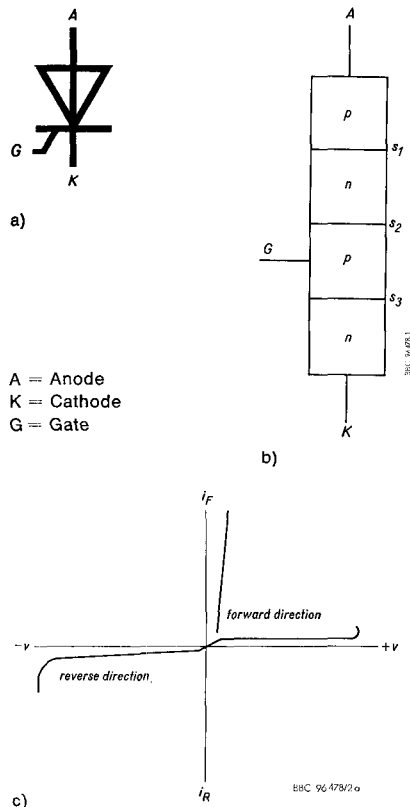


Printed order nr.
D GHS 30393 E

Thyristors



Thyristors are controlled semiconductor cells. They are being produced in a four layer arrangement with altogether three pn junctions s_1, s_2, s_3 , see Fig. 1 b. In reverse direction such a device acts like a diode in blocking direction. In forward direction – corresponding to the forward direction of a diode – the device has two stable states. The intermediate pn junction s_2 also blocks in the event of a positive voltage being applied to anode A. Not until a gate trigger current passes from gate G to the cathode will charge carriers flow across the intermediate pn junction s_2 causing the device to be transferred to the conducting condition.

Fig. 1 c shows the characteristic of a thyristor. On initiation of the gate trigger current the positive reverse characteristic changes to the normal forward characteristic, if voltage is applied in forward direction.

For firing the thyristor a trigger pulse is necessary. The values for trigger current, voltage and time are dependent upon the temperature.

Thyristors are available in two versions.

Thyristors for application at system frequency (50 or 60 Hz) are as a rule not supposed to meet special requirements with respect to recovery time as well as to “turn-off” and “turn-on” response.

Thyristors for application at higher frequencies (e.g. in self-commutated and load-commutated frequency converters up to max. 10 kHz) are being constructed with special gate configurations and emitter structures, these properties gaining importance with increasing frequency.

Type code of Brown Boveri thyristors

Example: CS 15,9-06 g t 2

CS — Silicon thyristor
15,9 — Current rating (9 = Thyristor: fast turn-off and inverter type)
06 — Voltage class (06 = 600 V)
g — Critical dv/dt class $g \geq 200 \text{ V}/\mu\text{s}$
t — Turn-off-time – class $t_q, t \leq 12 \mu\text{s}$
2 — Modification

d	$\geq 20 \text{ V}/\mu\text{s}$	z	$\leq 60 \mu\text{s}$
e	$\geq 50 \text{ V}/\mu\text{s}$	y	$\leq 50 \mu\text{s}$
f	$\geq 100 \text{ V}/\mu\text{s}$	x	$\leq 40 \mu\text{s}$
g	$\geq 200 \text{ V}/\mu\text{s}$	w	$\leq 30 \mu\text{s}$
h	$\geq 500 \text{ V}/\mu\text{s}$	v	$\leq 25 \mu\text{s}$
i	$\geq 1000 \text{ V}/\mu\text{s}$	u	$\leq 20 \mu\text{s}$
k	$\geq 1500 \text{ V}/\mu\text{s}$	p	$\leq 15 \mu\text{s}$
l	$\geq 2000 \text{ V}/\mu\text{s}$	t	$\leq 12 \mu\text{s}$
z	= Typical value given in data sheets	o	= Typical value given in data sheets

Figure 1: Thyristor
a) Symbol, switch sign
b) Schematic constitution
c) Current-voltage characteristic

Glossary of terms and symbols

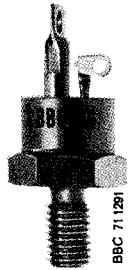
V_{RRM} = Repetitive peak reverse blocking voltage, instantaneous value
 V_{DRM} = Repetitive peak forward blocking voltage, instantaneous value
 I_{TRMS} = Maximum forward current, RMS value
 I_{TAVM} = Mean forward current at 40 to 400 Hz of one halfsine wave
 $\geq 60 \text{ Hz} \left(\frac{di}{dt} \right)_{crit} \leq 5 \text{ A}/\mu\text{s}$ for standard types (phase control types)
 ϑ_{amb} = 45° C , convection cooling and R_{thJA} , resp.
 ϑ_{case} = 85° C and R_{thJC}
 I_{TSM} = Peak one cycle surge forward current, 10 ms, starting temperature $\vartheta_{(VJ)max}$
 $\int i^2 dt$ = $I^2 t$ for fusing
 I_R = Maximum reverse and forward blocking current at $\vartheta_{(VJ)max}$ and U_{RRM} resp. U_{DRM}

Terms and symbols largely correspond to the international recommendations (IEC)

V_T = Forward voltage drop at 3,14 times the mean forward current, typical value
 I_{GT} = Minimum gate trigger current, $\vartheta_{(VJ)} = 25^\circ \text{ C}$
 V_{GT} = Minimum gate trigger voltage, $\vartheta_{(VJ)} = 25^\circ \text{ C}$
 $\left(\frac{dv}{dt} \right)_{crit}$ = Critical rate of rise of forward voltage
 $\left(\frac{di}{dt} \right)_{crit}$ = Critical rate of rise of forward current
 t_q = Turn-off-time
 $\vartheta_{(VJ)}$ = Virtual junction temperature
 $\vartheta_{(VJ)max}$ = Maximum junction temperature
 ϑ_{case} = Case temperature
 R_{thJC} = Thermal resistance, junction to case
 R_{thJA} = Thermal resistance, junction to ambient

Thyristors: Standard Types (Phase Control Types)

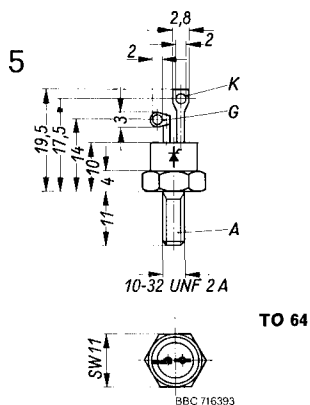
I_{TAVM} : ...16 up to 48 A



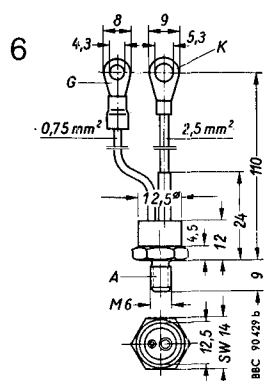
Type	V_{DRM} V_{RRM}	I_{TRMS}	I_{TAVM}	I_{TSM}	$\int i^2 dt$	I_D I_R	V_T (ref. i_T)	$(\frac{dv}{dt})_{crit}$	$(\frac{di}{dt})_{crit}$	I_{GT}	V_{GT}	t_q	θ (VJ)max	R_{thJC}	Weight	Outline
	V	A	A	A	A ² s	mA	V	V/ μ s	A/ μ s	mA	V	μ s	$^{\circ}$ C	$^{\circ}$ C/W	g	Nr.
2 N 685 688 690 692	200 400 600 800	25	16	200	200	≤ 3	$\leq 1,6$ (33 A)	200	150	50	2,5	60	125	$\leq 1,5$	12	8
CS 16 -02 go1 -04 go1 -06 go1 -08 go1 -10 go1 -12 go1*	200 400 600 800 1000 1200	30	19 ($\theta_{case} = 95^{\circ}$)	250	310	≤ 3	$\leq 1,8$ (60 A)	d=20 g=200 h=500 i=1000	150	≤ 50	2,5	60	125	$\leq 1,0$	12	6, 7, 8
2 N 3897 3898 3899	200 400 600	35	22	400	800	≤ 3	$\leq 1,8$ (60 A)	200	150	50	2,5	60	125	$\leq 1,0$	12	8
CS 22 -04 do1* -05 do1 -06 do1 -07 do1 -08 do1 -09 do1 -10 do1 -11 do1 -12 do1 -13 do1*	400 500 600 600 800 900 1000 1100 1200 1300	50	22	375	700	≤ 10	$\leq 2,1$ (70 A)	d=20 e=50 g=200	25	100	3	80	125	$\leq 1,0$	30	9
CS 42 -06 go1 -08 go1 -10 go1 -12 go1 -14 go1 -16 go1	600 800 1000 1200 1400 1600	130	48	800	3200	≤ 10	$\leq 1,9$ (180 A)	g=200 h=500 i=1000	100	110	2	250	120	$\leq 0,47$	75	10

* Delivery time on request

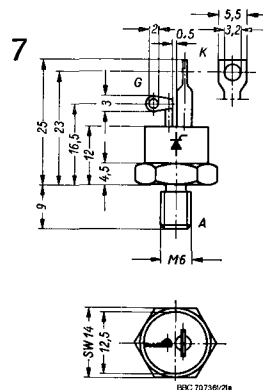
Dimensions in mm, A = Anode, K = Cathode, G = Gate



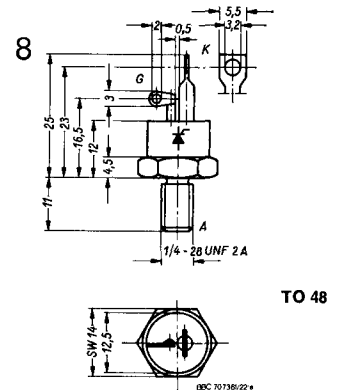
CS 4,9 version 3
CS 5 version 3
CS 8 version 3



CS 16 version 1



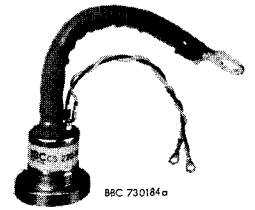
CS 15,9 version 2
CS 16 version 2



CS 16 version 3
2N685 ... 692
2N3897 ... 3899

Thyristors: Standard Types (Phase Control Types)

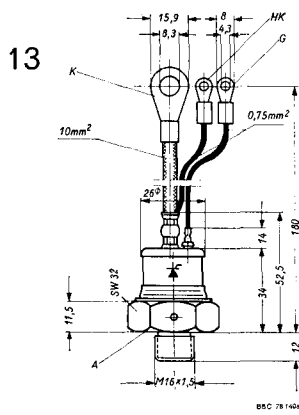
I_{TAVM} : ...160 up to 330 A



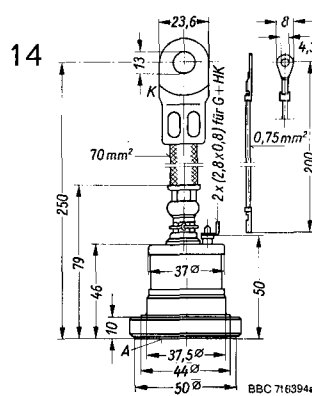
Type	V_{DRM} V_{RRM} V	I_{TRSM} A	I_{TAVM} A	I_{TSM} A	$\int i^2 dt$ A ² s	I_D I_R mA	V_T (ref. I_T) V	$(\frac{dv}{dt})_{crit}$ V/ μ s	$(\frac{di}{dt})_{crit}$ A/ μ s	I_{GT} mA	V_{GT} V	t_q μ s	$\theta(VJ)_{max}$ $^{\circ}$ C	R_{thJC} $^{\circ}$ C/W	Weight g	Outline Nr.
CS 160-08 io2 -10 io2 -12 io2 -14 io2 -15 io2 -16 io2	800 1000 1200 1400 1500 1600	350	160	3 500	61 000	≤ 40	$\leq 1,7$ (400 A)	$g=200$ $h=500$ $i=1000$	75	200	3	150	125	$\leq 0,15$	500	14
CS 200-18 io2 -20 io2 -23 io2 -25 io2 -27 io2*	1800 2000 2300 2500 2700	450	225	4 000	80 000	≤ 40	$\leq 1,82$ (600 A)	$g=200$ $h=500$ $i=1000$	50	200	3	150	125	0,1	500	14
CS 220-08 io2 -10 io2 -11 io2 -12 io2 -13 io2 -14 io2 -15 io2 -16 io2 -17 io2* -18 io2*	800 1000 1100 1200 1300 1400 1500 1600 1700 1800	450	220	5 700	134 000	≤ 40	$\leq 1,55$ (600 A)	$g=200$ $h=500$ $i=1000$	75	150	2	150	125	0,12	500	14
CS 300-08 io3 -10 io3 -11 io3 -12 io3 -13 io3 -14 io3 -15 io3 -16 io3 -17 io3* -18 io3*	800 1000 1100 1200 1300 1400 1500 1600 1700 1800	600	330	8 000	320 000	≤ 40	$\leq 1,43$ (1000 A)	$g=200$ $h=500$ $i=1000$	100	150	2	150	125	0,09	500	15

* Delivery time on request

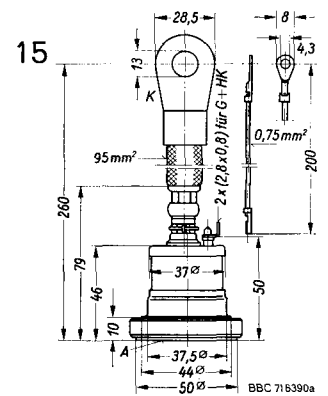
Dimensions in mm A = Anode K = Cathode
G = Gate HK = Auxiliary cathode



CS 80



CS 130 CS 149
CS 160 CS 188
CS 200 CS 189
CS 220 CS 239



CS 300

Thyristors: Standard Types (Phase Control Types)

I_{TAVM} : ... 400 up to 550 A



B5C 730180

Type	V_{DRM} V_{RRM}	I_{TRSM}	I_{TAVM}	I_{TSM}	$\int i^2 dt$	I_{DR}	V_T (ref. i_T)	$(\frac{dv}{dt})_{crit}$	$(\frac{di}{dt})_{crit}$	I_{GT}	V_{GT}	t_q	$\vartheta(VJ)_{max}$	R_{thJC}	Weight	Outline
	V	A	A	A	A ² s	mA	V	V/ μ s	A/ μ s	mA	V	μ s	°C	°C/W	g	Nr.
CS 400-08 io2	800	1 200	400	7 500	280 000	≤ 40	$\leq 1,55$ (1200 A)	$g=200$ $h=500$ $i=1000$	100	200	2,5	150	125	R_{thJK} 0,06	240	16
-10 io2	1000															
-11 io2	1100															
-12 io2	1200															
-13 io2	1300															
-14 io2	1400															
-15 io2	1500															
-16 io2	1600															
CS 401-18 io2	1800	900	330	€ 000	180 000	≤ 40	$\leq 2,13$ (1200 A)	$g=200$ $h=500$ $i=1000$	50	200	2,5	150	125	R_{thJK} 0,06	240	16
-20 io2	2000															
-21 io2	2100															
-22 io2	2200															
-23 io2	2300															
-24 io2*	2400															
-25 io2*	2500															
CS 500-08 io4	800	1 500	500	9 400	440 000	≤ 40	$\leq 1,68$ (1500 A)	$g=200$ $h=500$ $i=1000$	75	200	2,5	150	125	R_{thJK} 0,045	210	17
-10 io4	1000															
-12 io4	1200															
-14 io4	1400															
-15 io4	1500															
-16 io4	1600															
CS 550-08 io1	800	1 500	550	9 400	550 000	≤ 40	$\leq 1,55$ (1500 A)	$g=200$ $h=500$ $i=1000$	75	200	2,5	150	125	0,044	250	16
-10 io1	1000															
-12 io1	1200															
-13 io1	1300															
-14 io1	1400															
-15 io1	1500															
-16 io1	1600															

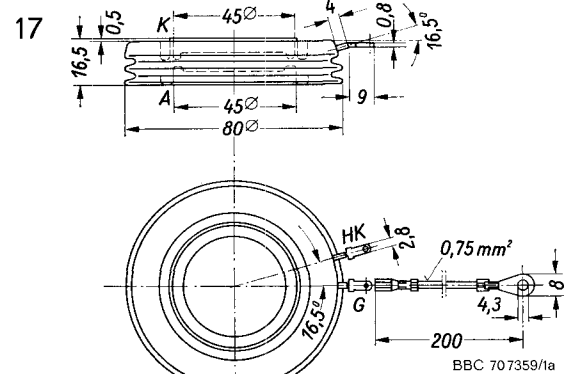
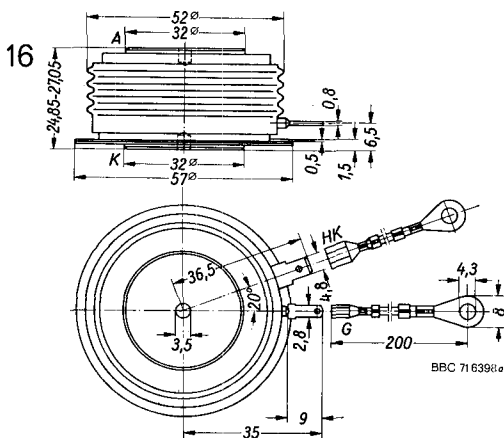
* Delivery time on request

① Only supplied completely mounted with heat sink

Dimensions in mm

A = Anode K = Cathode

G = Gate HK = Auxiliary cathode



CS 400 CS 550
CS 401

CS 500

Thyristors: Fast Turn-Off and Inverter Types

I_{TAVM} : ... 9 up to 80 A



BBC 730896

Type **)	V_{DRM} V_{RRM}	I_{TRMS}	I_{TAVM}	I_{TSM}	$\int i^2 dt$	I_D I_R	V_T (ref. i_T)	$(\frac{dv}{dt})_{crit}$	$(\frac{di}{dt})_{crit}$	I_{GT}	V_{GT}	t_q	$\theta(VJ)_{max}$	R_{thJC}	Weight	Outline
	V	A	A	A	A ² s	mA	V	V/ μ s	A/ μ s	mA	V	μ s	°C	°C/W	g	Nr.
CS 4,9-02 g·2 -04 g·2 -05 g·2 -06 g·2	200 400 500 600	25	9	70	25	≤ 5	≤ 2 (15 A)	g=200	200	≤ 60	3	t ≤ 12 u ≤ 20 w ≤ 30	125	$\leq 1,8$	6	4, 5
CS 15,9-02 g·2 -04 g·2 -05 g·2 -06 g·2 -08 g·2 -10 g·2	200 400 500 600 800 1000	35	17	170	145	≤ 5	$\leq 2,3$ (50 A)	g=200 h=500 i=1000	200	≤ 80	3	t ≤ 12 u ≤ 20 w ≤ 30	125	$\leq 1,1$	12	7, 8
CS 19 -01 e·1 -02 e·1 -03 e·1 -04 e·1 -05 e·1 -06 e·1 -07 e·1 -08 e·1 -09 e·1	100 200 300 400 500 600 700 800 900	40	18	360	650	≤ 10	$\leq 2,3$ (60 A)	e 50	25	50	3	t ≤ 12 u ≤ 20	125	$\leq 1,1$	30	9
CS 38 -02 g·2 and CS 39 ①	200 400 600 800 1000 1100 1200 1300	110	40	700	2450	≤ 15	$\leq 2,13$ (120 A)	g=200 h=500 i=1000	150	100	3	CS 38 u ≤ 20 v ≤ 25 w ≤ 30 CS 39 w ≤ 30 x ≤ 40 y ≤ 50	125	$\leq 0,53$	110	11, 12
CS 78 -02 g·2 and CS 79 ②	200 400 600 800 1000 1100 1200 1300	160	80	1250	7800	≤ 15	$\leq 2,13$ (250 A)	g=200 h=500 i=1000	100	150	3	CS 78 u ≤ 20 v ≤ 25 w ≤ 30 CS 79 w ≤ 30 x ≤ 40 y ≤ 50	125	$\leq 0,26$	110	11, 12

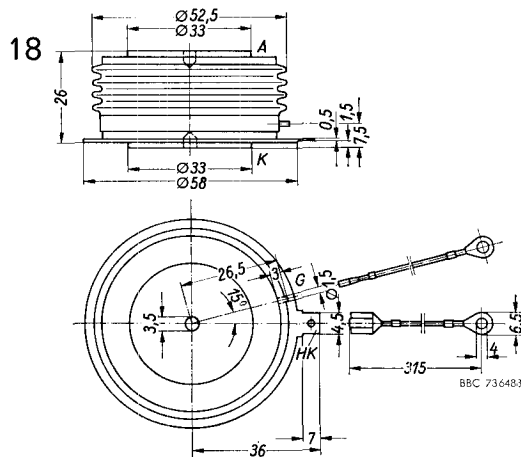
① CS 38 up to 1 kHz-, CS 39 up to 10 kHz-Application
② CS 78 up to 1 kHz-, CS 79 up to 10 kHz-Application

* Delivery time on request

** The point of type designation replaces the t_q -classes u, v, w ...

Dimensions in mm A = Anode K = Cathode

G = Gate HK = Auxiliary cathode



CS 399

Thyristors: Fast Turn-Off and Inverter Types

I_{TAVM} : ... 150 up to 370 A

Type **)	VDRM VRRM V	ITRMS A	ITAVM A	ITSM A	$\int i^2 dt$ A ² s	I_D I_R mA	v_T (ref. i_T) V	$(\frac{dv}{dt})_{crit}$ V/ μ s	$(\frac{di}{dt})_{crit}$ A/ μ s	IGT mA	VGT V	t_q μ s	$\theta(VJ)_{max}$ °C	R _{th} JC °C/W	Weight g	Outline Nr.
CS 149-04 g-2 -06 g-2 -08 g-2 -10 g-2 -11 g-2 -12 g-2 -13 g-2*	400 600 800 1000 1100 1200 1300	450	150	3 500	61 000	≤ 30	≤ 2,05 (600 A)	g=200 h=500 i=1000	150	200	2,5	u ≤ 20 v ≤ 25 w ≤ 30 x ≤ 40 y ≤ 50	125	≤ 0,16	500	14
CS 188-06 g-3 and -08 g-3 CS 189 ① -10 g-3 -11 g-3 -12 g-3 -13 g-3*	600 800 1000 1100 1200 1300	450	200	4 000	80 000	≤ 30	≤ 1,82 (600 A)	g=200 h=500 i=1000	150	200	2,5	CS 188 u ≤ 20 v ≤ 25 w ≤ 30 CS 189 w ≤ 30 x ≤ 40 y ≤ 50	125	≤ 0,12	500	14
CS 189-02 g-5 ① -04 g-5	200 400	450	200	4 000	80 000	≤ 30	≤ 1,82 (600 A)	g=200	150	200	2,5	u ≤ 20	125	≤ 0,12	500	14
CS 239-02 g-3 -04 g-3 -06 g-3 -08 g-3 -09 g-3 -10 g-3	200 400 600 800 900 1000	450	260	6 400	205 000	≤ 30	≤ 1,9 (1000 A)	g=200 h=500 i=1000	150	200	2,5	u ≤ 20 v ≤ 25 w ≤ 30 x ≤ 40	125	≤ 0,1	500	14
CS 399-05 h-2 -06 h-2 -08 h-2 -10 h-2 -11 h-2 -12 h-2	500 600 800 1000 1100 1200	1000	370	7 000	245 000	≤ 45	≤ 2,0 (1200 A)	g=200 h=500	200	150	3	u ≤ 20* v ≤ 25 w ≤ 30 x ≤ 40	125	≤ 0,06	240	18

* Delivery time on request ** The point of type designation replaces the t_q -classes u, v, w...

① CS 188 up to 1,5 kHz-, CS 189 up to 3 kHz-Application

Detailed data sheets with diagrams covering the whole range of devices are available. Write for further information to:

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