

SKiM® 4

Trench IGBT Modules

SKiM301MLI12E4

Features

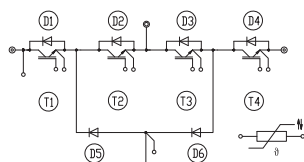
- IGBT 4 Trench Gate Technology
- Solder technology
- $V_{CE(sat)}$ with positive temperature coefficient
- Low inductance case
- Insulated by Al_2O_3 DCB (Direct Copper Bonded) ceramic substrate
- Pressure contact technology for thermal contacts
- Spring contact system to attach driver PCB to the control terminals
- High short circuit capability, self limiting to $6 \times I_C$
- Integrated temperature sensor

Typical Applications

- UPS
- 3 Level Inverter

Remarks*

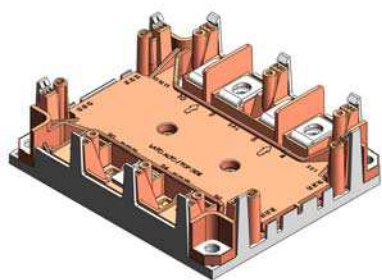
- Case temperature limited to $T_s = 125^\circ C$ max; $T_c = T_s$ (for baseplateless modules)
- Recommended $T_{jop} = -40 \dots +150^\circ C$
- IGBT1 : outer IGBTs T1 & T4
- IGBT2 : inner IGBTs T2 & T3
- Diode1 : outer diodes D1 & D4
- Diode2 : inner diodes D2 & D3
- Diode5 : clamping diodes D5 & D6



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Absolute Maximum Ratings

Symbol	Conditions		Values	Unit
IGBT1				
V _{CES}	T _j = 25 °C		1200	V
I _C	T _j = 175 °C	T _s = 25 °C	311	A
		T _s = 70 °C	252	A
I _{Cnom}			300	A
I _{CRM}	I _{CRM} = 3 x I _{Cnom}		900	A
V _{GES}			-20 ... 20	V
t _{psc}	V _{CC} = 800 V, V _{GE} ≤ 15 V, T _j = 150 °C, V _{CES} ≤ 1200 V		10	μs
T _j			-40 ... 175	°C
IGBT2				
V _{CES}	T _j = 25 °C		1200	V
I _C	T _j = 175 °C	T _s = 25 °C	311	A
		T _s = 70 °C	252	A
I _{Cnom}			300	A
I _{CRM}	I _{CRM} = 3 x I _{Cnom}		900	A
V _{GES}			-20 ... 20	V
t _{psc}	V _{CC} = 800 V, V _{GE} ≤ 15 V, T _j = 150 °C, V _{CES} ≤ 1200 V		10	μs
T _j			-40 ... 175	°C
Diode1				
V _{RRM}	T _j = 25 °C		1200	V
I _F	T _j = 175 °C	T _s = 25 °C	282	A
		T _s = 70 °C	223	A
I _{Fnom}			300	A
I _{FRM}	I _{FRM} = 3 x I _{Fnom}		900	A
I _{FSM}	10 ms, sin 180°, T _j = 25 °C		1485	A
T _j			-40 ... 175	°C
Diode2				
V _{RRM}	T _j = 25 °C		1200	V
I _F	T _j = 175 °C	T _s = 25 °C	282	A
		T _s = 70 °C	223	A
I _{Fnom}			300	A
I _{FRM}	I _{FRM} = 3 x I _{Fnom}		900	A
I _{FSM}	10 ms, sin 180°, T _j = 25 °C		1485	A
T _j			-40 ... 175	°C
Diode5				
V _{RRM}	T _j = 25 °C		1200	V
I _F	T _j = 175 °C	T _s = 25 °C	219	A
		T _s = 70 °C	172	A
I _{Fnom}			300	A
I _{FRM}	I _{FRM} = 3 x I _{Fnom}		900	A
I _{FSM}	10 ms, sin 180°, T _j = 25 °C		1620	A
T _j			-40 ... 175	°C
Module				
I _{t(RMS)}			400	A
T _{stg}			-40 ... 125	°C
V _{isol}	AC sinus 50 Hz, t = 1 min		2500	V



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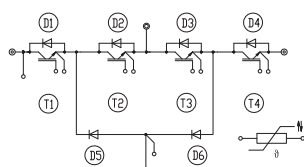
Typical Applications

- UPS
- 3 Level Inverter

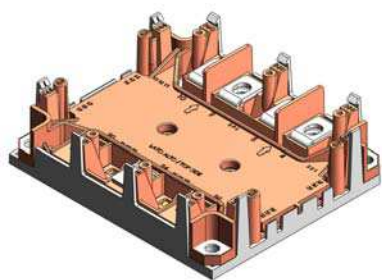
Remarks*

- Case temperature limited to $T_s = 125^\circ C$ max; $T_c = T_s$ (for baseplateless modules)
- Recommended $T_{jop} = -40 \dots +150^\circ C$
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- Diode1 : outer diodes D1 & D4
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- Diode5 : clamping diodes D5 & D6

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 chiplevel	T _j = 150 °C		2.20	2.40	V
V _{CE0}	chiplevel	T _j = 25 °C		0.80	0.90	V
		T _j = 150 °C		0.70	0.80	V
r _{CE}	V _{GE} = 15 V	T _j = 25 °C		3.3	3.8	mΩ
	chiplevel	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		18.45		nF
C _{oes}		f = 1 MHz		1.215		nF
C _{res}		f = 1 MHz		1.035		nF
Q _G	V _{GE} = - 15 V...+ 15 V			2400		nC
R _{Gint}	T _j = 25 °C			2.5		Ω
t _{d(on)}	V _{CE} = 600 V	T _j = 150 °C		182		ns
t _r	I _C = 300 A	T _j = 150 °C		52		ns
E _{on}	V _{GE} = +15/-15 V R _{G on} = 1 Ω	T _j = 150 °C		22.2		mJ
t _{d(off)}	R _{G off} = 1 Ω	T _j = 150 °C		446		ns
t _f	di/dt _{on} = 5700 A/μs di/dt _{off} = 2600 A/μs	T _j = 150 °C		98		ns
E _{off}		T _j = 150 °C		33.9		mJ
R _{th(j-s)}	per IGBT			0.19		K/W
IGBT2						
V _{CE(sat)}	I _C = 300 A	T _j = 25 °C		1.80	2.05	V
	V _{GE} = 15 V chiplevel	T _j = 150 °C		2.20	2.40	V
V _{CE0}	chiplevel	T _j = 25 °C		0.80	0.90	V
		T _j = 150 °C		0.70	0.80	V
r _{CE}	V _{GE} = 15 V	T _j = 25 °C		3.3	3.8	mΩ
	chiplevel	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		18.45		nF
C _{oes}		f = 1 MHz		1.215		nF
C _{res}		f = 1 MHz		1.035		nF
Q _G	V _{GE} = - 15 V...+ 15 V			2400		nC
R _{Gint}	T _j = 25 °C			2.5		Ω
t _{d(on)}	V _{CE} = 600 V	T _j = 150 °C		184		ns
t _r	I _C = 300 A	T _j = 150 °C		59		ns
E _{on}	V _{GE} = +15/-15 V R _{G on} = 1 Ω	T _j = 150 °C		11		mJ
t _{d(off)}	R _{G off} = 1 Ω	T _j = 150 °C		457		ns
t _f	di/dt _{on} = 4960 A/μs di/dt _{off} = 1840 A/μs	T _j = 150 °C		73		ns
E _{off}		T _j = 150 °C		35.8		mJ
R _{th(j-s)}	per IGBT			0.19		K/W



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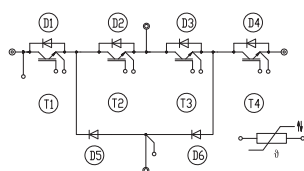
Typical Applications

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- 3 Level Inverter

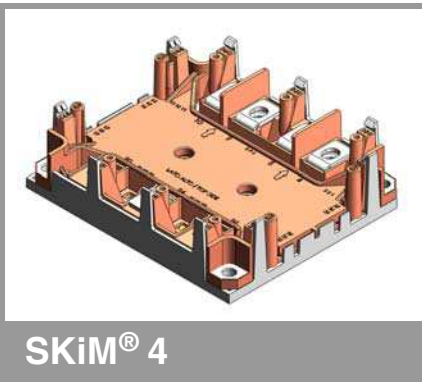
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- Recommended $T_{jop} = -40 \dots +150^\circ C$
- IGBT1 : outer IGBTs T1 & T4
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- Diode1 : outer diodes D1 & D4
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- Diode5 : clamping diodes D5 & D6

Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
Diode1						
V _F = V _{EC}	I _F = 300 A	T _j = 25 °C		2.20	2.52	V
		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		3.0	3.4	mΩ
		T _j = 150 °C		4.2	4.6	mΩ
I _{RRM}	I _F = 300 A	T _j = 150 °C		320		A
Q _{rr}	di/dt _{off} = 5000 A/μs	T _j = 150 °C		54.7		μC
E _{rr}	V _R = 600 V	T _j = 150 °C		21.8		mJ
	V _{GE} = +15/-15 V					
R _{th(j-s)}				0.24		K/W
Diode2						
V _F = V _{EC}	I _F = 300 A	T _j = 25 °C		2.20	2.52	V
		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		3.0	3.4	mΩ
		T _j = 150 °C		4.2	4.6	mΩ
I _{RRM}	I _F = 300 A	T _j = 150 °C		320		A
Q _{rr}	di/dt _{off} = 5000 A/μs	T _j = 150 °C		54.7		μC
E _{rr}	V _R = 600 V	T _j = 150 °C		-		mJ
	V _{GE} = +15/-15 V					
R _{th(j-s)}				0.24		K/W
Diode5						
V _F = V _{EC}	I _F = 300 A	T _j = 25 °C		2.14	2.46	V
		T _j = 150 °C		2.07	2.38	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		2.8	3.2	mΩ
		T _j = 150 °C		3.9	4.3	mΩ
I _{RRM}	I _F = 300 A	T _j = 150 °C		322		A
Q _{rr}	di/dt _{off} = 5700 A/μs	T _j = 150 °C		53		μC
E _{rr}	V _R = 600 V	T _j = 150 °C		24		mJ
	V _{GE} = +15/-15 V					
R _{th(i-s)}				0.36		K/W



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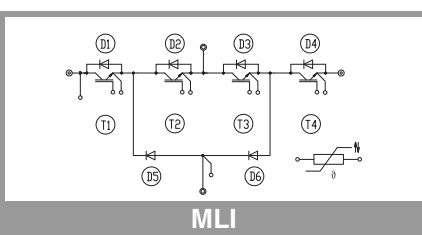
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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
Module						
L _{sCE1}				32		nH
L _{sCE2}				25		nH
R _{CC'+EE'}	measured between terminal 4 and 24	T _s = 25 °C		0.4		mΩ
		T _s = 125 °C		0.6		mΩ
M _s	to heat sink M5		2		3	Nm
M _t		to terminals M6	4		5	Nm
						Nm
w				317		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



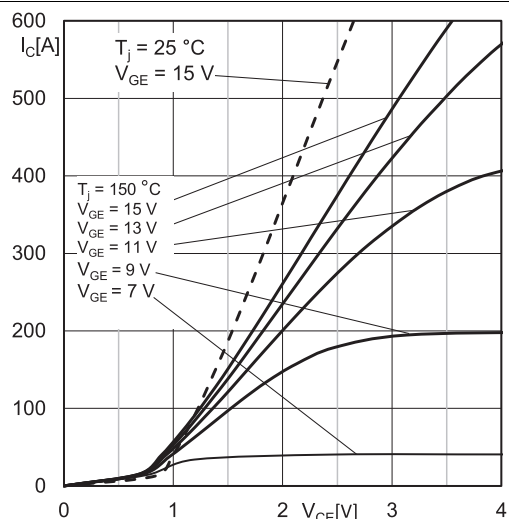


Fig. 1: Typ. IGBT1 output characteristic, incl. $R_{CC'+EE'}$

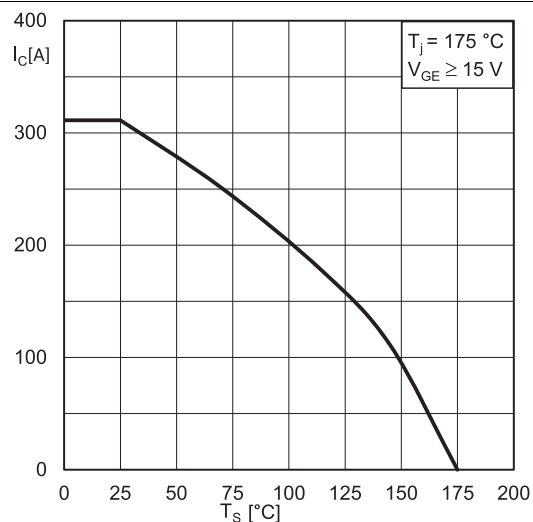


Fig. 2: IGBT1 rated current vs. Temperature $I_C=f(T_s)$

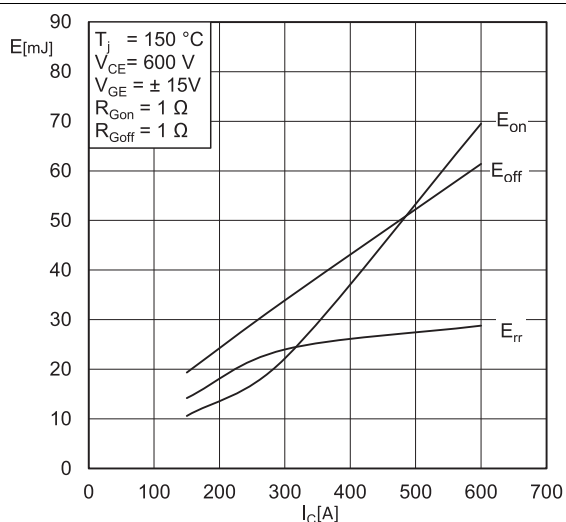


Fig. 3: Typ. IGBT1 & Diode5 turn-on /-off energy = $f(I_C)$

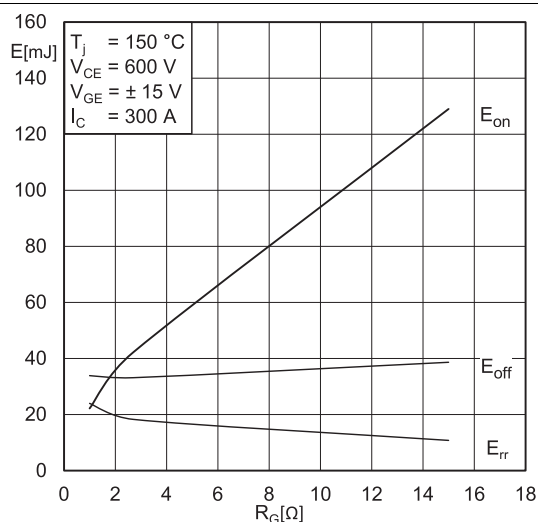


Fig. 4: Typ. IGBT1 & Diode5 turn-on /-off energy = $f(R_G)$

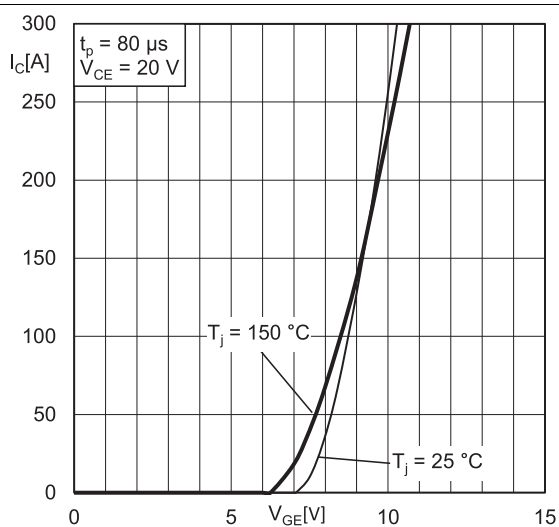


Fig. 5: Typ. IGBT1 transfer characteristic

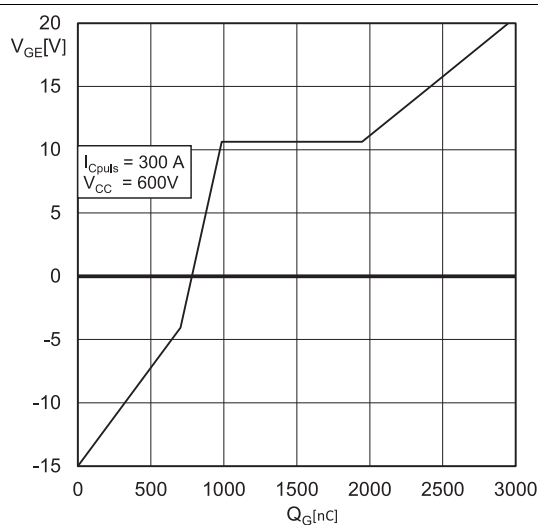


Fig. 6: Typ. IGBT1 gate charge characteristic

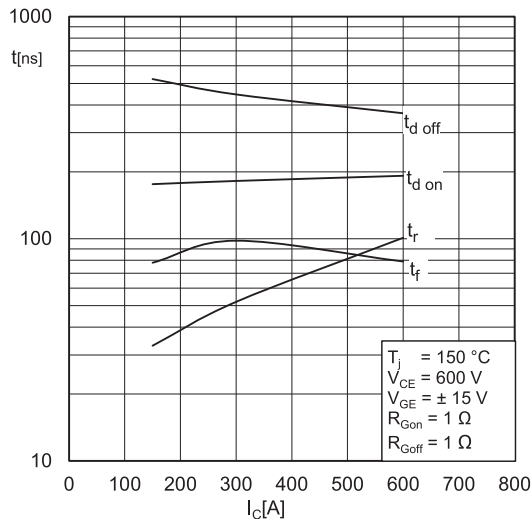


Fig. 7: Typ. IGBT1 switching times vs. I_C

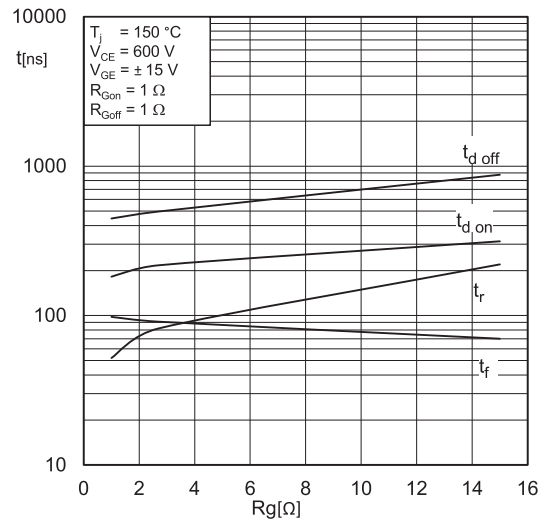


Fig. 8: Typ. IGBT1 switching times vs. gate resistor R_G

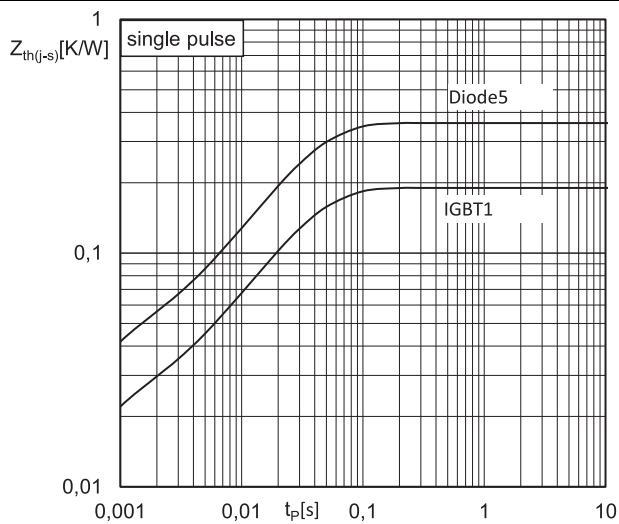


Fig. 9: Transient thermal impedance of IGBT1 & Diode5

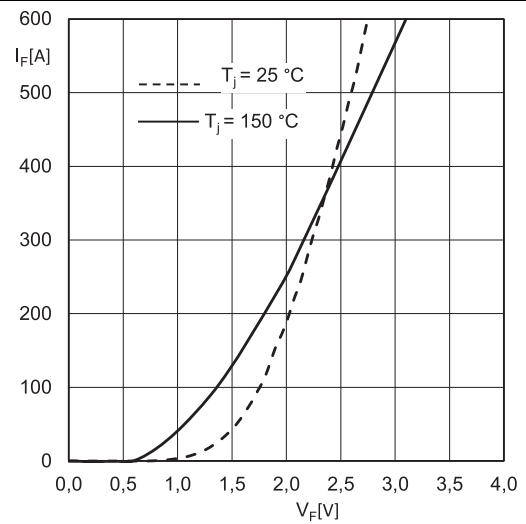


Fig. 10: Typ. Diode5 forward characteristic, incl. $R_{CC'+EE'}$

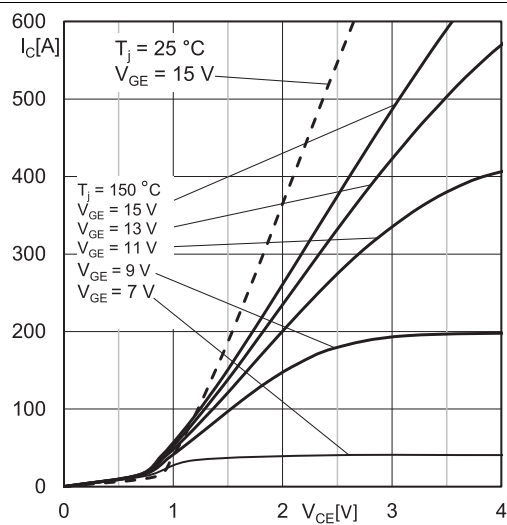


Fig. 13: Typ. IGBT2 output characteristic, incl. $R_{CC'+EE'}$

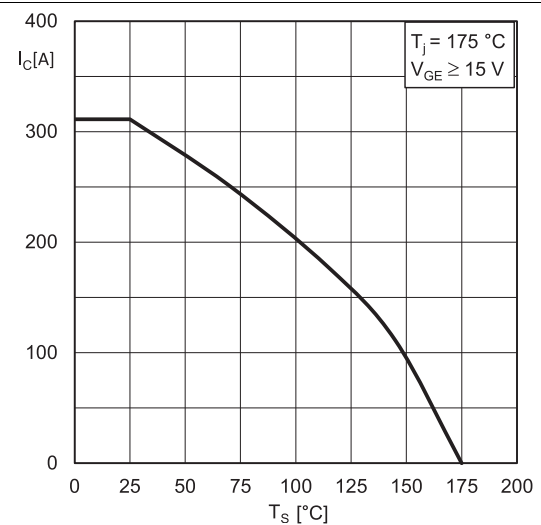


Fig. 14: IGBT2 Rated current vs. Temperature $I_C = f(T_s)$

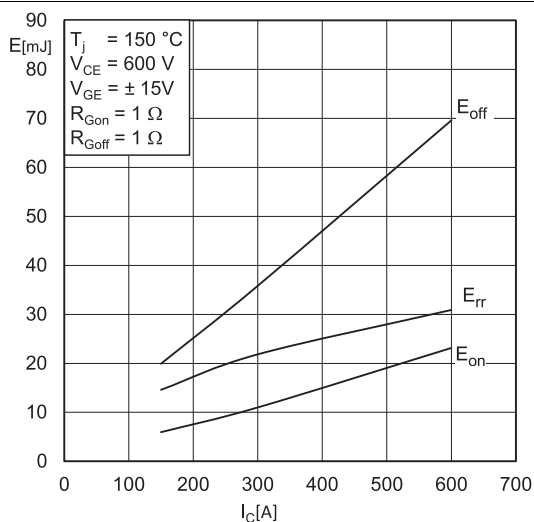


Fig. 15: Typ. IGBT2 & Diode1 turn-on /-off energy = $f(I_C)$

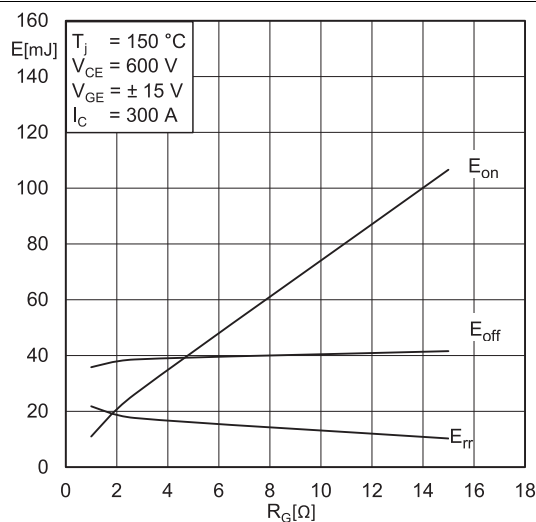


Fig. 16: Typ. IGBT2 & Diode1 turn-on / -off energy = $f(R_G)$

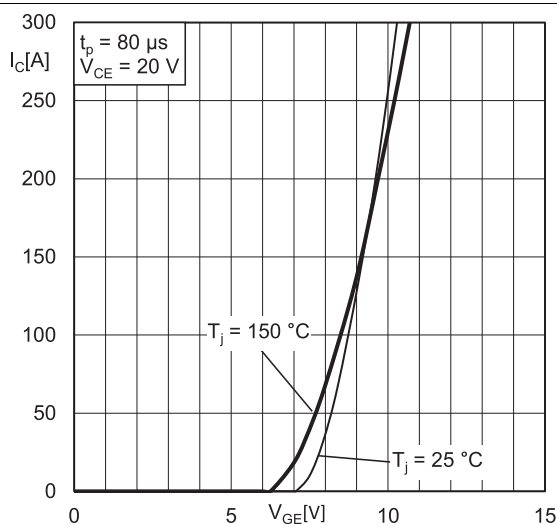


Fig. 17: Typ. IGBT2 transfer characteristic

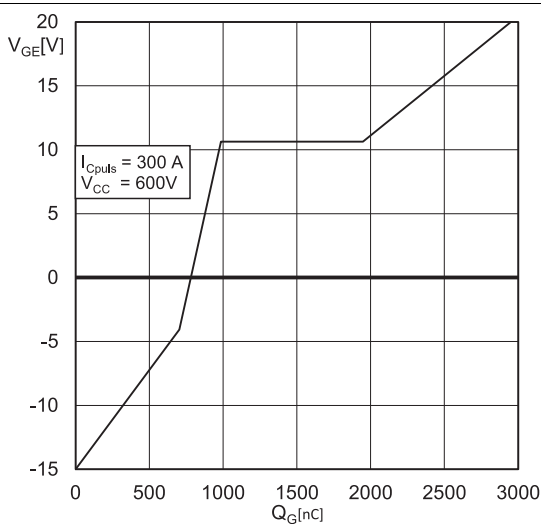


Fig. 18: Typ. IGBT2 gate charge characteristic

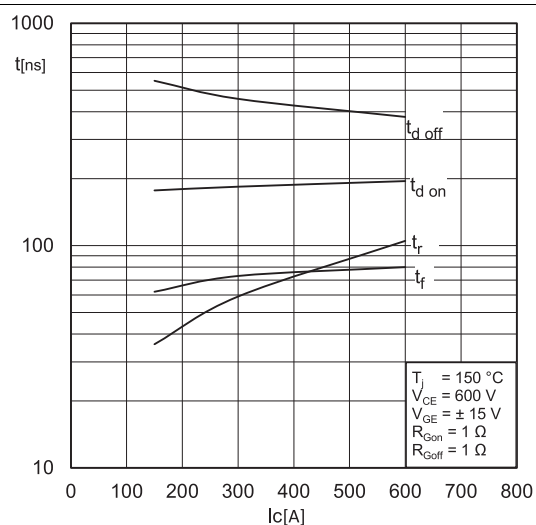


Fig. 19: Typ. IGBT2 switching times vs. I_C

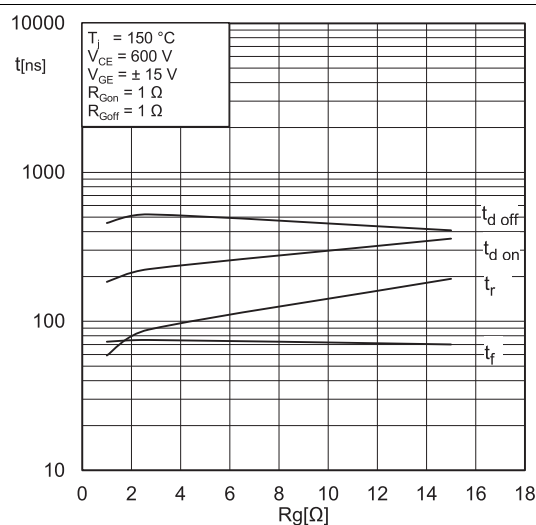


Fig. 20: Typ. IGBT2 switching times vs. gate resistor R_G

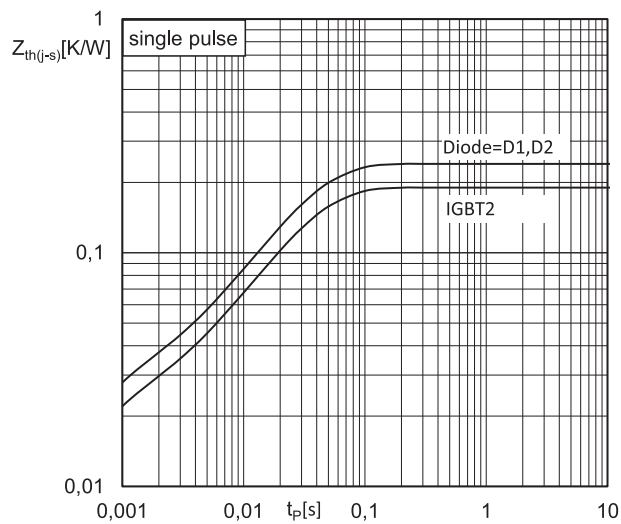


Fig. 21: Transient thermal impedance of IGBT2, Diode1 & Diode2

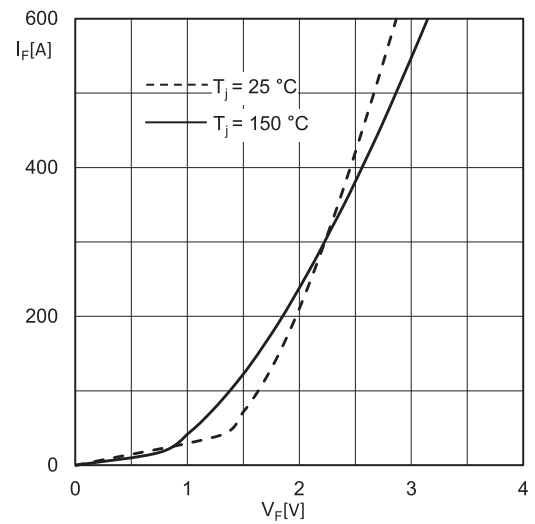
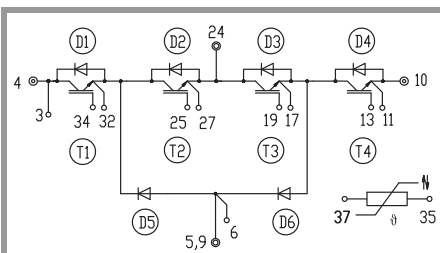


Fig. 22: Typ. Diode1 & Diode2 forward characteristic, incl. $R_{CC'+EE'}$



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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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