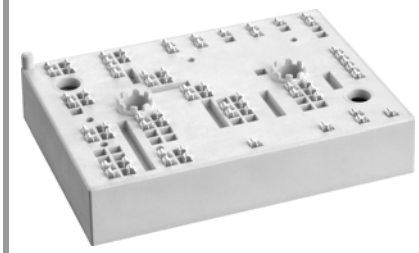
# SKiiP 39MLI12T4V1



**MiniSKiiP® 3**

## 3-Level NPC IGBT-Module

**SKiiP 39MLI12T4V1**

### Features*

- Trench 4 IGBTs
- Robust and soft freewheeling diodes in CAL technology
- Highly reliable spring contacts for electrical connections
- UL recognised: File no. E63532
- NTC T-Sensor

### Remarks*

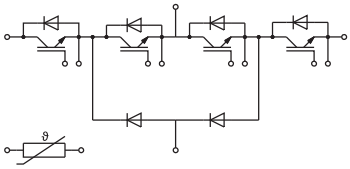
- Max. case temperature limited to $T_C$= 125°C
- Product reliability results valid for $T_j$≤150°C (recommended $T_{j,op}$=-40...+150°C)
- IGBT1: outer IGBTs T1 & T4
- IGBT2: inner IGBTs T2 & T3
- Diode1: outer diodes D1 & D4
- Diode2: inner diodes D2 & D3
- Diode5: clamping diodes D5 & D6

### Footnotes

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

**Absolute Maximum Ratings**

| Symbol | Conditions | | Values | Unit |
|---|---|---|---|---|
| **IGBT1** | | | | |
| $V_{CES}$ | $T_j$ = 25 °C | | 1200 | V |
| $I_C$ | $\lambda_{paste}$=0.8 W/(mK) $T_j$ = 175 °C | $T_s$ = 25 °C | 157 | A |
| | | $T_s$ = 70 °C | 127 | A |
| $I_C$ | $\lambda_{paste}$=2.5 W/(mK) $T_j$ = 175 °C | $T_s$ = 25 °C | 193 | A |
| | | $T_s$ = 70 °C | 157 | A |
| $I_{Cnom}$ | | | 150 | A |
| $I_{CRM}$ | | | 450 | 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 |
| $I_C$ | $\lambda_{paste}$=0.8 W/(mK) $T_j$ = 175 °C | $T_s$ = 25 °C | 162 | A |
| | | $T_s$ = 70 °C | 131 | A |
| $I_C$ | $\lambda_{paste}$=2.5 W/(mK) $T_j$ = 175 °C | $T_s$ = 25 °C | 198 | A |
| | | $T_s$ = 70 °C | 161 | A |
| $I_{Cnom}$ | | | 150 | A |
| $I_{CRM}$ | | | 450 | 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 |
| $I_F$ | $\lambda_{paste}$=0.8 W/(mK) $T_j$ = 175 °C | $T_s$ = 25 °C | 120 | A |
| | | $T_s$ = 70 °C | 94 | A |
| $I_F$ | $\lambda_{paste}$=2.5 W/(mK) $T_j$ = 175 °C | $T_s$ = 25 °C | 145 | A |
| | | $T_s$ = 70 °C | 115 | A |
| $I_{FRM}$ | | | 300 | A |
| $I_{FSM}$ | 10 ms, sin 180°, $T_j$ = 25 °C | | 900 | A |
| $T_j$ | | | -40 ... 175 | °C |
| **Diode2** | | | | |
| $V_{RRM}$ | $T_j$ = 25 °C | | 1200 | V |
| $I_F$ | $\lambda_{paste}$=0.8 W/(mK) $T_j$ = 175 °C | $T_s$ = 25 °C | 131 | A |
| | | $T_s$ = 70 °C | 103 | A |
| $I_F$ | $\lambda_{paste}$=2.5 W/(mK) $T_j$ = 175 °C | $T_s$ = 25 °C | 158 | A |
| | | $T_s$ = 70 °C | 126 | A |
| $I_{FRM}$ | | | 300 | A |
| $I_{FSM}$ | 10 ms, sin 180°, $T_j$ = 25 °C | | 900 | A |
| $T_j$ | | | -40 ... 175 | °C |



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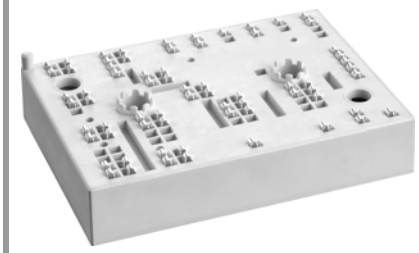

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### Footnotes

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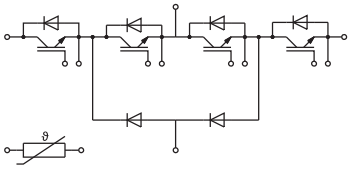

**MLI**

**Absolute Maximum Ratings**

| Symbol | Conditions | | Values | Unit |
|---|---|---|---|---|
| **Diode5** | | | | |
| $V_{RRM}$ | $T_j$ = 25 °C | | 1200 | V |
| $I_F$ | $\lambda_{paste}$=0.8 W/(mK) | $T_s$ = 25 °C | 119 | A |
| | $T_j$ = 175 °C | $T_s$ = 70 °C | 93 | A |
| $I_F$ | $\lambda_{paste}$=2.5 W/(mK) | $T_s$ = 25 °C | 145 | A |
| | $T_j$ = 175 °C | $T_s$ = 70 °C | 115 | A |
| $I_{FRM}$ | | | 300 | A |
| $I_{FSM}$ | 10 ms, sin 180°, $T_j$ = 25 °C | | 900 | A |
| $T_j$ | | | -40 ... 175 | °C |
| **Module** | | | | |
| $I_{t(RMS)}$ | 20 A per spring | | 160 | A |
| $T_{stg}$ | module without TIM | | -40 ... 125 | °C |
| $V_{isol}$ | AC sinus 50 Hz, t = 1 min | | 2500 | V |

**Characteristics**

| Symbol | Conditions | | min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|
| **IGBT1** | | | | | | |
| $V_{CE(sat)}$ | $I_C$ = 150 A<br>$V_{GE}$ = 15 V<br>chiplevel | $T_j$ = 25 °C | | 1.85 | 2.10 | V |
| | | $T_j$ = 150 °C | | 2.25 | 2.45 | 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 | | 7.0 | 8.0 | mΩ |
| | | $T_j$ = 150 °C | | 10 | 11 | mΩ |
| $V_{GE(th)}$ | $V_{GE}$ = $V_{CE}$, $I_C$ = 6 mA | | 5 | 5.8 | 6.5 | V |
| $I_{CES}$ | $V_{GE}$ = 0 V, $V_{CE}$ = 1200 V, $T_j$ = 25 °C | | | | 1.5 | mA |
| $C_{ies}$ | $V_{CE}$ = 25 V<br>$V_{GE}$ = 0 V | f = 1 MHz | | 8.80 | | nF |
| $C_{oes}$ | | f = 1 MHz | | 0.58 | | nF |
| $C_{res}$ | | f = 1 MHz | | 0.47 | | nF |
| $Q_G$ | $V_{GE}$ = - 8 V...+ 15 V | | | 850 | | nC |
| $R_{Gint}$ | $T_j$ = 25 °C | | | 5.0 | | Ω |
| $t_{d(on)}$ | $V_{CE}$ = 600 V<br>$I_C$ = 150 A<br>$V_{GE}$ = +15/-15 V<br>$R_{G\ on}$ = 1 Ω<br>$R_{G\ off}$ = 1 Ω<br>di/dt$_{on}$ = 4000 A/µs<br>di/dt$_{off}$ = 1700 A/µs<br>dv/dt = 3800 V/µs<br>$L_s$ = 25 nH | $T_j$ = 150 °C | | 129 | | ns |
| $t_r$ | | $T_j$ = 150 °C | | 37 | | ns |
| $E_{on}$ | | $T_j$ = 150 °C | | 17 | | mJ |
| $t_{d(off)}$ | | $T_j$ = 150 °C | | 355 | | ns |
| $t_f$ | | $T_j$ = 150 °C | | 77 | | ns |
| $E_{off}$ | | $T_j$ = 150 °C | | 15 | | mJ |
| $R_{th(j-s)}$ | per IGBT, $\lambda_{paste}$=0.8 W/(mK) | | | 0.36 | | K/W |
| $R_{th(j-s)}$ | per IGBT, $\lambda_{paste}$=2.5 W/(mK) | | | 0.25 | | K/W |

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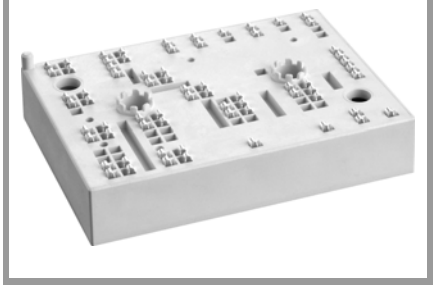

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### Remarks*

- Max. case temperature limited to $T_C$= 125°C
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- IGBT1: outer IGBTs T1 & T4
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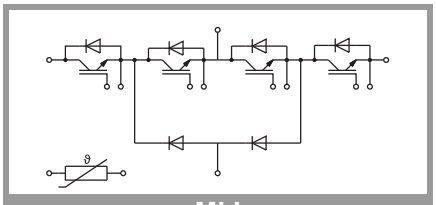

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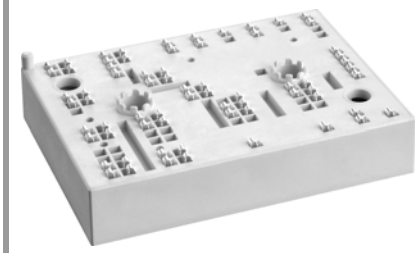
**Characteristics**

| Symbol | Conditions | | min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|
| **IGBT2** | | | | | | |
| $V_{CE(sat)}$ | $I_C$ = 150 A<br>$V_{GE}$ = 15 V<br>chiplevel | $T_j$ = 25 °C | | 1.85 | 2.10 | V |
| | | $T_j$ = 150 °C | | 2.25 | 2.45 | 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 | | 7.0 | 8.0 | mΩ |
| | | $T_j$ = 150 °C | | 10 | 11 | mΩ |
| $V_{GE(th)}$ | $V_{GE}$ = $V_{CE}$, $I_C$ = 6 mA | | 5 | 5.8 | 6.5 | V |
| $I_{CES}$ | $V_{GE}$ = 0 V, $V_{CE}$ = 1200 V, $T_j$ = 25 °C | | | | 1.5 | mA |
| $C_{ies}$ | $V_{CE}$ = 25 V<br>$V_{GE}$ = 0 V | f = 1 MHz | | 8.80 | | nF |
| $C_{oes}$ | | f = 1 MHz | | 0.58 | | nF |
| $C_{res}$ | | f = 1 MHz | | 0.47 | | nF |
| $Q_G$ | $V_{GE}$ = - 8 V...+ 15 V | | | 850 | | nC |
| $R_{Gint}$ | $T_j$ = 25 °C | | | 5.0 | | Ω |
| $t_{d(on)}$ | $V_{CC}$ = 600 V<br>$I_C$ = 150 A<br>$V_{GE}$ = +15/-15 V<br>$R_{G\ on}$ = 1 Ω<br>$R_{G\ off}$ = 1 Ω<br>di/dt$_{on}$ = 3200 A/µs<br>di/dt$_{off}$ = 1400 A/µs<br>dv/dt = 4400 V/µs<br>$L_s$ = 25 nH | $T_j$ = 150 °C | | 128 | | ns |
| $t_r$ | | $T_j$ = 150 °C | | 44 | | ns |
| $E_{on}$ | | $T_j$ = 150 °C | | 16.5 | | mJ |
| $t_{d(off)}$ | | $T_j$ = 150 °C | | 360 | | ns |
| $t_f$ | | $T_j$ = 150 °C | | 67 | | ns |
| $E_{off}$ | | $T_j$ = 150 °C | | 15 | | mJ |
| $R_{th(j-s)}$ | per IGBT, $\lambda_{paste}$=0.8 W/(mK) | | | 0.34 | | K/W |
| $R_{th(j-s)}$ | per IGBT, $\lambda_{paste}$=2.5 W/(mK) | | | 0.24 | | K/W |
| **Diode1** | | | | | | |
| $V_F = V_{EC}$ | $I_F$ = 150 A<br>$V_{GE}$ = 0 V<br>chiplevel | $T_j$ = 25 °C | | 2.14 | 2.46 | V |
| | | $T_j$ = 150 °C | | 2.07 | 2.38 | 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 | | 5.6 | 6.4 | mΩ |
| | | $T_j$ = 150 °C | | 7.8 | 8.5 | mΩ |
| $I_{RRM}$ | $I_F$ = 150 A<br>di/dt$_{off}$ = 3200 A/µs<br>$V_R$ = 600 V<br>$V_{GE}$ = +15/-15 V<br>$L_s$ = 25 nH | $T_j$ = 150 °C | | 143 | | A |
| $Q_{rr}$ | | $T_j$ = 150 °C | | 34 | | µC |
| $E_{rr}$ | | $T_j$ = 150 °C | | 13 | | mJ |
| $R_{th(j-s)}$ | per Diode, $\lambda_{paste}$=0.8 W/(mK) | | | 0.63 | | K/W |
| $R_{th(j-s)}$ | per Diode, $\lambda_{paste}$=2.5 W/(mK) | | | 0.47 | | K/W |
| **Diode2** | | | | | | |
| $V_F = V_{EC}$ | $I_F$ = 150 A<br>$V_{GE}$ = 0 V<br>chiplevel | $T_j$ = 25 °C | | 2.14 | 2.46 | V |
| | | $T_j$ = 150 °C | | 2.07 | 2.38 | 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 | | 5.6 | 6.4 | mΩ |
| | | $T_j$ = 150 °C | | 7.8 | 8.5 | mΩ |
| $I_{RRM}$ | $I_F$ = 150 A<br>$V_R$ = 600 V<br>$V_{GE}$ = +15/-15 V | $T_j$ = 150 °C | | t.b.d. | | A |
| $Q_{rr}$ | | $T_j$ = 150 °C | | t.b.d. | | µC |
| $E_{rr}$ [1] | | $T_j$ = 150 °C | | t.b.d. | | mJ |
| $R_{th(j-s)}$ | per Diode, $\lambda_{paste}$=0.8 W/(mK) | | | 0.55 | | K/W |
| $R_{th(j-s)}$ | per Diode, $\lambda_{paste}$=2.5 W/(mK) | | | 0.41 | | K/W |



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- IGBT1: outer IGBTs T1 & T4
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- Diode1: outer diodes D1 & D4
- Diode2: inner diodes D2 & D3
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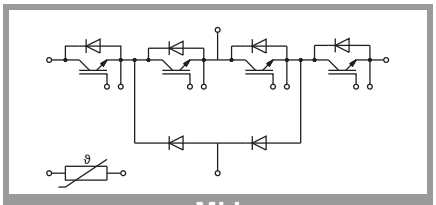
### Footnotes

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

**Characteristics**

| Symbol | Conditions | | min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|
| **Diode5** | | | | | | |
| $V_F = V_{EC}$ | $I_F$ = 150 A<br>$V_{GE}$ = 0 V<br>chiplevel | $T_j$ = 25 °C | | 2.14 | 2.46 | V |
| | | $T_j$ = 150 °C | | 2.07 | 2.38 | 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 | | 5.6 | 6.4 | mΩ |
| | | $T_j$ = 150 °C | | 7.8 | 8.5 | mΩ |
| $I_{RRM}$ | $I_F$ = 150 A<br>$di/dt_{off}$ = 3900 A/µs<br>$V_R$ = 600 V<br>$V_{GE}$ = +15/-15 V<br>$L_s$ = 25 nH | $T_j$ = 150 °C | | 177 | | A |
| $Q_{rr}$ | | $T_j$ = 150 °C | | 32 | | µC |
| $E_{rr}$ | | $T_j$ = 150 °C | | 12.6 | | mJ |
| $R_{th(j-s)}$ | per Diode, $\lambda_{paste}$=0.8 W/(mK) | | | 0.64 | | K/W |
| $R_{th(j-s)}$ | per Diode, $\lambda_{paste}$=2.5 W/(mK) | | | 0.47 | | K/W |
| **Module** | | | | | | |
| $L_{sCE1}$ | | | | - | | nH |
| $L_{sCE2}$ | | | | - | | nH |
| $R_{CC'+EE'}$ | | $T_s$ = 25 °C | | - | | mΩ |
| | | $T_s$ = 125 °C | | - | | mΩ |
| $M_s$ | to heat sink | | 2 | | 2.5 | Nm |
| $M_t$ | | | | - | | Nm |
| | | | | - | | Nm |
| w | | | | 82 | | 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 |



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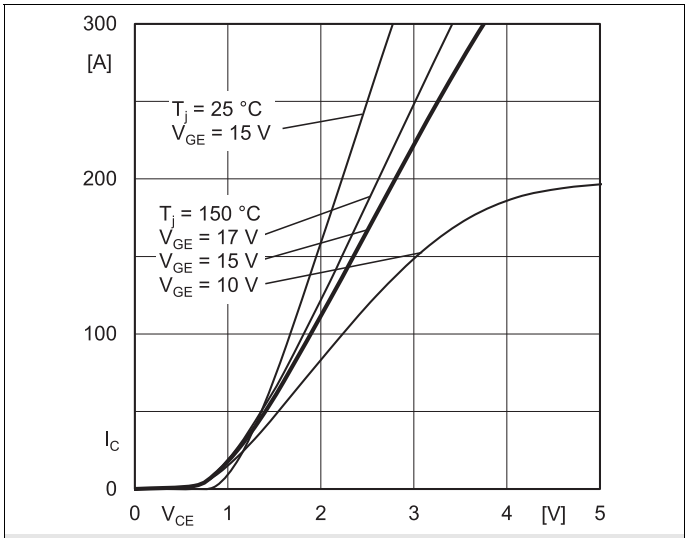


Fig. 1: Typ. IGBT1 output characteristic, incl. $R_{CC'+EE'}$

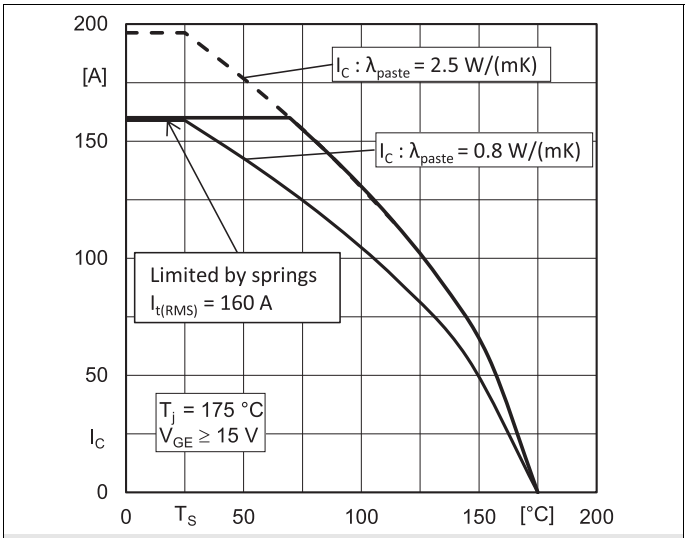


Fig. 2: IGBT1 rated current vs. Temperature $I_c=f(T_s)$

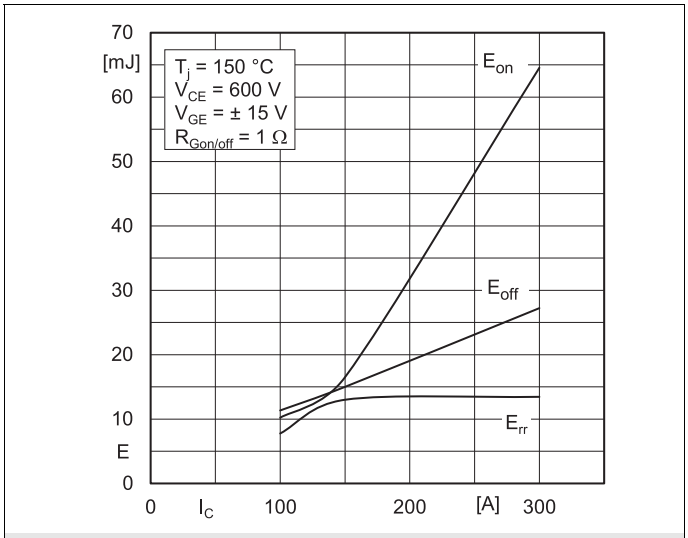


Fig. 3: Typ. IGBT1 & Diode5 turn-on /-off energy = f ($I_C$)

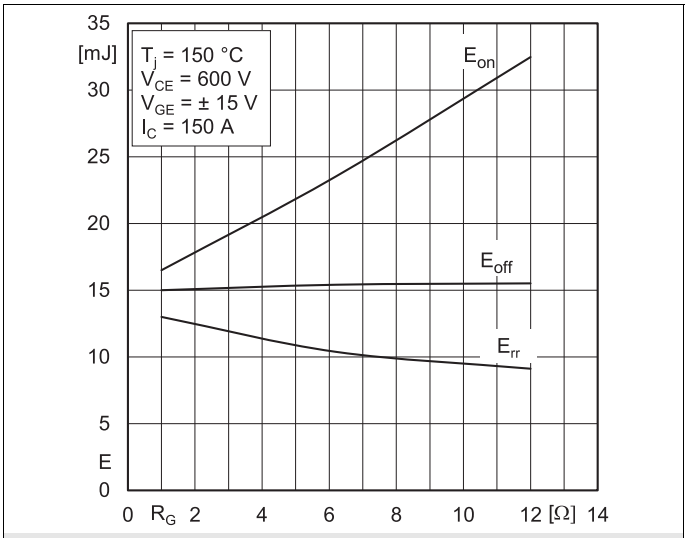


Fig. 4: Typ. IGBT1 & Diode5 turn-on /-off energy = f($R_G$)

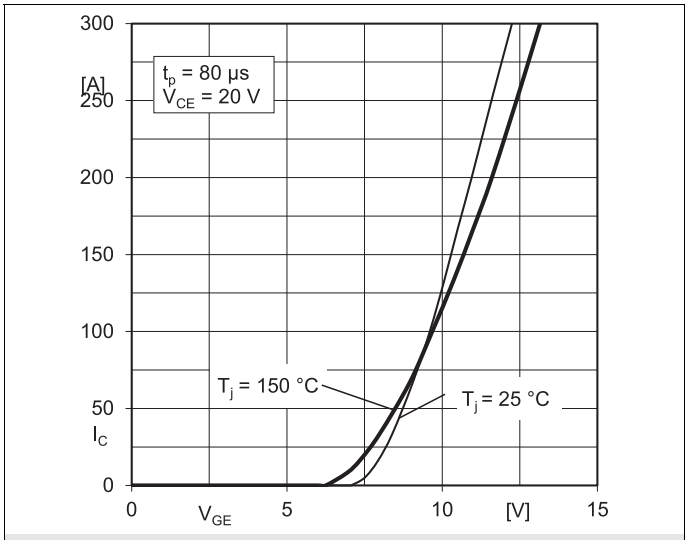


Fig. 5: Typ. IGBT1 transfer characteristic

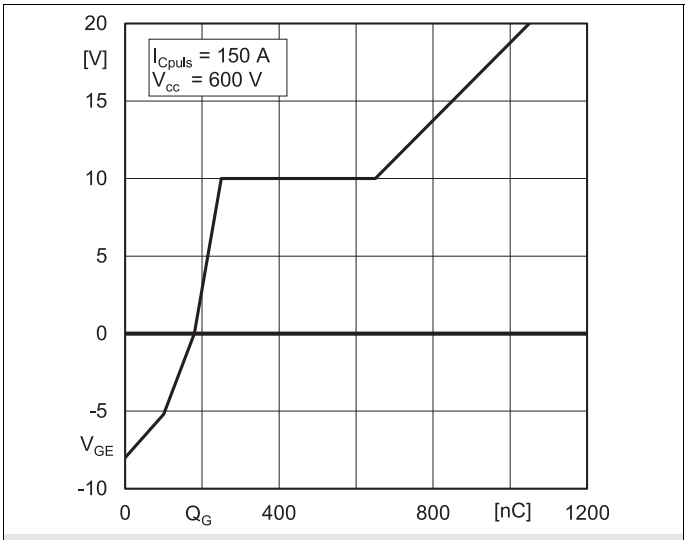


Fig. 6: Typ. IGBT1 gate charge characteristic

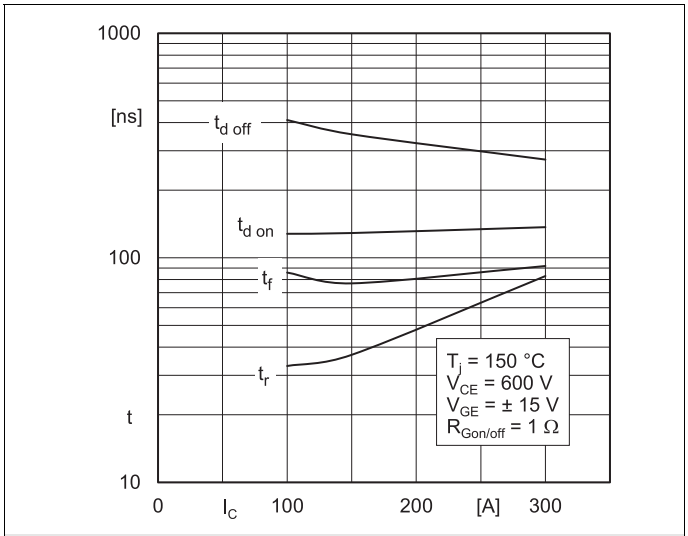


Fig. 7: Typ. IGBT1 switching times vs. $I_C$

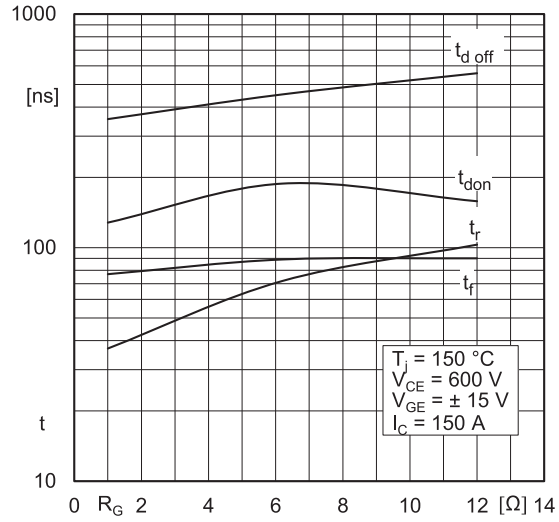


Fig. 8: Typ. IGBT1 switching times vs. gate resistor $R_G$

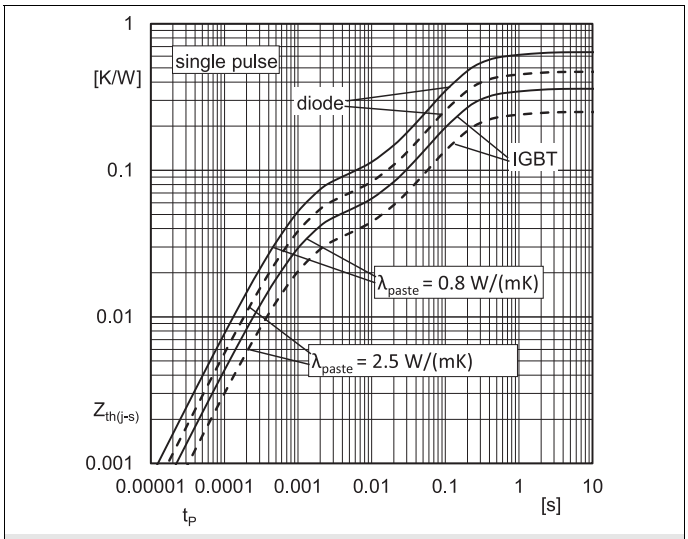


Fig. 9: Typ. transient thermal impedance of IGBT1 & Diode5

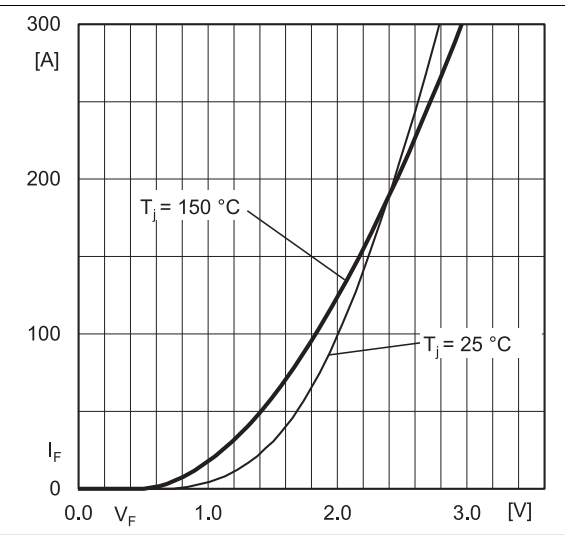


Fig. 10: Typ. Diode5 forward characteristic, incl. $R_{CC'+EE'}$

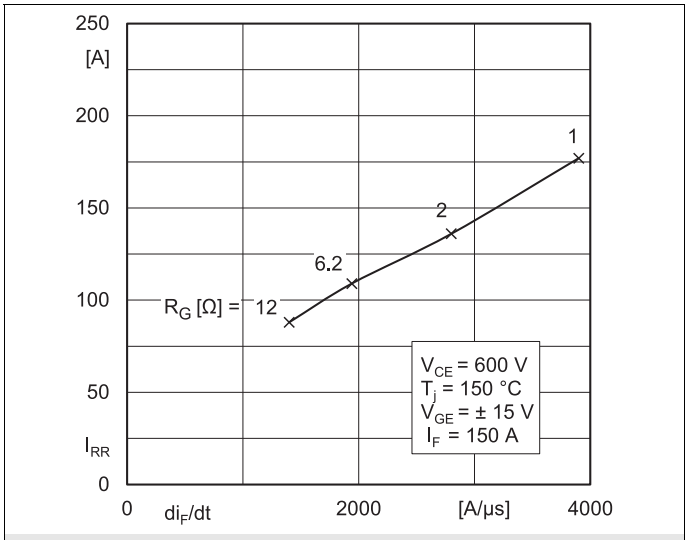


Fig. 11: Typ. Diode5 peak reverse recovery current

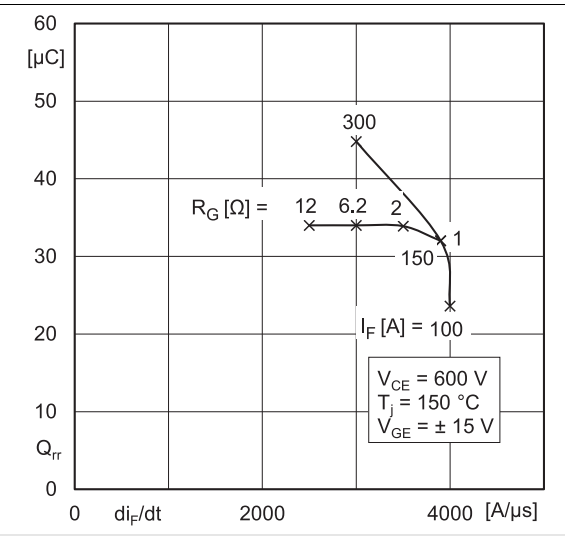


Fig. 12: Typ. Diode5 recovery charge

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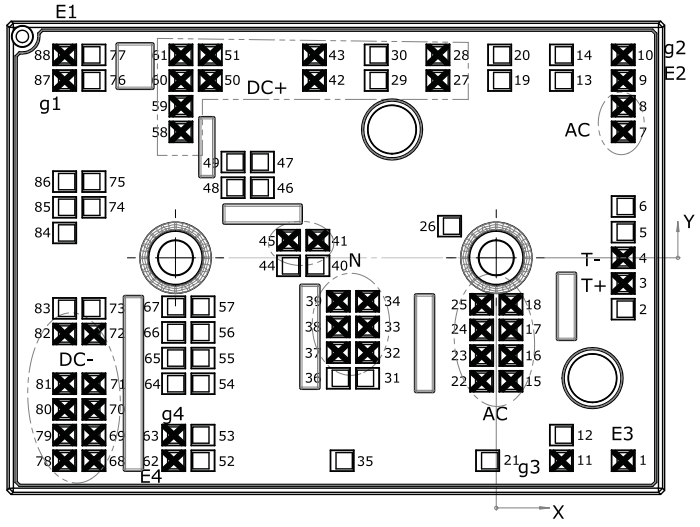
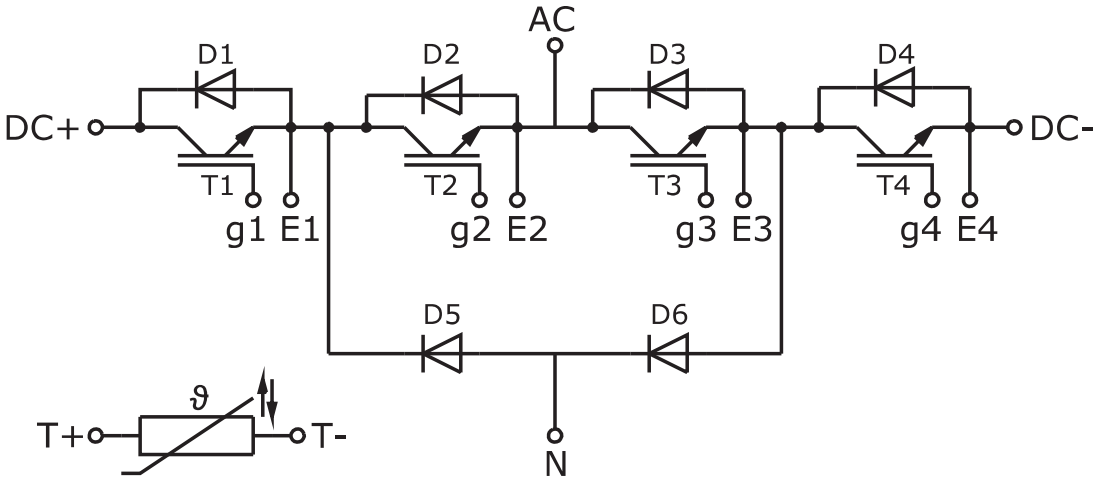
| Pin out | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Pin* | *X* | *Y* | *Function* | *Pin* | *X* | *Y* | *Function* | *Pin* | *X* | *Y* | *Function* |
| 1 | 15,83 | -25,30 | E3 | 31 | -16,05 | -15,02 | | 61 | -39,33 | 25,30 | DC+ |
| 2 | 15,83 | -6,40 | | 32 | -16,05 | -11,82 | N | 62 | -40,23 | -25,30 | E4 |
| 3 | 15,83 | -3,20 | T+ | 33 | -16,05 | -8,62 | N | 63 | -40,23 | -22,10 | g4 |
| 4 | 15,83 | 0 | T- | 34 | -16,05 | -5,42 | N | 64 | -40,23 | -15,70 | |
| 5 | 15,83 | 3,20 | | 35 | -19,23 | -25,30 | | 65 | -40,23 | -12,50 | |
| 6 | 15,83 | 6,40 | | 36 | -19,70 | -15,02 | | 66 | -40,23 | -9,30 | |
| 7 | 15,83 | 15,70 | AC | 37 | -19,70 | -11,82 | N | 67 | -40,23 | -6,10 | |
| 8 | 15,83 | 18,90 | AC | 38 | -19,70 | -8,62 | N | 68 | -50,18 | -25,30 | DC- |
| 9 | 15,83 | 22,10 | E2 | 39 | -19,70 | -5,42 | N | 69 | -50,18 | -22,10 | DC- |
| 10 | 15,83 | 25,30 | g2 | 40 | -22,26 | -1,00 | | 70 | -50,18 | -18,90 | DC- |
| 11 | 8,13 | -25,30 | g3 | 41 | -22,26 | 2,20 | N | 71 | -50,18 | -15,70 | DC- |
| 12 | 8,13 | -22,10 | | 42 | -22,68 | 22,10 | DC+ | 72 | -50,18 | -9,50 | DC- |
| 13 | 8,13 | 22,10 | | 43 | -22,68 | 25,30 | DC+ | 73 | -50,18 | -6,30 | |
| 14 | 8,13 | 25,30 | | 44 | -25,91 | -1,00 | | 74 | -50,18 | 6,30 | |
| 15 | 1,83 | -15,39 | AC | 45 | -25,91 | 2,20 | N | 75 | -50,18 | 9,50 | |
| 16 | 1,83 | -12,19 | AC | 46 | -29,18 | 8,74 | | 76 | -50,18 | 22,10 | |
| 17 | 1,83 | -8,99 | AC | 47 | -29,18 | 11,94 | | 77 | -50,18 | 25,30 | |
| 18 | 1,83 | -5,79 | AC | 48 | -32,83 | 8,74 | | 78 | -53,83 | -25,30 | DC- |
| 19 | 0,43 | 22,10 | | 49 | -32,83 | 11,94 | | 79 | -53,83 | -22,10 | DC- |
| 20 | 0,43 | 25,30 | | 50 | -35,68 | 22,10 | DC+ | 80 | -53,83 | -18,90 | DC- |
| 21 | -1,08 | -25,30 | | 51 | -35,68 | 25,30 | DC+ | 81 | -53,83 | -15,70 | DC- |
| 22 | -1,83 | -15,39 | AC | 52 | -36,58 | -25,30 | | 82 | -53,83 | -9,50 | DC- |
| 23 | -1,83 | -12,19 | AC | 53 | -36,58 | -22,10 | | 83 | -53,83 | -6,30 | |
| 24 | -1,83 | -8,99 | AC | 54 | -36,58 | -15,70 | | 84 | -53,83 | 3,10 | |
| 25 | -1,83 | -5,79 | AC | 55 | -36,58 | -12,50 | | 85 | -53,83 | 6,30 | |
| 26 | -5,83 | 3,95 | | 56 | -36,58 | -9,30 | | 86 | -53,83 | 9,50 | |
| 27 | -7,28 | 22,10 | DC+ | 57 | -36,58 | -6,10 | | 87 | -53,83 | 22,10 | g1 |
| 28 | -7,28 | 25,30 | DC+ | 58 | -39,33 | 15,70 | DC+ | 88 | -53,83 | 25,30 | E1 |
| 29 | -14,98 | 22,10 | | 59 | -39,33 | 18,90 | DC+ | | | | |
| 30 | -14,98 | 25,30 | | 60 | -39,33 | 22,10 | DC+ | | | | |

all values in mm




**Pinout and Dimensions**




**Pinout**

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

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