

SEMiX405TMLI12E4B



SEMiX® 5

3-Level TNPC IGBT-Module

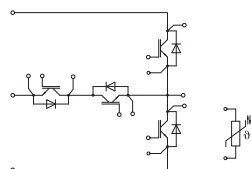
SEMiX405TMLI12E4B

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 $T_c=125^\circ\text{C}$ max
- Product reliability results are valid for $T_{jop}=150^\circ\text{C}$
- IGBT1: outer IGBTs T1 & T4
- IGBT2: inner IGBTs T2 & T3
- Diode1: outer diodes D1 & D4
- Diode2: inner diodes D2 & D3
- For storage and case temperature with TIM see document "TP(HALA P8) SEMiX 5p"



TMLI

Absolute Maximum Ratings				
Symbol	Conditions	Values	Unit	
IGBT1				
V_{CES}	$T_j = 25^\circ\text{C}$	1200	V	
I_C	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	636	A
		$T_c = 80^\circ\text{C}$	490	A
I_{Cnom}		400	A	
I_{CRM}		1200	A	
V_{GES}		-20 ... 20	V	
t_{psc}	$V_{CC} = 800\text{ V}, V_{GE} \leq 15\text{ V}, T_j = 150^\circ\text{C}, V_{CES} \leq 1200\text{ V}$	10	μs	
T_j		-40 ... 175	$^\circ\text{C}$	
IGBT2				
V_{CES}	$T_j = 25^\circ\text{C}$	650	V	
I_C	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	452	A
		$T_c = 80^\circ\text{C}$	339	A
I_{Cnom}		400	A	
I_{CRM}		1200	A	
V_{GES}		-20 ... 20	V	
t_{psc}	$V_{CC} = 360\text{ V}, V_{GE} \leq 15\text{ V}, T_j = 150^\circ\text{C}, V_{CES} \leq 650\text{ V}$	10	μs	
T_j		-40 ... 175	$^\circ\text{C}$	
Diode1				
V_{RRM}	$T_j = 25^\circ\text{C}$	1200	V	
I_F	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	461	A
		$T_c = 80^\circ\text{C}$	345	A
I_{FRM}		800	A	
I_{FSM}	10 ms, sin 180°, $T_j = 25^\circ\text{C}$	1980	A	
T_j		-40 ... 175	$^\circ\text{C}$	
Diode2				
V_{RRM}	$T_j = 25^\circ\text{C}$	650	V	
I_F	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	466	A
		$T_c = 80^\circ\text{C}$	338	A
I_{FRM}		800	A	
I_{FSM}	10 ms, sin 180°, $T_j = 25^\circ\text{C}$	2646	A	
T_j		-40 ... 175	$^\circ\text{C}$	
Module				
$I_t(\text{RMS})$		450	A	
T_{stg}	module without TIM	-40 ... 125	$^\circ\text{C}$	
V_{isol}	AC sinus 50Hz, t = 1 min	4000	V	



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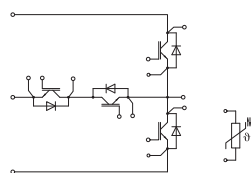
Typical Applications

- UPS
- Solar
- Motor drives

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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
IGBT 1						
$V_{CE(sat)}$	$I_C = 400\text{ A}$ $V_{GE} = 15\text{ V}$ chipllevel	$T_j = 25^\circ\text{C}$		1.80	2.05	V
		$T_j = 150^\circ\text{C}$		2.20	2.40	V
V_{CE0}	chipllevel	$T_j = 25^\circ\text{C}$		0.80	0.90	V
		$T_j = 150^\circ\text{C}$		0.70	0.80	V
r_{CE}	$V_{GE} = 15\text{ V}$ chipllevel	$T_j = 25^\circ\text{C}$		2.5	2.9	m Ω
		$T_j = 150^\circ\text{C}$		3.8	4.0	m Ω
$V_{GE(th)}$	$V_{GE} = V_{CE}, I_C = 15.2\text{ mA}$		5	5.8	6.5	V
I_{CES}	$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}, T_j = 25^\circ\text{C}$				5	mA
C_{ies}	$V_{CE} = 25\text{ V}$ $V_{GE} = 0\text{ V}$	$f = 1\text{ MHz}$		24.6		nF
C_{oes}		$f = 1\text{ MHz}$		1.62		nF
C_{res}		$f = 1\text{ MHz}$		1.38		nF
Q_G	$V_{GE} = -15\text{V}...+15\text{V}$			3026		nC
R_{Gint}	$T_j = 25^\circ\text{C}$			1.9		Ω
$t_{d(on)}$	$V_{CC} = 300\text{ V}$	$T_j = 150^\circ\text{C}$		215		ns
t_r	$I_C = 400\text{ A}$	$T_j = 150^\circ\text{C}$		116		ns
E_{on}	$V_{GE\ neg} = -15\text{ V}$ $V_{GE\ pos} = 15\text{ V}$	$T_j = 150^\circ\text{C}$		21.4		mJ
$t_{d(off)}$	$R_{G\ on} = 2.5\ \Omega$	$T_j = 150^\circ\text{C}$		434		ns
t_f	$R_{G\ off} = 1.5\ \Omega$	$T_j = 150^\circ\text{C}$		128		ns
E_{off}	$di/dt_{on} = 3010\text{ A}/\mu\text{s}$ $di/dt_{off} = 2740\text{ A}/\mu\text{s}$ $dv/dt = 2390\text{ V}/\mu\text{s}$ $L_s = 18\text{ nH}$	$T_j = 150^\circ\text{C}$		29		mJ
$t_{d(on)}$	$V_{CC} = 300\text{ V}$	$T_j = 150^\circ\text{C}$		222		ns
t_r	$I_C = 400\text{ A}$	$T_j = 150^\circ\text{C}$		97		ns
E_{on}	$V_{GE\ neg} = -15\text{ V}$ $V_{GE\ pos} = 15\text{ V}$	$T_j = 150^\circ\text{C}$		13		mJ
$t_{d(off)}$	$R_{G\ on} = 1\ \Omega$	$T_j = 150^\circ\text{C}$		770		ns
t_f	$R_{G\ off} = 1.5\ \Omega$	$T_j = 150^\circ\text{C}$		130		ns
E_{off}	$di/dt_{on} = 3800\text{ A}/\mu\text{s}$ $di/dt_{off} = 2740\text{ A}/\mu\text{s}$ $dv/dt = 2390\text{ V}/\mu\text{s}$ $C_{GE} = 22\text{ nF}$ DC-Link-snubber= 680 nF	$T_j = 150^\circ\text{C}$		29		mJ
$R_{th(j-c)}$	per IGBT				0.068	K/W
$R_{th(c-s)}$	per IGBT ($\lambda_{grease}=0.81\text{ W}/(\text{m}^2\text{K})$)			0.027		K/W
$R_{th(c-s)}$	per IGBT, pre-applied phase change material			0.015		K/W



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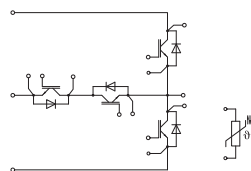
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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
IGBT 2						
$V_{CE(sat)}$	$I_C = 400\text{ A}$ $V_{GE} = 15\text{ V}$ chipllevel	$T_j = 25^{\circ}\text{C}$		1.55	1.95	V
		$T_j = 150^{\circ}\text{C}$		1.75	2.15	V
V_{CE0}	chipllevel	$T_j = 25^{\circ}\text{C}$		0.90	1.00	V
		$T_j = 150^{\circ}\text{C}$		0.82	0.90	V
r_{CE}	$V_{GE} = 15\text{ V}$ chipllevel	$T_j = 25^{\circ}\text{C}$		1.63	2.4	m Ω
		$T_j = 150^{\circ}\text{C}$		2.3	3.1	m Ω
$V_{GE(th)}$	$V_{GE} = V_{CE}, I_C = 8\text{ mA}$		5.1	5.8	6.4	V
I_{CES}	$V_{GE} = 0\text{ V}, V_{CE} = 650\text{ V}, T_j = 25^{\circ}\text{C}$				0.7	mA
C_{ies}	$V_{CE} = 25\text{ V}$ $V_{GE} = 0\text{ V}$	$f = 1\text{ MHz}$		24.7		nF
C_{oes}		$f = 1\text{ MHz}$		1.54		nF
C_{res}		$f = 1\text{ MHz}$		0.73		nF
Q_G	$V_{GE} = -15\text{V}...+15\text{V}$			4420		nC
R_{Gint}	$T_j = 25^{\circ}\text{C}$			1.0		Ω
$t_{d(on)}$	$V_{CC} = 300\text{ V}$ $I_C = 400\text{ A}$	$T_j = 150^{\circ}\text{C}$		143		ns
t_r	$R_{G\ on} = 0.5\ \Omega$ $R_{G\ off} = 0.5\ \Omega$	$T_j = 150^{\circ}\text{C}$		66		ns
E_{on}	$R_{G\ on} = 0.5\ \Omega$	$T_j = 150^{\circ}\text{C}$		2.8		mJ
$t_{d(off)}$	$di/dt_{on} = 5720\text{ A}/\mu\text{s}$	$T_j = 150^{\circ}\text{C}$		311		ns
t_f	$di/dt_{off} = 2970\text{ A}/\mu\text{s}$	$T_j = 150^{\circ}\text{C}$		125		ns
E_{off}	$V_{GE} = +15/-15\text{ V}$ $dv/dt = 3610\text{ V}/\mu\text{s}$ $L_s = 18\text{ nH}$	$T_j = 150^{\circ}\text{C}$		23.9		mJ
$R_{th(j-c)}$	per IGBT				0.14	K/W
$R_{th(c-s)}$	per IGBT ($\lambda_{grease}=0.81\text{ W}/(\text{m}^*\text{K})$)			0.058		K/W
$R_{th(c-s)}$	per IGBT, pre-applied phase change material			0.046		K/W

Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
Diode 1						
$V_F = V_{EC}$	$I_F = 400\text{ A}$ $V_{GE} = 0\text{ V}$ chipllevel	$T_j = 25^{\circ}\text{C}$		2.20	2.52	V
		$T_j = 150^{\circ}\text{C}$		2.15	2.47	V
V_{F0}	chipllevel	$T_j = 25^{\circ}\text{C}$		1.30	1.50	V
		$T_j = 150^{\circ}\text{C}$		0.90	1.10	V
r_F	chipllevel	$T_j = 25^{\circ}\text{C}$		2.3	2.6	m Ω
		$T_j = 150^{\circ}\text{C}$		3.1	3.4	m Ω
I_{RRM}	$I_F = 400\text{ A}$	$T_j = 150^{\circ}\text{C}$		292		A
Q_{rr}	$di/dt_{off} = 5720\text{ A}/\mu\text{s}$	$T_j = 150^{\circ}\text{C}$		52.9		μC
E_{rr}	$V_{GE} = -15\text{ V}$ $V_{CC} = 300\text{ V}$	$T_j = 150^{\circ}\text{C}$		16.4		mJ
$R_{th(j-c)}$	per diode				0.13	K/W
$R_{th(c-s)}$	per diode ($\lambda_{grease}=0.81\text{ W}/(\text{m}^*\text{K})$)			0.036		K/W
$R_{th(c-s)}$	per diode, pre-applied phase change material			0.028		K/W



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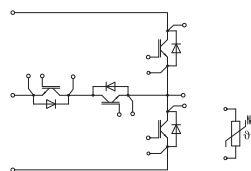
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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
Diode 2						
$V_F = V_{EC}$	$I_F = 400\text{ A}$ $V_{GE} = 0\text{ V}$ chipelevel	$T_j = 25^\circ\text{C}$		1.39	1.75	V
		$T_j = 150^\circ\text{C}$		1.38	1.76	V
V_{F0}	chipelevel	$T_j = 25^\circ\text{C}$		1.04	1.24	V
		$T_j = 150^\circ\text{C}$		0.85	0.99	V
r_F	chipelevel	$T_j = 25^\circ\text{C}$		0.88	1.30	mΩ
		$T_j = 150^\circ\text{C}$		1.32	1.93	mΩ
I_{RRM}	$I_F = 400\text{ A}$	$T_j = 150^\circ\text{C}$		227		A
Q_{rr}	$di/dt_{off} = 3010\text{ A}/\mu\text{s}$	$T_j = 150^\circ\text{C}$		33.5		μC
E_{rr}	$V_{GE} = -15\text{ V}$ $V_{CC} = 300\text{ V}$	$T_j = 150^\circ\text{C}$		7.8		mJ
I_{RRM}	$I_F = 400\text{ A}$	$T_j = 150^\circ\text{C}$		314		A
Q_{rr}	$di/dt_{off} = 3800\text{ A}/\mu\text{s}$	$T_j = 150^\circ\text{C}$		37		μC
E_{rr}	$V_{GE} = -15\text{ V}$ $V_R = 300\text{ V}$	$T_j = 150^\circ\text{C}$		8.5		mJ
$R_{th(j-c)}$	per diode				0.18	K/W
$R_{th(c-s)}$	per diode ($\lambda_{grease}=0.81\text{ W}/(\text{m}^*\text{K})$)			0.053		K/W
$R_{th(c-s)}$	per diode, pre-applied phase change material			0.046		K/W

Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
Module						
L_{sCE1}				31		nH
L_{CE}				42		nH
$R_{CC'+EE'}$	measured between terminal 5 and 1	$T_C = 25^\circ\text{C}$		0.8		mΩ
		$T_C = 125^\circ\text{C}$		1.1		mΩ
$R_{th(c-s)1}$	calculated without thermal coupling			0.005		K/W
$R_{th(c-s)2}$	including thermal coupling, T_s underneath module ($\lambda_{grease}=0.81\text{ W}/(\text{m}^*\text{K})$)			0.008		K/W
$R_{th(c-s)2}$	including thermal coupling, T_s underneath module, pre-applied phase change material			0.006		K/W
M_s	to heat sink (M5)		3		6	Nm
M_t	to terminals (M6)		3		6	Nm
w				398		g

Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
Temperature Sensor						
R_{100}	$T_C=100^\circ\text{C}$ ($R_{25}=5\text{ k}\Omega$)			$493 \pm 5\%$		Ω
$B_{100/125}$	$R_{(T)}=R_{100}\exp[B_{100/125}(1/T-1/T_{100})]$; $T[\text{K}]$;			$3550 \pm 2\%$		K

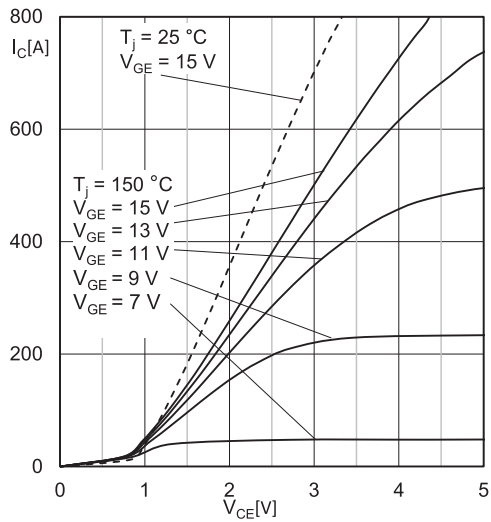


Fig. 1: Typ. IGBT1 output characteristic, incl. $R_{CC'+EE'}$

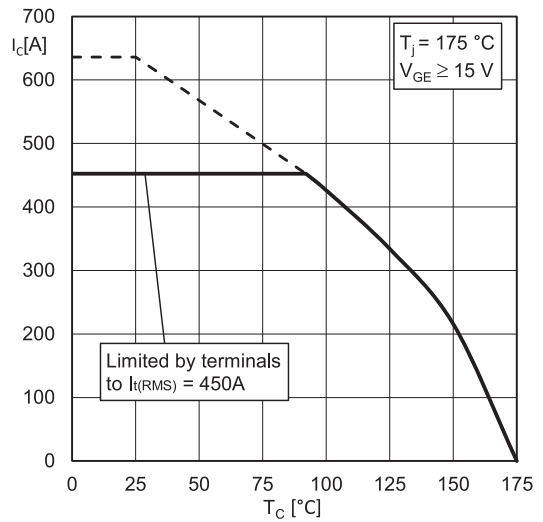


Fig. 2: IGBT1 rated current vs. Temperature $I_c=f(T_c)$

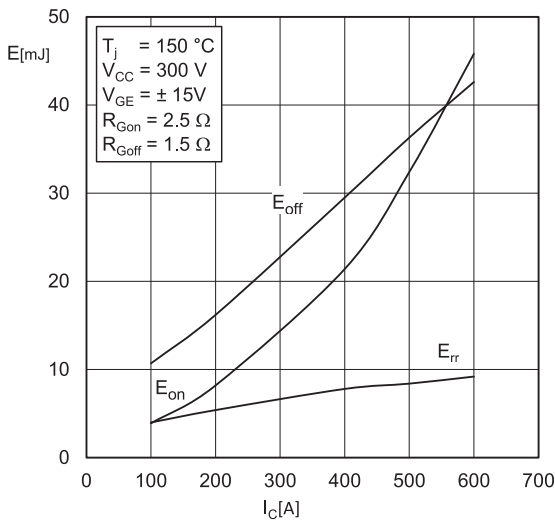


Fig. 3: Typ. IGBT1 & Diode2 turn-on /-off energy = $f(I_c)$

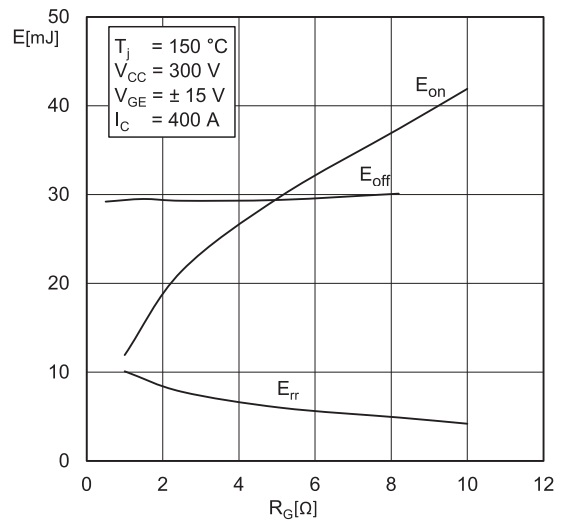


Fig. 4: Typ. IGBT1 & Diode2 turn-on /-off energy = $f(R_G)$

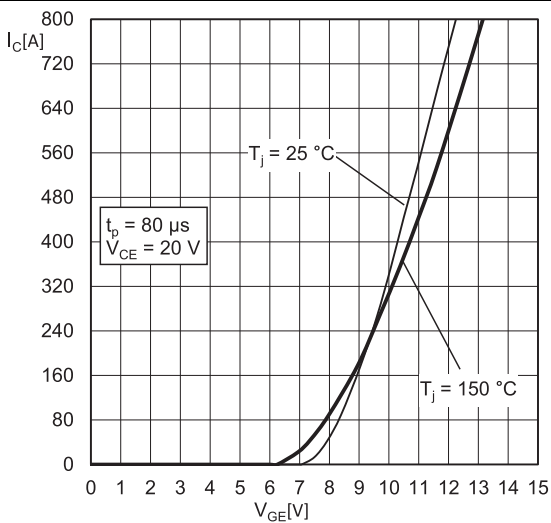


Fig. 5: Typ. IGBT1 transfer characteristic

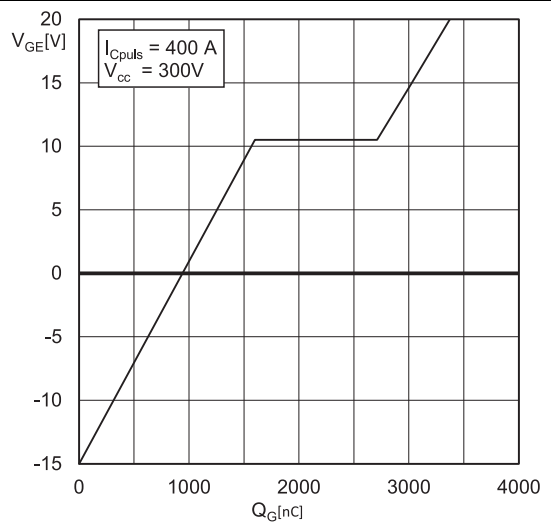
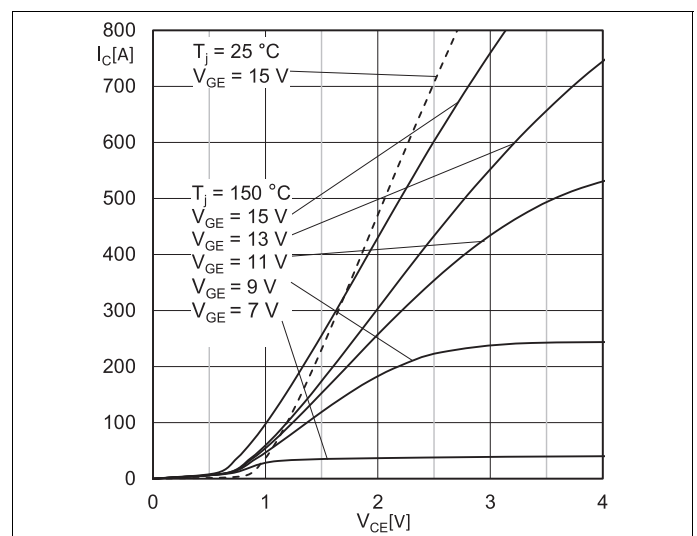
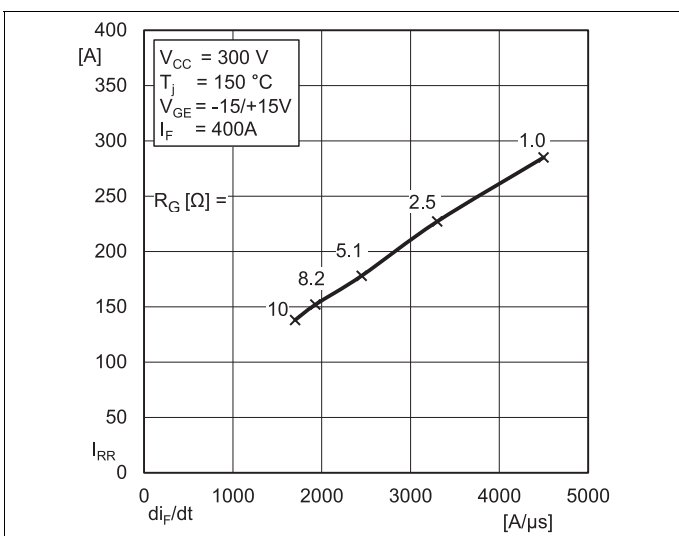
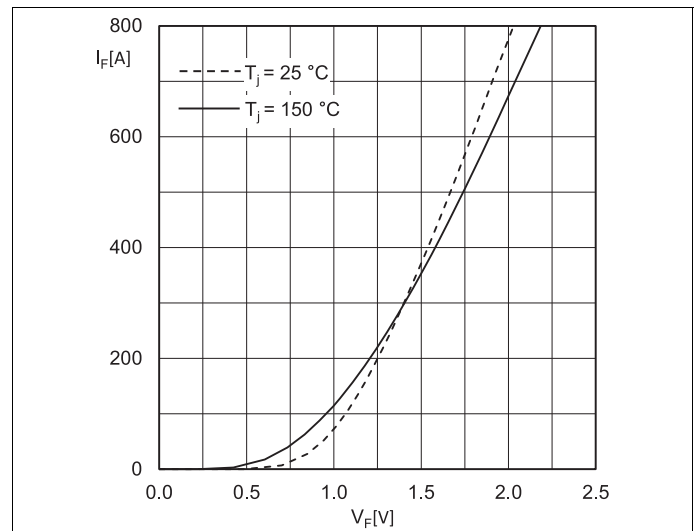
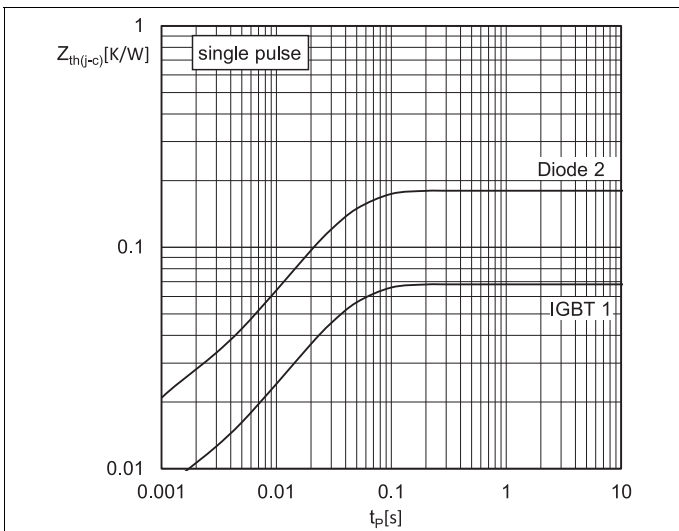
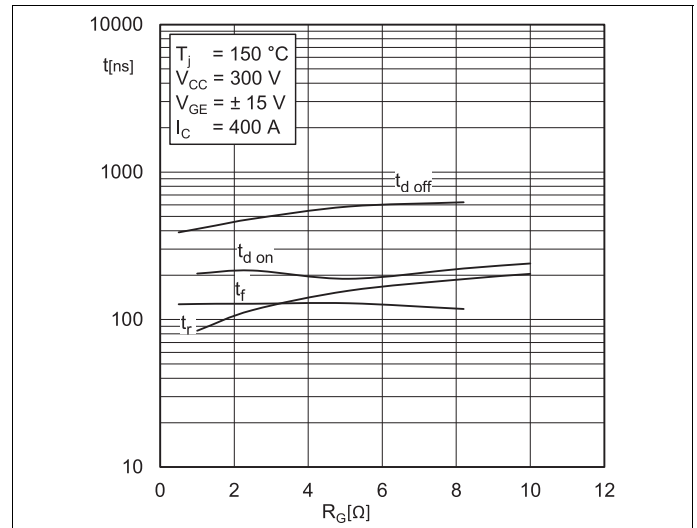
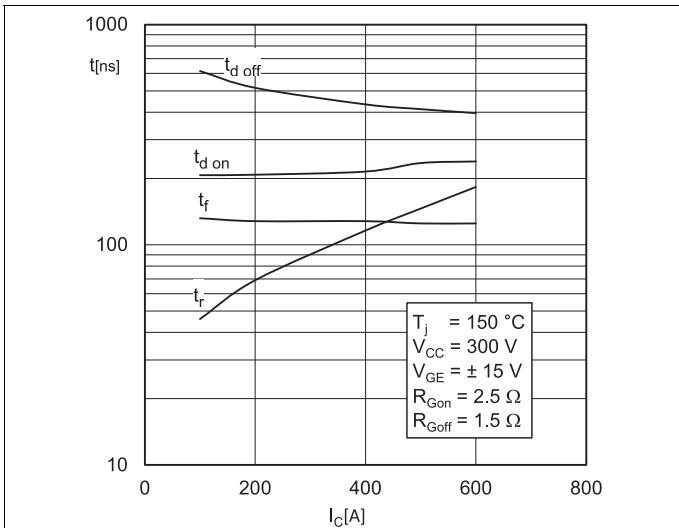


Fig. 6: Typ. IGBT1 gate charge characteristic



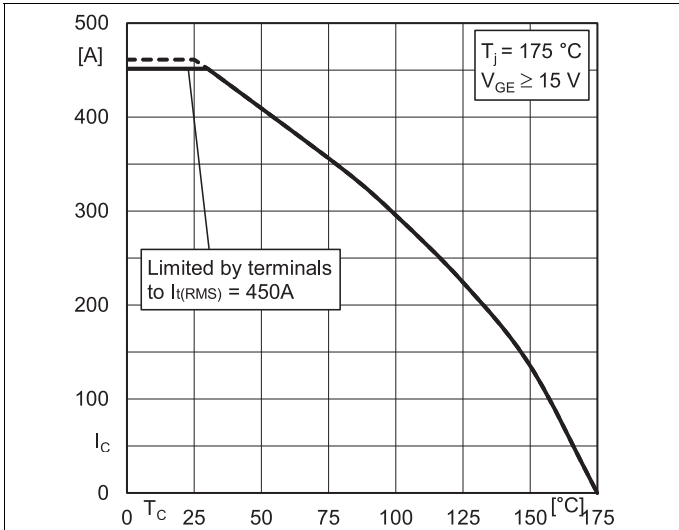


Fig. 14: IGBT2 Rated current vs. Temperature $I_c = f(T_c)$

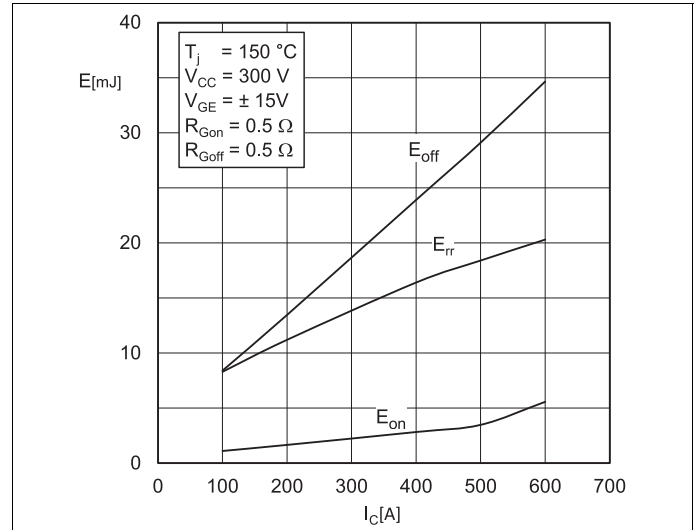


Fig. 15: Typ. IGBT2 & Diode1 turn-on /-off energy = $f(I_c)$

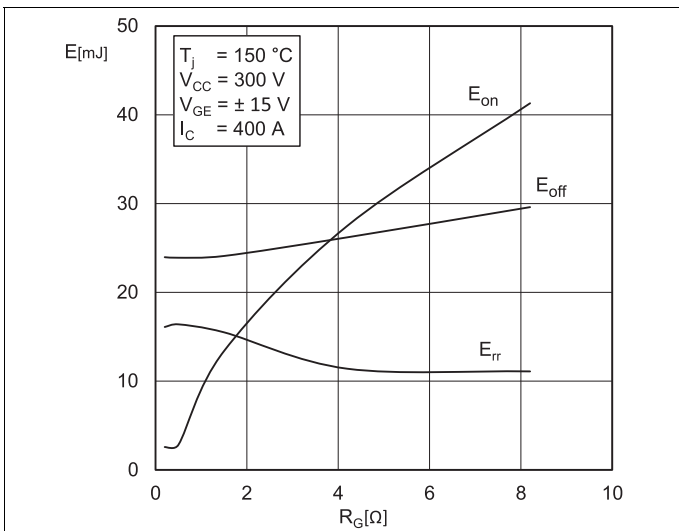


Fig. 16: Typ. IGBT2 & Diode1 turn-on /-off energy = $f(R_G)$

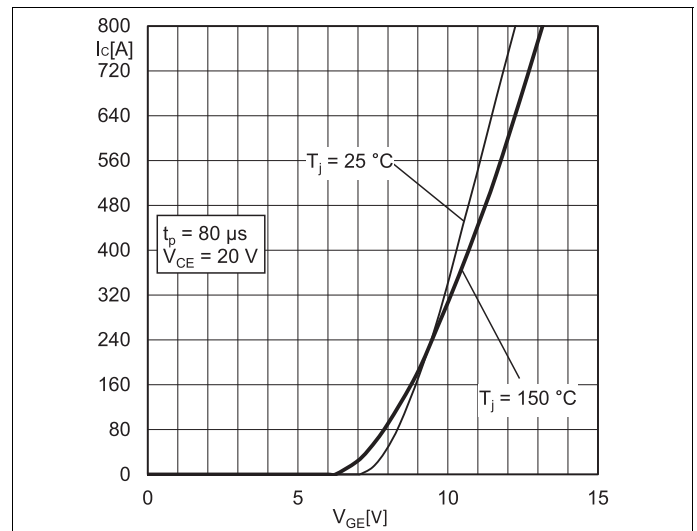


Fig. 17: Typ. IGBT2 transfer characteristic

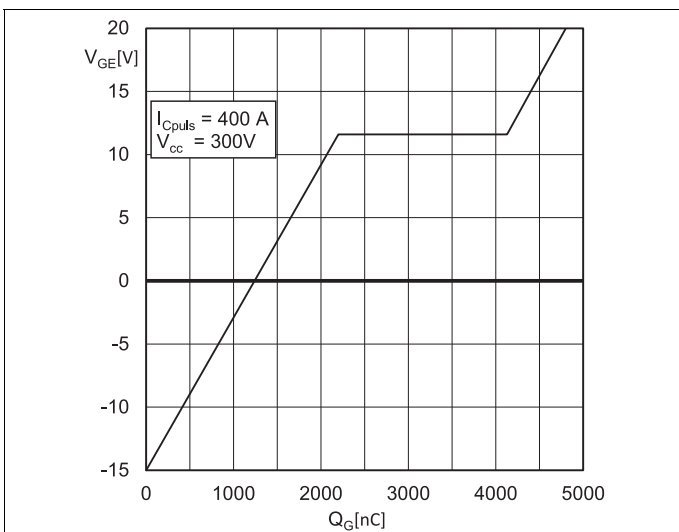


Fig. 18: Typ. IGBT2 gate charge characteristic

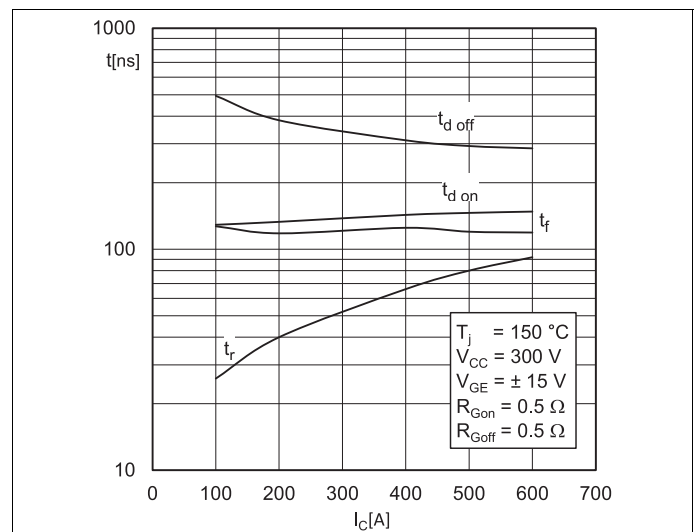


Fig. 19: Typ. IGBT2 switching times vs. I_c

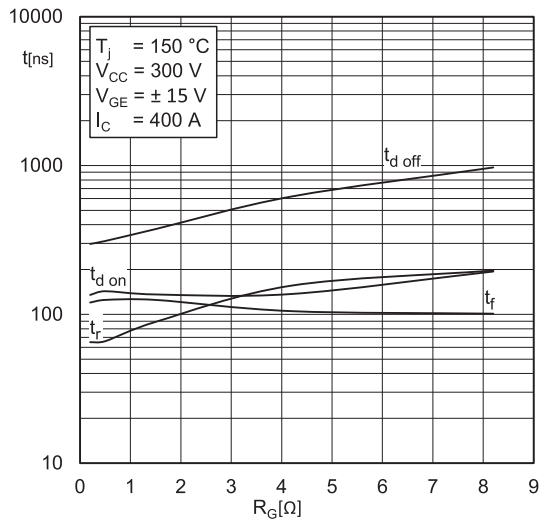


Fig. 20: Typ. IGBT2 switching times vs. gate resistor R_G

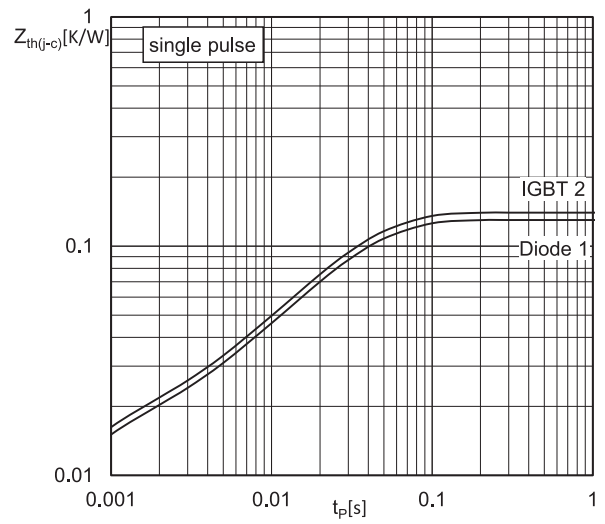


Fig. 21: Transient thermal impedance of IGBT2 & Diode1

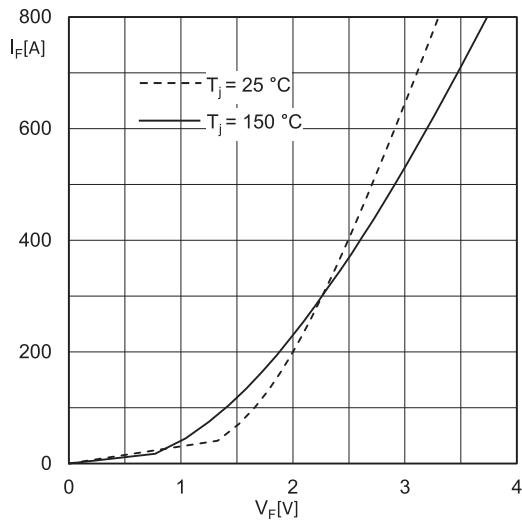


Fig. 22: Typ. Diode1 forward characteristic, incl. R_{CC+EE}

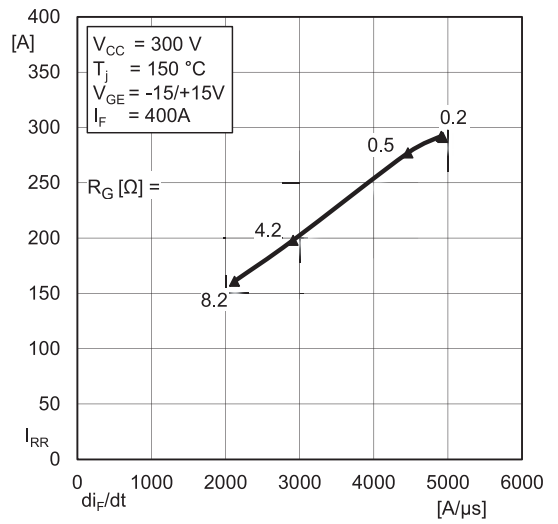
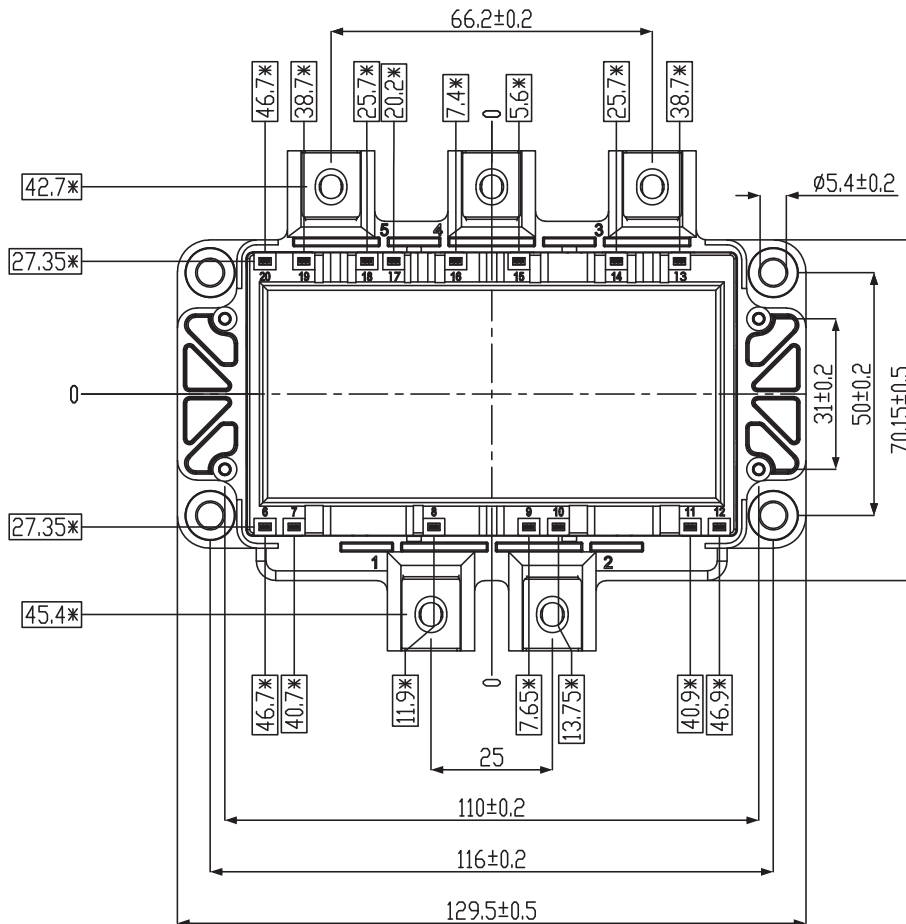
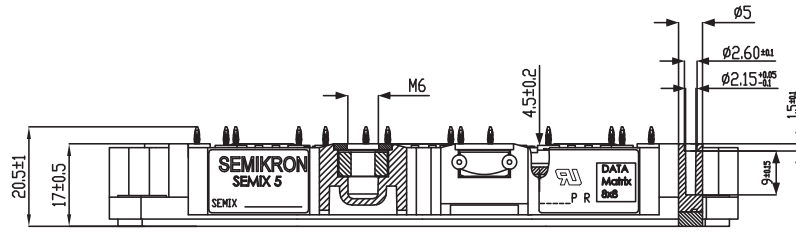


Fig. 23: Typ. Diode1 peak reverse recovery current

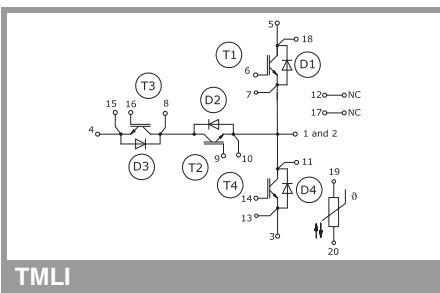
SEMiX405TMLI12E4B



* = Dimensions in mm with tolerance of ± 0.4

For technical details please refer
to SEMiX(R)5 Mounting Instruction

SEMiX5p



TMLI

This is an electrostatic discharge sensitive device (ESDS) due to international standard IEC 61340.

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