### Features
- "PS: 75A parallel switch (75A and 99mΩ MOSFET)
- Neutral point clamped inverter
- Reactive power capability
- Low inductance layout

### Target Applications
- Solar inverter
- UPS

### Types
- 10-FZ06NRA084FP03-P969F78
- 10-PZ06NRA084FP03-P969F78Y

### 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>
</thead>
<tbody>
<tr>
<td><strong>Boost Inv. Diode</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>( V_{RRM} )</td>
<td></td>
<td>600</td>
<td>V</td>
</tr>
<tr>
<td>Forward current per diode</td>
<td>( I_{FAV} )</td>
<td>DC current, ( T_{j}=80°C )</td>
<td>7</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( T_{j}=80°C )</td>
<td>11</td>
<td>A</td>
</tr>
<tr>
<td>Maximum repetitive forward current</td>
<td>( I_{FRM} )</td>
<td>( I_{f}=10\text{ms} )</td>
<td>20</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( T_{j}=25°C )</td>
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<td></td>
</tr>
<tr>
<td>I2t-value</td>
<td>( I_{I2T} )</td>
<td></td>
<td>9.5</td>
<td>A²s</td>
</tr>
<tr>
<td>Power dissipation per Diode</td>
<td>( P_{D} )</td>
<td>( T_{1}=T_{j}\text{max} )</td>
<td>44</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( T_{j}=80°C )</td>
<td>66</td>
<td></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>

**Buck IGBT**

<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>( V_{CE} )</td>
<td></td>
<td>600</td>
<td>V</td>
</tr>
<tr>
<td>DC collector current</td>
<td>( I_C )</td>
<td>( T_{j}=T_{j}\text{max} )</td>
<td>61</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( T_{j}=80°C )</td>
<td>80</td>
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</tr>
<tr>
<td>Pulsed collector current</td>
<td>( I_{pu} )</td>
<td>( I_{p}, \text{limited by} \ T_{j}\text{max} )</td>
<td>225</td>
<td>A</td>
</tr>
<tr>
<td>Turn off safe operating area</td>
<td></td>
<td></td>
<td>225</td>
<td>A</td>
</tr>
<tr>
<td>Power dissipation per IGBT</td>
<td>( P_{D} )</td>
<td>( T_{1}=T_{j}\text{max} )</td>
<td>108</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( T_{j}=80°C )</td>
<td>163</td>
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</tr>
<tr>
<td>Gate-emitter peak 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>
</tbody>
</table>
### Maximum Ratings

**Parameter** | **Symbol** | **Condition** | **Value** | **Unit**
--- | --- | --- | --- | ---
**Buck Diode**
Peak Repetitive Reverse Voltage | $V_{max}$ | $T_j=25^\circ C$ | 600 | V
DC forward current | $I_f$ | $T_j=T_{max}$ | 25 | A
$T_j=80^\circ C$ | 34 | A
Non-repetitive Peak Surge Current | $I_{FSM}$ | 60Hz Single Half-Sine Wave | 300 | A
Power dissipation per Diode | $P_{tot}$ | $T_j=T_{max}$ | 40 | W
$T_j=80^\circ C$ | 61 | W
Maximum Junction Temperature | $T_{j,max}$ | 150 | °C

**Buck MOSFET**
Drain to source breakdown voltage | $V_{DS}$ | | 600 | V
DC drain current | $I_D$ | $T_j=T_{max}$ | 17 | A
$T_j=80^\circ C$ | 21 | A
Pulsed drain current | $I_{pulser}$ | $I_p$ limited by $T_{j,max}$ | 112 | A
Power dissipation | $P_{tot}$ | $T_j=T_{max}$ | 60 | W
$T_j=80^\circ C$ | 91 | W
Gate-source peak voltage | $V_{gs}$ | | $\leq 20$ | V
Maximum Junction Temperature | $T_{j,max}$ | 150 | °C

**Boost IGBT**
Collector-emitter break down voltage | $V_{CE}$ | | 600 | V
DC collector current | $I_C$ | $T_j=T_{max}$ | 58 | A
$T_j=80^\circ C$ | 75 | A
Pulsed collector current | $I_{puls}$ | $I_p$ limited by $T_{j,max}$ | 225 | A
Turn off safe operating area | | | 225 | A
Power dissipation per IGBT | $P_{tot}$ | $T_j=T_{max}$ | 93 | W
$T_j=80^\circ C$ | 141 | W
Gate-emitter peak voltage | $V_{GE}$ | | $\leq 20$ | V
Short circuit ratings | $I_{SC}$ | $T_j=150^\circ C$ | 6 | μA
$V_{GE}=15 V$ | 360 | μA
Maximum Junction Temperature | $T_{j,max}$ | 175 | °C

**Boost Diode**
Peak Repetitive Reverse Voltage | $V_{max}$ | | 1200 | V
DC forward current | $I_f$ | $T_j=T_{max}$ | 22 | A
$T_j=80^\circ C$ | 29 | A
Repetitive peak forward current | $I_{FRM}$ | $I_p$ limited by $T_{j,max}$, 20 kHz Square Wave | 70 | A
Power dissipation per Diode | $P_{tot}$ | $T_j=T_{max}$ | 51 | W
$T_j=80^\circ C$ | 77 | W
Maximum Junction Temperature | $T_{j,max}$ | 175 | °C
## Maximum Ratings

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

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<tr>
<th>Parameter</th>
<th>Symbol</th>
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<th>Unit</th>
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<tbody>
<tr>
<td><strong>Thermal Properties</strong></td>
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<td></td>
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<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>
<td></td>
<td>-40…+(Tjmax - 25)</td>
<td>°C</td>
</tr>
<tr>
<td><strong>Insulation Properties</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Insulation voltage</td>
<td>$V_{in}$</td>
<td>t=2s DC voltage</td>
<td>4000</td>
<td>V</td>
</tr>
<tr>
<td>Creepage distance</td>
<td></td>
<td></td>
<td>min 12.7</td>
<td>mm</td>
</tr>
<tr>
<td>Clearance</td>
<td></td>
<td></td>
<td>min 12.7</td>
<td>mm</td>
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## Characteristic Values

### Buck Inv. Diode

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Forward voltage</td>
<td>$V_F$</td>
<td>Tj=25°C</td>
<td>9.44 V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tj=125°C</td>
<td>7.24 V</td>
</tr>
<tr>
<td>Threshold voltage (for power loss calc. only)</td>
<td>$V_{th}$</td>
<td>Tj=25°C</td>
<td>8.32 V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tj=125°C</td>
<td>6.62 V</td>
</tr>
<tr>
<td>Slope resistance (for power loss calc. only)</td>
<td>$r_s$</td>
<td>Tj=25°C</td>
<td>0.11 Ω</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tj=125°C</td>
<td>0.06 Ω</td>
</tr>
<tr>
<td>Reverse current</td>
<td>$I_L$</td>
<td>Tj=25°C</td>
<td>0.027 mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tj=125°C</td>
<td></td>
</tr>
<tr>
<td>Thermal resistance chip to heatsink per chip</td>
<td>$R_{thJH}$</td>
<td></td>
<td>2.17 K/W</td>
</tr>
<tr>
<td>Thermal resistance chip to case per chip</td>
<td>$R_{thJC}$</td>
<td></td>
<td>1.43 K/W</td>
</tr>
</tbody>
</table>

### Buck IGBT *

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gate emitter threshold voltage</td>
<td>$V_{GE(th)}$</td>
<td>VCE=VGE</td>
<td>3.5 V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tj=125°C</td>
<td>4.5 V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6 V</td>
</tr>
<tr>
<td>Collector-emitter saturation voltage</td>
<td>$V_{CE(sat)}$</td>
<td>0.00025</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tj=25°C</td>
<td>2.55 V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tj=125°C</td>
<td>1.87 V</td>
</tr>
<tr>
<td>Collector-emitter cut-off current incl. Diode</td>
<td>$I_ESS$</td>
<td>15</td>
<td>250 mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tj=25°C</td>
<td></td>
</tr>
<tr>
<td>Gate-emitter leakage current</td>
<td>$I_{GES}$</td>
<td>0.020</td>
<td>±400 nA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tj=25°C</td>
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</tr>
<tr>
<td>Integrated Gate resistor</td>
<td>$R_{ig}$</td>
<td></td>
<td>none</td>
</tr>
<tr>
<td>Input capacitance **</td>
<td>$C_i$</td>
<td>f=1MHz</td>
<td>4.47 nF</td>
</tr>
<tr>
<td>Output capacitance</td>
<td>$C_o$</td>
<td>0.025</td>
<td>400 pF</td>
</tr>
<tr>
<td>Reverse transfer capacitance</td>
<td>$C_{rss}$</td>
<td></td>
<td>115 pF</td>
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<tr>
<td>Gate charge**</td>
<td>$Q_{Gate}$</td>
<td>15</td>
<td>248±70 nC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tj=25°C</td>
<td></td>
</tr>
<tr>
<td>Thermal resistance chip to heatsink per chip</td>
<td>$R_{thJH}$</td>
<td>Thermal grease thickness: 50µm $\lambda = 1 \text{W/mK}$</td>
<td>0.88 K/W</td>
</tr>
</tbody>
</table>

### Buck Diode

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
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<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diode forward voltage</td>
<td>$V_F$</td>
<td>30</td>
<td>2.67 V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tj=125°C</td>
<td>2.7 V</td>
</tr>
<tr>
<td>Reverse leakage current</td>
<td>$I_L$</td>
<td>600</td>
<td>2.76 µA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tj=125°C</td>
<td></td>
</tr>
<tr>
<td>Peak reverse recovery current</td>
<td>$I_{RRM}$</td>
<td>$t=4 \Omega$</td>
<td>80 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tj=25°C</td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>$t_r$</td>
<td>350</td>
<td>90 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tj=25°C</td>
<td>22 ns</td>
</tr>
<tr>
<td>Reverse recovered charge</td>
<td>$Q_{rec}$</td>
<td>$t=4 \Omega$</td>
<td>0.59 µC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tj=25°C</td>
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</tr>
<tr>
<td>Peak rate of fall of recovery current</td>
<td>$dI/dt$</td>
<td>$t=4 \Omega$</td>
<td>14099 A/µs</td>
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<tr>
<td></td>
<td></td>
<td>Tj=25°C</td>
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</tr>
<tr>
<td>Reverse recovered energy</td>
<td>$E_{rec}$</td>
<td></td>
<td>0.13 mWs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tj=125°C</td>
<td></td>
</tr>
<tr>
<td>Thermal resistance chip to heatsink per chip</td>
<td>$R_{thJH}$</td>
<td>Thermal grease thickness: 50µm $\lambda = 1 \text{W/mK}$</td>
<td>1.73 K/W</td>
</tr>
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</table>
### Buck MOSFET

<table>
<thead>
<tr>
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<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static drain to source ON resistance</td>
<td>$R_{\text{g(on)}}$</td>
<td>10</td>
<td>16</td>
<td>mΩ</td>
</tr>
<tr>
<td>Gate threshold voltage</td>
<td>$V_{\text{GS(th)}}$</td>
<td>$0.0012$</td>
<td>$V_{\text{GS}}$</td>
<td>$V_{\text{GE}}$</td>
</tr>
<tr>
<td>Gate to Source Leakage Current</td>
<td>$I_{\text{DS}}$</td>
<td>20</td>
<td>8</td>
<td>mA</td>
</tr>
<tr>
<td>Zero Gate Voltage Drain Current</td>
<td>$I_{\text{DS}}$</td>
<td>0</td>
<td>600</td>
<td>μA</td>
</tr>
<tr>
<td>Turn On Delay Time</td>
<td>$t_{\text{ON}}$</td>
<td>15</td>
<td>350</td>
<td>40</td>
</tr>
<tr>
<td>Rise Time</td>
<td>$t_{\text{i}}$</td>
<td>30</td>
<td>125°C</td>
<td>1.05</td>
</tr>
<tr>
<td>Turn-off delay time</td>
<td>$t_{\text{OFF}}$</td>
<td>15</td>
<td>350</td>
<td>40</td>
</tr>
<tr>
<td>Fall time</td>
<td>$t_{\text{f}}$</td>
<td>30</td>
<td>125°C</td>
<td>1.05</td>
</tr>
<tr>
<td>Turn-on energy loss per pulse</td>
<td>$E_{\text{on}}$</td>
<td>5</td>
<td>100</td>
<td>2660</td>
</tr>
<tr>
<td>Turn-off energy loss per pulse</td>
<td>$E_{\text{off}}$</td>
<td>5</td>
<td>100</td>
<td>2660</td>
</tr>
<tr>
<td>Total gate charge</td>
<td>$Q_g$</td>
<td>40</td>
<td>18.1</td>
<td>14</td>
</tr>
<tr>
<td>Gate to source charge</td>
<td>$Q_{gs}$</td>
<td>10</td>
<td>480</td>
<td>1.16</td>
</tr>
<tr>
<td>Gate to drain charge</td>
<td>$Q_{gd}$</td>
<td>10</td>
<td>480</td>
<td>1.16</td>
</tr>
<tr>
<td>Input capacitance</td>
<td>$C_{iss}$</td>
<td>0</td>
<td>100</td>
<td>2660</td>
</tr>
<tr>
<td>Output capacitance</td>
<td>$C_{oss}$</td>
<td>0</td>
<td>100</td>
<td>2660</td>
</tr>
<tr>
<td>Thermal resistance chip to heatsink per chip</td>
<td>$R_{\text{JH}}$</td>
<td>$0.0012$</td>
<td>$V_{\text{JH}}$</td>
<td>$V_{\text{HE}}$</td>
</tr>
</tbody>
</table>

**see schematic of the Gate-complex at characteristic figures**

### Boost IGBT

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-emitter threshold voltage</td>
<td>$V_{\text{CE(th)}}$</td>
<td>$0.0012$</td>
<td>$V_{\text{CE}}$</td>
<td>$V_{\text{GS}}$</td>
</tr>
<tr>
<td>Collector-emitter saturation voltage</td>
<td>$V_{\text{CEO}}$</td>
<td>15</td>
<td>30</td>
<td>5</td>
</tr>
<tr>
<td>Collector-emitter cut-off incl diode</td>
<td>$I_{\text{CES}}$</td>
<td>0</td>
<td>600</td>
<td>0</td>
</tr>
<tr>
<td>Gate-emitter leakage current</td>
<td>$I_{\text{GSS}}$</td>
<td>20</td>
<td>600</td>
<td>0</td>
</tr>
<tr>
<td>Integrated Gate resistor</td>
<td>$R_{\text{gss}}$</td>
<td>10</td>
<td>18.1</td>
<td>14</td>
</tr>
<tr>
<td>Turn-on delay time</td>
<td>$t_{\text{ON}}$</td>
<td>15</td>
<td>350</td>
<td>50</td>
</tr>
<tr>
<td>Rise time</td>
<td>$t_{\text{i}}$</td>
<td>30</td>
<td>125°C</td>
<td>1.05</td>
</tr>
<tr>
<td>Turn-off delay time</td>
<td>$t_{\text{OFF}}$</td>
<td>15</td>
<td>350</td>
<td>50</td>
</tr>
<tr>
<td>Fall time</td>
<td>$t_{\text{f}}$</td>
<td>30</td>
<td>125°C</td>
<td>1.05</td>
</tr>
<tr>
<td>Turn-on energy loss per pulse</td>
<td>$E_{\text{on}}$</td>
<td>5</td>
<td>100</td>
<td>2660</td>
</tr>
<tr>
<td>Turn-off energy loss per pulse</td>
<td>$E_{\text{off}}$</td>
<td>5</td>
<td>100</td>
<td>2660</td>
</tr>
<tr>
<td>Input capacitance</td>
<td>$C_{iss}$</td>
<td>0</td>
<td>100</td>
<td>2660</td>
</tr>
<tr>
<td>Output capacitance</td>
<td>$C_{oss}$</td>
<td>0</td>
<td>100</td>
<td>2660</td>
</tr>
<tr>
<td>Reverse transfer capacitance</td>
<td>$C_{iss}$</td>
<td>0</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td>Gate charge</td>
<td>$Q_{\text{gss}}$</td>
<td>15</td>
<td>480</td>
<td>75</td>
</tr>
<tr>
<td>Thermal resistance chip to heatsink per chip</td>
<td>$R_{\text{JH}}$</td>
<td>$0.0012$</td>
<td>$V_{\text{JH}}$</td>
<td>$V_{\text{HE}}$</td>
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</table>

**see schematic of the Gate-complex at characteristic figures**
### Characteristic Values

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<tr>
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<tbody>
<tr>
<td>Boost Diode</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diode forward voltage</td>
<td>$V_F$</td>
<td>V</td>
<td>$T_j=25,^\circ\text{C}$</td>
<td>2.23</td>
</tr>
<tr>
<td>Reverse leakage current</td>
<td>$I_r$</td>
<td>µA</td>
<td>$T_j=25,^\circ\text{C}$</td>
<td>104</td>
</tr>
<tr>
<td>Peak reverse recovery current</td>
<td>$I_{\text{fmax}}$</td>
<td>A</td>
<td>$T_j=25,^\circ\text{C}$</td>
<td>79</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>$t_{rr}$</td>
<td>ns</td>
<td>$T_j=25,^\circ\text{C}$</td>
<td>26</td>
</tr>
<tr>
<td>Reverse recovered charge</td>
<td>$Q_{rr}$</td>
<td>µC</td>
<td>$T_j=25,^\circ\text{C}$</td>
<td>3.00</td>
</tr>
<tr>
<td>Peak rate of fall of recovery current</td>
<td>$s_{d} \left( \text{rec} \right)_{\text{max}}$</td>
<td>A/µs</td>
<td>$T_j=25,^\circ\text{C}$</td>
<td>11385</td>
</tr>
<tr>
<td>Reverse recovery energy</td>
<td>$E_{\text{rec}}$</td>
<td>mWs</td>
<td>$T_j=25,^\circ\text{C}$</td>
<td>7906</td>
</tr>
<tr>
<td>Thermal resistance chip to heatsink per chip</td>
<td>$R_{\text{ch}}$</td>
<td>K/W</td>
<td>$T_j=25,^\circ\text{C}$</td>
<td>1.87</td>
</tr>
<tr>
<td>Thermistor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated resistance</td>
<td>$R$</td>
<td>Ω</td>
<td>$T_j=25,^\circ\text{C}$</td>
<td>21511</td>
</tr>
<tr>
<td>Deviation of $R_{100}$</td>
<td>$\Delta R , R_{100}$</td>
<td>%</td>
<td>$T_c=100,^\circ\text{C}$</td>
<td>-4.5</td>
</tr>
<tr>
<td>Power dissipation constant</td>
<td>$P$</td>
<td>mW</td>
<td>$T_j=25,^\circ\text{C}$</td>
<td>210</td>
</tr>
<tr>
<td>A-value</td>
<td>$B_{(25/50)}$</td>
<td>K</td>
<td>$T_j=25,^\circ\text{C}$</td>
<td>3884</td>
</tr>
<tr>
<td>B-value</td>
<td>$B_{(25/100)}$</td>
<td>K</td>
<td>$T_j=25,^\circ\text{C}$</td>
<td>3964</td>
</tr>
<tr>
<td>Vincotech NTC Reference</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Buck**

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

<table>
<thead>
<tr>
<th>$V_{CE}$ (V)</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_C$ (A)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>$V_{CE}$ (V)</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_C$ (A)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>$V_{GE}$ (V)</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_C$ (A)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

At  
$t_p = 250 \mu s$  
$T_j = T_{j,\text{max}} - 25 \degree C$  
$V_{CE} = 10$ V

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

<table>
<thead>
<tr>
<th>$V_F$ (V)</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_F$ (A)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

At  
$t_p = 250 \mu s$  
$T_j = 25 \degree C$  
$T_j = T_{j,\text{max}} - 25 \degree C$  
$T_j = 25 \degree C$
Figure 5  MOSFET+IGBT
Typical switching energy losses
as a function of collector current
\[ E = f(I_C) \]

![Graph showing energy losses as a function of collector current.]

With an inductive load at
- \( T_j = 25/125 \) °C
- \( V_{CE} = 350 \) V
- \( V_{GE} = \pm 15 \) V
- \( R_{on} = 4 \) Ω
- \( R_{off} = 4 \) Ω

Figure 6  MOSFET+IGBT
Typical switching energy losses
as a function of gate resistor
\[ E = f(R_G) \]

![Graph showing energy losses as a function of gate resistor.]

With an inductive load at
- \( T_j = 25/125 \) °C
- \( V_{CE} = 350 \) V
- \( V_{GE} = \pm 15 \) V
- \( I_C = 40 \) A

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

![Graph showing reverse recovery energy loss as a function of collector current.]

With an inductive load at
- \( T_j = 25/125 \) °C
- \( V_{CE} = 350 \) V
- \( V_{GE} = \pm 15 \) V
- \( R_{on} = 4 \) Ω

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

![Graph showing reverse recovery energy loss as a function of gate resistor.]

With an inductive load at
- \( T_j = 25/125 \) °C
- \( V_{CE} = 350 \) V
- \( V_{GE} = \pm 15 \) V
- \( I_C = 40 \) A
Typical switching times as a function of collector current

\[ t = f(I_C) \]

With an inductive load at:
- \( T_j = 125 \degree C \)
- \( V_{CE} = 350 \text{ V} \)
- \( V_{GE} = \pm 15 \text{ V} \)
- \( R_{\text{on}} = 4 \Omega \)
- \( R_{\text{off}} = 4 \Omega \)

MOSFET turn off delayed with 350 nS

Figure 11

Typical reverse recovery time as a function of collector current

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

At:
- \( T_j = 25/125 \degree C \)
- \( V_{CE} = 350 \text{ V} \)
- \( V_{GE} = \pm 15 \text{ V} \)
- \( R_{\text{on}} = 4 \Omega \)

MOSFET turn off delayed with 350 nS

Figure 12

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

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

At:
- \( T_j = 25/125 \degree C \)
- \( V_{CE} = 350 \text{ V} \)
- \( V_{GE} = \pm 15 \text{ V} \)
- \( l_c = 40 \text{ A} \)
Figure 13
Typical reverse recovery charge as a function of collector current
\[ Q_{rr} = f(I_C) \]

![Graph showing typical reverse recovery charge as a function of collector current.]

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

![Graph showing typical reverse recovery charge as a function of IGBT turn on gate resistor.]

At
- \( T_j = 25/125 \, ^\circ C\)
- \( V_{GE} = 350 \, V\)
- \( I_F = 40 \, A\)
- \( V_{GE} = \pm 15 \, V\)

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

![Graph showing typical reverse recovery current as a function of collector current.]

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

![Graph showing typical reverse recovery current as a function of IGBT turn on gate resistor.]

At
- \( T_j = 25/125 \, ^\circ C\)
- \( V_{GE} = 350 \, V\)
- \( I_F = 40 \, A\)
- \( V_{GE} = \pm 15 \, V\)
Figure 17
Typical rate of fall of forward and reverse recovery current as a function of collector current
\( \frac{dI}{dt}, \frac{dI_{rec}}{dt} = f(I_c) \)

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

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

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

At
- \( T_j = 25/125 °C \)
- Gate on/off resistor of IGBT is fixed 4 \( Ω \)
- MOSFET turn off delayed with 350 nS
- \( V_R = 350 V \)
- \( V_{GE} = ±15 V \)
- \( I_F = 40 A \)
- \( R_{gon} = 4 Ω \)
- \( V_{CE} = 350 V \)

IGBT thermal model values
- \( R (C/W) \)
- \( \tau (s) \)
- 0.14, 1.8E+00
- 0.36, 2.1E-01
- 0.28, 7.5E-02
- 0.08, 1.2E-02
- 0.02, 1.1E-03

FWD thermal model values
- \( R (C/W) \)
- \( \tau (s) \)
- 0.08, 4.5E+00
- 0.17, 9.6E-01
- 0.63, 1.6E-01
- 0.53, 5.6E-02
- 0.20, 1.2E-02
- 0.12, 2.3E-03
Figure 21  
Power dissipation as a function of heatsink temperature
$P_{\text{tot}} = f(T_h)$

At
$T_j = 175 \, ^\circ\text{C}$

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

At
$T_j = 175 \, ^\circ\text{C}$
$V_{GE} = 15 \, \text{V}$

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

At
$T_j = 150 \, ^\circ\text{C}$

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

At
$T_j = 150 \, ^\circ\text{C}$
Buck

**Figure 25**
Safe operating area as a function of collector-emitter voltage

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

**Figure 26**
Gate voltage vs Gate charge

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

At

D = single pulse
Th = 80 °C
\[ V_{GE} = \pm 15 \text{ V} \]
\[ T_j = T_{jmax} \text{ °C} \]

**Figure 27**
MOSFET transient thermal impedance as a function of pulse width

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

**Figure 28**
Gate voltage vs Gate charge

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

At

\[ I_C = 75 \]

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

\[ R_{thJH} = 1.16 \text{ K/W} \]

**MOSFET thermal model values**

<table>
<thead>
<tr>
<th>R (C/W)</th>
<th>( \text{Tau} ) (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.11</td>
<td>4.7E+00</td>
</tr>
<tr>
<td>0.22</td>
<td>9.0E-01</td>
</tr>
<tr>
<td>0.39</td>
<td>1.7E-01</td>
</tr>
<tr>
<td>0.25</td>
<td>4.8E-02</td>
</tr>
<tr>
<td>0.10</td>
<td>1.3E-02</td>
</tr>
<tr>
<td>0.05</td>
<td>2.5E-03</td>
</tr>
</tbody>
</table>

MOSFET thermal model values

\[ R (\text{C/W}) \quad \text{Tau} \quad \text{(s)} \]

\[ 0.11 \quad 4.7E+00 \]

\[ 0.22 \quad 9.0E-01 \]

\[ 0.39 \quad 1.7E-01 \]

\[ 0.25 \quad 4.8E-02 \]

\[ 0.10 \quad 1.3E-02 \]

\[ 0.05 \quad 2.5E-03 \]
**Boost**

**Figure 1**
**Typical output characteristics**
$I_c = f(V_{ce})$

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

**Figure 2**
**Typical output characteristics**
$I_c = f(V_{ce})$

- $t_p = 250 \, \mu$s
- $T_j = 125 \, \degree \mathrm{C}$
- $V_{ce}$ 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**
$I_f = f(V_f)$

- $t_p = 250 \, \mu$s

$V_{ce}$ from 10 V to 20 V in steps of 1 V

Copyright Vincotech
Figure 5
IGBT
Typical switching energy losses as a function of collector current
$E = f(I_C)$

With an inductive load at
$T_J = 25/125 \degree C$
$V_{CE} = 350 \text{ V}$
$V_{GE} = \pm 15 \text{ V}$
$R_{GS(on)} = 4 \Omega$
$R_{GS(off)} = 4 \Omega$

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

With an inductive load at
$T_J = 25/125 \degree C$
$V_{CE} = 350 \text{ V}$
$V_{GE} = \pm 15 \text{ V}$
$I_C = 50 \text{ A}$

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

With an inductive load at
$T_J = 25/125 \degree C$
$V_{CE} = 350 \text{ V}$
$V_{GE} = \pm 15 \text{ V}$
$R_{GS(on)} = 4 \Omega$

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

With an inductive load at
$T_J = 25/125 \degree C$
$V_{CE} = 350 \text{ V}$
$V_{GE} = \pm 15 \text{ V}$
$I_C = 50 \text{ A}$
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

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

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

**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

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

**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

\[
I_{RRM} = f(R_{gon})
\]
Figure 17: Typical rate of fall of forward and reverse recovery current as a function of collector current
\[
\frac{dI_0}{dt}, \frac{dI_{\text{rec}}}{dt} = f(I_c)
\]

At
- \( T_j = 25/125 \) °C
- \( V_{CE} = 350 \) V
- \( V_{GE} = \pm 15 \) V
- \( R_{\text{gon}} = 4 \) Ω

Figure 18: Typical rate of fall of forward and reverse recovery current as a function of pulse width
\[
\frac{dI_0}{dt}, \frac{dI_{\text{rec}}}{dt} = f(R_{\text{gon}})
\]

At
- \( T_j = 25/125 \) °C
- \( V_{R} = 350 \) V
- \( I_F = 50 \) A
- \( V_{GE} = \pm 15 \) V

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

At
- \( D = \frac{t_p}{T} \)
- \( R_{\text{RTHJH}} = 1.02 \) K/W

IGBT thermal model values

<table>
<thead>
<tr>
<th>R (C/W)</th>
<th>( \tau ) (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.08</td>
<td>4.3E+00</td>
</tr>
<tr>
<td>0.12</td>
<td>1.0E+00</td>
</tr>
<tr>
<td>0.47</td>
<td>1.5E-01</td>
</tr>
<tr>
<td>0.26</td>
<td>4.9E-02</td>
</tr>
</tbody>
</table>

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

At
- \( D = \frac{t_p}{T} \)
- \( R_{\text{RTHJH}} = 1.87 \) K/W

FWD thermal model values

<table>
<thead>
<tr>
<th>R (C/W)</th>
<th>( \tau ) (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.08</td>
<td>2.9E+00</td>
</tr>
<tr>
<td>0.22</td>
<td>4.4E-01</td>
</tr>
<tr>
<td>1.10</td>
<td>1.1E-01</td>
</tr>
<tr>
<td>0.21</td>
<td>3.3E-02</td>
</tr>
<tr>
<td>0.15</td>
<td>7.2E-03</td>
</tr>
<tr>
<td>0.12</td>
<td>1.0E-03</td>
</tr>
</tbody>
</table>
Power dissipation as a function of heatsink temperature

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

At

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

Forward current as a function of heatsink temperature

\[ I_F = f(T_h) \]

At

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

\[ V_{GE} = 15 \, \text{V} \]
**Boost Inv.**

Figure 25  IGBT Inverse Diode

Typical diode forward current as a function of forward voltage

\[ I_F = f(V_F) \]

Figure 26  IGBT Inverse Diode

Diode transient thermal impedance as a function of pulse width

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

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

\[ t_p = 250 \mu s \]

\[ R_{thJH} = 2.17 \text{ K/W} \]

Figure 27  IGBT Inverse Diode

Power dissipation as a function of heatsink temperature

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

\[ T_j = 25^\circ C \]

\[ T_j = T_{max} - 25^\circ C \]

At

\[ t_p = 250 \mu s \]

Figure 28  IGBT Inverse Diode

Forward current as a function of heatsink temperature

\[ I_F = f(T_h) \]

\[ T_j = 175^\circ C \]

At

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

Thermistor

Typical NTC characteristic as a function of temperature

$R_T = f(T)$
Switching Definitions BUCK IGBT & MOSFET

General conditions

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( R_{\text{on,IGBT}} )</td>
<td>4 ( \Omega )</td>
</tr>
<tr>
<td>( R_{\text{off,IGBT}} )</td>
<td>4 ( \Omega )</td>
</tr>
<tr>
<td>( R_{\text{on,MOSFET}} )</td>
<td>4 ( \Omega )</td>
</tr>
<tr>
<td>( R_{\text{off,MOSFET}} )</td>
<td>4 ( \Omega )</td>
</tr>
</tbody>
</table>

MOSFET turn off delayed time with 350 nS

Figure 1
Turn-off Switching Waveforms & definition of \( t_{\text{off}} \), \( t_{\text{eff}} \)

\( t_{\text{off}} \) = Integrating time for \( E_{\text{off}} \)

- \( V_{\text{GE}} \) (0%) = -15 V
- \( V_{\text{GE}} \) (100%) = 15 V
- \( V_{\text{CE}} \) (100%) = 700 V
- \( I_{\text{C}} \) (100%) = 40 A
- \( t_{\text{off}} \) = 0.41 \( \mu \)s
- \( t_{\text{eff}} \) = 0.44 \( \mu \)s

Figure 2
Turn-on Switching Waveforms & definition of \( t_{\text{on}} \), \( t_{\text{eff}} \)

\( t_{\text{on}} \) = Integrating time for \( E_{\text{on}} \)

- \( V_{\text{GE}} \) (0%) = -15 V
- \( V_{\text{GE}} \) (100%) = 15 V
- \( V_{\text{CE}} \) (100%) = 700 V
- \( I_{\text{C}} \) (100%) = 40 A
- \( t_{\text{on}} \) = 0.04 \( \mu \)s
- \( t_{\text{eff}} \) = 0.06 \( \mu \)s

Figure 3
Turn-off Switching Waveforms & definition of \( t_{\text{f}} \)

- \( V_{\text{CE}} \) (100%) = 700 V
- \( I_{\text{C}} \) (100%) = 40 A
- \( t_{\text{f}} \) = 0.004 \( \mu \)s

Figure 4
Turn-on Switching Waveforms & definition of \( t_{\text{r}} \)

- \( V_{\text{CE}} \) (100%) = 700 V
- \( I_{\text{C}} \) (100%) = 40 A
- \( t_{\text{r}} \) = 0.003 \( \mu \)s
Switching Definitions BUCK IGBT&MOSFET

**Figure 5**
BUCK IGBT&MOSFET

Turn-off Switching Waveforms & definition of \( t_{\text{Eoff}} \)

- \( P_{\text{off}} \) (100%) = 28,07 kW
- \( E_{\text{off}} \) (100%) = 0,23 mJ
- \( t_{\text{Eoff}} \) = 0,44 \( \mu \)s

**Figure 6**
BUCK IGBT&MOSFET

Turn-on Switching Waveforms & definition of \( t_{\text{Eon}} \)

- \( P_{\text{on}} \) (100%) = 28,07 kW
- \( E_{\text{on}} \) (100%) = 0,28 mJ
- \( t_{\text{Eon}} \) = 0,06 \( \mu \)s

**Figure 7**
BUCK IGBT&MOSFET

Turn-off Switching Waveforms & definition of \( t_{\text{rr}} \)

- \( V_{\text{d}} \) (100%) = 700 V
- \( i_{\text{F}} \) (100%) = 40 A
- \( i_{\text{Fmin}} \) (100%) = -90 A
- \( t_{\text{rr}} \) = 0,02 \( \mu \)s

**Figure 8**
BUCK FWD

Turn-on Switching Waveforms & definition of \( t_{\text{Qrr}} \)

- \( V_{\text{d}} \) (100%) = 700 V
- \( i_{\text{F}} \) (100%) = 40 A
- \( Q_{\text{rr}} \) (100%) = 1,18 \( \mu \)C
- \( t_{\text{Qrr}} \) = 0,04 \( \mu \)s
Switching Definitions BUCK IGBT&MOSFET

Figure 9
BUCK FWD
Turn-on Switching Waveforms & definition of $t_{E_{rec}}$

$t_{E_{rec}}$ = integrating time for $E_{rec}$

$P_{rec}$(100%) = 28.07 kW

$E_{rec}$(100%) = 0.19 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 (T5,T6)
Ordering Code and Marking - Outline - Pinout

### Ordering Code & Marking

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### Outline

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### Pinout
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