# flowNPC0 600V/30A

## Features
- Neutral-point-Clamped inverter
- Clip-In PCB mounting
- Low Inductance Layout

## Target Applications
- UPS and Solar

## Types
- 10-FZ06NIA030SA-P924F33

## Maximum Ratings

Tjunction = 25°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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</thead>
<tbody>
<tr>
<td>Collector-emitter break down voltage</td>
<td>VCES</td>
<td>Tj=25°C, Tc=80°C</td>
<td>600</td>
<td>V</td>
</tr>
<tr>
<td>DC collector current</td>
<td>Ic</td>
<td>Tj=Tmax, Tc=80°C</td>
<td>30</td>
<td>A</td>
</tr>
<tr>
<td>Pulsed collector current</td>
<td>Ipulse</td>
<td>Ic limited by Tjmax</td>
<td>90</td>
<td>A</td>
</tr>
<tr>
<td>Power dissipation per IGBT</td>
<td>Ptot</td>
<td>Tj=Tmax, Tc=80°C</td>
<td>56</td>
<td>W</td>
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<tr>
<td>Gate-emitter peak voltage</td>
<td>VGE</td>
<td>Tj=25°C, VGE=15V</td>
<td>±20</td>
<td>V</td>
</tr>
<tr>
<td>Short circuit ratings</td>
<td>tsc</td>
<td>Tj≤150°C, VCE=15V</td>
<td>6</td>
<td>µs</td>
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<tr>
<td>Maximum Junction Temperature</td>
<td>Tjmax</td>
<td></td>
<td>175</td>
<td>°C</td>
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<tr>
<td>Turn off safe operating area</td>
<td>Tj≤150°C, VCE=VCES</td>
<td></td>
<td>60</td>
<td>A</td>
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</table>

## Buck FWD

<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>Peak Repetitive Reverse Voltage</td>
<td>Vmax</td>
<td>Tj=25°C</td>
<td>600</td>
<td>V</td>
</tr>
<tr>
<td>DC forward current</td>
<td>If</td>
<td>Tj=Tmax, Tc=80°C</td>
<td>27</td>
<td>A</td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>Ifrm</td>
<td>If limited by Tjmax</td>
<td>90</td>
<td>A</td>
</tr>
<tr>
<td>Power dissipation per Diode</td>
<td>Ptot</td>
<td>Tj=Tmax, Tc=80°C</td>
<td>44</td>
<td>W</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>Tjmax</td>
<td></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>
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<tbody>
<tr>
<td>Boost IGBT</td>
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<tr>
<td>Collector-emitter break down voltage</td>
<td>$V_{CES}$</td>
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<td>600</td>
<td>V</td>
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<tr>
<td>DC collector current</td>
<td>$I_C$</td>
<td>$T_j=T_{max}$</td>
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<td>A</td>
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<tr>
<td></td>
<td></td>
<td>$T_e=80°C$</td>
<td>39</td>
<td>A</td>
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<td></td>
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<td>$T_c=80°C$</td>
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<td>Pulsed collector current</td>
<td>$I_{CPUL}$</td>
<td>$I_p$ limited by $T_{max}$</td>
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<td>A</td>
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<td>Power dissipation per IGBT</td>
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<td>$T_j=T_{max}$</td>
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<td>W</td>
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<td></td>
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<td>$T_e=80°C$</td>
<td>85</td>
<td>W</td>
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<td></td>
<td></td>
<td>$T_c=80°C$</td>
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<td>W</td>
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<tr>
<td>Gate-emitter peak voltage</td>
<td>$V_{GE}$</td>
<td></td>
<td>±20</td>
<td>V</td>
</tr>
<tr>
<td>Short circuit ratings</td>
<td>$I_{SC}$</td>
<td>$T_j\leq150°C$</td>
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<td>μs</td>
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<td></td>
<td></td>
<td>$V_{GE}=15V$</td>
<td>360</td>
<td>μs</td>
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<td></td>
<td>$V_{CC}$</td>
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<td>°C</td>
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<td>Turn off safe operating area</td>
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<td>$T_j\leq150°C$</td>
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<td>A</td>
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<td></td>
<td></td>
<td>$V_{CC} \leq V_{CES}$</td>
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### Buck and Boost Inverse FWD

<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>Peak Repetitive Reverse Voltage</td>
<td>$V_{RRM}$</td>
<td>$T_j=25°C$</td>
<td>600</td>
<td>V</td>
</tr>
<tr>
<td>DC forward current</td>
<td>$I_F$</td>
<td>$T_j=T_{max}$</td>
<td>26</td>
<td>A</td>
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<td></td>
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<td>$T_e=80°C$</td>
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<tr>
<td>Repetitive peak forward current</td>
<td>$I_{PRM}$</td>
<td>$I_p$ limited by $T_{max}$</td>
<td>90</td>
<td>A</td>
</tr>
<tr>
<td>Power dissipation per Diode</td>
<td>$P_{tot}$</td>
<td>$T_j=T_{max}$</td>
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<td>W</td>
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<td></td>
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<td>$T_e=80°C$</td>
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<td>W</td>
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<tr>
<td>Maximum Junction Temperature</td>
<td>$T_j$</td>
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### Thermal Properties

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<th>Parameter</th>
<th>Symbol</th>
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<th>Unit</th>
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<tbody>
<tr>
<td>Storage temperature</td>
<td>$T_{stg}$</td>
<td></td>
<td>-40...+125</td>
<td>°C</td>
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<tr>
<td>Operation temperature under switching condition</td>
<td>$T_{op}$</td>
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<td>-40...+($T_{max} - 25$)</td>
<td>°C</td>
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### Insulation Properties

<table>
<thead>
<tr>
<th>Parameter</th>
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<th>Condition</th>
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<td>Insulation voltage</td>
<td>$V_i$</td>
<td>$I=2s$</td>
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<td></td>
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<td>DC voltage</td>
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<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>
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<td>min 12.7</td>
<td>mm</td>
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<tr>
<td>Parameter</td>
<td>Symbol</td>
<td>Conditions</td>
<td>Value</td>
<td>Unit</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>------------</td>
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<td>------</td>
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<tr>
<td>Collector-emitter saturation voltage</td>
<td>V&lt;sub&gt;CES&lt;/sub&gt;</td>
<td>V&lt;sub&gt;CES=V&lt;sub&gt;CE&lt;/sub&gt;&lt;/sub&gt;</td>
<td>0,00043</td>
<td>V</td>
</tr>
<tr>
<td>Collector-emitter cut-off current incl. Diode</td>
<td>I&lt;sub&gt;CES&lt;/sub&gt;</td>
<td>V&lt;sub&gt;CES=V&lt;sub&gt;CE&lt;/sub&gt;&lt;/sub&gt;</td>
<td>16, 30</td>
<td>μA</td>
</tr>
<tr>
<td>Gate-emitter leakage current</td>
<td>I&lt;sub&gt;GES&lt;/sub&gt;</td>
<td>V&lt;sub&gt;CES=V&lt;sub&gt;CE&lt;/sub&gt;&lt;/sub&gt;</td>
<td>20, 0</td>
<td>nA</td>
</tr>
<tr>
<td>Integrated Gate resistor</td>
<td>R&lt;sub&gt;off&lt;/sub&gt;</td>
<td>none</td>
<td>none</td>
<td>Ω</td>
</tr>
<tr>
<td>Turn-on delay time</td>
<td>t&lt;sub&gt;on&lt;/sub&gt;</td>
<td>Rgoff=16 Ω</td>
<td>1,75, 2,05</td>
<td>s</td>
</tr>
<tr>
<td>Turn-off delay time</td>
<td>t&lt;sub&gt;off&lt;/sub&gt;</td>
<td>Rgon=16 Ω</td>
<td>1,75, 2,05</td>
<td>s</td>
</tr>
<tr>
<td>Fall time</td>
<td>t&lt;sub&gt;f&lt;/sub&gt;</td>
<td>Rgoff=16 Ω</td>
<td>1,75, 2,05</td>
<td>s</td>
</tr>
<tr>
<td>Turn-on energy loss per pulse</td>
<td>E&lt;sub&gt;on&lt;/sub&gt;</td>
<td>Rgon=16 Ω</td>
<td>0,47, 0,62</td>
<td>mWs</td>
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<tr>
<td>Turn-off energy loss per pulse</td>
<td>E&lt;sub&gt;off&lt;/sub&gt;</td>
<td>Rgoff=16 Ω</td>
<td>0,80, 1,02</td>
<td>mWs</td>
</tr>
<tr>
<td>Input capacitance</td>
<td>C&lt;sub&gt;in&lt;/sub&gt;</td>
<td>RinMHz</td>
<td>1630</td>
<td>pF</td>
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<tr>
<td>Output capacitance</td>
<td>C&lt;sub&gt;out&lt;/sub&gt;</td>
<td>RinMHz</td>
<td>108</td>
<td>pF</td>
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<tr>
<td>Reverse transfer capacitance</td>
<td>C&lt;sub&gt;rss&lt;/sub&gt;</td>
<td>RinMHz</td>
<td>50</td>
<td>pF</td>
</tr>
<tr>
<td>Gate charge</td>
<td>Q&lt;sub&gt;gate&lt;/sub&gt;</td>
<td>±15</td>
<td>480, 30</td>
<td>nC</td>
</tr>
<tr>
<td>Thermal resistance chip to heatsink per chip</td>
<td>R&lt;sub&gt;thJH&lt;/sub&gt;</td>
<td>Thermal grease thickness=500μm</td>
<td>1,69</td>
<td>K/W</td>
</tr>
</tbody>
</table>

**Buck FWD**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
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<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diode forward voltage</td>
<td>V&lt;sub&gt;D&lt;/sub&gt;</td>
<td>±15</td>
<td>30</td>
<td>V</td>
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<tr>
<td>Peak reverse recovery current</td>
<td>I&lt;sub&gt;RM&lt;/sub&gt;</td>
<td>Rgoff=16 Ω</td>
<td>1,75, 2,05</td>
<td>A</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>t&lt;sub&gt;p&lt;/sub&gt;</td>
<td>Rgon=16 Ω</td>
<td>1,75, 2,05</td>
<td>ns</td>
</tr>
<tr>
<td>Reverse recovered charge</td>
<td>Q&lt;sub&gt;rec&lt;/sub&gt;</td>
<td>Rgoff=16 Ω</td>
<td>1,75, 2,05</td>
<td>μC</td>
</tr>
<tr>
<td>Peak rate of fall of recovery current</td>
<td>d&lt;sub&gt;rec&lt;/sub&gt;</td>
<td>Rgon=16 Ω</td>
<td>1,75, 2,05</td>
<td>A/μs</td>
</tr>
<tr>
<td>Reverse recovered energy</td>
<td>E&lt;sub&gt;rec&lt;/sub&gt;</td>
<td>Rgoff=16 Ω</td>
<td>1,75, 2,05</td>
<td>mWs</td>
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<tr>
<td>Thermal resistance chip to heatsink per chip</td>
<td>R&lt;sub&gt;thJH&lt;/sub&gt;</td>
<td>Thermal grease thickness=500μm</td>
<td>2,15</td>
<td>K/W</td>
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## Characteristic Values

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<tr>
<td>Boost IGBT</td>
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<td></td>
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<tr>
<td>Gate emitter threshold voltage</td>
<td>V_{GE(th)}</td>
<td>V_{GE}=V_{GE}</td>
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<tr>
<td>Collector-emitter saturation voltage</td>
<td>V_{C(sat)}</td>
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<td>15</td>
<td>V</td>
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<tr>
<td>Collector-emitter cut-off incl diode</td>
<td>I_{GES}</td>
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<td>30</td>
<td>µA</td>
</tr>
<tr>
<td>Gate-emitter leakage current</td>
<td>I_{GES}</td>
<td>20</td>
<td>1</td>
<td>nA</td>
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<tr>
<td>Integrated Gate resistor</td>
<td>R_{goff}</td>
<td>none</td>
<td>1</td>
<td>Ω</td>
</tr>
<tr>
<td>Turn-on delay time</td>
<td>t_{on}</td>
<td>±15</td>
<td>350</td>
<td>ns</td>
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<tr>
<td>Rise time</td>
<td>t_{r}</td>
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<td>1</td>
<td>15</td>
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<tr>
<td>Fall time</td>
<td>t_{f}</td>
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<td>18</td>
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<td>Turn-off delay time</td>
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<td>Turn-on energy loss per pulse</td>
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<td>mWs</td>
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<tr>
<td>Turn-off energy loss per pulse</td>
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<td>Input capacitance</td>
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<td>1630</td>
<td>pF</td>
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<td>Output capacitance</td>
<td>C_{oss}</td>
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<td>108</td>
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<td>Reverse transfer capacitance</td>
<td>C_{rss}</td>
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<td>Gate charge</td>
<td>Q_{gmax}</td>
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<td>167</td>
<td>nC</td>
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<tr>
<td>Thermal resistance chip to heatsink per chip</td>
<td>R_{thJH}</td>
<td>Thermal grease thickness50um $\kappa = 1 \text{ W/mK}$</td>
<td>1,69</td>
<td>KW</td>
</tr>
</tbody>
</table>

## Buck and Boost Inverse FWD

| Diode forward voltage                          | V_{F} | 20                              | 15     | V    |
| Thermal resistance chip to heatsink per chip   | R_{thJH}| Thermal grease thickness50um $\kappa = 1 \text{ W/mK}$ | 2,15   | KW   |

## Thermistor

| Rated resistance                               | R      | T=25°C                           | 22000  | Ω    |
| Deviation of R100                              | ΔR/R  | R100=1486 Ω                       | 5      | %    |
| Power dissipation                              | P      | T=25°C                           | 200    | mW   |
| Power dissipation constant                     | P      | T=25°C                           | 2      | mW/K |
| B-value                                        | B_{(25)} | Tol. ±3%                          | 3950   | K    |
| B-value                                        | B_{(25)} | Tol. ±3%                          | 3966   | K    |
| Vincotech NTC Reference                        |        | T=25°C                           | B      |      |
Buck

**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

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

**Figure 4**

Typical diode forward current as a function of forward voltage

\[ I_F = f(V_F) \]

At

- \( t_p = 250 \ \mu s \)
- \( T_j = 25 \ ^\circ C \)
- \( T_j = T_{j\max} - 25 \ ^\circ C \)
- \( V_{CE} = 10 \ V \)
Figure 5  
**IGBT**  
Typical switching energy losses as a function of collector current  
$E = f(I_C)$

![Figure 5](image)

With an inductive load at  
$T_j = 25/125 \, ^\circ C$  
$V_{CE} = 350 \, V$  
$V_{GE} = \pm 15 \, V$  
$R_{gon} = 16 \, \Omega$  
$R_{goff} = 16 \, \Omega$

Figure 6  
**IGBT**  
Typical switching energy losses as a function of gate resistor  
$E = f(R_G)$

![Figure 6](image)

With an inductive load at  
$T_j = 25/125 \, ^\circ C$  
$V_{CE} = 350 \, V$  
$V_{GE} = \pm 15 \, V$  
$I_C = 31 \, A$

Figure 7  
**FWD**  
Typical reverse recovery energy loss as a function of collector current  
$E_{rec} = f(I_C)$

![Figure 7](image)

With an inductive load at  
$T_j = 25/125 \, ^\circ C$  
$V_{CE} = 350 \, V$  
$V_{GE} = \pm 15 \, V$  
$R_{gon} = 16 \, \Omega$

Figure 8  
**FWD**  
Typical reverse recovery energy loss as a function of gate resistor  
$E_{rec} = f(R_G)$

![Figure 8](image)

With an inductive load at  
$T_j = 25/125 \, ^\circ C$  
$V_{CE} = 350 \, V$  
$V_{GE} = \pm 15 \, V$  
$I_C = 31 \, A$
Buck

**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
- \( R_{gon} = 16 \) Ω
- \( R_{goff} = 16 \) Ω

**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
- \( I_C = 31 \) 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
- \( R_{gon} = 16 \) Ω

**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
- \( I_F = 31 \) A
- \( V_{GE} = \pm 15 \) V
**Buck**

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

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

At  
\[ T_J = 25/125 \, ^\circ C \]
\[ V_{CE} = 350 \, V \]
\[ V_{GE} = \pm 15 \, V \]
\[ R_{gon} = 16 \, \Omega \]

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

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

At  
\[ T_J = 25/125 \, ^\circ C \]
\[ V_{CE} = 350 \, V \]
\[ V_{GE} = \pm 15 \, V \]
\[ I_F = 31 \, A \]
\[ V_{GE} = \pm 15 \, V \]
Figure 17
Typical rate of fall of forward and reverse recovery current as a function of collector current
\( \frac{dI}{dt}, \frac{dI_{rec}}{dt} = f(I_c) \)

At
- \( T_j = 25/125 \, ^\circ C \)
- \( V_{CE} = 350 \, V \)
- \( V_{GE} = \pm 15 \, V \)
- \( I_F = 31 \, A \)
- \( R_{gon} = 16 \, \Omega \)

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

At
- \( T_j = 25/125 \, ^\circ C \)
- \( V_{CE} = 350 \, V \)
- \( I_F = 31 \, A \)
- \( V_{GE} = \pm 15 \, V \)

Figure 19
IGBT transient thermal impedance as a function of pulse width
\( Z_{th,JH} = f(t_p) \)

At
- \( D = \frac{t_p}{T} \)
- \( R_{th,SH} = 1.69 \, KW \)

IGBT thermal model values

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Figure 20
FWD transient thermal impedance as a function of pulse width
\( Z_{th,JH} = f(t_p) \)

At
- \( D = \frac{t_p}{T} \)
- \( R_{th,SH} = 2.15 \, KW \)

FWD thermal model values

<table>
<thead>
<tr>
<th>R (C/W)</th>
<th>Tau (s)</th>
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Buck

**Figure 21**  
Power dissipation as a function of heatsink temperature  
\[ P_{\text{tot}} = f(T_h) \]

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

**Figure 22**  
Collector current as a function of heatsink temperature  
\[ I_C = f(T_h) \]

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

**Figure 23**  
Power dissipation as a function of heatsink temperature  
\[ P_{\text{tot}} = f(T_h) \]

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

**Figure 24**  
Forward current as a function of heatsink temperature  
\[ I_F = f(T_h) \]

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

\[ V_{GE} = 15 \, \text{V} \]
**Buck & Boost**

**Figure 25**  
Turn on safe operating area as a function of collector-emitter voltage  
\[ I_C = f(V_{CE}) \]

At  
\[ T_J = T_{J \text{max}} \degree C \]

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

At  
\[ I_C = 31 \text{ A} \]

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**Typical output characteristics**

- $I_C = f(V_{CE})$

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

**Boost**

**Typical transfer characteristics**

- $I_C = f(V_{CE})$

**At**
- $t_p = 250 \ \mu s$
- $T_j = 125 \ \degree C$
- $V_{CE}$ from 7 V to 17 V in steps of 1 V
**Figure 4**

Typical switching energy losses as a function of collector current

\[ E = f(I_C) \]

With an inductive load at

- \( T_j = 25/125 \, ^\circ C \)
- \( V_{CE} = 350 \, V \)
- \( V_{GE} = \pm 15 \, V \)
- \( R_{gon} = 16 \, \Omega \)
- \( R_{goff} = 16 \, \Omega \)

**Figure 5**

Typical switching energy losses as a function of gate resistor

\[ E = f(R_G) \]

With an inductive load at

- \( T_j = 25/125 \, ^\circ C \)
- \( V_{CE} = 350 \, V \)
- \( V_{GE} = \pm 15 \, V \)
- \( I_e = 29 \, A \)

**Figure 6**

Typical reverse recovery energy loss as a function of collector current

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

With an inductive load at

- \( T_j = 25/125 \, ^\circ C \)
- \( V_{CE} = 350 \, V \)
- \( V_{GE} = \pm 15 \, V \)
- \( R_{gon} = 16 \, \Omega \)

**Figure 7**

Typical reverse recovery energy loss as a function of gate resistor

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

With an inductive load at

- \( T_j = 25/125 \, ^\circ C \)
- \( V_{CE} = 350 \, V \)
- \( V_{GE} = \pm 15 \, V \)
- \( I_e = 29 \, A \)
Typical switching times as a function of collector current

\[ t = f(I_C) \]

With an inductive load at

- \( T_j = 125 \, ^\circ C \)
- \( V_{CE} = 350 \, V \)
- \( V_{GE} = \pm 15 \, V \)
- \( R_{gon} = 16 \, \Omega \)
- \( V_{GE} = \pm 15 \, V \)
- \( I_C = 29 \, A \)

Typical reverse recovery time as a function of collector current

\[ t_r = f(I_C) \]

At

- \( T_j = 25/125 \, ^\circ C \)
- \( V_{CE} = 350 \, V \)
- \( V_{GE} = \pm 15 \, V \)
- \( R_{gon} = 16 \, \Omega \)
Typical reverse recovery charge as a function of collector current

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

At

- $T_J = 25/125 \, ^\circ C$
- $V_{CE} = 350 \, V$
- $V_{GE} = \pm 15 \, V$
- $R_{gon} = 16 \, \Omega$

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

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

At

- $T_J = 25/125 \, ^\circ C$
- $V_{BE} = 350 \, V$
- $I_F = 29 \, A$
- $V_{GE} = \pm 15 \, V$

Typical reverse recovery current as a function of collector current

$$I_{CRM} = f(I_C)$$

At

- $T_J = 25/125 \, ^\circ C$
- $V_{CE} = 350 \, V$
- $V_{GE} = \pm 15 \, V$
- $R_{gon} = 16 \, \Omega$

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

$$I_{CRM} = f(R_{gon})$$

At

- $T_J = 25/125 \, ^\circ C$
- $V_{BE} = 350 \, V$
- $I_F = 29 \, A$
- $V_{GE} = \pm 15 \, V$
**Boost**

**Figure 16**  
Typical rate of fall of forward and reverse recovery current as a function of collector current  
\[ \frac{dI_0}{dt}, \frac{dI_{rec}}{dt} = f(I_c) \]

At  
- \( T_j = 25/125 \) °C  
- \( V_{CE} = 350 \) V  
- \( V_{GE} = \pm 15 \) V  
- \( I_F = 29 \) A  
- \( R_{gon} = 16 \) Ω

**Figure 17**  
Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor  
\[ \frac{dI_0}{dt}, \frac{dI_{rec}}{dt} = f(R_{gon}) \]

At  
- \( T_j = 25/125 \) °C  
- \( V_{CE} = 350 \) V  
- \( I_F = 29 \) A  
- \( V_{GE} = \pm 15 \) V

**Figure 18**  
IGBT transient thermal impedance as a function of pulse width  
\[ Z_{thJH} = f(t_p) \]

At  
- \( D = \frac{t_p}{T} \)  
- \( R_{th,JH} = 1.69 \) K/W

R (C/W)  
- 0.05: 7.4E+00  
- 0.23: 1.0E+00  
- 0.62: 1.5E-01  
- 0.50: 2.6E-02  
- 0.18: 4.3E-03  
- 0.11: 3.2E-04
Boost

**Figure 19**
Power dissipation as a function of heatsink temperature

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

At
\[ T_j = 175 \degree C \]

**Figure 20**
Collector current as a function of heatsink temperature

\[ I_C = f(T_{\text{h}}) \]

At
\[ T_j = 175 \degree C \]
\[ V_{GE} = 15 \text{ V} \]
Buck and Boost Inverse Diode

**Figure 1** Buck and Boost Inverse Diode

Typical diode forward current as a function of forward voltage

\[ I_F = f(V_F) \]

\[ V_F = T_{pul-25°C} \]

\[ T_J = 25°C \]

At

\[ t_p = 350 \ \mu s \]

**Figure 2** Buck and Boost Inverse Diode

Diode transient thermal impedance as a function of pulse width

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

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

\[ R_{thJH} = 2.15 \ \text{K/W} \]

**Figure 3** Buck and Boost Inverse Diode

Power dissipation as a function of heatsink temperature

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

At

\[ T_J = 175°C \]

**Figure 4** Buck and Boost Inverse Diode

Forward current as a function of heatsink temperature

\[ I_F = f(T_h) \]

At

\[ T_J = 175°C \]
Thermistor

Figure 1
Typical NTC characteristic as a function of temperature

\[ R_T = f(T) \]

Figure 2
Typical NTC resistance values

\[ R(T) = R_{25} \cdot e^{\left( \frac{B_{25\Omega}}{T} - \frac{1}{T_{25}} \right)} \] [\Omega]

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<th>T (°C)</th>
<th>R (Ω)</th>
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Switching Definitions BUCK IGBT

General conditions

\[
\begin{align*}
T_J &= 125 \, ^\circ C \\
R_{on} &= 16 \, \Omega \\
R_{off} &= 16 \, \Omega 
\end{align*}
\]

Figure 1
Output inverter IGBT

Turn-off Switching Waveforms & definition of \( t_{\text{off}}, t_{\text{onoff}} \)
\( (t_{\text{off}} = \text{integrating time for } E_{\text{off}}) \)

- \( V_{GE} \) (%)
- \( V_C \) (%)
- IC (%)
- \( t_{\text{off}} \)
- \( t_{\text{onoff}} \)

\begin{align*}
V_{GE} (0\%) &= -15 \, V \\
V_{CE} (0\%) &= -15 \, V \\
V_{CE} (100\%) &= 15 \, V \\
V_{CE} (100\%) &= 15 \, V \\
I_C (100\%) &= 31 \, A \\
I_C (100\%) &= 31 \, A \\
t_{\text{off}} &= 0.17 \, \mu s \\
t_{\text{onoff}} &= 0.41 \, \mu s
\end{align*}

Figure 2
Output inverter IGBT

Turn-on Switching Waveforms & definition of \( t_{\text{on}}, t_{\text{eon}} \)
\( (t_{\text{on}} = \text{integrating time for } E_{\text{on}}) \)

- \( V_{GE} \) (%)
- \( V_C \) (%)
- IC (%)
- \( t_{\text{on}} \)
- \( t_{\text{eon}} \)

\begin{align*}
V_{GE} (0\%) &= -15 \, V \\
V_{GE} (100\%) &= 15 \, V \\
V_{CE} (100\%) &= 350 \, V \\
V_{CE} (100\%) &= 350 \, V \\
I_C (100\%) &= 31 \, A \\
I_C (100\%) &= 31 \, A \\
t_{\text{on}} &= 0.10 \, \mu s \\
t_{\text{eon}} &= 0.21 \, \mu s
\end{align*}

Figure 3
Output inverter IGBT

Turn-off Switching Waveforms & definition of \( t_f \)

- \( V_C \) (%)
- IC (%)
- \( t_f \)

\begin{align*}
V_C (100\%) &= 350 \, V \\
I_C (100\%) &= 31 \, A \\
t_f &= 0.11 \, \mu s
\end{align*}

Figure 4
Output inverter IGBT

Turn-on Switching Waveforms & definition of \( t_r \)

- \( V_C \) (%)
- IC (%)
- \( t_r \)

\begin{align*}
V_C (100\%) &= 350 \, V \\
I_C (100\%) &= 31 \, A \\
t_r &= 0.02 \, \mu s
\end{align*}
Switching Definitions BUCK IGBT

Figure 5  
Output inverter IGBT
Turn-off Switching Waveforms & definition of $t_{\text{Eoff}}$

Figure 6  
Output inverter IGBT
Turn-on Switching Waveforms & definition of $t_{\text{Eon}}$

Figure 7  
Output inverter FWD
Gate voltage vs Gate charge (measured)

Figure 8  
Output inverter IGBT
Turn-off Switching Waveforms & definition of $t_{\text{tr}}$

$P_{\text{off}}$(100%) = 10.70 kW  
$E_{\text{off}}$(100%) = 1.02 mJ  
$t_{\text{Eoff}}$ = 0.41 $\mu$s

$P_{\text{on}}$(100%) = 10.70 kW  
$E_{\text{on}}$(100%) = 0.62 mJ  
$t_{\text{Eon}}$ = 0.21 $\mu$s

$V_{\text{GEloff}}$ = -15 V  
$V_{\text{GEfon}}$ = 15 V  
$V_{\text{d}}$(100%) = 350 V  
$I_{\text{d}}$(100%) = 31 A  
$Q_{\text{g}}$ = 261.94 nC

$V_{\text{d}}$(100%) = 350 V  
$I_{\text{d}}$(100%) = 31 A  
$t_{\text{ir}}$ = 0.18 $\mu$s
Switching Definitions BUCK IGBT

Figure 9  Output inverter FWD
Turn-on Switching Waveforms & definition of $t_{Qr}$
($t_{Qr}$ = integrating time for $Q_r$)

$\text{Id (100\%) = 31 A}$

$\text{Q_r (100\%) = 2.29 \mu C}$

$\text{t_{Qr} = 0.87 \mu s}$

Figure 10  Output inverter FWD
Turn-on Switching Waveforms & definition of $t_{Erec}$
($t_{Erec} =$ integrating time for $E_{rec}$)

$\text{P_{rec (100\%) = 10.70 kW}}$

$\text{E_{rec (100\%) = 0.55 mJ}}$

$\text{t_{Erec} = 0.67 \mu s}$

Measurement circuits

Figure 11  BUCK stage switching measurement circuit

Figure 12  BOOST stage switching measurement circuit

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Ordering Code & Marking

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<th>Ordering Code</th>
<th>in DataMatrix as</th>
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Outline

Ordering Code and Marking - Outline - Pinout

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14  4.4  22.8
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Pinout

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### PRODUCT STATUS DEFINITIONS

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<td>This datasheet contains the design specifications for product development. Specifications may change in any manner without notice. The data contained is exclusively intended for technically trained staff.</td>
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<td>First Production</td>
<td>This datasheet contains preliminary data, and supplementary data may be published at a later date. Vincotech reserves the right to make changes at any time without notice in order to improve design. The data contained is exclusively intended for technically trained staff.</td>
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<tr>
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