# SEMiX305TMLI12E4B

**SEMiX® 5**

3-Level TNPC IGBT-Module

**SEMiX305TMLI12E4B**

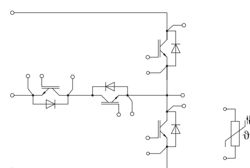
### Features

- 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°C max.
- Product reliability results are valid for $T_{jop}$=150°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"

| Absolute Maximum Ratings | | | | |
|---|---|---|---|---|
| **Symbol** | **Conditions** | | **Values** | **Unit** |
| **IGBT1** | | | | |
| $V_{CES}$ | $T_j$ = 25 °C | | 1200 | V |
| $I_C$ | $T_j$ = 175 °C | $T_c$ = 25 °C | 479 | A |
| | | $T_c$ = 80 °C | 369 | A |
| $I_{Cnom}$ | | | 300 | A |
| $I_{CRM}$ | $I_{CRM}$ = 3 x $I_{Cnom}$ | | 900 | A |
| $V_{GES}$ | | | -20 ... 20 | V |
| $t_{psc}$ | $V_{CC}$ = 800 V, $V_{GE}$ ≤ 15 V, $T_j$ = 150 °C, $V_{CES}$ ≤1200 V | | 10 | µs |
| $T_j$ | | | -40 ... 175 | °C |
| **IGBT2** | | | | |
| $V_{CES}$ | $T_j$ = 25 °C | | 650 | V |
| $I_C$ | $T_j$ = 175 °C | $T_c$ = 25 °C | 360 | A |
| | | $T_c$ = 80 °C | 271 | A |
| $I_{Cnom}$ | | | 300 | A |
| $I_{CRM}$ | $I_{CRM}$ = 3 x $I_{Cnom}$ | | 900 | A |
| $V_{GES}$ | | | -20 ... 20 | V |
| $t_{psc}$ | $V_{CC}$ = 360 V, $V_{GE}$ ≤ 15 V, $T_j$ = 150 °C, $V_{CES}$ ≤ 650 V | | 10 | µs |
| $T_j$ | | | -40 ... 175 | °C |
| **Diode1** | | | | |
| $V_{RRM}$ | $T_j$ = 25 °C | | 1200 | V |
| $I_F$ | $T_j$ = 175 °C | $T_c$ = 25 °C | 363 | A |
| | | $T_c$ = 80 °C | 272 | A |
| $I_{Fnom}$ | | | 300 | A |
| $I_{FRM}$ | $I_{FRM}$ = 2 x $I_{Fnom}$ | | 600 | A |
| $I_{FSM}$ | 10 ms, sin 180°, $T_j$ = 25 °C | | 1485 | A |
| $T_j$ | | | -40 ... 175 | °C |
| **Diode2** | | | | |
| $V_{RRM}$ | $T_j$ = 25 °C | | 650 | V |
| $I_F$ | $T_j$ = 175 °C | $T_c$ = 25 °C | 366 | A |
| | | $T_c$ = 80 °C | 267 | A |
| $I_{Fnom}$ | | | 300 | A |
| $I_{FRM}$ | $I_{FRM}$ = 2 x $I_{Fnom}$ | | 600 | A |
| $I_{FSM}$ | 10 ms, sin 180°, $T_j$ = 25 °C | | 2160 | A |
| $T_j$ | | | -40 ... 175 | °C |
| **Module** | | | | |
| $I_{t(RMS)}$ | | | 400 | A |
| $T_{stg}$ | module without TIM | | -40 ... 125 | °C |
| $V_{isol}$ | AC sinus 50Hz, t = 1 min | | 4000 | V |



TMLI

SEMiX® 5

3-Level TNPC IGBT-Module

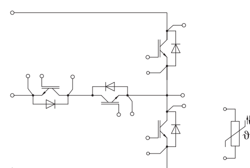
**SEMiX305TMLI12E4B**

### 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°C max.
- Product reliability results are valid for $T_{jop}$=150°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

**Characteristics**

| Symbol | Conditions | | min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|
| **IGBT1** | | | | | | |
| $V_{CE(sat)}$ | $I_C$ = 300 A, $V_{GE}$ = 15 V, chiplevel | $T_j$ = 25 °C | | 1.80 | 2.05 | V |
| | | $T_j$ = 150 °C | | 2.20 | 2.40 | V |
| $V_{CE0}$ | chiplevel | $T_j$ = 25 °C | | 0.80 | 0.90 | V |
| | | $T_j$ = 150 °C | | 0.70 | 0.80 | V |
| $r_{CE}$ | $V_{GE}$ = 15 V, chiplevel | $T_j$ = 25 °C | | 3.3 | 3.8 | mΩ |
| | | $T_j$ = 150 °C | | 5.0 | 5.3 | mΩ |
| $V_{GE(th)}$ | $V_{GE}$ = $V_{CE}$, $I_C$ = 11.4 mA | | 5 | 5.8 | 6.5 | V |
| $I_{CES}$ | $V_{GE}$ = 0 V, $V_{CE}$ = 1200 V, $T_j$ = 25 °C | | | | 4 | mA |
| $C_{ies}$ | $V_{CE}$ = 25 V, $V_{GE}$ = 0 V | f = 1 MHz | | 18.5 | | nF |
| $C_{oes}$ | | f = 1 MHz | | 1.22 | | nF |
| $C_{res}$ | | f = 1 MHz | | 1.04 | | nF |
| $Q_G$ | $V_{GE}$ = - 15 V...+ 15 V | | | 2265 | | nC |
| $R_{Gint}$ | $T_j$ = 25 °C | | | 2.5 | | Ω |
| $t_{d(on)}$ | $V_{CC}$ = 300 V, $I_C$ = 300 A, $V_{GE}$ = +15/-15 V, $R_{G\ on}$ = 2 Ω, $R_{G\ off}$ = 2 Ω, $di/dt_{on}$ = 2437 A/µs, $di/dt_{off}$ = 3000 A/µs | $T_j$ = 150 °C | | 232 | | ns |
| $t_r$ | | $T_j$ = 150 °C | | 128 | | ns |
| $E_{on}$ | | $T_j$ = 150 °C | | 4.5 | | mJ |
| $t_{d(off)}$ | | $T_j$ = 150 °C | | 422 | | ns |
| $t_f$ | | $T_j$ = 150 °C | | 121 | | ns |
| $E_{off}$ | | $T_j$ = 150 °C | | 21 | | mJ |
| $R_{th(j-c)}$ | per IGBT | | | | 0.09 | K/W |
| $R_{th(c-s)}$ | per IGBT (λgrease=0.81 W/(m*K)) | | | 0.04 | | K/W |
| $R_{th(c-s)}$ | per IGBT, pre-applied phase change material | | | 0.021 | | K/W |
| **IGBT2** | | | | | | |
| $V_{CE(sat)}$ | $I_C$ = 300 A, $V_{GE}$ = 15 V, chiplevel | $T_j$ = 25 °C | | 1.55 | 1.95 | V |
| | | $T_j$ = 150 °C | | 1.75 | 2.15 | V |
| $V_{CE0}$ | chiplevel | $T_j$ = 25 °C | | 0.90 | 1.00 | V |
| | | $T_j$ = 150 °C | | 0.82 | 0.90 | V |
| $r_{CE}$ | $V_{GE}$ = 15 V, chiplevel | $T_j$ = 25 °C | | 2.2 | 3.2 | mΩ |
| | | $T_j$ = 150 °C | | 3.1 | 4.2 | mΩ |
| $V_{GE(th)}$ | $V_{GE}$ = $V_{CE}$, $I_C$ = 8 mA | | 5.1 | 5.8 | 6.4 | V |
| $I_{CES}$ | $V_{GE}$ = 0 V, $V_{CE}$ = 650 V, $T_j$ = 25 °C | | | | 0.3 | mA |
| $C_{ies}$ | $V_{CE}$ = 25 V, $V_{GE}$ = 0 V | f = 1 MHz | | 18.5 | | nF |
| $C_{oes}$ | | f = 1 MHz | | 1.16 | | nF |
| $C_{res}$ | | f = 1 MHz | | 0.55 | | nF |
| $Q_G$ | $V_{GE}$ = - 15 V...+ 15 V | | | 3318 | | nC |
| $R_{Gint}$ | $T_j$ = 25 °C | | | 1.0 | | Ω |
| $t_{d(on)}$ | $V_{CC}$ = 300 V, $I_C$ = 300 A, $V_{GE}$ = +15/-15 V, $R_{G\ on}$ = 2 Ω, $R_{G\ off}$ = 2 Ω, $di/dt_{on}$ = 3100 A/µs, $di/dt_{off}$ = 2800 A/µs | $T_j$ = 150 °C | | 170 | | ns |
| $t_r$ | | $T_j$ = 150 °C | | 118 | | ns |
| $E_{on}$ | | $T_j$ = 150 °C | | 2.25 | | mJ |
| $t_{d(off)}$ | | $T_j$ = 150 °C | | 380 | | ns |
| $t_f$ | | $T_j$ = 150 °C | | 127 | | ns |
| $E_{off}$ | | $T_j$ = 150 °C | | 17.25 | | mJ |
| $R_{th(j-c)}$ | per IGBT | | | | 0.17 | K/W |
| $R_{th(c-s)}$ | per IGBT (λgrease=0.81 W/(m*K)) | | | 0.064 | | K/W |
| $R_{th(c-s)}$ | per IGBT, pre-applied phase change material | | | 0.059 | | K/W |

 © by SEMIKRON

**SEMiX® 5**

## 3-Level TNPC IGBT-Module

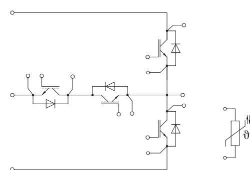
**SEMiX305TMLI12E4B**

### 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°C max.
- Product reliability results are valid for $T_{jop}$=150°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

| Characteristics | | | | | | |
|---|---|---|---|---|---|---|
| **Symbol** | **Conditions** | | **min.** | **typ.** | **max.** | **Unit** |
| **Diode1** | | | | | | |
| $V_F = V_{EC}$ | $I_F$ = 300 A<br>$V_{GE}$ = 0 V<br>chiplevel | $T_j$ = 25 °C | | 2.20 | 2.52 | V |
| | | $T_j$ = 150 °C | | 2.15 | 2.47 | V |
| $V_{F0}$ | chiplevel | $T_j$ = 25 °C | | 1.30 | 1.50 | V |
| | | $T_j$ = 150 °C | | 0.90 | 1.10 | V |
| $r_F$ | chiplevel | $T_j$ = 25 °C | | 3.0 | 3.4 | mΩ |
| | | $T_j$ = 150 °C | | 4.2 | 4.6 | mΩ |
| $I_{RRM}$ | $I_F$ = 300 A<br>di/dt$_{off}$ = 3100 A/µs<br>$V_{CC}$ = 300 V<br>$V_{GE}$ = +15/-15 V | $T_j$ = 150 °C | | 160 | | A |
| $Q_{rr}$ | | $T_j$ = 150 °C | | 41.7 | | µC |
| $E_{rr}$ | | $T_j$ = 150 °C | | 8.8 | | mJ |
| $R_{th(j-c)}$ | per diode | | | | 0.16 | K/W |
| $R_{th(c-s)}$ | per diode (λgrease=0.81 W/(m*K)) | | | 0.05 | | K/W |
| $R_{th(c-s)}$ | per diode, pre-applied phase change material | | | 0.041 | | K/W |
| **Diode2** | | | | | | |
| $V_F = V_{EC}$ | $I_F$ = 300 A<br>$V_{GE}$ = 0 V<br>chiplevel | $T_j$ = 25 °C | | 1.40 | 1.76 | V |
| | | $T_j$ = 150 °C | | 1.39 | 1.77 | V |
| $V_{F0}$ | chiplevel | $T_j$ = 25 °C | | 1.04 | 1.24 | V |
| | | $T_j$ = 150 °C | | 0.85 | 0.99 | V |
| $r_F$ | chiplevel | $T_j$ = 25 °C | | 1.19 | 1.76 | mΩ |
| | | $T_j$ = 150 °C | | 1.79 | 2.6 | mΩ |
| $I_{RRM}$ | $I_F$ = 300 A<br>di/dt$_{off}$ = 2437 A/µs<br>$V_R$ = 300 V<br>$V_{GE}$ = +15/-15 V | $T_j$ = 150 °C | | 181 | | A |
| $Q_{rr}$ | | $T_j$ = 150 °C | | 34.5 | | µC |
| $E_{rr}$ | | $T_j$ = 150 °C | | 8.2 | | mJ |
| $R_{th(j-c)}$ | per diode | | | | 0.22 | K/W |
| $R_{th(c-s)}$ | per diode (λgrease=0.81 W/(m*K)) | | | 0.06 | | K/W |
| $R_{th(c-s)}$ | per diode, pre-applied phase change material | | | 0.059 | | K/W |
| **Module** | | | | | | |
| $L_{sCE1}$ | | | | 31 | | nH |
| $L_{CE}$ | | | | 42 | | nH |
| $R_{CC'+EE'}$ | measured between terminal 5 and 1 | $T_C$ = 25 °C | | 0.8 | | mΩ |
| | | $T_C$ = 125 °C | | 1.1 | | mΩ |
| $Rth_{(c-s)1}$ | calculated without thermal coupling | | | 0.006 | | K/W |
| $Rth_{(c-s)2}$ | including thermal coupling, Ts underneath module ($λ_{grease}$=0.81 W/(m*K)) | | | 0.0106 | | K/W |
| $Rth_{(c-s)2}$ | including thermal coupling, Ts underneath module, pre-applied phase change material | | | 0.0077 | | 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°C ($R_{25}$=5 kΩ) | | | 493 ± 5% | | Ω |
| $B_{100/125}$ | $R_{(T)}=R_{100}exp[B_{100/125}(1/T-1/T_{100})]$; T[K]; | | | 3550 ±2% | | K |

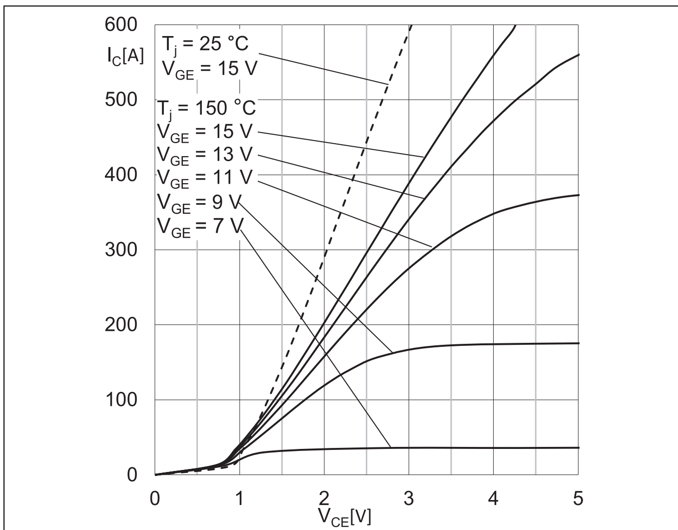



Fig. 1: Typ. IGBT1 output characteristic, incl. $R_{CC'+EE'}$

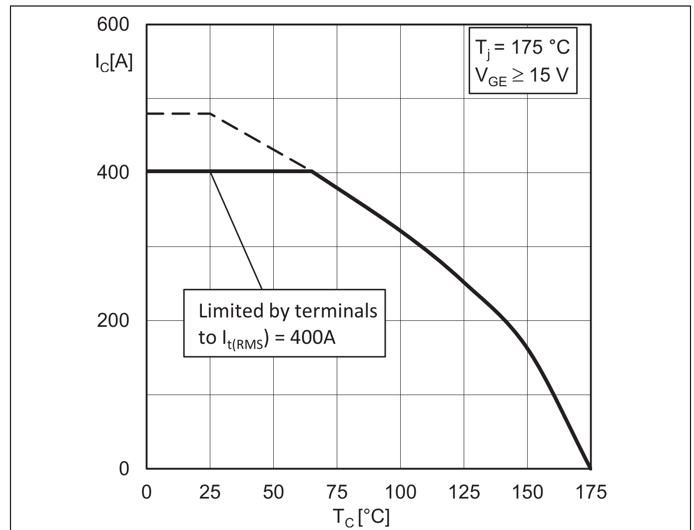



Fig. 2: IGBT1 rated current vs. Temperature $I_c$=f($T_c$)

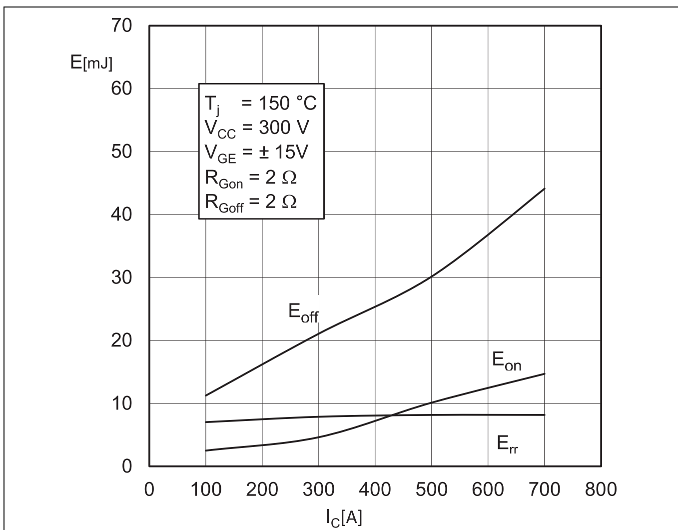



Fig. 3: Typ. IGBT1 & Diode2 turn-on /-off energy = f ($I_C$)

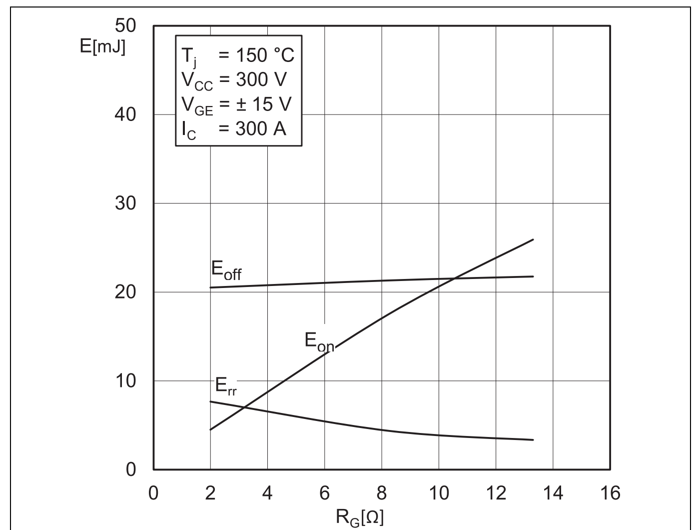



Fig. 4: Typ. IGBT1 & Diode2 turn-on /-off energy = f($R_G$)

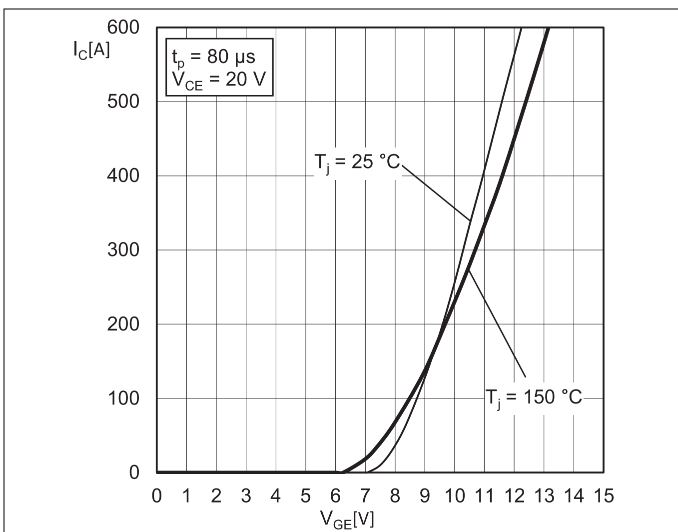



Fig. 5: Typ. IGBT1 transfer characteristic

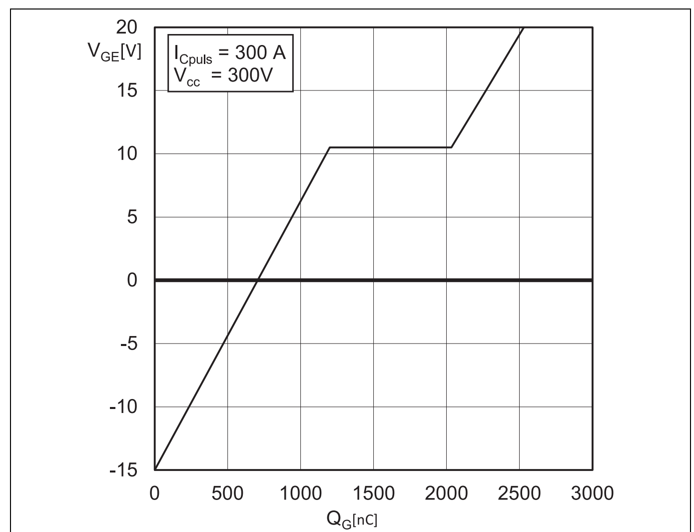



Fig. 6: Typ. IGBT1 gate charge characteristic

 © by SEMIKRON

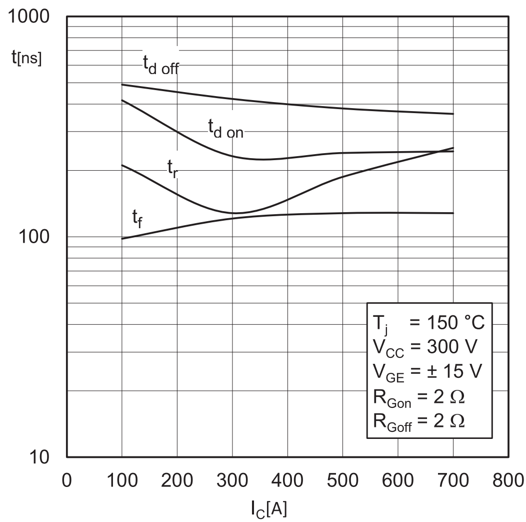



Fig. 7: Typ. IGBT1 switching times vs. $I_C$

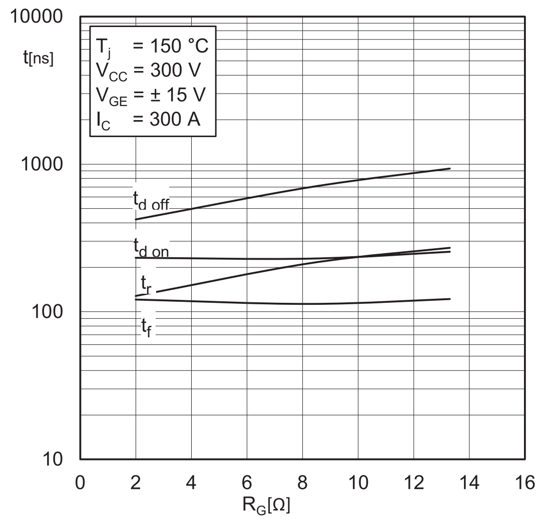



Fig. 8: Typ. IGBT1 switching times vs. gate resistor $R_G$

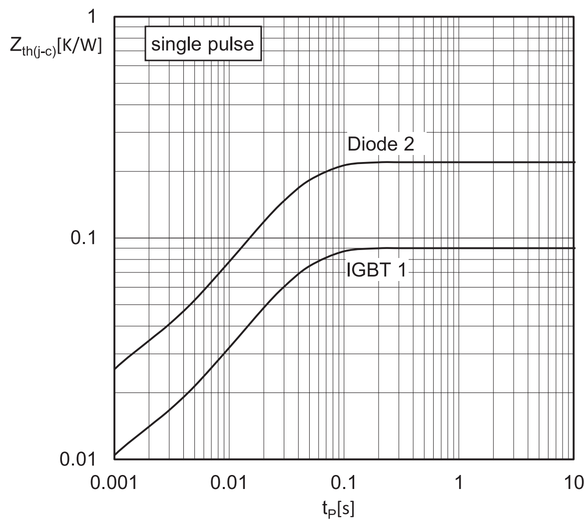



Fig. 9: Transient thermal impedance of IGBT1 & Diode2

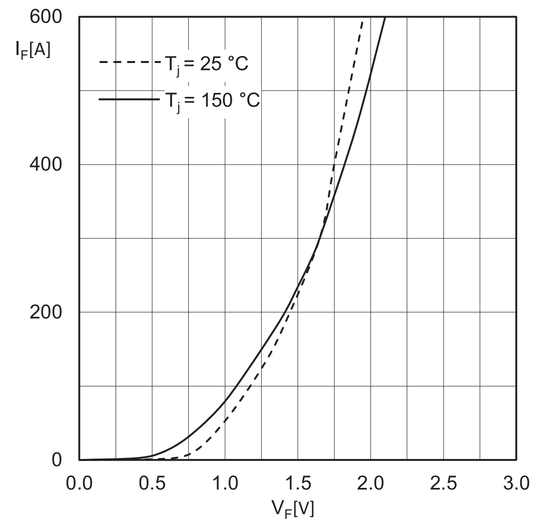



Fig. 10: Typ. Diode2 forward characteristic, incl. $R_{CC'+EE'}$

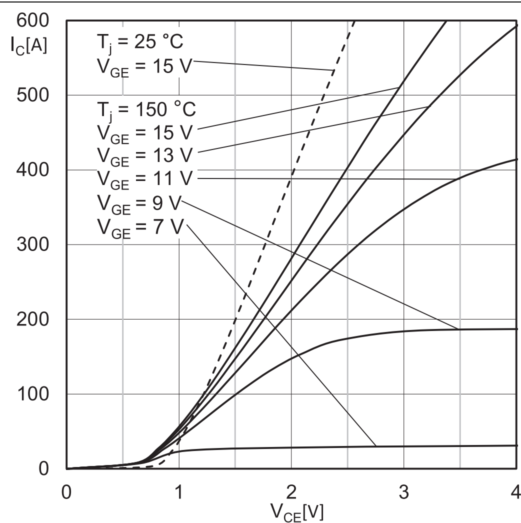



Fig. 13: Typ. IGBT2 output characteristic, incl. $R_{CC'+EE'}$

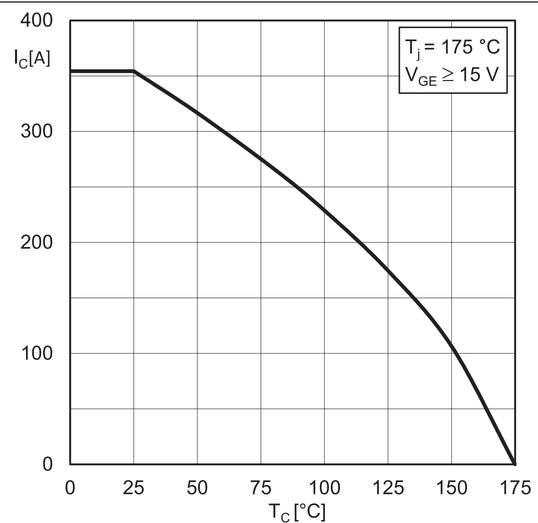



Fig. 14: IGBT2 Rated current vs. Temperature $I_c$= f ($T_c$)

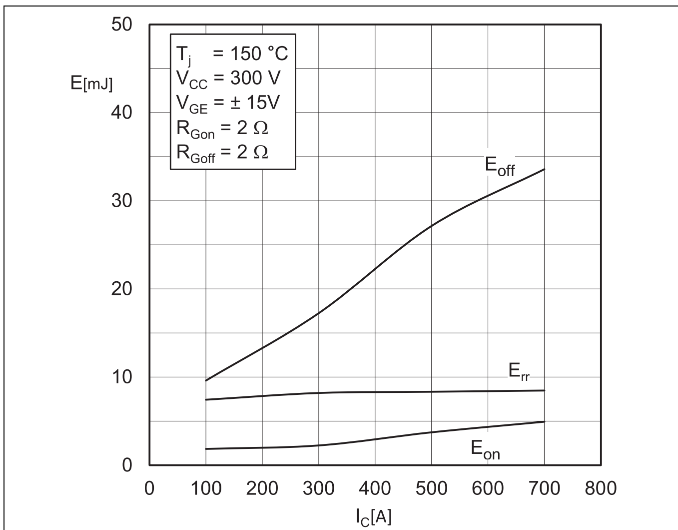



Fig. 15: Typ. IGBT2 & Diode1 turn-on /-off energy = f ($I_C$)

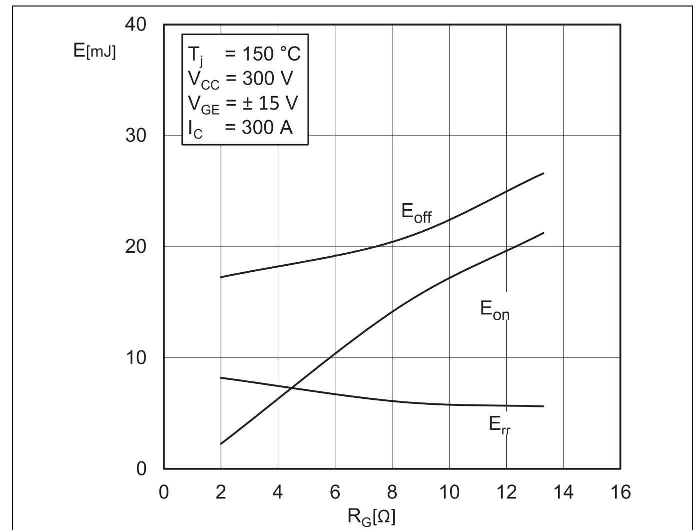



Fig. 16: Typ. IGBT2 & Diode1 turn-on / -off energy = f($R_G$)

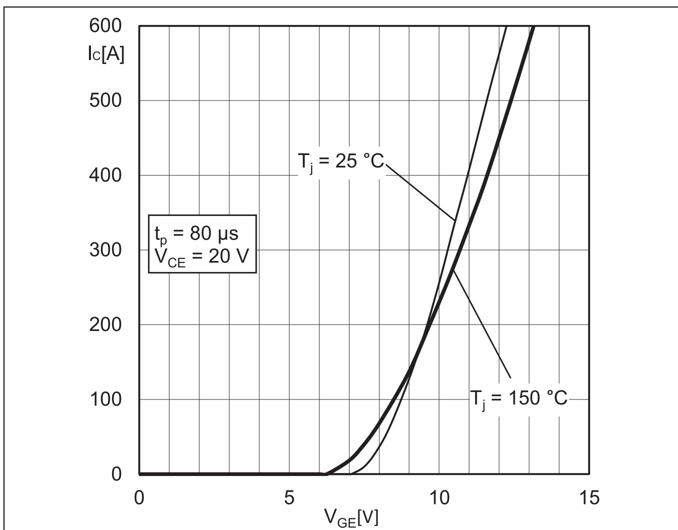



Fig. 17: Typ. IGBT2 transfer characteristic

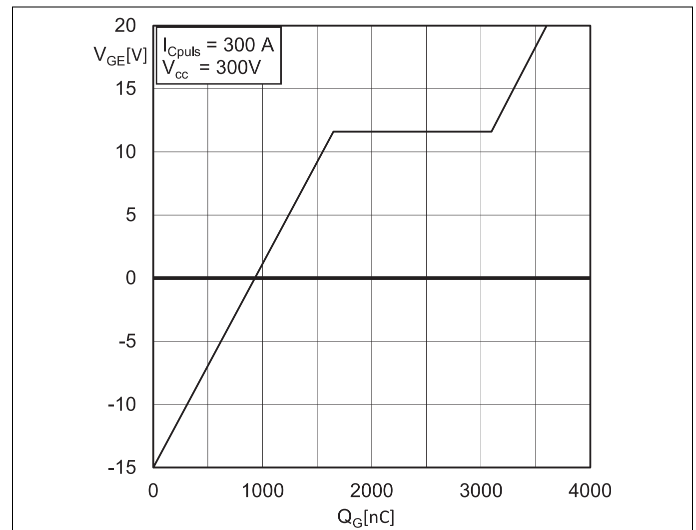



Fig. 18: Typ. IGBT2 gate charge characteristic

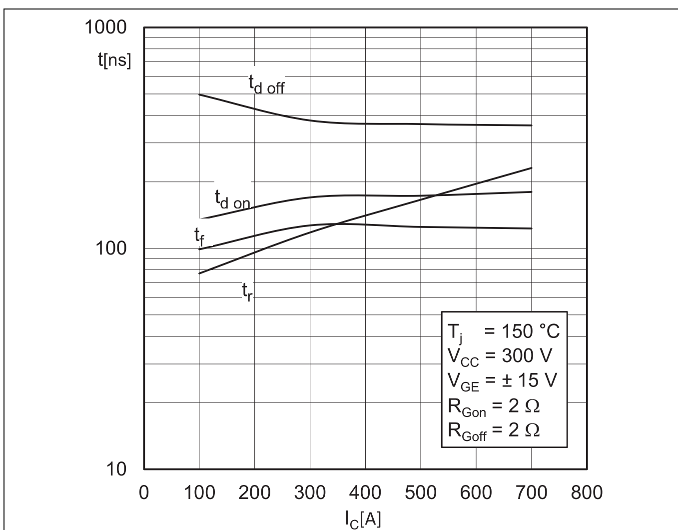



Fig. 19: Typ. IGBT2 switching times vs. $I_C$

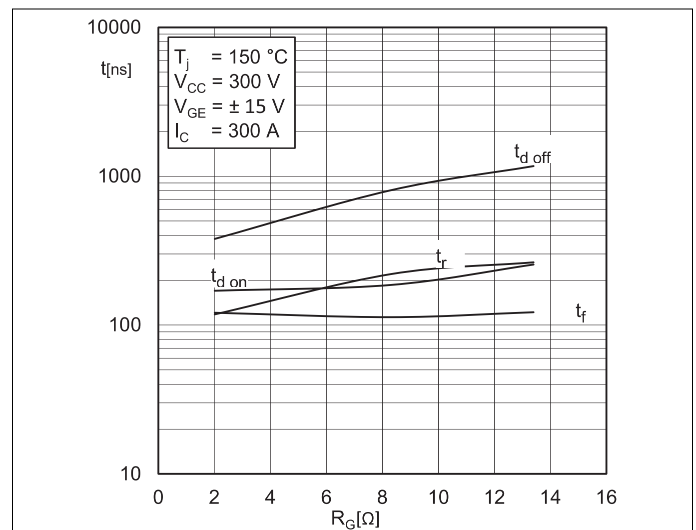



Fig. 20: Typ. IGBT2 switching times vs. gate resistor $R_G$

 © by SEMIKRON

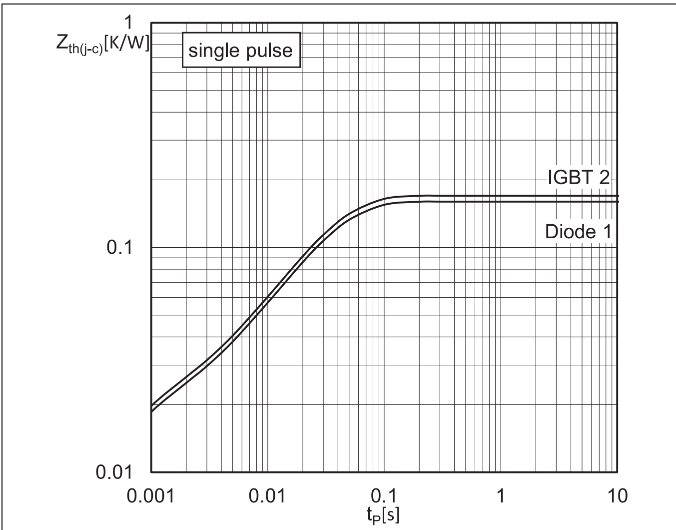



Fig. 21: Transient thermal impedance of IGBT2 & Diode1

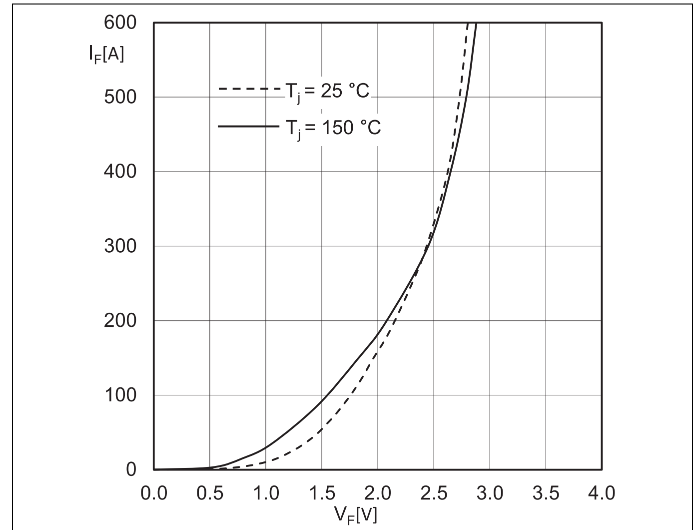
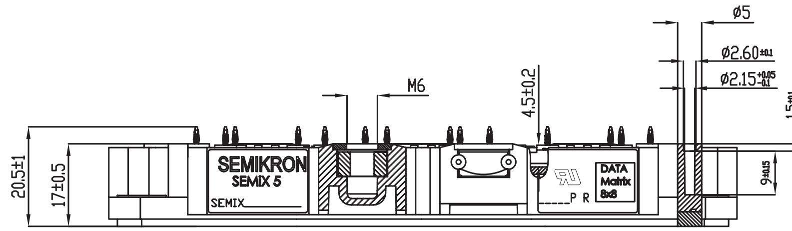
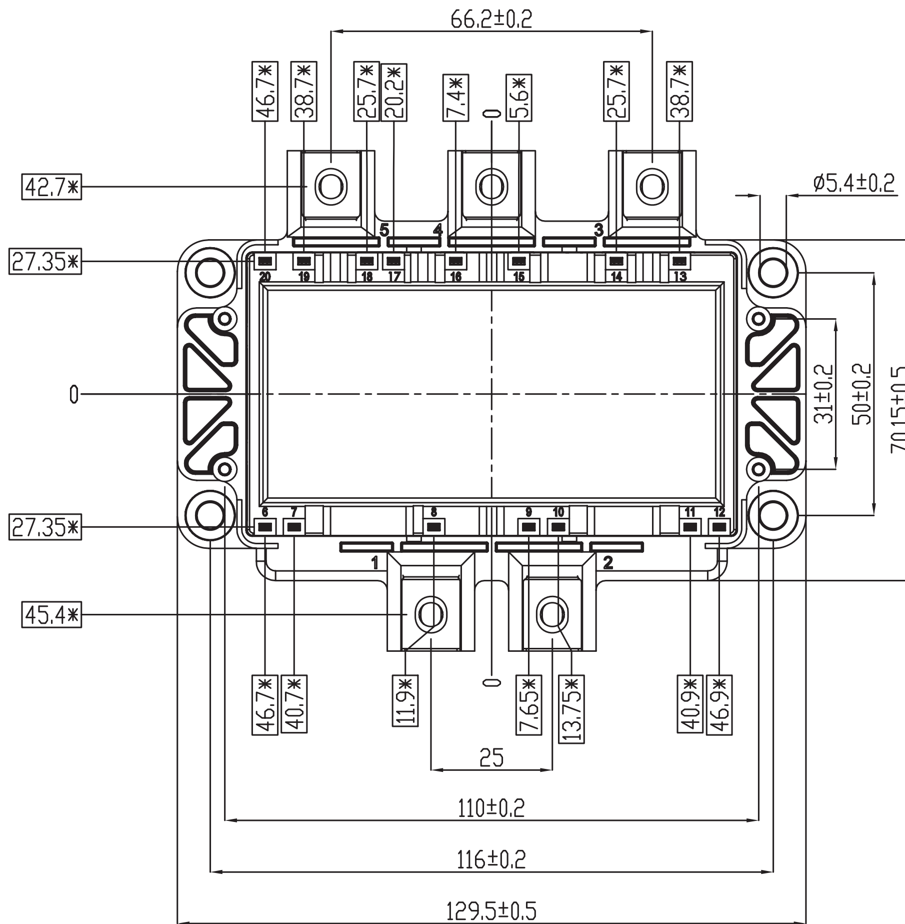



Fig. 22: Typ. Diode1 forward characteristic, incl. $R_{CC'+ EE'}$

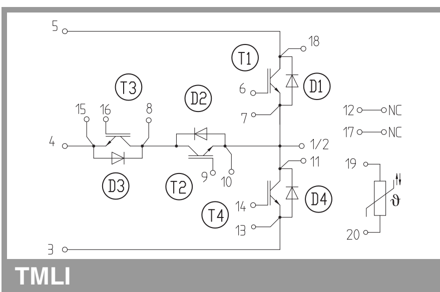



* = All dimension with tolerance of ⌖ Ø 0.4

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

SEMiX5p




TMLI

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

***IMPORTANT INFORMATION AND WARNINGS**

The specifications of SEMIKRON products may not be considered as guarantee or assurance of product characteristics ("Beschaffenheitsgarantie"). The specifications of SEMIKRON products describe only the usual characteristics of products to be expected in typical applications, which may still vary depending on the specific application. Therefore, products must be tested for the respective application in advance. Application adjustments may be necessary. The user of SEMIKRON products is responsible for the safety of their applications embedding SEMIKRON products and must take adequate safety measures to prevent the applications from causing a physical injury, fire or other problem if any of SEMIKRON products become faulty. The user is responsible to make sure that the application design is compliant with all applicable laws, regulations, norms and standards. Except as otherwise explicitly approved by SEMIKRON in a written document signed by authorized representatives of SEMIKRON, SEMIKRON products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury. No representation or warranty is given and no liability is assumed with respect to the accuracy, completeness and/or use of any information herein, including without limitation, warranties of non-infringement of intellectual property rights of any third party. SEMIKRON does not assume any liability arising out of the applications or use of any product; neither does it convey any license under its patent rights, copyrights, trade secrets or other intellectual property rights, nor the rights of others. SEMIKRON makes no representation or warranty of non-infringement or alleged non-infringement of intellectual property rights of any third party which may arise from applications. Due to technical requirements our products may contain dangerous substances. For information on the types in question please contact the nearest SEMIKRON sales office. This document supersedes and replaces all information previously supplied and may be superseded by updates. SEMIKRON reserves the right to make changes.