### Maximum Ratings

$T_i = 25 \, ^\circ\text{C}$, 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>H-Bridge Switch</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collector-emitter voltage</td>
<td>$V_{CES}$</td>
<td>$T_i = T_{j\text{max}}$</td>
<td>650</td>
<td>V</td>
</tr>
<tr>
<td>Collector current</td>
<td>$I_c$</td>
<td>$T_i = T_{j\text{max}}$</td>
<td>29</td>
<td>A</td>
</tr>
<tr>
<td>Repetitive peak collector current</td>
<td>$I_{CRM}$</td>
<td>$I_c$, limited by $T_{j\text{max}}$</td>
<td>90</td>
<td>A</td>
</tr>
<tr>
<td>Total power dissipation</td>
<td>$P_{tot}$</td>
<td>$T_i = T_{j\text{max}}$</td>
<td>57</td>
<td>W</td>
</tr>
<tr>
<td>Gate-emitter voltage</td>
<td>$V_{GES}$</td>
<td></td>
<td>±20</td>
<td>V</td>
</tr>
<tr>
<td>Maximum junction temperature</td>
<td>$T_{j\text{max}}$</td>
<td></td>
<td>175</td>
<td>°C</td>
</tr>
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</table>
## Maximum Ratings

\( T_i = 25 \, ^\circ C \), unless otherwise specified

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
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<th>Value</th>
<th>Unit</th>
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<tbody>
<tr>
<td><strong>H-Bridge Diode</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak repetitive reverse voltage</td>
<td>( V_{RRM} )</td>
<td></td>
<td>650</td>
<td>V</td>
</tr>
<tr>
<td>Continuous (direct) forward current</td>
<td>( I_{f} )</td>
<td>( T_i = T_{i_{max}} ), ( T_i = 80 , ^\circ C )</td>
<td>13</td>
<td>A</td>
</tr>
<tr>
<td>Total power dissipation</td>
<td>( P_{T} )</td>
<td>( T_i = T_{i_{max}} ), ( T_i = 80 , ^\circ C )</td>
<td>25</td>
<td>W</td>
</tr>
<tr>
<td>Maximum junction temperature</td>
<td>( T_{j_{max}} )</td>
<td></td>
<td>175</td>
<td>(^\circ C)</td>
</tr>
<tr>
<td><strong>Boost Switch</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collector-emitter voltage</td>
<td>( V_{CE} )</td>
<td></td>
<td>650</td>
<td>V</td>
</tr>
<tr>
<td>Collector current</td>
<td>( I_{C} )</td>
<td>( T_i = T_{i_{max}} ), ( T_i = 80 , ^\circ C )</td>
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<td>A</td>
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<tr>
<td>Repetitive peak collector current</td>
<td>( I_{PK} )</td>
<td>( t_\text{p} ) limited by ( T_{i_{max}} )</td>
<td>90</td>
<td>A</td>
</tr>
<tr>
<td>Total power dissipation</td>
<td>( P_{T} )</td>
<td>( T_i = T_{i_{max}} ), ( T_i = 80 , ^\circ C )</td>
<td>57</td>
<td>W</td>
</tr>
<tr>
<td>Gate-emitter voltage</td>
<td>( V_{GE} )</td>
<td></td>
<td>( \pm 20 )</td>
<td>V</td>
</tr>
<tr>
<td>Maximum junction temperature</td>
<td>( T_{j_{max}} )</td>
<td></td>
<td>175</td>
<td>(^\circ C)</td>
</tr>
<tr>
<td><strong>Boost Diode</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak repetitive reverse voltage</td>
<td>( V_{RRM} )</td>
<td></td>
<td>650</td>
<td>V</td>
</tr>
<tr>
<td>Continuous (direct) forward current</td>
<td>( I_{f} )</td>
<td>( T_i = T_{i_{max}} ), ( T_i = 80 , ^\circ C )</td>
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<td>A</td>
</tr>
<tr>
<td>Total power dissipation</td>
<td>( P_{T} )</td>
<td>( T_i = T_{i_{max}} ), ( T_i = 80 , ^\circ C )</td>
<td>25</td>
<td>W</td>
</tr>
<tr>
<td>Maximum junction temperature</td>
<td>( T_{j_{max}} )</td>
<td></td>
<td>175</td>
<td>(^\circ C)</td>
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<tr>
<td><strong>Boost Sw.Prot. Diode</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak repetitive reverse voltage</td>
<td>( V_{RRM} )</td>
<td></td>
<td>650</td>
<td>V</td>
</tr>
<tr>
<td>Continuous (direct) forward current</td>
<td>( I_{f} )</td>
<td>( T_i = T_{i_{max}} ), ( T_i = 80 , ^\circ C )</td>
<td>10</td>
<td>A</td>
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<tr>
<td>Repetitive peak forward current</td>
<td>( I_{PK} )</td>
<td></td>
<td>20</td>
<td>A</td>
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<tr>
<td>Total power dissipation</td>
<td>( P_{T} )</td>
<td>( T_i = T_{i_{max}} ), ( T_i = 80 , ^\circ C )</td>
<td>39</td>
<td>W</td>
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<tr>
<td>Maximum junction temperature</td>
<td>( T_{j_{max}} )</td>
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<td>175</td>
<td>(^\circ C)</td>
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</table>
Maximum Ratings

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Value</th>
<th>Unit</th>
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<tbody>
<tr>
<td>ByPass Diode</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Peak repetitive reverse voltage</td>
<td>$V_{RRM}$</td>
<td>$T_i = T_{max}$</td>
<td>1600</td>
<td>V</td>
</tr>
<tr>
<td>Continuous (direct) forward current</td>
<td>$I_F$</td>
<td>$T_i = T_{max}$</td>
<td>35</td>
<td>A</td>
</tr>
<tr>
<td>Surge (non-repetitive) forward current</td>
<td>$I_{FSM}$</td>
<td>$T_i = T_{max}$</td>
<td>270</td>
<td>A</td>
</tr>
<tr>
<td>Surge current capability</td>
<td>$I_t$</td>
<td>$t_p = 10 , ms , 50 , Hz , sine$</td>
<td>370</td>
<td>A$^2$s</td>
</tr>
<tr>
<td>Total power dissipation</td>
<td>$P_{tot}$</td>
<td>$T_i = T_{max}$</td>
<td>60</td>
<td>W</td>
</tr>
<tr>
<td>Maximum junction temperature</td>
<td>$T_{jmax}$</td>
<td></td>
<td>150</td>
<td>$^\circ C$</td>
</tr>
</tbody>
</table>

Module Properties

Thermal Properties

| Storage temperature | $T_{stg}$ | | -40...+125 | $^\circ C$ |
| Operation temperature under switching condition | $T_{jop}$ | | -40...($T_{max} - 25$) | $^\circ C$ |

Isolation Properties

| Isolation voltage | $V_{isol}$ | DC Test Voltage* | $t_p = 2 \, s$ | 6000 | V |
| AC Voltage | $t_p = 1 \, min$ | 2500 | V |
| Creepage distance | | | min. 12,7 | mm |
| Clearance | Solder pin | 8,66 | mm |
| | Press-fit pin | 9,17 | mm |
| Comparative Tracking Index | CTI | | > 200 | |

*100 % tested in production
## Characteristic Values

### H-Bridge Switch

#### Static

<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>$V_{GE} = V_{CE}$</td>
<td>0,0003</td>
<td>V</td>
</tr>
<tr>
<td>Collector-emitter saturation voltage</td>
<td>$V_{CEsat}$</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>Collector-emitter cut-off current</td>
<td>$I_{CES}$</td>
<td>0</td>
<td>650</td>
</tr>
<tr>
<td>Gate-emitter leakage current</td>
<td>$I_{GES}$</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>Internal gate resistance</td>
<td>$r_{g}$</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Input capacitance</td>
<td>$C_{in}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output capacitance</td>
<td>$C_{out}$</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>Reverse transfer capacitance</td>
<td>$C_{res}$</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Gate charge</td>
<td>$Q_{g}$</td>
<td>15</td>
<td>520</td>
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#### Thermal

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal resistance junction to sink</td>
<td>$R_{th(j-s)}$</td>
<td>λpaste = 3,4 W/mK (PSX)</td>
<td>1,67</td>
</tr>
</tbody>
</table>

#### Dynamic

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turn-on delay time</td>
<td>$t_{on}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rise time</td>
<td>$t_{r}$</td>
<td>$R_{on} = 16,,Ω$</td>
<td>25</td>
</tr>
<tr>
<td>Turn-off delay time</td>
<td>$t_{off}$</td>
<td>$R_{off} = 16,,Ω$</td>
<td>25</td>
</tr>
<tr>
<td>Fall time</td>
<td>$t_{f}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn-on energy (per pulse)</td>
<td>$E_{on}$</td>
<td>$Q_{on} = 1,1,,μC$</td>
<td>25</td>
</tr>
<tr>
<td>Turn-off energy (per pulse)</td>
<td>$E_{off}$</td>
<td>$Q_{off} = 2,4,,μC$</td>
<td>25</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>$V_G$ [V]</td>
<td></td>
<td></td>
<td>Min</td>
<td>Typ</td>
</tr>
<tr>
<td>$V_G$ [V]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{CE}$ [V]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{DS}$ [V]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_F$ [V]</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>$I_C$ [A]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_D$ [A]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_F$ [A]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_j$ [°C]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### H-Bridge Diode

**Static**

- **Forward voltage**
  - $V_F$
  - Conditions: 15 25 125 150
  - Value: 1,44 1,20 1,14 V

- **Reverse leakage current**
  - $I_R$
  - Conditions: 650 25
  - Value: 5 µA

**Thermal**

- **Thermal resistance junction to sink** $R_{th(j-s)}$
  - $\lambda_{paste} = 3,4 \text{ W/mK (PSX)}$
  - Value: 1,81 K/W

**Dynamic**

- **Peak recovery current**
  - $I_{RMS}$
  - Conditions: $\pm15$ 400 30
  - Value: 25 125 150
  - Value: 33 48 54 A

- **Reverse recovery time**
  - $t_{rr}$
  - Conditions: 25 125 150
  - Value: 89 115 129 ns

- **Recovered charge**
  - $Q_d$
  - $di/dt = 3260 \text{ A/µs}$ 25 125 150
  - Value: 1,08 2,37 3,50 µC

- **Reverse recovered energy**
  - $E_{rec}$
  - 25 125 150
  - Value: 0,198 0,481 0,888 mWs

- **Peak rate of fall of recovery current**
  - $(di/dt)_{max}$
  - Conditions: 25 125 150
  - Value: 2649 1253 1360 A/µs
### 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>Gate-emitter threshold voltage</td>
<td>$V_{GE}$</td>
<td>$V_{GE} = V_{CE}$</td>
<td>0,003</td>
<td>V</td>
</tr>
<tr>
<td>Collector-emitter saturation voltage</td>
<td>$V_{ESAT}$</td>
<td>15 30 25 125 163 1,65 2,22</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Collector-emitter cut-off current</td>
<td>$I_{CES}$</td>
<td>0 650 25 40</td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>Gate-emitter leakage current</td>
<td>$I_{GES}$</td>
<td>20 0 25 120</td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>Internal gate resistance</td>
<td>$r_s$</td>
<td>none 1800</td>
<td></td>
<td>Ω</td>
</tr>
<tr>
<td>Input capacitance</td>
<td>$C_{in}$</td>
<td>$f = 1$ MHz 0 25 25 25</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>Output capacitance</td>
<td>$C_{out}$</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse transfer capacitance</td>
<td>$C_{res}$</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gate charge</td>
<td>$Q_g$</td>
<td>15 520 30 25 70</td>
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<td>nC</td>
</tr>
<tr>
<td>Thermal resistance to sink</td>
<td>$R_{th(j-s)}$</td>
<td>$λ_{PSX} = 3,4$ W/mK</td>
<td>1,67</td>
<td>K/W</td>
</tr>
<tr>
<td>Turn-on delay time</td>
<td>$t_{(on)}$</td>
<td>25 125 150</td>
<td>20 19 17</td>
<td>ns</td>
</tr>
<tr>
<td>Rise time</td>
<td>$r$</td>
<td>$R_{on} = 16$ Ω  25 125 150 8 9 10</td>
<td>25 125 150 137 155 159</td>
<td>ns</td>
</tr>
<tr>
<td>Turn-off delay time</td>
<td>$t_{(off)}$</td>
<td>$R_{off} = 16$ Ω  0 / 15 400 30 25 125 150</td>
<td>25 125 150</td>
<td>ns</td>
</tr>
<tr>
<td>Fall time</td>
<td>$f$</td>
<td>25 125 150</td>
<td>4 9 10</td>
<td></td>
</tr>
<tr>
<td>Turn-on energy (per pulse)</td>
<td>$E_{on}$</td>
<td>$Q_{E_{on}} = 1,1$ µC  25 125 150</td>
<td>0,618 0,894 0,962</td>
<td>mWs</td>
</tr>
<tr>
<td>Turn-off energy (per pulse)</td>
<td>$E_{off}$</td>
<td>$Q_{E_{off}} = 2,3$ µC  25 125 150</td>
<td>0,172 0,305 0,326</td>
<td>mWs</td>
</tr>
</tbody>
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### Characteristic Values

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<th>Value</th>
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<tbody>
<tr>
<td>Boost Diode</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Static</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>$V_C$</td>
<td>15</td>
<td>25 125 150</td>
<td>1,44 1,20 1,14</td>
</tr>
<tr>
<td>Reverse leakage current</td>
<td>$I_R$</td>
<td>650</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td><strong>Thermal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal resistance junction to sink</td>
<td>$R_{th(j-s)}$</td>
<td></td>
<td></td>
<td>1,81</td>
</tr>
<tr>
<td><strong>Dynamic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak recovery current</td>
<td>$I_{RRM}$</td>
<td>0/15</td>
<td>25 125 150</td>
<td>33 50 56</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>$t_{rr}$</td>
<td>25</td>
<td>92 113 121</td>
<td>ns</td>
</tr>
<tr>
<td>Recovered charge</td>
<td>$Q_r$</td>
<td>0 / 15</td>
<td>25 125 150</td>
<td>1,10 2,28 2,72</td>
</tr>
<tr>
<td>Reverse recovered energy</td>
<td>$E_{rec}$</td>
<td>25</td>
<td>0,213 0,489 0,665</td>
<td>mWs</td>
</tr>
<tr>
<td>Peak rate of fall of recovery current</td>
<td>$(di/dt)_{max}$</td>
<td>25 125 150</td>
<td>2721 1492 1645</td>
<td>A/μs</td>
</tr>
<tr>
<td><strong>Boost Sw.Prot. Diode</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Static</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>$V_C$</td>
<td>10</td>
<td>25 125</td>
<td>1,67 1,56 1,87</td>
</tr>
<tr>
<td>Reverse leakage current</td>
<td>$I_R$</td>
<td>650</td>
<td>25</td>
<td>0,14</td>
</tr>
<tr>
<td><strong>Thermal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal resistance junction to sink</td>
<td>$R_{th(j-s)}$</td>
<td></td>
<td></td>
<td>2,44</td>
</tr>
<tr>
<td><strong>ByPass Diode</strong></td>
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<td></td>
</tr>
<tr>
<td><strong>Static</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>$V_C$</td>
<td>13</td>
<td>25 125</td>
<td>0,99 0,90 1,21</td>
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<tr>
<td>Reverse leakage current</td>
<td>$I_R$</td>
<td>1600</td>
<td>25 150</td>
<td>50 1100</td>
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<tr>
<td><strong>Thermal</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal resistance junction to sink</td>
<td>$R_{th(j-s)}$</td>
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<td>1,16</td>
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### 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>VGE [V]</td>
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<tr>
<td>VGS [V]</td>
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<tr>
<td>VCE [V]</td>
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<td>VF [V]</td>
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<tr>
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<tr>
<td>IF [A]</td>
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<tr>
<td>Tj [°C]</td>
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</tr>
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</table>

#### Thermistor

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Rated resistance</td>
<td>R</td>
<td></td>
<td>25</td>
<td>22</td>
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<tr>
<td>Deviation of R&lt;sub&gt;25&lt;/sub&gt;</td>
<td>Δ&lt;sub&gt;R&lt;/sub&gt;</td>
<td>R&lt;sub&gt;25&lt;/sub&gt; = 1486 Ω</td>
<td>100</td>
<td>-12</td>
</tr>
<tr>
<td>Power dissipation</td>
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<td>25</td>
<td>200</td>
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<td>Power dissipation constant</td>
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<td></td>
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<td>2</td>
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<td>B-value</td>
<td>B(25/25)</td>
<td>Tol. ±3%</td>
<td>25</td>
<td>3950</td>
</tr>
<tr>
<td>B-value</td>
<td>B(25/100)</td>
<td>Tol. ±3%</td>
<td>25</td>
<td>3998</td>
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<tr>
<td>Vincotech NTC Reference</td>
<td></td>
<td></td>
<td></td>
<td>B</td>
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</tbody>
</table>
H-Bridge Switch Characteristics

**Figure 1.** IGBT
Typical output characteristics
$I_C = f(V_{CE})$

**Figure 2.** IGBT
Typical output characteristics
$I_C = f(V_{GE})$

**Figure 3.** IGBT
Typical transfer characteristics
$I_C = f(V_{GE})$

**Figure 4.** IGBT
Transient thermal impedance as function of pulse duration
$\theta_{th(j-s)} = f(t_p)$
H-Bridge Switch Characteristics

**Figure 5.**
Gate voltage vs gate charge

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

**Figure 6.**
Safe operating area

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

- \( D = \) single pulse
- \( T_s = 80 \) °C
- \( V_{CES} = \pm 15 \) V
- \( T_j = T_{jmax} \)

**Figure 7.**
Power dissipation as a function of heatsink temperature

\[ P_{tot} = f(T_h) \]

- At \( T_j = 175 \) °C

**Figure 8.**
Collector current as a function of heatsink temperature

\[ I_C = f(T_h) \]

- At \( T_j = 175 \) °C
  - \( V_{CE} = 15 \) V
**H-Bridge Diode Characteristics**

**figure 1.** Typical forward characteristics

\[ I_F = f(V_F) \]

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

\[ t_p = 250 \mu s \]

\[ T_j: \]

- 25 °C
- 125 °C
- 150 °C

**figure 2.** Transient thermal impedance as a function of pulse width

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

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

\[ R_{th(j-s)} = 1.81 \, \text{K/W} \]

**FWD thermal model values**

<table>
<thead>
<tr>
<th>( R_{th(j-s)} )</th>
<th>( \tau ) (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.18E-02</td>
<td>2.84E+00</td>
</tr>
<tr>
<td>2.48E-01</td>
<td>2.83E-01</td>
</tr>
<tr>
<td>8.26E-01</td>
<td>5.02E-02</td>
</tr>
<tr>
<td>3.94E-01</td>
<td>8.85E-03</td>
</tr>
<tr>
<td>2.67E-01</td>
<td>1.33E-03</td>
</tr>
</tbody>
</table>

**figure 3.** Power dissipation as a function of heatsink temperature

\[ P_{tot} = f(T_h) \]

\[ T_j = 175 \, \text{°C} \]

**figure 4.** Forward current as a function of heatsink temperature

\[ I_F = f(T_h) \]

\[ T_j = 175 \, \text{°C} \]
Boost Switch Characteristics

**Figure 1.** IGBT

Typical output characteristics

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

- \( t_p = 250 \mu s \)
- \( V_{CE} = 15 \text{ V} \)
- \( T_j = 25 \text{ °C} \)

**Figure 2.** IGBT

Typical output characteristics

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

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

**Figure 3.** IGBT

Typical transfer characteristics

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

- \( t_p = 100 \mu s \)
- \( V_{CE} = 10 \text{ V} \)
- \( T_j = 125 \text{ °C} \)

**Figure 4.** IGBT

Transient thermal impedance as a function of pulse duration

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

- \( D = \frac{t_p}{T} \)
- \( R_{th(j-s)} = 1,67 \text{ K/W} \)
- IGBT thermal model values
  - \( R \) (K/W)
  - \( t \) (s)
  - 1,80E-01, 1,06E+00
  - 3,72E-01, 1,72E-01
  - 6,97E-01, 5,52E-02
  - 3,21E-01, 1,27E-02
  - 1,54E-01, 3,03E-03
Boost Switch Characteristics

**figure 5.** IGBT
Gate voltage vs gate charge

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

\[ I_C = 30 \text{ A} \]

\[ D = \text{single pulse} \]
\[ T_s = 80 \degree \text{C} \]
\[ V_{GE} = \pm 15 \text{ V} \]
\[ T_j = T_{jmax} \]
\[ V_{CE} = 130 \text{ V} \]
\[ 520 \text{ V} \]

**figure 6.** IGBT
Safe operating area

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

**figure 7.** IGBT
Power dissipation as a function of heatsink temperature

\[ P_{tot} = f(T_h) \]

At
\[ T_j = 175 \degree \text{C} \]

**figure 8.** IGBT
Collector current as a function of heatsink temperature

\[ I_C = f(T_h) \]

At
\[ T_j = 175 \degree \text{C} \]
\[ V_{CE} = 15 \text{ V} \]
Boost Diode Characteristics

**figure 1.** Typical forward characteristics

\[ I_F = f(V_F) \]

**figure 2.** Transient thermal impedance as a function of pulse width

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

- \( t_p = 250 \ \mu s \)
- \( T_j = 25^\circ C \)
- \( T_j = 125^\circ C \)
- \( T_j = 150^\circ C \)

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

\[ R_{th(j-s)} = 1.81 \ K/W \]

FWD thermal model values

\[ R (K/W) \quad \tau (s) \]

- \( 7.18E-02 \quad 2.84E+00 \)
- \( 2.48E-01 \quad 2.83E-01 \)
- \( 8.26E-01 \quad 5.02E-02 \)
- \( 3.94E-01 \quad 8.85E-03 \)
- \( 2.67E-01 \quad 1.33E-03 \)

**figure 3.** Power dissipation as a function of heatsink temperature

\[ P_{tot} = f(T_h) \]

- At \( T_j = 175^\circ C \)

**figure 4.** Forward current as a function of heatsink temperature

\[ I_F = f(T_h) \]

- At \( T_j = 175^\circ C \)
Boost Sw. Prot. Diode Characteristics

**Figure 1.** Typical forward characteristics

\[ I_F = f(V_F) \]

**Figure 2.** Transient thermal impedance as a function of pulse width

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

**Figure 3.** Power dissipation as a function of heatsink temperature

\[ P_{tot} = f(T_h) \]

**Figure 4.** Forward current as a function of heatsink temperature

\[ I_F = f(T_h) \]
ByPass Diode Characteristics

**Figure 1.** Rectifier Diode

Typical forward characteristics

\[ I_F = f(V_F) \]

![Graph showing typical forward characteristics of a rectifier diode.](image1)

- \( t_p = 250 \mu s \)
- \( T_j = 25 ^\circ C \)
- \( T_j = 125 ^\circ C \)

**Figure 2.** Rectifier Diode

Transient thermal impedance as a function of pulse width

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

![Graph showing transient thermal impedance as a function of pulse width.](image2)

- \( D = \frac{t_p}{T} \)
- \( R_{th(j-s)} = 1.16 \text{ K/W} \)

Diode thermal model values

<table>
<thead>
<tr>
<th>( R (\text{K/W}) )</th>
<th>( \tau (\text{s}) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.14E-02</td>
<td>1.28E+01</td>
</tr>
<tr>
<td>1.22E-01</td>
<td>9.21E-01</td>
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<tr>
<td>5.42E-01</td>
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<td>3.74E-01</td>
<td>2.87E-02</td>
</tr>
<tr>
<td>9.37E-02</td>
<td>2.38E-03</td>
</tr>
</tbody>
</table>

**Figure 3.** Rectifier Diode

Power dissipation as a function of heatsink temperature

\[ P_{tot} = f(T_h) \]

![Graph showing power dissipation as a function of heatsink temperature.](image3)

At \( T_j = 175 ^\circ C \)

**Figure 4.** Rectifier Diode

Forward current as a function of heatsink temperature

\[ I_F = f(T_h) \]

![Graph showing forward current as a function of heatsink temperature.](image4)

At \( T_j = 175 ^\circ C \)
Thermistor Characteristics

Figure 1. Thermistor

Typical NTC characteristic as a function of temperature

$R = f(T)$

<table>
<thead>
<tr>
<th>$R$ (Ω)</th>
<th>$T$ (°C)</th>
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</thead>
<tbody>
<tr>
<td>25000</td>
<td>25</td>
</tr>
<tr>
<td>20000</td>
<td>50</td>
</tr>
<tr>
<td>15000</td>
<td>75</td>
</tr>
<tr>
<td>10000</td>
<td>100</td>
</tr>
<tr>
<td>5000</td>
<td>125</td>
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</table>

NTC-typical temperature characteristic
H-Bridge Switching Characteristics

Figure 1. IGBT
Typical switching energy losses as a function of collector current

$$E = E_F$$

With an inductive load at

- $V_{DS} = 400$ V
- $T_J = 125$ °C
- $R_{on} = 16$ Ω

Figure 2. IGBT
Typical switching energy losses as a function of gate resistor

$$E = E_{on}$$

With an inductive load at

- $V_{DS} = 400$ V
- $T_J = 125$ °C
- $I_C = 30$ A

Figure 3. FWD
Typical reverse recovered energy loss as a function of collector current

$$E_{rec} = E_{off}$$

With an inductive load at

- $V_{DS} = 400$ V
- $T_J = 125$ °C
- $I_C = 30$ A

Figure 4. FWD
Typical reverse recovered energy loss as a function of gate resistor

$$E_{rec} = E_{off}$$

With an inductive load at

- $V_{DS} = 400$ V
- $T_J = 125$ °C
- $I_C = 30$ A
H-Bridge Switching Characteristics

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

\[ t = f(I_C) \]

With an inductive load at
- \( T_j = 150 \, ^\circ\text{C} \)
- \( V_{CE} = 400 \, \text{V} \)
- \( V_{GE} = \pm15 \, \text{V} \)
- \( R_{gon} = 16 \, \Omega \)
- \( I_C = 30 \, \text{A} \)

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

\[ t = f(R_g) \]

With an inductive load at
- \( T_j = 150 \, ^\circ\text{C} \)
- \( V_{CE} = 400 \, \text{V} \)
- \( V_{GE} = \pm15 \, \text{V} \)
- \( R_{gon} = 16 \, \Omega \)
- \( I_C = 30 \, \text{A} \)

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

\[ t_{rr} = f(I_C) \]

With an inductive load at
- \( T_j = 25 \, ^\circ\text{C} \)
- \( V_{CE} = 400 \, \text{V} \)
- \( V_{GE} = \pm15 \, \text{V} \)
- \( R_{gon} = 16 \, \Omega \)

**Figure 8.** FWD
Typical reverse recovery time as a function of IGBT turn-on gate resistor

\[ t_{rr} = f(R_{gon}) \]

With an inductive load at
- \( T_j = 25 \, ^\circ\text{C} \)
- \( V_{CE} = 400 \, \text{V} \)
- \( V_{GE} = \pm15 \, \text{V} \)
- \( I_C = 30 \, \text{A} \)
H-Bridge Switching Characteristics

Figure 9. Typical recovered charge as a function of collector current

\[ Q_r = f(I_C) \]

With an inductive load at

- \( V_{CC} = 400 \text{ V} \)
- \( T_J = 25 \text{ °C} \)
- \( V_{CE} = 400 \text{ V} \)
- \( V_{GE} = \pm 15 \text{ V} \)
- \( R_{gon} = 16 \text{ Ω} \)
- \( I_C = 30 \text{ A} \)

Figure 10. Typical recovered charge as a function of IGBT turn on gate resistor

\[ Q_r = f(R_{gon}) \]

With an inductive load at

- \( V_{CC} = 400 \text{ V} \)
- \( T_J = 25 \text{ °C} \)
- \( V_{CE} = 400 \text{ V} \)
- \( V_{GE} = \pm 15 \text{ V} \)
- \( I_C = 30 \text{ A} \)

Figure 11. Typical peak reverse recovery current as a function of collector current

\[ I_{RM} = f(I_C) \]

With an inductive load at

- \( V_{CC} = 400 \text{ V} \)
- \( T_J = 25 \text{ °C} \)
- \( V_{CE} = 400 \text{ V} \)
- \( V_{GE} = \pm 15 \text{ V} \)
- \( R_{gon} = 16 \text{ Ω} \)

Figure 12a. Typical peak reverse recovery current as a function of IGBT turn on gate resistor

\[ I_{RM} = f(R_{gon}) \]

With an inductive load at

- \( V_{CC} = 400 \text{ V} \)
- \( T_J = 25 \text{ °C} \)
- \( V_{CE} = 400 \text{ V} \)
- \( V_{GE} = \pm 15 \text{ V} \)
- \( I_C = 30 \text{ A} \)
H-Bridge Switching Characteristics

**Figure 13.** FWD
Typical rate of fall of forward and reverse recovery current as a function of collector current
\[
\frac{dI_F}{dt}, \frac{dI_{rr}}{dt} = f(I_C)
\]

With an inductive load at 25 °C
- \( V_{CE} = 400 \text{ V} \)
- \( V_{GE} = \pm 15 \text{ V} \)
- \( R_{gon} = 16 \Omega \)
- \( I_C = 30 \text{ A} \)

**Figure 14.** FWD
Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor
\[
\frac{dI_F}{dt}, \frac{dI_{rr}}{dt} = f(R_{gon})
\]

With an inductive load at 25 °C
- \( V_{CE} = 400 \text{ V} \)
- \( V_{GE} = \pm 15 \text{ V} \)
- \( I_C = 30 \text{ A} \)
- \( T_j = 125 \text{ °C} \)

**Figure 15.** IGBT
Reverse bias safe operating area
\[
I_t = f(V_{CE})
\]

At
- \( T_j = 125 \text{ °C} \)
- \( R_{gon} = 16 \Omega \)
- \( R_{goff} = 16 \Omega \)
H-Bridge Switching Definitions

General conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_j$</td>
<td>125 °C</td>
</tr>
<tr>
<td>$R_{g,on}$</td>
<td>16 Ω</td>
</tr>
<tr>
<td>$R_{g,off}$</td>
<td>16 Ω</td>
</tr>
</tbody>
</table>

Figure 1. IGBT
Turn-off Switching Waveforms & definition of $t_{doff}, t_{Eoff}$ ($t_{Eoff}$ = integrating time for $E_{off}$)

- $V_{CE}(0\%)$ = -15 V
- $V_{CE}(100\%)$ = 15 V
- $I_C(100\%)$ = 30 A
- $t_{doff}$ = 86 ns

Figure 2. IGBT
Turn-on Switching Waveforms & definition of $t_{don}, t_{Eon}$ ($t_{Eon}$ = integrating time for $E_{on}$)

- $V_{CE}(0\%)$ = -15 V
- $V_{CE}(100\%)$ = 15 V
- $I_C(100\%)$ = 30 A
- $t_{don}$ = 66 ns

Figure 3. IGBT
Turn-off Switching Waveforms & definition of $t_f$

- $V_{CE}(90\%)$ = 400 V
- $I_C(10\%)$ = 30 A
- $t_f$ = 10 ns

Figure 4. IGBT
Turn-on Switching Waveforms & definition of $t_r$

- $V_{CE}(90\%)$ = 400 V
- $I_C(10\%)$ = 30 A
- $t_r$ = 9 ns
H-Bridge Switching Characteristics

Figure 5. Turn-off Switching Waveforms & definition of $t_{rr}$

- $V_F (100\%) = 400 \text{ V}$
- $I_F (100\%) = 30 \text{ A}$
- $I_{RRM (100\%)} = 48 \text{ A}$
- $t_{rr} = 115 \text{ ns}$

Figure 6. Turn-on Switching Waveforms & definition of $t_{Qr}$ ($t_{Qr}$ = integrating time for $Q_r$)

- $I_{RRM (100\%)} = 2.37 \text{ μC}$

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Boost Switching Characteristics

**Figure 1.** IGBT

Typical switching energy losses as a function of collector current

\[ E = f(I_C) \]

\[ E_{on} \quad E_{off} \quad E_{on} \quad E_{off} \]

With an inductive load at 25 °C

- \( V_{DS} = 400 \) V
- \( T_J = 125 \) °C
- \( R_g = 16 \) Ω

- \( V_{DS} = 0 \) V / 15 V
- \( T_J = 150 \) °C

**Figure 2.** IGBT

Typical switching energy losses as a function of gate resistor

\[ E = f(R_g) \]

\[ E_{on} \quad E_{off} \quad E_{on} \quad E_{off} \]

With an inductive load at 25 °C

- \( V_{DS} = 400 \) V
- \( T_J = 125 \) °C
- \( R_g = 16 \) Ω

- \( V_{DS} = 0 \) V / 15 V
- \( T_J = 150 \) °C

**Figure 3.** FWD

Typical reverse recovered energy loss as a function of collector current

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

\[ E_{rec} \]

With an inductive load at 25 °C

- \( V_{DS} = 400 \) V
- \( T_J = 125 \) °C
- \( R_g = 16 \) Ω

- \( V_{DS} = 0 \) V / 15 V
- \( T_J = 150 \) °C

**Figure 4.** FWD

Typical reverse recovered energy loss as a function of gate resistor

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

\[ E_{rec} \]

With an inductive load at 25 °C

- \( V_{DS} = 400 \) V
- \( T_J = 125 \) °C
- \( R_g = 16 \) Ω

- \( V_{DS} = 0 \) V / 15 V
- \( T_J = 150 \) °C
Boost Switching Characteristics

**Figure 5.** IGBT

Typical switching times as a function of collector current

$t_d(on) = f(I_C)$

With an inductive load at

- $T_j = 150 °C$
- $V_{CE} = 400 V$
- $V_{GE} = 0 / 15 V$
- $R_{gon} = 16 Ω$
- $I_C = 30 A$

$t_d(off) = f(I_C)$

**Figure 6.** IGBT

Typical switching times as a function of gate resistor

$t_d(on) = f(R_g)$

With an inductive load at

- $T_j = 150 °C$
- $V_{CE} = 400 V$
- $V_{GE} = 0 / 15 V$
- $R_{gon} = 16 Ω$
- $I_C = 30 A$

$t_d(off) = f(R_g)$

**Figure 7.** FWD

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$

With an inductive load at

- $T_j = 25 °C$
- $V_{CE} = 400 V$
- $V_{GE} = 0 / 15 V$
- $R_{gon} = 16 Ω$

**Figure 8.** FWD

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

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

With an inductive load at

- $T_j = 25 °C$
- $V_{CE} = 400 V$
- $V_{GE} = 0 / 15 V$
- $R_{gon} = 16 Ω$
- $I_C = 30 A$

$t_{rr} = f(R_{gon})$
Boost Switching Characteristics

**Figure 9.**  
Typical recovered charge as a function of collector current  
\[ Q_r = f(I_C) \]

With an inductive load at  
\[ V_{CC} = 400 \text{ V} \]  
\[ V_{GS} = 0 / 15 \text{ V} \]  
\[ R_{gon} = 16 \Omega \]

at 25 °C

**Figure 10.**  
Typical recovered charge as a function of IGBT turn-on gate resistor  
\[ Q_r = f(R_{gon}) \]

With an inductive load at  
\[ V_{CC} = 400 \text{ V} \]  
\[ V_{GS} = 0 / 15 \text{ V} \]  
\[ I_c = 30 \text{ A} \]

at 25 °C

**Figure 11.**  
Typical peak reverse recovery current as a function of collector current  
\[ I_{RM} = f(I_C) \]

With an inductive load at  
\[ V_{CC} = 400 \text{ V} \]  
\[ V_{GS} = 0 / 15 \text{ V} \]  
\[ R_{gon} = 16 \Omega \]

at 25 °C

**Figure 12.**  
Typical peak reverse recovery current as a function of IGBT turn-on gate resistor  
\[ I_{RM} = f(R_{gon}) \]

With an inductive load at  
\[ V_{CC} = 400 \text{ V} \]  
\[ V_{GS} = 0 / 15 \text{ V} \]  
\[ I_c = 30 \text{ A} \]

at 25 °C
Boost Switching Characteristics

**Figure 13.** FWD

Typical rate of fall of forward and reverse recovery current as a function of collector current

\[ \frac{d\text{i}_{\text{F}}}{dt}, \frac{d\text{i}_{\text{rr}}}{dt} = f(I_{\text{C}}) \]

With an inductive load at 25 °C

- \( V_{\text{CE}} = 400 \) V
- \( T_j = 125 \) °C
- \( R_{\text{gon}} = 16 \) Ω

**Figure 14.** FWD

Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor

\[ \frac{d\text{i}_{\text{F}}}{dt}, \frac{d\text{i}_{\text{rr}}}{dt} = f(R_{\text{gon}}) \]

With an inductive load at 25 °C

- \( V_{\text{CE}} = 400 \) V
- \( T_j = 125 \) °C
- \( V_{\text{GE}} = 0 / 15 \) V
- \( R_{\text{gon}} = 16 \) Ω
- \( I_{\text{C}} = 30 \) A

**Figure 15.** IGBT

Reverse bias safe operating area

\[ I_{\text{C}} = f(V_{\text{CE}}) \]

At

- \( T_j = 125 \) °C
- \( R_{\text{gon}} = 16 \) Ω
- \( R_{\text{goff}} = 16 \) Ω
**Boost Switching Definitions**

### General conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_1$</td>
<td>125 °C</td>
</tr>
<tr>
<td>$R_{gss}$</td>
<td>16 Ω</td>
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</tbody>
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### Figures

**Figure 1.** Turn-off Switching Waveforms & definition of $t_{doff}$ ($t_{Eoff}$ = integrating time for $E_{off}$)

- $V_{GE}(0\%) = 0$ V
- $V_{CE}(0\%) = 15$ V
- $V_{GE}(100\%) = 400$ V
- $I_{C}(100\%) = 30$ A
- $t_{doff} = 155$ ns

**Figure 2.** Turn-on Switching Waveforms & definition of $t_{don}$ ($t_{Eon}$ = integrating time for $E_{on}$)

- $V_{CE}(0\%) = 0$ V
- $V_{CE}(100\%) = 15$ V
- $V_{GE}(100\%) = 400$ V
- $I_{C}(100\%) = 30$ A
- $t_{don} = 19$ ns

**Figure 3.** Turn-off Switching Waveforms & definition of $t_f$

- $V_{CE}(1\%) = 400$ V
- $I_{C}(10\%) = 30$ A
- $t_f = 9$ ns

**Figure 4.** Turn-on Switching Waveforms & definition of $t_r$

- $V_{CE}(1\%) = 400$ V
- $I_{C}(10\%) = 30$ A
- $t_r = 9$ ns
Boost Switching Characteristics

Figure 5. FWD

Turn-off Switching Waveforms & definition of t\text{rr}

- \( V_F(100\%) = 400 \text{ V} \)
- \( I_F(100\%) = 30 \text{ A} \)
- \( I_{RRM}(100\%) = 50 \text{ A} \)
- \( t_{rr} = 113 \text{ ns} \)

Figure 6. FWD

Turn-on Switching Waveforms & definition of t\text{Qr} (t\text{Qr} = \text{integrating time for Qr})

- \( I_R(100\%) = 30 \text{ A} \)
- \( Q_r(100\%) = 2,28 \mu\text{C} \)
### Ordering Code & Marking

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**Packaging instruction**

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**Handling instruction**

Handling instructions for flow 0 packages see vincotech.com website.

**Package data**

Package data for flow 0 packages see vincotech.com website.

**UL recognition and file number**

This device is certified according to UL 1557 standard, UL file number E192116. For more information see vincotech.com website.

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### PACKAGING INSTRUCTION

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