SEMiX® 5

3-Level NPC IGBT-Module

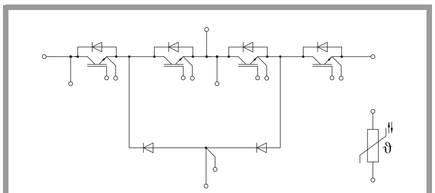
SEMiX405MLI07E4

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°C max.
- Product reliability results are valid for T_{jop}=150°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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Remarks*

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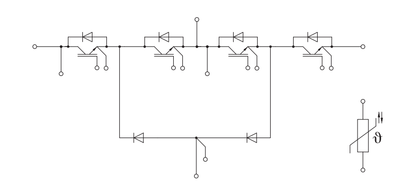

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Characteristics

Symbol	Conditions		min.	typ.	max.	Unit
IGBT1						
$V_{CE(sat)}$	I_C = 400 A, V_{GE} = 15 V, chiplevel	T_j = 25 °C		1.55	1.95	V
		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				0.4	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, I_C = 400 A, V_{GE} = +15/-15 V, $R_{G\,on}$ = 2 Ω, $R_{G\,off}$ = 1.6 Ω, di/dt$_{on}$ = 4750 A/µs, di/dt$_{off}$ = 3300 A/µs	T_j = 150 °C		145		ns
t_r		T_j = 150 °C		89		ns
E_{on}		T_j = 150 °C		5.3		mJ
$t_{d(off)}$		T_j = 150 °C		414		ns
t_f		T_j = 150 °C		100		ns
E_{off}		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, V_{GE} = 15 V, chiplevel	T_j = 25 °C		1.55	1.95	V
		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				0.4	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, I_C = 400 A, V_{GE} = +15/-15 V, $R_{G\,on}$ = 2 Ω, $R_{G\,off}$ = 1.6 Ω, di/dt$_{on}$ = 4750 A/µs, di/dt$_{off}$ = 3300 A/µs	T_j = 150 °C		114.6		ns
t_r		T_j = 150 °C		88.4		ns
E_{on}		T_j = 150 °C		6		mJ
$t_{d(off)}$		T_j = 150 °C		412.6		ns
t_f		T_j = 150 °C		121.6		ns
E_{off}		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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- UL recognized file no. E63532
- NTC temperature sensor inside

Remarks*

- Case temperature limited to T_C=125°C max.
- Product reliability results are valid for T_{jop}=150°C
- IGBT1 : outer IGBTs T1 & T4
- IGBT2 : inner IGBTs T2 & T3
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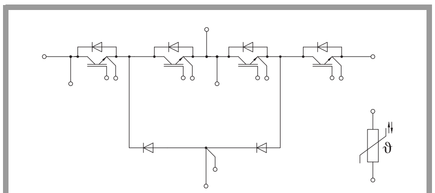
- Diode5 : clamping diodes D5 & D6
- For storage and case temperature with TIM see document “TP(HALA P8) SEMiX 5p”



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Characteristics

Symbol	Conditions		min.	typ.	max.	Unit
Diode1						
$V_F = V_{EC}$	I_F = 300 A V_{GE} = 0 V chiplevel	T_j = 25 °C		1.40	1.76	V
		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 di/dt$_{off}$ = 4750 A/µs V_{CC} = 300 V V_{GE} = +15/-15 V	T_j = 150 °C		212		A
Q_{rr}		T_j = 150 °C		21.63		µC
E_{rr}		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 V_{GE} = 0 V chiplevel	T_j = 25 °C		1.40	1.76	V
		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 di/dt$_{off}$ = 4750 A/µs V_R = 300 V V_{GE} = +15/-15 V	T_j = 150 °C		212		A
Q_{rr}		T_j = 150 °C		4		µC
E_{rr}		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 chiplevel	T_j = 25 °C		1.40	1.76	V
		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 di/dt$_{off}$ = 4750 A/µs V_R = 300 V V_{GE} = +15/-15 V	T_j = 150 °C		309		A
Q_{rr}		T_j = 150 °C		40		µC
E_{rr}		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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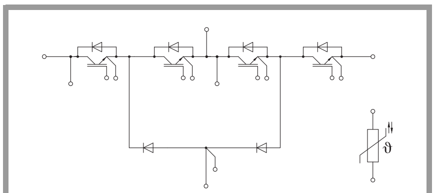

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Characteristics						
Symbol	**Conditions**		**min.**	**typ.**	**max.**	**Unit**
Module						
L_{sCE1}				27		nH
L_{sCE2}				34		nH
$R_{CC'+EE'}$	measured between terminal 5 and 1	T_C = 25 °C		0.8		mΩ
		T_C = 125 °C		1.1		mΩ
$R_{th(c-s)1}$	calculated 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

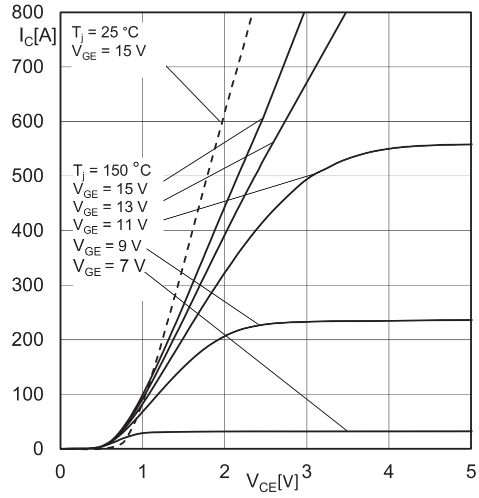


Fig. 1: Typ. IGBT1 output characteristic, incl. $R_{CC'+ EE'}$

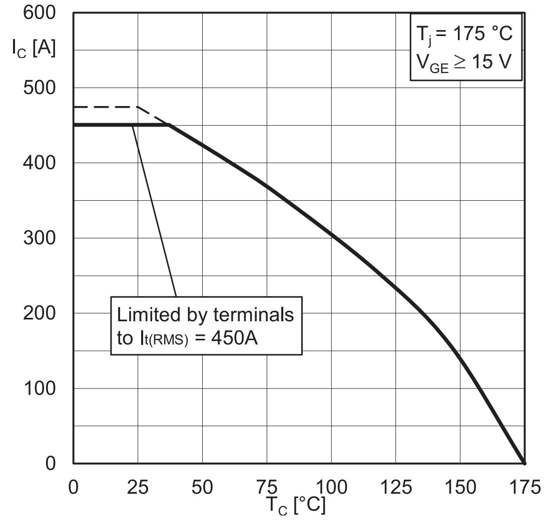


Fig. 2: IGBT1 rated current vs. Temperature I_c=f(T_c)

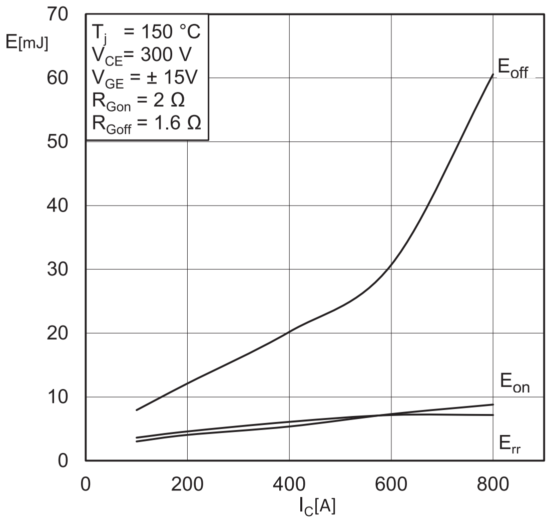


Fig. 3: Typ. IGBT1 & Diode5 turn-on /-off energy = f (I_C)

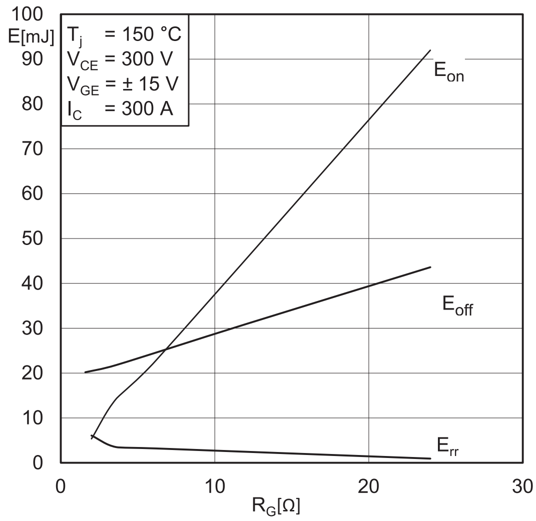


Fig. 4: Typ. IGBT1 & Diode5 turn-on /-off energy = f(R_G)

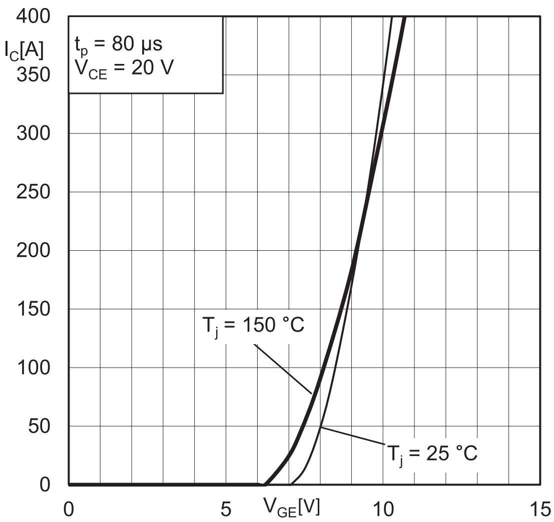


Fig. 5: Typ. IGBT1 transfer characteristic

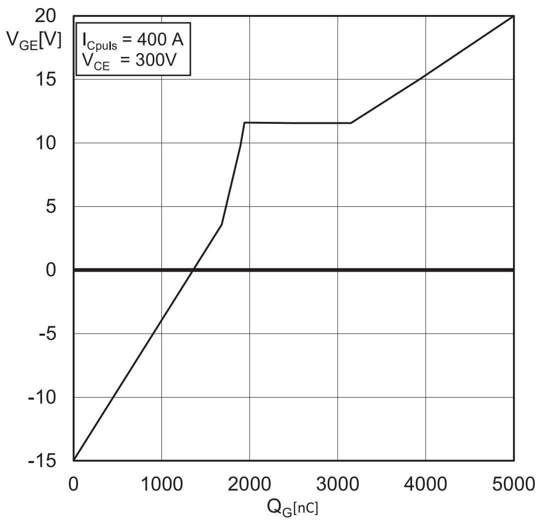


Fig. 6: Typ. IGBT1 gate charge characteristic

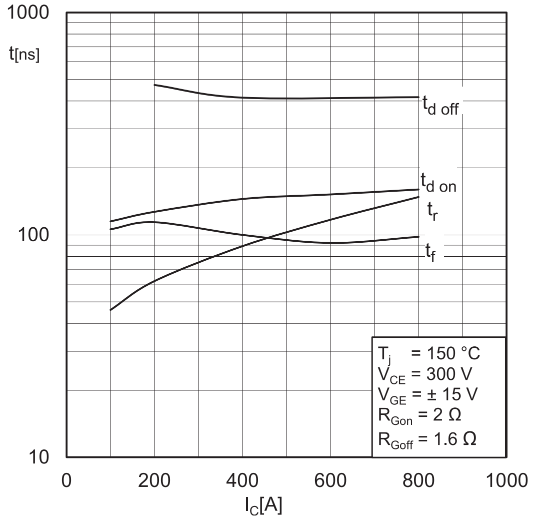


Fig. 7: Typ. IGBT1 switching times vs. I_C

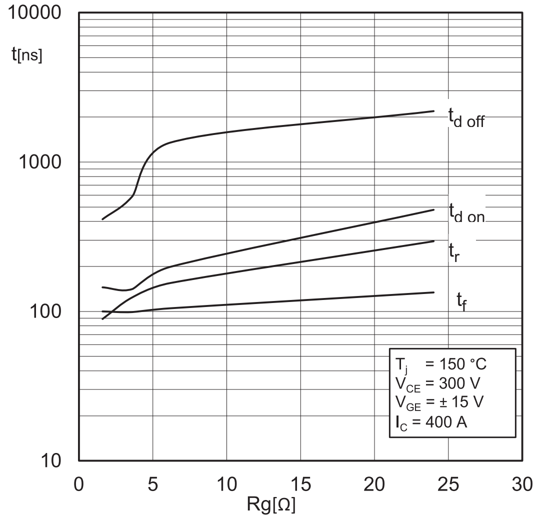


Fig. 8: Typ. IGBT1 switching times vs. gate resistor R_G

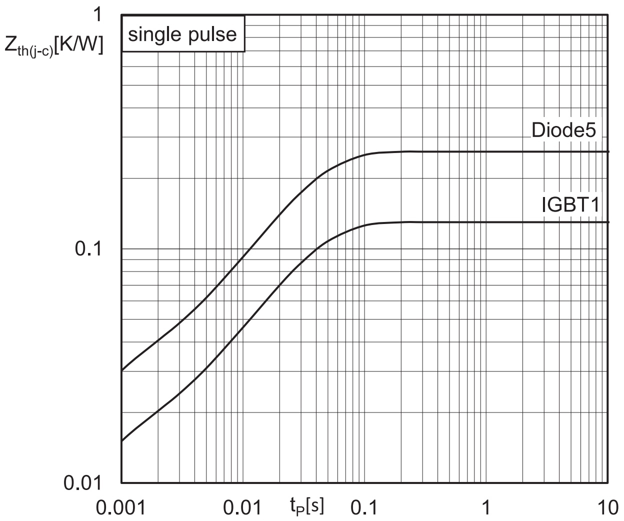


Fig. 9: Transient thermal impedance of IGBT1 & Diode5

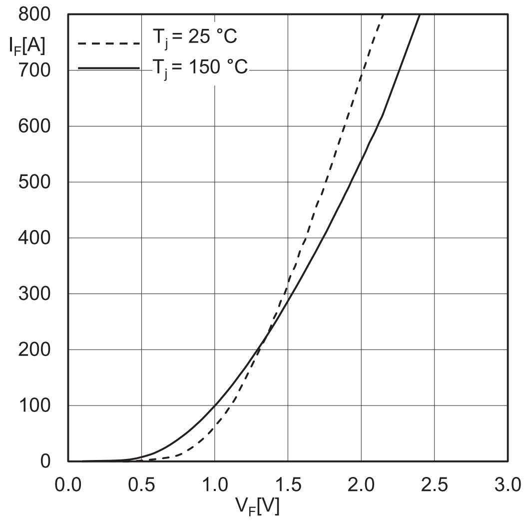


Fig. 10: Typ. Diode5 forward characteristic, incl. $R_{CC'+EE'}$

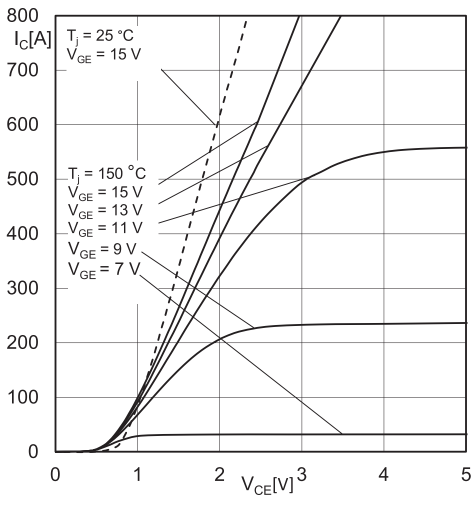


Fig. 13: Typ. IGBT2 output characteristic, incl. $R_{CC'+EE'}$

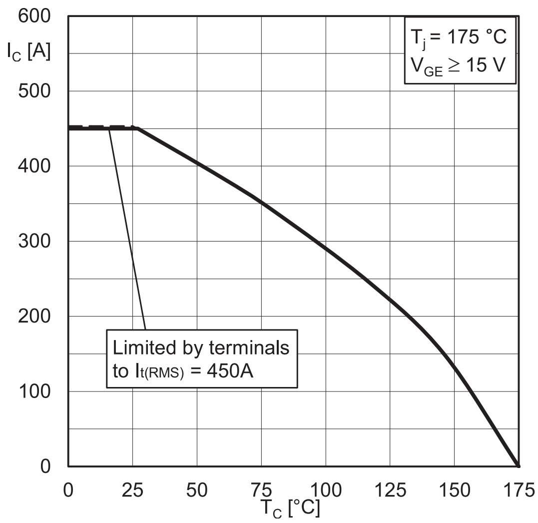


Fig. 14: IGBT2 Rated current vs. Temperature I_c= f (T_c)

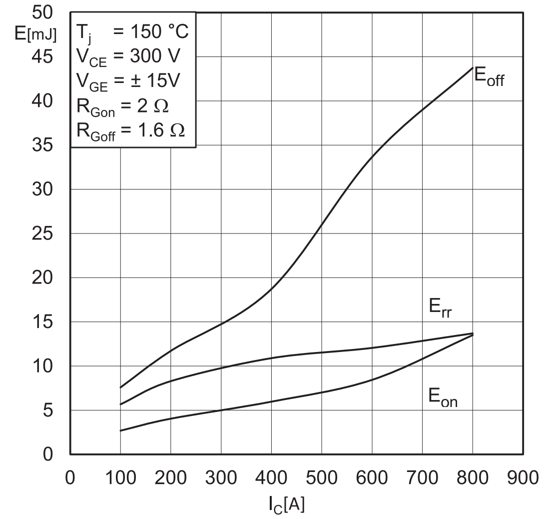


Fig. 15: Typ. IGBT2 & Diode1 turn-on /-off energy = f (I_C)

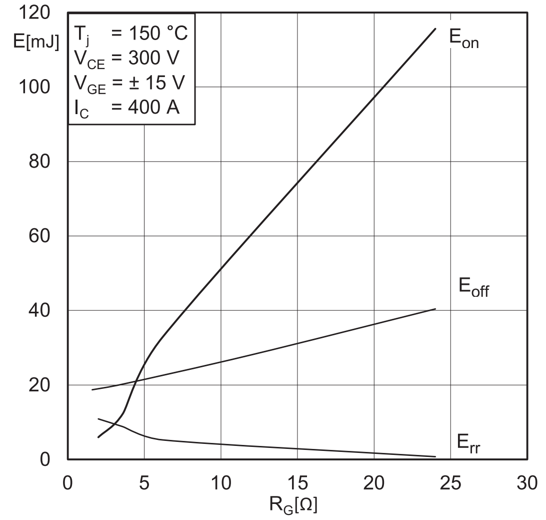


Fig. 16: Typ. IGBT2 & Diode1 turn-on / -off energy = f(R_G)

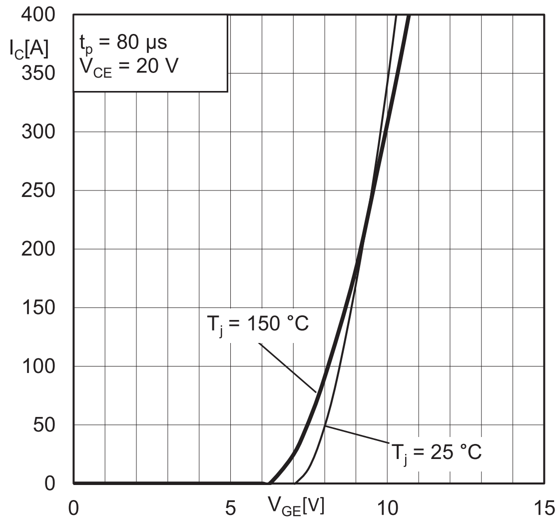


Fig. 17: Typ. IGBT2 transfer characteristic

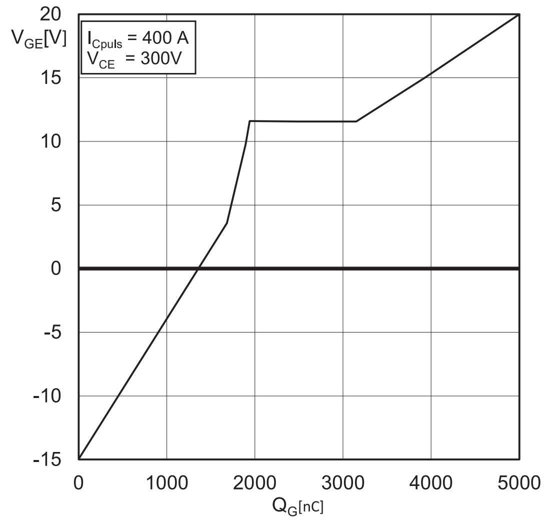


Fig. 18: Typ. IGBT2 gate charge characteristic

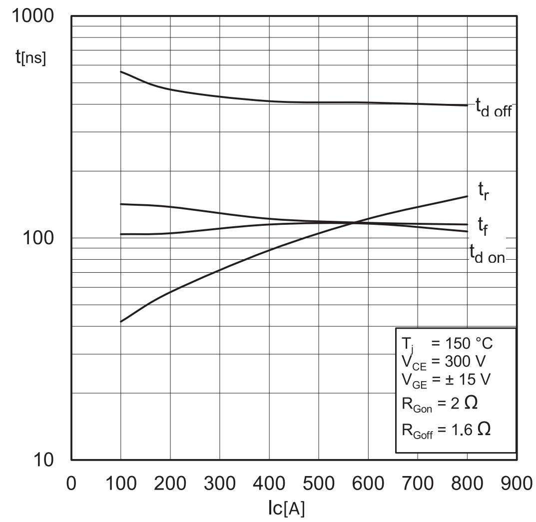


Fig. 19: Typ. IGBT2 switching times vs. I_C

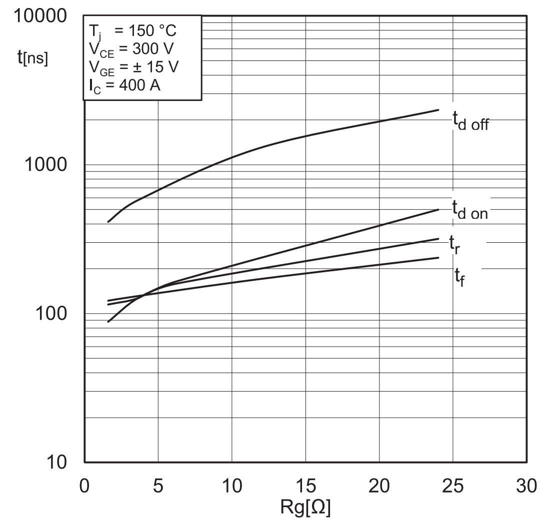


Fig. 20: Typ. IGBT2 switching times vs. gate resistor R_G

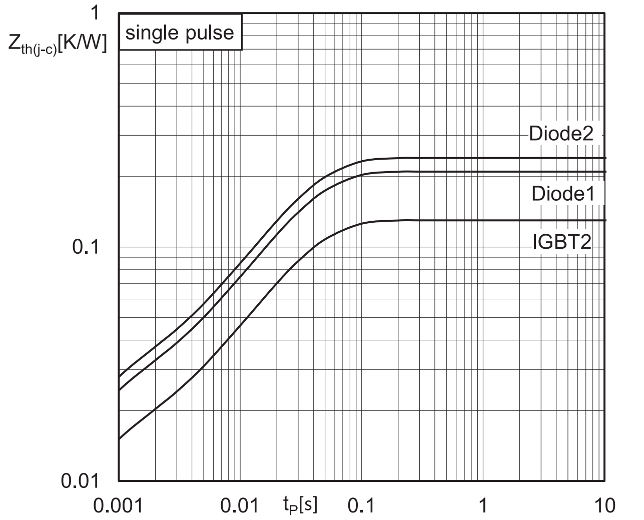


Fig. 21: Transient thermal impedance of IGBT2, Diode1 & Diode2

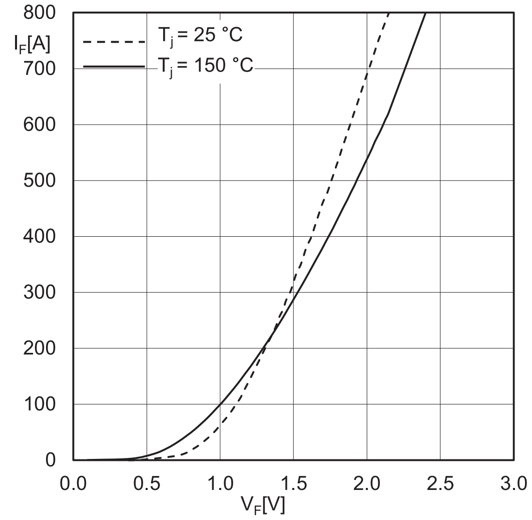
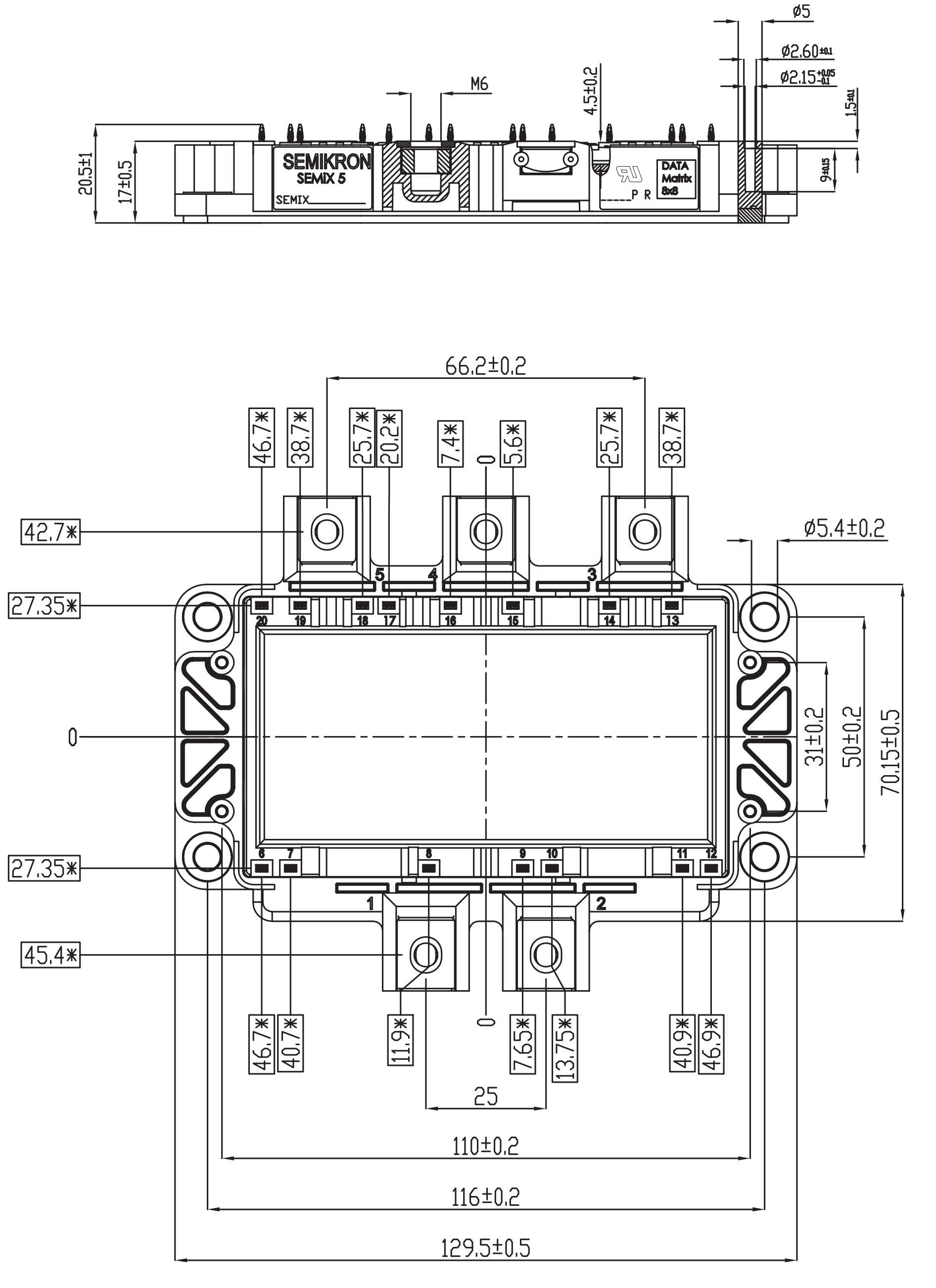


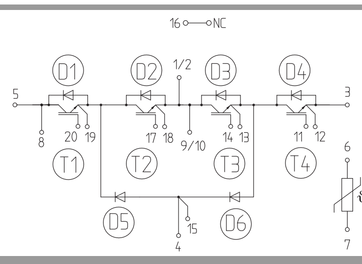
Fig. 22: Typ. Diode1 & Diode2 forward characteristic, incl. $R_{CC'+EE'}$



* = All dimension with tolerance of ⌖ Ø 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), international standard IEC 60747-1, chapter IX.

***IMPORTANT INFORMATION AND WARNINGS**

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