

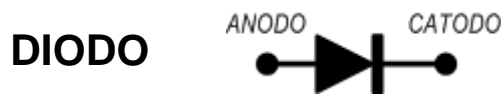
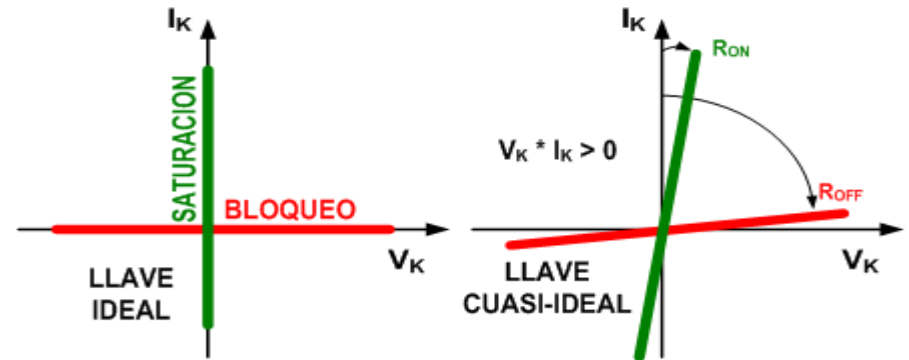
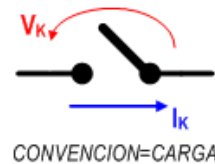


## RECTIFICADORES CONTROLADOS

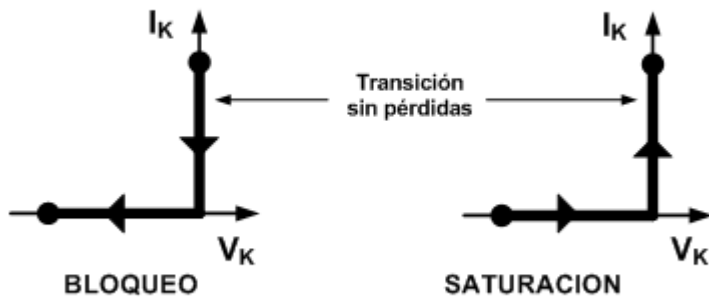
*Operación de Semiconductores en modo conmutación*

Diodo / SCR:

- Gran capacidad de sobrecarga de corriente
- Elevado MTBF
- Gran capacidad de bloqueo de tensión

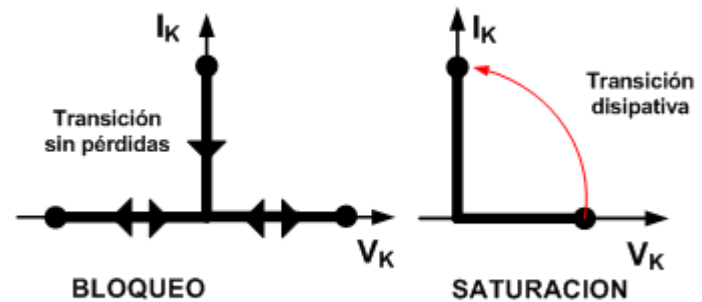


**CONMUTACION NATURAL (ESPONTANEA)**  
(Interruptores sin electrodo de comando)



PUNTOS DE FUNCIONAMIENTO ANTES Y DESPUES DE LA CONMUTACION SOBRE SEGMENTOS ORTOGONALES DE SIGNO CONTRARIO => TRANSICION NO DISIPATIVA

**CONMUTACION COMANDADA**  
(Interruptores con electrodo de comando)



PUNTOS DE FUNCIONAMIENTO ANTES Y DESPUES DE LA CONMUTACION SOBRE SEGMENTOS ORTOGONALES DEL MISMO SIGNO => TRANSICION DISIPATIVA

**Rectificadores Controlados a SCR**

[www3.fi.mdp.edu.ar/control403](http://www3.fi.mdp.edu.ar/control403)

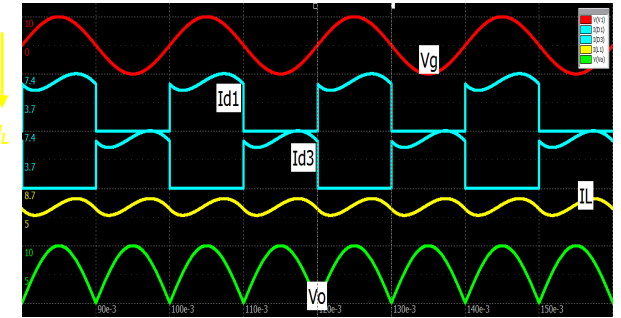
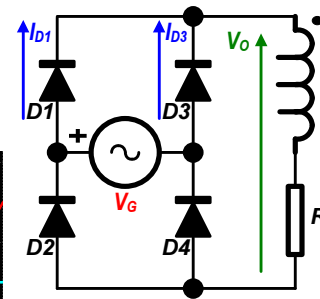
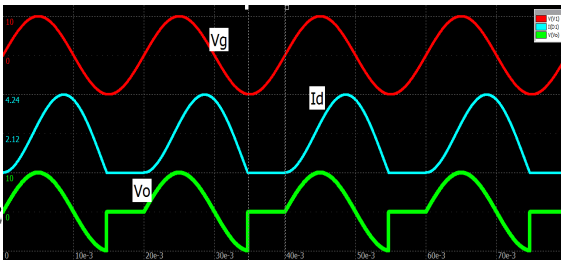
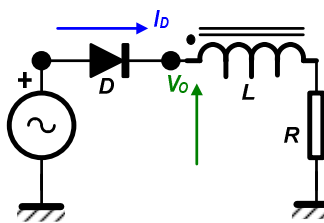
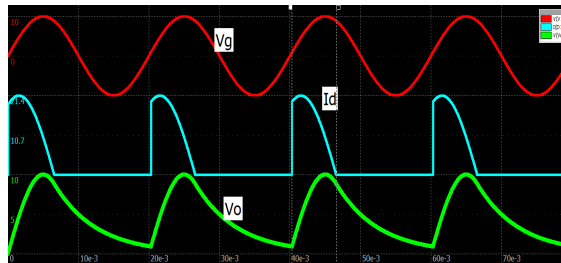
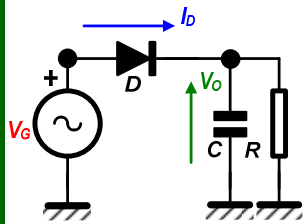
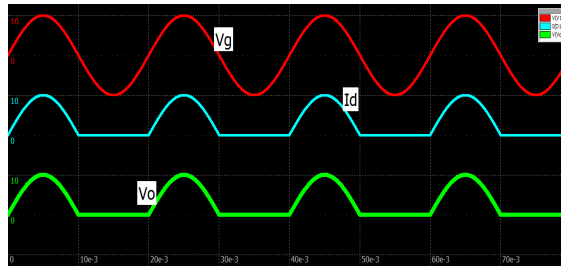
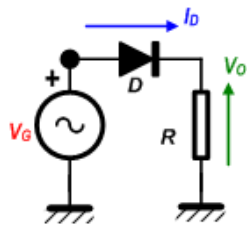




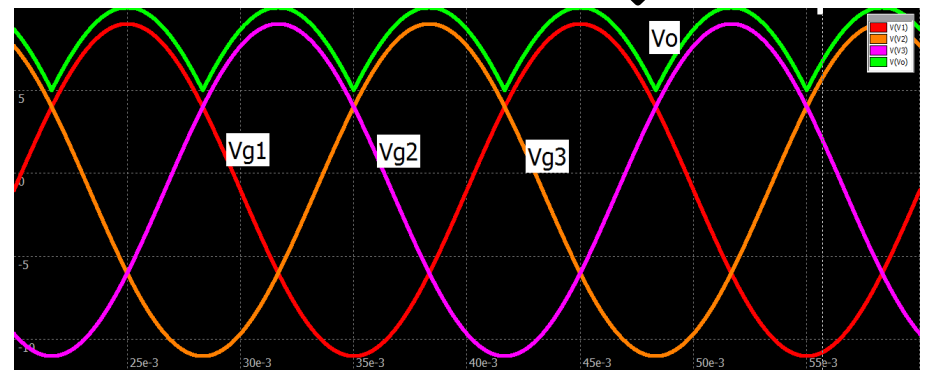
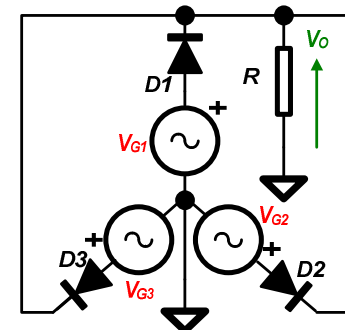
P=2 (dos pulsos por ciclo)

Rectificadores NO controlados

P=1 (un pulso por ciclo)

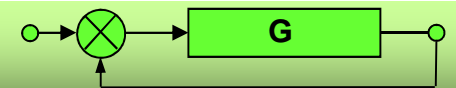


P=3 (tres pulsos por ciclo)



Rectificadores Controlados a SCR

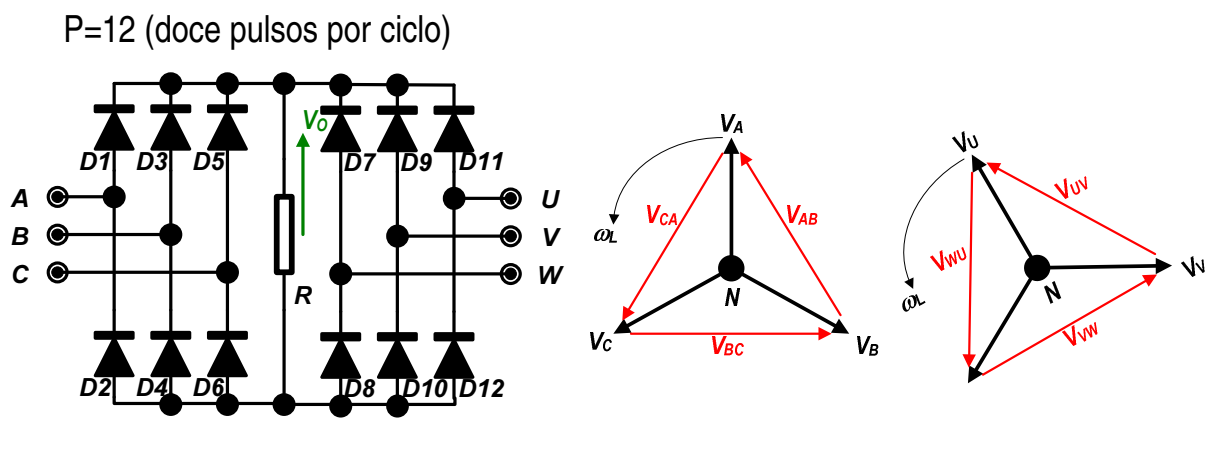
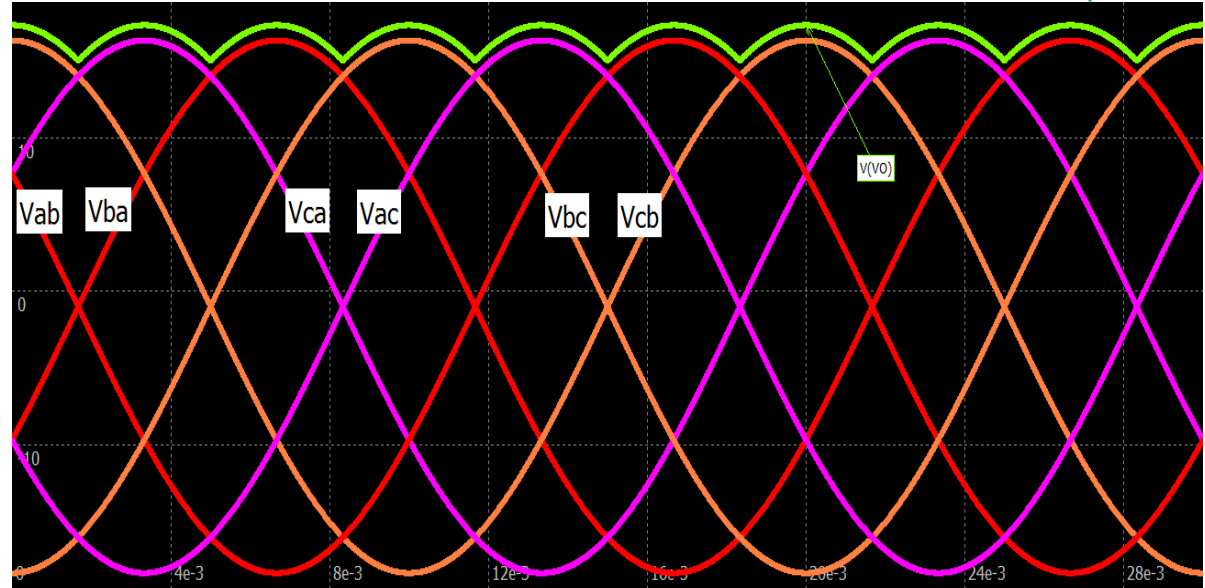
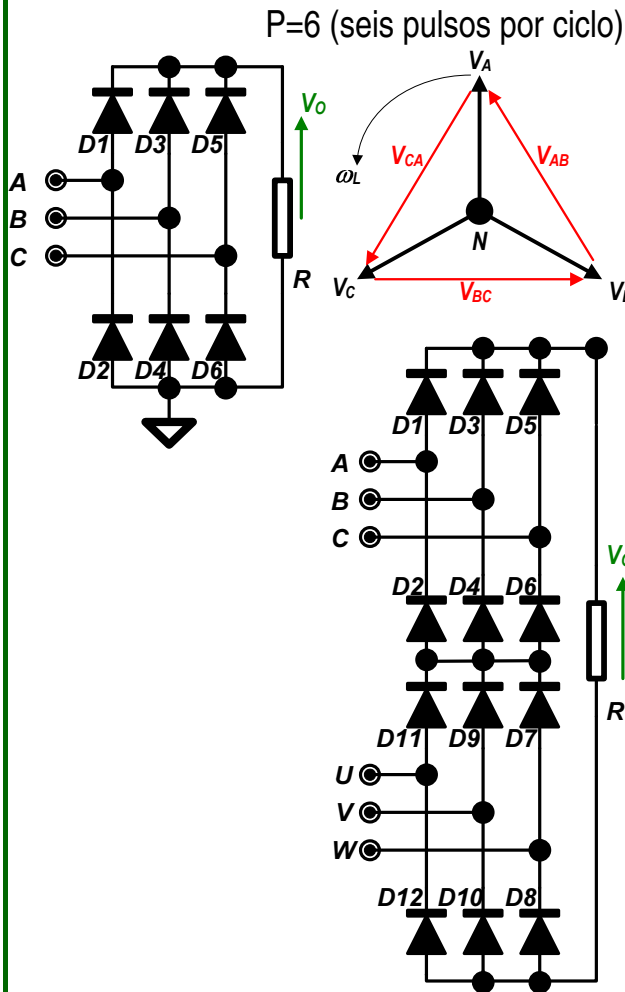
[www3.fi.mdp.edu.ar/control403](http://www3.fi.mdp.edu.ar/control403)



SISTEMAS DE CONTROL



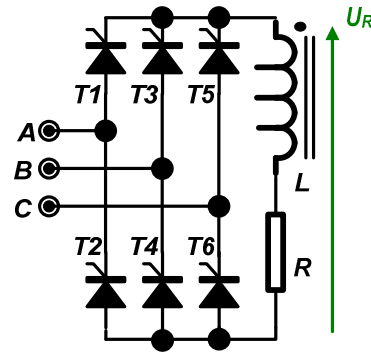
Rectificadores NO controlados



Rectificadores Controlados a SCR

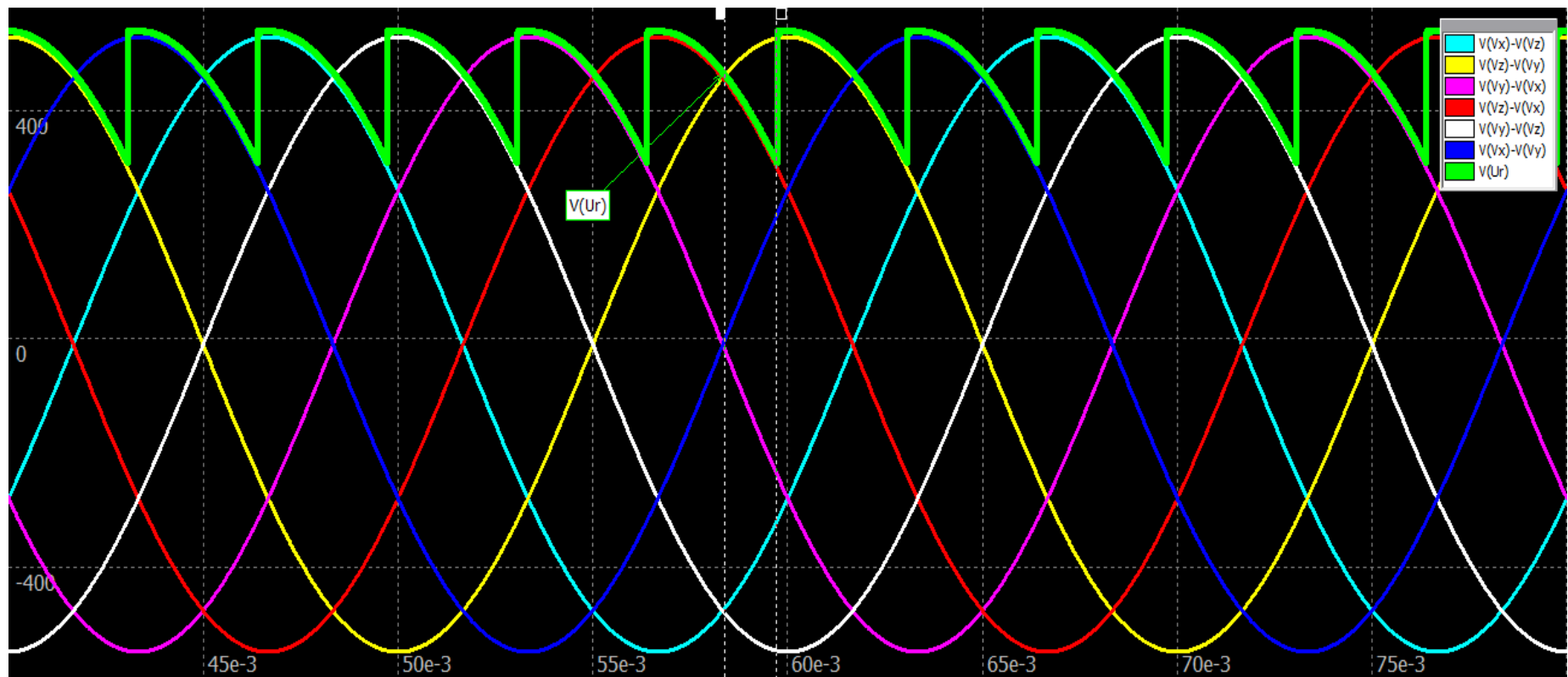
[www3.fi.mdp.edu.ar/control403](http://www3.fi.mdp.edu.ar/control403)





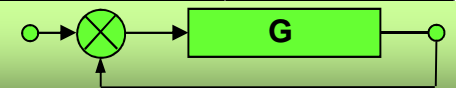
P=6 – Alpha=25

Cómo controlar el valor promedio de salida?

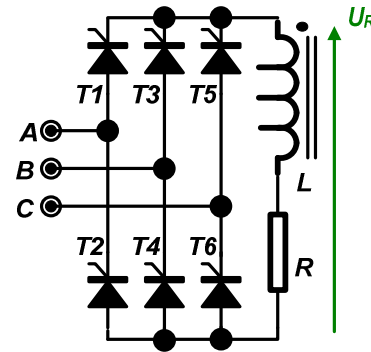


**Rectificadores Controlados a SCR**

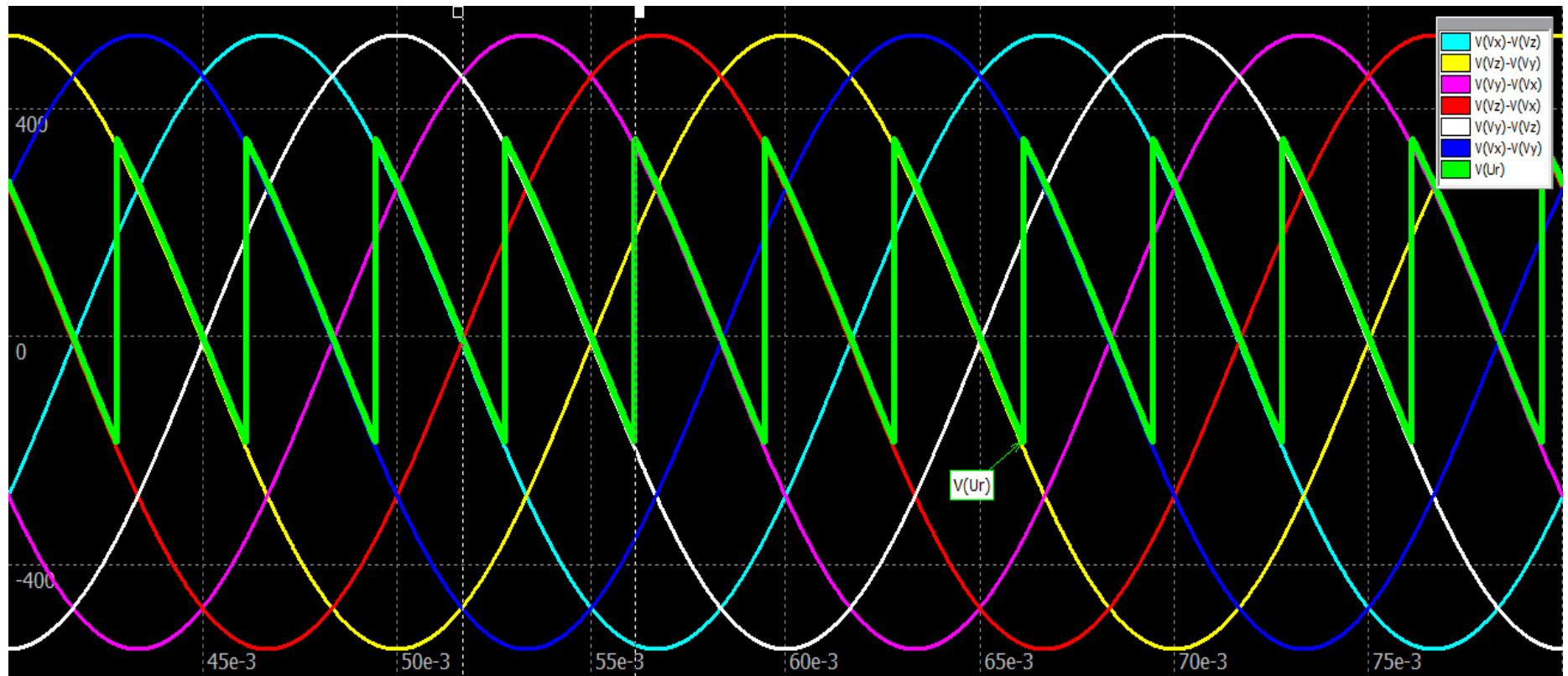
[www3.fi.mdp.edu.ar/control403](http://www3.fi.mdp.edu.ar/control403)



**SISTEMAS DE CONTROL**



P=6 - Alpha=80

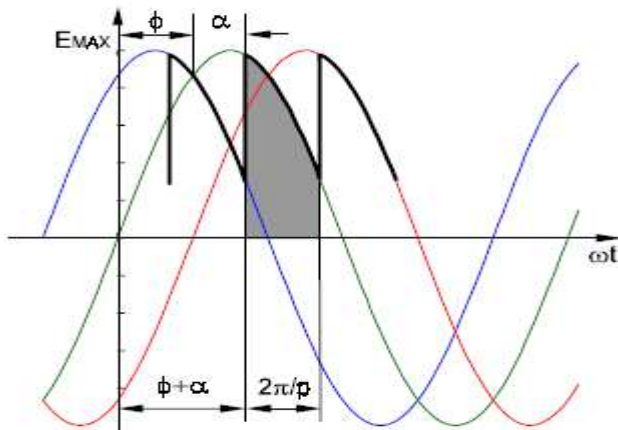
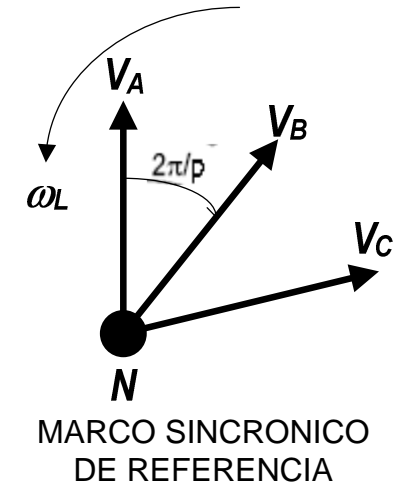
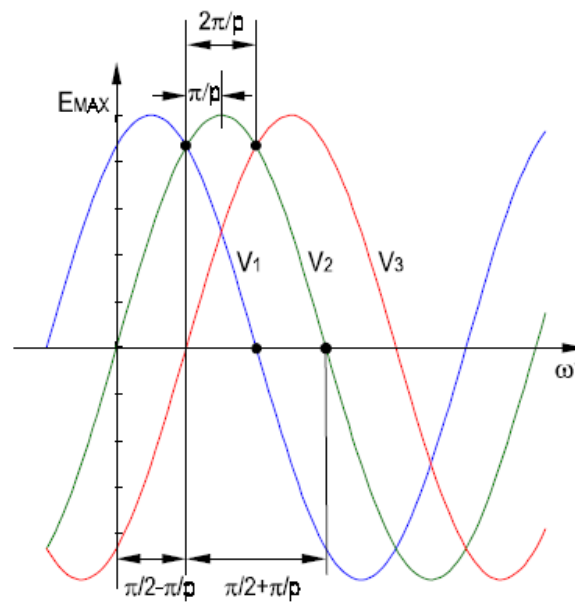
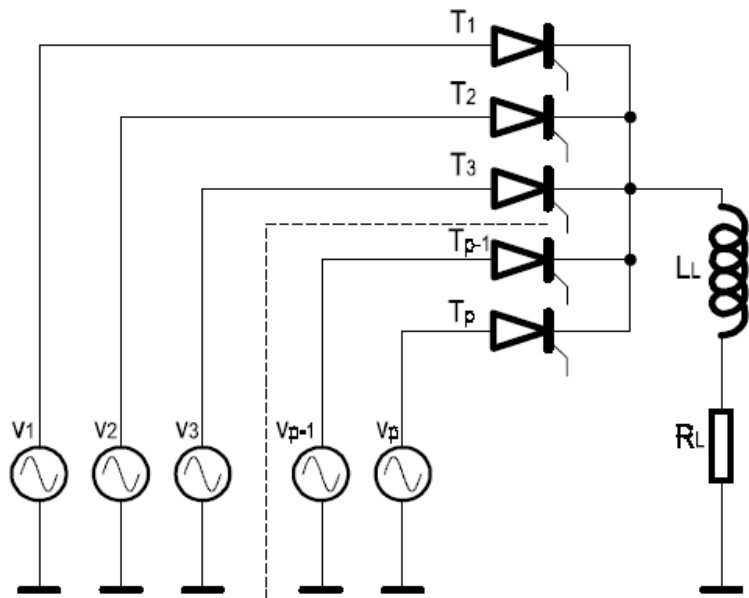


**Rectificadores Controlados a SCR**

[www3.fi.mdp.edu.ar/control403](http://www3.fi.mdp.edu.ar/control403)



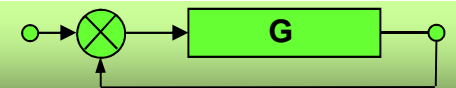
**SISTEMAS DE CONTROL**



$$E_D = \frac{p}{2\pi} \int_{\phi+\alpha}^{\phi+\alpha+2\pi/p} E_{MAX} \text{sen}(\omega t) d\omega t = \frac{p}{\pi} E_{MAX} \text{sen}\left(\frac{\pi}{p}\right) \cos(\alpha)$$

$$E_{D MAX} = E_{D0} = \frac{p}{\pi} E_{MAX} \text{sen}\left(\frac{\pi}{p}\right)$$

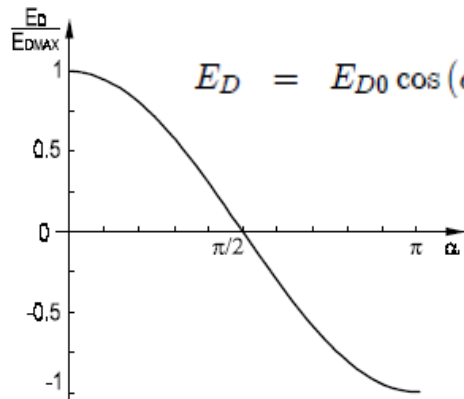
$$E_D = E_{D0} \cos(\alpha)$$



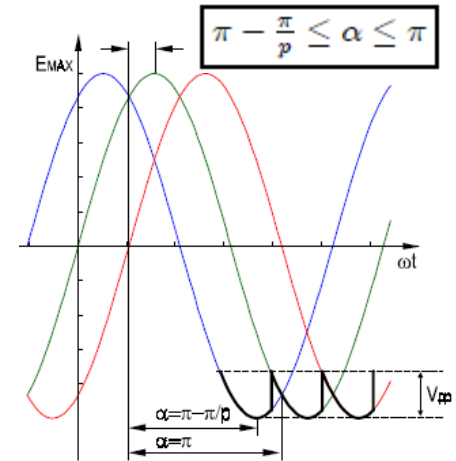
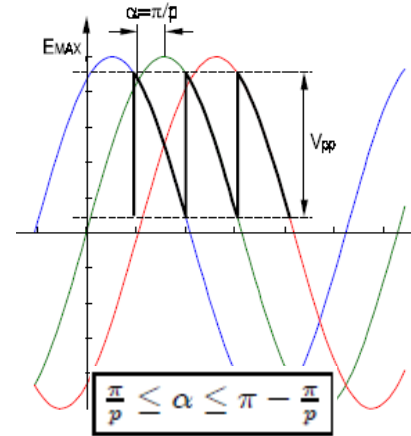
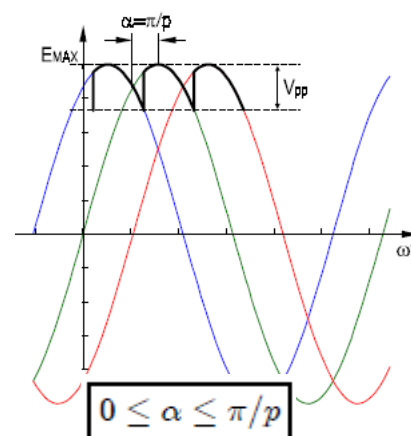




VALOR MEDIO EN CCM



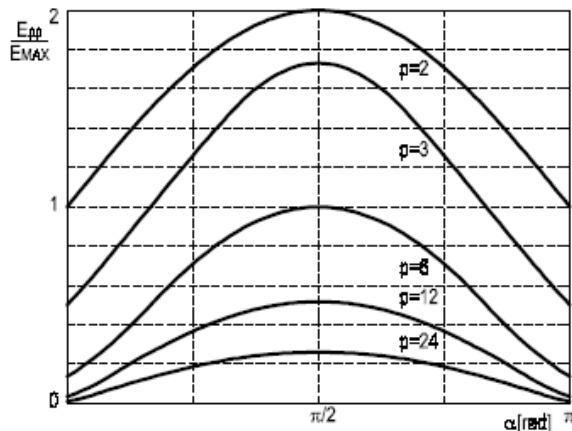
RIPPLE PP EN CCM



$$\frac{E_{pp}}{E_{MAX}} = 1 - \cos\left(\alpha + \frac{\pi}{p}\right)$$

$$\frac{E_{pp}}{E_{MAX}} = 2 \operatorname{sen}\left(\frac{\pi}{p}\right) \operatorname{sen}(\alpha)$$

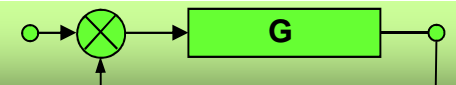
RIPPLE PP EN CCM



El valor máximo de ripple en modo CCM se obtiene para  $\alpha = 90^\circ$  que corresponde con el caso 2. Su valor resulta:

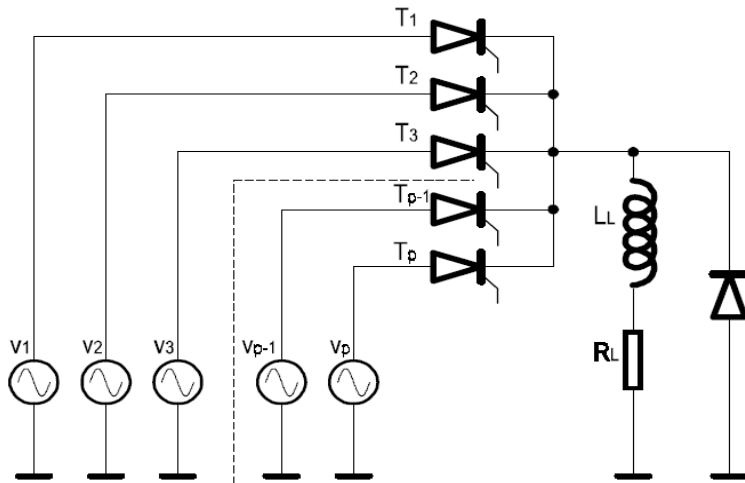
$$\left. \frac{E_{pp}}{E_{MAX}} \right|_{MAX} = 2 \operatorname{sen}\left(\frac{\pi}{p}\right) = K \quad (4.25)$$

- $K = 1.73$  para  $p = 3$
- $K = 1$  para  $p = 6$
- $K = 0.52$  para  $p = 12$





RECTIFICADOR CON  
DIODO DE RUEDA LIBRE  
EN CCM

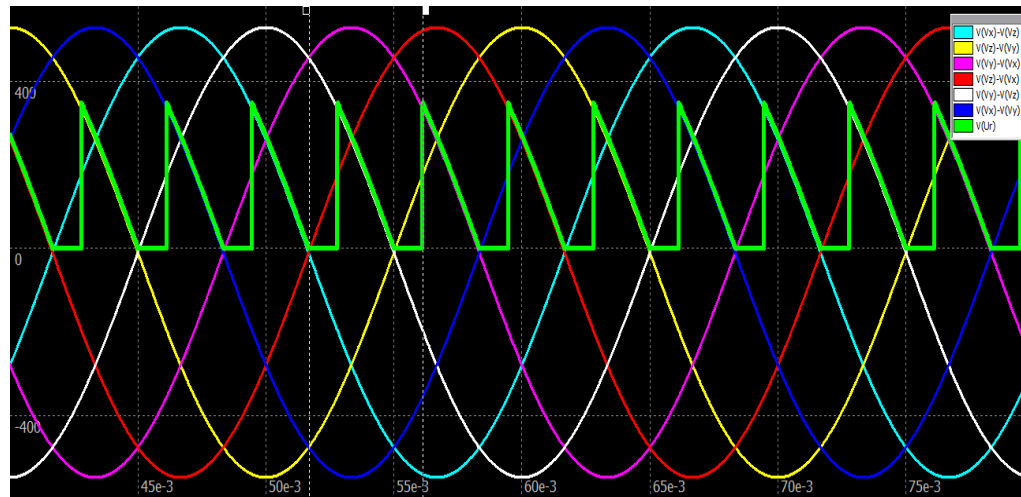


$$0 \leq \alpha \leq \pi/2 - \pi/p$$

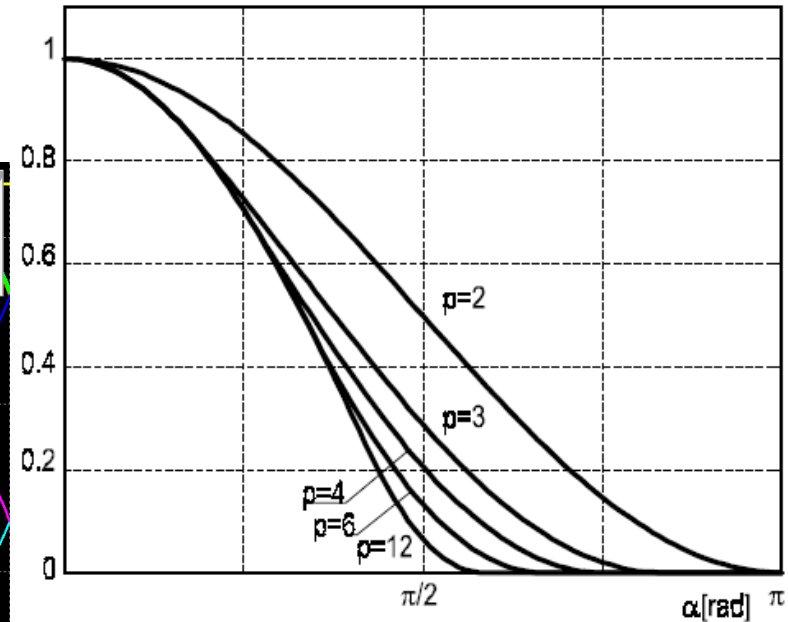
$$\pi/2 - \pi/p \leq \alpha \leq \pi/2 + \pi/p$$

$$E_D = E_{D0} \cos(\alpha)$$

$$\frac{E_D}{E_{D0}} = \frac{1 - \sin\left(\alpha - \frac{\pi}{p}\right)}{2 \sin\left(\frac{\pi}{p}\right)}$$



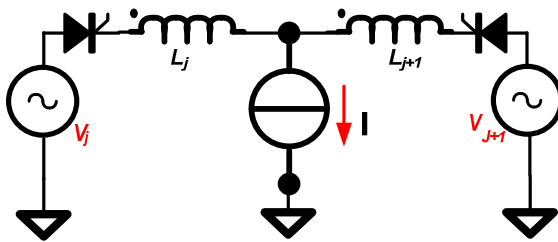
TENSION RECTIFICADA PROMEDIO EN  
CCM C/DIODO DE RUEDA LIBRE



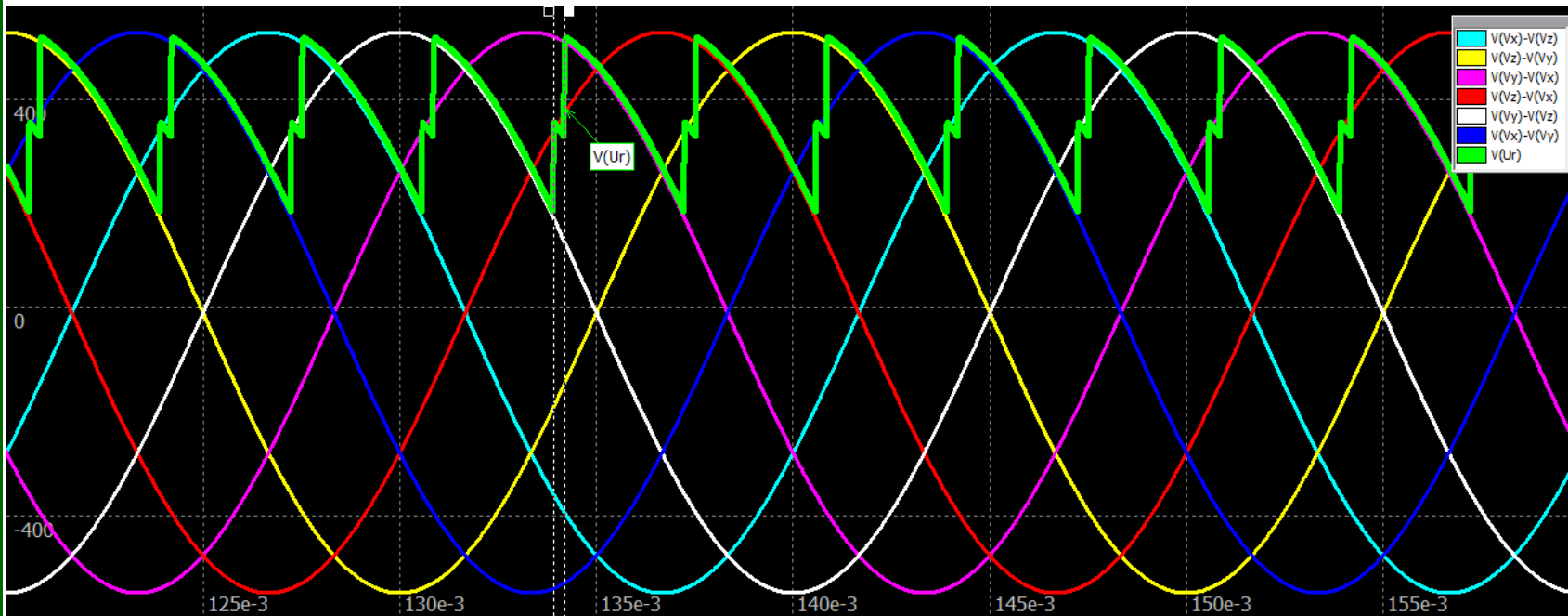
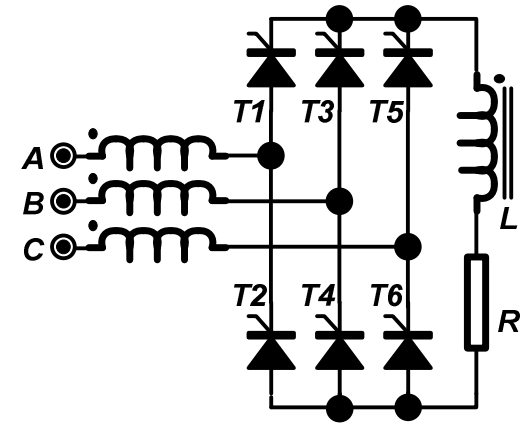




EFFECTO DE LA  
INDUCTANCIA DE RED



Modelo de Análisis  
Transitorio



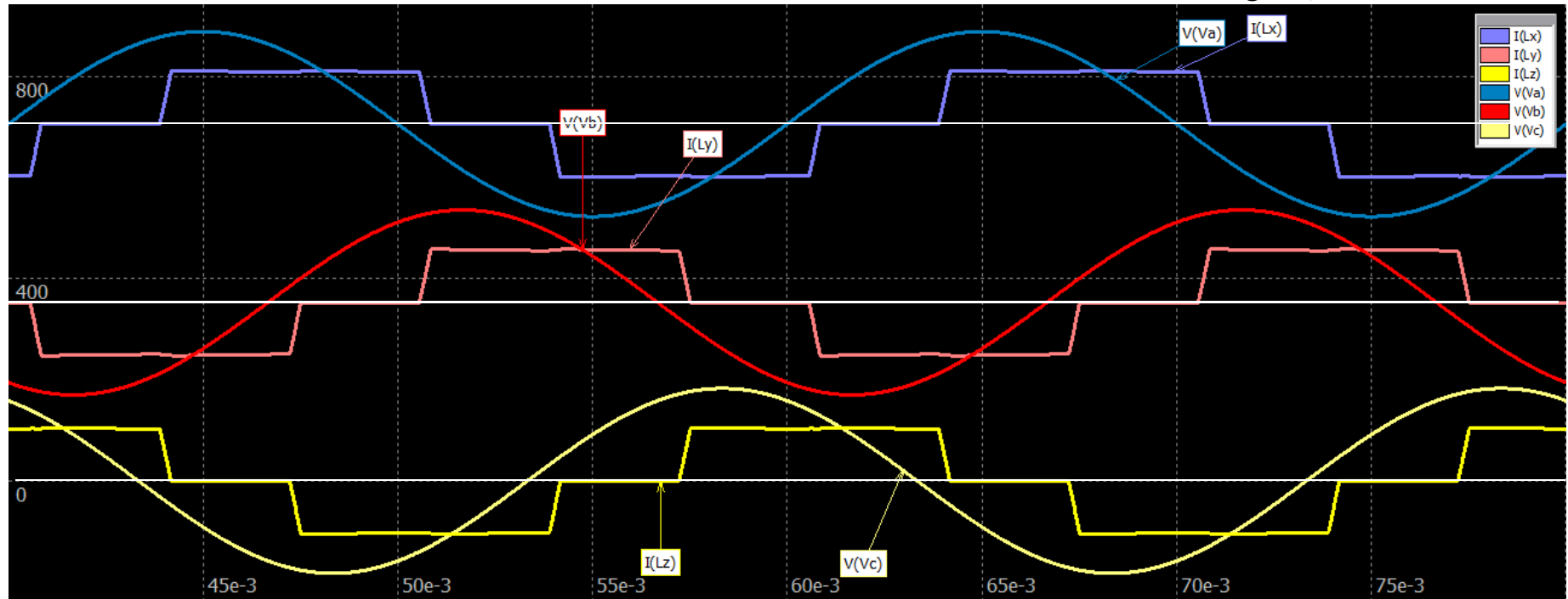
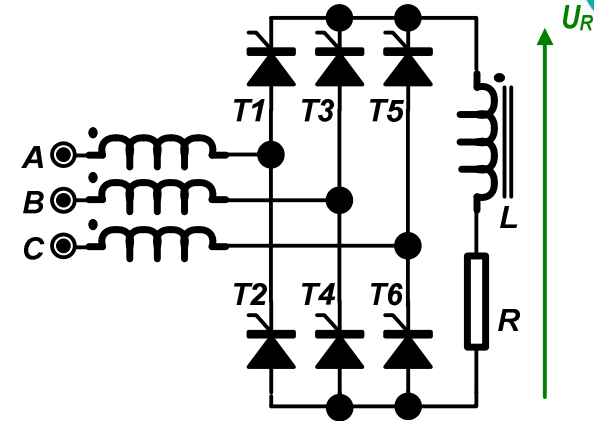
**Rectificadores Controlados a SCR**

[www3.fi.mdp.edu.ar/control403](http://www3.fi.mdp.edu.ar/control403)





CORRIENTES DE RED



**Rectificadores Controlados a SCR**

[www3.fi.mdp.edu.ar/control403](http://www3.fi.mdp.edu.ar/control403)

