# Maximum Ratings

T<sub>j</sub>=25°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>Repetitive peak reverse voltage</td>
<td>V&lt;sub&gt;RRM&lt;/sub&gt;</td>
<td>DC current</td>
<td>600</td>
<td>V</td>
</tr>
<tr>
<td>Forward current per diode</td>
<td>I&lt;sub&gt;F&lt;/sub&gt;</td>
<td>T&lt;sub&gt;j&lt;/sub&gt;=80°C</td>
<td>15</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T&lt;sub&gt;c&lt;/sub&gt;=80°C</td>
<td>20</td>
<td>A</td>
</tr>
<tr>
<td>Maximum repetitive forward current</td>
<td>I&lt;sub&gt;PRM&lt;/sub&gt;</td>
<td>tp limited by T&lt;sub&gt;j&lt;/sub&gt;max</td>
<td>20</td>
<td>A</td>
</tr>
<tr>
<td>t&lt;sup&gt;2&lt;/sup&gt;-value</td>
<td>I&lt;sup&gt;t&lt;/sup&gt;</td>
<td>T&lt;sub&gt;j&lt;/sub&gt;=25°C</td>
<td>9,5</td>
<td>A&lt;sup&gt;2&lt;/sup&gt;s</td>
</tr>
<tr>
<td>Power dissipation per Diode</td>
<td>P&lt;sub&gt;Tot&lt;/sub&gt;</td>
<td>T&lt;sub&gt;j&lt;/sub&gt;=T&lt;sub&gt;j&lt;/sub&gt;max</td>
<td>26</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T&lt;sub&gt;j&lt;/sub&gt;=80°C</td>
<td>39</td>
<td>W</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>T&lt;sub&gt;j&lt;/sub&gt;</td>
<td>T&lt;sub&gt;j&lt;/sub&gt;max</td>
<td>175</td>
<td>°C</td>
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</table>

## Buck IGBT

<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 break down voltage</td>
<td>V&lt;sub&gt;CES&lt;/sub&gt;</td>
<td>T&lt;sub&gt;j&lt;/sub&gt;=T&lt;sub&gt;j&lt;/sub&gt;max</td>
<td>650</td>
<td>V</td>
</tr>
<tr>
<td>DC collector current</td>
<td>I&lt;sub&gt;C&lt;/sub&gt;</td>
<td>T&lt;sub&gt;j&lt;/sub&gt;=T&lt;sub&gt;j&lt;/sub&gt;max</td>
<td>53</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T&lt;sub&gt;j&lt;/sub&gt;=80°C</td>
<td>70</td>
<td>A</td>
</tr>
<tr>
<td>Pulsed collector current</td>
<td>I&lt;sub&gt;pulse&lt;/sub&gt;</td>
<td>tp limited by T&lt;sub&gt;j&lt;/sub&gt;max</td>
<td>180</td>
<td>A</td>
</tr>
<tr>
<td>Turn off safe operating area</td>
<td></td>
<td>T&lt;sub&gt;j&lt;/sub&gt;≤150°C</td>
<td>180</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V&lt;sub&gt;CE&lt;/sub&gt;≤V&lt;sub&gt;CES&lt;/sub&gt;</td>
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<td></td>
</tr>
<tr>
<td>Power dissipation per IGBT</td>
<td>P&lt;sub&gt;Tot&lt;/sub&gt;</td>
<td>T&lt;sub&gt;j&lt;/sub&gt;=T&lt;sub&gt;j&lt;/sub&gt;max</td>
<td>108</td>
<td>W</td>
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<tr>
<td></td>
<td></td>
<td>T&lt;sub&gt;j&lt;/sub&gt;=80°C</td>
<td>163</td>
<td>W</td>
</tr>
<tr>
<td>Gate-emitter peak voltage</td>
<td>V&lt;sub&gt;GE&lt;/sub&gt;</td>
<td>T&lt;sub&gt;j&lt;/sub&gt;=T&lt;sub&gt;j&lt;/sub&gt;max</td>
<td>±20</td>
<td>V</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>T&lt;sub&gt;j&lt;/sub&gt;</td>
<td>T&lt;sub&gt;j&lt;/sub&gt;max</td>
<td>175</td>
<td>°C</td>
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</table>
### Maximum Ratings

**Tj = 25°C, unless otherwise specified**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Value</th>
<th>Unit</th>
</tr>
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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_{EBR}</td>
<td>Tj=25°C</td>
<td>600</td>
<td>V</td>
</tr>
<tr>
<td>DC forward current</td>
<td>Ip</td>
<td>Tj=Tj,max</td>
<td>27</td>
<td>A</td>
</tr>
<tr>
<td>Non-repetitive Peak Surge Current</td>
<td>Irms</td>
<td>60Hz Single Half-Sine Wave</td>
<td>300</td>
<td>A</td>
</tr>
<tr>
<td>Power dissipation per Diode</td>
<td>Ptot</td>
<td>Tj=Tj,max</td>
<td>60</td>
<td>W</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>Tj,max</td>
<td></td>
<td>150</td>
<td>°C</td>
</tr>
</tbody>
</table>

| **Boost IGBT** |         |           |       |      |
| Collector-emitter break down voltage | V_{CES} | Tj=Tj,max | 600   | V    |
| DC collector current | Ic | Tj=Tj,max   | 46   | A    |
| Pulsed collector current | Ipuls | Tj,Tj,max limited by Tj,max | 225  | A    |
| Turn off safe operating area | Vgs | Tj=150°C, Vce<V_{CES} | 225  | A    |
| Power dissipation per IGBT | Ptot | Tj=Tj,max   | 103  | W    |
| Gate-emitter peak voltage | V_{GE} |   | ±20 | V    |
| Short circuit ratings | tSC | Tj=150°C, Vce=15V | 6    | μs   |
| Maximum Junction Temperature | Tj,max  |         | 175   | °C   |

| **Boost Diode** |         |           |       |      |
| Peak Repetitive Reverse Voltage | V_{EBR} | Tj=25°C   | 1200  | V    |
| DC forward current | Ip | Tj=Tj,max     | 16   | A    |
| Repetitive peak forward current | Ipmax | Tj,Tj,max limited by Tj,max, 20kHz Square Wave | 36   | A    |
| Power dissipation per Diode | Ptot | Tj=Tj,max   | 48   | W    |
| Maximum Junction Temperature | Tj,max  |         | 150   | °C   |

| **Thermal Properties** |         |           |       |      |
| Storage temperature | Tstg |           | -40...+125 | °C   |
| Operation temperature under switching condition | Tsp |           | -40...+(Tj,max - 25) | °C   |

| **Insulation Properties** |         |           |       |      |
| Insulation voltage | Vins | t=2s DC voltage | 4000  | V    |
| Creepage distance |     |               | min 12,7 | mm  |
| Clearance |     |               | 9,15  | mm   |
## Characteristic Values

### Buck & Boost Inv. Diode

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward voltage</td>
<td>( V_{F} )</td>
<td></td>
<td>10</td>
<td>1,25</td>
</tr>
<tr>
<td>Threshold voltage (for power loss calc. only)</td>
<td>( V_{th} )</td>
<td></td>
<td>10</td>
<td>1,52</td>
</tr>
<tr>
<td>Slope resistance (for power loss calc. only)</td>
<td>( r_{s} )</td>
<td></td>
<td>600</td>
<td>0,005</td>
</tr>
<tr>
<td>Reverse current</td>
<td>( I_{r} )</td>
<td></td>
<td></td>
<td>0,027</td>
</tr>
<tr>
<td>Thermal resistance chip to heatsink per chip</td>
<td>( R_{thJH} )</td>
<td>Thermal grease thickness≤50u m ( \lambda = 1 \text{ W/mK} )</td>
<td></td>
<td>3,66</td>
</tr>
</tbody>
</table>

### Buck IGBT

<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(th)} )</td>
<td>( V_{CE}=V_{GE} )</td>
<td>0,00025</td>
<td>3,9</td>
</tr>
<tr>
<td>Collector-emitter saturation voltage</td>
<td>( V_{CBO} )</td>
<td></td>
<td></td>
<td>4,5</td>
</tr>
<tr>
<td>Collector-emitter cut-off current incl. Diode</td>
<td>( I_{CES} )</td>
<td></td>
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<td>5,6</td>
</tr>
<tr>
<td>Gate-emitter leakage current</td>
<td>( I_{GES} )</td>
<td></td>
<td></td>
<td>none</td>
</tr>
<tr>
<td>Integrated Gate resistor</td>
<td>( R_{gint} )</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>15</td>
</tr>
<tr>
<td>Turn-off delay time</td>
<td>( t_{off} )</td>
<td>( R_{goff}=4 \Omega ) ( R_{goff}=4 \Omega )</td>
<td>350</td>
<td>30</td>
</tr>
<tr>
<td>Fall time</td>
<td>( t_{f} )</td>
<td>( R_{goff}=4 \Omega ) ( R_{goff}=4 \Omega )</td>
<td>115</td>
<td>30</td>
</tr>
<tr>
<td>Turn-on energy loss per pulse</td>
<td>( E_{on} )</td>
<td></td>
<td></td>
<td>5</td>
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<tr>
<td>Turn-off energy loss per pulse</td>
<td>( E_{off} )</td>
<td></td>
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<td>0,38</td>
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<tr>
<td>Input capacitance</td>
<td>( C_{in} )</td>
<td>( f=1\text{MHz} )</td>
<td>2915</td>
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<tr>
<td>Output capacitance</td>
<td>( C_{out} )</td>
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<td>270</td>
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</tr>
<tr>
<td>Reverse transfer capacitance</td>
<td>( C_{r} )</td>
<td></td>
<td>85</td>
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</tr>
<tr>
<td>Gate charge</td>
<td>( Q_{G} )</td>
<td></td>
<td>189</td>
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</tr>
<tr>
<td>Thermal resistance chip to heatsink per chip</td>
<td>( R_{thJH} )</td>
<td>Thermal grease thickness≤50u m ( \lambda = 1 \text{ W/mK} )</td>
<td></td>
<td>0,88</td>
</tr>
</tbody>
</table>

### Buck Diode

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diode forward voltage</td>
<td>( V_{F} )</td>
<td></td>
<td>30</td>
<td>2,15</td>
</tr>
<tr>
<td>Reverse leakage current</td>
<td>( I_{t} )</td>
<td></td>
<td>600</td>
<td>100</td>
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<tr>
<td>Peak reverse recovery current</td>
<td>( I_{RRM} )</td>
<td></td>
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<td>50</td>
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<tr>
<td>Reverse recovery time</td>
<td>( t_{rr} )</td>
<td>( R_{off}=4 \Omega )</td>
<td>350</td>
<td>30</td>
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<tr>
<td>Reverse recovered charge</td>
<td>( Q_{r} )</td>
<td>( R_{off}=4 \Omega )</td>
<td>0,94</td>
<td>30</td>
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<tr>
<td>Peak rate of fall of recovery current</td>
<td>( d\left(I_{RRK}\right)/dt )</td>
<td></td>
<td>16743</td>
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<tr>
<td>Reverse recovered energy</td>
<td>( E_{rec} )</td>
<td></td>
<td>0,022</td>
<td></td>
</tr>
<tr>
<td>Thermal resistance chip to heatsink per chip</td>
<td>( R_{thJH} )</td>
<td>Thermal grease thickness≤50u m ( \lambda = 1 \text{ W/mK} )</td>
<td></td>
<td>1,77</td>
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*10-Jun-2015 / Revision 4*
### 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>Boost IGBT</td>
<td>Gate emitter threshold voltage</td>
<td>( V_{GE} ) or ( V_{GS} ) [V]</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Collector-emitter saturation voltage</td>
<td>( V_{CE} ) [V]</td>
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<td></td>
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<tr>
<td></td>
<td>Collector-emitter cut-off incl diode</td>
<td>( t_{rr} ) or ( t_{CE} ) [ns]</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Gate-emitter leakage current</td>
<td>( I_{G} ) [mA] or ( I_{C} ) [A]</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Integrated Gate resistor</td>
<td>( R_{gint} ) [Ω]</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Turn-on delay time (( t_{on} ))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rise time (( t_{r} ))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Turn-off delay time (( t_{off} ))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fall time (( t_{f} ))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Turn-on energy loss per pulse</td>
<td>( E_{on} ) [mWs]</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Turn-off energy loss per pulse</td>
<td>( E_{off} ) [mWs]</td>
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<td></td>
</tr>
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<td></td>
<td>Input capacitance</td>
<td>( C_{iss} ) [pF]</td>
<td>4620</td>
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<tr>
<td></td>
<td>Output capacitance</td>
<td>( C_{oss} ) [pF]</td>
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<td>nC</td>
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<td>Reverse transfer capacitance</td>
<td>( C_{riss} ) [pF]</td>
<td>137</td>
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<tr>
<td></td>
<td>Gate charge</td>
<td>( Q_{gate} ) [nC]</td>
<td>15</td>
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<td></td>
<td>Thermal resistance chip to heatsink per chip</td>
<td>( R_{thJH} ) [K/W]</td>
<td>1.40</td>
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### Boost Diode

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diode forward voltage</td>
<td>( V_{f} )</td>
<td></td>
<td>2.43</td>
<td>V</td>
</tr>
<tr>
<td>Reverse leakage current</td>
<td>( I_{r} )</td>
<td>1200</td>
<td>100</td>
<td>μA</td>
</tr>
<tr>
<td>Peak reverse recovery current</td>
<td>( I_{rr} )</td>
<td></td>
<td>69</td>
<td>A</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>( t_{rr} )</td>
<td></td>
<td>25</td>
<td>ns</td>
</tr>
<tr>
<td>Reverse recovered charge</td>
<td>( Q_{rr} )</td>
<td></td>
<td>6.27</td>
<td>μC</td>
</tr>
<tr>
<td>Peak rate of fall of recovery current</td>
<td>( dv/(dt)_{max} )</td>
<td></td>
<td>9632</td>
<td>A/μs</td>
</tr>
<tr>
<td>Reverse recovery energy</td>
<td>( E_{r} )</td>
<td></td>
<td>1.04</td>
<td>mWs</td>
</tr>
<tr>
<td>Thermal resistance chip to heatsink per chip</td>
<td>( R_{thJH} )</td>
<td></td>
<td>2.21</td>
<td>K/W</td>
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### Thermistor

<table>
<thead>
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<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>
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<td>21500</td>
<td>Ω</td>
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<td>Deviation of R25</td>
<td>( \Delta R/R )</td>
<td>( R_{100}=1486 ) Ω</td>
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<tr>
<td>Power dissipation</td>
<td>( P )</td>
<td>( T_{25} )</td>
<td>210</td>
<td>mW</td>
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<td>Power dissipation constant</td>
<td>( B(25/50) )</td>
<td>( T_{25} )</td>
<td>3.5</td>
<td>mW/K</td>
</tr>
<tr>
<td>( B(25/100) )</td>
<td>( T_{25} )</td>
<td>3964</td>
<td>K</td>
<td></td>
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<tr>
<td>Vincotech NTC Reference</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
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  
$t_p = 250 \ \mu s$  
$V_{CE} = 10 \ V$

Figure 4  
**Typical diode forward current as a function of forward voltage**  
$I_F = f(V_F)$  
At  
$t_p = 250 \ \mu s$
Figure 5  
**IGBT**
Typical switching energy losses as a function of collector current

\[ E = f(I_C) \]

With an inductive load at

\[ T_j = 25/125 \, ^\circ C \]

\[ V_{CE} = 350 \, V \]

\[ V_{GE} = \pm 15 \, V \]

\[ R_{GON} = 4 \, \Omega \]

\[ I_C = 30 \, A \]

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

\[ E = f(R_G) \]

With an inductive load at

\[ T_j = 25/125 \, ^\circ C \]

\[ V_{CE} = 350 \, V \]

\[ V_{GE} = \pm 15 \, V \]

\[ I_C = 30 \, A \]

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

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

With an inductive load at

\[ T_j = 25/125 \, ^\circ C \]

\[ V_{CE} = 350 \, V \]

\[ V_{GE} = \pm 15 \, V \]

\[ R_{GON} = 4 \, \Omega \]

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

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

With an inductive load at

\[ T_j = 25/125 \, ^\circ C \]

\[ V_{CE} = 350 \, V \]

\[ V_{GE} = \pm 15 \, V \]

\[ I_C = 30 \, A \]
Figure 9
Typical switching times as a function of collector current
$t = f(I_C)$

With an inductive load at
$T_J = 125 \, ^\circ C$
$V_{CE} = 350 \, V$
$V_{GE} = \pm 15 \, V$
$R_{gon} = 4 \, \Omega$
$R_{goff} = 4 \, \Omega$

Figure 10
Typical switching times as a function of gate resistor
$t = f(R_G)$

With an inductive load at
$T_J = 125 \, ^\circ C$
$V_{CE} = 350 \, V$
$V_{GE} = \pm 15 \, V$
$I_F = 30 \, A$

Figure 11
Typical reverse recovery time as a function of collector current
$t_{rr} = f(I_C)$

At
$T_J = 25/125 \, ^\circ C$
$V_{CE} = 350 \, V$
$V_{GE} = \pm 15 \, V$
$R_{gon} = 4 \, \Omega$

Figure 12
Typical reverse recovery time as a function of IGBT turn on gate resistor
$t_{rr} = f(R_{gon})$

At
$T_J = 25/125 \, ^\circ C$
$V_{CE} = 350 \, V$
$I_F = 30 \, A$
$V_{GE} = \pm 15 \, V$
Figure 13  FWD
Typical reverse recovery charge as a function of collector current
\[ Q_{rr} = f(I_C) \]

At
- \( T_J = 25/125 \, ^\circ C \)
- \( V_{CE} = 350 \, V \)
- \( V_{GE} = \pm 15 \, V \)
- \( R_{gon} = 4 \, \Omega \)

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

At
- \( T_J = 25/125 \, ^\circ C \)
- \( V_{CE} = 350 \, V \)
- \( I_F = 30 \, A \)
- \( V_{GE} = \pm 15 \, V \)

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

At
- \( T_J = 25/125 \, ^\circ C \)
- \( V_{CE} = 350 \, V \)
- \( V_{GE} = \pm 15 \, V \)
- \( R_{gon} = 4 \, \Omega \)

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

At
- \( T_J = 25/125 \, ^\circ C \)
- \( V_{CE} = 350 \, V \)
- \( I_F = 30 \, A \)
- \( V_{GE} = \pm 15 \, V \)
**Figure 17**
Typical rate of fall of forward and reverse recovery current as a function of collector current
\[ \frac{dI_o}{dt}, \frac{dI_{rec}}{dt} = f(I_c) \]

- At
  - \( T_j = 25/125 \) °C
  - \( V_{CE} = 350 \) V
  - \( I_F = 30 \) A
  - \( R_{gon} = 4 \) Ω

**Figure 18**
Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor
\[ \frac{dI_o}{dt}, \frac{dI_{rec}}{dt} = f(R_{gon}) \]

- At
  - \( T_j = 25/125 \) °C
  - \( V_e = 350 \) V
  - \( I_e = 30 \) A
  - \( V_{GE} = ±15 \) V

**Figure 19**
IGBT transient thermal impedance as a function of pulse width
\[ Z_{thJH} = f(t_p) \]

- At
  - \( D = t_p / T \)
  - \( R_{30H} = 0,88 \) K/W
  - \( R_{60H} = 0,59 \) K/W

**Figure 20**
FWD transient thermal impedance as a function of pulse width
\[ Z_{thJH} = f(t_p) \]

- At
  - \( D = t_p / T \)
  - \( R_{30H} = 1,77 \) K/W
  - \( R_{60H} = 1,18 \) K/W

**IGBT thermal model values**

<table>
<thead>
<tr>
<th>Thermal grease</th>
<th>Phase change interface</th>
<th>R (K/W)</th>
<th>Tau (s)</th>
<th>R (K/W)</th>
<th>Tau (s)</th>
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<td>0,08</td>
<td>2,8E+00</td>
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<td>1,2E-02</td>
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**FWD thermal model values**

<table>
<thead>
<tr>
<th>Thermal grease</th>
<th>Phase change interface</th>
<th>R (K/W)</th>
<th>Tau (s)</th>
<th>R (K/W)</th>
<th>Tau (s)</th>
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<td>0,12</td>
<td>1,3E-03</td>
<td>0,08</td>
<td>0,00</td>
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</table>
Power dissipation as a Collector current as a function of heatsink temperature

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

At

\[ T_j = 175 \, ^\circ\text{C} \]

Power dissipation as a Forward current as a function of heatsink temperature

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

At

\[ T_j = 150 \, ^\circ\text{C} \]
Figure 25  
Safe operating area as a function of collector-emitter voltage  
\[ I_C = f(V_{CE}) \]

At  
- **D**: single pulse  
- **Th**: 80 °C  
- **V_{GIR}**: ±15 V  
- **TJ**: T_{max} °C

Figure 26  
Gate voltage vs Gate charge  
\[ V_{GIR} = f(Q_g) \]

At  
- **I_C**: 60 A
Figure 1: IGBT
Typical output characteristics
$I_C = f(V_{CE})$

At
$t_p = 250 \mu s$
$T_J = 25 \degree C$
$V_{GE}$ from 7 V to 17 V in steps of 1 V

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

At
$t_p = 250 \mu s$
$T_J = 125 \degree C$
$V_{GE}$ from 7 V to 17 V in steps of 1 V

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

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
$t_p = 250 \mu s$
Figure 5
Typical switching energy losses as a function of collector current

\[ E = f(I_C) \]

With an inductive load at
\[ T_J = 25/125 \, ^\circ C \]
\[ V_{CE} = 350 \, V \]
\[ V_{GE} = \pm 15 \, V \]
\[ R_{Gepp} = 4 \, \Omega \]
\[ R_{Goff} = 4 \, \Omega \]

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

\[ E = f(R_G) \]

With an inductive load at
\[ T_J = 25/125 \, ^\circ C \]
\[ V_{CE} = 350 \, V \]
\[ V_{GE} = \pm 15 \, V \]
\[ I_C = 50 \, A \]

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

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

With an inductive load at
\[ T_J = 25/125 \, ^\circ C \]
\[ V_{CE} = 350 \, V \]
\[ V_{GE} = \pm 15 \, V \]
\[ R_{Gepp} = 4 \, \Omega \]

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

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

With an inductive load at
\[ T_J = 25/125 \, ^\circ C \]
\[ V_{CE} = 350 \, V \]
\[ V_{GE} = \pm 15 \, V \]
\[ I_C = 50 \, A \]
**Typical switching times as a function of collector current**

$$t = f(I_C)$$

With an inductive load at:
- $T_J = 125 \, ^\circ C$
- $V_{CE} = 350 \, V$
- $V_{GE} = \pm 15 \, V$
- $R_{gon} = 4 \, \Omega$
- $R_{goff} = 4 \, \Omega$

**Typical reverse recovery time as a function of collector current**

$$t_{rr} = f(I_C)$$

**Boost**

**Typical switching times as a function of gate resistor**

$$t = f(R_G)$$

With an inductive load at:
- $T_J = 125 \, ^\circ C$
- $V_{CE} = 350 \, V$
- $V_{GE} = \pm 15 \, V$
- $I_C = 50 \, A$

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

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

At:
- $T_J = 25/125 \, ^\circ C$
- $V_{BE} = 350 \, V$
- $V_{GE} = \pm 15 \, V$
- $R_{gon} = 4 \, \Omega$

At:
- $T_J = 25/125 \, ^\circ C$
- $V_{BE} = 350 \, V$
- $I_R = 50 \, A$
- $V_{GE} = \pm 15 \, V$
Figure 13
Typical reverse recovery charge as a function of collector current
\[ Q_{rr} = f(I_C) \]

At
\[ T_j = 25/125 \, ^\circ C \]
\[ V_{CE} = 350 \, V \]
\[ V_{GE} = \pm 15 \, V \]
\[ R_{gon} = 4 \, \Omega \]

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

At
\[ T_j = 25/125 \, ^\circ C \]
\[ V_A = 350 \, V \]
\[ I_F = 50 \, A \]
\[ V_{GE} = \pm 15 \, V \]

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

At
\[ T_j = 25/125 \, ^\circ C \]
\[ V_{CE} = 350 \, V \]
\[ V_{GE} = \pm 15 \, V \]
\[ R_{gon} = 4 \, \Omega \]

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

At
\[ T_j = 25/125 \, ^\circ C \]
\[ V_A = 350 \, V \]
\[ I_F = 50 \, A \]
\[ V_{GE} = \pm 15 \, V \]
**Figure 17**

Typical rate of fall of forward and reverse recovery current as a function of collector current $dI_0/dt, dI_{rec}/dt = f(Ic)$

- Parameter values:
  - $T_j = 25/125 ^\circ C$
  - $V_{CE} = 350 V$
  - $V_{GE} = \pm 15 V$
  - $I_F = 50 A$

**Figure 18**

Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor $dI_0/dt, dI_{rec}/dt = f(R_{gon})$

- Parameter values:
  - $T_j = 25/125 ^\circ C$
  - $V_{CE} = 350 V$
  - $V_{GE} = \pm 15 V$

**Figure 19**

IGBT transient thermal impedance as a function of pulse width $Z_{thJH} = f(t_p)$

- Thermal grease Phase change interface
  - $R (K/W)$ $\tau (s)$
  - $0.25$ $8.1E+00$ $0.17$ $5.45$
  - $0.22$ $4.7E-01$ $0.14$ $0.32$
  - $0.69$ $9.9E-02$ $0.47$ $0.07$
  - $0.14$ $2.0E-02$ $0.10$ $0.01$
  - $0.05$ $4.1E-03$ $0.03$ $0.00$
  - $0.05$ $4.0E-04$ $0.03$ $0.00$

**Figure 20**

FWD transient thermal impedance as a function of pulse width $Z_{thJH} = f(t_p)$

- Thermal grease Phase change interface
  - $R (K/W)$ $\tau (s)$
  - $0.08$ $2.5E+00$ $0.05$ $1.64$
  - $0.32$ $3.3E-01$ $0.21$ $0.22$
  - $1.23$ $8.5E-02$ $0.82$ $0.06$
  - $0.32$ $1.1E-02$ $0.21$ $0.01$
  - $0.18$ $2.1E-03$ $0.12$ $0.00$
  - $0.09$ $5.7E-04$ $0.06$ $0.00$

---

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Boost datasheet

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10 Jun. 2015 / Revision 4
Figure 21  
**IGBT**  
Power dissipation as a function of heatsink temperature

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

---

**Figure 22  
IGBT**  
Collector current as a function of heatsink temperature

\[ I_C = f(T_h) \]

---

**Figure 23  
FWD**  
Power dissipation as a function of heatsink temperature

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

---

**Figure 24  
FWD**  
Forward current as a function of heatsink temperature

\[ I_F = f(T_h) \]

---

At  
\[ T_j = 175 \, ^\circ C \]

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

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

At  
\[ V_{GE} = 15 \, V \]
Buck & Boost Inverse Diode

**Figure 25**

Boost Inverse Diode

Typical diode forward current as a function of forward voltage

\[ I_F = f(V_F) \]

![Graph showing typical diode forward current as a function of forward voltage.](image)

At

\[ t_p = 250 \ \mu s \]

**Figure 26**

Boost Inverse Diode

Diode transient thermal impedance as a function of pulse width

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

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

At

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

\[ R_{thJH} = 3.66 \ \text{K/W} \]

**Figure 27**

Boost Inverse Diode

Power dissipation as a function of heatsink temperature

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

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

At

\[ T_j = 175 \ ^\circ C \]

**Figure 28**

Boost Inverse Diode

Forward current as a function of heatsink temperature

\[ I_F = f(T_h) \]

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

At

\[ T_j = 175 \ ^\circ C \]
Figure 1

Typical NTC characteristic as a function of temperature

\[ R_T = f(T) \]
## Switching Definitions BUCK IGBT

### General conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_J$</td>
<td>$125 , ^\circ C$</td>
</tr>
<tr>
<td>$R_{gon}$</td>
<td>$4 , \Omega$</td>
</tr>
<tr>
<td>$R_{goff}$</td>
<td>$4 , \Omega$</td>
</tr>
</tbody>
</table>

### Turn-off Switching Waveforms & definition of $t_{doff}$, $t_{Eoff}$

- **$V_{GE}$ (0%)**: $-15 \, V$
- **$V_{CE}$ (100%)**: $700 \, V$
- **$I_C$ (100%)**: $30 \, A$
- **$t_{doff}$**: $0.12 \, \mu s$
- **$t_{Eoff}$**: $0.26 \, \mu s$

### Turn-on Switching Waveforms & definition of $t_{don}$, $t_{Eon}$

- **$V_{GE}$ (0%)**: $-15 \, V$
- **$V_{CE}$ (100%)**: $700 \, V$
- **$I_C$ (100%)**: $30 \, A$
- **$t_{don}$**: $0.05 \, \mu s$
- **$t_{Eon}$**: $0.09 \, \mu s$

### Turn-off Switching Waveforms & definition of $t_f$

- **$V_{CE}$ (100%)**: $700 \, V$
- **$I_C$ (100%)**: $30 \, A$
- **$t_f$**: $0.006 \, \mu s$

### Turn-on Switching Waveforms & definition of $t_r$

- **$V_{CE}$ (100%)**: $700 \, V$
- **$I_C$ (100%)**: $30 \, A$
- **$t_r$**: $0.004 \, \mu s
Switching Definitions BUCK IGBT

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>$P_{off}$ (100%)</td>
<td>21.01 kW</td>
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<tr>
<td>$E_{off}$ (100%)</td>
<td>0.39 mJ</td>
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<td>$t_{E_{off}}$</td>
<td>0.26 μs</td>
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</table>

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

<table>
<thead>
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<th>Parameter</th>
<th>Value</th>
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</thead>
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<tr>
<td>$P_{on}$ (100%)</td>
<td>21.01 kW</td>
</tr>
<tr>
<td>$E_{on}$ (100%)</td>
<td>0.35 mJ</td>
</tr>
<tr>
<td>$t_{E_{on}}$</td>
<td>0.09 μs</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_d$ (100%)</td>
<td>700 V</td>
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<tr>
<td>$I_d$ (100%)</td>
<td>30 A</td>
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<tr>
<td>$I_{RRM}$ (100%)</td>
<td>10 A</td>
</tr>
<tr>
<td>$t_{rr}$</td>
<td>0.026 μs</td>
</tr>
</tbody>
</table>

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Switching Definitions BUCK IGBT

**Figure 8**
Turn-on Switching Waveforms & definition of $t_{qrr}$
($t_{qrr}$ = integrating time for $Q_{rr}$)

- $I_d$ (100%) = 30 A
- $Q_{rr}$ (100%) = 0.943 μC
- $t_{qrr}$ = 0.05 μs

<table>
<thead>
<tr>
<th>$I_d$ (100%)</th>
<th>30 A</th>
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</thead>
<tbody>
<tr>
<td>$Q_{rr}$ (100%)</td>
<td>0.943 μC</td>
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<tr>
<td>$t_{qrr}$</td>
<td>0.05 μs</td>
</tr>
</tbody>
</table>

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

- $P_{rec}$ (100%) = 21.01 kW
- $E_{rec}$ (100%) = 0.098 mJ
- $t_{rec}$ = 0.05 μs

<table>
<thead>
<tr>
<th>$P_{rec}$ (100%)</th>
<th>21.01 kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>$E_{rec}$ (100%)</td>
<td>0.098 mJ</td>
</tr>
<tr>
<td>$t_{rec}$</td>
<td>0.05 μs</td>
</tr>
</tbody>
</table>

**Measurement circuits**

**Figure 10**
BUCK stage switching measurement circuit

**Figure 11**
BOOST stage switching measurement circuit
Switching Definitions BOOST IGBT

General conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>$T_j$</td>
<td>124 °C</td>
</tr>
<tr>
<td>$R_{gon}$</td>
<td>4 Ω</td>
</tr>
<tr>
<td>$R_{goff}$</td>
<td>4 Ω</td>
</tr>
</tbody>
</table>

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

- $V_{GE} (0\%) = -15$ V
- $V_{GE} (100\%) = 15$ V
- $V_{CE} (100\%) = 350$ V
- $I_{C} (100\%) = 50$ A
- $t_{doff} = 0,20$ µs
- $t_{Eoff} = 0,53$ µs

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

- $V_{GE} (0\%) = -15$ V
- $V_{GE} (100\%) = 15$ V
- $V_{CE} (100\%) = 350$ V
- $I_{C} (100\%) = 50$ A
- $t_{don} = 0,088$ µs
- $t_{Eon} = 0,14$ µs

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

- $V_{CE} (100\%) = 350$ V
- $I_{C} (100\%) = 50$ A
- $t_f = 0,093$ µs

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

- $V_{CE} (100\%) = 350$ V
- $I_{C} (100\%) = 50$ A
- $t_r = 0,012$ µs
Switching Definitions BOOST IGBT

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

- $P_{off}$ (100%) = 17,48 kW
- $E_{off}$ (100%) = 2,25 mJ
- $t_{Eoff}$ = 0,53 µs

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

- $P_{on}$ (100%) = 17,48 kW
- $E_{on}$ (100%) = 0,54 mJ
- $t_{Eon}$ = 0,14 µs

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

- $Vd$ (100%) = 350 V
- $Id$ (100%) = 50 A
- $I_{RRM}$ (100%) = 10 A
- $t_{rr}$ = 0,123 µs
Switching Definitions BOOST IGBT

**Figure 8**

**BOOST FWD**

Turn-on Switching Waveforms & definition of $t_{qrr}$  
($t_{qrr} =$ integrating time for $Q_{rr}$)

<table>
<thead>
<tr>
<th>Time (μs)</th>
<th>Id</th>
<th>Qrr</th>
<th>$t_{qrr}$</th>
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<td>3.2</td>
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<td>3.3</td>
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</table>

**Figure 9**

**BOOST FWD**

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

<table>
<thead>
<tr>
<th>Time (μs)</th>
<th>$P_{rec}$</th>
<th>$E_{rec}$</th>
<th>$t_{Erec}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>200</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>200</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>3.2</td>
<td>200</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>3.3</td>
<td>200</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>3.4</td>
<td>200</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>3.5</td>
<td>200</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>3.6</td>
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<td>200</td>
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</tr>
<tr>
<td>3.7</td>
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</tr>
<tr>
<td>3.8</td>
<td>200</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>3.9</td>
<td>200</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>4.0</td>
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<td>200</td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>200</td>
<td>200</td>
<td></td>
</tr>
</tbody>
</table>

Id (100%) = 50 A  
Qrr (100%) = 6,267 μC  
$t_{qrr} =$ 1,00 μs

Prec (100%) = 17,48 kW  
Erec (100%) = 1,966 mJ  
$t_{Erec} =$ 1,00 μs

Measurement circuits

**Figure 10**

**BUCK stage switching measurement circuit**

**Figure 11**

**BOOST stage switching measurement circuit**
Ordering Code and Marking - Outline - Pinout

### Ordering Code & Marking

<table>
<thead>
<tr>
<th>Version</th>
<th>Ordering Code</th>
<th>In DataMatrix as</th>
<th>In packaging barcode as</th>
</tr>
</thead>
<tbody>
<tr>
<td>w/o thermal paste 12mm housing solder pin</td>
<td>10-FZ06NRA060FU-P967F08</td>
<td>P967F08</td>
<td>P967F08</td>
</tr>
<tr>
<td>w/o thermal paste 12mm housing Press-fit pin</td>
<td>10-PZ06NRA060FU-P967F08Y</td>
<td>P967F08Y</td>
<td>P967F08Y</td>
</tr>
</tbody>
</table>

### Pinout

![Diagram of pinout](image)

- **Pinout Diagram**

### Identification

<table>
<thead>
<tr>
<th>ID</th>
<th>Component</th>
<th>Voltage</th>
<th>Current</th>
<th>Function</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>T5, T6</td>
<td>IGBT</td>
<td>650V</td>
<td>30A</td>
<td>Buck switch</td>
<td></td>
</tr>
<tr>
<td>D3, D4</td>
<td>FWD</td>
<td>600V</td>
<td>30A</td>
<td>Buck diode</td>
<td></td>
</tr>
<tr>
<td>T1, T2</td>
<td>IGBT</td>
<td>600V</td>
<td>50A</td>
<td>Boost switch</td>
<td></td>
</tr>
<tr>
<td>D1, D2</td>
<td>FWD</td>
<td>1200V</td>
<td>18A</td>
<td>Boost diode</td>
<td></td>
</tr>
<tr>
<td>D13, D14</td>
<td>FWD</td>
<td>600V</td>
<td>10A</td>
<td>Buck inverse diode</td>
<td></td>
</tr>
<tr>
<td>D9, D10</td>
<td>FWD</td>
<td>600V</td>
<td>10A</td>
<td>Boost inverse diode</td>
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<tr>
<td>T</td>
<td>NTC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Pinout Table**

- **Identification Table**

- **Function Table**

- **Comment Table**

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10 Jun. 2015 / Revision 4

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