

Electrónica de potencia

1 Introducción Componentes

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ELECTRÓNICA

SEÑALES

- DE COMUNICACIONES
- ANALÓGICA
- DIGITAL
- INSTRUMENTACIÓN
- DE POTENCIA

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COMPONENTES DE LA ELECTRÓNICA DE POTENCIA

PASIVOS
Transformadores
Bobinas
Condensadores
....

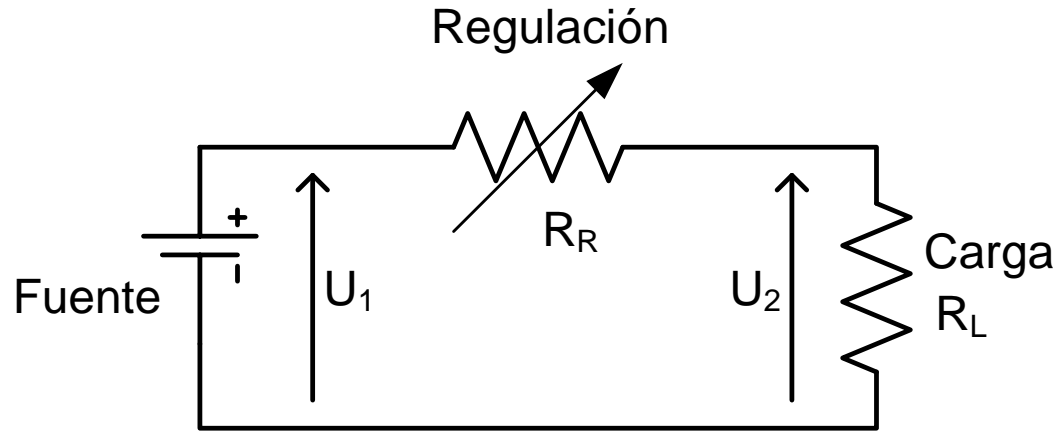
Componentes
No controlados
Diodos
Controlados
Control total

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Es necesario transformar la energía eléctrica de las fuentes para ser utilizada adecuadamente por las cargas



$$U_2 = \frac{R_L}{R_L + R_R} U_1$$

$$\eta = \frac{U_2 I}{U_1 I} = \frac{R_L}{R_L + R_R}$$

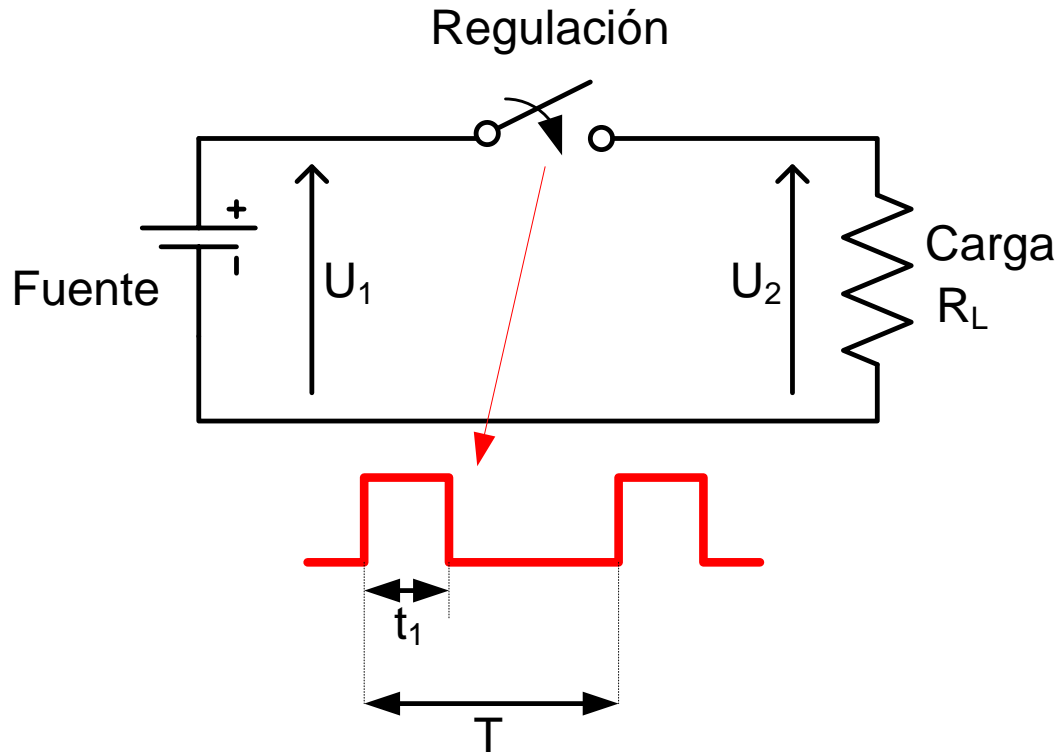
Rendimiento

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Mejora del rendimiento



t_1

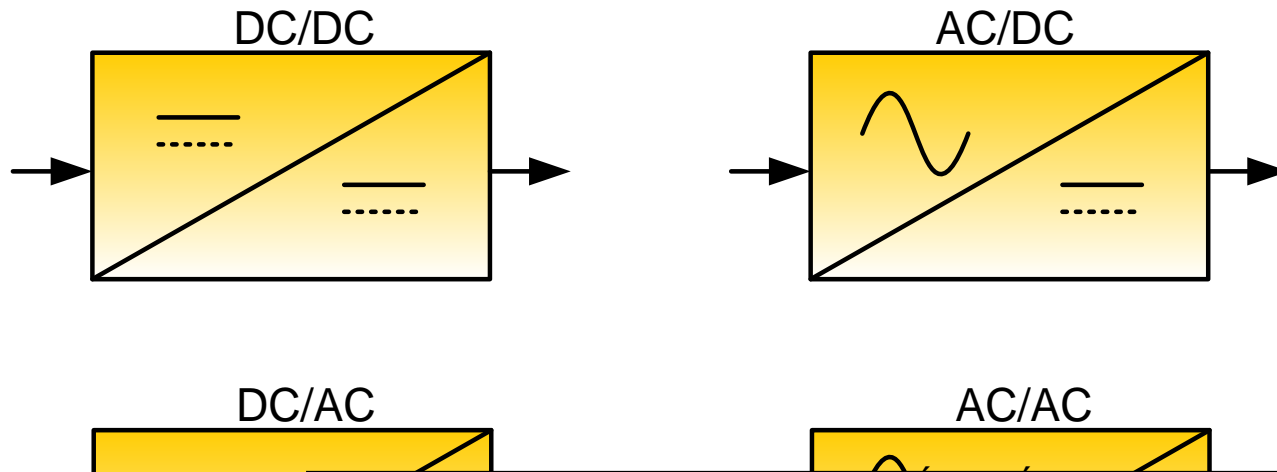
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COMPONENTES DE LA ELECTRÓNICA DE POTENCIA

▪ NO CONTROLADOS

- o *Diodo*
- o *Diac*

CONTROLADOS

- o *Transistores*
 - Bipolar
 - MOS
 - IGBT

- o *Tiristores*
 - Tirisitor
 - GTO

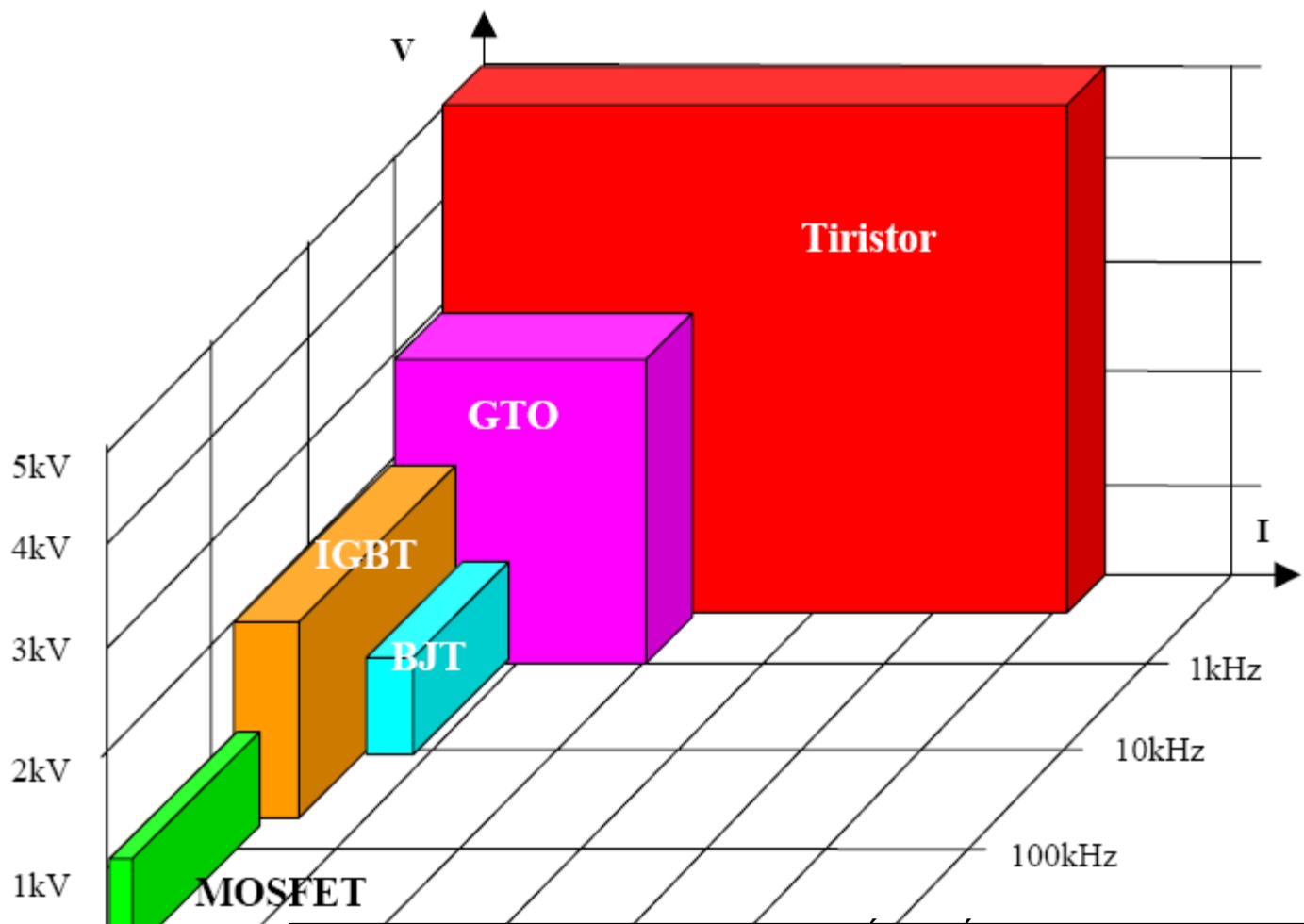
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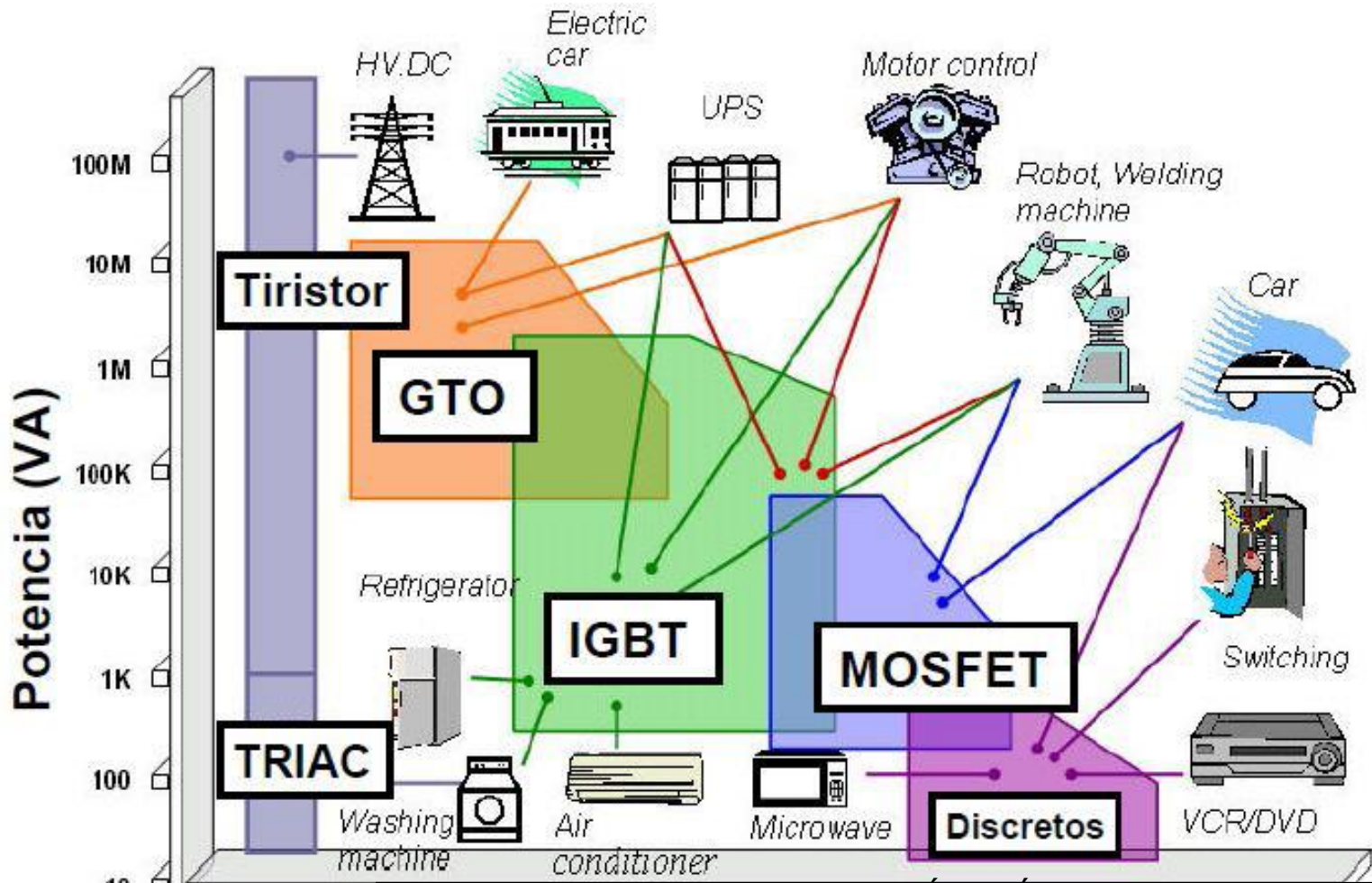
COMPONENTES: Límites de utilización



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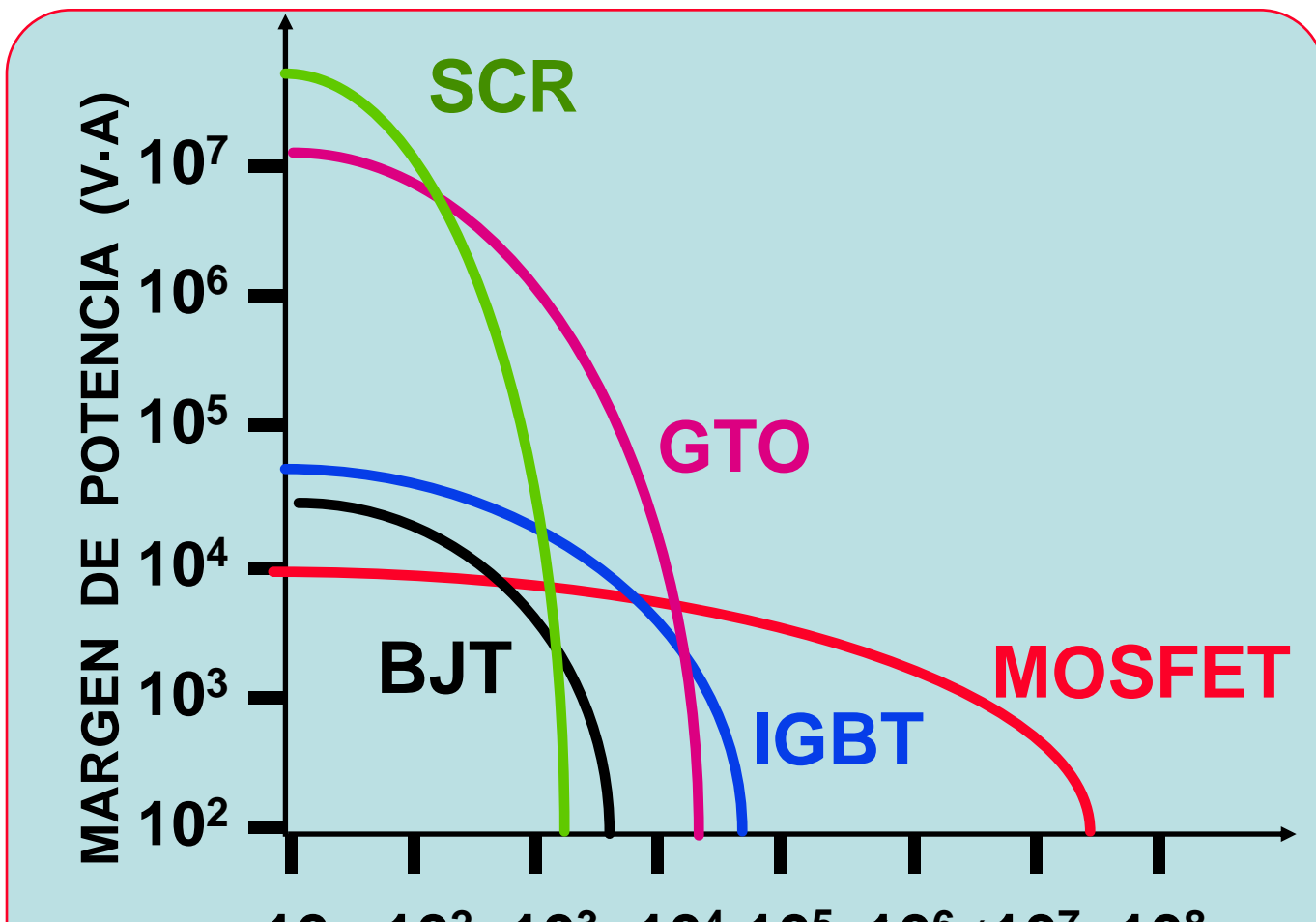
COMPONENTES: Aplicaciones



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COMPONENTES: Comparativa

	<i>Dispositivos</i>					
	DIODO	SCR	GTO	BJT	MOSFET	IGBT
Características de disparo	-----	En corriente	En corriente	En corriente	En tensión	En tensión
Potencia del circuito de mando	-----	Media - Alta	Alta	Media - Alta	Muy baja	Muy Baja
Complejidad del circuito de mando	-----	Baja	Alta	Alta	Muy Baja	Muy Baja
Densidad de corriente	Media p/ Alta	Alta	Media - Alta	Media	Alta - Baja	Alta
Máxima tensión inversa	Media	Alta	Alta	Baja - Media	Media - Baja	Media - Alta
Perdidas en conmutación (circuitos convencionales)	Baja p/ media	Alta	Alta	Media - Alta	Muy Baja	Media - Alta

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COMPONENTES "ON/OFF"

Tiristores

EST (Emitter-Switched Thyristor)

IGTT (Insulated Gate Turn-off Thyristor)

IGT (Insulated Gate Thyristor)

MTO (MOS Turn-Off thyristor)

GTO (Gate Turn-Off thyristor)

MCT (MOS-Controlled Thyristor)

FCT (Field-Controlled Thyristor)

IGCT (Integrated Gate-Commutated Thyristor)

Transistores

IGBT (Insulated Gate Bipolar Transistor)

Bipolar

Darlington

MOSFET

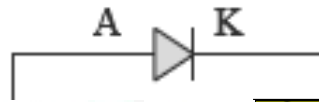
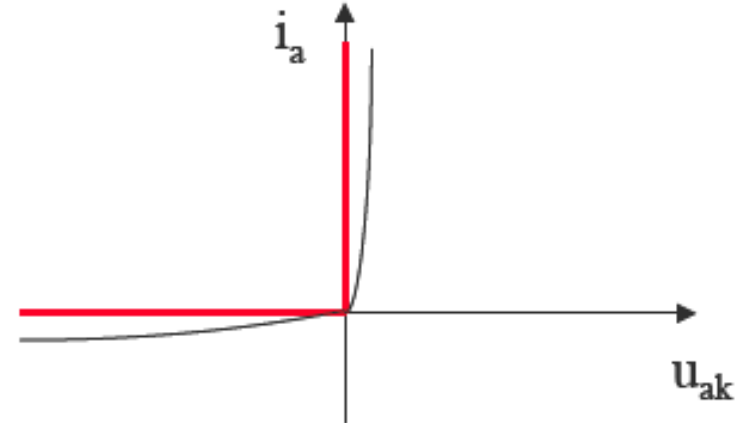
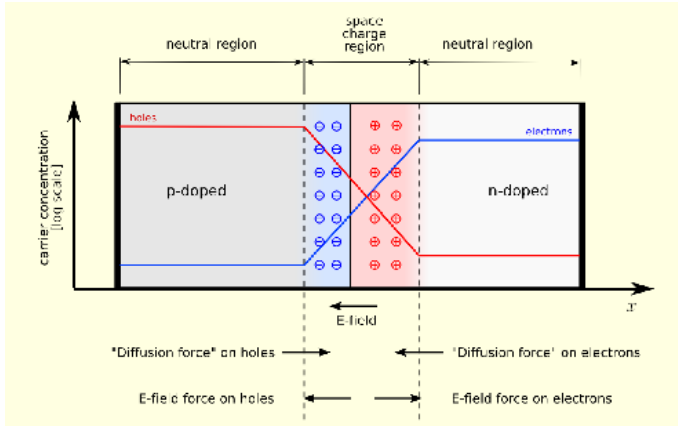
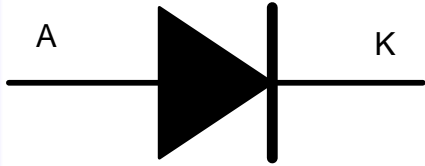
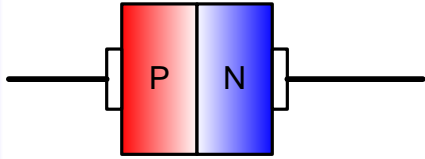
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DIODO

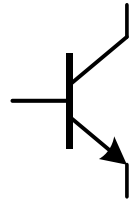


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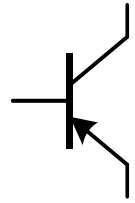
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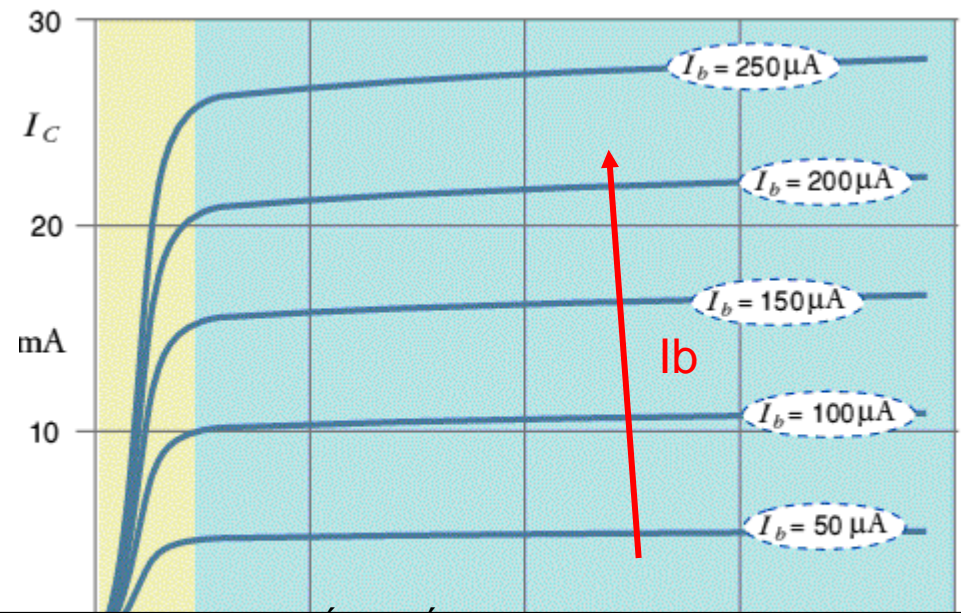
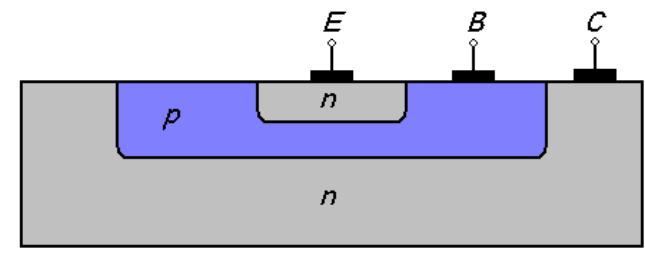
Transistor bipolar



NPN



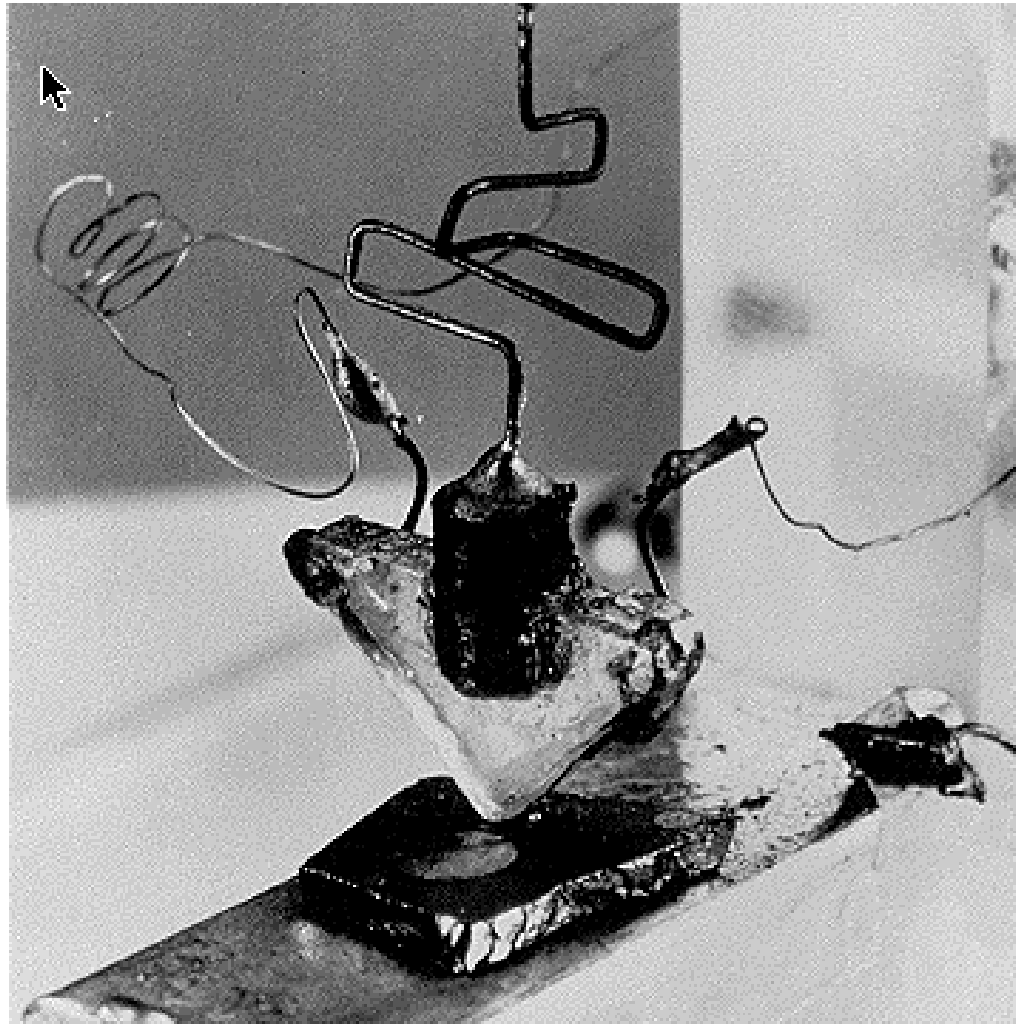
PNP



- Fáciles de controlar
- Pérdidas por conducción reducidas
- Caída de tensión 1-2V
- Frecuencia de conmutación 3 kHz
- No soporta potencias muy elevadas

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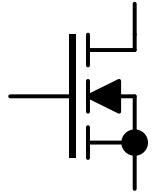
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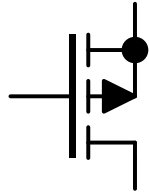
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William Shockley, John Bardeen, and Walter Brattain

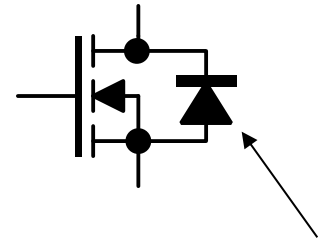
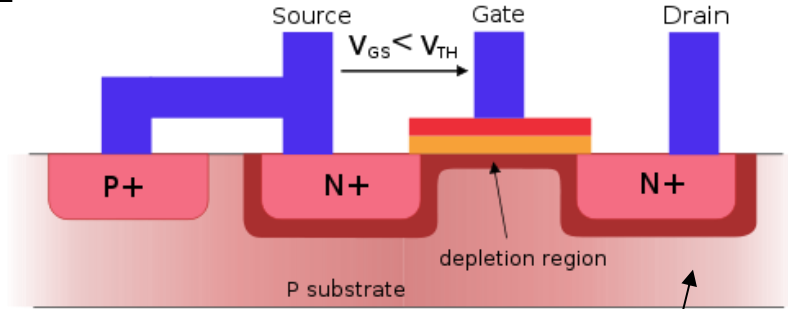
MOSFET



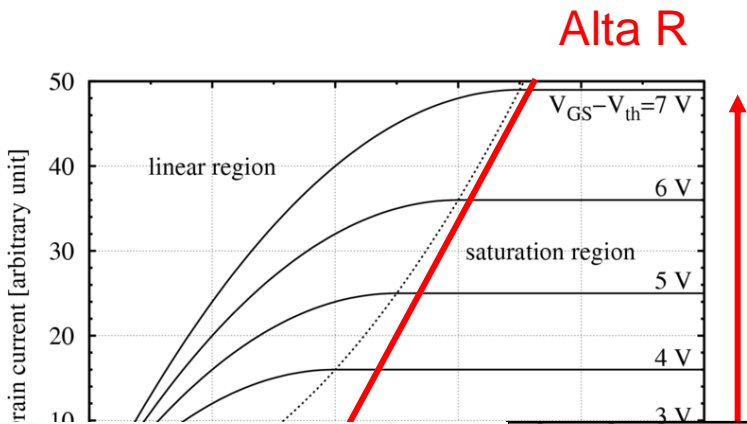
Canal N



Canal P



Diodo intrínseco



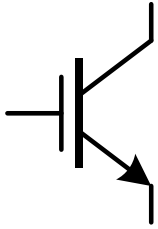
- Fácil de controlar
- Frecuencia de conmutación superior a 100 kHz

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IGBT (Insulated Gate Bipolar Transistor)



Tamaño reducido

Bajo coste de fabricación

Caída de tensión reducida, independientes de la corriente

Frecuencia máxima 20 kHz

No soporta derivadas altas de tensión

Límites de tensión 3300 V, de corriente 1200 A

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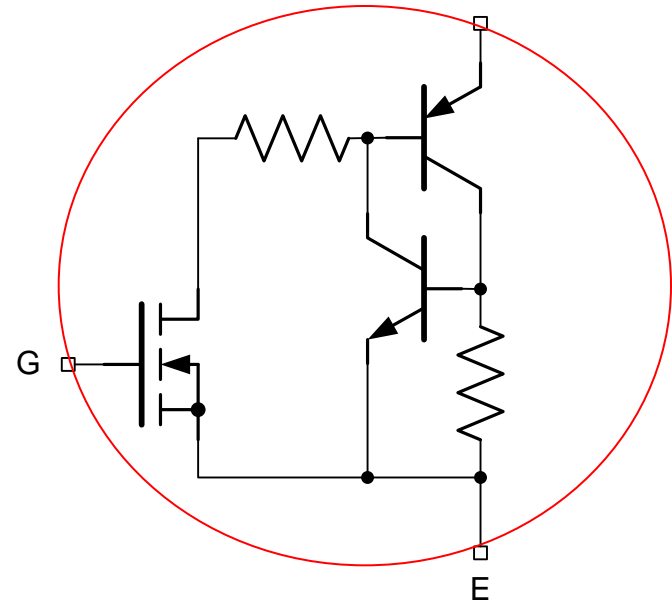
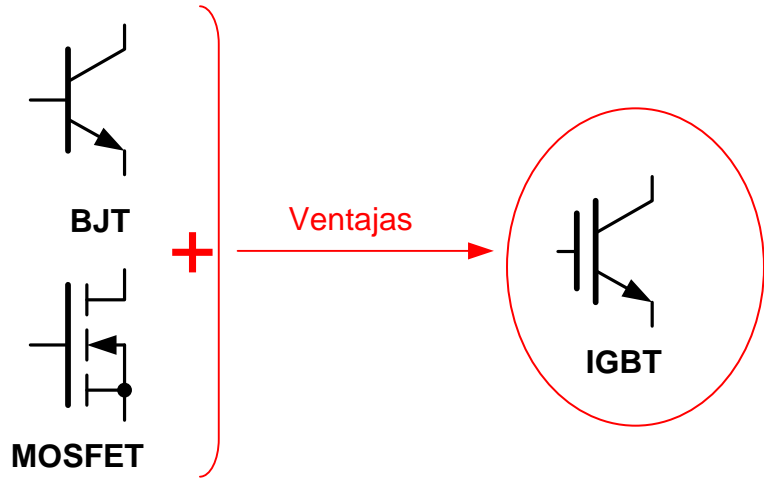
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IGBT

Circuito equivalente



MOSFET

- Alta frecuencia de conmutación (>100 kHz)
- Baja tensión (100's V)

IGBT

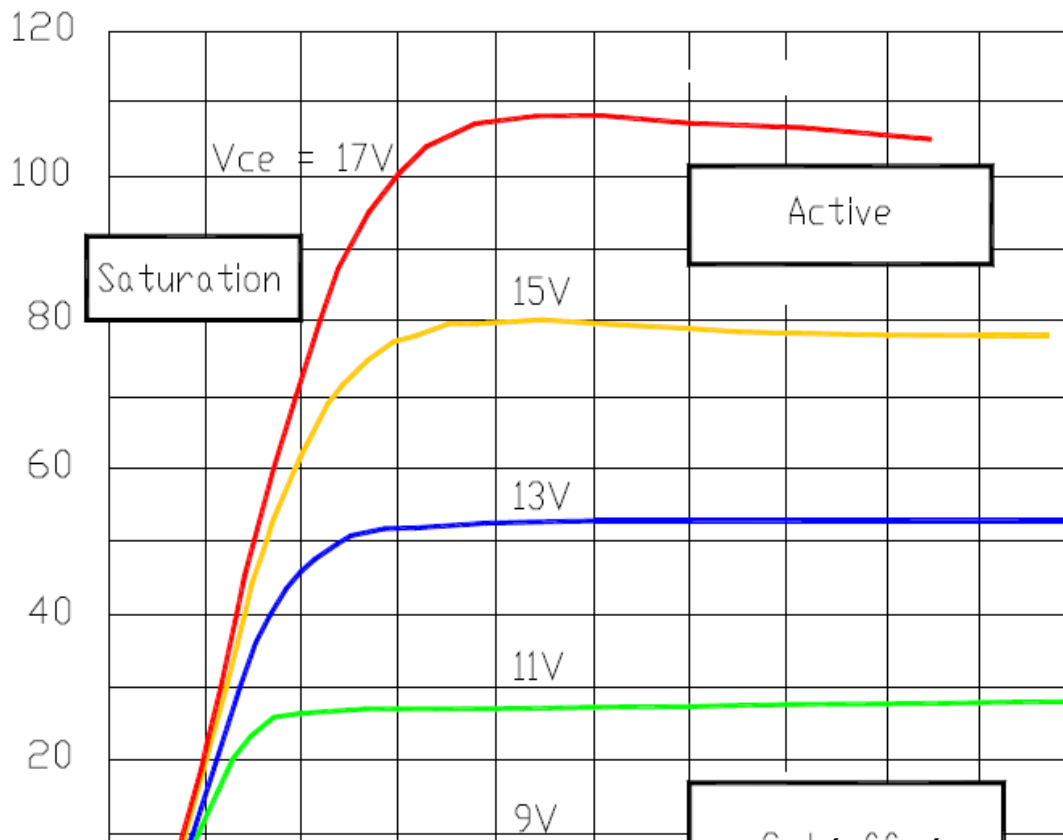
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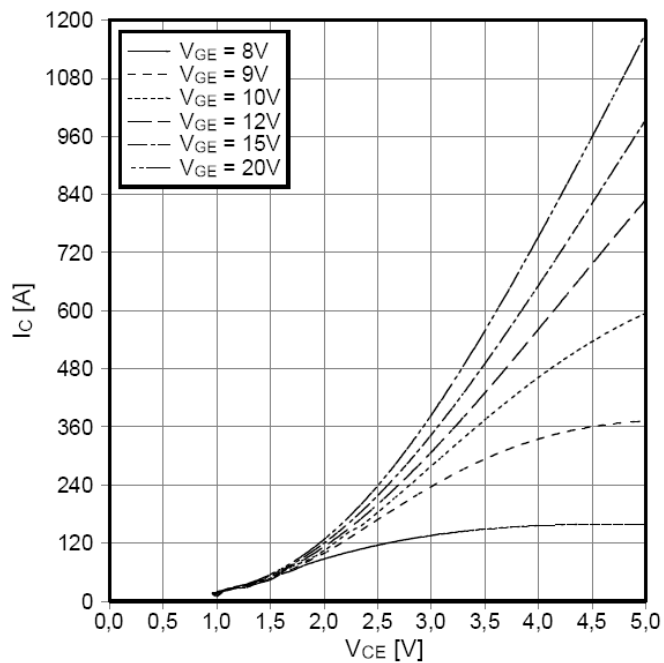
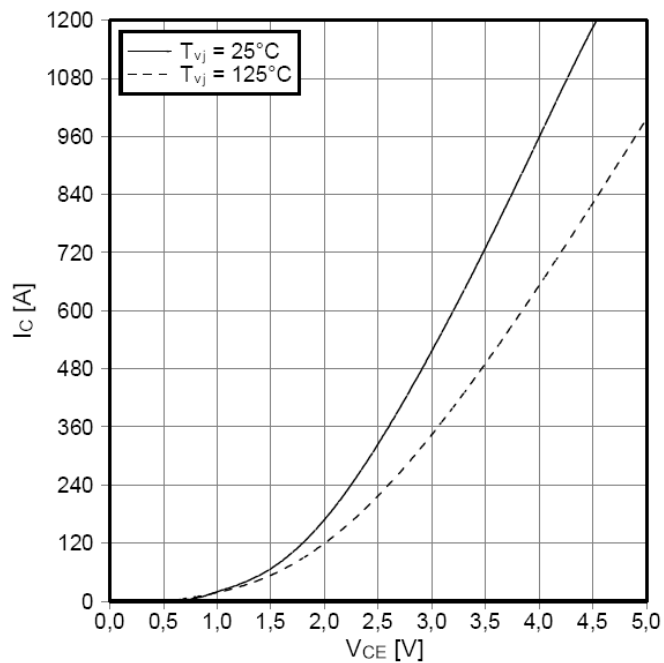


IGBT

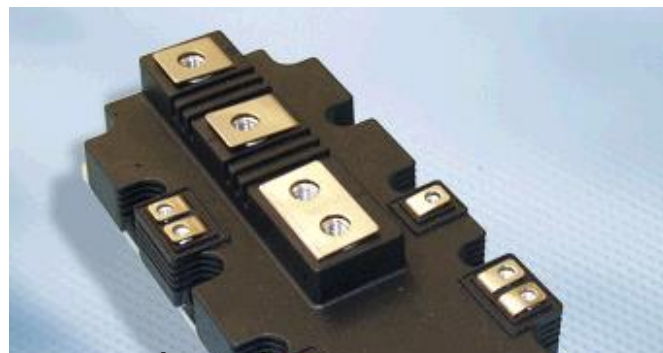


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IGBT

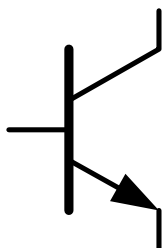


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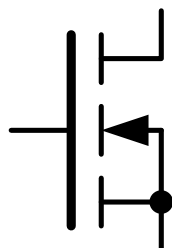
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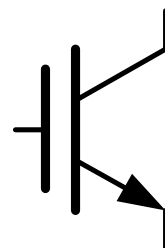
TRANSISTORES DE POTENCIA



BJT



MOSFET



IGBT

Control por corriente

Control por tensión



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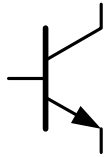
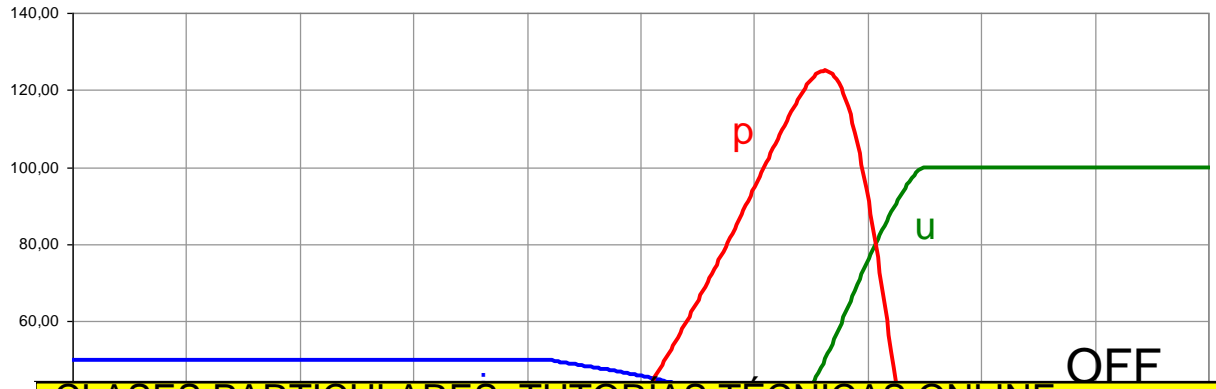
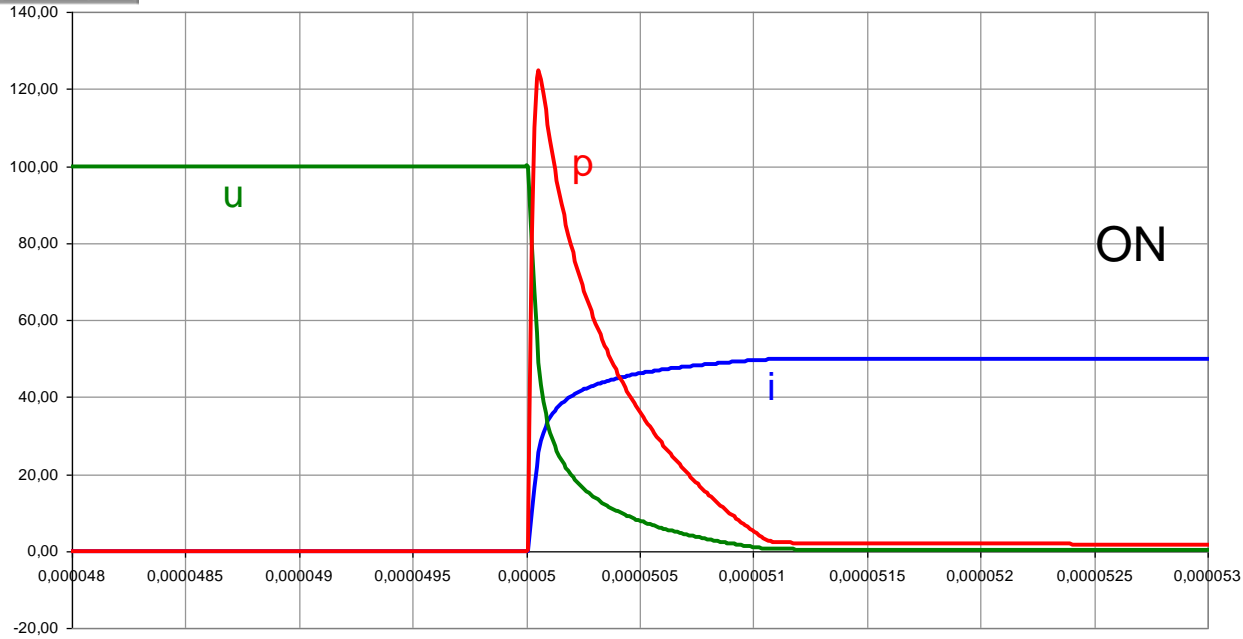


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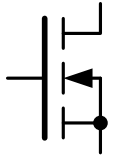
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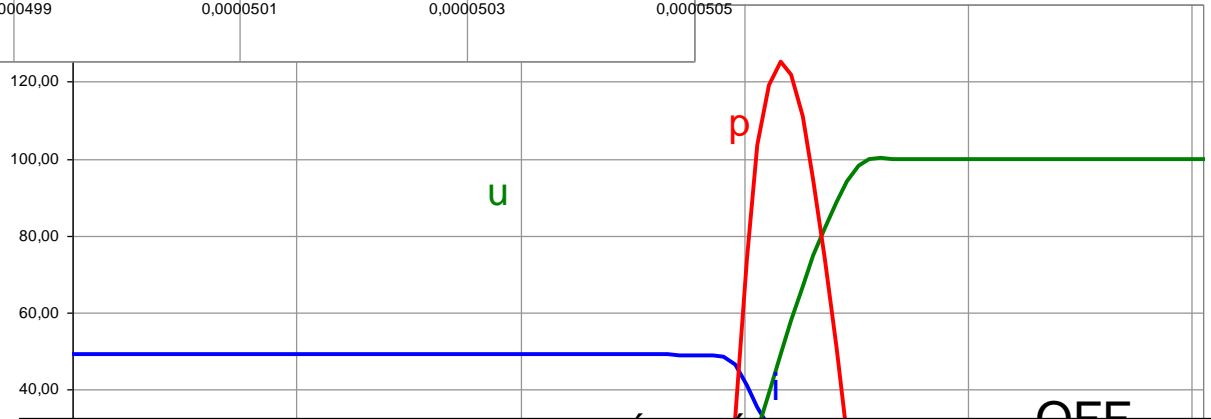
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+ rápido

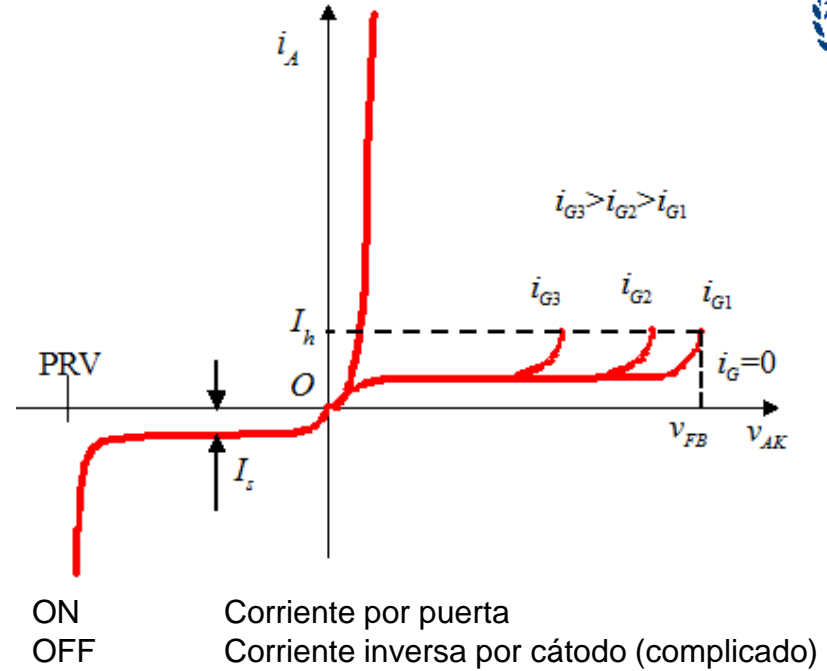
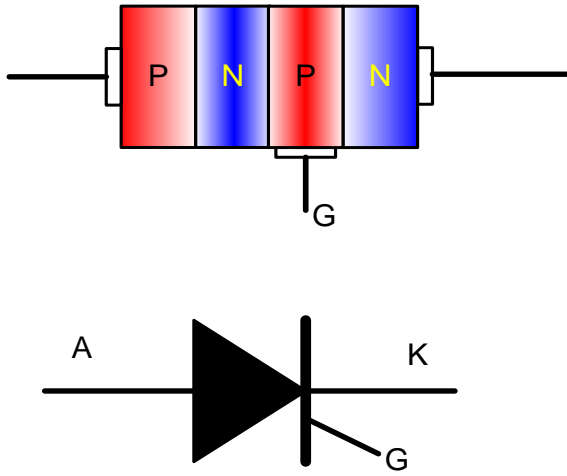


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TIRISTOR



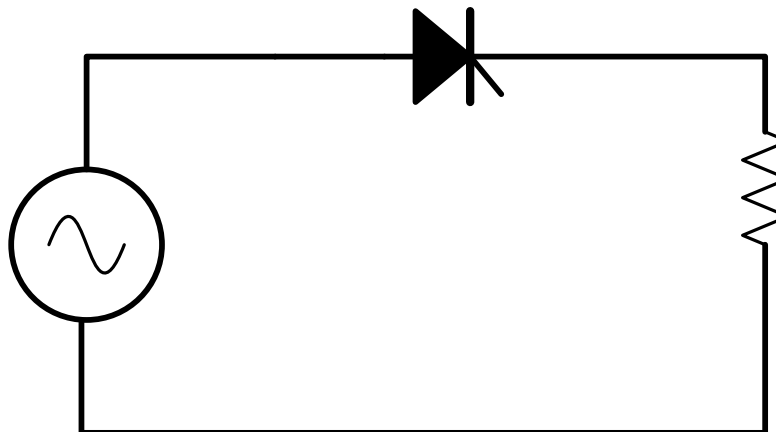
- Robusto y fiable
- Soporta elevadas sobreintensidades transitorias
- Caída de tensión baja, 1-3V
- Frecuencia menor de 1 kHz

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TIRISTOR: rectificador controlado



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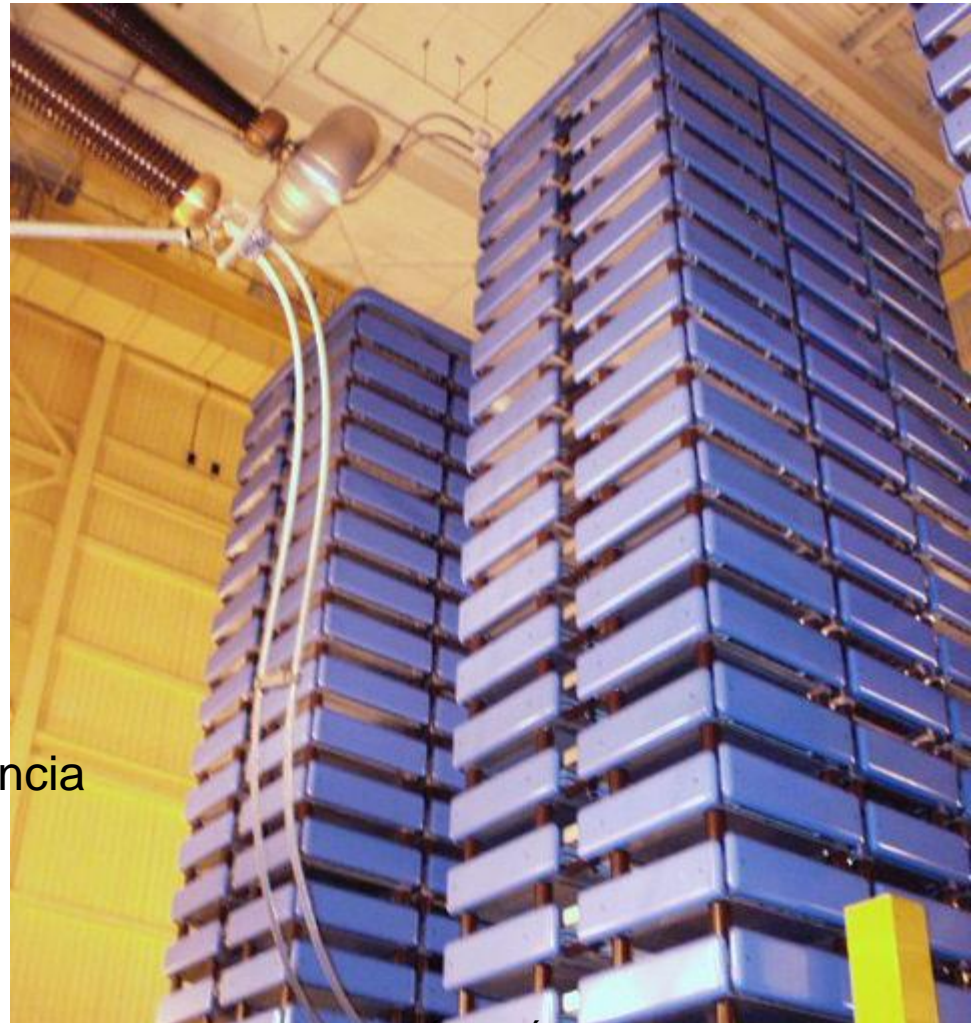
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0s 5ms 10ms 15ms 20ms 25ms 30ms 35ms 40ms 45ms

TIRISTOR

Aplicaciones de muy alta potencia



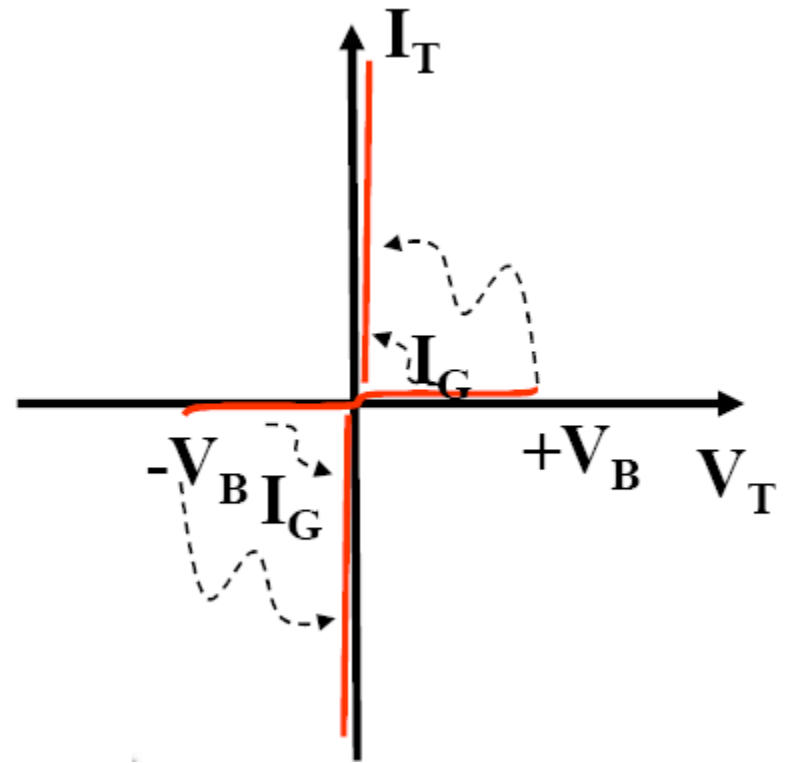
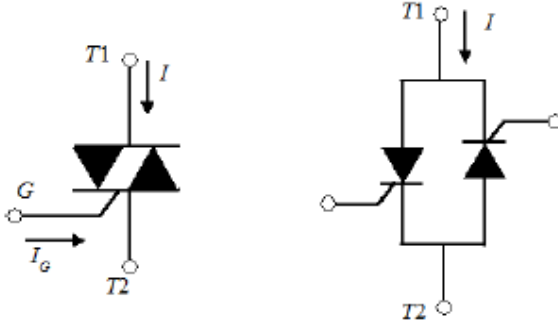
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TRIAC



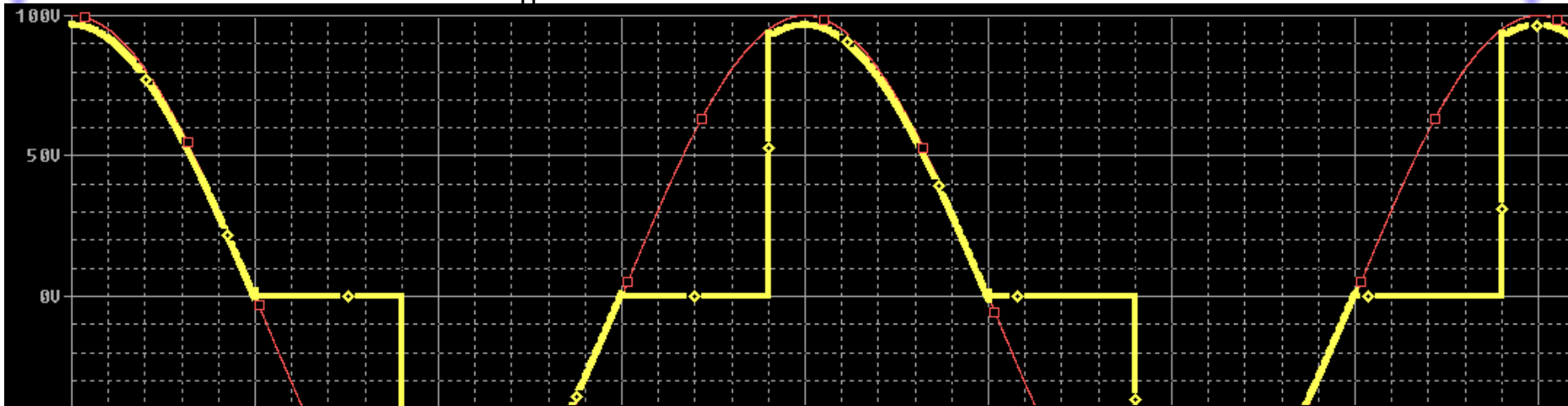
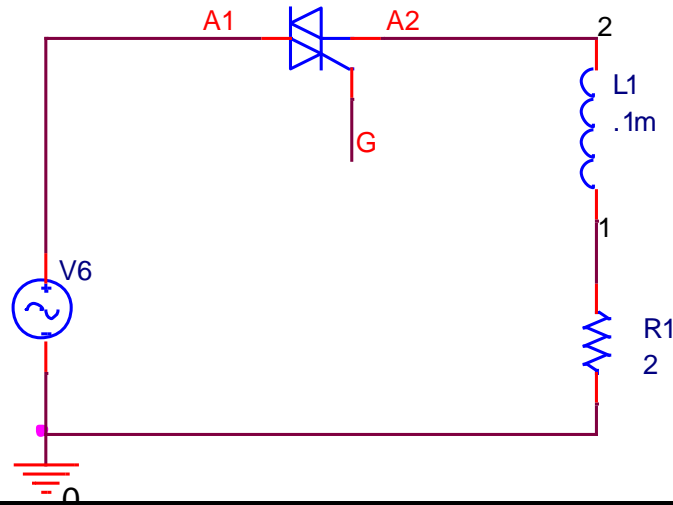
Tiristor bidireccional

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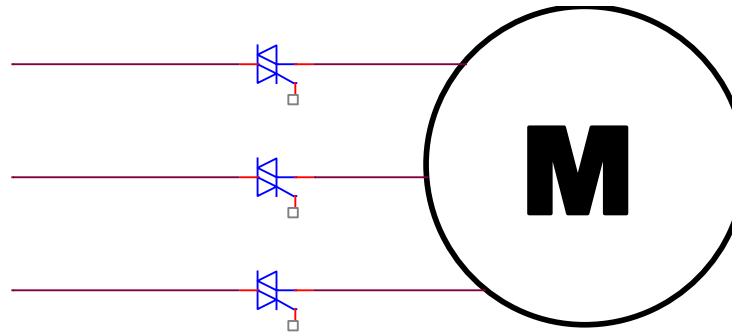


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TRIAC



Ejemplo de aplicación:
Arranque suave de máquinas

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GTO (Gate Turn-Off Thyristor)

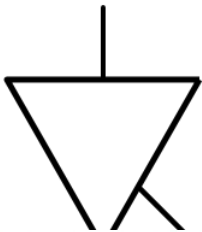
Apagado por impulso negativo de corriente por la puerta.
Elevadas pérdidas por conmutación
Bajas pérdidas por conducción
Alta tensiones y corrientes, 4500V – 3000 A

Mejora



IGCT (Integrated Gate-Commutated Thyristor)

Baja resistencia en conducción.
Robustez.
Capacidad de apagado por la puerta.



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Device	Operation	Description
Silicon Diode Family of Devices		
Diode		Conducts positive current
Thyristor Family of Devices		
Silicon Controlled Rectifier (SCR)		Gate current triggers the flow of positive current. After loss of gate signal, turns off the positive current at next zero cross over.
Gate Turn Off Thyristor (GTO)		Small positive gate signal turns on positive current, a large reverse gate turns off the positive current.
Integrated Gate Commutated Thyristor (IGCT)		A GTO with electronics for gate control integrated onto a printed circuit wrapped around the device. Blocks voltage in one direction.

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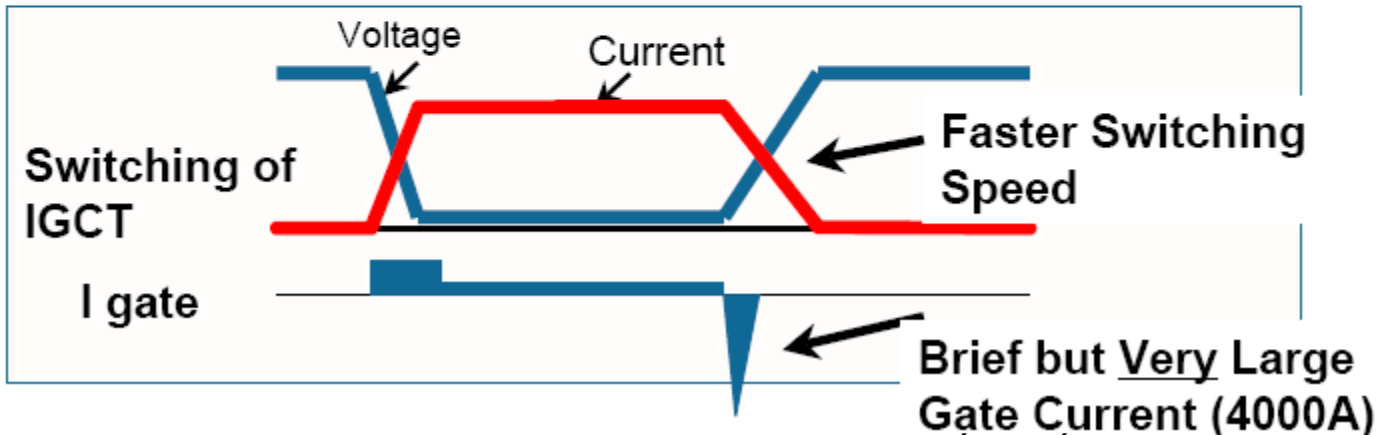
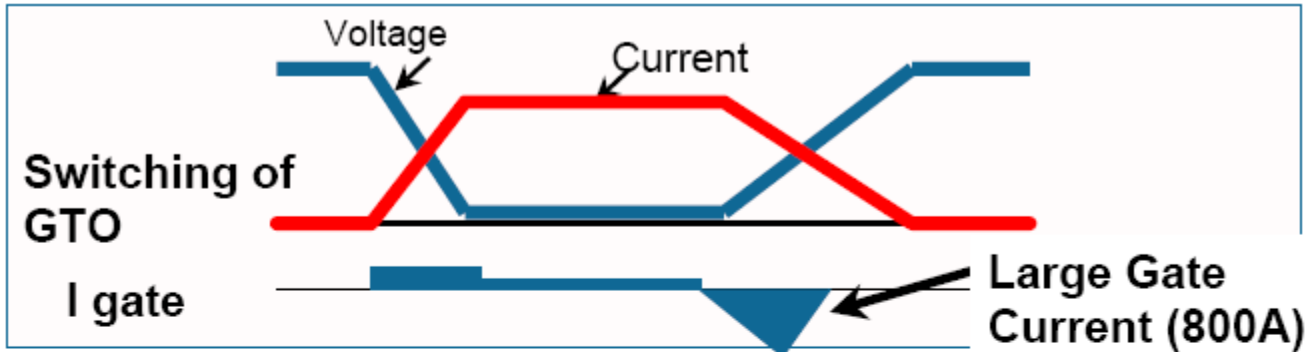


Device	Operation	Description
Transistor Family of Devices		
Bipolar Power Transistor (BPT)		Controls the flow of positive current with current injected into its base.
Insulated Gate Bipolar Transistor (IGBT)		A hybrid device with very a high input resistance gate transistor providing current to turn it on.
Injection Enhanced Gate Transistor (IEGT)		A high-power advanced form of the IGBT with a very low on-state voltage and even lower

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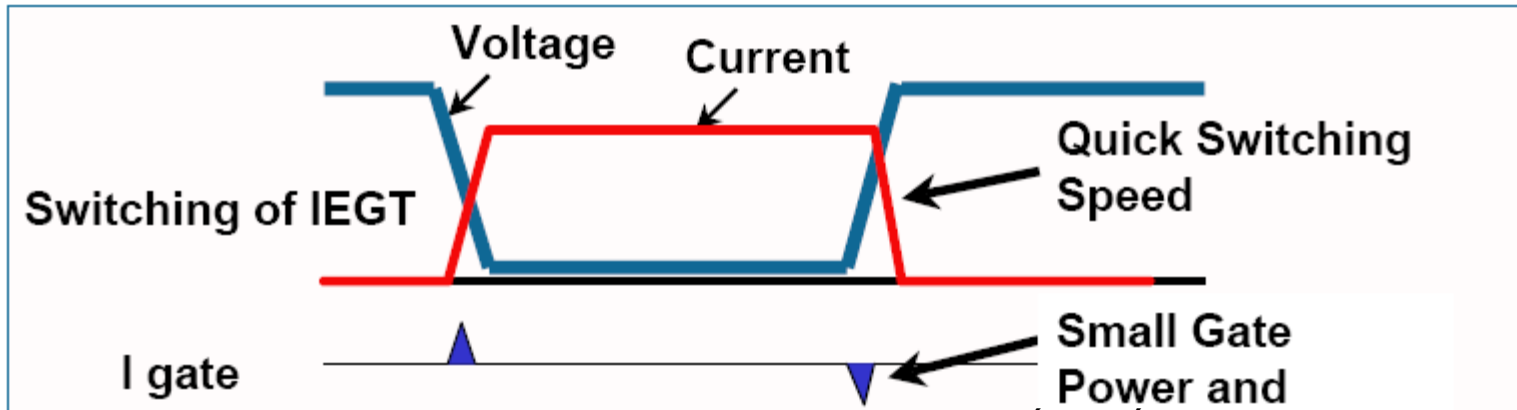
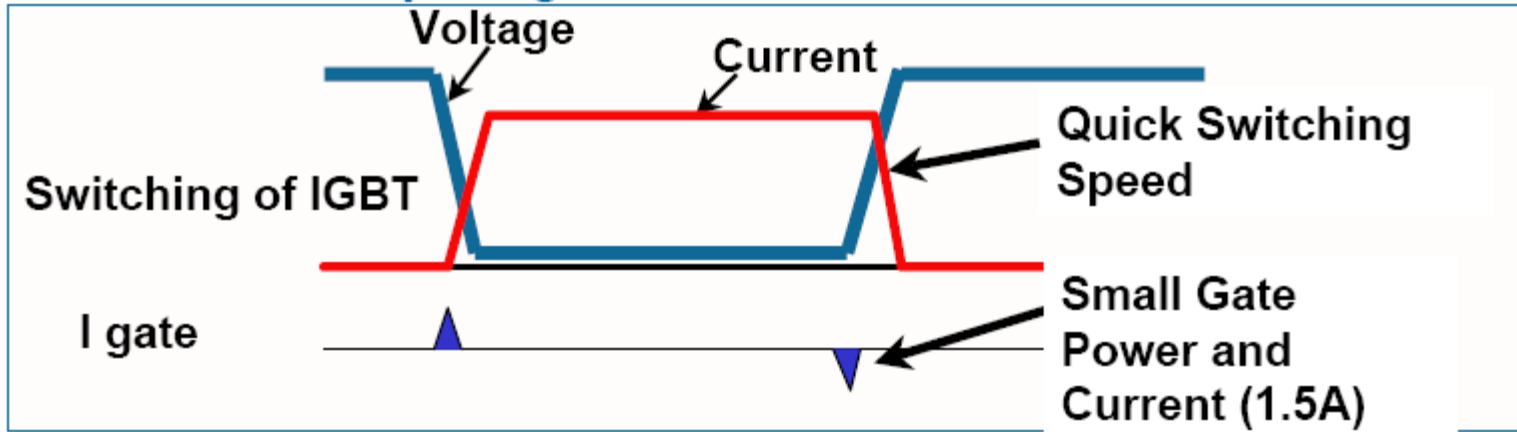
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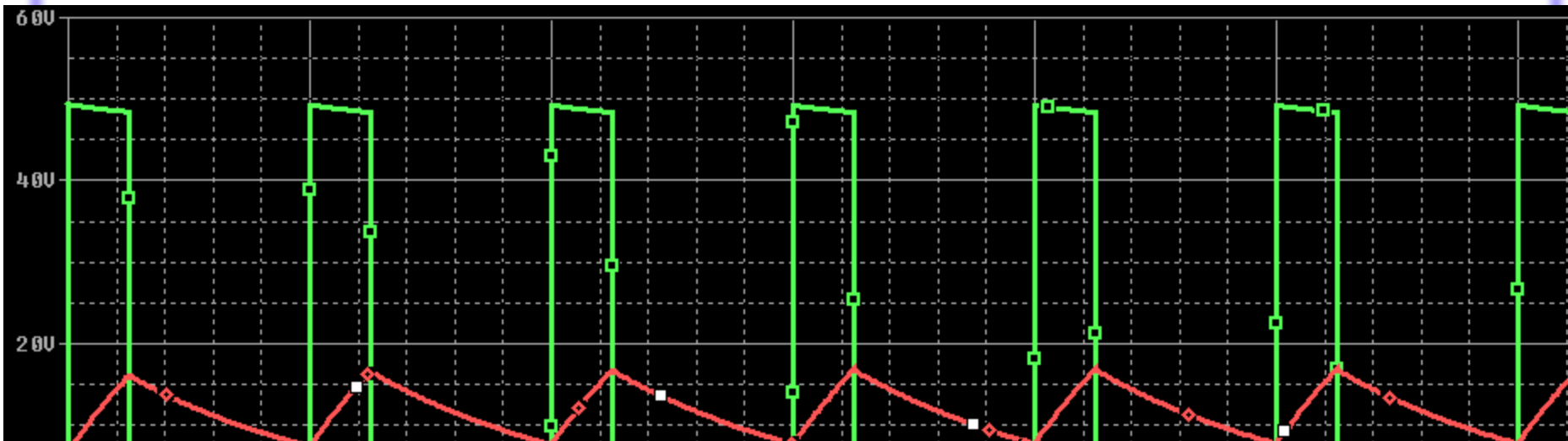
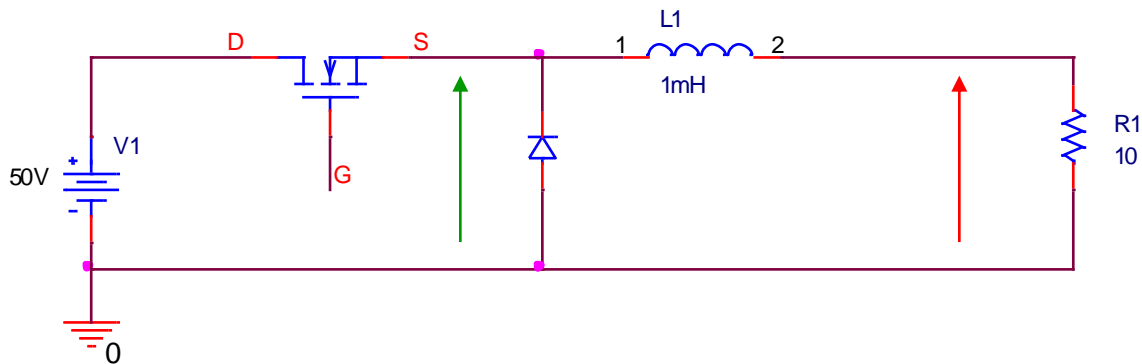
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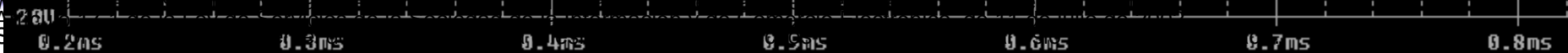
(BUCK: reductor)



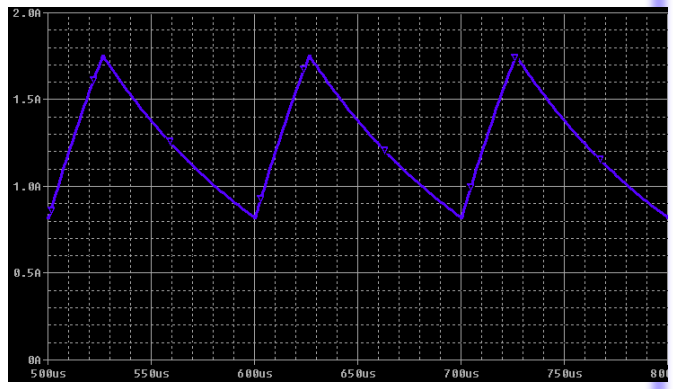
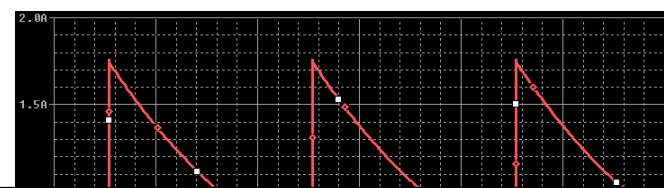
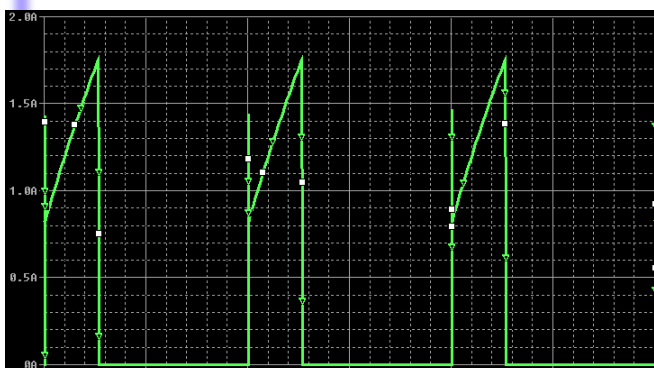
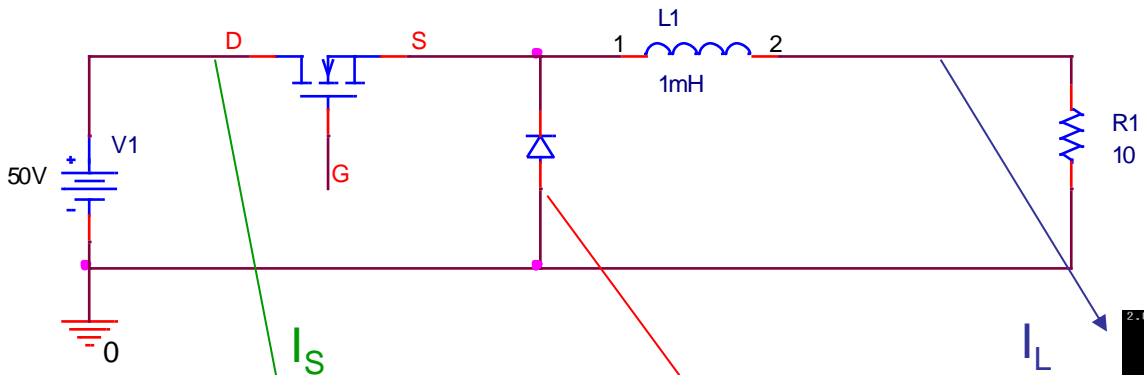
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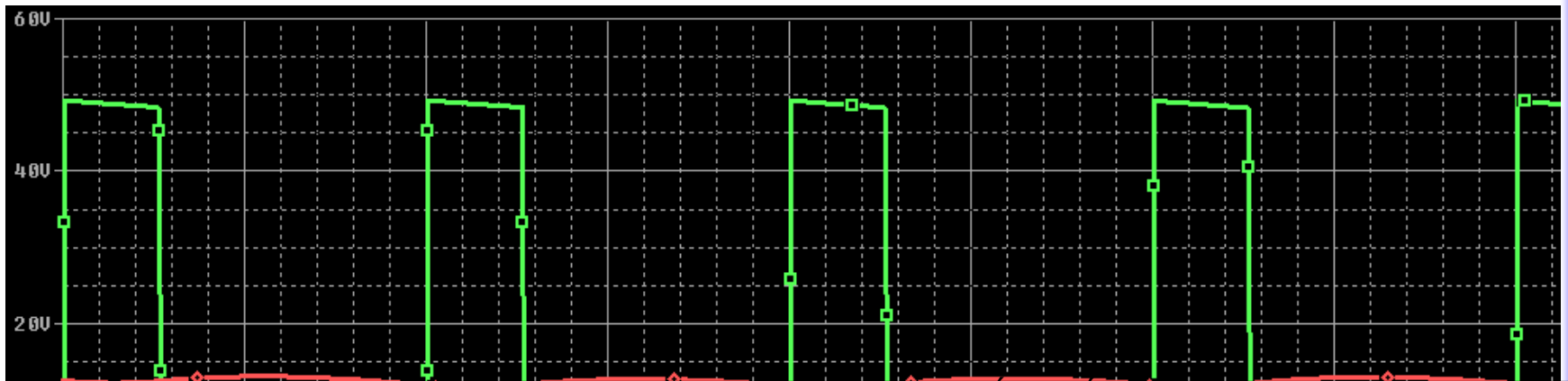
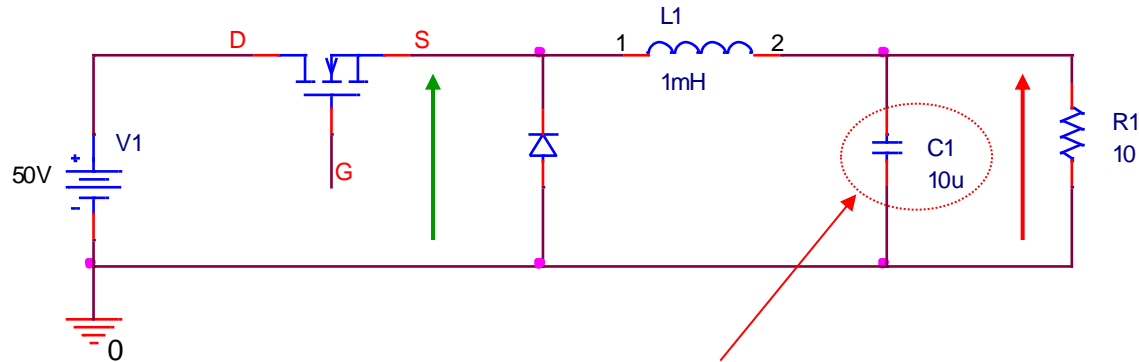


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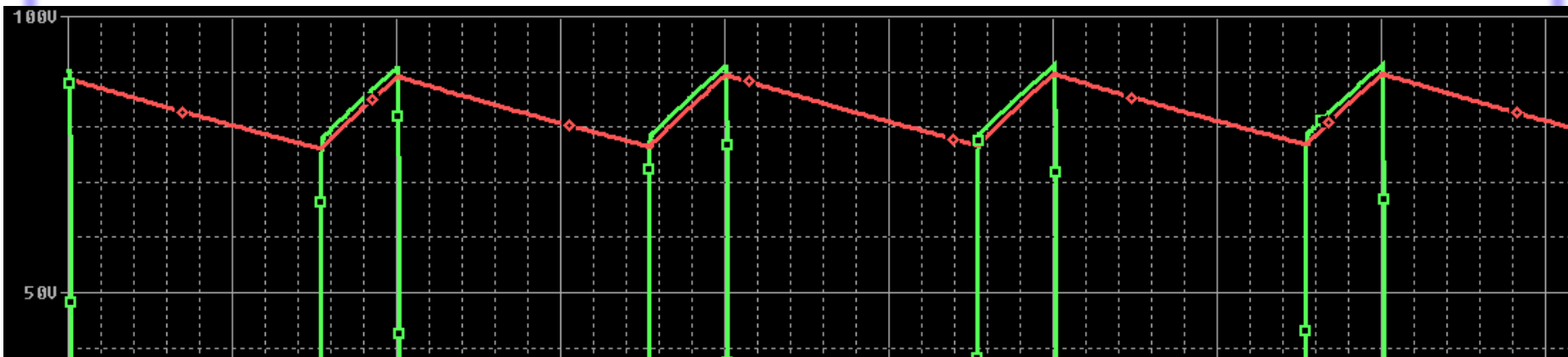
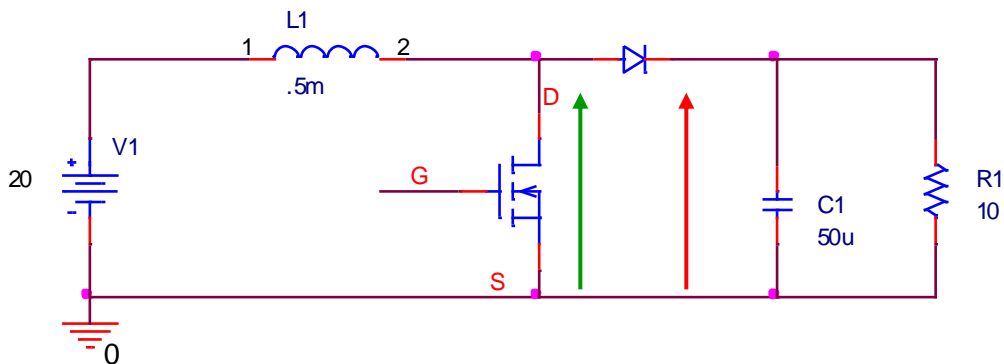
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(BOOST: elevador)

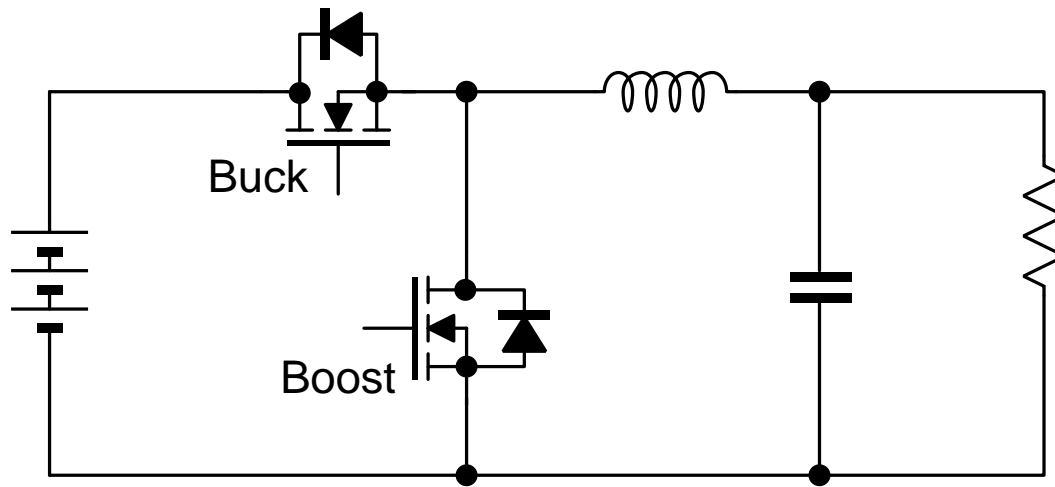


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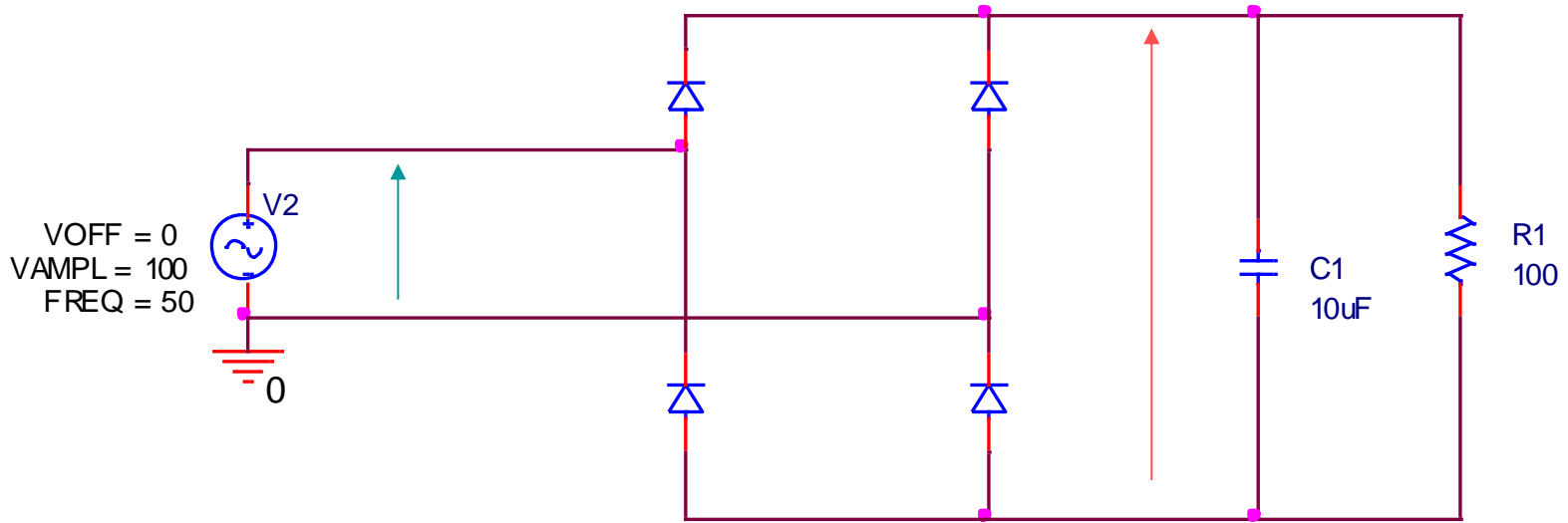
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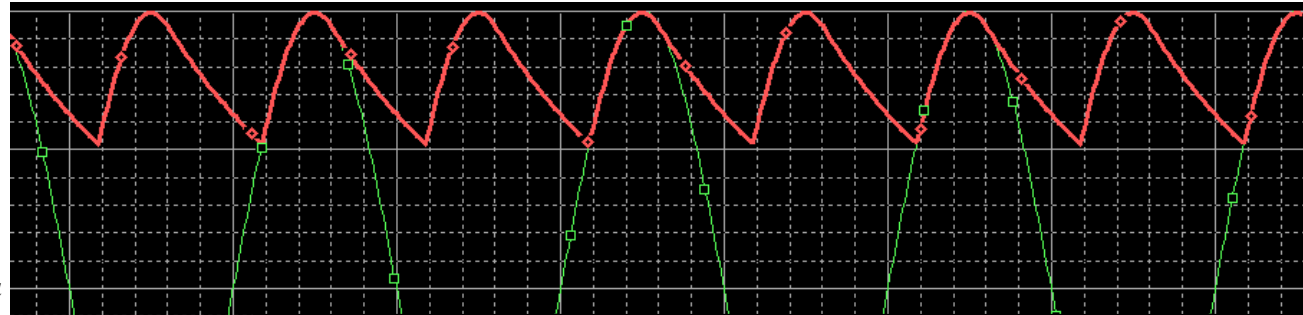
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RECTIFICADOR



$$U_d = U_a$$

$$U_{d(p)} = \sqrt{2}U_a$$



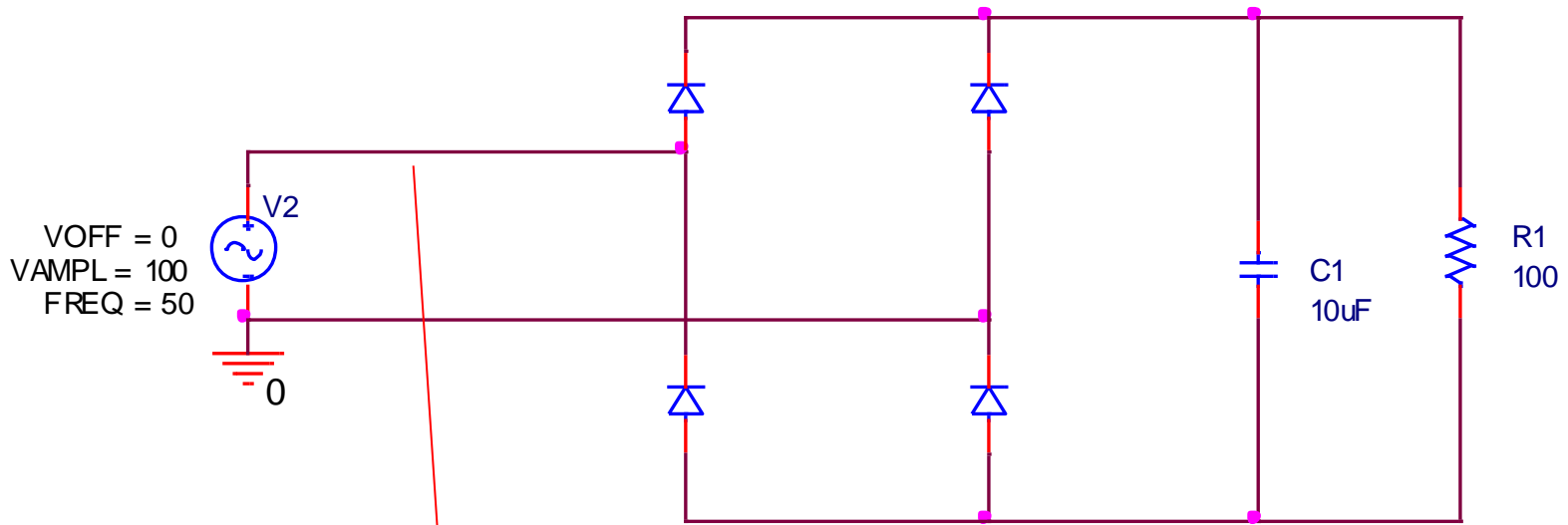
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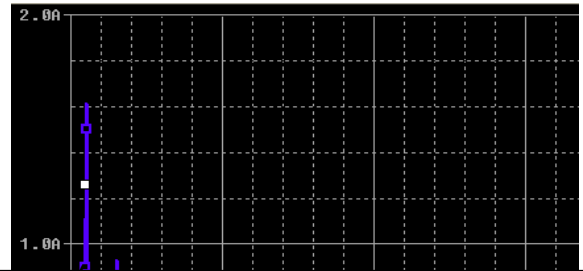
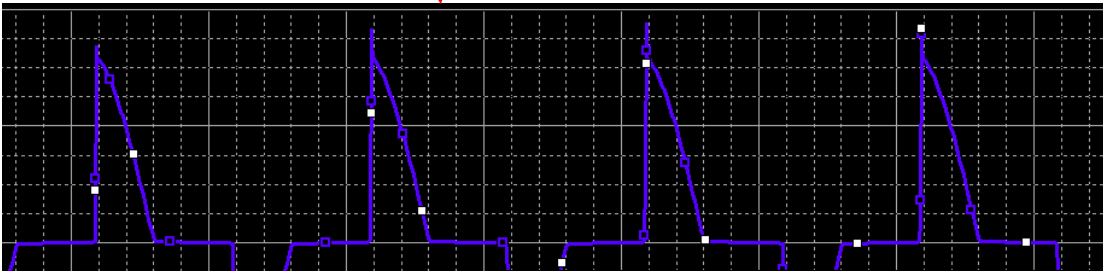


RECTIFICADOR NO CONTROLADO



Iac

Armónicos



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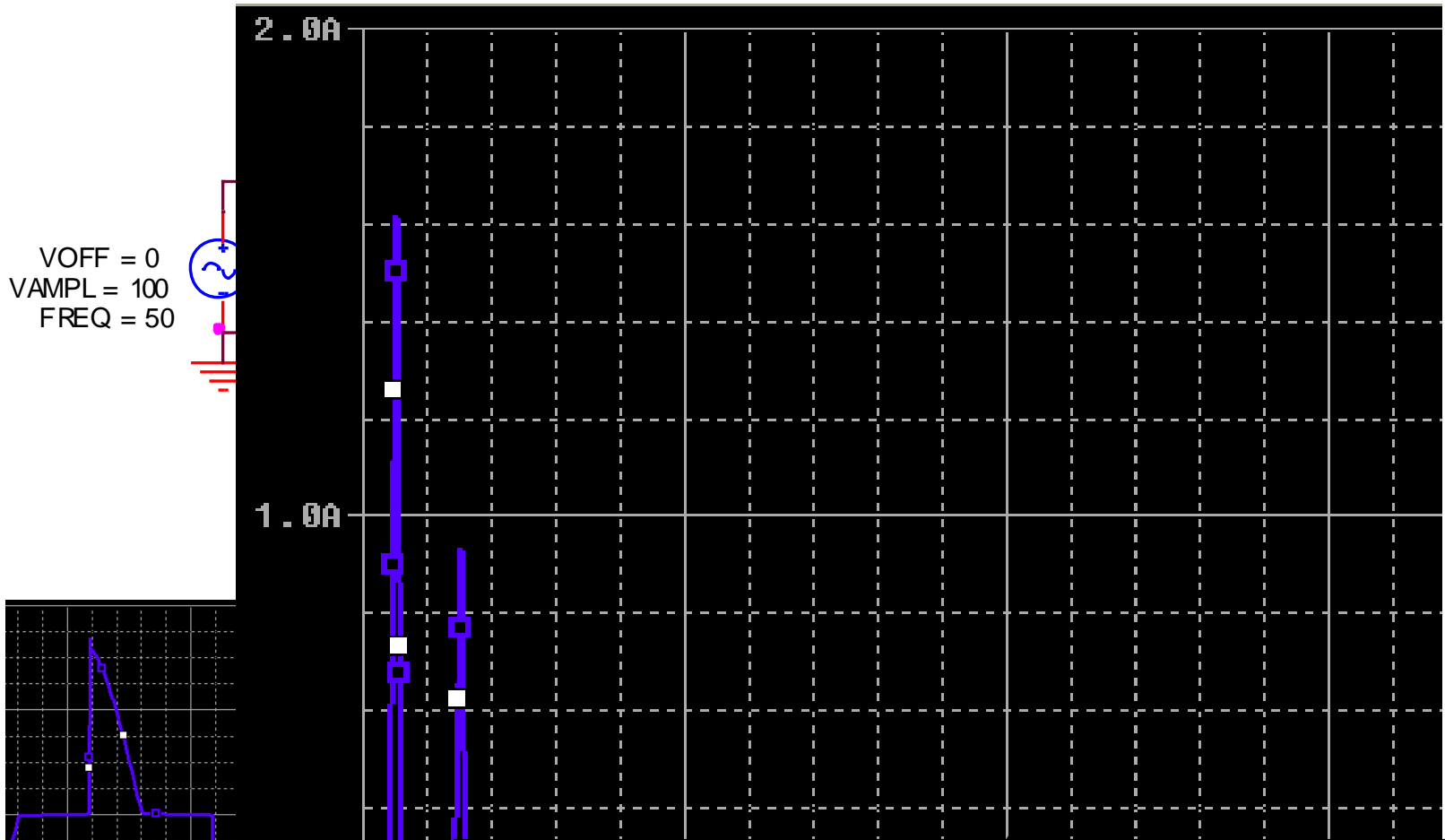
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10ms 20ms 30ms 40ms 50ms 60ms 70ms 80ms 0Hz 0.5kHz 1.0kHz 1.5kHz



RECTIFICADOR

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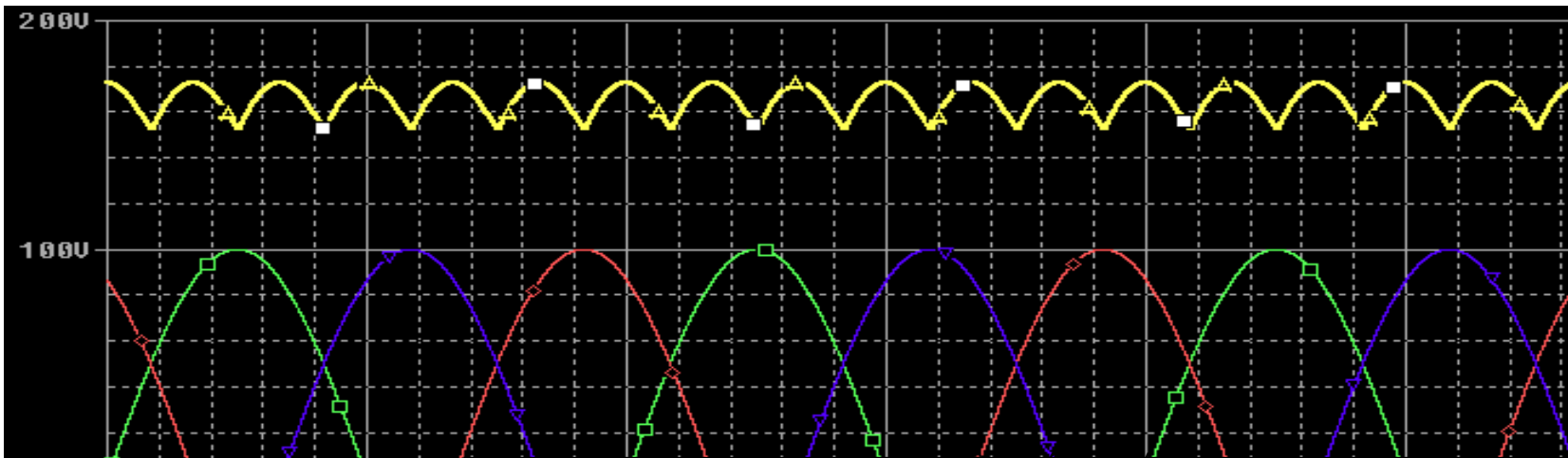
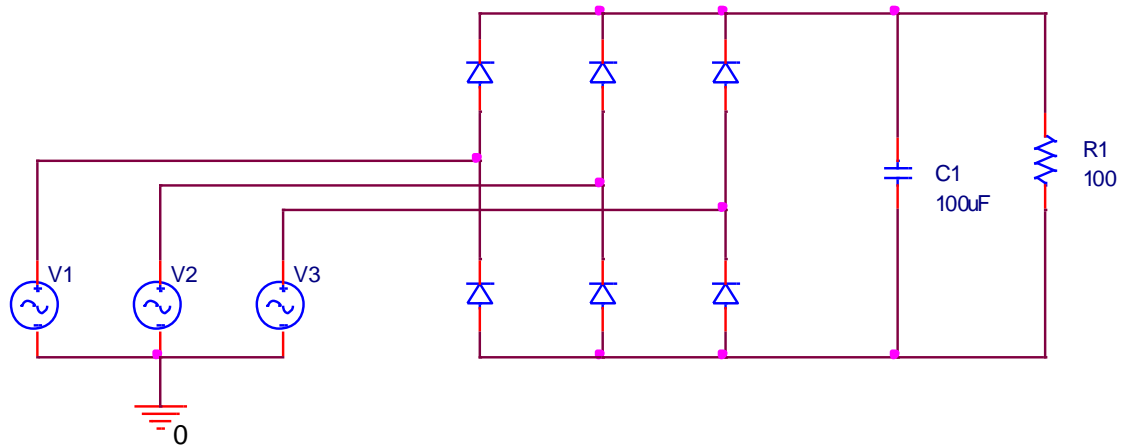
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RECTIFICADOR TRIFÁSICO

$$U_d = \frac{3\sqrt{3}}{\pi} U_a$$

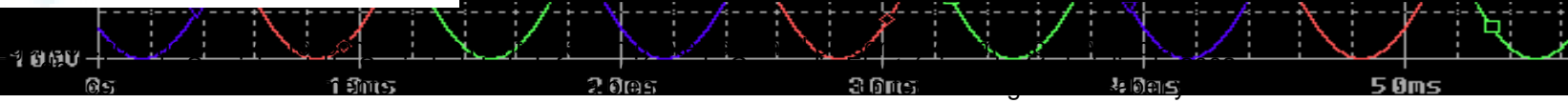
$$U_d = \frac{sq\sqrt{2}}{\pi} \text{sen} \frac{\pi}{q} U_f$$



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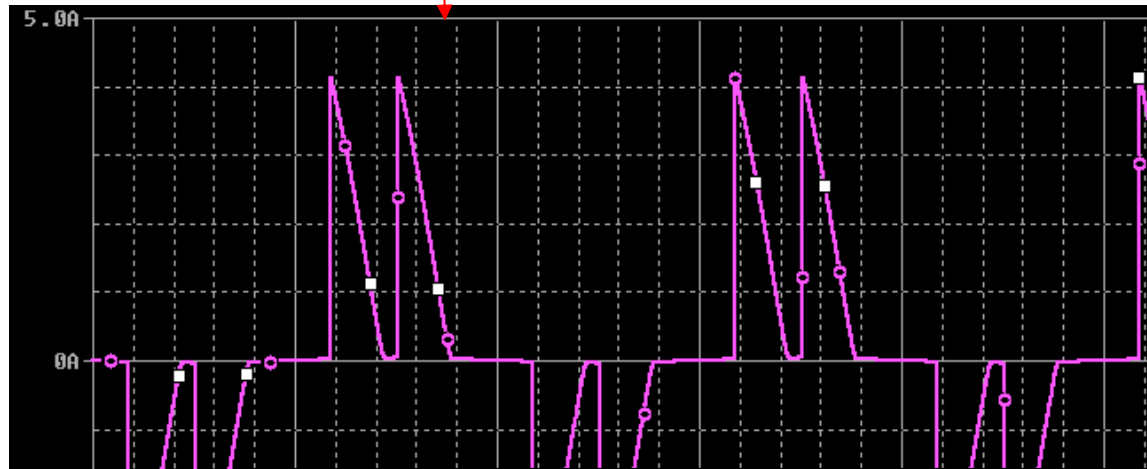
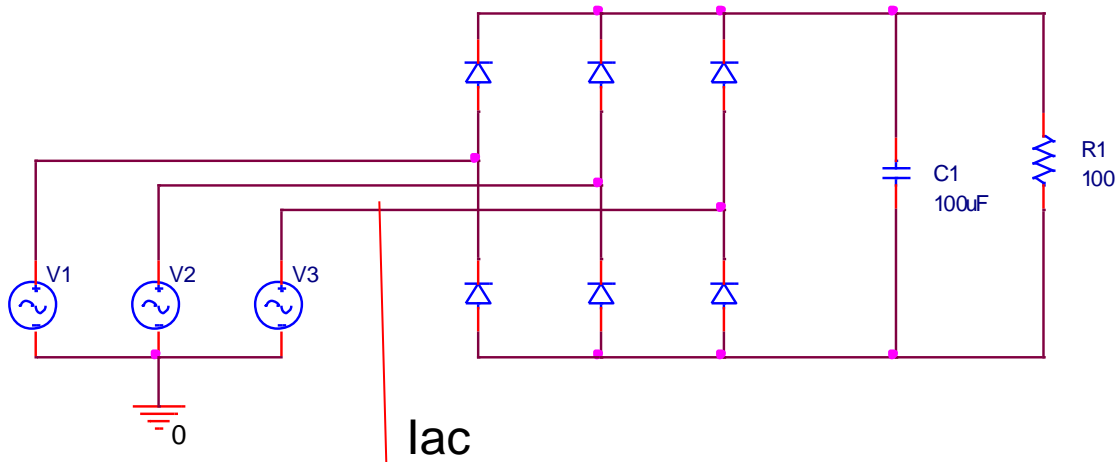
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RECTIFICADOR



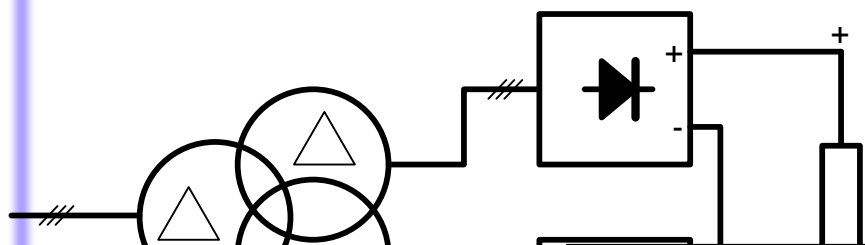
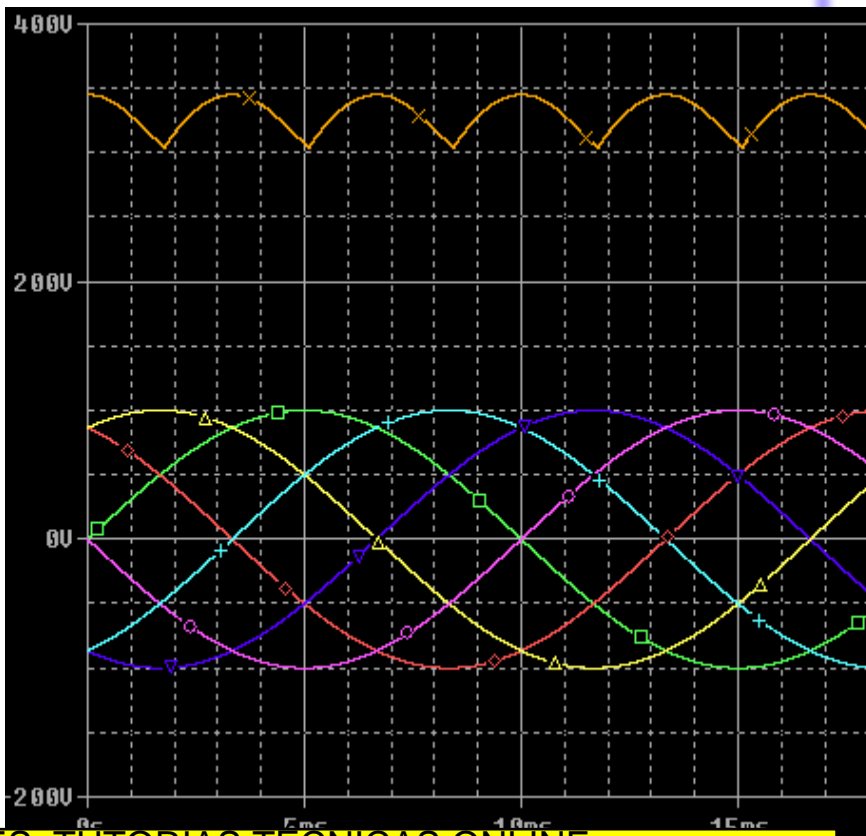
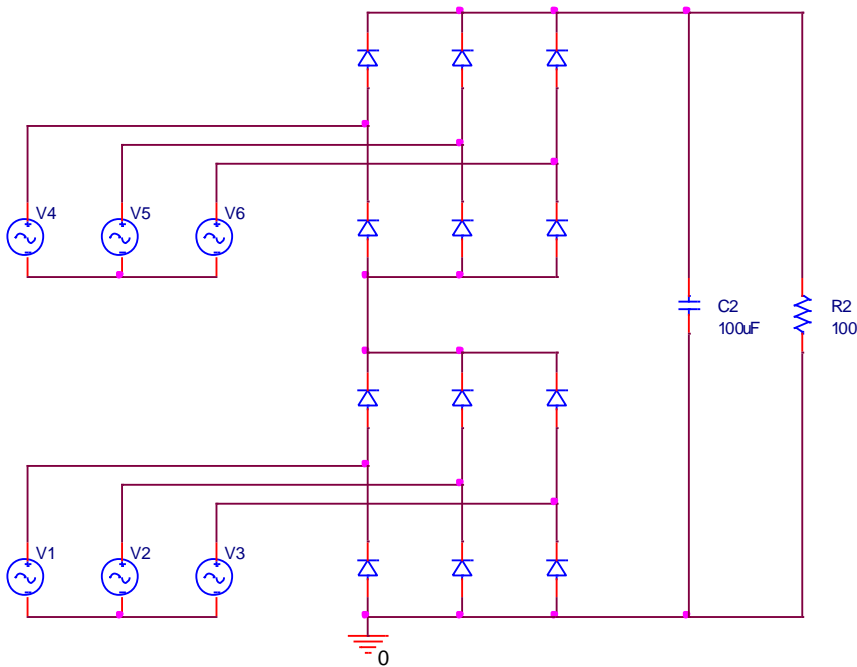
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$$U_d = \frac{6\sqrt{3}}{\pi} U_a$$

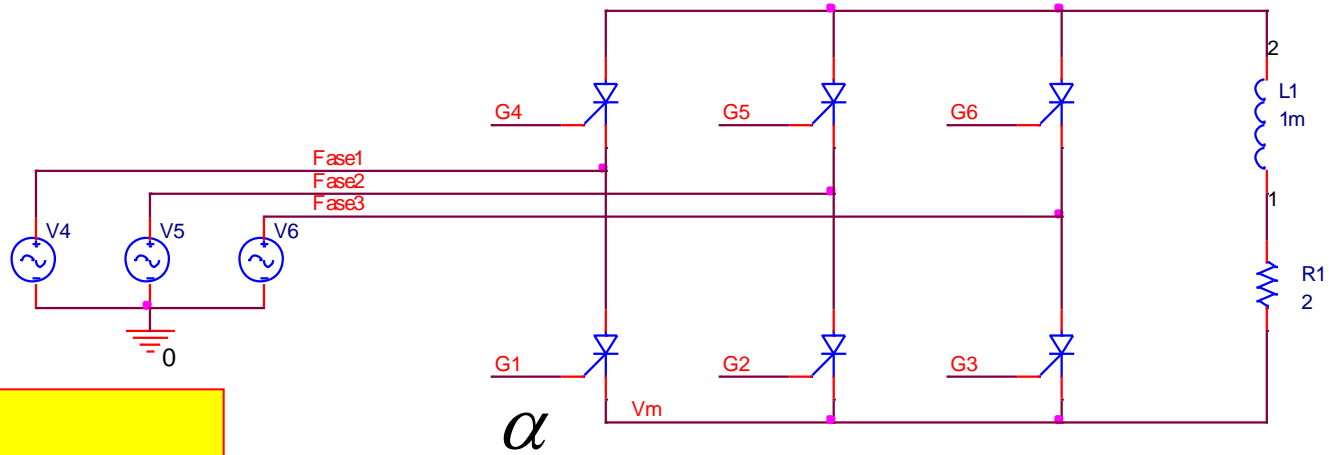


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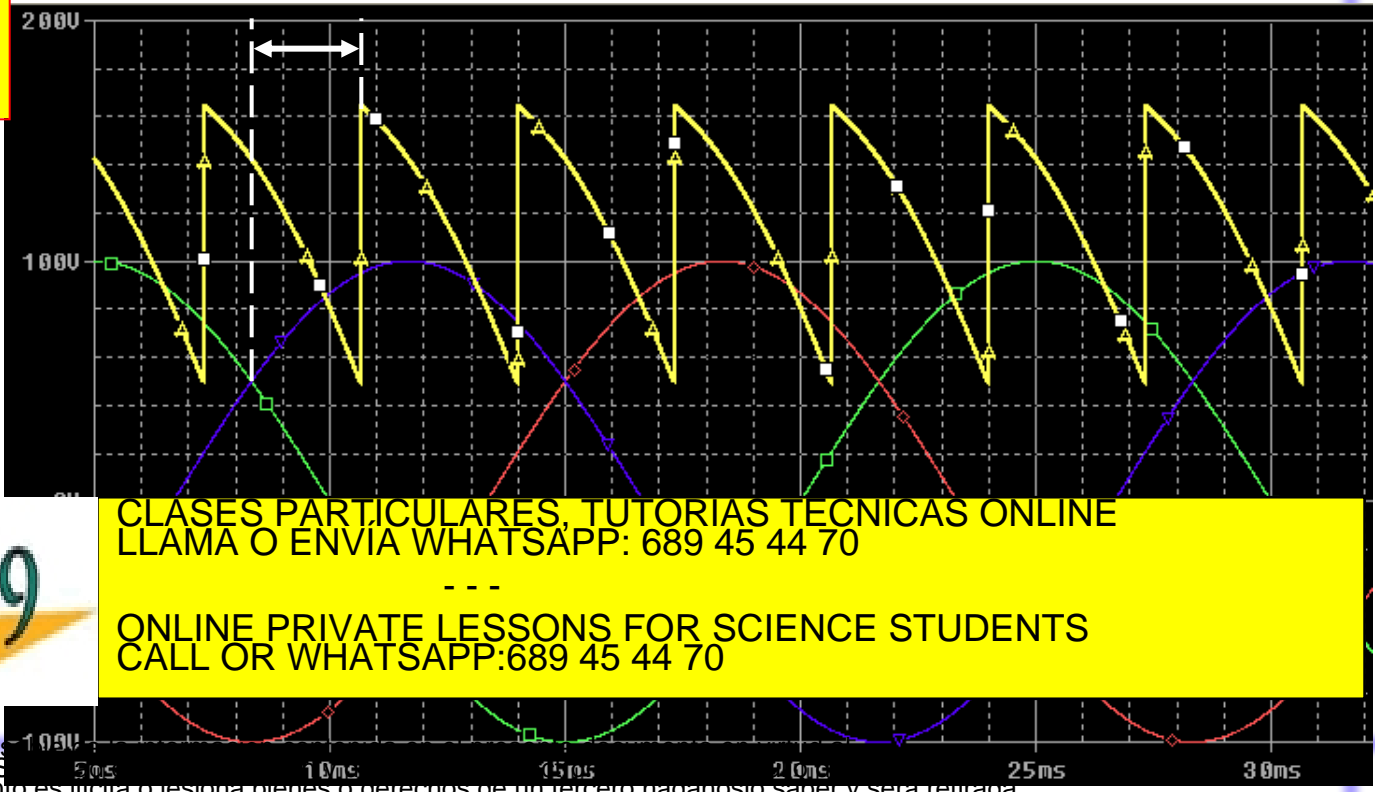
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RECTIFICADOR CONTROLADO



$$U_d = \frac{3\sqrt{3}}{\pi} U_a \cos \alpha$$



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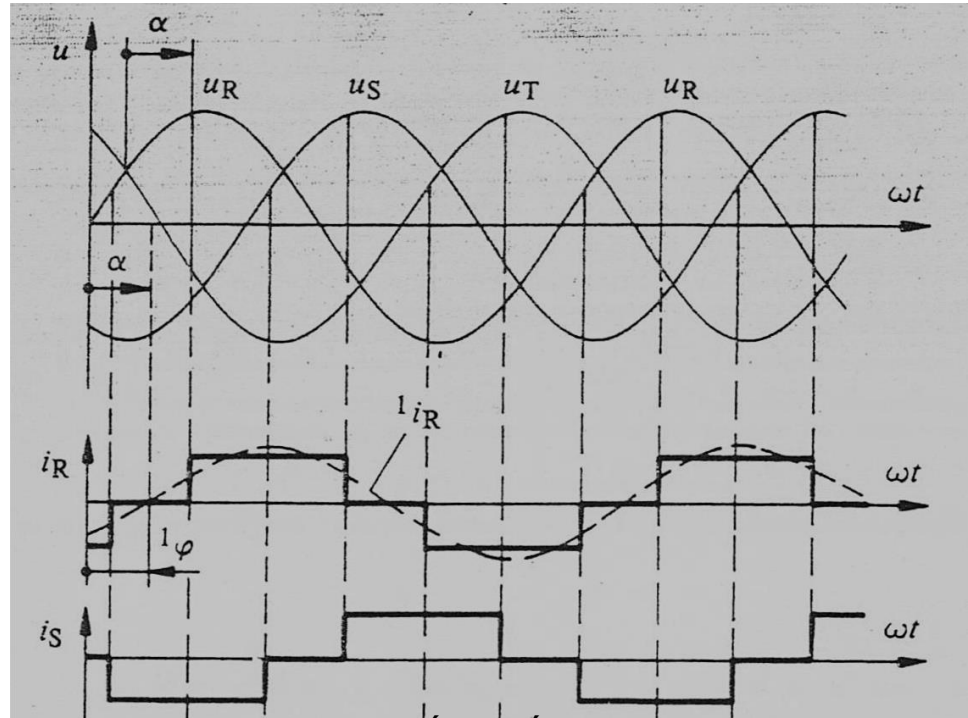
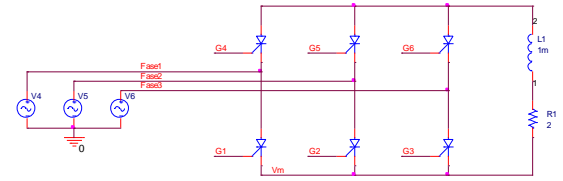
RECTIFICADOR CONTROLADO

$$P = P_1 = 3U_f I_1 \cos \alpha$$

$$Q = Q_1 = 3U_f I_1 \sin \alpha$$

$$I_1 = \frac{\sqrt{6}}{\pi} I_d$$

$$S = 3U_f I = 3U_f \sqrt{\frac{2}{3}} I_d$$



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4 INVERSORES

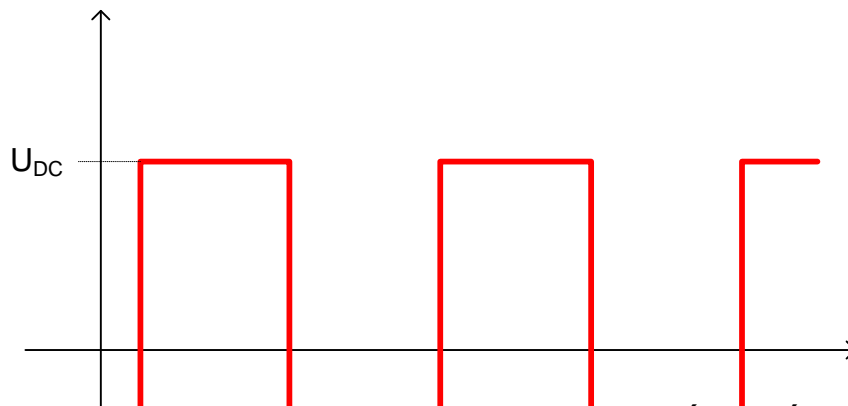
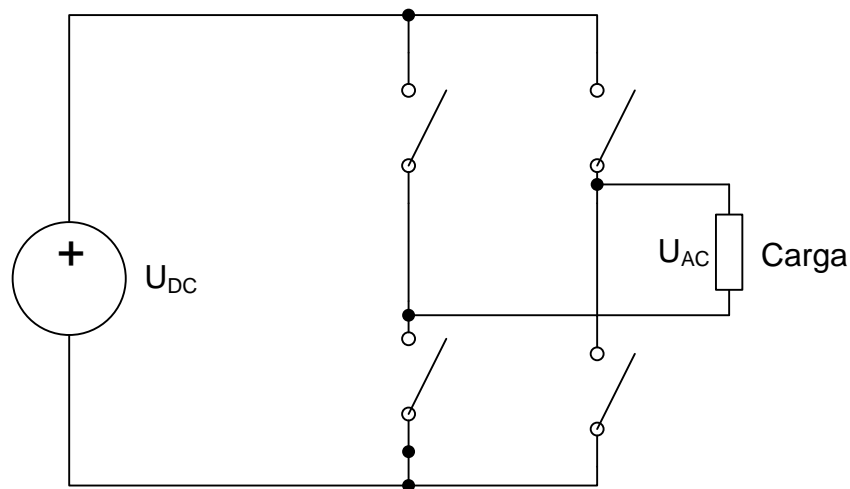
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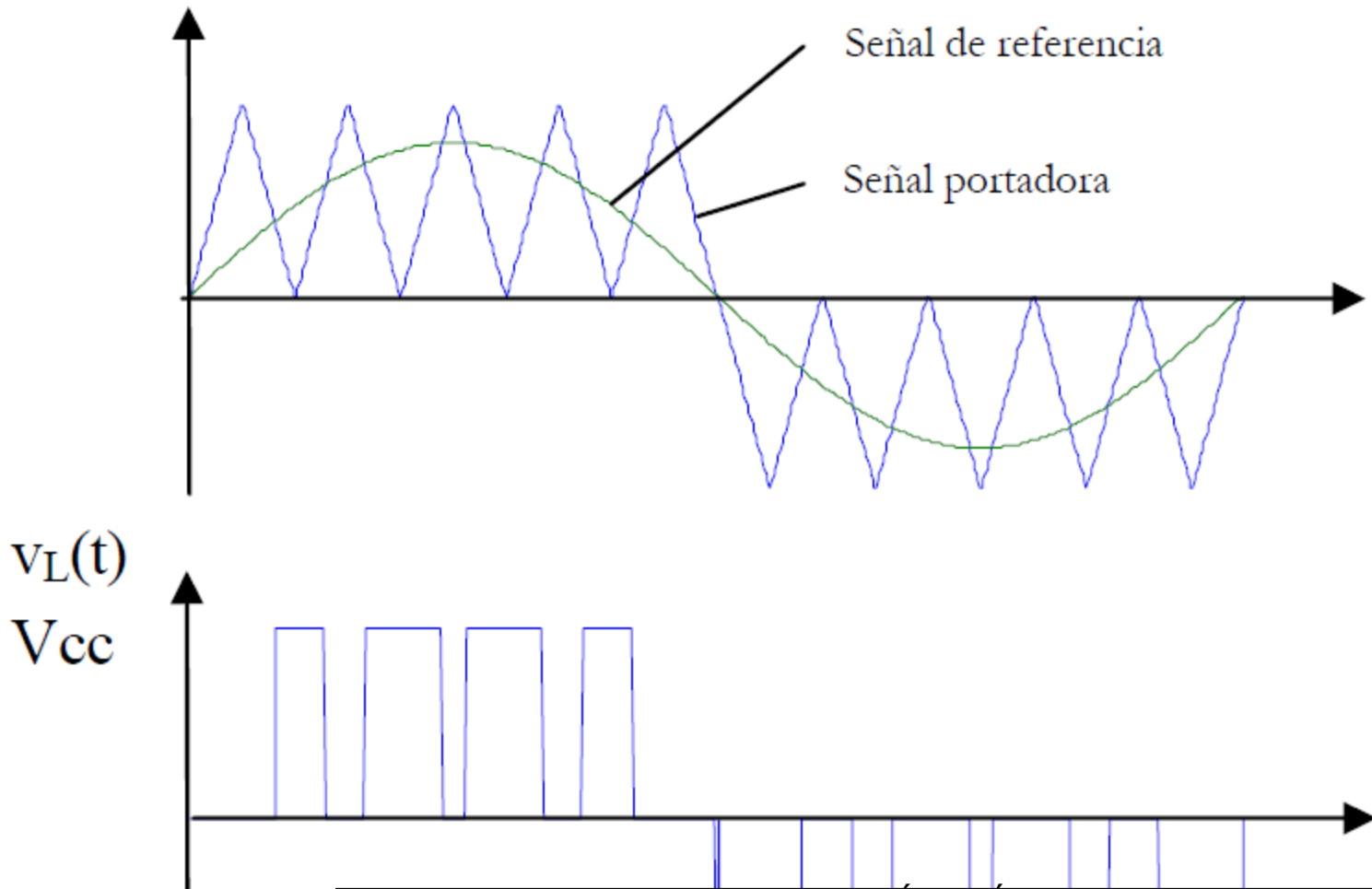
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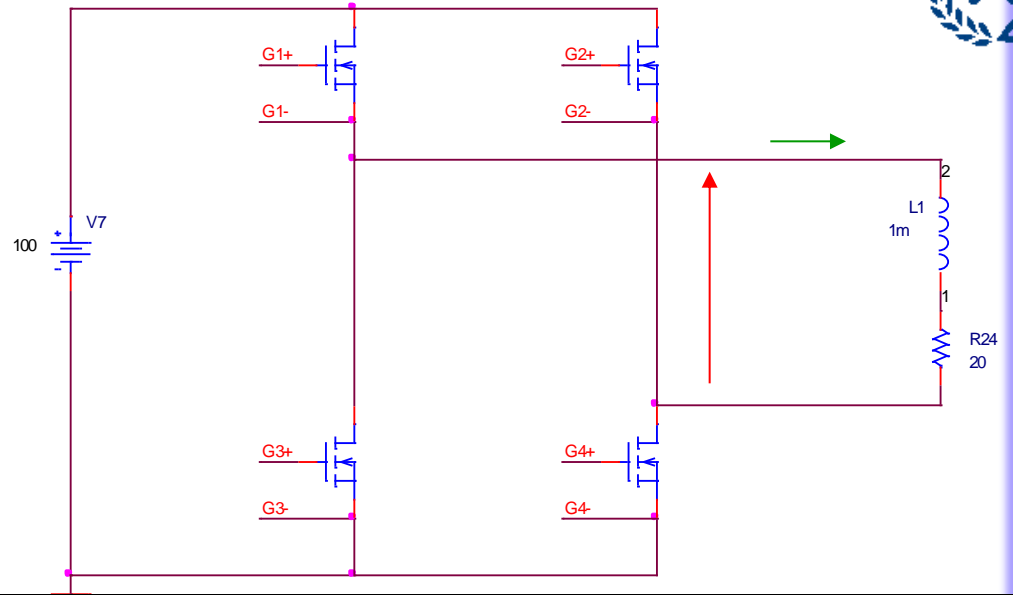
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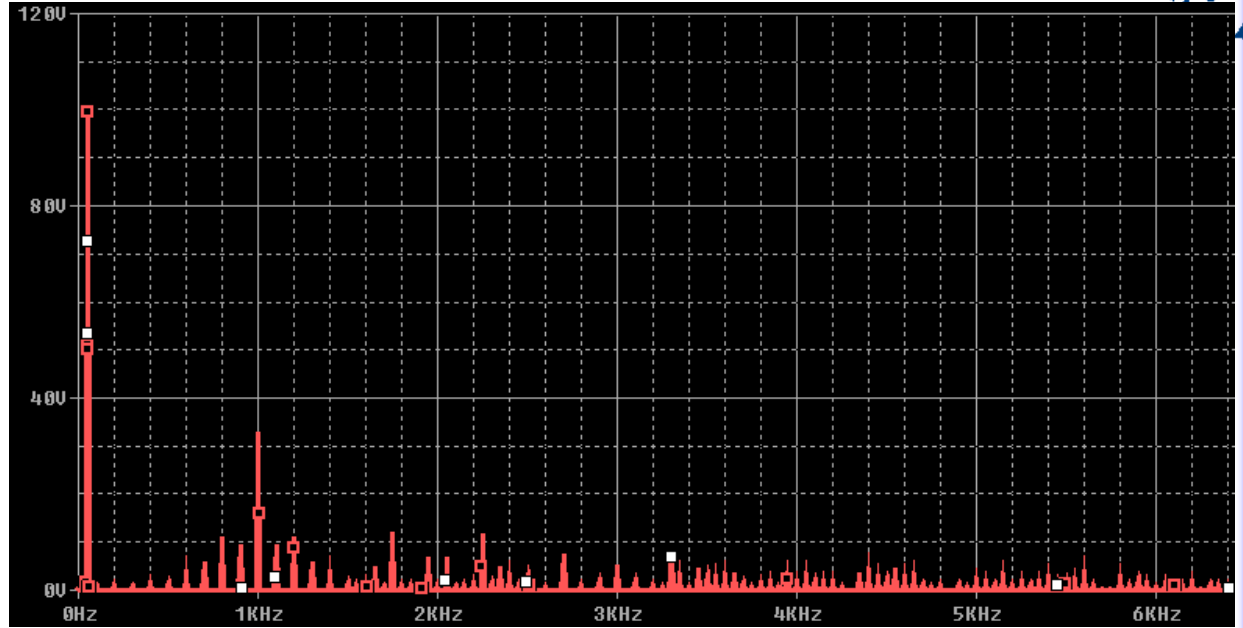


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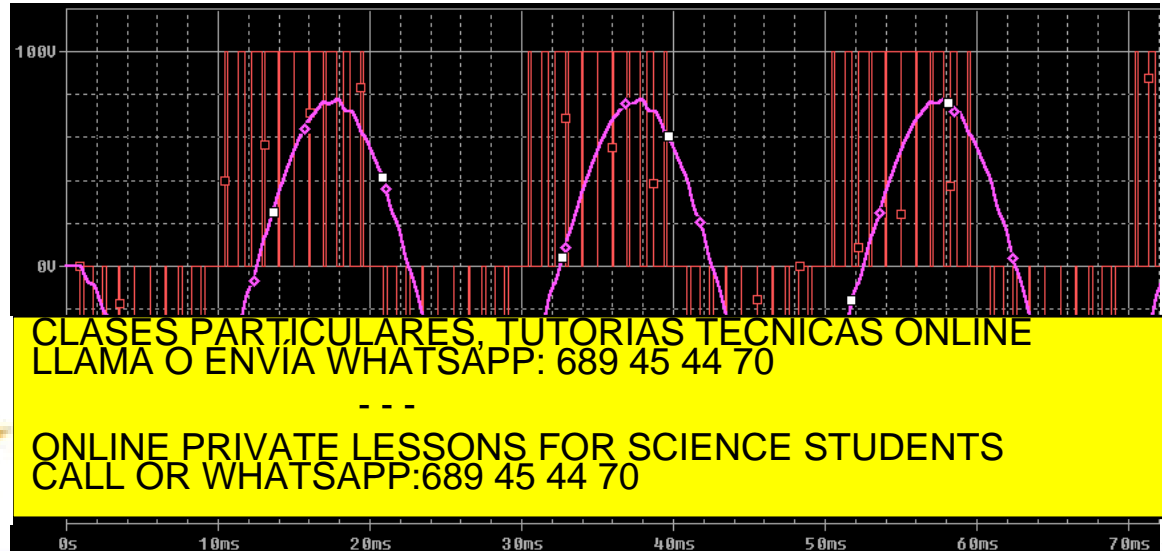


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PWM
armónicos



PWM
filtrado

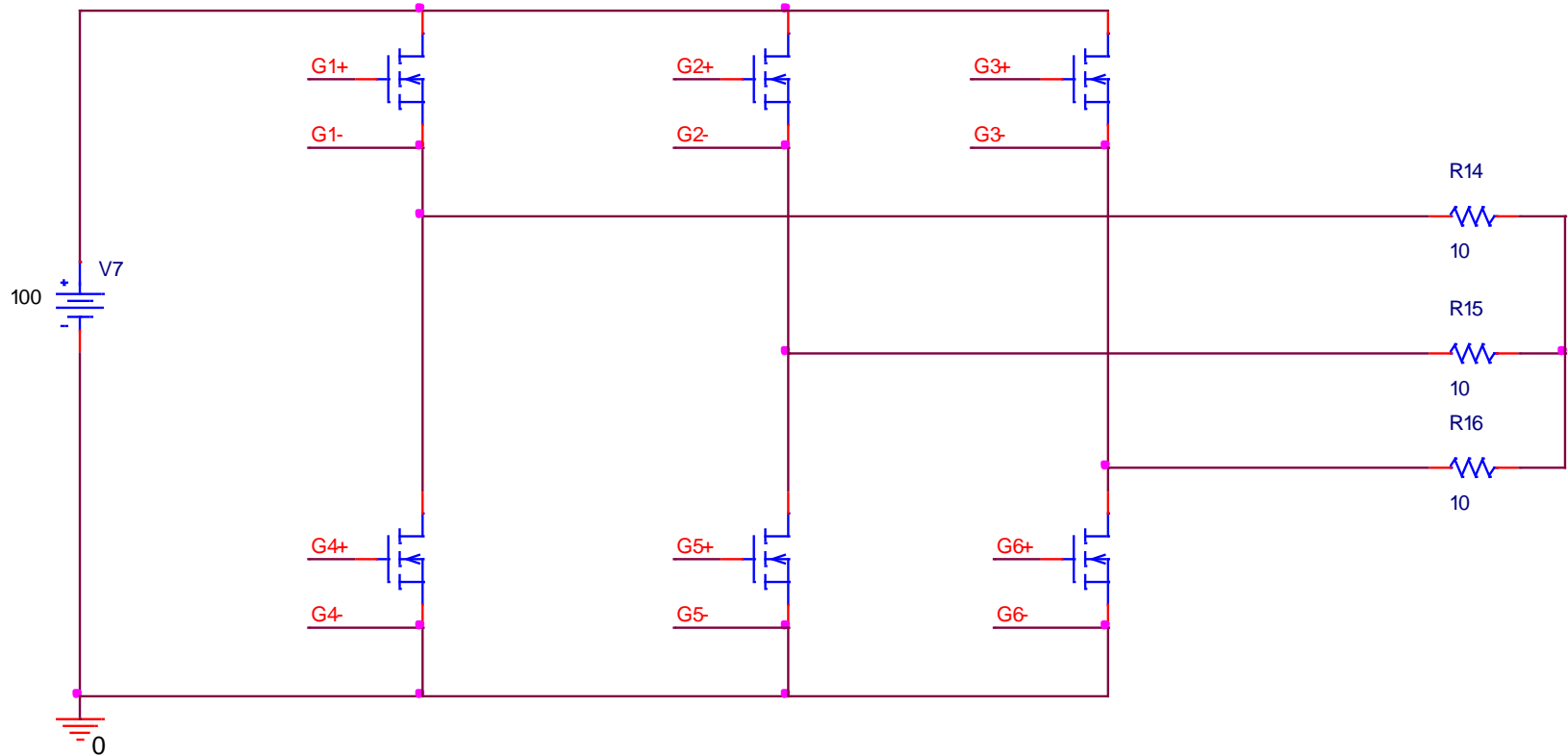


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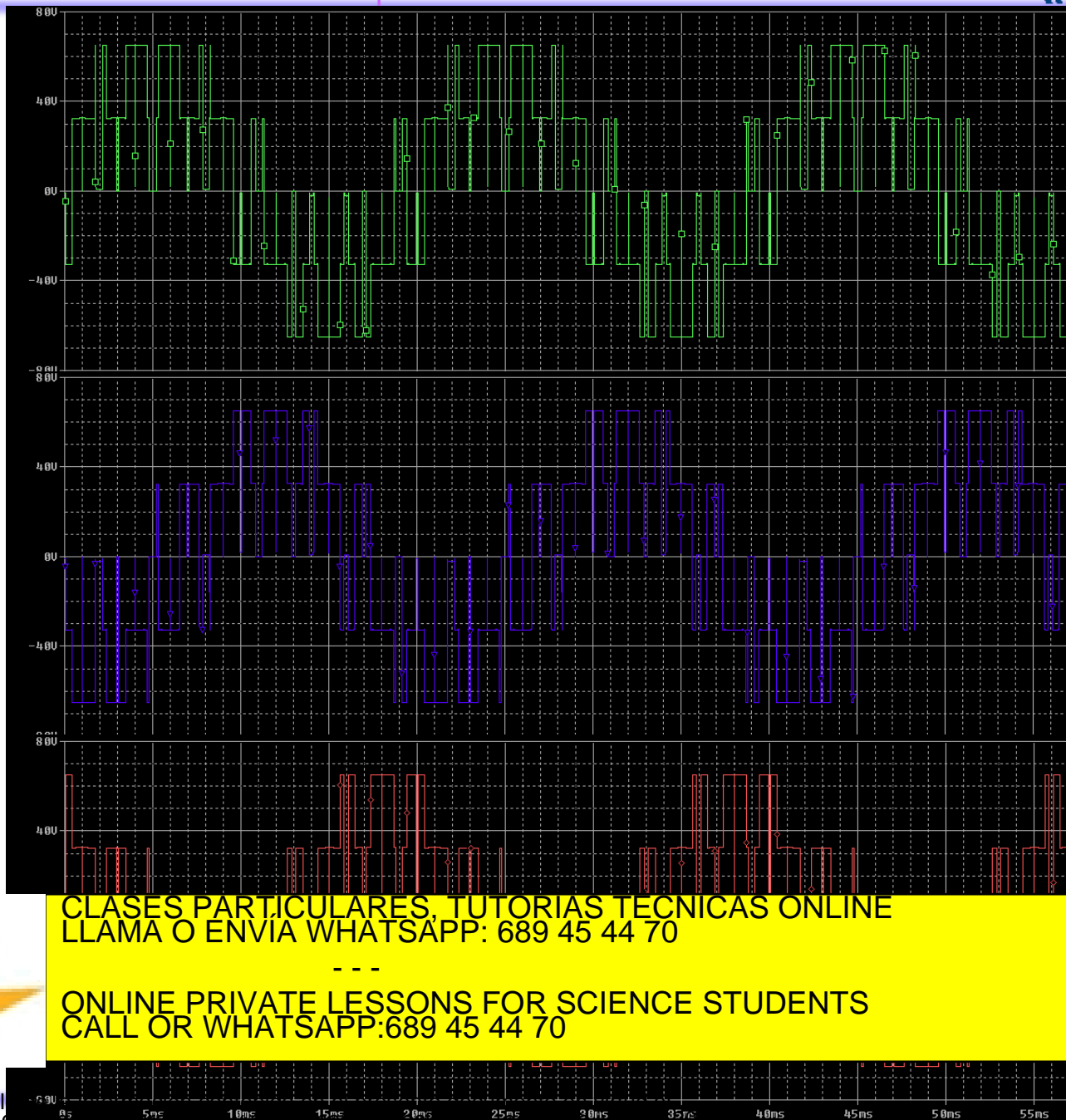
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U_{S1}

U_{S2}



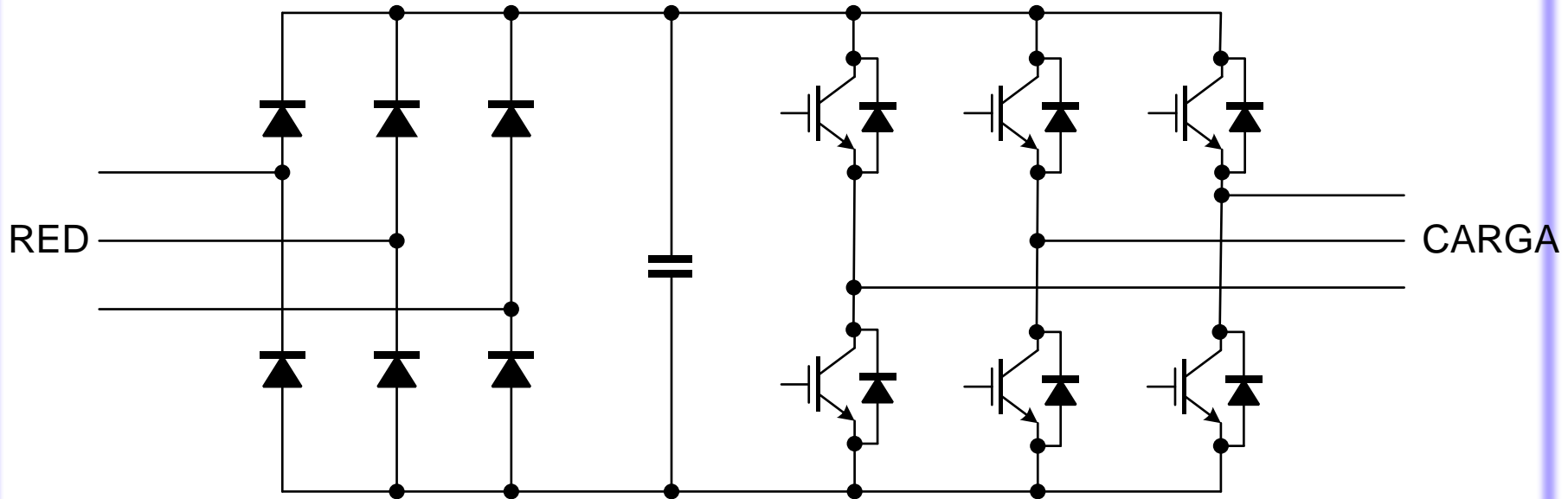
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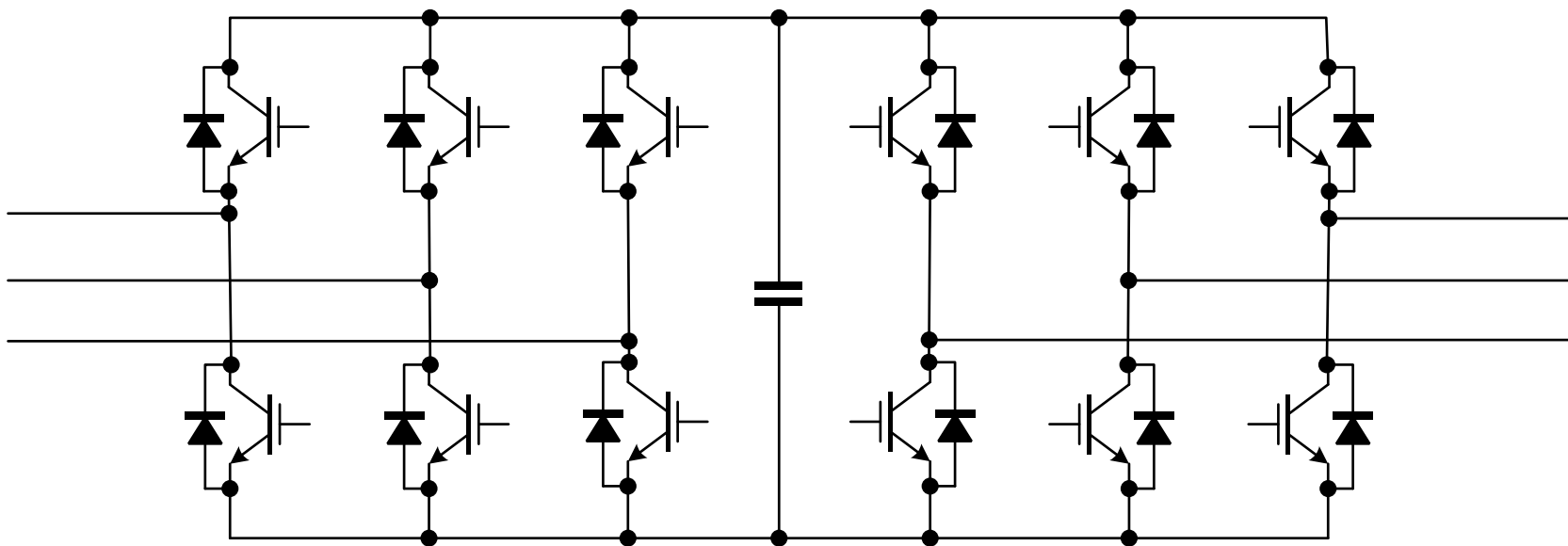
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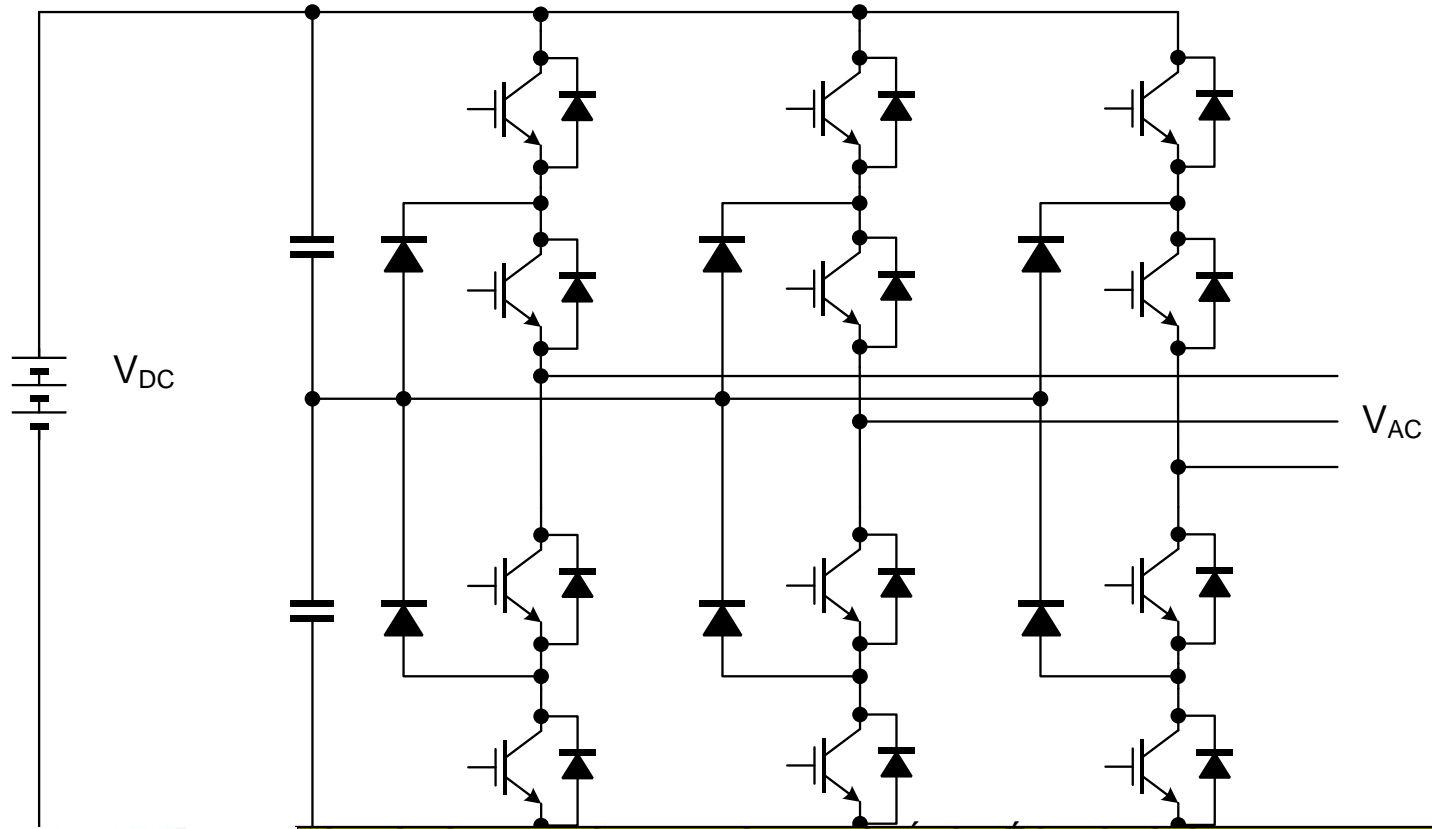


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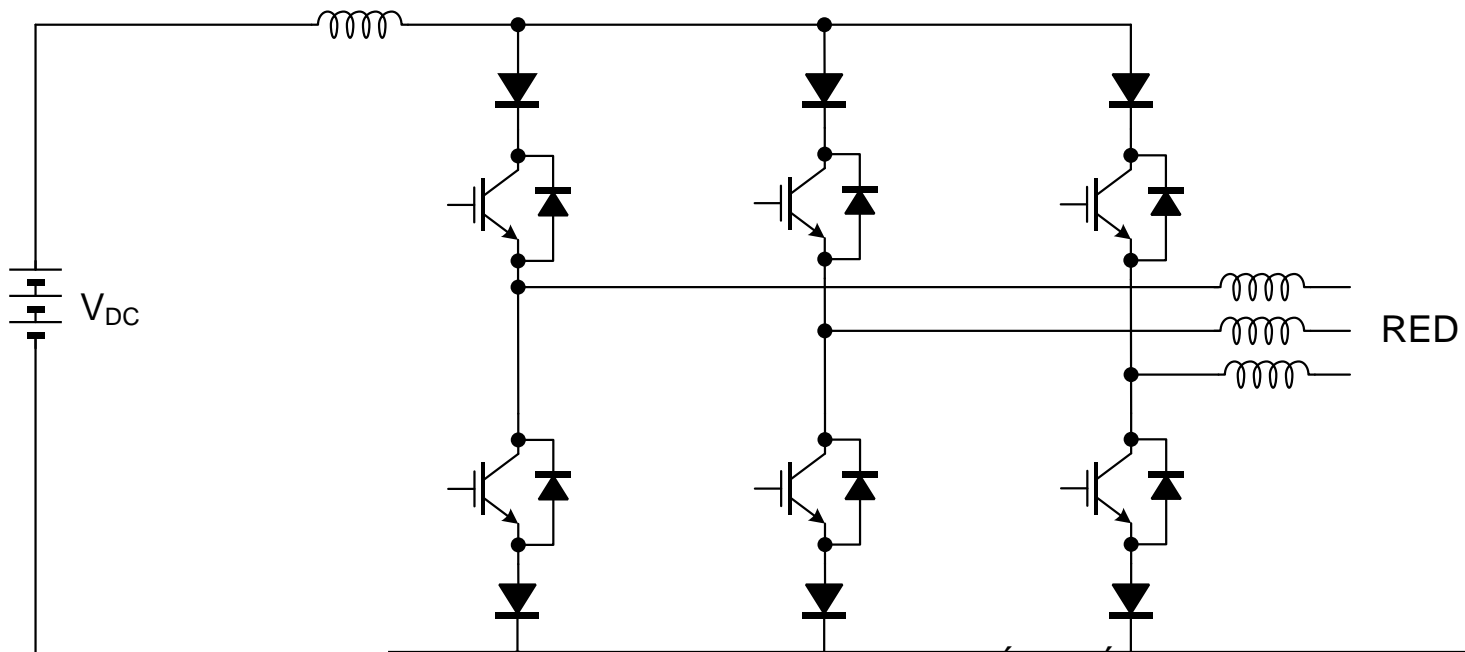


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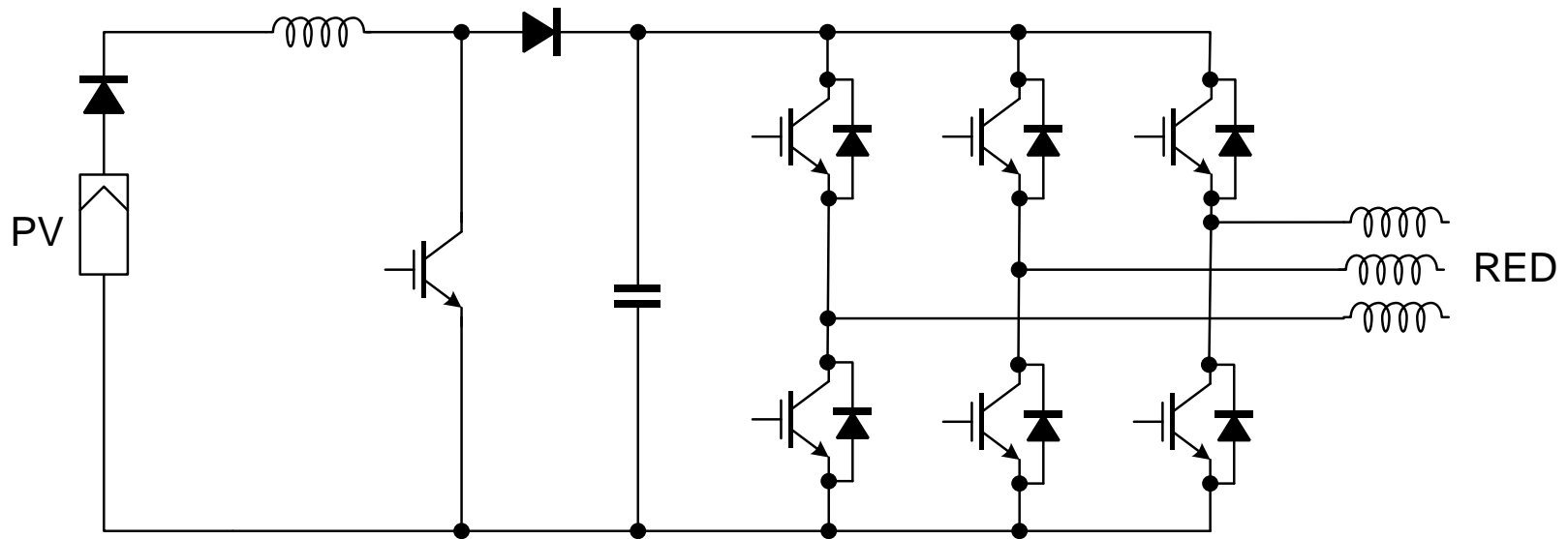
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+
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