**flow MNPC 0**

**Features**
- mixed voltage component topology
- neutral point clamped inverter
- reactive power capability
- low inductance layout
- improved LVRT

**Target applications**
- Solar inverter
- UPS

**Types**
- 10-PZ12NMA080SH23-M260F03Y

---

**Maximum Ratings**

\(T_0=25^\circ C,\) 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 break down voltage</td>
<td>(V_{CE})</td>
<td>(T_J=T_{J\text{max}}), (T_A=80^\circ 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>
<td>67</td>
<td>A</td>
</tr>
<tr>
<td>Pulsed collector current</td>
<td>(I_{CRM})</td>
<td>(t_c), limited by (T_{J\text{max}})</td>
<td>240</td>
<td>A</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>(P_{tot})</td>
<td>(T_J=T_{J\text{max}}), (T_A=80^\circ C)</td>
<td>153</td>
<td>W</td>
</tr>
<tr>
<td>Gate-emitter peak voltage</td>
<td>(V_{CE})</td>
<td></td>
<td>±20</td>
<td>V</td>
</tr>
<tr>
<td>Short circuit ratings</td>
<td>(t_{sc})</td>
<td>(T_J\leq 150^\circ C) (V_{GE}=15)</td>
<td>10</td>
<td>(\mu s)</td>
</tr>
<tr>
<td></td>
<td>(V_{CC})</td>
<td></td>
<td>800</td>
<td>V</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>(T_{Pak})</td>
<td></td>
<td>175</td>
<td>^\circ C</td>
</tr>
</tbody>
</table>
### Half Bridge Diode

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Repetitive Reverse Voltage</td>
<td>$V_{RRM}$</td>
<td></td>
<td>650</td>
<td>V</td>
</tr>
<tr>
<td>Continuous (direct) forward current</td>
<td>$I_F$</td>
<td>$T_j = T_{jmax}$, $T_a = 80°C$</td>
<td>46</td>
<td>A</td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>$I_{FRM}$</td>
<td></td>
<td>100</td>
<td>A</td>
</tr>
<tr>
<td>Total power dissipation</td>
<td>$P_{tot}$</td>
<td>$T_j = T_{jmax}$, $T_a = 80°C$</td>
<td>74</td>
<td>W</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>$T_{jmax}$</td>
<td></td>
<td>175</td>
<td>°C</td>
</tr>
</tbody>
</table>

### Neutral Point Switch

<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 break down voltage</td>
<td>$V_{CEO}$</td>
<td></td>
<td>600</td>
<td>V</td>
</tr>
<tr>
<td>DC collector current</td>
<td>$I_C$</td>
<td>$T_j = T_{jmax}$, $T_a = 80°C$</td>
<td>49</td>
<td>A</td>
</tr>
<tr>
<td>Pulsed collector current</td>
<td>$I_{CRM}$</td>
<td>$t_p$ limited by $T_{jmax}$</td>
<td>225</td>
<td>A</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>$P_{tot}$</td>
<td>$T_j = T_{jmax}$, $T_a = 80°C$</td>
<td>68</td>
<td>W</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>$t_{sc}$</td>
<td>$T_j \leq 150°C$, $V_{GE} = 15V$</td>
<td>6</td>
<td>µs</td>
</tr>
<tr>
<td></td>
<td>$V_{GC}$</td>
<td></td>
<td>360</td>
<td>V</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>$T_{jmax}$</td>
<td></td>
<td>175</td>
<td>°C</td>
</tr>
</tbody>
</table>

### Neutral Point Diode

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Repetitive Reverse Voltage</td>
<td>$V_{RRM}$</td>
<td></td>
<td>650</td>
<td>V</td>
</tr>
<tr>
<td>Continuous (direct) forward current</td>
<td>$I_F$</td>
<td>$T_j = T_{jmax}$, $T_a = 80°C$</td>
<td>49</td>
<td>A</td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>$I_{FRM}$</td>
<td></td>
<td>150</td>
<td>A</td>
</tr>
<tr>
<td>Total power dissipation</td>
<td>$P_{tot}$</td>
<td>$T_j = T_{jmax}$, $T_a = 80°C$</td>
<td>59</td>
<td>W</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>$T_{jmax}$</td>
<td></td>
<td>175</td>
<td>°C</td>
</tr>
</tbody>
</table>
### Module Properties

#### Thermal Properties

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>$T_{stg}$</td>
<td></td>
<td>-40...+125</td>
<td>°C</td>
</tr>
<tr>
<td>Operation Junction Temperature</td>
<td>$T_{jop}$</td>
<td></td>
<td>-40...$T_{jmax}$ - 25</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Isolation Properties

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>DC voltage</th>
<th>$t_p=2s$</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolation voltage</td>
<td>$V_{isol}$</td>
<td></td>
<td></td>
<td>4000</td>
<td>V</td>
</tr>
<tr>
<td>Creepage distance</td>
<td></td>
<td></td>
<td></td>
<td>min 12,7</td>
<td>mm</td>
</tr>
<tr>
<td>Clearance</td>
<td></td>
<td></td>
<td></td>
<td>8,95</td>
<td>mm</td>
</tr>
<tr>
<td>Comparative Tracking Index</td>
<td>CTI</td>
<td></td>
<td></td>
<td>&gt;200</td>
<td></td>
</tr>
</tbody>
</table>
## Characteristic Values

### Half Bridge Switch

<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>$V_{CE}=V_{CE}$</td>
<td>0,003</td>
<td></td>
</tr>
<tr>
<td>Collector-emitter saturation voltage</td>
<td>$V_{CEsat}$</td>
<td></td>
<td>15</td>
<td>80</td>
</tr>
<tr>
<td>Collector-emitter cut-off</td>
<td>$I_{CES}$</td>
<td></td>
<td>0</td>
<td>1200</td>
</tr>
<tr>
<td>Gate-emitter leakage current</td>
<td>$J_{GES}$</td>
<td></td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>Integrated Gate resistor</td>
<td>$R_{geo}$</td>
<td></td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Input capacitance</td>
<td>$C_{in}$</td>
<td>$f = 1$ MHz</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>Reverse transfer capacitance</td>
<td>$C_{rxx}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal resistance chip to heatsink</td>
<td>$R_{th(j-s)}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal grease thickness 50 um, $\lambda = 1$ W/mK</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IGBT Switching</td>
<td>$t_{d(on)}$</td>
<td>$R_{geo} = 4$ $\Omega$</td>
<td>25</td>
<td>125</td>
</tr>
<tr>
<td>Rise time</td>
<td>$t_{r}$</td>
<td>$R_{geo} = 4$ $\Omega$</td>
<td>25</td>
<td>125</td>
</tr>
<tr>
<td>Turn-off delay time</td>
<td>$t_{d(off)}$</td>
<td></td>
<td>25</td>
<td>125</td>
</tr>
<tr>
<td>Fall time</td>
<td>$t_{f}$</td>
<td></td>
<td>25</td>
<td>125</td>
</tr>
<tr>
<td>Turn-on energy (per pulse)</td>
<td>$E_{on}$</td>
<td>$Q_{sto} = 2,1$ $\mu$C</td>
<td>25</td>
<td>125</td>
</tr>
<tr>
<td>Turn-off energy (per pulse)</td>
<td>$E_{off}$</td>
<td>$Q_{sto} = 3,8$ $\mu$C</td>
<td>25</td>
<td>125</td>
</tr>
</tbody>
</table>
## Characteristic Values

### Neutral Point Diode

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward voltage</td>
<td>$V_F$</td>
<td>75</td>
<td>1,53</td>
<td>V</td>
</tr>
<tr>
<td>Reverse leakage current</td>
<td>$I_R$</td>
<td>650</td>
<td>3,8</td>
<td>$\mu$A</td>
</tr>
<tr>
<td>Thermal resistance junction to sink</td>
<td>$R_{th(j-s)}$</td>
<td>Thermal grease thickness≤50um $\lambda = 1$ W/mK</td>
<td>1.61</td>
<td>K/W</td>
</tr>
<tr>
<td>Peak recovery current</td>
<td>$I_{RRM}$</td>
<td>25, 125, 150</td>
<td>±15 350 50</td>
<td>A</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>$t_{rr}$</td>
<td>25, 125, 150</td>
<td>25, 125, 150</td>
<td>ns</td>
</tr>
<tr>
<td>Recovered charge</td>
<td>$Q_r$</td>
<td>25, 125, 150</td>
<td>25, 125, 150</td>
<td>$\mu$C</td>
</tr>
<tr>
<td>Reverse recovered energy</td>
<td>$E_{rec}$</td>
<td>25, 125, 150</td>
<td>25, 125, 150</td>
<td>mWs</td>
</tr>
<tr>
<td>Peak rate of fall of recovery current</td>
<td>$(di/dt)_{max}$</td>
<td>25, 125, 150</td>
<td>25, 125, 150</td>
<td>A/µs</td>
</tr>
</tbody>
</table>
Neutral Point Switch

<table>
<thead>
<tr>
<th>Characteristic Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>Gate emitter threshold voltage</td>
</tr>
<tr>
<td>Collector-emitter saturation voltage</td>
</tr>
<tr>
<td>Collector-emitter cut-off</td>
</tr>
<tr>
<td>Gate-emitter leakage current</td>
</tr>
<tr>
<td>Integrated Gate resistor</td>
</tr>
<tr>
<td>Input capacitance</td>
</tr>
<tr>
<td>Output capacitance</td>
</tr>
<tr>
<td>Reverse transfer capacitance</td>
</tr>
<tr>
<td>Gate charge</td>
</tr>
</tbody>
</table>

Thermal

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal resistance chip to heatsink</td>
<td>$R_{DG(j-s)}$</td>
<td></td>
<td>1,40</td>
<td>K/W</td>
</tr>
</tbody>
</table>

IGBT Switching

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turn-on delay time</td>
<td>$t_{on}$</td>
<td>$R_{GS} = 4$ Ω</td>
<td>25</td>
<td>125</td>
</tr>
<tr>
<td>Rise time</td>
<td>$t_r$</td>
<td>$R_{GS} = 4$ Ω</td>
<td>25</td>
<td>125</td>
</tr>
<tr>
<td>Turn-off delay time</td>
<td>$t_{off}$</td>
<td>$Q_{Cmax} = 5,3$ µC</td>
<td>25</td>
<td>125</td>
</tr>
<tr>
<td>Fall time</td>
<td>$t_f$</td>
<td>$Q_{Cmax} = 8,2$ µC</td>
<td>25</td>
<td>125</td>
</tr>
</tbody>
</table>
Characteristic Values

Half Bridge Diode

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power dissipation constant</td>
<td>$P_{Bx}$</td>
<td>25</td>
<td>200</td>
<td>mW</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>$P$</td>
<td>25</td>
<td>200</td>
<td>mW</td>
</tr>
<tr>
<td>B-value</td>
<td>$B_{25/100}$</td>
<td>25</td>
<td>3950</td>
<td>K</td>
</tr>
<tr>
<td>B-value</td>
<td>$B_{25/148}$</td>
<td>25</td>
<td>3998</td>
<td>K</td>
</tr>
<tr>
<td>Vincotech NTC Reference</td>
<td></td>
<td></td>
<td>B</td>
<td></td>
</tr>
</tbody>
</table>

FWD Switching

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward voltage</td>
<td>$V_T$</td>
<td>25</td>
<td>1,73</td>
<td>V</td>
</tr>
<tr>
<td>Reverse leakage current</td>
<td>$I_R$</td>
<td>25</td>
<td>10</td>
<td>$\mu$A</td>
</tr>
</tbody>
</table>

Thermal

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal resistance junction to sink</td>
<td>$R_{es(\theta)}$</td>
<td>25</td>
<td>1,29</td>
<td>K/W</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>25</td>
<td>22</td>
<td>k$\Omega$</td>
</tr>
<tr>
<td>Deviation of R100</td>
<td>$\Delta R_{100}$</td>
<td>100</td>
<td>-12</td>
<td>%</td>
</tr>
<tr>
<td>Power dissipation constant</td>
<td>$P_{Bx}$</td>
<td>25</td>
<td>2</td>
<td>mW/K</td>
</tr>
</tbody>
</table>

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Half Bridge Switch Characteristics

Typical output characteristics

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

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

\[ t_p = 250 \ \mu s \]

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

\[ T_j: \ 125 \ ^\circ\text{C} \]

\[ 150 \ ^\circ\text{C} \]

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

Typical transfer characteristics

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

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

\[ t_p = 100 \ \mu s \]

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

\[ T_j: \ 125 \ ^\circ\text{C} \]

\[ 150 \ ^\circ\text{C} \]

Transient thermal impedance as a function of pulse width

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

\[ Z_{thJH} = f(I_{th}) \]

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

\[ R_{thJH} = 0,6 \ \text{K/W} \]

IGBT thermal model values

\[ R \ (\text{K/W}) \quad \tau \ (\text{s}) \]

<table>
<thead>
<tr>
<th>( R )</th>
<th>( \tau )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,00E-01</td>
<td>1,75E+00</td>
</tr>
<tr>
<td>3,00E-01</td>
<td>2,50E-01</td>
</tr>
<tr>
<td>1,60E-01</td>
<td>6,33E-02</td>
</tr>
<tr>
<td>3,61E-02</td>
<td>6,32E-03</td>
</tr>
<tr>
<td>2,47E-02</td>
<td>3,87E-04</td>
</tr>
</tbody>
</table>

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**Gate voltage vs Gate charge**

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

At
\[ I_C = 80 \text{ A} \]

**Short circuit withstand time as a function of \( V_{GE} \)**

\[ t_{sc} = f(V_{GE}) \]

At
\[ V_{CE} \leq 600 \text{ V} \]
\[ T_J \leq 150 \text{ °C} \]

**Typical short circuit collector current as a function of \( V_{GE} \)**

\[ I_{SC} = f(V_{GE}) \]

At
\[ V_{CE} \leq 600 \text{ V} \]
\[ T_J \leq 25 \text{ °C} \]
Neutral Point Diode Characteristics

Typical forward characteristics

\[ I_F = f(V_F) \]

Transient thermal impedance as a function of pulse width

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

\[ t_p = 250 \mu s \]

25 °C

25 °C

25 °C

D = \frac{t_p}{T}

\[ T_j: 125 \degree C \]

\[ R_{th(j-s)} = 1,61 K/W \]

FWD thermal model values

<table>
<thead>
<tr>
<th>R (K/W)</th>
<th>( \tau ) (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.80E-02</td>
<td>5.80E+00</td>
</tr>
<tr>
<td>3.03E-01</td>
<td>8.55E-01</td>
</tr>
<tr>
<td>6.51E-01</td>
<td>1.83E-01</td>
</tr>
<tr>
<td>3.18E-01</td>
<td>4.79E-02</td>
</tr>
<tr>
<td>1.83E-01</td>
<td>1.14E-02</td>
</tr>
<tr>
<td>5.88E-02</td>
<td>1.69E-03</td>
</tr>
</tbody>
</table>

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Neutral Point Switch Characteristics

Typical output characteristics

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

Typical transfer characteristics

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

Transient thermal impedance as a function of pulse width

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

\[
\begin{array}{|c|c|c|}
\hline
D & t_p / T & R_{thJH} (K/W) \\
\hline
1.40 & 0.5 & 1.40 \\
0.70 & 1 & 0.70 \\
0.50 & 2 & 0.50 \\
0.25 & 4 & 0.25 \\
0.12 & 8 & 0.12 \\
0.06 & 16 & 0.06 \\
0.03 & 32 & 0.03 \\
0.01 & 64 & 0.01 \\
\hline
\end{array}
\]
Gate voltage vs Gate charge

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

At
\[ I_C = 75 \text{ A} \]

Short circuit withstand time as a function of \( V_{GE} \)

\[ t_{sc} = f(V_{GE}) \]

At
\[ V_{CE} \leq 600 \text{ V} \]
\[ T_j \leq 175 \text{ °C} \]

Typical short circuit collector current as a function of \( V_{GE} \)

\[ I_{SC} = f(V_{GE}) \]

At
\[ V_{CE} \leq 600 \text{ V} \]
\[ T_j \leq 175 \text{ °C} \]
Half Bridge Diode Characteristics

**Typical forward characteristics (FWD)**

$$I_F = f(V_F)$$

**Transient thermal impedance as a function of pulse width (FWD)**

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

- $$t_p = 250 \mu s$$
- $$T_j: 25^\circ C$$
- $$125^\circ C$$
- $$150^\circ C$$

D = $$t_p / T$$

$$R_{th(j-s)} = 1.29 K/W$$

**FWD thermal model values**

<table>
<thead>
<tr>
<th>$$R$$ (K/W)</th>
<th>$$\tau$$ (s)</th>
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<tr>
<td>7.18E-02</td>
<td>3.30E-00</td>
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<td>3.55E-01</td>
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<tr>
<td>6.00E-01</td>
<td>6.90E-02</td>
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<tr>
<td>1.46E-01</td>
<td>1.13E-02</td>
</tr>
<tr>
<td>5.33E-02</td>
<td>1.66E-03</td>
</tr>
<tr>
<td>6.20E-02</td>
<td>2.38E-04</td>
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</tbody>
</table>

**Thermistor**

**Thermistor typical temperature characteristic**

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

$$R_T = f(T)$$
Half Bridge Switching Characteristics

**Figure 1.** IGBT

Typical switching energy losses as a function of collector current

\[ E = f(I_C) \]

With an inductive load at 25 °C

- \( V_{IS} = 350 \text{ V} \)
- \( T_J = 125 \text{ °C} \)
- \( r_{on} = 4 \text{ Ω} \)
- \( r_{off} = 4 \text{ Ω} \)

**Figure 2.** IGBT

Typical switching energy loss as a function of gate resistor

\[ E = f(r_g) \]

With an inductive load at 25 °C

- \( V_{IS} = 350 \text{ V} \)
- \( T_J = 125 \text{ °C} \)
- \( r_g = 4 \text{ Ω} \)
- \( I_g = 50 \text{ A} \)

**Figure 3.** FWD

Typical reverse recovered energy as a function of collector current

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

With an inductive load at 25 °C

- \( V_{IS} = 350 \text{ V} \)
- \( T_J = 125 \text{ °C} \)
- \( r_{on} = 4 \text{ Ω} \)

**Figure 4.** FWD

Typical reverse recovered energy loss as a function of gate resistor

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

With an inductive load at 25 °C

- \( V_{IS} = 350 \text{ V} \)
- \( T_J = 125 \text{ °C} \)
- \( I_g = 50 \text{ A} \)

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Half Bridge Switching Characteristics

**Figure 5. IGBT**

Typical switching times as a function of collector current

$t = f(I_C)$

![Graph](image)

With an inductive load at

- $T_j = 125 °C$
- $V_{CE} = 350 V$
- $V_{GE} = \pm 15 V$
- $R_{gon} = 4 \Omega$
- $I_{C} = 50 A$

**Figure 6. IGBT**

Typical switching times as a function of gate resistor

$t = f(r_g)$

![Graph](image)

With an inductive load at

- $T_j = 125 °C$
- $V_{CE} = 350 V$
- $V_{GE} = \pm 15 V$
- $R_{gon} = 4 \Omega$
- $I_{C} = 50 A$

**Figure 7. FWD**

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$

![Graph](image)

At

- $V_{CE} = 350 V$
- $V_{GE} = \pm 15 V$
- $R_{gon} = 4 \Omega$

**Figure 8. FWD**

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

$t_{rr} = f(R_{gon})$

![Graph](image)

At

- $V_{CE} = 350 V$
- $V_{GE} = \pm 15 V$
- $I_{C} = 50 A$

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Half Bridge Switching Characteristics

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

$Q_r = f(I_C)$

- At $V_{CE} = 350$ V, $T_j = 25 \degree C$
- $V_{GE} = \pm 15$ V
- $R_{gon} = 4 \Omega$ at $150 \degree C$

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

$Q_r = f(R_{gon})$

- At $V_{CE} = 350$ V, $T_j = 25 \degree C$
- $V_{GE} = \pm 15$ V
- $i_C = 50$ A at $150 \degree C$

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

$I_{RM} = f(I_C)$

- At $V_{CE} = 350$ V, $T_j = 25 \degree C$
- $V_{GE} = \pm 15$ V
- $R_{gon} = 4 \Omega$ at $150 \degree C$

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

$I_{RM} = f(R_{gon})$

- At $V_{CE} = 350$ V, $T_j = 25 \degree C$
- $V_{GE} = \pm 15$ V
- $i_C = 50$ A at $150 \degree C$
Half Bridge Switching Characteristics

Figure 13. FWD Typical rate of fall of forward and reverse recovery current as a function of collector current

\[
\frac{di_F}{dt}, \frac{di_{rr}}{dt} = f(I_c)
\]

At

\begin{align*}
V_{CE} &= 350 \text{ V} \\
T_j &= 25 \text{ °C} \\
R_{gon} &= 4 \text{ Ω}
\end{align*}

Figure 14. FWD Typical rate of fall of forward and reverse recovery current as a function of IGBT turn-on gate resistor

\[
\frac{di_F}{dt}, \frac{di_{rr}}{dt} = f(R_g)
\]

At

\begin{align*}
V_{CE} &= 350 \text{ V} \\
V_{ds} &= \pm 15 \text{ V} \\
R_{gon} &= 4 \text{ Ω}
\end{align*}

Figure 15. IGBT Reverse bias safe operating area

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

At

\begin{align*}
T_j &= 175 \text{ °C} \\
R_{on} &= 4 \text{ Ω} \\
R_{off} &= 4 \text{ Ω}
\end{align*}
Half Bridge Switching Characteristics

General conditions

<table>
<thead>
<tr>
<th>$T_J$</th>
<th>125 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{DS}$</td>
<td>4 Ω</td>
</tr>
<tr>
<td>$R_{GON}$</td>
<td>4 Ω</td>
</tr>
</tbody>
</table>

Figure 1. IGBT

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

- $V_{GE}(0\%) = -15$ V
- $V_{CE}(0\%) = 15$ V
- $V_{CE}(100\%) = 700$ V
- $I_{C}(100\%) = 50$ A
- $t_{off} = 0.242$ µs
- $t_{Eoff} = 0.615$ µs

Figure 2. IGBT

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

- $V_{GE}(0\%) = -15$ V
- $V_{CE}(0\%) = 15$ V
- $V_{CE}(100\%) = 700$ V
- $I_{C}(100\%) = 50$ A
- $t_{on} = 0.079$ µs
- $t_{Eon} = 0.214$ µs

Figure 3. IGBT

Turn-off Switching Waveforms & definition of $t_f$

- $V_{CE} = 700$ V
- $I_{C} = 50$ A
- $t_f = 0.076$ µs

Figure 4. IGBT

Turn-on Switching Waveforms & definition of $t_r$

- $V_{CE} = 700$ V
- $I_{C} = 50$ A
- $t_r = 0.014$ µs
Half Bridge Switching Characteristics

**Figure 5. IGBT**

Turn-off Switching Waveforms & definition of tEoff

- Poff(100%) = 35.05 kW
- Eoff(100%) = 2.28 mJ
- tEoff = 0.615 µs

**Figure 6. IGBT**

Turn-on Switching Waveforms & definition of tEon

- Pon(100%) = 35.05 kW
- Eon(100%) = 0.98 mJ
- tEon = 0.214 µs

**Figure 7. FWD**

Turn-off Switching Waveforms & definition of trr

- Vd(100%) = 700 V
- Id(100%) = 50 A
- frrm(100%) = -73 A
- ttr = 0.092 µs

- Vd(10%) = 150 V
- Id(10%) = 50 A
- frrm(10%) = -73 A
- ttr = 0.092 µs
Half Bridge Switching Characteristics

**Figure 8.** Turn-on Switching Waveforms & definition of $t_{Qrr}$ (integrating time for $Q_{rr}$)

- $I_d(100\%) = 50$ A
- $Q_{rr}(100\%) = 3,80$ μC
- $E_{rec}(100\%) = 0,85$ mJ
- $t_{Qrr} = 0,197$ μs

**Figure 9.** Turn-on Switching Waveforms & definition of $t_{Erec}$ (integrating time for $E_{rec}$)

- $P_{rec}(100\%) = 35,05$ kW
- $E_{rec}(100\%) = 0,85$ mJ
- $t_{Erec} = 0,197$ μs
Neutral Point 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

- \( V_{CE} = 350 \text{ V} \)
- \( T_J = 125 \text{ °C} \)
- \( R_{g_{on}} = 4 \Omega \)
- \( I_C = 55 \text{ A} \)

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

\[ E = f(r_g) \]

With an inductive load at 25 °C

- \( V_{CE} = 350 \text{ V} \)
- \( T_J = 125 \text{ °C} \)
- \( I_C = 55 \text{ A} \)

**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

- \( V_{CE} = 415 \text{ V} \)
- \( T_J = 150 \text{ °C} \)
- \( R_{g_{on}} = 4 \Omega \)

**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

- \( V_{CE} = 415 \text{ V} \)
- \( T_J = 150 \text{ °C} \)
- \( I_C = 55 \text{ A} \)
Neutral Point Switching Characteristics

Figure 5. IGBT
Typical switching times as a function of collector current

$t = f(I_C)$

With an inductive load at

- $T_j = 125 \degree C$
- $V_{CE} = 350 V$
- $V_{GE} = \pm 15 V$
- $R_{gon} = 4 \Omega$
- $R_{goff} = 4 \Omega$

Figure 6. IGBT
Typical switching times as a function of gate resistor

$t = f(r_g)$

With an inductive load at

- $T_j = 125 \degree C$
- $V_{CE} = 350 V$
- $V_{GE} = \pm 15 V$
- $I_C = 55 A$

Figure 7. FWD
Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$

At $V_{CE} = 350 V$, $T_j = 25 \degree C$
- $V_{CE} = \pm 15 V$
- $I_C = 55 A$
- $R_{pwm} = 4 \Omega$

Figure 8. FWD
Typical reverse recovery time as a function of IGBT turn-on gate resistor

$t_{rr} = f(R_{gon})$

At $V_{CE} = 350 V$, $T_j = 25 \degree C$
- $V_{CE} = \pm 15 V$
- $I_C = 55 A$
- $R_{gon} = 4 \Omega$
- $R_{goff} = 4 \Omega$
Neutral Point Switching Characteristics

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

\[ Q_r = f(I_C) \]

At \( V_{CE} = 350 \) V, 25 °C
\( V_{GS} = \pm 15 \) V, \( R_{gon} = 4 \) Ω
\( I_C = 55 \) A, 150 °C

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

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

At \( V_{CE} = 350 \) V, 25 °C
\( V_{GS} = \pm 15 \) V, \( R_{gon} = 4 \) Ω
\( I_C = 55 \) A, 150 °C

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

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

At \( V_{CE} = 350 \) V, 25 °C
\( V_{GS} = \pm 15 \) V, \( R_{gon} = 4 \) Ω
\( I_C = 55 \) A, 150 °C

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

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

At \( V_{CE} = 350 \) V, 25 °C
\( V_{GS} = \pm 15 \) V, \( R_{gon} = 4 \) Ω
\( I_C = 55 \) A, 150 °C
Neutral Point Switching Characteristics

Figure 13. FWD
Typical rate of fall of forward and reverse recovery current as a function of collector current
\(\frac{di_f}{dt}, \frac{di_{rr}}{dt} = f(I_c)\)

\[\text{At } V_{ce} = 350 \text{ V, } T_j = 25 \degree C\]
\[\text{At } V_{gs} = \pm 15 \text{ V, } R_g = 4 \Omega\]

Figure 14. FWD
Typical rate of fall of forward and reverse recovery current as a function of IGBT turn-on gate resistor
\(\frac{di_f}{dt}, \frac{di_{rr}}{dt} = f(R_g)\)

\[\text{At } V_{ce} = 350 \text{ V, } T_j = 125 \degree C\]
\[\text{At } V_{gs} = \pm 15 \text{ V, } I_c = 55 \text{ A}\]

Figure 15. IGBT
Reverse bias safe operating area

\(I_C = f(V_{ce})\)

\[\text{At } T_j = 175 \degree C\]
\[R_{on} = 4 \Omega\]
\[R_{off} = 4 \Omega\]
Neutral Point Switching Characteristics

General conditions

\begin{align*}
T_j &= 125 \degree C \\
R_{DS(on)} &= 4 \Omega \\
R_{DS(off)} &= 4 \Omega
\end{align*}

Figure 1. IGBT Turnoff Switching Waveforms & definition of \( t_{d_{off}} \), \( t_{E_{off}} \) (\( t_{E_{off}} \) = integrating time for \( E_{off} \))

Figure 2. IGBT Turn-on Switching Waveforms & definition of \( t_{d_{on}} \), \( t_{E_{on}} \) (\( t_{E_{on}} \) = integrating time for \( E_{on} \))

Figure 3. IGBT Turn-off Switching Waveforms & definition of \( t_f \)

Figure 4. IGBT Turn-on Switching Waveforms & definition of \( t_r \)

\begin{align*}
V_{GE}(0\%) &= -15 \text{ V} \\
V_{GE}(100\%) &= 15 \text{ V} \\
V_{CE}(0\%) &= 350 \text{ V} \\
V_{CE}(100\%) &= 56 \text{ A} \\
t_{d_{off}} &= 0.205 \mu s \\
t_{E_{off}} &= 0.582 \mu s
\end{align*}

\begin{align*}
V_{CE}(0\%) &= 295 \text{ V} \\
V_{CE}(100\%) &= 33 \text{ V} \\
V_{GE}(90\%) &= 0.085 \mu s \\
V_{GE}(90\%) &= 0.157 \mu s
\end{align*}

\begin{align*}
I_{C}(1\%) &= 5.6 \text{ A} \\
I_{C}(90\%) &= 56 \text{ A} \\
t_{d_{on}} &= 0.105 \mu s \\
t_{E_{on}} &= 0.012 \mu s
\end{align*}
Neutral Point Switching Characteristics

Figure 5. IGBT

Turn-off Switching Waveforms & definition of tEoff

- $P_{off}(100\%) = 19.56 \text{ kW}$
- $E_{off}(100\%) = 2.50 \text{ mJ}$
- $t_{Eoff} = 0.58 \mu\text{s}$

Figure 6. IGBT

Turn-on Switching Waveforms & definition of tEon

- $P_{on}(100\%) = 19.56 \text{ kW}$
- $E_{on}(100\%) = 0.75 \text{ mJ}$
- $t_{Eon} = 0.16 \mu\text{s}$

Figure 7. FWD

Turn-off Switching Waveforms & definition of trr

- $V_{d}(100\%) = 350 \text{ V}$
- $I_{d}(100\%) = 56 \text{ A}$
- $I_{rms}(100\%) = 118 \text{ A}$
- $t_{rr} = 0.148 \mu\text{s}$
## Neutral Point Switching Characteristics

### Figure 8

**Turn-on Switching Waveforms & definition of $t_{Qrr}$, integrating time for $Q_{rr}$**

| $I_d$ (100%) | 56 | A |
| $Q_{rr}$ (100%) | 8.22 | µC |
| $t_{Qrr}$ | 1.00 | µs |

### Figure 9

**Turn-on Switching Waveforms & definition of $t_{Erec}$, integrating time for $E_{rec}$**

| $P_{rec}$ (100%) | 19.56 | kW |
| $E_{rec}$ (100%) | 2.42 | mJ |
| $t_{Erec}$ | 1.00 | µs |
### Pinout

```
+DC 15,16
T1 G 17 18
D1 S
       G 03,04
D2 S
T2 G 02 01
D3 S
D4 G 07 06
T3 G 08,09,10,11
GND 05,14
Line
D1 650V
-DC
```

### Identification

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<tr>
<th>ID</th>
<th>Component</th>
<th>Voltage</th>
<th>Current</th>
<th>Function</th>
<th>Comment</th>
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<tr>
<td>T1,T2</td>
<td>IGBT</td>
<td>1200V</td>
<td>80A</td>
<td>Half Bridge Switch</td>
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<td>D1,D2</td>
<td>FWD</td>
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**Packaging instruction**

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<th>&gt;SPQ</th>
<th>Standard</th>
<th>&lt;SPQ</th>
<th>Sample</th>
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**Handling instruction**

Handling instructions for flow 0 packages see vincotech.com website.

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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.