flowSOL 1 BI

650V / 41mOhm

Features
- Low inductive 12mm flow1 package
- Booster:
  - Dual boost topology
  - MOSFET 650V/37mOhm + ultrafast FWD
  - Bypass rectifier
- Inverter:
  - Pseudo H-bridge topology
  - MOSFET 650V/41mOhm CFD + ultrafast FWD
  - Integrated DC-capacitors
- Temperature sensor

Target Applications
- Solar Inverter:
  - High efficient transformer-less solar inverter with bipolar modulation

Types
- 10-FY07BIA041MF-M528E68

Bypass Diode

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit 1</th>
<th>Value 1</th>
<th>Unit 2</th>
<th>Value 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{(RSM)}$</td>
<td>V</td>
<td>1600</td>
<td></td>
<td></td>
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<tr>
<td>Forward current per diode</td>
<td>$I_{(FAC)}$</td>
<td>DC current</td>
<td>$T_{j}=80^\circ C$</td>
<td>41</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$T_{c}=80^\circ C$</td>
<td>55</td>
<td>A</td>
</tr>
<tr>
<td>Surge forward current</td>
<td>$I_{(FSM)}$</td>
<td>$I_{p}=10\text{ms}$</td>
<td>$T_{j}=25^\circ C$</td>
<td>370</td>
<td>A</td>
</tr>
<tr>
<td>$I_2t$-value</td>
<td>$i_{2t}$</td>
<td>$A\cdot s$</td>
<td>370</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Power dissipation per Diode</td>
<td>$P_{(Diode)}$</td>
<td>$T_{j}=T_{j,\text{max}}$</td>
<td>$T_{j}=80^\circ C$</td>
<td>50</td>
<td>W</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>$T_{c}=80^\circ C$</td>
<td>76</td>
<td>W</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>$T_{j,\text{max}}$</td>
<td>°C</td>
<td>150</td>
<td>°C</td>
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Input Boost MOSFET

<table>
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<tr>
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<th>Symbol</th>
<th>Unit</th>
<th>Value 1</th>
<th>Unit 2</th>
<th>Value 2</th>
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<tbody>
<tr>
<td>Drain to source breakdown voltage</td>
<td>$V_{(DS)}$</td>
<td>V</td>
<td>650</td>
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<tr>
<td>DC drain current</td>
<td>$I_D$</td>
<td>$T_{j}=T_{j,\text{max}}$</td>
<td>$T_{j}=80^\circ C$</td>
<td>35</td>
<td>A</td>
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<td></td>
<td></td>
<td></td>
<td>$T_{c}=80^\circ C$</td>
<td>42</td>
<td>A</td>
</tr>
<tr>
<td>Pulsed drain current</td>
<td>$I_{(pMax)}$</td>
<td>$i_{p}$ limited by $T_{j,\text{max}}$</td>
<td></td>
<td>297</td>
<td>A</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>$P_{(Diode)}$</td>
<td>$T_{j}=T_{j,\text{max}}$</td>
<td>$T_{j}=80^\circ C$</td>
<td>105</td>
<td>W</td>
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<td></td>
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<td>$T_{c}=80^\circ C$</td>
<td>159</td>
<td>W</td>
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<tr>
<td>Gate-source peak voltage</td>
<td>$V_{(GS)}$</td>
<td>V</td>
<td>±20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>$T_{j,\text{max}}$</td>
<td>°C</td>
<td>150</td>
<td>°C</td>
<td></td>
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</tbody>
</table>
## Pseudo H-Bridge MOSFET

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Condition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drain to source breakdown voltage VDS</td>
<td></td>
<td>650 V</td>
</tr>
<tr>
<td>DC drain current I_D</td>
<td>Tj=Tjmax, Tc=80°C</td>
<td>35 A</td>
</tr>
<tr>
<td>Pulsed drain current I_D</td>
<td>Tc=25°C</td>
<td>255 A</td>
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<tr>
<td>Power dissipation P_D</td>
<td>Tj=Tjmax, Tc=80°C</td>
<td>111 W</td>
</tr>
<tr>
<td>Gate-source peak voltage Vgs</td>
<td></td>
<td>±20 V</td>
</tr>
<tr>
<td>Maximum Junction Temperature Tj,max</td>
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<td>150 °C</td>
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## Pseudo H-Bridge Diode

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Condition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Repetitive Reverse Voltage V_FRM</td>
<td>Tj=25°C</td>
<td>650 V</td>
</tr>
<tr>
<td>DC forward current I_F</td>
<td>Tj=Tjmax, Tc=80°C</td>
<td>27 A</td>
</tr>
<tr>
<td>Repetitive peak forward current I_PWM</td>
<td>Tc=80°C</td>
<td>180 A</td>
</tr>
<tr>
<td>Power dissipation P_PWM</td>
<td>Tj=Tjmax, Tc=80°C</td>
<td>49 W</td>
</tr>
<tr>
<td>Maximum Junction Temperature Tj,max</td>
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<td>175 °C</td>
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</table>

## DC link Capacitor

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Condition</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Max DC voltage V_MAX</td>
<td>Tc=25°C</td>
<td>630 V</td>
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## Thermal Properties

<table>
<thead>
<tr>
<th>Parameter</th>
<th>T_range</th>
<th>°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature T_as</td>
<td></td>
<td>-40…+125</td>
</tr>
<tr>
<td>Operation temperature under switching condition T_op</td>
<td></td>
<td>-40…+(Tjmax - 25)</td>
</tr>
</tbody>
</table>

## Insulation Properties

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulation voltage V_in</td>
<td>4000 V</td>
</tr>
<tr>
<td>Creepage distance</td>
<td>min 12,7 mm</td>
</tr>
<tr>
<td>Clearance</td>
<td>min 12,7 mm</td>
</tr>
</tbody>
</table>
### 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>Input Boost MOSFET</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Static drain to source ON resistance</td>
<td>( R_{\text{ds(on)}} )</td>
<td>10</td>
<td>33</td>
<td>38</td>
</tr>
<tr>
<td>Gate threshold voltage</td>
<td>( V_{\text{G(th)}} )</td>
<td>0.0033</td>
<td>2.5</td>
<td>3</td>
</tr>
<tr>
<td>Gate to Source Leakage Current</td>
<td>( I_{\text{gs}} )</td>
<td>20</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Zero Gate Voltage Drain Current</td>
<td>( I_{\text{ds}} )</td>
<td>0</td>
<td>650</td>
<td>2000</td>
</tr>
<tr>
<td>Turn On Delay Time</td>
<td>( t_{\text{on}} )</td>
<td>10</td>
<td>400</td>
<td>30</td>
</tr>
<tr>
<td>Rise Time</td>
<td>( t_{\text{r}} )</td>
<td>10</td>
<td>400</td>
<td>30</td>
</tr>
<tr>
<td>Turn off delay time</td>
<td>( t_{\text{off}} )</td>
<td>10</td>
<td>400</td>
<td>30</td>
</tr>
<tr>
<td>Fall time</td>
<td>( t_{\text{f}} )</td>
<td>10</td>
<td>400</td>
<td>30</td>
</tr>
<tr>
<td>Turn-on energy loss per pulse</td>
<td>( E_{\text{on}} )</td>
<td>10</td>
<td>400</td>
<td>30</td>
</tr>
<tr>
<td>Turn-off energy loss per pulse</td>
<td>( E_{\text{off}} )</td>
<td>10</td>
<td>400</td>
<td>30</td>
</tr>
<tr>
<td>Total gate charge</td>
<td>( Q_{\text{g}} )</td>
<td>10</td>
<td>400</td>
<td>30</td>
</tr>
<tr>
<td>Gate to source charge</td>
<td>( Q_{\text{gs}} )</td>
<td>10</td>
<td>400</td>
<td>30</td>
</tr>
<tr>
<td>Gate to drain charge</td>
<td>( Q_{\text{gd}} )</td>
<td>10</td>
<td>400</td>
<td>30</td>
</tr>
<tr>
<td>Input capacitance</td>
<td>( C_{\text{iss}} )</td>
<td>10</td>
<td>400</td>
<td>30</td>
</tr>
<tr>
<td>Output capacitance</td>
<td>( C_{\text{oss}} )</td>
<td>10</td>
<td>400</td>
<td>30</td>
</tr>
<tr>
<td>Thermal resistance chip to heatsink per chip</td>
<td>( R_{\text{thJH}} )</td>
<td>10</td>
<td>400</td>
<td>30</td>
</tr>
<tr>
<td><strong>Input Boost Diode</strong></td>
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<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>( V_{\text{ce}} )</td>
<td>30</td>
<td>2.45</td>
<td>2.03</td>
</tr>
<tr>
<td>Reverse leakage current</td>
<td>( I_{\text{f}} )</td>
<td>10</td>
<td>400</td>
<td>30</td>
</tr>
<tr>
<td>Peak recovery current</td>
<td>( I_{\text{rm}} )</td>
<td>10</td>
<td>400</td>
<td>30</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>( t_{\text{r}} )</td>
<td>10</td>
<td>400</td>
<td>30</td>
</tr>
<tr>
<td>Reverse recovery charge</td>
<td>( Q_{\text{r}} )</td>
<td>10</td>
<td>400</td>
<td>30</td>
</tr>
<tr>
<td>Reverse recovered energy</td>
<td>( E_{\text{r}} )</td>
<td>10</td>
<td>400</td>
<td>30</td>
</tr>
<tr>
<td>Peak rate of fall of recovery current</td>
<td>( \frac{d</td>
<td>\text{rec}</td>
<td>}{dt} )</td>
<td>10</td>
</tr>
<tr>
<td>Thermal resistance chip to heatsink per chip</td>
<td>( R_{\text{thJH}} )</td>
<td>10</td>
<td>400</td>
<td>30</td>
</tr>
</tbody>
</table>

---

**Note:** All values are at specific operating conditions and are subject to change with variations in input conditions.
## Characteristic Values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pseudo H-Bridge MOSFET</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Static drain to source ON resistance</td>
<td></td>
<td>R_{on}</td>
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<tr>
<td>Gate threshold voltage</td>
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<td>V_{G(th)}</td>
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<tr>
<td>Gate to Source Leakage Current</td>
<td></td>
<td>t_{on}</td>
<td>100</td>
</tr>
<tr>
<td>Zero Gate Voltage Drain Current</td>
<td></td>
<td>t_{off}</td>
<td>100</td>
</tr>
<tr>
<td>Rise time</td>
<td></td>
<td>t_r</td>
<td>100</td>
</tr>
<tr>
<td>Fall time</td>
<td></td>
<td>t_f</td>
<td>100</td>
</tr>
<tr>
<td>Turn-on energy loss per pulse</td>
<td></td>
<td>E_{on}</td>
<td>100</td>
</tr>
<tr>
<td>Turn-off energy loss per pulse</td>
<td></td>
<td>E_{off}</td>
<td>100</td>
</tr>
<tr>
<td>Total gate charge</td>
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<td>Q_{g}</td>
<td>100</td>
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<tr>
<td>Gate to source charge</td>
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<td>Q_{gs}</td>
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<td>Gate to drain charge</td>
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<td>Q_{gd}</td>
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<td>Input capacitance</td>
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<td>Output capacitance</td>
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<td>C_{out}</td>
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<td>Thermal resistance chip to heatsink per chip</td>
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<td><strong>Pseudo H-Bridge Diode</strong></td>
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<td>Diode forward voltage</td>
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<td>Reverse recovery time</td>
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<td>t_r</td>
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<td>Reverse recovered charge</td>
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<td>Q_{R}</td>
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<td>Reverse recovery energy</td>
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<td>E_{rec}</td>
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<td>Thermal resistance chip to heatsink per chip</td>
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<td><strong>DC link Capacitor</strong></td>
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<td>Vincotech NTC Reference</td>
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</table>
Pseudo H-Bridge

**Figure 1** MOSFET
Typical output characteristics
$IC = f(V_{CE})$

At
$t_p = 250 \ \mu s$
$T_j = 25 °C$
$V_{GE}$ from 0 V to 20 V in steps of 2 V

**Figure 2** MOSFET
Typical output characteristics
$IC = f(V_{CE})$

At
$t_p = 250 \ \mu s$
$T_j = 125 °C$
$V_{CE}$ from 0 V to 20 V in steps of 2 V

**Figure 3** MOSFET
Typical transfer characteristics
$IC = f(V_{GE})$

At
$t_p = 250 \ \mu s$
$V_{CE} = 10 V$

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

At
$t_p = 250 \ \mu s$
$T_j = T_j_{max}-25°C$

Copyright by Vincotech
Pseudo H-Bridge

**Figure 5**
Typical switching energy losses as a function of collector current
\[ E = f(I_C) \]

With an inductive load at
- \( T_j = 25/125 \, ^\circ\text{C} \)
- \( V_{CE} = 400 \, \text{V} \)
- \( V_{GE} = 10 \, \text{V} \)
- \( R_{gon} = 2 \, \Omega \)
- \( R_{goff} = 2 \, \Omega \)

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

With an inductive load at
- \( T_j = 25/125 \, ^\circ\text{C} \)
- \( V_{CE} = 400 \, \text{V} \)
- \( V_{GE} = 10 \, \text{V} \)
- \( I_C = 30 \, \text{A} \)

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

With an inductive load at
- \( T_j = 25/125 \, ^\circ\text{C} \)
- \( V_{CE} = 400 \, \text{V} \)
- \( V_{GE} = 10 \, \text{V} \)
- \( R_{gon} = 2 \, \Omega \)

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

With an inductive load at
- \( T_j = 25/125 \, ^\circ\text{C} \)
- \( V_{CE} = 400 \, \text{V} \)
- \( V_{GE} = 10 \, \text{V} \)
- \( I_C = 30 \, \text{A} \)
Pseudo H-Bridge

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

With an inductive load at
$T_j = 125 \, ^\circ C$
$V_{CE} = 400 \, V$
$V_{GE} = 10 \, V$
$R_{gon} = 2 \, \Omega$
$R_{goff} = 2 \, \Omega$

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

With an inductive load at
$T_j = 125 \, ^\circ C$
$V_{CE} = 400 \, V$
$V_{GE} = 10 \, V$
$I_C = 30 \, A$

Figure 11
Typical reverse recovery time as a function of collector current
$trr = f(I_C)$

At
$T_j = 25/125 \, ^\circ C$
$V_{CE} = 400 \, V$
$V_{GE} = 10 \, V$
$R_{gon} = 2 \, \Omega$

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

At
$T_j = 25/125 \, ^\circ C$
$V_R = 400 \, V$
$I_R = 30 \, A$
$V_{GE} = 10 \, V$
Pseudo H-Bridge

**Figure 13**
Typical reverse recovery charge as a function of collector current

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

- At
  - \( T_j = 25/125 \) °C
  - \( V_{CE} = 400 \) V
  - \( V_{GE} = 10 \) V
  - \( R_{gon} = 2 \) 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
  - \( V_{GE} = 10 \) V
  - \( I_F = 30 \) A
  - \( V_{GE} = 400 \) V

**Figure 15**
Typical reverse recovery current as a function of collector current

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

- At
  - \( T_j = 25/125 \) °C
  - \( V_{CE} = 400 \) V
  - \( V_{GE} = 10 \) V
  - \( R_{gon} = 2 \) 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
  - \( V_{GE} = 10 \) V
  - \( I_F = 30 \) A
  - \( V_{GE} = 400 \) V
**Pseudo H-Bridge**

**Figure 17**
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

- \( T_j = 25/125 \) °C
- \( V_{CE} = 400 \) V
- \( V_{GE} = 10 \) V
- \( R_{gon} = 2 \) Ω

**Figure 18**
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

- \( T_j = 25/125 \) °C
- \( V_{GE} = 10 \) V
- \( I_F = 30 \) A
- \( V_{GE} = 10 \) V

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

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

At

- \( D = \frac{t_p}{T} \)
- \( R_{thJH} = 0.63 \) KW

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

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

At

- \( D = \frac{t_p}{T} \)
- \( R_{thJH} = 1.94 \) KW

**IGBT thermal model values**

\[
\begin{array}{|c|c|}
\hline
R (C/W) & \text{Tau (s)} \\
0.04 & 5.1E+00 \\
0.08 & 1.0E+00 \\
0.30 & 2.1E-01 \\
0.14 & 8.6E-02 \\
0.03 & 1.3E-02 \\
0.02 & 1.4E-03 \\
\hline
\end{array}
\]

**FWD thermal model values**

\[
\begin{array}{|c|c|}
\hline
R (C/W) & \text{Tau (s)} \\
0.05 & 6.0E+00 \\
0.14 & 8.1E-01 \\
0.72 & 1.4E-01 \\
0.42 & 4.5E-02 \\
0.33 & 1.0E-02 \\
0.19 & 1.8E-03 \\
\hline
\end{array}
\]

Copyright by Vincotech
Pseudo H-Bridge

Figure 21
Power dissipation as a function of heatsink temperature
\[ P_{tot} = f(T_h) \]

<table>
<thead>
<tr>
<th>TH (°C)</th>
<th>Ptot (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>250</td>
</tr>
<tr>
<td>50</td>
<td>200</td>
</tr>
<tr>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>150</td>
<td>100</td>
</tr>
<tr>
<td>200</td>
<td>50</td>
</tr>
</tbody>
</table>

At
\[ T_j = 150 \ °C \]

Figure 22
Collector current as a function of heatsink temperature
\[ I_C = f(T_h) \]

<table>
<thead>
<tr>
<th>TH (°C)</th>
<th>IC (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>60</td>
</tr>
<tr>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>100</td>
<td>40</td>
</tr>
<tr>
<td>150</td>
<td>30</td>
</tr>
<tr>
<td>200</td>
<td>20</td>
</tr>
</tbody>
</table>

At
\[ T_j = 150 \ °C \]
\[ V_{GE} = 15 \ V \]

Figure 23
Power dissipation as a function of heatsink temperature
\[ P_{tot} = f(T_h) \]

<table>
<thead>
<tr>
<th>TH (°C)</th>
<th>Ptot (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>50</td>
<td>80</td>
</tr>
<tr>
<td>100</td>
<td>60</td>
</tr>
<tr>
<td>150</td>
<td>40</td>
</tr>
<tr>
<td>200</td>
<td>20</td>
</tr>
</tbody>
</table>

At
\[ T_j = 175 \ °C \]

Figure 24
Forward current as a function of heatsink temperature
\[ I_F = f(T_h) \]

<table>
<thead>
<tr>
<th>TH (°C)</th>
<th>IF (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>55</td>
</tr>
<tr>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>100</td>
<td>40</td>
</tr>
<tr>
<td>150</td>
<td>30</td>
</tr>
<tr>
<td>200</td>
<td>20</td>
</tr>
</tbody>
</table>

At
\[ T_j = 175 \ °C \]
Figure 25: MOSFET Safe operating area as a function of collector-emitter voltage

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

At
\[ D = \text{single pulse} \]
\[ T_h = 80 \, ^\circ\text{C} \]
\[ V_{GE} = 15 \, \text{V} \]
\[ T_j = T_{\text{max}} \, ^\circ\text{C} \]

Figure 26: Gate voltage vs Gate charge

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

At
\[ I_C = 50 \, \text{A} \]
Figure 1  BOOST MOSFET
Typical output characteristics
\( I_d = f(V_{GS}) \)

At
\[ t_p = 250 \, \mu s \]
\[ T_j = 25 \, ^\circ C \]
\[ V_{GS} \text{ from } 3 \text{ V to } 13 \text{ V in steps of } 1 \text{ V} \]

Figure 2  BOOST MOSFET
Typical output characteristics
\( I_d = f(V_{GS}) \)

At
\[ t_p = 250 \, \mu s \]
\[ T_j = 125 \, ^\circ C \]
\[ V_{GS} \text{ from } 3 \text{ V to } 13 \text{ V in steps of } 1 \text{ V} \]

Figure 3  BOOST MOSFET
Typical transfer characteristics
\( I_d = f(V_{GS}) \)

At
\[ t_p = 250 \, \mu s \]
\[ T_j = T_j_{\text{max}} - 25 \, ^\circ C \]
\[ V_{GS} = 10 \, \text{ V} \]

Figure 4  BOOST FWD
Typical diode forward current as a function of forward voltage
\( I_d = f(V_f) \)

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

With an inductive load at  
- \( T_J = 25/125 ^\circ C \)  
- \( V_{DS} = 400 \text{ V} \)  
- \( V_{GS} = 10 \text{ V} \)  
- \( R_{gon} = 2 \Omega \)  
- \( R_{goff} = 2 \Omega \)

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

With an inductive load at  
- \( T_J = 25/125 ^\circ C \)  
- \( V_{DS} = 400 \text{ V} \)  
- \( V_{GS} = 10 \text{ V} \)  
- \( I_B = 30 \text{ A} \)

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

With an inductive load at  
- \( T_J = 25/125 ^\circ C \)  
- \( V_{DS} = 400 \text{ V} \)  
- \( V_{GS} = 10 \text{ V} \)  
- \( R_{gon} = 2 \Omega \)  
- \( R_{goff} = 2 \Omega \)

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

With an inductive load at  
- \( T_J = 25/125 ^\circ C \)  
- \( V_{DS} = 400 \text{ V} \)  
- \( V_{GS} = 10 \text{ V} \)  
- \( I_B = 30 \text{ A} \)
**Figure 9**

**BOOST MOSFET**

Typical switching times as a function of collector current

$t = f(I_c)$

With an inductive load at

$T_j = 125 \, ^\circ C$

$V_{DS} = 400 \, V$

$V_{GS} = 10 \, V$

$R_{gon} = 2 \, \Omega$

$R_{goff} = 2 \, \Omega$

---

**Figure 10**

**BOOST MOSFET**

Typical switching times as a function of gate resistor

$t = f(R_g)$

With an inductive load at

$T_j = 125 \, ^\circ C$

$V_{DS} = 400 \, V$

$V_{GS} = 10 \, V$

$I_c = 30 \, A$

---

**Figure 11**

**BOOST FWD**

Typical reverse recovery time as a function of collector current

$\tau_{rr} = f(I_c)$

At

$T_j = 25/125 \, ^\circ C$

$V_{DS} = 400 \, V$

$V_{GS} = 10 \, V$

$R_{gon} = 2 \, \Omega$

---

**Figure 12**

**BOOST FWD**

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

$\tau_{rr} = f(R_{gon})$

At

$T_j = 25/125 \, ^\circ C$

$V_{BB} = 400 \, V$

$I_c = 30 \, A$

$V_{GS} = 10 \, V$
Figure 13 **BOOST FWD**
Typical reverse recovery charge as a function of collector current
\[ Q_{rr} = f(I_C) \]

At:
- \( T_j = 25/125 \) °C
- \( V_{CE} = 400 \) V
- \( V_{GS} = 10 \) V
- \( R_{gon} = 2 \) Ω

Figure 14 **BOOST FWD**
Typical reverse recovery charge as a function of IGBT turn on gate resistor
\[ Q_{rr} = f(R_{gon}) \]

At:
- \( T_j = 25/125 \) °C
- \( V_{CE} = 400 \) V
- \( I_F = 30 \) A
- \( V_{GS} = 10 \) V

Figure 15 **BOOST FWD**
Typical reverse recovery current as a function of collector current
\[ I_{RRM} = f(I_C) \]

At:
- \( T_j = 25/125 \) °C
- \( V_{CE} = 400 \) V
- \( V_{GS} = 10 \) V
- \( R_{gon} = 2 \) Ω

Figure 16 **BOOST FWD**
Typical reverse recovery current as a function of IGBT turn on gate resistor
\[ I_{RRM} = f(R_{gon}) \]

At:
- \( T_j = 25/125 \) °C
- \( V_{CE} = 400 \) V
- \( I_F = 30 \) A
- \( V_{GS} = 10 \) V
**INPUT BOOST**

**Figure 17**
Typical rate of fall of forward and reverse recovery current as a function of collector current
\( \frac{di_0}{dt}, \frac{dr}{dt} = f(I_c) \)

**Figure 18**
Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor
\( \frac{di_0}{dt}, \frac{dr}{dt} = f(R_{gon}) \)

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

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

**Table: IGBT thermal model values**

<table>
<thead>
<tr>
<th>R (C/W)</th>
<th>Tau (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.56E-02</td>
<td>5.26E+00</td>
</tr>
<tr>
<td>8.98E-02</td>
<td>9.94E-01</td>
</tr>
<tr>
<td>3.76E-01</td>
<td>1.88E-01</td>
</tr>
<tr>
<td>1.04E-01</td>
<td>6.08E-02</td>
</tr>
<tr>
<td>3.76E-02</td>
<td>1.20E-02</td>
</tr>
<tr>
<td>2.56E-02</td>
<td>9.33E-04</td>
</tr>
</tbody>
</table>

**Table: FWD thermal model values**

<table>
<thead>
<tr>
<th>R (C/W)</th>
<th>Tau (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.65E-02</td>
<td>5.96E+00</td>
</tr>
<tr>
<td>1.38E-01</td>
<td>8.06E-01</td>
</tr>
<tr>
<td>7.19E-01</td>
<td>1.42E-01</td>
</tr>
<tr>
<td>4.17E-01</td>
<td>4.54E-02</td>
</tr>
<tr>
<td>3.26E-01</td>
<td>1.02E-02</td>
</tr>
<tr>
<td>1.85E-01</td>
<td>1.84E-03</td>
</tr>
</tbody>
</table>

---

**At**
- \( T_j = 25/125 \) °C
- \( V_{CE} = 400 \) V
- \( V_{GE} = 10 \) V
- \( R_{gon} = 2 \) Ω

**At**
- \( T_j = 25/125 \) °C
- \( V_{CE} = 400 \) V
- \( V_{GS} = 10 \) V

---

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INPUT BOOST

**Figure 21**
Power dissipation as a function of heatsink temperature
\[ P_{tot} = f(T_h) \]

At
\[ T_j = 150 \, ^{\circ}\text{C} \]

**Figure 22**
Collector/Drain current as a function of heatsink temperature
\[ I_C = f(T_h) \]

At
\[ T_j = 150 \, ^{\circ}\text{C} \]
\[ V_{GS} = 10 \, \text{V} \]

**Figure 23**
Power dissipation as a function of heatsink temperature
\[ P_{tot} = f(T_h) \]

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

**Figure 24**
Forward current as a function of heatsink temperature
\[ I_F = f(T_h) \]

At
\[ T_j = 175 \, ^{\circ}\text{C} \]
**Figure 25**
Safe operating area as a function of drain-source voltage

\[ I_D = f(V_{DS}) \]

- **At**
  - \( D = \) single pulse
  - \( T_s = 80 \) °C
  - \( V_{GS} = 10 \) V
  - \( T_j = T_{j\text{max}} \) °C

**Figure 26**
Gate voltage vs Gate charge

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

- **At**
  - \( I_D = 50 \) A

---

**INPUT BOOST**

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Bypass Diode

**Figure 1**
Typical diode forward current as a function of forward voltage
\[ I_F = f(V_F) \]

\[ T_j = 250 \, ^\circ\text{C} \quad T_j = 25\, ^\circ\text{C} \]

\[ t_p = 250 \mu\text{s} \]

**Figure 2**
Diode transient thermal impedance as a function of pulse width
\[ Z_{thJH} = f(t_p) \]

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

\[ R_{thJH} = 1.397 \, \text{K/W} \]

**Figure 3**
Power dissipation as a function of heatsink temperature
\[ P_{tot} = f(T_h) \]

\[ D = 0.5 \quad 0.2 \quad 0.1 \quad 0.05 \quad 0.02 \quad 0.01 \quad 0.005 \quad 0.000 \]

**Figure 4**
Forward current as a function of heatsink temperature
\[ I_F = f(T_h) \]

\[ T_j = 150 \, ^\circ\text{C} \]

\[ T_j = T_{jmax} - 25 \, ^\circ\text{C} \]
Figure 1

Thermistor

Typical NTC characteristic
as a function of temperature

\[ R_T = f(T) \]
Switching Definitions H-Bridge MOSFET

General conditions

- $T_J = 125 \degree C$
- $R_{on} = 2 \Omega$
- $R_{off} = 2 \Omega$

**Figure 1**
Turn-off Switching Waveforms & definition of $t_{off}$, $t_{off}$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{GE}(0%)$</td>
<td>0 V</td>
</tr>
<tr>
<td>$V_{GE}(100%)$</td>
<td>10 V</td>
</tr>
<tr>
<td>$V_C(100%)$</td>
<td>400 V</td>
</tr>
<tr>
<td>$I_C(100%)$</td>
<td>30 A</td>
</tr>
<tr>
<td>$t_{off} = t_{on}$</td>
<td>0.15 $\mu$s</td>
</tr>
<tr>
<td>$t_{off} = t_{on}$</td>
<td>0.18 $\mu$s</td>
</tr>
</tbody>
</table>

**Figure 2**
Turn-on Switching Waveforms & definition of $t_{on}$, $t_{on}$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{GE}(0%)$</td>
<td>0 V</td>
</tr>
<tr>
<td>$V_{GE}(100%)$</td>
<td>10 V</td>
</tr>
<tr>
<td>$V_C(100%)$</td>
<td>400 V</td>
</tr>
<tr>
<td>$I_C(100%)$</td>
<td>30 A</td>
</tr>
<tr>
<td>$t_{on} = t_{off}$</td>
<td>0.04 $\mu$s</td>
</tr>
<tr>
<td>$t_{on} = t_{off}$</td>
<td>0.07 $\mu$s</td>
</tr>
</tbody>
</table>

**Figure 3**
Turn-off Switching Waveforms & definition of $t_f$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_C(100%)$</td>
<td>400 V</td>
</tr>
<tr>
<td>$I_C(100%)$</td>
<td>30 A</td>
</tr>
<tr>
<td>$t_f = t_{on}$</td>
<td>0.00 $\mu$s</td>
</tr>
</tbody>
</table>

**Figure 4**
Turn-on Switching Waveforms & definition of $t_r$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_C(100%)$</td>
<td>400 V</td>
</tr>
<tr>
<td>$I_C(100%)$</td>
<td>30 A</td>
</tr>
<tr>
<td>$t_r = t_{off}$</td>
<td>0.01 $\mu$s</td>
</tr>
</tbody>
</table>
Switching Definitions H-Bridge MOSFET

Figure 5  
Turn-off Switching Waveforms & definition of $t_{Eoff}$

- $P_{off}(100\%) = 12.15$ kW
- $E_{off}(100\%) = 0.05$ mJ
- $t_{Eoff} = 0.18$ μs

Figure 6  
Turn-on Switching Waveforms & definition of $t_{Eon}$

- $P_{on}(100\%) = 12.15$ kW
- $E_{on}(100\%) = 0.31$ mJ
- $t_{Eon} = 0.07$ μs

Figure 7  
Gate voltage vs Gate charge (measured)

- $V_{GEoff} = 0$ V
- $V_{GEon} = 10$ V
- $V_{d}(100\%) = 400$ V
- $I_{d}(100\%) = 30$ A
- $Q_{g} = 186.04$ nC

Figure 8  
Turn-off Switching Waveforms & definition of $t_{rr}$

- $V_{d}(100\%) = 400$ V
- $I_{d}(100\%) = 30$ A
- $I_{RRM}(100\%) = -61$ A
- $t_{rr} = 0.04$ μs
Switching Definitions H-Bridge MOSFET

**Figure 9**

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

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

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

$I_d (100\%) = 30$ A  
$Q_{rr} (100\%) = 1.29$ μC  
$t_{Qrr} = 0.09$ μs  
$E_{rec} (100\%) = 0.35$ mJ  
$t_{Erec} = 0.09$ μs

**Figure 10**

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

$P_{inc} (100\%) = 12.15$ kW  
$E_{rec} (100\%) = 0.35$ mJ  
$t_{Erec} = 0.09$ μs
Ordering Code and Marking - Outline - Pinout

Ordering Code & Marking

<table>
<thead>
<tr>
<th>Version</th>
<th>Ordering Code</th>
<th>in DataMatrix as</th>
<th>in packaging barcode as</th>
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<tbody>
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<td>without thermal paste 12mm housing</td>
<td>10-FY07BIA041MF-M528E68</td>
<td>M528E68</td>
<td>M528E68</td>
</tr>
</tbody>
</table>

Outline

Tolerance of pinpositions ±0,5mm at the end of pins
Dimension of coordinate axis is only offset without tolerance
PCB cutouts and holes see in handling instructions document

Pinout

Pins 3,4,9,12 are not connected.
PRODUCT STATUS DEFINITIONS

<table>
<thead>
<tr>
<th>Datasheet Status</th>
<th>Product Status</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>Formative or In Design</td>
<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>
</tr>
<tr>
<td>Preliminary</td>
<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>
</tr>
<tr>
<td>Final</td>
<td>Full Production</td>
<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>
</tr>
</tbody>
</table>

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.