

# SKM400GAL17E4



SEMITRANS® 3

## IGBT4 Modules

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#### Features\*

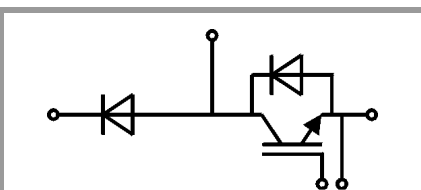
- IGBT4 = 4th generation medium fast trench IGBT (Infineon)
- CAL4 = Soft switching 4th generation CAL-Diode
- Insulated copper baseplate using DBC Technology (Direct Copper Bonding)
- With integrated Gate resistor
- For switching frequencies up to 8kHz
- UL recognized, file no. E63532

#### 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  $T_j = 150^\circ\text{C}$



GAL

Absolute Maximum Ratings				
Symbol	Conditions		Values	Unit
<b>IGBT</b>				
$V_{CES}$	$T_j = 25^\circ\text{C}$		1700	V
$I_C$	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	614	A
		$T_c = 80^\circ\text{C}$	474	A
$I_{Cnom}$			400	A
$I_{CRM}$			1200	A
$V_{GES}$			-20 ... 20	V
$t_{psc}$	$V_{CC} = 1000\text{ V}$	$T_j = 150^\circ\text{C}$	10	$\mu\text{s}$
	$V_{GE} \leq 15\text{ V}$ $V_{CES} \leq 1700\text{ V}$			
$T_j$			-40 ... 175	$^\circ\text{C}$
<b>Inverse diode</b>				
$V_{RRM}$	$T_j = 25^\circ\text{C}$		1700	V
$I_F$	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	443	A
		$T_c = 80^\circ\text{C}$	327	A
$I_{FRM}$			800	A
$I_{FSM}$	$t_p = 10\text{ ms, sin } 180^\circ, T_j = 25^\circ\text{C}$		2340	A
$T_j$			-40 ... 175	$^\circ\text{C}$
<b>Freewheeling diode</b>				
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$T_j$			-40 ... 175	$^\circ\text{C}$
<b>Module</b>				
$I_{t(RMS)}$			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
<b>IGBT</b>						
$V_{CE(sat)}$	$I_C = 400\text{ A}$ $V_{GE} = 15\text{ V}$ chipllevel	$T_j = 25^\circ\text{C}$	1.92	2.20		V
		$T_j = 150^\circ\text{C}$	2.30	2.60		V
$V_{CE0}$	chipllevel	$T_j = 25^\circ\text{C}$	0.80	0.90		V
		$T_j = 150^\circ\text{C}$	0.70	0.80		V
$r_{CE}$	$V_{GE} = 15\text{ V}$ chipllevel	$T_j = 25^\circ\text{C}$	2.8	3.3		$\text{m}\Omega$
		$T_j = 150^\circ\text{C}$	4.0	4.5		$\text{m}\Omega$
$V_{GE(th)}$	$V_{GE} = V_{CE}, I_C = 16\text{ mA}$		5.2	5.8	6.4	V
$I_{CES}$	$V_{GE} = 0\text{ V}, V_{CE} = 1700\text{ V}, T_j = 25^\circ\text{C}$				5	mA
$C_{ies}$	$V_{CE} = 25\text{ V}$ $V_{GE} = 0\text{ V}$	$f = 1\text{ MHz}$	36.0			nF
$C_{oes}$		$f = 1\text{ MHz}$	1.36			nF
$C_{res}$		$f = 1\text{ MHz}$	1.16			nF
$Q_G$	$V_{GE} = -8\text{ V} \dots +15\text{ V}$		3200			nC
$R_{Gint}$	$T_j = 25^\circ\text{C}$		1.9			$\Omega$

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- With integrated Gate resistor
- For switching frequencies up to 8kHz
- UL recognized, file no. E63532

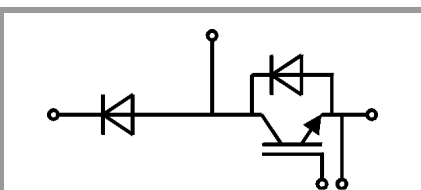
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#### Remarks

- 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  $T_j = 150^\circ\text{C}$

Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
<b>IGBT</b>						
$t_{d(on)}$	$V_{CC} = 1200\text{ V}$	$T_j = 150^\circ\text{C}$		280		ns
$t_r$	$I_c = 400\text{ A}$	$T_j = 150^\circ\text{C}$		45		ns
$E_{on}$	$V_{GE} = +15/-15\text{ V}$	$T_j = 150^\circ\text{C}$		157		mJ
$t_{d(off)}$	$R_{G\ on} = 2\ \Omega$	$T_j = 150^\circ\text{C}$		760		ns
$t_f$	$R_{G\ off} = 1\ \Omega$	$T_j = 150^\circ\text{C}$		140		ns
$E_{off}$	$di/dt_{on} = 10000\text{ A}/\mu\text{s}$ $di/dt_{off} = 2300\text{ A}/\mu\text{s}$ $dv/dt = 5600\text{ V}/\mu\text{s}$	$T_j = 150^\circ\text{C}$		180		mJ
$R_{th(j-c)}$	per IGBT				0.066	K/W
$R_{th(c-s)}$	per IGBT ( $\lambda_{grease}=0.81\text{ W}/(\text{m}^2\text{K})$ )			0.028		K/W
$R_{th(c-s)}$	per IGBT, pre-applied phase change material			0.017		K/W
<b>Inverse diode</b>						
$V_F = V_{EC}$	$I_F = 400\text{ A}$	$T_j = 25^\circ\text{C}$		2.00	2.40	V
	$V_{GE} = 0\text{ V}$ chipllevel	$T_j = 150^\circ\text{C}$		2.16	2.57	V
$V_{F0}$	chipllevel	$T_j = 25^\circ\text{C}$		1.32	1.56	V
		$T_j = 150^\circ\text{C}$		1.08	1.22	V
$r_F$	chipllevel	$T_j = 25^\circ\text{C}$		1.71	2.1	m $\Omega$
		$T_j = 150^\circ\text{C}$		2.7	3.4	m $\Omega$
$I_{RRM}$	$I_F = 400\text{ A}$	$T_j = 150^\circ\text{C}$		615		A
$Q_{rr}$	$di/dt_{off} = 10100\text{ A}/\mu\text{s}$	$T_j = 150^\circ\text{C}$		150		$\mu\text{C}$
$E_{rr}$	$V_{GE} = -15\text{ V}$ $V_{CC} = 1200\text{ V}$	$T_j = 150^\circ\text{C}$		130		mJ
$R_{th(j-c)}$	per diode				0.13	K/W
$R_{th(c-s)}$	per diode ( $\lambda_{grease}=0.81\text{ W}/(\text{m}^2\text{K})$ )			0.038		K/W
$R_{th(c-s)}$	per diode, pre-applied phase change material			0.032		K/W
<b>Freewheeling diode</b>						
$V_F = V_{EC}$	$I_F = 400\text{ A}$	$T_j = 25^\circ\text{C}$		2.00	2.40	V
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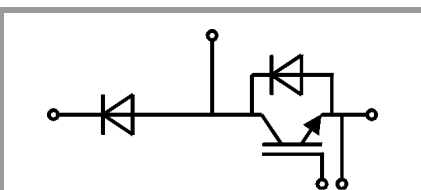
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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
<b>Module</b>						
$L_{CE}$				15		nH
$R_{CC'+EE'}$	measured per switch	$T_C = 25^\circ\text{C}$		0.55		m $\Omega$
		$T_C = 125^\circ\text{C}$		0.85		m $\Omega$
$R_{th(c-s)1}$	calculated without thermal coupling			0.0161		K/W
	including thermal coupling, $T_s$ underneath module ( $\lambda_{grease}=0.81 \text{ W}/(\text{m}^*\text{K})$ )			0.018		K/W
$R_{th(c-s)2}$	including thermal coupling, $T_s$ underneath module, pre-applied phase change material			0.012		K/W
$M_s$	to heat sink M6		3		5	Nm
$M_t$	to terminals M6				5	Nm
						Nm
$w$					325	g



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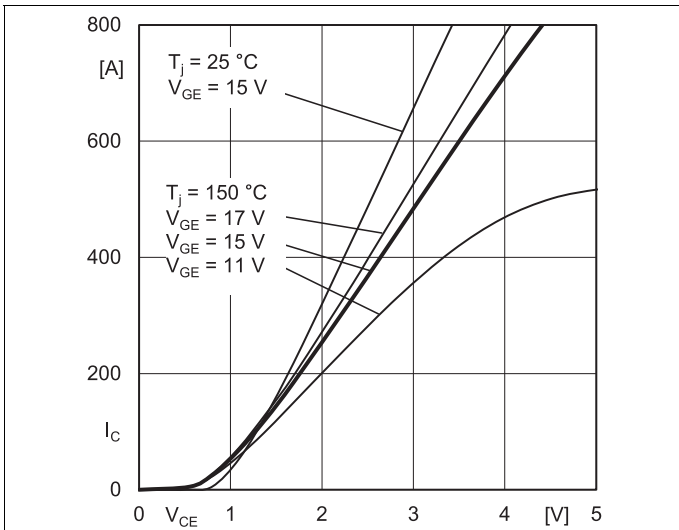


Fig. 1: Typ. output characteristic, inclusive R<sub>CC+EE</sub>

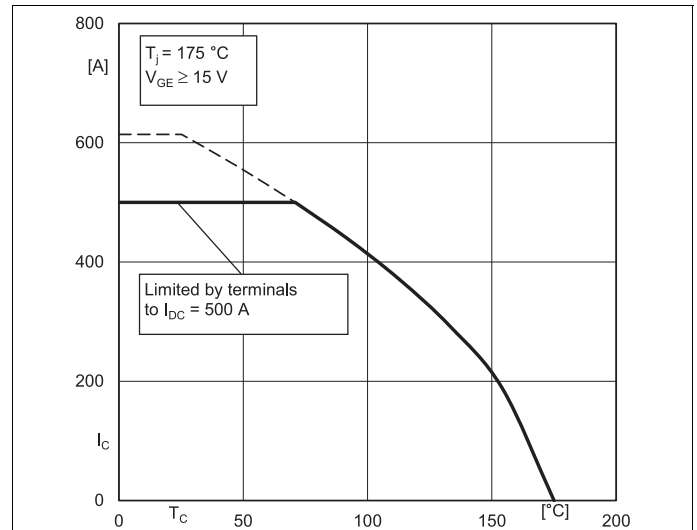


Fig. 2: Rated current vs. temperature I<sub>C</sub> = f(T<sub>C</sub>)

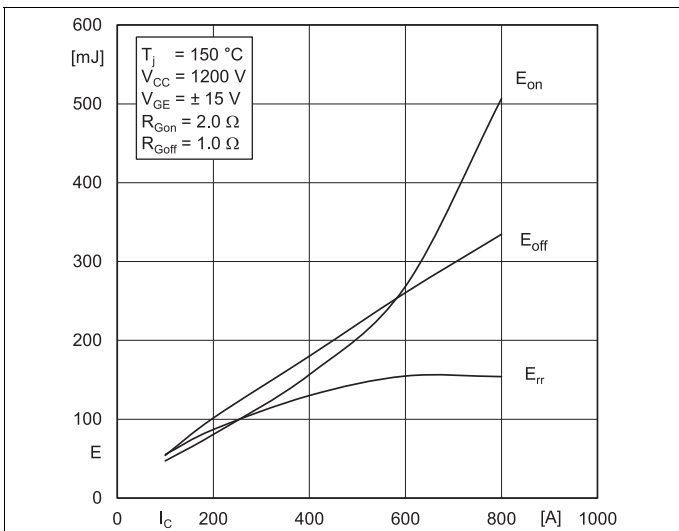


Fig. 3: Typ. turn-on /-off energy = f(I<sub>C</sub>)

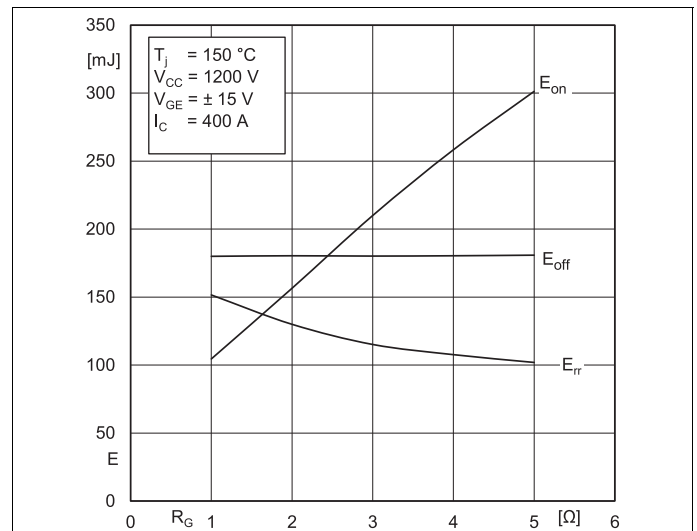


Fig. 4: Typ. turn-on /-off energy = f(R<sub>G</sub>)

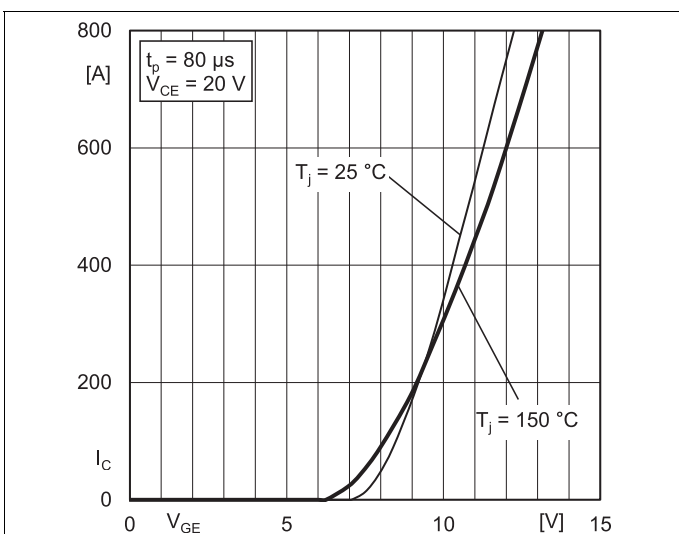


Fig. 5: Typ. transfer characteristic

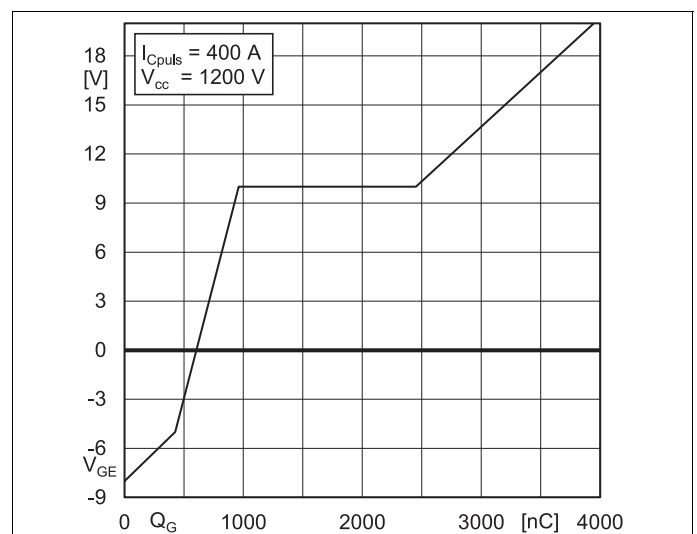


Fig. 6: Typ. gate charge characteristic

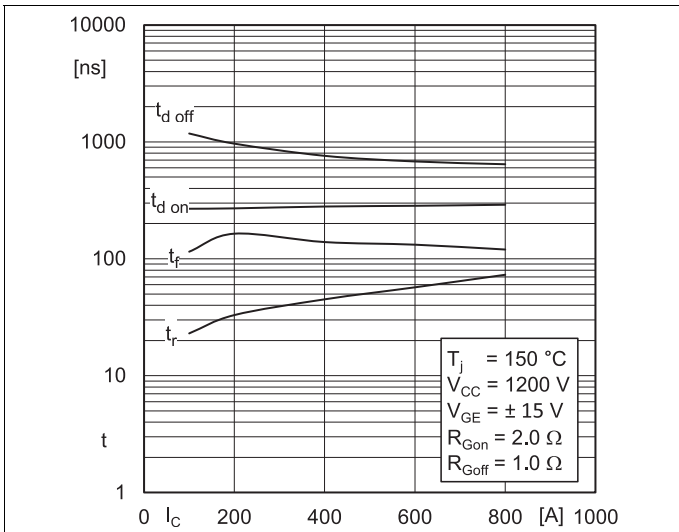


Fig. 7: Typ. switching times vs.  $I_C$

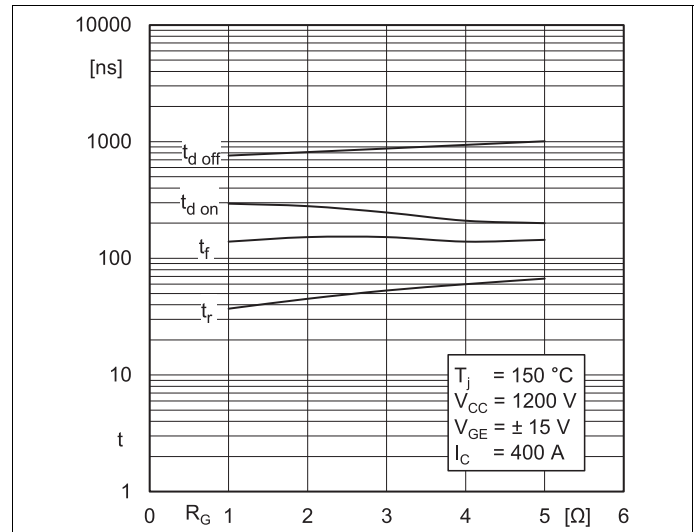


Fig. 8: Typ. switching times vs. gate resistor  $R_G$

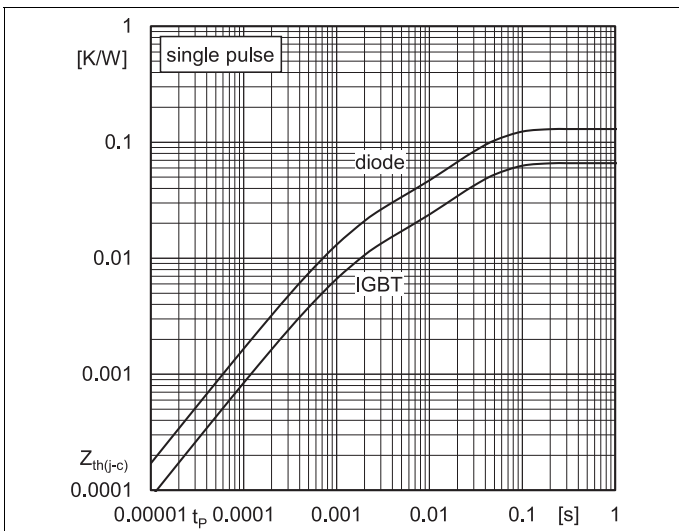


Fig. 9: Transient thermal impedance

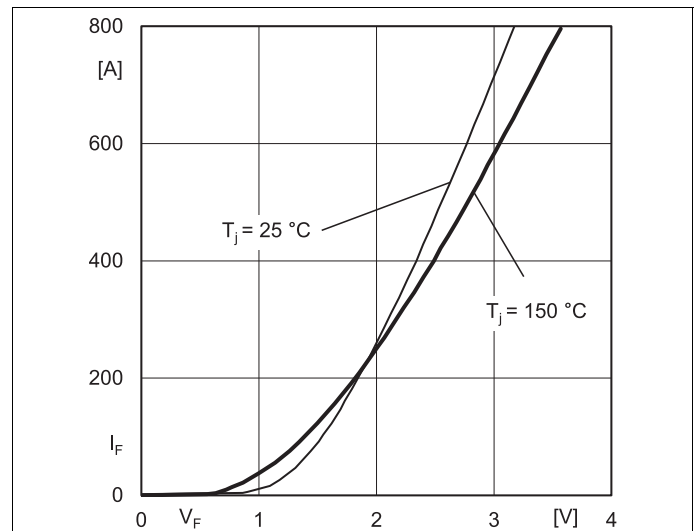


Fig. 10: Typ. CAL diode forward charact., incl.  $R_{CC+EE}$

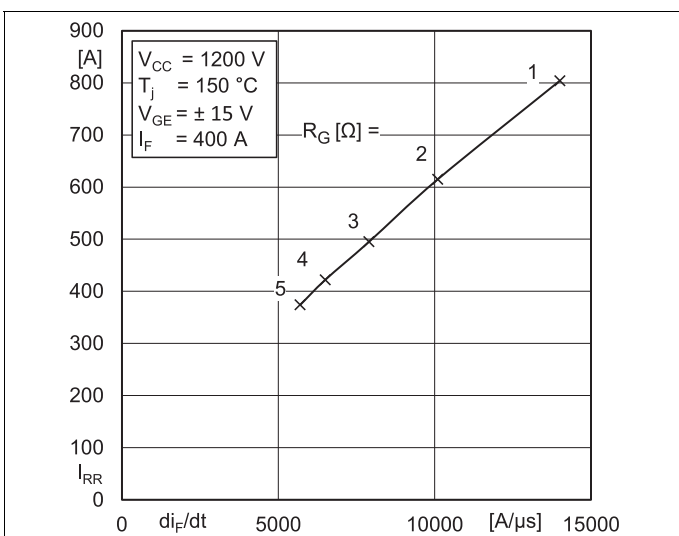


Fig. 11: Typ. CAL diode peak reverse recovery current

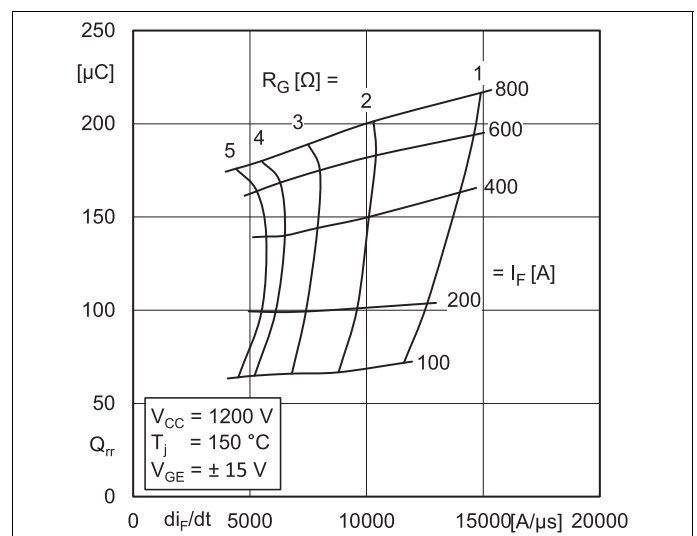
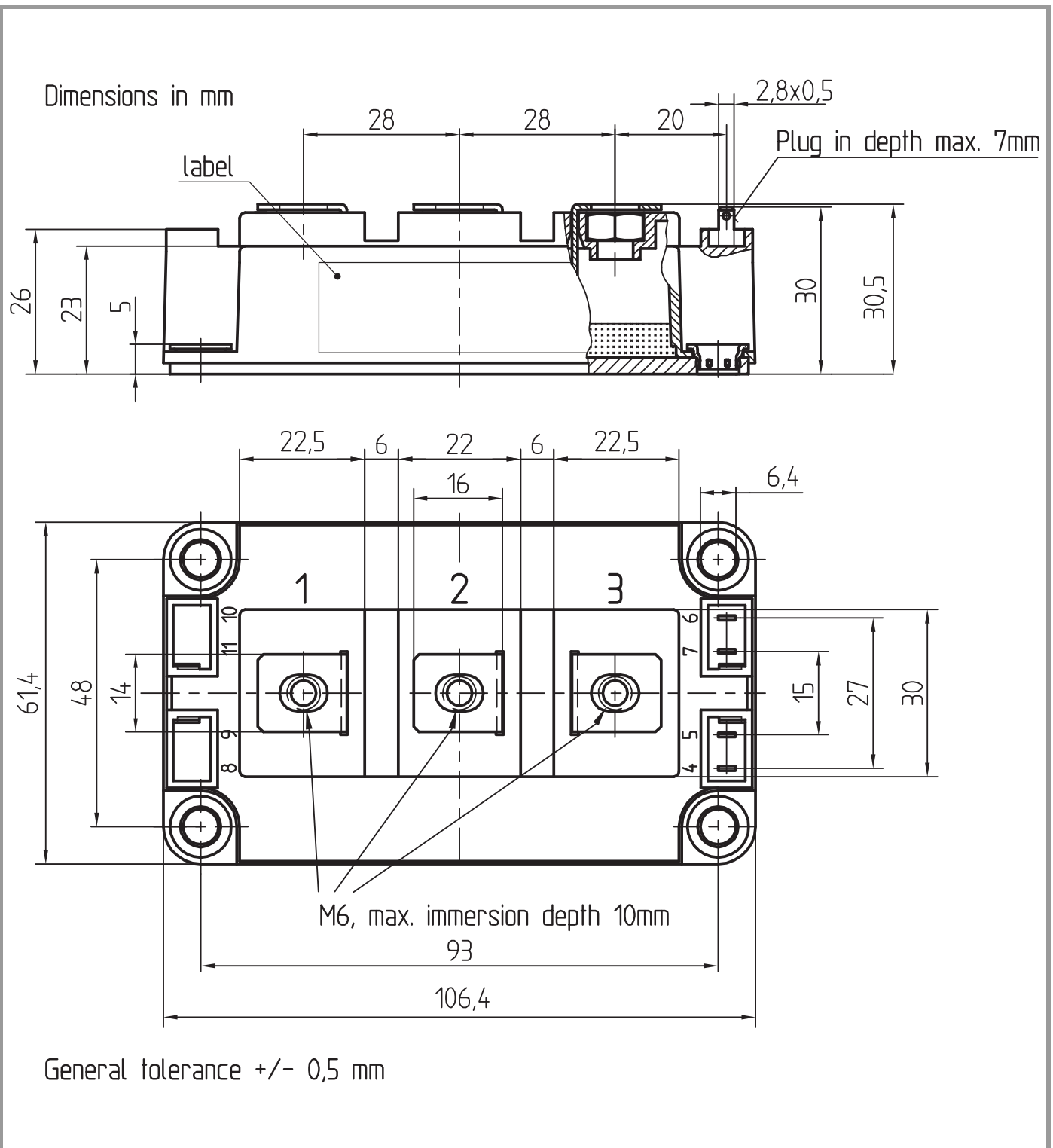
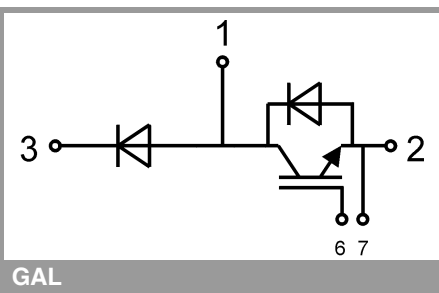


Fig. 12: Typ. CAL diode peak reverse recovery charge

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This is an electrostatic discharge sensitive device (ESDS) due to international standard IEC 61340.

## **\*IMPORTANT INFORMATION AND WARNINGS**

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