

SKiM[®] 4

Trench IGBT Modules

SKiM201MLI12E4

Features

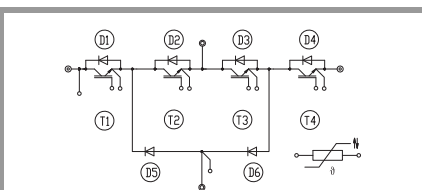
- IGBT 4 Trench Gate Technology
- Solder technology
- $V_{CE(sat)}$ with positive temperature coefficient
- Low inductance case
- Insulated by Al_2O_3 DCB (Direct Copper Bonded) ceramic substrate
- Pressure contact technology for thermal contacts
- Spring contact system to attach driver PCB to the control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

Typical Applications

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

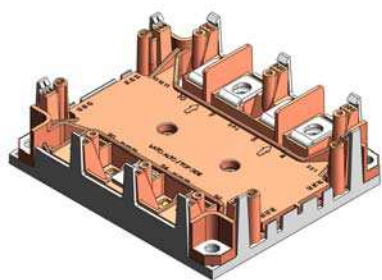
Remarks*

- Case temperature limited to $T_s = 125^\circ C$ 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}	$T_j = 25^\circ C$	1200	V
I_C	$T_j = 175^\circ C$	$T_s = 25^\circ C$	206
		$T_s = 70^\circ C$	166
I_{Cnom}		200	A
I_{CRM}	$I_{CRM} = 3 \times I_{Cnom}$	600	A
V_{GES}		-20 ... 20	V
t_{psc}	$V_{CC} = 800 V, V_{GE} \leq 15 V, T_j = 150^\circ C, V_{CES} \leq 1200 V$	10	μs
T_j		-40 ... 175	$^\circ C$
IGBT2			
V_{CES}	$T_j = 25^\circ C$	1200	V
I_C	$T_j = 175^\circ C$	$T_s = 25^\circ C$	206
		$T_s = 70^\circ C$	166
I_{Cnom}		200	A
I_{CRM}	$I_{CRM} = 3 \times I_{Cnom}$	600	A
V_{GES}		-20 ... 20	V
t_{psc}	$V_{CC} = 800 V, V_{GE} \leq 15 V, T_j = 150^\circ C, V_{CES} \leq 1200 V$	10	μs
T_j		-40 ... 175	$^\circ C$
Diode1			
V_{RRM}	$T_j = 25^\circ C$	1200	V
I_F	$T_j = 175^\circ C$	$T_s = 25^\circ C$	187
		$T_s = 70^\circ C$	148
I_{Fnom}		200	A
I_{FRM}	$I_{FRM} = 2 \times I_{Fnom}$	400	A
I_{FSM}	10 ms, sin 180°, $T_j = 25^\circ C$	990	A
T_j		-40 ... 175	$^\circ C$
Diode2			
V_{RRM}	$T_j = 25^\circ C$	1200	V
I_F	$T_j = 175^\circ C$	$T_s = 25^\circ C$	187
		$T_s = 70^\circ C$	148
I_{Fnom}		200	A
I_{FRM}	$I_{FRM} = 2 \times I_{Fnom}$	400	A
I_{FSM}	10 ms, sin 180°, $T_j = 25^\circ C$	990	A
T_j		-40 ... 175	$^\circ C$
Diode5			
V_{RRM}	$T_j = 25^\circ C$	1200	V
I_F	$T_j = 175^\circ C$	$T_s = 25^\circ C$	141
		$T_s = 70^\circ C$	111
I_{Fnom}		200	A
I_{FRM}	$I_{FRM} = 2 \times I_{Fnom}$	400	A
I_{FSM}	10 ms, sin 180°, $T_j = 25^\circ C$	990	A
T_j		-40 ... 175	$^\circ C$
Module			
$I_{t(RMS)}$		400	A
T_{stg}		-40 ... 125	$^\circ C$
V_{isol}	AC sinus 50 Hz, t = 1 min	2500	V



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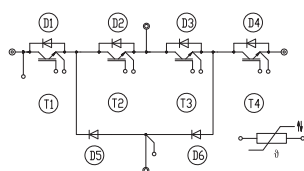
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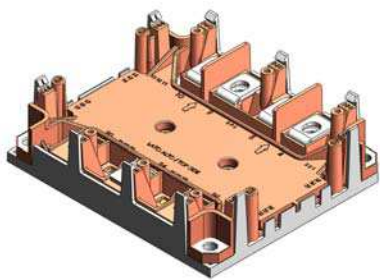
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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
IGBT1						
$V_{CE(sat)}$	$I_C = 200 \text{ A}$ $V_{GE} = 15 \text{ V}$ chipllevel	$T_j = 25^\circ C$		1.80	2.05	V
		$T_j = 150^\circ C$		2.20	2.40	V
V_{CE0}	chipllevel	$T_j = 25^\circ C$		0.80	0.90	V
		$T_j = 150^\circ C$		0.70	0.80	V
r_{CE}	$V_{GE} = 15 \text{ V}$ chipllevel	$T_j = 25^\circ C$		5.0	5.8	m Ω
		$T_j = 150^\circ C$		7.5	8.0	m Ω
$V_{GE(th)}$	$V_{GE} = V_{CE}, I_C = 7.6 \text{ mA}$		5	5.8	6.5	V
I_{CES}	$V_{GE} = 0 \text{ V}, V_{CE} = 1200 \text{ V}, T_j = 25^\circ C$				2.7	mA
C_{ies}	$V_{CE} = 25 \text{ V}$ $V_{GE} = 0 \text{ V}$	$f = 1 \text{ MHz}$		12.3		nF
C_{oes}		$f = 1 \text{ MHz}$		0.81		nF
C_{res}		$f = 1 \text{ MHz}$		0.69		nF
Q_G	$V_{GE} = -15 \text{ V} \dots +15 \text{ V}$			1600		nC
R_{Gint}	$T_j = 25^\circ C$			3.8		Ω
$t_{d(on)}$	$V_{CE} = 600 \text{ V}$	$T_j = 150^\circ C$		182		ns
t_r	$I_C = 200 \text{ A}$	$T_j = 150^\circ C$		52		ns
E_{on}	$V_{GE} = +15/-15 \text{ V}$	$T_j = 150^\circ C$		14.81		mJ
$t_{d(off)}$	$R_{G on} = 1.5 \Omega$	$T_j = 150^\circ C$		446		ns
t_f	$R_{G off} = 1.5 \Omega$	$T_j = 150^\circ C$		98		ns
E_{off}	$di/dt_{on} = 5700 \text{ A}/\mu\text{s}$ $di/dt_{off} = 2600 \text{ A}/\mu\text{s}$	$T_j = 150^\circ C$		22.6		mJ
$R_{th(j-s)}$	per IGBT			0.29		K/W
IGBT2						
$V_{CE(sat)}$	$I_C = 200 \text{ A}$ $V_{GE} = 15 \text{ V}$ chipllevel	$T_j = 25^\circ C$		1.80	2.05	V
		$T_j = 150^\circ C$		2.20	2.40	V
V_{CE0}	chipllevel	$T_j = 25^\circ C$		0.80	0.90	V
		$T_j = 150^\circ C$		0.70	0.80	V
r_{CE}	$V_{GE} = 15 \text{ V}$ chipllevel	$T_j = 25^\circ C$		5.0	5.8	m Ω
		$T_j = 150^\circ C$		7.5	8.0	m Ω
$V_{GE(th)}$	$V_{GE} = V_{CE}, I_C = 7.6 \text{ mA}$		5	5.8	6.5	V
I_{CES}	$V_{GE} = 0 \text{ V}, V_{CE} = 1200 \text{ V}, T_j = 25^\circ C$				2.7	mA
C_{ies}	$V_{CE} = 25 \text{ V}$ $V_{GE} = 0 \text{ V}$	$f = 1 \text{ MHz}$		12.3		nF
C_{oes}		$f = 1 \text{ MHz}$		0.81		nF
C_{res}		$f = 1 \text{ MHz}$		0.69		nF
Q_G	$V_{GE} = -15 \text{ V} \dots +15 \text{ V}$			1600		nC
R_{Gint}	$T_j = 25^\circ C$			3.8		Ω
$t_{d(on)}$	$V_{CE} = 600 \text{ V}$	$T_j = 150^\circ C$		184		ns
t_r	$I_C = 200 \text{ A}$	$T_j = 150^\circ C$		59		ns
E_{on}	$V_{GE} = +15/-15 \text{ V}$	$T_j = 150^\circ C$		7.33		mJ
$t_{d(off)}$	$R_{G on} = 1.5 \Omega$	$T_j = 150^\circ C$		457		ns
t_f	$R_{G off} = 1.5 \Omega$	$T_j = 150^\circ C$		73		ns
E_{off}	$di/dt_{on} = 4960 \text{ A}/\mu\text{s}$ $di/dt_{off} = 1840 \text{ A}/\mu\text{s}$	$T_j = 150^\circ C$		23.87		mJ
$R_{th(j-s)}$	per IGBT			0.29		K/W



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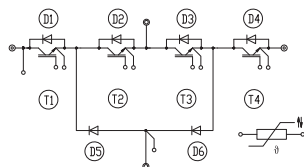
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- Solder technology
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- Low inductance case
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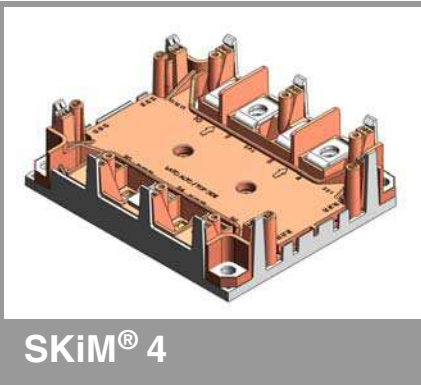
Remarks*

- 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
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- Diode5 : clamping diodes D5 & D6



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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
Diode1						
$V_F = V_{EC}$	$I_F = 200 \text{ A}$	$T_j = 25^\circ C$		2.20	2.52	V
		chipelevel	$T_j = 150^\circ C$	2.15	2.47	V
V_{F0}	chipelevel	$T_j = 25^\circ C$		1.30	1.50	V
		$T_j = 150^\circ C$		0.90	1.10	V
r_F	chipelevel	$T_j = 25^\circ C$		4.5	5.1	m Ω
		$T_j = 150^\circ C$		6.3	6.9	m Ω
I_{RRM}	$I_F = 200 \text{ A}$	$T_j = 150^\circ C$		211		A
Q_{rr}	$di/dt_{off} = 5000 \text{ A}/\mu\text{s}$ $V_R = 600 \text{ V}$	$T_j = 150^\circ C$		36.47		μC
E_{rr}	$V_{GE} = +15/-15 \text{ V}$	$T_j = 150^\circ C$		14.53		mJ
$R_{th(j-s)}$				0.36		K/W
Diode2						
$V_F = V_{EC}$	$I_F = 200 \text{ A}$	$T_j = 25^\circ C$		2.20	2.52	V
		chipelevel	$T_j = 150^\circ C$	2.15	2.47	V
V_{F0}	chipelevel	$T_j = 25^\circ C$		1.30	1.50	V
		$T_j = 150^\circ C$		0.90	1.10	V
r_F	chipelevel	$T_j = 25^\circ C$		4.5	5.1	m Ω
		$T_j = 150^\circ C$		6.3	6.9	m Ω
I_{RRM}	$I_F = 200 \text{ A}$	$T_j = 150^\circ C$		212		A
Q_{rr}	$di/dt_{off} = 5000 \text{ A}/\mu\text{s}$ $V_R = 600 \text{ V}$	$T_j = 150^\circ C$		36.47		μC
E_{rr}	$V_{GE} = +15/-15 \text{ V}$	$T_j = 150^\circ C$		-		mJ
$R_{th(j-s)}$				0.36		K/W
Diode5						
$V_F = V_{EC}$	$I_F = 200 \text{ A}$	$T_j = 25^\circ C$		2.20	2.52	V
		chipelevel	$T_j = 150^\circ C$	2.15	2.47	V
V_{F0}	chipelevel	$T_j = 25^\circ C$		1.30	1.50	V
		$T_j = 150^\circ C$		0.90	1.10	V
r_F	chipelevel	$T_j = 25^\circ C$		4.5	5.1	m Ω
		$T_j = 150^\circ C$		6.3	6.9	m Ω
I_{RRM}	$I_F = 200 \text{ A}$	$T_j = 150^\circ C$		212		A
Q_{rr}	$di/dt_{off} = 5700 \text{ A}/\mu\text{s}$ $V_R = 600 \text{ V}$	$T_j = 150^\circ C$		34.87		μC
E_{rr}	$V_{GE} = +15/-15 \text{ V}$	$T_j = 150^\circ C$		15.79		mJ
$R_{th(j-s)}$				0.55		K/W



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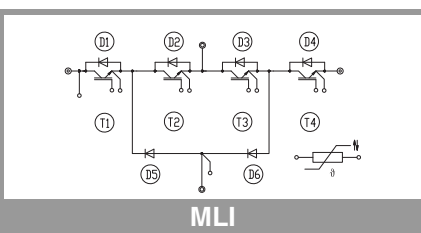
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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
Module						
L_{sCE1}				25		nH
L_{sCE2}				32		nH
$R_{CC'+EE'}$	measured between terminal 4 and 24	$T_s = 25^\circ C$		0.4		m Ω
		$T_s = 125^\circ C$		0.6		m Ω
M_s	to heat sink M5		2		3	Nm
M_t	to terminals M6		4		5	Nm
w				317		g
Temperature Sensor						
R_{100}	$T_c=100^\circ C$ ($R_{25}=5$ k Ω)			$493 \pm 5\%$		Ω
$B_{100/125}$	$R_{(T)}=R_{100}\exp[B_{100/125}(1/T-1/T_{100})]$; T[K];			$3550 \pm 2\%$		K

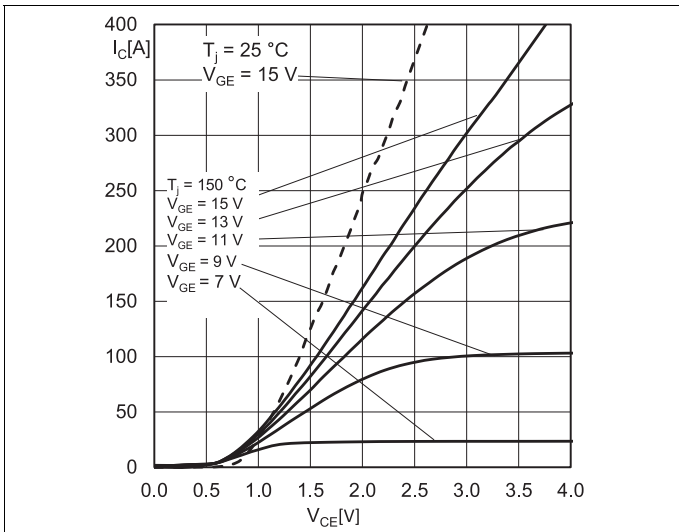


Fig. 1: Typ. IGBT1 output characteristic, incl. $R_{CC'+EE'}$

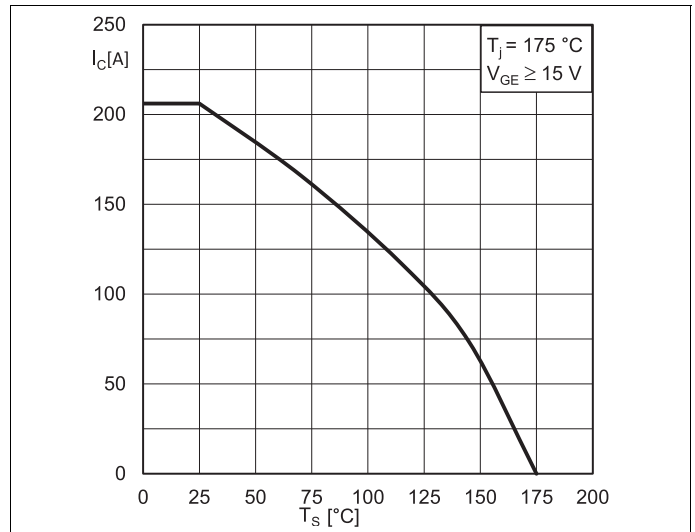


Fig. 2: IGBT1 rated current vs. Temperature $I_C=f(T_s)$

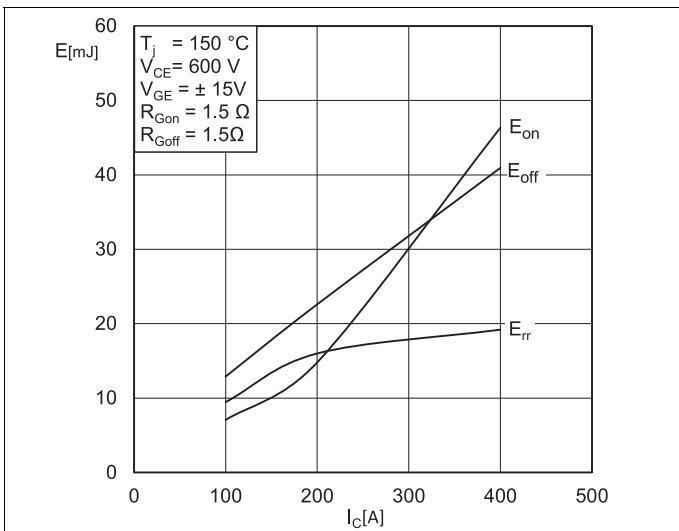


Fig. 3: Typ. IGBT1 & Diode5 turn-on /-off energy = $f(I_C)$

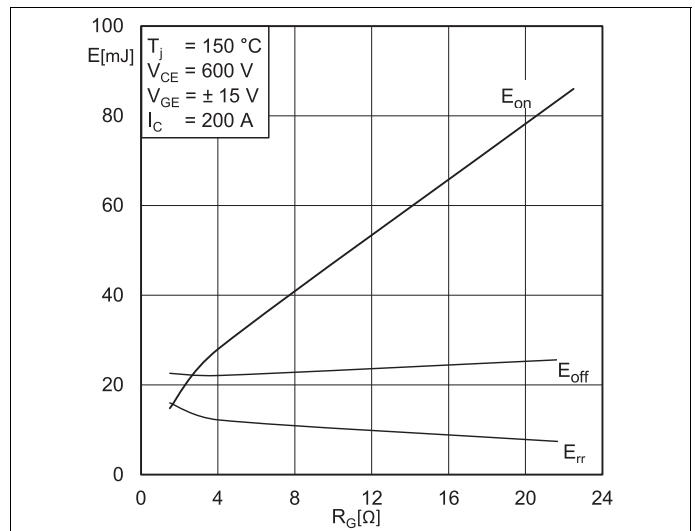


Fig. 4: Typ. IGBT1 & Diode5 turn-on /-off energy = $f(R_G)$

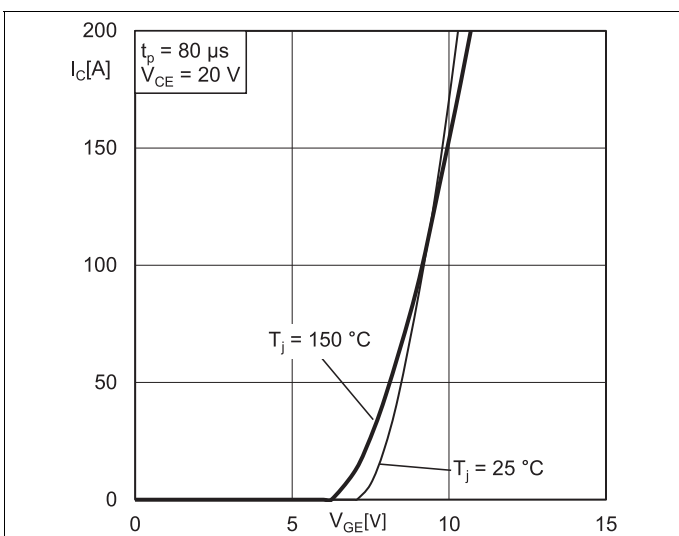


Fig. 5: Typ. IGBT1 transfer characteristic

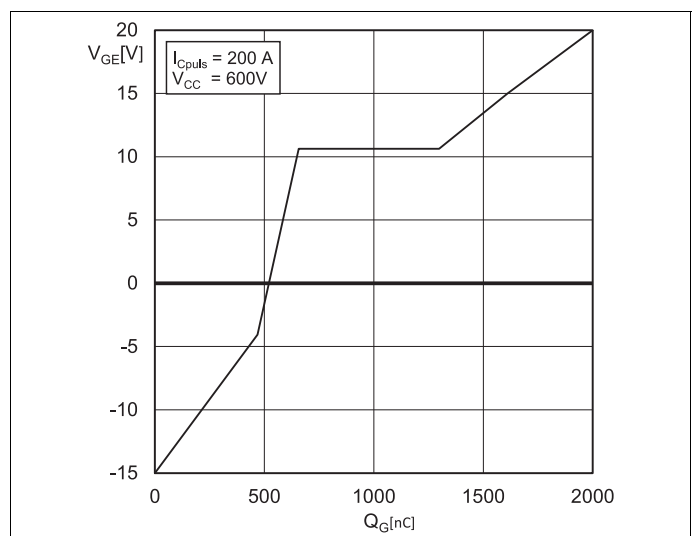


Fig. 6: Typ. IGBT1 gate charge characteristic

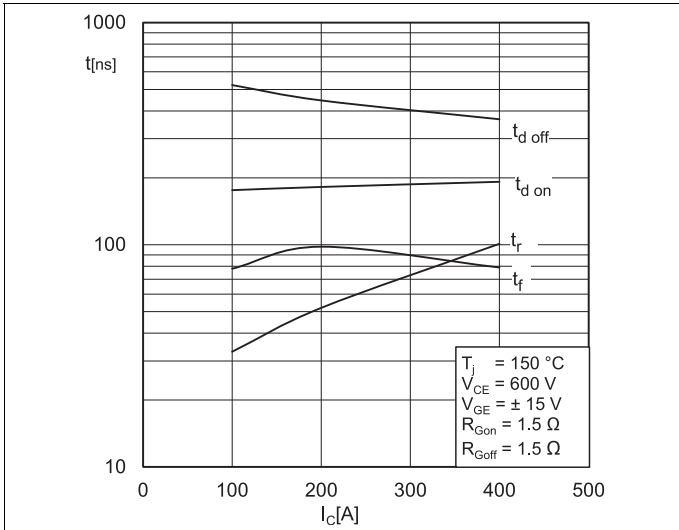


Fig. 7: Typ. IGBT1 switching times vs. I_c

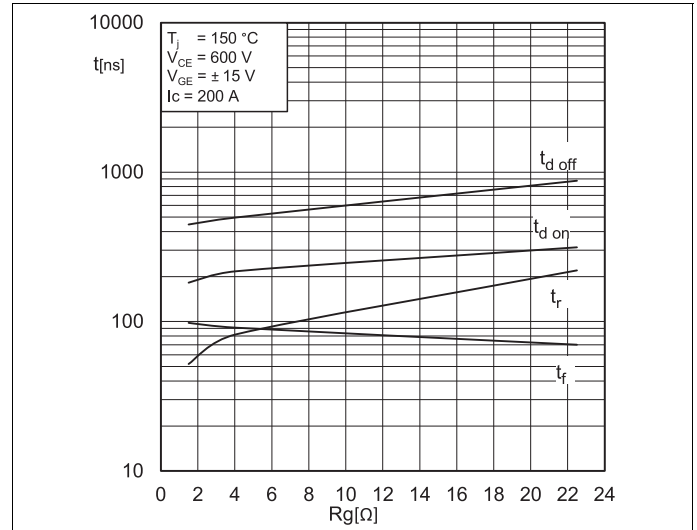


Fig. 8: Typ. IGBT1 switching times vs. gate resistor R_G

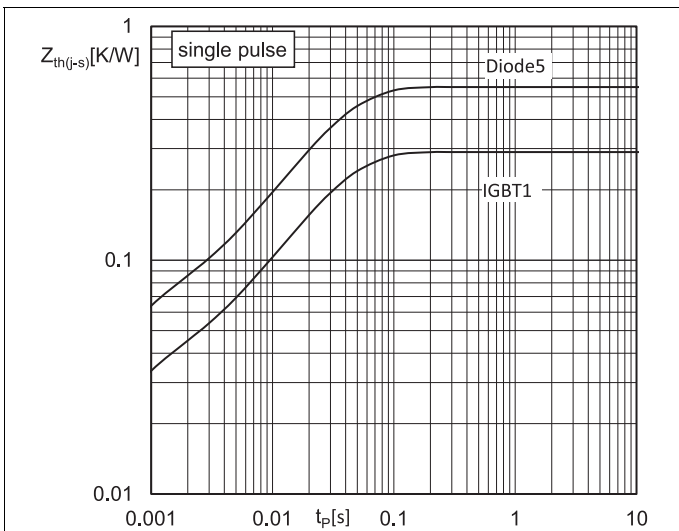


Fig. 9: Transient thermal impedance of IGBT1 & Diode5

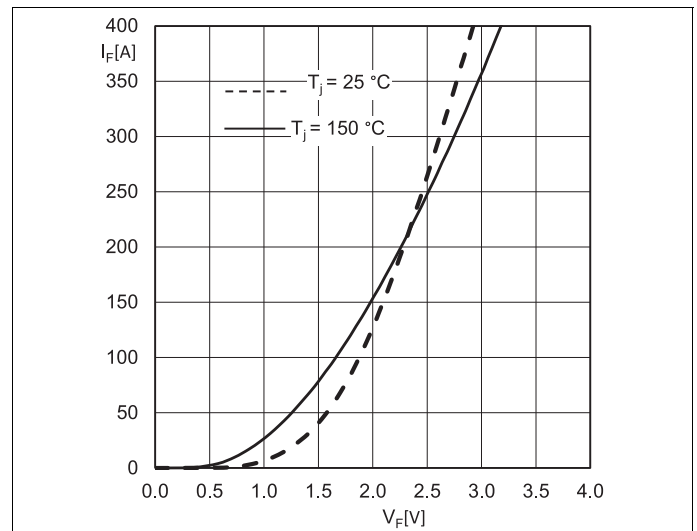


Fig. 10: Typ. Diode5 forward characteristic, incl. $R_{CC+EE'}$

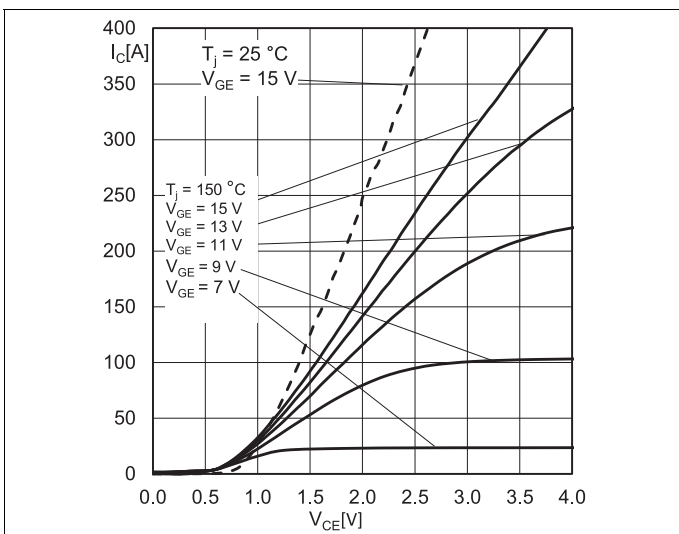


Fig. 13: Typ. IGBT2 output characteristic, incl. $R_{CC+EE'}$

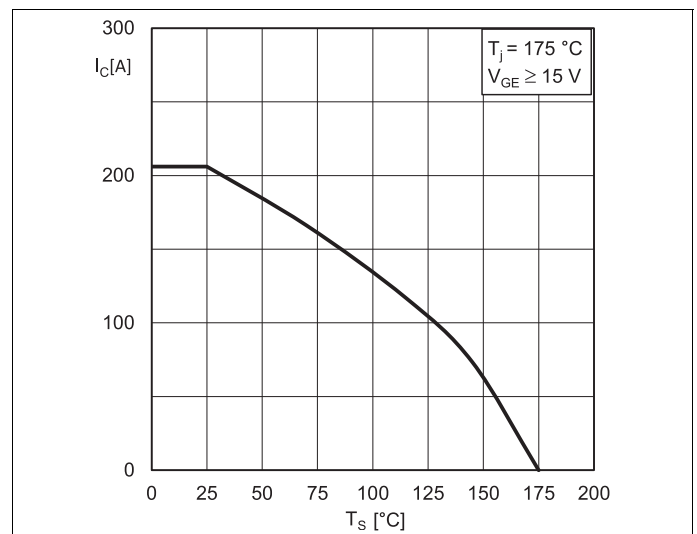


Fig. 14: IGBT2 Rated current vs. Temperature $I_c = f(T_s)$

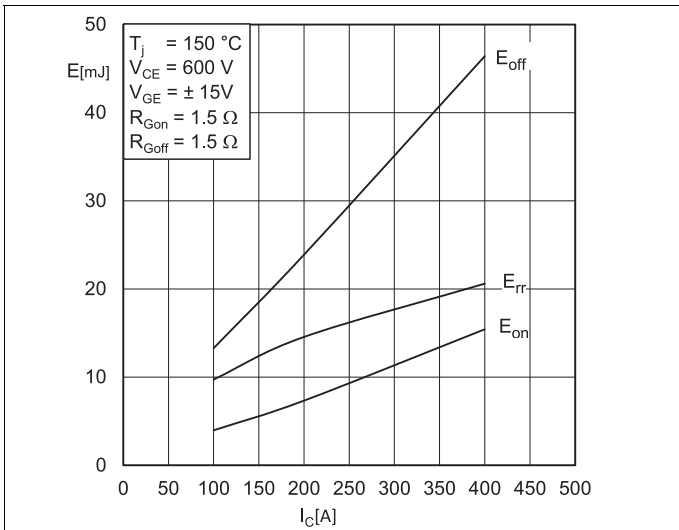


Fig. 15: Typ. IGBT2 & Diode1 turn-on /-off energy = $f(I_c)$

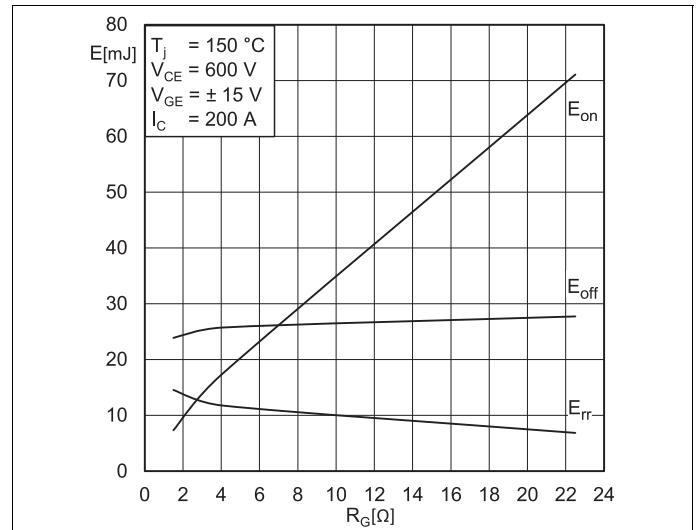


Fig. 16: Typ. IGBT2 & Diode1 turn-on / -off energy = $f(R_G)$

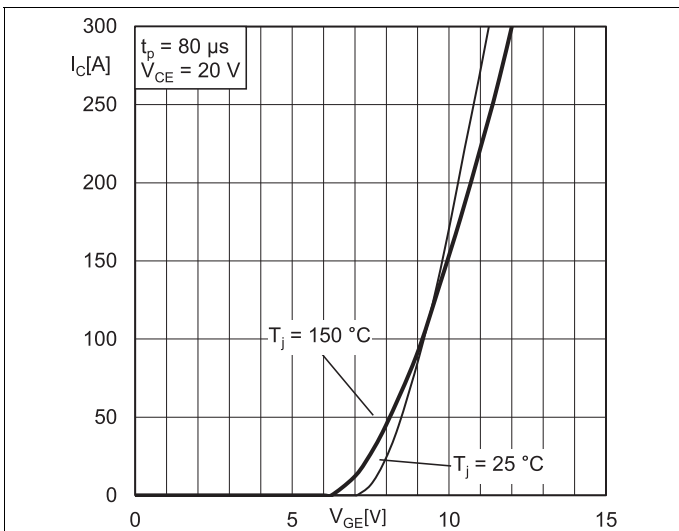


Fig. 17: Typ. IGBT2 transfer characteristic

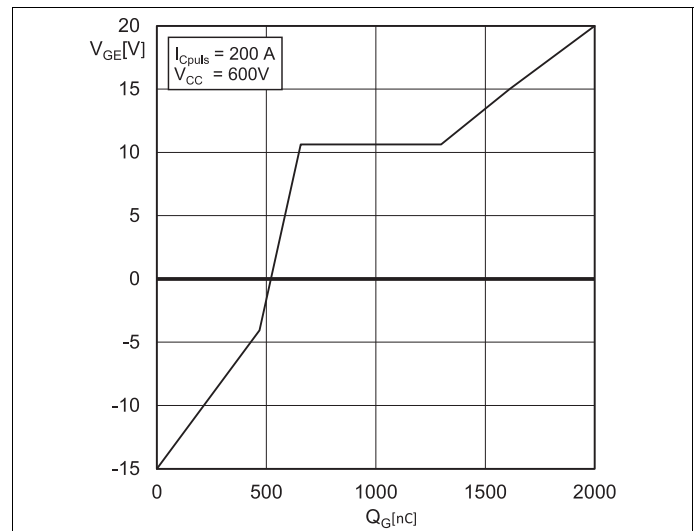


Fig. 18: Typ. IGBT2 gate charge characteristic

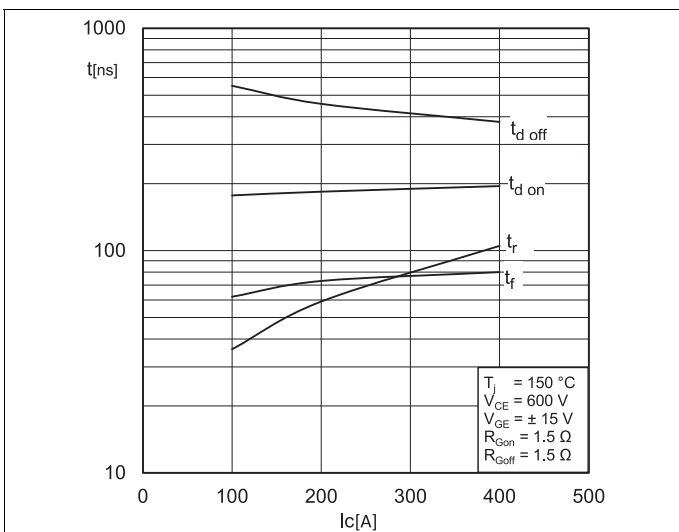


Fig. 19: Typ. IGBT2 switching times vs. I_c

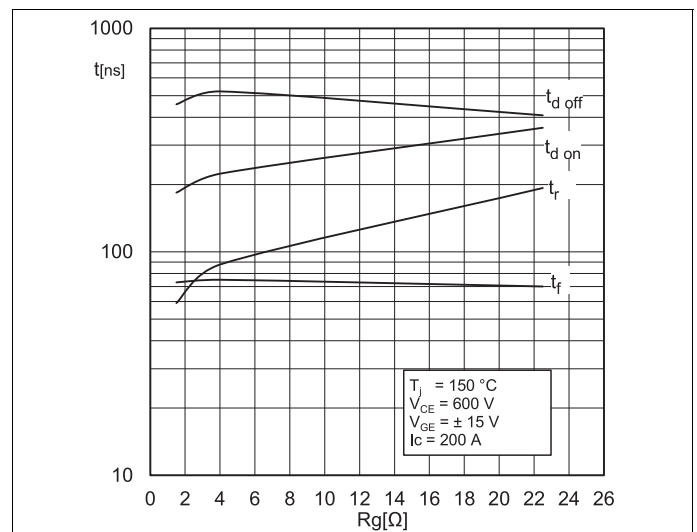


Fig. 20: Typ. IGBT2 switching times vs. gate resistor R_G

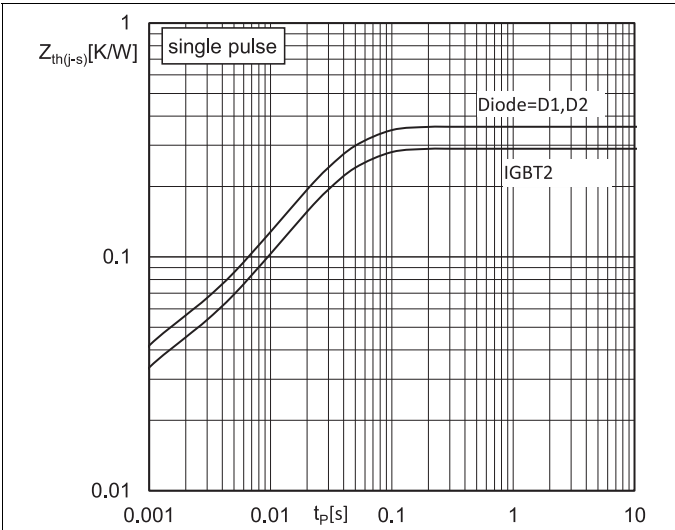


Fig. 21: Transient thermal impedance of IGBT2, Diode1 & Diode2

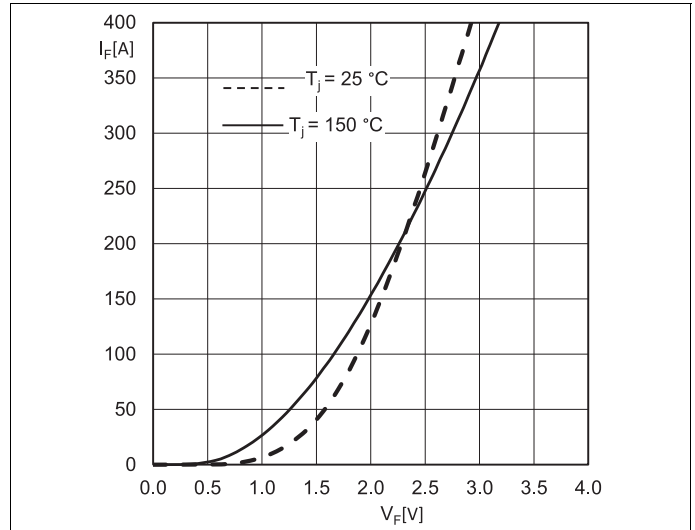
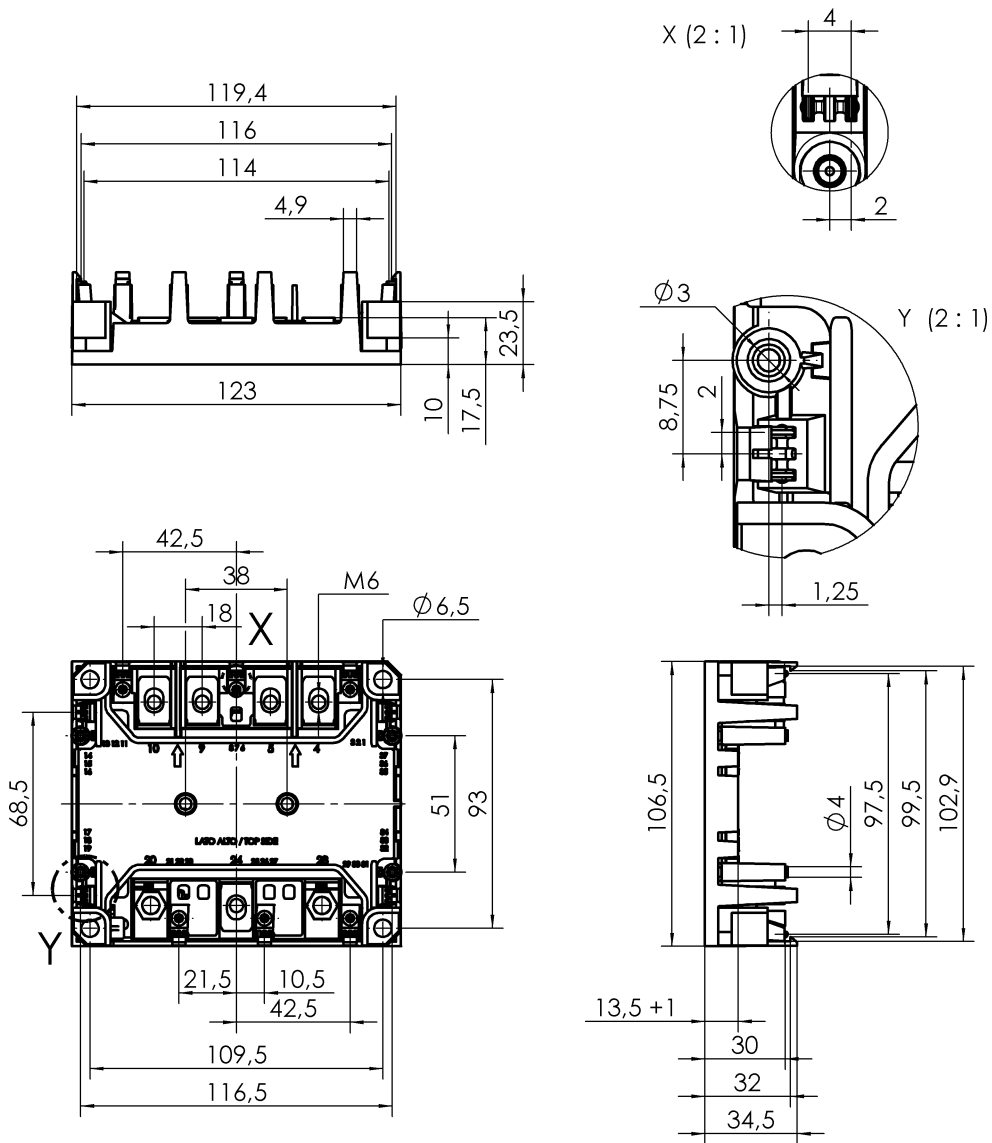
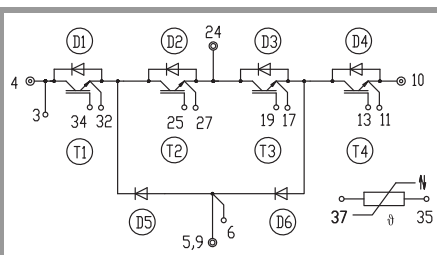


Fig. 22: Typ. Diode1 & Diode2 forward characteristic, incl. $R_{CC'+EE'}$

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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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