**Features**

- IGBT M7 technology with low $V_{CEsat}$ and improved EMC behavior
- Low inductive package
- High efficiency
- Integrated snubber capacitors

**Target applications**

- Solar Inverters
- UPS

**Types**

- 70-W212NMA600M7-LC09F71

---

### Maximum Ratings

$T_a = 25 \, ^\circ\text{C}$, 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 voltage</td>
<td>$V_{CE}$</td>
<td>$T_a = T_{j\text{max}}$</td>
<td>1200</td>
<td>V</td>
</tr>
<tr>
<td>Collector current</td>
<td>$I_C$</td>
<td>$T_a = T_{j\text{max}}$</td>
<td>479</td>
<td>A</td>
</tr>
<tr>
<td>Repetitive peak collector current</td>
<td>$I_{CEM}$</td>
<td>$T_a = T_{j\text{max}}$</td>
<td>1200</td>
<td>A</td>
</tr>
<tr>
<td>Total power dissipation</td>
<td>$P_{tot}$</td>
<td>$T_a = T_{j\text{max}}$</td>
<td>819</td>
<td>W</td>
</tr>
<tr>
<td>Gate-emitter voltage</td>
<td>$V_{GES}$</td>
<td>$T_a = T_{j\text{max}}$</td>
<td>±20</td>
<td>V</td>
</tr>
<tr>
<td>Short circuit ratings</td>
<td>$t_{sc}$</td>
<td>$V_{CE} = 15 , \text{V}$, $V_{CC} = 800 , \text{V}$, $T_a = 150 , ^\circ\text{C}$</td>
<td>9.5</td>
<td>$\mu$S</td>
</tr>
<tr>
<td>Maximum junction temperature</td>
<td>$T_{j\text{max}}$</td>
<td></td>
<td>175</td>
<td>$^\circ\text{C}$</td>
</tr>
</tbody>
</table>
### Maximum Ratings

$T_a = 25 \, ^\circ C$, 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>$V_{RRM}$</td>
<td></td>
<td>650</td>
<td>V</td>
</tr>
<tr>
<td>Continuous (direct) forward current</td>
<td>$I_F$</td>
<td>$T_a = T_{j,\text{max}}$, $T_i = 80 , ^\circ C$</td>
<td>361</td>
<td>A</td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>$I_{F,\text{RM}}$</td>
<td></td>
<td>1200</td>
<td>A</td>
</tr>
<tr>
<td>Total power dissipation</td>
<td>$P_{tot}$</td>
<td>$T_a = T_{j,\text{max}}$, $T_i = 80 , ^\circ C$</td>
<td>475</td>
<td>W</td>
</tr>
<tr>
<td>Maximum junction temperature</td>
<td>$T_{j,\text{max}}$</td>
<td></td>
<td>175</td>
<td>°C</td>
</tr>
</tbody>
</table>

| **Buck Sw. Protection Diode** | | | | |
| Peak repetitive reverse voltage | $V_{RRM}$ | | 1200 | V |
| Continuous (direct) forward current | $I_F$ | | 20 | A |
| Total power dissipation | $P_{tot}$ | $T_a = T_{j,\text{max}}$, $T_i = 80 \, ^\circ C$ | 39 | W |
| Maximum junction temperature | $T_{j,\text{max}}$ | | 175 | °C |

| **Boost Switch** | | | | |
| Collector-emitter voltage | $V_{CES}$ | Relative moisture level ≤ 50% > 50% | 650 500 | V |
| Collector current | $I_C$ | $T_a = T_{j,\text{max}}$, $T_i = 80 \, ^\circ C$ | 471 | A |
| Repetitive peak collector current | $I_{C,\text{RM}}$ | $I_t$ limited by $T_{j,\text{max}}$ | 1200 | A |
| Total power dissipation | $P_{tot}$ | $T_a = T_{j,\text{max}}$, $T_i = 80 \, ^\circ C$ | 625 | W |
| Gate-emitter voltage | $V_{GES}$ | | ≤20 | V |
| Short circuit ratings | | | 9 | µs |
| Maximum junction temperature | $T_{j,\text{max}}$ | | 175 | °C |

| **Boost Diode** | | | | |
| Peak repetitive reverse voltage | $V_{RRM}$ | | 1200 | V |
| Continuous (direct) forward current | $I_F$ | $T_a = T_{j,\text{max}}$, $T_i = 80 \, ^\circ C$ | 347 | A |
| Repetitive peak forward current | $I_{F,\text{RM}}$ | | 1200 | A |
| Total power dissipation | $P_{tot}$ | $T_a = T_{j,\text{max}}$, $T_i = 80 \, ^\circ C$ | 511 | W |
| Maximum junction temperature | $T_{j,\text{max}}$ | | 175 | °C |
# Maximum Ratings

\( T_i = 25 \, ^\circ\text{C}, \) unless otherwise specified

## Boost Sw. Protection Diode

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak repetitive reverse voltage</td>
<td>( V_{\text{RRM}} )</td>
<td></td>
<td>650</td>
<td>V</td>
</tr>
<tr>
<td>Continuous (direct) forward current</td>
<td>( I_{\text{F}} )</td>
<td></td>
<td>40</td>
<td>A</td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>( I_{\text{FRM}} )</td>
<td></td>
<td>80</td>
<td>A</td>
</tr>
<tr>
<td>Total power dissipation</td>
<td>( P_{\text{tot}} ) ( T_j = T_{\text{max}}, T_i = 80 , ^\circ\text{C} )</td>
<td>84</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td>Maximum junction temperature</td>
<td>( T_{\text{max}} )</td>
<td></td>
<td>175</td>
<td>°C</td>
</tr>
</tbody>
</table>

## Capacitor (DC)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum DC voltage</td>
<td>( V_{\text{MAX}} )</td>
<td></td>
<td>630</td>
<td>V</td>
</tr>
<tr>
<td>Operation Temperature</td>
<td>( T_{\text{op}} )</td>
<td></td>
<td>-40..+105</td>
<td>°C</td>
</tr>
</tbody>
</table>

## Module Properties

### Thermal Properties

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>( T_{\text{stg}} )</td>
<td></td>
<td>-40..+125</td>
<td>°C</td>
</tr>
<tr>
<td>Operation temperature under switching condition</td>
<td>( T_{\text{jop}} )</td>
<td></td>
<td>-40...(T_{\text{max}} - 25)</td>
<td>°C</td>
</tr>
<tr>
<td>Maximum allowed PCB temperature</td>
<td>( T_{\text{PCB}} )</td>
<td></td>
<td>125</td>
<td>°C</td>
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</table>

### Isolation Properties

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolation voltage</td>
<td>( V_{\text{isol}} ) DC Test Voltage* ( t_p = 2 , \text{s} )</td>
<td></td>
<td>4000</td>
<td>V</td>
</tr>
<tr>
<td>AC Voltage</td>
<td></td>
<td>( t_p = 1 , \text{min} )</td>
<td>2500</td>
<td>V</td>
</tr>
<tr>
<td>Creepage distance</td>
<td></td>
<td></td>
<td>min. 12,7</td>
<td>mm</td>
</tr>
<tr>
<td>Clearance</td>
<td></td>
<td></td>
<td>min. 12,7</td>
<td>mm</td>
</tr>
<tr>
<td>Comparative Tracking Index</td>
<td>CTI</td>
<td></td>
<td>&gt; 200</td>
<td></td>
</tr>
</tbody>
</table>

*100 % tested in production
### Buck Switch

#### Static

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gate-emitter threshold voltage</td>
<td>$V_{GE(th)}$</td>
<td>10</td>
<td>0,06</td>
<td>25</td>
</tr>
<tr>
<td>Collector-emitter saturation voltage</td>
<td>$V_{CEsat}$</td>
<td>15</td>
<td>600</td>
<td>25</td>
</tr>
<tr>
<td>Collector-emitter cut-off current</td>
<td>$I_{ss}$</td>
<td>0</td>
<td>1200</td>
<td>25</td>
</tr>
<tr>
<td>Gate-emitter leakage current</td>
<td>$I_{GES}$</td>
<td>20</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>Internal gate resistance</td>
<td>$r_{g}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input capacitance</td>
<td>$C_{ies}$</td>
<td>0</td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>Output capacitance</td>
<td>$C_{oes}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse transfer capacitance</td>
<td>$C_{res}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gate charge</td>
<td>$Q_{g}$</td>
<td>15</td>
<td>600</td>
<td>600</td>
</tr>
</tbody>
</table>

#### Thermal

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal resistance junction to sink</td>
<td>$R_{th(j-s)}$</td>
<td>$λ_{paste} = 3,4 \text{ W/mK}$ (PSX)</td>
<td></td>
<td>0,116</td>
</tr>
</tbody>
</table>

#### Dynamic

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turn-on delay time</td>
<td>$t_{on}$</td>
<td>±15</td>
<td>350</td>
<td>600</td>
</tr>
<tr>
<td>Rise time</td>
<td>$t_{r}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn-off delay time</td>
<td>$t_{off}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall time</td>
<td>$t_{f}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn-on energy (per pulse)</td>
<td>$E_{on}$</td>
<td>$Q_{on} = 45,4 \text{ μC}$</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Turn-off energy (per pulse)</td>
<td>$E_{off}$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

Copyright Vincotech
## 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>Voltages</td>
<td>$V_{GE}$</td>
<td>600</td>
<td>1,62</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>$V_{GS}$</td>
<td>125</td>
<td>1,63</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$V_{CE}$</td>
<td>150</td>
<td>1,63</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$I_D$</td>
<td>0</td>
<td>200</td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td>$T_j$</td>
<td>125</td>
<td>354</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>$T_j$</td>
<td>25</td>
<td>631</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>$I_F$</td>
<td>±15</td>
<td>45,437</td>
<td>µC</td>
</tr>
<tr>
<td></td>
<td>$Q_{rd}$</td>
<td>350</td>
<td>10,469</td>
<td>mWs</td>
</tr>
<tr>
<td></td>
<td>$E_{rec}$</td>
<td>600</td>
<td>20,264</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$(di/dt)_{max}$</td>
<td>±15</td>
<td>3597</td>
<td>A/µs</td>
</tr>
<tr>
<td></td>
<td>$(di/dt)_{max}$</td>
<td>25</td>
<td>2787</td>
<td></td>
</tr>
</tbody>
</table>

**Buck Diode**

**Static**
- Forward voltage: $V_f$  
- Reverse leakage current: $I_R$

**Thermal**
- Thermal resistance junction to sink: $R_{th(j-s)}$

**Dynamic**
- Peak recovery current: $I_{rr}$
- Reverse recovery time: $t_{rr}$
- Recovered charge: $Q_r$
- Reverse recovered energy: $E_{rec}$
- Peak rate of fall of recovery current: $(di/dt)_{max}$

**Buck Sw. Protection Diode**

**Static**
-Forward voltage: $V_f$
- Reverse leakage current: $I_R$

**Thermal**
-Thermal resistance junction to sink: $R_{th(j-s)}$
# Characteristic Values

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<th>Unit</th>
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<td>Gate-emitter threshold voltage</td>
<td>$V_{GE(th)}$</td>
<td>10</td>
<td>0,06</td>
<td>25</td>
</tr>
<tr>
<td>Collector-emitter saturation voltage</td>
<td>$V_{CEsat}$</td>
<td>15</td>
<td>600</td>
<td>25</td>
</tr>
<tr>
<td>Collector-emitter cut-off current</td>
<td>$I_{CM}$</td>
<td>0</td>
<td>650</td>
<td>25</td>
</tr>
<tr>
<td>Gate-emitter leakage current</td>
<td>$I_{GES}$</td>
<td>20</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>Internal gate resistance</td>
<td>$r_{g}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input capacitance</td>
<td>$C_{IES}$</td>
<td>0</td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>Output capacitance</td>
<td>$C_{oes}$</td>
<td>0</td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>Reverse transfer capacitance</td>
<td>$C_{res}$</td>
<td>0</td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>Gate charge</td>
<td>$Q_{g}$</td>
<td>15</td>
<td>300</td>
<td>600</td>
</tr>
</tbody>
</table>

## Boost Switch

### Static

- **Gate-emitter threshold voltage**
  - $V_{GE(th)}$
  - Conditions: Min 10, Typ 0,06, Max 25
  - Value: 5,4, 6, 6,6, V

- **Collector-emitter saturation voltage**
  - $V_{CEsat}$
  - Conditions: Min 15, Typ 600, Max 25
  - Value: 1,37, 1,44, 1,45, V

- **Collector-emitter cut-off current**
  - $I_{CM}$
  - Conditions: Min 0, Typ 650, Max 25
  - Value: 200, µA

- **Gate-emitter leakage current**
  - $I_{GES}$
  - Conditions: Min 20, Typ 0, Max 25
  - Value: 2000, nA

### Dynamic

- **Turn-on delay time**
  - $t_{d(on)}$
  - Conditions: Min 0, Typ 350, Max 600
  - Value: 25, 125, 65 | 324 | 125, 333

- **Rise time**
  - $t_{r}$
  - Conditions: Min 0, Typ 350, Max 600
  - Value: 25, 125, 65 | 25, 125, 82

- **Fall time**
  - $t_{f}$
  - Conditions: Min 0, Typ 350, Max 600
  - Value: 25, 125, 70 | 25, 125, 83

- **Turn-on energy (per pulse)**
  - $E_{on}$
  - Conditions: Min 0, Typ 350, Max 600
  - Value: 25, 125, 18,502 | 25, 125, 27,757

- **Turn-off energy (per pulse)**
  - $E_{off}$
  - Conditions: Min 0, Typ 350, Max 600
  - Value: 25, 125, 22,297 | 25, 125, 29,763
## 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>Min</td>
<td>Typ</td>
</tr>
<tr>
<td></td>
<td>$V_{GE}$ [V]</td>
<td>$V_{GS}$ [V]</td>
<td>$I_{C}$ [A]</td>
<td>$I_{D}$ [A]</td>
</tr>
<tr>
<td>Boost Diode</td>
<td></td>
<td></td>
<td>$V_{CE}$ [V]</td>
<td>$V_{DS}$ [V]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>600</td>
<td>25</td>
</tr>
<tr>
<td>Boost Sw. Protection Diode</td>
<td></td>
<td></td>
<td>$I_{R}$</td>
<td>1200</td>
</tr>
<tr>
<td>Capacitor (DC)</td>
<td></td>
<td></td>
<td>$C$</td>
<td>1360</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$f$</td>
<td>1 kHz</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>$T_{r}$</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$f_{max}$</td>
<td>40/105/56</td>
</tr>
</tbody>
</table>

### Boost Diode

#### Static
- Forward voltage: $V_{FE}$
- Reverse leakage current: $I_{R}$

#### Thermal
- Thermal resistance junction to sink: $R_{th(j-s)}$

#### Dynamic
- Peak recovery current: $I_{rr}$
- Reverse recovery time: $t_{rr}$
- Recovered charge: $Q_{rd}$
- Reverse recovered energy: $E_{rec}$
- Peak rate of fall of recovery current: $(di/dt)_{max}$

### Boost Sw. Protection Diode

#### Static
- Forward voltage: $V_{FE}$
- Reverse leakage current: $I_{R}$

#### Thermal
- Thermal resistance junction to sink: $R_{th(j-s)}$

### Capacitor (DC)

- Capacitance: $C$
- Tolerance: -10% to +10%
- Dissipation factor: $f = 1$ kHz
- Climatic category: 40/105/56
### 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>V&lt;sub&gt;GE&lt;/sub&gt; [V]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V&lt;sub&gt;GS&lt;/sub&gt; [V]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;C&lt;/sub&gt; [A]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;D&lt;/sub&gt; [A]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;F&lt;/sub&gt; [A]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V&lt;sub&gt;CE&lt;/sub&gt; [V]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V&lt;sub&gt;DS&lt;/sub&gt; [V]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V&lt;sub&gt;F&lt;/sub&gt; [V]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T&lt;sub&gt;j&lt;/sub&gt; [°C]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Thermistor

| Rated resistance       | R      |                  | 25    | 22   | kΩ   |
| Deviation of R<sub>250</sub> | ΔR/R<sub>250</sub> = 1484 Ω |          | 100   | -5   | 5 %  |
| Power dissipation      | P      |                  | 25    | 5    | mW   |
| Power dissipation constant |         |                  | 25    | 1,5  | mW/K |
| B-value                 | B<sub>25/50</sub> | Tol. ±1 %        | 25    | 3962 | K    |
| B-value                 | B<sub>25/100</sub> | Tol. ±1 %        | 25    | 4000 | K    |
| Vincotech NTC Reference | I      |                  |       |      |      |
Buck Switch Characteristics

**Figure 1.** Typical output characteristics

![Typical output characteristics graph](image1)

- $I_c = f(V_{ce})$
- $t_p = 250\ \mu s$
- $25^\circ C$
- $V_{GE} = 15\ V$
- $125^\circ C$
- $T_j = 150^\circ C$
- $V_{GE}$ from 7 V to 17 V in steps of 1 V

**Figure 2.** Typical output characteristics

![Typical output characteristics graph](image2)

- $I_c = f(V_{ge})$
- $Z_{th(j-s)} = f(t_p)$
- $t_p = 250\ \mu s$
- $25^\circ C$
- $D = t_p / T$
- $V_{ce} = 10\ V$
- $150^\circ C$
- $R_{th(j-s)} = 0.116\ K/W$

**Figure 3.** Typical output characteristics

![Typical output characteristics graph](image3)

- $I_c = f(V_{ce})$
- $t_p = 100\ \mu s$
- $25^\circ C$
- $V_{ce} = 10\ V$
- $125^\circ C$
- $150^\circ C$

**Figure 4.** Transient thermal impedance as function of pulse duration

![Transient thermal impedance graph](image4)

- $Z_{th(j-s)} = f(t_p)$
- $k = 10^{-3}$
- $R_{th(j-s)} = 0.116\ K/W$

**IGBT thermal model values**

- $R\ (K/W)$
- $f\ (K)

| $R\ (K/W)$ | $f\ (K) $
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>9,54E-03</td>
<td>1,81E+00</td>
</tr>
<tr>
<td>1,68E-02</td>
<td>3,27E-01</td>
</tr>
<tr>
<td>2,45E-02</td>
<td>6,01E-02</td>
</tr>
<tr>
<td>4,18E-02</td>
<td>1,35E-02</td>
</tr>
<tr>
<td>1,36E-02</td>
<td>4,71E-03</td>
</tr>
<tr>
<td>4,16E-03</td>
<td>9,56E-04</td>
</tr>
<tr>
<td>5,57E-03</td>
<td>1,19E-04</td>
</tr>
</tbody>
</table>
Buck Switch Characteristics

**Figure 5.** IGBT Gate voltage vs gate charge

- $V_{GE} = f(Q_G)$
- $I_C = f(V_{CE})$
- $I_C = 600$ A
- $T_s = 80$ ºC
- $V_{GE} = \pm 15$ V
- $T_j = T_{jmax}$

**Figure 6.** Safe operating area

- $I_C = f(V_{CE})$
- $V_{CE}$
- $R_{gd}(V)$
- $I_C$
- $V_{CE}$
- $R_{gd}(V)$

- $I_C$ = single pulse
- $T_s = 80$ ºC
- $V_{GE} = \pm 15$ V
- $T_j = T_{jmax}$
Buck Diode Characteristics

**Figure 1.** FWD
Typical forward characteristics

\[ I_F = f(V_F) \]

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Forward Impedance ($Z_{th(j-s)}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25°C</td>
<td>0.200 K/W</td>
</tr>
<tr>
<td>125°C</td>
<td></td>
</tr>
<tr>
<td>150°C</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 2.** FWD
Transient thermal impedance as a function of pulse width

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

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Thermal Impedance ($Z_{th(j-s)}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25°C</td>
<td>0.200 K/W</td>
</tr>
<tr>
<td>125°C</td>
<td></td>
</tr>
<tr>
<td>150°C</td>
<td></td>
</tr>
</tbody>
</table>

Buck Sw. Protection Diode Characteristics

**Figure 1.** FWD
Typical forward characteristics

\[ I_F = f(V_F) \]

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Forward Impedance ($Z_{th(j-s)}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25°C</td>
<td>2.444 K/W</td>
</tr>
<tr>
<td>125°C</td>
<td></td>
</tr>
<tr>
<td>150°C</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 2.** FWD
Transient thermal impedance as a function of pulse width

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

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Thermal Impedance ($Z_{th(j-s)}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25°C</td>
<td>2.444 K/W</td>
</tr>
<tr>
<td>125°C</td>
<td></td>
</tr>
<tr>
<td>150°C</td>
<td></td>
</tr>
</tbody>
</table>
Boost Switch Characteristics

Figure 1. IGBT
Typical output characteristics
$I_C = f(V_{CE})$

Figure 2. IGBT
Typical output characteristics
$I_C = f(V_{GE})$

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

Figure 4. IGBT
Transient thermal impedance as function of pulse duration
$Z_{th(j-s)} = f(t_p)$

<table>
<thead>
<tr>
<th>$t_p$ (μs)</th>
<th>$Z_{th(j-s)}$ (K/W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>25 °C</td>
</tr>
<tr>
<td>100</td>
<td>25 °C</td>
</tr>
<tr>
<td>150</td>
<td>125 °C</td>
</tr>
<tr>
<td>150</td>
<td>150 °C</td>
</tr>
<tr>
<td>7 V to 17 V</td>
<td>in steps of 1 V</td>
</tr>
</tbody>
</table>

IGBT thermal model values

<table>
<thead>
<tr>
<th>$R$ (K/W)</th>
<th>$f(x)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,25E-02</td>
<td>2,37E+00</td>
</tr>
<tr>
<td>2,20E-02</td>
<td>4,29E-01</td>
</tr>
<tr>
<td>3,21E-02</td>
<td>7,88E-02</td>
</tr>
<tr>
<td>5,48E-02</td>
<td>2,04E-02</td>
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<tr>
<td>1,78E-02</td>
<td>6,17E-03</td>
</tr>
<tr>
<td>5,45E-03</td>
<td>1,25E-03</td>
</tr>
<tr>
<td>7,30E-03</td>
<td>1,56E-04</td>
</tr>
</tbody>
</table>

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09 Apr. 2019 / Revision 2
Boost Switch Characteristics

Figure 6. IGBT Safe operating area

$I_c = f(V_{CE})$

- $\delta$ = single pulse
- $T_j = 80$ °C
- $V_{GE} = \pm 15$ V
- $T_j = T_{jmax}$

$V_{CE}(V)$

$J_c$ (A)

DC 100ms 10ms 1ms 100µs 10µs

0

0.01

0.1

1

10

100

1000

10000

0,01

0,1

1

10

100

1000

10000

1 10 100 1000

Copyright Vincotech
**Boost Diode Characteristics**

**Figure 1.**
Typical forward characteristics

\[ I_F = f(V_F) \]

<table>
<thead>
<tr>
<th>( I_F ) (A)</th>
<th>( V_F ) (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

**Figure 2.**
Transient thermal impedance as a function of pulse width

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

<table>
<thead>
<tr>
<th>( t_p ) (s)</th>
<th>( Z_{th(j-s)} ) (K/W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.001</td>
<td>100</td>
</tr>
<tr>
<td>0.01</td>
<td>10</td>
</tr>
</tbody>
</table>

**Boost Sw. Protection Diode Characteristics**

**Figure 1.**
Typical forward characteristics

\[ I_F = f(V_F) \]

<table>
<thead>
<tr>
<th>( I_F ) (A)</th>
<th>( V_F ) (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
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**Figure 2.**
Transient thermal impedance as a function of pulse width

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

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<th>( Z_{th(j-s)} ) (K/W)</th>
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<td>100</td>
</tr>
<tr>
<td>0.01</td>
<td>10</td>
</tr>
</tbody>
</table>

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Thermistor Characteristics

Figure 1. Typical NTC characteristic as a function of temperature

$r = f(T)$

<table>
<thead>
<tr>
<th>$r$ (Ω)</th>
<th>$T$ (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25000</td>
<td>0</td>
</tr>
<tr>
<td>20000</td>
<td>25</td>
</tr>
<tr>
<td>15000</td>
<td>50</td>
</tr>
<tr>
<td>10000</td>
<td>75</td>
</tr>
<tr>
<td>5000</td>
<td>100</td>
</tr>
</tbody>
</table>

NTC-typical temperature characteristic
Buck Switching Characteristics

**Figure 1.** Typical switching energy losses as a function of collector current

\[ E = f(I_C) \]

With an inductive load at:
- \( V_{in} = 350 \) V
- \( V_{out} = \pm 15 \) V
- \( R_{m} = 1 \) Ω
- \( I_C = 600 \) A

- \( T_j = 25^\circ \)C
- \( T_j = 125^\circ \)C

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

\[ E = f(R_g) \]

With an inductive load at:
- \( V_{in} = 350 \) V
- \( V_{out} = \pm 15 \) V
- \( I_C = 600 \) A

- \( T_j = 25^\circ \)C
- \( T_j = 125^\circ \)C

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

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

With an inductive load at:
- \( V_{in} = 350 \) V
- \( V_{out} = \pm 15 \) V
- \( R_{m} = 1 \) Ω

- \( T_j = 25^\circ \)C
- \( T_j = 125^\circ \)C

**Figure 4.** Typical reverse recovered energy loss as a function of gate resistor

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

With an inductive load at:
- \( V_{in} = 350 \) V
- \( V_{out} = \pm 15 \) V
- \( I_C = 600 \) A

- \( T_j = 25^\circ \)C
- \( T_j = 125^\circ \)C
Buck Switching Characteristics

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

$t_{d(on)} = f(I_C)$
$t_{d(off)} = f(I_C)$

With an inductive load at
$T_j = 25 \degree C$
$V_{CE} = 350 \text{ V}$
$V_{GS} = \pm 15 \text{ V}$
$R_{on} = 1 \Omega$
$I_C = 600 \text{ A}$

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

$t_{d(on)} = f(R_{on})$
$t_{d(off)} = f(R_{on})$

With an inductive load at
$T_j = 125 \degree C$
$V_{CE} = 350 \text{ V}$
$V_{GS} = \pm 15 \text{ V}$
$I_C = 600 \text{ A}$

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

$t_{rr} = f(I_C)$

With an inductive load at
$T_j = 25 \degree C$
$V_{CE} = 350 \text{ V}$
$V_{GS} = \pm 15 \text{ V}$
$R_{on} = 1 \Omega$

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

$t_{rr} = f(R_{on})$

With an inductive load at
$T_j = 125 \degree C$
$V_{CE} = 350 \text{ V}$
$V_{GS} = \pm 15 \text{ V}$
$J_C = 600 \text{ A}$
Buck Switching Characteristics

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

\[ Q_r = f(I_C) \]

With an inductive load at

- \( V_{in} = 350 \) V
- \( V_{gs} = \pm 15 \) V
- \( R_{gon} = 1 \) Ω

\[ T_j = 25 \, ^\circ\text{C} \quad \text{and} \quad 125 \, ^\circ\text{C} \]

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

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

With an inductive load at

- \( V_{in} = 350 \) V
- \( V_{gs} = \pm 15 \) V
- \( I_C = 600 \) A

\[ T_j = 25 \, ^\circ\text{C} \quad \text{and} \quad 125 \, ^\circ\text{C} \]

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

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

With an inductive load at

- \( V_{in} = 350 \) V
- \( V_{gs} = \pm 15 \) V
- \( R_{gon} = 1 \) Ω

\[ T_j = 25 \, ^\circ\text{C} \quad \text{and} \quad 125 \, ^\circ\text{C} \]

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

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

With an inductive load at

- \( V_{in} = 350 \) V
- \( V_{gs} = \pm 15 \) V
- \( I_C = 600 \) A

\[ T_j = 25 \, ^\circ\text{C} \quad \text{and} \quad 125 \, ^\circ\text{C} \]
Buck Switching Characteristics

Figure 13: Typical rate of fall of forward and reverse recovery current as a function of collector current

\[
diF/dt, \quad dirr/dt = f(I_C)\]

With an inductive load at

\[V_{CE} = 350 \text{ V}, \quad \theta_{on} = \pm 15 ^\circ \text{C}, \quad R_{gon} = 1 \Omega, \quad I_C = 600 \text{ A}\]

Figure 14: Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor

\[
diF/dt, \quad dirr/dt = f(R_{gon})\]

With an inductive load at

\[V_{CE} = 350 \text{ V}, \quad \theta_{on} = \pm 15 ^\circ \text{C}, \quad R_{gon} = 1 \Omega, \quad I_C = 600 \text{ A}\]

Figure 15: IGBT Reverse bias safe operating area

\[I_{C} = f(V_{CE})\]

At

\[T_J = 125 ^\circ \text{C}, \quad R_{ps} = 1 \Omega, \quad R_{ms} = 1 \Omega\]
Buck Switching Definitions

General conditions

<table>
<thead>
<tr>
<th>Condition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_{th}$</td>
<td>125 °C</td>
</tr>
<tr>
<td>$R_{on}$</td>
<td>1 Ω</td>
</tr>
<tr>
<td>$R_{off}$</td>
<td>1 Ω</td>
</tr>
</tbody>
</table>

**Figure 1.** IGBT Turn-off Switching Waveforms & definition of $t_{doff}$, $t_{Eoff}$ ($t_{Eoff}$ = integrating time for $E_{off}$)

- $V_{GE}(0\%) = -15$ V
- $V_{GE}(100\%) = 15$ V
- $V_{CE}(90\%) = 350$ V
- $I_{C}(100\%) = 600$ A
- $t_{doff} = 386$ ns

**Figure 2.** IGBT Turn-on Switching Waveforms & definition of $t_{don}$, $t_{Eon}$ ($t_{Eon}$ = integrating time for $E_{on}$)

- $V_{GE}(0\%) = -15$ V
- $V_{GE}(100\%) = 15$ V
- $V_{CE}(90\%) = 350$ V
- $I_{C}(100\%) = 600$ A
- $t_{don} = 472$ ns

**Figure 3.** IGBT Turn-off Switching Waveforms & definition of $t_{f}$

- $V_{CE}(90\%) = 350$ V
- $I_{C}(100\%) = 600$ A
- $t_{f} = 84$ ns

**Figure 4.** IGBT Turn-on Switching Waveforms & definition of $t_{r}$

- $V_{CE}(90\%) = 350$ V
- $I_{C}(100\%) = 600$ A
- $t_{r} = 89$ ns
**Buck Switching Characteristics**

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

- \( V_{F}(100\%) = 350 \) V
- \( I_{F}(100\%) = 600 \) A
- \( I_{RRM}(100\%) = 348 \) A
- \( t_{rr} = 631 \) ns

**Figure 6.** Turn-on Switching Waveforms & definition of \( t_{Qr} \), \( t_{rr} \) (integrating time for \( Q_{r} \))

- \( I_{r}(100\%) = 600 \) A
- \( Q_{r}(100\%) = 0 \) \( \mu \)C
Boost Switching Characteristics

**Figure 1.** IGBT
Typical switching energy losses as a function of collector current

\[ E = f(I_C) \]

With an inductive load at
- \( V_D = 350 \) V
- \( V_{CG} = \pm 15 \) V
- \( R_{gon} = 1 \) Ω
- \( I_C = 600 \) A

\[ T_J = 25 \, ^\circ C \]
\[ T_J = 125 \, ^\circ C \]

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

\[ E = f(R_g) \]

With an inductive load at
- \( V_D = 350 \) V
- \( V_{CG} = \pm 15 \) V
- \( R_{gon} = 1 \) Ω
- \( I_C = 600 \) A

\[ T_J = 25 \, ^\circ C \]
\[ T_J = 125 \, ^\circ C \]

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

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

With an inductive load at
- \( V_D = 350 \) V
- \( V_{CG} = \pm 15 \) V
- \( R_{gon} = 1 \) Ω

\[ T_J = 25 \, ^\circ C \]
\[ T_J = 125 \, ^\circ C \]

**Figure 4.** FWD
Typical reverse recovered energy losses as a function of gate resistor

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

With an inductive load at
- \( V_D = 350 \) V
- \( V_{CG} = \pm 15 \) V
- \( I_C = 600 \) A

\[ T_J = 25 \, ^\circ C \]
\[ T_J = 125 \, ^\circ C \]
Boost Switching Characteristics

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

\[ t = f(I_C) \]

With an inductive load at
- \( T_j = 125 \) °C
- \( V_{CE} = 350 \) V
- \( V_{GE} = \pm 15 \) V
- \( R_{gon} = 1 \) Ω
- \( I_C = 600 \) A

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

\[ t = f(R_g) \]

With an inductive load at
- \( T_j = 125 \) °C
- \( V_{CE} = 350 \) V
- \( V_{GE} = \pm 15 \) V
- \( I_C = 600 \) A
- \( R_{goff} = 1 \) Ω

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

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

With an inductive load at
- \( T_j = 25 \) °C
- \( V_{CE} = 350 \) V
- \( V_{GE} = \pm 15 \) V
- \( R_{gon} = 1 \) Ω

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

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

With an inductive load at
- \( T_j = 25 \) °C
- \( V_{CE} = 350 \) V
- \( V_{GE} = \pm 15 \) V
- \( I_C = 600 \) A
Boost Switching Characteristics

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

\[ Q_r = f(I_C) \]

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

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

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

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

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

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

**Figure 13.** FWD

Typical rate of fall of forward and reverse recovery current as a function of collector current

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

With an inductive load at

- \( V_{CE} = 350 \text{ V} \)
- \( T_j = 125 \text{ °C} \)
- \( R_{gon} = 1 \text{ Ω} \)
- \( R_{goff} = 1 \text{ Ω} \)
- \( I_C = 600 \text{ A} \)

**Figure 14.** FWD

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

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

With an inductive load at

- \( V_{CE} = 350 \text{ V} \)
- \( T_j = 125 \text{ °C} \)
- \( R_{gon} = 1 \text{ Ω} \)
- \( R_{goff} = 1 \text{ Ω} \)
- \( I_C = 600 \text{ A} \)

**Figure 15.** IGBT

Reverse bias safe operating area

At

- \( T_j = 125 \text{ °C} \)
- \( R_{gon} = 1 \text{ Ω} \)
- \( R_{goff} = 1 \text{ Ω} \)
Boost Switching Definitions

General conditions

<table>
<thead>
<tr>
<th>Condition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tj</td>
<td>125 °C</td>
</tr>
<tr>
<td>Rgs</td>
<td>1 Ω</td>
</tr>
<tr>
<td>Rps</td>
<td>1 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)

figure 2. IGBT
Turn-on Switching Waveforms & definition of t_don, t_Eon (t_Eon = integrating time for E_on)

VGE(0%) = -15 V
VGE(100%) = 15 V
VCE(100%) = 350 V
IC(100%) = 600 A

VGE(0%) = -15 V
VGE(100%) = 15 V
VCE(100%) = 350 V
IC(100%) = 600 A

t_doff = 309 ns

t_Eoff = 83 ns

t_don = 333 ns

t_Eon = 82 ns
Boost Switching Characteristics

**Figure 5.** FWD

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

- \( V_F \) (100%) = 350 V
- \( I_F \) (100%) = 600 A
- \( I_{RRM} \) (100%) = 398 A
- \( t_{rr} \) = 477 ns

**Figure 6.** FWD

Turn-on Switching Waveforms & definition of \( t_{Qr} = \) integrating time for \( Q_r \)

- \( I_F \) (100%) = 600 A
- \( Q_r \) (100%) = 0 μC
70-W212NMA600M7-LC09F71 datasheet

### Ordering Code & Marking

<table>
<thead>
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<th>70-W212NMA600M7-LC09F71</th>
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#### Datamatrix

#### Outline

#### Driver pins

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#### Low current connections

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### Pinout

- **DC+**
- **DC+ desat**
- **C10**
- **G11-n**
- **G12-n**
- **S12-n**
- **G13-n**
- **G14-n**
- **C20**
- **T11-n**
- **T12-n**
- **T13-n**
- **T14-n**
- **GND**
- **GND_desat**
- **D11**
- **D12**
- **D13**
- **D14**
- **D41**
- **D42**
- **D43**
- **D44**
- **R1**
- **Therm1**
- **Therm2**
- **Phase**
- **Ph**

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

### Identification

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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.

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**Packaging instruction**

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**Handling instruction**

Handling instructions for VINco X4 packages see vincotech.com website.

**Package data**

Package data for VINco X4 packages see vincotech.com website.

**UL recognition and file number**

This device is certified according to UL 1557 standard, UL file number E192116. For more information see vincotech.com website.

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