**SEMiX® 5**

## 3-Level TNPC IGBT-Module

**SEMiX305TMLI12E4B**

### Features

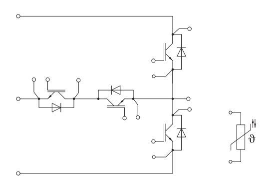
- Solderless assembling solution with PressFIT signal pins and screw power terminals
- IGBT 4 Trench Gate Technology
- $V_{CE(sat)}$ with positive temperature coefficient
- Low inductance case
- Reliable mechanical design with injection moulded terminals and reliable internal connections
- UL recognized 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**

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**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
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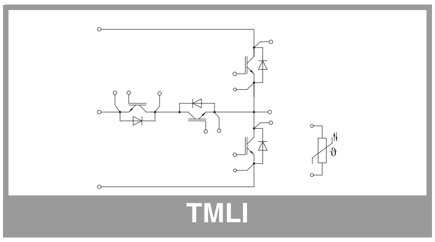
- For storage and case temperature with TIM see document “TP(HALA P8) SEMiX 5p”



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**Characteristics**

| Symbol | Conditions | | min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|
| **IGBT1** | | | | | | |
| $V_{CE(sat)}$ | $I_C$ = 300 A<br>$V_{GE}$ = 15 V<br>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<br>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<br>$V_{GE}$ = 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<br>$I_C$ = 300 A<br>$V_{GE}$ = +15/-15 V<br>$R_{G\ on}$ = 2 Ω<br>$R_{G\ off}$ = 2 Ω<br>di/dt$_{on}$ = 2437 A/µs<br>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<br>$V_{GE}$ = 15 V<br>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<br>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<br>$V_{GE}$ = 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<br>$I_C$ = 300 A<br>$V_{GE}$ = +15/-15 V<br>$R_{G\ on}$ = 2 Ω<br>$R_{G\ off}$ = 2 Ω<br>di/dt$_{on}$ = 3100 A/µs<br>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 |

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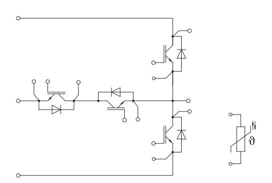
- IGBT 4 Trench Gate Technology
- $V_{CE(sat)}$ with positive temperature coefficient
- Low inductance case
- Reliable mechanical design with injection moulded terminals and reliable internal connections
- UL recognized file no. E63532
- NTC temperature sensor inside

### 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<br>±2% | | K |

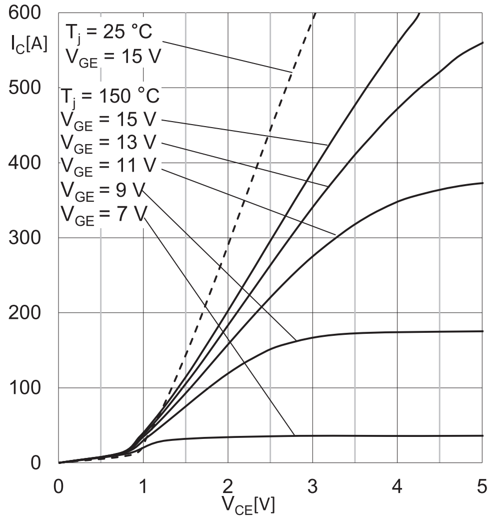


Fig. 1: Typ. IGBT1 output characteristic, incl. $R_{CC'+EE'}$

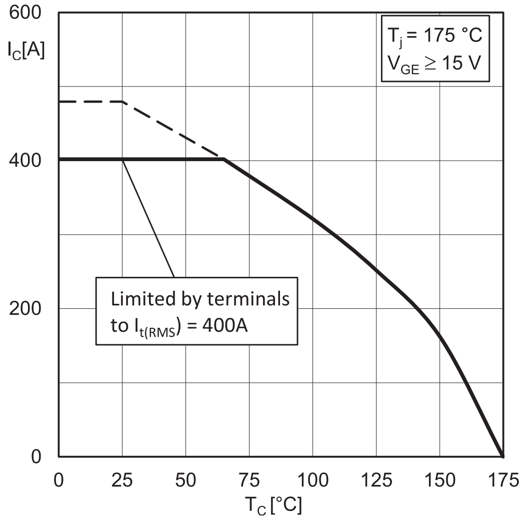


Fig. 2: IGBT1 rated current vs. Temperature $I_c$=f($T_c$)

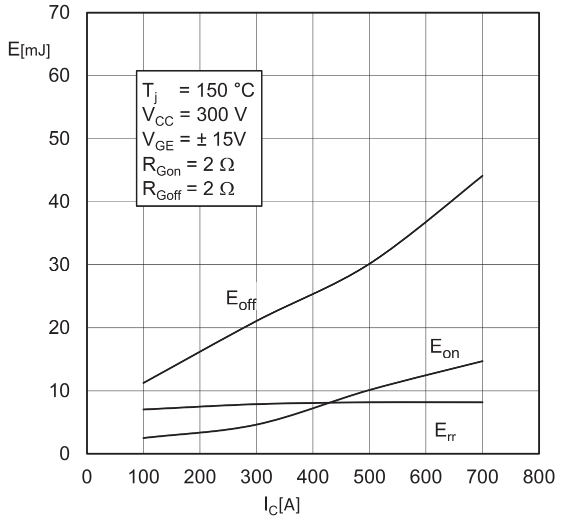


Fig. 3: Typ. IGBT1 & Diode2 turn-on /-off energy = f ($I_C$)

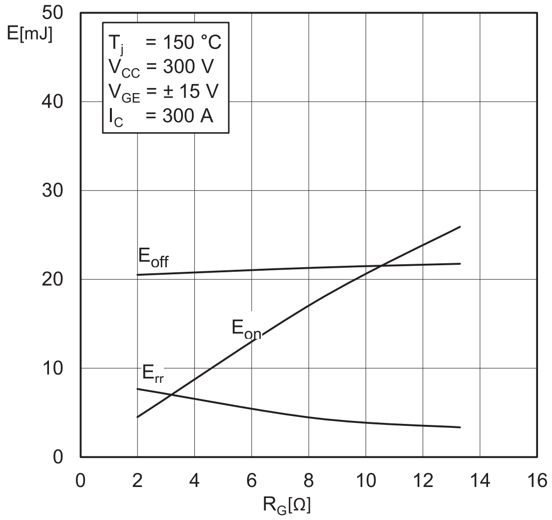


Fig. 4: Typ. IGBT1 & Diode2 turn-on /-off energy = f($R_G$)

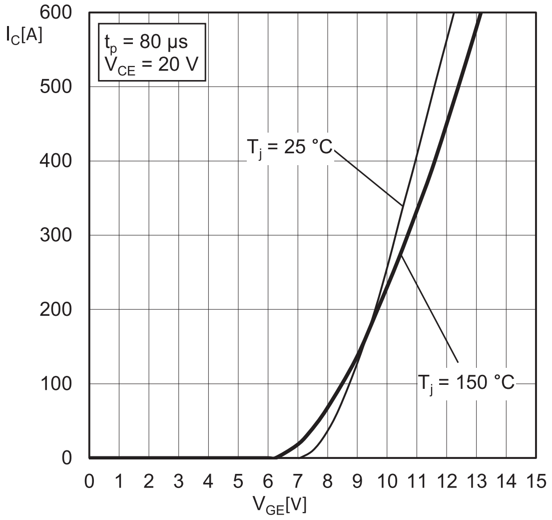


Fig. 5: Typ. IGBT1 transfer characteristic

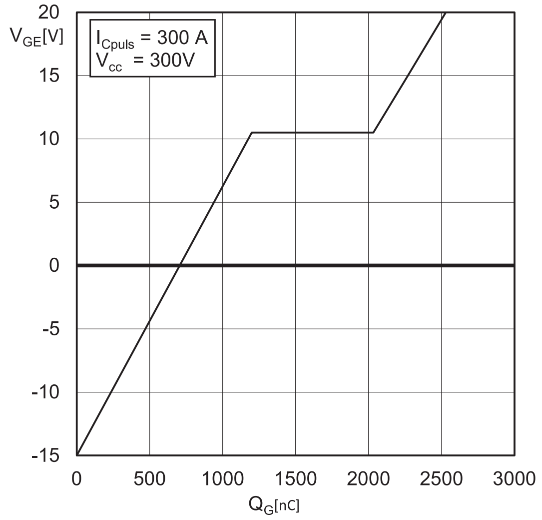


Fig. 6: Typ. IGBT1 gate charge characteristic

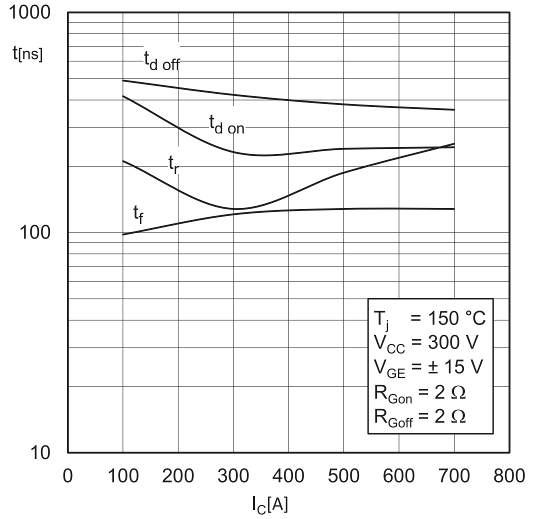


Fig. 7: Typ. IGBT1 switching times vs. $I_C$

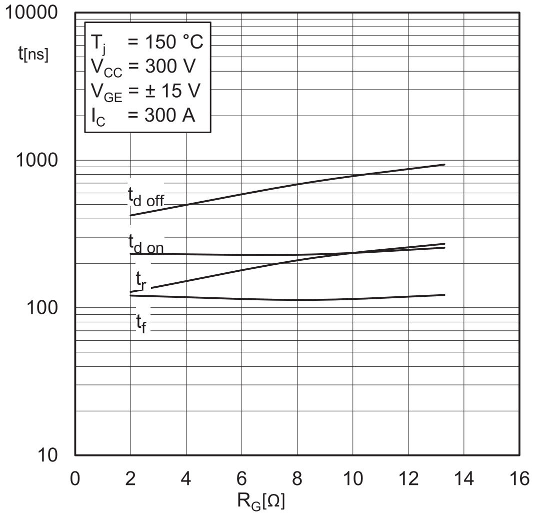


Fig. 8: Typ. IGBT1 switching times vs. gate resistor $R_G$

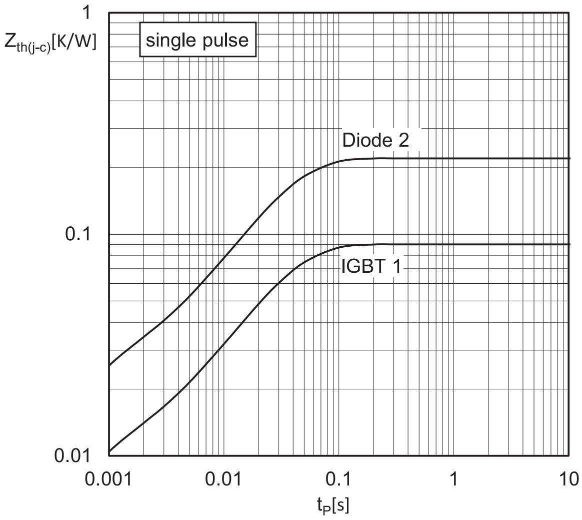


Fig. 9: Transient thermal impedance of IGBT1 & Diode2

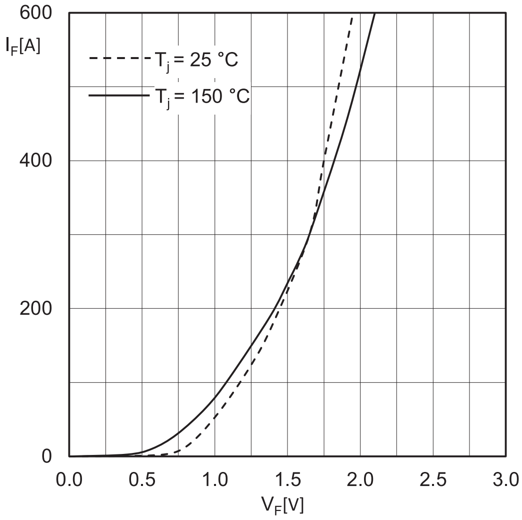


Fig. 10: Typ. Diode2 forward characteristic, incl. $R_{CC'+EE'}$

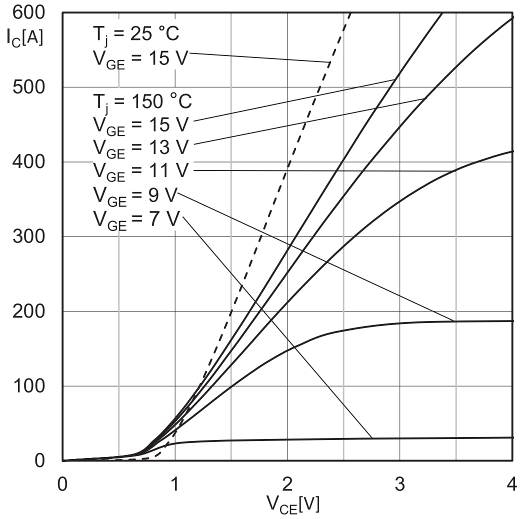


Fig. 13: Typ. IGBT2 output characteristic, incl. $R_{CC'+EE'}$

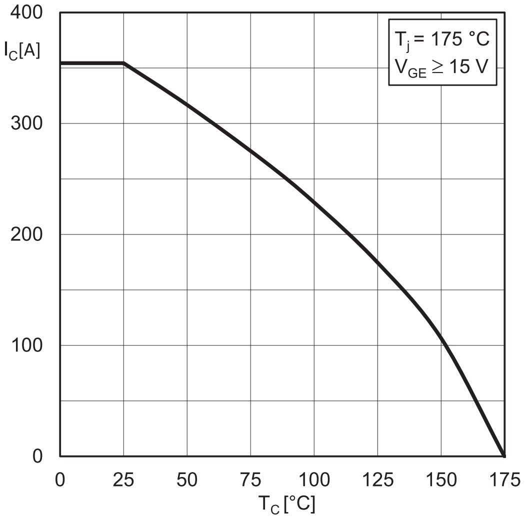


Fig. 14: IGBT2 Rated current vs. Temperature $I_c = f(T_c)$

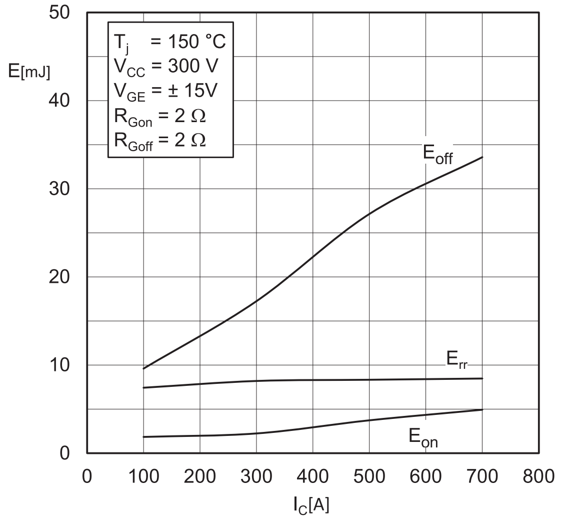


Fig. 15: Typ. IGBT2 & Diode1 turn-on /-off energy = f ($I_C$)

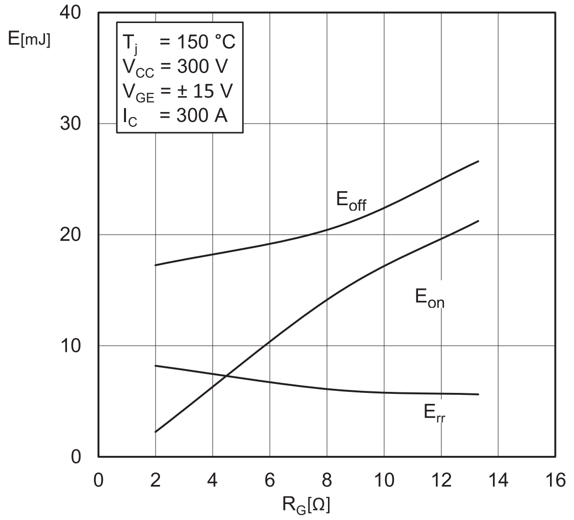


Fig. 16: Typ. IGBT2 & Diode1 turn-on / -off energy = f($R_G$)

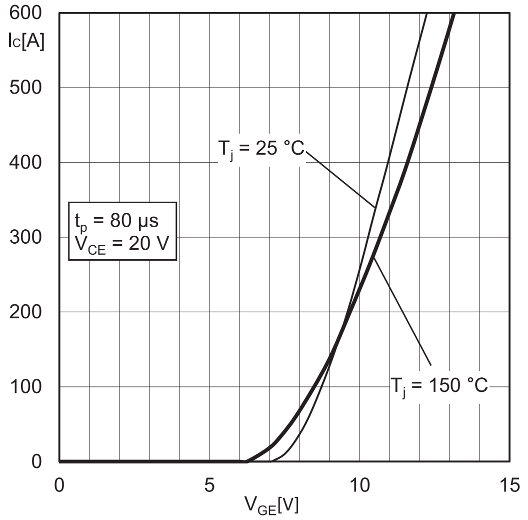


Fig. 17: Typ. IGBT2 transfer characteristic

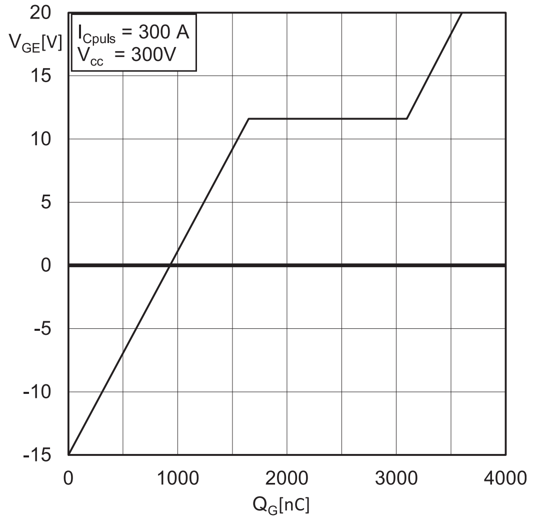


Fig. 18: Typ. IGBT2 gate charge characteristic

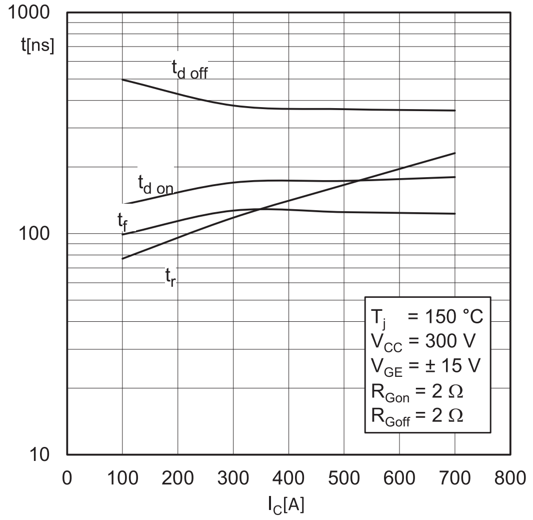


Fig. 19: Typ. IGBT2 switching times vs. $I_C$

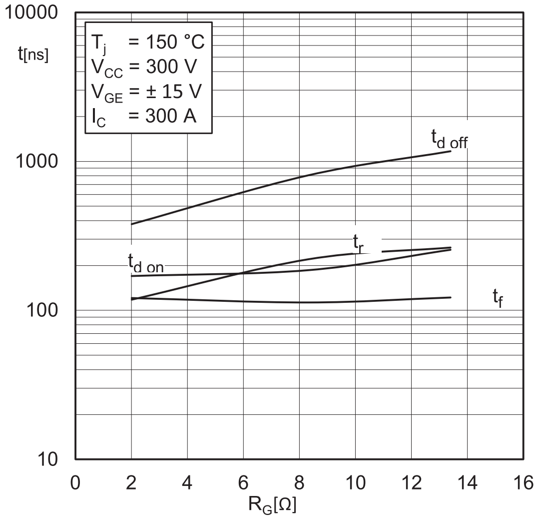


Fig. 20: Typ. IGBT2 switching times vs. gate resistor $R_G$

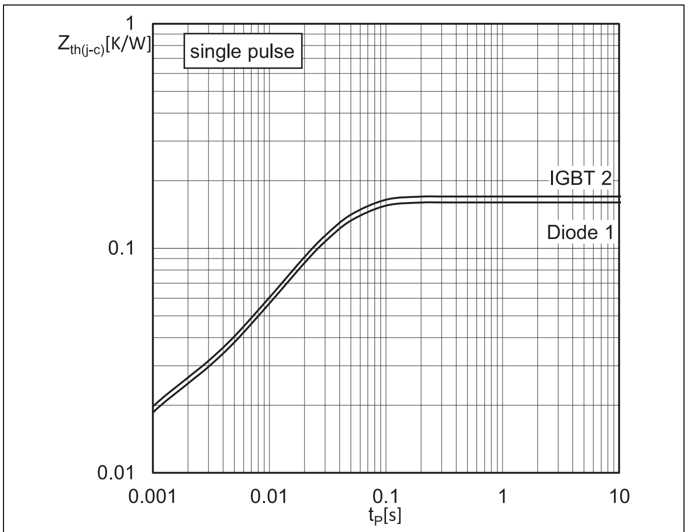


Fig. 21: Transient thermal impedance of IGBT2 & Diode1

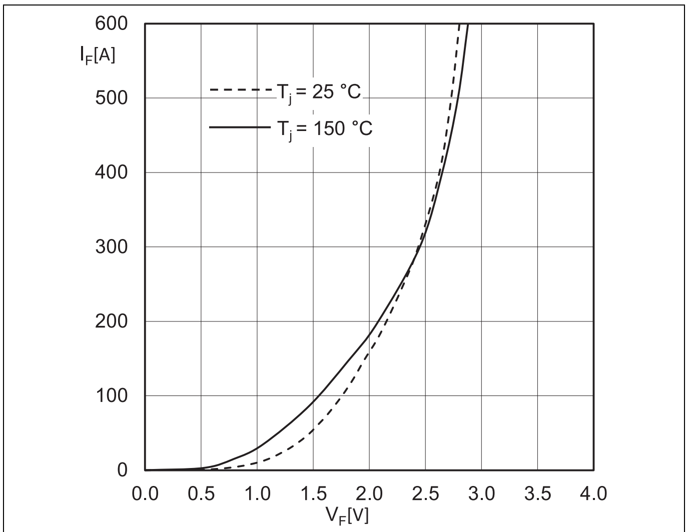
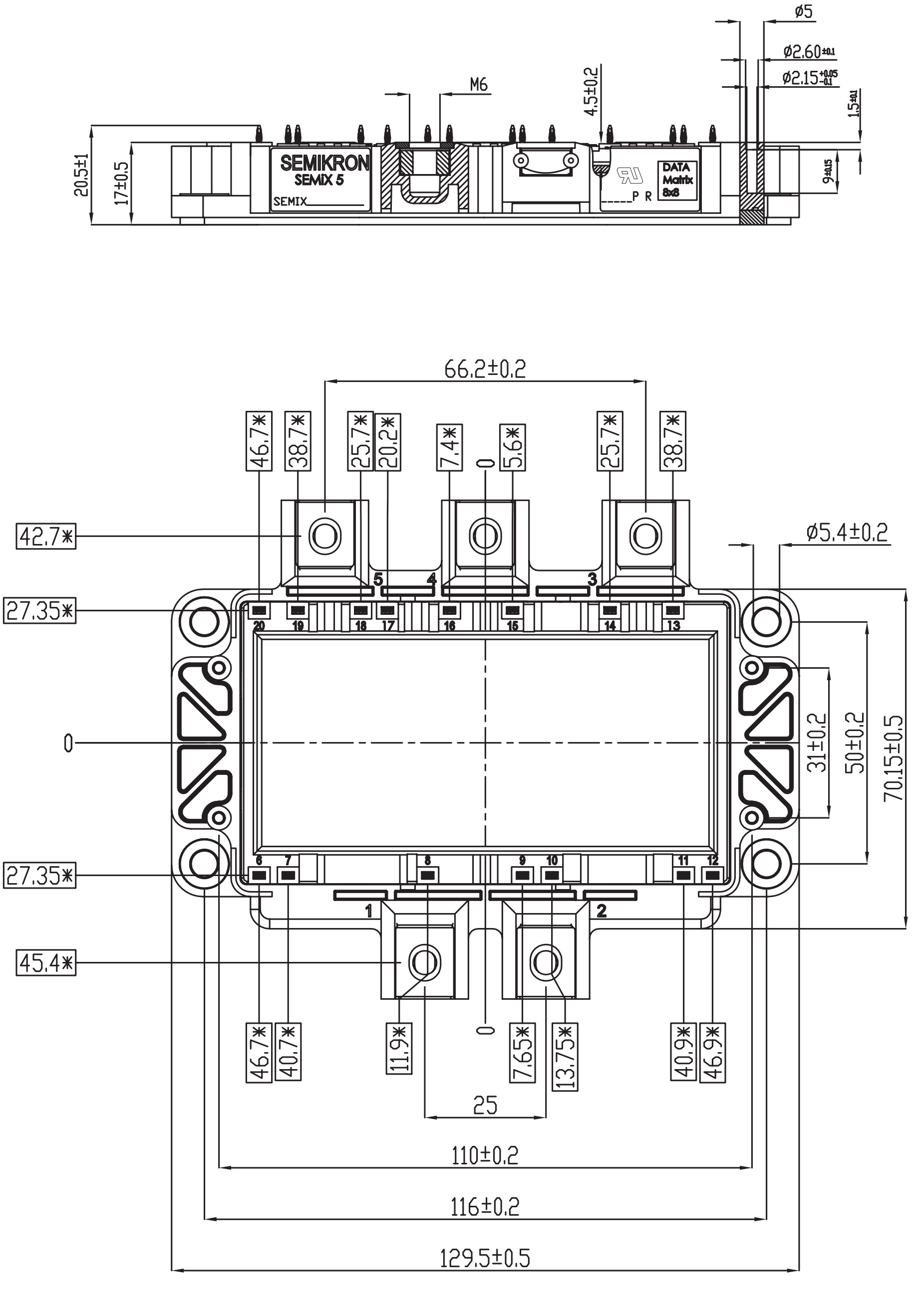


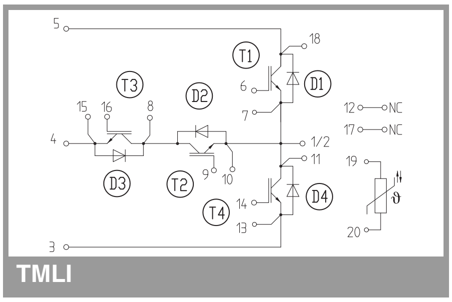
Fig. 22: Typ. Diode1 forward characteristic, incl. $R_{CC'+EE'}$



* = 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**

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