

SEMITOP®E2

## 3-phase Converter-Inverter-Brake (CIB)

### SK50DGDLO66ETE2

#### Features\*

- Optimized design for superior thermal performance
- Low inductive design
- Press-Fit contact technology
- 600V Trench IGBT3 (066)
- Robust and soft switching CAL HD diode technology
- Integrated NTC temperature sensor
- UL recognized file no. E 63 532

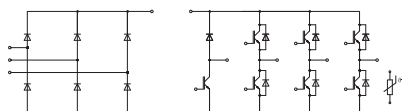
#### Typical Applications

- Motor drives
- Air conditioning
- Auxiliary Inverters

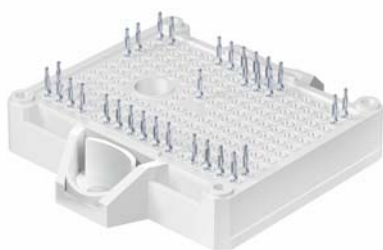
#### Remarks

- Recommended  $T_{j,op} = -40 \dots +150 \text{ }^{\circ}\text{C}$

| Absolute Maximum Ratings |                                                                               |                         |             |      |
|--------------------------|-------------------------------------------------------------------------------|-------------------------|-------------|------|
| Symbol                   | Conditions                                                                    |                         | Values      | Unit |
| Inverter - IGBT          |                                                                               |                         |             |      |
| V <sub>CES</sub>         | T <sub>j</sub> = 25 °C                                                        |                         | 600         | V    |
| I <sub>C</sub>           | λ <sub>paste</sub> =0.8 W/(mK)                                                | T <sub>s</sub> = 70 °C  | 50          | A    |
|                          | T <sub>j</sub> = 175 °C                                                       | T <sub>s</sub> = 100 °C | 40          | A    |
| I <sub>C</sub>           | λ <sub>paste</sub> =2.5 W/(mK)                                                | T <sub>s</sub> = 70 °C  | 63          | A    |
|                          | T <sub>j</sub> = 175 °C                                                       | T <sub>s</sub> = 100 °C | 51          | A    |
| I <sub>Cnom</sub>        |                                                                               |                         | 50          | A    |
| I <sub>CRM</sub>         |                                                                               |                         | 100         | A    |
| V <sub>GES</sub>         |                                                                               |                         | -20 ... 20  | V    |
| t <sub>psc</sub>         | V <sub>CC</sub> = 360 V<br>V <sub>GE</sub> ≤ 15 V<br>V <sub>CES</sub> ≤ 600 V | T <sub>j</sub> = 150 °C | 6           | μs   |
| T <sub>j</sub>           |                                                                               |                         | -40 ... 175 | °C   |
| Chopper - IGBT           |                                                                               |                         |             |      |
| V <sub>CES</sub>         | T <sub>j</sub> = 25 °C                                                        |                         | 600         | V    |
| I <sub>C</sub>           | λ <sub>paste</sub> =0.8 W/(mK)                                                | T <sub>s</sub> = 70 °C  | 50          | A    |
|                          | T <sub>j</sub> = 175 °C                                                       | T <sub>s</sub> = 100 °C | 40          | A    |
| I <sub>C</sub>           | λ <sub>paste</sub> =2.5 W/(mK)                                                | T <sub>s</sub> = 70 °C  | 63          | A    |
|                          | T <sub>j</sub> = 175 °C                                                       | T <sub>s</sub> = 100 °C | 51          | A    |
| I <sub>Cnom</sub>        |                                                                               |                         | 50          | A    |
| I <sub>CRM</sub>         |                                                                               |                         | 100         | A    |
| V <sub>GES</sub>         |                                                                               |                         | -20 ... 20  | V    |
| t <sub>psc</sub>         | V <sub>CC</sub> = 360 V<br>V <sub>GE</sub> ≤ 15 V<br>V <sub>CES</sub> ≤ 600 V | T <sub>j</sub> = 150 °C | 6           | μs   |
| T <sub>j</sub>           |                                                                               |                         | -40 ... 175 | °C   |
| Inverse - Diode          |                                                                               |                         |             |      |
| V <sub>RRM</sub>         | T <sub>j</sub> = 25 °C                                                        |                         | 600         | V    |
| I <sub>F</sub>           | λ <sub>paste</sub> =0.8 W/(mK)                                                | T <sub>s</sub> = 70 °C  | 47          | A    |
|                          | T <sub>j</sub> = 175 °C                                                       | T <sub>s</sub> = 100 °C | 38          | A    |
| I <sub>F</sub>           | λ <sub>paste</sub> =2.5 W/(mK)                                                | T <sub>s</sub> = 70 °C  | 58          | A    |
|                          | T <sub>j</sub> = 175 °C                                                       | T <sub>s</sub> = 100 °C | 46          | A    |
| I <sub>FRM</sub>         |                                                                               |                         | 100         | A    |
| I <sub>FSM</sub>         | t <sub>p</sub> = 10 ms, sin 180°, T <sub>j</sub> = 150 °C                     |                         | 320         | A    |
| T <sub>j</sub>           |                                                                               |                         | -40 ... 175 | °C   |
| Freewheeling - Diode     |                                                                               |                         |             |      |
| V <sub>RRM</sub>         | T <sub>j</sub> = 25 °C                                                        |                         | 600         | V    |
| I <sub>F</sub>           | λ <sub>paste</sub> =0.8 W/(mK)                                                | T <sub>s</sub> = 70 °C  | 47          | A    |
|                          | T <sub>j</sub> = 175 °C                                                       | T <sub>s</sub> = 100 °C | 38          | A    |
| I <sub>F</sub>           | λ <sub>paste</sub> =2.5 W/(mK)                                                | T <sub>s</sub> = 70 °C  | 58          | A    |
|                          | T <sub>j</sub> = 175 °C                                                       | T <sub>s</sub> = 100 °C | 46          | A    |
| I <sub>FRM</sub>         |                                                                               |                         | 100         | A    |
| I <sub>FSM</sub>         | t <sub>p</sub> = 10 ms, sin 180°, T <sub>j</sub> = 150 °C                     |                         | 320         | A    |
| T <sub>j</sub>           |                                                                               |                         | -40 ... 175 | °C   |



DGDL-ET



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- Motor drives
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#### Remarks

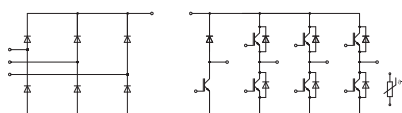
- Recommended  $T_{j,op} = -40 \dots +150 \text{ }^{\circ}\text{C}$

#### Absolute Maximum Ratings

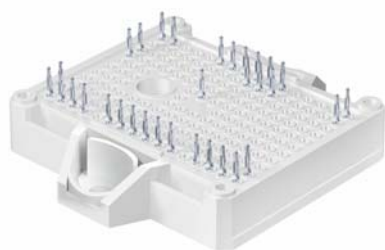
| Symbol              | Conditions                                            |                         | Values      | Unit             |
|---------------------|-------------------------------------------------------|-------------------------|-------------|------------------|
| Rectifier - Diode   |                                                       |                         |             |                  |
| V <sub>RRM</sub>    | T <sub>j</sub> = 25 °C                                |                         | 1600        | V                |
| I <sub>F</sub>      | λ <sub>paste</sub> =0.8 W/(mK)                        | T <sub>s</sub> = 70 °C  | 42          | A                |
|                     | T <sub>j</sub> = 150 °C                               | T <sub>s</sub> = 100 °C | 30          | A                |
| I <sub>F</sub>      | λ <sub>paste</sub> =2.5 W/(mK)                        | T <sub>s</sub> = 70 °C  | 52          | A                |
|                     | T <sub>j</sub> = 150 °C                               | T <sub>s</sub> = 100 °C | 37          | A                |
| I <sub>FSM</sub>    | t <sub>p</sub> = 10 ms                                | T <sub>j</sub> = 25 °C  | 520         | A                |
|                     | sin 180°                                              | T <sub>j</sub> = 150 °C | 350         | A                |
| i <sup>2</sup> t    | t <sub>p</sub> = 10 ms                                | T <sub>j</sub> = 25 °C  | 1350        | A <sup>2</sup> s |
|                     | sin 180°                                              | T <sub>j</sub> = 150 °C | 613         | A <sup>2</sup> s |
| T <sub>j</sub>      |                                                       |                         | -40 ... 150 | °C               |
| Module              |                                                       |                         |             |                  |
| I <sub>t(RMS)</sub> | , ΔT <sub>terminal</sub> at PCB joint = 30 K, per pin |                         | 30          | A                |
| T <sub>stg</sub>    | module without TIM                                    |                         | -40 ... 125 | °C               |
| V <sub>isol</sub>   | AC, sinusoidal, 1 min                                 |                         | 2500        | V                |

#### Characteristics

| Symbol                 | Conditions                                                                        | min.                                 | typ. | max. | Unit             |
|------------------------|-----------------------------------------------------------------------------------|--------------------------------------|------|------|------------------|
| <b>Inverter - IGBT</b> |                                                                                   |                                      |      |      |                  |
| $V_{CE(sat)}$          | $I_C = 50 \text{ A}$                                                              | $T_j = 25 \text{ }^{\circ}\text{C}$  | 1.45 | 1.85 | V                |
|                        | $V_{GE} = 15 \text{ V}$                                                           | $T_j = 150 \text{ }^{\circ}\text{C}$ | 1.65 | 2.05 | V                |
| $V_{CE0}$              | chipelevel                                                                        | $T_j = 25 \text{ }^{\circ}\text{C}$  | 0.90 | 1.10 | V                |
|                        |                                                                                   | $T_j = 150 \text{ }^{\circ}\text{C}$ | 0.80 | 1.00 | V                |
| $r_{CE}$               | $V_{GE} = 15 \text{ V}$<br>chipelevel                                             | $T_j = 25 \text{ }^{\circ}\text{C}$  | 11   | 15   | $\text{m}\Omega$ |
|                        |                                                                                   | $T_j = 150 \text{ }^{\circ}\text{C}$ | 17   | 21   | $\text{m}\Omega$ |
| $V_{GE(th)}$           | $V_{GE} = V_{CE}, I_C = 0.8 \text{ mA}$                                           | 5                                    | 5.8  | 6.5  | V                |
| $I_{CES}$              | $V_{GE} = 0 \text{ V}, V_{CE} = 600 \text{ V}, T_j = 25 \text{ }^{\circ}\text{C}$ |                                      |      | 1    | mA               |
| $C_{ies}$              | $V_{CE} = 25 \text{ V}$                                                           | $f = 1 \text{ MHz}$                  | 3.14 |      | nF               |
| $C_{oes}$              | $V_{GE} = 0 \text{ V}$                                                            | $f = 1 \text{ MHz}$                  | 0.20 |      | nF               |
| $C_{res}$              |                                                                                   | $f = 1 \text{ MHz}$                  | 0.09 |      | nF               |
| $Q_G$                  | $V_{GE} = -15 \text{ V} \dots +15 \text{ V}$                                      |                                      | 580  |      | nC               |
| $R_{Gint}$             | $T_j = 25 \text{ }^{\circ}\text{C}$                                               |                                      | 0    |      | $\Omega$         |
| $t_{d(on)}$            | $V_{CC} = 300 \text{ V}$                                                          | $T_j = 150 \text{ }^{\circ}\text{C}$ | 24   |      | ns               |
| $t_r$                  | $I_C = 50 \text{ A}$                                                              | $T_j = 150 \text{ }^{\circ}\text{C}$ | 30   |      | ns               |
|                        | $R_{G on} = 10 \Omega$                                                            | $T_j = 150 \text{ }^{\circ}\text{C}$ | 1.57 |      | mJ               |
| $E_{on}$               | $R_{G off} = 10 \Omega$                                                           | $T_j = 150 \text{ }^{\circ}\text{C}$ | 208  |      | ns               |
| $t_{d(off)}$           | $di/dt_{on} = 1400 \text{ A}/\mu\text{s}$                                         | $T_j = 150 \text{ }^{\circ}\text{C}$ | 38   |      | ns               |
| $t_f$                  | $di/dt_{off} = 1200 \text{ A}/\mu\text{s}$                                        | $T_j = 150 \text{ }^{\circ}\text{C}$ |      |      |                  |
| $E_{off}$              | $dv/dt = 3900 \text{ V}/\mu\text{s}$                                              | $T_j = 150 \text{ }^{\circ}\text{C}$ | 1.43 |      | mJ               |
|                        | $V_{GE} = +15/-15 \text{ V}$                                                      |                                      |      |      |                  |
| $R_{th(j-s)}$          | per IGBT, $\lambda_{paste}=0.8 \text{ W/(mK)}$                                    |                                      | 1.01 |      | K/W              |
| $R_{th(j-s)}$          | per IGBT, $\lambda_{paste}=2.5 \text{ W/(mK)}$                                    |                                      | 0.71 |      | K/W              |



DGDLE-T



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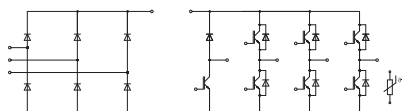
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- Motor drives
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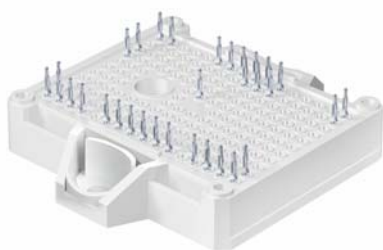
#### Remarks

- Recommended  $T_{j,op} = -40 \dots +150 \text{ }^{\circ}\text{C}$

| Characteristics                  |                                                                        |                         |      |      |      |      |
|----------------------------------|------------------------------------------------------------------------|-------------------------|------|------|------|------|
| Symbol                           | Conditions                                                             |                         | min. | typ. | max. | Unit |
| Chopper - IGBT                   |                                                                        |                         |      |      |      |      |
| V <sub>CE(sat)</sub>             | I <sub>C</sub> = 50 A                                                  | T <sub>j</sub> = 25 °C  |      | 1.45 | 1.85 | V    |
|                                  | V <sub>GE</sub> = 15 V<br>chipelevel                                   | T <sub>j</sub> = 150 °C |      | 1.65 | 2.05 | V    |
| V <sub>CE0</sub>                 | chipelevel                                                             | T <sub>j</sub> = 25 °C  |      | 0.90 | 1.10 | V    |
|                                  |                                                                        | T <sub>j</sub> = 150 °C |      | 0.80 | 1.00 | V    |
| r <sub>CE</sub>                  | V <sub>GE</sub> = 15 V                                                 | T <sub>j</sub> = 25 °C  |      | 11   | 15   | mΩ   |
|                                  | chipelevel                                                             | T <sub>j</sub> = 150 °C |      | 17   | 21   | mΩ   |
| V <sub>GE(th)</sub>              | V <sub>GE</sub> = V <sub>CE</sub> , I <sub>C</sub> = 0.8 mA            |                         | 5    | 5.8  | 6.5  | V    |
| I <sub>CES</sub>                 | V <sub>GE</sub> = 0 V, V <sub>CE</sub> = 600 V, T <sub>j</sub> = 25 °C |                         |      |      | 1    | mA   |
| C <sub>ies</sub>                 | V <sub>CE</sub> = 25 V<br>V <sub>GE</sub> = 0 V                        | f = 1 MHz               |      | 3.14 |      | nF   |
| C <sub>oes</sub>                 |                                                                        | f = 1 MHz               |      | 0.20 |      | nF   |
| C <sub>res</sub>                 |                                                                        | f = 1 MHz               |      | 0.09 |      | nF   |
| Q <sub>G</sub>                   | V <sub>GE</sub> = -15 V...+15 V                                        |                         |      | 580  |      | nC   |
| R <sub>Gint</sub>                | T <sub>j</sub> = 25 °C                                                 |                         |      | 0    |      | Ω    |
| t <sub>d(on)</sub>               | V <sub>CC</sub> = 300 V                                                | T <sub>j</sub> = 150 °C |      | 24   |      | ns   |
| t <sub>r</sub>                   | I <sub>C</sub> = 50 A                                                  | T <sub>j</sub> = 150 °C |      | 30   |      | ns   |
| E <sub>on</sub>                  | R <sub>G on</sub> = 10 Ω                                               | T <sub>j</sub> = 150 °C |      | 1.57 |      | mJ   |
|                                  | R <sub>G off</sub> = 10 Ω                                              | T <sub>j</sub> = 150 °C |      |      |      |      |
| t <sub>d(off)</sub>              | di/dt <sub>on</sub> = 1400 A/μs                                        | T <sub>j</sub> = 150 °C |      | 208  |      | ns   |
| t <sub>f</sub>                   | di/dt <sub>off</sub> = 1200 A/μs                                       | T <sub>j</sub> = 150 °C |      | 38   |      | ns   |
|                                  | dv/dt = 3900 V/μs                                                      | T <sub>j</sub> = 150 °C |      |      |      |      |
| E <sub>off</sub>                 | V <sub>GE</sub> = +15/-15 V                                            |                         | 1.43 |      | mJ   |      |
| R <sub>th(j-s)</sub>             | per IGBT, λ <sub>paste</sub> =0.8 W/(mK)                               |                         |      | 1.01 |      | K/W  |
| R <sub>th(j-s)</sub>             | per IGBT, λ <sub>paste</sub> =2.5 W/(mK)                               |                         |      | 0.71 |      | K/W  |
| Inverse - Diode                  |                                                                        |                         |      |      |      |      |
| V <sub>F</sub> = V <sub>EC</sub> | I <sub>F</sub> = 50 A                                                  | T <sub>j</sub> = 25 °C  |      | 1.47 | 1.87 | V    |
|                                  | chipelevel                                                             | T <sub>j</sub> = 150 °C |      | 1.50 | 1.78 | V    |
| V <sub>F0</sub>                  |                                                                        | T <sub>j</sub> = 25 °C  |      | 0.99 | 1.10 | V    |
|                                  | chipelevel                                                             | T <sub>j</sub> = 150 °C |      | 0.80 | 0.89 | V    |
| r <sub>F</sub>                   | chipelevel                                                             | T <sub>j</sub> = 25 °C  |      | 9.6  | 15   | mΩ   |
|                                  |                                                                        | T <sub>j</sub> = 150 °C |      | 14   | 18   | mΩ   |
| I <sub>RRM</sub>                 | I <sub>F</sub> = 50 A                                                  | T <sub>j</sub> = 150 °C |      | 35   |      | A    |
| Q <sub>rr</sub>                  | di/dt <sub>off</sub> = 1300 A/μs                                       | T <sub>j</sub> = 150 °C |      | 3.1  |      | μC   |
| E <sub>rr</sub>                  | V <sub>GE</sub> = -15 V                                                | T <sub>j</sub> = 150 °C |      | 0.91 |      | mJ   |
|                                  | V <sub>CC</sub> = 300 V                                                |                         |      |      |      |      |
| R <sub>th(j-s)</sub>             | per Diode, λ <sub>paste</sub> =0.8 W/(mK)                              |                         |      | 1.36 |      | K/W  |
| R <sub>th(j-s)</sub>             | per Diode, λ <sub>paste</sub> =2.5 W/(mK)                              |                         |      | 1.01 |      | K/W  |
| Freewheeling - Diode             |                                                                        |                         |      |      |      |      |
| V <sub>F</sub> = V <sub>EC</sub> | I <sub>F</sub> = 50 A                                                  | T <sub>j</sub> = 25 °C  |      | 1.47 | 1.87 | V    |
|                                  | chipelevel                                                             | T <sub>j</sub> = 150 °C |      | 1.50 | 1.78 | V    |
| V <sub>F0</sub>                  |                                                                        | T <sub>j</sub> = 25 °C  |      | 0.99 | 1.10 | V    |
|                                  | chipelevel                                                             | T <sub>j</sub> = 150 °C |      | 0.80 | 0.89 | V    |
| r <sub>F</sub>                   | chipelevel                                                             | T <sub>j</sub> = 25 °C  |      | 9.6  | 15   | mΩ   |
|                                  |                                                                        | T <sub>j</sub> = 150 °C |      | 14   | 18   | mΩ   |
| I <sub>RRM</sub>                 | I <sub>F</sub> = 50 A                                                  | T <sub>j</sub> = 150 °C |      | 35   |      | A    |
| Q <sub>rr</sub>                  | di/dt <sub>off</sub> = 1300 A/μs                                       | T <sub>j</sub> = 150 °C |      | 3.1  |      | μC   |
| E <sub>rr</sub>                  | V <sub>GE</sub> = -15 V                                                | T <sub>j</sub> = 150 °C |      | 0.91 |      | mJ   |
|                                  | V <sub>CC</sub> = 300 V                                                |                         |      |      |      |      |
| R <sub>th(j-s)</sub>             | per Diode, λ <sub>paste</sub> =0.8 W/(mK)                              |                         |      | 1.36 |      | K/W  |
| R <sub>th(j-s)</sub>             | per Diode, λ <sub>paste</sub> =2.5 W/(mK)                              |                         |      | 1.01 |      | K/W  |



DGDLET



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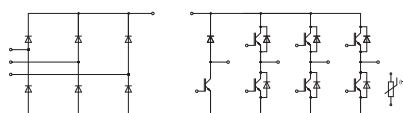
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#### Remarks

- Recommended  $T_{j,op} = -40 \dots +150 \text{ }^{\circ}\text{C}$

| Characteristics      |                                                                               |                         |      |          |      |      |
|----------------------|-------------------------------------------------------------------------------|-------------------------|------|----------|------|------|
| Symbol               | Conditions                                                                    |                         | min. | typ.     | max. | Unit |
| Rectifier - Diode    |                                                                               |                         |      |          |      |      |
| V <sub>F</sub>       | I <sub>F</sub> = 50 A                                                         | T <sub>j</sub> = 25 °C  |      | 1.21     | 1.62 | V    |
|                      | chiplevel                                                                     | T <sub>j</sub> = 125 °C |      | 1.20     | 1.58 | V    |
| V <sub>F0</sub>      |                                                                               | T <sub>j</sub> = 25 °C  |      | 0.88     | 0.98 | V    |
|                      | chiplevel                                                                     | T <sub>j</sub> = 125 °C |      | 0.73     | 0.83 | V    |
| r <sub>F</sub>       |                                                                               | T <sub>j</sub> = 25 °C  |      | 6.7      | 13   | mΩ   |
|                      | chiplevel                                                                     | T <sub>j</sub> = 125 °C |      | 9.4      | 15   | mΩ   |
| I <sub>R</sub>       | T <sub>j</sub> = 145 °C, V <sub>RRM</sub>                                     |                         |      | 2        |      | mA   |
| R <sub>th(j-s)</sub> | per Diode, λ <sub>paste</sub> =0.8 W/(mK)                                     |                         |      | 1.31     |      | K/W  |
| R <sub>th(j-s)</sub> | per Diode, λ <sub>paste</sub> =2.5 W/(mK)                                     |                         |      | 0.97     |      | K/W  |
| Module               |                                                                               |                         |      |          |      |      |
| M <sub>s</sub>       | to heatsink                                                                   |                         | 1.6  |          | 2.3  | Nm   |
| w                    |                                                                               |                         |      | 35       |      | g    |
| L <sub>CE</sub>      |                                                                               |                         |      | 30       |      | nH   |
| Temperature Sensor   |                                                                               |                         |      |          |      |      |
| R <sub>100</sub>     | T <sub>c</sub> =100°C (R <sub>25</sub> =5 kΩ)                                 |                         |      | 493 ± 5% |      | Ω    |
| B <sub>25/85</sub>   | R <sub>(T)</sub> =R <sub>25</sub> *exp[B <sub>25/85</sub> *(1/T-1/298)], T[K] |                         |      | 3420     |      | K    |



DGDLET

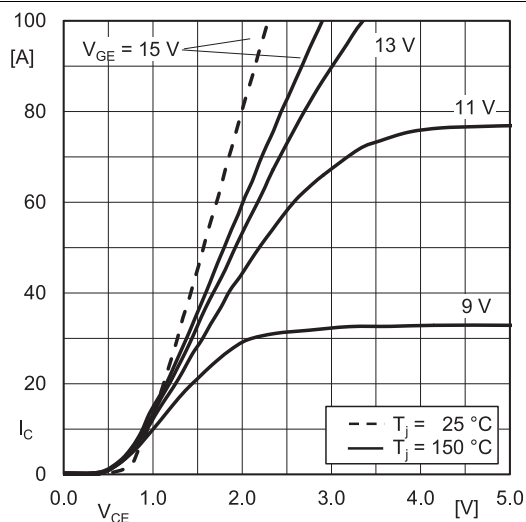


Fig. 1: Typ. IGBT output characteristic, incl.  $R_{CC+EE'}$

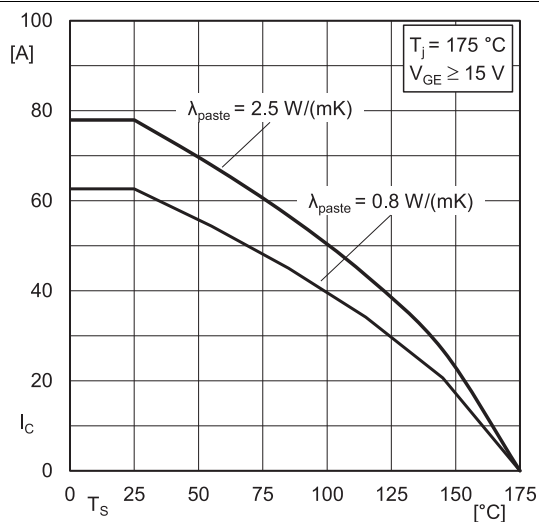


Fig. 2: IGBT rated current vs. temperature  $I_C=f(T_s)$

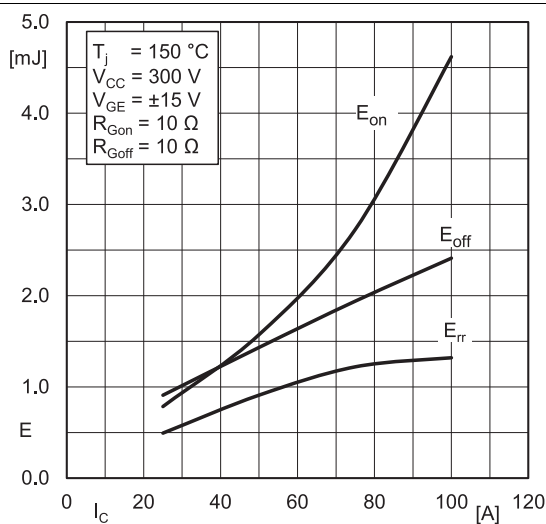


Fig. 3: Typ. turn-on /-off energy =  $f(I_C)$

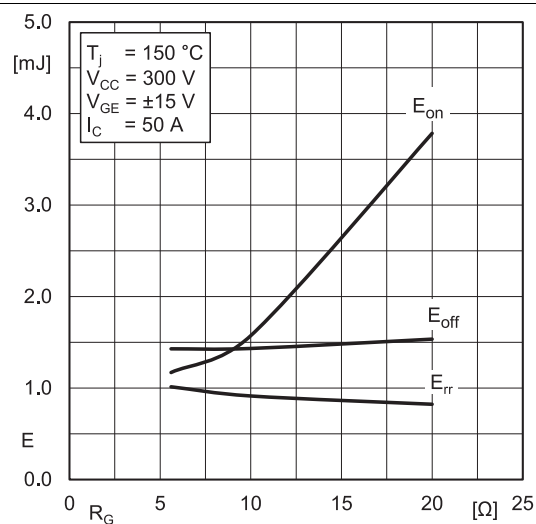


Fig. 4: Typ. turn-on /-off energy =  $f(R_G)$

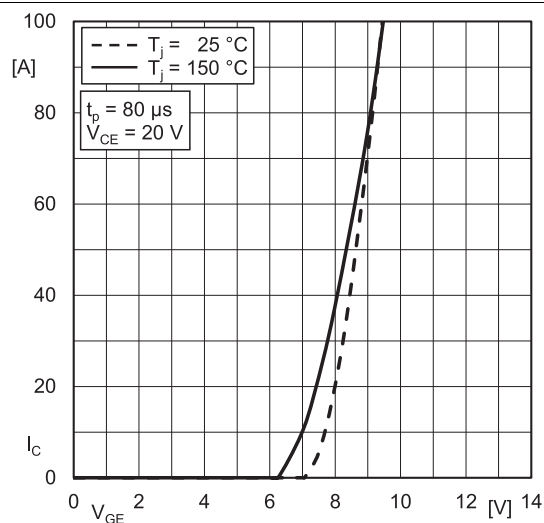


Fig. 5: Typ. IGBT transfer characteristic

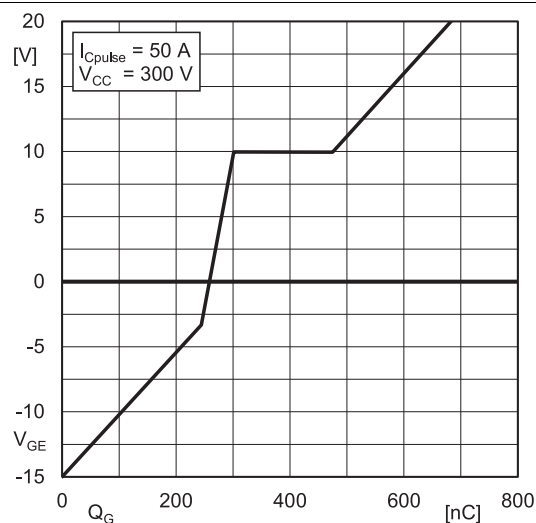


Fig. 6: Typ. IGBT gate charge characteristic

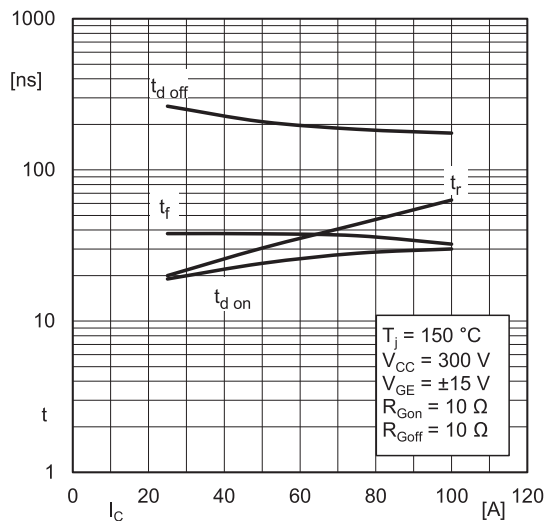


Fig. 7: Typ. switching times =  $f(I_C)$

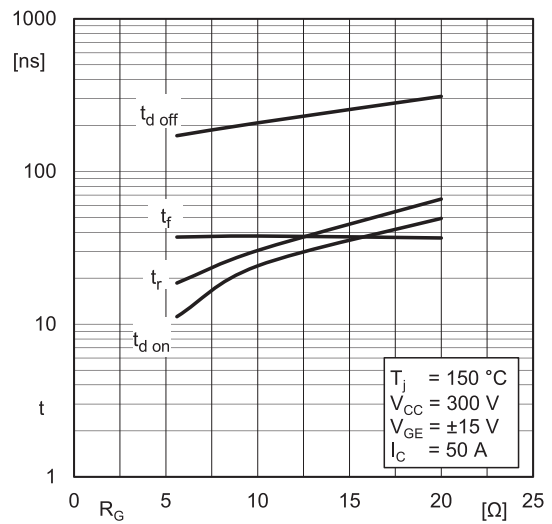


Fig. 8: Typ. switching times =  $f(R_G)$

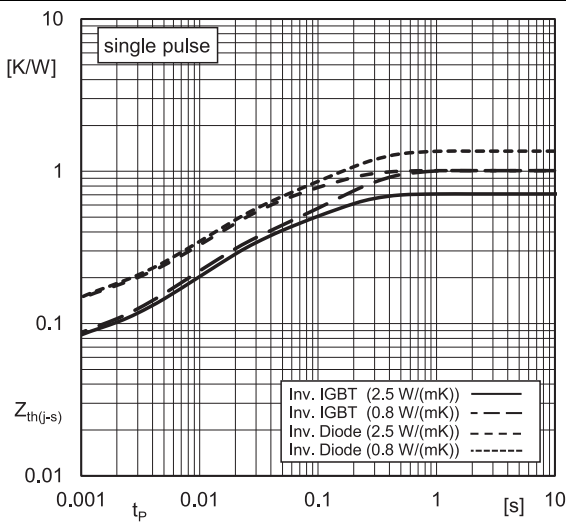


Fig. 9: Typ. transient thermal impedance

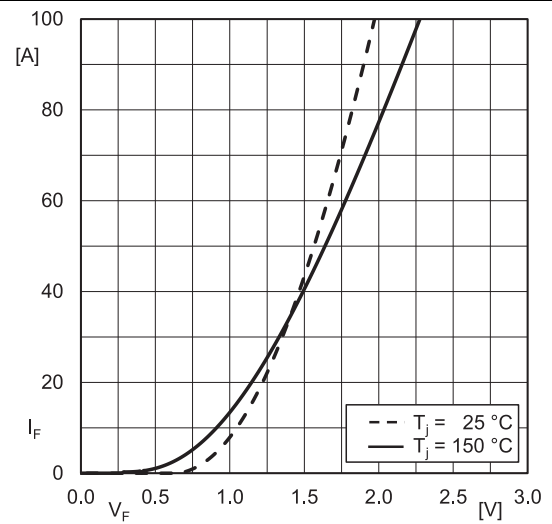


Fig. 10: Typ. Inv. diode forward charact., incl.  $R_{CC} + EE'$

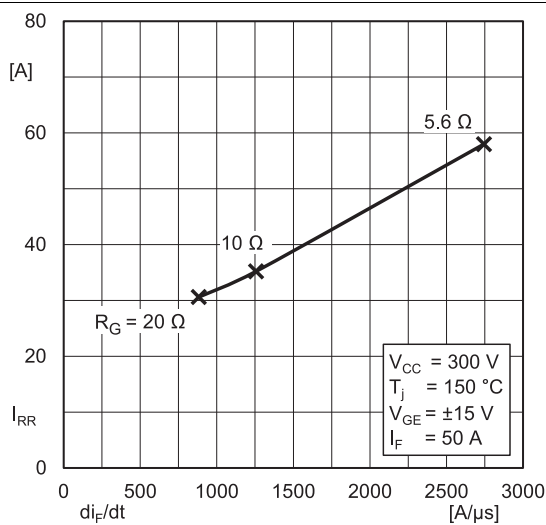


Fig. 11: Typ. Inv. diode peak reverse recovery current

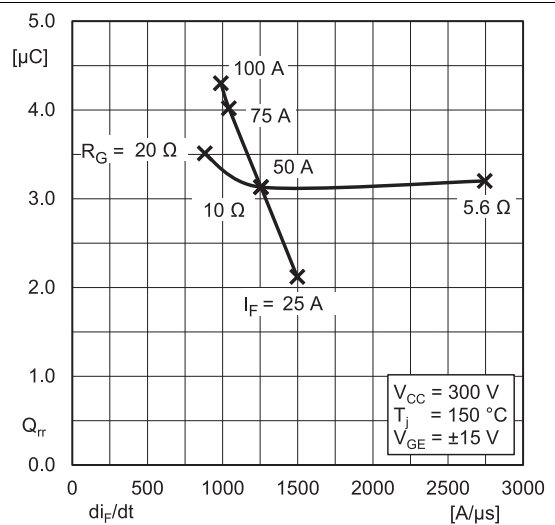


Fig. 12: Typ. Inv. diode reverse recovery charge

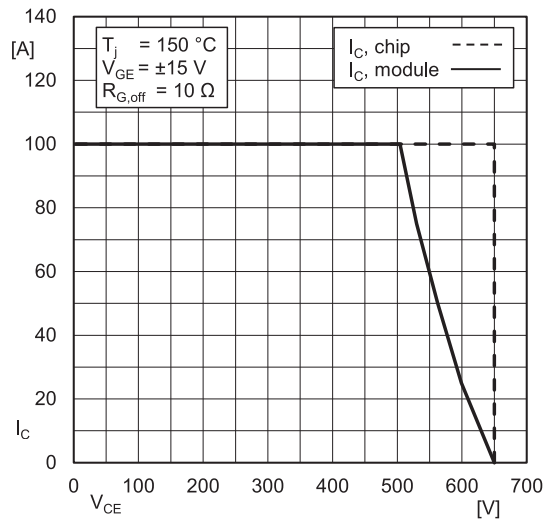


Fig. 13: IGBT Reverse Bias Safe Operating Area (RBSOA)

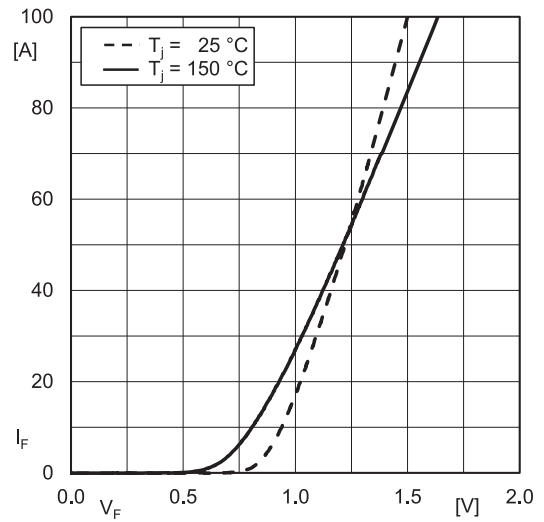
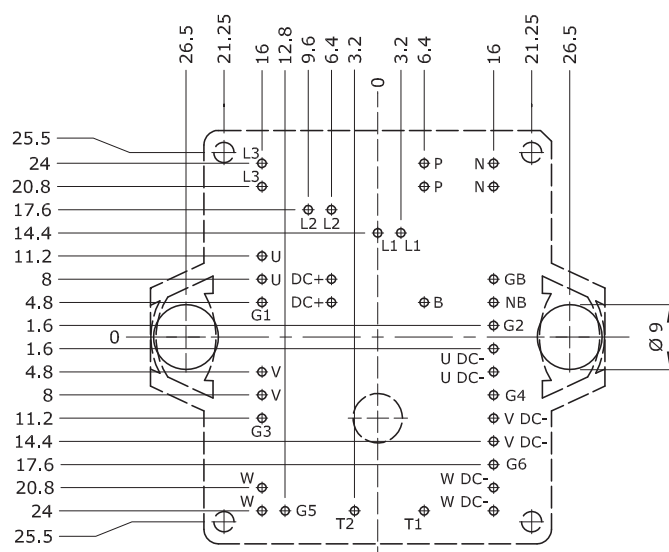
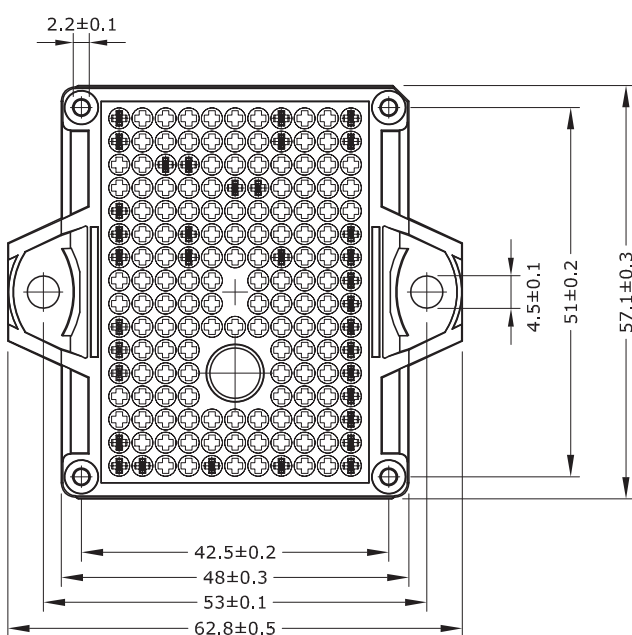
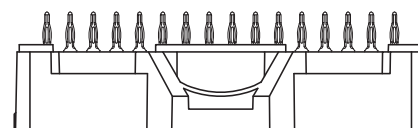
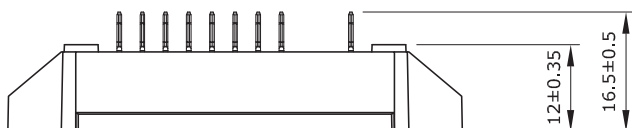
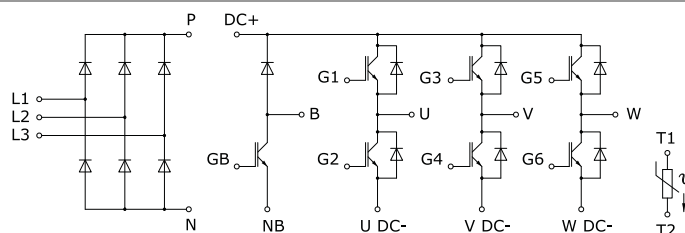


Fig. 14: Typ. Rect. diode forward charact., incl.  $R_{CC'+EE'}$



- Pin-Grid 3.2 mm
- Tolerance of PCB hole pattern  $\Phi \pm 0.1$
- Diameters of drill  $\Phi 1.15\text{mm}$
- Copper thickness in hole 25 - 50  $\mu\text{m}$
- Hole specification for contacts:  
refer to SEMITOP E1/E2 Mounting Instruction

SEMITOP®E2



DGDL-ET

This is an electrostatic discharge sensitive device (ESDS) due to international standard IEC 61340.

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