# V23990-P549-A/ C-PM

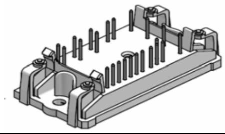
preliminary datasheet

***flow*PIM 0** | **1200 V/8 A**

### Features

- Clip in PCB mountin
- Trench Fieldstop IGBT's for low saturation losses
- Optional w/o BRC

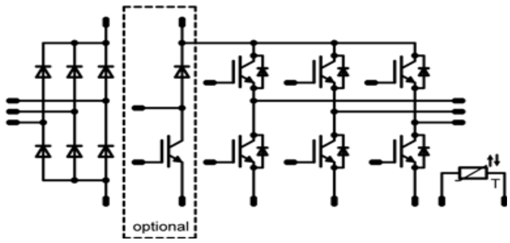
### *flow*PIM 0



### Target Applications

- Industrial Drives
- Embedded Drives

### Schematic




### Types

- V23990-P549-A-PM
- V23990-P549-C-PM without 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 |
| DC forward current | $I_{FAV}$ | $T_j$=$T_j$max | $T_h$=80°C<br>$T_c$=80°C | 27<br>37 | A |
| Surge forward current | $I_{FSM}$ | $t_p$=10ms | $T_j$=25°C | 220 | A |
| I2t-value | $I^2t$ | | | 200 | $A^2s$ |
| Power dissipation per Diode | $P_{tot}$ | $T_j$=$T_j$max | $T_h$=80°C<br>$T_c$=80°C | 33<br>50 | 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 | 13<br>16 | A |
| Repetitive peak collector current | $I_{Cpulse}$ | $t_p$ limited by $T_j$max | | 24 | A |
| Turn off safe operating area | | VCE ≤ 1200V, Tj ≤ Top max | | 24 | A |
| Power dissipation per IGBT | $P_{tot}$ | $T_j$=$T_j$max | $T_h$=80°C<br>$T_c$=80°C | 35<br>53 | 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>1200 | μs<br>V |
| Maximum Junction Temperature | $T_j$max | | | 150 | °C |

# Maximum Ratings

$T_j$=25°C, unless otherwise specified

| Parameter | Symbol | Condition | | Value | Unit |
|---|---|---|---|---|---|
| **Inverter Diode** | | | | | |
| Peak Repetitive Reverse Voltage | $V_{RRM}$ | $T_j$=25°C | | 1200 | V |
| DC forward current | $I_F$ | $T_j$=$T_j$max | $T_h$=80°C<br>$T_c$=80°C | 11<br>14 | A |
| Repetitive peak forward current | $I_{FRM}$ | $t_p$ limited by $T_j$max | | 9 | A |
| Power dissipation per Diode | $P_{tot}$ | $T_j$=$T_j$max | $T_h$=80°C<br>$T_c$=80°C | 29<br>44 | W |
| Maximum Junction Temperature | $T_j$max | | | 175 | °C |
| **Brake 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 | 12<br>16 | A |
| Repetitive peak collector current | $I_{Cpuls}$ | $t_p$ limited by $T_j$max | | 24 | A |
| Turn off safe operating area | | VCE ≤ 1200V, Tj ≤ Top max | | 24 | A |
| Power dissipation per IGBT | $P_{tot}$ | $T_j$=$T_j$max | $T_h$=80°C<br>$T_c$=80°C | 33<br>51 | 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>1200 | μs<br>V |
| Maximum Junction Temperature | $T_j$max | | | 150 | °C |
| **Brake Diode** | | | | | |
| Peak Repetitive Reverse Voltage | $V_{RRM}$ | $T_j$=25°C | | 1200 | V |
| DC forward current | $I_F$ | $T_j$=$T_j$max | $T_h$=80°C<br>$T_c$=80°C | 7<br>7 | A |
| Repetitive peak forward current | $I_{FRM}$ | $t_p$ limited by $T_j$max | | 8 | A |
| Power dissipation per Diode | $P_{tot}$ | $T_j$=$T_j$max | $T_h$=80°C<br>$T_c$=80°C | 18<br>27 | W |
| Maximum Junction Temperature | $T_j$max | | | 150 | °C |
| **Thermal Properties** | | | | | |
| Storage temperature | $T_{stg}$ | | | -40…+125 | °C |
| Operation temperature under switching condition | $T_{op}$ | | | -40…+(Tjmax - 25) | °C |
| **Insulation Properties** | | | | | |
| Insulation voltage | $V_{is}$ | t=2s | DC voltage | 4000 | V |
| Creepage distance | | | | min 12,7 | mm |
| Clearance | | | | min 12,7 | mm |
| Comparative tracking index | CTI | | | >200 | |

## 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] | $T_j$ | Value Min | Value Typ | Value Max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| **Input Rectifier Diode** | | | | | | | | | | |
| Forward voltage | $V_F$ | | | | 25 | Tj=25°C<br>Tj=125°C | 0,8 | 1,20<br>1,17 | 1,8 | V |
| Threshold voltage (for power loss calc. only) | $V_{to}$ | | | | 25 | Tj=25°C<br>Tj=125°C | | 0,93<br>0,80 | | V |
| Slope resistance (for power loss calc. only) | $r_t$ | | | | 25 | Tj=25°C<br>Tj=125°C | | 11<br>15 | | mΩ |
| Reverse current | $I_r$ | | | 1600 | | Tj=25°C<br>Tj=125°C | | | 0,01 | mA |
| Thermal resistance chip to heatsink per chip | $R_{thJH}$ | Thermal grease thickness≤50um λ = 1 W/mK | | | | | | 2,13 | | K/W |
| **Inverter Transistor** | | | | | | | | | | |
| Gate emitter threshold voltage | $V_{GE(th)}$ | $V_{CE}=V_{GE}$ | | | 0,0003 | Tj=25°C<br>Tj=125°C | 5 | 5,8 | 6,5 | V |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ | | 15 | | 8 | Tj=25°C<br>Tj=125°C | 1,35 | 1,64<br>1,83 | 2,05 | 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 | | | 120 | nA |
| Integrated Gate resistor | $R_{gint}$ | | | | | | | none | | Ω |
| Turn-on delay time | $t_{d(on)}$ | Rgoff=64 Ω<br>Rgon=64 Ω | ±15 | 600 | 10 | Tj=25°C<br>Tj=125°C | | 133<br>132 | | ns |
| Rise time | $t_r$ | | | | | Tj=25°C<br>Tj=125°C | | 17<br>23 | | |
| Turn-off delay time | $t_{d(off)}$ | | | | | Tj=25°C<br>Tj=125°C | | 233<br>291 | | |
| Fall time | $t_f$ | | | | | Tj=25°C<br>Tj=125°C | | 144<br>159 | | |
| Turn-on energy loss per pulse | $E_{on}$ | | | | | Tj=25°C<br>Tj=125°C | | 0,82<br>1,13 | | mWs |
| Turn-off energy loss per pulse | $E_{off}$ | | | | | Tj=25°C<br>Tj=125°C | | 0,66<br>1,01 | | |
| Input capacitance | $C_{ies}$ | f=1MHz | 0 | 25 | | Tj=25°C | | 605 | | pF |
| Output capacitance | $C_{oss}$ | | | | | | | 37 | | |
| Reverse transfer capacitance | $C_{rss}$ | | | | | | | 29 | | |
| Gate charge | $Q_{Gate}$ | | ±15 | 960 | 8 | Tj=25°C | | 52 | | nC |
| Thermal resistance chip to heatsink per chip | $R_{thJH}$ | Thermal grease thickness≤50um λ = 1 W/mK | | | | | | 1,99 | | K/W |
| **Inverter Diode** | | | | | | | | | | |
| Diode forward voltage | $V_F$ | | | | 0,00025 | Tj=25°C<br>Tj=150°C | 1,46 | 2,25<br>1,73 | 2,61 | V |
| Peak reverse recovery current | $I_{RRM}$ | Rgon=64 Ω | ±15 | 600 | 10 | Tj=25°C<br>Tj=150°C | | 11<br>12 | | A |
| Reverse recovery time | $t_{rr}$ | | | | | Tj=25°C<br>Tj=150°C | | 329<br>504 | | ns |
| Reverse recovered charge | $Q_{rr}$ | | | | | Tj=25°C<br>Tj=150°C | | 1,31<br>2,30 | | μC |
| Peak rate of fall of recovery current | di(rec)max /dt | | | | | Tj=25°C<br>Tj=150°C | | 90<br>39 | | A/μs |
| Reverse recovered energy | Erec | | | | | Tj=25°C<br>Tj=150°C | | 0,49<br>0,93 | | mWs |
| Thermal resistance chip to heatsink per chip | $R_{thJH}$ | Thermal grease thickness≤50um λ = 1 W/mK | | | | | | 3,30 | | K/W |

## Characteristic Values

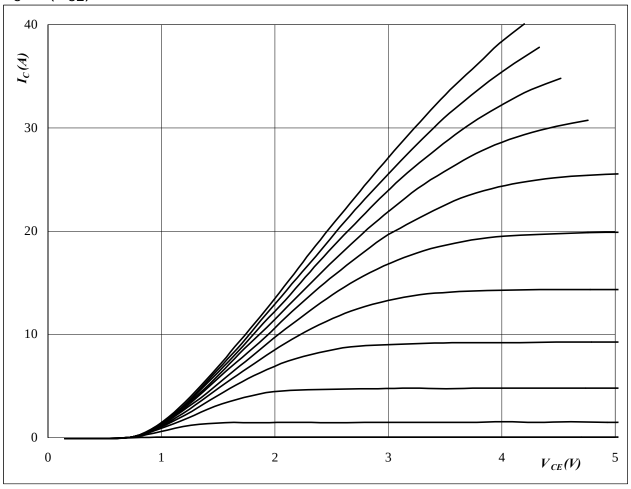
| Parameter | Symbol | Conditions | | | | | Value | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $V_{GE}$ [V] or<br>$V_{GS}$ [V] | $V_r$ [V] or<br>$V_{CE}$ [V] or<br>$V_{DS}$ [V] | $I_C$ [A] or<br>$I_F$ [A] or<br>$I_D$ [A] | $T_j$ | Min | Typ | Max | |
| **Brake Transistor** | | | | | | | | | | |
| Gate emitter threshold voltage | $V_{GE(th)}$ | $V_{CE}=V_{GE}$ | | | 0,0003 | Tj=25°C<br>Tj=125°C | 5 | 5,8 | 6,5 | V |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ | | 15 | | 8 | Tj=25°C<br>Tj=125°C | 1,35 | 1,72<br>1,96 | 2,05 | V |
| Collector-emitter cut-off 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 | | | 120 | nA |
| Integrated Gate resistor | $R_{gint}$ | | | | | | | none | | Ω |
| Turn-on delay time | $t_{d(on)}$ | Rgoff=64 Ω<br>Rgon=64 Ω | ±15 | 600 | 10 | Tj=25°C<br>Tj=125°C | | 131<br>130 | | ns |
| Rise time | $t_r$ | | | | | Tj=25°C<br>Tj=125°C | | 15<br>20 | | |
| Turn-off delay time | $t_{d(off)}$ | | | | | Tj=25°C<br>Tj=125°C | | 250<br>312 | | |
| Fall time | $t_f$ | | | | | Tj=25°C<br>Tj=125°C | | 93<br>159 | | |
| Turn-on energy loss per pulse | $E_{on}$ | | | | | Tj=25°C<br>Tj=125°C | | 0,46<br>0,58 | | mWs |
| Turn-off energy loss per pulse | $E_{off}$ | | | | | Tj=25°C<br>Tj=125°C | | 0,54<br>0,82 | | |
| Input capacitance | $C_{ies}$ | f=1MHz | 0 | 25 | | Tj=25°C | | 605 | | pF |
| Output capacitance | $C_{oss}$ | | | | | | | 37 | | |
| Reverse transfer capacitance | $C_{rss}$ | | | | | | | 29 | | |
| Gate charge | $Q_{Gate}$ | | ±15 | 960 | 8 | Tj=25°C | | 52 | | nC |
| Thermal resistance chip to heatsink per chip | $R_{thJH}$ | Thermal grease<br>thickness≤50um<br>λ = 1 W/mK | | | | | | 2,09 | | K/W |
| **Brake Diode** | | | | | | | | | | |
| Diode forward voltage | $V_F$ | | | | 4 | Tj=25°C<br>Tj=125°C | 1 | 1,76<br>1,87 | 2,35 | V |
| Reverse leakage current | $I_r$ | Rgon=64 Ω | ±15 | 600 | 10 | Tj=25°C<br>Tj=125°C | | | 250 | μA |
| Peak reverse recovery current | $I_{RRM}$ | Rgon=64 Ω<br>Rgon=64 Ω | ±15 | 600 | 10 | Tj=25°C<br>Tj=125°C | | 7<br>8 | | A |
| Reverse recovery time | $t_{rr}$ | | | | | Tj=25°C<br>Tj=125°C | | 321<br>476 | | ns |
| Reverse recovered charge | $Q_{rr}$ | | | | | Tj=25°C<br>Tj=125°C | | 0,74<br>0,74 | | μC |
| Peak rate of fall of recovery current | di(rec)max<br>/dt | | | | | Tj=25°C<br>Tj=125°C | | 101<br>59 | | A/μs |
| Reverse recovery energy | $E_{rec}$ | | | | | Tj=25°C<br>Tj=125°C | | 0,30<br>0,51 | | mWs |
| Thermal resistance chip to heatsink per chip | $R_{thJH}$ | Thermal grease<br>thickness≤50um<br>λ = 1 W/mK | | | | | | 3,97 | | K/W |
| **Thermistor** | | | | | | | | | | |
| Rated resistance | R | | | | | T=25°C | | 22000 | | Ω |
| Deviation of R100 | ΔR/R | R100=1486 Ω | | | | T=100°C | -5 | | 5 | % |
| Power dissipation | P | | | | | T=25°C | | 210 | | mW |
| Power dissipation constant | | | | | | T=25°C | | 3,5 | | mW/K |
| B-value | $B_{(25/50)}$ | Tol. ±3% | | | | T=25°C | | | | K |
| B-value | $B_{(25/100)}$ | Tol. ±3% | | | | T=25°C | | 4000 | | K |
| Vincotech NTC Reference | | | | | | | | | A | |

# Output Inverter

**Figure 1** Output inverter IGBT

**Typical output characteristics**

$I_C = f(V_{CE})$



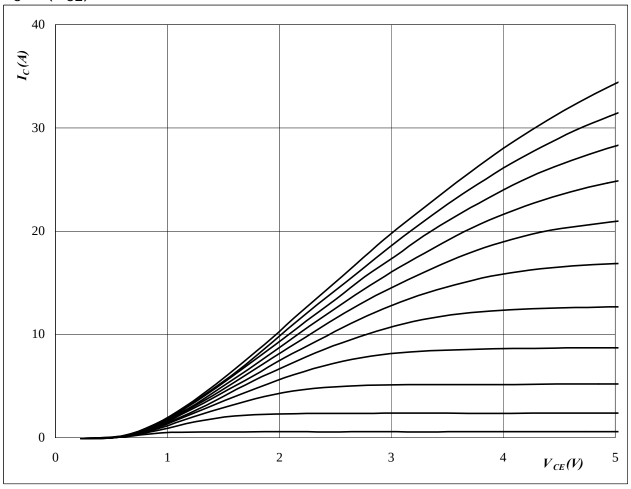

**At**

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

**Figure 2** Output inverter IGBT

**Typical output characteristics**

$I_C = f(V_{CE})$



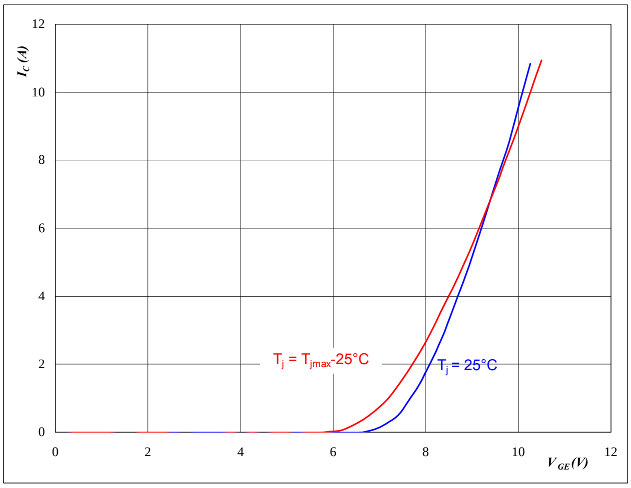

**At**

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

**Figure 3** Output inverter IGBT

**Typical transfer characteristics**

$I_C = f(V_{GE})$



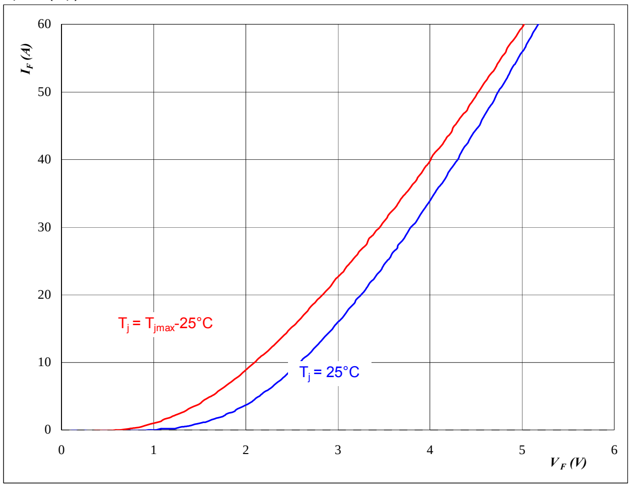

**At**

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

**Figure 4** Output inverter FWD

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

$I_F = f(V_F)$




**At**

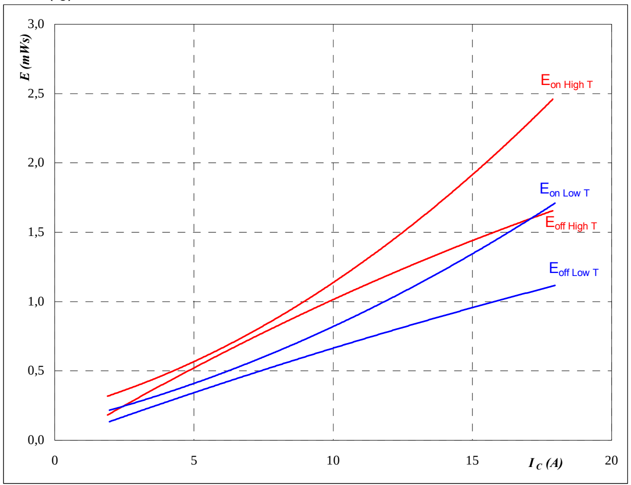
| | | |
|---|---|---|
| $t_p$ = | 250 | µs |

# Output Inverter

**Figure 5** Output inverter IGBT

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

E = f($I_C$)



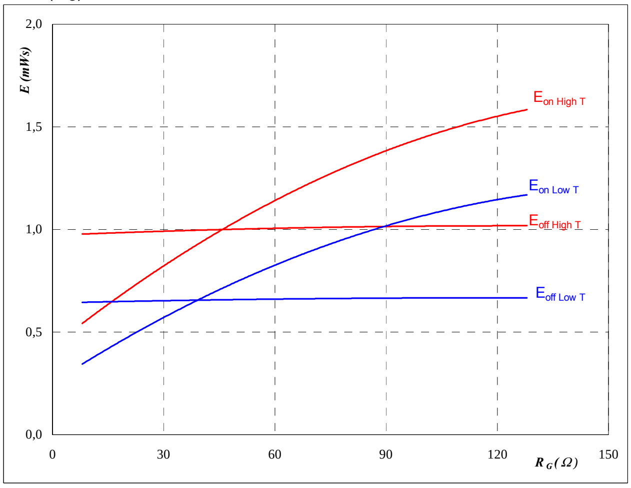

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 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($R_G$)



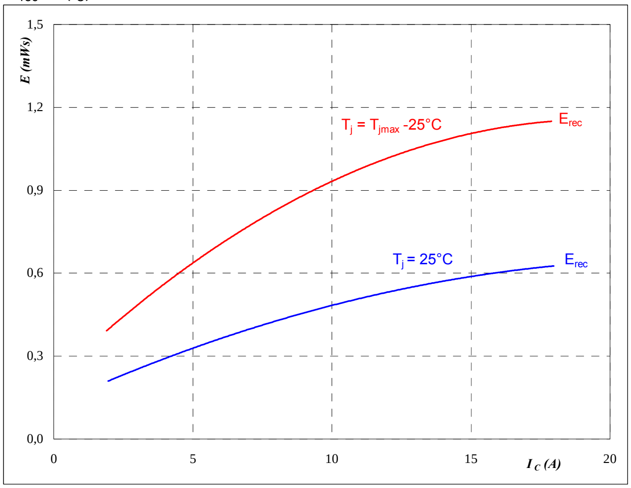

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 10 | A |

**Figure 7** Output inverter FWD

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

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



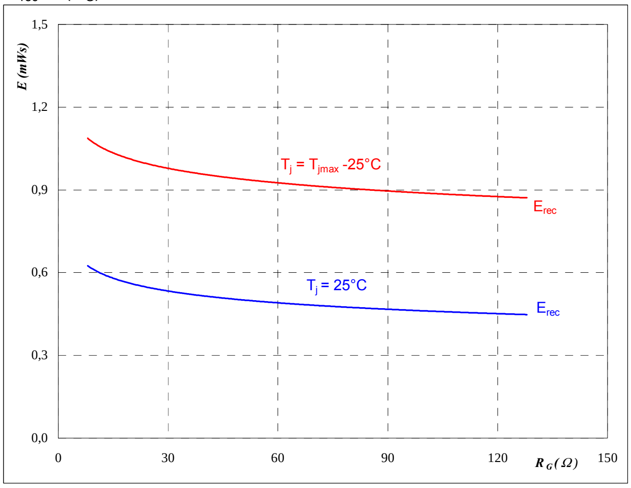

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 64 | Ω |

**Figure 8** Output inverter FWD

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

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




With an inductive load at

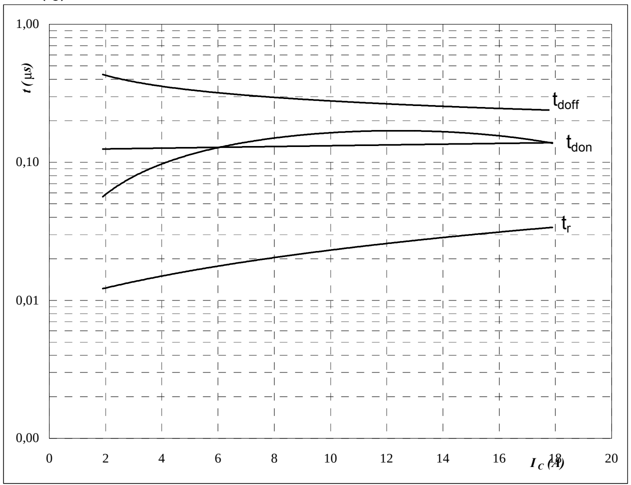
| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 10 | A |

# Output Inverter

**Figure 9** Output inverter IGBT

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

t = f($I_C$)



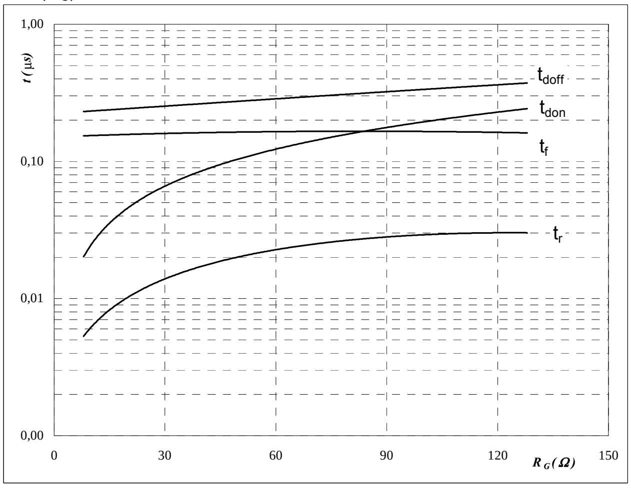

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 125 | °C |
| $V_{CE}$ = | 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($R_G$)



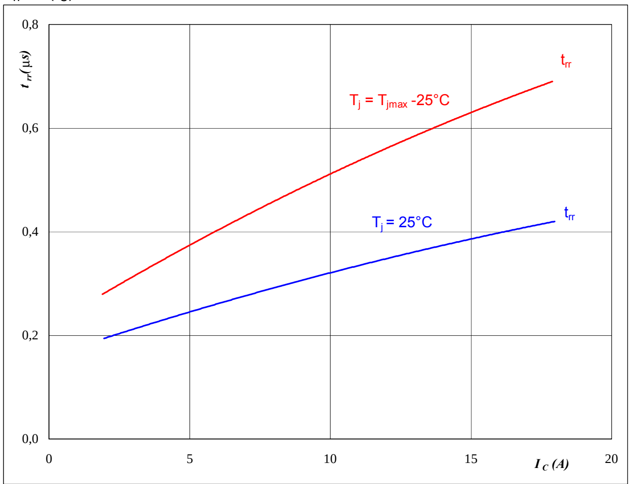

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 125 | °C |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 10 | A |

**Figure 11** Output inverter FWD

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

$t_{rr}$ = f($I_C$)



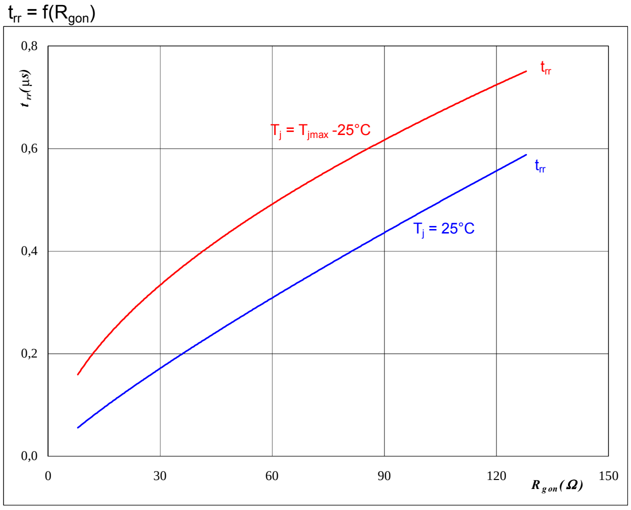

**At**

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 64 | Ω |

**Figure 12** Output inverter FWD

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

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




**At**

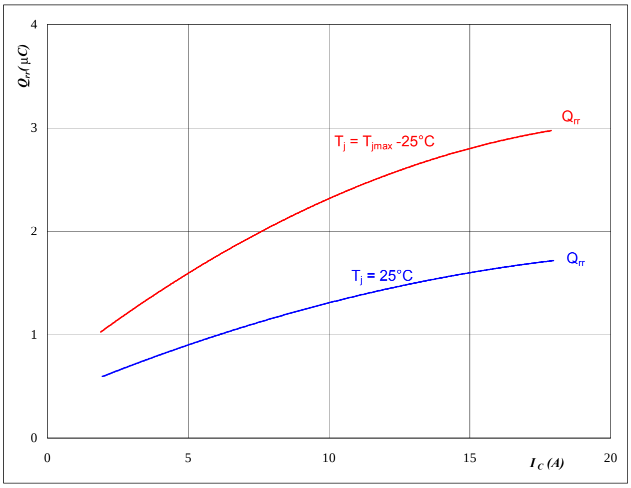
| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_R$ = | 600 | V |
| $I_F$ = | 10 | A |
| $V_{GE}$ = | ±15 | V |

# Output Inverter

**Figure 13** Output inverter FWD

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

$Q_{rr} = f(I_C)$



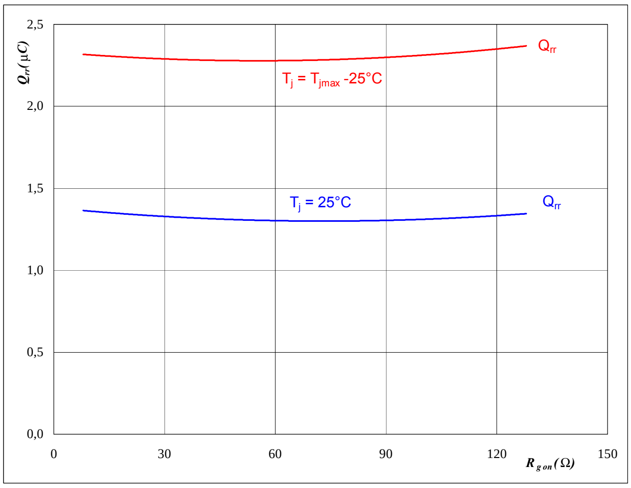

**At**

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 64 | Ω |

**Figure 14** Output inverter FWD

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

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



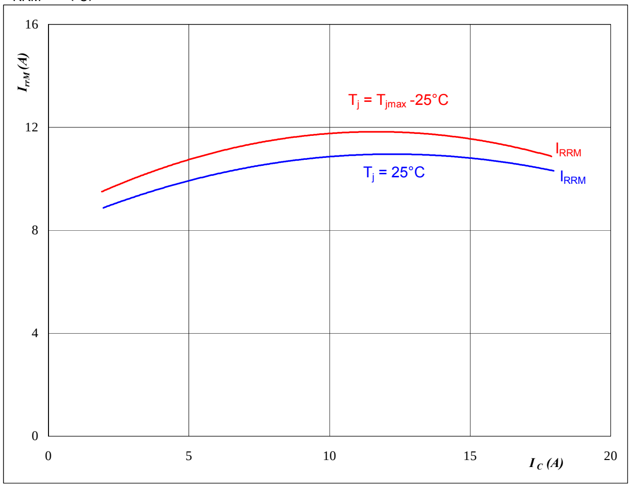

**At**

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_R$ = | 600 | V |
| $I_F$ = | 10 | A |
| $V_{GE}$ = | ±15 | V |

**Figure 15** Output inverter FWD

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

$I_{RRM} = f(I_C)$



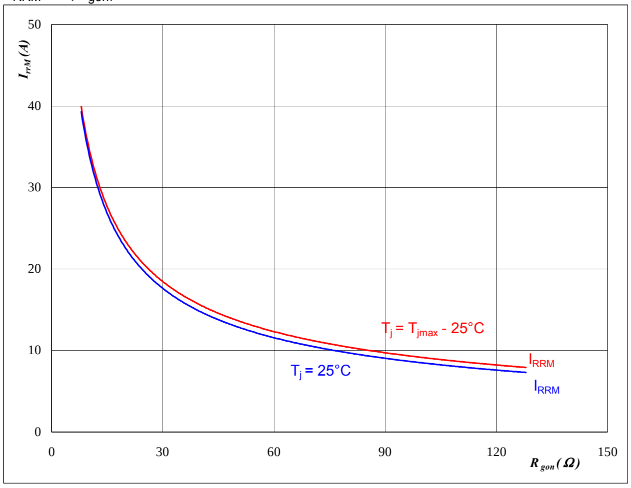

**At**

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 64 | Ω |

**Figure 16** Output inverter FWD

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

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




**At**

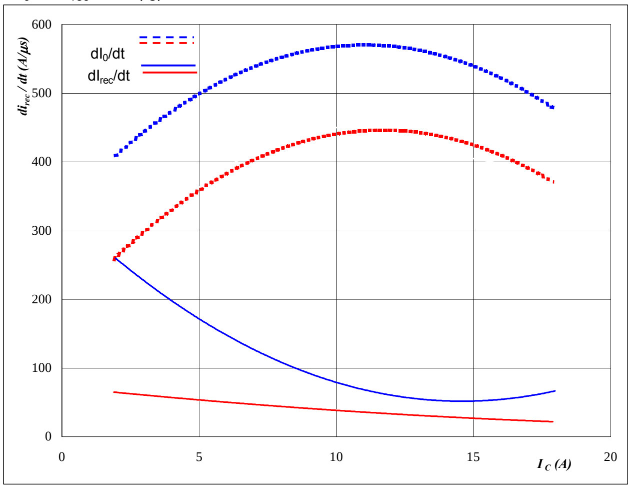
| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_R$ = | 600 | V |
| $I_F$ = | 10 | A |
| $V_{GE}$ = | ±15 | V |

# Output Inverter

**Figure 17** — Output inverter FWD

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

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



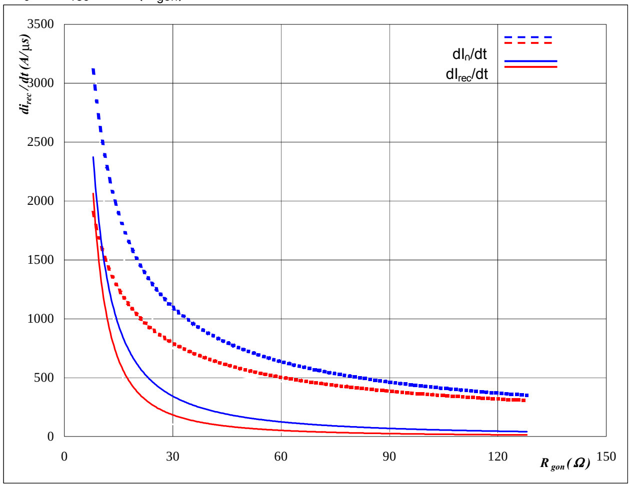

At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 64 | Ω |

**Figure 18** — Output inverter FWD

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

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



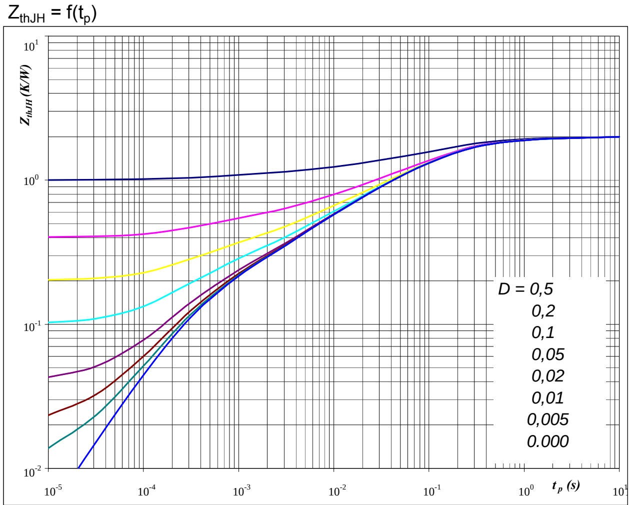

At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_R$ = | 600 | V |
| $I_F$ = | 10 | A |
| $V_{GE}$ = | ±15 | V |

**Figure 19** — Output inverter IGBT

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

$Z_{thJH} = f(t_p)$



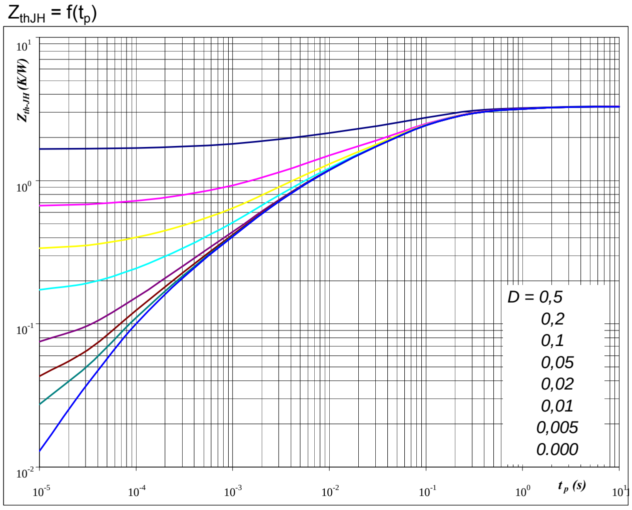

At

| | | | | | |
|---|---|---|---|---|---|
| D = | $t_p$ / T | | | | |
| $R_{thJH}$ = | 1,99 | K/W | RthJH = | 1,93 | K/W |

**Figure 20** — Output inverter FWD

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

$Z_{thJH} = f(t_p)$




At

| | | | | | |
|---|---|---|---|---|---|
| D = | $t_p$ / T | | | | |
| $R_{thJH}$ = | 3,30 | K/W | RthJH = | 3,20 | K/W |

IGBT thermal model values

| Thermal grease | | Phase change interface | |
|---|---|---|---|
| R (C/W) | Tau (s) | R (C/W) | Tau (s) |
| 0,09 | 4,8E+00 | 0,09 | 4,7E+00 |
| 0,35 | 4,4E-01 | 0,34 | 4,2E-01 |
| 0,86 | 1,0E-01 | 0,83 | 9,7E-02 |
| 0,39 | 1,6E-02 | 0,37 | 1,5E-02 |
| 0,17 | 2,9E-03 | 0,16 | 2,8E-03 |
| 0,14 | 3,5E-04 | 0,14 | 3,4E-04 |

FWD thermal model values

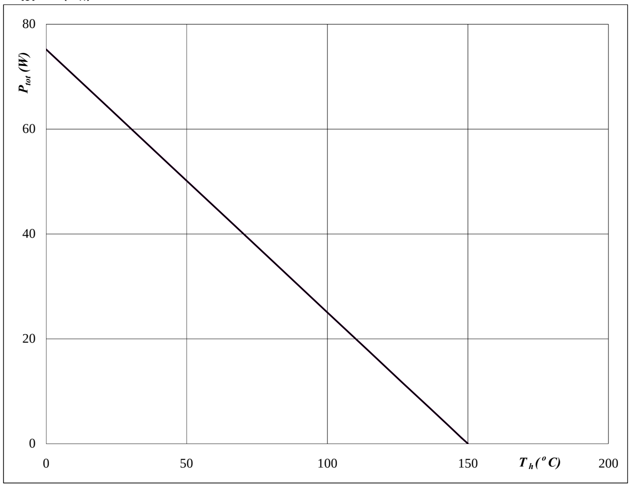
| Thermal grease | | Phase change interface | |
|---|---|---|---|
| R (C/W) | Tau (s) | R (C/W) | Tau (s) |
| 0,04 | 6,0E+01 | 0,00 | 0,0E+00 |
| 0,23 | 1,4E+00 | 0,00 | 0,0E+00 |
| 1,03 | 1,5E-01 | 0,00 | 0,0E+00 |
| 0,99 | 4,1E-02 | 0,00 | 0,0E+00 |
| 0,63 | 6,0E-03 | 0,00 | 0,0E+00 |
| 0,29 | 1,1E-03 | 0,00 | 0,0E+00 |

# Output Inverter

**Figure 21** Output inverter IGBT

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

$P_{tot} = f(T_h)$



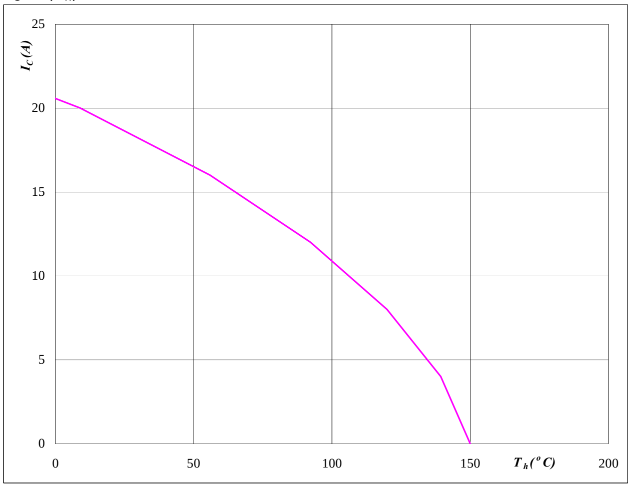

**At**

$T_j$ = 175 °C

**Figure 22** Output inverter IGBT

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

$I_C = f(T_h)$




**At**

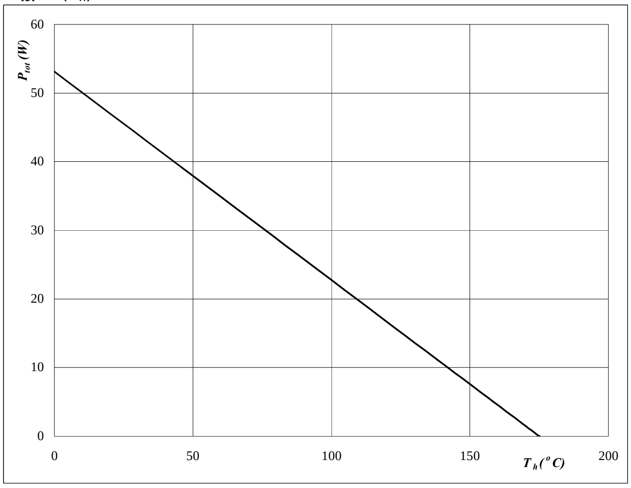
$T_j$ = 175 °C

$V_{GE}$ = 15 V

**Figure 23** Output inverter FWD

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

$P_{tot} = f(T_h)$



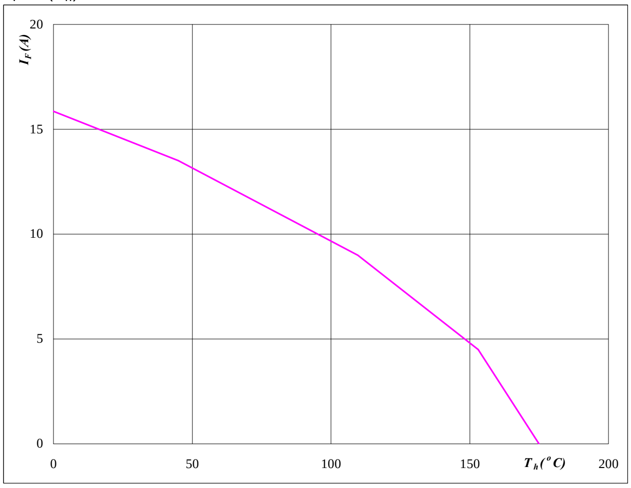

**At**

$T_j$ = 175 °C

**Figure 24** Output inverter FWD

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

$I_F = f(T_h)$




**At**

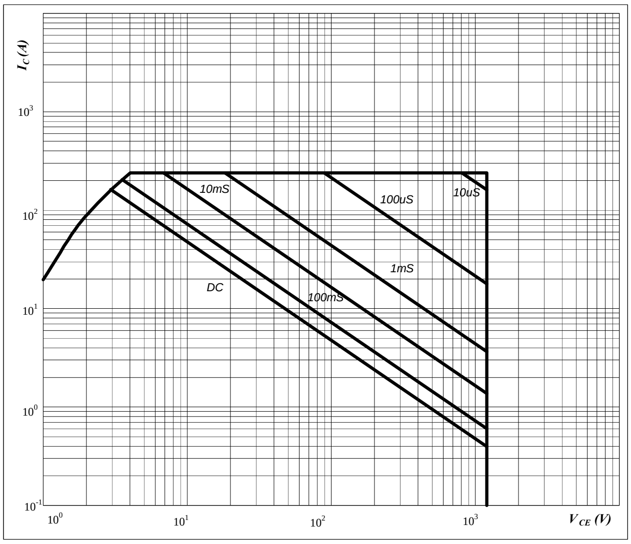
$T_j$ = 175 °C

# Output Inverter

**Figure 25** Output inverter IGBT

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

$I_C = f(V_{CE})$



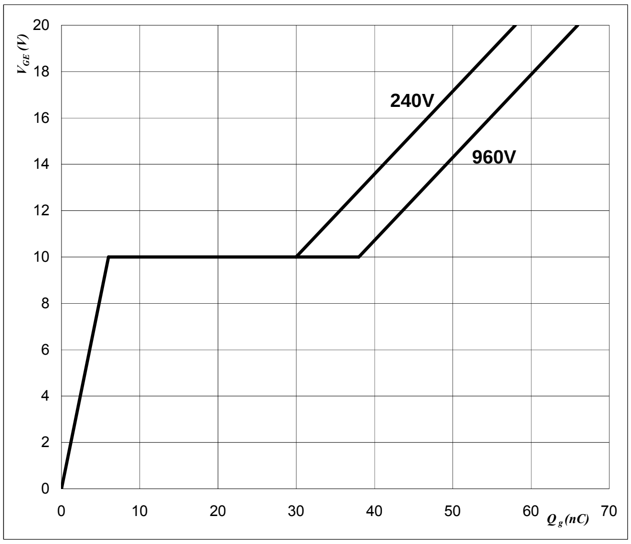

**At**

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

**Figure 26** Output inverter IGBT

**Gate voltage vs Gate charge**

$V_{GE} = f(Q_{GE})$



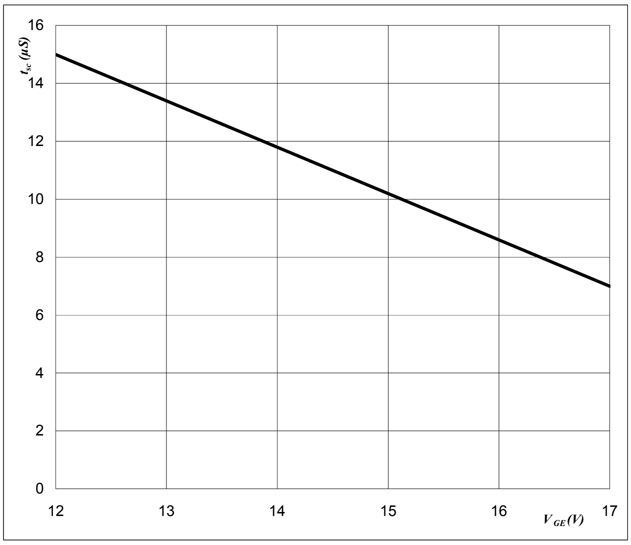

**At**

| | | |
|---|---|---|
| $I_C$ = | 10 | A |

**Figure 27** Output inverter IGBT

**Short circuit withstand time as a function of gate-emitter voltage**

$t_{sc} = f(V_{GE})$



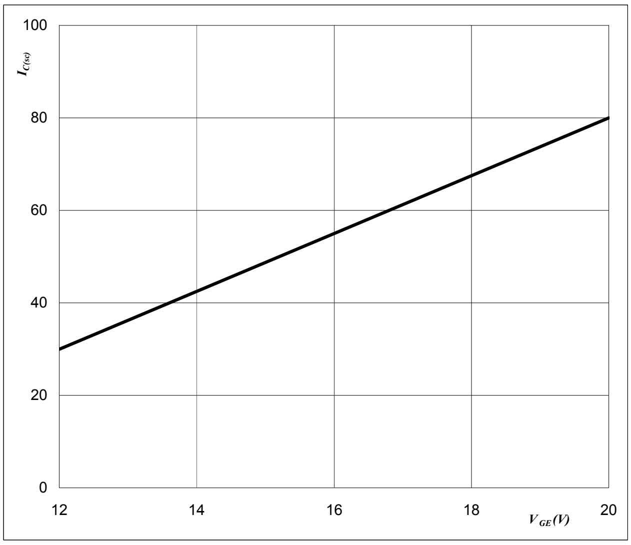

**At**

| | | |
|---|---|---|
| $V_{CE}$ = | 1200 | V |
| $T_j$ ≤ | 175 | ºC |

**Figure 28** Output inverter IGBT

**Typical short circuit collector current as a function of gate-emitter voltage**

$V_{GE} = f(Q_{GE})$



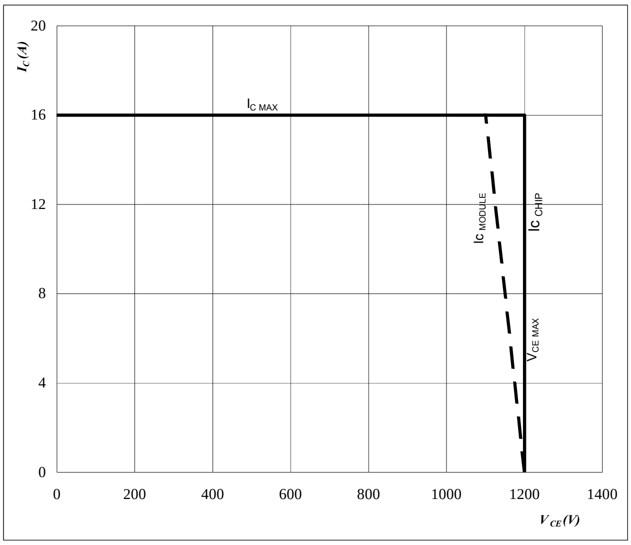

**At**

| | | |
|---|---|---|
| $V_{CE}$ ≤ | 1200 | V |
| $T_j$ = | 175 | ºC |

**Figure 29** IGBT

**Reverse bias safe operating area**

$I_C = f(V_{CE})$




**At**

$T_j$ = $T_{jmax}$-25 ºC

$U_{ccminus}$=$U_{ccplus}$

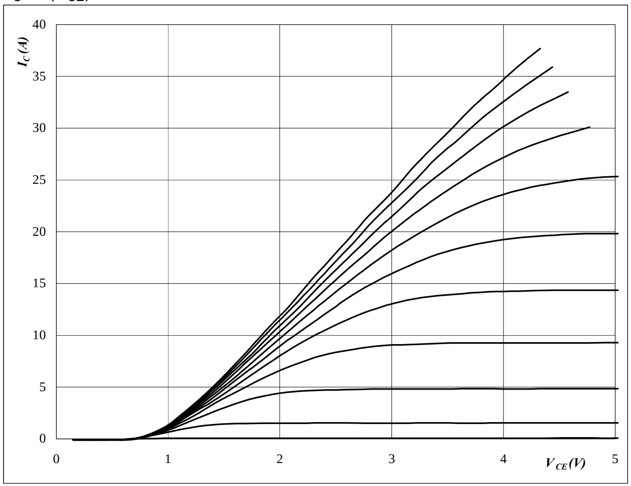
Switching mode : 3 level switching

# Brake

**Figure 1** Brake IGBT

**Typical output characteristics**

$I_C = f(V_{CE})$




**At**

$t_p$ = 250 µs

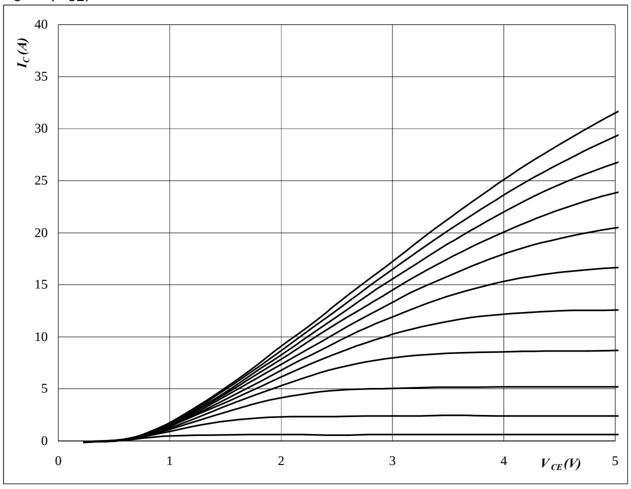
$T_j$ = 25 °C

$V_{GE}$ from 7 V to 17 V in steps of 1 V

**Figure 2** Brake IGBT

**Typical output characteristics**

$I_C = f(V_{CE})$




**At**

$t_p$ = 250 µs

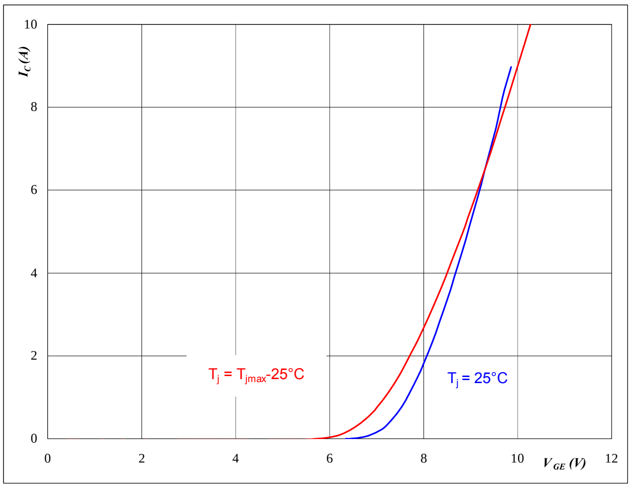
$T_j$ = 125 °C

$V_{GE}$ from 7 V to 17 V in steps of 1 V

**Figure 3** Brake IGBT

**Typical transfer characteristics**

$I_C = f(V_{GE})$




**At**

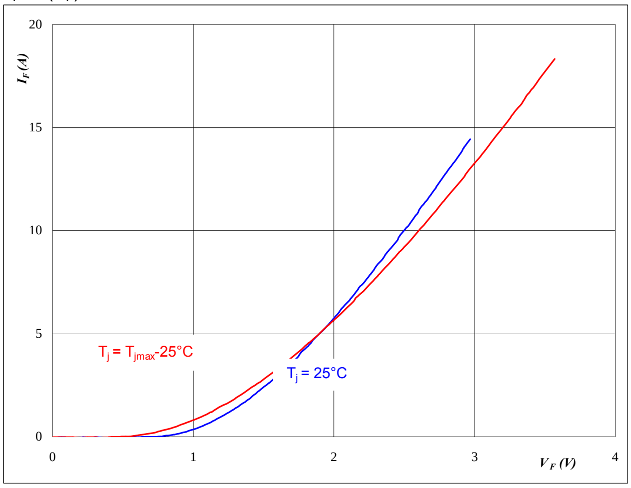
$t_p$ = 250 µs

$V_{CE}$ = 10 V

**Figure 4** Brake FWD

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

$I_F = f(V_F)$




**At**

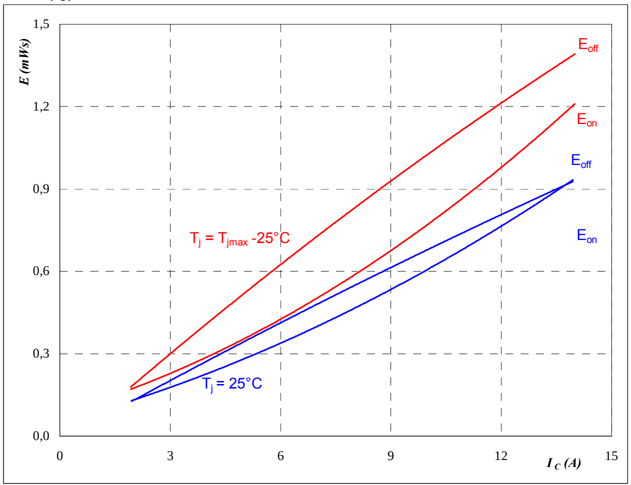
$t_p$ = 250 µs

# Brake

**Figure 5** Brake IGBT

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

$E = f(I_C)$



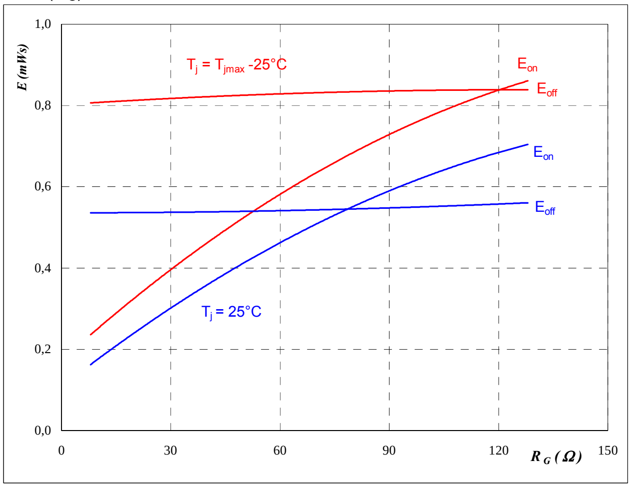

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °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**

$E = f(R_G)$



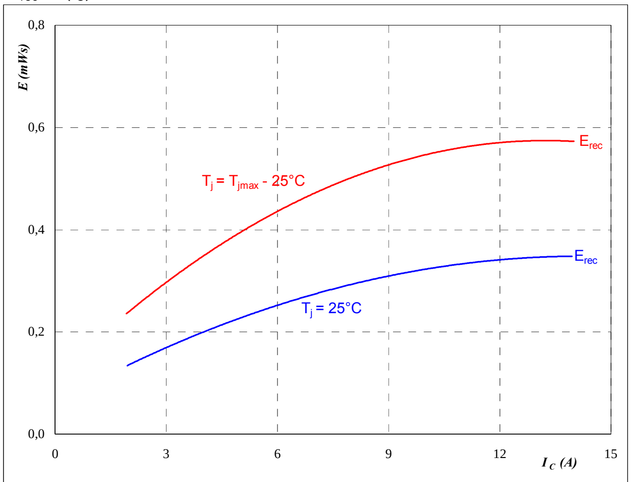

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 8 | A |

**Figure 7** Brake FWD

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

$E_{rec} = f(I_C)$



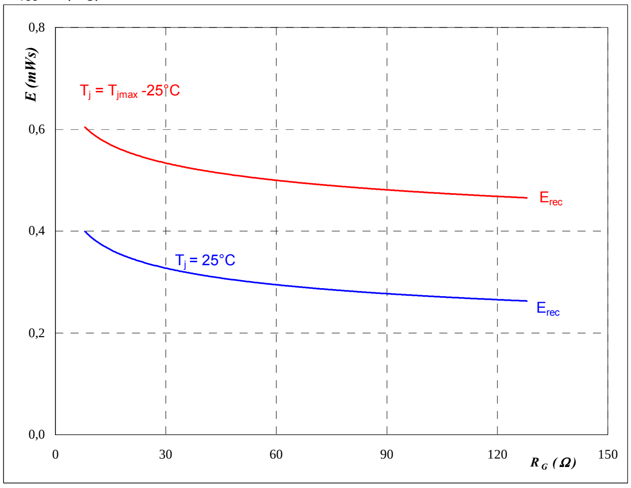

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 64 | Ω |

**Figure 8** Brake FWD

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

$E_{rec} = f(R_G)$



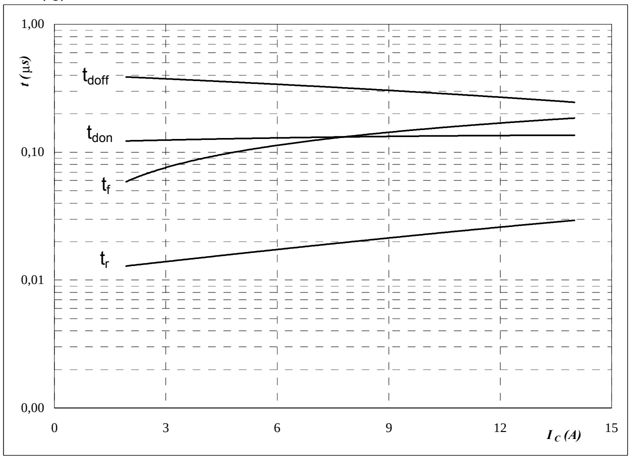

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 8 | A |

# Brake

| **Figure 9** | Brake IGBT |
| --- | --- |

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

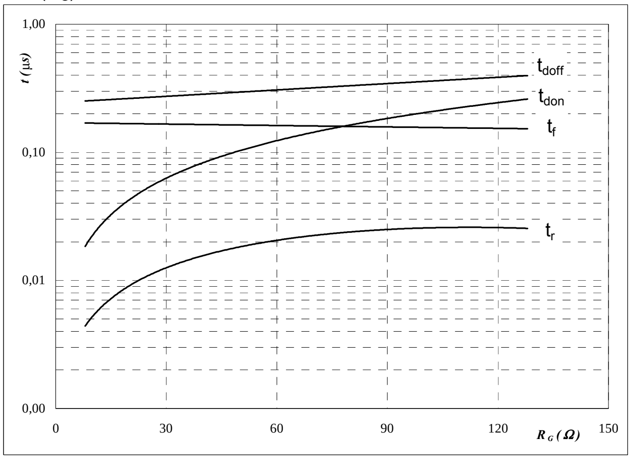



With an inductive load at

| | | |
| --- | --- | --- |
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 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**
$t = f(R_G)$

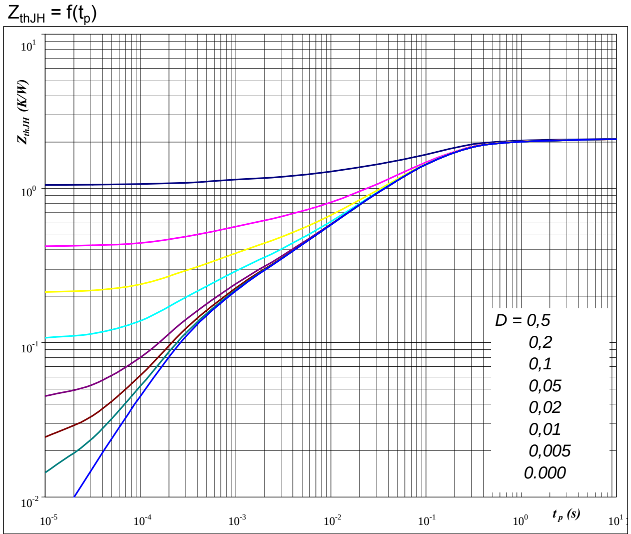



With an inductive load at

| | | |
| --- | --- | --- |
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 8 | A |

| **Figure 11** | Brake IGBT |
| --- | --- |

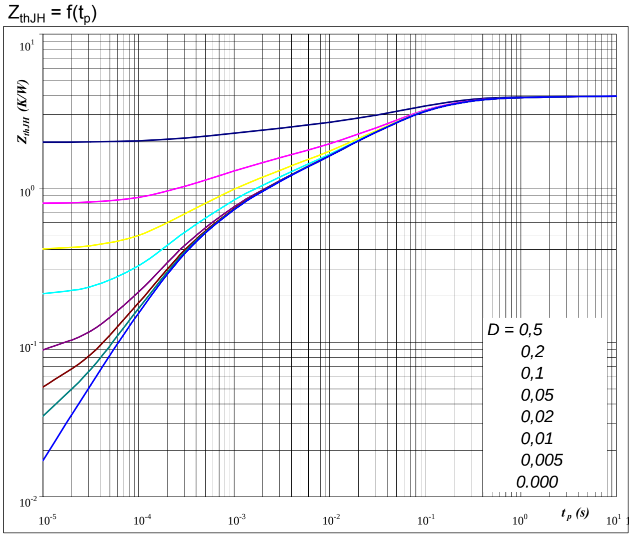
**IGBT transient thermal impedance as a function of pulse width**
$Z_{thJH} = f(t_p)$




| At | | D = | tp / T | | |
| --- | --- | --- | --- | --- | --- |
| Thermal grease | | | Phase change interface | | |
| $R_{thJH}$ = | 2,09 | K/W | $R_{thJH}$ = | 0,60 | K/W |

| **Figure 12** | Brake FWD |
| --- | --- |

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



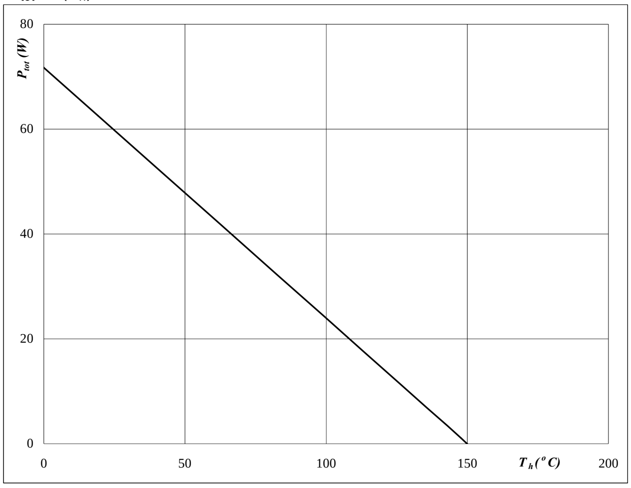

| At | | D = | tp / T | | |
| --- | --- | --- | --- | --- | --- |
| Thermal grease | | | Phase change interface | | |
| $R_{thJH}$ = | 3,97 | K/W | $R_{thJH}$ = | 1,27 | K/W |

# Brake

**Figure 13** Brake IGBT

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

$P_{tot} = f(T_h)$



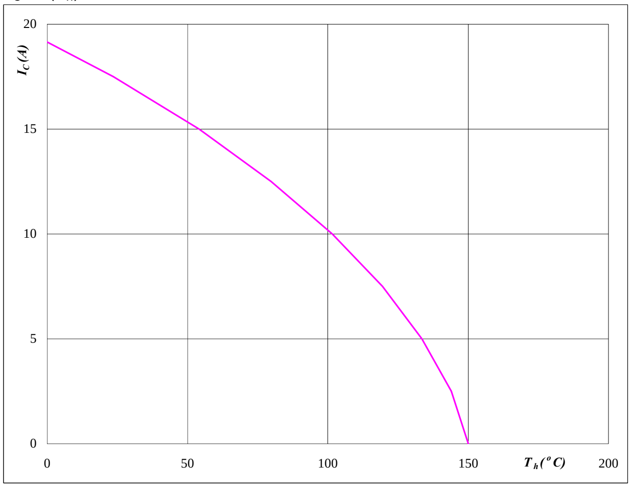

**At**

| | | |
|---|---|---|
| $T_j$ = | 175 | °C |

**Figure 14** Brake IGBT

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

$I_C = f(T_h)$



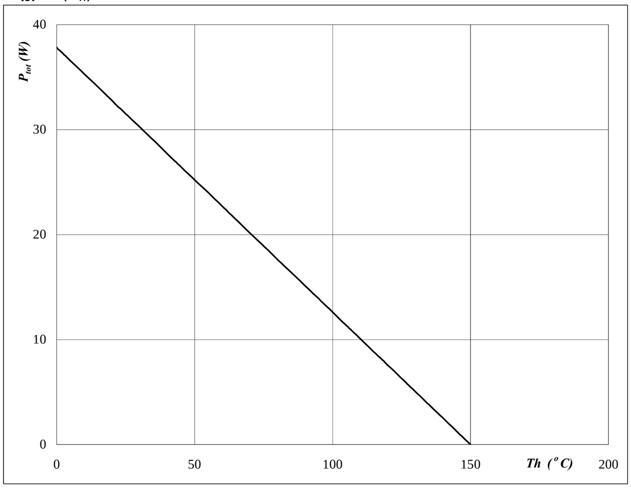

**At**

| | | |
|---|---|---|
| $T_j$ = | 175 | °C |
| $V_{GE}$ = | 15 | V |

**Figure 15** Brake FWD

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

$P_{tot} = f(T_h)$



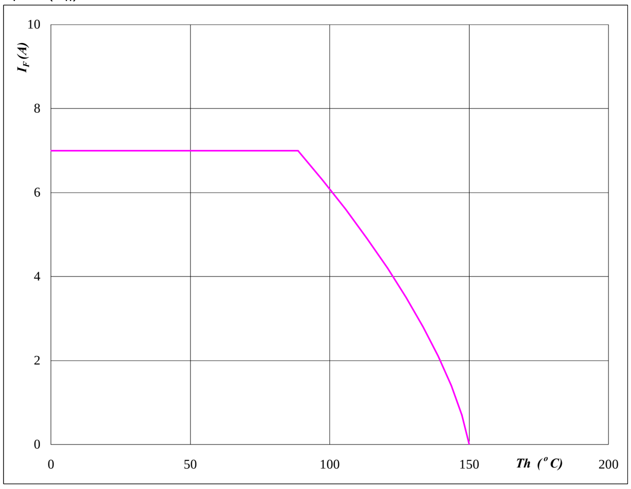

**At**

| | | |
|---|---|---|
| $T_j$ = | 175 | °C |

**Figure 16** Brake FWD

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

$I_F = f(T_h)$




**At**

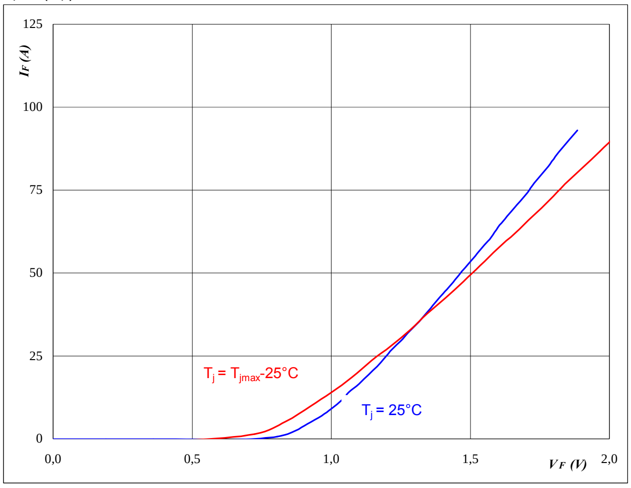
| | | |
|---|---|---|
| $T_j$ = | 175 | °C |

# Input Rectifier Bridge

| **Figure 1** | Rectifier diode |
|---|---|

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

$I_F = f(V_F)$



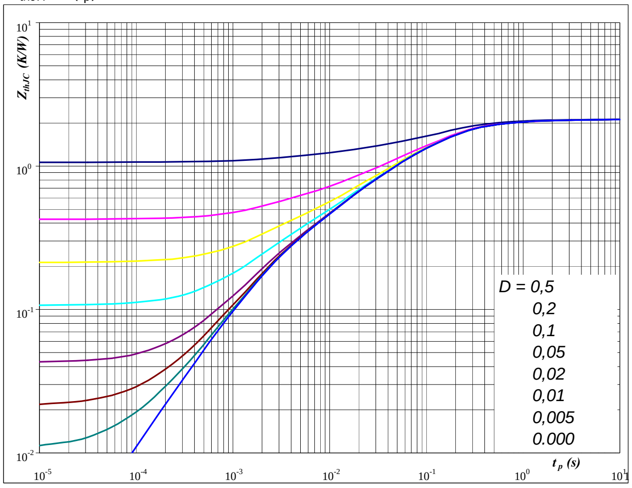

**At**

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

| **Figure 2** | Rectifier diode |
|---|---|

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

$Z_{thJH} = f(t_p)$



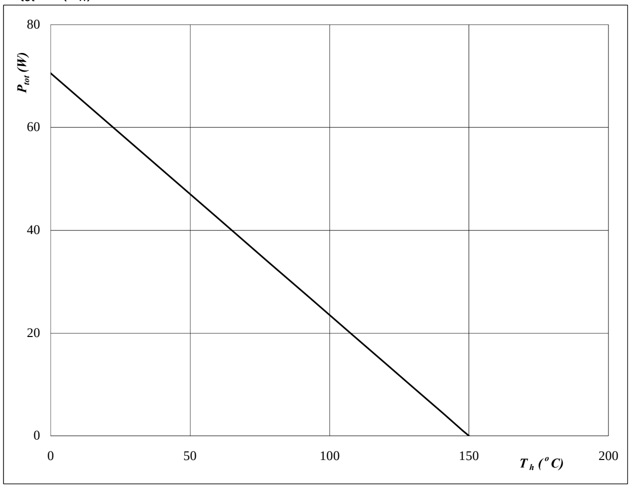

**At**

| | | |
|---|---|---|
| D = | $t_p$ / T | |
| $R_{thJH}$ = | 2,126 | K/W |

| **Figure 3** | Rectifier diode |
|---|---|

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

$P_{tot} = f(T_h)$



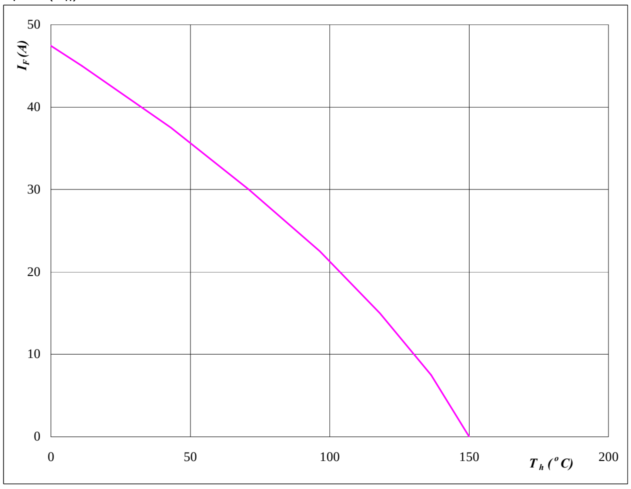

**At**

| | | |
|---|---|---|
| $T_j$ = | 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**
$R_T = f(T)$

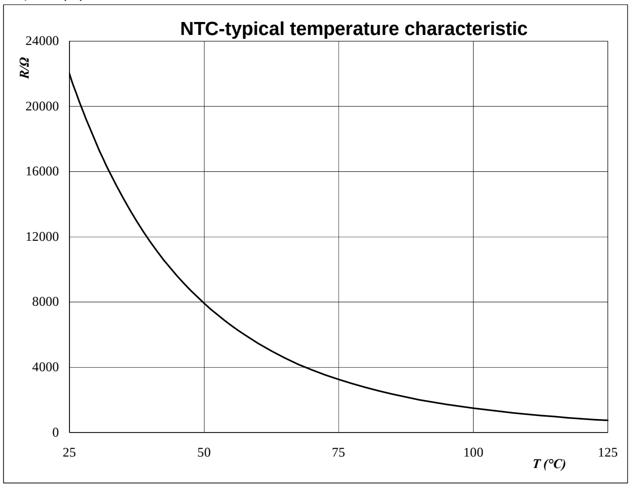



**Figure 2** Thermistor

**Typical NTC resistance values**

$$R(T) = R_{25} \cdot e^{\left(B_{25/100} \cdot \left(\frac{1}{T} - \frac{1}{T_{25}}\right)\right)} \quad [\Omega]$$

| T [°C] | $R_{nom}$ [Ω] | $R_{min}$ [Ω] | $R_{max}$ [Ω] | △R/R [±%] |
|---|---|---|---|---|
| -55 | 2089434,5 | 1506495,4 | 2672373,6 | 27,9 |
| 0 | 71804,2 | 59724,4 | 83884 | 16,8 |
| 10 | 43780,4 | 37094,4 | 50466,5 | 15,3 |
| 20 | 27484,6 | 23684,6 | 31284,7 | 13,8 |
| 25 | 22000 | 19109,3 | 24890,7 | 13,1 |
| 30 | 17723,3 | 15512,2 | 19934,4 | 12,5 |
| 60 | 5467,9 | 4980,6 | 5955,1 | 8,9 |
| 70 | 3848,6 | 3546 | 4151,1 | 7,9 |
| 80 | 2757,7 | 2568,2 | 2947,1 | 6,9 |
| 90 | 2008,9 | 1889,7 | 2128,2 | 5,9 |
| **100** | **1486,1** | **1411,8** | **1560,4** | **5** |
| 150 | 400,2 | 364,8 | 435,7 | 8,8 |

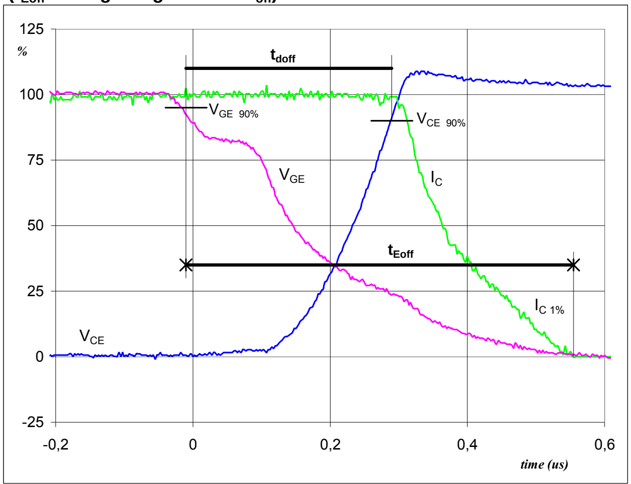
# Switching Definitions Output Inverter

**General conditions**

| | | |
|---|---|---|
| $T_j$ | = | 125 °C |
| $R_{gon}$ | = | 64 Ω |
| $R_{goff}$ | = | 64 Ω |

**Figure 1** Output inverter IGBT

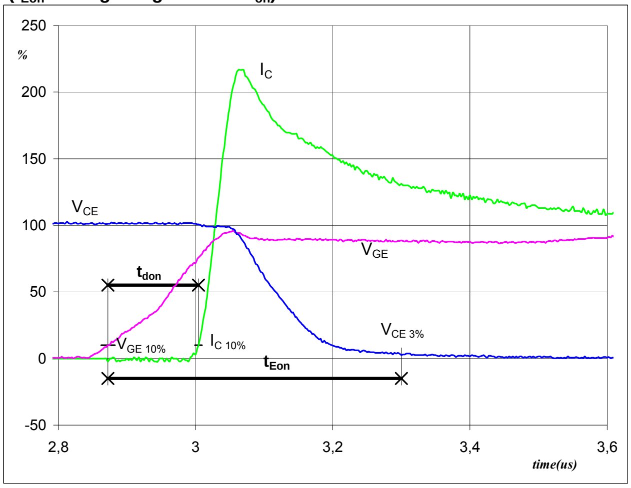
**Turn-off Switching Waveforms & definition of $t_{doff}$, $t_{Eoff}$**
**($t_{Eoff}$ = integrating time for $E_{off}$)**




| | | |
|---|---|---|
| $V_{GE}$ (0%) = | -15 | V |
| $V_{GE}$ (100%) = | 15 | V |
| $V_C$ (100%) = | 600 | V |
| $I_C$ (100%) = | 10 | A |
| $t_{doff}$ = | 0,29 | μs |
| $t_{Eoff}$ = | 0,56 | μs |

**Figure 2** Output inverter IGBT

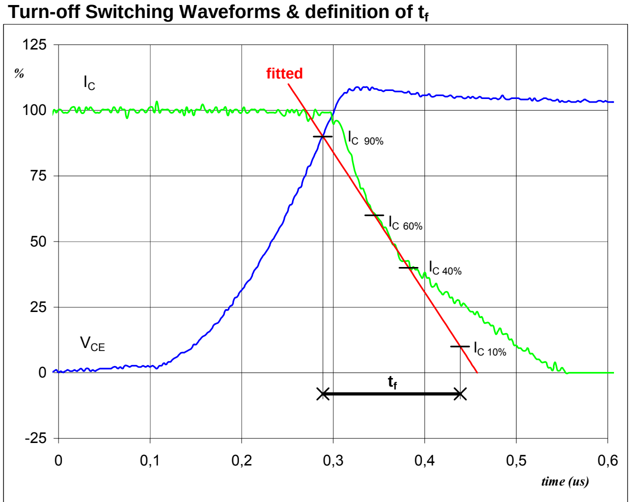
**Turn-on Switching Waveforms & definition of tdon, $t_{Eon}$**
**($t_{Eon}$ = integrating time for $E_{on}$)**




| | | |
|---|---|---|
| $V_{GE}$ (0%) = | -15 | V |
| $V_{GE}$ (100%) = | 15 | V |
| $V_C$ (100%) = | 600 | V |
| $I_C$ (100%) = | 10 | A |
| $t_{don}$ = | 0,13 | μs |
| $t_{Eon}$ = | 0,43 | μs |

**Figure 3** Output inverter IGBT

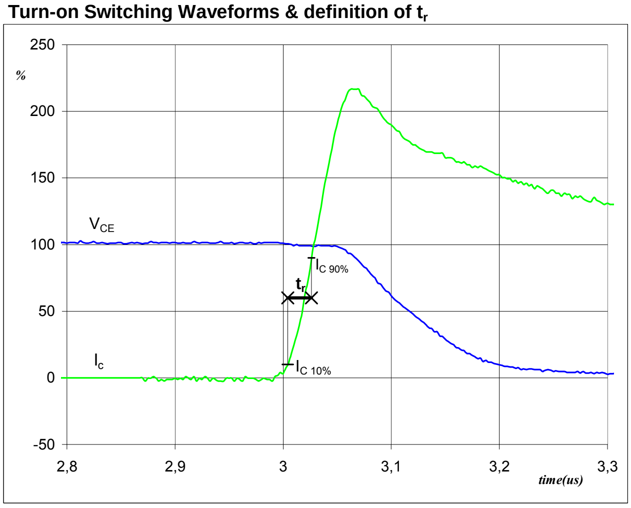
**Turn-off Switching Waveforms & definition of $t_f$**




| | | |
|---|---|---|
| $V_C$ (100%) = | 600 | V |
| $I_C$ (100%) = | 10 | A |
| $t_f$ = | 0,16 | μs |

**Figure 4** Output inverter IGBT

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

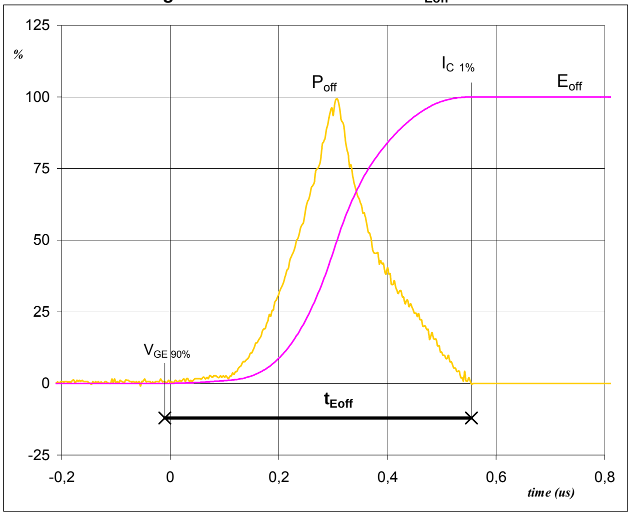



| | | |
|---|---|---|
| $V_C$ (100%) = | 600 | V |
| $I_C$ (100%) = | 10 | A |
| $t_r$ = | 0,02 | μs |

# Switching Definitions Output Inverter

**Figure 5** — Output inverter IGBT

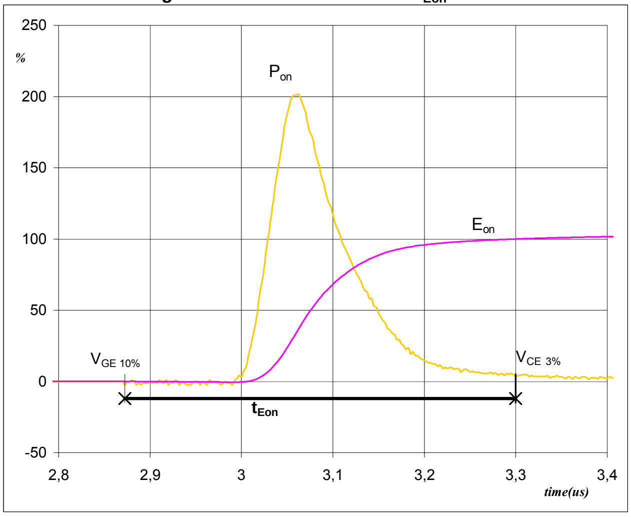
**Turn-off Switching Waveforms & definition of $t_{Eoff}$**




| | | |
|---|---|---|
| $P_{off}$ (100%) = | 5,97 | kW |
| $E_{off}$ (100%) = | 1,01 | mJ |
| $t_{Eoff}$ = | 0,56 | μs |

**Figure 6** — Output inverter IGBT

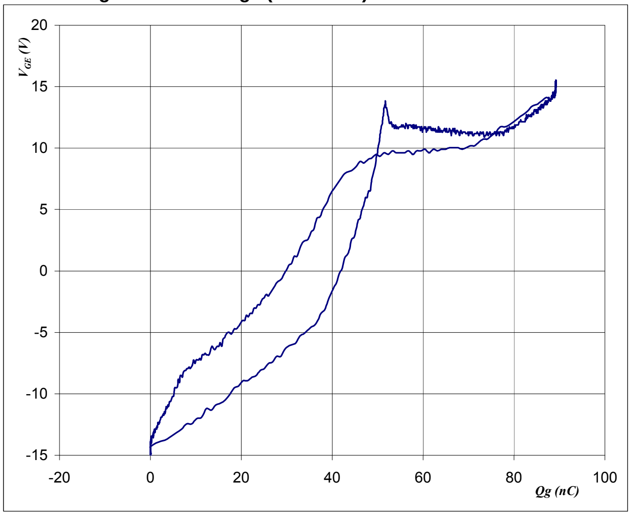
**Turn-on Switching Waveforms & definition of $t_{Eon}$**




| | | |
|---|---|---|
| $P_{on}$ (100%) = | 5,97 | kW |
| $E_{on}$ (100%) = | 1,13 | mJ |
| $t_{Eon}$ = | 0,43 | μs |

**Figure 7** — Output inverter FWD

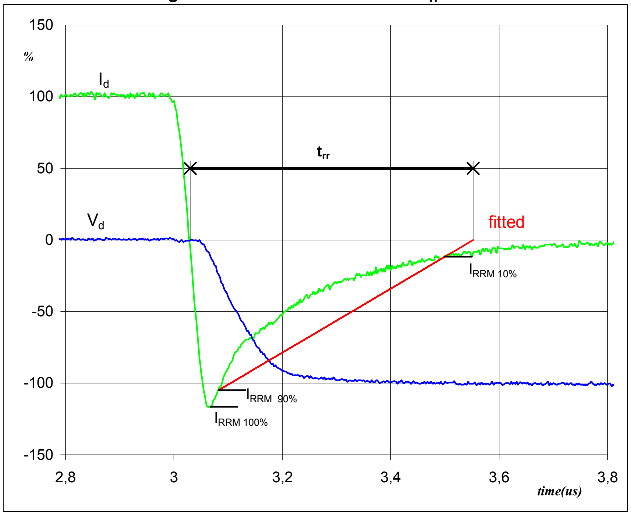
**Gate voltage vs Gate charge (measured)**




| | | |
|---|---|---|
| $V_{GEoff}$ = | -15 | V |
| $V_{GEon}$ = | 15 | V |
| $V_C$ (100%) = | 600 | V |
| $I_C$ (100%) = | 10 | A |
| $Q_g$ = | 89,25 | nC |

**Figure 8** — Output inverter IGBT

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

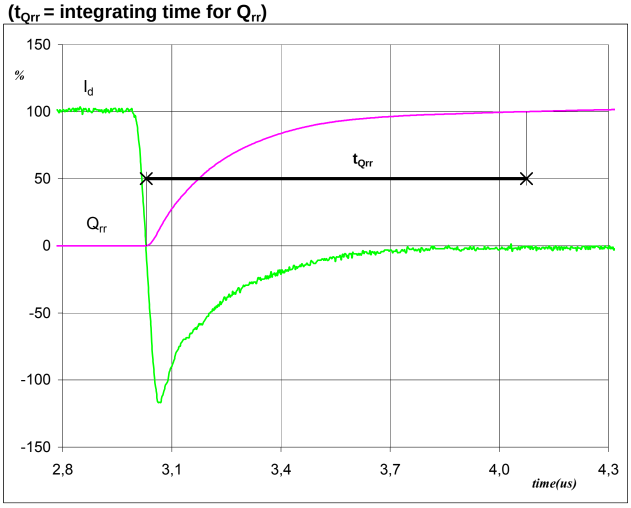



| | | |
|---|---|---|
| $V_d$ (100%) = | 600 | V |
| $I_d$ (100%) = | 10 | A |
| $I_{RRM}$ (100%) = | 12 | A |
| $t_{rr}$ = | 0,50 | μs |

# Switching Definitions Output Inverter

**Figure 9** Output inverter FWD

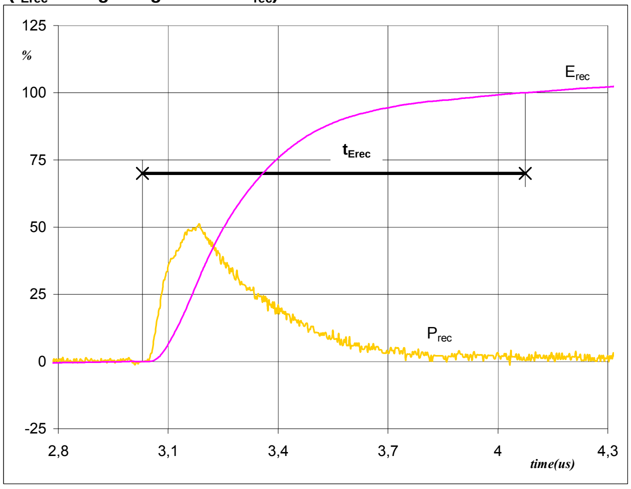
**Turn-on Switching Waveforms & definition of $t_{Qrr}$**
**($t_{Qrr}$ = integrating time for $Q_{rr}$)**




| | | |
|---|---|---|
| $I_d$ (100%) = | 10 | A |
| $Q_{rr}$ (100%) = | 2,30 | µC |
| $t_{Qrr}$ = | 1,04 | µs |

**Figure 10** Output inverter FWD

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




| | | |
|---|---|---|
| $P_{rec}$ (100%) = | 5,97 | kW |
| $E_{rec}$ (100%) = | 0,93 | mJ |
| $t_{Erec}$ = | 1,04 | µs |

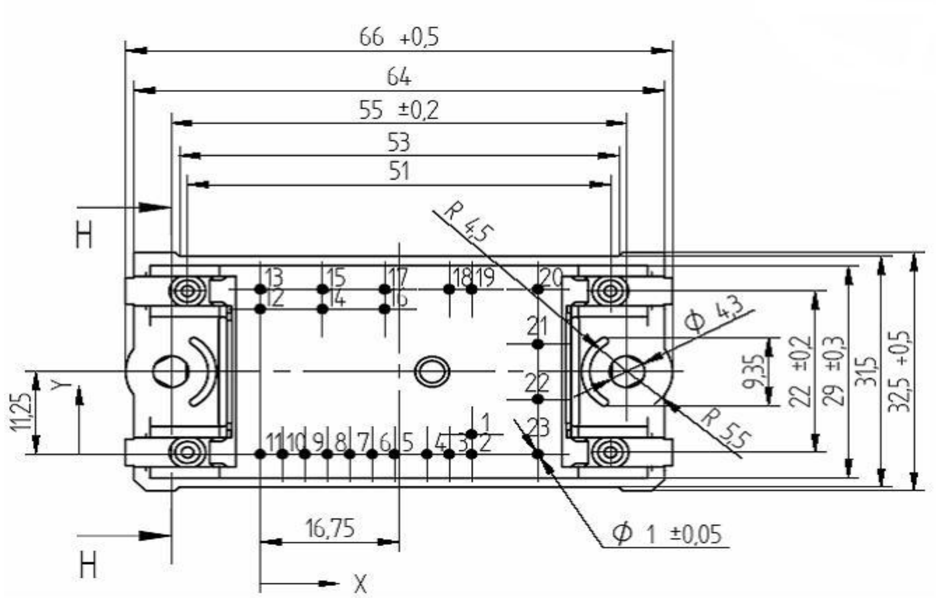
# Ordering Code and Marking - Outline - Pinout

## Ordering Code & Marking

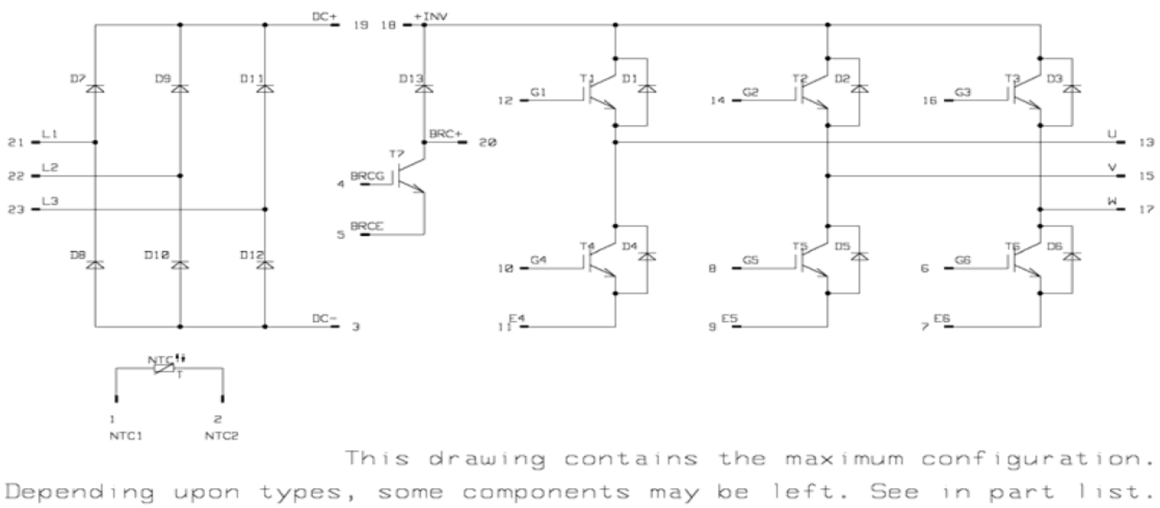
| Version | Ordering Code | in DataMatrix as | in packaging barcode as |
|---|---|---|---|
| without thermal paste 12mm housing | V23990-P549-A-PM | P549-A | P549-A |

## 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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| Datasheet Status | Product Status | Definition |
|---|---|---|
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