

# SKM450GB12T4D1



SEMITRANS® 3

## Fast IGBT4 Modules

### SKM450GB12T4D1

#### Features\*

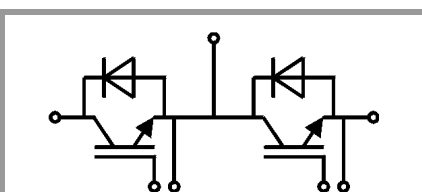
- IGBT4 = 4th generation fast trench IGBT (Infineon)
- CAL4 = Soft switching 4th generation CAL-diode
- Insulated copper baseplate using DBC technology (Direct Bonded Copper)
- Increased power cycling capability
- With integrated gate resistor
- For higher switching frequencies up to 20kHz
- UL recognized, file no. E63532
- SKM...D1: increased diode performance

#### Typical Applications

- AC inverter drives
- UPS
- Electronic welders at fsw up to 20 kHz

#### Remarks

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



GB

| Absolute Maximum Ratings |                                                                                |                         |             |      |
|--------------------------|--------------------------------------------------------------------------------|-------------------------|-------------|------|
| Symbol                   | Conditions                                                                     |                         | Values      | Unit |
| IGBT                     |                                                                                |                         |             |      |
| V <sub>CES</sub>         | T <sub>j</sub> = 25 °C                                                         |                         | 1200        | V    |
| I <sub>C</sub>           | T <sub>j</sub> = 175 °C                                                        | T <sub>c</sub> = 25 °C  | 699         | A    |
|                          |                                                                                | T <sub>c</sub> = 80 °C  | 538         | A    |
| I <sub>Cnom</sub>        |                                                                                |                         | 450         | A    |
| I <sub>CRM</sub>         | I <sub>CRM</sub> = 3 x I <sub>Cnom</sub>                                       |                         | 1350        | A    |
| V <sub>GES</sub>         |                                                                                |                         | -20 ... 20  | V    |
| t <sub>psc</sub>         | V <sub>CC</sub> = 800 V<br>V <sub>GE</sub> ≤ 15 V<br>V <sub>CES</sub> ≤ 1200 V | T <sub>j</sub> = 150 °C | 10          | μs   |
| T <sub>j</sub>           |                                                                                |                         | -40 ... 175 | °C   |
| Inverse diode            |                                                                                |                         |             |      |
| V <sub>RRM</sub>         | T <sub>j</sub> = 25 °C                                                         |                         | 1200        | V    |
| I <sub>F</sub>           | T <sub>j</sub> = 175 °C                                                        | T <sub>c</sub> = 25 °C  | 623         | A    |
|                          |                                                                                | T <sub>c</sub> = 80 °C  | 466         | A    |
| I <sub>Fnom</sub>        |                                                                                |                         | 500         | A    |
| I <sub>FRM</sub>         | I <sub>FRM</sub> = 2xI <sub>Fnom</sub>                                         |                         | 1000        | A    |
| I <sub>FSM</sub>         | t <sub>p</sub> = 10 ms, sin 180°, T <sub>j</sub> = 25 °C                       |                         | 2736        | A    |
| T <sub>j</sub>           |                                                                                |                         | -40 ... 175 | °C   |
| Module                   |                                                                                |                         |             |      |
| I <sub>t(RMS)</sub>      |                                                                                |                         | 500         | A    |
| T <sub>stg</sub>         | module without TIM                                                             |                         | -40 ... 125 | °C   |
| V <sub>isol</sub>        | AC sinus 50 Hz, t = 1 min                                                      |                         | 4000        | V    |

| Characteristics      |                                                                                          |                         |      |       |       |      |
|----------------------|------------------------------------------------------------------------------------------|-------------------------|------|-------|-------|------|
| Symbol               | Conditions                                                                               |                         | min. | typ.  | max.  | Unit |
| IGBT                 |                                                                                          |                         |      |       |       |      |
| V <sub>CE(sat)</sub> | I <sub>C</sub> = 450 A                                                                   | T <sub>j</sub> = 25 °C  |      | 1.84  | 2.07  | V    |
|                      | V <sub>GE</sub> = 15 V<br>chiplevel                                                      | T <sub>j</sub> = 150 °C |      | 2.23  | 2.42  | V    |
| V <sub>CE0</sub>     | chiplevel                                                                                | T <sub>j</sub> = 25 °C  |      | 0.80  | 0.90  | V    |
|                      |                                                                                          | T <sub>j</sub> = 150 °C |      | 0.70  | 0.80  | V    |
| r <sub>CE</sub>      | V <sub>GE</sub> = 15 V<br>chiplevel                                                      | T <sub>j</sub> = 25 °C  |      | 2.3   | 2.6   | mΩ   |
|                      |                                                                                          | T <sub>j</sub> = 150 °C |      | 3.4   | 3.6   | mΩ   |
| V <sub>GE(th)</sub>  | V <sub>GE</sub> =V <sub>CE</sub> , I <sub>C</sub> = 16.4 mA                              |                         | 5.3  | 5.8   | 6.3   | V    |
| I <sub>CES</sub>     | V <sub>GE</sub> = 0 V, V <sub>CE</sub> = 1200 V, T <sub>j</sub> = 25 °C                  |                         |      |       | 5     | mA   |
| C <sub>ies</sub>     | V <sub>CE</sub> = 25 V<br>V <sub>GE</sub> = 0 V                                          | f = 1 MHz               |      | 27.2  |       | nF   |
| C <sub>oes</sub>     |                                                                                          | f = 1 MHz               |      | 1.76  |       | nF   |
| C <sub>res</sub>     |                                                                                          | f = 1 MHz               |      | 1.50  |       | nF   |
| Q <sub>G</sub>       | V <sub>GE</sub> = - 8 V...+ 15 V                                                         |                         |      | 2500  |       | nC   |
| R <sub>Gint</sub>    | T <sub>j</sub> = 25 °C                                                                   |                         |      | 1.9   |       | Ω    |
| t <sub>d(on)</sub>   | V <sub>CC</sub> = 600 V                                                                  | T <sub>j</sub> = 150 °C |      | 248   |       | ns   |
| t <sub>r</sub>       | I <sub>C</sub> = 450 A                                                                   | T <sub>j</sub> = 150 °C |      | 59    |       | ns   |
| E <sub>on</sub>      | V <sub>GE</sub> = +15/-15 V                                                              | T <sub>j</sub> = 150 °C |      | 28    |       | mJ   |
| t <sub>d(off)</sub>  | R <sub>G on</sub> = 1 Ω                                                                  | T <sub>j</sub> = 150 °C |      | 492   |       | ns   |
| t <sub>f</sub>       | R <sub>G off</sub> = 1 Ω                                                                 | T <sub>j</sub> = 150 °C |      | 100   |       | ns   |
| E <sub>off</sub>     | di/dt <sub>on</sub> = 8300 A/μs<br>di/dt <sub>off</sub> = 3800 A/μs<br>dv/dt = 3700 V/μs | T <sub>j</sub> = 150 °C |      | 48    |       | mJ   |
| R <sub>th(j-c)</sub> | per IGBT                                                                                 |                         |      |       | 0.062 | K/W  |
| R <sub>th(c-s)</sub> | per IGBT (λ <sub>grease</sub> =0.81 W/(m*K))                                             |                         |      | 0.028 |       | K/W  |
| R <sub>th(c-s)</sub> | per IGBT, pre-applied phase change material                                              |                         |      | 0.017 |       | K/W  |



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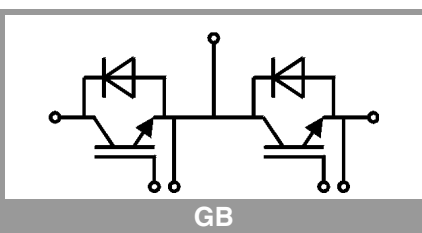
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#### Remarks

- Case temperature limited to  $T_c = 125^\circ\text{C}$  max.
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| Characteristics                  |                                                                                            |                         |      |       |       |      |
|----------------------------------|--------------------------------------------------------------------------------------------|-------------------------|------|-------|-------|------|
| Symbol                           | Conditions                                                                                 |                         | min. | typ.  | max.  | Unit |
| Inverse diode                    |                                                                                            |                         |      |       |       |      |
| V <sub>F</sub> = V <sub>EC</sub> | I <sub>F</sub> = 450 A                                                                     | T <sub>j</sub> = 25 °C  |      | 2.04  | 2.35  | V    |
|                                  | V <sub>GE</sub> = 0 V<br>chipelevel                                                        | T <sub>j</sub> = 150 °C |      | 1.94  | 2.23  | V    |
| V <sub>F0</sub>                  | chipelevel                                                                                 | T <sub>j</sub> = 25 °C  |      | 1.30  | 1.50  | V    |
|                                  |                                                                                            | T <sub>j</sub> = 150 °C |      | 0.90  | 1.10  | V    |
| r <sub>F</sub>                   | chipelevel                                                                                 | T <sub>j</sub> = 25 °C  |      | 1.64  | 1.88  | mΩ   |
|                                  |                                                                                            | T <sub>j</sub> = 150 °C |      | 2.3   | 2.5   | mΩ   |
| I <sub>RRM</sub>                 | I <sub>F</sub> = 450 A                                                                     | T <sub>j</sub> = 150 °C |      | 498   |       | A    |
| Q <sub>rr</sub>                  | di/dt <sub>off</sub> = 7900 A/μs                                                           | T <sub>j</sub> = 150 °C |      | 79    |       | μC   |
| E <sub>rr</sub>                  | V <sub>GE</sub> = -15 V<br>V <sub>CC</sub> = 600 V                                         | T <sub>j</sub> = 150 °C |      | 32    |       | mJ   |
| R <sub>th(j-c)</sub>             | per diode                                                                                  |                         |      |       | 0.095 | K/W  |
| R <sub>th(c-s)</sub>             | per diode (λ <sub>grease</sub> =0.81 W/(m*K))                                              |                         |      | 0.037 |       | K/W  |
| R <sub>th(c-s)</sub>             | per diode, pre-applied phase change material                                               |                         |      | 0.03  |       | K/W  |
| Module                           |                                                                                            |                         |      |       |       |      |
| L <sub>CE</sub>                  |                                                                                            |                         |      | 15    |       | nH   |
| R <sub>CC'+EE'</sub>             | measured per switch                                                                        | T <sub>C</sub> = 25 °C  |      | 0.55  |       | mΩ   |
|                                  |                                                                                            | T <sub>C</sub> = 125 °C |      | 0.85  |       | mΩ   |
| R <sub>th(c-s)1</sub>            | calculated without thermal coupling                                                        |                         |      | 0.008 |       | K/W  |
| R <sub>th(c-s)2</sub>            | including thermal coupling,<br>Ts underneath module<br>(λ <sub>grease</sub> =0.81 W/(m*K)) |                         |      | 0.013 |       | K/W  |
| R <sub>th(c-s)2</sub>            | including thermal coupling,<br>Ts underneath module, pre-applied<br>phase change material  |                         |      | 0.009 |       | K/W  |
| M <sub>s</sub>                   | to heat sink M6                                                                            |                         | 3    |       | 5     | Nm   |
| M <sub>t</sub>                   |                                                                                            | to terminals M6         | 2.5  |       | 5     | Nm   |
|                                  |                                                                                            |                         |      |       |       | Nm   |
| w                                |                                                                                            |                         |      |       | 325   | g    |



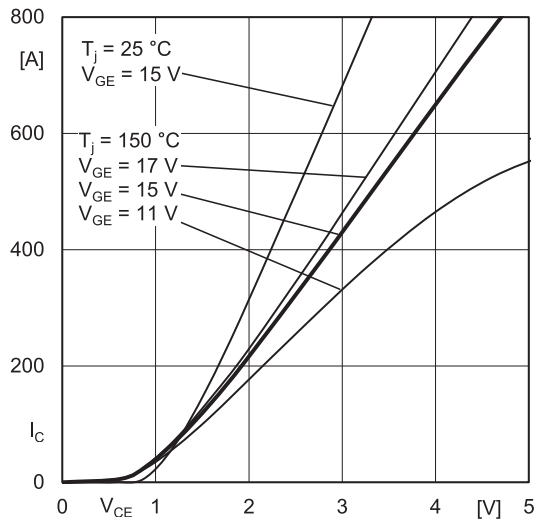


Fig. 1: Typ. output characteristic, inclusive  $R_{CC'} + E_{E'}$

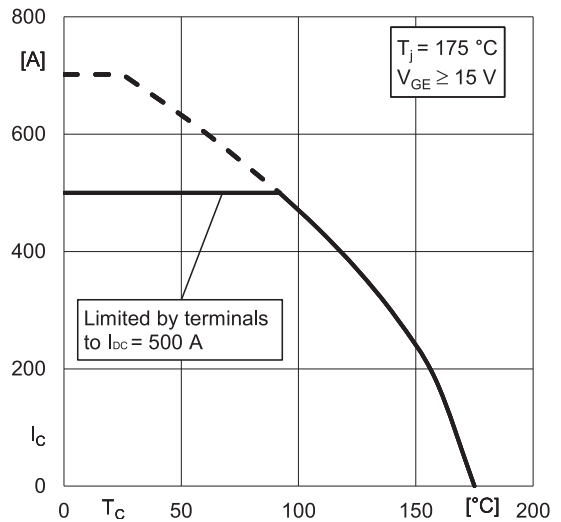


Fig. 2: Rated current vs. temperature  $I_C = f(T_C)$

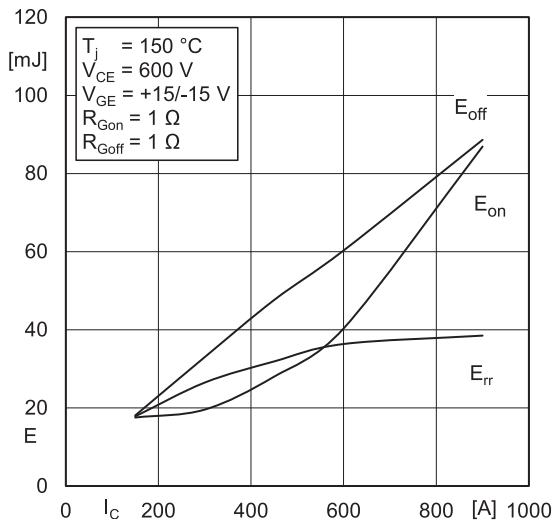


Fig. 3: Typ. turn-on /-off energy =  $f(I_C)$

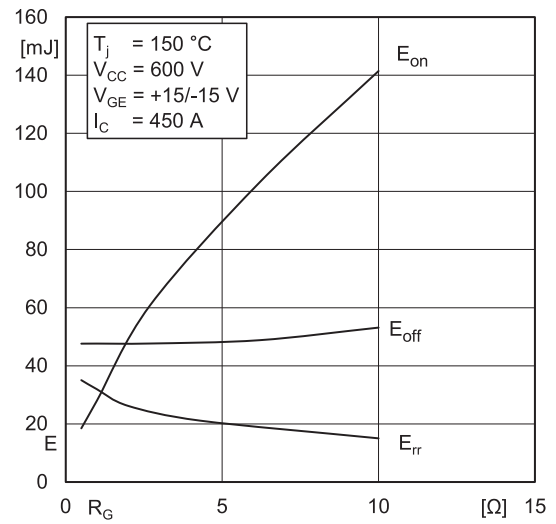


Fig. 4: Typ. turn-on /-off energy =  $f(R_G)$

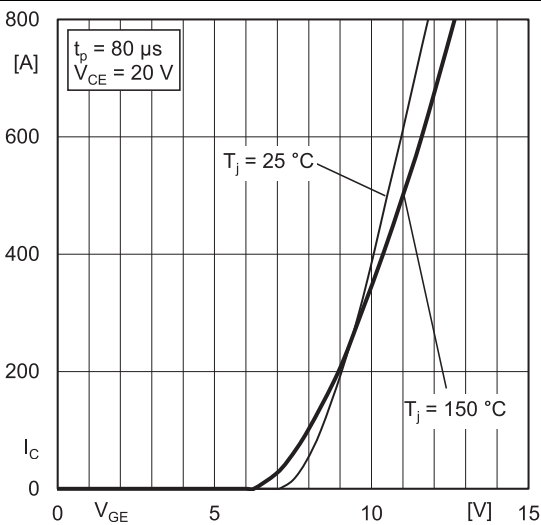


Fig. 5: Typ. transfer characteristic

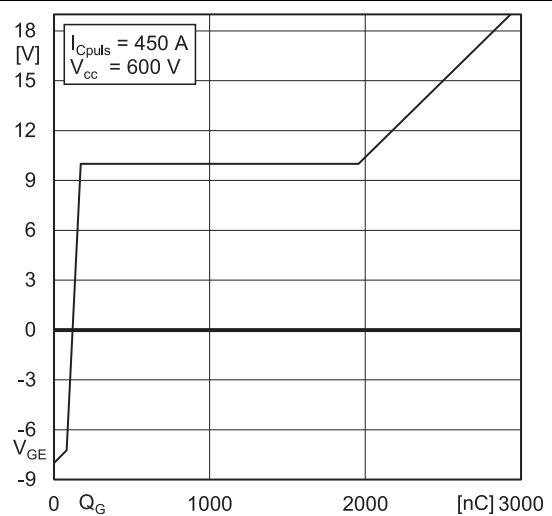


Fig. 6: Typ. gate charge characteristic

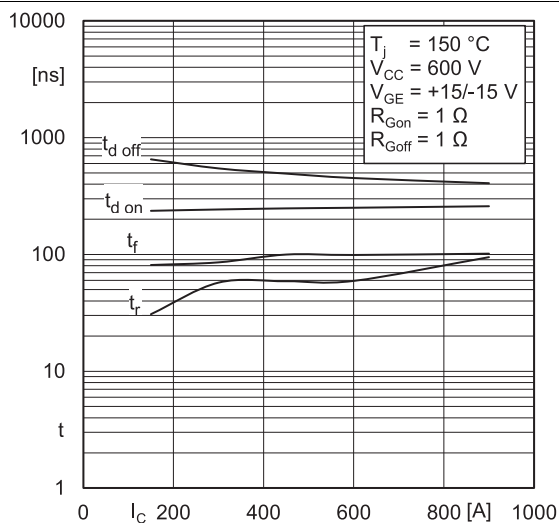


Fig. 7: Typ. switching times vs.  $I_C$

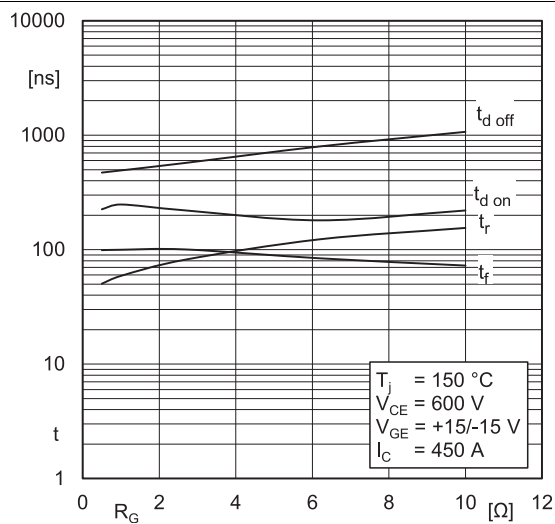


Fig. 8: Typ. switching times vs. gate resistor  $R_G$

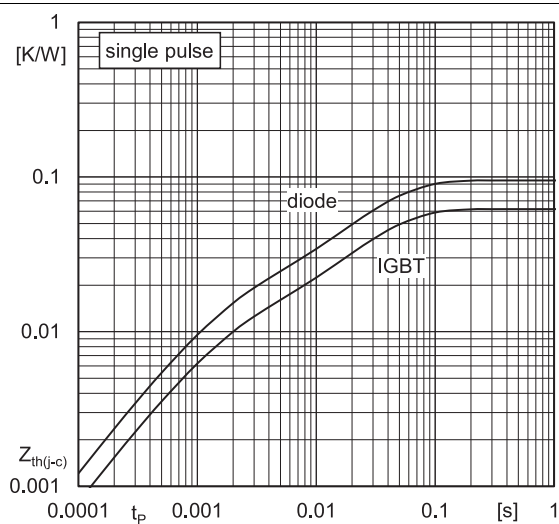


Fig. 9: Transient thermal impedance

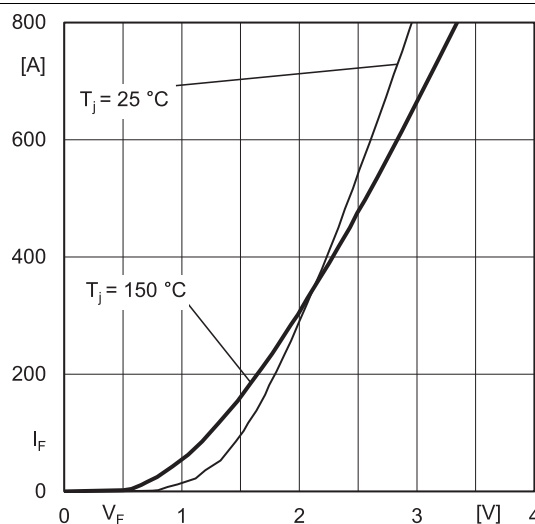


Fig. 10: Typ. CAL diode forward charact., incl.  $R_{CC'} + EE'$

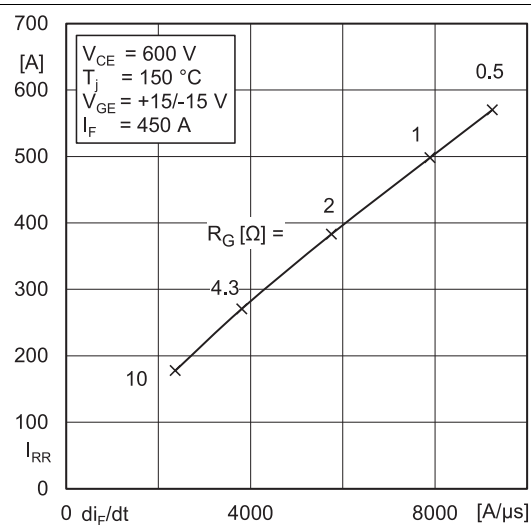


Fig. 11: Typ. CAL diode peak reverse recovery current

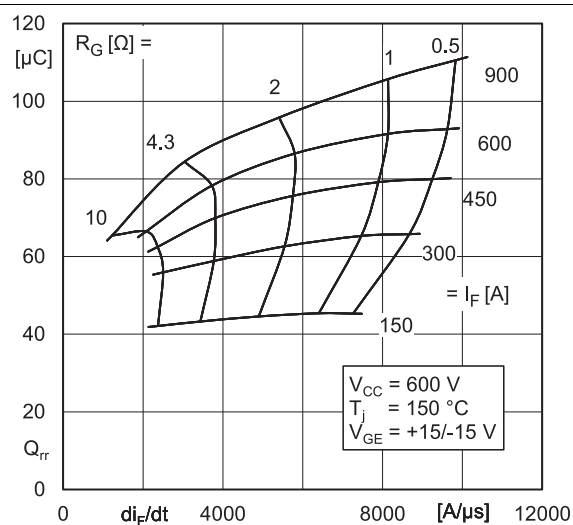


Fig. 12: Typ. CAL diode peak reverse recovery charge



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

## **\*IMPORTANT INFORMATION AND WARNINGS**

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