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>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>$T_i = T_{j\text{max}}$</td>
<td>104</td>
<td>A</td>
</tr>
<tr>
<td>Repetitive peak collector current</td>
<td>$I_{CEM}$</td>
<td>limited by $T_{j\text{max}}$</td>
<td>450</td>
<td>A</td>
</tr>
<tr>
<td>Total power dissipation</td>
<td>$P_{D}$</td>
<td>$T_i = T_{j\text{max}}$</td>
<td>145</td>
<td>W</td>
</tr>
<tr>
<td>Gate-emitter voltage</td>
<td>$V_{GE}$</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

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Value</th>
<th>Unit</th>
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<tbody>
<tr>
<td><strong>Buck 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>$T_j = T_{j_{max}}$, $T_i = 80 , ^{\circ}\text{C}$</td>
<td>101</td>
<td>A</td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>$I_{F_{RM}}$</td>
<td>$t_{f}$ limited by $T_{j_{max}}$</td>
<td>300</td>
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</tr>
<tr>
<td>Total power dissipation</td>
<td>$P_{tot}$</td>
<td>$T_j = T_{j_{max}}$, $T_i = 80 , ^{\circ}\text{C}$</td>
<td>127</td>
<td>W</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>$T_{j_{max}}$</td>
<td></td>
<td>175</td>
<td>°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>$V_{CES}$</td>
<td></td>
<td>650</td>
<td>V</td>
</tr>
<tr>
<td>Collector current</td>
<td>$I_C$</td>
<td>$T_j = T_{j_{max}}$, $T_i = 80 , ^{\circ}\text{C}$</td>
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<td>A</td>
</tr>
<tr>
<td>Repetitive peak collector current</td>
<td>$I_{CE_{RM}}$</td>
<td>$t_{f}$ limited by $T_{j_{max}}$</td>
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<tr>
<td>Total power dissipation</td>
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<td>$T_j = T_{j_{max}}$, $T_i = 80 , ^{\circ}\text{C}$</td>
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<td>W</td>
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<tr>
<td>Gate-emitter voltage</td>
<td>$V_{GES}$</td>
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<td>±20</td>
<td>V</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>$T_{j_{max}}$</td>
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<td>175</td>
<td>°C</td>
</tr>
<tr>
<td><strong>Boost 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>$T_j = T_{j_{max}}$, $T_i = 80 , ^{\circ}\text{C}$</td>
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<td>Repetitive peak forward current</td>
<td>$I_{F_{RM}}$</td>
<td>$t_{f}$ limited by $T_{j_{max}}$</td>
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<td>Total power dissipation</td>
<td>$P_{tot}$</td>
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<td>W</td>
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<td>Maximum Junction Temperature</td>
<td>$T_{j_{max}}$</td>
<td></td>
<td>175</td>
<td>°C</td>
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<td><strong>Boost Sw.Inv.Diode</strong></td>
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<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>$T_j = T_{j_{max}}$, $T_i = 80 , ^{\circ}\text{C}$</td>
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<td>A</td>
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<tr>
<td>Repetitive peak forward current</td>
<td>$I_{F_{RM}}$</td>
<td>$t_{f}$ limited by $T_{j_{max}}$</td>
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<tr>
<td>Total power dissipation</td>
<td>$P_{tot}$</td>
<td>$T_j = T_{j_{max}}$, $T_i = 80 , ^{\circ}\text{C}$</td>
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<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>°C</td>
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</table>
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>
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<tbody>
<tr>
<td><strong>Module Properties</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Thermal Properties</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>( T_{\text{stg}} )</td>
<td></td>
<td>-40...+125</td>
<td>(^\circ\text{C})</td>
</tr>
<tr>
<td>Operation temperature under switching condition</td>
<td>( T_{\text{op}} )</td>
<td></td>
<td>-40...(( T_{\text{max}} ) - 25)</td>
<td>(^\circ\text{C})</td>
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<tr>
<td><strong>Isolation Properties</strong></td>
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<tr>
<td>Isolation voltage</td>
<td>( V_{\text{isol}} )</td>
<td>DC Test Voltage* ( t_s = 2 , \text{s} )</td>
<td>6000</td>
<td>V</td>
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<tr>
<td></td>
<td></td>
<td>AC Voltage ( t_o = 1 , \text{min} )</td>
<td>2500</td>
<td>V</td>
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<tr>
<td>Creepage distance</td>
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<td>min. 12,7</td>
<td>mm</td>
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<tr>
<td>Clearance</td>
<td></td>
<td></td>
<td>7,92</td>
<td>mm</td>
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<td>Comparative Tracking Index</td>
<td>CTI</td>
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<td>&gt; 200</td>
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*100 % tested in production
## Characteristic Values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>V&lt;sub&gt;GE&lt;/sub&gt;</td>
<td>[V]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V&lt;sub&gt;GS&lt;/sub&gt;</td>
<td>[V]</td>
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<td>V&lt;sub&gt;CE&lt;/sub&gt;</td>
<td>[V]</td>
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<td></td>
</tr>
<tr>
<td>V&lt;sub&gt;DS&lt;/sub&gt;</td>
<td>[V]</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>V&lt;sub&gt;F&lt;/sub&gt;</td>
<td>[V]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;C&lt;/sub&gt;</td>
<td>[A]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;D&lt;/sub&gt;</td>
<td>[A]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;F&lt;/sub&gt;</td>
<td>[A]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T&lt;sub&gt;j&lt;/sub&gt;</td>
<td>[°C]</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Min</td>
<td>Typ</td>
<td>Max</td>
<td></td>
<td></td>
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</tbody>
</table>

### Buck 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&lt;sub&gt;thG&lt;/sub&gt;</td>
<td>V&lt;sub&gt;GE&lt;/sub&gt; = V&lt;sub&gt;CE&lt;/sub&gt;</td>
<td>0.0015</td>
</tr>
<tr>
<td>Collector-emitter saturation voltage</td>
<td>V&lt;sub&gt;CEsat&lt;/sub&gt;</td>
<td>15</td>
<td>150</td>
</tr>
<tr>
<td>Collector-emitter cut-off current</td>
<td>I&lt;sub&gt; CES&lt;/sub&gt;</td>
<td>0</td>
<td>650</td>
</tr>
<tr>
<td>Gate-emitter leakage current</td>
<td>I&lt;sub&gt; GES&lt;/sub&gt;</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>Internal gate resistance</td>
<td>r&lt;sub&gt;i&lt;/sub&gt;</td>
<td>none</td>
<td>Ω</td>
</tr>
<tr>
<td>Input capacitance</td>
<td>C&lt;sub&gt; G&lt;/sub&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output capacitance</td>
<td>C&lt;sub&gt; C&lt;/sub&gt;</td>
<td>f = 1 MHz</td>
<td>0</td>
</tr>
<tr>
<td>Reverse transfer capacitance</td>
<td>C&lt;sub&gt; r&lt;/sub&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gate charge</td>
<td>Q&lt;sub&gt; g&lt;/sub&gt;</td>
<td>15</td>
<td>520</td>
</tr>
</tbody>
</table>

#### 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&lt;sub&gt;th(j-s)&lt;/sub&gt;</td>
<td>phase-change material</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>λ = 3.4 W/mK</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.65</td>
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#### 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&lt;sub&gt;d(on)&lt;/sub&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Rise time</td>
<td>t&lt;sub&gt;r&lt;/sub&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Turn-off delay time</td>
<td>t&lt;sub&gt;d(off)&lt;/sub&gt;</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Fall time</td>
<td>t&lt;sub&gt;f&lt;/sub&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Turn-on energy (per pulse)</td>
<td>E&lt;sub&gt;on&lt;/sub&gt;</td>
<td>θ&lt;sub&gt;θθ&lt;/sub&gt; = 3.3 μC</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>θ&lt;sub&gt;θθθθ&lt;/sub&gt; = 6.8 μC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>θ&lt;sub&gt;θθθθ&lt;/sub&gt; = 7.8 μC</td>
<td></td>
<td></td>
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<tr>
<td>Turn-off energy (per pulse)</td>
<td>E&lt;sub&gt;off&lt;/sub&gt;</td>
<td>θ&lt;sub&gt;θθ&lt;/sub&gt; = 3.3 μC</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>θ&lt;sub&gt;θθθθ&lt;/sub&gt; = 6.8 μC</td>
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<td></td>
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<tr>
<td></td>
<td>θ&lt;sub&gt;θθθθ&lt;/sub&gt; = 7.8 μC</td>
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## Characteristic Values

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<thead>
<tr>
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<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Forward voltage</td>
<td>$V_F$</td>
<td>150</td>
<td>25</td>
<td>125</td>
</tr>
<tr>
<td>Reverse leakage current</td>
<td>$I_r$</td>
<td>650</td>
<td>25</td>
<td>7,6</td>
</tr>
</tbody>
</table>

### Thermal

| Thermal resistance junction to sink | $R_{th(j-s)}$ | phase-change material $\lambda = 3,4 \text{ W/mK}$ | 0,75 | K/W |

### Dynamic

| Peak recovery current | $I_{RRM}$ | $di/dt = 7165 \text{ A/µs}$ | 25 | 125 | 150 | 124 | 158 | 167 | A |
| Reverse recovery time | $t_{rr}$ | $di/dt = 8521 \text{ A/µs}$ | 25 | 125 | 150 | 44 | 74 | 85 | ns |
| Recovered charge | $Q_r$ | $di/dt = 7698 \text{ A/µs}$ | 25 | 125 | 150 | 3,349 | 6,779 | 7,785 | µC |
| Reverse recovered energy | $E_{rec}$ | $di/dt = 7165 \text{ A/µs}$ | 25 | 125 | 150 | 0,870 | 1,722 | 1,922 | mWs |
| Peak rate of fall of recovery current | $(di/dt)_{max}$ | $di/dt = 8521 \text{ A/µs}$ | 25 | 125 | 150 | 3889 | 3024 | 3127 | A/µs |
## Characteristic Values

<table>
<thead>
<tr>
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<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$V_{GS}$ [V] $V_{GS}$ [V] $I_{G}$ [A] $I_{D}$ [A] $T_{J}$ [°C]</td>
<td>Min</td>
<td>Typ</td>
</tr>
<tr>
<td>Boost Switch</td>
<td>Static</td>
<td>$V_{GE(th)}$</td>
<td>0,002</td>
<td>25</td>
</tr>
<tr>
<td>Collector-emitter saturation voltage</td>
<td>$V_{CEsat}$</td>
<td>0</td>
<td>650</td>
<td>25</td>
</tr>
<tr>
<td>Collector-emitter cut-off current</td>
<td>$I_{CES}$</td>
<td>0</td>
<td>650</td>
<td>25</td>
</tr>
<tr>
<td>Gate-emitter leakage current</td>
<td>$I_{GES}$</td>
<td>none</td>
<td>none</td>
<td>0</td>
</tr>
<tr>
<td>Internal gate resistance</td>
<td>$r_{g}$</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Input capacitance</td>
<td>$C_{in}$</td>
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<td>25</td>
<td>25</td>
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<tr>
<td>Reverse transfer capacitance</td>
<td>$C_{res}$</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Gate charge</td>
<td>$Q_{g}$</td>
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<td>520</td>
<td>75</td>
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<tr>
<td>Thermal</td>
<td>phase-change material</td>
<td>$R_{th(j-s)} = 3,4 \text{ W/mK}$</td>
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<td>none</td>
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<tr>
<td>Dynamic</td>
<td>$R_{off} = 4 \Omega$</td>
<td>25</td>
<td>125</td>
<td>150</td>
</tr>
<tr>
<td>Turn-on delay time</td>
<td>$t_{on}$</td>
<td>$R_{off} = 4 \Omega$</td>
<td>25</td>
<td>125</td>
</tr>
<tr>
<td>Rise time</td>
<td>$t_{r}$</td>
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<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Turn-off delay time</td>
<td>$t_{off}$</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Fall time</td>
<td>$t_{f}$</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Turn-on energy (per pulse)</td>
<td>$E_{on}$</td>
<td>$Q_{RMS} = 4,3 \mu C$</td>
<td>25</td>
<td>125</td>
</tr>
<tr>
<td>Turn-off energy (per pulse)</td>
<td>$E_{off}$</td>
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<td>none</td>
<td>none</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>
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<tbody>
<tr>
<td>Datasheet</td>
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<td></td>
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<td><strong>Boost Diode</strong></td>
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<td></td>
<td></td>
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<tr>
<td>Static</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Forward voltage</td>
<td>$V_I$</td>
<td>100</td>
<td>1,77</td>
<td>V</td>
</tr>
<tr>
<td>Reverse leakage current</td>
<td>$I_R$</td>
<td>650</td>
<td>1,2</td>
<td>µA</td>
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<tr>
<td><strong>Thermal</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Thermal resistance junction to sink</td>
<td>$R_{th(j-s)}$</td>
<td>phase-change material $\lambda = 3,4 \text{ W/mK}$</td>
<td>0,78</td>
<td>K/W</td>
</tr>
<tr>
<td><strong>Dynamic</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Peak recovery current</td>
<td>$I_{\text{rr}}$</td>
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<td>A</td>
</tr>
<tr>
<td>Reverse recovery time</td>
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<td>107</td>
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<td>Recovered charge</td>
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<tr>
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<td>$E_{\text{rec}}$</td>
<td>25</td>
<td>1,157</td>
<td>mWs</td>
</tr>
<tr>
<td>Peak rate of fall of recovery current</td>
<td>$(dI/dt)_{\text{bus}}$</td>
<td>25</td>
<td>5512</td>
<td>A/µs</td>
</tr>
<tr>
<td><strong>Boost Sw.Inv.Diode</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Static</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>$V_I$</td>
<td>100</td>
<td>1,77</td>
<td>V</td>
</tr>
<tr>
<td>Reverse leakage current</td>
<td>$I_R$</td>
<td>650</td>
<td>1,2</td>
<td>µA</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>phase-change material $\lambda = 3,4 \text{ W/mK}$</td>
<td>0,78</td>
<td>K/W</td>
</tr>
</tbody>
</table>
## Characteristic Values

<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><strong>Thermistor</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated resistance</td>
<td>$R$</td>
<td></td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Deviation of $R_{25}$</td>
<td>$\Delta R/R_{25}$</td>
<td>$R_{250} = 1484 , \Omega$</td>
<td>100</td>
<td>-5</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>$P$</td>
<td></td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Power dissipation constant</td>
<td></td>
<td></td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>B-value</td>
<td>$B_{(25/50)}$</td>
<td>Tol. ±1 %</td>
<td>25</td>
<td>3962</td>
</tr>
<tr>
<td>B-value</td>
<td>$B_{(25/100)}$</td>
<td>Tol. ±1 %</td>
<td>25</td>
<td>4000</td>
</tr>
<tr>
<td>Vincotech NTC Reference</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Buck Switch Characteristics

**Figure 1.** IGBT Typical output characteristics

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

\[ t_p = 250 \mu s \quad 25 \, ^\circ C \]

\[ V_{CE} = 15 \, V \quad 125 \, ^\circ C \]

\[ V_{CE} = 150 \, ^\circ C \]

**Figure 2.** IGBT Typical output characteristics

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

\[ t_p = 250 \mu s \quad 25 \, ^\circ C \]

\[ V_{GE} = 15 \, V \quad 125 \, ^\circ C \]

\[ T_j = 150 \, ^\circ C \]

\[ V_{GE} \text{ from 7 V to 17 V in steps of 1 V} \]

**Figure 3.** IGBT Typical transfer characteristics

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

\[ t_p = 100 \mu s \quad 25 \, ^\circ C \]

\[ V_{CE} = 10 \, V \quad 125 \, ^\circ C \]

\[ V_{CE} \text{ from 10 V to 5 V in steps of 1 V} \]

**Figure 4.** IGBT Transient thermal impedance as function of pulse duration

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

\[ D = t_p / \tau \]

\[ R_{th(j-s)} = 0,65 \quad \text{K/W} \]

IGBT thermal model values

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

<table>
<thead>
<tr>
<th>( R )</th>
<th>( \tau )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,13E-01</td>
<td>8,66E-01</td>
</tr>
<tr>
<td>2,91E-01</td>
<td>1,23E-01</td>
</tr>
<tr>
<td>1,38E-01</td>
<td>3,33E-02</td>
</tr>
<tr>
<td>6,68E-02</td>
<td>8,32E-03</td>
</tr>
<tr>
<td>1,32E-02</td>
<td>2,63E-03</td>
</tr>
<tr>
<td>3,21E-02</td>
<td>3,23E-04</td>
</tr>
</tbody>
</table>

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Buck Switch Characteristics

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

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

- \( I_C = 150 \) A
- \( D = \) single pulse
- \( T_s = 80 \) °C
- \( V_{CE} = \pm 15 \) V
- \( T_j = T_{jmax} \)

**Figure 6.** Safe operating area

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

Typical forward characteristics

\[ I_f = f(V_f) \]

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

- \( t_p = 250 \mu s \)
- \( 25 \, ^{\circ}C \)
- \( 125 \, ^{\circ}C \)
- \( 150 \, ^{\circ}C \)

Transient thermal impedance as a function of pulse width

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

FWD thermal model values

<table>
<thead>
<tr>
<th>( R (K/W) )</th>
<th>( \tau \ (s) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,88E-02</td>
<td>7,46E+00</td>
</tr>
<tr>
<td>7,02E-02</td>
<td>1,27E+00</td>
</tr>
<tr>
<td>1,95E-01</td>
<td>2,04E-01</td>
</tr>
<tr>
<td>2,65E-01</td>
<td>6,33E-02</td>
</tr>
<tr>
<td>1,21E-01</td>
<td>1,27E-02</td>
</tr>
<tr>
<td>3,39E-02</td>
<td>3,05E-03</td>
</tr>
<tr>
<td>3,36E-02</td>
<td>3,74E-04</td>
</tr>
</tbody>
</table>
Boost Switch Characteristics

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

Figure 2: IGBT
Typical output characteristics
$I_C = f(V_{CE})$

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

Figure 4: IGBT
Transient Thermal Impedance as function of Pulse duration
$Z_{th(j-s)} = f(t_p)$

$t_p = 250 \mu s$
$V_{CE} = 15 V$
$T_j: 25^\circ C$
$T_j: 125^\circ C$
$T_j: 150^\circ C$

$V_{GE}$ from 7 V to 17 V in steps of 1 V

$t_p = 100 \mu s$
$V_{CE} = 10 V$
$T_j: 25^\circ C$
$T_j: 125^\circ C$
$T_j: 150^\circ C$

$D = \frac{t_p}{T}$

$R_{th(j-s)} = 0.72 K/W$

IGBT thermal model values
$R (K/W) \quad \tau (s)$
$1.29E-01 \quad 2.09E+00$
$1.33E-01 \quad 4.46E-01$
$3.21E-01 \quad 8.45E-02$
$6.42E-02 \quad 2.97E-02$
$5.12E-02 \quad 7.88E-03$
$1.68E-02 \quad 1.62E-03$
Boost Switch Characteristics

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

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

- $I_C = 150$ A
- $D = \text{single pulse}$
- $T_s = 80$ °C
- $V_{CE} = \pm 15$ V
- $T_j = T_{jmax}$

**Figure 6.** Safe operating area

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

- $V_{GE} = 130$ V
- $V_{CE} = 520$ 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

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

Typical forward characteristics

- **\( I_F = f(V_F) \)**
- **\( t_p = 250 \, \mu s \)**
- **\( T_j = 25 \, ^\circ C \)**
- **\( T_j = 150 \, ^\circ C \)**

**FWD thermal model values**

<table>
<thead>
<tr>
<th>( R ) (K/W)</th>
<th>( \tau ) (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5,76E-02</td>
<td>5,42E+00</td>
</tr>
<tr>
<td>8,79E-02</td>
<td>1,09E+00</td>
</tr>
<tr>
<td>2,14E-01</td>
<td>1,59E-01</td>
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<tr>
<td>2,31E-01</td>
<td>4,95E-02</td>
</tr>
<tr>
<td>1,16E-01</td>
<td>1,05E-02</td>
</tr>
<tr>
<td>3,20E-02</td>
<td>2,39E-03</td>
</tr>
<tr>
<td>4,19E-02</td>
<td>4,10E-04</td>
</tr>
</tbody>
</table>

**Notes:**
- \( D = \frac{t_p}{\tau} \)
- \( R_{th(j-s)} = 0,78 \, \text{K/W} \)
Boost Sw.Inv.Diode Characteristics

Typical forward characteristics

\[ I_F = f(V_F) \]

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

Typical forward characteristics

- Forward voltage \( V_F \)
- Forward current \( I_F \)
- Thermal impedance \( Z_{th} \)

Transient thermal impedance as a function of pulse width

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

\[ R_{th(j-s)} = 0.78 \, \text{K/W} \]

FWD thermal model values

<table>
<thead>
<tr>
<th>( R_{(K/W)} )</th>
<th>( \tau ) (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.76E-02</td>
<td>5.42E+00</td>
</tr>
<tr>
<td>8.79E-02</td>
<td>1.09E+00</td>
</tr>
<tr>
<td>2.14E-01</td>
<td>1.59E-01</td>
</tr>
<tr>
<td>2.31E-01</td>
<td>4.95E-02</td>
</tr>
<tr>
<td>1.16E-01</td>
<td>1.05E-02</td>
</tr>
<tr>
<td>3.20E-02</td>
<td>2.39E-03</td>
</tr>
<tr>
<td>4.19E-02</td>
<td>4.10E-04</td>
</tr>
</tbody>
</table>

\( R_{th(j-s)} \) is the thermal resistance in Kelvin per Watt.
NTC Characteristics

Figure 1. Typical NTC characteristic as a function of temperature

\[ R = f(T) \]

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

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

\[ E = f(I_C) \]

With an inductive load at 25 °C
- \( V_{CC} = 350 \) V
- \( V_{GE} = +15/-5 \) V
- \( R_{gon} = 2 \) Ω

With an inductive load at 125 °C
- \( V_{CC} = 350 \) V
- \( V_{GE} = +15/-5 \) V
- \( R_{gon} = 2 \) Ω

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

\[ E = f(R_g) \]

With an inductive load at 25 °C
- \( V_{CC} = 350 \) V
- \( V_{GE} = +15/-5 \) V
- \( I_c = 90 \) A

With an inductive load at 125 °C
- \( V_{CC} = 350 \) V
- \( V_{GE} = +15/-5 \) V
- \( I_c = 90 \) A

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

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

With an inductive load at 25 °C
- \( V_{CC} = 350 \) V
- \( V_{GE} = +15/-5 \) V
- \( R_{gon} = 2 \) Ω

With an inductive load at 125 °C
- \( V_{CC} = 350 \) V
- \( V_{GE} = +15/-5 \) V
- \( R_{gon} = 2 \) Ω

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

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

With an inductive load at 25 °C
- \( V_{CC} = 350 \) V
- \( V_{GE} = +15/-5 \) V
- \( I_c = 90 \) A

With an inductive load at 125 °C
- \( V_{CC} = 350 \) V
- \( V_{GE} = +15/-5 \) V
- \( I_c = 90 \) A
Buck Switching Characteristics

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

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

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

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

With an inductive load at
- $T_j = 150 \, ^\circ C$
- $V_{DC} = 350 \, V$
- $V_{GE} = +15/-5 \, V$
- $R_{gon} = 2 \, \Omega$
- $I_C = 90 \, A$

With an inductive load at
- $T_j = 150 \, ^\circ C$
- $V_{DC} = 350 \, V$
- $V_{GE} = +15/-5 \, V$
- $I_t = 90 \, A$

At
- $V_{DC} = 350 \, V$
- $V_{GE} = +15/-5 \, V$
- $T_j = 125 \, ^\circ C$
- $R_{gon} = 2 \, \Omega$
- $I_C = 90 \, A$

At
- $V_{DC} = 350 \, V$
- $V_{GE} = +15/-5 \, V$
- $T_j = 125 \, ^\circ C$
- $R_{gon} = 2 \, \Omega$
Buck Switching Characteristics

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

\[ Q_r = f(I_C) \]

At
- \( V_{CE} = 350 \text{ V} \)
- \( V_{GE} = +15/\text{V} \)
- \( R_{gon} = 2 \Omega \)
- \( T_j = 25 \text{ °C} \)
- \( T_j = 125 \text{ °C} \)
- \( I_C = 90 \text{ A} \)
- \( T_j = 150 \text{ °C} \)

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

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

At
- \( V_{CE} = 350 \text{ V} \)
- \( V_{GE} = +15/\text{V} \)
- \( R_{gon} = 2 \Omega \)
- \( T_j = 25 \text{ °C} \)
- \( T_j = 125 \text{ °C} \)
- \( I_C = 90 \text{ A} \)
- \( T_j = 150 \text{ °C} \)

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

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

At
- \( V_{CE} = 350 \text{ V} \)
- \( V_{GE} = +15/\text{V} \)
- \( R_{gon} = 2 \Omega \)
- \( T_j = 25 \text{ °C} \)
- \( T_j = 125 \text{ °C} \)
- \( T_j = 150 \text{ °C} \)

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

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

At
- \( V_{CE} = 350 \text{ V} \)
- \( V_{GE} = +15/\text{V} \)
- \( R_{gon} = 2 \Omega \)
- \( T_j = 25 \text{ °C} \)
- \( T_j = 125 \text{ °C} \)
- \( T_j = 150 \text{ °C} \)
Buck Switching Characteristics

**Figure 13.** FWD
Typical rate of fall of forward and reverse recovery current as a function of collector current
\[ \frac{d^2i_F}{dt^2}, \frac{d^2i_{rr}}{dt^2} = f(I_C) \]

At
- \( V_{CE} = 350 \text{ V} \)
- \( V_{GE} = +15/-5 \text{ V} \)
- \( R_{gon} = 2 \text{ Ω} \)
- \( I_C = 90 \text{ A} \)

**Figure 14.** FWD
Typical rate of fall of forward and reverse recovery current as a function of IGBT turn-on gate resistor
\[ \frac{d^2i_F}{dt^2}, \frac{d^2i_{rr}}{dt^2} = f(R_{gon}) \]

At
- \( V_{CE} = 350 \text{ V} \)
- \( V_{GE} = +15/-5 \text{ V} \)
- \( I_C = 90 \text{ A} \)
- \( R_{gon} = 2 \text{ Ω} \)

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

At
- \( T_J = 175 \text{ °C} \)
- \( R_{gs} = 2 \text{ Ω} \)
- \( R_{ps} = 2 \text{ Ω} \)
Buck Switching Definitions

**General conditions**
- \( V \) = 125 °C
- \( R_{\text{on}} \) = 2 Ω
- \( R_{\text{off}} \) = 2 Ω

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

- \( V_{\text{CE}}(0\%) = 0 \) V
- \( V_{\text{CE}}(100\%) = 20 \) V
- \( I_{\text{C}}(100\%) = 89 \) A
- \( t_{\text{doff}} = 0.170 \) μs
- \( t_{\text{Eoff}} = 0.254 \) μs

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

- \( V_{\text{CE}}(0\%) = 0 \) V
- \( V_{\text{CE}}(100\%) = 20 \) V
- \( I_{\text{C}}(100\%) = 89 \) A
- \( t_{\text{don}} = 0.050 \) μs
- \( t_{\text{Eon}} = 0.104 \) μs

**Figure 3.** IGBT
Turn-off Switching Waveforms & definition of \( t_{\text{f}}, t_{\text{r}} \)

- \( V_{\text{CE}}(100\%) = 350 \) V
- \( I_{\text{C}}(100\%) = 89 \) A
- \( t_{\text{f}} = 0.019 \) μs

**Figure 4.** IGBT
Turn-on Switching Waveforms & definition of \( t_{\text{f}}, t_{\text{r}} \)

- \( V_{\text{CE}}(100\%) = 350 \) V
- \( I_{\text{C}}(100\%) = 89 \) A
- \( t_{\text{r}} = 0.010 \) μs
Buck Switching Characteristics

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

- $P_{off}(100\%) = 31.31$ kW
- $E_{off}(100\%) = 1.56$ mJ
- $t_{Eoff} = 0.25$ μs

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

- $P_{on}(100\%) = 31.31$ kW
- $E_{on}(100\%) = 0.61$ mJ
- $t_{Eon} = 0.10$ μs

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

- $V_{F}(100\%) = 350$ V
- $I_{F}(100\%) = 89$ A
- $I_{Fmax}(100\%) = -158$ A
- $t_{rr} = 0.074$ μs
Buck Switching Characteristics

**Figure 8.** FWD

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

$I_F(100\%) = 89$ A

$Q_r(100\%) = 6.78$ μC

$t_{Qr} = 0.15$ μs

**Figure 9.** FWD

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

$P_{rec}(100\%) = 31.31$ kW

$E_{rec}(100\%) = 1.72$ mJ

$t_{Erec} = 0.15$ μs
Boost Switching Characteristics

**Figure 1.** IGBT

Typical switching energy losses as a function of collector current

\[ E = f(I_C) \]

With an inductive load at 25 °C

- \( V_{CE} = 350 \) V
- \( T_J = 125 ^\circ C \)
- \( V_{GE} = \pm 15 \) V
- \( I_C = 89 \) A
- \( R_{gon} = 4 \Omega \)

**Figure 2.** IGBT

Typical switching energy losses as a function of gate resistor

\[ E = f(R_g) \]

With an inductive load at 25 °C

- \( V_{CE} = 350 \) V
- \( T_J = 125 ^\circ C \)
- \( V_{GE} = \pm 15 \) V
- \( I_C = 89 \) A
- \( R_{goff} = 4 \Omega \)

**Figure 3.** FWD

Typical reverse recovered energy loss as a function of collector current

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

With an inductive load at 25 °C

- \( V_{CE} = 350 \) V
- \( T_J = 125 ^\circ C \)
- \( V_{GE} = \pm 15 \) V
- \( I_C = 89 \) A
- \( R_{gon} = 4 \Omega \)

**Figure 4.** FWD

Typical reverse recovered energy loss as a function of gate resistor

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

With an inductive load at 25 °C

- \( V_{CE} = 350 \) V
- \( T_J = 125 ^\circ C \)
- \( V_{GE} = \pm 15 \) V
- \( I_C = 89 \) A
- \( R_{goff} = 4 \Omega \)
Boost Switching Characteristics

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

\[ t = f(I_C) \]

With an inductive load at

- \( T_J = 150 \, ^\circ C \)
- \( V_{IC} = 350 \, V \)
- \( V_{GE} = \pm 15 \, V \)
- \( R_{gon} = 4 \, \Omega \)
- \( I_C = 89 \, A \)

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

\[ t = f(R_g) \]

With an inductive load at

- \( T_J = 150 \, ^\circ C \)
- \( V_{IC} = 350 \, V \)
- \( V_{GE} = \pm 15 \, V \)
- \( R_{gon} = 4 \, \Omega \)
- \( I_C = 89 \, A \)

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

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

At

- \( V_{IC} = 350 \, V \)
- \( V_{GE} = \pm 15 \, V \)
- \( T_J = 25 \, ^\circ C \)
- \( R_{gon} = 4 \, \Omega \)
- \( I_C = 89 \, A \)

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

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

At

- \( V_{IC} = 350 \, V \)
- \( V_{GE} = \pm 15 \, V \)
- \( T_J = 25 \, ^\circ C \)
- \( I_C = 89 \, A \)
- \( R_{gon} = 4 \, \Omega \)
Boost Switching Characteristics

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

\[ Q_r = f(I_C) \]

- \( V_{CE} = 350 \, \text{V} \)
- \( T_j = 25 \, ^\circ\text{C} \)
- \( I_{C} = 89 \, \text{A} \)
- \( R_{gon} = 4 \, \Omega \)

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

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

- \( V_{CE} = 350 \, \text{V} \)
- \( T_j = 25 \, ^\circ\text{C} \)
- \( I_{C} = 89 \, \text{A} \)
- \( R_{gon} = 4 \, \Omega \)

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

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

- \( V_{CE} = 350 \, \text{V} \)
- \( T_j = 25 \, ^\circ\text{C} \)
- \( I_{C} = 89 \, \text{A} \)
- \( R_{gon} = 4 \, \Omega \)

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

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

- \( V_{CE} = 350 \, \text{V} \)
- \( T_j = 25 \, ^\circ\text{C} \)
- \( I_{C} = 89 \, \text{A} \)
- \( R_{gon} = 4 \, \Omega \)
Boost Switching Characteristics

**Figure 13.**
Typical rate of fall of forward and reverse recovery current as a function of collector current
\[
d_i/dt, d_{r}/dt = f(I_C)
\]

**Figure 14.**
Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor
\[
d_i/dt, d_{r}/dt = f(R_{gon})
\]

**Figure 15.**
Reverse bias safe operating area
\[
I_C = f(V_{CE})
\]
Boost Switching Definitions

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

- $V_{GE}(0\%) = -15$ V
- $V_{CE}(0\%) = 350$ V
- $I_C(0\%) = 89$ A
- $t_{\text{doff}} = 0.349$ μs
- $t_{\text{Eoff}} = 0.892$ μs

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

- $V_{CE}(100\%) = -15$ V
- $V_{CE}(100\%) = 350$ V
- $I_C(100\%) = 89$ A
- $t_{\text{don}} = 0.184$ μs
- $t_{\text{Eon}} = 0.273$ μs

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

- $V_{CE}(100\%) = 350$ V
- $I_C(10\%) = 89$ A
- $t_{\text{f}} = 0.083$ μs

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

- $V_{CE}(100\%) = 350$ V
- $I_C(10\%) = 89$ A
- $t_r = 0.012$ μs
Boost Switching Characteristics

**Figure 5.** IGBT
Turn-on Switching Waveforms & definition of $t_{Eon}$

- $P_{on}(100%) = 31.19$ kW
- $E_{on}(100%) = 0.61$ mJ
- $t_{Eon} = 0.27$ μs

**Figure 6.** IGBT
Turn-off Switching Waveforms & definition of $t_{Eoff}$

- $P_{off}(100%) = 31.19$ kW
- $E_{off}(100%) = 6.30$ mJ
- $t_{Eoff} = 0.89$ μs

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

- $V_{F}(100%) = 350$ V
- $I_{F}(100%) = 89$ A
- $I_{RRM}(100%) = -132$ A
- $t_{rr} = 0.184$ μs
Boost Switching Characteristics

**Figure 8.** FWD
*Turn-on Switching Waveforms & definition of \( t_{Qr} \) (\( t_{Qr} \) = integrating time for \( Q_r \))

- \( I_F \) (100%) = 89 A
- \( Q_r \) (100%) = 8.48 μC
- \( t_{Qr} \) = 0.42 μs

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

- \( P_{rec} \) (100%) = 31.19 kW
- \( E_{rec} \) (100%) = 2.42 mJ
- \( t_{Erec} \) = 0.42 μs
**Pinout**

- **DC+**
  - Pin 19, 20, 21, 22, 23, 24
- **GND**
  - Pin 15, 16, 17, 18
- **OUT**
  - Pin 31, 32, 33, 34, 35, 36, 37
- **D5**
- **D6**

**Identification**

<table>
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<tr>
<th>ID</th>
<th>Component</th>
<th>Voltage</th>
<th>Current</th>
<th>Function</th>
<th>Comment</th>
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<td>150 A</td>
<td>Buck Switch</td>
<td>Parallel devices with separate control. Values apply to complete device.</td>
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<tr>
<td>T2-a, T2-b, T3-a, T3-b</td>
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<td>Boost Switch</td>
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