

SEMiX405TMLI12E4B



SEMiX® 5

3-Level TNPC IGBT-Module

SEMiX405TMLI12E4B

Features*

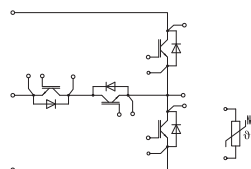
- Solderless assembling solution with PressFIT signal pins and screw power terminals
- IGBT 4 Trench Gate Technology
- $V_{CE(sat)}$ with positive temperature coefficient
- Low inductance case
- Reliable mechanical design with injection moulded terminals and reliable internal connections
- UL recognized 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	$T_j = 175^{\circ}\text{C}$	$T_c = 25^{\circ}\text{C}$	636
		$T_c = 80^{\circ}\text{C}$	490
I_{Cnom}		400	A
I_{CRM}		1200	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	$T_j = 175^{\circ}\text{C}$	$T_c = 25^{\circ}\text{C}$	452
		$T_c = 80^{\circ}\text{C}$	339
I_{Cnom}		400	A
I_{CRM}		1200	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	$T_j = 175^{\circ}\text{C}$	$T_c = 25^{\circ}\text{C}$	461
		$T_c = 80^{\circ}\text{C}$	345
I_{FRM}		800	A
I_{FSM}	10 ms, sin 180°, $T_j = 25^{\circ}\text{C}$	1980	A
T_j		-40 ... 175	$^{\circ}\text{C}$
Diode2			
V_{RRM}	$T_j = 25^{\circ}\text{C}$	650	V
I_F	$T_j = 175^{\circ}\text{C}$	$T_c = 25^{\circ}\text{C}$	466
		$T_c = 80^{\circ}\text{C}$	338
I_{FRM}		800	A
I_{FSM}	10 ms, sin 180°, $T_j = 25^{\circ}\text{C}$	2646	A
T_j		-40 ... 175	$^{\circ}\text{C}$
Module			
$I_t(\text{RMS})$		450	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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- NTC temperature sensor inside

Typical Applications

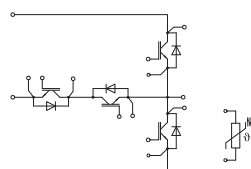
- UPS
- Solar
- Motor drives

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Characteristics

Symbol	Conditions	min.	typ.	max.	Unit
IGBT 1					
$V_{CE(sat)}$	$I_C = 400\text{ A}$ $V_{GE} = 15\text{ V}$ chipllevel	$T_j = 25^{\circ}\text{C}$	1.80	2.05	V
		$T_j = 150^{\circ}\text{C}$	2.20	2.40	V
V_{CE0}	chipllevel	$T_j = 25^{\circ}\text{C}$	0.80	0.90	V
		$T_j = 150^{\circ}\text{C}$	0.70	0.80	V
r_{CE}	$V_{GE} = 15\text{ V}$ chipllevel	$T_j = 25^{\circ}\text{C}$	2.5	2.9	m Ω
		$T_j = 150^{\circ}\text{C}$	3.8	4.0	m Ω
$V_{GE(th)}$	$V_{GE} = V_{CE}, I_C = 15.2\text{ mA}$	5	5.8	6.5	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	$V_{GE} = -15\text{ V} \dots +15\text{ V}$		3026		nC
R_{Gint}	$T_j = 25^{\circ}\text{C}$		1.9		Ω
$t_{d(on)}$	$V_{CC} = 300\text{ V}$ $I_C = 400\text{ A}$	$T_j = 150^{\circ}\text{C}$	215		ns
t_r	$V_{GE\text{ neg}} = -15\text{ V}$ $V_{GE\text{ pos}} = 15\text{ V}$	$T_j = 150^{\circ}\text{C}$	116		ns
E_{on}	$R_{G\text{ on}} = 2.5\text{ }\Omega$	$T_j = 150^{\circ}\text{C}$	21.4		mJ
$t_{d(off)}$	$R_{G\text{ off}} = 1.5\text{ }\Omega$	$T_j = 150^{\circ}\text{C}$	434		ns
t_f	$di/dt_{on} = 3010\text{ A}/\mu\text{s}$ $di/dt_{off} = 2740\text{ A}/\mu\text{s}$ $dv/dt = 2390\text{ V}/\mu\text{s}$ $L_s = 18\text{ nH}$	$T_j = 150^{\circ}\text{C}$	128		ns
E_{off}		$T_j = 150^{\circ}\text{C}$	29		mJ
$t_{d(on)}$	$V_{CC} = 300\text{ V}$ $I_C = 400\text{ A}$	$T_j = 150^{\circ}\text{C}$	222		ns
t_r	$V_{GE\text{ neg}} = -15\text{ V}$ $V_{GE\text{ pos}} = 15\text{ V}$	$T_j = 150^{\circ}\text{C}$	97		ns
E_{on}	$R_{G\text{ on}} = 1\text{ }\Omega$	$T_j = 150^{\circ}\text{C}$	13		mJ
$t_{d(off)}$	$R_{G\text{ off}} = 1.5\text{ }\Omega$	$T_j = 150^{\circ}\text{C}$	770		ns
t_f	$di/dt_{on} = 3800\text{ A}/\mu\text{s}$ $di/dt_{off} = 2740\text{ A}/\mu\text{s}$ $dv/dt = 2390\text{ V}/\mu\text{s}$ $C_{GE} = 22\text{ nF}$ DC-Link-snubber = 680 nF	$T_j = 150^{\circ}\text{C}$	130		ns
E_{off}		$T_j = 150^{\circ}\text{C}$	29		mJ
$R_{th(j-c)}$	per IGBT			0.068	K/W
$R_{th(c-s)}$	per IGBT ($\lambda_{grease}=0.81\text{ W}/(\text{m}^2\text{K})$)		0.027		K/W
$R_{th(c-s)}$	per IGBT, pre-applied phase change material		0.015		K/W



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- UL recognized file no. E63532
- NTC temperature sensor inside

Typical Applications

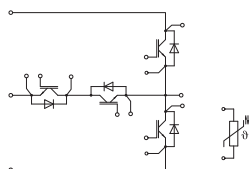
- UPS
- Solar
- Motor drives

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
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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
IGBT 2						
V _{CE(sat)}	I _C = 400 A	T _j = 25 °C		1.55	1.95	V
	V _{GE} = 15 V chiplevel	T _j = 150 °C		1.75	2.15	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		1.63	2.4	mΩ
		T _j = 150 °C		2.3	3.1	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				0.7	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} = -15V...+15V			4420		nC
R _{Gint}	T _j = 25 °C			1.0		Ω
t _{d(on)}	V _{CC} = 300 V	T _j = 150 °C		143		ns
t _r	I _C = 400 A	T _j = 150 °C		66		ns
E _{on}	R _{G on} = 0.5 Ω	T _j = 150 °C		2.8		mJ
	R _{G off} = 0.5 Ω	T _j = 150 °C				
t _{d(off)}	di/dt _{on} = 5720 A/μs	T _j = 150 °C		311		ns
t _f	di/dt _{off} = 2970 A/μs	T _j = 150 °C		125		ns
E _{off}	V _{GE} = +15/-15 V dv/dt = 3610 V/μs L _s = 18 nH	T _j = 150 °C		23.9		mJ
R _{th(j-c)}	per IGBT				0.14	K/W
R _{th(c-s)}	per IGBT (λgrease=0.81 W/(m*K))			0.058		K/W
R _{th(c-s)}	per IGBT, pre-applied phase change material			0.046		K/W

Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
Diode 1						
V _F = V _{EC}	I _F = 400 A	T _j = 25 °C		2.20	2.52	V
	V _{GE} = 0 V chiplevel	T _j = 150 °C		2.15	2.47	V
V _{F0}	chiplevel	T _j = 25 °C		1.30	1.50	V
		T _j = 150 °C		0.90	1.10	V
r _F	chiplevel	T _j = 25 °C		2.3	2.6	mΩ
		T _j = 150 °C		3.1	3.4	mΩ
I _{RRM}	I _F = 400 A	T _j = 150 °C		292		A
Q _{rr}	di/dt _{off} = 5720 A/μs	T _j = 150 °C		52.9		μC
E _{rr}	V _{GE} = -15 V V _{CC} = 300 V	T _j = 150 °C		16.4		mJ
R _{th(j-c)}	per diode				0.13	K/W
R _{th(c-s)}	per diode (λgrease=0.81 W/(m*K))			0.036		K/W
R _{th(c-s)}	per diode, pre-applied phase change material			0.028		K/W



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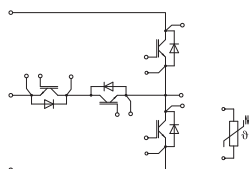
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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
Diode 2						
V _F = V _{EC}	I _F = 400 A	T _j = 25 °C		1.39	1.75	V
	V _{GE} = 0 V chiplevel	T _j = 150 °C		1.38	1.76	V
V _{F0}	chiplevel	T _j = 25 °C		1.04	1.24	V
		T _j = 150 °C		0.85	0.99	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	T _j = 150 °C		227		A
Q _{rr}	di/dt _{off} = 3010 A/μs	T _j = 150 °C		33.5		μC
E _{rr}	V _{GE} = -15 V V _{CC} = 300 V	T _j = 150 °C		7.8		mJ
I _{RRM}	I _F = 400 A	T _j = 150 °C		314		A
Q _{rr}	di/dt _{off} = 3800 A/μs	T _j = 150 °C		37		μC
E _{rr}	V _{GE} = -15 V V _R = 300 V	T _j = 150 °C		8.5		mJ
R _{th(j-c)}	per diode			0.18		K/W
R _{th(c-s)}	per diode (λgrease=0.81 W/(m*K))			0.053		K/W
R _{th(c-s)}	per diode, pre-applied phase change material			0.046		K/W

Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
Module						
L _{sCE1}				31		nH
L _{CE}				42		nH
R _{CC'+EE'}	measured	T _C = 25 °C		0.8		mΩ
	between terminal 5 and 1	T _C = 125 °C		1.1		mΩ
R _{th(c-s)1}	calculated without thermal coupling			0.005		K/W
R _{th(c-s)2}	including thermal coupling, T _s underneath module (λ _{grease} =0.81 W/(m*K))			0.008		K/W
R _{th(c-s)2}	including thermal coupling, T _s underneath module, pre-applied phase change material			0.006		K/W
M _s	to heat sink (M5)		3		6	Nm
M _t	to terminals (M6)		3		6	Nm
w				398		g

Characteristics					
Symbol	Conditions	min.	typ.	max.	Unit
Temperature 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



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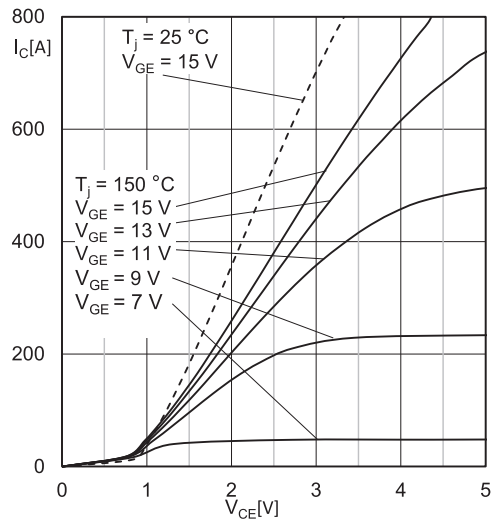


Fig. 1: Typ. IGBT1 output characteristic, incl. $R_{CC}'+EE'$

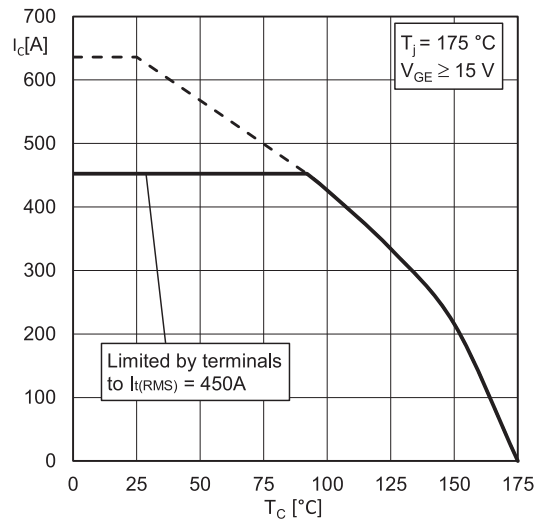


Fig. 2: IGBT1 rated current vs. Temperature $I_c=f(T_c)$

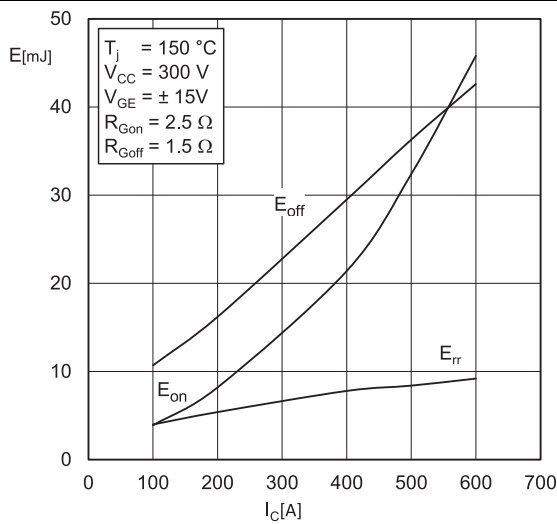


Fig. 3: Typ. IGBT1 & Diode2 turn-on /-off energy = $f(I_C)$

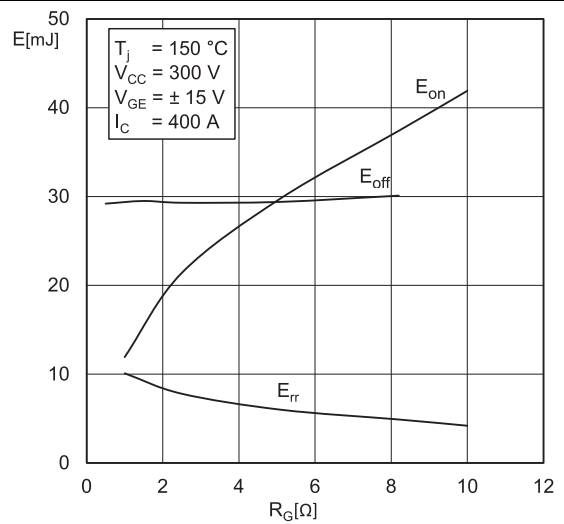


Fig. 4: Typ. IGBT1 & Diode2 turn-on /-off energy = $f(R_G)$

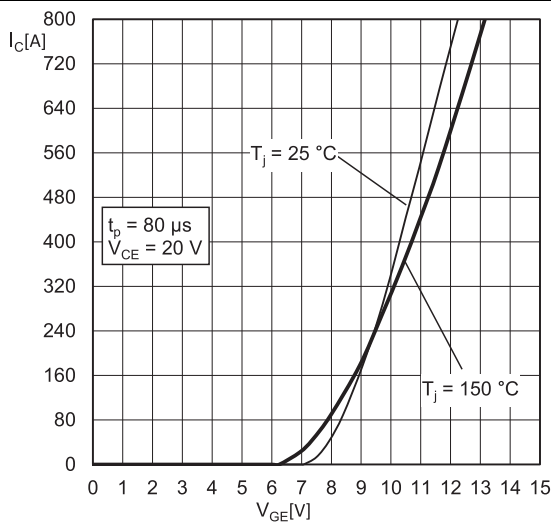


Fig. 5: Typ. IGBT1 transfer characteristic

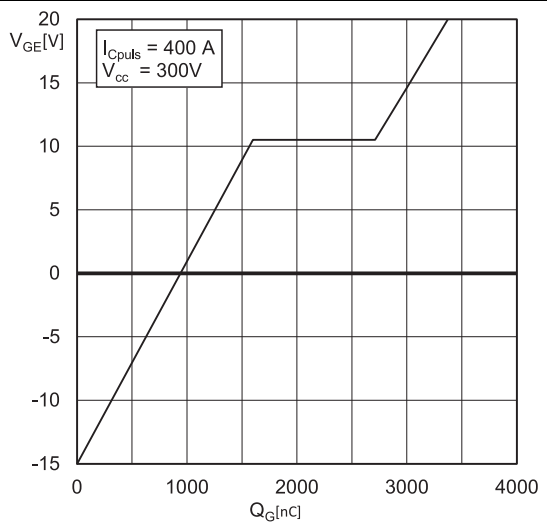


Fig. 6: Typ. IGBT1 gate charge characteristic

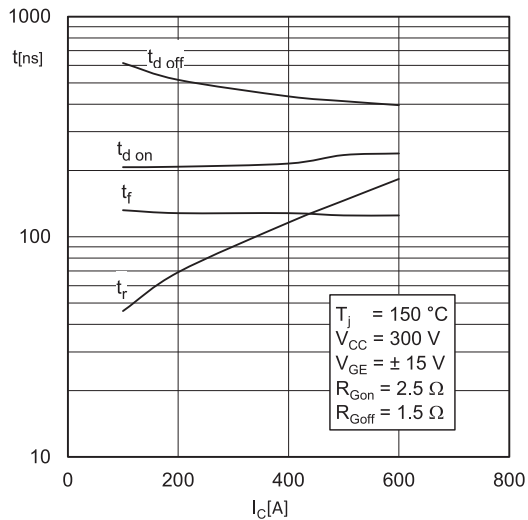


Fig. 7: Typ. IGBT1 switching times vs. I_C

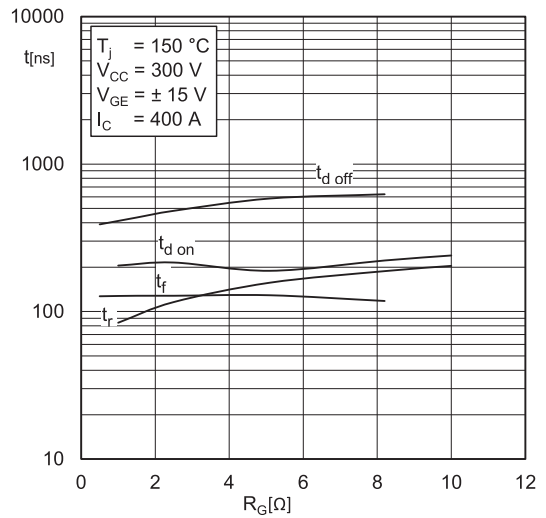


Fig. 8: Typ. IGBT1 switching times vs. gate resistor R_G

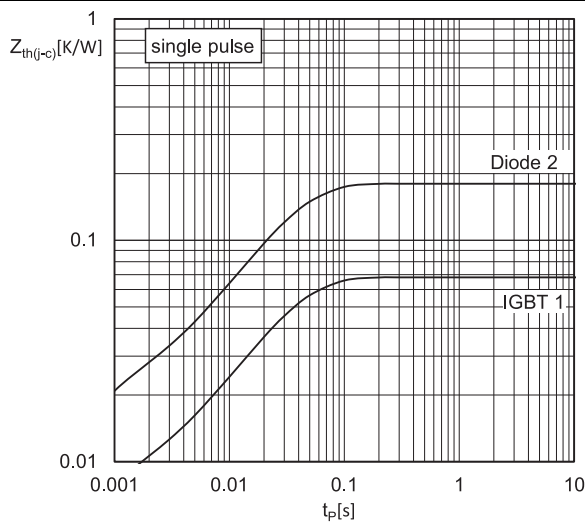


Fig. 9: Typ. Transient thermal impedance of IGBT1 & Diode2

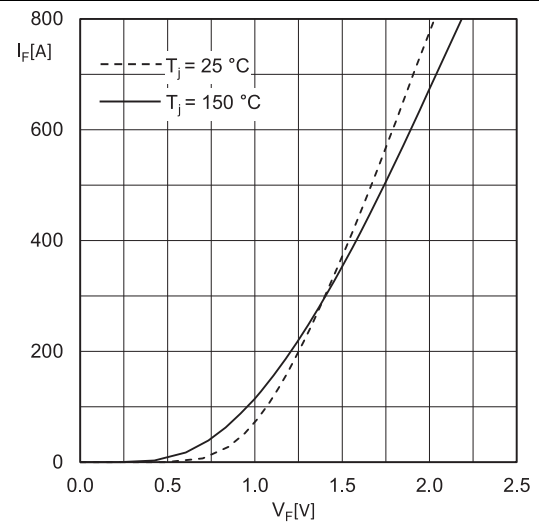


Fig. 10: Typ. Diode2 forward characteristic, incl. $R_{CC'} + EE'$

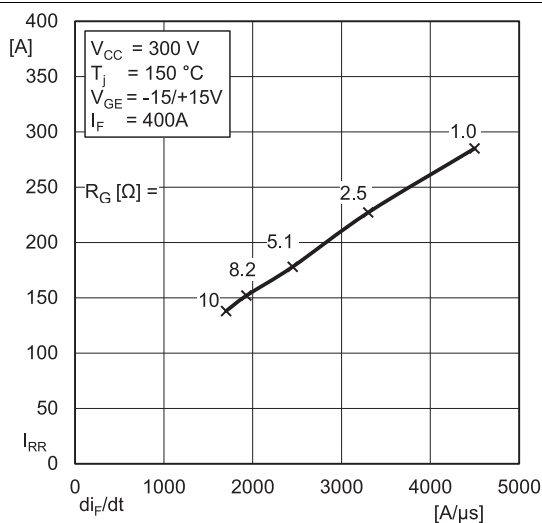


Fig. 11: Typ. Diode2 peak reverse recovery current

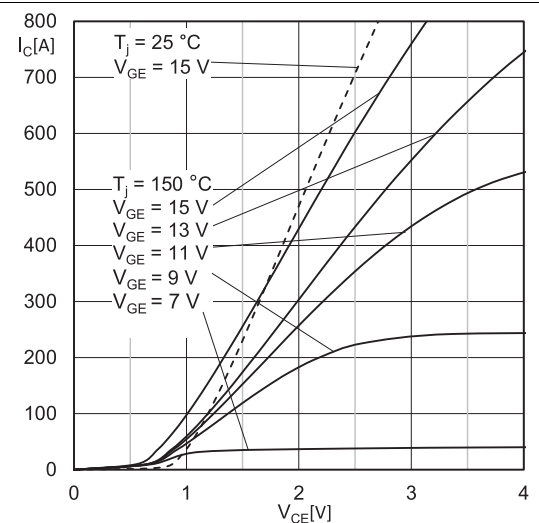


Fig. 13: Typ. IGBT2 output characteristic, incl. $R_{CC'} + EE'$

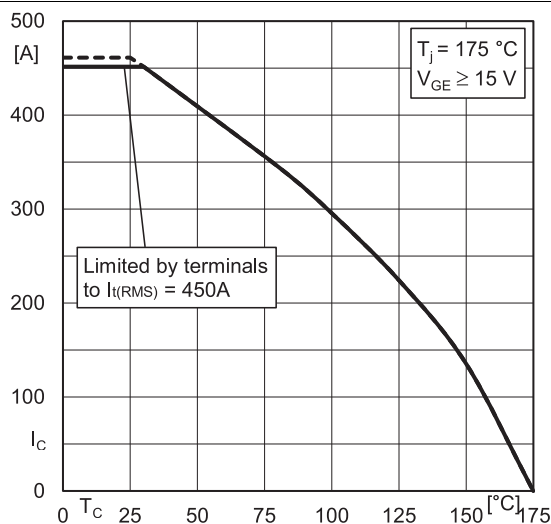


Fig. 14: IGBT2 Rated current vs. Temperature $I_c = f(T_c)$

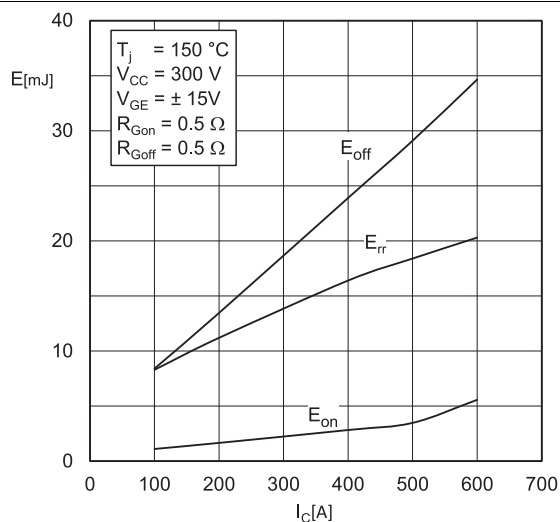


Fig. 15: Typ. IGBT2 & Diode1 turn-on /-off energy = $f(I_c)$

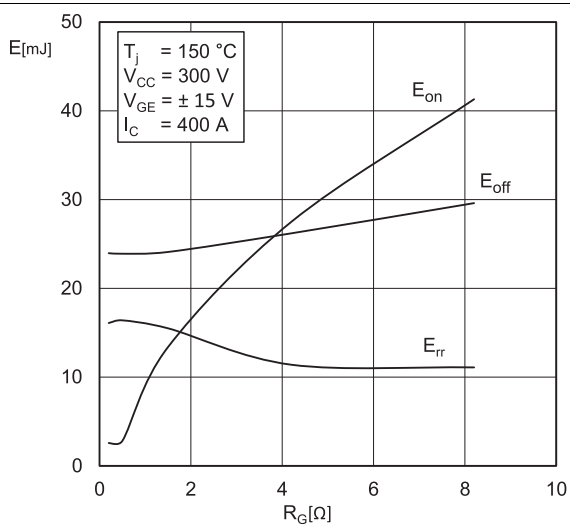


Fig. 16: Typ. IGBT2 & Diode1 turn-on /-off energy = $f(R_G)$

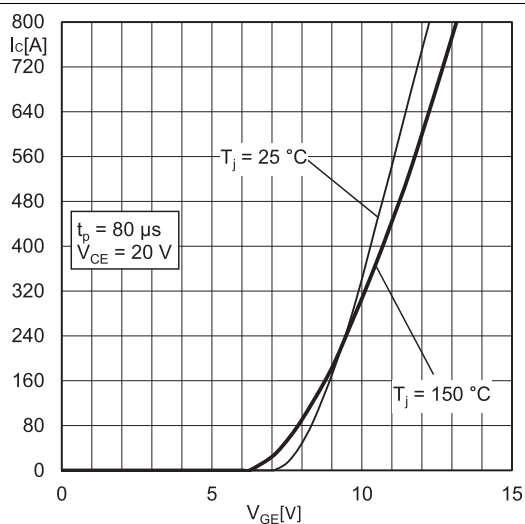


Fig. 17: Typ. IGBT2 transfer characteristic

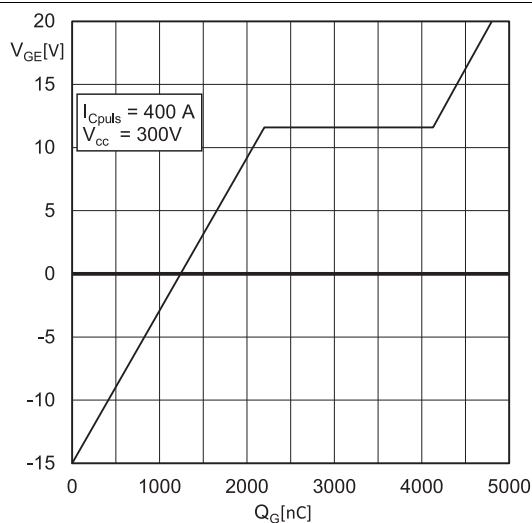


Fig. 18: Typ. IGBT2 gate charge characteristic

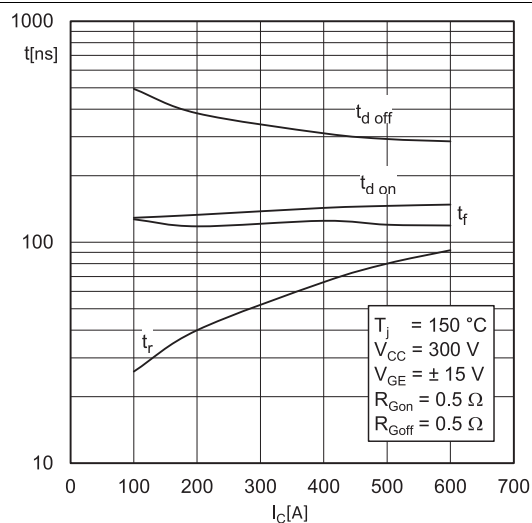


Fig. 19: Typ. IGBT2 switching times vs. I_c

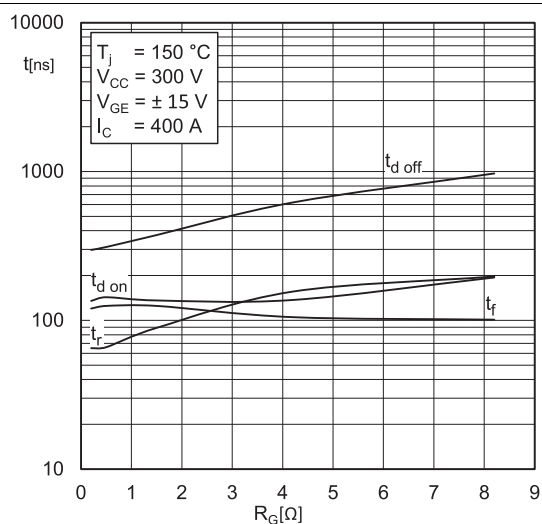


Fig. 20: Typ. IGBT2 switching times vs. gate resistor R_G

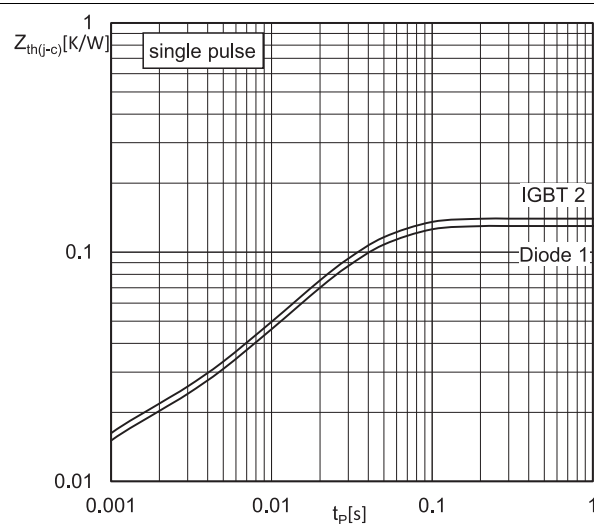


Fig. 21: Transient thermal impedance of IGBT2 & Diode1

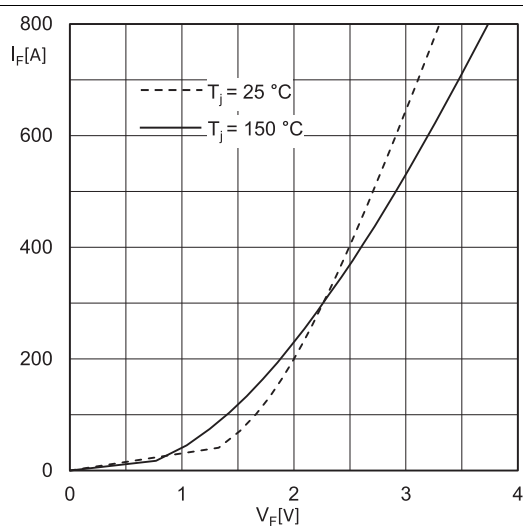


Fig. 22: Typ. Diode1 forward characteristic, incl. $R_{CC'+EE'}$

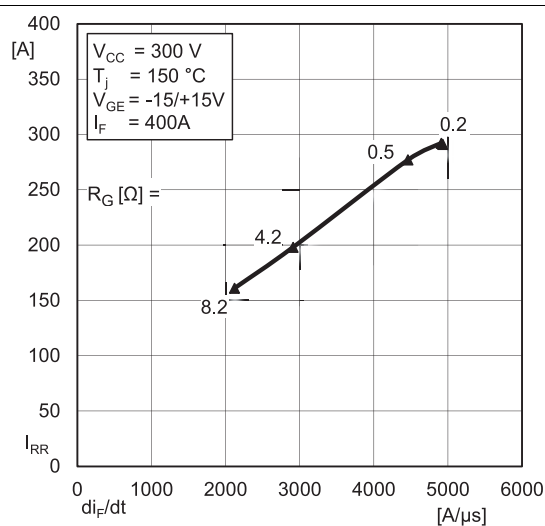
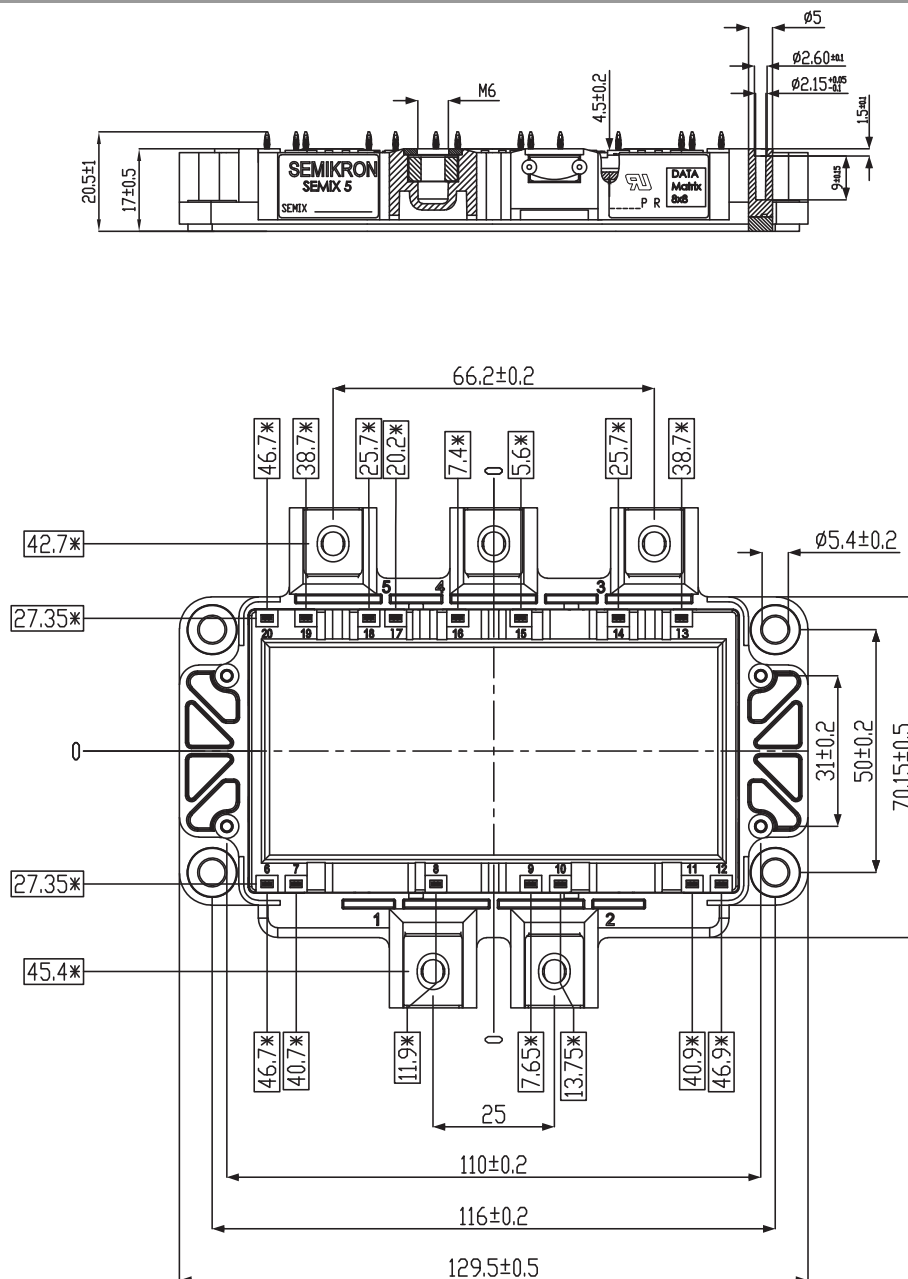


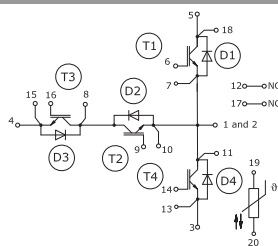
Fig. 23: Typ. Diode1 peak reverse recovery current



* = Dimensions in mm with tolerance of ± 0.4

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

SEMiX5p



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

***IMPORTANT INFORMATION AND WARNINGS**

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