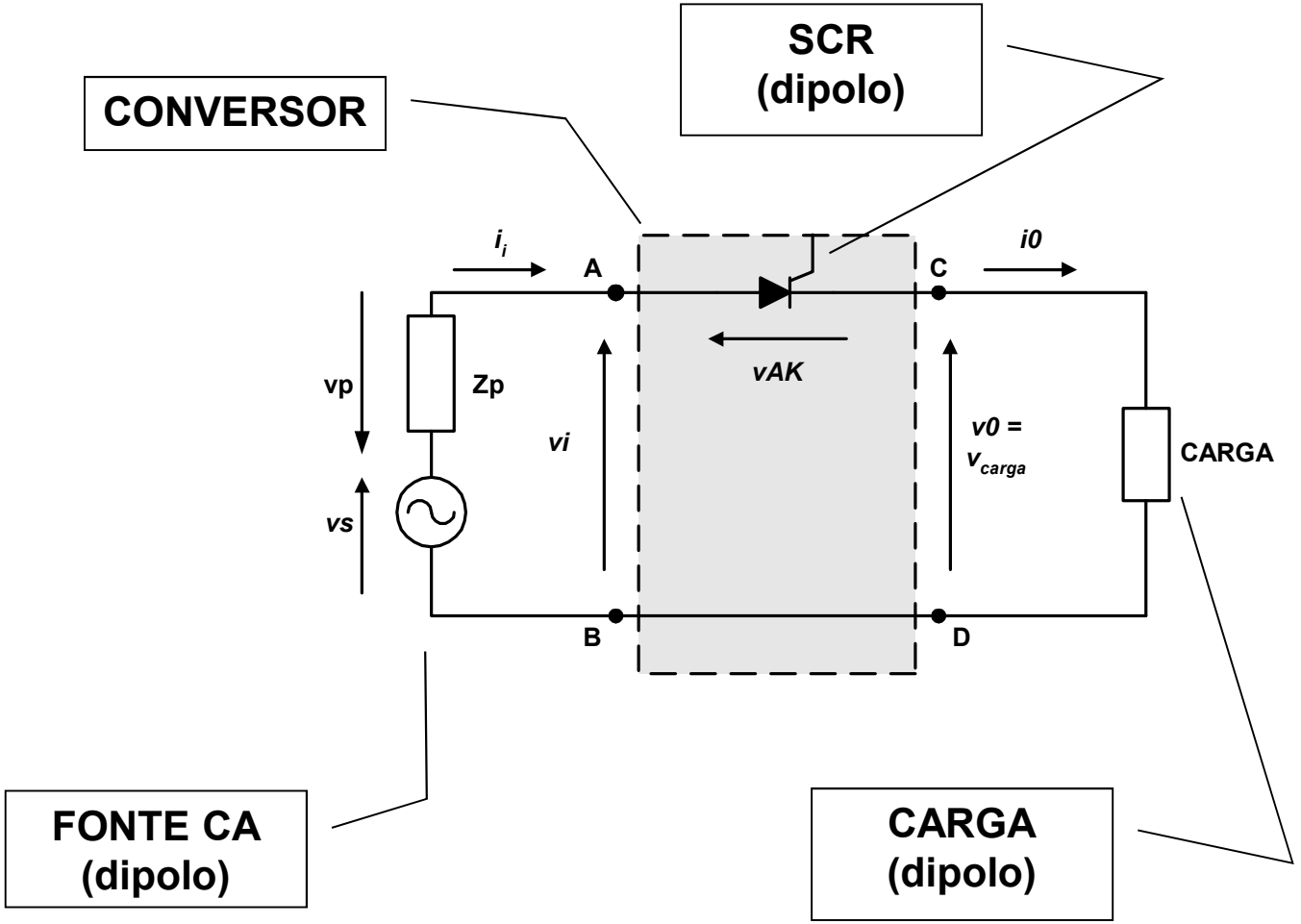
RETIFICADORES MONOFÁSICOS DE MEIA-ONDA

CONTROLADO

Prof. Azauri A. de Oliveira Jr.

RETIFICADOR MONOFÁSICO DE MEIA-ONDA (ESTRUTURA BÁSICA)

RETIFICADOR CONTROLADO



DIPOLOS SÃO CARACTERIZADOS PELAS SUAS RELAÇÕES TENSÃO x CORRENTE EM SEUS TERMINAIS

MODELOS DOS DIPOLOS?

HIPÓTESES

FINALIDADE

ESTUDAR O COMPORTAMENTO DO SISTEMA FONTE-CONVERSOR-CARGA

FINALIDADE

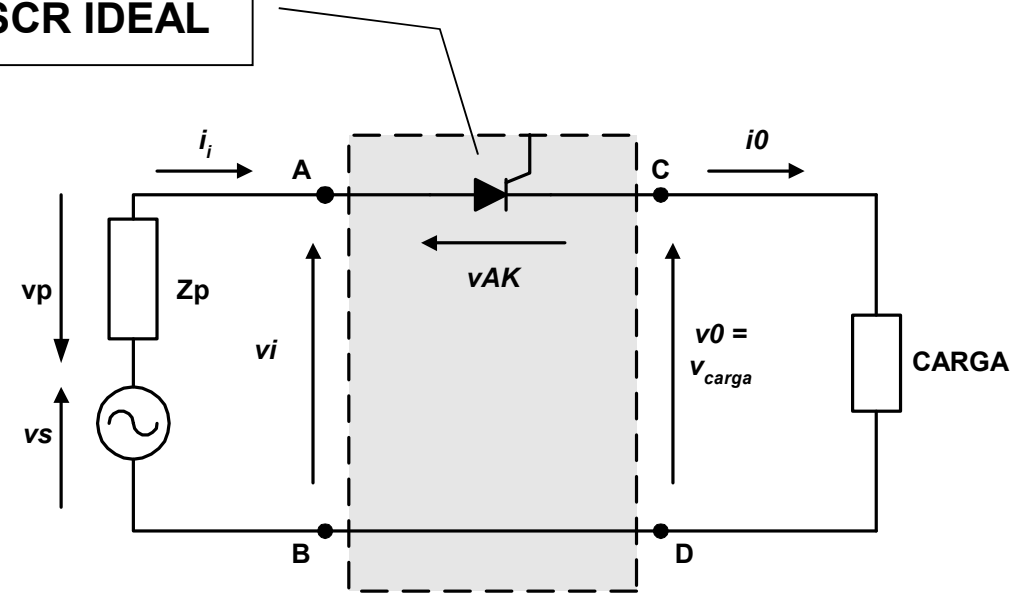
HIPÓTESES:

A TENSÃO DE CONDUÇÃO E A CORRENTE DE FUGA DO DIODO SÃO MUITO MENORES QUE AS DEMAIS TENSÕES E CORRENTES DO CIRCUITO (SISTEMA)

A FREQUÊNCIA DAS TENSÕES E CORRENTES DO CIRCUITO É "BAIXA"

MODELO

SCR IDEAL



COMPORTAMENTO DAS TENSÕES E CORRENTES DO SISTEMA

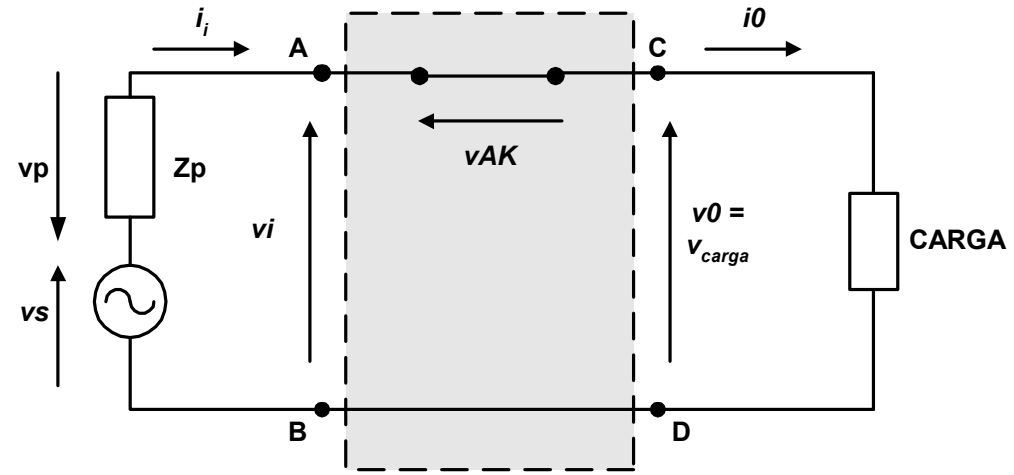
$$v_i = v_{AK} + v_o$$

$$v_0 = v_{\text{carga}}$$

$$v_s = v_p + v_i$$

$$i_0 = i_i$$

TOPOLOGIAS DO RETIFICADOR RELACIONADAS AOS ESTADOS DE CHAVEAMENTO SCR IDEAL



DIODO OU (SCR) EM CONDUÇÃO

$$v_{AK} = 0$$

$$v_0 = v_i = v_{\text{carga}}$$

$$v_s = v_p + v_i = v_p + v_0 = v_p + v_{\text{carga}}$$

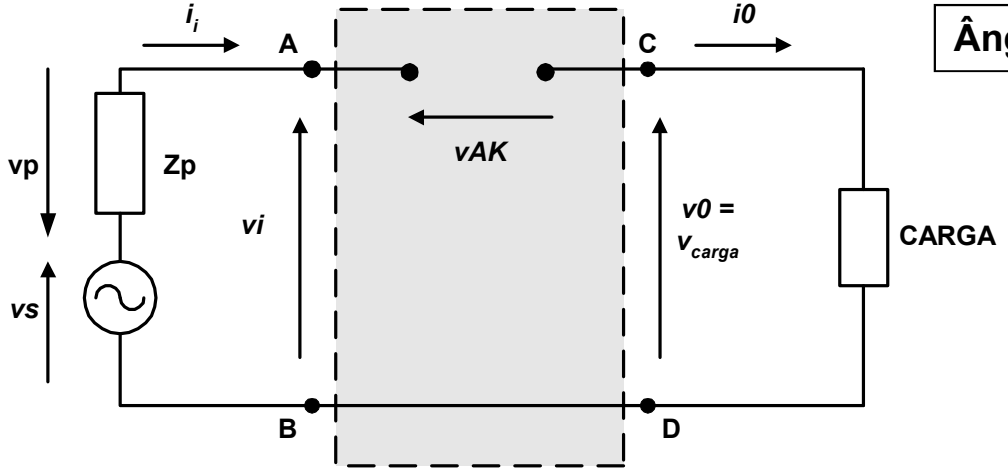
$$i_0 = i_i$$

Ângulo de Corte

$$\gamma = \beta - \alpha$$

Ângulo de Disparo

Ângulo de Condução



DIODO (OU SCR) EM BLOQUEIO

$$v_0 = v_{\text{carga}}$$

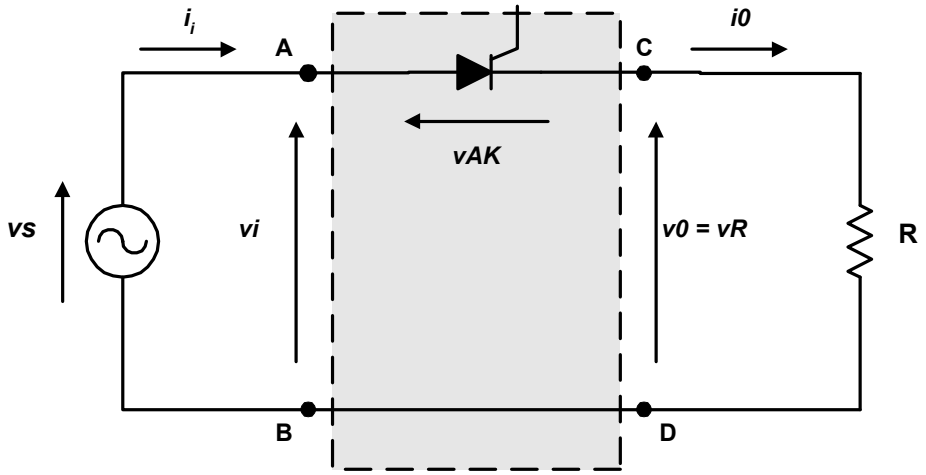
$$v_{AK} = v_i - v_0 = v_i - v_{\text{carga}}$$

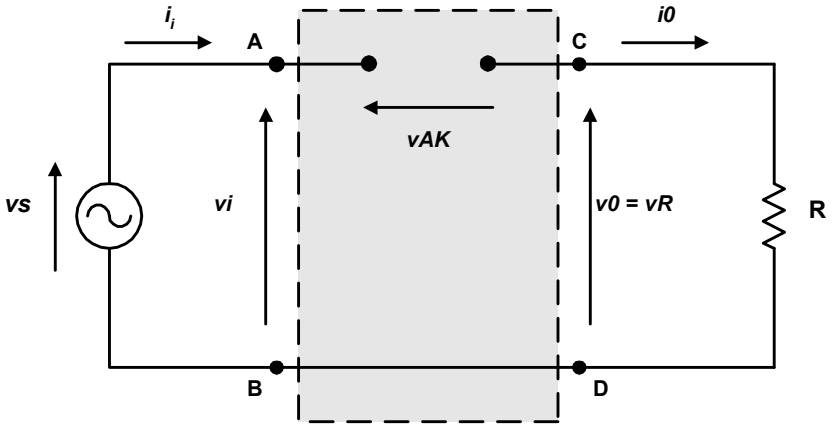
$$i_0 = i_i = 0$$

$$v_i = v_s - v_p$$

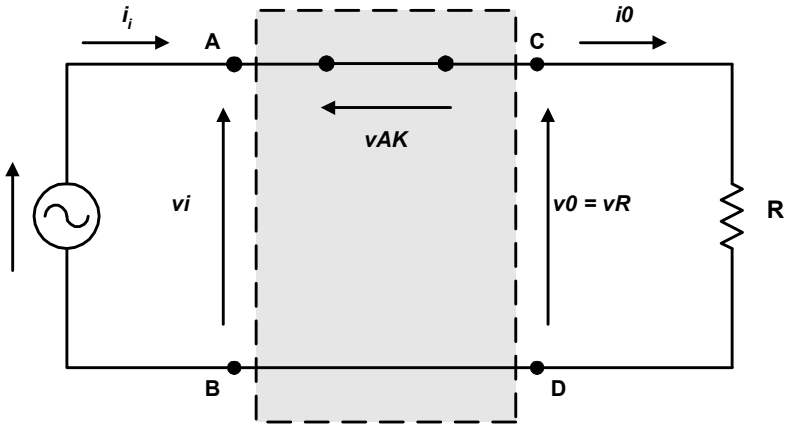
RETIFICADOR MONOFÁSICO DE MEIA-ONDA (CARGA RESISTIVA)

RETIFICADOR CONTROLADO



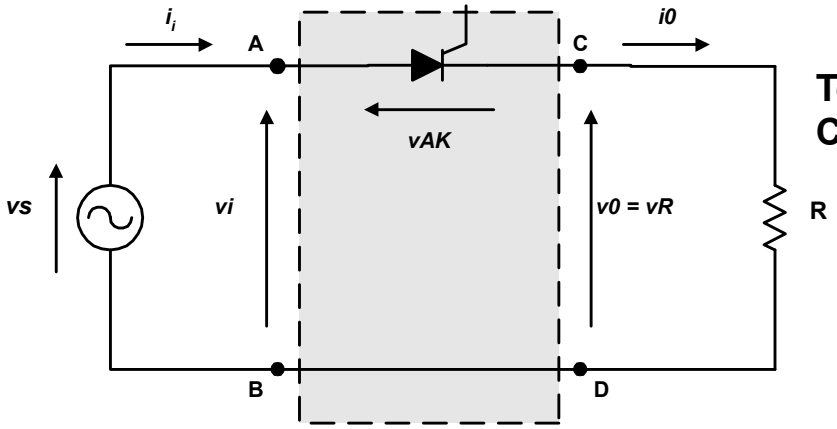


SCR EM BLOQUEIO

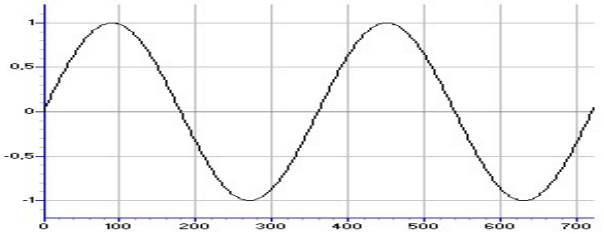


SCR EM CONDUÇÃO

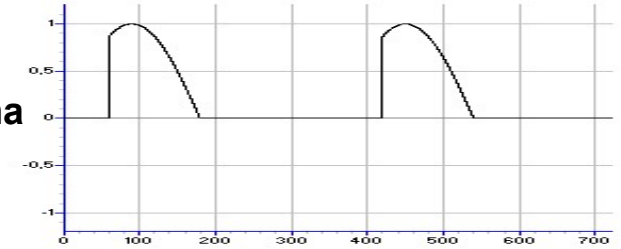
RETIFICADOR CONTROLADO COM CARGA RESISTIVA - FORMAS DE ONDA



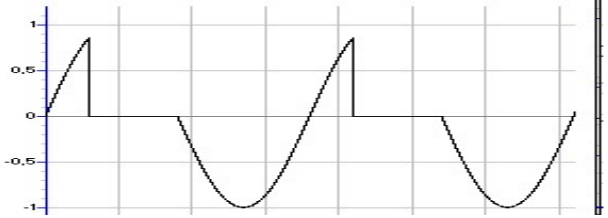
Tensão da Fonte



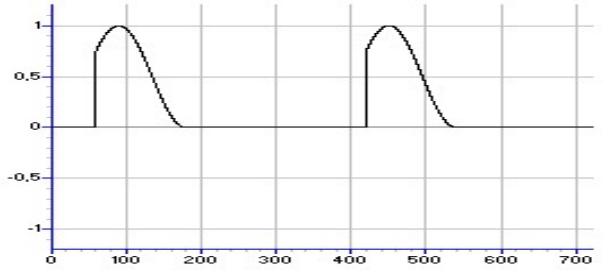
Tensão e corrente na Carga



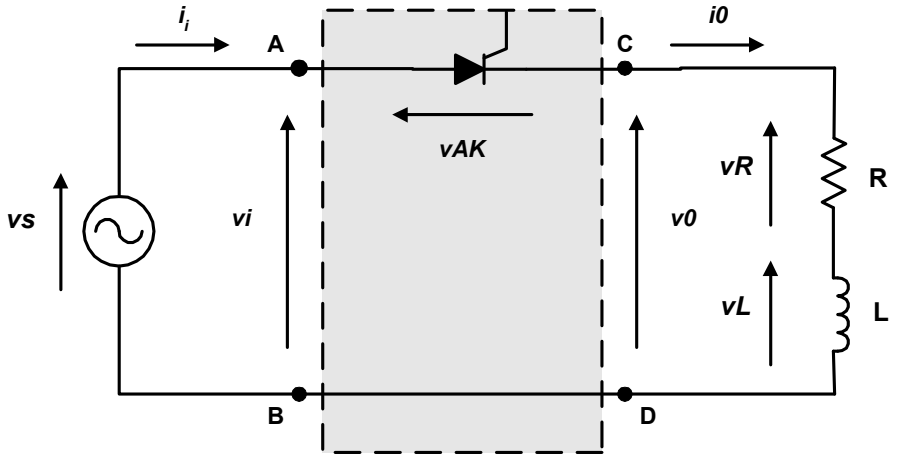
Tensão no SCR

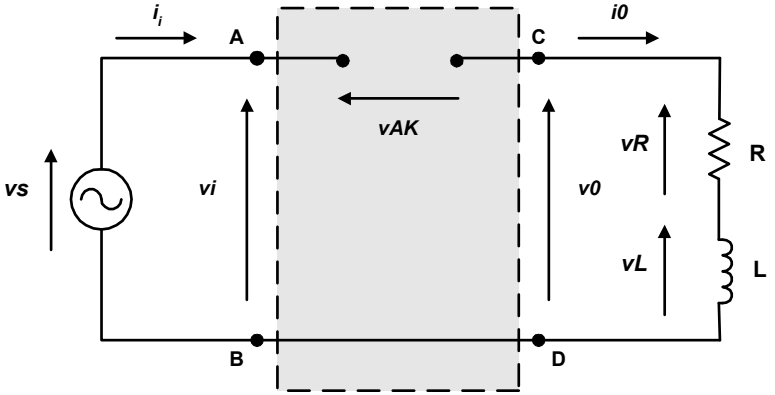


Potência na Fonte e na Carga

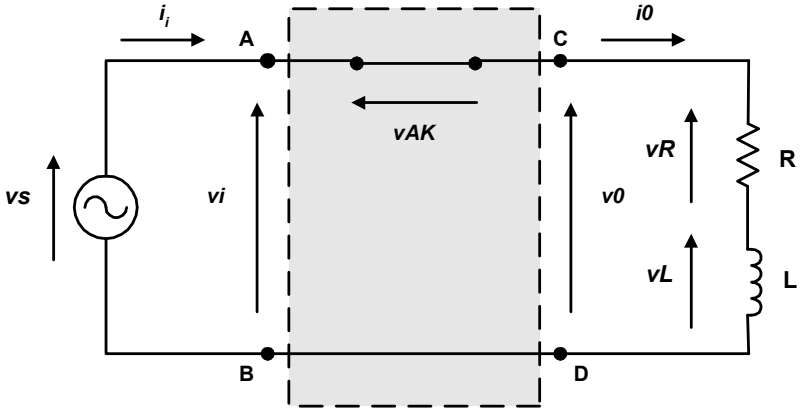


RETIFICADOR MONOFÁSICO DE MEIA-ONDA (CARGA INDUTIVA)



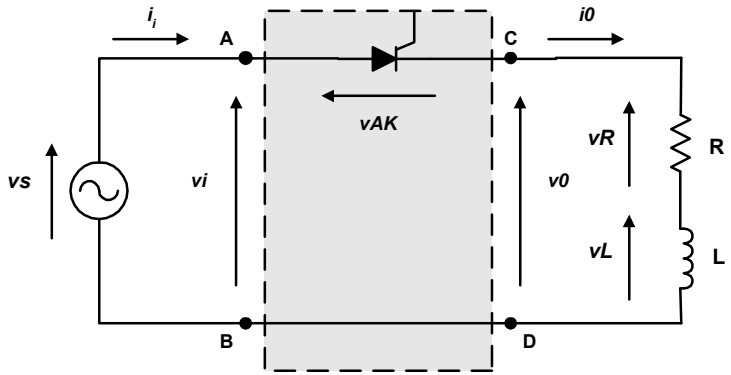


DIODO (OU SCR) EM BLOQUEIO

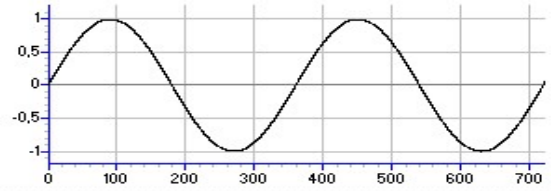


DIODO (OU SCR) EM CONDUÇÃO

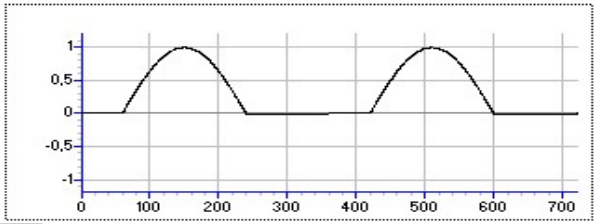
RETIFICADOR CONTROLADO COM CARGA INDUTIVA - FORMAS DE ONDA



Tensão da Fonte



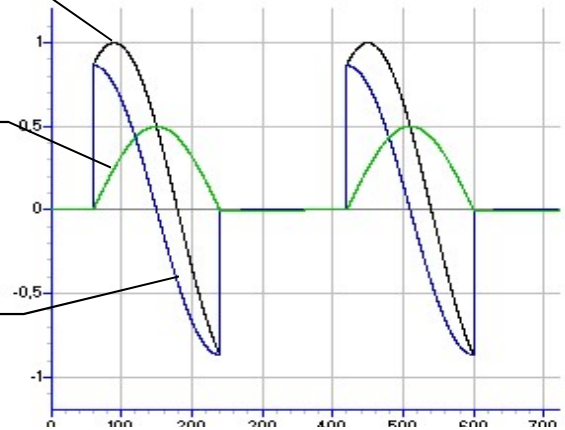
Corrente



Tensão de saída

Tensão em R

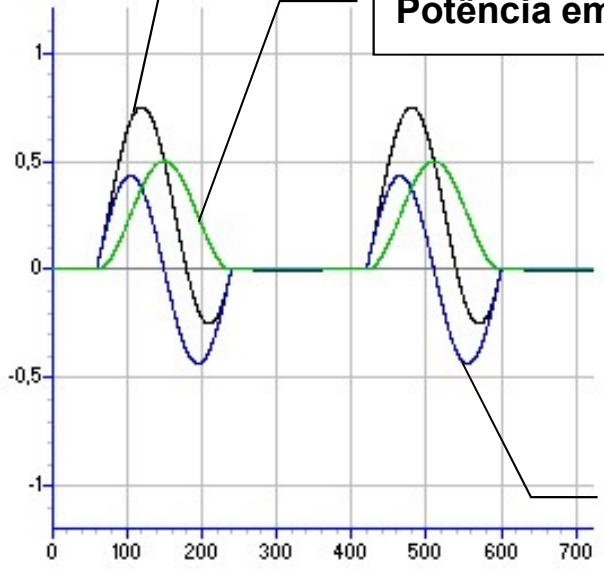
Tensão em L



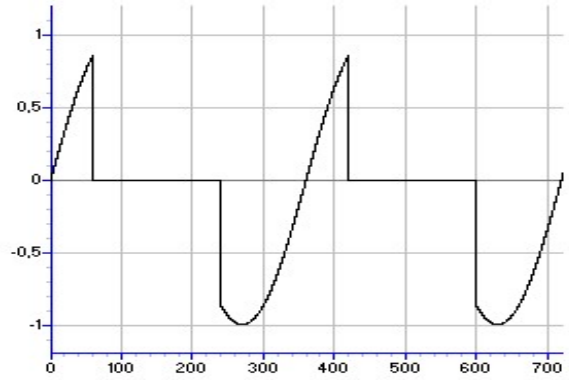
Potência na Fonte

Potência em R

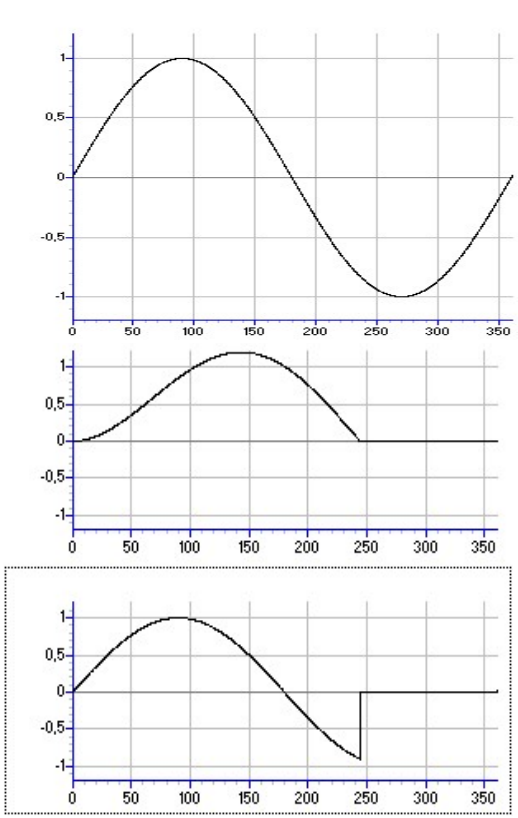
Potência em L



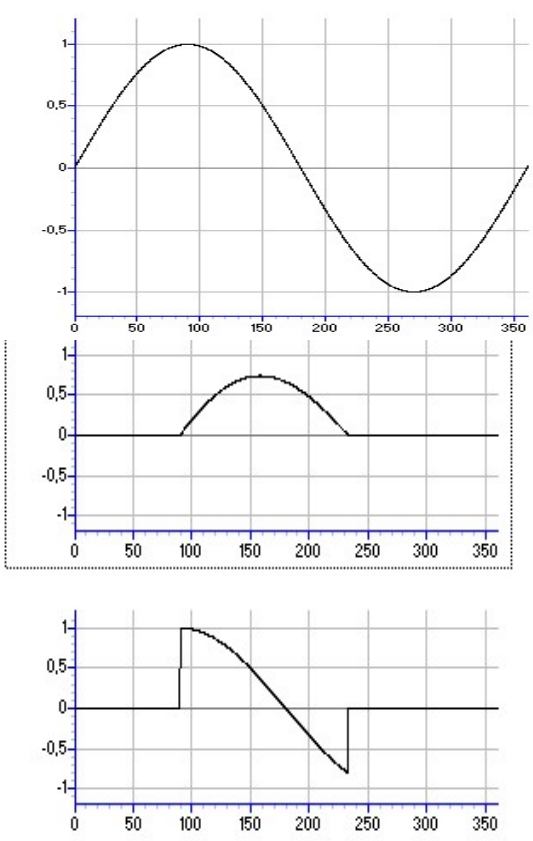
Tensão no SCR



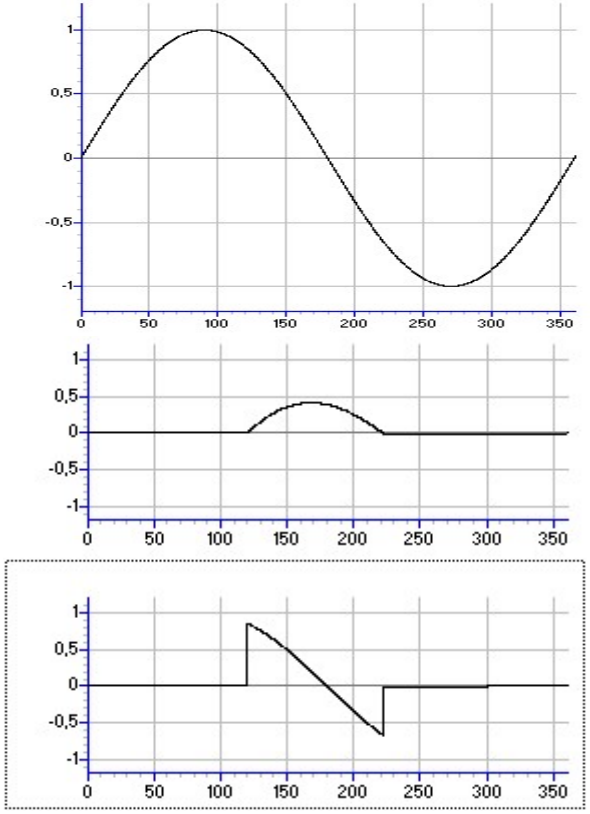
VARIAÇÕES DA CORRENTE E DA TENSÃO NA CARGA COM O ÂNGULO DE DISPARO



$\alpha = 0^0$



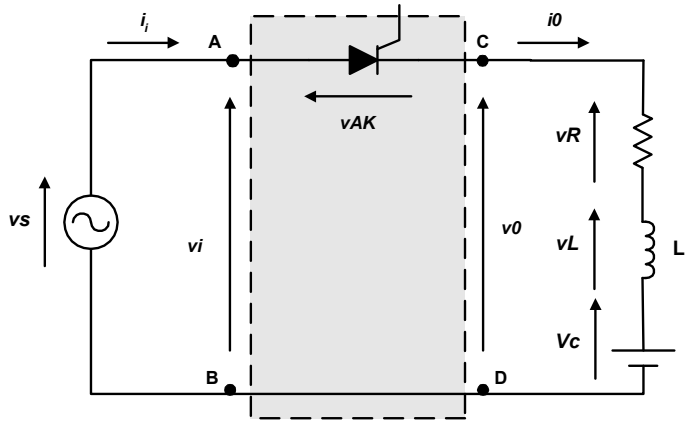
$\alpha = 90^0$

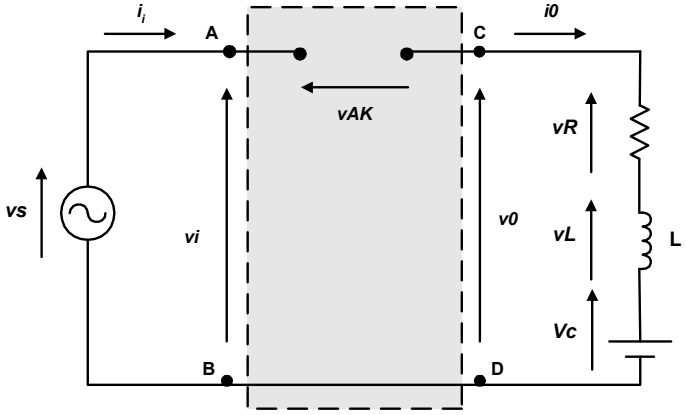


$\alpha = 120^0$

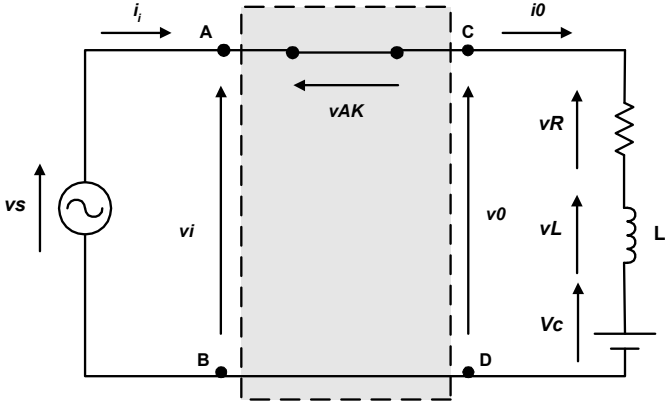
RETIFICADOR MONOFÁSICO DE MEIA-ONDA (CARGA COM FEM)

RETIFICADOR CONTROLADO



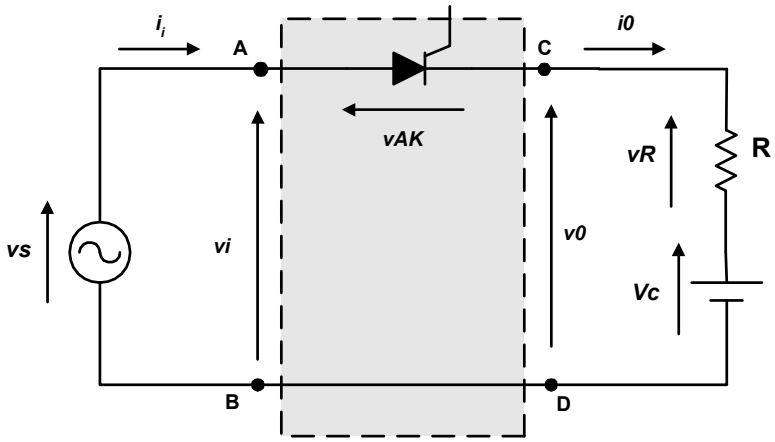


DIODO (OU SCR) NO CORTE

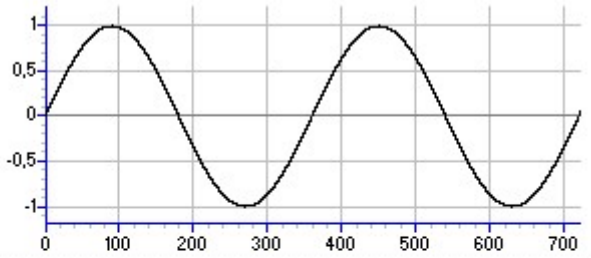


DIODO (OU SCR) EM CONDUÇÃO

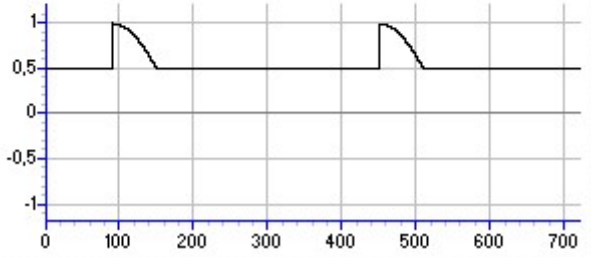
RETIFICADOR CONTROLADO – CARGA R-FEM
(FORMAS DE ONDA)



Tensão da Fonte



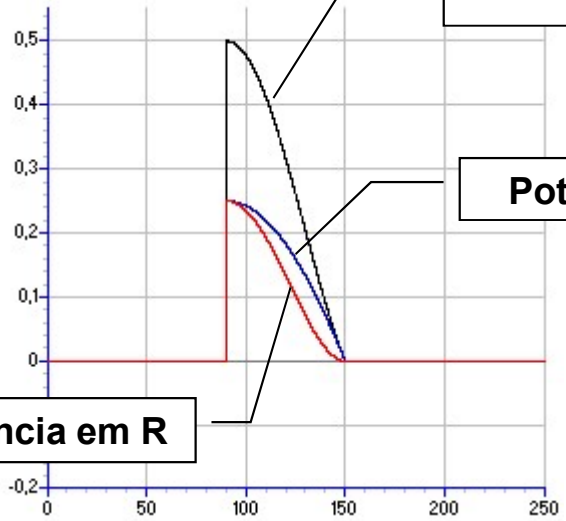
Tensão da Carga



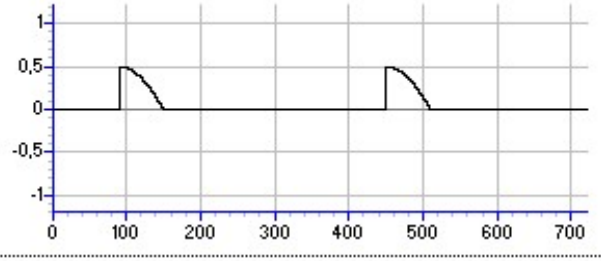
Potência de Saída

Potência em Vc

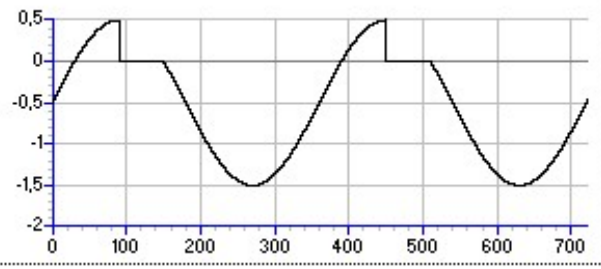
Potência em R



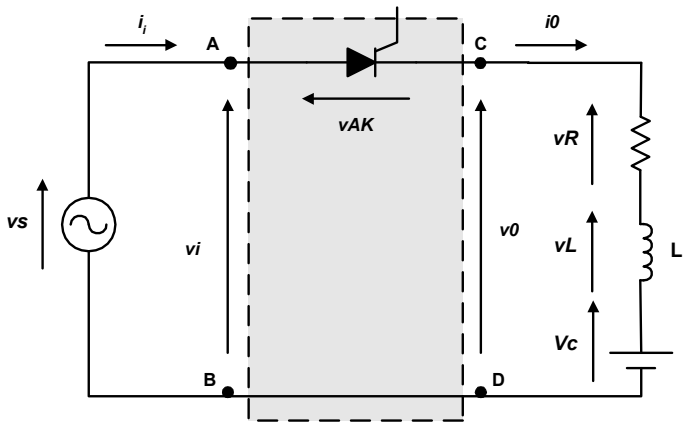
Corrente



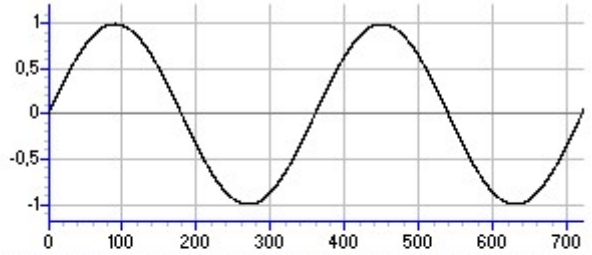
Tensão no SCR



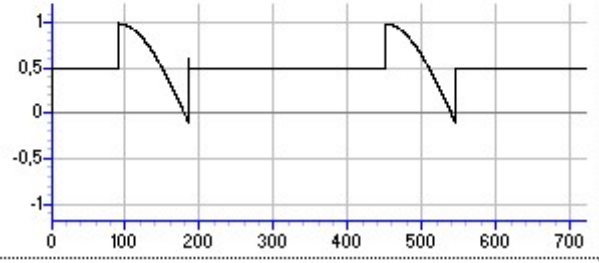
RETIFICADOR CONTROLADO – CARGA RL-FEM
(FORMAS DE ONDA)



Tensão da Fonte



Tensão da Carga

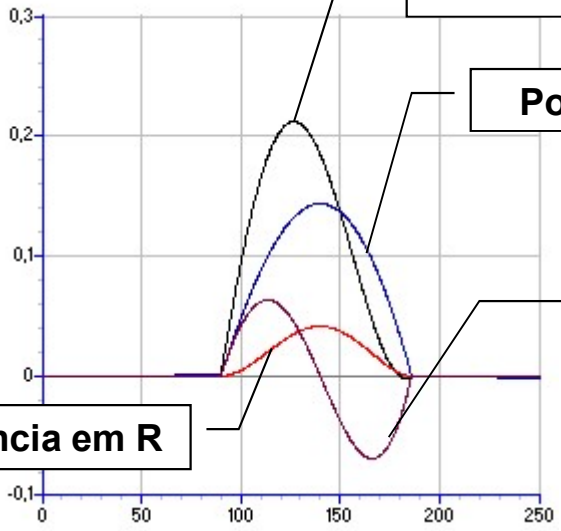


Potência de Saída

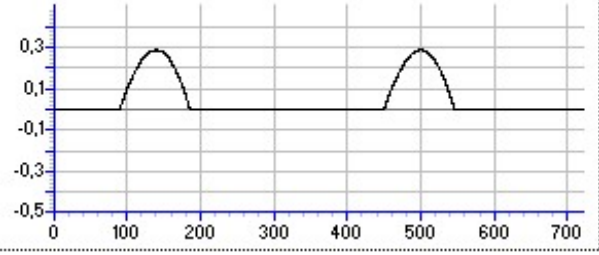
Potência em Vc

Potência em L

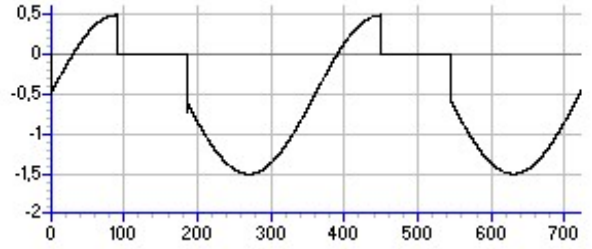
Potência em R



Corrente



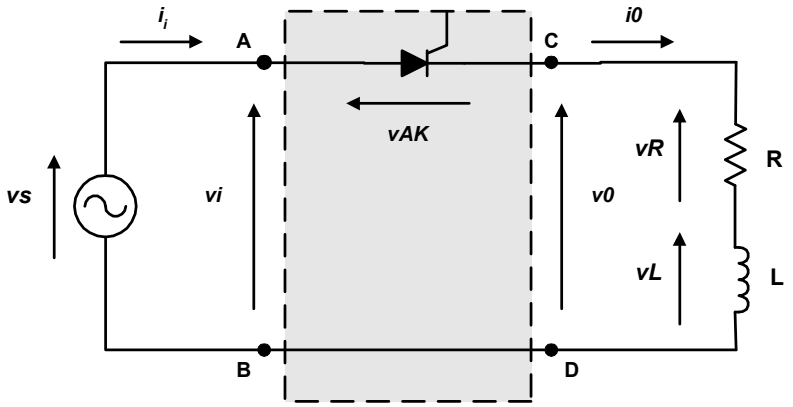
Tensão no SCR



Retificadores Monofásicos de Meia-Onda

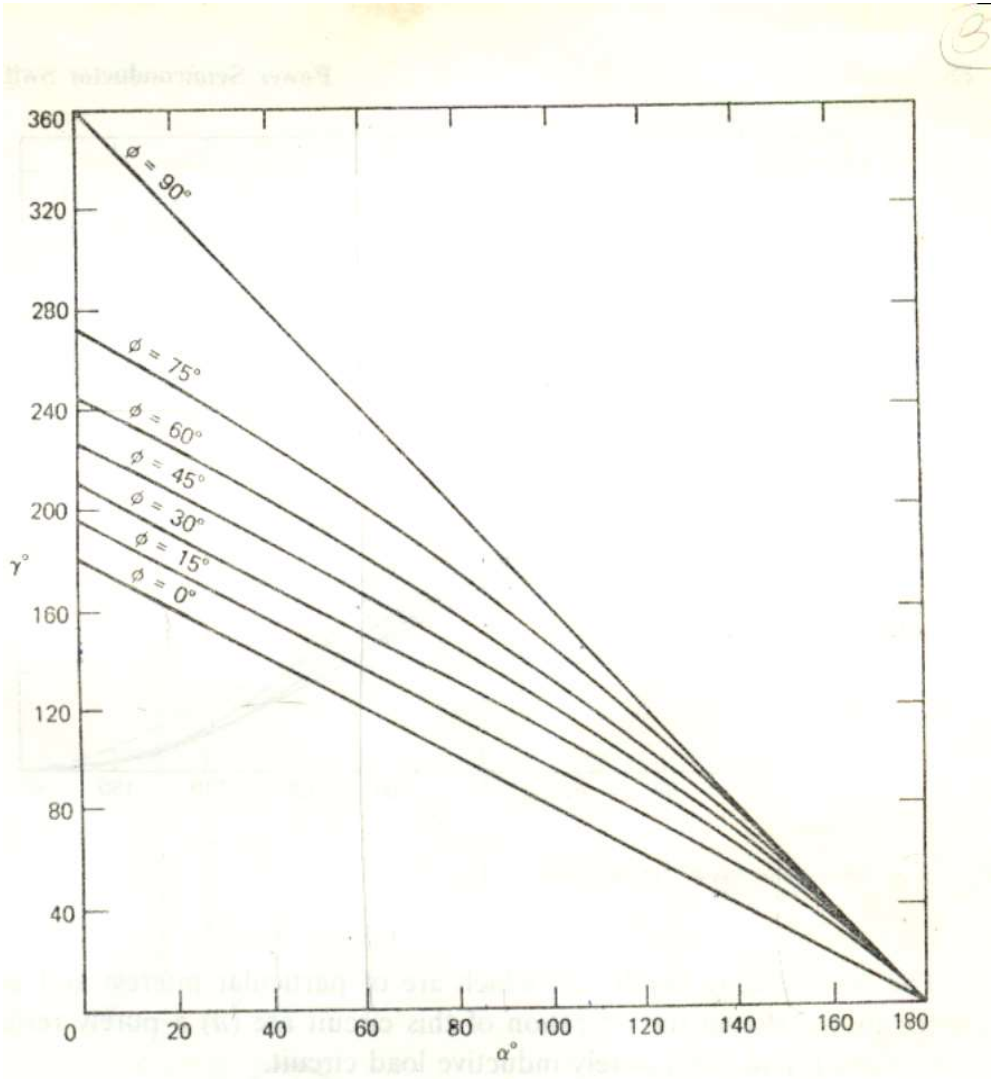
Curvas Teóricas

RETIFICADOR MONOFÁSICO DE MEIA-ONDA CONTROLADO
Ângulo de Condução – Carga RL

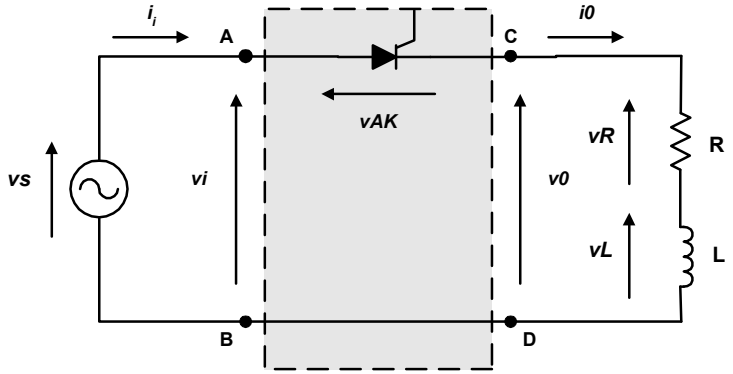


$$\text{sen}(\beta - \phi) = \text{sen}(\alpha - \phi).e^{[\alpha-\beta]/\tan\phi}$$

$$\gamma = \beta - \alpha$$



RETIFICADOR MONOFÁSICO DE MEIA-ONDA CONTROLADO
Corrente Média Normalizada – Carga RL

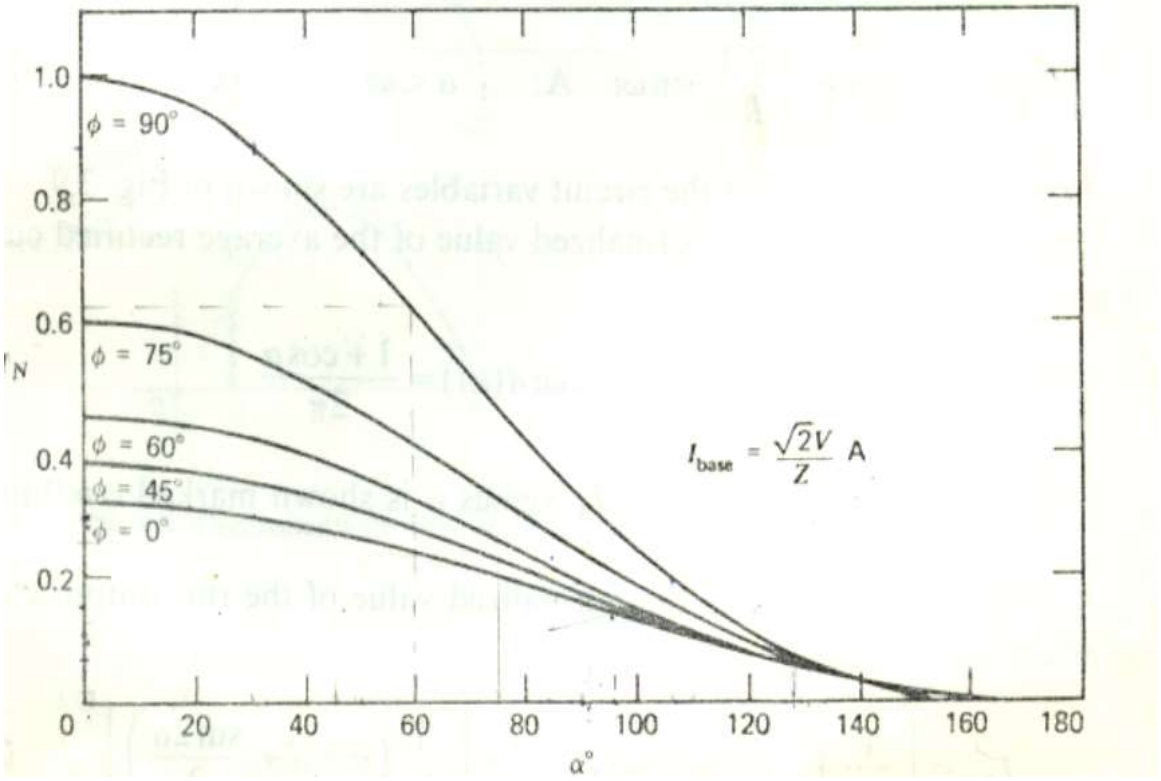


$$i_N = \text{sen}(\omega.t - \phi) - e^{(\alpha - \omega.t)/\tan\phi}.\text{sen}(\alpha - \phi)$$

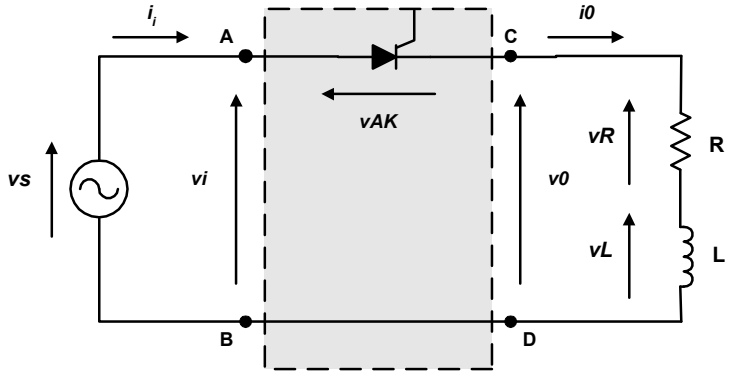
$$i_N = i(\omega.t) \Big/ I_{base} \quad ; \quad I_{base} = \sqrt{2}.V \Big/ Z$$

$$Z = \sqrt{R^2 + (\omega.L)^2} \quad ; \quad \phi = \arctan\left(\omega.L \Big/ R\right)$$

$$I_N = \frac{1}{2.\pi}\int_{\alpha}^{\beta=\gamma+\alpha} i_N .d\omega t$$



RETIFICADOR MONOFÁSICO DE MEIA-ONDA CONTROLADO
Corrente RMS Normalizada – Carga RL

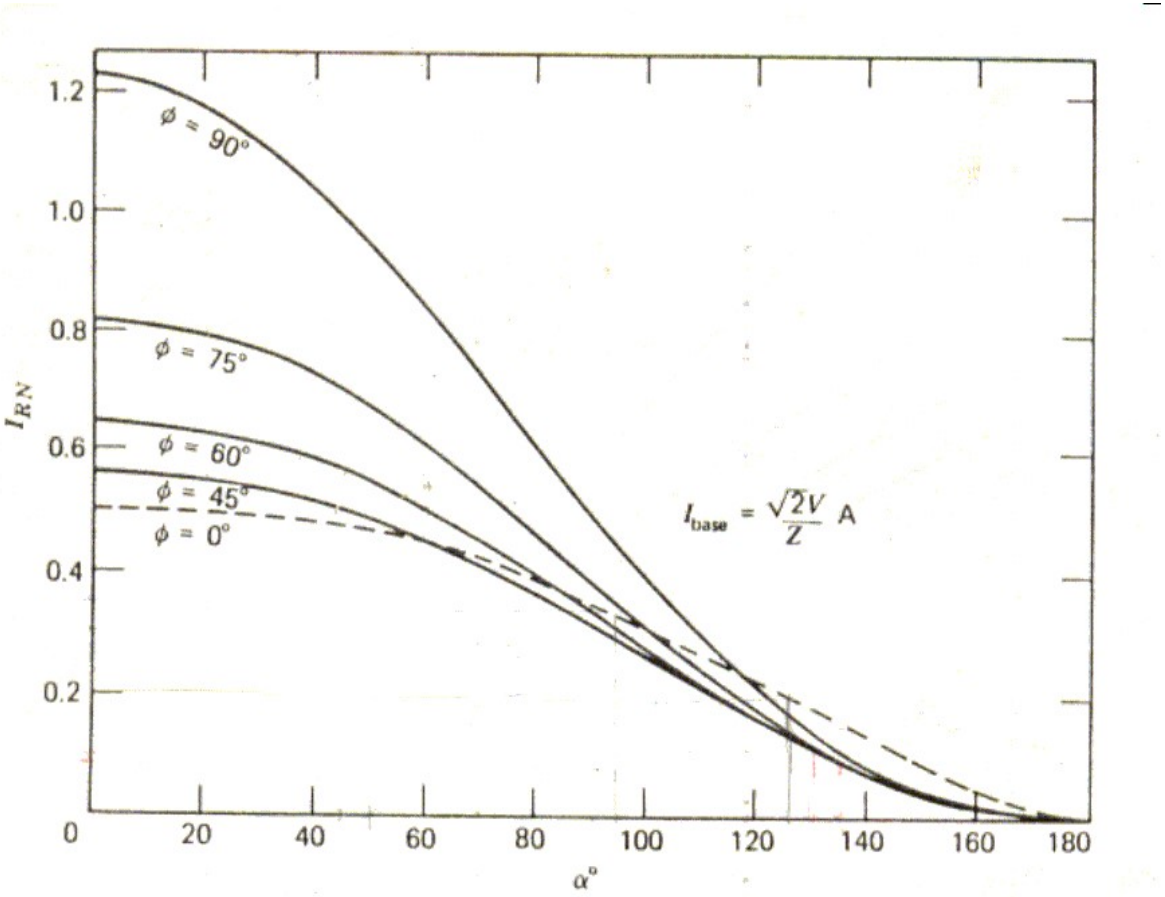


$$i_N = \text{sen}(\omega.t - \phi) - e^{(\alpha - \omega.t)/\tan\phi}.\text{sen}(\alpha - \phi)$$

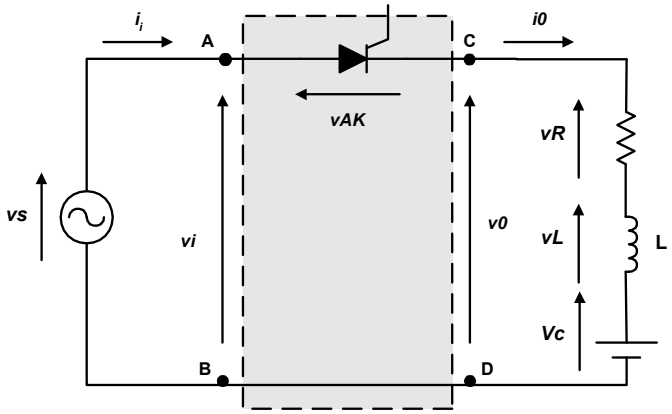
$$i_N = i(\omega.t)/I_{base} \quad ; \quad I_{base} = \sqrt{2}.V/Z$$

$$Z = \sqrt{R^2 + (\omega.L)^2} \quad ; \quad \phi = \arctan(\omega.L/R)$$

$$I_{RN} = \sqrt{\frac{1}{2.\pi}\int_{\alpha}^{\beta=\gamma+\alpha} i_N^2 .d\omega t}$$



RETIFICADOR MONOFÁSICO DE MEIA-ONDA CONTROLADO
Ângulo de Condução – Carga RL+fem

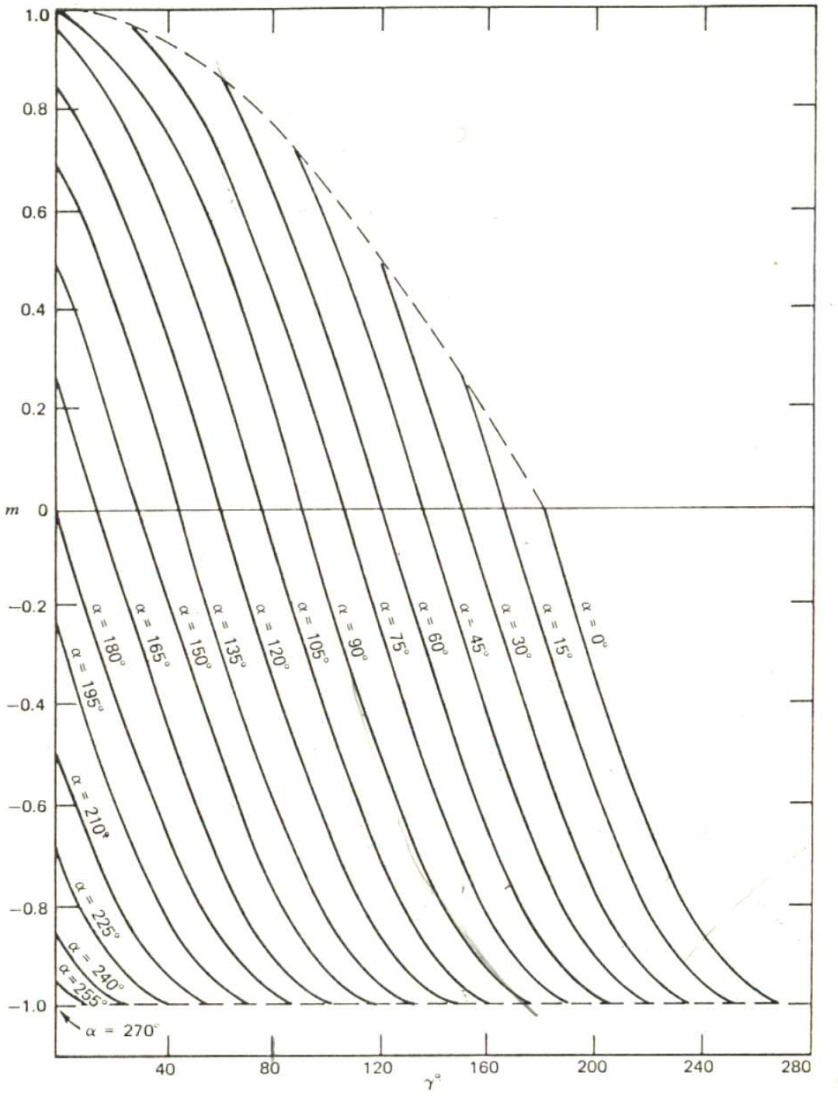


$$\frac{(m/\cos\phi)-\operatorname{sen}(\alpha+\gamma-\phi)}{(m/\cos\phi)-\operatorname{sen}(\alpha-\phi)} = e^{-\gamma/\tan\phi}$$

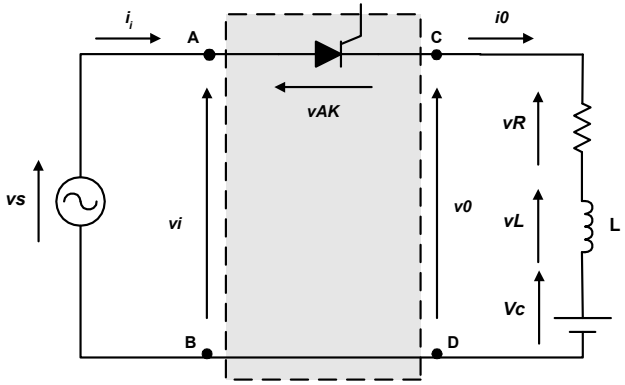
$$\gamma = \beta - \alpha$$

$$\eta = \operatorname{arcsen}(m) = \operatorname{arcsen}\left(V_c \Big/ \sqrt{2}.V\right)$$

$$\phi = 0^0$$



RETIFICADOR MONOFÁSICO DE MEIA-ONDA CONTROLADO
Corrente Média Normalizada – Carga RL+fem

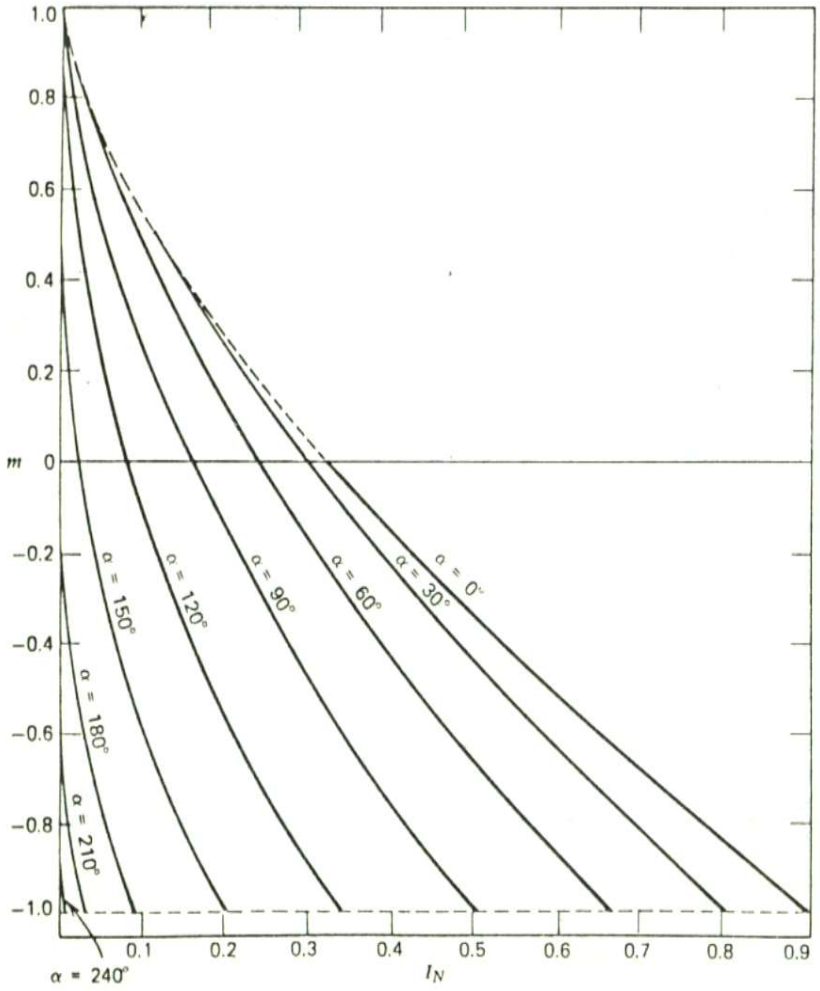


$$i_N = \operatorname{sen}(\omega.t - \phi) - \left[\frac{m}{\cos\phi} - B.e^{(\alpha - \omega.t)/\tan\phi} \right]$$

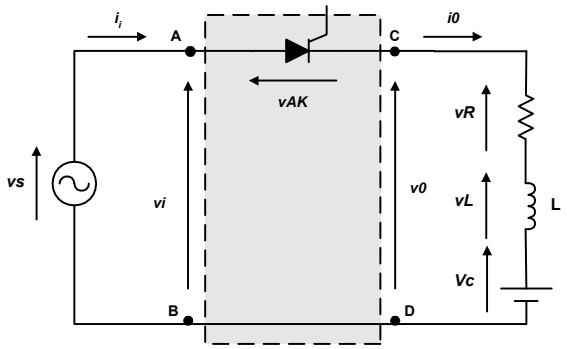
$$B = \left[\frac{m}{\cos\phi} - \operatorname{sen}(\alpha - \phi) \right]$$

$$i_N = {i(\omega.t)}/{I_{base}} \quad ; \quad I_{base} = {\sqrt{2}.V}/{Z}$$

$$I_{RN} = \frac{1}{2\pi} \int_{\alpha}^{\beta=\gamma+\alpha} i_N .d\omega t \quad ; \quad \phi = 0^0$$



RETIFICADOR MONOFÁSICO DE MEIA-ONDA CONTROLADO
Corrente RMS Normalizada – Carga RL+fem

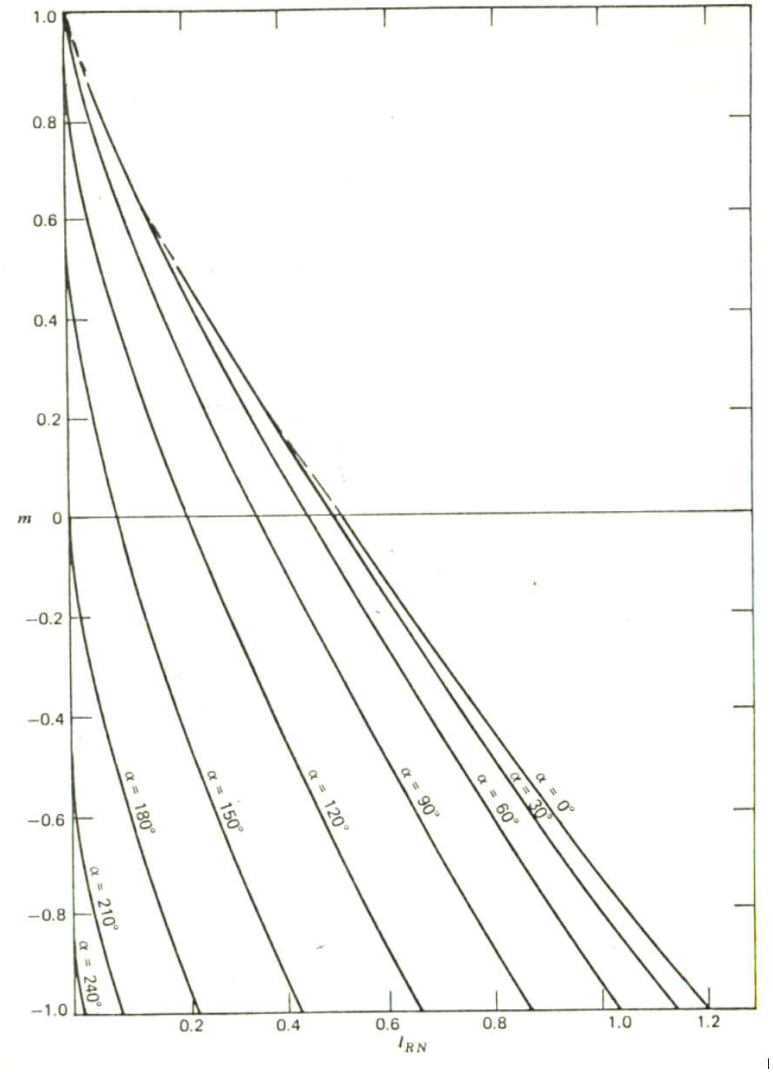


$$i_N = \operatorname{sen}(\omega.t - \phi) - \left[\frac{m}{\cos\phi} - B.e^{(\alpha - \omega.t)/\tan\phi} \right]$$

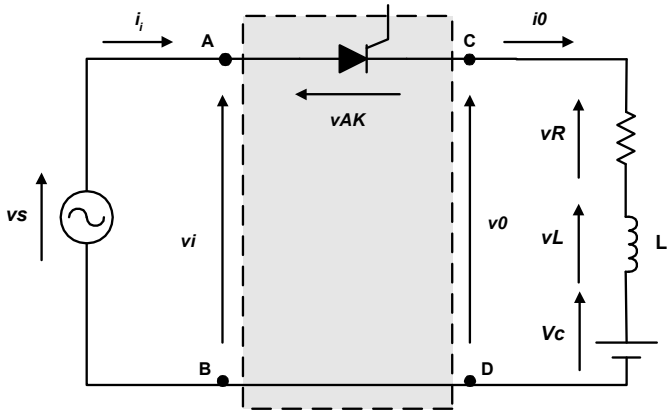
$$B = \left[\frac{m}{\cos\phi} - \operatorname{sen}(\alpha - \phi) \right]$$

$$i_N = {i(\omega.t)}/{I_{base}} \quad ; \quad I_{base} = {\sqrt{2}.V}/{Z}$$

$$I_{RN} = \sqrt{\frac{1}{2.\pi}\int_{\alpha}^{\beta=\gamma+\alpha} i_N^2 .d\omega t} \quad ; \quad \phi = 0^0$$



RETIFICADOR MONOFÁSICO DE MEIA-ONDA CONTROLADO
Ângulo de Condução – Carga RL+fem

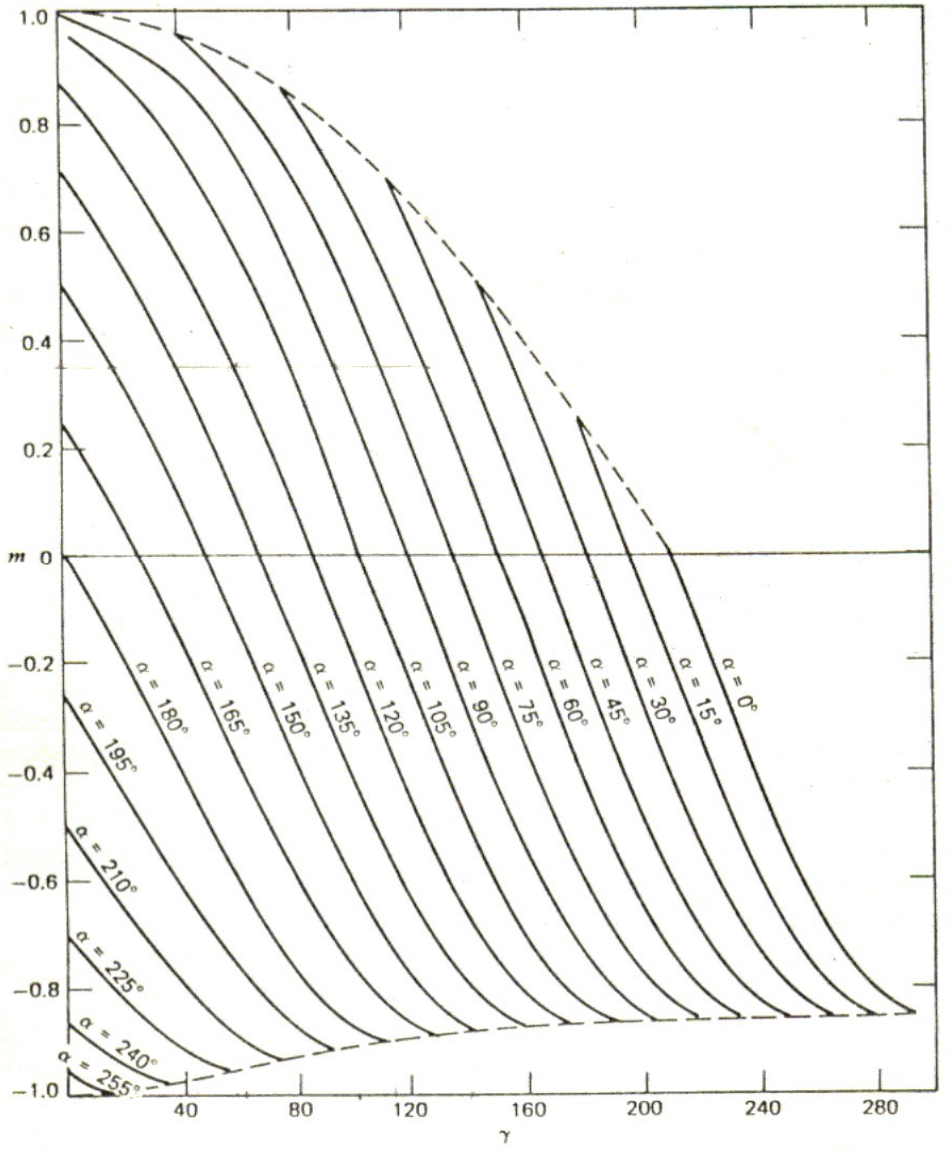


$$\frac{(m/\cos\phi)-\operatorname{sen}(\alpha+\gamma-\phi)}{(m/\cos\phi)-\operatorname{sen}(\alpha-\phi)}=e^{-\gamma/\tan\phi}$$

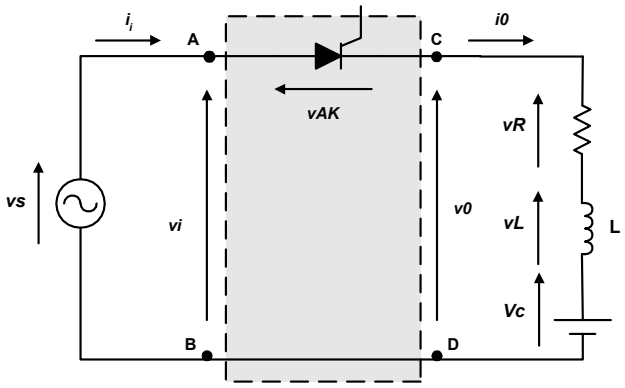
$$\gamma=\beta-\alpha$$

$$\eta=\operatorname{arcsen}(m)=\operatorname{arcsen}\left(V_c/\sqrt{2}.V\right)$$

$$\phi=30^0$$



RETIFICADOR MONOFÁSICO DE MEIA-ONDA CONTROLADO
Corrente Média Normalizada – Carga RL+fem

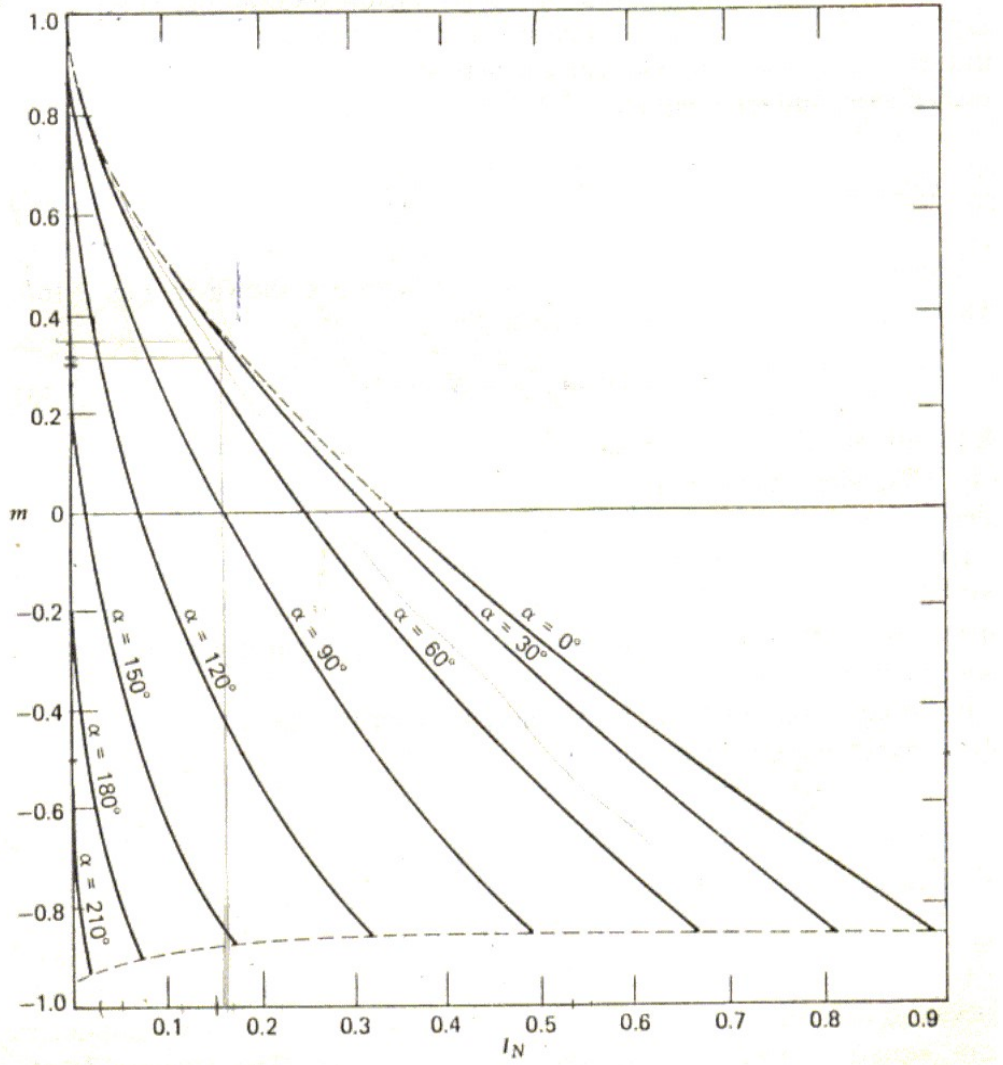


$$i_N = \operatorname{sen}(\omega.t - \phi) - \left[\frac{m}{\cos\phi} - B.e^{(\alpha - \omega.t)/\tan\phi} \right]$$

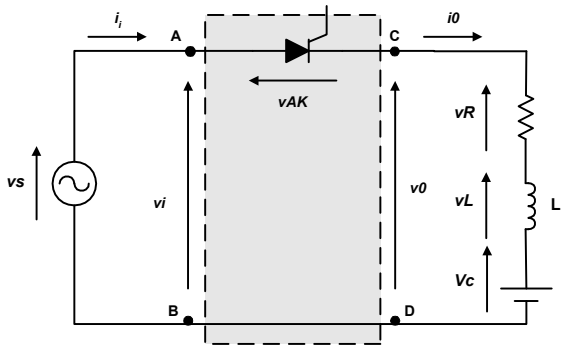
$$B = \left[\frac{m}{\cos\phi} - \operatorname{sen}(\alpha - \phi) \right]$$

$$i_N = {i(\omega.t)}/{I_{base}} \quad ; \quad I_{base} = {\sqrt{2}.V}/{Z}$$

$$I_{RN} = \frac{1}{2\pi} \int_{\alpha}^{\beta=\gamma+\alpha} i_N . d\omega t \quad ; \quad \phi = 30^0$$



RETIFICADOR MONOFÁSICO DE MEIA-ONDA CONTROLADO
Corrente RMS Normalizada – Carga RL+fem



$$i_N = \operatorname{sen}(\omega.t - \phi) - \left[\frac{m}{\cos\phi} - B.e^{(\alpha - \omega.t)/\tan\phi} \right]$$

$$B = \left[\frac{m}{\cos\phi} - \operatorname{sen}(\alpha - \phi) \right]$$

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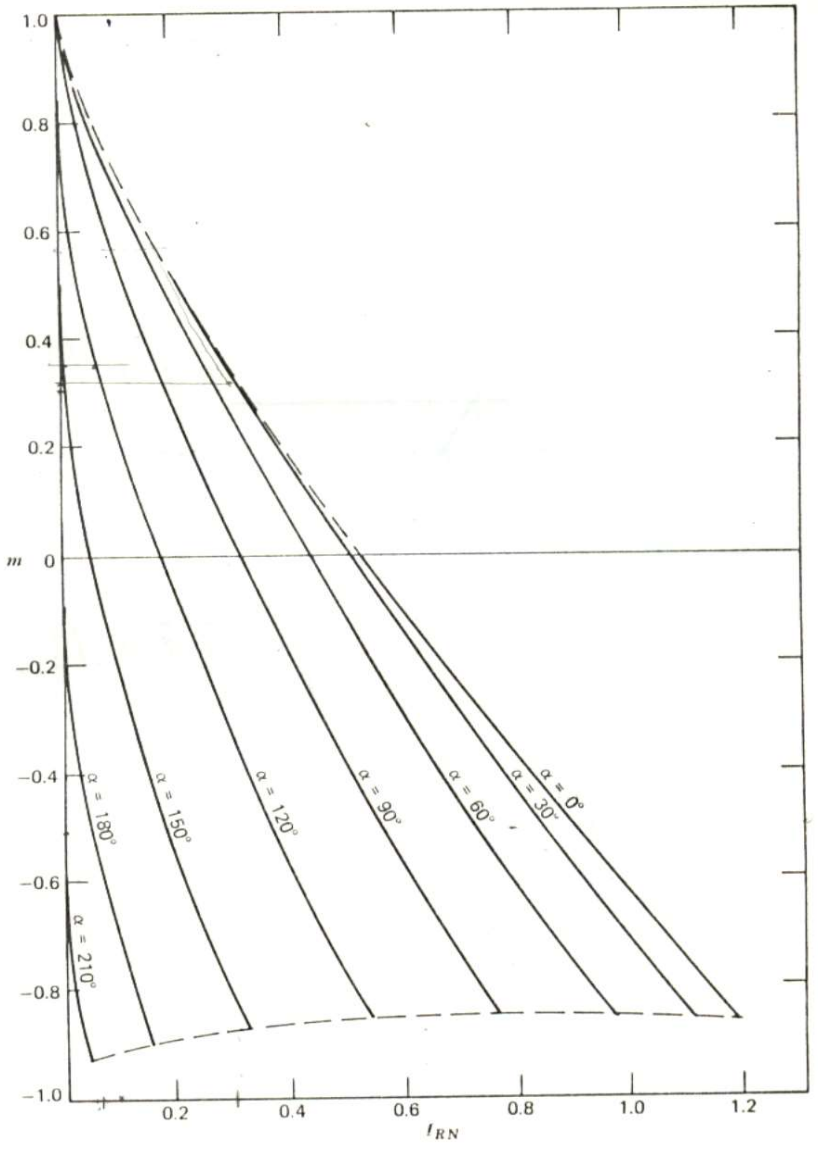
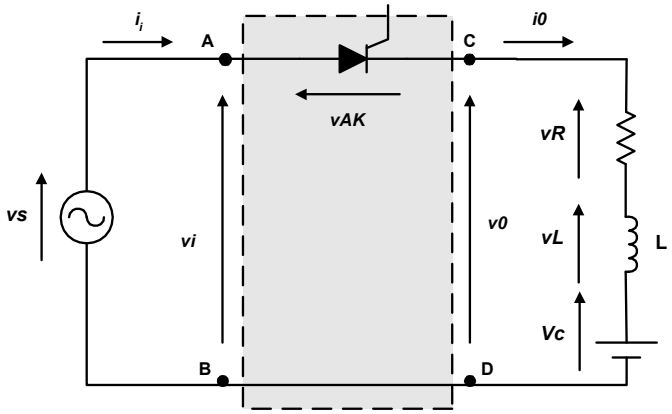
$$I_{RN} = \sqrt{\frac{1}{2.\pi}\int_{\alpha}^{\beta=\gamma+\alpha} i_N^2 .d\omega t} \quad ; \quad \phi = 30^0$$



RETIFICADOR MONOFÁSICO DE MEIA-ONDA CONTROLADO
Ângulo de Condução – Carga RL+fem

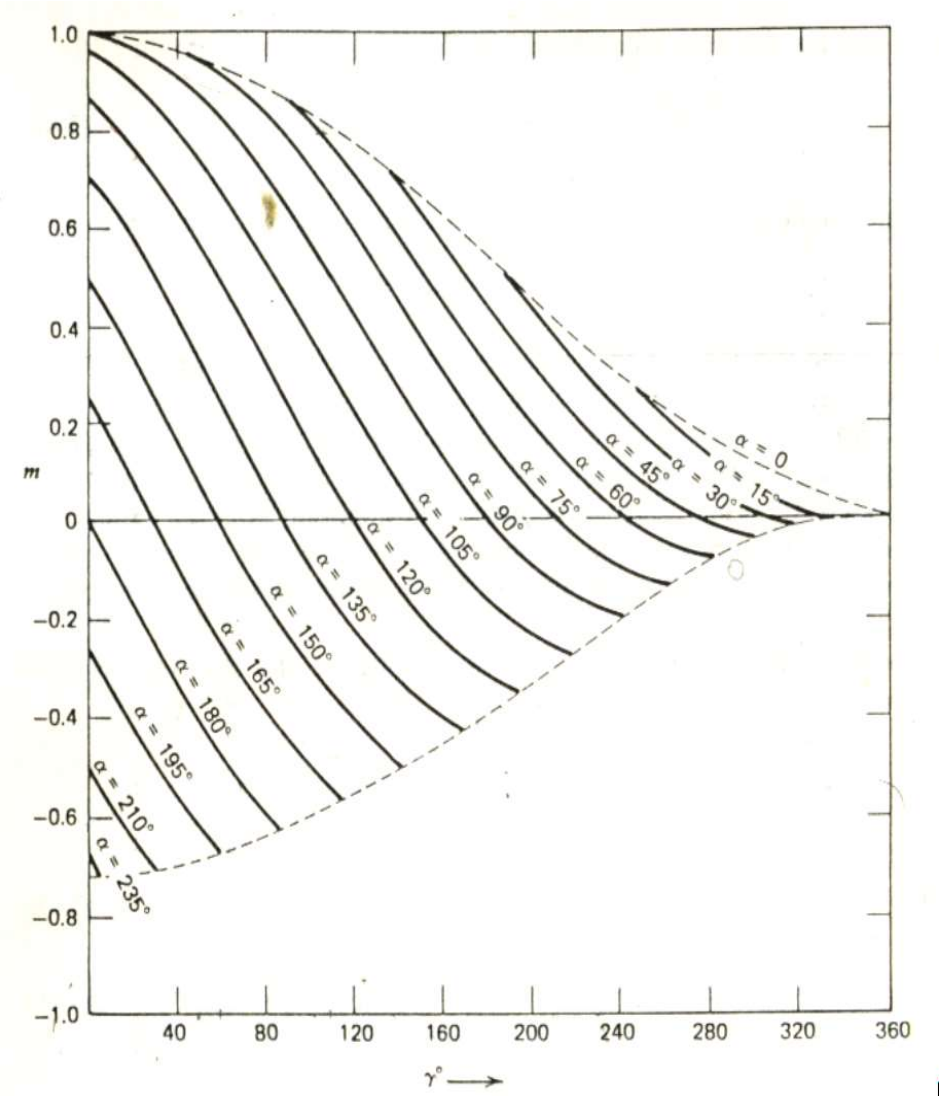


$$\frac{(m/\cos\phi)-\operatorname{sen}(\alpha+\gamma-\phi)}{(m/\cos\phi)-\operatorname{sen}(\alpha-\phi)}=e^{-\gamma/\tan\phi}$$

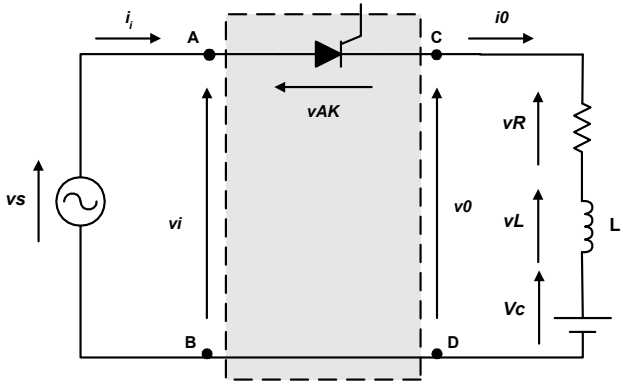
$$\gamma=\beta-\alpha$$

$$\eta=\operatorname{arcsen}(m)=\operatorname{arcsen}\left(V_c/\sqrt{2}.V\right)$$

$$\phi=90^0$$



RETIFICADOR MONOFÁSICO DE MEIA-ONDA CONTROLADO
Corrente Média Normalizada – Carga RL+fem

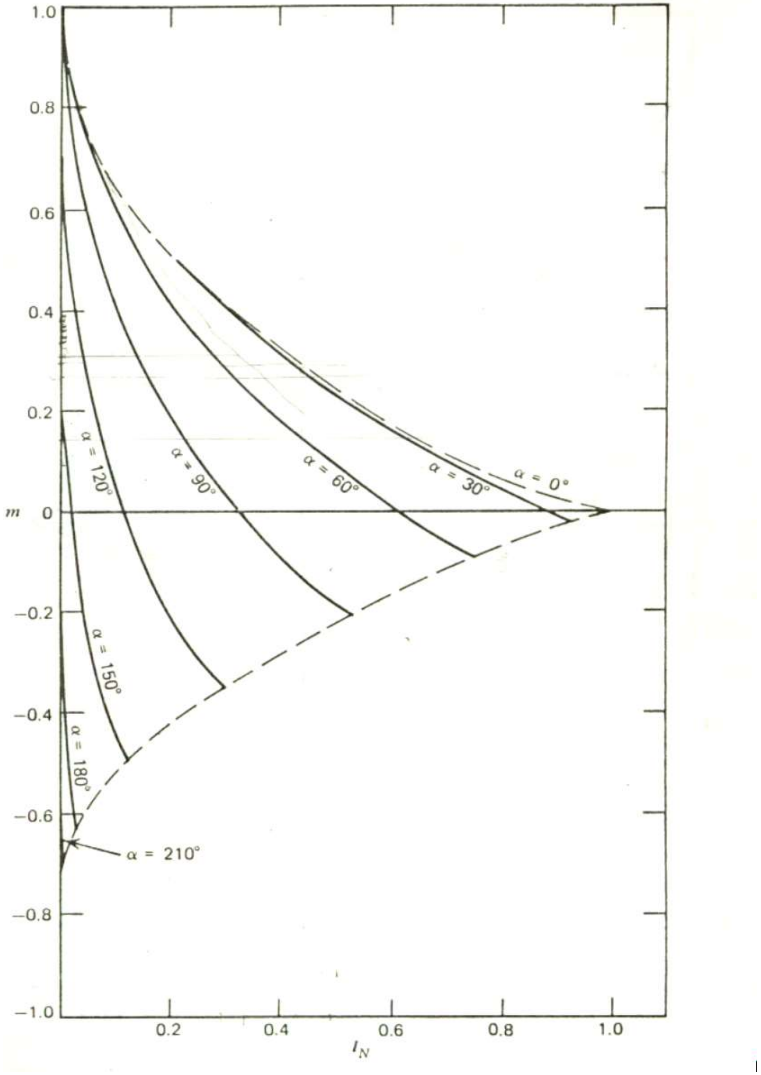


$$i_N = \operatorname{sen}(\omega.t - \phi) - \left[\frac{m}{\cos\phi} - B.e^{(\alpha - \omega.t)/\tan\phi} \right]$$

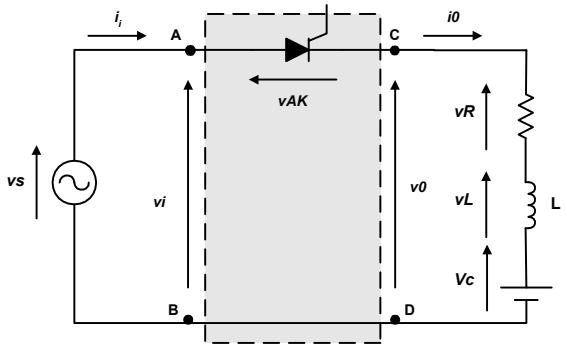
$$B = \left[\frac{m}{\cos\phi} - \operatorname{sen}(\alpha - \phi) \right]$$

$$i_N = {i(\omega.t)}/{I_{base}} \quad ; \quad I_{base} = {\sqrt{2}.V}/{Z}$$

$$I_{RN} = \frac{1}{2\pi} \int_{\alpha}^{\beta=\gamma+\alpha} i_N .d\omega t \quad ; \quad \phi = 90^0$$



RETIFICADOR MONOFÁSICO DE MEIA-ONDA CONTROLADO
Corrente RMS Normalizada – Carga RL+fem



$$i_N = \operatorname{sen}(\omega.t - \phi) - \left[\frac{m}{\cos\phi} - B.e^{(\alpha - \omega.t)/\tan\phi} \right]$$

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