10-F1127PA050SC-L169E09
datasheet

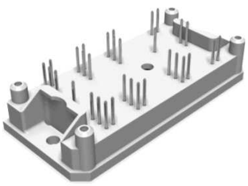
Vincotech

*flow* 7PACK 1 — 1200 V / 50 A

## Features

- Compact Flow 1 housing
- Trench Fieldstop IGBT4 Technology
- Compact and Low Inductance Design
- Built-in NTC

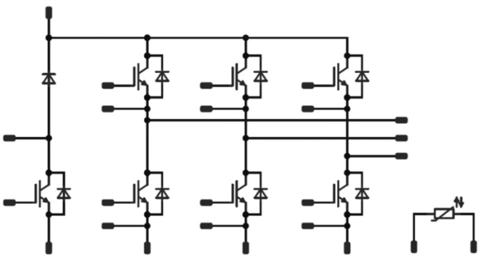
## *flow* 1 17mm housing



## Target applications

- Motor Drives
- Power Generation

## Schematic



## Types

- 10-F1127PA050SC-L169E09

# Maximum Ratings

$T_j$=25°C, unless otherwise specified

| Parameter | Symbol | Condition | | Value | Unit |
|---|---|---|---|---|---|
| **Inverter Switch** | | | | | |
| Collector-emitter voltage | $V_{CES}$ | | | 1200 | V |
| Collector current | $I_C$ | $T_j=T_j$max | $T_S$=80°C | 56 | A |
| Repetitive peak collector current | $I_{CRM}$ | $t_p$ limited by $T_j$max | | 150 | A |
| Total power dissipation | $P_{tot}$ | $T_j=T_j$max | $T_S$=80°C | 144 | W |
| Gate-emitter voltage | $V_{GES}$ | | | ±20 | V |
| Maximum Junction Temperature | $T_{jmax}$ | | | 175 | °C |

| Parameter | Symbol | Conditions | | Value | Unit |
|---|---|---|---|---|---|
| **Inverter Diode** | | | | | |
| Peak Repetitive Reverse Voltage | $V_{RRM}$ | | | 1200 | V |
| Continuous (direct) forward current | $I_F$ | $T_j=T_{jmax}$ | $T_h$=80°C | 51 | A |
| Repetitive peak forward current | $I_{FRM}$ | | | 100 | A |
| Total power dissipation | $P_{tot}$ | $T_j=T_{jmax}$ | $T_h$=80°C | 90 | W |
| Maximum Junction Temperature | $T_{jmax}$ | | | 175 | °C |

| Parameter | Symbol | Condition | | Value | Unit |
|---|---|---|---|---|---|
| **Brake Switch** | | | | | |
| Collector-emitter voltage | $V_{CES}$ | | | 1200 | V |
| Collector current | $I_C$ | $T_j=T_j$max | $T_S$=80°C | 39 | A |
| Repetitive peak collector current | $I_{CRM}$ | $t_p$ limited by $T_j$max | | 105 | A |
| Total power dissipation | $P_{tot}$ | $T_j=T_j$max | $T_S$=80°C | 101 | W |
| Gate-emitter voltage | $V_{GES}$ | | | ±20 | V |
| Short circuit ratings | $t_{SC}$<br>$V_{CC}$ | $T_j$ ≤ 150°C<br>$V_{GE}$ = 15V | | 10<br>800 | µs<br>V |
| Maximum Junction Temperature | $T_{jmax}$ | | | 175 | °C |

| Parameter | Symbol | Conditions | | Value | Unit |
|---|---|---|---|---|---|
| **Brake Diode** | | | | | |
| Peak Repetitive Reverse Voltage | $V_{RRM}$ | | | 1200 | V |
| Continuous (direct) forward current | $I_F$ | $T_j=T_{jmax}$ | $T_h$=80°C | 24 | A |
| Repetitive peak forward current | $I_{FRM}$ | | | 30 | A |
| Total power dissipation | $P_{tot}$ | $T_j=T_{jmax}$ | $T_h$=80°C | 52 | W |
| Maximum Junction Temperature | $T_{jmax}$ | | | 175 | °C |

| Parameter | Symbol | Conditions | | Value | Unit |
|---|---|---|---|---|---|
| **Brake Inv. Diode** | | | | | |
| Peak Repetitive Reverse Voltage | $V_{RRM}$ | | | 1200 | V |
| Continuous (direct) forward current | $I_F$ | $T_j=T_{jmax}$ | $T_h$=80°C | 15 | A |
| Repetitive peak forward current | $I_{FRM}$ | | | 15 | A |
| Total power dissipation | $P_{tot}$ | $T_j=T_{jmax}$ | $T_h$=80°C | 33 | 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 Junction Temperature | $T_{jop}$ | | | -40...+($T_{jmax}$ - 25) | °C |
| **Isolation Properties** | | | | | |
| Isolation voltage | $V_{isol}$ | DC voltage | $t_p$=2s | 4000 | V |
| Creepage distance | | | | min 12,7 | mm |
| Clearance | | | | 12,63 | mm |
| Comparative Tracking Index | CTI | | | >200 | |

# Characteristic Values

## Inverter Switch

| Parameter | Symbol | Conditions | $V_{GE}$ [V] | $V_{CE}$ [V] | $I_C$ [A] | $T_j$ [°C] | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| **Static** | | | | | | | | | | |
| Gate-emitter threshold voltage | $V_{GE(th)}$ | $V_{GE}=V_{CE}$ | | | 0,0017 | 25<br>125 | 5,3 | 5,8 | 6,3 | V |
| Collector-emitter saturation voltage | $V_{CEsat}$ | | 15 | | 50 | 25<br>125<br>150 | 1,58 | 1,88<br>-<br>2,30 | 2,07 | V |
| Collector-emitter cut-off current | $I_{CES}$ | | 0 | 1200 | | 25<br>125 | | | 10 | µA |
| Gate-emitter leakage current | $I_{GES}$ | | 20 | 0 | | 25<br>125 | | | 600 | nA |
| Internal gate resistance | $r_g$ | | | | | | | 4 | | Ω |
| Input capacitance | $C_{ies}$ | f=1MHz | 0 | 25 | | 25 | | 2800 | | pF |
| Reverse transfer capacitance | $C_{res}$ | f=1MHz | 0 | 25 | | 25 | | 100 | | pF |
| **Thermal** | | | | | | | | | | |
| Thermal resistance junction to sink | $R_{th(j\text{-}s)}$ | Phase-Change Material<br>λ=3,4W/mK | | | | | | 0,66 | | K/W |
| **IGBT Switching** | | | | | | | | | | |
| Turn-on delay time | $t_{d(on)}$ | $R_{goff}$ = 8 Ω<br>$R_{gon}$ = 8 Ω | ±15 | 600 | 50 | 25<br>150 | | 96<br>101 | | ns |
| Rise time | $t_r$ | $R_{goff}$ = 8 Ω<br>$R_{gon}$ = 8 Ω | ±15 | 600 | 50 | 25<br>150 | | 17<br>24 | | ns |
| Turn-off delay time | $t_{d(off)}$ | $R_{goff}$ = 8 Ω<br>$R_{gon}$ = 8 Ω | ±15 | 600 | 50 | 25<br>150 | | 214<br>281 | | ns |
| Fall time | $t_f$ | $R_{goff}$ = 8 Ω<br>$R_{gon}$ = 8 Ω | ±15 | 600 | 50 | 25<br>150 | | 87<br>122 | | ns |
| Turn-on energy (per pulse) | $E_{on}$ | $Q_{rFWD}$ = 4,8 µC<br>$Q_{rFWD}$ = 9,7 µC | ±15 | 600 | 50 | 25<br>150 | | 2,701<br>4,211 | | mWs |
| Turn-off energy (per pulse) | $E_{off}$ | | ±15 | 600 | 50 | 25<br>150 | | 2,744<br>4,531 | | mWs |

## Inverter Diode

| Parameter | Symbol | Conditions | | | | | Value | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $V_r$ [V] | $I_F$ [A] | $T_j$ [°C] | Min | Typ | Max | |
| **Static** | | | | | | | | | | |
| Forward voltage | $V_F$ | | | | 50 | 25<br>125<br>150 | | 1,74<br>1,79<br>1,77 | 2,05 | V |
| Reverse leakage current | $I_r$ | | | 1200 | | 25<br>150 | | | 10<br>- | μA |
| **Thermal** | | | | | | | | | | |
| Thermal resistance junction to sink | $R_{th(j-s)}$ | Phase-Change Material λ=3,4W/mK | | | | | | 1,06 | | K/W |
| **FWD Switching** | | | | | | | | | | |
| Peak recovery current | $I_{RRM}$ | di/dt = 3866 A/μs<br>di/dt = 2820 A/μs | ±15 | 600 | 50 | 25<br>150 | | 81<br>85 | | A |
| Reverse recovery time | $t_{rr}$ | | | | | 25<br>150 | | 139<br>316 | | ns |
| Recovered charge | $Q_r$ | | | | | 25<br>150 | | 4,797<br>9,708 | | μC |
| Reverse recovered energy | $E_{rec}$ | | | | | 25<br>150 | | 1,790<br>3,972 | | mWs |
| Peak rate of fall of recovery current | $(di_{rf}/dt)_{max}$ | | | | | 25<br>150 | | 4803<br>1209 | | A/μs |

**10-F1127PA050SC-L169E09**
datasheet

Vincotech

## Brake Switch

| Parameter | Symbol | Conditions | $V_{GE}$ [V] | $V_{CE}$ [V] | $I_C$ [A] | $T_j$ [°C] | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| **Static** | | | | | | | | | | |
| Gate-emitter threshold voltage | $V_{GE(th)}$ | $V_{GE}$=$V_{CE}$ | | | 0,0012 | 25<br>125 | 5,3 | 5,8 | 6,3 | V |
| Collector-emitter saturation voltage | $V_{CEsat}$ | | 15 | | 35 | 25<br>125<br>150 | 1,58 | 1,87<br>-<br>2,30 | 2,07 | V |
| Collector-emitter cut-off current | $I_{CES}$ | | 0 | 1200 | | 25<br>125 | | | 5 | µA |
| Gate-emitter leakage current | $I_{GES}$ | | 20 | 0 | | 25<br>125 | | | 120 | nA |
| Internal gate resistance | $r_g$ | | | | | | | none | | Ω |
| Input capacitance | $C_{ies}$ | f=1 MHz | 0 | 25 | | 25 | | 2000 | | pF |
| Reverse transfer capacitance | $C_{res}$ | | | | | | | 70 | | |

| Parameter | Symbol | Conditions | $V_{GE}$ [V] | $V_{CE}$ [V] | $I_C$ [A] | $T_j$ [°C] | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| **Thermal** | | | | | | | | | | |
| Thermal resistance junction to sink | $R_{th(j-s)}$ | Phase-Change Material<br>λ=3,4W/mK | | | | | | 0,94 | | K/W |

| Parameter | Symbol | Conditions | $V_{GE}$ [V] | $V_{CE}$ [V] | $I_C$ [A] | $T_j$ [°C] | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| **IGBT Switching** | | | | | | | | | | |
| Turn-on delay time | $t_{d(on)}$ | $R_{goff}$ = 16 Ω<br>$R_{gon}$ = 16 Ω | ±15 | 600 | 35 | 25<br>125<br>150 | | 86<br>87<br>89 | | ns |
| Rise time | $t_r$ | | | | | 25<br>125<br>150 | | 42<br>43<br>42 | | |
| Turn-off delay time | $t_{d(off)}$ | | | | | 25<br>125<br>150 | | 206<br>258<br>272 | | |
| Fall time | $t_f$ | | | | | 25<br>125<br>150 | | 71<br>126<br>140 | | |
| Turn-on energy (per pulse) | $E_{on}$ | $Q_{rFWD}$ = 2,3 µC<br>$Q_{rFWD}$ = 3,9 µC<br>$Q_{rFWD}$ = 4,4 µC | | | | 25<br>125<br>150 | | 2,600<br>3,278<br>3,463 | | mWs |
| Turn-off energy (per pulse) | $E_{off}$ | | | | | 25<br>125<br>150 | | 2,058<br>3,158<br>3,526 | | |

## Brake Diode

| Parameter | Symbol | Conditions | | | | | Value | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $V_r$ [V] | $I_F$ [A] | $T_j$ [°C] | Min | Typ | Max | |
| **Static** | | | | | | | | | | |
| Forward voltage | $V_F$ | | | | 15 | 25<br>125<br>150 | | 1,80<br>-<br>1,77 | 2,05 | V |
| Reverse leakage current | $I_r$ | | | 1200 | | 25<br>150 | | | 3,5<br>- | µA |
| **Thermal** | | | | | | | | | | |
| Thermal resistance junction to sink | $R_{th(j-s)}$ | Phase-Change Material λ=3,4W/mK | | | | | | 1,83 | | K/W |

## Brake Inv. Diode

| Parameter | Symbol | Conditions | | | | | Value | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $V_r$ [V] | $I_F$ [A] | $T_j$ [°C] | Min | Typ | Max | |
| **Static** | | | | | | | | | | |
| Forward voltage | $V_F$ | | | | 8 | 25<br>125<br>150 | | 1,65<br>1,61<br>- | | V |
| Reverse leakage current | $I_r$ | | | 1200 | | 25<br>150 | | | 250<br>- | µA |
| **Thermal** | | | | | | | | | | |
| Thermal resistance junction to sink | $R_{th(j-s)}$ | Phase-Change Material λ=3,4W/mK | | | | | | 2,12 | | K/W |

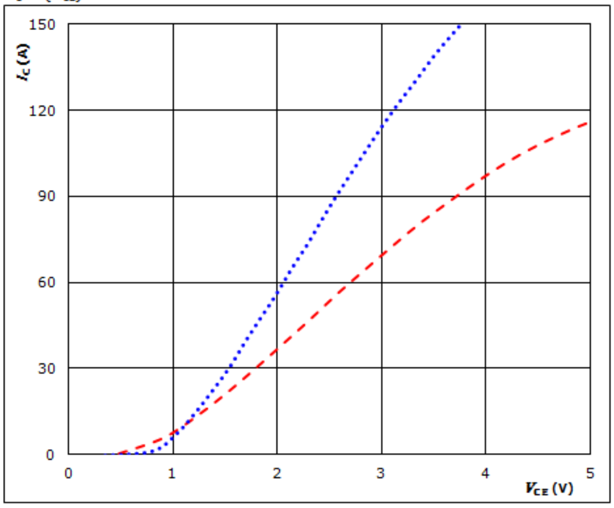
## Thermistor

| Parameter | Symbol | Conditions | | | | | Value | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $V_{GE}$ [V] | $V_{CE}$ [V] | $I_C$ [A] | $T_j$ [°C] | Min | Typ | Max | |
| Rated resistance | R | | | | | 25 | | 21,5 | | kΩ |
| Deviation of R100 | $\Delta_{R/R}$ | R100=1486 Ω | | | | 100 | -4,5 | | +4,5 | % |
| Power dissipation | $P$ | | | | | 25 | | 210 | | mW |
| Power dissipation constant | | | | | | 25 | | 3,5 | | mW/K |
| B-value | $B_{(25/50)}$ | | | | | 25 | | 3884 | | K |
| B-value | $B_{(25/100)}$ | | | | | 25 | | 3964 | | K |
| Vincotech NTC Reference | | | | | | | | | F | |

# Inverter Switch Characteristics

**Typical output characteristics** **IGBT**

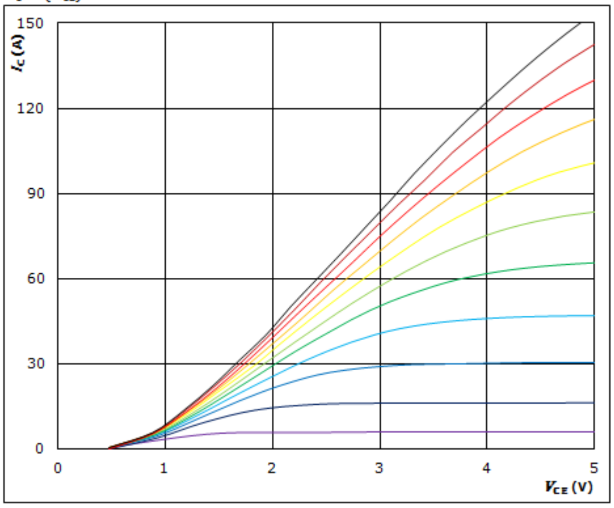
$I_C = f(V_{CE})$




| | | | | |
|---|---|---|---|---|
| $t_p$ = | 250 | µs | 25 °C | ............ |
| $V_{CE}$= | 15 | V | 125 °C | ——— |
| | | | 150 °C | – – – – |

**Typical output characteristics** **IGBT**

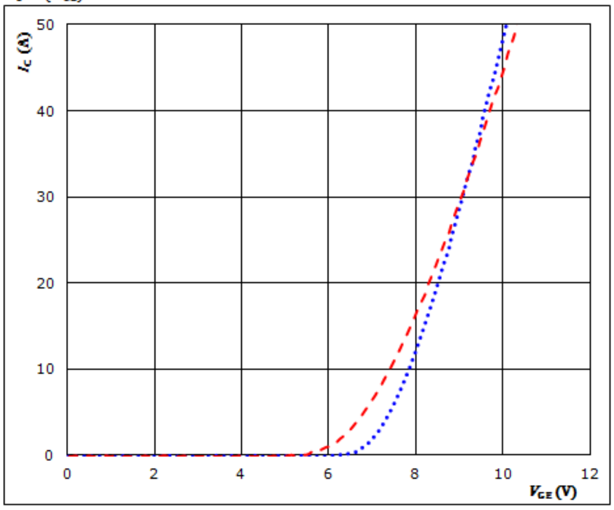
$I_C = f(V_{CE})$




| | | |
|---|---|---|
| $t_p$ = | 250 | µs |
| $T_j$ = | 150 | °C |
| $V_{GE}$ from | 7 V to 17 V in steps of 1 V | |

**Typical transfer characteristics** **IGBT**

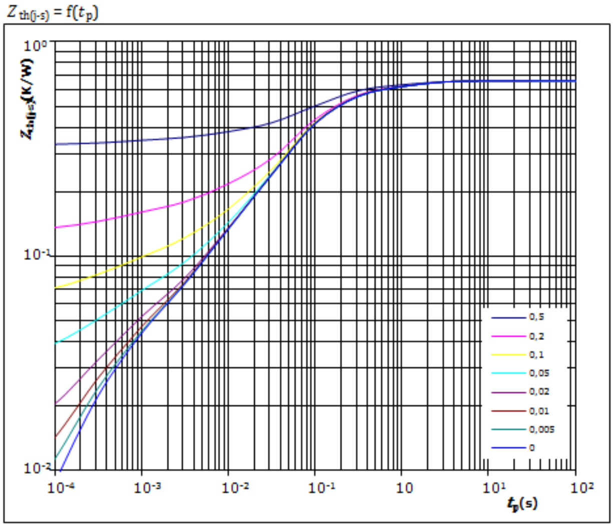
$I_C = f(V_{GE})$




| | | | | |
|---|---|---|---|---|
| $t_p$ = | 100 | µs | 25 °C | ............ |
| $V_{CE}$ = | 10 | V | 125 °C | ——— |
| | | | 150 °C | – – – – |

**Transient Thermal Impedance as function of Pulse duration** **IGBT**

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




| | | |
|---|---|---|
| D = | $t_p$ / $T$ | |
| $R_{th(j-s)}$ = | 0,66 | K/W |

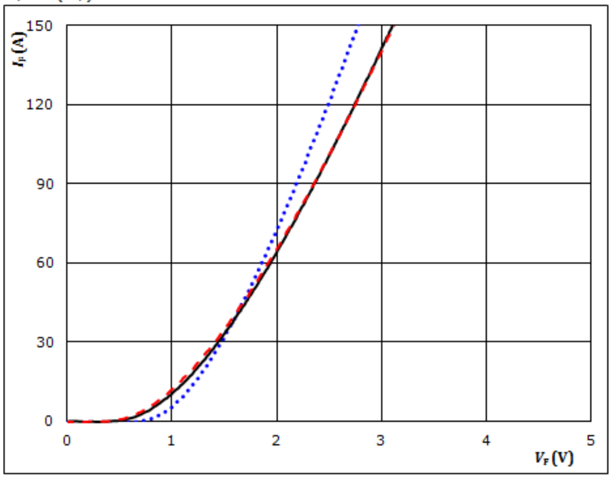
IGBT thermal model values

| $R_{th}$ (K/W) | τ (s) |
|---|---|
| 8,54E-02 | 1,27E+00 |
| 1,79E-01 | 1,86E-01 |
| 3,14E-01 | 6,03E-02 |
| 5,28E-02 | 4,65E-03 |
| 2,90E-02 | 3,68E-04 |

# Inverter Diode Characteristics

**Typical forward characteristics** **FWD**

$I_F = f(V_F)$

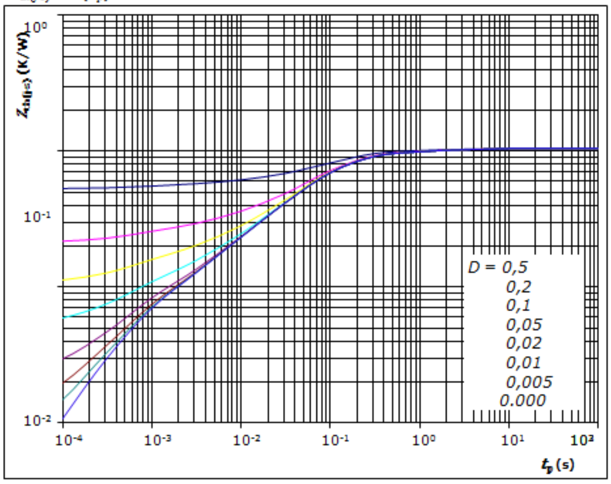



$t_p$ = 250 µs

$T_j$: 25 °C, 125 °C, 150 °C

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

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




D = $t_p$ / $T$

$R_{th(j-s)}$ = 1,06 K/W

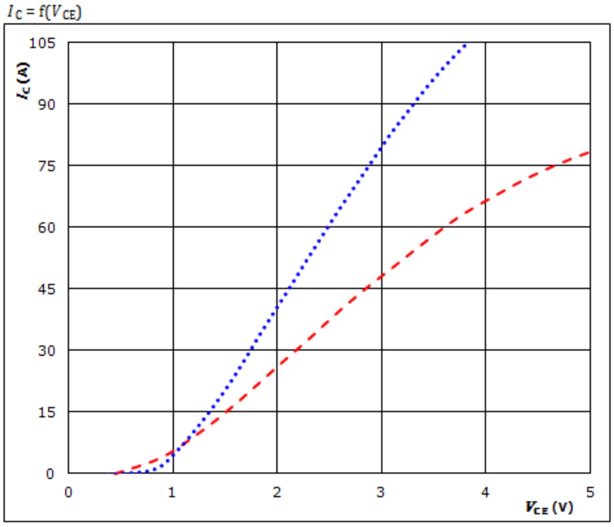
FWD thermal model values

| R (K/W) | τ (s) |
|---|---|
| 4,19E-02 | 4,68E+00 |
| 8,50E-02 | 8,80E-01 |
| 4,99E-01 | 1,21E-01 |
| 2,83E-01 | 4,12E-02 |
| 9,28E-02 | 6,53E-03 |
| 5,92E-02 | 6,76E-04 |

# Brake Switch Characteristics

**Typical output characteristics** IGBT

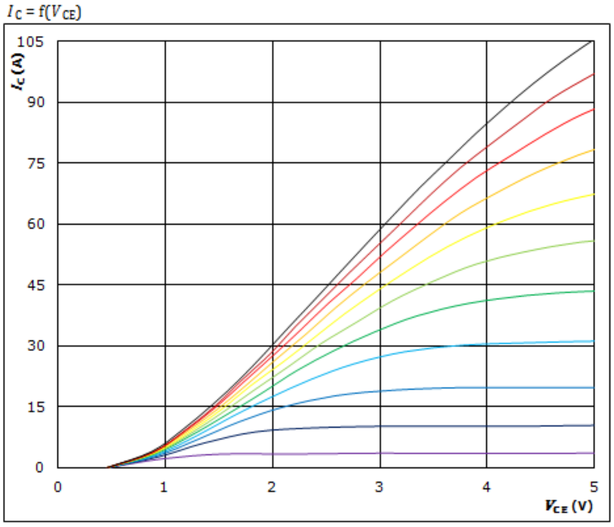
$I_C = f(V_{CE})$




| | | | | |
|---|---|---|---|---|
| $t_p$ = | 250 | µs | 25 °C | ··········· |
| $V_{GE}$= | 15 | V | 125 °C | ——— |
| | | | 150 °C | – – – – |

**Typical output characteristics** IGBT

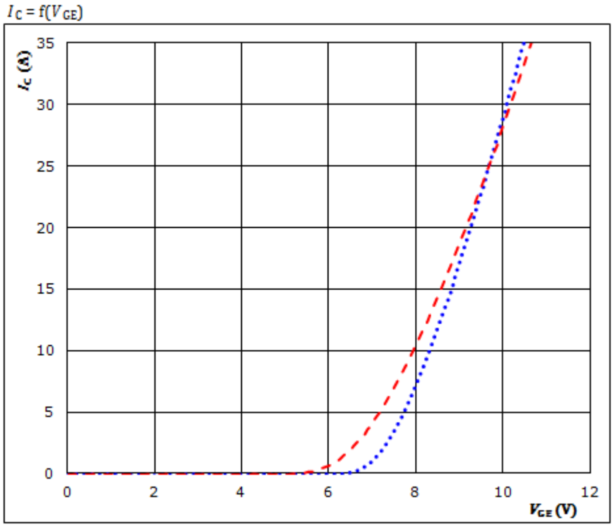
$I_C = f(V_{CE})$




| | | |
|---|---|---|
| $t_p$ = | 250 | µs |
| $T_j$ = | 150 | °C |
| $V_{GE}$ from | 7 V to 17 V in steps of 1 V | |

**Typical transfer characteristics** IGBT

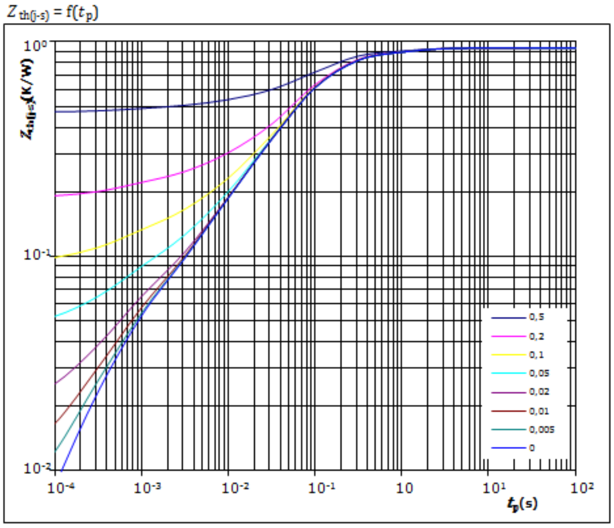
$I_C = f(V_{GE})$




| | | | | |
|---|---|---|---|---|
| $t_p$ = | 100 | µs | 25 °C | ··········· |
| $V_{CE}$ = | 10 | V | 125 °C | ——— |
| | | | 150 °C | – – – – |

**Transient Thermal Impedance as function of Pulse duration** IGBT

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




| | | |
|---|---|---|
| D = | $t_p$ / $T$ | |
| $R_{th(j-s)}$ = | 0,94 | K/W |

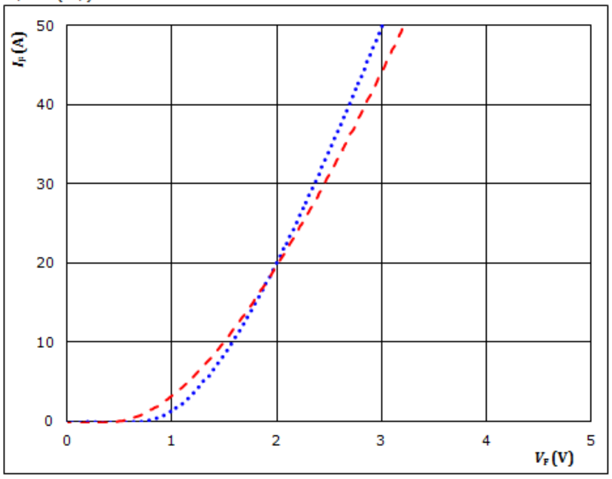
IGBT thermal model values

| $R_{th}$ (K/W) | τ (s) |
|---|---|
| 1,15E-01 | 9,47E-01 |
| 4,15E-01 | 1,24E-01 |
| 2,99E-01 | 4,81E-02 |
| 7,22E-02 | 5,86E-03 |
| 3,82E-02 | 5,62E-04 |

# Brake Diode Characteristics

| Typical forward characteristics | FWD |
|---|---|

$I_F = f(V_F)$

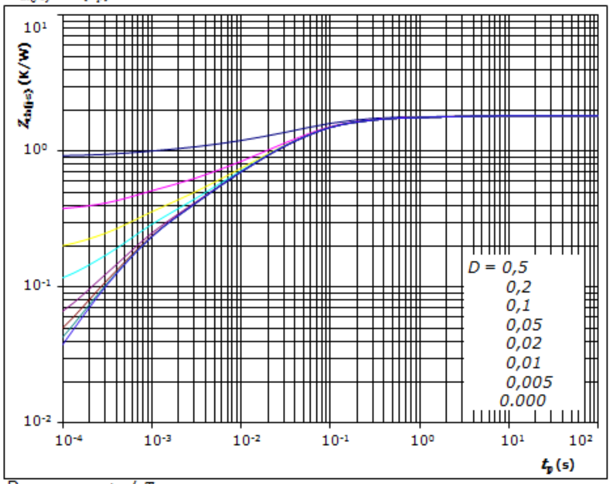



$t_p$ = 250 µs

$T_j$: 25 °C ········
125 °C ——
150 °C – – –

| Transient thermal impedance as a function of pulse width | FWD |
|---|---|

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




D = $t_p / T$

$R_{th(j-s)}$ = 1,83 K/W

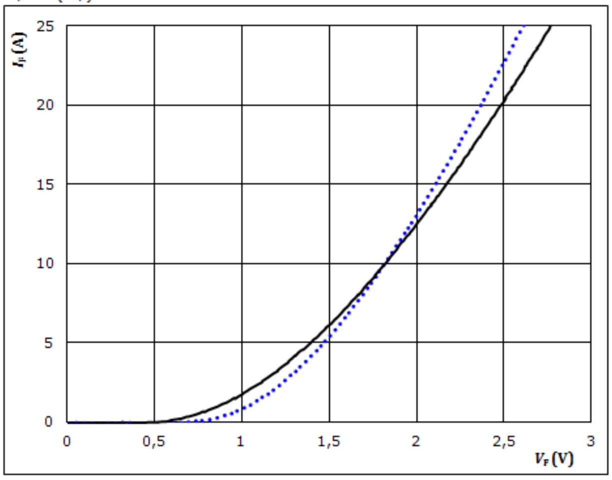
FWD thermal model values

| R (K/W) | τ (s) |
|---|---|
| 6,16E-02 | 2,79E+00 |
| 1,40E-01 | 3,93E-01 |
| 7,06E-01 | 6,76E-02 |
| 4,97E-01 | 1,96E-02 |
| 2,49E-01 | 4,04E-03 |
| 1,76E-01 | 5,86E-04 |
| 1,96E-01 | 3,48E-04 |

# Brake Inv. Diode Characteristics

**Typical forward characteristics** **FWD**

$I_F = f(V_F)$

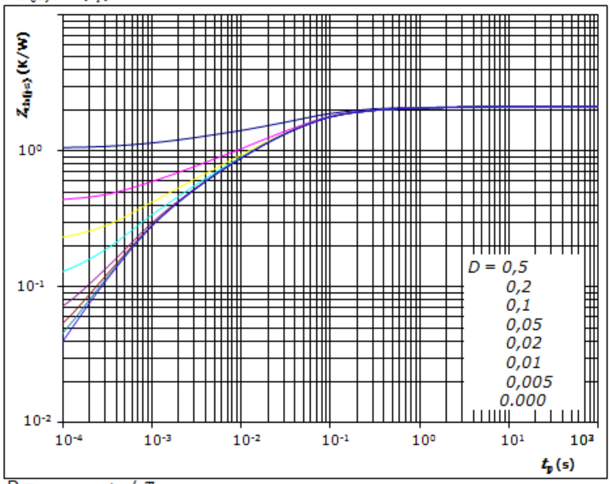



$t_p$ = 250 μs

$T_j$: 25 °C ············ ; 125 °C ——— ; 150 °C – – – –

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

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




D = $t_p$ / $T$

$R_{th(j-s)}$ = 2,12 K/W

FWD thermal model values

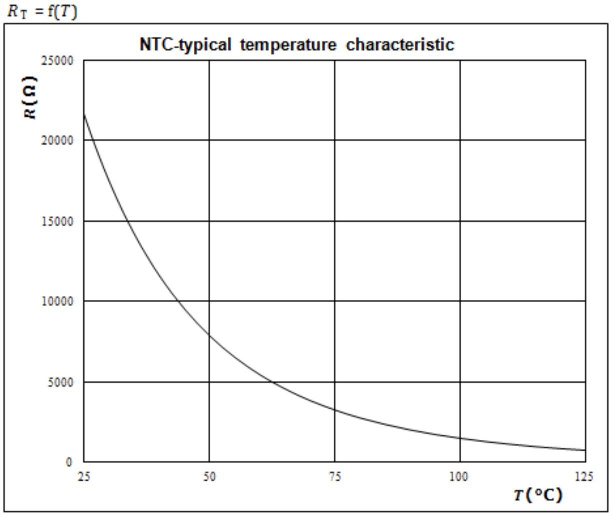
| R (K/W) | τ (s) |
|---|---|
| 7,00E-02 | 3,23E+00 |
| 1,48E-01 | 4,03E-01 |
| 7,34E-01 | 6,67E-02 |
| 5,90E-01 | 2,04E-02 |
| 3,47E-01 | 4,32E-03 |
| 2,36E-01 | 8,05E-04 |

# NTC Characteristics

**Thermistor typical temperature characteristic**

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

$R_T = f(T)$

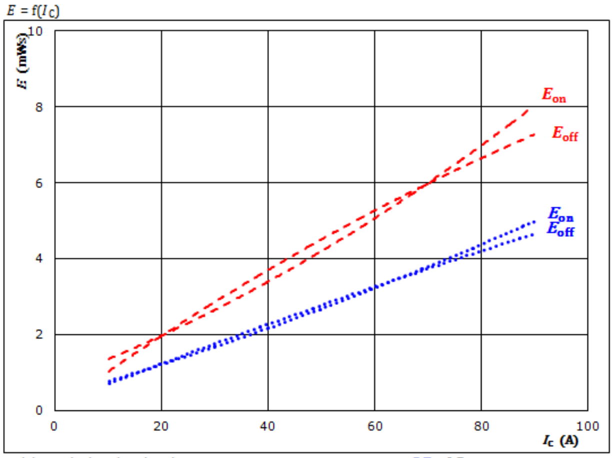


# Inverter Switching Characteristics

**Figure 1.** **IGBT**

Typical switching energy losses as a function of collector current

$E = f(I_C)$



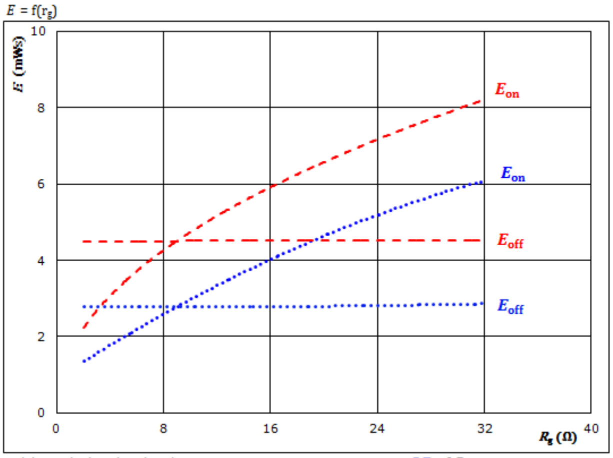

With an inductive load at

| | | | | | |
|---|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | $T_j$: | 25 °C | ············ |
| $V_{GE}$ = | ±15 | V | | 125 °C | ——— |
| $R_{gon}$ = | 8 | Ω | | 150 °C | – – – |
| $R_{goff}$ = | 8 | Ω | | | |

**Figure 2.** **IGBT**

Typical switching energy losses as a function of gate resistor

$E = f(r_g)$



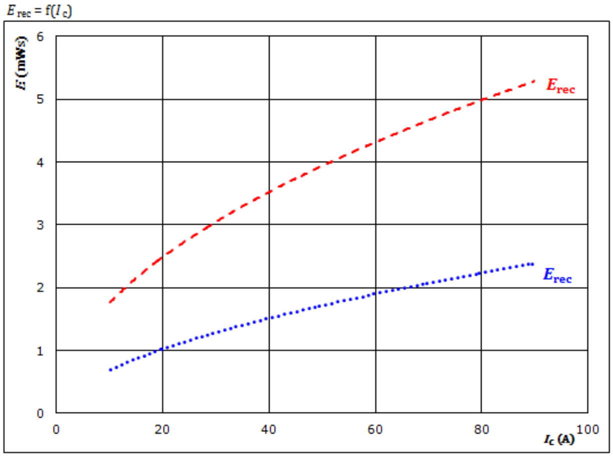

With an inductive load at

| | | | | | |
|---|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | $T_j$: | 25 °C | ············ |
| $V_{GE}$ = | ±15 | V | | 125 °C | ——— |
| $I_C$ = | 50 | A | | 150 °C | – – – |

**Figure 3.** **FWD**

Typical reverse recovered energy loss as a function of collector current

$E_{rec} = f(I_C)$



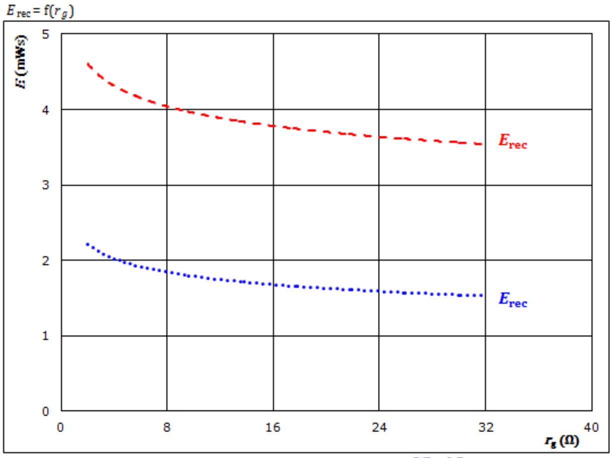

With an inductive load at

| | | | | | |
|---|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | $T_j$: | 25 °C | ············ |
| $V_{GE}$ = | ±15 | V | | 125 °C | ——— |
| $R_{gon}$ = | 8 | Ω | | 150 °C | – – – |

**Figure 4.** **FWD**

Typical reverse recovered energy loss as a function of gate resistor

$E_{rec} = f(r_g)$




With an inductive load at

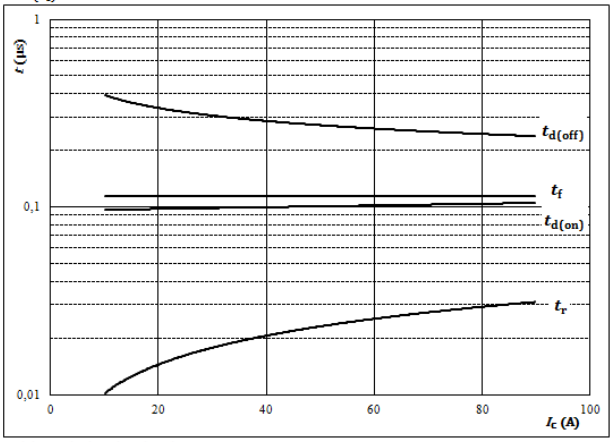
| | | | | | |
|---|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | $T_j$: | 25 °C | ············ |
| $V_{GE}$ = | ±15 | V | | 125 °C | ——— |
| $I_C$ = | 50 | A | | 150 °C | – – – |

# Inverter Switching Characteristics

**Figure 5.** **IGBT**

Typical switching times as a function of collector current

$t = f(I_C)$



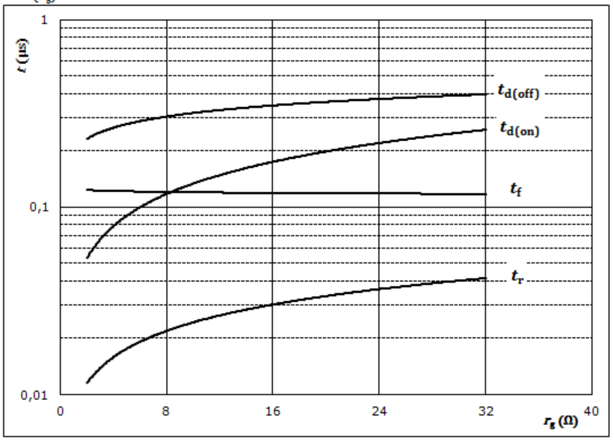

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 150 | °C |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 8 | Ω |
| $R_{goff}$ = | 8 | Ω |

**Figure 6.** **IGBT**

Typical switching times as a function of gate resistor

$t = f(r_g)$



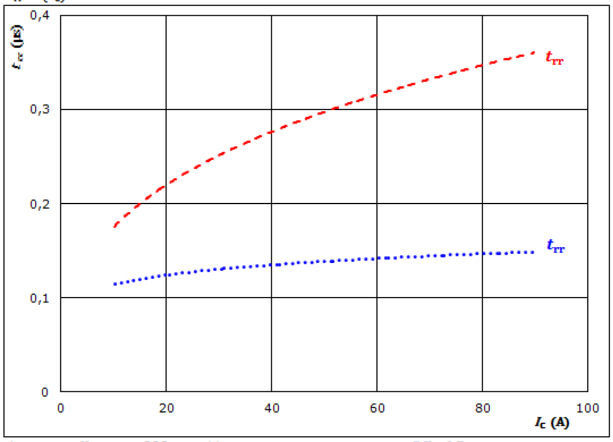

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 150 | °C |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 50 | A |

**Figure 7.** **FWD**

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$

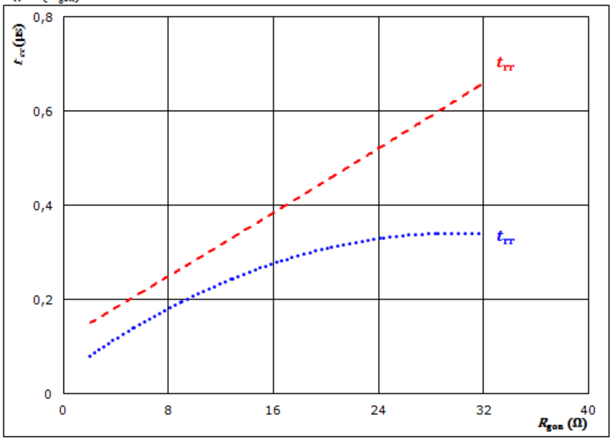



| At | | | | | |
|---|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | | 25 °C | ·········· |
| $V_{GE}$ = | ±15 | V | $T_j$: | 125 °C | —— |
| $R_{gon}$ = | 8 | Ω | | 150 °C | – – – |

**Figure 8.** **FWD**

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

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



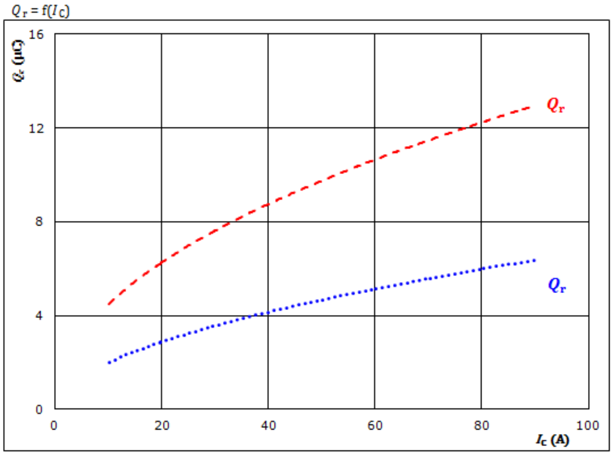

| At | | | | | |
|---|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | | 25 °C | ·········· |
| $V_{GE}$ = | ±15 | V | $T_j$: | 125 °C | —— |
| $I_C$ = | 50 | A | | 150 °C | – – – |

# Inverter Switching Characteristics

**Figure 9.** **FWD**

Typical recovered charge as a function of collector current

$Q_r = f(I_C)$

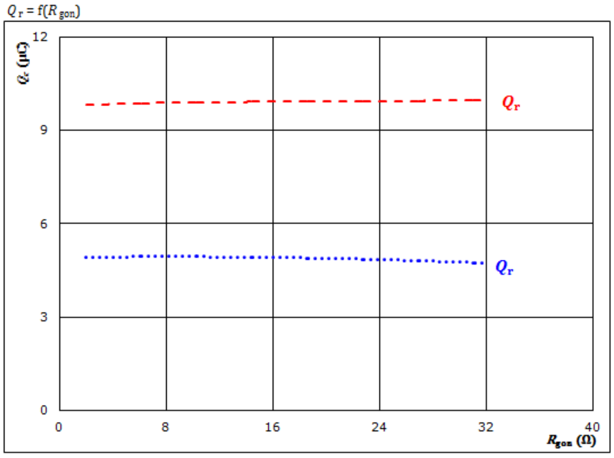



| At | | | | | |
|---|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | | 25 °C | ············ |
| $V_{GE}$ = | ±15 | V | $T_j$: | 125 °C | ——— |
| $R_{gon}$ = | 8 | Ω | | 150 °C | – – – – |

**Figure 10.** **FWD**

Typical recoved charge as a function of IGBT turn on gate resistor

$Q_r = f(R_{gon})$

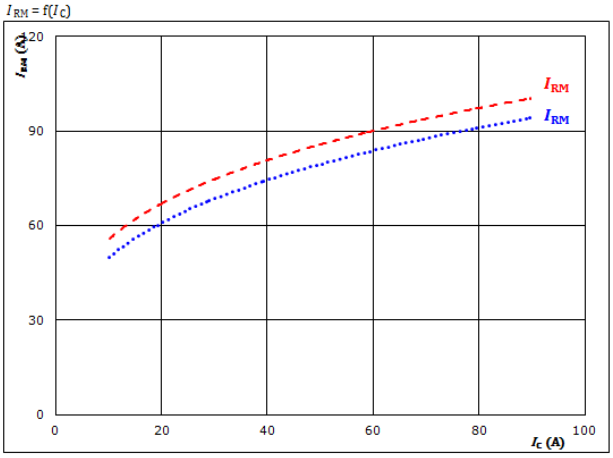



| At | | | | | |
|---|---|---|---|---|---|
| $V_{CE}$= | 600 | V | | 25 °C | ············ |
| $V_{GE}$ = | ±15 | V | $T_j$: | 125 °C | ——— |
| $I_C$= | 50 | A | | 150 °C | – – – – |

**Figure 11.** **FWD**

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

$I_{RM} = f(I_C)$

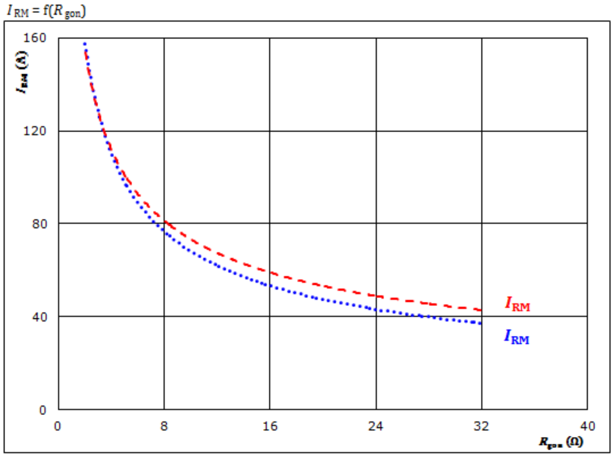



| At | | | | | |
|---|---|---|---|---|---|
| $V_{CE}$ | 600 | V | | 25 °C | ············ |
| $V_{GE}$ = | ±15 | V | $T_j$: | 125 °C | ——— |
| $R_{gon}$ = | 8 | Ω | | 150 °C | – – – – |

**Figure 12.** **FWD**

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

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



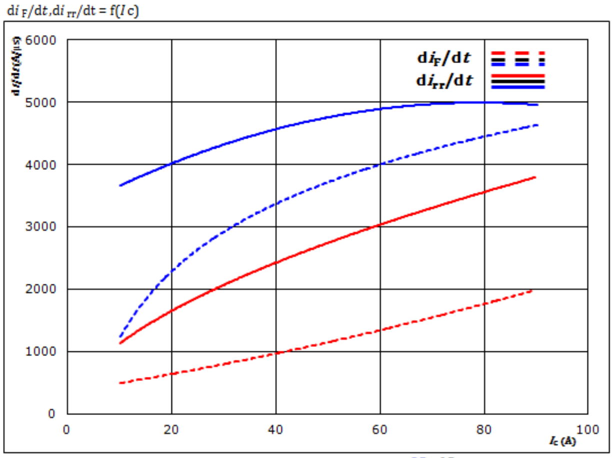

| At | | | | | |
|---|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | | 25 °C | ············ |
| $V_{GE}$ = | ±15 | V | $T_j$: | 125 °C | ——— |
| $I_C$= | 50 | A | | 150 °C | – – – – |

# Inverter Switching Characteristics

**Figure 13.** **FWD**

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

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

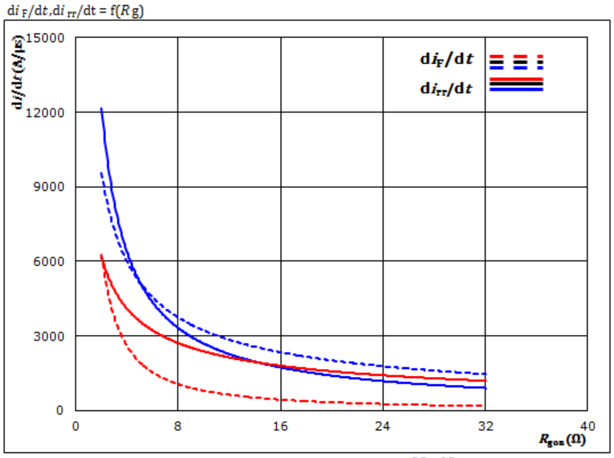



| At | | | | | | |
|---|---|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | | 25 °C | ··············· |
| $V_{GE}$ = | ±15 | V | $T_j$: | 125 °C | ———— |
| $R_{gon}$ = | 8 | Ω | | 150 °C | – – – – |

**Figure 14.** **FWD**

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

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

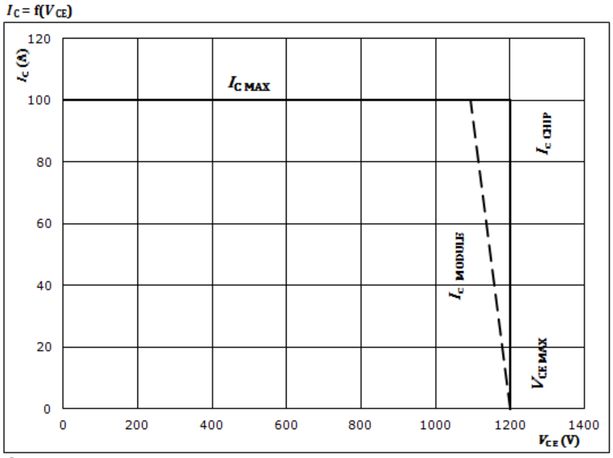



| At | | | | | | |
|---|---|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | | 25 °C | ··············· |
| $V_{GE}$ = | ±15 | V | $T_j$: | 125 °C | ———— |
| $I_C$ = | 50 | A | | 150 °C | – – – – |

**Figure 15.** **IGBT**

Reverse bias safe operating area

$I_C = f(V_{CE})$




**At**

| | | |
|---|---|---|
| $T_j$ = | 175 | °C |
| $R_{gon}$ = | 8 | Ω |
| $R_{goff}$ = | 8 | Ω |

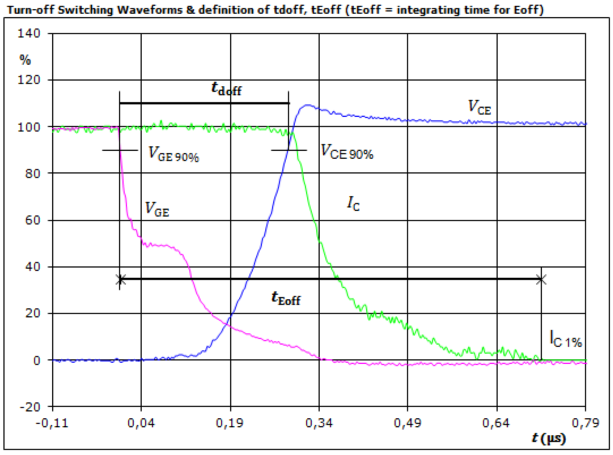
# Inverter Switching Definitions

**General conditions**

| | | |
|---|---|---|
| $T_j$ | = | 150 °C |
| $R_{gon}$ | = | 8 Ω |
| $R_{goff}$ | = | 8 Ω |

**Figure 1.** IGBT

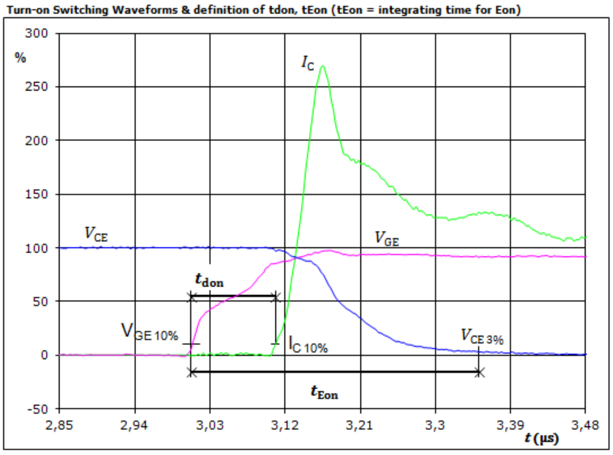
Turn-off Switching Waveforms & definition of tdoff, tEoff (tEoff = integrating time for Eoff)




| | | |
|---|---|---|
| $V_{GE}(0\%)$ = | -15 | V |
| $V_{GE}(100\%)$ = | 15 | V |
| $V_C(100\%)$ = | 600 | V |
| $I_C(100\%)$ = | 50 | A |
| $t_{doff}$ = | 0,281 | µs |
| $t_{Eoff}$ = | 0,710 | µs |

**Figure 2.** IGBT

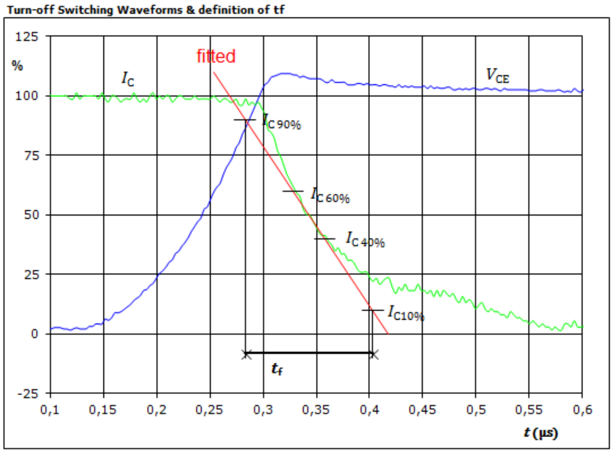
Turn-on Switching Waveforms & definition of tdon, tEon (tEon = integrating time for Eon)




| | | |
|---|---|---|
| $V_{GE}(0\%)$ = | -15 | V |
| $V_{GE}(100\%)$ = | 15 | V |
| $V_C(100\%)$ = | 600 | V |
| $I_C(100\%)$ = | 50 | A |
| $t_{don}$ = | 0,101 | µs |
| $t_{Eon}$ = | 0,345 | µs |

**Figure 3.** IGBT

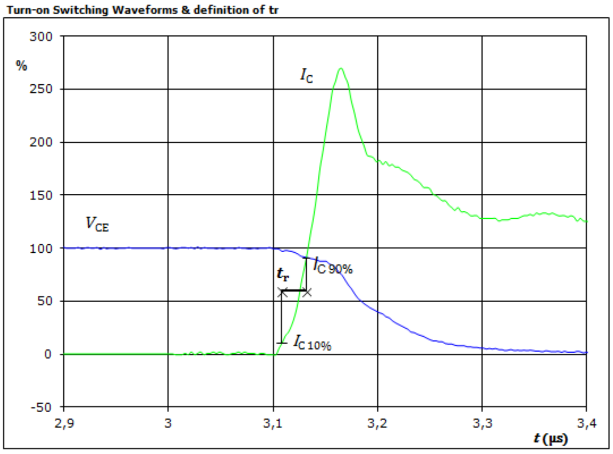
Turn-off Switching Waveforms & definition of tf




| | | |
|---|---|---|
| $V_C(100\%)$ = | 600 | V |
| $I_C(100\%)$ = | 50 | A |
| $t_f$ = | 0,122 | µs |

**Figure 4.** IGBT

Turn-on Switching Waveforms & definition of tr

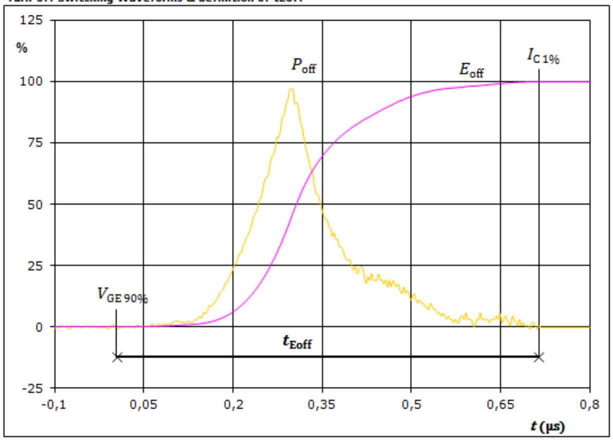



| | | |
|---|---|---|
| $V_C(100\%)$ = | 600 | V |
| $I_C(100\%)$ = | 50 | A |
| $t_r$ = | 0,024 | µs |

# Inverter Switching Definitions

| **Figure 5.** | **IGBT** |
|---|---|

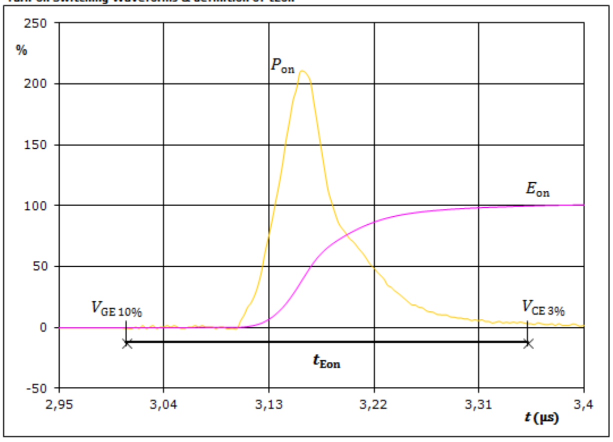
Turn-off Switching Waveforms & definition of tEoff




| | | |
|---|---|---|
| $P_{off}$ (100%) = | 30,10 | kW |
| $E_{off}$ (100%) = | 4,53 | mJ |
| $t_{Eoff}$ = | 0,71 | µs |

| **Figure 6.** | **IGBT** |
|---|---|

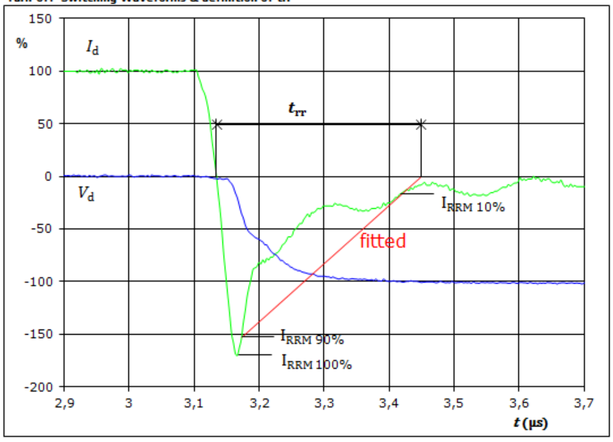
Turn-on Switching Waveforms & definition of tEon




| | | |
|---|---|---|
| $P_{on}$ (100%) = | 30,10 | kW |
| $E_{on}$ (100%) = | 4,21 | mJ |
| $t_{Eon}$ = | 0,345 | µs |

| **Figure 7.** | **FWD** |
|---|---|

Turn-off Switching Waveforms & definition of trr

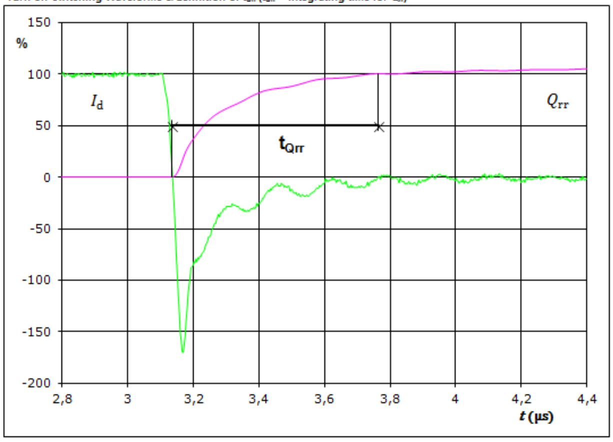



| | | |
|---|---|---|
| $V_d$ (100%) = | 600 | V |
| $I_d$ (100%) = | 50 | A |
| $I_{RRM}$ (100%) = | -85 | A |
| $t_{rr}$ = | 0,316 | µs |

# Inverter Switching Definitions

**Figure 8.** **FWD**

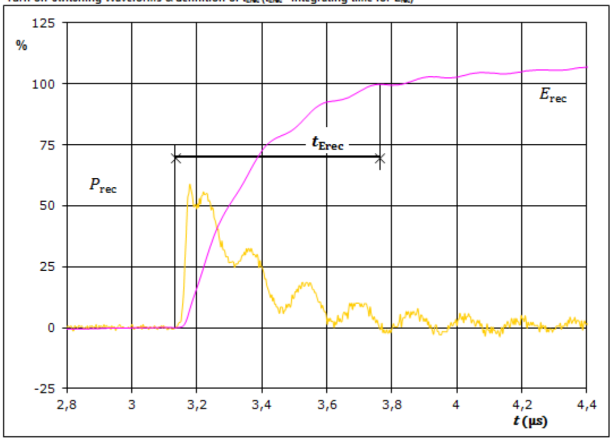
Turn-on Switching Waveforms & definition of $t_{Qrr}$ ($t_{Qrr}$ = integrating time for $Q_{rr}$)




| | | |
|---|---|---|
| $I_d$ (100%) = | 50 | A |
| $Q_{rr}$ (100%) = | 9,71 | µC |
| $t_{Qrr}$ = | 0,63 | µs |

**Figure 9.** **FWD**

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



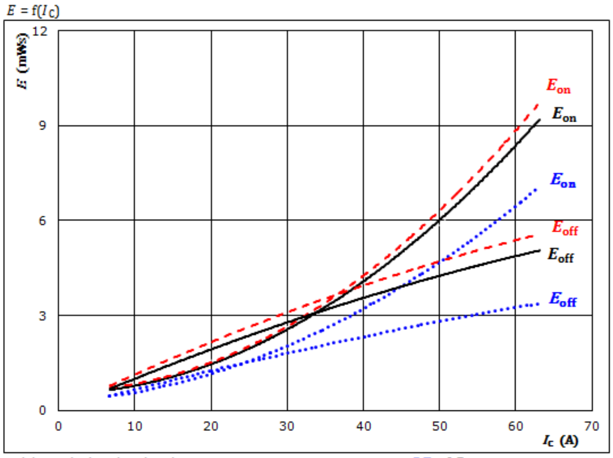

| | | |
|---|---|---|
| $P_{rec}$ (100%) = | 30,10 | kW |
| $E_{rec}$ (100%) = | 3,97 | mJ |
| $t_{Erec}$ = | 0,63 | µs |

# Brake Switching Characteristics

**Figure 1.** **IGBT**

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

$E = f(I_C)$



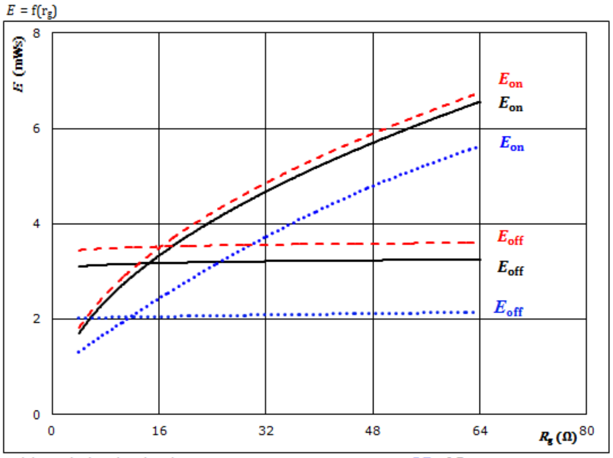

With an inductive load at

| | | | | |
|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | $T_j$: | 25 °C ············ |
| $V_{GE}$ = | ±15 | V | | 125 °C ——— |
| $R_{gon}$ = | 16 | Ω | | 150 °C – – – |
| $R_{goff}$ = | 16 | Ω | | |

**Figure 2.** **IGBT**

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

$E = f(r_g)$



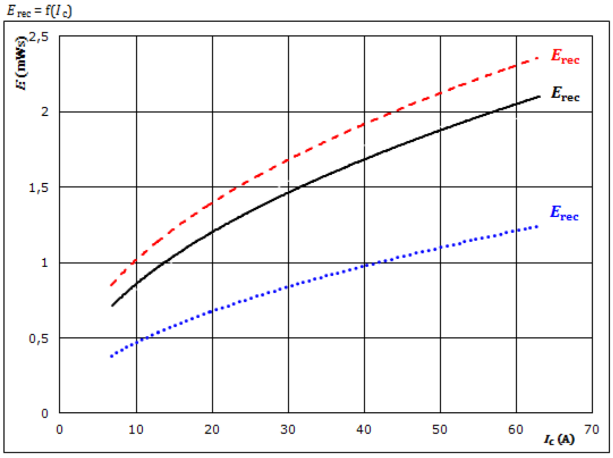

With an inductive load at

| | | | | |
|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | $T_j$: | 25 °C ············ |
| $V_{GE}$ = | ±15 | V | | 125 °C ——— |
| $I_C$ = | 35 | A | | 150 °C – – – |

**Figure 3.** **FWD**

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

$E_{rec} = f(I_c)$



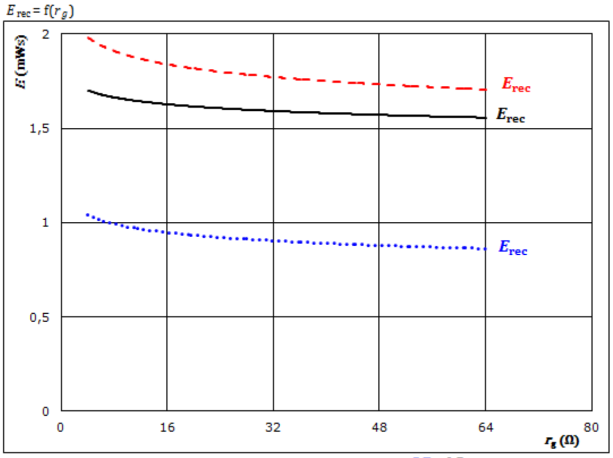

With an inductive load at

| | | | | |
|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | $T_j$: | 25 °C ············ |
| $V_{GE}$ = | ±15 | V | | 125 °C ——— |
| $R_{gon}$ = | 16 | Ω | | 150 °C – – – |

**Figure 4.** **FWD**

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

$E_{rec} = f(r_g)$




With an inductive load at

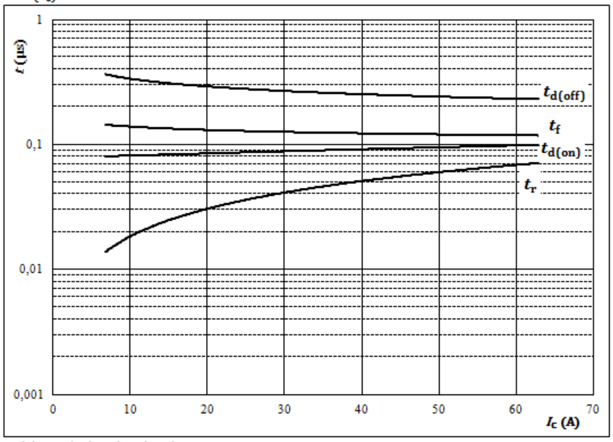
| | | | | |
|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | $T_j$: | 25 °C ············ |
| $V_{GE}$ = | ±15 | V | | 125 °C ——— |
| $I_C$ = | 35 | A | | 150 °C – – – |

# Brake Switching Characteristics

**Figure 5.** **IGBT**

Typical switching times as a function of collector current

$t = f(I_C)$



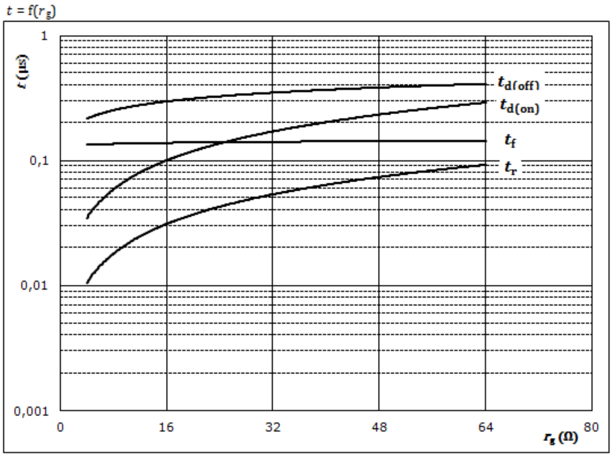

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 150 | °C |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 16 | Ω |
| $R_{goff}$ = | 16 | Ω |

**Figure 6.** **IGBT**

Typical switching times as a function of gate resistor

$t = f(r_g)$



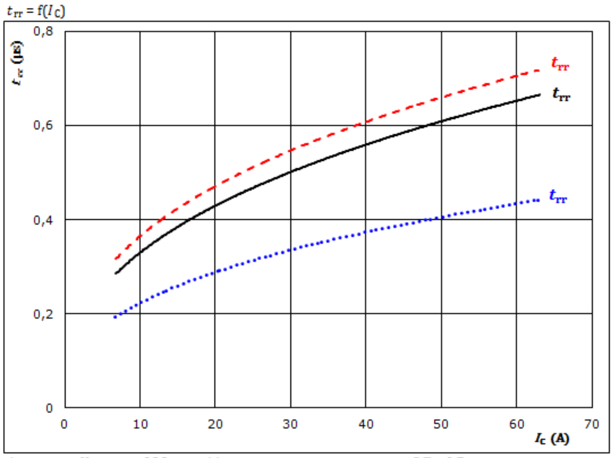

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 150 | °C |
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $I_C$ = | 35 | A |

**Figure 7.** **FWD**

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$

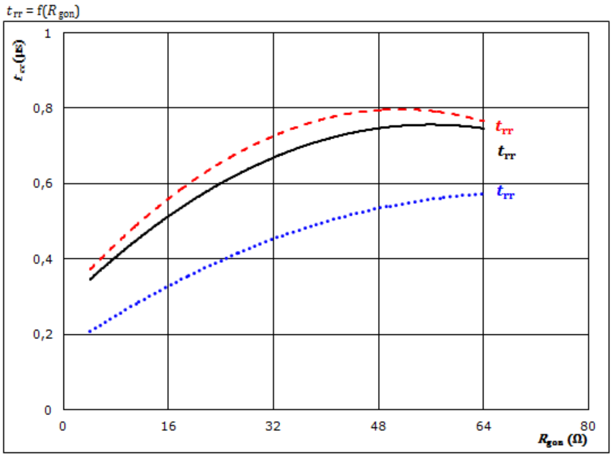



| At | | | | | |
|---|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | | 25 °C | ············ |
| $V_{GE}$ = | ±15 | V | $T_j$: | 125 °C | ——— |
| $R_{gon}$ = | 16 | Ω | | 150 °C | – – – – |

**Figure 8.** **FWD**

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

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



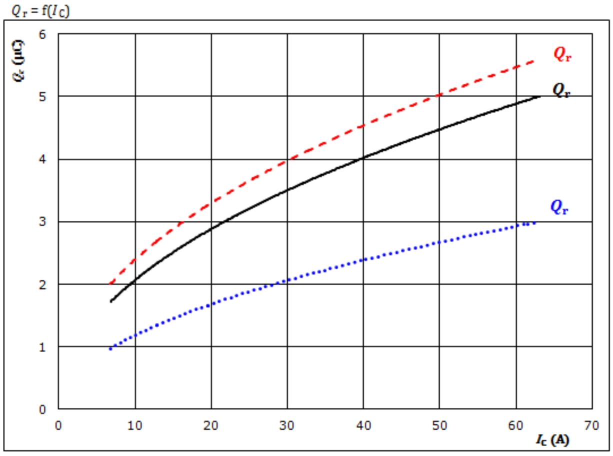

| At | | | | | |
|---|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | | 25 °C | ············ |
| $V_{GE}$ = | ±15 | V | $T_j$: | 125 °C | ——— |
| $I_C$ = | 35 | A | | 150 °C | – – – – |

# Brake Switching Characteristics

**Figure 9.** **FWD**

Typical recovered charge as a function of collector current

$Q_r = f(I_C)$

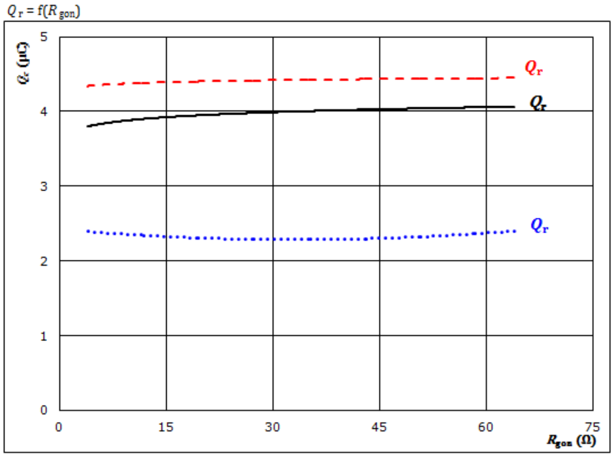



| At | | | | | |
|---|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | | 25 °C | ··········· |
| $V_{GE}$ = | ±15 | V | $T_j$: | 125 °C | ——— |
| $R_{gon}$ = | 16 | Ω | | 150 °C | – – – |

**Figure 10.** **FWD**

Typical recoved charge as a function of IGBT turn on gate resistor

$Q_r = f(R_{gon})$

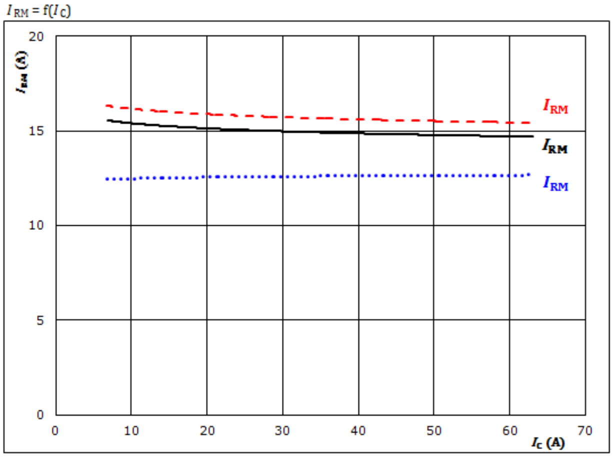



| At | | | | | |
|---|---|---|---|---|---|
| $V_{CE}$= | 600 | V | | 25 °C | ··········· |
| $V_{GE}$ = | ±15 | V | $T_j$: | 125 °C | ——— |
| $I_C$= | 35 | A | | 150 °C | – – – |

**Figure 11.** **FWD**

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

$I_{RM} = f(I_C)$

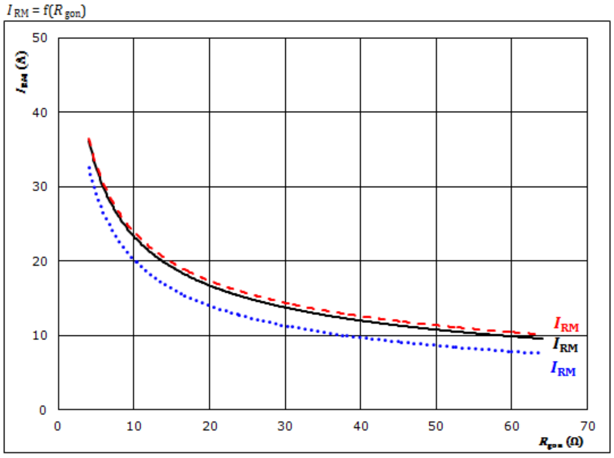



| At | | | | | |
|---|---|---|---|---|---|
| $V_{CE}$ | 600 | V | | 25 °C | ··········· |
| $V_{GE}$ = | ±15 | V | $T_j$: | 125 °C | ——— |
| $R_{gon}$ = | 16 | Ω | | 150 °C | – – – |

**Figure 12.** **FWD**

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

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



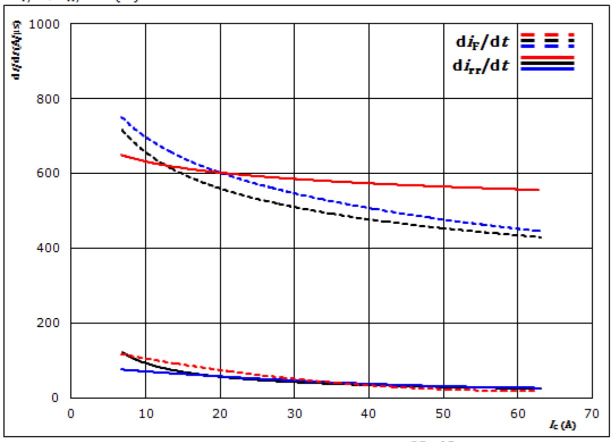

| At | | | | | |
|---|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | | 25 °C | ··········· |
| $V_{GE}$ = | ±15 | V | $T_j$: | 125 °C | ——— |
| $I_C$= | 35 | A | | 150 °C | – – – |

# Brake Switching Characteristics

**Figure 13.** **FWD**

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

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

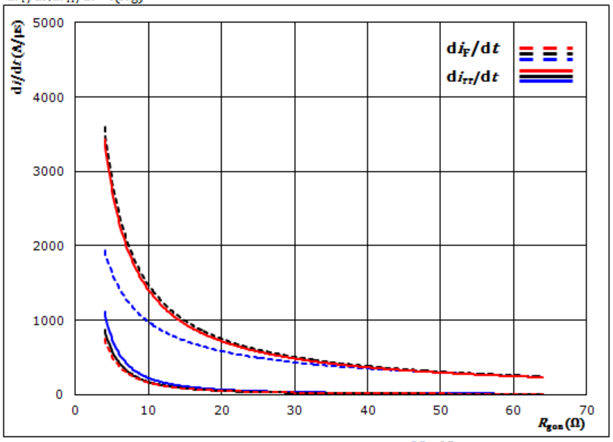



At
$V_{CE}$ = 600 V
$V_{GE}$ = ±15 V
$R_{gon}$ = 16 Ω
$T_j$: 25 °C, 125 °C, 150 °C

**Figure 14.** **FWD**

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

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

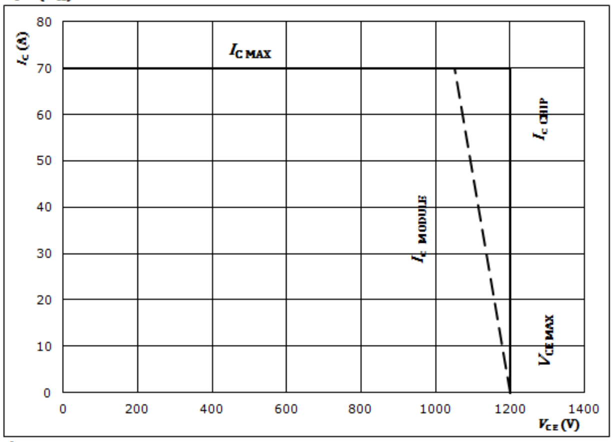



At
$V_{CE}$ = 600 V
$V_{GE}$ = ±15 V
$I_C$ = 35 A
$T_j$: 25 °C, 125 °C, 150 °C

**Figure 15.** **IGBT**

Reverse bias safe operating area

$I_C = f(V_{CE})$




At
$T_j$ = 175 °C
$R_{gon}$ = 16 Ω
$R_{goff}$ = 16 Ω

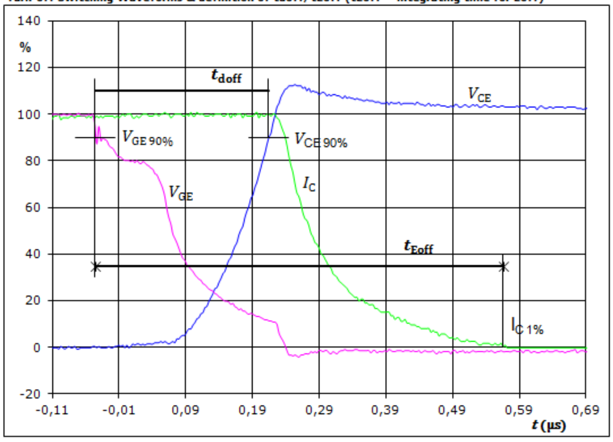
# Brake Switching Definitions

General conditions

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

**Figure 1.** IGBT

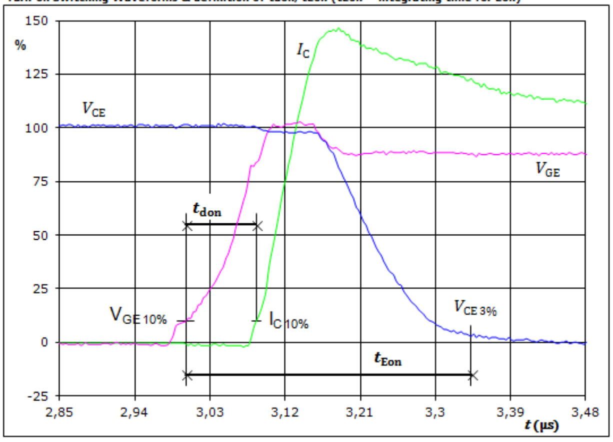
Turn-off Switching Waveforms & definition of tdoff, tEoff (tEoff = integrating time for Eoff)



| | | |
|---|---|---|
| $V_{GE}(0\%)$ = | -15 | V |
| $V_{GE}(100\%)$ = | 15 | V |
| $V_C(100\%)$ = | 600 | V |
| $I_C(100\%)$ = | 35 | A |
| $t_{doff}$ = | 0,258 | μs |
| $t_{Eoff}$ = | 0,612 | μs |

**Figure 2.** IGBT

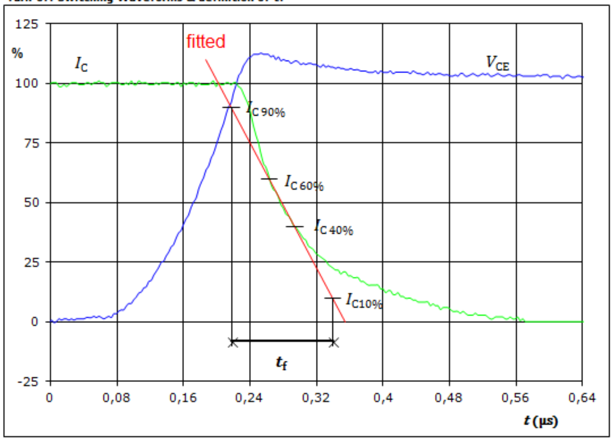
Turn-on Switching Waveforms & definition of tdon, tEon (tEon = integrating time for Eon)



| | | |
|---|---|---|
| $V_{GE}(0\%)$ = | -15 | V |
| $V_{GE}(100\%)$ = | 15 | V |
| $V_C(100\%)$ = | 600 | V |
| $I_C(100\%)$ = | 35 | A |
| $t_{don}$ = | 0,087 | μs |
| $t_{Eon}$ = | 0,342 | μs |

**Figure 3.** IGBT

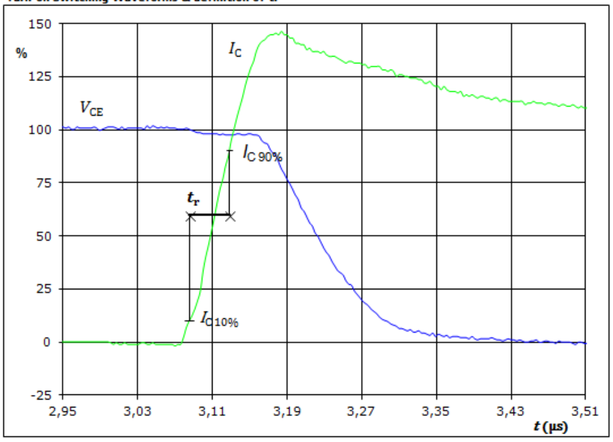
Turn-off Switching Waveforms & definition of tf



| | | |
|---|---|---|
| $V_C(100\%)$ = | 600 | V |
| $I_C(100\%)$ = | 35 | A |
| $t_f$ = | 0,126 | μs |

**Figure 4.** IGBT

Turn-on Switching Waveforms & definition of tr

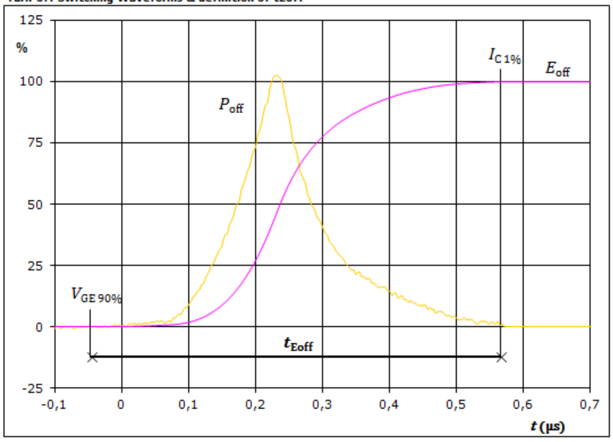


| | | |
|---|---|---|
| $V_C(100\%)$ = | 600 | V |
| $I_C(100\%)$ = | 35 | A |
| $t_r$ = | 0,043 | μs |

# Brake Switching Definitions

**Figure 5.** **IGBT**

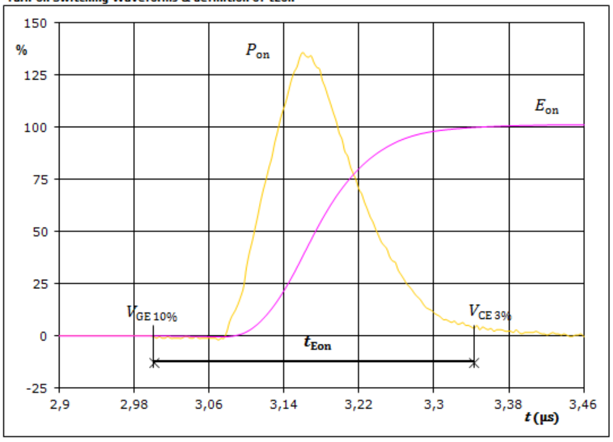
Turn-off Switching Waveforms & definition of tEoff




| | | |
|---|---|---|
| $P_{off}$ (100%) = | 20,92 | kW |
| $E_{off}$ (100%) = | 3,16 | mJ |
| $t_{Eoff}$ = | 0,612 | µs |

**Figure 6.** **IGBT**

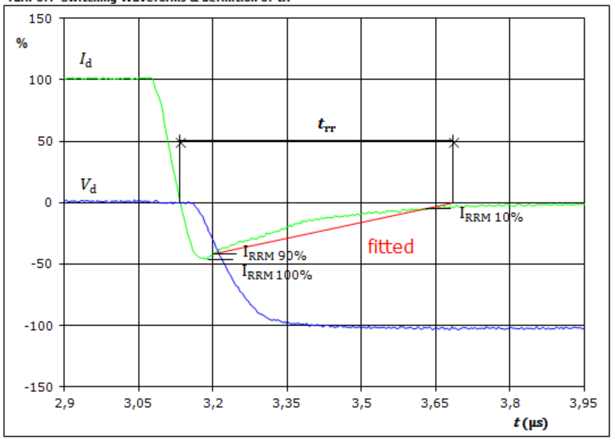
Turn-on Switching Waveforms & definition of tEon




| | | |
|---|---|---|
| $P_{on}$ (100%) = | 20,92 | kW |
| $E_{on}$ (100%) = | 3,28 | mJ |
| $t_{Eon}$ = | 0,342 | µs |

**Figure 7.** **FWD**

Turn-off Switching Waveforms & definition of trr

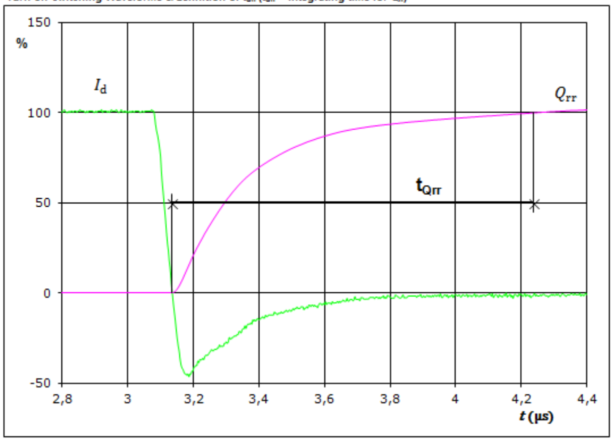



| | | |
|---|---|---|
| $V_d$ (100%) = | 600 | V |
| $I_d$ (100%) = | 35 | A |
| $I_{RRM}$ (100%) = | -16 | A |
| $t_{rr}$ = | 0,552 | µs |

# Brake Switching Definitions

**Figure 8.** **FWD**

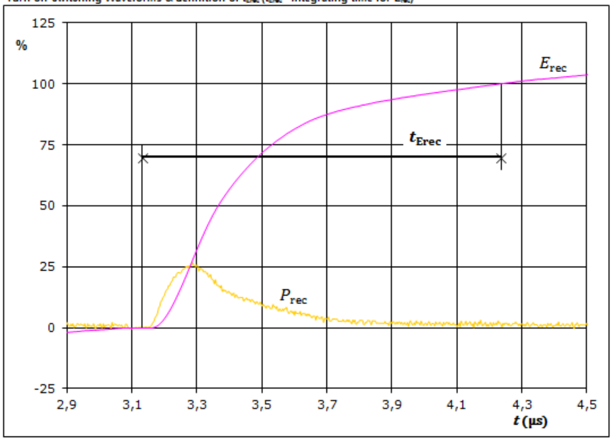
Turn-on Switching Waveforms & definition of $t_{Qrr}$ ($t_{Qrr}$ = integrating time for $Q_{rr}$)




| | | |
|---|---|---|
| $I_d$ (100%) = | 35 | A |
| $Q_{rr}$ (100%) = | 3,92 | µC |
| $t_{Qrr}$ = | 1,10 | µs |

**Figure 9.** **FWD**

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




| | | |
|---|---|---|
| $P_{rec}$ (100%) = | 20,92 | kW |
| $E_{rec}$ (100%) = | 1,68 | mJ |
| $t_{Erec}$ = | 1,10 | µs |

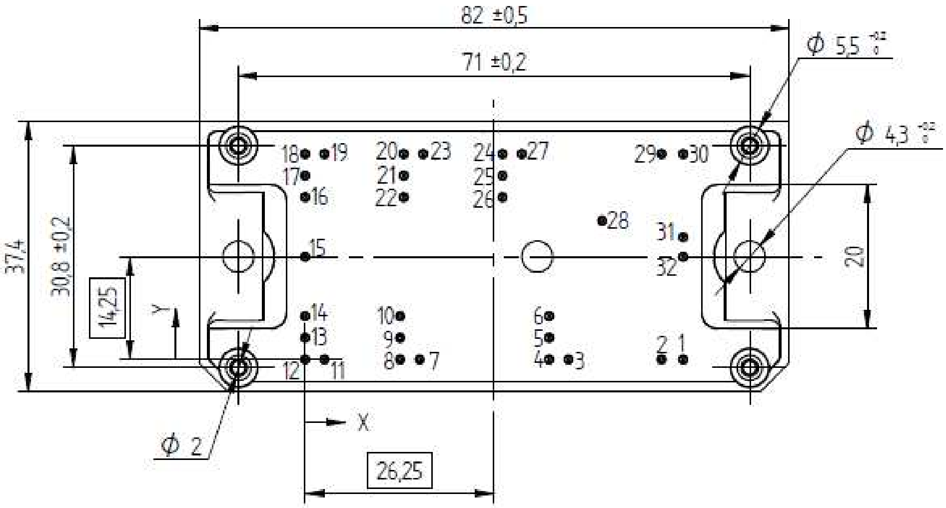
## Ordering Code & Marking

| Version | Ordering Code | in DataMatrix as | in packaging barcode as |
|---|---|---|---|
| without thermal paste 17mm housing | 10-F1127PA050SC-L169E09 | L169E09 | L169E09 |
| | | | |
| | | | |
| | | | |

NN-NNNNNNNNNNNNNN
NNNNNNNN WWYY UL
Vinco LLLLL SSSS

| | | | | | | |
|---|---|---|---|---|---|---|
| **Text** | **Name** | **Date code** | **UL & Vinco** | **Lot** | **Serial** | |
| | NN-NNNNNNNNNNNNNN-NNNNNNNN | WWYY | UL Vinco | LLLLL | SSSS | |
| **Datamatrix** | **Type** | **Lot number** | **Serial** | **Date code** | | |
| | TTTT-TTT | LLLLL | SSSS | WWYY | | |

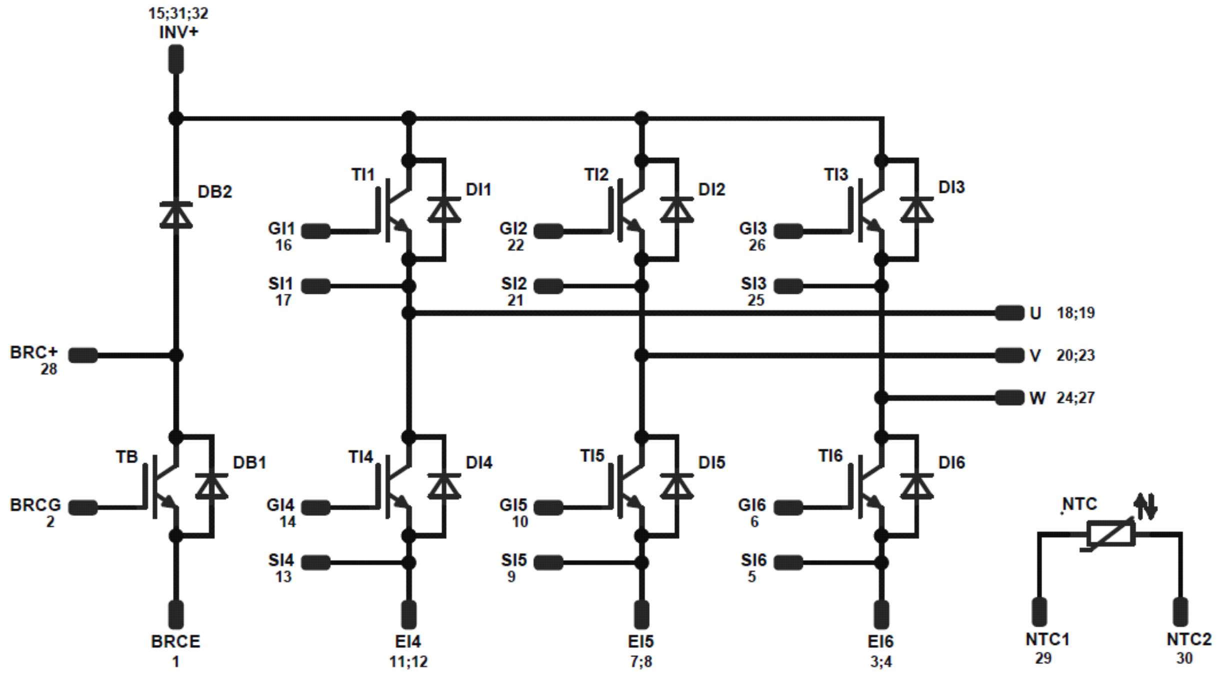
## Outline




Pin table [mm]

| Pin | X | Y | Function |
|---|---|---|---|
| 1 | 52,5 | 0 | BRCE |
| 2 | 49,5 | 0 | BRCG |
| 3 | 36,6 | 0 | EI6 |
| 4 | 33,9 | 0 | EI6 |
| 5 | 33,9 | 3 | SI6 |
| 6 | 33,9 | 6 | GI6 |
| 7 | 15,9 | 0 | EI5 |
| 8 | 13,2 | 0 | EI5 |
| 9 | 13,2 | 3 | SI5 |
| 10 | 13,2 | 6 | GI5 |
| 11 | 2,7 | 0 | EI4 |
| 12 | 0 | 0 | EI4 |
| 13 | 0 | 3 | SI4 |
| 14 | 0 | 6 | GI4 |
| 15 | 0 | 14,25 | INV+ |
| 16 | 0 | 22,5 | GI1 |
| 17 | 0 | 25,5 | SI1 |
| 18 | 0 | 28,5 | U |
| 19 | 2,7 | 28,5 | U |
| 20 | 13,7 | 28,5 | V |
| 21 | 13,7 | 25,5 | SI2 |
| 22 | 13,7 | 22,5 | GI2 |
| 23 | 16,4 | 28,5 | V |
| 24 | 27,4 | 28,5 | W |
| 25 | 27,4 | 25,5 | SI3 |
| 26 | 27,4 | 22,5 | GI3 |
| 27 | 30,1 | 28,5 | W |
| 28 | 41,25 | 19,25 | BRC+ |
| 29 | 49,5 | 28,5 | NTC1 |
| 30 | 52,5 | 28,5 | NTC2 |
| 31 | 52,5 | 16,95 | INV+ |
| 32 | 52,5 | 14,25 | INV+ |

## Pinout




## Identification

| ID | Component | Voltage | Technology | Current | Function | Comment |
|---|---|---|---|---|---|---|
| TI1-TI6 | IGBT | 1200V | | 50A | Inverter switch | |
| DI1-DI6 | FWD | 1200V | | 35A | Inverter diode | |
| TB | IGBT | 1200V | | 35A | Brake switch | |
| DB2 | FWD | 1200V | | 15A | Brake diode | |
| DB1 | FWD | 1200V | | 7,5A | Brake inv. diode | |
| $R_t$ | NTC | | | | Thermistor | |

| Packaging instruction | | | | | |
|---|---|---|---|---|---|
| Standard packaging quantity (SPQ) | 100 | >SPQ | Standard | <SPQ | Sample |

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

| Document No.: | Date: | Modification: | Pages |
|---|---|---|---|
| 10-F1127PA050SC-L169E09-D2-14 | 04 Jun. 2015 | PM name, Disclaimer, colours | |