



SEMITRANS®3

Fast IGBT4 Modules

SKM400GAL12T4

Features

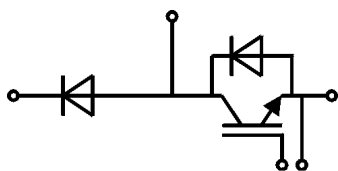
- $V_{CE(sat)}$ with positive temperature coefficient
- High short circuit capability, self limiting to $6 \times I_{Cnom}$
- Fast & soft inverse CAL diodes
- Large clearance (10 mm) and creepage distances (20 mm)
- Isolated copper baseplate using DBC Technology (Direct Copper Bonding)

Typical Applications

- DC/DC – converter
- Brake chopper
- Switched reluctance motor
- DC – motor

Remarks

- Case temperature limited to $T_c = 125^\circ\text{C}$ max, recomm.
 $T_{op} = -40 \dots +150^\circ\text{C}$, product rel. results valid for $T_j = 150^\circ$



GAL

Absolute Maximum Ratings

Symbol	Conditions		Values	Unit
IGBT				
V _{CES}			1200	V
I _C	T _j = 175 °C	T _c = 25 °C	618	A
		T _c = 80 °C	475	A
I _{Cnom}			400	A
I _{CRM}	I _{CRM} = 3xI _{Cnom}		1200	A
V _{GES}			-20 ... 20	V
t _{psc}	V _{CC} = 800 V V _{GE} ≤ 15 V V _{CES} ≤ 1200 V	T _j = 150 °C	10	µs
T _j			-40 ... 175	°C
Inverse diode				
I _F	T _j = 175 °C	T _c = 25 °C	440	A
		T _c = 80 °C	329	A
I _{Fnom}			400	A
I _{FRM}	I _{FRM} = 3xI _{Fnom}		1200	A
I _{FSM}	t _p = 10 ms, sin 180°, T _j = 25 °C		1980	A
T _j			-40 ... 175	°C
Freewheeling diode				
I _F	T _j = 175 °C	T _c = 25 °C	440	A
		T _c = 80 °C	329	A
I _{Fnom}			400	A
I _{FRM}	I _{FRM} = 3xI _{Fnom}		1200	A
I _{FSM}	t _p = 10 ms, sin 180°, T _j = 25 °C		1980	A
T _j			-40 ... 175	°C
Module				
I _{t(RMS)}			500	A
T _{stg}			-40 ... 125	°C
V _{isol}	AC sinus 50Hz, t = 1 min		4000	V

Characteristics

Symbol	Conditions	min.	typ.	max.	Unit
IGBT					
$V_{CE(sat)}$	$I_C = 400\text{ A}$ $V_{GE} = 15\text{ V}$ chipelevel	$T_j = 25^\circ\text{C}$	1.8	2.05	V
		$T_j = 150^\circ\text{C}$	2.2	2.4	V
V_{CE0}		$T_j = 25^\circ\text{C}$	0.8	0.9	V
		$T_j = 150^\circ\text{C}$	0.7	0.8	V
r_{CE}	$V_{GE} = 15\text{ V}$	$T_j = 25^\circ\text{C}$	2.5	2.9	$\text{m}\Omega$
		$T_j = 150^\circ\text{C}$	3.8	4.0	$\text{m}\Omega$
$V_{GE(th)}$	$V_{GE} = V_{CE}$, $I_C = 15.2\text{ mA}$	5	5.8	6.5	V
I_{CES}	$V_{GE} = 0\text{ V}$ $V_{CE} = 1200\text{ V}$	$T_j = 25^\circ\text{C}$	0.1	0.3	mA
		$T_j = 150^\circ\text{C}$			mA
C_{ies}	$V_{CE} = 25\text{ V}$	$f = 1\text{ MHz}$	24.6		nF
C_{oes}	$V_{GE} = 0\text{ V}$	$f = 1\text{ MHz}$	1.62		nF
C_{res}		$f = 1\text{ MHz}$	1.38		nF
Q_G	$V_{GE} = -8\text{ V} \dots +15\text{ V}$		2260		nC
R_{Gint}	$T_j = 25^\circ\text{C}$		1.9		Ω



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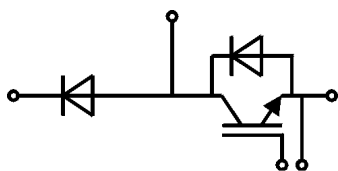
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Remarks

- Case temperature limited to $T_c = 125^\circ\text{C}$ max, recomm.
 $T_{op} = -40 \dots +150^\circ\text{C}$, product rel. results valid for $T_j = 150^\circ$

Characteristics					
Symbol	Conditions		min.	typ.	max. Unit
$t_{d(on)}$	$V_{CC} = 600\text{ V}$	$T_j = 150^\circ\text{C}$		220	ns
t_r	$I_C = 400\text{ A}$	$T_j = 150^\circ\text{C}$		47	ns
E_{on}	$V_{GE} = \pm 15\text{ V}$	$T_j = 150^\circ\text{C}$		33	mJ
$t_{d(off)}$	$R_{G\ on} = 1\ \Omega$	$T_j = 150^\circ\text{C}$		505	ns
t_f	$R_{G\ off} = 1\ \Omega$	$T_j = 150^\circ\text{C}$		78	ns
E_{off}	$di/dt_{on} = 9700\text{ A}/\mu\text{s}$	$T_j = 150^\circ\text{C}$		42	mJ
$R_{th(j-c)}$	$di/dt_{off} = 4300\text{ A}/\mu\text{s}$	$T_j = 150^\circ\text{C}$			0.072 K/W
	per IGBT				
Inverse diode					
$V_F = V_{EC}$	$I_F = 400\text{ A}$	$T_j = 25^\circ\text{C}$		2.2	2.52 V
	$V_{GE} = 0\text{ V}$	$T_j = 150^\circ\text{C}$		2.15	2.47 V
	chip				
V_{F0}		$T_j = 25^\circ\text{C}$		1.3	1.5 V
		$T_j = 150^\circ\text{C}$		0.9	1.1 V
r_F		$T_j = 25^\circ\text{C}$		2.3	2.5 m Ω
		$T_j = 150^\circ\text{C}$		3.1	3.4 m Ω
I_{RRM}	$I_F = 400\text{ A}$	$T_j = 150^\circ\text{C}$		450	A
Q_{rr}	$di/dt_{off} = 8800\text{ A}/\mu\text{s}$	$T_j = 150^\circ\text{C}$		68	μC
E_{rr}	$V_{GE} = \pm 15\text{ V}$	$T_j = 150^\circ\text{C}$		30.5	mJ
	$V_{CC} = 600\text{ V}$	$T_j = 150^\circ\text{C}$			
$R_{th(j-c)}$	per diode			0.14	K/W
Freewheeling diode					
$V_F = V_{EC}$	$I_F = 400\text{ A}$	$T_j = 25^\circ\text{C}$		2.2	2.52 V
	$V_{GE} = 0\text{ V}$	$T_j = 150^\circ\text{C}$		2.15	2.47 V
	chip				
V_{F0}		$T_j = 25^\circ\text{C}$		1.3	1.5 V
		$T_j = 150^\circ\text{C}$		0.9	1.1 V
r_F		$T_j = 25^\circ\text{C}$		2.3	2.5 m Ω
		$T_j = 150^\circ\text{C}$		3.1	3.4 m Ω
I_{RRM}	$I_F = 400\text{ A}$	$T_j = 150^\circ\text{C}$		450	A
Q_{rr}	$di/dt_{off} = 8800\text{ A}/\mu\text{s}$	$T_j = 150^\circ\text{C}$		68	μC
E_{rr}	$V_{GE} = \pm 15\text{ V}$	$T_j = 150^\circ\text{C}$		30.5	mJ
	$V_{CC} = 600\text{ V}$	$T_j = 150^\circ\text{C}$			
$R_{th(j-c)}$	per Diode			0.14	K/W
Module					
L_{CE}				15	20 nH
$R_{CC'+EE'}$	terminal-chip	$T_c = 25^\circ\text{C}$		0.25	m Ω
		$T_c = 125^\circ\text{C}$		0.5	m Ω
$R_{th(c-s)}$	per module			0.02	0.038 K/W
M_s	to heat sink M6		3	5	Nm
M_t		to terminals M6	2.5	5	Nm
					Nm
w				325	g



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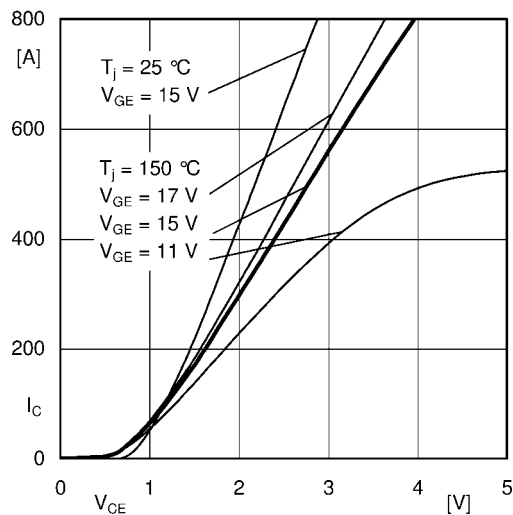


Fig. 1: Typ. output characteristic, inclusive $R_{CC'} + E_{E'}$

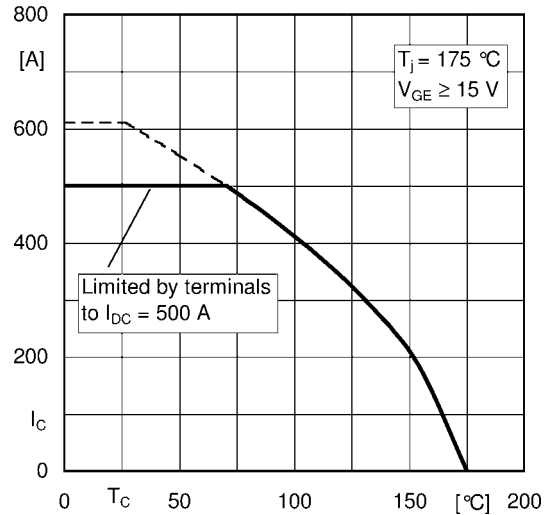


Fig. 2: Rated current vs. temperature $I_C = f(T_C)$

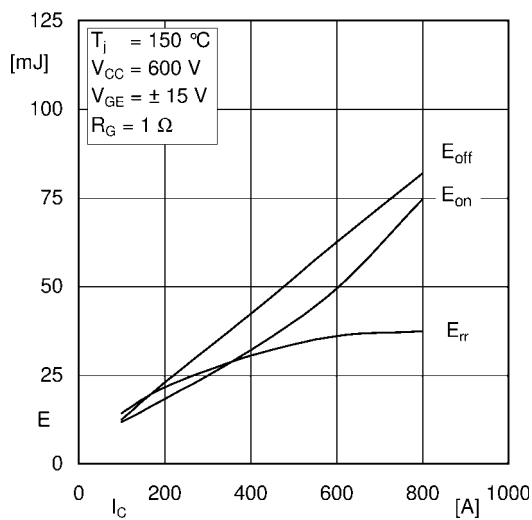


Fig. 3: Typ. turn-on /-off energy = $f(I_C)$

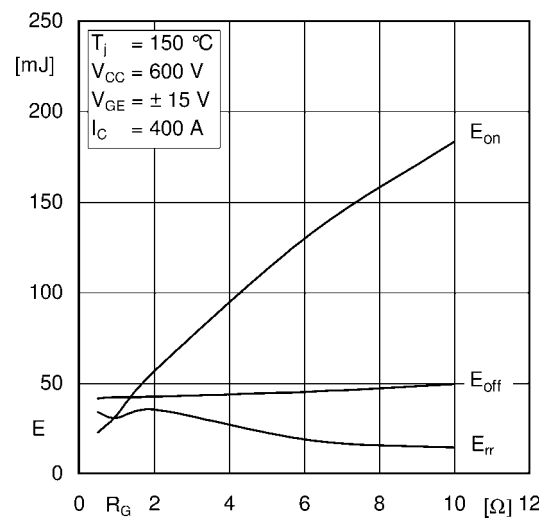


Fig. 4: Typ. turn-on /-off energy = $f(R_G)$

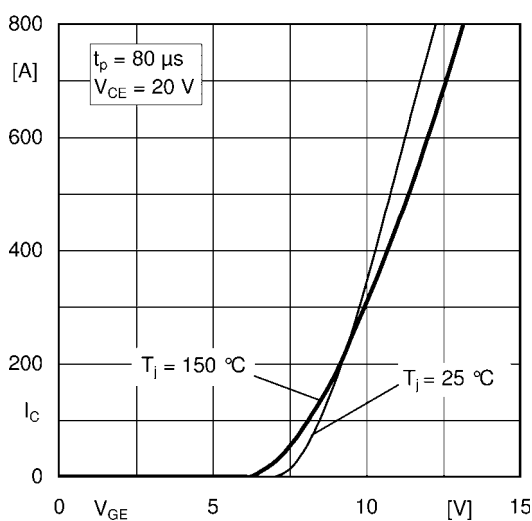


Fig. 5: Typ. transfer characteristic

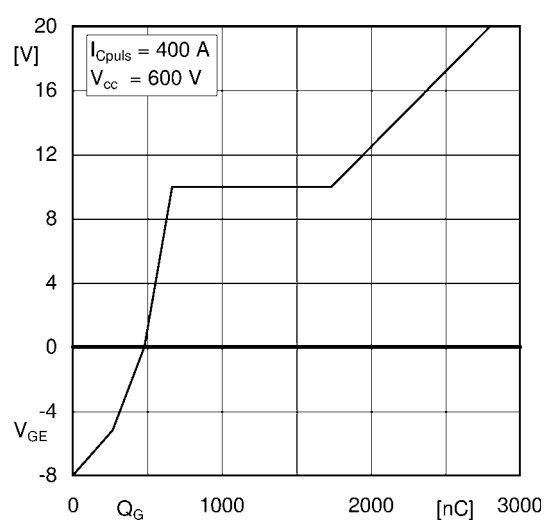


Fig. 6: Typ. gate charge characteristic

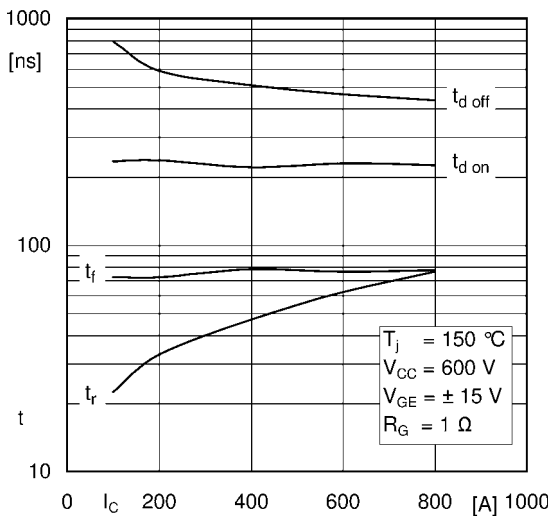


Fig. 7: Typ. switching times vs. I_C

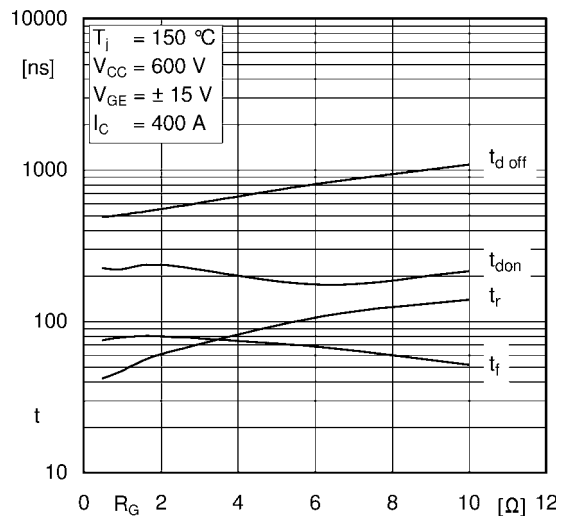


Fig. 8: Typ. switching times vs. gate resistor R_G

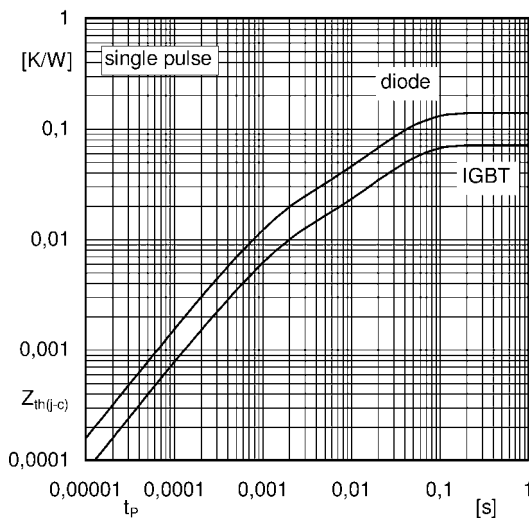


Fig. 9: Transient thermal impedance

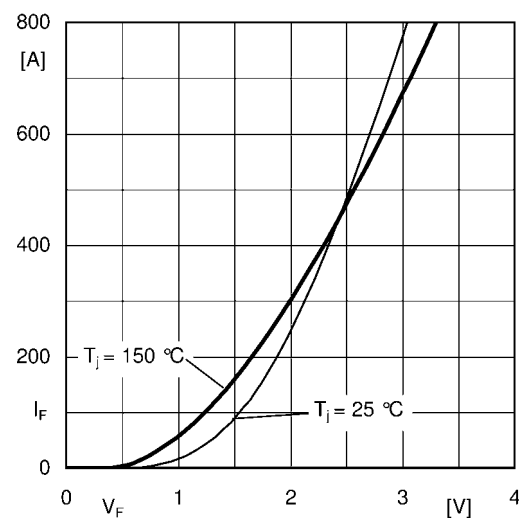


Fig. 10: CAL diode forward characteristic

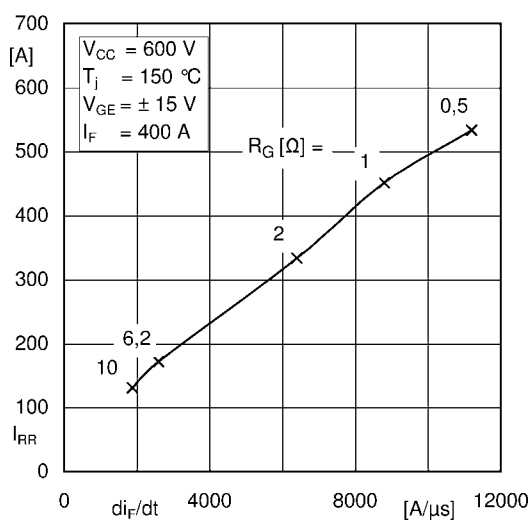


Fig. 11: CAL diode peak reverse recovery current

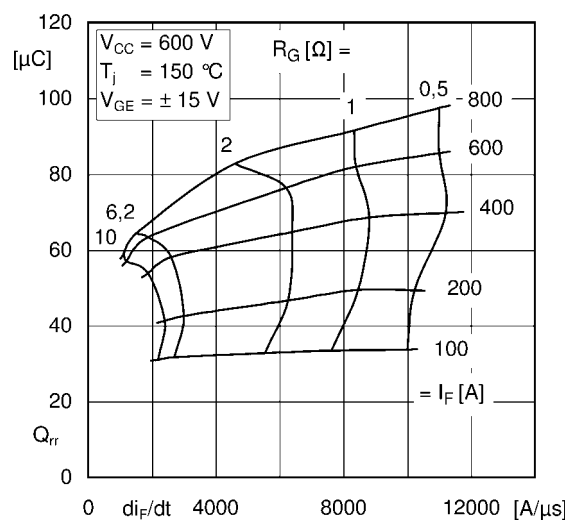
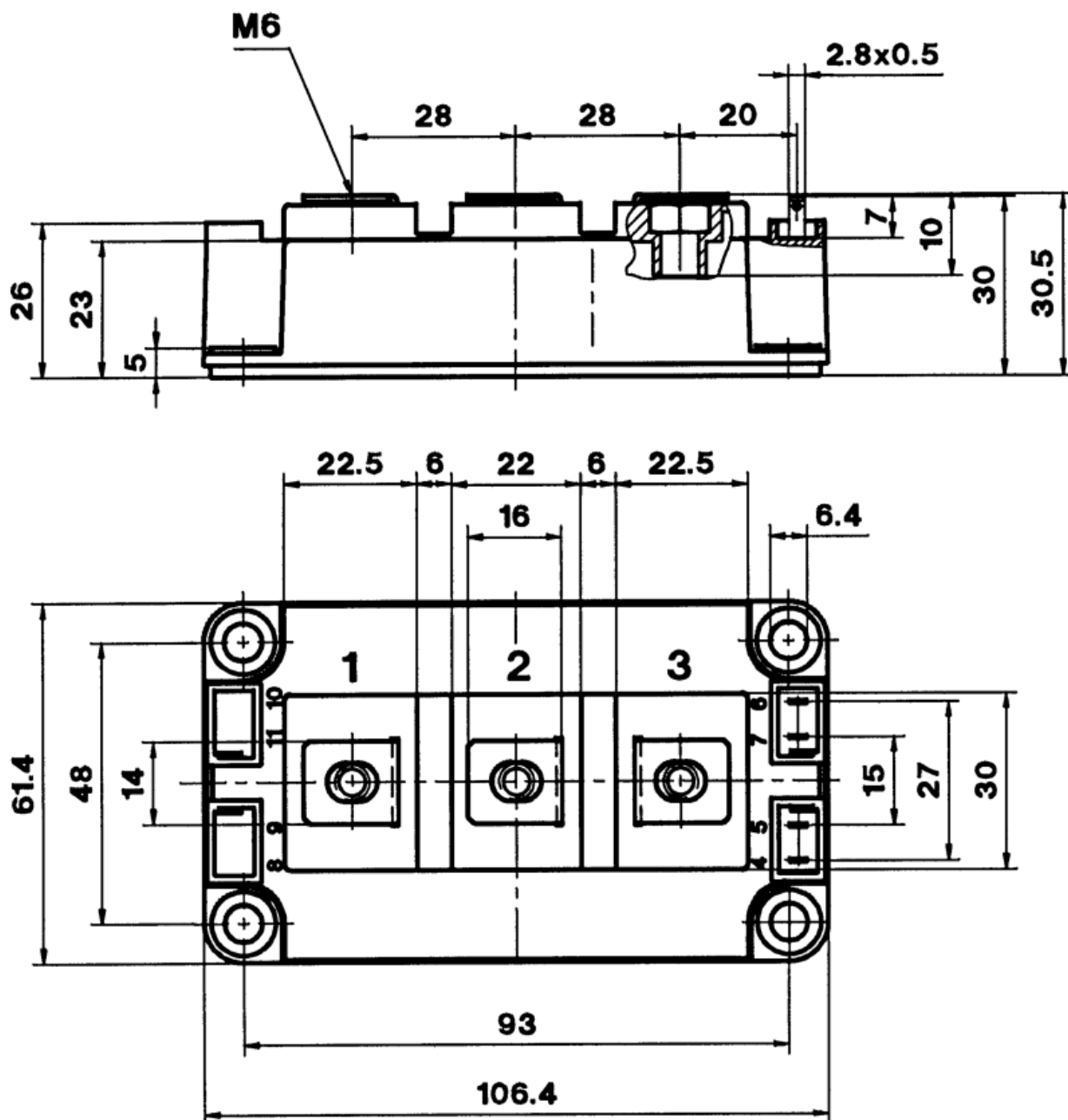
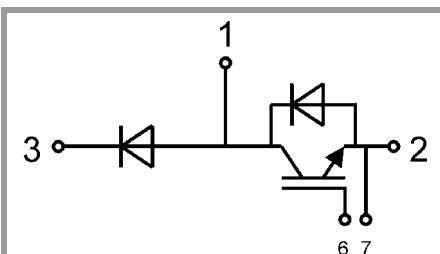


Fig. 12: Typ. CAL diode peak reverse recovery charge



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This is an electrostatic discharge sensitive device (ESDS), international standard IEC 60747-1, Chapter IX.

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