# SKM400GAR12F4

**SEMITRANS® 3**

## High Speed IGBT4 Modules

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### Features*

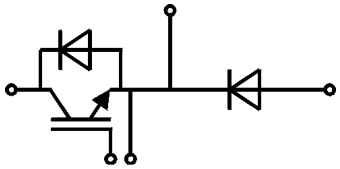
- High speed trench and field-stop IGBT
- CAL4 ultra-fast = soft switching 4. generation CAL-diode
- Insulated copper baseplate using DBC technology (Direct Bonded Copper)
- Increased power cycling capability
- For higher switching frequencies above 15kHz
- UL recognized, file no. E63532

### Typical Applications

- Electronic welders
- DC/DC – converter
- Brake chopper
- Switched reluctance motor

### Remarks

- Case temperature limited to $T_c$ = 125°C max.
- Recommended $T_{op}$ = -40 ... +150°C
- Product reliability results valid for $T_j$ = 150°C



**GAR**

**Absolute Maximum Ratings**

| Symbol | Conditions | | Values | Unit |
|---|---|---|---|---|
| **IGBT** | | | | |
| $V_{CES}$ | $T_j$ = 25 °C | | 1200 | V |
| $I_C$ | $T_j$ = 175 °C | $T_c$ = 25 °C | 548 | A |
| | | $T_c$ = 80 °C | 418 | A |
| $I_{Cnom}$ | | | 400 | A |
| $I_{CRM}$ | $I_{CRM}$ = 2 x $I_{Cnom}$ | | 800 | A |
| $V_{GES}$ | | | -20 ... 20 | V |
| $t_{psc}$ | $V_{CC}$ = 800 V<br>$V_{GE}$ ≤ 15 V<br>$V_{CES}$ ≤ 1200 V<br>$R_{G\ on/off}$ ≥ 3 Ω | $T_j$ = 150 °C | 10 | µs |
| $T_j$ | | | -40 ... 175 | °C |
| **Inverse diode** | | | | |
| $V_{RRM}$ | $T_j$ = 25 °C | | 1200 | V |
| $I_F$ | $T_j$ = 175 °C | $T_c$ = 25 °C | 402 | A |
| | | $T_c$ = 80 °C | 295 | A |
| $I_{Fnom}$ | | | 400 | A |
| $I_{FRM}$ | $I_{FRM}$ = 2x$I_{Fnom}$ | | 800 | A |
| $I_{FSM}$ | $t_p$ = 10 ms, sin 180°, $T_j$ = 25 °C | | 1980 | A |
| $T_j$ | | | -40 ... 175 | °C |
| **Freewheeling diode** | | | | |
| $V_{RRM}$ | $T_j$ = 25 °C | | 1200 | V |
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| $T_j$ | | | -40 ... 175 | °C |
| **Module** | | | | |
| $I_{t(RMS)}$ | | | 500 | A |
| $T_{stg}$ | module without TIM | | -40 ... 125 | °C |
| $V_{isol}$ | AC sinus 50 Hz, t = 1 min | | 4000 | V |

**Characteristics**

| Symbol | Conditions | | min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|
| **IGBT** | | | | | | |
| $V_{CE(sat)}$ | $I_C$ = 400 A<br>$V_{GE}$ = 15 V<br>chiplevel | $T_j$ = 25 °C | | 2.06 | 2.44 | V |
| | | $T_j$ = 150 °C | | 2.59 | 2.97 | V |
| $V_{CE0}$ | chiplevel | $T_j$ = 25 °C | | 1.10 | 1.28 | V |
| | | $T_j$ = 150 °C | | 0.95 | 1.13 | V |
| $r_{CE}$ | $V_{GE}$ = 15 V<br>chiplevel | $T_j$ = 25 °C | | 2.4 | 2.9 | mΩ |
| | | $T_j$ = 150 °C | | 4.1 | 4.6 | mΩ |
| $V_{GE(th)}$ | $V_{GE}$=$V_{CE}$, $I_C$ = 15.2 mA | | 5.1 | 5.8 | 6.4 | V |
| $I_{CES}$ | $V_{GE}$ = 0 V<br>$V_{CE}$ = 1200 V | $T_j$ = 25 °C | | | 5 | mA |
| | | $T_j$ = 150 °C | | - | | mA |
| $C_{ies}$ | $V_{CE}$ = 25 V<br>$V_{GE}$ = 0 V | f = 1 MHz | | 24.6 | | nF |
| $C_{oes}$ | | f = 1 MHz | | 1.62 | | nF |
| $C_{res}$ | | f = 1 MHz | | 1.38 | | nF |
| $Q_G$ | $V_{GE}$ = - 8 V...+ 15 V | | | 2268 | | nC |
| $R_{Gint}$ | $T_j$ = 25 °C | | | 1.6 | | Ω |

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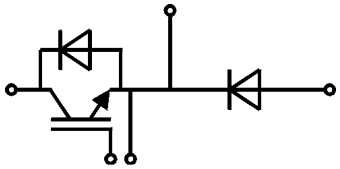

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**Characteristics**

| Symbol | Conditions | | min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$ | $V_{CC}$ = 600 V<br>$I_C$ = 400 A<br>$V_{GE}$ = +15/-15 V<br>$R_{G\ on}$ = 2 Ω<br>$R_{G\ off}$ = 1 Ω<br>$di/dt_{on}$ = 7960 A/µs<br>$di/dt_{off}$ = 4430 A/µs<br>dv/dt = 4530 V/µs | $T_j$ = 150 °C | | 110 | | ns |
| $t_r$ | | $T_j$ = 150 °C | | 55 | | ns |
| $E_{on}$ | | $T_j$ = 150 °C | | 28 | | mJ |
| $t_{d(off)}$ | | $T_j$ = 150 °C | | 415 | | ns |
| $t_f$ | | $T_j$ = 150 °C | | 75 | | ns |
| $E_{off}$ | | $T_j$ = 150 °C | | 32 | | mJ |
| $R_{th(j-c)}$ | per IGBT | | | | 0.072 | K/W |
| $R_{th(c-s)}$ | per IGBT ($\lambda_{grease}$=0.81 W/(m*K)) | | | 0.041 | | K/W |
| **Inverse diode** | | | | | | |
| $V_F = V_{EC}$ | $I_F$ = 400 A<br>$V_{GE}$ = 0 V<br>chiplevel | $T_j$ = 25 °C | | 2.55 | 2.93 | V |
| | | $T_j$ = 150 °C | | 2.44 | 2.80 | V |
| $V_{F0}$ | chiplevel | $T_j$ = 25 °C | | 1.51 | 1.75 | V |
| | | $T_j$ = 150 °C | | 1.16 | 1.40 | V |
| $r_F$ | chiplevel | $T_j$ = 25 °C | | 2.6 | 2.9 | mΩ |
| | | $T_j$ = 150 °C | | 3.2 | 3.5 | mΩ |
| $I_{RRM}$ | $I_F$ = 400 A<br>$di/dt_{off}$ = 7183 A/µs<br>$V_{GE}$ = -15 V<br>$V_{CC}$ = 600 V | $T_j$ = 150 °C | | 424 | | A |
| $Q_{rr}$ | | $T_j$ = 150 °C | | 51 | | µC |
| $E_{rr}$ | | $T_j$ = 150 °C | | 18.5 | | mJ |
| $R_{th(j-c)}$ | per diode | | | | 0.14 | K/W |
| $R_{th(c-s)}$ | per diode ($\lambda_{grease}$=0.81 W/(m*K)) | | | 0.047 | | K/W |
| **Freewheeling diode** | | | | | | |
| $V_F = V_{EC}$ | $I_F$ = 400 A<br>$V_{GE}$ = 0 V<br>chiplevel | $T_j$ = 25 °C | | 2.55 | 2.93 | V |
| | | $T_j$ = 150 °C | | 2.44 | 2.80 | V |
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| $E_{rr}$ | | $T_j$ = 150 °C | | 18.5 | | mJ |
| $R_{th(j-c)}$ | per diode | | | | 0.14 | K/W |
| $R_{th(c-s)}$ | per diode ($\lambda_{grease}$=0.81 W/(m*K)) | | | 0.047 | | K/W |
| **Module** | | | | | | |
| $L_{CE}$ | | | | 15 | | nH |
| $R_{CC'+EE'}$ | measured per switch | $T_C$ = 25 °C | | 0.55 | | mΩ |
| | | $T_C$ = 125 °C | | 0.85 | | mΩ |
| $R_{th(c-s)1}$ | calculated without thermal coupling ($\lambda_{grease}$=0.81 W/(m*K)) | | | 0.0219 | | K/W |
| $R_{th(c-s)2}$ | including thermal coupling, $T_s$ underneath module ($\lambda_{grease}$=0.81 W/(m*K)) | | | 0.024 | | K/W |
| $M_s$ | to heat sink M6 | | 3 | | 5 | Nm |
| $M_t$ | | to terminals M6 | 2.5 | | 5 | Nm |
| | | | | | | Nm |
| w | | | | | 325 | g |

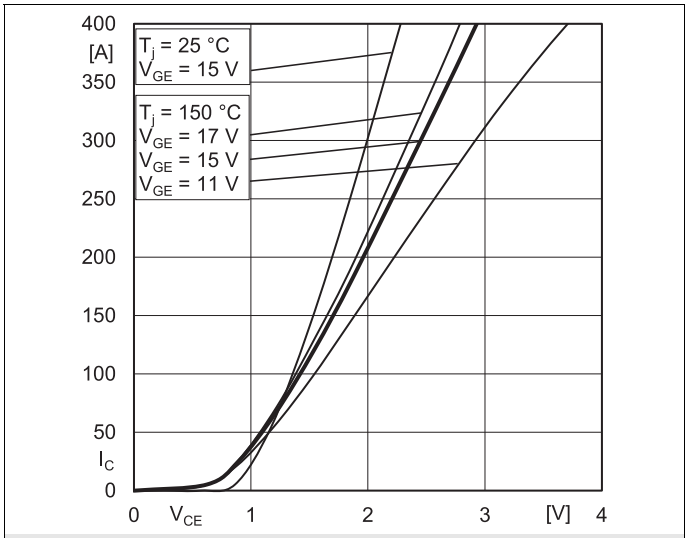



Fig. 1: Typ. output characteristic, inclusive $R_{CC'+EE'}$

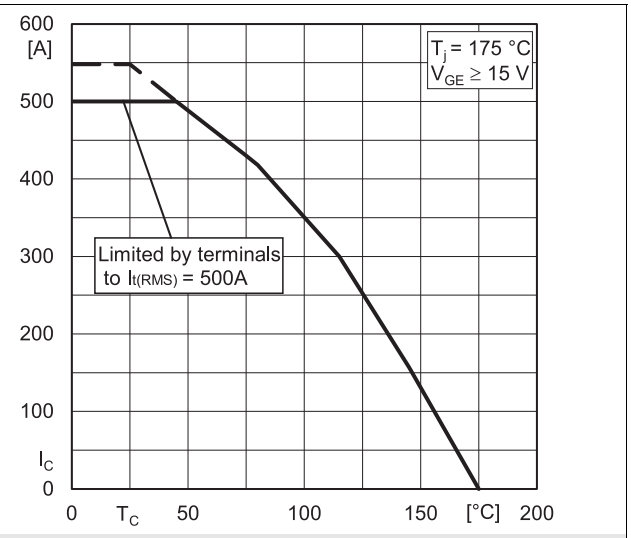



Fig. 2: Rated current vs. temperature $I_C = f(T_C)$

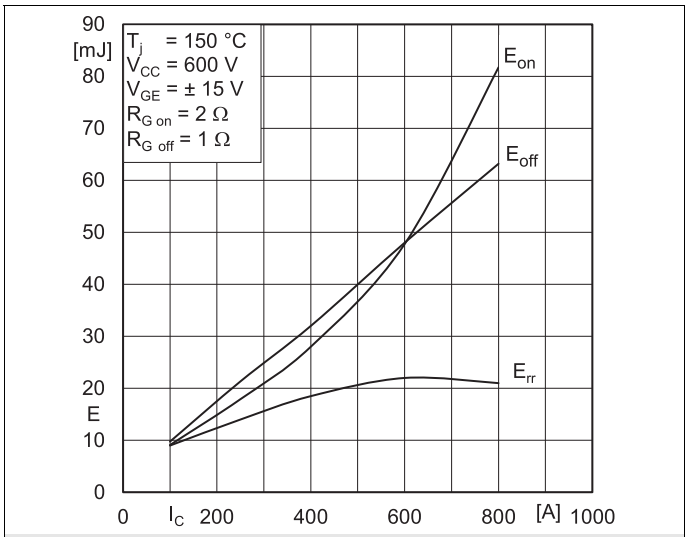



Fig. 3: Typ. turn-on /-off energy = f ($I_C$)

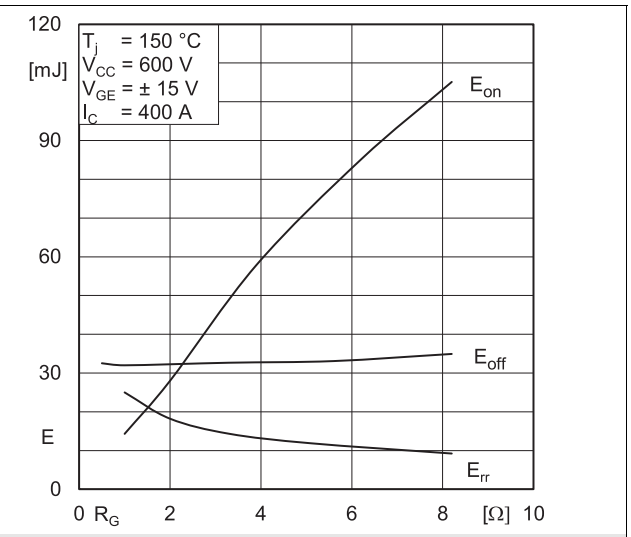



Fig. 4: Typ. turn-on /-off energy = f ($R_G$)

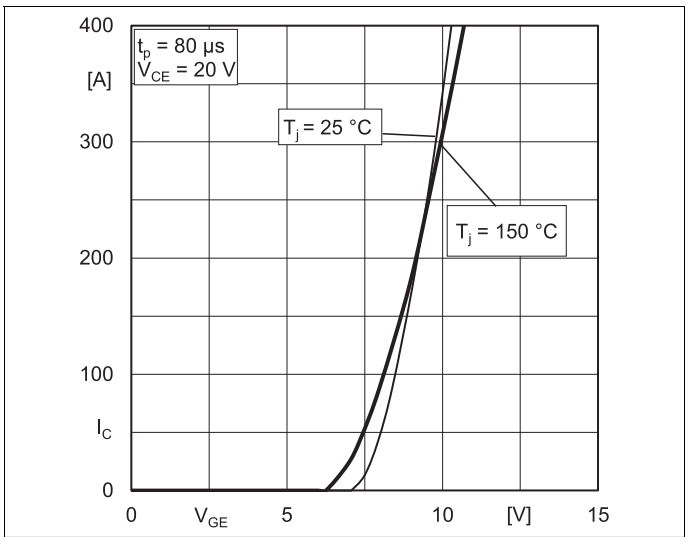



Fig. 5: Typ. transfer characteristic

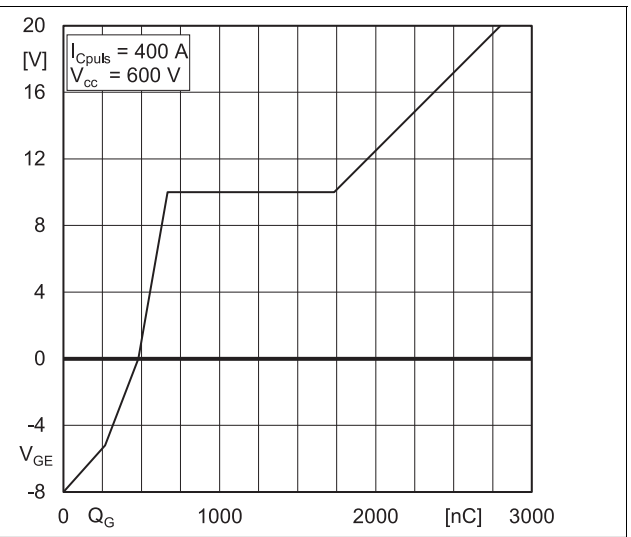



Fig. 6: Typ. gate charge characteristic

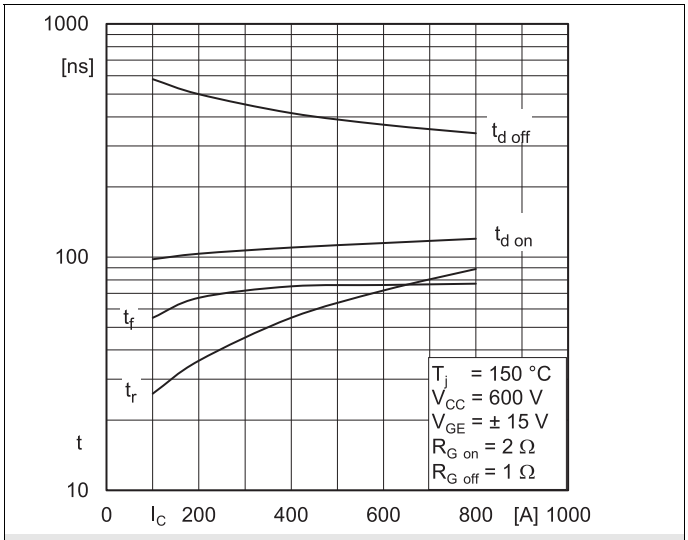



Fig. 7: Typ. switching times vs. $I_C$

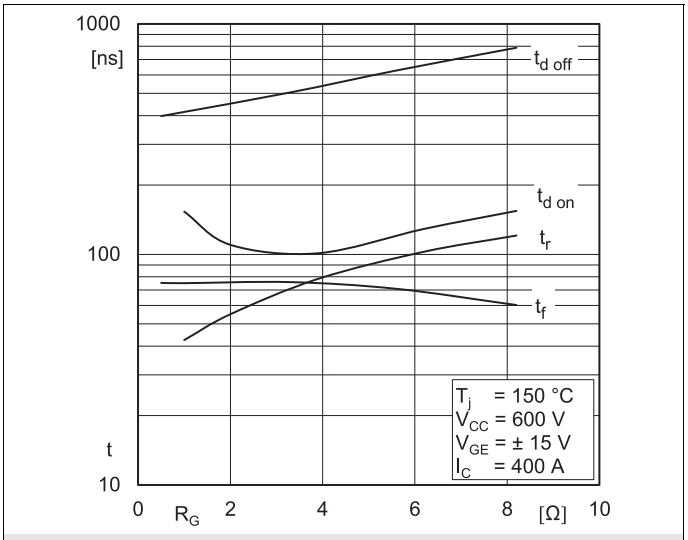



Fig. 8: Typ. switching times vs. gate resistor $R_G$

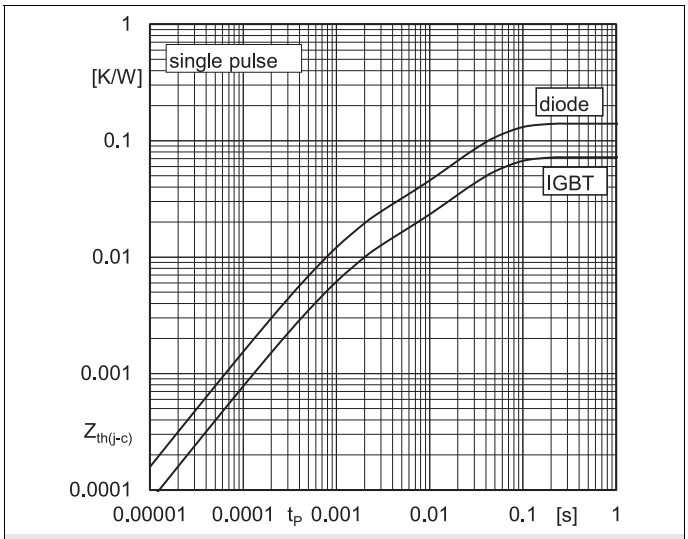



Fig. 9: Transient thermal impedance

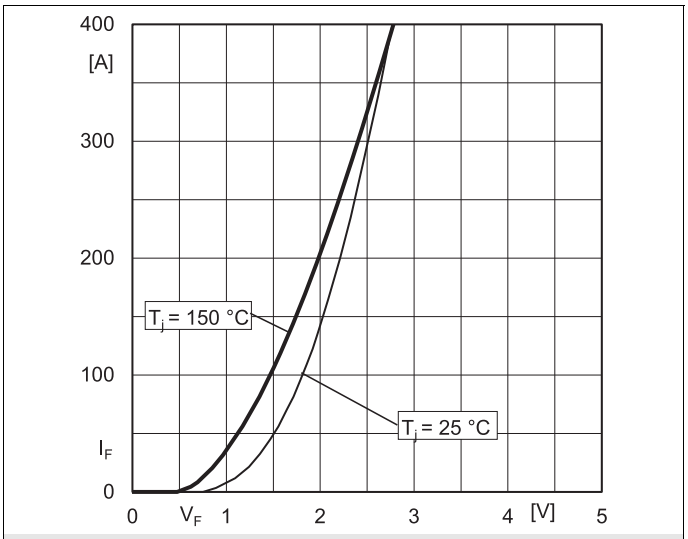



Fig. 10: Typ. CAL diode forward charact., incl. $R_{CC'+EE'}$

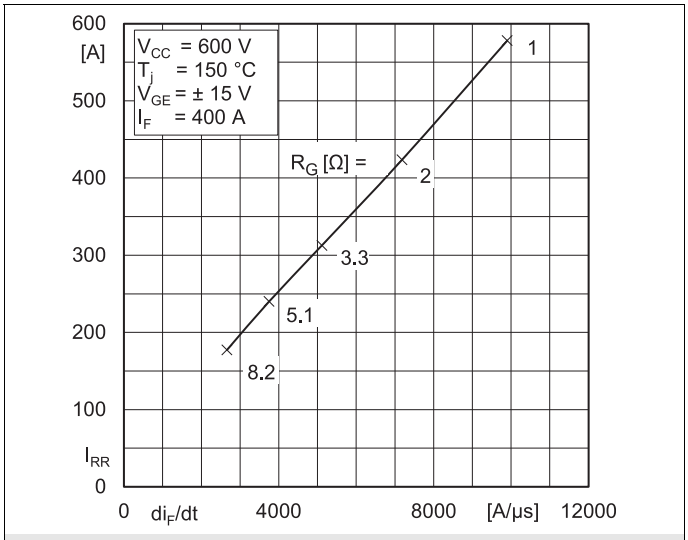



Fig. 11: Typ. CAL diode peak reverse recovery current

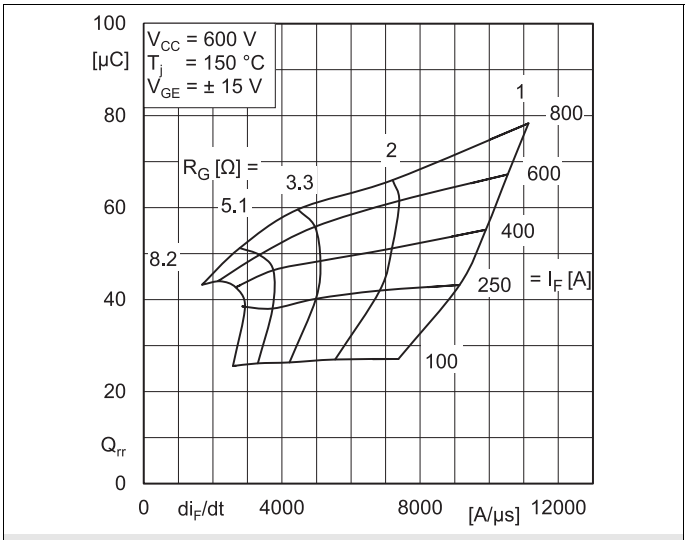



Fig. 12: Typ. CAL diode peak reverse recovery charge

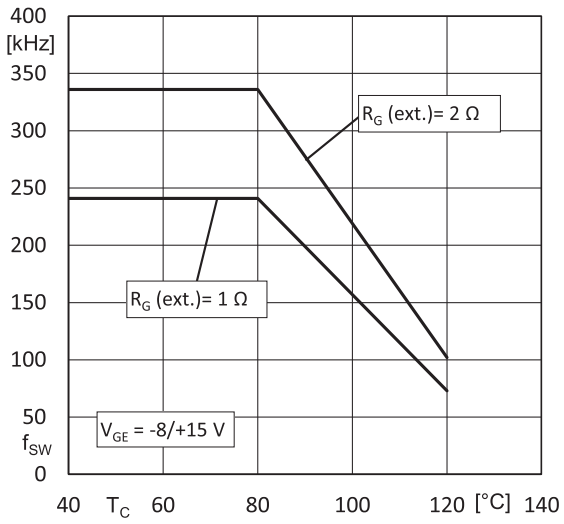
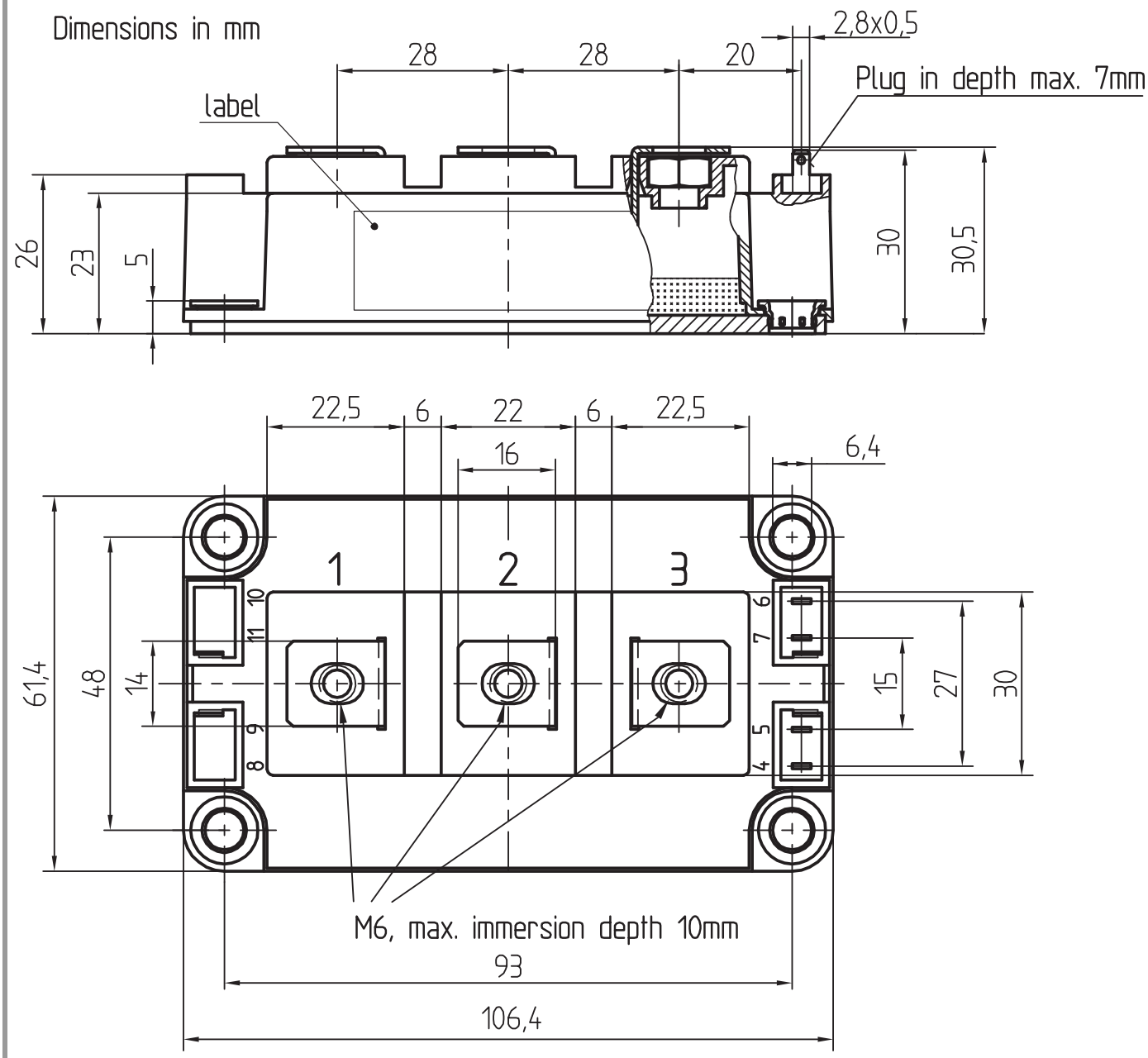



Fig. 13: Max. switching frequency vs. case temperature
$f_{sw} = f(T_c)$

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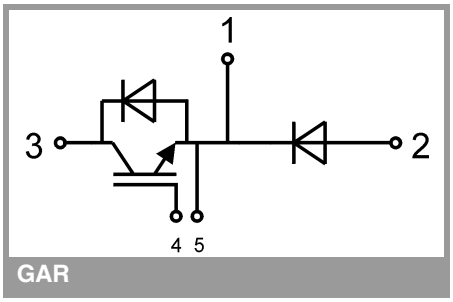


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This is an electrostatic discharge sensitive device (ESDS), international standard IEC 60747-1, chapter IX.

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