SEMITRANS® 3

Trench IGBT Modules

SKM400GAL07E3

Features*

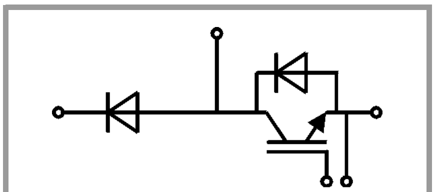
- $V_{CE(sat)}$ with positive temperature coefficient
- High short circuit capability, self limiting to 6 x I_{cnom}
- Fast & soft switching inverse CAL diodes
- Insulated copper baseplate using DCB Technology (Direct Copper Bonding)
- With integrated gate resistor

Typical Applications

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

Remarks

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



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Absolute Maximum Ratings

Symbol	Conditions		Values	Unit
IGBT				
V_{CES}	T_j = 25 °C		650	V
I_C	T_j = 175 °C	T_c = 25 °C	506	A
		T_c = 80 °C	381	A
I_{Cnom}			400	A
I_{CRM}	I_{CRM} = 3 x I_{Cnom}		1200	A
V_{GES}			-20 ... 20	V
t_{psc}	V_{CC} = 360 V V_{GE} ≤ 15 V V_{CES} ≤ 650 V	T_j = 150 °C	6	µs
T_j			-40 ... 175	°C
Inverse diode				
V_{RRM}	T_j = 25 °C		650	V
I_F	T_j = 175 °C	T_c = 25 °C	447	A
		T_c = 80 °C	324	A
I_{Fnom}			400	A
I_{FRM}	I_{FRM} = 2 x I_{Fnom}		800	A
I_{FSM}	t_p = 10 ms, sin 180°, T_j = 25 °C		2646	A
T_j			-40 ... 175	°C
Freewheeling diode				
V_{RRM}	T_j = 25 °C		650	V
I_F	T_j = 175 °C	T_c = 25 °C	447	A
		T_c = 80 °C	324	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		2646	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		1.45	1.90	V
		T_j = 150 °C		1.70	2.10	V
V_{CE0}	chiplevel	T_j = 25 °C		0.90	1.00	V
		T_j = 150 °C		0.82	0.90	V
r_{CE}	V_{GE} = 15 V chiplevel	T_j = 25 °C		1.38	2.3	mΩ
		T_j = 150 °C		2.2	3.0	mΩ
$V_{GE(th)}$	V_{GE}=V_{CE}, I_C = 6.4 mA		5.1	5.8	6.4	V
I_{CES}	V_{GE} = 0 V, V_{CE} = 650 V, T_j = 25 °C				0.3	mA
C_{ies}	V_{CE} = 25 V V_{GE} = 0 V	f = 1 MHz		24.7		nF
C_{oes}		f = 1 MHz		1.54		nF
C_{res}		f = 1 MHz		0.73		nF
Q_G	V_{GE} = - 8 V...+ 15 V			3200		nC
R_{Gint}	T_j = 25 °C			1.0		Ω

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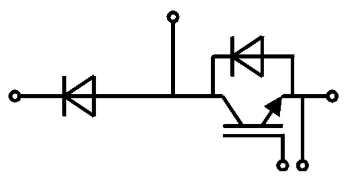

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Characteristics						
Symbol	**Conditions**		**min.**	**typ.**	**max.**	**Unit**
IGBT						
$t_{d(on)}$	V_{CC} = 300 V I_C = 400 A V_{GE} = +15/-7.5 V $R_{G\ on}$ = 1 Ω $R_{G\ off}$ = 4.2 Ω di/dt$_{on}$ = 7000 A/µs di/dt$_{off}$ = 5000 A/µs dv/dt = 2200 V/µs L_s = 18 nH	T_j = 150 °C		190		ns
t_r		T_j = 150 °C		60		ns
E_{on}		T_j = 150 °C		4		mJ
$t_{d(off)}$		T_j = 150 °C		850		ns
t_f		T_j = 150 °C		50		ns
E_{off}		T_j = 150 °C		17		mJ
$R_{th(j-c)}$	per IGBT				0.12	K/W
$R_{th(c-s)}$	per IGBT (λ_{grease}=0.81 W/(m*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 A V_{GE} = 0 V chiplevel	T_j = 25 °C		1.39	1.75	V
		T_j = 150 °C		1.38	1.76	V
V_{F0}	chiplevel	T_j = 25 °C		1.04	1.24	V
		T_j = 150 °C		0.85	0.99	V
r_F	chiplevel	T_j = 25 °C		0.88	1.30	mΩ
		T_j = 150 °C		1.32	1.93	mΩ
I_{RRM}	I_F = 400 A di/dt$_{off}$ = 7000 A/µs V_{GE} = +15/-7.5 V V_{CC} = 300 V	T_j = 150 °C		459		A
Q_{rr}		T_j = 150 °C		61		µC
E_{rr}		T_j = 150 °C		12		mJ
$R_{th(j-c)}$	per diode				0.191	K/W
$R_{th(c-s)}$	per diode (λ_{grease}=0.81 W/(m*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 A V_{GE} = 0 V chiplevel	T_j = 25 °C		1.39	1.75	V
		T_j = 150 °C		1.38	1.76	V
V_{F0}	chiplevel	T_j = 25 °C		1.04	1.24	V
		T_j = 150 °C		0.85	0.99	V
r_F	chiplevel	T_j = 25 °C		0.88	1.30	mΩ
		T_j = 150 °C		1.32	1.93	mΩ
I_{RRM}	I_F = 400 A di/dt$_{off}$ = 7000 A/µs V_{GE} = +15/-7.5 V V_{CC} = 300 V	T_j = 150 °C		459		A
Q_{rr}		T_j = 150 °C		61		µC
E_{rr}		T_j = 150 °C		12		mJ
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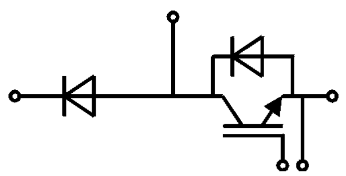

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Characteristics						
Symbol	**Conditions**		**min.**	**typ.**	**max.**	**Unit**
Module						
L_{CE}				15		nH
$R_{CC'+EE'}$	measured per switch	T_C = 25 °C		0.55		mΩ
		T_C = 125 °C		0.85		mΩ
$R_{th(c-s)1}$	calculated without thermal coupling			0.0202		K/W
$R_{th(c-s)2}$	including thermal coupling, T_s underneath module (λ_{grease}=0.81 W/(m*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		to terminals M6	2.5		5	Nm
						Nm
w					325	g

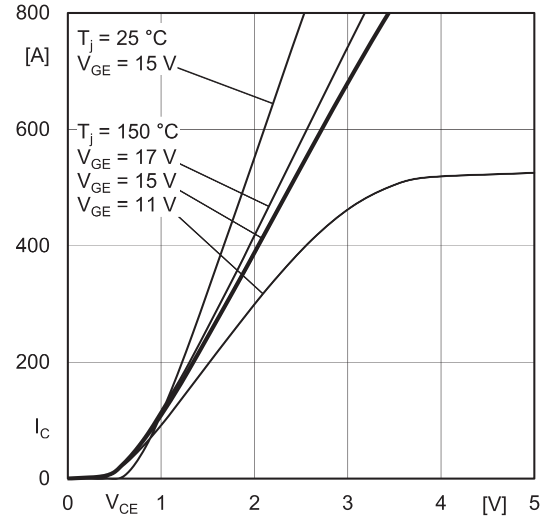


Fig. 1: Typ. output characteristic, inclusive $R_{CC'+ EE'}$

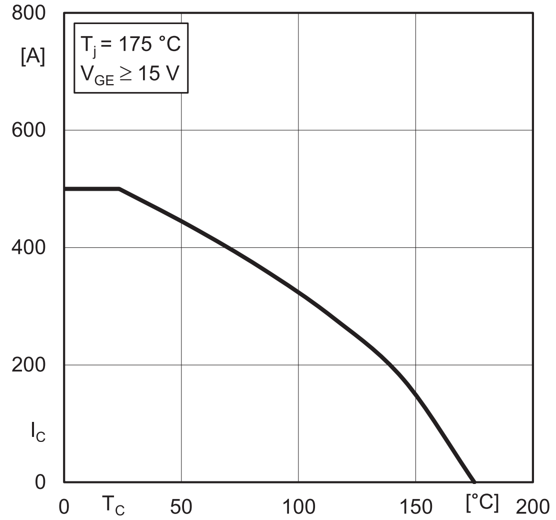


Fig. 2: Rated current vs. temperature $I_C = f(T_C)$

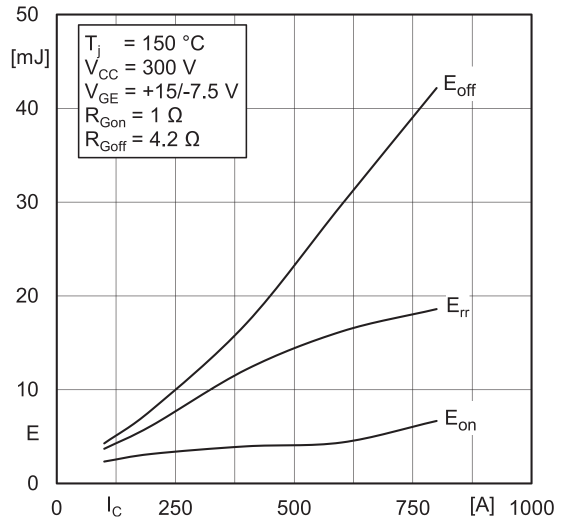


Fig. 3: Typ. turn-on /-off energy = f (I_C)

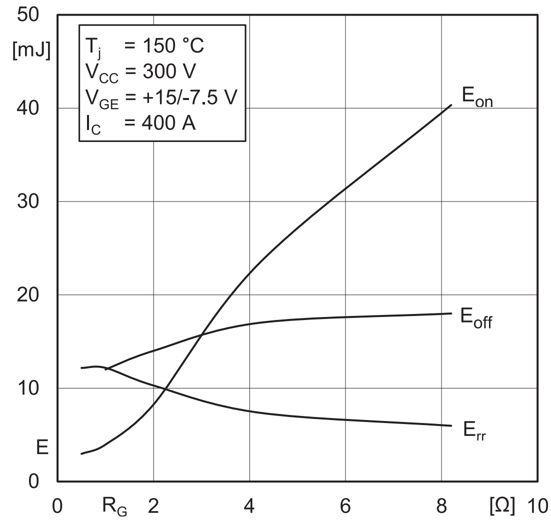


Fig. 4: Typ. turn-on /-off energy = f (R_G)

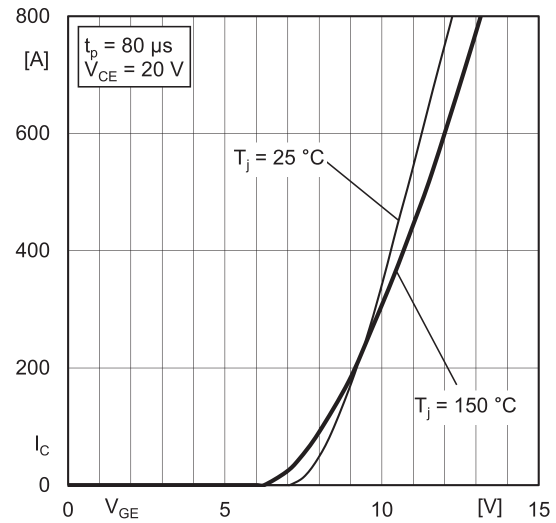


Fig. 5: Typ. transfer characteristic

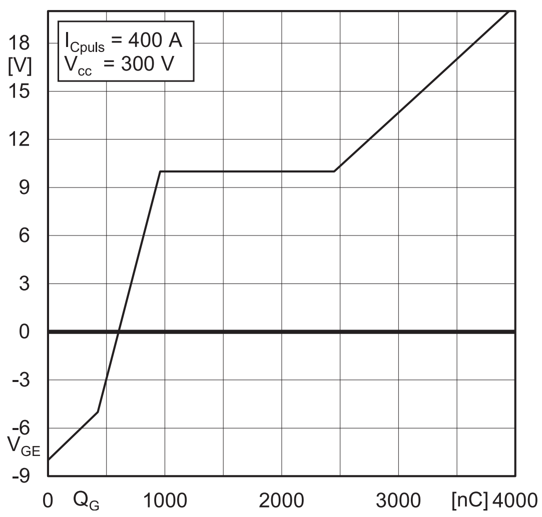


Fig. 6: Typ. gate charge characteristic

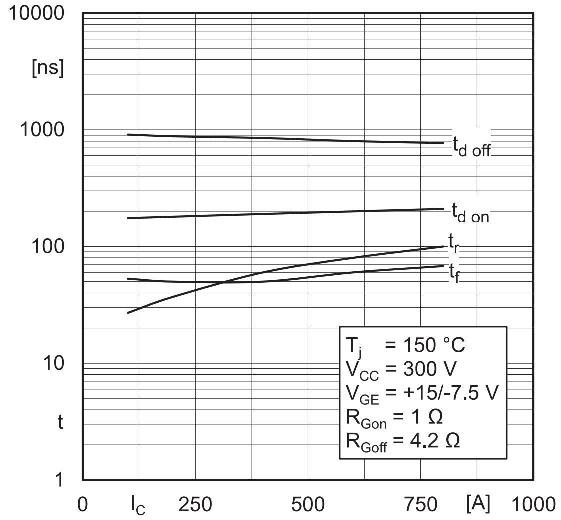


Fig. 7: Typ. switching times vs. I_C

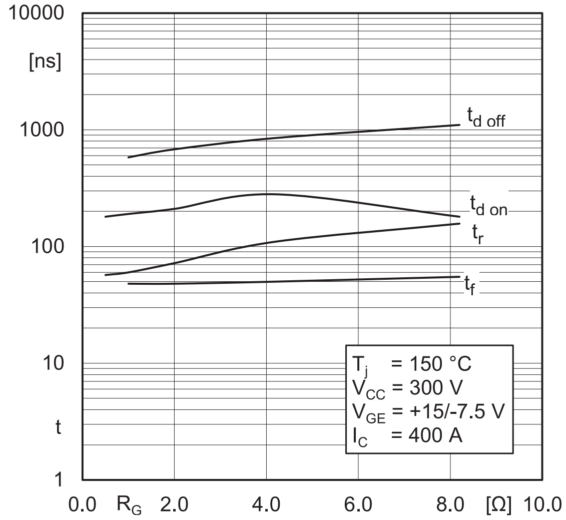


Fig. 8: Typ. switching times vs. gate resistor R_G

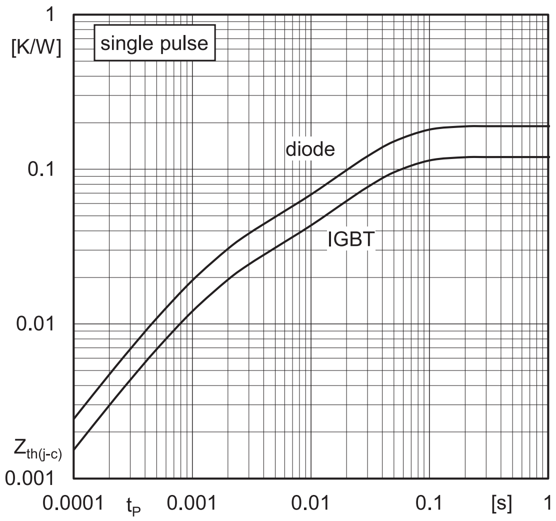


Fig. 9: Transient thermal impedance

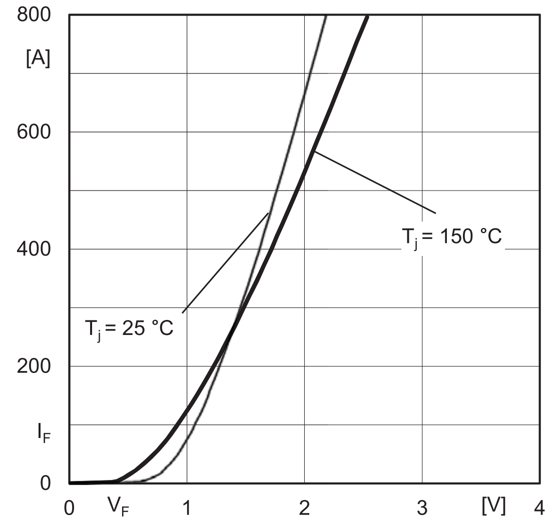


Fig. 10: Typ. CAL diode forward charact., incl. $R_{CC'+EE'}$

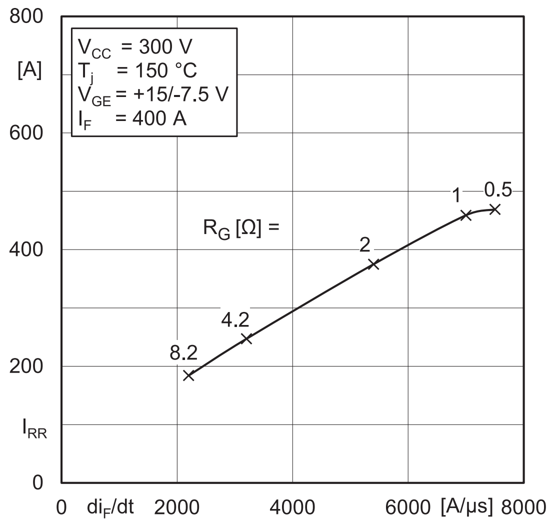


Fig. 11: Typ. CAL diode peak reverse recovery current

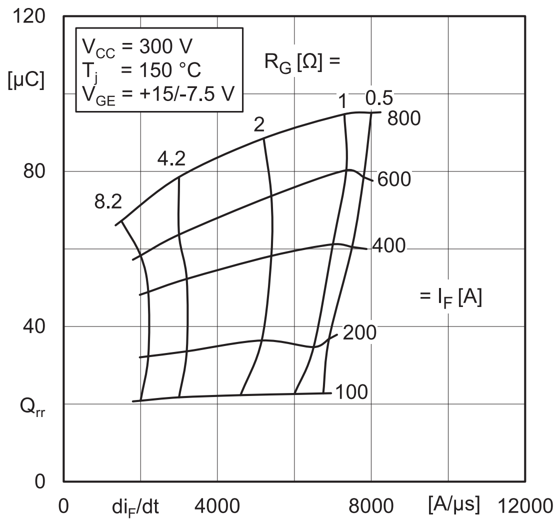
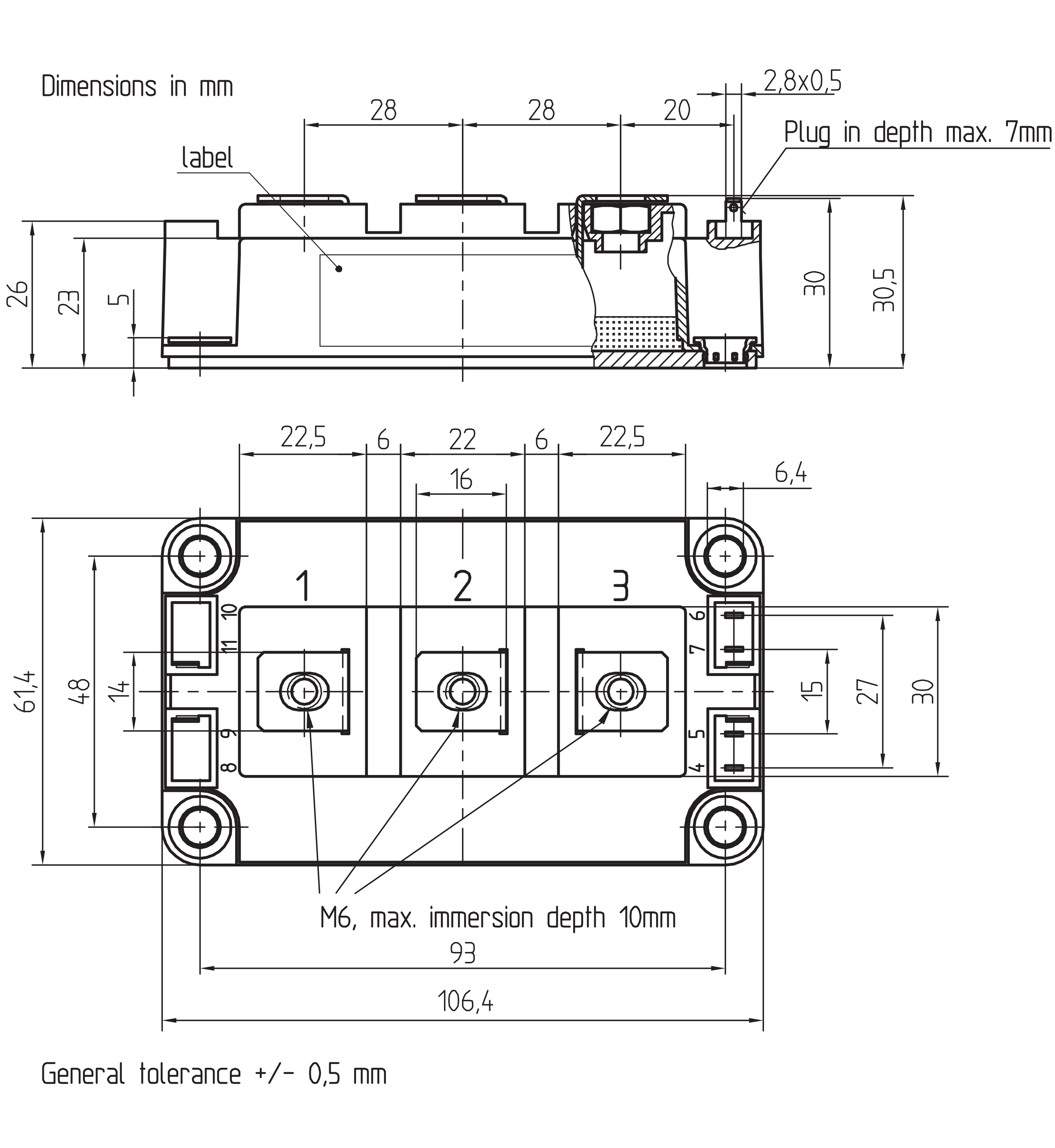


Fig. 12: Typ. CAL diode peak reverse recovery charge



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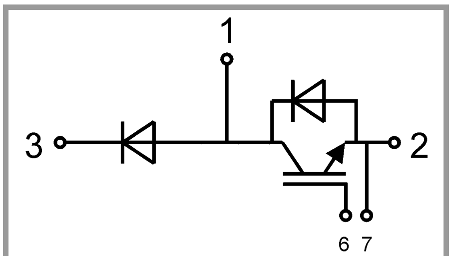

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This is an electrostatic discharge sensitive device (ESDS), international standard IEC 60747-1, chapter IX.

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