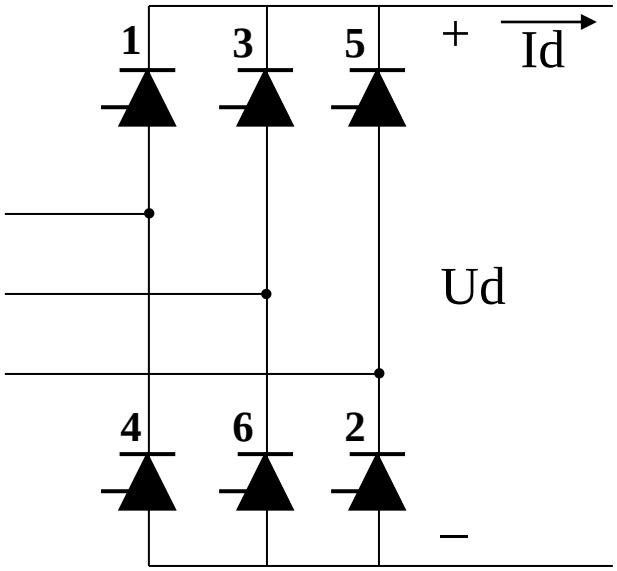
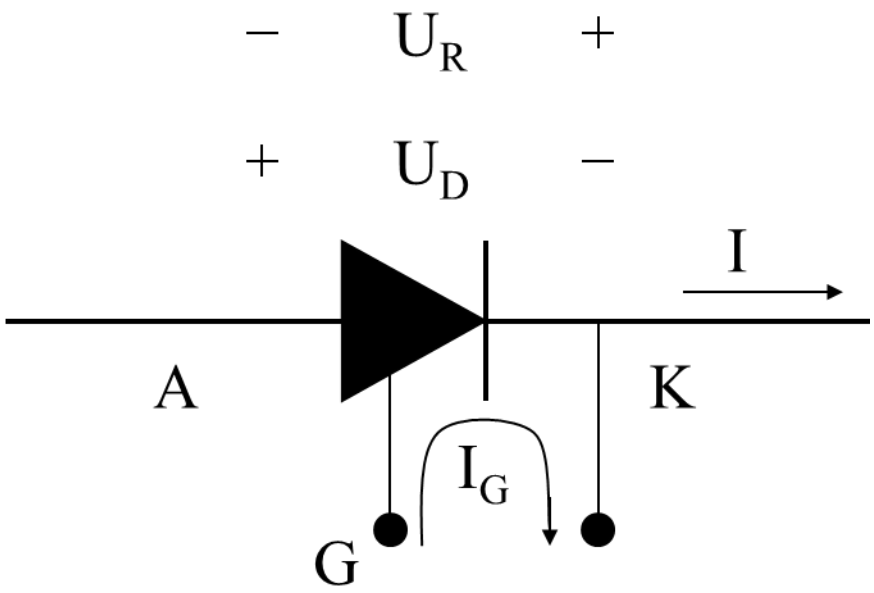
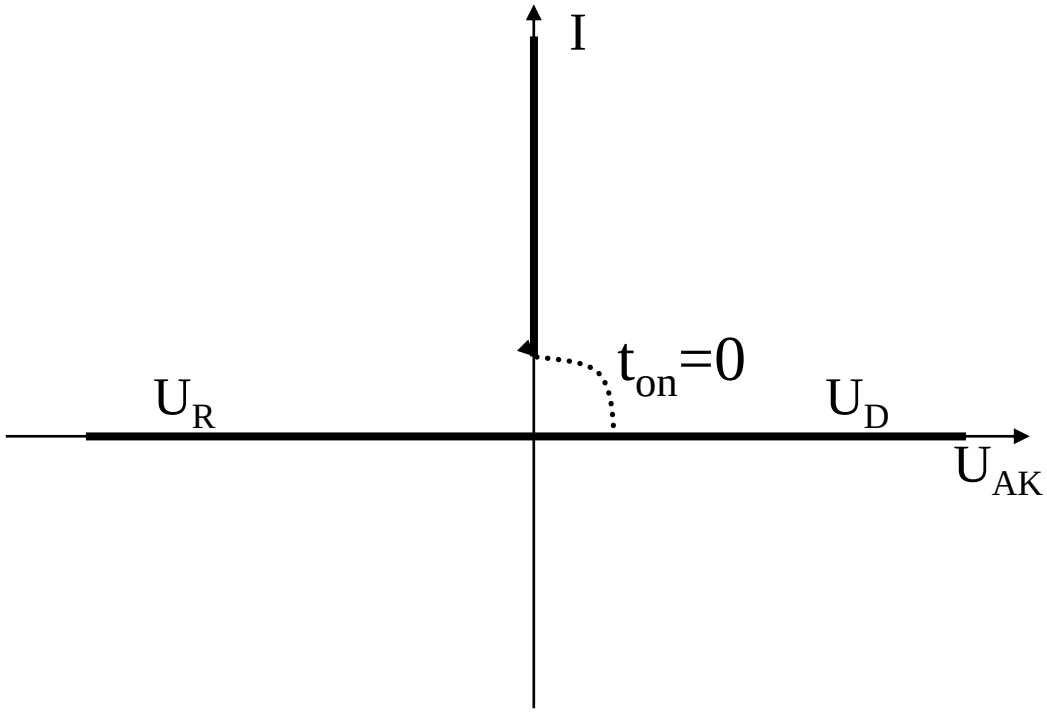
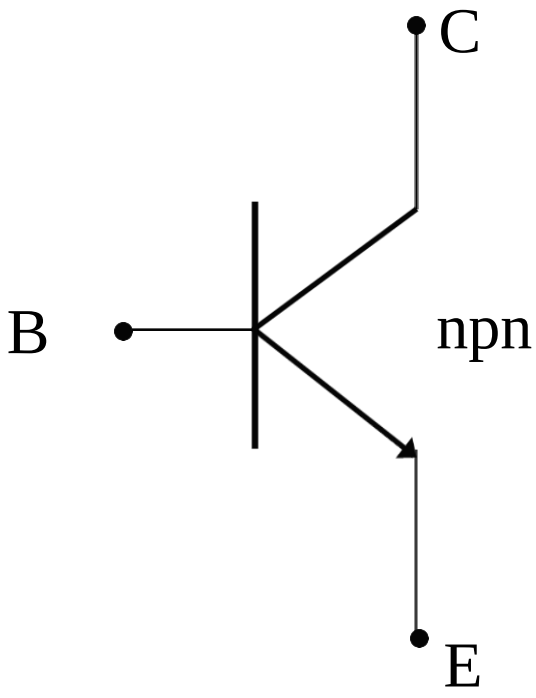
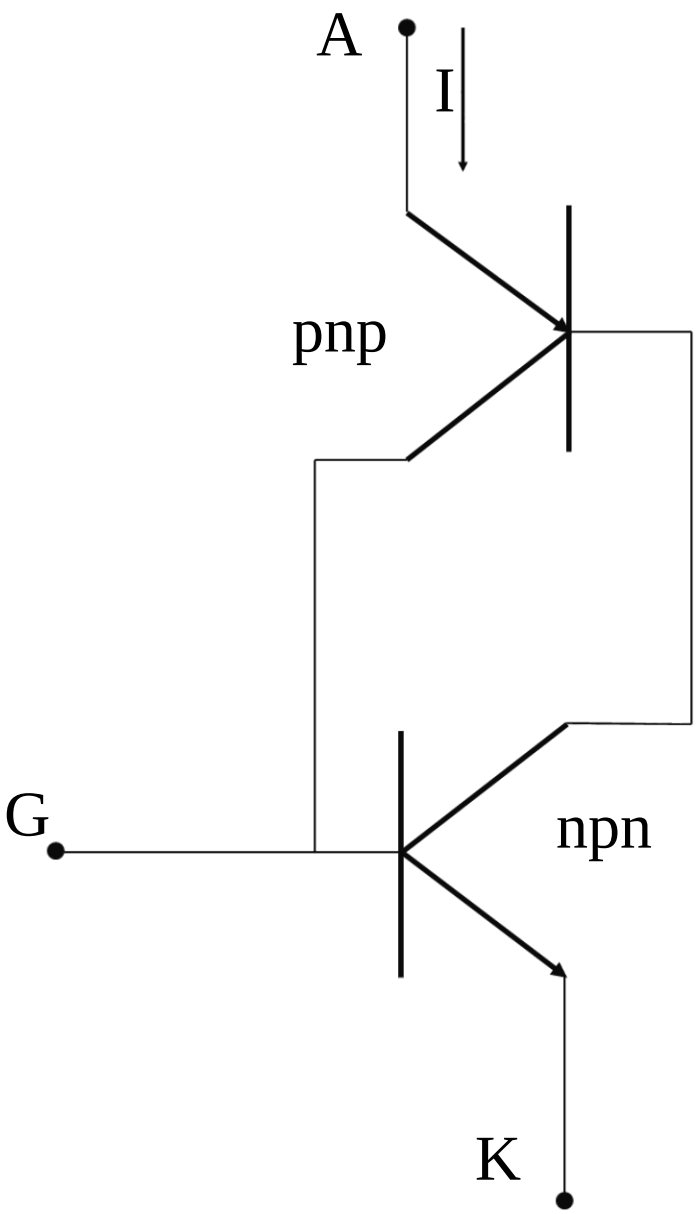
Componentes – Tiristores

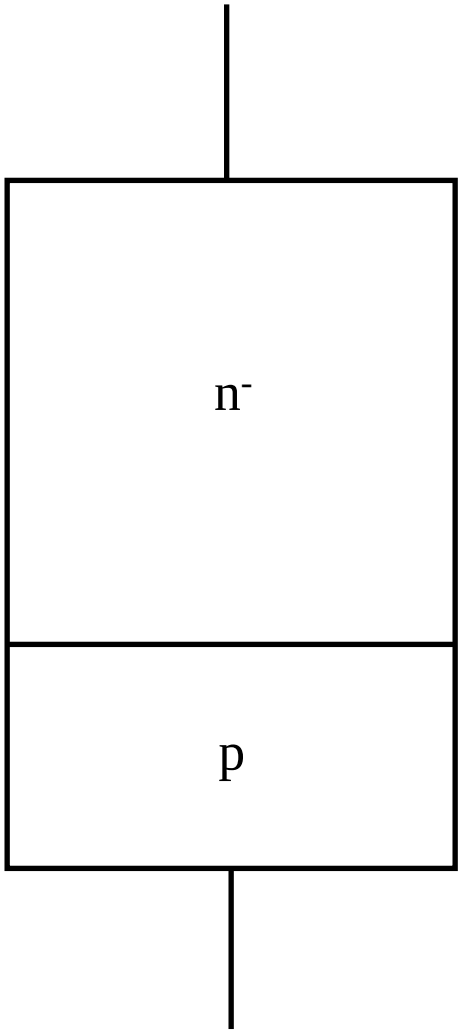



− U_R +
+ U_D −
I
A
K
I_G
G

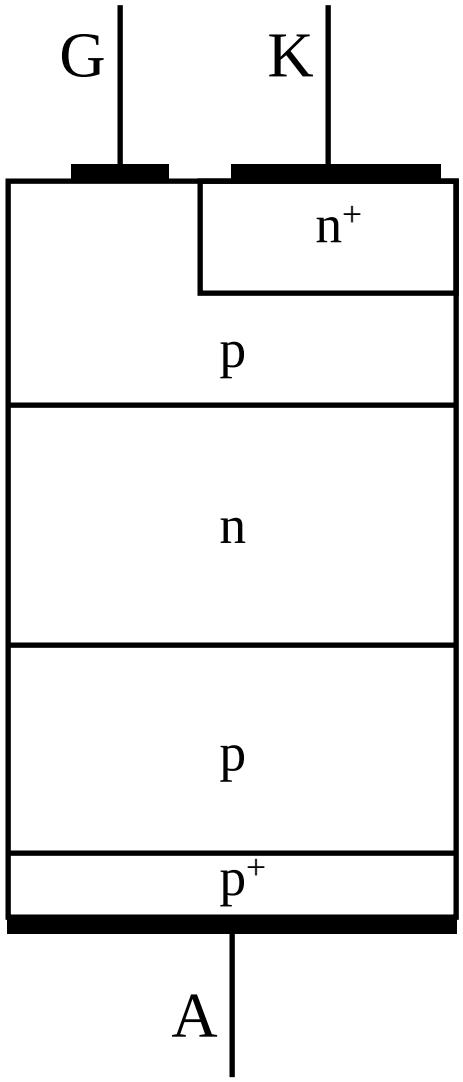

I
t_{on}=0
U_R
U_D
U_{AK}


C
B
npn
E

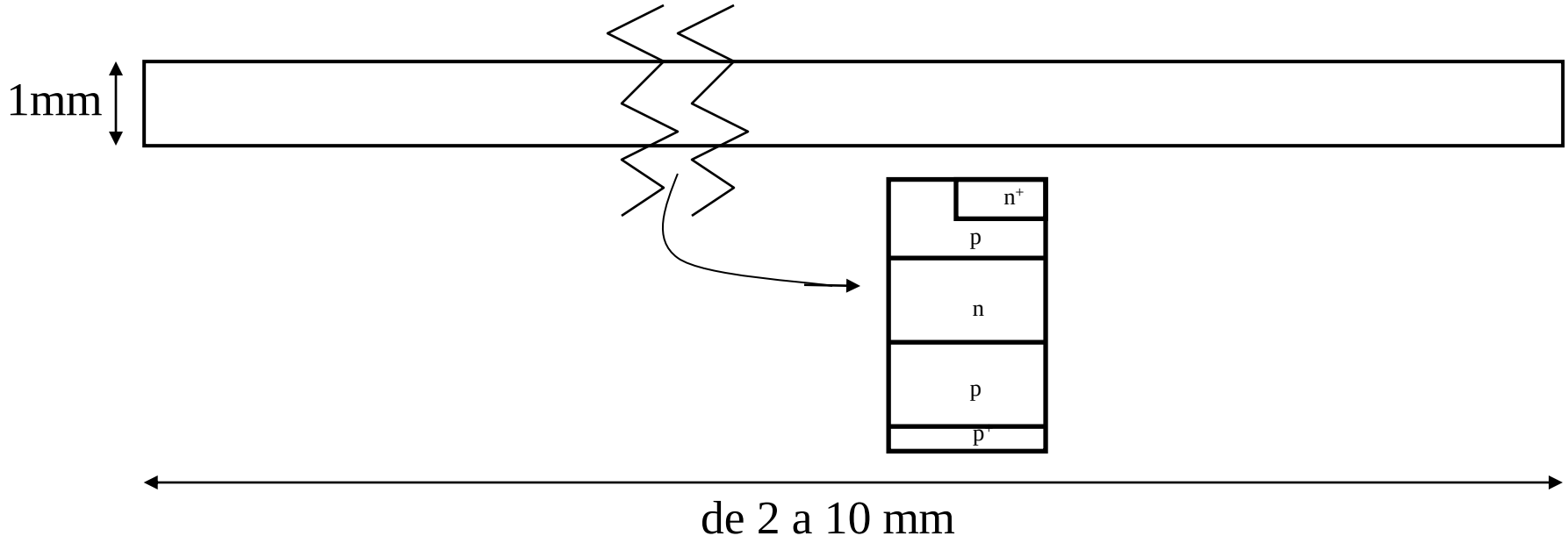

A
I
pnp
G
npn
K


n-
p

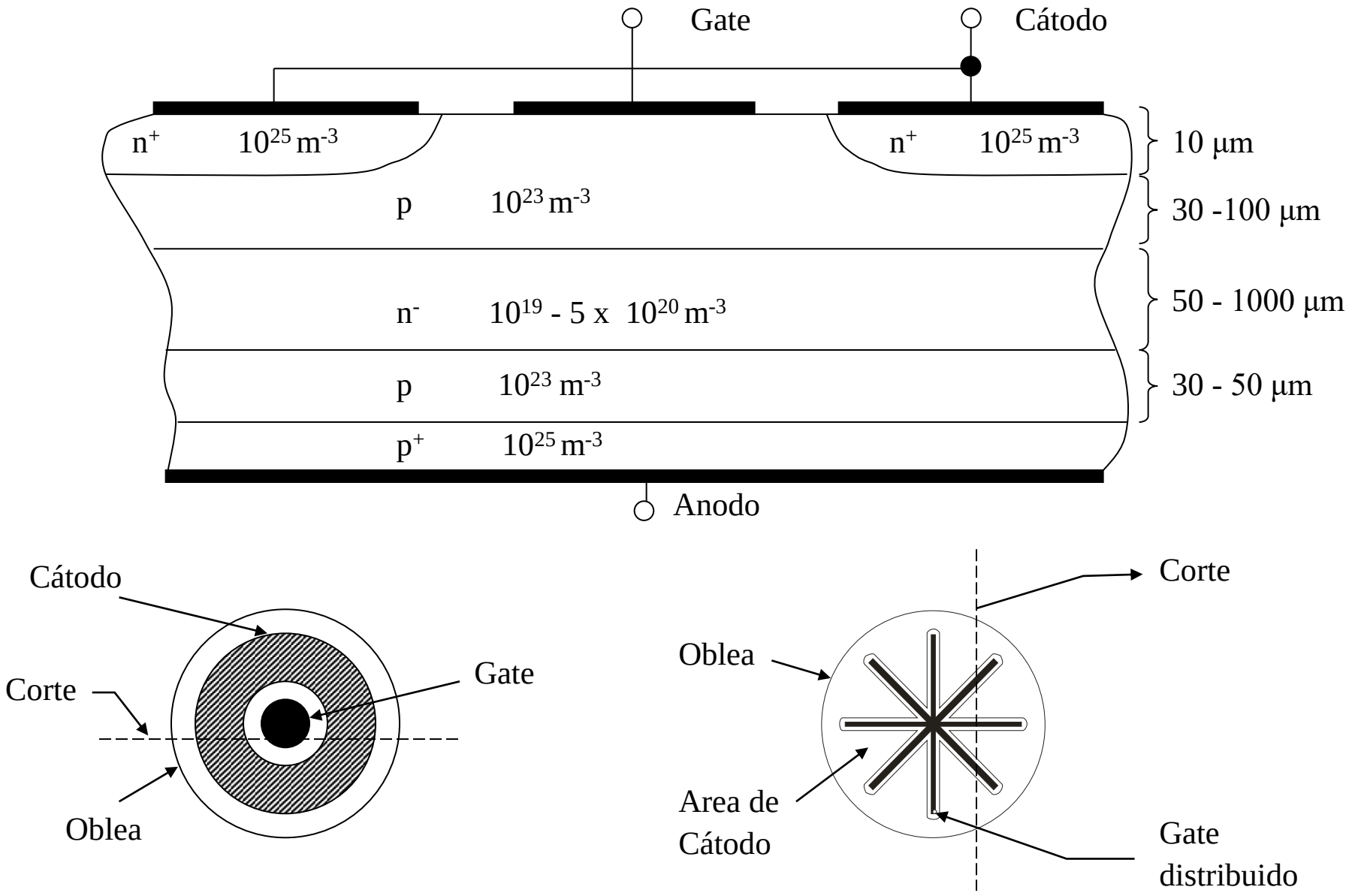
Esquema constructivo del tiristor



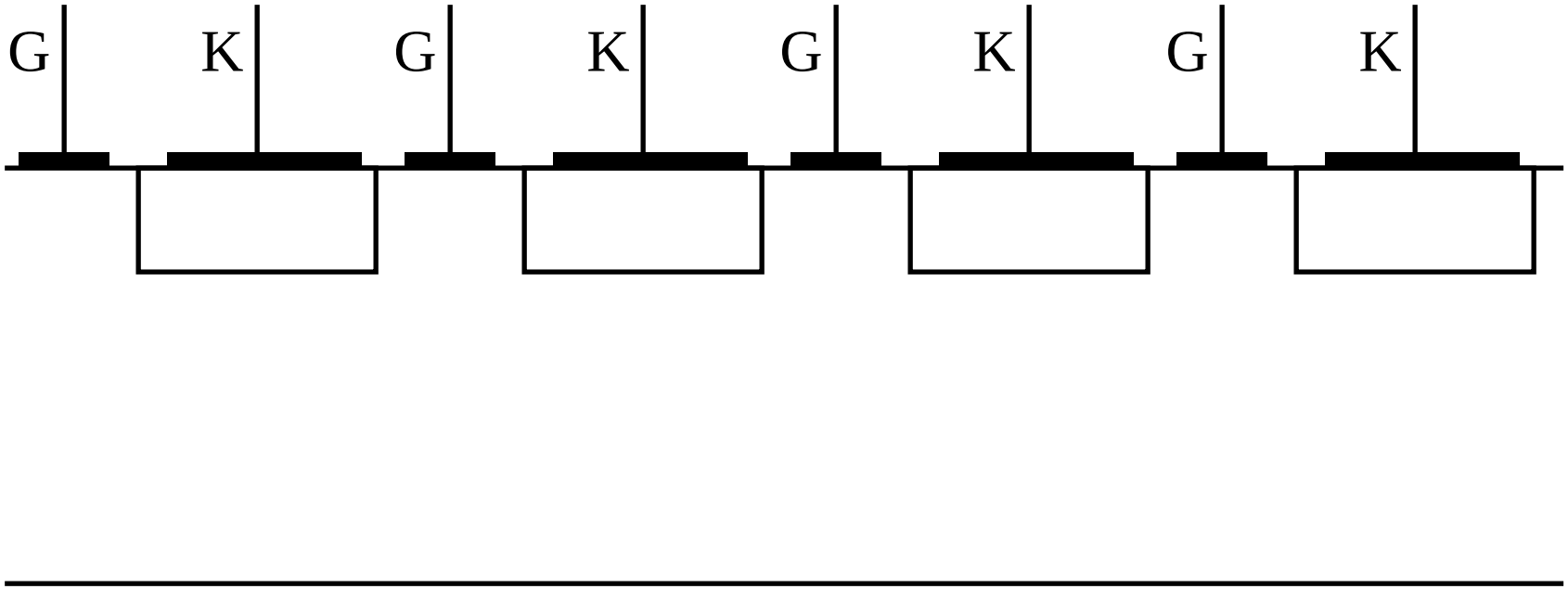
Oblea de silicio con dimensiones



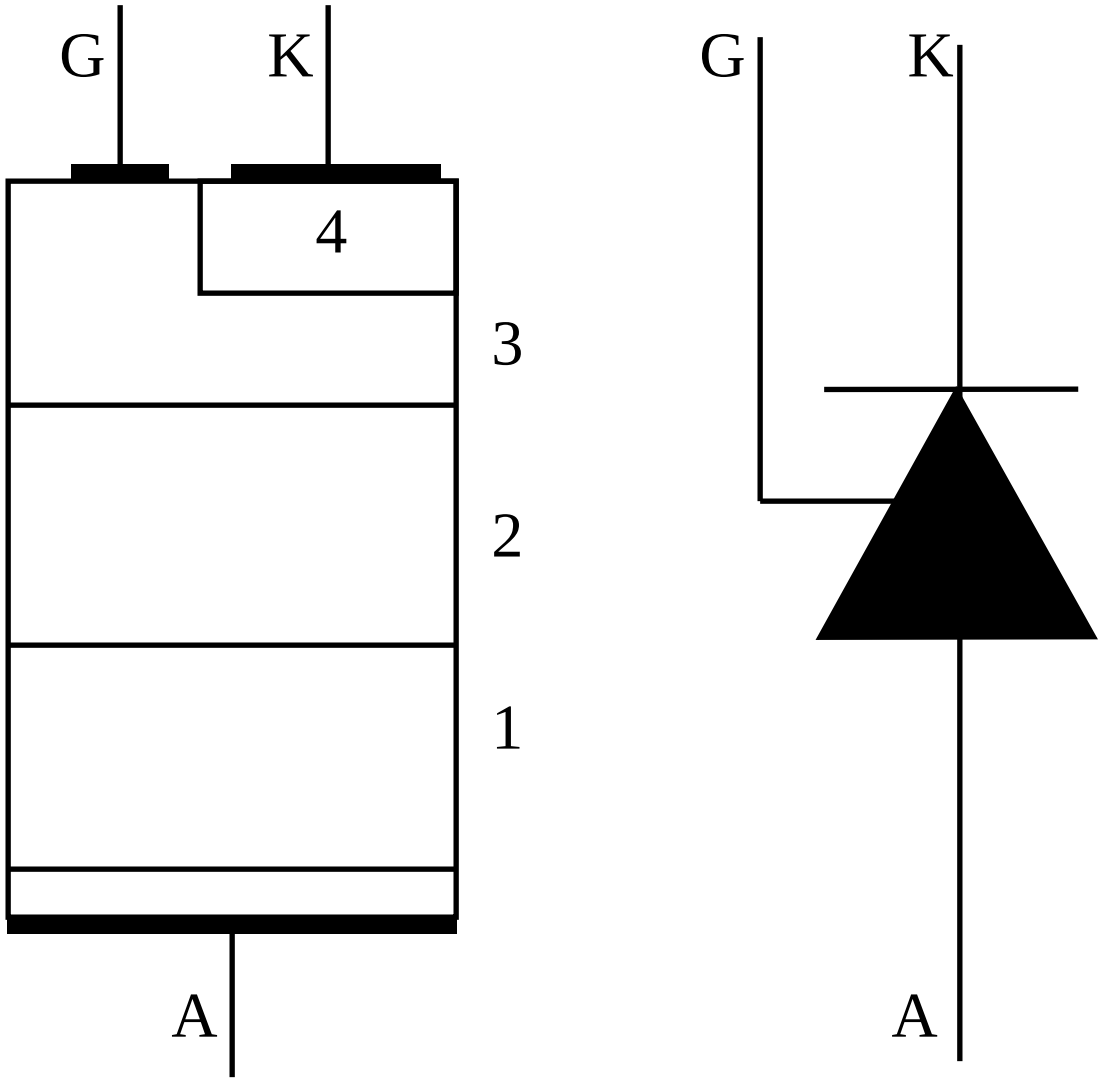
(largo o diámetro - puede ser circular o cuadrado)

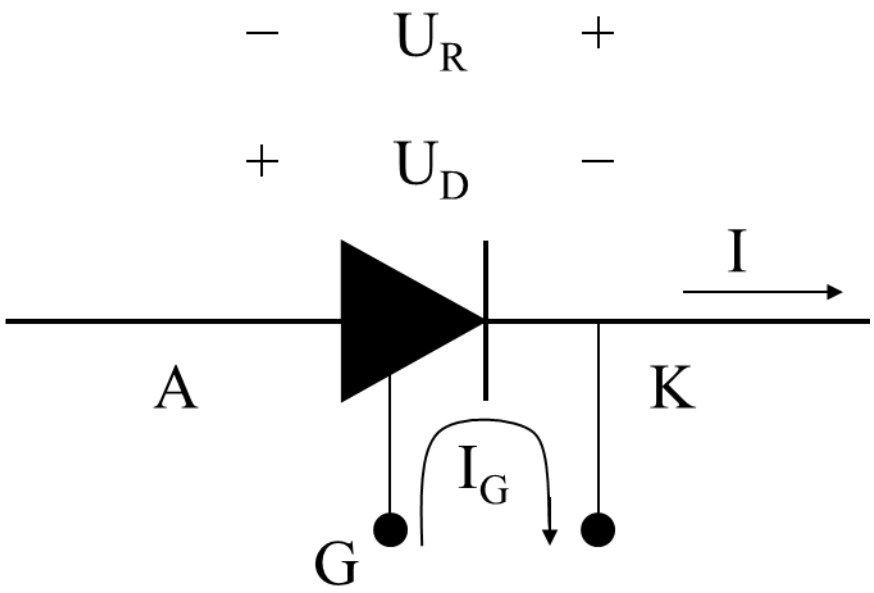

Gate
Cátodo
n+ 10^25 m^-3
n+ 10^25 m^-3
10 μm
p 10^23 m^-3
30 -100 μm
n- 10^19 - 5 x 10^20 m^-3
50 - 1000 μm
p 10^23 m^-3
30 - 50 μm
p+ 10^25 m^-3
Anodo
Cátodo
Corte
Gate
Oblea
Corte
Oblea
Area de
Cátodo
Gate
distribuido

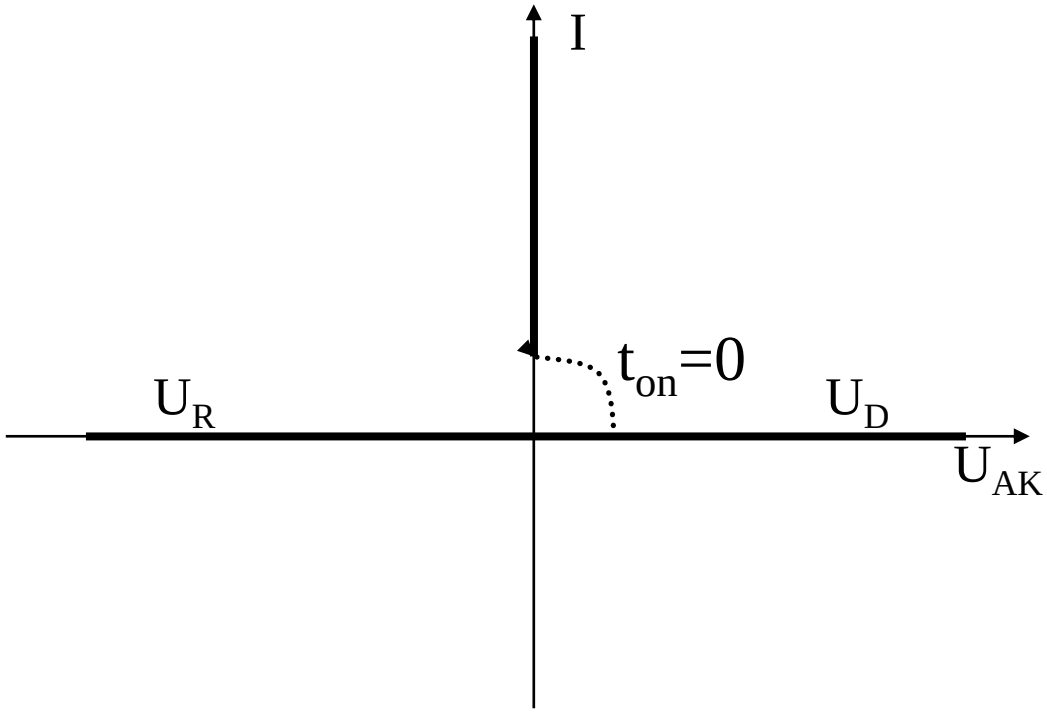
Esquema constructivo tiristor III



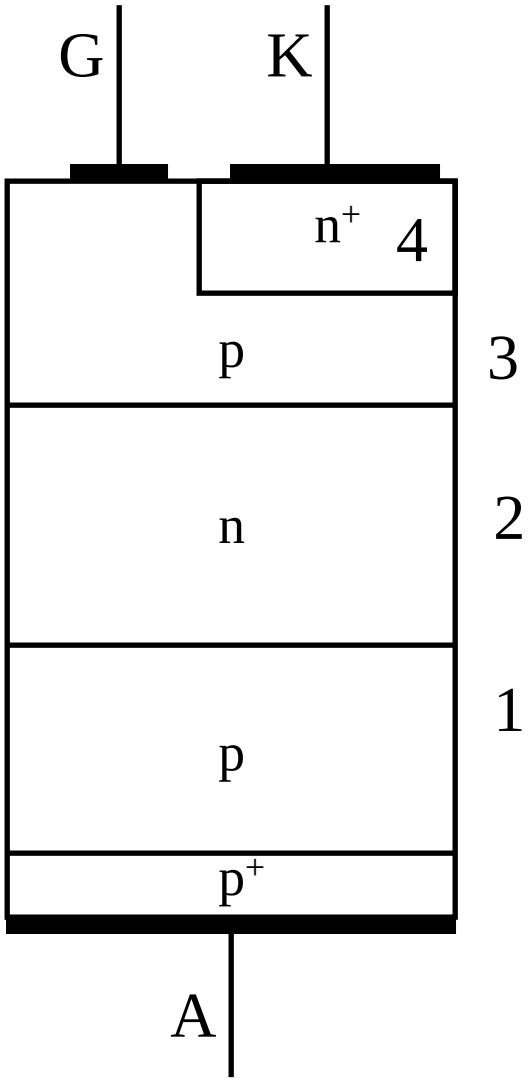
Esquema constructivo tiristor IV



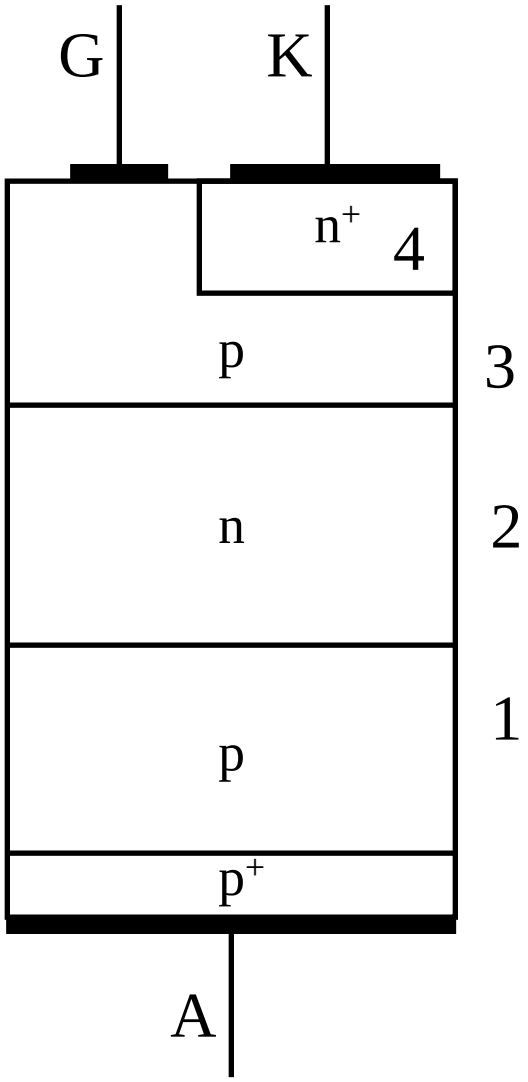

− U_R +
+ U_D −
I
A
K
I_G
G


I
t_{on}=0
U_R
U_D
U_{AK}

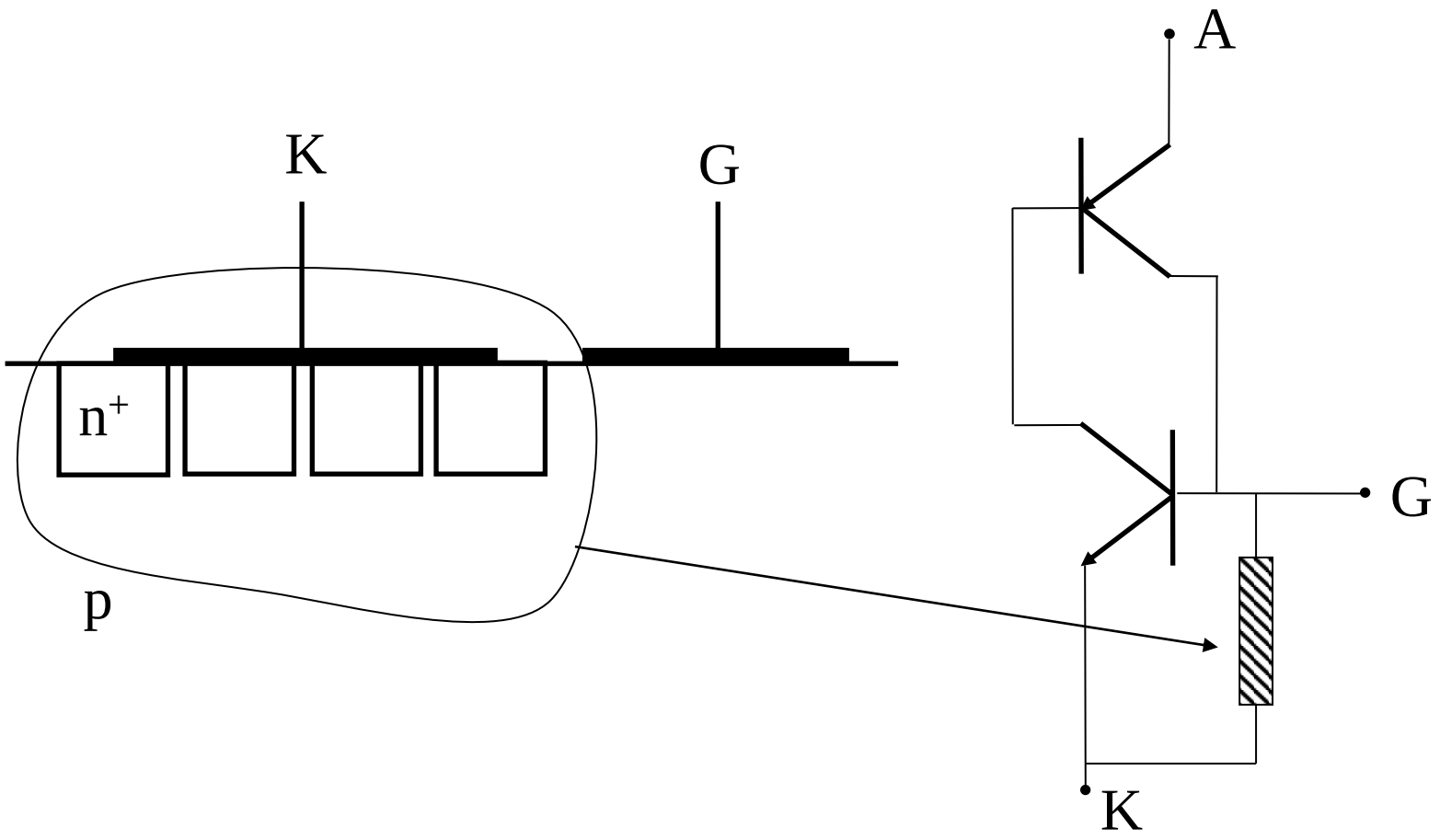
Bloqueo inverso



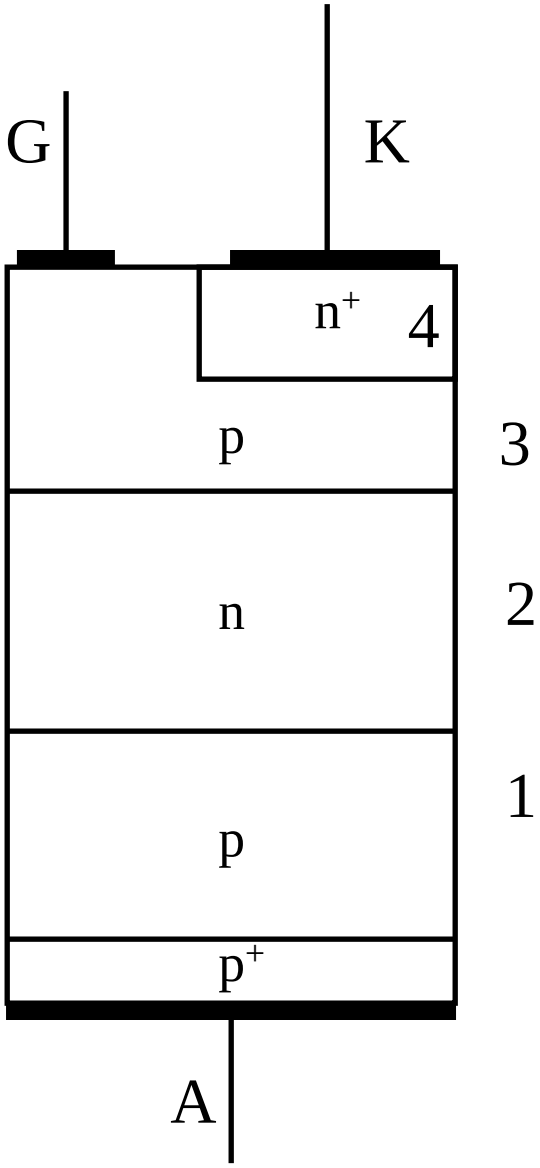
Bloqueo directo



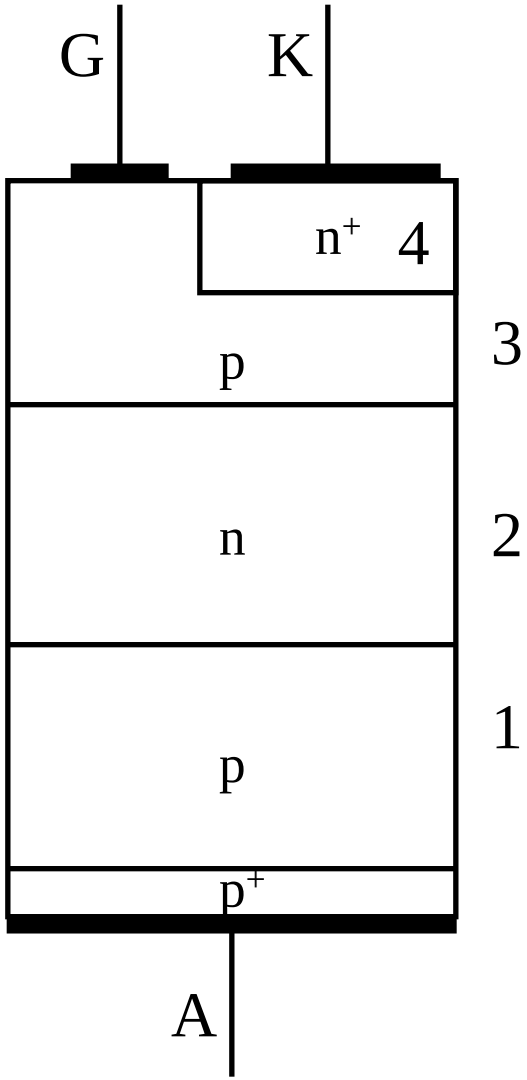
Modificación para aumentar IG



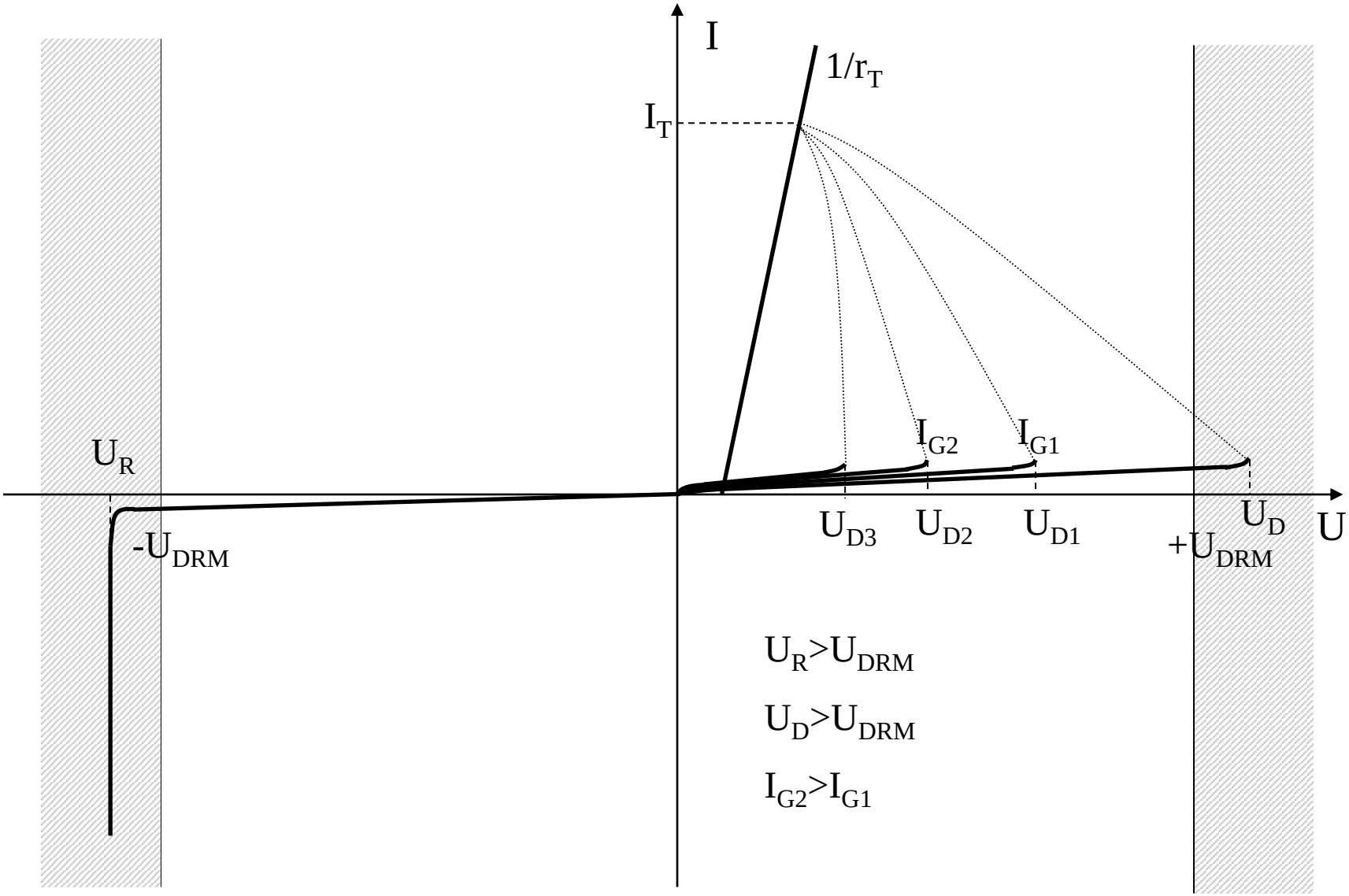
Conducción



Comportamiento en conducción

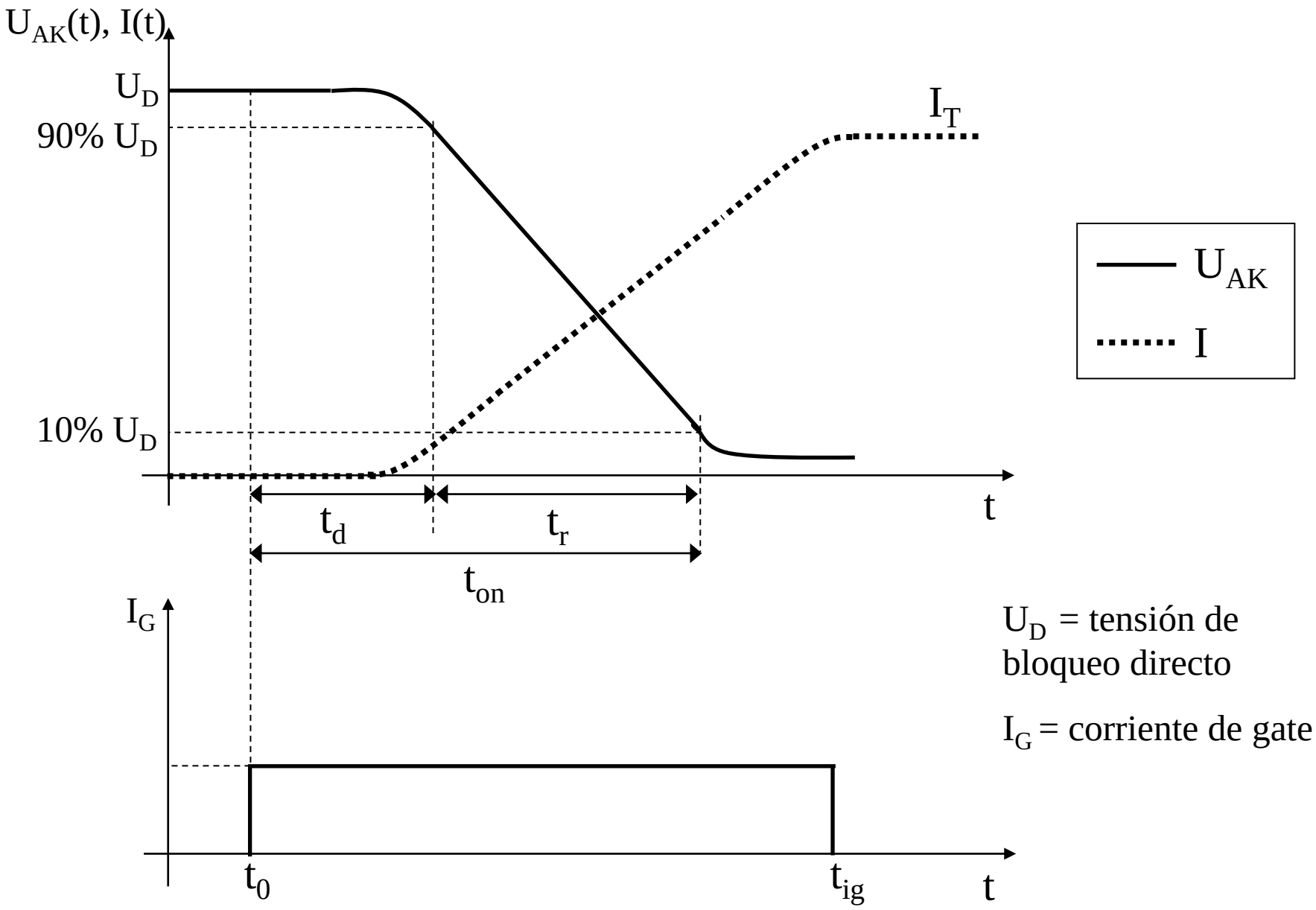


Característica ánodo-cátodo del tiristor



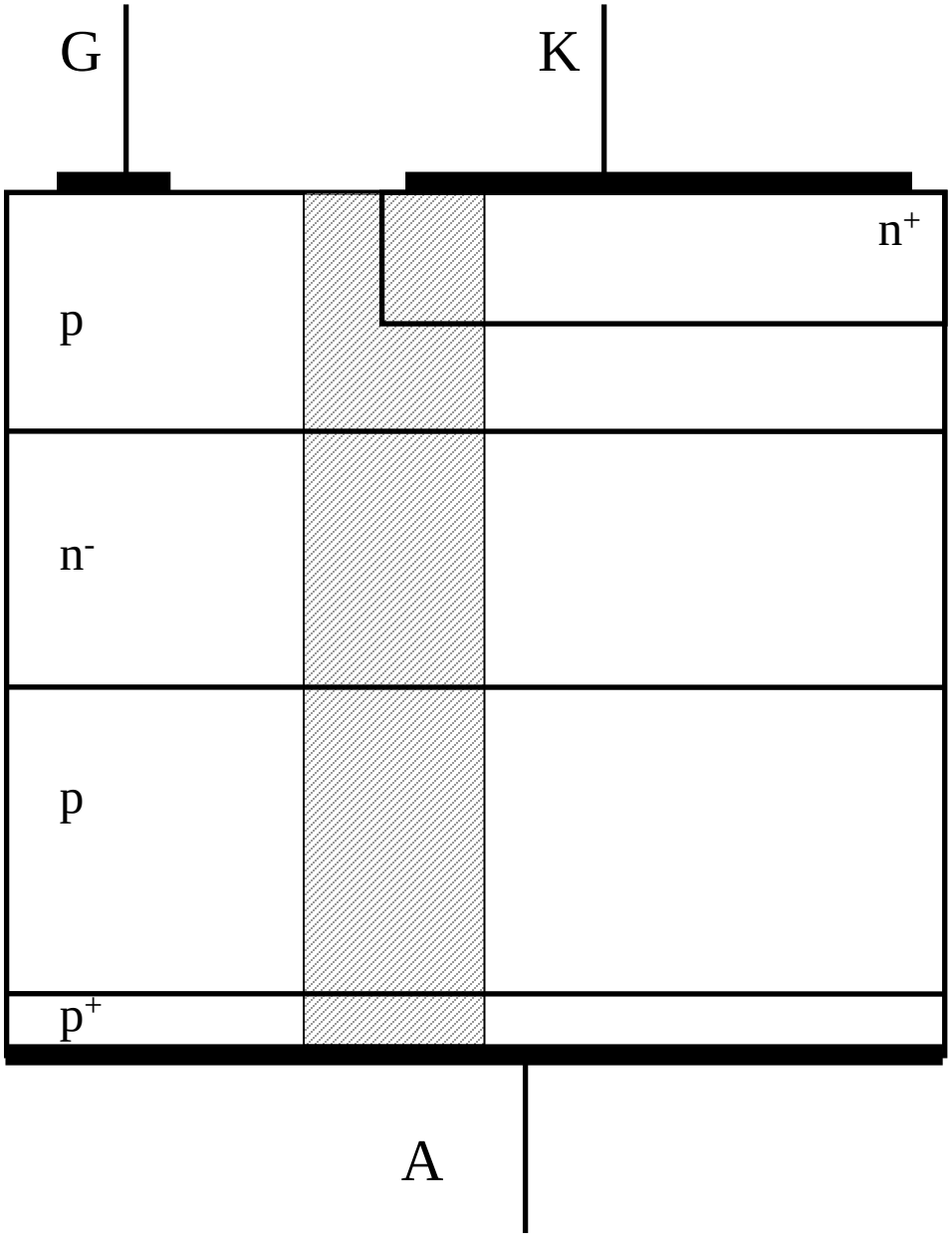
Ratings	Características
U_{DRM}	U_T
I_{Tmax} (average)	I_f
I_{Tmax} (RMS)	I_g
T_{jmax} (temperatura)	t_{on}
	t_{off}

Disipación de calor en un tiristor

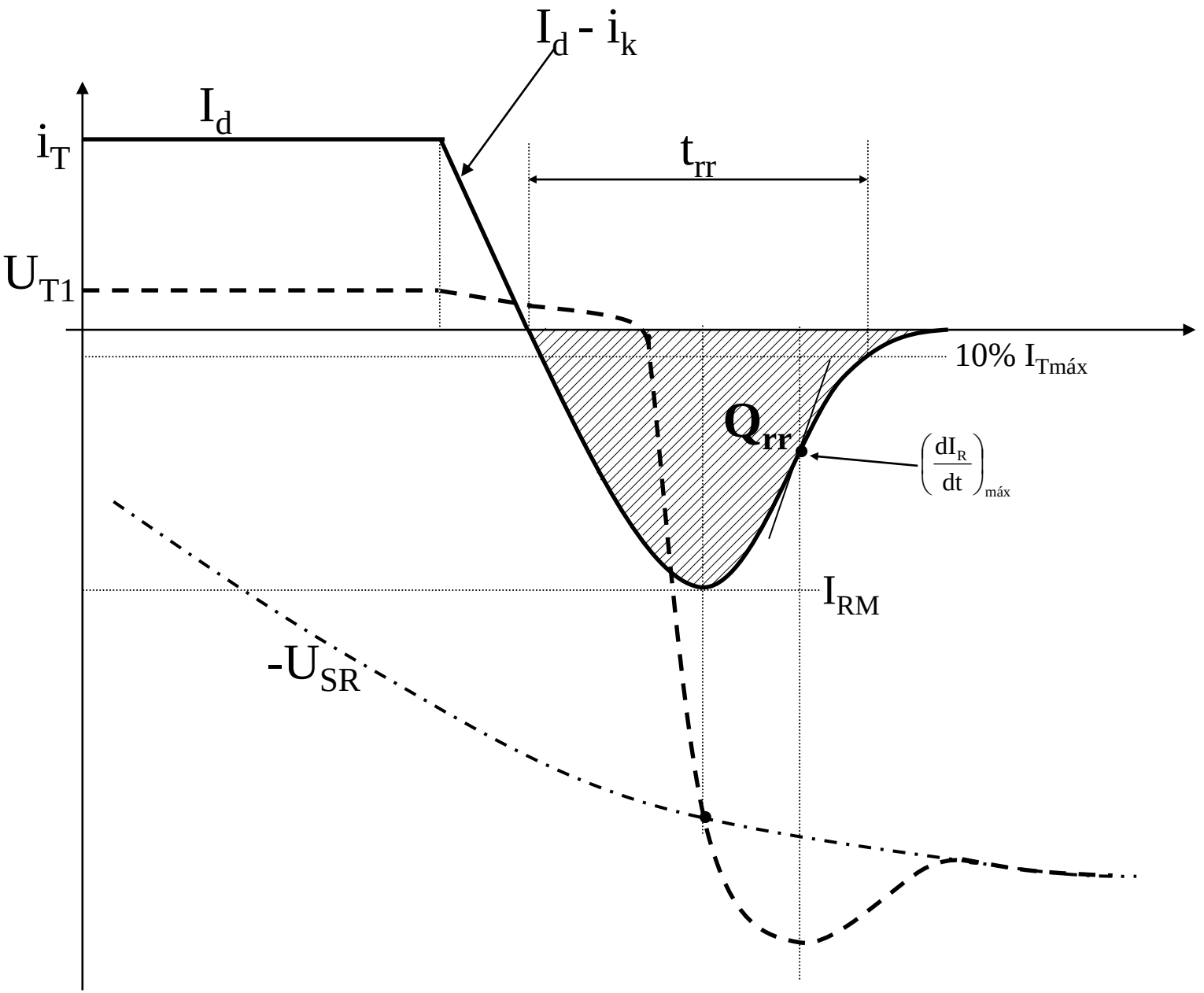


U_D = tensión de bloqueo directo

I_G = corriente de gate

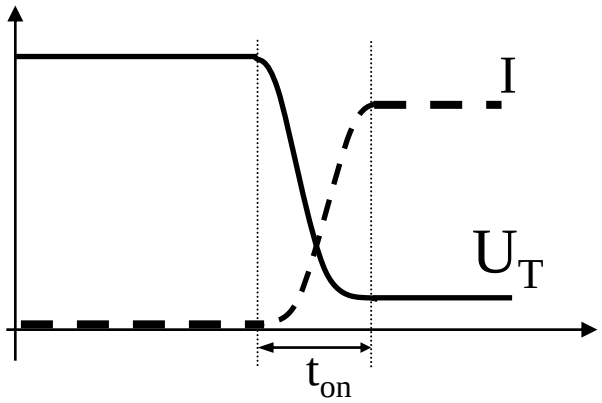

G
K
n+
p
n-
p
p+
A

Formas de onda en detalle apagado



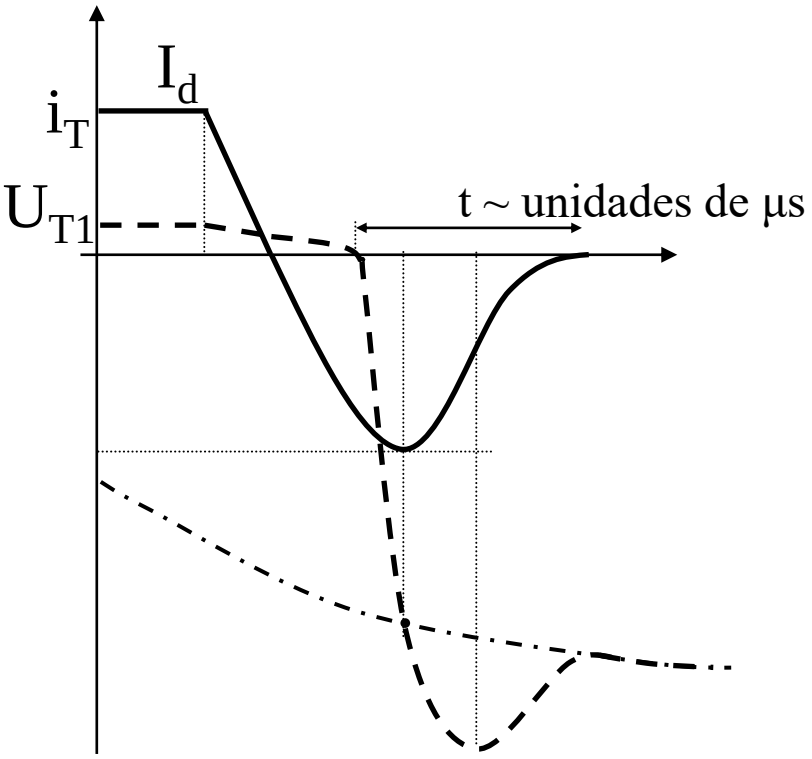
Encendido y apagado

Encendido



(1 a 5 μs)

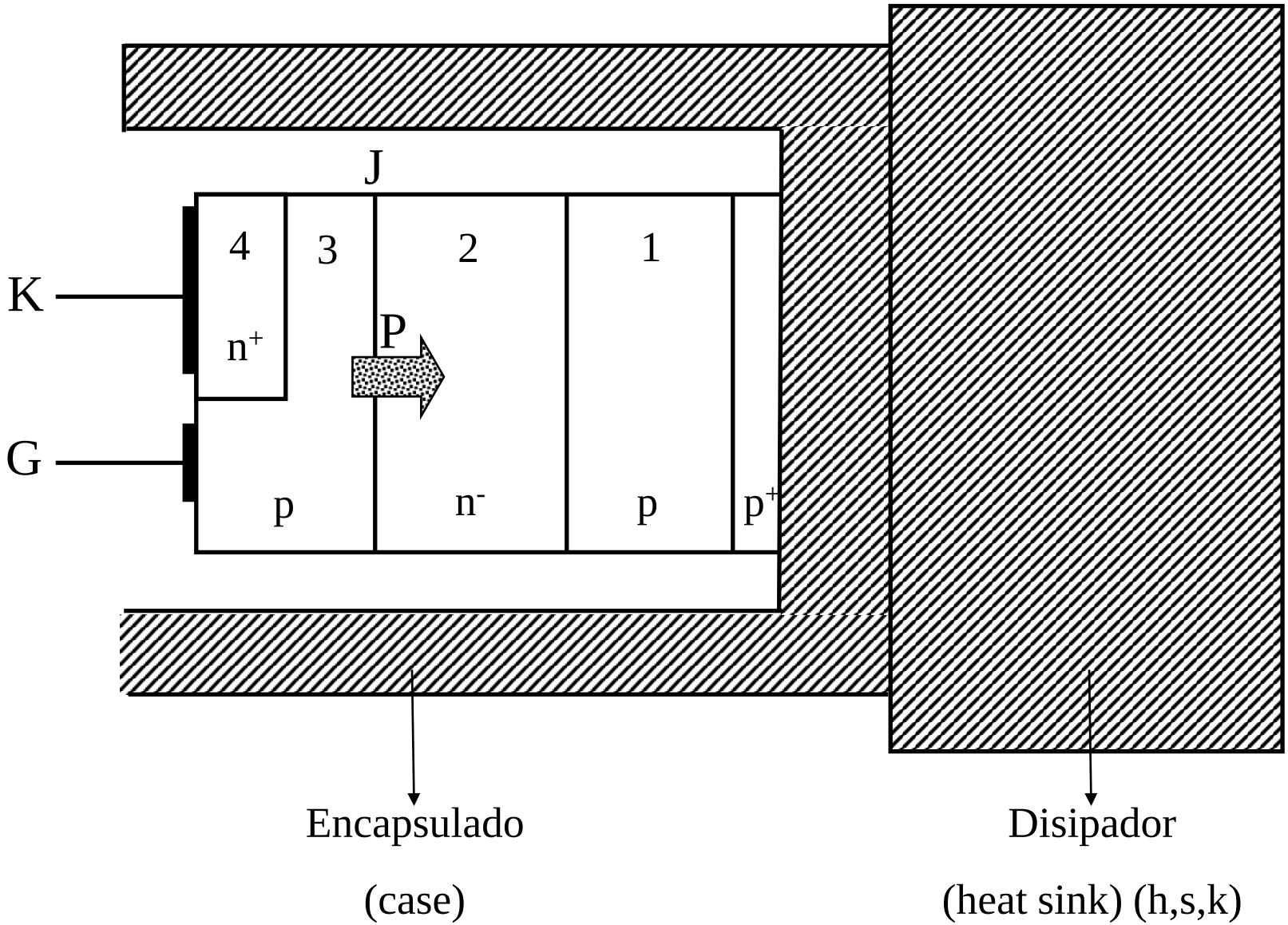
Apagado



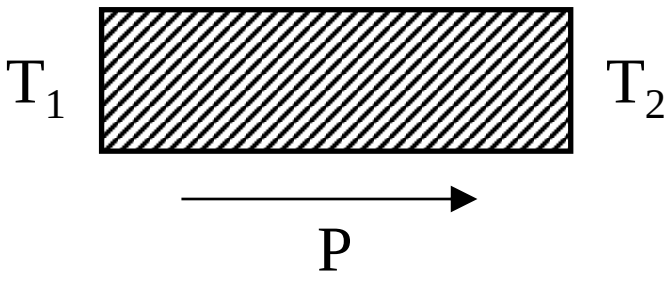
Cálculo de la potencia disipada por el dispositivo en el encendido y el apagado

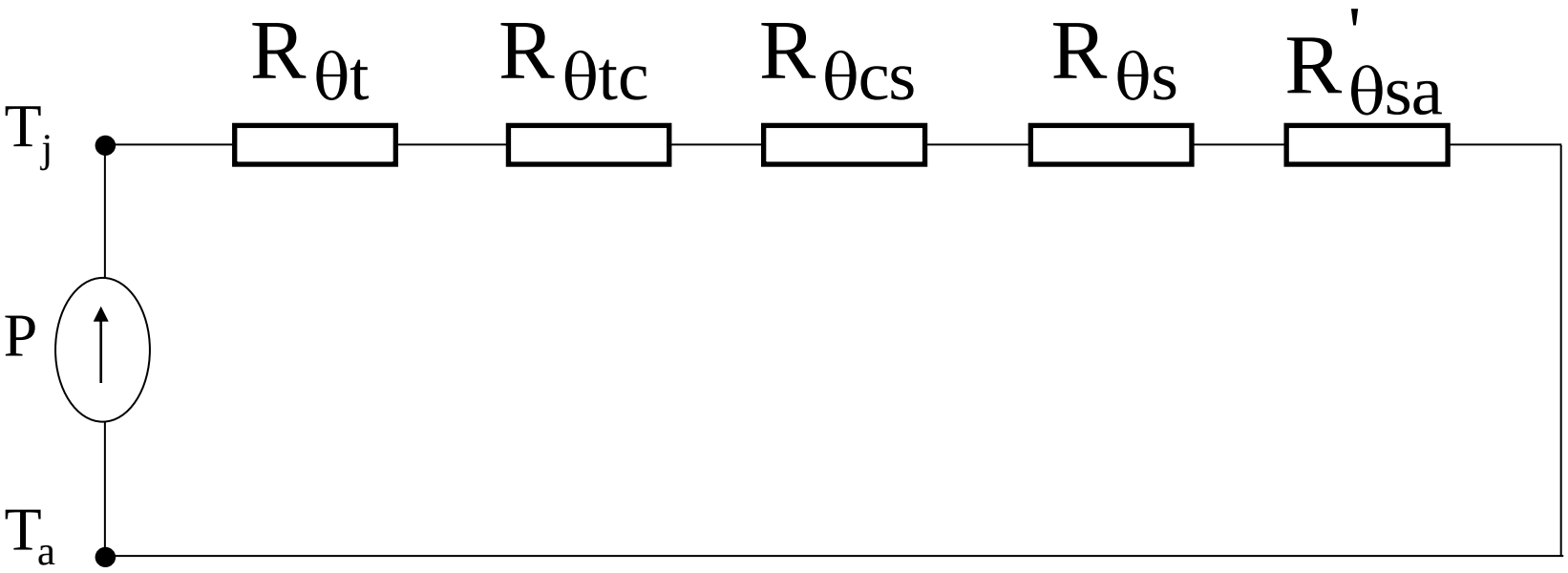
Cálculo de la potencia disipada por el dispositivo en conducción

Tiristor - case - disipador

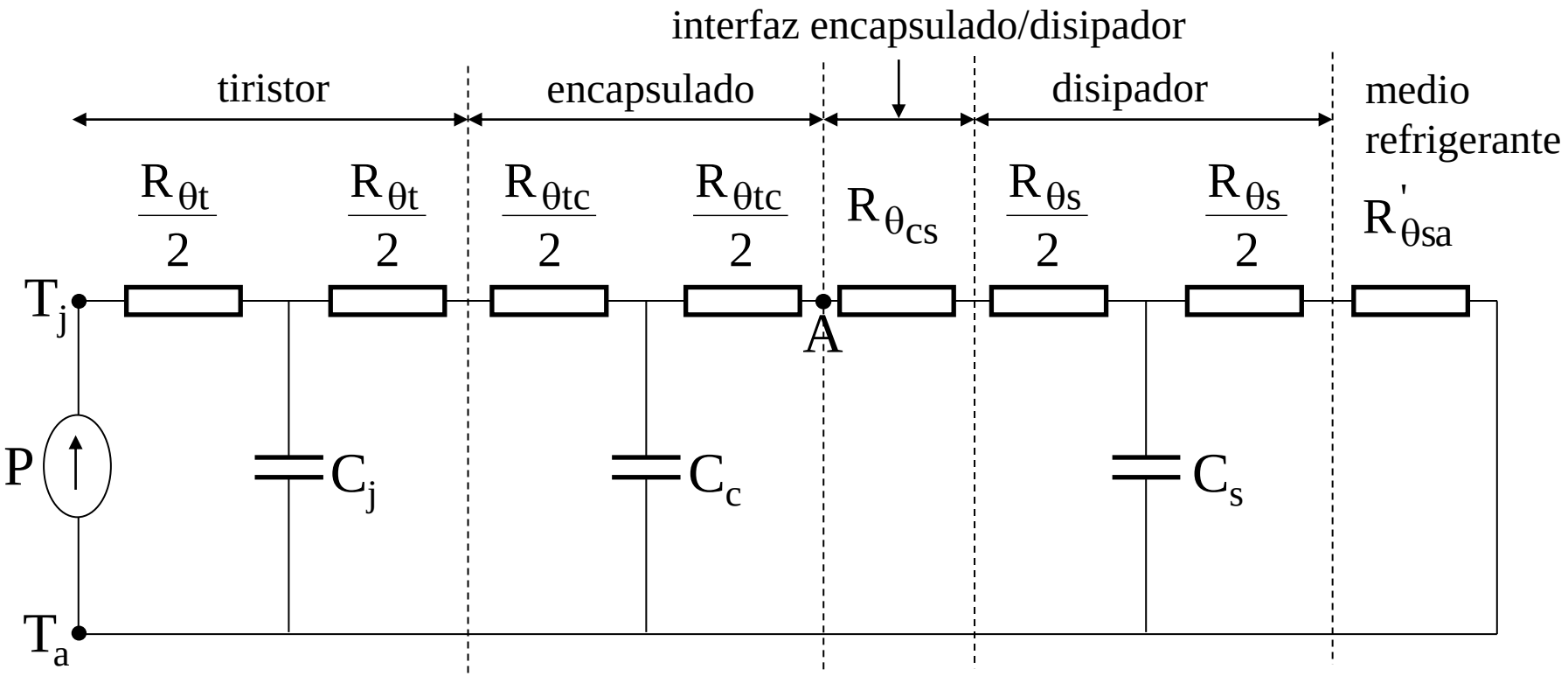


Transmisión de calor

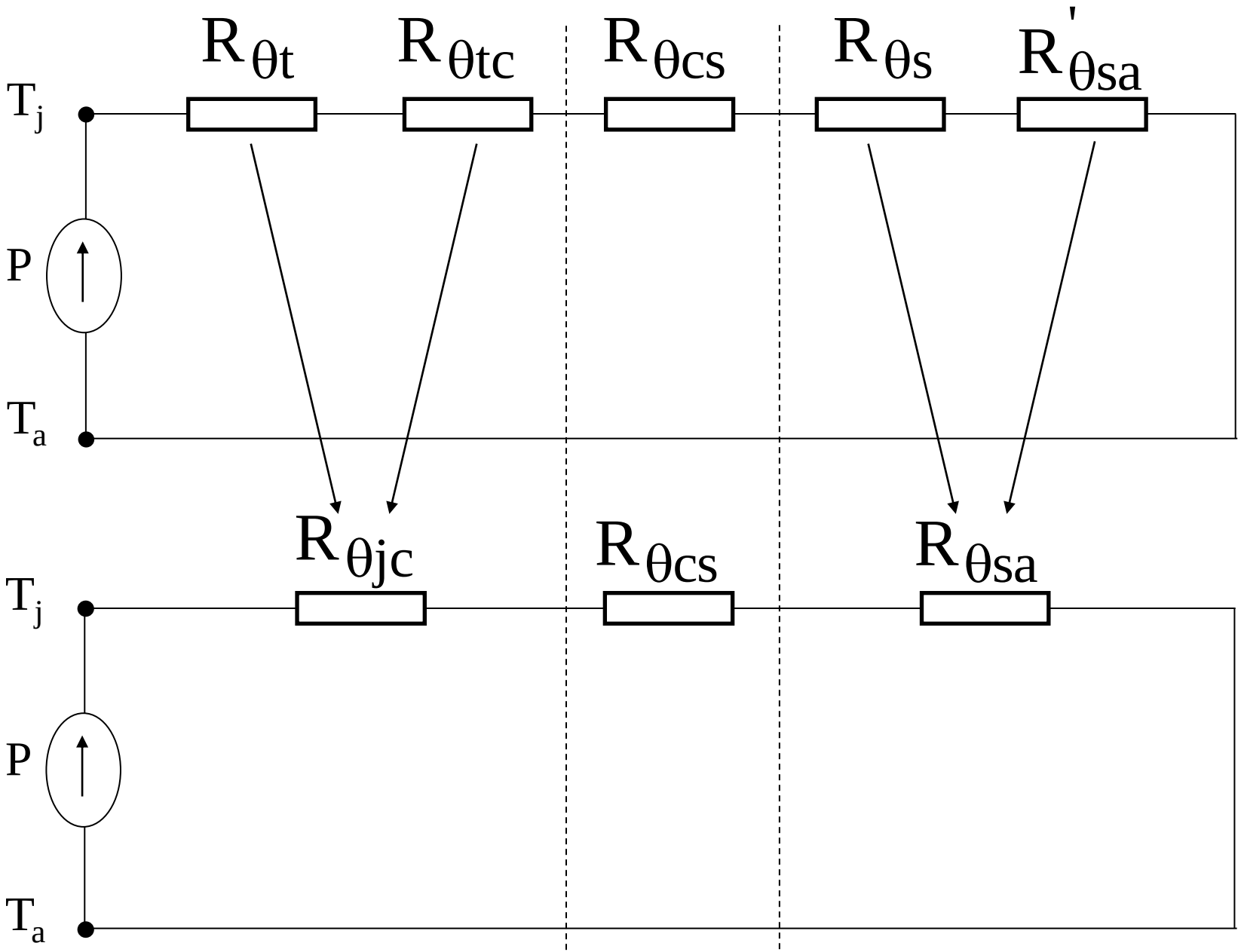



$R_{\theta t}$
$R_{\theta tc}$
$R_{\theta cs}$
$R_{\theta s}$
$R'_{\theta sa}$
T_j
P
T_a

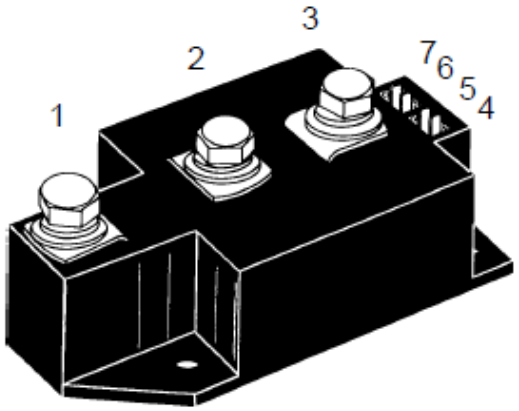
Circuito térmico tiristor

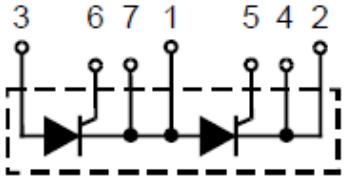


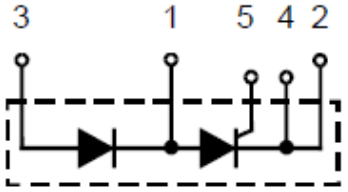
Circuito térmico tiristor estacionario

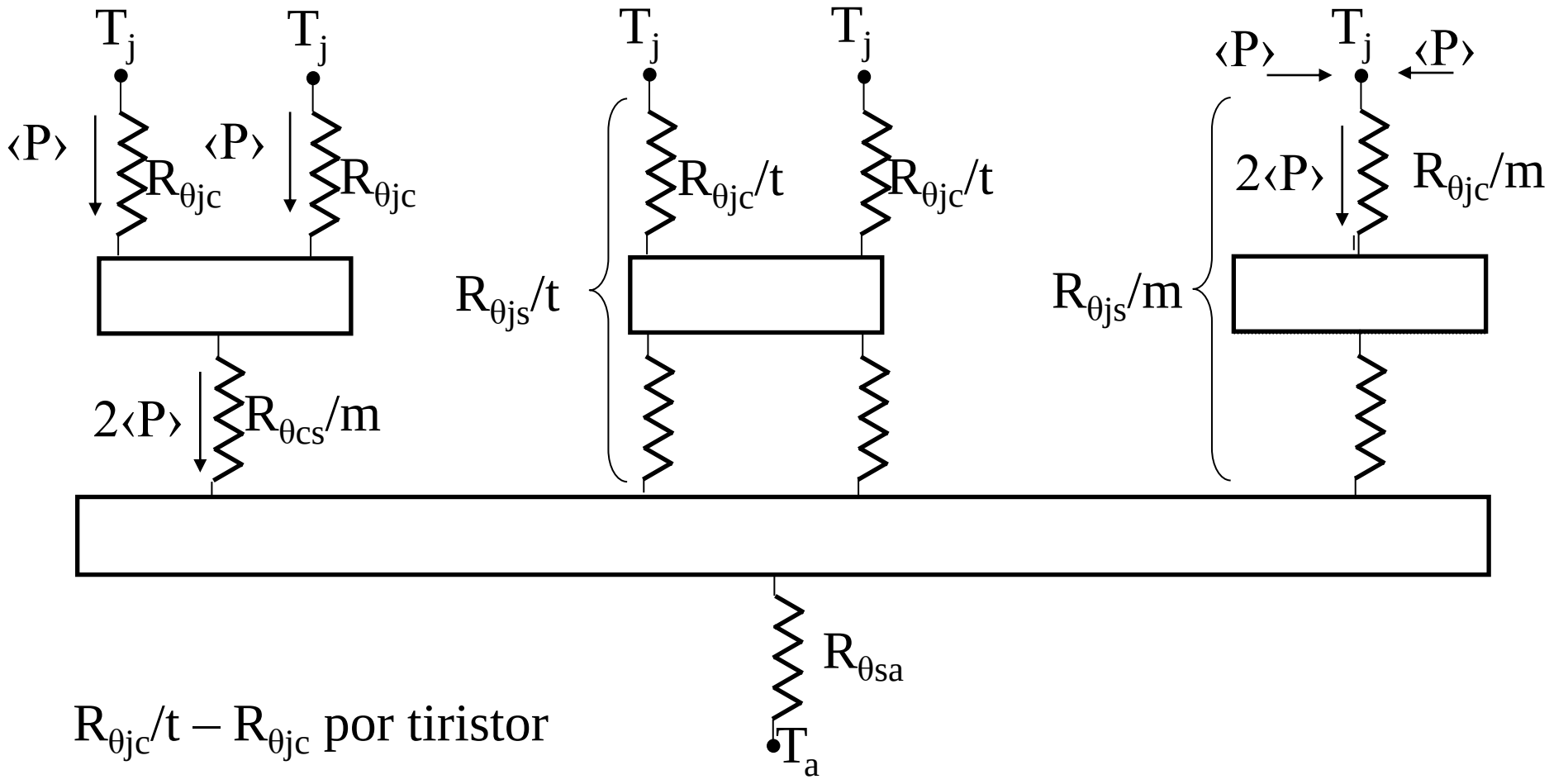


Módulo de tiristores – MCC / MCD 250









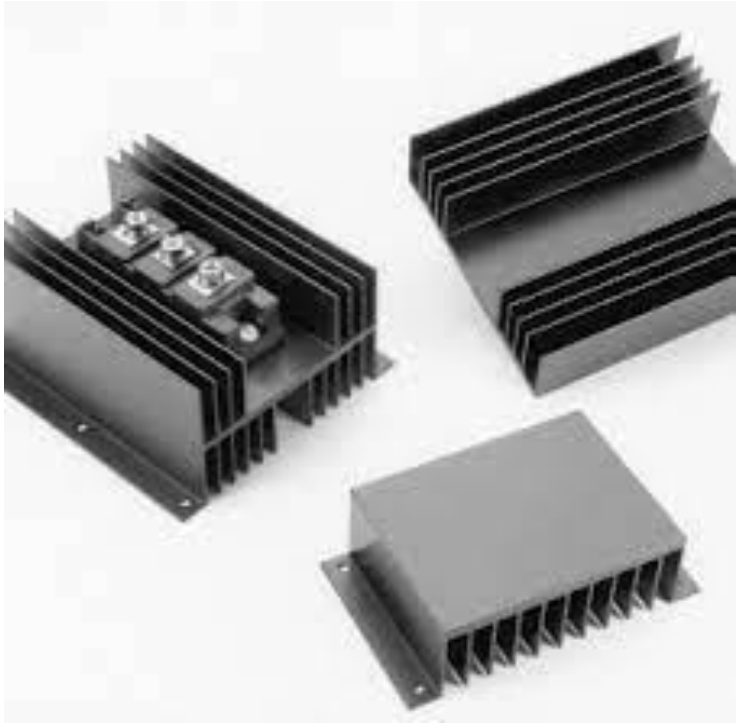
$R_{\theta jc}/t$ – $R_{\theta jc}$ por tiristor

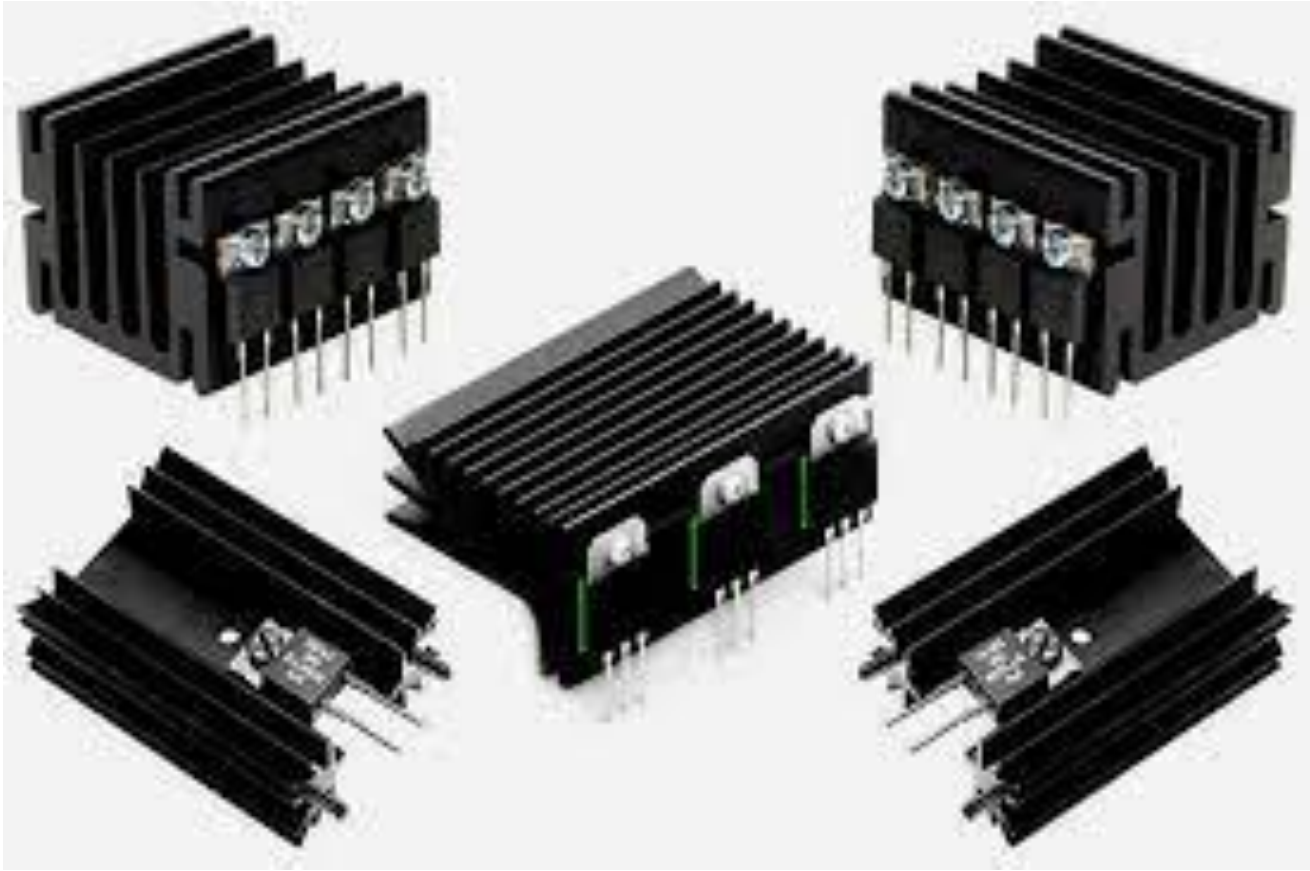
$R_{\theta js}/t$ – $R_{\theta js}$ por tiristor

$R_{\theta jc}/m$ – $R_{\theta jc}$ por módulo

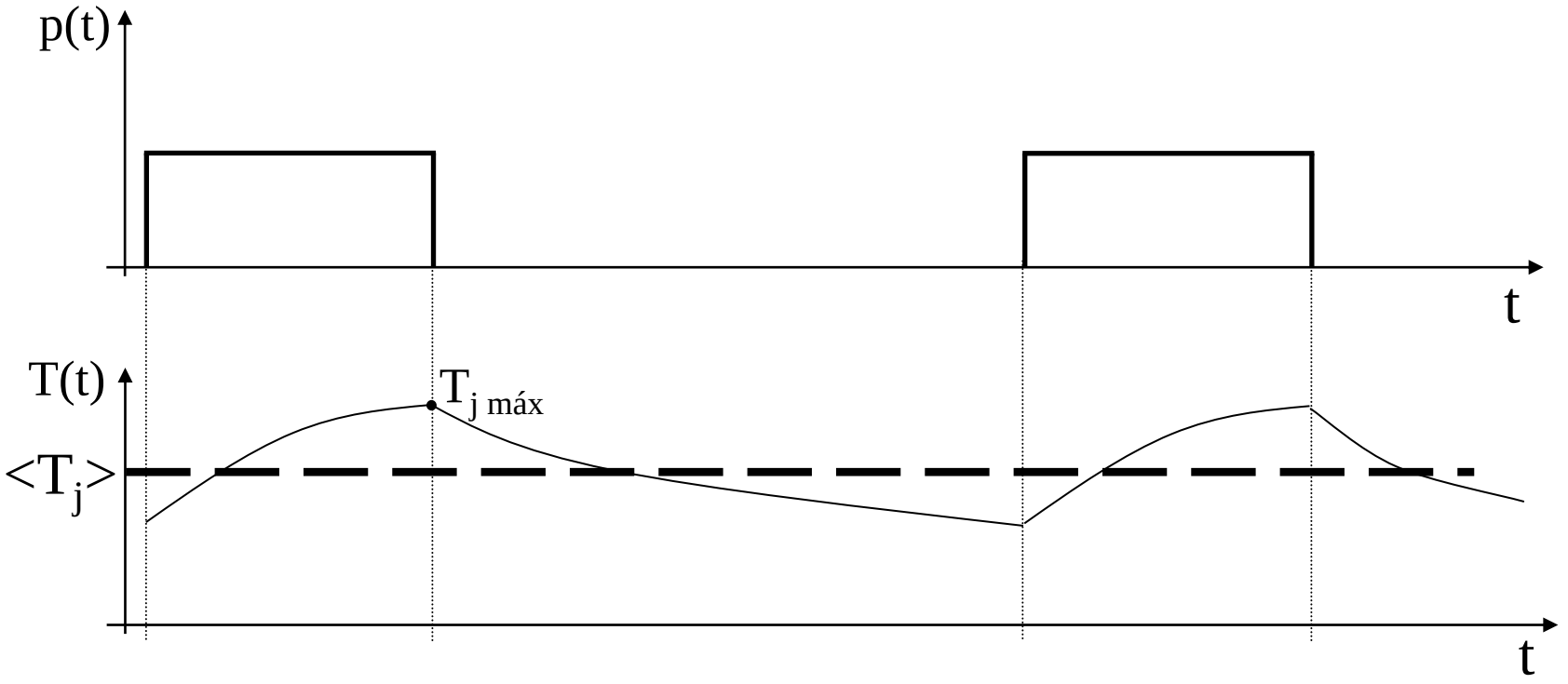
$R_{\theta js}/m$ – $R_{\theta js}$ por módulo


IXYS
1439X
MCC 26 - 16 IO1B
Lot No: 340732
1
AK 2
2
K1
4
5
7
3
A
6

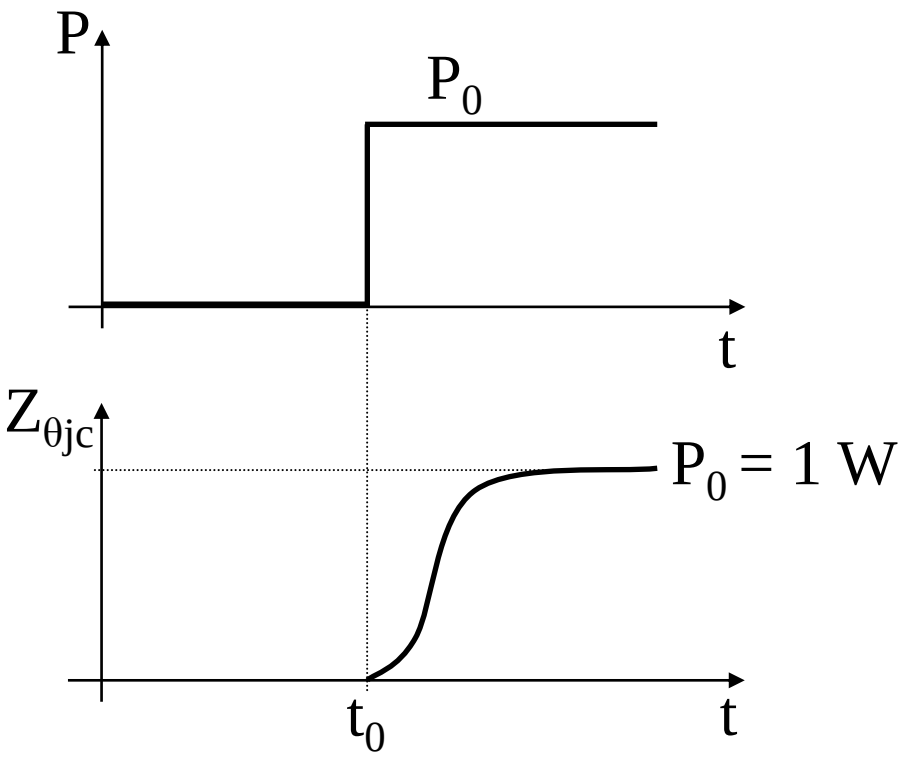




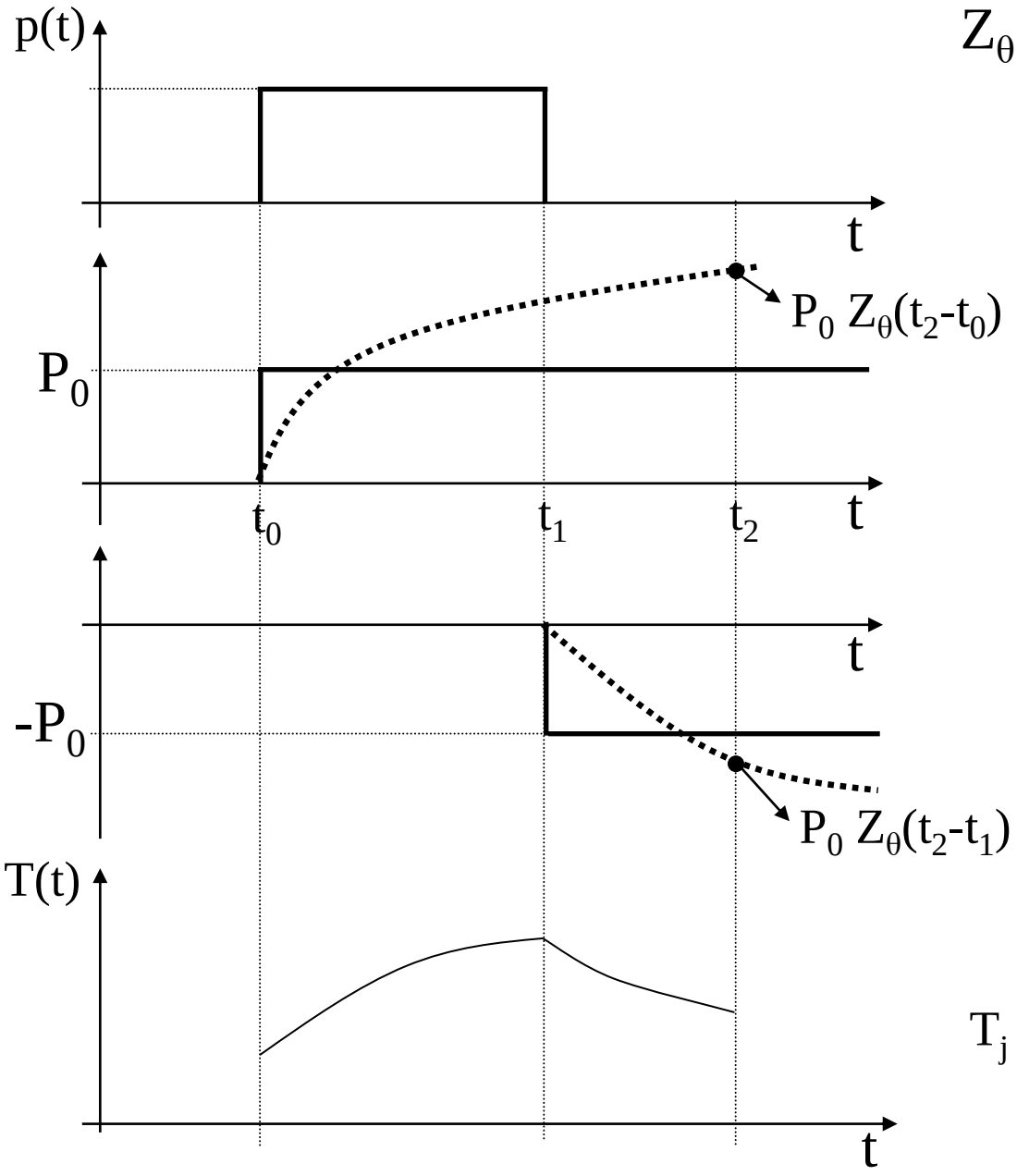
Evolución potencia y temperatura

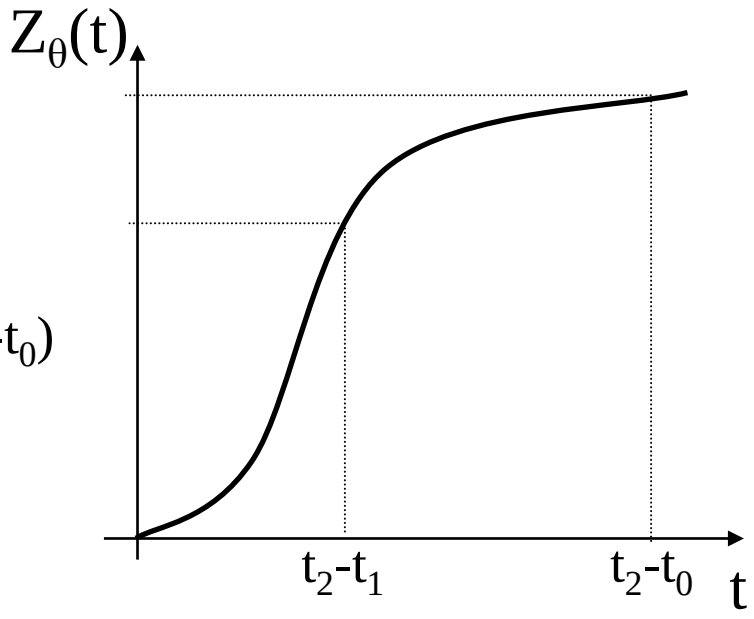


Impedancia térmica transitoria



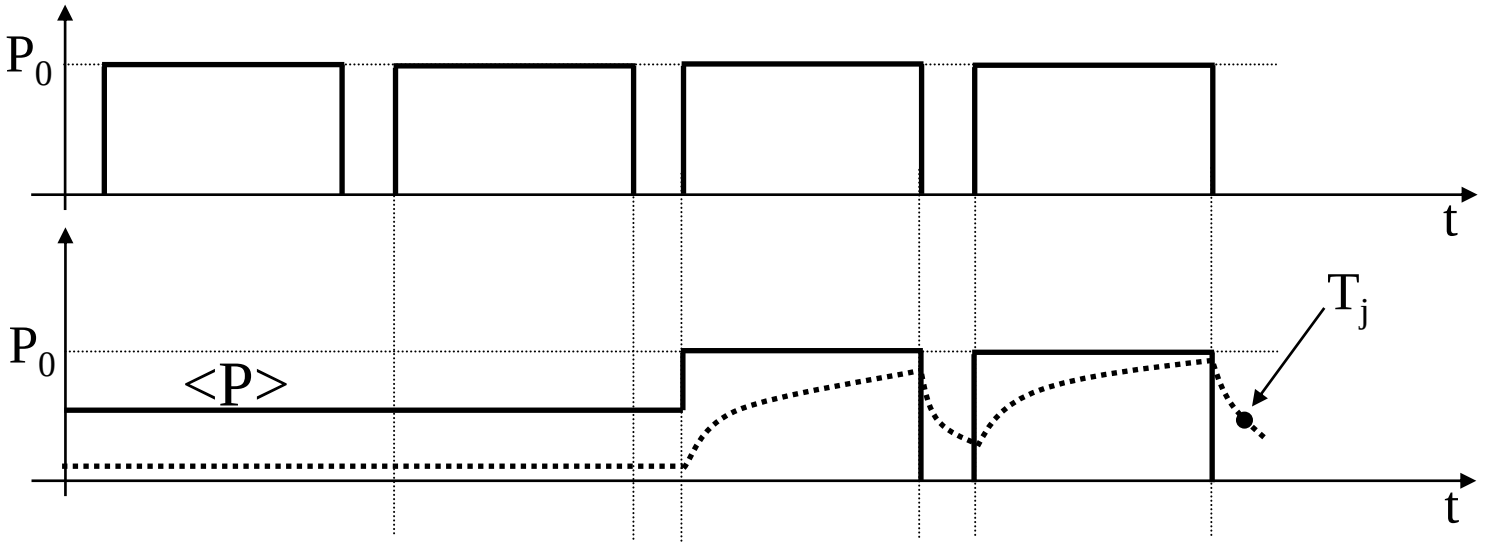
Superposición

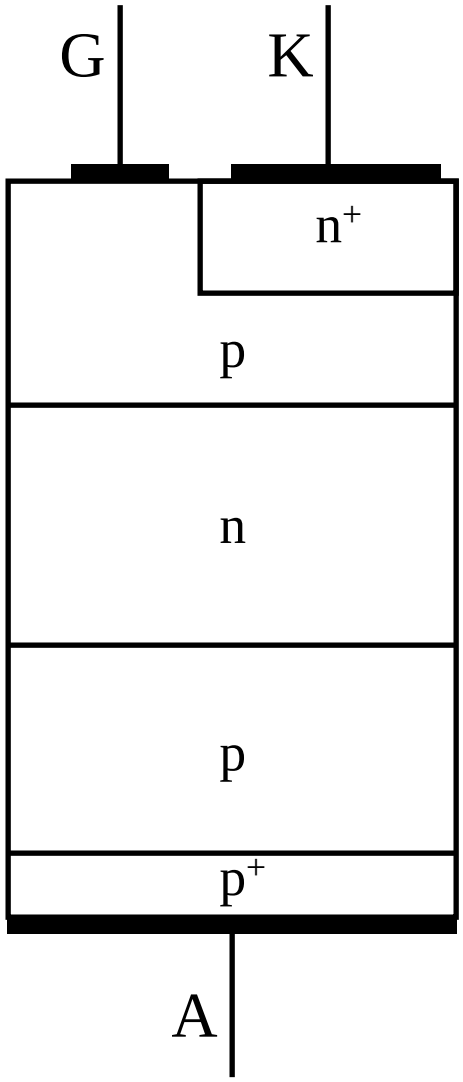




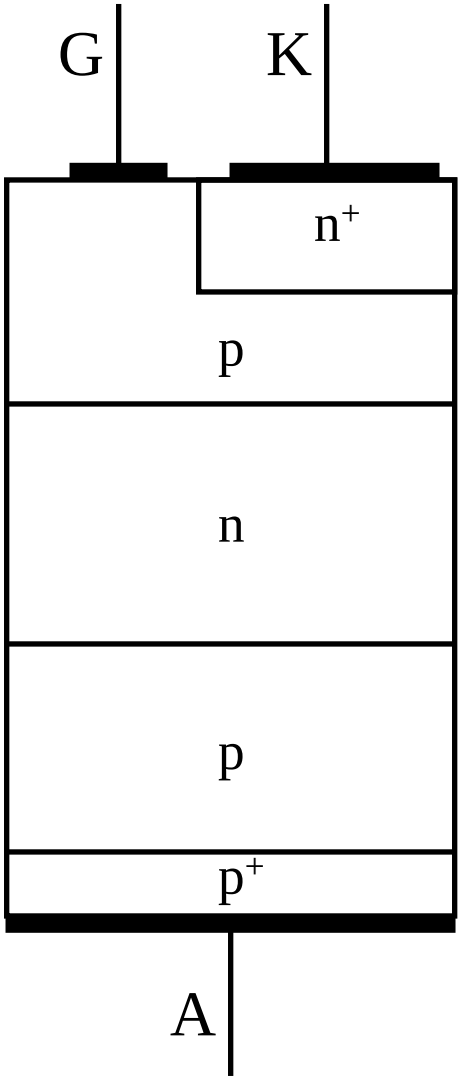
$$T_j - T_c = P_0 * [\, Z_\theta(t_2-t_0) - Z_\theta(t_2-t_1)]$$

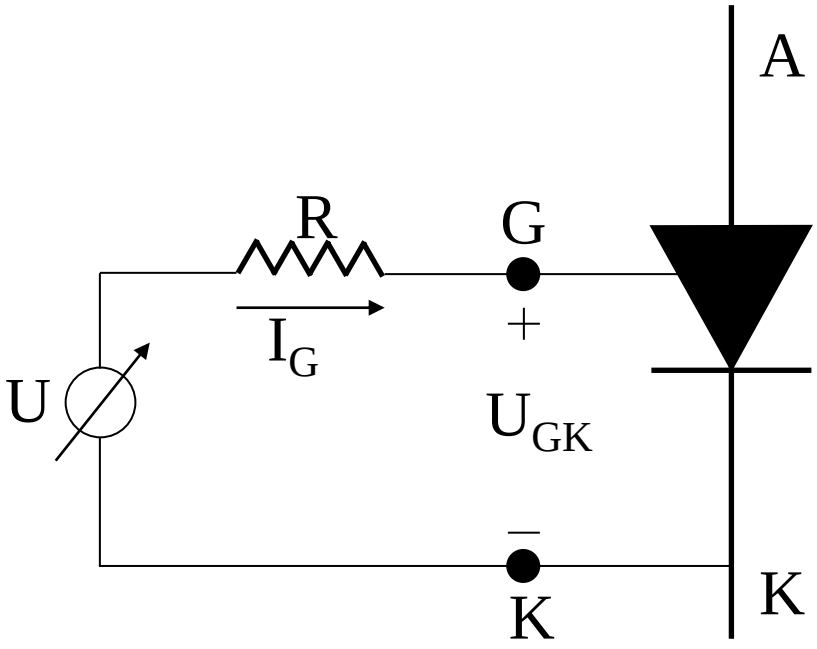
Consideraciones para una onda periódica



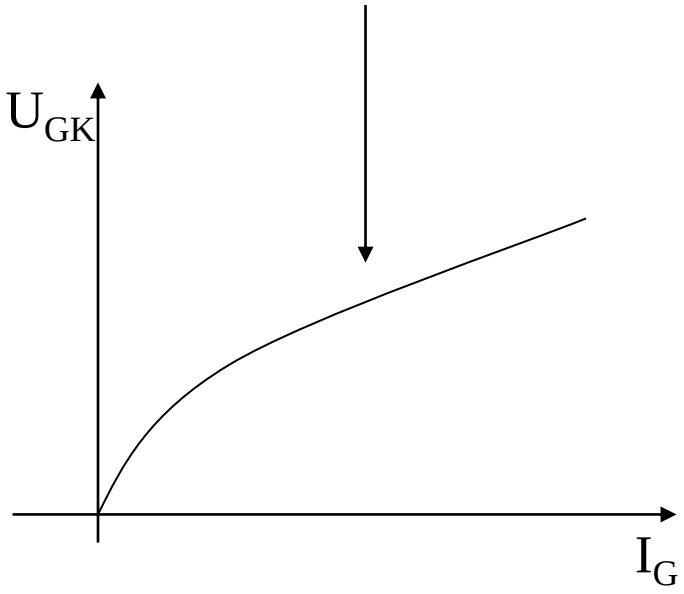

G
K
n+
p
n
p
p+
A

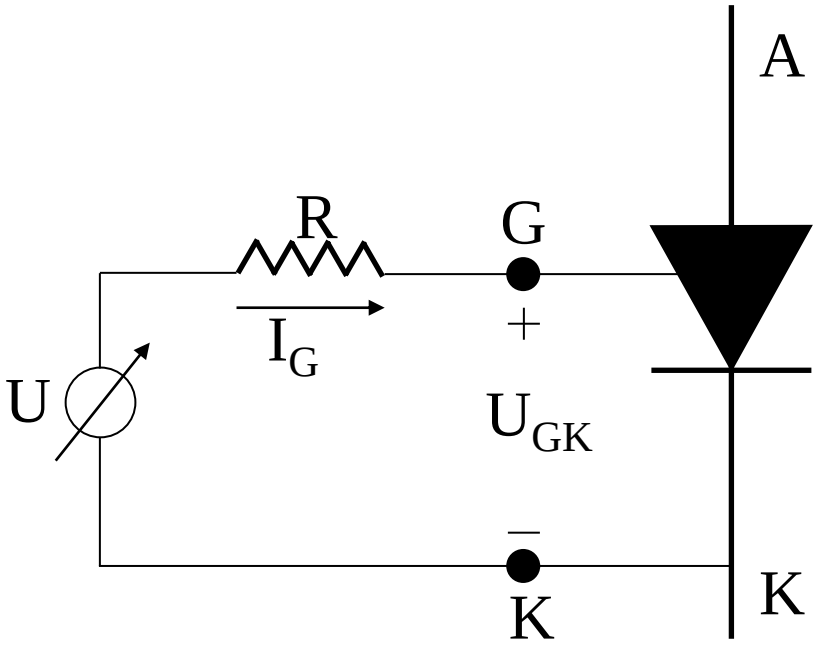
Encendido del tiristor

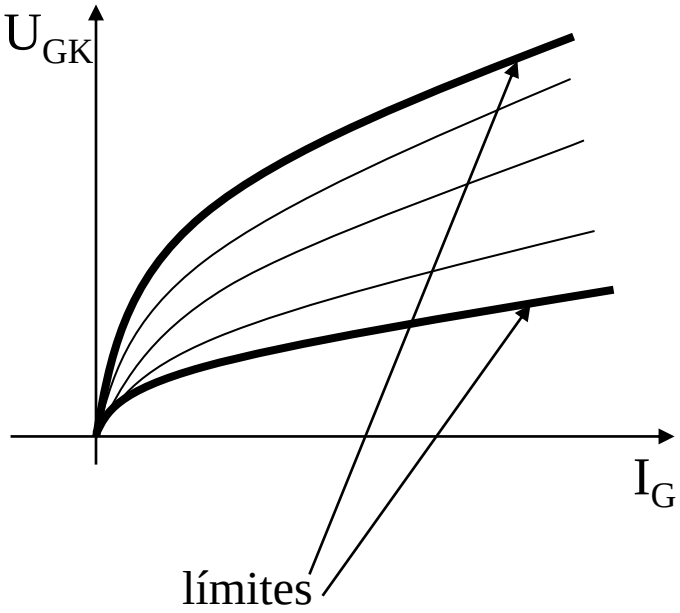


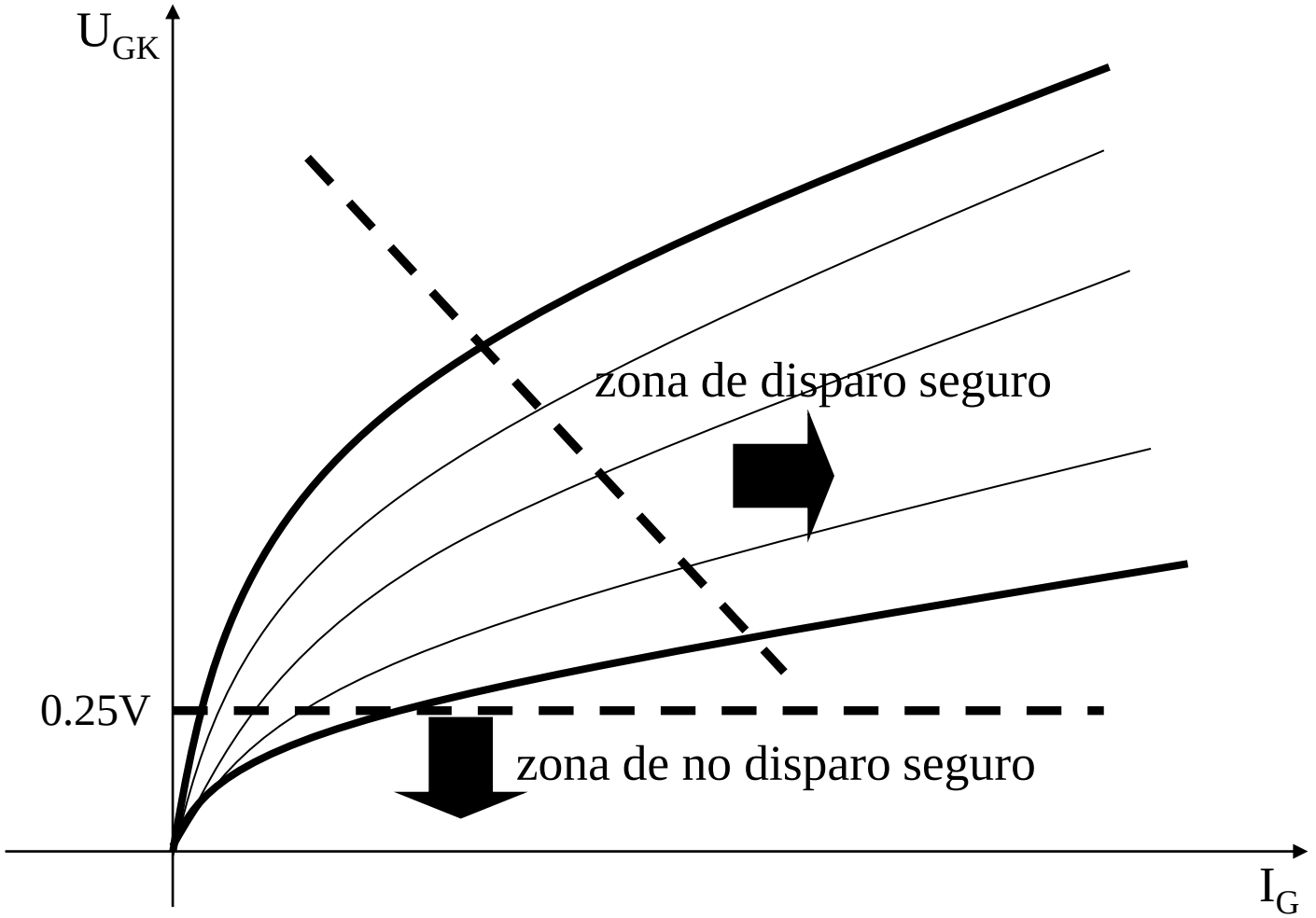


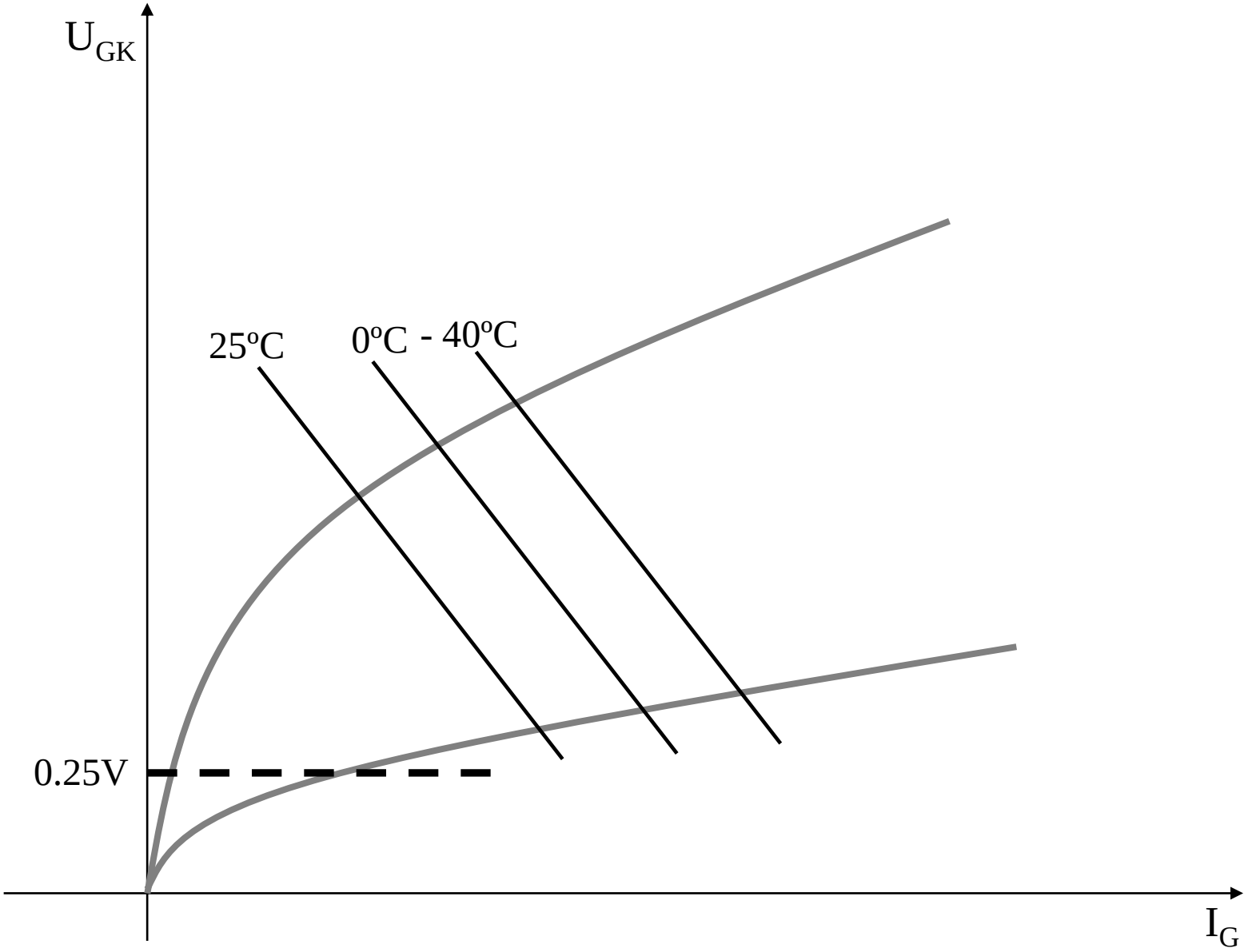
Característica de gate del tiristor

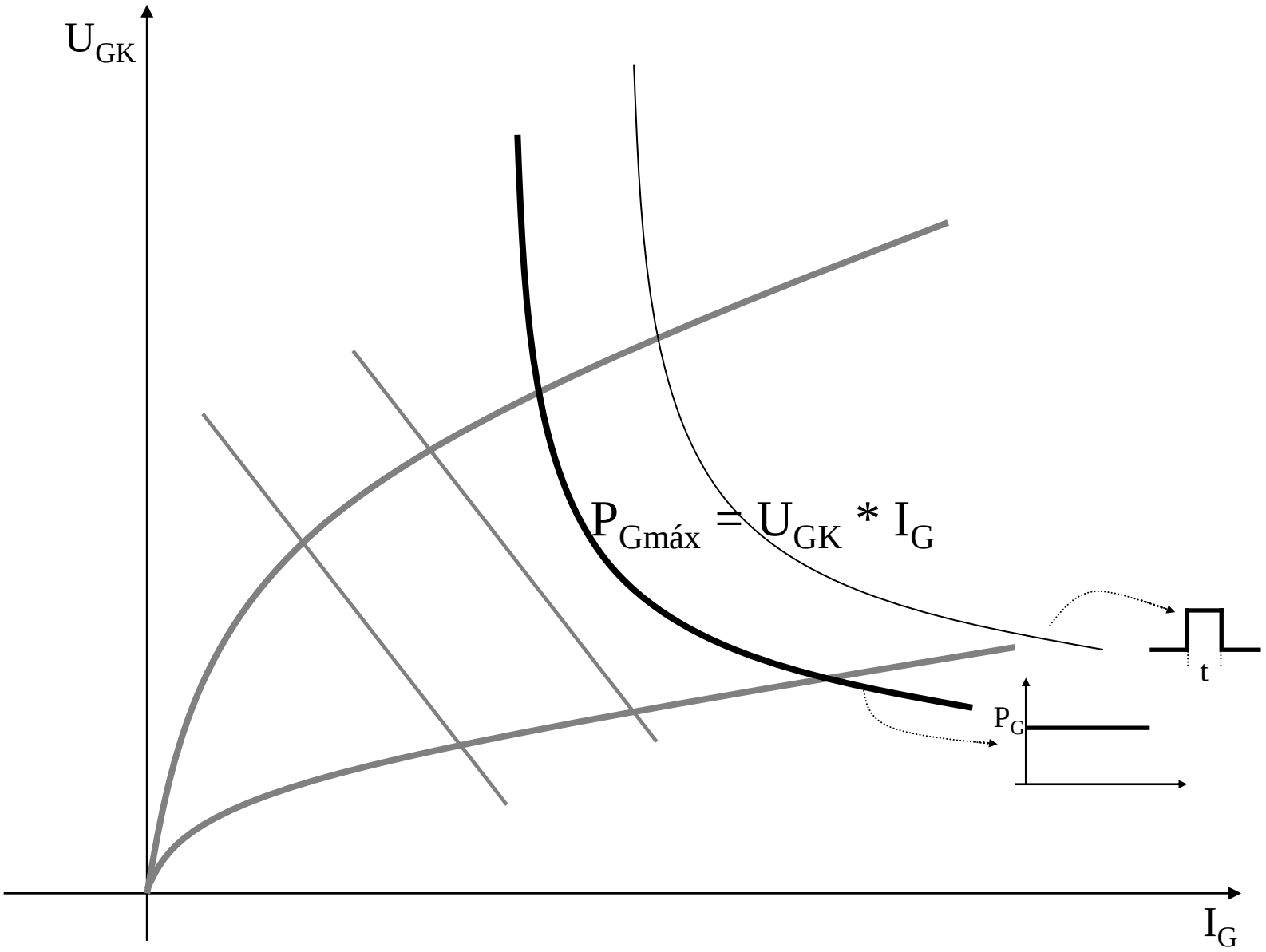



A
R
G
I_G
+
U
U_{GK}
–
K
K

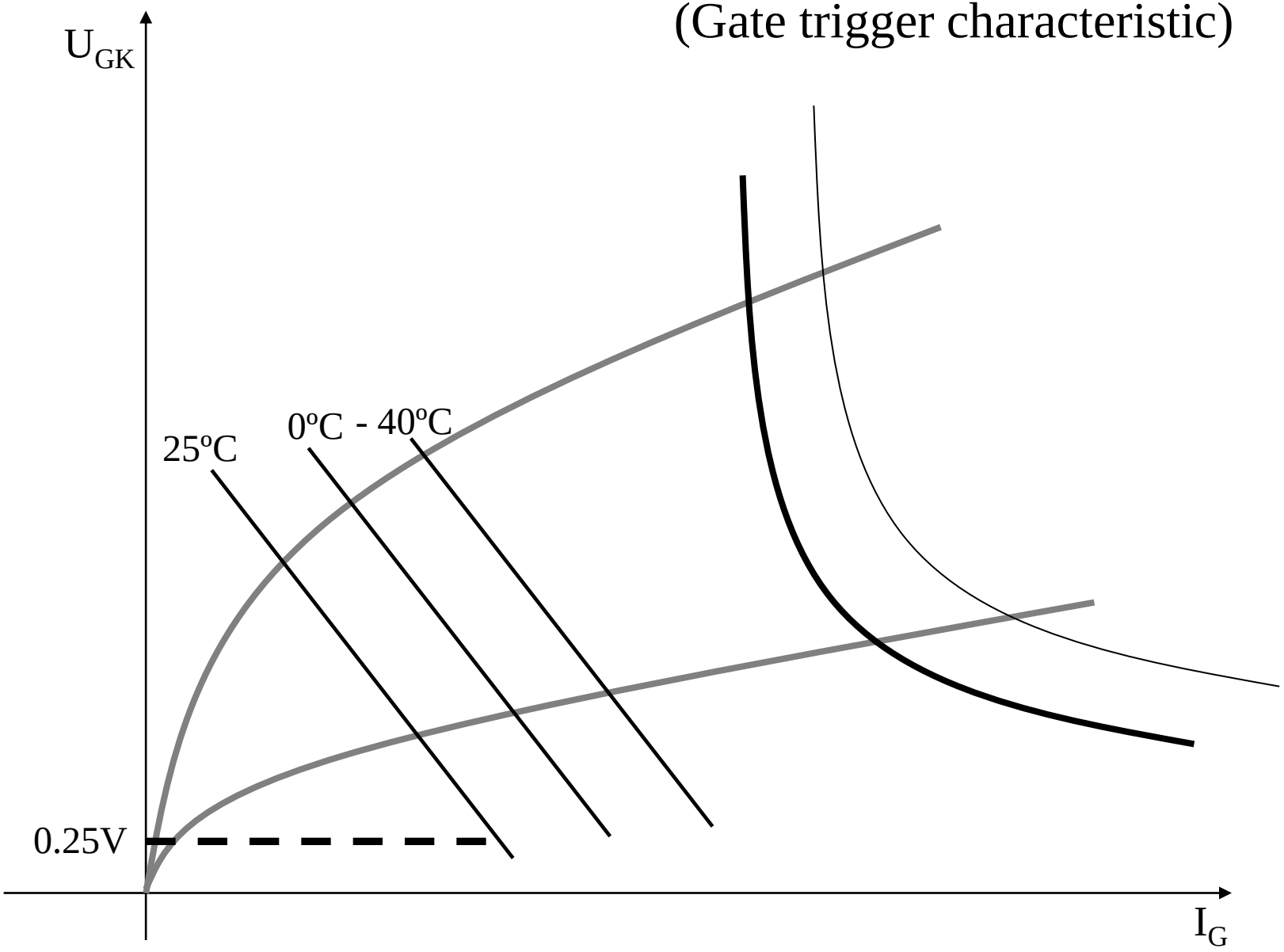

U_{GK}
I_G
límites

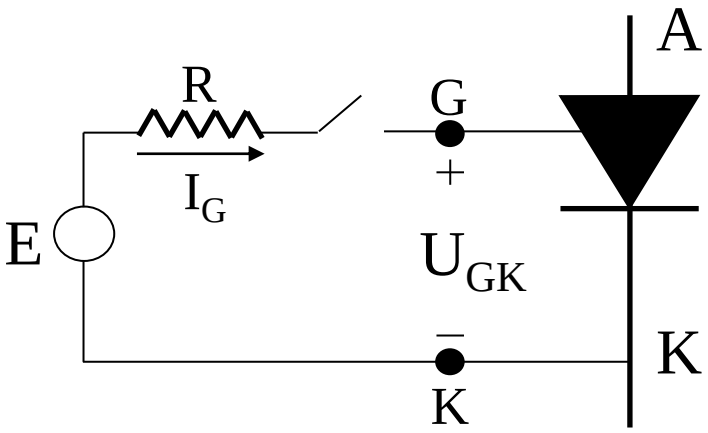

U_{GK}
zona de disparo seguro
0.25V
zona de no disparo seguro
I_G

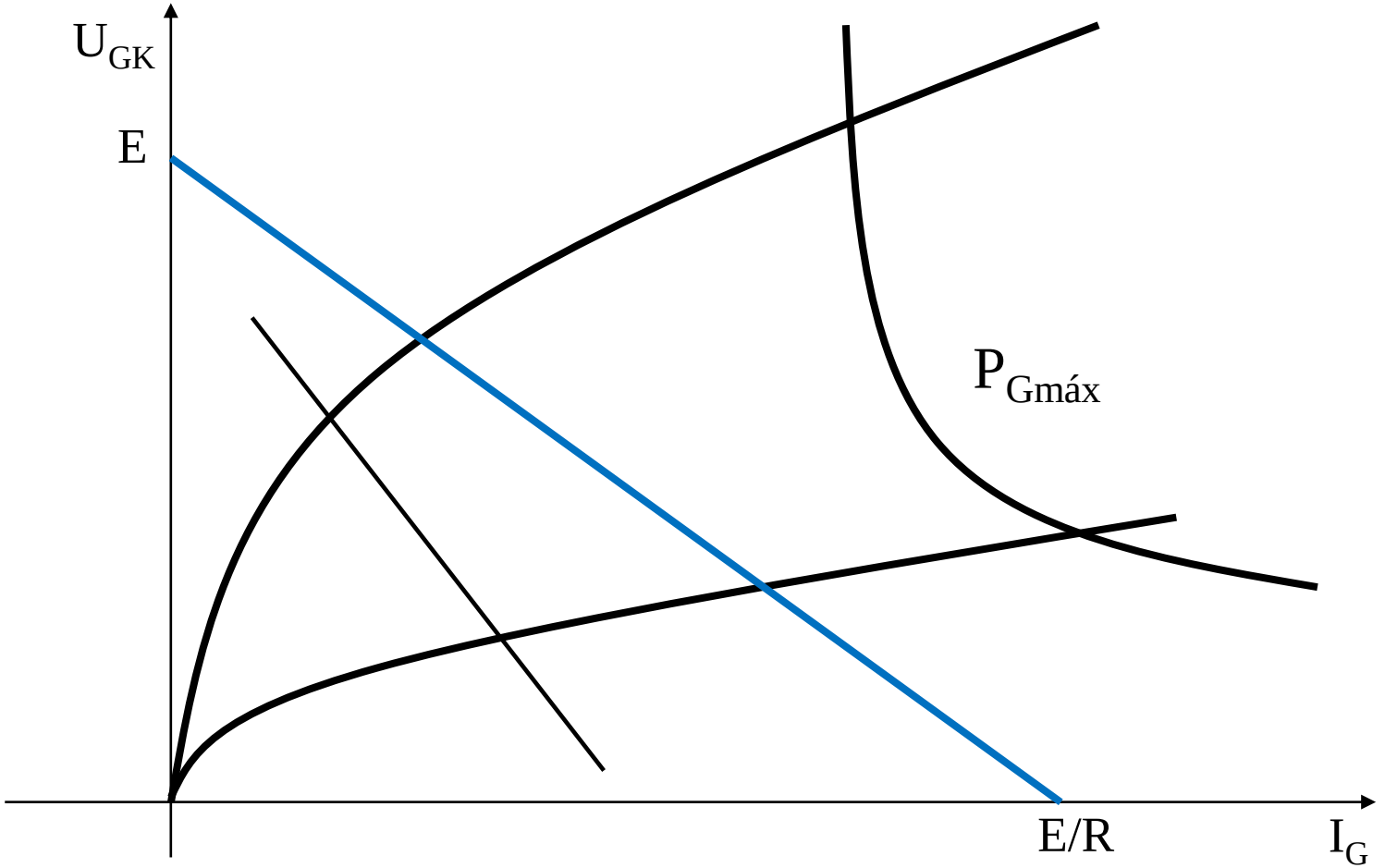

U_{GK}
25ºC
0ºC - 40ºC
0.25V
I_G

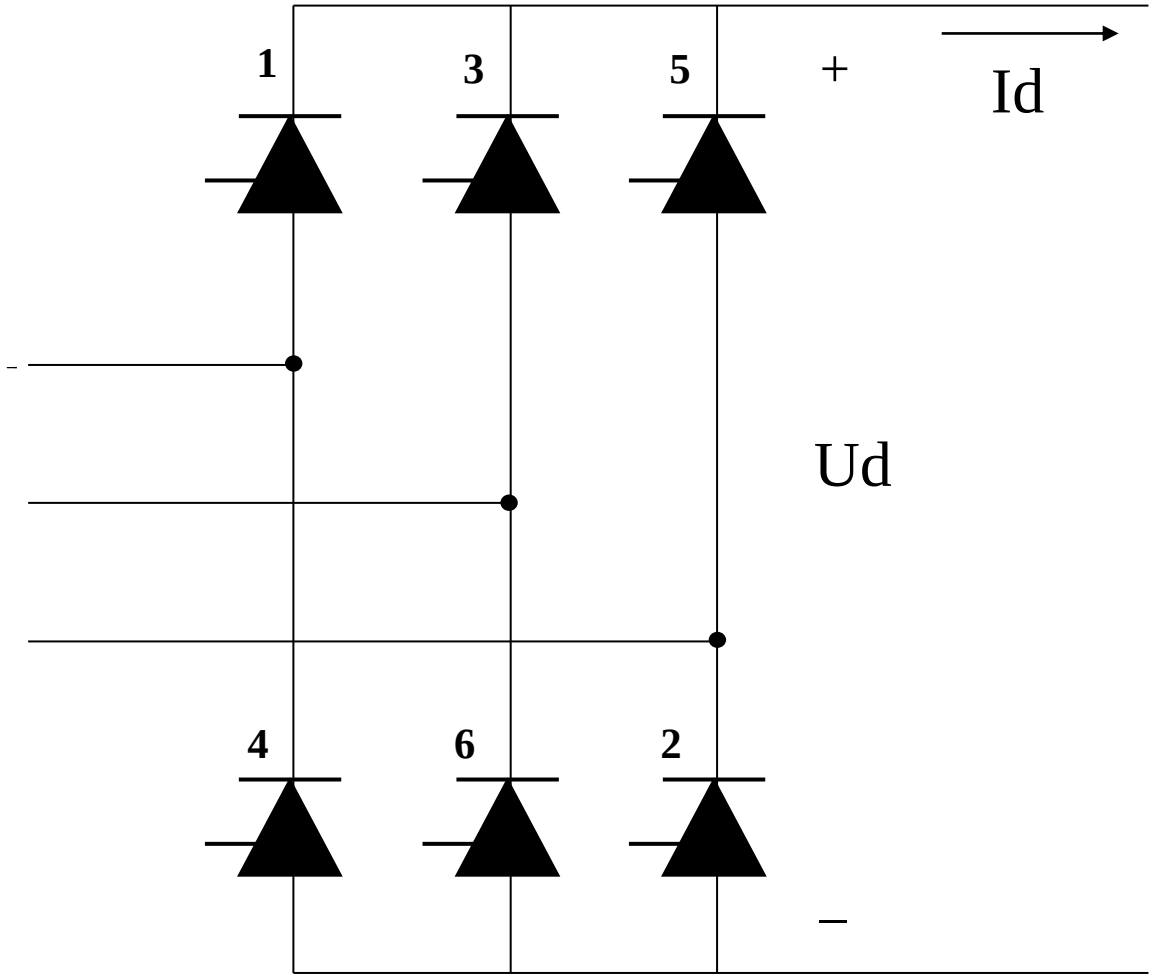

U_{GK}
$P_{Gmáx} = U_{GK} * I_G$
t
P_G
I_G

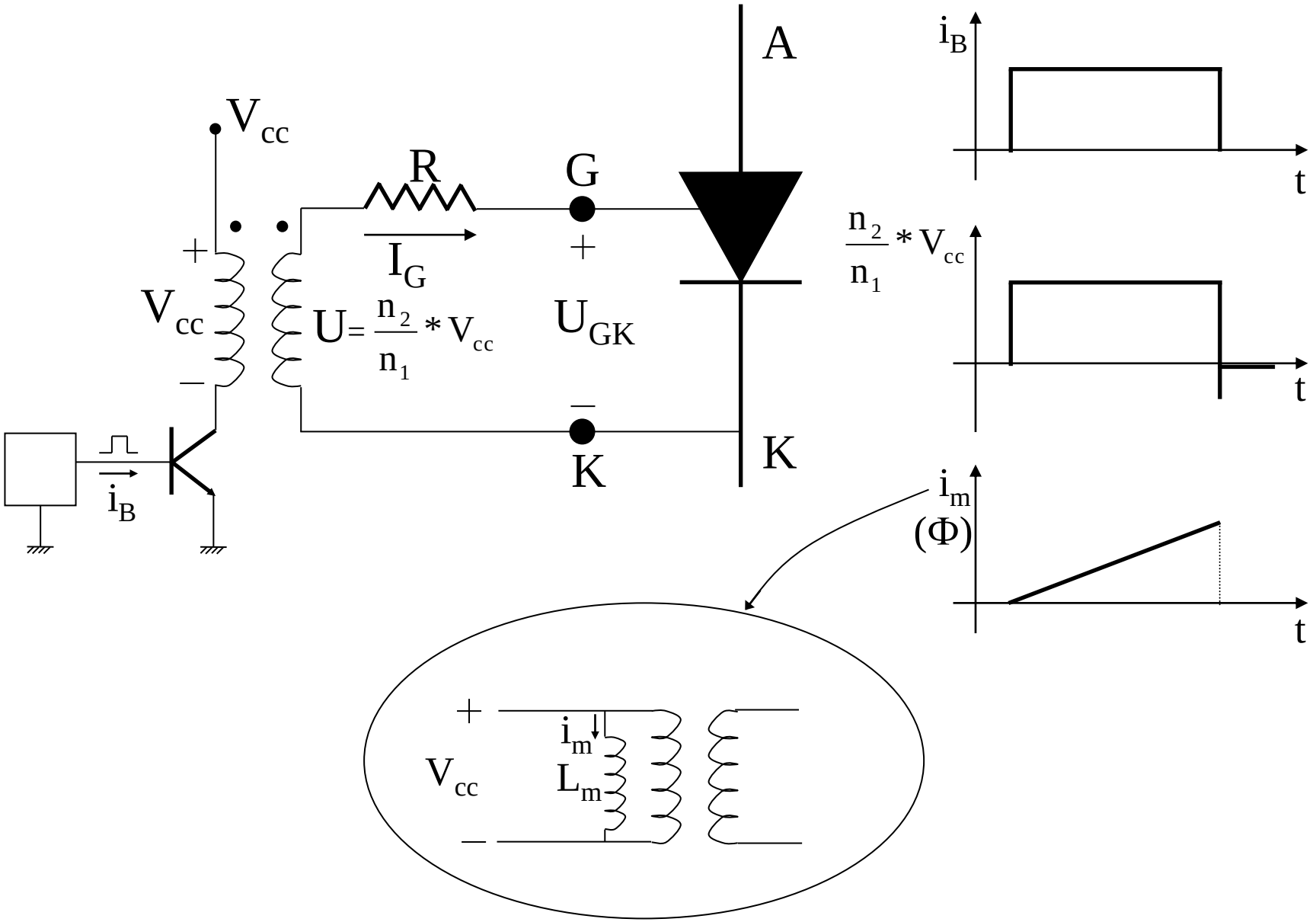
Característica de disparo de Gate
(Gate trigger characteristic)

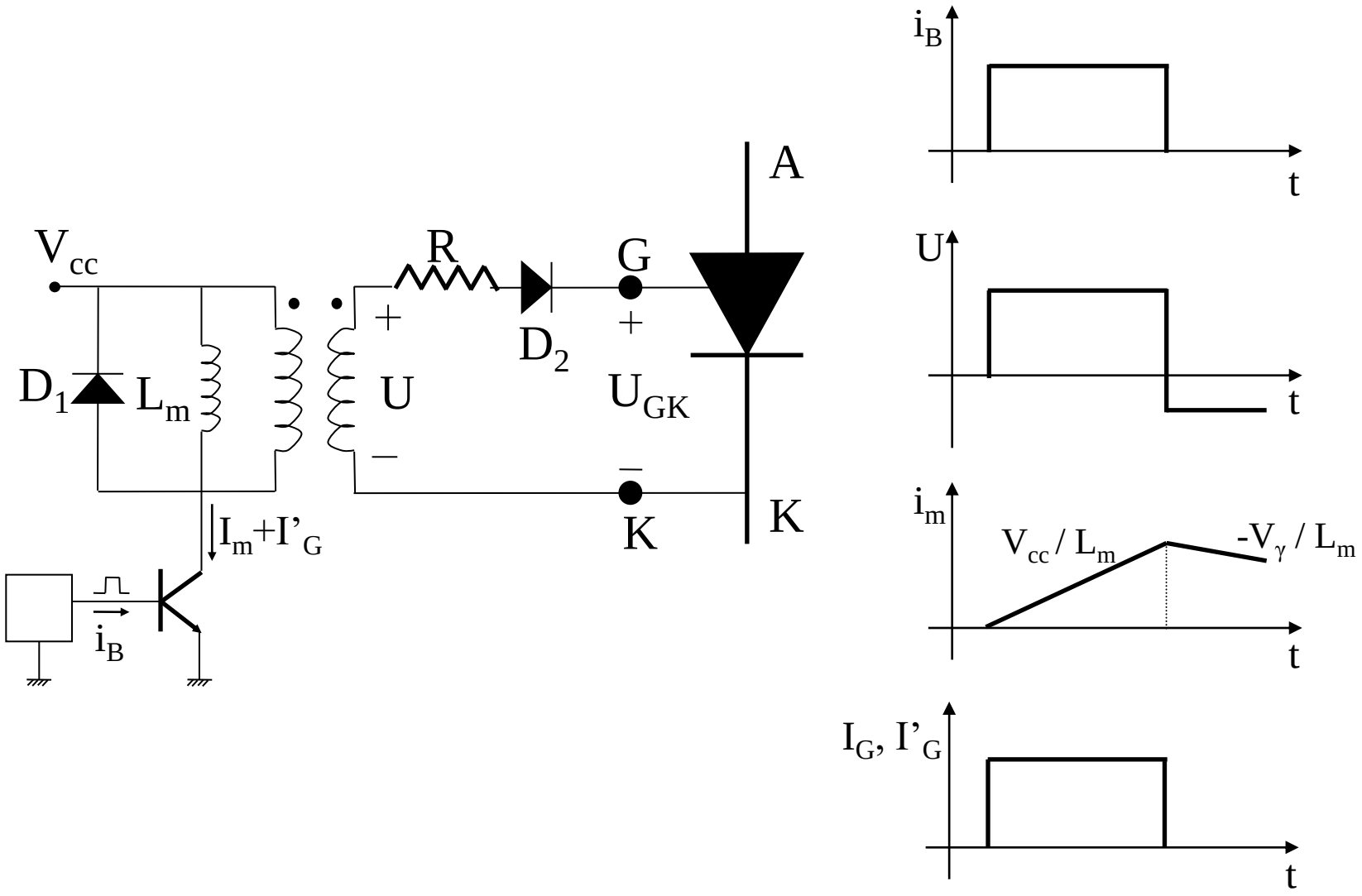


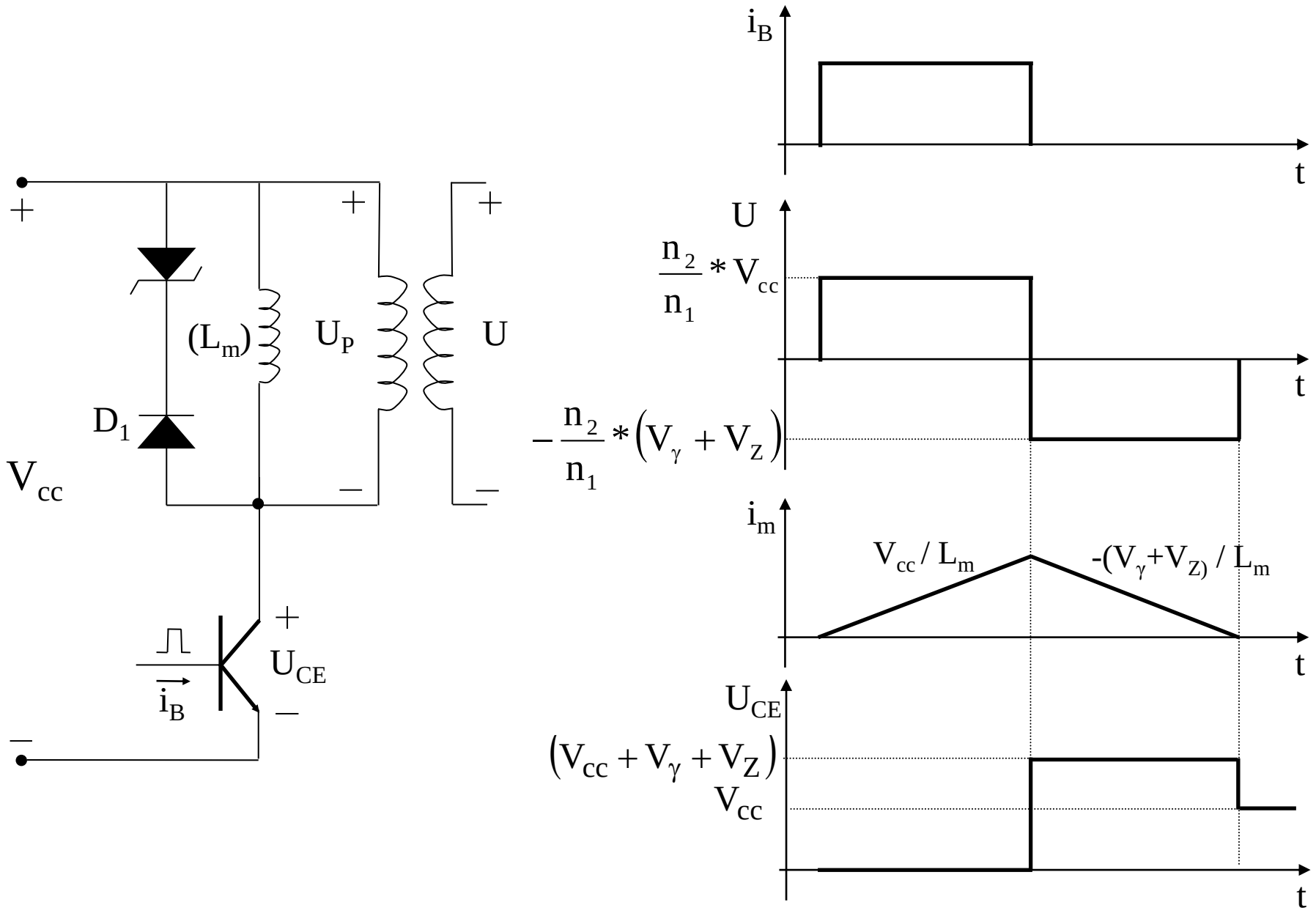

A
R
G
I_G
+
E
U_{GK}
–
K
K

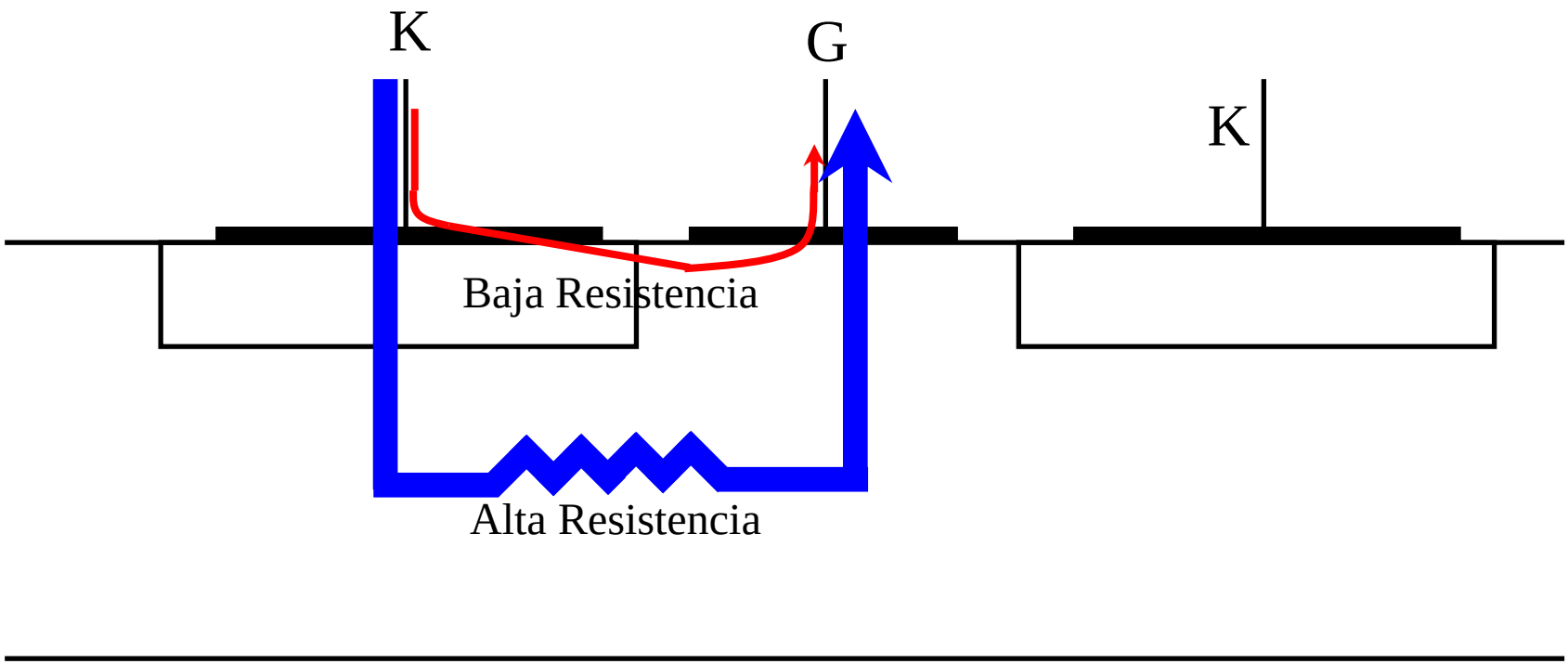

U_{GK}
E
$P_{Gmáx}$
E/R
I_G

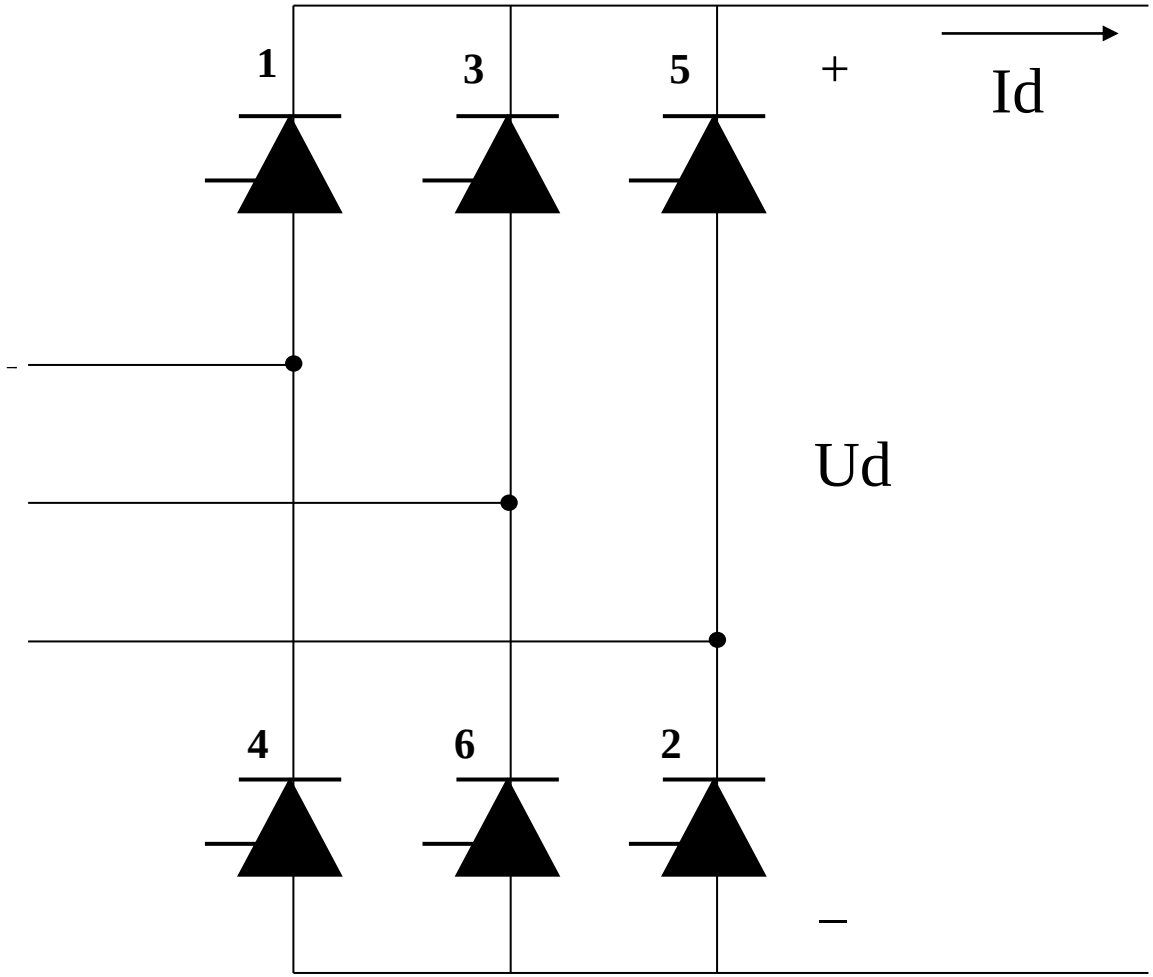

1
3
5
+
Id
-
Ud
4
6
2
–

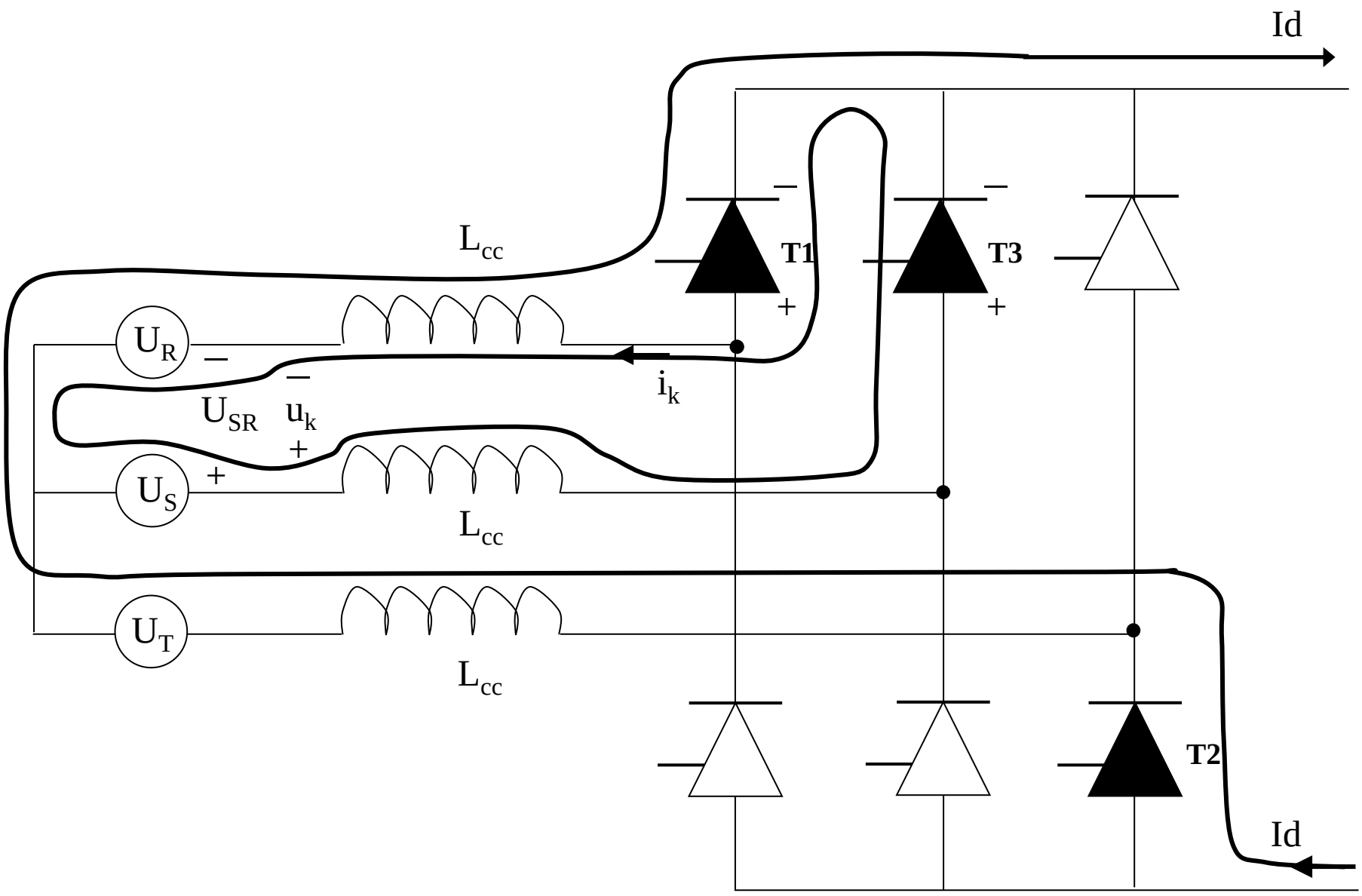

A
V_{cc}
R
G
I_G
V_{cc}
$U = \frac{n_2}{n_1} * V_{cc}$
U_{GK}
K
i_B
i_B
t
$\frac{n_2}{n_1} * V_{cc}$
t
i_m
(Φ)
t
V_{cc}
i_m
L_m

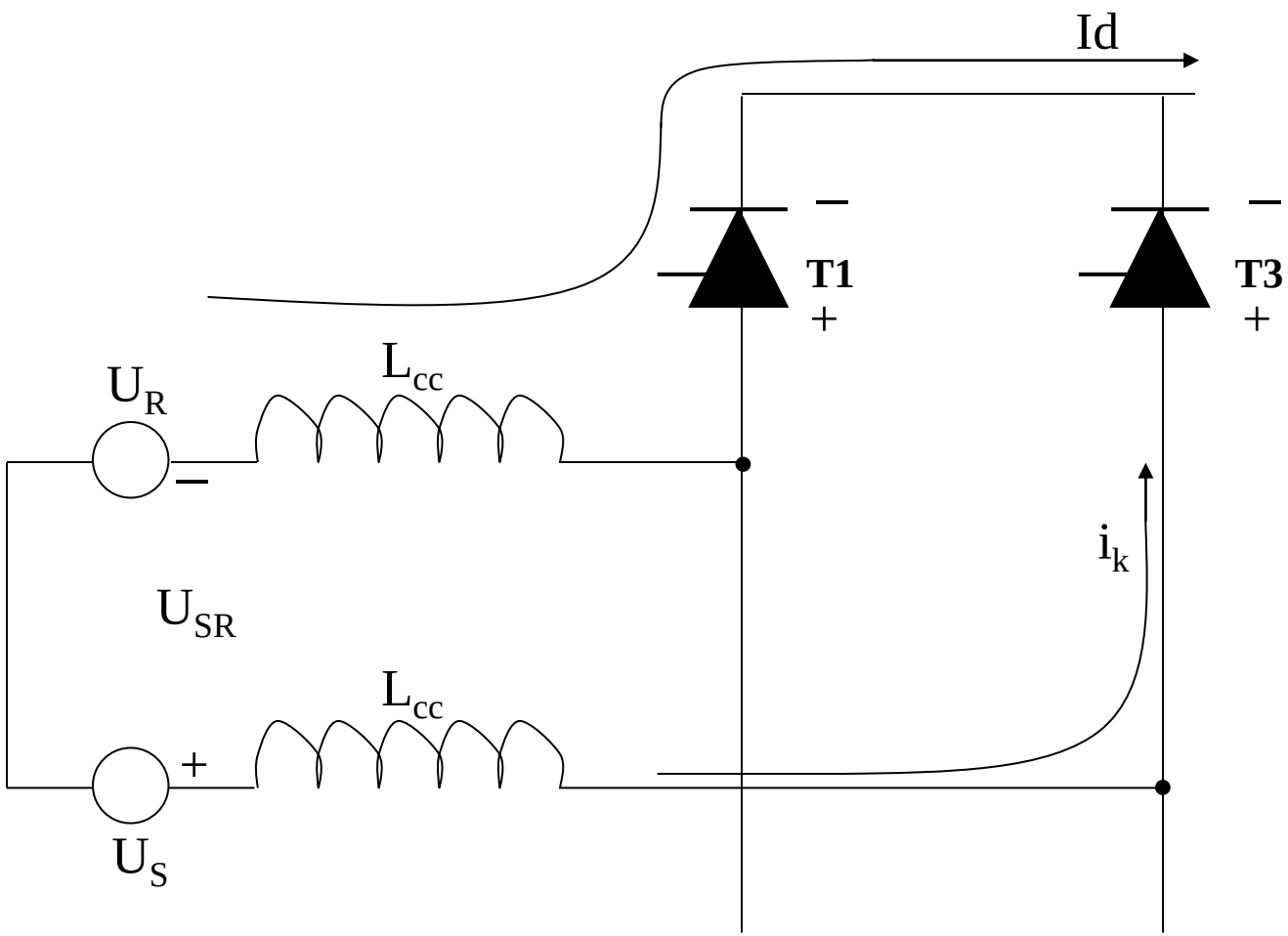

V_{cc}
R
G
A
D_1
L_m
U
D_2
U_{GK}
$I_m+I'_G$
K
K
i_B
i_B
t
U
t
i_m
V_{cc} / L_m
$-V_\gamma$ / L_m
t
I_G, I'_G
t


+
+
+
(L_m)
U_P
U
D_1
V_cc
–
–
+
U_CE
i_B
–
–
i_B
t
U
n_2 / n_1 * V_cc
t
– n_2 / n_1 * (V_γ + V_Z)
i_m
V_cc / L_m
-(V_γ+V_Z) / L_m
t
U_CE
(V_cc + V_γ + V_Z)
V_cc
t

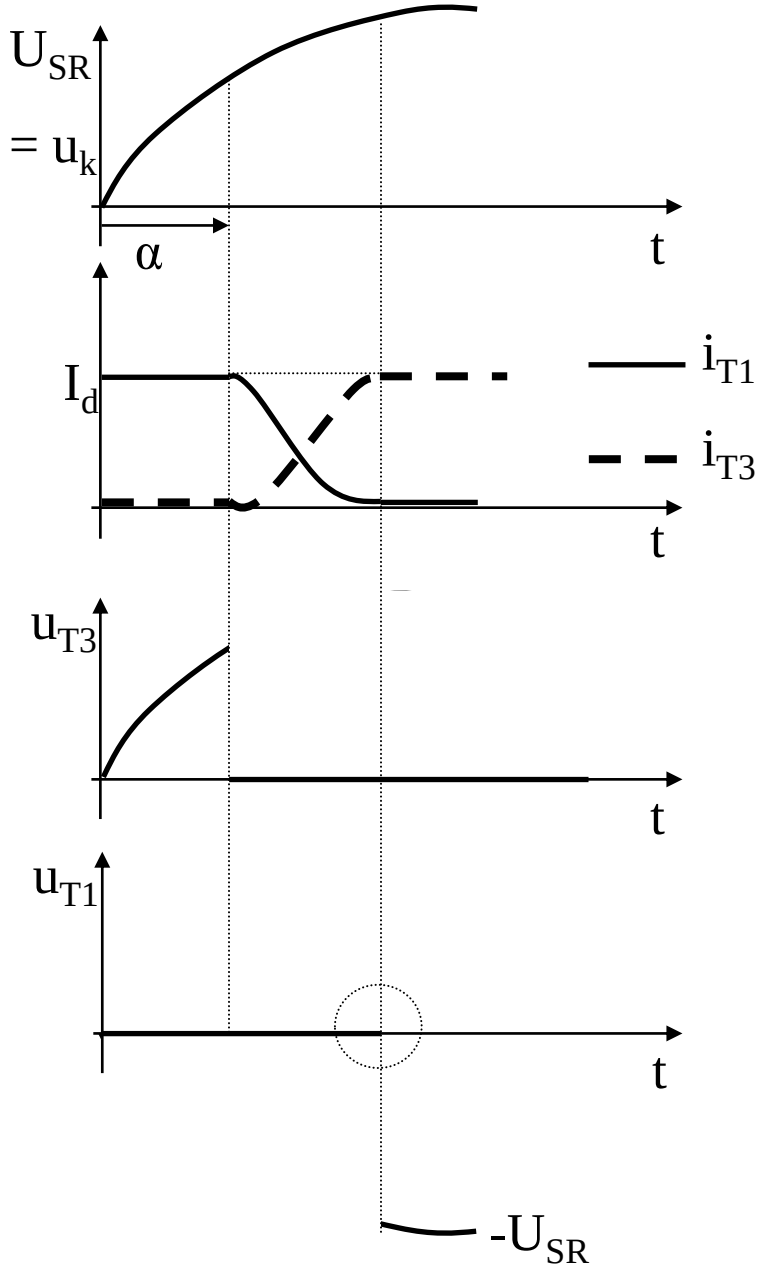

K
G
K
Baja Resistencia
Alta Resistencia

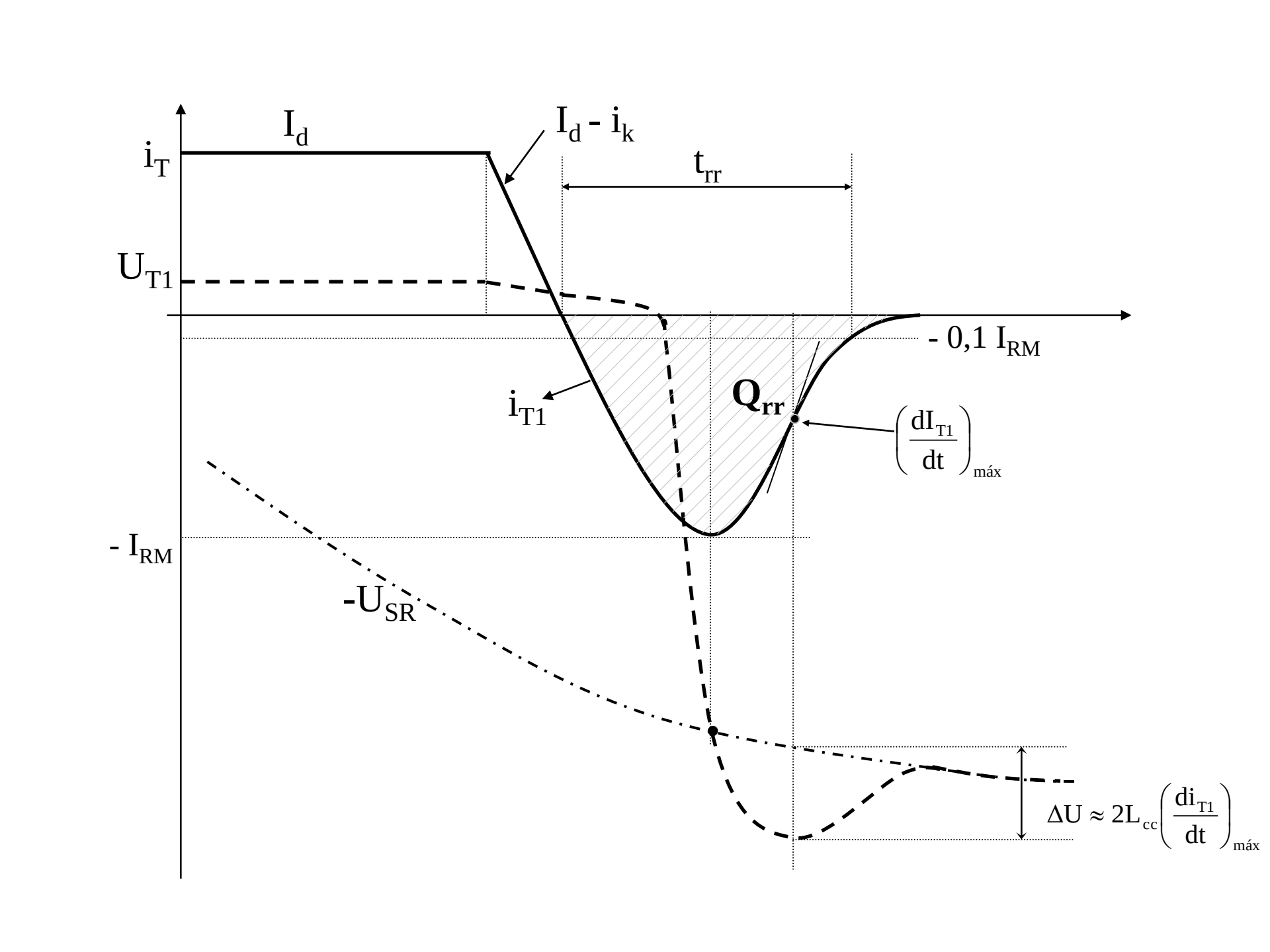

1
3
5
+
Id
-
Ud
4
6
2
–

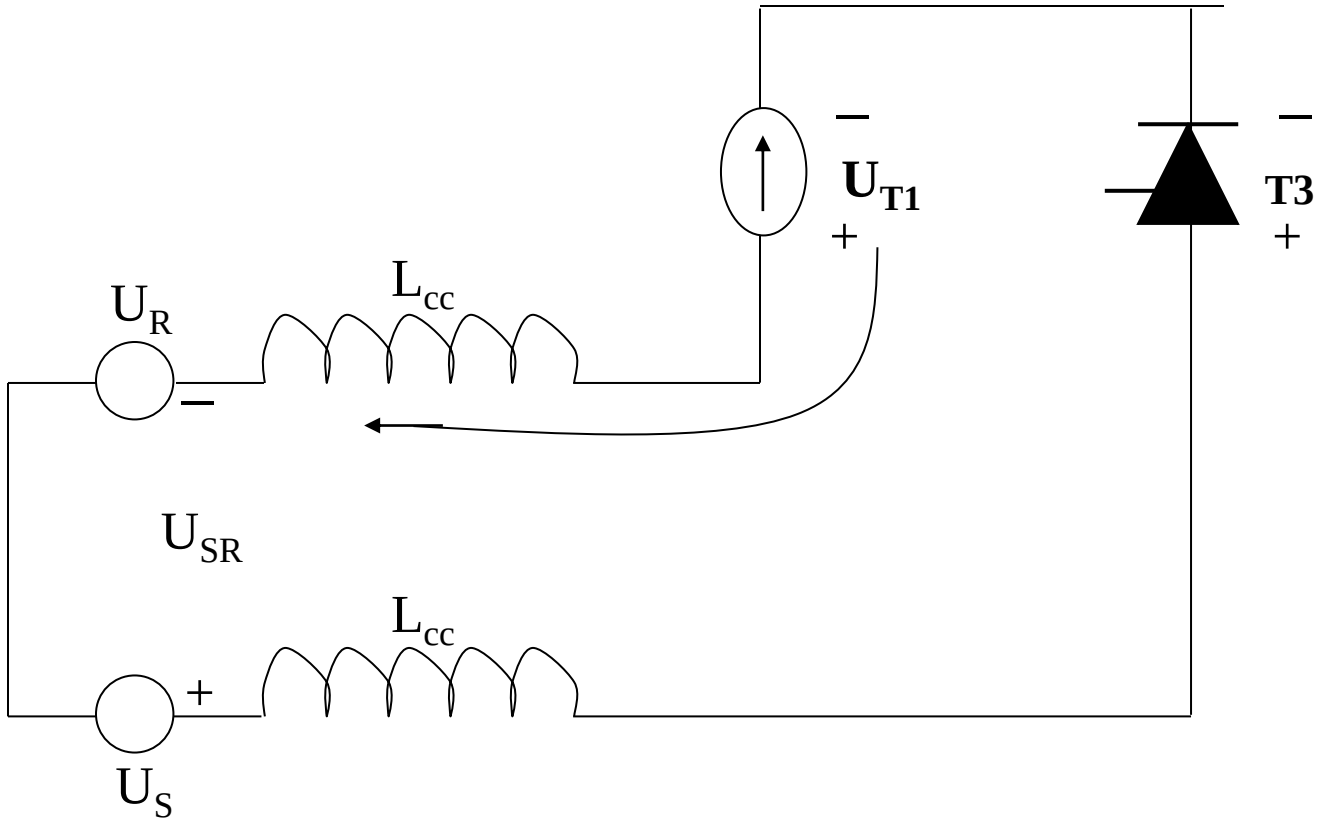

Id
T1
T3
T2
L_{cc}
L_{cc}
L_{cc}
U_R
U_S
U_T
U_{SR}
u_k
i_k
–
+
Id


Id
T1
T3
L_{cc}
U_R
U_{SR}
L_{cc}
i_k
U_S

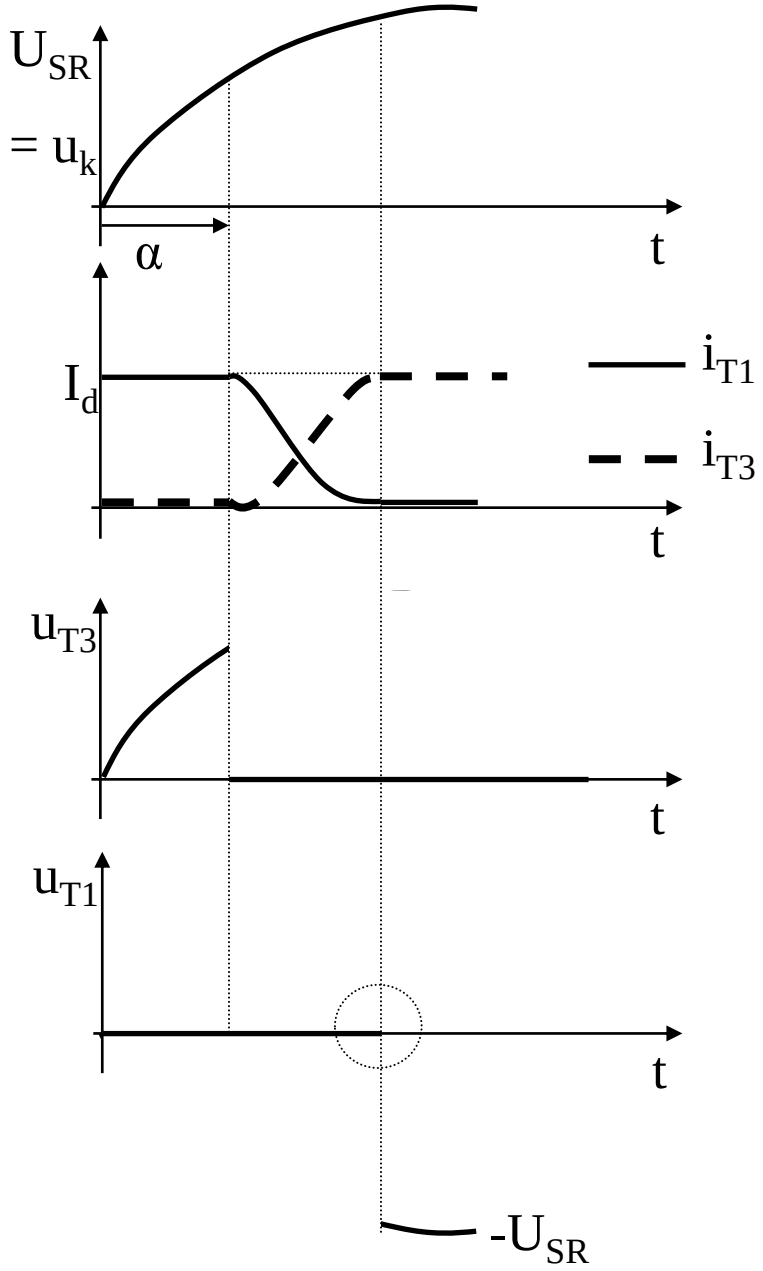
Formas de onda conmutación rectificador

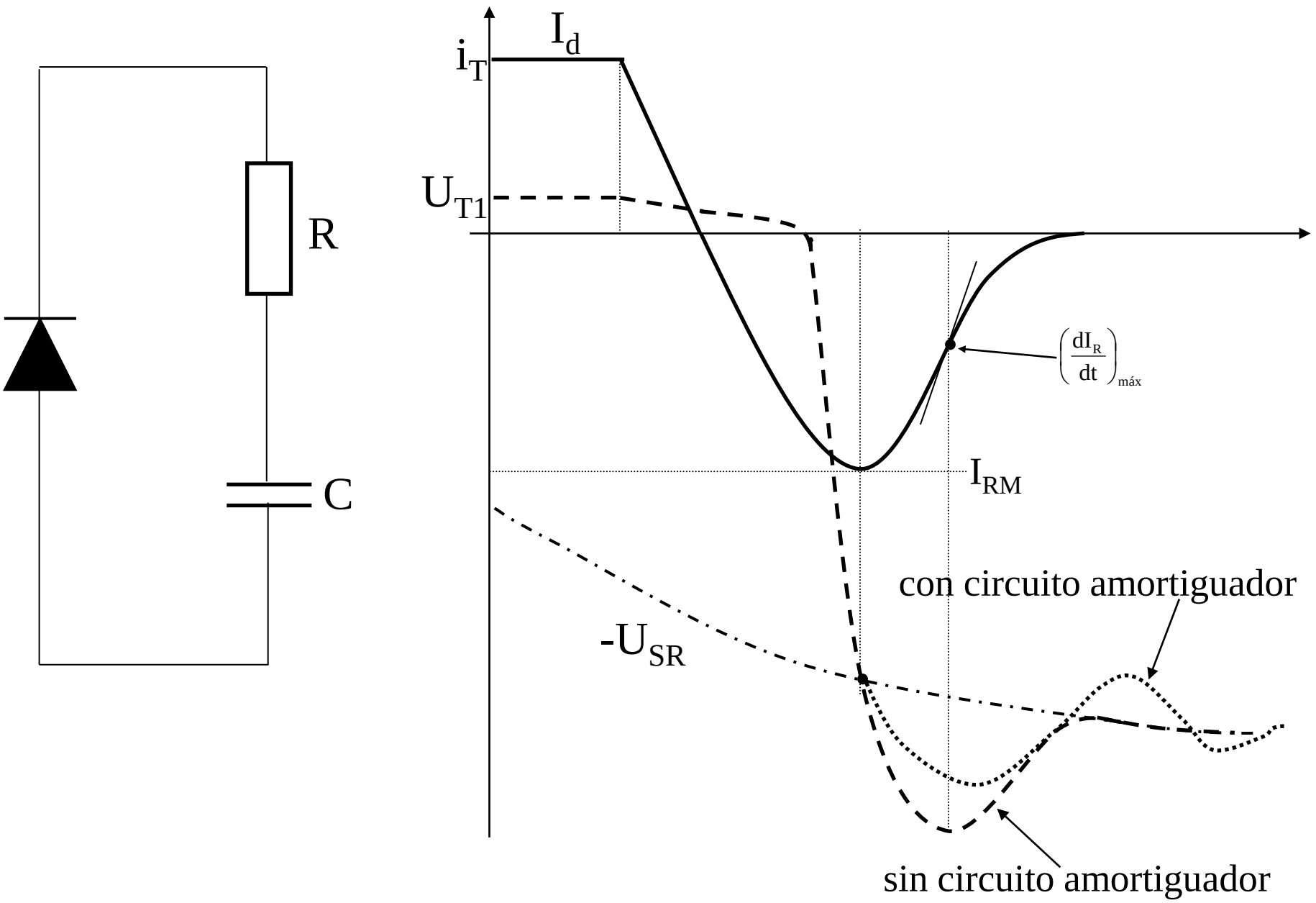



I_d
$I_d - i_k$
i_T
t_{rr}
U_{T1}
$- 0{,}1\ I_{RM}$
i_{T1}
$\mathbf{Q_{rr}}$
$\left(\frac{dI_{T1}}{dt}\right)_{máx}$
$- I_{RM}$
$-U_{SR}$
$\Delta U \approx 2L_{cc}\left(\frac{di_{T1}}{dt}\right)_{máx}$

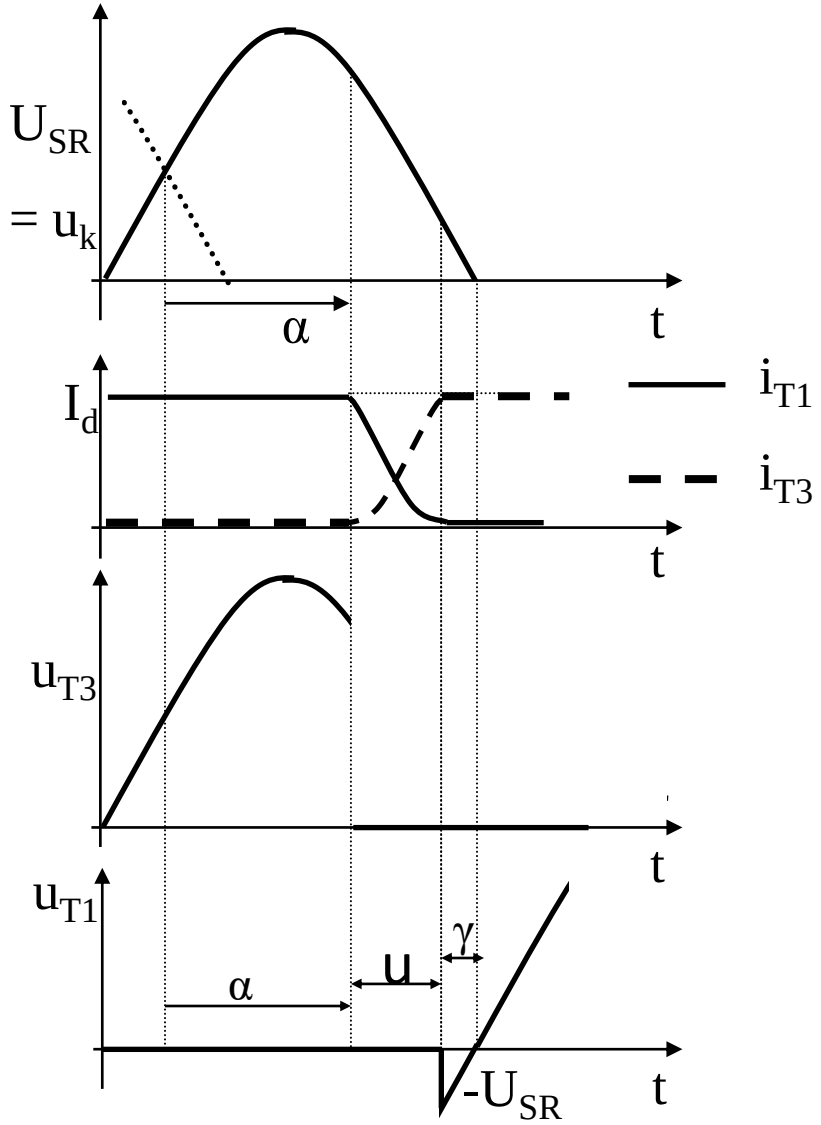

U_T1
T3
U_R
L_cc
U_SR
L_cc
U_S

Formas de onda conmutación rectificador




R
C
I_d
i_T
U_{T1}
$\left(\frac{dI_R}{dt}\right)_{máx}$
I_{RM}
$-U_{SR}$
con circuito amortiguador
sin circuito amortiguador

Curvas conmutación en funcionamiento como inversor



Curvas de apagado como inversor