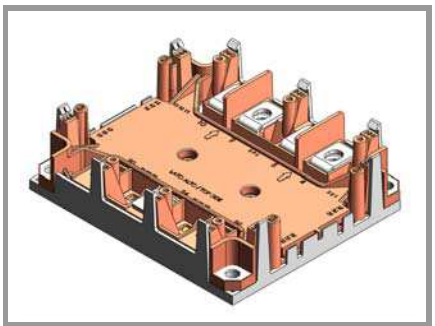


SKiM® 4

Trench IGBT Modules

SKiM201MLI12E4

Features

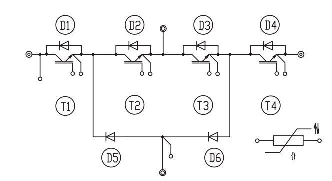
- IGBT 4 Trench Gate Technology
- Solder technology
- $V_{CE(sat)}$ with positive temperature coefficient
- Low inductance case
- Insulated by Al_2O_3 DCB (Direct Copper Bonded) ceramic substrate
- Pressure contact technology for thermal contacts
- Spring contact system to attach driver PCB to the control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

Typical Applications

- Automotive inverter
- High reliability AC inverter wind
- High reliability AC inverter drives

Remarks*

- Case temperature limited to T_s = 125°C max; T_c = T_s (for baseplateless modules)
- Recommended T_{jop} = -40 ... +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



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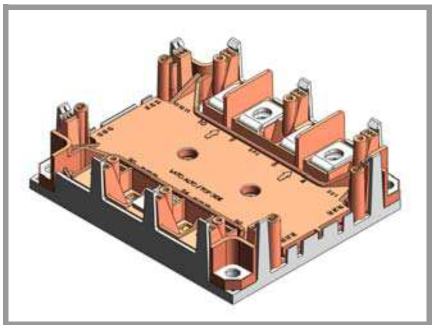
Absolute Maximum Ratings

Symbol	Conditions		Values	Unit
IGBT1				
V_{CES}	T_j = 25 °C		1200	V
I_C	T_j = 175 °C	T_s = 25 °C	206	A
		T_s = 70 °C	166	A
I_{Cnom}			200	A
I_{CRM}	I_{CRM} = 3 x I_{Cnom}		600	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	206	A
		T_s = 70 °C	166	A
I_{Cnom}			200	A
I_{CRM}	I_{CRM} = 3 x I_{Cnom}		600	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	187	A
		T_s = 70 °C	148	A
I_{Fnom}			200	A
I_{FRM}	I_{FRM} = 2 x I_{Fnom}		400	A
I_{FSM}	10 ms, sin 180°, T_j = 25 °C		990	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	187	A
		T_s = 70 °C	148	A
I_{Fnom}			200	A
I_{FRM}	I_{FRM} = 2 x I_{Fnom}		400	A
I_{FSM}	10 ms, sin 180°, T_j = 25 °C		990	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	141	A
		T_s = 70 °C	111	A
I_{Fnom}			200	A
I_{FRM}	I_{FRM} = 2 x I_{Fnom}		400	A
I_{FSM}	10 ms, sin 180°, T_j = 25 °C		990	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



SKiM® 4

Trench IGBT Modules

SKiM201MLI12E4

Features

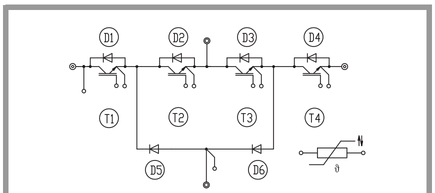
- IGBT 4 Trench Gate Technology
- Solder technology
- $V_{CE(sat)}$ with positive temperature coefficient
- Low inductance case
- Insulated by Al_2O_3 DCB (Direct Copper Bonded) ceramic substrate
- Pressure contact technology for thermal contacts
- Spring contact system to attach driver PCB to the control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

Typical Applications

- Automotive inverter
- High reliability AC inverter wind
- High reliability AC inverter drives

Remarks*

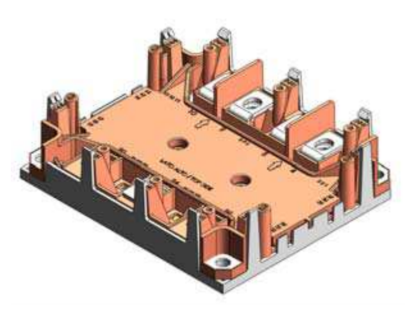
- Case temperature limited to T_s = 125°C max; $T_c = T_s$ (for baseplateless modules)
- Recommended T_{jop} = -40 ... +150°C
- IGBT1 : outer IGBTs T1 & T4
- IGBT2 : inner IGBTs T2 & T3
- Diode1 : outer diodes D1 & D4
- Diode2 : inner diodes D2 & D3
- Diode5 : clamping diodes D5 & D6



MLI

Characteristics

Symbol	Conditions		min.	typ.	max.	Unit
IGBT1						
$V_{CE(sat)}$	I_C = 200 A, V_{GE} = 15 V, chiplevel	T_j = 25 °C		1.80	2.05	V
		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, chiplevel	T_j = 25 °C		5.0	5.8	mΩ
		T_j = 150 °C		7.5	8.0	mΩ
$V_{GE(th)}$	$V_{GE} = V_{CE}$, I_C = 7.6 mA		5	5.8	6.5	V
I_{CES}	V_{GE} = 0 V, V_{CE} = 1200 V, T_j = 25 °C				2.7	mA
C_{ies}	V_{CE} = 25 V, V_{GE} = 0 V	f = 1 MHz		12.3		nF
C_{oes}		f = 1 MHz		0.81		nF
C_{res}		f = 1 MHz		0.69		nF
Q_G	V_{GE} = - 15 V...+ 15 V			1600		nC
R_{Gint}	T_j = 25 °C			3.8		Ω
$t_{d(on)}$	V_{CE} = 600 V, I_C = 200 A, V_{GE} = +15/-15 V, $R_{G\,on}$ = 1.5 Ω, $R_{G\,off}$ = 1.5 Ω, di/dt_{on} = 5700 A/µs, di/dt_{off} = 2600 A/µs	T_j = 150 °C		182		ns
t_r		T_j = 150 °C		52		ns
E_{on}		T_j = 150 °C		14.81		mJ
$t_{d(off)}$		T_j = 150 °C		446		ns
t_f		T_j = 150 °C		98		ns
E_{off}		T_j = 150 °C		22.6		mJ
$R_{th(j-s)}$	per IGBT			0.29		K/W
IGBT2						
$V_{CE(sat)}$	I_C = 200 A, V_{GE} = 15 V, chiplevel	T_j = 25 °C		1.80	2.05	V
		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, chiplevel	T_j = 25 °C		5.0	5.8	mΩ
		T_j = 150 °C		7.5	8.0	mΩ
$V_{GE(th)}$	$V_{GE} = V_{CE}$, I_C = 7.6 mA		5	5.8	6.5	V
I_{CES}	V_{GE} = 0 V, V_{CE} = 1200 V, T_j = 25 °C				2.7	mA
C_{ies}	V_{CE} = 25 V, V_{GE} = 0 V	f = 1 MHz		12.3		nF
C_{oes}		f = 1 MHz		0.81		nF
C_{res}		f = 1 MHz		0.69		nF
Q_G	V_{GE} = - 15 V...+ 15 V			1600		nC
R_{Gint}	T_j = 25 °C			3.8		Ω
$t_{d(on)}$	V_{CE} = 600 V, I_C = 200 A, V_{GE} = +15/-15 V, $R_{G\,on}$ = 1.5 Ω, $R_{G\,off}$ = 1.5 Ω, di/dt_{on} = 4960 A/µs, di/dt_{off} = 1840 A/µs	T_j = 150 °C		184		ns
t_r		T_j = 150 °C		59		ns
E_{on}		T_j = 150 °C		7.33		mJ
$t_{d(off)}$		T_j = 150 °C		457		ns
t_f		T_j = 150 °C		73		ns
E_{off}		T_j = 150 °C		23.87		mJ
$R_{th(j-s)}$	per IGBT			0.29		K/W



SKiM® 4

Trench IGBT Modules

SKiM201MLI12E4

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 x I_C
- Integrated temperature sensor

Typical Applications

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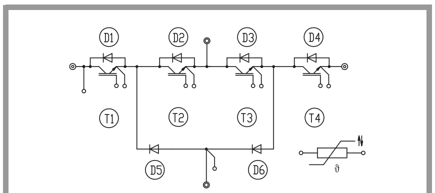
- High reliability AC inverter wind
- High reliability AC inverter drives

Remarks*

- Case temperature limited to T_s = 125°C max; $T_c = T_s$ (for baseplateless modules)
- Recommended T_{jop} = -40 ... +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



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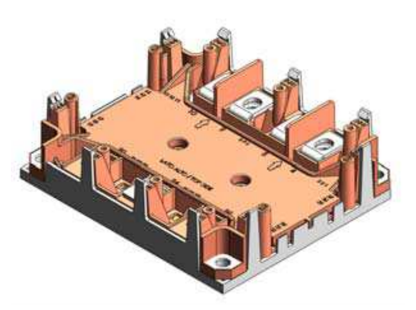
Characteristics

Symbol	Conditions		min.	typ.	max.	Unit
Diode1						
$V_F = V_{EC}$	I_F = 200 A	T_j = 25 °C		2.20	2.52	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		4.5	5.1	mΩ
		T_j = 150 °C		6.3	6.9	mΩ
I_{RRM}	I_F = 200 A	T_j = 150 °C		211		A
Q_{rr}	di/dt_{off} = 5000 A/µs V_R = 600 V	T_j = 150 °C		36.47		µC
E_{rr}	V_{GE} = +15/-15 V	T_j = 150 °C		14.53		mJ
$R_{th(j-s)}$				0.36		K/W
Diode2						
$V_F = V_{EC}$	I_F = 200 A	T_j = 25 °C		2.20	2.52	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		4.5	5.1	mΩ
		T_j = 150 °C		6.3	6.9	mΩ
I_{RRM}	I_F = 200 A	T_j = 150 °C		212		A
Q_{rr}	di/dt_{off} = 5000 A/µs V_R = 600 V	T_j = 150 °C		36.47		µC
E_{rr}	V_{GE} = +15/-15 V	T_j = 150 °C		-		mJ
$R_{th(j-s)}$				0.36		K/W
Diode5						
$V_F = V_{EC}$	I_F = 200 A	T_j = 25 °C		2.20	2.52	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		4.5	5.1	mΩ
		T_j = 150 °C		6.3	6.9	mΩ
I_{RRM}	I_F = 200 A	T_j = 150 °C		212		A
Q_{rr}	di/dt_{off} = 5700 A/µs V_R = 600 V	T_j = 150 °C		34.87		µC
E_{rr}	V_{GE} = +15/-15 V	T_j = 150 °C		15.79		mJ
$R_{th(j-s)}$				0.55		K/W



SKiM® 4

Characteristics						
Symbol	**Conditions**		**min.**	**typ.**	**max.**	**Unit**
Module						
L_{sCE1}				25		nH
L_{sCE2}				32		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

Trench IGBT Modules

SKiM201MLI12E4

Features

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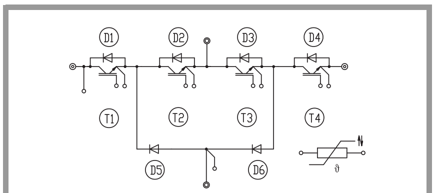
Remarks*

- Case temperature limited to T_s = 125°C max; $T_c = T_s$ (for baseplateless modules)
- Recommended T_{jop} = -40 ... +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



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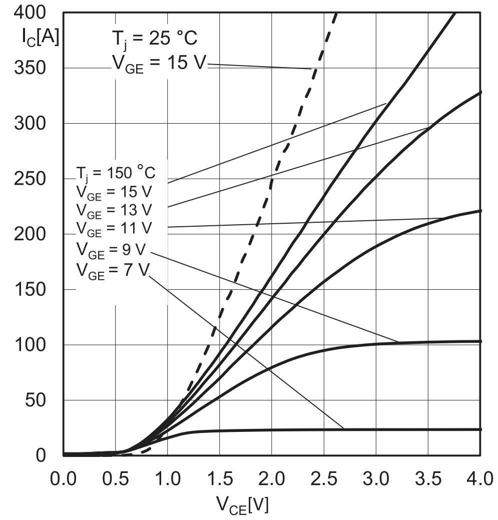


Fig. 1: Typ. IGBT1 output characteristic, incl. $R_{CC'+EE'}$

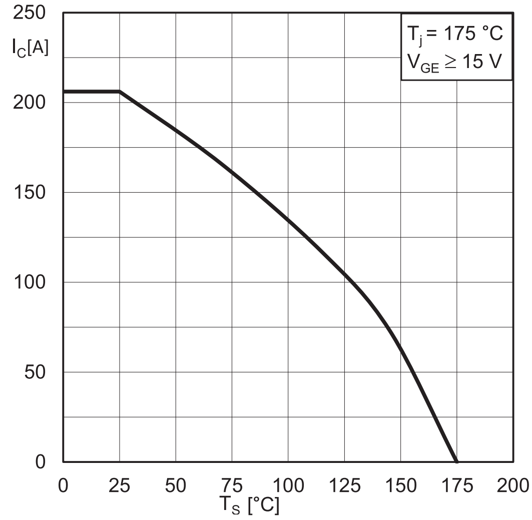


Fig. 2: IGBT1 rated current vs. Temperature I_c=f(T_s)

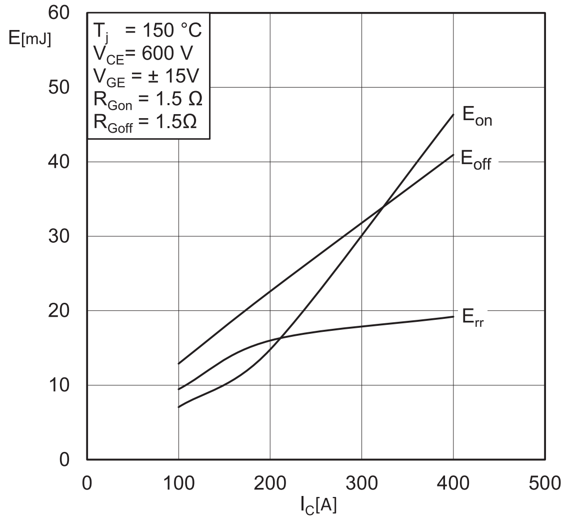


Fig. 3: Typ. IGBT1 & Diode5 turn-on /-off energy = f (I_C)

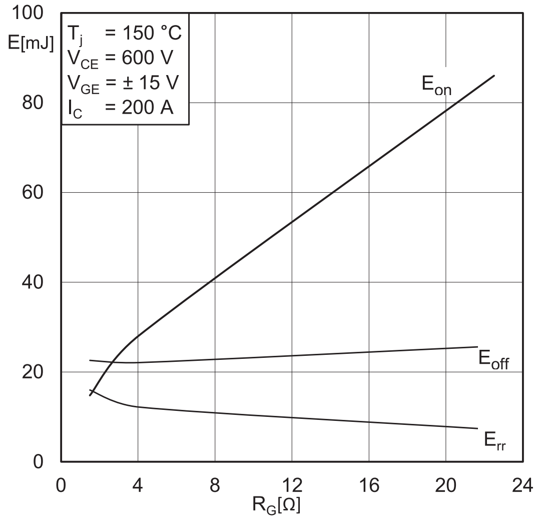


Fig. 4: Typ. IGBT1 & Diode5 turn-on /-off energy = f(R_G)

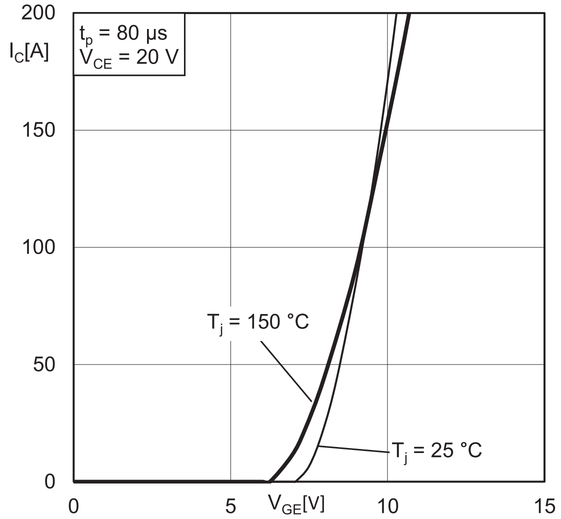


Fig. 5: Typ. IGBT1 transfer characteristic

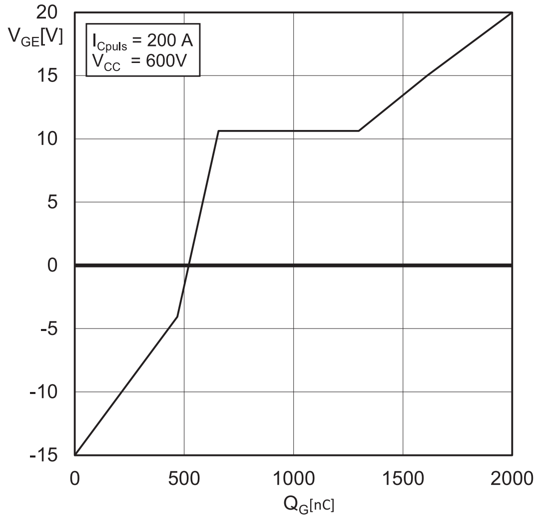


Fig. 6: Typ. IGBT1 gate charge characteristic

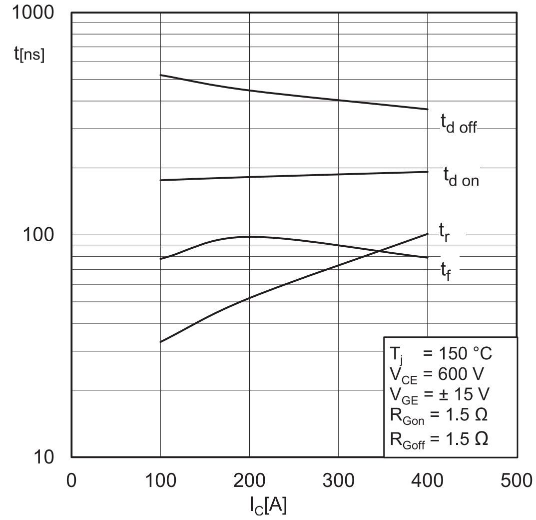


Fig. 7: Typ. IGBT1 switching times vs. I_C

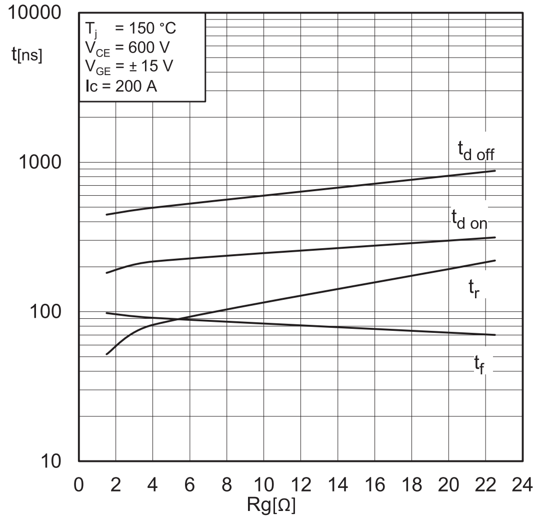


Fig. 8: Typ. IGBT1 switching times vs. gate resistor R_G

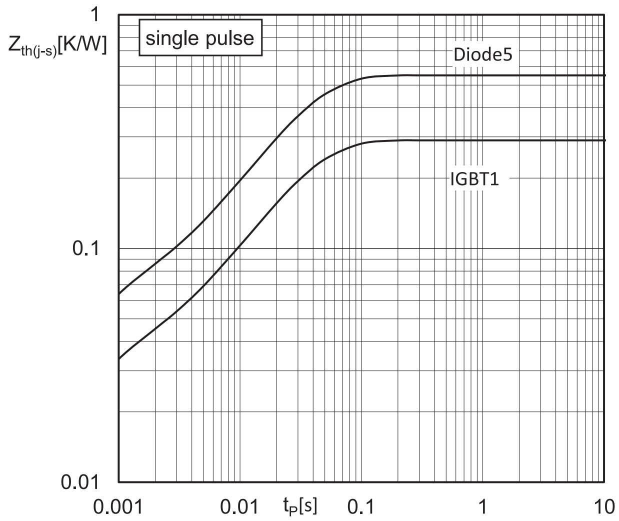


Fig. 9: Transient thermal impedance of IGBT1 & Diode5

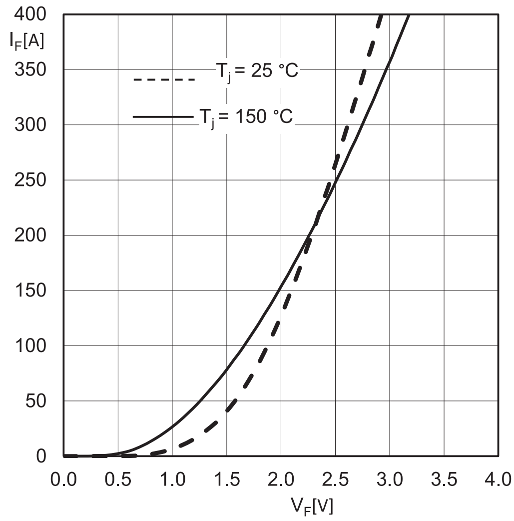


Fig. 10: Typ. Diode5 forward characteristic, incl. $R_{CC'+EE'}$

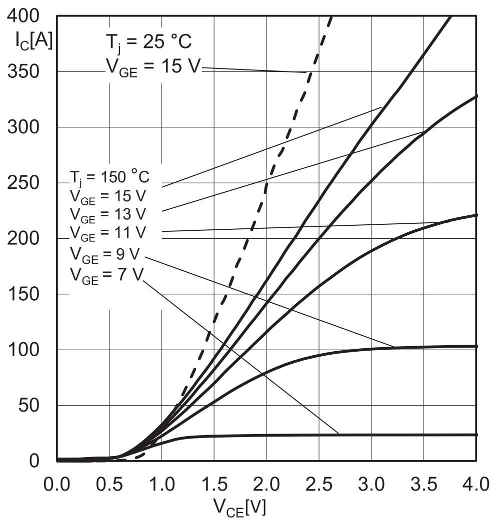


Fig. 13: Typ. IGBT2 output characteristic, incl. $R_{CC'+EE'}$

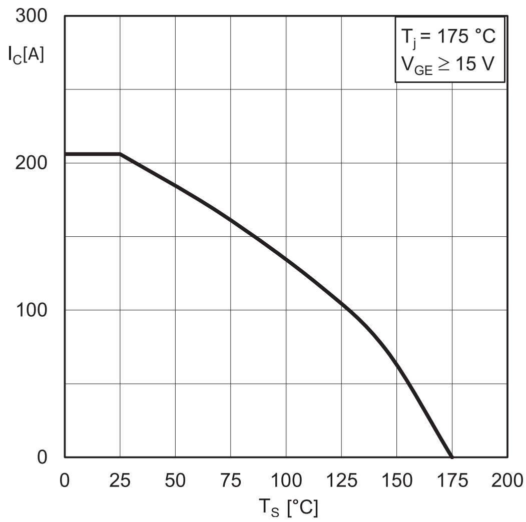


Fig. 14: IGBT2 Rated current vs. Temperature I_c= f (T_s)

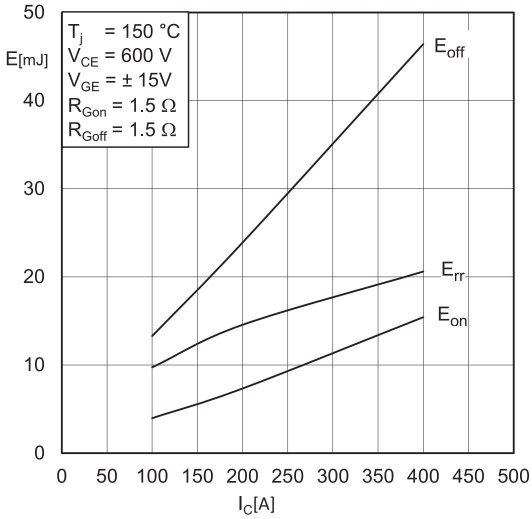


Fig. 15: Typ. IGBT2 & Diode1 turn-on /-off energy = f (I_C)

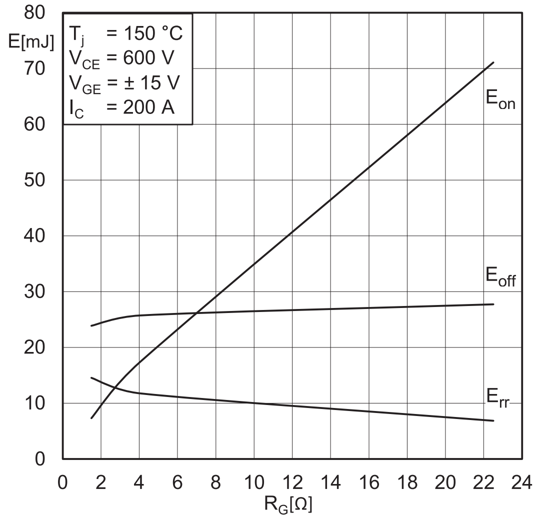


Fig. 16: Typ. IGBT2 & Diode1 turn-on / -off energy = f(R_G)

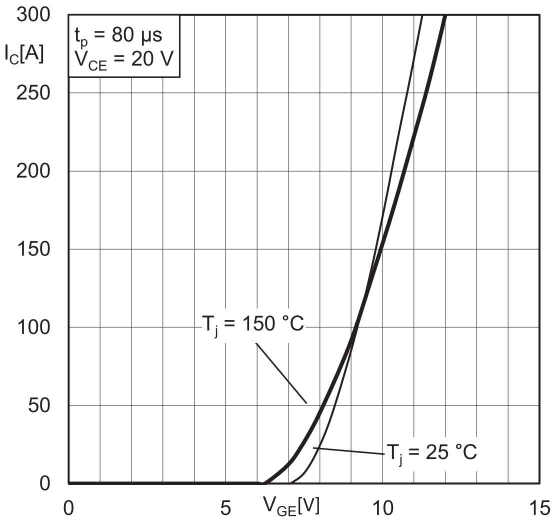


Fig. 17: Typ. IGBT2 transfer characteristic

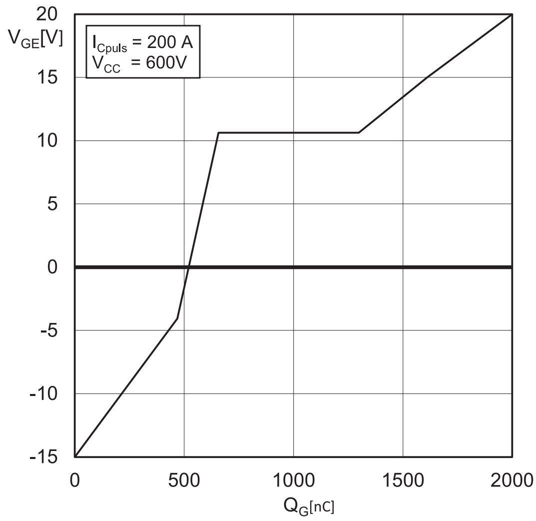


Fig. 18: Typ. IGBT2 gate charge characteristic

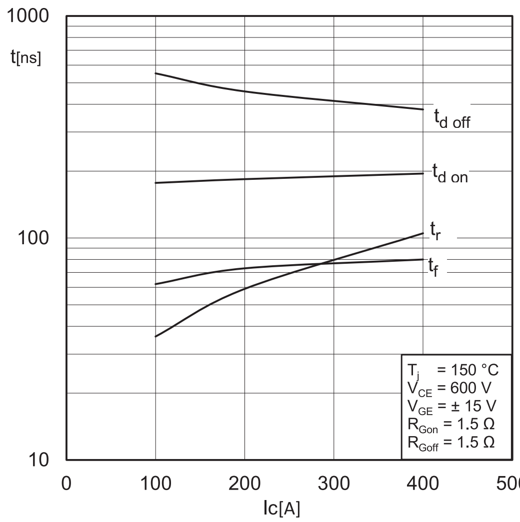


Fig. 19: Typ. IGBT2 switching times vs. I_C

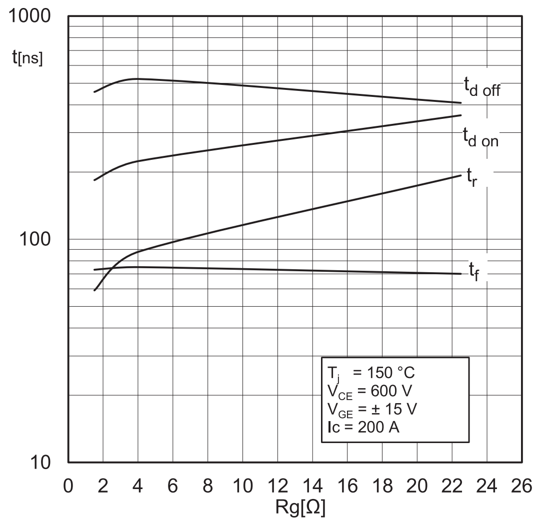


Fig. 20: Typ. IGBT2 switching times vs. gate resistor R_G

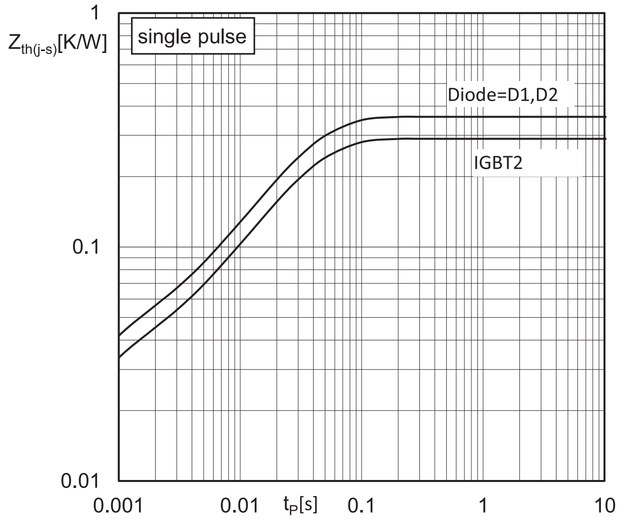


Fig. 21: Transient thermal impedance of IGBT2, Diode1 & Diode2

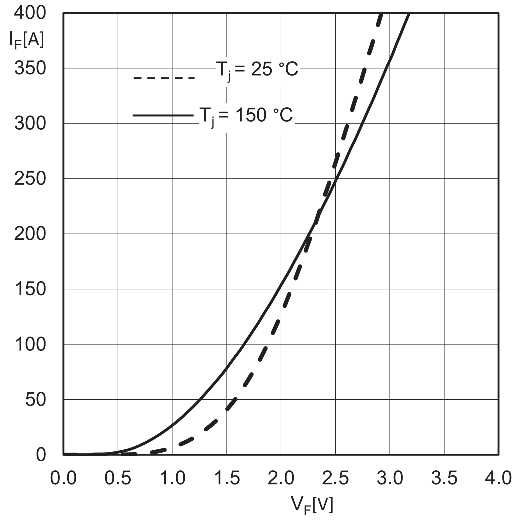
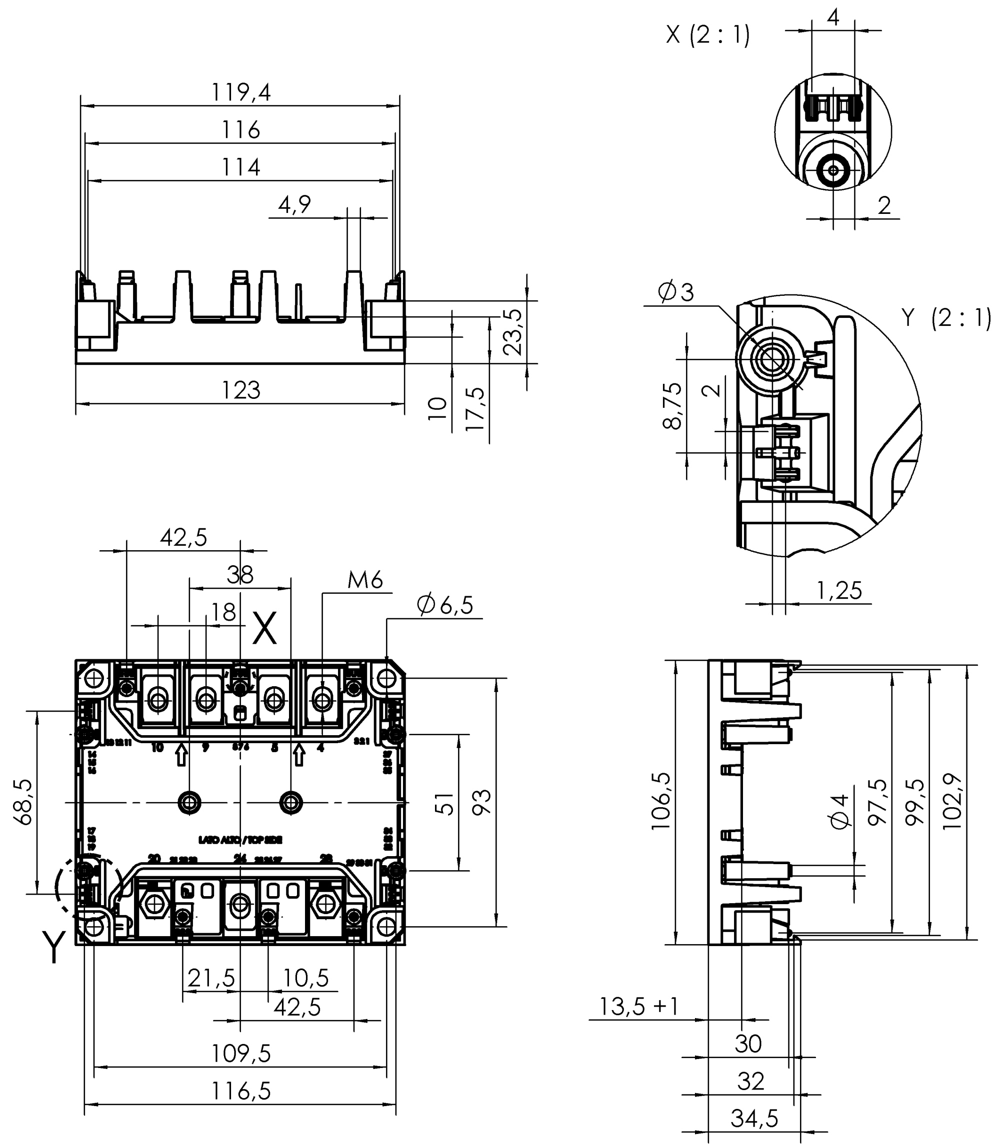
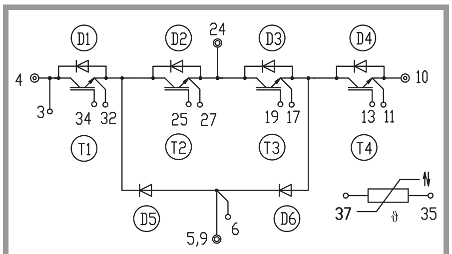


Fig. 22: Typ. Diode1 & Diode2 forward characteristic, incl. $R_{CC'+ EE'}$


X (2 : 1)
Y (2 : 1)
119,4
116
114
4,9
123
23,5
10
17,5
4
2
Ø3
8,75
2
1,25
42,5
38
18
X
M6
Ø6,5
68,5
51
93
Y
21,5
10,5
42,5
109,5
116,5
106,5
Ø4
97,5
99,5
102,9
13,5 +1
30
32
34,5

SKiM 4


D1
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MLI

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

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