



# BUK9504-40A

N-channel TrenchMOS logic level FET

Rev. 2 — 7 February 2011

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

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

### 1.3 Applications

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

### 1.4 Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
$V_{DS}$	drain-source voltage	$T_j \geq 25^\circ\text{C}; T_j \leq 175^\circ\text{C}$	-	-	40	V	
$I_D$	drain current	$V_{GS} = 5\text{ V}; T_{mb} = 25^\circ\text{C}$ ; see <a href="#">Figure 1</a> ; see <a href="#">Figure 3</a>	[1]	-	-	75	A
$P_{tot}$	total power dissipation	$T_{mb} = 25^\circ\text{C}$ ; see <a href="#">Figure 2</a>	-	-	300	W	
Static characteristics							
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = 4.3\text{ V}; I_D = 25\text{ A}; T_j = 25^\circ\text{C}$	-	3.7	5.9	$\text{m}\Omega$	
		$V_{GS} = 10\text{ V}; I_D = 25\text{ A}; T_j = 25^\circ\text{C}$	-	2.9	4	$\text{m}\Omega$	
		$V_{GS} = 5\text{ V}; I_D = 25\text{ A}; T_j = 25^\circ\text{C}$ ; see <a href="#">Figure 11</a> ; see <a href="#">Figure 12</a>	-	3.5	4.4	$\text{m}\Omega$	



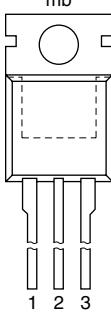
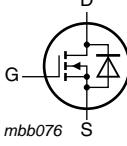
Table 1. Quick reference data ...continued

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Avalanche ruggedness</b>						
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$I_D = 75 \text{ A}$ ; $V_{sup} \leq 40 \text{ V}$ ; $R_{GS} = 50 \Omega$ ; $V_{GS} = 5 \text{ V}$ ; $T_{j(init)} = 25 \text{ }^\circ\text{C}$ ; unclamped	-	-	1.6	J
<b>Dynamic characteristics</b>						
$Q_{GD}$	gate-drain charge	$V_{GS} = 5 \text{ V}$ ; $I_D = 25 \text{ A}$ ; $V_{DS} = 32 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$ ; see <a href="#">Figure 13</a>	-	56	-	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		
2	D	drain		
3	S	source		
mb	D	mounting base; connected to drain		

**SOT78A (TO-220AB)**

## 3. Ordering information

Table 3. Ordering information

Type number	Package			Version
	Name	Description		
BUK9504-40A	TO-220AB	plastic single-ended package; heatsink mounted; 1 mounting hole; 3-lead TO-220AB		SOT78A

## 4. Limiting values

**Table 4. Limiting values**

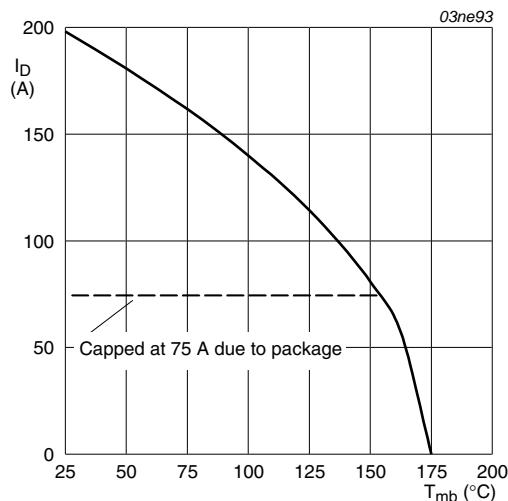
In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
$V_{DS}$	drain-source voltage	$T_j \geq 25^\circ\text{C}$ ; $T_j \leq 175^\circ\text{C}$	-	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	$T_{mb} = 100^\circ\text{C}$ ; $V_{GS} = 5\text{ V}$ ; see <a href="#">Figure 1</a>	[1]	-	75 A
		$T_{mb} = 25^\circ\text{C}$ ; $V_{GS} = 5\text{ V}$ ; see <a href="#">Figure 1</a> ; see <a href="#">Figure 3</a>	[1]	-	75 A
			[2]	-	198 A
$I_{DM}$	peak drain current	$T_{mb} = 25^\circ\text{C}$ ; pulsed; $t_p \leq 10\text{ }\mu\text{s}$ ; see <a href="#">Figure 3</a>	-	794	A
$P_{tot}$	total power dissipation	$T_{mb} = 25^\circ\text{C}$ ; see <a href="#">Figure 2</a>	-	300	W
$T_{stg}$	storage temperature		-55	175	°C
$T_j$	junction temperature		-55	175	°C
<b>Source-drain diode</b>					
$I_S$	source current	$T_{mb} = 25^\circ\text{C}$	[3]	-	198 A
			[1]	-	75 A
$I_{SM}$	peak source current	pulsed; $t_p \leq 10\text{ }\mu\text{s}$ ; $T_{mb} = 25^\circ\text{C}$	-	794	A
<b>Avalanche ruggedness</b>					
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$I_D = 75\text{ A}$ ; $V_{sup} \leq 40\text{ V}$ ; $R_{GS} = 50\text{ }\Omega$ ; $V_{GS} = 5\text{ V}$ ; $T_{j(init)} = 25^\circ\text{C}$ ; unclamped	-	1.6	J

[1] Continuous current is limited by package.

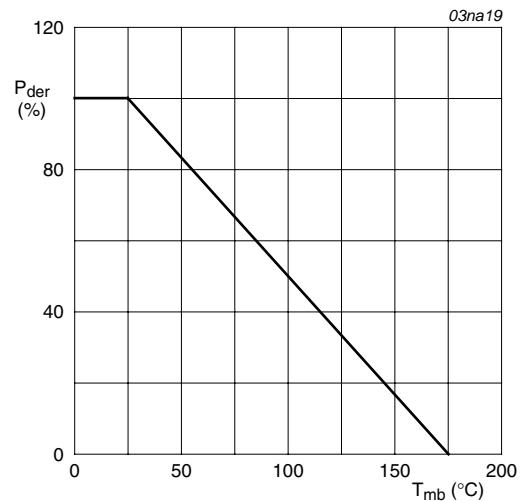
[2] Current is limited by power dissipation chip rating.

[3] Current is limited by power dissipation chip rating



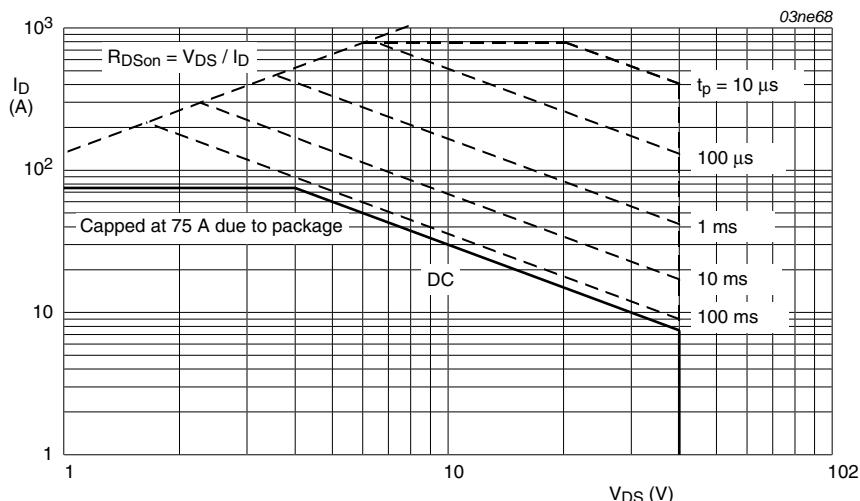
$$V_{GS} \geq 5V$$

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



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

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



$$T_{mb} = 25^\circ\text{C}; I_{DM} \text{ is single pulse}$$

**Fig 3. 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
$R_{th(j\text{-mb})}$	thermal resistance from junction to mounting base	see <a href="#">Figure 4</a>	-	-	0.5	K/W
$R_{th(j\text{-a})}$	thermal resistance from junction to ambient	vertical in still air	-	60	-	K/W

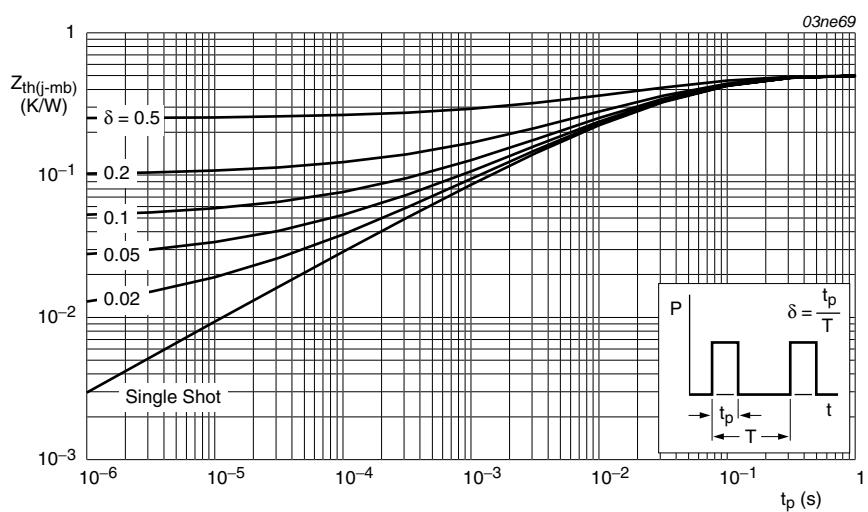


Fig 4. Transient thermal impedance from junction to mounting base as a function of pulse duration

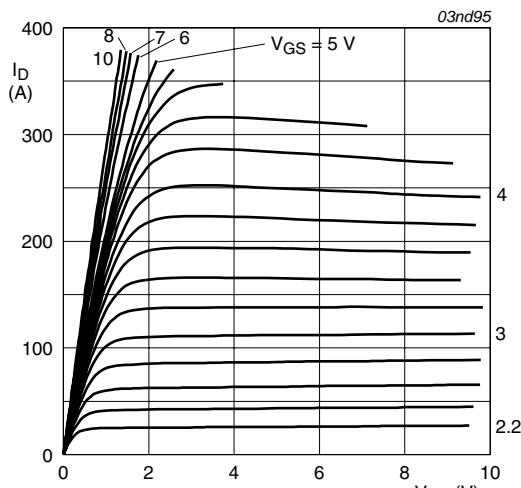
## 6. Characteristics

**Table 6. Characteristics**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics</b>						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 0.25 \text{ mA}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$ $I_D = 0.25 \text{ mA}; V_{GS} = 0 \text{ V}; T_j = -55 \text{ }^\circ\text{C}$	40	-	-	V
$V_{GS(\text{th})}$	gate-source threshold voltage	$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 25 \text{ }^\circ\text{C};$ see <a href="#">Figure 10</a> $I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 175 \text{ }^\circ\text{C};$ see <a href="#">Figure 10</a> $I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = -55 \text{ }^\circ\text{C};$ see <a href="#">Figure 10</a>	1	1.5	2	V
$I_{DSS}$	drain leakage current	$V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$ $V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 175 \text{ }^\circ\text{C}$	-	0.05	10	$\mu\text{A}$
$I_{GSS}$	gate leakage current	$V_{GS} = 10 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$ $V_{GS} = -10 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	2	100	nA
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = 4.3 \text{ V}; I_D = 25 \text{ A}; T_j = 25 \text{ }^\circ\text{C}$ $V_{GS} = 10 \text{ V}; I_D = 25 \text{ A}; T_j = 25 \text{ }^\circ\text{C}$ $V_{GS} = 5 \text{ V}; I_D = 25 \text{ A}; T_j = 175 \text{ }^\circ\text{C};$ see <a href="#">Figure 11</a> ; see <a href="#">Figure 12</a> $V_{GS} = 5 \text{ V}; I_D = 25 \text{ A}; T_j = 25 \text{ }^\circ\text{C};$ see <a href="#">Figure 11</a> ; see <a href="#">Figure 12</a>	-	3.7	5.9	$\text{m}\Omega$
<b>Dynamic characteristics</b>						
$Q_{G(\text{tot})}$	total gate charge	$I_D = 25 \text{ A}; V_{DS} = 32 \text{ V}; V_{GS} = 5 \text{ V};$	-	128	-	nC
$Q_{GS}$	gate-source charge	$T_j = 25 \text{ }^\circ\text{C};$ see <a href="#">Figure 13</a>	-	13	-	nC
$Q_{GD}$	gate-drain charge		-	56	-	nC
$C_{iss}$	input capacitance	$V_{GS} = 0 \text{ V}; V_{DS} = 25 \text{ V}; f = 1 \text{ MHz};$	-	6200	8260	pF
$C_{oss}$	output capacitance	$T_j = 25 \text{ }^\circ\text{C};$ see <a href="#">Figure 14</a>	-	1040	1250	pF
$C_{rss}$	reverse transfer capacitance		-	680	940	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = 30 \text{ V}; R_L = 1.2 \text{ }\Omega; V_{GS} = 5 \text{ V};$	-	62	-	ns
$t_r$	rise time	$R_{G(\text{ext})} = 10 \text{ }\Omega; T_j = 25 \text{ }^\circ\text{C}$	-	309	-	ns
$t_{d(off)}$	turn-off delay time		-	365	-	ns
$t_f$	fall time		-	306	-	ns
$L_D$	internal drain inductance	from contact screw on mounting base to centre of die SOT78 ; $T_j = 25 \text{ }^\circ\text{C}$	-	3.5	-	nH
		from drain lead 6 mm from package to centre of die ; $T_j = 25 \text{ }^\circ\text{C}$	-	4.5	-	nH
$L_S$	internal source inductance	from source lead to source bond pad ; $T_j = 25 \text{ }^\circ\text{C}$	-	7.5	-	nH

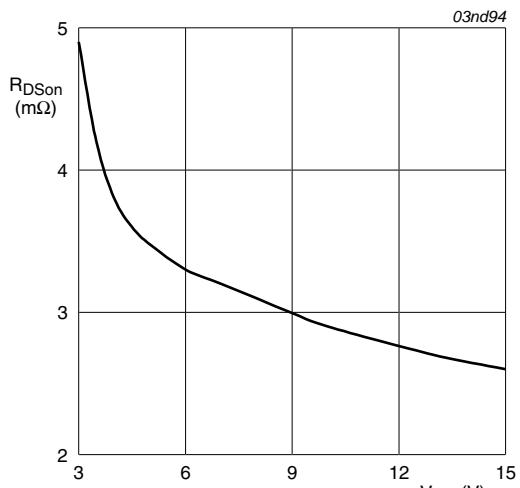
Table 6. Characteristics ...continued

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Source-drain diode</b>						
$V_{SD}$	source-drain voltage	$I_S = 40 \text{ A}$ ; $V_{GS} = 0 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$ ; see <a href="#">Figure 15</a>	-	0.85	1.2	V
$t_{rr}$	reverse recovery time	$I_S = 20 \text{ A}$ ; $dI_S/dt = -100 \text{ A}/\mu\text{s}$	-	260	-	ns
$Q_r$	recovered charge	$V_{GS} = -10 \text{ V}$ ; $V_{DS} = 30 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	531	-	nC



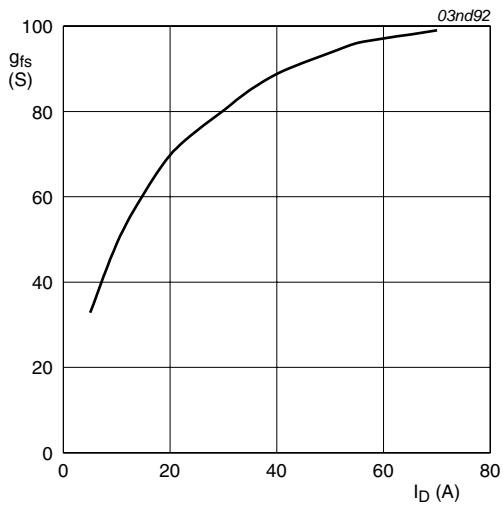
$T_j = 25 \text{ }^\circ\text{C}$ ;  $t_p = 300 \mu\text{s}$

Fig 5. Output characteristics: drain current as a function of drain-source voltage; typical values



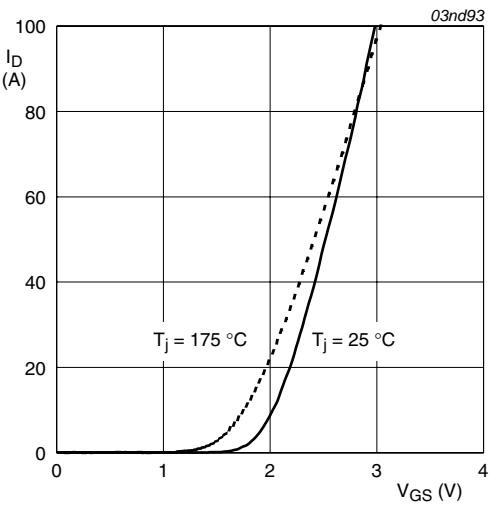
$T_j = 25 \text{ }^\circ\text{C}$ ;  $I_D = 25 \text{ A}$

Fig 6. Drain-source on-state resistance as a function of gate-source voltage; typical values



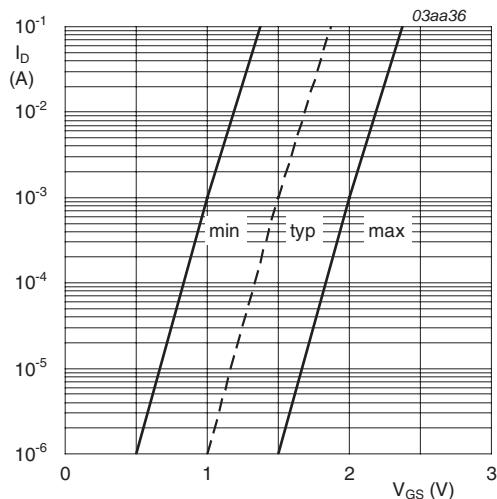
$T_j = 25 \text{ }^\circ\text{C}$ ;  $V_{DS} = 25 \text{ V}$

Fig 7. Forward transconductance as a function of drain current; typical values



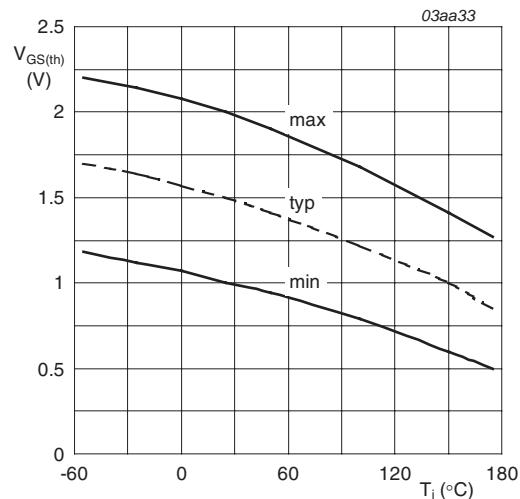
$V_{DS} = 25 \text{ V}$

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



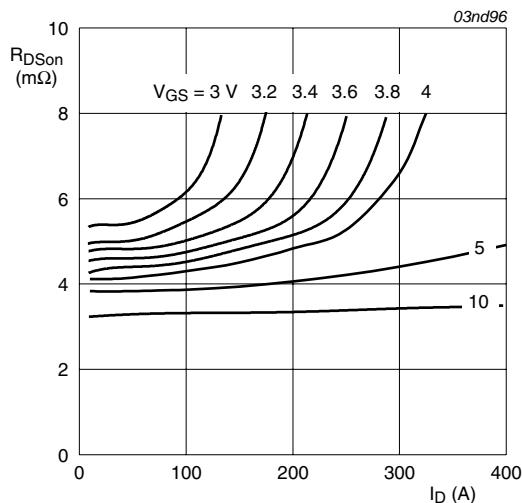
$T_j = 25^\circ C; V_{DS} = 5 V$

**Fig 9. Sub-threshold drain current as a function of gate-source voltage**



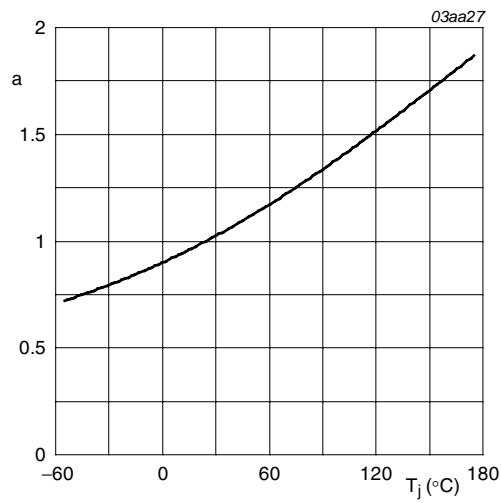
$I_D = 1 mA; V_{DS} = V_{GS}$

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



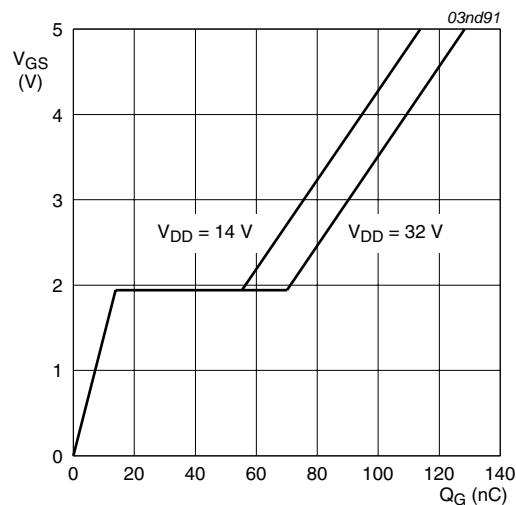
$T_j = 25^\circ C$

**Fig 11. Drain-source on-state resistance as a function of drain current; typical values**



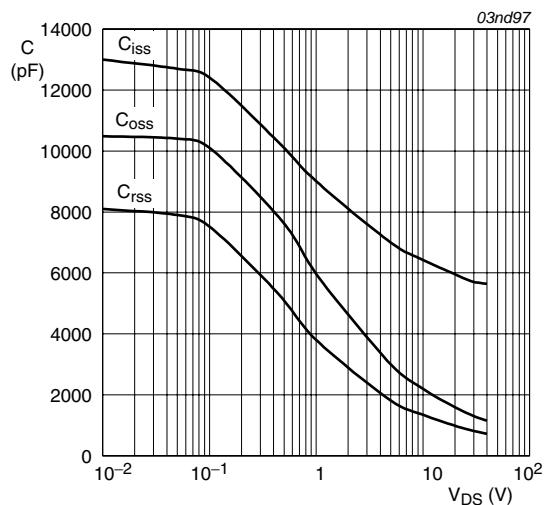
$$a = \frac{R_{DSon}}{R_{DSon}(25^\circ C)}$$

**Fig 12. Normalized drain-source on-state resistance factor as a function of junction temperature**



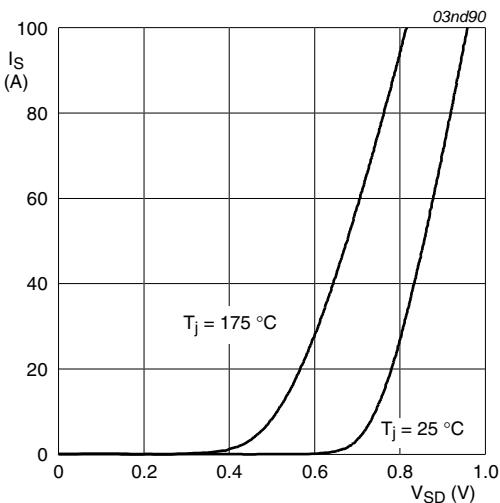
$T_j = 25^\circ\text{C}; I_D = 25\text{A}$

**Fig 13. Gate-source voltage as a function of turn-on gate charge; typical values**



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

**Fig 14. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values**



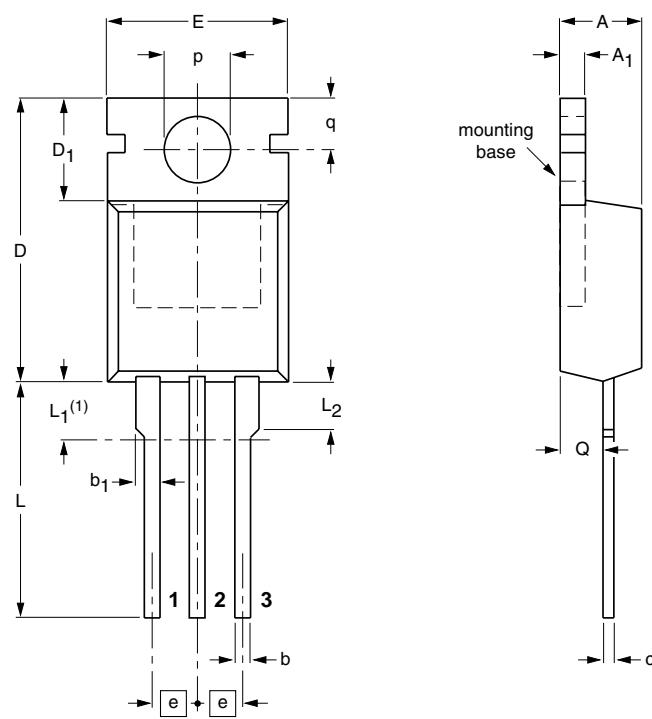
$V_{GS} = 0\text{V}$

**Fig 15. Reverse diode current as a function of reverse diode voltage; typical values**

## 7. Package outline

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

SOT78A



0 5 10 mm  
scale

### DIMENSIONS (mm are the original dimensions)

UNIT	A	A <sub>1</sub>	b	b <sub>1</sub>	c	D	D <sub>1</sub>	E	e	L	L <sub>1(1)</sub>	L <sub>2</sub> max.	p	q	Q
mm	4.5 4.1	1.39 1.27	0.9	1.3 1.0	0.7 0.4	15.8 15.2	6.4 5.9	10.3 9.7	2.54	15.0 13.5	3.30 2.79	3.0	3.8 3.6	3.0 2.7	2.6 2.2

### Note

1. Terminals in this zone are not tinned.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT78A		3-lead TO-220AB	SC-46			-03-01-22- 05-03-14

Fig 16. Package outline SOT78A (TO-220AB)

## 8. Revision history

**Table 7. Revision history**

Document ID	Release date	Data sheet status	Change notice	Supersedes
BUK9604-40A v.2	20110207	Product data sheet	-	BUK95_96_9E04_40A-01
Modifications:	<ul style="list-style-type: none"><li>• The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors.</li><li>• Legal texts have been adapted to the new company name where appropriate.</li><li>• Type number BUK9604-40A separated from data sheet BUK95_96_9E04_40A-01.</li></ul>			
BUK95_96_9E04_40A-01	20011024	Product specification	-	-

## 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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Date of release: 7 February 2011

Document identifier: BUK9504-40A