**flowNPC 2**

**Features**
- Enhanced efficiency
- Enables high switching frequencies
- Low inductive package
- Allows four quadrant operation

**Target applications**
- Industrial Drives
- Solar Inverters
- UPS

**Types**
- 30-FT07NIB300S503-LH36F58
- 30-PT07NIB300S503-LH36F58Y

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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>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-emitter voltage</td>
<td>$V_{CE}$</td>
<td></td>
<td>650</td>
<td>V</td>
</tr>
<tr>
<td>Collector current</td>
<td>$I_C$</td>
<td>$T_j = T_{j\text{max}}$</td>
<td>$T_s = 80 , ^\circ C$</td>
<td>260</td>
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<tr>
<td>Repetitive peak collector current</td>
<td>$I_{CEM}$</td>
<td>$I_s$ limited by $T_{j\text{max}}$</td>
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<tr>
<td>Total power dissipation</td>
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<tr>
<td>Gate-emitter voltage</td>
<td>$V_{GES}$</td>
<td></td>
<td>±20</td>
<td>V</td>
</tr>
<tr>
<td>Maximum junction temperature</td>
<td>$T_{j\text{max}}$</td>
<td></td>
<td>175</td>
<td>°C</td>
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### Maximum Ratings

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

<table>
<thead>
<tr>
<th>Parameter</th>
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<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>$V_{RSS}$</td>
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<td>650</td>
<td>V</td>
</tr>
<tr>
<td>Continuous (direct) forward current</td>
<td>$I_D$</td>
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<td>Repetitive peak forward current</td>
<td>$I_{FWM}$</td>
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<td>$P_{tot}$</td>
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<td>W</td>
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<tr>
<td>Maximum junction temperature</td>
<td>$T_{j_{max}}$</td>
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<td>175</td>
<td>°C</td>
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<tr>
<td><strong>Buck Sw. Protection Diode</strong></td>
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<tr>
<td>Maximum junction temperature</td>
<td>$T_{j_{max}}$</td>
<td></td>
<td>175</td>
<td>°C</td>
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<tr>
<td><strong>Boost Switch</strong></td>
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<tr>
<td>Collector-emitter voltage</td>
<td>$V_{CEO}$</td>
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<td>$T_{j_{max}}$</td>
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<td><strong>Boost Diode</strong></td>
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<td>Peak repetitive reverse voltage</td>
<td>$V_{RSS}$</td>
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<td>V</td>
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<td>Continuous (direct) forward current</td>
<td>$I_D$</td>
<td>$T_i = T_{j_{max}}$ $T_i = 80 , ^\circ\text{C}$</td>
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<tr>
<td>Total power dissipation</td>
<td>$P_{tot}$</td>
<td>$T_i = T_{j_{max}}$ $T_i = 80 , ^\circ\text{C}$</td>
<td>273</td>
<td>W</td>
</tr>
<tr>
<td>Maximum junction temperature</td>
<td>$T_{j_{max}}$</td>
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<td>175</td>
<td>°C</td>
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### Maximum Ratings

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

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<thead>
<tr>
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<tbody>
<tr>
<td><strong>Boost Sw. Inv.Diode</strong></td>
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<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>$I_F$</td>
<td>$T_j = T_{\text{max}}$, $T_s = 80 , ^\circ\text{C}$</td>
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<td>A</td>
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<tr>
<td>Repetitive peak forward current</td>
<td>$I_{\text{Fp}}$</td>
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<td>600</td>
<td>A</td>
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<tr>
<td>Total power dissipation</td>
<td>$P_{\text{tot}}$</td>
<td>$T_j = T_{\text{max}}$, $T_s = 80 , ^\circ\text{C}$</td>
<td>273</td>
<td>W</td>
</tr>
<tr>
<td>Maximum junction temperature</td>
<td>$T_{\text{max}}$</td>
<td></td>
<td>175</td>
<td>°C</td>
</tr>
</tbody>
</table>

| **Boost Sw. Protection Diode** | | | | |
| Peak repetitive reverse voltage | $V_{\text{RRM}}$ | | 650 | V |
| Continuous (direct) forward current | $I_F$ | $T_j = T_{\text{max}}$, $T_s = 80 \, ^\circ\text{C}$ | 30 | A |
| Repetitive peak forward current | $I_{\text{Fp}}$ | | 60 | A |
| Total power dissipation | $P_{\text{tot}}$ | $T_j = T_{\text{max}}$, $T_s = 80 \, ^\circ\text{C}$ | 59 | W |
| Maximum junction temperature | $T_{\text{max}}$ | | 175 | °C |

| **Capacitor (DC)** | | | | |
| Maximum DC voltage | $V_{\text{MAX}}$ | | 630 | V |
| Operation Temperature | $T_{\text{op}}$ | | -55...+150 | °C |

| **Module Properties** | | | | |
| **Thermal Properties** | | | | |
| Storage temperature | $T_{\text{stg}}$ | | -40...+125 | °C |
| Operation temperature under switching condition | $T_{\text{op}}$ | | -40...($T_{\text{max}} - 25$) | °C |

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

*100 % tested in production
### Characteristic Values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
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<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{GE}$ [V]</td>
<td>$V_{GS}$ [V]</td>
<td>$I_{C}$ [A]</td>
<td>$I_{B}$ [A]</td>
<td>$T_{j}$ [°C]</td>
</tr>
<tr>
<td>$V_{CE}$ [V]</td>
<td>$V_{DS}$ [V]</td>
<td>$V_{F}$ [V]</td>
<td>$I_{C}$ [A]</td>
<td>$I_{D}$ [A]</td>
</tr>
</tbody>
</table>

#### Buck Switch

##### Static

**Gate-emitter threshold voltage**

$V_{GE}(th) = V_{CE} = 0.003$  
$V_{GE} = 25$, $I_{C} = 4$, $I_{D} = 4.8$, $V$  

**Collector-emitter saturation voltage**

$V_{CE} = 15$, $I_{C} = 300$, $25$, $I_{D} = 1.43$, $I_{F} = 1.75$, $V$  

**Collector-emitter cut-off current**

$I_{CES} = 0$, $I_{D} = 650$, $25$, $200$, $µA$  

**Gate-emitter leakage current**

$I_{GES} = 20$, $I_{D} = 0$, $25$, $400$, $nA$  

**Internal gate resistance**

$r_{g} = $ none, $Ω$  

**Input capacitance**

$C_{in} = 18000$, $pF$  

**Output capacitance**

$C_{out} = 520$, $pF$  

**Reverse transfer capacitance**

$C_{res} = 68$, $pF$  

**Gate charge**

$Q_{g} = 15$, $I_{D} = 520$, $300$, $25$, $656$, $nC$  

#### Thermal

**Thermal resistance junction to sink**

$R_{th(j-s)} = 3.4 W/mK$ (PSX)  

$0.24$, $K/W$  

#### Dynamic

**Turn-on delay time**

$t_{d(on)} = 2 Ω$  

$25$, $I_{D} = 125$, $150$, $117$, $116$, $116$, $ns$  

**Rise time**

$t_{r} = 2 Ω$  

$25$, $I_{D} = 125$, $150$, $16$, $16$, $17$, $ns$  

**Turn-off delay time**

$t_{d(off)} = 2 Ω$  

$25$, $I_{D} = 125$, $150$, $130$, $148$, $153$, $ns$  

**Fall time**

$t_{f} = 2 Ω$  

$25$, $I_{D} = 125$, $150$, $14$, $21$, $24$, $ns$  

**Turn-on energy (per pulse)**

$E_{on} = 7.3 µC$  

$25$, $I_{D} = 125$, $150$, $2.72$, $3.17$, $5.61$, $mWs$  

**Turn-off energy (per pulse)**

$E_{off} = 14.9 µC$  

$25$, $I_{D} = 125$, $150$, $2.72$, $3.17$, $5.61$, $mWs$  

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## Characteristic Values

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<tbody>
<tr>
<td>Forward voltage</td>
<td>$V_i$</td>
<td>300</td>
<td>25 125 150</td>
<td>1.53 1.49 1.47</td>
</tr>
<tr>
<td>Reverse leakage current</td>
<td>$I_h$</td>
<td>650</td>
<td>25</td>
<td>15.2</td>
</tr>
<tr>
<td>Thermal resistance junction to sink</td>
<td>$R_{th(j-s)}$</td>
<td>$\lambda_{paste} = 3.4$ W/mK (PSX)</td>
<td>0.35</td>
<td>K/W</td>
</tr>
<tr>
<td>Peak recovery current</td>
<td>$I_{RMS}$</td>
<td>±15</td>
<td>350</td>
<td>25 125 150</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>$t_{rr}$</td>
<td></td>
<td>25 125 150</td>
<td>56 77 86</td>
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<tr>
<td>Recovered charge</td>
<td>$Q_r$</td>
<td></td>
<td>25 125 150</td>
<td>7.34 14.87 17.59</td>
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<td>Reverse recovered energy</td>
<td>$E_{rec}$</td>
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<td>25 125 150</td>
<td>1.52 3.49 3.95</td>
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<tr>
<td>Peak rate of fall of recovery current</td>
<td>$(di/dt)_{max}$</td>
<td></td>
<td>25 125 150</td>
<td>6515 6781 5496</td>
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</tbody>
</table>

### Buck Diode

#### Static

- **Forward voltage**
  - $V_i$ 300 25 125 150
- **Reverse leakage current**
  - $I_h$ 650 25
- **Thermal resistance junction to sink**
  - $R_{th(j-s)} = 3.4$ W/mK (PSX) 1.61 K/W

#### Dynamic

- **Peak recovery current**
  - $I_{RMS}$ ±15 350 25 125 150
- **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**
  - $V_i$ 30 25 150
- **Reverse leakage current**
  - $I_h$ 650 25

#### Thermal

- **Thermal resistance junction to sink**
  - $R_{th(j-s)} = 3.4$ W/mK (PSX) 1.61 K/W
### Characteristic Values

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<tbody>
<tr>
<td>Source-drain saturation voltage</td>
<td>$V_{DS}$</td>
<td>$V_{CE} = 25$</td>
<td>$650$</td>
<td>µA</td>
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<tr>
<td>Collector-emitter saturation voltage</td>
<td>$V_{CEsat}$</td>
<td>$V_{CE}$</td>
<td>$0$</td>
<td>$25$</td>
</tr>
<tr>
<td>Collector-emitter cut-off current</td>
<td>$I_{COS}$</td>
<td>$V_{CE}$</td>
<td>$0$</td>
<td>$650$</td>
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<tr>
<td>Gate-emitter leakage current</td>
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<td>$V_{BE}$</td>
<td>$20$</td>
<td>$0$</td>
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<tr>
<td>Internal gate resistance</td>
<td>$r_{g}$</td>
<td>$r_{g}$</td>
<td>$0$</td>
<td>$= 1$ Mhz</td>
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<tr>
<td>Input capacitance</td>
<td>$C_{in}$</td>
<td>$C_{in}$</td>
<td>$0$</td>
<td>$= 1$ Mhz</td>
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<tr>
<td>Output capacitance</td>
<td>$C_{out}$</td>
<td>$C_{out}$</td>
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<td>Reverse transfer capacitance</td>
<td>$Q_{g}$</td>
<td>$Q_{g}$</td>
<td>$15$</td>
<td>$= 1$ Mhz</td>
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<tr>
<td>Thermal resistance junction to sink</td>
<td>$R_{th(j-s)}$</td>
<td>$R_{th(j-s)}$</td>
<td>$0$</td>
<td>$= 3.4$ W/mK (PSX)</td>
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<tr>
<td>Turn-on delay time</td>
<td>$t_{(on)}$</td>
<td>$R_{ON} = 2 Ω$</td>
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<tr>
<td>Rise time</td>
<td>$t_{r}$</td>
<td>$R_{ON} = 2 Ω$</td>
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<td>$= 1$ Mhz</td>
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<tr>
<td>Turn-off delay time</td>
<td>$t_{(off)}$</td>
<td>$R_{OFF} = 2 Ω$</td>
<td>$25$</td>
<td>$= 1$ Mhz</td>
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<tr>
<td>Fall time</td>
<td>$t_{f}$</td>
<td>$R_{OFF} = 2 Ω$</td>
<td>$25$</td>
<td>$= 1$ Mhz</td>
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<tr>
<td>Turn-on energy (per pulse)</td>
<td>$E_{on}$</td>
<td>$Q_{on} = 8.1 µC$</td>
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<tr>
<td>Turn-off energy (per pulse)</td>
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<td>$Q_{off} = 16.2 µC$</td>
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<tbody>
<tr>
<td>[V]</td>
<td>V_{CE}</td>
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<td>[V]</td>
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<td>[A]</td>
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<td>°C</td>
<td>T_{j}</td>
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<tr>
<td>Boost Diode</td>
<td></td>
<td></td>
<td>Min Typ Max</td>
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</tbody>
</table>

#### Static

- **Forward voltage**
  - $V_i$: 25, 125, 150
  - Value: 1.53, 1.49, 1.47
  - Unit: V

- **Reverse leakage current**
  - $I_r$: 650, 25
  - Value: 15.2
  - Unit: μA

#### Thermal

- **Thermal resistance junction to sink**
  - $R_{th(j-s)}$: 0.35 K/W

#### Dynamic

- **Peak recovery current**
  - $I_{RM}$: 25, 125, 150
  - Value: 170, 254, 273
  - Unit: A

- **Reverse recovery time**
  - $t_{rr}$: 25, 125, 150
  - Value: 70, 99, 109
  - Unit: ns

- **Recovered charge**
  - $Q_r$: 25, 125, 150
  - Value: 8,076, 16,202, 18,915
  - Unit: μC

- **Reverse recovered energy**
  - $E_{rec}$: 25, 125, 150
  - Value: 1,923, 3,759, 4,384
  - Unit: mWs

- **Peak rate of fall of recovery current**
  - $(dV/dt)_{max}$: 25, 125, 150
  - Value: 2039, 2120, 1892
  - Unit: A/μs

### Boost Sw.Inv.Diode

#### Static

- **Forward voltage**
  - $V_i$: 300, 25, 125, 150
  - Value: 1.53, 1.49, 1.47
  - Unit: V

- **Reverse leakage current**
  - $I_r$: 650, 25
  - Value: 15.2
  - Unit: μA

#### Thermal

- **Thermal resistance junction to sink**
  - $R_{th(j-s)}$: 0.35 K/W

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<th>Unit</th>
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<td>Boost Sw. Protection Diode</td>
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<tr>
<td>Static</td>
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<td>Forward voltage</td>
<td>$V_\text{F}$</td>
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<td>1,64 1,56</td>
<td>V</td>
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<td>0,36 µA</td>
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<td>Capacitor (DC)</td>
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<td>Thermistor</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated resistance</td>
<td>$R$</td>
<td>25</td>
<td>22</td>
<td>kΩ</td>
</tr>
<tr>
<td>Deviation of $R_{25}$</td>
<td>$\Delta R$</td>
<td>$R_{250} = 1484 , \Omega$</td>
<td>100 -5</td>
<td>5 %</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>$P$</td>
<td>25</td>
<td>5</td>
<td>mW</td>
</tr>
<tr>
<td>Power dissipation constant</td>
<td></td>
<td>25</td>
<td>1,5</td>
<td>mW/K</td>
</tr>
<tr>
<td>B-value</td>
<td>$R_{(25/100)}$</td>
<td>Tol. ±1 %</td>
<td>25 3962</td>
<td>K</td>
</tr>
<tr>
<td>B-value</td>
<td>$R_{(25/1000)}$</td>
<td>Tol. ±1 %</td>
<td>25 4000</td>
<td>K</td>
</tr>
<tr>
<td>Vincotech NTC Reference</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>
**Buck Switch Characteristics**

**Figure 1.** IGBT

*Typical output characteristics

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

- \( t_p \): 250 \( \mu s \)
- \( V_{CE} \): 15 \( V \)
- \( T_j \): 25 \( ^\circ C \)
- \( T_j \): 125 \( ^\circ C \)
- \( V_{CE} \): from 7 \( V \) to 17 \( V \) in steps of 1 \( V \)

**Figure 2.** IGBT

*Typical output characteristics

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

- \( t_p \): 250 \( \mu s \)
- \( V_{CE} \): 15 \( V \)
- \( T_j \): 125 \( ^\circ C \)
- \( T_j \): 150 \( ^\circ C \)
- \( V_{CE} \): 7 \( V \) to 17 \( V \)

**Figure 3.** IGBT

*Typical transfer characteristics

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

- \( t_p \): 100 \( \mu s \)
- \( V_{CE} \): 10 \( V \)
- \( T_j \): 25 \( ^\circ C \)
- \( T_j \): 125 \( ^\circ C \)
- \( V_{CE} \): from 7 \( V \) to 17 \( V \)

**Figure 4.** IGBT

*Transient thermal impedance as function of pulse duration

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

- \( D = \frac{t_p}{T} \)
- \( R_{th(j-s)} = 0,24 \) K/W

**IGBT thermal model values**

- \( R \) (K/W)
  - 3,19E-02
  - 3,56E-02
  - 5,47E-02
  - 9,39E-02
  - 2,10E-02
  - 7,41E-03
- \( t \) (s)
  - 4,04E+00
  - 8,39E-01
  - 1,56E-01
  - 3,22E-02
  - 7,54E-03
  - 1,20E-03
Buck Switch Characteristics

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

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

**Figure 6.** Safe operating area

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

- \( I_C = 300 \text{ A} \)
- \( D = \text{single pulse} \)
- \( T_J = 80 \degree \text{C} \)
- \( V_{CE} = \pm15 \text{ V} \)
- \( T_J = T_{J\text{max}} \)
Buck Diode Characteristics

**Figure 1.** Typical forward characteristics

\[ I_F = f(V_F) \]

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

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

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

\[ 25 \, ^\circ C \]

\[ 125 \, ^\circ C \]

\[ 150 \, ^\circ C \]

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

\[ R_{th(j-s)} = 0,35 \, K/W \]

**FWD thermal model values**

<table>
<thead>
<tr>
<th>( R ) (K/W)</th>
<th>( \tau ) (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,86E-02</td>
<td>5,43E+00</td>
</tr>
<tr>
<td>5,04E-02</td>
<td>9,81E-01</td>
</tr>
<tr>
<td>7,36E-02</td>
<td>1,80E-01</td>
</tr>
<tr>
<td>1,26E-01</td>
<td>4,67E-02</td>
</tr>
<tr>
<td>4,07E-02</td>
<td>1,41E-02</td>
</tr>
<tr>
<td>1,25E-02</td>
<td>2,87E-03</td>
</tr>
<tr>
<td>1,67E-02</td>
<td>3,56E-04</td>
</tr>
</tbody>
</table>
Buck Sw. Protection Diode Characteristics

**Figure 1.**
Typical forward characteristics

\[ J_F = f(V_F) \]

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

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

- \( t_p = 250 \mu s \)
- \( T_j = 25 ^\circ C \)
- \( D = \frac{t_p}{T} \)
- \( R_{th(j-s)} = 1.61 \text{ K/W} \)

<table>
<thead>
<tr>
<th>( R_{th(j-s)} ) (K/W)</th>
<th>( \tau ) (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.05E-01</td>
<td>3.05E+00</td>
</tr>
<tr>
<td>1.86E-01</td>
<td>2.04E-01</td>
</tr>
<tr>
<td>6.60E-01</td>
<td>3.00E-02</td>
</tr>
<tr>
<td>3.40E-01</td>
<td>8.15E-03</td>
</tr>
<tr>
<td>1.24E-01</td>
<td>1.07E-03</td>
</tr>
</tbody>
</table>
Boost Switch Characteristics

**figure 1.** Typical output characteristics

I_C = f(V_CE)

<table>
<thead>
<tr>
<th>t_p</th>
<th>V_CE</th>
<th>T_j</th>
<th>I_C</th>
</tr>
</thead>
<tbody>
<tr>
<td>250 μs</td>
<td>15 V</td>
<td>25 °C</td>
<td></td>
</tr>
<tr>
<td>100 μs</td>
<td>10 V</td>
<td>125 °C</td>
<td></td>
</tr>
</tbody>
</table>

**figure 2.** Typical output characteristics

I_C = f(V_CE)

<table>
<thead>
<tr>
<th>t_p</th>
<th>V_CE</th>
<th>T_j</th>
<th>I_C</th>
</tr>
</thead>
<tbody>
<tr>
<td>250 μs</td>
<td>7 V to 17 V in steps of 1 V</td>
<td>150 °C</td>
<td></td>
</tr>
</tbody>
</table>

**figure 3.** Typical transfer characteristics

I_C = f(V_GE)

<table>
<thead>
<tr>
<th>t_p</th>
<th>V_CE</th>
<th>T_j</th>
<th>I_C</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 μs</td>
<td>10 V</td>
<td>25 °C</td>
<td></td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>D = t_p / τ</th>
<th>Z_{th(j-s)} (K/W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>3.76E-02</td>
</tr>
<tr>
<td>0.2</td>
<td>4.38E-02</td>
</tr>
<tr>
<td>0.1</td>
<td>7.93E-02</td>
</tr>
<tr>
<td>0.05</td>
<td>1.25E-01</td>
</tr>
<tr>
<td>0.025</td>
<td>2.76E-02</td>
</tr>
<tr>
<td>0.0125</td>
<td>1.27E-02</td>
</tr>
</tbody>
</table>

IGBT thermal model values

\[
R (K/W) \quad \tau (s) \\
3.76E-02 \quad 5.13E+00 \\
4.38E-02 \quad 1.11E+00 \\
7.93E-02 \quad 1.80E-01 \\
1.25E-01 \quad 3.35E-02 \\
2.76E-02 \quad 6.84E-03 \\
1.27E-02 \quad 7.61E-04 \\
\]

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Boost Switch Characteristics

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

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

**Figure 6.** Safe operating area

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

- \( I_C = 225 \) A
- \( V_{GE} = \pm 15 \) V
- \( T_j = T_{jmax} \)
- \( D = \) single pulse
- \( T_s = 80 \) °C
- \( V_{CE} = \pm 15 \) V
Boost Diode Characteristics

**Figure 1.** Typical forward characteristics

\[ I_F = f(V_F) \]

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

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

- \( t_p = 250 \mu s \)
- \( 25^\circ C \)
- \( 125^\circ C \)
- \( 150^\circ C \)

\[ R_{th}(K/W) \]

\[ \tau (s) \]

- 2.86E-02 5.43E+00
- 5.04E-02 9.81E-01
- 7.36E-02 1.80E-01
- 1.26E-01 4.67E-02
- 4.07E-02 1.41E-02
- 1.25E-02 2.87E-03
- 1.67E-02 3.56E-04

---

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Boost Sw.Inv.Diode Characteristics

**Figure 1.**
Typical forward characteristics

\[ I_F = f(V_F) \]

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

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

<table>
<thead>
<tr>
<th>( t_p ) ((\mu s))</th>
<th>250</th>
<th>25°C</th>
<th>25°C</th>
<th>125°C</th>
<th>150°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>( D = t_p / T )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( R_{th(j-s)} ) (K/W)</td>
<td>0.35</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FWD thermal model values</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( R ) (K/W)</td>
<td>( \tau ) (s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.86E-02</td>
<td>5.43E+00</td>
<td></td>
<td></td>
<td></td>
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<td>1.26E-01</td>
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<td>4.07E-02</td>
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</table>
Boost Sw. Protection Diode Characteristics

**figure 1.** FWD

Typical Forward characteristics

\[ I_F = f(V_F) \]

<table>
<thead>
<tr>
<th>( V_F ) (V)</th>
<th>0</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>( I_F ) (A)</td>
<td>0</td>
<td>15</td>
<td>45</td>
</tr>
</tbody>
</table>

**figure 2.** FWD

Transient thermal impedance as a function of pulse width

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

\( t_p = 250 \mu s \)

\( T = 25 \degree C \)

\( D = t_p / T \)

\( R_{th(j-s)} = 1.61 \ degree \ C/W \)

FWD thermal model values

<table>
<thead>
<tr>
<th>( R ) (K/W)</th>
<th>( \tau ) (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.05E-01</td>
<td>3.05E+00</td>
</tr>
<tr>
<td>1.86E-01</td>
<td>2.04E-01</td>
</tr>
<tr>
<td>6.60E-01</td>
<td>3.00E-02</td>
</tr>
<tr>
<td>3.40E-01</td>
<td>8.15E-03</td>
</tr>
<tr>
<td>1.24E-01</td>
<td>1.07E-03</td>
</tr>
</tbody>
</table>

Thermistor Characteristics

**figure 1.** Thermistor

Typical NTC characteristic as a function of temperature

\[ R = f(T) \]

<table>
<thead>
<tr>
<th>( R ) (Ω)</th>
<th>0</th>
<th>5000</th>
<th>10000</th>
<th>15000</th>
<th>20000</th>
<th>25000</th>
</tr>
</thead>
<tbody>
<tr>
<td>( T ) (°C)</td>
<td>25</td>
<td>50</td>
<td>75</td>
<td>100</td>
<td>125</td>
<td></td>
</tr>
</tbody>
</table>
Buck Switching Characteristics

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

\[
E = f(I_C)
\]

With an inductive load at 25°C

- \( V_{CE} = 350 \, \text{V} \)
- \( T_J = 125 \, ^\circ\text{C} \)
- \( R_{gon} = 2 \, \Omega \)
- \( I_C = 252 \, \text{A} \)

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

\[
E = f(R_g)
\]

With an inductive load at 25°C

- \( V_{CE} = 350 \, \text{V} \)
- \( T_J = 125 \, ^\circ\text{C} \)
- \( V_{GE} = \pm 15 \, \text{V} \)
- \( I_C = 252 \, \text{A} \)

With an inductive load at 125°C

- \( V_{CE} = 350 \, \text{V} \)
- \( T_J = 150 \, ^\circ\text{C} \)
- \( V_{GE} = \pm 15 \, \text{V} \)
- \( I_C = 252 \, \text{A} \)

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

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

With an inductive load at 25°C

- \( V_{CE} = 350 \, \text{V} \)
- \( T_J = 125 \, ^\circ\text{C} \)
- \( R_{gon} = 2 \, \Omega \)

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

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

With an inductive load at 25°C

- \( V_{CE} = 350 \, \text{V} \)
- \( T_J = 125 \, ^\circ\text{C} \)
- \( V_{GE} = \pm 15 \, \text{V} \)
- \( I_C = 252 \, \text{A} \)
Buck Switching Characteristics

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

\[ t = f(I_C) \]

With an inductive load at:
- \( T_j = 150 \) °C
- \( V_{CE} = 350 \) V
- \( V_{DS} = 415 \) V
- \( R_{gon} = 2 \) Ω
- \( R_{goff} = 2 \) Ω

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

\[ t = f(R_g) \]

With an inductive load at:
- \( T_j = 150 \) °C
- \( V_{CE} = 350 \) V
- \( V_{DS} = 415 \) V
- \( I_C = 252 \) A

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

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

At:
- \( V_{CE} = 350 \) V
- \( V_{DS} = 415 \) V
- \( T_j = 25 \) °C
- \( R_{g} = 2 \) Ω
- \( 125 \) °C

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

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

At:
- \( V_{DS} = 350 \) V
- \( V_{DS} = 415 \) V
- \( T_j = 125 \) °C
- \( I_C = 252 \) A
- \( 150 \) °C
Buck Switching Characteristics

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

\[ Q_r = f(I_C) \]

- \( V_{CC} = 350 \) V
- \( V_{CE} = \pm 15 \) V
- \( R_{gon} = 2 \) \( \Omega \)
- \( T_J = 25 \) °C
- \( I_C = 252 \) A

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

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

- \( V_{CC} = 350 \) V
- \( V_{CE} = \pm 15 \) V
- \( I_C = 252 \) A
- \( T_J = 125 \) °C

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

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

- \( V_{CC} = 350 \) V
- \( V_{CE} = \pm 15 \) V
- \( R_{gon} = 2 \) \( \Omega \)
- \( T_J = 25 \) °C
- \( I_C = 252 \) A

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

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

- \( V_{CC} = 350 \) V
- \( V_{CE} = \pm 15 \) V
- \( I_C = 252 \) A
- \( T_J = 125 \) °C

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Buck Switching Characteristics

**Figure 13.** FWD

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

\[
\frac{d i_F}{dt}, \frac{d i_{rr}}{dt} = f(I_C)
\]

At

\[
\begin{align*}
V_{CE} &= 350 \text{ V} \\
V_{GE} &= \pm 15 \text{ V} \\
R_{gs} &= 2 \ \Omega \\
T_j &= 25 \ ^\circ\text{C}
\end{align*}
\]

**Figure 14.** FWD

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

\[
\frac{d i_F}{dt}, \frac{d i_{rr}}{dt} = f(R_{gon})
\]

At

\[
\begin{align*}
V_{CE} &= 350 \text{ V} \\
V_{GE} &= \pm 15 \text{ V} \\
R_{gs} &= 2 \ \Omega \\
T_j &= 125 \ ^\circ\text{C}
\end{align*}
\]

**Figure 15.** IGBT

Reverse bias safe operating area

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

At

\[
\begin{align*}
V_{CE} &= 700 \text{ V} \\
T_j &= 125 \ ^\circ\text{C} \\
R_{gs} &= 2 \ \Omega \\
R_{gss} &= 2 \ \Omega
\end{align*}
\]
Buck Switching Definitions

General conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_1$</td>
<td>125 °C</td>
</tr>
<tr>
<td>$R_{on}$</td>
<td>2 Ω</td>
</tr>
<tr>
<td>$R_{off}$</td>
<td>2 Ω</td>
</tr>
</tbody>
</table>

Figure 1. 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
- $V_{CE}(0\%) = 350$ V
- $V_{CE}(100\%) = 15$ V
- $I_{C}(0\%) = 252$ A
- $I_{C}(100\%) = 252$ A
- $t_{doff} = 148$ ns

Figure 2. 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
- $V_{CE}(0\%) = 350$ V
- $V_{CE}(100\%) = 15$ V
- $I_{C}(0\%) = 252$ A
- $I_{C}(100\%) = 252$ A
- $t_{don} = 116$ ns

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

- $V_{CE}(1\%) = 350$ V
- $I_{C}(1\%) = 252$ A
- $t_f = 21$ ns

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

- $V_{CE}(1\%) = 350$ V
- $I_{C}(1\%) = 252$ A
- $t_r = 18$ ns
Buck Switching Characteristics

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

- $V_f (100\%) = 350 \text{ V}$
- $I_f (100\%) = 252 \text{ A}$
- $I_{Fmax}(100\%) = 298 \text{ A}$
- $t_{rr} = 77 \text{ ns}$

**Figure 6.** Turn-on Switching Waveforms & definition of $t_{Qr}$ ($t_{Qr}$ = integrating time for $Q_r$)

- $I_r (100\%) = 252 \text{ A}$
- $Q_r (100\%) = 14.87 \text{ µC}$
Boost Switching Characteristics

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

![Graph showing energy losses vs. collector current](image)

With an inductive load at
- $V_{CC} = 350$ V
- $V_{DS} = ±15$ V
- $R_{ON} = 2$ Ω

25 °C

25 °C

125 °C

150 °C

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

![Graph showing energy losses vs. gate resistor](image)

With an inductive load at
- $V_{CC} = 350$ V
- $V_{DS} = ±15$ V
- $I_C = 252$ A

25 °C

25 °C

125 °C

150 °C

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

![Graph showing reverse recovered energy loss vs. collector current](image)

With an inductive load at
- $V_{CC} = 350$ V
- $V_{DS} = ±15$ V
- $R_{OFF} = 2$ Ω

25 °C

25 °C

125 °C

150 °C

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

![Graph showing reverse recovered energy loss vs. gate resistor](image)

With an inductive load at
- $V_{CC} = 350$ V
- $V_{DS} = ±15$ V
- $I_C = 252$ A

25 °C

25 °C

125 °C

150 °C
Boost Switching Characteristics

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

$t = f(I_C)$

With an inductive load at
- $T_J = 150 \degree C$
- $V_CE = 350 \text{ V}$
- $V_{GE} = \pm 15 \text{ V}$
- $R_{gon} = 2 \Omega$
- $I_C = 252 \text{ A}$

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

$t = f(R_g)$

With an inductive load at
- $T_J = 150 \degree C$
- $V_CE = 350 \text{ V}$
- $V_{GE} = \pm 15 \text{ V}$
- $R_{goff} = 2 \Omega$
- $I_C = 252 \text{ A}$

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

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

With an inductive load at
- $T_J = 25 \degree C$
- $V_CE = 350 \text{ V}$
- $V_{GE} = \pm 15 \text{ V}$
- $R_{gon} = 2 \Omega$

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

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

With an inductive load at
- $T_J = 25 \degree C$
- $V_CE = 350 \text{ V}$
- $V_{GE} = \pm 15 \text{ V}$
- $R_{goff} = 2 \Omega$
- $I_C = 252 \text{ A}$
Boost Switching Characteristics

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

\[ Q_r = f(I_C) \]

With an inductive load at
- \( V_{CC} = 350 \, \text{V} \)
- \( V_{CC} = \pm 15 \, \text{V} \)
- \( R_{gon} = 2 \, \Omega \)

Temperature
- 25 °C
- 125 °C
- 150 °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
- \( V_{CC} = 350 \, \text{V} \)
- \( V_{CC} = \pm 15 \, \text{V} \)
- \( I_C = 252 \, \text{A} \)

Temperature
- 25 °C
- 125 °C
- 150 °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
- \( V_{CC} = 350 \, \text{V} \)
- \( V_{CC} = \pm 15 \, \text{V} \)
- \( R_{gon} = 2 \, \Omega \)

Temperature
- 25 °C
- 125 °C
- 150 °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
- \( V_{CC} = 350 \, \text{V} \)
- \( V_{CC} = \pm 15 \, \text{V} \)
- \( I_C = 252 \, \text{A} \)

Temperature
- 25 °C
- 125 °C
- 150 °C
Boost Switching Characteristics

**Figure 13.** FWD
Typical rate of fall of forward and reverse recovery current as a function of collector current
\[
d_i/dt, d_i_{rr}/dt = f(I_C)
\]

With an inductive load at 25 °C
- \( V_{CE} = 350 \text{ V} \)
- \( V_{GE} = \pm 15 \text{ V} \)
- \( R_{gon} = 2 \Omega \)
- \( I_C = 252 \text{ A} \)
- \( T_j = 125 \text{ °C} \)

**Figure 14.** FWD
Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor
\[
d_i/dt, d_i_{rr}/dt = f(R_{gon})
\]

With an inductive load at 25 °C
- \( V_{CE} = 350 \text{ V} \)
- \( V_{GE} = \pm 15 \text{ V} \)
- \( R_{goff} = 2 \Omega \)
- \( I_{C} = 252 \text{ A} \)
- \( T_j = 150 \text{ °C} \)

**Figure 15.** IGBT
Reverse bias safe operating area
\[
I_c = f(V_{CE})
\]

With 
- \( V_{CE} \) from 0 to 700 V
- \( I_C \) from 0 to 450 A
- \( I_{C MAX} \)
- \( I_{C CHIP} \)
- \( I_{B MOD} \)

With 
- \( T_j = 125 \text{ °C} \)
- \( R_{goff} = 2 \Omega \)
- \( R_{gon} = 2 \Omega \)
**Boost Switching Definitions**

### General Conditions

- $R_{	ext{on}} = 253 \, \text{ns}$
- $R_{	ext{off}} = 2 \, \Omega$

### Figure 1: IGBT

**Turn-off Switching Waveforms & definition of $t_{	ext{doff}}$, $t_{	ext{Eoff}}$ (integrating time for $E_{	ext{off}}$)**

- $V_{\text{CE}(0\%)} = -15 \, \text{V}$
- $V_{\text{CE}(100\%)} = 350 \, \text{V}$
- $I_{\text{C}(100\%)} = 252 \, \text{A}$
- $t_{\text{doff}} = 253 \, \text{ns}$

### Figure 2: IGBT

**Turn-on Switching Waveforms & definition of $t_{	ext{don}}$, $t_{	ext{Eon}}$ (integrating time for $E_{	ext{on}}$)**

- $V_{\text{CE}(0\%)} = -15 \, \text{V}$
- $V_{\text{CE}(100\%)} = 350 \, \text{V}$
- $I_{\text{C}(100\%)} = 252 \, \text{A}$
- $t_{\text{don}} = 188 \, \text{ns}$

### Figure 3: IGBT

**Turn-off Switching Waveforms & definition of $I_{\text{C}}$**

- $I_{\text{C}(0\%)} = 350 \, \text{V}$
- $I_{\text{C}(100\%)} = 252 \, \text{A}$
- $t_{\text{f}} = 210 \, \text{ns}$

### Figure 4: IGBT

**Turn-on Switching Waveforms & definition of $I_{\text{C}}$**

- $I_{\text{C}(100\%)} = 350 \, \text{V}$
- $I_{\text{C}(90\%)} = 252 \, \text{A}$
- $t_{\text{r}} = 18 \, \text{ns}$
Boost Switching Characteristics

**Figure 5.** FWD

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

- $V_{F}$ (100%) = 350 V
- $I_{F}$ (100%) = 252 A
- $I_{MAX 100\%}$ = 254 A
- $t_{RRM}$ = 99 ns

**Figure 6.** FWD

Turn-off Switching Waveforms & definition of $t_{rr}$ ($t_{rr}$ = integrating time for $Q_r$)

- $I_{RRM 10\%}$
- $I_{RRM 90\%}$
- $I_{RRM 100\%}$

- $I_{F}$ (100%) = 252 A
- $Q_r$ (100%) = 16.20 μC
### Pinout

![Pinout diagram](image)

### Identification

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Handling instruction

Handling instructions for flow 2 packages see vincotech.com website.

Package data

Package data for flow 2 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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