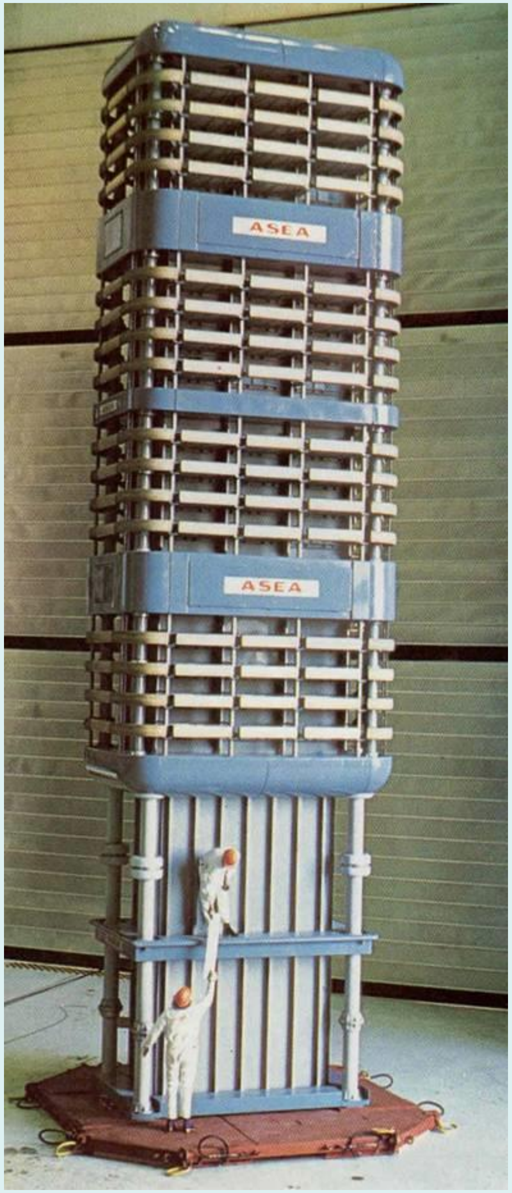
Electrónica Analógica I

Tiristores

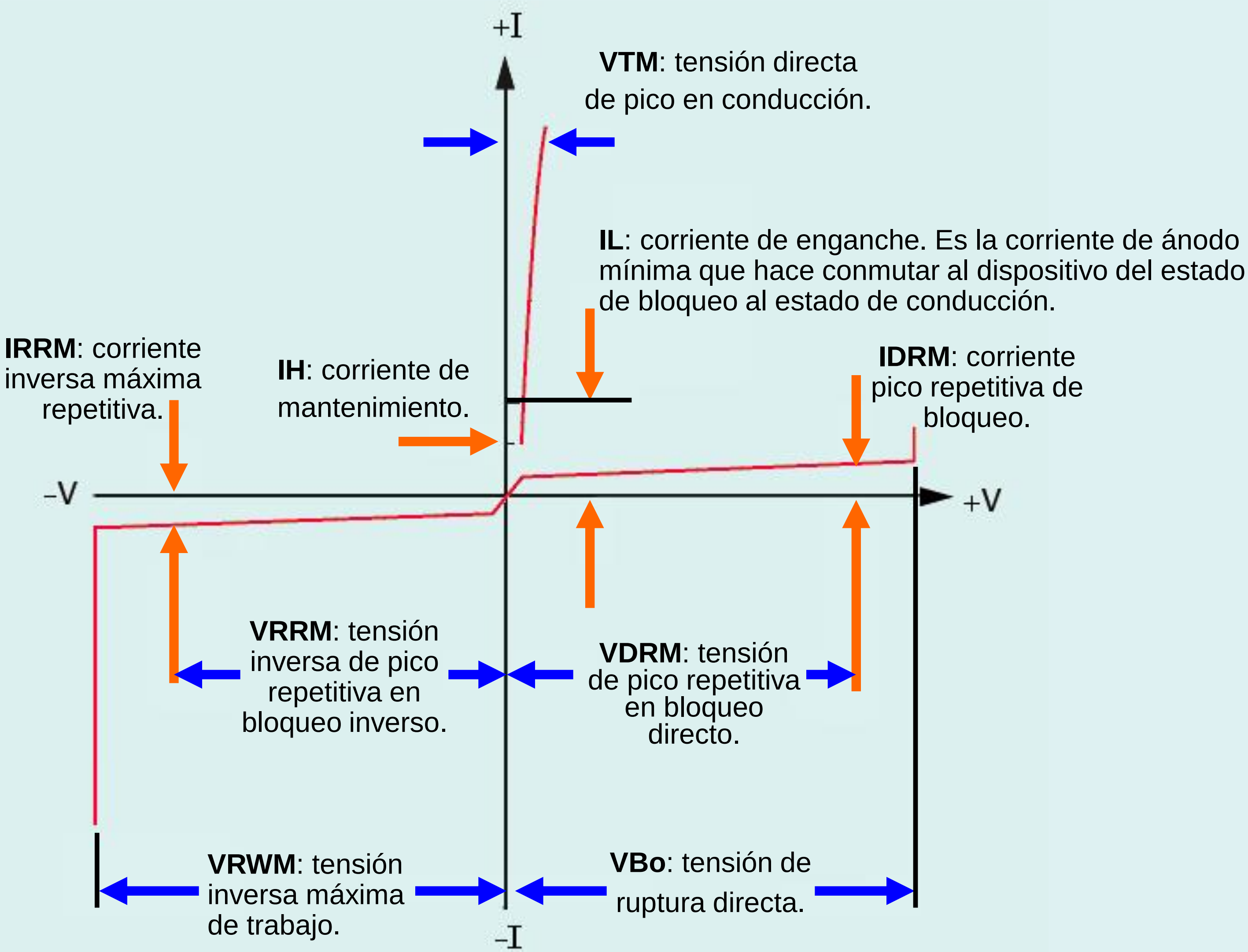
(Silicon Controlled Rectifier)

- *EL SCR es el dispositivo electrónico mas robusto que existe.*
- *Puede manejar tensiones y corrientes realmente impresionantes.*
- *Algunos ejemplos son realmente espectaculares.*



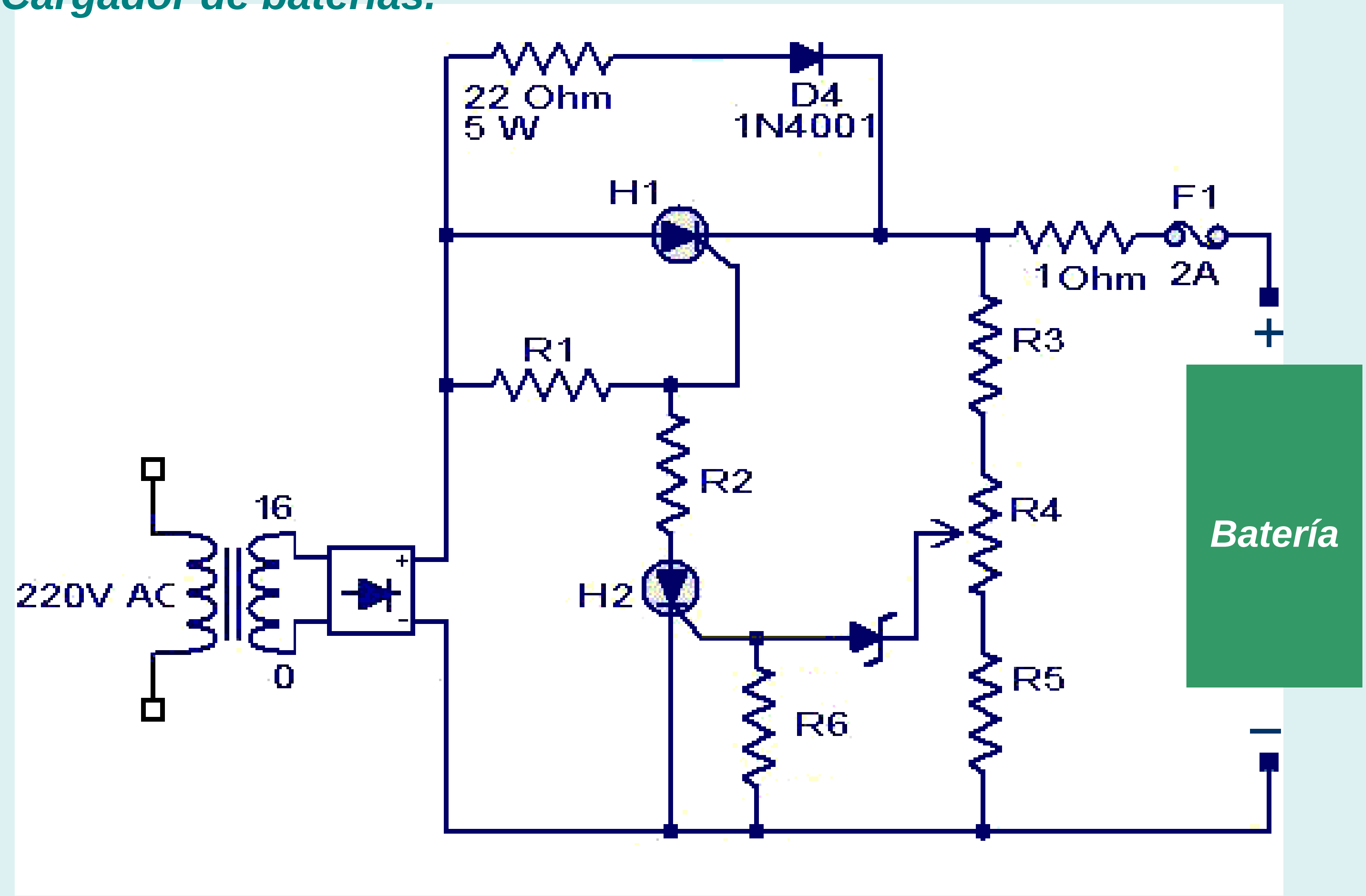
Este es uno de los 12 SCR para un rectificador trifásico de 500 MW y 500 KV (Inga-Shaba, ZAIRE)

SCR - Caracteristica tensión corriente.



Ejemplo de funcionamiento:

Cargador de baterías.



Tiristor de paso del cargador.

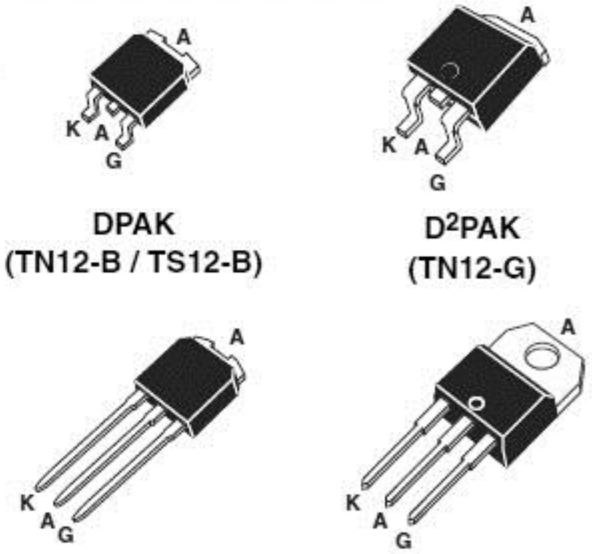
TN12, TS12 and TYNx12 Series

SENSITIVE & STANDARD

12A SCRs

Table 1: Main Features

Symbol	Value	Unit
$I_{T(RMS)}$	12	A
V_{DRM}/V_{RRM}	600 to 1000	V
I_{GT}	0.2 to 15	mA



DPAK (TN12-B / TS12-B)

D²PAK (TN12-G)

IPAK (TN12-H / TS12-H)

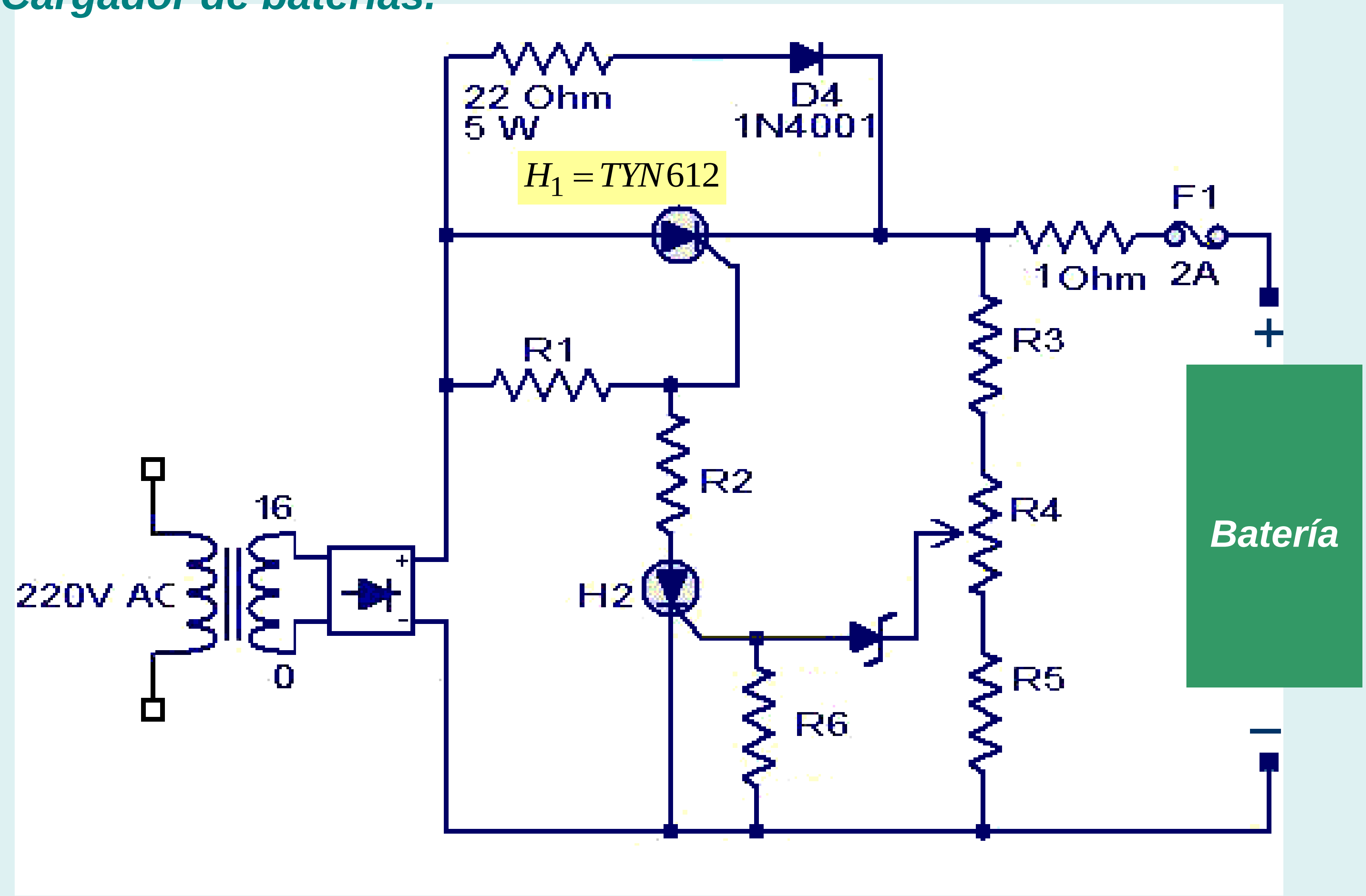
TO-220AB (TYNx12RG)

DESCRIPTION

Available either in sensitive **(TS12)** or standard **(TN12 / TYN)** gate triggering levels, the 12A SCR series is suitable to fit all modes of control, found in applications such as overvoltage crowbar protection, motor control circuits in power tools

Ejemplo de funcionamiento:

Cargador de baterías.



Tiristor de paso del cargador.

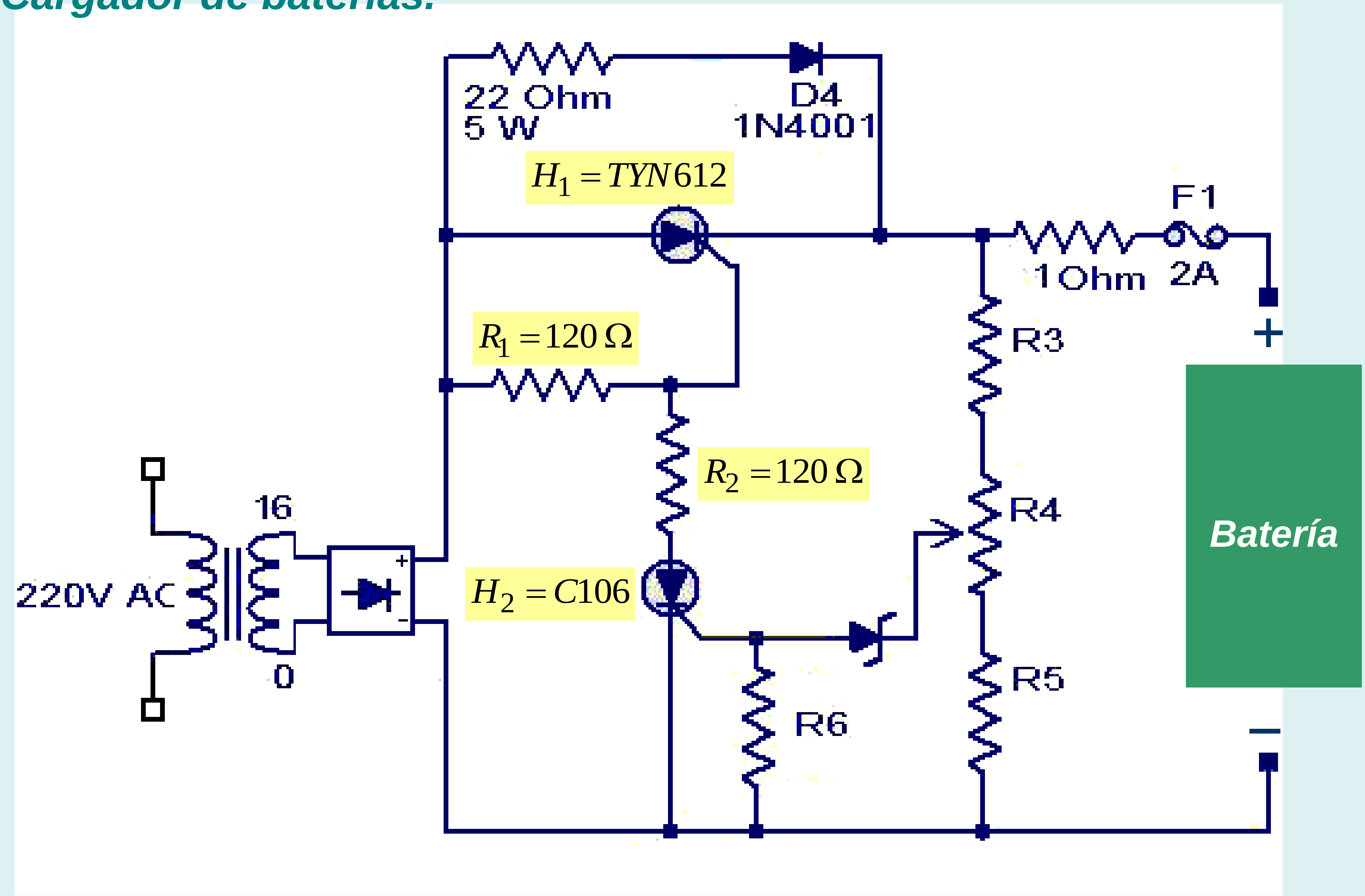
TN12, TS12 and TYNx12 Series

■ **STANDARD**

Symbol	Test Conditions			TN1215		TYN		Unit
				B / H	G	x12T	x12	
I_{GT}	$V_D = 12$ V $R_L = 33\ \Omega$		MIN.	2		0.5	2	mA
			MAX.	15		5	15	
V_{GT}			MAX.	1.3				V
V_{GD}	$V_D = V_{DRM}$ $R_L = 3.3$ kΩ	$T_j = 125°C$	MIN.	0.2				V
I_H	$I_T = 500$ mA Gate open		MAX.	40	30	15	30	mA
I_L	$I_G = 1.2\ I_{GT}$		MAX.	80	60	30	60	mA
dV/dt	$V_D =$ 67 % V_{DRM} Gate open	$T_j = 125°C$	MIN.	200		40	200	V/µs
V_{TM}	$I_{TM} =$ 24 A $t_p = 380$ µs	$T_j = 25°C$	MAX.	1.6				V
V_{t0}	Threshold voltage	$T_j = 125°C$	MAX.	0.85				V
R_d	Dynamic resistance	$T_j = 125°C$	MAX.	30				mΩ
I_{DRM} I_{RRM}	$V_{DRM} = V_{RRM}$	$T_j = 25°C$	MAX.	5				µA
		$T_j = 125°C$		2				mA

Ejemplo de funcionamiento:

Cargador de baterías.



Tiristor de control del cargador.

C106 Series

Preferred Devices

Sensitive Gate Silicon Controlled Rectifiers

Reverse Blocking Thyristors

Glassivated PNPN devices designed for high volume consumer applications such as temperature, light, and speed control; process and remote control, and warning systems where reliability of operation is important.

Features

- Glassivated Surface for Reliability and Uniformity
- Power Rated at Economical Prices
- Practical Level Triggering and Holding Characteristics
- Flat, Rugged, Thermopad Construction for Low Thermal Resistance, High Heat Dissipation and Durability
- Sensitive Gate Triggering
- Pb−Free Packages are Available*

ON Semiconductor®

http://onsemi.com

SCRs
4 A RMS, 200 − 600 Volts

TO−225AA
CASE 077
STYLE 2

Tiristor de control del cargador.

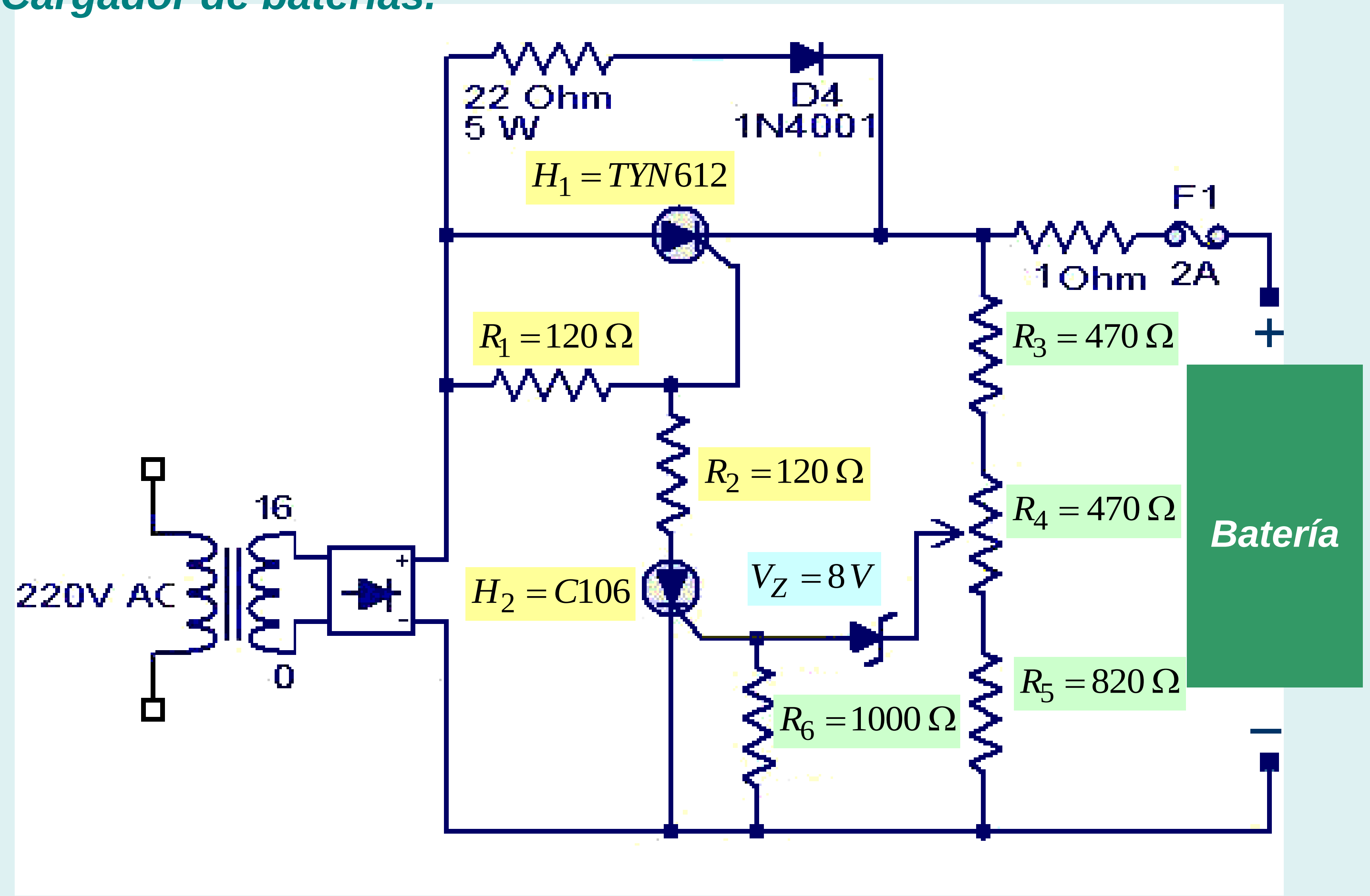
C106 Series

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Peak Repetitive Forward or Reverse Blocking Current (V_{AK} = Rated V_{DRM} or V_{RRM}, R_{GK} = 1000 Ohms)	T_J = 25°C T_J = 110°C	I_{DRM}, I_{RRM}	– –	– –	10 100	μA μA
ON CHARACTERISTICS						
Peak Forward On−State Voltage (Note 3) (I_{TM} = 4 A)		V_{TM}	–	–	2.2	V
Gate Trigger Current (Continuous dc) (Note 4) (V_{AK} = 6 Vdc, R_L = 100 Ohms)	T_J = 25°C T_J = −40°C	I_{GT}	– –	15 35	200 500	μA
Peak Reverse Gate Voltage (I_{GR} = 10 μA)		V_{GRM}	–	–	6.0	V
Gate Trigger Voltage (Continuous dc) (Note 4) (V_{AK} = 6 Vdc, R_L = 100 Ohms)	T_J = 25°C T_J = −40°C	V_{GT}	0.4 0.5	0.60 0.75	0.8 1.0	V
Gate Non−Trigger Voltage (Continuous dc) (Note 4) (V_{AK} = 12 V, R_L = 100 Ohms, T_J = 110°C)		V_{GD}	0.2	–	–	V
Latching Current (V_{AK} = 12 V, I_G = 20 mA)	T_J = 25°C T_J = −40°C	I_L	– –	0.20 0.35	5.0 7.0	mA
Holding Current (V_D = 12 Vdc) (Initiating Current = 20 mA, Gate Open)	T_J = 25°C T_J = −40°C T_J = +110°C	I_H	– – –	0.19 0.33 0.07	3.0 6.0 2.0	mA

Ejemplo de funcionamiento:

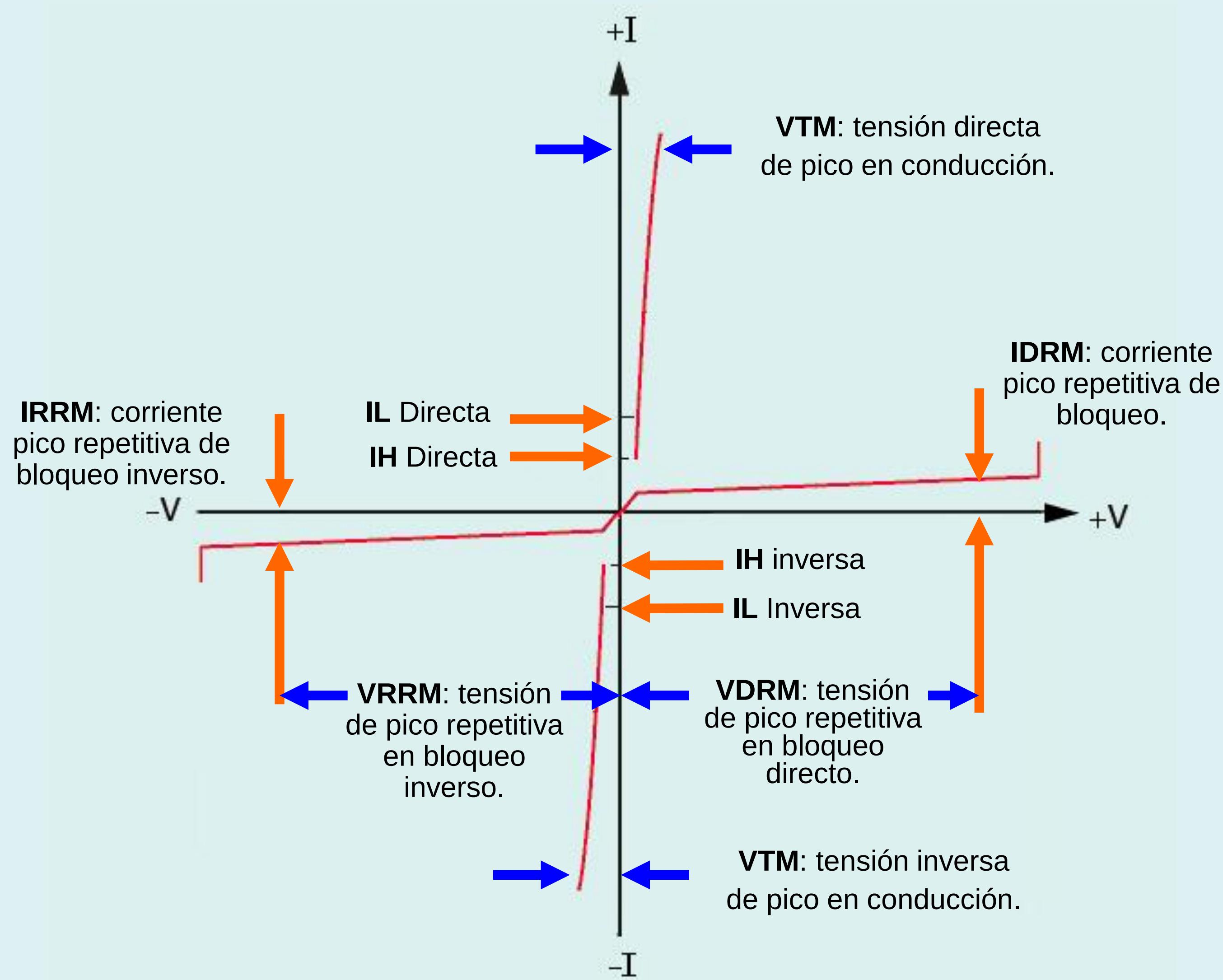
Cargador de baterías.



TRIAC

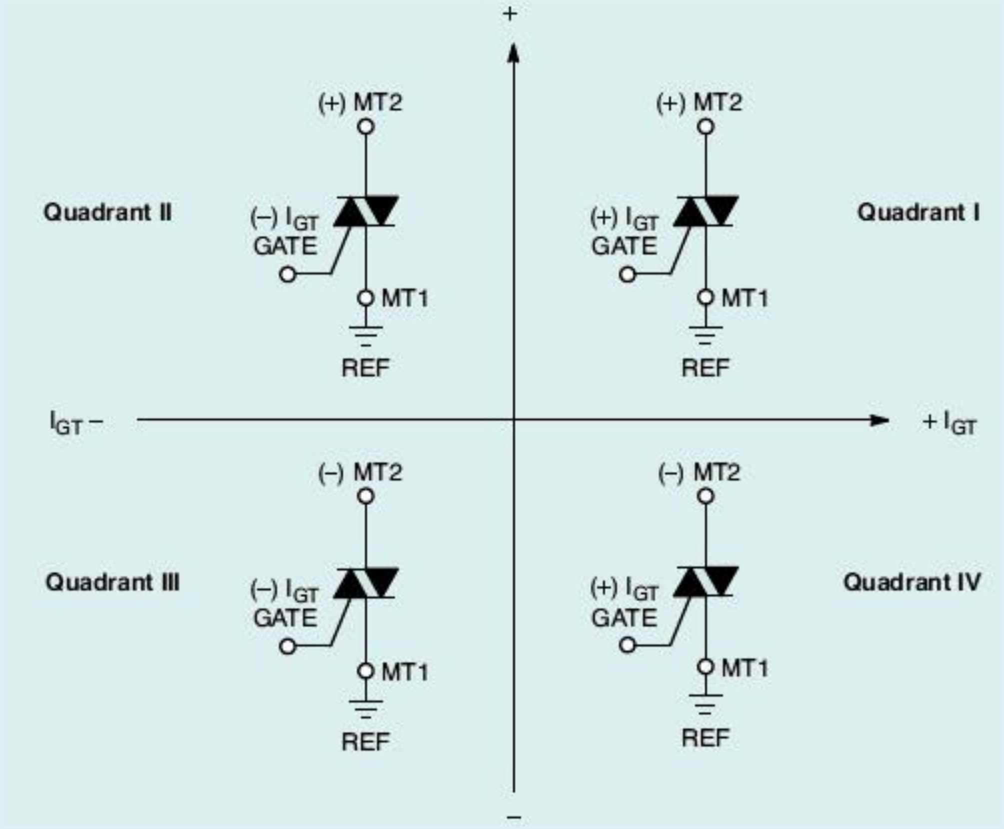
(Tiristores bidireccionales)

TRIAC - Caracteristica tensión corriente.



Características de disparo

MT2 en el semiciclo positivo



MT2 en el semiciclo negativo

Todas las polaridades referidas al MT1

Se puede disparar en los cuatro cuadrantes.

TRIAC (Tiristores bidireccionales)

BTA40, BTA41, BTB41

40 A standard TRIACs

Features

- High current TRIAC
- Low thermal resistance with clip bonding
- High commutation capability
- BTA series UL1557 certified (File ref: 81734)
- Packages are RoHS (2002/95/EC) compliant

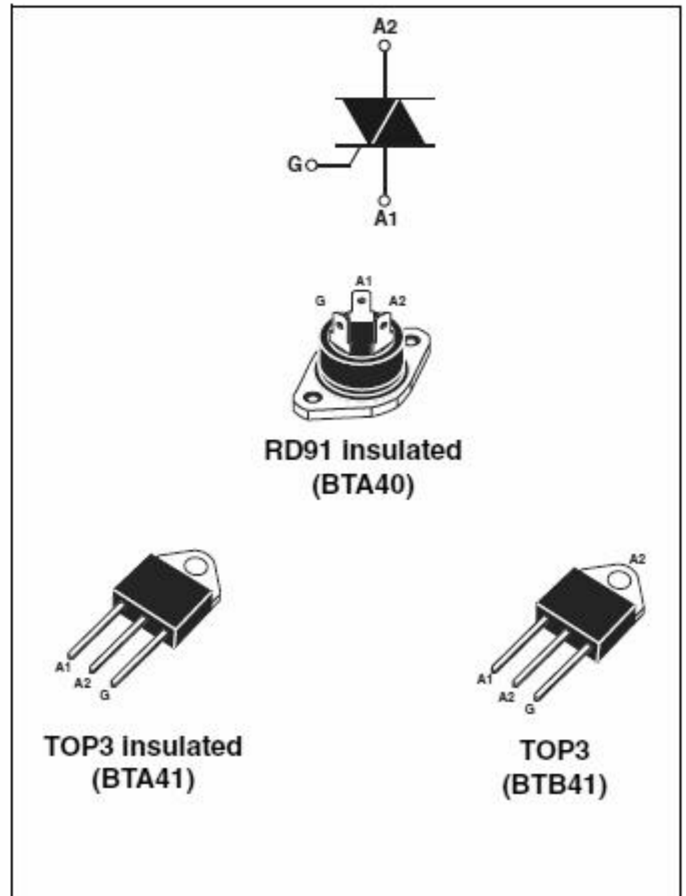
Applications

- On/off function in static relays, heating regulation, induction motor starting circuits
- Phase control operations in light dimmers, motor speed controllers, and similar

Description

Available in high power packages, the BTA/BTB40-41 series is suitable for general purpose AC switching.

The BTA series provides an insulated tab (rated at 2500 V rms).



BTA40, BTA41, BTB41

40 A standard TRIACs

Table 1. Device summary

Symbol	Parameter	BTA40[1]	BTA41[1]	BTB41	Unit
$I_{T(RMS)}$	On-state rms current	40	41	41	A
V_{DRM}/V_{RRM}	Repetitive peak off-state voltage	600 and 800	600 and 800	600 and 800	V
I_{GT}	Triggering gate current	50	50	50	mA

Table 2. Absolute maximum ratings

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	On-state rms current (full sine wave)	TOP3	$T_c = 95$ °C	40	A
		RD91 / TOP ins.	$T_c = 80$ °C		
I_{TSM}	Non repetitive surge peak on-state current (full cycle, T_j initial = 25 °C)	F = 50 Hz	t = 20 ms	400	A
		F = 60 Hz	t = 16.7 ms	420	
I^2t	I^2t Value for fusing	$t_p = 10$ ms		1000	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, $t_r \leq 100$ ns	F = 120 Hz	$T_j = 125$ °C	50	A/µs
V_{DSM}/V_{RSM}	Non repetitive surge peak off-state voltage	$t_p = 10$ ms	$T_j = 25$ °C	V_{DSM}/V_{RSM} + 100	V
I_{GM}	Peak gate current	$t_p = 20$ µs	$T_j = 125$ °C	8	A
$P_{G(AV)}$	Average gate power dissipation		$T_j = 125$ °C	1	W
T_{stg} T_j	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125	°C

BTA40, BTA41, BTB41

40 A standard TRIACs

Table 3. Electrical characteristics (T_j = 25 °C, unless otherwise specified)

Symbol	Parameter			Value	Unit
I_{GT} (1)	V_D = 12 V R_L = 33 Ω	I - II - III IV	MAX.	50 100	mA
V_{GT}		ALL	MAX.	1.3	V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ T_j = 125 °C	ALL	MIN.	0.2	V
I_H (2)	I_T = 500 mA		MAX.	80	mA
I_L	$I_G = 1.2\ I_{GT}$	I - III - IV	MAX.	70	mA
		II		160	
dV/dt(2)	V_D = 67% V_{DRM} gate open	T_j = 125 °C	MIN.	500	V/µs
(dV/dt)c(2)	(dI/dt)c = 20 A/ms	T_j = 125 °C	MIN.	10	V/µs

Table 4. Static characteristics

Symbol	Test conditions			Value	Unit
V_T (1)	I_{TM} = 60 A t_p = 380 µs	T_j = 25 °C	MAX.	1.55	V
V_{t0} (2)	Threshold voltage	T_j = 125 °C	MAX.	0.85	V
R_d (2)	Dynamic resistance	T_j = 125 °C	MAX.	10	mΩ
I_{DRM} I_{RRM}	$V_{DRM} = V_{RRM}$	T_j = 25 °C	MAX.	5	µA
		T_j = 125 °C		5	mA

2N6071A/B Series

Preferred Device

Sensitive Gate Triacs

Silicon Bidirectional Thyristors

Designed primarily for full-wave AC control applications, such as light dimmers, motor controls, heating controls and power supplies; or wherever full-wave silicon gate controlled solid-state devices are needed. Triac type thyristors switch from a blocking to a conducting state for either polarity of applied anode voltage with positive or negative gate triggering.

Features

- Sensitive Gate Triggering Uniquely Compatible for Direct Coupling to TTL, HTL, CMOS and Operational Amplifier Integrated Circuit Logic Functions
- Gate Triggering: 4 Mode – 2N6071A, B; 2N6073A, B; 2N6075A, B
- Blocking Voltages to 600 V
- All Diffused and Glass Passivated Junctions for Greater Parameter Uniformity and Stability
- Small, Rugged, Thermopad Construction for Low Thermal Resistance, High Heat Dissipation and Durability
- Device Marking: Device Type, e.g., 2N6071A, Date Code

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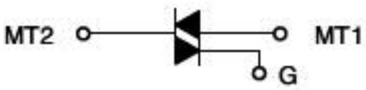
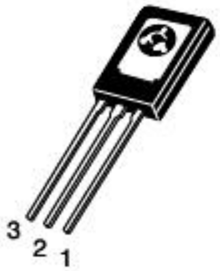
TRIACS
4.0 A RMS, 200 – 600 V





REAR VIEW
SHOW TAB

TO–225
CASE 077
STYLE 5

TRIAC (Tiristores bidireccionales)

2N6071A/B Series

Preferred Device

Sensitive Gate Triacs

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted; Electricals apply in both directions)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
*Peak Repetitive Blocking Current ($V_D = V_{DRM} = V_{RRM}$; Gate Open) T_J = 25°C T_J = 110°C	I_{DRM}, I_{RRM}	– –	– –	10 2	µA mA
ON CHARACTERISTICS					
*Peak On-State Voltage (Note 3) (I_{TM} = ± 6.0 A Peak)	V_{TM}	–	–	2	V
*Gate Trigger Voltage (Continuous DC), All Quadrants (Main Terminal Voltage = 12 Vdc, R_L = 100 Ω, T_J = –40°C)	V_{GT}	–	1.4	2.5	V
Gate Non-Trigger Voltage, All Quadrants (Main Terminal Voltage = 12 Vdc, R_L = 100 Ω, T_J = 110°C)	V_{GD}	0.2	–	–	V
*Holding Current (Main Terminal Voltage = 12 Vdc, Gate Open, Initiating Current = ±1 Adc) T_J = –40°C T_J = 25°C	I_H	– –	– –	30 15	mA
Turn-On Time (I_{TM} = 14 Adc, I_{GT} = 100 mAdc)	t_{gt}	–	1.5	–	µs

			QUADRANT (Maximum Value)			
	Type	I_{GT} @ T_J	I mA	II mA	III mA	IV mA
Gate Trigger Current (Continuous DC) (Main Terminal Voltage = 12 Vdc, R_L = 100 Ω)	2N6071A 2N6073A 2N6075A	+25°C	5	5	5	10
		-40°C	20	20	20	30
	2N6071B 2N6073B 2N6075B	+25°C	3	3	3	5
		-40°C	15	15	15	20

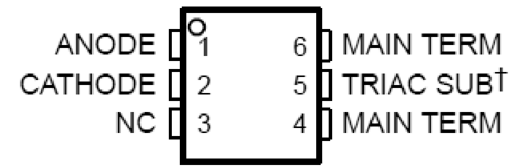
TRIAC (Tiristores bidireccionales)

MOC3020 THRU MOC3023
OPTOCOUPLERS/OPTOISOLATORS

SOES025 – OCTOBER 1986 – REVISED OCTOBER 1995

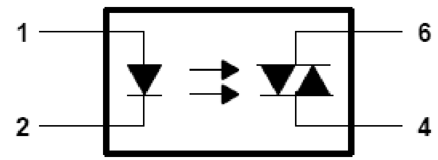
- 250 V Phototriac Driver Output
- Gallium-Arsenide-Diode Infrared Source and Optically-Coupled Silicon Traic Driver (Bilateral Switch)
- UL Recognized . . . File Number E65085
- High Isolation . . . 7500 V Peak
- Output Driver Designed for 220 V ac
- Standard 6-Terminal Plastic DIP
- Directly Interchangeable with Motorola MOC3020, MOC3021, MOC3022, and MOC3023
- Direct Replacements for:
  - TRW Optron OPI3020, OPI3021, OPI3022, and OPI3023;
  - General Instrument MCP3020, MCP3021, and MCP3022;
  - General Electric GE3020, GE3021, GE3022, and GE3023

MOC3020 – MOC3023 . . . PACKAGE
(TOP VIEW)



† Do not connect this terminal
NC – No internal connection

logic diagram



MOC3020 THRU MOC3023
OPTOCOUPLERS/OPTOISOLATORS

SOES025 – OCTOBER 1986 – REVISED OCTOBER 1995

APPLICATIONS INFORMATION

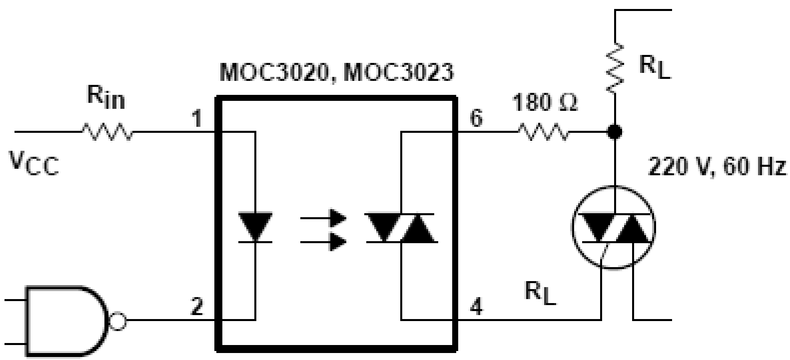


Figure 5. Resistive Load

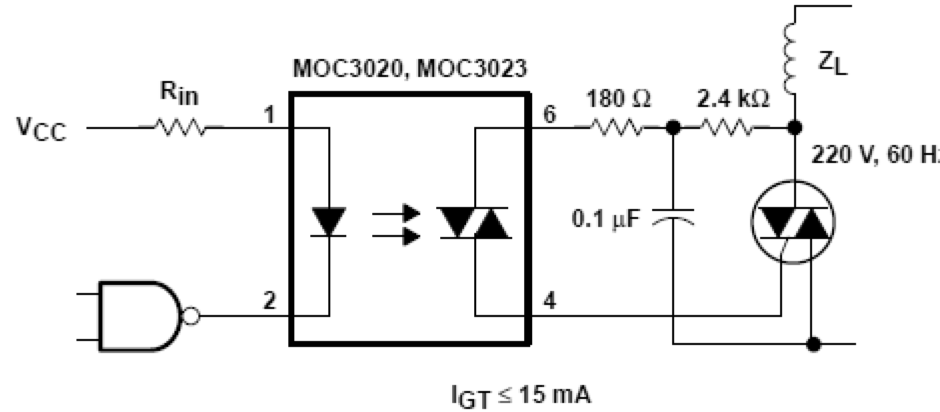


Figure 6. Inductive Load With Sensitive-Gate Triac

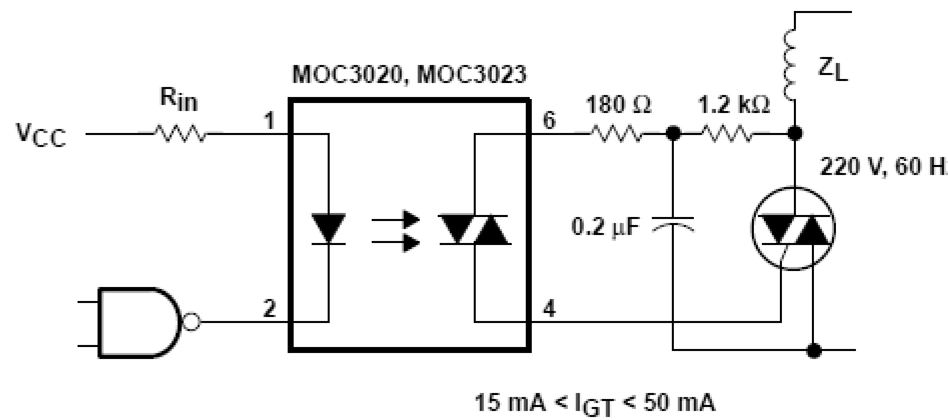


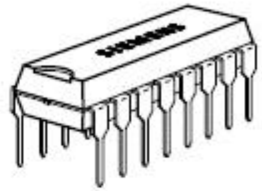
Figure 7. Inductive Load With Nonsensitive-Gate Triac

SIEMENS

TCA 785

Bipolar IC

Phase Control IC



P-DIP-16-1

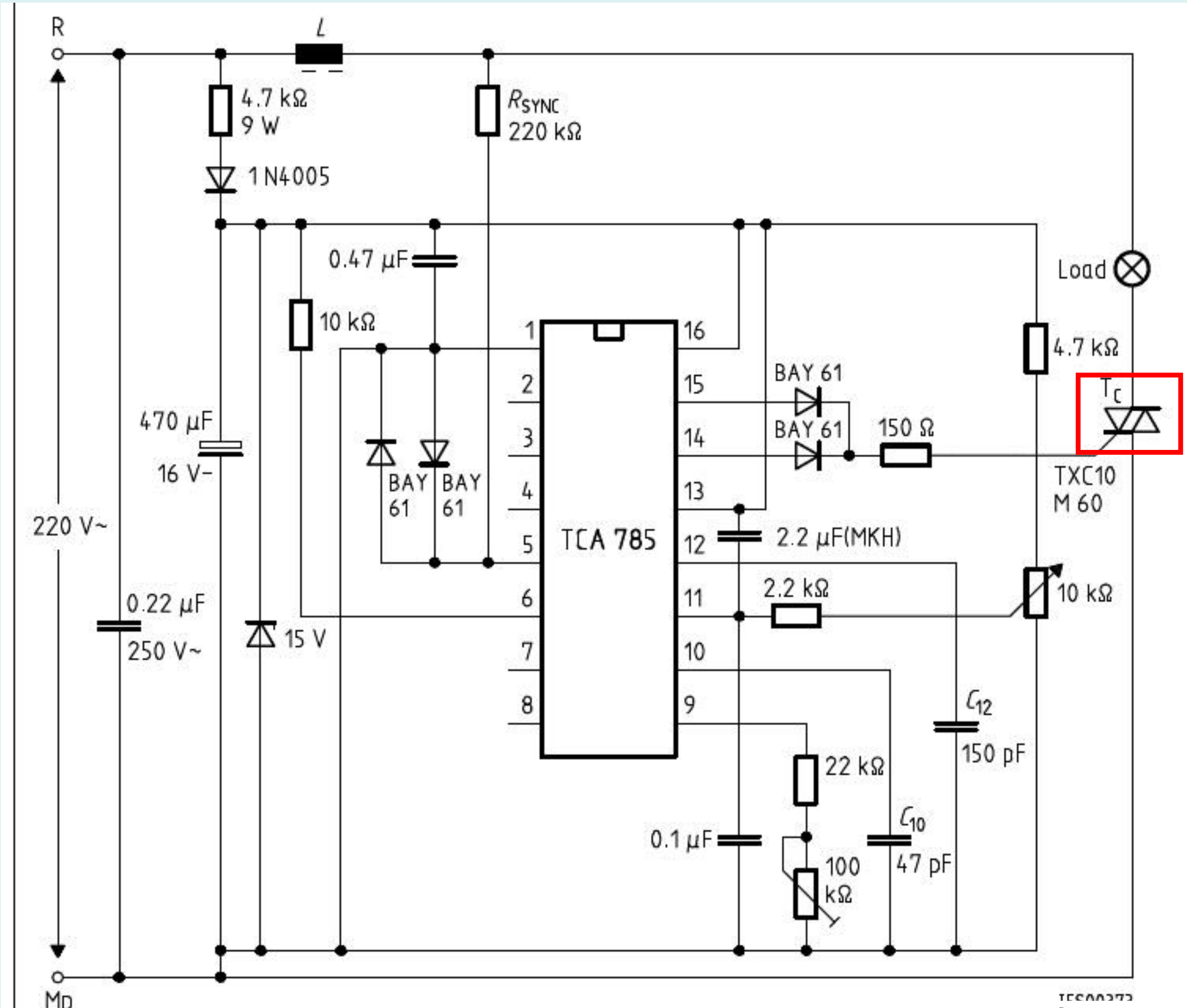
Features

- Reliable recognition of zero passage
- Large application scope
- May be used as zero point switch
- LSL compatible
- Three-phase operation possible (3 ICs)
- Output current 250 mA
- Large ramp current range
- Wide temperature range

Type	Ordering Code	Package
TCA 785	Q67000-A2321	P-DIP-16-1

This phase control IC is intended to control thyristors, triacs, and transistors. The trigger pulses can be shifted within a phase angle between 0 ° and 180 °. Typical applications include converter circuits, AC controllers and three-phase current controllers.

This IC replaces the previous types TCA 780 and TCA 780 D.



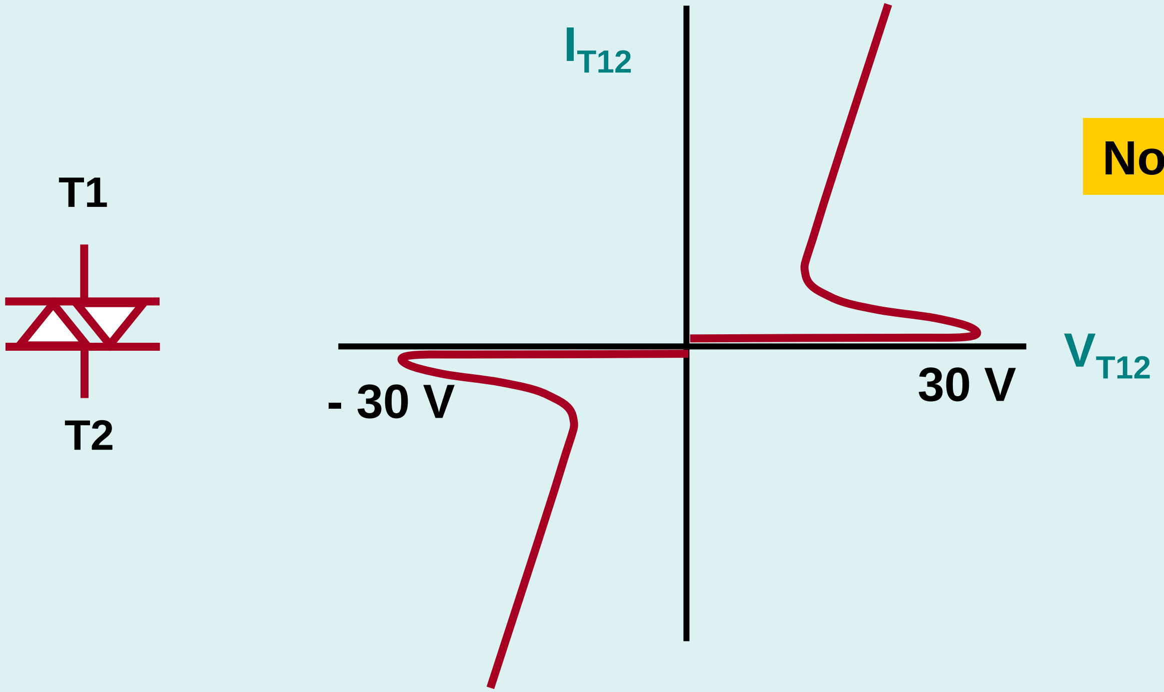
Application Examples
Triac Control for up to 50 mA Gate Trigger Current

Para rectificación onda completa

$$U_{EF} = \frac{U_{MAX}}{\sqrt{2}}\left(\sqrt{1 - \frac{\alpha}{\pi} + \frac{sen2\alpha}{2\pi}}\right)$$

EL DIAC

- *Una vez disparado se comporta como un diodo*
- *Cuando su corriente pasa por cero, se apaga*
- *Para dispararlo hay que sobrepasar una tensión característica V_{DIAC} que suele ser de 30 V.*
- *Es totalmente simétrico*



No es un interruptor

EL DIAC

DB3 DB4 SMDB3

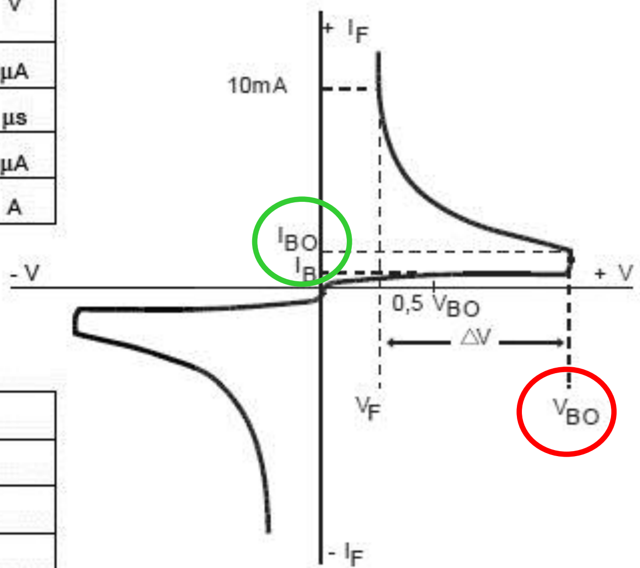
ELECTRICAL CHARACTERISTICS (Tj = 25°C unless otherwise specified)

Symbol	Parameter	Test Conditions		SMDB3	DB3	DB4	Unit
V_{BO}	Breakover voltage *	C = 22nF **	MIN.	28	28	35	V
			TYP.	32	32	40	
			MAX.	36	36	45	
$\lvert V_{BO1} - V_{BO2} \rvert$	Breakover voltage symmetry	C = 22nF **	MAX.	3			V
ΔV	Dynamic breakover voltage *	V_{BO} and V_F at 10mA	MIN.	10	5		V
V_O	Output voltage *	see diagram 2 (R=20Ω)	MIN.	10	5		V
I_{BO}	Breakover current *	C = 22nF **	MAX.	10	50		µA
tr	Rise time *	see diagram 3	MAX.	0.50	2		µs
I_R	Leakage current *	V_R = 0.5 V_{BO} max	MAX.	1	10		µA
I_P	Peak current *	see diagram 2 (Gate)	MIN.	1	0.30		A

* Applicable to both forward and reverse directions.
** Connected in parallel to the device.

DO-35
(DB3 and DB4)

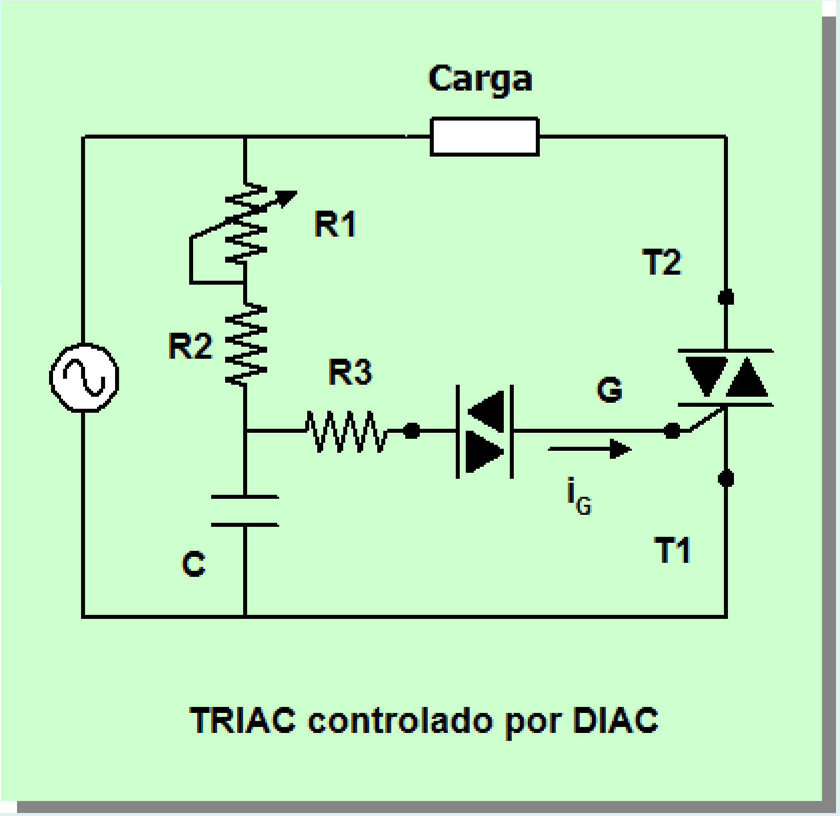
SOT-23
(SMDB3)*
Pin 1 and 3 must be shorted together

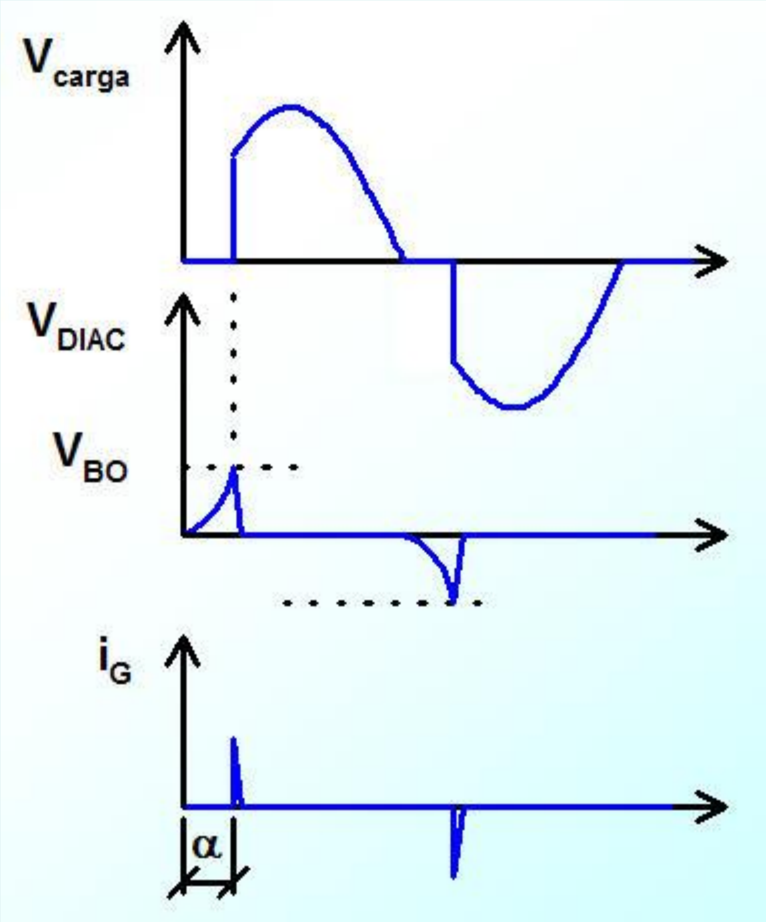


PRODUCT SELECTOR

Part Number	V_{BO}	Package
SMDB3	28 - 36	SOT-23
DB3	28 - 36	DO-35
DB4	35 - 45	DO-35

Ejemplo de aplicación del DIAC

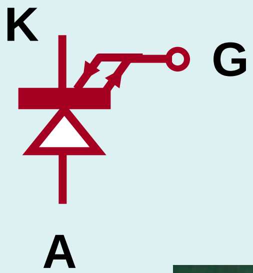




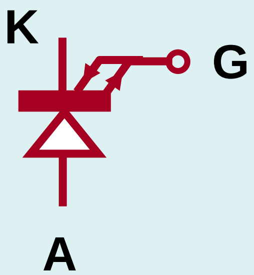
R1 = 0 , máxima potencia
R1 = Elevada, mínima potencia

GTO

Gate Turn-Off Thirystor

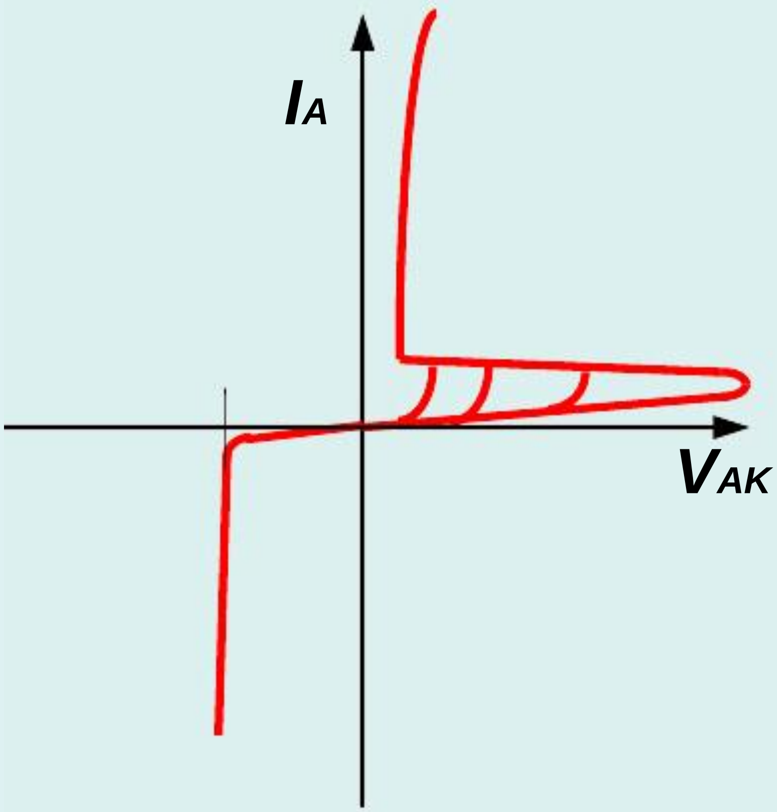


EL GTO



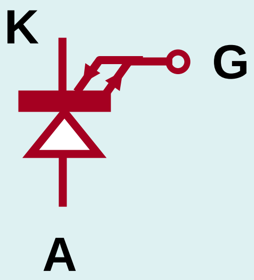
EL GTO

SG2500GX



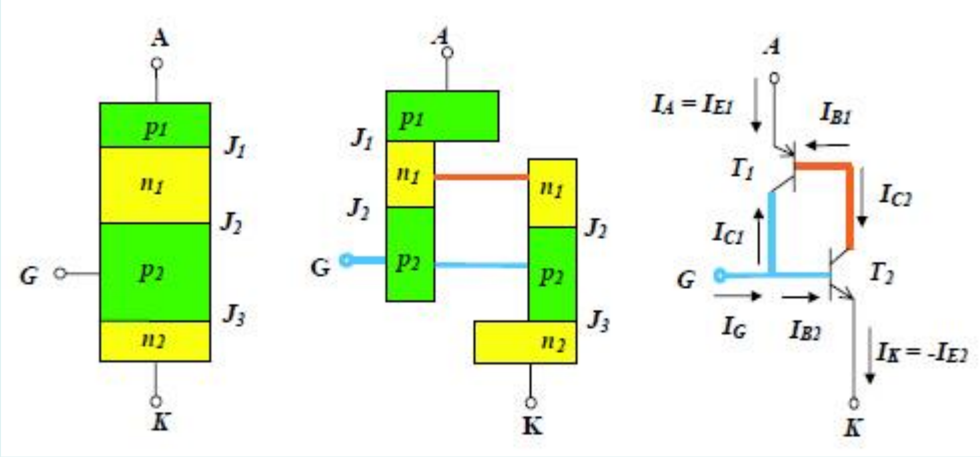
- En muchas aplicaciones, el hecho de no poder apagar el SCR es un grave problema.
- El GTO solventa ese inconveniente.
- Con corriente entrante por puerta, se dispara.
- Con corriente saliente por puerta, se apaga.

Tiristores (GTO) Gate Turn-Off Thirystor



EL GTO

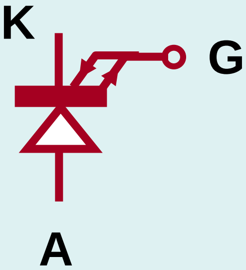
- El GTO es básicamente igual que un SCR.
- Se han modificado algunos parámetros constructivos para poder apagarlo por puerta.



- La Ganancia de corriente en el momento del corte es :

$$\beta_{off} = \frac{\alpha_2}{\alpha_1 + \alpha_2 + 1}$$

⇒ $\alpha 2 \approx 1$ implica que la base de T2 (capa de control) sea estrecha y poco dopada y que su emisor (capa catódica) esté muy dopado.
⇒ $\alpha 1 \approx 0$ implica que la base de T1 (capa de bloqueo) sea ancha y tenga una vida media de los huecos muy corta.



EL GTO

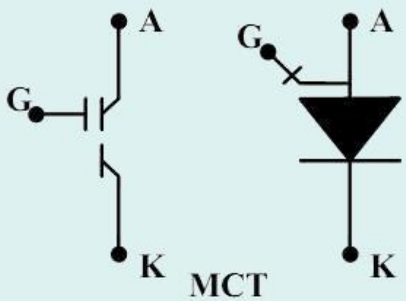
Existen también en el mercado las tarjetas de disparo de compuerta para los GTO (GTO Gate Drivers) , también conocidos como GTO Gate Units.
Estos dispositivos están especialmente diseñados para cada aplicación proporcionando características como:

- Compensación de Temperatura para Corriente de Compuerta.
- Tensión Negativa Continua para Condición de Bloqueo.
- Fibra Óptica para la interfase de señal con confirmación de estatus
- Pulsos de Encendido y Apagado.
- Fuente de poder con Transformador de Aislamiento

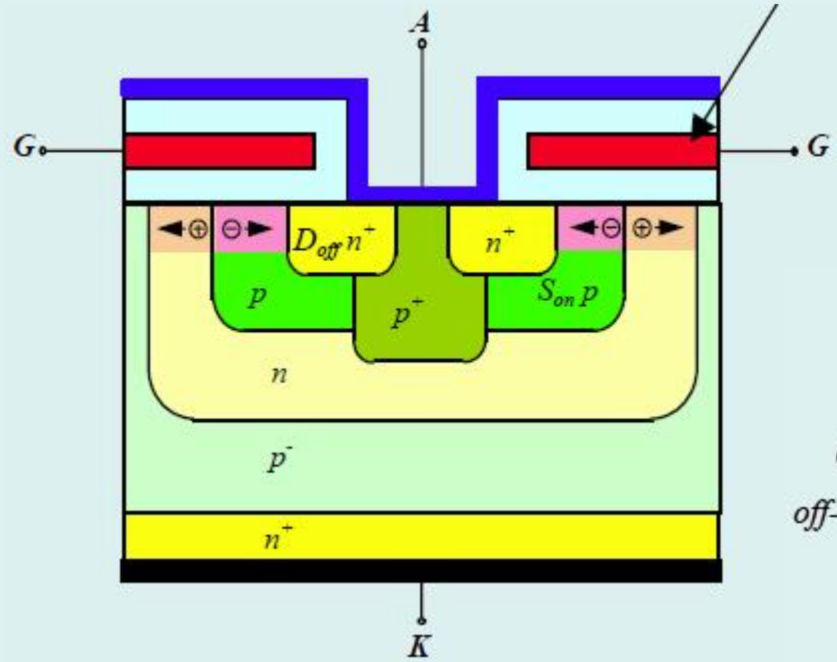
MCT

Tiristor controlado por Mos

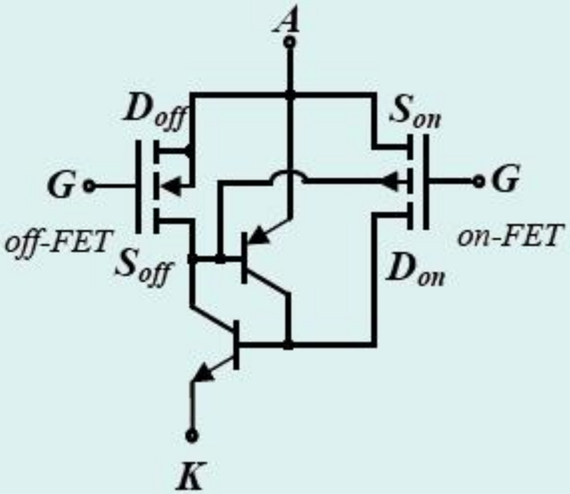
MCT (Tiristor controlado por Mos)



Símbolo



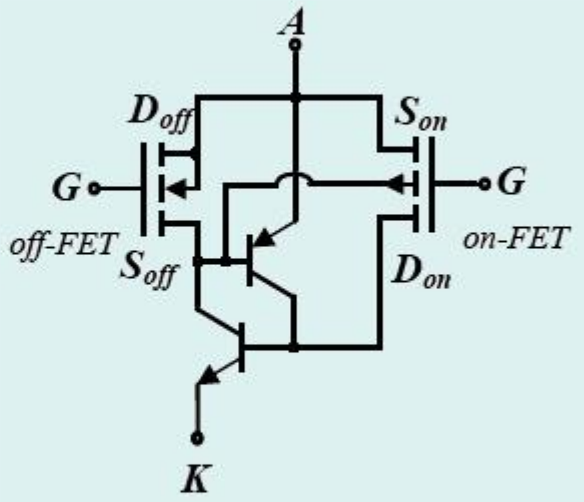
Estructura Interna



Circuito equivalente

MCT - Descripción

➢ *El MCT es un GTO con mejor tolerancia más un transistor P-MOS entre la compuerta y la fuente y un N-MOS adicional para su encendido.*



➢ *Mientras un GTO se corta mediante un pulso negativo de compuerta, debido a sus estrechos márgenes de conducción, el GTO interno de un MCT se corta cortocircuitando sus terminales de compuerta y cátodo.*

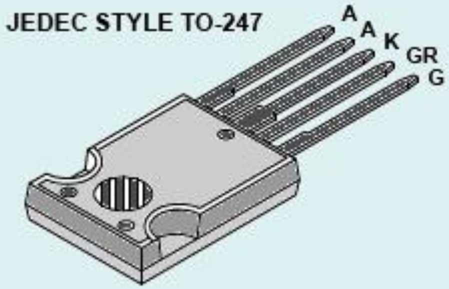
➢ *En consecuencia, su excitación es similar a la de un MOS y su comportamiento al de un GTO.*

MCT - Características

- *Puesta en conducción por tensión negativa en puerta*
- *Apagado por tensión positiva en puerta*
- *Ganancia elevada de tensión de control*
- *Disponibles hasta 1000V. Y 100A.*
- *Potencias medias bajas.*
- *Tiempo de activación bajo (cerca de 0.4 μs)*
- *Tiempo de apagado del MCT es muy bajo (cerca de 1.25 μs)*
- *Es un dispositivo de conmutación ideal*
  (elevado di/dt (1000 A/μs) y dv/dt (5000 V/μs)

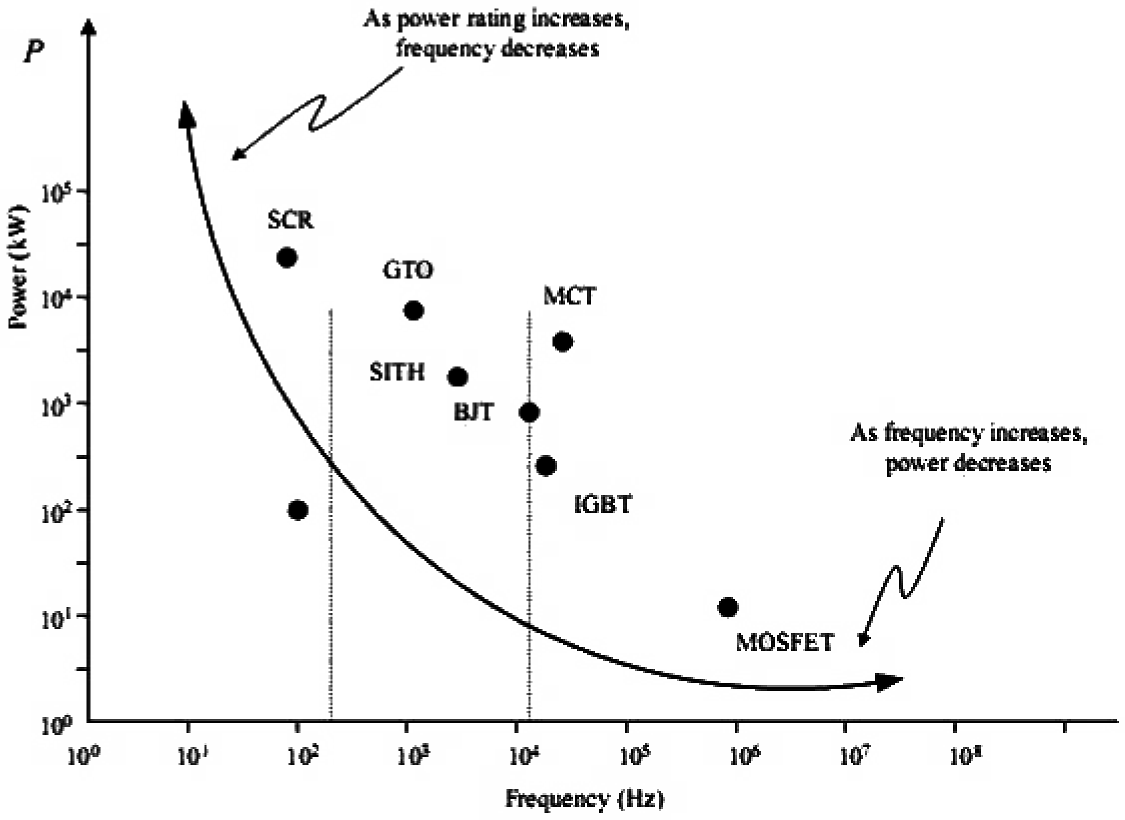
MCT - Características

- *Integra las ventajas de los GTO y los de una compuerta de MOSFET.*
- *Alta impedancia de entrada.*
- *Posibilidad de control.*
- *Mayor velocidad de conmutación.*
- *Potencias On-Off y tiempo de retardo pequeños.*
- *Baja caída de voltaje directo durante conducción.*
- *Bajas pérdidas de conmutación.*
- *Baja capacidad de bloqueo en voltaje inverso.*



MCT - Comparación

- *No alcanza potencias elevadas.*
- *No es competitivo con el MOS en bajas potencias (frecuencia menor y mayor complejidad de fabricación ⇒ mayor costo).*



Power vs frequency for different power devices.

COMPARACIÓN