# BUK6212-40C

## N-channel TrenchMOS intermediate level FET

Rev. 01 — 12 May 2010 Objective data sheet

## 1. Product profile

### 1.1 General description

Intermediate level gate drive N-channel enhancement mode Field-Effect Transistor (FET) in a plastic package using TrenchMOS technology. This product has been designed and qualified to the appropriate AEC standard for use in automotive critical applications.

### 1.2 Features and benefits

- AEC Q101 compliant
- Suitable for intermediate level gate drive sources
- Suitable for thermally demanding environments due to 175 °C rating

### 1.3 Applications

- 12 V Automotive systems
- Electric and electro-hydraulic power steering
- Motors, lamps and solenoids
- Start-Stop micro-hybrid applications
- Transmission control
- Ultra high performance power switching

### 1.4 Quick reference data

**Table 1. Quick reference data**

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{DS}$ | drain-source voltage | $T_j$ ≥ 25 °C; $T_j$ ≤ 175 °C | | - | - | 40 | V |
| $I_D$ | drain current | $V_{GS}$ = 10 V; $T_{mb}$ = 25 °C; see Figure 1; see Figure 4 | [1] | - | - | 50 | A |
| $P_{tot}$ | total power dissipation | see Figure 2 | | - | - | 80 | W |
| **Static characteristics** | | | | | | | |
| $R_{DSon}$ | drain-source on-state resistance | $V_{GS}$ = 10 V; $I_D$ = 25 A; $T_j$ = 25 °C; see Figure 13; see Figure 12 | | - | 9.8 | 12 | mΩ |

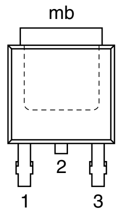
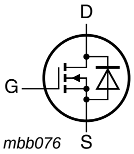
**Table 1. Quick reference data** *…continued*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Avalanche ruggedness** | | | | | | |
| $E_{DS(AL)S}$ | non-repetitive drain-source avalanche energy | $I_D$ = 50 A; $V_{sup} \leq$ 40 V; $V_{GS}$ = 10 V; $T_{j(init)}$ = 25 °C; unclamped | - | - | 55 | mJ |
| **Dynamic characteristics** | | | | | | |
| $Q_{GD}$ | gate-drain charge | $I_D$ = 25 A; $V_{DS}$ = 32 V; $V_{GS}$ = 10 V; see Figure 14; see Figure 15 | - | 10.1 | - | nC |

[1] Continuous current is limited by package.

## 2. Pinning information

**Table 2. Pinning information**

| Pin | Symbol | Description | Simplified outline | Graphic symbol |
|---|---|---|---|---|
| 1 | G | gate |  <br>SOT428 (DPAK) |  |
| 2 | D | drain | | |
| 3 | S | source | | |
| mb | D | mounting base; connected to drain | | |

## 3. Ordering information

**Table 3. Ordering information**

| Type number | Package | | |
|---|---|---|---|
| | Name | Description | Version |
| BUK6212-40C | DPAK | plastic single-ended surface-mounted package (DPAK); 3 leads (one lead cropped) | SOT428 |

## 4. Limiting values

**Table 4. Limiting values**

*In accordance with the Absolute Maximum Rating System (IEC 60134).*

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{DS}$ | drain-source voltage | $T_j \geq 25$ °C; $T_j \leq 175$ °C | | - | - | 40 | V |
| $V_{GS}$ | gate-source voltage | DC | | -16 | - | 16 | V |
| $I_D$ | drain current | $T_{mb} = 25$ °C; $V_{GS} = 10$ V; see Figure 1; see Figure 4 | [1] | - | - | 50 | A |
| | | $T_{mb} = 100$ °C; $V_{GS} = 10$ V; see Figure 1 | | - | - | 40 | A |
| $I_{DM}$ | peak drain current | $T_{mb} = 25$ °C; $t_p \leq 10$ µs; pulsed; see Figure 4 | | - | - | 226 | A |
| $P_{tot}$ | total power dissipation | see Figure 2 | | - | - | 80 | W |
| $T_{stg}$ | storage temperature | | | -55 | - | 175 | °C |
| $T_j$ | junction temperature | | | -55 | - | 175 | °C |
| $V_{GS}$ | gate-source voltage | | [2][3] | -20 | - | 20 | V |
| **Source-drain diode** | | | | | | | |
| $I_S$ | source current | | [1] | - | - | 50 | A |
| $I_{SM}$ | peak source current | $t_p \leq 10$ µs; pulsed | | - | - | 226 | A |
| **Avalanche ruggedness** | | | | | | | |
| $E_{DS(AL)S}$ | non-repetitive drain-source avalanche energy | $I_D = 50$ A; $V_{sup} \leq 40$ V; $V_{GS} = 10$ V; $T_{j(init)} = 25$ °C; unclamped | | - | - | 55 | mJ |
| $E_{DS(AL)R}$ | repetitive drain-source avalanche energy | see Figure 3 | [4][5][6] | - | - | - | J |

[1] Continuous current is limited by package.

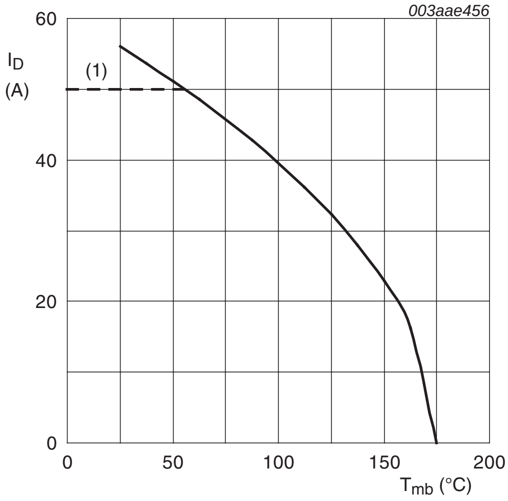
[2] Pulsed

[3] Accumulated pulse duration not to exceed 5 minutes.

[4] Single-pulse avalanche rating limited by maximum junction temperature of 175 °C.

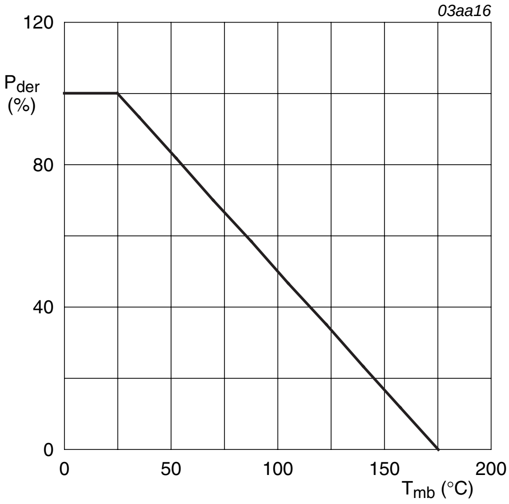
[5] Repetitive avalanche rating limited by an average junction temperature of 170 °C.

[6] Refer to application note AN10273 for further information.



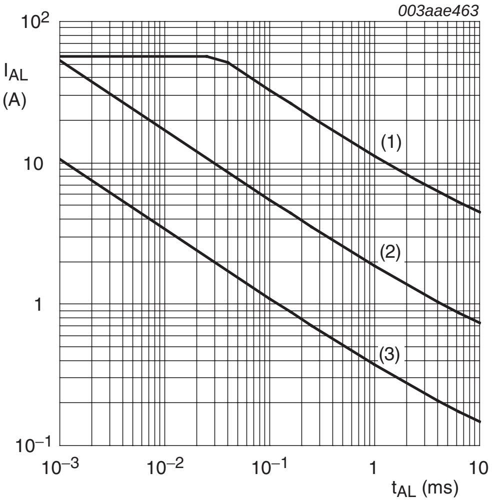
(1) Capped at 50 A due to package

**Fig 1. Continuous drain current as a function of mounting base temperature**



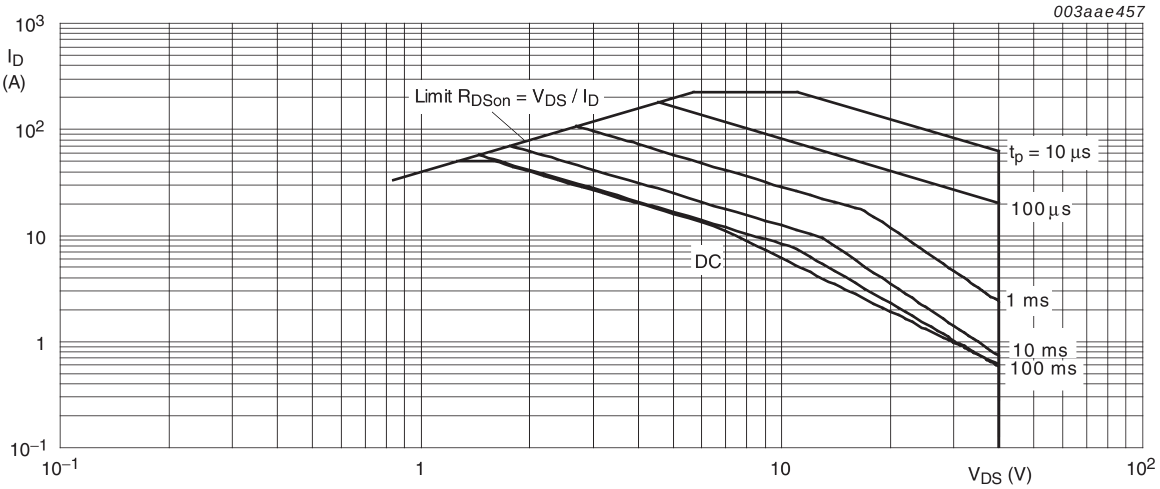
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\,\%$$

**Fig 2. Normalized total power dissipation as a function of mounting base temperature**



(1) Single pulse, $T_j = 25$ °C(2) Single pulse, $T_j = 125$ °C(3) Repetitive pulse

**Fig 3. Single-pulse and repetitive avalanche rating; avalanche current as a function of avalanche time**



$T_{mb} = 25\ °C$; $I_{DM}$ is a single pulse

**Fig 4.** Safe operating area; continuous and peak drain currents as a function of drain-source voltage

## 5. Thermal characteristics

**Table 5.** Thermal characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $R_{th(j-mb)}$ | thermal resistance from junction to mounting base | see Figure 5 | - | - | 1.87 | K/W |

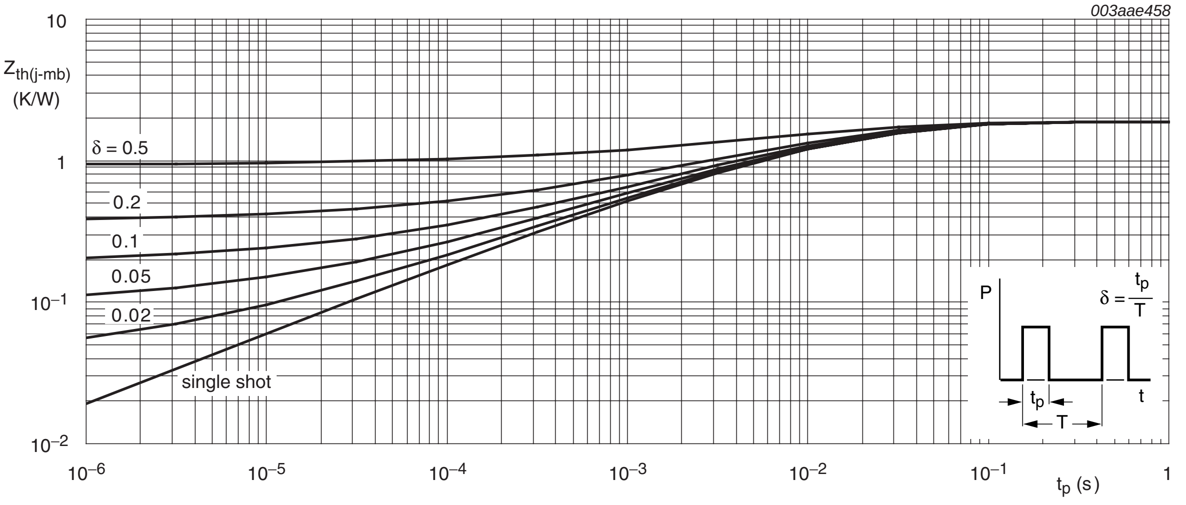
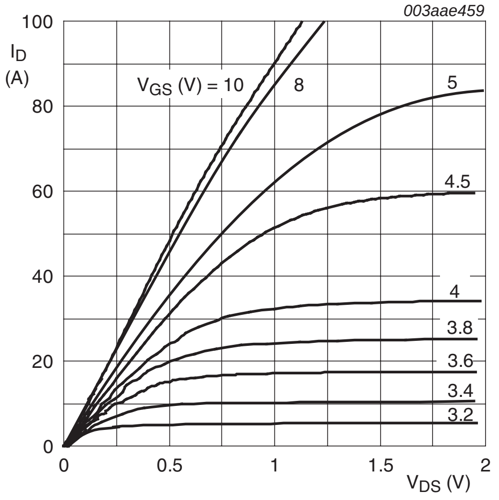


**Fig 5.** Transient thermal impedance from junction to mounting base as a function of pulse duration

# 6. Characteristics

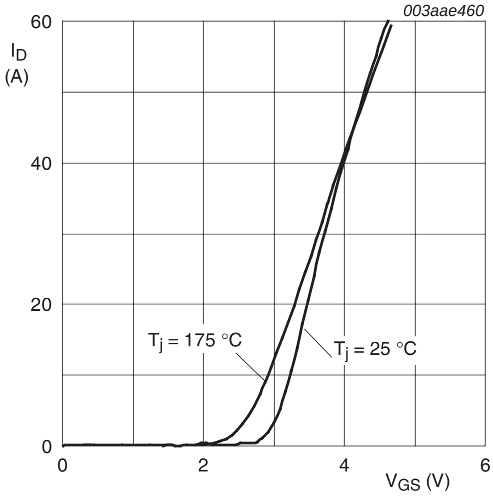
**Table 6. Characteristics**

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Static characteristics** | | | | | | |
| $V_{(BR)DSS}$ | drain-source breakdown voltage | $I_D$ = 250 µA; $V_{GS}$ = 0 V; $T_j$ = 25 °C | 40 | - | - | V |
| | | $I_D$ = 250 µA; $V_{GS}$ = 0 V; $T_j$ = -55 °C | 36 | - | - | V |
| $V_{GS(th)}$ | gate-source threshold voltage | $I_D$ = 1 mA; $V_{DS}$ = $V_{GS}$; $T_j$ = 25 °C; see Figure 10; see Figure 11 | 1.8 | 2.3 | 2.8 | V |
| | | $I_D$ = 1 mA; $V_{DS}$ = $V_{GS}$; $T_j$ = -55 °C; see Figure 10; see Figure 10 | - | - | 3.3 | V |
| | | $I_D$ = 1 mA; $V_{DS}$ = $V_{GS}$; $T_j$ = 175 °C | 0.8 | - | - | V |
| $I_{DSS}$ | drain leakage current | $V_{DS}$ = 40 V; $V_{GS}$ = 0 V; $T_j$ = 25 °C | - | 0.02 | 1 | µA |
| | | $V_{DS}$ = 40 V; $V_{GS}$ = 0 V; $T_j$ = 175 °C | - | - | 500 | µA |
| $I_{GSS}$ | gate leakage current | $V_{DS}$ = 0 V; $V_{GS}$ = 20 V; $T_j$ = 25 °C | - | 2 | 100 | nA |
| | | $V_{DS}$ = 0 V; $V_{GS}$ = -20 V; $T_j$ = 25 °C | - | 2 | 100 | nA |
| $R_{DSon}$ | drain-source on-state resistance | $V_{GS}$ = 4.5 V; $I_D$ = 25 A; $T_{mb}$ = 25 °C; see Figure 12 | - | 15.2 | 18.5 | mΩ |
| | | $V_{GS}$ = 10 V; $I_D$ = 25 A; $T_j$ = 175 °C; see Figure 13 | - | 19.8 | 25.2 | mΩ |
| | | $V_{GS}$ = 5 V; $I_D$ = 25 A; $T_{mb}$ = 25 °C; see Figure 12 | - | 13.3 | 16 | mΩ |
| | | $V_{GS}$ = 10 V; $I_D$ = 25 A; $T_j$ = 25 °C; see Figure 13; see Figure 12 | - | 9.8 | 12 | mΩ |
| **Dynamic characteristics** | | | | | | |
| $Q_{G(tot)}$ | total gate charge | $I_D$ = 25 A; $V_{DS}$ = 32 V; $V_{GS}$ = 10 V; see Figure 14; see Figure 15 | - | 33.9 | - | nC |
| $Q_{GS}$ | gate-source charge | | - | 5.4 | - | nC |
| $Q_{GD}$ | gate-drain charge | | - | 10.1 | - | nC |
| $C_{iss}$ | input capacitance | $V_{GS}$ = 0 V; $V_{DS}$ = 30 V; f = 1 MHz; $T_j$ = 25 °C; see Figure 16 | - | 1433 | 1911 | pF |
| $C_{oss}$ | output capacitance | | - | 184 | 221 | pF |
| $C_{rss}$ | reverse transfer capacitance | | - | 120 | 164 | pF |
| $t_{d(on)}$ | turn-on delay time | $V_{DS}$ = 30 V; $R_L$ = 1.2 Ω; $V_{GS}$ = 10 V; $R_{G(ext)}$ = 10 Ω | - | 9.8 | - | ns |
| $t_r$ | rise time | | - | 21 | - | ns |
| $t_{d(off)}$ | turn-off delay time | | - | 54 | - | ns |
| $t_f$ | fall time | | - | 32 | - | ns |
| $L_D$ | internal drain inductance | measured from source lead to source bond pad; ; $T_j$ = 25 °C | - | 3.5 | - | nH |
| $L_S$ | internal source inductance | $T_j$ = 25 °C; measured from drain to centre of die; | - | 2.5 | - | nH |
| **Source-drain diode** | | | | | | |
| $V_{SD}$ | source-drain voltage | $I_S$ = 25 A; $V_{GS}$ = 0 V; $T_j$ = 25 °C; see Figure 17 | - | 0.9 | 1.2 | V |
| $t_{rr}$ | reverse recovery time | $I_S$ = 20 A; $dI_S/dt$ = -100 A/µs; $V_{GS}$ = 0 V; $V_{DS}$ = 25 V | - | 35.6 | - | ns |
| $Q_r$ | recovered charge | | - | 38.2 | - | nC |



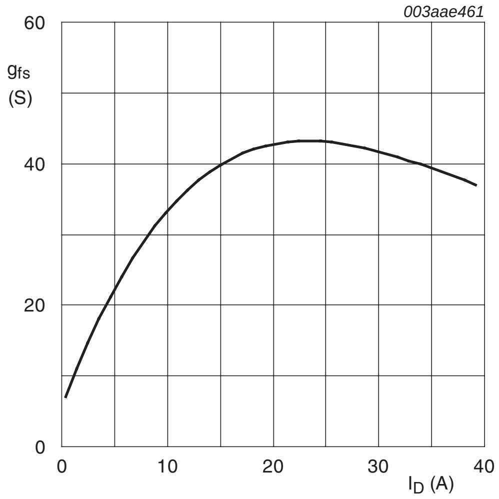
$T_j = 25\ °C;\ t_p = 300\ \mu s$

**Fig 6. Output characteristics: drain current as a function of drain-source voltage; typical values**



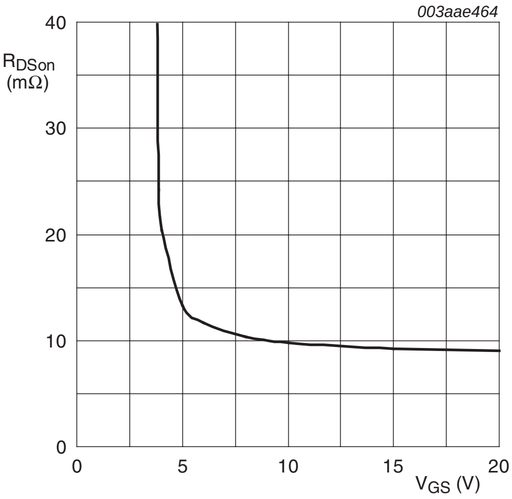
$V_{DS} = 20\ V$

**Fig 7. Transfer characteristics: drain current as a function of gate-source voltage; typical values**



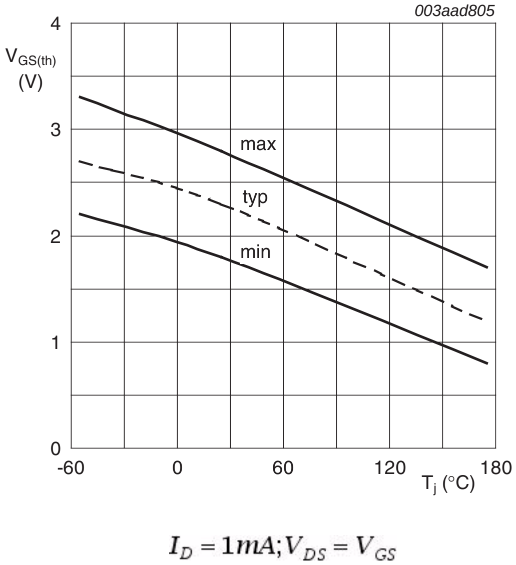
$T_j = 25\ °C;\ V_{DS} = 25\ V$

**Fig 8. Forward transconductance as a function of drain current; typical values**



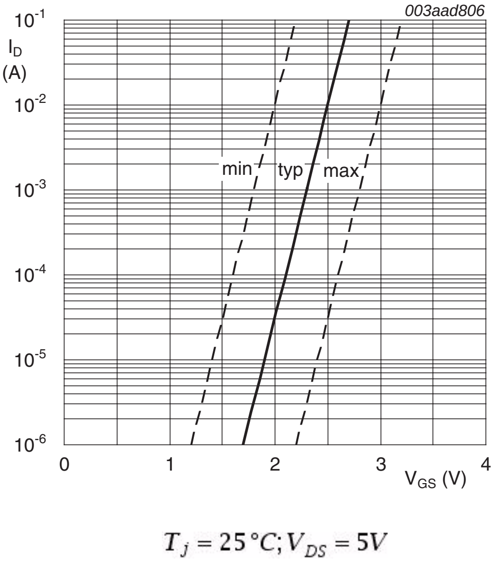
$T_j = 25\ °C;\ I_D = 25\ A$

**Fig 9. Drain-source on-state resistance as a function of gate-source voltage; typical values**



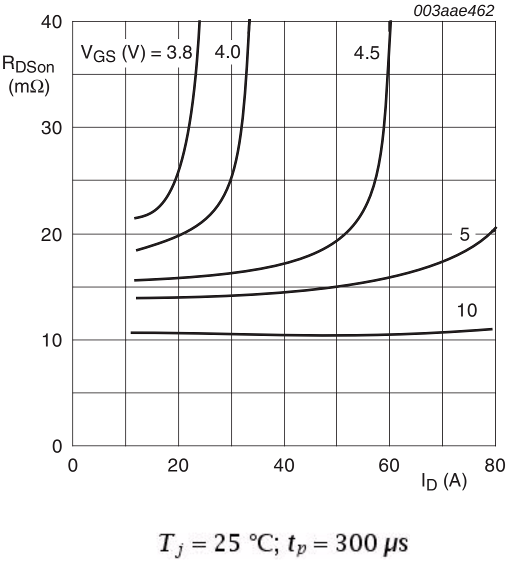
$I_D = 1mA; V_{DS} = V_{GS}$

**Fig 10.** Gate-source threshold voltage as a function of junction temperature



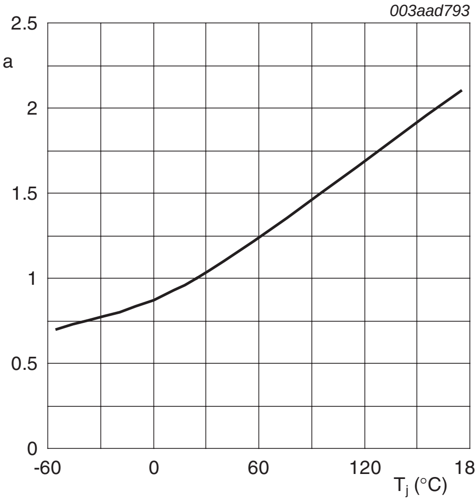
$T_j = 25\,°C; V_{DS} = 5V$

**Fig 11.** Sub-threshold drain current as a function of gate-source voltage



$T_j = 25\ °C;\ t_p = 300\ \mu s$

**Fig 12.** Drain-source on-state resistance as a function of drain current; typical values



$$a = \frac{R_{DSon}}{R_{DSon(25\,°C)}}$$

**Fig 13.** Normalized drain-source on-state resistance factor as a function of junction temperature

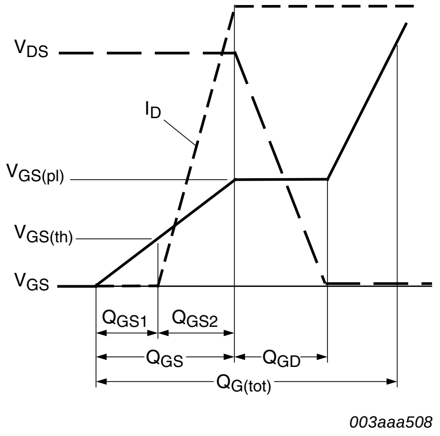
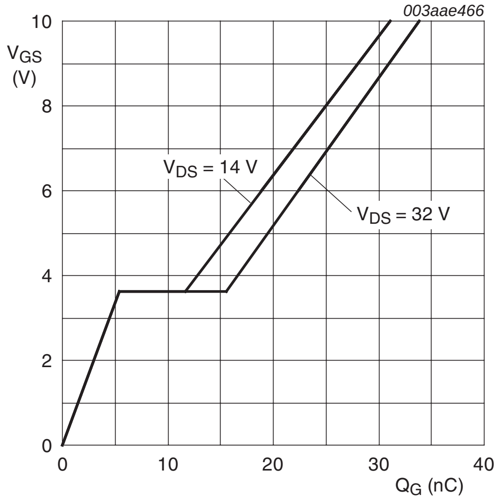
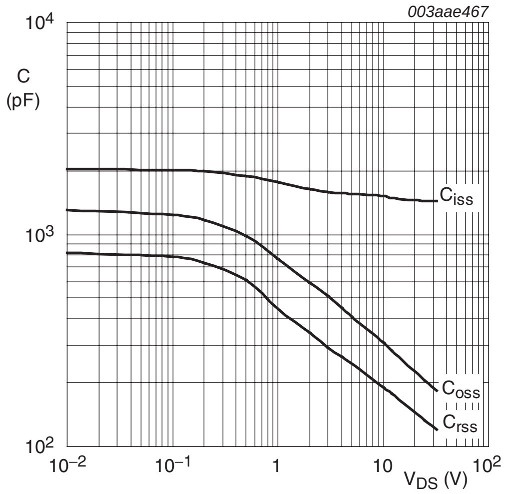


Fig 14. Gate charge waveform definitions



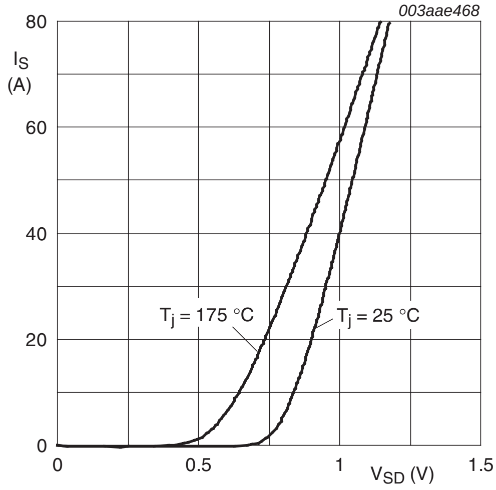
$T_j = 25\ °C; I_D = 25\ A$

Fig 15. Gate-source voltage as a function of gate charge; typical values



$V_{GS} = 0\ V$; f = 1 MHz

Fig 16. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

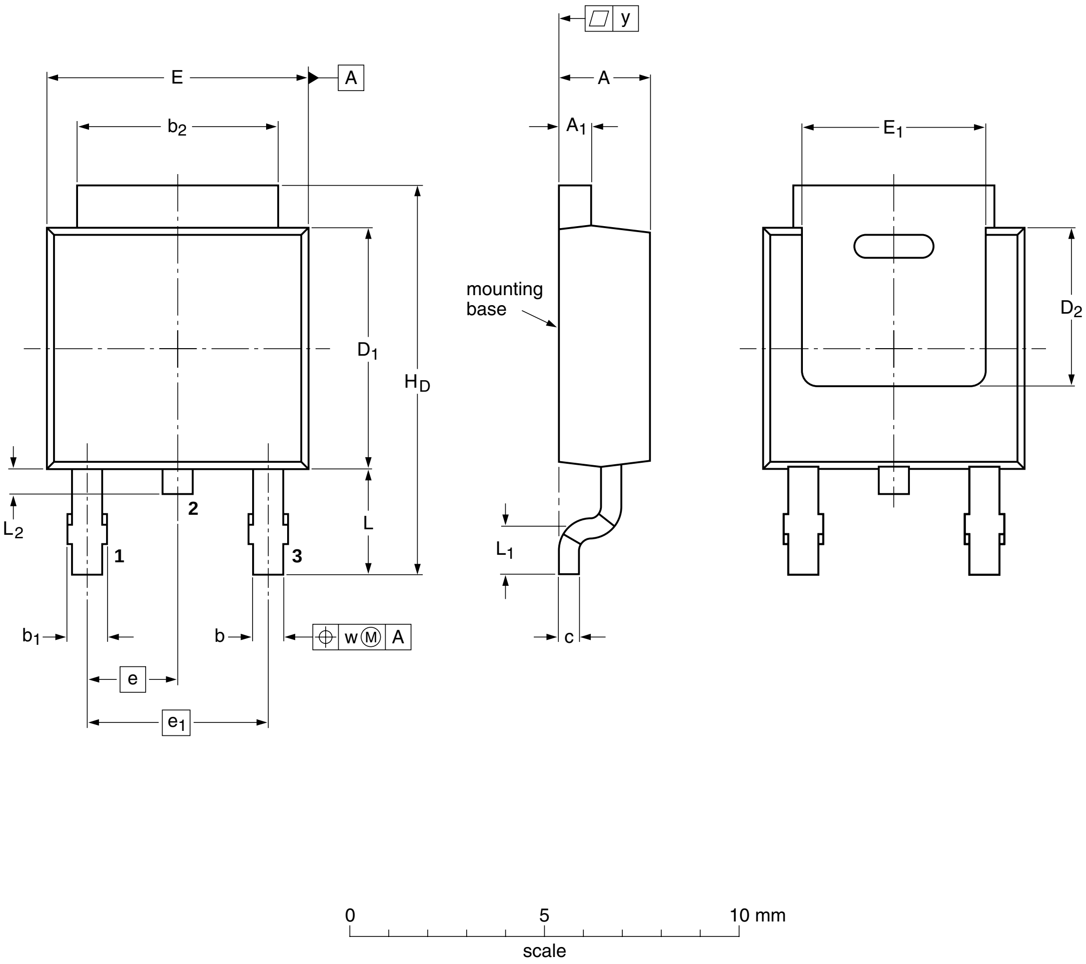


$V_{GS} = 0\ V$

Fig 17. Source (diode forward) current as a function of source-drain (diode forward) voltage; typical values

## 7. Package outline

**Plastic single-ended surface-mounted package (DPAK); 3 leads (one lead cropped)** **SOT428**



**DIMENSIONS (mm are the original dimensions)**

| UNIT | A | $A_1$ | b | $b_1$ | $b_2$ | c | $D_1$ | $D_2$ min | E | $E_1$ min | e | $e_1$ | $H_D$ | L | $L_1$ min | $L_2$ | w | y max |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 2.38<br>2.22 | 0.93<br>0.46 | 0.89<br>0.71 | 1.1<br>0.9 | 5.46<br>5.00 | 0.56<br>0.20 | 6.22<br>5.98 | 4.0 | 6.73<br>6.47 | 4.45 | 2.285 | 4.57 | 10.4<br>9.6 | 2.95<br>2.55 | 0.5 | 0.9<br>0.5 | 0.2 | 0.2 |

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT428 | | TO-252 | SC-63 | | | ~~06-02-14~~<br>06-03-16 |

Fig 18. Package outline SOT428 (DPAK)

## 8. Revision history

Table 7. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| BUK6212-40C v.1 | 20100512 | Objective data sheet | - | - |

# 9. Legal information

## 9.1 Data sheet status

| Document status[1][2] | Product status[3] | Definition |
|---|---|---|
| Objective [short] data sheet | Development | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet | Qualification | This document contains data from the preliminary specification. |
| Product [short] data sheet | Production | This document contains the product specification. |

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.nxp.com.

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## 11. Contents

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**Date of release: 12 May 2010**

**Document identifier: BUK6212-40C**