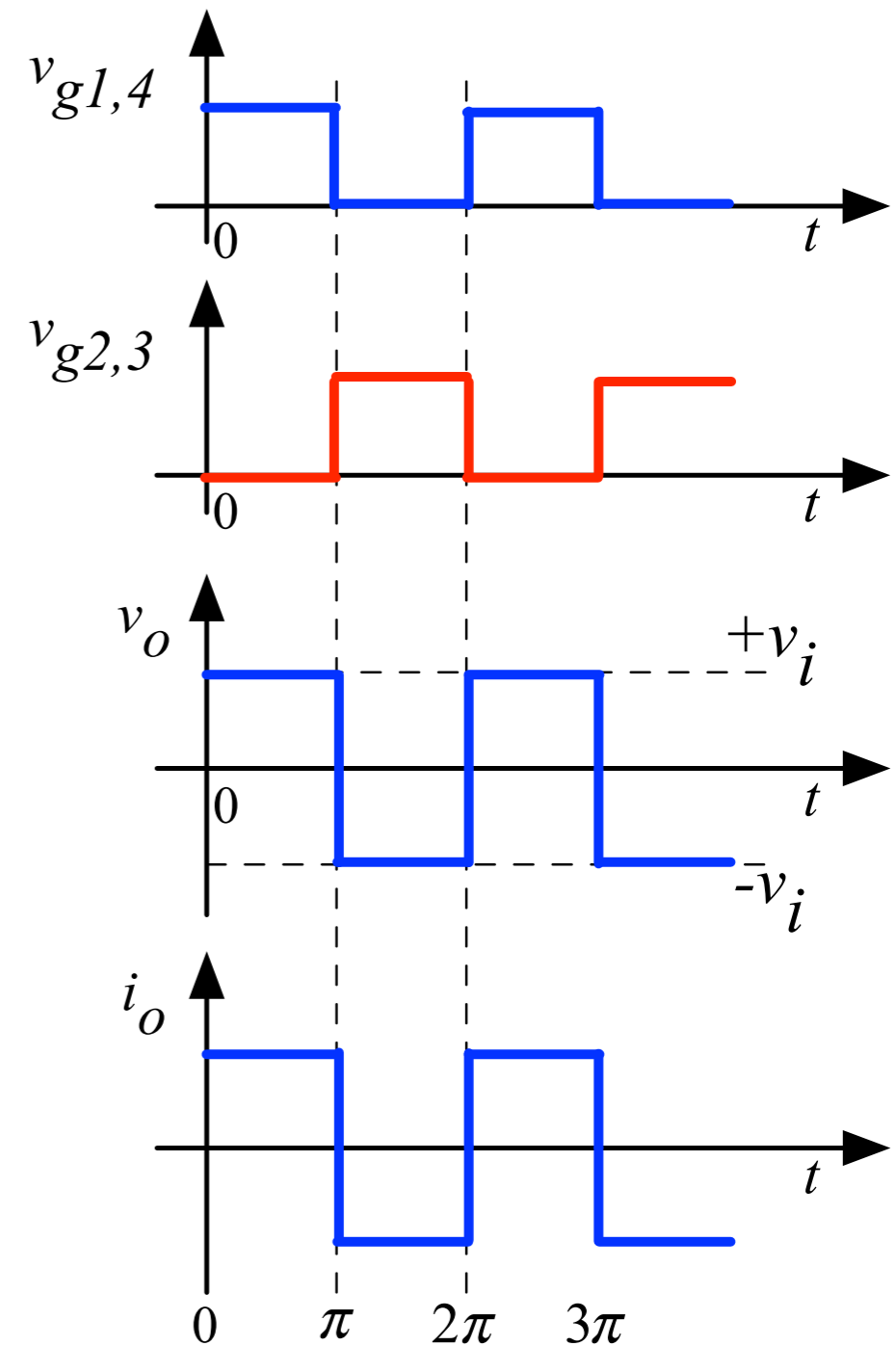


Primeira etapa



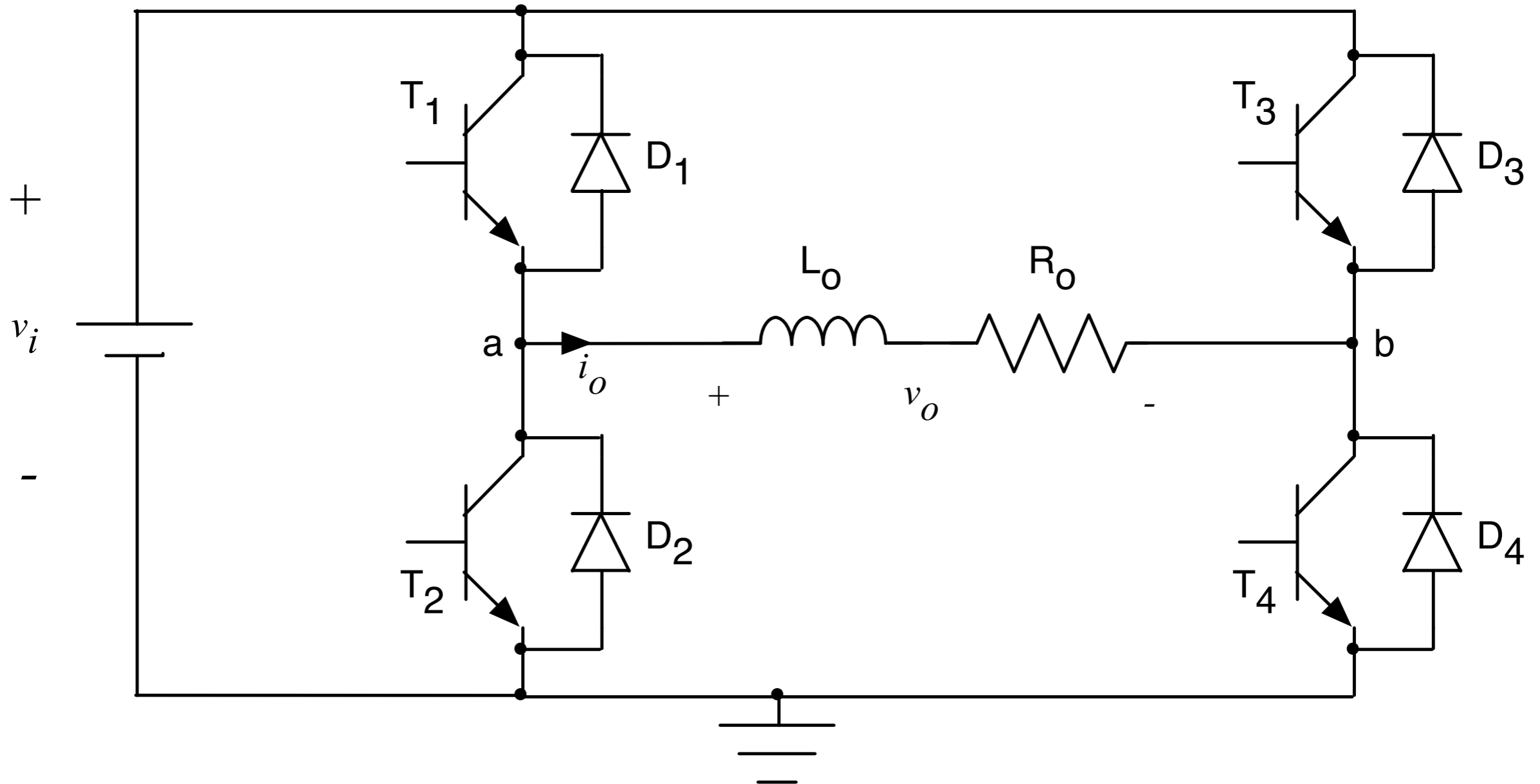
Segunda etapa

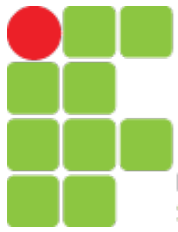
Onda Quadrada



Conversor Ponte Completa

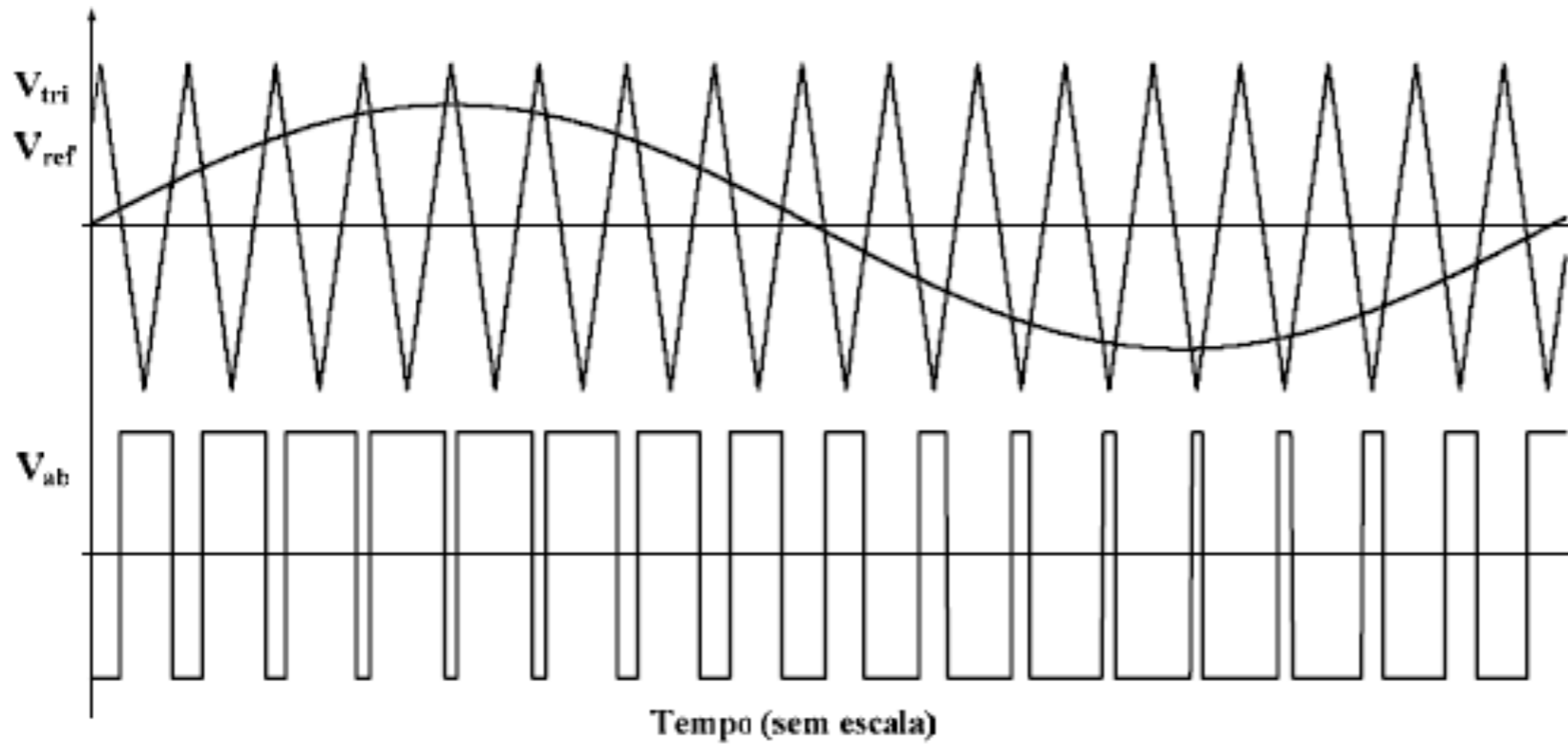
Dois ou Três níveis



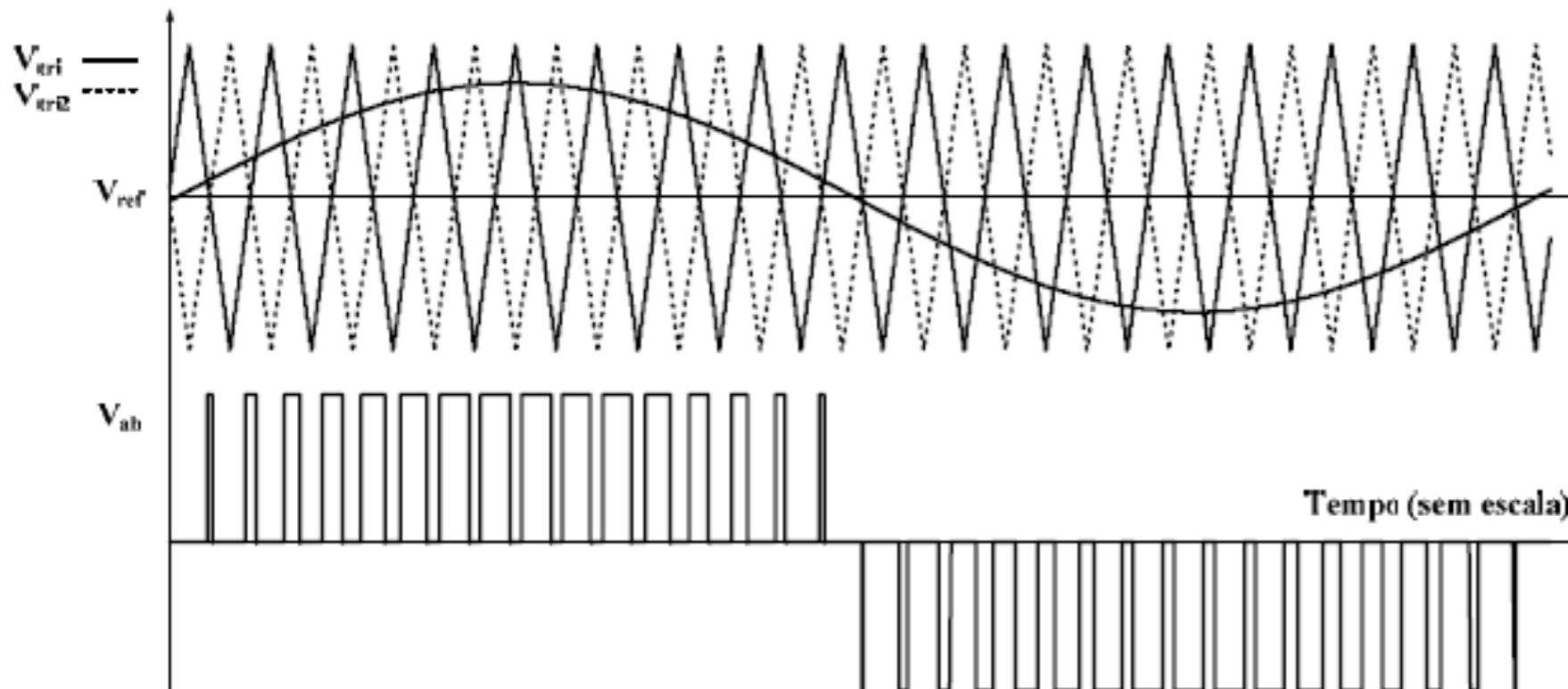


Conversor Ponte Completa

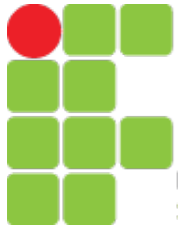
Dois ou Três níveis



Dois níveis



Três níveis

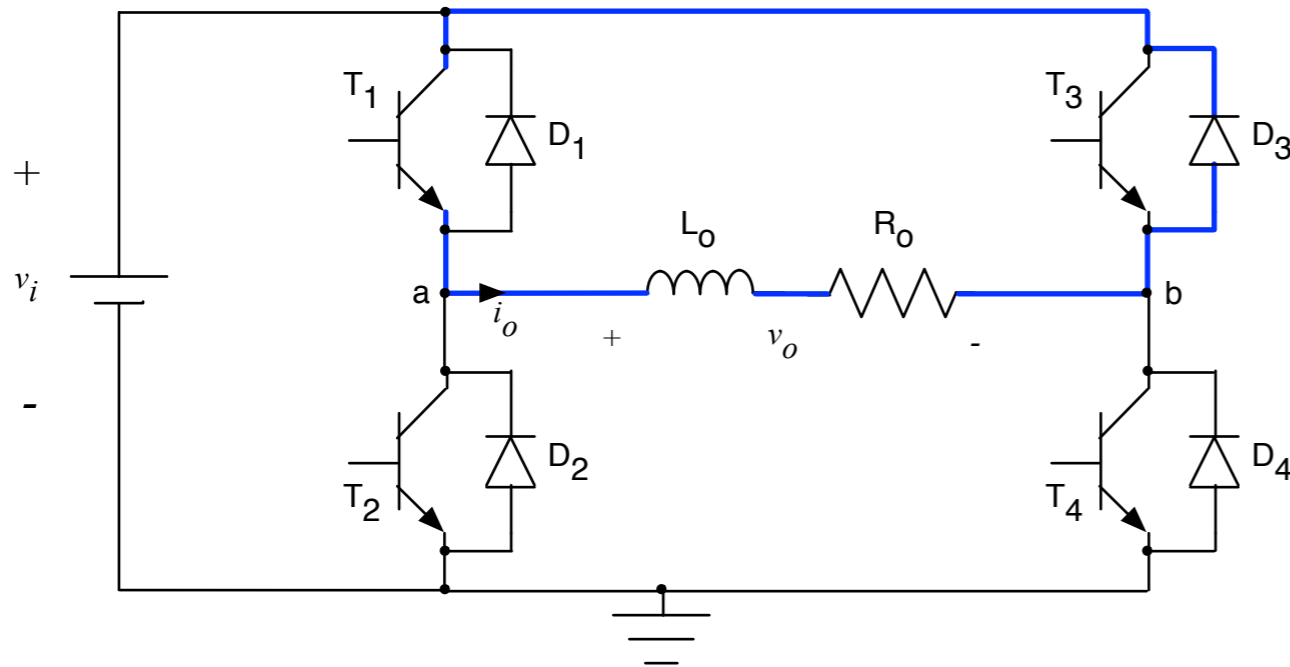


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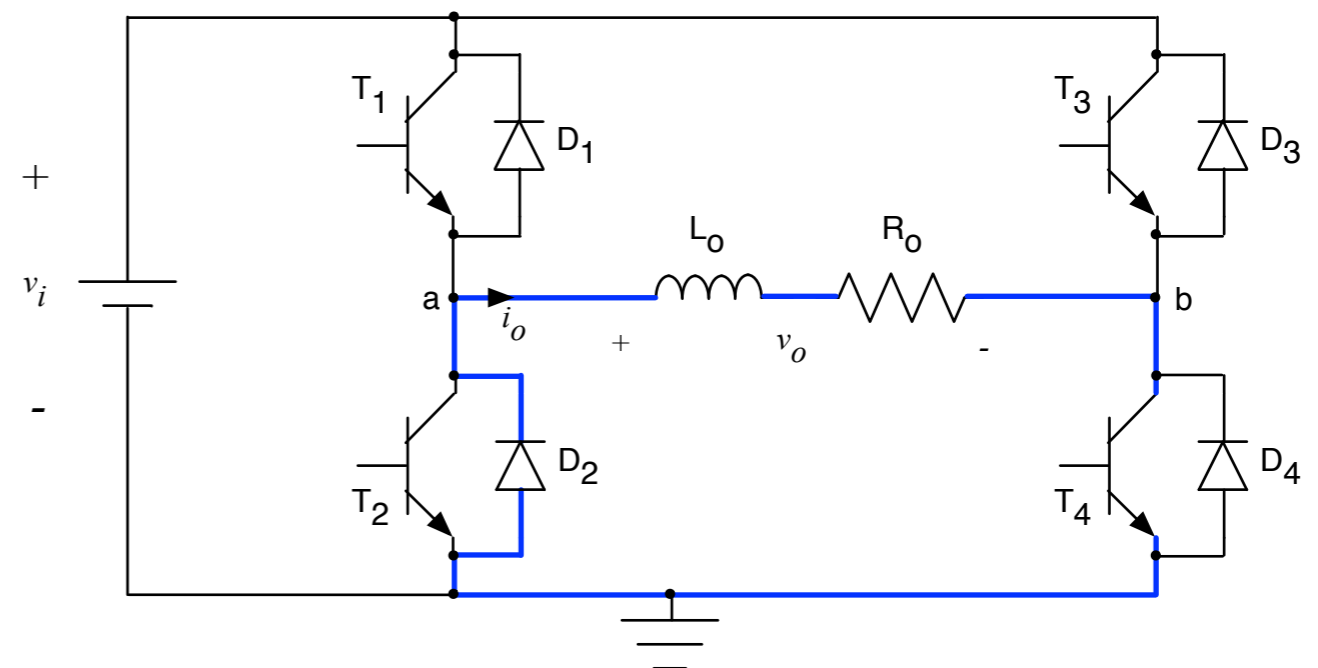
Conversor Ponte Completa

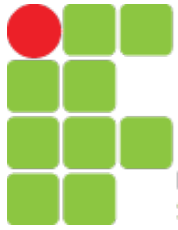
Três níveis

Nível zero



Semiciclo positivo

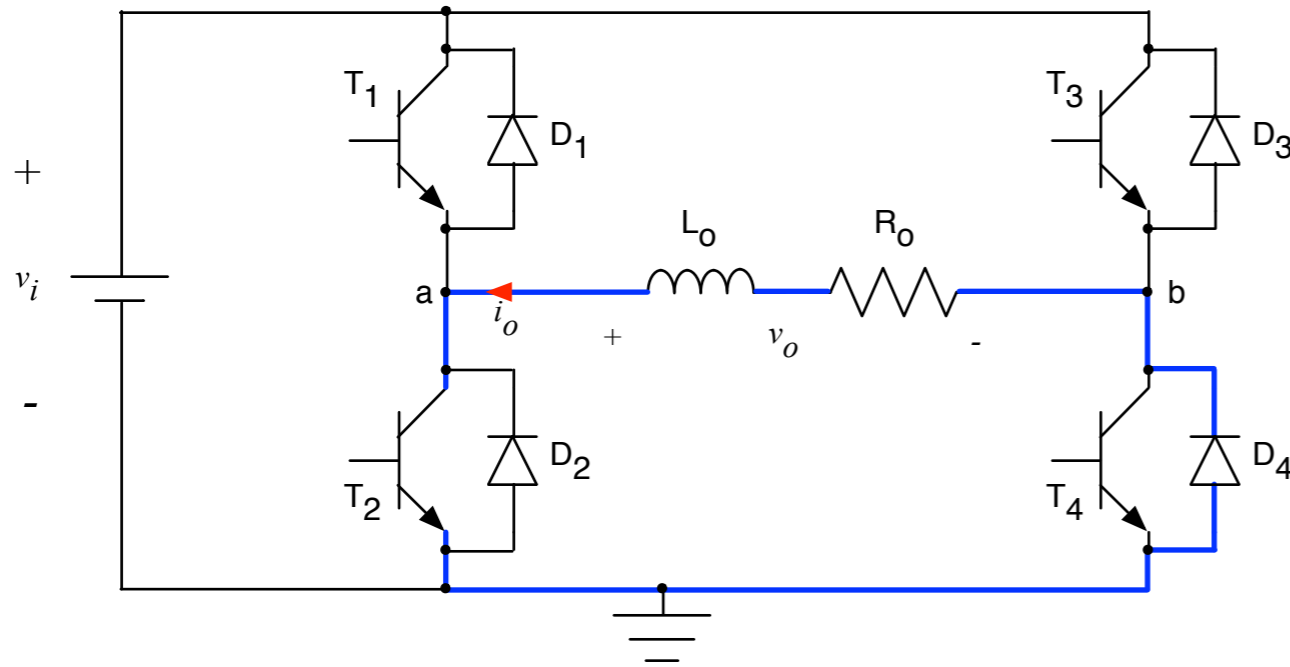




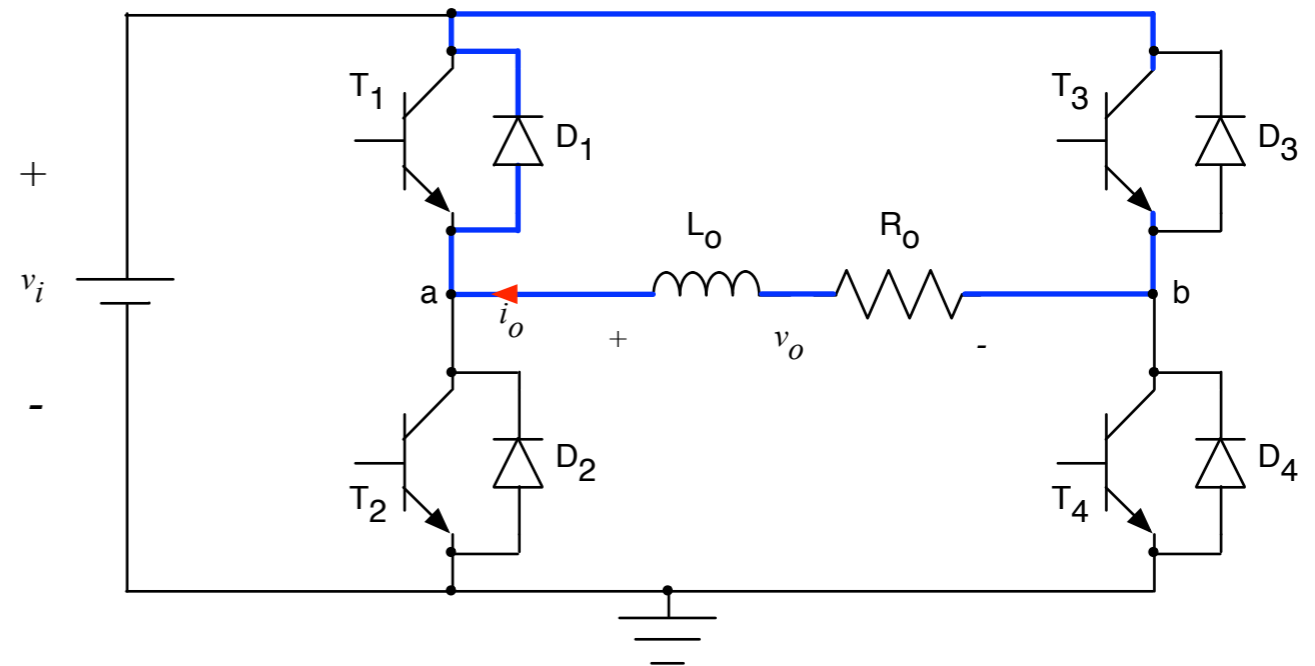
Conversor Ponte Completa

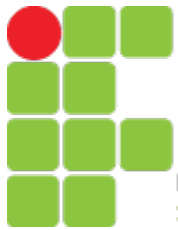
Três níveis

Nível zero

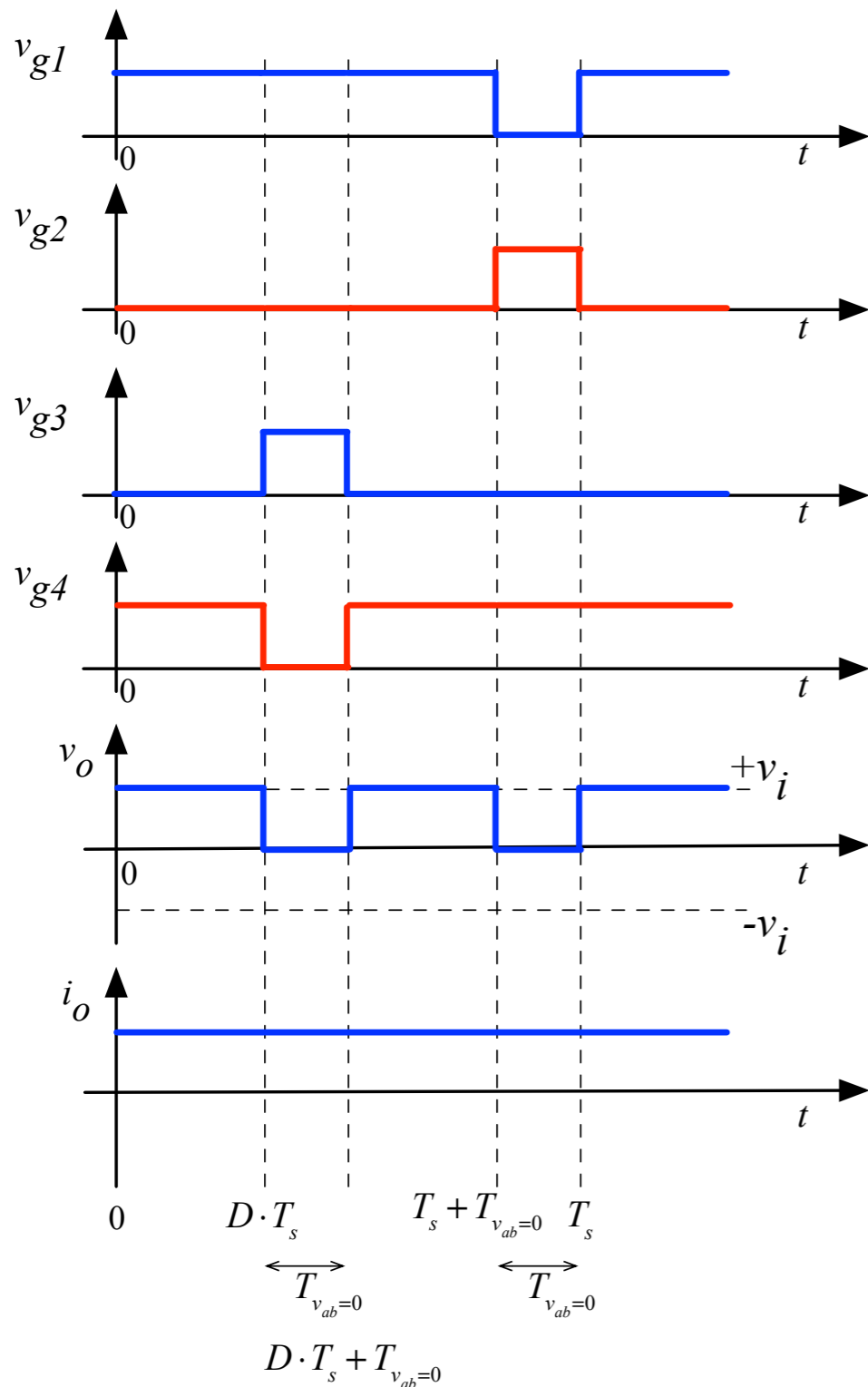


Semiciclo negativo



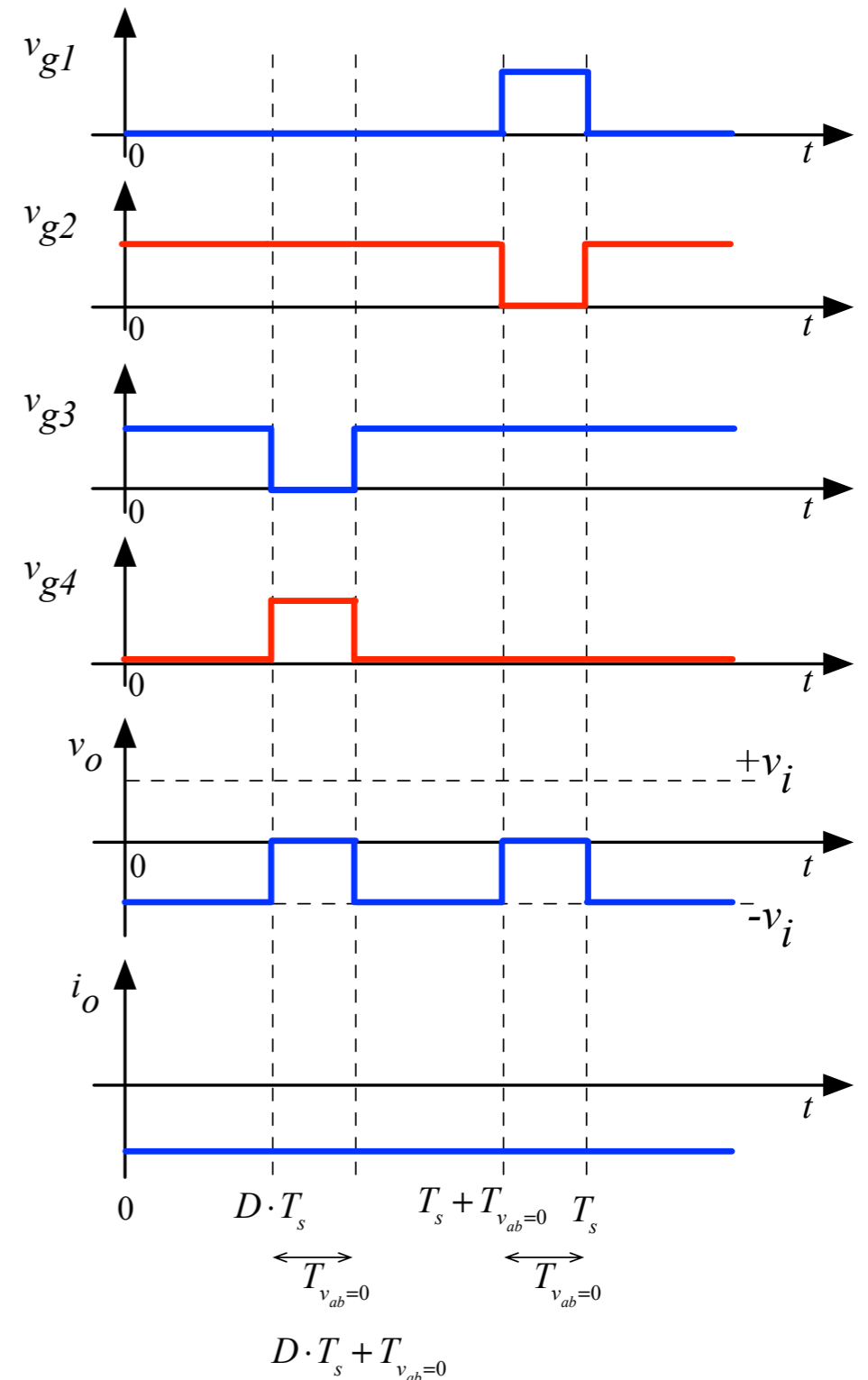


Conversor Ponte Completa

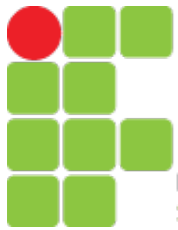


Semiciclo positivo

Três níveis



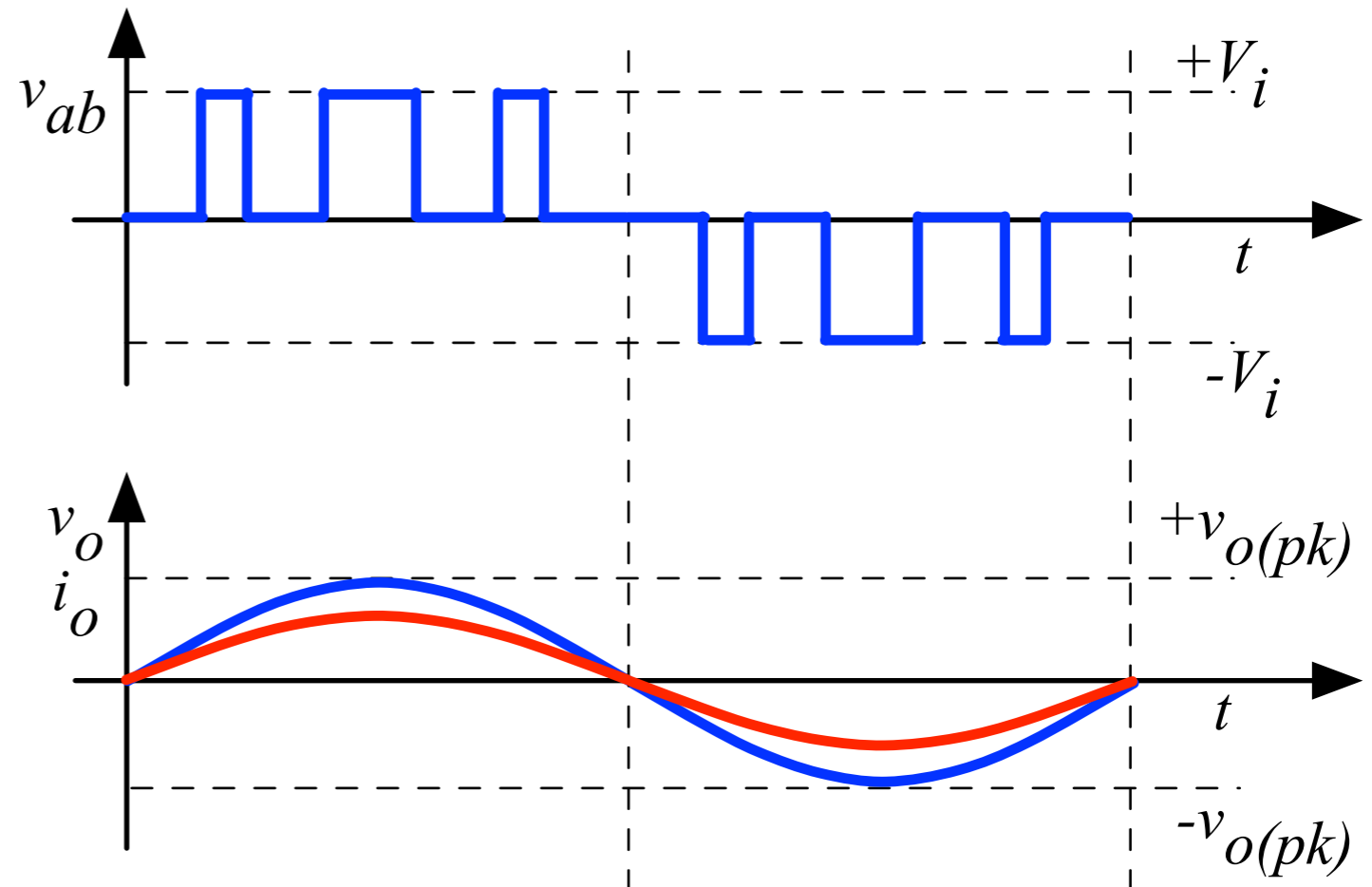
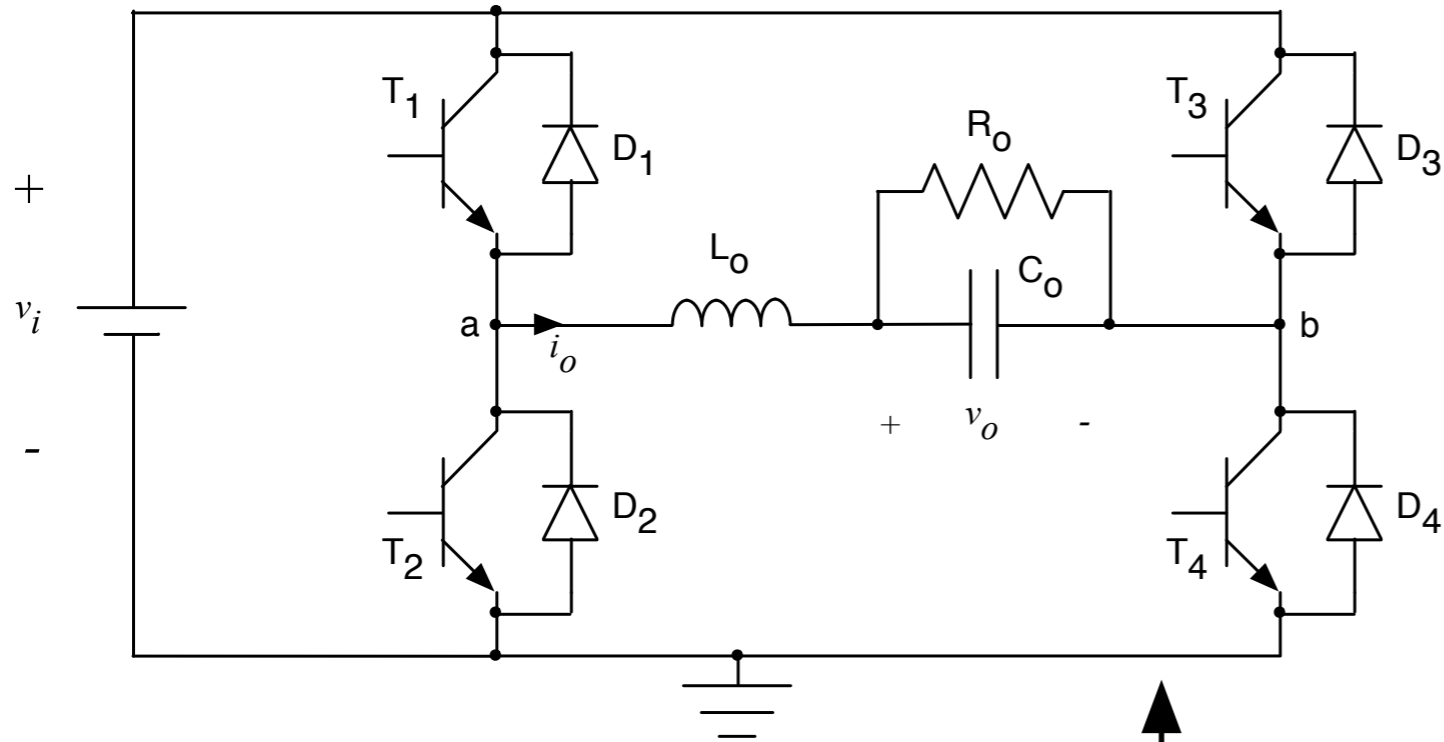
Semiciclo negativo

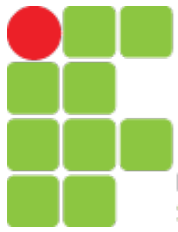


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Conversor Ponte Completa

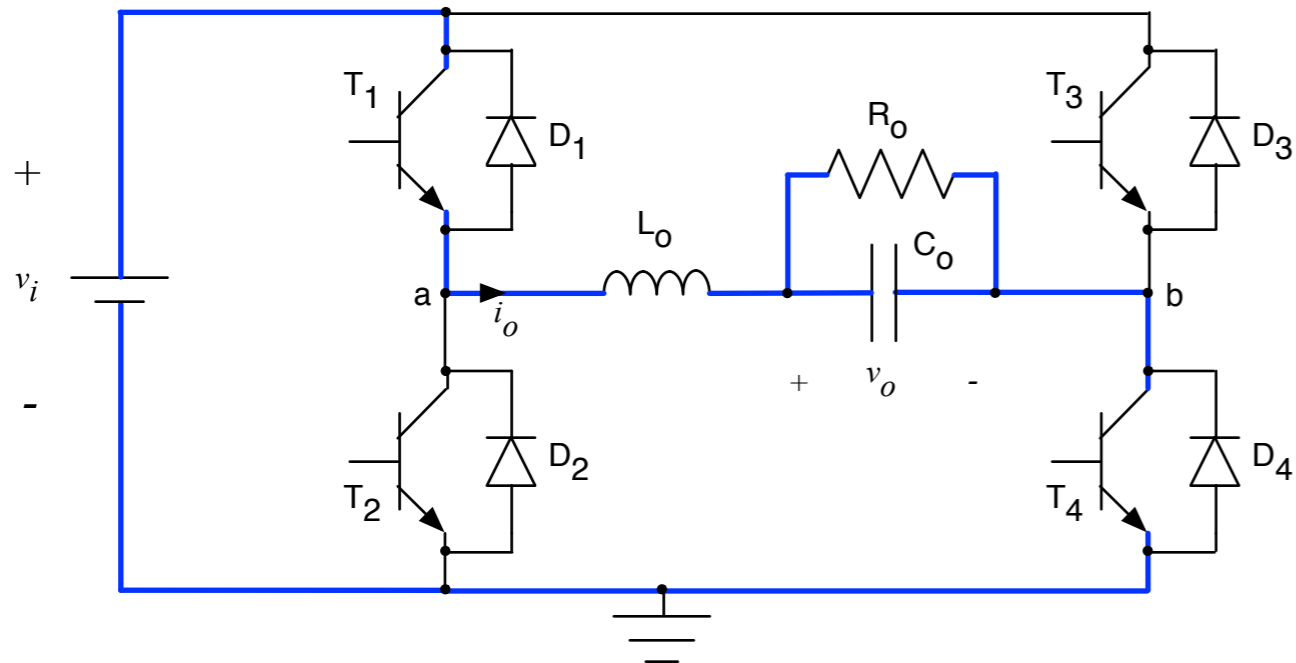
PWM Senoidal



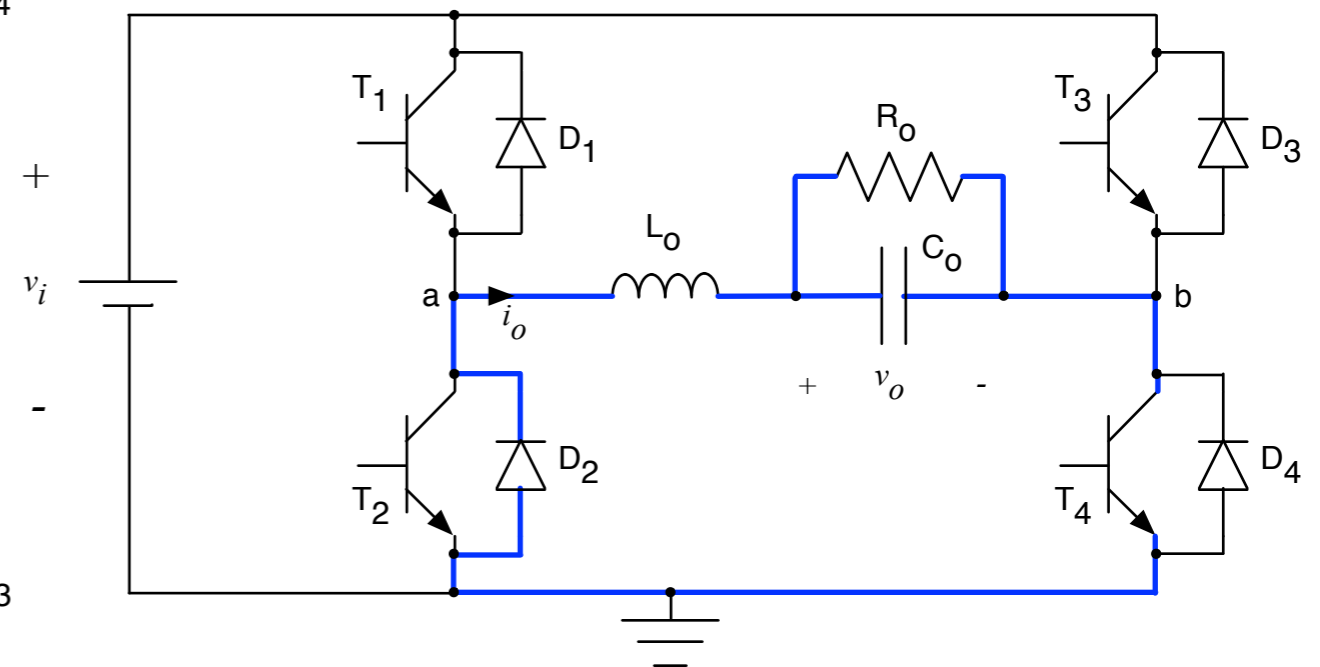
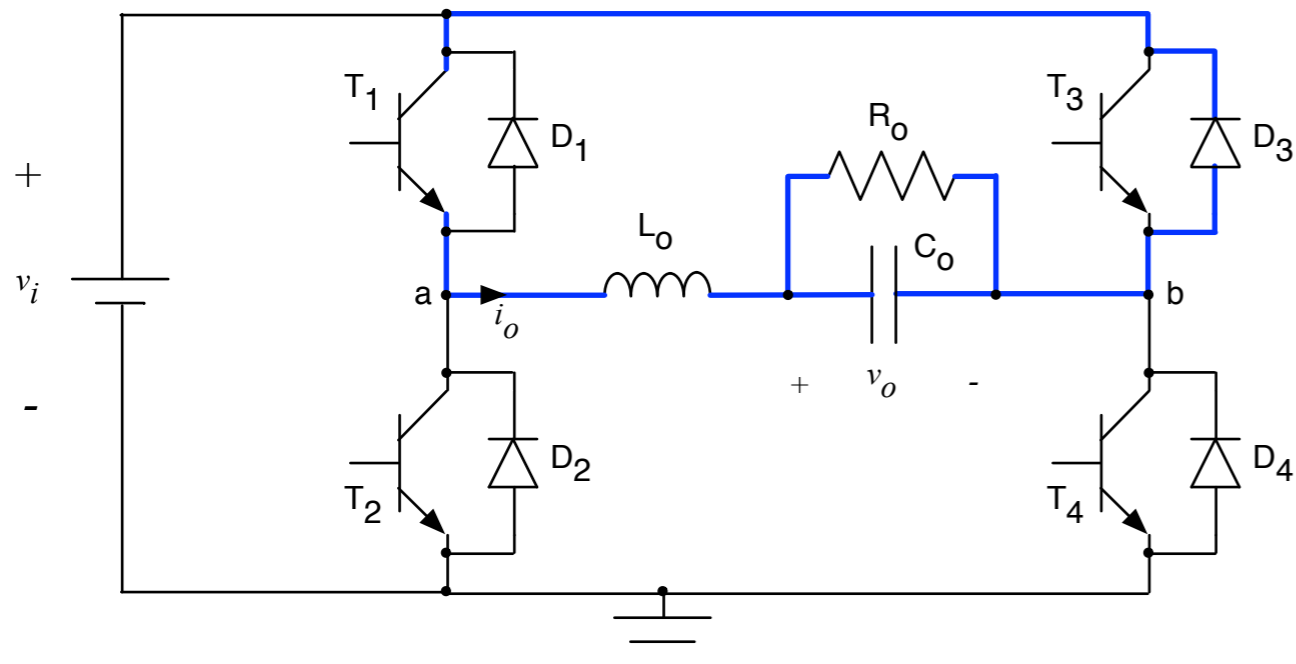


Conversor Ponte Completa

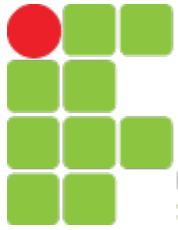
PWM Senoidal



$$v_{ab} = +V_i \text{ e } i_o > 0$$

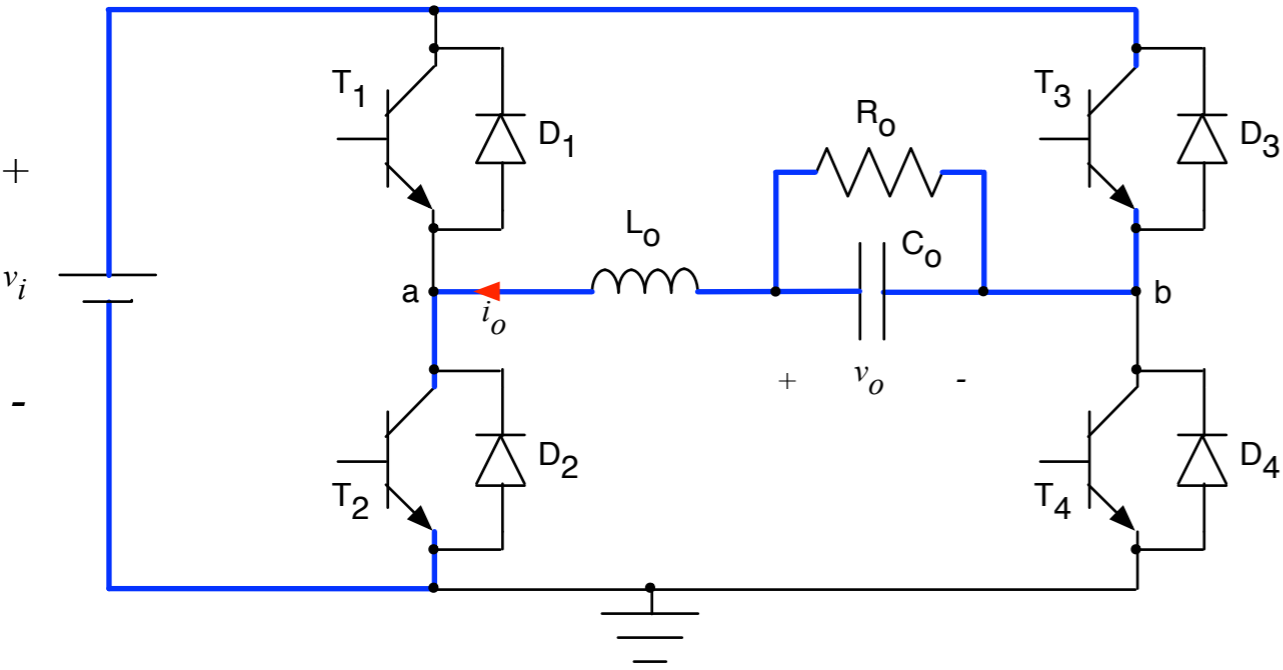


$$v_{ab} = 0 \text{ e } i_o > 0$$

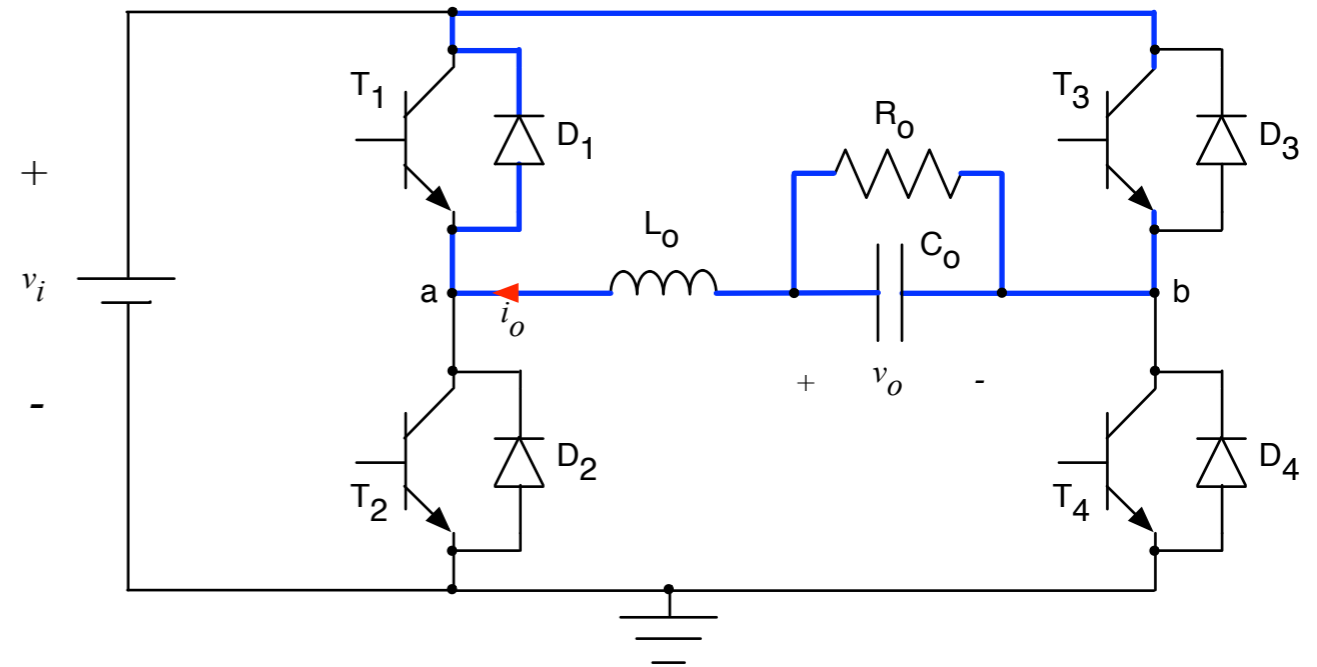
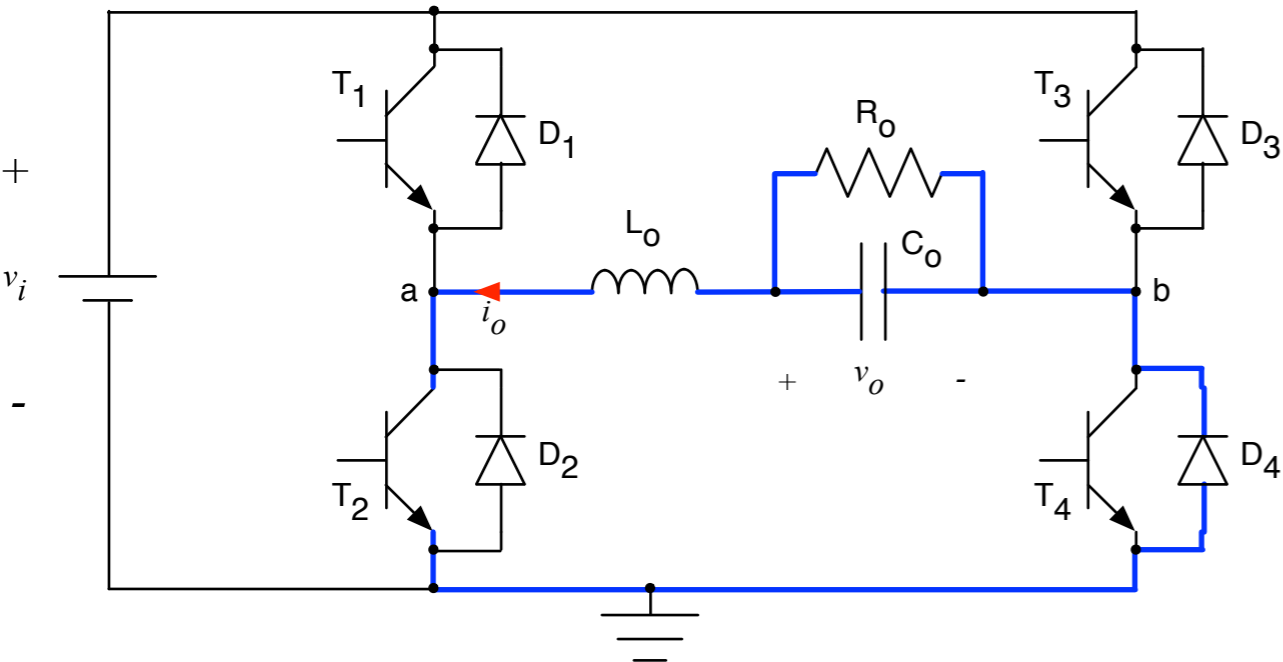


Conversor Ponte Completa

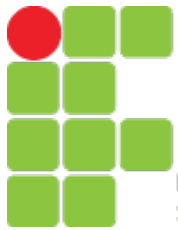
PWM Senoidal



$$v_{ab} = -V_i \text{ e } i_o < 0$$

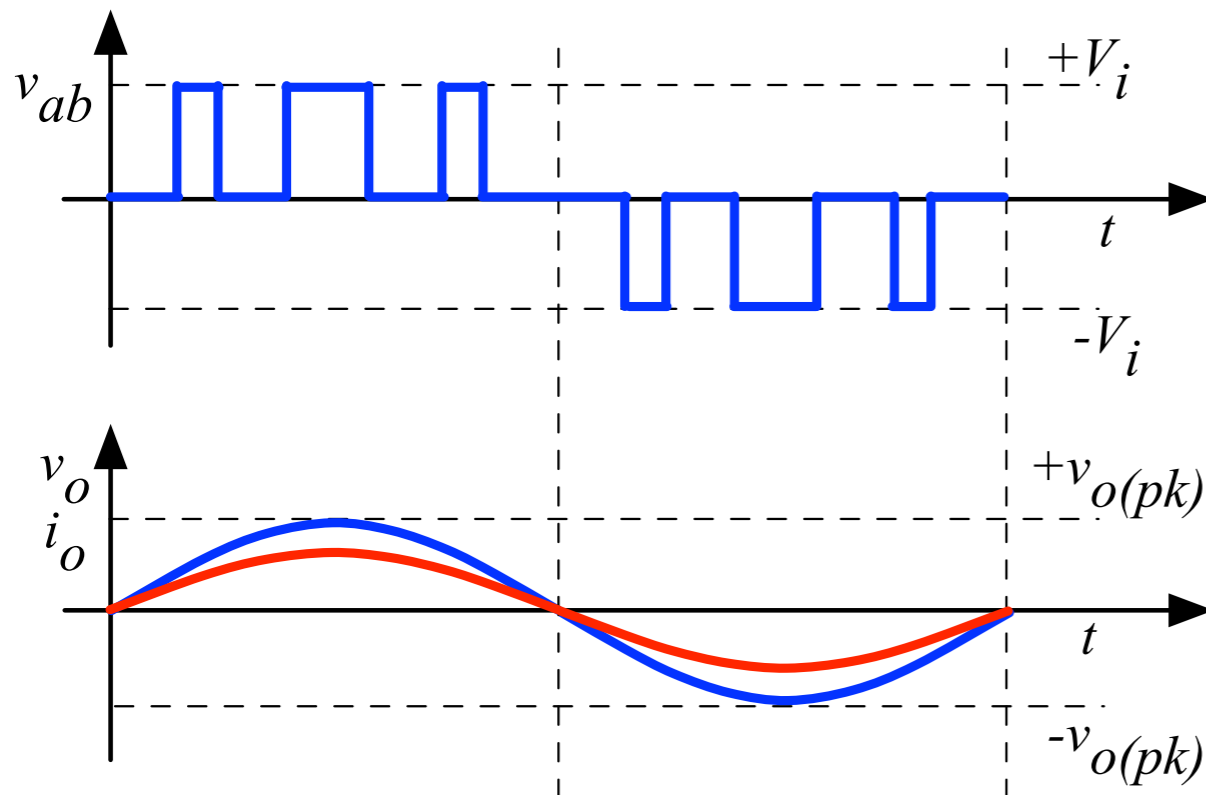
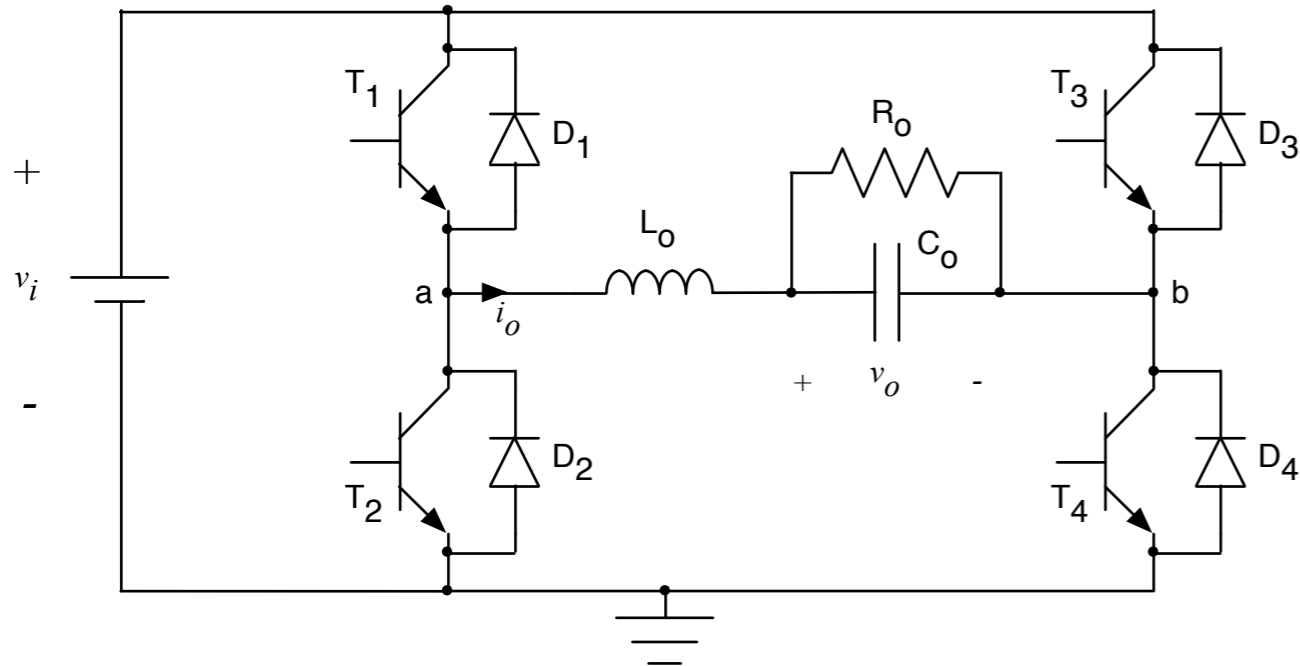


$$v_{ab} = 0 \text{ e } i_o < 0$$



Conversor Ponte Completa

PWM Senoidal



$V_i =$ definida

$$V_{ab} = \frac{1}{T_s} \cdot V_i \cdot D \cdot T_s$$

$$V_{ab} = V_i \cdot D$$

$$V_{Lo} = 0 \rightarrow V_o = V_{ab} \rightarrow V_o = V_i \cdot D$$

$$V_{o(ef)} = \frac{V_{o(pk)}}{\sqrt{2}}$$

Conversor Ponte Completa

PWM Senoidal

$$v_o(t) = V_{o(pk)} \cdot \text{seno}(t)$$

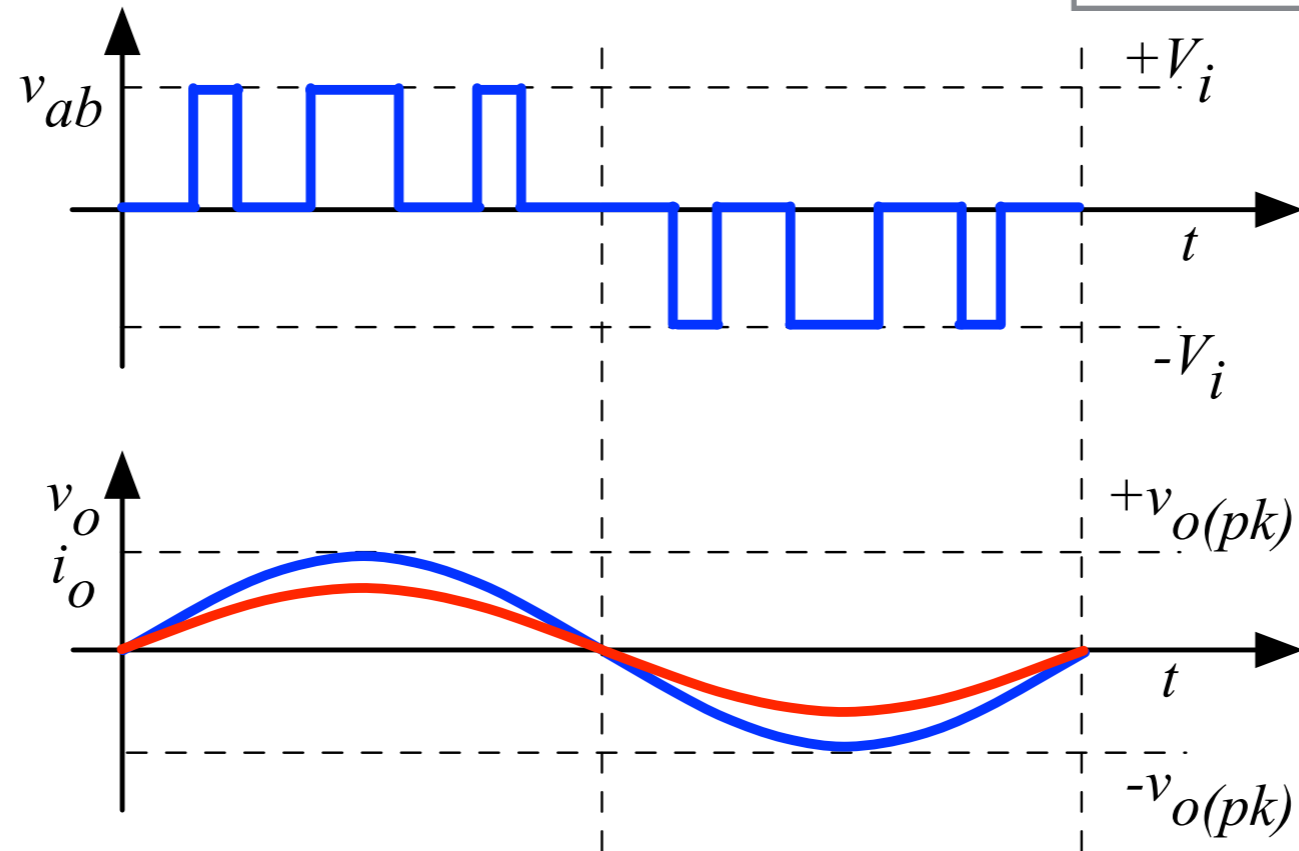
$$V_{o(pk)} \cdot \text{seno}(t) = V_i \cdot d(t)$$

$$d(t) = \frac{V_{o(pk)} \cdot \text{seno}(t)}{V_i} \rightarrow d(t) = \frac{V_{o(pk)}}{V_i} \cdot \text{seno}(t)$$

$$IM = \frac{V_{o(pk)}}{V_i} \rightarrow d(t) = IM \cdot \text{seno}(t)$$

Conversor Ponte Completa

PWM Senoidal



$$\Delta i = \% \cdot I_o [A]$$

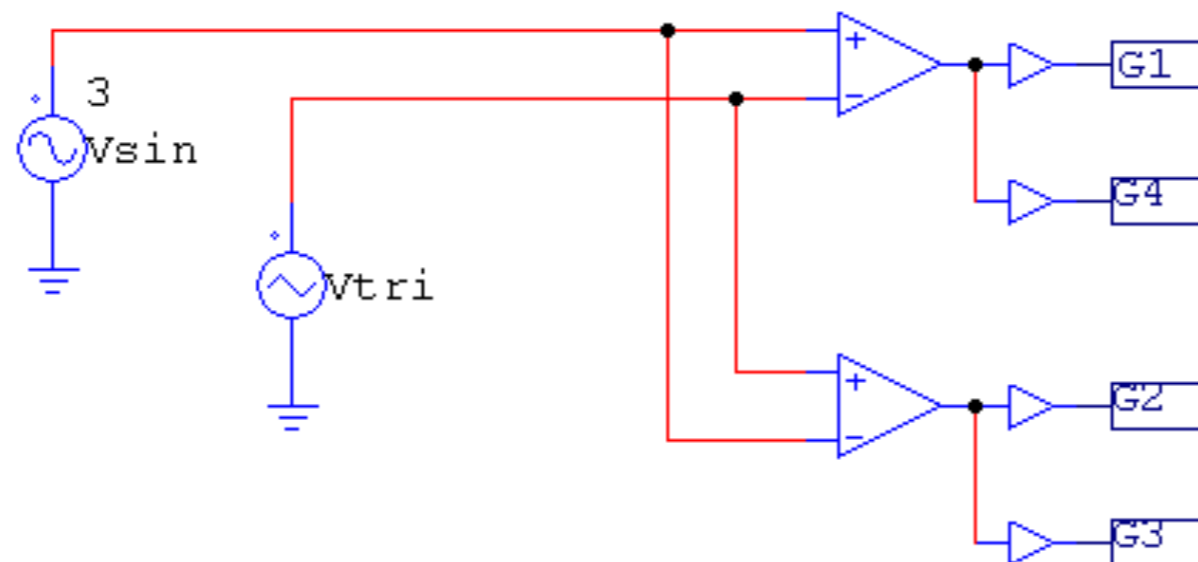
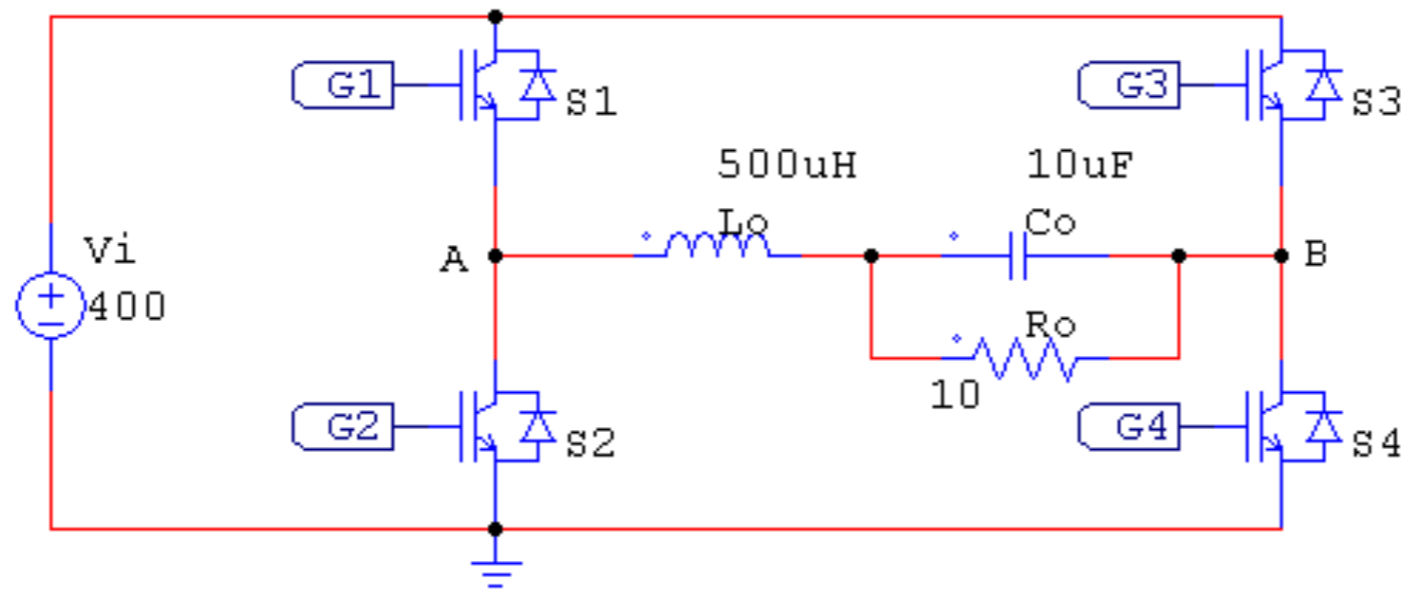
$$\Delta v = \% \cdot V_o [V]$$

$$L_o = \frac{V_i}{2 \cdot \Delta i \cdot F_s} \cdot D \cdot (1 - D)$$

$$C_o = \frac{V_i}{4 \cdot \pi^3 \cdot \Delta v \cdot L_o \cdot F_s^2}$$

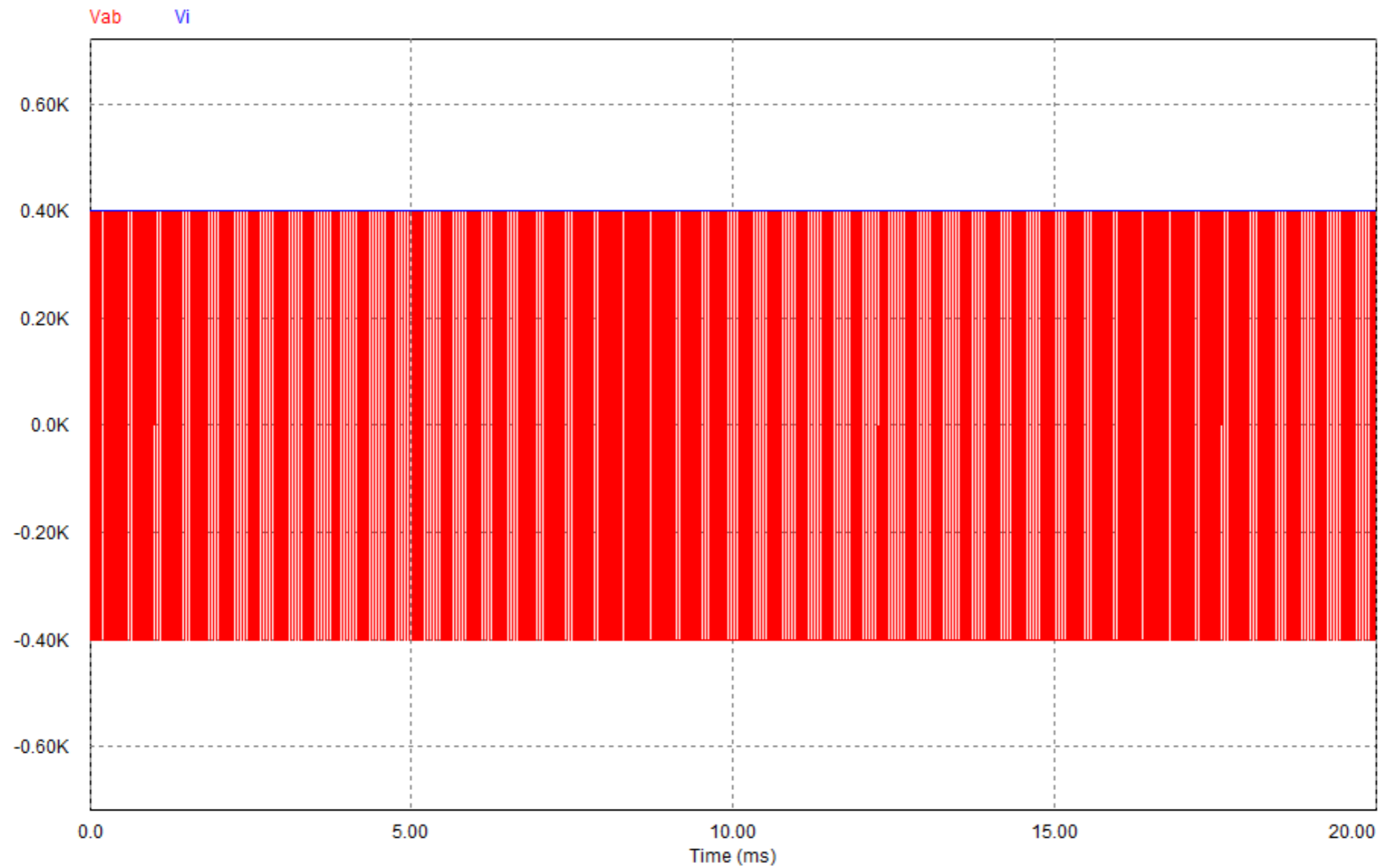
Conversor Ponte Completa

Simulação (modulação SPWM bipolar):



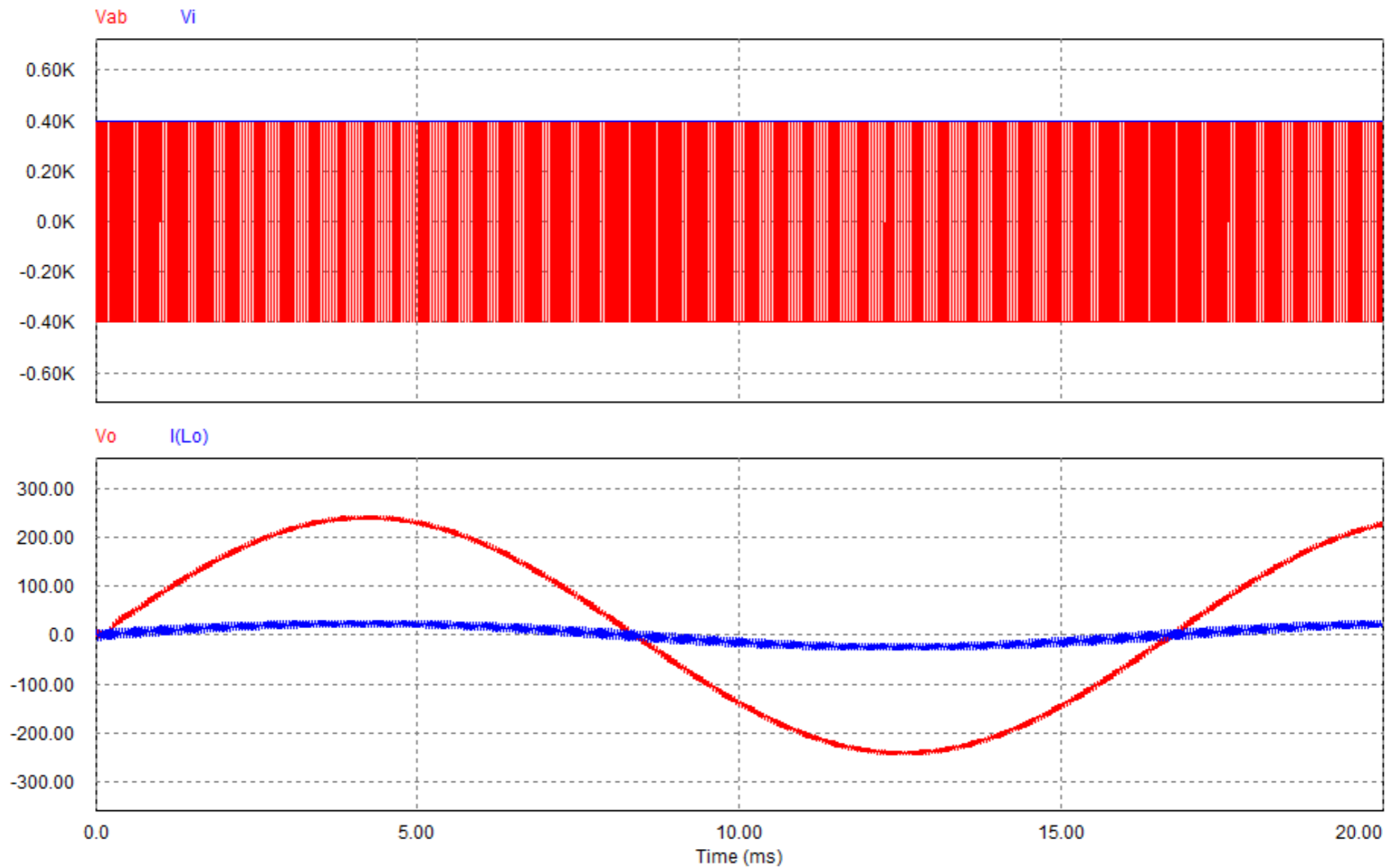
Conversor Ponte Completa

Simulação (modulação SPWM bipolar):



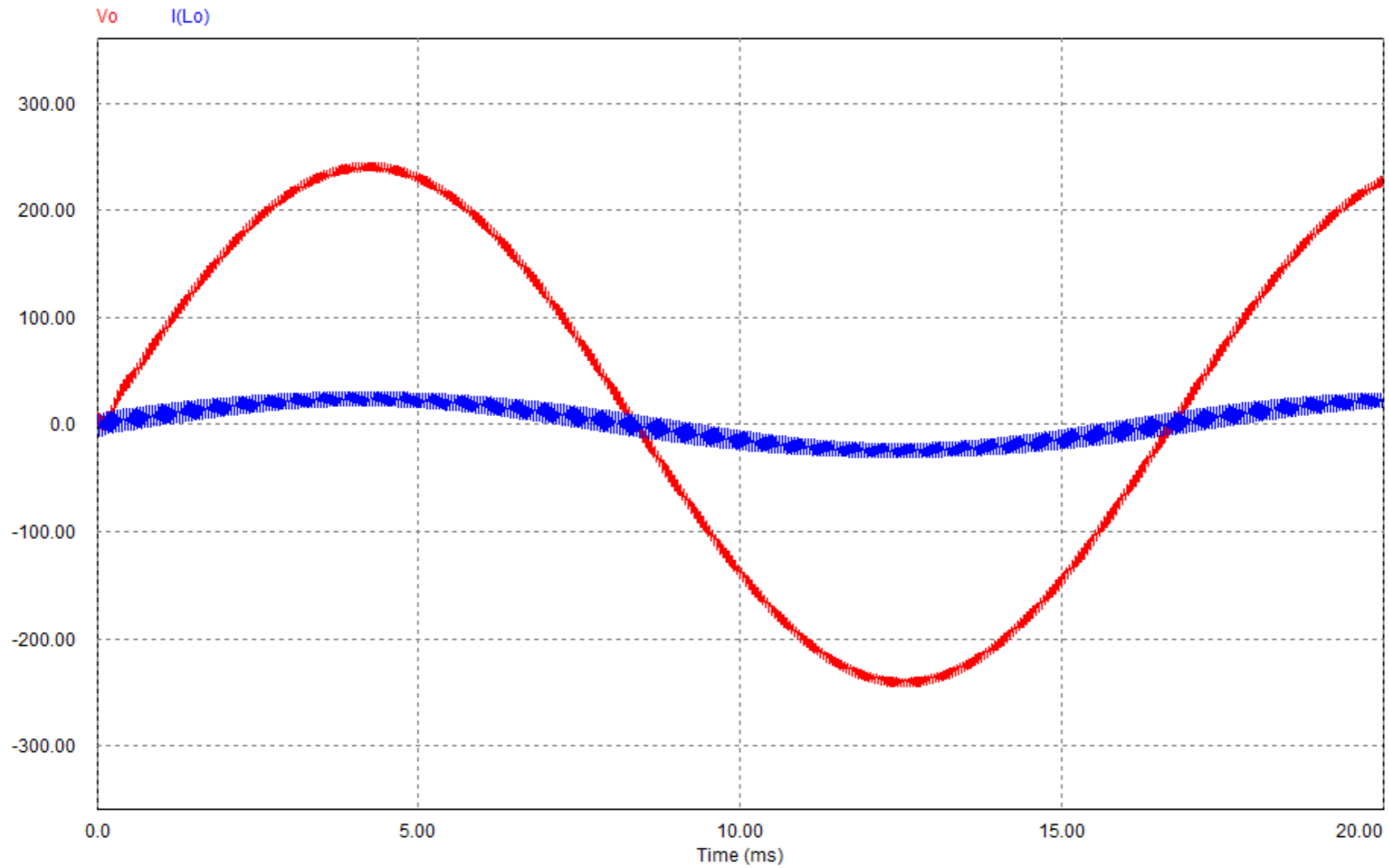
Conversor Ponte Completa

Simulação (modulação SPWM bipolar):



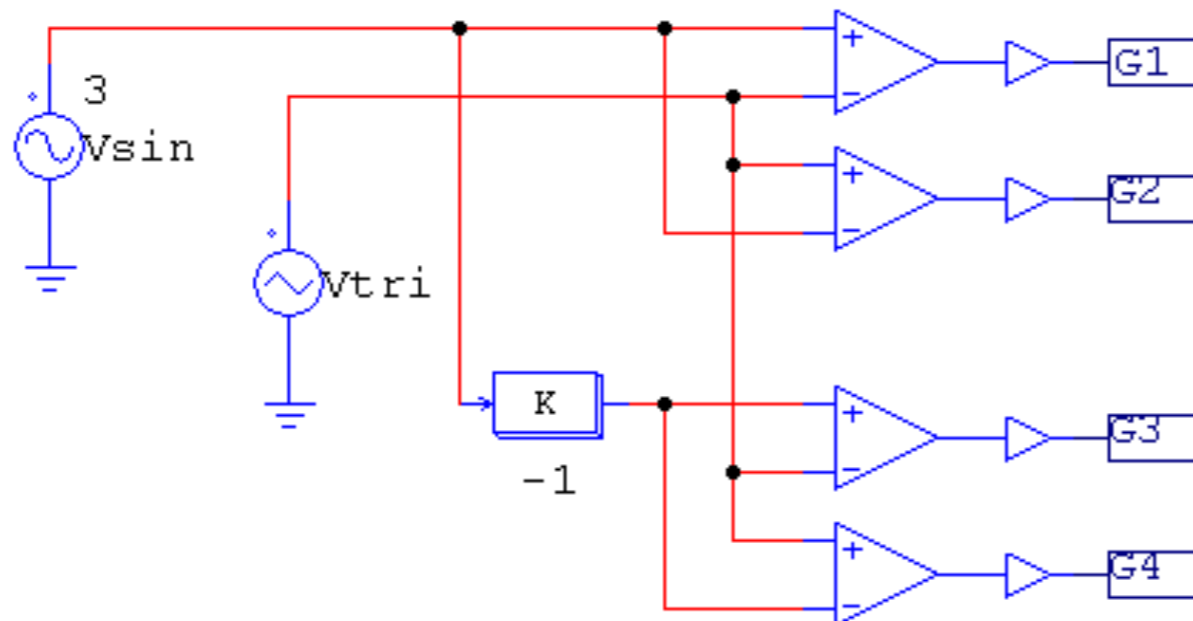
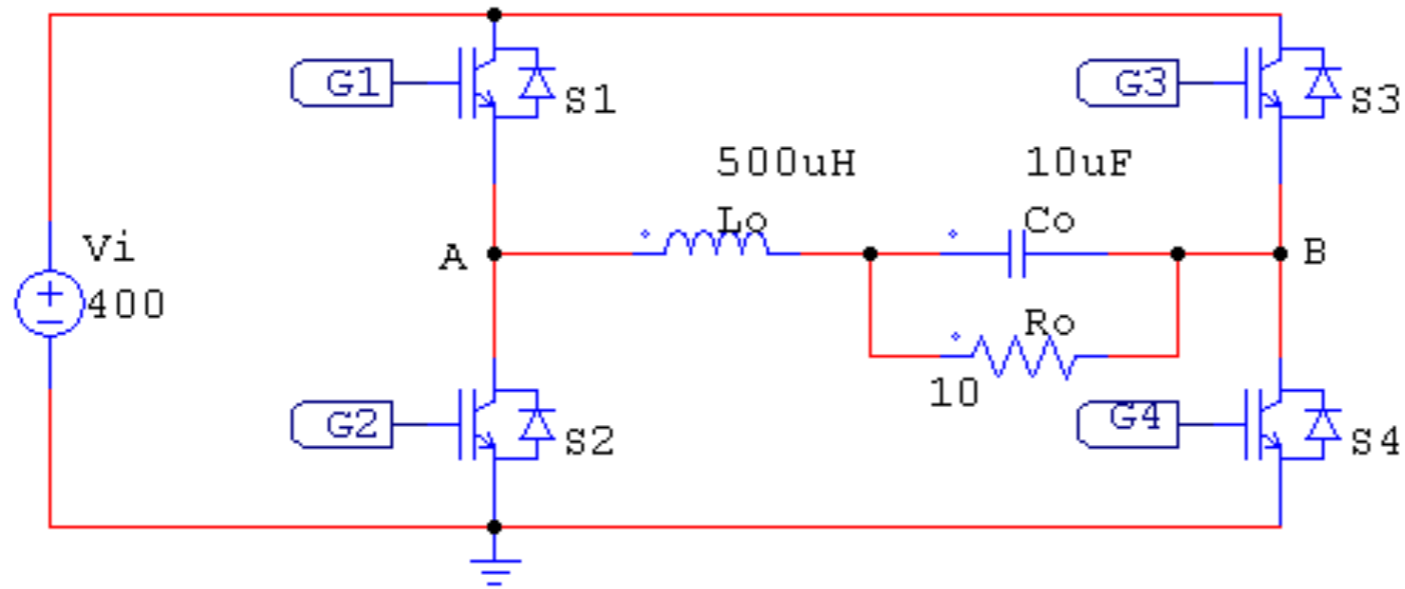
Conversor Ponte Completa

Simulação (modulação SPWM bipolar):



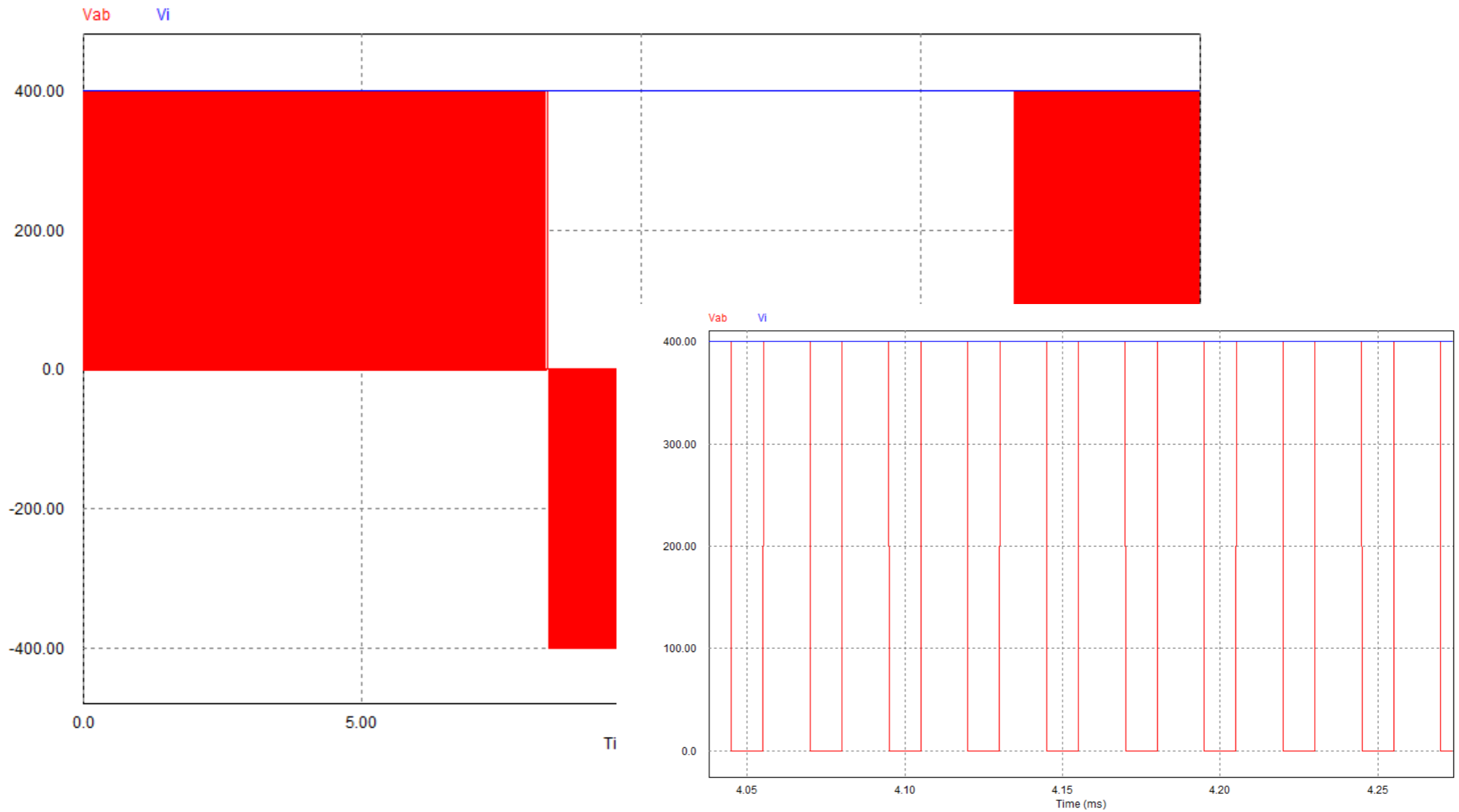
Conversor Ponte Completa

Simulação (modulação SPWM unipolar):



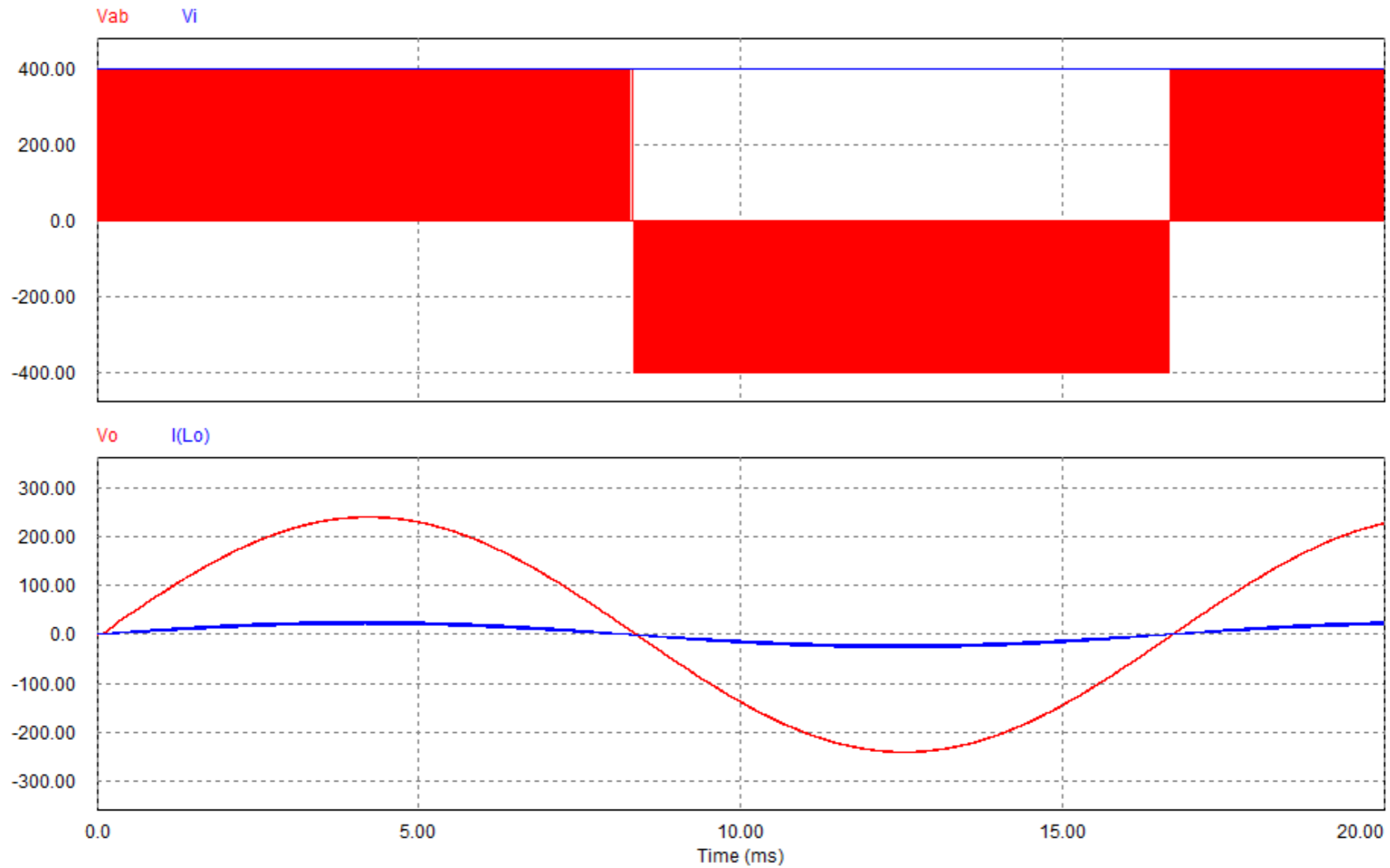
Conversor Ponte Completa

Simulação (modulação SPWM unipolar):



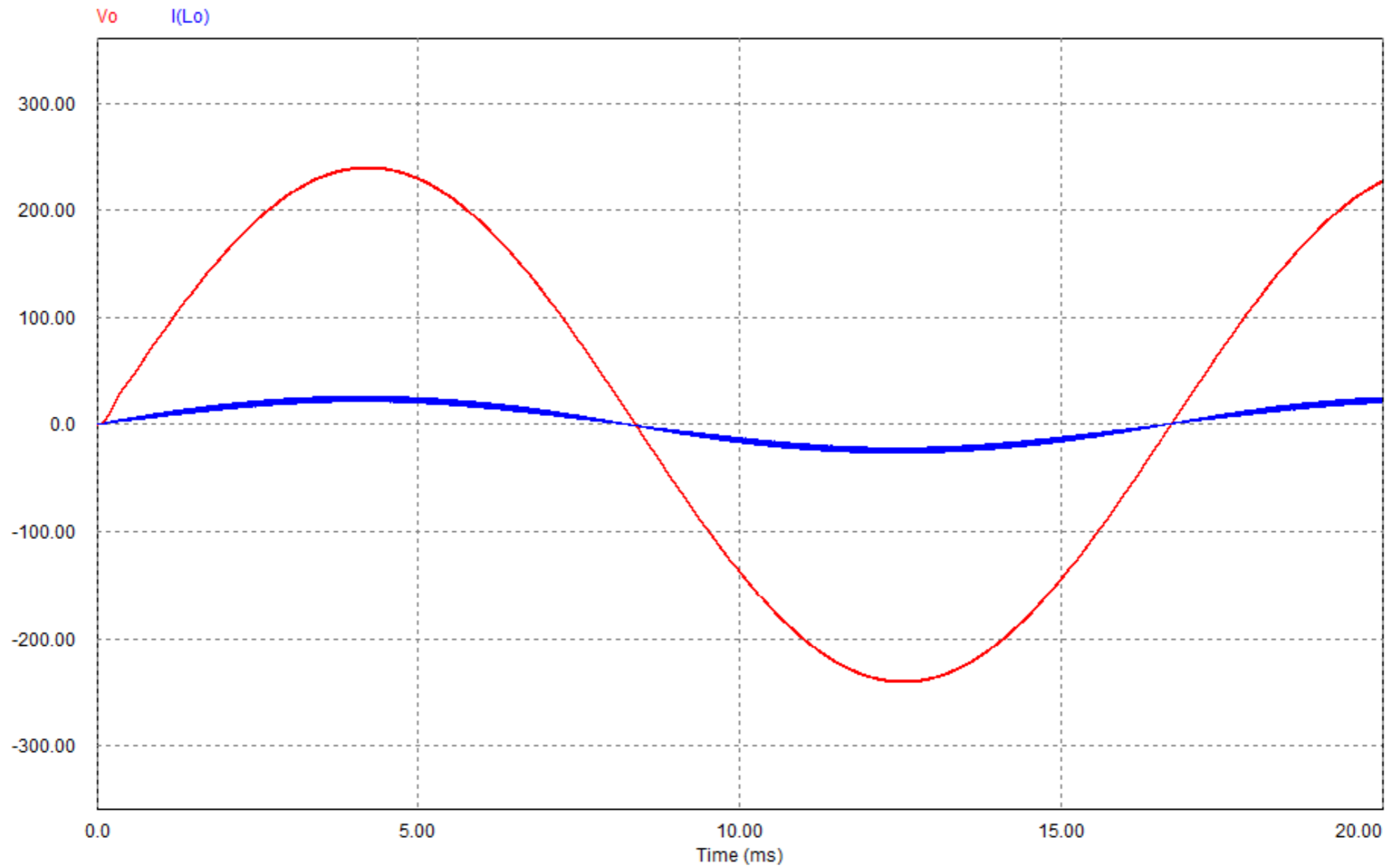
Conversor Ponte Completa

Simulação (modulação SPWM unipolar):



Conversor Ponte Completa

Simulação (modulação SPWM unipolar):



Próxima Aula

Conversores cc-ca:

- Inversor PWM senoidal.

