

# BUK9E2R4-40C

## N-channel TrenchMOS logic level FET

Rev. 01 — 11 April 2008

Product data sheet

## 1. Product profile

### 1.1 General description

Logic level 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

- Low conduction losses due to low on-state resistance
- Suitable for logic level gate drive sources
- Q101 compliant
- Suitable for thermally demanding environments due to 175 °C rating

### 1.3 Applications

- 12 V loads
- General purpose power switching
- Automotive systems
- Motors, lamps and solenoids

### 1.4 Quick reference data

Table 1. Quick reference

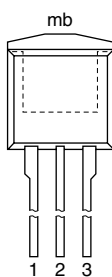
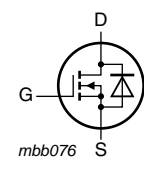
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{DS}$	drain-source voltage	$T_j \geq 25\text{ °C}; T_j \leq 175\text{ °C}$	-	-	40	V
$I_D$	drain current	$V_{GS} = 5\text{ V}; T_j = 25\text{ °C};$ see <a href="#">Figure 1</a> and <a href="#">4</a>	<a href="#">[1]</a> <a href="#">[2]</a>	-	100	A
$P_{tot}$	total power dissipation	$T_{mb} = 25\text{ °C};$ see <a href="#">Figure 2</a>	-	-	333	W
<b>Avalanche ruggedness</b>						
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$I_D = 100\text{ A}; V_{sup} \leq 40\text{ V};$ $R_{GS} = 50\ \Omega; V_{GS} = 5\text{ V};$ $T_{j(init)} = 25\text{ °C};$ unclamped	-	-	1.2	J
<b>Dynamic characteristics</b>						
$Q_{GD}$	gate-drain charge	$V_{GS} = 5\text{ V}; I_D = 25\text{ A};$ $V_{DS} = 32\text{ V};$ see <a href="#">Figure 14</a>	-	73	-	nC
<b>Static characteristics</b>						
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 5\text{ V}; I_D = 25\text{ A};$ $T_j = 25\text{ °C};$ see <a href="#">Figure 12</a> , <a href="#">11</a> and <a href="#">13</a>	-	2.1	2.4	m $\Omega$

[1] Continuous current is limited by package.

[2] Refer to document 9397 750 12572 for further information.

## 2. Pinning information

**Table 2. Pinning**

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	G	gate		
2	D	drain		
3	S	source		
mb	D	mounting base; connected to drain		

**SOT226 (I2-PAK)**

## 3. Ordering information

**Table 3. Ordering information**

Type number	Package		Version
	Name	Description	
BUK9E2R4-40C	I2PAK	plastic single-ended package (I2PAK); low-profile 3-lead TO-220AB	SOT226

## 4. Limiting values

**Table 4. Limiting values**

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

Symbol	Parameter	Conditions	Min	Max	Unit
$V_{DS}$	drain-source voltage	$T_j \geq 25\text{ °C}$ ; $T_j \leq 175\text{ °C}$	-	40	V
$V_{DGR}$	drain-gate voltage	$R_{GS} = 20\text{ k}\Omega$	-	40	V
$V_{GS}$	gate-source voltage		-15	15	V
$I_D$	drain current	$T_{mb} = 25\text{ °C}$ ; $V_{GS} = 5\text{ V}$ ; see <a href="#">Figure 1</a>	[1]	270	A
		$V_{GS} = 5\text{ V}$ ; $T_j = 100\text{ °C}$ ; see <a href="#">Figure 1</a>	[2][3]	100	A
		$V_{GS} = 5\text{ V}$ ; $T_j = 25\text{ °C}$ ; see <a href="#">Figure 1</a> and <a href="#">4</a>	[2][3]	100	A
$I_{DM}$	peak drain current	$T_{mb} = 25\text{ °C}$ ; $t_p \leq 10\text{ }\mu\text{s}$ ; pulsed; see <a href="#">Figure 4</a>	-	1080	A
$P_{tot}$	total power dissipation	$T_{mb} = 25\text{ °C}$ ; see <a href="#">Figure 2</a>	-	333	W
$T_{stg}$	storage temperature		-55	175	°C
$T_j$	junction temperature		-55	175	°C

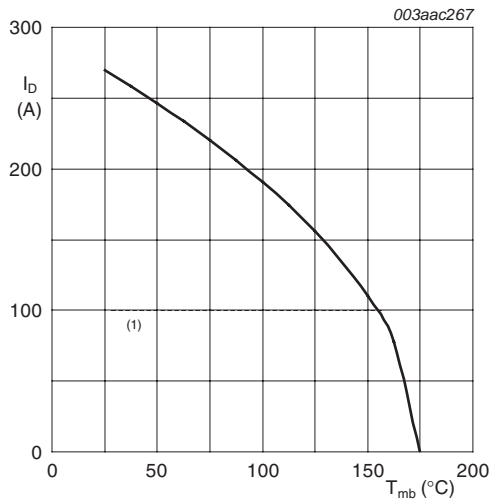
### Avalanche ruggedness

$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$I_D = 100\text{ A}$ ; $V_{sup} \leq 40\text{ V}$ ; $R_{GS} = 50\text{ }\Omega$ ; $V_{GS} = 5\text{ V}$ ; $T_{j(init)} = 25\text{ °C}$ ; unclamped	-	1.2	J
$E_{DS(AL)R}$	repetitive drain-source avalanche energy	see <a href="#">Figure 3</a>	[4][5] [6]	-	J

### Source-drain diode

$I_S$	source current	$T_{mb} = 25\text{ °C}$	[2][3]	100	A
$I_{SM}$	peak source current	$t_p \leq 10\text{ }\mu\text{s}$ ; pulsed; $T_{mb} = 25\text{ °C}$	-	1080	A

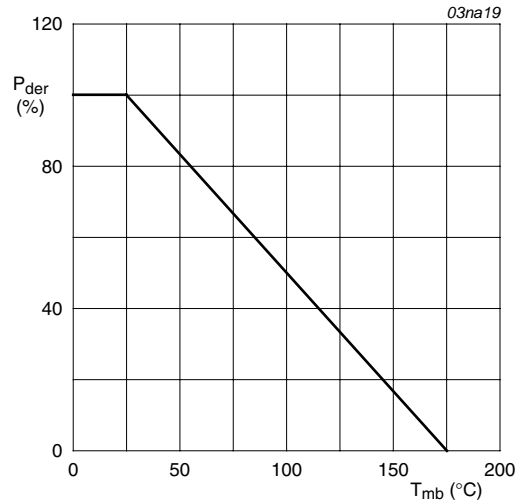
- [1] Current is limited by chip power dissipation rating.
- [2] Continuous current is limited by package.
- [3] Refer to document 9397 750 12572 for further information.
- [4] Single-pulse avalanche rating limited by maximum junction temperature of 175 °C.
- [5] Repetitive avalanche rating limited by an average junction temperature of 170 °C.
- [6] Refer to application note AN10273 for further information.



$V_{GS} \geq 5V$

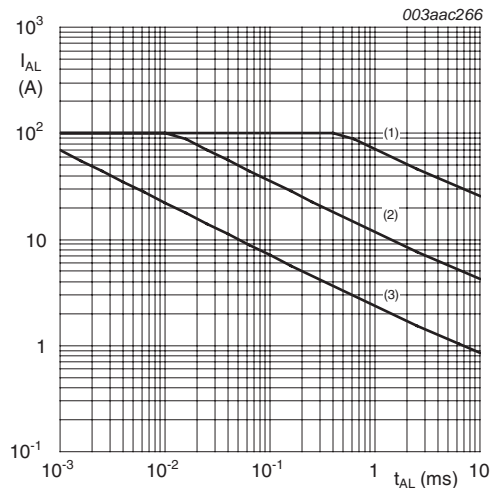
(1) Capped at 100 A due to package.

**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**

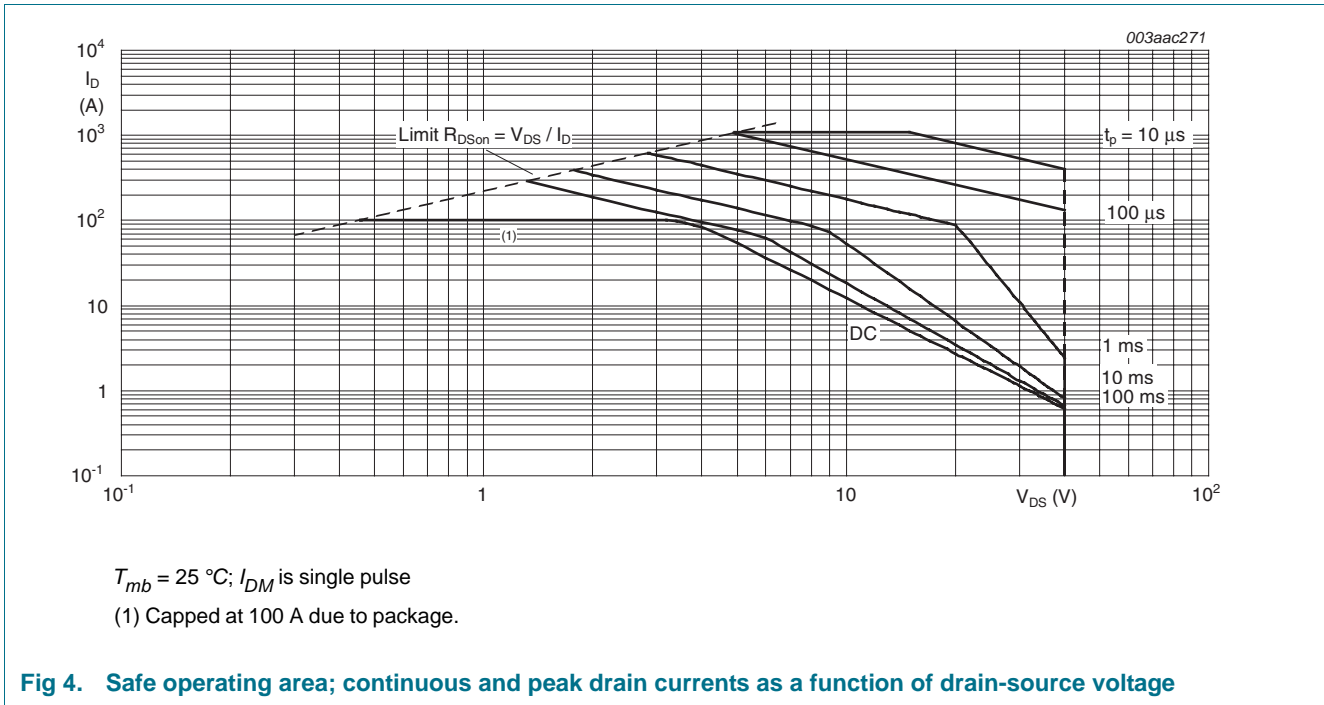


(1) Single-pulse;  $T_j = 25^{\circ}C$ .

(2) Single-pulse;  $T_j = 150^{\circ}C$ .

(3) Repetitive.

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

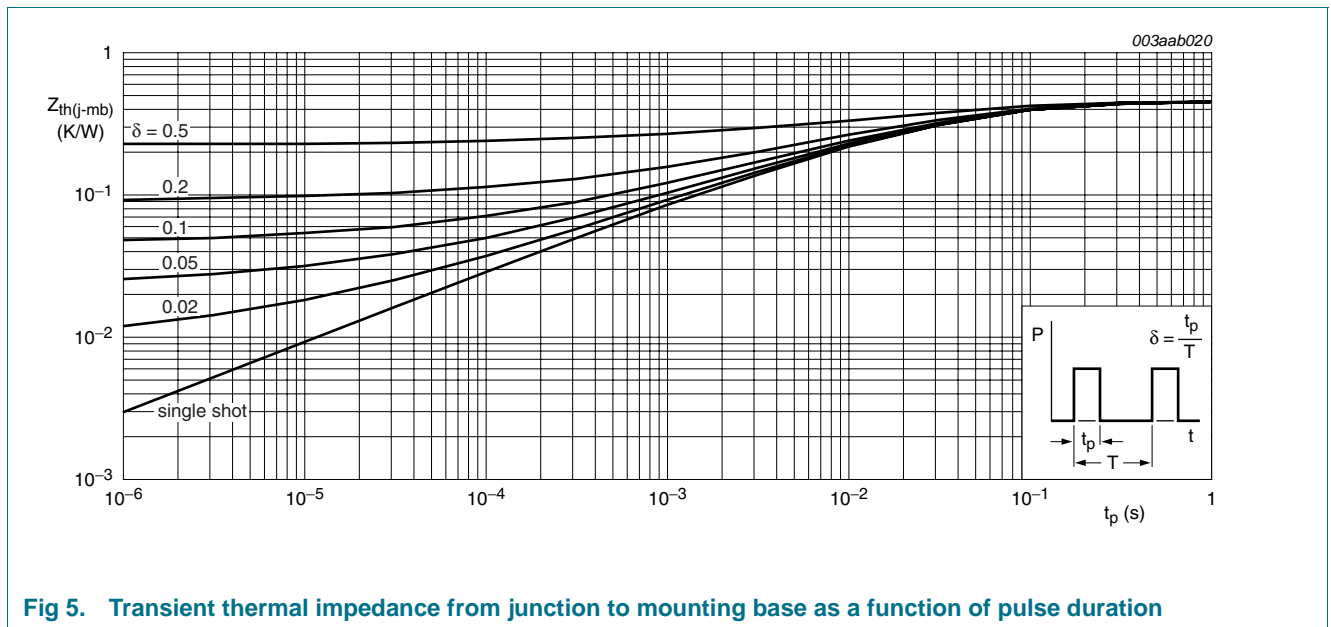


**Fig 4. Safe operating area; continuous and peak drain currents as a function of drain-source voltage**

## 5. Thermal characteristics

**Table 5. Thermal characteristics**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	vertical in free air	-	60	-	K/W
$R_{th(j-mb)}$	thermal resistance from junction to mounting base	see <a href="#">Figure 5</a>	-	-	0.45	K/W



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

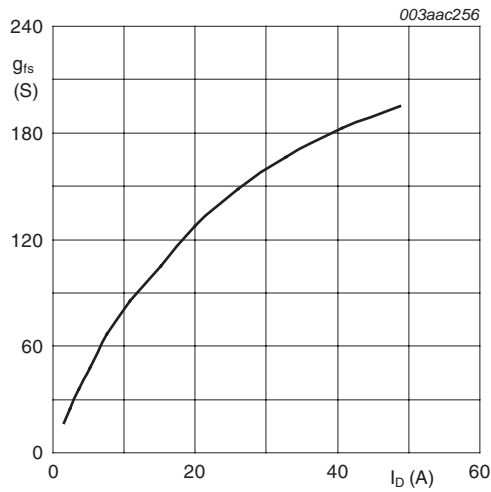
## 6. Characteristics

**Table 6. Characteristics**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics</b>						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 250 \mu A; V_{GS} = 0 V; T_j = 25 \text{ }^\circ C$	40	-	-	V
		$I_D = 250 \mu A; V_{GS} = 0 V; T_j = -55 \text{ }^\circ C$	36	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 25 \text{ }^\circ C;$ see <a href="#">Figure 9</a> and <a href="#">10</a>	1	1.5	2	V
		$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = -55 \text{ }^\circ C;$ see <a href="#">Figure 9</a>	-	-	2.3	V
		$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 175 \text{ }^\circ C;$ see <a href="#">Figure 9</a>	0.5	-	-	V
$I_{DSS}$	drain leakage current	$V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 175 \text{ }^\circ C$	-	-	500	$\mu A$
		$V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ C$	-	0.02	1	$\mu A$

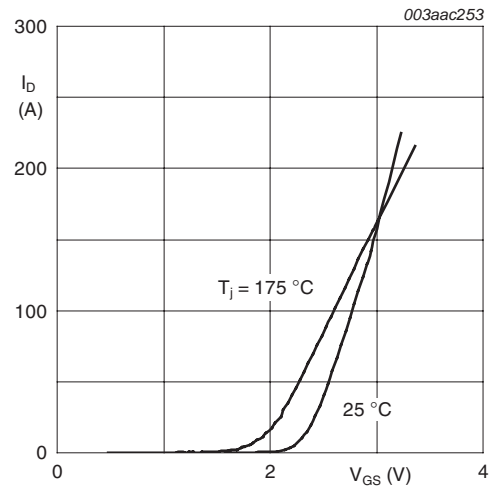
Table 6. Characteristics ...continued

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I <sub>GSS</sub>	gate leakage current	V <sub>DS</sub> = 0 V; V <sub>GS</sub> = 15 V; T <sub>j</sub> = 25 °C	-	2	100	nA
		V <sub>DS</sub> = 0 V; V <sub>GS</sub> = -15 V; T <sub>j</sub> = 25 °C	-	2	100	nA
R <sub>DSon</sub>	drain-source on-state resistance	V <sub>GS</sub> = 4.5 V; I <sub>D</sub> = 25 A; T <sub>j</sub> = 25 °C	-	-	2.7	mΩ
		V <sub>GS</sub> = 10 V; I <sub>D</sub> = 25 A; T <sub>j</sub> = 25 °C	-	1.8	2.1	mΩ
		V <sub>GS</sub> = 5 V; I <sub>D</sub> = 25 A; T <sub>j</sub> = 175 °C; see <a href="#">Figure 11</a>	-	-	4.6	mΩ
		V <sub>GS</sub> = 5 V; I <sub>D</sub> = 25 A; T <sub>j</sub> = 25 °C; see <a href="#">Figure 12</a> , <a href="#">11</a> and <a href="#">13</a>	-	2.1	2.4	mΩ
<b>Source-drain diode</b>						
V <sub>SD</sub>	source-drain voltage	I <sub>S</sub> = 25 A; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C; see <a href="#">Figure 16</a>	-	0.85	1.2	V
t <sub>rr</sub>	reverse recovery time	I <sub>S</sub> = 25 A; dI <sub>S</sub> /dt = 100 A/μs;	-	70	-	ns
Q <sub>r</sub>	recovered charge	V <sub>GS</sub> = 0 V; V <sub>DS</sub> = 30 V	-	60	-	nC
<b>Dynamic characteristics</b>						
Q <sub>G(tot)</sub>	total gate charge	I <sub>D</sub> = 25 A; V <sub>DS</sub> = 32 V; V <sub>GS</sub> = 5 V; see <a href="#">Figure 14</a>	-	120	-	nC
Q <sub>GS</sub>	gate-source charge		-	30	-	nC
Q <sub>GD</sub>	gate-drain charge		-	73	-	nC
C <sub>iss</sub>	input capacitance	V <sub>GS</sub> = 0 V; V <sub>DS</sub> = 25 V;	-	12487	16700	pF
C <sub>oss</sub>	output capacitance	f = 1 MHz; T <sub>j</sub> = 25 °C; see <a href="#">Figure 15</a>	-	1323	1600	pF
C <sub>rss</sub>	reverse transfer capacitance		-	938	1290	pF
t <sub>d(on)</sub>	turn-on delay time	V <sub>DS</sub> = 30 V; R <sub>L</sub> = 1.2 Ω;	-	130	-	ns
t <sub>r</sub>	rise time	V <sub>GS</sub> = 5 V; R <sub>G(ext)</sub> = 10 Ω	-	310	-	ns
t <sub>d(off)</sub>	turn-off delay time		-	380	-	ns
t <sub>f</sub>	fall time		-	250	-	ns
L <sub>D</sub>	internal drain inductance	from drain lead 6 mm from package to centre of die	-	4.5	-	nH
L <sub>S</sub>	internal source inductance	from source lead to source bond pad	-	7.5	-	nH



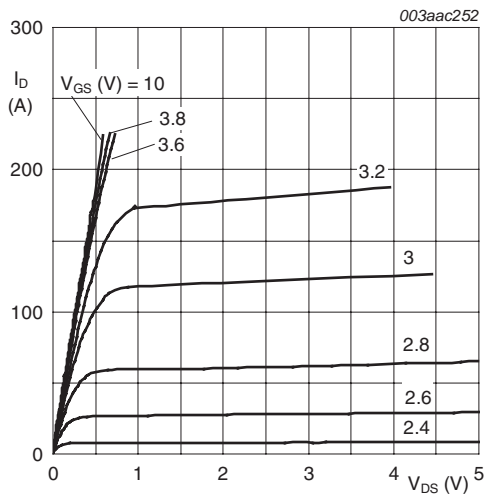
$T_j = 25\text{ }^\circ\text{C}; V_{DS} = 25\text{ V}$

**Fig 6. Forward transconductance as a function of drain current; typical values**



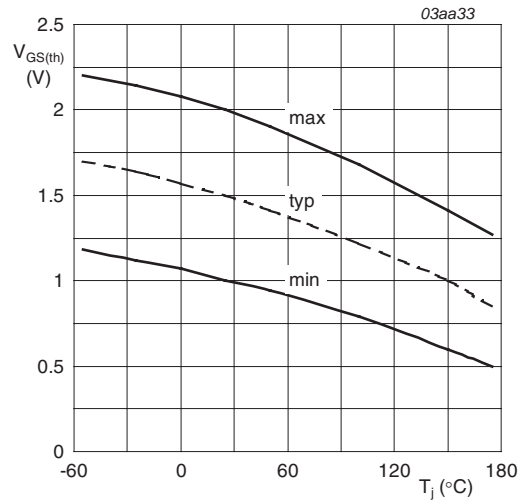
$V_{DS} = 25\text{ V}$

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



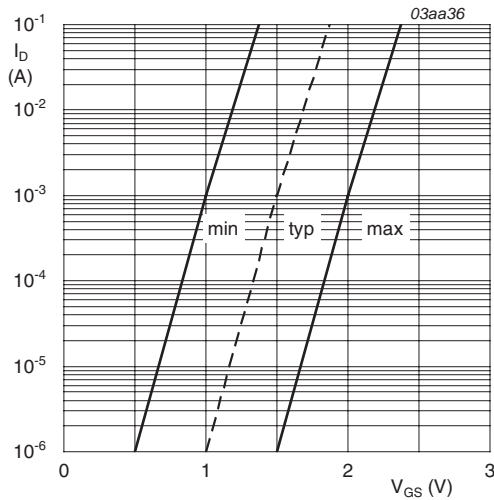
$T_j = 25\text{ }^\circ\text{C}$

**Fig 8. Output characteristics: drain current as a function of drain-source voltage; typical values**



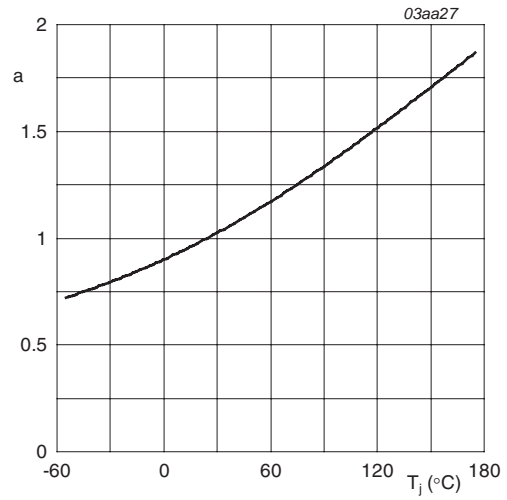
$I_D = 1\text{ mA}; V_{DS} = V_{GS}$

**Fig 9. Gate-source threshold voltage as a function of junction temperature**



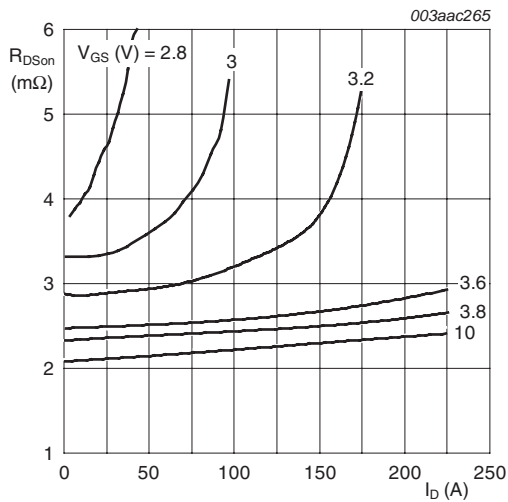
$T_j = 25\text{ }^\circ\text{C}; V_{DS} = V_{GS}$

Fig 10. Sub-threshold drain current as a function of gate-source voltage



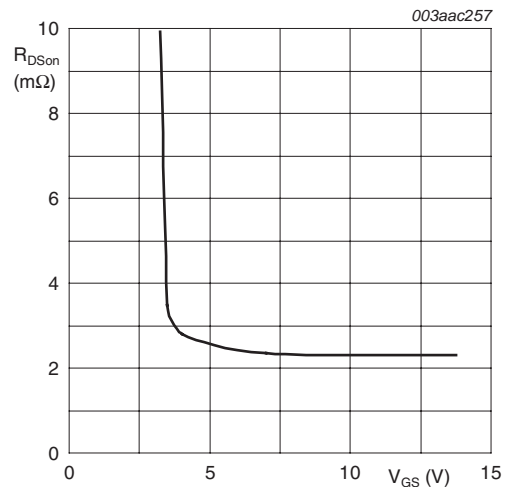
$$a = \frac{R_{DSon}}{R_{DSon(25^\circ\text{C})}}$$

Fig 11. Normalized drain-source on-state resistance factor as a function of junction temperature



$T_j = 25\text{ }^\circ\text{C}$

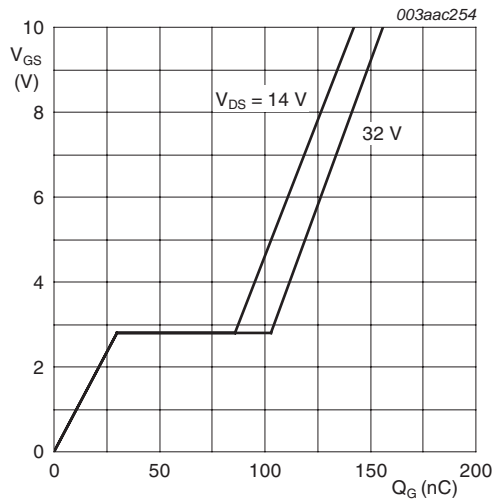
Fig 12. Drain-source on-state resistance as a function of drain current; typical values



$T_j = 25\text{ }^\circ\text{C}; I_D = 25\text{ A}$

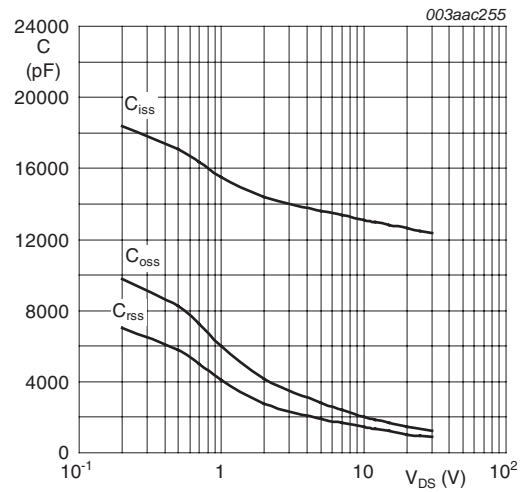
Fig 13. Drain-source on-state resistance as a function of gate-source voltage; typical values





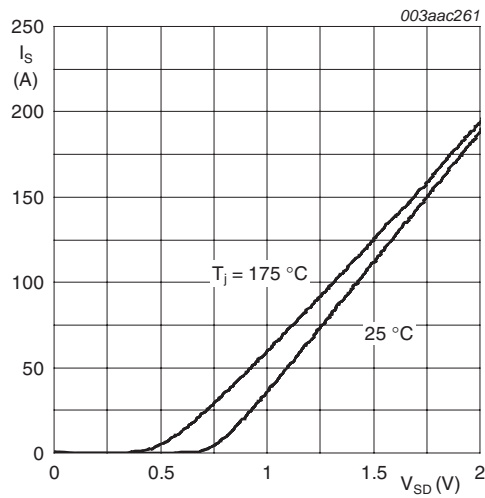
$T_j = 25\text{ }^\circ\text{C}; I_D = 25\text{ A}$

**Fig 14. Gate-source voltage as a function of gate charge; typical values**



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

**Fig 15. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values**



$V_{GS} = 0\text{ V}$

**Fig 16. Source (diode forward) current as a function of source-drain (diode forward) voltage; typical values**

**7. Package outline**

Plastic single-ended package (I2PAK); low-profile 3-lead TO-220AB

SOT226

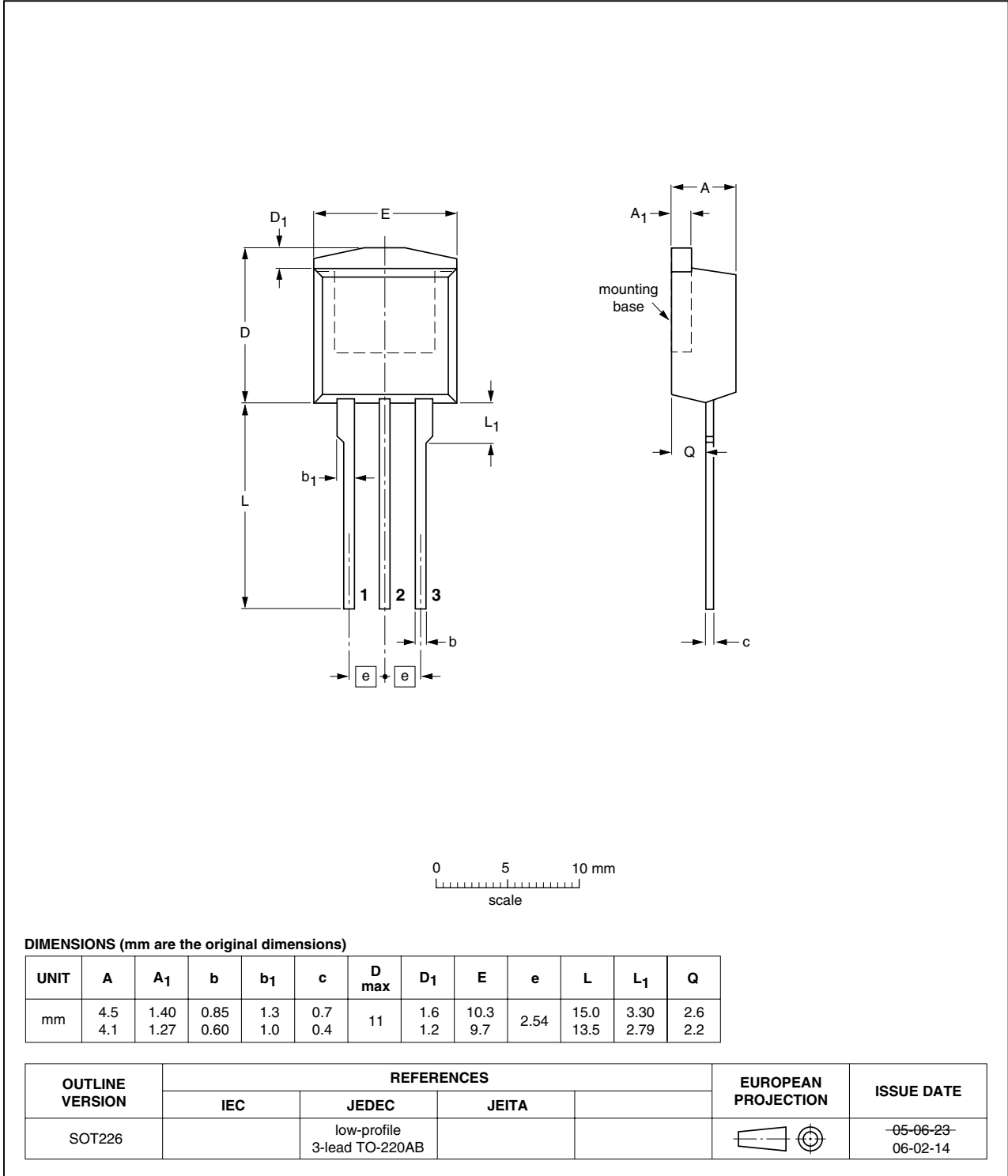


Fig 17. Package outline SOT226 (I2PAK)

## 8. Revision history

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Table 7. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BUK9E2R4-40C_1	20080411	Product data sheet	-	-

## 9. Legal information

### 9.1 Data sheet status

Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
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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".

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