# Modelagem e Controle de Sistemas Fotovoltaicos

## Aula 08 – P1: Controle do Inversor Fotovoltaico: Malhas Internas – Correntes

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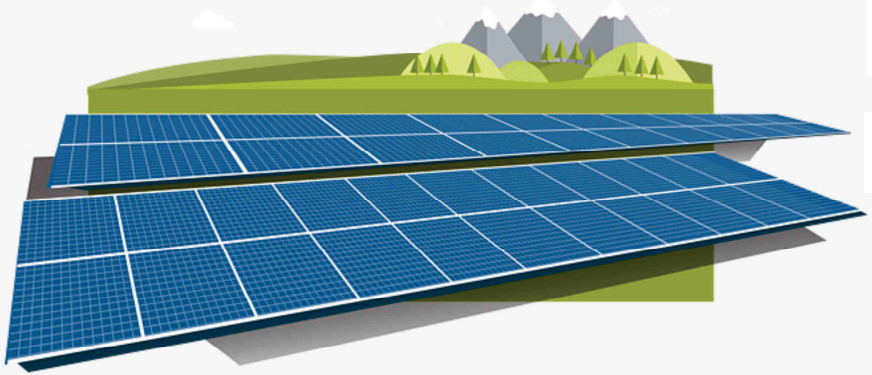
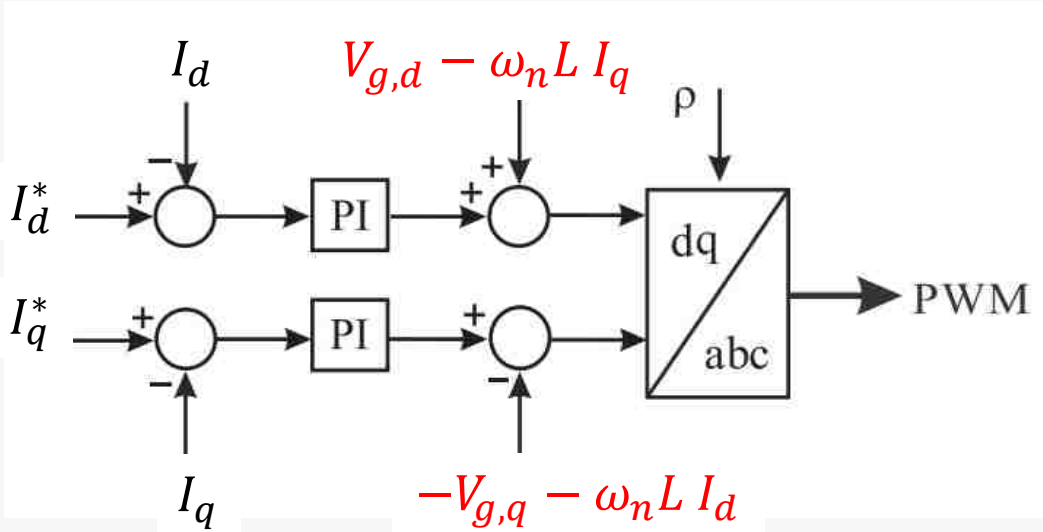
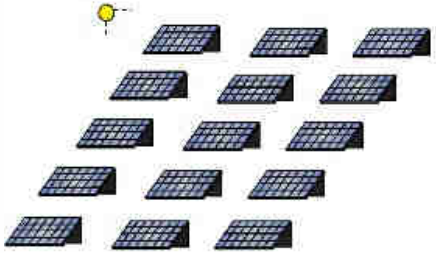
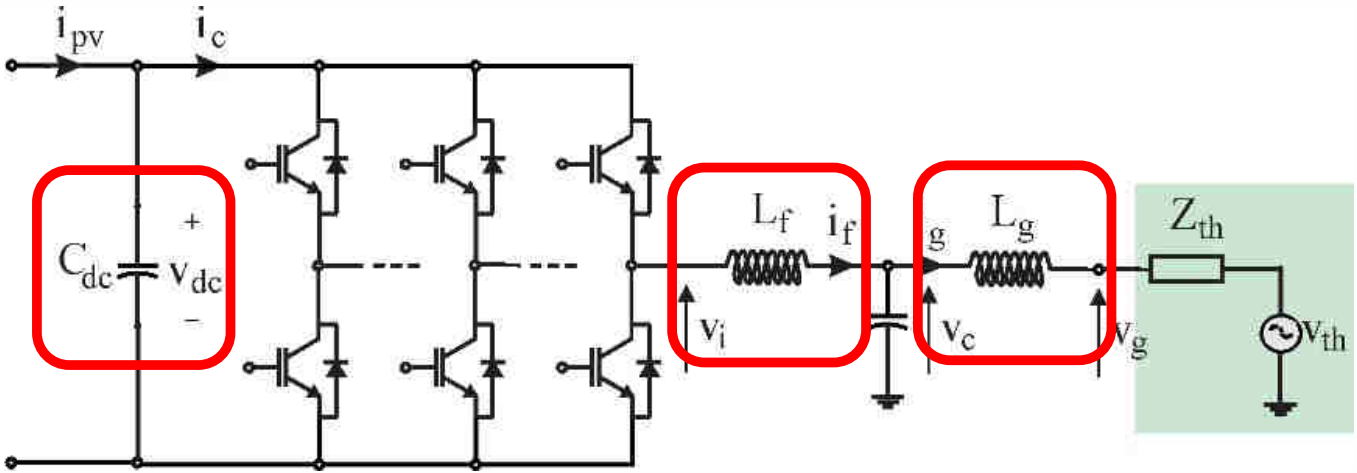
heverton.pereira@ufv.br





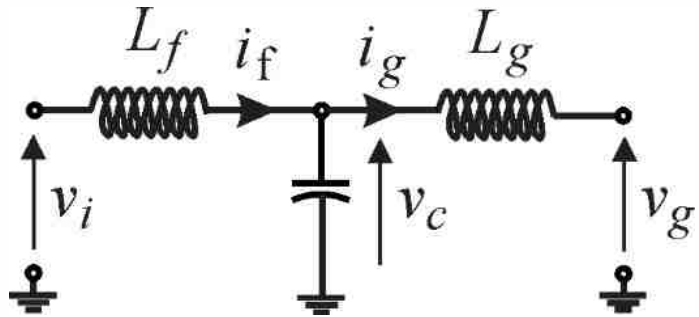
# O que eu posso controlar?

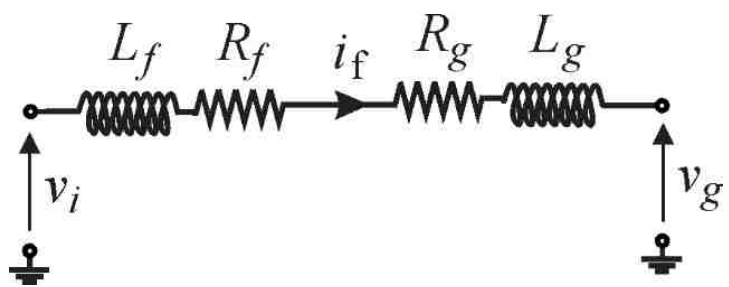




# Modelagem do Inversor

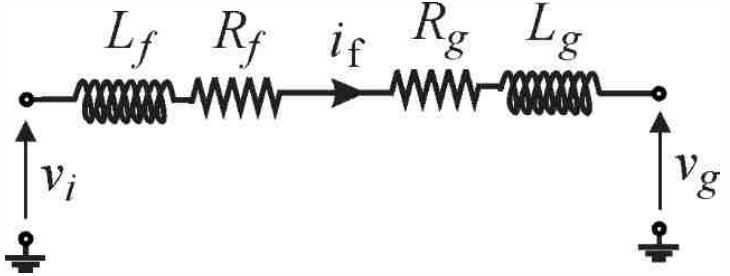
- ✓ Modelagem do lado ca:



# Modelagem do Inversor: coordenadas abc

✓ Modelagem do lado ca:



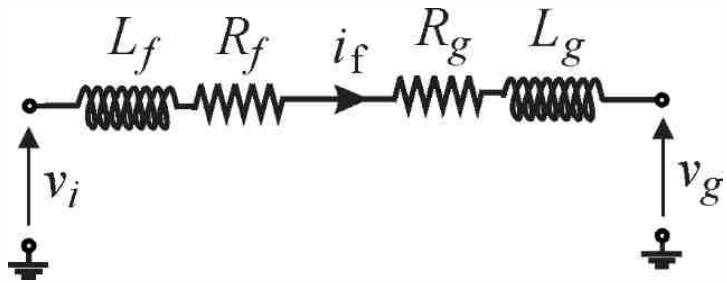

✓ Em coordenadas abc

$$\begin{cases} v_{ia}(t) - \left(R_f + R_g\right) i_a(t) - \left(L_f + L_g\right) \dfrac{di_a(t)}{dt} - v_{ga}(t) = 0 \\ v_{ib}(t) - \left(R_f + R_g\right) i_b(t) - \left(L_f + L_g\right) \dfrac{di_b(t)}{dt} - v_{gb}(t) = 0 \\ v_{ic}(t) - \left(R_f + R_g\right) i_c(t) - \left(L_f + L_g\right) \dfrac{di_c(t)}{dt} - v_{gc}(t) = 0 \end{cases}$$

$$\boxed{\vec{v_i} - R\,\vec{i} - L\,\frac{d\vec{i}}{dt} - \vec{V_g} = 0}$$

# Modelagem do Inversor: coordenadas $\alpha\beta$

✓ Modelagem do lado ca:




✓ Em coordenadas $\alpha\beta$

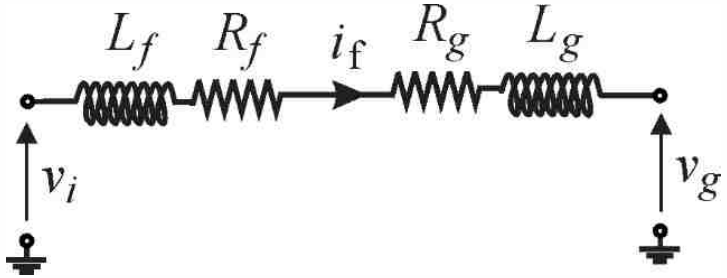
$$\begin{cases} v_{i\alpha}(t) - Ri_{\alpha}(t) - L\dfrac{di_{\alpha}(t)}{dt} - v_{g\alpha}(t) = 0 \\ v_{i\beta}(t) - Ri_{\beta}(t) - L\dfrac{di_{\beta}(t)}{dt} - v_{g\beta}(t) = 0 \end{cases}$$

$$\boxed{R = R_f + R_g}$$

$$\boxed{L = L_f + L_g.}$$

# Modelagem do Inversor: coordenadas dq

- ✓ Modelagem do lado ca:




- ✓ Em coordenadas $dq$

$$\begin{cases} v_{i,d} - R\, i_d - L\, \dfrac{di_d}{dt} + L\, i_q \dfrac{d\rho}{dt} - v_{g,d} = 0 \\ v_{i,q} - R\, i_q - L\, \dfrac{di_q}{dt} - L\, i_d \dfrac{d\rho}{dt} - v_{g,q} = 0 \end{cases}$$

$$R = R_f + R_g$$

$$L = L_f + L_g.$$

# Modelagem do Inversor: coordenadas dq

- ✓ Em coordenadas $dq$

$$\begin{cases} V_{i,d}(s) - R\, I_d(s) - sLI_d(s) + \omega_n L\, I_q(s) - V_{g,d}(s) = 0 \\ V_{\mathrm{i},q}(s) - R\, I_q(s) - sLI_q(s) - \omega_n L\, I_d(s) - V_{g,q}(s) = 0 \end{cases}$$

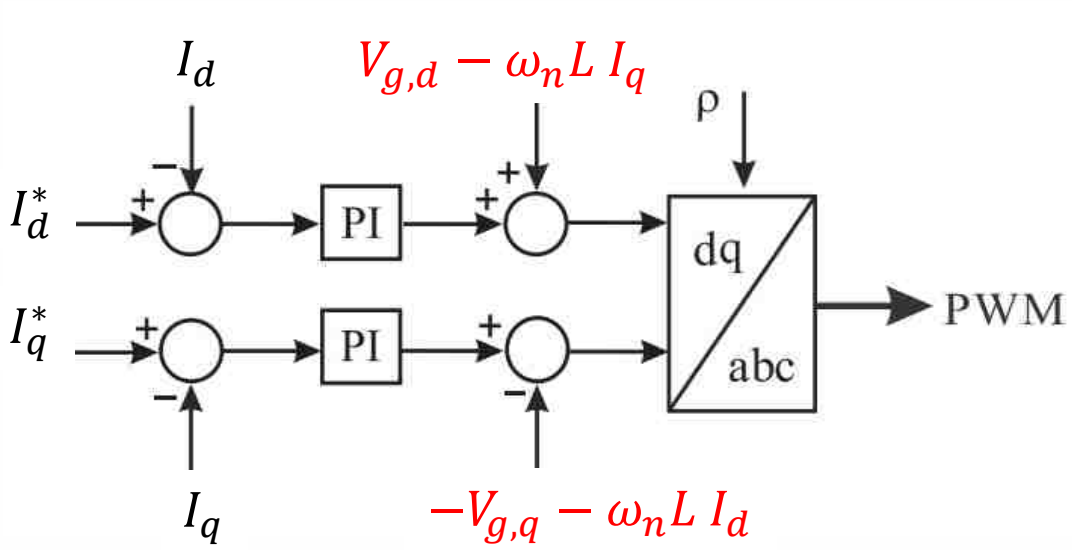
$$\begin{cases} V_{i,d}(s) - R\, I_d(s) - sLI_d(s) = 0 \\ V_{\mathrm{i},q}(s) - R\, I_q(s) - sLI_q(s) = 0 \end{cases}$$

$$\begin{cases} I_d(s) = \dfrac{V_{i,d}(s)}{R + sL} \\ I_q(s) = \dfrac{V_{i,q}(s)}{R + sL} \end{cases}$$

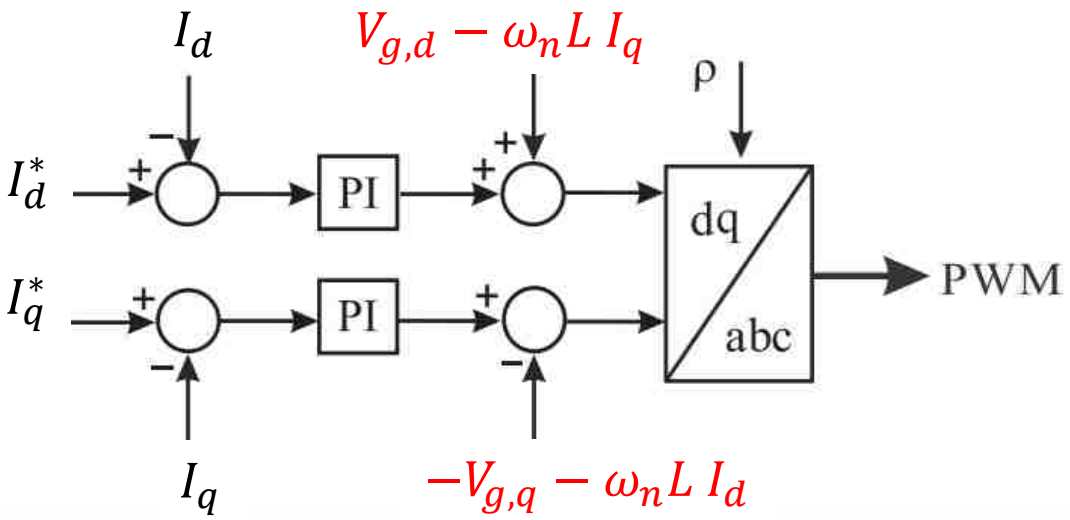
# Modelagem do Inversor: coordenadas dq

- ✓ Em coordenadas $dq$

$$\begin{cases} I_d(s) = \dfrac{V_{i,d}(s)}{R + sL} \\ I_q(s) = \dfrac{V_{i,q}(s)}{R + sL} \end{cases}$$



# Modelagem do Inversor: coordenadas dq



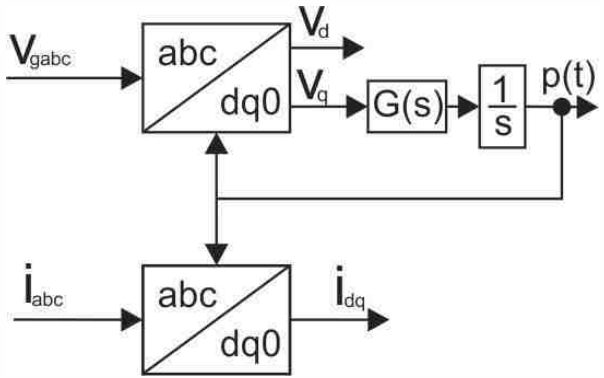

- ✓ Controlador PI

$$G_c(s) = PI(s) = K_p + \frac{K_i}{s}$$

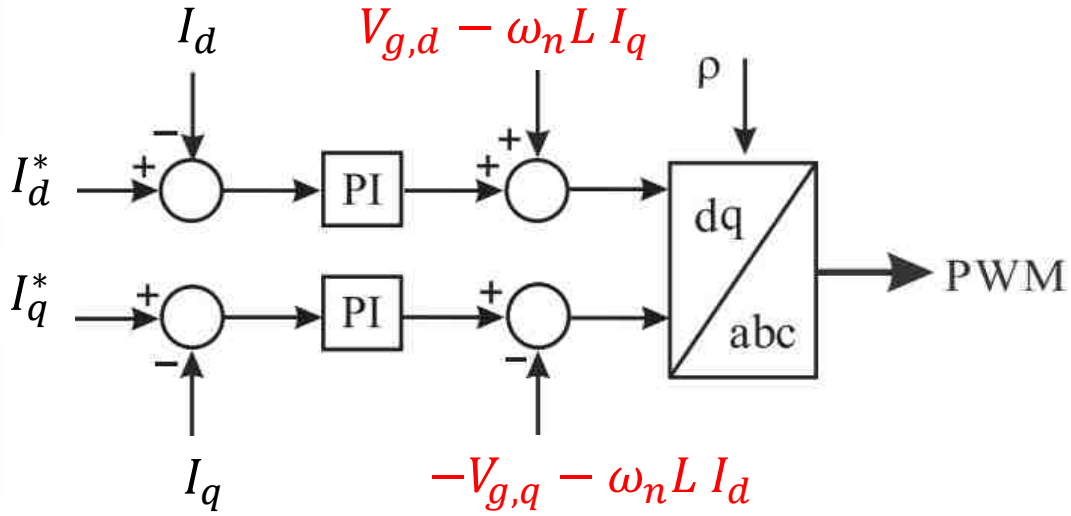
$$\begin{cases} K_p = \dfrac{2\pi f_s L}{10} \\ K_i = \dfrac{2\pi f_s R}{10} \end{cases}$$

# Etapas para controlar o Inversor

- ✓ Etapa 1 : Obter as correntes no referencia dq

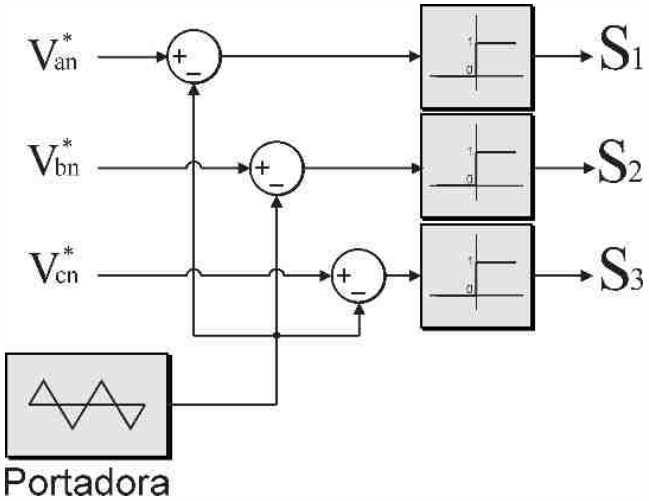


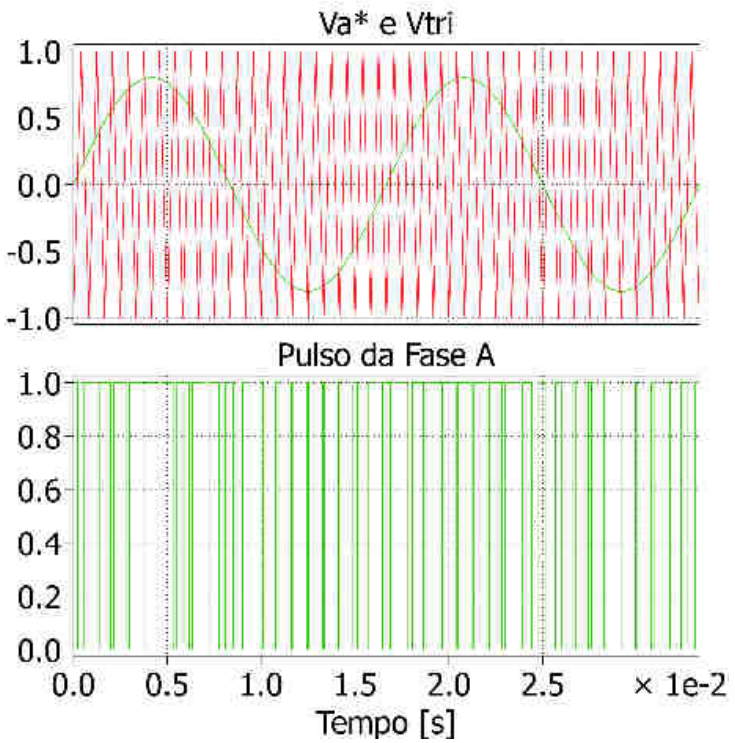

- ✓ Etapa 2 : Sistema de controle das corrente dq



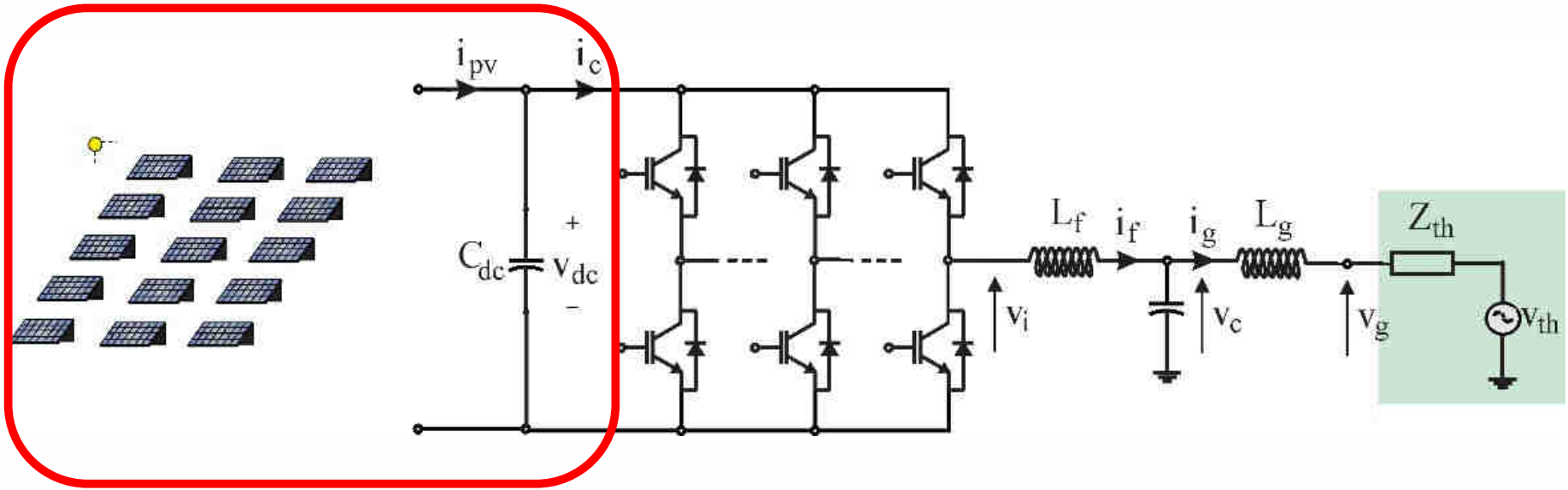
# Etapas para controlar o Inversor

- ✓ Etapa 3 :Geração dos pulsos para acionar os IGBTs



# Teste de controle da Malha interna

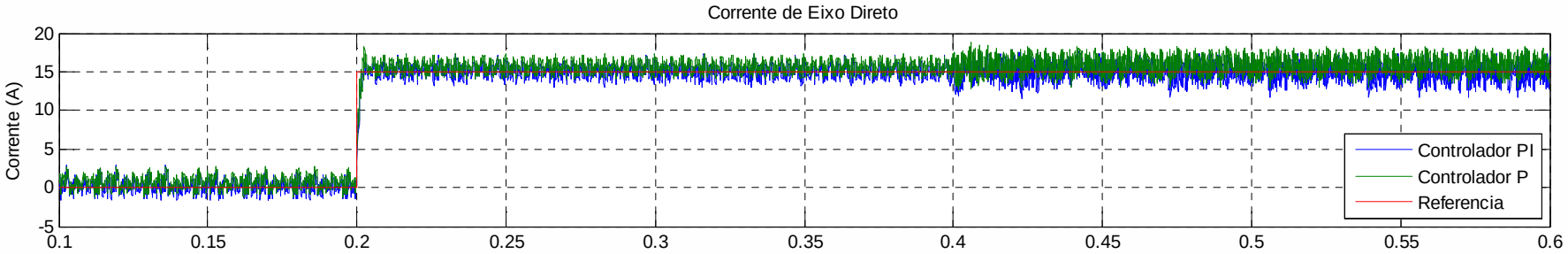



✓ Substituir por uma fonte de tensão constante

# Teste de controle da Malha interna

| | |
|---|---|
| $S_n$ | **20 kVA** |
| $V_g$ | 380 V |
| $f_n$ | 60 Hz |
| $f_s$ | 6 kHz |
| $V_{dc}$ | 700 V |

# Modelagem do Inversor: coordenadas dq



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Gesep

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Gesep UFV

EStimate - Sistemas Fotovoltaicos

Google Play

https://play.google.com/store/apps/details?id=br.developer.gesep.estimate

# Obrigado!

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