V23990-P544-A20/ C20-PM
preliminary datasheet

flowPIM 0

Features
- Vincotech clip-in housing
- Trench Fieldstop IGBT’s for low saturation losses
- Optional w/o BRC

Target Applications
- Industrial Drives
- Embedded Generation

Types
- V23990-P544-A20-PM
- V23990-P544-C20-PM without BRC

Maximum Ratings

T_J = 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>DC forward current</td>
<td>I_{F(AV)}</td>
<td>T_J=T_{max}</td>
<td>27</td>
<td>A</td>
</tr>
<tr>
<td>Surge forward current</td>
<td>I_{F(SM)}</td>
<td>I_F=10ms</td>
<td>220</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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<tr>
<td>Repetitive peak collector current</td>
<td>I_{C(PD)}</td>
<td>I_F limited by T_{max}</td>
<td>45</td>
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<tr>
<td>Turn off safe operating area</td>
<td>V_CE ≤ 1200V, T_J ≤ T_{TOP max}</td>
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<td>45</td>
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</tr>
<tr>
<td>Power dissipation per IGBT</td>
<td>P_{tot}</td>
<td>T_J=T_{max}</td>
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<td>W</td>
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<tr>
<td>Collector-emitter break down voltage</td>
<td>V_CE</td>
<td></td>
<td>600</td>
<td>V</td>
</tr>
<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_NC</td>
<td>V_CE=15V</td>
<td>6</td>
<td>µs</td>
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<tr>
<td></td>
<td>V_{GC}</td>
<td>V_CE=15V</td>
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<tr>
<td>Maximum Junction Temperature</td>
<td>T_J</td>
<td></td>
<td>175</td>
<td>°C</td>
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Downloaded from Arrow.com.
## Maximum Ratings

<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>Inverter Diode</td>
<td></td>
<td></td>
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<tr>
<td>Peak Repetitive Reverse Voltage</td>
<td>V_{RRM}</td>
<td>( T_j=25^\circ C )</td>
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<td>V</td>
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<tr>
<td>DC forward current</td>
<td>I_F</td>
<td>( T_j=T_{\text{max}} ), ( T_c=80^\circ C )</td>
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<td>Repetitive peak forward current</td>
<td>I_{F_{\text{THRM}}}</td>
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<td>Power dissipation per Diode</td>
<td>P_{\text{Diode}}</td>
<td>( T_j=T_{\text{max}} ), ( T_c=80^\circ C )</td>
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<td>W</td>
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<tr>
<td>Maximum Junction Temperature</td>
<td>T_{\text{max}}</td>
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<td>175</td>
<td>(^\circ C)</td>
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<tr>
<td>Brake Transistor</td>
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<tr>
<td>Collector-emitter break down voltage</td>
<td>V_{CE}</td>
<td>( T_j=T_{\text{max}} )</td>
<td>600</td>
<td>V</td>
</tr>
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<td>DC collector current</td>
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<td>( T_j=T_{\text{max}} ), ( T_c=80^\circ C )</td>
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<tr>
<td>Turn off safe operating area</td>
<td>P_{\text{off}}</td>
<td>( V_{CE} \leq 1200V ), ( T_j \leq T_{\text{op max}} )</td>
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<td>Power dissipation per IGBT</td>
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<td>( T_j=T_{\text{max}} ), ( T_c=80^\circ C )</td>
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<td>W</td>
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<td>Gate-emitter peak voltage</td>
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<td>( T_j \leq 150^\circ C ), ( V_{GE}=15V )</td>
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<td>( \mu s )</td>
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<td>Short circuit ratings</td>
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<td>( V_{CC} )</td>
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<td>V</td>
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<tr>
<td>Maximum Junction Temperature</td>
<td>T_{\text{max}}</td>
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<td>175</td>
<td>(^\circ C)</td>
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<tr>
<td>Brake Diode</td>
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</tr>
<tr>
<td>Peak Repetitive Reverse Voltage</td>
<td>V_{RRM}</td>
<td>( T_j=25^\circ C )</td>
<td>600</td>
<td>V</td>
</tr>
<tr>
<td>DC forward current</td>
<td>I_F</td>
<td>( T_j=T_{\text{max}} ), ( T_c=80^\circ C )</td>
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<td>A</td>
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<td>Repetitive peak forward current</td>
<td>I_{F_{\text{THRM}}}</td>
<td>( I_L ) limited by ( T_{\text{max}} )</td>
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<td>A</td>
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<td>Power dissipation per Diode</td>
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<td>( T_j=T_{\text{max}} ), ( T_c=80^\circ C )</td>
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<td>W</td>
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<tr>
<td>Maximum Junction Temperature</td>
<td>T_{\text{max}}</td>
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<td>(^\circ C)</td>
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<td>Thermal Properties</td>
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<tr>
<td>Storage temperature</td>
<td>T_{\text{stg}}</td>
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<td>-40...+125</td>
<td>(^\circ C)</td>
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<tr>
<td>Operation temperature under switching condition</td>
<td>T_{\text{op}}</td>
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<td>-40...+(T_{\text{max}} - 25)</td>
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<td>Insulation Properties</td>
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<td>Insulation voltage</td>
<td>V_{ins}</td>
<td>( t=2s ), DC voltage</td>
<td>4000</td>
<td>V</td>
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<td>Creepage distance</td>
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<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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<td>Comparative tracking index</td>
<td>CTI</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>
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<tbody>
<tr>
<td>Input Rectifier Diode</td>
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<td>Forward voltage</td>
<td>$V_F$</td>
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<td>0.8</td>
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<td>Threshold voltage (for power loss calc. only)</td>
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<td>Slope resistance (for power loss calc. only)</td>
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<td>Reverse current</td>
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<td>Thermal resistance chip to heatsink per chip</td>
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<td>Thermal grease thickness≤50um</td>
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<td>1 W/mK</td>
<td>2.10</td>
<td>K/W</td>
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<td>Turn-on delay time</td>
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<tr>
<td>Rise time</td>
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<td>Turn-off delay time</td>
<td>$t_{off}$</td>
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<tr>
<td>Fall time</td>
<td>$t_f$</td>
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<tr>
<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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<tr>
<td>Input capacitance</td>
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<tr>
<td>Output capacitance</td>
<td>$C_{oss}$</td>
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<tr>
<td>Reverse transfer capacitance</td>
<td>$C_{iss}$</td>
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<td></td>
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<tr>
<td>Gate charge</td>
<td>$Q_{gate}$</td>
<td>±15</td>
<td>480</td>
<td>15</td>
</tr>
<tr>
<td>Thermal resistance chip to heatsink per chip</td>
<td>$R_{thJH}$</td>
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<tr>
<td>Inverter Transistor</td>
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<td>Gate emitter threshold voltage</td>
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<td>Collector-emitter saturation voltage</td>
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<td>5.8</td>
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<tr>
<td>Collector-emitter cut-off current incl. Diode</td>
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<tr>
<td>Gate-emitter leakage current</td>
<td>$I_{CES}$</td>
<td>20</td>
<td>0</td>
<td>300</td>
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<td>Integrated Gate resistor</td>
<td>$R_{gint}$</td>
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<tr>
<td>Turn-on delay time</td>
<td>$t_{on}$</td>
<td>≤15</td>
<td>300</td>
<td>15</td>
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<tr>
<td>Rise time</td>
<td>$t_r$</td>
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<tr>
<td>Turn-off delay time</td>
<td>$t_{off}$</td>
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<tr>
<td>Fall time</td>
<td>$t_f$</td>
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<tr>
<td>Turn-on energy loss per pulse</td>
<td>$E_{on}$</td>
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<td></td>
</tr>
<tr>
<td>Turn-off energy loss per pulse</td>
<td>$E_{off}$</td>
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<td></td>
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<tr>
<td>Input capacitance</td>
<td>$C_{iss}$</td>
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<tr>
<td>Output capacitance</td>
<td>$C_{oss}$</td>
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<tr>
<td>Reverse transfer capacitance</td>
<td>$C_{iss}$</td>
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<td></td>
</tr>
<tr>
<td>Gate charge</td>
<td>$Q_{gate}$</td>
<td>±15</td>
<td>480</td>
<td>15</td>
</tr>
<tr>
<td>Thermal resistance chip to heatsink per chip</td>
<td>$R_{thJH}$</td>
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<tr>
<td>Inverter Diode</td>
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<tr>
<td>Diode forward voltage</td>
<td>$V_F$</td>
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<tr>
<td>Peak reverse recovery current</td>
<td>$I_{RRM}$</td>
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<td>Reverse recovery time</td>
<td>$t_{RR}$</td>
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<tr>
<td>Reverse recovered charge</td>
<td>$Q_{RR}$</td>
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<tr>
<td>Peak rate of fall of recovery current</td>
<td>$dI_{Cerr}/dt_{max}$</td>
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<tr>
<td>Reverse recovered energy</td>
<td>$E_{rec}$</td>
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<tr>
<td>Thermal resistance chip to heatsink per chip</td>
<td>$R_{thJH}$</td>
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</table>
### Brake Transistor

<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>$V_{GE}$</td>
<td>$V_{CE}$</td>
<td>$V_{GS}$</td>
<td>$V_{GE}$ \text{ or } $V_{GS}$</td>
</tr>
<tr>
<td>Collector-emitter saturation voltage</td>
<td>$V_{CE}$</td>
<td>$V_{GS}$</td>
<td>$I_{D}$</td>
<td>$I_{C}$</td>
</tr>
<tr>
<td>Collector-emitter cut-off incl diode</td>
<td>$I_{SS}$</td>
<td>$V_{CE}$</td>
<td>$V_{GS}$</td>
<td>$I_{D}$</td>
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<tr>
<td>Gate-emitter leakage current</td>
<td>$I_{SS}$</td>
<td>$V_{CE}$</td>
<td>$V_{GS}$</td>
<td>$I_{D}$</td>
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<td>Integrated Gate resistor</td>
<td>$R_{int}$</td>
<td>none</td>
<td>$T_j$</td>
<td>Min</td>
</tr>
<tr>
<td>Turn-on delay time</td>
<td>$t_{on}$</td>
<td>$T_j$</td>
<td>$T_j$</td>
<td>Min</td>
</tr>
<tr>
<td>Rise time</td>
<td>$t_{rise}$</td>
<td>$R_{goff}=16 , \Omega$</td>
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<td>Min</td>
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<tr>
<td>Turn-off delay time</td>
<td>$t_{off}$</td>
<td>$R_{gon}=32 , \Omega$</td>
<td>$T_j$</td>
<td>Min</td>
</tr>
<tr>
<td>Fall time</td>
<td>$t_f$</td>
<td>$T_j$</td>
<td>$T_j$</td>
<td>Min</td>
</tr>
<tr>
<td>Turn-on energy loss per pulse</td>
<td>$E_{on}$</td>
<td>none</td>
<td>$T_j$</td>
<td>Min</td>
</tr>
<tr>
<td>Turn-off energy loss per pulse</td>
<td>$E_{off}$</td>
<td>none</td>
<td>$T_j$</td>
<td>Min</td>
</tr>
<tr>
<td>Input capacitance</td>
<td>$C_{in}$</td>
<td>$f=1 \text{MHz}$</td>
<td>$T_j$</td>
<td>Min</td>
</tr>
<tr>
<td>Output capacitance</td>
<td>$C_{out}$</td>
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<td>$T_j$</td>
<td>Min</td>
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<tr>
<td>Reverse transfer capacitance</td>
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<td>none</td>
<td>$T_j$</td>
<td>Min</td>
</tr>
<tr>
<td>Gate charge</td>
<td>$Q_{gate}$</td>
<td>$T_j$</td>
<td>$T_j$</td>
<td>Min</td>
</tr>
<tr>
<td>Thermal resistance chip to heatsink per chip</td>
<td>$R_{thJH}$</td>
<td>Thermal grease thickness 550um $k = 1 \text{W/mK}$</td>
<td>$T_j$</td>
<td>Min</td>
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### Brake Diode

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Diode forward voltage</td>
<td>$V_D$</td>
<td>$T_j$</td>
<td>$T_j$</td>
<td>Min</td>
</tr>
<tr>
<td>Reverse leakage current</td>
<td>$I_r$</td>
<td>$R_{gon}=32 , \Omega$</td>
<td>$T_j$</td>
<td>Min</td>
</tr>
<tr>
<td>Peak reverse recovery current</td>
<td>$I_{Rmax}$</td>
<td>$R_{gon}=32 , \Omega$</td>
<td>$T_j$</td>
<td>Min</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>$t_{rr}$</td>
<td>$R_{gon}=32 , \Omega$</td>
<td>$T_j$</td>
<td>Min</td>
</tr>
<tr>
<td>Reverse recovered charge</td>
<td>$Q_{r}$</td>
<td>$R_{gon}=32 , \Omega$</td>
<td>$T_j$</td>
<td>Min</td>
</tr>
<tr>
<td>Peak rate of fall of recovery current</td>
<td>$E_{rec} = \frac{Q_{r}}{f}$</td>
<td>$R_{gon}=32 , \Omega$</td>
<td>$T_j$</td>
<td>Min</td>
</tr>
<tr>
<td>Reverse recovery energy</td>
<td>$E_{rec}$</td>
<td>none</td>
<td>$T_j$</td>
<td>Min</td>
</tr>
<tr>
<td>Thermal resistance chip to heatsink per chip</td>
<td>$R_{thJH}$</td>
<td>Thermal grease thickness 550um $k = 1 \text{W/mK}$</td>
<td>$T_j$</td>
<td>Min</td>
</tr>
</tbody>
</table>

### Thermistor

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated resistance</td>
<td>$R$</td>
<td>$T_j$</td>
<td>$T_j$</td>
<td>Min</td>
</tr>
<tr>
<td>Deviation of $R_{100}$</td>
<td>$\Delta R/R$</td>
<td>$R_{100}=1486 , \Omega$</td>
<td>\text{or} $T_c=100^\circ\text{C}$</td>
<td>$-5$</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>$P$</td>
<td>$T_c=100^\circ\text{C}$</td>
<td>$T_c=100^\circ\text{C}$</td>
<td>$210$</td>
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<tr>
<td>Power dissipation constant</td>
<td>$T_j=25^\circ\text{C}$</td>
<td>$T_j=25^\circ\text{C}$</td>
<td>$3.5$</td>
<td>$\text{mW/K}$</td>
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<tr>
<td>B-value</td>
<td>$B_{25/50}$</td>
<td>$T_j=25^\circ\text{C}$</td>
<td>$T_j=25^\circ\text{C}$</td>
<td>$4000$</td>
</tr>
<tr>
<td>Vincotech NTC Reference</td>
<td>$B_{25/50}$</td>
<td>$T_j=25^\circ\text{C}$</td>
<td>$T_j=25^\circ\text{C}$</td>
<td>$K$</td>
</tr>
</tbody>
</table>

Copyright by Vincotech
Output Inverter

**Figure 1** Output inverter IGBT

Typical output characteristics

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

At

\[ t_p = 250 \ \mu s \]

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

\[ V_{CE} \text{ from } 7 \text{ V to } 17 \text{ V in steps of } 1 \text{ V} \]

**Figure 2** Output inverter IGBT

Typical output characteristics

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

At

\[ t_p = 250 \ \mu s \]

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

\[ V_{CE} \text{ from } 7 \text{ V to } 17 \text{ V in steps of } 1 \text{ V} \]

**Figure 3** Output inverter IGBT

Typical transfer characteristics

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

At

\[ t_p = 250 \ \mu s \]

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

\[ V_{CE} = 10 \text{ V} \]

**Figure 4** Output inverter FWD

Typical diode forward current as a function of forward voltage

\[ I_F = f(V_F) \]

At

\[ t_p = 250 \ \mu s \]

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

\[ T_j = T_{j\text{max}} - 25 \ ^\circ C \]
Figure 5: Output inverter IGBT
Typical switching energy losses as a function of collector current
\[ E = f(I_c) \]

With an inductive load at
\[ T_j = 25/125 \, ^\circ C \]
\[ V_C = 300 \, V \]
\[ V_{GE} = 15 \, V \]
\[ R_{g(on)} = 16 \, \Omega \]
\[ R_{g(off)} = 8 \, \Omega \]

Figure 6: Output inverter IGBT
Typical switching energy losses as a function of gate resistor
\[ E = f(R_g) \]

With an inductive load at
\[ T_j = 25/125 \, ^\circ C \]
\[ V_C = 300 \, V \]
\[ V_{GE} = 15 \, V \]
\[ I_c = 15 \, A \]

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

With an inductive load at
\[ T_j = 25/125 \, ^\circ C \]
\[ V_C = 300 \, V \]
\[ V_{GE} = 15 \, V \]
\[ R_{g(on)} = 16 \, \Omega \]

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

With an inductive load at
\[ T_j = 25/125 \, ^\circ C \]
\[ V_C = 300 \, V \]
\[ V_{GE} = 15 \, V \]
\[ I_c = 15 \, A \]
Figure 9: Output inverter IGBT
Typical switching times as a function of collector current
\[ t = f(I_C) \]

With an inductive load at
- \( T_j = 125 \, ^\circ C \)
- \( V_{CE} = 300 \, V \)
- \( V_{GE} = 15 \, V \)
- \( R_{gon} = 16 \, \Omega \)
- \( R_{goff} = 8 \, \Omega \)

Figure 10: Output inverter IGBT
Typical switching times as a function of gate resistor
\[ t = f(R_g) \]

With an inductive load at
- \( T_j = 125 \, ^\circ C \)
- \( V_{CE} = 300 \, V \)
- \( V_{GE} = 15 \, V \)
- \( I_C = 15 \, A \)

Figure 11: Output inverter FWD
Typical reverse recovery time as a function of collector current
\[ t_{rr} = f(I_C) \]

At
- \( T_j = 25/125 \, ^\circ C \)
- \( V_{CE} = 300 \, V \)
- \( V_{GE} = 15 \, V \)
- \( R_{gon} = 16 \, \Omega \)

Figure 12: Output inverter FWD
Typical reverse recovery time as a function of IGBT turn on gate resistor
\[ t_{rr} = f(R_{gon}) \]

At
- \( T_j = 25/125 \, ^\circ C \)
- \( V_{CE} = 300 \, V \)
- \( I_C = 15 \, A \)
- \( V_{GE} = 15 \, V \)
Output Inverter

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

\[ Q_{rr} \]

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

\[ T_j = 25^\circ C \]

\[ 0 \]

\[ 0.3 \]

\[ 0.6 \]

\[ 0.9 \]

\[ 1.2 \]

\[ 1.5 \]

\[ 0 \]

\[ 5 \]

\[ 10 \]

\[ 15 \]

\[ 20 \]

\[ 25 \]

\[ 30 \]

\[ I_C (A) \]

\[ T_{j_{max}} \]

\[ 25 \]

\[ 125 \]

\[ °C \]

\[ V_C E = 300 V \]

\[ V_{GE} = 15 V \]

\[ R_{gon} = 16 \Omega \]

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

\[ Q_{rr} \]

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

\[ T_j = 25^\circ C \]

\[ 0 \]

\[ 0.2 \]

\[ 0.4 \]

\[ 0.6 \]

\[ 0.8 \]

\[ 1 \]

\[ 0 \]

\[ 30 \]

\[ 60 \]

\[ 90 \]

\[ 120 \]

\[ 150 \]

\[ R_{gon} (\Omega) \]

\[ Q_{rr} \]

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

\[ T_j = 25^\circ C \]

\[ 0 \]

\[ 0.3 \]

\[ 0.6 \]

\[ 0.9 \]

\[ 1.2 \]

\[ 1.5 \]

\[ 0 \]

\[ 30 \]

\[ 60 \]

\[ 90 \]

\[ 120 \]

\[ 150 \]

\[ I_C (A) \]

\[ T_{j_{max}} \]

\[ 25 \]

\[ 125 \]

\[ °C \]

\[ V_C E = 300 V \]

\[ V_{GE} = 15 V \]

\[ I_F = 15 A \]

\[ V_{GE} = 15 V \]

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

\[ I_{RRM} \]

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

\[ T_j = 25^\circ C \]

\[ 0 \]

\[ 5 \]

\[ 10 \]

\[ 15 \]

\[ 20 \]

\[ 25 \]

\[ 30 \]

\[ I_C (A) \]

\[ T_{j_{max}} \]

\[ 25 \]

\[ 125 \]

\[ °C \]

\[ V_C E = 300 V \]

\[ V_{GE} = 15 V \]

\[ I_F = 15 A \]

\[ V_{GE} = 15 V \]

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

\[ I_{RRM} \]

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

\[ T_j = 25^\circ C \]

\[ 0 \]

\[ 2 \]

\[ 4 \]

\[ 6 \]

\[ 8 \]

\[ 10 \]

\[ 12 \]

\[ 14 \]

\[ 16 \]

\[ 18 \]

\[ 0 \]

\[ 5 \]

\[ 10 \]

\[ 15 \]

\[ 20 \]

\[ 25 \]

\[ R_{gon} (\Omega) \]

\[ I_{RRM} \]

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

\[ T_j = 25^\circ C \]

\[ 0 \]

\[ 2 \]

\[ 4 \]

\[ 6 \]

\[ 8 \]

\[ 10 \]

\[ 12 \]

\[ 14 \]

\[ 16 \]

\[ 18 \]

\[ 20 \]

\[ 22 \]

\[ 24 \]

\[ 26 \]

\[ 28 \]

\[ 30 \]

\[ 0 \]

\[ 30 \]

\[ 60 \]

\[ 90 \]

\[ 120 \]

\[ 150 \]

\[ I_C (A) \]

\[ T_{j_{max}} \]

\[ 25 \]

\[ 125 \]

\[ °C \]

\[ V_C E = 300 V \]

\[ V_{GE} = 15 V \]

\[ I_F = 15 A \]

\[ V_{GE} = 15 V \]
Output Inverter

**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
- \( T_j = 25/125 \degree C \)
- \( V_{CE} = 300 \text{ V} \)
- \( V_{GE} = 15 \text{ V} \)
- \( I_F = 15 \text{ A} \)
- \( R_{gon} = 16 \text{ }\Omega\)

**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
- \( T_j = 25/125 \degree C \)
- \( V_{GE} = 15 \text{ V} \)
- \( I_F = 15 \text{ A} \)
- \( V_{GE} = 15 \text{ V} \)

**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
\[Z_{th,JH} = f(t_p)\]

**IGBT thermal model values**

<table>
<thead>
<tr>
<th>Thermal grease</th>
<th>Phase change interface</th>
<th>R (C/W)</th>
<th>Tau (s)</th>
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<td>0.19</td>
<td>3.0E-04</td>
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<td>2.4E-04</td>
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</table>

**FWD thermal model values**

<table>
<thead>
<tr>
<th>Thermal grease</th>
<th>Phase change interface</th>
<th>R (C/W)</th>
<th>Tau (s)</th>
</tr>
</thead>
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<td>8.5E-04</td>
<td>0.19</td>
<td>6.9E-04</td>
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</table>
Output Inverter

Figure 21 Output inverter IGBT
Power dissipation as a function of heatsink temperature
\[ P_{\text{tot}} = f(T_j) \]

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

Figure 22 Output inverter IGBT
Collector current as a function of heatsink temperature
\[ I_C = f(T_j) \]

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

Figure 23 Output inverter FWD
Power dissipation as a function of heatsink temperature
\[ P_{\text{tot}} = f(T_j) \]

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

Figure 24 Output inverter FWD
Forward current as a function of heatsink temperature
\[ I_F = f(T_j) \]

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

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

At
- Single pulse
- \( T_J = 80 \, ^\circ C \)
- \( V_{GE} = 15 \, V \)
- \( T_j = T_{j_{max}} \, ^\circ C \)

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

At
- \( I_C = 15 \, A \)

Figure 27
Short circuit withstand time as a function of gate-emitter voltage
\[ t_{sc} = f(V_{GE}) \]

At
- \( V_{CE} \leq 600 \, V \)
- \( T_j \leq 175 \, ^\circ C \)

Figure 28
Typical short circuit collector current as a function of gate-emitter voltage
\[ I_{c_{(sc)}} = f(V_{GE}) \]

At
- \( V_{CE} \leq 600 \, V \)
- \( T_j = 175 \, ^\circ C \)
Figure 29  
IGBT  
Reverse bias safe operating area

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

At
\[ T_j = T_{j_{max}} - 25 ^\circ C \]
\[ U_{cc_{minus}} = U_{cc_{plus}} \]
Switching mode : 3 level switching
Brake

**Figure 1** Brake IGBT

Typical output characteristics

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

At

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

**Figure 2** Brake IGBT

Typical output characteristics

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

At

\[ t_p = 250 \mu s \]
\[ T_j = 125^\circ C \]
\[ V_{CE} \text{ from } 7 \text{ V to } 17 \text{ V in steps of } 1 \text{ V} \]

**Figure 3** Brake IGBT

Typical transfer characteristics

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

At

\[ t_p = 250 \mu s \]
\[ V_{CE} \text{ from } 10 \text{ V} \]

**Figure 4** Brake FWD

Typical diode forward current as a function of forward voltage

\[ I_F = f(V_F) \]

At

\[ t_p = 250 \mu s \]
\[ T_j = T_{j\text{max}} - 25^\circ C \]
Brake

**Typical switching energy losses**

Typical switching energy losses as a function of collector current

\[ E = f(I_C) \]

With an inductive load at

- \( T_j = 25/125 \, ^\circ C \)
- \( V_{CE} = 300 \, V \)
- \( V_{GE} = 15 \, V \)
- \( R_{gon} = 32 \, \Omega \)
- \( R_{goff} = 16 \, \Omega \)

**Typical reverse recovery energy loss**

Typical reverse recovery energy loss as a function of collector current

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

With an inductive load at

- \( T_j = 25/125 \, ^\circ C \)
- \( V_{CE} = 300 \, V \)
- \( V_{GE} = 15 \, V \)
- \( I_c = 10 \, A \)
Brake

**Figure 9** Brake IGBT

Typical switching times as a function of collector current

\[ t = f(I_C) \]

With an inductive load at

- \( T_j = 25/125 \) °C
- \( V_{CE} = 300 \) V
- \( V_{GE} = 15 \) V
- \( R_{GON} = 32 \) Ω
- \( R_{GOFF} = 16 \) Ω

**Figure 10** Brake IGBT

Typical switching times as a function of gate resistor

\[ t = f(R_G) \]

With an inductive load at

- \( T_j = 25/125 \) °C
- \( V_{CE} = 300 \) V
- \( V_{GE} = 15 \) V
- \( I_C = 10 \) A

**Figure 11** Brake IGBT

IGBT transient thermal impedance as a function of pulse width

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

**Figure 12** Brake FWD

FWD transient thermal impedance as a function of pulse width

\[ Z_{THJH} = f(t_p) \]
Brake

Power dissipation as a function of heatsink temperature

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

At

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

Forward current as a function of heatsink temperature

\[ I_F = f(T_h) \]

At

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

\[ V_{GE} = 15 \, V \]
**Input Rectifier Bridge**

**Figure 1**
Typical diode forward current as a function of forward voltage $I_F = f(V_F)$

![Graph showing forward current as a function of forward voltage.]

At $T_j = 250 \, \mu s$

**Figure 2**
Diode transient thermal impedance as a function of pulse width $Z_{thJH} = f(t_p)$

![Graph showing thermal impedance as a function of pulse width.]

At $D = 0.5$

**Figure 3**
Power dissipation as a function of heatsink temperature $P_{tot} = f(T_h)$

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

At $T_j = 150 \, ^\circ C$

**Figure 4**
Forward current as a function of heatsink temperature $I_F = f(T_h)$

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

At $T_j = 150 \, ^\circ C$
**Thermistor**

**Figure 1**

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

\[ R_T = f(T) \]

**Figure 2**

**Typical NTC resistance values**

\[
R(T) = R_{25} \cdot e^{\left( \frac{R_{25}}{100} \cdot \left( \frac{1}{T - 25} \right) \right)} [\Omega]
\]

<table>
<thead>
<tr>
<th>T (°C)</th>
<th>R_{25} [Ω]</th>
<th>R_{min} [Ω]</th>
<th>R_{max} [Ω]</th>
<th>ΔR/R [%]</th>
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<td>430.7</td>
<td>9.9</td>
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Switching Definitions Output Inverter

General conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>$T_j$</td>
<td>125 °C</td>
</tr>
<tr>
<td>$R_{son}$</td>
<td>32 Ω</td>
</tr>
<tr>
<td>$R_{goff}$</td>
<td>16 Ω</td>
</tr>
</tbody>
</table>

Figure 1: Output inverter IGBT

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

$t_{doff}$ = integrating time for $E_{off}$

$t_{Eoff}$ = integrating time for $E_{off}$

- $V_{CE}$ (0%) = 0 V
- $V_{CE}$ (100%) = 15 V
- $V_C$ (100%) = 300 V
- $I_C$ (100%) = 15 A
- $t_{doff}$ = 0.21 μs
- $t_{Eoff}$ = 0.44 μs

Figure 2: Output inverter IGBT

Turn-on Switching Waveforms & definition of $tdon$, $tEon$

$tdon$ = integrating time for $E_{on}$

$tEon$ = integrating time for $E_{on}$

- $V_{CE}$ (0%) = 0 V
- $V_{CE}$ (100%) = 15 V
- $V_C$ (100%) = 300 V
- $I_C$ (100%) = 15 A
- $tdon$ = 0.02 μs
- $tEon$ = 0.20 μs

Figure 3: Output inverter IGBT

Turn-off Switching Waveforms & definition of $t_f$

- $V_C$ (100%) = 300 V
- $I_C$ (100%) = 15 A
- $t_f$ = 0.09 μs

Figure 4: Output inverter IGBT

Turn-on Switching Waveforms & definition of $tr$

- $V_C$ (100%) = 300 V
- $I_C$ (100%) = 15 A
- $t_r$ = 0.02 μs
### Switching Definitions Output Inverter

**Figure 5**

**Output inverter IGBT**

**Turn-off Switching Waveforms & definition of** $t_{\text{Eoff}}$

- $P_{\text{off}}(100\%) = 4.47 \text{ kW}$
- $E_{\text{off}}(100\%) = 0.40 \text{ mJ}$
- $t_{\text{Eoff}} = 0.44 \mu\text{s}$

**Figure 6**

**Output inverter IGBT**

**Turn-on Switching Waveforms & definition of** $t_{\text{Eon}}$

- $P_{\text{on}}(100\%) = 4.47 \text{ kW}$
- $E_{\text{on}}(100\%) = 0.34 \text{ mJ}$
- $t_{\text{Eon}} = 0.20 \mu\text{s}$

**Figure 7**

**Output inverter FWD**

**Gate voltage vs Gate charge (measured)**

- $V_{\text{GEoff}} = 0 \text{ V}$
- $V_{\text{GEon}} = 15 \text{ V}$
- $V_{\text{C}}(100\%) = 300 \text{ V}$
- $I_{\text{off}}(100\%) = 15 \text{ A}$
- $Q_{\text{g}} = 105.74 \text{ nC}$

**Figure 8**

**Output inverter IGBT**

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

- $I_{\text{d}}(100\%) = 300 \text{ V}$
- $I_{\text{ff}}(100\%) = 15 \text{ A}$
- $t_{\text{rr}} = 0.21 \mu\text{s}$
Switching Definitions Output Inverter

**Figure 9**
Turn-on Switching Waveforms & definition of $t_{Qrr}$
($t_{Qrr} = \text{integrating time for } Q_r$)

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<thead>
<tr>
<th>Time (μs)</th>
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<th>3.3</th>
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<tr>
<td>Qr (100%)</td>
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<tr>
<td>tQrr</td>
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</tbody>
</table>

$Id (100%) = 15 \text{ A}$  
$Qr (100%) = 1.01 \text{ μC}$  
$t_{Qrr} = 0.49 \text{ μs}$

**Figure 10**
Turn-on Switching Waveforms & definition of $t_{Erec}$
($t_{Erec} = \text{integrating time for } \text{Erec}$)

<table>
<thead>
<tr>
<th>Time (μs)</th>
<th>2.9</th>
<th>3.1</th>
<th>3.3</th>
<th>3.5</th>
<th>3.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erec (100%)</td>
<td>150</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prec (100%)</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tErec</td>
<td>0.49</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$P_{rec} (100%) = 4.47 \text{ kW}$  
$E_{rec} (100%) = 0.20 \text{ mJ}$  
$t_{Erec} = 0.49 \text{ μs}$
Ordering Code and Marking

<table>
<thead>
<tr>
<th>Version</th>
<th>Ordering Code</th>
<th>in DataMatrix as</th>
<th>in packaging barcode as</th>
</tr>
</thead>
<tbody>
<tr>
<td>without thermal paste 12mm housing</td>
<td>V23990-P544-A20-PM</td>
<td>P544-A20</td>
<td>P544-A20</td>
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</tbody>
</table>

Outline

Pinout

This drawing contains the maximum configuration. Depending upon types, some components may be left. See in part list.
### PRODUCT STATUS DEFINITIONS

<table>
<thead>
<tr>
<th>Datasheet Status</th>
<th>Product Status</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>Formative or In Design</td>
<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>
</tr>
<tr>
<td>Preliminary</td>
<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>
</tr>
<tr>
<td>Final</td>
<td>Full Production</td>
<td>This datasheet contains final specifications. 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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</table>

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.