## flowNPC 2 — 600V/200A

### Features

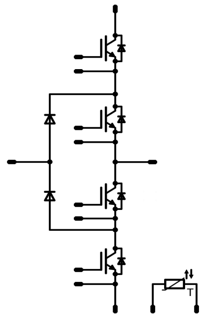
- Neutral-point-Clamped inverter
- High power flow2 housing
- Low Inductance Layout

### flow2 housing

### Target Applications

- UPS
- Solar inverters

### Schematic



### Types

- F206NIA200SA

# Maximum Ratings

Tj=25℃, unless otherwise specified

| Parameter | Symbol | Condition | Value | Unit |
|---|---|---|---|---|
| **Buck IGBT** | | | | |
| Collector-emitter break down voltage | $V_{CE}$ | | 600 | V |
| DC collector current | $I_C$ | $T_j=T_j$max $T_h$=80℃<br>$T_c$=80℃ | 155<br>200 | A |
| Repetitive peak collector current | $I_{Cpulse}$ | $t_p$ limited by $T_j$max | 600 | A |
| Power dissipation | $P_{tot}$ | $T_j=T_j$max $T_h$=80℃<br>$T_c$=80℃ | 245<br>372 | W |
| Gate-emitter peak voltage | $V_{GE}$ | | ±20 | V |
| Short circuit ratings | $t_{SC}$<br>$V_{CC}$ | $T_j$≤150℃<br>$V_{GE}$=15V | 6<br>360 | µs<br>V |
| Maximum Junction Temperature | $T_j$max | | 175 | ℃ |
| **Buck FWD** | | | | |
| Peak Repetitive Reverse Voltage | $V_{RRM}$ | $T_j$=25℃ | 600 | V |
| DC forward current | $I_F$ | $T_j=T_j$max $T_h$=80℃<br>$T_c$=80℃ | 109<br>144 | A |
| Repetitive peak forward current | $I_{FRM}$ | $t_p$ limited by $T_j$max $T_c$=100℃ | 600 | A |
| Power dissipation | $P_{tot}$ | $T_j=T_j$max $T_h$=80℃<br>$T_c$=80℃ | 158<br>239 | W |
| Maximum Junction Temperature | $T_j$max | | 175 | ℃ |

# Maximum Ratings

Tj=25℃, unless otherwise specified

| Parameter | Symbol | Condition | | Value | Unit |
|---|---|---|---|---|---|
| **Boost IGBT** | | | | | |
| Collector-emitter break down voltage | $V_{CE}$ | | | 600 | V |
| DC collector current | $I_C$ | $T_j=T_j$max | $T_h=80$℃<br>$T_c=80$℃ | 154<br>200 | A |
| Repetitive peak collector current | $I_{Cpuls}$ | $t_p$ limited by $T_j$max | | 600 | A |
| Power dissipation | $P_{tot}$ | $T_j=T_j$max | $T_h=80$℃<br>$T_c=80$℃ | 245<br>372 | W |
| Gate-emitter peak voltage | $V_{GE}$ | | | ±20 | V |
| Short circuit ratings | $t_{SC}$<br>$V_{CC}$ | $T_j\leq150$℃<br>$V_{GE}=15$V | | 6<br>360 | µs<br>V |
| Maximum Junction Temperature | $T_j$max | | | 175 | ℃ |
| **Boost Inverse Diode** | | | | | |
| Peak Repetitive Reverse Voltage | $V_{RRM}$ | $T_c=25$℃ | | 600 | V |
| DC forward current | $I_F$ | $T_j=T_j$max | $T_h=80$℃<br>$T_c=80$℃ | 136<br>145 | A |
| Repetitive peak forward current | $I_{FRM}$ | $t_p$ limited by $T_j$max | | 600 | A |
| Power dissipation per Diode | $P_{tot}$ | $T_j=T_j$max | $T_h=80$℃<br>$T_c=80$℃ | 190<br>190 | W |
| Maximum Junction Temperature | $T_j$max | | | 175 | ℃ |
| **Boost FWD** | | | | | |
| Peak Repetitive Reverse Voltage | $V_{RRM}$ | $T_j=25$℃ | | 600 | V |
| DC forward current | $I_F$ | $T_j=T_j$max | $T_h=80$℃<br>$T_c=80$℃ | 138<br>183 | A |
| Repetitive peak forward current | $I_{FRM}$ | $t_p$ limited by $T_j$max | | 600 | A |
| Power dissipation | $P_{tot}$ | $T_j=T_j$max | $T_h=80$℃<br>$T_c=80$℃ | 190<br>287 | W |
| Maximum Junction Temperature | $T_j$max | | | 175 | ℃ |
| **Thermal Properties** | | | | | |
| Storage temperature | $T_{stg}$ | | | -40…+125 | ℃ |
| Operation temperature under switching condition | $T_{op}$ | | | -40…+(Tjmax - 25) | ℃ |
| **Insulation Properties** | | | | | |
| Insulation voltage | $V_{is}$ | t=2s | DC voltage | 4000 | V |
| Creepage distance | | | | min 12,7 | mm |
| Clearance | | | | min 12,7 | mm |

## Characteristic Values

| Parameter | Symbol | Conditions | $V_{GE}$ [V] or $V_{GS}$ [V] | $V_r$ [V] or $V_{CE}$ [V] or $V_{DS}$ [V] | $I_C$ [A] or $I_F$ [A] or $I_D$ [A] | $T_j$ | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| **Buck IGBT** | | | | | | | | | | |
| Gate emitter threshold voltage | $V_{GE(th)}$ | VCE=VGE | | | 0,0032 | Tj=25°C<br>Tj=150°C | 5 | 5,8 | 6,5 | V |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ | | 15 | | 200 | Tj=25°C<br>Tj=150°C | 1,05 | 1,51<br>1,75 | 1,85 | V |
| Collector-emitter cut-off current incl. Diode | $I_{CES}$ | | 0 | 600 | | Tj=25°C<br>Tj=150°C | | | 0,66 | mA |
| Gate-emitter leakage current | $I_{GES}$ | | 20 | 0 | | Tj=25°C<br>Tj=150°C | | | 700 | nA |
| Integrated Gate resistor | $R_{gint}$ | | | | | | | 1 | | Ω |
| Turn-on delay time | $t_{d(on)}$ | Rgoff=4 Ω<br>Rgon=4 Ω | ±15 | 350 | 200 | Tj=25°C<br>Tj=150°C | | 240<br>245 | | ns |
| Rise time | $t_r$ | | | | | Tj=25°C<br>Tj=150°C | | 42<br>42 | | |
| Turn-off delay time | $t_{d(off)}$ | | | | | Tj=25°C<br>Tj=150°C | | 310<br>341 | | |
| Fall time | $t_f$ | | | | | Tj=25°C<br>Tj=150°C | | 71<br>104 | | |
| Turn-on energy loss per pulse | $E_{on}$ | | | | | Tj=25°C<br>Tj=150°C | | 3,14<br>4,22 | | mWs |
| Turn-off energy loss per pulse | $E_{off}$ | | | | | Tj=25°C<br>Tj=150°C | | 6,14<br>7,89 | | |
| Input capacitance | $C_{ies}$ | f=1MHz | 0 | 25 | | Tj=25°C | | 12320 | | pF |
| Output capacitance | $C_{oss}$ | | | | | | | 768 | | |
| Reverse transfer capacitance | $C_{rss}$ | | | | | | | 366 | | |
| Gate charge | $Q_{Gate}$ | | 15 | 700 | 200 | Tj=25°C | | 2100 | | nC |
| Thermal resistance chip to heatsink | $R_{thJH}$ | Thermal grease thickness≤50um<br>λ = 1 W/mK | | | | | | 0,39 | | K/W |
| Thermal resistance chip to case | $R_{thJC}$ | | | | | | | 0,26 | | |
| **Buck FWD** | | | | | | | | | | |
| Diode forward voltage | $V_F$ | | | | 200 | Tj=25°C<br>Tj=125°C | 1,5 | 1,77<br>1,89 | 3,3 | V |
| Peak reverse recovery current | $I_{RRM}$ | Rgoff=4 Ω | ±15 | 350 | 200 | Tj=25°C<br>Tj=125°C | | 136<br>172 | | A |
| Reverse recovery time | $t_{rr}$ | | | | | Tj=25°C<br>Tj=125°C | | 137<br>269 | | ns |
| Reverse recovered charge | $Q_{rr}$ | | | | | Tj=25°C<br>Tj=125°C | | 8,5<br>16,2 | | µC |
| Peak rate of fall of recovery current | di(rec)max<br>/dt | | | | | Tj=25°C<br>Tj=125°C | | 3158<br>2901 | | A/µs |
| Reverse recovered energy | Erec | | | | | Tj=25°C<br>Tj=125°C | | 2,02<br>3,66 | | mWs |
| Thermal resistance chip to heatsink | $R_{thJH}$ | Thermal grease thickness≤50um<br>λ = 1 W/mK | | | | | | 0,60 | | K/W |
| Thermal resistance chip to case | $R_{thJC}$ | | | | | | | 0,40 | | |

## Characteristic Values

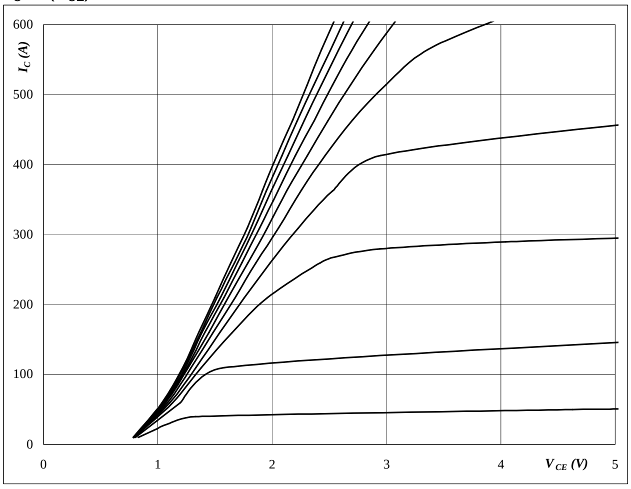
| Parameter | Symbol | Conditions | | | | | Value | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $V_{GE}$ [V] or $V_{GS}$ [V] | $V_r$ [V] or $V_{CE}$ [V] or $V_{DS}$ [V] | $I_C$ [A] or $I_F$ [A] or $I_D$ [A] | $T_j$ | Min | Typ | Max | |
| **Boost IGBT** | | | | | | | | | | |
| Gate emitter threshold voltage | $V_{GE(th)}$ | $V_{CE}=V_{GE}$ | | | 0,0032 | Tj=25℃<br>Tj=125℃ | 5 | 5,8 | 6,5 | V |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ | | 15 | | 200 | Tj=25℃<br>Tj=125℃ | 1,05 | 1,51<br>1,75 | 1,85 | V |
| Collector-emitter cut-off incl diode | $I_{CES}$ | | 0 | 600 | | Tj=25℃<br>Tj=125℃ | | | 0,66 | mA |
| Gate-emitter leakage current | $I_{GES}$ | | 20 | 0 | | Tj=25℃<br>Tj=125℃ | | | 700 | nA |
| Integrated Gate resistor | $R_{gint}$ | | | | | | | 1 | | Ω |
| Turn-on delay time | $t_{d(on)}$ | | | | | Tj=25℃<br>Tj=125℃ | | 233<br>239 | | |
| Rise time | $t_r$ | | | | | Tj=25℃<br>Tj=125℃ | | 43<br>45 | | ns |
| Turn-off delay time | $t_{d(off)}$ | Rgoff=4 Ω<br>Rgon=4 Ω | ±15 | 350 | 200 | Tj=25℃<br>Tj=125℃ | | 309<br>335 | | |
| Fall time | $t_f$ | | | | | Tj=25℃<br>Tj=125℃ | | 65<br>88 | | |
| Turn-on energy loss per pulse | $E_{on}$ | | | | | Tj=25℃<br>Tj=125℃ | | 3,95<br>4,87 | | mWs |
| Turn-off energy loss per pulse | $E_{off}$ | | | | | Tj=25℃<br>Tj=125℃ | | 5,88<br>7,64 | | |
| Input capacitance | $C_{ies}$ | | | | | | | 12320 | | |
| Output capacitance | $C_{oss}$ | f=1MHz | 0 | 25 | | Tj=25℃ | | 768 | | pF |
| Reverse transfer capacitance | $C_{rss}$ | | | | | | | 366 | | |
| Gate charge | $Q_{Gate}$ | | 15 | 700 | 200 | Tj=25℃ | | 2100 | | nC |
| Thermal resistance chip to heatsink | $R_{thJH}$ | Thermal grease thickness≤50um<br>λ = 1 W/mK | | | | | | 0,39 | | K/W |
| Thermal resistance chip to case | $R_{thJC}$ | | | | | | | 0,26 | | |
| **Boost Inverse Diode** | | | | | | | | | | |
| Diode forward voltage | $V_F$ | | | | 200 | Tj=25℃<br>Tj=125℃ | 1,5 | 1,60<br>1,64 | 3,3 | V |
| Thermal resistance chip to heatsink | $R_{thJH}$ | Thermal grease thickness≤50um<br>λ = 1 W/mK | | | | | | 0,50 | | K/W |
| Thermal resistance chip to case | $R_{thJC}$ | | | | | | | 0,33 | | |
| **Boost FWD** | | | | | | | | | | |
| Diode forward voltage | $V_F$ | | | | 200 | Tj=25℃<br>Tj=150℃ | 1,5 | 1,60<br>1,65 | 3,3 | V |
| Reverse leakage current | $I_r$ | | | 600 | | Tj=25℃<br>Tj=150℃ | | | 600 | µA |
| Peak reverse recovery current | $I_{RRM}$ | | | | | Tj=25℃<br>Tj=150℃ | | 132<br>163 | | A |
| Reverse recovery time | $t_{rr}$ | | | | | Tj=25℃<br>Tj=150℃ | | 138<br>211 | | ns |
| Reverse recovered charge | $Q_{rr}$ | Rgoff=4 Ω | ±15 | 350 | 200 | Tj=25℃<br>Tj=150℃ | | 9,1<br>16,5 | | µC |
| Peak rate of fall of recovery current | di(rec)max/dt | | | | | Tj=25℃<br>Tj=150℃ | | 2672<br>1616 | | A/µs |
| Reverse recovery energy | $E_{rec}$ | | | | | Tj=25℃<br>Tj=150℃ | | 2,17<br>4,15 | | mWs |
| Thermal resistance chip to heatsink | $R_{thJH}$ | Thermal grease thickness≤50um<br>λ = 1 W/mK | | | | | | 0,50 | | K/W |
| Thermal resistance chip to case | $R_{thJC}$ | | | | | | | 0,33 | | |
| **Thermistor** | | | | | | | | | | |
| Rated resistance | R | | | | | T=25℃ | | 22000 | | Ω |
| Deviation of R100 | ΔR/R | R100=1486 Ω | | | | T=100℃ | -5 | | 5 | % |
| Power dissipation | P | | | | | T=25℃ | | 200 | | mW |
| Power dissipation constant | | | | | | T=25℃ | | 2 | | mW/K |
| B-value | B(25/50) | Tol. ±3% | | | | T=25℃ | | 3950 | | K |
| B-value | B(25/100) | Tol. ±3% | | | | T=25℃ | | 3996 | | K |
| Vincotech NTC Reference | | | | | | | | | B | |

# Buck

**Figure 1** IGBT

**Typical output characteristics**

$I_C = f(V_{CE})$



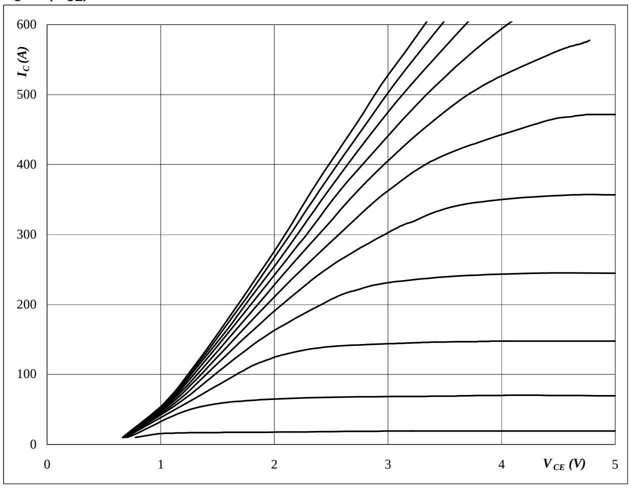

At

| | | |
|---|---|---|
| $t_p$ = | 350 | µs |
| $T_j$ = | 25 | ℃ |
| $V_{GE}$ from | 7 V to 17 V in steps of 1 V | |

**Figure 2** IGBT

**Typical output characteristics**

$I_C = f(V_{CE})$



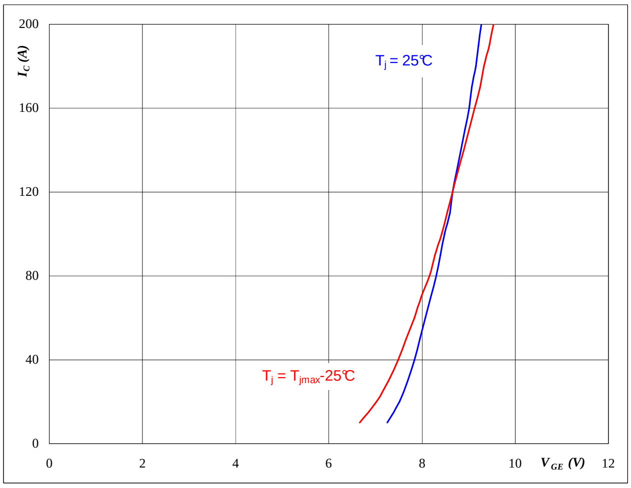

At

| | | |
|---|---|---|
| $t_p$ = | 350 | µs |
| $T_j$ = | 25 | ℃ |
| $V_{GE}$ from | 7 V to 17 V in steps of 1 V | |

**Figure 3** IGBT

**Typical transfer characteristics**

$I_C = f(V_{GE})$



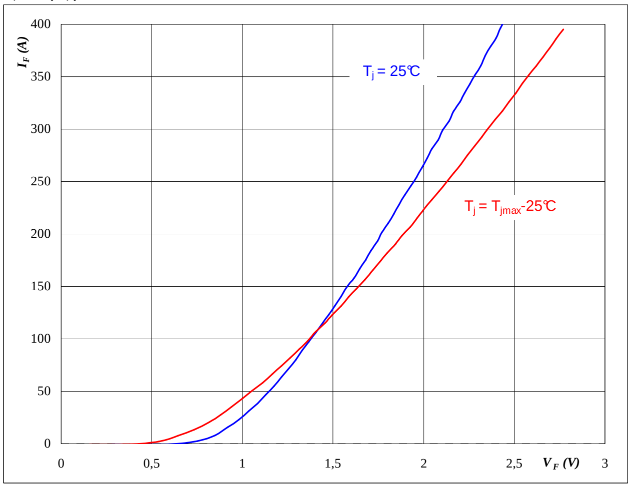

At

| | | |
|---|---|---|
| $t_p$ = | 350 | µs |
| $V_{CE}$ = | 10 | V |

**Figure 4** FRED

**Typical diode forward current as a function of forward voltage**

$I_F = f(V_F)$




At

| | | |
|---|---|---|
| $t_p$ = | 350 | µs |

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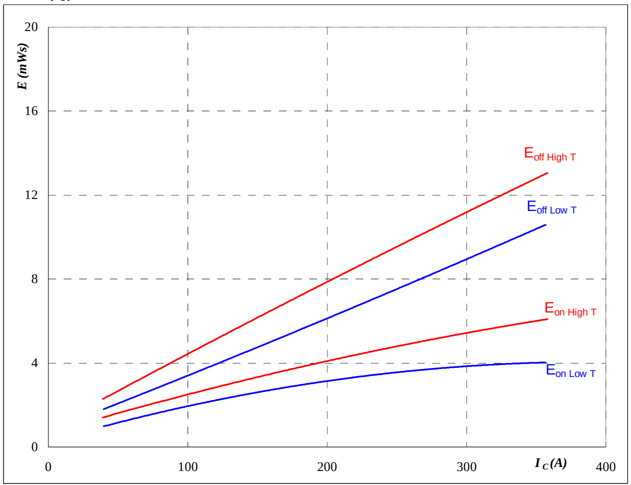
**Figure 5** IGBT

**Typical switching energy losses**
**as a function of collector current**

E = f($I_C$)



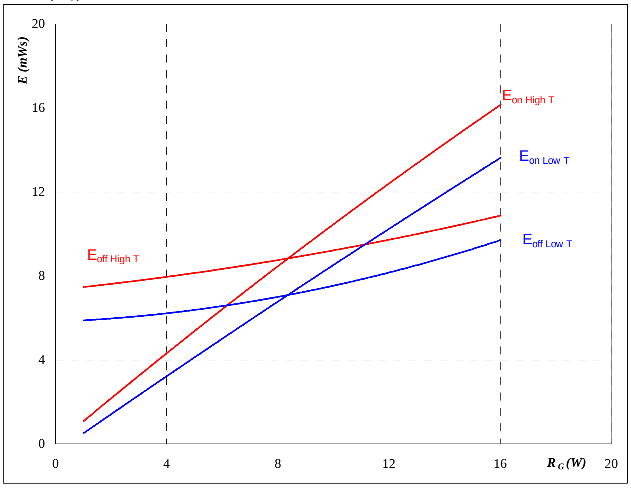

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/125 | ℃ |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 4 | Ω |
| $R_{goff}$ = | 4 | Ω |

**Figure 6** IGBT

**Typical switching energy losses**
**as a function of gate resistor**

E = f($R_G$)



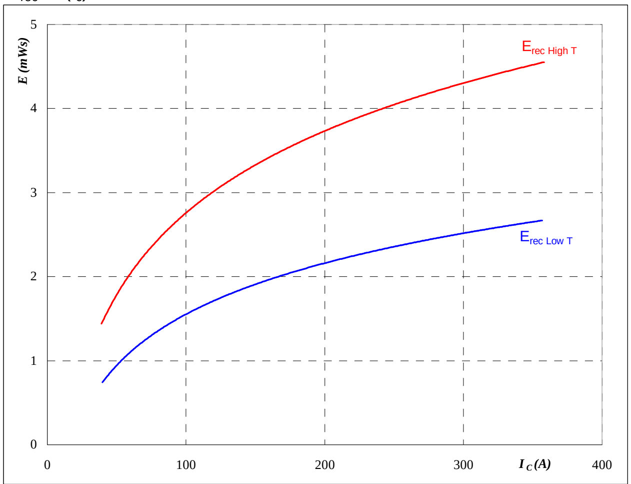

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/125 | ℃ |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 200 | A |

**Figure 7** FRED

**Typical reverse recovery energy loss**
**as a function of collector current**

$E_{rec}$ = f($I_c$)



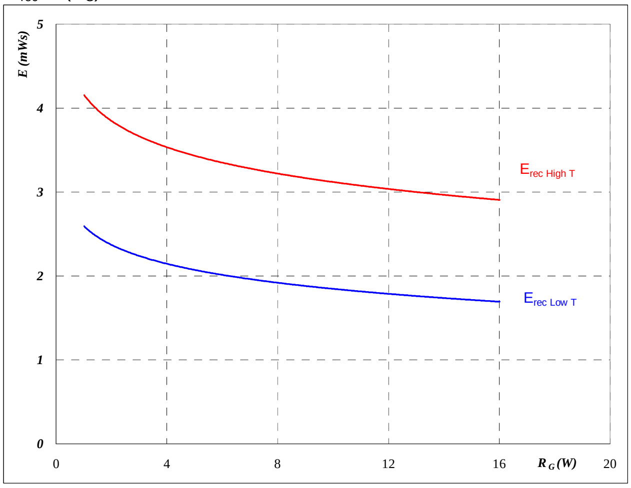

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/125 | ℃ |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 4 | Ω |

**Figure 8** FRED

**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 | ℃ |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 200 | A |

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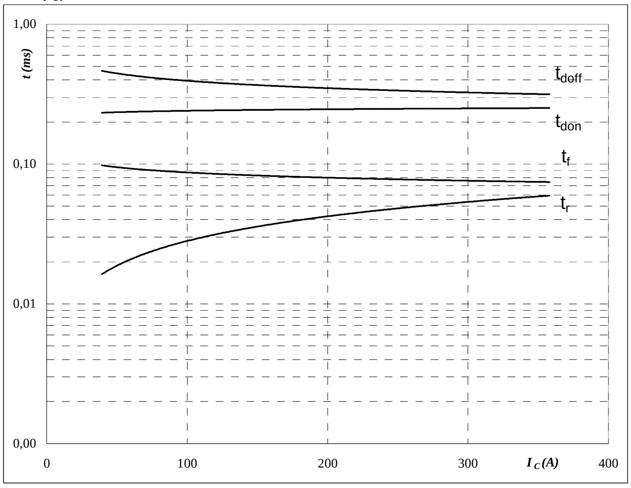
**Figure 9** IGBT

**Typical switching times as a function of collector current**

t = f($I_C$)



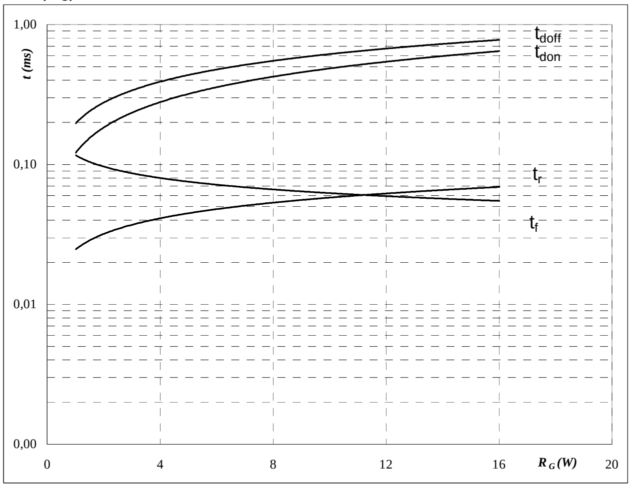

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 125 | ℃ |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 4 | Ω |
| $R_{goff}$ = | 4 | Ω |

**Figure 10** IGBT

**Typical switching times as a function of gate resistor**

t = f($R_G$)



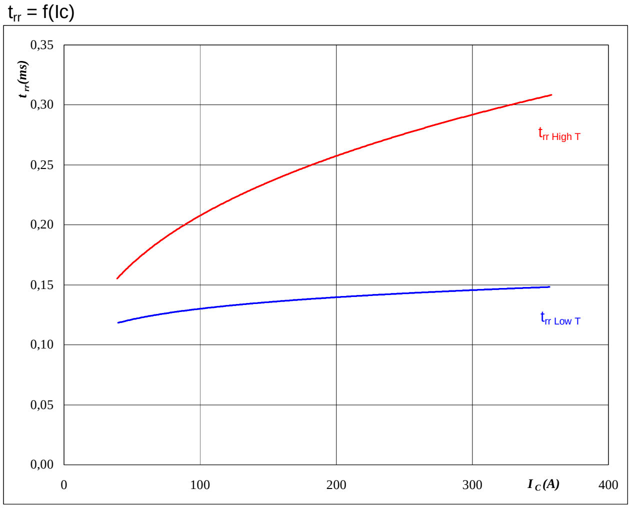

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 125 | ℃ |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 200 | A |

**Figure 11** FRED

**Typical reverse recovery time as a function of collector current**

$t_{rr}$ = f(Ic)



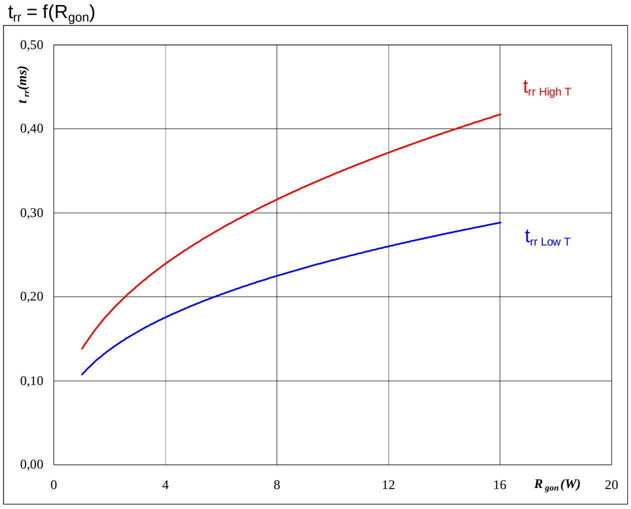

At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | ℃ |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 4 | Ω |

**Figure 12** FRED

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

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




At

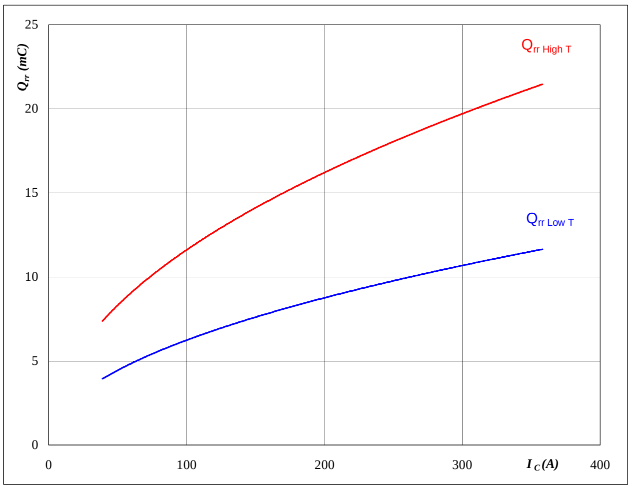
| | | |
|---|---|---|
| $T_j$ = | 25/125 | ℃ |
| $V_R$ = | 350 | V |
| $I_F$ = | 200 | A |
| $V_{GE}$ = | ±15 | V |

# Buck

**Figure 13** FRED

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

$Q_{rr} = f(I_C)$



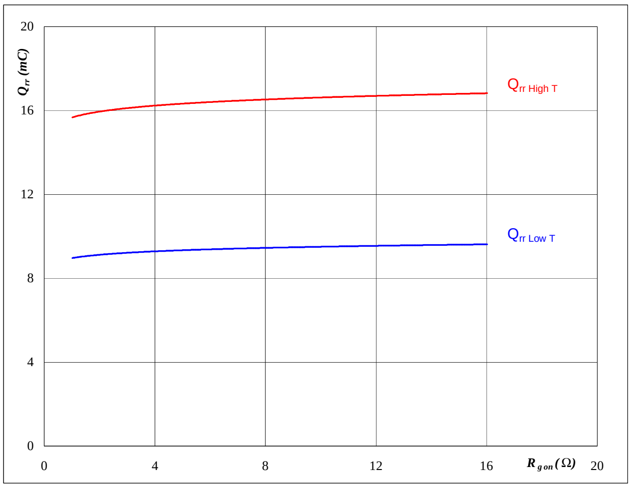

At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | ℃ |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 4 | Ω |

**Figure 14** FRED

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

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



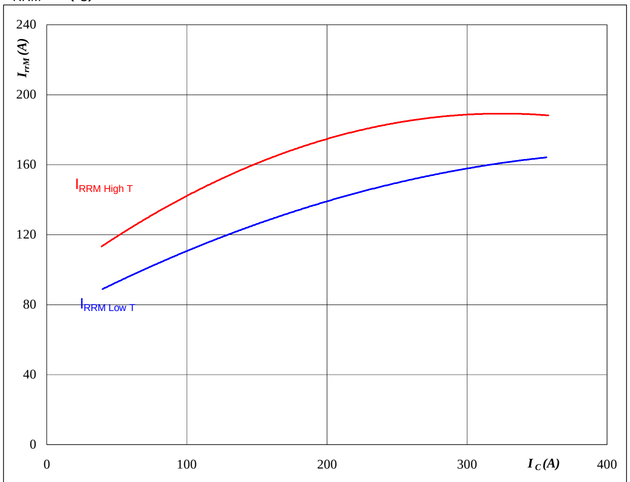

At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | ℃ |
| $V_R$ = | 350 | V |
| $I_F$ = | 200 | A |
| $V_{GE}$ = | ±15 | V |

**Figure 15** FRED

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

$I_{RRM} = f(I_C)$



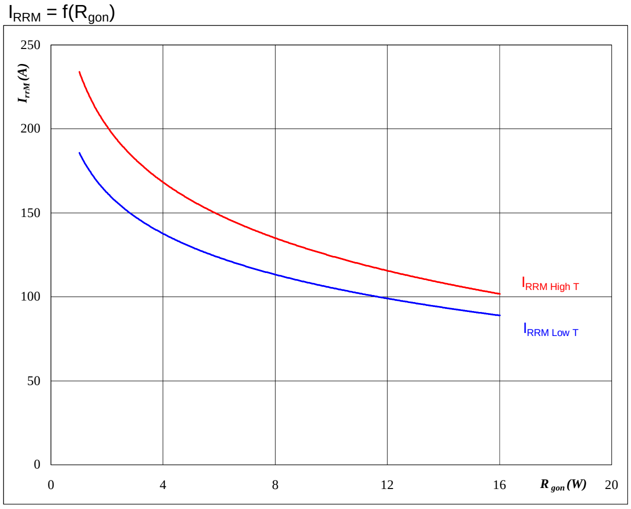

At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | ℃ |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 4 | Ω |

**Figure 16** FRED

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

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




At

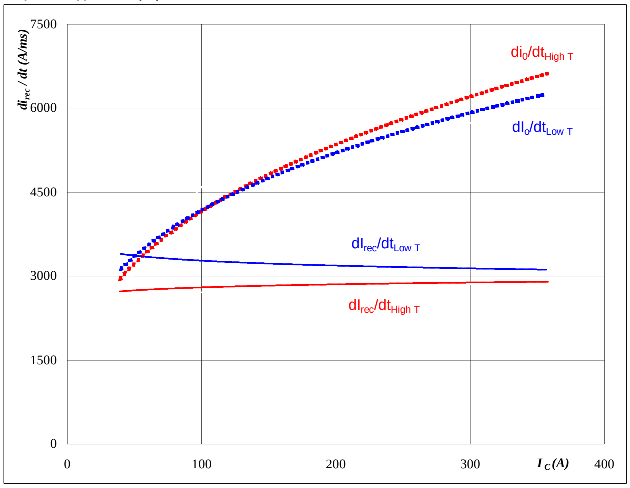
| | | |
|---|---|---|
| $T_j$ = | 25/125 | ℃ |
| $V_R$ = | 350 | V |
| $I_F$ = | 200 | A |
| $V_{GE}$ = | ±15 | V |

# Buck

**Figure 17** FRED

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

$dI_0/dt, dI_{rec}/dt = f(Ic)$



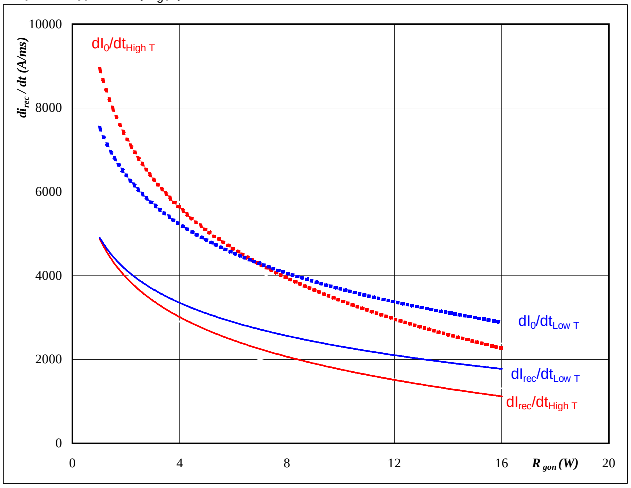

At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | ℃ |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 4 | Ω |

**Figure 18** FRED

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

$dI_0/dt, dI_{rec}/dt = f(R_{gon})$



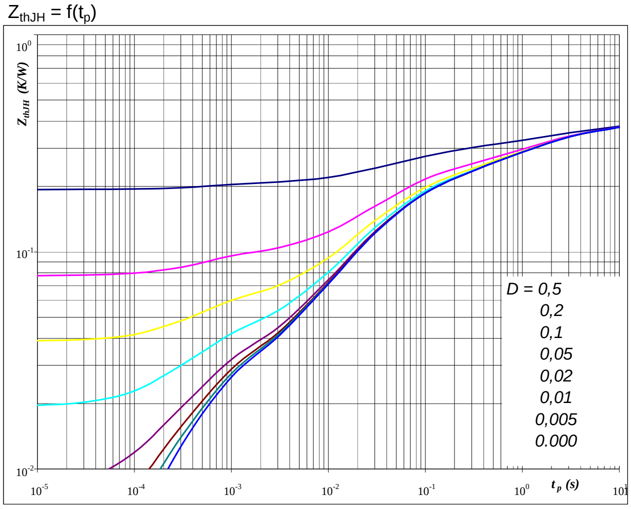

At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | ℃ |
| $V_R$ = | 350 | V |
| $I_F$ = | 200 | A |
| $V_{GE}$ = | ±15 | V |

**Figure 19** IGBT

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

$Z_{thJH} = f(t_p)$




At

| | | |
|---|---|---|
| D = | $t_p$ / T | |
| $R_{thJH}$ = | 0,39 | K/W |

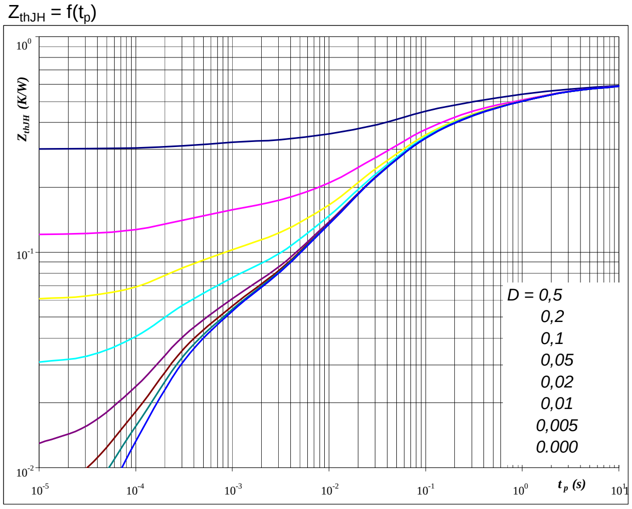
IGBT thermal model values

| R (C/W) | Tau (s) |
|---|---|
| 0,02 | 1,2E+01 |
| 0,10 | 2,6E+00 |
| 0,07 | 4,8E-01 |
| 0,11 | 5,9E-02 |
| 0,05 | 1,3E-02 |
| 0,02 | 4,9E-04 |

**Figure 20** FRED

**FRED transient thermal impedance as a function of pulse width**

$Z_{thJH} = f(t_p)$




At

| | | |
|---|---|---|
| D = | $t_p$ / T | |
| $R_{thJH}$ = | 0,60 | K/W |

FRED thermal model values

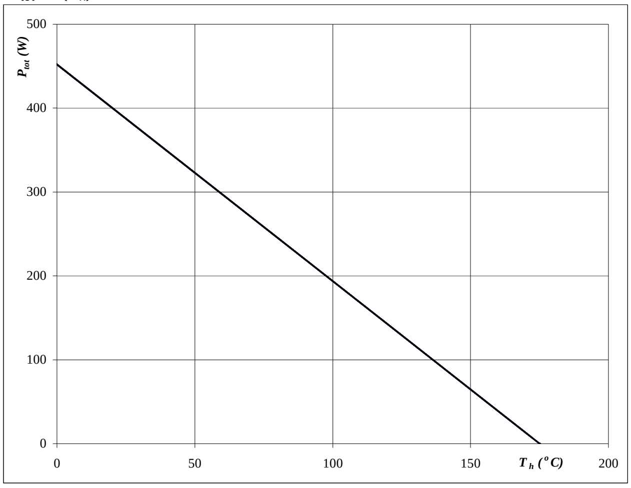
| R (C/W) | Tau (s) |
|---|---|
| 0,04 | 9,1E+00 |
| 0,12 | 1,6E+00 |
| 0,18 | 1,9E-01 |
| 0,19 | 3,1E-02 |
| 0,04 | 3,5E-03 |
| 0,04 | 2,8E-04 |

# Buck

| Figure 21 | IGBT |
|---|---|

**Power dissipation as a function of heatsink temperature**

$P_{tot} = f(T_h)$



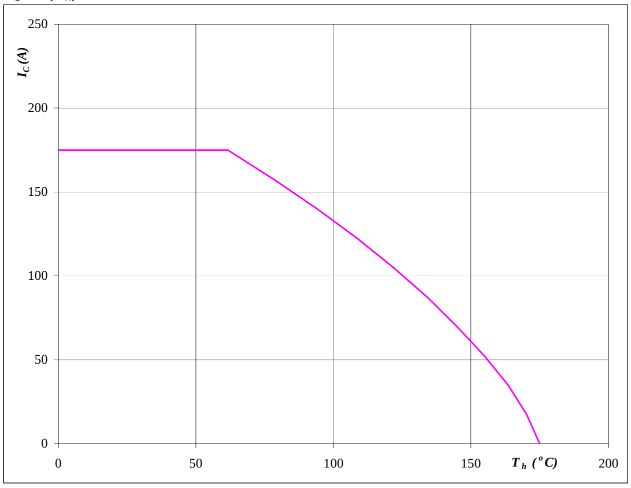

**At**

$T_j$ = 175 ℃

| Figure 22 | IGBT |
|---|---|

**Collector current as a function of heatsink temperature**

$I_C = f(T_h)$




**At**

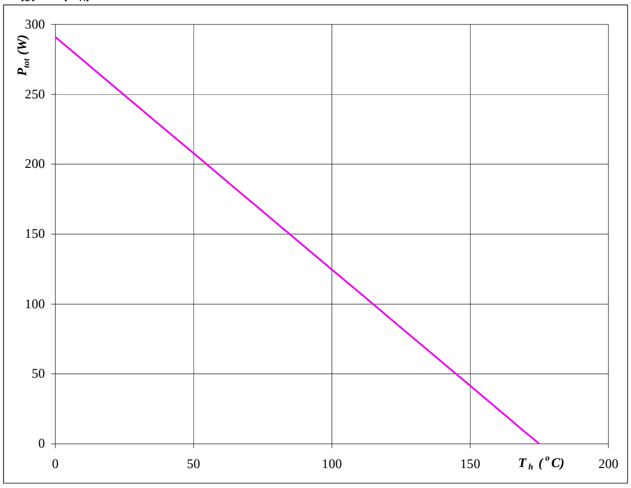
$T_j$ = 175 ℃

$V_{GE}$ = 15 V

| Figure 23 | FRED |
|---|---|

**Power dissipation as a function of heatsink temperature**

$P_{tot} = f(T_h)$



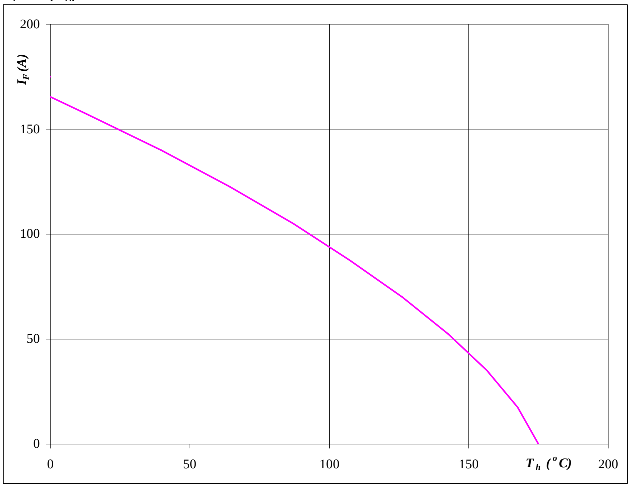

**At**

$T_j$ = 175 ℃

| Figure 24 | FRED |
|---|---|

**Forward current as a function of heatsink temperature**

$I_F = f(T_h)$




**At**

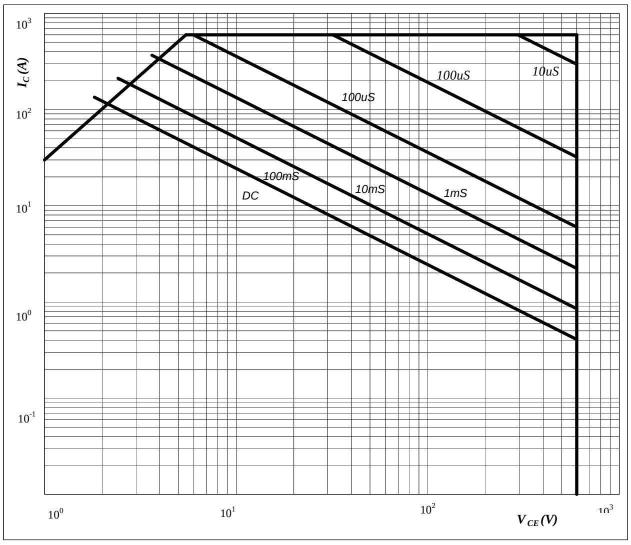
$T_j$ = 175 ℃

# Buck

| Figure 25 | IGBT |
|---|---|

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

$I_C = f(V_{CE})$



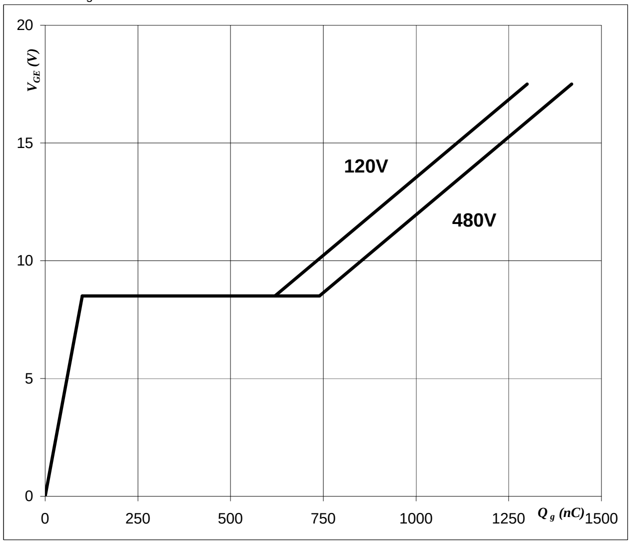

**At**

| | | |
|---|---|---|
| D = | single pulse | |
| Th = | 80 | ºC |
| $V_{GE}$ = | ±15 | V |
| $T_j$ = | $T_{jmax}$ | ºC |

| Figure 26 | IGBT |
|---|---|

**Gate voltage vs Gate charge**

$V_{GE} = f(Q_g)$




**At**

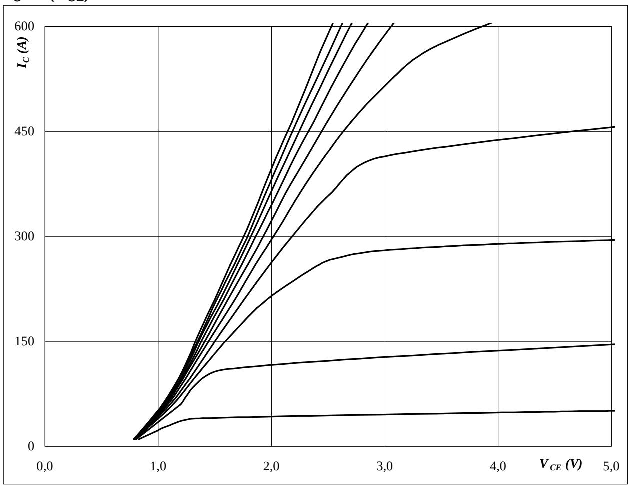
| | | |
|---|---|---|
| $I_C$ = | 200 | A |

# Boost

| **Figure 1** | IGBT |
|---|---|

**Typical output characteristics**

$I_C = f(V_{CE})$



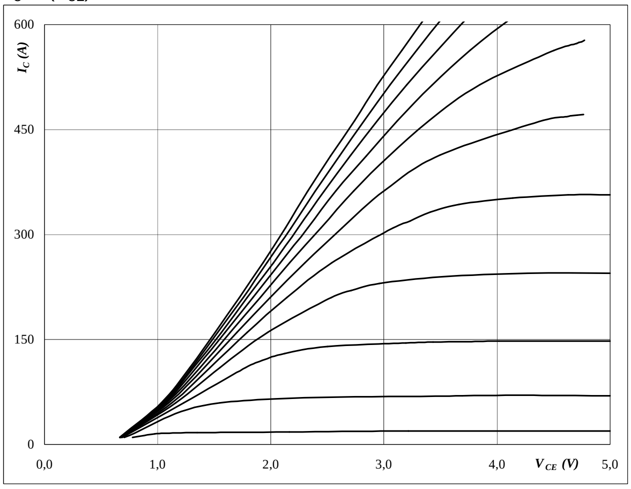

**At**

| | | |
|---|---|---|
| $t_p$ = | 250 | µs |
| $T_j$ = | 25 | °C |
| $V_{GE}$ from | 7 V to 17 V in steps of 1 V | |

| **Figure 2** | IGBT |
|---|---|

**Typical output characteristics**

$I_C = f(V_{CE})$



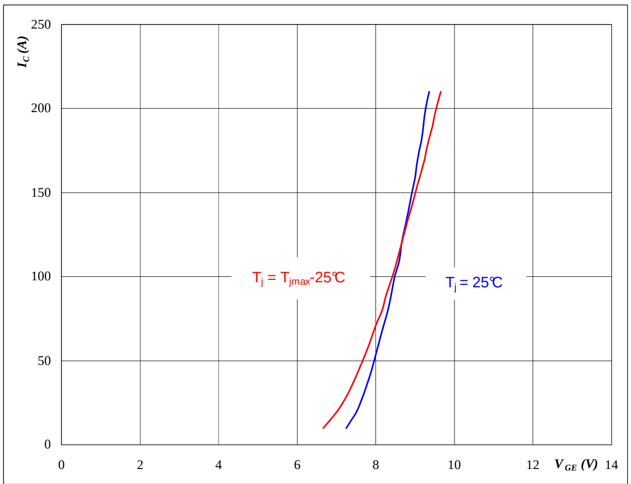

**At**

| | | |
|---|---|---|
| $t_p$ = | 250 | µs |
| $T_j$ = | 125 | °C |
| $V_{GE}$ from | 7 V to 17 V in steps of 1 V | |

| **Figure 3** | IGBT |
|---|---|

**Typical transfer characteristics**

$I_C = f(V_{GE})$



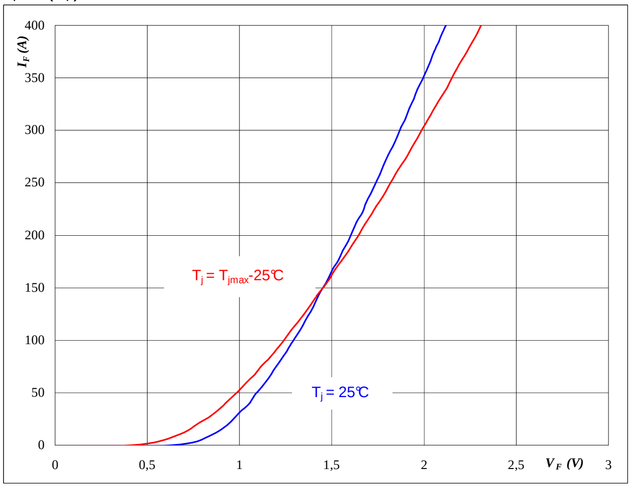

**At**

| | | |
|---|---|---|
| $t_p$ = | 250 | µs |
| $V_{CE}$ = | 10 | V |

| **Figure 4** | FRED |
|---|---|

**Typical diode forward current as a function of forward voltage**

$I_F = f(V_F)$




**At**

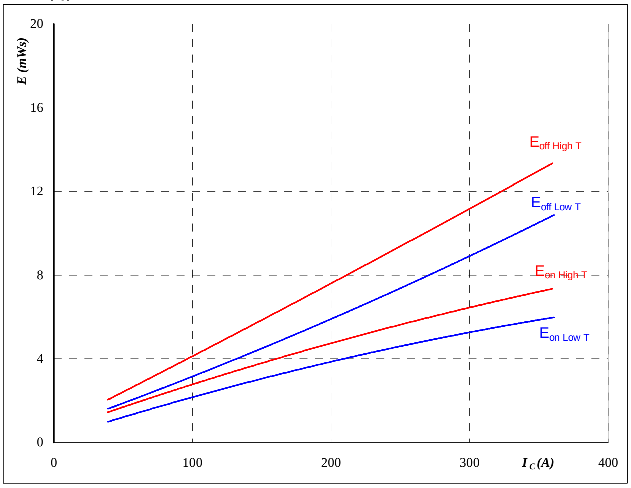
| | | |
|---|---|---|
| $t_p$ = | 250 | µs |

# Boost

**Figure 5** IGBT

**Typical switching energy losses**
**as a function of collector current**

E = f($I_C$)



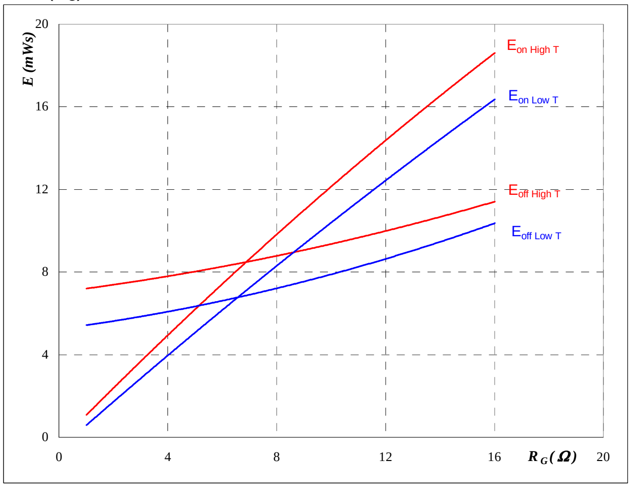

With an inductive load at

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

**Figure 6** IGBT

**Typical switching energy losses**
**as a function of gate resistor**

E = f($R_G$)



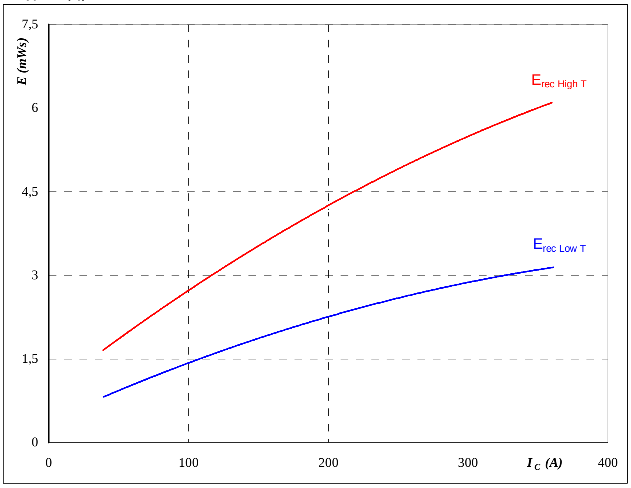

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 201 | A |

**Figure 7** IGBT

**Typical reverse recovery energy loss**
**as a function of collector current**

$E_{rec}$ = f($I_c$)



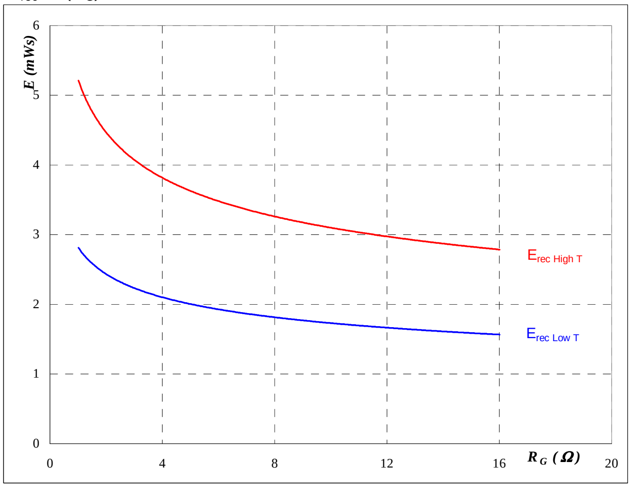

With an inductive load at

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

**Figure 8** IGBT

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

$E_{rec}$ = f($R_G$)




With an inductive load at

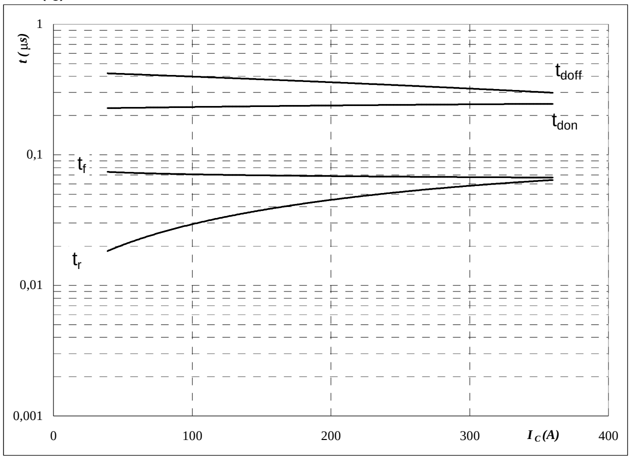
| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 201 | A |

# Boost

**Figure 9** IGBT

**Typical switching times as a function of collector current**

$t = f(I_C)$



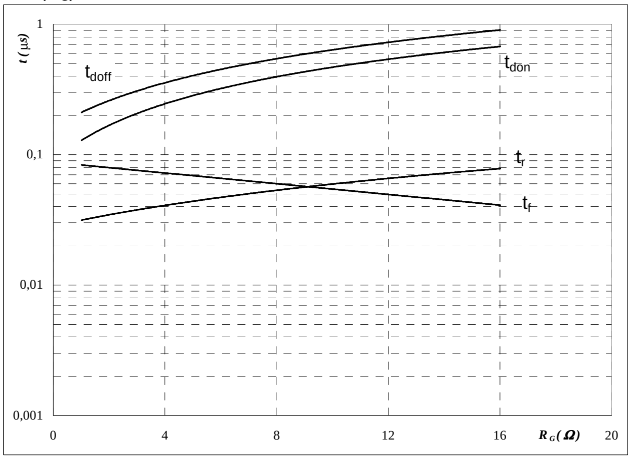

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 125 | °C |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 4 | Ω |
| $R_{goff}$ = | 4 | Ω |

**Figure 10** IGBT

**Typical switching times as a function of gate resistor**

$t = f(R_G)$



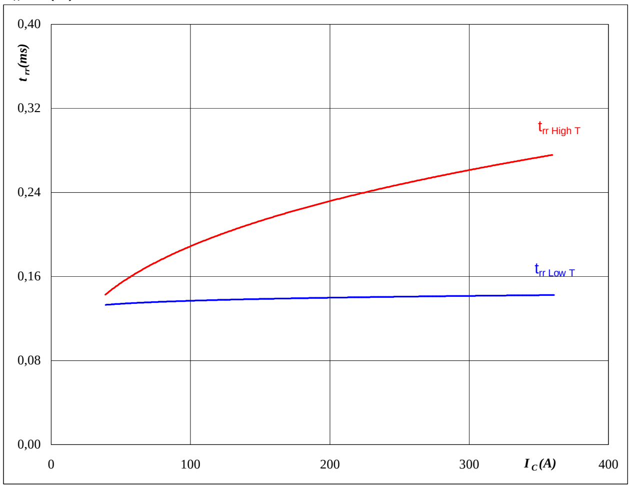

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 125 | °C |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 201 | A |

**Figure 11** FRED

**Typical reverse recovery time as a function of collector current**

$t_{rr} = f(Ic)$



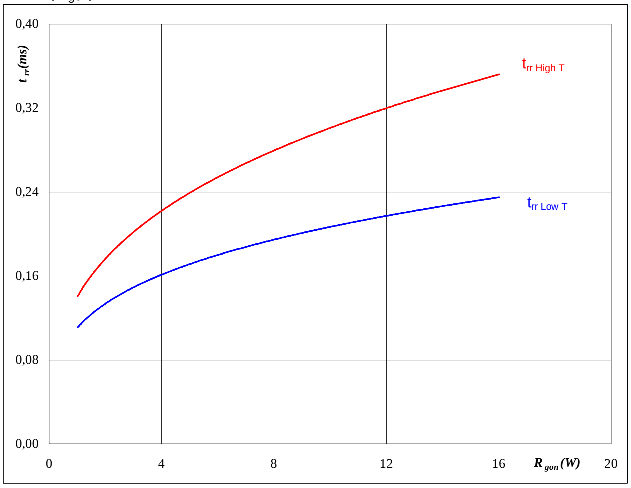

**At**

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

**Figure 12** FRED

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

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




**At**

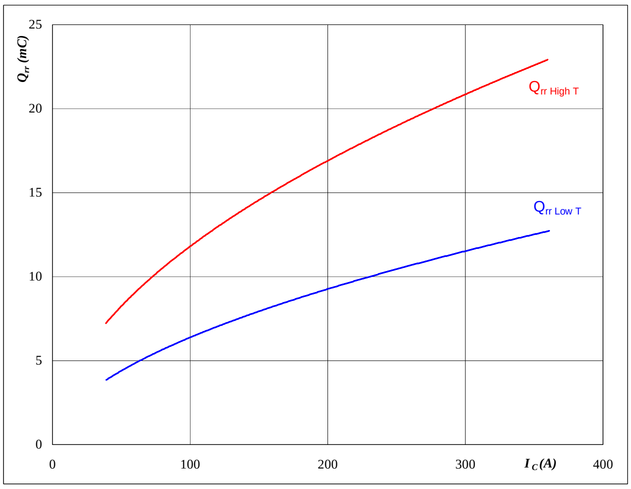
| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_R$ = | 350 | V |
| $I_F$ = | 201 | A |
| $V_{GE}$ = | ±15 | V |

# Boost

**Figure 13** FRED

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

$Q_{rr} = f(I_C)$



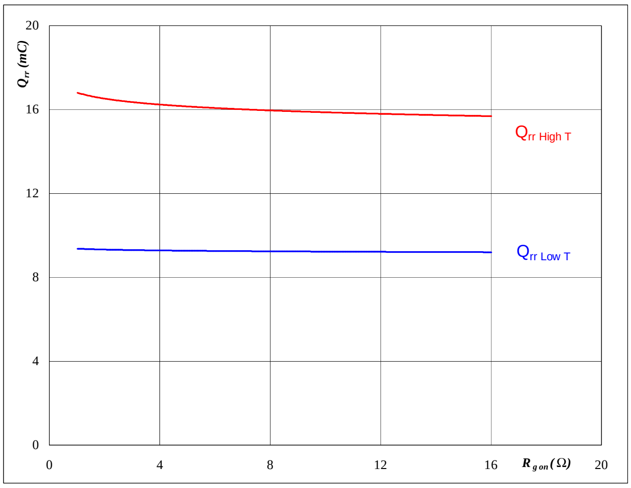

At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | ℃ |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 4 | Ω |

**Figure 14** FRED

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

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



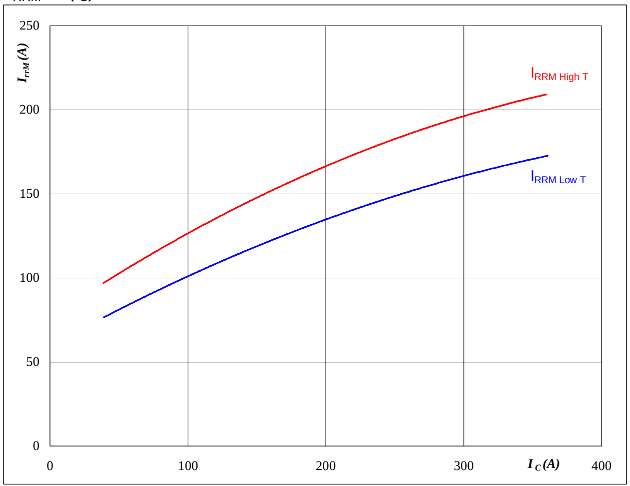

At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | ℃ |
| $V_R$ = | 350 | V |
| $I_F$ = | 201 | A |
| $V_{GE}$ = | ±15 | V |

**Figure 15** FRED

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

$I_{RRM} = f(I_C)$



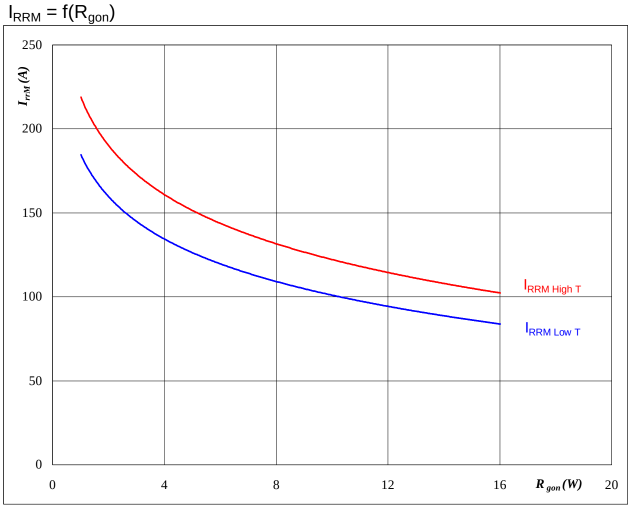

At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | ℃ |
| $V_{CE}$ = | 350 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 4 | Ω |

**Figure 16** FRED

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

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




At

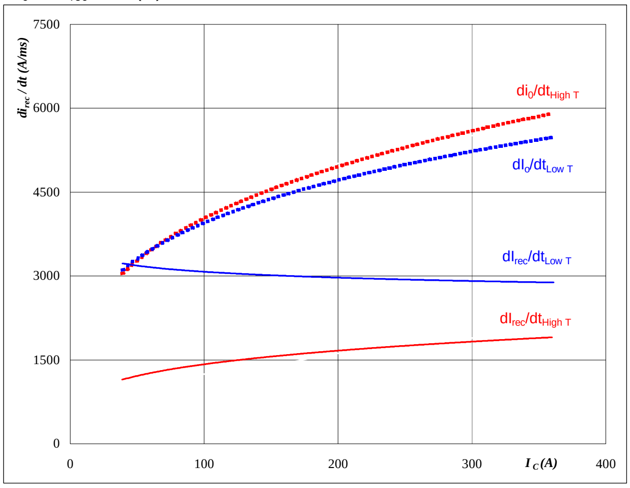
| | | |
|---|---|---|
| $T_j$ = | 25/125 | ℃ |
| $V_R$ = | 350 | V |
| $I_F$ = | 201 | A |
| $V_{GE}$ = | ±15 | V |

# Boost

**Figure 17** FRED

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

$dI_0/dt, dI_{rec}/dt = f(Ic)$



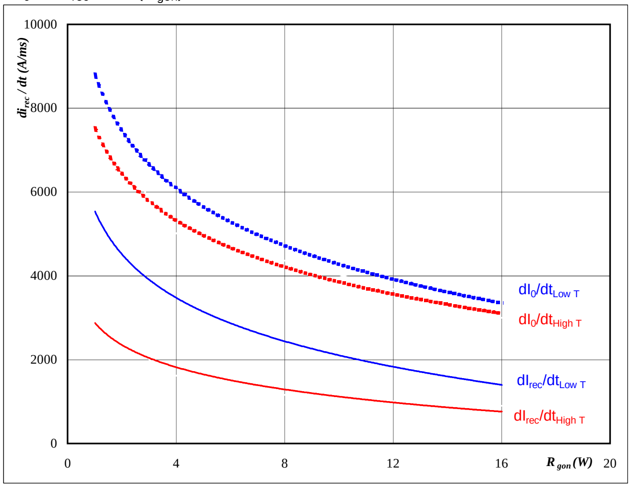

At

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

**Figure 18** FRED

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

$dI_0/dt, dI_{rec}/dt = f(R_{gon})$



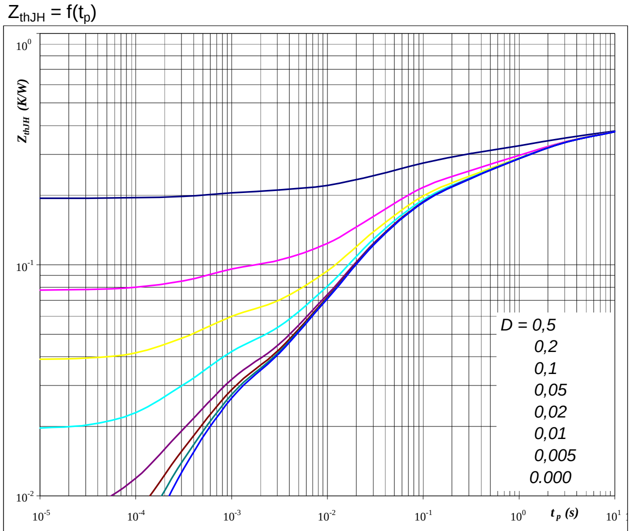

At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_R$ = | 350 | V |
| $I_F$ = | 201 | A |
| $V_{GE}$ = | ±15 | V |

**Figure 19** IGBT

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

$Z_{thJH} = f(t_p)$




At

| | | |
|---|---|---|
| D = | tp / T | |
| $R_{thJH}$ = | 0,39 | K/W |

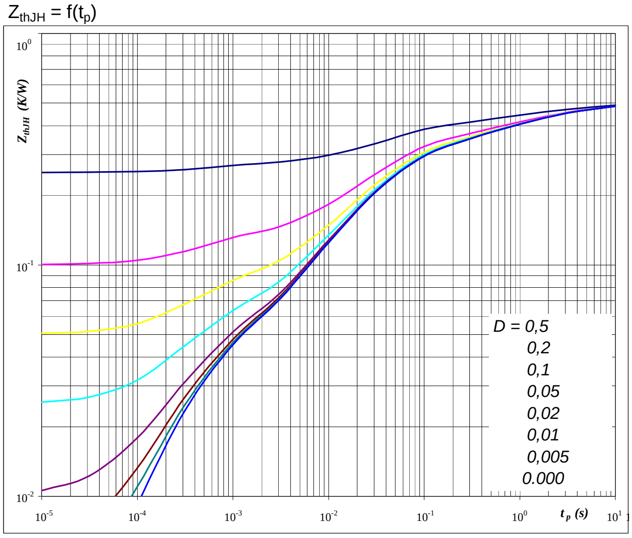
IGBT thermal model values

| R (C/W) | Tau (s) |
|---|---|
| 0,02 | 1,2E+01 |
| 0,10 | 2,6E+00 |
| 0,07 | 4,8E-01 |
| 0,11 | 5,9E-02 |
| 0,05 | 1,3E-02 |
| 0,02 | 4,9E-04 |

**Figure 20** FRED

**FRED transient thermal impedance as a function of pulse width**

$Z_{thJH} = f(t_p)$




At

| | | |
|---|---|---|
| D = | tp / T | |
| $R_{thJH}$ = | 0,50 | K/W |

FRED thermal model values

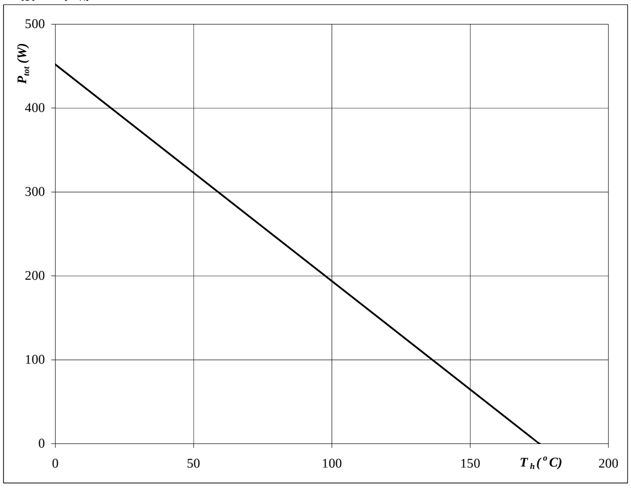
| R (C/W) | Tau (s) |
|---|---|
| 0,04 | 9,6E+00 |
| 0,10 | 1,7E+00 |
| 0,09 | 2,6E-01 |
| 0,18 | 3,6E-02 |
| 0,05 | 7,1E-03 |
| 0,04 | 4,0E-04 |

# Boost

**Figure 21** IGBT

**Power dissipation as a function of heatsink temperature**

$P_{tot} = f(T_h)$



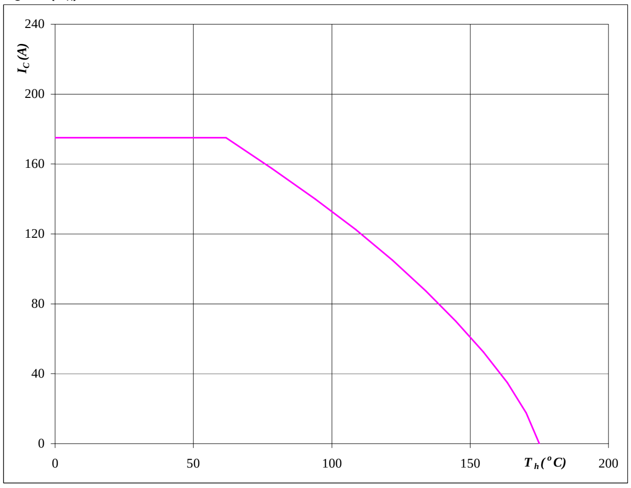

**At**

$T_j$ = 175 ºC

**Figure 22** IGBT

**Collector current as a function of heatsink temperature**

$I_C = f(T_h)$




**At**

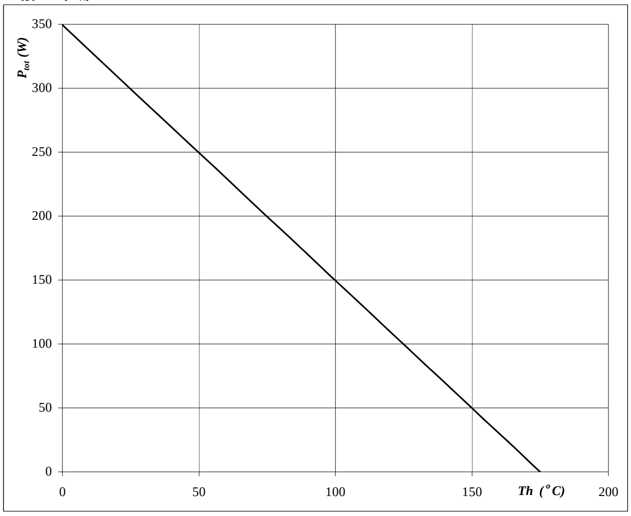
$T_j$ = 175 ºC

$V_{GE}$ = 15 V

**Figure 23** FRED

**Power dissipation as a function of heatsink temperature**

$P_{tot} = f(T_h)$



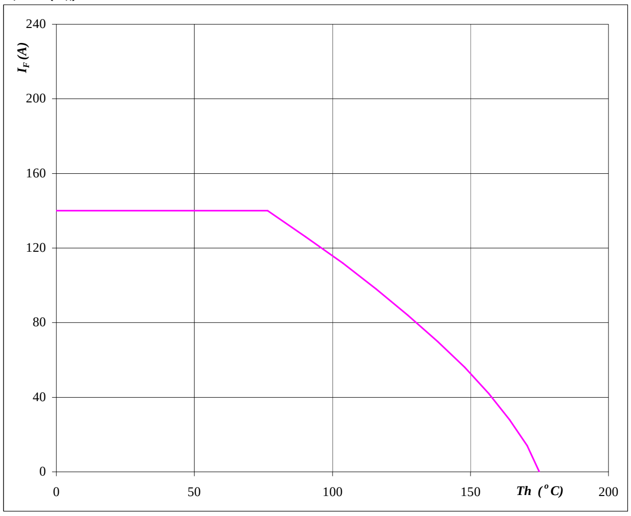

**At**

$T_j$ = 175 ºC

**Figure 24** FRED

**Forward current as a function of heatsink temperature**

$I_F = f(T_h)$




**At**

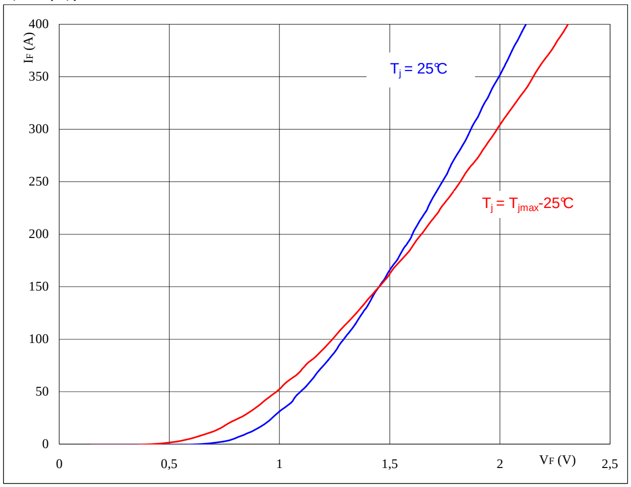
$T_j$ = 175 ºC

# Boost

**Figure 25** Boost Inverse Diode

**Typical diode forward current as a function of forward voltage**

$I_F = f(V_F)$



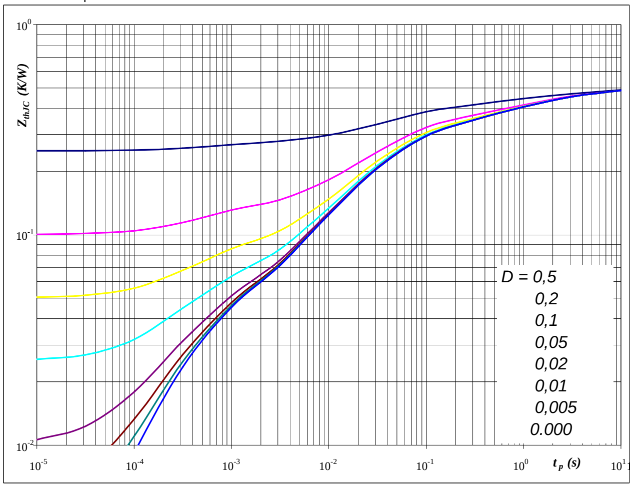

At

$t_p$ = 250 µs

**Figure 26** Boost Inverse Diode

**Diode transient thermal impedance as a function of pulse width**

$Z_{thJH} = f(t_p)$




At

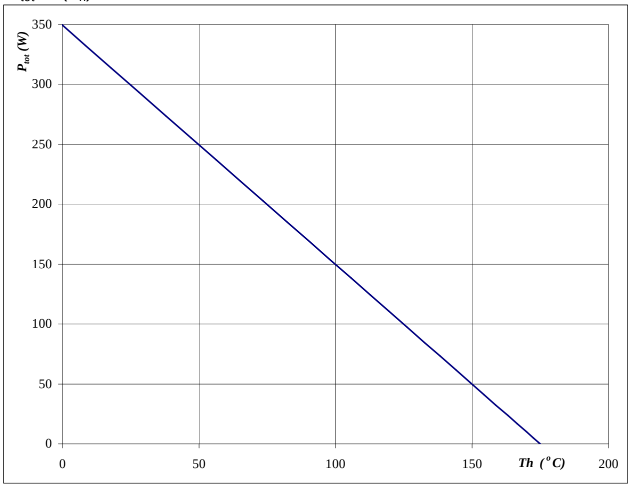
D = tp / T

$R_{thJH}$ = 0,50 K/W

**Figure 27** Boost Inverse Diode

**Power dissipation as a function of heatsink temperature**

$P_{tot} = f(T_h)$



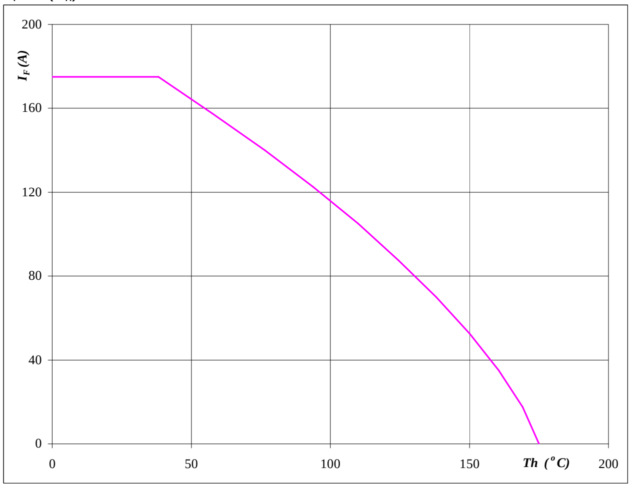

At

$T_j$ = 175 ºC

**Figure 28** Boost Inverse Diode

**Forward current as a function of heatsink temperature**

$I_F = f(T_h)$



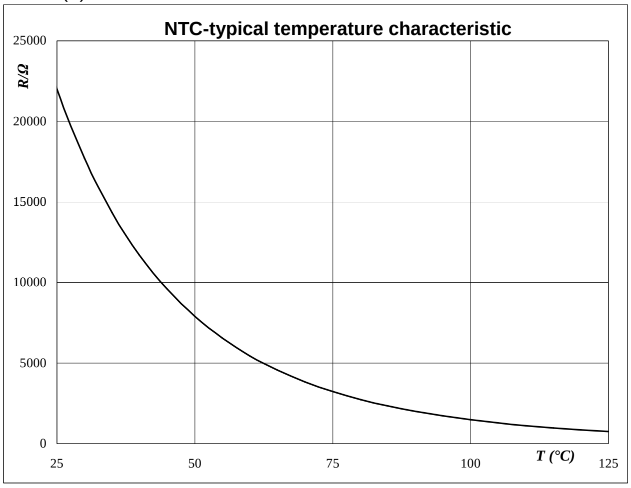

At

$T_j$ = 175 ºC

# Thermistor

| **Figure 1** | Thermistor |
|---|---|

**Typical NTC characteristic**
**as a function of temperature**
$R_T$ = f(T)



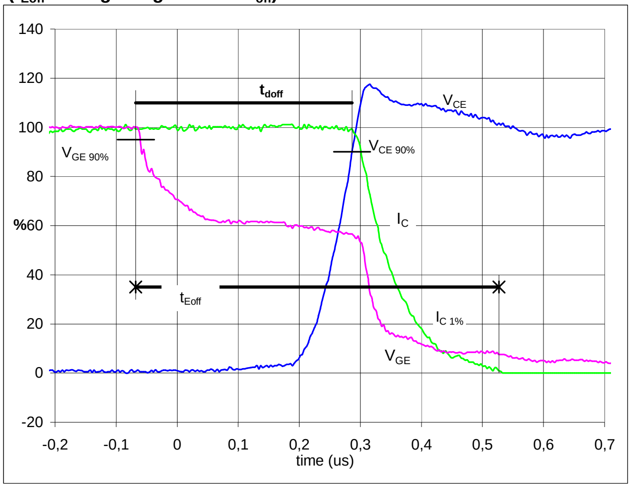
# Switching Definitions BUCK IGBT

**General conditions**

| | | |
|---|---|---|
| **$T_j$** | **=** | **125 °C** |
| **$R_{gon}$** | **=** | **4 Ω** |
| **$R_{goff}$** | **=** | **4 Ω** |

**Figure 1** Output inverter IGBT

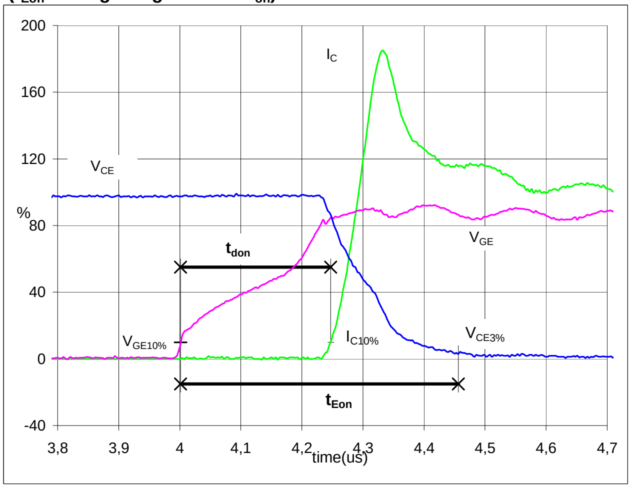
**Turn-off Switching Waveforms & definition of $t_{doff}$, $t_{Eoff}$**
**($t_{Eoff}$ = integrating time for $E_{off}$)**




| | | |
|---|---|---|
| $V_{GE}$ (0%) = | -15 | V |
| $V_{GE}$ (100%) = | 15 | V |
| $V_C$ (100%) = | 700 | V |
| $I_C$ (100%) = | 201 | A |
| $t_{doff}$ = | 0,34 | µs |
| $t_{Eoff}$ = | 0,59 | µs |

**Figure 2** Output inverter IGBT

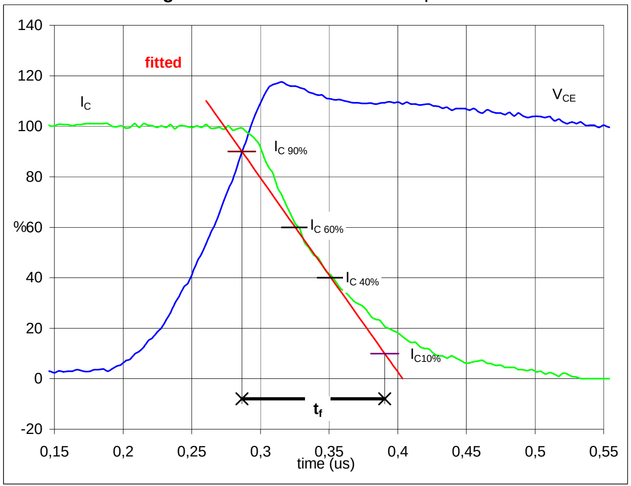
**Turn-on Switching Waveforms & definition of $t_{don}$, $t_{Eon}$**
**($t_{Eon}$ = integrating time for $E_{on}$)**




| | | |
|---|---|---|
| $V_{GE}$ (0%) = | -15 | V |
| $V_{GE}$ (100%) = | 15 | V |
| $V_C$ (100%) = | 700 | V |
| $I_C$ (100%) = | 201 | A |
| $t_{don}$ = | 0,25 | µs |
| $t_{Eon}$ = | 0,45 | µs |

**Figure 3** Output inverter IGBT

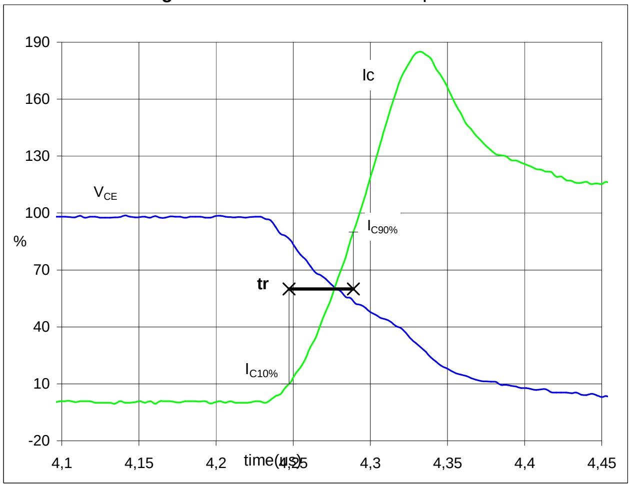
**Turn-off Switching Waveforms & definition of $t_f$**




| | | |
|---|---|---|
| $V_C$ (100%) = | 700 | V |
| $I_C$ (100%) = | 201 | A |
| $t_f$ = | 0,10 | µs |

**Figure 4** Output inverter IGBT

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

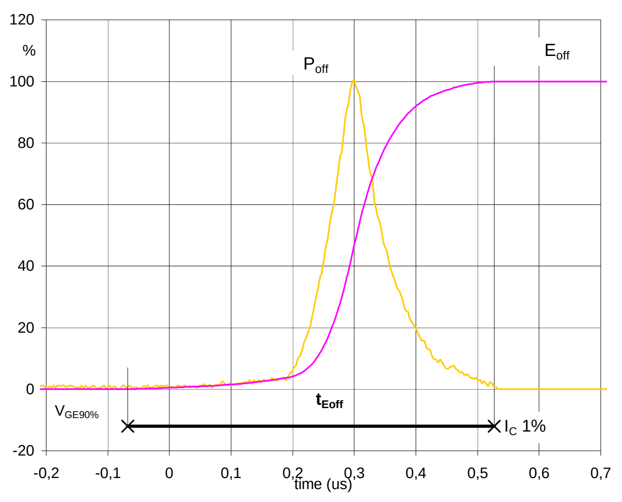



| | | |
|---|---|---|
| $V_C$ (100%) = | 700 | V |
| $I_C$ (100%) = | 201 | A |
| $t_r$ = | 0,04 | µs |

# Switching Definitions BUCK MOSFET

**Figure 5** Output inverter IGBT

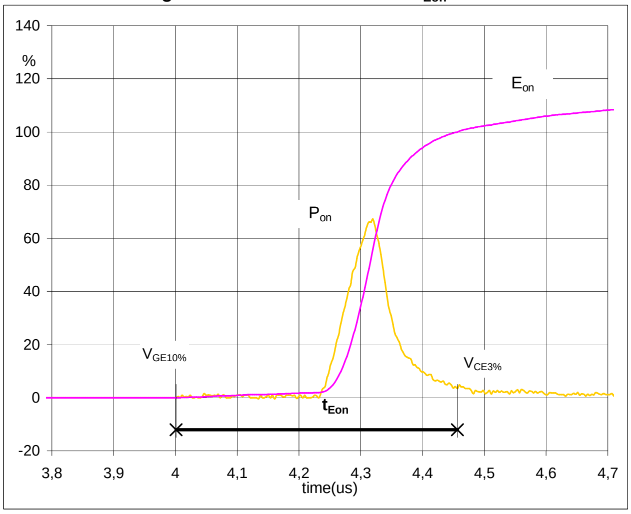
**Turn-off Switching Waveforms & definition of $t_{Eoff}$**




| | | |
|---|---|---|
| $P_{off}$ (100%) = | 140,86 | kW |
| $E_{off}$ (100%) = | 7,89 | mJ |
| $t_{Eoff}$ = | 0,59 | µs |

**Figure 6** Output inverter IGBT

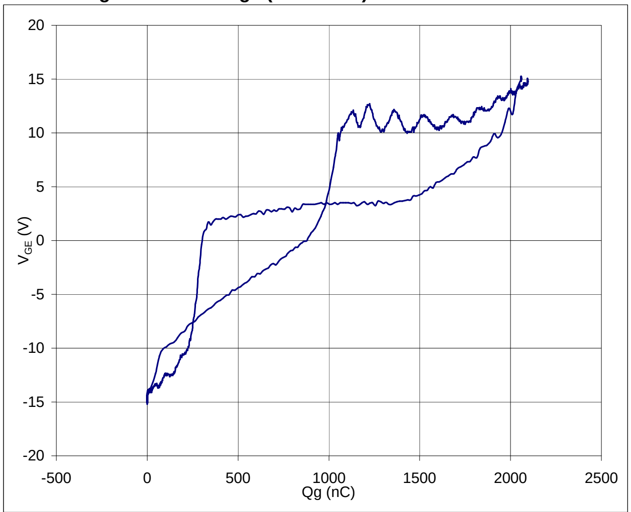
**Turn-on Switching Waveforms & definition of $t_{Eon}$**




| | | |
|---|---|---|
| $P_{on}$ (100%) = | 140,86 | kW |
| $E_{on}$ (100%) = | 4,22 | mJ |
| $t_{Eon}$ = | 0,45 | µs |

**Figure 7** Output inverter FRED

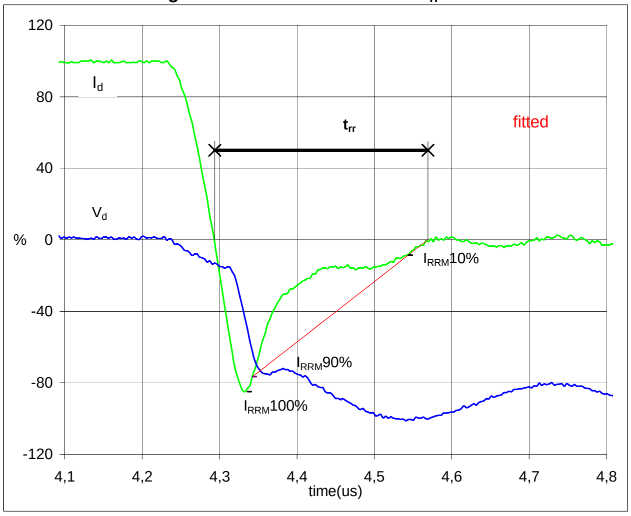
**Gate voltage vs Gate charge (measured)**




| | | |
|---|---|---|
| $V_{GEoff}$ = | -15 | V |
| $V_{GEon}$ = | 15 | V |
| $V_C$ (100%) = | 700 | V |
| $I_C$ (100%) = | 201 | A |
| $Q_g$ = | 2106,06 | nC |

**Figure 8** Output inverter IGBT

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

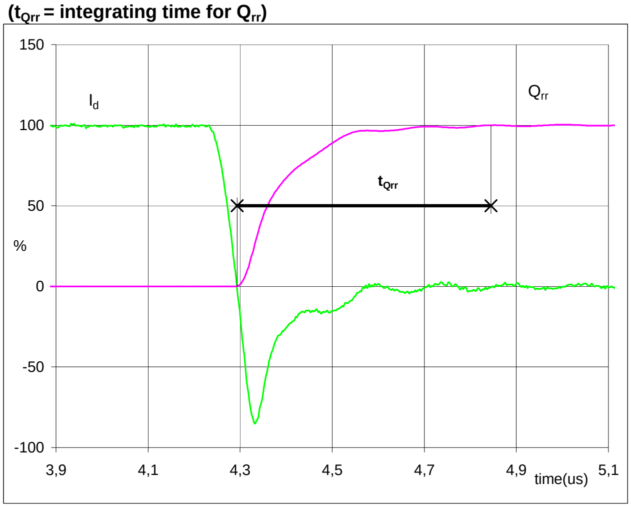



| | | |
|---|---|---|
| $V_d$ (100%) = | 700 | V |
| $I_d$ (100%) = | 201 | A |
| $I_{RRM}$ (100%) = | -172 | A |
| $t_{rr}$ = | 0,27 | µs |

# Switching Definitions BUCK MOSFET

| **Figure 9** | Output inverter FRED |
|---|---|

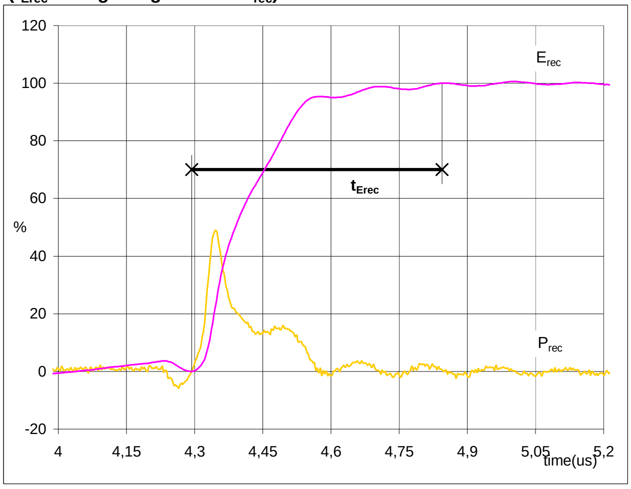
**Turn-on Switching Waveforms & definition of $t_{Qrr}$**
**($t_{Qrr}$ = integrating time for $Q_{rr}$)**




| | | |
|---|---|---|
| $I_d$ (100%) = | 201 | A |
| $Q_{rr}$ (100%) = | 16,20 | µC |
| $t_{Qrr}$ = | 0,55 | µs |

| **Figure 10** | Output inverter FRED |
|---|---|

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




| | | |
|---|---|---|
| $P_{rec}$ (100%) = | 140,86 | kW |
| $E_{rec}$ (100%) = | 3,66 | mJ |
| $t_{Erec}$ = | 0,55 | µs |

# Measurement circuits

**Figure 11**

**BUCK stage switching measurement circuit**

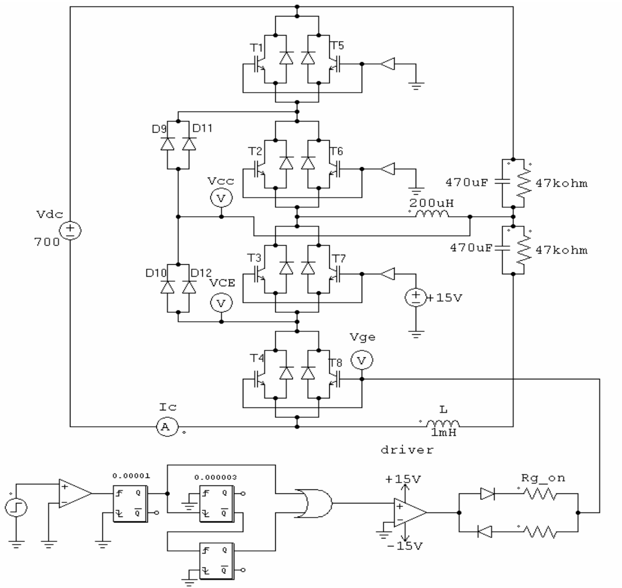
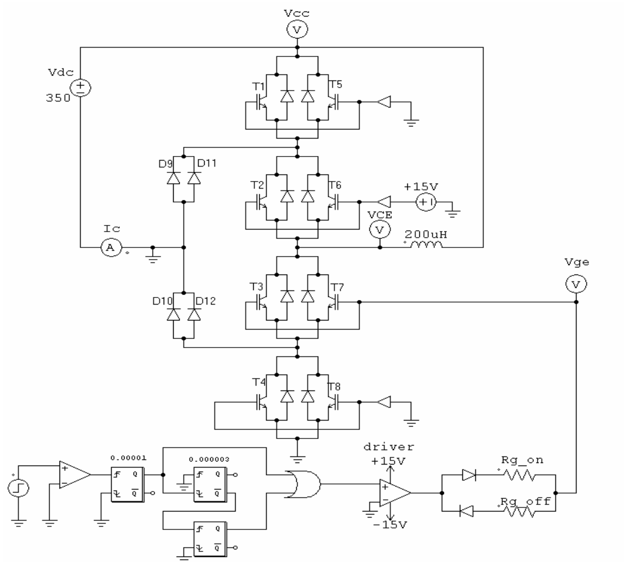



**Figure 12**

**BOOST stage switching measurement circuit**



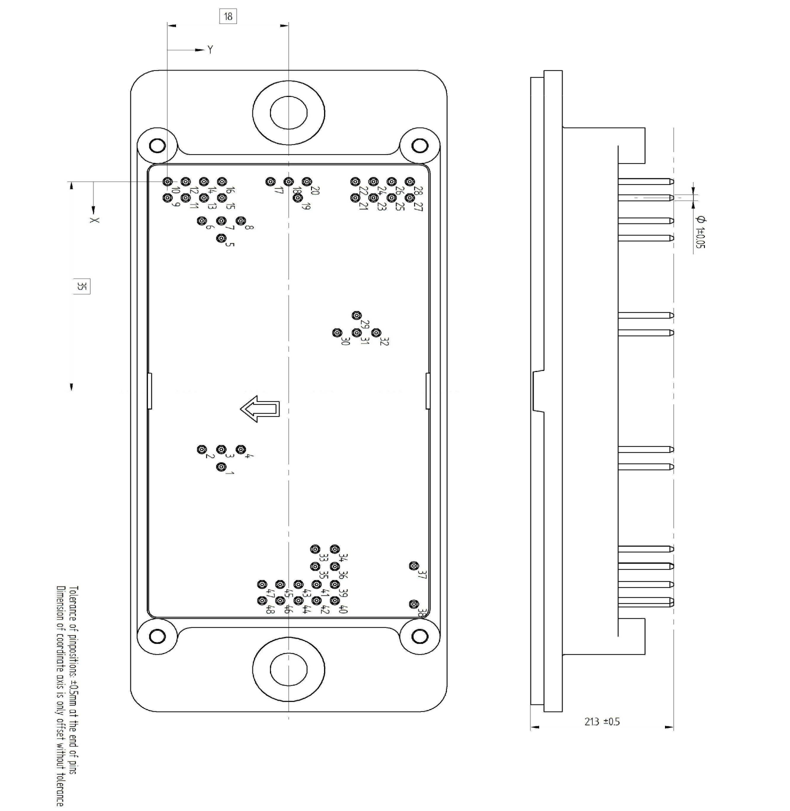
# Ordering Code and Marking - Outline - Pinout

## Ordering Code & Marking

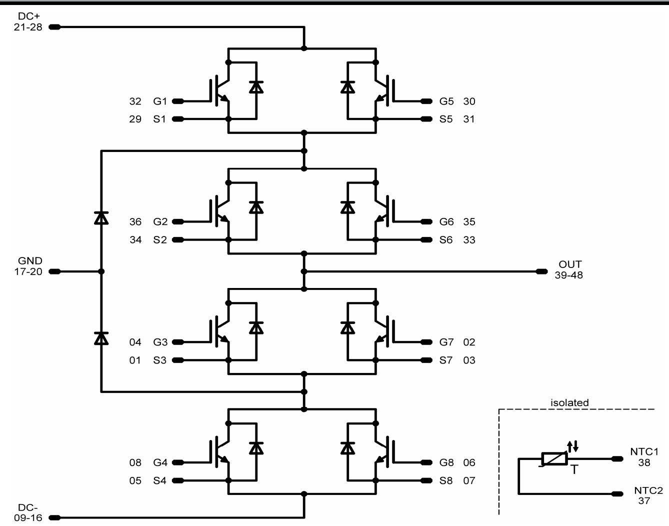
| Version | Ordering Code | in DataMatrix as | in packaging barcode as |
|---|---|---|---|
| Standard in flow2 housing | 30-F206NIA200SA-M105F | M105F | M105F |

## Outline

| Pin table | | | | Pin table | | | |
|---|---|---|---|---|---|---|---|
| Pin | Note 1 | X | Y | Pin | Note 1 | X | Y |
| 1 | S3 | 47,65 | 8 | 25 | DC+ | 2,7 | 33,3 |
| 2 | G7 | 44,75 | 5,1 | 26 | DC+ | 0 | 33,3 |
| 3 | S7 | 44,75 | 8 | 27 | DC+ | 2,7 | 36 |
| 4 | G3 | 44,75 | 10,9 | 28 | DC+ | 0 | 36 |
| 5 | S4 | 9,45 | 8 | 29 | S1 | 22,35 | 28,1 |
| 6 | G8 | 6,55 | 5,1 | 30 | G5 | 25,25 | 25,2 |
| 7 | S8 | 6,55 | 8 | 31 | S5 | 25,25 | 28,1 |
| 8 | G4 | 6,55 | 10,9 | 32 | G1 | 25,25 | 31 |
| 9 | DC- | 2,7 | 0 | 33 | S6 | 61,4 | 21,95 |
| 10 | DC- | 0 | 0 | 34 | S2 | 61,4 | 24,85 |
| 11 | DC- | 2,7 | 2,7 | 35 | G6 | 64,3 | 21,95 |
| 12 | DC- | 0 | 2,7 | 36 | G2 | 64,3 | 24,85 |
| 13 | DC- | 2,7 | 5,4 | 37 | NTC2 | 64,2 | 36,6 |
| 14 | DC- | 0 | 5,4 | 38 | NTC1 | 70,6 | 36,6 |
| 15 | DC- | 2,7 | 8,1 | 39 | OUT | 67,3 | 24,85 |
| 16 | DC- | 0 | 8,1 | 40 | OUT | 70 | 24,85 |
| 17 | GND | 0 | 15,3 | 41 | OUT | 67,3 | 22,15 |
| 18 | GND | 0 | 18 | 42 | OUT | 70 | 22,15 |
| 19 | GND | 2,7 | 19,35 | 43 | OUT | 67,3 | 19,45 |
| 20 | GND | 0 | 20,7 | 44 | OUT | 70 | 19,45 |
| 21 | DC+ | 2,7 | 27,9 | 45 | OUT | 67,3 | 16,75 |
| 22 | DC+ | 0 | 27,9 | 46 | OUT | 70 | 16,75 |
| 23 | DC+ | 2,7 | 30,6 | 47 | OUT | 67,3 | 14,05 |
| 24 | DC+ | 0 | 30,6 | 48 | OUT | 70 | 14,05 |




## Pinout



**PRODUCT STATUS DEFINITIONS**

| Datasheet Status | Product Status | Definition |
|---|---|---|
| Target | Formative or In Design | 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. |
| Preliminary | First Production | 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. |
| Final | Full Production | 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. |

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