

SKM400GAL12T4



SEMITRANS®3

Fast IGBT4 Modules

SKM400GAL12T4

Features

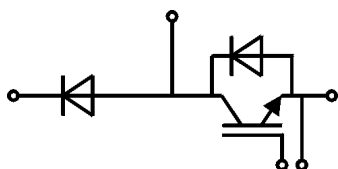
- $V_{CE(sat)}$ with positive temperature coefficient
- High short circuit capability, self limiting to $6 \times I_{Cnom}$
- Fast & soft inverse CAL diodes
- Large clearance (10 mm) and creepage distances (20 mm)
- Isolated copper baseplate using DBC Technology (Direct Copper Bonding)

Typical Applications

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

Remarks

- Case temperature limited to $T_c = 125^\circ\text{C}$ max, recomm. $T_{op} = -40 \dots +150^\circ\text{C}$, product rel. results valid for $T_j = 150^\circ$



GAL

| Absolute Maximum Ratings | | | | |
|---------------------------|--|---------------------------|-------------|------------------|
| Symbol | Conditions | | Values | Unit |
| IGBT | | | | |
| V_{CES} | | | 1200 | V |
| I_C | $T_j = 175^\circ\text{C}$ | $T_c = 25^\circ\text{C}$ | 618 | A |
| | | $T_c = 80^\circ\text{C}$ | 475 | A |
| I_{Cnom} | | | 400 | A |
| I_{CRM} | $I_{CRM} = 3 \times I_{Cnom}$ | | 1200 | A |
| V_{GES} | | | -20 ... 20 | V |
| t_{psc} | $V_{CC} = 800\text{ V}$ | $T_j = 150^\circ\text{C}$ | 10 | μs |
| | $V_{GE} \leq 15\text{ V}$ $V_{CES} \leq 1200\text{ V}$ | | | |
| T_j | | | -40 ... 175 | $^\circ\text{C}$ |
| Inverse diode | | | | |
| I_F | $T_j = 175^\circ\text{C}$ | $T_c = 25^\circ\text{C}$ | 440 | A |
| | | $T_c = 80^\circ\text{C}$ | 329 | A |
| I_{Fnom} | | | 400 | A |
| I_{FRM} | $I_{FRM} = 3 \times I_{Fnom}$ | | 1200 | A |
| I_{FSM} | $t_p = 10\text{ ms, sin } 180^\circ, T_j = 25^\circ\text{C}$ | | 1980 | A |
| T_j | | | -40 ... 175 | $^\circ\text{C}$ |
| Freewheeling diode | | | | |
| I_F | $T_j = 175^\circ\text{C}$ | $T_c = 25^\circ\text{C}$ | 440 | A |
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| T_j | | | -40 ... 175 | $^\circ\text{C}$ |
| Module | | | | |
| $I_{t(RMS)}$ | | | 500 | A |
| T_{stg} | | | -40 ... 125 | $^\circ\text{C}$ |
| V_{isol} | AC sinus 50Hz, $t = 1\text{ min}$ | | 4000 | V |

| Characteristics | | | | | | |
|-----------------|--|---------------------------|------|------|------|------------------|
| Symbol | Conditions | | min. | typ. | max. | Unit |
| IGBT | | | | | | |
| $V_{CE(sat)}$ | $I_C = 400\text{ A}$ $V_{GE} = 15\text{ V}$ chipelevel | $T_j = 25^\circ\text{C}$ | 1.8 | 2.05 | | V |
| | | $T_j = 150^\circ\text{C}$ | 2.2 | 2.4 | | V |
| V_{CE0} | | $T_j = 25^\circ\text{C}$ | 0.8 | 0.9 | | V |
| | | $T_j = 150^\circ\text{C}$ | 0.7 | 0.8 | | V |
| r_{CE} | $V_{GE} = 15\text{ V}$ | $T_j = 25^\circ\text{C}$ | 2.5 | 2.9 | | $\text{m}\Omega$ |
| | | $T_j = 150^\circ\text{C}$ | 3.8 | 4.0 | | $\text{m}\Omega$ |
| $V_{GE(th)}$ | $V_{GE} = V_{CE}, I_C = 15.2\text{ mA}$ | | 5 | 5.8 | 6.5 | V |
| I_{CES} | $V_{GE} = 0\text{ V}$ $V_{CE} = 1200\text{ V}$ | $T_j = 25^\circ\text{C}$ | 0.1 | 0.3 | | mA |
| | | $T_j = 150^\circ\text{C}$ | | | | mA |
| C_{ies} | $V_{CE} = 25\text{ V}$ $V_{GE} = 0\text{ V}$ | $f = 1\text{ MHz}$ | 24.6 | | | nF |
| C_{oes} | | $f = 1\text{ MHz}$ | 1.62 | | | nF |
| C_{res} | | $f = 1\text{ MHz}$ | 1.38 | | | nF |
| Q_G | $V_{GE} = -8\text{ V} \dots +15\text{ V}$ | | 2260 | | | nC |
| R_{Gint} | $T_j = 25^\circ\text{C}$ | | 1.9 | | | Ω |

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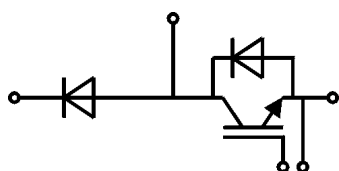
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- Brake chopper
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Remarks

- Case temperature limited to $T_c = 125^\circ\text{C}$ max, recomm. $T_{op} = -40 \dots +150^\circ\text{C}$, product rel. results valid for $T_j = 150^\circ$

| Characteristics | | | | | | |
|--------------------|---|---------------------------|------|------|-------|---------------|
| Symbol | Conditions | | min. | typ. | max. | Unit |
| $t_{d(on)}$ | $V_{CC} = 600\text{ V}$ | $T_j = 150^\circ\text{C}$ | | 220 | | ns |
| t_r | $I_C = 400\text{ A}$ | $T_j = 150^\circ\text{C}$ | | 47 | | ns |
| E_{on} | $V_{GE} = \pm 15\text{ V}$ | $T_j = 150^\circ\text{C}$ | | 33 | | mJ |
| $t_{d(off)}$ | $R_{G\ on} = 1\ \Omega$ | $T_j = 150^\circ\text{C}$ | | 505 | | ns |
| t_f | $R_{G\ off} = 1\ \Omega$ | $T_j = 150^\circ\text{C}$ | | 78 | | ns |
| E_{off} | $di/dt_{on} = 9700\text{ A}/\mu\text{s}$ | $T_j = 150^\circ\text{C}$ | | 42 | | mJ |
| $R_{th(j-c)}$ | per IGBT | | | | 0.072 | K/W |
| Inverse diode | | | | | | |
| $V_F = V_{EC}$ | $I_F = 400\text{ A}$ | $T_j = 25^\circ\text{C}$ | | 2.2 | 2.52 | V |
| | $V_{GE} = 0\text{ V}$ chip | $T_j = 150^\circ\text{C}$ | | 2.15 | 2.47 | V |
| V_{F0} | | $T_j = 25^\circ\text{C}$ | | 1.3 | 1.5 | V |
| | | $T_j = 150^\circ\text{C}$ | | 0.9 | 1.1 | V |
| r_F | | $T_j = 25^\circ\text{C}$ | | 2.3 | 2.5 | m Ω |
| | | $T_j = 150^\circ\text{C}$ | | 3.1 | 3.4 | m Ω |
| I_{RRM} | $I_F = 400\text{ A}$ | $T_j = 150^\circ\text{C}$ | | 450 | | A |
| Q_{rr} | $di/dt_{off} = 8800\text{ A}/\mu\text{s}$ | $T_j = 150^\circ\text{C}$ | | 68 | | μC |
| E_{rr} | $V_{GE} = \pm 15\text{ V}$ $V_{CC} = 600\text{ V}$ | $T_j = 150^\circ\text{C}$ | | 30.5 | | mJ |
| $R_{th(j-c)}$ | per diode | | | | 0.14 | K/W |
| Freewheeling diode | | | | | | |
| $V_F = V_{EC}$ | $I_F = 400\text{ A}$ | $T_j = 25^\circ\text{C}$ | | 2.2 | 2.52 | V |
| | $V_{GE} = 0\text{ V}$ chip | $T_j = 150^\circ\text{C}$ | | 2.15 | 2.47 | V |
| V_{F0} | | $T_j = 25^\circ\text{C}$ | | 1.3 | 1.5 | V |
| | | $T_j = 150^\circ\text{C}$ | | 0.9 | 1.1 | V |
| r_F | | $T_j = 25^\circ\text{C}$ | | 2.3 | 2.5 | m Ω |
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| I_{RRM} | $I_F = 400\text{ A}$ | $T_j = 150^\circ\text{C}$ | | 450 | | A |
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| E_{rr} | $V_{GE} = \pm 15\text{ V}$ $V_{CC} = 600\text{ V}$ | $T_j = 150^\circ\text{C}$ | | 30.5 | | mJ |
| $R_{th(j-c)}$ | per Diode | | | | 0.14 | K/W |
| Module | | | | | | |
| L_{CE} | | | | 15 | 20 | nH |
| $R_{CC'+EE'}$ | terminal-chip | $T_c = 25^\circ\text{C}$ | | 0.25 | | m Ω |
| | | $T_c = 125^\circ\text{C}$ | | 0.5 | | m Ω |
| $R_{th(c-s)}$ | per module | | | 0.02 | 0.038 | K/W |
| M_s | to heat sink M6 | | | 3 | 5 | Nm |
| M_t | | to terminals M6 | | 2.5 | 5 | Nm |
| | | | | | | Nm |
| w | | | | | 325 | g |



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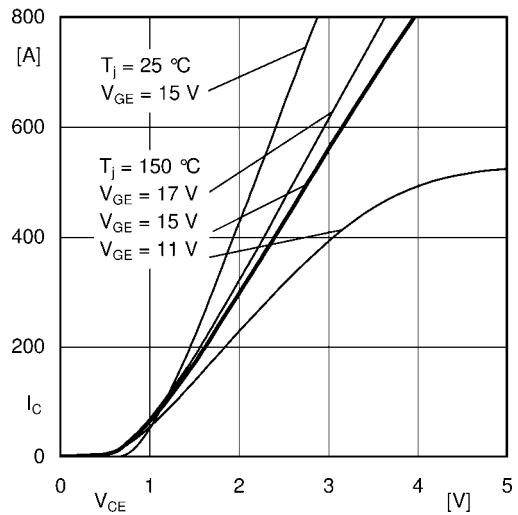


Fig. 1: Typ. output characteristic, inclusive $R_{CC'+EE'}$

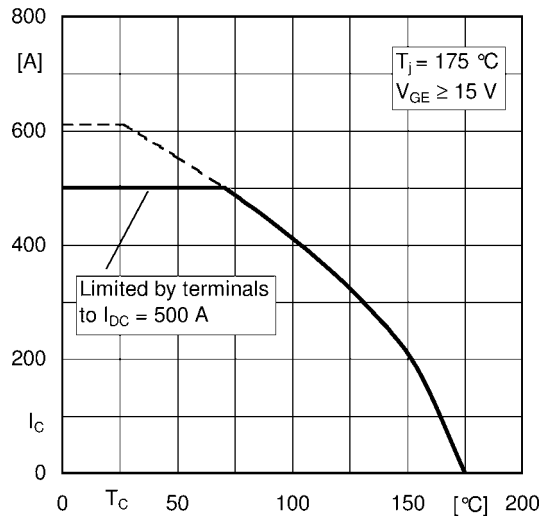


Fig. 2: Rated current vs. temperature $I_C = f(T_C)$

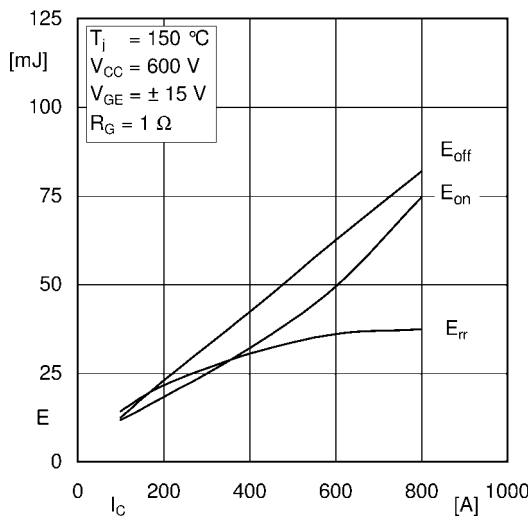


Fig. 3: Typ. turn-on /-off energy = $f(I_C)$

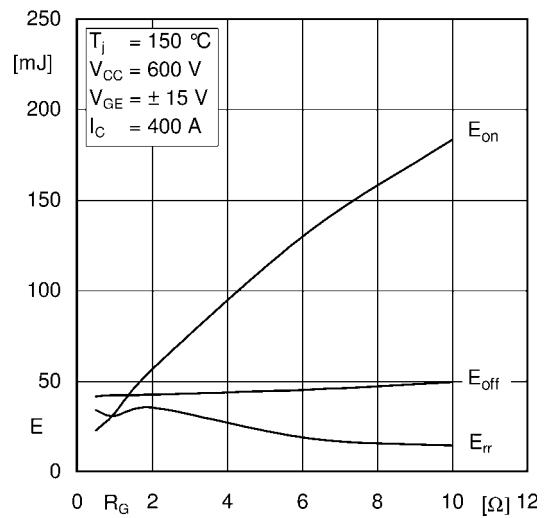


Fig. 4: Typ. turn-on /-off energy = $f(R_G)$

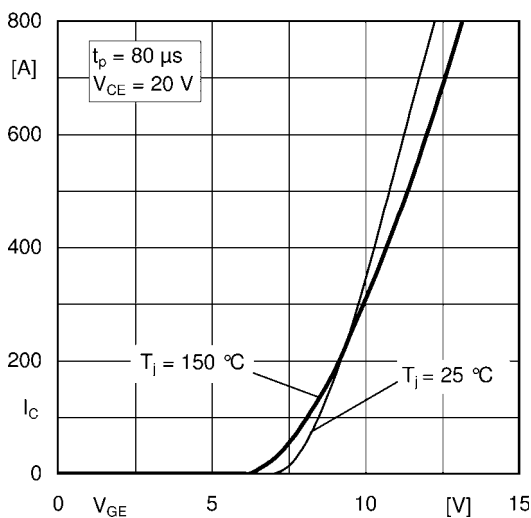


Fig. 5: Typ. transfer characteristic

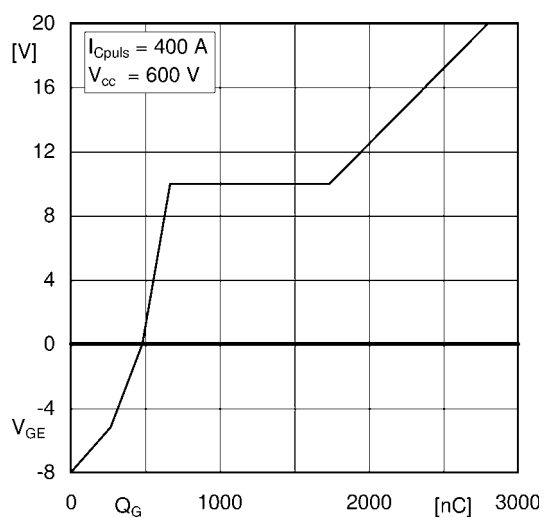


Fig. 6: Typ. gate charge characteristic

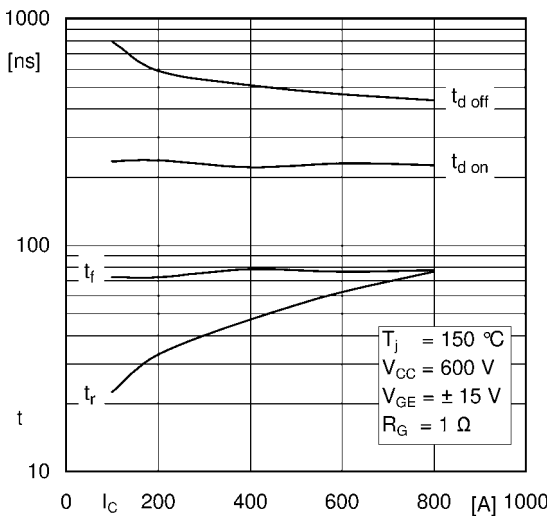


Fig. 7: Typ. switching times vs. I_C

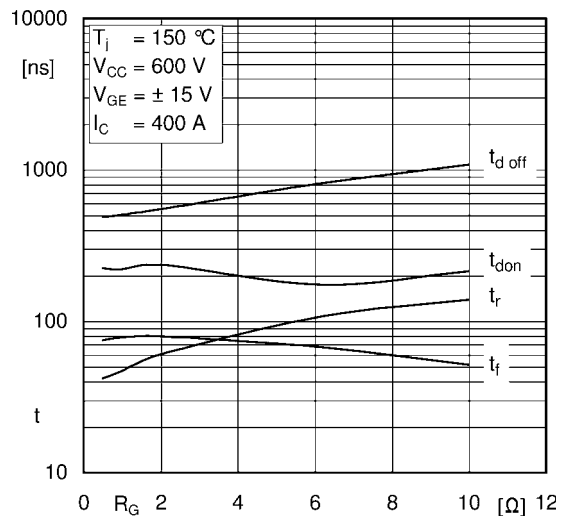


Fig. 8: Typ. switching times vs. gate resistor R_G

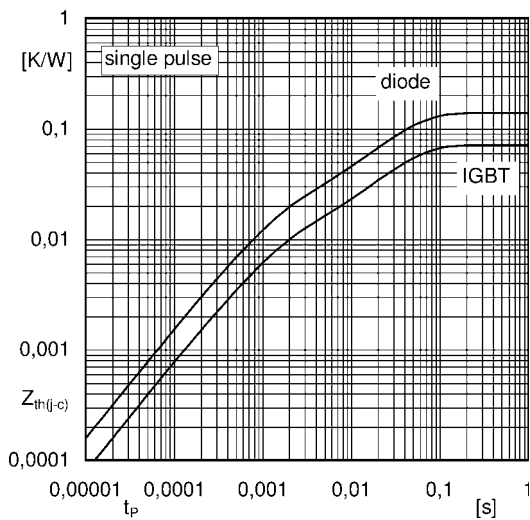


Fig. 9: Transient thermal impedance

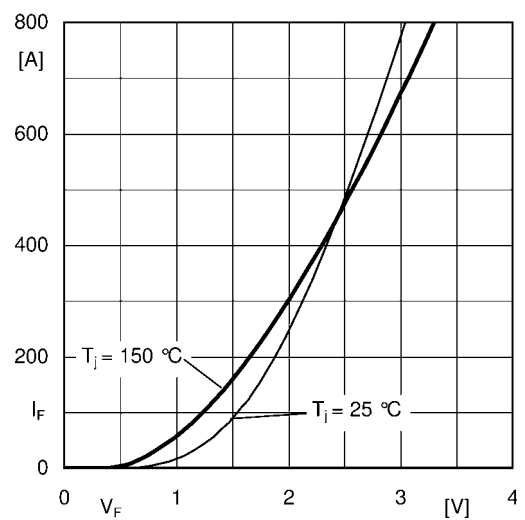


Fig. 10: CAL diode forward characteristic

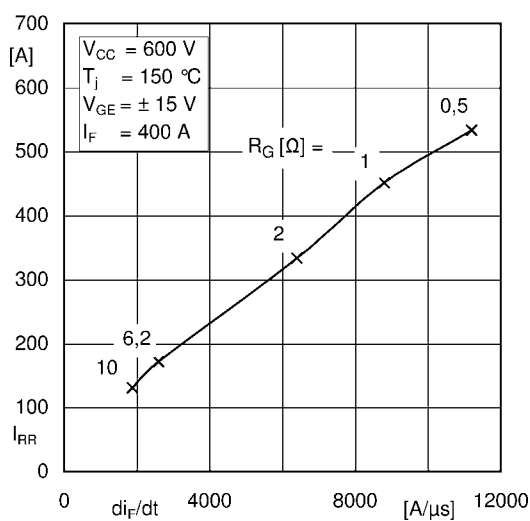


Fig. 11: CAL diode peak reverse recovery current

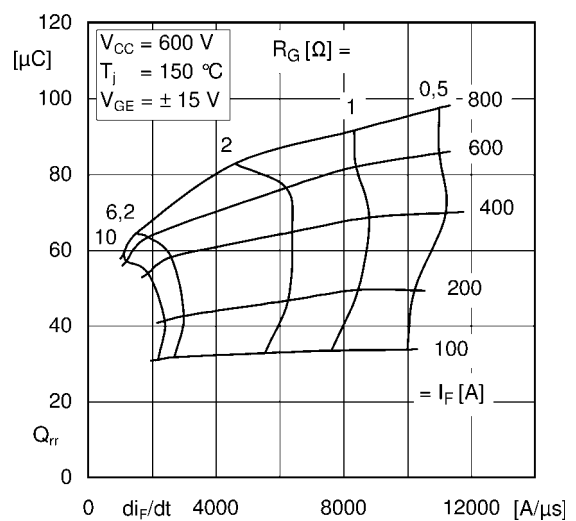
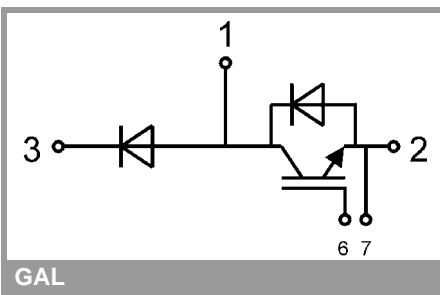


Fig. 12: Typ. CAL diode peak reverse recovery charge



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

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