### Features
- High efficiency dual boost
- Ultra fast switching frequency
- Low Inductance Layout
- 1200V IGBT and 1200V Si diode

### Target Applications
- Solar inverter

### Types
- V23990-P629-F73-PM

### 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>Bypass Diode</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$</td>
<td>$T_j=25°C$</td>
<td>1600</td>
<td>V</td>
</tr>
<tr>
<td>DC forward current</td>
<td>$I_{F(AV)}$</td>
<td>$T_j=T_{j\text{max}}$</td>
<td>34</td>
<td>A</td>
</tr>
<tr>
<td>Surge forward current</td>
<td>$I_{SM}$</td>
<td>$t_p=10\text{ms}$</td>
<td>220</td>
<td>A</td>
</tr>
<tr>
<td>$I^2t$-value</td>
<td>$I^2t$</td>
<td>$T_j=25°C$</td>
<td>200</td>
<td>A$s$</td>
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<tr>
<td>Power dissipation per Diode</td>
<td>$P_{ss}$</td>
<td>$T_j=T_{j\text{max}}$</td>
<td>41</td>
<td>W</td>
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<tr>
<td>Maximum Junction Temperature</td>
<td>$T_{j\text{max}}$</td>
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<td>150</td>
<td>°C</td>
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<tr>
<td>Boost IGBT</td>
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<tr>
<td>Collector-emitter break down voltage</td>
<td>$V_{CE}$</td>
<td>$T_j=25°C$</td>
<td>1200</td>
<td>V</td>
</tr>
<tr>
<td>DC collector current</td>
<td>$I_C$</td>
<td>$T_j=T_{j\text{max}}$</td>
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<td>A</td>
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<td>Pulsed collector current</td>
<td>$I_{P(10ms)}$</td>
<td>$I_p$ limited by $T_{j\text{max}}$</td>
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<td>A</td>
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<tr>
<td>Turn off safe operating area</td>
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<td>$V_{CE} \leq 800\text{V}$, $T_j \leq \text{Top max}$</td>
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<tr>
<td>Power dissipation per IGBT</td>
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<td>$T_j=T_{j\text{max}}$</td>
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<td>Gate-emitter peak voltage</td>
<td>$V_{GE}$</td>
<td>$T_j \leq 150°C$</td>
<td>±25</td>
<td>V</td>
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<td>Short circuit ratings</td>
<td>$I_{DC}$</td>
<td>$V_{CE}$</td>
<td>$V_{GE}=15\text{V}$</td>
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<tr>
<td>Maximum Junction Temperature</td>
<td>$T_{j\text{max}}$</td>
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## Maximum Ratings

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<tr>
<td><strong>Boost IGBT Protection Diode</strong></td>
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<tr>
<td>Peak Repetitive Reverse Voltage</td>
<td>$V_{\text{RRM}}$</td>
<td>$T_j=25^\circ C$</td>
<td>1600</td>
<td>V</td>
</tr>
<tr>
<td>DC forward current</td>
<td>$I_F$</td>
<td>$T_j=T_{\text{max}}$</td>
<td>$T_j=80^\circ C$</td>
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<td>Surge forward current</td>
<td>$I_{F SM}$</td>
<td>$t_p=10\text{ms}, \sin 180^\circ$</td>
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<td>A</td>
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<td>Power dissipation per Diode</td>
<td>$P_{\text{tot}}$</td>
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<tr>
<td>Maximum Junction Temperature</td>
<td>$T_{\text{max}}$</td>
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<td>°C</td>
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<tr>
<td><strong>Boost FWD</strong></td>
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<td>Peak Repetitive Reverse Voltage</td>
<td>$V_{\text{RRM}}$</td>
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<td>V</td>
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<td>DC forward current</td>
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<td>Repetitive peak forward current</td>
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<td>Maximum Junction Temperature</td>
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<td>175</td>
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<td><strong>Thermal Properties</strong></td>
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<td>Storage temperature</td>
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<td>-40...+125</td>
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<tr>
<td>Operation temperature under switching condition</td>
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<td>-40..-40...+T_{\text{max}} - 25</td>
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<td><strong>Insulation Properties</strong></td>
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<td>Insulation voltage</td>
<td>$V_\text{is}$</td>
<td>$I=2s$ DC voltage</td>
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<td>Creepage distance</td>
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<td>mm</td>
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<tr>
<td>Clearance</td>
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<td>min 12.7</td>
<td>mm</td>
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### Characteristic Values

<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>Bypass Diode</strong></td>
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<tr>
<td>Forward voltage</td>
<td>$V_{F}$</td>
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<td>$1.13$</td>
<td>$V$</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>$I_{r}$</td>
<td>$1600$</td>
<td>$0.05$</td>
<td>mA</td>
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<td>Thermal resistance chip to heatsink per chip</td>
<td>$R_{thJH}$</td>
<td></td>
<td></td>
<td>kW</td>
</tr>
<tr>
<td>Thermal resistance chip to case per chip</td>
<td>$R_{thJC}$</td>
<td></td>
<td></td>
<td>kW</td>
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<tr>
<td><strong>Boost IGBT</strong></td>
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<tr>
<td>Gate-emitter threshold voltage</td>
<td>$V_{GE(th)}$</td>
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<td>$15$</td>
<td>$V$</td>
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<tr>
<td>Collector-emitter saturation voltage</td>
<td>$V_{CE(sat)}$</td>
<td>$40$</td>
<td>$2.74$</td>
<td>$V$</td>
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<td>Collector-emitter cut-off</td>
<td>$I_{CSS}$</td>
<td>$1200$</td>
<td>$1$</td>
<td>mA</td>
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<td>Gate-emitter leakage current</td>
<td>$I_{fss}$</td>
<td>$\pm 25$</td>
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<td>Integrated Gate resistor</td>
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<td>Ω</td>
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<td>Turn-on delay time</td>
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<td>$25$</td>
<td>$26$</td>
<td>ns</td>
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<td>Rise time</td>
<td>$t_{r}$</td>
<td>$25$</td>
<td>$25$</td>
<td>ns</td>
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<td>Turn-off delay time</td>
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<td>$16$</td>
<td>ns</td>
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<td>Fall time</td>
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<td>Turn-on energy loss per pulse</td>
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<td>Turn-off energy loss per pulse</td>
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<td>mWs</td>
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<td>Input capacitance</td>
<td>$C_{in}$</td>
<td>$f=1MHz$</td>
<td>$3200$</td>
<td>pF</td>
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<td>Output capacitance</td>
<td>$C_{out}$</td>
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<td>$370$</td>
<td>pF</td>
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<td>Reverse transfer capacitance</td>
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<td>$125$</td>
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<td>Gate charge</td>
<td>$Q_{gate}$</td>
<td>$15$</td>
<td>$220$</td>
<td>nC</td>
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<tr>
<td>Thermal resistance chip to heatsink per chip</td>
<td>$R_{thJH}$</td>
<td>Thermal grease thickness550um $\lambda = 1 \text{ W/mK}$</td>
<td>$0.65$</td>
<td>kW</td>
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<tr>
<td>Thermal resistance chip to case per chip</td>
<td>$R_{thJC}$</td>
<td>Thermal grease thickness550um $\lambda = 1 \text{ W/mK}$</td>
<td>$0.43$</td>
<td>kW</td>
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<tr>
<td><strong>Boost IGBT Protection Diode</strong></td>
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<tr>
<td>Diode forward voltage</td>
<td>$V_{F}$</td>
<td>$25$</td>
<td>$1.13$</td>
<td>$V$</td>
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<td>Thermal resistance chip to heatsink per chip</td>
<td>$R_{thJH}$</td>
<td>Thermal grease thickness550um $\lambda = 1 \text{ W/mK}$</td>
<td>$1.71$</td>
<td>kW</td>
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<td>Thermal resistance chip to case per chip</td>
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<td>$1.13$</td>
<td>kW</td>
</tr>
<tr>
<td><strong>Boost FWD</strong></td>
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</tr>
<tr>
<td>Forward voltage</td>
<td>$V_{F}$</td>
<td>$50$</td>
<td>$2.25$</td>
<td>$V$</td>
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<td>Reverse leakage current</td>
<td>$I_{bn}$</td>
<td>$700$</td>
<td>$60$</td>
<td>µA</td>
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<td>Peak recovery current</td>
<td>$I_{F}$</td>
<td>$700$</td>
<td>$98$</td>
<td>A</td>
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<td>Reverse recovery time</td>
<td>$t_{off}$</td>
<td>$700$</td>
<td>$117$</td>
<td>ns</td>
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<td>Reverse recovery charge</td>
<td>$Q_{off}$</td>
<td>$700$</td>
<td>$3.71$</td>
<td>µC</td>
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<td>Reverse recovered energy</td>
<td>$E_{off}$</td>
<td>$700$</td>
<td>$3.69$</td>
<td>mWs</td>
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<td>Peak rate of fall of recovery current</td>
<td>$di/dt_{m ax}$</td>
<td>$700$</td>
<td>$3120$</td>
<td>A/µs</td>
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<td>Thermal resistance chip to heatsink per chip</td>
<td>$R_{thJH}$</td>
<td>Thermal grease thickness550um $\lambda = 1 \text{ W/mK}$</td>
<td>$1.16$</td>
<td>kW</td>
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<td>Thermal resistance chip to case per chip</td>
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<td>Thermal grease thickness550um $\lambda = 1 \text{ W/mK}$</td>
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<td>kW</td>
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<tr>
<td>Thermistor</td>
<td>R</td>
<td>Tol. ±5%</td>
<td>$T_j=25\degree C$</td>
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<td>Deviation of R25</td>
<td>$\Delta R/R$</td>
<td>$R_{100}=1503\Omega$</td>
<td>$T_c=100\degree C$</td>
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<td>Power dissipation</td>
<td>P</td>
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<td>mW</td>
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<td>Power dissipation constant</td>
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<td>mW/K</td>
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<td>B-value</td>
<td>$B(25/50)$</td>
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<tr>
<td>B-value</td>
<td>$B(25/100)$</td>
<td>Tol. ±3%</td>
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<td>Vincotech NTC Reference</td>
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<td>B</td>
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</table>
Boost IGBT Protection Diode

Figure 1: Boost IGBT Protection Diode
Typical FWD forward current as a function of forward voltage
\( I_F = f(V_F) \)

At
\( t_p = 250 \mu s \)

Figure 2: Boost IGBT Protection Diode
Diode transient thermal impedance as a function of pulse width
\( Z_{thJH} = f(t_p) \)

At
\( D = \frac{t_p}{T} \)
\( R_{thJH} = 1.71 K/W \)

Figure 3: Boost IGBT Protection Diode
Power dissipation as a function of heatsink temperature
\( P_{tot} = f(T_h) \)

At
\( T_j = 150 ^\circ C \)

Figure 4: Boost IGBT Protection Diode
Forward current as a function of heatsink temperature
\( I_F = f(T_h) \)

At
\( T_j = 150 ^\circ C \)
INPUT BOOST

Figure 3  BOOST IGBT
Typical output characteristics
\[ I_C = f(V_{CE}) \]

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

Figure 4  BOOST FWD
Typical output characteristics
\[ I_C = f(V_{CE}) \]

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

Figure 3  BOOST IGBT
Typical transfer characteristics
\[ I_C = f(V_{GE}) \]

Figure 4  BOOST FWD
Typical FWD forward current as a function of forward voltage
\[ I_F = f(V_F) \]

At
\[ t_p = 250 \ \mu s \]
\[ V_{DS} = 10 \ V \]
**Figure 5**   
**Typical switching energy losses**  
as a function of collector current  
\[ E = f(I_C) \]

With an inductive load at  
\[ T_J = 25/126 \, ^\circ\mathrm{C} \]  
\[ V_{DS} = 700 \, \mathrm{V} \]  
\[ V_{GS} = 15 \, \mathrm{V} \]  
\[ R_{gon} = 4 \, \Omega \]  
\[ I_D = 40 \, \mathrm{A} \]

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

With an inductive load at  
\[ T_J = 25/126 \, ^\circ\mathrm{C} \]  
\[ V_{DS} = 700 \, \mathrm{V} \]  
\[ V_{GS} = 15 \, \mathrm{V} \]  
\[ I_D = 40 \, \mathrm{A} \]

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

With an inductive load at  
\[ T_J = 25/126 \, ^\circ\mathrm{C} \]  
\[ V_{DS} = 700 \, \mathrm{V} \]  
\[ V_{GS} = 15 \, \mathrm{V} \]  
\[ R_{gon} = 4 \, \Omega \]

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

With an inductive load at  
\[ T_J = 25/126 \, ^\circ\mathrm{C} \]  
\[ V_{DS} = 700 \, \mathrm{V} \]  
\[ V_{GS} = 15 \, \mathrm{V} \]  
\[ I_D = 40 \, \mathrm{A} \]
Typical switching times as a function of collector current

\( t = f(I_C) \)

With an inductive load at

- \( T_j = 126 \) °C
- \( V_{DS} = 700 \) V
- \( V_{GS} = 15 \) V
- \( R_{gon} = 4 \) Ω
- \( R_{goff} = 4 \) Ω

Typical reverse recovery time as a function of collector current

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

At

- \( T_j = 25/126 \) °C
- \( V_{DS} = 700 \) V
- \( V_{GS} = 15 \) V
- \( R_{gsn} = 4 \) Ω
- \( V_{GS} = 15 \) V
- \( I_C = 40 \) A
Typical reverse recovery charge as a function of collector current

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

At

- \( T_J = 25/126 \, ^\circ\text{C} \)
- \( V_{CE} = 700 \, V \)
- \( V_{GS} = 15 \, V \)
- \( R_{GON} = 4 \, \Omega \)

Typical reverse recovery current as a function of collector current

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

At

- \( T_J = 25/126 \, ^\circ\text{C} \)
- \( V_{CH} = 700 \, V \)
- \( V_{GS} = 15 \, V \)
- \( R_{GON} = 4 \, \Omega \)

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

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

At

- \( T_J = 25/126 \, ^\circ\text{C} \)
- \( V_{TH} = 700 \, V \)
- \( I_F = 40 \, A \)
- \( V_{GS} = 15 \, V \)

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

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

At

- \( T_J = 25/126 \, ^\circ\text{C} \)
- \( V_{TH} = 700 \, V \)
- \( I_F = 40 \, A \)
- \( V_{GS} = 15 \, V \)
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
- \( T_j = 25/126 \) °C
- \( V_{CE} = 700 \) V
- \( V_{GE} = 15 \) V
- \( R_{gon} = 4 \) Ω

**Figure 19**
IGBT/MOSFET transient thermal impedance as a function of pulse width
\( Z_{thJH} = f(t_p) \)

At
- \( D = 0.5 \)
- \( R_{thJH} = 0.65 \) K/W

IGBT thermal model values

<table>
<thead>
<tr>
<th>R (C/W)</th>
<th>Tau (s)</th>
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<tbody>
<tr>
<td>0.198</td>
<td>0.495</td>
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<td>0.347</td>
<td>0.111</td>
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<td>0.075</td>
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<td>0.028</td>
<td>0.001</td>
</tr>
<tr>
<td>0.027</td>
<td>0.004</td>
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</tbody>
</table>

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

At
- \( D = 0.5 \)
- \( R_{thJH} = 1.16 \) K/W

FWD thermal model values

<table>
<thead>
<tr>
<th>R (C/W)</th>
<th>Tau (s)</th>
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<td>0.053</td>
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<td>0.154</td>
<td>0.012</td>
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</table>
Figure 21  
**BOOST IGBT**  
Power dissipation as a function of heatsink temperature

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

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

---

Figure 22  
**BOOST IGBT**  
Collector/Drain current as a function of heatsink temperature

\[ I_{\text{C}} = f(T_h) \]

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

---

Figure 23  
**BOOST FWD**  
Power dissipation as a function of heatsink temperature

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

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

---

Figure 24  
**BOOST FWD**  
Forward current as a function of heatsink temperature

\[ I_{\text{F}} = f(T_h) \]

At
\[ T_j = 175 \, ^\circ\text{C} \]
Figure 25
Safe operating area as a function of drain-source voltage

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

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

At
- \( D = \) single pulse
- \( T_A = 80 \) °C
- \( V_{GS} = 15 \) V
- \( T_J = T_{J\text{max}} \) °C

Figure 26
Gate voltage vs Gate charge

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

At
- \( I_D = 40 \) A

200V
600V

0 0.5 1 1.5 2 2.5
0 50 100 150 200 250

Qg (nC)

0 3 6 9 12 15

V_{GE} (V)
Figure 1: Typical Diode forward current as a function of forward voltage

\[ I_f = f(V_f) \]

At
\[ t_p = 250 \ \mu s \]

Figure 2: Diode transient thermal impedance as a function of pulse width

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

At
\[ D = \frac{t_p}{T}, \quad R_{thJH} = 1.705 \ \text{K/W} \]

Figure 3: Power dissipation as a function of heatsink temperature

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

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

Figure 4: Forward current as a function of heatsink temperature

\[ I_f = f(T_h) \]

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

Figure 1

Typical NTC characteristic as a function of temperature

\[ R_T = f(T) \]
Switching Definitions BOOST IGBT

General conditions

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Value</th>
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<tbody>
<tr>
<td>( T_j )</td>
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<tr>
<td>( R_{son} )</td>
<td>4 ( \Omega )</td>
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<tr>
<td>( R_{goff} )</td>
<td>4 ( \Omega )</td>
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Figure 1: Boost IGBT

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

- \( t_{doff} \) (integrating time for \( E_{off} \))
- \( t_{Eoff} \) (integrating time for \( E_{off} \))

- \( V_{GE} (0\%) = 0 \) V
- \( V_{GE} (100\%) = 15 \) V
- \( V_C (100\%) = 700 \) V
- \( I_C (100\%) = 40 \) A
- \( t_{doff} = 0.20 \) \( \mu \)s
- \( t_{Eoff} = 0.54 \) \( \mu \)s

Figure 2: Boost IGBT

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

- \( t_{don} \) (integrating time for \( E_{on} \))
- \( t_{Eon} \) (integrating time for \( E_{on} \))

- \( V_{GE} (0\%) = 0 \) V
- \( V_{GE} (100\%) = 15 \) V
- \( V_C (100\%) = 700 \) V
- \( I_C (100\%) = 40 \) A
- \( t_{don} = 0.03 \) \( \mu \)s
- \( t_{Eon} = 0.15 \) \( \mu \)s

Figure 3: Boost IGBT

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

- \( V_C (100\%) = 700 \) V
- \( I_C (100\%) = 40 \) A
- \( t_f = 0.04 \) \( \mu \)s

Figure 4: Boost IGBT

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

- \( V_C (100\%) = 700 \) V
- \( I_C (100\%) = 40 \) A
- \( t_r = 0.01 \) \( \mu \)s
Switching Definitions BOOST IGBT

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

- $P_{\text{off}} (100\%) = 27.95 \text{ kW}$
- $E_{\text{off}} (100\%) = 1.87 \text{ mJ}$
- $t_{\text{Eoff}} = 0.54 \mu \text{s}$

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

- $P_{\text{on}} (100\%) = 27.95 \text{ kW}$
- $E_{\text{on}} (100\%) = 2.23 \text{ mJ}$
- $t_{\text{Eon}} = 0.15 \mu \text{s}$

**Figure 7**
Boost IGBT
Gate voltage vs Gate charge (measured)

- $V_{GE\text{off}} = 0 \text{ V}$
- $V_{GE\text{on}} = 15 \text{ V}$
- $V_{C}(100\%) = 700 \text{ V}$
- $I_{d}(100\%) = 40 \text{ A}$
- $Q_{g} = 178.86 \text{ nC}$

**Figure 8**
Boost FWD
Turn-off Switching Waveforms & definition of $t_{\text{Eoff}}$

- $V_{d}(100\%) = 700 \text{ V}$
- $I_{d}(100\%) = 40 \text{ A}$
- $I_{\text{max}} (100\%) = -117 \text{ A}$
- $t_{\text{on}} = 0.15 \mu \text{s}$

---

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Switching Definitions BOOST FWD

**Figure 9**

Turn-on Switching Waveforms & definition of $t_{Qrr}$
($t_{Qrr}$ = integrating time for $Q_{rr}$)

- $I_d(100\%) = 40$ A
- $Q_{rr}(100\%) = 7.08 \mu C$
- $t_{Qrr} = 1.00 \mu s$

**Figure 10**

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

- $P_{rec}(100\%) = 27.95$ kW
- $E_{rec}(100\%) = 3.68$ mJ
- $t_{Erec} = 1.00 \mu s$
### PRODUCT STATUS DEFINITIONS

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<th>Datasheet Status</th>
<th>Product Status</th>
<th>Definition</th>
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<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>
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<td>First Production</td>
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