<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$</td>
<td>$I_f = I_{pos}$</td>
<td>1600</td>
<td>V</td>
</tr>
<tr>
<td>DC forward current</td>
<td>$I_{f,DC}$</td>
<td>$T_s = 80 , ^\circ C$</td>
<td>36</td>
<td>A</td>
</tr>
<tr>
<td>Surge (non-repetitive) forward current</td>
<td>$I_{VM}$</td>
<td>$T_s = 10 , ms$</td>
<td>230</td>
<td>A</td>
</tr>
<tr>
<td>I2t-value</td>
<td>$I_{f,t}$</td>
<td>$T_s = 80 , ^\circ C$</td>
<td>260</td>
<td>A²s</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>$P_{tot}$</td>
<td>$T_s = 80 , ^\circ C$</td>
<td>51</td>
<td>W</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>$T_{j,max}$</td>
<td></td>
<td>150</td>
<td>°C</td>
</tr>
</tbody>
</table>

### Inverter Switch

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-emitter breakdown voltage</td>
<td>$V_{CE}$</td>
<td></td>
<td>1200</td>
<td>V</td>
</tr>
<tr>
<td>DC collector current</td>
<td>$I_C$</td>
<td>$T_s = 80 , ^\circ C$</td>
<td>21</td>
<td>A</td>
</tr>
<tr>
<td>Repetitive peak collector current</td>
<td>$I_{CRM}$</td>
<td>$I_f$ limited by $I_{pos}$</td>
<td>45</td>
<td>A</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>$P_{tot}$</td>
<td>$T_s = 80 , ^\circ C$</td>
<td>59</td>
<td>W</td>
</tr>
<tr>
<td>Gate-emitter peak voltage</td>
<td>$V_{GE}$</td>
<td></td>
<td>±20</td>
<td>V</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>$T_{j,max}$</td>
<td></td>
<td>150</td>
<td>°C</td>
</tr>
</tbody>
</table>
## Maximum Ratings

$T_j = 25 \, ^\circ C$, unless otherwise specified

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inverter Diode</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak Repetitive Reverse Voltage</td>
<td>$V_{RSM}$</td>
<td></td>
<td>1200</td>
<td>V</td>
</tr>
<tr>
<td>DC forward current</td>
<td>$I_f$</td>
<td>$T_j = T_{pass}$, $T_s = 80 , ^\circ C$</td>
<td>21</td>
<td>A</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>$P_{tot}$</td>
<td>$T_j = T_{pass}$, $T_s = 80 , ^\circ C$</td>
<td>58</td>
<td>W</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>$T_{jmax}$</td>
<td></td>
<td>175</td>
<td>°C</td>
</tr>
</tbody>
</table>

| **Brake Switch** | | | | |
| Collector-emitter breakdown voltage | $V_{DC}$ | | 1200 | V |
| DC collector current | $I_c$ | $T_j = T_{pass}$, $T_s = 80 \, ^\circ C$ | 11 | A |
| Repetitive peak collector current | $I_{CEM}$ | $T_j$ limited by $T_{pass}$ | 24 | A |
| Power dissipation | $P_{tot}$ | $T_j = T_{pass}$, $T_s = 80 \, ^\circ C$ | 46 | W |
| Gate-emitter peak voltage | $V_{GE}$ | | 820 | V |
| Maximum Junction Temperature | $T_{jmax}$ | | 150 | °C |

| **Brake Diode** | | | | |
| Peak Repetitive Reverse Voltage | $V_{RSM}$ | | 1200 | V |
| DC forward current | $I_f$ | $T_j = T_{pass}$, $T_s = 80 \, ^\circ C$ | 8 | A |
| Power dissipation | $P_{tot}$ | $T_j = T_{pass}$, $T_s = 80 \, ^\circ C$ | 28 | W |
| Maximum Junction Temperature | $T_{jmax}$ | | 175 | °C |

| **Thermal Properties** | | | | |
| Storage temperature | $T_{stg}$ | | -40...+125 | °C |
| Operation temperature under switching condition | $T_{op}$ | | -40...+(T_{pass} - 25) | °C |

| **Isolation Properties** | | | | |
| Isolation voltage | $V_{i}$ | $t = 2 \, s$, DC Test Voltage | 4000 | V |
| Creepage distance | | | min 12,7 | mm |
| Clearance | | | min 12,7 | mm |
| Comparative tracking index | CTI | | >200 | |

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### Rectifier Diode

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward voltage</td>
<td>( V_F )</td>
<td>25</td>
<td>30 (Min)</td>
</tr>
<tr>
<td>Threshold voltage (for power loss calc.)</td>
<td>( V_{br} )</td>
<td>25, 125</td>
<td>1.23 (Min)</td>
</tr>
<tr>
<td>Slope resistance (for power loss calc.)</td>
<td>( r_v )</td>
<td>25</td>
<td>30 (Min)</td>
</tr>
<tr>
<td>Reverse current</td>
<td>( I_v )</td>
<td>15</td>
<td>16 (Typ)</td>
</tr>
<tr>
<td>Thermal resistance junction to sink</td>
<td>( R_{th(j-s)} )</td>
<td>phase-change material ( s = 3.4 , \text{W/mK} )</td>
<td>1.36 (Max)</td>
</tr>
</tbody>
</table>

### Inverter Switch

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gate emitter threshold voltage</td>
<td>( V_{GEMI} )</td>
<td>0.0005</td>
<td>0 (Min)</td>
</tr>
<tr>
<td>Collector-emitter saturation voltage</td>
<td>( V_{CEsat} )</td>
<td>15</td>
<td>16 (Typ)</td>
</tr>
<tr>
<td>Collector-emitter cut-off incl. Diode</td>
<td>( I_{COSS} )</td>
<td>0</td>
<td>1200 (Max)</td>
</tr>
<tr>
<td>Gate-emitter leakage current</td>
<td>( I_{EISS} )</td>
<td>20</td>
<td>0 (Max)</td>
</tr>
<tr>
<td>Integrated Gate resistor</td>
<td>( R_{PN} )</td>
<td>none</td>
<td>Ω (Max)</td>
</tr>
<tr>
<td>Turn-on delay time</td>
<td>( t_{on} )</td>
<td>25</td>
<td>600 (Min)</td>
</tr>
<tr>
<td>Turn-off delay time</td>
<td>( t_{off} )</td>
<td>15</td>
<td>15 (Max)</td>
</tr>
<tr>
<td>Rise time</td>
<td>( t_{r} )</td>
<td>±15</td>
<td>600 (Max)</td>
</tr>
<tr>
<td>Fall time</td>
<td>( t_{f} )</td>
<td>15</td>
<td>125 (Max)</td>
</tr>
<tr>
<td>Turn-on energy loss</td>
<td>( E_{on} )</td>
<td>5</td>
<td>5 (Min)</td>
</tr>
<tr>
<td>Turn-off energy loss</td>
<td>( E_{off} )</td>
<td>1.35</td>
<td>6.5 (Max)</td>
</tr>
<tr>
<td>Input capacitance</td>
<td>( C_{in} )</td>
<td>15</td>
<td>1.69 (Max)</td>
</tr>
<tr>
<td>Output capacitance</td>
<td>( C_{oss} )</td>
<td>25</td>
<td>58 (Max)</td>
</tr>
<tr>
<td>Reverse transfer capacitance</td>
<td>( C_{rss} )</td>
<td>0</td>
<td>48 (Max)</td>
</tr>
<tr>
<td>Thermal resistance junction to sink</td>
<td>( R_{th(j-s)} )</td>
<td>phase-change material ( s = 3.4 , \text{W/mK} )</td>
<td>1.19 (Max)</td>
</tr>
</tbody>
</table>

### Inverter Diode

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diode forward voltage</td>
<td>( V_D )</td>
<td>15</td>
<td>25 (Min)</td>
</tr>
<tr>
<td>Peak reverse recovery current</td>
<td>( I_{RRC} )</td>
<td>25</td>
<td>30 (Max)</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>( t_{rr} )</td>
<td>±15</td>
<td>600 (Max)</td>
</tr>
<tr>
<td>Reverse recovered charge</td>
<td>( Q_{rr} )</td>
<td>25</td>
<td>15 (Max)</td>
</tr>
<tr>
<td>Peak rate of fall of recovery current</td>
<td>( f_{RRC}(V_{ds}=0) )</td>
<td>2.57</td>
<td>μC (Max)</td>
</tr>
<tr>
<td>Reverse recovered energy</td>
<td>( E_{on} )</td>
<td>2.37</td>
<td>2.48 (Max)</td>
</tr>
<tr>
<td>Thermal resistance junction to sink</td>
<td>( R_{th(j-s)} )</td>
<td>phase-change material ( s = 3.4 , \text{W/mK} )</td>
<td>1.64 (Max)</td>
</tr>
</tbody>
</table>
## Characteristic Values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Brake Switch</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gate emitter threshold voltage</td>
<td>( V_{GE(th)} )</td>
<td></td>
<td>( V_{CE} = V_{GE} )</td>
<td>0.0003</td>
</tr>
<tr>
<td>Collector-emitter saturation voltage</td>
<td>( V_{CE sat} )</td>
<td></td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Collector-emitter cut-off incl diode</td>
<td>( I_{CBO} )</td>
<td>0</td>
<td>1200</td>
<td></td>
</tr>
<tr>
<td>Gate-emitter leakage current</td>
<td>( I_{GON} )</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integrated Gate resistor</td>
<td>( R_{gon} )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn-on delay time</td>
<td>( t_{ON} )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rise time</td>
<td>( t_{r} )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn-off delay time</td>
<td>( t_{OFF} )</td>
<td>( R_{pay} = 81 \ \Omega )</td>
<td>15</td>
<td>600</td>
</tr>
<tr>
<td>Fall time</td>
<td>( t_{f} )</td>
<td>( R_{pay} = 81 \ \Omega )</td>
<td>15</td>
<td>600</td>
</tr>
<tr>
<td>Turn-on energy loss</td>
<td>( E_{on} )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn-off energy loss</td>
<td>( E_{off} )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input capacitance</td>
<td>( C_{iss} )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output capacitance</td>
<td>( C_{oss} )</td>
<td></td>
<td>( f = 1 \ \text{MHz} )</td>
<td>0</td>
</tr>
<tr>
<td>Reverse transfer capacitance</td>
<td>( C_{rss} )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal resistance junction to sink</td>
<td>( R_{th(j-s)} )</td>
<td>phase-change material</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Brake Diode</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diode forward voltage</td>
<td>( V_{F} )</td>
<td></td>
<td>25</td>
<td>240,8</td>
</tr>
<tr>
<td>Reverse leakage current</td>
<td>( I_{R} )</td>
<td>( R_{pay} = 81 \ \Omega )</td>
<td>1200</td>
<td>25</td>
</tr>
<tr>
<td>Peak reverse recovery current</td>
<td>( I_{RRM} )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>( t_{rr} )</td>
<td>( R_{pay} = 81 \ \Omega )</td>
<td>15</td>
<td>600</td>
</tr>
<tr>
<td>Reverse recovered charge</td>
<td>( Q_{rr} )</td>
<td>( R_{pay} = 81 \ \Omega )</td>
<td>15</td>
<td>600</td>
</tr>
<tr>
<td>Peak rate of fall of recovery current</td>
<td>( \left( \frac{dI_{RRM}}{dt} \right)_{max} )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse recovery energy</td>
<td>( E_{off} )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal resistance junction to sink</td>
<td>( R_{th(j-s)} )</td>
<td>phase-change material</td>
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</table>

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24 Aug. 2016 / Revision 2
## Characteristic Values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$V_{GE}$ [V]</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{GS}$ [V]</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{r}$ [V]</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE}$ [V]</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{DS}$ [V]</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C$ [A]</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_S$ [A]</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_D$ [A]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_J$ [°C]</td>
<td></td>
<td>Min</td>
<td>Typ</td>
<td>Max</td>
</tr>
</tbody>
</table>

### Thermistor

- **Rated resistance**
  - $R$
  - 25
  - 22000
  - $\Omega$

- **Deviation of $R_{TH}$**
  - $\Delta R/R_{TH} = 1484 \Omega$
  - 100
  - -5
  - 5
  - $\%$

- **Power dissipation**
  - $P$
  - 25
  - 5
  - mW

- **Power dissipation constant**
  - $P_{DC}$
  - 25
  - 1.5
  - mW/K

- **B-value**
  - $R_{(25/50)}$
  - 25
  - 3962
  - K

- **B-value**
  - $R_{(25/100)}$
  - 25
  - 4000
  - K

Vincotech NTC Reference
Inverter Characteristics

**figure 1.**
Typical output characteristics

$I_C = f(V_{CE})$

- At $t_p = 250\ \mu s$
- $T_j = 25\ ^\circ C$
- $V_{CE}$ from 7 V to 17 V in steps of 1 V

**figure 2.**
Typical output characteristics

$I_C = f(V_{CE})$

- At $t_p = 250\ \mu s$
- $T_j = 125\ ^\circ C$
- $V_{CE}$ from 7 V to 17 V in steps of 1 V

**figure 3.**
Typical transfer characteristics

$I_C = f(V_{GE})$

- At $t_p = 250\ \mu s$
- $T_j = 25\ ^\circ C$
- $T_j = T_{jmax} - 25\ ^\circ C$

**figure 4.**
Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$

- At $t_p = 250\ \mu s$
- $T_j = 25\ ^\circ C$
- $T_j = T_{jmax} - 25\ ^\circ C$
Inverter Characteristics

**Figure 5.** IGBT
Typical switching energy losses as a function of collector current

\[ E = f(I_c) \]

With an inductive load at

- \( T_j = 125 \, ^\circ C \)
- \( V_{ce} = 600 \, V \)
- \( V_{ce} = \pm 15 \, V \)
- \( R_{gon} = 54 \, \Omega \)
- \( R_{goff} = 54 \, \Omega \)

**Figure 6.** IGBT
Typical switching energy losses as a function of gate resistor

\[ E = f(R_g) \]

With an inductive load at

- \( T_j = 125 \, ^\circ C \)
- \( V_{ce} = 600 \, V \)
- \( V_{ce} = \pm 15 \, V \)
- \( I_c = 15 \, A \)

**Figure 7.** FWD
Typical reverse recovery energy loss as a function of collector current

\[ E_{rec} = f(I_c) \]

With an inductive load at

- \( T_j = 125 \, ^\circ C \)
- \( V_{ce} = 600 \, V \)
- \( V_{ce} = \pm 15 \, V \)
- \( R_{gon} = 54 \, \Omega \)

**Figure 8.** FWD
Typical reverse recovery energy loss as a function of gate resistor

\[ E_{rec} = f(R_g) \]

With an inductive load at

- \( T_j = 125 \, ^\circ C \)
- \( V_{ce} = 600 \, V \)
- \( V_{ce} = \pm 15 \, V \)
- \( I_c = 15 \, A \)
Inverter Characteristics

**Figure 9. IGBT**

Typical switching times as a function of collector current

$t = f(I_C)$

With an inductive load at

- $T_J = 125 \degree C$
- $V_{CE} = 600 \text{ V}$
- $V_{GE} = \pm 15 \text{ V}$
- $R_{gon} = 54 \Omega$
- $R_{goff} = 54 \Omega$

**Figure 10. IGBT**

Typical switching times as a function of gate resistor

$t = f(R_G)$

With an inductive load at

- $T_J = 125 \degree C$
- $V_{CE} = 600 \text{ V}$
- $V_{GE} = \pm 15 \text{ V}$
- $I_C = 15 \text{ A}$

**Figure 11. FWD**

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$

At

- $T_J = 125 \degree C$
- $V_{CE} = 600 \text{ V}$
- $V_{GE} = \pm 15 \text{ V}$
- $R_{gon} = 54 \Omega$

**Figure 12. FWD**

Typical reverse recovery time as a function of IGBT turn on gate resistor

$t_{rr} = f(R_{gon})$

At

- $T_J = T_{J_{max}} - 25 \degree C$
- $V_{CE} = 600 \text{ V}$
- $V_{GE} = \pm 15 \text{ V}$
Inverter Characteristics

figure 13. FWD
Typical reverse recovery charge as a function of collector current
\[ Q_{rr} = f(I_C) \]

At
\[ T_j = 125 \, ^\circ\text{C} \]
\[ V_{CE} = 600 \, \text{V} \]
\[ V_{GE} = \pm 15 \, \text{V} \]
\[ R_{gon} = 54 \, \Omega \]

figure 14. FWD
Typical reverse recovery charge as a function of IGBT turn on gate resistor
\[ Q_{rr} = f(R_{gon}) \]

At
\[ T_j = 125 \, ^\circ\text{C} \]
\[ V_{CE} = 600 \, \text{V} \]
\[ I_F = 15 \, \text{A} \]
\[ V_{GE} = \pm 15 \, \text{V} \]

figure 15. FWD
Typical reverse recovery current as a function of collector current
\[ I_{RRM} = f(I_C) \]

At
\[ T_j = 125 \, ^\circ\text{C} \]
\[ V_{CE} = 600 \, \text{V} \]
\[ V_{GE} = \pm 15 \, \text{V} \]
\[ R_{gon} = 54 \, \Omega \]

figure 16. FWD
Typical reverse recovery current as a function of IGBT turn on gate resistor
\[ I_{RRM} = f(R_{gon}) \]

At
\[ T_j = 125 \, ^\circ\text{C} \]
\[ V_{CE} = 600 \, \text{V} \]
\[ I_F = 15 \, \text{A} \]
\[ V_{GE} = \pm 15 \, \text{V} \]
Typical rate of fall of forward and reverse recovery current as a function of collector current:

\[
\frac{di_f}{dt}, \frac{di_{rec}}{dt} = f(I_C)
\]

At

\[
T_j = 125 \, ^\circ\text{C},
\]
\[
V_{CE} = 600 \, \text{V},
\]
\[
V_{GE} = \pm 15 \, \text{V},
\]
\[
I_F = 15 \, \text{A},
\]
\[
R_{gon} = 54 \, \Omega.
\]

IGBT transient thermal impedance as a function of pulse width:

\[
Z_{th(J-H)} = f(t_p)
\]

At

\[
D = \frac{t_p}{T},
\]
\[
R_{th(J-H)} = 1.19 \, \text{K/W}
\]

IGBT thermal model values

<table>
<thead>
<tr>
<th>(R) (K/W)</th>
<th>(\tau) (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.03</td>
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<td>7.5E-01</td>
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<td>1.8E-01</td>
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<tr>
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<td>3.2E-02</td>
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<td>6.7E-03</td>
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<tr>
<td>0.07</td>
<td>6.0E-04</td>
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FWD transient thermal impedance as a function of pulse width:

\[
Z_{th(J-H)} = f(t_p)
\]

At

\[
D = \frac{t_p}{T},
\]
\[
R_{th(J-H)} = 1.64 \, \text{K/W}
\]

FWD thermal model values

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<th>(R) (K/W)</th>
<th>(\tau) (s)</th>
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<td>0.48</td>
<td>1.1E-02</td>
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<tr>
<td>0.24</td>
<td>1.9E-03</td>
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</tbody>
</table>
Inverter Characteristics

**figure 21.** IGBT
Power dissipation as a function of heatsink temperature

\[ P_{\text{tot}} = f(T_s) \]

At
\[ T_j = 150 \degree C \]

**figure 22.** IGBT
Collector current as a function of heatsink temperature

\[ I_C = f(T_s) \]

At
\[ T_j = 150 \degree C \]
\[ V_{GE} = 15 \text{ V} \]

**figure 23.** FWD
Power dissipation as a function of heatsink temperature

\[ P_{\text{tot}} = f(T_s) \]

At
\[ T_j = 175 \degree C \]

**figure 24.** FWD
Forward current as a function of heatsink temperature

\[ I_f = f(T_s) \]

At
\[ T_j = 175 \degree C \]
Inverter Characteristics

figure 25. IGBT

Reverse bias safe operating area

\[ I_C = f(V_{ce}) \]

At \[ T_j = 125 \, ^\circ C \]
\[ R_{gon} = 54 \, \Omega \]
\[ R_{goff} = 54 \, \Omega \]
Brake Characteristics

**figure 1. IGBT**

Typical output characteristics

\[ I_C = f(V_{CE}) \]

At

- \( t_p = 250 \ \mu s \)
- \( T_j = 25 \ ^\circ C \)
- \( V_{CE} \) from 7 V to 17 V in steps of 1 V

**figure 2. IGBT**

Typical output characteristics

\[ I_C = f(V_{CE}) \]

At

- \( t_p = 250 \ \mu s \)
- \( T_j = 125 \ ^\circ C \)
- \( V_{CE} \) from 7 V to 17 V in steps of 1 V

**figure 3. IGBT**

Typical transfer characteristics

\[ I_C = f(V_{GE}) \]

At

- \( t_p = 250 \ \mu s \)
- \( V_{CE} = 10 \ \text{V} \)

**figure 4. FWD**

Typical diode forward current as a function of forward voltage

\[ I_F = f(V_F) \]

At

- \( t_p = 250 \ \mu s \)
- \( T_j = T_{jmax} - 25 \ ^\circ C \)
Brake Characteristics

**figure 5.** IGBT

**Figure 5.**

*Typical switching energy losses as a function of collector current*

\[ E = f(I_C) \]

With an inductive load at

\( T_j = 125 \, ^\circ \text{C} \)
\( V_{CE} = 600 \, \text{V} \)
\( V_{GE} = \pm 15 \, \text{V} \)
\( R_{gon} = 81 \, \Omega \)
\( I_C = 8 \, \text{A} \)

**figure 6.** IGBT

**Figure 6.**

*Typical switching energy losses as a function of gate resistor*

\[ E = f(R_G) \]

With an inductive load at

\( T_j = 125 \, ^\circ \text{C} \)
\( V_{CE} = 600 \, \text{V} \)
\( V_{GE} = \pm 15 \, \text{V} \)
\( I_C = 8 \, \text{A} \)

**figure 7.** FWD

**Figure 7.**

*Typical reverse recovery energy loss as a function of collector current*

\[ E_{rec} = f(I_C) \]

With an inductive load at

\( T_j = 125 \, ^\circ \text{C} \)
\( V_{CE} = 600 \, \text{V} \)
\( V_{GE} = \pm 15 \, \text{V} \)
\( R_{gon} = 81 \, \Omega \)

**figure 8.** FWD

**Figure 8.**

*Typical reverse recovery energy loss as a function of gate resistor*

\[ E_{rec} = f(R_G) \]

With an inductive load at

\( T_j = 125 \, ^\circ \text{C} \)
\( V_{CE} = 600 \, \text{V} \)
\( V_{GE} = \pm 15 \, \text{V} \)
\( I_C = 8 \, \text{A} \)
Brake Characteristics

**figure 9.**
IGBT

Typical switching times as a function of collector current

\[ t = f(I_C) \]

With an inductive load at

- \( T_j = 125 \, ^\circ C \)
- \( V_{CE} = 600 \, V \)
- \( V_{GS} = \pm 15 \, V \)
- \( R_{gon} = 81 \, \Omega \)
- \( R_{goff} = 81 \, \Omega \)

**figure 10.**
IGBT

Typical switching times as a function of gate resistor

\[ t = f(R_G) \]

With an inductive load at

- \( T_j = 125 \, ^\circ C \)
- \( V_{CE} = 600 \, V \)
- \( V_{GS} = \pm 15 \, V \)
- \( I_C = 8 \, A \)

**figure 11.**
IGBT

IGBT transient thermal impedance as a function of pulse width

\[ Z_{th(j-s)} = f(t_p) \]

At

\[ D = \frac{t_p}{T} \]

\[ R_{th(j-q)} = 1.51 \, \text{K/W} \]

**figure 12.**
FWD

FWD transient thermal impedance as a function of pulse width

\[ Z_{th(j-q)} = f(t_p) \]

At

\[ D = \frac{t_p}{T} \]

\[ R_{th(j-q)} = 2.10 \, \text{K/W} \]
Brake Characteristics

**figure 13.** IGBT
Power dissipation as a function of heatsink temperature

\[ P_{\text{tot}} = f(T_s) \]

- At \( T_j = 150 \ ^\circ\text{C} \)

**figure 14.** IGBT
Collector current as a function of heatsink temperature

\[ I_C = f(T_s) \]

- At \( T_j = 150 \ ^\circ\text{C} \)
- \( V_{\text{GE}} = 15 \ \text{V} \)

**figure 15.** FWD
Power dissipation as a function of heatsink temperature

\[ P_{\text{tot}} = f(T_s) \]

- At \( T_j = 175 \ ^\circ\text{C} \)

**figure 16.** FWD
Forward current as a function of heatsink temperature

\[ I_F = f(T_s) \]

- At \( T_j = 175 \ ^\circ\text{C} \)
Rectifier Diode Characteristics

**figure 1.** Rectifier Diode
Typical diode forward current as a function of forward voltage
\[ I_F = f(V_F) \]

![Graph 1](image1)

At
\[ t_p = 250 \ \mu s \]

**figure 2.** Rectifier Diode
Diode transient thermal impedance as a function of pulse width
\[ Z_{th(j-s)} = f(t_p) \]

![Graph 2](image2)

At
\[ D = \frac{t_p}{T_R} \]
\[ R_{th(j-s)} = 1,36 \ \text{K/W} \]

**figure 3.** Rectifier Diode
Power dissipation as a function of heatsink temperature
\[ P_{tot} = f(T_h) \]

![Graph 3](image3)

At
\[ T_j = 150 \ \degree C \]

**figure 4.** Rectifier Diode
Forward current as a function of heatsink temperature
\[ I_F = f(T_j) \]

![Graph 4](image4)

At
\[ T_j = 150 \ \degree C \]
figure 1. Thermistor

Typical NTC characteristic as a function of temperature $R_T = f(T)$

![NTC-typical temperature characteristic graph](image)
Switching Definitions Inverter

General conditions
- \( T_j = 125 \, ^\circ C \)
- \( R_{\text{gon}} = 54 \, \Omega \)
- \( R_{\text{goff}} = 54 \, \Omega \)

**figure 1.** IGBT

Turn-Off Switching Waveforms & definition of \( t_{\text{doff}} \) \( t_{\text{Eoff}} \)

\( (t_{\text{Eoff}} = \text{integrating time for } E_{\text{off}}) \)

**figure 2.** IGBT

Turn-On Switching Waveforms & definition of \( t_{\text{don}} \) \( t_{\text{Eon}} \)

\( (t_{\text{Eon}} = \text{integrating time for } E_{\text{on}}) \)

**figure 3.** IGBT

Turn-Off Switching Waveforms & definition of \( t_{f} \)

\( \)
**Switching Definitions Inverter**

### Figure 5. IGBT
**Turn-off Switching Waveforms & definition of $t_{Eoff}$**

- $P_{off} (100\%) = 8.97 \text{ kW}$
- $E_{off} (100\%) = 1.67 \text{ mJ}$
- $t_{Eoff} = 0.70 \mu\text{s}$

### Figure 6. IGBT
**Turn-on Switching Waveforms & definition of $t_{Eon}$**

- $P_{on} (100\%) = 8.97 \text{ kW}$
- $E_{on} (100\%) = 1.69 \text{ mJ}$
- $t_{Eon} = 0.47 \mu\text{s}$

### Figure 7. FWD
**Turn-off Switching Waveforms & definition of $t_{rr}$**

- $V_{d} (100\%) = 600 \text{ V}$
- $I_{d} (100\%) = 15 \text{ A}$
- $I_{RRM} (100\%) = 32 \text{ A}$
- $t_{rr} = 0.29 \mu\text{s}$
Switching Definitions Inverter

**figure 8.** FWD
Turn-on Switching Waveforms & definition of $t_{Qr}$
($t_{Qr}$ = integrating time for $Q_{rr}$)

$I_d (100\%) = 15 \text{ A}$
$Q_{rr} (100\%) = 2,57 \text{ µC}$
$t_{Qrr} = 0,48 \text{ µs}$

**figure 9.** FWD
Turn-on Switching Waveforms & definition of $t_{Erec}$
($t_{Erec}$ = integrating time for $E_{rec}$)

$P_{rec} (100\%) = 8,97 \text{ kW}$
$E_{rec} (100\%) = 0,79 \text{ mJ}$
$t_{Erec} = 0,48 \text{ µs}$
## Ordering Code & Outline

### Pin table [mm]

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<tr>
<th>Pin</th>
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<th>Function</th>
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### Outline

![Outline Diagram]

**Notes:**
- Tolerance of proportions ±0.25mm at the end of pins.
- Dimension of coordinate pins is only offset without tolerance.
### Pinout & Identification

#### Pinout

![Pinout Diagram](image)

#### Identification

<table>
<thead>
<tr>
<th>ID</th>
<th>Component</th>
<th>Voltage</th>
<th>Current</th>
<th>Function</th>
<th>Comment</th>
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<tbody>
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<td>IGBT</td>
<td>1200 V</td>
<td>15 A</td>
<td>Inverter Diode</td>
<td></td>
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<td>Inverter Diode</td>
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