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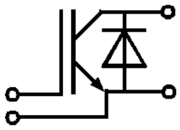
SEMITRANS® M IGBT Modules

SKM 400 GA 173 D
SKM 400 GA 173 D1 S

SEMITRANS 4



GA

Absolute Maximum Ratings

Symbol	Conditions 1)	Values		Units
V_{CES}		1700		V
V_{CGR}	R_{GE} = 20 kΩ	1700		V
I_C	T_{case} = 25/80 °C	440 / 300		A
I_{CM}	T_{case} = 25/80 °C; t_p = 1 ms	880 / 600		A
V_{GES}		± 20		V
P_{tot}	per IGBT, T_{case} = 25 °C	2500		W
T_j, (T_{stg})		– 40 . . .+150 (125)		°C
V_{isol}	AC, 1 min.	4000		V
humidity	DIN 40 040	Class F		
climate	DIN IEC 68 T.1	40/125/56		
Inverse Diode 8)			D1 S	
$I_F = -I_C$	T_{case} = 25/80 °C	300 / 200	400 / 270	A
$I_{FM} = -I_{CM}$	T_{case} = 25/80 °C; t_p = 1 ms	880 / 600	880 / 600	A
I_{FSM}	t_p = 10 ms; sin.; T_j = 150 °C	2900	4400	A
I^2t	t_p = 10 ms; T_j = 150 °C	42000	96000	A^2s

Characteristics

Symbol	Conditions 1)	min.	typ.	max.	Units
$V_{(BR)CES}$	V_{GE} = 0, I_C = 5,6 mA	≥ V_{CES}	–	–	V
$V_{GE(th)}$	$V_{GE} = V_{CE}$, I_C = 20 mA	4,8	5,5	6,2	V
I_{CES}	V_{GE} = 0 ⎫ T_j = 25 °C	–	–	2	mA
	$V_{CE} = V_{CES}$ ⎭ T_j = 125 °C	–	–	4,5	mA
I_{GES}	V_{GE} = 20 V, V_{CE} = 0 V	–	–	400	nA
V_{CEsat}	I_C = 300 A ⎧ V_{GE} = 15 V;	–	3,0(4,3)	3,9(5)	V
V_{CEsat}	I_C = 400 A ⎩ T_j = 25 (125) °C	–	3,8(5,5)	–	V
g_{fs}	V_{CE} = 20 V, I_C = 300 A	108	–	–	S
C_{CHC}	per IGBT	–	–	400	pF
C_{ies}	V_{GE} = 0	–	44	–	nF
C_{oes}	V_{CE} = 25 V	–	3,5	–	nF
C_{res}	f = 1 MHz	–	1	–	nF
L_{CE}		–	–	20	nH
$t_{d(on)}$	V_{CC} = 1200 V	–	550	–	ns
t_r	V_{GE} = + 15 V / - 15 V 3)	–	120	–	ns
$t_{d(off)}$	I_C = 300 A, ind. load	–	850	–	ns
t_f	$R_{Gon} = R_{Goff}$ = 2 Ω	–	50	–	ns
E_{on}	T_j = 125 °C	–	180	–	mWs
E_{off}		–	10	–	mWs
Inverse Diode 8)					
$V_F = V_{EC}$	I_F = 300 A ⎧ V_{GE} = 0 V;	–	2,2(1,9)	2,7(2,4)	V
$V_F = V_{EC}$	I_F = 400 A ⎩ T_j = 25 (125) °C	–	2,46(2,25)	–	V
V_{TO}	T_j = 125 °C	–	1,3	1,5	V
r_T	T_j = 125 °C	–	2,9	3,2	mΩ
I_{RR}	I_F = 300 A; T_j = 25 (125) °C 2)	–	120(170)	–	A
Q_{rr}	I_F = 300 A; T_j = 25 (125) °C 2)	–	30(72)	–	µC
Diodes of "D1" 8)					
$V_F = V_{EC}$	I_F = 300 A ⎧ V_{GE} = 0 V;	–	2,1(1,8)	2,4	V
$V_F = V_{EC}$	I_F = 400 A ⎩ T_j = 25 (125) °C	–	2,2(2,1)	2,7	V
V_{TO}	T_j = 125 °C	–	1,3	1,5	V
r_T	T_j = 125 °C	–	2	2,5	mΩ
I_{RR}	I_F = 300 A; T_j = 25 (125) °C 2)	–	120(180)	–	A
Q_{rr}	I_F = 300 A; T_j = 25 (125) °C 2)	–	60(85)	–	µC
Thermal Characteristics					
R_{thjc}	per IGBT	–	–	0,05	°C/W
R_{thjc}	per diode D / "D1 S"	–	–	0,17/0,12	°C/W
R_{thch}	per module	–	–	0,038	°C/W

Features

- MOS input (voltage controlled)
- N channel, Homogeneous Si
- Low inductance case
- Very low tail current with low temperature dependence
- High short circuit capability, self limiting to 6 * I_{cnom}
- Latch-up free
- Fast & soft inverse CAL diodes 8)
- Isolated copper baseplate using DCB Direct Copper Bonding
- Large clearance (13 mm) and creepage distances (20 mm).

Typical Applications:

- AC inverter drives on mains 575 - 750 V_{AC}
- DC bus voltage 750 - 1200 V_{DC}
- Public transport
- Switching (not for linear use)

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1) T_{case} = 25 °C, unless otherwise specified

2) $I_F = -I_C$, V_R = 1200 V, – dI_F/dt = 1500 A/µs, V_{GE} = 0 V

3) Use VGEoff = -5 ... -15 V

8) CAL = Controlled Axial Lifetime Technology.

Cases and mech. data → B6-276
"D1S" → B6-212

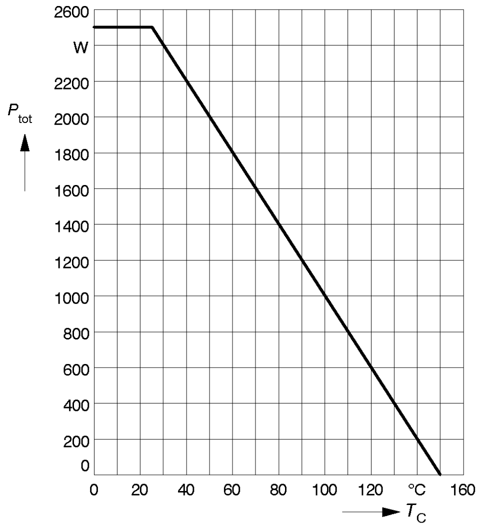
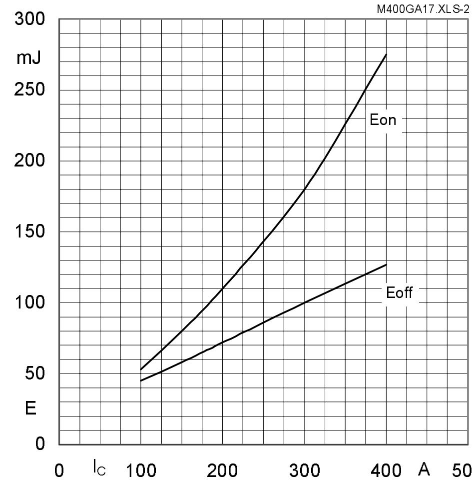
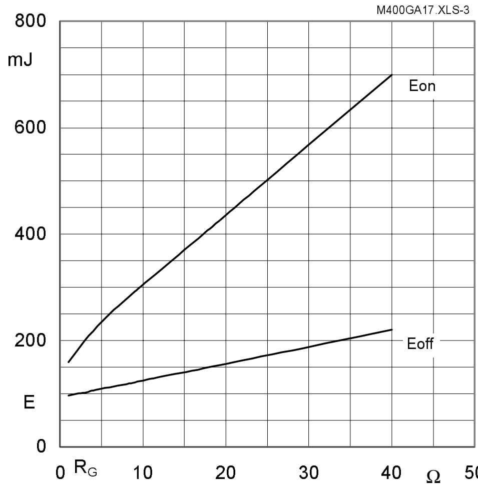


Fig. 1 Rated power dissipation $P_{tot} = f(T_C)$



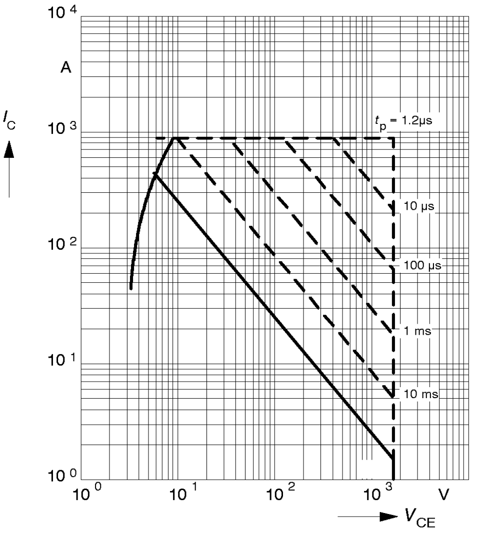
$T_j = 125$ °C
$V_{CE} = 1200$ V
$V_{GE} = \pm 15$ V
$R_G = 2\ \Omega$

Fig. 2 Turn-on /-off energy = f (I_C)



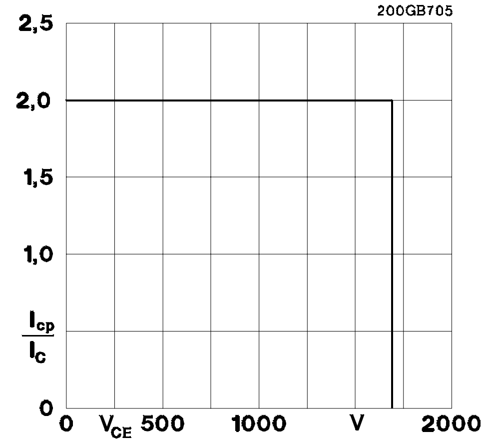
$T_j = 125$ °C
$V_{CE} = 1200$ V
$V_{GE} = \pm 15$ V
$I_C = 300$ A

Fig. 3 Turn-on /-off energy = f (R_G)



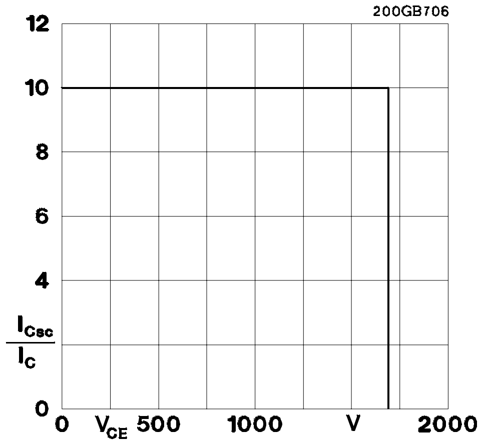
1 pulse
$T_C = 25$ °C
$T_j \leq 150$ °C

Fig. 4 Maximum safe operating area (SOA) $I_C = f(V_{CE})$



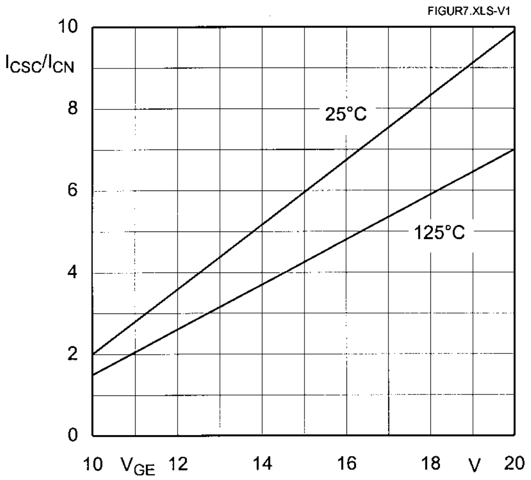
$T_j \leq 150$ °C
$V_{GE} = \pm 15$ V
$R_{Goff} = 2\ \Omega$
$I_C = 300$ A

Fig. 5 Turn-off safe operating area (RBSOA)



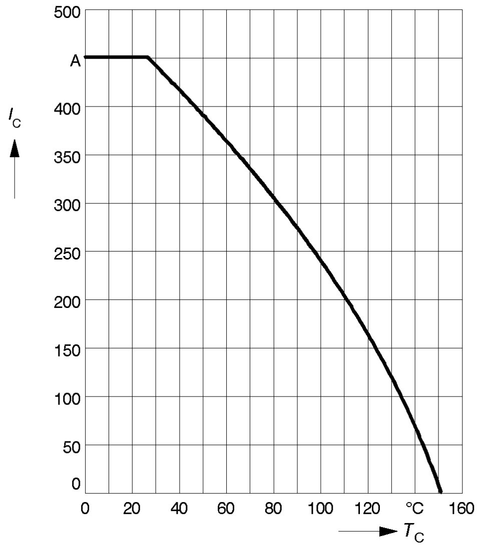
$T_j \leq 150$ °C
$V_{GE} = \pm 15$ V
$t_{sc} \leq 10$ μs
$L_{ext} < 50$ nH
$I_C = 300$ A

Fig. 6 Safe operating area at short circuit $I_C = f(V_{CE})$



V_C = 1200 V
I_C = 300 A
R_G = 2 Ω
$L_{ext} \leq$ 50 nH
self-limiting

Fig. 7 Short circuit current vs. turn-on gate voltage



T_j = 150 °C
$V_{GE} \geq$ 15 V

Fig. 8 Rated current vs. temperature $I_C = f(T_C)$

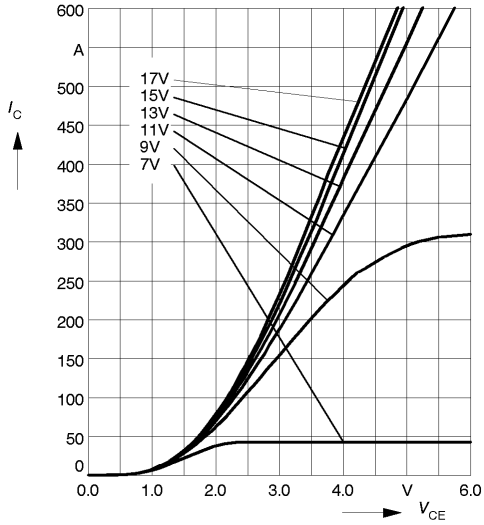


Fig. 9 Typ. output characteristic, t_p = 80 µs; T_j = 25 °C

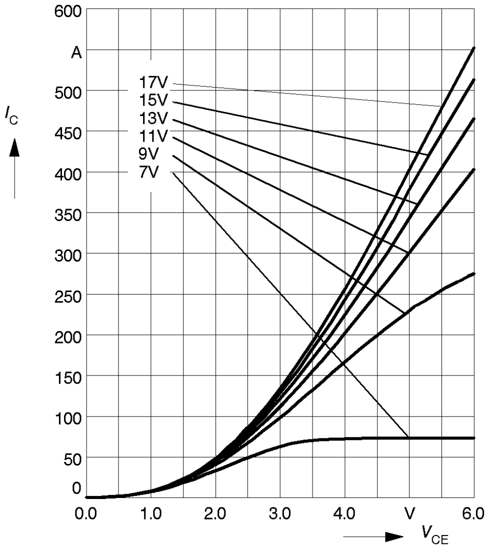


Fig. 10 Typ. output characteristic, t_p = 80 µs; T_j = 125 °C

$P_{cond(t)} = V_{CEsat(t)} \cdot I_{C(t)}$

$V_{CEsat(t)} = V_{CE(TO)(Tj)} + r_{CE(Tj)} \cdot I_{C(t)}$

$V_{CE(TO)(Tj)} \leq 1{,}9 + 0{,}003\ (T_j - 25)$ [V]

$r_{CE(Tj)} = 0{,}006 + 0{,}00002\ (T_j - 25)$ [Ω]

valid for $V_{GE} = +\,15\,^{+\,2}_{-\,1}$ [V]; $I_C \geq 0{,}3\ I_{Cnom}$

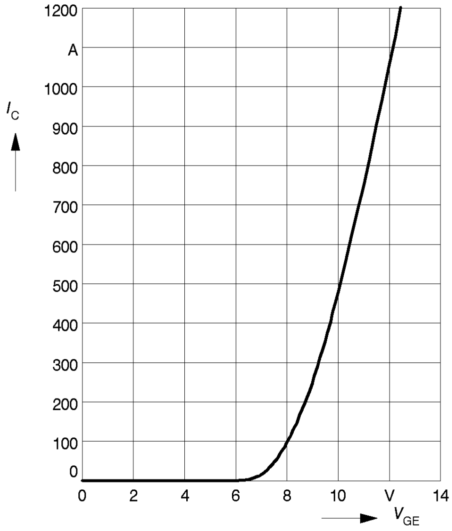
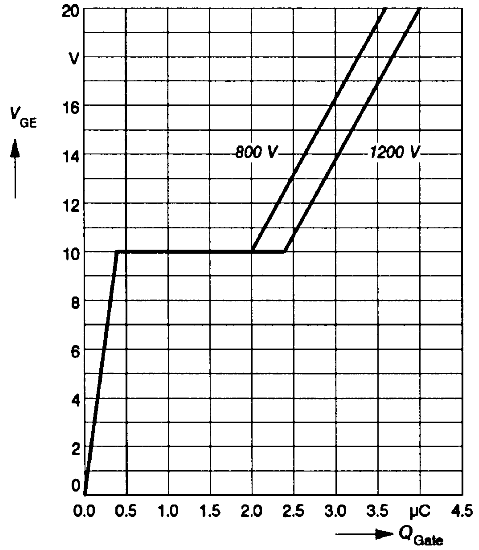


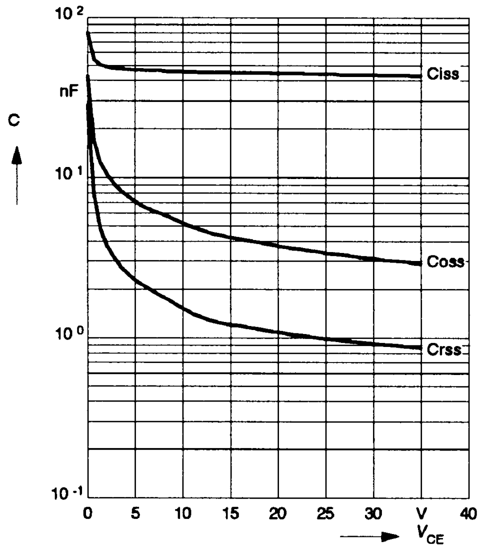
Fig. 11 Typ. saturation characteristic (IGBT)
Calculation elements and equations

Fig. 12 Typ. transfer characteristic, t_p = 80 µs; V_{CE} = 20 V



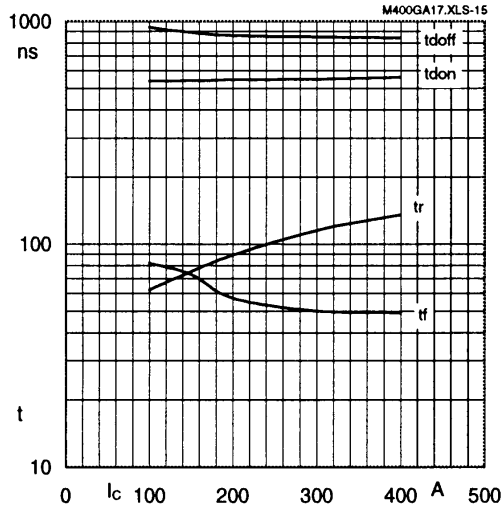
I_{Cpuls} = 300 A

Fig. 13 Typ. gate charge characteristic



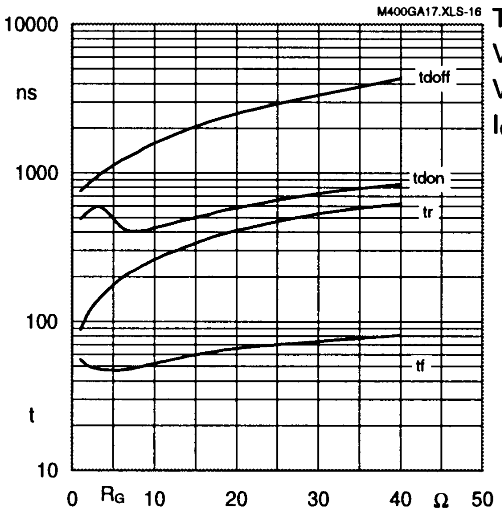
V_{GE} = 0 V
f = 1 MHZ

Fig. 14 Typ. capacitances vs.V_{CE}



T_j = 125 °C
V_{CC} = 1200 V
V_{GE} = ± 15 V
R_g = 2 Ω

Fig. 15 Typ. switching times vs. I_C



T_j = 125 °C
V_{CC} = 1200 V
V_{GE} = ± 15 V
I_C = 300 A

Fig. 16 Typ. switching times vs. R_G

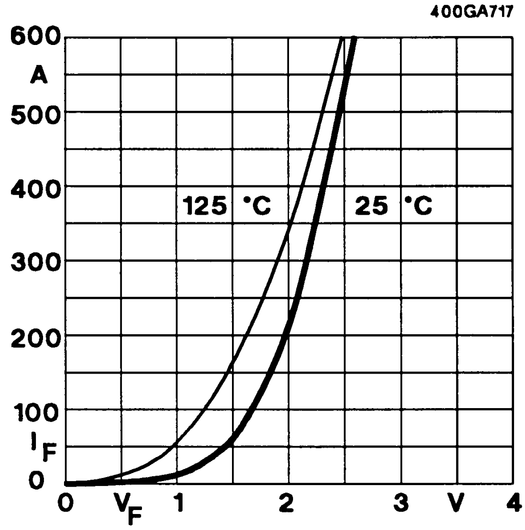


Fig. 17 Typ. CAL diode forward characteristic

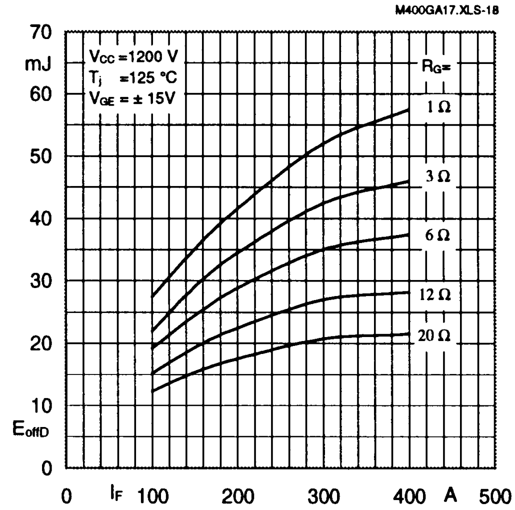


Fig. 18 Typ. Diode turn-off energy dissipation per pulse

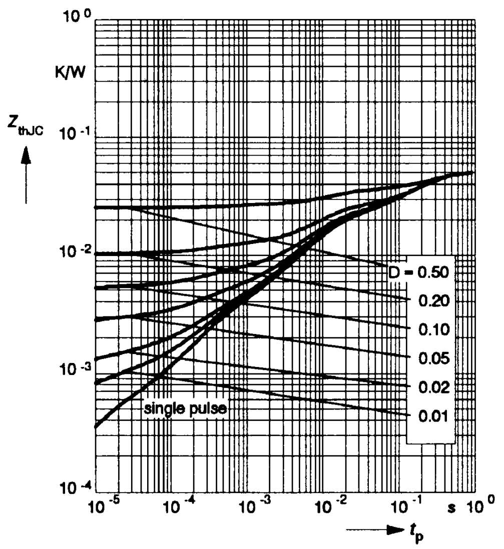


Fig. 19 Transient thermal impedance of IGBT: $Z_{thjc} = f(t_p)$; $D = t_p / t_c = t_p \cdot f$

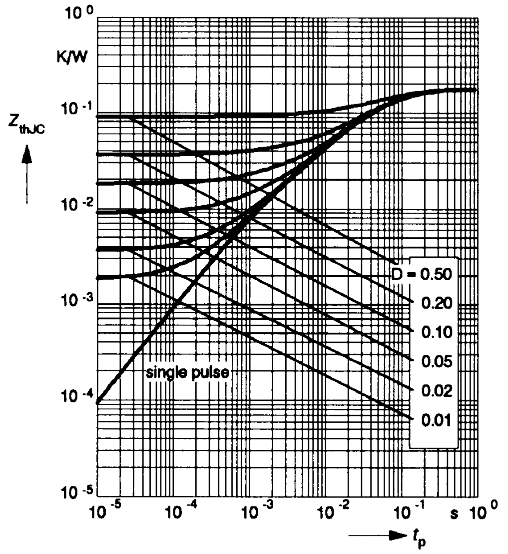


Fig. 20 Transient thermal impedance of inverse diode: $Z_{thjcD} = f(t_p)$

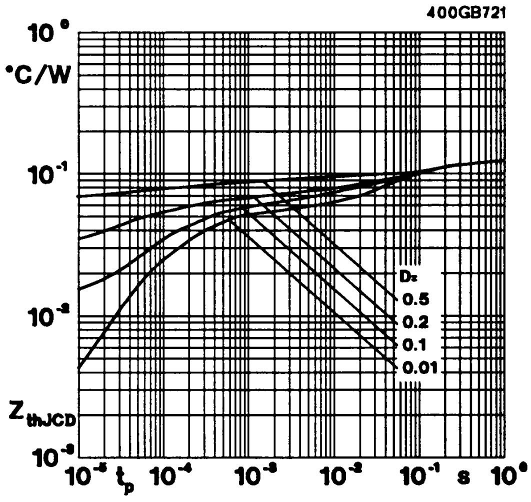


Fig. 21 Transient thermal impedance of Diode D1: $Z_{thjcD} = f(t_p)$

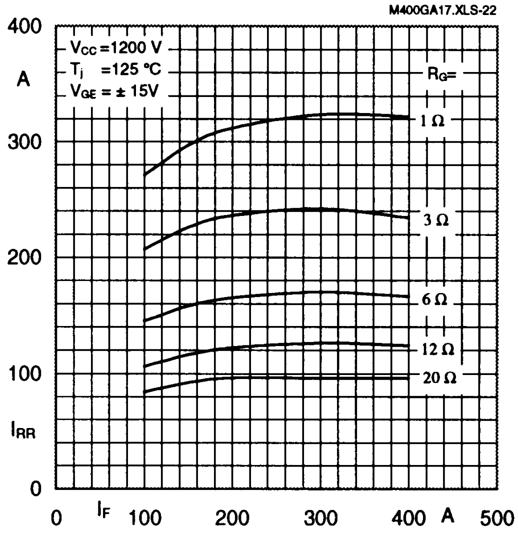


Fig. 22 Typ. CAL diode peak reverse recovery current $I_{RR} = f(I_F; R_G)$

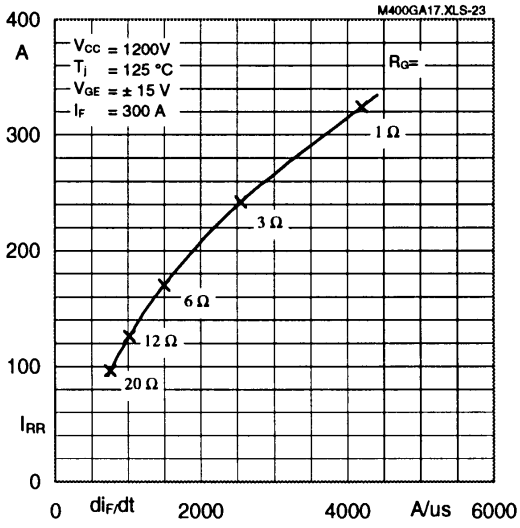


Fig. 23 Typ. CAL diode peak reverse recovery current $I_{RR} = f(di_F/dt)$

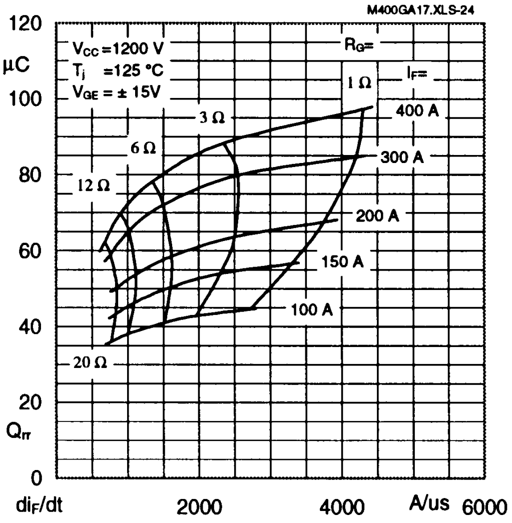


Fig. 24 Typ. CAL diode recovered charge Qrr

SEMITRANS 4

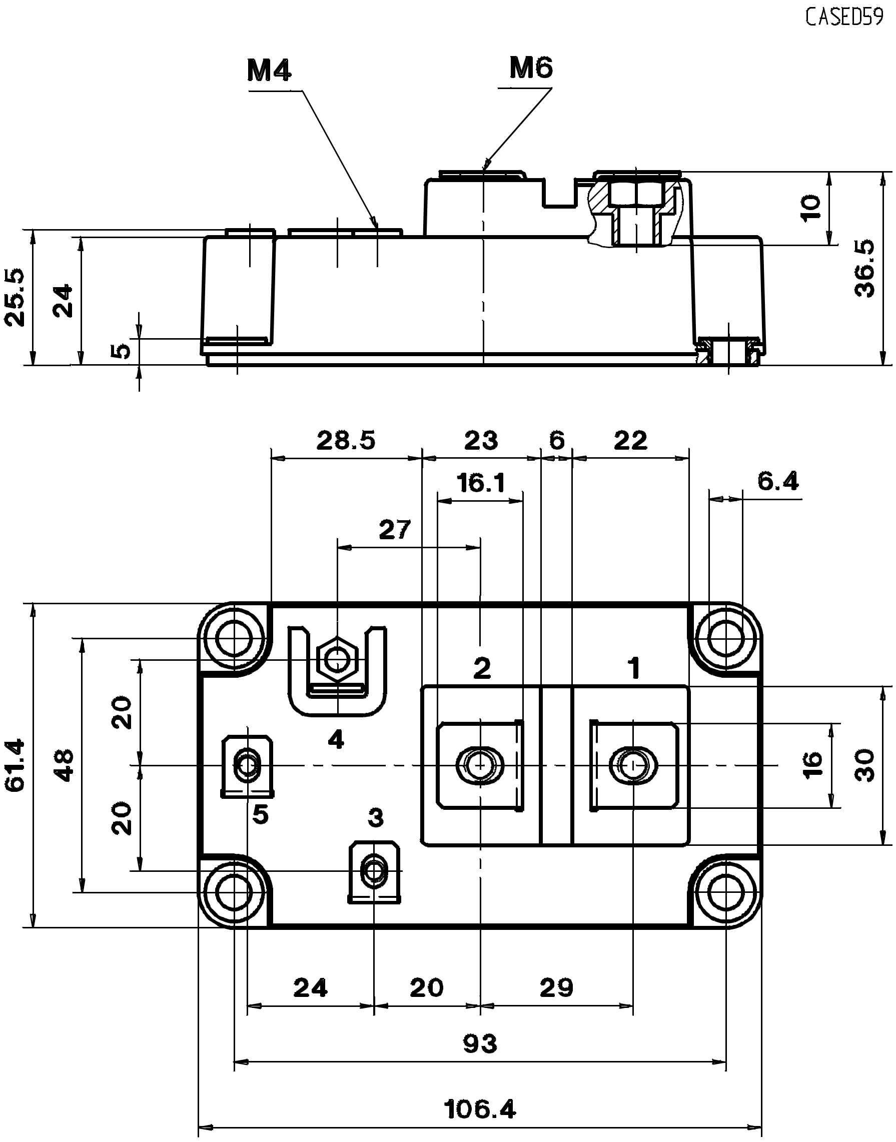
Case D 59

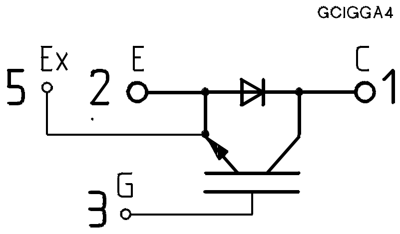
UL Recognized

File no. E 63 532

SKM 400 GA 173 D

SKM 500 GA 123 D





Dimensions in mm

Option SKM 400 GA 173 D1S on request:
Terminal 4 = collector sense V_{CE}, add suffix "S". → B 6 – 212.

Outline and circuit

Mechanical Data

Symbol	Conditions	Values min.	Values typ.	Values max.	Units
M_1	to heatsink, SI Units (M6)	3	–	5	Nm
	to heatsink, US Units	27	–	44	lb.in.
M_2	for terminals, SI Units (M6/M4)	2,5/1,1	–	5/2	Nm
	for terminals US Units	22/10	–	44/18	lb.in.
a		–	–	5x9,81	m/s^2
w		–	–	330	g

**This is an electrostatic discharge sensitive device (ESDS).
Please observe the international standard IEC 747-1, Chapter IX.**

Three devices are supplied in one SEMIBOX B without mounting hardware, which can be ordered separately under Ident No. 33321100 (for 10 SEMITRANS 4). Larger packing units of 12 and 20 pieces are used if suitable
Accessories → B 6 - 4.
SEMIBOX B → C - 2.