

# SK25DGD12T7ETE1



SEMITOP®E1

## 3-phase Converter-Inverter (CI)

### SK25DGD12T7ETE1

#### Features\*

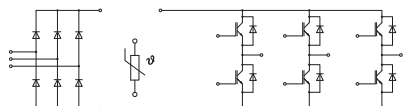
- Optimized design for superior thermal performance
- Low inductive design
- Press-Fit contact technology
- 1200V Generation 7 IGBT (T7)
- Robust and soft switching CAL4F diode technology
- PEP rectifier diode technology for enhanced power and environmental robustness
- Integrated NTC temperature sensor
- UL recognized file no. E 63 532

#### Typical Applications

- Motor drives
- Air conditioning
- Auxiliary Inverters

#### Remarks

- Recommended  $T_{j,op} = -40 \dots +150 \text{ }^{\circ}\text{C}$
- $T_{j,op} > 150 \text{ }^{\circ}\text{C}$  during overload (details in AN19-002)



DGD-ET

#### Absolute Maximum Ratings

| Symbol              | Conditions                                                                     |                         | Values      | Unit             |
|---------------------|--------------------------------------------------------------------------------|-------------------------|-------------|------------------|
| Inverter - IGBT     |                                                                                |                         |             |                  |
| V <sub>CES</sub>    |                                                                                |                         | 1200        | V                |
| I <sub>C</sub>      | P12                                                                            | T <sub>s</sub> = 70 °C  | 33          | A                |
|                     | T <sub>j</sub> = 175 °C                                                        | T <sub>s</sub> = 100 °C | 27          | A                |
| I <sub>C</sub>      | HPTP / HP-PCM                                                                  | T <sub>s</sub> = 70 °C  | 38          | A                |
|                     | T <sub>j</sub> = 175 °C                                                        | T <sub>s</sub> = 100 °C | 31          | A                |
| I <sub>Cnom</sub>   |                                                                                |                         | 25          | A                |
| I <sub>CRM</sub>    |                                                                                |                         | 50          | 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> = 175 °C | 7           | 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>      | P12                                                                            | T <sub>s</sub> = 70 °C  | 17          | A                |
|                     | T <sub>j</sub> = 175 °C                                                        | T <sub>s</sub> = 100 °C | 14          | A                |
| I <sub>F</sub>      | HPTP / HP-PCM                                                                  | T <sub>s</sub> = 70 °C  | 20          | A                |
|                     | T <sub>j</sub> = 175 °C                                                        | T <sub>s</sub> = 100 °C | 16          | A                |
| I <sub>FRM</sub>    |                                                                                |                         | 45          | A                |
| I <sub>FSM</sub>    | t <sub>p</sub> = 10 ms, sin 180°, T <sub>j</sub> = 150 °C                      |                         | 65          | A                |
| T <sub>j</sub>      |                                                                                |                         | -40 ... 175 | °C               |
| Rectifier - Diode   |                                                                                |                         |             |                  |
| V <sub>RRM</sub>    | T <sub>j</sub> = 25 °C                                                         |                         | 1600        | V                |
| I <sub>F</sub>      | P12                                                                            | T <sub>s</sub> = 70 °C  | 47          | A                |
|                     | T <sub>j</sub> = 175 °C                                                        | T <sub>s</sub> = 100 °C | 37          | A                |
| I <sub>F</sub>      | HPTP / HP-PCM                                                                  | T <sub>s</sub> = 70 °C  | 57          | A                |
|                     | T <sub>j</sub> = 175 °C                                                        | T <sub>s</sub> = 100 °C | 45          | A                |
| I <sub>FSM</sub>    | t <sub>p</sub> = 10 ms<br>sin 180°                                             | T <sub>j</sub> = 25 °C  | 370         | A                |
|                     |                                                                                | T <sub>j</sub> = 150 °C | 270         | A                |
| i <sup>2</sup> t    | t <sub>p</sub> = 10 ms<br>sin 180°                                             | T <sub>j</sub> = 25 °C  | 685         | A <sup>2</sup> s |
|                     |                                                                                | T <sub>j</sub> = 150 °C | 365         | A <sup>2</sup> s |
| T <sub>j</sub>      |                                                                                |                         | -40 ... 175 | °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 |
|-----------------|--------------------------------------------|-------------------------------------|------|------|------|------|
| Inverter - IGBT |                                            |                                     |      |      |      |      |
| $V_{CE(sat)}$   | $I_C = 25\text{ A}$                        | $T_j = 25\text{ }^{\circ}\text{C}$  |      | 1.60 | 1.75 | V    |
|                 | $V_{GE} = 15\text{ V}$                     | $T_j = 150\text{ }^{\circ}\text{C}$ |      | 1.78 | 1.93 | V    |
|                 | chiplevel                                  | $T_j = 175\text{ }^{\circ}\text{C}$ |      | 1.82 | 1.97 | V    |
| $V_{CE0}$       |                                            | $T_j = 25\text{ }^{\circ}\text{C}$  |      | 1.00 | 1.05 | V    |
|                 | chiplevel                                  | $T_j = 150\text{ }^{\circ}\text{C}$ |      | 0.80 | 0.85 | V    |
|                 |                                            | $T_j = 175\text{ }^{\circ}\text{C}$ |      | 0.75 | 0.80 | V    |
| $r_{CE}$        | $V_{GE} = 15\text{ V}$                     | $T_j = 25\text{ }^{\circ}\text{C}$  |      | 24   | 28   | mΩ   |
|                 | chiplevel                                  | $T_j = 150\text{ }^{\circ}\text{C}$ |      | 39   | 43   | mΩ   |
|                 |                                            | $T_j = 175\text{ }^{\circ}\text{C}$ |      | 43   | 47   | mΩ   |
| $V_{GE(th)}$    | $V_{GE} = V_{CE}$ , $I_C = 0.53\text{ mA}$ |                                     | 5.15 | 5.8  | 6.45 | V    |



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#### Features\*

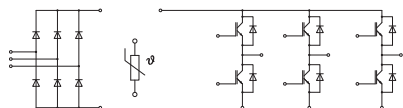
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#### Remarks

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- $T_{j,op} > 150 \text{ }^{\circ}\text{C}$  during overload (details in AN19-002)



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| Characteristics                  |                                                                                                                                              |                                                                                                                                                    |                         |      |      |      |     |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|------|------|------|-----|
| Symbol                           | Conditions                                                                                                                                   |                                                                                                                                                    | min.                    | typ. | max. | Unit |     |
| Inverter - IGBT                  |                                                                                                                                              |                                                                                                                                                    |                         |      |      |      |     |
| I <sub>CES</sub>                 | V <sub>GE</sub> = 0 V, V <sub>CE</sub> = 1200 V, T <sub>j</sub> = 25 °C                                                                      |                                                                                                                                                    |                         |      | 1    | mA   |     |
| C <sub>ies</sub>                 | V <sub>CE</sub> = 25 V                                                                                                                       | f = 1 MHz                                                                                                                                          |                         | 4.80 |      | nF   |     |
| C <sub>oes</sub>                 |                                                                                                                                              | f = 1 MHz                                                                                                                                          |                         | 0.06 |      | nF   |     |
| C <sub>res</sub>                 |                                                                                                                                              | f = 1 MHz                                                                                                                                          |                         | 0.02 |      | nF   |     |
| Q <sub>G</sub>                   | V <sub>GE</sub> = -15 V ... +15 V                                                                                                            |                                                                                                                                                    |                         | 354  |      | nC   |     |
| R <sub>Gint</sub>                | T <sub>j</sub> = 25 °C                                                                                                                       |                                                                                                                                                    |                         | 0    |      | Ω    |     |
| t <sub>d(on)</sub>               | V <sub>CC</sub> = 600 V<br>I <sub>C</sub> = 25 A<br>R <sub>G on</sub> = 6.2 Ω<br>R <sub>G off</sub> = 6.2 Ω                                  | T <sub>j</sub> = 25 °C                                                                                                                             |                         | 28   |      | ns   |     |
|                                  |                                                                                                                                              | T <sub>j</sub> = 150 °C                                                                                                                            |                         | 30   |      | ns   |     |
|                                  |                                                                                                                                              | T <sub>j</sub> = 175 °C                                                                                                                            |                         | 32   |      | ns   |     |
| t <sub>r</sub>                   |                                                                                                                                              | T <sub>j</sub> = 25 °C                                                                                                                             |                         | 23   |      | ns   |     |
|                                  |                                                                                                                                              | T <sub>j</sub> = 150 °C                                                                                                                            |                         | 25   |      | ns   |     |
|                                  |                                                                                                                                              | T <sub>j</sub> = 175 °C                                                                                                                            |                         | 26   |      | ns   |     |
| E <sub>on</sub>                  |                                                                                                                                              | T <sub>j</sub> = 25 °C                                                                                                                             |                         | 1.41 |      | mJ   |     |
|                                  |                                                                                                                                              | T <sub>j</sub> = 150 °C                                                                                                                            |                         | 2.06 |      | mJ   |     |
|                                  |                                                                                                                                              | T <sub>j</sub> = 175 °C                                                                                                                            |                         | 2.32 |      | mJ   |     |
| t <sub>d(off)</sub>              |                                                                                                                                              | V <sub>GE</sub> = +15/-15 V<br>(T <sub>j</sub> = 150 °C)<br>di/dt <sub>on</sub> = 880 A/μs<br>di/dt <sub>off</sub> = 210 A/μs<br>dv/dt = 5400 V/μs | T <sub>j</sub> = 25 °C  |      | 191  |      | ns  |
|                                  |                                                                                                                                              |                                                                                                                                                    | T <sub>j</sub> = 150 °C |      | 231  |      | ns  |
|                                  |                                                                                                                                              |                                                                                                                                                    | T <sub>j</sub> = 175 °C |      | 251  |      | ns  |
| t <sub>f</sub>                   |                                                                                                                                              |                                                                                                                                                    | T <sub>j</sub> = 25 °C  |      | 66   |      | ns  |
|                                  |                                                                                                                                              |                                                                                                                                                    | T <sub>j</sub> = 150 °C |      | 101  |      | ns  |
|                                  |                                                                                                                                              |                                                                                                                                                    | T <sub>j</sub> = 175 °C |      | 108  |      | ns  |
| E <sub>off</sub>                 | T <sub>j</sub> = 25 °C                                                                                                                       |                                                                                                                                                    |                         | 2.04 |      | mJ   |     |
|                                  | T <sub>j</sub> = 150 °C                                                                                                                      |                                                                                                                                                    |                         | 2.71 |      | mJ   |     |
|                                  | T <sub>j</sub> = 175 °C                                                                                                                      |                                                                                                                                                    |                         | 3.09 |      | mJ   |     |
| R <sub>th(j-s)</sub>             | per IGBT, P12 (Reference)                                                                                                                    |                                                                                                                                                    |                         | 1.32 |      | K/W  |     |
| R <sub>th(j-s)</sub>             | per IGBT, HPTP / HP-PCM                                                                                                                      |                                                                                                                                                    |                         | 1.06 |      | K/W  |     |
| Inverse - Diode                  |                                                                                                                                              |                                                                                                                                                    |                         |      |      |      |     |
| V <sub>F</sub> = V <sub>EC</sub> | I <sub>F</sub> = 15 A                                                                                                                        | T <sub>j</sub> = 25 °C                                                                                                                             |                         | 2.38 | 2.71 | V    |     |
|                                  | chiplevel                                                                                                                                    | T <sub>j</sub> = 150 °C                                                                                                                            |                         | 2.44 | 2.77 | V    |     |
|                                  |                                                                                                                                              | T <sub>j</sub> = 175 °C                                                                                                                            |                         | 2.26 | 2.58 | V    |     |
| V <sub>F0</sub>                  |                                                                                                                                              | T <sub>j</sub> = 25 °C                                                                                                                             |                         | 1.30 | 1.50 | V    |     |
|                                  | chiplevel                                                                                                                                    | T <sub>j</sub> = 150 °C                                                                                                                            |                         | 0.90 | 1.10 | V    |     |
|                                  |                                                                                                                                              | T <sub>j</sub> = 175 °C                                                                                                                            |                         | 0.82 | 0.98 | V    |     |
| r <sub>F</sub>                   |                                                                                                                                              | T <sub>j</sub> = 25 °C                                                                                                                             |                         | 72   | 81   | mΩ   |     |
|                                  | chiplevel                                                                                                                                    | T <sub>j</sub> = 150 °C                                                                                                                            |                         | 103  | 111  | mΩ   |     |
|                                  |                                                                                                                                              | T <sub>j</sub> = 175 °C                                                                                                                            |                         | 96   | 107  | mΩ   |     |
| I <sub>RRM</sub>                 |                                                                                                                                              | T <sub>j</sub> = 25 °C                                                                                                                             |                         | 16   |      | A    |     |
|                                  | I <sub>F</sub> = 25 A<br>V <sub>GE</sub> = -15 V<br>V <sub>CC</sub> = 600 V<br>(T <sub>j</sub> = 150 °C)<br>di/dt <sub>off</sub> = 1050 A/μs | T <sub>j</sub> = 150 °C                                                                                                                            |                         | 23   |      | A    |     |
|                                  |                                                                                                                                              | T <sub>j</sub> = 175 °C                                                                                                                            |                         | 24   |      | A    |     |
| Q <sub>rr</sub>                  |                                                                                                                                              | T <sub>j</sub> = 25 °C                                                                                                                             |                         | 1.01 |      | μC   |     |
|                                  |                                                                                                                                              | T <sub>j</sub> = 150 °C                                                                                                                            |                         | 2.69 |      | μC   |     |
|                                  |                                                                                                                                              | T <sub>j</sub> = 175 °C                                                                                                                            |                         | 3.04 |      | μC   |     |
| E <sub>rr</sub>                  |                                                                                                                                              | T <sub>j</sub> = 25 °C                                                                                                                             |                         | 0.37 |      | mJ   |     |
|                                  |                                                                                                                                              | T <sub>j</sub> = 150 °C                                                                                                                            |                         | 1.17 |      | mJ   |     |
|                                  |                                                                                                                                              | T <sub>j</sub> = 175 °C                                                                                                                            |                         | 1.79 |      | mJ   |     |
| R <sub>th(j-s)</sub>             |                                                                                                                                              | per Diode, P12 (Reference)                                                                                                                         |                         |      | 2.13 |      | K/W |
| R <sub>th(j-s)</sub>             | per Diode, HPTP / HP-PCM                                                                                                                     |                                                                                                                                                    |                         | 1.74 |      | K/W  |     |

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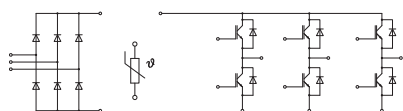
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#### Remarks

- Recommended  $T_{j,op} = -40 \dots +150 \text{ }^{\circ}\text{C}$
- $T_{j,op} > 150 \text{ }^{\circ}\text{C}$  during overload (details in AN19-002)

| Characteristics                  |                                                                  |                         |      |          |      |      |
|----------------------------------|------------------------------------------------------------------|-------------------------|------|----------|------|------|
| Symbol                           | Conditions                                                       |                         | min. | typ.     | max. | Unit |
| Rectifier - Diode                |                                                                  |                         |      |          |      |      |
| V <sub>F</sub> = V <sub>EC</sub> | I <sub>F</sub> = 25 A<br>chiplevel                               | T <sub>j</sub> = 25 °C  |      | 1.04     | 1.30 | V    |
|                                  |                                                                  | T <sub>j</sub> = 150 °C |      | 0.95     | 1.21 | V    |
|                                  |                                                                  | T <sub>j</sub> = 175 °C |      | 0.94     | 1.21 | V    |
| V <sub>F0</sub>                  | chiplevel                                                        | T <sub>j</sub> = 25 °C  |      | 0.89     | 1.09 | V    |
|                                  |                                                                  | T <sub>j</sub> = 150 °C |      | 0.73     | 0.92 | V    |
|                                  |                                                                  | T <sub>j</sub> = 175 °C |      | 0.69     | 0.88 | V    |
| r <sub>F</sub>                   | chiplevel                                                        | T <sub>j</sub> = 25 °C  |      | 6.2      | 8.5  | mΩ   |
|                                  |                                                                  | T <sub>j</sub> = 150 °C |      | 8.8      | 12   | mΩ   |
|                                  |                                                                  | T <sub>j</sub> = 175 °C |      | 10.0     | 13   | mΩ   |
| I <sub>R</sub>                   | T <sub>j</sub> = 150 °C, V <sub>RRM</sub>                        |                         |      |          | 2    | mA   |
| R <sub>th(j-s)</sub>             | per Diode, P12 (Reference)                                       |                         |      | 1.48     |      | K/W  |
| R <sub>th(j-s)</sub>             | per Diode, HPTP / HP-PCM                                         |                         |      | 1.14     |      | K/W  |
| Module                           |                                                                  |                         |      |          |      |      |
| M <sub>s</sub>                   | to heatsink                                                      |                         | 1.6  |          | 2.3  | Nm   |
| w                                |                                                                  |                         |      | 25       |      | 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(T)=R <sub>25</sub> *exp[B <sub>25/85</sub> *(1/T-1/298)], T[K] |                         |      | 3420     |      | K    |



**DGD-ET**

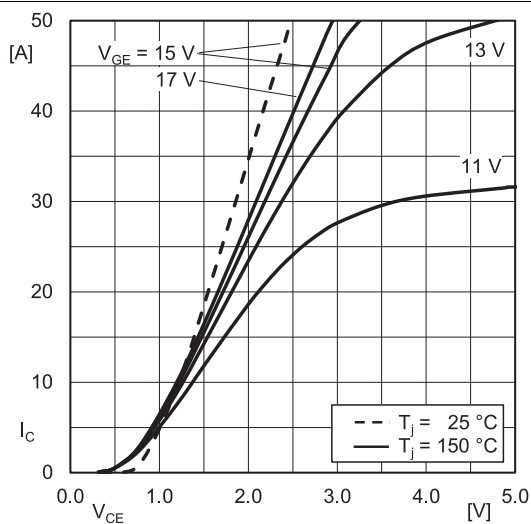


Fig. 1: Typ. IGBT output characteristic, incl.  $R_{CC+EE'}$

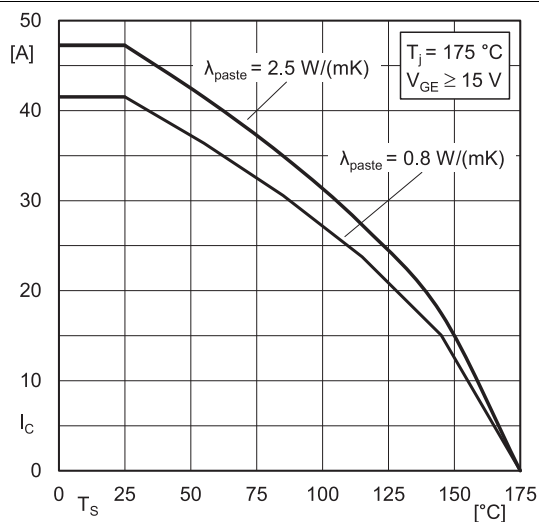


Fig. 2: IGBT rated current vs. Temperature  $I_C=f(T_s)$

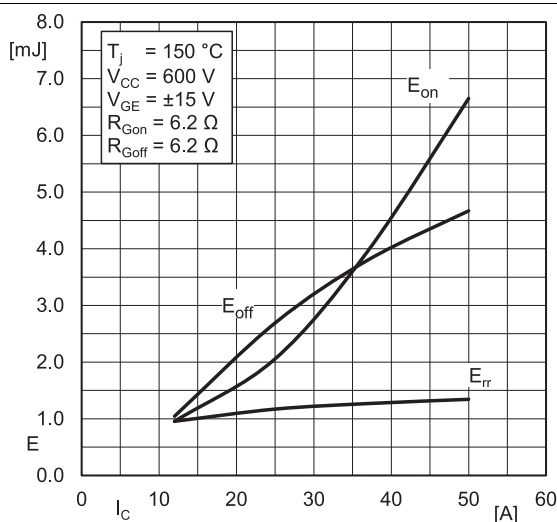


Fig. 3: Typ. turn-on /-off energy =  $f(I_C)$

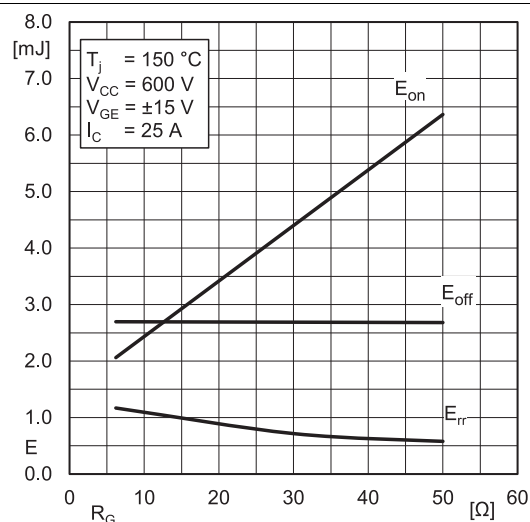


Fig. 4: Typ. turn-on /-off energy =  $f(R_G)$

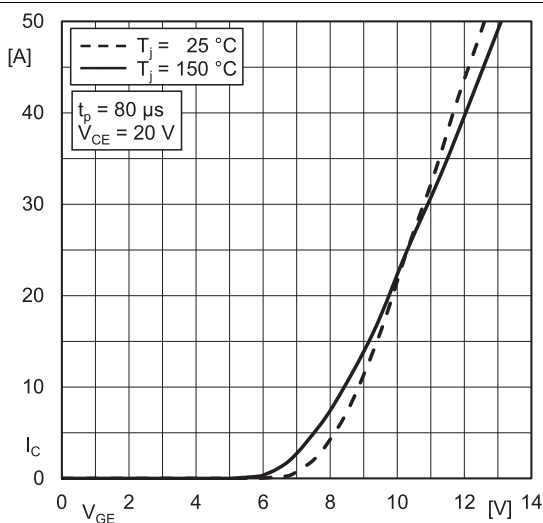


Fig. 5: Typ. IGBT transfer characteristic

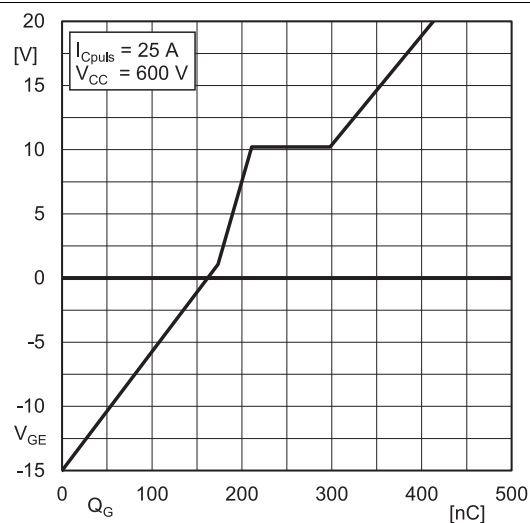


Fig. 6: Typ. IGBT gate charge characteristic

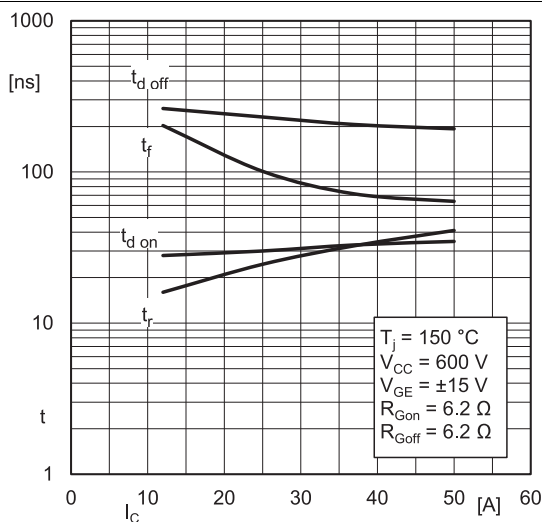


Fig. 7: Typ. switching times =  $f(I_C)$

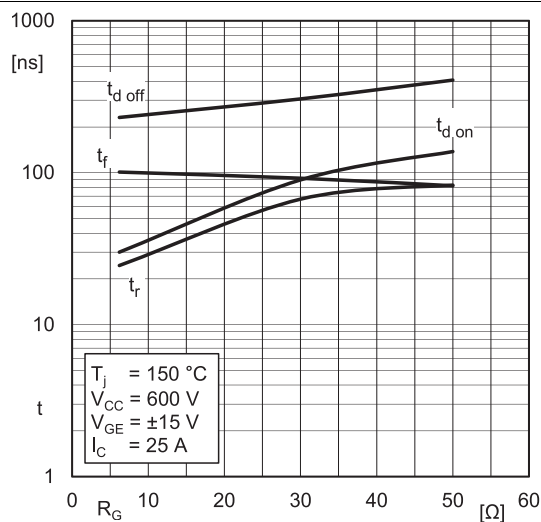


Fig. 8: Typ. switching times =  $f(R_G)$

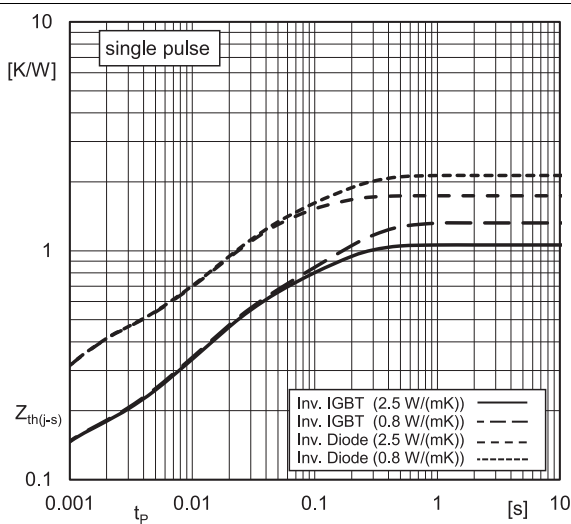


Fig. 9: Typ. transient thermal impedance

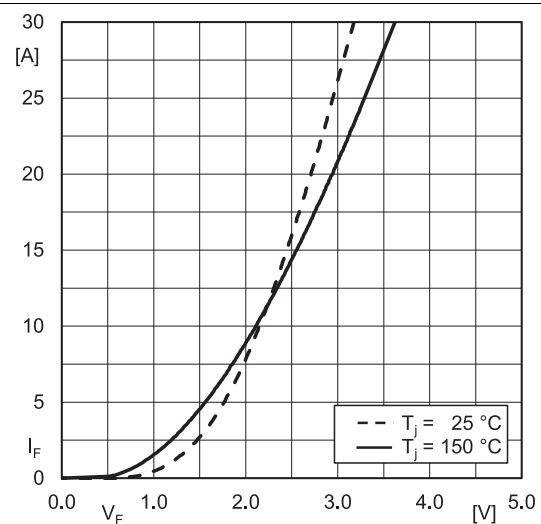


Fig. 10: Typ. Inv. diode forward charact., incl.  $R_{CC} + EE'$

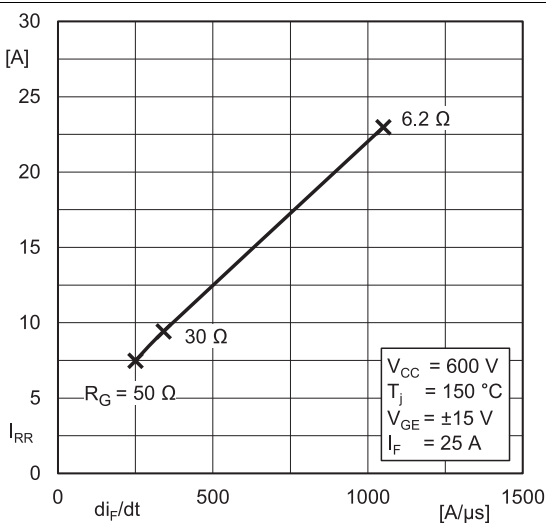


Fig. 11: Typ. Inv. diode peak reverse recovery current

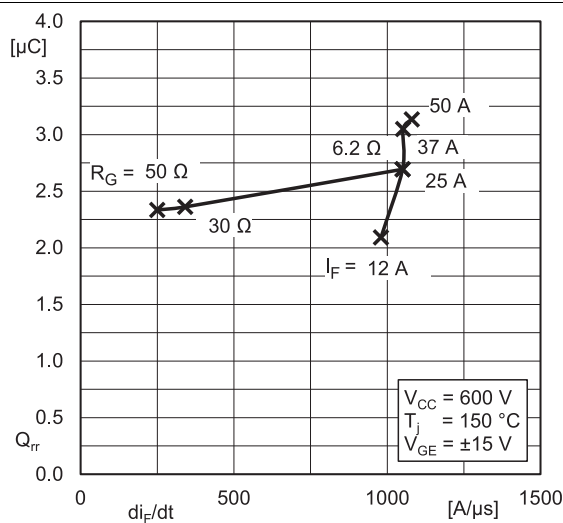


Fig. 12: Typ. Inv. diode reverse recovery charge

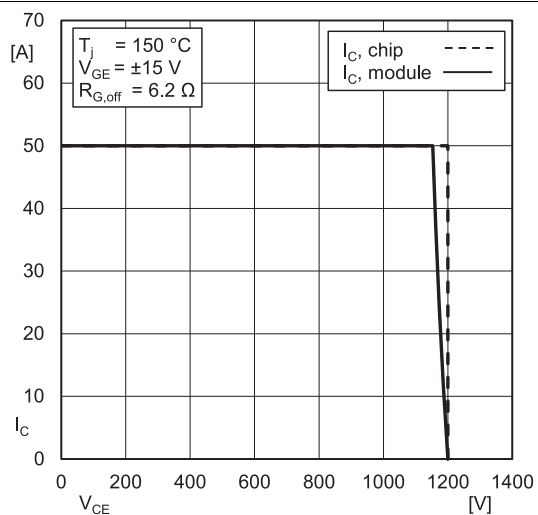


Fig. 13: IGBT Reverse Bias Safe Operating Area (RBSOA)

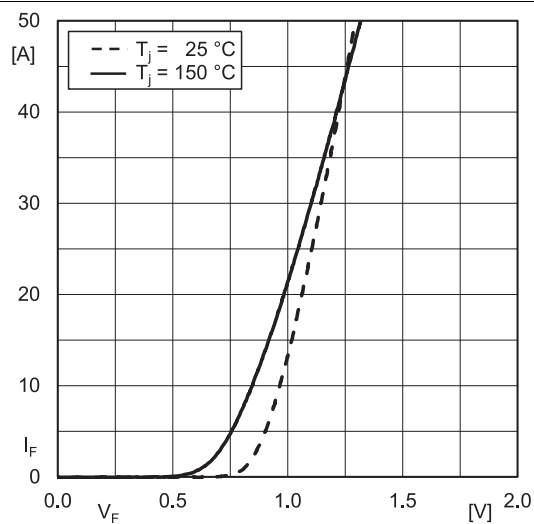
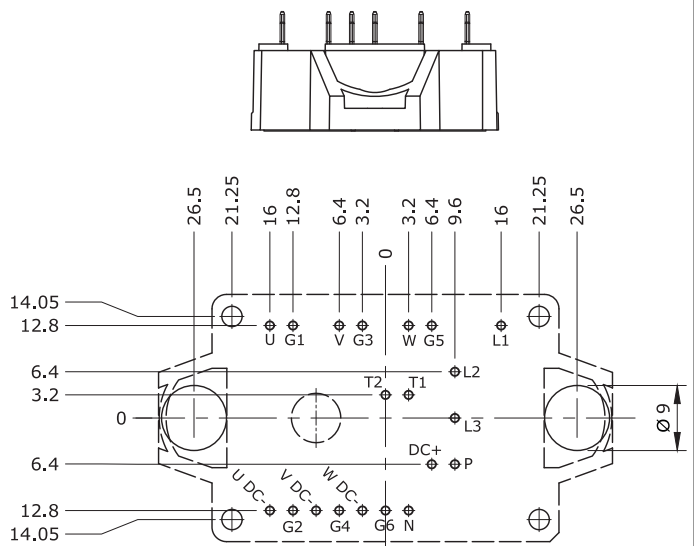
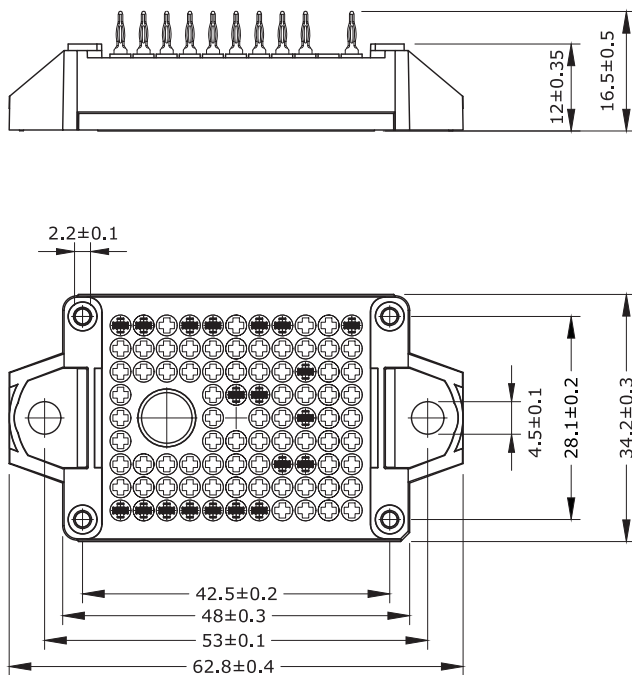
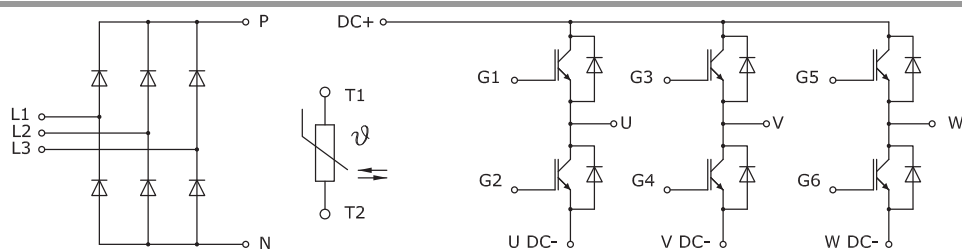


Fig. 14: Typ. Rect. diode forward charact., incl.  $R_{CC'+EE'}$



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

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DGD-ET

## IMPORTANT INFORMATION AND WARNINGS

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

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