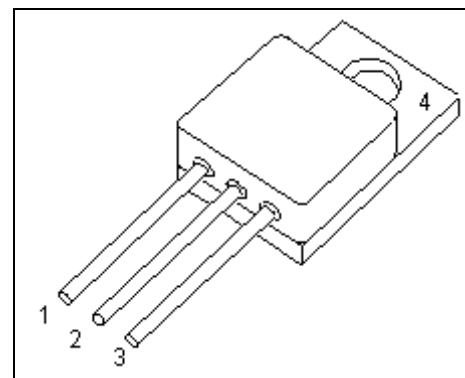


# 60V Radiation Hard power MOSFET

## BUY06CS23K-01(ES)

### Features

- Low  $R_{DS(on)}$
- Single Event Effect (SEE) hardened  
 LET 95, Range: 86 $\mu$ m (Pb)      LET 62, Range: 73 $\mu$ m (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. 03

### Description

**Table 1**      **Product information**

| Type                          | Comment                         | Pin Configuration |   |   |               | Package  |
|-------------------------------|---------------------------------|-------------------|---|---|---------------|----------|
|                               |                                 | 1                 | 2 | 3 | 4             |          |
| BUY06CS23K-01(ES)             | For flight use                  | D                 | S | G | Not connected | TO-257AA |
| BUY06CS23K-01(P) <sup>1</sup> | Not for flight use <sup>1</sup> |                   |   |   |               |          |

<sup>1</sup> (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

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## Maximum ratings

# 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 <sup>1</sup> | $I_D$     | -      | -    | 23<br>19 | A    | $T_C = 25\text{ °C}$<br>$T_C = 100\text{ °C}$ |
| Continuous source current             | $I_S$     | -      | -    | 23       | A    |                                               |
| Drain current pulsed                  | $I_{DM}$  | -      | -    | 100      | Apk  | $t_p$ limited by $T_{j,max}$                  |
| Total power dissipation <sup>2</sup>  | $P_{tot}$ | -      | -    | 75       | W    | $T_C \leq 25\text{ °C}$                       |
| Operating and storage temperature     | $T_{op}$  | -55    | -    | 150      | °C   |                                               |
| Avalanche energy                      | $E_{AS}$  | -      | -    | 200      | mJ   |                                               |

<sup>1</sup> Limited by package<sup>2</sup> For  $T_C > 25\text{ °C}$  derating is required.

## 2 Thermal characteristics

**Table 3 Thermal characteristics**

| Parameter                           | Symbol      | Values |      |      | Unit | Note / Test Condition                                                                                   |
|-------------------------------------|-------------|--------|------|------|------|---------------------------------------------------------------------------------------------------------|
|                                     |             | Min.   | Typ. | Max. |      |                                                                                                         |
| Thermal resistance, junction - case | $R_{th,JC}$ | -      | -    | 1.66 | 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. |

## Electrical characteristics

## 3 Electrical characteristics

at  $T_A=25^\circ\text{C}$ , 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                   | $I_D = 0.25\text{mA}$ , $V_{GS} = 0\text{V}$                                 |
| Temperature coefficient of $BV_{DSS}$         | $\Delta BV_{DSS}/\Delta T_J$ | -      | 0.08 | -    | V/ $^\circ\text{C}$ |                                                                              |
| Gate threshold voltage                        | $V_{GS(th)}$                 | 2      | -    | 4    | V                   | $I_D = 1.0\text{mA}$ , $V_{DS} \geq V_{GS}$ , $T_A = 25^\circ\text{C}$       |
|                                               |                              | 1.5    | -    | -    |                     | $I_D = 1.0\text{mA}$ , $V_{DS} \geq V_{GS}$ , $T_A = 125^\circ\text{C}$      |
|                                               |                              | -      | -    | 5    |                     | $I_D = 1.0\text{mA}$ , $V_{DS} \geq V_{GS}$ , $T_A = -55^\circ\text{C}$      |
| Gate to source leakage current                | $I_{GSS}$                    | -100   | -    | 100  | nA                  | $V_{DS} = 0\text{V}$ , $V_{GS} = \pm 20\text{V}$ , $T_A = 25^\circ\text{C}$  |
|                                               |                              | -200   | -    | 200  |                     | $V_{DS} = 0\text{V}$ , $V_{GS} = \pm 20\text{V}$ , $T_A = 125^\circ\text{C}$ |
| Zero gate voltage drain current               | $I_{DSS}$                    | -      | -    | 25   | $\mu\text{A}$       | $V_{DS} = 48\text{V}$ , $V_{GS} = 0\text{V}$ , $T_A = 25^\circ\text{C}$      |
|                                               |                              | -      | -    | 250  |                     | $V_{DS} = 48\text{V}$ , $V_{GS} = 0\text{V}$ , $T_A = 125^\circ\text{C}$     |
| Drain source on-state resistance <sup>1</sup> | $R_{DS(ON)}$                 | -      | 36   | 40   | m $\Omega$          | $V_{GS} = 10\text{V}$ , $I_D = 19\text{A}$ , $T_A = 25^\circ\text{C}$        |
|                                               |                              | -      | -    | 65   |                     | $V_{GS} = 10\text{V}$ , $I_D = 19\text{A}$ , $T_A = 125^\circ\text{C}$       |
| Diode forward voltage <sup>1,2</sup>          | $V_{SD}$                     | -      | -    | 1.3  | V                   | $V_{GS} = 0\text{V}$ , $I_S = 23\text{A}$                                    |

Table 5 Dynamic characteristics

| Parameter                                  | Symbol       | Values |      |      | Unit     | Note / Test Condition                                               |
|--------------------------------------------|--------------|--------|------|------|----------|---------------------------------------------------------------------|
|                                            |              | Min.   | Typ. | Max. |          |                                                                     |
| Turn-on delay time                         | $t_{d(ON)}$  | -      | 12   | 18   | ns       | $V_{DD} = 50\% V_{DS}$ , $I_D = 19\text{A}$ , $R_G = 4.7\Omega$     |
| Rise time                                  | $t_r$        | -      | 11   | 20   | ns       | $V_{DD} = 50\% V_{DS}$ , $I_D = 19\text{A}$ , $R_G = 4.7\Omega$     |
| Turn-off delay time                        | $t_{d(OFF)}$ | -      | 19   | 28   | ns       | $V_{DD} = 50\% V_{DS}$ , $I_D = 19\text{A}$ , $R_G = 4.7\Omega$     |
| Fall time                                  | $t_f$        | -      | 7    | 12   | ns       | $V_{DD} = 50\% V_{DS}$ , $I_D = 19\text{A}$ , $R_G = 4.7\Omega$     |
| Reverse recovery time                      | $t_{rr}$     | -      | 200  | 220  | ns       | $V_{DD} \leq 50\text{V}$ , $I_D = 23\text{A}$                       |
| Common source input capacitance            | $C_{iss}$    | 1.5    | 1.6  | 1.7  | nF       | $V_{DS} = 40\text{V}$ , $V_{GS} = 0\text{V}$ , $f = 1.0\text{MHz}$  |
| Common source output capacitance           | $C_{oss}$    | 450    | 530  | 600  | pF       | $V_{DS} = 40\text{V}$ , $V_{GS} = 0\text{V}$ , $f = 1.0\text{MHz}$  |
| Common source reverse transfer capacitance | $C_{rss}$    | 75     | 90   | 105  | pF       | $V_{DS} = 40\text{V}$ , $V_{GS} = 0\text{V}$ , $f = 1.0\text{MHz}$  |
| Gate resistance                            | $R_G$        | -      | 1.2  | -    | $\Omega$ | $f = 1.0\text{MHz}$ , open drain                                    |
| Total gate charge                          | $Q_G$        | -      | 26   | 28   | nC       | $V_{DD} = 50\% V_{DS}$ , $V_{GS} = 10\text{V}$ , $I_D = 23\text{A}$ |

<sup>1</sup> Pulsed measurement: Pulse Width < 300 $\mu\text{s}$ , Duty Cycle < 2.0%.<sup>2</sup> 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:

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

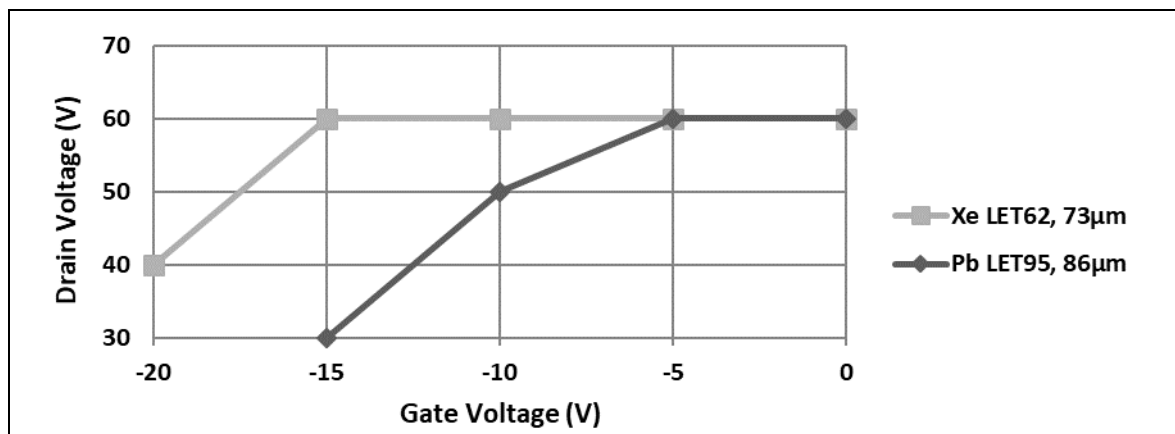
**Table 6 Electrical characteristics at  $T_A=25^{\circ}C$ , post Total Dose Irradiation**

| Parameter                                     | Symbol       | 100 kRad(Si) |          |      | Unit       | Note / Test Condition            |
|-----------------------------------------------|--------------|--------------|----------|------|------------|----------------------------------|
|                                               |              | Drift Values | Absolute |      |            |                                  |
|                                               |              |              | Min.     | Max. |            |                                  |
| Drain-source breakdown voltage                | $BV_{DSS}$   | $\pm 20\%$   | 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                | $I_{GSS}$    | $\pm 20\%$   | -100     | 100  | nA         | $V_{DS}= 0V, V_{GS}= +/- 20V$    |
| Zero gate voltage drain current               | $I_{DSS}$    | -            | -        | 25   | $\mu A$    | $V_{DS}= 48V, V_{GS}= 0V$        |
| Drain source on-state resistance <sup>1</sup> | $R_{DS(ON)}$ | $\pm 20\%$   | -        | 40   | m $\Omega$ | $V_{GS}= 10V, I_D= 19A$          |
| Diode forward voltage <sup>1,2</sup>          | $V_{SD}$     | $\pm 10\%$   | -        | 1.3  | V          | $V_{GS}= 0V, I_S= 23A$           |

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<br>[MeV/(mg/cm <sup>2</sup> )] | Range [ $\mu m$ ] | $V_{DS}$ [V]  |                |                 |                 |                 |
|-----|------------------------------------|-------------------|---------------|----------------|-----------------|-----------------|-----------------|
|     |                                    |                   | $V_{GS} = 0V$ | $V_{GS} = -5V$ | $V_{GS} = -10V$ | $V_{GS} = -15V$ | $V_{GS} = -20V$ |
| Xe  | $62 \pm 5\%$                       | $73 \pm 5\%$      | 60            | 60             | 60              | 60              | 40              |
| Pb  | $95 \pm 5\%$                       | $86 \pm 5\%$      | 60            | 60             | 50              | 30              | -               |



<sup>1</sup> Pulsed measurement: Pulse Width < 300μs, Duty Cycle < 2.0%.

<sup>2</sup> Measured within 2.0 mm of case

## 5 Electrical characteristics diagrams

Diagram 1: Safe operating area

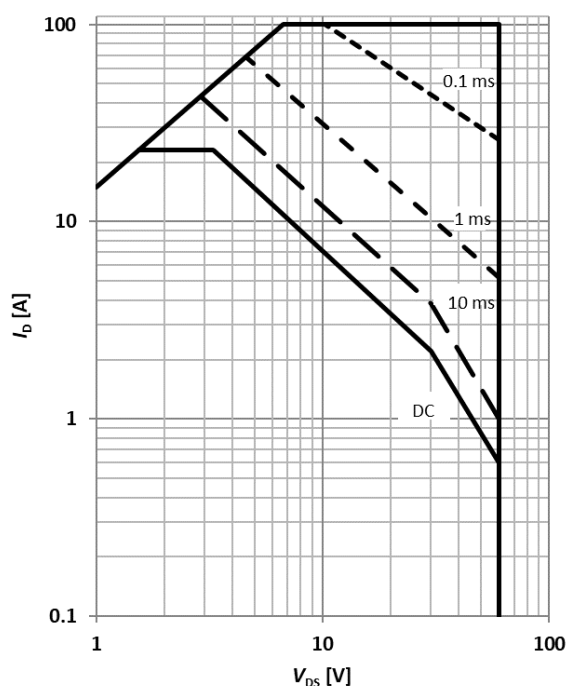

 $I_D = f(V_{DS}); T_C = 25^\circ\text{C}; D=0; \text{parameter: } t_p$ 

Diagram 2: Max. transient thermal impedance

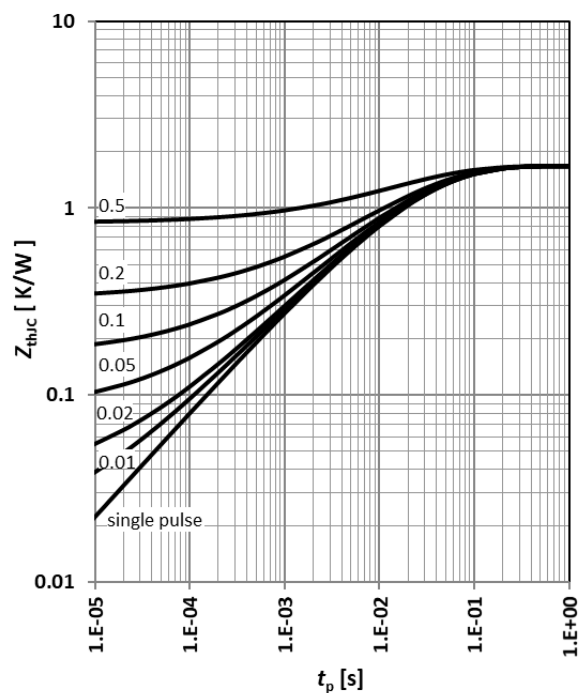

 $Z_{thJC} = f(t_p); \text{parameter: } D = t_p/T$ 

Diagram 3: Typ. output characteristics

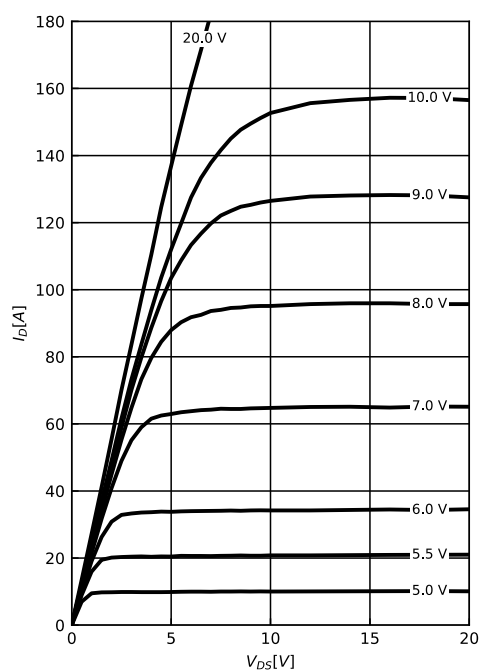
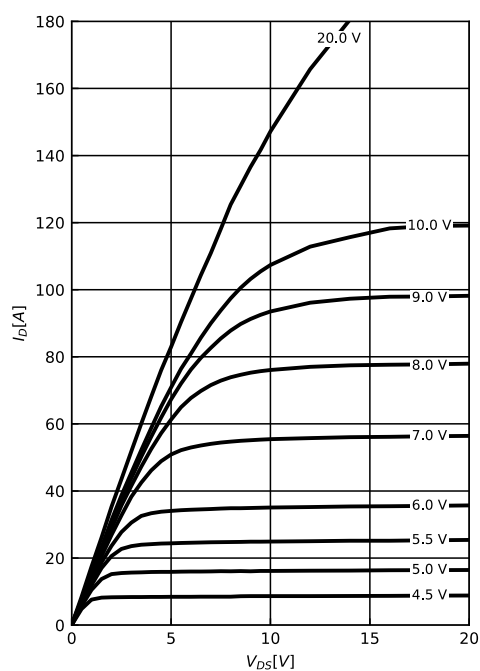
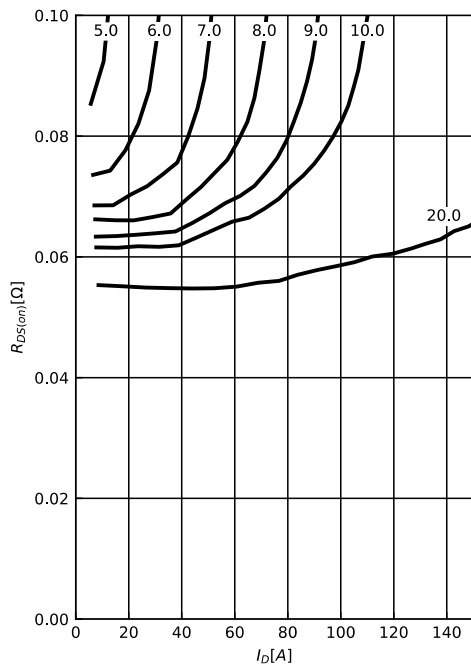

 $I_D = f(V_{DS}); T_J = 25^\circ\text{C}; \text{parameter: } V_{GS}$ 

Diagram 4: Typ. output characteristics


 $I_D = f(V_{DS}); T_J = 150^\circ\text{C}; \text{parameter: } V_G$

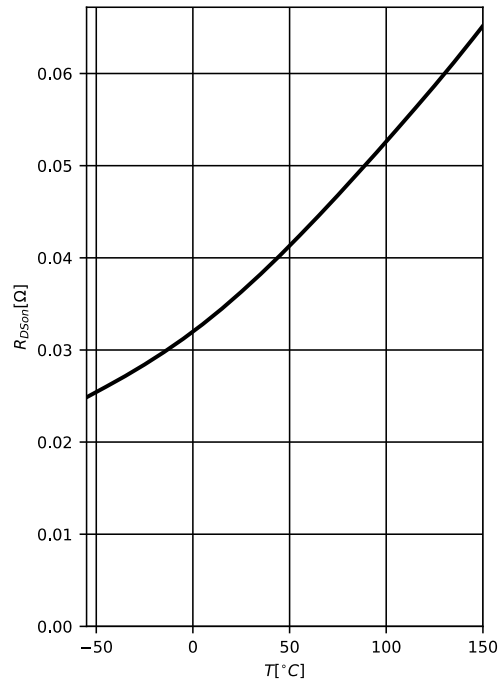
Electrical characteristics diagrams

Diagram 5: Typ. drain-source on-state resistance



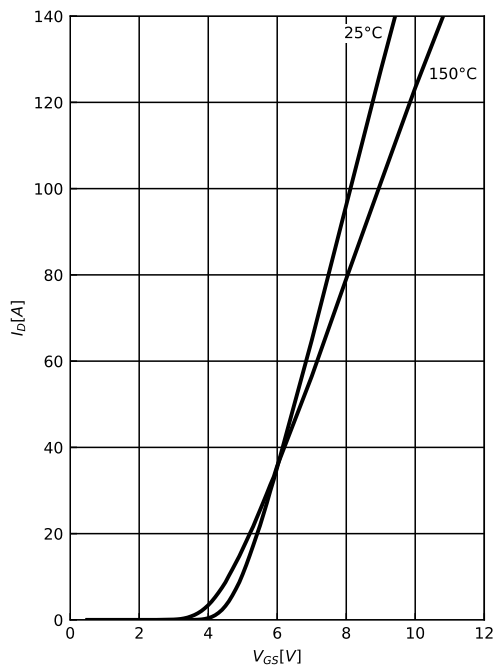
$R_{DS(on)} = f(I_D); T_j = 150^\circ\text{C}; \text{parameter: } V_{GS}$

Diagram 6: Typ. drain-source on-state resistance



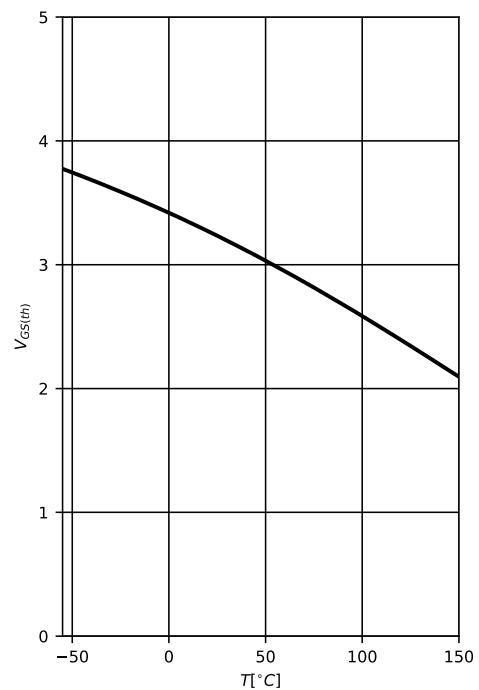
$R_{DS(on)} = f(T_j); I_D = 19\text{A}$

Diagram 7: Typ. transfer characteristics



$I_D = f(V_{GS}); V_{DS} = 20\text{V}; \text{parameter: } T_j$

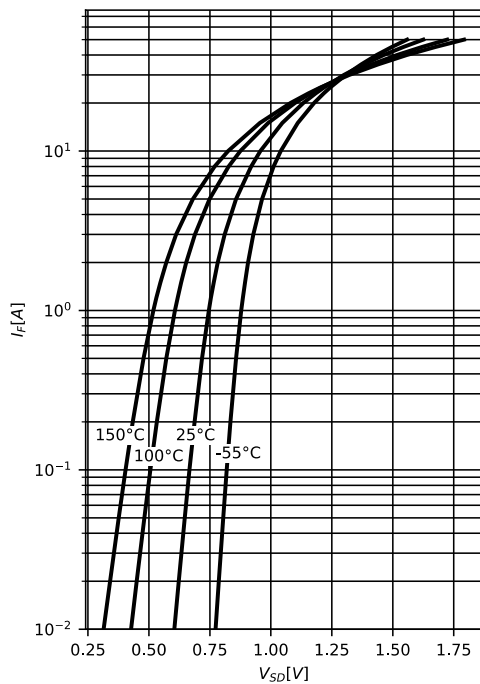
Diagram 8: Typ. gate threshold voltage



$V_{GS(th)} = f(T_j); I_D = 1\text{mA}$

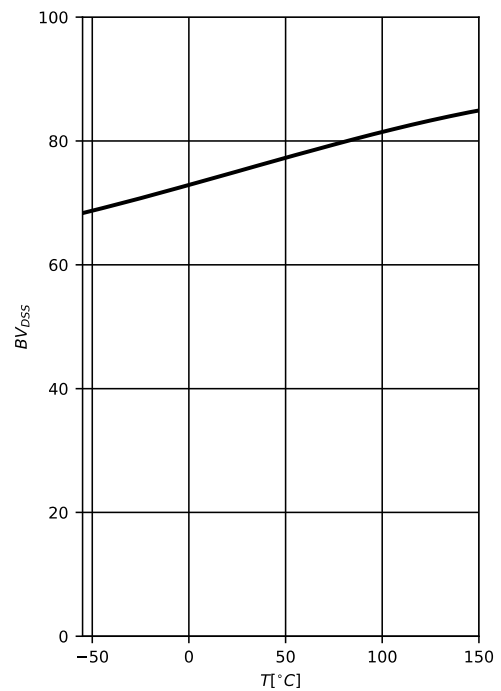
### Electrical characteristics diagrams

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



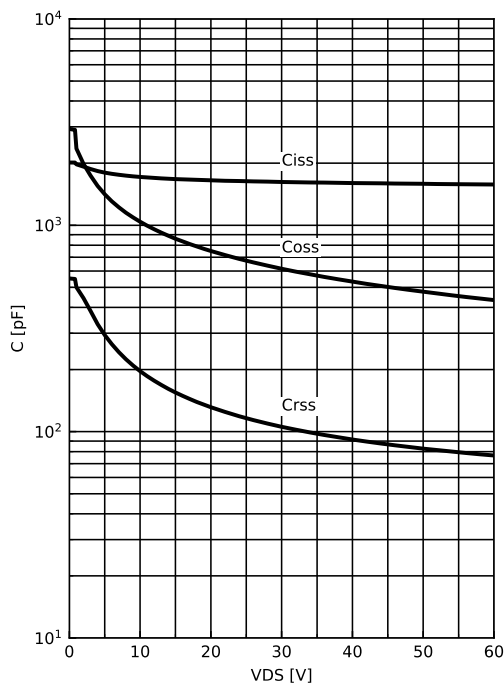
$$I_F = f(V_{DS}); \text{ parameter: } T_j$$

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



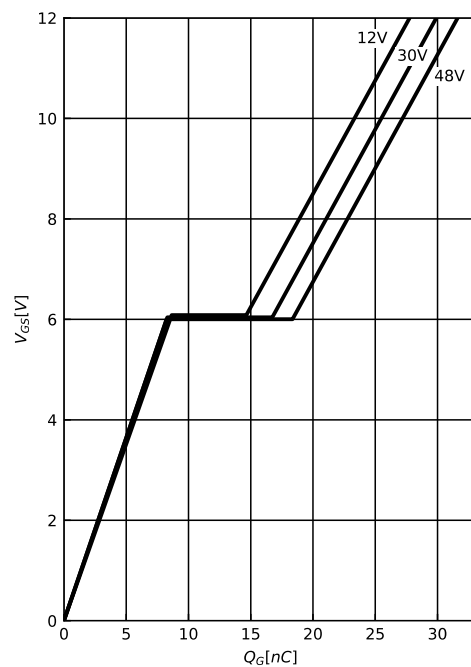
$$BV_{DS} = f(T_j); I_D = 250 \mu A$$

**Diagram 11: Typ. capacitances**



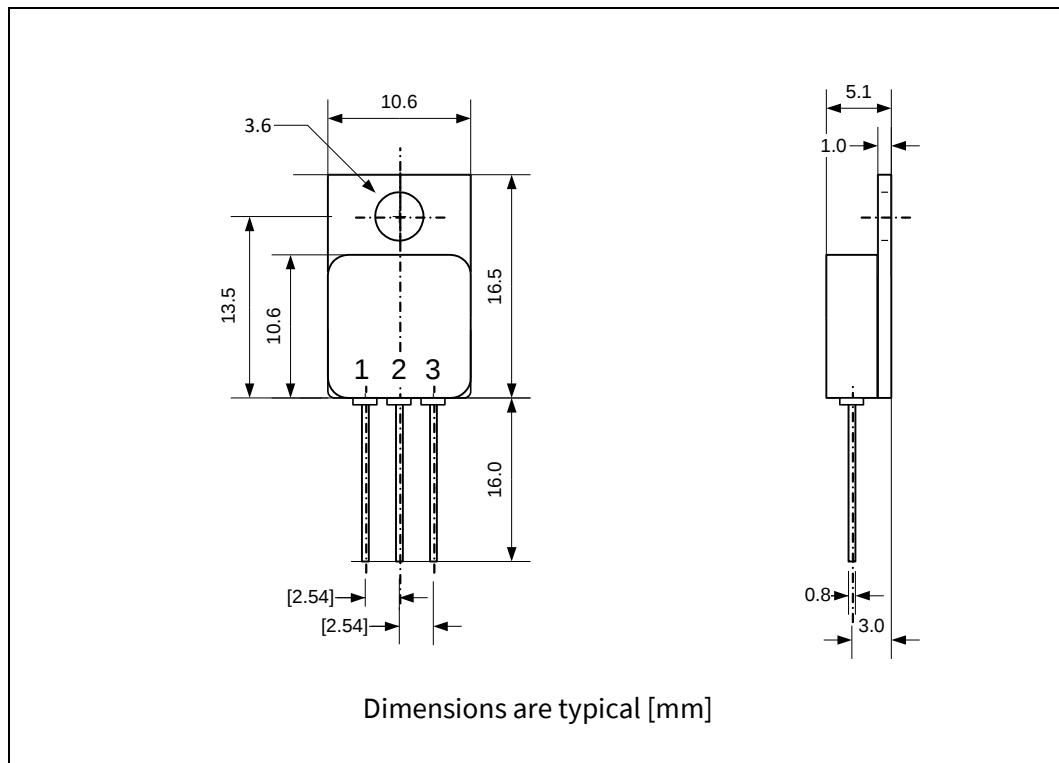
$$C = f(V_{DS}); V_{GS} = 0 V; f = 1 \text{ MHz}$$

**Diagram 12: Typ. gate charge**



$$V_{GS} = f(Q_{gate}); I_D = 23.0 \text{ A pulsed}; \text{ parameter: } V_{DD}$$

## 6 Package outlines



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