Vincotech

flow PFC 0 CD

Features
- High-efficient rectifier
- High-efficient IGBT H5 + Stealth 2 Diode
- Ultra-fast switching speed
- Integrated capacitors
- Thermistor

Target applications
- SMPS
- Welding

Types
- 10-FZ062TA050SM-P987D13

flow 0 12mm housing

Schematic

Maximum Ratings

$T_{j} = 25 \, ^\circ C$, unless otherwise specified

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-emitter voltage</td>
<td>$V_{ces}$</td>
<td></td>
<td>650</td>
<td>V</td>
</tr>
<tr>
<td>Collector current</td>
<td>$I_{C}$</td>
<td>$T_{j} = T_{jmax}$</td>
<td>43</td>
<td>A</td>
</tr>
<tr>
<td>Repetitive peak collector current</td>
<td>$I_{CRM}$</td>
<td>limited by $T_{jmax}$</td>
<td>150</td>
<td>A</td>
</tr>
<tr>
<td>Total power dissipation</td>
<td>$P_{tot}$</td>
<td>$T_{j} = T_{jmax}$</td>
<td>84</td>
<td>W</td>
</tr>
<tr>
<td>Gate-emitter voltage</td>
<td>$V_{ces}$</td>
<td></td>
<td>±20</td>
<td>V</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>$T_{jmax}$</td>
<td></td>
<td>175</td>
<td>°C</td>
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</tbody>
</table>

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## Maximum Ratings

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
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<th>Value</th>
<th>Unit</th>
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<tbody>
<tr>
<td><strong>PFC Diode</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak Repetitive Reverse Voltage</td>
<td>$V_{RSM}$</td>
<td></td>
<td>600</td>
<td>V</td>
</tr>
<tr>
<td>Continuous (direct) forward current</td>
<td>$I_s$</td>
<td>$T_j = T_{j\text{max}}$ $T_s = 80^\circ\text{C}$</td>
<td>26</td>
<td>A</td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>$I_{f\text{max}}$</td>
<td></td>
<td>90</td>
<td>A</td>
</tr>
<tr>
<td>Total power dissipation</td>
<td>$P_{tot}$</td>
<td>$T_j = T_{j\text{max}}$ $T_s = 80^\circ\text{C}$</td>
<td>48</td>
<td>W</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>$T_{j\text{max}}$</td>
<td></td>
<td>150</td>
<td>°C</td>
</tr>
<tr>
<td><strong>PFC Protection\ Current Transforme Protection Diode</strong></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Peak Repetitive Reverse Voltage</td>
<td>$V_{RSM}$</td>
<td></td>
<td>650</td>
<td>V</td>
</tr>
<tr>
<td>Continuous (direct) forward current</td>
<td>$I_s$</td>
<td>$T_j = T_{j\text{max}}$ $T_s = 80^\circ\text{C}$</td>
<td>17</td>
<td>A</td>
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<tr>
<td>Repetitive peak forward current</td>
<td>$I_{f\text{max}}$</td>
<td></td>
<td>20</td>
<td>A</td>
</tr>
<tr>
<td>Total power dissipation</td>
<td>$P_{tot}$</td>
<td>$T_j = T_{j\text{max}}$ $T_s = 80^\circ\text{C}$</td>
<td>33</td>
<td>W</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>$T_{j\text{max}}$</td>
<td></td>
<td>175</td>
<td>°C</td>
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<tr>
<td><strong>Rectifier \ Shunt Protection Diode</strong></td>
<td></td>
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</tr>
<tr>
<td>Peak Repetitive Reverse Voltage</td>
<td>$V_{RSM}$</td>
<td></td>
<td>1600</td>
<td>V</td>
</tr>
<tr>
<td>Continuous (direct) forward current</td>
<td>$I_s$</td>
<td>$T_j = T_{j\text{max}}$ $T_s = 80^\circ\text{C}$</td>
<td>46</td>
<td>A</td>
</tr>
<tr>
<td>Surge (non-repetitive) forward current</td>
<td>$I_{f\text{max}}$</td>
<td>50 Hz Single Half Sine Wave $\tau_p = 10 , \text{ms}$ 50 Hz sine $T_j = 150^\circ\text{C}$</td>
<td>280</td>
<td>A</td>
</tr>
<tr>
<td>Surge current capability</td>
<td>$I^{\text{2s}}$</td>
<td></td>
<td>390</td>
<td>A^2s</td>
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<tr>
<td>Total power dissipation</td>
<td>$P_{tot}$</td>
<td>$T_j = T_{j\text{max}}$ $T_s = 80^\circ\text{C}$</td>
<td>59</td>
<td>W</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>$T_{j\text{max}}$</td>
<td></td>
<td>150</td>
<td>°C</td>
</tr>
<tr>
<td><strong>DC Link Capacitor</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum DC voltage</td>
<td>$V_{\text{MAX}}$</td>
<td></td>
<td>1000</td>
<td>V</td>
</tr>
<tr>
<td>Operation Temperature</td>
<td>$T_{op}$</td>
<td></td>
<td>-55...+125</td>
<td>°C</td>
</tr>
<tr>
<td><strong>PFC Shunt</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max DC current</td>
<td>$I_{\text{MAX}}$</td>
<td>$T_c = 25 , ^\circ\text{C}$</td>
<td>27</td>
<td>A</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>$P_{\text{ac}}$</td>
<td>$T_c = 105 , ^\circ\text{C}$</td>
<td>5</td>
<td>W</td>
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# Maximum Ratings

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Value</th>
<th>Unit</th>
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<tbody>
<tr>
<td><strong>Module Properties</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Thermal Properties</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>$T_{stg}$</td>
<td></td>
<td>-40...+125</td>
<td>°C</td>
</tr>
<tr>
<td>Operation temperature under switching condition</td>
<td>$T_{jop}$</td>
<td></td>
<td>-40...+$T_{jmax} - 25$</td>
<td>°C</td>
</tr>
<tr>
<td><strong>Isolation Properties</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isolation voltage</td>
<td>$V_{ isol }$</td>
<td>DC Voltage</td>
<td>$t_p = 2s$</td>
<td>4000</td>
</tr>
<tr>
<td>Creepage distance</td>
<td></td>
<td></td>
<td></td>
<td>min. 12,7</td>
</tr>
<tr>
<td>Clearance</td>
<td></td>
<td></td>
<td></td>
<td>9,42</td>
</tr>
<tr>
<td>Comparative Tracking Index</td>
<td></td>
<td></td>
<td></td>
<td>&gt; 200</td>
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### Characteristic Values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gate-emitter threshold voltage</td>
<td>$V_{GE(th)}$</td>
<td>$V_{CE} = V_{GS}$</td>
<td>0,0005</td>
<td>25</td>
</tr>
<tr>
<td>Collector-emitter saturation voltage</td>
<td>$V_{CEsat}$</td>
<td></td>
<td>15</td>
<td>50</td>
</tr>
<tr>
<td>Collector-emitter cut-off current</td>
<td>$I_{CES}$</td>
<td></td>
<td>0</td>
<td>650</td>
</tr>
<tr>
<td>Gate-emitter leakage current</td>
<td>$I_{CRES}$</td>
<td></td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>Internal gate resistance</td>
<td>$r_g$</td>
<td></td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Input capacitance</td>
<td>$C_{ins}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output capacitance</td>
<td>$C_{oes}$</td>
<td>$f = 1$ MHz</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>Reverse transfer capacitance</td>
<td>$C_{res}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gate charge</td>
<td>$Q_r$</td>
<td></td>
<td>15</td>
<td>520</td>
</tr>
</tbody>
</table>

### PFC Switch

#### Static

- **Gate-emitter threshold voltage**
  - $V_{GE(th)}$:
  - $V_{CE} = V_{GS}$:
  - Conditions: 0,0005, 25
  - Value: 3,3, 4, 4,7 V

- **Collector-emitter saturation voltage**
  - $V_{CEsat}$:
  - Conditions: 15, 50
  - Value: 25, 125
  - Value: 1,82, 2,00, 2,22 V

- **Collector-emitter cut-off current**
  - $I_{CES}$:
  - Conditions: 0, 650
  - Value: 25
  - Value: 40 µA

- **Gate-emitter leakage current**
  - $I_{CRES}$:
  - Conditions: 20, 0
  - Value: 25
  - Value: 120 nA

- **Internal gate resistance**
  - $r_g$:
  - Conditions: none
  - Value: none Ω

- **Input capacitance**
  - $C_{ins}$:
  - Conditions: f = 1 MHz
  - Value: 25
  - Value: 25
  - Value: 3000 pF

- **Output capacitance**
  - $C_{oes}$:
  - Conditions: 0, 25
  - Value: 25
  - Value: 50 µF

- **Reverse transfer capacitance**
  - $C_{res}$:
  - Conditions: none
  - Value: 11 nF

- **Gate charge**
  - $Q_r$:
  - Conditions: 15, 520
  - Value: 50
  - Value: 120 nC

#### Thermal

- **Thermal resistance junction to sink**
  - $R_{th(j-s)}$:
  - Value: 1,13 K/W

#### IGBT Switching

- **Turn-on delay time**
  - $t_{(on)}$:
  - Conditions: 25, 125
  - Value: 24 ns

- **Rise time**
  - $t_r$:
  - Conditions: 25, 125
  - Value: 11 ns

- **Turn-off delay time**
  - $t_{(off)}$:
  - Conditions: 25, 125
  - Value: 137 ns

- **Fall time**
  - $t_f$:
  - Conditions: 25, 125
  - Value: 154 ns

- **Turn-on energy (per pulse)**
  - $E_{on}$:
  - Conditions: $Q_{onmax} = 0,3 µC$
  - Conditions: $Q_{onmin} = 1 µC$
  - Value: 25, 125
  - Value: 0,561, 0,874 mWs

- **Turn-off energy (per pulse)**
  - $E_{off}$:
  - Conditions: $Q_{offmax} = 0,241 µC$
  - Conditions: $Q_{offmin} = 0,428 µC$
  - Value: 25, 125
  - Value: 0,241, 0,428 mWs
### Characteristic Values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
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<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VGE [V]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VGS [V]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VCE [V]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ic [A]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is [A]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tj [°C]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min</td>
<td>Typ</td>
<td>Max</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### PFC Diode

#### Static
- **Forward voltage** $V_F$  
  - Conditions: 30  
  - Value: 25  
  - Value: 25  
  - Unit: [V]
- **Reverse leakage current** $I_r$  
  - Conditions: 600  
  - Value: 25  
  - Value: 100  
  - Unit: [µA]

#### Thermal
- **Thermal resistance junction to sink** $R_{th(j-s)}$  
  - Phase-change material  
  - $\lambda = 3,4 \text{ W/mK}$  
  - Value: 1,46  
  - Unit: [K/W]

### FWD Switching
- **Peak recovery current** $I_{RRM}$  
  - Conditions: 15/0  
  - Value: 25  
  - Value: 25  
  - Unit: [A]
- **Reverse recovery time** $t_{rr}$  
  - Conditions: 0  
  - Value: 25  
  - Value: 25  
  - Unit: [ns]
- **Recovered charge** $Q_r$  
  - Conditions: 0  
  - Value: 25  
  - Value: 25  
  - Unit: [µC]
- **Reverse recovered energy** $E_{rec}$  
  - Conditions: 0  
  - Value: 25  
  - Value: 25  
  - Unit: [mWs]
- **Peak rate of fall of recovery current** $(dI_{rf}/dt)_{max}$  
  - Conditions: 0  
  - Value: 25  
  - Value: 25  
  - Unit: [A/µs]

### PFC Protection\ Current Transforme Protection Diode

#### Static
- **Forward voltage** $V_F$  
  - Conditions: 10  
  - Value: 25  
  - Value: 25  
  - Unit: [V]
- **Reverse leakage current** $I_r$  
  - Conditions: 650  
  - Value: 25  
  - Value: 0,14  
  - Unit: [µA]

#### Thermal
- **Thermal resistance junction to sink** $R_{th(j-s)}$  
  - Phase-change material  
  - $\lambda = 3,4 \text{ W/mK}$  
  - Value: 2,87  
  - Unit: [K/W]

### Rectifier \ Shunt Protection Diode

#### Static
- **Forward voltage** $V_F$  
  - Conditions: 30  
  - Value: 25  
  - Value: 1,16  
  - Value: 1,16  
  - Unit: [V]
- **Reverse leakage current** $I_r$  
  - Conditions: 1600  
  - Value: 25  
  - Value: 20  
  - Unit: [µA]

#### Thermal
- **Thermal resistance junction to sink** $R_{th(j-s)}$  
  - Phase-change material  
  - $\lambda = 3,4 \text{ W/mK}$  
  - Value: 1,19  
  - Unit: [K/W]

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### 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>DC Link Capacitor</td>
<td></td>
<td>$ V_{GE} \ [V]$ $ V_{GS} \ [V]$ $ V_{CE} \ [V]$ $ T_i \ [^\circ C]$</td>
<td>Min</td>
<td>Typ</td>
</tr>
<tr>
<td>PFC Shunt</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Static</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistance</td>
<td>$R$</td>
<td></td>
<td>6,8</td>
<td>mΩ</td>
</tr>
<tr>
<td>Tolerance</td>
<td></td>
<td></td>
<td>-1</td>
<td>+1</td>
</tr>
<tr>
<td>Temperature coefficient</td>
<td>$\varepsilon_t$</td>
<td>20 - 60</td>
<td>50</td>
<td>ppm/K</td>
</tr>
<tr>
<td>Internal heat resistance</td>
<td>$R_{thi}$</td>
<td></td>
<td>13</td>
<td>K/W</td>
</tr>
<tr>
<td>Thermistor</td>
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<tr>
<td>Rated resistance</td>
<td>$R$</td>
<td></td>
<td>25</td>
<td>22</td>
</tr>
<tr>
<td>Deviation of R100</td>
<td>$\Delta_{R100}$</td>
<td>R100 = 1486 Ω</td>
<td>100</td>
<td>-12</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>$P$</td>
<td>25</td>
<td>200</td>
<td>mW</td>
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<td>Power dissipation constant</td>
<td></td>
<td>25</td>
<td>2</td>
<td>mW/K</td>
</tr>
<tr>
<td>B-value</td>
<td>$R_{25/100}$ Tol. ±3%</td>
<td>25</td>
<td>3950</td>
<td>K</td>
</tr>
<tr>
<td>B-value</td>
<td>$R_{25/100}$ Tol. ±3%</td>
<td>25</td>
<td>3998</td>
<td>K</td>
</tr>
<tr>
<td>Vincotech NTC Reference</td>
<td></td>
<td></td>
<td></td>
<td>B</td>
</tr>
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</table>
PFC Switch Characteristics

Typical output characteristics IGBT

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

Typical output characteristics IGBT

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

Typical transfer characteristics IGBT

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

Transient Thermal Impedance as function of Pulse duration IGBT

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

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

\[ R_{th(j-s)} = 1,13 \text{ K/W} \]

IGBT thermal model values

<table>
<thead>
<tr>
<th>( R ) (K/W)</th>
<th>( r ) (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7,12E-02</td>
<td>8,15E+00</td>
</tr>
<tr>
<td>1,29E-01</td>
<td>6,00E-01</td>
</tr>
<tr>
<td>4,31E-01</td>
<td>9,13E-02</td>
</tr>
<tr>
<td>3,15E-01</td>
<td>2,59E-02</td>
</tr>
<tr>
<td>1,31E-01</td>
<td>5,80E-03</td>
</tr>
<tr>
<td>5,02E-02</td>
<td>8,53E-04</td>
</tr>
</tbody>
</table>
PFC Switch Characteristics

Gate voltage vs Gate charge

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

Safe operating area

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

At

\[ I_C = 50 \text{ A} \]

At

\[ D = \text{single pulse} \]

\[ T_s = 80 \degree C \]

\[ V_{CE} = \pm 15 \text{ V} \]

\[ T_j = T_{jmax} \degree C \]
PFC Diode Characteristics

**Typical forward characteristics**

$I_F = f(V_F)$

![Graph showing typical forward characteristics](image)

- $t_p = 250 \mu s$
- $T_j = 25^\circ C$
- $D = 0.5$

**Transient thermal impedance as a function of pulse width**

$Z_{th(j-s)} = f(t_p)$

![Graph showing transient thermal impedance](image)

- $D = 0.5$
- $R_{th(j-s)} = 1.46 \text{ K/W}$

**FWD thermal model values**

<table>
<thead>
<tr>
<th>$R$ (K/W)</th>
<th>$\tau$ (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.840E-02</td>
<td>2.7070E+00</td>
</tr>
<tr>
<td>1.8520E-01</td>
<td>3.2980E-01</td>
</tr>
<tr>
<td>7.7650E-01</td>
<td>6.8840E-02</td>
</tr>
<tr>
<td>2.2980E-01</td>
<td>1.9350E-02</td>
</tr>
<tr>
<td>1.1460E-01</td>
<td>3.4610E-03</td>
</tr>
<tr>
<td>8.1930E-02</td>
<td>7.0190E-04</td>
</tr>
</tbody>
</table>

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PFC Protection \ Current Transformer Protection Diode Characteristics

Typical forward characteristics

\[ I_F = f(V_F) \]

Prot. Diode

Transient thermal impedance as a function of pulse width

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

Prot. Diode

\[ t_p = 250 \mu s \]

\[ T_j: 25 \ ^\circ C \]

\[ R_{th(j-s)} = 2.87 \ K/W \]

\[ 125 \ ^\circ C \]

\[ 150 \ ^\circ C \]

Prot. Diode thermal model values

<table>
<thead>
<tr>
<th>( R (K/W) )</th>
<th>( \tau (s) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.529E-02</td>
<td>3.939E+00</td>
</tr>
<tr>
<td>1.476E-01</td>
<td>4.483E-01</td>
</tr>
<tr>
<td>1.313E+00</td>
<td>5.964E-02</td>
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<td>1.361E-02</td>
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<td>4.044E-01</td>
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<td>2.106E-01</td>
<td>5.372E-04</td>
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</table>

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Rectifier \ Shunt Protection  Diode Characteristics

**Typical forward characteristics**

$I_F = f(V_F)$

<table>
<thead>
<tr>
<th>$V_F$ (V)</th>
<th>0</th>
<th>0.5</th>
<th>1</th>
<th>1.5</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_F$ (A)</td>
<td>0</td>
<td>30</td>
<td>60</td>
<td>90</td>
<td>90</td>
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</table>

$\tau_p = 250 \, \mu s$

$T_J: 25 \, ^\circ C$

$R_{th(j-s)} = 1.19 \, K/W$

**Transient thermal impedance as a function of pulse width**

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

$R_{th(j-s)} = 1.19 \, K/W$

Diode thermal model values

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<th>$R$ (K/W)</th>
<th>$\tau$ (s)</th>
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<td>3.27E-02</td>
<td>9.47E-00</td>
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<td>3.75E-02</td>
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<td>6.56E-02</td>
<td>5.63E-03</td>
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<td>3.68E-02</td>
<td>8.27E-04</td>
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**Thermistor Characteristics**

**Thermistor typical temperature characteristic**

$R = f(T)$

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<th>50</th>
<th>75</th>
<th>100</th>
<th>125</th>
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<tbody>
<tr>
<td>$R$ (Ω)</td>
<td>25000</td>
<td>15000</td>
<td>10000</td>
<td>5000</td>
<td>0</td>
</tr>
</tbody>
</table>

**Typical NTC characteristic as a function of temperature**

$R = f(T)$

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PFC Switching Characteristics

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

\[ E = f(I_c) \]

With an inductive load at 25 °C

- \( V_{in} = 400 \) V
- \( T_{j} = 125 \) °C
- \( R_{on} = 8 \) Ω
- \( I_c = 50 \) A

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

\[ E = f(r_g) \]

With an inductive load at 25 °C

- \( V_{in} = 400 \) V
- \( V_{in} = 15/0 \) V
- \( I_i = 50 \) A

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

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

With an inductive load at 25 °C

- \( V_{in} = 400 \) V
- \( V_{in} = 15/0 \) V
- \( R_{on} = 8 \) Ω

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

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

With an inductive load at 25 °C

- \( V_{in} = 400 \) V
- \( V_{in} = 15/0 \) V
- \( I_i = 50 \) A
PFC Switching Characteristics

Figure 5. IGBT
Typical switching times as a function of collector current
\[ t = f(I_C) \]

With an inductive load at
- \( T_j = 125 ^\circ C \)
- \( V_{CE} = 400 \text{ V} \)
- \( V_{GE} = 15/0 \text{ V} \)
- \( R_{gon} = 8 \Omega \)
- \( I_C = 50 \text{ A} \)

Figure 6. IGBT
Typical switching times as a function of gate resistor
\[ t = f(r_g) \]

With an inductive load at
- \( T_j = 125 ^\circ C \)
- \( V_{CE} = 400 \text{ V} \)
- \( V_{GE} = 15/0 \text{ V} \)
- \( R_{gon} = 8 \Omega \)
- \( I_C = 50 \text{ A} \)

Figure 7. FWD
Typical reverse recovery time as a function of collector current
\[ t_{rr} = f(I_C) \]

At
- \( V_{CE} = 400 \text{ V} \)
- \( V_{GE} = 15/0 \text{ V} \)
- \( R_{pm} = 8 \Omega \)

Figure 8. FWD
Typical reverse recovery time as a function of IGBT turn-on gate resistor
\[ t_{rr} = f(R_{gon}) \]

At
- \( V_{CE} = 400 \text{ V} \)
- \( V_{GE} = 15/0 \text{ V} \)
- \( I_C = 50 \text{ A} \)
PFC Switching Characteristics

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

\[ Q_r = f(I_C) \]

At
\[ V_{cc}= 400 \text{ V} \]
\[ V_{gs}= 15/0 \text{ V} \]
\[ R_{gs}= 8 \Omega \]

25 \(^\circ\text{C}\)

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

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

At
\[ V_{cc}= 400 \text{ V} \]
\[ V_{gs}= 15/0 \text{ V} \]
\[ R_{gs}= 8 \Omega \]

25 \(^\circ\text{C}\)

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

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

At
\[ V_{cc}= 400 \text{ V} \]
\[ V_{gs}= 15/0 \text{ V} \]
\[ R_{gs}= 8 \Omega \]

25 \(^\circ\text{C}\)

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

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

At
\[ V_{cc}= 400 \text{ V} \]
\[ V_{gs}= 15/0 \text{ V} \]
\[ R_{gs}= 8 \Omega \]
\[ I_C= 50 \text{ A} \]

25 \(^\circ\text{C}\)
PFC Switching Characteristics

Figure 13. FWD
Typical rate of fall of forward and reverse recovery current as a function of collector current
\[ \frac{dI}{dt}, \frac{dI_{rr}}{dt} = f(I_{C}) \]

At
- \( V_{CE} = 400 \) V
- \( V_{GE} = 15/0 \) V
- \( T_j = 125 ^{\circ}C \)
- \( R_{gon} = 8 \) Ω

Figure 14. FWD
Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor
\[ \frac{dI}{dt}, \frac{dI_{rr}}{dt} = f(R_{g}) \]

At
- \( V_{CE} = 400 \) V
- \( V_{GE} = 15/0 \) V
- \( T_j = 125 ^{\circ}C \)
- \( I_C = 50 \) A

Figure 15. IGBT
Reverse bias safe operating area

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

General conditions

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<tr>
<th>Condition</th>
<th>Value</th>
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<td>$T_j$</td>
<td>$125 , ^\circ C$</td>
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<tr>
<td>$R_{GS}$</td>
<td>$8 , \Omega$</td>
</tr>
<tr>
<td>$R_{DS}$</td>
<td>$8 , \Omega$</td>
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Figure 1. IGBT

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

Figure 2. IGBT

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

Figure 3. IGBT

Turn-off Switching Waveforms & definition of $t_f$ 

Figure 4. IGBT

Turn-on Switching Waveforms & definition of $t_r$
PFC Switching Definitions

**Figure 5.** IGBT

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

- $V_{GE(100\%)} = 20.05$ kW
- $E_{off(100\%)} = 0.43$ mJ
- $t_{E_{off}} = 0.19$ µs

**Figure 6.** IGBT

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

- $P_{on(100\%)} = 20.05$ kW
- $E_{on(100\%)} = 0.87$ mJ
- $t_{E_{on}} = 0.13$ µs

**Figure 7.** FWD

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

- $V_{d(100\%)} = 400$ V
- $I_{d(100\%)} = 50$ A
- $I_{fitted} = -51$ A
- $t_{rr} = 0.035$ µs

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PFC Switching Definitions

Figure 8. FWD
Turn-on Switching Waveforms & definition of $I_{Q_{rr}}$, integrating time for $Q_{rr}$

$\begin{align*}
I_d(100\%) &= 50 \text{ A} \\
Q_{rr}(100\%) &= 1.04 \text{ µC} \\
t_{Q_{rr}} &= 0.07 \text{ µs}
\end{align*}$

Figure 9. FWD
Turn-on Switching Waveforms & definition of $E_{rec}$, integrating time for $E_{rec}$

$\begin{align*}
P_{rec}(100\%) &= 20.05 \text{ kW} \\
E_{rec}(100\%) &= 0.16 \text{ mJ} \\
t_{E_{rec}} &= 0.07 \text{ µs}
\end{align*}$
### Ordering Code & Marking

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### Outline

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**Dimension of corona pin is only offset without tolerance**

**Tolerance of 40 pins: ±5µm at the end of pins**

---

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11 Mar. 2016 / Revision 1
## Identification

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<tr>
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<th>Current</th>
<th>Function</th>
<th>Comment</th>
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<td>50 A</td>
<td>PFC Switch</td>
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