SKiM® 93

Trench IGBT Modules

**SKiM609GAR12E4**

### Features

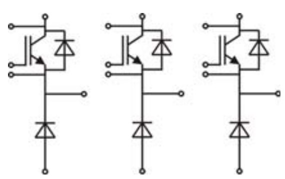
- IGBT 4 Trench Gate Technology
- Solderless sinter technology
- $V_{CE(sat)}$ with positive temperature coefficient
- Low inductance case
- Isolated by $Al_2O_3$ DCB (Direct Copper Bonded) ceramic substrate
- Pressure contact technology for thermal contacts
- Spring contact system to attach driver PCB to the control terminals
- High short circuit capability, self limiting to 6 x $I_C$
- Integrated temperature sensor

### Typical Applications*

- Automotive inverter
- High reliability AC inverter wind
- High reliability AC inverter drives

### Remarks

- Case temperature limited to $T_s$ = 125°C max; $T_c$ = $T_s$ (for baseplateless modules)
- Recommended $T_{op}$ = -40 … +150°C



GAR

**Absolute Maximum Ratings**

| Symbol | Conditions | | Values | Unit |
|---|---|---|---|---|
| **IGBT** | | | | |
| $V_{CES}$ | | | 1200 | V |
| $I_C$ | $T_j$ = 175 °C | $T_s$ = 25 °C | 748 | A |
| | | $T_s$ = 70 °C | 608 | A |
| $I_{Cnom}$ | | | 600 | A |
| $I_{CRM}$ | $I_{CRM}$ = 3x$I_{Cnom}$ | | 1800 | A |
| $V_{GES}$ | | | -20 ... 20 | V |
| $t_{psc}$ | $V_{CC}$ = 800 V<br>$V_{GE} \leq$ 15 V<br>$V_{CES} \leq$ 1200 V | $T_j$ = 150 °C | 10 | µs |
| $T_j$ | | | -40 ... 175 | °C |
| **Inverse diode** | | | | |
| $I_F$ | $T_j$ = 175 °C | $T_s$ = 25 °C | 139 | A |
| | | $T_s$ = 70 °C | 110 | A |
| $I_{Fnom}$ | | | 600 | A |
| $I_{FRM}$ | $I_{FRM}$ = 3x$I_{Fnom}$ | | 1800 | A |
| $I_{FSM}$ | $t_p$ = 10 ms, sin 180°, $T_j$ = 25 °C | | 900 | A |
| $T_j$ | | | -40 ... 175 | °C |
| **Freewheeling diode** | | | | |
| $I_F$ | $T_j$ = 175 °C | $T_s$ = 25 °C | 1397 | A |
| | | $T_s$ = 70 °C | 1107 | A |
| $I_{Fnom}$ | | | 1350 | A |
| $I_{FRM}$ | $I_{FRM}$ = 3x$I_{Fnom}$ | | 4050 | A |
| $I_{FSM}$ | $t_p$ = 10 ms, sin 180°, $T_j$ = 25 °C | | 6480 | A |
| $T_j$ | | | -40 ... 175 | °C |
| **Module** | | | | |
| $I_{t(RMS)}$ | $T_{terminal}$ = 80 °C | | 700 | A |
| $T_{stg}$ | | | -40 ... 125 | °C |
| $V_{isol}$ | AC sinus 50 Hz, t = 1 min | | 2500 | V |

**Characteristics**

| Symbol | Conditions | | min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|
| **IGBT** | | | | | | |
| $V_{CE(sat)}$ | $I_C$ = 600 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 |
| $V_{CE0}$ | | $T_j$ = 25 °C | | 0.8 | 0.9 | V |
| | | $T_j$ = 150 °C | | 0.7 | 0.8 | V |
| $r_{CE}$ | $V_{GE}$ = 15 V | $T_j$ = 25 °C | | 1.8 | 2.0 | mΩ |
| | | $T_j$ = 150 °C | | 2.6 | 2.8 | mΩ |
| $V_{GE(th)}$ | $V_{GE}$=$V_{CE}$, $I_C$ = 24 mA | | 5 | 5.8 | 6.5 | V |
| $I_{CES}$ | $V_{GE}$ = 0 V<br>$V_{CE}$ = 1200 V | $T_j$ = 25 °C | | 0.1 | 0.3 | mA |
| | | $T_j$ = 150 °C | | | | mA |
| $C_{ies}$ | $V_{CE}$ = 25 V<br>$V_{GE}$ = 0 V | f = 1 MHz | | 35.20 | | nF |
| $C_{oes}$ | | f = 1 MHz | | 2.32 | | nF |
| $C_{res}$ | | f = 1 MHz | | 1.88 | | nF |
| $Q_G$ | $V_{GE}$ = - 8 V...+ 15 V | | | 3400 | | nC |
| $R_{Gint}$ | $T_j$ = 25 °C | | | 1.3 | | Ω |

**SKiM® 93**

## Trench IGBT Modules

**SKiM609GAR12E4**

### Features

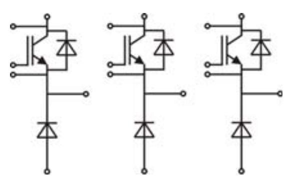
- IGBT 4 Trench Gate Technology
- Solderless sinter technology
- $V_{CE(sat)}$ with positive temperature coefficient
- Low inductance case
- Isolated by $Al_2O_3$ DCB (Direct Copper Bonded) ceramic substrate
- Pressure contact technology for thermal contacts
- Spring contact system to attach driver PCB to the control terminals
- High short circuit capability, self limiting to 6 x $I_C$
- Integrated temperature sensor

### Typical Applications*

- Automotive inverter
- High reliability AC inverter wind
- High reliability AC inverter drives

### Remarks

- Case temperature limited to $T_s$ = 125°C max; $T_c = T_s$ (for baseplateless modules)
- Recommended $T_{op}$ = -40 … +150°C



**GAR**

| **Characteristics** | | | | | | |
|---|---|---|---|---|---|---|
| **Symbol** | **Conditions** | | **min.** | **typ.** | **max.** | **Unit** |
| $t_{d(on)}$ | $V_{CC}$ = 600 V | $T_j$ = 150 °C | | 150 | | ns |
| $t_r$ | $I_C$ = 600 A | $T_j$ = 150 °C | | 121 | | ns |
| $E_{on}$ | $V_{GE}$ = ±15 V | $T_j$ = 150 °C | | 136 | | mJ |
| $t_{d(off)}$ | $R_{G\,on}$ = 4.1 Ω<br>$R_{G\,off}$ = 4.1 Ω | $T_j$ = 150 °C | | 808 | | ns |
| $t_f$ | $di/dt_{on}$ = 5000 A/µs | $T_j$ = 150 °C | | 100 | | ns |
| $E_{off}$ | $di/dt_{off}$ = 4400 A/µs | $T_j$ = 150 °C | | 83 | | mJ |
| $R_{th(j-s)}$ | per IGBT | | | | 0.068 | K/W |
| **Inverse diode** | | | | | | |
| $V_F = V_{EC}$ | $I_F$ = 150 A | $T_j$ = 25 °C | | 2.1 | 2.5 | V |
| | $V_{GE}$ = 0 V<br>chiplevel | $T_j$ = 150 °C | | 2.1 | 2.4 | V |
| $V_{F0}$ | | $T_j$ = 25 °C | 1.1 | 1.3 | 1.5 | V |
| | | $T_j$ = 150 °C | 0.7 | 0.9 | 1.1 | V |
| $r_F$ | | $T_j$ = 25 °C | 4.3 | 5.6 | 6.4 | mΩ |
| | | $T_j$ = 150 °C | 6.7 | 7.8 | 8.5 | mΩ |
| $I_{RRM}$ | $I_F$ = 150 A | $T_j$ = 150 °C | | 153 | | A |
| $Q_{rr}$ | $di/dt_{off}$ = 3300 A/µs | $T_j$ = 150 °C | | 15 | | µC |
| $E_{rr}$ | $V_{GE}$ = -15 V<br>$V_{CC}$ = 600 V | $T_j$ = 150 °C | | 9 | | mJ |
| $R_{th(j-s)}$ | per diode | | | | 0.501 | K/W |
| **Freewheeling diode** | | | | | | |
| $V_F = V_{EC}$ | $I_F$ = 600 A | $T_j$ = 25 °C | | 1.7 | 1.9 | V |
| | $V_{GE}$ = 0 V<br>chiplevel | $T_j$ = 150 °C | | 1.4 | 1.7 | V |
| $V_{F0}$ | | $T_j$ = 25 °C | 1.1 | 1.3 | 1.5 | V |
| | | $T_j$ = 150 °C | 0.7 | 0.9 | 1.1 | V |
| $r_F$ | | $T_j$ = 25 °C | 0.5 | 0.6 | 0.7 | mΩ |
| | | $T_j$ = 150 °C | 0.7 | 0.9 | 0.9 | mΩ |
| $I_{RRM}$ | $I_F$ = 600 A | $T_j$ = 150 °C | | 510 | | A |
| $Q_{rr}$ | $di/dt_{off}$ = 5300 A/µs | $T_j$ = 150 °C | | 123 | | µC |
| $E_{rr}$ | $V_{GE}$ = -15 V<br>$V_{CC}$ = 600 V | $T_j$ = 150 °C | | 39 | | mJ |
| $R_{th(j-s)}$ | per diode | | | | 0.048 | K/W |
| **Module** | | | | | | |
| $L_{CE}$ | | | | 10 | 15 | nH |
| $R_{CC'+EE'}$ | terminal-chip | $T_s$ = 25 °C | | 0.3 | | mΩ |
| | | $T_s$ = 125 °C | | 0.5 | | mΩ |
| w | | | | 1042 | | g |
| **Temperature Sensor** | | | | | | |
| $R_{100}$ | $T_{Sensor}$ = 100 °C ($R_{25}$ = 5 kΩ) | | | 339 | | Ω |
| $B_{100/125}$ | $R_{(T)} = R_{100}exp[B_{100/125}(1/T-1/373)]$; T[K]; | | | 4096 | | K |

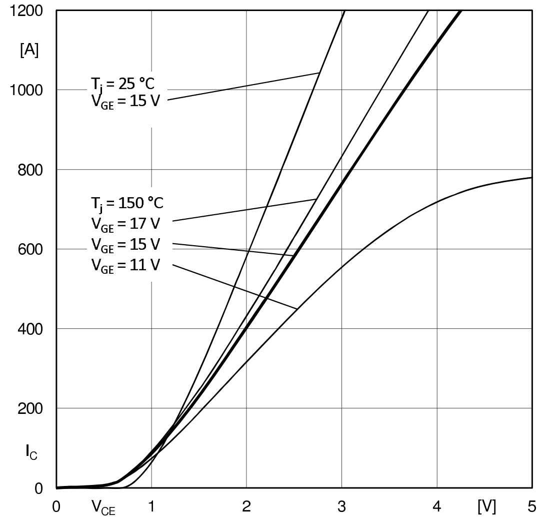



Fig. 1: Typ. output characteristic, inclusive $R_{CC'+ EE'}$

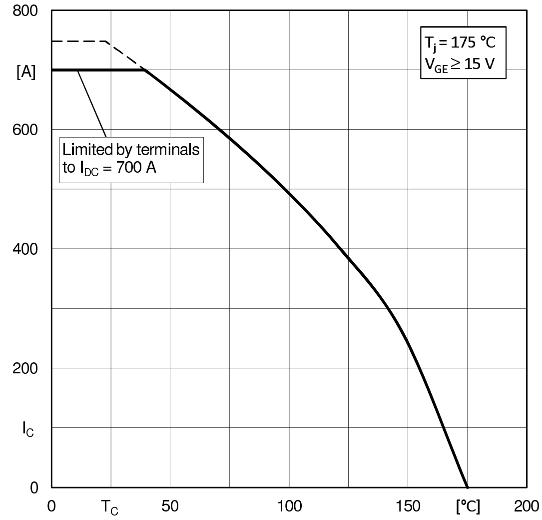



Fig. 2: Rated current vs. temperature $I_C$ = f ($T_C$)

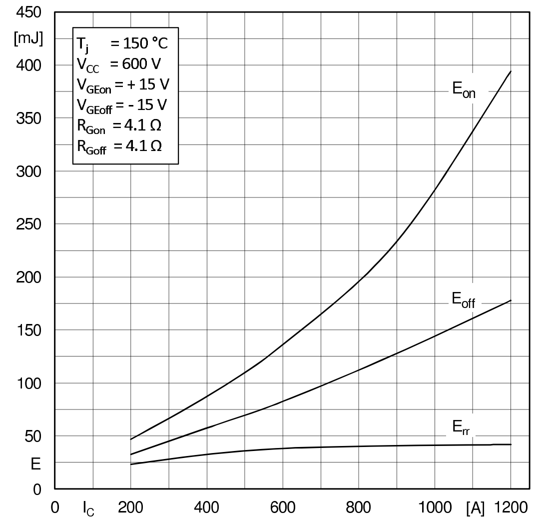



Fig. 3: Typ. turn-on /-off energy = f ($I_C$)

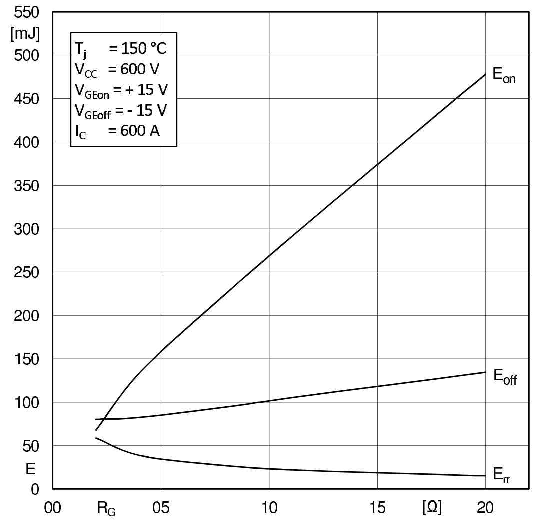



Fig. 4: Typ. turn-on /-off energy = f ($R_G$)

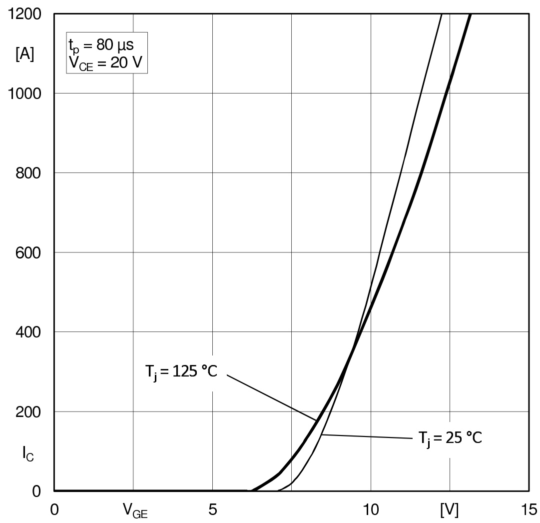



Fig. 5: Typ. transfer characteristic

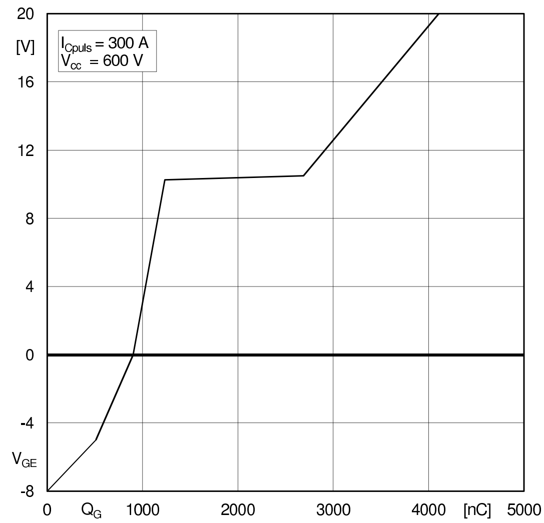



Fig. 6: Typ. gate charge characteristic

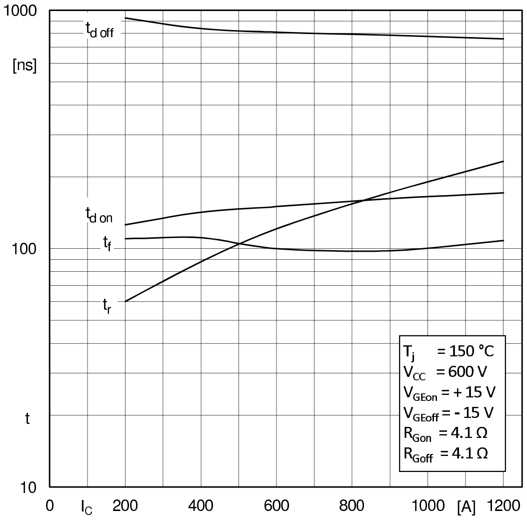



Fig. 7: Typ. switching times vs. $I_C$

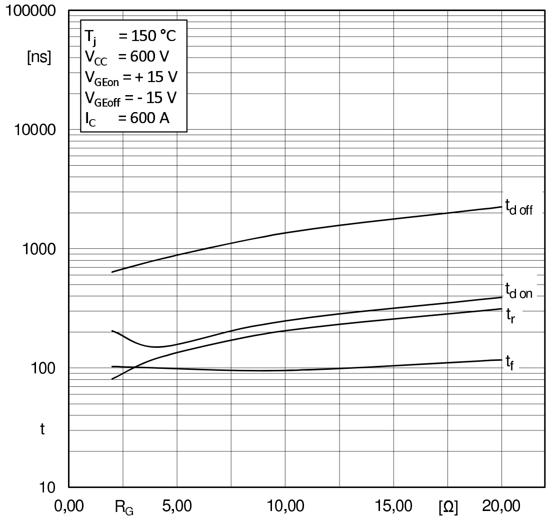



Fig. 8: Typ. switching times vs. gate resistor $R_G$

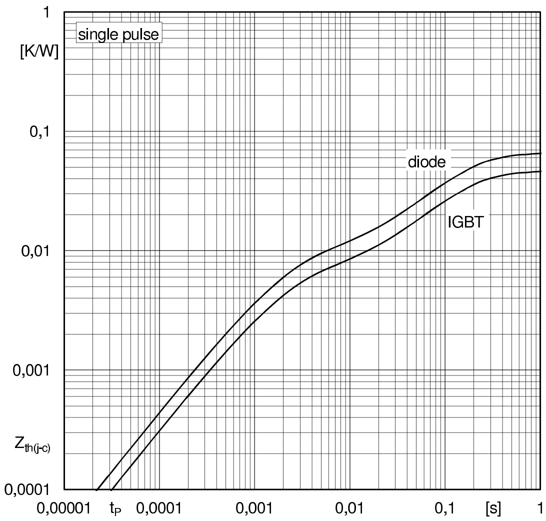



Fig. 9: Typ. transient thermal impedance

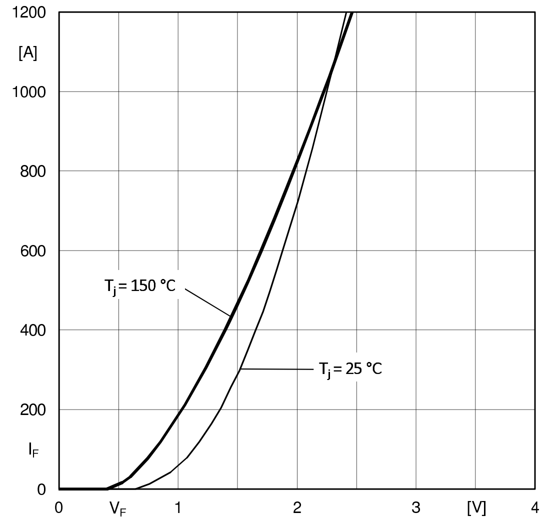



Fig. 10: Typ. CAL diode forward charact., incl. $R_{CC'+EE'}$

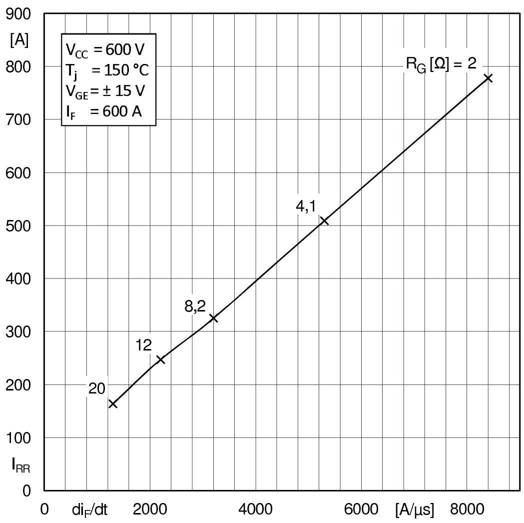



Fig. 11: Typ. CAL diode peak reverse recovery current

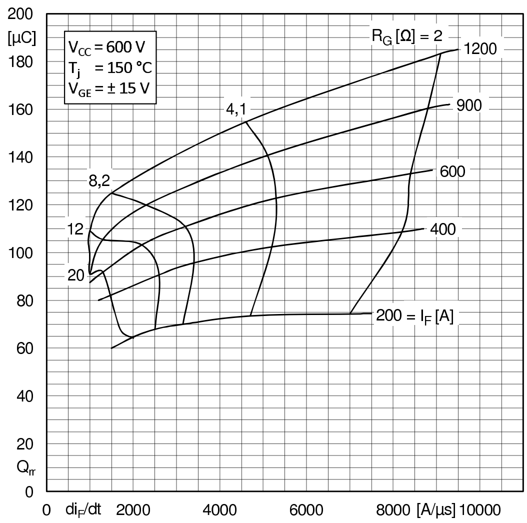
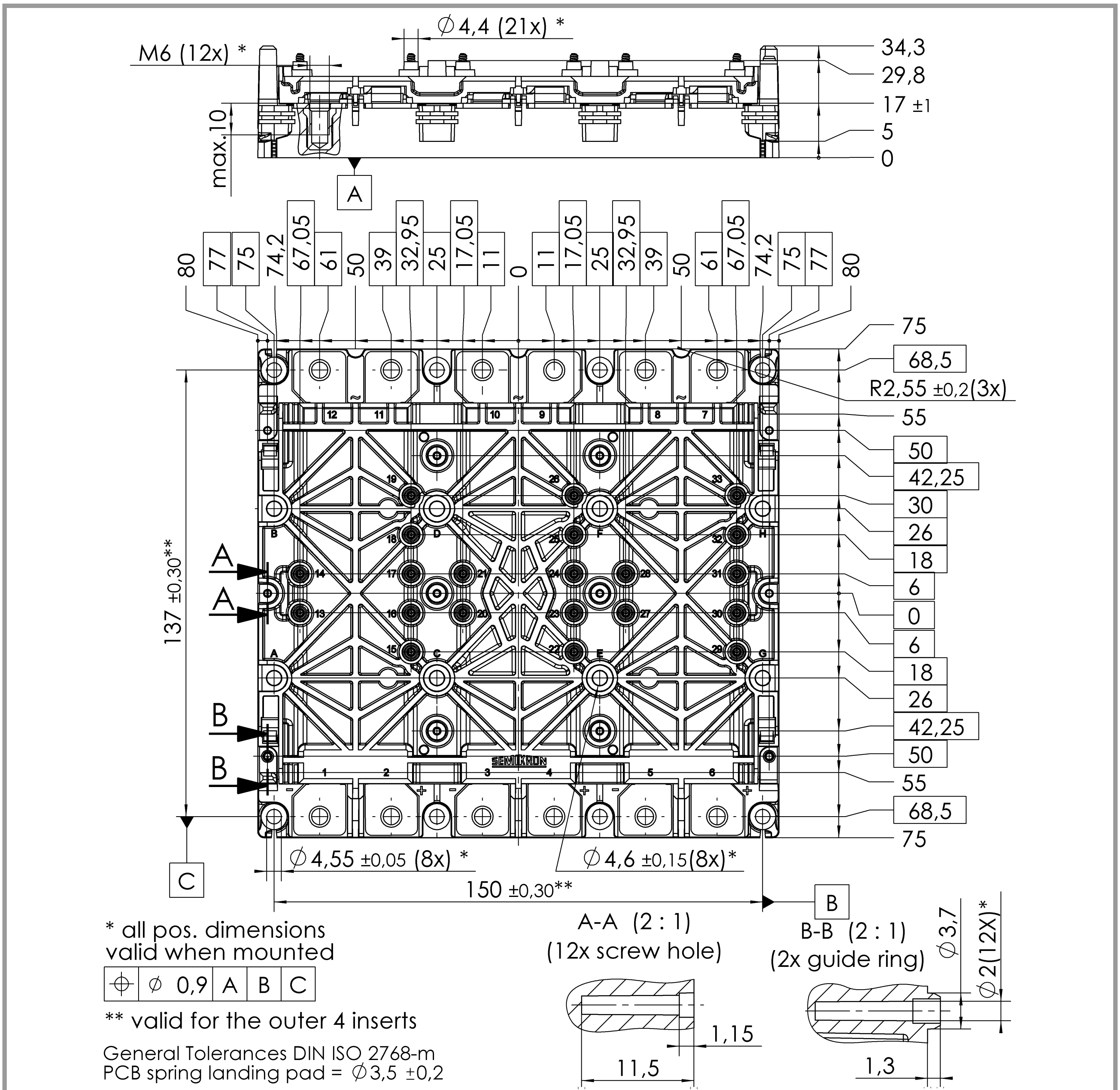
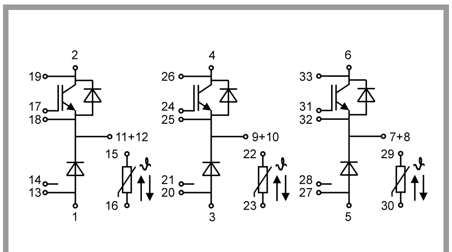



Fig. 12: Typ. CAL diode recovery charge




SKIM 93




GAR

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

* The specifications of our components may not be considered as an assurance of component characteristics. Components have to be tested for the respective application. Adjustments may be necessary. The use of SEMIKRON products in life support appliances and systems is subject to prior specification and written approval by SEMIKRON. We therefore strongly recommend prior consultation of our staff.