



SEMiX® 5

3-Level TNPC IGBT-Module

SEMiX305TMLI12E4B

Features

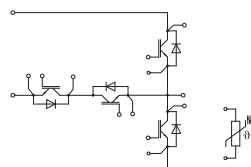
- Solderless assembling solution with PressFIT signal pins and screw power terminals
- IGBT 4 Trench Gate Technology
- $V_{CE(sat)}$ with positive temperature coefficient
- Low inductance case
- Reliable mechanical design with injection moulded terminals and reliable internal connections
- UL recognized file no. E63532
- NTC temperature sensor inside

Remarks*

- Case temperature limited to $T_C=125^{\circ}\text{C}$ max.
- Product reliability results are valid for $T_{jop}=150^{\circ}\text{C}$
- IGBT1: outer IGBTs T1 & T4
- IGBT2: inner IGBTs T2 & T3
- Diode1: outer diodes D1 & D4
- Diode2: inner diodes D2 & D3
- For storage and case temperature with TIM see document "TP(HALA P8) SEMiX 5p"

Absolute Maximum Ratings

Symbol	Conditions	Values	Unit
IGBT1			
V_{CES}	$T_j = 25^{\circ}\text{C}$	1200	V
I_C	$T_j = 175^{\circ}\text{C}$	$T_c = 25^{\circ}\text{C}$	479
		$T_c = 80^{\circ}\text{C}$	369
I_{Cnom}		300	A
I_{CRM}	$I_{CRM} = 3 \times I_{Cnom}$	900	A
V_{GES}		-20 ... 20	V
t_{psc}	$V_{CC} = 800\text{ V}, V_{GE} \leq 15\text{ V}, T_j = 150^{\circ}\text{C}, V_{CES} \leq 1200\text{ V}$	10	μs
T_j		-40 ... 175	$^{\circ}\text{C}$
IGBT2			
V_{CES}	$T_j = 25^{\circ}\text{C}$	650	V
I_C	$T_j = 175^{\circ}\text{C}$	$T_c = 25^{\circ}\text{C}$	360
		$T_c = 80^{\circ}\text{C}$	271
I_{Cnom}		300	A
I_{CRM}	$I_{CRM} = 3 \times I_{Cnom}$	900	A
V_{GES}		-20 ... 20	V
t_{psc}	$V_{CC} = 360\text{ V}, V_{GE} \leq 15\text{ V}, T_j = 150^{\circ}\text{C}, V_{CES} \leq 650\text{ V}$	10	μs
T_j		-40 ... 175	$^{\circ}\text{C}$
Diode1			
V_{RRM}	$T_j = 25^{\circ}\text{C}$	1200	V
I_F	$T_j = 175^{\circ}\text{C}$	$T_c = 25^{\circ}\text{C}$	363
		$T_c = 80^{\circ}\text{C}$	272
I_{Fnom}		300	A
I_{FRM}	$I_{FRM} = 2 \times I_{Fnom}$	600	A
I_{FSM}	10 ms, sin 180°, $T_j = 25^{\circ}\text{C}$	1485	A
T_j		-40 ... 175	$^{\circ}\text{C}$
Diode2			
V_{RRM}	$T_j = 25^{\circ}\text{C}$	650	V
I_F	$T_j = 175^{\circ}\text{C}$	$T_c = 25^{\circ}\text{C}$	366
		$T_c = 80^{\circ}\text{C}$	267
I_{Fnom}		300	A
I_{FRM}	$I_{FRM} = 2 \times I_{Fnom}$	600	A
I_{FSM}	10 ms, sin 180°, $T_j = 25^{\circ}\text{C}$	2160	A
T_j		-40 ... 175	$^{\circ}\text{C}$
Module			
$I_{t(RMS)}$		400	A
T_{stg}	module without TIM	-40 ... 125	$^{\circ}\text{C}$
V_{isol}	AC sinus 50Hz, $t = 1\text{ min}$	4000	V



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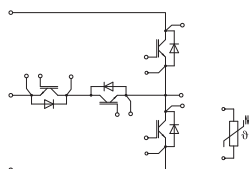
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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
IGBT1						
V _{CE(sat)}	I _C = 300 A	T _j = 25 °C		1.80	2.05	V
	V _{GE} = 15 V chipelevel	T _j = 150 °C		2.20	2.40	V
V _{CE0}	chipelevel	T _j = 25 °C		0.80	0.90	V
		T _j = 150 °C		0.70	0.80	V
r _{CE}	V _{GE} = 15 V chipelevel	T _j = 25 °C		3.3	3.8	mΩ
		T _j = 150 °C		5.0	5.3	mΩ
V _{GE(th)}	V _{GE} = V _{CE} , I _C = 11.4 mA		5	5.8	6.5	V
I _{CES}	V _{GE} = 0 V, V _{CE} = 1200 V, T _j = 25 °C				4	mA
C _{ies}	V _{CE} = 25 V V _{GE} = 0 V	f = 1 MHz		18.5		nF
C _{oes}		f = 1 MHz		1.22		nF
C _{res}		f = 1 MHz		1.04		nF
Q _G	V _{GE} = - 15 V...+ 15 V			2265		nC
R _{Gint}	T _j = 25 °C			2.5		Ω
t _{d(on)}	V _{CC} = 300 V	T _j = 150 °C		232		ns
t _r	I _C = 300 A	T _j = 150 °C		128		ns
E _{on}	V _{GE} = +15/-15 V	T _j = 150 °C		4.5		mJ
t _{d(off)}	R _{G on} = 2 Ω	T _j = 150 °C		422		ns
t _f	R _{G off} = 2 Ω	T _j = 150 °C		121		ns
E _{off}	di/dt _{on} = 2437 A/μs di/dt _{off} = 3000 A/μs	T _j = 150 °C		21		mJ
R _{th(j-c)}	per IGBT				0.09	K/W
R _{th(c-s)}	per IGBT (λgrease=0.81 W/(m*K))			0.04		K/W
R _{th(c-s)}	per IGBT, pre-applied phase change material			0.021		K/W
IGBT2						
V _{CE(sat)}	I _C = 300 A	T _j = 25 °C		1.55	1.95	V
	V _{GE} = 15 V chipelevel	T _j = 150 °C		1.75	2.15	V
V _{CE0}	chipelevel	T _j = 25 °C		0.90	1.00	V
		T _j = 150 °C		0.82	0.90	V
r _{CE}	V _{GE} = 15 V chipelevel	T _j = 25 °C		2.2	3.2	mΩ
		T _j = 150 °C		3.1	4.2	mΩ
V _{GE(th)}	V _{GE} = V _{CE} , I _C = 8 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		18.5		nF
C _{oes}		f = 1 MHz		1.16		nF
C _{res}		f = 1 MHz		0.55		nF
Q _G	V _{GE} = - 15 V...+ 15 V			3318		nC
R _{Gint}	T _j = 25 °C			1.0		Ω
t _{d(on)}	V _{CC} = 300 V	T _j = 150 °C		170		ns
t _r	I _C = 300 A	T _j = 150 °C		118		ns
E _{on}	V _{GE} = +15/-15 V	T _j = 150 °C		2.25		mJ
t _{d(off)}	R _{G on} = 2 Ω	T _j = 150 °C		380		ns
t _f	R _{G off} = 2 Ω	T _j = 150 °C		127		ns
E _{off}	di/dt _{on} = 3100 A/μs di/dt _{off} = 2800 A/μs	T _j = 150 °C		17.25		mJ
R _{th(j-c)}	per IGBT				0.17	K/W
R _{th(c-s)}	per IGBT (λgrease=0.81 W/(m*K))			0.064		K/W
R _{th(c-s)}	per IGBT, pre-applied phase change material			0.059		K/W

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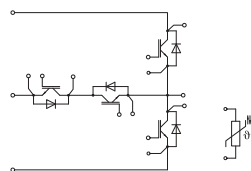
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Characteristics

Symbol	Conditions	min.	typ.	max.	Unit
Diode1					
$V_F = V_{EC}$	$I_F = 300\text{ A}$ $V_{GE} = 0\text{ V}$ chipelevel	$T_j = 25^\circ\text{C}$	2.20	2.52	V
		$T_j = 150^\circ\text{C}$	2.15	2.47	V
V_{F0}	chipelevel	$T_j = 25^\circ\text{C}$	1.30	1.50	V
		$T_j = 150^\circ\text{C}$	0.90	1.10	V
r_F	chipelevel	$T_j = 25^\circ\text{C}$	3.0	3.4	mΩ
		$T_j = 150^\circ\text{C}$	4.2	4.6	mΩ
I_{RRM}	$I_F = 300\text{ A}$	$T_j = 150^\circ\text{C}$	160		A
Q_{rr}	$di/dt_{off} = 3100\text{ A}/\mu\text{s}$ $V_{CC} = 300\text{ V}$	$T_j = 150^\circ\text{C}$	41.7		μC
E_{rr}	$V_{GE} = +15/-15\text{ V}$	$T_j = 150^\circ\text{C}$	8.8		mJ
$R_{th(j-c)}$	per diode			0.16	K/W
$R_{th(c-s)}$	per diode ($\lambda_{grease}=0.81\text{ W}/(\text{m}^2\text{K})$)		0.05		K/W
$R_{th(c-s)}$	per diode, pre-applied phase change material		0.041		K/W
Diode2					
$V_F = V_{EC}$	$I_F = 300\text{ A}$ $V_{GE} = 0\text{ V}$ chipelevel	$T_j = 25^\circ\text{C}$	1.40	1.76	V
		$T_j = 150^\circ\text{C}$	1.39	1.77	V
V_{F0}	chipelevel	$T_j = 25^\circ\text{C}$	1.04	1.24	V
		$T_j = 150^\circ\text{C}$	0.85	0.99	V
r_F	chipelevel	$T_j = 25^\circ\text{C}$	1.19	1.76	mΩ
		$T_j = 150^\circ\text{C}$	1.79	2.6	mΩ
I_{RRM}	$I_F = 300\text{ A}$	$T_j = 150^\circ\text{C}$	181		A
Q_{rr}	$di/dt_{off} = 2437\text{ A}/\mu\text{s}$ $V_R = 300\text{ V}$	$T_j = 150^\circ\text{C}$	34.5		μC
E_{rr}	$V_{GE} = +15/-15\text{ V}$	$T_j = 150^\circ\text{C}$	8.2		mJ
$R_{th(j-c)}$	per diode			0.22	K/W
$R_{th(c-s)}$	per diode ($\lambda_{grease}=0.81\text{ W}/(\text{m}^2\text{K})$)		0.06		K/W
$R_{th(c-s)}$	per diode, pre-applied phase change material		0.059		K/W
Module					
L_{sCE1}			31		nH
L_{CE}			42		nH
$R_{CC'+EE'}$	measured between terminal 5 and 1	$T_C = 25^\circ\text{C}$	0.8		mΩ
		$T_C = 125^\circ\text{C}$	1.1		mΩ
$R_{th(c-s)1}$	calculated without thermal coupling		0.006		K/W
$R_{th(c-s)2}$	including thermal coupling, Ts underneath module ($\lambda_{grease}=0.81\text{ W}/(\text{m}^2\text{K})$)		0.0106		K/W
$R_{th(c-s)2}$	including thermal coupling, Ts underneath module, pre-applied phase change material		0.0077		K/W
M_s	to heat sink (M5)		3	6	Nm
M_t		to terminals (M6)	3	6	Nm
					Nm
w			398		g
Temperature Sensor					
R_{100}	$T_C=100^\circ\text{C}$ ($R_{25}=5\text{ k}\Omega$)		$493 \pm 5\%$		Ω
$B_{100/125}$	$R(T)=R_{100}\exp[B_{100/125}(1/T-1/T_{100})]$; $T[K]$		$3550 \pm 2\%$		K

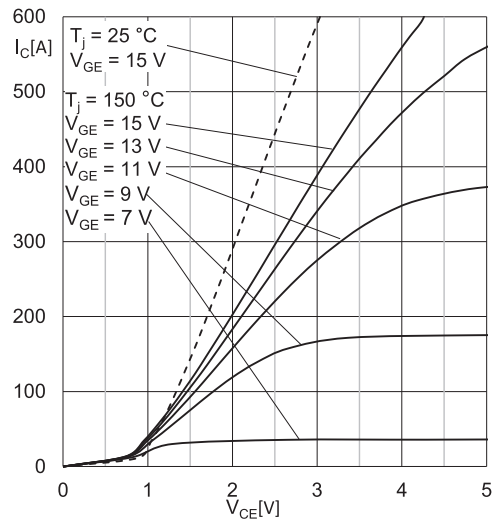


Fig. 1: Typ. IGBT1 output characteristic, incl. $R_{CC'+EE'}$

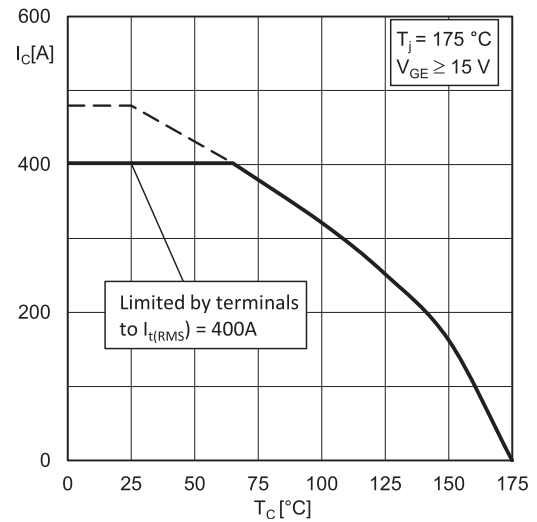


Fig. 2: IGBT1 rated current vs. Temperature $I_C=f(T_c)$

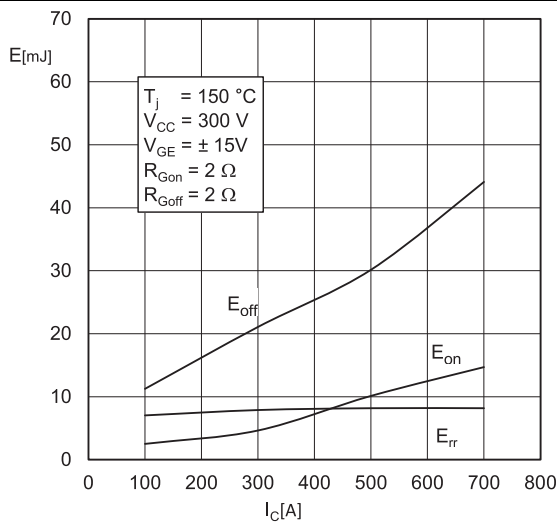


Fig. 3: Typ. IGBT1 & Diode2 turn-on /-off energy = $f(I_C)$

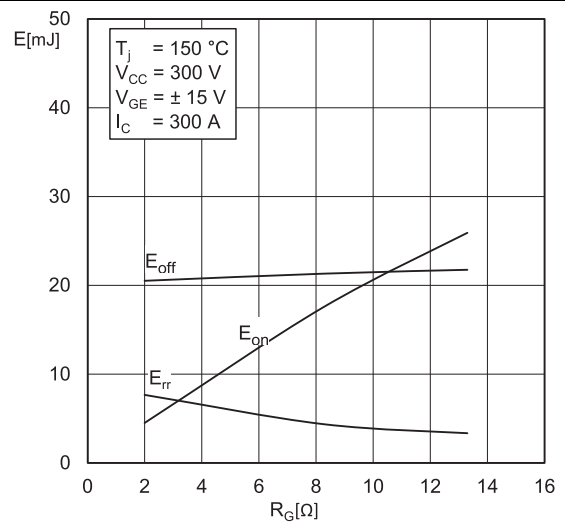


Fig. 4: Typ. IGBT1 & Diode2 turn-on /-off energy = $f(R_G)$

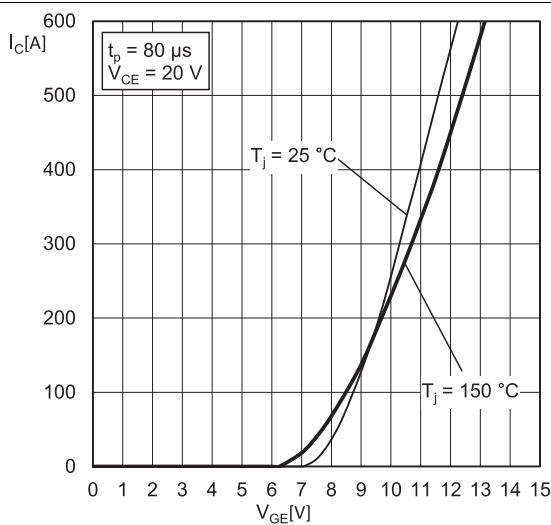


Fig. 5: Typ. IGBT1 transfer characteristic

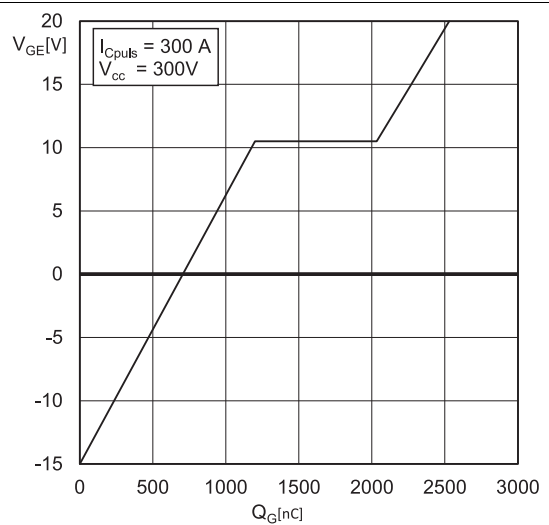


Fig. 6: Typ. IGBT1 gate charge characteristic

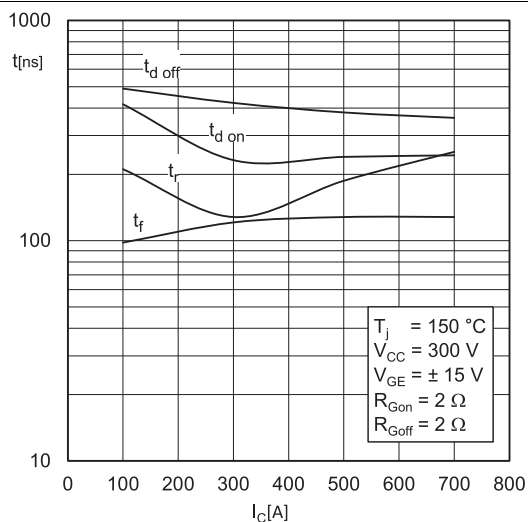


Fig. 7: Typ. IGBT1 switching times vs. I_C

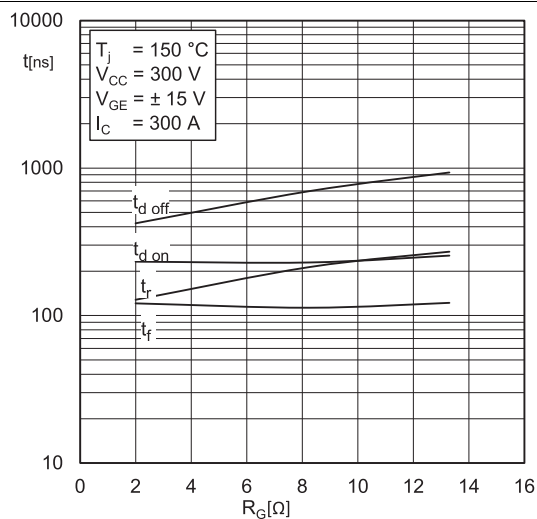


Fig. 8: Typ. IGBT1 switching times vs. gate resistor R_G

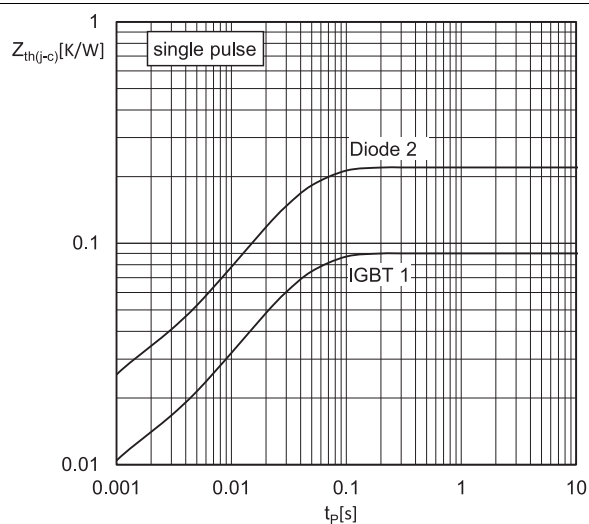


Fig. 9: Transient thermal impedance of IGBT1 & Diode2

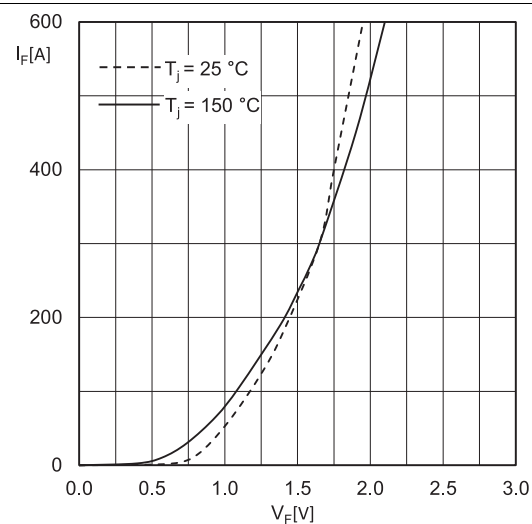


Fig. 10: Typ. Diode2 forward characteristic, incl. $R_{CC'+EE'}$

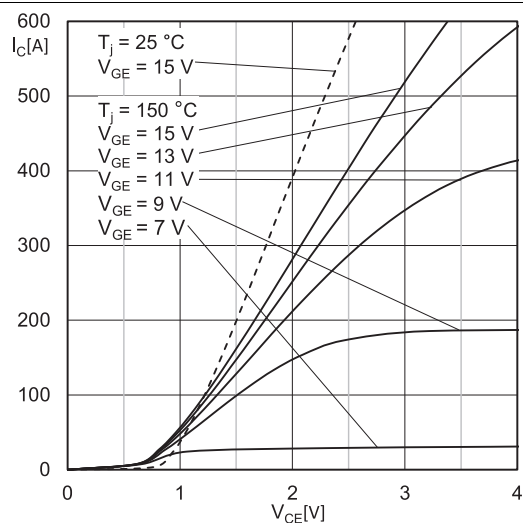


Fig. 13: Typ. IGBT2 output characteristic, incl. $R_{CC'+EE'}$

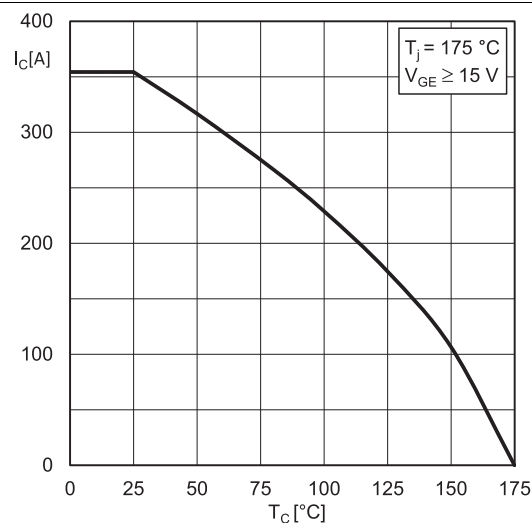


Fig. 14: IGBT2 Rated current vs. Temperature $I_C = f(T_C)$

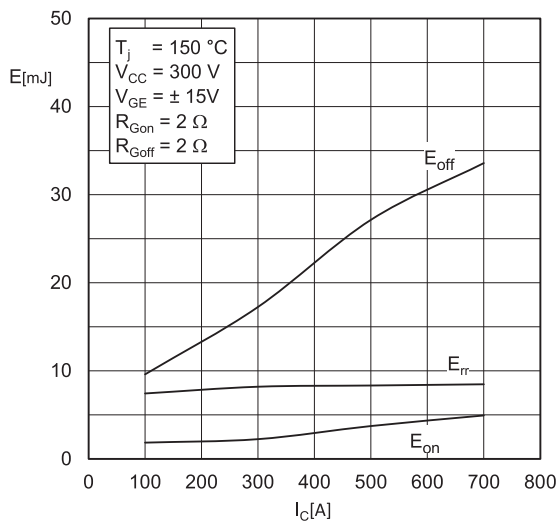


Fig. 15: Typ. IGBT2 & Diode1 turn-on /-off energy = $f(I_C)$

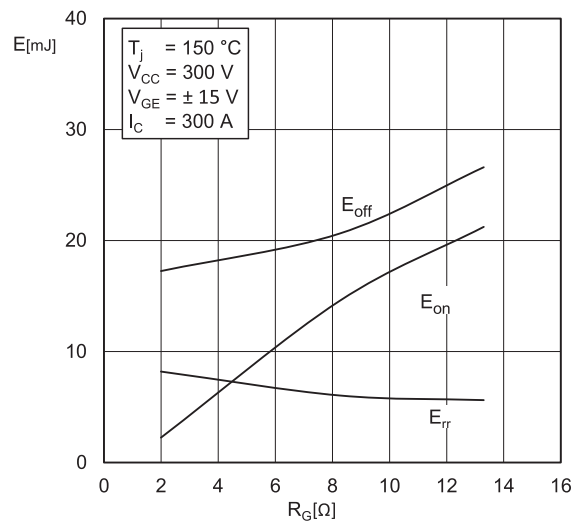


Fig. 16: Typ. IGBT2 & Diode1 turn-on /-off energy = $f(R_G)$

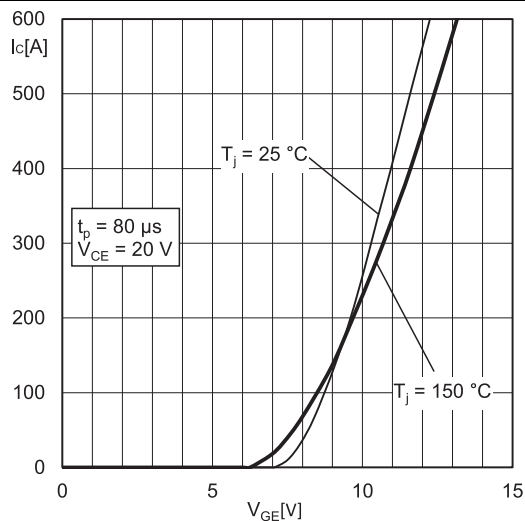


Fig. 17: Typ. IGBT2 transfer characteristic

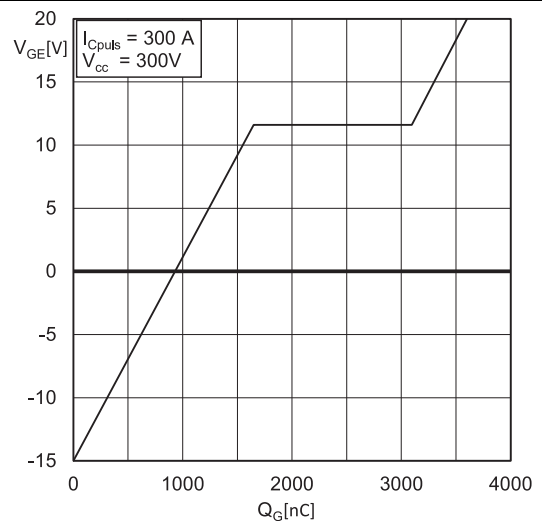


Fig. 18: Typ. IGBT2 gate charge characteristic

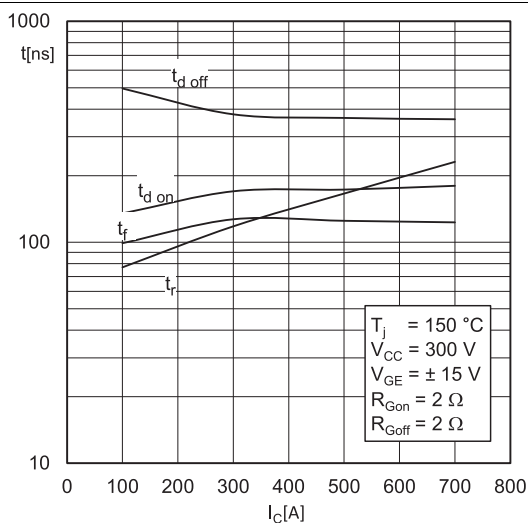


Fig. 19: Typ. IGBT2 switching times vs. I_C

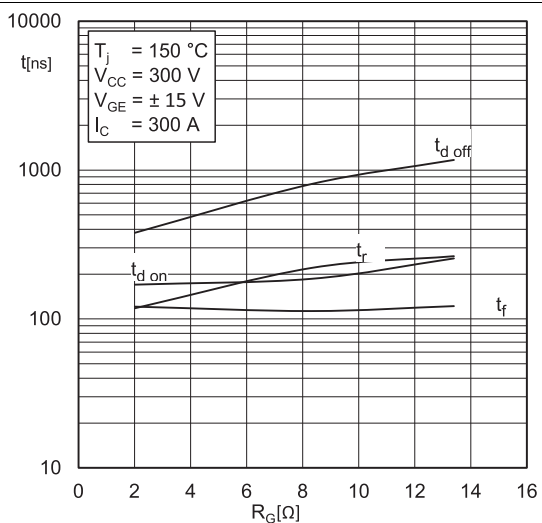


Fig. 20: Typ. IGBT2 switching times vs. gate resistor R_G

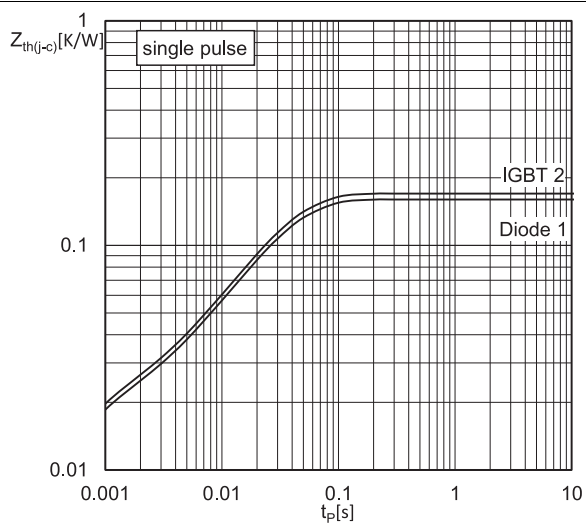


Fig. 21: Transient thermal impedance of IGBT2 & Diode1

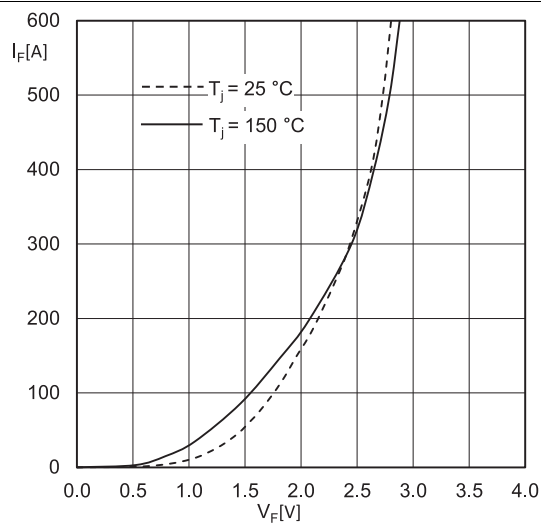
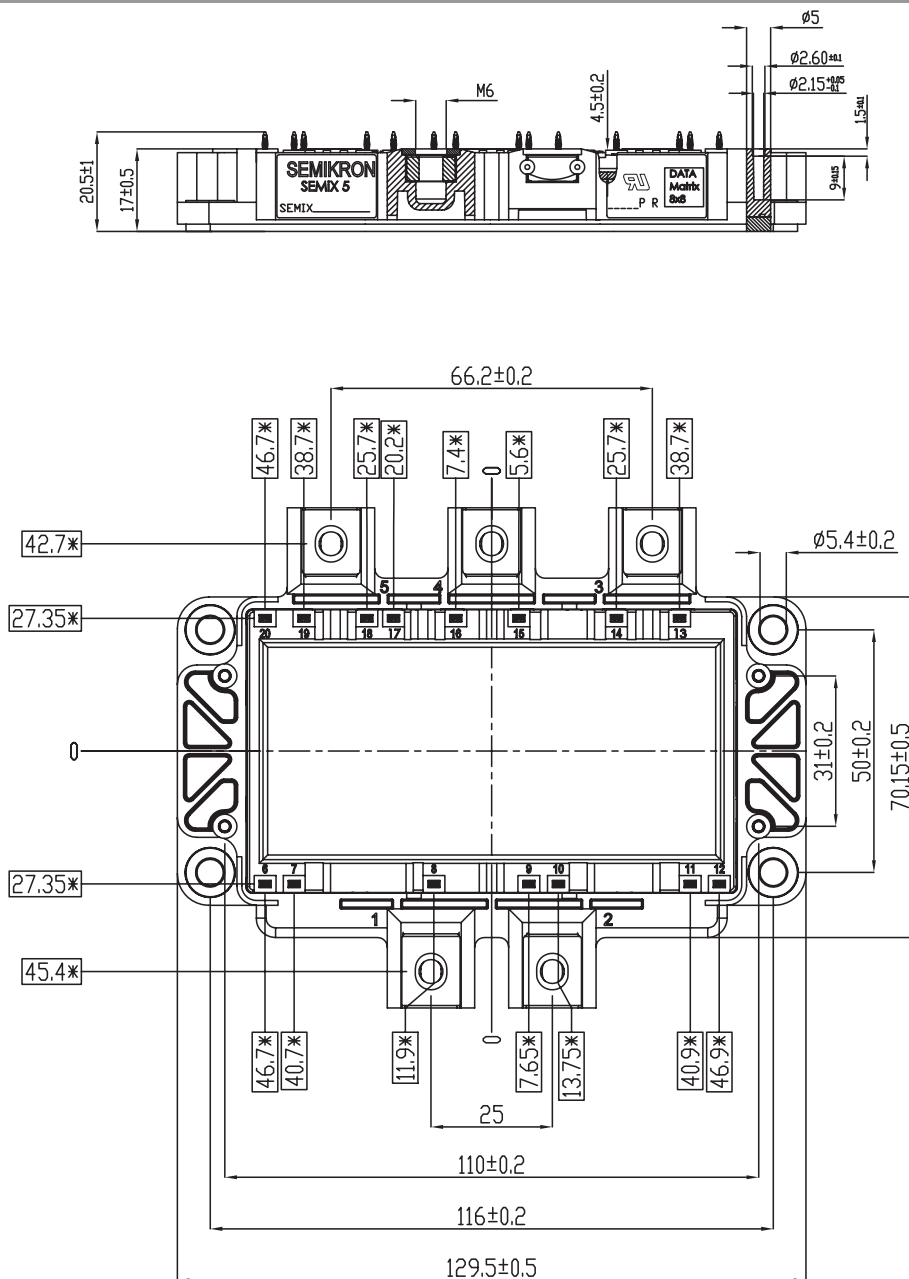


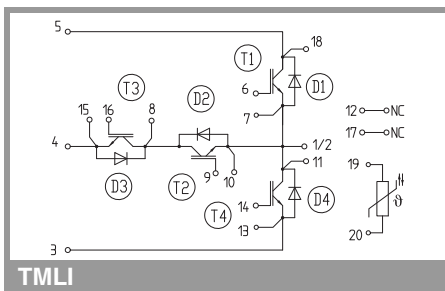
Fig. 22: Typ. Diode1 forward characteristic, incl. $R_{cc'+EE'}$



* = All dimension with tolerance of ± 0.4

For technical details please refer to SEMiX(R)5 Mounting Instruction

SEMIX5p



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

***IMPORTANT INFORMATION AND WARNINGS**

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