

# SKM400GB12E4



**SEMITRANS® 3**

## IGBT4 Modules

### SKM400GB12E4

#### Features

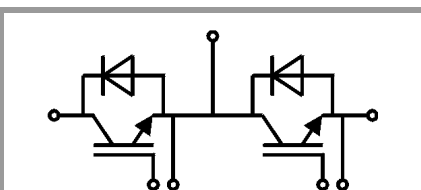
- IGBT4 = 4. Generation (Trench)IGBT
- $V_{CEsat}$  with positive temperature coefficient
- High short circuit capability, self limiting to  $6 \times I_{CNOM}$
- Soft switching 4. Generation CAL diode (CAL4)
- UL recognized, file no. E63532

#### Typical Applications\*

- AC inverter drives
- UPS
- Electronic welders at  $f_{sw}$  up to 20 kHz

#### 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  $T_j = 150^\circ$



**GB**

| Absolute Maximum Ratings |  |                           |             |                  |
|--------------------------|--|---------------------------|-------------|------------------|
| Symbol                   | Conditions   |                           | Values      | Unit             |
| <b>IGBT</b>              |  |                           |             |                  |
| $V_{CES}$                | $T_j = 25^\circ\text{C}$                                     |                           | 1200        | V                |
| $I_C$                    | $T_j = 175^\circ\text{C}$                                    | $T_c = 25^\circ\text{C}$  | 616         | A                |
|                          |  | $T_c = 80^\circ\text{C}$  | 474         | 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          | $\mu\text{s}$    |
|                          | $V_{GE} \leq 15\text{ V}$                                    |                           |             |                  |
|                          | $V_{CES} \leq 1200\text{ V}$                                 |                           |             |                  |
| $T_j$                    |  |                           | -40 ... 175 | $^\circ\text{C}$ |
| <b>Inverse diode</b>     |  |                           |             |                  |
| $I_F$                    | $T_j = 175^\circ\text{C}$                                    | $T_c = 25^\circ\text{C}$  | 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 | $^\circ\text{C}$ |
| <b>Module</b>            |  |                           |             |                  |
| $I_{t(RMS)}$             | 80 $^\circ\text{C}$  |                           | 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             |
| <b>IGBT</b>     |   |   |      |      |       |                  |
| $V_{CE(sat)}$   | $I_C = 400\text{ A}$                      | $T_j = 25^\circ\text{C}$                  |      | 1.80 | 2.05  | V                |
|                 |   | $T_j = 150^\circ\text{C}$                 |      | 2.20 | 2.40  | 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                |
| $r_{CE}$        | $V_{GE} = 15\text{ V}$                    | $T_j = 25^\circ\text{C}$                  |      | 2.50 | 2.88  | $\text{m}\Omega$ |
|                 |   | $T_j = 150^\circ\text{C}$                 |      | 3.75 | 4.00  | $\text{m}\Omega$ |
| $V_{GE(th)}$    | $V_{GE} = V_{CE}, I_C = 15.2\text{ mA}$   |   | 5    | 5.8  | 6.5   | V                |
| $I_{CES}$       | $V_{GE} = 0\text{ V}$                     | $T_j = 25^\circ\text{C}$                  |      | 0.1  | 0.3   | $\text{mA}$      |
|                 |   | $T_j = 150^\circ\text{C}$                 |      |      |       | $\text{mA}$      |
| $C_{ies}$       | $V_{CE} = 25\text{ V}$                    | $f = 1\text{ MHz}$                        |      | 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  |       | $\Omega$         |
| $t_{d(on)}$     | $V_{CC} = 600\text{ V}$                   | $T_j = 150^\circ\text{C}$                 |      | 242  |       | ns               |
| $t_r$           | $I_C = 400\text{ A}$                      | $T_j = 150^\circ\text{C}$                 |      | 47   |       | ns               |
|                 |   | $V_{GE} = \pm 15\text{ V}$                |      |      |       |                  |
| $E_{on}$        | $R_{Gon} = 1\ \Omega$                     | $T_j = 150^\circ\text{C}$                 |      | 33   |       | mJ               |
| $t_{d(off)}$    | $R_{Goff} = 1\ \Omega$                    | $T_j = 150^\circ\text{C}$                 |      | 580  |       | ns               |
| $t_f$           | $di/dt_{on} = 9700\text{ A}/\mu\text{s}$  | $T_j = 150^\circ\text{C}$                 |      | 101  |       | ns               |
|                 |   | $di/dt_{off} = 4300\text{ A}/\mu\text{s}$ |      |      |       |                  |
| $E_{off}$       |   | $T_j = 150^\circ\text{C}$                 |      | 56   |       | mJ               |
| $R_{th(j-c)}$   | per IGBT                                  |   |      |      | 0.072 | K/W              |



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| Characteristics      |  |                           |      |      |       |               |
|----------------------|--|---------------------------|------|------|-------|---------------|
| Symbol               | Conditions   |                           | min. | typ. | max.  | Unit          |
| <b>Inverse diode</b> |  |                           |      |      |       |               |
| $V_F = V_{EC}$       | $I_F = 400 \text{ A}$<br>$V_{GE} = 0 \text{ V}$<br>chip  | $T_j = 25^\circ\text{C}$  |      | 2.20 | 2.52  | V             |
|                      |  | $T_j = 150^\circ\text{C}$ |      | 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 $\Omega$    |
|                      |  | $T_j = 150^\circ\text{C}$ |      | 3.1  | 3.4   | m $\Omega$    |
| $I_{RRM}$            | $I_F = 400 \text{ A}$<br>$di/dt_{off} = 8800 \text{ A}/\mu\text{s}$<br>$V_{GE} = \pm 15 \text{ V}$<br>$V_{CC} = 600 \text{ V}$ | $T_j = 150^\circ\text{C}$ |      | 450  |       | A             |
| $Q_{rr}$             |  | $T_j = 150^\circ\text{C}$ |      | 68   |       | $\mu\text{C}$ |
| $E_{rr}$             |  | $T_j = 150^\circ\text{C}$ |      | 30.5 |       | mJ            |
| $R_{th(j-c)}$        | per diode  |                           |      |      | 0.14  | K/W           |
| <b>Module</b>        |  |                           |      |      |       |               |
| $L_{CE}$             |  |                           |      | 15   | 20    | nH            |
| $R_{CC'+EE'}$        | terminal-chip  | $T_c = 25^\circ\text{C}$  |      | 0.25 |       | m $\Omega$    |
|                      |  | $T_c = 125^\circ\text{C}$ |      | 0.5  |       | m $\Omega$    |
| $R_{th(c-s)}$        | 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             |



**GB**

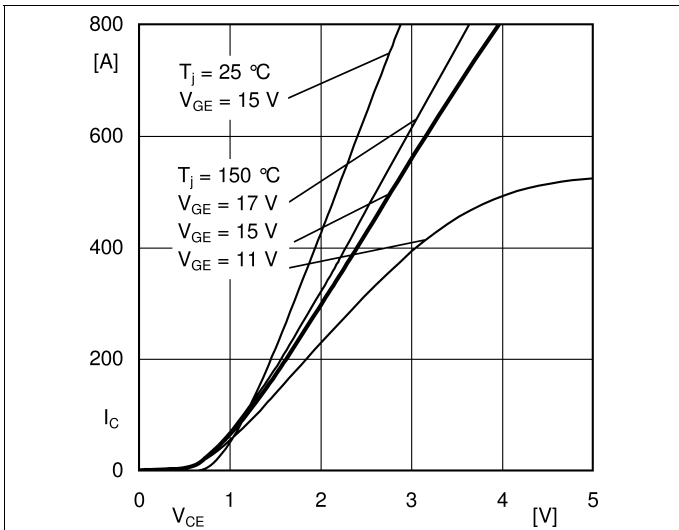


Fig. 1: Typ. output characteristic, inclusive  $R_{CC+EE}$

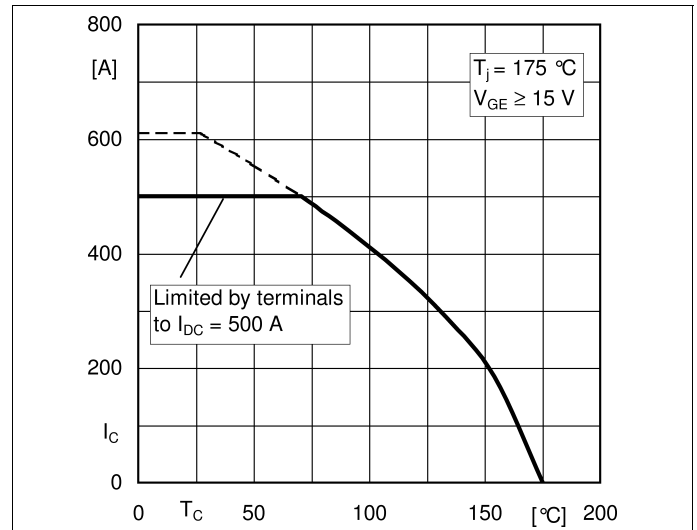


Fig. 2: Rated current vs. temperature  $I_C = f(T_C)$

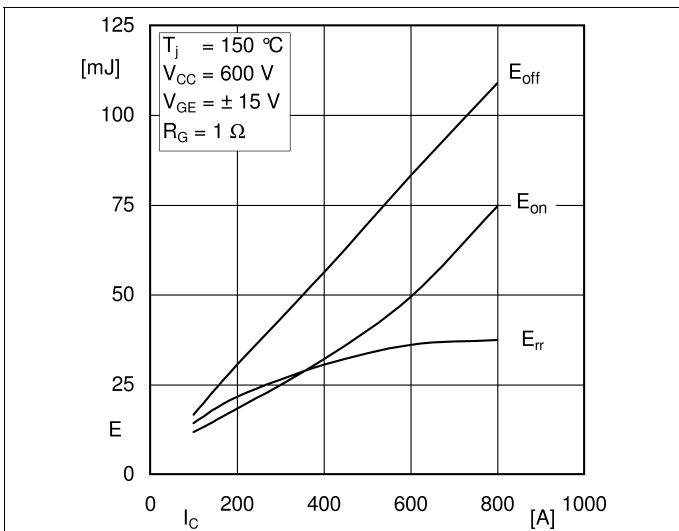


Fig. 3: Typ. turn-on /-off energy =  $f(I_C)$

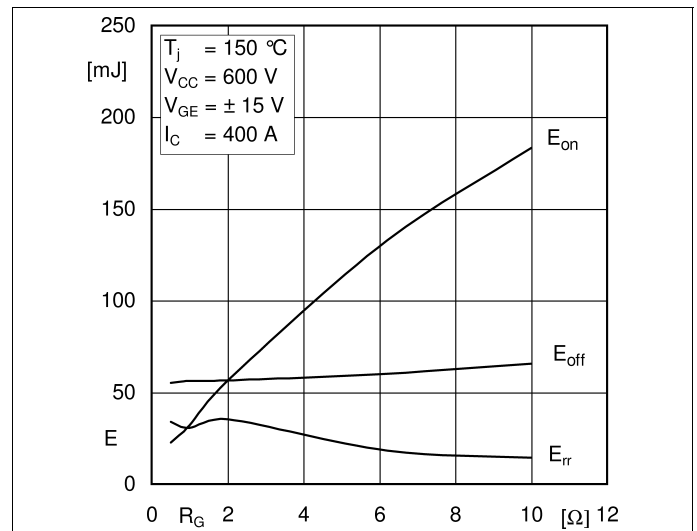


Fig. 4: Typ. turn-on /-off energy =  $f(R_G)$

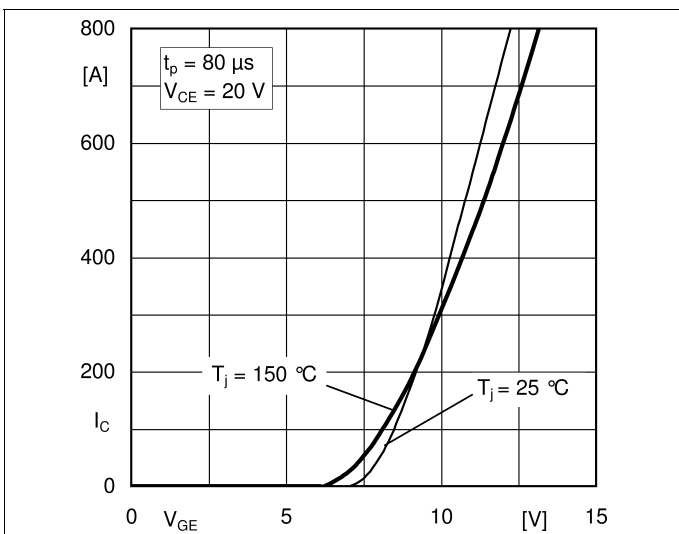


Fig. 5: Typ. transfer characteristic

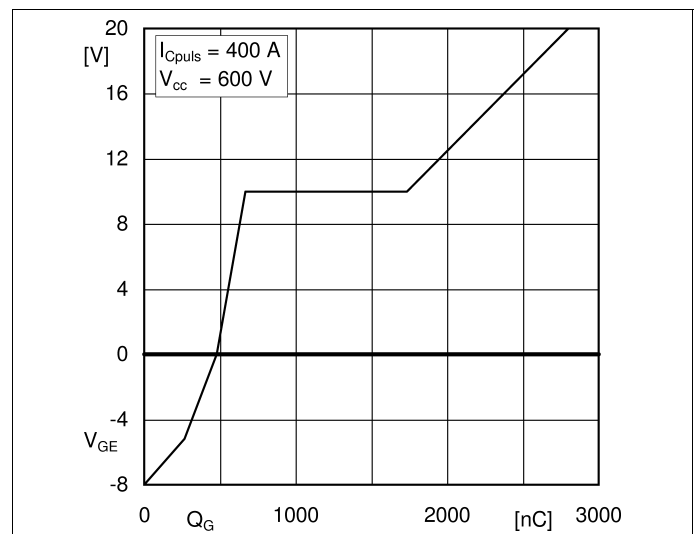


Fig. 6: Typ. gate charge characteristic

