SEMiX® 5

# 3-Level NPC IGBT-Module

**Engineering Sample**

**SEMiX205MLI12E4**

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. E63532
- NTC temperature sensor inside

## Remarks*

- Case temperature limited to $T_C$=125°C max.
- Product reliability results valid for $T_j$ ≤150°C (recommended $T_{j,op}$= -40…+150°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

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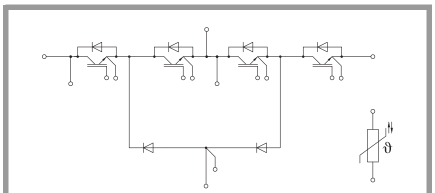

MLI

| 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 | 313 | A |
| | | $T_c$ = 80 °C | 241 | A |
| $I_{Cnom}$ | | | 200 | A |
| $I_{CRM}$ | $I_{CRM}$ = 3 x $I_{Cnom}$ | | 600 | 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 | | 1200 | V |
| $I_C$ | $T_j$ = 175 °C | $T_c$ = 25 °C | 290 | A |
| | | $T_c$ = 80 °C | 223 | A |
| $I_{Cnom}$ | | | 200 | A |
| $I_{CRM}$ | $I_{CRM}$ = 3 x $I_{Cnom}$ | | 600 | 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 |
| **Diode1** | | | | |
| $V_{RRM}$ | $T_j$ = 25 °C | | 1200 | V |
| $I_F$ | $T_j$ = 175 °C | $T_c$ = 25 °C | 229 | A |
| | | $T_c$ = 80 °C | 172 | A |
| $I_{Fnom}$ | | | 200 | A |
| $I_{FRM}$ | $I_{FRM}$ = 2 x $I_{Fnom}$ | | 400 | A |
| $I_{FSM}$ | 10 ms, sin 180°, $T_j$ = 25 °C | | 990 | A |
| $T_j$ | | | -40 ... 175 | °C |
| **Diode2** | | | | |
| $V_{RRM}$ | $T_j$ = 25 °C | | 1200 | V |
| $I_F$ | $T_j$ = 175 °C | $T_c$ = 25 °C | 214 | A |
| | | $T_c$ = 80 °C | 160 | A |
| $I_{Fnom}$ | | | 200 | A |
| $I_{FRM}$ | $I_{FRM}$ = 2 x $I_{Fnom}$ | | 400 | A |
| $I_{FSM}$ | 10 ms, sin 180°, $T_j$ = 25 °C | | 990 | A |
| $T_j$ | | | -40 ... 175 | °C |
| **Diode5** | | | | |
| $V_{RRM}$ | $T_j$ = 25 °C | | 1200 | V |
| $I_F$ | $T_j$ = 175 °C | $T_c$ = 25 °C | 219 | A |
| | | $T_c$ = 80 °C | 163 | A |
| $I_{Fnom}$ | | | 200 | A |
| $I_{FRM}$ | $I_{FRM}$ = 2 x $I_{Fnom}$ | | 400 | A |
| $I_{FSM}$ | 10 ms, sin 180°, $T_j$ = 25 °C | | 990 | A |
| $T_j$ | | | -40 ... 175 | °C |
| **Module** | | | | |
| $I_{t(RMS)}$ | | | 300 | A |
| $T_{stg}$ | module without TIM | | -40 ... 125 | °C |
| $V_{isol}$ | AC sinus 50Hz, t = 1 min | | 4000 | V |

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**Engineering Sample**

**SEMiX205MLI12E4**

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- 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”

### Footnotes

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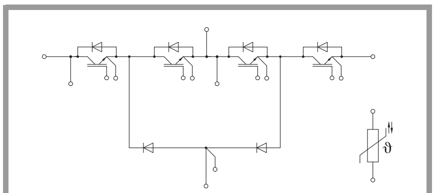

MLI

| Characteristics | | | | | | |
|---|---|---|---|---|---|---|
| **Symbol** | **Conditions** | | **min.** | **typ.** | **max.** | **Unit** |
| **IGBT1** | | | | | | |
| $V_{CE(sat)}$ | $I_C$ = 200 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 | | 5.0 | 5.8 | mΩ |
| | | $T_j$ = 150 °C | | 7.5 | 8.0 | mΩ |
| $V_{GE(th)}$ | $V_{GE}$ = $V_{CE}$, $I_C$ = 7.6 mA | | 5 | 5.8 | 6.5 | V |
| $I_{CES}$ | $V_{GE}$ = 0 V, $V_{CE}$ = 1200 V, $T_j$ = 25 °C | | | | 2.7 | mA |
| $C_{ies}$ | $V_{CE}$ = 25 V<br>$V_{GE}$ = 0 V | f = 1 MHz | | 12.3 | | nF |
| $C_{oes}$ | | f = 1 MHz | | 0.81 | | nF |
| $C_{res}$ | | f = 1 MHz | | 0.69 | | nF |
| $Q_G$ | $V_{GE}$ = - 8 V...+ 15 V | | | 1130 | | nC |
| $R_{Gint}$ | $T_j$ = 25 °C | | | 3.8 | | Ω |
| $t_{d(on)}$ | $V_{CC}$ = 600 V<br>$I_C$ = 200 A<br>$V_{GE}$ = +15/-8 V<br>$R_{G\ on}$ = 0.5 Ω<br>$R_{G\ off}$ = 1 Ω<br>$di/dt_{on}$ = 3610 A/µs<br>$di/dt_{off}$ = 1530 A/µs<br>du/dt = 3530 V/µs | $T_j$ = 150 °C | | 78 | | ns |
| $t_r$ | | $T_j$ = 150 °C | | 54 | | ns |
| $E_{on}$ | | $T_j$ = 150 °C | | 12.8 | | mJ |
| $t_{d(off)}$ | | $T_j$ = 150 °C | | 490 | | ns |
| $t_f$ | | $T_j$ = 150 °C | | 114 | | ns |
| $E_{off}$ | | $T_j$ = 150 °C | | 24.6 | | mJ |
| $R_{th(j-c)}$ | per IGBT | | | | 0.14 | K/W |
| $R_{th(c-s)}$ | per IGBT (λgrease=0.81 W/(m*K)) | | | 0.046 | | K/W |
| $R_{th(c-s)}$ | per IGBT, pre-applied phase change material | | | 0.036 | | K/W |
| **IGBT2** | | | | | | |
| $V_{CE(sat)}$ | $I_C$ = 200 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 | | 5.0 | 5.8 | mΩ |
| | | $T_j$ = 150 °C | | 7.5 | 8.0 | mΩ |
| $V_{GE(th)}$ | $V_{GE}$ = $V_{CE}$, $I_C$ = 7.6 mA | | 5 | 5.8 | 6.5 | V |
| $I_{CES}$ | $V_{GE}$ = 0 V, $V_{CE}$ = 1200 V, $T_j$ = 25 °C | | | | 2.7 | mA |
| $C_{ies}$ | $V_{CE}$ = 25 V<br>$V_{GE}$ = 0 V | f = 1 MHz | | 12.3 | | nF |
| $C_{oes}$ | | f = 1 MHz | | 0.81 | | nF |
| $C_{res}$ | | f = 1 MHz | | 0.69 | | nF |
| $Q_G$ | $V_{GE}$ = - 8 V...+ 15 V | | | 1130 | | nC |
| $R_{Gint}$ | $T_j$ = 25 °C | | | 3.8 | | Ω |
| $t_{d(on)}$ | $V_{CC}$ = 600 V<br>$I_C$ = 200 A<br>$V_{GE}$ = +15/-8 V<br>$R_{G\ on}$ = 0.5 Ω<br>$R_{G\ off}$ = 1 Ω<br>$di/dt_{on}$ = 3450 A/µs<br>$di/dt_{off}$ = 1430 A/µs<br>du/dt = 3560 V/µs | $T_j$ = 150 °C | | 85 | | ns |
| $t_r$ | | $T_j$ = 150 °C | | 57 | | ns |
| $E_{on}$ | | $T_j$ = 150 °C | | 8.4 | | mJ |
| $t_{d(off)}$ | | $T_j$ = 150 °C | | 504 | | ns |
| $t_f$ | | $T_j$ = 150 °C | | 120 | | ns |
| $E_{off}$ | | $T_j$ = 150 °C | | 25.4 | | mJ |
| $R_{th(j-c)}$ | per IGBT | | | | 0.16 | K/W |
| $R_{th(c-s)}$ | per IGBT (λgrease=0.81 W/(m*K)) | | | 0.052 | | K/W |
| $R_{th(c-s)}$ | per IGBT, pre-applied phase change material | | | 0.041 | | K/W |

 

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**Engineering Sample**

**SEMiX205MLI12E4**

Target Data

### Features

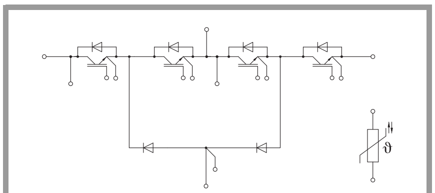
- Solderless assembling solution with PressFIT signal pins and screw power terminals
- IGBT 4 Trench Gate Technology
- $V_{CE(sat)}$ with positive temperature coefficient
- Low inductance case
- Reliable mechanical design with injection moulded terminals and reliable internal connections
- UL recognized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

### Remarks*

- Case temperature limited to $T_C$=125°C max.
- Product reliability results valid for $T_j$ ≤150°C (recommended $T_{j,op}$= -40…+150°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

1) Please find further technical information on the SEMIKRON website.



MLI

| Characteristics | | | | | | |
|---|---|---|---|---|---|---|
| **Symbol** | **Conditions** | | **min.** | **typ.** | **max.** | **Unit** |
| **Diode1** | | | | | | |
| $V_F = V_{EC}$ | $I_F$ = 200 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 | | 4.5 | 5.1 | mΩ |
| | | $T_j$ = 150 °C | | 6.3 | 6.9 | mΩ |
| $I_{RRM}$ | $I_F$ = 200 A<br>$di/dt_{off}$ = 3450 A/µs<br>$V_{CC}$ = 600 V<br>$V_{GE}$ = +15/-8 V | $T_j$ = 150 °C | | 158 | | A |
| $Q_{rr}$ | | $T_j$ = 150 °C | | 23.9 | | µC |
| $E_{rr}$ | | $T_j$ = 150 °C | | 5.8 | | mJ |
| $R_{th(j-c)}$ | per diode | | | | 0.26 | 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 | | | 0.051 | | K/W |
| **Diode2** | | | | | | |
| $V_F = V_{EC}$ | $I_F$ = 200 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 | | 4.5 | 5.1 | mΩ |
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| $I_{RRM}$ | $I_F$ = 200 A<br>$V_R$ = 600 V<br>$V_{GE}$ = +15/-8 V | $T_j$ = 150 °C | | 158 | | A |
| $Q_{rr}$ | | $T_j$ = 150 °C | | 23.9 | | µC |
| $E_{rr}$ 1) | | $T_j$ = 150 °C | | - | | mJ |
| $R_{th(j-c)}$ | per diode | | | | 0.29 | K/W |
| $R_{th(c-s)}$ | per diode (λgrease=0.81 W/(m*K)) | | | 0.067 | | K/W |
| $R_{th(c-s)}$ | per diode, pre-applied phase change material | | | 0.056 | | K/W |
| **Diode5** | | | | | | |
| $V_F = V_{EC}$ | $I_F$ = 200 A<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 | | 4.5 | 5.1 | mΩ |
| | | $T_j$ = 150 °C | | 6.3 | 6.9 | mΩ |
| $I_{RRM}$ | $I_F$ = 200 A<br>$di/dt_{off}$ = 3610 A/µs<br>$V_R$ = 600 V<br>$V_{GE}$ = +15/-8 V | $T_j$ = 150 °C | | 185 | | A |
| $Q_{rr}$ | | $T_j$ = 150 °C | | 28.7 | | µC |
| $E_{rr}$ | | $T_j$ = 150 °C | | 16 | | mJ |
| $R_{th(j-c)}$ | per diode | | | | 0.28 | K/W |
| $R_{th(c-s)}$ | per diode (λgrease=0.81 W/(m*K)) | | | 0.086 | | K/W |
| $R_{th(c-s)}$ | per diode, pre-applied phase change material | | | 0.069 | | K/W |

 


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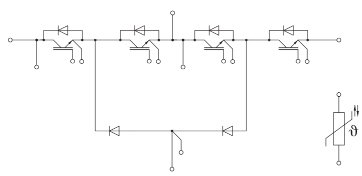


MLI

| Characteristics | | | | | | |
|---|---|---|---|---|---|---|
| **Symbol** | **Conditions** | | **min.** | **typ.** | **max.** | **Unit** |
| **Module** | | | | | | |
| $L_{sCE1}$ | | | | 27 | | nH |
| $L_{sCE2}$ | | | | 34 | | nH |
| $R_{CC'+EE'}$ | measured between terminal 5 and 1 | $T_C$ = 25 °C | | 0.8 | | mΩ |
| | | $T_C$ = 125 °C | | 1.1 | | mΩ |
| $R_{th(c-s)1}$ | calculated without thermal coupling | | | 0.006 | | K/W |
| $R_{th(c-s)2}$ | including thermal coupling, Ts underneath module ($\lambda_{grease}$=0.81 W/(m*K)) | | | 0.010 | | K/W |
| $R_{th(c-s)2}$ | including thermal coupling, Ts underneath module, pre-applied phase change material | | | 0.008 | | 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 |

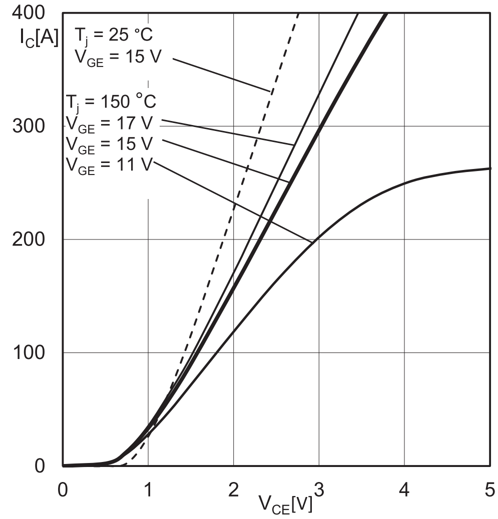



Fig. 1: Typ. IGBT1 output characteristic, incl. $R_{CC'+EE'}$

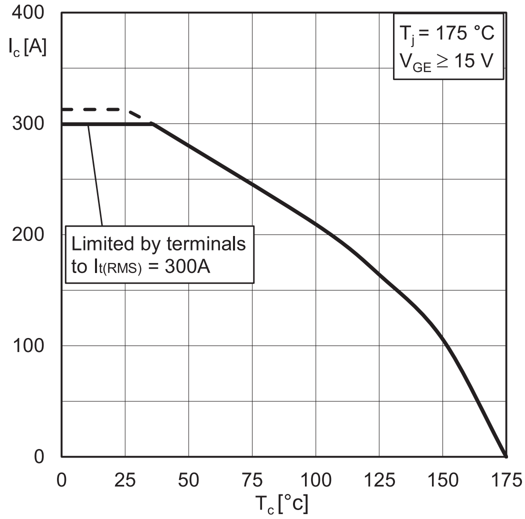



Fig. 2: IGBT1 rated current vs. Temperature $I_c=f(T_c)$

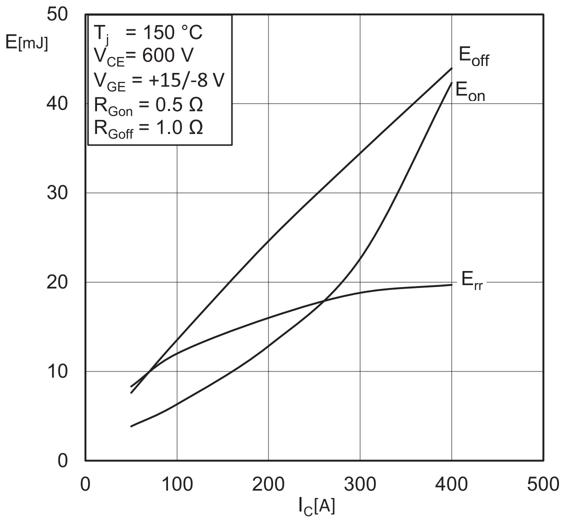



Fig. 3: Typ. IGBT1 & Diode5 turn-on /-off energy = f ($I_C$)

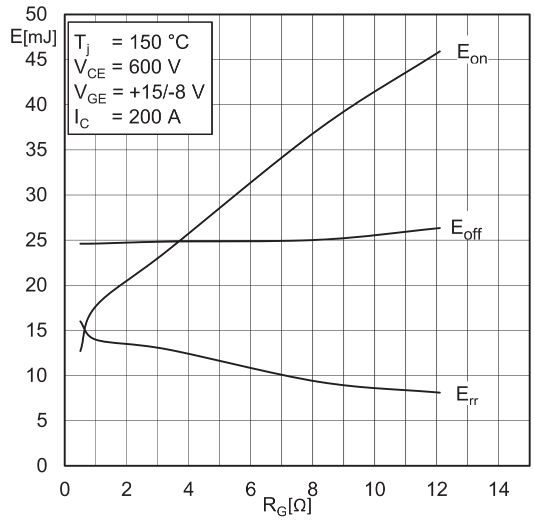



Fig. 4: Typ. IGBT1 & Diode5 turn-on /-off energy = f($R_G$)

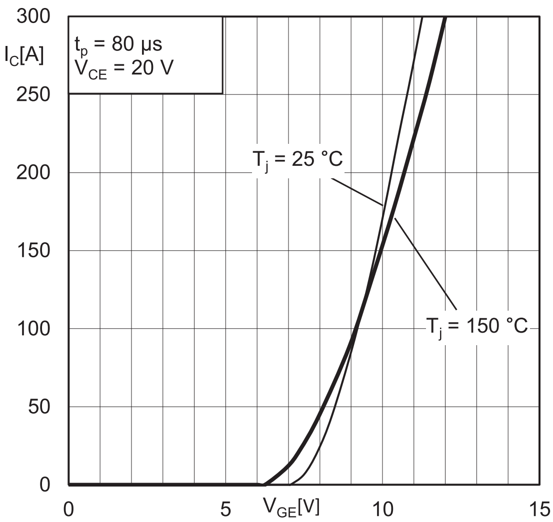



Fig. 5: Typ. IGBT1 transfer characteristic

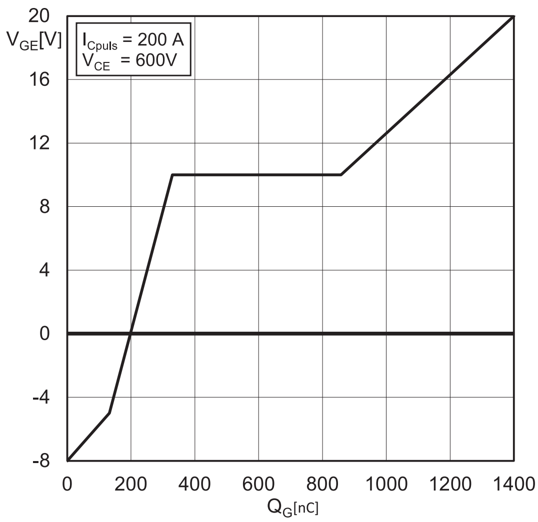



Fig. 6: Typ. IGBT1 gate charge characteristic

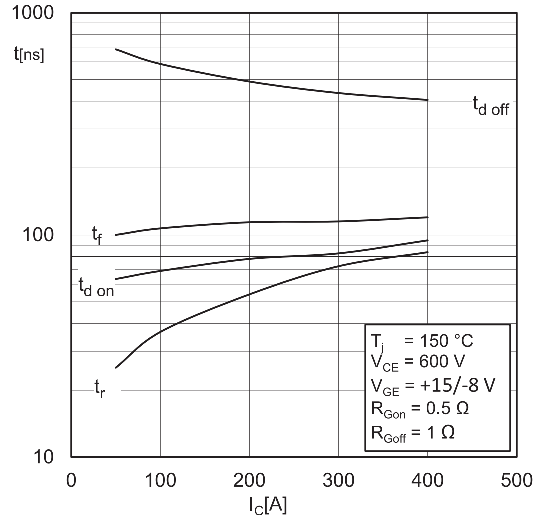



Fig. 7: Typ. IGBT1 switching times vs. $I_C$

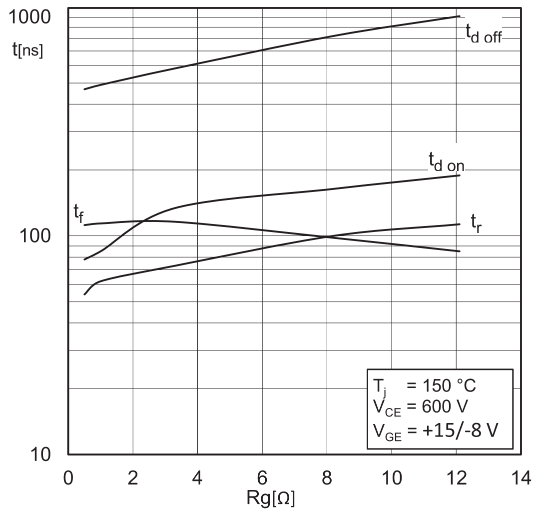



Fig. 8: Typ. IGBT1 switching times vs. gate resistor $R_G$

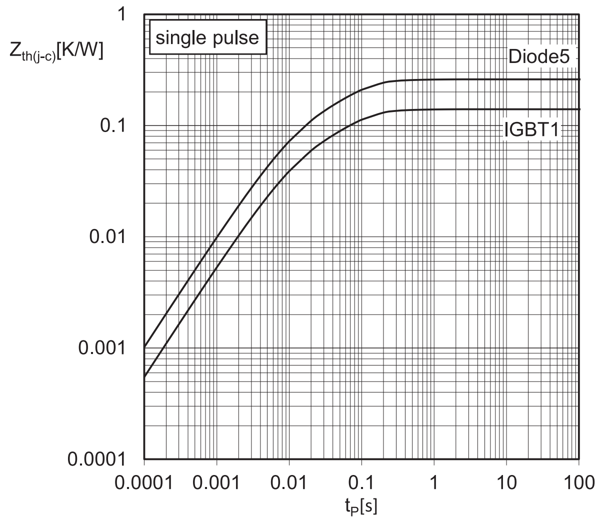



Fig. 9: Transient thermal impedance of IGBT1 & Diode5

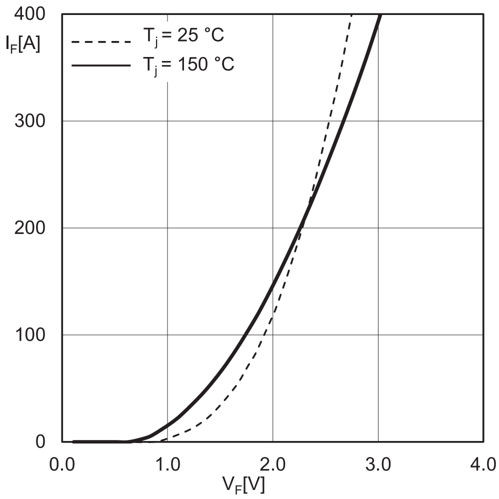



Fig. 10: Typ. Diode5 forward characteristic, incl. $R_{CC'+EE'}$

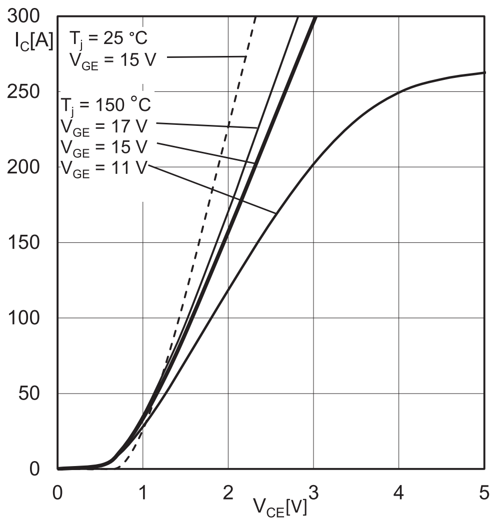



Fig. 13: Typ. IGBT2 output characteristic, incl. $R_{CC'+EE'}$

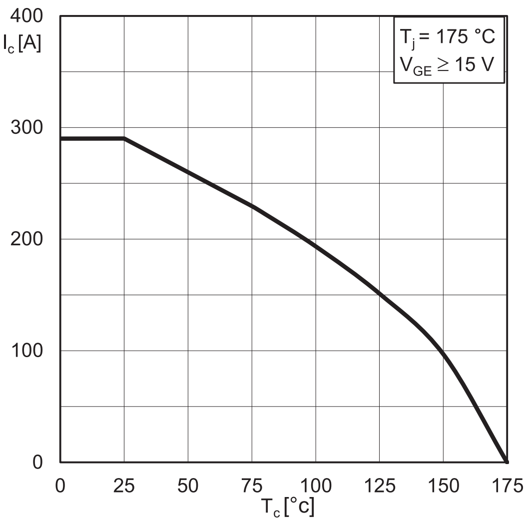



Fig. 14: IGBT2 rated current vs. Temperature $I_c$= f ($T_c$)

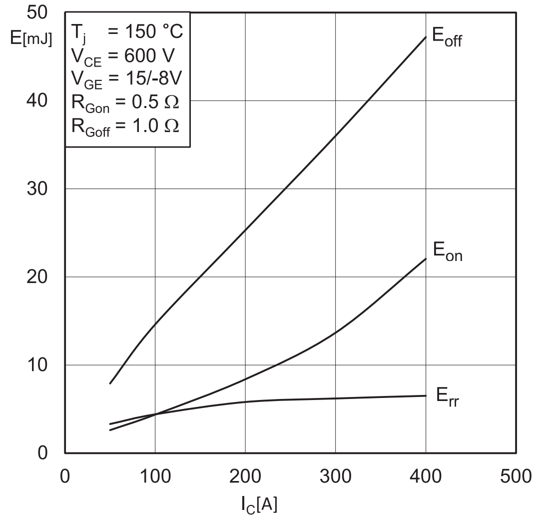



Fig. 15: Typ. IGBT2 & Diode1 turn-on /-off energy = f ($I_C$)

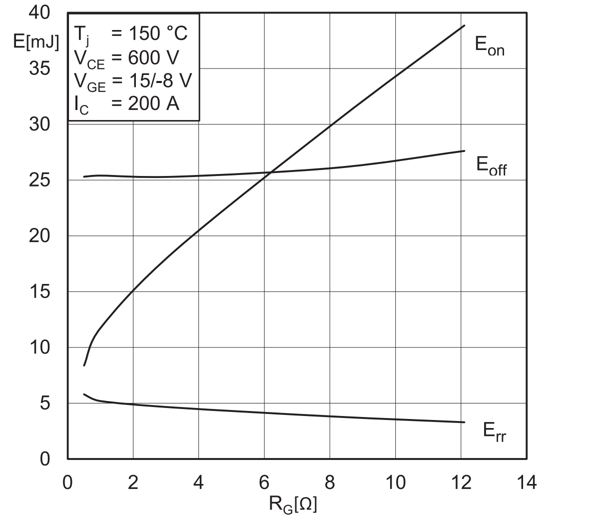



Fig. 16: Typ. IGBT2 & Diode1 turn-on / -off energy = f($R_G$)

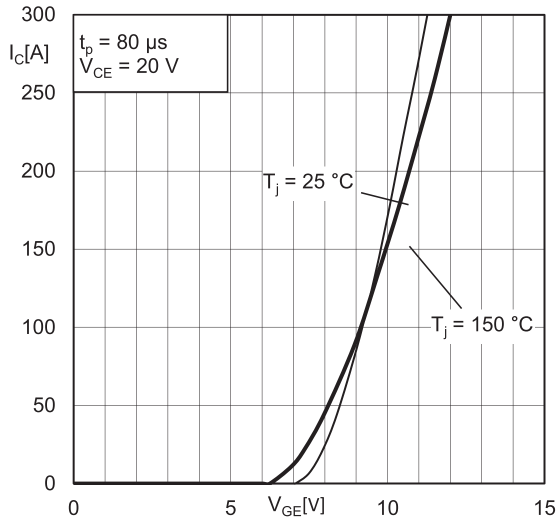



Fig. 17: Typ. IGBT2 transfer characteristic

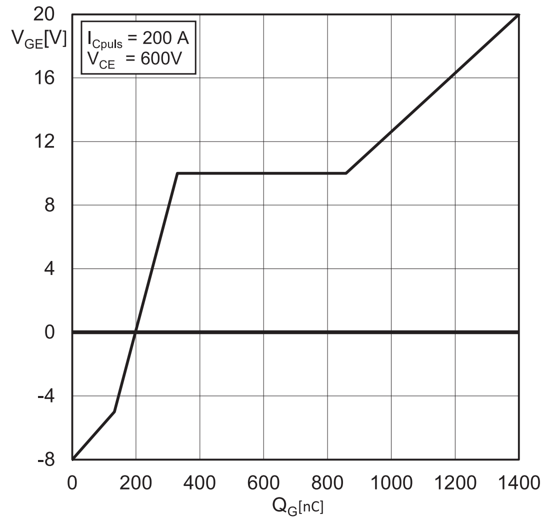



Fig. 18: Typ. IGBT2 gate charge characteristic

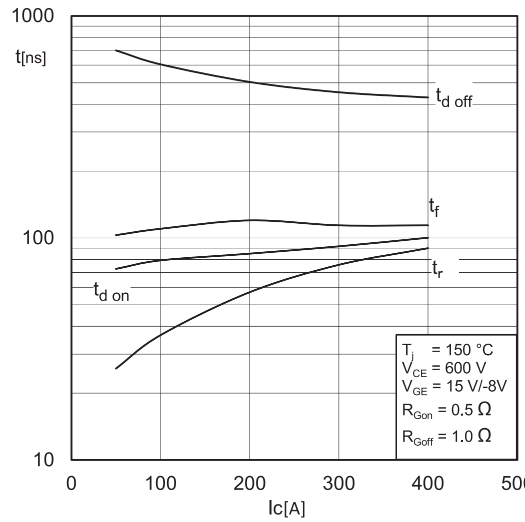



Fig. 19: Typ. IGBT2 switching times vs. $I_C$

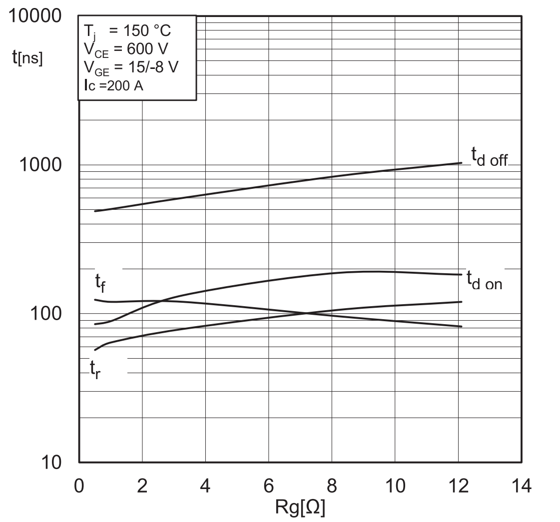



Fig. 20: Typ. IGBT2 switching times vs. gate resistor $R_G$

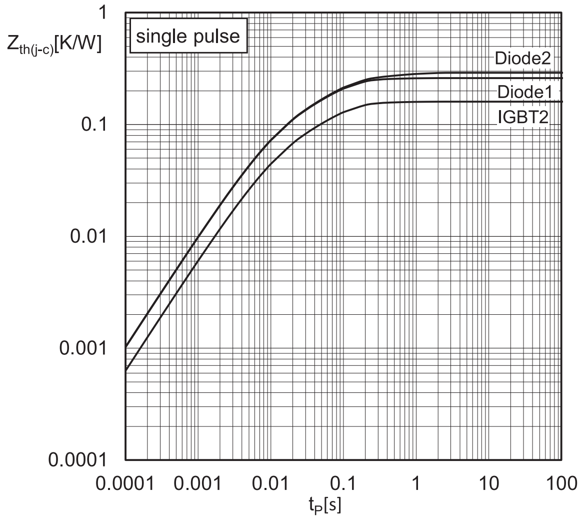



Fig. 21: Transient thermal impedance of IGBT2, Diode1 & Diode2

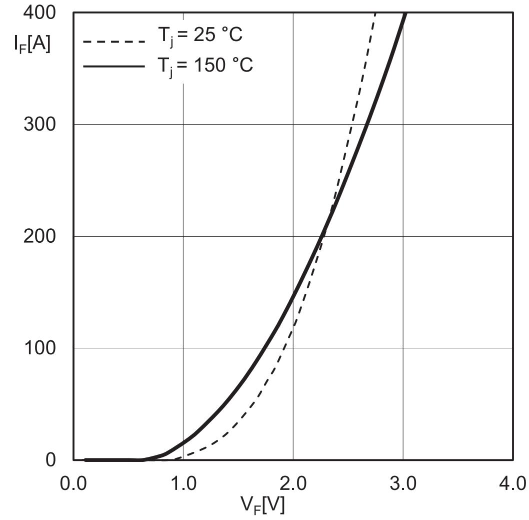
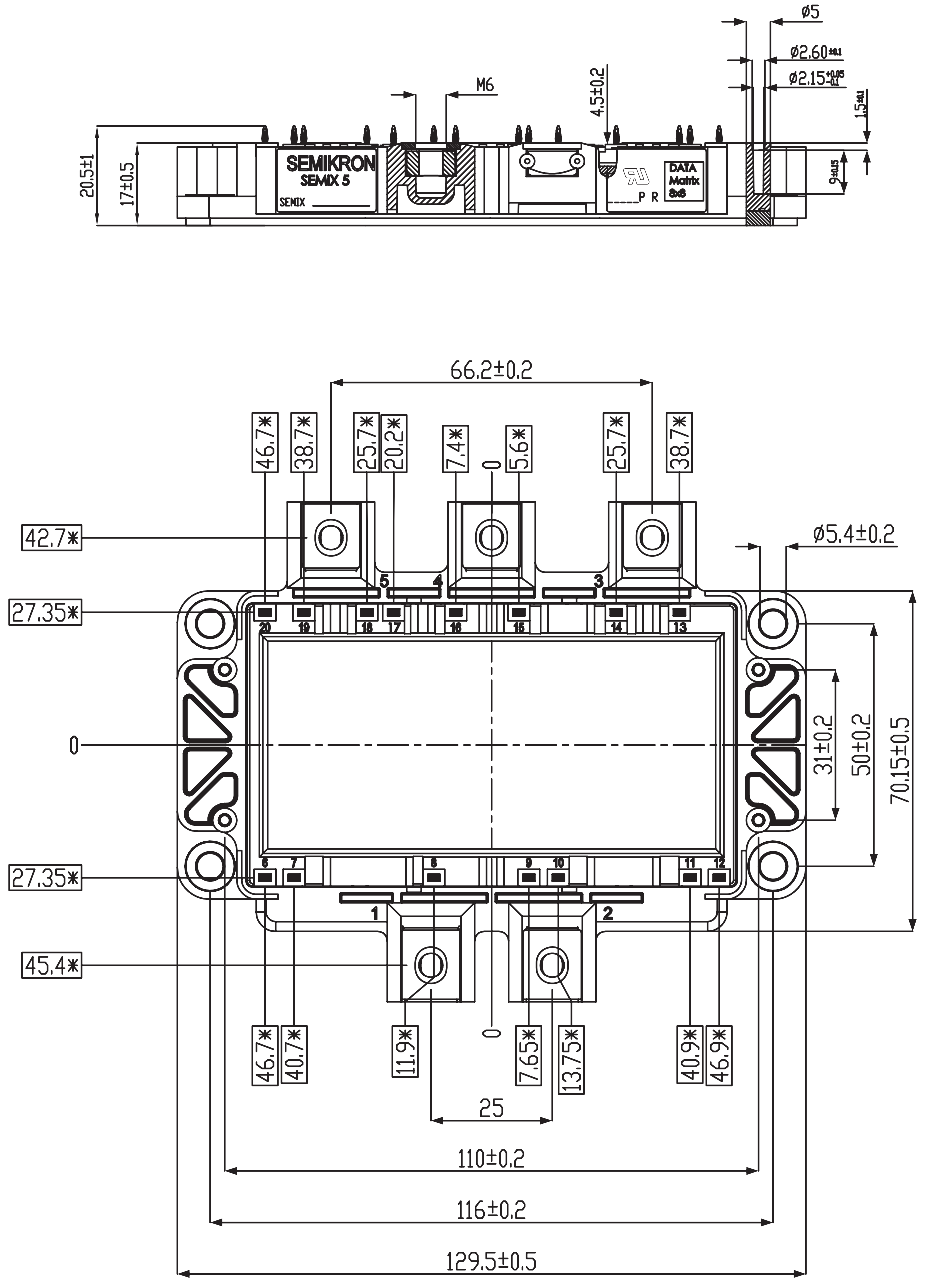



Fig. 22: Typ. Diode1 & Diode2 forward characteristic, incl. $R_{CC'+EE'}$

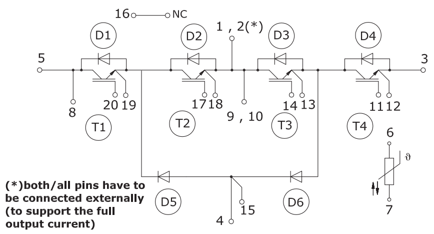
 




* = All dimensions with tolerance of ⌖ Ø 0.4

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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