

SKiM® 4

Trench IGBT Modules

SKiM401TMLI12E4B

Features

- IGBT 4 Trench Gate Technology
- Solder technology
- $V_{CE(sat)}$ with positive temperature coefficient
- Low inductance case
- Isolated 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

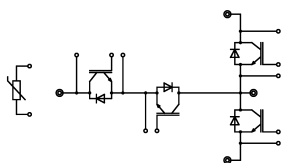
Remarks

- Case temperature limited to $T_s = 125^\circ\text{C}$ max; $T_c = T_s$ (for baseplateless modules)
- Recommended $T_{op} = -40 \dots +150^\circ\text{C}$

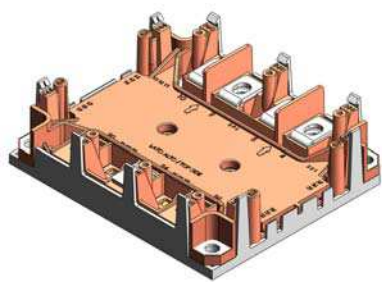
Absolute Maximum Ratings				
Symbol	Conditions		Values	Unit
IGBT 1				
V _{CES}	T _j = 25 °C		1200	V
I _C	T _j = 150 °C	T _s = 25 °C	348	A
		T _s = 70 °C	264	A
I _C	T _j = 175 °C	T _s = 25 °C	388	A
		T _s = 70 °C	312	A
I _{Cnom}			400	A
I _{CRM}	I _{CRM} = 3 x I _{Cnom}		1200	A
V _{GES}			-20 ... 20	V
t _{psc}	V _{CC} = 800 V V _{GE} ≤ 15 V V _{CES} ≤ 1200 V	T _j = 150 °C	10	μs
T _j			-40 ... 175	°C

Absolute Maximum Ratings				
Symbol	Conditions		Values	Unit
IGBT 2				
V _{CES}	T _j = 25 °C		650	V
I _C	T _j = 150 °C	T _s = 25 °C	283	A
		T _s = 70 °C	209	A
I _C	T _j = 175 °C	T _s = 25 °C	319	A
		T _s = 70 °C	252	A
I _{Cnom}			400	A
I _{CRM}	I _{CRM} = 2 x I _{Cnom}		800	A
V _{GES}			-20 ... 20	V
t _{psc}	V _{CC} = 360 V V _{GE} ≤ 15 V V _{CES} ≤ 650 V	T _j = 150 °C	10	μs
T _j			-40 ... 175	°C

Absolute Maximum Ratings			
Symbol	Conditions	Values	Unit
Module			
$I_{t(RMS)}$	$T_{terminal} = 80^\circ\text{C}$	400	A
T_{stg}		-40 ... 125	$^\circ\text{C}$
V_{isol}	AC sinus 50 Hz, $t = 1\text{ min}$	2500	V



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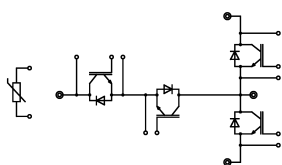
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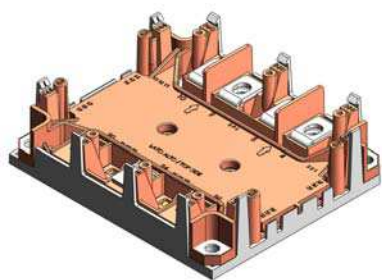
Symbol	Conditions	Values	Unit
Diode 1			
V_{RRM}	$T_j = 25^\circ\text{C}$	1200	V
I_F	$T_j = 175^\circ\text{C}$	$T_s = 25^\circ\text{C}$	311
		$T_s = 70^\circ\text{C}$	245
I_F	$T_j = 175^\circ\text{C}$	$T_s = 25^\circ\text{C}$	311
		$T_s = 70^\circ\text{C}$	245
I_{Fnom}		400	A
I_{FRM}	$I_{FRM} = 3 \times I_{Fnom}$	1200	A
I_{FSM}	10 ms, sin 180° , $T_j = 150^\circ\text{C}$	1980	A
T_j		-40 ... 175	$^\circ\text{C}$

Absolute Maximum Ratings

Symbol	Conditions	Values	Unit
Diode 2			
V_{RRM}	$T_j = 25^\circ\text{C}$	650	V
I_F	$T_j = 175^\circ\text{C}$	$T_s = 25^\circ\text{C}$	334
		$T_s = 70^\circ\text{C}$	256
I_F	$T_j = 175^\circ\text{C}$	$T_s = 25^\circ\text{C}$	334
		$T_s = 70^\circ\text{C}$	256
I_{Fnom}		400	A
I_{FRM}	$I_{FRM} = 2 \times I_{Fnom}$	800	A
I_{FSM}	10 ms sin 180°	$T_j = 25^\circ\text{C}$	2646
		$T_j = 150^\circ\text{C}$	2322
T_j		-40 ... 175	$^\circ\text{C}$



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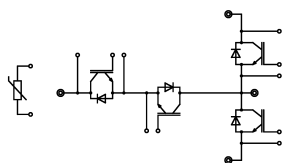
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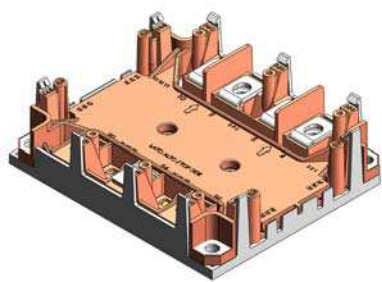
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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
IGBT 1						
V _{CE(sat)}	I _C = 400 A	T _j = 25 °C		1.80	2.05	V
	V _{GE} = 15 V chipelevel	T _j = 150 °C		2.20	2.40	V
V _{CE0}	chipelevel	T _j = 25 °C		0.8	0.9	V
		T _j = 150 °C		0.7	0.8	V
r _{CE}	V _{GE} = 15 V chipelevel	T _j = 25 °C		2.5	2.9	mΩ
		T _j = 150 °C		3.8	4.0	mΩ
V _{GE(th)}	V _{GE} = V _{CE} V, I _C = 15.2 mA		5	5.8	6.5	V
I _{CES}	V _{GE} = 0 V	T _j = 25 °C				mA
	V _{CE} = 1200 V					mA
C _{ies}	V _{CE} = 25 V V _{GE} = 0 V	f = 1 MHz		24.6		nF
C _{oes}		f = 1 MHz		1.62		nF
C _{res}		f = 1 MHz		1.38		nF
Q _G	- 8 V...+ 15 V			2242.3		nC
R _{Gint}	T _j = 25 °C			1.88		Ω
t _{d(on)}	V _{CE} = 300 V	T _j = 150 °C		290.57		ns
t _r	I _C = 400 A	T _j = 150 °C		92.57		ns
E _{on}	R _{G on} = 2 Ω	T _j = 150 °C		8.83		mJ
	R _{G off} = 2 Ω					
t _{d(off)}	di/dt _{on} = 4822 A/μs	T _j = 150 °C		474		ns
t _f	di/dt _{off} = 2259 A/μs	T _j = 150 °C		121.7		ns
E _{off}	V _{GE neg} = -15 V	T _j = 150 °C				
	V _{GE pos} = 15 V					
R _{th(j-s)}	per IGBT			0.16		K/W

Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
IGBT 2						
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	2.1	V
V _{CE0}	chipelevel	T _j = 25 °C		0.9	1	V
		T _j = 150 °C		0.82	0.9	V
r _{CE}	V _{GE} = 15 V	T _j = 25 °C		1.6	2.4	mΩ
	chipelevel	T _j = 150 °C		2.3	3.0	mΩ
V _{GE(th)}	V _{GE} = V _{CE} V, I _C = 8 mA		5.1	5.8	6.4	V
I _{CES}	V _{GE} = 0 V	T _j = 25 °C				mA
	V _{CE} = 650 V	T _j = 150 °C				mA
C _{ies}	V _{CE} = 25 V V _{GE} = 0 V	f = 1 MHz	24.67			nF
C _{oes}		f = 1 MHz				nF
C _{res}		f = 1 MHz	0.732			nF
Q _G	- 8 V...+ 15 V			2718.25		nC
R _{Gint}	T _j = 25 °C			1.00		Ω
t _{d(on)}	V _{CE} = 300 V	T _j = 150 °C		149.14		ns
t _r	I _C = 400 A	T _j = 150 °C		79.7		ns
E _{on}	R _{G on} = 2 Ω	T _j = 150 °C		3.32		mJ
	R _{G off} = 2 Ω					
t _{d(off)}	di/dt _{on} = 5566 A/μs	T _j = 150 °C		420		ns
t _f	di/dt _{off} = 1547 A/μs	T _j = 150 °C		180		ns
E _{off}	V _{GE neg} = -15 V V _{GE pos} = 15 V	T _j = 150 °C		20.91		mJ
R _{th(j-s)}	per IGBT			0.25		K/W



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Typical Applications*

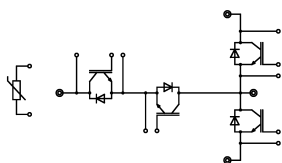
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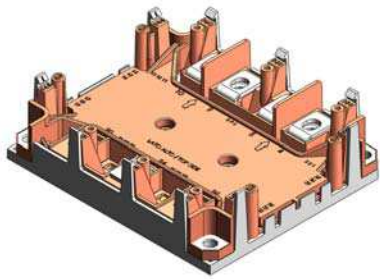
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- Recommended $T_{op} = -40 \dots +150^\circ C$

Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
Diode 1						
V _F = V _{EC}	I _F = 400 A	T _j = 25 °C		2.20	2.52	V
	V _{GE} = 15 V chiplevel	T _j = 150 °C		2.15	2.47	V
V _{F0}	chiplevel	T _j = 25 °C	1.1	1.3	1.5	V
		T _j = 150 °C	0.7	0.9	1.1	V
r _F	chiplevel	T _j = 25 °C	2.0	2.3	2.5	mΩ
		T _j = 150 °C	2.6	3.1	3.4	mΩ
I _{RRM}	I _F = 400 A		176.57			A
Q _{rr}	di/dt _{off} = 1430 A/μs		28.63			μC
E _{rr}	V _R = 300 V		2.391			mJ
R _{th(j-s)}	per DIODE			0.24		K/W

Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
Diode 2						
V _F = V _{EC}	I _F = 400 A	T _j = 25 °C		1.4	1.80	V
	chiplevel	T _j = 150 °C		1.38	1.76	V
V _{F0}	chiplevel	T _j = 25 °C	0.95	1.04	1.236	V
		T _j = 150 °C		0.85	0.99	V
r _F	chiplevel	T _j = 25 °C	0.6	0.9	1.3	mΩ
		T _j = 150 °C		1.3	1.9	mΩ
I _{RRM}	I _F = 400 A			168.85		A
Q _{rr}	di/dt _{off} = 1182 A/μs			31.66		μC
E _{rr}	V _R = 300 V			2.26		mJ
R _{th(l-s)}	per DIODE			0.29		K/W



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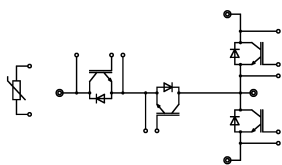
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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
Module						
L _{CE}			18			nH
R _{CC'+EE'}	terminal-chip	T _s = 25 °C	1.35			mΩ
		T _s = 125 °C	1.75			mΩ
R _{th(c-s)}	per module					K/W
M _s	to heat sink (M5)		2		3	Nm
M _t		to terminals M6	4		5	Nm
				Nm		
w			317			g

Characteristics					
Symbol	Conditions	min.	typ.	max.	Unit
Temperature Sensor					
R ₁₀₀	T _r = 100 °C, tolerance = 3 %	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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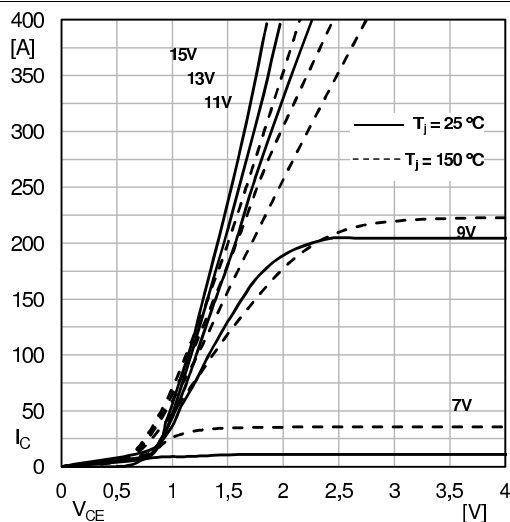


Fig. 1: Typ. IGBT 1 output characteristic, incl. $R_{CC'+EE'}$

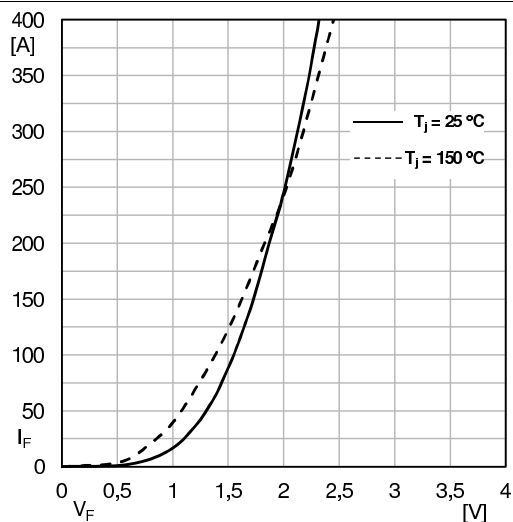


Fig. 2: Typ. Diode 1 output characteristics

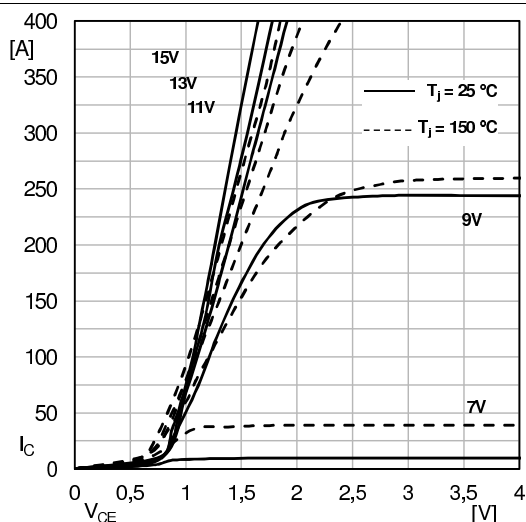


Fig. 3: Typ. IGBT 2 output characteristic, inclusive $R_{CC'+EE'}$

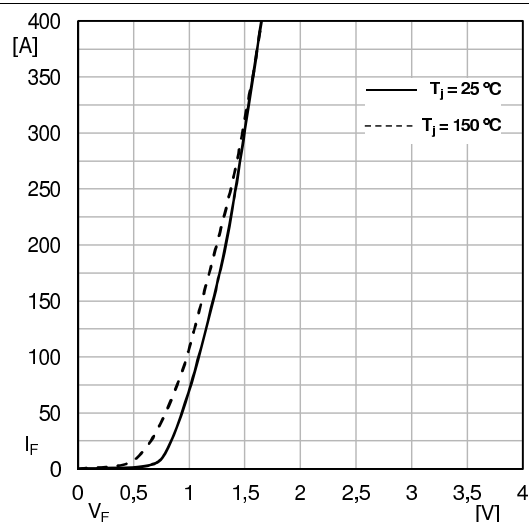


Fig. 4: Typ. Diode 2 output characteristic

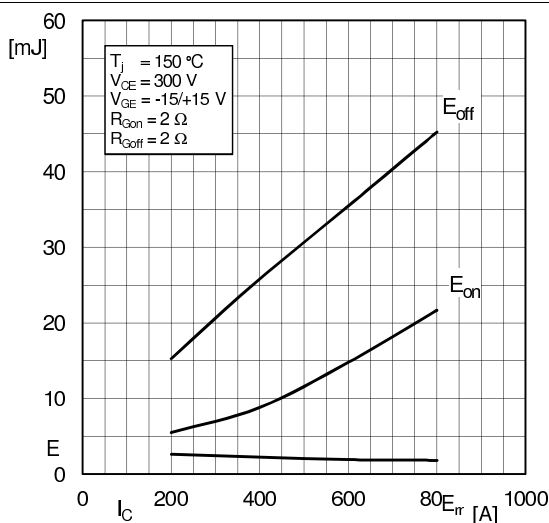


Fig. 5: Typ. IGBT 1 turn-on /-off energy = $f(I_C)$

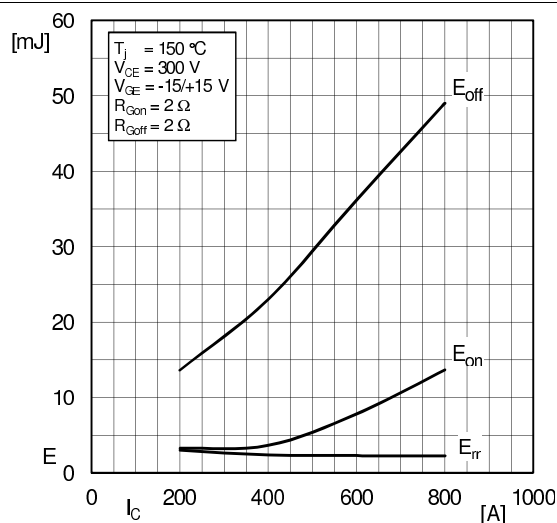
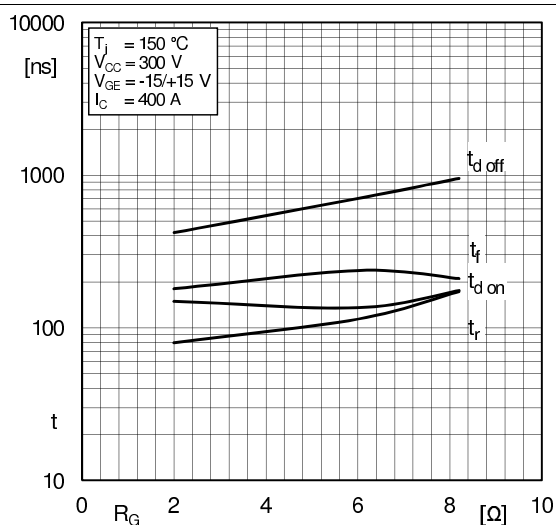
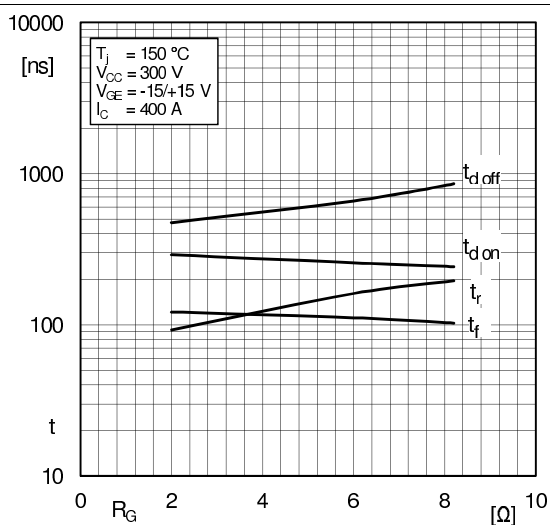
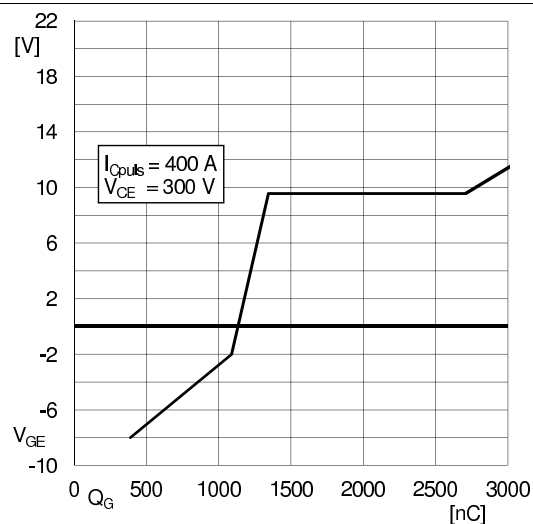
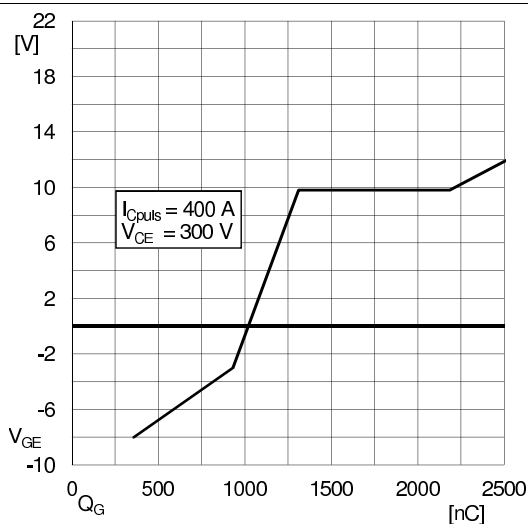
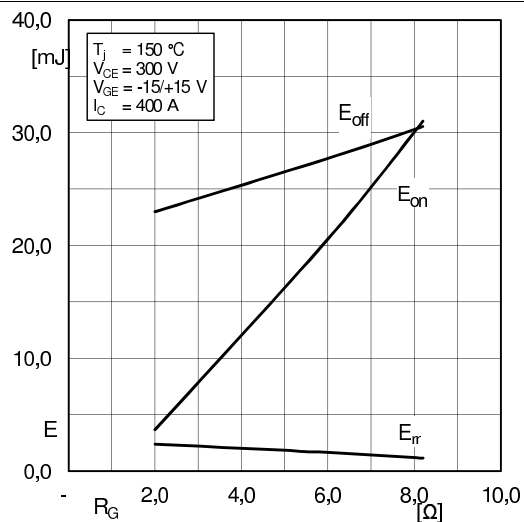
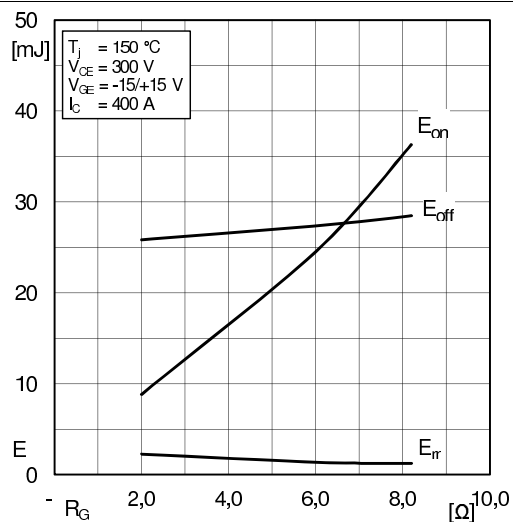


Fig. 6: Typ. IGBT 2 turn-on /-off energy = $f(I_C)$



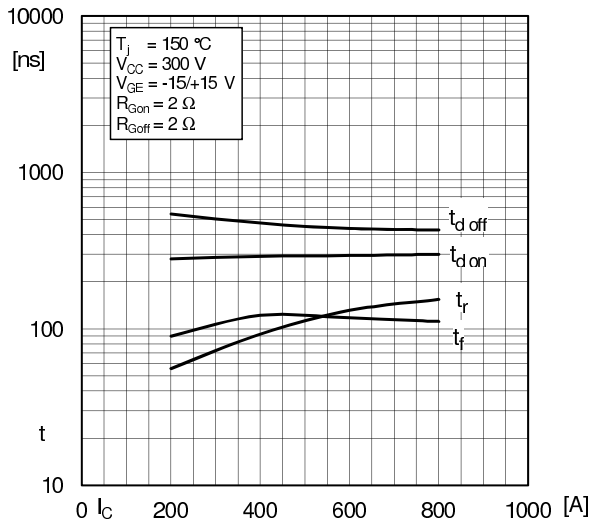


Fig. 13: Typ. IGBT 1 switching times vs. I_C

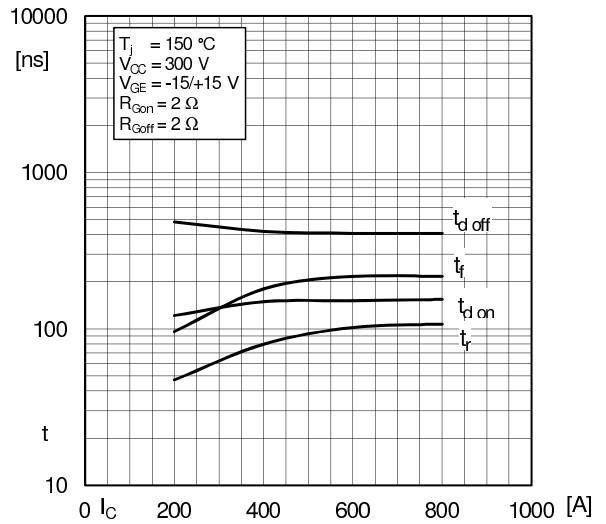


Fig. 14: Typ. IGBT 2 switching times vs. I_C

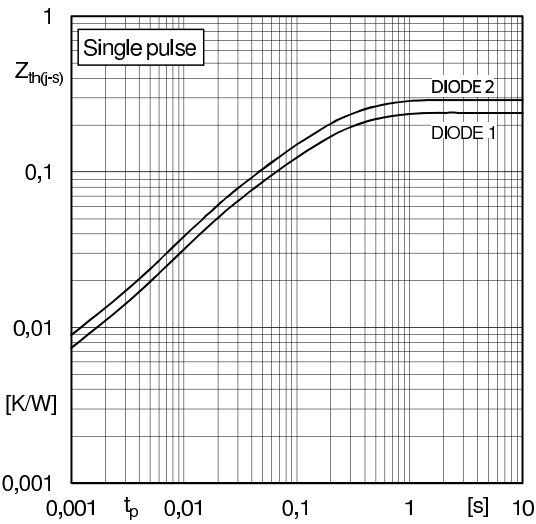


Fig. 15: Typ. DIODEs transient thermal impedance

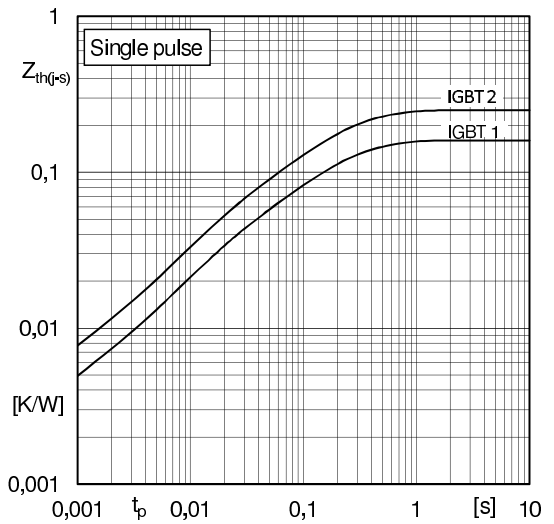
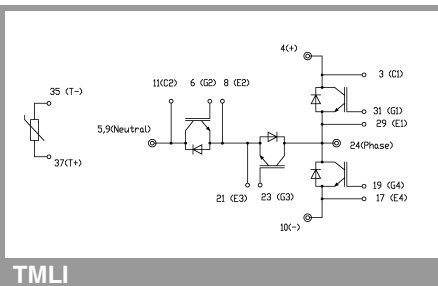
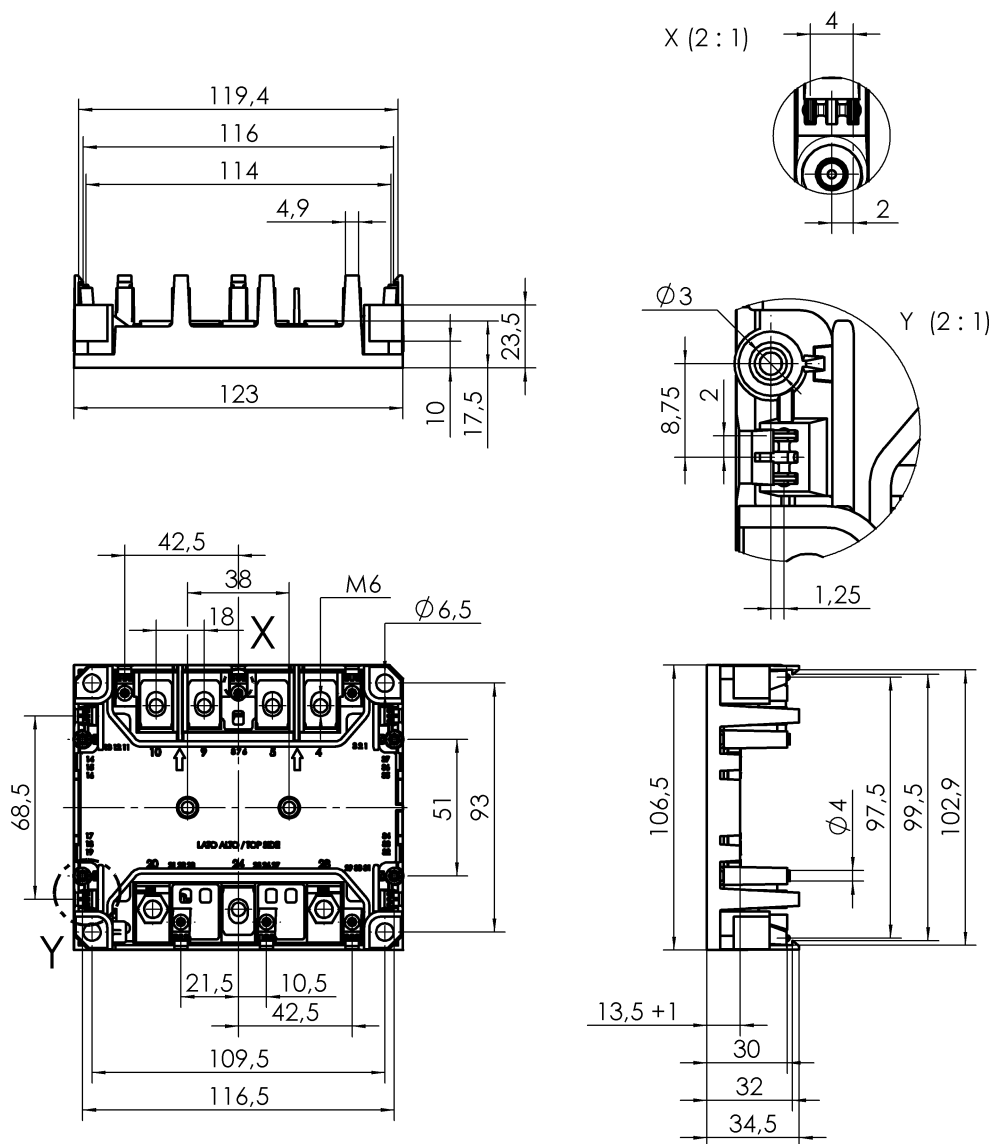


Fig. 16: Typ. IGBTs transient thermal impedance



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

* The specifications of our components may not be considered as an assurance of component characteristics. Components have to be tested for the respective application. Adjustments may be necessary. The use of SEMIKRON products in life support appliances and systems is subject to prior specification and written approval by SEMIKRON. We therefore strongly recommend prior consultation of our staff.