



SEMITRANS® 3

Trench IGBT Modules

SKM400GAR07E3

Features*

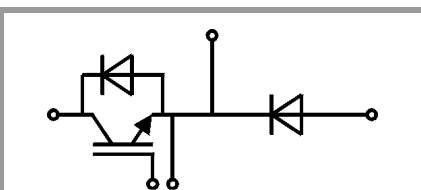
- $V_{CE(sat)}$ with positive temperature coefficient
- High short circuit capability, self limiting to $6 \times I_{Cnom}$
- Fast & soft switching inverse CAL diodes
- Insulated copper baseplate using DCB Technology (Direct Copper Bonding)
- With integrated gate resistor

Typical Applications

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

Remarks

- Case temperature limited to $T_c = 125^\circ\text{C}$ max.
- Recommended $T_{op} = -40 \dots +150^\circ\text{C}$
- Product reliability results valid for $T_j = 150^\circ\text{C}$
- Use of soft R_G necessary



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Absolute Maximum Ratings			
Symbol	Conditions	Values	Unit
IGBT			
V_{CES}	$T_j = 25^\circ\text{C}$	650	V
I_C	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	506
		$T_c = 80^\circ\text{C}$	381
I_{Cnom}		400	A
I_{CRM}	$I_{CRM} = 3 \times I_{Cnom}$	1200	A
V_{GES}		-20 ... 20	V
t_{psc}	$V_{CC} = 360\text{ V}$ $V_{GE} \leq 15\text{ V}$ $V_{CES} \leq 650\text{ V}$	$T_j = 150^\circ\text{C}$	6
T_j		-40 ... 175	$^\circ\text{C}$
Inverse diode			
V_{RRM}	$T_j = 25^\circ\text{C}$	650	V
I_F	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	447
		$T_c = 80^\circ\text{C}$	324
I_{Fnom}		400	A
I_{FRM}	$I_{FRM} = 2 \times I_{Fnom}$	800	A
I_{FSM}	$t_p = 10\text{ ms, sin } 180^\circ, T_j = 25^\circ\text{C}$	2646	A
T_j		-40 ... 175	$^\circ\text{C}$
Freewheeling diode			
V_{RRM}	$T_j = 25^\circ\text{C}$	650	V
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T_j		-40 ... 175	$^\circ\text{C}$
Module			
$I_{t(RMS)}$		500	A
T_{stg}	module without TIM	-40 ... 125	$^\circ\text{C}$
V_{isol}	AC sinus 50 Hz, $t = 1\text{ min}$	4000	V

Characteristics					
Symbol	Conditions	min.	typ.	max.	Unit
IGBT					
$V_{CE(sat)}$	$I_C = 400\text{ A}$ $V_{GE} = 15\text{ V}$ chipelevel	$T_j = 25^\circ\text{C}$	1.45	1.90	V
		$T_j = 150^\circ\text{C}$	1.70	2.10	V
V_{CE0}	chipelevel	$T_j = 25^\circ\text{C}$	0.90	1.00	V
		$T_j = 150^\circ\text{C}$	0.82	0.90	V
r_{CE}	$V_{GE} = 15\text{ V}$ chipelevel	$T_j = 25^\circ\text{C}$	1.38	2.3	$\text{m}\Omega$
		$T_j = 150^\circ\text{C}$	2.2	3.0	$\text{m}\Omega$
$V_{GE(th)}$	$V_{GE} = V_{CE}, I_C = 6.4\text{ mA}$	5.1	5.8	6.4	V
I_{CES}	$V_{GE} = 0\text{ V}, V_{CE} = 650\text{ V}, T_j = 25^\circ\text{C}$			0.3	mA
C_{ies}	$V_{CE} = 25\text{ V}$ $V_{GE} = 0\text{ V}$	$f = 1\text{ MHz}$	24.7		nF
C_{oes}		$f = 1\text{ MHz}$	1.54		nF
C_{res}		$f = 1\text{ MHz}$	0.73		nF
Q_G	$V_{GE} = -8\text{ V} \dots +15\text{ V}$		3200		nC
R_{Gint}	$T_j = 25^\circ\text{C}$		1.0		Ω



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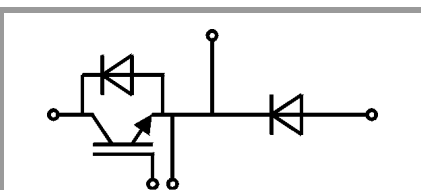
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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
IGBT						
$t_{d(on)}$	$V_{CC} = 300\text{ V}$	$T_j = 150^\circ\text{C}$		190		ns
t_r	$I_c = 400\text{ A}$	$T_j = 150^\circ\text{C}$		60		ns
E_{on}	$V_{GE} = +15/-7.5\text{ V}$	$T_j = 150^\circ\text{C}$		4		mJ
	$R_{G\ on} = 1\ \Omega$					
$t_{d(off)}$	$R_{G\ off} = 4.2\ \Omega$	$T_j = 150^\circ\text{C}$		850		ns
t_f	$di/dt_{on} = 7000\text{ A}/\mu\text{s}$	$T_j = 150^\circ\text{C}$		50		ns
	$di/dt_{off} = 5000\text{ A}/\mu\text{s}$					
E_{off}	$dv/dt = 2200\text{ V}/\mu\text{s}$	$T_j = 150^\circ\text{C}$		17		mJ
	$L_s = 18\text{ nH}$					
$R_{th(j-c)}$	per IGBT				0.12	K/W
$R_{th(c-s)}$	per IGBT ($\lambda_{grease}=0.81\text{ W}/(\text{m}^2\text{K})$)			0.04		K/W
$R_{th(c-s)}$	per IGBT, pre-applied phase change material			0.033		K/W
Inverse diode						
$V_F = V_{EC}$	$I_F = 400\text{ A}$	$T_j = 25^\circ\text{C}$		1.39	1.75	V
	$V_{GE} = 0\text{ V}$	$T_j = 150^\circ\text{C}$		1.38	1.76	V
	chipllevel					
V_{F0}		$T_j = 25^\circ\text{C}$		1.04	1.24	V
	chipllevel	$T_j = 150^\circ\text{C}$		0.85	0.99	V
r_F		$T_j = 25^\circ\text{C}$		0.88	1.30	m Ω
	chipllevel	$T_j = 150^\circ\text{C}$		1.32	1.93	m Ω
I_{RRM}	$I_F = 400\text{ A}$	$T_j = 150^\circ\text{C}$		459		A
Q_{rr}	$di/dt_{off} = 7000\text{ A}/\mu\text{s}$	$T_j = 150^\circ\text{C}$		61		μC
E_{rr}	$V_{GE} = +15/-7.5\text{ V}$	$T_j = 150^\circ\text{C}$		12		mJ
	$V_{CC} = 300\text{ V}$					
$R_{th(j-c)}$	per diode				0.191	K/W
$R_{th(c-s)}$	per diode ($\lambda_{grease}=0.81\text{ W}/(\text{m}^2\text{K})$)			0.041		K/W
$R_{th(c-s)}$	per diode, pre-applied phase change material			0.036		K/W
Freewheeling diode						
$V_F = V_{EC}$	$I_F = 400\text{ A}$	$T_j = 25^\circ\text{C}$		1.39	1.75	V
	$V_{GE} = 0\text{ V}$	$T_j = 150^\circ\text{C}$		1.38	1.76	V
	chipllevel					
V_{F0}		$T_j = 25^\circ\text{C}$		1.04	1.24	V
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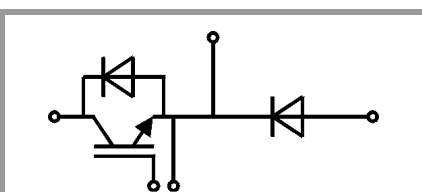
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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
Module						
L_{CE}				15		nH
$R_{CC'+EE'}$	measured per switch	$T_C = 25^\circ\text{C}$		0.55		m Ω
		$T_C = 125^\circ\text{C}$		0.85		m Ω
$R_{th(c-s)1}$	calculated without thermal coupling			0.0202		K/W
$R_{th(c-s)2}$	including thermal coupling, T_s underneath module ($\lambda_{grease}=0.81 \text{ W}/(\text{m}^*\text{K})$)			0.021		K/W
$R_{th(c-s)2}$	including thermal coupling, T_s underneath module, pre-applied phase change material			0.017		K/W
M_s	to heat sink M6		3		5	Nm
M_t					5	Nm
						Nm
w					325	g



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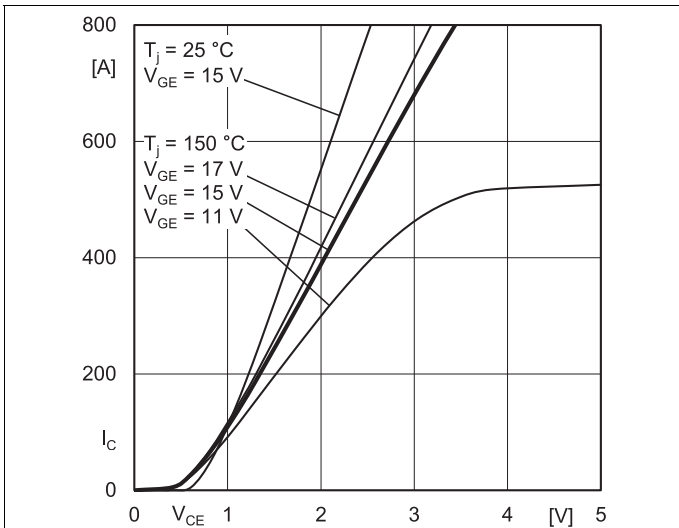


Fig. 1: Typ. output characteristic, inclusive R_{CC+EE}

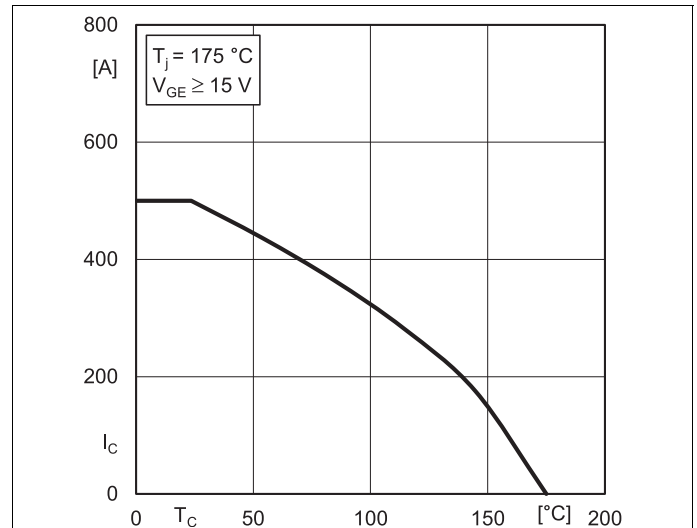


Fig. 2: Rated current vs. temperature $I_C = f(T_C)$

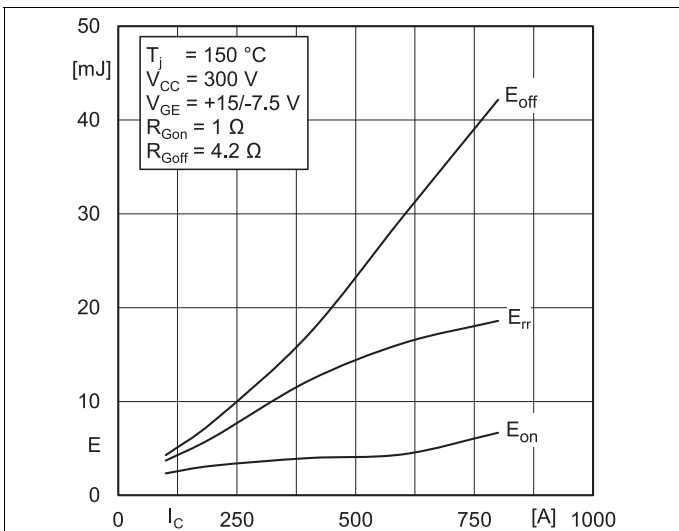


Fig. 3: Typ. turn-on /-off energy = $f(I_C)$

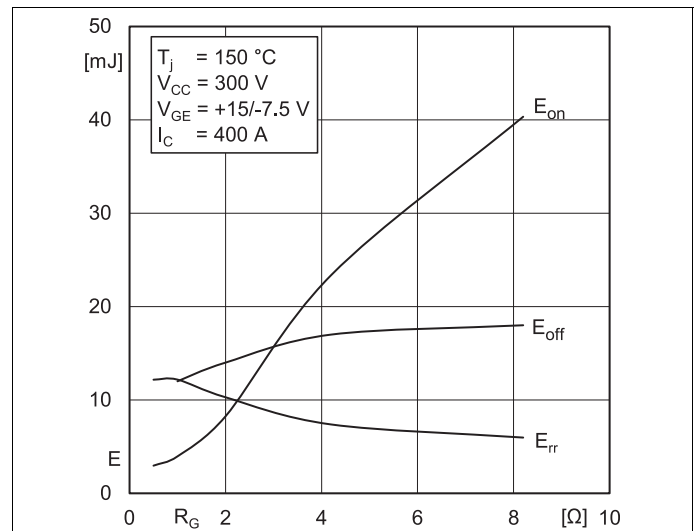


Fig. 4: Typ. turn-on /-off energy = $f(R_G)$

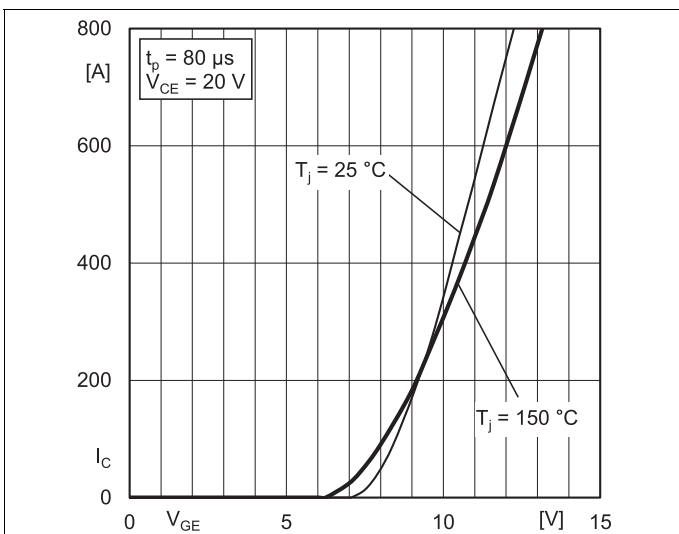


Fig. 5: Typ. transfer characteristic

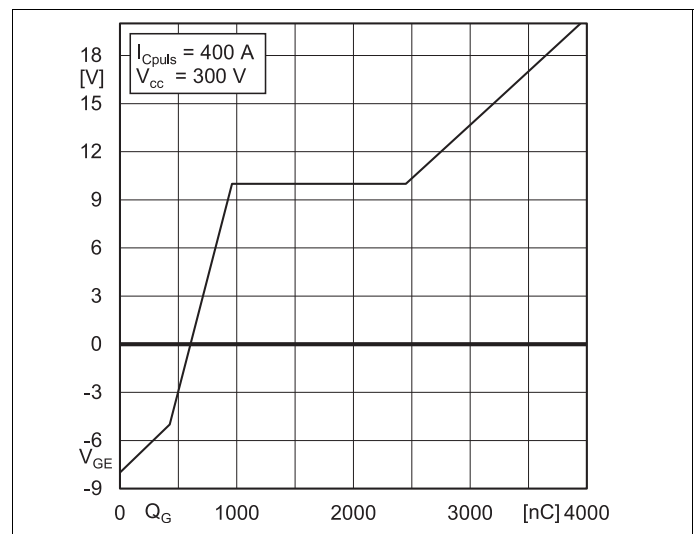


Fig. 6: Typ. gate charge characteristic

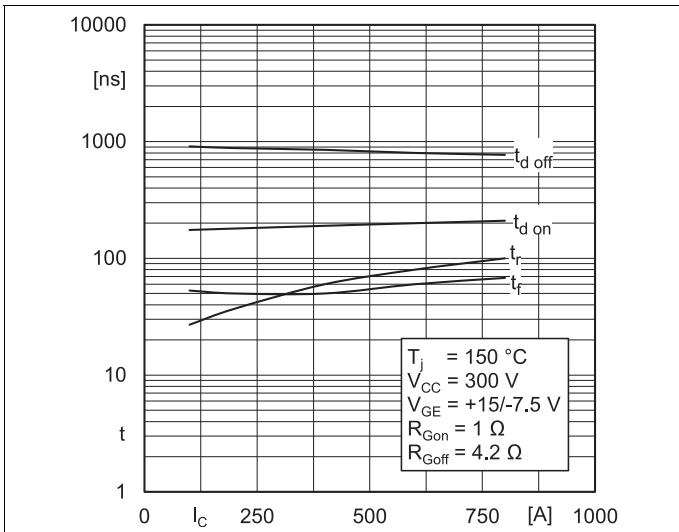


Fig. 7: Typ. switching times vs. I_C

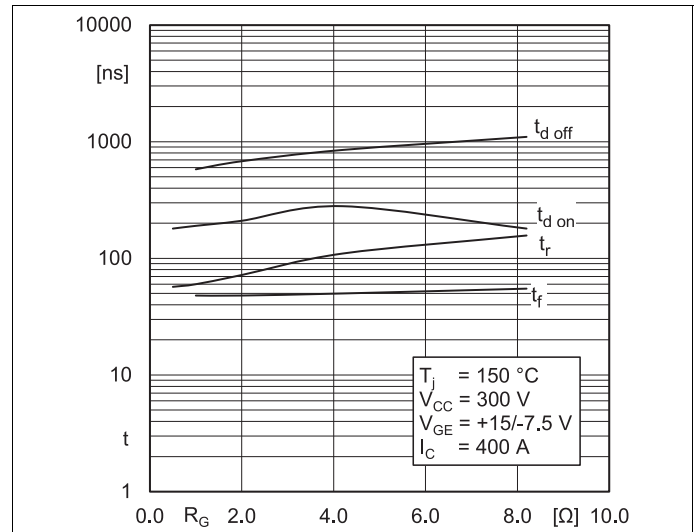


Fig. 8: Typ. switching times vs. gate resistor R_G

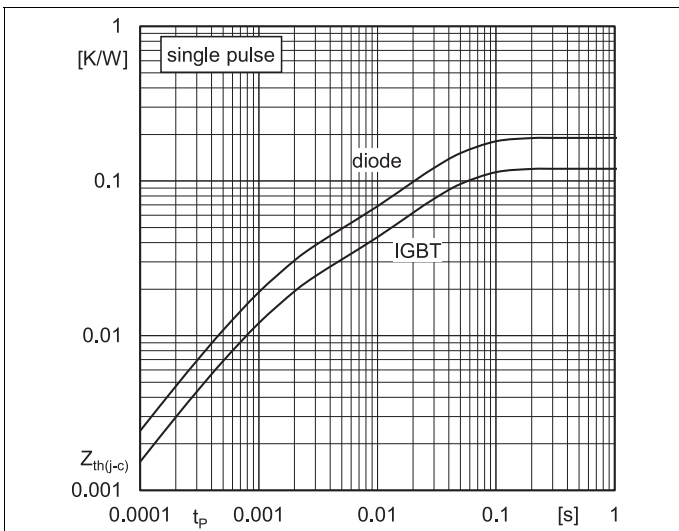


Fig. 9: Transient thermal impedance

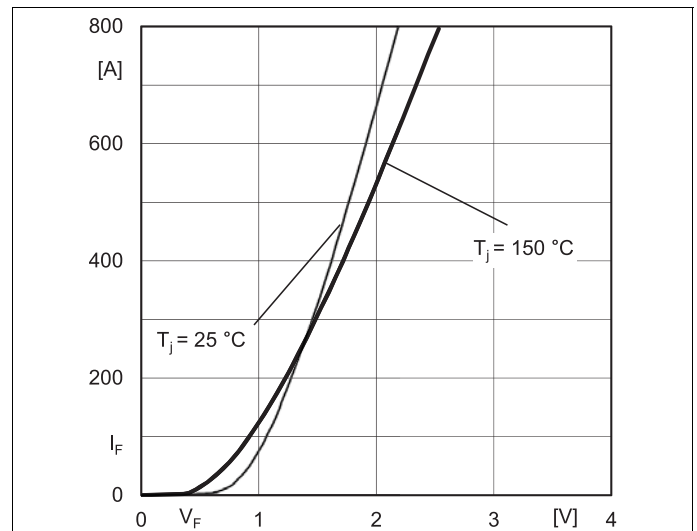


Fig. 10: Typ. CAL diode forward charact., incl. $R_{CC+EE'}$

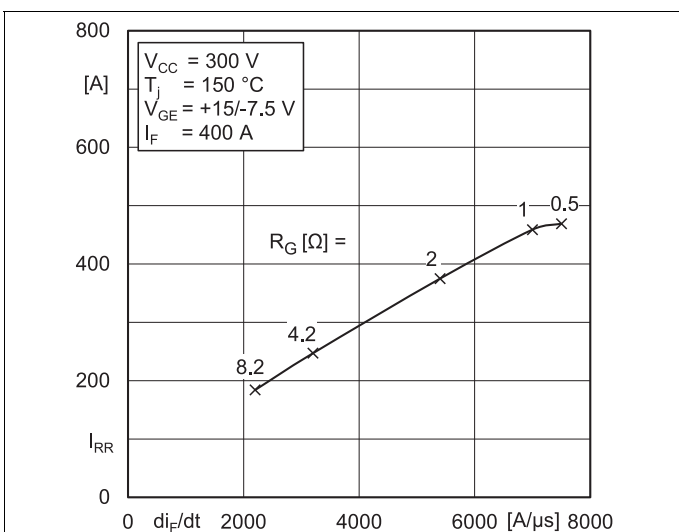


Fig. 11: Typ. CAL diode peak reverse recovery current

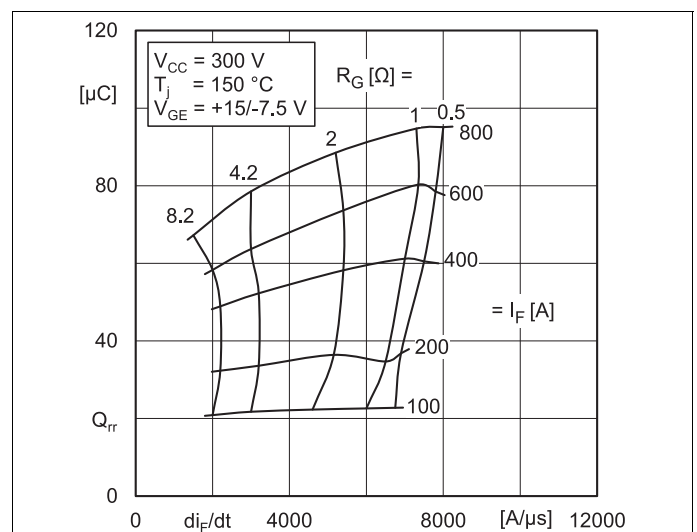
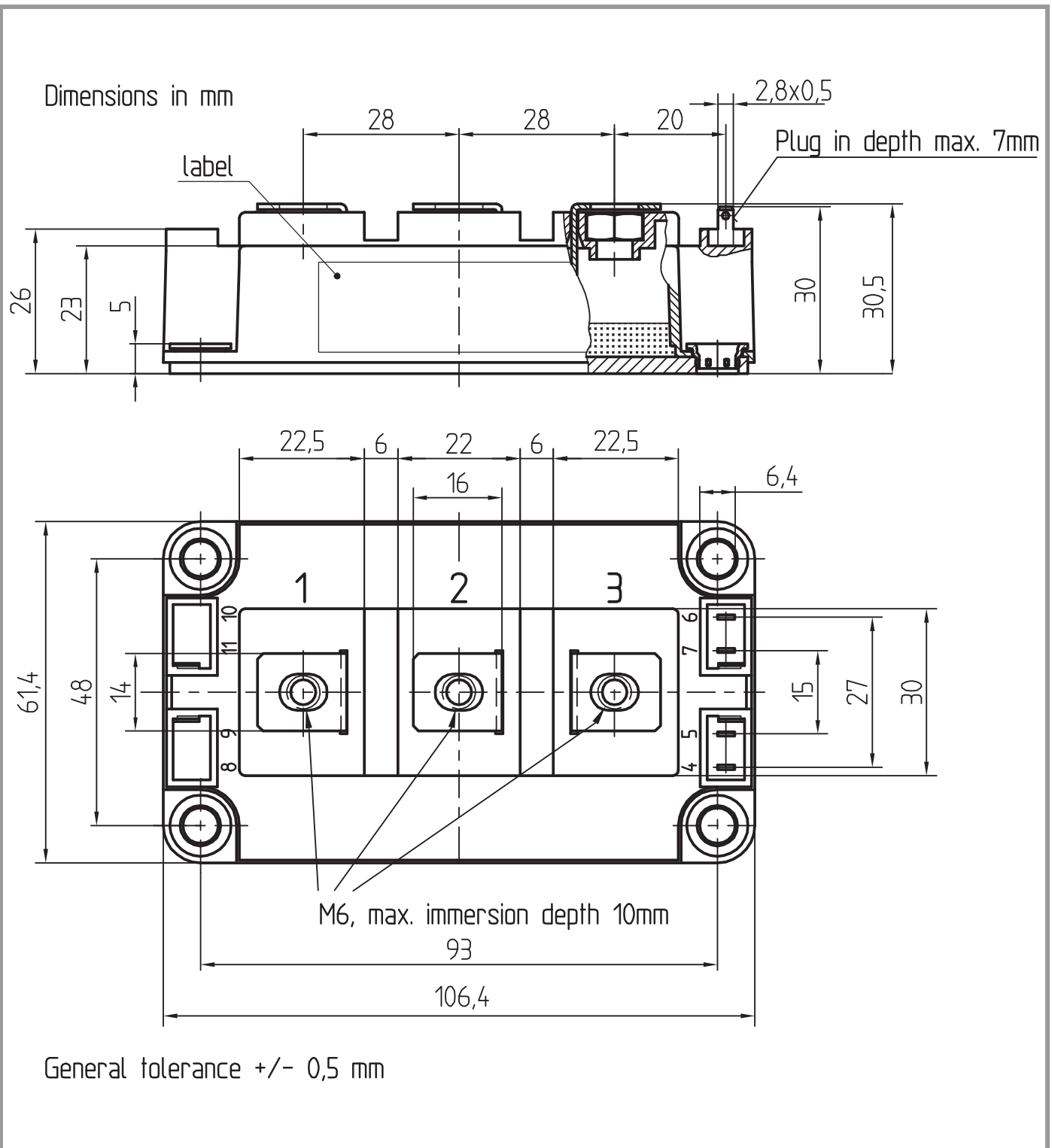
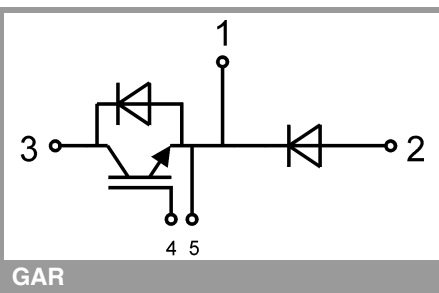


Fig. 12: Typ. CAL diode peak reverse recovery charge

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

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