

# BUK952R4-40C

## N-channel TrenchMOS logic level FET

Rev. 02 — 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

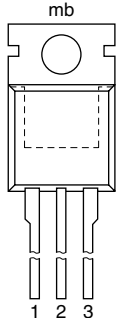
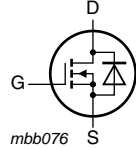
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{DS}$	drain-source voltage	$T_j \geq 25\text{ °C}; T_j \leq 175\text{ °C}$	-	-	40	V
$I_D$	drain current	$V_{GS} = 5\text{ V}; T_j = 25\text{ °C};$ see <a href="#">Figure 1</a> and <a href="#">4</a>	[1][2]	-	100	A
$P_{tot}$	total power dissipation	$T_{mb} = 25\text{ °C};$ see <a href="#">Figure 2</a>	-	-	333	W
<b>Avalanche ruggedness</b>						
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$I_D = 100\text{ A}; V_{sup} \leq 40\text{ V};$ $R_{GS} = 50\text{ }\Omega; V_{GS} = 5\text{ V};$ $T_{j(init)} = 25\text{ °C};$ 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		

**SOT78 (TO-220AB)**

## 3. Ordering information

**Table 3. Ordering information**

Type number	Package		Version
	Name	Description	
BUK952R4-40C	TO-220AB	plastic single-ended package; heatsink mounted; 1 mounting hole; 3-lead TO-220AB	SOT78

## 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

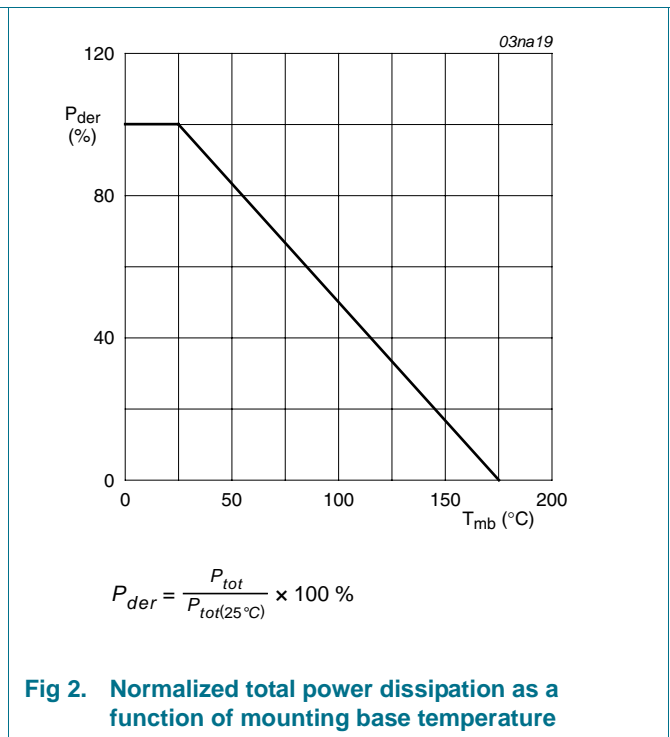
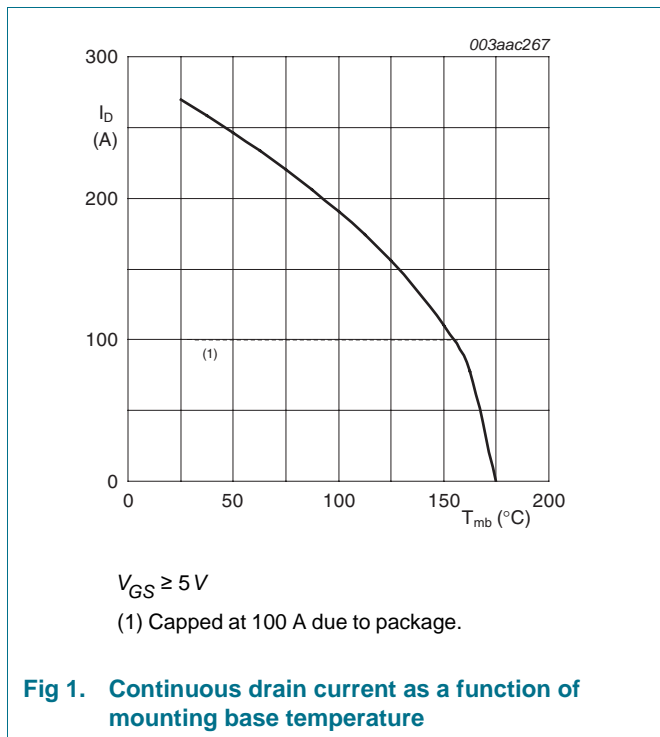
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$I_D = 100\text{ A}$ ; $V_{sup} \leq 40\text{ V}$ ; $R_{GS} = 50\text{ }\Omega$ ; $V_{GS} = 5\text{ V}$ ; $T_{j(init)} = 25\text{ °C}$ ; unclamped	-	1.2	J
$E_{DS(AL)R}$	repetitive drain-source avalanche energy	see <a href="#">Figure 3</a>	[4][5]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

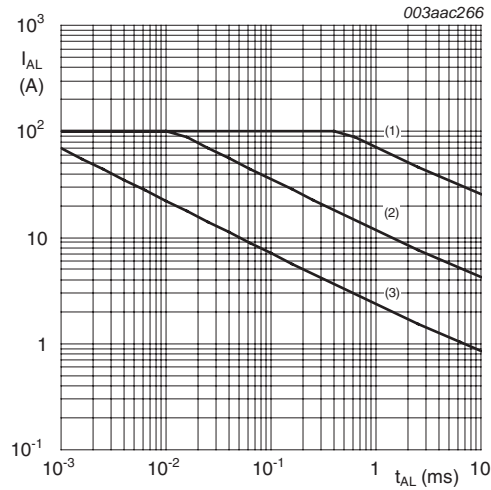
**Table 4. Limiting values ...continued**

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

Symbol	Parameter	Conditions	Min	Max	Unit
<b>Source-drain diode</b>					
$I_S$	source current	$T_{mb} = 25\text{ °C}$	[2][3]	100	A
$I_{SM}$	peak source current	$t_p \leq 10\ \mu\text{s}$ ; pulsed; $T_{mb} = 25\text{ °C}$	-	1080	A

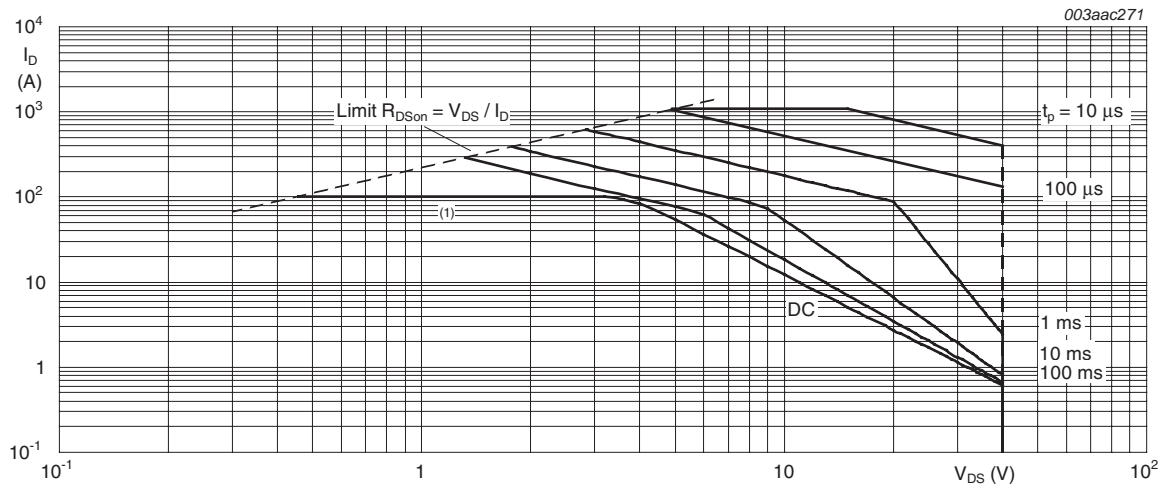
- [1] Current is limited by chip power dissipation rating.
- [2] Continuous current is limited by package.
- [3] Refer to document 9397 750 12572 for further information.
- [4] Single-pulse avalanche rating limited by maximum junction temperature of 175 °C.
- [5] Repetitive avalanche rating limited by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





- (1) Single-pulse;  $T_j = 25\text{ }^\circ\text{C}$ .
- (2) Single-pulse;  $T_j = 150\text{ }^\circ\text{C}$ .
- (3) Repetitive.

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



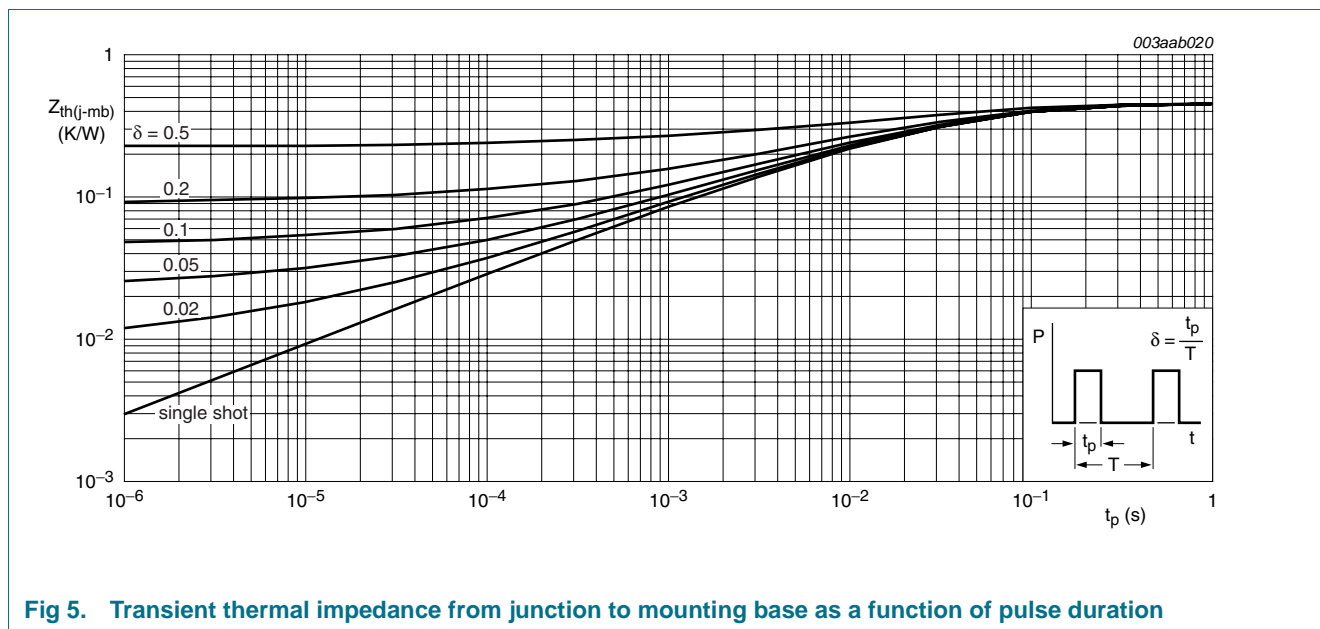
- $T_{mb} = 25\text{ }^\circ\text{C}$ ;  $I_{DM}$  is single pulse
- (1) Capped at 100 A due to package.

**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**

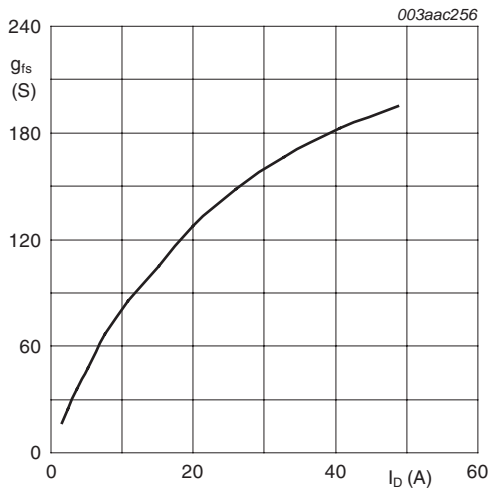
## 6. Characteristics

**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	$\mu A$

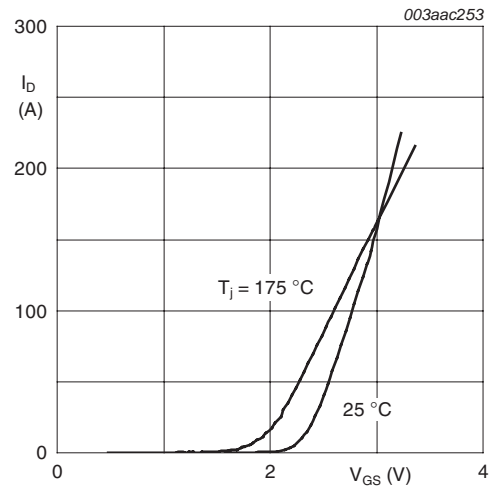
Table 6. Characteristics ...continued

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 contact screw on mounting base to centre of die	-	3.5	-	nH
		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



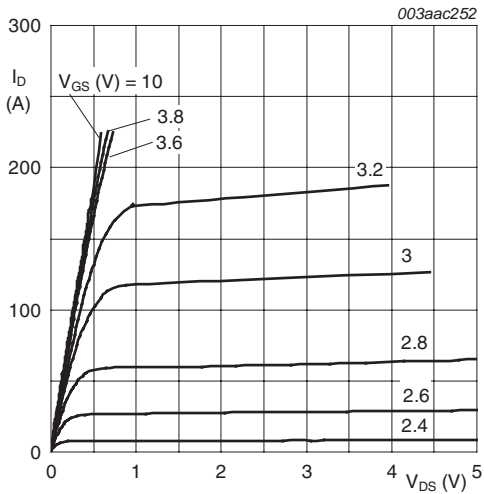
$T_j = 25\text{ }^\circ\text{C}; V_{DS} = 25\text{ V}$

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



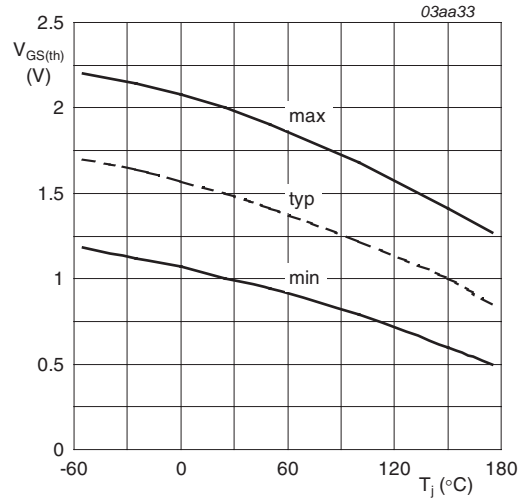
$V_{DS} = 25\text{ V}$

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



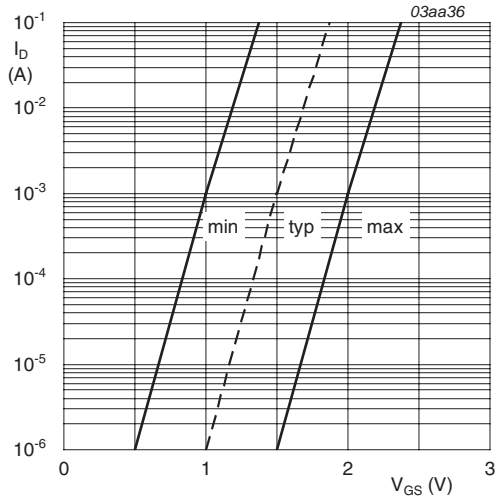
$T_j = 25\text{ }^\circ\text{C}$

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



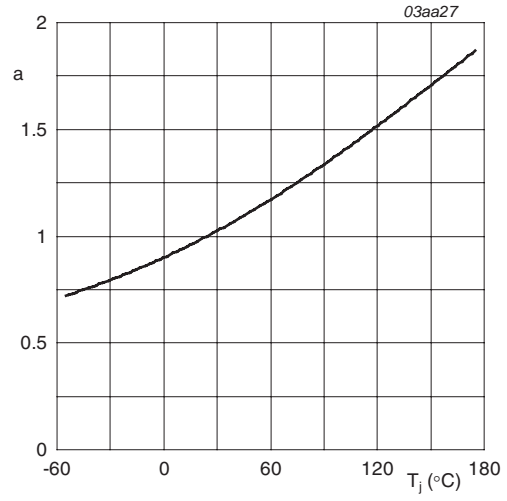
$I_D = 1\text{ mA}; V_{DS} = V_{GS}$

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



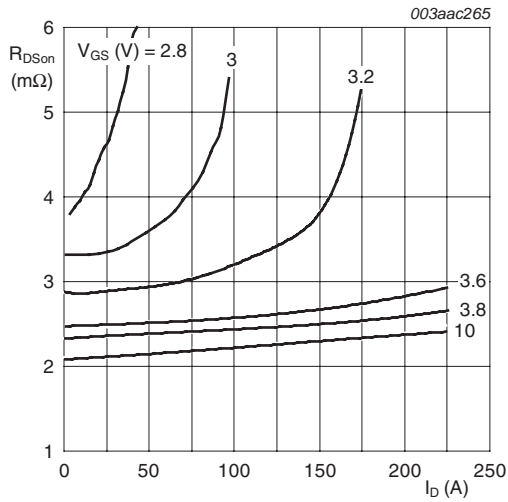
$T_j = 25\text{ }^\circ\text{C}; V_{DS} = V_{GS}$

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



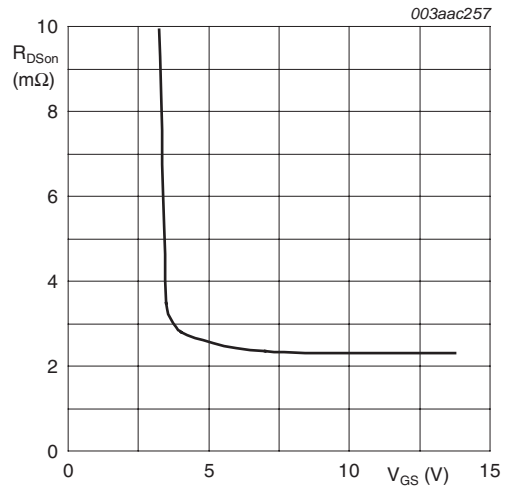
$$a = \frac{R_{DSon}}{R_{DSon(25^\circ\text{C})}}$$

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



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

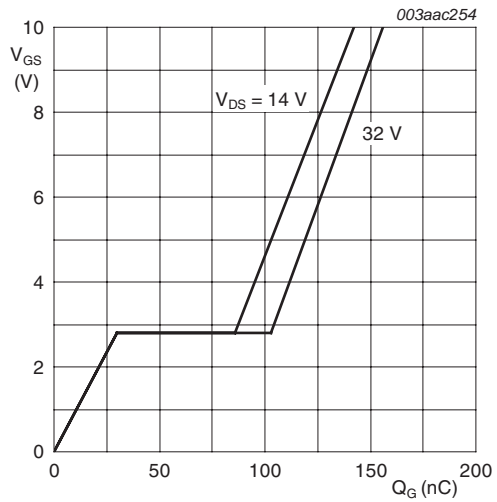
**Fig 12. Drain-source on-state resistance as a function of drain current; typical values**



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

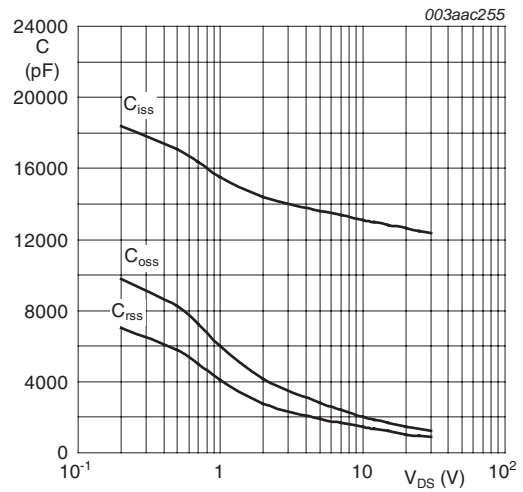
**Fig 13. Drain-source on-state resistance as a function of gate-source voltage; typical values**





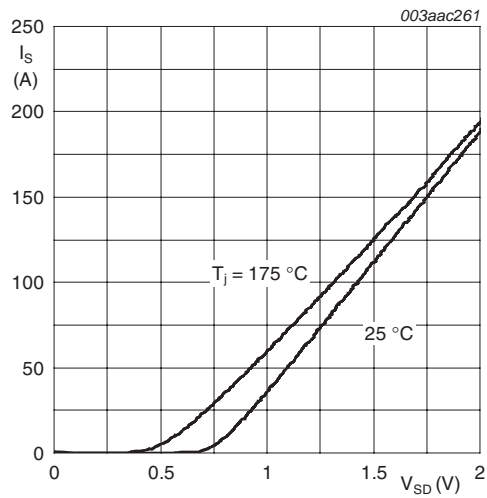
$T_j = 25\text{ }^\circ\text{C}; I_D = 25\text{ A}$

**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**



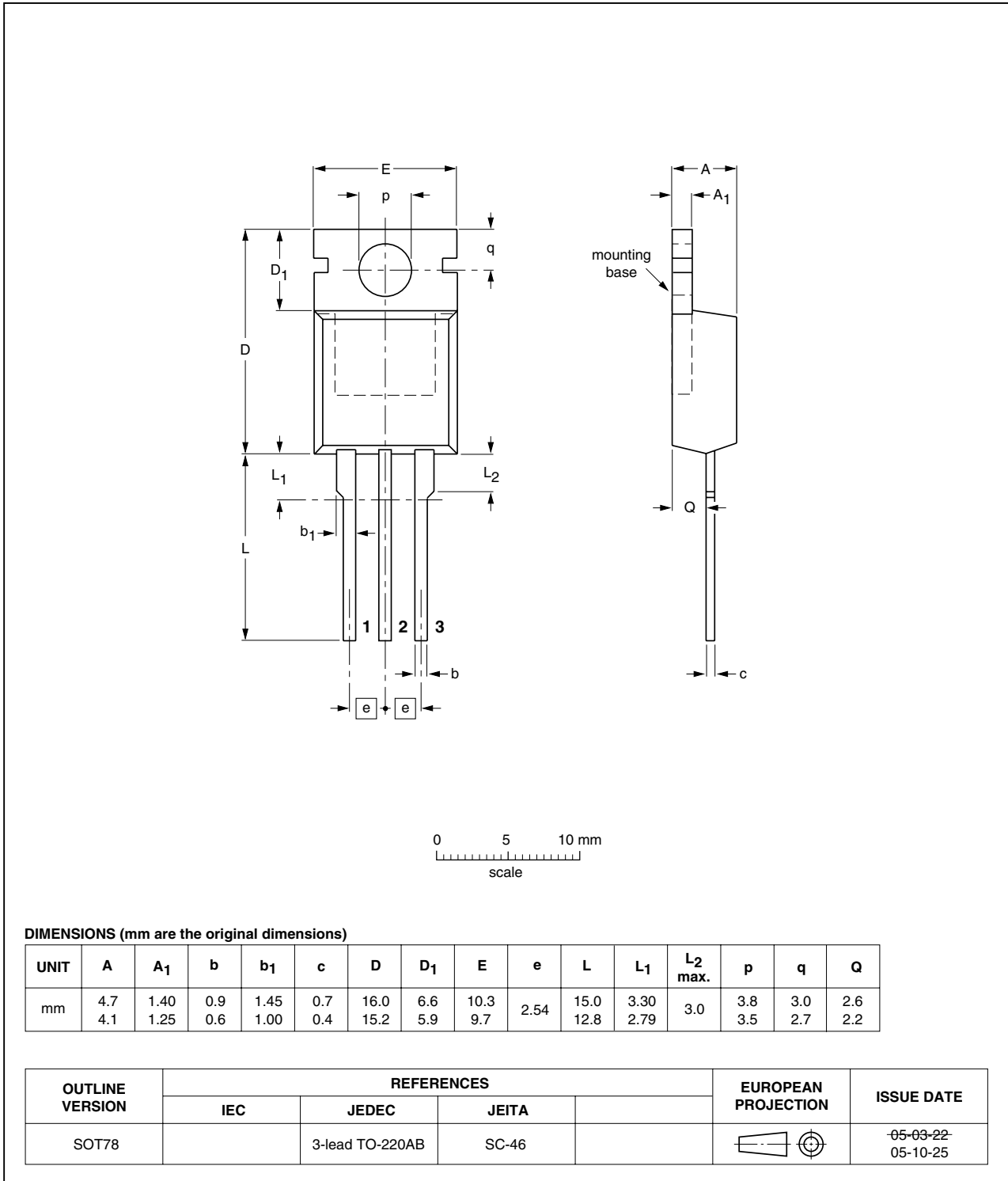
$V_{GS} = 0\text{ V}$

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

**7. Package outline**

Plastic single-ended package; heatsink mounted; 1 mounting hole; 3-lead TO-220AB

SOT78



**Fig 17. Package outline SOT78 (TO-220AB)**

## 8. Revision history

Table 7. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BUK952R4-40C_2	20080411	Product data sheet		BUK952R4-40C_1
Modifications:	• <a href="#">Table 6</a> : $V_{DS}$ condition for $I_{DSS}$ corrected.			
BUK952R4-40C_1	20080328	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.
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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