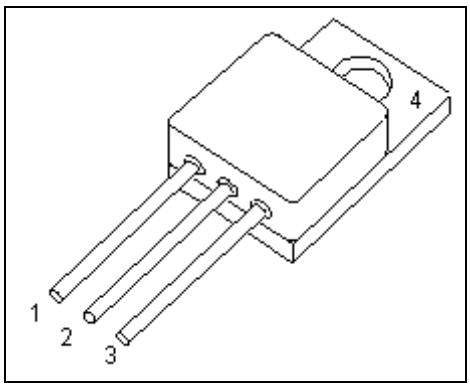
# 60V Radiation Hard power MOSFET

## BUY06CS45B-01(ES)




## Features

- Low $R_{DS(on)}$
- Single Event Effect (SEE) hardened
  LET 95, Range: 86µm (Pb) LET 62, Range: 73µm (Xe)
  $V_{GS}$ = -5V, $V_{DS}$ = 60V $V_{GS}$ = -15V, $V_{DS}$ = 60V
  $V_{GS}$ = -10V, $V_{DS}$ = 50V $V_{GS}$ = -20V, $V_{DS}$ = 40V
- Total Ionisation Dose (TID) hardened
  100 kRad approved (Level R)
- Hermetically sealed
- N-channel

## Product validation

- esa **Space Qualified**
  ESCC Detail Spec. No.: 5205/032
  Type Variant No. 04

## Description

**Table 1 Product information**

| Type | Comment | Pin Configuration | | | | Package |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | |
| BUY06CS45B-01(ES) | For flight use | D | G | S | Not connected | TO-254AA Low Ohmic |
| BUY06CS45B-01(P)[1] | Not for flight use[1] | | | | | |

[1] (P) parts have the same fit, form and function as (ES) parts,
no radiation hardness; no screening acc. to Chart F3 in ESCC Generic Specification No. 5000

## Table of contents

# 1 Maximum ratings

**Table 2 Maximum ratings**

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Drain source voltage | $V_{DS}$ | - | - | 60 | V | |
| Gate source voltage | $V_{GS}$ | -20 | - | 20 | V | static |
| Drain gate voltage | $V_{DG}$ | - | - | 60 | V | |
| Continuous drain current [1] | $I_D$ | -<br>- | -<br>- | 45<br>35 | A | $T_C$= 25 °C<br>$T_C$= 100 °C |
| Continuous source current | $I_S$ | - | - | 45 | A | |
| Drain current pulsed | $I_{DM}$ | - | - | 200 | Apk | $t_p$ limited by $T_{j,max}$ |
| Total power dissipation [2] | $P_{tot}$ | - | - | 208 | W | $T_C \leq 25$ °C |
| Operating and storage temperature | $T_{op}$ | -55 | - | 150 | °C | |
| Avalanche energy | $E_{AS}$ | - | - | 900 | mJ | |

[1] Limited by package

[2] For $T_C > 25$°C derating is required.

# 2 Thermal characteristics

**Table 3 Thermal characteristics**

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Thermal resistance, junction - case | $R_{th,JC}$ | - | - | 0.6 | K/W | |
| Soldering temperature | $T_{sol}$ | - | - | 250 | °C | Duration 10 seconds maximum and the same terminal shall not be resoldered until 3 minutes have elapsed. |

# 3 Electrical characteristics

at $T_A$=25°C, unless otherwise specified

**Table 4 Static characteristics**

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Drain-source breakdown voltage | $BV_{DSS}$ | 60 | - | - | V | $I_D$= 0.25mA, $V_{GS}$= 0V |
| Temperature coefficiend of $BV_{DSS}$ | $\Delta BV_{DSS}/\Delta T_J$ | - | 0.08 | - | V/°C | |
| Gate threshold voltage | $V_{GS(th)}$ | 2<br>1.5<br>- | -<br>-<br>- | 4<br>-<br>5 | V | $I_D$= 1.0mA, $V_{DS} \geq V_{GS}$, $T_A$= 25°C<br>$I_D$= 1.0mA, $V_{DS} \geq V_{GS}$, $T_A$= 125°C<br>$I_D$= 1.0mA, $V_{DS} \geq V_{GS}$, $T_A$= -55°C |
| Gate to source leakage current | $I_{GSS}$ | -100<br>-200 | -<br>- | 100<br>200 | nA | $V_{DS}$= 0V, $V_{GS}$= +/- 20V, $T_A$= 25°C<br>$V_{DS}$= 0V, $V_{GS}$= +/- 20V, $T_A$= 125°C |
| Zero gate voltage drain current | $I_{DSS}$ | -<br>- | -<br>- | 25<br>250 | µA | $V_{DS}$= 48V, $V_{GS}$= 0V, $T_A$= 25°C<br>$V_{DS}$= 48V, $V_{GS}$= 0V, $T_A$= 125°C |
| Drain source on-state resistance [1] | $R_{DS(ON)}$ | -<br>- | 13.5<br>- | 15<br>24 | mΩ | $V_{GS}$= 10V, $I_D$= 35A, $T_A$= 25°C<br>$V_{GS}$= 10V, $I_D$= 35A, $T_A$= 125°C |
| Diode forward voltage [1,2] | $V_{SD}$ | - | - | 1.2 | V | $V_{GS}$= 0V, $I_S$= 45A |

**Table 5 Dynamic characteristics**

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Turn-on delay time | $t_{d(ON)}$ | - | 23 | 30 | ns | $V_{DD}$= 50% $V_{DS}$, $I_D$= 35A, $R_G$= 4.7Ω |
| Rise time | $t_r$ | - | 25 | 40 | ns | $V_{DD}$= 50% $V_{DS}$, $I_D$= 35A, $R_G$= 4.7Ω |
| Turn-off delay time | $t_{d(OFF)}$ | - | 42 | 55 | ns | $V_{DD}$= 50% $V_{DS}$, $I_D$= 35A, $R_G$= 4.7Ω |
| Fall time | $t_f$ | - | 20 | 30 | ns | $V_{DD}$= 50% $V_{DS}$, $I_D$= 35A, $R_G$= 4.7Ω |
| Reverse recovery time | $t_{rr}$ | - | 270 | 300 | ns | $V_{DD} \leq$ 50V, $I_D$= 45A |
| Common source input capacitance | $C_{iss}$ | 4.5 | 4.75 | 5.0 | nF | $V_{DS}$= 40V, $V_{GS}$= 0V, $f$= 1.0MHz |
| Common source output capacitance | $C_{oss}$ | 1250 | 1500 | 1750 | pF | $V_{DS}$= 40V, $V_{GS}$= 0V, $f$= 1.0MHz |
| Common source reverse transfer capacitance | $C_{rss}$ | 230 | 270 | 310 | pF | $V_{DS}$= 40V, $V_{GS}$= 0V, $f$= 1.0MHz |
| Gate resistance | $R_G$ | | 0.8 | | Ω | $f$= 1.0MHz, open drain |
| Total gate charge | $Q_G$ | - | 75 | 85 | nC | $V_{DD}$= 50% $V_{DS}$, $V_{GS}$= 10V, $I_D$= 45A |

[1] Pulsed measurement: Pulse Width < 300µs, Duty Cycle <2.0%.

[2] Measured within 2.0 mm of case

# 4 Radiation characteristics

Infineon radiation hard power MOSFETs are tested to verify their radiation hardness capability. Every manufacturing wafer lot is tested for total dose steady-state irradiation according to the ESCC Basic Specification No. 22900. The following bias condition is used during irradiation testing:

- $V_{GS}$ = +15V
- $V_{DS}$= 0V

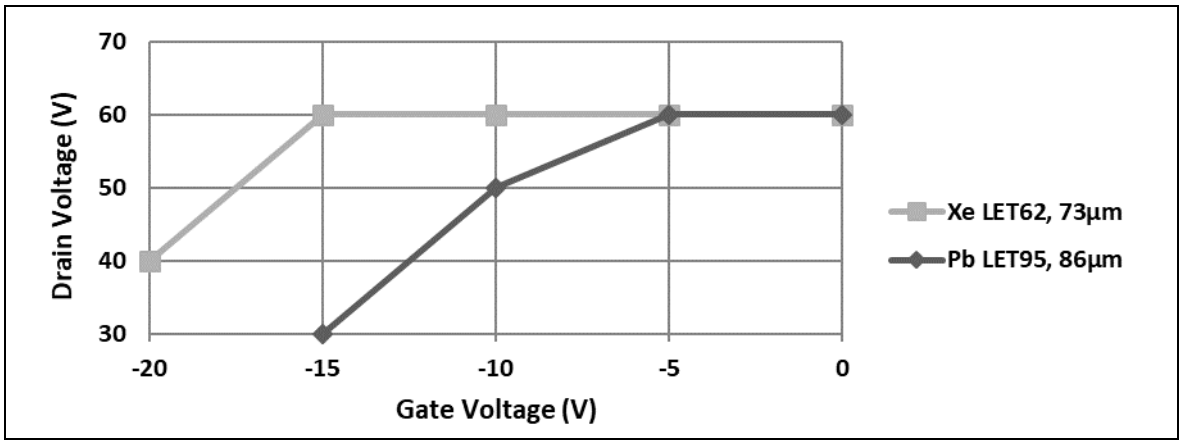
**Table 6 Electrical characteristics at $T_A$=25°C, post Total Dose Irradiation**

| Parameter | Symbol | 100 kRad(Si) | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Drift Values | Absolute | | | |
| | | | Min. | Max. | | |
| Drain-source breakdown voltage | $BV_{DSS}$ | ± 20% | 60 | - | V | $I_D$= 0.25mA, $V_{GS}$= 0V |
| Gate threshold voltage | $V_{GS(th)}$ | +10%, -50% | 2 | 4 | V | $I_D$= 1.0mA, $V_{DS} \geq V_{GS}$ |
| Gate to source leakage current | $I_{GSS}$ | ± 20% | -100 | 100 | nA | $V_{DS}$= 0V, $V_{GS}$= +/- 20V |
| Zero gate voltage drain current | $I_{DSS}$ | - | - | 25 | µA | $V_{DS}$= 48V, $V_{GS}$= 0V |
| Drain source on-state resistance [1] | $R_{DS(ON)}$ | ± 20% | - | 15 | mΩ | $V_{GS}$= 10V, $I_D$= 35A |
| Diode forward voltage [1,2] | $V_{SD}$ | ± 10% | - | 1.2 | V | $V_{GS}$= 0V, $I_S$= 45A |

Infineon radiation hard power MOSFETs have been characterized in heavy ion environments for Single Event Effects (SEE) according to the ESCC Basic Specification No. 25100

**Table 7 Typical Single Event Effect safe operating area**

| Ion | LET [MeV/(mg/cm²)] | Range [µm] | $V_{DS}$ [V] | | | | |
|---|---|---|---|---|---|---|---|
| | | | $V_{GS}$= 0V | $V_{GS}$= -5V | $V_{GS}$= -10V | $V_{GS}$= -15V | $V_{GS}$= -20V |
| Xe | 62 ± 5% | 73 ± 5% | 60 | 60 | 60 | 60 | 40 |
| Pb | 95 ± 5% | 86 ± 5% | 60 | 60 | 50 | 30 | - |

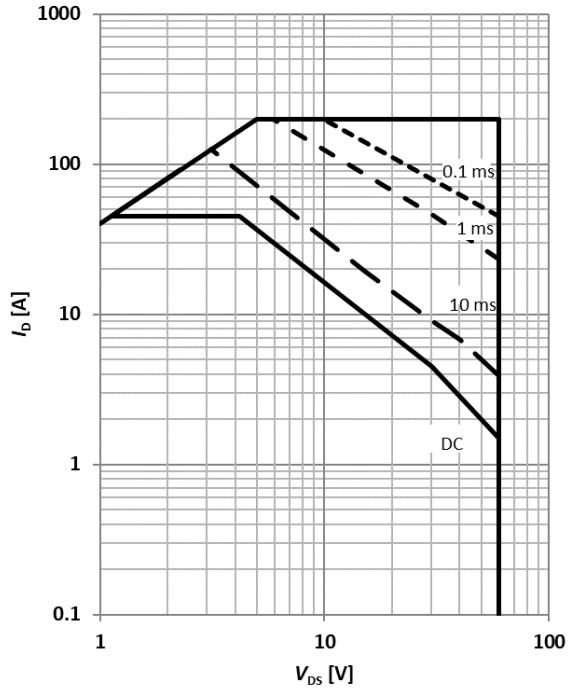



[1] Pulsed measurement: Pulse Width < 300µs, Duty Cycle <2.0%.

[2] Measured within 2.0 mm of case

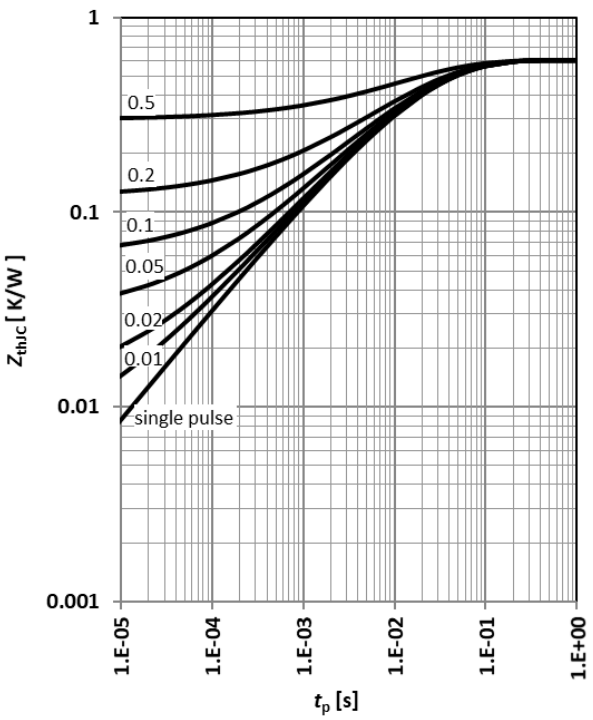
# 5 Electrical characteristics diagrams

**Diagram 1: Safe operating area**



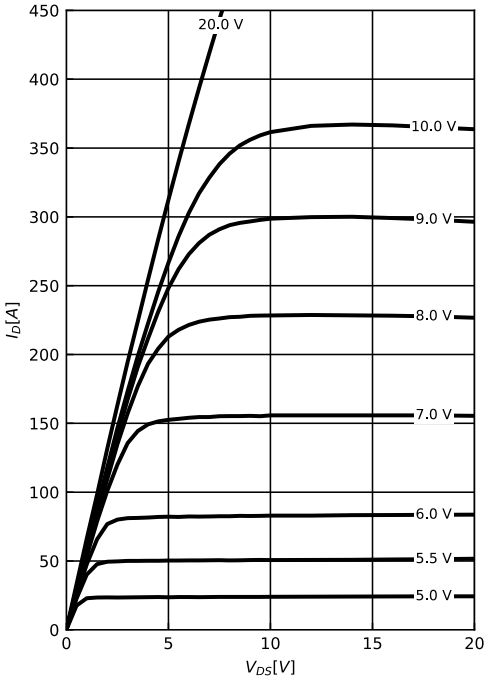

$I_D = f(V_{DS})$; $T_C = 25°C$; D=0; parameter: $t_p$

**Diagram 2: Max. transient thermal impedance**



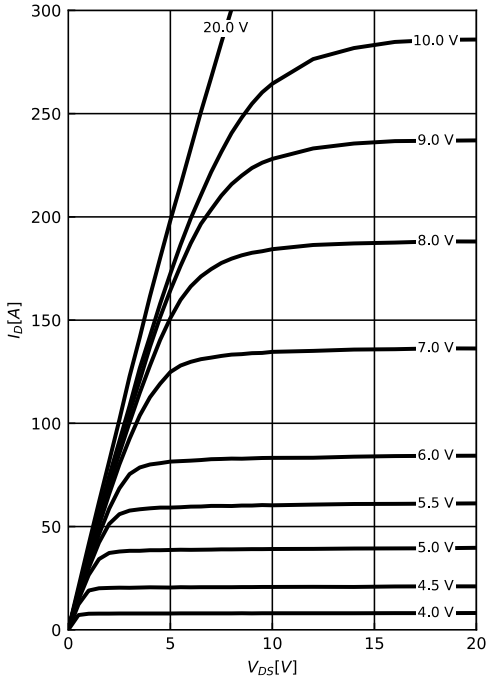

$Z_{thJC} = f(t_p)$; parameter: $D = t_p/T$

**Diagram 3: Typ. output characteristics**

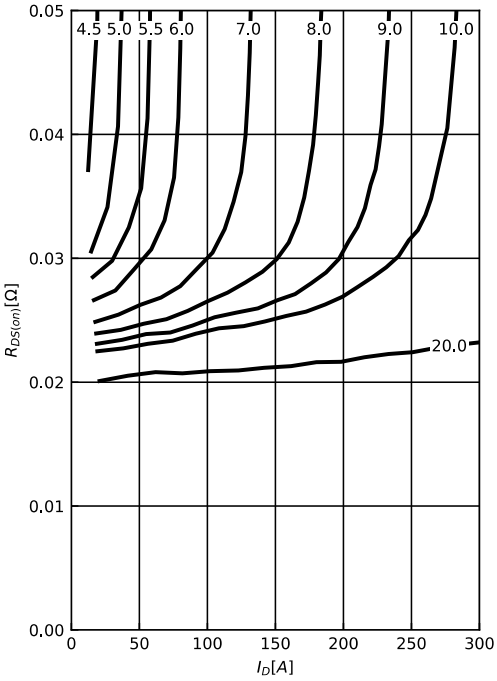
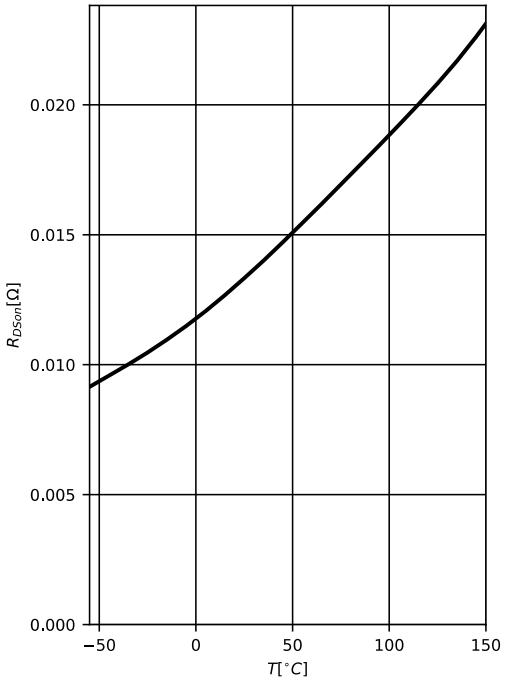



$I_D = f(V_{DS})$; $T_j = 25$ °C; parameter: $V_{GS}$

**Diagram 4: Typ. output characteristics**




$I_D = f(V_{DS})$; $T_j = 150$ °C; parameter: $V_G$

| Diagram 5: Typ. drain-source on-state resistance | Diagram 6: Typ. drain-source on-state resistance |
|---|---|
|  |  |
| $R_{DS(on)}$ = f($I_D$); $T_j$ = 150 °C; parameter: $V_{GS}$ | $R_{DS(on)}$ = f($T_j$); $I_D$=35A |

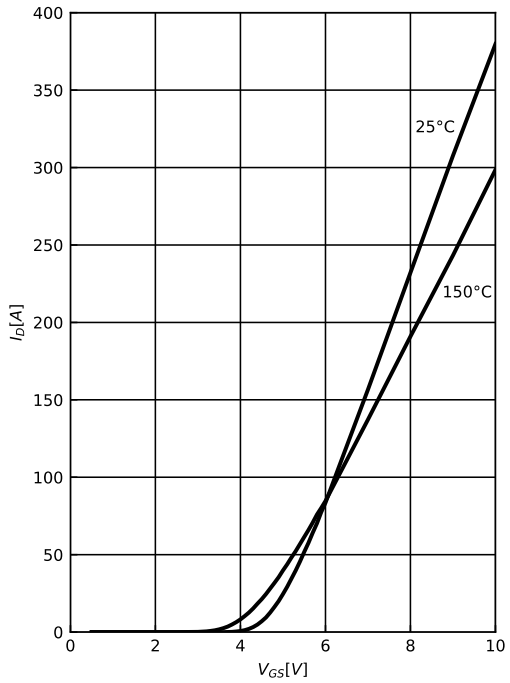
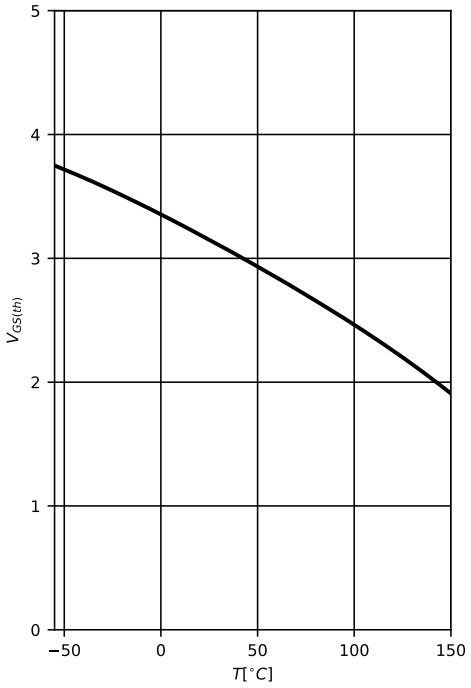
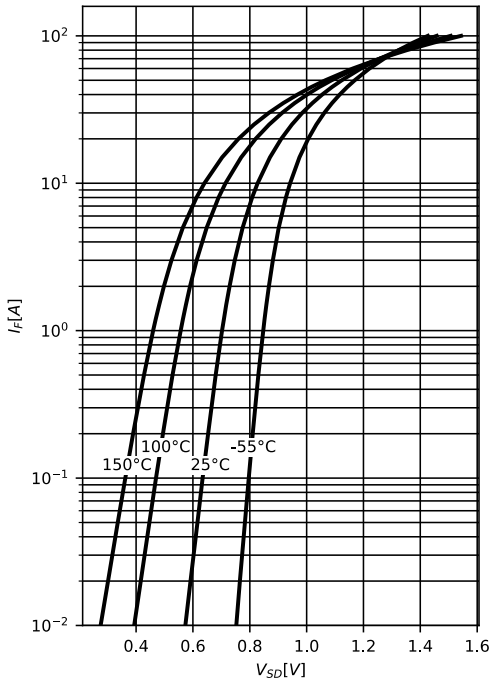
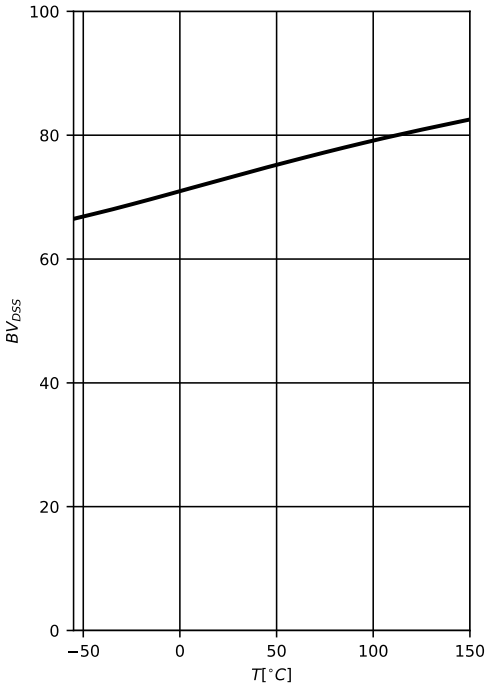
| Diagram 7: Typ. transfer characteristics | Diagram 8: Typ. gate threshold voltage |
|---|---|
|  |  |
| $I_D$ = f($V_{GS}$); $V_{DS}$ = 20V; parameter: $T_j$ | $I_D$=f($T_j$); $I_D$ = 1mA |

**Diagram 9: Forward characteristics of reverse diode**



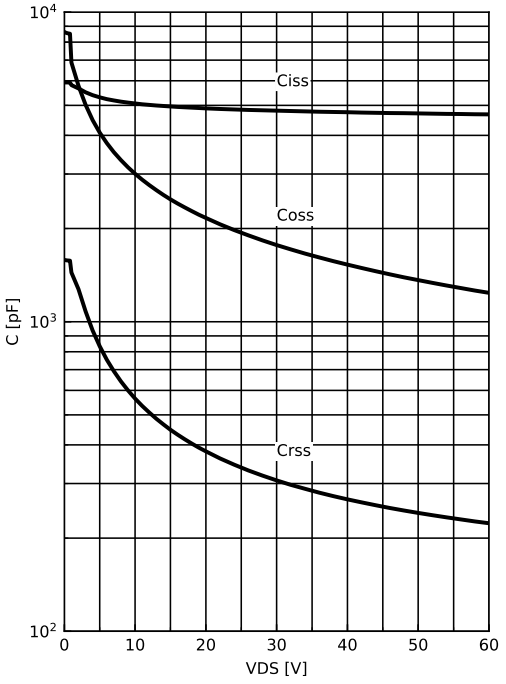

$I_F = f(V_{SD})$; parameter: $T_j$

**Diagram 10: Drain-source breakdown voltage**



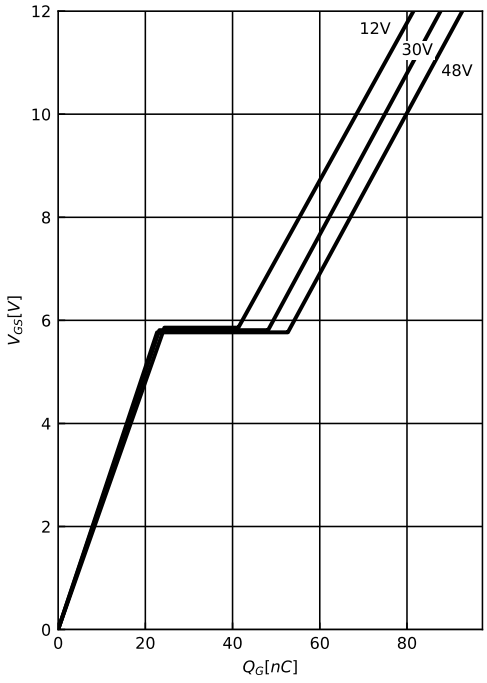

$BV_{DSS} = f(T_j)$; $I_D = 250\mu A$

**Diagram 11: Typ. capacitances**



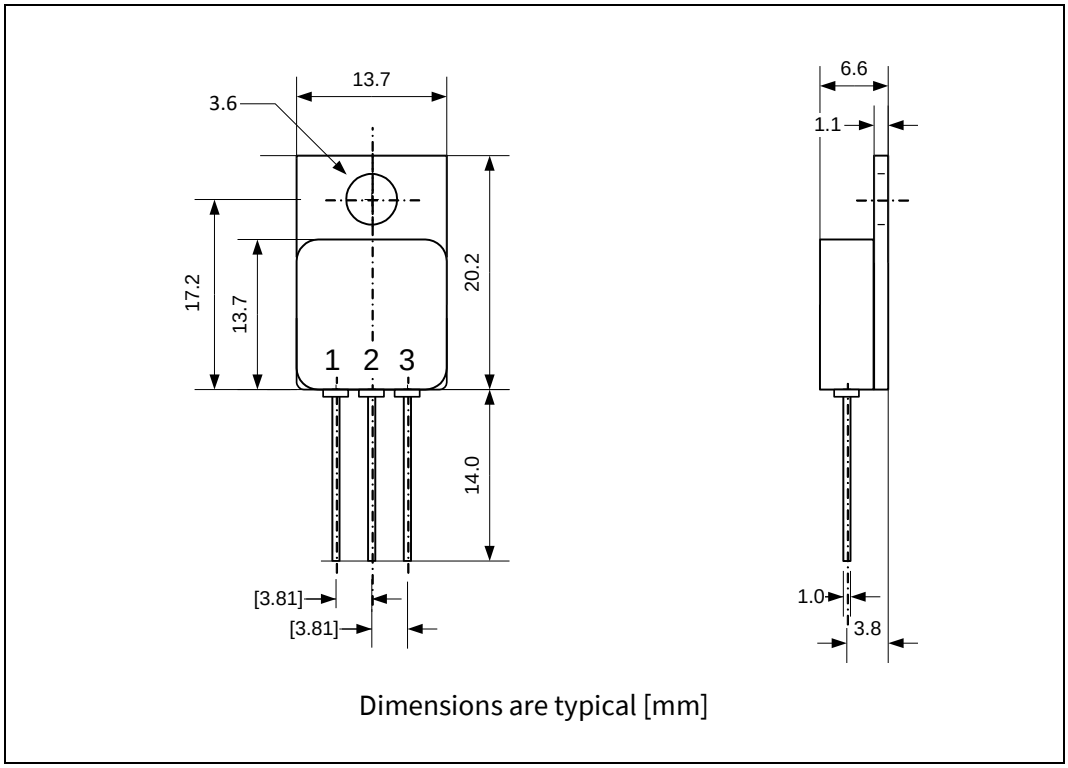

$C = f(V_{DS})$; $V_{GS} = 0$ V; $f = 1$ MHz

**Diagram 12: Typ. gate charge**




$V_{GS} = f(Q_{gate})$; $I_D = 45.0$ A pulsed; parameter: $V_{DD}$

# 6 Package outlines




Dimensions are typical [mm]

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