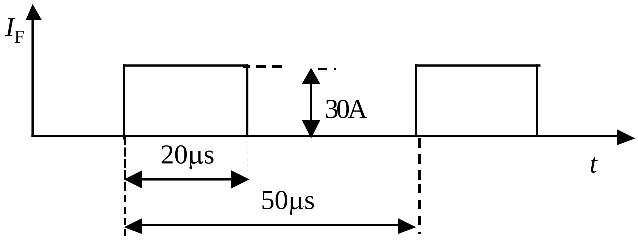
ELEC-E8421 Tehoelektroniikan komponentit

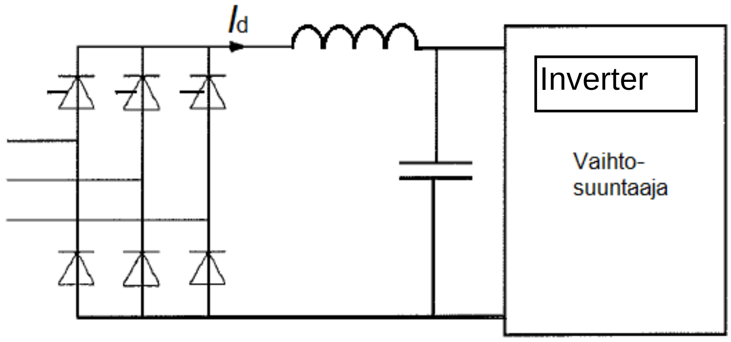
Harjoitus 2.

1. Frequency converter will use schottky-diode modules CSD20120. Module's diodes are connected in parallel and total current through module is shown in figure below. Ambient temperature is 50 C and voltage under blocking state is 600 V. What is the maximum viable thermal resistance for the cooling element, cooling the whole module. You may assume the switching energy losses are equal to diode internal capacitance stored energy

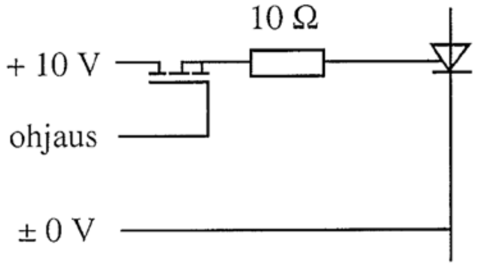


2. What is the maximum allowed cooling air temperature, when the circuit below has thyristors of type SKT 240/16 E and dual sided cooling (DSC) element thermal resistance Rth(h-a) = 0.15 K/W. Inverter power is 200 kW and DC voltage is 540 V. Assume Id as constant DC.

Rth(h-a) heatsink-ambient.



3. Thyristor module SKKT 71 thyristor gate pulse is amplified with a circuit shown below. MOSFET-transistors internal resistance Rds is 1 Ohm. Is it certain that the thyristor will turn-on at -40 C temperature. What is the greatest possible thyristor gatedriver loss power the circuit can generate.



CSD20120
Silicon Carbide Schottky Diode

ZERO RECOVERY® RECTIFIER

V_{RRM}=1200V
I_{F}=20A

Features

- 1200 Volt Schottky Rectifier
- Zero Reverse Recovery
- Zero Forward Recovery
- High Frequency Operation
- Temperature Independent Switching Behavior
- Extremely Fast Switching
- Positive Temperature Coefficient on V_F

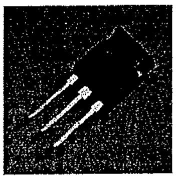
Benefits

- Replace Bipolar with Unipolar Rectifiers
- Essentially No Switching Losses
- Higher Efficiency
- Reduction Of Heat Sink Requirements
- Parallel Devices without Thermal Runaway

Applications

- Switch Mode Power Supplies
- Power Factor Correction
- Motor Drives

Package



CSD20120D

Maximum Ratings

Parameter	Symbol	Value	Unit
Repetitive Peak Reverse Voltage	V_{RRM}	1200	V
Surge Peak Reverse Voltage	V_{RSM}	1200	V
DC Blocking Voltage	V_{DC}	1200	V
Average Forward Current (Per Device) T_C=160°C (Per Leg)	$I_{F(AV)}$	20 10	A
Repetitive Peak Forward Surge Current (Per Leg) T_C=25°C, t_P=8.3ms, Half Sine Wave	I_{FRM}	50	A
Non-Repetitive Peak Forward Surge Current (Per Leg) T_C=25°C, t_P=10μs, Pulse	I_{FSM}	250	A
Power Dissipation (Per Leg) T_C = 25°C	P_{tot}	312	W
Operating Junction and Storage Temperature	T_J, T_{stg}	-55 to +175	°C

ELECTRICAL CHARACTERISTICS (PER LEG)

Parameter	Symbol	Min	Typ	Max	Units
Forward Voltage I_F = 10A T_J=25°C I_F = 10A T_J=175°C	V_F		1.6 2.5	1.8 3.0	V
Reverse Current V_R = 1200V T_J=25°C V_R = 1200V T_J=175°C	I_R		10 20	200 1000	µA
Total Capacitive Charge V_R = 1200V, I_F = 10A, di/dt = 500 A/µs, T_J = 25°C	Q_C		61		nC
Total Capacitance V_R = 0V, T_J = 25°C, f =1MHz V_R = 200V, T_J = 25°C, f =1MHz V_R = 400V, T_J = 25°C, f =1MHz	C		1000 80 59		pF

NOTE:
1. This is a majority carrier diode, so there is no reverse recovery charge.

THERMAL CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Units
Thermal Resistance from Junction to Case	Per Leg	$R_{\theta JC}$		0.48		°C/W
	Per Device	$R_{\theta JC}$		0.24		°C/W

Typical Performance (Per Leg)

Figure 1. Forward Characteristics

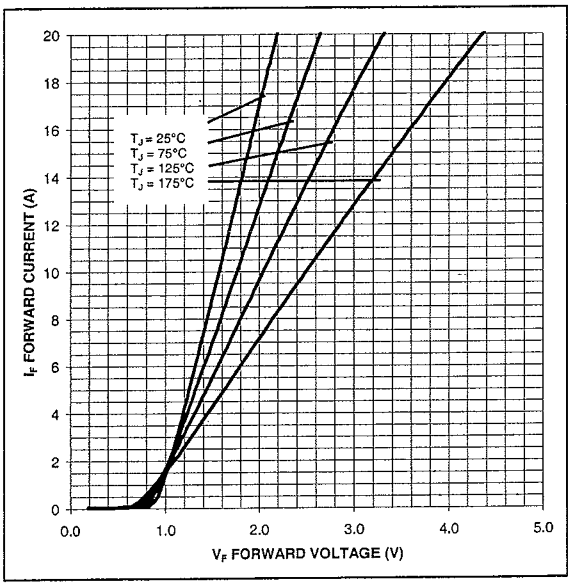
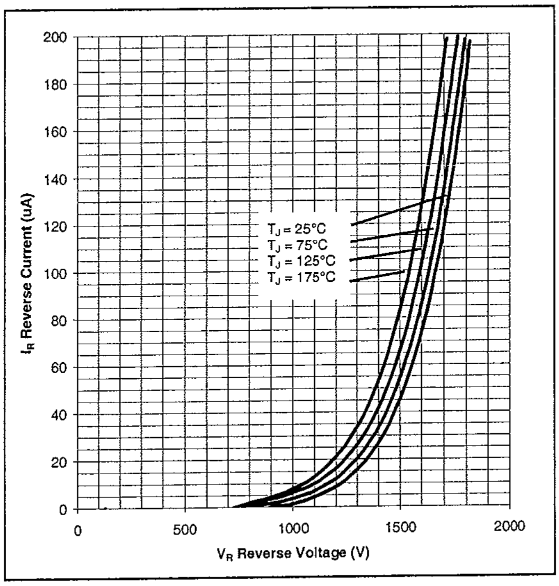


Figure 2. Reverse Characteristics



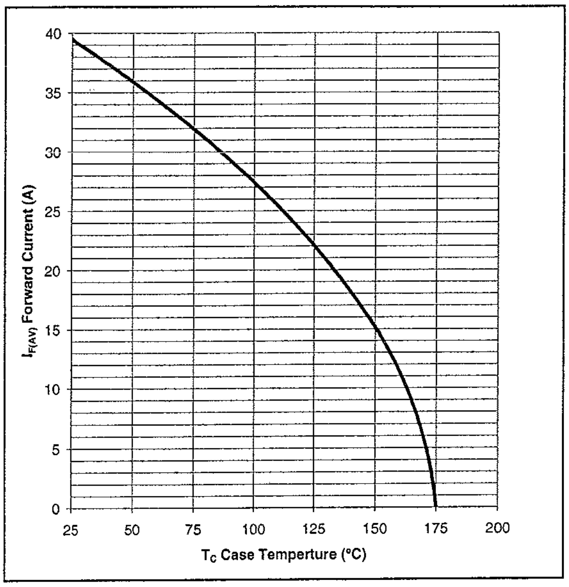


Figure 3. Current Derating

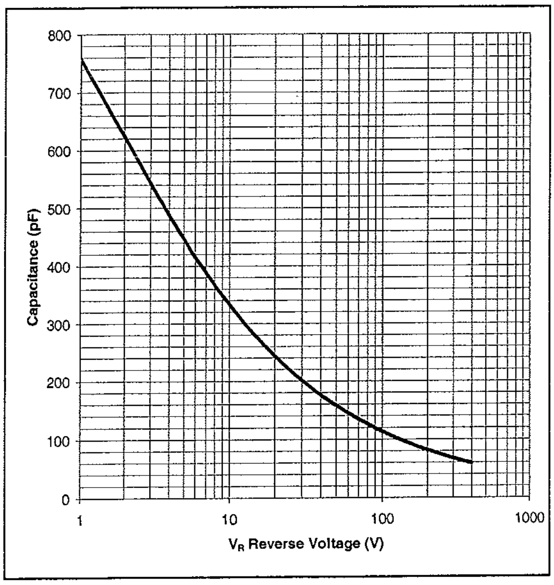


Figure 4. Capacitance vs. Reverse Voltage

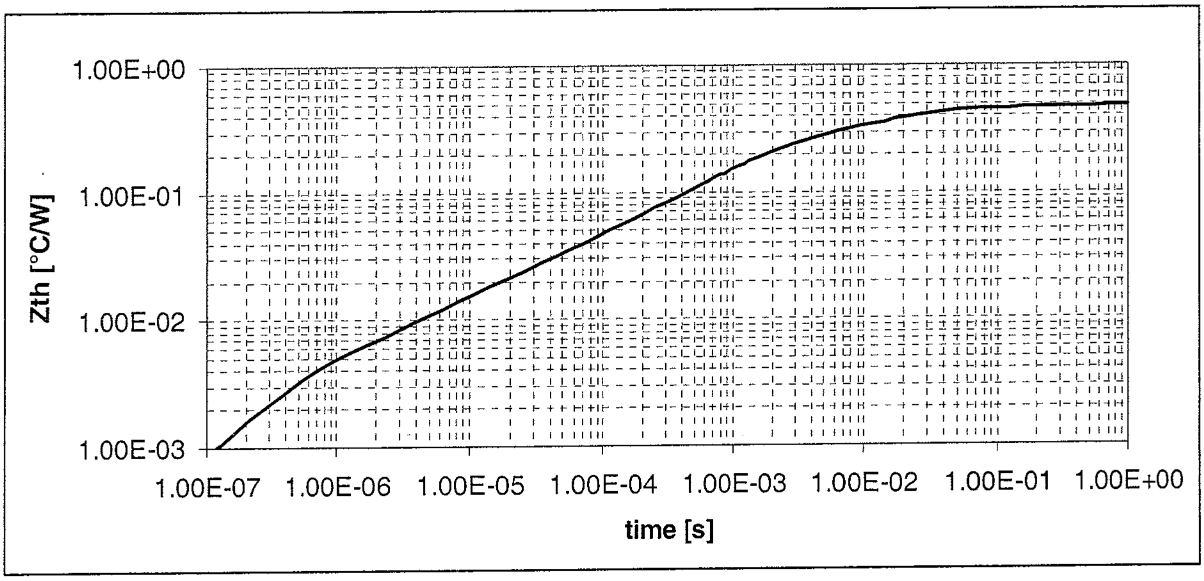
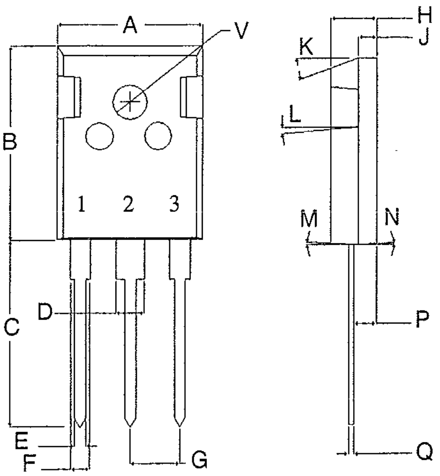


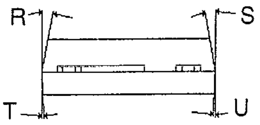
Figure 5. Transient Thermal Impedance

Package Dimensions

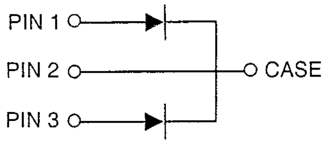
CSD20120

Package TO-247-3



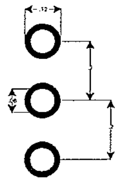


POS	Inches		Millimeters	
	Min	Max	Min	Max
A	.621	.631	15.773	16.027
B	.820	.830	20.823	21.077
C	.789	.799	20.053	20.307
D	.120	.126	3.044	3.196
E	.047	.052	1.200	1.327
F	.075	.084	1.903	2.132
G	.215 TYP		5.450 TYP	
H	.193	.203	4.903	5.157
J	.075	.081	1.904	2.056
K	19°	21°	19°	21°
L	4°	6°	4°	6°
M	2°	4°	2°	4°
N	2°	4°	2°	4°
P	.093	.097	2.349	2.451
Q	.024	.030	.600	.752
R	9°	11°	9°	11°
S	9°	11°	9°	11°
T	2°	4°	2°	4°
U	2°	4°	2°	4°
V	.140	.144	3.560	3.660



Part Number	Package	Marking
CSD20120D	TO-247-3	CSD20120

Recommended solder pad layout.



TO-247-3

This product has not been designed or tested for use in, and is not intended for use in, applications implanted into the human body nor in applications in which failure of the product could lead to death, personal injury or property damage, including but not limited to equipment used in the operation of nuclear facilities, life-support machines, cardiac defibrillators or similar emergency medical equipment, aircraft navigation or communication or control systems, air traffic control systems, or weapons systems.

The information in this document is subject to change without notice.

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www.creepower.com

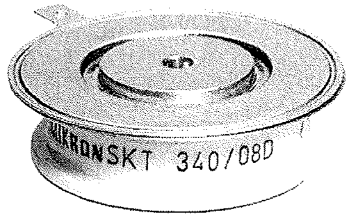
back zurück

SEMIKRON

Thyristors

SKT 240
SKT 340

V_{RSM}	V_{RRM} V_{DRM}	$(dv/dt)_{cr}$	I_{TRMS} (maximum values for continuous operation) 600 A	700 A
			I_{TAV} (sin. 180; T_{case} = . . .; DSC) 380 A (60 °C)	450 A (57 °C)
V	V	V/µs		
500	400	500	**SKT 240/04 D**	**SKT 340/04 D**
900	800	1000	**SKT 240/08 E**	**SKT 340/08 E**
1300	1200	1000	**SKT 240/12 E**	**SKT 340/12 E**
1500	1400	1000	**SKT 240/14 E**	**SKT 340/14 E**
1700	1600	1000	**SKT 240/16 E**	**SKT 340/16 E**
1900	1800	1000	**SKT 240/18 E**	**SKT 340/18 E**
2100	2000	1000	**SKT 240/20 E**	–
2300	2200	1000	**SKT 240/22 E**	–



Symbol	Conditions	SKT 240	SKT 340	Units
I_{TAV}	sin. 180; (T_{case} = . . .); DSC	240 (92)	340 (82)	A °C
I_{TSM}	T_{vj} = 25 °C; 10 ms	5 000	5 700	A
	T_{vj} = 125 °C; 10 ms	4 500	5 200	A
i^2t	T_{vj} = 25 °C; 8,3 ... 10 ms	125 000	162 000	A^2s
	T_{vj} = 125 °C; 8,3 ... 10 ms	101 000	135 000	A^2s
t_{gd}	T_{vj} = 25 °C I_G = 1 A di_G/dt = 1 A/µs	typ. 1		µs
t_{gr}	V_D = 0,67 · V_{DRM}	typ. 2		µs
$(di/dt)_{cr}$	f = 50 ... 60 Hz	125		A/µs
I_H	T_{vj} = 25 °C; typ./max.	150 / 400		mA
I_L	T_{vj} = 25 °C; typ./max.	0,3 / 1		A
t_q	T_{vj} = 125 °C; typ.	50 ... 150		µs
V_T	T_{vj} = 25 °C; I_T = 1000 A; max.	2,3	1,9	V
$V_{T(TO)}$	T_{vj} = 125 °C	1,0	1,0	V
r_T	T_{vj} = 125 °C	1,4	0,9	mΩ
I_{DD}; I_{RD}	T_{vj} = 125 °C; V_{RD} = V_{RRM} V_{DD} = V_{DRM}	40	40	mA
V_{GT}	T_{vj} = 25 °C	2		V
I_{GT}	T_{vj} = 25 °C	150		mA
V_{GD}	T_{vj} = 125 °C	0,25		V
I_{GD}	T_{vj} = 125 °C	10		mA
R_{thjc}	cont.; DSC	0,070		°C/W
	sin. 180; DSC/SSC	0,072 / 0,151		°C/W
	rec. 120; DSC/SSC	0,080 / 0,168		°C/W
R_{thch}	DSC/SSC	0,020 / 0,040		°C/W
T_{vj}		– 40 ... + 125		°C
T_{stg}		– 40 ... + 130		°C
F	SI units	4 ... 5		kN
	US units	900 ... 1100		lbs.
w		61		g
Case	→ page B 3 – 32	B 8		

Features

- Hermetic metal cases with ceramic insulators
- Capsule packages for double sided cooling
- Shallow design with single sided cooling
- International standard cases
- Off-state and reverse voltages up to 1800 V

Typical Applications

- DC motor control (e. g. for machine tools)
- Controlled rectifiers (e. g. for battery charging)
- AC controllers (e. g. for temperature control)

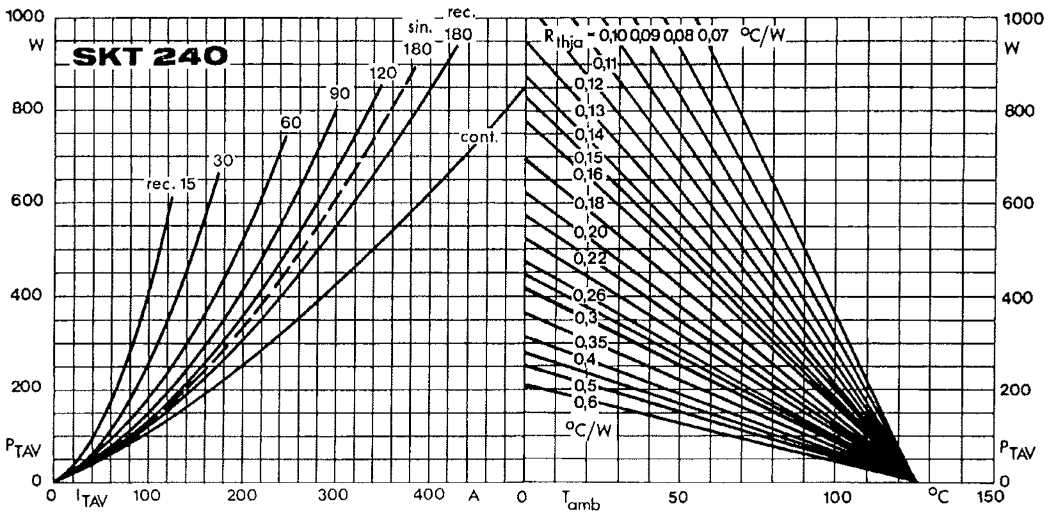


Fig. 1 a Power dissipation vs. on-state current and ambient temperature

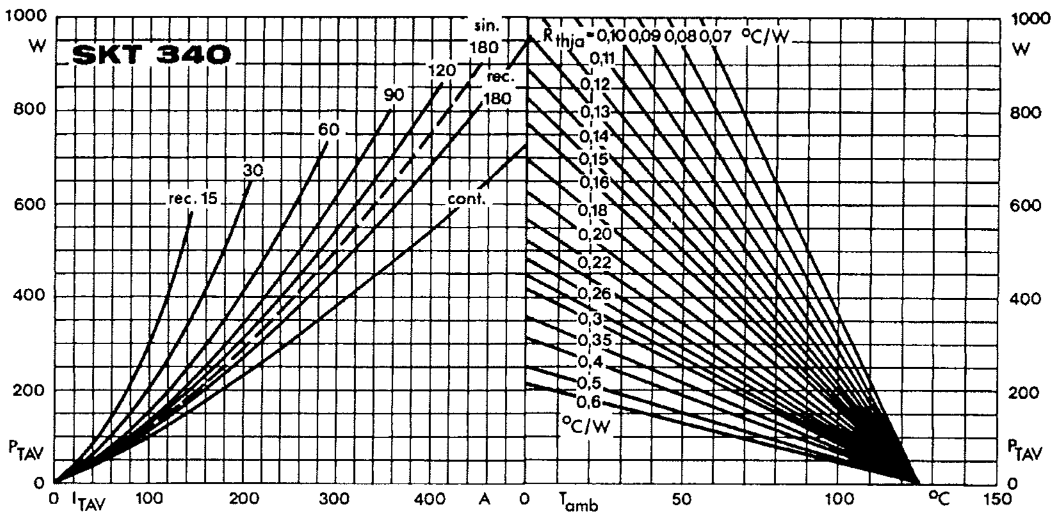


Fig. 1 b Power dissipation vs. on-state current and ambient temperature

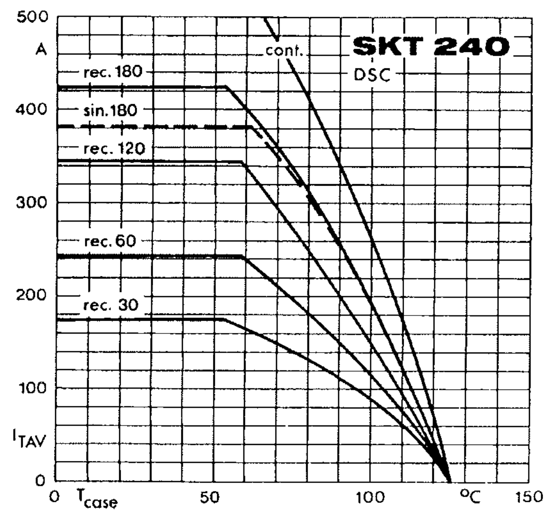


Fig. 2 a Rated on-state current vs. case temperature

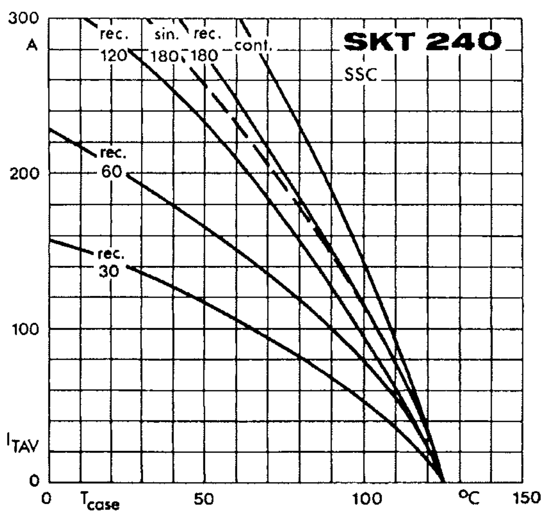


Fig. 2 b Rated on-state current vs. case temperature

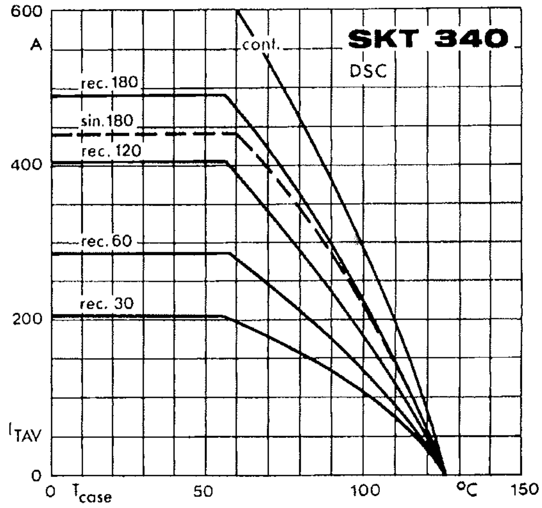


Fig. 2 c Rated on-state current vs. case temperature

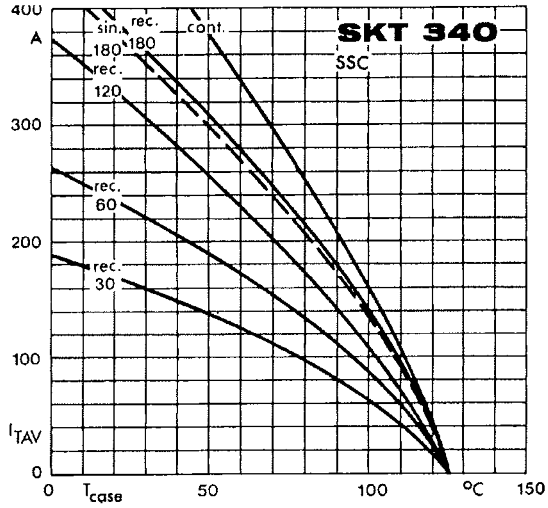


Fig. 2 d Rated on-state current vs. case temperature

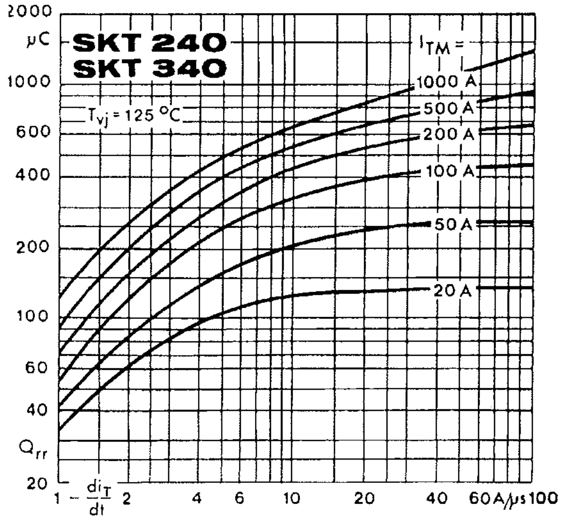
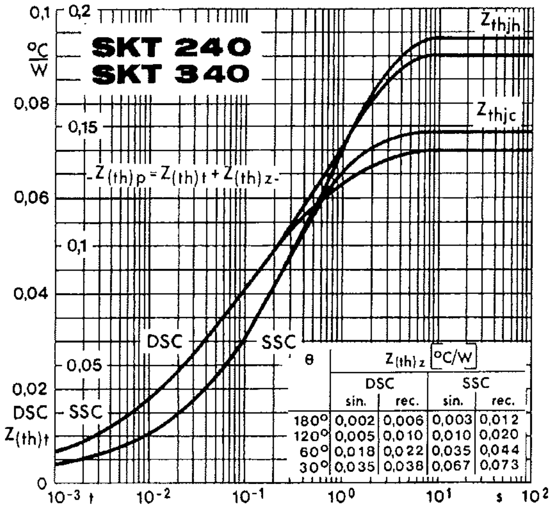


Fig. 3 Recovered charge vs. current decrease



θ	$Z_{(th)z}$ [°C/W] DSC sin.	DSC rec.	SSC sin.	SSC rec.
180°	0,002	0,006	0,003	0,012
120°	0,005	0,010	0,010	0,020
60°	0,018	0,022	0,035	0,044
30°	0,035	0,038	0,067	0,073

Fig. 4 Transient thermal impedance vs. time

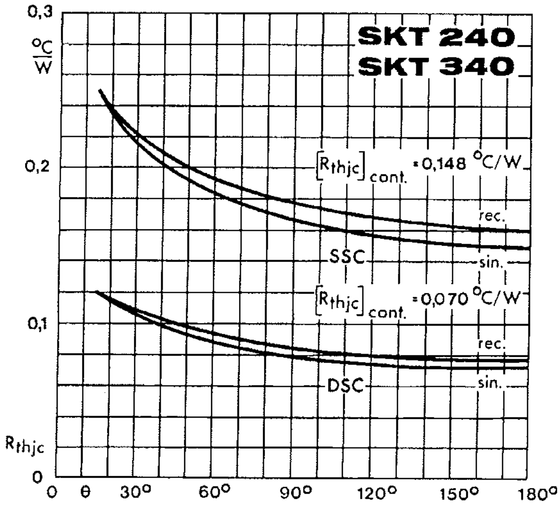


Fig. 5 Thermal resistance vs. conduction angle

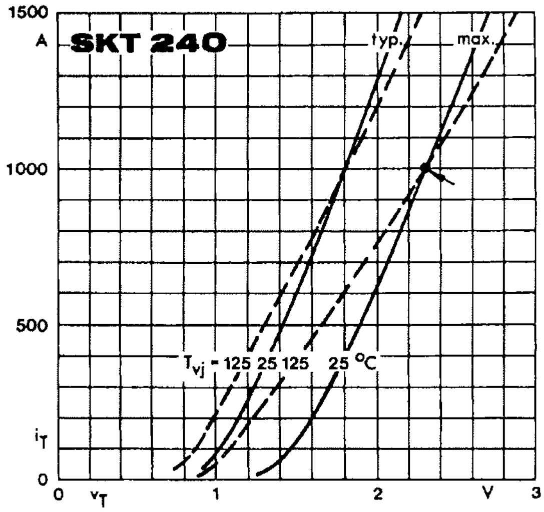


Fig. 6 a On-state characteristics

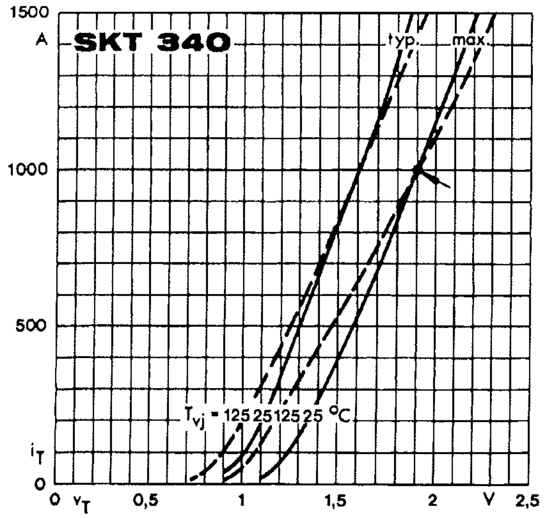


Fig. 6 b On-state characteristics

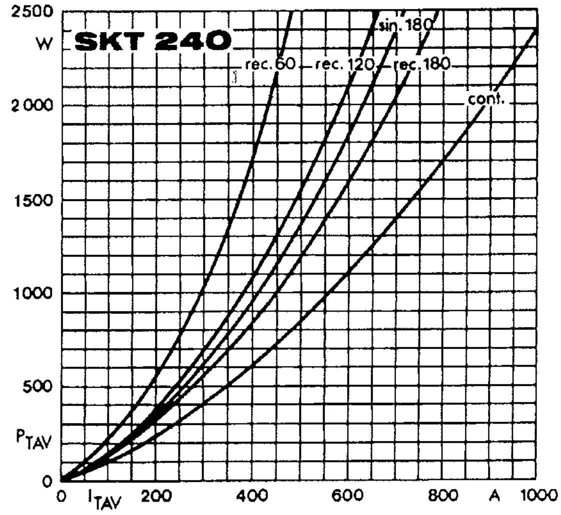


Fig. 7 a Power dissipation vs. on-state current

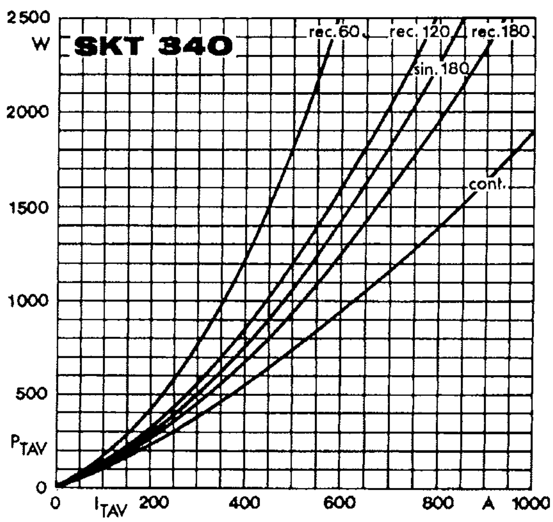


Fig. 7 b Power dissipation vs. on-state current

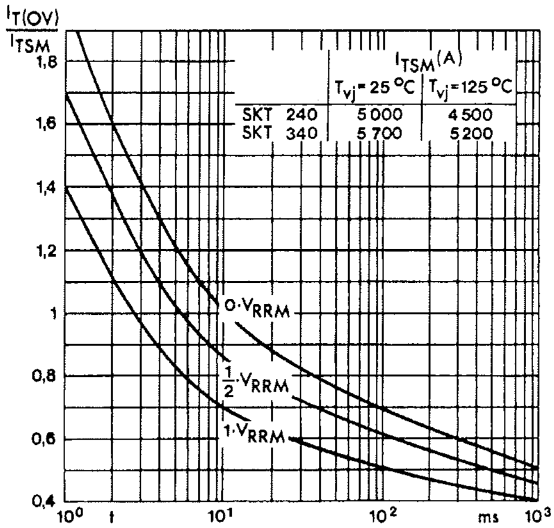


Fig. 8 Surge overload current vs. time

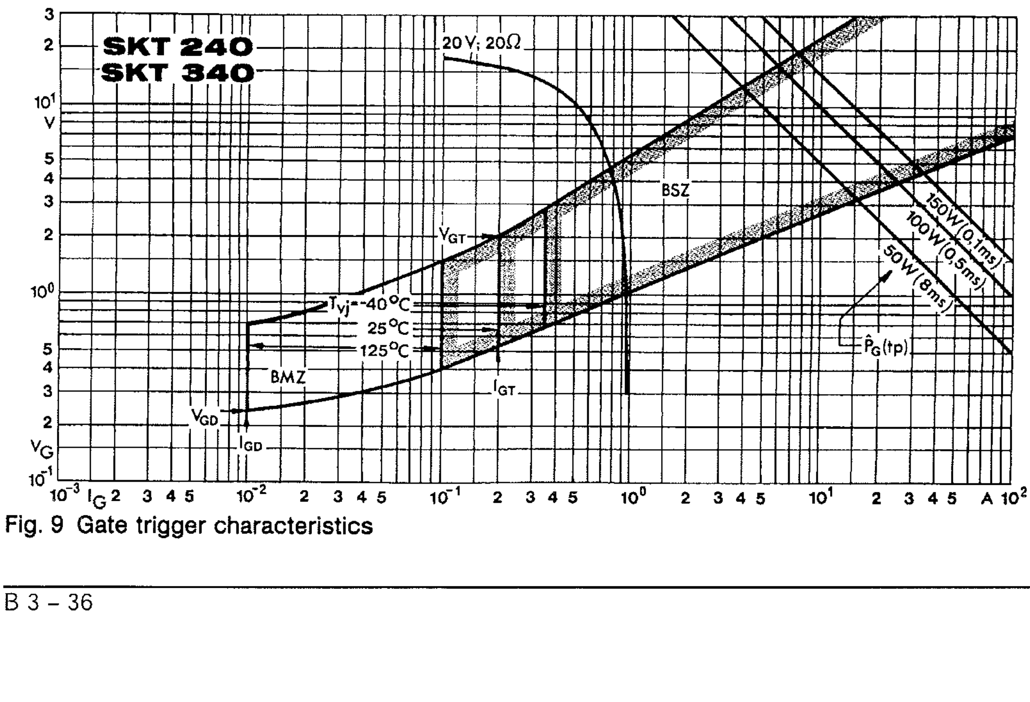
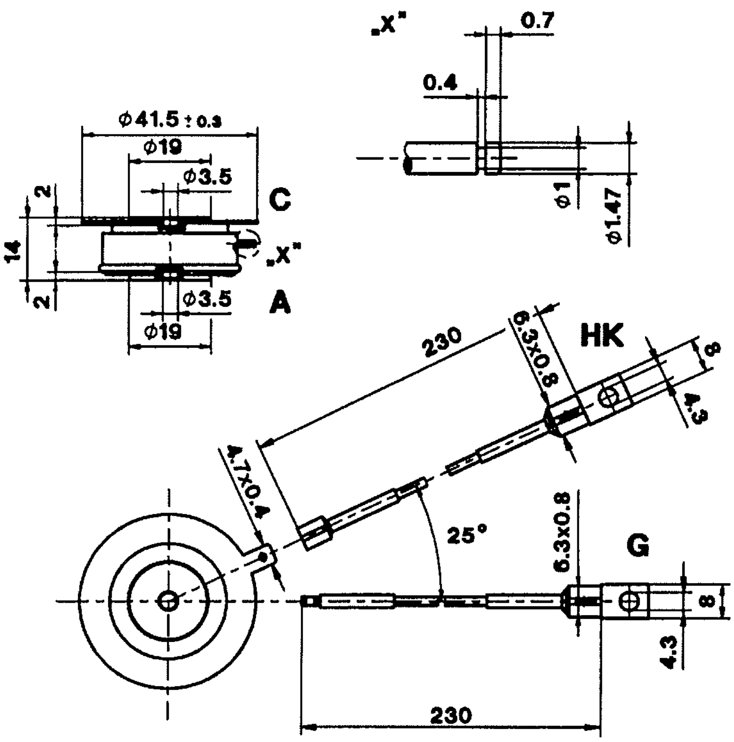


Fig. 9 Gate trigger characteristics

SKT 240
SKT 340

Case B 8

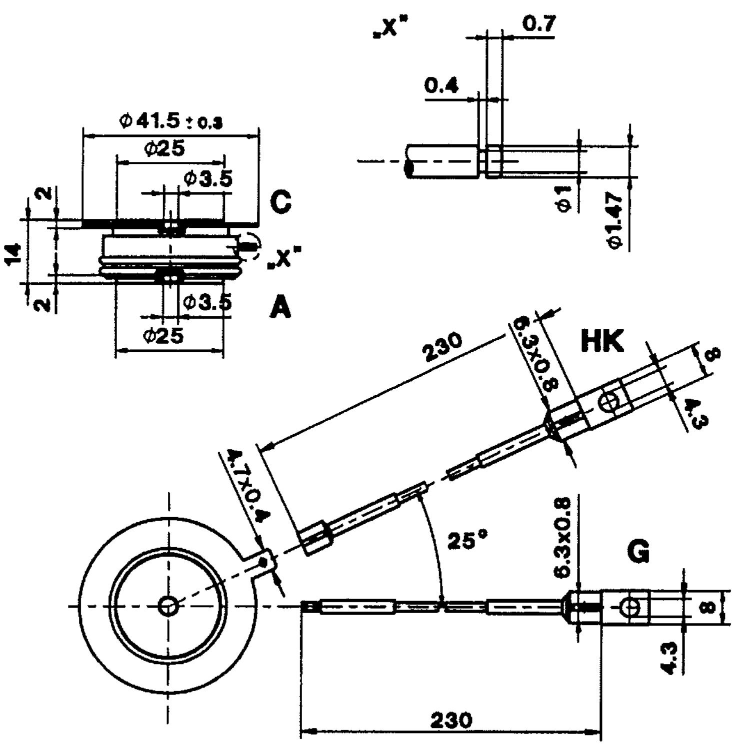
DIN 41814: 151 A 4
JEDEC: TO-200 AB



SKT 491
SKT 551

Case B 11

DIN 41814: 152 A 4
JEDEC: TO-200 AB



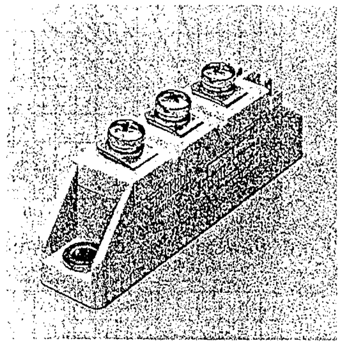
C: Cathode terminal (red sleeve)
A: Anode terminal
G: Gate terminal (yellow sleeve)
HK: Auxiliary cathode terminal (red sleeve)

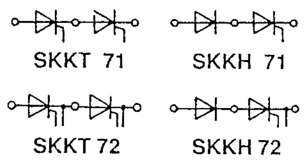
Dimensions in mm

SEMIKRON

SEMIPACK® 1
Thyristor/ Diode Modules

SKKT 71 SKKH 71
SKKT 72 SKKH 72
SKKT 72 B





V_{RSM} V	V_{RRM} V_{DRM} V	$(dv/dt)_{cr}$ V/µs	I_{TRMS} (maximum value for continuous operation) 125 A; I_{TAV} (sin. 180; T_{case} = 78 °C) 80 A			
700	600	500	SKKT 71/06 D	SKKT 72/06 D	–	SKKH 72/06 D
900	800	500	SKKT 71/08 D	SKKT 72/08 D[1)]	SKKH 71/08 D	SKKH 72/08 D
1300	1200	500	SKKT 71/12 D	–	SKKH 71/12 D	–
		1000	SKKT 71/12 E	SKKT 72/12 E[1)]	–	SKKH 72/12 E
1500	1400	1000	SKKT 71/14 E	SKKT 72/14 E[1)]	SKKH 71/14 E	SKKH 72/14 E
1700	1600	1000	SKKT 71/16 E	SKKT 72/16 E[1)]	SKKH 71/16 E	SKKH 72/16 E
1900	1800	1000	SKKT 71/18 E	SKKT 72/18 E	SKKH 71/18 E	–
2100	2000	1000	SKKT 71/20 E	SKKT 72/20 E	SKKH 71/20 E	–

Symbol	Conditions	SKKT 71, SKKH 71 / SKKT 72, SKKT 72 B, SKKH 72
I_{TAV}	sin. 180; (T_{case} = . . .)	80 A (78 °C)
		70 A (85 °C)
I_D	B2/B6 T_{amb} = 35 °C; P 3/180 F	115 A/150 A
I_{RMS}	W1/W3 T_{amb} = 35 °C; P 3/180 F	155 A/3 x 115 A
I_{TSM}	T_{vj} = 25 °C	1600 A
	T_{vj} = 125 °C	1450 A
i^2t	T_{vj} = 25 °C	13000 A^2s
	T_{vj} = 125 °C	10500 A^2s
t_{gd}	T_{vj} = 25 °C; I_G = 1 A; di_G/dt = 1 A/µs	1 µs
t_{gr}	V_D = 0,67 · V_{DRM}	2 µs
$(di/dt)_{cr}$	T_{vj} = 125 °C	typ. 100 A/µs
t_q	T_{vj} = 125 °C	typ. 80 µs
I_H	T_{vj} = 25 °C;	typ. 150 mA; max. 250 mA
I_L	T_{vj} = 25 °C; R_G = 33 Ω	typ. 300 mA; max. 600 mA
V_T	T_{vj} = 25 °C; I_T = 200 A	max. 1,9 V
$V_{T(TO)}$	T_{vj} = 125 °C	0,9 V
r_T	T_{vj} = 125 °C	3,5 mΩ
I_{DD}; I_{RD}	T_{vj} = 125 °C; V_{DD} = V_{DRM}; V_{RD} = V_{RRM}	max. 20 mA
V_{GT}	T_{vj} = 25 °C; d. c.	3 V
I_{GT}	T_{vj} = 25 °C; d. c.	150 mA
V_{GD}	T_{vj} = 125 °C; d. c.	0,25 V
I_{GD}	T_{vj} = 125 °C; d. c.	6 mA
R_{thjc}	cont. } per thyristor/per module	0,35 °C/W / 0,18 °C/W
	sin. 180 } per thyristor/per module	0,37 °C/W / 0,19 °C/W
	rec.120 } per thyristor/per module	0,39 °C/W / 0,20 °C/W
R_{thch}		0,2 °C/W / 0,1 °C/W
T_{vj}		– 40 ... +125 °C
T_{stg}		– 40 ... +125 °C
V_{isol}	a. c. 50 Hz; r.m.s.; 1 s/1 min	3000 V~ /2500 V~
M_1	Case to heatsink } SI units/US units	5 Nm/44 lb. in. ± 15 %[2)]
M_2	Busbars to terminals } SI units/US units	3 Nm/26 lb. in. ± 15 %
a		5 · 9,81 m/s^2
w	approx.	120 g
Case	→ page B 1 – 85	SKKT 71: A 5 SKKT 72: A 46

Features
- Heat transfer through aluminium oxide ceramic isolated metal baseplate
- Hard soldered joints for high reliability
- UL recognized, file no. E 63 532

Typical Applications
- DC motor control (e. g. for machine tools)
- AC motor soft starters
- Temperature control (e. g. for ovens, chemical processes)
- Professional light dimming (studios, theaters)

[1)] The voltage grades SKKT 72/08 D, 12 E, 14 E and 16 E are also available in SKKT . . . B configuration (case A 48).

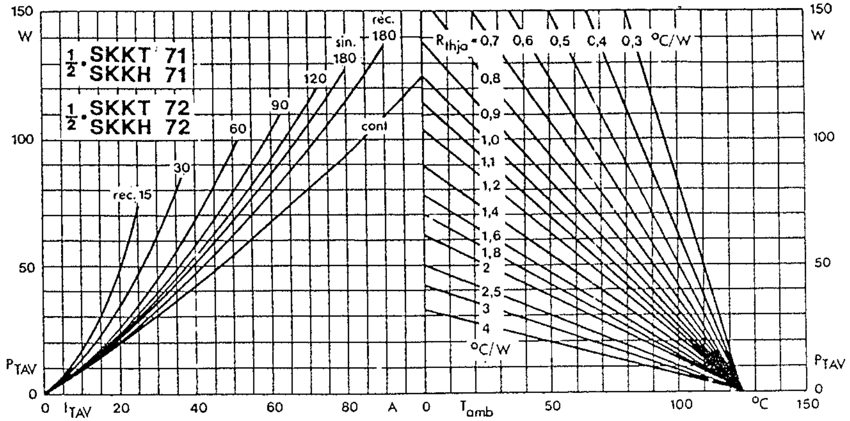


Fig. 1 Power dissipation per thyristor vs. on-state current and ambient temperature

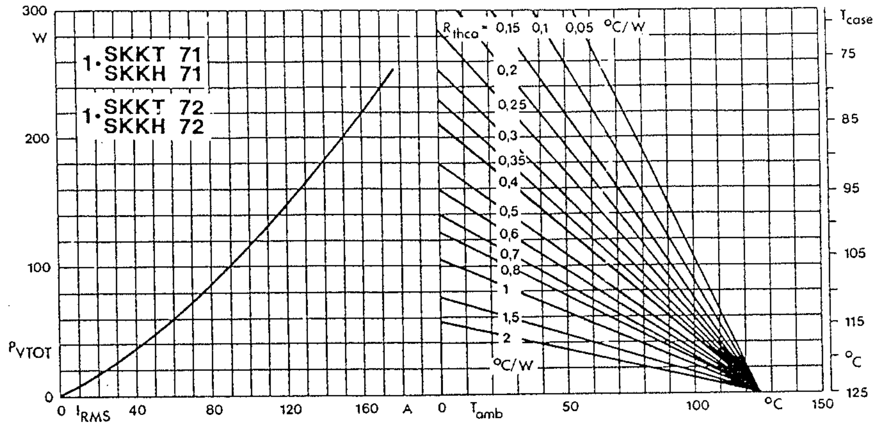


Fig. 2 Power dissipation per module vs. rms current and case temperature

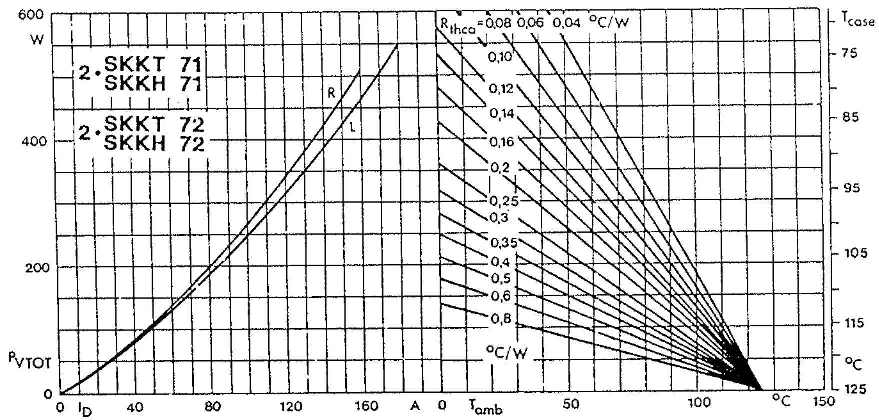


Fig. 3 Power dissipation of two modules vs. direct current and case temperature

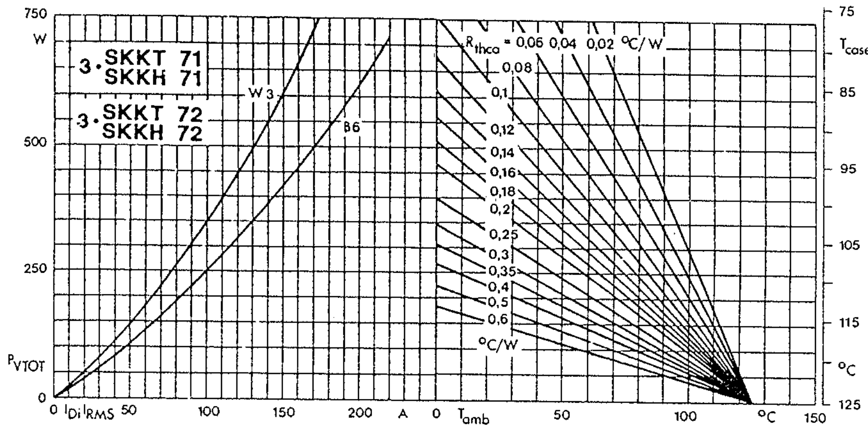


Fig. 4 Power dissipation of three modules vs. direct and rms current and case temperature

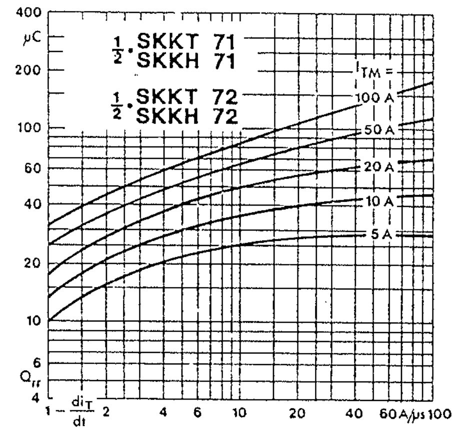


Fig. 5 Recovered charge vs. current decrease

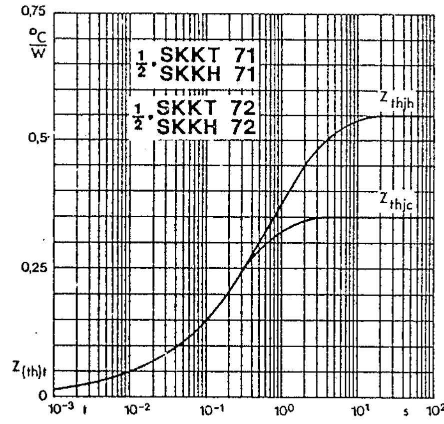


Fig. 6 Transient thermal impedance vs. time

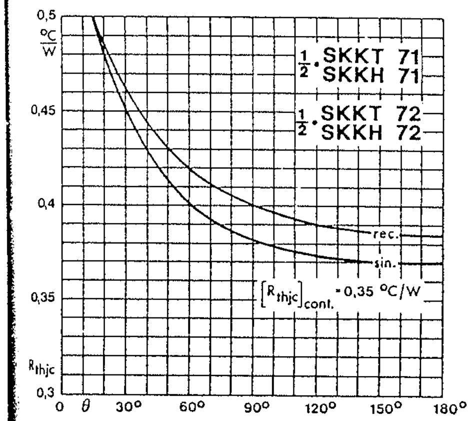


Fig. 7 Thermal resistance vs. conduction angle

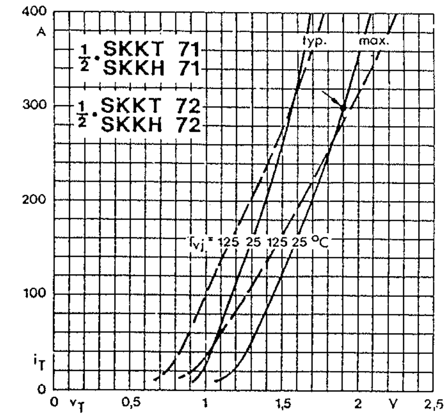


Fig. 8 On-state characteristics

8

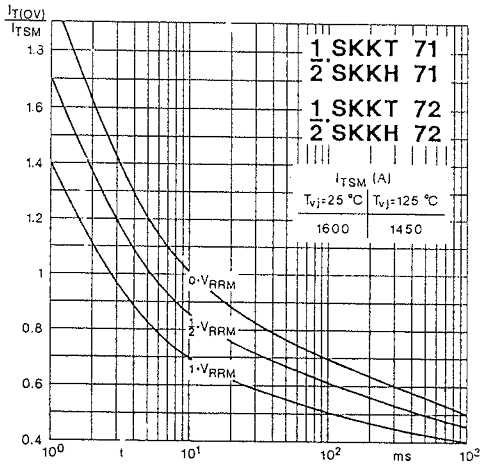


Fig. 9 Surge overload current vs. time

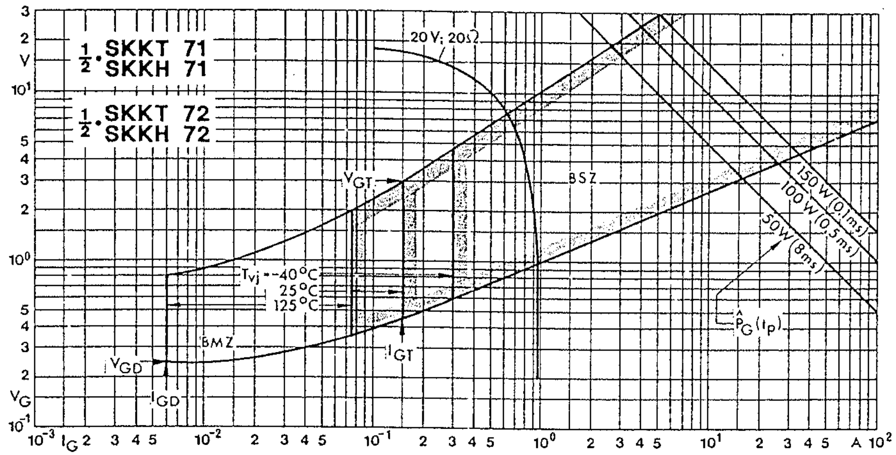


Fig. 10 Gate trigger characteristics

V_{RSM}	\
V	
500	
700	
900	
1300	
1500	
1700	

Symb
I_{TAV}
I_D
I_{RMS}
I_{TSM}
i^2t
t_{gd}
t_{gr}
(di/dt
t_q
I_H
I_L
V_T
$V_{T(TC}$
r_T
I_{DD}; I
V_{GT}
I_{GT}
V_{GD}
I_{GD}
R_{thjc}
R_{thch}
T_{vj}
T_{stg}
V_{isol}
M_1
M_2
a
w
Case