VINcoNPC X12  
1500 V / 1200 A

**Features**
- 1500V NPC-topology
- Low inductive
- High power screw interface

**Target Applications**
- Solar inverter
- Wind Power
- Motor Drive

**Types**
- 70-W624N3A1K2SC-L400FP

---

**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>Collector-emitter break down voltage</td>
<td>$V_{CE}$</td>
<td>$T_j = T_{max}$, $T_i = 80$ °C</td>
<td>1200</td>
<td>V</td>
</tr>
<tr>
<td>DC collector current</td>
<td>$I_C$</td>
<td>$T_i = T_{max}$, $T_j = 150$ °C</td>
<td>940</td>
<td>A</td>
</tr>
<tr>
<td>Pulsed collector current</td>
<td>$I_{CEM}$</td>
<td>$r_s$ limited by $T_{max}$</td>
<td>3600</td>
<td>A</td>
</tr>
<tr>
<td>Turn off safe operating area</td>
<td>$V_{CE}$</td>
<td>$V_{Ce} \leq 1200V$, $T_i \leq T_{op;max}$</td>
<td>2400</td>
<td>A</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>$P_{tot}$</td>
<td>$T_i = T_{max}$, $T_j = 80$ °C</td>
<td>2470</td>
<td>W</td>
</tr>
<tr>
<td>Gate-emitter peak voltage</td>
<td>$V_{GE}$</td>
<td>$T_j = T_{max}$</td>
<td>±20</td>
<td>V</td>
</tr>
<tr>
<td>Short circuit ratings</td>
<td>$t_{SC}$</td>
<td>$T_j \leq 150$ °C</td>
<td>10</td>
<td>µs</td>
</tr>
<tr>
<td>$V_{max}$</td>
<td>$800$</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>$T_{max}$</td>
<td></td>
<td>175</td>
<td>°C</td>
</tr>
</tbody>
</table>
### Maximum Ratings

\( T_j = 25 \, ^\circ C \), unless otherwise specified

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Buck Diode</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak Repetitive Reverse Voltage</td>
<td>( V_{\text{SEM}} )</td>
<td></td>
<td>1200</td>
<td>V</td>
</tr>
<tr>
<td>DC forward current</td>
<td>( I_d ) ( T_i = T_{\text{max}} ) ( T_j = 80 , ^\circ C )</td>
<td>744</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>( I_{\text{DM}} ) ( T_i = 10 , \text{ms}, \sin 180^\circ )</td>
<td>2400</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Power dissipation</td>
<td>( P_{\text{tot}} ) ( T_i = T_{\text{max}} ) ( T_j = 80 , ^\circ C )</td>
<td>1490</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>( T_{\text{Jmax}} )</td>
<td>175</td>
<td>( ^\circ C )</td>
<td></td>
</tr>
<tr>
<td><strong>Boost Switch</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collector-emitter break down voltage</td>
<td>( V_{\text{CE}} )</td>
<td></td>
<td>1200</td>
<td>V</td>
</tr>
<tr>
<td>DC collector current</td>
<td>( I_C ) ( T_i = T_{\text{max}} ) ( T_j = 80 , ^\circ C )</td>
<td>922</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Pulsed collector current</td>
<td>( I_{\text{DM}} ) ( T_i ) limited by ( T_{\text{max}} )</td>
<td>3600</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Turn off safe operating area</td>
<td>( V_{\text{CE}} \leq 1200 , \text{V}, T_i \leq T_{\text{Jmax}} )</td>
<td>2400</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Power dissipation</td>
<td>( P_{\text{tot}} ) ( T_i = T_{\text{max}} ) ( T_j = 80 , ^\circ C )</td>
<td>2192</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td>Gate-emitter peak voltage</td>
<td>( V_{\text{GE}} )</td>
<td>( \pm 20 )</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Short circuit ratings</td>
<td>( t_{\text{SC}} ) ( V_{\text{CE}} \leq 150 , ^\circ C ) ( V_{\text{CS}} = 15 , \text{V} )</td>
<td>10</td>
<td>( \mu s )</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>800</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>( T_{\text{Jmax}} )</td>
<td>175</td>
<td>( ^\circ C )</td>
<td></td>
</tr>
<tr>
<td><strong>Boost Inverse Diode</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak Repetitive Reverse Voltage</td>
<td>( V_{\text{SEM}} )</td>
<td></td>
<td>1200</td>
<td>V</td>
</tr>
<tr>
<td>DC forward current</td>
<td>( I_d ) ( T_i = T_{\text{max}} ) ( T_j = 80 , ^\circ C )</td>
<td>634</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>( I_{\text{DM}} ) ( T_i ) limited by ( T_{\text{max}} )</td>
<td>1800</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Power dissipation</td>
<td>( P_{\text{tot}} ) ( T_i = T_{\text{max}} ) ( T_j = 80 , ^\circ C )</td>
<td>1069</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>( T_{\text{Jmax}} )</td>
<td>175</td>
<td>( ^\circ C )</td>
<td></td>
</tr>
<tr>
<td><strong>Boost Diode</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak Repetitive Reverse Voltage</td>
<td>( V_{\text{SEM}} )</td>
<td></td>
<td>1200</td>
<td>V</td>
</tr>
<tr>
<td>DC forward current</td>
<td>( I_d ) ( T_i = T_{\text{max}} ) ( T_j = 80 , ^\circ C )</td>
<td>648</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>( I_{\text{DM}} ) ( T_i ) limited by ( T_{\text{max}} )</td>
<td>1800</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Power dissipation</td>
<td>( P_{\text{tot}} ) ( T_i = T_{\text{max}} ) ( T_j = 80 , ^\circ C )</td>
<td>1069</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>( T_{\text{Jmax}} )</td>
<td>175</td>
<td>( ^\circ C )</td>
<td></td>
</tr>
</tbody>
</table>
### Maximum Ratings

$T_j = 25 \degree C$, 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>Module Properties</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Thermal Properties</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>$T_{stg}$</td>
<td>-40...+125°C</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Operation temperature under switching condition</td>
<td>$T_{op}$</td>
<td>-40...+($T_{jmax} - 25$) °C</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Maximum allowed PCB temperature</td>
<td>$T_{PCB}$</td>
<td>125°C</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td><strong>Insulation Properties</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulation voltage</td>
<td>$V_{isol}$</td>
<td>$t = 2$ s DC Test Voltage*</td>
<td>4000</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$t = 1$ min AC Voltage</td>
<td>2500</td>
<td>V</td>
</tr>
<tr>
<td>Creepage distance</td>
<td></td>
<td>min 12,7 mm</td>
<td></td>
<td>mm</td>
</tr>
<tr>
<td>Clearance</td>
<td></td>
<td>min 12,7 mm</td>
<td></td>
<td>mm</td>
</tr>
<tr>
<td>Competative Tracking Index</td>
<td>CTI</td>
<td>&gt;200</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* 100 % Tested in production
## Characteristic Values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Buck Switch</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gate-emitter threshold voltage</td>
<td>$V_{GE(th)}$</td>
<td></td>
<td>0,0408</td>
<td>V</td>
</tr>
<tr>
<td>Collector-emitter saturation voltage</td>
<td>$V_{CEsat}$</td>
<td>15</td>
<td>25</td>
<td>1,7</td>
</tr>
<tr>
<td>Collector-emitter cut-off current incl. Diode</td>
<td>$I_{f,off}$</td>
<td>0</td>
<td>1200</td>
<td>25</td>
</tr>
<tr>
<td>Gate-emitter leakage current</td>
<td>$I_{f,off}$</td>
<td>20</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>Integrated Gate resistor</td>
<td>$R_{ Gate}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn-on delay time</td>
<td>$t_{d(on)}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rise time</td>
<td>$t_{r}$</td>
<td>25</td>
<td>125</td>
<td>43</td>
</tr>
<tr>
<td>Turn-off delay time</td>
<td></td>
<td>$t_{f,off}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall time</td>
<td></td>
<td>$t_{f}$</td>
<td>25</td>
<td>125</td>
</tr>
<tr>
<td>Turn-on energy loss per pulse</td>
<td></td>
<td>$E_{rec}$</td>
<td>25</td>
<td>125</td>
</tr>
<tr>
<td>Turn-off energy loss per pulse</td>
<td></td>
<td>$E_{off}$</td>
<td>25</td>
<td>125</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>Output capacitance</td>
<td>$C_{out}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse transfer capacitance</td>
<td>$C_{rss}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal resistance chip to heatsink</td>
<td>$R_{th(j-s)}$</td>
<td>phase-change material</td>
<td>$j = 5,4$ W/mK</td>
<td>0,038</td>
</tr>
<tr>
<td><strong>Buck Diode</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diode forward voltage</td>
<td>$V_{f_{d}}$</td>
<td>1200</td>
<td>25</td>
<td>2,34</td>
</tr>
<tr>
<td>Reverse leakage current</td>
<td>$I_{f_{r}}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak reverse recovery current</td>
<td>$I_{f_{Rec}}$</td>
<td></td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>$t_{f}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse recovered charge</td>
<td>$Q_{f}$</td>
<td>$R_{f} = 0,42$ Ω</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak rate of fall of recovery current</td>
<td></td>
<td>$(dI/dt)_{max}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse recovered energy</td>
<td></td>
<td>$E_{f}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal resistance chip to heatsink</td>
<td>$R_{th(j-s)}$</td>
<td>phase-change material</td>
<td>$j = 5,4$ W/mK</td>
<td>0,06</td>
</tr>
</tbody>
</table>
### Characteristic Values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Boost Inverse Diode</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diode forward voltage ( V_F )</td>
<td>900</td>
<td>1.35</td>
<td>V</td>
</tr>
<tr>
<td>Reverse leakage current ( I_L )</td>
<td>25</td>
<td>1.84</td>
<td>mA</td>
</tr>
<tr>
<td>Reverse recovery energy ( E_{on} )</td>
<td>960</td>
<td>1.09</td>
<td>mWs</td>
</tr>
<tr>
<td>Reverse resistance to heat sink ( R_{th(j-s)} )</td>
<td>phase-change material, ( \lambda = 3.4 \text{ W/mK} )</td>
<td>0.04</td>
<td>K/W</td>
</tr>
<tr>
<td><strong>Boost Diode</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diode forward voltage ( V_F )</td>
<td>900</td>
<td>1.35</td>
<td>V</td>
</tr>
<tr>
<td>Reverse leakage current ( I_L )</td>
<td>25</td>
<td>1.84</td>
<td>mA</td>
</tr>
<tr>
<td>Peak reverse recovery current ( I_{rr} )</td>
<td>1.25</td>
<td>168</td>
<td>µA</td>
</tr>
<tr>
<td>Reverse recovery time ( t_{rr} )</td>
<td>10/15</td>
<td>25</td>
<td>ns</td>
</tr>
<tr>
<td>Reverse recovery energy ( E_{on} )</td>
<td>960</td>
<td>1.09</td>
<td>mWs</td>
</tr>
<tr>
<td>Thermal resistance to heat sink ( R_{th(j-s)} )</td>
<td>phase-change material, ( \lambda = 3.4 \text{ W/mK} )</td>
<td>0.09</td>
<td>K/W</td>
</tr>
</tbody>
</table>

---

### Boost Switch

<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_{th} )</td>
<td>15</td>
<td>0.0456</td>
<td>V</td>
</tr>
<tr>
<td>Collector-emitter saturation voltage ( V_{c} )</td>
<td>1200</td>
<td>25</td>
<td>V</td>
</tr>
<tr>
<td>Collector-emitter cut-off diode ( I_{s(th)} )</td>
<td>9</td>
<td>1200</td>
<td>25</td>
</tr>
<tr>
<td>Gate-emitter leakage current ( I_{l} )</td>
<td>30</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>Integrated Gate resistor ( R_{ip} )</td>
<td></td>
<td>25</td>
<td>0.625</td>
</tr>
<tr>
<td>Turn-on delay time ( t_{on} )</td>
<td></td>
<td>1200</td>
<td>174</td>
</tr>
<tr>
<td>Rise time ( t_{r} )</td>
<td>15</td>
<td>64</td>
<td>ns</td>
</tr>
<tr>
<td>Turn-off delay time ( t_{off} )</td>
<td></td>
<td>125</td>
<td>273</td>
</tr>
<tr>
<td>Fall time ( t_{f} )</td>
<td></td>
<td>125</td>
<td>57</td>
</tr>
<tr>
<td>Turn-on energy loss per pulse ( E_{on} )</td>
<td>0.04</td>
<td>125</td>
<td>92</td>
</tr>
<tr>
<td>Turn-off energy loss per pulse ( E_{off} )</td>
<td></td>
<td>125</td>
<td>104.7</td>
</tr>
<tr>
<td>Input capacitance ( C_{in} )</td>
<td>4860</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>Output capacitance ( C_{out} )</td>
<td>4140</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>Gate charge ( Q_G )</td>
<td>960</td>
<td>9600</td>
<td>nC</td>
</tr>
<tr>
<td>Thermal resistance to heat sink ( R_{th(j-s)} )</td>
<td>phase-change material, ( \lambda = 3.4 \text{ W/mK} )</td>
<td>0.04</td>
<td>K/W</td>
</tr>
</tbody>
</table>

---

**Copyright** Vincotech 5 10 Jul. 2019 / Revision 3
## Characteristic Values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermistor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated resistance</td>
<td>R</td>
<td>25</td>
<td>22000</td>
<td>Ω</td>
</tr>
<tr>
<td>Deviation of R&lt;sub&gt;min&lt;/sub&gt;</td>
<td>Δ&lt;sub&gt;R&lt;/sub&gt;</td>
<td>R&lt;sub&gt;min&lt;/sub&gt; = 1484 Ω</td>
<td>100</td>
<td>-5</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>P</td>
<td>25</td>
<td>5</td>
<td>mW</td>
</tr>
<tr>
<td>Power dissipation constant</td>
<td></td>
<td>25</td>
<td>1.5</td>
<td>mW/K</td>
</tr>
<tr>
<td>B-value</td>
<td>B&lt;sub&gt;(25/100)&lt;/sub&gt;</td>
<td>Tol. ±1%</td>
<td>25</td>
<td>3962</td>
</tr>
<tr>
<td>B-value</td>
<td>B&lt;sub&gt;(25/50)&lt;/sub&gt;</td>
<td>Tol. ±1%</td>
<td>25</td>
<td>4000</td>
</tr>
<tr>
<td>Vincotech NTC Reference</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Module Properties

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module inductance (from chips to PCB)</td>
<td>L&lt;sub&gt;CLC&lt;/sub&gt;</td>
<td>Buck - Boost</td>
<td>5</td>
<td>nH</td>
</tr>
<tr>
<td>Weight</td>
<td>m</td>
<td></td>
<td>1930</td>
<td>g</td>
</tr>
</tbody>
</table>
**Buck**

Buck IGBT and Buck FWD

**figure 1.**  
Typical output characteristics  
$I_C = f(V_{CE})$

![IGBT output characteristics graph]

- $t_p = 350 \ \mu$s  
- $T_j = 25 \ ^\circ\text{C}$  
- $V_{CE}$ from 7 V to 17 V in steps of 1 V

**figure 2.**  
Typical output characteristics  
$I_C = f(V_{CE})$

![IGBT output characteristics graph]

- $t_p = 350 \ \mu$s  
- $T_j = 125 \ ^\circ\text{C}$  
- $V_{CE}$ from 7 V to 17 V in steps of 1 V

**figure 3.**  
Typical transfer characteristics  
$I_C = f(V_{GE})$

![IGBT transfer characteristics graph]

- $t_p = 350 \ \mu$s  
- $T_j = 25 \ ^\circ\text{C}$  
- $T_j = 125 \ ^\circ\text{C}$  
- $V_{CE} = 10 \ \text{V}$

**figure 4.**  
Typical FWD forward current as a function of forward voltage  
$I_F = f(V_F)$

![FWD forward current graph]

- $I_F = 350 \ \mu$s  
- $T_j = 25 \ ^\circ\text{C}$  
- $T_j = 125 \ ^\circ\text{C}$

Tj = 25 °C

Tj = 125 °C

Vincotech
Buck

Buck IGBT and Buck FWD

**IGBT**

**figure 5.**

Typical switching energy losses as a function of collector current

\[ E = f(I_c) \]

With an inductive load at

\[ T_j = 25/125 \, ^\circ C \]

\[ V_{CE} = 600 \, V \]

\[ V_{GE} = -10/+15 \, V \]

\[ R_{gon} = 0.42 \, \Omega \]

\[ R_{goff} = 0.42 \, \Omega \]

**figure 7.**

Typical switching times as a function of collector current

\[ t = f(I_c) \]

With an inductive load at

\[ T_j = 125 \, ^\circ C \]

\[ V_{CE} = 600 \, V \]

\[ V_{GE} = -10/+15 \, V \]

\[ R_{gon} = 0.42 \, \Omega \]

\[ R_{goff} = 0.42 \, \Omega \]

**FWD**

**figure 6.**

Typical reverse recovery energy loss as a function of collector current

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

With an inductive load at

\[ T_j = 25/125 \, ^\circ C \]

\[ V_{CE} = 600 \, V \]

\[ V_{GE} = -10/+15 \, V \]

\[ R_{gon} = 0.42 \, \Omega \]

**figure 8.**

Typical reverse recovery time as a function of collector current

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

At

\[ T_j = 25/125 \, ^\circ C \]

\[ V_{CE} = 600 \, V \]

\[ V_{GE} = -10/+15 \, V \]

\[ R_{gon} = 0.42 \, \Omega \]
**Buck**

Buck IGBT and Buck FWD

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

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

At

- \( T_j = 25/125 \degree C \)
- \( V_{CE} = 600 \) V
- \( V_{GE} = -10/+15 \) V
- \( R_{pos} = 0.42 \) Ω

**Figure 10.**
Typical reverse recovery current as a function of collector current

\[ I_{\text{rr}} = f(I_C) \]

At

- \( T_j = 25/125 \degree C \)
- \( V_{CE} = 600 \) V
- \( V_{GE} = -10/+15 \) V
- \( R_{pos} = 0.42 \) Ω

**Figure 11.**
Typical rate of fall of forward and reverse recovery current as a function of collector current

\[ \frac{dI}{dt}, \frac{dI_{\text{rec}}}{dt} = f(I_C) \]

At

- \( T_j = 25/125 \degree C \)
- \( V_{CE} = 600 \) V
- \( V_{GE} = -10/+15 \) V
- \( R_{pos} = 0.42 \) Ω
Buck

Buck IGBT and Buck FWD

**figure 12.** IGBT transient thermal impedance as a function of pulse width
\[ Z_{th} = f(t_p) \]

**figure 13.** FWD transient thermal impedance as a function of pulse width
\[ Z_{th} = f(t_p) \]

**figure 14.** Power dissipation as a function of heatsink temperature
\[ P_{tot} = f(T_s) \]

**figure 15.** Collector current as a function of heatsink temperature
\[ I_C = f(T_s) \]

**Table:**

<table>
<thead>
<tr>
<th>D</th>
<th>( R_{th} ) (K/W)</th>
<th>( \text{Tau (s)} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>0,038</td>
<td>1,65E-02</td>
</tr>
<tr>
<td>1</td>
<td>0,064</td>
<td>2,31E+00</td>
</tr>
</tbody>
</table>

At

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

IGBT thermal model values with phase-change material

\[ R_{th} = 0,038 \text{ K/W} \]

FWD thermal model values with phase-change material

\[ R_{th} = 0,064 \text{ K/W} \]

With phase change material

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

<table>
<thead>
<tr>
<th>( \text{Tau (s)} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,65E-02</td>
</tr>
<tr>
<td>2,31E+00</td>
</tr>
<tr>
<td>3,15E-01</td>
</tr>
<tr>
<td>6,36E-02</td>
</tr>
<tr>
<td>1,92E-02</td>
</tr>
<tr>
<td>2,08E-03</td>
</tr>
<tr>
<td>5,82E-04</td>
</tr>
</tbody>
</table>

**Formula:**

\[ R_{th} = \frac{V_{GE}}{A} \]

\[ R_{th} = \frac{V_{GE}}{I_{C}} \]

With phase change material

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

\[ I_{C} = \frac{V_{GE}}{R_{th}} \]

\[ I_{C} = \frac{V_{GE}}{R_{th}} \]

**Parameters:**

- **IGBT**
  - Collector current as a function of heatsink temperature
  - Power dissipation as a function of heatsink temperature

- **FWD**
  - Transient thermal impedance as a function of pulse width
  - Collector current as a function of heatsink temperature

**Data Sheet:**

70-W624N3A1K2SC-L400FP datasheet

Vincotech
Buck
Buck IGBT and Buck FWD

**Figure 16.**
Power dissipation as a function of heatsink temperature
\[ P_{\text{tot}} = f(T_s) \]

![Graph showing power dissipation vs. heatsink temperature](image)

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

**Figure 17.**
Forward current as a function of heatsink temperature
\[ I_F = f(T_s) \]

![Graph showing forward current vs. heatsink temperature](image)

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

**Figure 18.**
Safe operating area as a function of collector-emitter voltage
\[ I_C = f(V_{CE}) \]

![Graph showing safe operating area](image)

At
\[ D = \text{single pulse} \quad V_{\text{ol}} = 15 \, V \]
\[ T_s = 80 \, ^\circ C \quad T_j = T_{\text{max}} \]
Buck

Reverse bias safe operating area

$I_C = f(V_{CE})$

Switching mode: 3 level switching
Boost IGBT and Boost FWD

**figure 1.**
Typical output characteristics

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

At
- \( T_j = 25 \) °C
- \( V_{CE} \) from 7 V to 17 V in steps of 1 V

\[ t_p = 350 \ \mu s \]

**figure 2.**
Typical output characteristics

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

At
- \( T_j = 125 \) °C
- \( V_{CE} \) from 7 V to 17 V in steps of 1 V

\[ t_p = 350 \ \mu s \]

**figure 3.**
Typical transfer characteristics

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

At
- \( T_j = 25 \) °C
- \( V_{CE} = 10 \) V

\[ t_p = 350 \ \mu s \]

**figure 4.**
Typical FWD forward current as a function of forward voltage

\[ I_F = f(V_F) \]

At
- \( T_j = 25 \) °C
- \( T_j = 125 \) °C

\[ t_p = 350 \ \mu s \]
Boost

Boost IGBT and Boost FWD

**figure 5.**
Typical switching energy losses as a function of collector current

\[ E = f(I_C) \]

With an inductive load at

- \( T_j = 25/125 \degree C \)
- \( V_{CE} = 600 \) V
- \( V_{CE} = -10/ +15 \) V
- \( R_{gon} = 0,42 \) Ω
- \( R_{goff} = 0,42 \) Ω

**figure 6.**
Typical reverse recovery energy loss as a function of collector current

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

With an inductive load at

- \( T_j = 25/125 \degree C \)
- \( V_{CE} = 600 \) V
- \( V_{CE} = -10/ +15 \) V
- \( R_{gon} = 0,42 \) Ω

**figure 7.**
Typical switching times as a function of collector current

\[ t = f(I_C) \]

With an inductive load at

- \( T_j = 125 \degree C \)
- \( V_{CE} = 600 \) V
- \( V_{CE} = -10/ +15 \) V
- \( R_{gon} = 0,42 \) Ω

**figure 8.**
Typical reverse recovery time as a function of collector current

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

At

- \( T_j = 25/125 \degree C \)
- \( V_{CE} = 600 \) V
- \( V_{CE} = -10/ +15 \) V
- \( R_{gon} = 0,42 \) Ω
Boost
Boost IGBT and Boost FWD

**figure 9.**
Typical reverse recovery charge as a function of collector current
\[ Q_{rr} = f(I_C) \]

- \[ T_j = 25/125 \, ^\circ\text{C} \]
- \[ V_{CE} = 600 \, \text{V} \]
- \[ V_{GE} = -10/ +15 \, \text{V} \]
- \[ R_{gs} = 0.42 \, \Omega \]

**figure 10.**
Typical reverse recovery current as a function of collector current
\[ I_{RRM} = f(I_C) \]

- \[ T_j = 25/125 \, ^\circ\text{C} \]
- \[ V_{CE} = 600 \, \text{V} \]
- \[ V_{GE} = -10/ +15 \, \text{V} \]
- \[ R_{gs} = 0.42 \, \Omega \]

**figure 11.**
Typical rate of fall of forward and reverse recovery current as a function of collector current
\[ \frac{dI_0}{dt}, \frac{dI_{rec}}{dt} = f(I_C) \]

- \[ T_j = 25/125 \, ^\circ\text{C} \]
- \[ V_{CE} = 600 \, \text{V} \]
- \[ V_{GE} = -10/ +15 \, \text{V} \]
- \[ R_{gs} = 0.4 \, \Omega \]
Boost
Boost IGBT and Boost FWD

**IGBT transient thermal impedance as a function of pulse width**

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

**FWD transient thermal impedance as a function of pulse width**

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

At

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

**IGBT thermal model values with phase change material**

<table>
<thead>
<tr>
<th>( R_{th(j-s)} ) (K/W)</th>
<th>( \text{Tau} ) (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.98E-02</td>
<td>1.78E+00</td>
</tr>
<tr>
<td>1.01E-02</td>
<td>1.66E-01</td>
</tr>
<tr>
<td>1.07E-02</td>
<td>3.06E-02</td>
</tr>
<tr>
<td>1.43E-03</td>
<td>2.59E-03</td>
</tr>
<tr>
<td>1.32E-03</td>
<td>2.69E-04</td>
</tr>
</tbody>
</table>

**FWD thermal model values with phase change material**

<table>
<thead>
<tr>
<th>( R_{th(j-s)} ) (K/W)</th>
<th>( \text{Tau} ) (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.39E-02</td>
<td>5.78E+00</td>
</tr>
<tr>
<td>1.77E-02</td>
<td>1.38E+00</td>
</tr>
<tr>
<td>1.62E-02</td>
<td>2.57E-01</td>
</tr>
<tr>
<td>2.22E-02</td>
<td>5.31E-02</td>
</tr>
<tr>
<td>9.23E-03</td>
<td>1.60E-02</td>
</tr>
<tr>
<td>3.35E-03</td>
<td>2.27E-03</td>
</tr>
<tr>
<td>6.26E-03</td>
<td>2.74E-04</td>
</tr>
</tbody>
</table>

**Power dissipation as a function of heatsink temperature**

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

At

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

**Collector current as a function of heatsink temperature**

\[ I_C = f(T_s) \]

At

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

\[ V_{GE} = 15 \, V \]
Boost
Boost IGBT and Boost FWD

**figure 16.**
Power dissipation as a function of heatsink temperature
\[ P_{\text{tot}} = f(T_h) \]

![Graph showing power dissipation vs. heatsink temperature](image)

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

**figure 17.**
Forward current as a function of heatsink temperature
\[ I_F = f(T_h) \]

![Graph showing forward current vs. heatsink temperature](image)

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

**figure 18.**
IGBT
Reverse bias safe operating area
\[ I_C = f(V_{CE}) \]

![Graph showing reverse bias safe operating area](image)

At
\[ V_{\text{JEAN}} = V_{\text{REF}} \]

Switching mode: 3 level switching
Boost Inverse Diode

**figure 19.** Boost Inverse Diode
Typical FWD forward current as a function of forward voltage
\[ I_F = f(V_F) \]
At
\[ t_p = 250 \, \mu s \]

**figure 20.** Boost Inverse Diode
FWD transient thermal impedance as a function of pulse width
\[ Z_{th(j-s)} = f(t_p) \]
At
\[ D = \frac{t_p}{T_{th}} = 0,09 \, K/W \]

**figure 21.** Boost Inverse Diode
Power dissipation as a function of heatsink temperature
\[ P_{tot} = f(T_s) \]
At
\[ T_j = 175 \, ^\circ C \]

**figure 22.** Boost Inverse Diode
Forward current as a function of heatsink temperature
\[ I_F = f(T_s) \]
At
\[ T_j = 175 \, ^\circ C \]
Thermistor

**figure 1.** Typical NTC characteristic as a function of temperature

\[ R = f(T) \]
Switching Definitions Buck

**General conditions**

\[
T_J = 125 \, ^\circ \text{C} \\
R_{\text{on}} = 0.42 \, \Omega \\
R_{\text{off}} = 0.42 \, \Omega
\]

**figure 1.** Turn-off Switching Waveforms & definition of \( t_{\text{doff}}, t_{\text{Eoff}} \)

\( t_{\text{doff}} = 0.23 \, \mu s \)

\( t_{\text{Eoff}} = 0.48 \, \mu s \)

**figure 2.** Turn-on Switching Waveforms & definition of \( t_{\text{don}}, t_{\text{Eon}} \)

\( t_{\text{don}} = 0.11 \, \mu s \)

\( t_{\text{Eon}} = 0.29 \, \mu s \)

**figure 3.** Turn-off Switching Waveforms & definition of \( t_{f} \)

\( t_f = 0.07 \, \mu s \)

**figure 4.** Turn-on Switching Waveforms & definition of \( t_{r} \)

\( t_r = 0.04 \, \mu s \)
Switching Definitions Buck

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

![IGBT Turn-off Waveforms](image)

$P_\text{off} (100\%) = 720.80 \text{ kW}$

$E_\text{off} (100\%) = 86.78 \text{ mJ}$

$t_\text{Eoff} = 0.48 \mu\text{s}$

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

![IGBT Turn-on Waveforms](image)

$P_\text{on} (100\%) = 720.80 \text{ kW}$

$E_\text{on} (100\%) = 48.91 \text{ mJ}$

$t_\text{Eon} = 0.29 \mu\text{s}$

**figure 7.** FWD
Turn-off Switching Waveforms & definition of $t_\text{rr}$

![FWD Turn-off Waveforms](image)

$V_d (100\%) = 600 \text{ V}$

$I_d (100\%) = 1201 \text{ A}$

$I_{\text{peak}} (100\%) = -1355 \text{ A}$

$t_{\text{rr}} = 0.21 \mu\text{s}$

copyright Vincotech
Switching Definitions Buck

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

- $I_d$ (100%) = 1201 A
- $Q_{rr}$ (100%) = 136.71 µC
- $t_{q_{rr}}$ = 0.42 µs

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

- $P_{rec}$ (100%) = 720.80 kW
- $E_{rec}$ (100%) = 61.41 mJ
- $t_{E_{rec}}$ = 0.42 µs
Switching Definitions Boost

General conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_J$</td>
<td>125 °C</td>
</tr>
<tr>
<td>$R_{gs}$</td>
<td>0,42 Ω</td>
</tr>
<tr>
<td>$R_{gs}$</td>
<td>0,42 Ω</td>
</tr>
</tbody>
</table>

figure 1. IGBT

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

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

$V_{CE} (0%) = -10$ V
$V_{CE} (100%) = 15$ V
$V_C (100%) = 600$ V
$I_C (100%) = 1200$ A
$t_{doff} = 0,34$ µs
$t_{Eoff} = 0,70$ µs

figure 2. IGBT

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

($t_{Eon} =$ integrating time for $E_{on}$)

$V_{CE} (0%) = -10$ V
$V_{CE} (100%) = 15$ V
$V_C (100%) = 600$ V
$I_C (100%) = 1200$ A
$t_{don} = 0,17$ µs
$t_{Eon} = 0,55$ µs

figure 3. IGBT

Turn-off Switching Waveforms & definition of $t_r$

$V_C (100%) = 600$ V
$I_C (100%) = 1200$ A
$t_r = 0,092$ µs

figure 4. IGBT

Turn-on Switching Waveforms & definition of $t_f$

$V_C (100%) = 600$ V
$I_C (100%) = 1200$ A
$t_f = 0,065$ µs

copyright Vincotech 23
10 Jul. 2019 / Revision 3
Switching Definitions Boost

**figure 5.** IGBT

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

\[
\begin{align*}
P_{\text{Eoff}} (100\%) &= 719,72 \text{ kW} \\
E_{\text{Eoff}} (100\%) &= 119,96 \text{ mJ} \\
t_{\text{Eoff}} &= 0,70 \mu\text{s}
\end{align*}
\]

**figure 6.** IGBT

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

\[
\begin{align*}
P_{\text{Eon}} (100\%) &= 719,724 \text{ kW} \\
E_{\text{Eon}} (100\%) &= 104,74 \text{ mJ} \\
t_{\text{Eon}} &= 0,55 \mu\text{s}
\end{align*}
\]

**figure 7.** FWD

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

\[
\begin{align*}
V_{d} (100\%) &= 600 \text{ V} \\
I_{d} (100\%) &= 1200 \text{ A} \\
I_{\text{RRM}} (100\%) &= -903 \text{ A} \\
t_{rr} &= 0,45 \mu\text{s}
\end{align*}
\]
**Switching Definitions Boost**

**figure 8.** Turn-on Switching Waveforms & definition of $t_{Qrr}$

($t_{Qrr}$ = integrating time for $Q_{rr}$)

![Waveform Graph]

$I_d (100\%) = 1200$ A  
$Q_{rr} (100\%) = 172,55$ µC  
$t_{Qrr} = 0,90$ µs

**figure 9.** Turn-on Switching Waveforms & definition of $t_{Erec}$

($t_{Erec}$ = integrating time for $E_{rec}$)

![Waveform Graph]

$P_{rec} (100\%) = 719,72$ kW  
$E_{rec} (100\%) = 69,81$ mJ  
$t_{Erec} = 0,90$ µs
## Ordering Code and Marking - Outline - Pinout

### Ordering Code & Marking

<table>
<thead>
<tr>
<th>Version</th>
<th>In DataMatrix as</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>70-W624N3A1K2SC-L400FP</td>
</tr>
<tr>
<td>Standard with thermal paste</td>
<td>70-W624N3A1K2SC-L400FP/-3/</td>
</tr>
</tbody>
</table>

#### Datamatrix

<table>
<thead>
<tr>
<th>Name</th>
<th>Date code</th>
<th>UL &amp; Vinco</th>
<th>Lot</th>
<th>Serial</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WWYY</td>
<td>UL</td>
<td>V</td>
<td>LLLLL</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>Ver</th>
<th>Lot number</th>
<th>Serial</th>
<th>Date code</th>
</tr>
</thead>
<tbody>
<tr>
<td>T11</td>
<td>T12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D11</td>
<td>D12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T13</td>
<td>T14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D13</td>
<td>D14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D15</td>
<td>D16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D41</td>
<td>D42</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D43</td>
<td>D44</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Pinout

![Pinout Diagram]

**NOTE:** Driver pins for parallel devices are not connected inside the module!

### Identification

<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>T11, T12</td>
<td>IGBT</td>
<td>1200 V</td>
<td>1200 A</td>
<td>Buck Switch</td>
<td></td>
</tr>
<tr>
<td>D11, D12</td>
<td>FWD</td>
<td>1200 V</td>
<td>1200 A</td>
<td>Buck Diode</td>
<td></td>
</tr>
<tr>
<td>T13, T14</td>
<td>IGBT</td>
<td>1200 V</td>
<td>1200 A</td>
<td>Boost Switch</td>
<td></td>
</tr>
<tr>
<td>D13, D14</td>
<td>FWD</td>
<td>1200 V</td>
<td>900 A</td>
<td>Boost Diode</td>
<td></td>
</tr>
<tr>
<td>D15, D16</td>
<td>FWD</td>
<td>1200 V</td>
<td>900 A</td>
<td>Boost Inverse Diode</td>
<td></td>
</tr>
<tr>
<td>D41, D42</td>
<td>FWD</td>
<td>1200 V</td>
<td>90 A</td>
<td>Buck sw. Prot. Diode</td>
<td></td>
</tr>
<tr>
<td>D43, D44</td>
<td>FWD</td>
<td>1200 V</td>
<td>90 A</td>
<td>Boost sw. Prot. Diode</td>
<td></td>
</tr>
<tr>
<td>RT</td>
<td>NTC</td>
<td></td>
<td></td>
<td></td>
<td>Thermistor</td>
</tr>
</tbody>
</table>

**Copyright Vincotech**

**10 Jul. 2019 / Revision 3**
LIFE SUPPORT POLICY

Vincotech products are not authorised for use as critical components in life support devices or systems without the express written approval of Vincotech.

As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in labelling can be reasonably expected to result in significant injury to the user.

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.