# B0-SP12VPA035M702-LR29A13T
datasheet

Vincotech

***flow*PIM S3 + 3xPFC** | **1200 V / 35 A**

## Topology features

- Open Emitter configuration
- Temperature sensor
- Inverter
- 3ph Vienna rectifier

## Component features

- Commutation rugged
- Easy to use / drive
- Suitable for hard and soft switching

## Housing features

- Base isolation: $Al_2O_3$
- CTI600 housing material
- Compact, baseplate-less housing
- VINcoPress Technology
- Thermo-mechanical push-and-pull force relief
- Press-fit pin
- Reliable cold welding connection

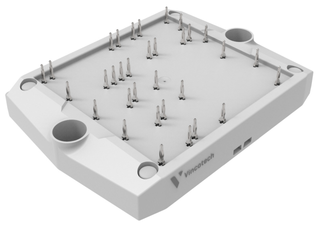
## Target applications

- Embedded Drives
- Heat Pumps
- HVAC
- Industrial Drives

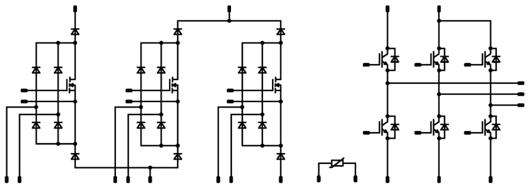
## Types

- B0-SP12VPA035M702-LR29A13T

## *flow* S3 12 mm housing



## Schematic



# 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 | 54 | A |
| Repetitive peak collector current | $I_{CRM}$ | $t_p$ limited by $T_{jmax}$ | | 70 | A |
| Total power dissipation | $P_{tot}$ | $T_j = T_{jmax}$ | $T_s$ = 80 °C | 118 | 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 | 9,5 | 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 | 39 | A |
| Repetitive peak forward current | $I_{FRM}$ | $t_p$ limited by $T_{jmax}$ | | 70 | A |
| Total power dissipation | $P_{tot}$ | $T_j = T_{jmax}$ | $T_s$ = 80 °C | 72 | W |
| Maximum junction temperature | $T_{jmax}$ | | | 175 | °C |

# Maximum Ratings

$T_j$ = 25 °C, unless otherwise specified

| Parameter | Symbol | Conditions | | Value | Unit |
|---|---|---|---|---|---|
| **Boost Switch** | | | | | |
| Drain-source voltage | $V_{DSS}$ | | | 600 | V |
| Drain current (DC current) | $I_D$ | $T_j = T_{jmax}$ | $T_s$ = 80 °C | 34 | A |
| Peak drain current | $I_{DM}$ | $t_p$ limited by $T_{jmax}$ | | 220 | A |
| Avalanche energy, single pulse | $E_{AS}$ | $V_{DD}$ = 50 V | $I_D$ = 11 A | 236 | mJ |
| Avalanche energy, repetitive | $E_{AR}$ | $V_{DD}$ = 50 V | $I_D$ = 11 A | 1,16 | mJ |
| MOSFET dv/dt ruggedness | $dv/dt$ | $V_{DS}$= 0..400 V | $T_s$ = 25 °C | 80 | V/ns |
| Total power dissipation | $P_{tot}$ | $T_j = T_{jmax}$ | $T_s$ = 80 °C | 108 | W |
| Gate-source voltage | $V_{GSS}$ | static | | ±20 | V |
| Reverse diode dv/dt | $dv/dt$ | | | 50 | V/ns |
| Maximum Junction Temperature | $T_{jmax}$ | | | 150 | °C |
| **Boost Diode** | | | | | |
| Peak repetitive reverse voltage | $V_{RRM}$ | | | 650 | V |
| Forward current (DC current) | $I_F$ | $T_j = T_{jmax}$ | $T_s$ = 80 °C | 36 | A |
| Total power dissipation | $P_{tot}$ | $T_j = T_{jmax}$ | $T_s$ = 80 °C | 58 | W |
| Maximum junction temperature | $T_{jmax}$ | | | 175 | °C |
| **Negative Boost Diode** | | | | | |
| Peak repetitive reverse voltage | $V_{RRM}$ | | | 650 | V |
| Forward current (DC current) | $I_F$ | $T_j = T_{jmax}$ | $T_s$ = 80 °C | 36 | A |
| Total power dissipation | $P_{tot}$ | $T_j = T_{jmax}$ | $T_s$ = 80 °C | 58 | W |
| Maximum junction temperature | $T_{jmax}$ | | | 175 | °C |

# Maximum Ratings

$T_j$ = 25 °C, unless otherwise specified

| 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 | 54 | A |
| Surge (non-repetitive) forward current | $I_{FSM}$ | Single Half Sine Wave, $t_p$ = 10 ms | $T_j$ = 150 °C | 280 | A |
| Surge current capability | $I^2t$ | | | 390 | $A^2s$ |
| Total power dissipation | $P_{tot}$ | $T_j = T_{jmax}$ | $T_s$ = 80 °C | 68 | W |
| Maximum junction temperature | $T_{jmax}$ | | | 150 | °C |
| **Module Properties** | | | | | |
| **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 | | | | 9,87 | mm |
| Clearance | | | | 7,99 | mm |
| Comparative Tracking Index | CTI | | | ≥ 600 | |

*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 | $V_{GE(th)}$ | | | 10 | 0,0035 | 25 | 5,4 | 6 | 6,6 | V |
| Collector-emitter saturation voltage | $V_{CEsat}$ | | 15 | | 35 | 25<br>125<br>150 | | 1,47<br>1,64<br>1,68 | 1,85(1) | V |
| Collector-emitter cut-off current | $I_{CES}$ | | 0 | 1200 | | 25 | | | 80 | µA |
| Gate-emitter leakage current | $I_{GES}$ | | 20 | 0 | | 25 | | | 200 | nA |
| Internal gate resistance | $r_g$ | | | | | | | None | | Ω |
| Input capacitance | $C_{ies}$ | | 0 | 10 | | 25 | | 7900 | | pF |
| Output capacitance | $C_{oes}$ | | | | | | | 270 | | pF |
| Reverse transfer capacitance | $C_{res}$ | | | | | | | 97 | | pF |
| Gate charge | $Q_g$ | $V_{CC}$ = 600 V | 0/15 | | 35 | 25 | | 260 | | nC |
| **Thermal** | | | | | | | | | | |
| Thermal resistance junction to sink(2) | $R_{th(j-s)}$ | $\lambda_{paste}$ = 5,2 W/mK (PTM) | | | | | | 0,81 | | K/W |
| **Dynamic** | | | | | | | | | | |
| Turn-on delay time | $t_{d(on)}$ | $R_{gon}$ = 8 Ω<br>$R_{goff}$ = 8 Ω | ±15 | 600 | 35 | 25<br>125<br>150 | | 131,52<br>128,96<br>128,64 | | ns |
| Rise time | $t_r$ | | | | | 25<br>125<br>150 | | 40<br>41,92<br>41,6 | | ns |
| Turn-off delay time | $t_{d(off)}$ | | | | | 25<br>125<br>150 | | 168,32<br>199,36<br>207,68 | | ns |
| Fall time | $t_f$ | | | | | 25<br>125<br>150 | | 106,88<br>140,55<br>151,44 | | ns |
| Turn-on energy (per pulse) | $E_{on}$ | $Q_{rFWD}$=3,25 µC<br>$Q_{rFWD}$=5,27 µC<br>$Q_{rFWD}$=5,9 µC | | | | 25<br>125<br>150 | | 2,88<br>3,55<br>3,69 | | mWs |
| Turn-off energy (per pulse) | $E_{off}$ | | | | | 25<br>125<br>150 | | 2,77<br>3,88<br>4,16 | | 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 | |
| **Inverter Diode** | | | | | | | | | | |
| **Static** | | | | | | | | | | |
| Forward voltage | $V_F$ | | | | 35 | 25<br>125<br>150 | | 1,66<br>1,76<br>1,75 | 2,1[1] | V |
| Reverse leakage current | $I_R$ | $V_r$ = 1200 V | | | | 25 | | | 40 | µA |
| **Thermal** | | | | | | | | | | |
| Thermal resistance junction to sink[2] | $R_{th(j-s)}$ | $\lambda_{paste}$ = 5,2 W/mK (PTM) | | | | | | 1,31 | | K/W |
| **Dynamic** | | | | | | | | | | |
| Peak recovery current | $I_{RM}$ | d*i*/d*t*=645 A/µs<br>d*i*/d*t*=639 A/µs<br>d*i*/d*t*=635 A/µs | ±15 | 600 | 35 | 25<br>125<br>150 | | 24,77<br>28,63<br>29,92 | | A |
| Reverse recovery time | $t_{rr}$ | | | | | 25<br>125<br>150 | | 302,49<br>451,23<br>492,98 | | ns |
| Recovered charge | $Q_r$ | | | | | 25<br>125<br>150 | | 3,25<br>5,27<br>5,9 | | µC |
| Reverse recovered energy | $E_{rec}$ | | | | | 25<br>125<br>150 | | 1,25<br>2,15<br>2,44 | | mWs |
| Peak rate of fall of recovery current | $(di_{rf}/dt)_{max}$ | | | | | 25<br>125<br>150 | | 224,65<br>167,29<br>163,58 | | 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 | |
| **Boost Switch** | | | | | | | | | | |
| **Static** | | | | | | | | | | |
| Drain-source on-state resistance | $r_{DS(on)}$ | | 10 | | 23,6 | 25<br>125 | | 44,8<br>79,8 | 40(1) | mΩ |
| Gate-source threshold voltage | $V_{GS(th)}$ | $V_{DS} = V_{GS}$ | | | 0,00118 | 25 | 3 | 3,5 | 4 | V |
| Gate to Source Leakage Current | $I_{GSS}$ | | 20 | 0 | | 25 | | | 200 | nA |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | | 0 | 600 | | 25 | | | 2 | µA |
| Internal gate resistance | $r_g$ | | | | | | | 2,4 | | Ω |
| Gate charge | $Q_g$ | | 0/10 | 400 | 23,6 | 25 | | 102 | | nC |
| Short-circuit input capacitance | $C_{iss}$ | $f$ = 250 kHz | 0 | 400 | 0 | 25 | | 4360 | | pF |
| Short-circuit output capacitance | $C_{oss}$ | | | | | | | 74 | | |
| **Thermal** | | | | | | | | | | |
| Thermal resistance junction to sink(2) | $R_{th(j-s)}$ | $\lambda_{paste}$ = 5,2 W/mK (PTM) | | | | | | 0,65 | | K/W |
| **Dynamic** | | | | | | | | | | |
| Turn-on delay time | $t_{d(on)}$ | $R_{gon}$ = 16 Ω<br>$R_{goff}$ = 16 Ω | 0/10 | 400 | 40 | 25<br>125 | | 56,93<br>51,37 | | ns |
| Rise time | $t_r$ | | | | | 25<br>125 | | 24,1<br>25,81 | | ns |
| Turn-off delay time | $t_{d(off)}$ | | | | | 25<br>125 | | 232,94<br>251,74 | | ns |
| Fall time | $t_f$ | | | | | 25<br>125 | | 22,41<br>25,17 | | ns |
| Turn-on energy (per pulse) | $E_{on}$ | $Q_{rFWD}$=0,396 µC<br>$Q_{rFWD}$=1,19 µC | | | | 25<br>125 | | 0,407<br>0,702 | | mWs |
| Turn-off energy (per pulse) | $E_{off}$ | | | | | 25<br>125 | | 0,552<br>0,611 | | mWs |

# 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 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Boost Diode** | | | | | | | | | | |
| **Static** | | | | | | | | | | |
| Forward voltage | $V_F$ | | | | 30 | 25<br>125<br>150 | | 2,33<br>1,76<br>1,65 | 3(1) | V |
| Reverse leakage current | $I_R$ | $V_r$ = 650 V | | | | 25 | | | 7 | µA |
| **Thermal** | | | | | | | | | | |
| Thermal resistance junction to sink(2) | $R_{th(j-s)}$ | $\lambda_{paste}$ = 5,2 W/mK (PTM) | | | | | | 1,63 | | K/W |
| **Dynamic** | | | | | | | | | | |
| Peak recovery current | $I_{RM}$ | d*i*/d*t*=1859 A/µs<br>d*i*/d*t*=1647 A/µs | 0/10 | 400 | 40 | 25<br>125 | | 24,04<br>37,73 | | A |
| Reverse recovery time | $t_{rr}$ | | | | | 25<br>125 | | 31,95<br>54,03 | | ns |
| Recovered charge | $Q_r$ | | | | | 25<br>125 | | 0,396<br>1,19 | | µC |
| Reverse recovered energy | $E_{rec}$ | | | | | 25<br>125 | | 0,091<br>0,269 | | mWs |
| Peak rate of fall of recovery current | $(di_{rf}/dt)_{max}$ | | | | | 25<br>125 | | 1310,25<br>1444,18 | | 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 | |
| **Negative Boost Diode** | | | | | | | | | | |
| **Static** | | | | | | | | | | |
| Forward voltage | $V_F$ | | | | 30 | 25<br>125<br>150 | | 2,33<br>1,76<br>1,65 | 3(1) | V |
| Reverse leakage current | $I_R$ | $V_r$ = 650 V | | | | 25 | | | 7 | µA |
| **Thermal** | | | | | | | | | | |
| Thermal resistance junction to sink(2) | $R_{th(j-s)}$ | $\lambda_{paste}$ = 5,2 W/mK (PTM) | | | | | | 1,63 | | K/W |
| **Dynamic** | | | | | | | | | | |
| Peak recovery current | $I_{RM}$ | d*i*/d*t*=1859 A/µs<br>d*i*/d*t*=1647 A/µs | 0/10 | 400 | 40 | 25<br>125 | | 24,04<br>37,73 | | A |
| Reverse recovery time | $t_{rr}$ | | | | | 25<br>125 | | 31,95<br>54,03 | | ns |
| Recovered charge | $Q_r$ | | | | | 25<br>125 | | 0,396<br>1,19 | | µC |
| Reverse recovered energy | $E_{rec}$ | | | | | 25<br>125 | | 0,091<br>0,269 | | mWs |
| Peak rate of fall of recovery current | $(di_{rf}/dt)_{max}$ | | | | | 25<br>125 | | 1310,25<br>1444,18 | | 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 | |
| **Rectifier Diode** | | | | | | | | | | |
| **Static** | | | | | | | | | | |
| Forward voltage | $V_F$ | | | | 50 | 25<br>125 | | 1,24<br>1,24 | 1,3(1)<br>1,33(1) | V |
| Reverse leakage current | $I_R$ | $V_r$ = 1600 V | | | | 25<br>150 | | | 20<br>1500 | µA |
| **Thermal** | | | | | | | | | | |
| Thermal resistance junction to sink(2) | $R_{th(j-s)}$ | $\lambda_{paste}$ = 5,2 W/mK (PTM) | | | | | | 1,03 | | K/W |
| **Thermistor** | | | | | | | | | | |
| **Static** | | | | | | | | | | |
| Rated resistance | $R$ | | | | | 25 | | 22 | | kΩ |
| Deviation of R100 | $\Delta_{R/R}$ | $R_{100}$ = 1484 Ω | | | | 100 | -5 | | 5 | % |
| Power dissipation | $P$ | | | | | 25 | | 130 | | mW |
| Power dissipation constant | $d$ | | | | | 25 | | 1,5 | | mW/K |
| B-value | $B_{(25/50)}$ | Tol. ±1 % | | | | | | 3962 | | K |
| B-value | $B_{(25/100)}$ | Tol. ±1 % | | | | | | 4000 | | K |
| Vincotech Thermistor Reference | | | | | | | | | I | |

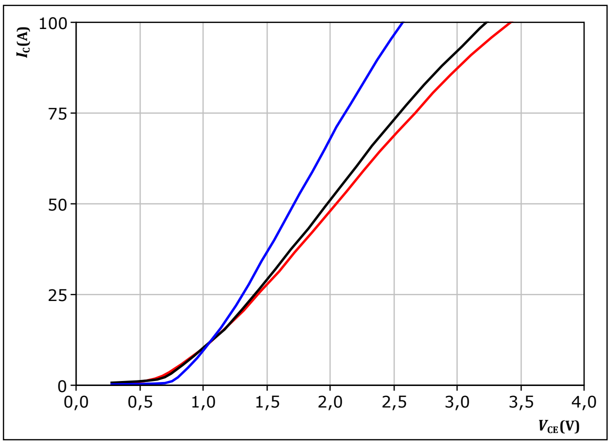
(1) Value at chip level
(2) Only valid with pre-applied Vincotech thermal interface material.

# Inverter Switch Characteristics

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

**Typical output characteristics**

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



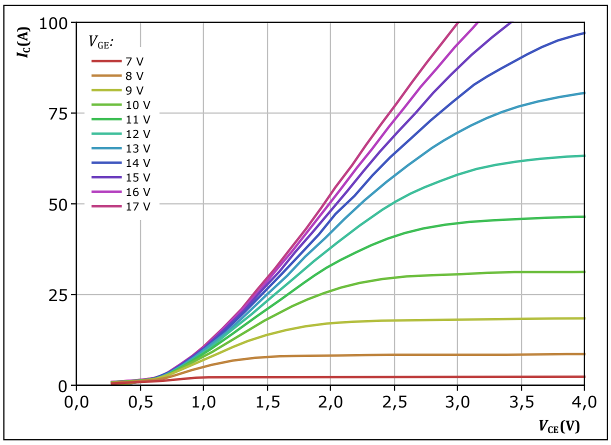

| | | |
|---|---|---|
| $t_p$ = | 250 | µs |
| $V_{GE}$ = | 15 | V |

$T_j$: 25 °C / 125 °C / 150 °C

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

**Typical output characteristics**

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



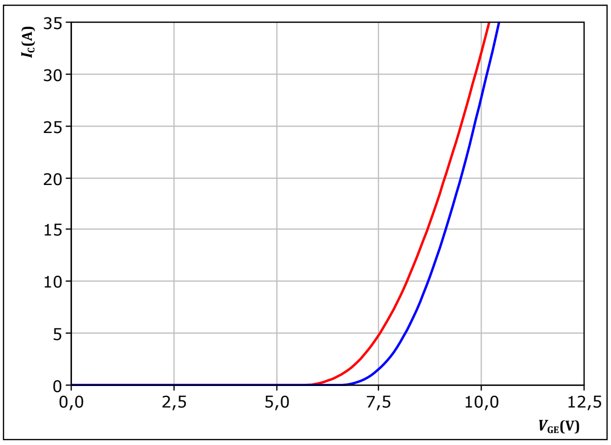

| | | |
|---|---|---|
| $t_p$ = | 250 | µs |
| $T_j$ = | 150 | °C |

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

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

**Typical transfer characteristics**

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



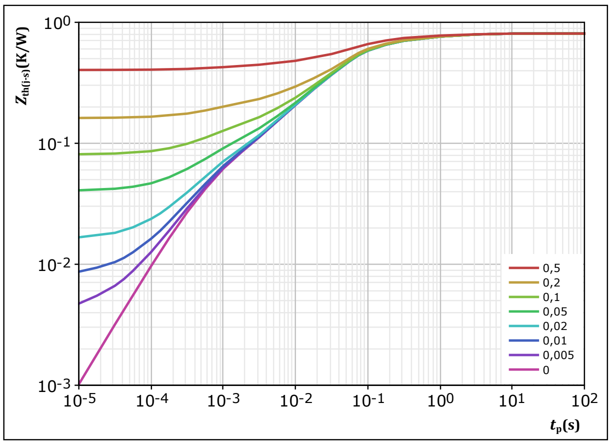

| | | |
|---|---|---|
| $t_p$ = | 250 | µs |
| $V_{CE}$ = | 10 | V |

$T_j$: 25 °C / 125 °C

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

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

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




| | | |
|---|---|---|
| $D$ = | $t_p$ / $T$ | |
| $R_{th(j-s)}$ = | 0,808 | K/W |

IGBT thermal model values

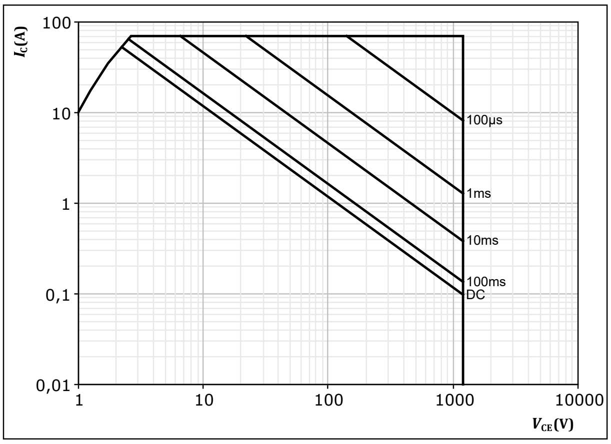
| $R$ (K/W) | $\tau$ (s) |
|---|---|
| 6,35E-02 | 2,08E+00 |
| 1,21E-01 | 3,43E-01 |
| 4,77E-01 | 5,37E-02 |
| 9,58E-02 | 7,23E-03 |
| 5,05E-02 | 6,30E-04 |

# Inverter Switch Characteristics

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

**Safe operating area**

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

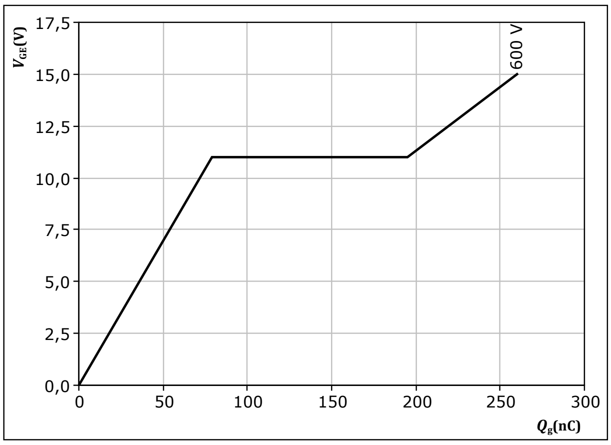



| | | |
| --- | --- | --- |
| $D$ = | single pulse | |
| $T_s$ = | 80 | °C |
| $V_{GE}$ = | 15 | V |
| $T_j$ = | $T_{jmax}$ | |

| figure 6. | IGBT |
| --- | --- |

**Gate voltage vs gate charge**

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



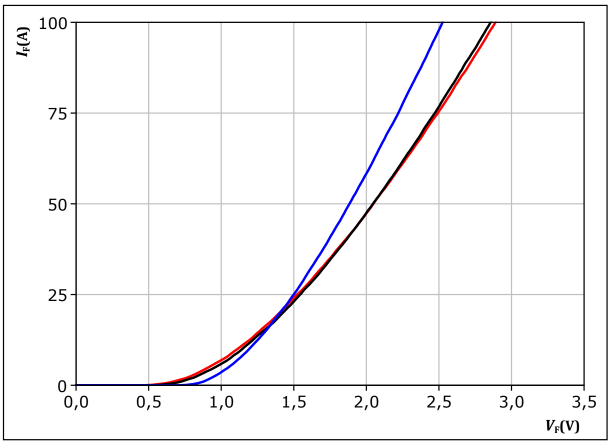

| | | |
| --- | --- | --- |
| $I_C$ = | 35 | A |
| $T_j$ = | 25 | °C |

# Inverter Diode Characteristics

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

**Typical forward characteristics**

$I_F$ = f( $V_F$)



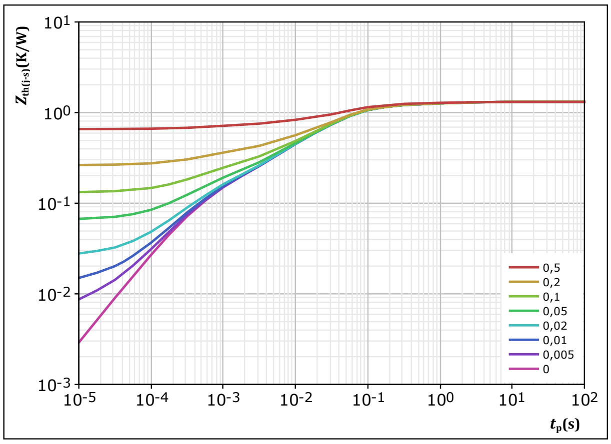

$t_p$ = 250 µs

$T_j$: 25 °C, 125 °C, 150 °C

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

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

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




$D$ = $t_p$ / $T$

$R_{th(j-s)}$ = 1,314 K/W

FWD thermal model values

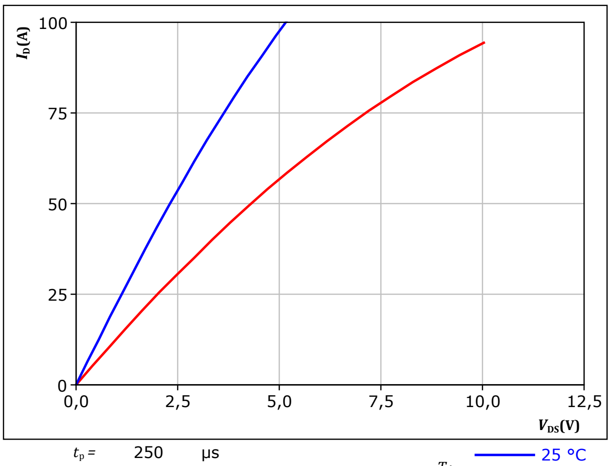
| $R$ (K/W) | $\tau$ (s) |
|---|---|
| 8,37E-02 | 1,83E+00 |
| 1,98E-01 | 1,73E-01 |
| 7,30E-01 | 3,93E-02 |
| 1,94E-01 | 5,22E-03 |
| 1,09E-01 | 4,63E-04 |

# Boost Switch Characteristics

**figure 9.** **MOSFET**

**Typical output characteristics**

$I_D$ = f( $V_{DS}$)

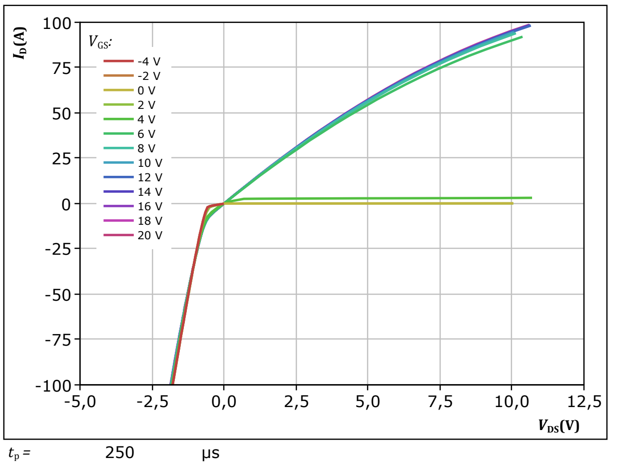



$t_p$ = 250 µs
$V_{GS}$ = 10 V
$T_j$: 25 °C, 125 °C

**figure 10.** **MOSFET**

**Typical output characteristics**

$I_D$ = f( $V_{DS}$)

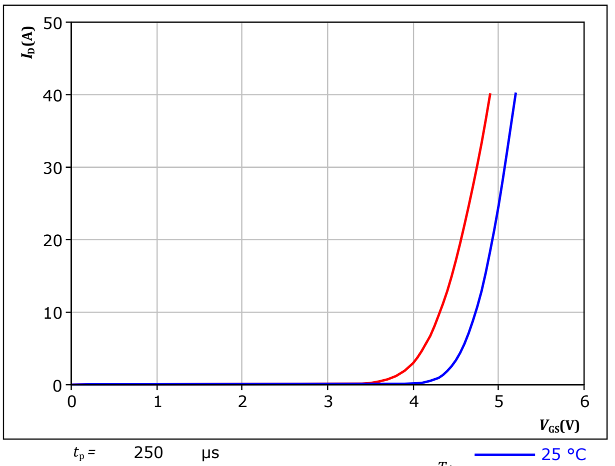



$t_p$ = 250 µs
$T_j$ = 125 °C
$V_{GS}$ from -4 V to 20 V in steps of 2 V

**figure 11.** **MOSFET**

**Typical transfer characteristics**

$I_D$ = f( $V_{GS}$)

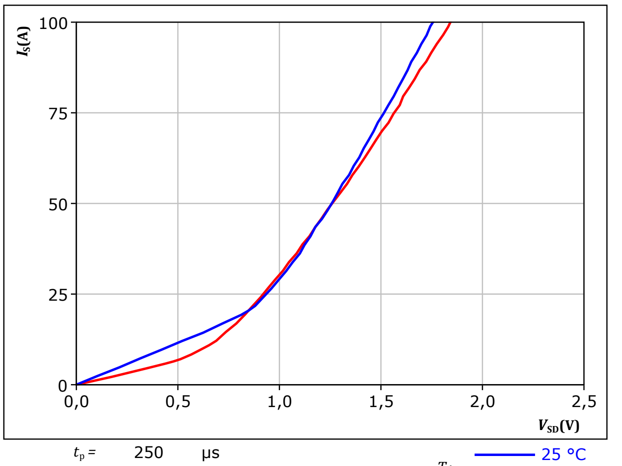



$t_p$ = 250 µs
$V_{DS}$ = 10 V
$T_j$: 25 °C, 125 °C

**figure 12.** **MOSFET**

**Typical reverse drain current characteristics**

$I_{SD}$ = f( $V_{SD}$)



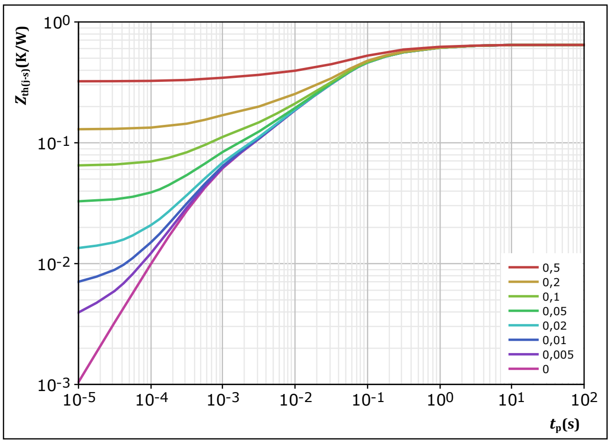

$t_p$ = 250 µs
$V_{GS}$ = 10 V
$T_j$: 25 °C, 125 °C

# Boost Switch Characteristics

**figure 13.** **MOSFET**

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

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




*D* = $t_p$ / *T*

$R_{th(j\text{-}s)}$ = 0,646 K/W

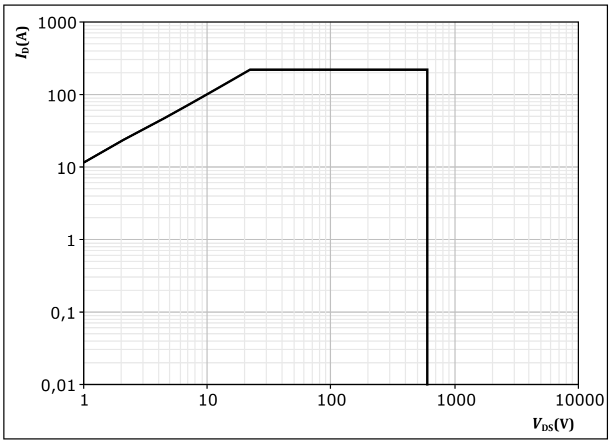
MOSFET thermal model values

| *R* (K/W) | τ (s) |
|---|---|
| 4,44E-02 | 2,13E+00 |
| 1,14E-01 | 3,41E-01 |
| 3,30E-01 | 5,71E-02 |
| 1,03E-01 | 7,52E-03 |
| 5,42E-02 | 6,34E-04 |

**figure 14.** **MOSFET**

**Safe operating area**

$I_D$ = f( $V_{DS}$)




*D* = single pulse

$T_s$ = 80 °C

$V_{GS}$ = 10 V

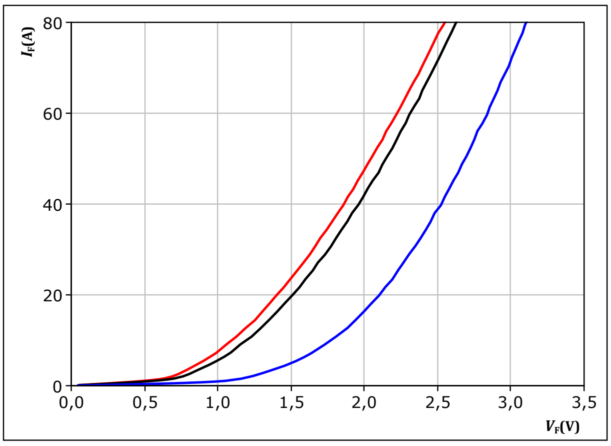
$T_j$ = $T_{jmax}$

# Boost Diode Characteristics

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

**Typical forward characteristics**

$I_F$ = f( $V_F$)



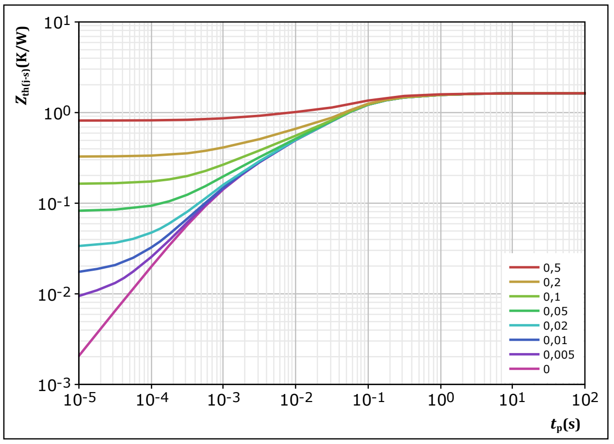

$t_p$ = 250 µs

$T_j$: 25 °C, 125 °C, 150 °C

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

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

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




$D$ = $t_p$ / $T$

$R_{th(j-s)}$ = 1,633 K/W

FWD thermal model values

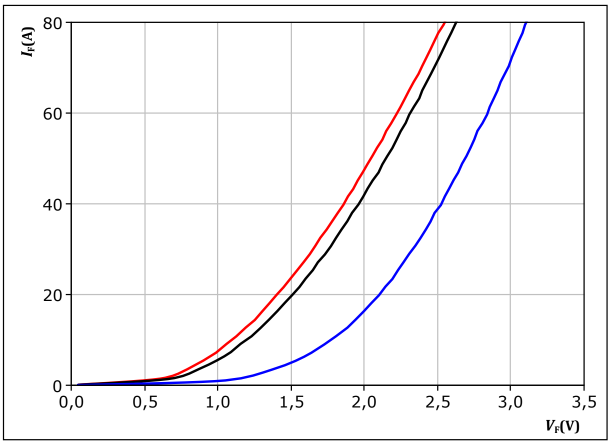
| $R$ (K/W) | $\tau$ (s) |
|---|---|
| 1,04E-01 | 1,98E+00 |
| 2,66E-01 | 2,44E-01 |
| 8,96E-01 | 5,30E-02 |
| 2,60E-01 | 4,95E-03 |
| 1,07E-01 | 7,81E-04 |

# Negative Boost Diode Characteristics

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

**Typical forward characteristics**

$I_F = f(V_F)$



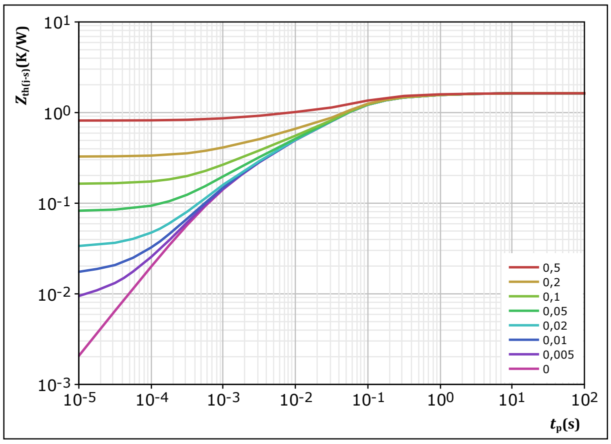

$t_p$ = 250 µs

$T_j$: 25 °C, 125 °C, 150 °C

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

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

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




$D$ = $t_p / T$

$R_{th(j-s)}$ = 1,633 K/W

FWD thermal model values

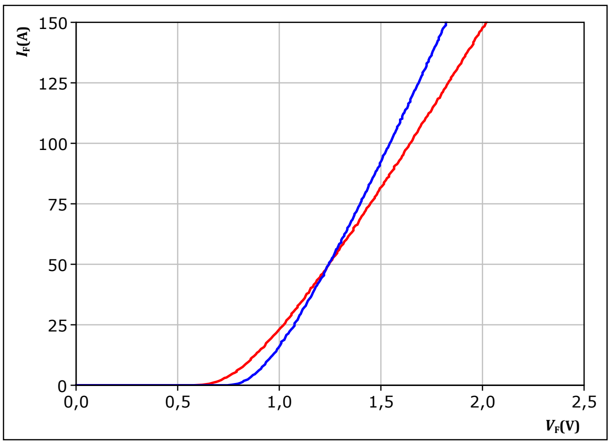
| $R$ (K/W) | $\tau$ (s) |
|---|---|
| 1,04E-01 | 1,98E+00 |
| 2,66E-01 | 2,44E-01 |
| 8,96E-01 | 5,30E-02 |
| 2,60E-01 | 4,95E-03 |
| 1,07E-01 | 7,81E-04 |

# Rectifier Diode Characteristics

**figure 19.** **Rectifier**

**Typical forward characteristics**

$I_F$ = f( $V_F$)



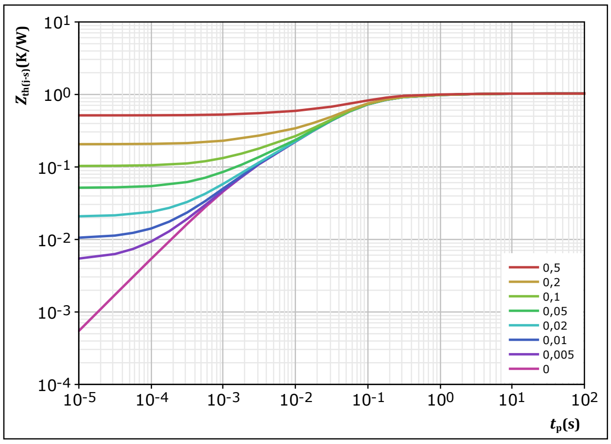

$t_p$ = 250 µs

$T_j$: 25 °C, 125 °C

**figure 20.** **Rectifier**

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

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




$D$ = $t_p$ / $T$

$R_{th(j-s)}$ = 1,03 K/W

Rectifier thermal model values

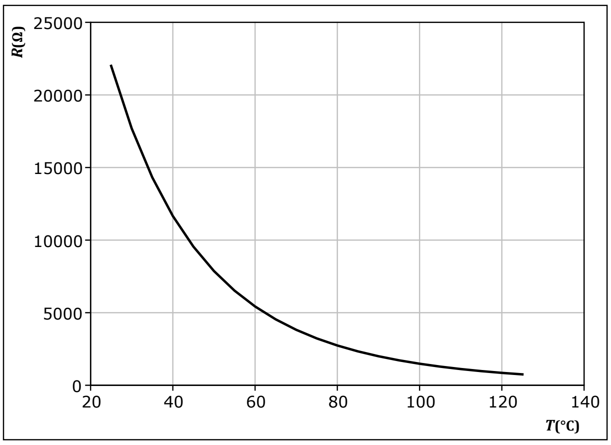
| $R$ (K/W) | $\tau$ (s) |
|---|---|
| 3,49E-02 | 4,44E+00 |
| 1,34E-01 | 4,89E-01 |
| 6,58E-01 | 6,96E-02 |
| 1,42E-01 | 1,42E-02 |
| 6,15E-02 | 1,75E-03 |

# Thermistor Characteristics

| figure 21. | Thermistor |
| --- | --- |

**Typical NTC characteristic as function of temperature**

$R_T$ = f( $T$)

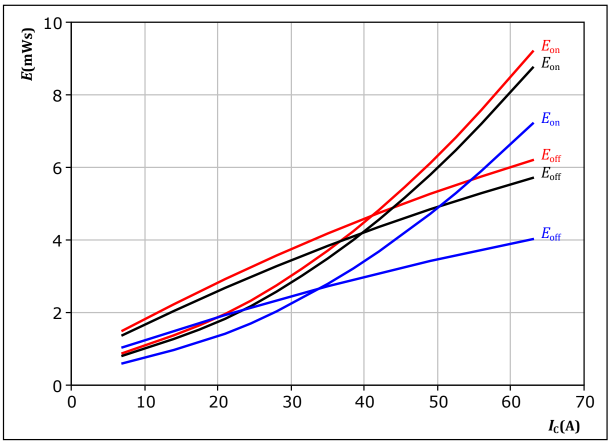


# Inverter Switching Characteristics

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

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

$E$ = f( $I_C$)



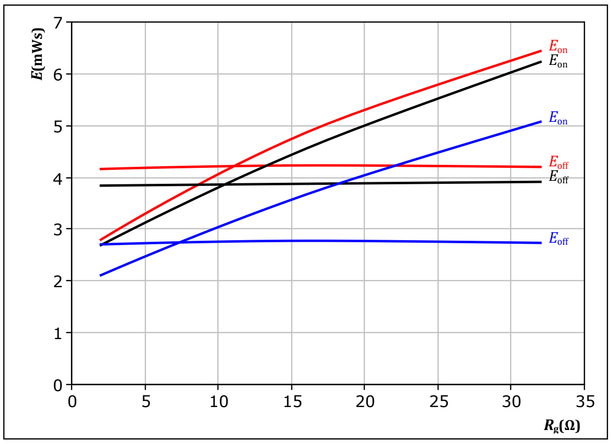

With an inductive load at

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

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

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

$E$ = f( $R_g$)



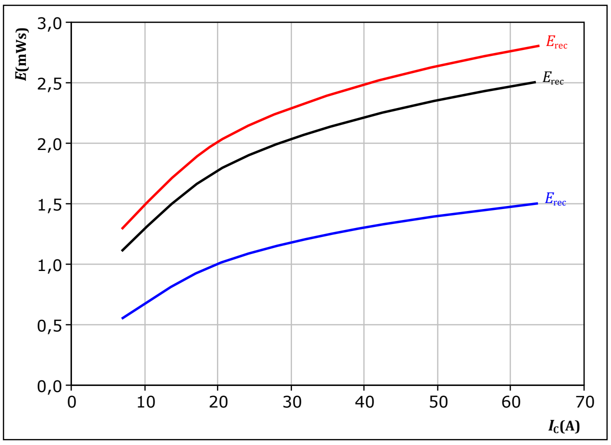

With an inductive load at

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

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

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

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



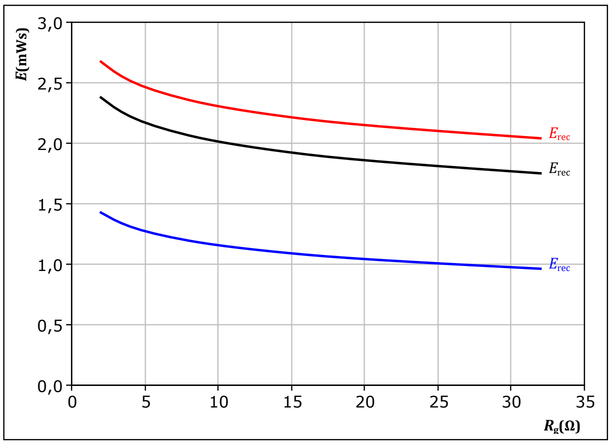

With an inductive load at

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

**figure 25.** **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

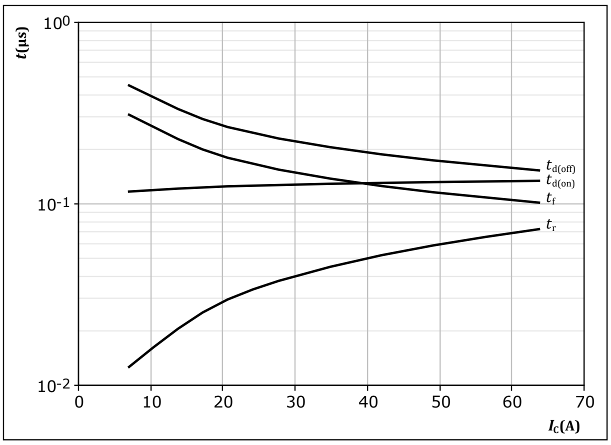
| | | | |
|---|---|---|---|
| $V_{CE}$ = | 600 | V | $T_j$: 25 °C |
| $V_{GE}$ = | ±15 | V | 125 °C |
| $I_C$ = | 35 | A | 150 °C |

# Inverter Switching Characteristics

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

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

$t$ = f( $I_C$)



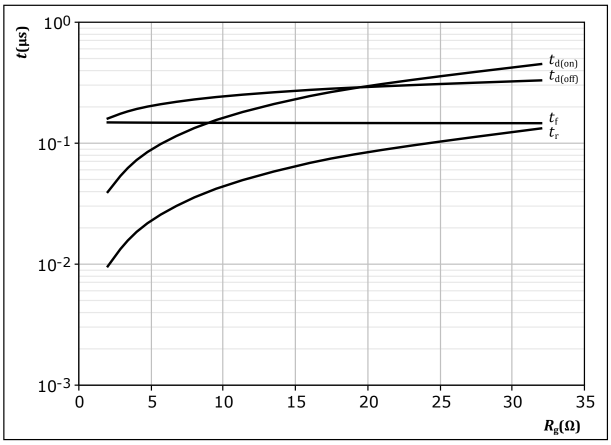

With an inductive load at

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

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

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

$t$ = f( $R_g$)



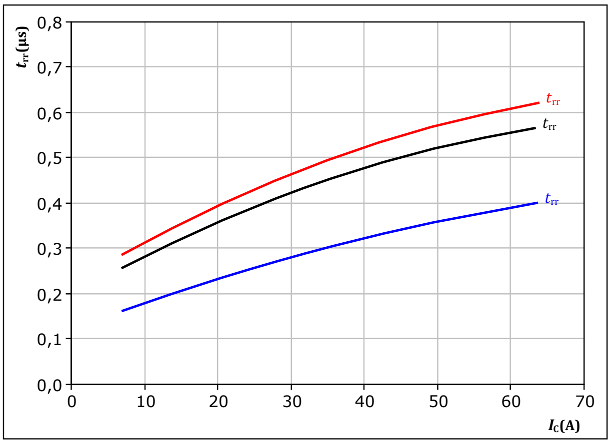

With an inductive load at

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

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

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

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




With an inductive load at

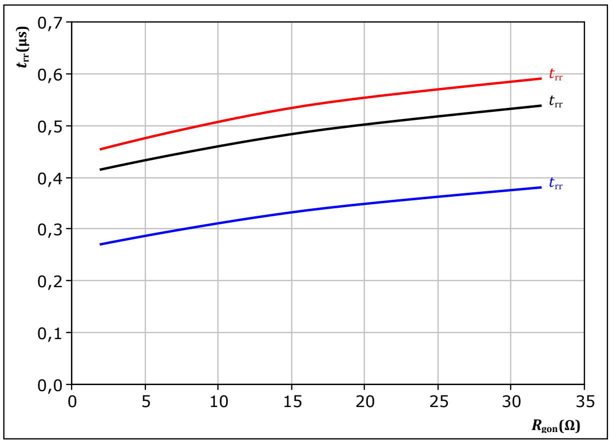
| | | |
|---|---|---|
| $V_{CE}$ = | 600 | V |
| $V_{GE}$ = | ±15 | V |
| $R_{gon}$ = | 8 | Ω |

$T_j$: 25 °C, 125 °C, 150 °C

**figure 29.** **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 |
| $I_C$ = | 35 | A |

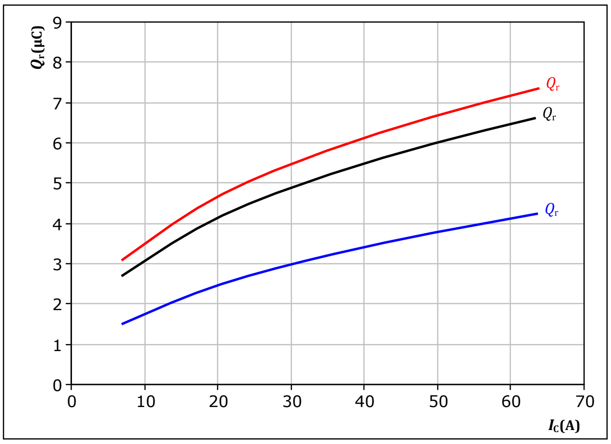
$T_j$: 25 °C, 125 °C, 150 °C

# Inverter Switching Characteristics

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

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

$Q_r$ = f( $I_C$)



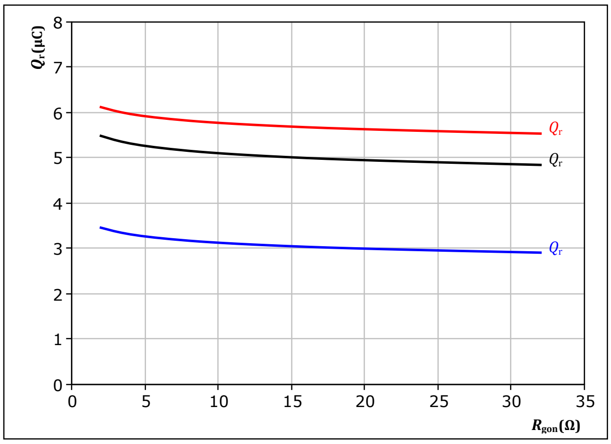

With an inductive load at

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

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

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

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



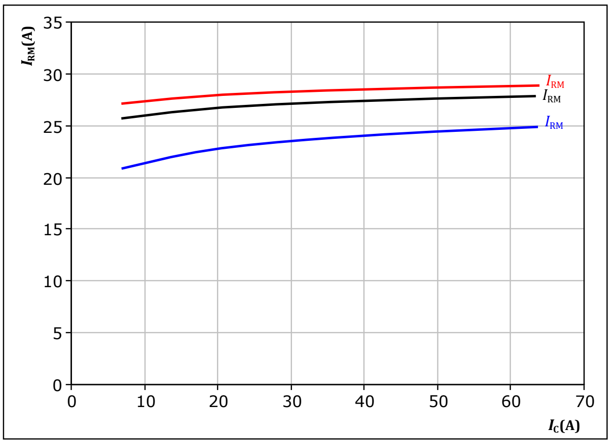

With an inductive load at

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

**figure 32.** **FWD**

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

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



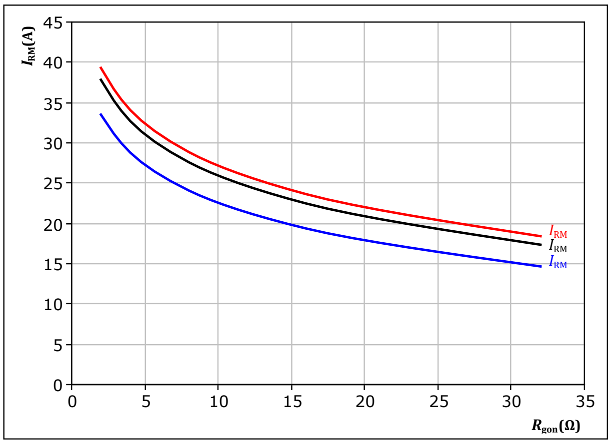

With an inductive load at

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

**figure 33.** **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

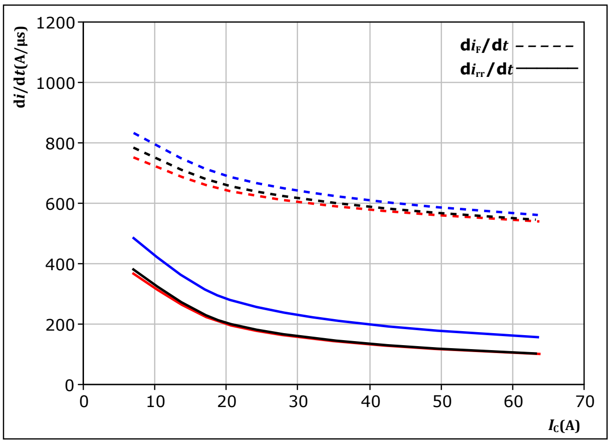
| | | | | |
|---|---|---|---|---|
| $V_{CE}$ = | 600 | V | $T_j$: | 25 °C |
| $V_{GE}$ = | ±15 | V | | 125 °C |
| $I_C$ = | 35 | A | | 150 °C |

# Inverter Switching Characteristics

**figure 34.** **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

$V_{GE}$ = ±15 V

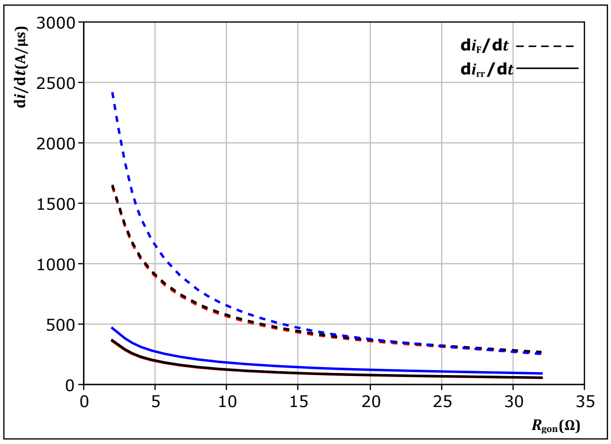
$R_{gon}$ = 8 Ω

$T_j$: 25 °C, 125 °C, 150 °C

**figure 35.** **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

$V_{GE}$ = ±15 V

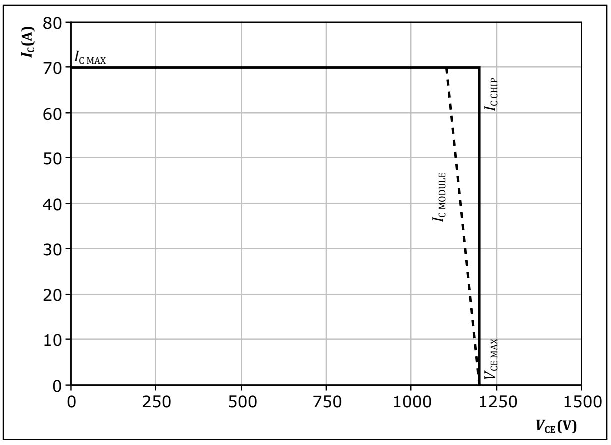
$I_C$ = 35 A

$T_j$: 25 °C, 125 °C, 150 °C

**figure 36.** **IGBT**

**Reverse bias safe operating area**

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




**At** $T_j$ = 150 °C

$R_{gon}$ = 8 Ω

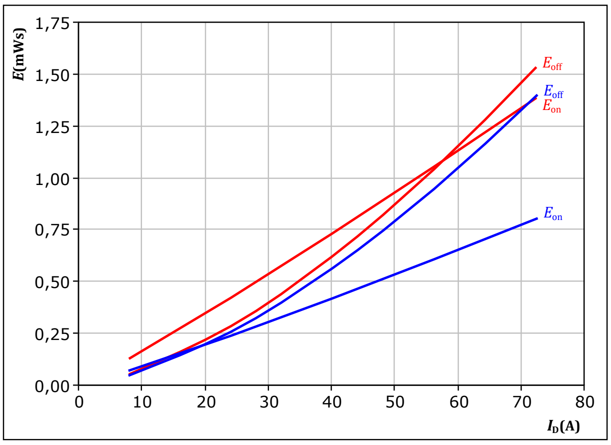
$R_{goff}$ = 8 Ω

# Boost Switching Characteristics

**figure 37.** **MOSFET**

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

$E = f(I_D)$



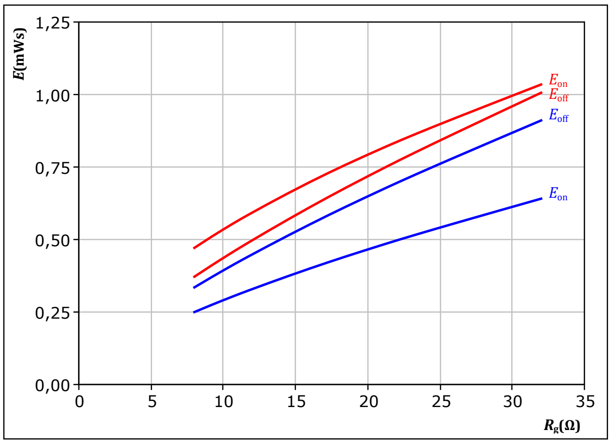

With an inductive load at

| | | | | |
|---|---|---|---|---|
| $V_{DS}$ = | 400 | V | $T_j$: | 25 °C |
| $V_{GS}$ = | 0/10 | V | | 125 °C |
| $R_{gon}$ = | 16 | Ω | | |
| $R_{goff}$ = | 16 | Ω | | |

**figure 38.** **MOSFET**

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

$E = f(R_g)$



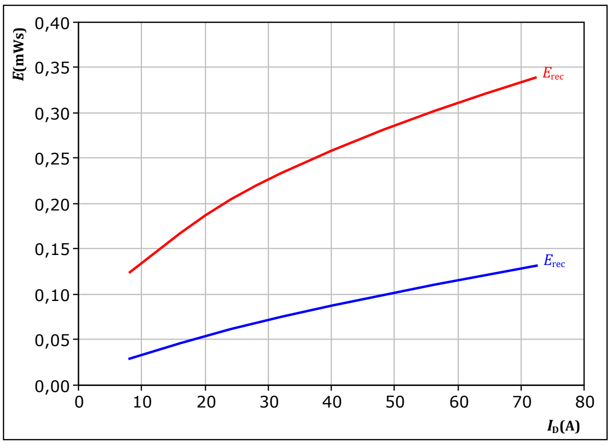

With an inductive load at

| | | | | |
|---|---|---|---|---|
| $V_{DS}$ = | 400 | V | $T_j$: | 25 °C |
| $V_{GS}$ = | 0/10 | V | | 125 °C |
| $I_D$ = | 40 | A | | |

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

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

$E_{rec} = f(I_D)$



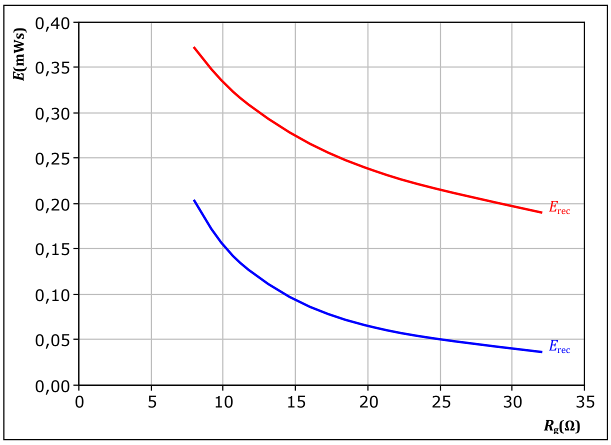

With an inductive load at

| | | | | |
|---|---|---|---|---|
| $V_{DS}$ = | 400 | V | $T_j$: | 25 °C |
| $V_{GS}$ = | 0/10 | V | | 125 °C |
| $R_{gon}$ = | 16 | Ω | | |

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

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

$E_{rec} = f(R_g)$




With an inductive load at

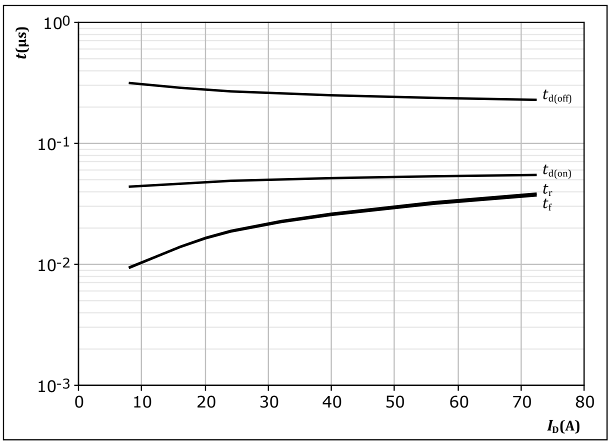
| | | | | |
|---|---|---|---|---|
| $V_{DS}$ = | 400 | V | $T_j$: | 25 °C |
| $V_{GS}$ = | 0/10 | V | | 125 °C |
| $I_D$ = | 40 | A | | |

# Boost Switching Characteristics

**figure 41.** **MOSFET**

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

$t$ = f( $I_D$)



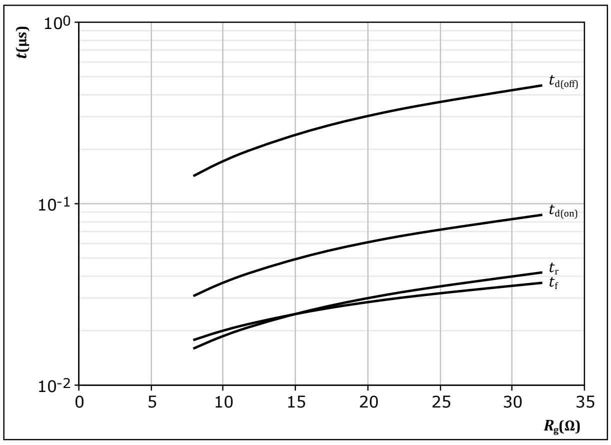

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 125 | °C |
| $V_{DS}$ = | 400 | V |
| $V_{GS}$ = | 0/10 | V |
| $R_{gon}$ = | 16 | Ω |
| $R_{goff}$ = | 16 | Ω |

**figure 42.** **MOSFET**

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

$t$ = f( $R_g$)



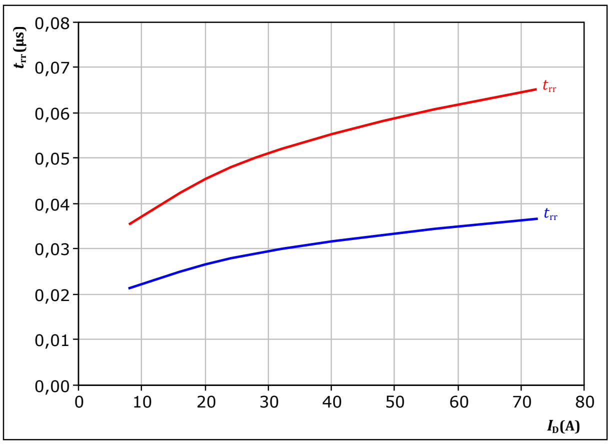

With an inductive load at

| | | |
|---|---|---|
| $T_j$ = | 125 | °C |
| $V_{DS}$ = | 400 | V |
| $V_{GS}$ = | 0/10 | V |
| $I_D$ = | 40 | A |

**figure 43.** **FWD**

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

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



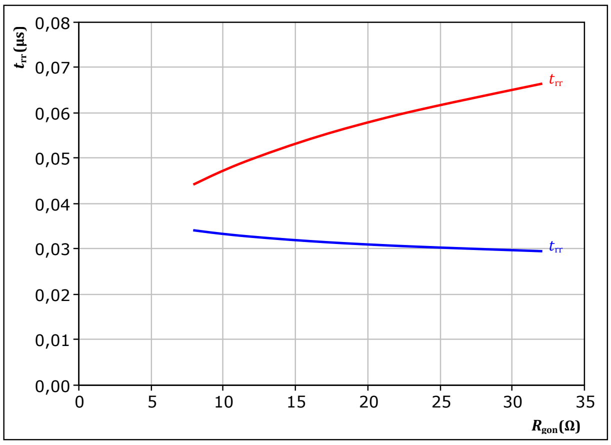

| At | | | |
|---|---|---|---|
| | $V_{DS}$ = | 400 | V |
| | $V_{GS}$ = | 0/10 | V |
| | $R_{gon}$ = | 16 | Ω |

$T_j$: 25 °C (blue), 125 °C (red)

**figure 44.** **FWD**

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

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




| At | | | |
|---|---|---|---|
| | $V_{DS}$ = | 400 | V |
| | $V_{GS}$ = | 0/10 | V |
| | $I_D$ = | 40 | A |

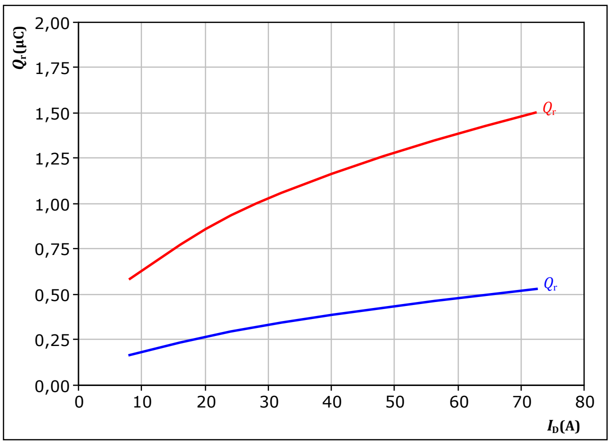
$T_j$: 25 °C (blue), 125 °C (red)

# Boost Switching Characteristics

| figure 45. | FWD |
|---|---|

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

$Q_r = f(I_D)$

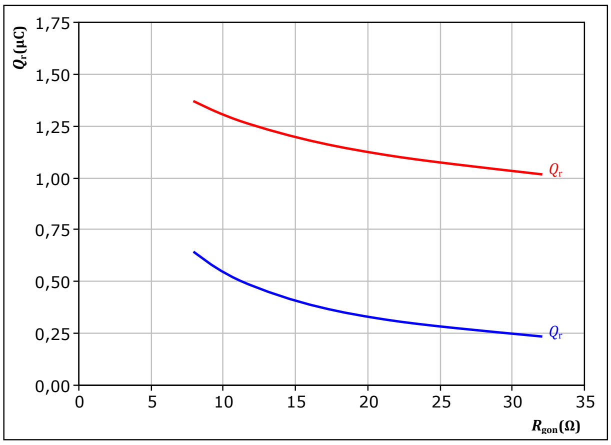



| At | | | | $T_j$: | |
|---|---|---|---|---|---|
| | $V_{DS}$ = | 400 | V | | 25 °C |
| | $V_{GS}$ = | 0/10 | V | | 125 °C |
| | $R_{gon}$ = | 16 | Ω | | |

| figure 46. | FWD |
|---|---|

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

$Q_r = f(R_{gon})$

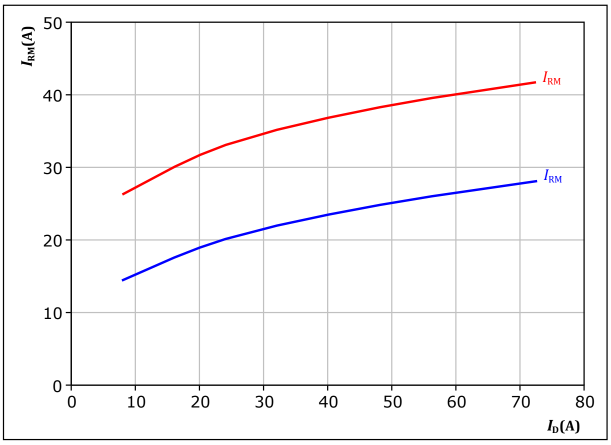



| At | | | | $T_j$: | |
|---|---|---|---|---|---|
| | $V_{DS}$ = | 400 | V | | 25 °C |
| | $V_{GS}$ = | 0/10 | V | | 125 °C |
| | $I_D$ = | 40 | A | | |

| figure 47. | FWD |
|---|---|

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

$I_{RM} = f(I_D)$

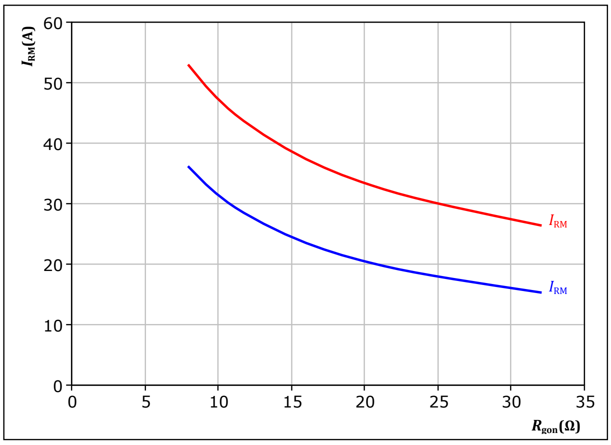



| At | | | | $T_j$: | |
|---|---|---|---|---|---|
| | $V_{DS}$ = | 400 | V | | 25 °C |
| | $V_{GS}$ = | 0/10 | V | | 125 °C |
| | $R_{gon}$ = | 16 | Ω | | |

| figure 48. | FWD |
|---|---|

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

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



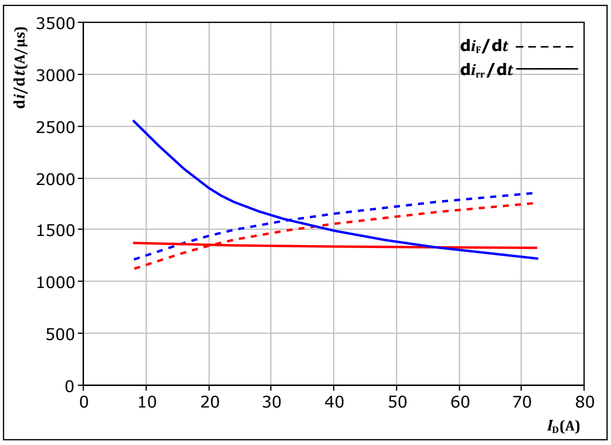

| At | | | | $T_j$: | |
|---|---|---|---|---|---|
| | $V_{DS}$ = | 400 | V | | 25 °C |
| | $V_{GS}$ = | 0/10 | V | | 125 °C |
| | $I_D$ = | 40 | A | | |

# Boost Switching Characteristics

**figure 49.** **FWD**

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

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

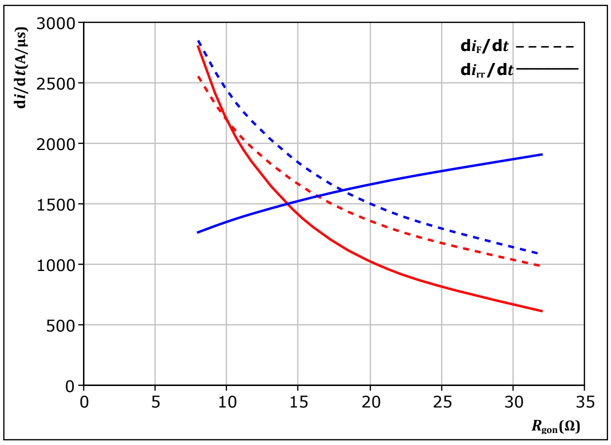



| At | | | | | |
|---|---|---|---|---|---|
| | $V_{DS}$ = | 400 | V | $T_j$: | 25 °C |
| | $V_{GS}$ = | 0/10 | V | | 125 °C |
| | $R_{gon}$ = | 16 | Ω | | |

**figure 50.** **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( $R_{gon}$)

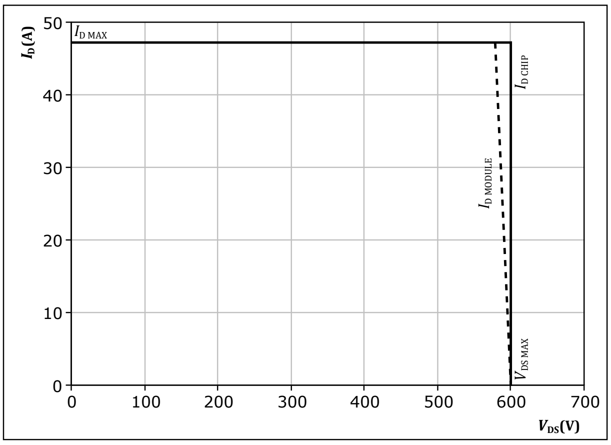



| At | | | | | |
|---|---|---|---|---|---|
| | $V_{DS}$ = | 400 | V | $T_j$: | 25 °C |
| | $V_{GS}$ = | 0/10 | V | | 125 °C |
| | $I_D$ = | 40 | A | | |

**figure 51.** **MOSFET**

**Reverse bias safe operating area**

$I_D$ = f( $V_{DS}$)




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

# Inverter Switching Definitions

**figure 52.** **IGBT**

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

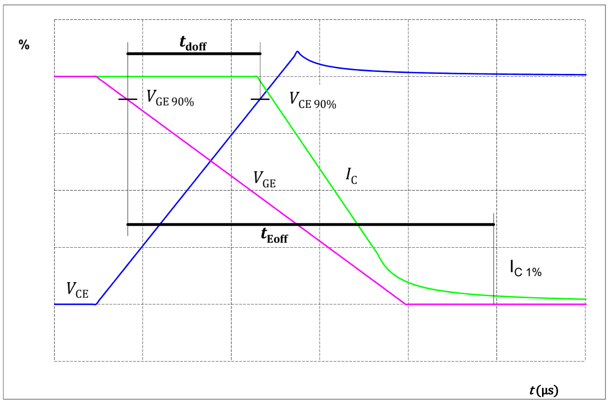



**figure 53.** **IGBT**

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

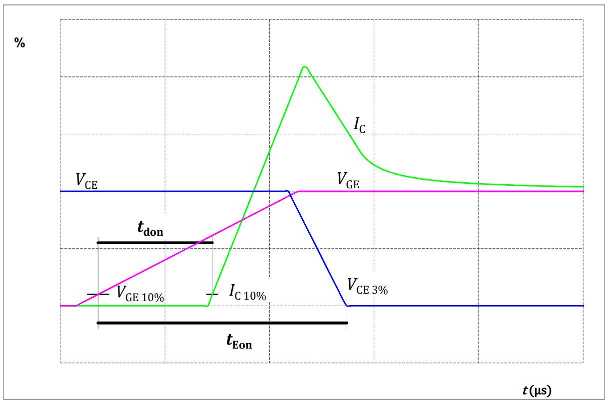



**figure 54.** **IGBT**

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

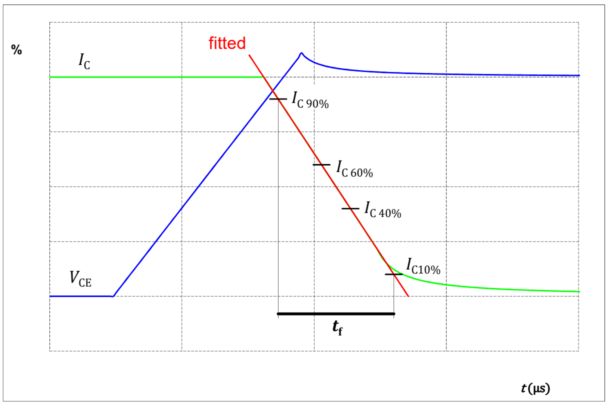
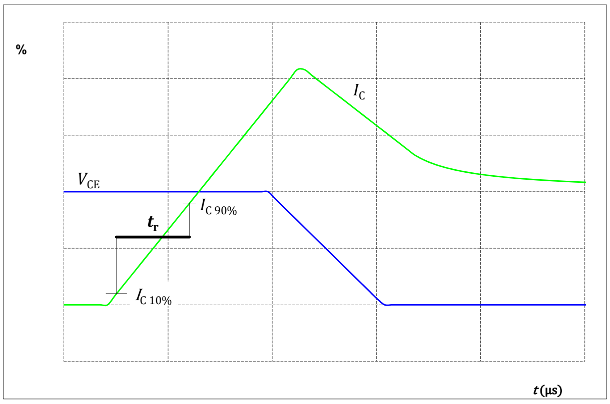



**figure 55.** **IGBT**

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



# Inverter Switching Definitions

**figure 56.** **FWD**

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

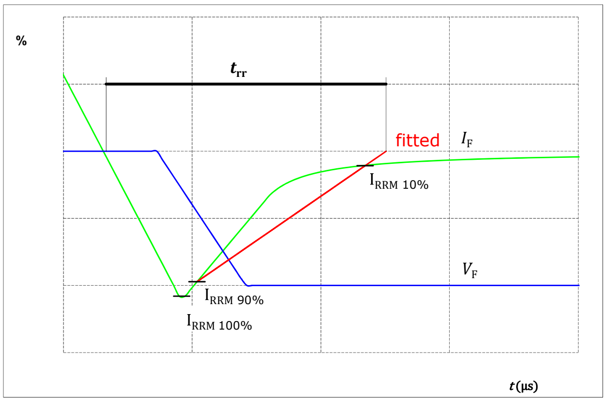
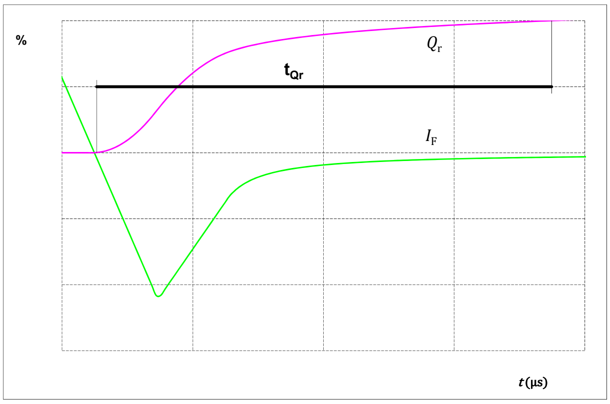



**figure 57.** **FWD**

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



# Boost Switching Definitions

**figure 52.** **MOSFET**

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

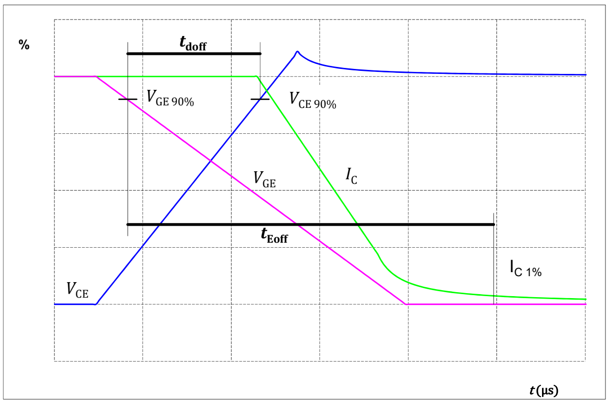



**figure 53.** **MOSFET**

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

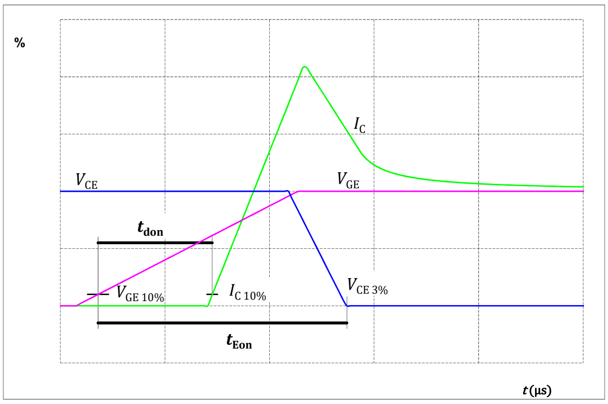



**figure 54.** **MOSFET**

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

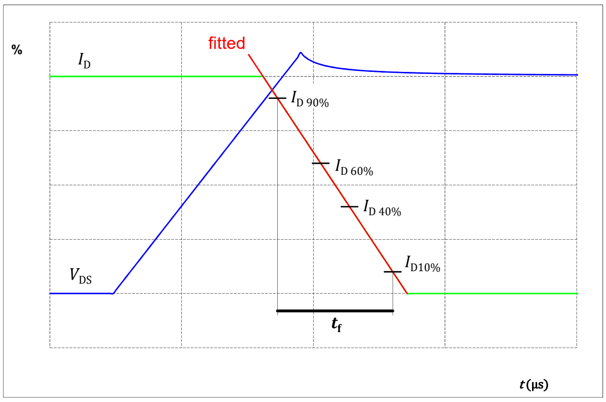
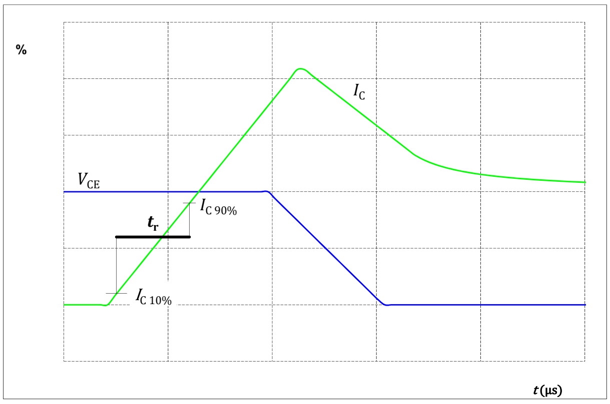



**figure 55.** **MOSFET**

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



# Boost Switching Definitions

**figure 56.** **FWD**

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

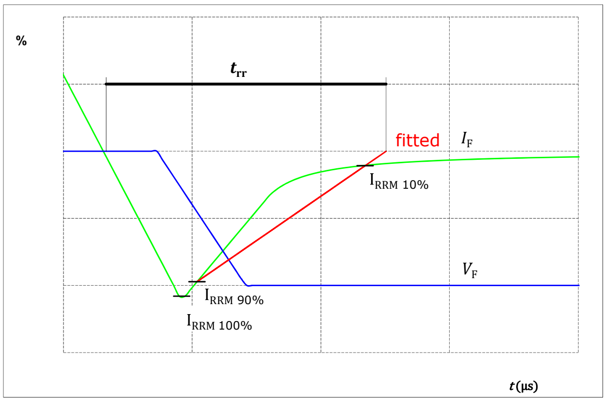



**figure 57.** **FWD**

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

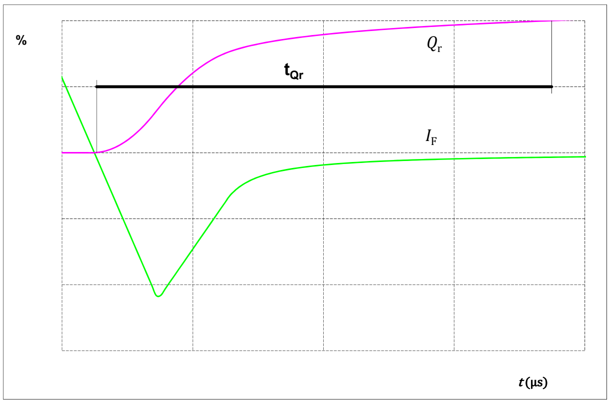
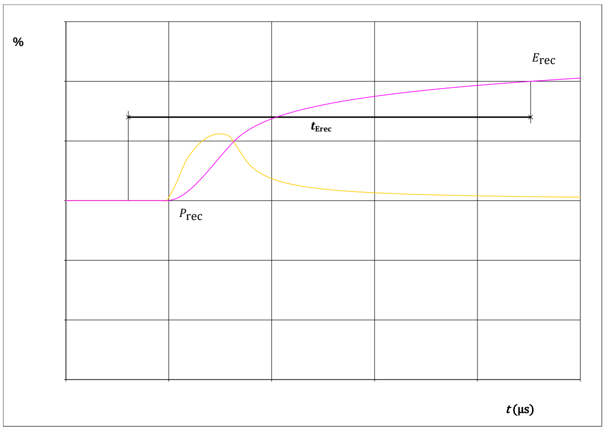



**figure 58.** **FWD**

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



## Ordering Code

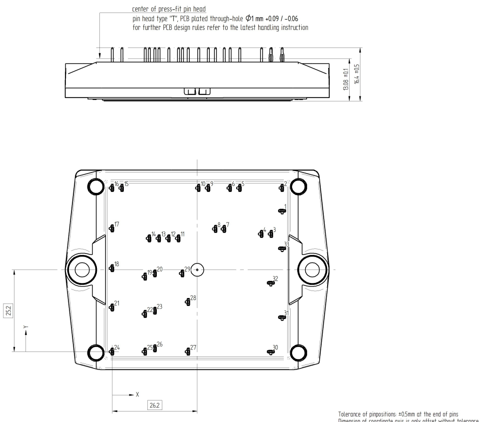
| Version | Ordering Code |
|---|---|
| Without thermal paste | B0-SP12VPA035M702-LR29A13T |
| With thermal paste (5,2 W/mK, PTM6000HV) | B0-SP12VPA035M702-LR29A13T-/7/ |
| With thermal paste (5,2 W/mK, PTM6000HV) and Protection Foil | B0-SP12VPA035M702-LR29A13T-/7F/ |

## Marking

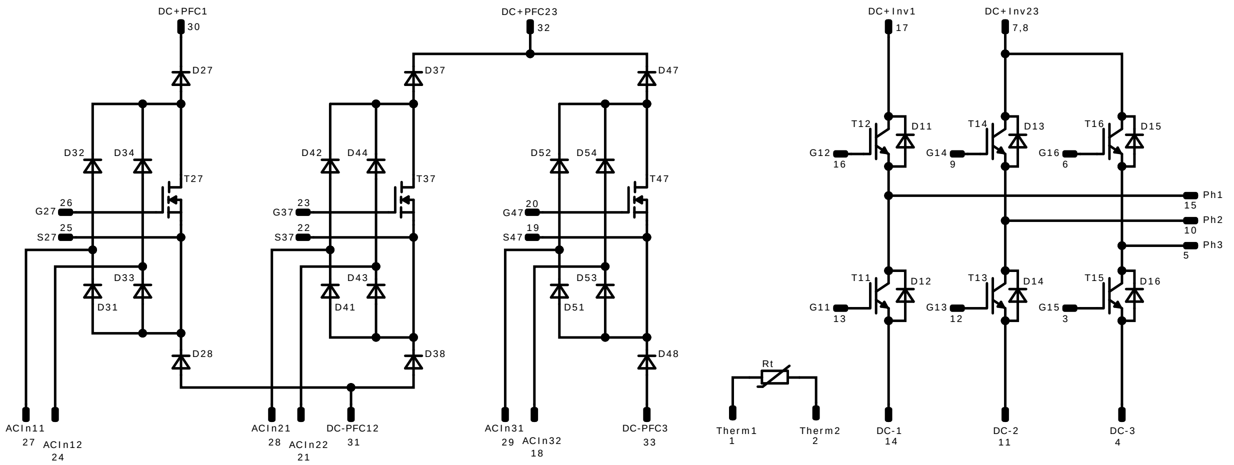

| | | Name | | Date code | UL & VIN | Lot | Serial |
|---|---|---|---|---|---|---|---|
| | **Text** | NN-NNNNNNNNNNNNNN-TTTTTTVV | | WWYY | UL VIN | LLLLL | SSSS |
| | **Datamatrix** | **Type&Ver** | **Lot number** | **Serial** | **Date code** | | |
| | | TTTTTTTVV | LLLLL | SSSS | WWYY | | |

## Outline

| Pin table [mm] | | | |
|---|---|---|---|
| Pin | X | Y | Function |
| 1 | 52,4 | 43,4 | Therm1 |
| 2 | 52,4 | 50,4 | Therm2 |
| 3 | 49,05 | 36,25 | G15 |
| 4 | 46,05 | 36,25 | DC-3 |
| 5 | 39,35 | 50,4 | Ph3 |
| 6 | 36,35 | 50,4 | G16 |
| 7 | 34,55 | 37,8 | DC+Inv23 |
| 8 | 31,85 | 37,8 | DC+Inv23 |
| 9 | 29,65 | 50,4 | G14 |
| 10 | 26,65 | 50,4 | Ph2 |
| 11 | 20,45 | 34,9 | DC-2 |
| 12 | 17,45 | 34,9 | G13 |
| 13 | 14,45 | 34,9 | G11 |
| 14 | 11,45 | 34,9 | DC-1 |
| 15 | 3 | 50,4 | Ph1 |
| 16 | 0 | 50,4 | G12 |
| 17 | 0 | 37,95 | DC+Inv1 |
| 18 | 0 | 25,7 | ACIn32 |
| 19 | 10,15 | 23,1 | S47 |
| 20 | 13,15 | 24,1 | G47 |
| 21 | 0 | 13,6 | ACIn22 |
| 22 | 10,15 | 11,6 | S37 |
| 23 | 13,15 | 12,6 | G37 |
| 24 | 0 | 0 | ACIn12 |
| 25 | 10,15 | 0 | S27 |
| 26 | 13,15 | 1 | G27 |
| 27 | 23,45 | 0 | ACIn11 |
| 28 | 23,45 | 15,3 | ACIn21 |
| 29 | 21,65 | 24,1 | ACIn31 |
| 30 | 48,9 | 0 | DC+PFC1 |
| 31 | 52,4 | 10,6 | DC-PFC12 |
| 32 | 48,9 | 21,2 | DC+PFC23 |
| 33 | 52,4 | 31,8 | DC-PFC3 |



## Pinout




## Identification

| ID | Component | Voltage | Current | Function | Comment |
|---|---|---|---|---|---|
| T11, T12, T13, T14, T15, T16 | IGBT | 1200 V | 35 A | Inverter Switch | |
| D11, D12, D13, D14, D15, D16 | FWD | 1200 V | 35 A | Inverter Diode | |
| T27, T37, T47 | MOSFET | 600 V | 34,5 mΩ | Boost Switch | |
| D27, D37, D47 | FWD | 650 V | 30 A | Boost Diode | |
| D28, D38, D48 | FWD | 650 V | 30 A | Negative Boost Diode | |
| D31, D32, D33, D34, D41, D42, D43, D44, D51, D52, D53, D54 | Rectifier | 1600 V | 50 A | Rectifier Diode | |
| Rt | Thermistor | | | Thermistor | |

| **Packaging instruction** | | | | |
|---|---|---|---|---|
| Standard packaging quantity (SPQ) 45 | >SPQ | Standard | <SPQ | Sample |

| **Handling instruction** |
|---|
| Handling instructions for *flow* S3 packages see vincotech.com website. |

| **Package data** |
|---|
| Package data for *flow* S3 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 $T_{j,op}$=150°C and up to 4000VAC/1min isolation voltage. For more information see vincotech.com website. |

| **Document No.:** | **Date:** | **Modification:** | **Pages** |
|---|---|---|---|
| B0-SP12VPA035M702-LR29A13T-D3-14 | 15 May. 2026 | Update Product Line | |