

# SKM400GB12F4



## SEMITRANS® 3

### High Speed IGBT4 Modules

#### SKM400GB12F4

##### Features\*

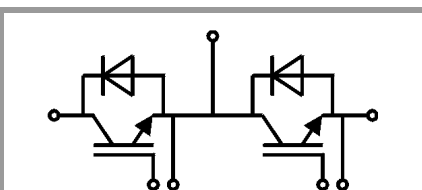
- High speed trench and field-stop IGBT
- CAL4 ultra-fast = soft switching 4. generation CAL-diode
- Insulated copper baseplate using DBC technology (Direct Bonded Copper)
- Increased power cycling capability
- For higher switching frequencies above 15kHz
- UL recognized, file no. E63532

##### Typical Applications

- UPS
- Electronic welders
- Inductive heating
- Switched mode power supplies

##### Remarks

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



GB

Absolute Maximum Ratings			
Symbol	Conditions	Values	Unit
<b>IGBT</b>			
$V_{CES}$	$T_j = 25^\circ\text{C}$	1200	V
$I_C$	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	566
		$T_c = 80^\circ\text{C}$	432
$I_{Cnom}$		400	A
$I_{CRM}$		800	A
$V_{GES}$		-20 ... 20	V
$t_{psc}$	$V_{CC} = 800\text{ V}$ $V_{GE} \leq 15\text{ V}$ $V_{CES} \leq 1200\text{ V}$ $R_{G\ on/off} \geq 3\ \Omega$	$T_j = 150^\circ\text{C}$	10
$T_j$		-40 ... 175	$^\circ\text{C}$
<b>Inverse diode</b>			
$V_{RRM}$	$T_j = 25^\circ\text{C}$	1200	V
$I_F$	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	402
		$T_c = 80^\circ\text{C}$	295
$I_{FRM}$		800	A
$I_{FSM}$	$t_p = 10\text{ ms, sin } 180^\circ, T_j = 25^\circ\text{C}$	1980	A
$T_j$		-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>					
$V_{CE(sat)}$	$I_C = 400\text{ A}$ $V_{GE} = 15\text{ V}$ chipelevel	$T_j = 25^\circ\text{C}$	2.06	2.44	V
		$T_j = 150^\circ\text{C}$	2.59	2.97	V
$V_{CE0}$	chipelevel	$T_j = 25^\circ\text{C}$	1.10	1.28	V
		$T_j = 150^\circ\text{C}$	0.95	1.13	V
$r_{CE}$	$V_{GE} = 15\text{ V}$ chipelevel	$T_j = 25^\circ\text{C}$	2.4	2.9	$\text{m}\Omega$
		$T_j = 150^\circ\text{C}$	4.1	4.6	$\text{m}\Omega$
$V_{GE(th)}$	$V_{GE} = V_{CE}, I_C = 15.2\text{ mA}$	5.1	5.8	6.4	V
$I_{CES}$	$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}, T_j = 25^\circ\text{C}$			5	mA
$C_{ies}$	$V_{CE} = 25\text{ V}$ $V_{GE} = 0\text{ V}$	$f = 1\text{ MHz}$	24.6		nF
$C_{oes}$		$f = 1\text{ MHz}$	1.62		nF
$C_{res}$		$f = 1\text{ MHz}$	1.38		nF
$Q_G$	$V_{GE} = -8\text{ V} \dots +15\text{ V}$		2268		nC
$R_{Gint}$	$T_j = 25^\circ\text{C}$		1.6		$\Omega$
$t_{d(on)}$	$V_{CC} = 600\text{ V}$	$T_j = 150^\circ\text{C}$	110		ns
$t_r$	$I_C = 400\text{ A}$ $V_{GE} = +15/-15\text{ V}$	$T_j = 150^\circ\text{C}$	55		ns
		$T_j = 150^\circ\text{C}$	28		mJ
$E_{on}$	$R_{G\ on} = 2\ \Omega$	$T_j = 150^\circ\text{C}$			mJ
$t_{d(off)}$	$R_{G\ off} = 1\ \Omega$	$T_j = 150^\circ\text{C}$	415		ns
$t_f$	$di/dt_{on} = 7960\text{ A}/\mu\text{s}$ $di/dt_{off} = 4430\text{ A}/\mu\text{s}$	$T_j = 150^\circ\text{C}$	75		ns
		$T_j = 150^\circ\text{C}$			mJ
$E_{off}$	$dv/dt = 4530\text{ V}/\mu\text{s}$	$T_j = 150^\circ\text{C}$	32		mJ
$R_{th(j-c)}$	per IGBT			0.068	K/W
$R_{th(c-s)}$	per IGBT ( $\lambda_{grease} = 0.81\text{ W}/(\text{m}^2\text{K})$ )			0.041	K/W



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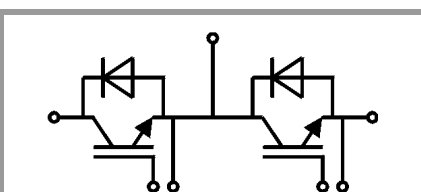
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#### Remarks

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

Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
<b>Inverse diode</b>						
$V_F = V_{EC}$	$I_F = 400\text{ A}$ $V_{GE} = 0\text{ V}$ chipllevel	$T_j = 25^\circ\text{C}$		2.55	2.93	V
		$T_j = 150^\circ\text{C}$		2.44	2.80	V
$V_{F0}$	chipllevel	$T_j = 25^\circ\text{C}$		1.51	1.75	V
		$T_j = 150^\circ\text{C}$		1.16	1.40	V
$r_F$	chipllevel	$T_j = 25^\circ\text{C}$		2.6	2.9	m $\Omega$
		$T_j = 150^\circ\text{C}$		3.2	3.5	m $\Omega$
$I_{RRM}$	$I_F = 400\text{ A}$	$T_j = 150^\circ\text{C}$		424		A
$Q_{rr}$	$di/dt_{off} = 7183\text{ A}/\mu\text{s}$	$T_j = 150^\circ\text{C}$		51		$\mu\text{C}$
$E_{rr}$	$V_{GE} = -15\text{ V}$ $V_{CC} = 600\text{ V}$	$T_j = 150^\circ\text{C}$		18.5		mJ
$R_{th(j-c)}$	per diode				0.14	K/W
$R_{th(c-s)}$	per diode ( $\lambda_{grease}=0.81\text{ W}/(\text{m}^*\text{K})$ )			0.047		K/W
<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			0.0109		K/W
$R_{th(c-s)2}$	including thermal coupling, $T_s$ underneath module ( $\lambda_{grease}=0.81\text{ W}/(\text{m}^*\text{K})$ )			0.017		K/W
$M_s$	to heat sink M6		3		5	Nm
$M_t$			2.5		5	Nm
	to terminals M6					Nm
$w$					325	g



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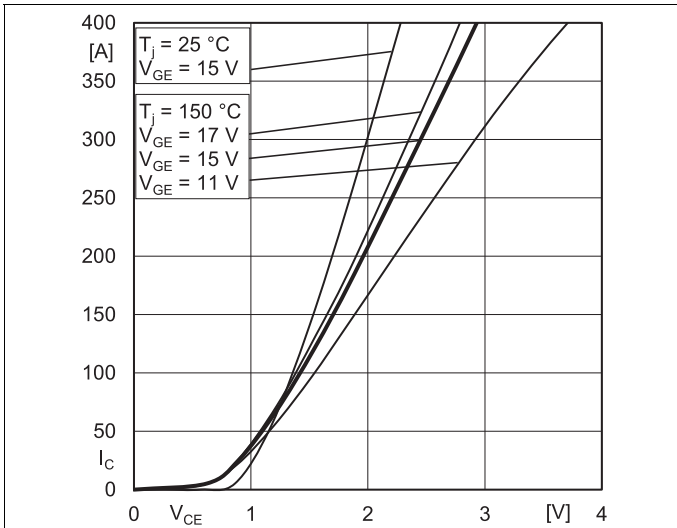


Fig. 1: Typ. output characteristic, inclusive  $R_{CC+EE}$

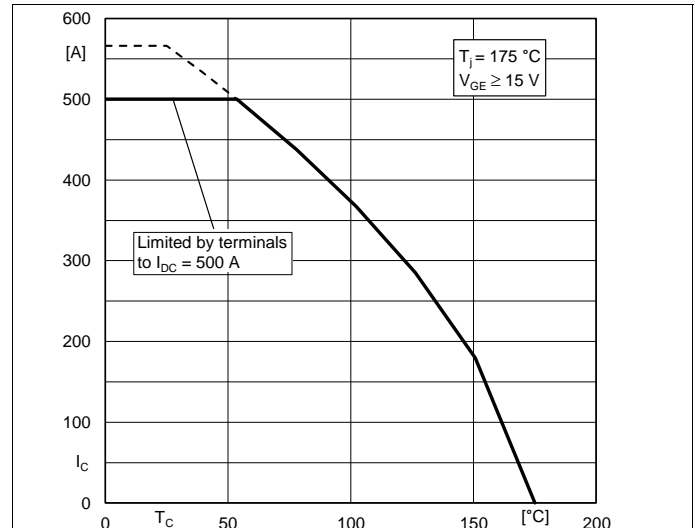


Fig. 2: Rated current vs. temperature  $I_C = f(T_C)$

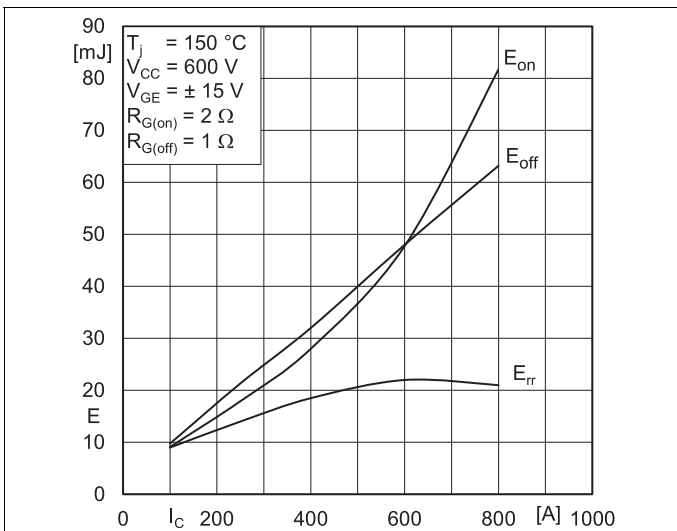


Fig. 3: Typ. turn-on /-off energy =  $f(I_C)$

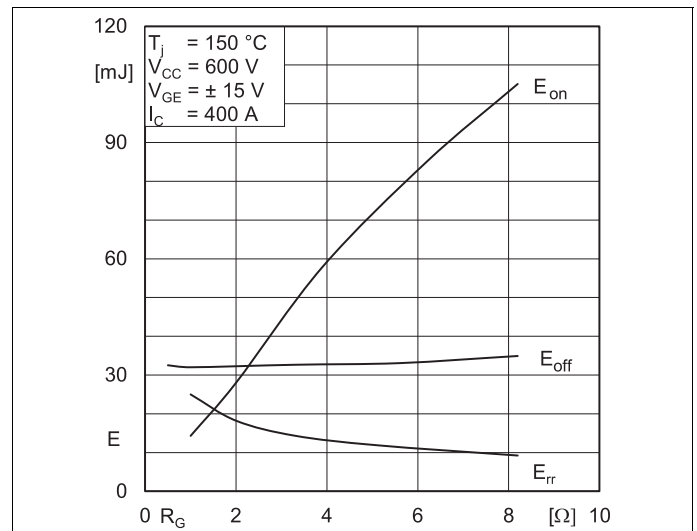


Fig. 4: Typ. turn-on /-off energy =  $f(R_G)$

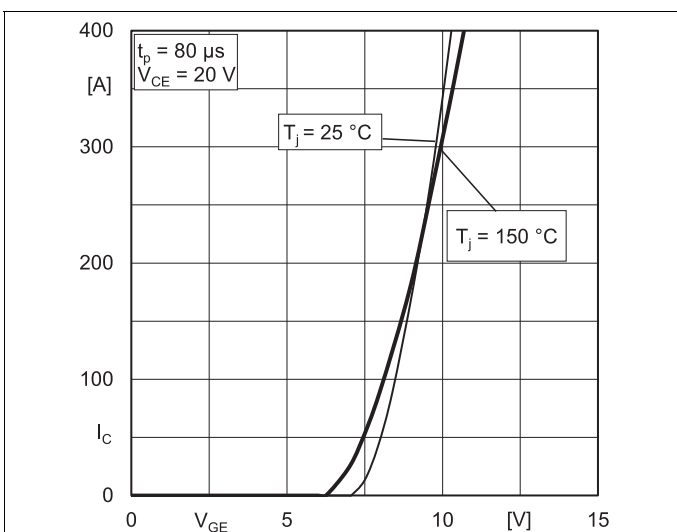


Fig. 5: Typ. transfer characteristic

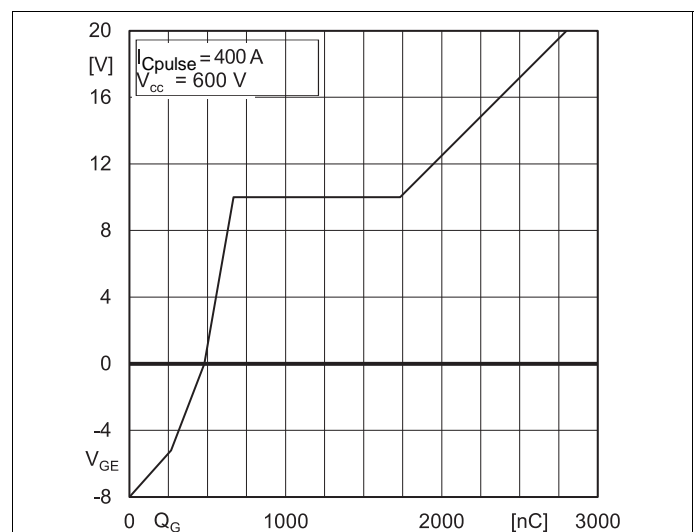


Fig. 6: Typ. gate charge characteristic

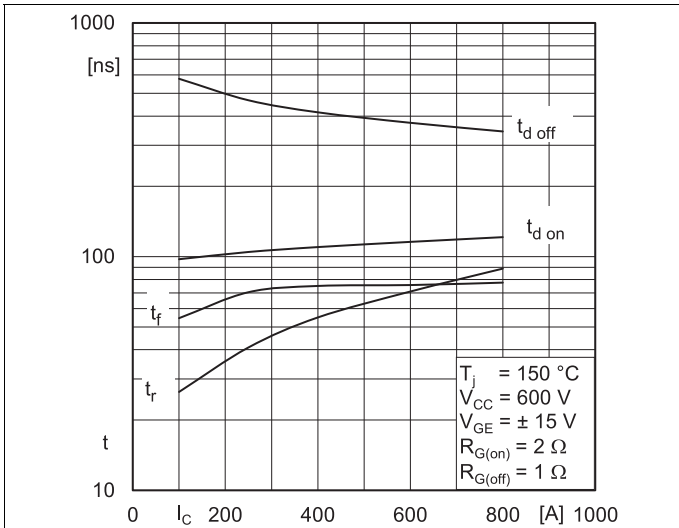


Fig. 7: Typ. switching times vs.  $I_C$

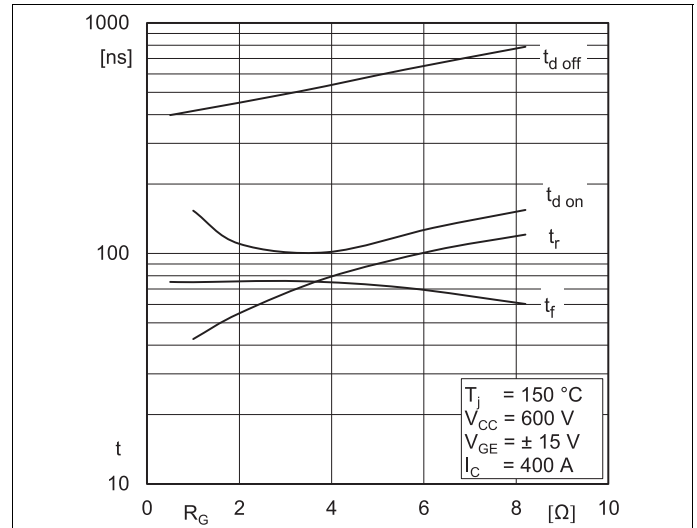


Fig. 8: Typ. switching times vs. gate resistor  $R_G$

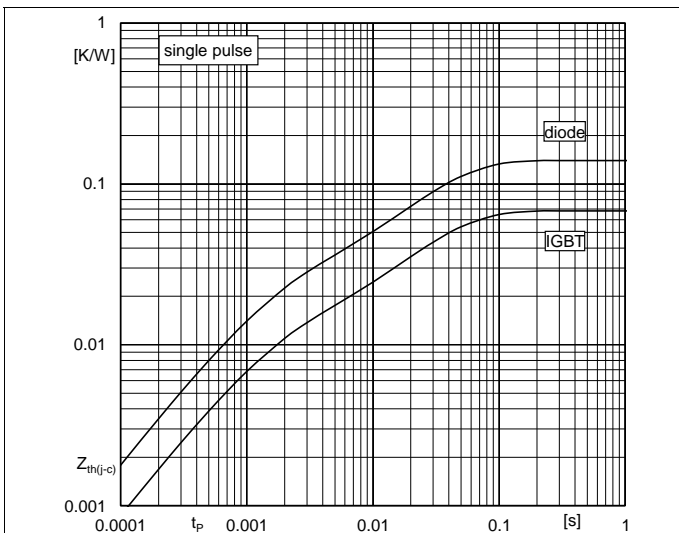


Fig. 9: Transient thermal impedance

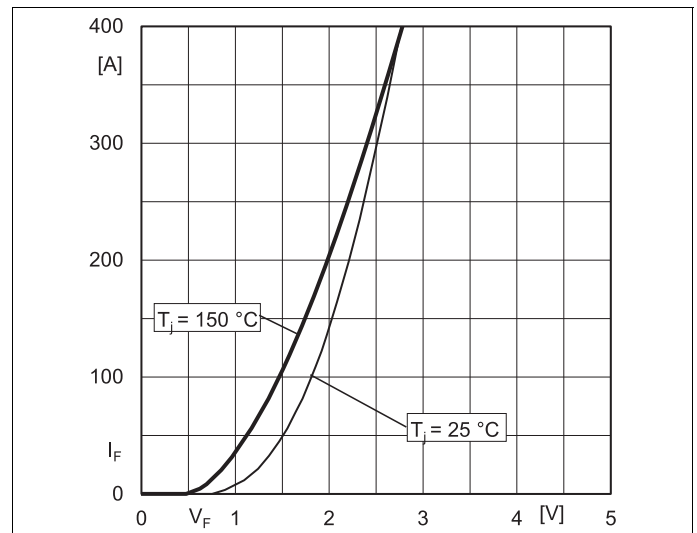


Fig. 10: Typ. CAL diode forward charact., incl.  $R_{CC+EE'}$

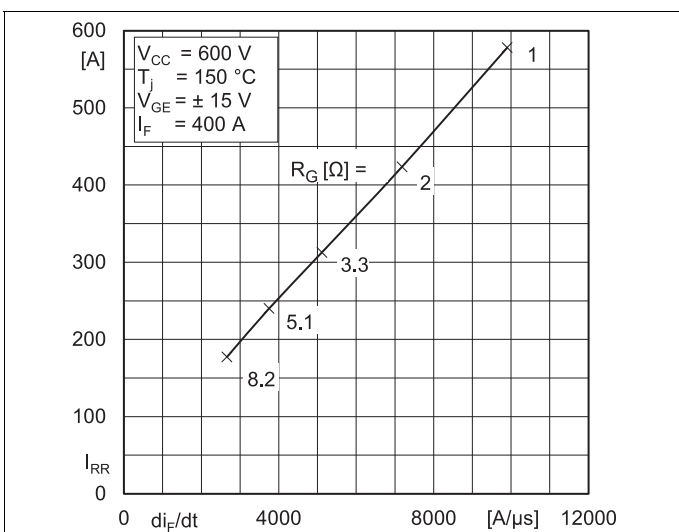


Fig. 11: Typ. CAL diode peak reverse recovery current

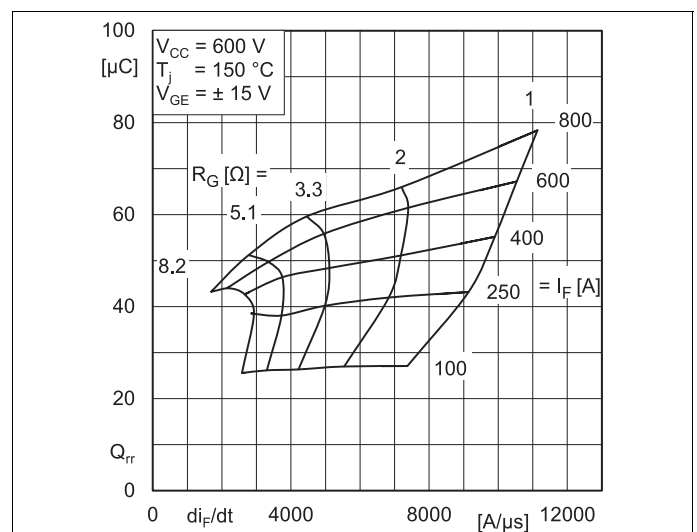


Fig. 12: Typ. CAL diode peak reverse recovery charge

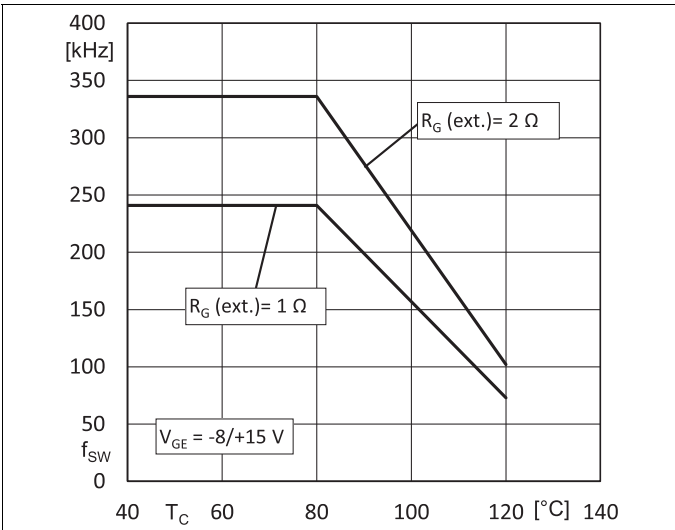
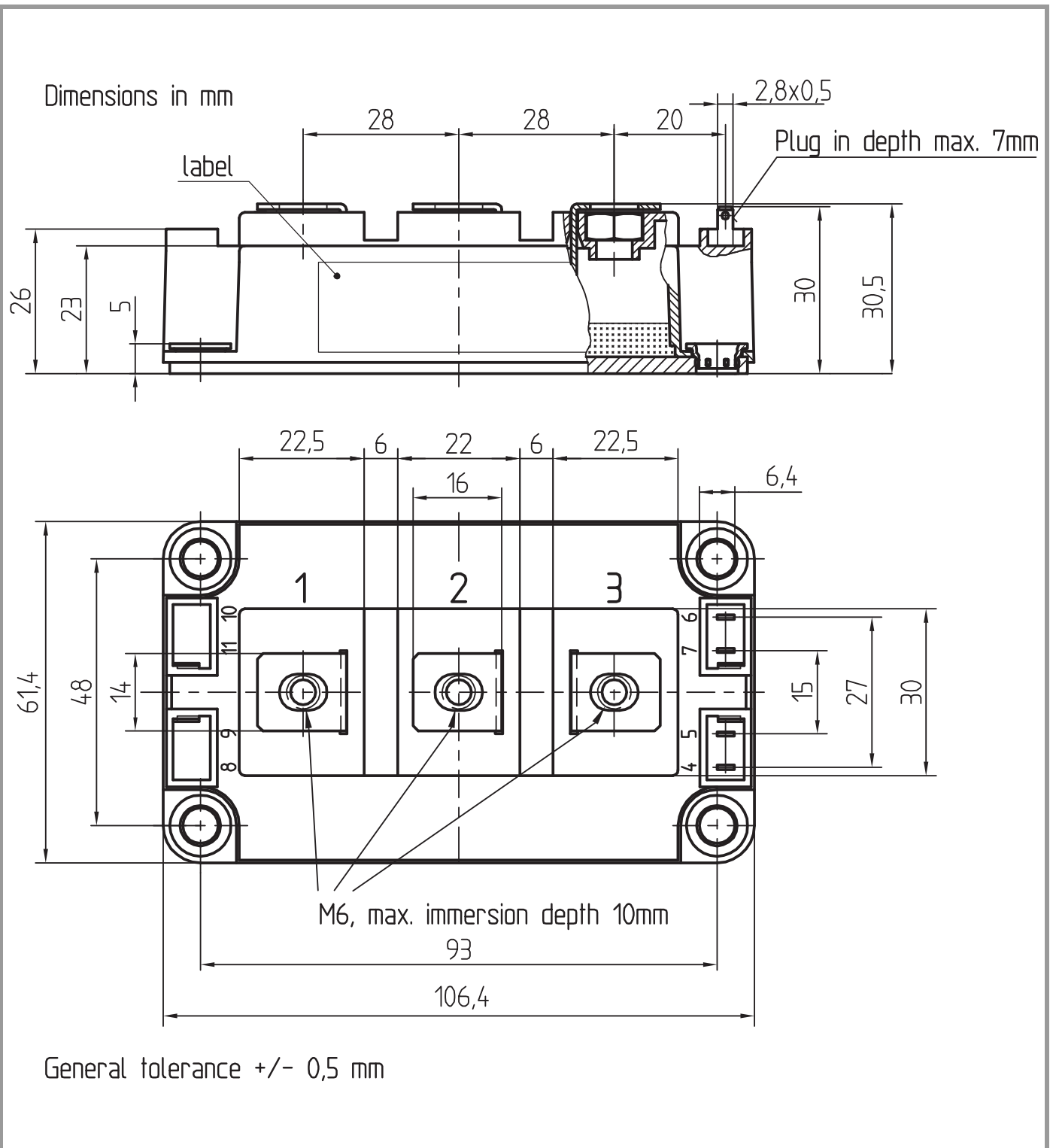
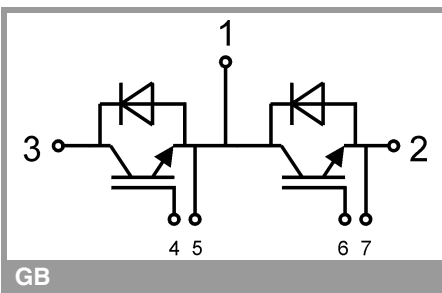


Fig. 13: Max. switching frequency vs. case temperature  
 $f_{sw} = f(T_c)$

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

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