



SEMiX® 5

3-Level NPC IGBT-Module

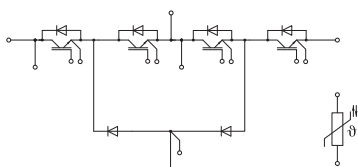
SEMiX405MLI07E4

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
- Diode5 : clamping diodes D5 & D6
- For storage and case temperature with TIM see document "TP(HALA P8) SEMiX 5p"



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Absolute Maximum Ratings

Symbol	Conditions		Values	Unit
IGBT1				
V _{CES}	T _j = 25 °C		650	V
I _C	T _j = 175 °C	T _c = 25 °C	474	A
		T _c = 80 °C	357	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, T _j = 150 °C, V _{CES} ≤650 V		10	μs
T _j			-40 ... 175	°C
IGBT2				
V _{CES}	T _j = 25 °C		650	V
I _C	T _j = 175 °C	T _c = 25 °C	453	A
		T _c = 80 °C	340	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, T _j = 150 °C, V _{CES} ≤ 650 V		10	μs
T _j			-40 ... 175	°C
Diode1				
V _{RRM}	T _j = 25 °C		650	V
I _F	T _j = 175 °C	T _c = 25 °C	377	A
		T _c = 80 °C	276	A
I _{Fnom}			300	A
I _{FRM}	I _{FRM} = 2 x I _{Fnom}		600	A
I _{FSM}	10 ms, sin 180°, T _j = 25 °C		2160	A
T _j			-40 ... 175	°C
Diode2				
V _{RRM}	T _j = 25 °C		650	V
I _F	T _j = 175 °C	T _c = 25 °C	345	A
		T _c = 80 °C	251	A
I _{Fnom}			300	A
I _{FRM}	I _{FRM} = 2 x I _{Fnom}		600	A
I _{FSM}	10 ms, sin 180°, T _j = 25 °C		2160	A
T _j			-40 ... 175	°C
Diode5				
V _{RRM}	T _j = 25 °C		650	V
I _F	T _j = 175 °C	T _c = 25 °C	327	A
		T _c = 80 °C	237	A
I _{Fnom}			300	A
I _{FRM}	I _{FRM} = 2 x I _{Fnom}		600	A
I _{FSM}	10 ms, sin 180°, T _j = 25 °C		2160	A
T _j			-40 ... 175	°C
Module				
I _t (RMS)			450	A
T _{stg}	module without TIM		-40 ... 125	°C
V _{isol}	AC sinus 50Hz, t = 1 min		4000	V



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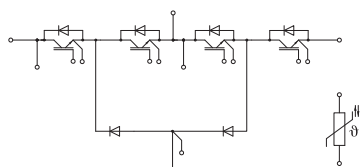
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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
IGBT1						
V _{CE(sat)}	I _C = 400 A	T _j = 25 °C		1.55	1.95	V
	V _{GE} = 15 V chipelevel	T _j = 150 °C		1.75	2.15	V
V _{CE0}	chipelevel	T _j = 25 °C		0.90	1.00	V
		T _j = 150 °C		0.82	0.90	V
r _{CE}	V _{GE} = 15 V chipelevel	T _j = 25 °C		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				0.4	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			3930		nC
R _{Gint}	T _j = 25 °C			1.0		Ω
t _{d(on)}	V _{CC} = 300 V	T _j = 150 °C		145		ns
t _r	I _C = 400 A	T _j = 150 °C		89		ns
E _{on}	V _{GE} = +15/-15 V	T _j = 150 °C		5.3		mJ
t _{d(off)}	R _{G on} = 2 Ω	T _j = 150 °C		414		ns
t _f	R _{G off} = 1.6 Ω	T _j = 150 °C		100		ns
E _{off}	di/dt _{on} = 4750 A/μs di/dt _{off} = 3300 A/μs	T _j = 150 °C		20.2		mJ
R _{th(j-c)}	per IGBT				0.13	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			0.03		K/W
IGBT2						
V _{CE(sat)}	I _C = 400 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		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				0.4	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			3930		nC
R _{Gint}	T _j = 25 °C			1.0		Ω
t _{d(on)}	V _{CC} = 300 V	T _j = 150 °C		114.6		ns
t _r	I _C = 400 A	T _j = 150 °C		88.4		ns
E _{on}	V _{GE} = +15/-15 V	T _j = 150 °C		6		mJ
t _{d(off)}	R _{G on} = 2 Ω	T _j = 150 °C		412.6		ns
t _f	R _{G off} = 1.6 Ω	T _j = 150 °C		121.6		ns
E _{off}	di/dt _{on} = 4750 A/μs di/dt _{off} = 3300 A/μs	T _j = 150 °C		18.7		mJ
R _{th(j-c)}	per IGBT				0.14	K/W
R _{th(c-s)}	per IGBT (λgrease=0.81 W/(m*K))			0.045		K/W
R _{th(c-s)}	per IGBT, pre-applied phase change material			0.026		K/W



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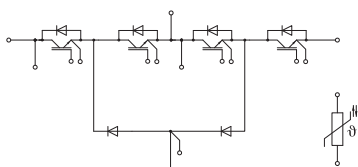
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- IGBT 4 Trench Gate Technology
- $V_{CE(sat)}$ with positive temperature coefficient
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- UL recognized file no. E63532
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Remarks*

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- Diode1 : outer diodes D1 & D4
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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
Diode1						
V _F = V _{EC}	I _F = 300 A	T _j = 25 °C		1.40	1.76	V
	V _{GE} = 0 V	T _j = 150 °C		1.39	1.77	V
	chiplevel					
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		1.19	1.76	mΩ
		T _j = 150 °C		1.79	2.6	mΩ
I _{RRM}	I _F = 400 A	T _j = 150 °C		212		A
Q _{rr}	di/dt _{off} = 4750 A/μs	T _j = 150 °C		21.63		μC
	V _{CC} = 300 V					
E _{rr}	V _{GE} = +15/-15 V	T _j = 150 °C		10.9		mJ
R _{th(j-c)}	per diode				0.21	K/W
R _{th(c-s)}	per diode (λgrease=0.81 W/(m*K))			0.038		K/W
R _{th(c-s)}	per diode, pre-applied phase change material			0.034		K/W
Diode2						
V _F = V _{EC}	I _F = 300 A	T _j = 25 °C		1.40	1.76	V
	V _{GE} = 0 V	T _j = 150 °C		1.39	1.77	V
	chiplevel					
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		1.19	1.76	mΩ
		T _j = 150 °C		1.79	2.6	mΩ
I _{RRM}	I _F = 400 A	T _j = 150 °C		212		A
Q _{rr}	di/dt _{off} = 4750 A/μs	T _j = 150 °C		4		μC
	V _R = 300 V					
E _{rr}	V _{GE} = +15/-15 V	T _j = 150 °C		-		mJ
R _{th(j-c)}	per diode				0.24	K/W
R _{th(c-s)}	per diode (λgrease=0.81 W/(m*K))			0.038		K/W
R _{th(c-s)}	per diode, pre-applied phase change material			0.03		K/W
Diode5						
V _F = V _{EC}	I _F = 300 A	T _j = 25 °C		1.40	1.76	V
	chiplevel	T _j = 150 °C		1.39	1.77	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		1.19	1.76	mΩ
		T _j = 150 °C		1.79	2.6	mΩ
I _{RRM}	I _F = 400 A	T _j = 150 °C		309		A
Q _{rr}	di/dt _{off} = 4750 A/μs	T _j = 150 °C		40		μC
	V _R = 300 V					
E _{rr}	V _{GE} = +15/-15 V	T _j = 150 °C		6.1		mJ
R _{th(j-c)}	per diode				0.26	K/W
R _{th(c-s)}	per diode (λgrease=0.81 W/(m*K))			0.047		K/W
R _{th(c-s)}	per diode, pre-applied phase change material			0.037		K/W



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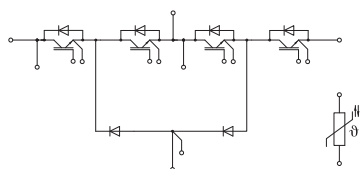
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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
Module						
L _{sCE1}				27		nH
L _{sCE2}				34		nH
R _{CC'+EE'}	measured between terminal 5 and 1	T _C = 25 °C		0.8		mΩ
		T _C = 125 °C		1.1		mΩ
R _{th(c-s)1}	calculated without thermal coupling			0.004		K/W
R _{th(c-s)2}	including thermal coupling, Ts underneath module (λ _{grease} =0.81 W/ (m*K))			0.007		K/W
R _{th(c-s)2}	including thermal coupling, Ts underneath module, pre-applied phase change material			0.005		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°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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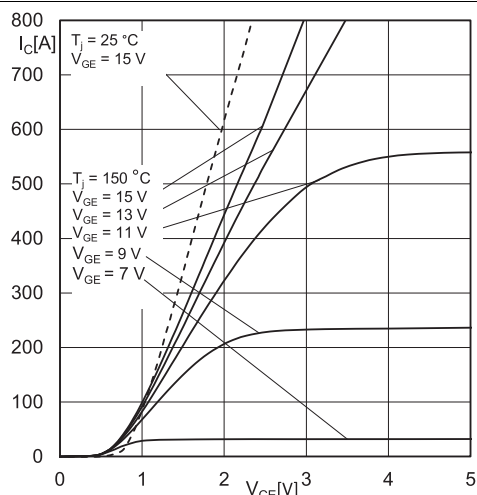
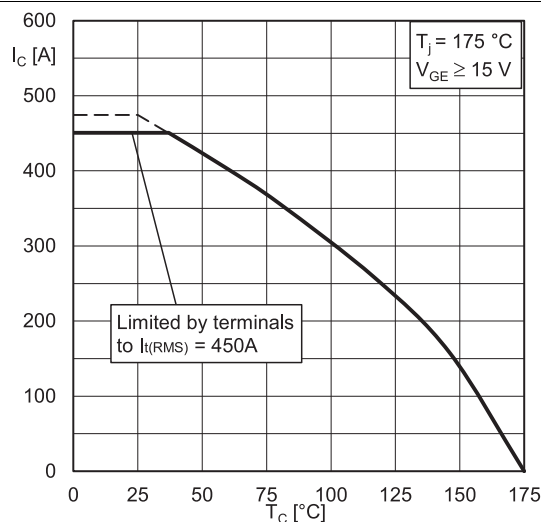
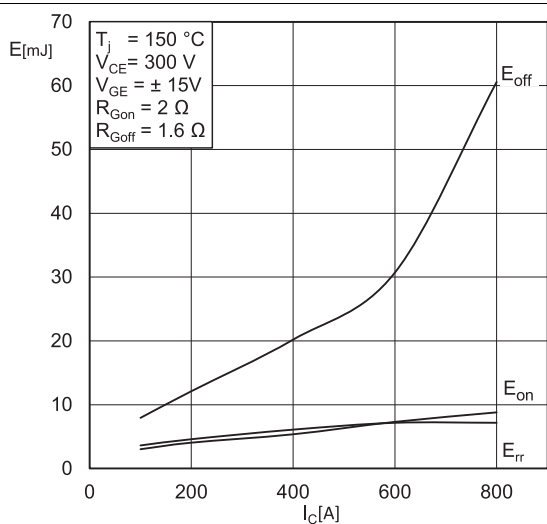
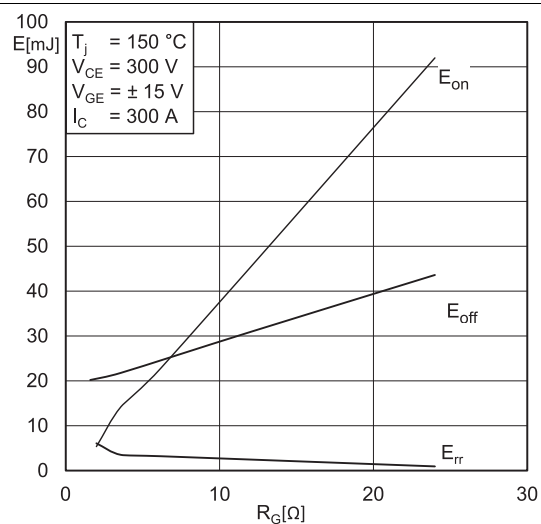
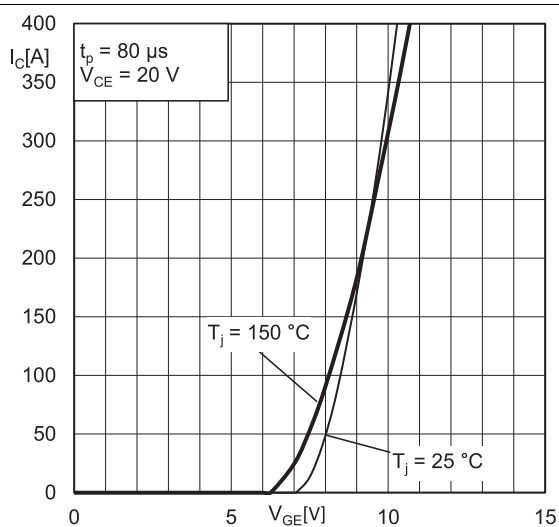
Fig. 1: Typ. IGBT1 output characteristic, incl. $R_{CC}'+EE'$ Fig. 2: IGBT1 rated current vs. Temperature $I_c=f(T_c)$ Fig. 3: Typ. IGBT1 & Diode5 turn-on /-off energy = $f(I_C)$ Fig. 4: Typ. IGBT1 & Diode5 turn-on /-off energy = $f(R_G)$ 

Fig. 5: Typ. IGBT1 transfer characteristic

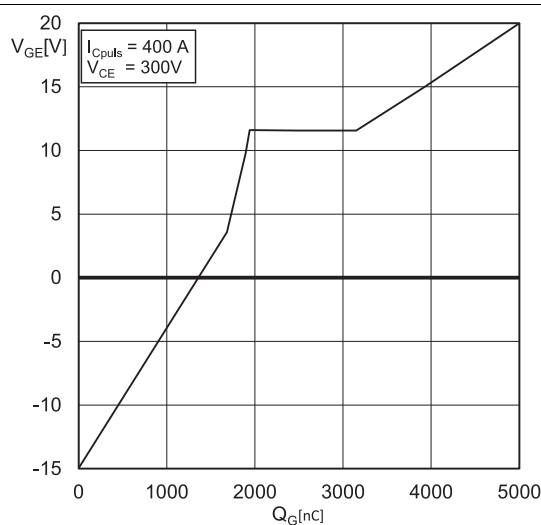


Fig. 6: Typ. IGBT1 gate charge characteristic

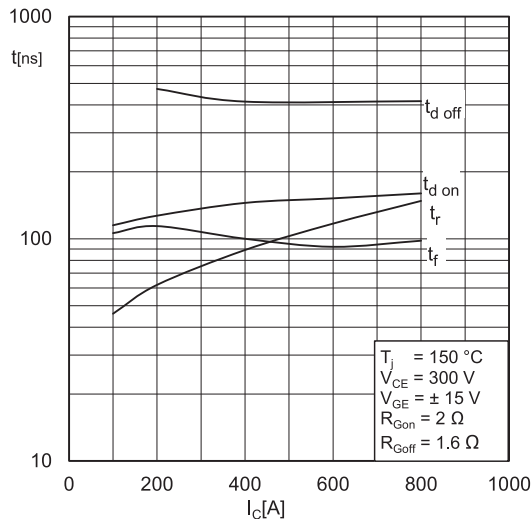


Fig. 7: Typ. IGBT1 switching times vs. I_C

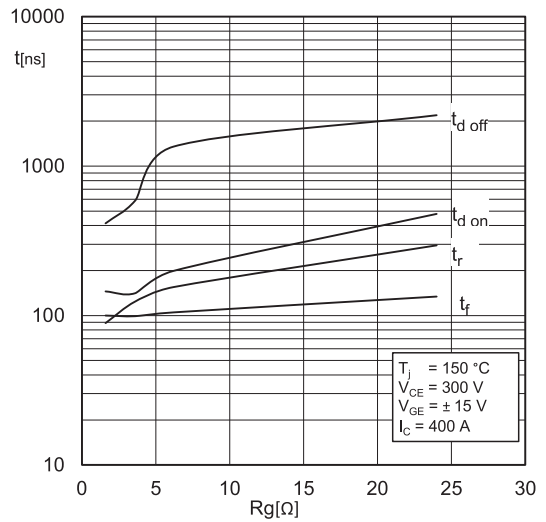


Fig. 8: Typ. IGBT1 switching times vs. gate resistor R_G

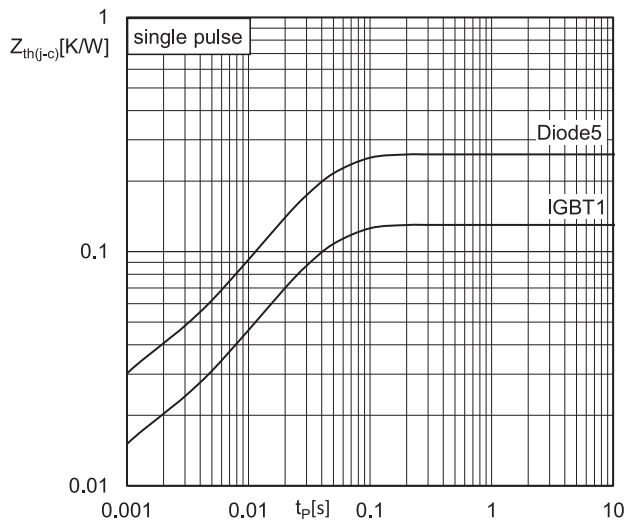


Fig. 9: Transient thermal impedance of IGBT1 & Diode5

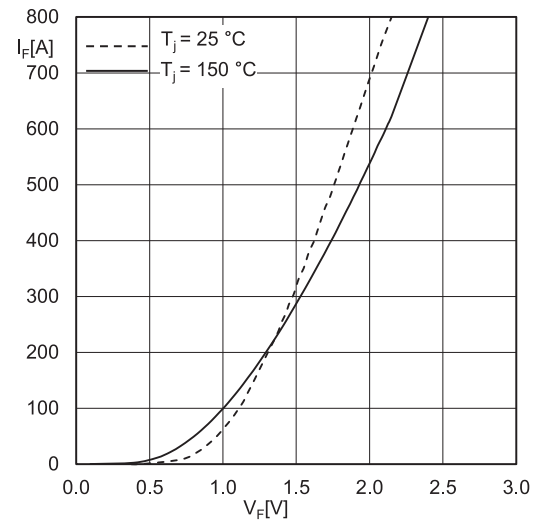


Fig. 10: Typ. Diode5 forward characteristic, incl. $R_{CC'+EE'}$

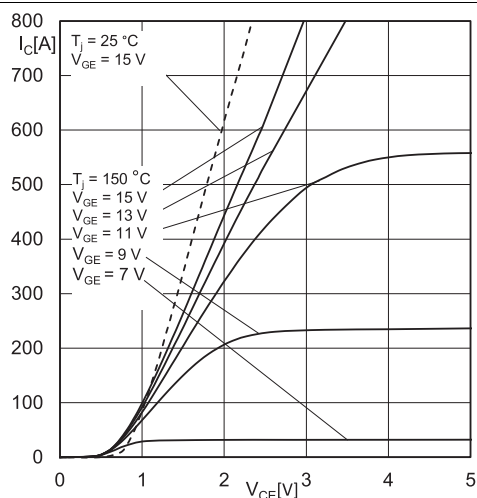


Fig. 13: Typ. IGBT2 output characteristic, incl. $R_{CC'+EE'}$

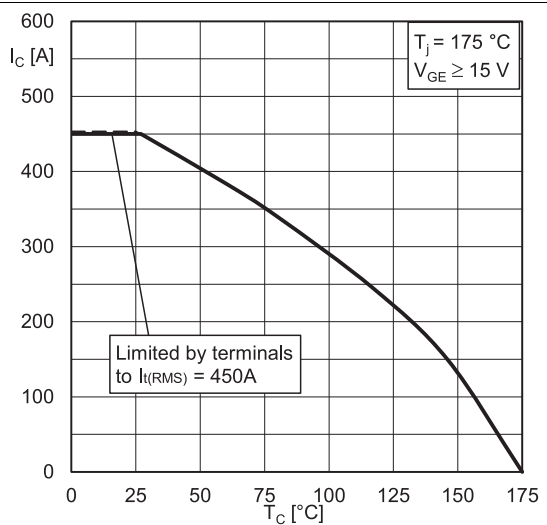


Fig. 14: IGBT2 Rated current vs. Temperature $I_C = f(T_C)$

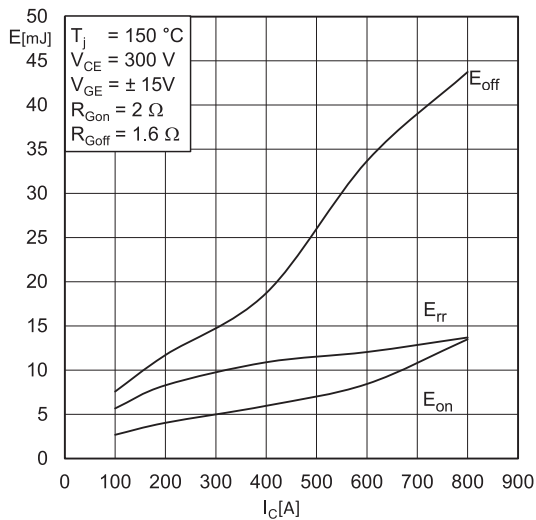


Fig. 15: Typ. IGBT2 & Diode1 turn-on /-off energy = f(I_C)

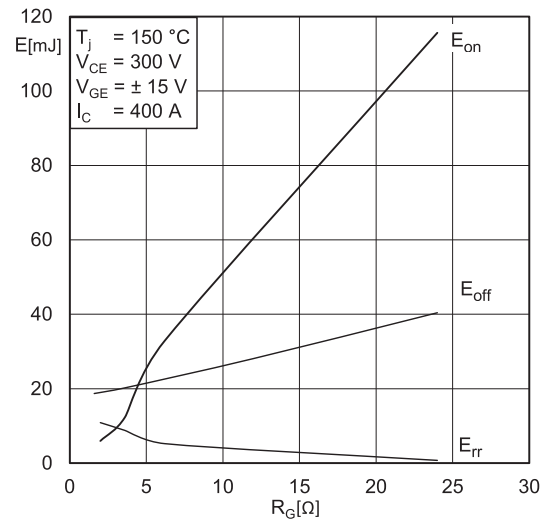


Fig. 16: Typ. IGBT2 & Diode1 turn-on / -off energy = f(R_G)

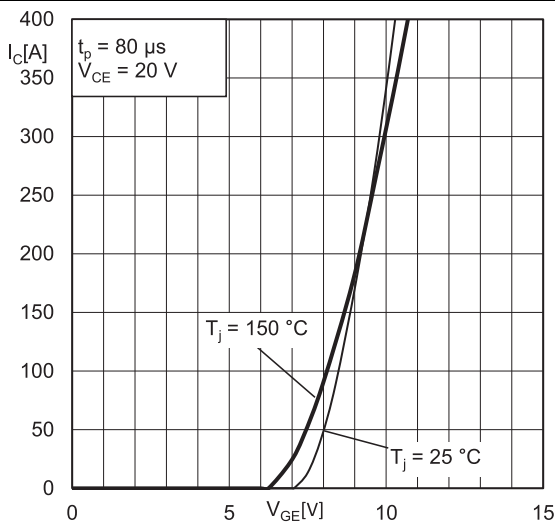


Fig. 17: Typ. IGBT2 transfer characteristic

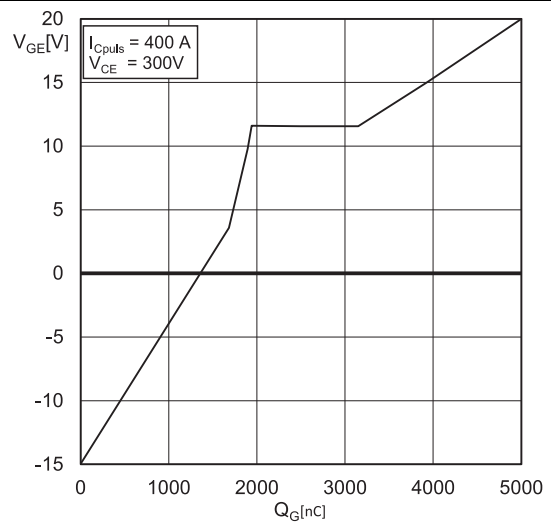


Fig. 18: Typ. IGBT2 gate charge characteristic

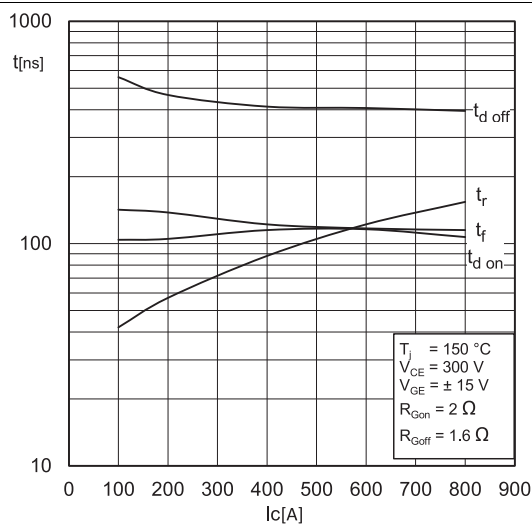


Fig. 19: Typ. IGBT2 switching times vs. I_C

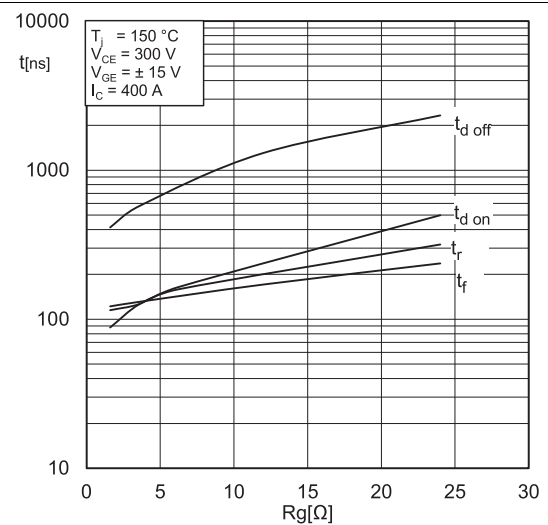


Fig. 20: Typ. IGBT2 switching times vs. gate resistor R_G

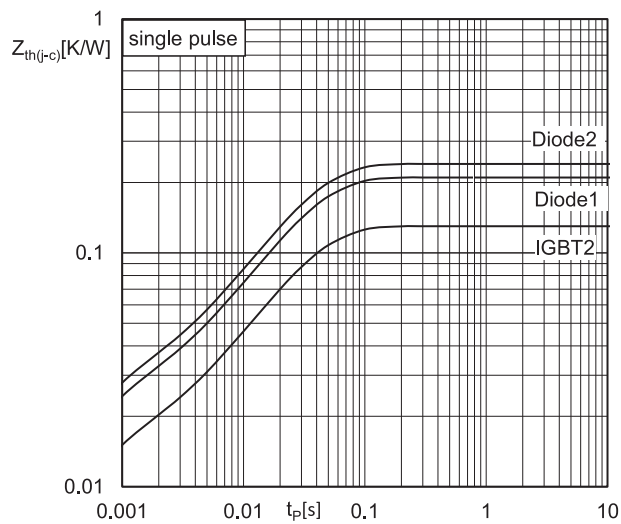


Fig. 21: Transient thermal impedance of IGBT2, Diode1 & Diode2

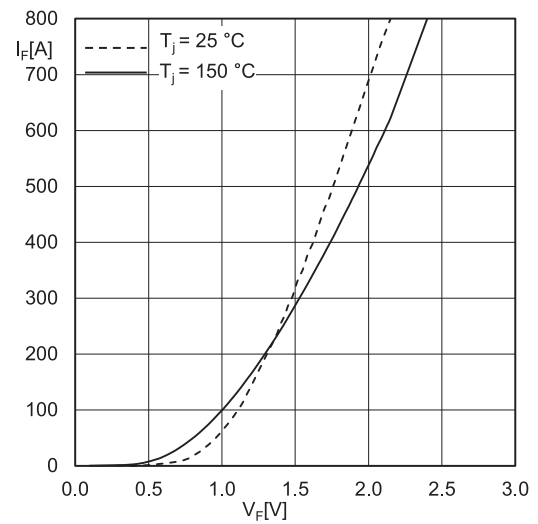
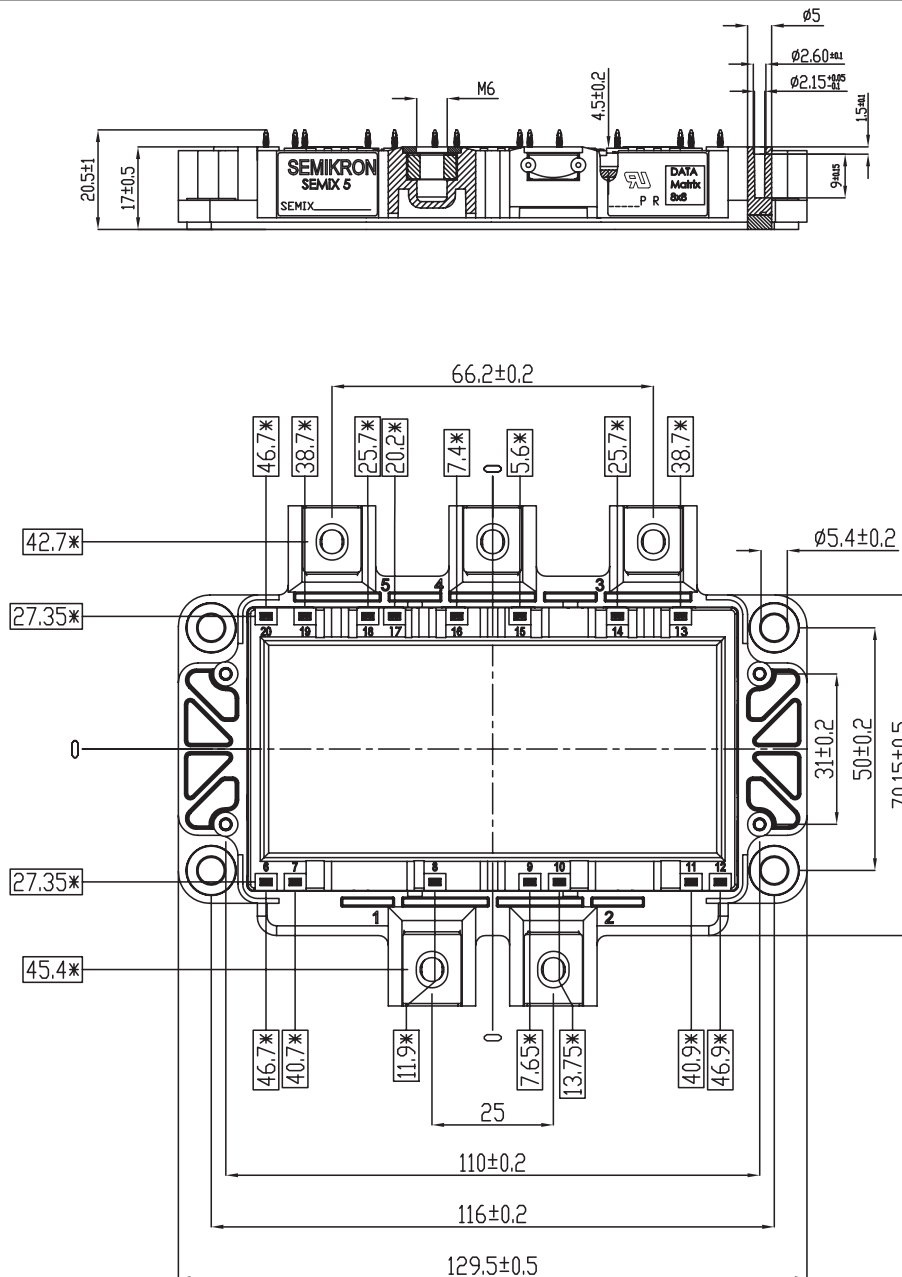


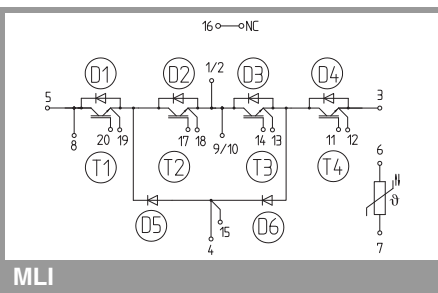
Fig. 22: Typ. Diode1 & Diode2 forward characteristic, incl. $R_{CC'+EE'}$



* = 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.

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