



# BUK7905-40AIE

## N-channel TrenchPLUS standard level FET

Rev. 05 — 10 February 2009

Product data sheet

## 1. Product profile

### 1.1 General description

Standard level N-channel enhancement mode Field-Effect Transistor (FET) in a plastic package using TrenchMOS technology. The devices include TrenchPLUS current sensing and diodes for ElectroStatic Discharge (ESD) protection. This product has been designed and qualified to the appropriate AEC standard for use in automotive critical applications.

### 1.2 Features and benefits

- Electrostatically robust due to integrated protection diodes
- Low conduction losses due to low on-state resistance
- Q101 compliant
- Reduced component count due to integrated current sensor
- Suitable for standard level gate drive sources

### 1.3 Applications

- Electrical Power Assisted Steering (EPAS)
- Variable Valve Timing for engines

### 1.4 Quick reference data

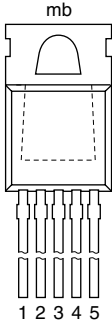
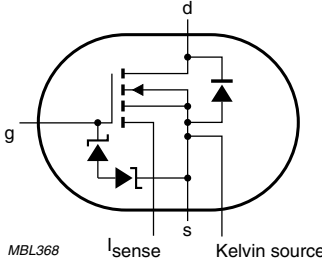
Table 1. Quick reference

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	$V_{GS} = 10\text{ V}; T_{mb} = 25\text{ °C};$ see <a href="#">Figure 2</a> ; see <a href="#">Figure 3</a> ;	[1]	-	155	A
<b>Static characteristics</b>						
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 10\text{ V}; I_D = 50\text{ A};$ $T_j = 25\text{ °C};$ see <a href="#">Figure 7</a> ; see <a href="#">Figure 8</a>	-	4.5	5	m $\Omega$
$I_D/I_{sense}$	ratio of drain current to sense current	$T_j > -55\text{ °C}; T_j < 175\text{ °C};$ $V_{GS} > 10\text{ V}$	450	500	550	

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

## 2. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	G	gate	 <p><b>SOT263B (TO-220)</b></p>	 <p>MBL368 I<sub>sense</sub> Kelvin source</p>
2	ISENSE	Sense current		
3	D	drain		
4	KS	Kelvin source		
5	S	source		
mb	D	mounting base; connected to drain		

## 3. Ordering information

Table 3. Ordering information

Type number	Package		Version
	Name	Description	
BUK7905-40AIE	TO-220	plastic single-ended package; heatsink mounted; 1 mounting hole; 5-lead TO-220	SOT263B

## 4. Limiting values

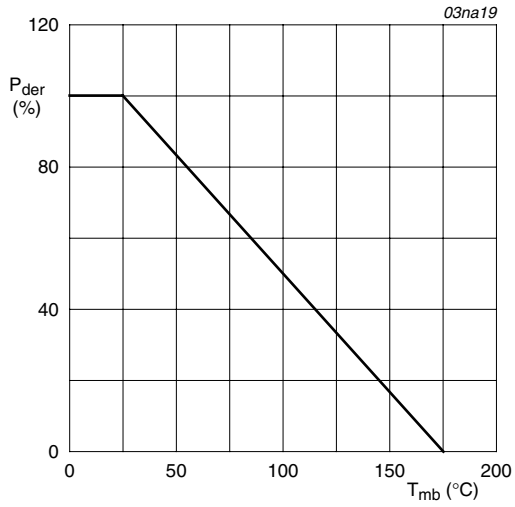
**Table 4. Limiting values**

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		-20	20	V	
$I_D$	drain current	$T_{mb} = 25\text{ °C}$ ; $V_{GS} = 10\text{ V}$ ; see <a href="#">Figure 2</a> ; see <a href="#">Figure 3</a>	[1]	-	155	A
			[2]	-	75	A
		$T_{mb} = 100\text{ °C}$ ; $V_{GS} = 10\text{ V}$ ; see <a href="#">Figure 2</a>	[2]	-	75	A
$I_{DM}$	peak drain current	$T_{mb} = 25\text{ °C}$ ; $t_p \leq 10\text{ }\mu\text{s}$ ; pulsed; see <a href="#">Figure 3</a>	-	620	A	
$P_{tot}$	total power dissipation	$T_{mb} = 25\text{ °C}$ ; see <a href="#">Figure 1</a>	-	272	W	
$I_{GS(CL)}$	gate-source clamping current	continuous	-	10	mA	
		pulsed; $t_p = 5\text{ ms}$ ; $\delta = 0.01$	-	50	mA	
$T_{stg}$	storage temperature		-55	175	°C	
$T_j$	junction temperature		-55	175	°C	
<b>Source-drain diode</b>						
$I_S$	source current	$T_{mb} = 25\text{ °C}$	[1]	-	155	A
			[2]	-	75	A
$I_{SM}$	peak source current	$t_p \leq 10\text{ }\mu\text{s}$ ; pulsed; $T_{mb} = 25\text{ °C}$	-	620	A	
<b>Avalanche ruggedness</b>						
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$I_D = 75\text{ A}$ ; $V_{sup} \leq 40\text{ V}$ ; $R_{GS} = 50\text{ }\Omega$ ; $V_{GS} = 10\text{ V}$ ; $T_{j(init)} = 25\text{ °C}$ ; unclamped	-	1.46	J	
<b>Electrostatic discharge</b>						
$V_{esd}$	electrostatic discharge voltage	HBM; $C = 100\text{ pF}$ ; $R = 1.5\text{ k}\Omega$	-	6	kV	

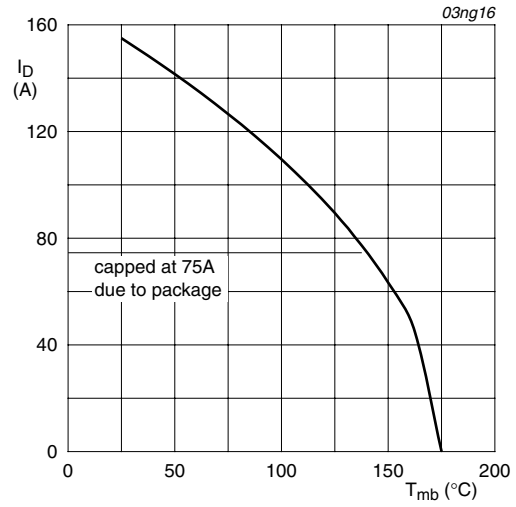
[1] Current is limited by power dissipation chip rating.

[2] Continuous current is limited by package.



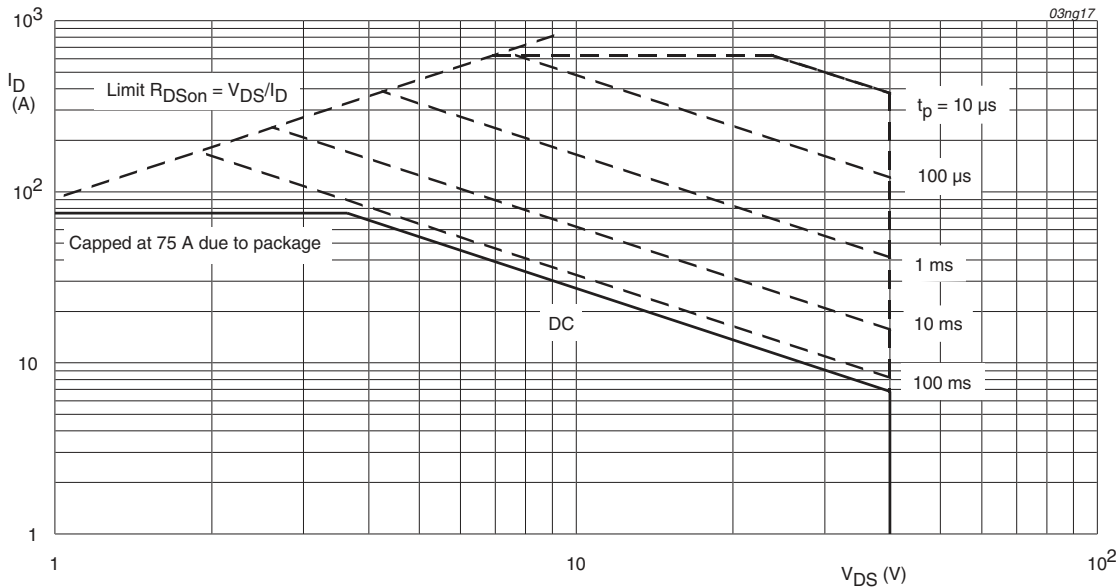
$$P_{der} = \frac{P_{tot}}{P_{tot(25^\circ C)}} \times 100\%$$

**Fig 1. Normalized total power dissipation as a function of mounting base temperature**



$$V_{GS} \geq 10V$$

**Fig 2. Continuous drain current as a function of mounting base temperature**



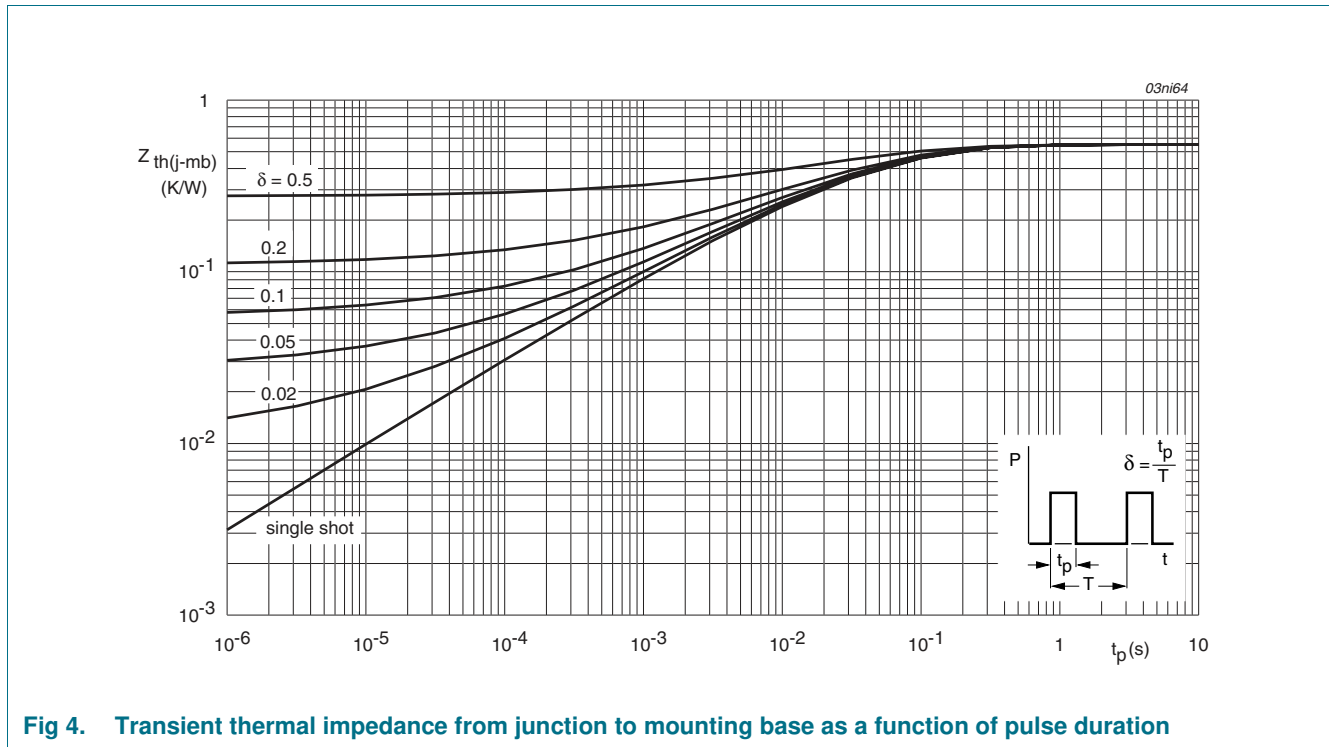
$T_{mb} = 25^\circ C; I_{DM}$  is single pulse

**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
$R_{th(j-a)}$	thermal resistance from junction to ambient	vertical in still air	-	60	-	K/W
$R_{th(j-mb)}$	thermal resistance from junction to mounting base	see <a href="#">Figure 4</a>	-	-	0.55	K/W



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

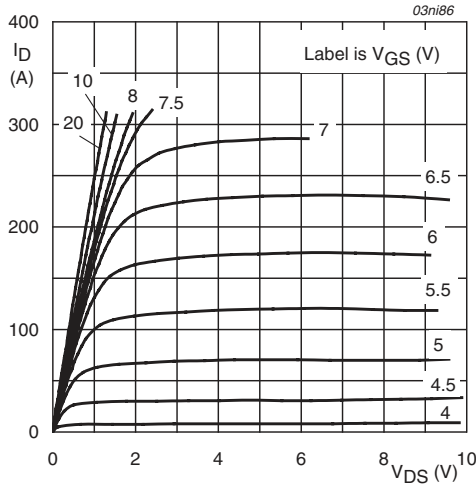
## 6. Characteristics

**Table 6. Characteristics**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics</b>						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 0.25 \text{ mA}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	40	-	-	V
		$I_D = 0.25 \text{ mA}; V_{GS} = 0 \text{ V}; T_j = -55 \text{ }^\circ\text{C}$	36	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 25 \text{ }^\circ\text{C};$ see <a href="#">Figure 9</a>	2	3	4	V
		$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 175 \text{ }^\circ\text{C};$ see <a href="#">Figure 9</a>	1	-	-	V
		$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = -55 \text{ }^\circ\text{C};$ see <a href="#">Figure 9</a>	-	-	4.4	V
$I_{DSS}$	drain leakage current	$V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	0.1	10	$\mu\text{A}$
		$V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 175 \text{ }^\circ\text{C}$	-	-	250	$\mu\text{A}$
$V_{(BR)GSS}$	gate-source breakdown voltage	$I_G = 1 \text{ mA}; V_{DS} = 0 \text{ V}; T_j < 175 \text{ }^\circ\text{C};$ $T_j > -55 \text{ }^\circ\text{C}$	20	22	-	V
		$I_G = -1 \text{ mA}; V_{DS} = 0 \text{ V}; T_j < 175 \text{ }^\circ\text{C};$ $T_j > -55 \text{ }^\circ\text{C}$	20	22	-	V
$I_{GSS}$	gate leakage current	$V_{DS} = 0 \text{ V}; V_{GS} = 10 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	22	1000	nA
		$V_{DS} = 0 \text{ V}; V_{GS} = -10 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	22	1000	nA
		$V_{DS} = 0 \text{ V}; V_{GS} = 10 \text{ V}; T_j = 175 \text{ }^\circ\text{C}$	-	-	10	$\mu\text{A}$
		$V_{DS} = 0 \text{ V}; V_{GS} = -10 \text{ V}; T_j = 175 \text{ }^\circ\text{C}$	-	-	10	$\mu\text{A}$
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 10 \text{ V}; I_D = 50 \text{ A}; T_j = 25 \text{ }^\circ\text{C};$ see <a href="#">Figure 7</a> ; see <a href="#">Figure 8</a>	-	4.5	5	m $\Omega$
		$V_{GS} = 10 \text{ V}; I_D = 50 \text{ A}; T_j = 175 \text{ }^\circ\text{C};$ see <a href="#">Figure 7</a> ; see <a href="#">Figure 8</a>	-	-	9.5	m $\Omega$
$R_{(D-ISENSE)on}$	drain-ISENSE on-state resistance	$V_{GS} = 10 \text{ V}; I_D = 100 \text{ mA}; T_j = 25 \text{ }^\circ\text{C};$ see <a href="#">Figure 16</a>	0.98	1.08	1.18	$\Omega$
		$V_{GS} = 10 \text{ V}; I_D = 100 \text{ mA}; T_j = 175 \text{ }^\circ\text{C};$ see <a href="#">Figure 16</a>	1.86	2.05	2.24	$\Omega$
$I_D/I_{sense}$	ratio of drain current to sense current	$V_{GS} > 10 \text{ V}; T_j > -55 \text{ }^\circ\text{C}; T_j < 175 \text{ }^\circ\text{C}$	450	500	550	
<b>Dynamic characteristics</b>						
$Q_{G(tot)}$	total gate charge	$I_D = 25 \text{ A}; V_{DS} = 32 \text{ V}; V_{GS} = 10 \text{ V};$ $T_j = 25 \text{ }^\circ\text{C};$ see <a href="#">Figure 14</a>	-	120	127	nC
$Q_{GS}$	gate-source charge		-	19	22	nC
$Q_{GD}$	gate-drain charge		-	50	60	nC
$C_{iss}$	input capacitance	$V_{GS} = 0 \text{ V}; V_{DS} = 25 \text{ V}; f = 1 \text{ MHz};$ $T_j = 25 \text{ }^\circ\text{C};$ see <a href="#">Figure 12</a>	-	4300	5000	pF
$C_{oss}$	output capacitance		-	1400	1670	pF
$C_{rss}$	reverse transfer capacitance		-	820	1100	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = 30 \text{ V}; R_L = 1.2 \text{ } \Omega; V_{GS} = 10 \text{ V};$ $R_{G(ext)} = 10 \text{ } \Omega; T_j = 25 \text{ }^\circ\text{C}$	-	35	-	ns
$t_r$	rise time		-	115	-	ns
$t_{d(off)}$	turn-off delay time		-	155	-	ns
$t_f$	fall time		-	110	-	ns

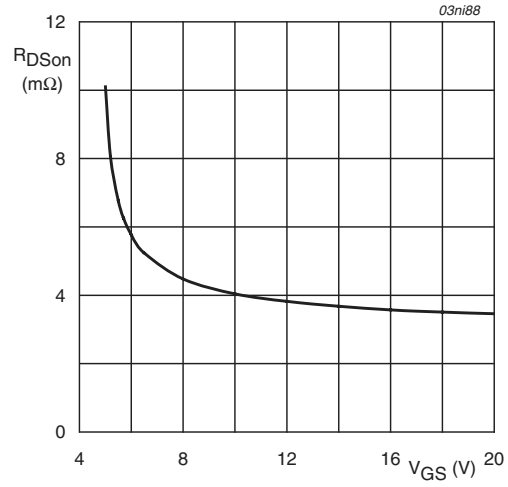
Table 6. Characteristics ...continued

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$L_D$	internal drain inductance	from upper edge of drain mounting base to centre of die; $T_j = 25\text{ °C}$	-	2.5	-	nH
$L_S$	internal source inductance	from source lead to source bond pad; $T_j = 25\text{ °C}$	-	7.5	-	nH
<b>Source-drain diode</b>						
$V_{SD}$	source-drain voltage	$I_S = 40\text{ A}$ ; $V_{GS} = 0\text{ V}$ ; $T_j = 25\text{ °C}$ ; see <a href="#">Figure 17</a>	-	0.85	1.2	V
$t_{rr}$	reverse recovery time	$I_S = 20\text{ A}$ ; $di_S/dt = -100\text{ A}/\mu\text{s}$ ; $V_{GS} = -10\text{ V}$ ;	-	96	-	ns
$Q_r$	recovered charge	$V_{DS} = 30\text{ V}$ ; $T_j = 25\text{ °C}$	-	224	-	nC



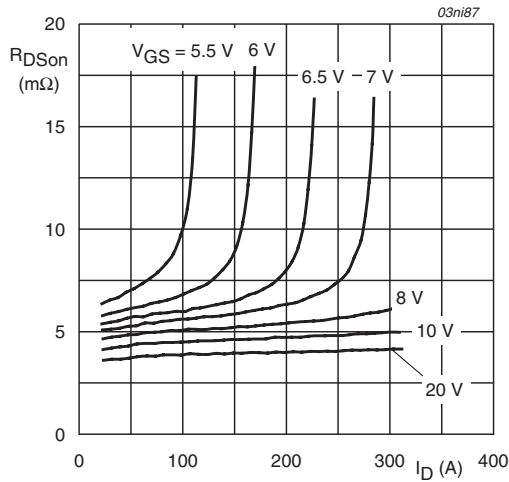
$T_j = 25^\circ\text{C}; t_p = 300\mu\text{s}$

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



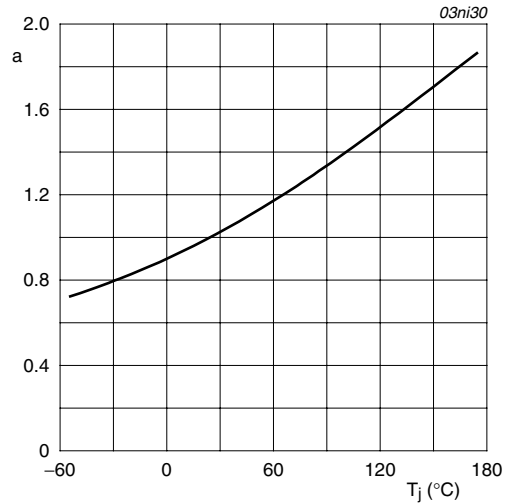
$T_j = 25^\circ\text{C}; I_D = 50\text{A}$

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



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

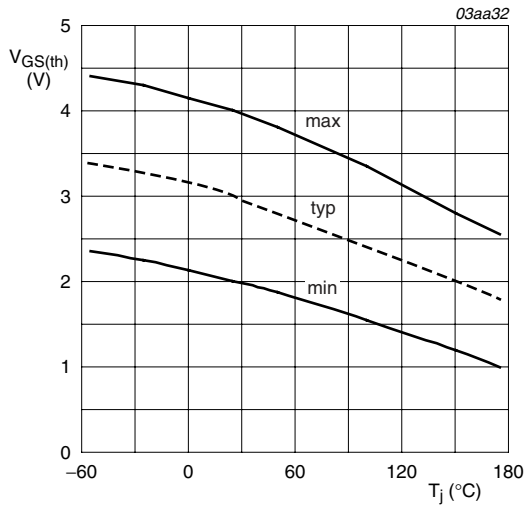
**Fig 7. Drain-source on-state resistance as a function of drain current; typical values**



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

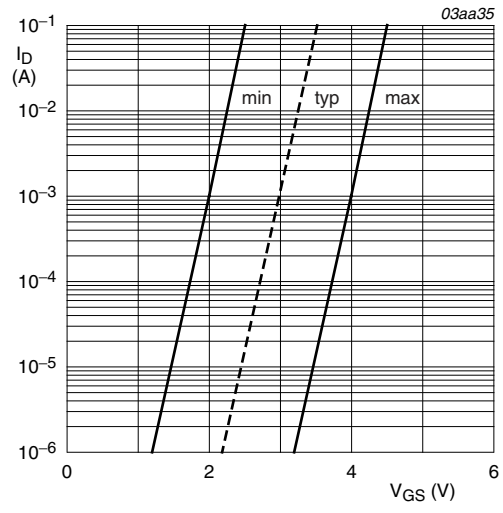
**Fig 8. Normalized drain-source on-state resistance factor as a function of junction temperature**





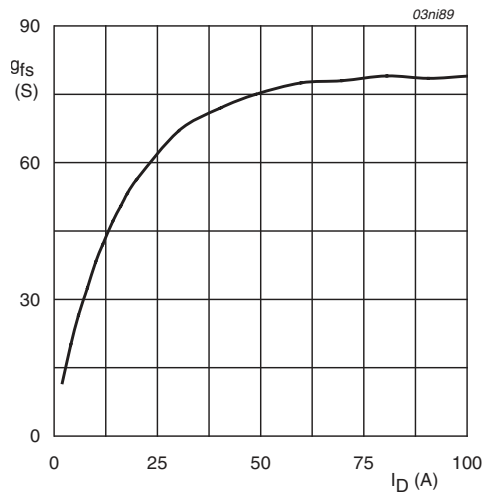
$I_D = 1\text{mA}; V_{DS} = V_{GS}$

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



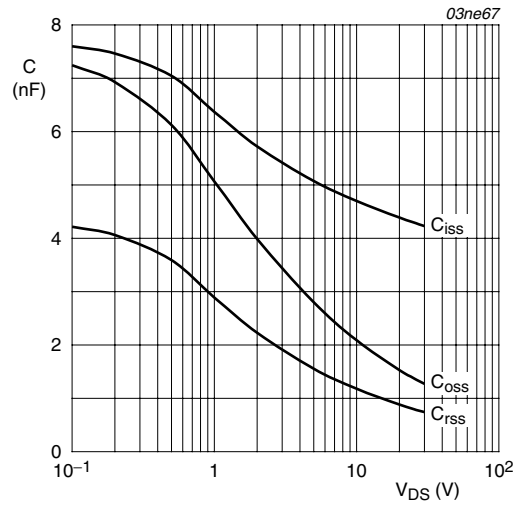
$T_j = 25^\circ\text{C}; V_{DS} = 5\text{V}$

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



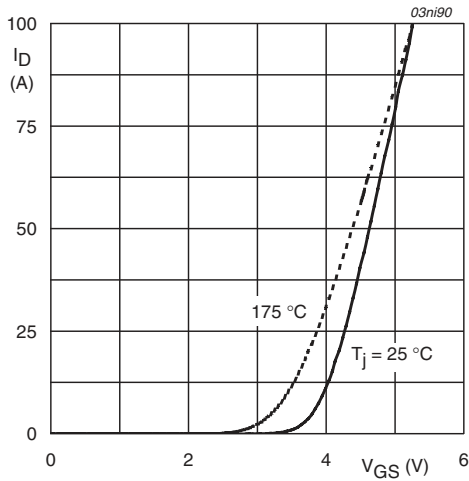
$T_j = 25^\circ\text{C}; V_{DS} = 25\text{V}$

**Fig 11. Forward transconductance as a function of drain current; typical values**



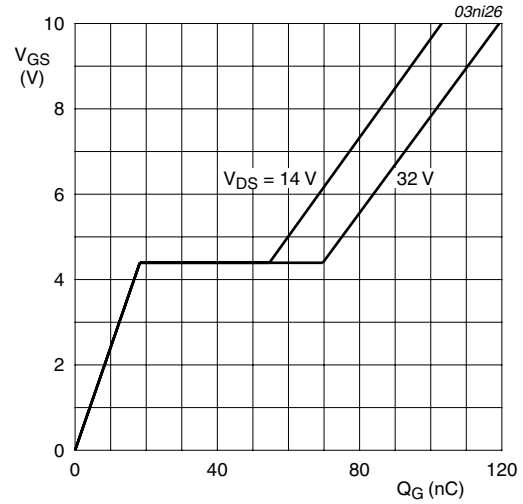
$V_{GS} = 0\text{V}; f = 1\text{MHz}$

**Fig 12. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values**



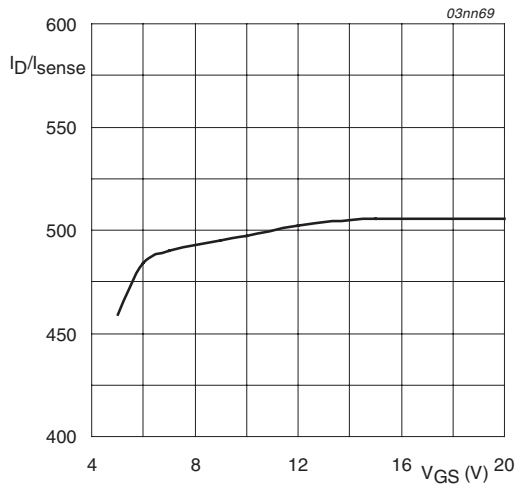
$V_{DS} = 25V$

**Fig 13. Transfer characteristics: drain current as a function of gate-source voltage; typical values**



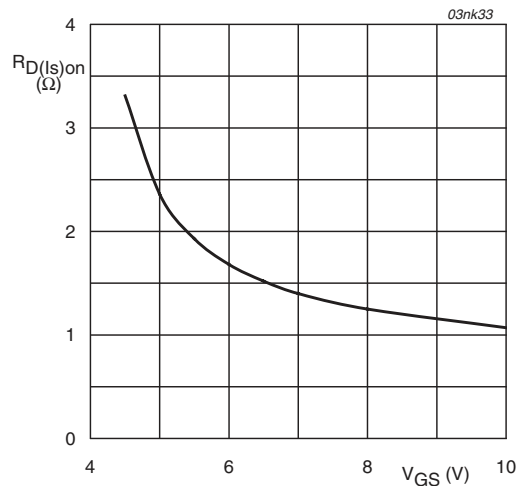
$T_j = 25\text{ °C}; I_D = 25A$

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



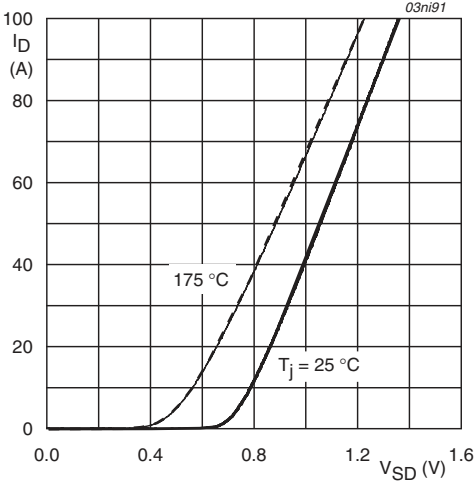
$I_D = 50A$

**Fig 15. Drain-sense current ratio as a function of gate-source voltage; typical values**



$I_{sense} = 25mA$

**Fig 16. Drain-sense current on-state resistance as a function of gate-source voltage; typical values**



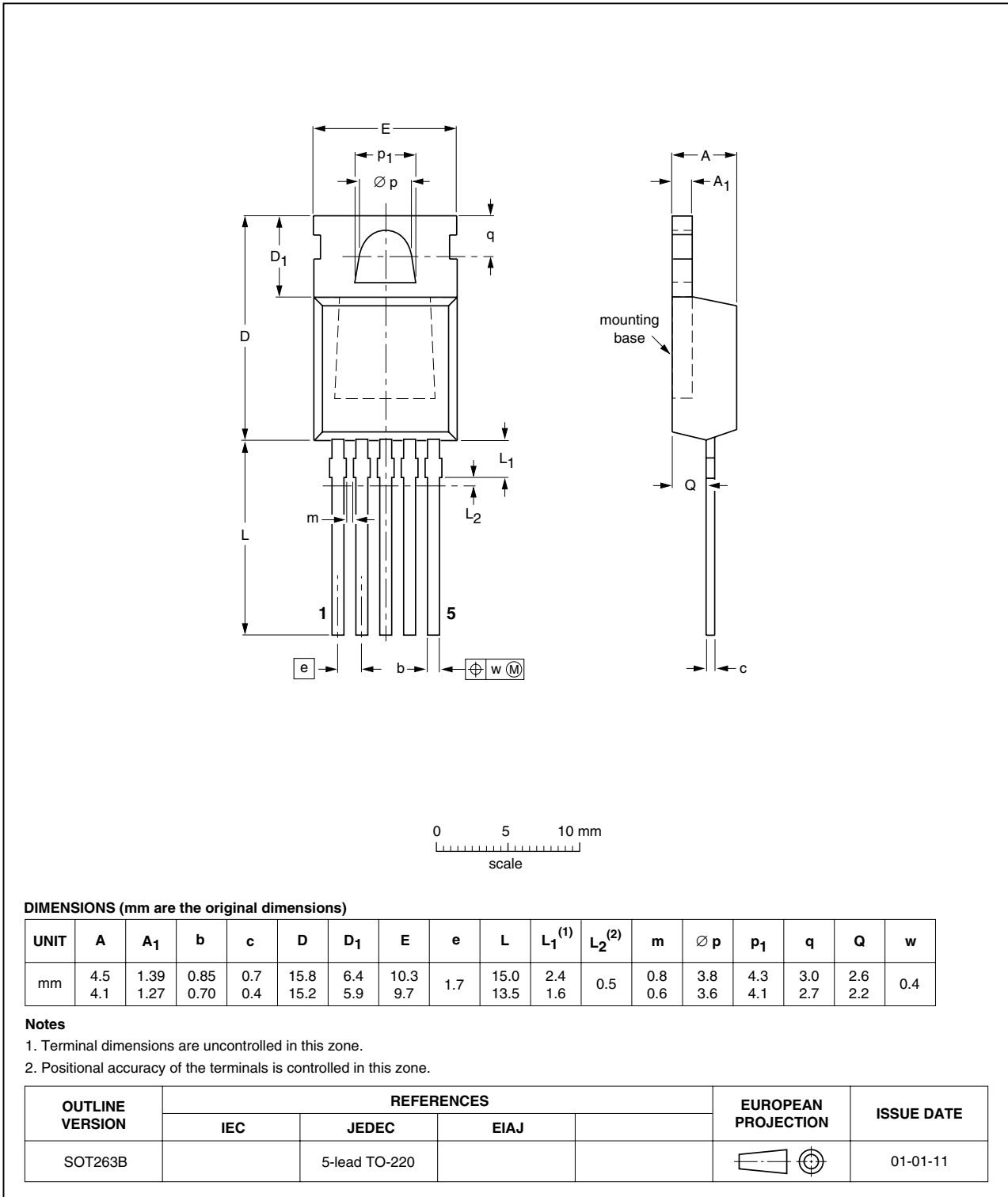
$V_{GS} = 0V$

**Fig 17. Drain current as a function of source-drain diode voltage; typical values**

**7. Package outline**

Plastic single-ended package; heatsink mounted; 1 mounting hole; 5-lead TO-220

SOT263B



**Fig 18. Package outline SOT263B (TO-220)**

## 8. Revision history

**Table 7. Revision history**

Document ID	Release date	Data sheet status	Change notice	Supersedes
BUK7905-40AIE_5	20090210	Product data sheet	-	BUK71_7905_40AIE-04
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 BUK7905-40AIE separated from data sheet BUK71_7905_40AIE-04.</li> </ul>		
BUK71_7905_40AIE-04	20040206	Product data	-	BUK71_7905_40AIE-03
BUK71_7905_40AIE-03	20030523	Product data	-	BUK71_7905_40AIE-02
BUK71_7905_40AIE-02	20021001	Product data	-	BUK71_7905_40AIE-01
BUK71_7905_40AIE-01	20020725	Product data	-	-

## 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.nexperia.com>.

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