SEMITRANS® 3

High Speed IGBT4 Modules

SKM400GAR12F4

Features*

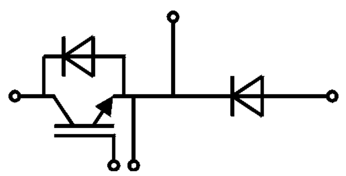
- High speed trench and field-stop IGBT
- CAL4 ultra-fast = soft switching 4. generation CAL-diode
- Insulated copper baseplate using DBC technology (Direct Bonded Copper)
- Increased power cycling capability
- For higher switching frequencies above 15kHz
- UL recognized, file no. E63532

Typical Applications

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

Remarks

- Case temperature limited to T_c = 125°C max.
- Recommended T_{op} = -40 ... +150°C
- Product reliability results valid for T_j = 150°C



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Absolute Maximum Ratings

Symbol	Conditions		Values	Unit
IGBT				
V_{CES}	T_j = 25 °C		1200	V
I_C	T_j = 175 °C	T_c = 25 °C	548	A
		T_c = 80 °C	418	A
I_{Cnom}			400	A
I_{CRM}	I_{CRM} = 2 x I_{Cnom}		800	A
V_{GES}			-20 ... 20	V
t_{psc}	V_{CC} = 800 V $V_{GE} \leq$ 15 V $V_{CES} \leq$ 1200 V $R_{G\ on/off} \geq$ 3 Ω	T_j = 150 °C	10	µs
T_j			-40 ... 175	°C
Inverse diode				
V_{RRM}	T_j = 25 °C		1200	V
I_F	T_j = 175 °C	T_c = 25 °C	402	A
		T_c = 80 °C	295	A
I_{Fnom}			400	A
I_{FRM}	I_{FRM} = 2xI_{Fnom}		800	A
I_{FSM}	t_p = 10 ms, sin 180°, T_j = 25 °C		1980	A
T_j			-40 ... 175	°C
Freewheeling diode				
V_{RRM}	T_j = 25 °C		1200	V
I_F	T_j = 175 °C	T_c = 25 °C	402	A
		T_c = 80 °C	295	A
I_{Fnom}			400	A
I_{FRM}	I_{FRM} = 2xI_{Fnom}		800	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}	module without TIM		-40 ... 125	°C
V_{isol}	AC sinus 50 Hz, t = 1 min		4000	V

Characteristics

Symbol	Conditions		min.	typ.	max.	Unit
IGBT						
$V_{CE(sat)}$	I_C = 400 A V_{GE} = 15 V chiplevel	T_j = 25 °C		2.06	2.44	V
		T_j = 150 °C		2.59	2.97	V
V_{CE0}	chiplevel	T_j = 25 °C		1.10	1.28	V
		T_j = 150 °C		0.95	1.13	V
r_{CE}	V_{GE} = 15 V chiplevel	T_j = 25 °C		2.4	2.9	mΩ
		T_j = 150 °C		4.1	4.6	mΩ
$V_{GE(th)}$	V_{GE}=V_{CE}, I_C = 15.2 mA		5.1	5.8	6.4	V
I_{CES}	V_{GE} = 0 V V_{CE} = 1200 V	T_j = 25 °C			5	mA
		T_j = 150 °C		-		mA
C_{ies}	V_{CE} = 25 V V_{GE} = 0 V	f = 1 MHz		24.6		nF
C_{oes}		f = 1 MHz		1.62		nF
C_{res}		f = 1 MHz		1.38		nF
Q_G	V_{GE} = - 8 V...+ 15 V			2268		nC
R_{Gint}	T_j = 25 °C			1.6		Ω

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Remarks

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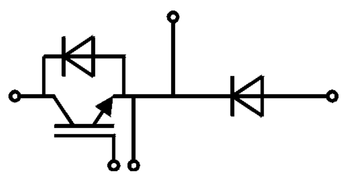
- Recommended T_{op} = -40 ... +150°C
- Product reliability results valid for T_j = 150°C



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Characteristics						
Symbol	**Conditions**		**min.**	**typ.**	**max.**	**Unit**
$t_{d(on)}$	V_{CC} = 600 V I_C = 400 A V_{GE} = +15/-15 V $R_{G\,on}$ = 2 Ω $R_{G\,off}$ = 1 Ω di/dt_{on} = 7960 A/µs di/dt_{off} = 4430 A/µs dv/dt = 4530 V/µs	T_j = 150 °C		110		ns
t_r		T_j = 150 °C		55		ns
E_{on}		T_j = 150 °C		28		mJ
$t_{d(off)}$		T_j = 150 °C		415		ns
t_f		T_j = 150 °C		75		ns
E_{off}		T_j = 150 °C		32		mJ
$R_{th(j-c)}$	per IGBT				0.072	K/W
$R_{th(c-s)}$	per IGBT (λ_{grease}=0.81 W/(m*K))			0.041		K/W
Inverse diode						
$V_F = V_{EC}$	I_F = 400 A V_{GE} = 0 V chiplevel	T_j = 25 °C		2.55	2.93	V
		T_j = 150 °C		2.44	2.80	V
V_{F0}	chiplevel	T_j = 25 °C		1.51	1.75	V
		T_j = 150 °C		1.16	1.40	V
r_F	chiplevel	T_j = 25 °C		2.6	2.9	mΩ
		T_j = 150 °C		3.2	3.5	mΩ
I_{RRM}	I_F = 400 A di/dt_{off} = 7183 A/µs V_{GE} = -15 V V_{CC} = 600 V	T_j = 150 °C		424		A
Q_{rr}		T_j = 150 °C		51		µC
E_{rr}		T_j = 150 °C		18.5		mJ
$R_{th(j-c)}$	per diode				0.14	K/W
$R_{th(c-s)}$	per diode (λ_{grease}=0.81 W/(m*K))			0.047		K/W
Freewheeling diode						
$V_F = V_{EC}$	I_F = 400 A V_{GE} = 0 V chiplevel	T_j = 25 °C		2.55	2.93	V
		T_j = 150 °C		2.44	2.80	V
V_{F0}	chiplevel	T_j = 25 °C		1.51	1.75	V
		T_j = 150 °C		1.16	1.40	V
r_F	chiplevel	T_j = 25 °C		2.6	2.9	mΩ
		T_j = 150 °C		3.2	3.5	mΩ
I_{RRM}	I_F = 400 A di/dt_{off} = 7183 A/µs V_{GE} = -15 V V_{CC} = 600 V	T_j = 150 °C		424		A
Q_{rr}		T_j = 150 °C		51		µC
E_{rr}		T_j = 150 °C		18.5		mJ
$R_{th(j-c)}$	per diode				0.14	K/W
$R_{th(c-s)}$	per diode (λ_{grease}=0.81 W/(m*K))			0.047		K/W
Module						
L_{CE}				15		nH
$R_{CC'+EE'}$	measured per switch	T_C = 25 °C		0.55		mΩ
		T_C = 125 °C		0.85		mΩ
$R_{th(c-s)1}$	calculated without thermal coupling (λ_{grease}=0.81 W/(m*K))			0.0219		K/W
$R_{th(c-s)2}$	including thermal coupling, T_s underneath module (λ_{grease}=0.81 W/(m*K))			0.024		K/W
M_s	to heat sink M6		3		5	Nm
M_t		to terminals M6	2.5		5	Nm
						Nm
w					325	g

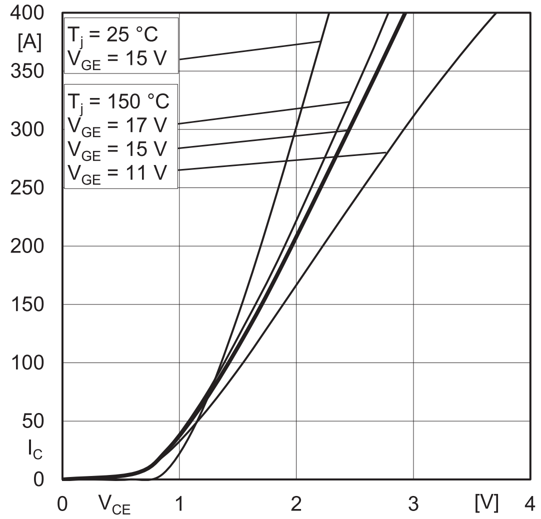


Fig. 1: Typ. output characteristic, inclusive $R_{CC'+EE'}$

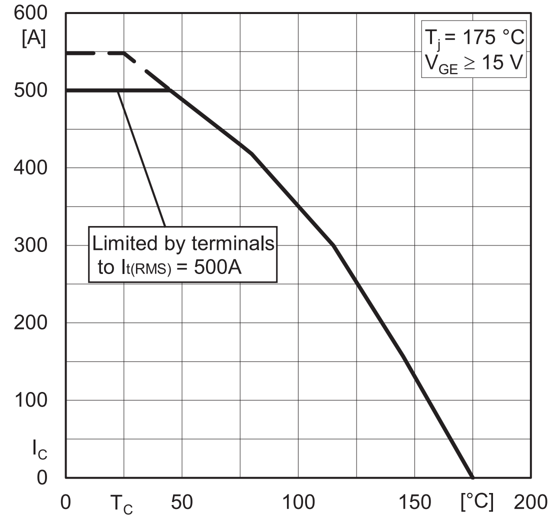


Fig. 2: Rated current vs. temperature $I_C = f(T_C)$

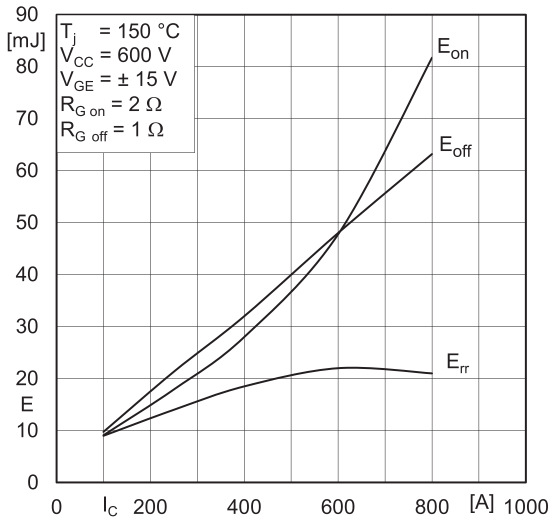


Fig. 3: Typ. turn-on /-off energy = f (I_C)

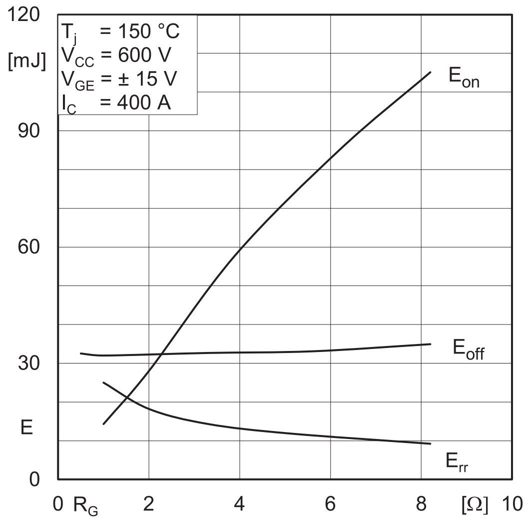


Fig. 4: Typ. turn-on /-off energy = f (R_G)

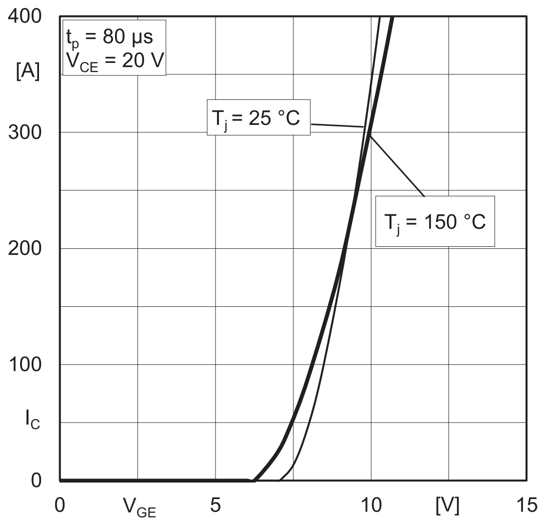


Fig. 5: Typ. transfer characteristic

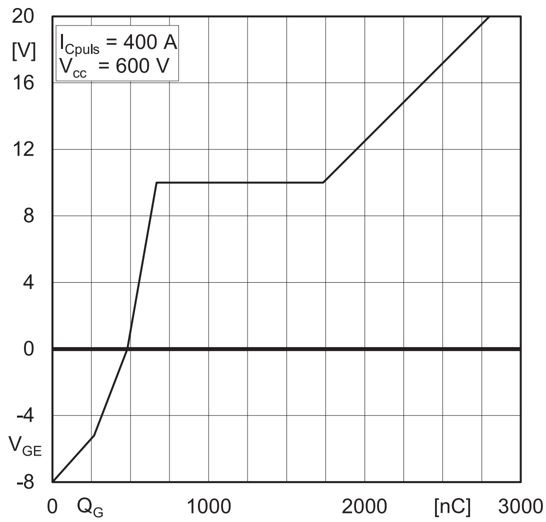


Fig. 6: Typ. gate charge characteristic

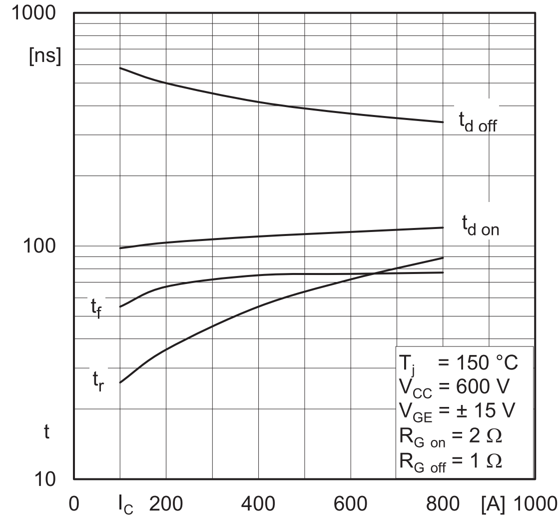


Fig. 7: Typ. switching times vs. I_C

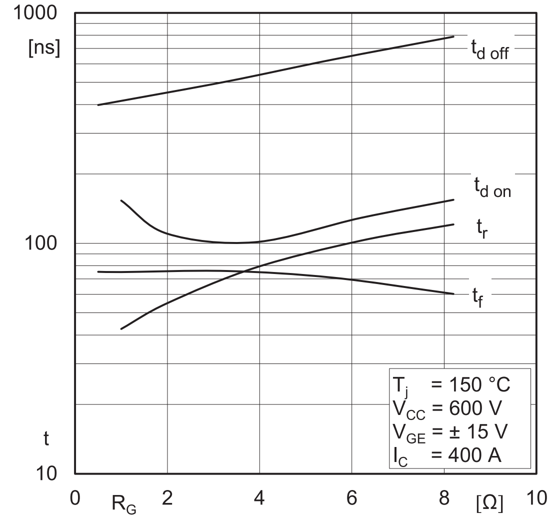


Fig. 8: Typ. switching times vs. gate resistor R_G

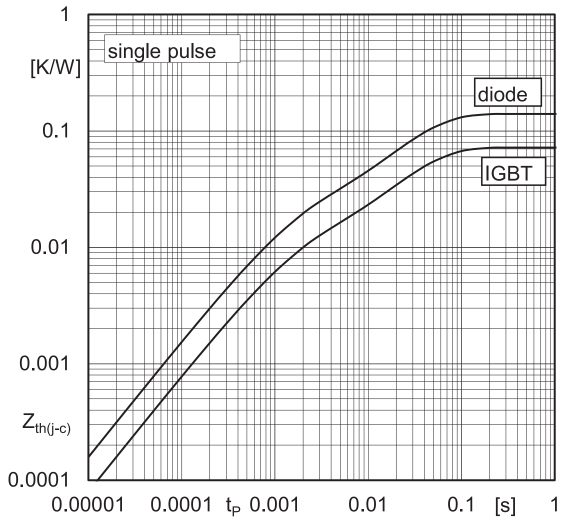


Fig. 9: Transient thermal impedance

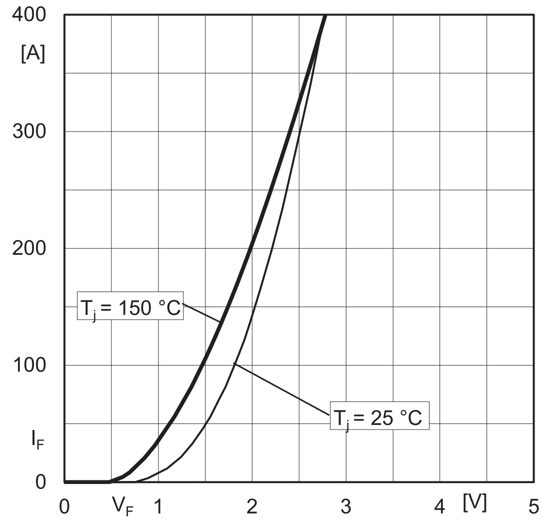


Fig. 10: Typ. CAL diode forward charact., incl. $R_{CC'+EE'}$

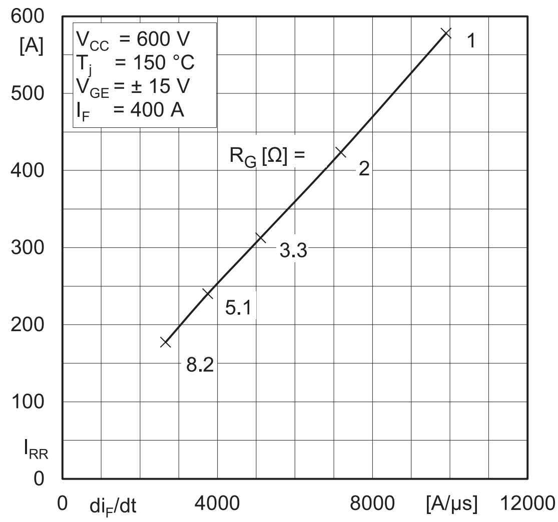


Fig. 11: Typ. CAL diode peak reverse recovery current

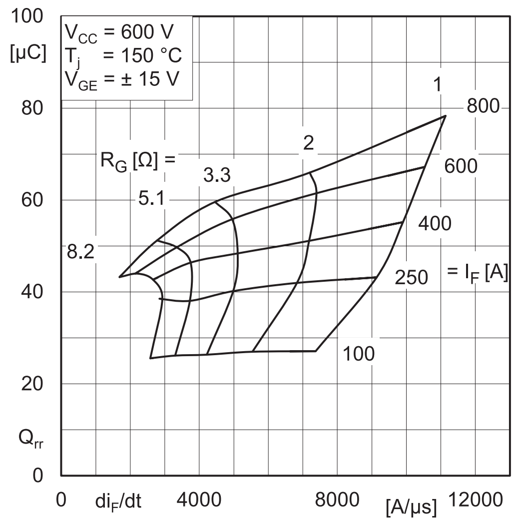


Fig. 12: Typ. CAL diode peak reverse recovery charge

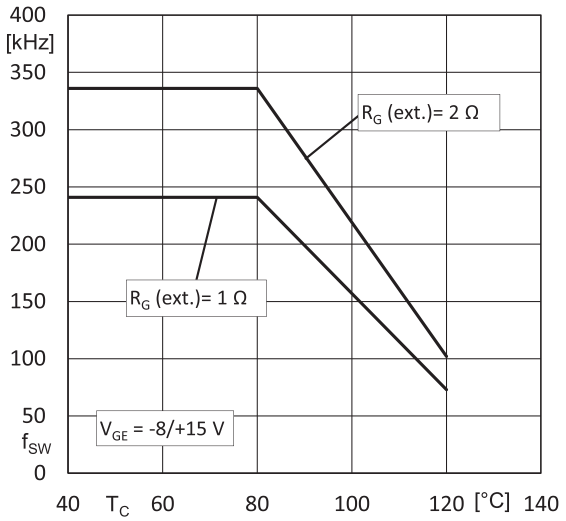
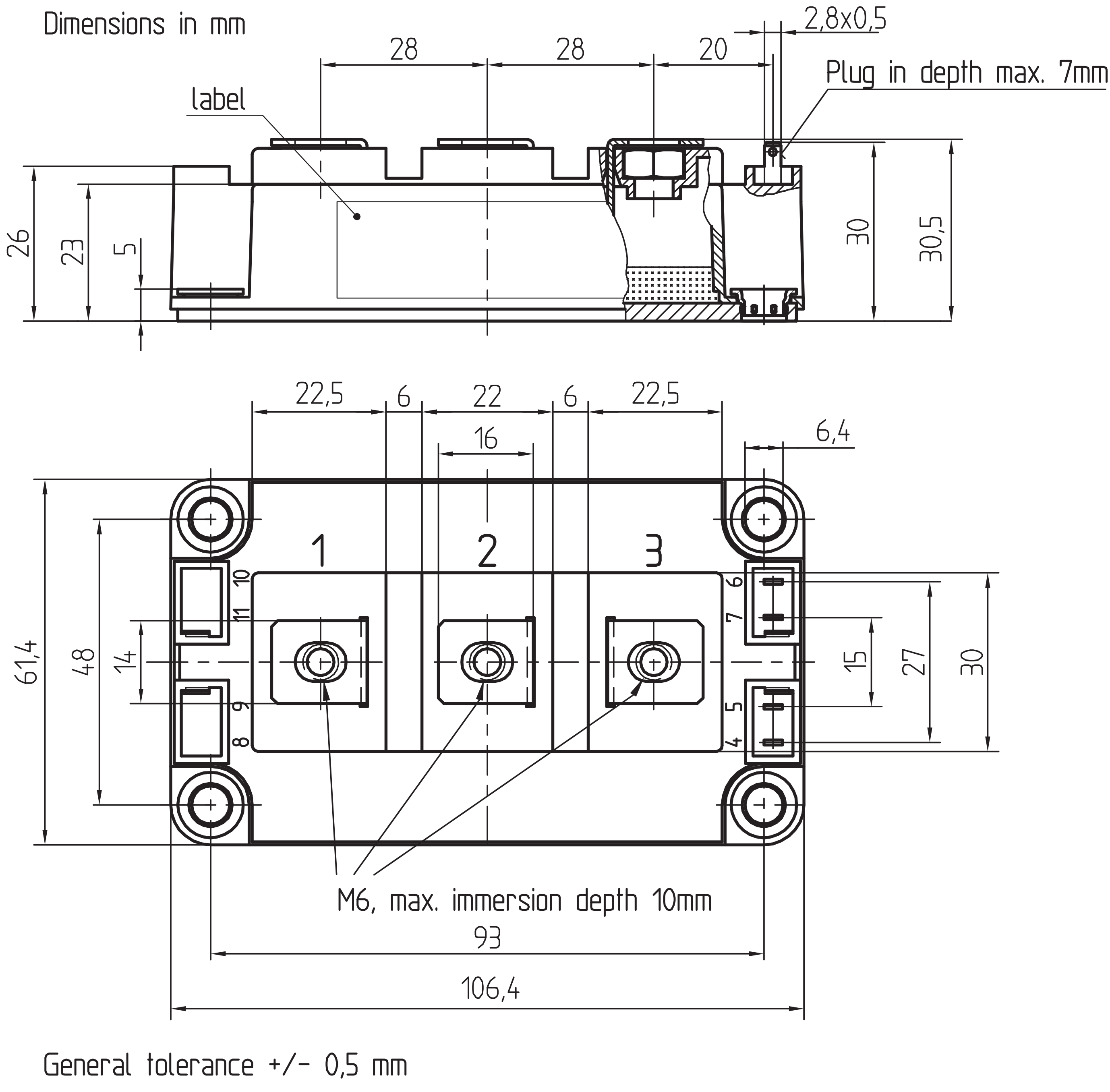


Fig. 13: Max. switching frequency vs. case temperature $f_{sw} = f(T_c)$



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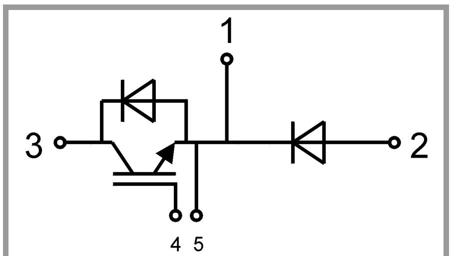

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This is an electrostatic discharge sensitive device (ESDS), international standard IEC 60747-1, chapter IX.

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