

# SEMiX205MLI12E4V2



**SEMiX® 5**

## 3-Level NPC IGBT-Module

### SEMiX205MLI12E4V2

#### 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

#### Typical Applications

- Solar, Power Supply

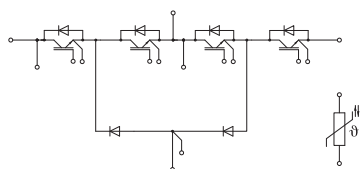
#### Remarks\*

- Case temperature limited to  $T_C=125^\circ\text{C}$  max.
- Product reliability results valid for  $T_j \leq 150^\circ\text{C}$  (recommended  $T_{j,op} = -40 \dots +150^\circ\text{C}$ )
- 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"

#### Footnotes

<sup>1)</sup> Please find further technical information on the SEMIKRON website.

Absolute Maximum Ratings			
Symbol	Conditions	Values	Unit
<b>IGBT1</b>			
$V_{CES}$	$T_j = 25^\circ\text{C}$	1200	V
$I_C$	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	313
		$T_c = 80^\circ\text{C}$	241
$I_{Cnom}$		200	A
$I_{CRM}$		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>			
$V_{CES}$	$T_j = 25^\circ\text{C}$	1200	V
$I_C$	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	289
		$T_c = 80^\circ\text{C}$	222
$I_{Cnom}$		200	A
$I_{CRM}$		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>Diode1</b>			
$V_{RRM}$	$T_j = 25^\circ\text{C}$	1200	V
$I_F$	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	229
		$T_c = 80^\circ\text{C}$	172
$I_{FRM}$		400	A
$I_{FSM}$	10 ms, sin 180°, $T_j = 25^\circ\text{C}$	990	A
$T_j$		-40 ... 175	$^\circ\text{C}$
<b>Diode2</b>			
$V_{RRM}$	$T_j = 25^\circ\text{C}$	1200	V
$I_F$	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	214
		$T_c = 80^\circ\text{C}$	160
$I_{FRM}$		400	A
$I_{FSM}$	10 ms, sin 180°, $T_j = 25^\circ\text{C}$	990	A
$T_j$		-40 ... 175	$^\circ\text{C}$
<b>Diode5</b>			
$V_{RRM}$	$T_j = 25^\circ\text{C}$	1200	V
$I_F$	$T_j = 175^\circ\text{C}$	$T_c = 25^\circ\text{C}$	219
		$T_c = 80^\circ\text{C}$	163
$I_{FRM}$		400	A
$I_{FSM}$	10 ms, sin 180°, $T_j = 25^\circ\text{C}$	990	A
$T_j$		-40 ... 175	$^\circ\text{C}$
<b>Module</b>			
$I_{t(RMS)}$		300	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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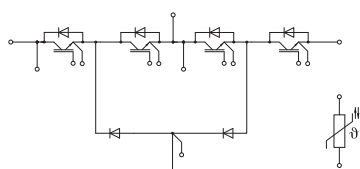
- Solar, Power Supply

#### Remarks\*

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- Product reliability results valid for  $T_j \leq 150^\circ\text{C}$  (recommended  $T_{j,op} = -40\dots+150^\circ\text{C}$ )
- IGBT1: outer IGBTs T1 & T4
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- Diode1: outer diodes D1 & D4
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- For storage and case temperature with TIM see document "TP(HALA P8) SEMIX 5p"

#### Footnotes

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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
<b>IGBT1</b>						
$V_{CE(sat)}$	$I_C = 200\text{ A}$ $V_{GE} = 15\text{ V}$ 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	$T_j = 25^\circ\text{C}$	5.0	5.8		m $\Omega$
		$T_j = 150^\circ\text{C}$	7.5	8.0		m $\Omega$
$V_{GE(th)}$	$V_{GE} = V_{CE}, I_C = 7.6\text{ mA}$		5	5.8	6.5	V
$I_{CES}$	$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}, T_j = 25^\circ\text{C}$				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
$Q_G$	$V_{GE} = -8V\dots+15V$			1130		nC
$R_{Gint}$	$T_j = 25^\circ\text{C}$			3.8		$\Omega$
$t_{d(on)}$	$V_{CC} = 600\text{ V}$ $I_C = 200\text{ A}$	$T_j = 150^\circ\text{C}$		78		ns
$t_r$	$V_{GE} = +15/-8\text{ V}$	$T_j = 150^\circ\text{C}$		54		ns
$E_{on}$	$R_{G\ on} = 0.5\ \Omega$	$T_j = 150^\circ\text{C}$		12.8		mJ
$t_{d(off)}$	$R_{G\ off} = 1\ \Omega$	$T_j = 150^\circ\text{C}$		490		ns
$t_f$	$di/dt_{on} = 3610\text{ A}/\mu\text{s}$ $di/dt_{off} = 1530\text{ A}/\mu\text{s}$	$T_j = 150^\circ\text{C}$		114		ns
$E_{off}$	$dv/dt = 3530\text{ V}/\mu\text{s}$	$T_j = 150^\circ\text{C}$		24.6		mJ
$R_{th(j-c)}$	per IGBT				0.14	K/W
$R_{th(c-s)}$	per IGBT ( $\lambda_{grease}=0.81\text{ W}/(\text{m}^*\text{K})$ )			0.077		K/W
$R_{th(c-s)}$	per IGBT, pre-applied phase change material			0.046		K/W
<b>IGBT2</b>						
$V_{CE(sat)}$	$I_C = 200\text{ A}$ $V_{GE} = 15\text{ V}$ 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	$T_j = 25^\circ\text{C}$	5.0	5.8		m $\Omega$
		$T_j = 150^\circ\text{C}$	7.5	8.0		m $\Omega$
$V_{GE(th)}$	$V_{GE} = V_{CE}, I_C = 7.6\text{ mA}$		5	5.8	6.5	V
$I_{CES}$	$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}, T_j = 25^\circ\text{C}$				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
$Q_G$	$V_{GE} = -8V\dots+15V$			1130		nC
$R_{Gint}$	$T_j = 25^\circ\text{C}$			3.8		$\Omega$
$t_{d(on)}$	$V_{CC} = 600\text{ V}$ $I_C = 200\text{ A}$	$T_j = 150^\circ\text{C}$		85		ns
$t_r$	$V_{GE} = +15/-8\text{ V}$	$T_j = 150^\circ\text{C}$		57		ns
$E_{on}$	$R_{G\ on} = 0.5\ \Omega$	$T_j = 150^\circ\text{C}$		8.4		mJ
$t_{d(off)}$	$R_{G\ off} = 1\ \Omega$	$T_j = 150^\circ\text{C}$		504		ns
$t_f$	$di/dt_{on} = 3450\text{ A}/\mu\text{s}$ $di/dt_{off} = 1430\text{ A}/\mu\text{s}$	$T_j = 150^\circ\text{C}$		120		ns
$E_{off}$	$dv/dt = 3560\text{ V}/\mu\text{s}$	$T_j = 150^\circ\text{C}$		25.4		mJ
$R_{th(j-c)}$	per IGBT				0.16	K/W
$R_{th(c-s)}$	per IGBT ( $\lambda_{grease}=0.81\text{ W}/(\text{m}^*\text{K})$ )			0.087		K/W
$R_{th(c-s)}$	per IGBT, pre-applied phase change material			0.052		K/W



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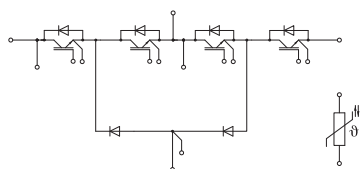
#### Remarks\*

- Case temperature limited to  $T_C=125^\circ\text{C}$  max.
- Product reliability results valid for  $T_j \leq 150^\circ\text{C}$  (recommended  $T_{j,op} = -40 \dots +150^\circ\text{C}$ )
- IGBT1: outer IGBTs T1 & T4
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- Diode1: outer diodes D1 & D4
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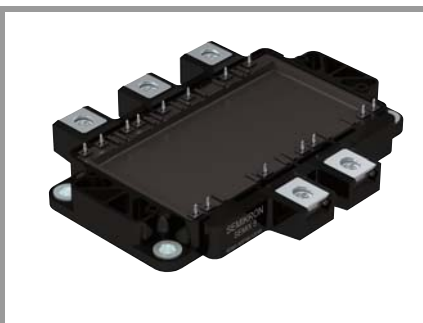
#### Footnotes

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Characteristics			min.	typ.	max.	Unit
Symbol	Conditions					
<b>Diode1</b>						
$V_F = V_{EC}$	$I_F = 200\text{ A}$ $V_{GE} = 0\text{ V}$ 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	$T_j = 25^\circ\text{C}$	4.5	5.1		mΩ
		$T_j = 150^\circ\text{C}$	6.3	6.9		mΩ
$I_{RRM}$	$I_F = 200\text{ A}$	$T_j = 150^\circ\text{C}$	158			A
$Q_{rr}$	$di/dt_{off} = 3450\text{ A}/\mu\text{s}$ $V_{CC} = 600\text{ V}$	$T_j = 150^\circ\text{C}$	23.9			μC
$E_{rr}$	$V_{GE} = +15/-8\text{ V}$	$T_j = 150^\circ\text{C}$	5.8			mJ
$R_{th(j-c)}$	per diode				0.26	K/W
$R_{th(c-s)}$	per diode ( $\lambda_{grease}=0.81\text{ W}/(\text{m}^*\text{K})$ )			0.09		K/W
$R_{th(c-s)}$	per diode, pre-applied phase change material			0.065		K/W
<b>Diode2</b>						
$V_F = V_{EC}$	$I_F = 200\text{ A}$ $V_{GE} = 0\text{ V}$ 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	$T_j = 25^\circ\text{C}$	4.5	5.1		mΩ
		$T_j = 150^\circ\text{C}$	6.3	6.9		mΩ
$I_{RRM}$	$I_F = 200\text{ A}$	$T_j = 150^\circ\text{C}$	158			A
$Q_{rr}$	$V_R = 600\text{ V}$	$T_j = 150^\circ\text{C}$	23.9			μC
$E_{rr} \text{ } ^1)$	$V_{GE} = +15/-8\text{ V}$	$T_j = 150^\circ\text{C}$	-			mJ
$R_{th(j-c)}$	per diode				0.29	K/W
$R_{th(c-s)}$	per diode ( $\lambda_{grease}=0.81\text{ W}/(\text{m}^*\text{K})$ )			0.098		K/W
$R_{th(c-s)}$	per diode, pre-applied phase change material			0.071		K/W
<b>Diode5</b>						
$V_F = V_{EC}$	$I_F = 200\text{ A}$ 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	$T_j = 25^\circ\text{C}$	4.5	5.1		mΩ
		$T_j = 150^\circ\text{C}$	6.3	6.9		mΩ
$I_{RRM}$	$I_F = 200\text{ A}$	$T_j = 150^\circ\text{C}$	185			A
$Q_{rr}$	$di/dt_{off} = 3610\text{ A}/\mu\text{s}$ $V_R = 600\text{ V}$	$T_j = 150^\circ\text{C}$	28.7			μC
$E_{rr}$	$V_{GE} = +15/-8\text{ V}$	$T_j = 150^\circ\text{C}$	16			mJ
$R_{th(j-c)}$	per diode				0.28	K/W
$R_{th(c-s)}$	per diode ( $\lambda_{grease}=0.81\text{ W}/(\text{m}^*\text{K})$ )			0.103		K/W
$R_{th(c-s)}$	per diode, pre-applied phase change material			0.074		K/W



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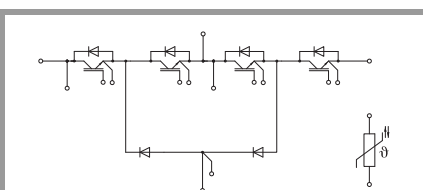
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Characteristics						
Symbol	Conditions		min.	typ.	max.	Unit
<b>Module</b>						
$L_{sCE1}$				27		nH
$L_{sCE2}$				34		nH
$R_{CC'+EE'}$	measured between terminal 5 and 1	$T_C = 25^\circ\text{C}$		0.8		m $\Omega$
		$T_C = 125^\circ\text{C}$		1.1		m $\Omega$
$R_{th(c-s)1}$	calculated without thermal coupling			0.009		K/W
$R_{th(c-s)2}$	including thermal coupling, $T_s$ underneath module ( $\lambda_{grease}=0.81 \text{ W}/(\text{m}^2\text{K})$ )			0.014		K/W
$R_{th(c-s)2}$	including thermal coupling, $T_s$ underneath module, pre-applied phase change material			0.009		K/W
$M_s$	to heat sink (M5)		3		6	Nm
$M_t$		to terminals (M6)	3		6	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



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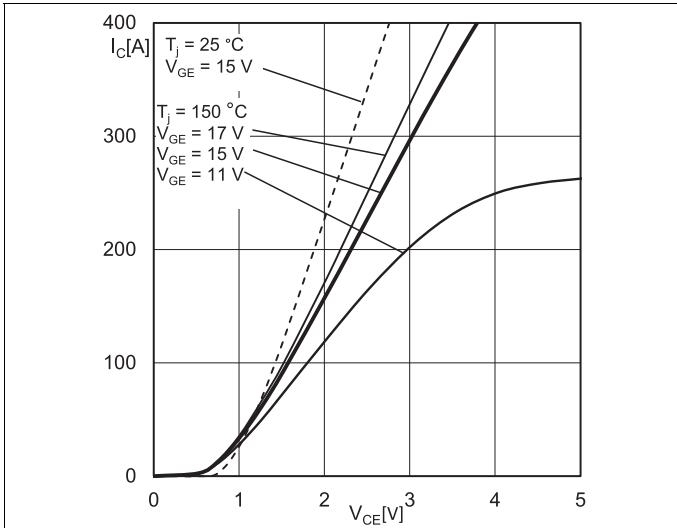


Fig. 1: Typ. IGBT1 output characteristic, incl.  $R_{CC'+EE'}$

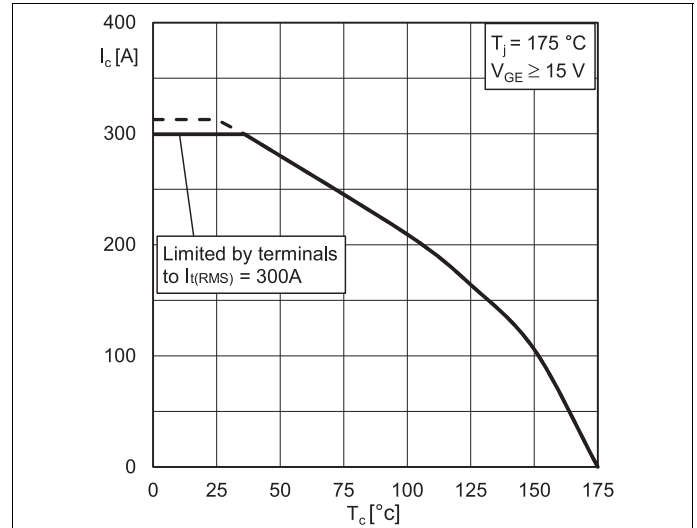


Fig. 2: IGBT1 rated current vs. Temperature  $I_c=f(T_c)$

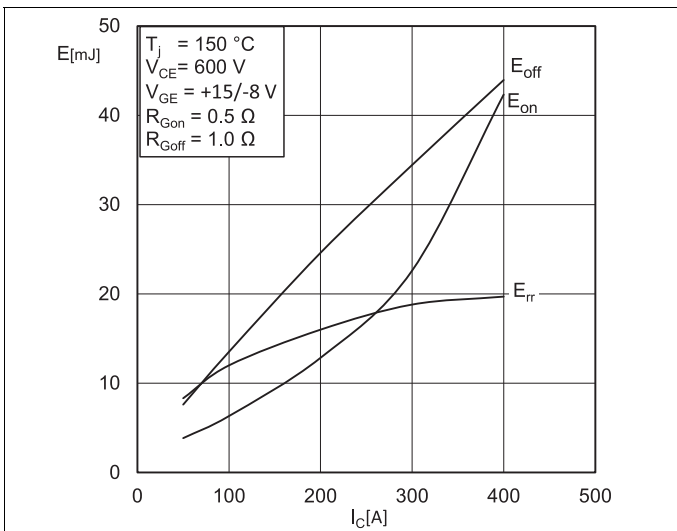


Fig. 3: Typ. IGBT1 & Diode5 turn-on /-off energy =  $f(I_c)$

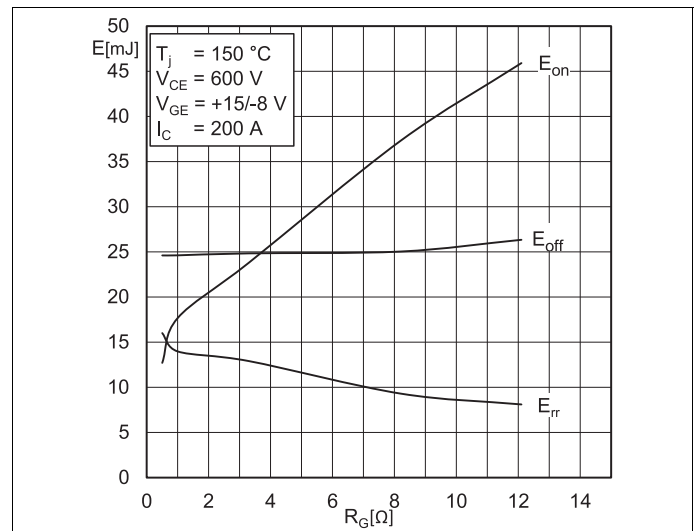


Fig. 4: Typ. IGBT1 & Diode5 turn-on /-off energy =  $f(R_G)$

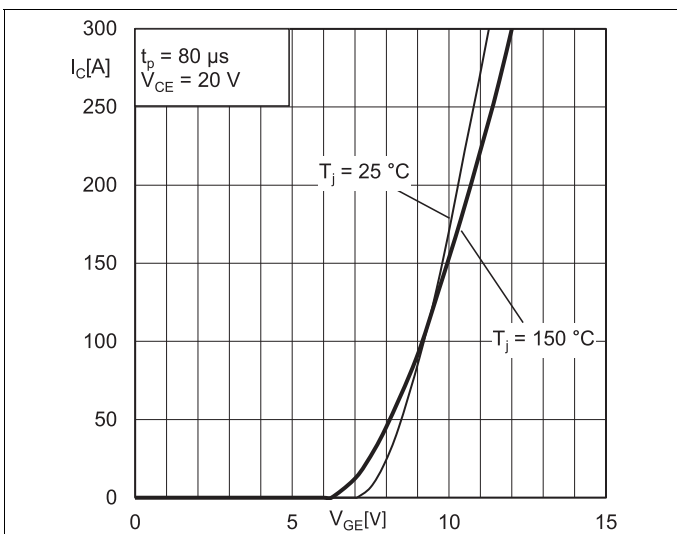


Fig. 5: Typ. IGBT1 transfer characteristic

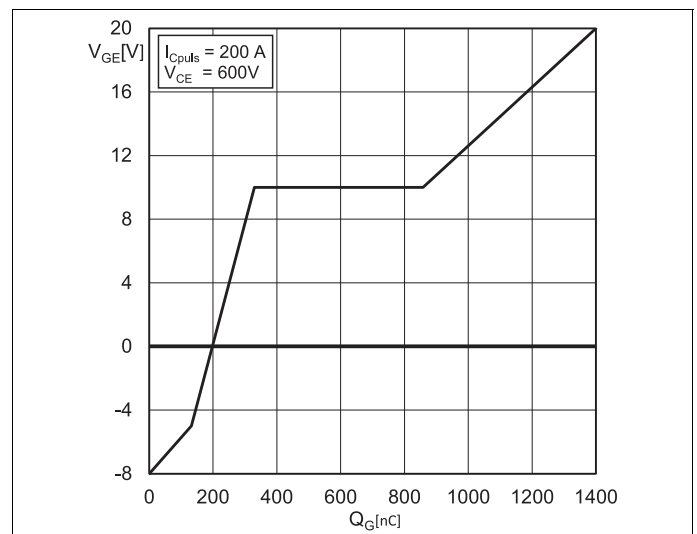


Fig. 6: Typ. IGBT1 gate charge characteristic

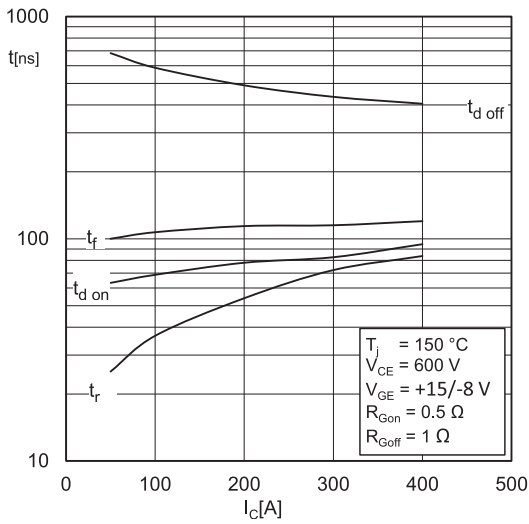


Fig. 7: Typ. IGBT1 switching times vs.  $I_c$

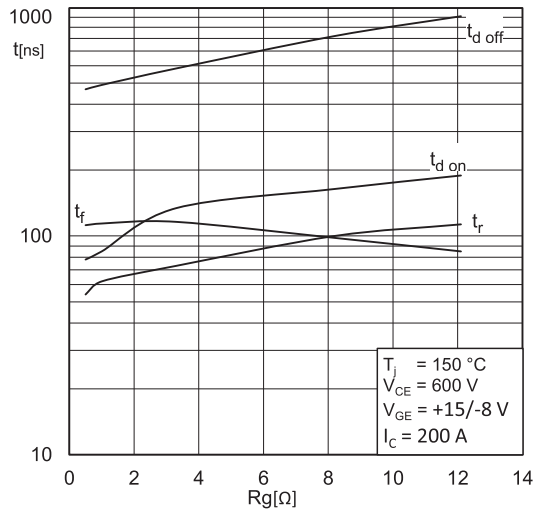


Fig. 8: Typ. IGBT1 switching times vs. gate resistor  $R_g$

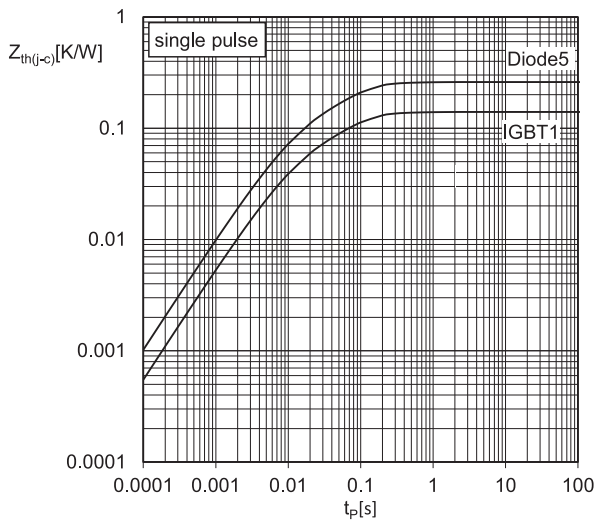


Fig. 9: Transient thermal impedance of IGBT1 & Diode5

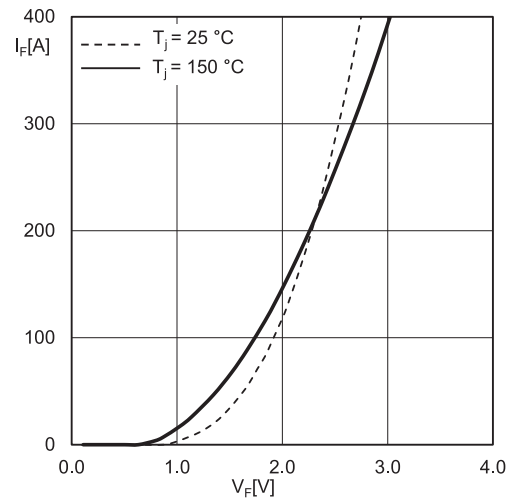


Fig. 10: Typ. Diode5 forward characteristic, incl.  $R_{CC+EE'}$

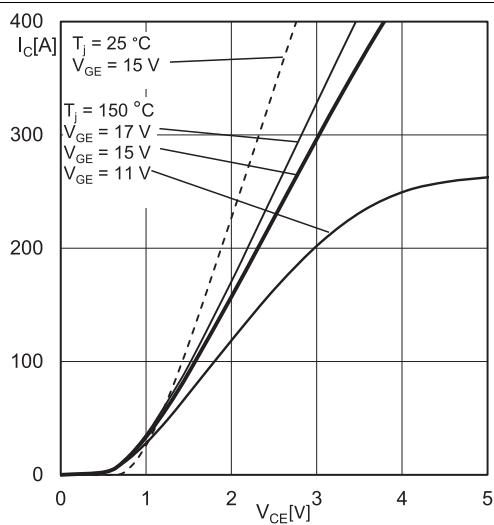


Fig. 13: Typ. IGBT2 output characteristic, incl.  $R_{CC+EE'}$

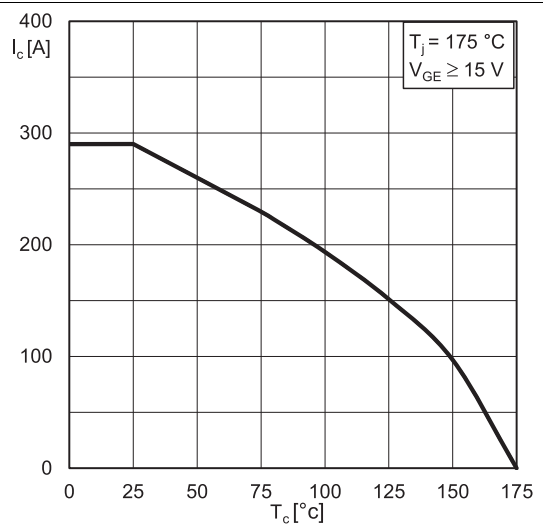
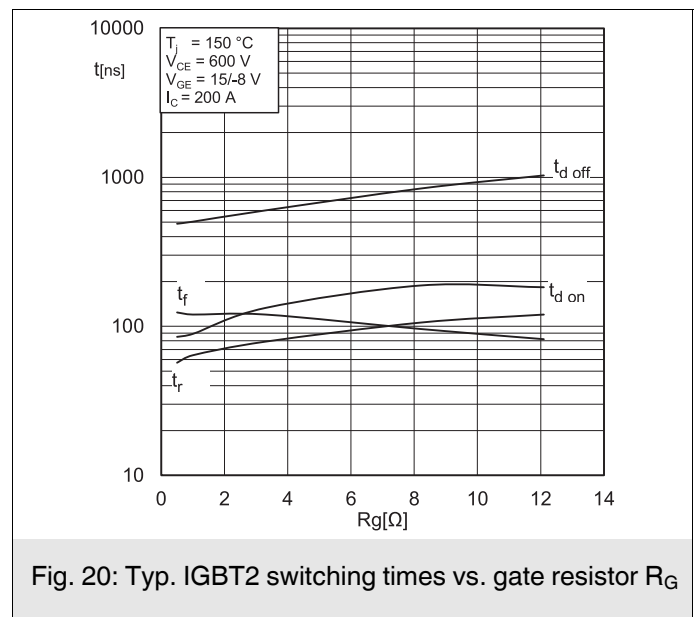
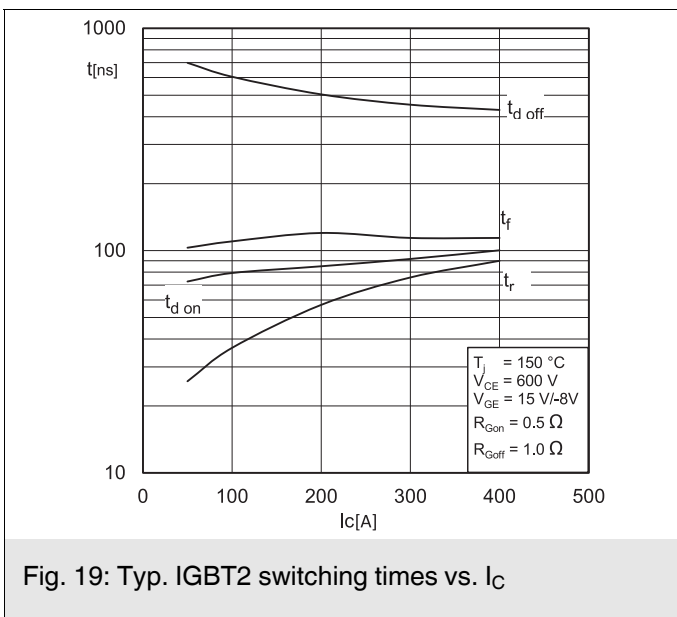
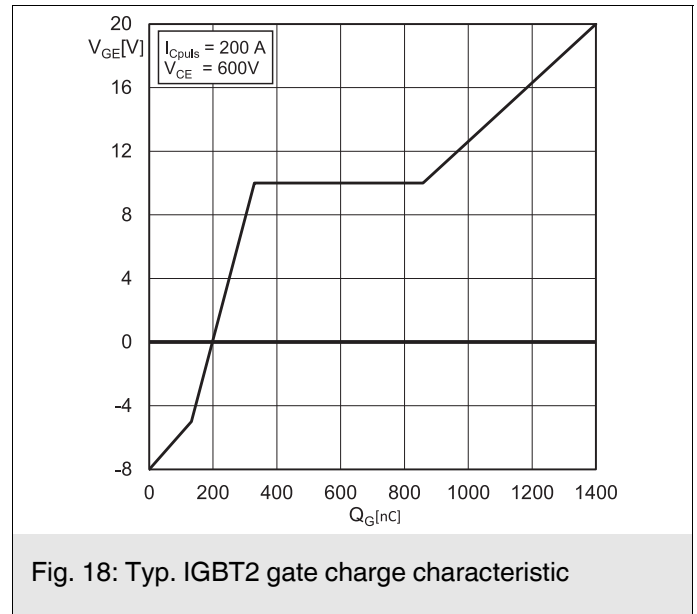
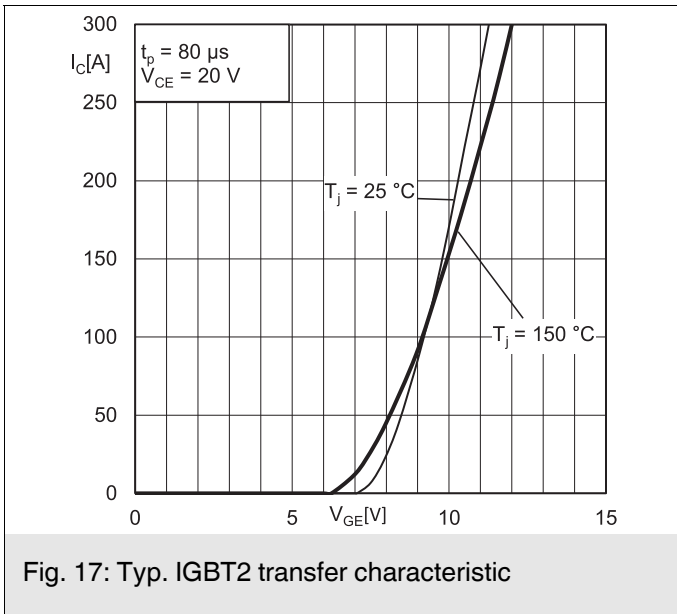
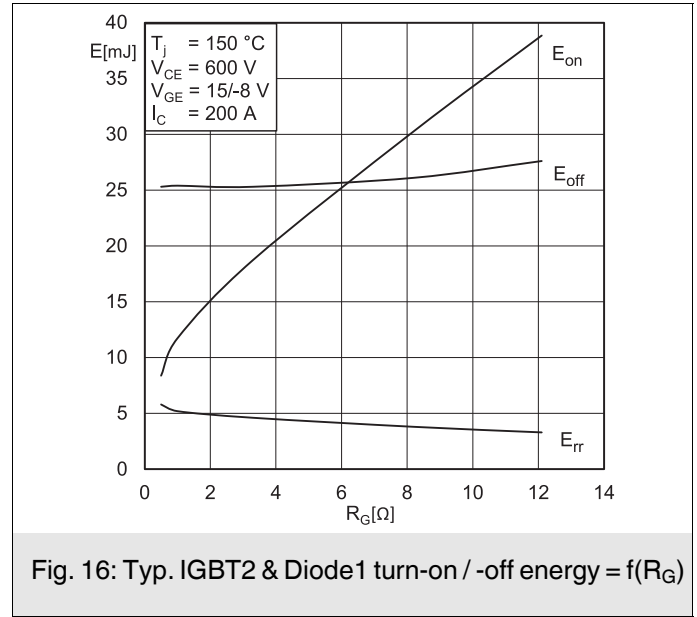
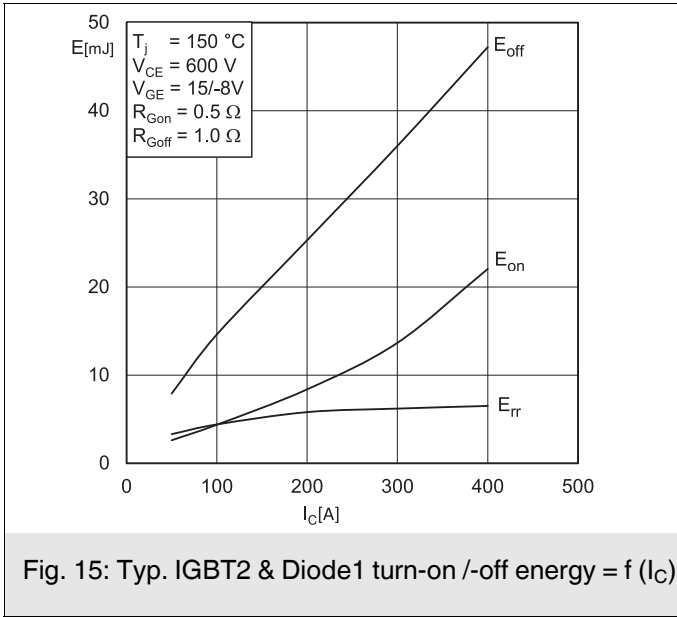


Fig. 14: IGBT2 rated current vs. Temperature  $I_c = f(T_c)$



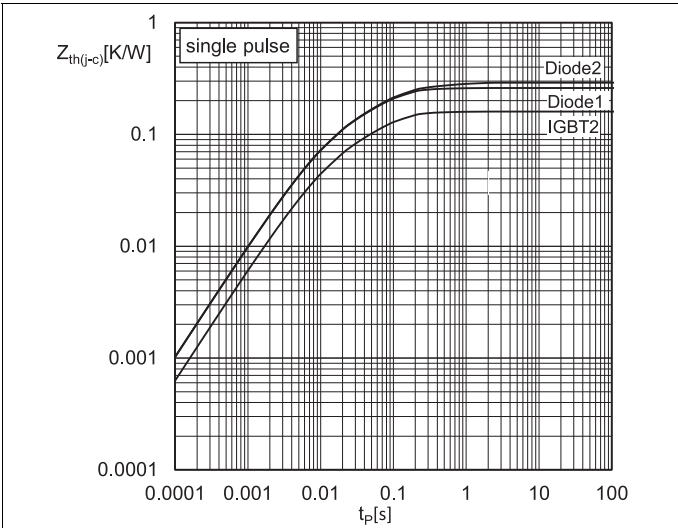


Fig. 21: Transient thermal impedance of IGBT2, Diode1 & Diode2

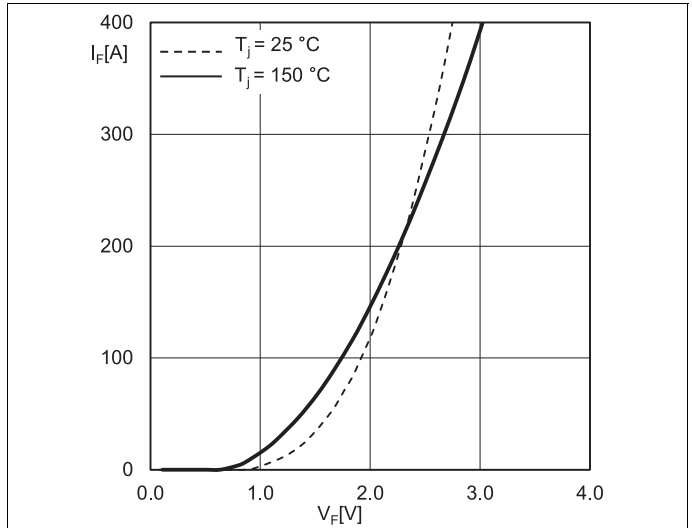
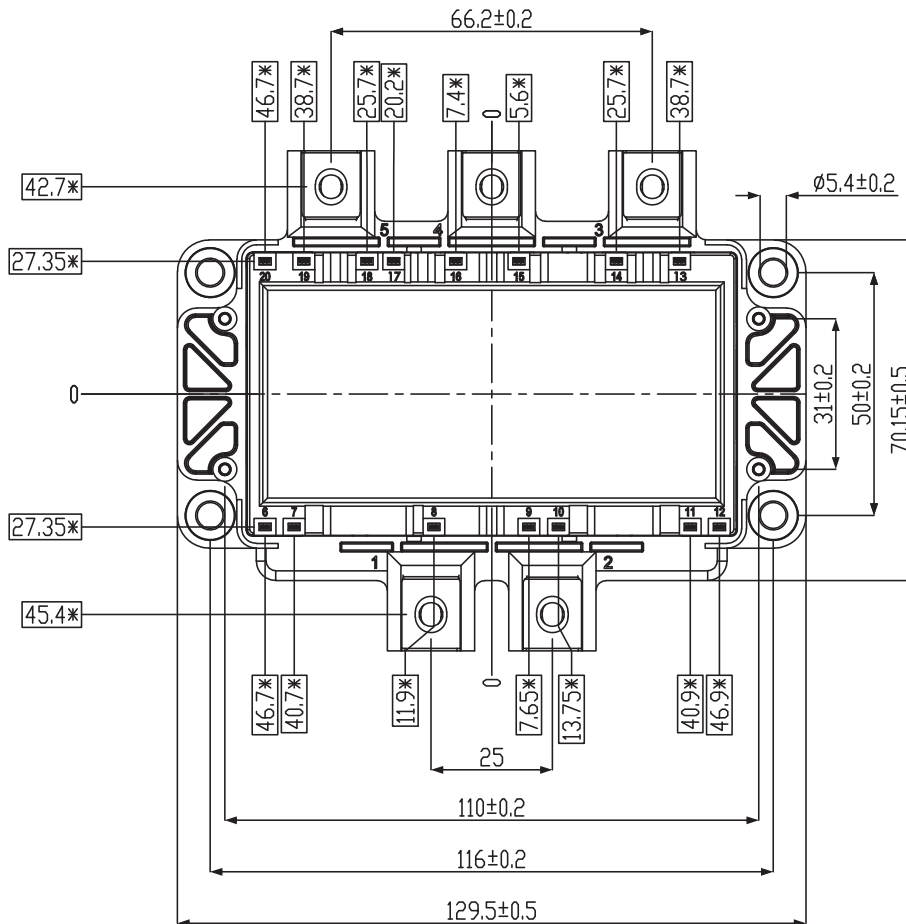
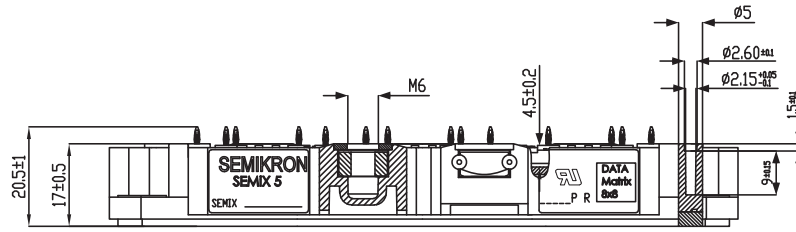


Fig. 22: Typ. Diode1 & Diode2 forward characteristic, incl.  $R_{CC'+EE'}$



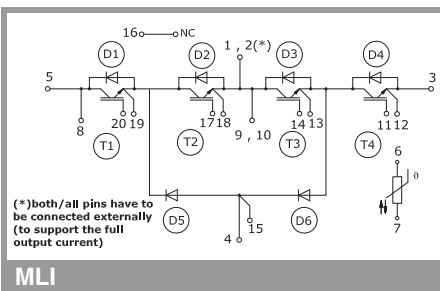
# SEMiX205MLI12E4V2



\* = Dimensions in mm with tolerance of  $\pm 0.4$

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

SEMiX5p



MLI

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

## **\*IMPORTANT INFORMATION AND WARNINGS**

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