Vincotech

# V23990-P630-A40-PM
datasheet

***flow*90PIM 1** | **1200 V / 15 A**

## Topology features

- Converter+Brake+Inverter
- Open Emitter configuration
- Temperature sensor

## Component features

- Easy paralleling
- Low turn-off losses
- Low collector emitter saturation voltage
- Positive temperature coefficient
- Short tail current

## Housing features

- Base isolation: $Al_2O_3$
- 90° mounting angle between heatsink and PCB
- Screw-on heatsink mounting
- Clip-in PCB mounting
- Thermo-mechanical push-and-pull force relief
- Solder pin

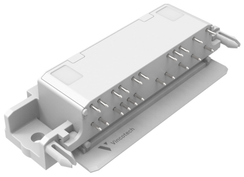
## Target applications

- Industrial Drives

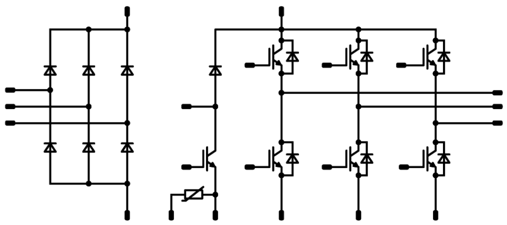
## Types

- V23990-P630-A40-PM

## *flow*90 1 housing



## Schematic



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# Maximum Ratings

$T_j$ = 25 °C, unless otherwise specified

| Parameter | Symbol | Conditions | | Value | Unit |
|---|---|---|---|---|---|
| **Inverter Switch** | | | | | |
| Collector-emitter voltage | $V_{CES}$ | | | 1200 | V |
| Collector current (DC current) | $I_C$ | $T_j = T_{jmax}$ | $T_s$ = 80 °C | 22 | A |
| Repetitive peak collector current | $I_{CRM}$ | $t_p$ limited by $T_{jmax}$ | | 45 | A |
| Total power dissipation | $P_{tot}$ | $T_j = T_{jmax}$ | $T_s$ = 80 °C | 65 | W |
| Gate-emitter voltage | $V_{GES}$ | | | ±20 | V |
| Short circuit ratings | $t_{SC}$ | $V_{GE}$ = 15 V, $V_{CC}$ = 800 V | $T_j$ = 150 °C | 10 | µs |
| Maximum junction temperature | $T_{jmax}$ | | | 175 | °C |
| **Inverter Diode** | | | | | |
| Peak repetitive reverse voltage | $V_{RRM}$ | | | 1200 | V |
| Forward current (DC current) | $I_F$ | $T_j = T_{jmax}$ | $T_s$ <= 80 °C | 30 (1) | A |
| Repetitive peak forward current | $I_{FRM}$ | $t_p$ limited by $T_{jmax}$ | | 30 | A |
| Total power dissipation | $P_{tot}$ | $T_j = T_{jmax}$ | $T_s$ = 80 °C | 54 | W |
| Maximum junction temperature | $T_{jmax}$ | | | 175 | °C |

(1) limited by $I_{FRM}$

| Parameter | Symbol | Conditions | | Value | Unit |
|---|---|---|---|---|---|
| **Brake Switch** | | | | | |
| Collector-emitter voltage | $V_{CES}$ | | | 1200 | V |
| Collector current (DC current) | $I_C$ | $T_j = T_{jmax}$ | $T_s$ <= 80 °C | 24 (2) | A |
| Repetitive peak collector current | $I_{CRM}$ | $t_p$ limited by $T_{jmax}$ | | 24 | A |
| Total power dissipation | $P_{tot}$ | $T_j = T_{jmax}$ | $T_s$ = 80 °C | 61 | W |
| Gate-emitter voltage | $V_{GES}$ | | | ±20 | V |
| Short circuit ratings | $t_{SC}$ | $V_{GE}$ = 15 V, $V_{CC}$ = 800 V | $T_j$ = 150 °C | 10 | µs |
| Maximum junction temperature | $T_{jmax}$ | | | 175 | °C |

(2) limited by $I_{CRM}$

# Maximum Ratings

$T_j$ = 25 °C, unless otherwise specified

| Parameter | Symbol | Conditions | | Value | Unit |
|---|---|---|---|---|---|
| **Brake Diode** | | | | | |
| Peak repetitive reverse voltage | $V_{RRM}$ | | | 1200 | V |
| Forward current (DC current) | $I_F$ | $T_j = T_{jmax}$ | $T_s$ <= 80 °C | 15 (3) | A |
| Repetitive peak forward current | $I_{FRM}$ | $t_p$ limited by $T_{jmax}$ | | 15 | A |
| Total power dissipation | $P_{tot}$ | $T_j = T_{jmax}$ | $T_s$ = 80 °C | 33 | W |
| Maximum junction temperature | $T_{jmax}$ | | | 150 | °C |

(3) limited by $I_{FRM}$

| Parameter | Symbol | Conditions | | Value | Unit |
|---|---|---|---|---|---|
| **Rectifier Diode** | | | | | |
| Peak repetitive reverse voltage | $V_{RRM}$ | | | 1600 | V |
| Forward current (DC current) | $I_F$ | $T_j = T_{jmax}$ | $T_s$ = 80 °C | 33 | A |
| Surge (non-repetitive) forward current | $I_{FSM}$ | Single Half Sine Wave, $t_p$ = 10 ms | $T_j$ = 150 °C | 270 | A |
| Surge current capability | $I^2t$ | | | 360 | $A^2s$ |
| Total power dissipation | $P_{tot}$ | $T_j = T_{jmax}$ | $T_s$ = 80 °C | 44 | W |
| Maximum junction temperature | $T_{jmax}$ | | | 150 | °C |

## Module Properties

| Parameter | Symbol | Conditions | | Value | Unit |
|---|---|---|---|---|---|
| **Thermal Properties** | | | | | |
| Storage temperature | $T_{stg}$ | | | -40…+125 | °C |
| Operation temperature under switching condition | $T_{jop}$ | | | -40…+($T_{jmax}$ - 25) | °C |
| **Isolation Properties** | | | | | |
| Isolation voltage | $V_{isol}$ | DC Test Voltage* | $t_p$ = 2 s | 6000 | V |
| Creepage distance | | | | >12,7 | mm |
| Clearance | | | | 11,84 | mm |
| Comparative Tracking Index | CTI | | | ≥ 200 | |

*100 % tested in production

# Characteristic Values

| Parameter | Symbol | Conditions | | | | | Values | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $V_{GE}$ [V] $V_{GS}$ [V] | $V_{CE}$ [V] $V_{DS}$ [V] $V_F$ [V] | $I_C$ [A] $I_D$ [A] $I_F$ [A] | $T_j$ [°C] | Min | Typ | Max | |
| **Inverter Switch** | | | | | | | | | | |
| **Static** | | | | | | | | | | |
| Gate-emitter threshold voltage | $V_{GE(th)}$ | $V_{CE} = V_{GE}$ | | | 0,0005 | 25 | 5,3 | 5,8 | 6,3 | V |
| Collector-emitter saturation voltage | $V_{CEsat}$ | | 15 | | 15 | 25<br>125<br>150 | 1,58 | 1,87<br>2,14<br>2,21 | 2,07(4) | V |
| Collector-emitter cut-off current | $I_{CES}$ | | 0 | 1200 | | 25 | | | 2 | µA |
| Gate-emitter leakage current | $I_{GES}$ | | 20 | 0 | | 25 | | | 120 | nA |
| Internal gate resistance | $r_g$ | | | | | | | None | | Ω |
| Input capacitance | $C_{ies}$ | $f$ = 1 Mhz | 0 | 25 | | 25 | | 890 | | pF |
| Reverse transfer capacitance | $C_{res}$ | | | | | | | 30 | | pF |
| Gate charge | $Q_g$ | | 20 | | 0 | 25 | | 120 | | nC |
| **Thermal** | | | | | | | | | | |
| Thermal resistance junction to sink(5) | $R_{th(j-s)}$ | $\lambda_{paste}$ = 3,4 W/mK (PSX) | | | | | | 1,45 | | K/W |
| **Dynamic** | | | | | | | | | | |
| Turn-on delay time | $t_{d(on)}$ | $R_{gon}$ = 32 Ω<br>$R_{goff}$ = 32 Ω | ±15 | 600 | 15 | 25<br>150 | | 85,2<br>93 | | ns |
| Rise time | $t_r$ | | | | | 25<br>150 | | 29,8<br>31,6 | | ns |
| Turn-off delay time | $t_{d(off)}$ | | | | | 25<br>150 | | 214<br>284,8 | | ns |
| Fall time | $t_f$ | | | | | 25<br>150 | | 82,7<br>142,43 | | ns |
| Turn-on energy (per pulse) | $E_{on}$ | $Q_{rFWD}$=1,51 µC<br>$Q_{rFWD}$=3,04 µC | | | | 25<br>150 | | 1,16<br>1,78 | | mWs |
| Turn-off energy (per pulse) | $E_{off}$ | | | | | 25<br>150 | | 0,892<br>1,53 | | mWs |

# Characteristic Values

| Parameter | Symbol | Conditions | | | | | Values | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $V_{GE}$ [V]<br>$V_{GS}$ [V] | $V_{CE}$ [V]<br>$V_{DS}$ [V]<br>$V_F$ [V] | $I_C$ [A]<br>$I_D$ [A]<br>$I_F$ [A] | $T_j$ [°C] | Min | Typ | Max | |
| **Inverter Diode** | | | | | | | | | | |
| **Static** | | | | | | | | | | |
| Forward voltage | $V_F$ | | | | 15 | 25<br>125<br>150 | 1,35 | 1,8<br>1,75<br>1,72 | 2,05[(4)] | V |
| Reverse leakage current | $I_R$ | $V_r$ = 1200 V | | | | 25 | | | 3,5 | µA |
| **Thermal** | | | | | | | | | | |
| Thermal resistance junction to sink[(5)] | $R_{th(j-s)}$ | $\lambda_{paste}$ = 3,4 W/mK (PSX) | | | | | | 1,78 | | K/W |
| **Dynamic** | | | | | | | | | | |
| Peak recovery current | $I_{RM}$ | d$i$/d$t$=489 A/µs<br>d$i$/d$t$=455 A/µs | ±15 | 600 | 15 | 25<br>150 | | 10,09<br>13,1 | | A |
| Reverse recovery time | $t_{rr}$ | | | | | 25<br>150 | | 296,62<br>505,12 | | ns |
| Recovered charge | $Q_r$ | | | | | 25<br>150 | | 1,51<br>3,04 | | µC |
| Reverse recovered energy | $E_{rec}$ | | | | | 25<br>150 | | 0,586<br>1,22 | | mWs |
| Peak rate of fall of recovery current | $(di_{rf}/dt)_{max}$ | | | | | 25<br>150 | | 50,12<br>40,82 | | A/µs |

## Characteristic Values

| Parameter | Symbol | Conditions | | | | | Values | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $V_{GE}$ [V] $V_{GS}$ [V] | $V_{CE}$ [V] $V_{DS}$ [V] $V_F$ [V] | $I_C$ [A] $I_D$ [A] $I_F$ [A] | $T_j$ [°C] | Min | Typ | Max | |
| **Brake Switch** | | | | | | | | | | |
| **Static** | | | | | | | | | | |
| Gate-emitter threshold voltage | $V_{GE(th)}$ | $V_{CE} = V_{GE}$ | | | 0,00015 | 25 | 5,3 | 5,8 | 6,3 | V |
| Collector-emitter saturation voltage | $V_{CEsat}$ | | 15 | | 8 | 25<br>125<br>150 | 1,58 | 1,86<br>2,14<br>2,23 | 2,07(4) | V |
| Collector-emitter cut-off current | $I_{CES}$ | | 0 | 1200 | | 25 | | | 1 | µA |
| Gate-emitter leakage current | $I_{GES}$ | | 20 | 0 | | 25 | | | 120 | nA |
| Internal gate resistance | $r_g$ | | | | | | | None | | Ω |
| Input capacitance | $C_{ies}$ | $f$ = 1 Mhz | 0 | 25 | | 25 | | 490 | | pF |
| Reverse transfer capacitance | $C_{res}$ | | | | | | | 30 | | pF |
| **Thermal** | | | | | | | | | | |
| Thermal resistance junction to sink(5) | $R_{th(j-s)}$ | $\lambda_{paste}$ = 3,4 W/mK (PSX) | | | | | | 1,57 | | K/W |
| **Dynamic** | | | | | | | | | | |
| Turn-on delay time | $t_{d(on)}$ | $R_{gon}$ = 32 Ω<br>$R_{goff}$ = 32 Ω | ±15 | 600 | 8 | 25<br>150 | | 60<br>61,2 | | ns |
| Rise time | $t_r$ | | | | | 25<br>150 | | 26,6<br>26 | | ns |
| Turn-off delay time | $t_{d(off)}$ | | | | | 25<br>150 | | 178,6<br>247,2 | | ns |
| Fall time | $t_f$ | | | | | 25<br>150 | | 68,31<br>136,63 | | ns |
| Turn-on energy (per pulse) | $E_{on}$ | $Q_{rFWD}$=1,01 µC<br>$Q_{rFWD}$=2,09 µC | | | | 25<br>150 | | 0,512<br>0,786 | | mWs |
| Turn-off energy (per pulse) | $E_{off}$ | | | | | 25<br>150 | | 0,449<br>0,776 | | mWs |

# Characteristic Values

| Parameter | Symbol | Conditions | | | | | Values | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $V_{GE}$ [V] $V_{GS}$ [V] | $V_{CE}$ [V] $V_{DS}$ [V] $V_F$ [V] | $I_C$ [A] $I_D$ [A] $I_F$ [A] | $T_j$ [°C] | Min | Typ | Max | |
| **Brake Diode** | | | | | | | | | | |
| **Static** | | | | | | | | | | |
| Forward voltage | $V_F$ | | | | 7,5 | 25<br>125 | 1,23 | 1,66<br>1,62 | 1,97(4) | V |
| Reverse leakage current | $I_R$ | $V_r$ = 1200 V | | | | 25 | | | 27 | µA |
| **Thermal** | | | | | | | | | | |
| Thermal resistance junction to sink(5) | $R_{th(j-s)}$ | $\lambda_{paste}$ = 3,4 W/mK (PSX) | | | | | | 2,12 | | K/W |
| **Dynamic** | | | | | | | | | | |
| Peak recovery current | $I_{RM}$ | d*i*/d*t*=319 A/µs<br>d*i*/d*t*=279 A/µs | ±15 | 600 | 8 | 25<br>150 | | 6,22<br>8,34 | | A |
| Reverse recovery time | $t_{rr}$ | | | | | 25<br>150 | | 373,84<br>637,21 | | ns |
| Recovered charge | $Q_r$ | | | | | 25<br>150 | | 1,01<br>2,09 | | µC |
| Reverse recovered energy | $E_{rec}$ | | | | | 25<br>150 | | 0,457<br>0,965 | | mWs |
| Peak rate of fall of recovery current | $(di_{rf}/dt)_{max}$ | | | | | 25<br>150 | | 38,9<br>34,5 | | A/µs |

# Characteristic Values

| Parameter | Symbol | Conditions | $V_{GE}$ [V] $V_{GS}$ [V] | $V_{CE}$ [V] $V_{DS}$ [V] $V_F$ [V] | $I_C$ [A] $I_D$ [A] $I_F$ [A] | $T_j$ [°C] | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| **Rectifier Diode** | | | | | | | | | | |
| **Static** | | | | | | | | | | |
| Forward voltage | $V_F$ | | | | 30 | 25<br>125<br>150 | | 1,28<br>1,28 | 1,29(4)<br><br>1,26(4) | V |
| Reverse leakage current | $I_R$ | $V_r$ = 1600 V | | | | 25<br>150 | | | 10<br>1 | µA<br>mA |
| **Thermal** | | | | | | | | | | |
| Thermal resistance junction to sink(5) | $R_{th(j-s)}$ | $\lambda_{paste}$ = 3,4 W/mK (PSX) | | | | | | 1,59 | | K/W |
| **Thermistor** | | | | | | | | | | |
| **Static** | | | | | | | | | | |
| Rated resistance | $R$ | | | | | 25 | | 22 | | kΩ |
| Deviation of R25 | $\Delta_{R/R}$ | $R_{25}$ = 22 kΩ | | | | 25 | -5 | | 5 | % |
| Deviation of R100 | $\Delta_{R/R}$ | $R_{100}$ = 1486 Ω | | | | 100 | -12 | | 14 | % |
| Power dissipation | $P$ | | | | | | | 200 | | mW |
| Power dissipation constant | $d$ | | | | | 25 | | 2 | | mW/K |
| B-value | $B_{(25/50)}$ | Tol. ±3 % | | | | | | 3950 | | K |
| B-value | $B_{(25/100)}$ | Tol. ±3 % | | | | | | 3998 | | K |
| Vincotech Thermistor Reference | | | | | | | | | B | |

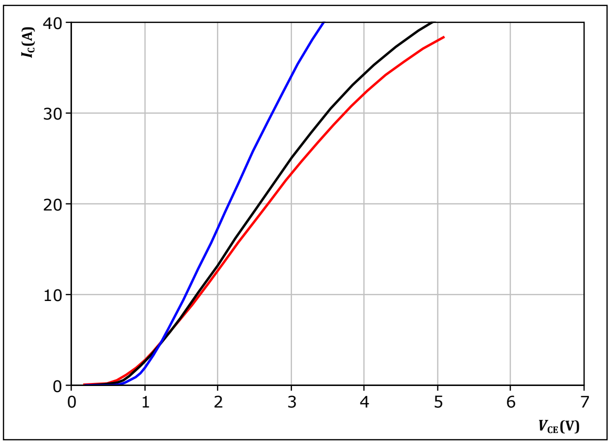
(4) Value at chip level
(5) Only valid with pre-applied Vincotech thermal interface material.

# Inverter Switch Characteristics

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

**Typical output characteristics**

$I_C$ = f( $V_{CE}$)



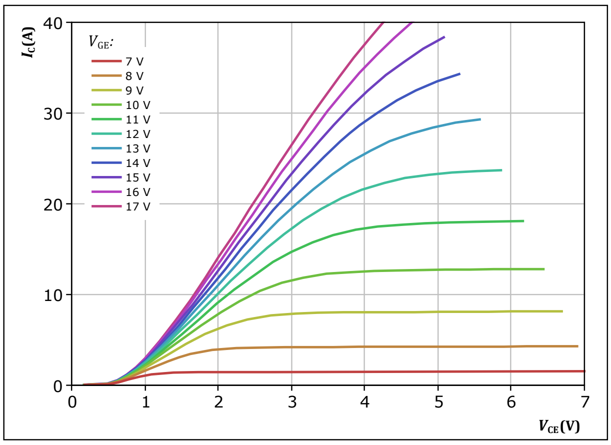

| | | |
|---|---|---|
| $t_p$ = | 250 | µs |
| $V_{GE}$ = | 15 | V |

$T_j$: 25 °C, 125 °C, 150 °C

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

**Typical output characteristics**

$I_C$ = f( $V_{CE}$)



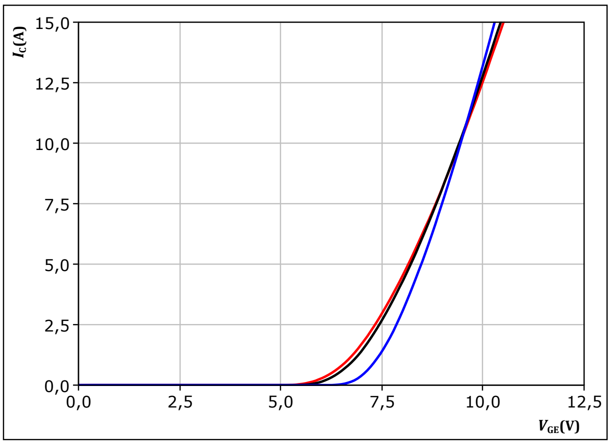

| | | |
|---|---|---|
| $t_p$ = | 250 | µs |
| $T_j$ = | 150 | °C |

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

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

**Typical transfer characteristics**

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



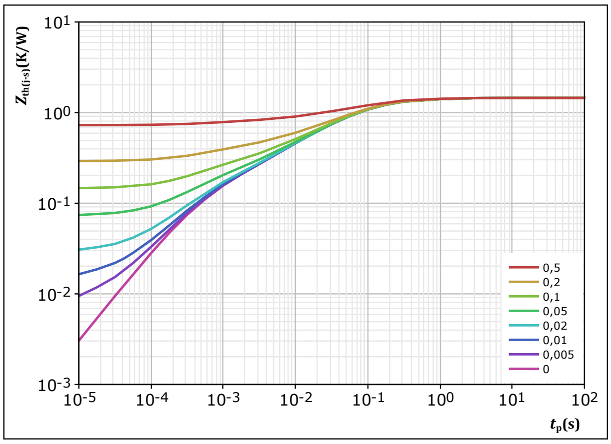

| | | |
|---|---|---|
| $t_p$ = | 250 | µs |
| $V_{CE}$ = | 10 | V |

$T_j$: 25 °C, 125 °C, 150 °C

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

**Transient thermal impedance as a function of pulse width**

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




| | | |
|---|---|---|
| $D$ = | $t_p$ / $T$ | |
| $R_{th(j-s)}$ = | 1,453 | K/W |

IGBT thermal model values

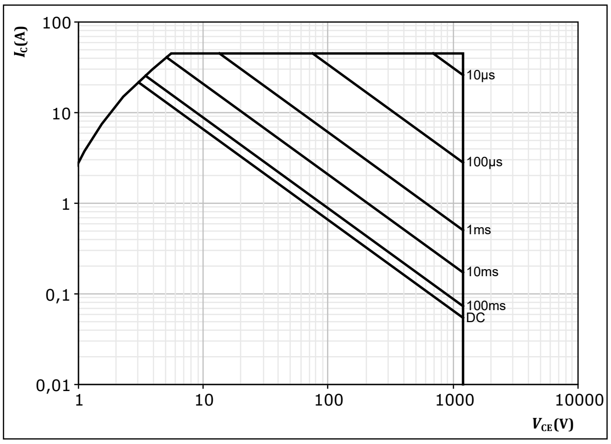
| $R$ (K/W) | $\tau$ (s) |
|---|---|
| 1,02E-01 | 1,17E+00 |
| 3,31E-01 | 1,69E-01 |
| 5,63E-01 | 5,65E-02 |
| 2,92E-01 | 1,03E-02 |
| 8,13E-02 | 1,50E-03 |
| 8,53E-02 | 4,00E-04 |

# Inverter Switch Characteristics

| figure 5. | IGBT |
| --- | --- |

**Safe operating area**

$I_C$ = f( $V_{CE}$ )



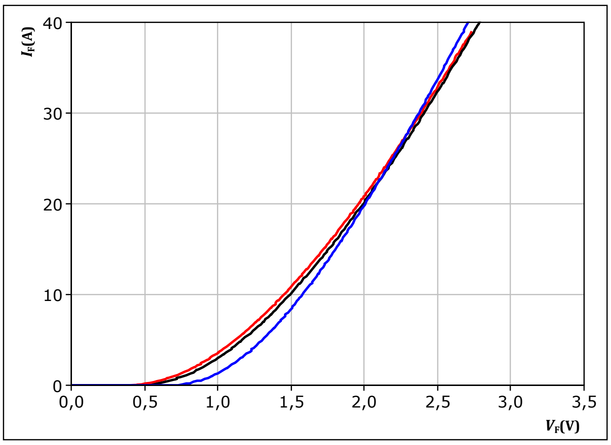

| | | |
| --- | --- | --- |
| $D$ = | single pulse | |
| $T_s$ = | 80 | °C |
| $V_{GE}$ = | 15 | V |
| $T_j$ = | $T_{jmax}$ | |

# Inverter Diode Characteristics

**figure 6.** **FWD**

**Typical forward characteristics**

$I_F = f(V_F)$



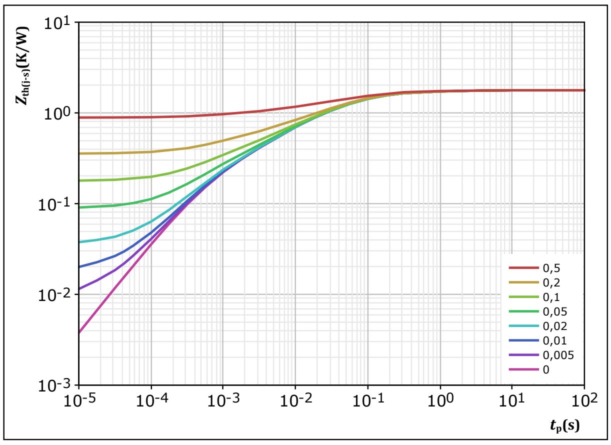

$t_p$ = 250 µs

$T_j$: 25 °C, 125 °C, 150 °C

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

**Transient thermal impedance as a function of pulse width**

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




$D = t_p / T$

$R_{th(j-s)}$ = 1,775 K/W

FWD thermal model values

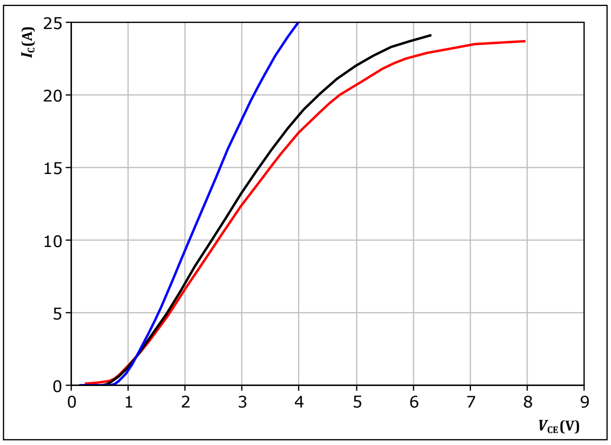
| R (K/W) | τ (s) |
|---|---|
| 8,20E-02 | 1,96E+00 |
| 1,92E-01 | 2,43E-01 |
| 6,68E-01 | 6,43E-02 |
| 4,69E-01 | 1,43E-02 |
| 2,32E-01 | 2,97E-03 |
| 1,33E-01 | 5,16E-04 |

# Brake Switch Characteristics

**figure 8.** **IGBT**

**Typical output characteristics**

$I_C$ = f( $V_{CE}$)

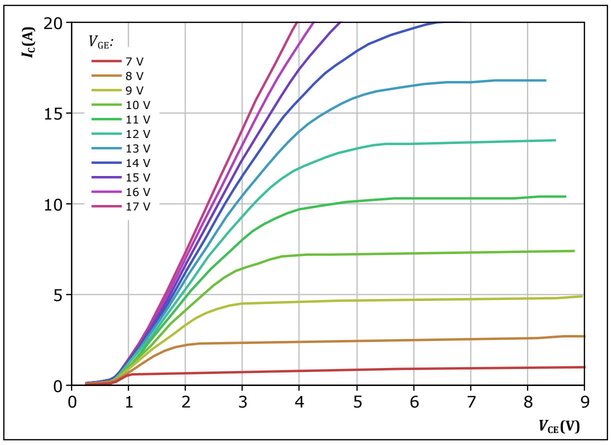



| | | | | |
|---|---|---|---|---|
| $t_p$ = | 250 | μs | | 25 °C |
| $V_{GE}$ = | 15 | V | $T_j$: | 125 °C |
| | | | | 150 °C |

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

**Typical output characteristics**

$I_C$ = f( $V_{CE}$)



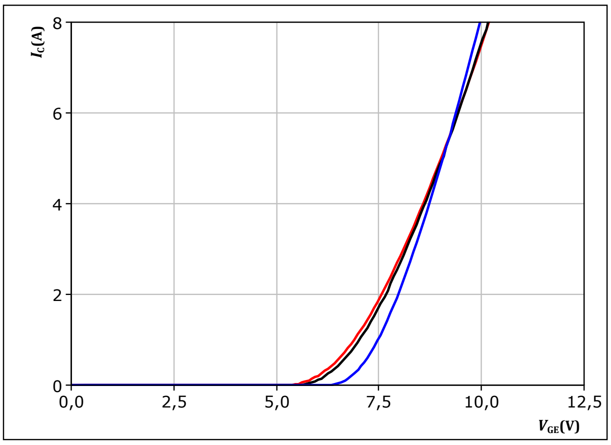

| | | |
|---|---|---|
| $t_p$ = | 250 | μs |
| $T_j$ = | 150 | °C |

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

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

**Typical transfer characteristics**

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

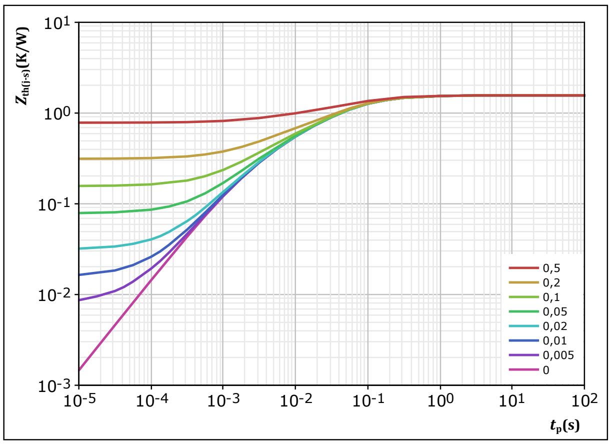



| | | | | |
|---|---|---|---|---|
| $t_p$ = | 250 | μs | | 25 °C |
| $V_{CE}$ = | 10 | V | $T_j$: | 125 °C |
| | | | | 150 °C |

**figure 11.** **IGBT**

**Transient thermal impedance as a function of pulse width**

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




| | | |
|---|---|---|
| $D$ = | $t_p$ / $T$ | |
| $R_{th(j\text{-}s)}$ = | 1,566 | K/W |

IGBT thermal model values

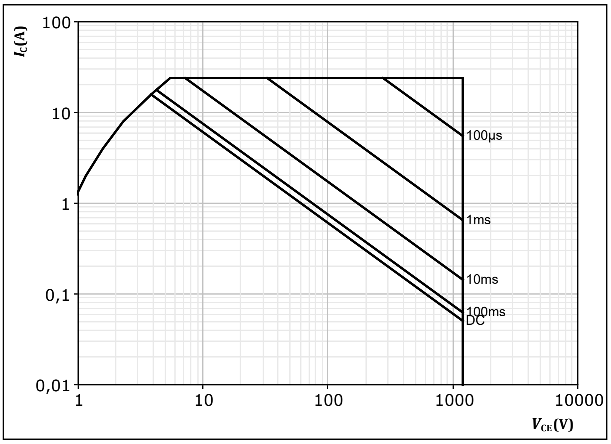
| $R$ (K/W) | $\tau$ (s) |
|---|---|
| 1,42E-01 | 5,98E-01 |
| 6,32E-01 | 7,71E-02 |
| 3,98E-01 | 2,43E-02 |
| 2,86E-01 | 6,16E-03 |
| 1,08E-01 | 1,44E-03 |

# Brake Switch Characteristics

**figure 12.** **IGBT**

**Safe operating area**

$I_C$ = f( $V_{CE}$ )




$D$ = single pulse

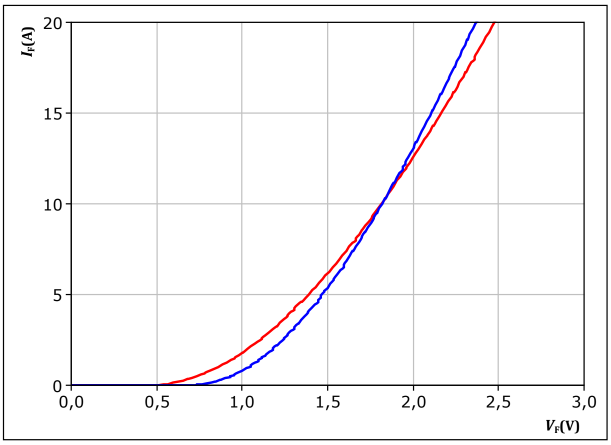
| | | |
|---|---|---|
| $T_s$ = | 80 | °C |
| $V_{GE}$ = | 15 | V |
| $T_j$ = | $T_{jmax}$ | |

# Brake Diode Characteristics

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

**Typical forward characteristics**

$I_F$ = f( $V_F$)



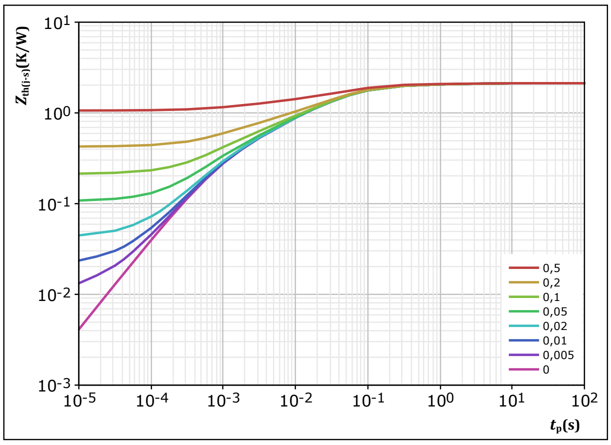

$t_p$ = 250 µs

$T_j$: 25 °C, 125 °C

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

**Transient thermal impedance as a function of pulse width**

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




$D$ = $t_p$ / $T$

$R_{th(j-s)}$ = 2,124 K/W

FWD thermal model values

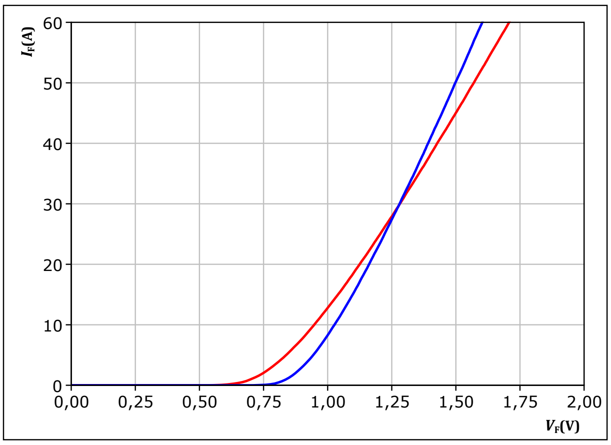
| R (K/W) | τ (s) |
|---|---|
| 7,00E-02 | 3,23E+00 |
| 1,48E-01 | 4,03E-01 |
| 7,34E-01 | 6,67E-02 |
| 5,90E-01 | 2,04E-02 |
| 3,47E-01 | 4,32E-03 |
| 2,36E-01 | 8,05E-04 |

# Rectifier Diode Characteristics

**figure 15.** **Rectifier**

**Typical forward characteristics**

$I_F$ = f( $V_F$)



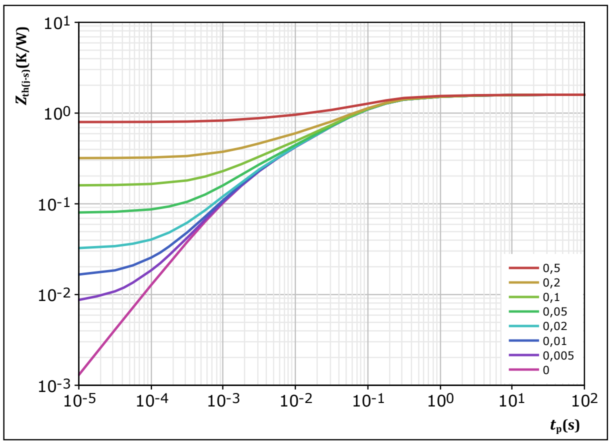

$t_p$ = 250 µs

$T_j$: 25 °C, 125 °C

**figure 16.** **Rectifier**

**Transient thermal impedance as a function of pulse width**

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




$D$ = $t_p$ / $T$

$R_{th(j-s)}$ = 1,594 K/W

Rectifier thermal model values

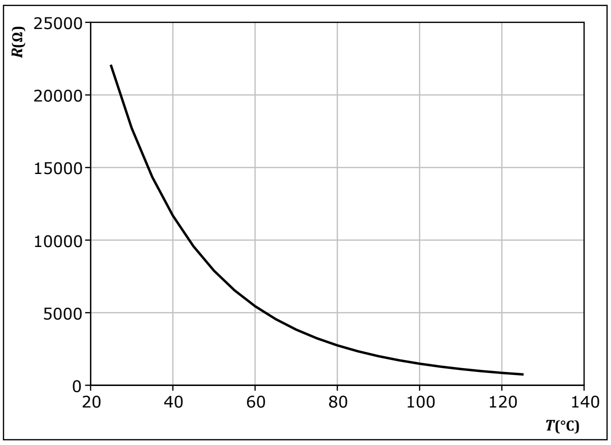
| $R$ (K/W) | $\tau$ (s) |
|---|---|
| 3,44E-02 | 9,66E+00 |
| 1,12E-01 | 1,22E+00 |
| 5,81E-01 | 1,45E-01 |
| 4,89E-01 | 5,05E-02 |
| 2,38E-01 | 9,26E-03 |
| 1,22E-01 | 1,79E-03 |
| 1,81E-02 | 7,88E-04 |

# Thermistor Characteristics

**figure 17.** **Thermistor**

**Typical NTC characteristic as function of temperature**

$R_T$ = f( $T$)

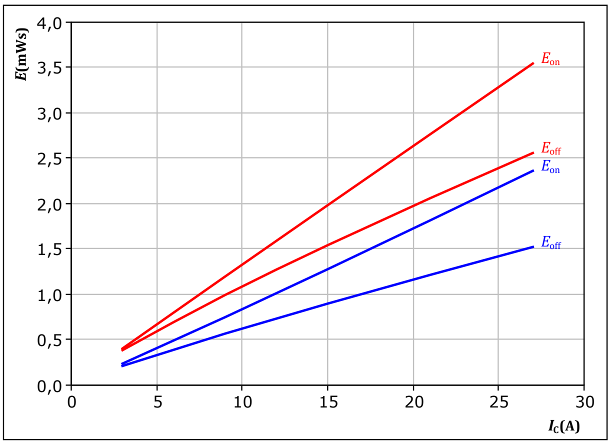


# Inverter Switching Characteristics

**figure 18.** **IGBT**

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

$E = f(I_C)$



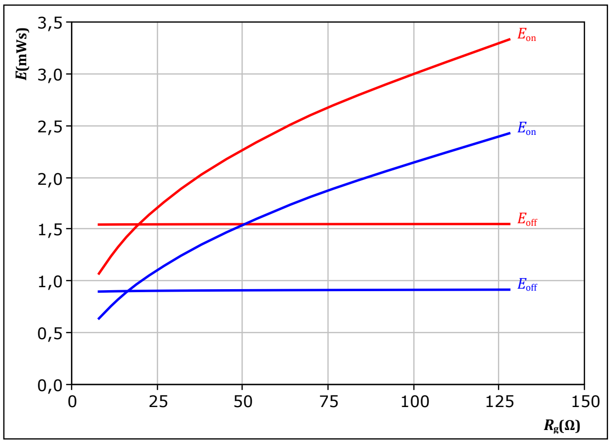

With an inductive load at

| | | | $T_j$: | |
|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | | 25 °C |
| $V_{GE}$ = | ±15 | V | | 150 °C |
| $R_{gon}$ = | 32 | Ω | | |
| $R_{goff}$ = | 32 | Ω | | |

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

**Typical switching energy losses as a function of IGBT turn on gate resistor**

$E = f(R_g)$



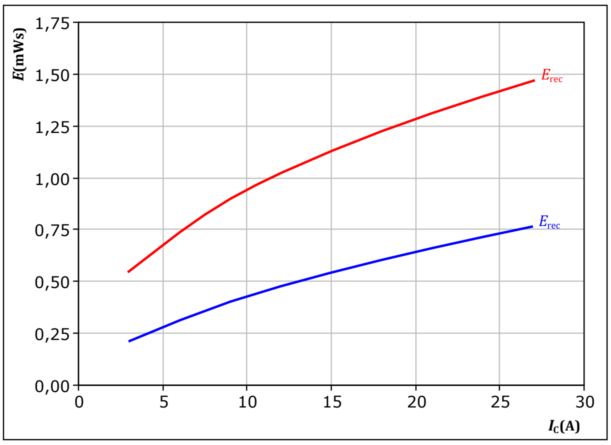

With an inductive load at

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

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

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

$E_{rec} = f(I_C)$



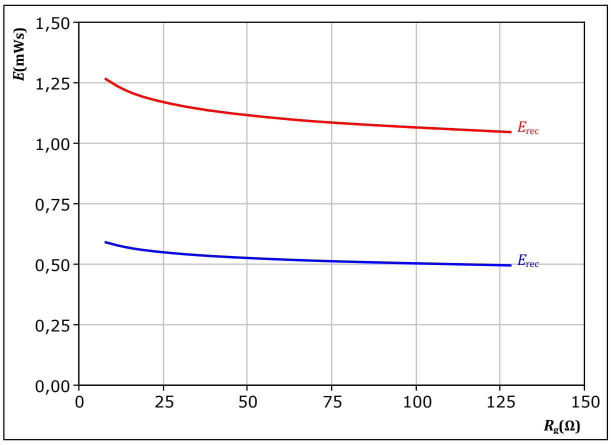

With an inductive load at

| | | | $T_j$: | |
|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | | 25 °C |
| $V_{GE}$ = | ±15 | V | | 150 °C |
| $R_{gon}$ = | 32 | Ω | | |

**figure 21.** **FWD**

**Typical reverse recovered energy loss as a function of IGBT turn on gate resistor**

$E_{rec} = f(R_g)$




With an inductive load at

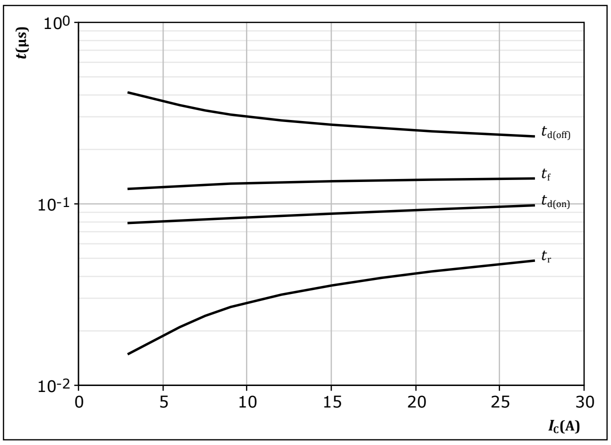
| | | | $T_j$: | |
|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | | 25 °C |
| $V_{GE}$ = | ±15 | V | | 150 °C |
| $I_C$ = | 15 | A | | |

# Inverter Switching Characteristics

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

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

$t = f(I_C)$



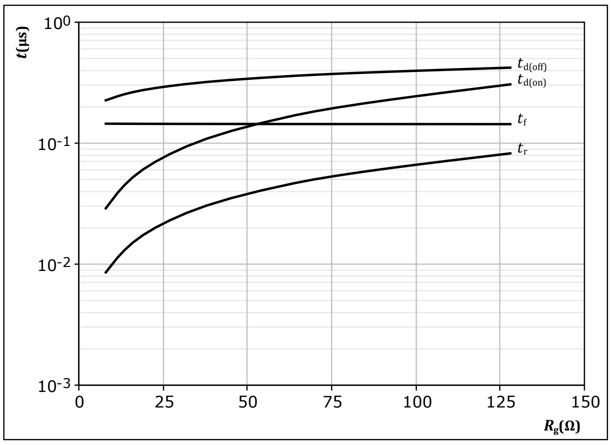

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 150 | °C |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 32 | Ω |
| $R_{goff}$ = | 32 | Ω |

**figure 23.** **IGBT**

**Typical switching times as a function of IGBT turn on gate resistor**

$t = f(R_g)$



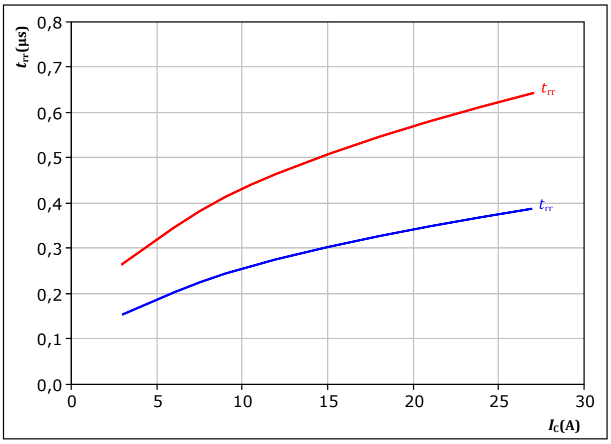

With an inductive load at

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

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

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

$t_{rr} = f(I_C)$




With an inductive load at

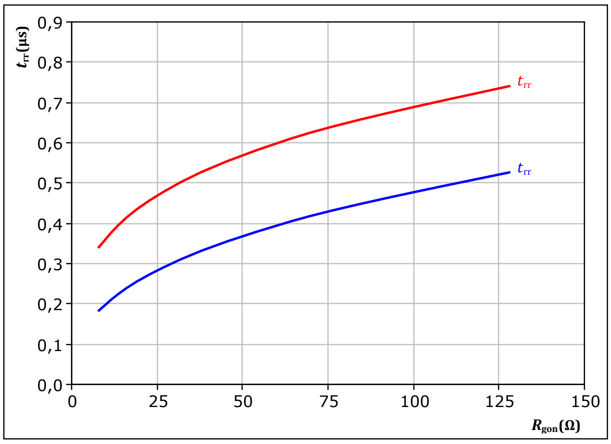
| | | |
|---|---|---|
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 32 | Ω |

$T_j$: 25 °C, 150 °C

**figure 25.** **FWD**

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

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




With an inductive load at

| | | |
|---|---|---|
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 15 | A |

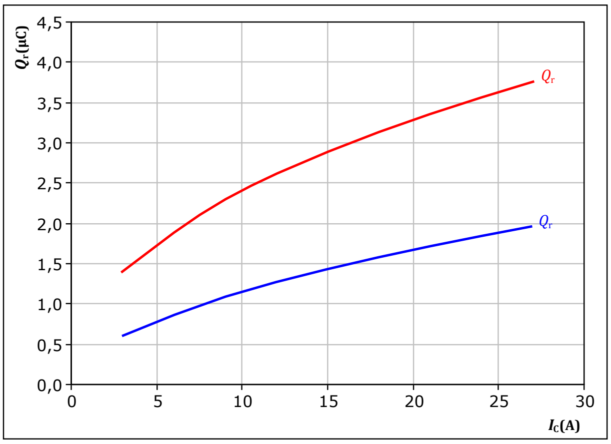
$T_j$: 25 °C, 150 °C

# Inverter Switching Characteristics

**figure 26.** **FWD**

**Typical recovered charge as a function of collector current**

$Q_r$ = f( $I_C$)



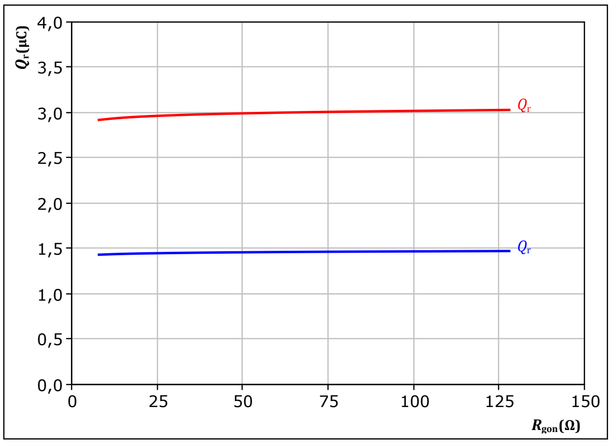

With an inductive load at

| | | | |
|---|---|---|---|
| $V_{CE}$ = | 600 | V | $T_j$: 25 °C (blue) |
| $V_{GE}$ = | ±15 | V | 150 °C (red) |
| $R_{gon}$ = | 32 | Ω | |

**figure 27.** **FWD**

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

$Q_r$ = f( $R_{gon}$)



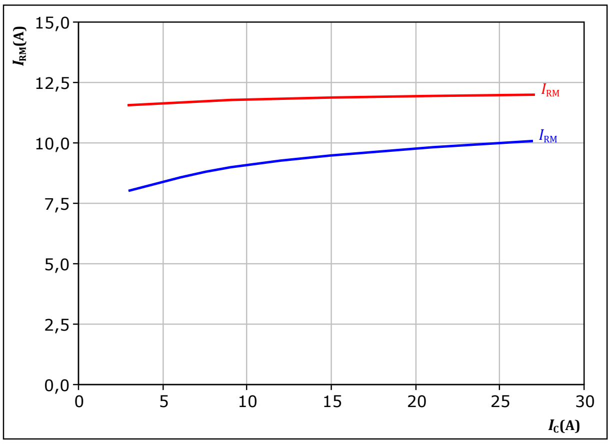

With an inductive load at

| | | | |
|---|---|---|---|
| $V_{CE}$ = | 600 | V | $T_j$: 25 °C (blue) |
| $V_{GE}$ = | ±15 | V | 150 °C (red) |
| $I_C$ = | 15 | A | |

**figure 28.** **FWD**

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

$I_{RM}$ = f( $I_C$)



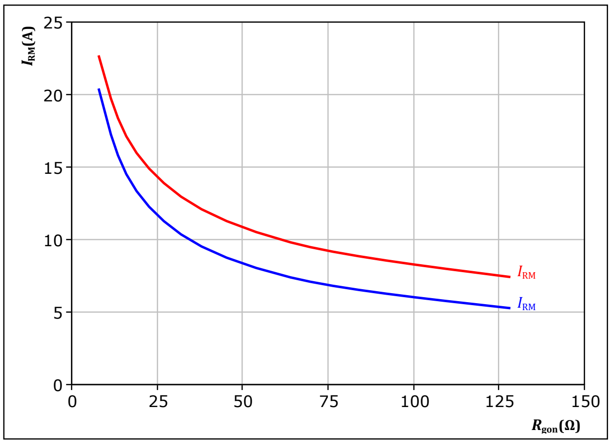

With an inductive load at

| | | | |
|---|---|---|---|
| $V_{CE}$ = | 600 | V | $T_j$: 25 °C (blue) |
| $V_{GE}$ = | ±15 | V | 150 °C (red) |
| $R_{gon}$ = | 32 | Ω | |

**figure 29.** **FWD**

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

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




With an inductive load at

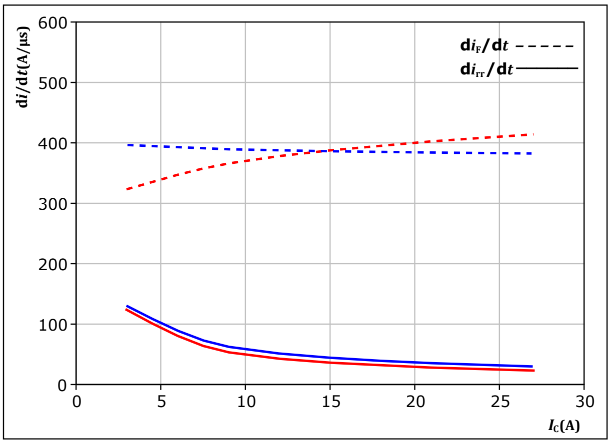
| | | | |
|---|---|---|---|
| $V_{CE}$ = | 600 | V | $T_j$: 25 °C (blue) |
| $V_{GE}$ = | ±15 | V | 150 °C (red) |
| $I_C$ = | 15 | A | |

# Inverter Switching Characteristics

**figure 30.** **FWD**

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

$di_F/dt$, $di_{rr}/dt$ = f( $I_C$)



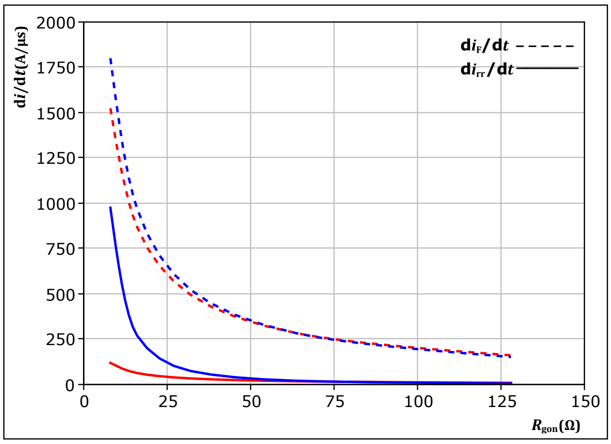

With an inductive load at

| | | | | |
|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | $T_j$: | 25 °C |
| $V_{GE}$ = | ±15 | V | | 150 °C |
| $R_{gon}$ = | 32 | Ω | | |

**figure 31.** **FWD**

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

$di_F/dt$, $di_{rr}/dt$ = f( $R_{gon}$)



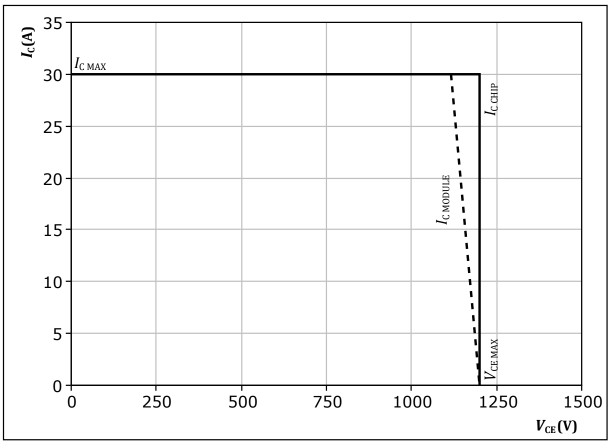

With an inductive load at

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

**figure 32.** **IGBT**

**Reverse bias safe operating area**

$I_C$ = f( $V_{CE}$)



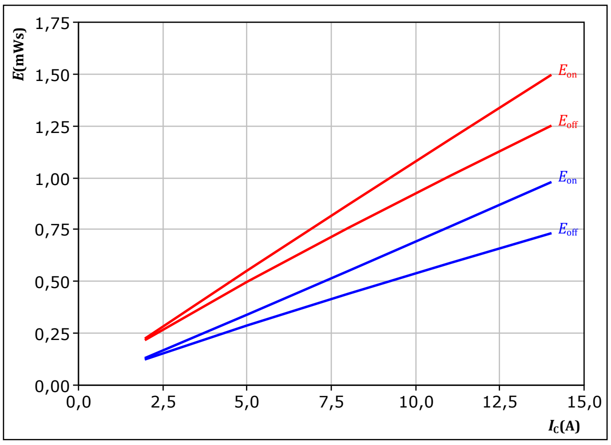

| | | | |
|---|---|---|---|
| **At** | $T_j$ = | 150 | °C |
| | $R_{gon}$ = | 32 | Ω |
| | $R_{goff}$ = | 32 | Ω |

# Brake Switching Characteristics

**figure 33.** **IGBT**

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

$E$ = f( $I_C$)



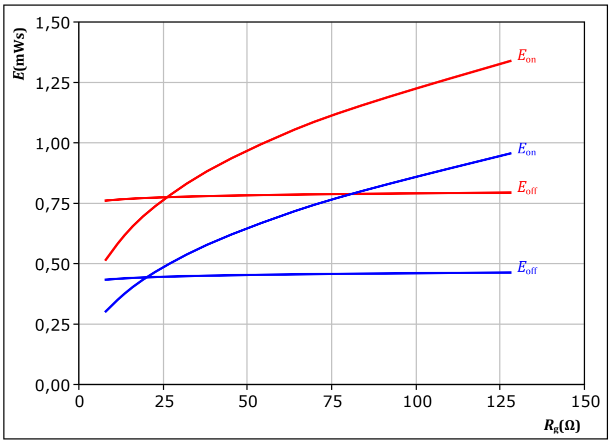

With an inductive load at

| | | | | |
|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | $T_j$: | 25 °C |
| $V_{GE}$ = | ±15 | V | | 150 °C |
| $R_{gon}$ = | 32 | Ω | | |
| $R_{goff}$ = | 32 | Ω | | |

**figure 34.** **IGBT**

**Typical switching energy losses as a function of IGBT turn on gate resistor**

$E$ = f( $R_g$)



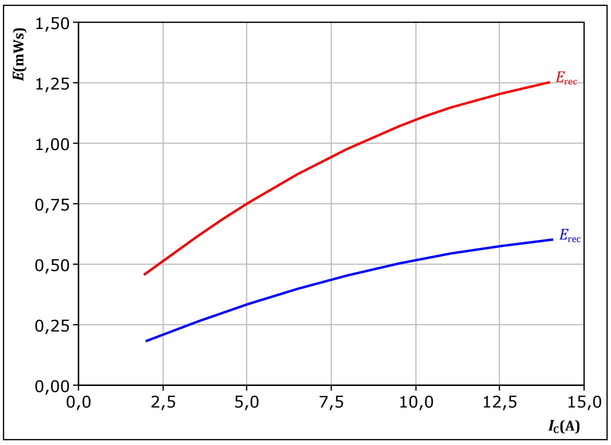

With an inductive load at

| | | | | |
|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | $T_j$: | 25 °C |
| $V_{GE}$ = | ±15 | V | | 150 °C |
| $I_C$ = | 8 | A | | |

**figure 35.** **FWD**

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

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



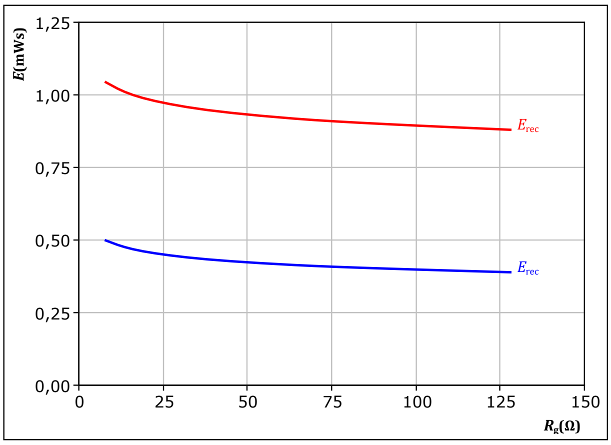

With an inductive load at

| | | | | |
|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | $T_j$: | 25 °C |
| $V_{GE}$ = | ±15 | V | | 150 °C |
| $R_{gon}$ = | 32 | Ω | | |

**figure 36.** **FWD**

**Typical reverse recovered energy loss as a function of IGBT turn on gate resistor**

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




With an inductive load at

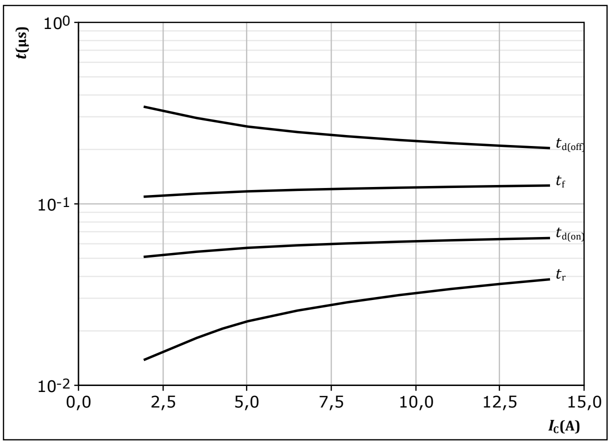
| | | | | |
|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | $T_j$: | 25 °C |
| $V_{GE}$ = | ±15 | V | | 150 °C |
| $I_C$ = | 8 | A | | |

# Brake Switching Characteristics

**figure 37.** **IGBT**

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

$t$ = f( $I_C$)



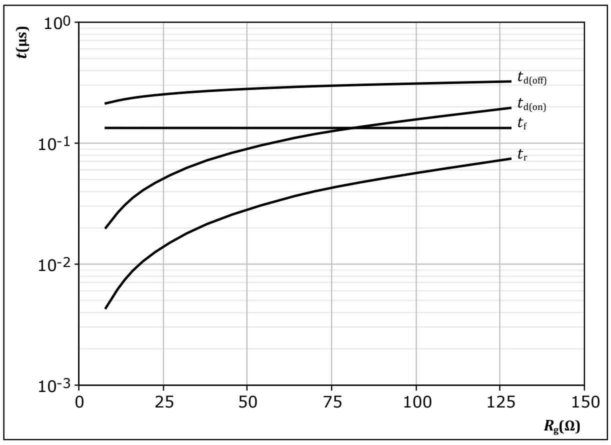

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 150 | °C |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 32 | Ω |
| $R_{goff}$ = | 32 | Ω |

**figure 38.** **IGBT**

**Typical switching times as a function of IGBT turn on gate resistor**

$t$ = f( $R_g$)



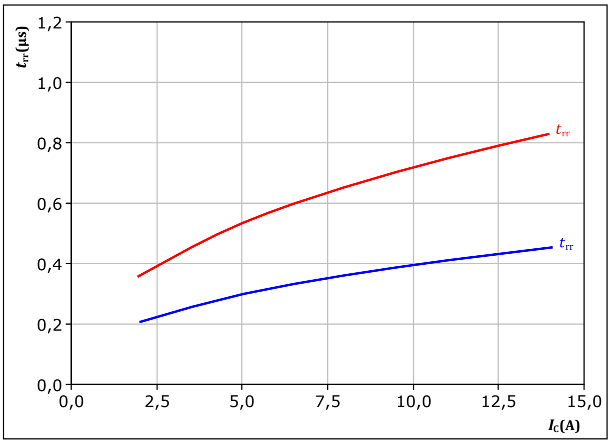

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 150 | °C |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 8 | A |

**figure 39.** **FWD**

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

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




With an inductive load at

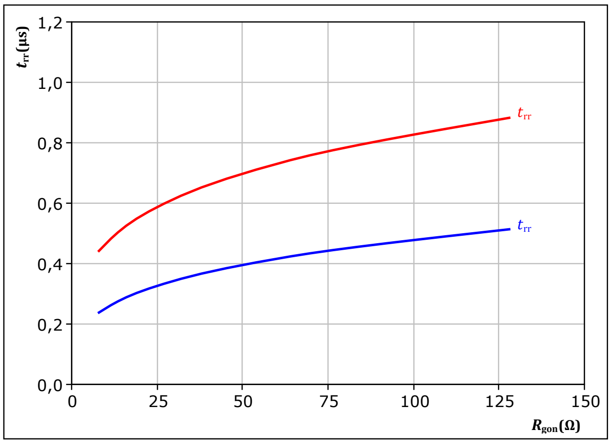
| | | |
|---|---|---|
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 32 | Ω |

$T_j$: 25 °C, 150 °C

**figure 40.** **FWD**

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

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




With an inductive load at

| | | |
|---|---|---|
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 8 | A |

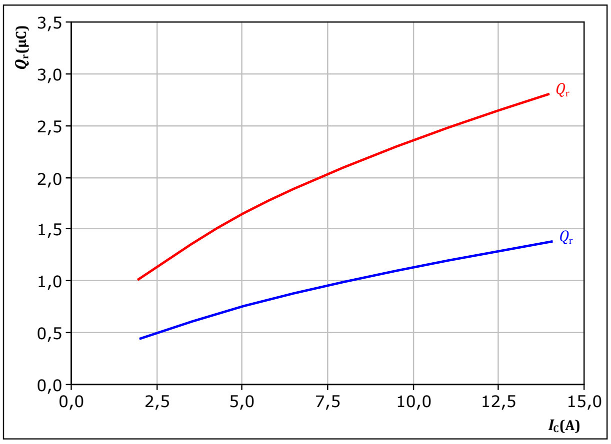
$T_j$: 25 °C, 150 °C

# Brake Switching Characteristics

**figure 41.** FWD

**Typical recovered charge as a function of collector current**

$Q_r$ = f( $I_C$ )




With an inductive load at

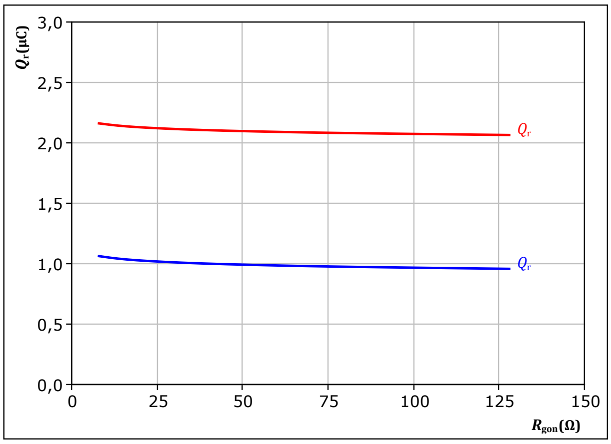
$V_{CE}$ = 600 V
$V_{GE}$ = ±15 V
$R_{gon}$ = 32 Ω

$T_j$: 25 °C, 150 °C

**figure 42.** FWD

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

$Q_r$ = f( $R_{gon}$ )




With an inductive load at

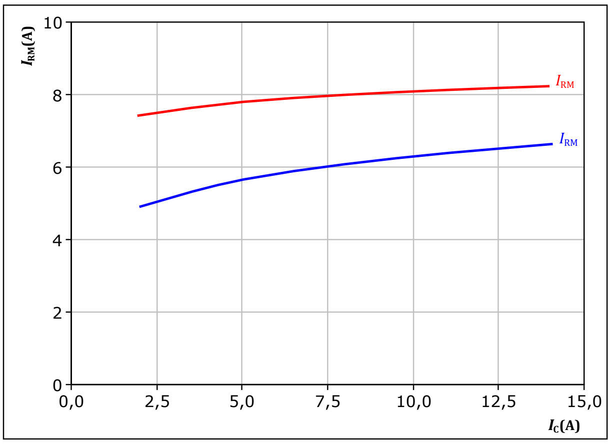
$V_{CE}$ = 600 V
$V_{GE}$ = ±15 V
$I_C$ = 8 A

$T_j$: 25 °C, 150 °C

**figure 43.** FWD

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

$I_{RM}$ = f( $I_C$ )




With an inductive load at

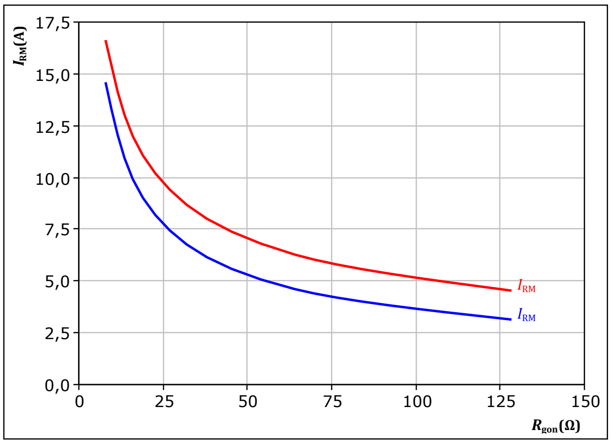
$V_{CE}$ = 600 V
$V_{GE}$ = ±15 V
$R_{gon}$ = 32 Ω

$T_j$: 25 °C, 150 °C

**figure 44.** FWD

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

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




With an inductive load at

$V_{CE}$ = 600 V
$V_{GE}$ = ±15 V
$I_C$ = 8 A

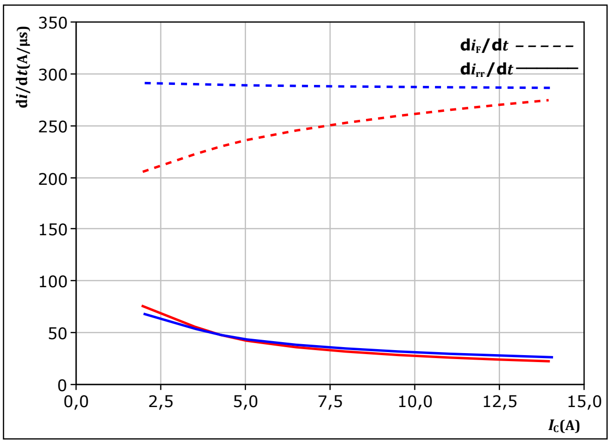
$T_j$: 25 °C, 150 °C

# Brake Switching Characteristics

**figure 45.** **FWD**

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

$di_F/dt$, $di_{rr}/dt$ = f( $I_C$)




With an inductive load at

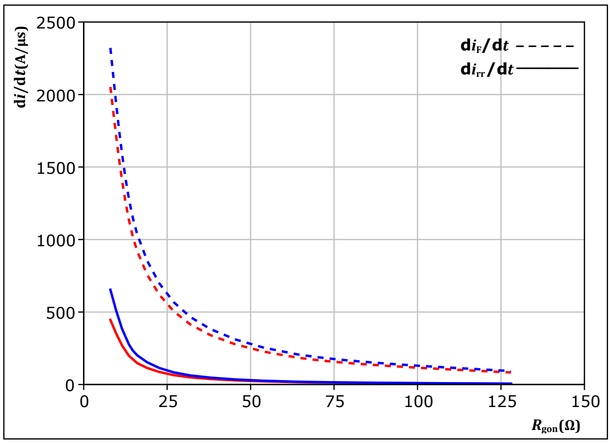
$T_j$: 25 °C, 150 °C

| | | |
|---|---|---|
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 32 | Ω |

**figure 46.** **FWD**

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

$di_F/dt$, $di_{rr}/dt$ = f( $R_{gon}$)




With an inductive load at

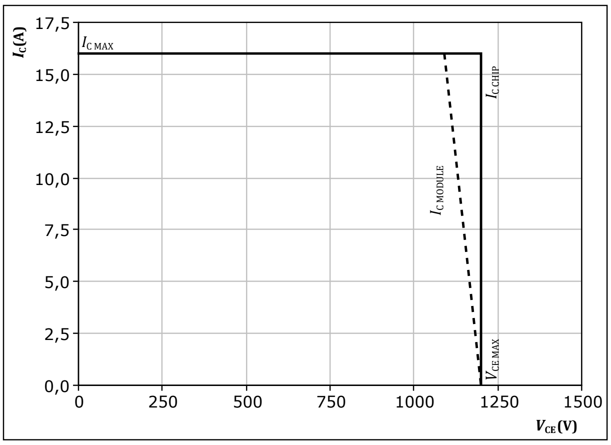
$T_j$: 25 °C, 150 °C

| | | |
|---|---|---|
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 8 | A |

**figure 47.** **IGBT**

**Reverse bias safe operating area**

$I_C$ = f( $V_{CE}$)

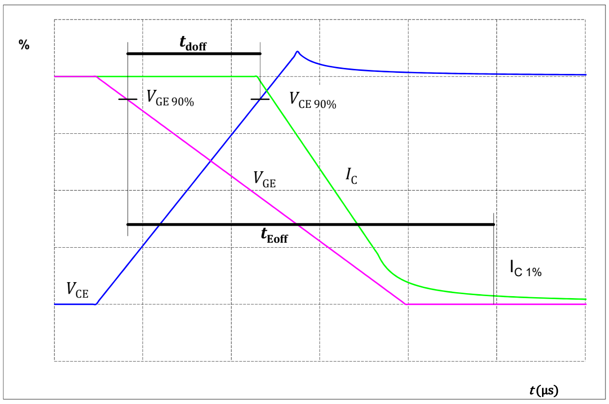



| **At** | | | |
|---|---|---|---|
| | $T_j$ = | 150 | °C |
| | $R_{gon}$ = | 32 | Ω |
| | $R_{goff}$ = | 32 | Ω |

# Switching Definitions

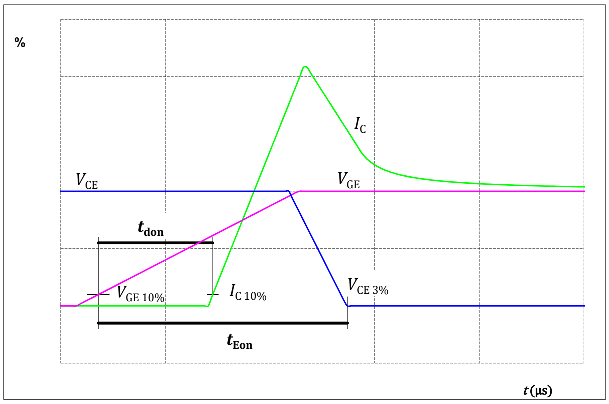
| figure 48. | IGBT |
|---|---|

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



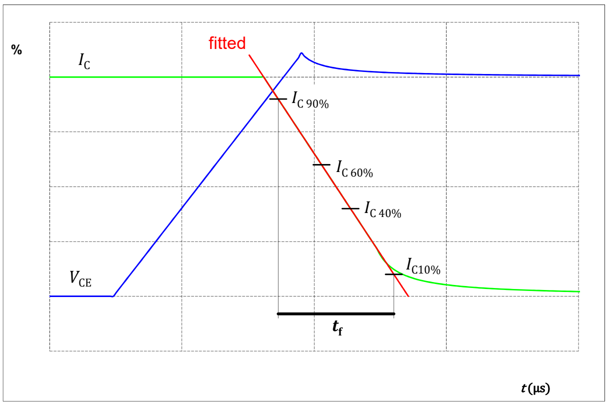

| figure 49. | IGBT |
|---|---|

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



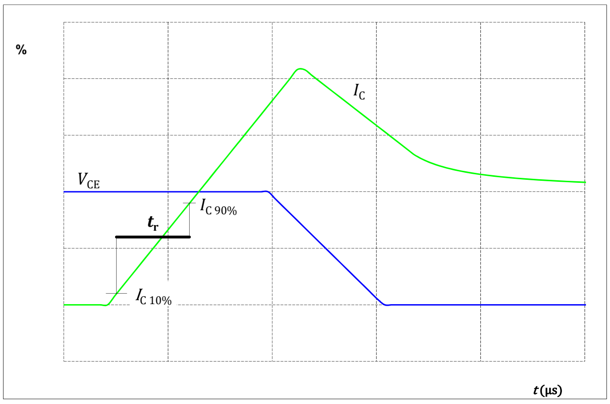

| figure 50. | IGBT |
|---|---|

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




| figure 51. | IGBT |
|---|---|

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



# Switching Definitions

**figure 52.** **FWD**

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

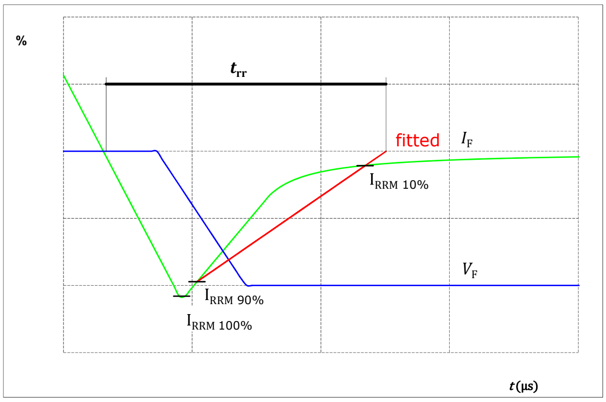
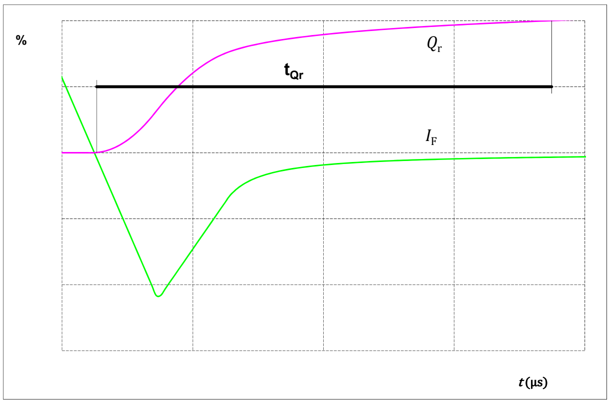



**figure 53.** **FWD**

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



V23990-P630-A40-PM
datasheet

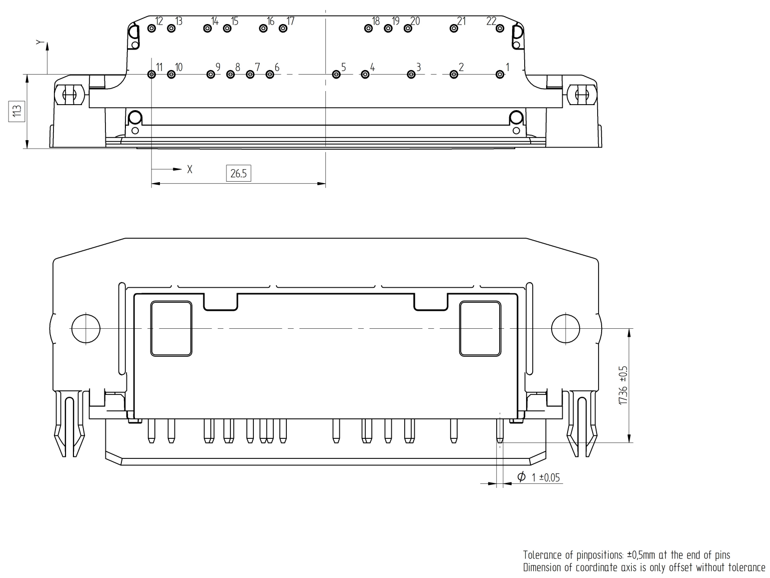
| Ordering Code | |
|---|---|
| **Version** | **Ordering Code** |
| Without thermal paste | V23990-P630-A40-PM |
| With thermal paste (3,4 W/mK, PSX-P7) | V23990-P630-A40-/3/-PM |

## Marking

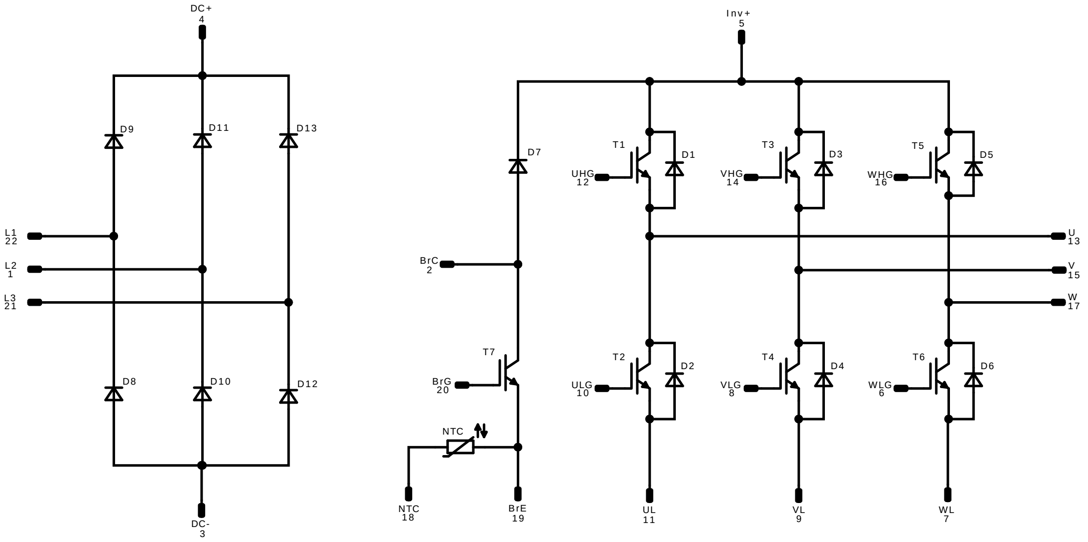
| | | | | | | | |
|---|---|---|---|---|---|---|---|
|  | **Text** | **VIN** | **Date code** | **Type&Ver** | **UL** | **Lot** | **Serial** |
| | | VIN | WWYY | TTTTTTTVV | UL | LLLLL | SSSS |
| | **Datamatrix** | **Type&Ver** | **Lot number** | **Serial** | **Date code** | | |
| | | TTTTTTTVV | LLLLL | SSSS | WWYY | | |

## Outline

| Pin table [mm] | | | |
|---|---|---|---|
| Pin | X | Y | Function |
| 1 | 53 | 0 | L2 |
| 2 | 46 | 0 | BrC |
| 3 | 39,5 | 0 | DC- |
| 4 | 32,5 | 0 | DC+ |
| 5 | 28,1 | 0 | Inv+ |
| 6 | 18 | 0 | WLG |
| 7 | 15 | 0 | WL |
| 8 | 12 | 0 | VLG |
| 9 | 9 | 0 | VL |
| 10 | 3 | 0 | ULG |
| 11 | 0 | 0 | UL |
| 12 | 0 | 7 | UHG |
| 13 | 3 | 7 | U |
| 14 | 8,5 | 7 | VHG |
| 15 | 11,5 | 7 | V |
| 16 | 17 | 7 | WHG |
| 17 | 20 | 7 | W |
| 18 | 33 | 7 | NTC |
| 19 | 36 | 7 | BrE |
| 20 | 39 | 7 | BrG |
| 21 | 46 | 7 | L3 |
| 22 | 53 | 7 | L1 |



## Pinout




## Identification

| ID | Component | Voltage | Current | Function | Comment |
|---|---|---|---|---|---|
| T2, T1, T4, T3, T6, T5 | IGBT | 1200 V | 15 A | Inverter Switch | |
| D2, D1, D4, D3, D6, D5 | FWD | 1200 V | 15 A | Inverter Diode | |
| T7 | IGBT | 1200 V | 8 A | Brake Switch | |
| D7 | FWD | 1200 V | 7,5 A | Brake Diode | |
| D8, D9, D10, D11, D12, D13 | Rectifier | 1600 V | 20 A | Rectifier Diode | |
| Rt | Thermistor | | | Thermistor | |

| Packaging instruction | | | | |
|---|---|---|---|---|
| Standard packaging quantity (SPQ) 80 | >SPQ | Standard | <SPQ | Sample |

| Handling instruction |
|---|
| Handling instructions for *flow*90 1 packages see vincotech.com website. |

| Package data |
|---|
| Package data for *flow*90 1 packages see vincotech.com website. |

| Vincotech thermistor reference |
|---|
| See Vincotech thermistor reference table at vincotech.com website. |

| UL recognition and file number |
|---|
| This device is UL 1557 recognized under E192116 up to a junction temperature under switching condition $T_{j,op}$=175°C and up to 3500VAC/1min isolation voltage. For more information see vincotech.com website. |

| Document No.: | Date: | Modification: | Pages |
|---|---|---|---|
| V23990-P630-A40-PM-D4-14 | 29 Feb. 2024 | Correct Rth of Inverter Switch | |