## Features
- 1500 V NPC-topology
- High power screw interface
- Low inductive interface for external DC-capacitors and paralleling on component level
- Snubber diode for optional asymmetrical inductance
- High speed buck IGBT’s
- Temperature sensor

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

## Types
- 70-W424NIA800SH-M800F

## VINco NPC X8 housing

## VINcoNPC X8
1500 V / 800 A

## Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Snubber Diode (D61, D62)</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$</td>
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<td>1200</td>
<td>V</td>
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<tr>
<td>Forward average current</td>
<td>$I_{FAM}$</td>
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<td>Surge forward current</td>
<td>$I_{FSM}$</td>
<td>$T_s = 10 ms$, sin 180°</td>
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<tr>
<td>$i't$-value</td>
<td>$j't$</td>
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<td>Maximum Junction Temperature</td>
<td>$T_{jmax}$</td>
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<tr>
<td><strong>Buck IGBT (T11, T12)</strong></td>
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<tr>
<td>Collector-emitter break down voltage</td>
<td>$V_{CE}$</td>
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<td>1200</td>
<td>V</td>
</tr>
<tr>
<td>DC collector current</td>
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## 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>
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<tbody>
<tr>
<td><strong>Buck Diode (D11, D12)</strong></td>
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<tr>
<td>Peak Repetitive Reverse Voltage</td>
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<td>DC forward current</td>
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<td>°C</td>
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<td><strong>Boost IGBT (T13, T14)</strong></td>
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<td>Collector-emitter break down voltage</td>
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<td><strong>Boost Inverse Diode (D15, D16)</strong></td>
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<td>Peak Repetitive Reverse Voltage</td>
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<td>DC forward current</td>
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<td><strong>Boost Diode (D14, D13)</strong></td>
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### Maximum Ratings

$T_j = 25 \, ^\circ C$, unless otherwise specified

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<tr>
<td><strong>Thermal Properties</strong></td>
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<tr>
<td>Storage temperature</td>
<td>$T_{stg}$</td>
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<td>-40...+125</td>
<td>°C</td>
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<tr>
<td>Operation temperature under switching condition</td>
<td>$T_{op}$ for power part</td>
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<td>-40...+(T$_{jmax}$ - 25)</td>
<td>°C</td>
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</tbody>
</table>

| **Insulation Properties** | | | | |
| Insulation voltage | $V_{isol}$ | DC Test Voltage* $\tau_p = 2 \, s$ | 4000 | V |
| AC Voltage | $\tau_p = 1 \, min$ | 2500 | V |
| Creepage distance | | min 12,7 | mm |
| Clearance | | min 12,7 | mm |
| Comparative Tracking Index | CTI | | >200 |

*100% tested in production
## Characteristic values

### Snubber Diode (D61, D62)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Forward voltage</td>
<td>VGE</td>
<td>Min</td>
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<td>1.91</td>
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<td>Threshold voltage (for power loss calc. only)</td>
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<tr>
<td>Slope resistance (for power loss calc. only)</td>
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<td>1.14</td>
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<tr>
<td>Reverse current</td>
<td>is</td>
<td>Min</td>
<td>25</td>
<td>0.003</td>
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<tr>
<td>Thermal resistance chip to heatsink</td>
<td>Rth(j-s)</td>
<td>Min</td>
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<td>Rth(j-c)</td>
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### Buck IGBT (T11, T12)

<table>
<thead>
<tr>
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<th>Symbol</th>
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<th>Value</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Gate-emitter threshold voltage</td>
<td>VGE</td>
<td>Min</td>
<td>15</td>
<td>0.2272</td>
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<tr>
<td>Collector-emitter saturation voltage</td>
<td>VCEsat</td>
<td>Min</td>
<td>25</td>
<td>5.2</td>
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<tr>
<td>Collector-emitter cut-off current incl. Diode</td>
<td>Is</td>
<td>Min</td>
<td>25</td>
<td>5.8</td>
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<tr>
<td>Gate-emitter leakage current</td>
<td>Ioss</td>
<td>Min</td>
<td>25</td>
<td>6.4</td>
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<tr>
<td>Integrated Gate resistor</td>
<td>Rgs</td>
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<td>0.25</td>
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<td>Turn-on delay time</td>
<td>t(on)</td>
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<tr>
<td>Rise time</td>
<td>tr</td>
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<td>15</td>
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<tr>
<td>Turn-off delay time</td>
<td>t(off)</td>
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<td>600</td>
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<tr>
<td>Fall time</td>
<td>tf</td>
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<td></td>
<td>824</td>
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<tr>
<td>Turn-on energy loss per pulse</td>
<td>Eon</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn-off energy loss per pulse</td>
<td>Eoff</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Input capacitance</td>
<td>Ciss</td>
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<tr>
<td>Output capacitance</td>
<td>Coss</td>
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<tr>
<td>Reverse transfer capacitance</td>
<td>Coss</td>
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<tr>
<td>Gate charge</td>
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<td>Rth(j-c)</td>
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### Buck Diode (D11, D12)

<table>
<thead>
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<th>Value</th>
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<tr>
<td>Diode forward voltage</td>
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<td>Reverse leakage current</td>
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<tr>
<td>Reverse recovery time</td>
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<td>25</td>
<td>2.32</td>
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<tr>
<td>Reverse recovery time</td>
<td>IFR</td>
<td>Min</td>
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<td>960</td>
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<td>Reverse recovered charge</td>
<td>Qrr</td>
<td>Min</td>
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<td>2.34</td>
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<tr>
<td>Peak rate of fall of recovery current</td>
<td>(di/dt)RRM</td>
<td>Min</td>
<td>25</td>
<td>115</td>
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<tr>
<td>Reverse recovered energy</td>
<td>Erec</td>
<td>Min</td>
<td>25</td>
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<td>Rth(j-c)</td>
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### Characteristic values

<table>
<thead>
<tr>
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<th>Value</th>
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<tbody>
<tr>
<td>Boost IGBT (T13, T14)</td>
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<tr>
<td>Gate emitter threshold voltage</td>
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<td>Collector-emitter saturation voltage</td>
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<tr>
<td>Collector-emitter cut-off incl diode</td>
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<td>Rise time</td>
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<td>Turn-on energy loss per pulse</td>
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<td>$R_{th(j-s)}$</td>
<td>$\lambda_{PSX} = 3,4 , W/mK$</td>
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<td>K/W</td>
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<td>$V_{F}$</td>
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<td>25</td>
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<td>Reverse leakage current</td>
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<td>25</td>
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<tr>
<td>Peak reverse recovery current</td>
<td>$I_{RRM}$</td>
<td>$E_{on} = 0,5 , \Omega$</td>
<td>±15</td>
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<td>Reverse recovery time</td>
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<td>$Q_{max}$</td>
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<td>Peak rate of fall of recovery current</td>
<td>$(dI_{diode}/dt)_{max}$</td>
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<td>K/W</td>
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## Characteristic values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
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<tr>
<td>[V]</td>
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<td>$R_{\text{on}} = 1486 , \Omega$</td>
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## Module Properties

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<th>Module Properties</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
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<td>Buck</td>
<td>9</td>
<td>nH</td>
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<td>Module inductance (from PCB to PCB using Intercon board)</td>
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<td>Boost</td>
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Buck

Buck IGBT and Buck FWD

**figure 1.** IGBT

Typical output characteristics

$I_C = f(V_{CE})$

At

$t_p = 350 \ \mu s$

$T_j = 25 \ ^\circ C$

$V_{CE}$ from 7 V to 17 V in steps of 1 V

**figure 2.** IGBT

Typical output characteristics

$I_C = f(V_{CE})$

At

$t_p = 350 \ \mu s$

$T_j = 125 \ ^\circ C$

$V_{CE}$ from 7 V to 17 V in steps of 1 V

**figure 3.** IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$

At

$t_p = 350 \ \mu s$

$T_j = 25 \ ^\circ C$

$V_{CE} = 10 \ \text{V}$

**figure 4.** FWD

Typical FWD forward current as a function of forward voltage

$I_F = f(V_{F})$

At

$t_p = 350 \ \mu s$

$T_j = 25 \ ^\circ C$

$T_j = 125 \ ^\circ C$
**Buck**

**Buck IGBT and Buck FWD**

**figure 5. IGBT**

**Typical switching energy losses**

as a function of collector current

\[ E = f(I_C) \]

With an inductive load at

- \( T_J = 25/125 \, ^\circ\text{C} \)
- \( V_{CE} = 600 \, \text{V} \)
- \( V_{GE} = \pm 15 \, \text{V} \)
- \( R_{gon} = 0.5 \, \Omega \)
- \( R_{goff} = 0.5 \, \Omega \)

**figure 6. IGBT**

**Typical switching energy losses**

as a function of gate resistor

\[ E = f(R_G) \]

With an inductive load at

- \( T_J = 25/125 \, ^\circ\text{C} \)
- \( V_{CE} = 600 \, \text{V} \)
- \( V_{GE} = \pm 15 \, \text{V} \)
- \( I_C = 824 \, \text{A} \)

**figure 7. FWD**

**Typical reverse recovery energy loss**

as a function of collector current

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

With an inductive load at

- \( T_J = 25/125 \, ^\circ\text{C} \)
- \( V_{CE} = 600 \, \text{V} \)
- \( V_{GE} = \pm 15 \, \text{V} \)
- \( R_{gon} = 0.5 \, \Omega \)

**figure 8. FWD**

**Typical reverse recovery energy loss**

as a function of gate resistor

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

With an inductive load at

- \( T_J = 25/125 \, ^\circ\text{C} \)
- \( V_{CE} = 600 \, \text{V} \)
- \( V_{GE} = \pm 15 \, \text{V} \)
- \( I_C = 824 \, \text{A} \)
figure 9. IGBT
Typical switching times as a function of collector current
\[ t = f(I_C) \]

With an inductive load at
\[ T_J = 125 ^\circ C \]
\[ V_{CE} = 600 \text{ V} \]
\[ V_{GE} = \pm 15 \text{ V} \]
\[ R_{gon} = 0.5 \text{ } \Omega \]
\[ R_{goff} = 0.5 \text{ } \Omega \]

figure 10. IGBT
Typical switching times as a function of gate resistor
\[ t = f(R_G) \]

With an inductive load at
\[ T_J = 125 ^\circ C \]
\[ V_{CE} = 600 \text{ V} \]
\[ V_{GE} = \pm 15 \text{ V} \]
\[ I_C = 824 \text{ A} \]

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

At
\[ T_J = 25/125 ^\circ C \]
\[ V_{CE} = 600 \text{ V} \]
\[ V_{GE} = \pm 15 \text{ V} \]
\[ R_{gon} = 0.5 \text{ } \Omega \]

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

At
\[ T_J = 25/125 ^\circ C \]
\[ V_s = 600 \text{ V} \]
\[ I_F = 824 \text{ A} \]
\[ V_{GE} = \pm 15 \text{ V} \]
Typical reverse recovery charge as a function of collector current

$$Q_{rr} = f(I_C)$$

**Figure 13.**

**Figure 14.**

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

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

**Figure 15.**

**Figure 16.**

Typical reverse recovery current as a function of collector current

$$I_{RRM} = f(I_C)$$

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

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

---

At

- $T_j = 25/125\, ^\circ \text{C}$
- $V_{CE} = 600\, \text{V}$
- $V_{GE} = \pm 15\, \text{V}$
- $R_{gon} = 0.5\, \Omega$

---

At

- $T_j = 25/125\, ^\circ \text{C}$
- $V_{CE} = 600\, \text{V}$
- $V_{GE} = \pm 15\, \text{V}$
- $I_F = 824\, \text{A}$
- $V_{GE} = \pm 15\, \text{V}$
**Buck**

Buck IGBT and Buck FWD

**Figure 17.**
Typical rate of fall of forward and reverse recovery current as a function of collector current

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

At

\[ T_j = 25/125 \, ^\circ C \]
\[ V_{CE} = 600 \, V \]
\[ V_{GE} = \pm 15 \, V \]
\[ R_{gon} = 0.5 \, \Omega \]

**Figure 18.**
Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor

\[
\frac{dI}{dt} \text{ and } \frac{dI_{rec}}{dt} = f(R_{gon})
\]

At

\[ T_j = 25/125 \, ^\circ C \]
\[ V_{CE} = 600 \, V \]
\[ V_{GE} = \pm 15 \, V \]
\[ I_F = 824 \, A \]

**Figure 19.**
IGBT transient thermal impedance as a function of pulse width

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

At

\[ D = \frac{t_p}{T} \]
\[ R_{th(j-s)} = 0.035 \, K/W \]

**Figure 20.**
FWD transient thermal impedance as a function of pulse width

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

At

\[ D = \frac{t_p}{T} \]
\[ R_{th(j-s)} = 0.054 \, K/W \]

**IGBT thermal model values**

- With phase change interface
  - \( R \) (K/W)  \( \tau \) (s)
  - 2.17E-02  3.38E+00
  - 9.75E-03  6.30E-01
  - 6.36E-03  1.08E-01
  - 1.02E-02  3.09E-02
  - 1.99E-03  4.92E-03
  - 2.38E-03  4.72E-04

**FWD thermal model values**

- With phase change interface
  - \( R \) (K/W)  \( \tau \) (s)
  - 8.86E-03  8.79E+00
  - 1.52E-02  1.88E+00
  - 1.55E-02  3.42E-01
  - 2.08E-02  7.47E-02
  - 1.61E-02  2.42E-02
  - 5.04E-03  2.16E-03
Buck
Buck IGBT and Buck FWD

**figure 21.**
Power dissipation as a function of heatsink temperature

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

**figure 22.**
Collector current as a function of heatsink temperature

\[ I_C = f(T_s) \]

At

\[ T_j = 175 \degree C \]

**figure 23.**
Power dissipation as a function of heatsink temperature

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

**figure 24.**
Forward current as a function of heatsink temperature

\[ I_F = f(T_s) \]

At

\[ T_j = 175 \degree C \]

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

Buck IGBT and Buck FWD

**figure 25.**
Safe operating area as a function of collector-emitter voltage

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

**figure 26.**
Gate voltage vs Gate charge

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

At

- \( D = \) single pulse
- \( T_s = 80 \) °C
- \( V_{GE} = 15 \) V
- \( T_j = T_{j_{max}} \)

**figure 27.**
Reverse bias safe operating area

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

At

- \( V_{CE} = V_{CE_{max}} - 25 \) °C
- \( U_{C_{max}} = U_{C_{plus}} \)
- Switching mode: 3 level switching
**Boost**

**Boost IGBT and Boost FWD**

**figure 1.**

**IGBT**

Typical output characteristics

$I_C = f(V_{CE})$

At

- $t_p = 350 \, \mu s$
- $T_j = 25 \, ^\circ C$

$V_{CE}$ from 7 V to 17 V in steps of 1 V

**figure 2.**

**IGBT**

Typical output characteristics

$I_C = f(V_{CE})$

At

- $t_p = 350 \, \mu s$
- $T_j = 125 \, ^\circ C$

$V_{CE}$ from 7 V to 17 V in steps of 1 V

**figure 3.**

**IGBT**

Typical transfer characteristics

$I_C = f(V_{GE})$

At

- $t_p = 350 \, \mu s$
- $T_j = 25 ^\circ C$

$V_{CE} = 10 \, V$

**figure 4.**

**FWD**

Typical FWD forward current as a function of forward voltage

$I_F = f(V_F)$

At

- $t_p = 350 \, \mu s$
- $T_j = 25 ^\circ C$

$V_F$ from 7 V to 17 V in steps of 1 V
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
- \( V_{CE} = \pm 15 \) V
- \( R_{on} = 0.5 \) Ω
- \( R_{off} = 0.5 \) Ω

**Figure 6.**
Typical switching energy losses
as a function of gate resistor

\[ E = f(R_{G}) \]

With an inductive load at
- \( T_j = 25/125 \degree C \)
- \( V_{CE} = 600 \) V
- \( V_{CE} = \pm 15 \) V
- \( I_C = 796 \) A

**Figure 7.**
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
- \( V_{CE} = \pm 15 \) V
- \( R_{ons} = 0.5 \) Ω

**Figure 8.**
Typical reverse recovery energy loss
as a function of gate resistor

\[ E_{rec} = f(R_{G}) \]

With an inductive load at
- \( T_j = 25/125 \degree C \)
- \( V_{CE} = 600 \) V
- \( V_{CE} = \pm 15 \) V
- \( I_C = 796 \) A
figure 9. 
Typical switching times as a function of collector current
\[ t = f(I_C) \]

With an inductive load at
\[ T_J = 125 \, ^\circ\text{C} \]
\[ V_{CE} = 600 \, \text{V} \]
\[ V_{SC} = \pm 15 \, \text{V} \]
\[ R_{gos} = 0.5 \, \Omega \]
\[ R_{goff} = 0.5 \, \Omega \]

figure 10. 
Typical switching times as a function of gate resistor
\[ t = f(R_G) \]

With an inductive load at
\[ T_J = 125 \, ^\circ\text{C} \]
\[ V_{CE} = 600 \, \text{V} \]
\[ V_{SC} = \pm 15 \, \text{V} \]
\[ I_C = 796 \, \text{A} \]

figure 11. 
Typical reverse recovery time as a function of collector current
\[ t_{rr} = f(I_C) \]

At
\[ T_J = 25/125 \, ^\circ\text{C} \]
\[ V_{CE} = 600 \, \text{V} \]
\[ V_{SC} = \pm 15 \, \text{V} \]
\[ R_{gos} = 0.5 \, \Omega \]

figure 12. 
Typical reverse recovery time as a function of IGBT turn on gate resistor
\[ t_{rr} = f(R_{gos}) \]

At
\[ T_J = 25/125 \, ^\circ\text{C} \]
\[ V_S = 600 \, \text{V} \]
\[ I_F = 796 \, \text{A} \]
\[ V_{GE} = \pm 15 \, \text{V} \]
**Boost**

Boost IGBT and Boost FWD

---

**figure 13.**

Typical reverse recovery charge as a function of collector current

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

At

- \( T_j = 25/125 \ ^\circ\text{C} \)
- \( V_{CE} = 600 \ \text{V} \)
- \( V_{GE} = \pm 15 \ \text{V} \)
- \( R_{gon} = 0.5 \ \Omega \)

---

**figure 14.**

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

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

At

- \( T_j = 25/125 \ ^\circ\text{C} \)
- \( V_s = 600 \ \text{V} \)
- \( I_f = 796 \ \text{A} \)
- \( V_{GE} = \pm 15 \ \text{V} \)

---

**figure 15.**

Typical reverse recovery current as a function of collector current

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

At

- \( T_j = 25/125 \ ^\circ\text{C} \)
- \( V_{CE} = 600 \ \text{V} \)
- \( V_{GE} = \pm 15 \ \text{V} \)
- \( I_f = 796 \ \text{A} \)
- \( R_{gon} = 0.5 \ \Omega \)

---

**figure 16.**

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

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

At

- \( T_j = 25/125 \ ^\circ\text{C} \)
- \( V_s = 600 \ \text{V} \)
- \( I_f = 796 \ \text{A} \)
- \( V_{GE} = \pm 15 \ \text{V} \)
figure 17. FWD
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
\[ T_J = \begin{cases} 25/125 \degree C \end{cases} \]
\[ V_{CE} = 600 \ \text{V} \]
\[ V_{GE} = \pm 15 \ \text{V} \]
\[ R_{gon} = 0.5 \ \Omega \]

figure 18. FWD
Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor
\[ \frac{dI_0}{dt}, \frac{dI_{rec}}{dt} = f(R_{gon}) \]

At
\[ T_J = \begin{cases} 25/125 \degree C \end{cases} \]
\[ V_R = 600 \ \text{V} \]
\[ I_F = 796 \ \text{A} \]
\[ V_{GE} = \pm 15 \ \text{V} \]

figure 19. IGBT
IGBT transient thermal impedance as a function of pulse width
\[ Z_{th(j-s)} = f(t_p) \]

At
\[ D = \frac{t_p}{T} \]
\[ R_{Alx} = 0.058 \ \text{K/W} \]
\[ R_{HJC} = 0.038 \]

1.07E-01 1.07E-02 1.07E-03 1.07E-04 1.07E-05
\[ 10^7 10^8 10^9 10^{10} 10^{11} \]
\[ t_p \ (\text{s}) \]
\[ Z_{th(j-s)} \ (\text{K/W}) \]

IGBT thermal model values
With phase change interface
R (K/W) Tau (s)
2,31E-02 2,75E+00
1,00E-02 6,14E-01
6,38E-03 1,36E-01
9,68E-03 3,02E-02
8,61E-04 3,49E-03

figure 20. FWD
FWD transient thermal impedance as a function of pulse width
\[ Z_{th(j-s)} = f(t_p) \]

At
\[ D = \frac{t_p}{T} \]
\[ R_{Alx} = 0.105 \ \text{K/W} \]
\[ R_{HJC} = 0.067 \]

1.07E-01 1.07E-02 1.07E-03 1.07E-04 1.07E-05
\[ 10^7 10^8 10^9 10^{10} 10^{11} \]
\[ t_p \ (\text{s}) \]
\[ Z_{th(j-s)} \ (\text{K/W}) \]

FWD thermal model values
With phase change interface
R (K/W) Tau (s)
1,01E-02 8,27E+00
3,26E-02 1,88E+00
2,33E-02 4,66E-01
2,66E-02 4,79E-02
6,01E-03 1,19E-02
3,24E-03 1,20E-03
**Boost**

Boost IGBT and Boost FWD

---

**figure 21.**

Power dissipation as a function of heatsink temperature

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

![Graph showing power dissipation](image)

At

\[ T_j = 175 \text{ °C} \]

---

**figure 22.**

Collector current as a function of heatsink temperature

\[ I_c = f(T_s) \]

![Graph showing collector current](image)

At

\[ T_j = 175 \text{ °C} \]

---

**figure 23.**

Power dissipation as a function of heatsink temperature

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

![Graph showing power dissipation](image)

At

\[ T_j = 175 \text{ °C} \]

---

**figure 24.**

Forward current as a function of heatsink temperature

\[ I_f = f(T_s) \]

![Graph showing forward current](image)

At

\[ T_j = 175 \text{ °C} \]

---
**Boost**

**Boost IGBT**

**figure 25.**  IGBT

**Reverse bias safe operating area**

$I_C = f(V_{CE})$

At

$T_J = T_{jmax} - 25 \degree C$

$V_{ccminus} = V_{ccplus}$

Switching mode : 3 level switching
Boost Inverse Diode

**figure 25.** Boost Inverse Diode
Typical FWD forward current as a function of forward voltage
\[ I_F = f(V_F) \]

![Graph showing FWD forward current as a function of forward voltage.](image)

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

**figure 26.** Boost Inverse Diode
FWD transient thermal impedance as a function of pulse width
\[ Z_{th(j-s)} = f(t_p) \]

![Graph showing FWD transient thermal impedance as a function of pulse width.](image)

At
\[ D = \frac{t_p}{T_{R th(j-s)}} \]
[\[ R_{th(j-s)} = 0,054 \ \text{K/W} \]

**figure 27.** Boost Inverse Diode
Power dissipation as a function of heatsink temperature
\[ P_{tot} = f(T_s) \]

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

At
\[ T_j = 175 \ \degree C \]

**figure 28.** Boost Inverse Diode
Forward current as a function of heatsink temperature
\[ I_F = f(T_s) \]

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

At
\[ T_j = 175 \ \degree C \]
**Snubber Diode**

**figure 1.** Snubber Diode

Typical thyristor forward current as a function of forward voltage

\[ I_F = f(V_F) \]

**At**

\[ t_p = 250 \ \mu s \]

**figure 2.** Snubber Diode

Thyristor transient thermal impedance as a function of pulse width

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

**At**

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

\[ R_{th(j-s)} = 0.294 \ \text{K/W} \]

**figure 3.** Snubber Diode

Power dissipation as a function of heatsink temperature

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

**At**

\[ T_j = 175 \ \degree C \]

**figure 4.** Snubber Diode

Forward current as a function of heatsink temperature

\[ I_F = f(T_s) \]

**At**

\[ T_j = 175 \ \degree C \]
figure 1. Typical NTC characteristic as a function of temperature

\[ R_T = f(T) \]
Buck switching definitions

General conditions

\[
\begin{align*}
T_j &= 125 ^\circ C \\
R_{on} &= 0,5 \Omega \\
R_{off} &= 0,5 \Omega
\end{align*}
\]

Test setup inductance: 9mH

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

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

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

\( t_{Eon} = \) 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 \( t_r \)

\[
\begin{align*}
V_{CE} (0\%) &= -8 \text{ V} \\
V_{CE} (100\%) &= 15 \text{ V} \\
V_C (100\%) &= 600 \text{ V} \\
i_C (100\%) &= 804 \text{ A} \\
t_{doff} &= 0,23 \mu s \\
t_{Eoff} &= 0,61 \mu s \\
i_C (100\%) &= 600 \text{ V} \\
i_C (100\%) &= 804 \text{ A} \\
t_{don} &= 0,10 \mu s \\
t_{Eon} &= 0,29 \mu s \\
V_C (100\%) &= 600 \text{ V} \\
i_C (100\%) &= 804 \text{ A} \\
t_f &= 0,046 \mu s \\
t_r &= 0,04 \mu s
\end{align*}
\]
Buck switching definitions

**Figure 5.** IGBT
Turn-off Switching Waveforms & definition of \( t_{\text{Eoff}} \)

- \( P_{\text{off}} \) (100\%) = 483 kW
- \( E_{\text{off}} \) (100\%) = 38.21 mJ
- \( t_{\text{Eoff}} \) = 0.58 μs

**Figure 6.** IGBT
Turn-on Switching Waveforms & definition of \( t_{\text{Eon}} \)

- \( P_{\text{on}} \) (100\%) = 483 kW
- \( E_{\text{on}} \) (100\%) = 13.39 mJ
- \( t_{\text{Eon}} \) = 0.38 μs

**Figure 7.** FWD
Turn-off Switching Waveforms & definition of \( t_{\text{rr}} \)

- \( V_{d} \) (100\%) = 600 V
- \( I_{d} \) (100\%) = 804 A
- \( I_{\text{RRM}} \) (100\%) = -1215 A
- \( t_{\text{rr}} \) = 0.26 μs
**Buck switching definitions**

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

- $I_d$ (100%) = 804 A
- $Q_{rr}$ (100%) = 132,40 μC
- $t_{Qrr}$ = 0,33 μs

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

- $P_{rec}$ (100%) = 482,56 kW
- $E_{rec}$ (100%) = 63,38 mJ
- $t_{Erec}$ = 0,33 μs

Copyright Vincotech
Boost switching definitions

General conditions

$T_J = 125 \, ^\circ\text{C}$
$R_{on} = 0.5 \, \Omega$
$R_{off} = 0.5 \, \Omega$

Test setup inductance: 9nH

**figure 1.** Boost IGBT

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

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

$t_{doff} = 0.34 \, \mu s$
$t_{Eoff} = 0.70 \, \mu s$

$V_{CE}(0\%) = -8 \, V$
$V_{CE}(100\%) = 600 \, V$
$I_C(100\%) = 827 \, A$

$V_{GE}(0\%) = -8 \, V$
$V_{GE}(100\%) = 15 \, V$
$I_C(100\%) = 600 \, V$

**figure 2.** Boost IGBT

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

$t_{Eon} = \text{integrating time for } E_{on}$

$t_{don} = 0.18 \, \mu s$
$t_{Eon} = 0.47 \, \mu s$

$V_{CE}(0\%) = -8 \, V$
$V_{CE}(100\%) = 600 \, V$
$I_C(100\%) = 827 \, A$

$V_{GE}(0\%) = -8 \, V$
$V_{GE}(100\%) = 15 \, V$
$I_C(100\%) = 600 \, V$

**figure 3.** Boost IGBT

**Turn-off Switching Waveforms & definition of $t_f$**

$V_{CE}(100\%) = 600 \, V$
$I_C(100\%) = 827 \, A$

$t_f = 0.079 \, \mu s$

**figure 4.** Boost IGBT

**Turn-on Switching Waveforms & definition of $t_r$**

$V_{CE}(100\%) = 600 \, V$
$I_C(100\%) = 827 \, A$

$t_r = 0.072 \, \mu s$
Boost switching definitions

**figure 5. Boost IGBT**

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

- $P_{off} (100\%) = 496$ kW
- $E_{off} (100\%) = 75$ mJ
- $t_{Eoff} = 0,70$ μs

**figure 6. Boost IGBT**

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

- $P_{on} (100\%) = 496$ kW
- $E_{on} (100\%) = 40$ mJ
- $t_{Eon} = 0,47$ μs

**figure 7. Boost FWD**

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

- $V_d (100\%) = 600$ V
- $I_d (100\%) = 827$ A
- $I_{SRM} (100\%) = 396$ A
- $t_{rr} = 0,47$ μs
Boost switching definitions

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

\[ I_d (100\%) = 827 \text{ A} \]
\[ Q_{rr} (100\%) = 83.52 \mu\text{C} \]
\[ t_{Qrr} = 1.17 \mu\text{s} \]

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

\[ P_{rec} (100\%) = 496,41 \text{ kW} \]
\[ E_{rec} (100\%) = 44.13 \text{ mJ} \]
\[ t_{Erec} = 1.17 \mu\text{s} \]
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#### Date code UL & VIN Lot Serial

**Name**

Vincotech

**UL & VIN**

WWYY UL VIN LLLLL SSSS

**Type & Ver Lot number Serial Date code**

TTTTTTTVV LLLLL SSSS WWYY

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#### Power connections

**Phase**

DC+ (desat)  GND (desat)  DC-

**Low current connections**

TR+  TR-  TR+

**Power connections**

- DC+
- GND
- DC-

**Function**

- S
- G
- T

**with thermal paste**

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**Ordering Code & Marking**

**Date code UL & VIN Lot Serial**

**Datasheet**

**Type & Ver Lot number Serial Date code**

**Tolerance of pin positions:** ±0.5mm at the end of pins

**PCB holes and connection parameters of pins see in the handling instruction document**

**Image:** Diagram of the component with pin numbers and connections.

**Copyright:** Vincotech
### Identification

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<td>1200 V</td>
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**NOTE:** Driver pins for parallel devices are not connected inside the module. Gx-1 to Gx-2 and Ex-1 to Ex2 shall be connected on customer PCB. Where x = 1 to 4.
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