Maximum Ratings

\( T_i = 25 \, ^\circ C, \) 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><strong>Inverter Switch</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collector-emitter voltage</td>
<td>( V_{CES} )</td>
<td></td>
<td>600</td>
<td>V</td>
</tr>
<tr>
<td>Collector current</td>
<td>( I_c )</td>
<td>( T_i = T_{j,max} ), ( T_i = 80 , ^\circ C )</td>
<td>14</td>
<td>A</td>
</tr>
<tr>
<td>Repetitive peak collector current</td>
<td>( I_{2dn} )</td>
<td>( T_i ), limited by ( T_{j,max} )</td>
<td>30</td>
<td>A</td>
</tr>
<tr>
<td>Turn off safe operating area</td>
<td></td>
<td>( T_i \leq 150 , ^\circ C, V_{ce} \leq 600 , V )</td>
<td>30</td>
<td>A</td>
</tr>
<tr>
<td>Total power dissipation</td>
<td>( P_{tot} )</td>
<td>( T_i = T_{j,max} ), ( T_i = 80 , ^\circ C )</td>
<td>34</td>
<td>W</td>
</tr>
<tr>
<td>Gate-emitter voltage</td>
<td>( V_{ges} )</td>
<td></td>
<td>±20</td>
<td>V</td>
</tr>
<tr>
<td>Short circuit ratings</td>
<td>( t_{fs} )</td>
<td>( T_i \leq 150 , ^\circ C )</td>
<td>6</td>
<td>( \mu ) s</td>
</tr>
<tr>
<td></td>
<td>( V_{cc} )</td>
<td>( V_{ce} = 15 , V )</td>
<td>360</td>
<td>V</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>( T_{j,max} )</td>
<td></td>
<td>175</td>
<td>( ^\circ C )</td>
</tr>
</tbody>
</table>
Maximum Ratings

\( T = 25 \, ^\circ C \), 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>Inverter Diode</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak Repetitive Reverse Voltage</td>
<td>( V_{RRM} )</td>
<td></td>
<td>600</td>
<td>V</td>
</tr>
<tr>
<td>DC forward current</td>
<td>( I_s )</td>
<td>( T_i = T_{j,max} ) ( T_i = 80 , ^\circ C )</td>
<td>17</td>
<td>A</td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>( I_{F,PK} )</td>
<td>( T_i = T_{j,max} ) ( T_i = 80 , ^\circ C )</td>
<td>20</td>
<td>A</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>( P_{tot} )</td>
<td>( T_i = T_{j,max} ) ( T_i = 80 , ^\circ C )</td>
<td>33</td>
<td>W</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>( T_{j,max} )</td>
<td></td>
<td>175</td>
<td>°C</td>
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Module Properties

<table>
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<tr>
<th>Thermal Properties</th>
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<th></th>
<th></th>
<th></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 temperature under switching condition</td>
<td>( T_{j/op} )</td>
<td></td>
<td>-40...+(( T_{j,max} - 25 ))</td>
<td>°C</td>
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</table>

<table>
<thead>
<tr>
<th>Isolation Properties</th>
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</thead>
<tbody>
<tr>
<td>Isolation voltage</td>
<td>( V_{isol} )</td>
<td>DC Test Voltage ( t_p = 2 , s )</td>
<td>4000</td>
<td>V</td>
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<tr>
<td>Creepage distance</td>
<td></td>
<td></td>
<td>min. 12,5</td>
<td>mm</td>
</tr>
<tr>
<td>Clearance</td>
<td></td>
<td></td>
<td>min. 12,5</td>
<td>mm</td>
</tr>
<tr>
<td>Comparative Tracking Index</td>
<td>CTI</td>
<td></td>
<td>&gt; 200</td>
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### Characteristic Values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gate-emitter threshold voltage ( V_{GE} )</td>
<td>( V_{CE} ) = ( V_{CE} )</td>
<td>0,00015</td>
<td>V</td>
</tr>
<tr>
<td>collector-emitter saturation voltage ( V_{cesat} )</td>
<td>15</td>
<td>25</td>
<td>150</td>
</tr>
<tr>
<td>collector-emitter cut-off current ( I_{ces} )</td>
<td>0</td>
<td>600</td>
<td>25</td>
</tr>
<tr>
<td>gate-emitter leakage current ( I_{ges} )</td>
<td>20</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>Internal gate resistance ( r_g )</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>gate capacitance ( C_{ies} )</td>
<td>( f ) = 1 MHz</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>reverse transfer capacitance ( C_{res} )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>gate charge ( Q_g )</td>
<td>15</td>
<td>480</td>
<td>10</td>
</tr>
<tr>
<td>Thermal resistance junction to sink ( R_{th(j-s)} )</td>
<td>Thermal grease thickness ≤ 50 µm ( \lambda = 1 \text{ W/mK} )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn-on delay time ( t_{ch} )</td>
<td>±15</td>
<td>400</td>
<td>10</td>
</tr>
<tr>
<td>Rise time ( t_r )</td>
<td>R_{on} = 32 Ω</td>
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<td></td>
</tr>
<tr>
<td>Turn-off delay time ( t_{ch} )</td>
<td>±15</td>
<td>400</td>
<td>10</td>
</tr>
<tr>
<td>Fall time ( t_f )</td>
<td>R_{off} = 32 Ω</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn-on energy (per pulse) ( E_{on} )</td>
<td>( \theta_{on} = 0,5 \mu C )</td>
<td>25</td>
<td>125</td>
</tr>
<tr>
<td>Turn-off energy (per pulse) ( E_{off} )</td>
<td>( \theta_{off} = 0,9 \mu C )</td>
<td>25</td>
<td>125</td>
</tr>
</tbody>
</table>

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08 Feb. 2016 / Revision 2
## Characteristic Values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
</table>
| $V_{GE}$ | $[V]$ | 25 | 1,60 | $V$
| $V_{GS}$ | $[V]$ | 150 | 1,95 | $V$
| $V_{CE}$ | $[V]$ | 10 | 1,56 | $V$
| $V_{DS}$ | $[V]$ | 25 | 1,95 | $V$
| $I_{C}$ | $[A]$ | 10 | 25 | $A$
| $I_{D}$ | $[A]$ | 150 | 25 | $A$
| $T_j$ | $[^{°}C]$ | Min | Typ | Max |

### Inverter Diode

#### Static

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
</table>
| Forward voltage | $V_t$ | 25 | 1,60 | $V$
| Reverse leakage current | $I_{IS}$ | 150 | 1,95 | $V$
| Thermal resistance chip to heatsink | $R_{th(j-s)}$ | 25 | 27 | $µA$
| Thermal grease thickness ≤ 50um | $\lambda = 1 W/mK$ | 125 | 4,5 | $%$
| λ | 1 W/mK | 25 | 65 | $A/µs$
| Peak rate of fall of recovery current | $(di/dt)_{RF}$ | 25 | 0,132 | $mWs$
| Reverse recovered energy | $E_{rec}$ | 125 | 0,255 | $mWs$
| Recovered charge | $Q_r$ | 25 | 0,466 | $µC$
| $\Delta R/R$ | $\Delta R/R$ | 100 | -4,5 | $%$
| $P$ | $P$ | 100 | 210 | $mW$
| Power dissipation constant | $B_{(25/100)}$ | 25 | 3884 | $K$
| B-value | $B_{(25/100)}$ | 25 | 3964 | $K$
| Vincotech NTC Reference | $F$ | | | |

### Thermistor

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
</table>
| Rated resistance | $R$ | 25 | 21,5 | $kΩ$
| Deviation of $R_{tot}$ | $\Delta R/R$ | $R_{tot} = 1486 \, Ω$ | 100 | -4,5 | $%$
| Power dissipation | $P$ | 25 | 210 | $mW/K$
| Power dissipation constant | $B_{(25/100)}$ | 25 | 3884 | $K$
| B-value | $B_{(25/100)}$ | 25 | 3964 | $K$
| Vincotech NTC Reference | $F$ | | | |
Inverter Switch Characteristics

**Typical output characteristics**  
\[ I_C = f(V_{CE}) \]

- \( t_p = 250 \mu s \)
- \( V_{CE} = 15 \text{ V} \)
- \( T_j = 25 \text{ °C} \)
- \( V_{CE} = 10 \text{ V} \)

**Typical transfer characteristics**  
\[ I_C = f(V_{GE}) \]

- \( t_p = 100 \mu s \)
- \( V_{CE} = 10 \text{ V} \)
- \( T_j = 25 \text{ °C} \)

**Transcendental Thermal Impedance as function of Pulse duration**  
\[ Z_{th(j-s)} = f(t_p) \]

- \( D = t_p / T \)
- \( R_{th(j-s)} = 2.80 \text{ K/W} \)

**IGBT thermal model values**

<table>
<thead>
<tr>
<th>( R ) (K/W)</th>
<th>( t ) (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.41E-02</td>
<td>7.26E+00</td>
</tr>
<tr>
<td>2.67E-01</td>
<td>6.41E-01</td>
</tr>
<tr>
<td>9.50E-01</td>
<td>1.13E-01</td>
</tr>
<tr>
<td>7.31E-01</td>
<td>1.82E-02</td>
</tr>
<tr>
<td>4.44E-01</td>
<td>3.63E-03</td>
</tr>
<tr>
<td>3.64E-01</td>
<td>3.98E-04</td>
</tr>
</tbody>
</table>

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Inverter Switch Characteristics

**Gate voltage vs Gate charge**

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

**Safe operating area**

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

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

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

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

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

Typical forward characteristics FWD

$\text{I}_F = f(\text{V}_F)$

$\text{Z}_{th(j-s)} = f(\text{t}_p)$

$\text{t}_p = 250 \mu\text{s}$

$\text{D} = \frac{\text{t}_p}{\text{T}}$

$\text{R}_{th(j-s)} = 2.85 \text{ K/W}$

FWD thermal model values

<table>
<thead>
<tr>
<th>$\text{R}_{(K/W)}$</th>
<th>$\text{R}_{(s)}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.35E-02</td>
<td>9.53E+00</td>
</tr>
<tr>
<td>2.14E-01</td>
<td>7.38E-01</td>
</tr>
<tr>
<td>7.92E-01</td>
<td>1.19E-01</td>
</tr>
<tr>
<td>7.47E-01</td>
<td>1.96E-02</td>
</tr>
<tr>
<td>6.00E-01</td>
<td>3.72E-03</td>
</tr>
<tr>
<td>4.58E-01</td>
<td>4.38E-04</td>
</tr>
</tbody>
</table>

$\text{V}_j$: 0 5 10 15 20 25 30

$\text{I}_F$: 10 1 10 0 10 -1 10 -2 10 -3 10 -4 10 -5

$\text{V}_F$: 10 100 1000 10000 20000

$\text{Z}_{th(j-s)}$: 10 9 7 5 3 1

$\text{t}_p$: 10 100 1000 10000 20000

$\text{D} = 0.5 0.2 0.1 0.05 0.02 0.01 0.005 0.000$

Thermistor Characteristics

Typical NTC characteristic as a function of temperature

$\text{R}_T = f(\text{T})$

NTC-typical temperature characteristic

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Inverter 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
- \( V_{in} = 400 \text{ V} \)
- \( V_{ce} = \pm 15 \text{ V} \)
- \( R_{g, on} = 32 \Omega \)
- \( I_C = 10 \text{ A} \)

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

\[ E = f(r_g) \]

With an inductive load at 25 °C
- \( V_{in} = 400 \text{ V} \)
- \( V_{ce} = \pm 15 \text{ V} \)
- \( R_{g, on} = 32 \Omega \)
- \( I_C = 10 \text{ A} \)

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

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

With an inductive load at 25 °C
- \( V_{in} = 400 \text{ V} \)
- \( V_{ce} = \pm 15 \text{ V} \)
- \( R_{g, on} = 32 \Omega \)
- \( I_C = 10 \text{ A} \)

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
- \( V_{in} = 400 \text{ V} \)
- \( V_{ce} = \pm 15 \text{ V} \)
- \( R_{g, on} = 32 \Omega \)
- \( I_C = 10 \text{ A} \)
Inverter Switching Characteristics

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

\[ t = f(I_C) \]

With an inductive load at
- \( T_j = 125 \, ^\circ C \)
- \( V_{CE} = 400 \, V \)
- \( V_{GE} = \pm 15 \, V \)
- \( R_{gon} = 32 \, \Omega \)
- \( I_C = 10 \, A \)

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

\[ t = f(r_g) \]

With an inductive load at
- \( T_j = 125 \, ^\circ C \)
- \( V_{CE} = 400 \, V \)
- \( V_{GE} = \pm 15 \, V \)
- \( R_{gon} = 32 \, \Omega \)
- \( I_C = 10 \, A \)

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

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

At
- \( V_{CE} = 400 \, V \)
- \( V_{GE} = \pm 15 \, V \)
- \( T_j = 25 \, ^\circ C \)
- \( R_{gon} = 32 \, \Omega \)

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

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

At
- \( V_{CE} = 400 \, V \)
- \( V_{GE} = \pm 15 \, V \)
- \( T_j = 125 \, ^\circ C \)
- \( I_C = 10 \, A \)
**Inverter Switching Characteristics**

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

\[ Q_r = f(I_C) \]

At
- \( V_{cb} = 400 \text{ V} \)
- \( V_{ce} = \pm 15 \text{ V} \)
- \( T_j = 25 \degree C \)
- \( R_{gon} = 32 \Omega \)

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

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

At
- \( V_{cb} = 400 \text{ V} \)
- \( V_{ce} = \pm 15 \text{ V} \)
- \( I_c = 10 \text{ A} \)
- \( T_j = 125 \degree C \)

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

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

At
- \( V_{cb} = 400 \text{ V} \)
- \( V_{ce} = \pm 15 \text{ V} \)
- \( T_j = 25 \degree C \)
- \( R_{gon} = 32 \Omega \)

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

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

At
- \( V_{cb} = 400 \text{ V} \)
- \( V_{ce} = \pm 15 \text{ V} \)
- \( I_c = 10 \text{ A} \)
- \( T_j = 125 \degree C \)
Inverter Switching Characteristics

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

\[
\frac{dI_F}{dt}, \frac{dI_{rr}}{dt} = f(I_c)
\]

**Figure 15.** IGBT
Reverse bias safe operating area

\[
I_c = f(V_{ce})
\]
Inverter Switching Characteristics

$T_j = \text{125 °C}$

$R_{on} = \text{32 Ω}$

$R_{off} = \text{32 Ω}$

Figure 1. IGBT

Turn-off Switching Waveforms & definition of tdoff, tEoff (tEoff = integrating time for Eoff)

Figure 2. IGBT

Turn-on Switching Waveforms & definition of tdon, tEon (tEon = integrating time for Eon)

Figure 3. IGBT

Turn-off Switching Waveforms & definition of tf

Figure 4. IGBT

Turn-on Switching Waveforms & definition of tr

$V_{GE}(0\%) = -15 \text{ V}$

$V_{CE}(10\%) = 15 \text{ V}$

$V_{CE}(100\%) = 400 \text{ V}$

$I_C(10\%) = 10 \text{ A}$

$t_doff = 0,159 \mu s$

$t_Eoff = 0,487 \mu s$

$t_don = 0,074 \mu s$

$t_Eon = 0,237 \mu s$

$t_f = 0,123 \mu s$

$t_r = 0,026 \mu s$
Inverter Switching Characteristics

**Figure 5. IGBT**

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

- \( P_{off} \) (100%) = 4.00 kW
- \( E_{off} \) (100%) = 0.45 mJ
- \( t_{Eoff} \) = 0.49 µs

**Figure 6. IGBT**

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

- \( P_{on} \) (100%) = 4.00 kW
- \( E_{on} \) (100%) = 0.38 mJ
- \( t_{Eon} \) = 0.24 µs

**Figure 7. FWD**

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

- \( V_{F} \) (100%) = 400 V
- \( J_{F} \) (100%) = 10 A
- \( J_{max} \) (100%) = -7 A
- \( \tau_{rr} \) = 0.270 µs
Inverter Switching Characteristics

Figure 8.
Turn-on Switching Waveforms & definition of \( t_{Q_r} \) (integrating time for \( Q_r \)).

- \( i_f(100\%) = 10 \) A
- \( Q_r(100\%) = 0,90 \) µC
- \( \tau_p = 0,56 \) µs

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

- \( P_{\text{out}}(100\%) = 4,00 \) kW
- \( E_{in}(100\%) = 0,26 \) mJ
- \( \tau_{E_{rec}} = 0,56 \) µs
### Ordering Code & Marking

<table>
<thead>
<tr>
<th>Text</th>
<th>Name</th>
<th>Type &amp; Ver</th>
<th>Date code</th>
<th>Vinco &amp; Lot</th>
<th>Serial &amp; UL</th>
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</thead>
<tbody>
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<td>WWYY</td>
<td>Vincotech</td>
<td>SSSS UL</td>
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#### Datamatrix

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<th>Serial</th>
<th>Date code</th>
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<td>WWYY</td>
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### Pin table [mm]

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<th>Y</th>
<th>Function</th>
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<tr>
<td>2</td>
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<td>E6</td>
</tr>
<tr>
<td>3</td>
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<tr>
<td>4</td>
<td>16.2</td>
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<td>E4</td>
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<tr>
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<td>0</td>
<td>0</td>
<td>G4</td>
</tr>
<tr>
<td>9</td>
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</tr>
<tr>
<td>10</td>
<td>2.9</td>
<td>13.7</td>
<td>G1</td>
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<td>11</td>
<td>8.8</td>
<td>13.7</td>
<td>DC+</td>
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<tr>
<td>12</td>
<td>14.6</td>
<td>13.7</td>
<td>V</td>
</tr>
<tr>
<td>13</td>
<td>17.5</td>
<td>13.7</td>
<td>G2</td>
</tr>
<tr>
<td>14</td>
<td>24.9</td>
<td>13.7</td>
<td>G3</td>
</tr>
<tr>
<td>15</td>
<td>27.8</td>
<td>13.7</td>
<td>W</td>
</tr>
</tbody>
</table>

**Outline**

Tolerance of pin positions ±0.05mm at the end of pins.
Dimension of coordinate axis is only offset without tolerance.
PEB cutouts and holes see in handling instruction document.
<table>
<thead>
<tr>
<th>ID</th>
<th>Component</th>
<th>Voltage</th>
<th>Current</th>
<th>Function</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1-T6</td>
<td>IGBT</td>
<td>600 V</td>
<td>10 A</td>
<td>Inverter Switch</td>
<td></td>
</tr>
<tr>
<td>D1-D6</td>
<td>FWD</td>
<td>600 V</td>
<td>10 A</td>
<td>Inverter Diode</td>
<td></td>
</tr>
<tr>
<td>NTC</td>
<td>NTC</td>
<td>600 V</td>
<td></td>
<td></td>
<td>Themistor</td>
</tr>
</tbody>
</table>
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