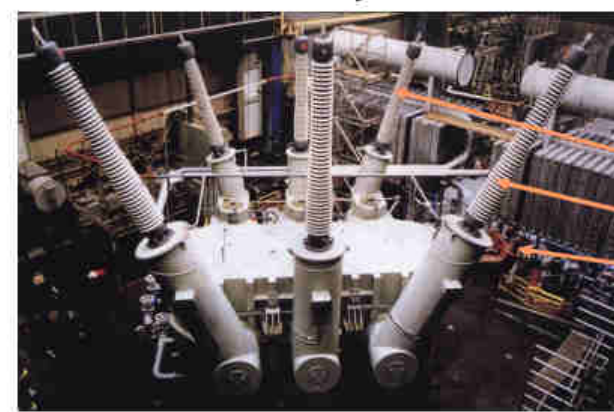




# Sistemas Elétricos de Potência

## Aula 08-P2 – Autotransformador: Cálculo de Curto-circuito Monofásico

Prof. Heverton Augusto Pereira  
[heverton.pereira@ufv.br](mailto:heverton.pereira@ufv.br)



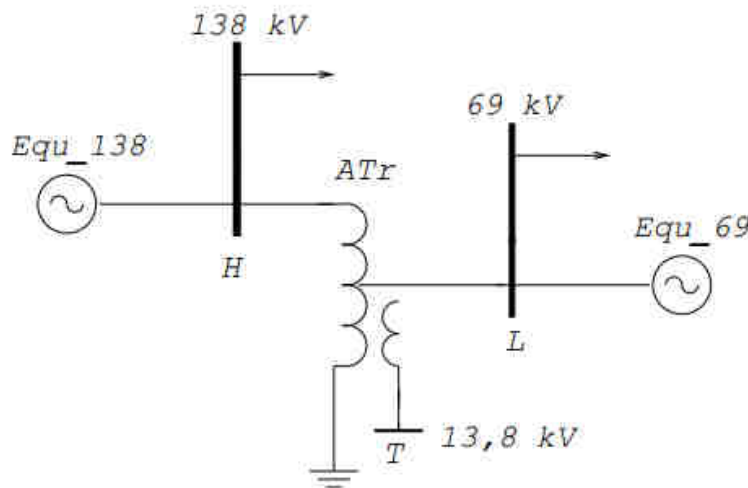
## Exemplo de Aplicação

$$S_{base} = 100 \text{ MVA}$$

$$V_{base} = 138 \text{ kV}$$

$$z_{eq138}^+ = j8\%$$

$$z_{eq138}^0 = j16\%$$



$$z_{HL}^+ = z_{HL}^0 = j6,07\% \quad (S_{base} = 25 \text{ MVA})$$

$$z_{HT}^+ = z_{HT}^0 = j5,99\% \quad (S_{base} = 8,75 \text{ MVA})$$

$$z_{LT}^+ = z_{LT}^0 = j3,7\% \quad (S_{base} = 8,75 \text{ MVA})$$



$$S_{base} = 100 \text{ MVA}$$

$$V_{base} = 69 \text{ kV}$$

$$z_{eq69}^+ = j40\%$$

$$z_{eq69}^0 = j80\%$$

$$S_{base} = 100 \text{ MVA}$$

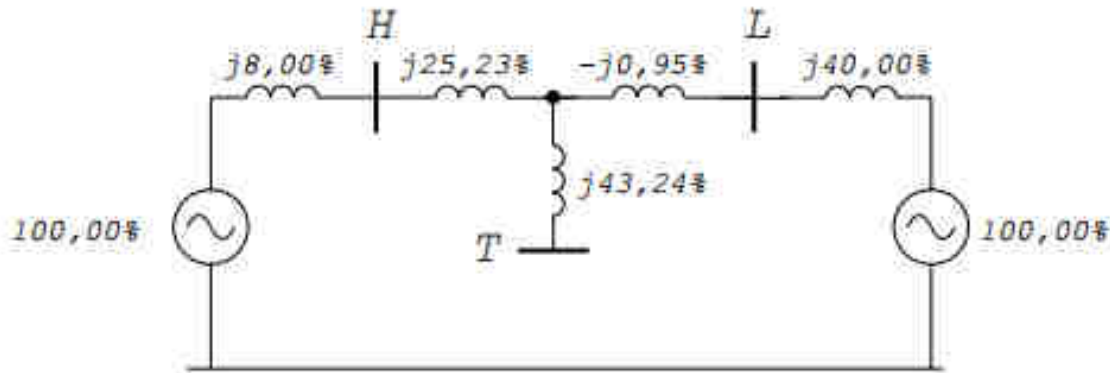
$$z_H\% = j25,23\%$$

$$z_L\% = -j0,95\%$$

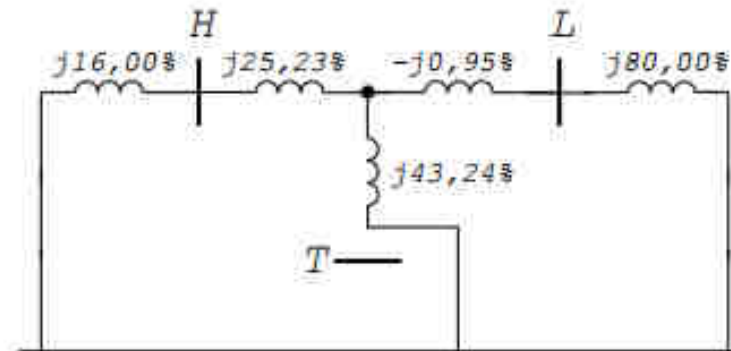
$$z_T\% = j43,24\%$$

# Diagramas de Sequência

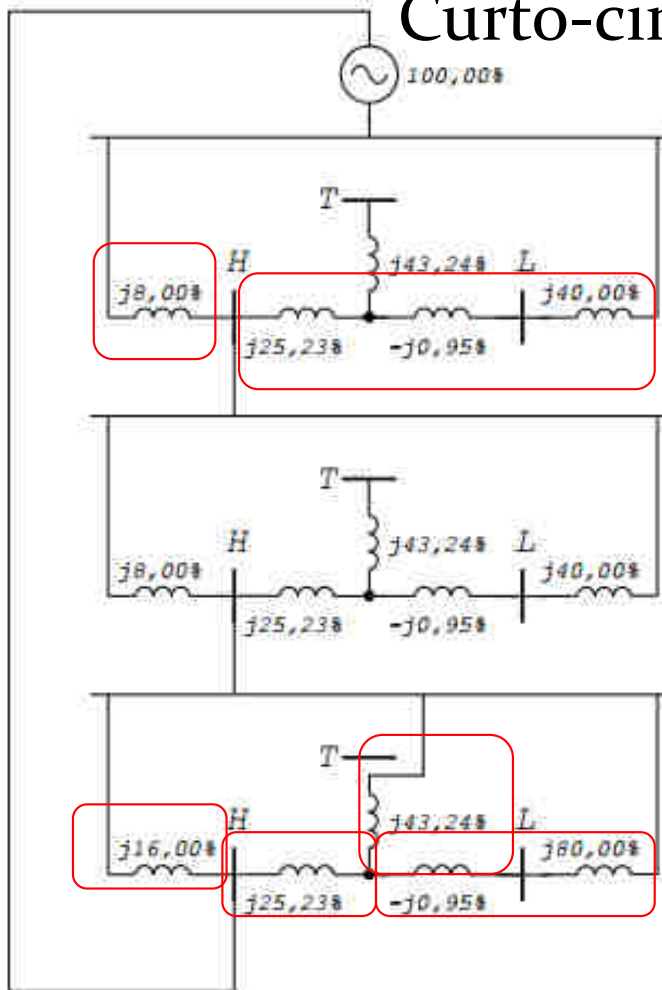
Sequência positiva:



Sequência zero:



# Curto-circuito Monofásico na Barra H



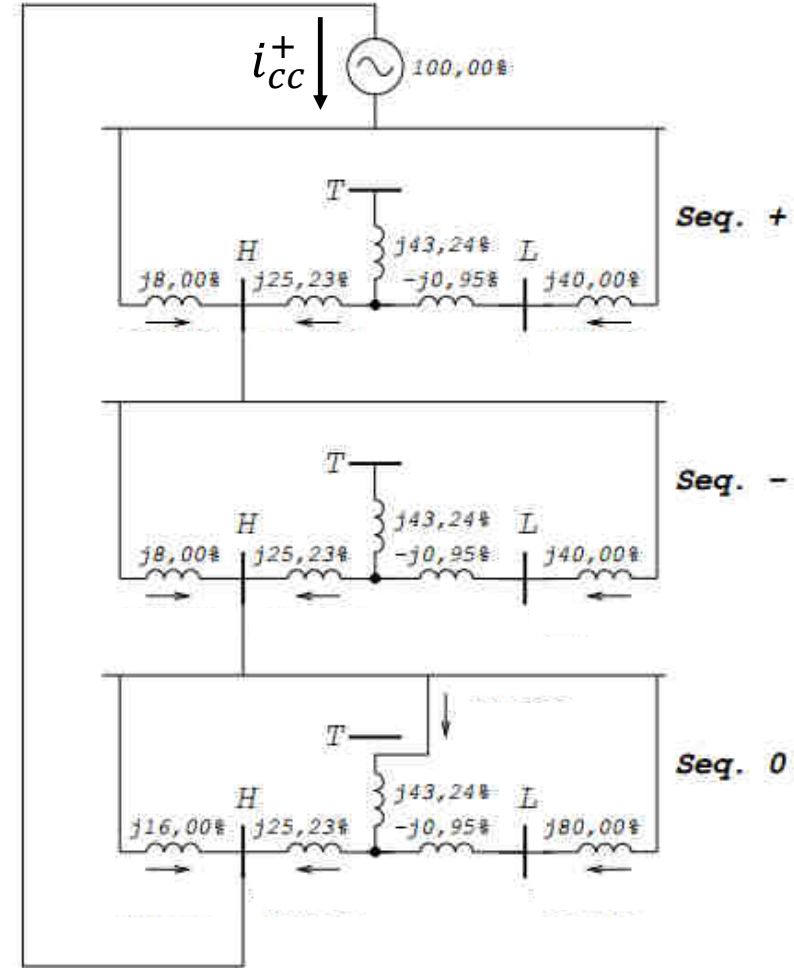
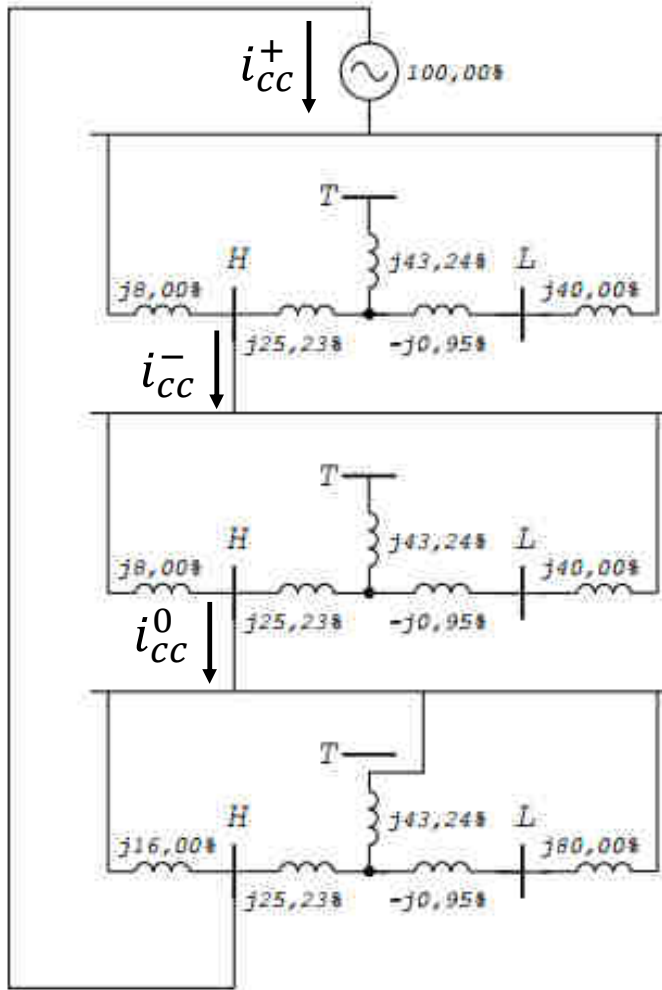
$$z_{\%}^{+}(eq_H) = z_{\%}^{-}(eq_H) = j7,1145\%$$

$$i_{cc}^{+} = \frac{100}{2 \times j7,1145 + j12,2996} = -j3,7695 \text{ pu}$$

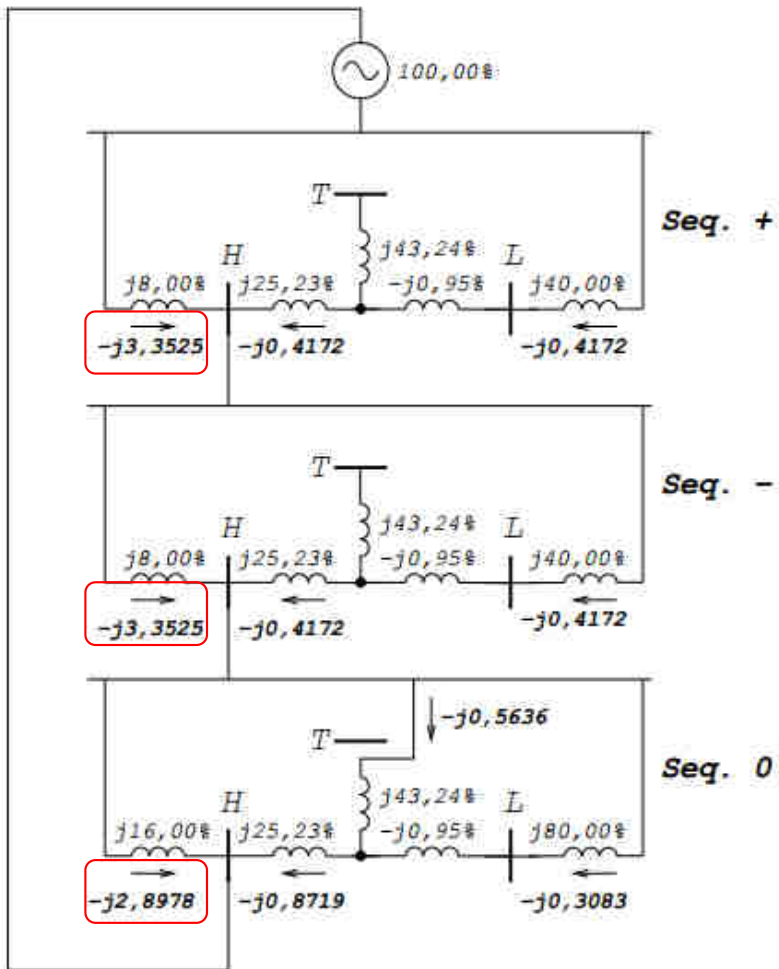
$$i_{cc}^{+} = i_{cc}^{-} = i_{cc}^0$$

$$z_{\%}^0(eq_H) = j12,2996\%$$

$$i_{cc}^+ = -j3,7695 \text{ pu}$$



# Contribuição da Barra de 138 kV



$$\hat{i}_{A_{138}} = 3,3525 \angle -90^\circ + 3,3525 \angle -90^\circ + 2,8978 \angle -90^\circ$$

$$\hat{i}_{B_{138}} = 3,3525 \angle 150^\circ + 3,3525 \angle 30^\circ + 2,8978 \angle -90^\circ$$

$$\hat{i}_{C_{138}} = 3,3525 \angle 30^\circ + 3,3525 \angle 150^\circ + 2,8978 \angle -90^\circ$$

$$\hat{i}_{A_{138}} = 9,6028 \angle -90^\circ$$

$$\hat{i}_{B_{138}} = 0,4547 \angle 90^\circ$$

$$\hat{i}_{C_{138}} = 0,4547 \angle 90^\circ$$

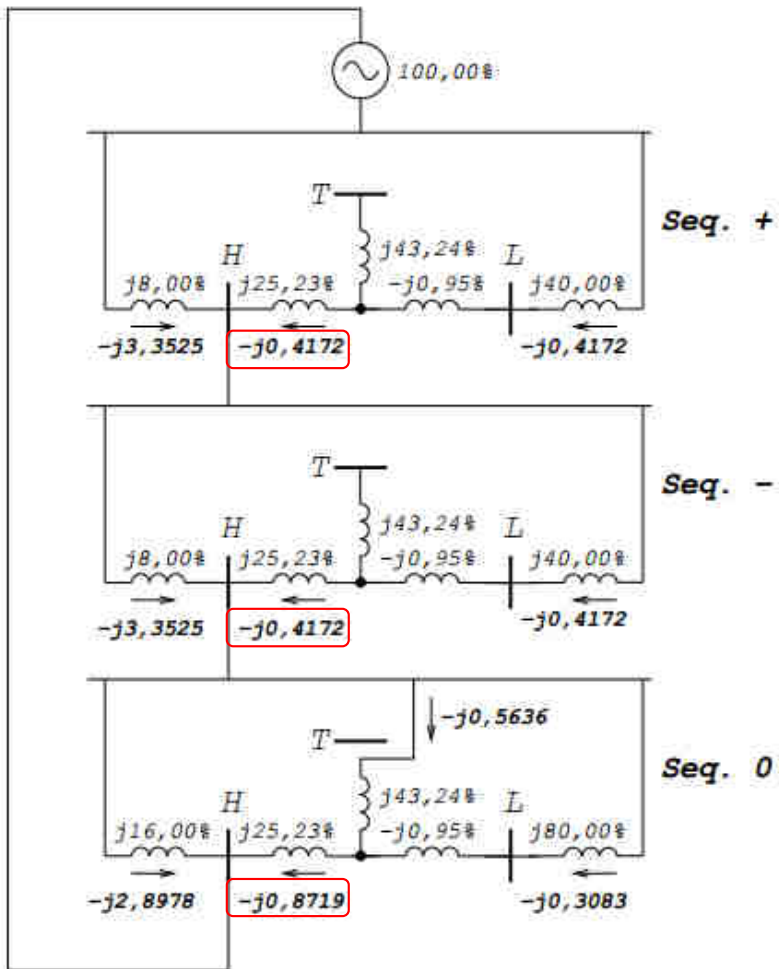
$$I_{base} = \frac{100 \times 10^6}{\sqrt{3} \times 138 \times 10^3} = 418,37 \text{ A}$$

$$\hat{I}_{A_{138}} = 9,6028 \angle -90^\circ \times 418,37 \text{ A} = -j4.017,5 \text{ A}$$

$$\hat{I}_{B_{138}} = 0,4547 \angle 90^\circ \times 418,37 \text{ A} = j190,2 \text{ A}$$

$$\hat{I}_{C_{138}} = 0,4547 \angle 90^\circ \times 418,37 \text{ A} = j190,2 \text{ A}$$

# Contribuição do Autotransformador



$$\hat{i}_{A_{ATr}} = 0,4174 \angle -90^\circ + 0,4174 \angle -90^\circ + 0,8719 \angle -90^\circ$$

$$\hat{i}_{B_{ATr}} = 0,4174 \angle 150^\circ + 0,4174 \angle 30^\circ + 0,8719 \angle -90^\circ$$

$$\hat{i}_{C_{ATr}} = 0,4174 \angle 30^\circ + 0,4174 \angle 150^\circ + 0,8719 \angle -90^\circ$$

$$\hat{i}_{A_{ATr}} = 1,7067 \angle -90^\circ$$

$$\hat{i}_{B_{ATr}} = 0,4545 \angle -90^\circ$$

$$\hat{i}_{C_{ATr}} = 0,4545 \angle -90^\circ$$

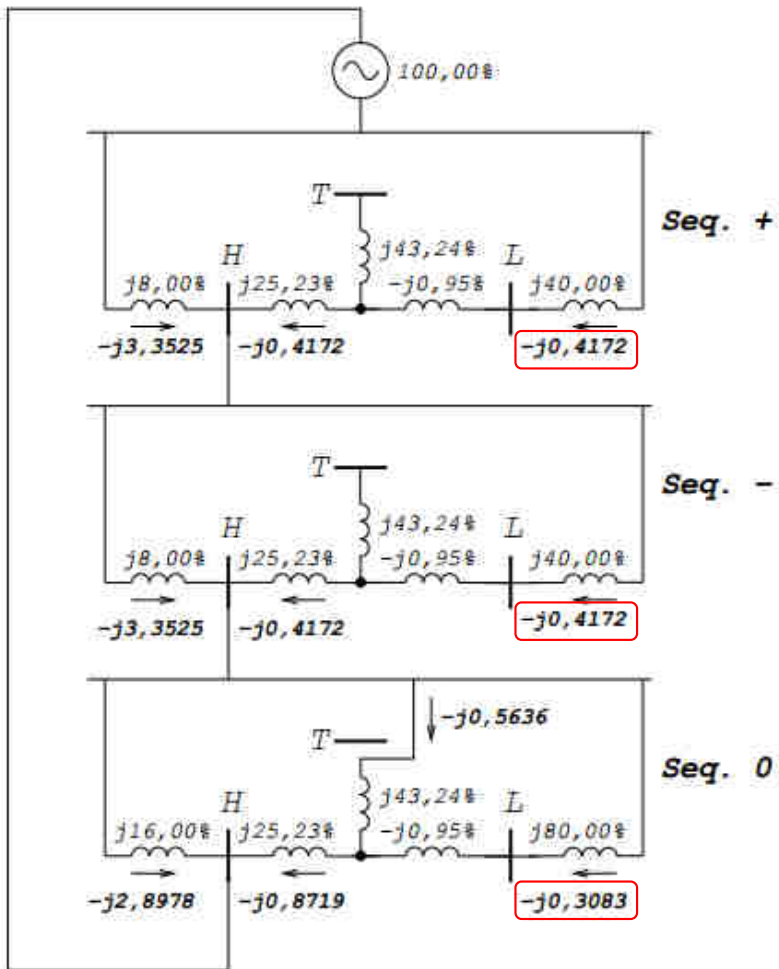
$$I_{base} = \frac{100 \times 10^6}{\sqrt{3} \times 138 \times 10^3} = 418,37 \text{ A}$$

$$\hat{I}_{A_{AT}} = 1,7067 \angle -90^\circ \times 418,37 \text{ A} = -j714,0 \text{ A}$$

$$\hat{I}_{B_{AT}} = 0,4545 \angle -90^\circ \times 418,37 \text{ A} = -j190,2 \text{ A}$$

$$\hat{I}_{C_{AT}} = 0,4545 \angle -90^\circ \times 418,37 \text{ A} = -j190,2 \text{ A}$$

## Contribuição da Barra de 69 kV



$$\hat{i}_{a69} = 0,4172 \angle -90^\circ + 0,4172 \angle -90^\circ + 0,3083 \angle -90^\circ$$

$$\hat{i}_{b69} = 0,4172 \angle 150^\circ + 0,4172 \angle 30^\circ + 0,3083 \angle -90^\circ$$

$$\hat{i}_{c69} = 0,4172 \angle 30^\circ + 0,4172 \angle 150^\circ + 0,3083 \angle -90^\circ$$

$$\hat{i}_{a69} = 1,1427 \angle -90^\circ$$

$$\hat{i}_{b69} = 0,1089 \angle 90^\circ$$

$$\hat{i}_{c69} = 0,1089 \angle 90^\circ$$

$$I_{base} = \frac{100 \times 10^6}{\sqrt{3} \times 69 \times 10^3} = 836,74 \text{ A}$$

$$\hat{I}_{A69} = 1,1427 \angle -90^\circ \times 836,74 \text{ A} = -j956,1 \text{ A}$$

$$\hat{I}_{B69} = 0,1089 \angle 90^\circ \times 836,74 \text{ A} = j91,1 \text{ A}$$

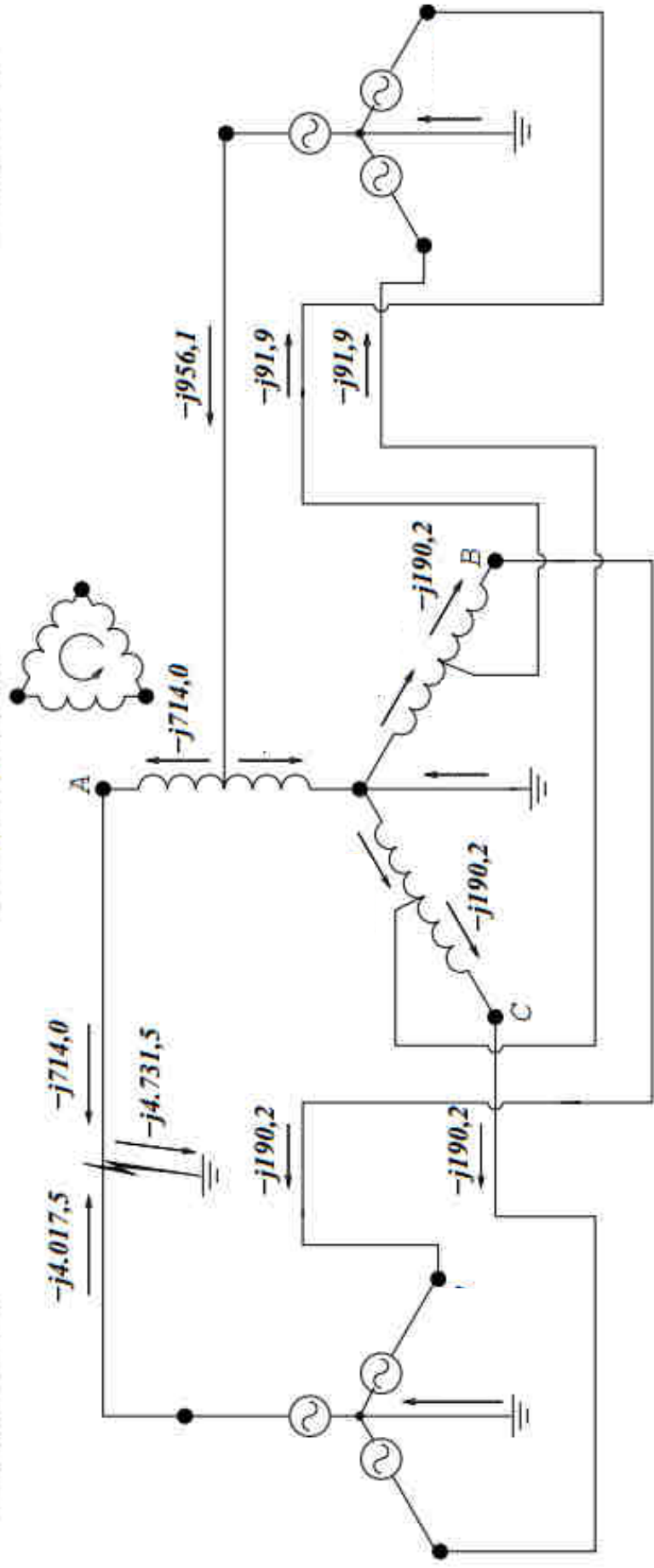
$$\hat{I}_{C69} = 0,1089 \angle 90^\circ \times 836,74 \text{ A} = j91,1 \text{ A}$$



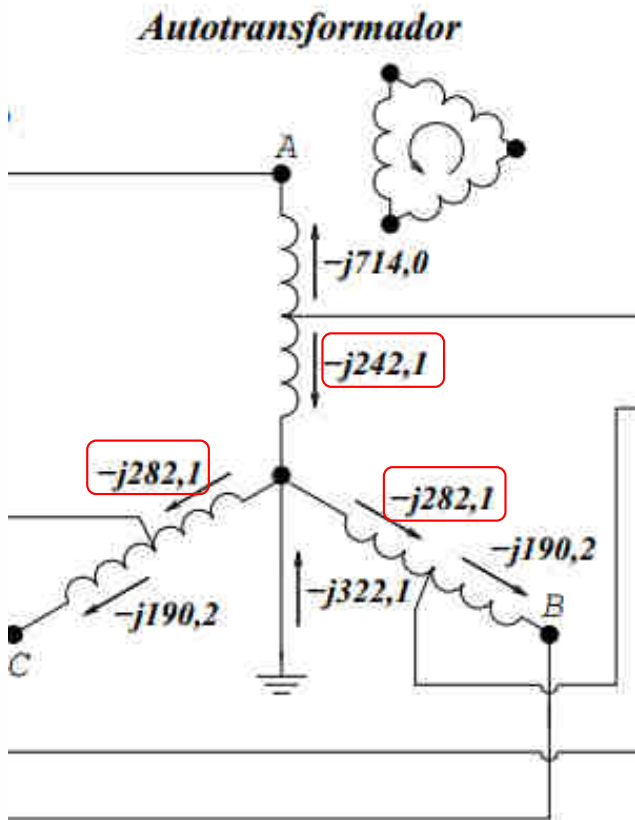
Sistema 138 kV

Autotransformador

Sistema 69 kV



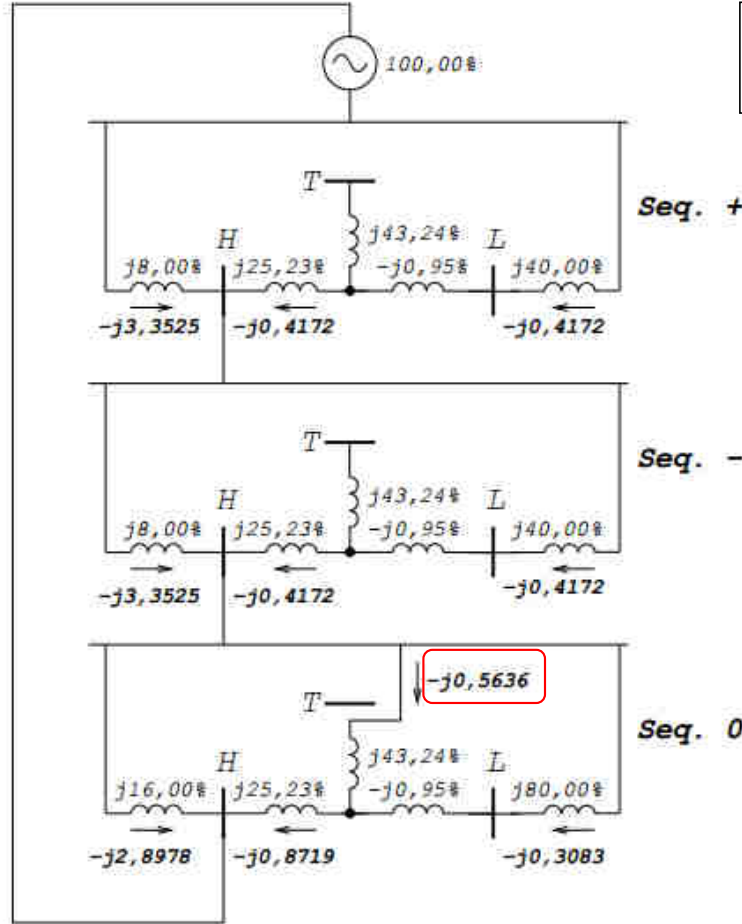
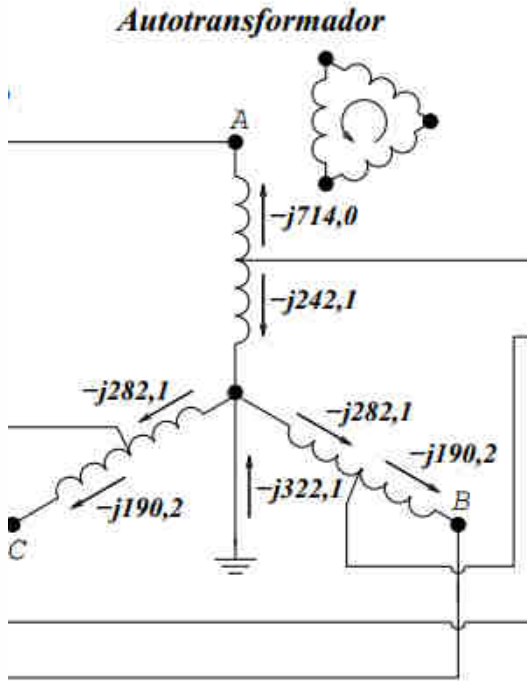
# Corrente no Neutro do Autotransformador



$$I_{NH} = -j242,1 - (-j282,1 - j282,1)$$

$$I_{NH} = -j322,1 \text{ A}$$

# Corrente no Delta do Autotransformador



$$I_{base} = \frac{100 \times 10^6}{3 \times 13,8 \times 10^3} = 2.415,46 \text{ A}$$

$$\text{Seq. + } I_{TH} = -j0,5636 \times 2.415,46$$

$$I_{TH} = -j1.361,4 \text{ A}$$



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Estimate - Sistemas  
Fotovoltaicos



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



# Obrigado!

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