### Features
- "PS: 45A parallel switch (40A PT and 99mΩ)
- neutral point clamped inverter
- reactive power capability
- low inductance layout

### Target Applications
- solar inverter
- UPS

### Types
- FZ06NPA045FP01

---

**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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<tr>
<td><strong>Buck IGBT</strong></td>
<td></td>
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<tr>
<td>Collector-emitter break down voltage</td>
<td>VCE</td>
<td>Tj=Tmax</td>
<td>600</td>
<td>V</td>
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<tr>
<td>DC collector current</td>
<td>IC</td>
<td>Tj=Tmax</td>
<td>31</td>
<td>A</td>
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<tr>
<td>Repetitive peak collector current</td>
<td>ICpulse</td>
<td>Tj=Tmax</td>
<td>82</td>
<td>W</td>
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<tr>
<td>Power dissipation per IGBT</td>
<td>Ptot</td>
<td>Tj=Tmax</td>
<td>54</td>
<td>W</td>
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<tr>
<td>Gate-emitter peak voltage</td>
<td>VGE</td>
<td>Tj=Tmax</td>
<td>±20</td>
<td>V</td>
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<tr>
<td>Short circuit ratings</td>
<td>tSC</td>
<td>Tj=150°C</td>
<td>3</td>
<td>μs</td>
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<td>Maximum Junction Temperature</td>
<td>Tjmax</td>
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<td>150</td>
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**Buck Diode**

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<th>Symbol</th>
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<tr>
<td>Peak Repetitive Reverse Voltage</td>
<td>Vmax</td>
<td>Tj=25°C</td>
<td>600</td>
<td>V</td>
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<tr>
<td>DC forward current</td>
<td>IF</td>
<td>Tj=Tmax</td>
<td>21</td>
<td>A</td>
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<td>Repetitive peak forward current</td>
<td>IFRM</td>
<td>Tj=Tmax</td>
<td>120</td>
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<td>Power dissipation per Diode</td>
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<td>Tj=Tmax</td>
<td>41</td>
<td>W</td>
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<td>Maximum Junction Temperature</td>
<td>Tjmax</td>
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<td>150</td>
<td>°C</td>
</tr>
</tbody>
</table>
## Maximum Ratings

**Parameter** | **Symbol** | **Condition** | **Value** | **Unit**
---|---|---|---|---
### Buck MOSFET

| Drain to source breakdown voltage | V_{DS} | | 600 | V |
| DC drain current | I_D | T_{j}=T_{max} | 600 | V |
| | | T_{c}=80°C | 16 | A |
| | | T_{c}=80°C | 21 | A |
| Pulsed drain current | I_{PD} | I_{D} limited by T_{j,max} | 93 | V |
| Power dissipation | P_{TOT} | T_{j}=T_{max} | 54 | W |
| | | T_{c}=80°C | 97 | W |
| Gate-source peak voltage | V_{GS} | | ±20 | V |
| Maximum Junction Temperature | T_{j,max} | | 150 | °C |

### Boost IGBT

| Collector-emitter break down voltage | V_{CE} | | 600 | V |
| DC collector current | I_C | T_{j}=T_{max} | 50 | A |
| | | T_{c}=80°C | 50 | A |
| Repetitive peak collector current | I_{CMP} | I_{C} limited by T_{j,max} | 225 | A |
| Power dissipation per IGBT | P_{TOT} | T_{j}=T_{max} | 85 | W |
| | | T_{c}=80°C | 129 | W |
| Gate-emitter peak voltage | V_{GE} | | ±20 | V |
| Short circuit ratings | t_{SC} | T_{j}≤150°C | 6 | μs |
| | | V_{CC}=15V | 360 | V |
| Maximum Junction Temperature | T_{j,max} | | 175 | °C |

### Boost Inverse Diode

| Peak Repetitive Reverse Voltage | V_{RMM} | T_{j}=25°C | 600 | V |
| DC forward current | I_F | T_{j}=T_{max} | 2 | A |
| | | T_{c}=80°C | 2 | A |
| Power dissipation per Diode | P_{TOT} | T_{j}=T_{max} | 21 | W |
| Maximum Junction Temperature | T_{j,max} | | 150 | °C |

### Boost Diode

| Peak Repetitive Reverse Voltage | V_{RMM} | T_{j}=25°C | 1200 | V |
| DC forward current | I_F | T_{j}=T_{max} | 15 | A |
| | | T_{c}=80°C | 21 | A |
| Repetitive peak forward current | I_{RMM} | I_{F} limited by T_{j,max} | 36 | A |
| Power dissipation per Diode | P_{TOT} | T_{j}=T_{max} | 30 | W |
| | | T_{c}=80°C | 46 | W |
| Maximum Junction Temperature | T_{j,max} | | 150 | °C |
### Maximum Ratings

Tj=25°C, unless otherwise specified

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<th>Symbol</th>
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<td>Storage temperature</td>
<td>$T_{slq}$</td>
<td></td>
<td>-40...+125</td>
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<tr>
<td>Operation temperature under switching condition</td>
<td>$T_{op}$</td>
<td></td>
<td>-40...+(Tjmax - 25)</td>
<td>°C</td>
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<tr>
<td><strong>Insulation Properties</strong></td>
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<td>Insulation voltage</td>
<td>$V_{in}$</td>
<td>t=2s</td>
<td>DC voltage</td>
<td>4000</td>
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<td>Creepage distance</td>
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<td>Clearance</td>
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<td>min 12.7</td>
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## Characteristic Values

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<td><strong>Buck IGBT</strong> *</td>
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<tr>
<td>Gate emitter threshold voltage</td>
<td>V_{GE(th)}</td>
<td>[V]</td>
<td>0.00025</td>
<td>Tj=25°C</td>
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<tr>
<td>Collector-emitter saturation voltage</td>
<td>V_{CE(sat)}</td>
<td>[V]</td>
<td>16</td>
<td>0.00025</td>
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<td>Collector-emitter cut-off current incl. Diode</td>
<td>I_{CES}</td>
<td>[mA]</td>
<td>0</td>
<td>0.00025</td>
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<tr>
<td>Gate-emitter leakage current</td>
<td>I_{GCE}</td>
<td>[mA]</td>
<td>0.020</td>
<td>0.00025</td>
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<tr>
<td>Integrated Gate resistor</td>
<td>R_{Gres}</td>
<td>[Ω]</td>
<td>none</td>
<td>0.00025</td>
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<tr>
<td>Input capacitance</td>
<td>C_{in}</td>
<td>[pF]</td>
<td>2.2</td>
<td>2.2+4.7</td>
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<tr>
<td>Output capacitance</td>
<td>C_{out}</td>
<td>[pF]</td>
<td>25</td>
<td>2.2+4.7</td>
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<tr>
<td>Reverse transfer capacitance</td>
<td>C_{Rmax}</td>
<td>[pF]</td>
<td>80</td>
<td>2.2+4.7</td>
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<td>Gate charge</td>
<td>Q_{Gmax}</td>
<td>[nC]</td>
<td>150</td>
<td>2.2+4.7</td>
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<td>Thermal resistance chip to heatsink per chip</td>
<td>R_{thJH}</td>
<td>[K/W]</td>
<td>1.30</td>
<td>2.2+4.7</td>
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* see dynamic characteristic at Buck MOSFET

**additional value stands for built-in capacitor

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<td><strong>Buck Diode</strong></td>
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<td>Diode forward voltage</td>
<td>V_{f}</td>
<td>[V]</td>
<td>30</td>
<td>Tj=25°C</td>
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<tr>
<td>Peak reverse recovery current</td>
<td>I_{Rmax}</td>
<td>[μA]</td>
<td>±15</td>
<td>0.00025</td>
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<tr>
<td>Reverse recovery time</td>
<td>t_{rr}</td>
<td>[ns]</td>
<td>350</td>
<td>0.00025</td>
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<tr>
<td>Reverse recovered charge</td>
<td>Q_{rr}</td>
<td>[nC]</td>
<td>1.15</td>
<td>0.00025</td>
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<td>Peak rate of fall of recovery current</td>
<td>dI_{rr}/dt</td>
<td>[A/μs]</td>
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<td>Reverse recovered energy</td>
<td>E_{rec}</td>
<td>[mWs]</td>
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<td>Thermal resistance chip to heatsink per chip</td>
<td>R_{thJH}</td>
<td>[K/W]</td>
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<th>Value</th>
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<td><strong>Buck MOSFET</strong></td>
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<td></td>
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<td>Static drain to source ON resistance</td>
<td>R_{on}</td>
<td>[Ω]</td>
<td>15</td>
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<tr>
<td>Gate threshold voltage</td>
<td>V_{GS(th)}</td>
<td>[V]</td>
<td>0.003</td>
<td>Tj=25°C</td>
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<td>Gate to Source Leakage Current</td>
<td>I_{gs}</td>
<td>[μA]</td>
<td>20</td>
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<tr>
<td>Zero Gate Voltage Drain Current</td>
<td>I_{g0}</td>
<td>[μA]</td>
<td>800</td>
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<tr>
<td>Turn On Delay Time</td>
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<td>[ns]</td>
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<td>0.00025</td>
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<tr>
<td>Rise time</td>
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<td>[ns]</td>
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<td>0.00025</td>
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<tr>
<td>Turn off delay time</td>
<td>t_{off}</td>
<td>[ns]</td>
<td>±15</td>
<td>0.00025</td>
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<tr>
<td>Fall time</td>
<td>t_{f}</td>
<td>[ns]</td>
<td>150</td>
<td>0.00025</td>
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<tr>
<td>Turn-on energy loss per pulse</td>
<td>E_{on}</td>
<td>[mWs]</td>
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<td>Turn-off energy loss per pulse</td>
<td>E_{off}</td>
<td>[mWs]</td>
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<td>Total gate charge</td>
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<td>[nC]</td>
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<td>Output capacitance</td>
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<td>Thermal resistance chip to heatsink per chip</td>
<td>R_{thJH}</td>
<td>[K/W]</td>
<td>1.29</td>
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</table>

* see schematic of the Gate-complex at characteristic figures

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*Copyright by Vincotech*
**Characteristic Values**

<table>
<thead>
<tr>
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<th>Symbol</th>
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<th>Unit</th>
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<td>$V_{CEsat}$ or $V_{CE}$</td>
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<td>Collector-emitter saturation voltage</td>
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<td>Tj=25°C, Tj=125°C</td>
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<td>Collector-emitter cut-off incl diode</td>
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<td>Turn-on delay time</td>
<td>$t_{DS(on)}$</td>
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<td>Rise time</td>
<td>$t_{r}$</td>
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<tr>
<td>Turn-off delay time</td>
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<td>$R_{g(off)}=8\ \Omega$</td>
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<td>Turn-on energy loss per pulse</td>
<td>$E_{on}$</td>
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<tr>
<td>Turn-off energy loss per pulse</td>
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<td>Output capacitance</td>
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<td>Gate charge</td>
<td>$Q_{Gate}$</td>
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<td>Thermal resistance chip to heatsink per chip</td>
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<td>Boost Inverse Diode</td>
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<td>Diode forward voltage</td>
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<td>Thermal resistance chip to heatsink per chip</td>
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<td>Thermal grease thickness=50μm</td>
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<td>Boost Diode</td>
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<td>Diode forward voltage</td>
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<td>Reverse leakage current</td>
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<td>Peak reverse recovery current</td>
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<td>Reverse recovery time</td>
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<td>$R_{g(on)}=8\ \Omega$</td>
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<td>Reverse recovery energy</td>
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<tr>
<td>Thermal resistance chip to heatsink per chip</td>
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<td>Thermal grease thickness=50μm</td>
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<td>Tol. ±5%</td>
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<td>Tol. ±3%</td>
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* see details on Thermistor charts on Figure 2.
Buck

Figure 1
Typical output characteristics
$IC = f(V_{CE})$

At $t_p = 250 \mu s$
$T_j = 25 \degree C$
$V_{CE}$ from 3 V to 19 V in steps of 2 V

Figure 2
Typical output characteristics
$IC = f(V_{CE})$

At $t_p = 250 \mu s$
$T_j = 125 \degree C$
$V_{CE}$ from 3 V to 19 V in steps of 2 V

Figure 3
Typical transfer characteristics
$IC = f(V_{GE})$

At $t_p = 250 \mu s$
$V_{CE} = 10 V$

Figure 4
Typical diode forward current as a function of forward voltage
$IF = f(V_F)$

At $t_p = 250 \mu s$
Typical switching energy losses as a function of collector current
\[ E = f(I_C) \]

With an inductive load at
\[ T_j = 25/125 \degree C \]
\[ V_{CE} = 350 \text{ V} \]
\[ V_{CC} = \pm 15 \text{ V} \]
\[ R_{gon} = 8 \Omega \]
\[ R_{goff} = 8 \Omega \]

Typical reverse recovery energy loss as a function of collector current
\[ E_{rec} = f(I_C) \]

With an inductive load at
\[ T_j = 25/125 \degree C \]
\[ V_{CE} = 350 \text{ V} \]
\[ V_{CC} = \pm 15 \text{ V} \]
\[ I_C = 30 \text{ A} \]
**Figure 9**

Typical switching times as a function of collector current

\[ t = f(I_C) \]

With an inductive load at

- \( T_j = 125 \, ^{\circ}C \)
- \( V_{CE} = 350 \, V \)
- \( V_{GE} = \pm 15 \, V \)
- \( R_{gon} = 8 \, \Omega \)
- \( R_{goff} = 8 \, \Omega \)

**Figure 10**

Typical switching times as a function of gate resistor

\[ t = f(R_g) \]

With an inductive load at

- \( T_j = 125 \, ^{\circ}C \)
- \( V_{CE} = 350 \, V \)
- \( V_{GE} = \pm 15 \, V \)
- \( I_C = 30 \, A \)

**Figure 11**

Typical reverse recovery time as a function of collector current

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

At

- \( T_j = 25/125 \, ^{\circ}C \)
- \( V_{CE} = 350 \, V \)
- \( V_{GE} = \pm 15 \, V \)
- \( R_{gon} = 8 \, \Omega \)

**Figure 12**

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

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

At

- \( T_j = 25/125 \, ^{\circ}C \)
- \( V_{CE} = 350 \, V \)
- \( V_{GE} = \pm 15 \, V \)
- \( I_C = 30 \, A \)
Typical reverse recovery charge as a function of collector current

\[ Q_{rr} = f(I_{CC}) \]

At

\[ T_j = 25/125 \, ^\circ C \]
\[ V_{CE} = 350 \, V \]
\[ V_{GE} = \pm 15 \, V \]
\[ R_{gon} = 8 \, \Omega \]

Typical reverse recovery current as a function of collector current

\[ I_{RRM} = f(I_{CC}) \]

At

\[ T_j = 25/125 \, ^\circ C \]
\[ V_{CE} = 350 \, V \]
\[ V_{GE} = \pm 15 \, V \]
\[ R_{gon} = 8 \, \Omega \]
**Figure 17**

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

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

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

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

\[ I_F = 30 \ A \]

\[ R_{gon} = 8 \ \Omega \]

**Figure 18**

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

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

\[ V_R = 350 \ V \]

\[ I_F = 30 \ A \]

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

**Figure 19**

IGBT transient thermal impedance as a function of pulse width

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

At

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

\[ R_{(CW)} = 1.30 \ KW \]

IGBT thermal model values

- \[ R (\text{C/W}) \]
- \[ \text{Ta}u (s) \]
- \[ 0.11 \ \text{9.8E+00} \]
- \[ 0.22 \ \text{6.3E-01} \]
- \[ 0.63 \ \text{1.2E-01} \]
- \[ 0.24 \ \text{1.8E-02} \]
- \[ 0.10 \ \text{1.3E-03} \]

**Figure 20**

FRED transient thermal impedance as a function of pulse width

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

At

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

\[ R_{(CW)} = 1.72 \ KW \]

FRED thermal model values

- \[ R (\text{C/W}) \]
- \[ \text{Ta}u (s) \]
- \[ 0.04 \ \text{7.9E+00} \]
- \[ 0.21 \ \text{8.8E-01} \]
- \[ 0.82 \ \text{1.3E-01} \]
- \[ 0.39 \ \text{3.0E-02} \]
- \[ 0.17 \ \text{4.1E-03} \]
- \[ 0.09 \ \text{6.3E-04} \]
Figure 21
Power dissipation as a function of heatsink temperature
\[ P_{tot} = f(T_h) \]
\[ I_C = f(T_h) \]

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

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

At
\[ T_j = 150 \, ^\circ C \]
\[ V_{GE} = 15 \, V \]

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

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

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

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

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

At
D = single pulse
\[ T_h = 80 \, ^\circ C \]
\[ V_{CE} = \pm 15 \, V \]
\[ T_j = T_{j_{max}} \, ^\circ C \]

Figure 26  IGBT
Gate voltage vs Gate charge

Figure 27  MOSFET
MOSFET transient thermal impedance as a function of pulse width
\[ Z_{thJH} = f(t_p) \]

At
D = \[ \frac{I_C}{T} \]
\[ R_{thJH} = 1.29 \, KW \]

MOSFET thermal model values
\[ R \text{ (C/W)} \]
\[ \text{Tau (s)} \]
0.09 9.2E+00
0.27 1.3E+00
0.53 2.1E-01
0.27 4.0E-02
0.08 4.8E-03
0.05 4.7E-04

Figure 28  MOSFET
Gate voltage vs Gate charge

At
\[ I_{g\text{REF}} = 1mA, \, R_L = 15\Omega \]
Figure 1
Typical output characteristics
$IC = f(V_{CE})$

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

Figure 2
Typical output characteristics
$IC = f(V_{CE})$

At
$\tau_p = 250 \ \mu s$
$T_j = 125 \ ^\circ \text{C}$
$V_{CE}$ from 6 V to 16 V in steps of 1 V

Figure 3
Typical transfer characteristics
$IC = f(V_{GE})$

At
$\tau_p = 250 \ \mu s$
$V_{CE} = 10 \ \text{V}$

Figure 4
Typical diode forward current as a function of forward voltage
$IF = f(V_F)$

At
$\tau_p = 250 \ \mu s$
Typical switching energy losses as a function of collector current

$$E = f(I_C)$$

With an inductive load at

- $T_j = 25/125 \degree C$
- $V_{CE} = 350 \text{ V}$
- $V_{GE} = 15 \text{ V}$
- $R_{gon} = 8 \Omega$
- $R_{goff} = 8 \Omega$

Typical reverse recovery energy loss as a function of collector current

$$E_{rec} = f(I_C)$$

With an inductive load at

- $T_j = 25/125 \degree C$
- $V_{CE} = 350 \text{ V}$
- $V_{GE} = 15 \text{ V}$
- $I_C = 30 \text{ A}$

Typical switching energy losses as a function of gate resistor

$$E = f(R_G)$$

With an inductive load at

- $T_j = 25/125 \degree C$
- $V_{CE} = 350 \text{ V}$
- $V_{GE} = 15 \text{ V}$
- $I_C = 30 \text{ A}$

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Figure 9  
**Typical switching times as a function of collector current**

$t = f(I_C)$

With an inductive load at:
- $T_J = 25/125 \, ^\circ C$
- $V_{CE} = 350 \, V$
- $V_{GE} = 15 \, V$
- $R_{gon} = 8 \, \Omega$
- $R_{goff} = 8 \, \Omega$

![Graph showing typical switching times as a function of collector current](image)

Figure 10  
**Typical switching times as a function of gate resistor**

$t = f(R_G)$

With an inductive load at:
- $T_J = 25/125 \, ^\circ C$
- $V_{CE} = 350 \, V$
- $V_{GE} = 15 \, V$
- $I_C = 30 \, A$
- $R_{gon} = 8 \, \Omega$

![Graph showing typical switching times as a function of gate resistor](image)

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

$trr = f(I_C)$

At:
- $T_J = 25/125 \, ^\circ C$
- $V_{CE} = 350 \, V$
- $V_{GE} = 15 \, V$
- $R_{gon} = 8 \, \Omega$

![Graph showing typical reverse recovery time as a function of collector current](image)

Figure 12  
**Typical reverse recovery time as a function of IGBT turn on gate resistor**

$trr = f(R_{gon})$

At:
- $T_J = 25/125 \, ^\circ C$
- $V_{CE} = 350 \, V$
- $V_{GE} = 15 \, V$
- $I_C = 30 \, A$
- $R_{gon} = 8 \, \Omega$

![Graph showing typical reverse recovery time as a function of IGBT turn on gate resistor](image)
### Figure 13
Typical reverse recovery charge as a function of collector current

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

**At**
- \( T_J = 25/125 \, \text{°C} \)
- \( V_{CE} = 350 \, \text{V} \)
- \( V_{GE} = 15 \, \text{V} \)
- \( R_{gon} = 8 \, \Omega \)

### Figure 14
Typical reverse recovery charge as a function of IGBT turn on gate resistor

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

**At**
- \( T_J = 25/125 \, \text{°C} \)
- \( V_R = 350 \, \text{V} \)
- \( I_F = 30 \, \text{A} \)
- \( V_{GE} = 15 \, \text{V} \)

### Figure 15
Typical reverse recovery current as a function of collector current

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

**At**
- \( T_J = 25/125 \, \text{°C} \)
- \( V_{CE} = 350 \, \text{V} \)
- \( V_{GE} = 15 \, \text{V} \)
- \( R_{gon} = 8 \, \Omega \)

### Figure 16
Typical reverse recovery current as a function of IGBT turn on gate resistor

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

**At**
- \( T_J = 25/125 \, \text{°C} \)
- \( V_R = 350 \, \text{V} \)
- \( I_F = 30 \, \text{A} \)
- \( V_{GE} = 15 \, \text{V} \)
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
- \( V_{GE} = 15 \) V
- \( I_F = 30 \) A
- \( R_{gon} = 8 \) Ω

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

At
- \( D = \frac{t_p}{T} \)
- \( R_{LCH} = 1.11 \) K/W

IGBT thermal model values
- \( R (C/W) \)
- \( \tau (s) \)

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

At
- \( D = \frac{t_p}{T} \)
- \( R_{LCH} = 2.32 \) K/W

FRED thermal model values
- \( R (C/W) \)
- \( \tau (s) \)
Figure 21: Power dissipation as a function of heatsink temperature

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

At

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

Figure 22: Collector current as a function of heatsink temperature

\[ I_C = f(T_h) \]

At

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

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

Figure 23: Power dissipation as a function of heatsink temperature

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

At

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

Figure 24: Forward current as a function of heatsink temperature

\[ I_F = f(T_h) \]

At

\[ T_j = 150 \, ^\circ C \]
**Figure 25**
Typical diode forward current as a function of forward voltage
\( I_F = f(V_F) \)

\[ T_j = 25°C \]
\[ T_j = T_j\text{max}-25°C \]

\( t_p = 250 \mu s \)

\( D = t_p / T \)

**Figure 26**
Diode transient thermal impedance as a function of pulse width
\( Z_{thJH} = f(t_p) \)

\[ D = 0.5 \]
\[ 0.2 \]
\[ 0.1 \]
\[ 0.05 \]
\[ 0.02 \]
\[ 0.01 \]
\[ 0.005 \]
\[ 0.000 \]

**Figure 27**
Power dissipation as a function of heatsink temperature
\( P_{tot} = f(T_{th}) \)

\[ T_j = 150°C \]

**Figure 28**
Forward current as a function of heatsink temperature
\( I_F = f(T_{th}) \)

\[ T_j = 150°C \]
**Figure 1**

Typical NTC characteristic as a function of temperature

\[ R_T = f(T) \]

**Figure 2**

Typical NTC resistance values

\[ R(T) = R_{25} \cdot e^{\left( \frac{R_{2510}}{T} \cdot \frac{T}{T_{25}} \right)} \] [\( \Omega \)]

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<th>T [°C]</th>
<th>R_{soil} [Ω]</th>
<th>R_{min} [Ω]</th>
<th>R_{max} [Ω]</th>
<th>( \Delta R/R ) [%]</th>
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## Switching Definitions BUCK MOSFET

### General conditions
- $T_J = 125 \, ^\circ\text{C}$
- $R_{th \text{ J to } C} = 8 \, \Omega$
- $R_{th \text{ J to } IG} = 8 \, \Omega$

### Figure 1
Output inverter IGBT
**Turn-off Switching Waveforms & definition of $t_{\text{Eoff}}, \ t_{\text{off}}$**

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

<table>
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<td>$V_{GE} (100%)$</td>
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<td>$V_C (100%)$</td>
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<tr>
<td>$I_C (100%)$</td>
<td>42 A</td>
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<tr>
<td>$t_{\text{off}}$</td>
<td>0.25 $\mu s$</td>
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<tr>
<td>$t_{\text{Eoff}}$</td>
<td>0.26 $\mu s$</td>
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### Figure 2
Output inverter IGBT
**Turn-on Switching Waveforms & definition of $t_{\text{Eon}}, \ t_{\text{on}}$**

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

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<td>$I_C (100%)$</td>
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<tr>
<td>$t_{\text{on}}$</td>
<td>0.10 $\mu s$</td>
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<tr>
<td>$t_{\text{Eon}}$</td>
<td>0.13 $\mu s$</td>
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### Figure 3
Output inverter IGBT
**Turn-off Switching Waveforms & definition of $t_f$**

$(t_f = \text{integrating time for } E_{\text{off}})$

<table>
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<td>$t_f$</td>
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### Figure 4
Output inverter IGBT
**Turn-on Switching Waveforms & definition of $t_r$**

$(t_r = \text{integrating time for } E_{\text{on}})$

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<tr>
<td>$V_C (100%)$</td>
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<td>$I_C (100%)$</td>
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<td>$t_r$</td>
<td>0.01 $\mu s$</td>
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Switching Definitions BUCK MOSFET

**Figure 5**
Output inverter IGBT

- Turn-off Switching Waveforms & definition of $t_{Eoff}$
- $P_{off} (100\%) = 14.63$ kW
- $E_{off} (100\%) = 0.24$ mJ
- $t_{Eoff} = 0.26 \mu s$

**Figure 6**
Output inverter IGBT

- Turn-on Switching Waveforms & definition of $t_{Eon}$
- $P_{on} (100\%) = 14.63$ kW
- $E_{on} (100\%) = 0.34$ mJ
- $t_{Eon} = 0.13 \mu s$

**Figure 7**
Output inverter IGBT

- Turn-off Switching Waveforms & definition of $t_{Qrr}$
- $V_d (100\%) = 350$ V
- $I_d (100\%) = 42$ A
- $I_{Qrr} (100\%) = -81$ A
- $t_{Qrr} = 0.02 \mu s$

**Figure 8**
Output inverter FRED

- Turn-on Switching Waveforms & definition of $t_{Qrr}$
- $I_d (100\%) = 42$ A
- $Q_{r} (100\%) = 1.10 \mu C$
- $t_{Qrr} = 0.04 \mu s$
Switching Definitions BUCK MOSFET

Figure 9
Output inverter FRED

Turn-on Switching Waveforms & definition of $t_{E_{rec}}$

$P_{rec} (100\%) = 14.63$ kW

$E_{rec} (100\%) = 0.18$ mJ

$t_{E_{rec}} = 0.04 \mu s$

Measurement circuits

Figure 11
BUCK stage switching measurement circuit

Figure 12
BOOST stage switching measurement circuit

Cg is included in the module
Ordering Code and Marking - Outline - Pinout

Ordering Code & Marking

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<td>First Production</td>
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