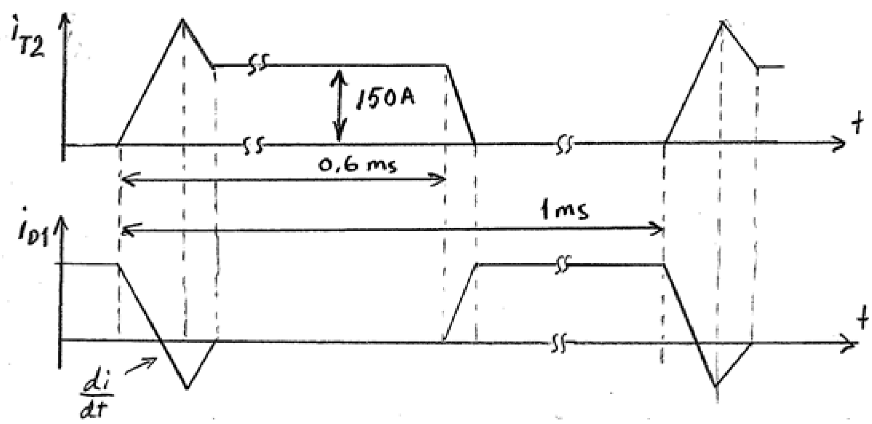
ELEC-E8421 Tehoelektroniikan komponentit

Harjoitus 4. session 4

1. IGBT module SEmiX223GB12Vs (datasheet attached) includes two IGBT transistors with freewheeling diodes. High side diode (D1) and low side IGBT (T2) conduct in alternative turns as shown in a figure below. Cooling element has thermal resistance Rth(s-a) = 0.08 K/W and cooling air is 45 C. What are the junction temperatures inside a diode and IGBT, when IGBT gate resistor is 3.8 ohms and voltage ± 15 V? (s) indicates heat sink in datasheets. DC voltage is 560 V.



2. What is previously described diode D1 reverse recovery current Irr, its derivative di/dt and duration (trr)?

SEMiX® 3s

SEMiX223GB12Vs

Features

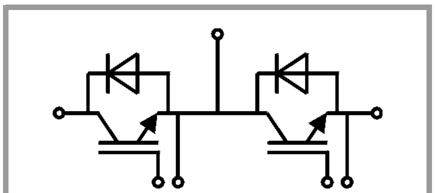
- Homogeneous Si
- $V_{CE(sat)}$ with positive temperature coefficient
- High short circuit capability
- UL recognised file no. E63532

Typical Applications*

- AC inverter drives
- UPS
- Electronic Welding

Remarks

- Case temperature limited to T_C=125°C max.
- Product reliability results are valid for T_j=150°C
- Dynamic values apply to the following combination of resistors:
  $R_{Gon,main}$ = 2,9 Ω
  $R_{Goff,main}$ = 2,9 Ω
  $R_{G,X}$ = 2,2 Ω
  $R_{E,X}$ = 0,5 Ω



GB

Absolute Maximum Ratings				
Symbol	**Conditions**		**Values**	**Unit**
IGBT				
V_{CES}			1200	V
I_C	T_j = 175 °C	T_c = 25 °C	323	A
		T_c = 80 °C	246	A
I_{Cnom}			225	A
I_{CRM}	I_{CRM} = 3xI_{Cnom}		675	A
V_{GES}			-20 ... 20	V
t_{psc}	V_{CC} = 600 V V_{GE} ≤ 15 V V_{CES} ≤ 1200 V	T_j = 125 °C	10	µs
T_j			-40 ... 175	°C
Inverse diode				
I_F	T_j = 175 °C	T_c = 25 °C	263	A
		T_c = 80 °C	197	A
I_{Fnom}			225	A
I_{FRM}	I_{FRM} = 3xI_{Fnom}		675	A
I_{FSM}	t_p = 10 ms, sin 180°, T_j = 25 °C		1161	A
T_j			-40 ... 175	°C
Module				
$I_{t(RMS)}$	$T_{terminal}$ = 80 °C		600	A
T_{stg}			-40 ... 125	°C
V_{isol}	AC sinus 50Hz, t = 1 min		4000	V

Characteristics						
Symbol	**Conditions**		**min.**	**typ.**	**max.**	**Unit**
IGBT						
$V_{CE(sat)}$	I_C = 225 A V_{GE} = 15 V chiplevel	T_j = 25 °C		1.85	2.3	V
		T_j = 150 °C		2.3	2.55	V
V_{CE0}		T_j = 25 °C		0.94	1.04	V
		T_j = 150 °C		0.88	0.98	V
r_{CE}	V_{GE} = 15 V	T_j = 25 °C		4.0	5.6	mΩ
		T_j = 150 °C		6.1	7.0	mΩ
$V_{GE(th)}$	V_{GE}=V_{CE}, I_C = 9 mA		5.5	6	6.5	V
I_{CES}	V_{GE} = 0 V V_{CE} = 1200 V	T_j = 25 °C		0.1	0.3	mA
		T_j = 150 °C				mA
C_{ies}	V_{CE} = 25 V V_{GE} = 0 V	f = 1 MHz		13.5		nF
C_{oes}		f = 1 MHz		1.33		nF
C_{res}		f = 1 MHz		1.33		nF
Q_G	V_{GE} = - 8 V...+ 15 V			2460		nC
R_{Gint}	T_j = 25 °C			3.33		Ω
$t_{d(on)}$	V_{CC} = 600 V I_C = 225 A V_{GE} = ±15 V $R_{G\ on}$ = 3.8 Ω $R_{G\ off}$ = 3.8 Ω di/dt_{on} = 3200 A/µs di/dt_{off} = 2000 A/µs du/dt_{off} = 6600 V/ µs	T_j = 150 °C		470		ns
t_r		T_j = 150 °C		72		ns
E_{on}		T_j = 150 °C		19.9		mJ
$t_{d(off)}$		T_j = 150 °C		665		ns
t_f		T_j = 150 °C		109		ns
E_{off}		T_j = 150 °C		27.2		mJ
$R_{th(j-c)}$	per IGBT				0.14	K/W

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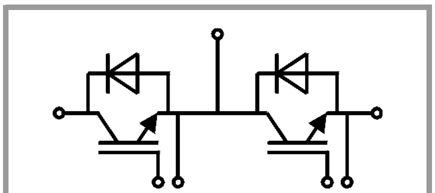


GB

Characteristics						
Symbol	**Conditions**		**min.**	**typ.**	**max.**	**Unit**
Inverse diode						
$V_F = V_{EC}$	I_F = 225 A V_{GE} = 0 V chip	T_j = 25 °C		2.2	2.49	V
		T_j = 150 °C		2.1	2.4	V
V_{F0}		T_j = 25 °C	1.1	1.3	1.5	V
		T_j = 150 °C	0.7	0.9	1.1	V
r_F		T_j = 25 °C	3.6	3.9	4.4	mΩ
		T_j = 150 °C	4.7	5.4	5.9	mΩ
I_{RRM}	I_F = 225 A di/dt_{off} = 3400 A/µs V_{GE} = -15 V V_{CC} = 600 V	T_j = 150 °C		210		A
Q_{rr}		T_j = 150 °C		39.4		µC
E_{rr}		T_j = 150 °C		16.4		mJ
$R_{th(j-c)}$	per diode				0.23	K/W
Module						
L_{CE}				20		nH
$R_{CC'+EE'}$	res., terminal-chip	T_C = 25 °C		0.7		mΩ
		T_C = 125 °C		1		mΩ
$R_{th(c-s)}$	per module			0.04		K/W
M_s	to heat sink (M5)		3		5	Nm
M_t		to terminals (M6)	2.5		5	Nm
						Nm
w					300	g
Temperatur Sensor						
R_{100}	T_c=100°C (R_{25}=5 kΩ)			493 ± 5%		Ω
$B_{100/125}$	$R_{(T)}=R_{100}exp[B_{100/125}(1/T-1/T_{100})]$; T[K];			3550 ±2%		K

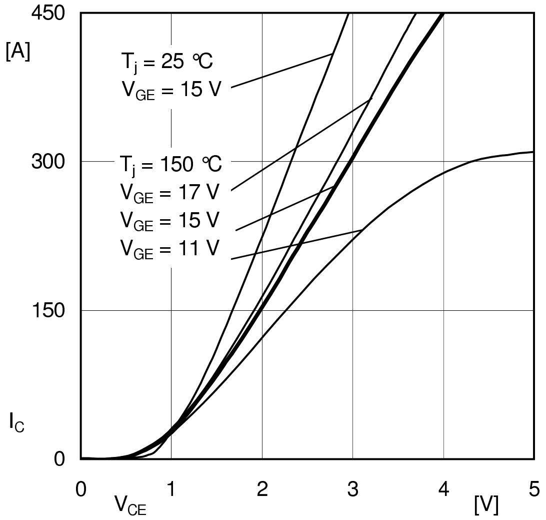


Fig. 1: Typ. output characteristic, inclusive $R_{CC'+ EE'}$

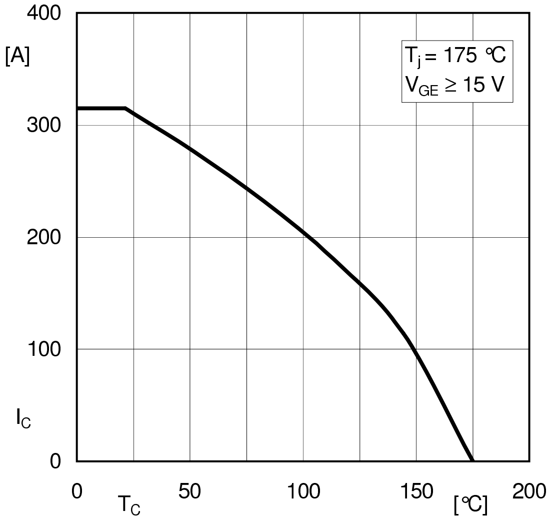


Fig. 2: Rated current vs. temperature $I_C = f(T_C)$

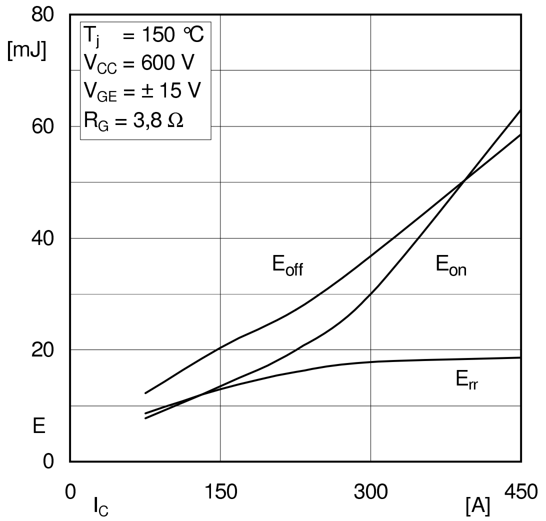


Fig. 3: Typ. turn-on /-off energy = f (I_C)

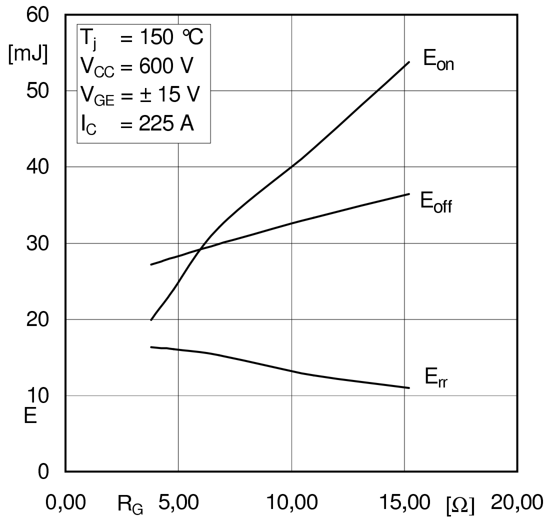


Fig. 4: Typ. turn-on /-off energy = f (R_G)

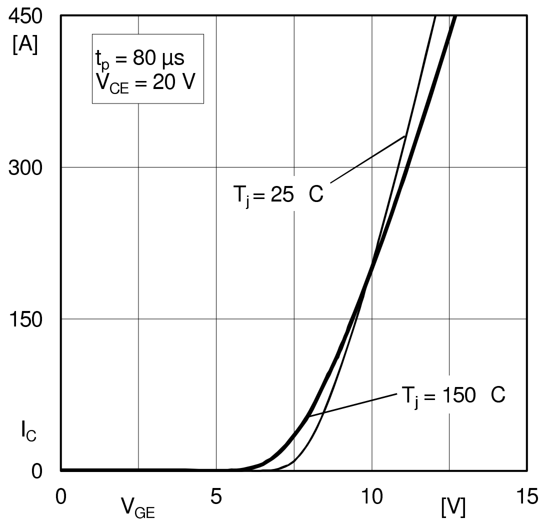


Fig. 5: Typ. transfer characteristic

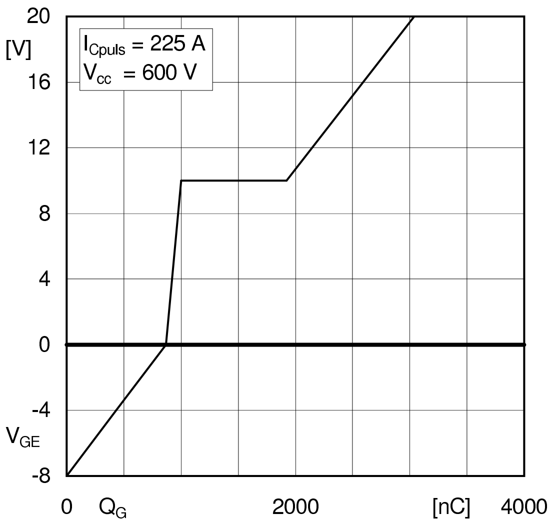


Fig. 6: Typ. gate charge characteristic

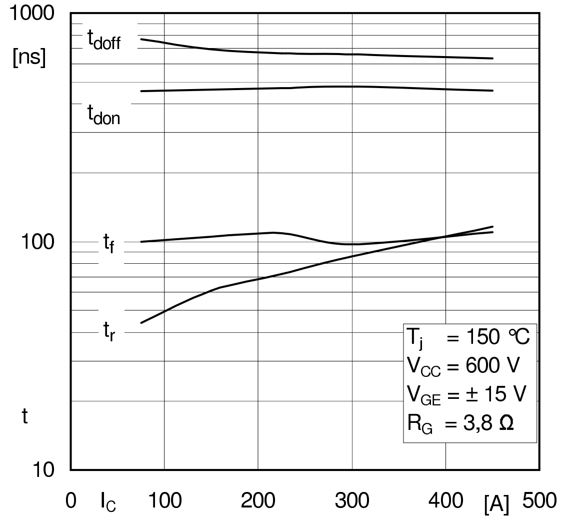


Fig. 7: Typ. switching times vs. I_C

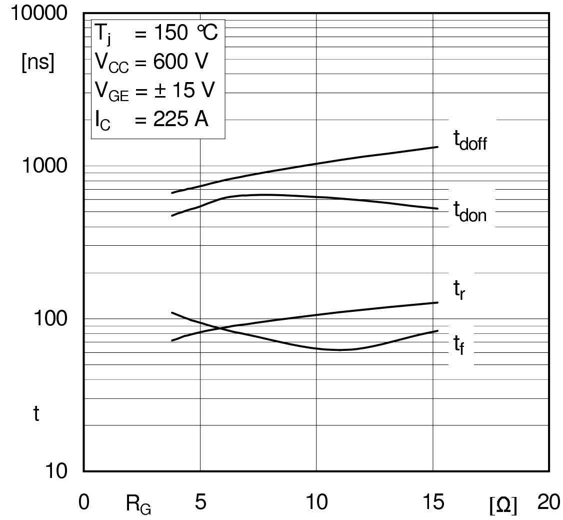


Fig. 8: Typ. switching times vs. gate resistor R_G

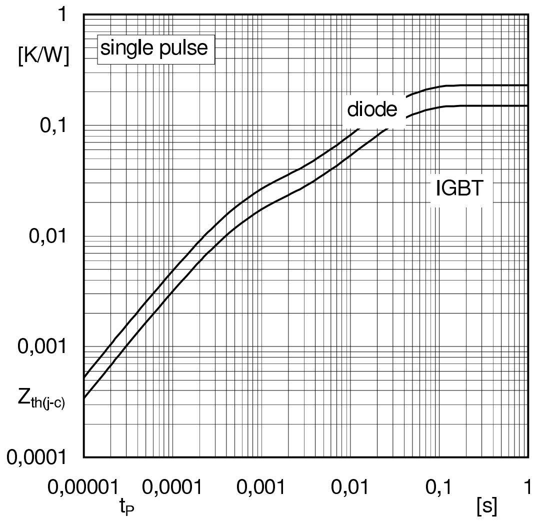


Fig. 9: Typ. transient thermal impedance

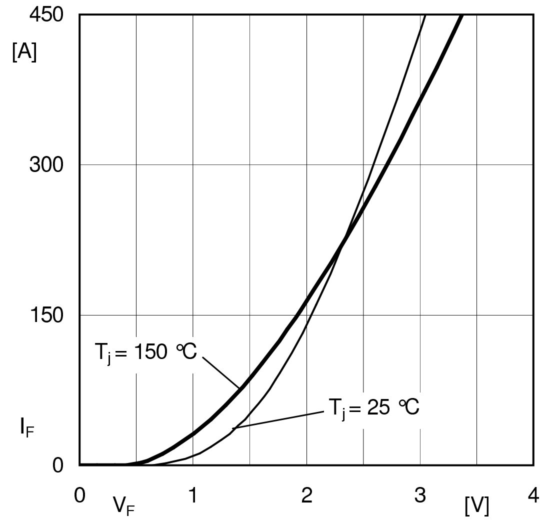


Fig. 10: Typ. CAL diode forward charact., incl. $R_{CC'+EE'}$

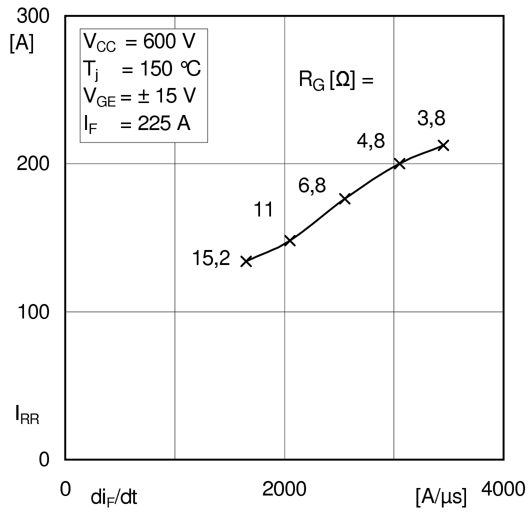


Fig. 11: Typ. CAL diode peak reverse recovery current

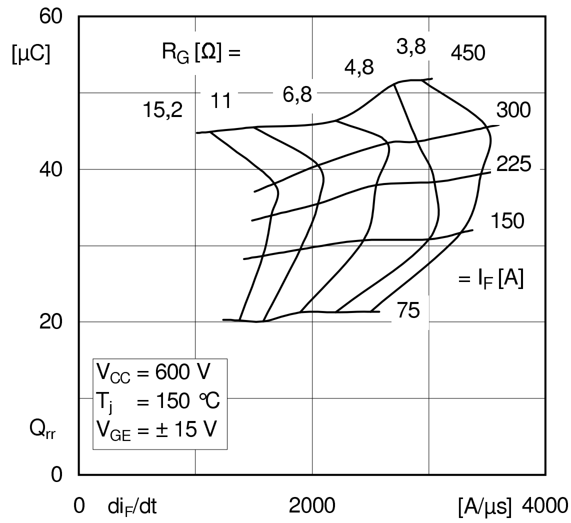
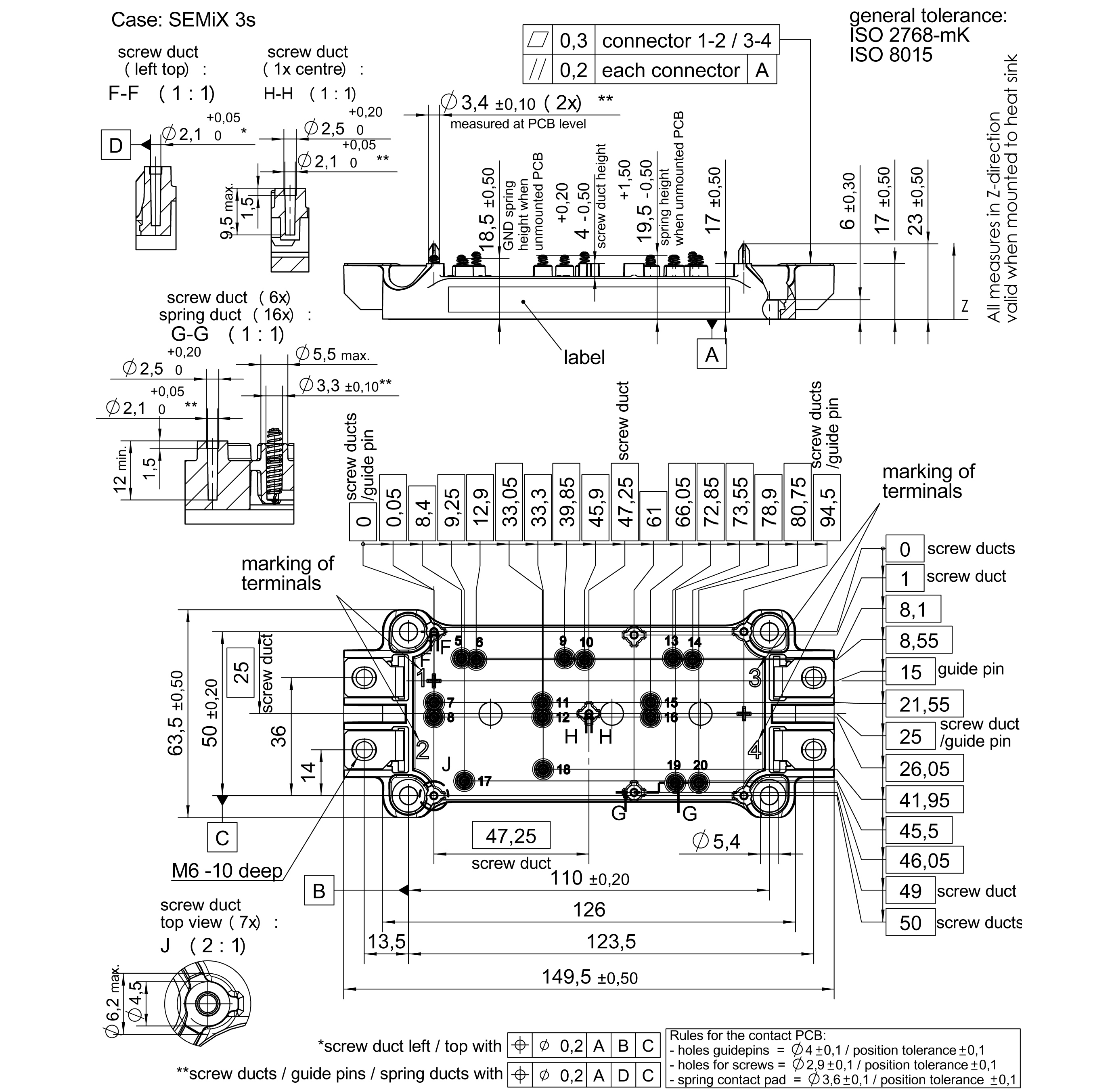


Fig. 12: Typ. CAL diode recovery charge



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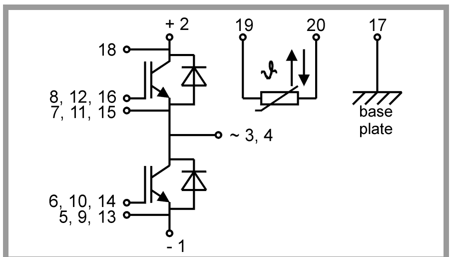

spring configuration

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

* The specifications of our components may not be considered as an assurance of component characteristics. Components have to be tested for the respective application. Adjustments may be necessary. The use of SEMIKRON products in life support appliances and systems is subject to prior specification and written approval by SEMIKRON. We therefore strongly recommend prior consultation of our staff.