Vincotech

# V23990-P848-A58/A59/C58/C59-PM

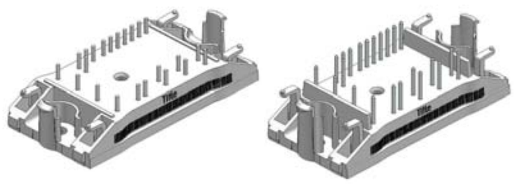
preliminary datasheet

**flowPIM 2 3rd** **1200V/4A**

### Features

- 2 Clips housing in 12 and 17mm height
- Trench Fieldstop Technology IGBT4
- Optional w/o BRC

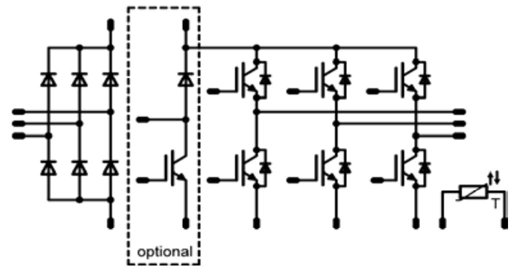
### flow0 Housing



### Target Applications

- Industrial Drives
- Embedded Generation

### Schematics




### Types

- V23990-P848-A58-PM 12mm height
- V23990-P848-A59-PM 17mm height
- V23990-P848-C58-PM 12mm height; w/o BRC
- V23990-P848-C59-PM 17mm height; w/o BRC

## Maximum Ratings

$T_j$=25°C, unless otherwise specified

| Parameter | Symbol | Condition | | Value | Unit |
|---|---|---|---|---|---|
| **Input Rectifier Diode** | | | | | |
| Repetitive peak reverse voltage | $V_{RRM}$ | | | 1600 | V |
| Forward current per diode | $I_{FAV}$ | DC current | $T_h$=80°C<br>$T_c$=80°C | 30 | A |
| Surge forward current | $I_{FSM}$ | $t_p$=10ms | $T_j$=25°C | 370 | A |
| I2t-value | $I^2t$ | | | 680 | $A^2s$ |
| Power dissipation per Diode | $P_{tot}$ | $T_j$=$T_j$max | $T_h$=80°C<br>$T_c$=80°C | 42 | W |
| Maximum Junction Temperature | $T_j$max | | | 150 | °C |
| **Inverter Transistor** | | | | | |
| Collector-emitter break down voltage | $V_{CE}$ | | | 1200 | V |
| DC collector current | $I_C$ | $T_j$=$T_j$max | $T_h$=80°C<br>$T_c$=80°C | 9 | A |
| Repetitive peak collector current | $I_{Cpulse}$ | $t_p$ limited by $T_j$max | $T_h$=80°C<br>$T_c$=80°C | 12 | A |
| Power dissipation per IGBT | $P_{tot}$ | $T_j$=$T_j$max | $T_h$=80°C<br>$T_c$=80°C | 38 | W |
| Gate-emitter peak voltage | $V_{GE}$ | | | ±20 | V |
| Short circuit ratings | $t_{SC}$<br>$V_{CC}$ | $T_j$≤150°C<br>$V_{GE}$=15V | | 10<br>800 | µs<br>V |
| Maximum Junction Temperature | $T_j$max | | | 175 | °C |

# Maximum Ratings

Tj=25℃, unless otherwise specified

| Parameter | Symbol | Condition | | Value | Unit |
|---|---|---|---|---|---|
| **Inverter Diode** | | | | | |
| Peak Repetitive Reverse Voltage | $V_{RRM}$ | $T_j$=25℃ | | 1200 | V |
| DC forward current | $I_F$ | $T_j$=$T_j$max | $T_h$=80℃<br>$T_c$=80℃ | 10 | A |
| Repetitive peak forward current | $I_{FRM}$ | $t_p$ limited by $T_j$max | $T_h$=80℃<br>$T_c$=80℃ | 32 | A |
| Power dissipation per Diode | $P_{tot}$ | $T_j$=$T_j$max | $T_h$=80℃<br>$T_c$=80℃ | 37 | W |
| Maximum Junction Temperature | $T_j$max | | | 175 | ℃ |
| **Brc Transistor** | | | | | |
| Collector-emitter break down voltage | $V_{CE}$ | | | 1200 | V |
| DC collector current | $I_C$ | $T_j$=$T_j$max | $T_h$=80℃<br>$T_c$=80℃ | 8 | A |
| Repetitive peak collector current | $I_{Cpuls}$ | $t_p$=1ms | $T_h$=80℃ | 12 | A |
| Power dissipation per IGBT | $P_{tot}$ | $T_j$=$T_j$max | $T_h$=80℃<br>$T_c$=80℃ | 32 | W |
| Gate-emitter peak voltage | $V_{GE}$ | | | ±20 | V |
| Short circuit ratings | $t_{SC}$<br>$V_{CC}$ | $T_j$≤150℃<br>$V_{GE}$=15V | | 10<br>800 | µs<br>V |
| Maximum Junction Temperature | $T_j$max | | | 175 | ℃ |
| **Brc. Diode** | | | | | |
| Peak Repetitive Reverse Voltage | $V_{RRM}$ | $T_j$=25℃ | | 1200 | V |
| DC forward current | $I_F$ | $T_j$=$T_j$max | $T_h$=80℃<br>$T_c$=80℃ | 7 | A |
| Repetitive peak forward current | $I_{FRM}$ | $t_p$=1ms | $T_h$=80℃<br>$T_c$=80℃ | 6 | A |
| Power dissipation per Diode | $P_{tot}$ | $T_j$=$T_j$max | $T_h$=80℃<br>$T_c$=80℃ | 18 | W |
| Maximum Junction Temperature | $T_j$max | | | 150 | ℃ |
| **Thermal Properties** | | | | | |
| Storage temperature | $T_{stg}$ | | | -40…+125 | ℃ |
| Operation temperature under switching condition | $T_{op}$ | | | -40…+125 | ℃ |
| **Insulation Properties** | | | | | |
| Insulation voltage | $V_{is}$ | t=2s | | 4000 | $V_{DC}$ |
| Creepage distance | | | | min 12,7 | mm |
| Clearance | | | | min 12,7 | mm |

## Characteristic Values

| Parameter | Symbol | Conditions | | | | | Value | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $V_{GE}$ [V] or<br>$V_{GS}$ [V] | $V_r$ [V] or<br>$V_{CE}$ [V] or<br>$V_{DS}$ [V] | $I_C$ [A] or<br>$I_F$ [A] or<br>$I_D$ [A] | $T_j$ | Min | Typ | Max | |
| **Input Rectifier Diode** | | | | | | | | | | |
| Forward voltage | $V_F$ | | | | 30 | Tj=25°C<br>Tj=125°C | 1 | 1,15<br>1,11 | 1,6 | V |
| Threshold voltage (for power loss calc. only) | $V_{to}$ | | | | 30 | Tj=25°C<br>Tj=125°C | | 0,91<br>0,77 | | V |
| Slope resistance (for power loss calc. only) | $r_t$ | | | | | Tj=25°C<br>Tj=125°C | | 0,008<br>0,011 | | Ω |
| Reverse current | $I_r$ | | | 1600 | | Tj=25°C<br>Tj=150°C | | | 0,1 | mA |
| Thermal resistance chip to heatsink per chip | $R_{thJH}$ | Thermal grease thickness≤50um<br>λ = 1 W/mK | | | | | | 1,66 | | K/W |
| **Inverter Transistor** | | | | | | | | | | |
| Gate emitter threshold voltage | $V_{GE(th)}$ | VCE=VGE | | | 0,00015 | Tj=25°C<br>Tj=125°C | 5 | 5,8 | 6,5 | V |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ | | 15 | | 4 | Tj=25°C<br>Tj=125°C | | 1,95<br>2,28 | | V |
| Collector-emitter cut-off current incl. Diode | $I_{CES}$ | | 0 | 1200 | | Tj=25°C<br>Tj=125°C | | | 0,05 | mA |
| Gate-emitter leakage current | $I_{GES}$ | | 20 | 0 | | Tj=25°C<br>Tj=125°C | | | 200 | nA |
| Integrated Gate resistor | $R_{gint}$ | | | | | | | none | | Ω |
| Turn-on delay time | $t_{d(on)}$ | Rgon=64Ohm<br>Rgoff=64Ohm | 15 | 600 | 4 | Tj=25°C<br>Tj=125°C | | 77<br>75 | | ns |
| Rise time | $t_r$ | | | | | Tj=25°C<br>Tj=125°C | | 18<br>23 | | |
| Turn-off delay time | $t_{d(off)}$ | | | | | Tj=25°C<br>Tj=125°C | | 176<br>226 | | |
| Fall time | $t_f$ | | | | | Tj=25°C<br>Tj=125°C | | 83<br>110 | | |
| Turn-on energy loss per pulse | $E_{on}$ | | | | | Tj=25°C<br>Tj=125°C | | 0,32<br>0,56 | | mWs |
| Turn-off energy loss per pulse | $E_{off}$ | | | | | Tj=25°C<br>Tj=125°C | | 0,21<br>0,31 | | |
| Input capacitance | $C_{ies}$ | f=1MHz | 0 | 25 | | Tj=25°C | | 250 | | pF |
| Output capacitance | $C_{oss}$ | | | | | | | 25 | | |
| Reverse transfer capacitance | $C_{rss}$ | | | | | | | 15 | | |
| Gate charge | $Q_{Gate}$ | | 15 | 960 | 4 | Tj=25°C | | 25 | | nC |
| Thermal resistance chip to heatsink per chip | $R_{thJH}$ | Thermal grease thickness≤50um<br>λ = 1 W/mK | | | | | | 2,51 | | K/W |
| **Inverter Diode** | | | | | | | | | | |
| Diode forward voltage | $V_F$ | | | | 10 | Tj=25°C<br>Tj=125°C | 1,35 | 1,41<br>1,25 | 2,2 | V |
| Peak reverse recovery current | $I_{RRM}$ | Rgon=32Ohm | 15 | 600 | 10 | Tj=25°C<br>Tj=125°C | | 5,2<br>6,4 | | A |
| Reverse recovery time | $t_{rr}$ | | | | | Tj=25°C<br>Tj=125°C | | 248<br>431 | | ns |
| Reverse recovered charge | $Q_{rr}$ | | | | | Tj=25°C<br>Tj=125°C | | 0,58<br>1,24 | | uC |
| Peak rate of fall of recovery current | di(rec)max /dt | | | | | Tj=25°C<br>Tj=125°C | | 95<br>49 | | A/µs |
| Reverse recovered energy | Erec | | | | | Tj=25°C<br>Tj=125°C | | 0,21<br>0,47 | | mWs |
| Thermal resistance chip to heatsink per chip | $R_{thJH}$ | Thermal grease thickness≤50um<br>λ = 1 W/mK | | | | | | 2,56 | | K/W |

## Characteristic Values

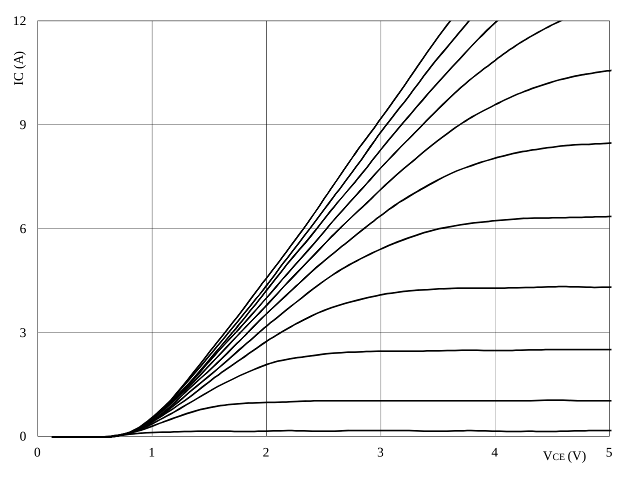
| Parameter | Symbol | Conditions | | | | | Value | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $V_{GE}$ [V] or $V_{GS}$ [V] | $V_r$ [V] or $V_{CE}$ [V] or $V_{DS}$ [V] | $I_C$ [A] or $I_F$ [A] or $I_D$ [A] | $T_j$ | Min | Typ | Max | |
| **Brc Transistor** | | | | | | | | | | |
| Gate emitter threshold voltage | $V_{GE(th)}$ | VCE=VGE | | | 0,00015 | Tj=25℃<br>Tj=125℃ | 5 | 5,8 | 6,5 | V |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ | | 15 | | 4 | Tj=25℃<br>Tj=125℃ | | 1,96<br>2,27 | | V |
| Collector-emitter cut-off incl diode | $I_{CES}$ | | 0 | 1200 | | Tj=25℃<br>Tj=125℃ | | | 0,05 | mA |
| Gate-emitter leakage current | $I_{GES}$ | | 20 | 0 | | Tj=25℃<br>Tj=125℃ | | | 200 | nA |
| Integrated Gate resistor | $R_{gint}$ | | | | | | | none | | Ω |
| Turn-on delay time | $t_{d(on)}$ | Rgon=64Ohm<br>Rgoff=64Ohm | 15 | 600 | 4 | Tj=25℃<br>Tj=125℃ | | 78<br>75 | | ns |
| Rise time | $t_r$ | | | | | Tj=25℃<br>Tj=125℃ | | 18<br>24 | | |
| Turn-off delay time | $t_{d(off)}$ | | | | | Tj=25℃<br>Tj=125℃ | | 170<br>217 | | |
| Fall time | $t_f$ | | | | | Tj=25℃<br>Tj=125℃ | | 81<br>103 | | |
| Turn-on energy loss per pulse | $E_{on}$ | | | | | Tj=25℃<br>Tj=125℃ | | 0,24<br>0,36 | | mWs |
| Turn-off energy loss per pulse | $E_{off}$ | | | | | Tj=25℃<br>Tj=125℃ | | 0,22<br>0,33 | | |
| Input capacitance | $C_{ies}$ | f=1MHz | 0 | 25 | | Tj=25℃ | | 250 | | pF |
| Output capacitance | $C_{oss}$ | | | | | | | 25 | | |
| Reverse transfer capacitance | $C_{rss}$ | | | | | | | 15 | | |
| Gate charge | $Q_{Gate}$ | | 15 | 960 | 4 | Tj=25℃ | | 25 | | nC |
| Thermal resistance chip to heatsink per chip | $R_{thJH}$ | Thermal grease thickness≤50um λ = 1 W/mK | | | | | | 2,93 | | K/W |
| **Brc. Diode** | | | | | | | | | | |
| Diode forward voltage | $V_F$ | | | | 4 | Tj=25℃<br>Tj=125℃ | 1 | 1,88<br>1,79 | 2,35 | V |
| Reverse leakage current | $I_r$ | | 15 | 600 | 4 | Tj=25℃<br>Tj=125℃ | | | 250 | μA |
| Peak reverse recovery current | $I_{RRM}$ | Rgon=64Ohm<br>Rgon=64Ohm | 15 | 600 | 4 | Tj=25℃<br>Tj=125℃ | | 4,0<br>4,5 | | A |
| Reverse recovery time | $t_{rr}$ | | | | | Tj=25℃<br>Tj=125℃ | | 276<br>485 | | ns |
| Reverse recovered charge | $Q_{rr}$ | | | | | Tj=25℃<br>Tj=125℃ | | 0,43<br>0,87 | | uC |
| Peak rate of fall of recovery current | di(rec)max /dt | | | | | Tj=25℃<br>Tj=125℃ | | 37<br>31 | | A/μs |
| Reverse recovery energy | $E_{rec}$ | | | | | Tj=25℃<br>Tj=125℃ | | 0,43<br>0,87 | | mWs |
| Thermal resistance chip to heatsink per chip | $R_{thJH}$ | Thermal grease thickness≤50um λ = 1 W/mK | | | | | | 3,86 | | K/W |
| **Thermistor** | | | | | | | | | | |
| Rated resistance | $R_{25}$ | Tol. ±13% | | | | Tj=25℃ | 19,1 | 22 | 24,9 | k Ω |
| | $R_{100}$ | Tol. ±5% | | | | Tj=100℃ | 1411 | 1486 | 1560 | k Ω |
| Power dissipation given Epcos-Typ | P | | | | | Tj=25℃ | | 210 | | mW |
| B-value | $B_{(25/100)}$ | Tol. ±3% | | | | Tj=25℃ | | 4000 | | K |

# Output Inverter

**Figure 1** Output inverter IGBT

**Typical output characteristics**

$I_C = f(V_{CE})$




**At**

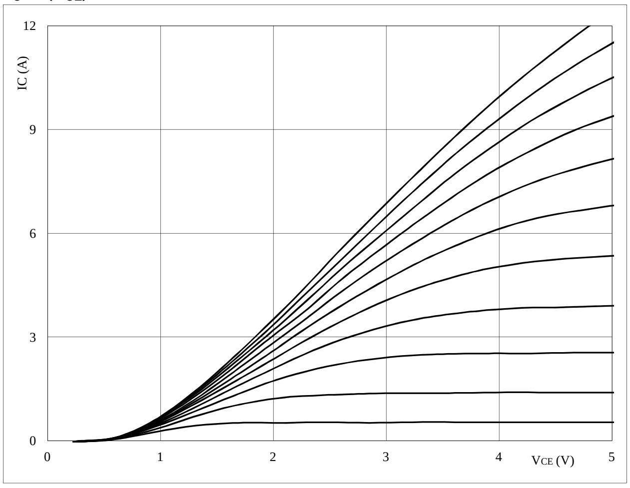
| | | |
|---|---|---|
| $t_p$ = | 250 | µs |
| $T_j$ = | 25 | °C |

VGE from 7 V to 17 V in steps of 1 V

**Figure 2** Output inverter IGBT

**Typical output characteristics**

$I_C = f(V_{CE})$




**At**

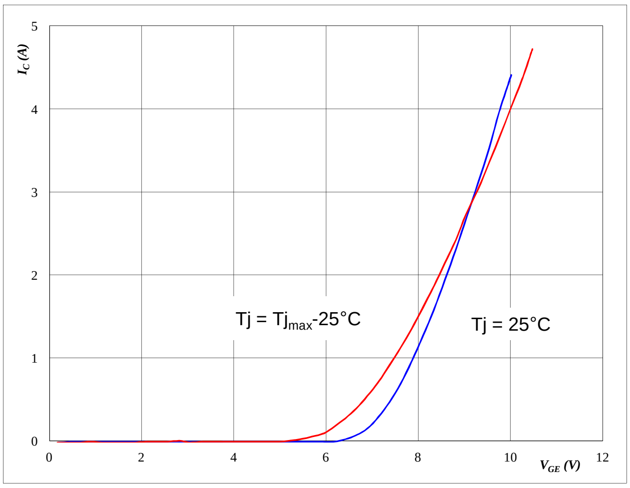
| | | |
|---|---|---|
| $t_p$ = | 250 | µs |
| $T_j$ = | 150 | °C |

VGE from 7 V to 17 V in steps of 1 V

**Figure 3** Output inverter IGBT

**Typical transfer characteristics**

$I_c = f(V_{GE})$



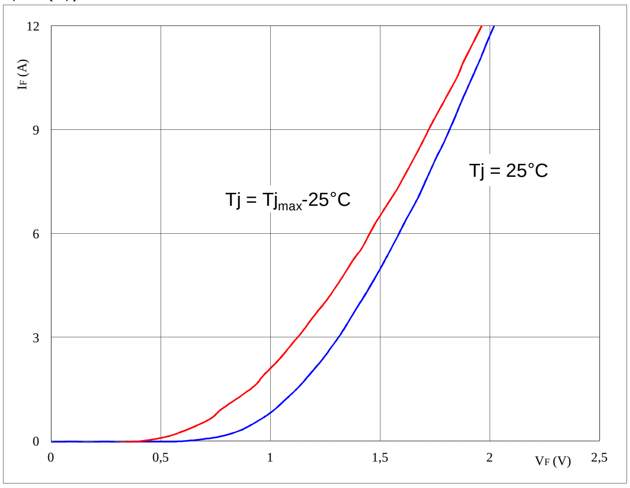

**At**

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

**Figure 4** Output inverter FRED

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

$I_F = f(V_F)$




**At**

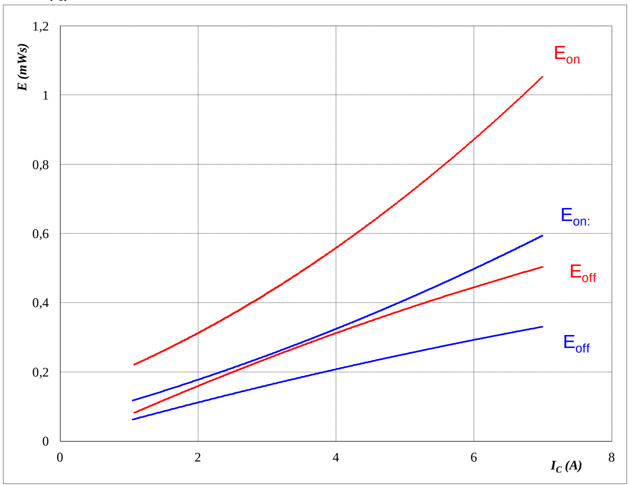
| | | |
|---|---|---|
| $t_p$ = | 250 | µs |

# Output Inverter

**Figure 5** Output inverter IGBT

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

$E = f(I_c)$



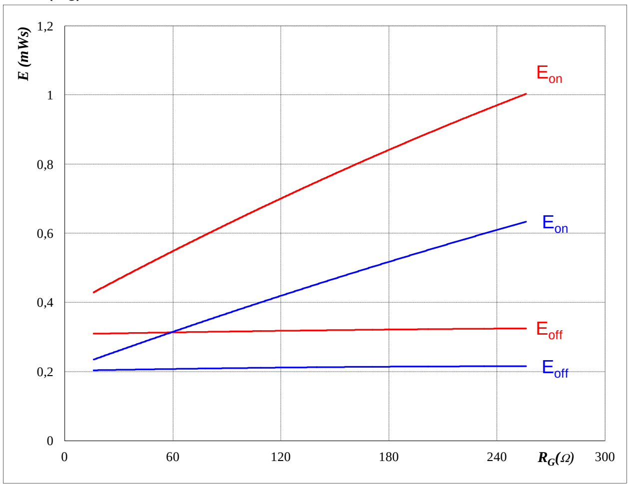

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/150 | ℃ |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 64 | Ω |
| $R_{goff}$ = | 64 | Ω |

**Figure 6** Output inverter IGBT

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

$E = f(R_G)$



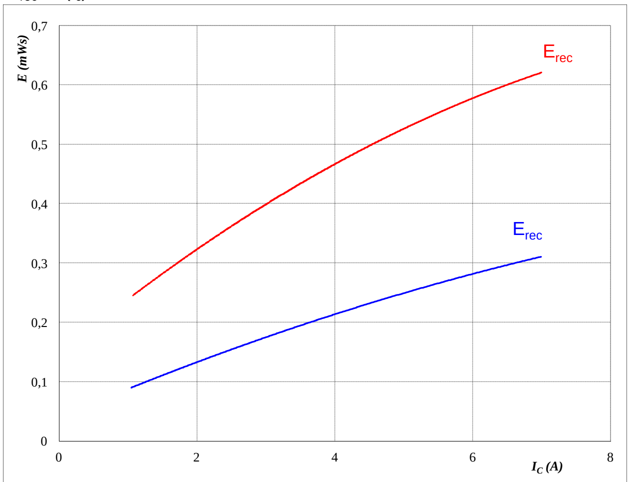

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/150 | ℃ |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 4 | A |

**Figure 7** Output inverter IGBT

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

$E_{rec} = f(I_c)$



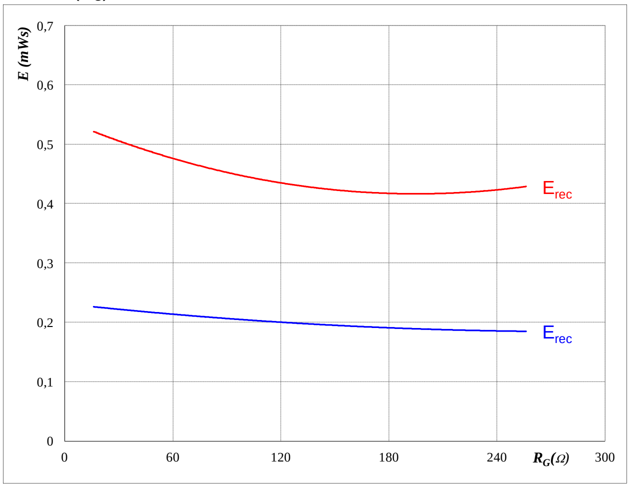

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/150 | ℃ |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 64 | Ω |

**Figure 8** Output inverter IGBT

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

$Erec = f(R_G)$




With an inductive load at

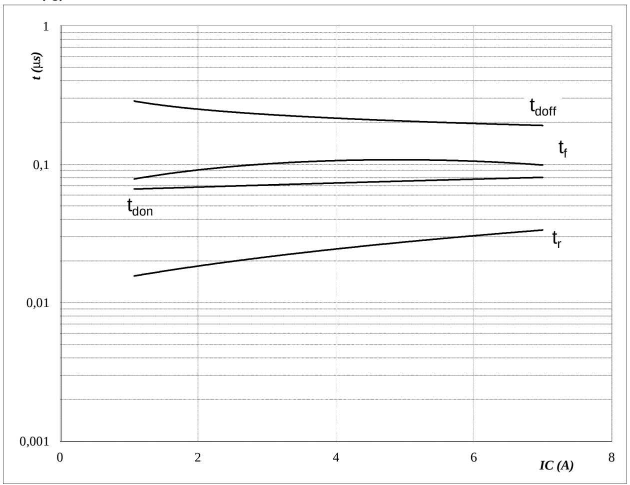
| | | |
|---|---|---|
| $T_j$ = | 25/150 | ℃ |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 4 | A |

# Output Inverter

**Figure 9** Output inverter IGBT

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

t = f($I_C$)



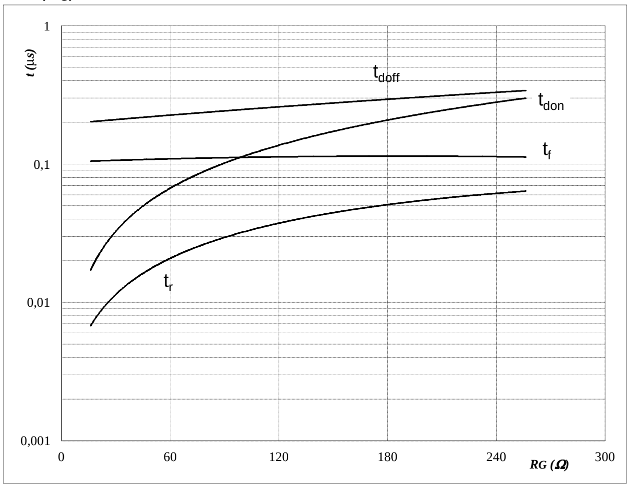

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 150 | ℃ |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 64 | Ω |
| $R_{goff}$ = | 64 | Ω |

**Figure 10** Output inverter IGBT

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

t = f($R_G$)



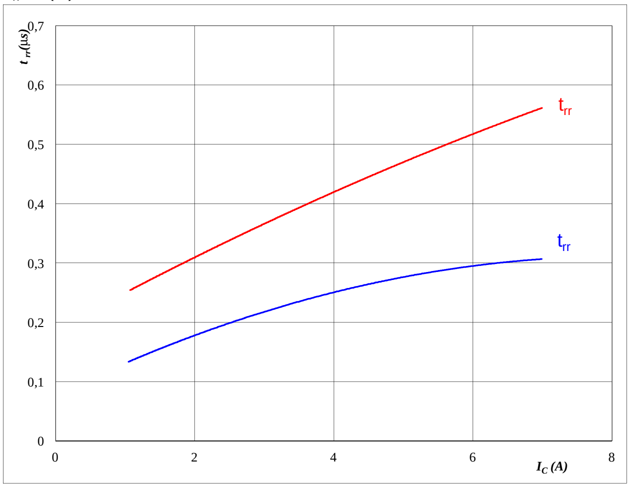

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 150 | ℃ |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 4 | A |

**Figure 11** Output inverter FRED

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

$t_{rr}$ = f(Ic)



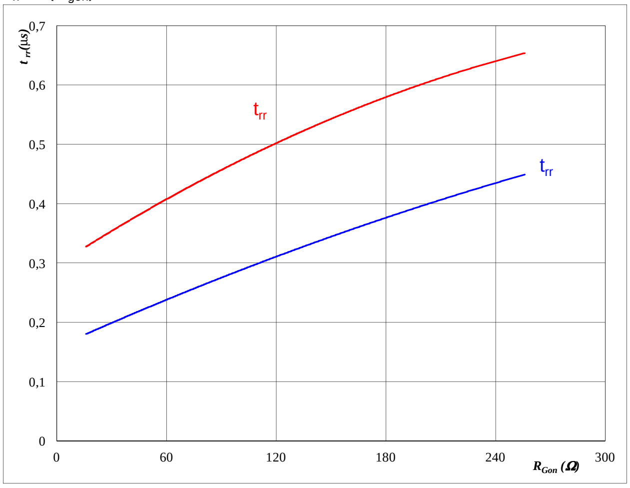

**At**

| | | |
|---|---|---|
| $T_j$ = | 25/150 | ℃ |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 64 | Ω |

**Figure 12** Output inverter FRED

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

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




**At**

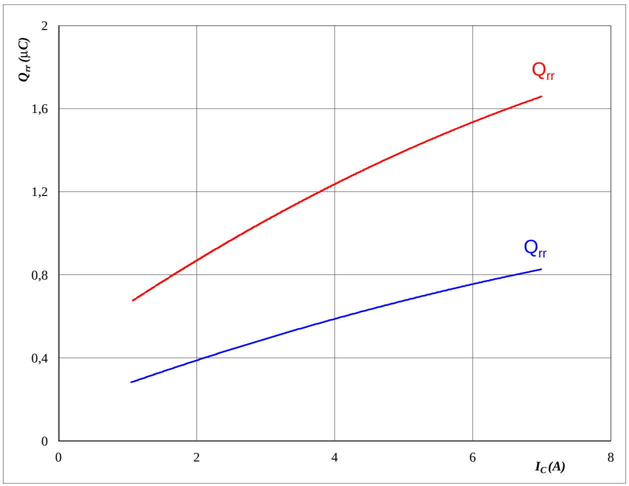
| | | |
|---|---|---|
| $T_j$ = | 25/150 | ℃ |
| $V_R$ = | 600 | V |
| $I_F$ = | 4 | A |
| $V_{GE}$ = | ±15 | V |

# Output Inverter

| Figure 13 | Output inverter FRED |
|---|---|

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

$Q_{rr} = f(Ic)$



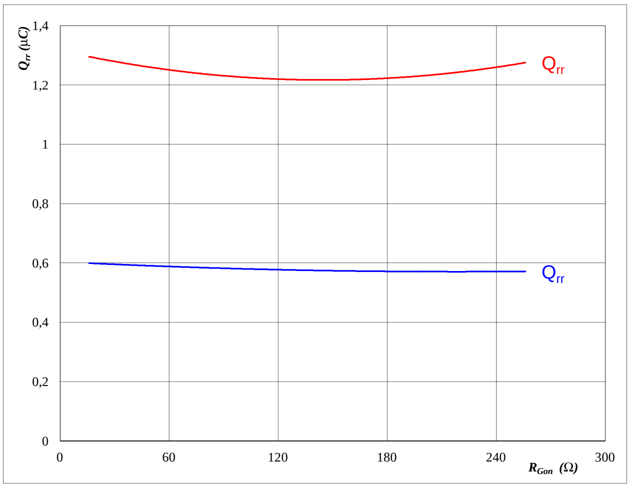

**At**

| | | |
|---|---|---|
| $T_j$ = | 25/150 | ℃ |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 64 | Ω |

| Figure 14 | Output inverter FRED |
|---|---|

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

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



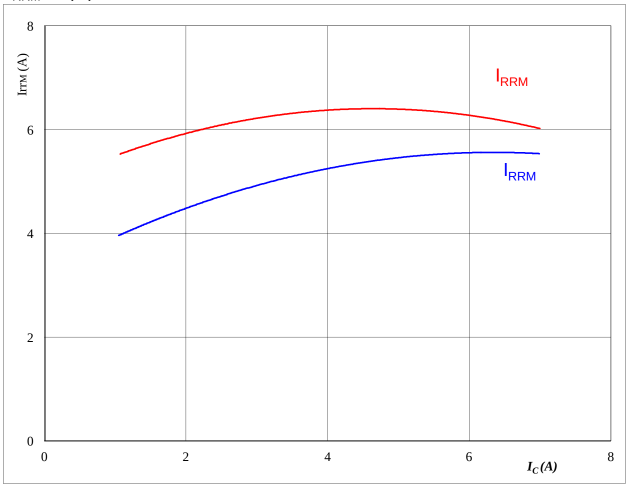

**At**

| | | |
|---|---|---|
| $T_j$ = | 25/150 | ℃ |
| $V_R$ = | 600 | V |
| $I_F$ = | 4 | A |
| $V_{GE}$ = | ±15 | V |

| Figure 15 | Output inverter FRED |
|---|---|

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

$I_{RRM} = f(Ic)$



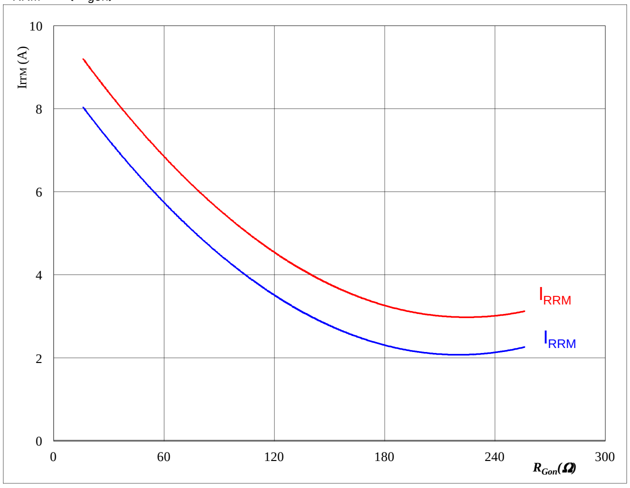

**At**

| | | |
|---|---|---|
| $T_j$ = | 25/150 | ℃ |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 64 | Ω |

| Figure 16 | Output inverter FRED |
|---|---|

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

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




**At**

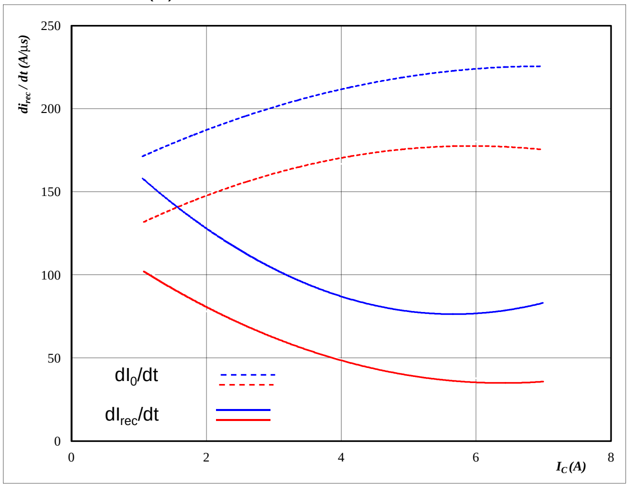
| | | |
|---|---|---|
| $T_j$ = | 25/150 | ℃ |
| $V_R$ = | 600 | V |
| $I_F$ = | 4 | A |
| $V_{GE}$ = | ±15 | V |

# Output Inverter

**Figure 17** — Output inverter FRED

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

dI0/dt,dIrec/dt = f(Ic)



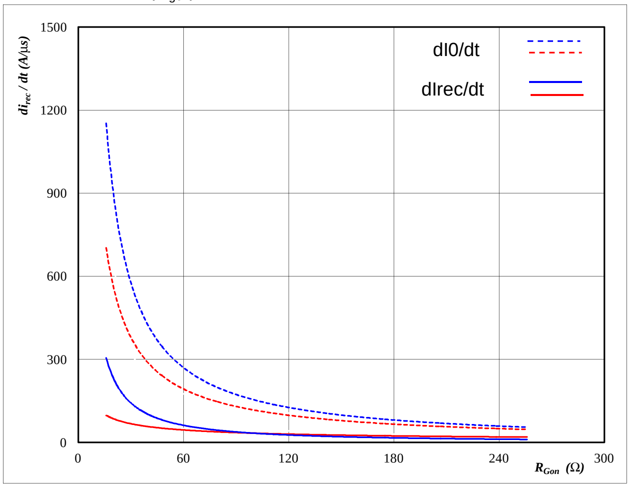

At

| | | |
|---|---|---|
| $T_j$ = | 25/150 | ℃ |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 64 | Ω |

**Figure 18** — Output inverter FRED

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

dI0/dt,dIrec/dt = f($R_{gon}$)



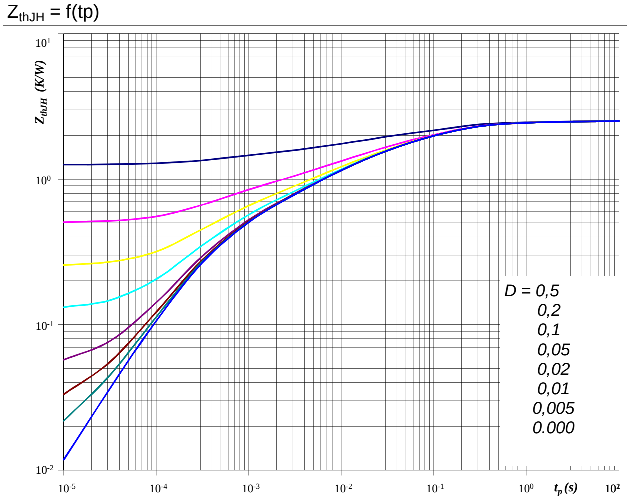

At

| | | |
|---|---|---|
| $T_j$ = | 25/150 | ℃ |
| $V_R$ = | 600 | V |
| $I_F$ = | 4 | A |
| $V_{GE}$ = | ±15 | V |

**Figure 19** — Output inverter IGBT

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

$Z_{thJH}$ = f(tp)




At

| | | |
|---|---|---|
| D = | tp / T | |
| $R_{thJH}$ = | 2,51 | K/W |

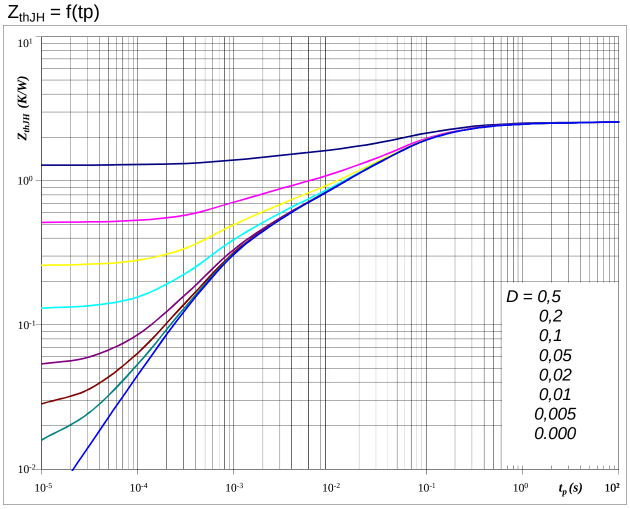
IGBT thermal model values

| R (C/W) | Tau (s) |
|---|---|
| 0,05 | 6,2E+00 |
| 0,26 | 4,9E-01 |
| 0,85 | 8,6E-02 |
| 0,64 | 1,3E-02 |
| 0,38 | 2,2E-03 |
| 0,33 | 3,4E-04 |

**Figure 20** — Output inverter FRED

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

$Z_{thJH}$ = f(tp)




At

| | | |
|---|---|---|
| D = | tp / T | |
| $R_{thJH}$ = | 2,56 | K/W |

FRED thermal model values

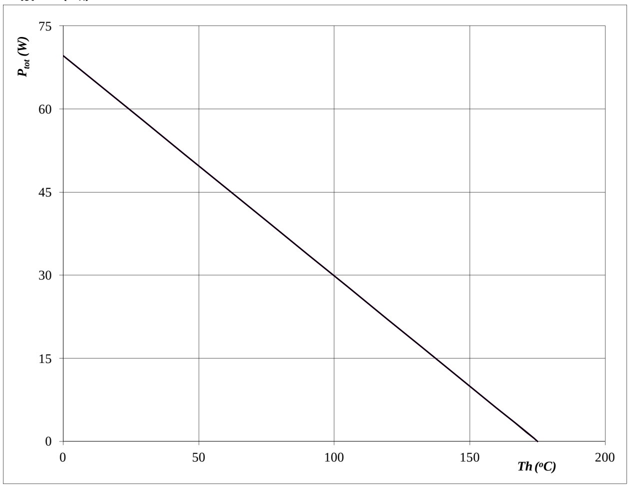
| R (C/W) | Tau (s) |
|---|---|
| 0,12 | 2,8E+00 |
| 0,62 | 2,1E-01 |
| 1,10 | 4,8E-02 |
| 0,37 | 7,2E-03 |
| 0,35 | 8,8E-04 |

# Output Inverter

**Figure 21** Output inverter IGBT

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

$P_{tot} = f(T_h)$




At

$T_j$ = 175 ℃

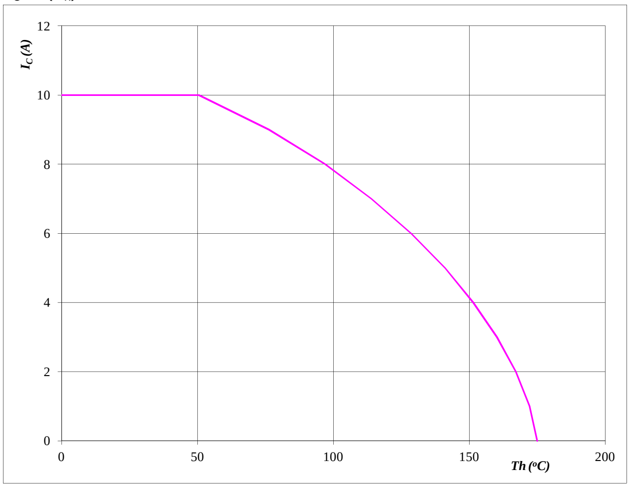
single heating

overall heating

**Figure 22** Output inverter IGBT

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

$I_C = f(T_h)$




At

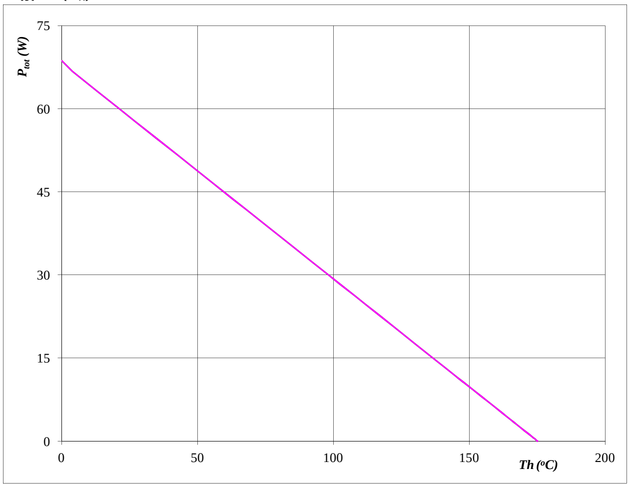
$T_j$ = 175 ℃

$V_{GE}$ = 15 V

**Figure 23** Output inverter FRED

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

$P_{tot} = f(T_h)$




At

$T_j$ = 175 ℃

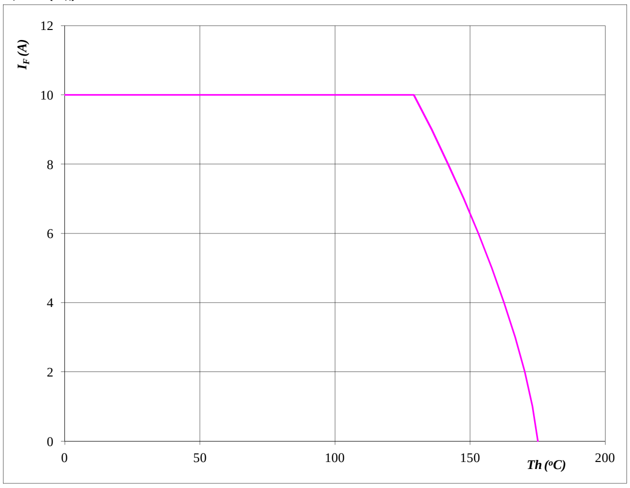
single heating

overall heating

**Figure 24** Output inverter FRED

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

$I_F = f(T_h)$




At

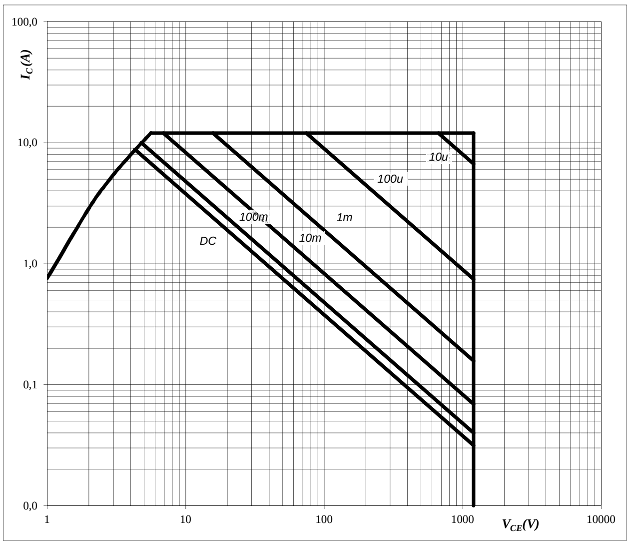
$T_j$ = 175 ℃

# Output Inverter

**Figure 25** Output inverter IGBT

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

$I_C = f(V_{CE})$



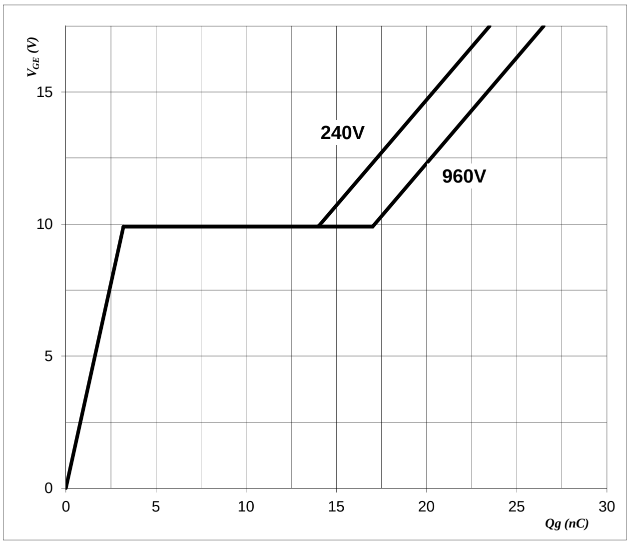

**At**

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

**Figure 26** Output inverter IGBT

**Gate voltage vs Gate charge**

$V_{GE} = f(Qg)$




**At**

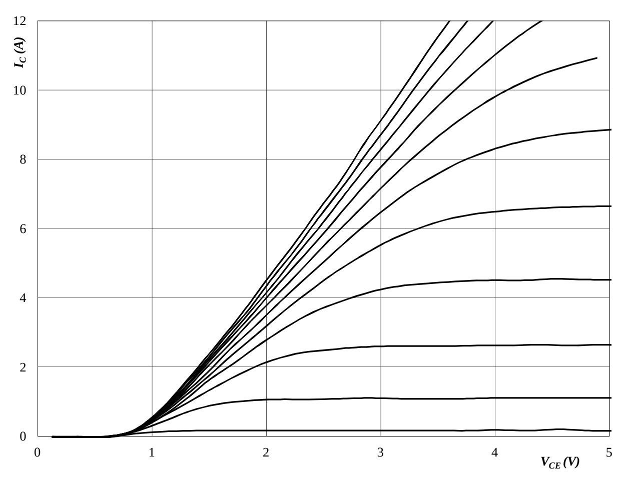
| | | |
|---|---|---|
| $I_C$ = | 4 | A |

# Brake

**Figure 1** Brake IGBT

**Typical output characteristics**

$I_C = f(V_{CE})$




**At**

$t_p$ = 250 µs

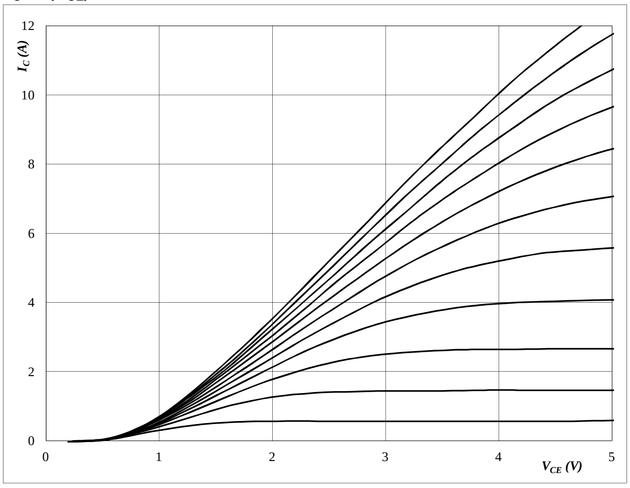
$T_j$ = 25 ℃

VGE from 7 V to 17 V in steps of 1 V

**Figure 2** Brake IGBT

**Typical output characteristics**

$I_C = f(V_{CE})$




**At**

$t_p$ = 250 µs

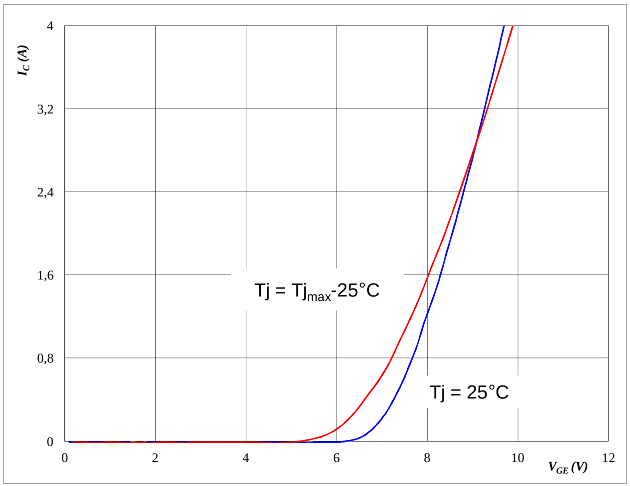
$T_j$ = 150 ℃

VGE from 7 V to 17 V in steps of 1 V

**Figure 3** Brake IGBT

**Typical transfer characteristics**

$I_C = f(V_{GE})$




**At**

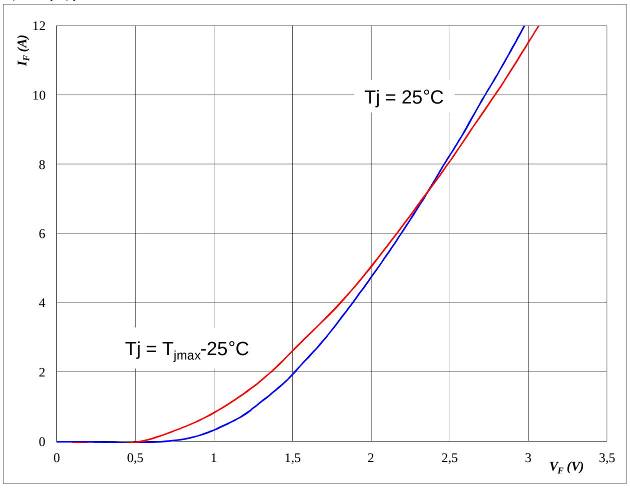
$t_p$ = 250 µs

$V_{CE}$ = 10 V

**Figure 4** Brake FRED

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

$I_F = f(V_F)$




**At**

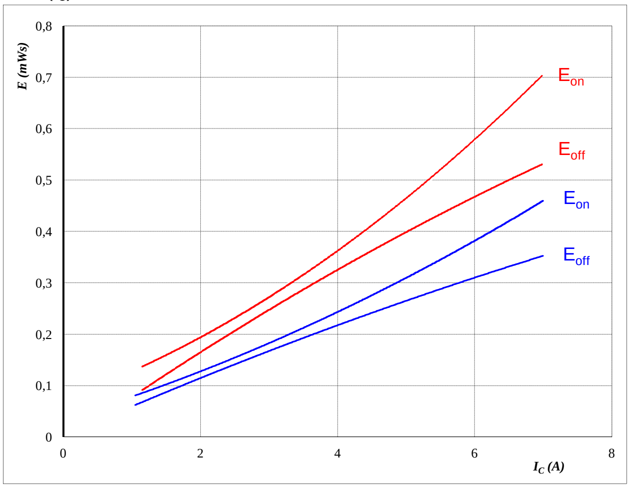
$t_p$ = 250 µs

# Brake

**Figure 5** Brake IGBT

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

E = f($I_C$)



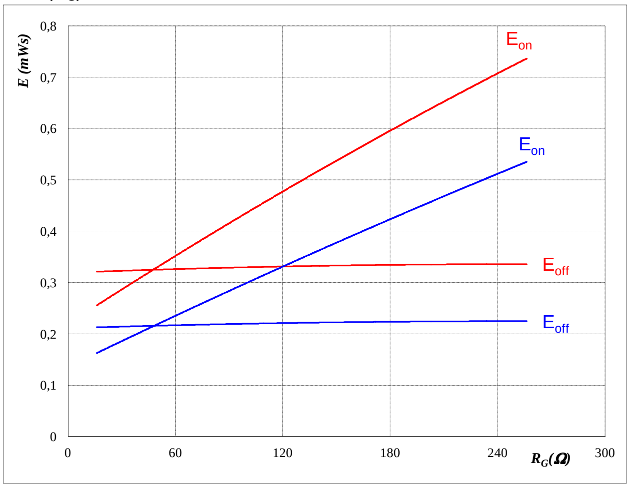

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/150 | °C |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 64 | Ω |
| $R_{goff}$ = | 64 | Ω |

**Figure 6** Brake IGBT

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

E = f($R_G$)



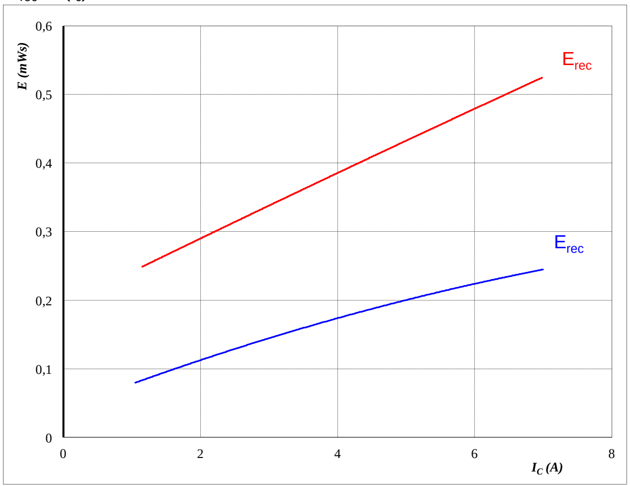

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/150 | °C |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 4 | A |

**Figure 7** Brake IGBT

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

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



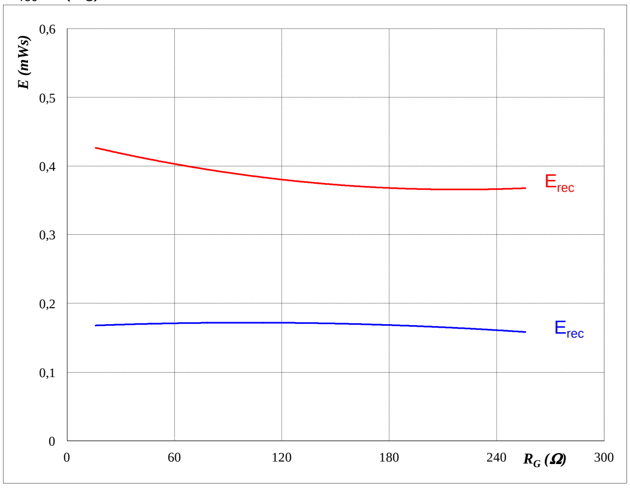

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/150 | °C |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 64 | Ω |

**Figure 8** Brake IGBT

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

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




With an inductive load at

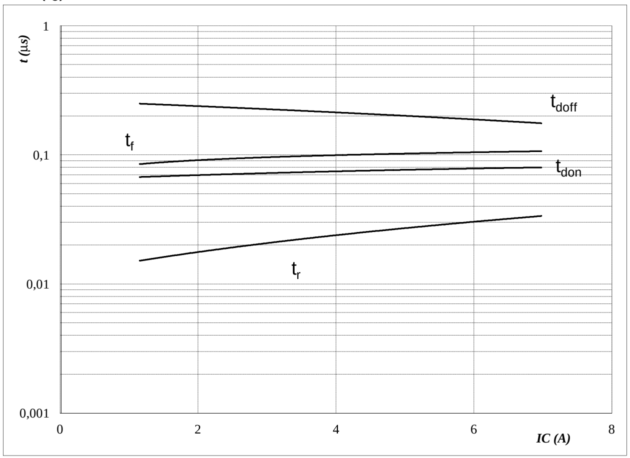
| | | |
|---|---|---|
| $T_j$ = | 25/150 | °C |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 4 | A |

# Brake

**Figure 9** Brake IGBT

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

t = f($I_C$)



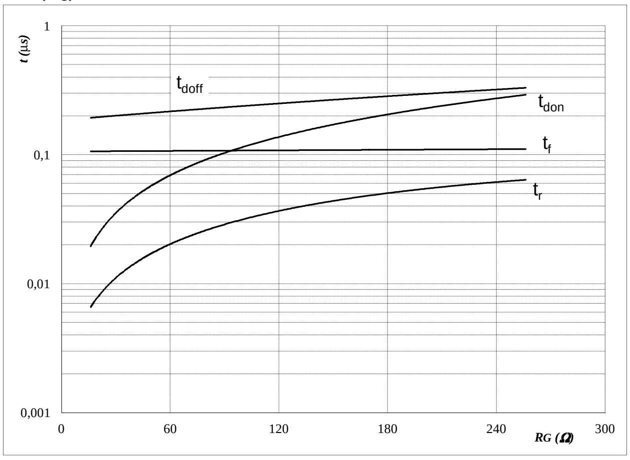

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/150 | ℃ |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 64 | Ω |
| $R_{goff}$ = | 64 | Ω |

**Figure 10** Brake IGBT

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

t = f($R_G$)



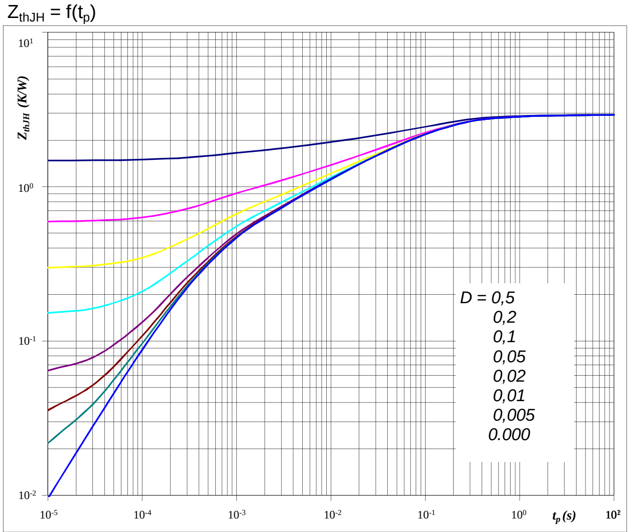

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/150 | ℃ |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 4 | A |

**Figure 11** Brake IGBT

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

$Z_{thJH}$ = f($t_p$)



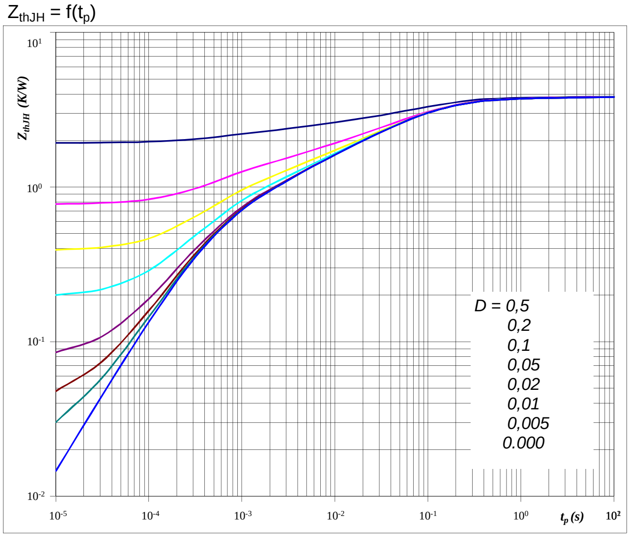

At

| | | |
|---|---|---|
| D = | tp / T | |
| $R_{thJH}$ = | 2,95 | K/W |

**Figure 12** Brake FRED

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

$Z_{thJH}$ = f($t_p$)




At

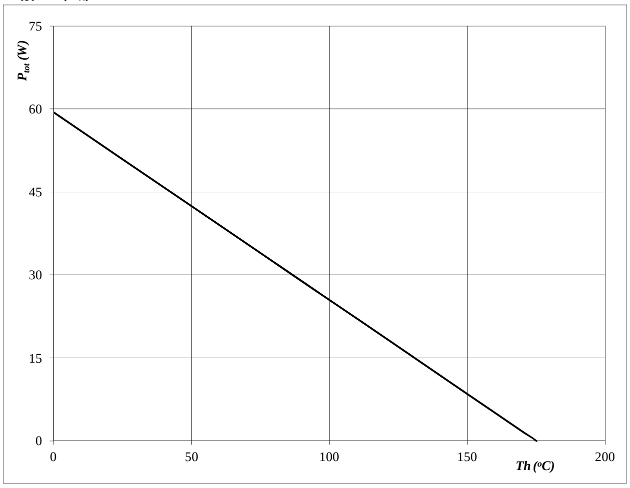
| | | |
|---|---|---|
| D = | tp / T | |
| $R_{thJH}$ = | 3,86 | K/W |

# Brake

**Figure 13** Brake IGBT

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

$P_{tot} = f(T_h)$



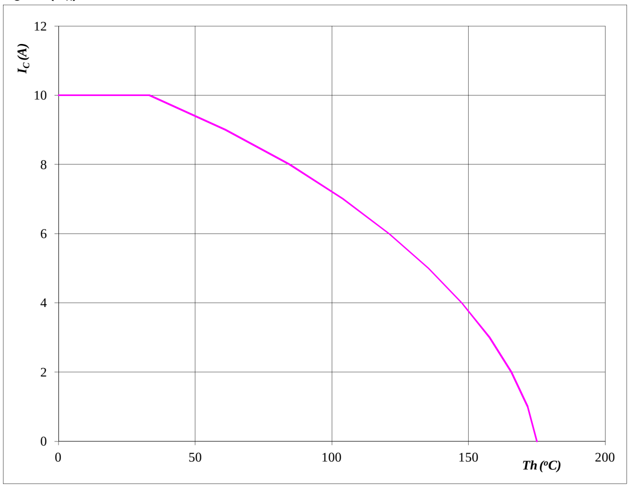

At

$T_j$ = 175 ºC

**Figure 14** Brake IGBT

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

$I_C = f(T_h)$




At

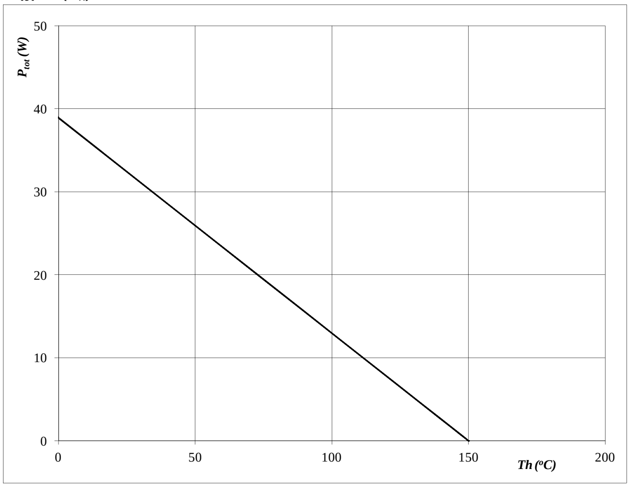
$T_j$ = 175 ºC

$V_{GE}$ = 15 V

**Figure 15** Brake FRED

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

$P_{tot} = f(T_h)$



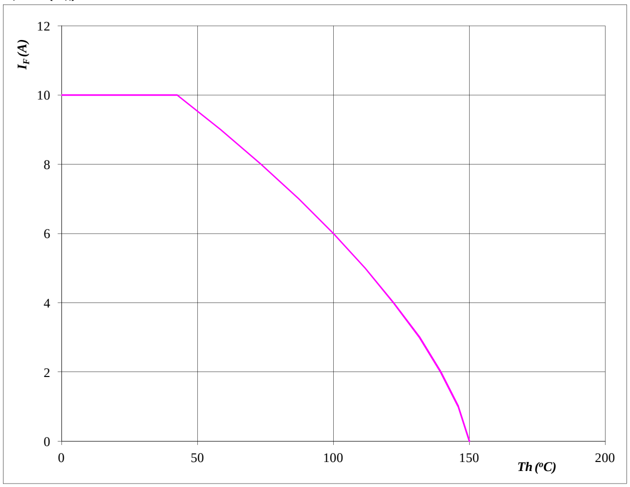

At

$T_j$ = 150 ºC

**Figure 16** Brake FRED

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

$I_F = f(T_h)$




At

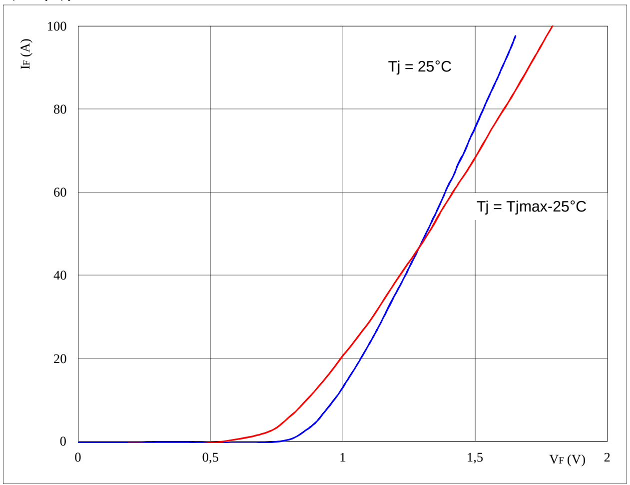
$T_j$ = 150 ºC

# Input Rectifier Bridge

**Figure 1** Rectifier diode

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

$I_F = f(V_F)$



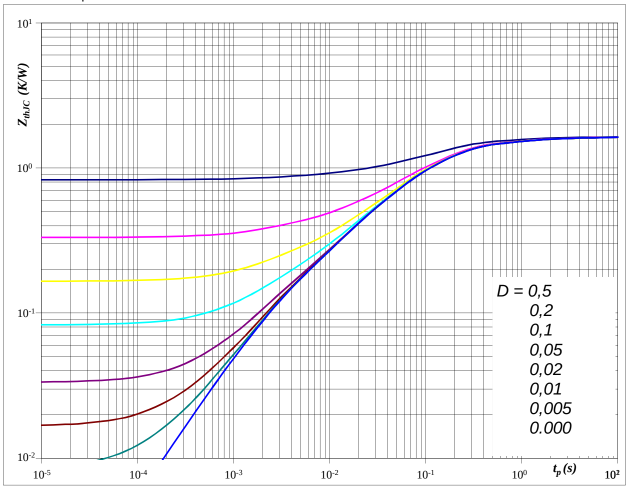

**At**

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

**Figure 2** Rectifier diode

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

$Z_{thJH} = f(t_p)$



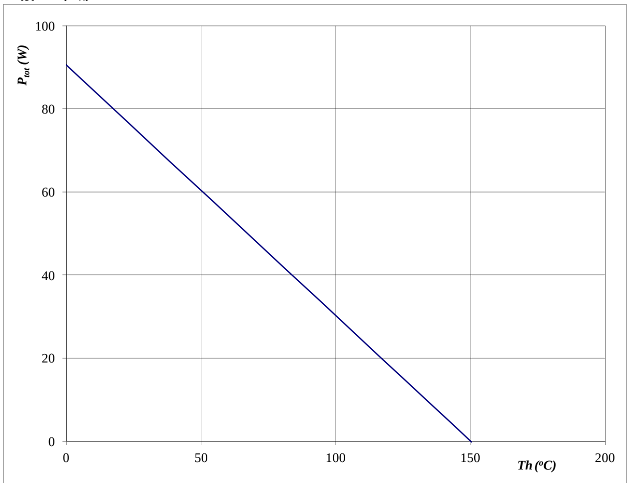

**At**

| | | |
|---|---|---|
| D = | tp / T | |
| $R_{thJH}$ = | 1,657 | K/W |

**Figure 3** Rectifier diode

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

$P_{tot} = f(T_h)$



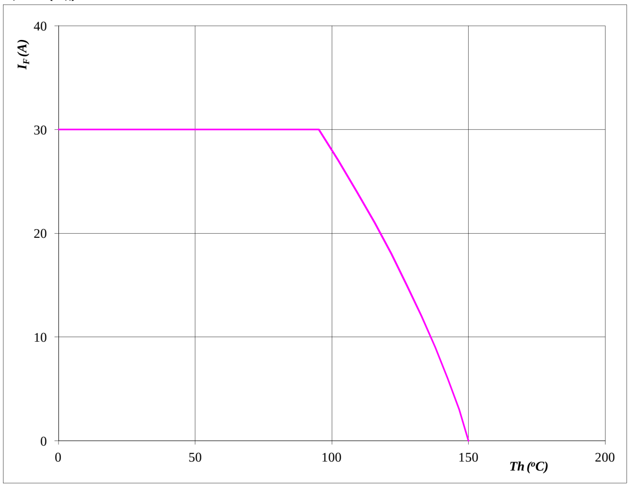

**At**

| | | |
|---|---|---|
| $T_j$ = | 150 | ºC |

**Figure 4** Rectifier diode

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

$I_F = f(T_h)$



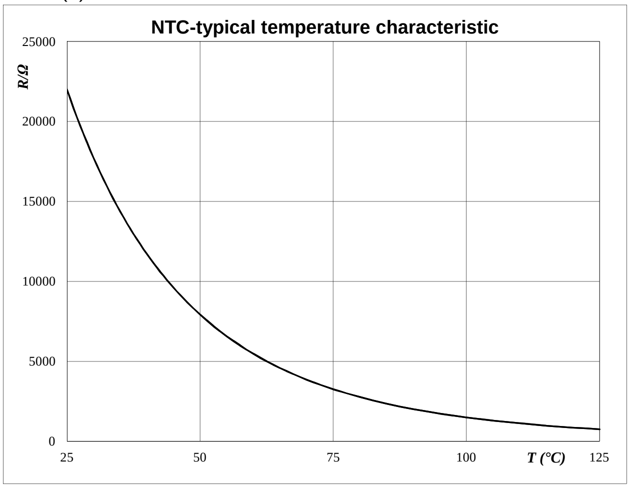

**At**

| | | |
|---|---|---|
| $T_j$ = | 150 | ºC |

# Thermistor

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

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



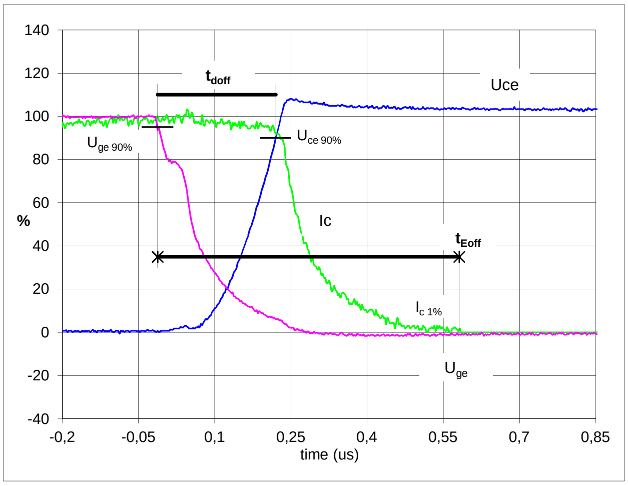
# Switching Definitions Output Inverter

**General conditions**

| | | |
|---|---|---|
| $T_j$ | = | 150 ℃ |
| $R_{gon}$ | = | 64 Ω |
| $R_{goff}$ | = | 64 Ω |

**Figure 1** Output inverter IGBT

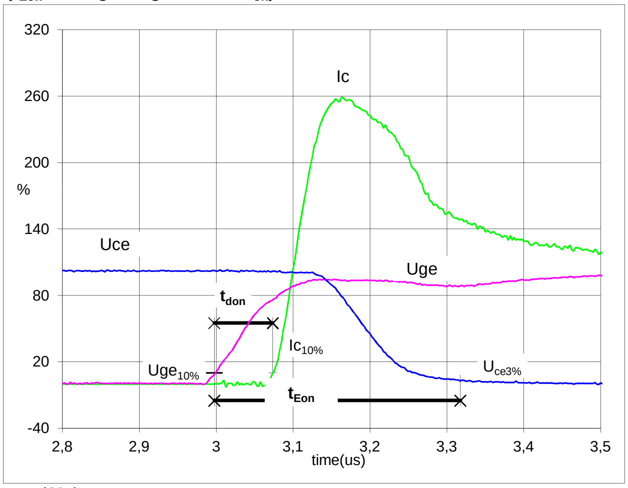
**Turn-off Switching Waveforms & definition of tdoff, tEoff**
**($t_{Eoff}$ = integrating time for $E_{off}$)**




| | | |
|---|---|---|
| $V_{GE}$ (0%) = | -15 | V |
| $V_{GE}$ (100%) = | 15 | V |
| $V_C$ (100%) = | 600 | V |
| $I_C$ (100%) = | 4 | A |
| $t_{doff}$ = | 0,23 | μs |
| $t_{Eoff}$ = | 0,59 | μs |

**Figure 2** Output inverter IGBT

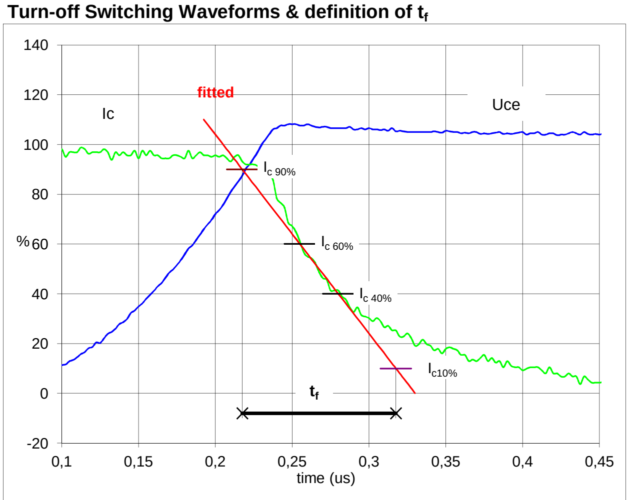
**Turn-on Switching Waveforms & definition of tdon, tEon**
**($t_{Eon}$ = integrating time for $E_{on}$)**




| | | |
|---|---|---|
| $V_{GE}$ (0%) = | -15 | V |
| $V_{GE}$ (100%) = | 15 | V |
| $V_C$ (100%) = | 600 | V |
| $I_C$ (100%) = | 4 | A |
| $t_{don}$ = | 0,08 | μs |
| $t_{Eon}$ = | 0,32 | μs |

**Figure 3** Output inverter IGBT

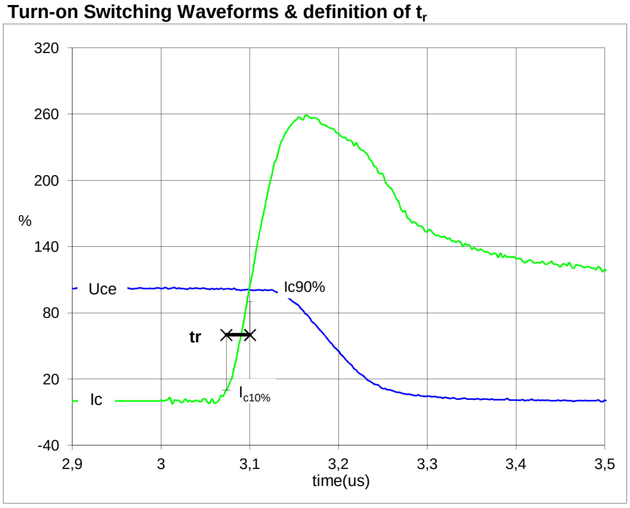
**Turn-off Switching Waveforms & definition of $t_f$**




| | | |
|---|---|---|
| $V_C$ (100%) = | 600 | V |
| $I_C$ (100%) = | 4 | A |
| $t_f$ = | 0,11 | μs |

**Figure 4** Output inverter IGBT

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

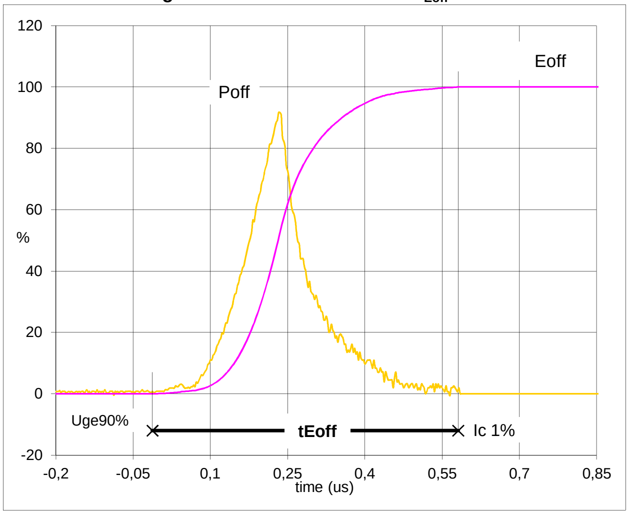



| | | |
|---|---|---|
| $V_C$ (100%) = | 600 | V |
| $I_C$ (100%) = | 4 | A |
| $t_r$ = | 0,02 | μs |

# Switching Definitions Output Inverter

**Figure 5** Output inverter IGBT

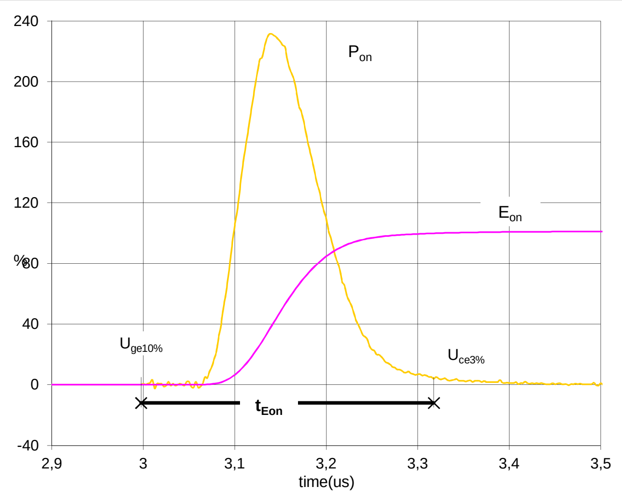
**Turn-off Switching Waveforms & definition of $t_{Eoff}$**




| | | |
|---|---|---|
| $P_{off}$ (100%) = | 2,41 | kW |
| $E_{off}$ (100%) = | 0,32 | mJ |
| $t_{Eoff}$ = | 0,59 | µs |

**Figure 6** Output inverter IGBT

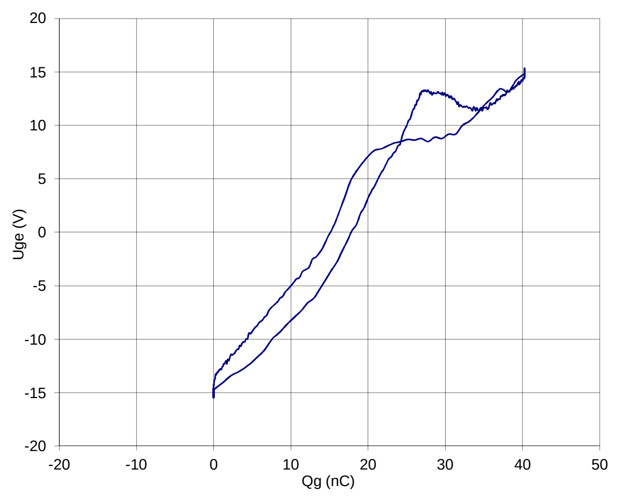
**Turn-on Switching Waveforms & definition of $t_{Eon}$**




| | | |
|---|---|---|
| $P_{on}$ (100%) = | 2,41 | kW |
| $E_{on}$ (100%) = | 0,56 | mJ |
| $t_{Eon}$ = | 0,32 | µs |

**Figure 7** Output inverter FRED

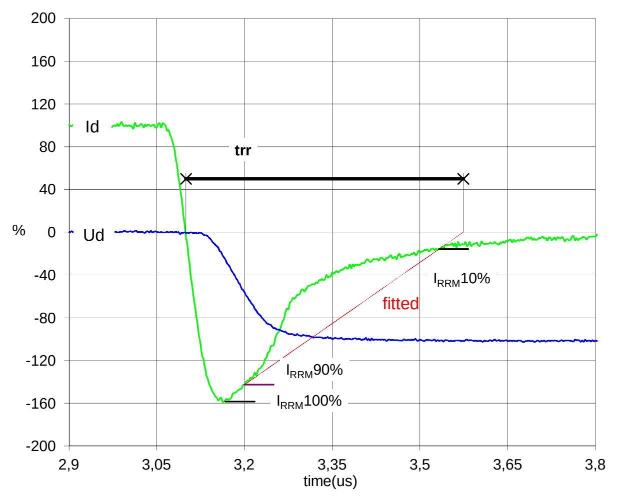
**Gate voltage vs Gate charge (measured)**




| | | |
|---|---|---|
| $V_{GEoff}$ = | -15 | V |
| $V_{GEon}$ = | 15 | V |
| $V_C$ (100%) = | 600 | V |
| $I_C$ (100%) = | 4 | A |
| $Q_g$ = | 40,28 | nC |

**Figure 8** Output inverter IGBT

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

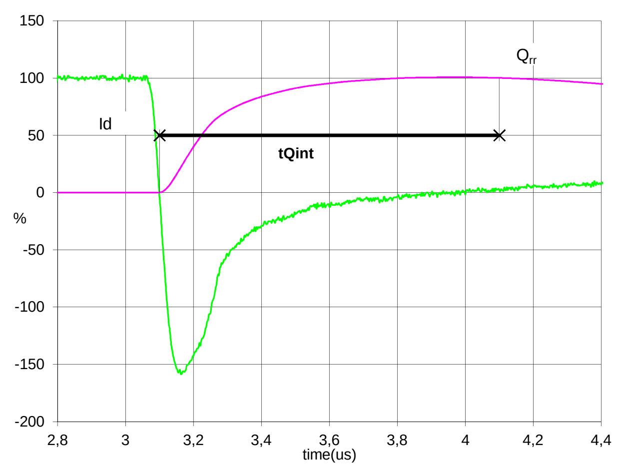



| | | |
|---|---|---|
| $V_d$ (100%) = | 600 | V |
| $I_d$ (100%) = | 4 | A |
| $I_{RRM}$ (100%) = | -6 | A |
| $t_{rr}$ = | 0,43 | µs |

# Switching Definitions Output Inverter

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

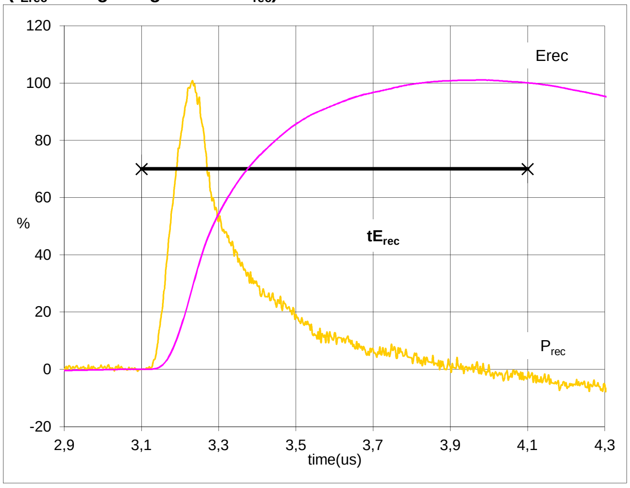
**Turn-on Switching Waveforms & definition of $t_{Qrr}$**
**($t_{Qrr}$ = integrating time for $Q_{rr}$)**




| | | |
|---|---|---|
| $I_d$ (100%) = | 4 | A |
| $Q_{rr}$ (100%) = | 1,24 | μC |
| $t_{Qint}$ = | 1,00 | μs |

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

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



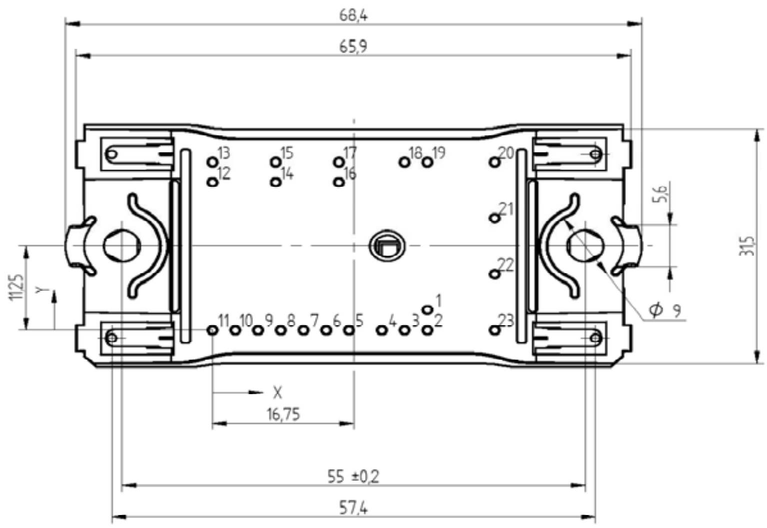

| | | |
|---|---|---|
| $P_{rec}$ (100%) = | 2,41 | kW |
| $E_{rec}$ (100%) = | 0,47 | mJ |
| $t_{Erec}$ = | 1,00 | μs |

# Package Outline and Pinout

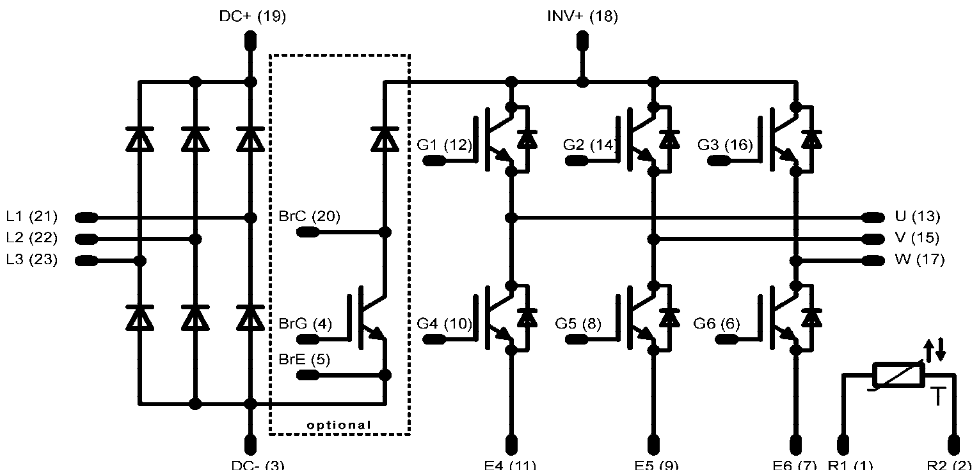
## Outline

Pin table

| Pin | X | Y |
|---|---|---|
| 1 | 25,5 | 2,7 |
| 2 | 25,5 | 0 |
| 3 | 22,8 | 0 |
| 4 | 20,1 | 0 |
| 5 | 16,2 | 0 |
| 6 | 13,5 | 0 |
| 7 | 10,8 | 0 |
| 8 | 8,1 | 0 |
| 9 | 5,4 | 0 |
| 10 | 2,7 | 0 |
| 11 | 0 | 0 |
| 12 | 0 | 19,8 |
| 13 | 0 | 22,5 |
| 14 | 7,5 | 19,8 |
| 15 | 7,5 | 22,5 |
| 16 | 15 | 19,8 |
| 17 | 15 | 22,5 |
| 18 | 22,8 | 22,5 |
| 19 | 25,5 | 22,5 |
| 20 | 33,5 | 22,5 |
| 21 | 33,5 | 15 |
| 22 | 33,5 | 7,5 |
| 23 | 33,5 | 0 |




## Pinout



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|---|---|---|
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