Vincotech

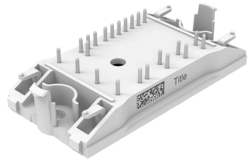
# V23990-P541-*3*-PM

***flow* PIM 0** 600 V / 6 A

## Features

- Trench Fieldstop IGBTs for low saturation losses
- Compact and low inductive design
- built in NTC
- Optional w/o BRC
- Enhanced rectifier

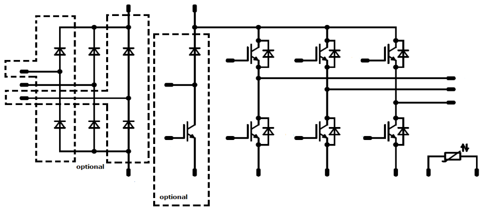
## *flow* 0 12 mm housing



## Target Applications

- Industrial drives
- Embedded drives

## Schematic




## Types

- V23990-P541-A38-PM
- V23990-P541-B138-PM
- V23990-P541-C38-PM
- V23990-P541-D138-PM

# Maximum Ratings

$T_j$ = 25 °C, unless otherwise specified

| Parameter | Symbol | Condition | | Value | Unit |
|---|---|---|---|---|---|
| **Rectifier Diode** | | | | | |
| Repetitive peak reverse voltage | $V_{RRM}$ | | | 1600 | V |
| DC forward current | $I_{FAV}$ | $T_j = T_{jmax}$ | $T_s$ = 80 °C | 33 | A |
| Surge (non-repetitive) forward current | $I_{FSM}$ | $t_p$ = 10 ms 50Hz half sine wave | $T_s$ = 150 °C | 270 | A |
| $I^2t$-value | $I^2t$ | | | 370 | $A^2s$ |
| Power dissipation | $P_{tot}$ | $T_j = T_{jmax}$ | $T_s$ = 80 °C | 37 | W |
| Maximum Junction Temperature | $T_{jmax}$ | | | 150 | °C |
| **Inverter Switch / Brake Switch** | | | | | |
| Collector-emitter break down voltage | $V_{CE}$ | | | 600 | V |
| DC collector current | $I_C$ | $T_j = T_{jmax}$ | $T_s$ = 80 °C | 12 | A |
| Repetitive peak collector current | $I_{CRM}$ | $t_p$ limited by $T_{jmax}$ | | 18 | A |
| Turn off safe operating area | | $V_{CE} \leq$ 600V, $T_j \leq T_{op}$ max | | 18 | A |
| Power dissipation | $P_{tot}$ | $T_j = T_{jmax}$ | $T_s$ = 80 °C | 36 | W |
| Gate-emitter peak voltage | $V_{GE}$ | | | ±20 | V |
| Short circuit ratings | $t_{SC}$<br>$V_{CC}$ | $T_j \leq$ 150 °C<br>$V_{GE}$ = 15 V | | 6<br>360 | μs<br>V |
| Maximum Junction Temperature | $T_{jmax}$ | | | 175 | °C |

# Maximum Ratings

$T_j$ = 25 °C, unless otherwise specified

| Parameter | Symbol | Condition | | Value | Unit |
|---|---|---|---|---|---|
| **Inverter Diode / Brake Diode** | | | | | |
| Peak Repetitive Reverse Voltage | $V_{RRM}$ | | | 600 | V |
| DC forward current | $I_F$ | $T_j = T_{jmax}$ | $T_s$ = 80 °C | 12 | A |
| Repetitive peak forward current | $I_{FRM}$ | $t_p$ limited by $T_{jmax}$ | | 12 | A |
| Power dissipation | $P_{tot}$ | $T_j = T_{jmax}$ | $T_s$ = 80 °C | 27 | W |
| Maximum Junction Temperature | $T_{jmax}$ | | | 175 | °C |
| **Thermal Properties** | | | | | |
| Storage temperature | $T_{stg}$ | | | -40…+125 | °C |
| Operation temperature under switching condition | $T_{op}$ | | | -40…+($T_{jmax}$ - 25) | °C |
| **Isolation Properties** | | | | | |
| Isolation voltage | $V_{is}$ | $t$ = 2 s | DC Test Voltage* | 6000 | V |
| | | $t$ = 1 min | AC Voltage | 2500 | V |
| Creepage distance | | | | min 12,7 | mm |
| Clearance | | | | 9,29 | mm |
| Comparative tracking index | CTI | | | >200 | |

* 100% tested in production

# Characteristic Values

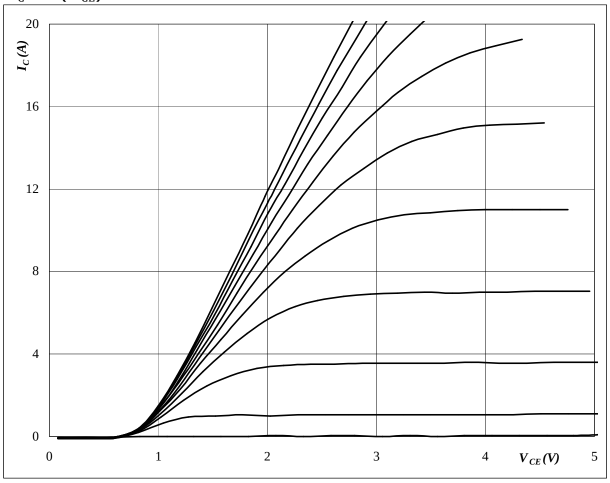
| Parameter | Symbol | Conditions | $V_{GE}$ [V]<br>$V_{GS}$ [V] | $V_r$ [V]<br>$V_{CE}$ [V]<br>$V_{DS}$ [V] | $I_C$ [A]<br>$I_F$ [A]<br>$I_D$ [A] | $T_j$ [°C] | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| **Rectifier Diode** | | | | | | | | | | |
| Forward voltage | $V_F$ | | | | 30 | 25<br>125 | #VALUE!<br>### | #VALUE!<br>#VALUE! | #VALUE!<br>### | V |
| Threshold voltage (for power loss calc. only) | $V_{to}$ | | | | 30 | 25<br>125 | ###<br>### | #VALUE!<br>#VALUE! | ###<br>### | V |
| Slope resistance (for power loss calc. only) | $r_t$ | | | | 30 | 25<br>125 | ###<br>### | #VALUE!<br>#VALUE! | ###<br>### | mΩ |
| Reverse current | $I_r$ | | | 1500 | | 150 | ###<br>### | ###<br>### | 2 | mA |
| Thermal resistance junction to sink | $R_{th(j-s)}$ | phase-change material<br>$\lambda$ = 3,4 W/mK | | | | | ### | #VALUE! | ### | K/W |
| **Inverter Switch** | | | | | | | | | | |
| Gate emitter threshold voltage | $V_{GE(th)}$ | $V_{CE} = V_{GE}$ | | | 0,00009 | 25 | #VALUE! | #VALUE! | #VALUE! | V |
| Collector-emitter saturation voltage | $V_{CEsat}$ | | 15 | | 6 | 25<br>150 | #VALUE!<br>### | #VALUE!<br>#VALUE! | #VALUE!<br>### | V |
| Collector-emitter cut-off current incl. Diode | $I_{CES}$ | | 0 | 600 | | 25 | ### | ### | #VALUE! | mA |
| Gate-emitter leakage current | $I_{GES}$ | | 20 | 0 | | 25 | ### | ### | #VALUE! | nA |
| Integrated Gate resistor | $R_{gint}$ | | | | | | ### | #VALUE! | ### | Ω |
| Turn-on delay time | $t_{d(on)}$ | $R_{goff}$ = 16 Ω<br>$R_{gon}$ = 32 Ω | 15 | 300 | 6 | 25<br>150 | ###<br>### | #VALUE!<br>#VALUE! | ###<br>### | ns |
| Rise time | $t_r$ | | | | | 25<br>150 | ###<br>### | #VALUE!<br>#VALUE! | ###<br>### | |
| Turn-off delay time | $t_{d(off)}$ | | | | | 25<br>150 | ###<br>### | #VALUE!<br>#VALUE! | ###<br>### | |
| Fall time | $t_f$ | | | | | 25<br>150 | ###<br>### | #VALUE!<br>#VALUE! | ###<br>### | |
| Turn-on energy loss | $E_{on}$ | | | | | 25<br>150 | ###<br>### | #VALUE!<br>#VALUE! | ###<br>### | mWs |
| Turn-off energy loss | $E_{off}$ | | | | | 25<br>150 | ###<br>### | #VALUE!<br>#VALUE! | ###<br>### | |
| Input capacitance | $C_{ies}$ | $f$ = 1 MHz | 0 | 25 | | 25 | ### | #VALUE! | ### | pF |
| Output capacitance | $C_{oss}$ | | | | | | ### | #VALUE! | ### | |
| Reverse transfer capacitance | $C_{rss}$ | | | | | | ### | #VALUE! | ### | |
| Gate charge | $Q_G$ | | 15 | 480 | 6 | 25 | ### | #VALUE! | ### | nC |
| Thermal resistance junction to sink | $R_{th(j-s)}$ | phase-change material<br>$\lambda$ = 3,4 W/mK | | | | | ### | #VALUE! | ### | K/W |
| **Inverter Diode** | | | | | | | | | | |
| Diode forward voltage | $V_F$ | | | | 6 | 25<br>150 | #VALUE!<br>### | #VALUE!<br>#VALUE! | #VALUE!<br>### | V |
| Peak reverse recovery current | $I_{RRM}$ | $R_{gon}$ = 32 Ω | 15 | 300 | 6 | 25<br>150 | ###<br>### | #VALUE!<br>#VALUE! | ###<br>### | A |
| Reverse recovery time | $t_{rr}$ | | | | | 25<br>150 | ###<br>### | #VALUE!<br>#VALUE! | ###<br>### | ns |
| Reverse recovered charge | $Q_{rr}$ | | | | | 25<br>150 | ###<br>### | #VALUE!<br>#VALUE! | ###<br>### | μC |
| Peak rate of fall of recovery current | $(di_{rf}/dt)_{max}$ | | | | | 25<br>150 | ###<br>### | #VALUE!<br>#VALUE! | ###<br>### | A/μs |
| Reverse recovered energy | $E_{rec}$ | | | | | 25<br>150 | ###<br>### | #VALUE!<br>#VALUE! | ###<br>### | mWs |
| Thermal resistance junction to sink | $R_{th(j-s)}$ | phase-change material<br>$\lambda$ = 3,4 W/mK | | | | | ### | #VALUE! | ### | K/W |
| **Thermistor** | | | | | | | | | | |
| Rated resistance | $R$ | | | | | 25 | ### | #VALUE! | ### | Ω |
| Deviation of $R_{100}$ | $\Delta_{R/R}$ | $R_{100}$ = 1486 Ω | | | | 100 | #VALUE! | ### | #VALUE! | % |
| Power dissipation | $P$ | | | | | 25 | ### | #VALUE! | ### | mW |
| Power dissipation constant | | | | | | 25 | ### | #VALUE! | ### | mW/K |
| B-value | $B_{(25/50)}$ | Tol. ±3% | | | | 25 | ### | ### | ### | K |
| B-value | $B_{(25/100)}$ | Tol. ±3% | | | | 25 | ### | #VALUE! | ### | K |
| Vincotech NTC Reference | | | | | | | ### | ### | #VALUE! | |

# Inverter / Brake Characteristics

**figure 1.** **IGBT**

**Typical output characteristics**

$I_C = f(V_{CE})$




**At**

$t_p$ = 250 µs

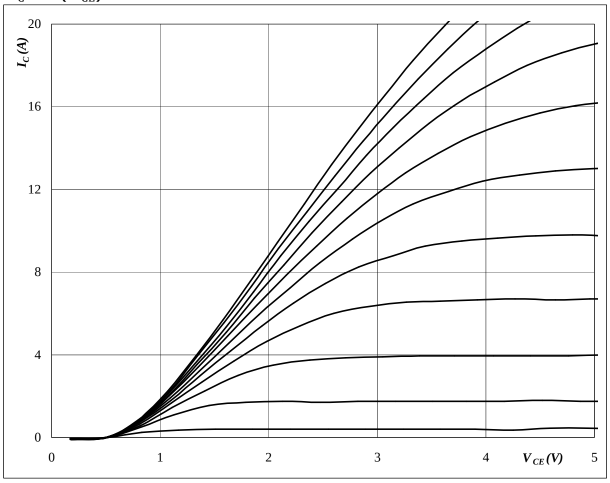
$T_j$ = 25 °C

$V_{GE}$ 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

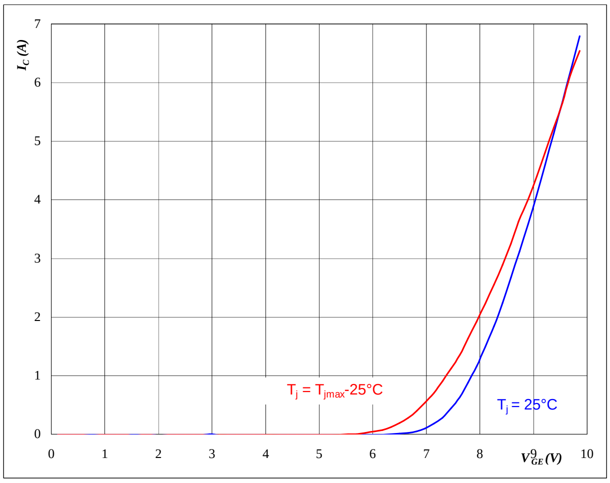
$T_j$ = 125 °C

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

**figure 3.** **IGBT**

**Typical transfer characteristics**

$I_C = f(V_{GE})$




**At**

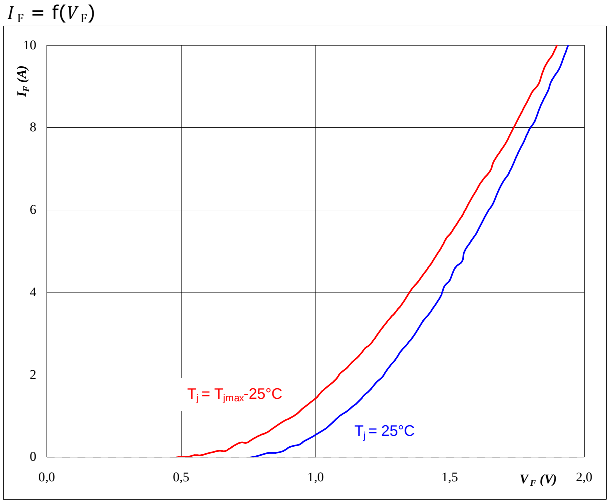
$t_p$ = 250 µs

$V_{CE}$ = 10 V

**figure 4.** **FWD**

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

$I_F = f(V_F)$




**At**

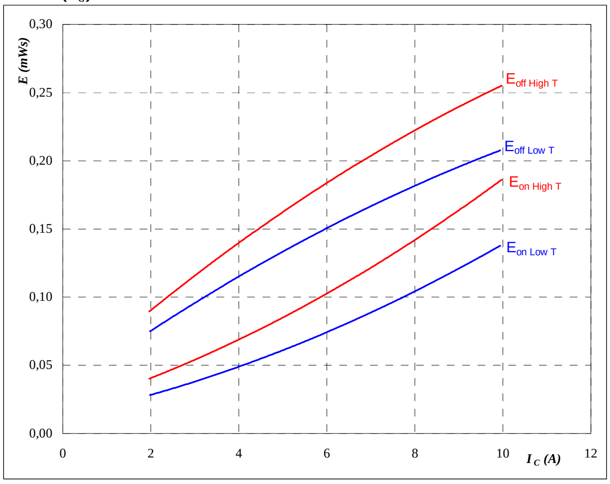
$t_p$ = 250 µs

# Inverter / Brake Characteristics

**figure 5.** **IGBT**

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

$E = f(I_C)$



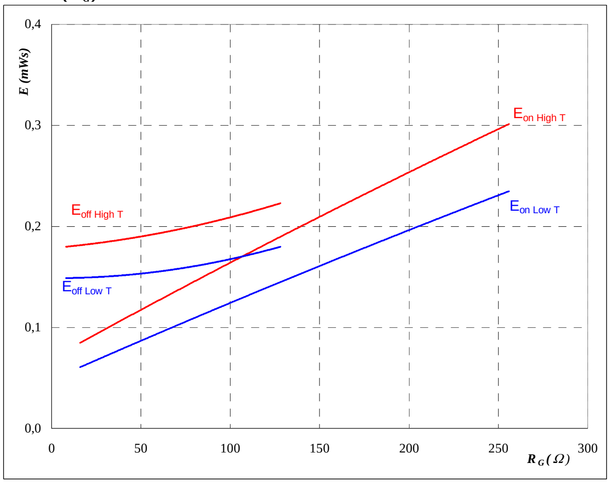

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 300 | V |
| $V_{GE}$ = | 15 | V |
| $R_{gon}$ = | 32 | Ω |
| $R_{goff}$ = | 16 | Ω |

**figure 6.** **IGBT**

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

$E = f(R_G)$



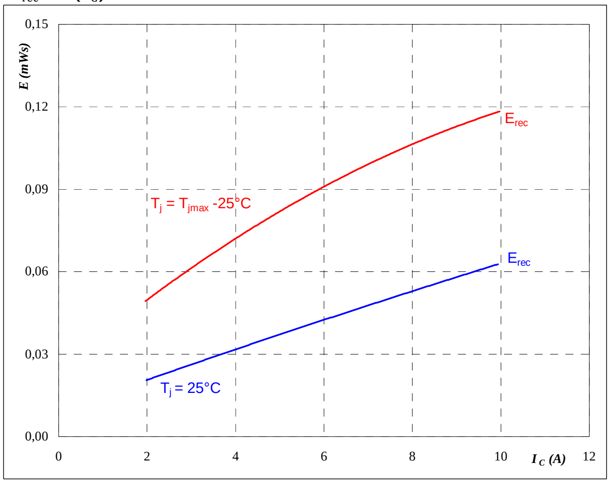

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 300 | V |
| $V_{GE}$ = | 15 | V |
| $I_C$ = | 6 | A |

**figure 7.** **FWD**

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

$E_{rec} = f(I_C)$



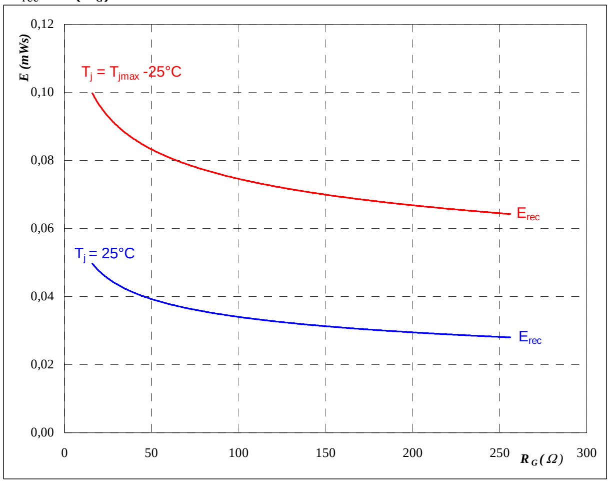

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 300 | V |
| $V_{GE}$ = | 15 | V |
| $R_{gon}$ = | 32 | Ω |

**figure 8.** **FWD**

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

$E_{rec} = f(R_G)$




With an inductive load at

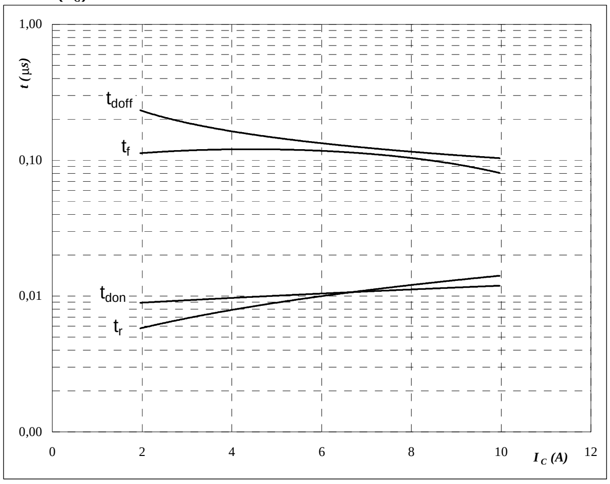
| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 300 | V |
| $V_{GE}$ = | 15 | V |
| $I_C$ = | 6 | A |

# Inverter / Brake Characteristics

**figure 9.** **IGBT**

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

$t = f(I_C)$



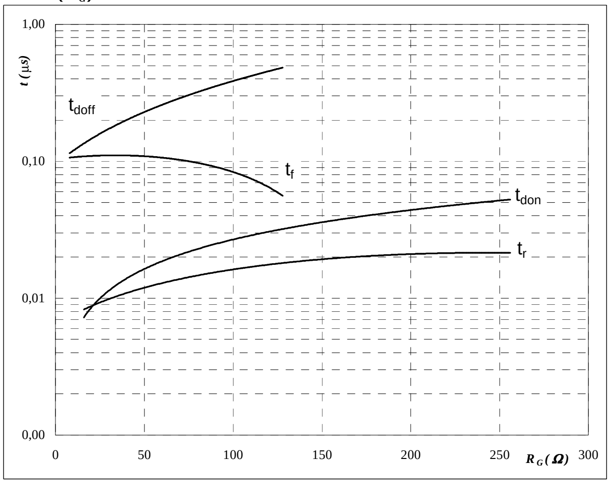

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 125 | °C |
| $V_{CE}$ = | 300 | V |
| $V_{GE}$ = | 15 | V |
| $R_{gon}$ = | 32 | Ω |
| $R_{goff}$ = | 16 | Ω |

**figure 10.** **IGBT**

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

$t = f(R_G)$



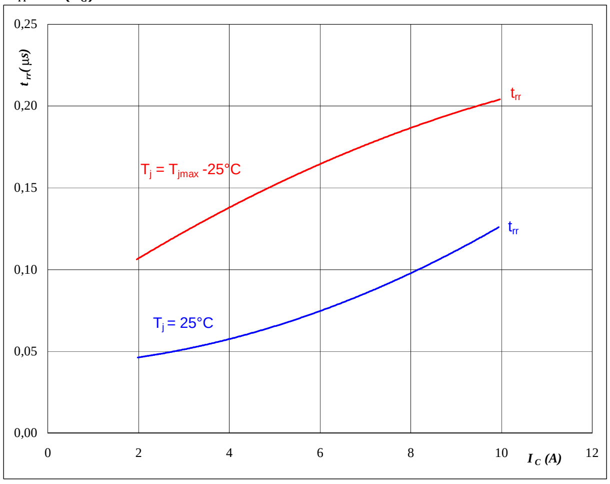

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 125 | °C |
| $V_{CE}$ = | 300 | V |
| $V_{GE}$ = | 15 | V |
| $I_C$ = | 6 | A |

**figure 11.** **FWD**

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

$t_{rr} = f(I_C)$



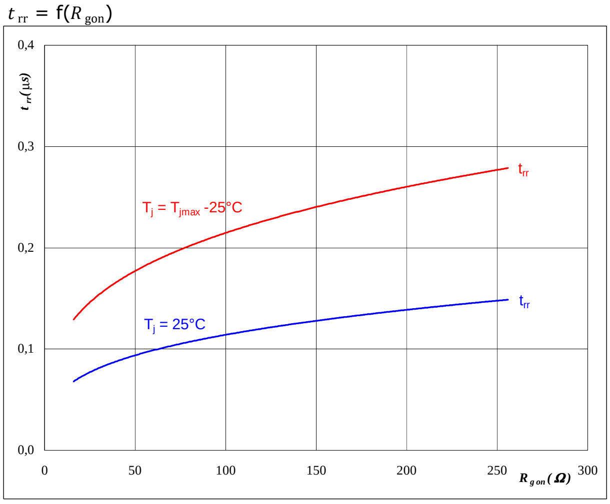

At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 300 | V |
| $V_{GE}$ = | 15 | V |
| $R_{gon}$ = | 32 | Ω |

**figure 12.** **FWD**

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

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




At

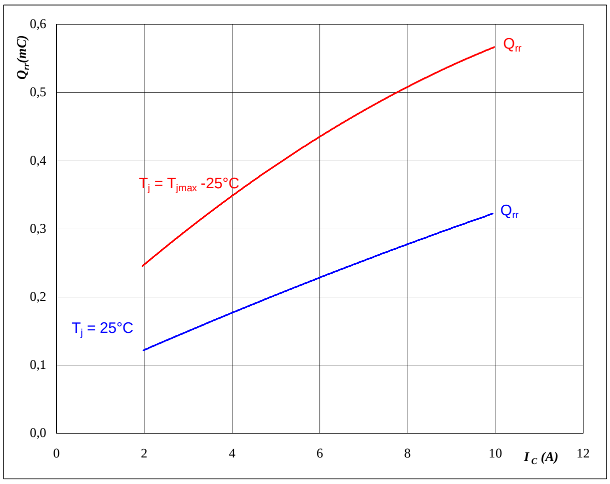
| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_R$ = | 300 | V |
| $I_F$ = | 6 | A |
| $V_{GE}$ = | 15 | V |

# Inverter / Brake Characteristics

**figure 13.** **FWD**

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

$Q_{rr} = f(I_C)$



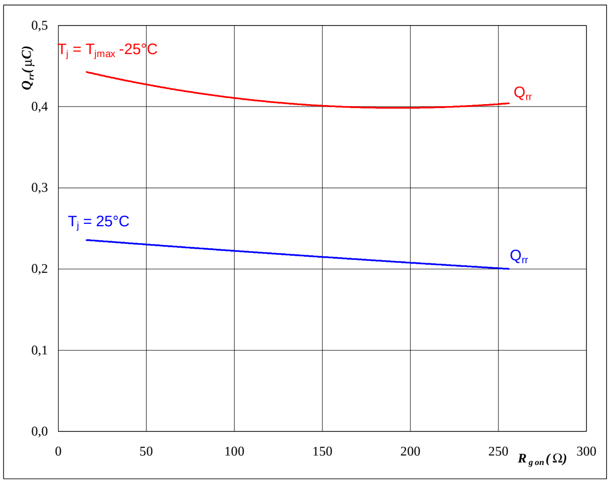

At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 300 | V |
| $V_{GE}$ = | 15 | V |
| $R_{gon}$ = | 32 | Ω |

**figure 14.** **FWD**

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

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



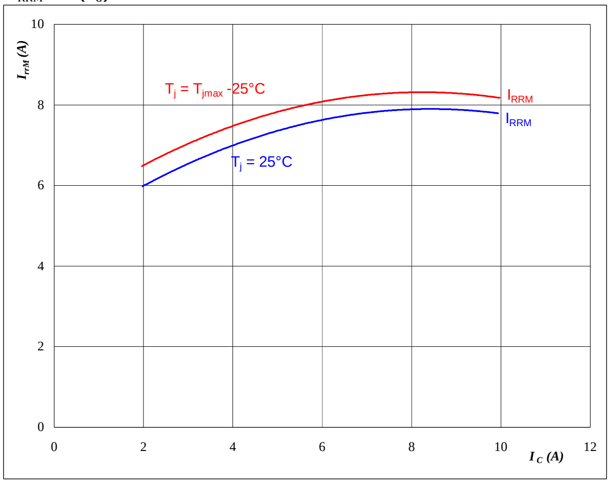

At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_R$ = | 300 | V |
| $I_F$ = | 6 | A |
| $V_{GE}$ = | 15 | V |

**figure 15.** **FWD**

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

$I_{RRM} = f(I_C)$



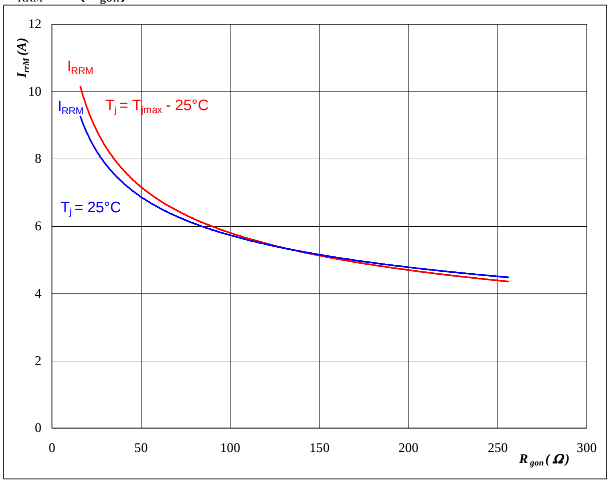

At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 300 | V |
| $V_{GE}$ = | 15 | V |
| $R_{gon}$ = | 32 | Ω |

**figure 16.** **FWD**

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

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




At

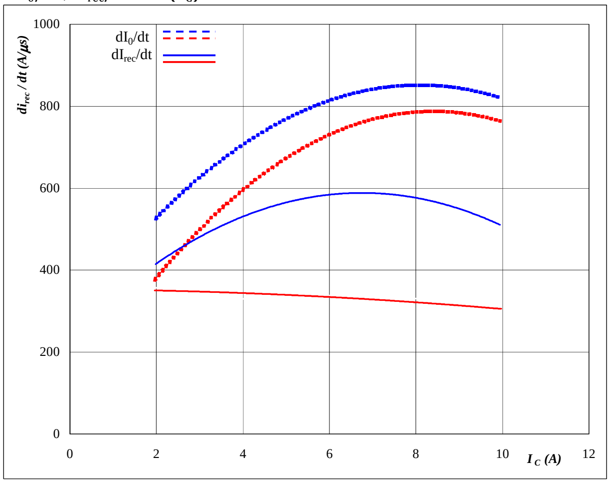
| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_R$ = | 300 | V |
| $I_F$ = | 6 | A |
| $V_{GE}$ = | 15 | V |

# Inverter / Brake Characteristics

**figure 17.** **FWD**

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

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



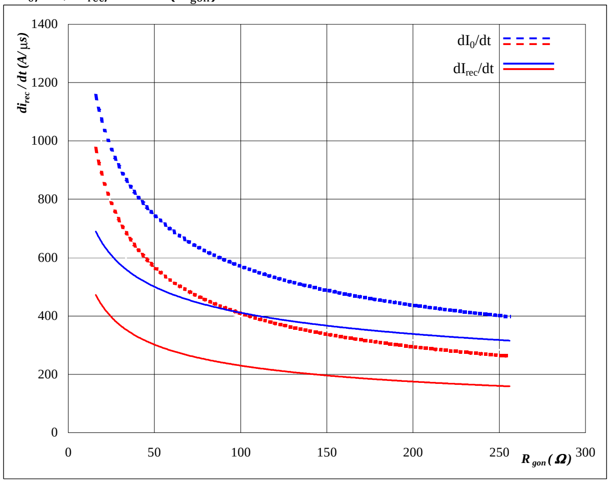

At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_{CE}$ = | 300 | V |
| $V_{GE}$ = | 15 | V |
| $R_{gon}$ = | 32 | Ω |

**figure 18.** **FWD**

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

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



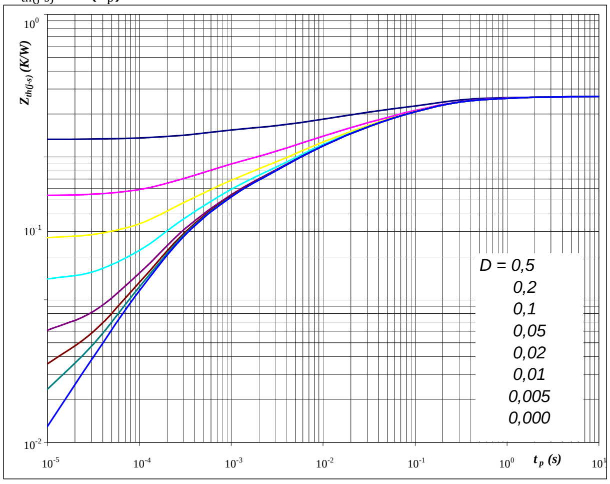

At

| | | |
|---|---|---|
| $T_j$ = | 25/125 | °C |
| $V_R$ = | 300 | V |
| $I_F$ = | 6 | A |
| $V_{GE}$ = | 15 | V |

**figure 19.** **IGBT**

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

$Z_{th(j-s)} = f(t_p)$




At

| | | |
|---|---|---|
| $D$ = | $t_p / T$ | |
| $R_{th(j-s)}$ = | 2,66 | K/W |

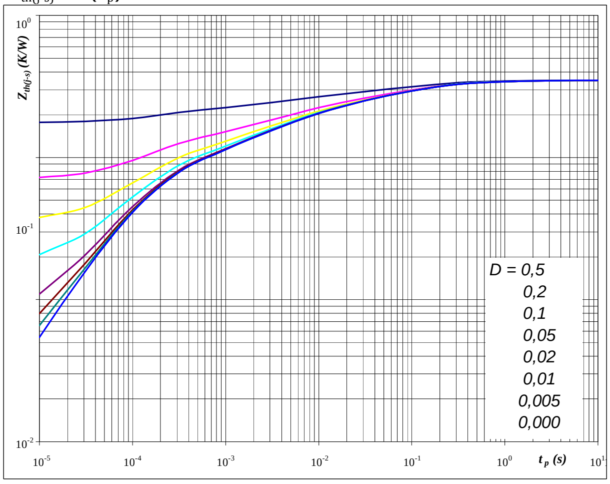
IGBT thermal model values

| $R$ (K/W) | Tau (s) |
|---|---|
| 7,05E-02 | 3,27E+00 |
| 3,24E-01 | 3,78E-01 |
| 8,86E-01 | 8,30E-02 |
| 6,07E-01 | 1,30E-02 |
| 4,23E-01 | 2,64E-03 |
| 3,49E-01 | 3,19E-04 |

**figure 20.** **FWD**

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

$Z_{th(j-s)} = f(t_p)$




At

| | | |
|---|---|---|
| $D$ = | $t_p / T$ | |
| $R_{th(j-s)}$ = | 3,49 | K/W |

FWD thermal model values

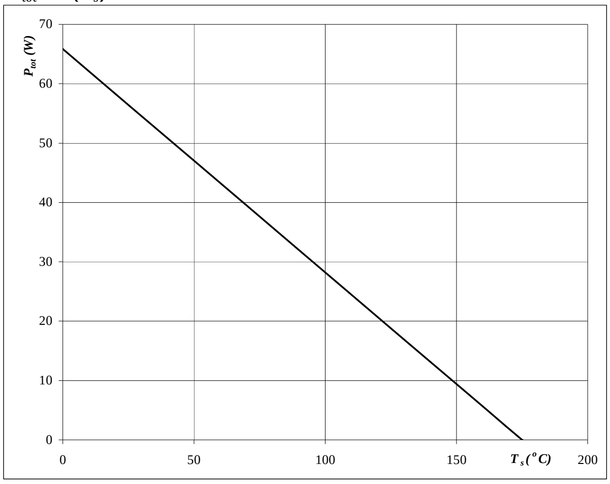
| $R$ (K/W) | Tau (s) |
|---|---|
| 4,22E-02 | 1,41E+01 |
| 1,90E-01 | 7,04E-01 |
| 8,32E-01 | 1,16E-01 |
| 6,58E-01 | 1,99E-02 |
| 7,36E-01 | 4,07E-03 |
| 4,19E-01 | 7,32E-04 |

# Inverter / Brake Characteristics

**figure 21.** **IGBT**

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

$P_{tot} = f(T_s)$



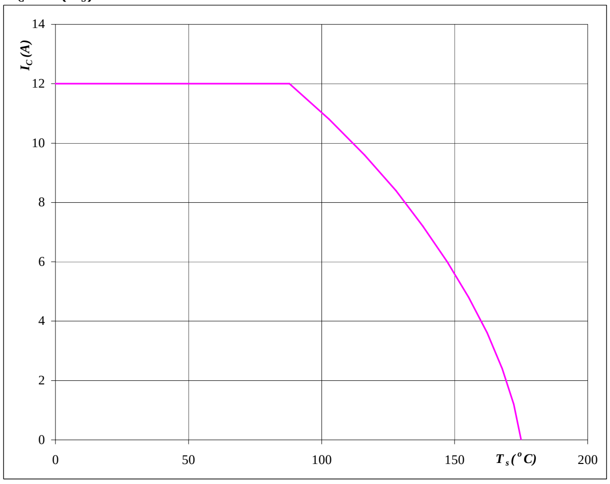

**At**

$T_j$ = 175 °C

**figure 22.** **IGBT**

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

$I_C = f(T_s)$




**At**

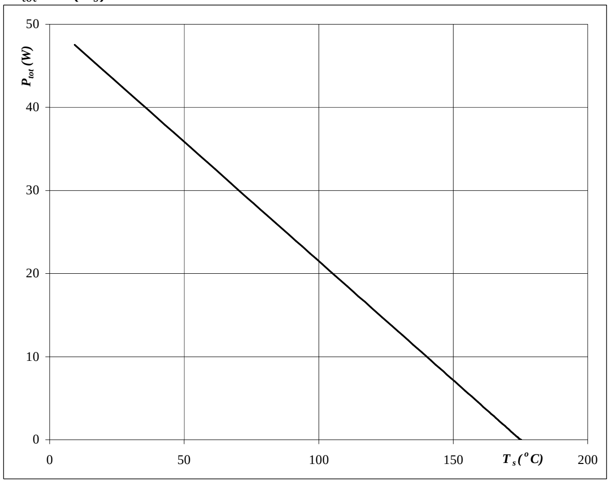
$T_j$ = 175 °C

$V_{GE}$ = 15 V

**figure 23.** **FWD**

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

$P_{tot} = f(T_s)$



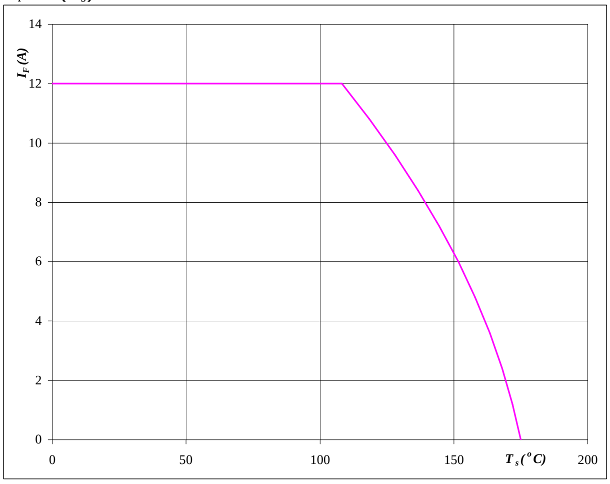

**At**

$T_j$ = 175 °C

**figure 24.** **FWD**

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

$I_F = f(T_s)$




**At**

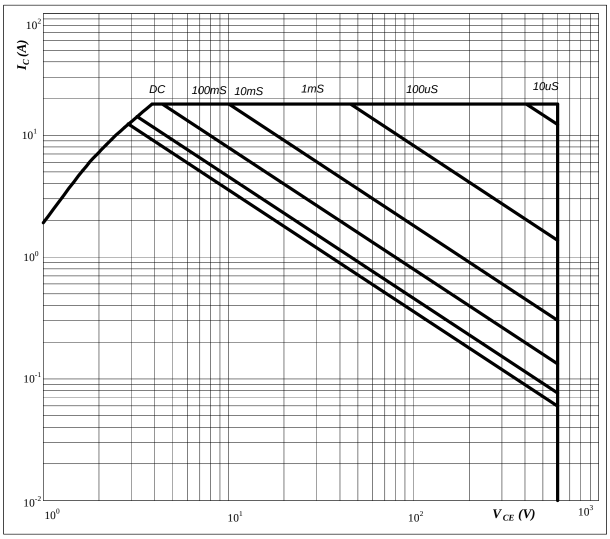
$T_j$ = 175 °C

# Inverter / Brake Characteristics

**figure 25.** **IGBT**

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

$I_C = f(V_{CE})$



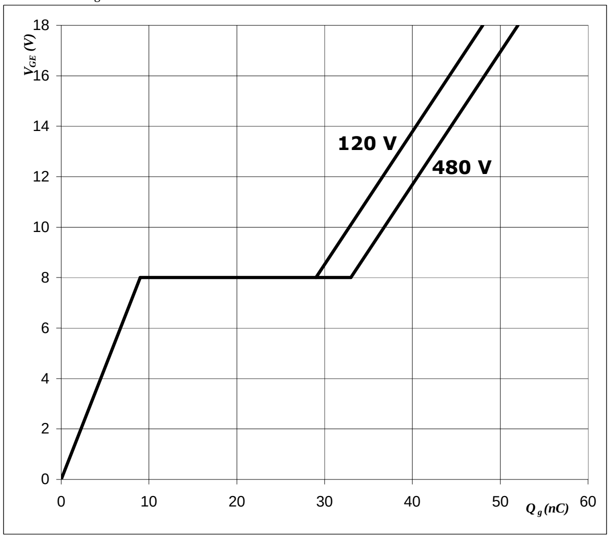

**At**

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

**figure 26.** **IGBT**

**Gate voltage vs Gate charge**

$V_{GE} = f(Q_g)$



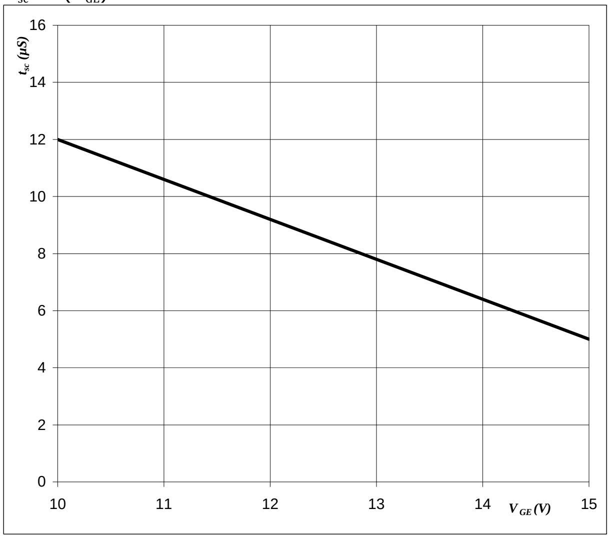

**At**

| | | |
|---|---|---|
| $I_C$ = | 6 | A |

**figure 27.** **IGBT**

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

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



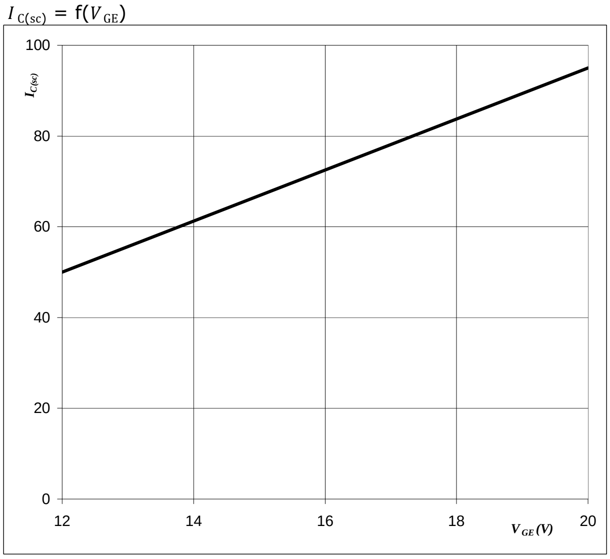

**At**

| | | |
|---|---|---|
| $V_{CE}$ = | 600 | V |
| $T_j$ ≤ | 150 | ºC |

**figure 28.** **IGBT**

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

$I_{C(sc)} = f(V_{GE})$



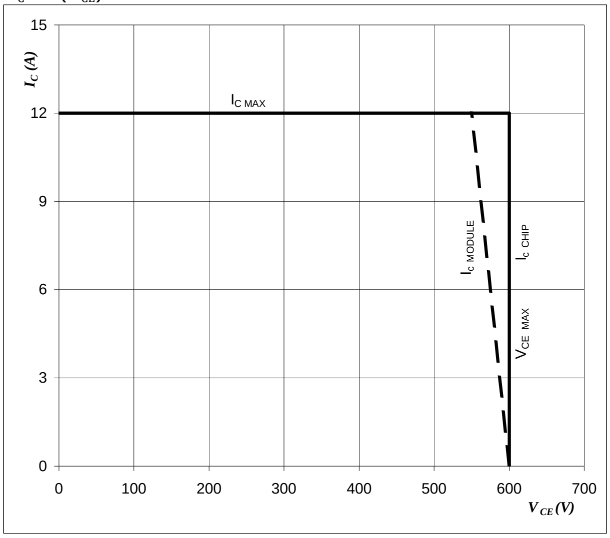

**At**

| | | |
|---|---|---|
| $V_{CE}$ ≤ | 400 | V |
| $T_j$ = | 150 | ºC |

| figure 29. | IGBT |
| --- | --- |

**Reverse bias safe operating area**

$I_C = f(V_{CE})$




**At**

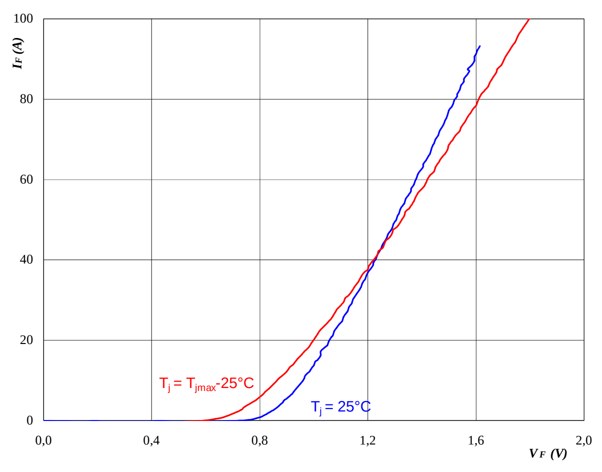
$T_j$ = $T_{jmax}$-25 ºC

# Rectifier Diode Characteristics

**figure 1.** **Rectifier Diode**

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

$I_F = f(V_F)$



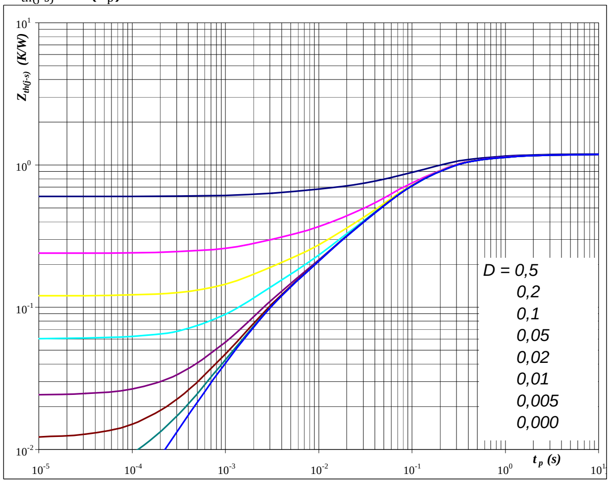

**At**

$t_p$ = 250 µs

**figure 2.** **Rectifier Diode**

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

$Z_{th(j-s)} = f(t_p)$




**At**

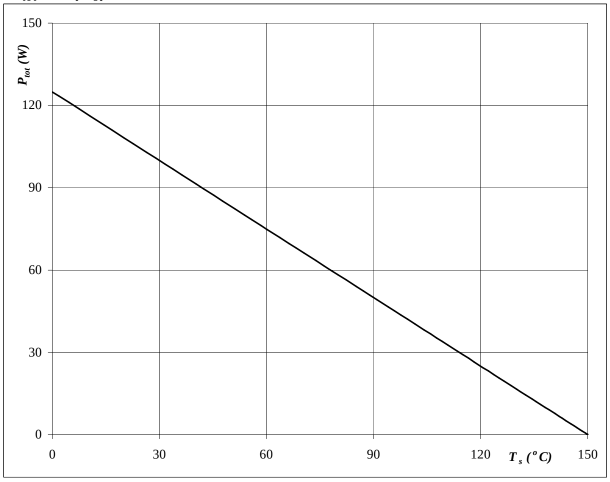
$D = t_p / T$

$R_{th(j-s)}$ = 1,25 K/W

**figure 3.** **Rectifier Diode**

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

$P_{tot} = f(T_s)$



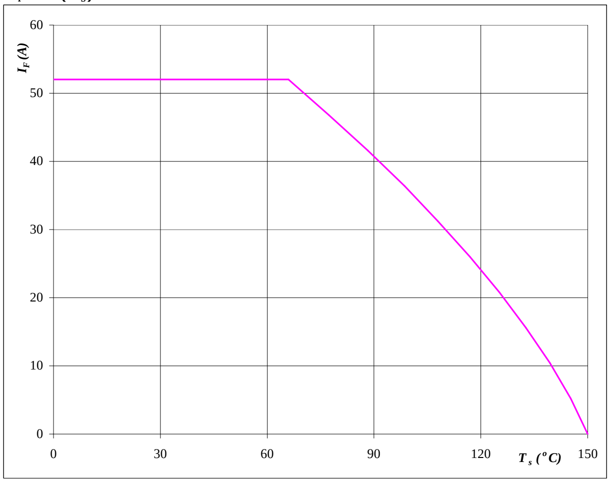

**At**

$T_j$ = 150 ºC

**figure 4.** **Rectifier Diode**

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

$I_F = f(T_s)$




**At**

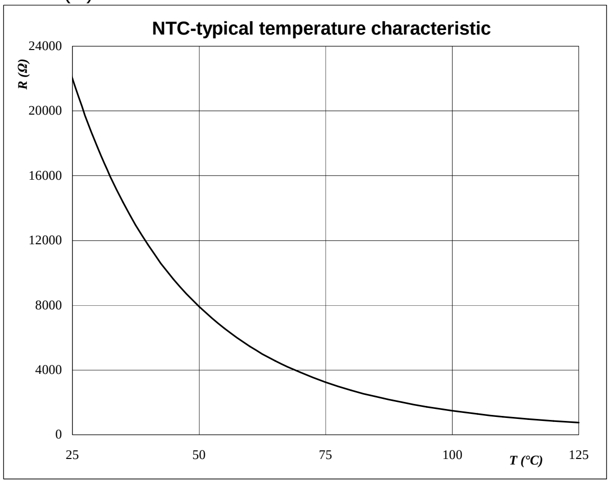
$T_j$ = 150 ºC

# Thermistor Characteristics

| figure 1. | Thermistor |
|---|---|

**Typical NTC characteristic**
**as a function of temperature**

$R = f(T)$



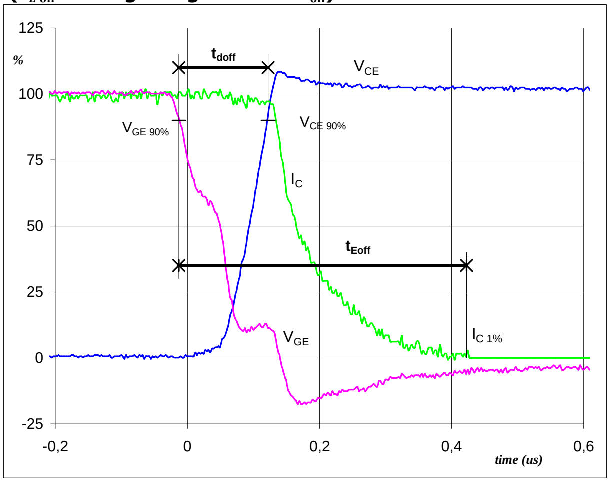
# Switching Definitions

**General conditions**

| | | |
|---|---|---|
| $T_j$ | = | 125 °C |
| $R_{gon}$ | = | 32 Ω |
| $R_{goff}$ | = | 16 Ω |

**figure 1.** **IGBT**

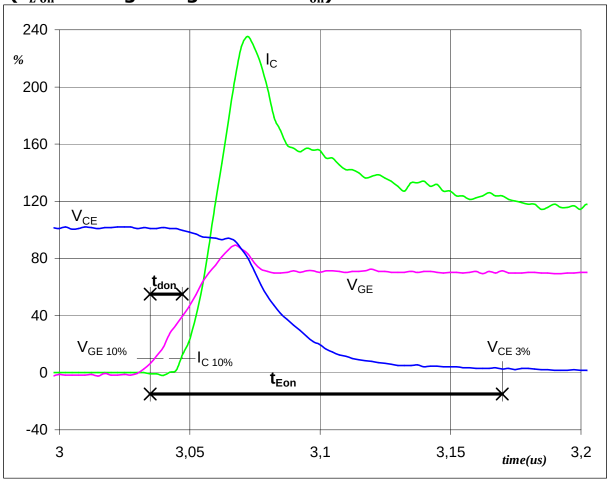
**Turn-off Switching Waveforms & definition of $t_{doff}$, $t_{Eoff}$**
**($t_{E\,off}$ = integrating time for $E_{off}$)**




| | | |
|---|---|---|
| $V_{GE}$ (0%) = | 0 | V |
| $V_{GE}$ (100%) = | 15 | V |
| $V_C$ (100%) = | 300 | V |
| $I_C$ (100%) = | 6 | A |
| $t_{doff}$ = | 0,13 | μs |
| $t_{E\,off}$ = | 0,44 | μs |

**figure 2.** **IGBT**

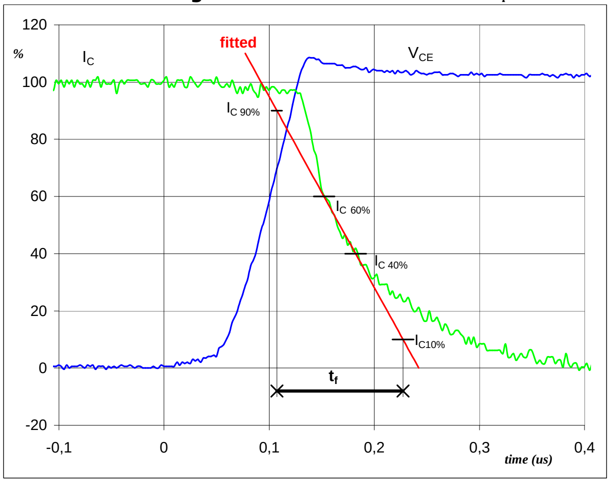
**Turn-on Switching Waveforms & definition of $t_{don}$, $t_{Eon}$**
**($t_{E\,on}$ = integrating time for $E_{on}$)**




| | | |
|---|---|---|
| $V_{GE}$ (0%) = | 0 | V |
| $V_{GE}$ (100%) = | 15 | V |
| $V_C$ (100%) = | 300 | V |
| $I_C$ (100%) = | 6 | A |
| $t_{don}$ = | 0,01 | μs |
| $t_{E\,on}$ = | 0,13 | μs |

**figure 3.** **IGBT**

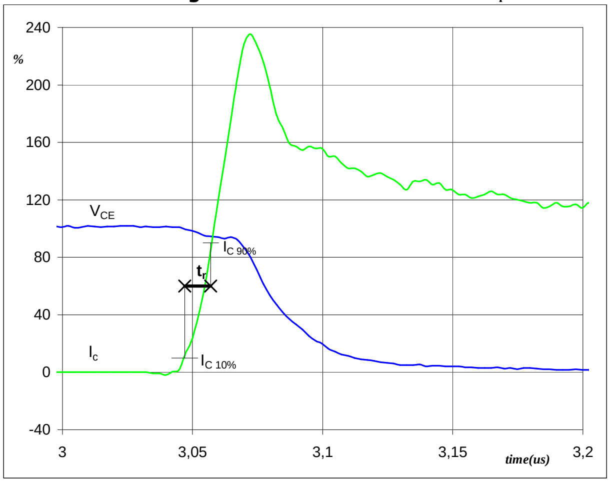
**Turn-off Switching Waveforms & definition of $t_f$**




| | | |
|---|---|---|
| $V_C$ (100%) = | 300 | V |
| $I_C$ (100%) = | 6 | A |
| $t_f$ = | 0,12 | μs |

**figure 4.** **IGBT**

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

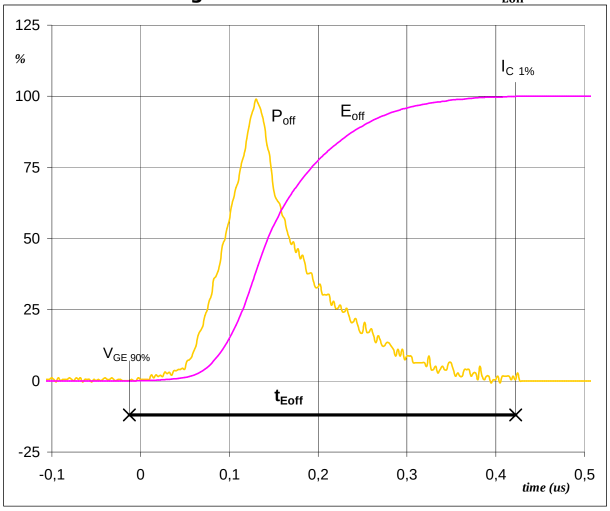



| | | |
|---|---|---|
| $V_C$ (100%) = | 300 | V |
| $I_C$ (100%) = | 6 | A |
| $t_r$ = | 0,01 | μs |

# Switching Definitions

**figure 5.** **IGBT**

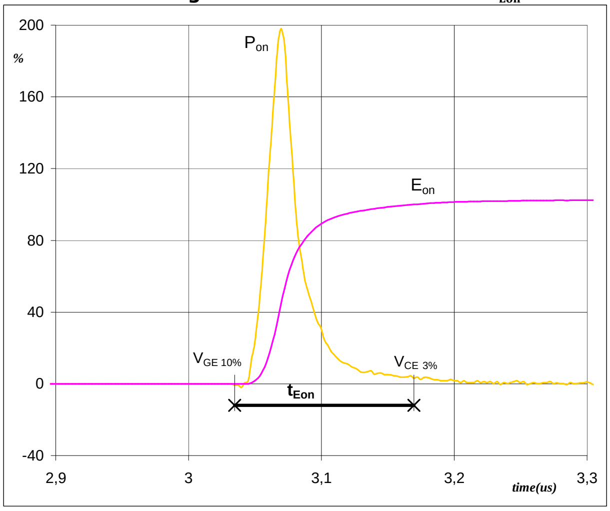
**Turn-off Switching Waveforms & definition of $t_{Eoff}$**




| | | |
|---|---|---|
| $P_{off}$ (100%) = | 1,79 | kW |
| $E_{off}$ (100%) = | 0,19 | mJ |
| $t_{E\,off}$ = | 0,44 | μs |

**figure 6.** **IGBT**

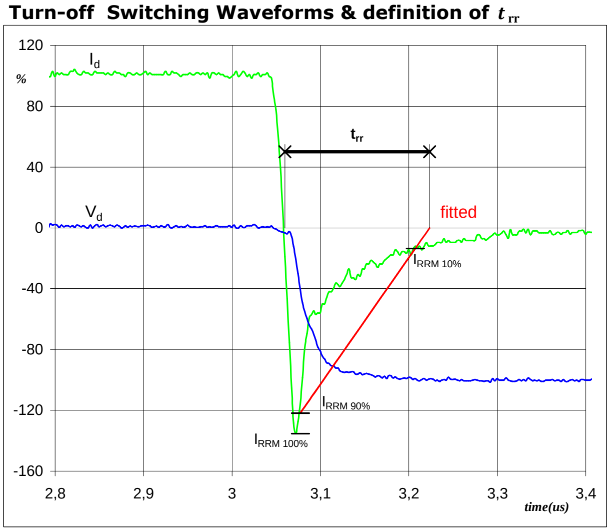
**Turn-on Switching Waveforms & definition of $t_{Eon}$**




| | | |
|---|---|---|
| $P_{on}$ (100%) = | 1,79 | kW |
| $E_{on}$ (100%) = | 0,10 | mJ |
| $t_{E\,on}$ = | 0,13 | μs |

**figure 7.** **IGBT**

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

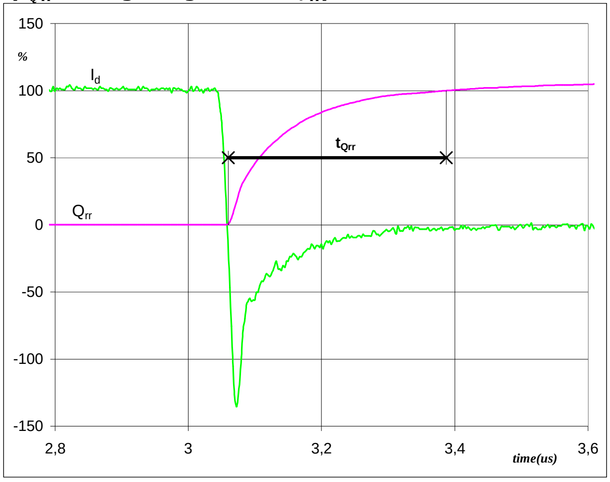



| | | |
|---|---|---|
| $V_d$ (100%) = | 300 | V |
| $I_d$ (100%) = | 6 | A |
| $I_{RRM}$ (100%) = | 8 | A |
| $t_{rr}$ = | 0,16 | μs |

# Switching Definitions

**figure 8.** **FWD**

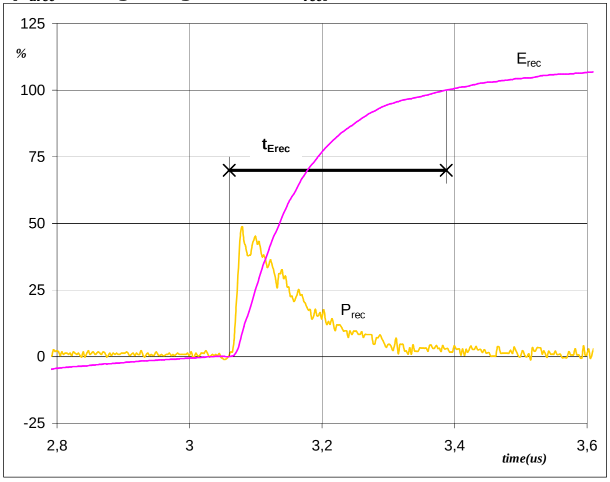
**Turn-on Switching Waveforms & definition of $t_{Qrr}$**
**($t_{Q rr}$ = integrating time for $Q_{rr}$)**




| | | |
|---|---|---|
| $I_d$ (100%) = | 6 | A |
| $Q_{rr}$ (100%) = | 0,43 | μC |
| $t_{Q rr}$ = | 0,33 | μs |

**figure 9.** **FWD**

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




| | | |
|---|---|---|
| $P_{rec}$ (100%) = | 1,79 | kW |
| $E_{rec}$ (100%) = | 0,09 | mJ |
| $t_{E rec}$ = | 0,33 | μs |

# Ordering Code and Marking - Features - Outline - Pinout

## Ordering Code & Marking

| Version | Ordering Code |
|---|---|
| without thermal paste 12 mm housing | V23990-P541-A38-PM |
| with thermal paste 12 mm housing | V23990-P541-A38-/3/-PM |
| without thermal paste 12 mm housing with one-phase rectifier | V23990-P541-B138-PM |
| with thermal paste 12 mm housing with one-phase rectifier | V23990-P541-B138-/3/-PM |
| without thermal paste 12 mm housing without brake | V23990-P541-C38-PM |
| with thermal paste 12 mm housing without brake | V23990-P541-C38-/3/-PM |
| without thermal paste 12 mm housing without brake with one-phase rectifier | V23990-P541-D138-PM |
| with thermal paste 12 mm housing without brake with one-phase rectifier | V23990-P541-D138-/3/-PM |

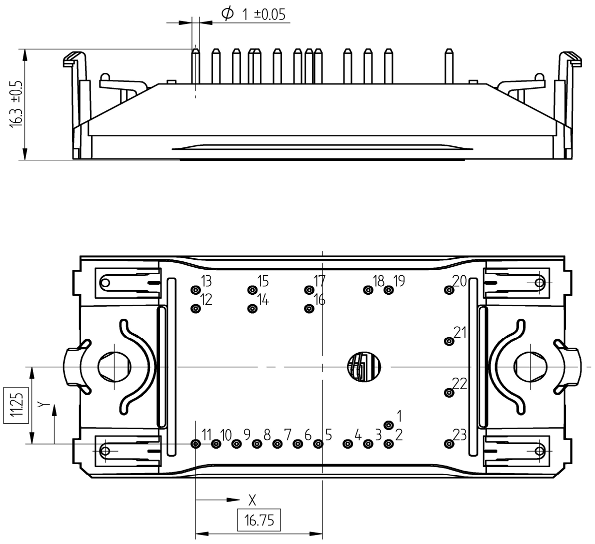
## Outline

Pin Table

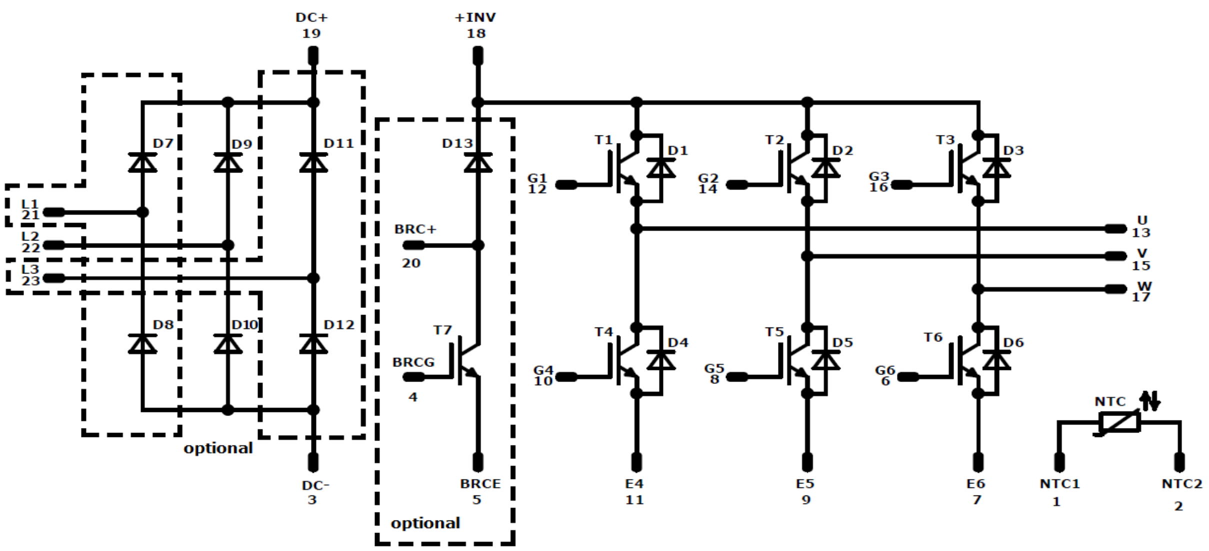
| Pin | X | Y |
|---|---|---|
| 1 | 25,5 | 2,7 |
| 2 | 25,5 | 0 |
| 3 | 22,8 | 0 |
| 4 | 20,1 | 0 |
| 5 | 16,2 | 0 |
| 6 | 13,5 | 0 |
| 7 | 10,8 | 0 |
| 8 | 8,1 | 0 |
| 9 | 5,4 | 0 |
| 10 | 2,7 | 0 |
| 11 | 0 | 0 |
| 12 | 0 | 19,8 |
| 13 | 0 | 22,5 |
| 14 | 7,5 | 19,8 |
| 15 | 7,5 | 22,5 |
| 16 | 15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

| N/A Pins | Module subtype |
|---|---|
| - | V23990-P541-A38-PM |
| 23 | V23990-P541-B138-PM |
| 4,5,20 | V23990-P541-C38-PM |
| 4,5,20,23 | V23990-P541-D138-PM |




## Pinout



| Packaging instruction | | | | | |
|---|---|---|---|---|---|
| Standard packaging quantity (SPQ) | **135** | >SPQ | Standard | <SPQ | Sample |

| Handling instruction |
|---|
| Handling instructions for *flow* 0 packages see vincotech.com website. |

| Package data |
|---|
| Package data for *flow* 0 packages see vincotech.com website. |

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

| Document No.: | Date: | Modification: | Pages |
|---|---|---|---|
| V23990-P541-x3x-D5-14 | 10 Jul. 2017 | one-phase rectifier subtypes added | |