

## 3-Level TNPC Inverter

### SEMIX205TMLI12E4B

#### Target Data

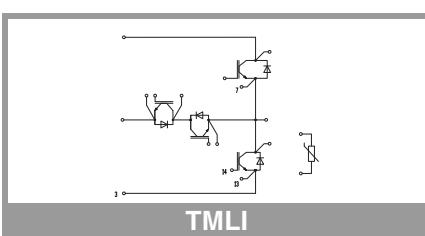
#### Features

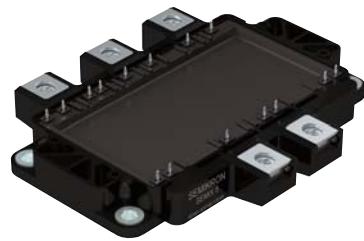
- Solderless assembling solution with PressFIT signal pins and screw power terminals
- IGBT 4 Trench Gate Technology
- $V_{CE(sat)}$  with positive temperature coefficient
- Low inductance case
- Reliable mechanical design with injection moulded terminals and reliable internal connections
- UL recognized file no. E65532
- 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
- Please find further technical information on the SEMIKRON website

Absolute Maximum Ratings		Values	Unit
Symbol	Conditions		
<b>IGBT1</b>			
$V_{CES}$	$T_j = 25^\circ\text{C}$	1200	V
$I_c$	$T_j = 175^\circ\text{C}$	271	A
		208	A
$I_{Cnom}$		200	A
$I_{CRM}$	$I_{CRM} = 3 \times I_{Cnom}$	600	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	$\mu\text{s}$
$T_j$		-40 ... 175	$^\circ\text{C}$
<b>IGBT2</b>			
$V_{CES}$	$T_j = 25^\circ\text{C}$	650	V
$I_c$	$T_j = 175^\circ\text{C}$	213	A
		160	A
$I_{Cnom}$		200	A
$I_{CRM}$	$I_{CRM} = 3 \times I_{Cnom}$	600	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	$\mu\text{s}$
$T_j$		-40 ... 175	$^\circ\text{C}$
<b>Diode1</b>			
$V_{RRM}$	$T_j = 25^\circ\text{C}$	1200	V
$I_F$	$T_j = 175^\circ\text{C}$	268	A
		195	A
$I_{Fnom}$		200	A
$I_{FRM}$	$I_{FRM} = 3 \times I_{Fnom}$	600	A
$I_{FSM}$	$10\text{ ms, sin }180^\circ, T_j = 25^\circ\text{C}$	1980	A
$T_j$		-40 ... 175	$^\circ\text{C}$
<b>Diode2</b>			
$V_{RRM}$	$T_j = 25^\circ\text{C}$	650	V
$I_F$	$T_j = 175^\circ\text{C}$	219	A
		159	A
$I_{Fnom}$		200	A
$I_{FRM}$	$I_{FRM} = 2 \times I_{Fnom}$	400	A
$I_{FSM}$	$10\text{ ms, sin }180^\circ, T_j = 25^\circ\text{C}$	1476	A
$T_j$		-40 ... 175	$^\circ\text{C}$
<b>Module</b>			
$I_{t(RMS)}$	$T_{\text{terminal}} = 80^\circ\text{C},$	600	A
$T_{stg}$		-40 ... 125	$^\circ\text{C}$
$V_{isol}$	AC sinus 50Hz, $t = 1\text{ min}$	4000	V





**SEMIX® 5**

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### SEMiX205TMLI12E4B

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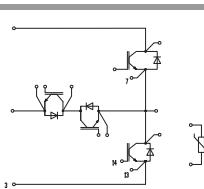
#### Features

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Characteristics		Conditions	min.	typ.	max.	Unit
Symbol						
<b>IGBT1</b>						
$V_{CE(\text{sat})}$	$I_C = 200 \text{ A}$ $V_{GE} = 15 \text{ V}$ chiplevel	$T_j = 25^\circ\text{C}$		1.80	2.05	V
		$T_j = 150^\circ\text{C}$		2.20	2.40	V
$V_{CE0}$	chiplevel	$T_j = 25^\circ\text{C}$	0.80	0.90	0.90	V
		$T_j = 150^\circ\text{C}$	0.70	0.80	0.80	V
$r_{CE}$	$V_{GE} = 15 \text{ V}$ chiplevel	$T_j = 25^\circ\text{C}$	5	5.8	6.5	$\text{m}\Omega$
		$T_j = 150^\circ\text{C}$	7.5	8	8	$\text{m}\Omega$
$V_{GE(\text{th})}$	$V_{GE} = V_{CE}, I_C = 7.6 \text{ mA}$		5	5.8	6.5	V
$I_{CES}$	$V_{GE} = 0 \text{ V}, V_{CE} = 1200 \text{ V}, T_j = 25^\circ\text{C}$					mA
$C_{ies}$	$V_{CE} = 25 \text{ V}$	$f = 1 \text{ MHz}$		12.3		nF
$C_{oes}$	$V_{GE} = 0 \text{ V}$	$f = 1 \text{ MHz}$		0.81		nF
$C_{res}$		$f = 1 \text{ MHz}$		0.69		nF
$Q_G$	-15 V...+15 V			1513		nC
$R_{Gint}$	$T_j = 25^\circ\text{C}$			3.8		$\Omega$
$t_{d(on)}$	$V_{CC} = 300 \text{ V}$	$T_j = 150^\circ\text{C}$		232		ns
$t_r$	$I_C = 200 \text{ A}$	$T_j = 150^\circ\text{C}$		128		ns
$E_{on}$	$V_{GE} = +15/-15 \text{ V}$	$R_{G\text{ on}} = 3 \Omega$	$T_j = 150^\circ\text{C}$	3		mJ
$t_{d(off)}$	$R_{G\text{ off}} = 3 \Omega$	$T_j = 150^\circ\text{C}$		422		ns
$t_f$	$\text{di/dt}_{\text{on}} = 4400 \text{ A}/\mu\text{s}$	$T_j = 150^\circ\text{C}$		121		ns
	$\text{di/dt}_{\text{off}} = 3000 \text{ A}/\mu\text{s}$	$T_j = 150^\circ\text{C}$			14	mJ
$E_{off}$		$T_j = 150^\circ\text{C}$				
$R_{th(j-c)}$	per IGBT				0.18	K/W
$R_{th(c-s)}$						K/W
<b>IGBT2</b>						
$V_{CE(\text{sat})}$	$I_C = 200 \text{ A}$ $V_{GE} = 15 \text{ V}$ chiplevel	$T_j = 25^\circ\text{C}$		1.55	1.95	V
		$T_j = 150^\circ\text{C}$		1.75	2.2	V
$V_{CE0}$	chiplevel	$T_j = 25^\circ\text{C}$	0.9	1	1	V
		$T_j = 150^\circ\text{C}$	0.82	0.9	0.9	V
$r_{CE}$	$V_{GE} = 15 \text{ V}$ chiplevel	$T_j = 25^\circ\text{C}$	3.3	4.8	6.5	$\text{m}\Omega$
		$T_j = 150^\circ\text{C}$	4.7	6.5	6.5	$\text{m}\Omega$
$V_{GE(\text{th})}$	$V_{GE} = V_{CE}, I_C = 8 \text{ mA}$		5.1	5.8	6.4	V
$I_{CES}$	$V_{GE} = 0 \text{ V}, V_{CE} = 650 \text{ V}, T_j = 25^\circ\text{C}$			0.06	0.18	mA
$C_{ies}$	$V_{CE} = 25 \text{ V}$	$f = 1 \text{ MHz}$		12.3		nF
$C_{oes}$	$V_{GE} = 0 \text{ V}$	$f = 1 \text{ MHz}$		0.37		nF
$C_{res}$		$f = 1 \text{ MHz}$				nF
$Q_G$	-15 V...+15 V			2212		nC
$R_{Gint}$	$T_j = 25^\circ\text{C}$			1		$\Omega$
$t_{d(on)}$	$V_{CC} = 300 \text{ V}$	$T_j = 150^\circ\text{C}$		170		ns
$t_r$	$I_C = 200 \text{ A}$	$T_j = 150^\circ\text{C}$		118		ns
$E_{on}$	$V_{GE} = +15/-15 \text{ V}$	$R_{G\text{ on}} = 3 \Omega$	$T_j = 150^\circ\text{C}$	1.5		mJ
$t_{d(off)}$	$R_{G\text{ off}} = 3 \Omega$	$T_j = 150^\circ\text{C}$		380		ns
$t_f$	$\text{di/dt}_{\text{on}} = 3100 \text{ A}/\mu\text{s}$	$T_j = 150^\circ\text{C}$		127		ns
	$\text{di/dt}_{\text{off}} = 2800 \text{ A}/\mu\text{s}$	$T_j = 150^\circ\text{C}$			11.5	mJ
$E_{off}$		$T_j = 150^\circ\text{C}$				
$R_{th(j-c)}$	per IGBT				0.3	K/W
$R_{th(c-s)}$						K/W



TMLI



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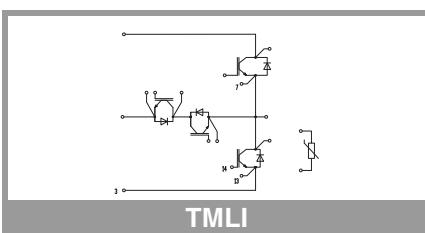
#### Features

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- IGBT 4 Trench Gate Technology
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#### Remarks\*

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- 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
- Please find further technical information on the SEMIKRON website

Characteristics		Conditions	min.	typ.	max.	Unit
Symbol						
<b>Diode1</b>						
$V_F = V_{EC}$	$I_F = 200 \text{ A}$	$T_j = 25^\circ\text{C}$		1.75	2.01	V
	$V_{GE} = 0 \text{ V}$ chiplevel	$T_j = 150^\circ\text{C}$		1.53	1.79	V
$V_{FO}$	chiplevel	$T_j = 25^\circ\text{C}$		1.3	1.5	V
		$T_j = 150^\circ\text{C}$		0.9	1.1	V
$r_F$	chiplevel	$T_j = 25^\circ\text{C}$		2.3	2.6	$\text{m}\Omega$
		$T_j = 150^\circ\text{C}$		3.1	3.4	$\text{m}\Omega$
$I_{RRM}$	$I_F = 200 \text{ A}$	$T_j = 150^\circ\text{C}$		106		A
$Q_{rr}$	$dI/dt_{off} = 3100 \text{ A}/\mu\text{s}$ $V_{GE} = -15 \text{ V}$	$T_j = 150^\circ\text{C}$		27.5		$\mu\text{C}$
		$V_{CC} = 300 \text{ V}$	$T_j = 150^\circ\text{C}$		5.9	mJ
$R_{th(j-c)}$	per diode				0.3	K/W
$R_{th(c-s)}$	per diode					K/W
<b>Diode2</b>						
$V_F = V_{EC}$	$I_F = 200 \text{ A}$	$T_j = 25^\circ\text{C}$		1.40	1.80	V
	$V_{GE} = 0 \text{ V}$ chiplevel	$T_j = 150^\circ\text{C}$		1.40	1.77	V
$V_{FO}$	chiplevel	$T_j = 25^\circ\text{C}$		1	1.2	V
		$T_j = 150^\circ\text{C}$		0.9	1	V
$r_F$	chiplevel	$T_j = 25^\circ\text{C}$		1.8	2.6	$\text{m}\Omega$
		$T_j = 150^\circ\text{C}$		2.7	3.9	$\text{m}\Omega$
$I_{RRM}$	$I_F = 200 \text{ A}$	$T_j = 150^\circ\text{C}$		121		A
$Q_{rr}$	$dI/dt_{off} = 4400 \text{ A}/\mu\text{s}$ $V_{GE} = -15 \text{ V}$	$T_j = 150^\circ\text{C}$		23		$\mu\text{C}$
		$V_R = 300 \text{ V}$	$T_j = 150^\circ\text{C}$		5.5	mJ
$R_{th(j-c)}$	per diode				0.39	K/W
$R_{th(c-s)}$	per diode					K/W
<b>Module</b>						
$L_{SCE1}$				32		nH
$L_{CE}$				t.b.d.		nH
$R_{CC+EE'}$	res. terminal-chip	$T_C = 25^\circ\text{C}$				$\text{m}\Omega$
		$T_C = 125^\circ\text{C}$				$\text{m}\Omega$
$R_{th(c-s)1}$	calculated without thermal coupling			t.b.d		K/W
$R_{th(c-s)2}$	including thermal coupling, Ts underneath module ( $\lambda_{grease}=0.81 \text{ W}/(\text{m}^*\text{K})$ )					K/W
$M_s$	to heat sink (M5)			3	5.5	Nm
$M_t$	to terminals (M6)			2.5	5	Nm
						Nm
$w$				398		g
<b>Temperature Sensor</b>						
$R_{100}$	$T_c=100^\circ\text{C}$ ( $R_{25}=5 \text{ k}\Omega$ )			493 $\pm$ 5%		$\Omega$
$B_{100/125}$	$R_{(T)}=R_{100}\exp[B_{100/125}(1/T-1/T_{100})]; T[\text{K}]$			3550 $\pm$ 2%		K



# SEMiX205TMLI12E4B

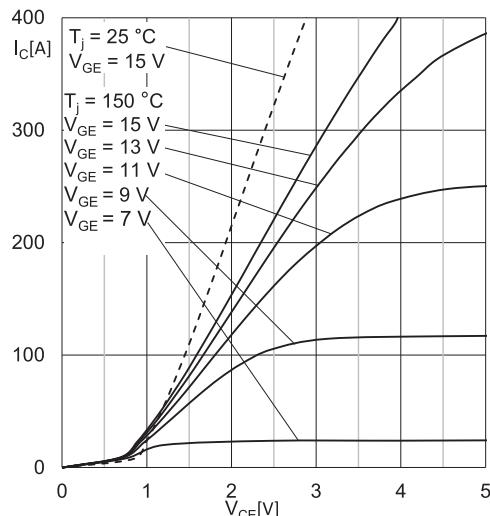


Fig. 1: Typ. IGBT1 output characteristic, incl.  $R_{CC} + EE$

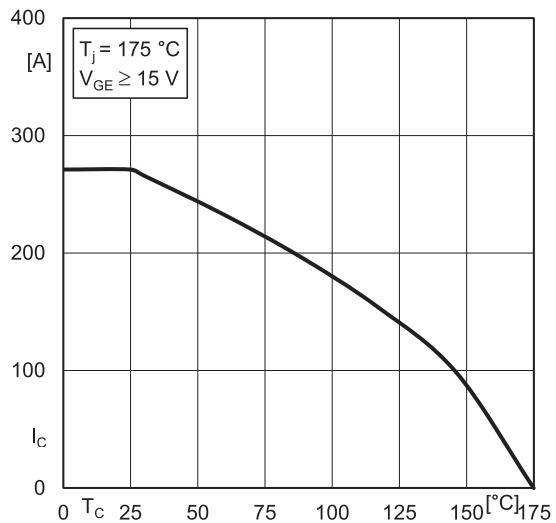


Fig. 2: IGBT1 rated current vs. Temperature  $I_c = f(T_s)$

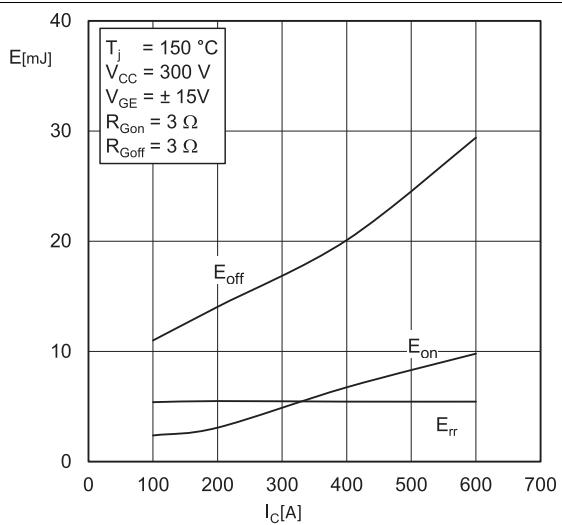


Fig. 3: Typ. IGBT1 & Diode2 turn-on /-off energy = f ( $I_C$ )

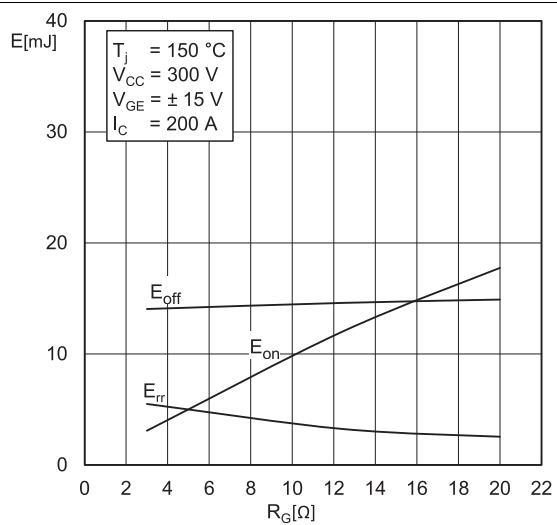


Fig. 4: Typ. IGBT1 & Diode2 turn-on /-off energy = f( $R_G$ )

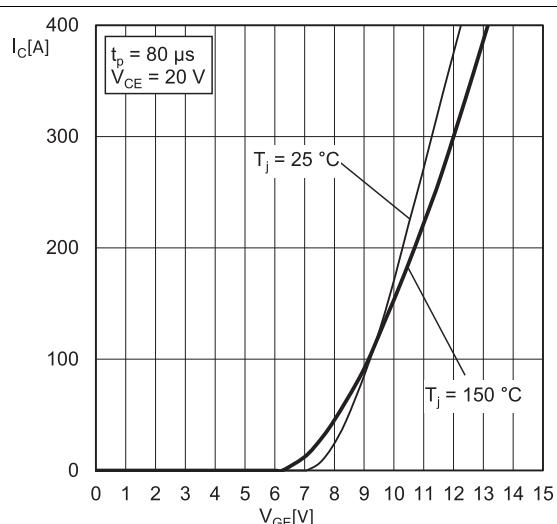


Fig. 5: Typ. IGBT1 transfer characteristic

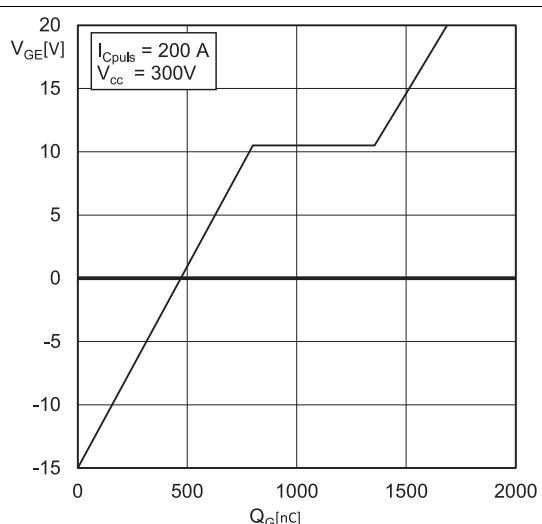


Fig. 6: Typ. IGBT1 gate charge characteristic

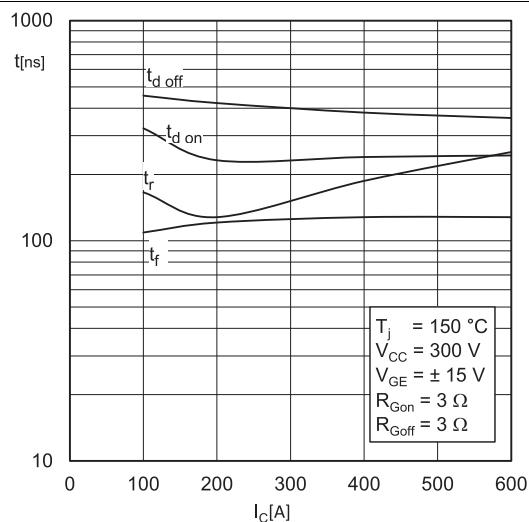


Fig. 7: Typ. IGBT1 switching times vs.  $I_C$

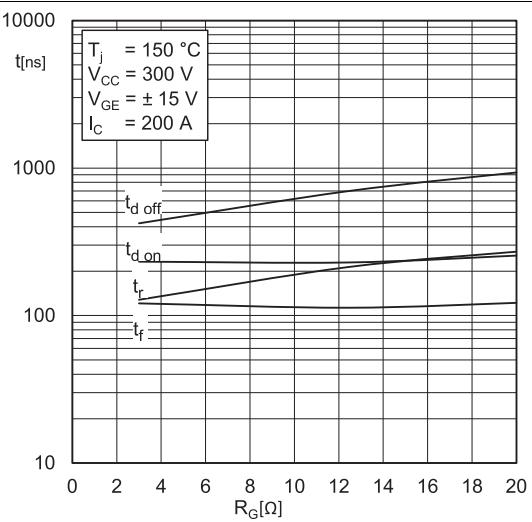


Fig. 8: Typ. IGBT1 switching times vs. gate resistor  $R_G$

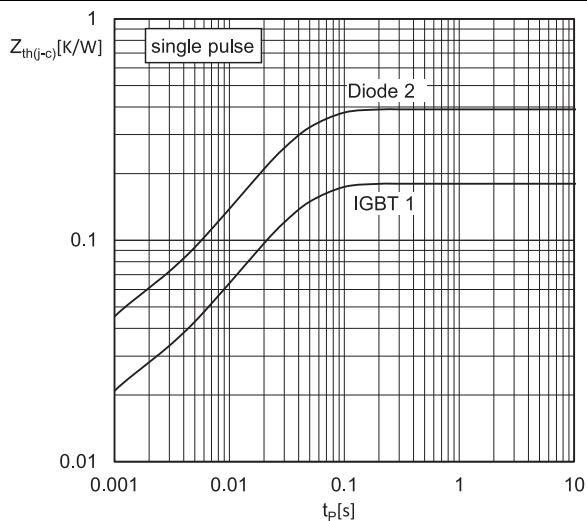


Fig. 9: Transient thermal impedance of IGBT1 & Diode2

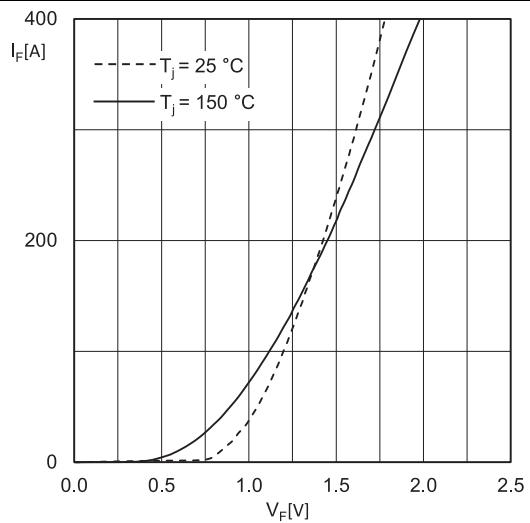


Fig. 10: Diode2 forward characteristic

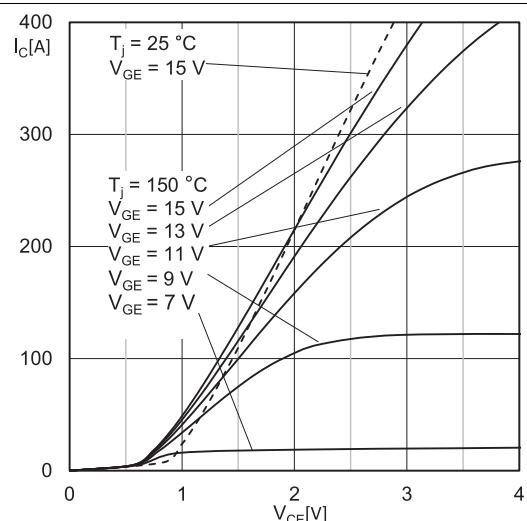


Fig. 13: Typ. IGBT2 output characteristic, incl.  $R_{CC+EE}$

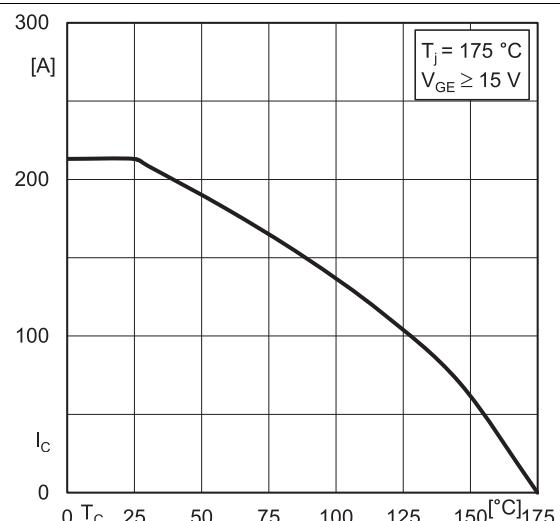


Fig. 14: IGBT2 Rated current vs. Temperature  $I_C = f(T_s)$

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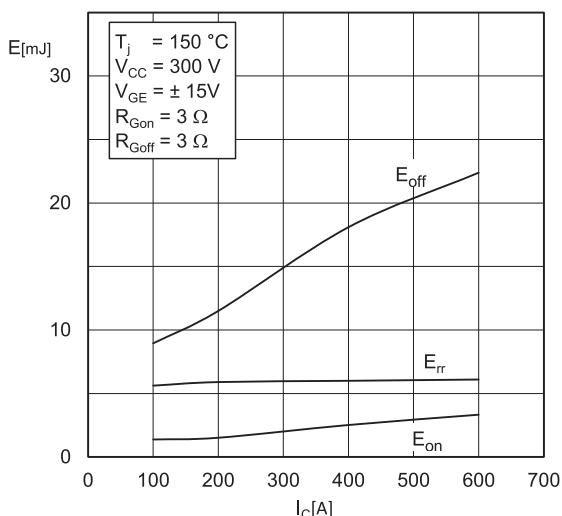


Fig. 15: Typ. IGBT2 & Diode1 turn-on /-off energy = f ( $I_C$ )

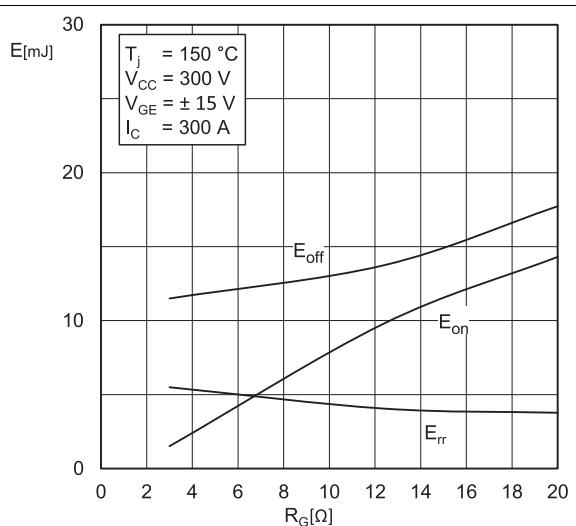


Fig. 16: Typ. IGBT2 & Diode1 turn-on /-off energy = f( $R_G$ )

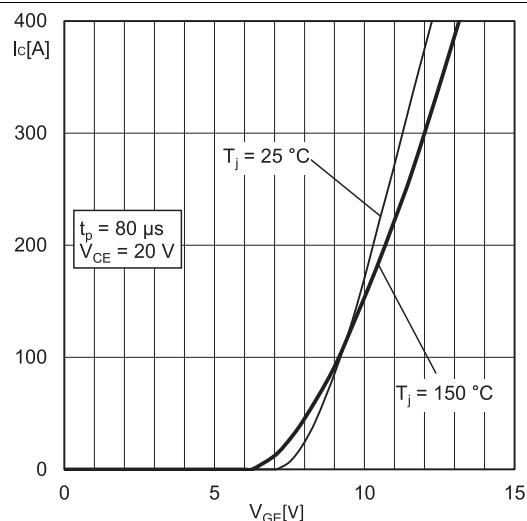


Fig. 17: Typ. IGBT2 transfer characteristic

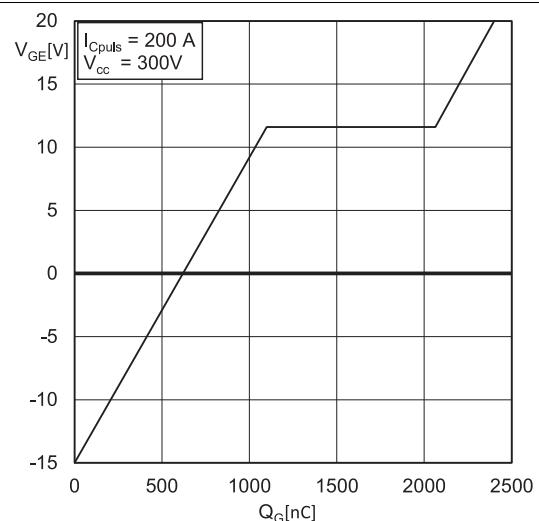


Fig. 18: Typ. IGBT2 gate charge characteristic

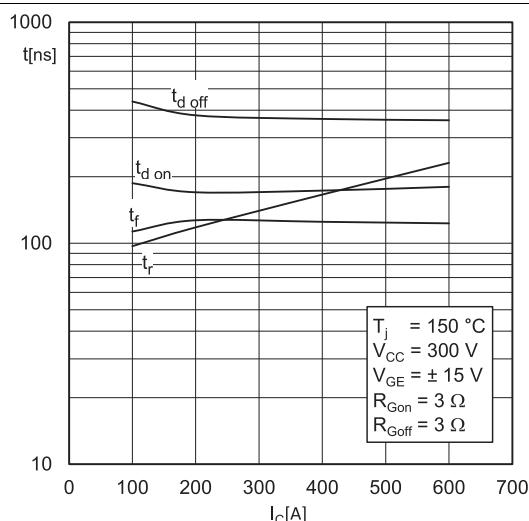


Fig. 19: Typ. IGBT2 switching times vs.  $I_C$

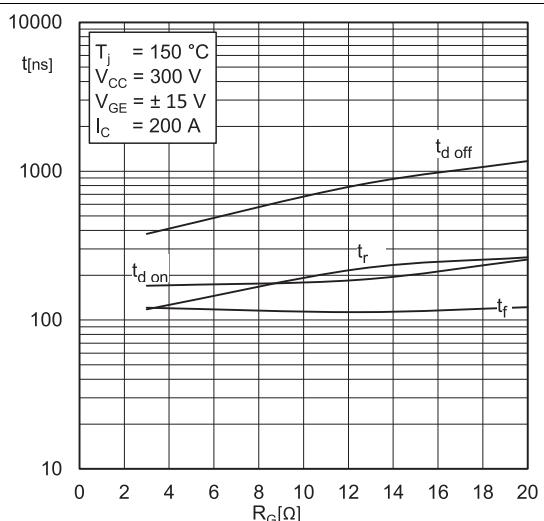


Fig. 20: Typ. IGBT2 switching times vs. gate resistor  $R_G$

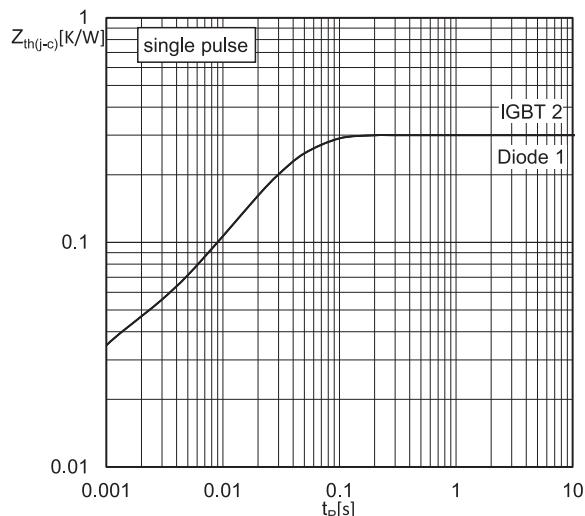


Fig. 21: Transient thermal impedance of IGBT2 & Diode1

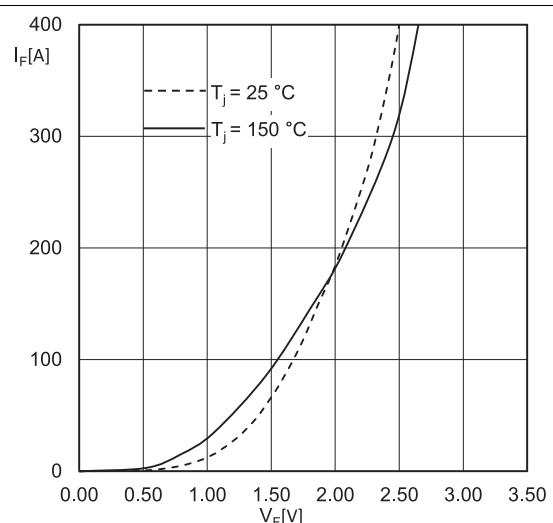
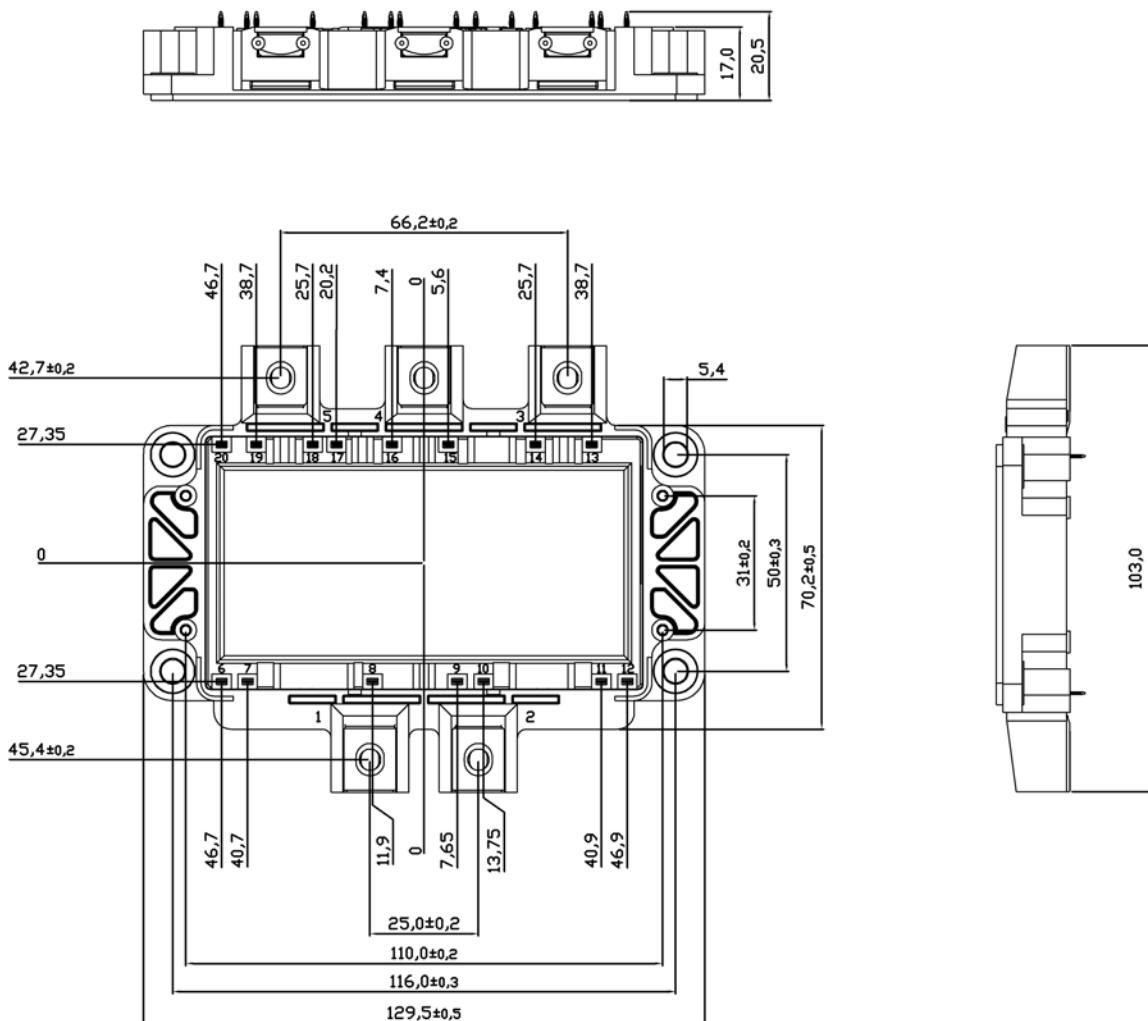


Fig. 22: Diode1 forward characteristic

# SEMiX205TMLI12E4B

Dimensions in mm  
Tolerance system: ISO 2768 – m

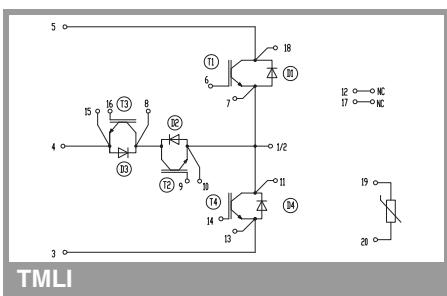


PRESSFIT Pins 0.6mm thickness  
Ø 1.09/-0.06 mm diameter of finished plated trough-hole  
Ø 1.15 mm diameter of drilled hole

For technical details please refer to SEMiX5 Mounting Instructions

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## SEMiX5p



TMLI

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.