**Features**
- Neutral-point-Clamped inverter
- High power flow2 housing
- Low Inductance Layout

**Target Applications**
- UPS
- Solar inverters

**Types**
- F206NIA200SA

**Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Value</th>
<th>Unit</th>
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<td>Collector-emitter break down voltage</td>
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<td>$T_{j}=T_{j}\text{max}$</td>
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<td>V</td>
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<td>DC collector current</td>
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<td>$T_{j}=T_{j}\text{max}$ $T_{j}=80°C$</td>
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### Maximum Ratings

**Tj=25°C, unless otherwise specified**

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<td>Storage temperature</td>
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<td>-40...-(( T_{j_{max}} )-25)</td>
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### Characteristic Values

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<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
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<tr>
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<td>V&lt;sub&gt;GE(th)&lt;/sub&gt;</td>
<td>V&lt;sub&gt;E=VGE&lt;/sub&gt;</td>
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<td>Collector-emitter cut-off current incl. Diode</td>
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<tr>
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<td>Fall time</td>
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<td>Turn-on energy loss per pulse</td>
<td>E&lt;sub&gt;on&lt;/sub&gt;</td>
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<td>1.89</td>
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<td>Turn-off energy loss per pulse</td>
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<td>Reverse transfer capacitance</td>
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<td>Gate charge</td>
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<td>Thermal resistance chip to heatsink</td>
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<td>Thermal resistance chip to case</td>
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### Buck FWD

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<td>Q&lt;sub&gt;r&lt;/sub&gt;</td>
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<td>Peak rate of fall of recovery current</td>
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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
\( t_p = 350 \ \mu s \)
\( T_j = 25 ^\circ C \)
\( V_{CE} \) from 7 V to 17 V in steps of 1 V

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

At
\( t_p = 350 \ \mu s \)
\( T_j = T_{jmax} - 25 ^\circ C \)
\( V_{CE} = 10 \ V \)

Figure 4: FRED
Typical diode forward current as a function of forward voltage
\( I_F = f(V_F) \)

At
\( t_p = 350 \ \mu s \)
Typical switching energy losses as a function of collector current
\[ E = f(I_C) \]

With an inductive load at
- \( T_j = 25/125 \) °C
- \( V_{CE} = 350 \) V
- \( V_{GE} = \pm 15 \) V
- \( R_{g0n} = 4 \) Ω
- \( I_C = 200 \) A

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

With an inductive load at
- \( T_j = 25/125 \) °C
- \( V_{CE} = 350 \) V
- \( V_{GE} = \pm 15 \) V
- \( I_C = 200 \) A
Buck

Figure 9  IGBT
Typical switching times as a function of collector current
$t = f(I_C)$

With an inductive load at
$T_J = 125 \degree C$
$V_{CE} = 350 \text{ V}$
$V_{GE} = \pm 15 \text{ V}$
$R_{gon} = 4 \text{ } \Omega$
$R_{goff} = 4 \text{ } \Omega$

Figure 10  IGBT
Typical switching times as a function of gate resistor
$t = f(R_G)$

With an inductive load at
$T_J = 125 \degree C$
$V_{CE} = 350 \text{ V}$
$V_{GE} = \pm 15 \text{ V}$
$I_C = 200 \text{ A}$

Figure 11  FRED
Typical reverse recovery time as a function of collector current
$t_{rr} = f(I_C)$

At
$T_J = 25/125 \degree C$
$V_{CE} = 350 \text{ V}$
$V_{GE} = \pm 15 \text{ V}$
$R_{gon} = 4 \text{ } \Omega$

Figure 12  FRED
Typical reverse recovery time as a function of IGBT turn on gate resistor
$t_{rr} = f(R_{gon})$

At
$T_J = 25/125 \degree C$
$V_{GE} = 350 \text{ V}$
$I_F = 200 \text{ A}$
$V_{GE} = \pm 15 \text{ V}$

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**Figure 13**

Typical reverse recovery charge as a function of collector current

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

**Figure 14**

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

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

**Figure 15**

Typical reverse recovery current as a function of collector current

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

**Figure 16**

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

\[ I_{RRM} = f(R_{gon}) \]
Figure 17
Typical rate of fall of forward and reverse recovery current as a function of collector current
\[
dI_0/dt, dI_{rec}/dt = f(I_c)
\]

![Graph showing di/dt vs Ic for FRED and IGBT.]

- **At**
  - \(T_j = 25/125 \, ^\circ \text{C} \)
  - \(V_{CE} = 350 \, \text{V} \)
  - \(V_{GE} = 15 \, \text{V} \)
  - \(R_{gon} = 4 \, \Omega \)

**IGBT**

IGBT transient thermal impedance as a function of pulse width
\[
Z_{thJH} = f(t_p)
\]

- **At**
  - \(D = 0.5 \)
  - \(R_{thJH} = 0.39 \, \text{KW} \)

**IGBT thermal model values**

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<th>(R , (\text{C/W}))</th>
<th>(\text{Tau} , (\text{s}))</th>
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Figure 18
Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor
\[
dI_0/dt, dI_{rec}/dt = f(R_{gon})
\]

![Graph showing di/dt vs Rgon for FRED and IGBT.]

- **At**
  - \(T_j = 25/125 \, ^\circ \text{C} \)
  - \(V_{GE} = 15 \, \text{V} \)
  - \(I_F = 200 \, \text{A} \)
  - \(V_{CE} = 350 \, \text{V} \)

**FRED**

FRED transient thermal impedance as a function of pulse width
\[
Z_{thJH} = f(t_p)
\]

- **At**
  - \(D = 0.5 \)
  - \(R_{thJH} = 0.60 \, \text{KW} \)

FRED thermal model values

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Power dissipation as a function of heatsink temperature

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

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

Power dissipation as a function of heatsink temperature

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

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

Collector current as a function of heatsink temperature

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

At
\[ T_j = 175 \, ^\circ C \]
\[ V_{GE} = 15 \, V \]

Forward current as a function of heatsink temperature

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

At
\[ T_j = 175 \, ^\circ C \]
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
\[ D = \text{single pulse} \]
\[ T_h = 80 \text{ } ^\circ \text{C} \]
\[ V_{GE} = \leq 15 \text{ } \text{V} \]
\[ T_j = T_{j\text{max}} \text{ } ^\circ \text{C} \]
Figure 1
Typical output characteristics
$I_C = f(V_{CE})$

At
$t_p = 250 \, \mu s$
$T_J = 25 \, ^\circ C$
$V_{CE}$ from 7 V to 17 V in steps of 1 V

Figure 2
Typical output characteristics
$I_C = f(V_{CE})$

At
$t_p = 250 \, \mu s$
$T_J = 125 \, ^\circ C$
$V_{CE}$ from 7 V to 17 V in steps of 1 V

Figure 3
Typical transfer characteristics
$I_C = f(V_{GE})$

At
$t_p = 250 \, \mu s$
$T_J = 25 \, ^\circ C$

Figure 4
Typical diode forward current as a function of forward voltage
$I_F = f(V_F)$

At
$t_p = 250 \, \mu s$
Figure 5  IGBT
Typical switching energy losses as a function of collector current
\[ E = f(I_C) \]

With an inductive load at
- \( T_j = 25/125 \, ^\circ C \)
- \( V_{CG} = 350 \, V \)
- \( V_{GE} = \pm 15 \, V \)
- \( R_{gon} = 4 \, \Omega \)
- \( R_{goff} = 4 \, \Omega \)

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

With an inductive load at
- \( T_j = 25/125 \, ^\circ C \)
- \( V_{CG} = 350 \, V \)
- \( V_{GE} = \pm 15 \, V \)
- \( I_C = 201 \, A \)

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

With an inductive load at
- \( T_j = 25/125 \, ^\circ C \)
- \( V_{CG} = 350 \, V \)
- \( V_{GE} = \pm 15 \, V \)
- \( R_{gon} = 4 \, \Omega \)

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

With an inductive load at
- \( T_j = 25/125 \, ^\circ C \)
- \( V_{CG} = 350 \, V \)
- \( V_{GE} = \pm 15 \, V \)
- \( I_C = 201 \, A \)
Figure 9
Typical switching times as a function of collector current
$t = f(I_C)$

With an inductive load at
$T_j = 125 ^\circ C$
$V_{CE} = 350 \text{ V}$
$V_{GE} = \pm 15 \text{ V}$
$R_{gon} = 4 \Omega$
$R_{goff} = 4 \Omega$

Figure 10
Typical switching times as a function of gate resistor
$t = f(R_g)$

With an inductive load at
$T_j = 125 ^\circ C$
$V_{CE} = 350 \text{ V}$
$V_{GE} = \pm 15 \text{ V}$
$I_C = 201 \text{ A}$

Figure 11
Typical reverse recovery time as a function of collector current
$t_{rr} = f(I_C)$

At
$T_j = 25/125 ^\circ C$
$V_{CE} = 350 \text{ V}$
$V_{GE} = \pm 15 \text{ V}$
$R_{gon} = 4 \Omega$

Figure 12
Typical reverse recovery time as a function of IGBT turn on gate resistor
$t_{rr} = f(R_{gon})$

At
$T_j = 25/125 ^\circ C$
$V_{CE} = 350 \text{ V}$
$I_C = 201 \text{ A}$
$V_{GE} = \pm 15 \text{ V}$
Figure 13
Typical reverse recovery charge as a function of collector current
Q_{rr} = f(I_C)

At
T_j = 25/125 °C
V_{CE} = 350 V
V_{GE} = ±15 V
R_{gon} = 4 Ω

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 °C
V_{CE} = 350 V
I_F = 201 A
V_{GE} = ±15 V

Figure 15
Typical reverse recovery current as a function of collector current
I_{RRM} = f(I_C)

At
T_j = 25/125 °C
V_{CE} = 350 V
V_{GE} = ±15 V
R_{gon} = 4 Ω

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 °C
V_{CE} = 350 V
I_F = 201 A
V_{GE} = ±15 V
Figure 17  FRED
Typical rate of fall of forward and reverse recovery current as a function of collector current $\frac{dI}{dt}, \frac{dI_{rec}}{dt} = f(I_c)$

At
- $T_j = 25/125$ °C
- $V_{CE} = 350$ V
- $V_GE = \pm 15$ V
- $I_F = 201$ A
- $R_{gon} = 4 \Omega$

Figure 18  FRED
Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor $\frac{dI}{dt}, \frac{dI_{rec}}{dt} = f(R_{gon})$

At
- $T_j = 25/125$ °C
- $V_{CE} = 350$ V
- $V_GE = \pm 15$ V
- $I_F = 201$ A
- $V_{GE} = \pm 15$ V

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

At
- $D = tp / T$
- $R_{thJH} = 0.39$ KW

IGBT thermal model values
- $R (C/W)$  $\tau (s)$
  - 0.02  1.2E+01
  - 0.10  2.6E+00
  - 0.07  4.8E-01
  - 0.11  5.9E-02
  - 0.05  1.3E-02
  - 0.02  4.9E-04

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

At
- $D = tp / T$
- $R_{thJH} = 0.50$ KW

FRED thermal model values
- $R (C/W)$  $\tau (s)$
  - 0.04  9.6E+00
  - 0.10  1.7E+00
  - 0.09  2.6E-01
  - 0.18  3.6E-02
  - 0.05  7.1E-03
  - 0.04  4.0E-04
Power dissipation as a Collector current as a function of heatsink temperature

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

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

Power dissipation as a Forward current as a function of heatsink temperature

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

At
\[ T_j = 175 \, ^\circ\text{C} \]
\[ V_{GE} = 15 \, \text{V} \]

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Figure 25
Boost Inverse Diode
Typical diode forward current as a function of forward voltage
$I_F = f(V_f)$

![Graph showing diode forward current as a function of forward voltage.]

At
$t_p = 250 \ \mu s$

Figure 26
Boost Inverse Diode
Diode transient thermal impedance as a function of pulse width
$Z_{thJH} = f(t_p)$

![Graph showing diode transient thermal impedance as a function of pulse width.]

At
$D = \frac{t_p}{T}$
$R_{thJH} = 0.50 \ \text{K/W}$

Figure 27
Boost Inverse Diode
Power dissipation as a function of heatsink temperature
$P_{tot} = f(T_h)$

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

At
$T_j = 175 ^\circ C$

Figure 28
Boost Inverse Diode
Forward current as a function of heatsink temperature
$I_F = f(T_h)$

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

At
$T_j = 175 ^\circ C$
Figure 1
Typical NTC characteristic as a function of temperature
\[ R_T = f(T) \]
Switching Definitions BUCK IGBT

General conditions

\[ T_j = 125 \, ^\circ C \]
\[ R_{son} = 4 \, \Omega \]
\[ R_{poff} = 4 \, \Omega \]

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

- \( V_G(0\%) = -15 \, V \)
- \( V_G(100\%) = 15 \, V \)
- \( I_C(100\%) = 201 \, A \)
- \( t_{doff} = 0.34 \, \mu s \)
- \( t_{Eoff} = 0.59 \, \mu s \)

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

- \( V_G(0\%) = -15 \, V \)
- \( V_G(100\%) = 15 \, V \)
- \( I_C(100\%) = 201 \, A \)
- \( t_{don} = 0.25 \, \mu s \)
- \( t_{Eon} = 0.45 \, \mu s \)

**Figure 3**
Output inverter IGBT
Turn-off Switching Waveforms & definition of \( t_f \)

- \( V_C(100\%) = 700 \, V \)
- \( I_C(100\%) = 201 \, A \)
- \( t_f = 0.10 \, \mu s \)

**Figure 4**
Output inverter IGBT
Turn-on Switching Waveforms & definition of \( t_r \)

- \( V_C(100\%) = 700 \, V \)
- \( I_C(100\%) = 201 \, A \)
- \( t_r = 0.04 \, \mu s \)

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Switching Definitions BUCK MOSFET

**Figure 5**
Output inverter IGBT
Turn-off Switching Waveforms & definition of $t_{Eoff}$

- $P_{off} (100\%) = 140.86$ kW
- $E_{off} (100\%) = 7.89$ mJ
- $t_{Eoff} = 0.59$ μs

**Figure 6**
Output inverter IGBT
Turn-on Switching Waveforms & definition of $t_{Eon}$

- $P_{on} (100\%) = 140.86$ kW
- $E_{on} (100\%) = 4.22$ mJ
- $t_{Eon} = 0.45$ μs

**Figure 7**
Output inverter FRED
Gate voltage vs Gate charge (measured)

- $V_{GEoff} = -15$ V
- $V_{GEon} = 15$ V
- $V_{C}(100\%) = 300$ V
- $I_{D}(100\%) = 201$ A
- $Q_g = 2106.06$ nC

**Figure 8**
Output inverter IGBT
Turn-off Switching Waveforms & definition of $t_r$

- $V_D (100\%) = 700$ V
- $I_D (100\%) = 201$ A
- $I_{max10\%} = -172$ A
- $t_r = 0.27$ μs
Switching Definitions BUCK MOSFET

**Figure 9**
Output inverter FRED
Turn-on Switching Waveforms & definition of $t_{Qrr}$
($t_{Qrr}$ = integrating time for $Q_{rr}$)

- $I_d (100\%) = 201$ A
- $Q_{rr} (100\%) = 16.20 \, \mu C$
- $t_{Qrr} = 0.55 \, \mu s$

**Figure 10**
Output inverter FRED
Turn-on Switching Waveforms & definition of $t_{Erec}$
($t_{Erec}$ = integrating time for $E_{rec}$)

- $P_{rec} (100\%) = 140.86 \, kW$
- $E_{rec} (100\%) = 3.66 \, mJ$
- $t_{Erec} = 0.55 \, \mu s$

**Measurement circuits**

**Figure 11**
BUCK stage switching measurement circuit

**Figure 12**
BOOST stage switching measurement circuit
Ordering Code and Marking - Outline - Pinout

### Ordering Code & Marking

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### Outline

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### Pinout

Diagram showing the pinout and electrical connections of the device.
PRODUCT STATUS DEFINITIONS

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<th>Definition</th>
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<td>This datasheet contains the design specifications for product development. Specifications may change in any manner without notice. The data contained is exclusively intended for technically trained staff.</td>
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<td>First Production</td>
<td>This datasheet contains preliminary data, and supplementary data may be published at a later date. Vincotech reserves the right to make changes at any time without notice in order to improve design. The data contained is exclusively intended for technically trained staff.</td>
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<td>This datasheet contains final specifications. Vincotech reserves the right to make changes at any time without notice in order to improve design. The data contained is exclusively intended for technically trained staff.</td>
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