



SEMiX® 5

3-Level NPC IGBT-Module

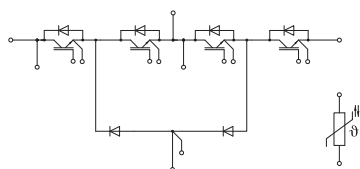
SEMiX305MLI07E4

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
- Diode5 : clamping diodes D5 & D6
- For storage and case temperature with TIM see document "TP(HALA P8) SEMiX 5p"



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Absolute Maximum Ratings			
Symbol	Conditions	Values	Unit
IGBT1			
V_{CES}	$T_j = 25^\circ\text{C}$	650	V
I_C	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	388
		$T_c = 80^\circ\text{C}$	293
I_{Cnom}		300	A
I_{CRM}	$I_{CRM} = 3 \times I_{Cnom}$	900	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	$^\circ\text{C}$
IGBT2			
V_{CES}	$T_j = 25^\circ\text{C}$	650	V
I_C	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	373
		$T_c = 80^\circ\text{C}$	282
I_{Cnom}		300	A
I_{CRM}	$I_{CRM} = 3 \times I_{Cnom}$	900	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}	$T_j = 25^\circ\text{C}$	650	V
I_F	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	294
		$T_c = 80^\circ\text{C}$	217
I_{Fnom}		200	A
I_{FRM}	$I_{FRM} = 2 \times I_{Fnom}$	400	A
I_{FSM}	10 ms, sin 180°, $T_j = 25^\circ\text{C}$	1476	A
T_j		-40 ... 175	$^\circ\text{C}$
Diode2			
V_{RRM}	$T_j = 25^\circ\text{C}$	650	V
I_F	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	267
		$T_c = 80^\circ\text{C}$	196
I_{Fnom}		200	A
I_{FRM}	$I_{FRM} = 2 \times I_{Fnom}$	400	A
I_{FSM}	10 ms, sin 180°, $T_j = 25^\circ\text{C}$	1476	A
T_j		-40 ... 175	$^\circ\text{C}$
Diode5			
V_{RRM}	$T_j = 25^\circ\text{C}$	650	V
I_F	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	255
		$T_c = 80^\circ\text{C}$	187
I_{Fnom}		200	A
I_{FRM}	$I_{FRM} = 2 \times I_{Fnom}$	400	A
I_{FSM}	10 ms, sin 180°, $T_j = 25^\circ\text{C}$	1476	A
T_j		-40 ... 175	$^\circ\text{C}$
Module			
$I_{t(RMS)}$		400	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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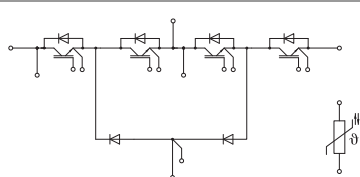
SEMiX305MLI07E4

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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
IGBT1						
$V_{CE(sat)}$	$I_C = 300\text{ A}$ $V_{GE} = 15\text{ V}$ 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	$T_j = 25^{\circ}\text{C}$		2.2	3.2	m Ω
		$T_j = 150^{\circ}\text{C}$		3.1	4.2	m Ω
$V_{GE(th)}$	$V_{GE} = V_{CE}, I_C = 8\text{ mA}$		5.1	5.8	6.4	V
I_{CES}	$V_{GE} = 0\text{ V}, V_{CE} = 650\text{ V}, T_j = 25^{\circ}\text{C}$				0.2	mA
C_{ies}	$V_{CE} = 25\text{ V}$ $V_{GE} = 0\text{ V}$	$f = 1\text{ MHz}$		18.5		nF
C_{oes}		$f = 1\text{ MHz}$		1.16		nF
C_{res}		$f = 1\text{ MHz}$		0.55		nF
Q_G	$V_{GE} = -15\text{ V} \dots +15\text{ V}$			3023		nC
R_{Gint}	$T_j = 25^{\circ}\text{C}$			1.0		Ω
$t_{d(on)}$	$V_{CC} = 300\text{ V}$ $I_C = 300\text{ A}$	$T_j = 150^{\circ}\text{C}$		55		ns
t_r	$V_{GE} = +15/-15\text{ V}$	$T_j = 150^{\circ}\text{C}$		67		ns
E_{on}	$R_{G\ on} = 1.5\ \Omega$	$T_j = 150^{\circ}\text{C}$		2.5		mJ
$t_{d(off)}$	$R_{G\ off} = 1.5\ \Omega$	$T_j = 150^{\circ}\text{C}$		340		ns
t_f	$di/dt_{on} = 4660\text{ A}/\mu\text{s}$ $di/dt_{off} = 2600\text{ A}/\mu\text{s}$	$T_j = 150^{\circ}\text{C}$		82		ns
E_{off}		$T_j = 150^{\circ}\text{C}$		15.6		mJ
$R_{th(j-c)}$	per IGBT				0.15	K/W
$R_{th(c-s)}$	per IGBT ($\lambda_{grease}=0.81\text{ W}/(\text{m}^{\circ}\text{K})$)			0.044		K/W
$R_{th(c-s)}$	per IGBT, pre-applied phase change material			0.031		K/W
IGBT2						
$V_{CE(sat)}$	$I_C = 300\text{ A}$ $V_{GE} = 15\text{ V}$ 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	$T_j = 25^{\circ}\text{C}$		2.2	3.2	m Ω
		$T_j = 150^{\circ}\text{C}$		3.1	4.2	m Ω
$V_{GE(th)}$	$V_{GE} = V_{CE}, I_C = 8\text{ mA}$		5.1	5.8	6.4	V
I_{CES}	$V_{GE} = 0\text{ V}, V_{CE} = 650\text{ V}, T_j = 25^{\circ}\text{C}$				0.2	mA
C_{ies}	$V_{CE} = 25\text{ V}$ $V_{GE} = 0\text{ V}$	$f = 1\text{ MHz}$		18.5		nF
C_{oes}		$f = 1\text{ MHz}$		1.16		nF
C_{res}		$f = 1\text{ MHz}$		0.55		nF
Q_G	$V_{GE} = -15\text{ V} \dots +15\text{ V}$			3023		nC
R_{Gint}	$T_j = 25^{\circ}\text{C}$			1.0		Ω
$t_{d(on)}$	$V_{CC} = 300\text{ V}$ $I_C = 300\text{ A}$	$T_j = 150^{\circ}\text{C}$		75		ns
t_r	$V_{GE} = +15/-15\text{ V}$	$T_j = 150^{\circ}\text{C}$		71		ns
E_{on}	$R_{G\ on} = 1.5\ \Omega$	$T_j = 150^{\circ}\text{C}$		3		mJ
$t_{d(off)}$	$R_{G\ off} = 1.5\ \Omega$	$T_j = 150^{\circ}\text{C}$		334		ns
t_f	$di/dt_{on} = 4010\text{ A}/\mu\text{s}$ $di/dt_{off} = 2210\text{ A}/\mu\text{s}$	$T_j = 150^{\circ}\text{C}$		122		ns
E_{off}		$T_j = 150^{\circ}\text{C}$		13		mJ
$R_{th(j-c)}$	per IGBT				0.16	K/W
$R_{th(c-s)}$	per IGBT ($\lambda_{grease}=0.81\text{ W}/(\text{m}^{\circ}\text{K})$)			0.05		K/W
$R_{th(c-s)}$	per IGBT, pre-applied phase change material			0.035		K/W



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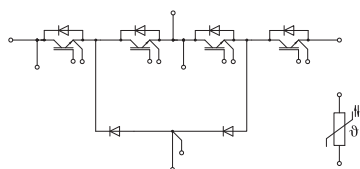
SEMiX305MLI07E4

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

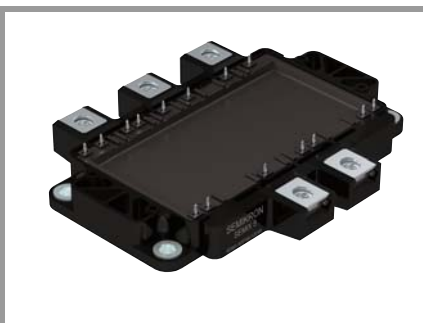
Remarks*

- 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
- Diode5 : clamping diodes D5 & D6
- For storage and case temperature with TIM see document "TP(HALA P8) SEMiX 5p"



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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
Diode1						
$V_F = V_{EC}$	$I_F = 200\text{ A}$ $V_{GE} = 0\text{ V}$ chipelevel	$T_j = 25^\circ\text{C}$	1.40	1.76		V
		$T_j = 150^\circ\text{C}$	1.38	1.77		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	$T_j = 25^\circ\text{C}$	1.78	2.6		mΩ
		$T_j = 150^\circ\text{C}$	2.7	3.9		mΩ
I_{RRM}	$I_F = 300\text{ A}$	$T_j = 150^\circ\text{C}$	190.5			A
Q_{rr}	$di/dt_{off} = 4010\text{ A}/\mu\text{s}$ $V_{CC} = 300\text{ V}$	$T_j = 150^\circ\text{C}$	20.2			μC
E_{rr}	$V_{GE} = +15/-15\text{ V}$	$T_j = 150^\circ\text{C}$	7.71			mJ
$R_{th(j-c)}$	per diode				0.25	K/W
$R_{th(c-s)}$	per diode ($\lambda_{grease}=0.81\text{ W}/(\text{m}^*\text{K})$)			0.044		K/W
$R_{th(c-s)}$	per diode, pre-applied phase change material			0.043		K/W
Diode2						
$V_F = V_{EC}$	$I_F = 200\text{ A}$ $V_{GE} = 0\text{ V}$ chipelevel	$T_j = 25^\circ\text{C}$	1.40	1.76		V
		$T_j = 150^\circ\text{C}$	1.38	1.77		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	$T_j = 25^\circ\text{C}$	1.78	2.6		mΩ
		$T_j = 150^\circ\text{C}$	2.7	3.9		mΩ
I_{RRM}	$I_F = 300\text{ A}$	$T_j = 150^\circ\text{C}$	190.5			A
Q_{rr}	$di/dt_{off} = 4900\text{ A}/\mu\text{s}$ $V_R = 300\text{ V}$	$T_j = 150^\circ\text{C}$	20.2			μC
E_{rr}	$V_{GE} = +15/-15\text{ V}$	$T_j = 150^\circ\text{C}$	-			mJ
$R_{th(j-c)}$	per diode				0.29	K/W
$R_{th(c-s)}$	per diode ($\lambda_{grease}=0.81\text{ W}/(\text{m}^*\text{K})$)			0.044		K/W
$R_{th(c-s)}$	per diode, pre-applied phase change material			0.039		K/W
Diode5						
$V_F = V_{EC}$	$I_F = 200\text{ A}$ chipelevel	$T_j = 25^\circ\text{C}$	1.40	1.76		V
		$T_j = 150^\circ\text{C}$	1.38	1.77		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	$T_j = 25^\circ\text{C}$	1.78	2.6		mΩ
		$T_j = 150^\circ\text{C}$	2.7	3.9		mΩ
I_{RRM}	$I_F = 300\text{ A}$	$T_j = 150^\circ\text{C}$	265			A
Q_{rr}	$di/dt_{off} = 4660\text{ A}/\mu\text{s}$ $V_R = 300\text{ V}$	$T_j = 150^\circ\text{C}$	35			μC
E_{rr}	$V_{GE} = +15/-15\text{ V}$	$T_j = 150^\circ\text{C}$	4.3			mJ
$R_{th(j-c)}$	per diode				0.31	K/W
$R_{th(c-s)}$	per diode ($\lambda_{grease}=0.81\text{ W}/(\text{m}^*\text{K})$)			0.055		K/W
$R_{th(c-s)}$	per diode, pre-applied phase change material			0.049		K/W



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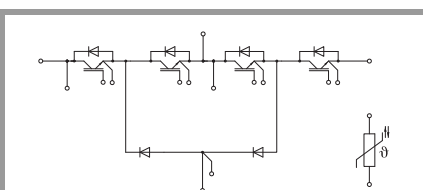
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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
Module						
L_{sCE1}				29		nH
L_{sCE2}				38		nH
$R_{CC'+EE'}$	measured between terminal 5 and 1	$T_C = 25^\circ\text{C}$		0.8		m Ω
		$T_C = 125^\circ\text{C}$		1.1		m Ω
$R_{th(c-s)1}$	calculated without thermal coupling			0.005		K/W
$R_{th(c-s)2}$	including thermal coupling, T_s underneath module ($\lambda_{grease}=0.81\text{ W}/(\text{m}^2\text{K})$)			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
						Nm
W				398		g
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



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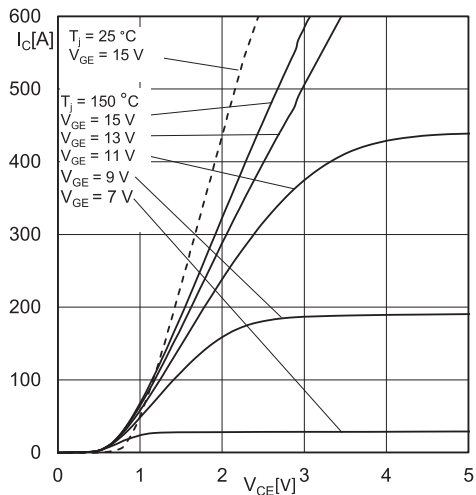


Fig. 1: Typ. IGBT1 output characteristic, incl. $R_{CC'+EE'}$

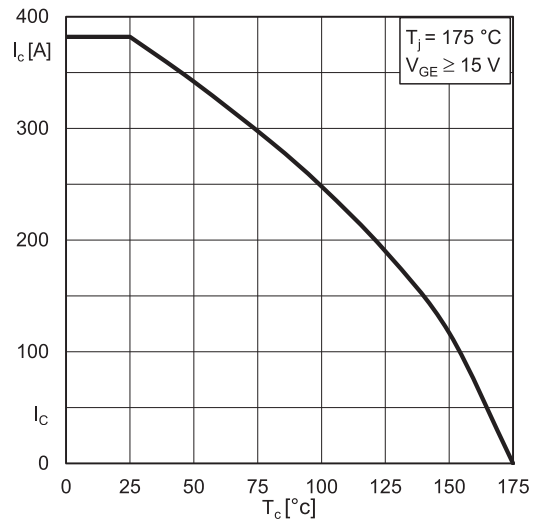


Fig. 2: IGBT1 rated current vs. Temperature $I_C=f(T_c)$

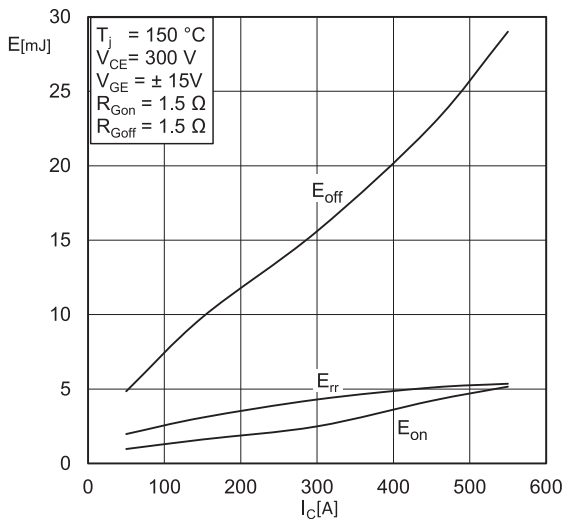


Fig. 3: Typ. IGBT1 & Diode5 turn-on /-off energy = $f(I_C)$

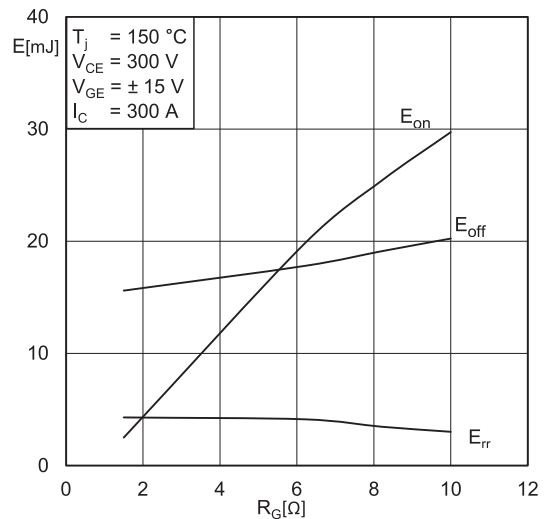


Fig. 4: Typ. IGBT1 & Diode5 turn-on /-off energy = $f(R_G)$

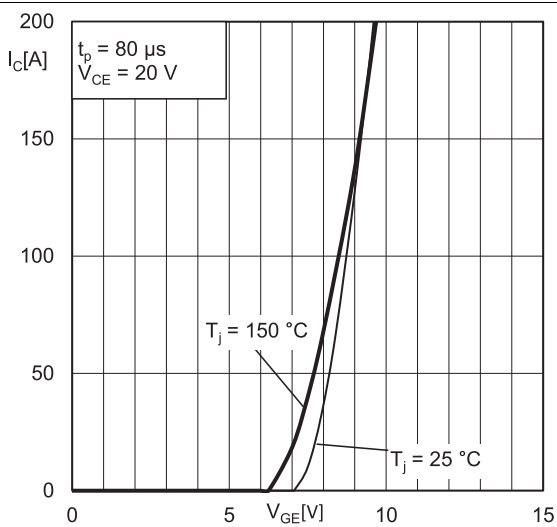


Fig. 5: Typ. IGBT1 transfer characteristic

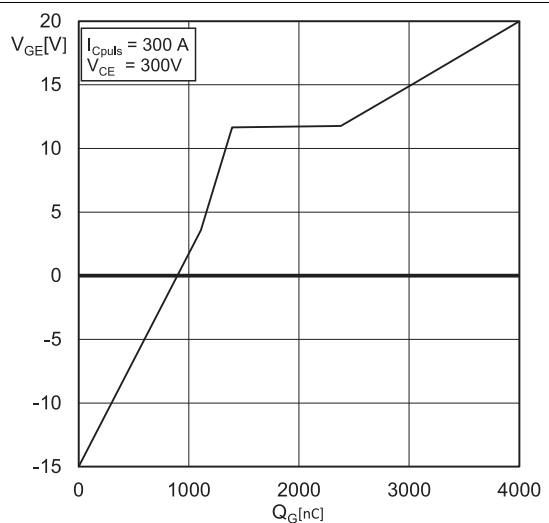


Fig. 6: Typ. IGBT1 gate charge characteristic

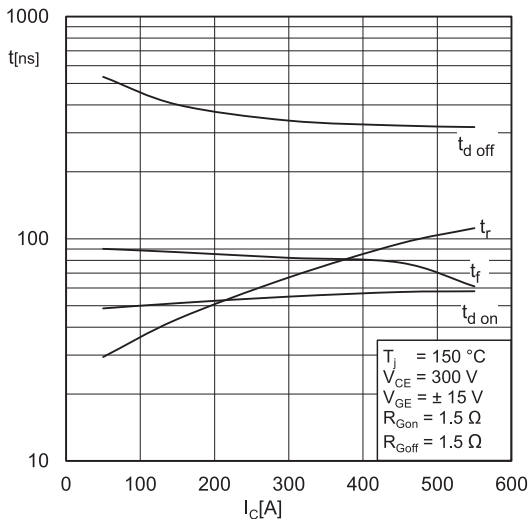


Fig. 7: Typ. IGBT1 switching times vs. I_c

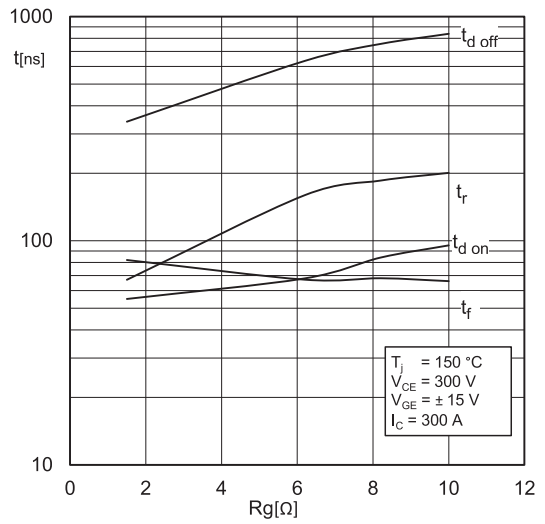


Fig. 8: Typ. IGBT1 switching times vs. gate resistor R_G

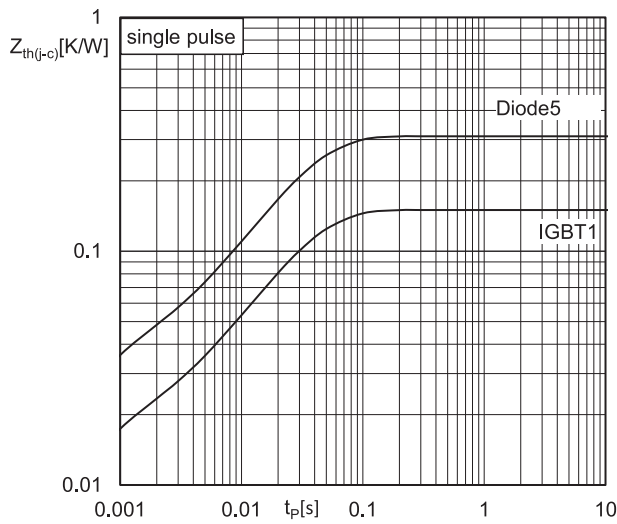


Fig. 9: Transient thermal impedance of IGBT1 & Diode5

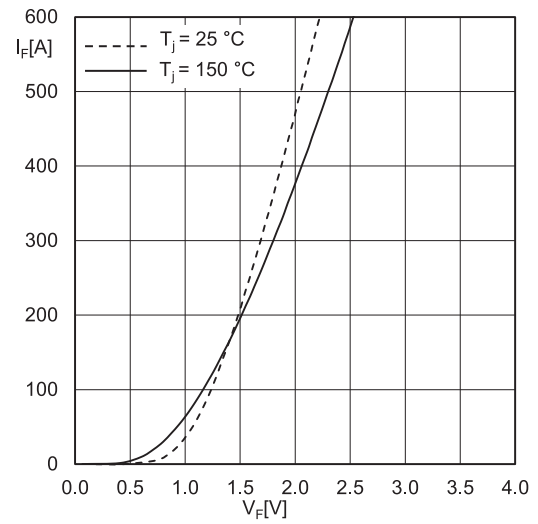


Fig. 10: Typ. Diode5 forward characteristic, incl. $R_{CC+EE'}$

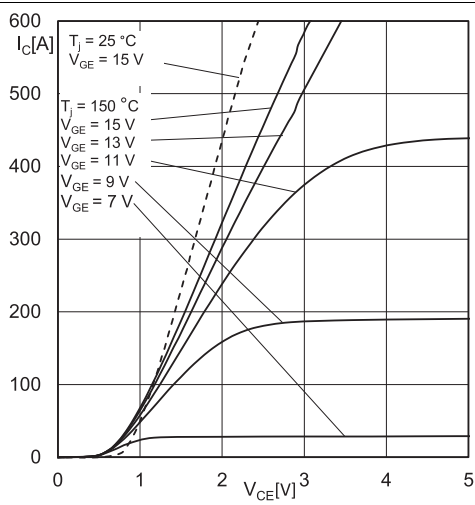


Fig. 13: Typ. IGBT2 output characteristic, incl. $R_{CC+EE'}$

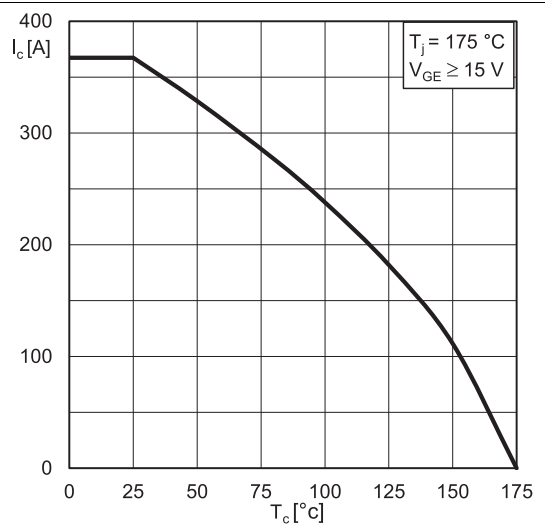


Fig. 14: IGBT2 Rated current vs. Temperature $I_c = f(T_c)$

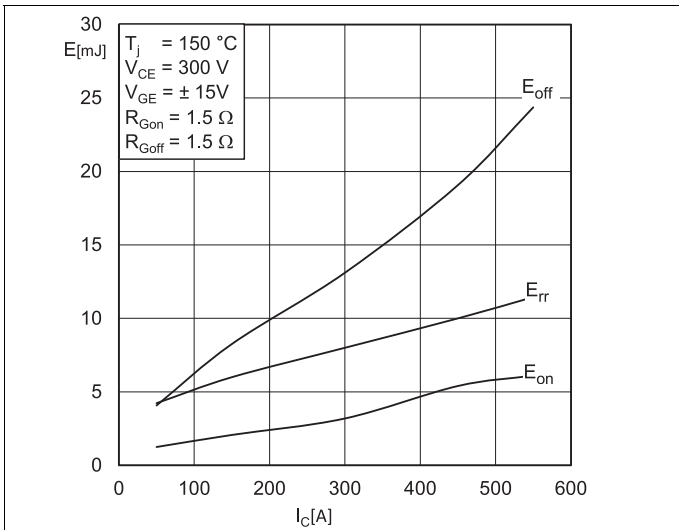


Fig. 15: Typ. IGBT2 & Diode1 turn-on /-off energy = $f(I_c)$

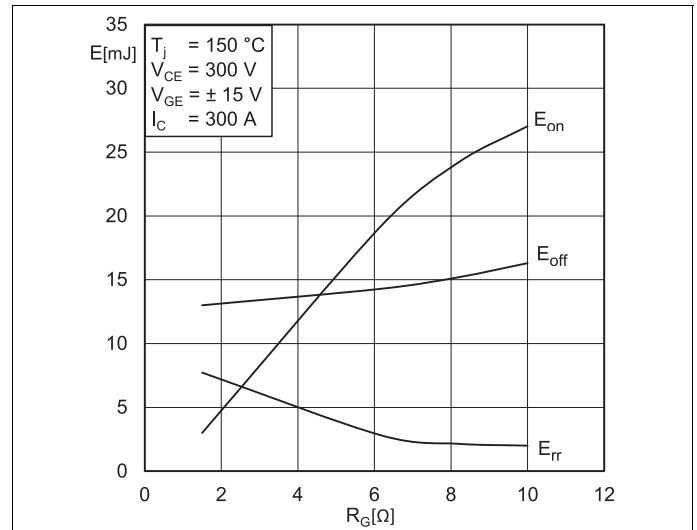


Fig. 16: Typ. IGBT2 & Diode1 turn-on /-off energy = $f(R_G)$

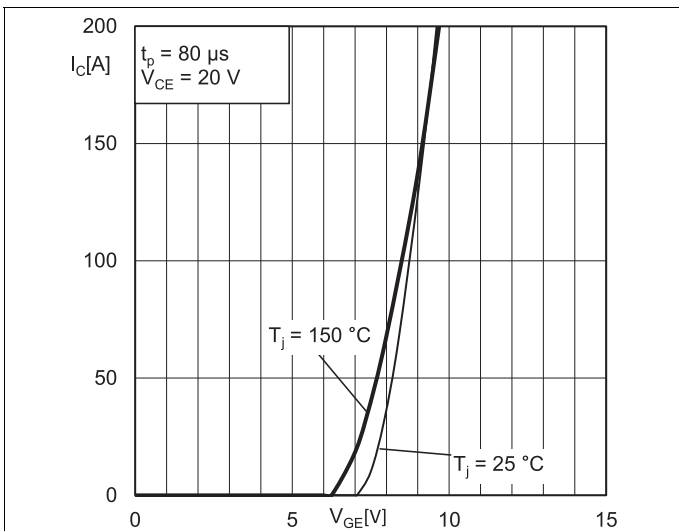


Fig. 17: Typ. IGBT2 transfer characteristic

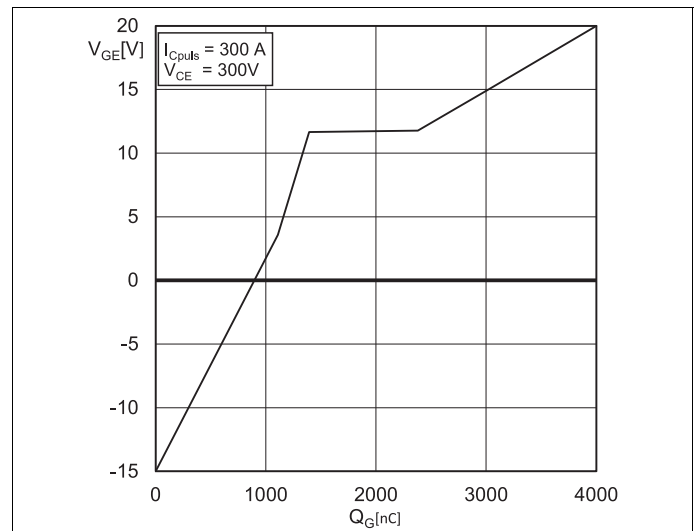


Fig. 18: Typ. IGBT2 gate charge characteristic

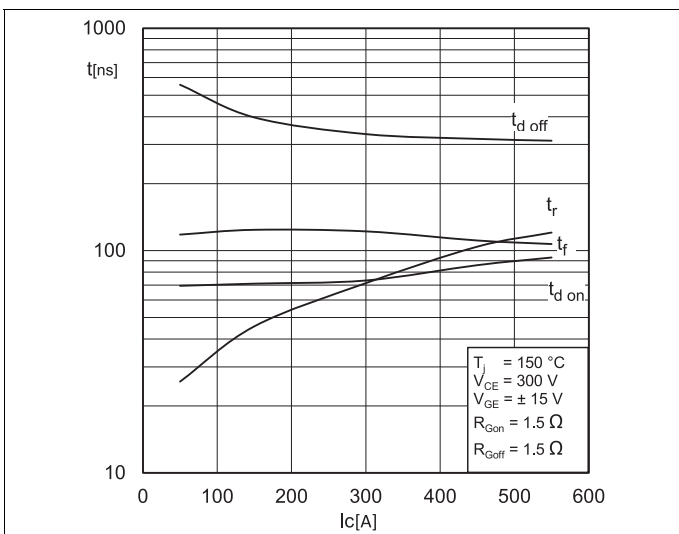


Fig. 19: Typ. IGBT2 switching times vs. I_c

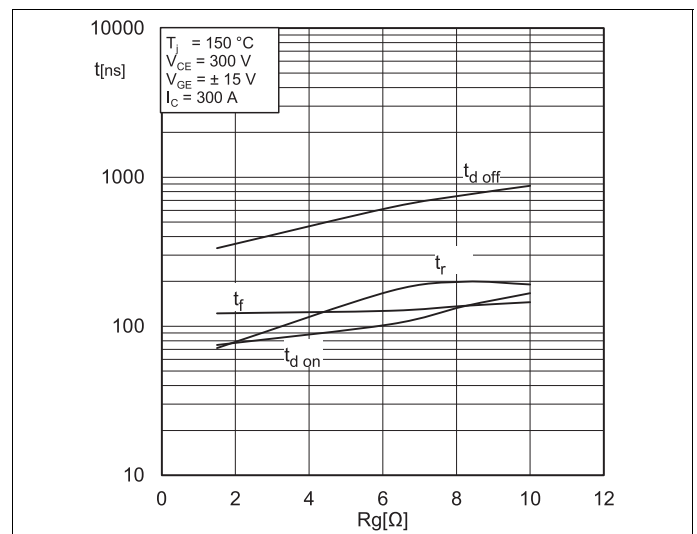


Fig. 20: Typ. IGBT2 switching times vs. gate resistor R_G

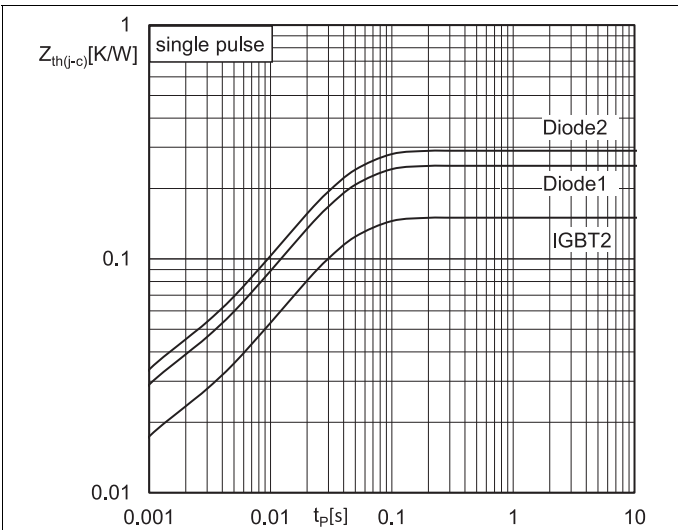


Fig. 21: Transient thermal impedance of IGBT2, Diode1 & Diode2

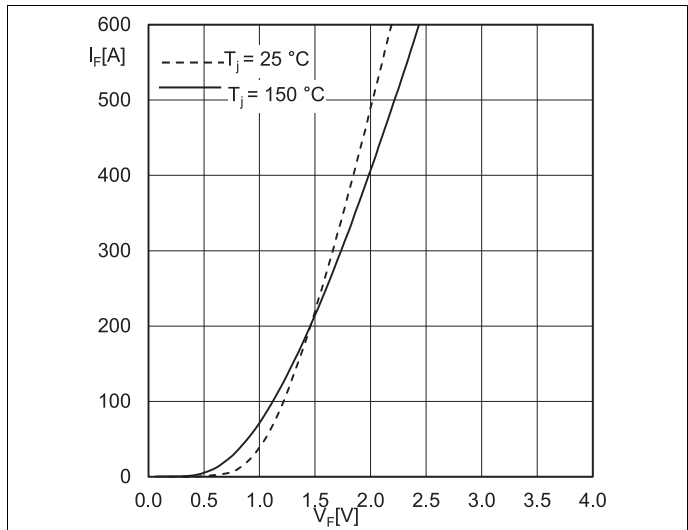
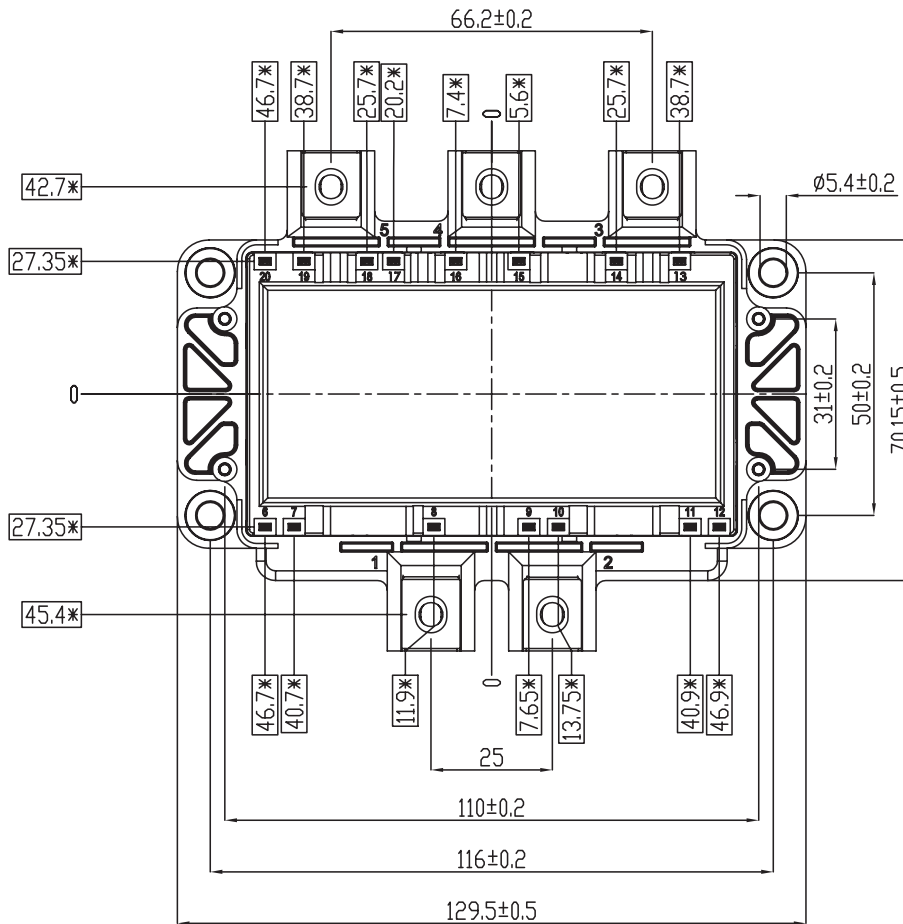
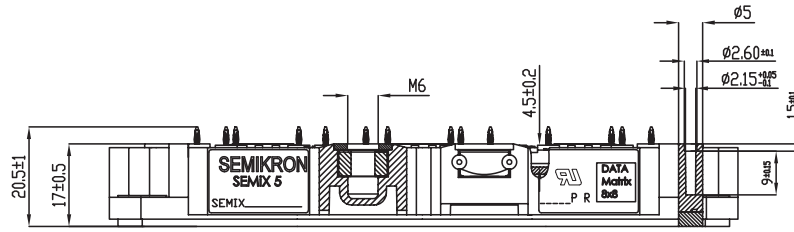


Fig. 22: Typ. Diode1 & Diode2 forward characteristic, incl. $R_{CC'+EE'}$

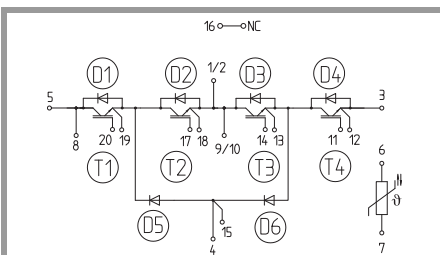
SEMiX305MLI07E4



* = All dimension with tolerance of $\begin{matrix} \oplus \\ \ominus \end{matrix} \begin{matrix} \oplus \\ \ominus \end{matrix} 0.4$

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

SEMiX5p



MLI

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

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