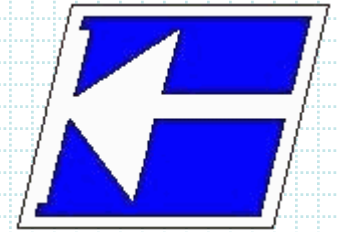


Instituto Federal de Educação, Ciência e Tecnologia de Santa Catarina
Departamento Acadêmico de Eletrônica
Eletrônica de Potência



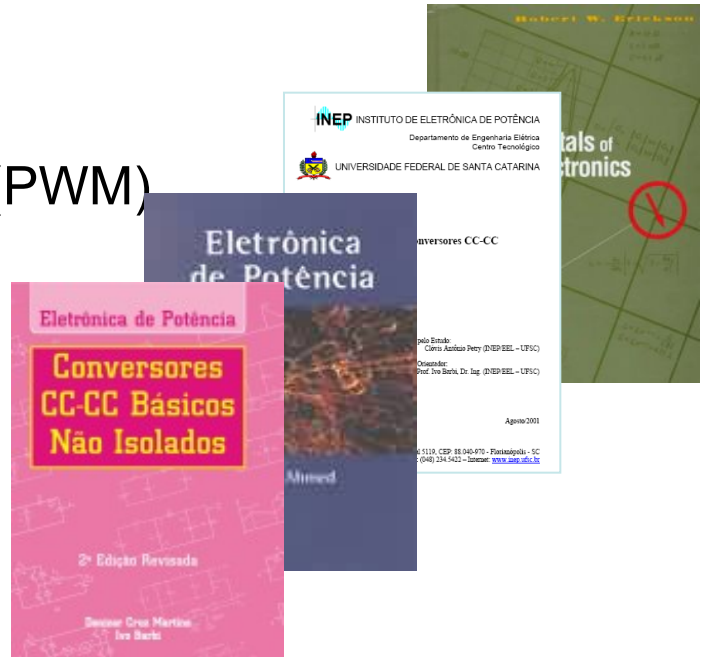
Modulação PWM Senoidal

Prof. Clóvis Antônio Petry

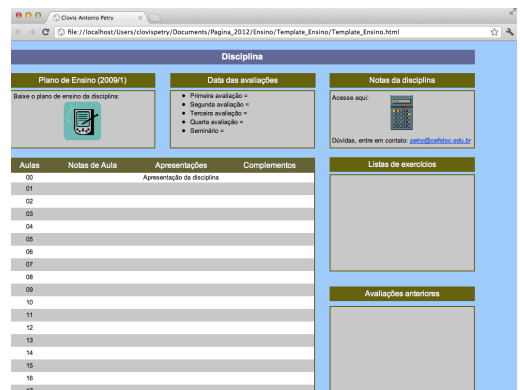
Florianópolis, novembro de 2013.

Capítulo 9: Choppers DC

1. Modulação por largura de pulsos (PWM)



www.ProfessorPetry.com.br

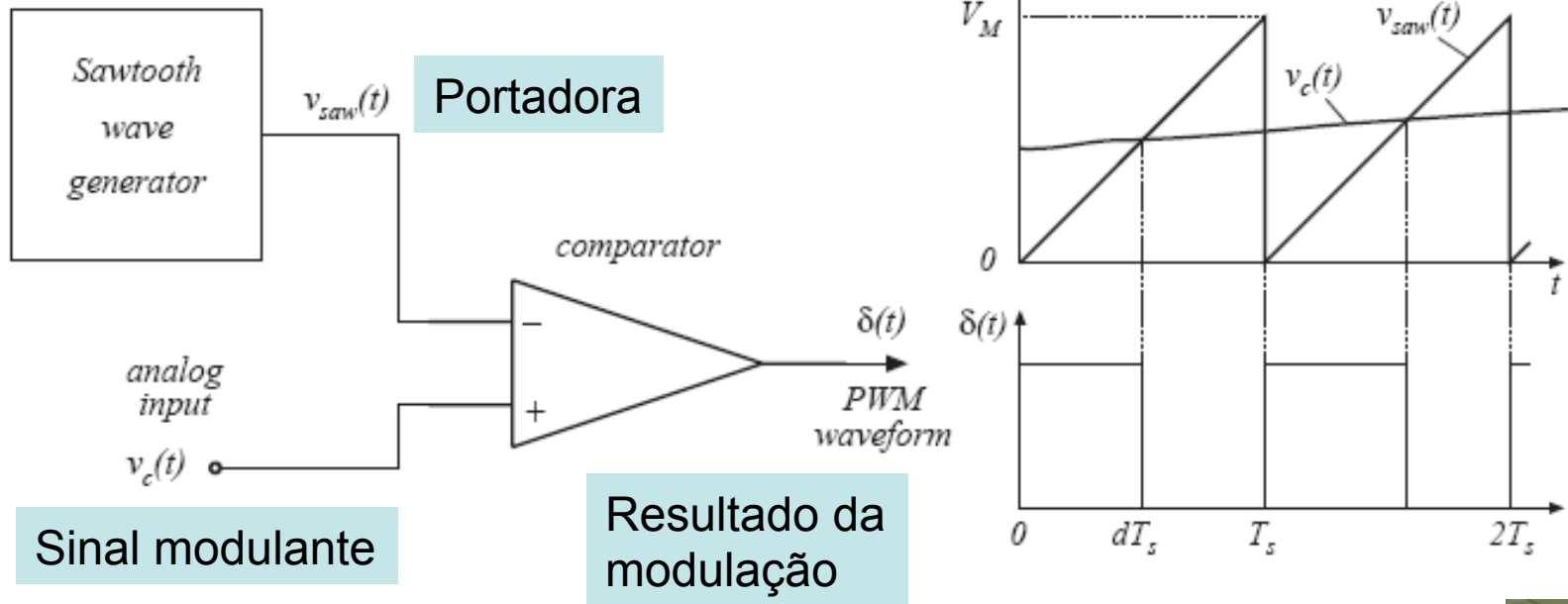


Conversores CC-CC – Modulação por largura de pulsos:

1. Princípio geral;
2. Circuitos analógicos;
3. Circuitos dedicados.

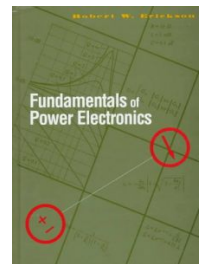
Conversores CC-CA – Modulação por largura de pulsos senoidal:

1. Simulação de conversores Buck;
2. Simulação com modulação PWM senoidal.



Considerações:

- A portadora define a frequência de comutação;
- O sinal modulante deve ser aproximadamente contínuo durante um período da portadora;
- O sinal modulante define a fundamental da grandeza de saída do conversor.

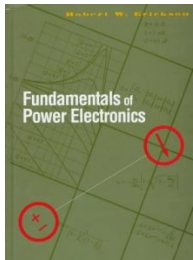
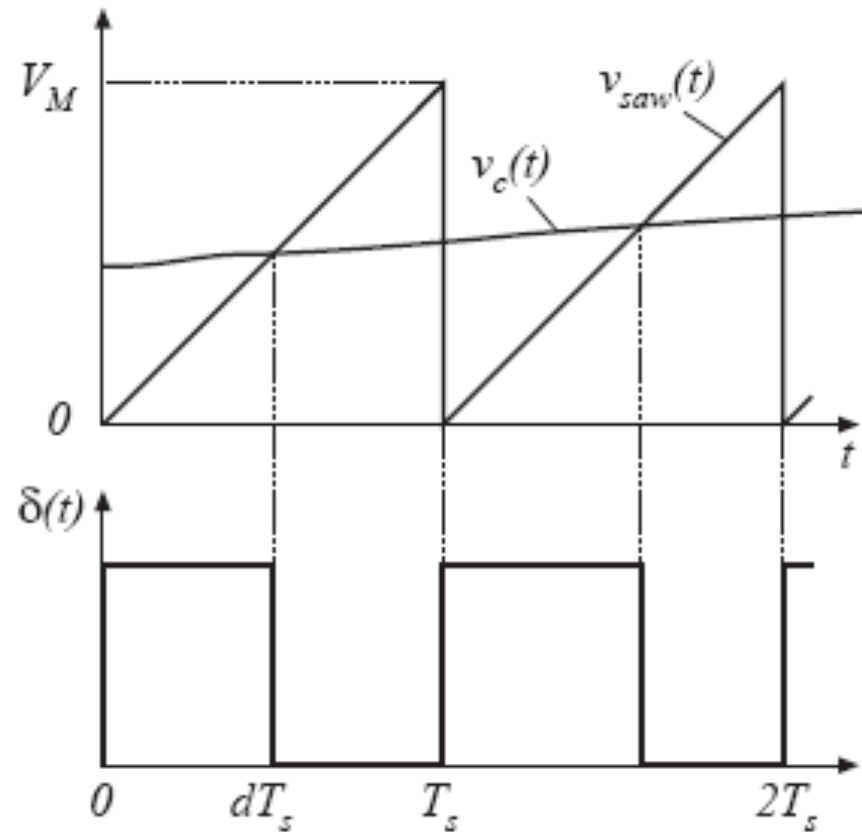


Considerando uma dente-de-serra linear:

$$d(t) = \frac{v_c(t)}{V_M}$$

Para:

$$0 \leq v_c(t) \leq V_M$$



Perturbando o sinal no tempo:

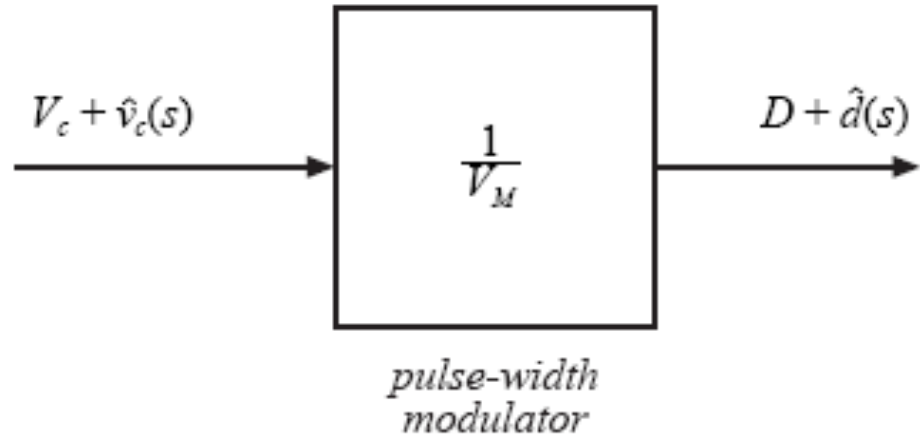
$$d(t) = D + \hat{d}(t)$$

$$v_c(t) = V_c + \hat{v}_c(t)$$

Resultado:

$$d(t) = \frac{v_c(t)}{V_M}$$

$$D + \hat{d}(t) = \frac{V_c + \hat{v}_c(t)}{V_M}$$

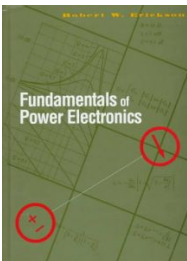


Relações CC:

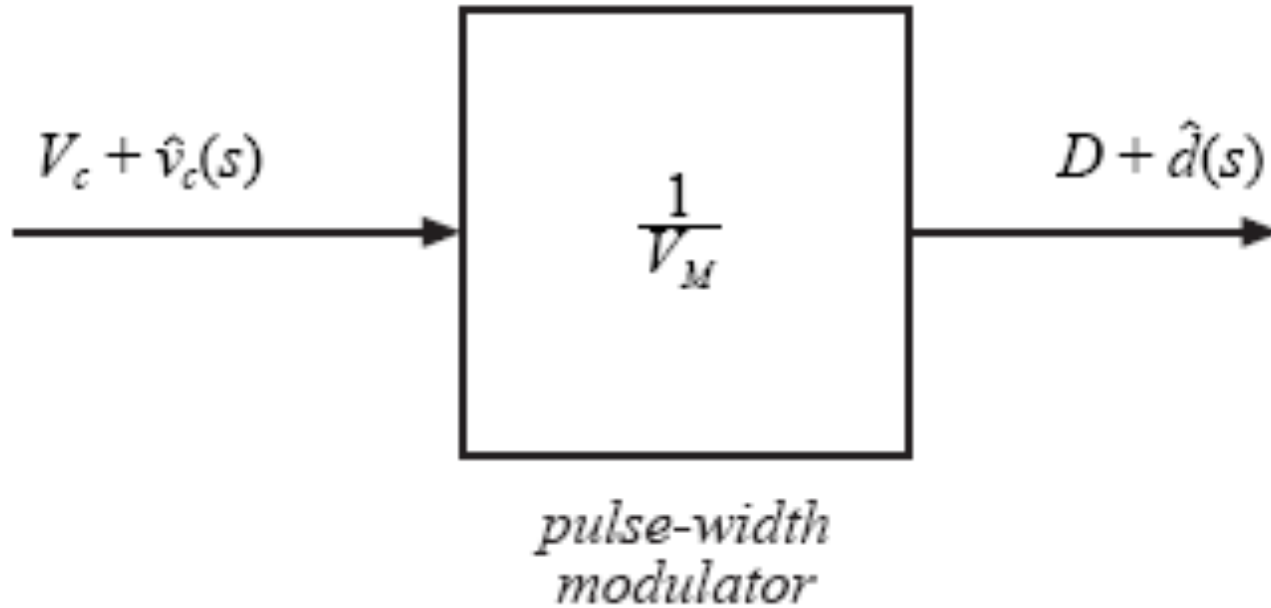
$$D = \frac{V_c}{V_M}$$

Relações CA:

$$\hat{d}(t) = \frac{\hat{v}_c(t)}{V_M}$$



Princípio Geral



$$D = \frac{V_c}{V_M}$$

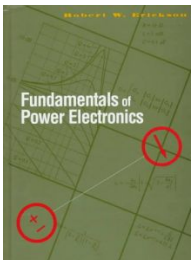
CC

$$\hat{d}(t) = \frac{\hat{v}_c(t)}{V_M}$$

No tempo

$$D(s) = \frac{V_c(s)}{V_M}$$

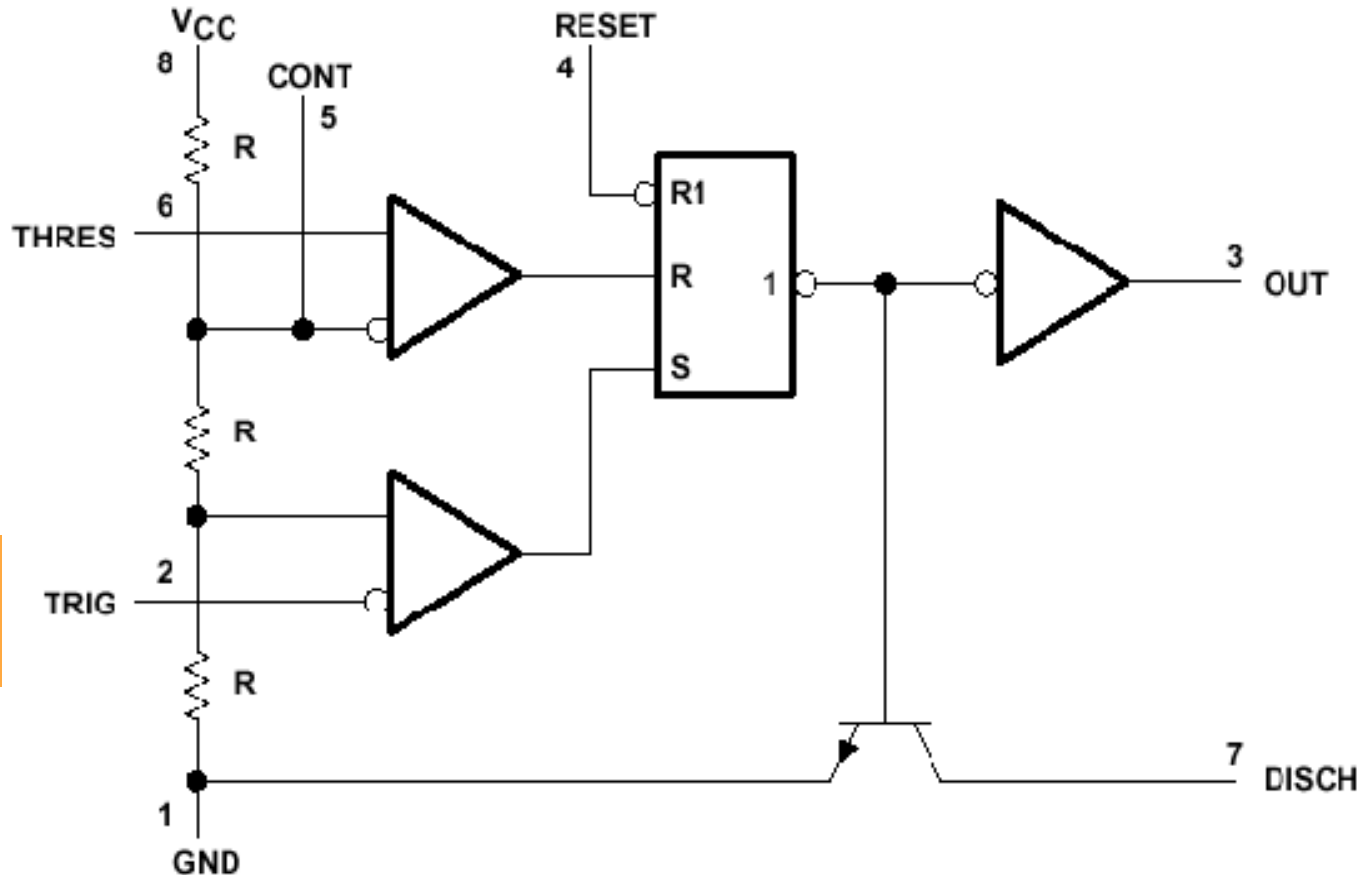
Na frequência



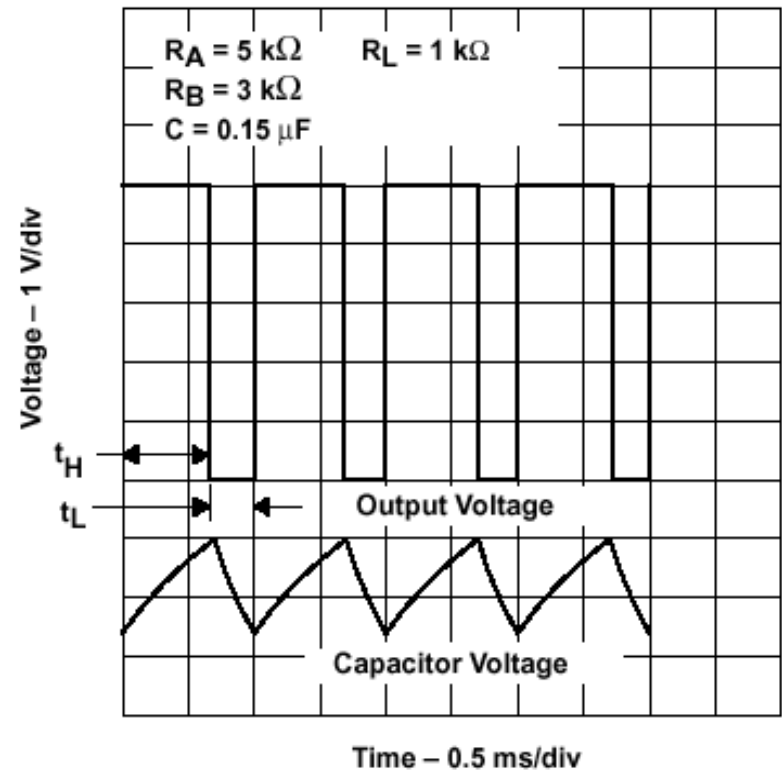
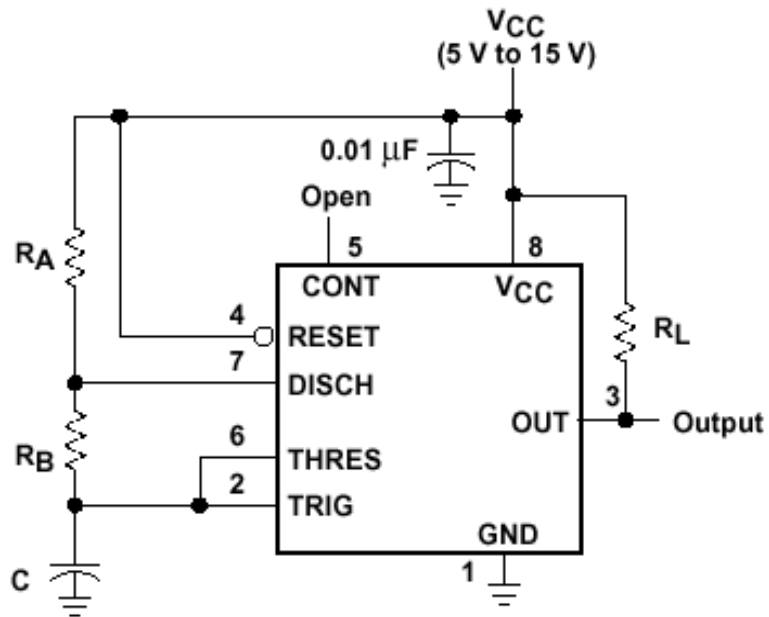
Modulador PWM usando temporizador 555:

$$V_6 > \frac{2}{3} V_{cc}$$

$$V_2 < \frac{1}{3} V_{cc}$$

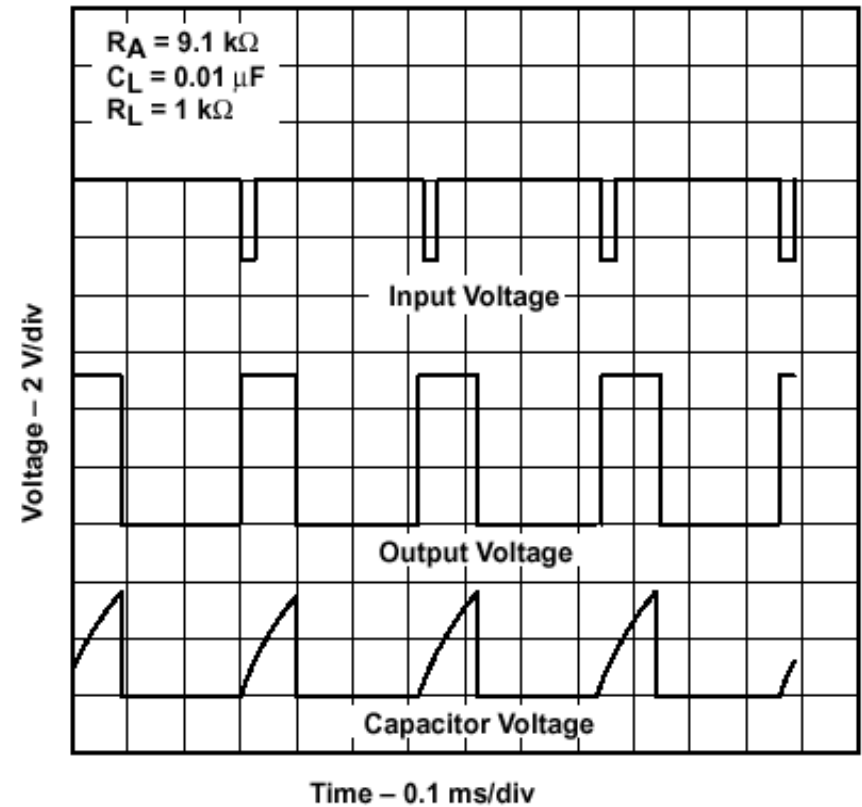
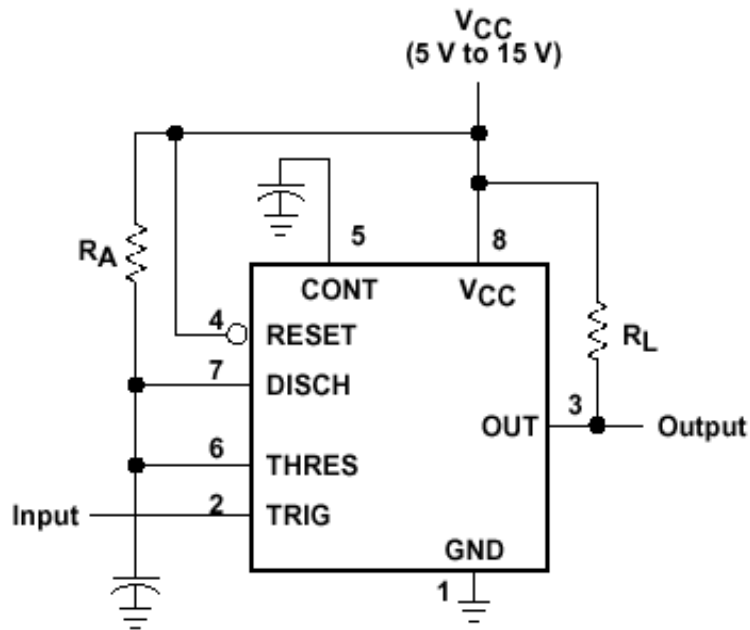


Modulador PWM usando temporizador 555:



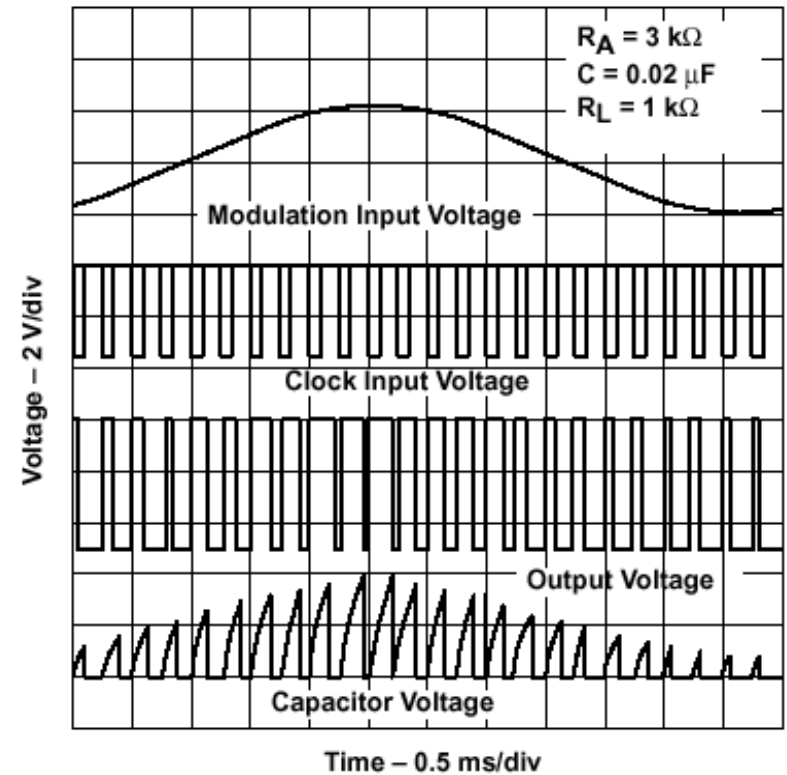
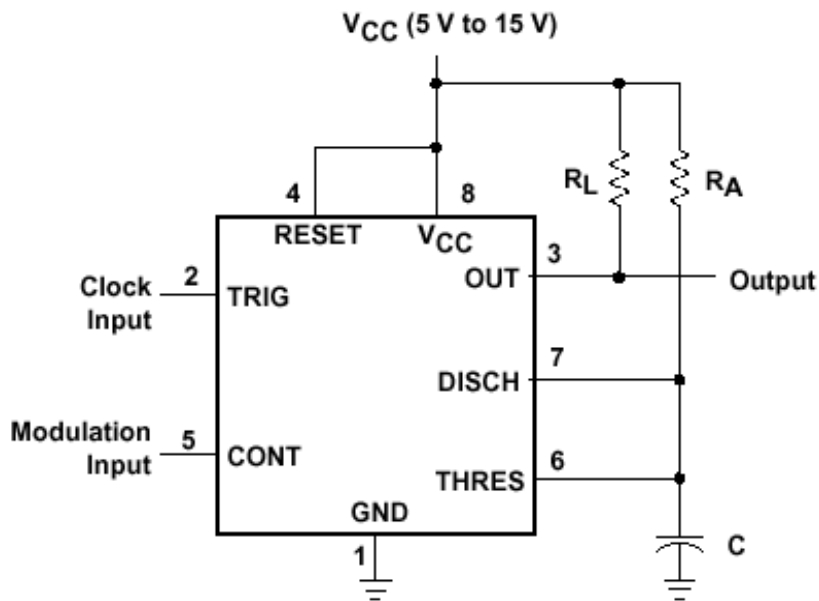
Multivibrador astável

Modulador PWM usando temporizador 555:



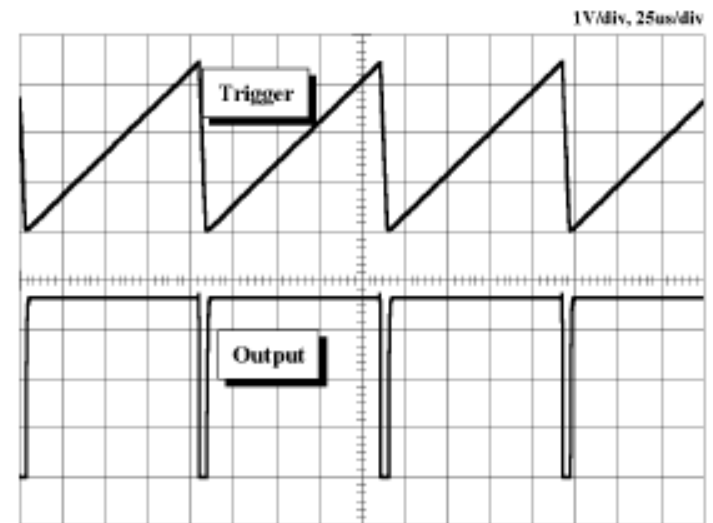
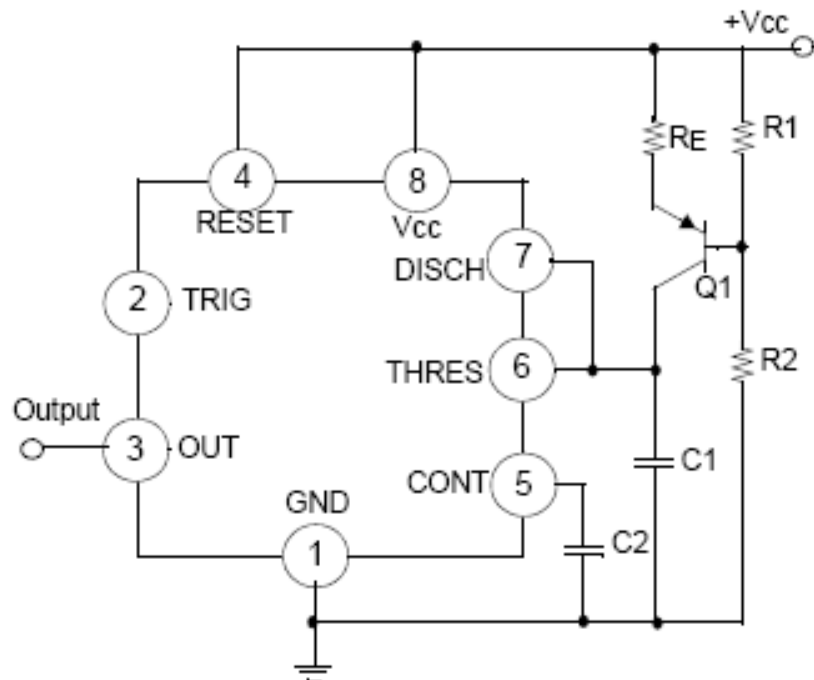
Multivibrador monoestável

Modulador PWM usando temporizador 555:



Modulador PWM

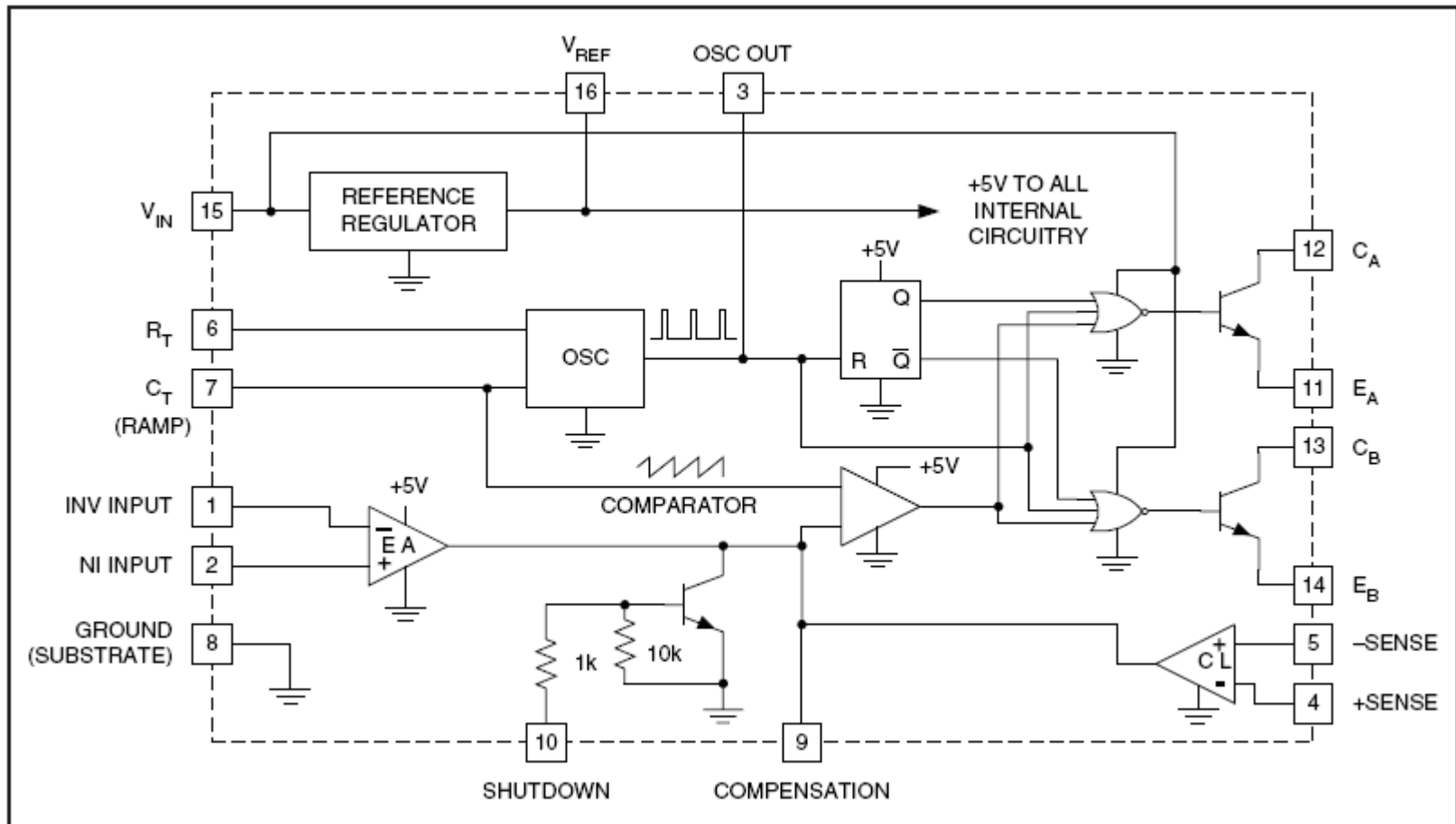
Gerador de rampa usando o temporizador 555:



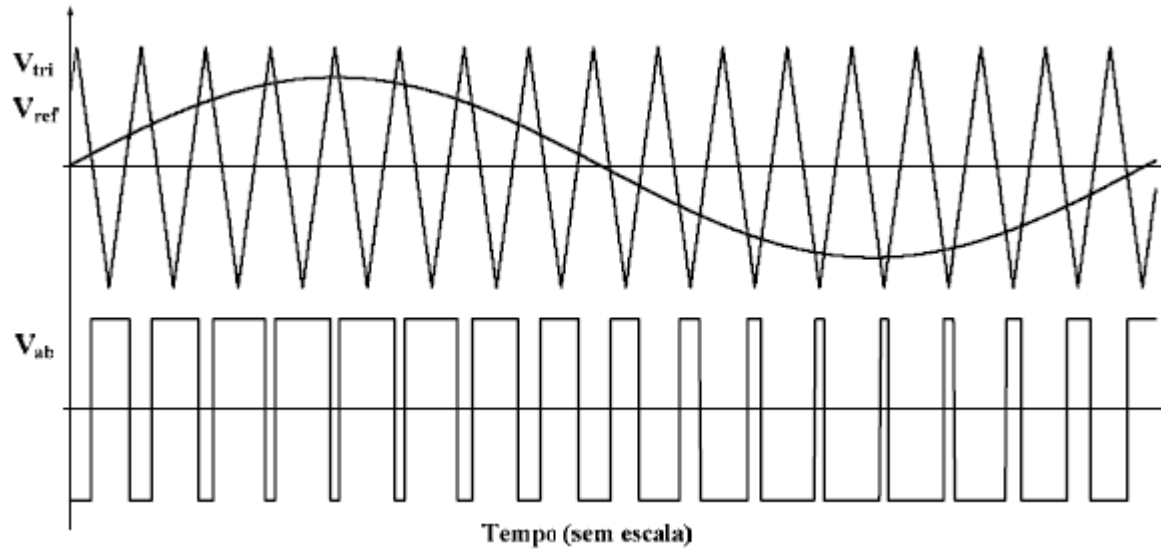
$R1=47k\Omega$, $R2=100k\Omega$, $R_E=2.7k\Omega$, $R_L=1k\Omega$, $C1=0.01\mu F$, $V_{cc}=5V$

UC3524N:

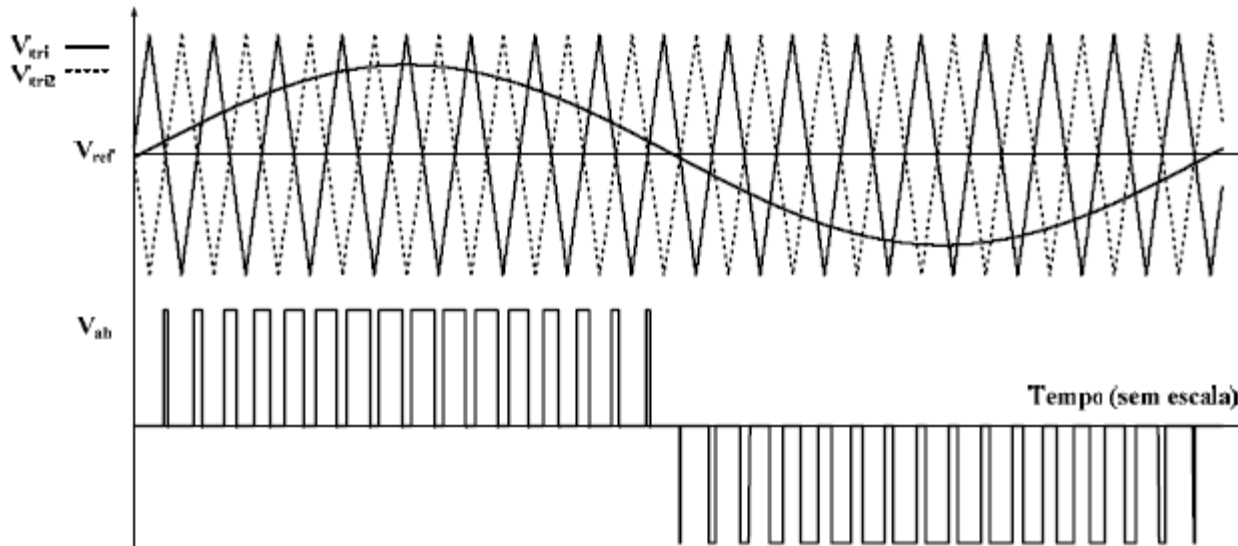
 **Unitrode Products**
from Texas Instruments



Modulação PWM Senoidal

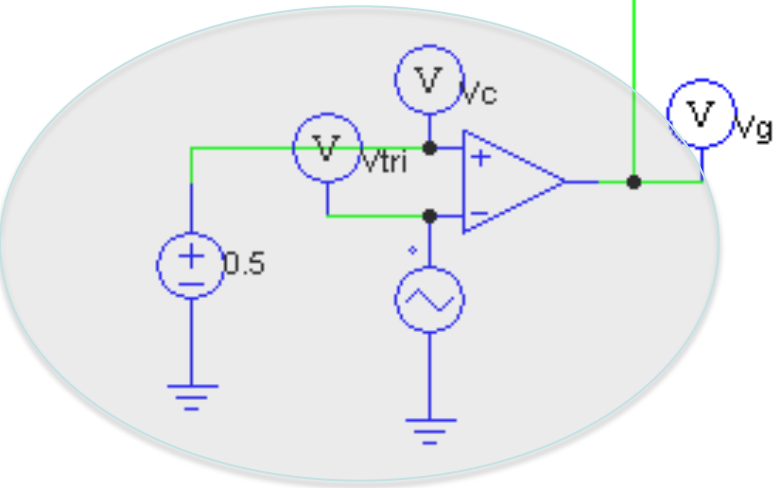
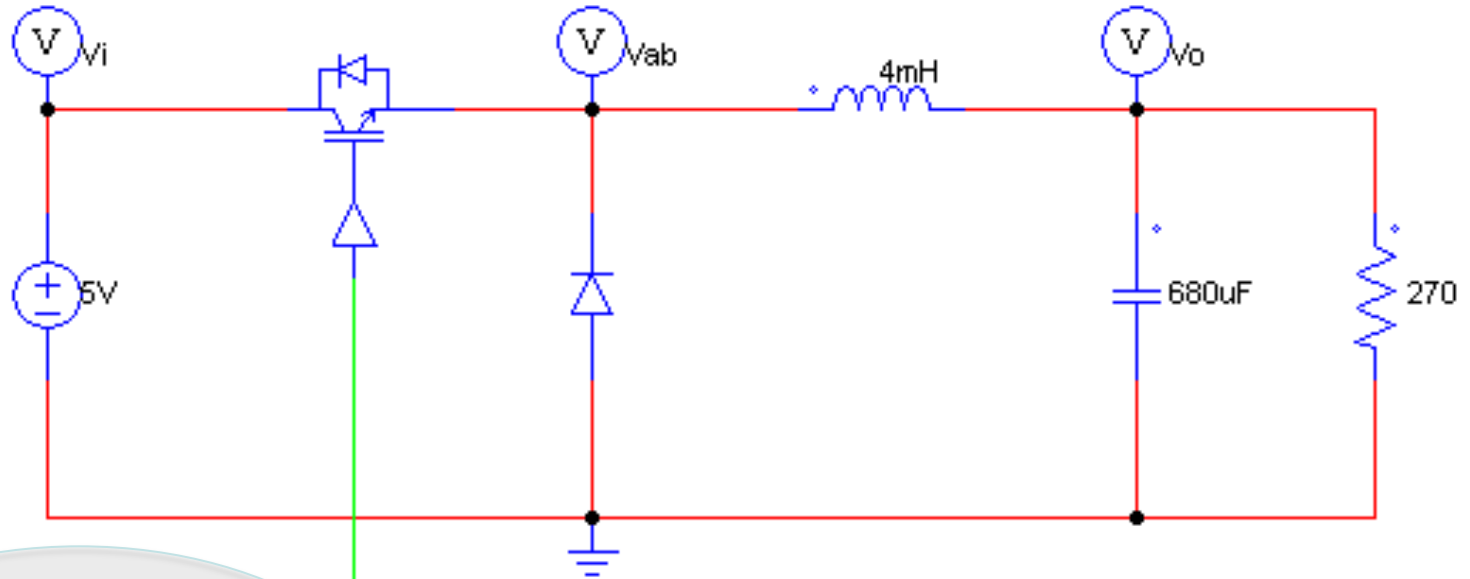


Dois níveis

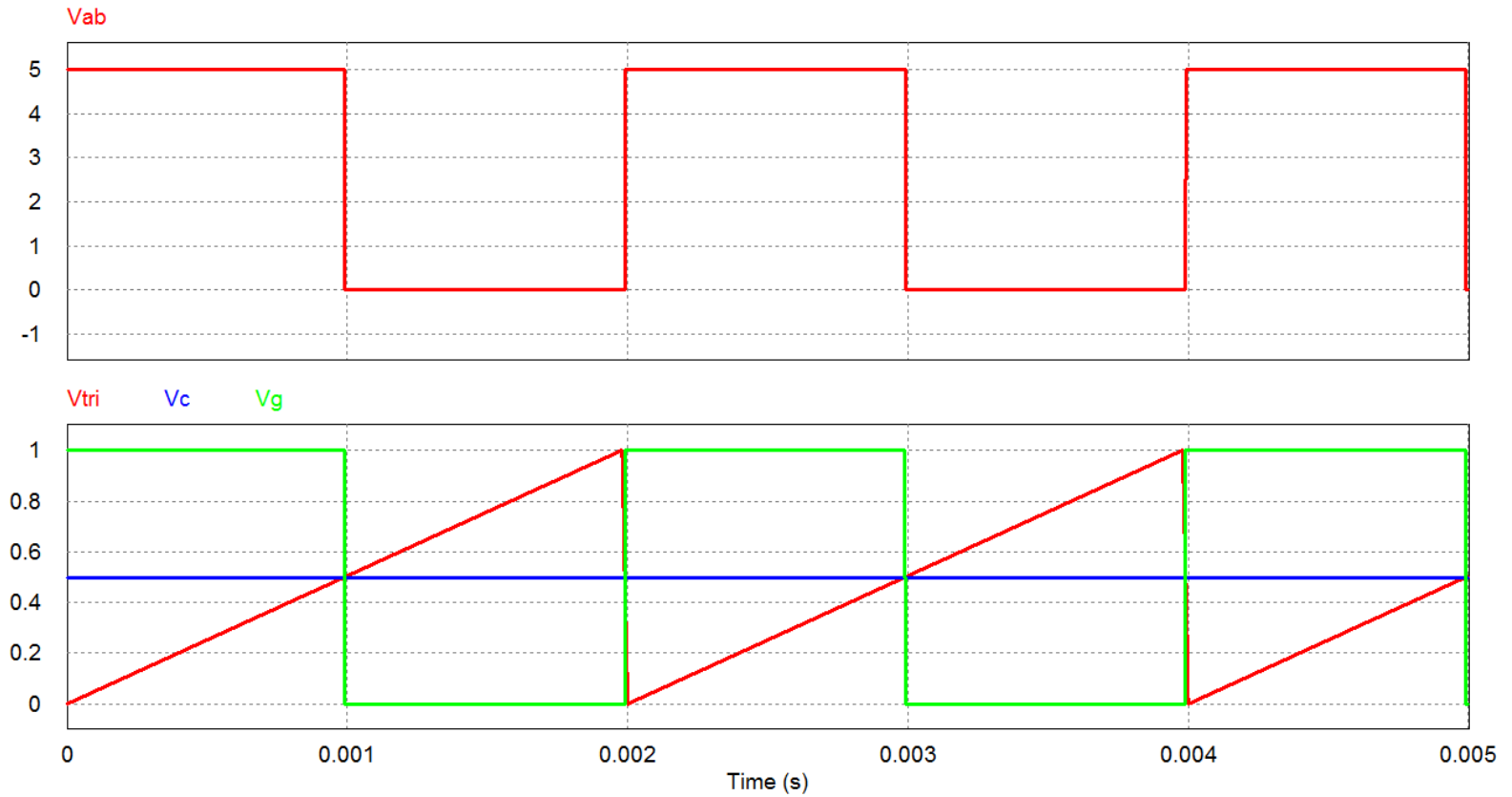


Três níveis

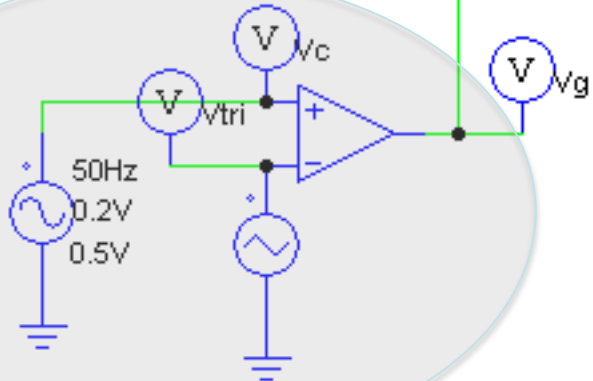
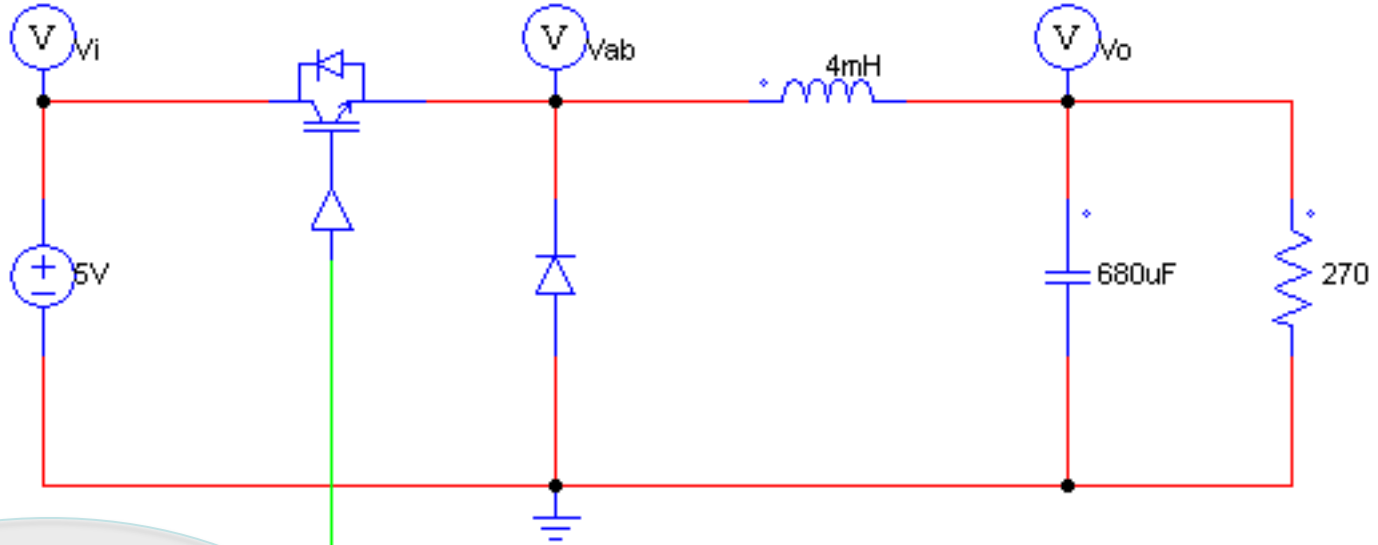
Simulação de um Conversor CC-CC



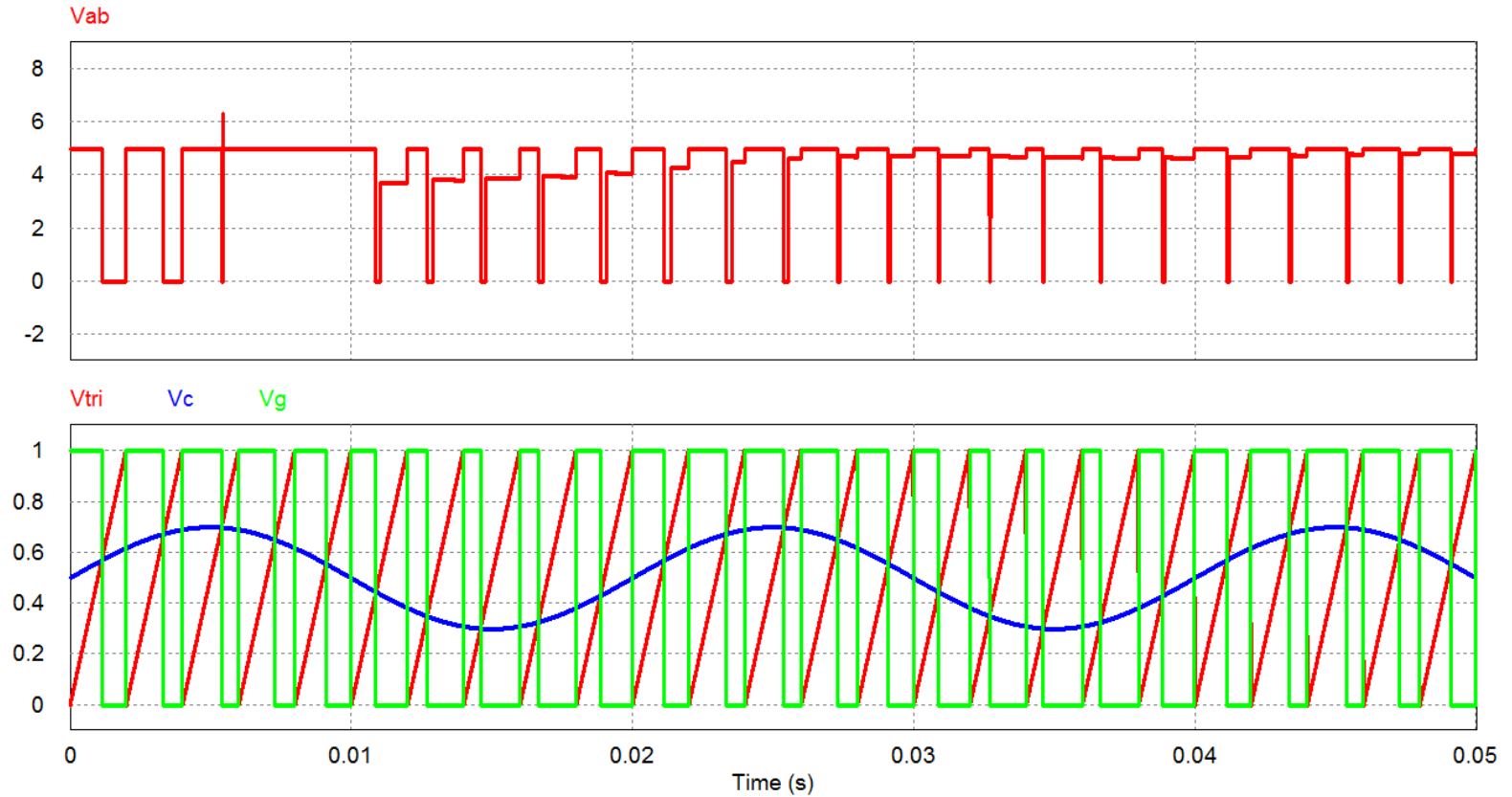
Simulação de um Conversor CC-CC



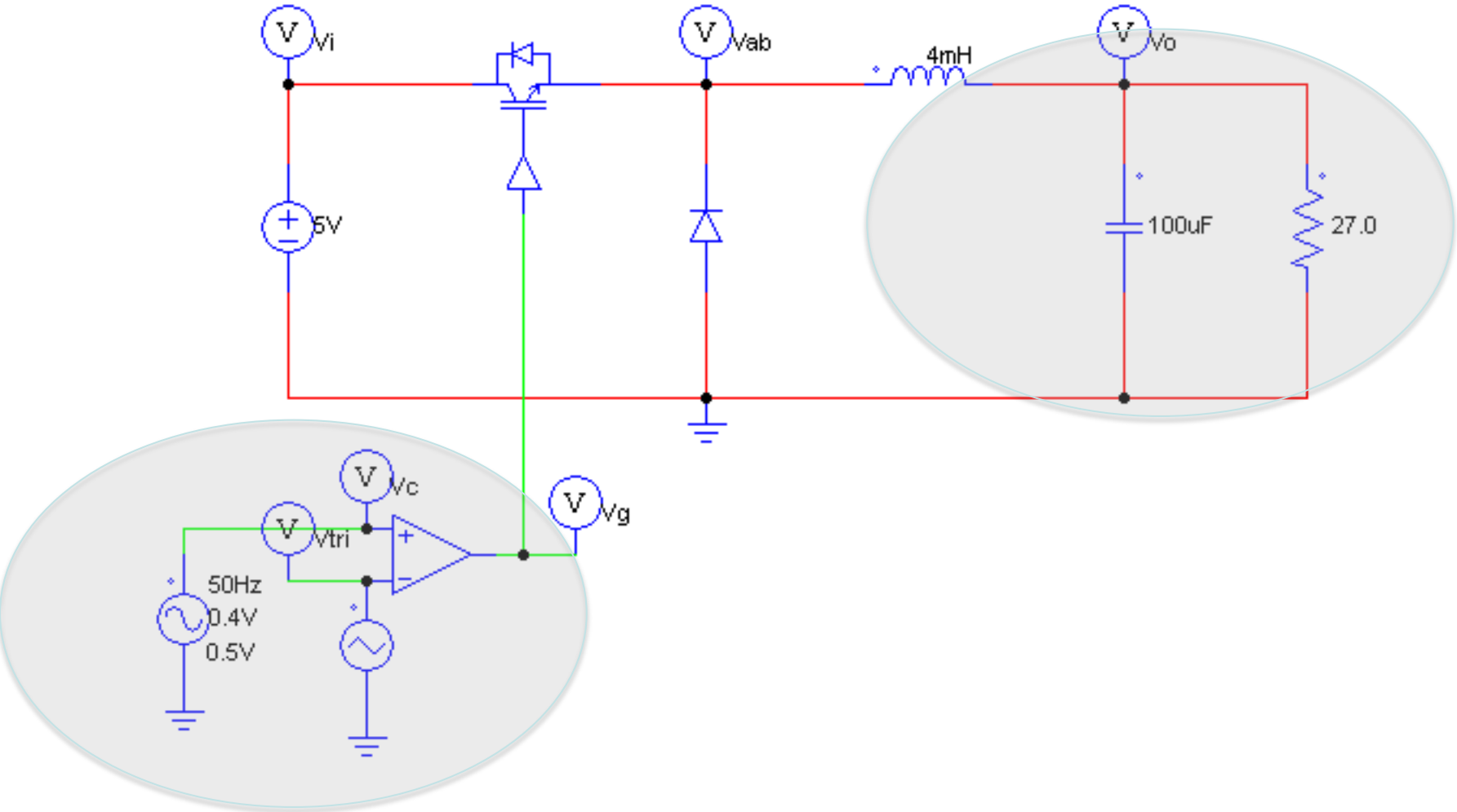
Simulação de um Conversor CC-CA



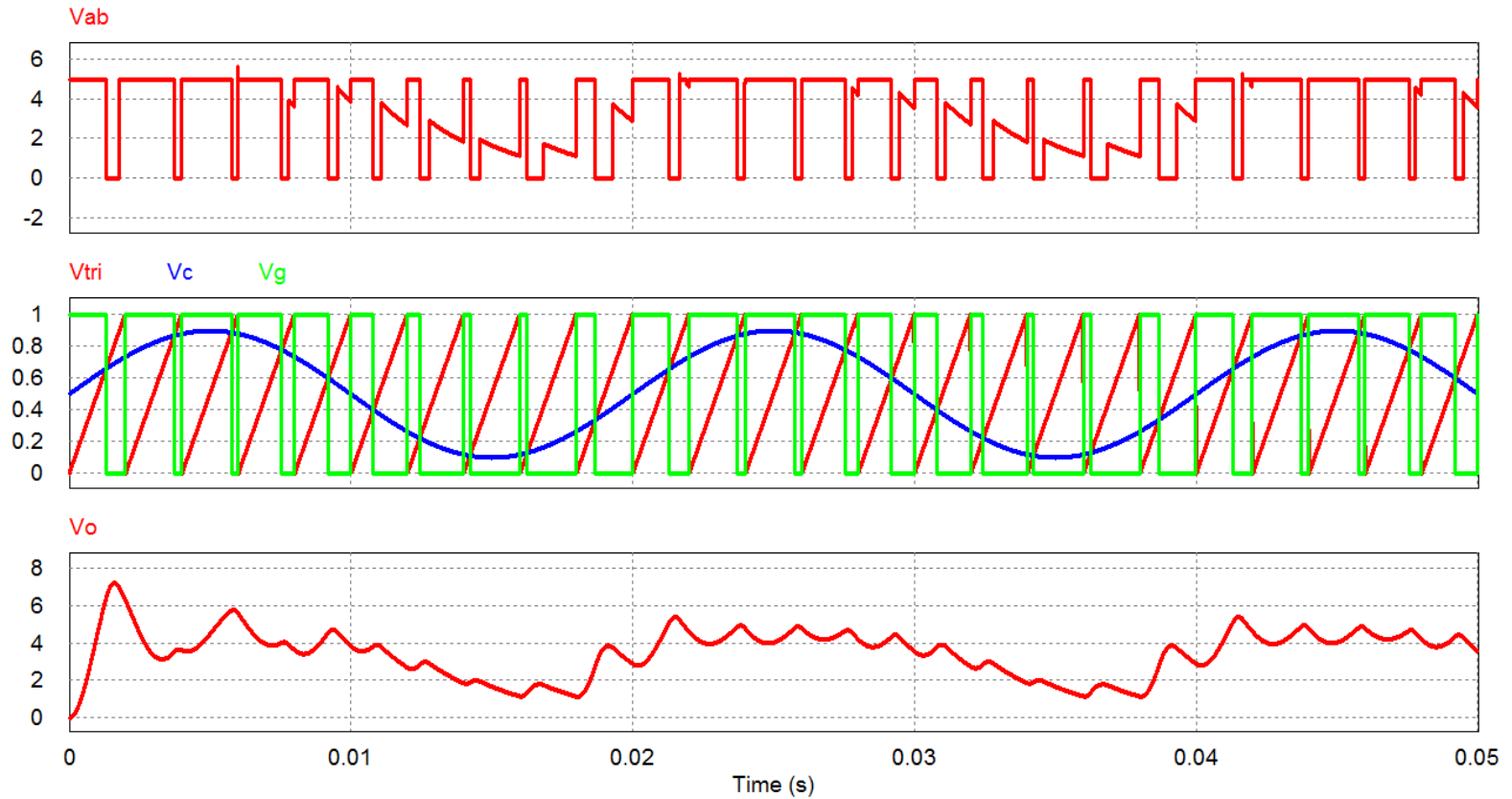
Simulação de um Conversor CC-CA



Simulação de um Conversor CC-CA



Simulação de um Conversor CC-CA



Conversores cc-ca:

- Conversor meia ponte.

