**Infineon technologies**

**BTS 247 Z**

**Speed TEMPFET®**

- N-Channel
- Enhancement mode
- Logic Level Input
- Analog driving possible
- Fast switching up to 1 MHz
- Potential-free temperature sensor with thyristor characteristics
- Overtemperature protection
- Avalanche rated

VPT05166
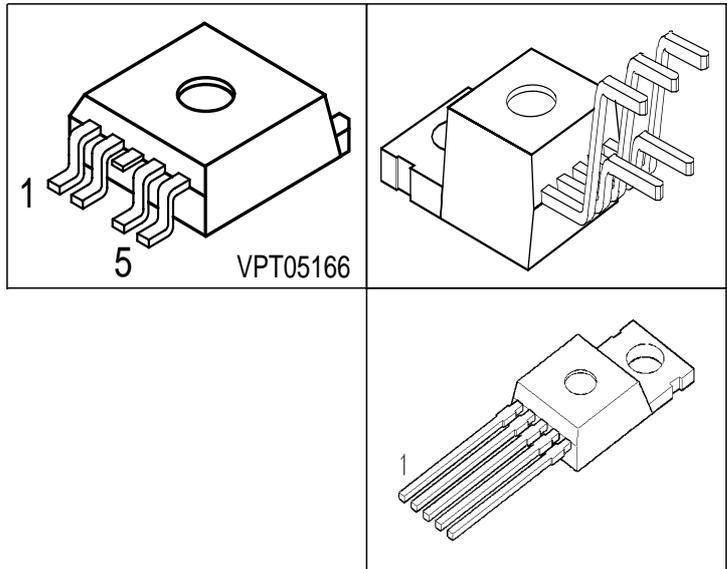
| Type | $V_{DS}$ | $R_{DS(on)}$ | Package | Ordering Code |
|---|---|---|---|---|
| BTS 247 Z | 55 V | 18 m$\Omega$ | P-TO220-5-3 | Q67060-S6001-A2 |
| | | | P-TO220-5-62 | Q67060-S6002-A2 |
| | | | TO-220-5-43 | Q67060-S6006 |

D Pin 3 and TAB

G Pin 1
A Pin 2

Temperature Sensor

K Pin 4

S Pin 5
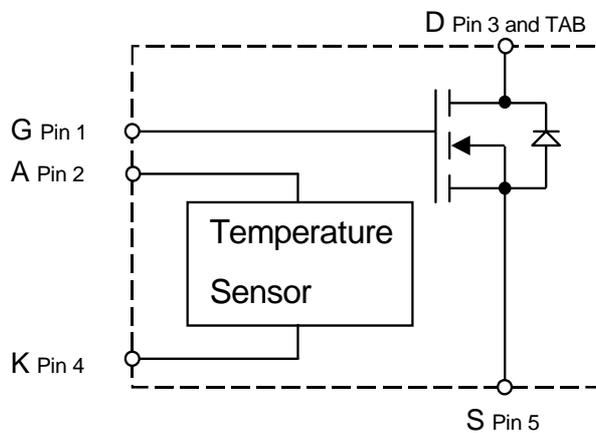
| Pin | Symbol | Function |
|---|---|---|
| 1 | G | Gate |
| 2 | A | Anode Temperature Sensor |
| 3 | D | Drain |
| 4 | K | Cathode Temperature Sensor |
| 5 | S | Source |

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**Maximum Ratings**

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Drain source voltage | $V_{DS}$ | 55 | V |
| Drain-gate voltage, $R_{GS}$ = 20 k$\Omega$ | $V_{DGR}$ | 55 | |
| Gate source voltage | $V_{GS}$ | $\pm$20 | |
| Nominal load current (ISO 10483)<br>$V_{GS}$ = 4.5 V, $V_{DS} \leq$ 0.5 V, $T_C$ = 85 °C<br>$V_{GS}$ = 10 V, $V_{DS} \leq$ 0.5 V, $T_C$ = 85 °C | $I_{D(ISO)}$ | <br>12<br>19 | A |
| Continuous drain current [1]<br>$T_C$ = 100 °C, $V_{GS}$ = 4.5V | $I_D$ | 33 | |
| Pulsed drain current | $I_{D\ puls}$ | 180 | |
| Avalanche energy, single pulse<br>$I_D$ = 12 A, $R_{GS}$ = 25 $\Omega$ | $E_{AS}$ | 1.3 | J |
| Power dissipation<br>$T_C$ = 25 °C | $P_{tot}$ | 120 | W |
| Operating temperature [2] | $T_j$ | -40 ...+175 | °C |
| Peak temperature ( single event ) | $T_{jpeak}$ | 200 | |
| Storage temperature | $T_{stg}$ | -55 ... +150 | |
| DIN humidity category, DIN 40 040 | | E | |
| IEC climatic category; DIN IEC 68-1 | | 40/150/56 | |

[1]current limited by bond wire

[2]Note: Thermal trip temperature of temperature sensor is below 175°C

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**BTS 247 Z**

## Thermal Characteristics

| Parameter | Symbol | Values | | | Unit |
|---|---|---|---|---|---|
| | | min. | typ. | max. | |

### Characteristics

| Parameter | Symbol | min. | typ. | max. | Unit |
|---|---|---|---|---|---|
| junction - case: | $R_{thJC}$ | - | - | 1.25 | K/W |
| Thermal resistance @ min. footprint | $R_{th(JA)}$ | - | - | 62 | |
| Thermal resistance @ 6 cm$^2$ cooling area [1] | $R_{th(JA)}$ | - | 33 | 40 | |

## Electrical Characteristics

| Parameter | Symbol | Values | | | Unit |
|---|---|---|---|---|---|
| at $T_j$ = 25°C, unless otherwise specified | | min. | typ. | max. | |

### Static Characteristics

| Parameter | Symbol | min. | typ. | max. | Unit |
|---|---|---|---|---|---|
| Drain-source breakdown voltage $V_{GS}$ = 0 V, $I_D$ = 0.25 mA | $V_{(BR)DSS}$ | 55 | - | - | V |
| Gate threshold voltage, $V_{GS}$ = $V_{DS}$ $I_D$ = 90 µA $I_D$ = 250 µA | $V_{GS(th)}$ | 1.2 - | 1.6 1.65 | 2 - | |
| Zero gate voltage drain current $V_{DS}$ = 50 V, $V_{GS}$ = 0 V, $T_j$ = -40 °C $V_{DS}$ = 50 V, $V_{GS}$ = 0 V, $T_j$ = 25 °C $V_{DS}$ = 50 V, $V_{GS}$ = 0 V, $T_j$ = 150 °C | $I_{DSS}$ | - - - | - 0.1 - | 0.1 1 100 | µA |
| Gate-source leakage current $V_{GS}$ = 20 V, $V_{DS}$ = 0 V, $T_j$ = 25 °C $V_{GS}$ = 20 V, $V_{DS}$ = 0 V, $T_j$ = 150 °C | $I_{GSS}$ | - - | 10 20 | 100 100 | nA |
| Drain-Source on-state resistance $V_{GS}$ = 4.5 V, $I_D$ = 12 A $V_{GS}$ = 10 V, $I_D$ = 12 A | $R_{DS(on)}$ | - - | 22 15 | 28 18 | mΩ |

[1] Device on 50mm*50mm*1.5mm epoxy PCB FR4 with 6cm$^2$ (one layer, 70µm thick) copper area for drain connection. PCB mounted vertical without blown air.

## Electrical Characteristics

| Parameter | Symbol | Values | | | Unit |
|---|---|---|---|---|---|
| at $T_j = 25°C$, unless otherwise specified | | min. | typ. | max. | |
| **Dynamic Characteristics** | | | | | |
| Forward transconductance $V_{DS}>2*I_D*R_{DS(on)max}$ , $I_D = 33$ A | $g_{fs}$ | 10 | - | - | S |
| Input capacitance $V_{GS} = 0$ V, $V_{DS} = 25$ V, $f = 1$ MHz | $C_{iss}$ | - | 1380 | 1730 | pF |
| Output capacitance $V_{GS} = 0$ V, $V_{DS} = 25$ V, $f = 1$ MHz | $C_{oss}$ | - | 410 | 515 | |
| Reverse transfer capacitance $V_{GS} = 0$ V, $V_{DS} = 25$ V, $f = 1$ MHz | $C_{rss}$ | - | 230 | 290 | |
| Turn-on delay time $V_{DD} = 30$ V, $V_{GS} = 4.5$ V, $I_D = 45$ A, $R_G = 3.6$ $\Omega$ | $t_{d(on)}$ | - | 15 | 25 | ns |
| Rise time $V_{DD} = 30$ V, $V_{GS} = 4.5$ V, $I_D = 45$ A, $R_G = 3.6$ $\Omega$ | $t_r$ | - | 30 | 45 | |
| Turn-off delay time $V_{DD} = 30$ V, $V_{GS} = 4.5$ V, $I_D = 45$ A, $R_G = 3.6$ $\Omega$ | $t_{d(off)}$ | - | 30 | 45 | |
| Fall time $V_{DD} = 30$ V, $V_{GS} = 4.5$ V, $I_D = 45$ A, $R_G = 3.6$ $\Omega$ | $t_f$ | - | 20 | 30 | |
| **Gate Charge Characteristics** | | | | | |
| Gate charge at threshold $V_{DD} = 40$ V, $I_D = 0.1$ A, $V_{GS} = 0$ to 1 V | $Q_{g(th)}$ | - | 2 | 3 | nC |
| Gate charge at 5.0 V $V_{DD} = 40$ V, $I_D = 45$ A, $V_{GS} = 0$ to 5 V | $Q_{g(5)}$ | - | 35 | 55 | |
| Gate charge total $V_{DD} = 40$ V, $I_D = 45$ A, $V_{GS} = 0$ to 10 V | $Q_{g(total)}$ | - | 60 | 90 | |
| Gate plateau voltage $V_{DD} = 40$ V, $I_D = 45$ A | $V_{(plateau)}$ | - | 4.5 | - | V |

## Electrical Characteristics

| Parameter | Symbol | Values | | | Unit |
|---|---|---|---|---|---|
| at $T_j$ = 25°C, unless otherwise specified | | **min.** | **typ.** | **max.** | |
| **Reverse Diode** | | | | | |
| Inverse diode continuous forward current $T_C$ = 25 °C | $I_S$ | 33 | - | - | A |
| Inverse diode direct current,pulsed $T_C$ = 25 °C | $I_{FM}$ | 180 | - | - | |
| Inverse diode forward voltage $V_{GS}$ = 0 V, $I_F$ = 90 A | $V_{SD}$ | - | 1.1 | 1.7 | V |
| Reverse recovery time $V_R$ = 30 V, $I_F$=$I_S$, d$i_F$/d$t$ = 100 A/µs | $t_{rr}$ | - | 75 | 115 | ns |
| Reverse recovery charge $V_R$ = 30 V, $I_F$=$I_S$, d$i_F$/d$t$ = 100 A/µs | $Q_{rr}$ | - | 0.15 | 0.25 | µC |

## Sensor Characteristics

For temperature sensing, i.e. temperature protection, please consider application note "Temperature sense concept - Speed TEMPFET".

For short circuit protection please consider application note "Short circuit behaviour of the Speed TEMPFET family".

All application notes are available at **http://www.infineon.com/tempfet/**

| Forward voltage $I_{AK(on)}$ = 5 mA, $T_j$ = -40...+150 °C $I_{AK(on)}$ = 1.5 mA, $T_j$ = 150 °C | $V_{AK(on)}$ | - - | 1.3 - | 1.4 0.9 | V |
|---|---|---|---|---|---|
| Sensor override $t_P$ = 100 µs, $T_j$ = -40...+150 °C | | - | - | 10 | |
| Forward current $T_j$ = -40...+150 °C | $I_{AK(on)}$ | - | - | 5 | mA |
| Sensor override $t_P$ = 100 µs, $T_j$ = -40...+150 °C | | - | - | 600 | |

## Electrical Characteristics

| Parameter | Symbol | Values | | | Unit |
|---|---|---|---|---|---|
| at $T_j$ = 25°C, unless otherwise specified | | min. | typ. | max. | |
| **Sensor Characteristics** | | | | | |
| Temperature sensor leakage current $T_j$ = 150 °C | $I_{AK(off)}$ | - | - | 4 | µA |
| Min. reset pulse duration [1] $T_j$ = -40...+150 °C, $I_{AK(on)}$ = 0.3 mA, $V_{AK(Reset)}$<0.5V | $t_{reset}$ | 100 | - | - | µs |
| $V_{AK}$ Recovery time[1][2] $T_j$ = -40...+150 °C, $I_{AK(on)}$ = 0.3 mA | $t_{recovery}$ | - | - | 150 | |

## Characteristics

| | | | | | |
|---|---|---|---|---|---|
| Holding current, $V_{AK(off)}$ = 5V | $I_{AK(hold)}$ | | | | mA |
| $T_j$ = 25 °C | | 0.05 | - | 0.5 | |
| $T_j$ = 150 °C | | 0.05 | - | 0.3 | |
| Thermal trip temperature $V_{TS}$ = 5V | $T_{TS(on)}$ | 150 | 160 | 170 | °C |
| Turn-off time (Pin G+A and K+S connected) $V_{TS}$ = 5V, $I_{TS(on)}$ = 2 mA | $t_{off}$ | 0.5 | - | 2.5 | µs |
| Reset voltage $T_j$ = -40...+150°C | $V_{AK(reset)}$ | 0.5 | - | - | V |

## Sensor recovery behaviour:
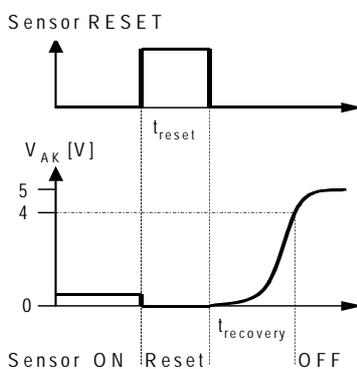


[1]See diagram Sensor recovery behaviour

[2]Time after reset pulse until $V_{AK}$ reaches 4V again

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## 1 Maximum allowable power dissipation

$P_{tot} = f(T_C)$
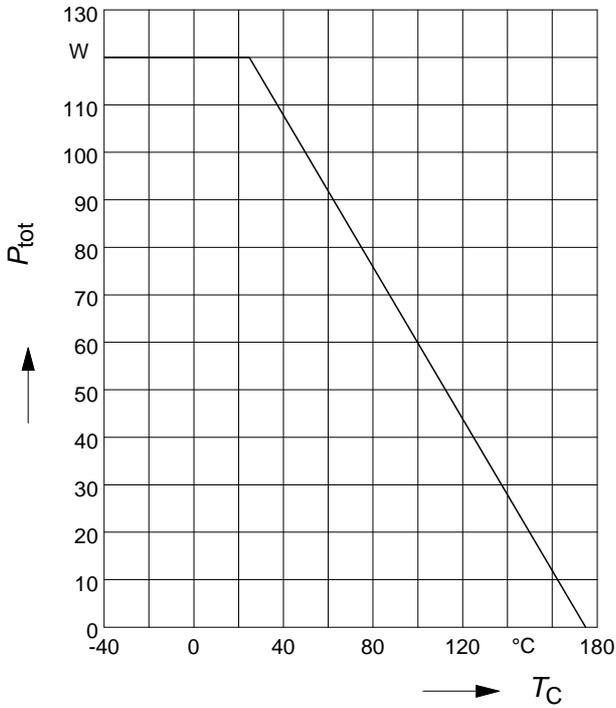
## 2 Drain current

$I_D = f(T_C)$; $V_{GS} \geq 4.5V$
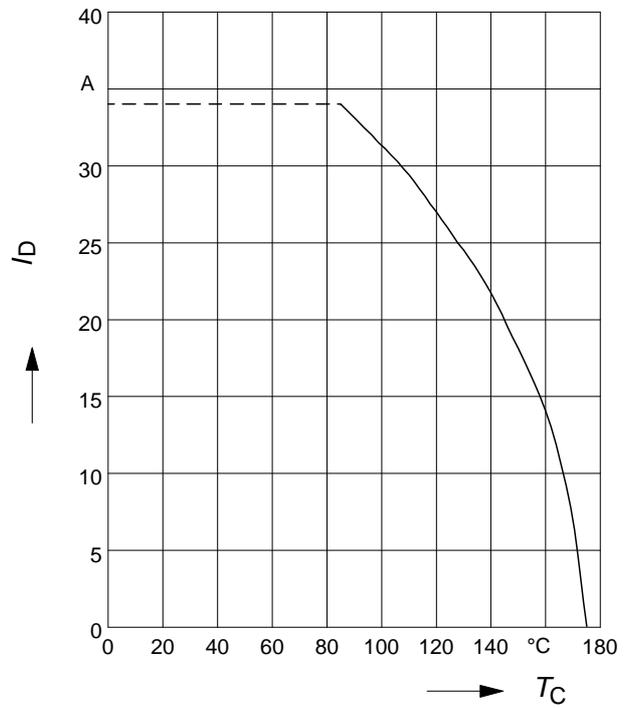


## 3 Typ. transient thermal impedance

$Z_{thJA} = f(t_p)$ @ 6 cm² cooling area

Parameter: $D = t_p/T$
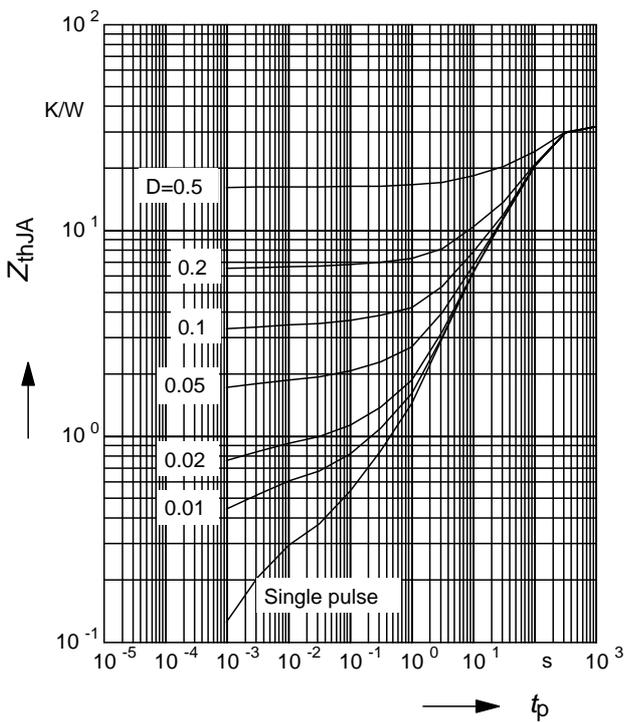
## 4 Transient thermal impedance

$Z_{thJC} = f(t_p)$

parameter : $D = t_p/T$

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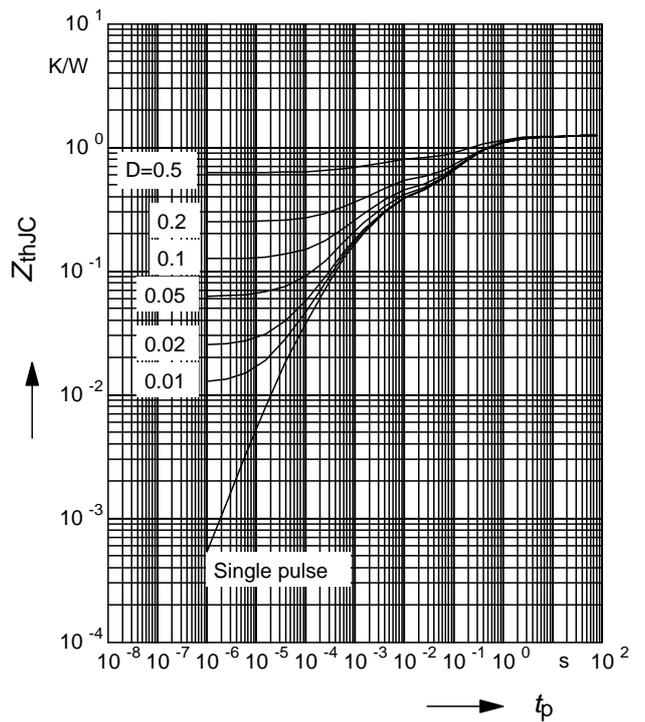
## 5 Safe operating area

$I_D$=f($V_{DS}$); $D$=0.01; $T_C$=25°C; $V_{GS}$=4.5V
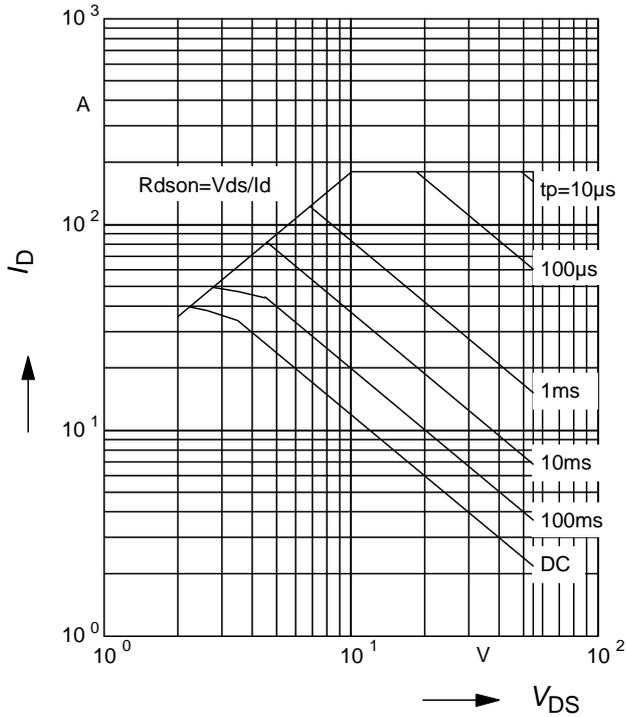


## 6 Typ. output characteristic

$I_D$ = f($V_{DS}$); $T_j$=25°C

Parameter: $V_{GS}$
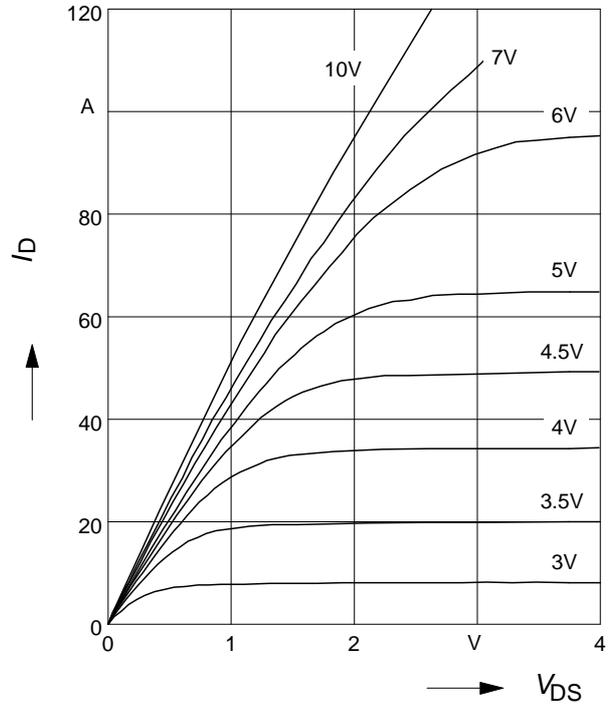


## 7 On-state resistance

$R_{ON}$ = f($T_j$); $I_D$=12A; $V_{GS}$ = 4.5V
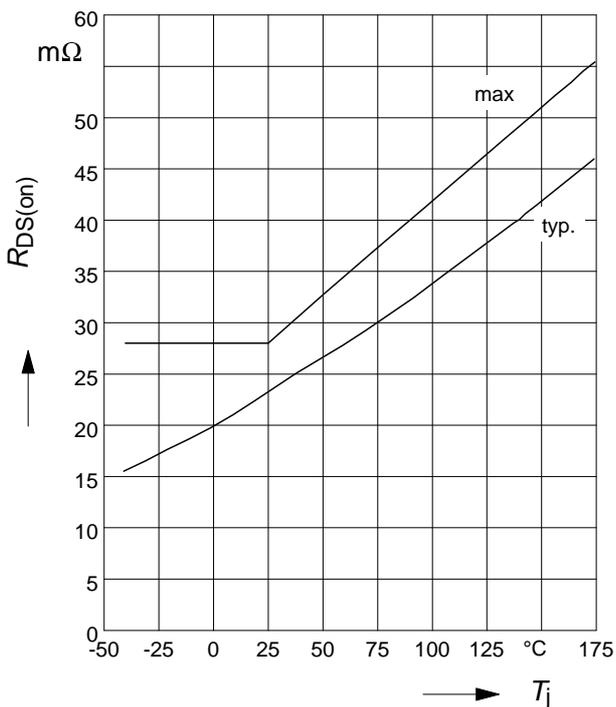


## 8 On-state resistance

$R_{ON}$ = f($T_j$); $I_D$=12A; $V_{GS}$ = 10V

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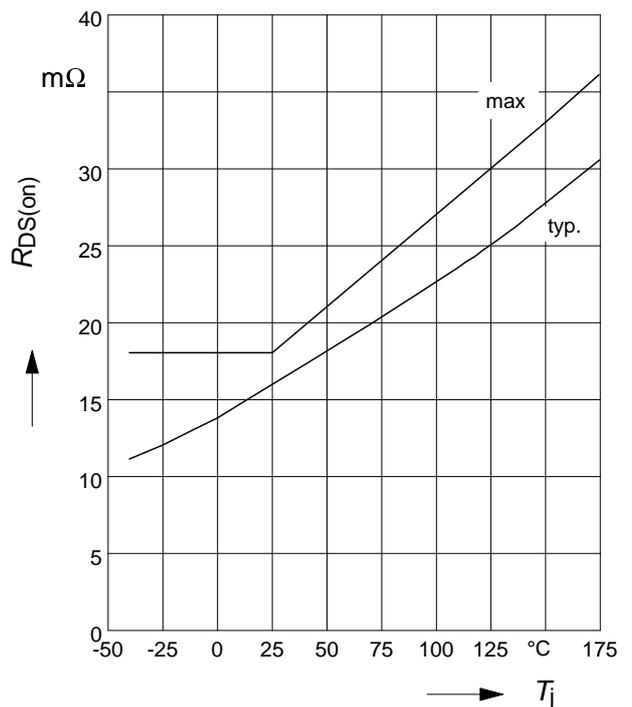
## 9 Typ. transfer characteristics

$I_D$ = f($V_{GS}$); $V_{DS}$ = 12V; $T_j$ = 25°C
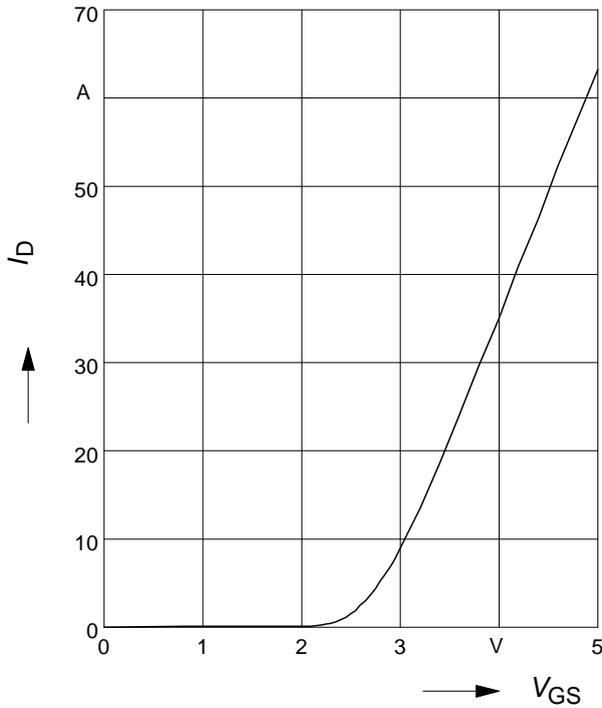


## 10 Typ. input threshold voltage

$V_{GS(th)}$ = f($T_j$); $V_{DS}$=$V_{GS}$

Parameter: $I_D$
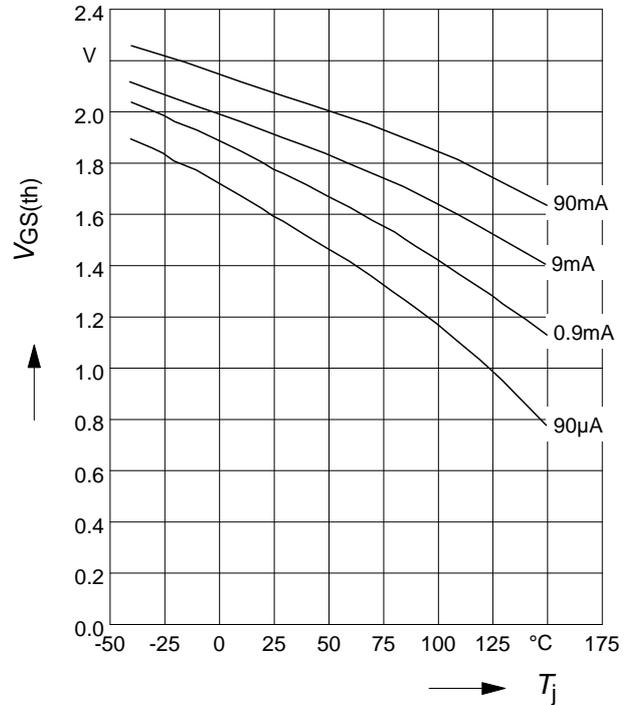


## 11 Typ. capacitances

$C$ = f($V_{DS}$); $V_{GS}$=0 V, $f$=1 MHz
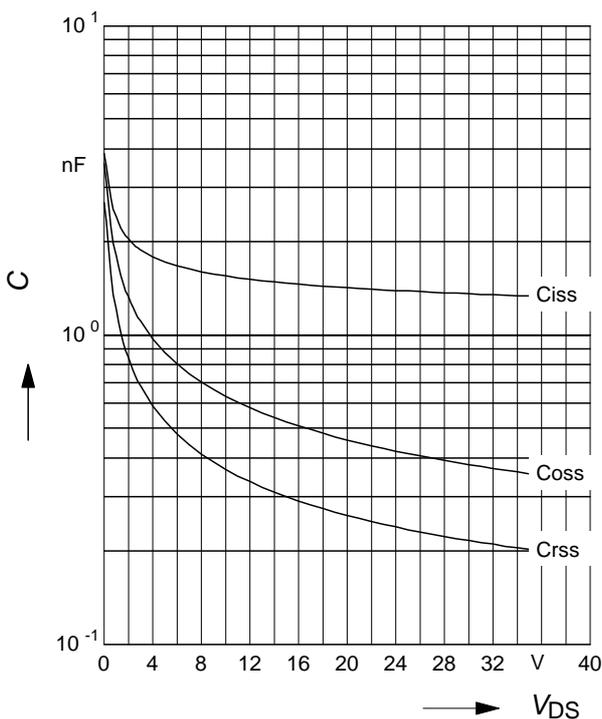


## 12 Typ. charcteristics of reverse diode $I_F$ = f($V_{SD}$)

$t_p$ = 80µs (spread); Parameter: $T_j$

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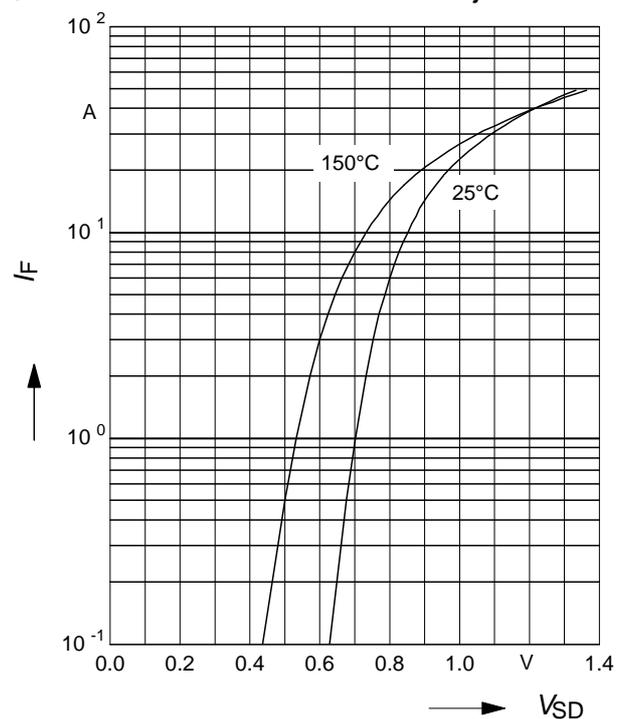
## 13 Typ. gate charge

$V_{GS} = f(Q_{Gate})$; $I_{D\,puls} = 45$ A

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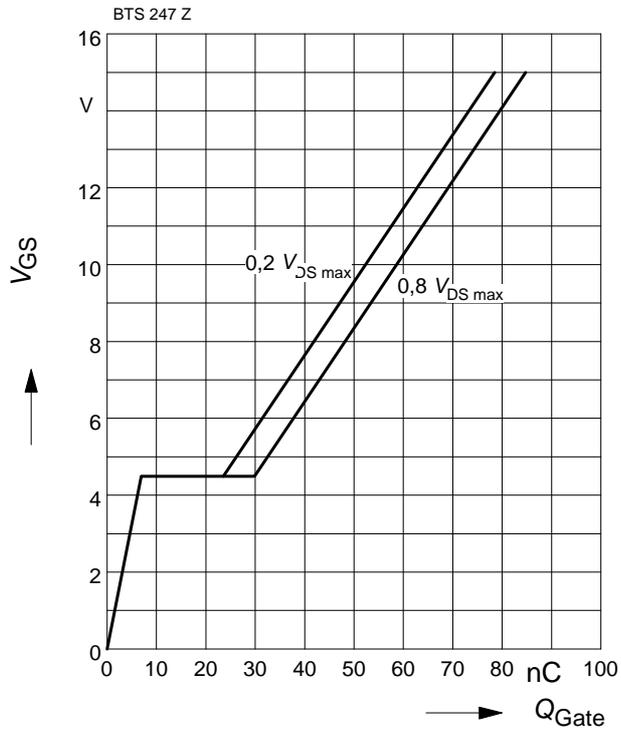


## 14 Drain-source break down voltage

$V_{(BR)DSS} = f(T_j)$
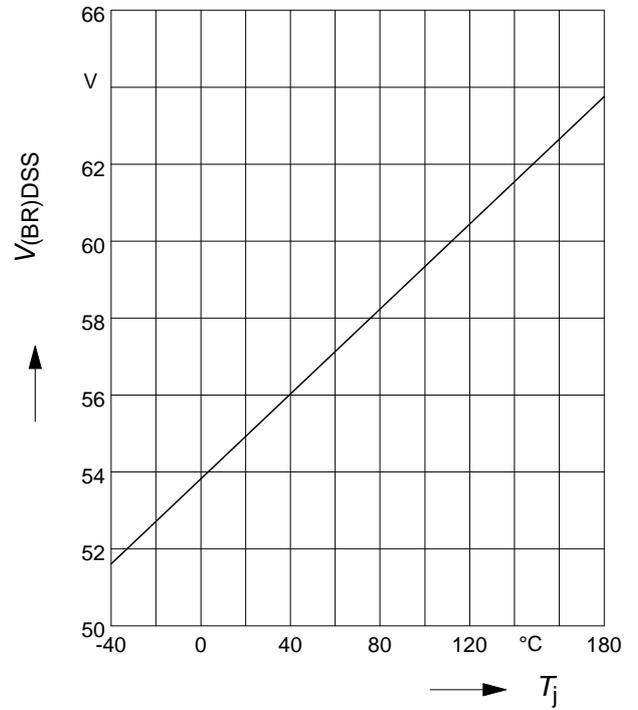
| Package | Ordering Code | Package | Ordering Code |
|---------|---------------|---------|---------------|
| P-TO220-5-3 | Q67060-S6001-A2 | P-TO220-5-62 | Q67060-S6002-A2 |



GPT05165

1) shear and punch direction no burrs this surface
2) min. length by tinning
3) max. 11 mm allowable by tinning



GPT05166
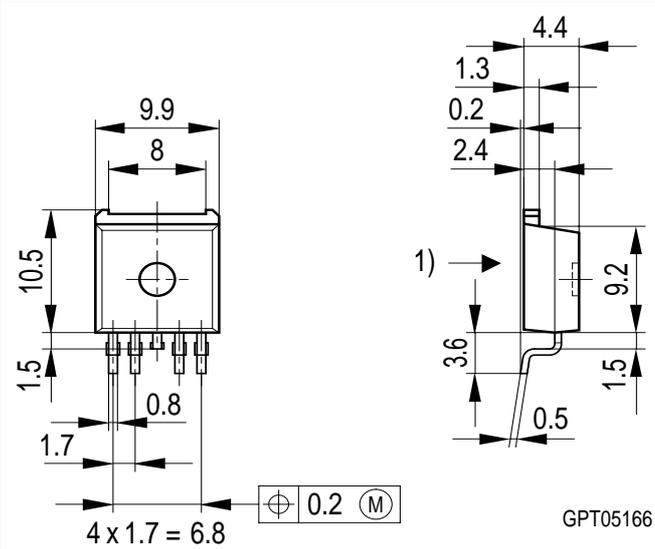
1) shear and punch direction no burrs this surface

| Package | Ordering Code |
|---------|---------------|
| TO-220-5-43 | Q67060-S6006 |



GPT05316
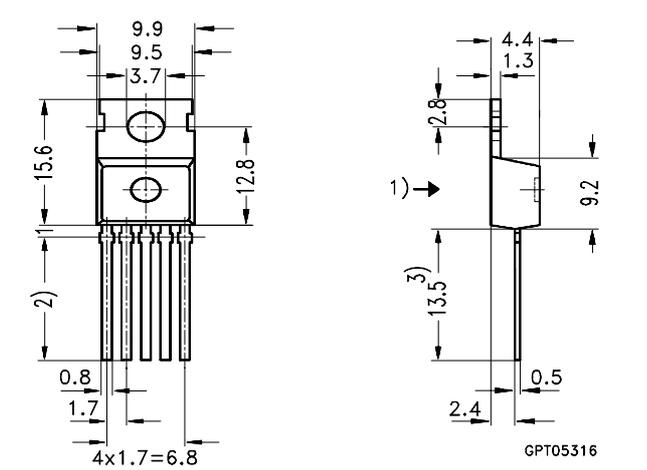
1) punch direction, burr max. 0.04
2) dip tinning
3) max. 14.5 by dip tinning press burr max. 0.05

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