**SEMITRANS™ 9**

Trench IGBT Modules

**SKM400GAL176DL3**

### Features*

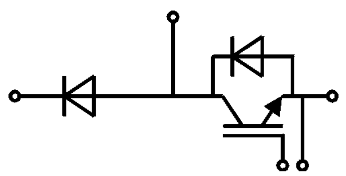
- Trench = Trenchgate technology
- $V_{CE(sat)}$ with positive temperature coefficient
- High short circuit capability, self limiting to 6 x $I_{cnom}$
- Insulated copper baseplate using aluminum nitride ceramic
- Large clearance (13mm) and creepage distance (20mm), to ground: 50mm

### Typical Applications

- AC inverter drives
- Mains 575 – 750 V AC
- Public transport
- Wind power

### Remarks

- Terminals 1,4 – 2,5 – 3,6 need to be connected externally



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**Absolute Maximum Ratings**

| Symbol | Conditions | | Values | Unit |
|---|---|---|---|---|
| **IGBT** | | | | |
| $V_{CES}$ | $T_j$ = 25 °C | | 1700 | V |
| $I_C$ | $T_j$ = 150 °C | $T_c$ = 25 °C | 442 | A |
| | | $T_c$ = 80 °C | 314 | A |
| $I_{Cnom}$ | | | 300 | A |
| $I_{CRM}$ | $I_{CRM}$ = 2 x $I_{Cnom}$ | | 600 | A |
| $V_{GES}$ | | | -20 ... 20 | V |
| $t_{psc}$ | $V_{CC}$ = 1000 V<br>$V_{GE} \leq$ 20 V<br>$V_{CES} \leq$ 1700 V | $T_j$ = 125 °C | 10 | µs |
| $T_j$ | | | -40 ... 150 | °C |
| **Inverse diode** | | | | |
| $I_F$ | $T_j$ = 150 °C | $T_c$ = 25 °C | 283 | A |
| | | $T_c$ = 80 °C | 187 | A |
| $I_{Fnom}$ | | | 200 | A |
| $I_{FRM}$ | $I_{FRM}$ = 2 x $I_{Fnom}$ | | 400 | A |
| $I_{FSM}$ | $t_p$ = 10 ms, sin 180°, $T_j$ = 25 °C | | 1530 | A |
| $T_j$ | | | -40 ... 150 | °C |
| **Freewheeling diode** | | | | |
| $I_F$ | $T_j$ = 150 °C | $T_c$ = 25 °C | 392 | A |
| | | $T_c$ = 80 °C | 259 | A |
| $I_{Fnom}$ | | | 300 | A |
| $I_{FRM}$ | $I_{FRM}$ = 2x$I_{Fnom}$ | | 600 | A |
| $I_{FSM}$ | $t_p$ = 10 ms, sin 180°, $T_j$ = 25 °C | | 2448 | A |
| $T_j$ | | | -40 ... 150 | °C |
| **Module** | | | | |
| $I_{t(RMS)}$ | | | - | A |
| $T_{stg}$ | | | -40 ... 125 | °C |
| $V_{isol}$ | AC sinus 50 Hz, t = 1 min | | 9500 | V |

**Characteristics**

| Symbol | Conditions | | min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|
| **IGBT** | | | | | | |
| $V_{CE(sat)}$ | $I_C$ = 300 A<br>$V_{GE}$ = 15 V<br>chiplevel | $T_j$ = 25 °C | | 1.99 | 2.45 | V |
| | | $T_j$ = 125 °C | | 2.46 | 2.90 | V |
| $V_{CE0}$ | chiplevel | $T_j$ = 25 °C | | 1.00 | 1.20 | V |
| | | $T_j$ = 125 °C | | 0.90 | 1.10 | V |
| $r_{CE}$ | $V_{GE}$ = 15 V<br>chiplevel | $T_j$ = 25 °C | | 3.3 | 4.2 | mΩ |
| | | $T_j$ = 125 °C | | 5.2 | 6.0 | mΩ |
| $V_{GE(th)}$ | $V_{GE}$=$V_{CE}$, $I_C$ = 12 mA | | 5.2 | 5.8 | 6.4 | V |
| $I_{CES}$ | $V_{GE}$ = 0 V<br>$V_{CE}$ = 1700 V | $T_j$ = 25 °C | | | 4 | mA |
| | | $T_j$ = 125 °C | | - | | mA |
| $C_{ies}$ | $V_{CE}$ = 25 V<br>$V_{GE}$ = 0 V | f = 1 MHz | | 26.4 | | nF |
| $C_{oes}$ | | f = 1 MHz | | 1.10 | | nF |
| $C_{res}$ | | f = 1 MHz | | 0.88 | | nF |
| $Q_G$ | $V_{GE}$ = - 8 V...+ 15 V | | | 2500 | | nC |
| $R_{Gint}$ | $T_j$ = 25 °C | | | 4.9 | | Ω |

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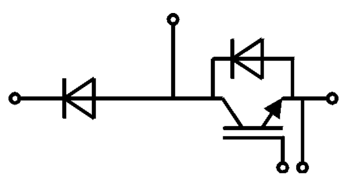

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| Characteristics | | | | | | |
|---|---|---|---|---|---|---|
| **Symbol** | **Conditions** | | **min.** | **typ.** | **max.** | **Unit** |
| $t_{d(on)}$ | $V_{CC}$ = 1200 V | $T_j$ = 125 °C | | 933 | | ns |
| $t_r$ | $I_C$ = 300 A | $T_j$ = 125 °C | | 159 | | ns |
| $E_{on}$ | $V_{GE}$ = +15/-15 V<br>$R_{G\,on}$ = 4 Ω | $T_j$ = 125 °C | | 143 | | mJ |
| $t_{d(off)}$ | $R_{G\,off}$ = 4 Ω | $T_j$ = 125 °C | | 1250 | | ns |
| $t_f$ | $di/dt_{on}$ = 2100 A/µs | $T_j$ = 125 °C | | 150 | | ns |
| $E_{off}$ | $di/dt_{off}$ = 2100 A/µs | $T_j$ = 125 °C | | 109 | | mJ |
| $R_{th(j-c)}$ | per IGBT | | | | 0.072 | K/W |
| **Inverse diode** | | | | | | |
| $V_F = V_{EC}$ | $I_F$ = 200 A | $T_j$ = 25 °C | | 1.71 | 2.01 | V |
| | $V_{GE}$ = 0 V<br>chiplevel | $T_j$ = 125 °C | | 1.75 | 2.04 | V |
| $V_{F0}$ | chiplevel | $T_j$ = 25 °C | | 1.24 | 1.52 | V |
| | | $T_j$ = 125 °C | | 1.07 | 1.38 | V |
| $r_F$ | chiplevel | $T_j$ = 25 °C | | 2.3 | 2.5 | mΩ |
| | | $T_j$ = 125 °C | | 3.4 | 3.3 | mΩ |
| $I_{RRM}$ | $I_F$ = 300 A | $T_j$ = 125 °C | | 120 | | A |
| $Q_{rr}$ | $di/dt_{off}$ = 2100 A/µs<br>$V_{GE}$ = -15 V | $T_j$ = 125 °C | | 45 | | µC |
| $E_{rr}$ | $V_{CC}$ = 1200 V | $T_j$ = 125 °C | | 22 | | mJ |
| $R_{th(j-c)}$ | per diode | | | | 0.19 | K/W |
| **Freewheeling diode** | | | | | | |
| $V_F = V_{EC}$ | $I_F$ = 300 A | $T_j$ = 25 °C | | 1.72 | 2.03 | V |
| | $V_{GE}$ = 0 V<br>chiplevel | $T_j$ = 125 °C | | 1.79 | 2.08 | V |
| $V_{F0}$ | chiplevel | $T_j$ = 25 °C | | 1.24 | 1.52 | V |
| | | $T_j$ = 125 °C | | 1.07 | 1.33 | V |
| $r_F$ | chiplevel | $T_j$ = 25 °C | | 1.61 | 1.71 | mΩ |
| | | $T_j$ = 125 °C | | 2.4 | 2.5 | mΩ |
| $I_{RRM}$ | $I_F$ = 300 A | $T_j$ = 125 °C | | 145 | | A |
| $Q_{rr}$ | $di/dt_{off}$ = 2100 A/µs<br>$V_{GE}$ = -15 V | $T_j$ = 125 °C | | 53 | | µC |
| $E_{rr}$ | $V_{CC}$ = 1200 V | $T_j$ = 125 °C | | 26 | | mJ |
| $R_{th(j-c)}$ | per diode | | | | 0.14 | K/W |
| **Module** | | | | | | |
| $L_{CE}$ | | | | - | | nH |
| $R_{CC'+EE'}$ | measured per switch | $T_C$ = 25 °C | | 0.35 | | mΩ |
| | | $T_C$ = 125 °C | | 0.5 | | mΩ |
| $R_{th(c-s)}$ | calculated without thermal coupling ($\lambda_{grease}$=0.81 W/(m*K)) | | | t.b.d. | 0.038 | K/W |
| $M_s$ | to heat sink M6 | | 3 | | 5 | Nm |
| $M_t$ | | M6 | 2.5 | | 5 | Nm |
| | | | | | | Nm |
| w | | | | | 460 | g |

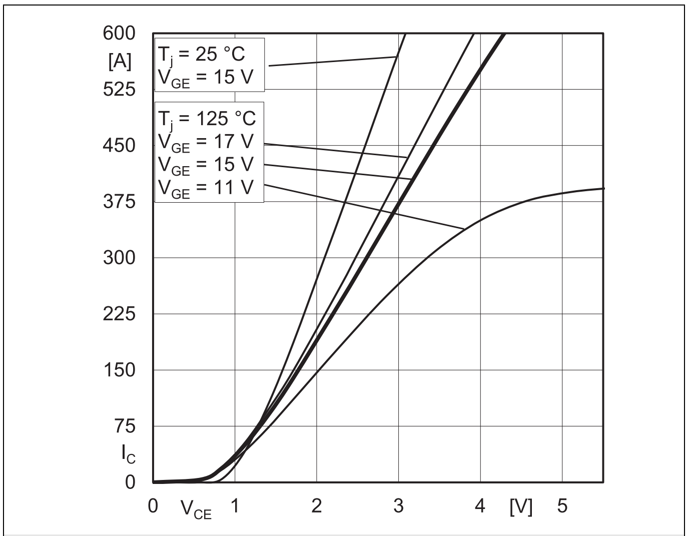



Fig. 1: Typ. output characteristic, inclusive $R_{CC'+ EE'}$

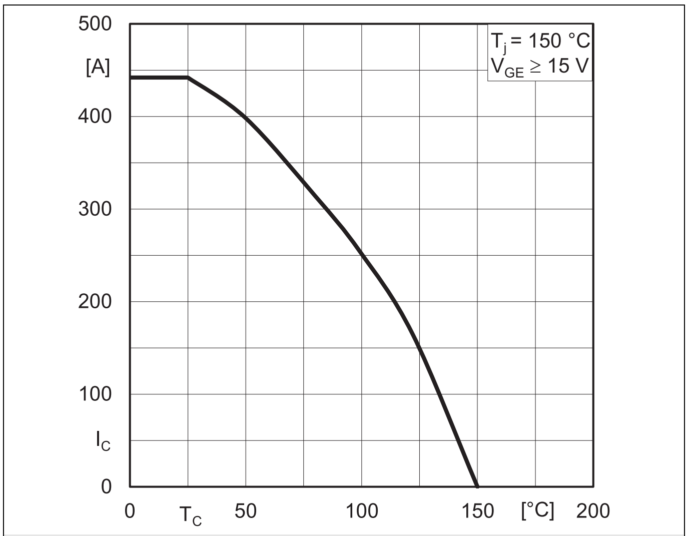



Fig. 2: Rated current vs. temperature $I_C = f (T_C)$

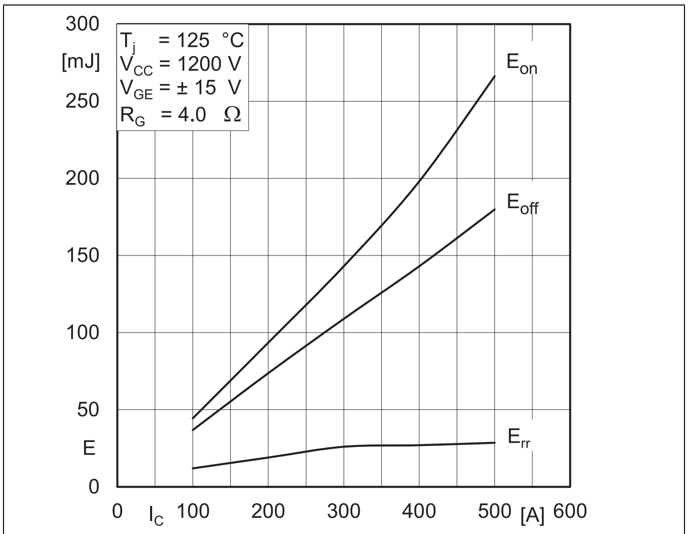



Fig. 3: Typ. turn-on /-off energy = f ($I_C$)

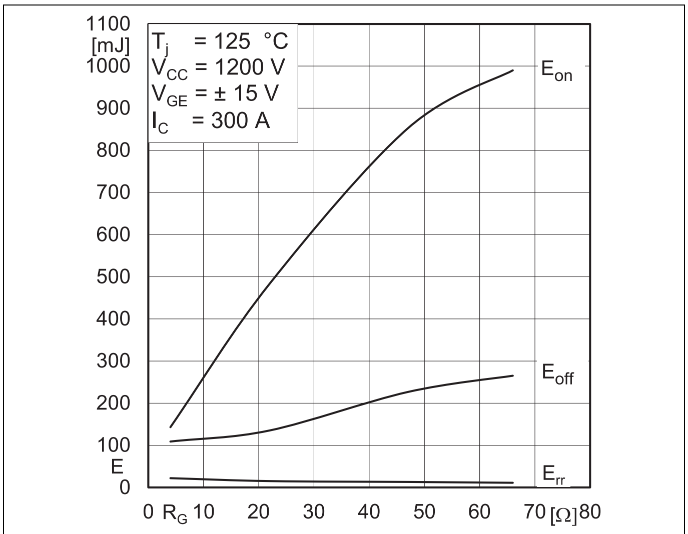



Fig. 4: Typ. turn-on /-off energy = f ($R_G$)

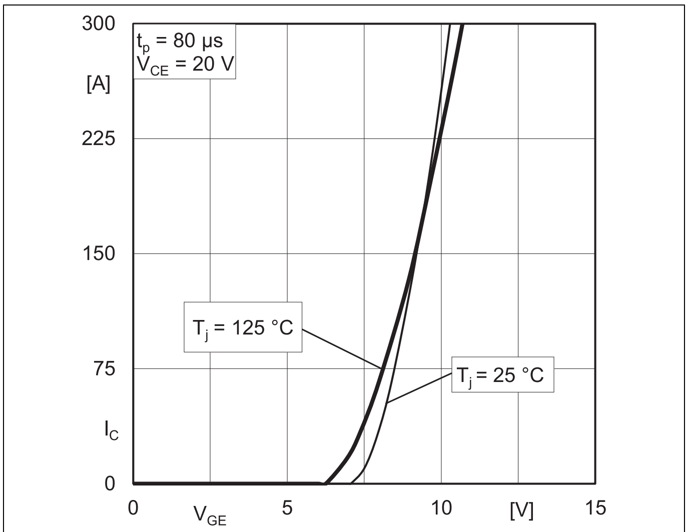



Fig. 5: Typ. transfer characteristic

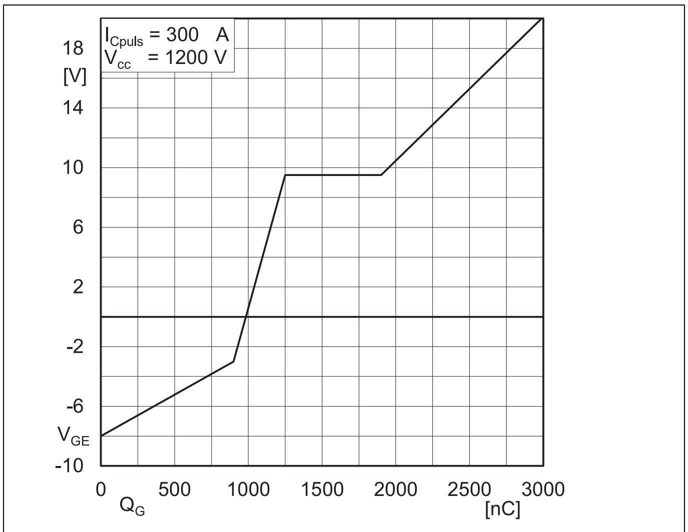



Fig. 6: Typ. gate charge characteristic

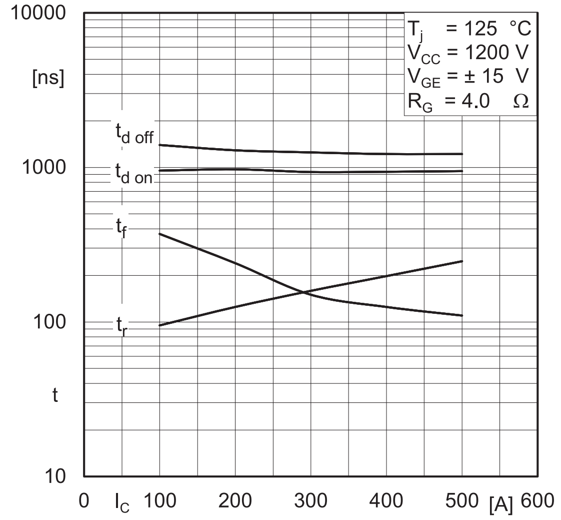



Fig. 7: Typ. switching times vs. $I_C$

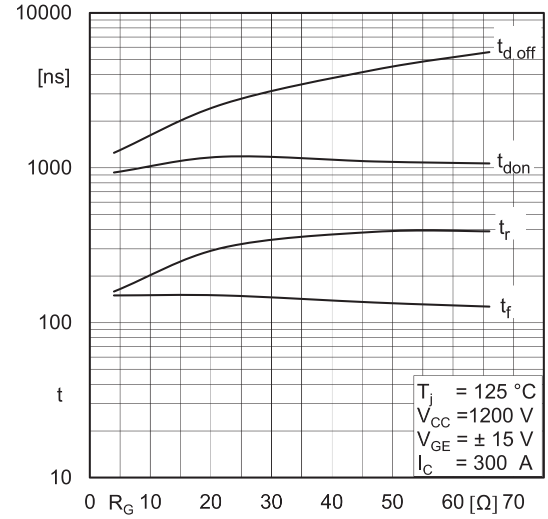



Fig. 8: Typ. switching times vs. gate resistor $R_G$

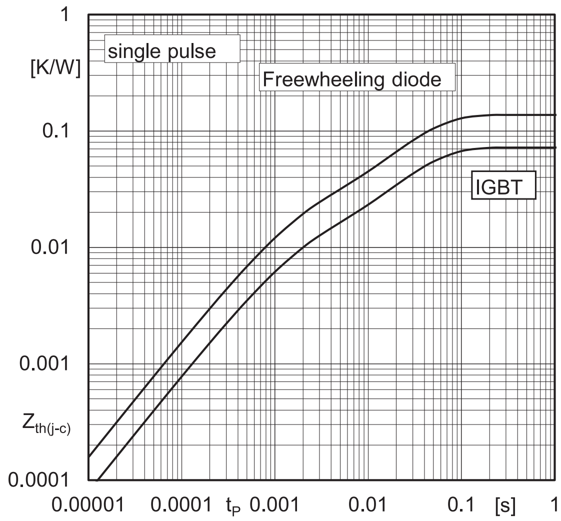



Fig. 9: Transient thermal impedance

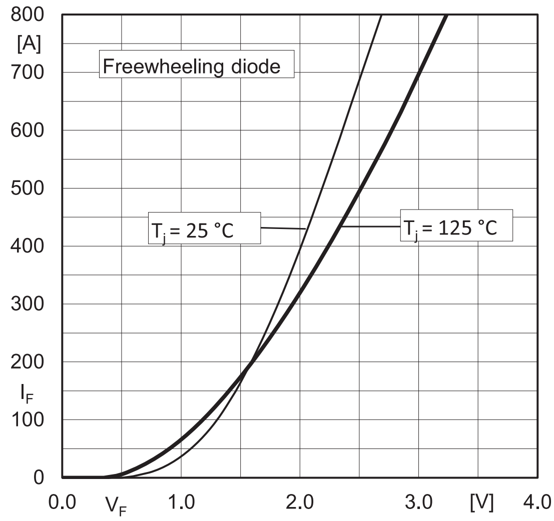
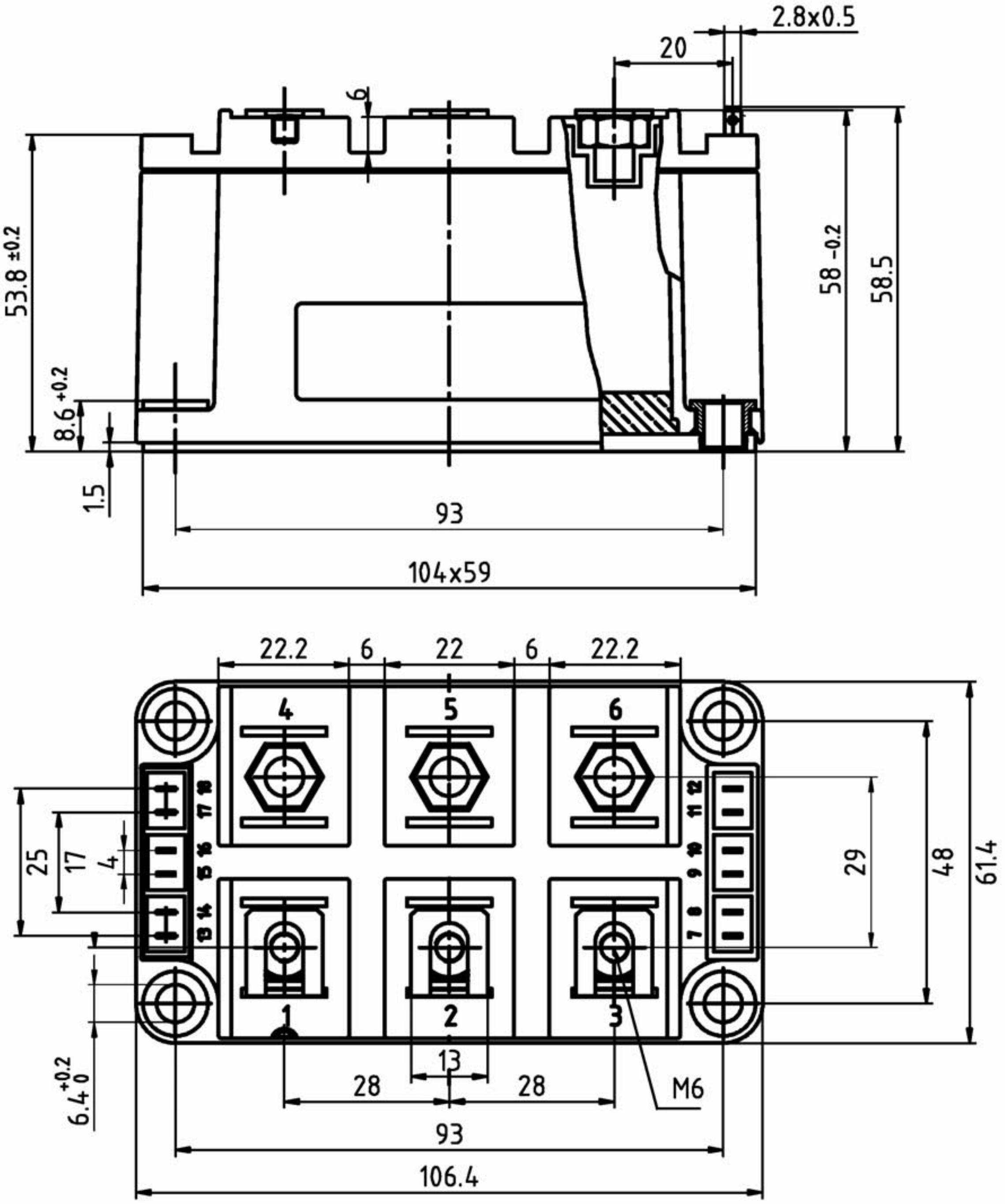



Fig. 10: Typ. CAL diode forward charact., incl. $R_{CC'+EE'}$

Dimensions in mm

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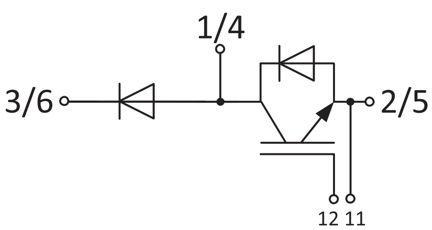


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This is an electrostatic discharge sensitive device (ESDS) due to international standard IEC 61340.

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