

# BUK95/96/9E06-55B

N-channel TrenchMOS™ logic level FET

Rev. 03 — 30 November 2004

Product data sheet

## 1. Product profile

### 1.1 General description

N-channel enhancement mode field-effect power transistor in a plastic package using Philips High-Performance Automotive (HPA) TrenchMOS™ technology, featuring very low on-state resistance.

### 1.2 Features

- TrenchMOS™ technology
- 175 °C rated
- Q101 compliant
- Logic level compatible.

### 1.3 Applications

- Automotive systems
- Motors, lamps and solenoids
- 12 V and 24 V loads
- General purpose power switching.

### 1.4 Quick reference data

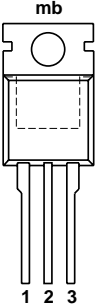
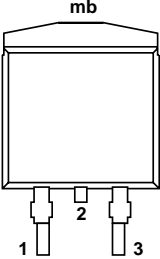
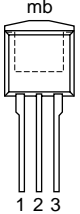
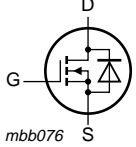
- $E_{DS(AL)S} \leq 679$  mJ
- $I_D \leq 75$  A
- $R_{DS(on)} = 5.1$  m $\Omega$  (typ)
- $P_{tot} \leq 258$  W.

## 2. Pinning information

Table 1: Pinning

Pin	Description	Simplified outline	Symbol
1	gate (G)		
2	drain (D) <a href="#">[1]</a>		
3	source (S)		
mb	mounting base; connected to drain (D)		

 SOT78 (TO-220AB)	 SOT404 (D²-PAK)	 SOT226 (I²-PAK)	 mbb076 S
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[1] It is not possible to make a connection to pin 2 of the SOT404 package.

### 3. Ordering information

**Table 2: Ordering information**

Type number	Package		Version
	Name	Description	
BUK9506-55B	TO-220AB	Plastic single-ended package; heatsink mounted; 1 mounting hole; 3-lead TO-220AB	SOT78
BUK9606-55B	D <sup>2</sup> -PAK	Plastic single-ended surface mounted package (Philips version of D <sup>2</sup> -PAK); 3 leads (one lead cropped)	SOT404
BUK9E06-55B	I <sup>2</sup> -PAK	Plastic single-ended package (Philips version of I <sup>2</sup> -PAK); low-profile 3 lead TO-220AB	SOT226

### 4. Limiting values

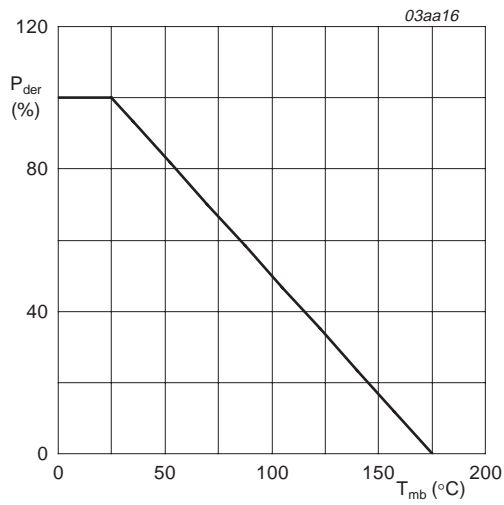
**Table 3: Limiting values**

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

Symbol	Parameter	Conditions	Min	Max	Unit	
V <sub>DS</sub>	drain-source voltage (DC)		-	55	V	
V <sub>DGR</sub>	drain-gate voltage (DC)	R <sub>GS</sub> = 20 kΩ	-	55	V	
V <sub>GS</sub>	gate-source voltage (DC)		-	±15	V	
I <sub>D</sub>	drain current (DC)	T <sub>mb</sub> = 25 °C; V <sub>GS</sub> = 5 V; <a href="#">Figure 2</a> and <a href="#">3</a>	<a href="#">[1]</a>	-	146	A
			<a href="#">[2]</a>	-	75	A
		T <sub>mb</sub> = 100 °C; V <sub>GS</sub> = 5 V; <a href="#">Figure 2</a>	<a href="#">[2]</a>	-	75	A
I <sub>DM</sub>	peak drain current	T <sub>mb</sub> = 25 °C; pulsed; t <sub>p</sub> ≤ 10 μs; <a href="#">Figure 3</a>	-	587	A	
P <sub>tot</sub>	total power dissipation	T <sub>mb</sub> = 25 °C; <a href="#">Figure 1</a>	-	258	W	
T <sub>stg</sub>	storage temperature		-55	+175	°C	
T <sub>j</sub>	junction temperature		-55	+175	°C	
<b>Source-drain diode</b>						
I <sub>DR</sub>	reverse drain current (DC)	T <sub>mb</sub> = 25 °C	<a href="#">[1]</a>	-	146	A
			<a href="#">[2]</a>	-	75	A
I <sub>DRM</sub>	peak reverse drain current	T <sub>mb</sub> = 25 °C; pulsed; t <sub>p</sub> ≤ 10 μs	-	587	A	
<b>Avalanche ruggedness</b>						
E <sub>DS(AL)S</sub>	non-repetitive drain-source avalanche energy	unclamped inductive load; I <sub>D</sub> = 75 A; V <sub>DS</sub> ≤ 55 V; R <sub>GS</sub> = 50 Ω; V <sub>GS</sub> = 5 V; starting at T <sub>j</sub> = 25 °C	-	679	mJ	

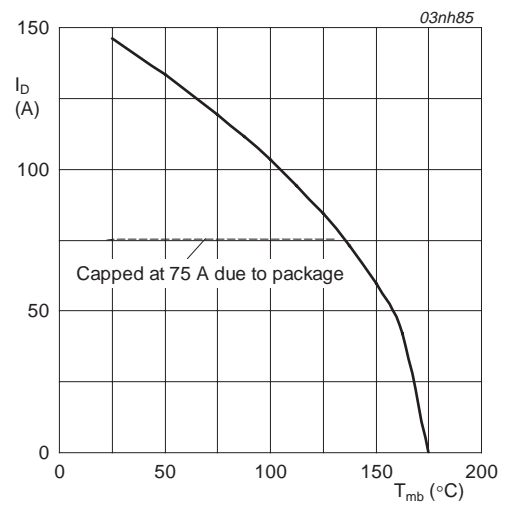
[1] Current is limited by power dissipation chip rating

[2] Continuous current is limited by package



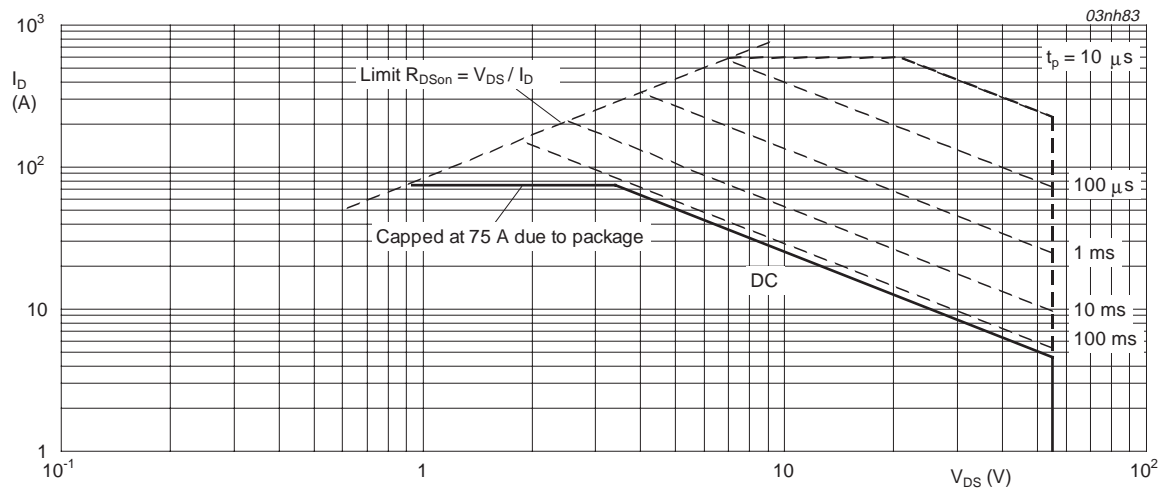
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\%$$

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



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

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



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

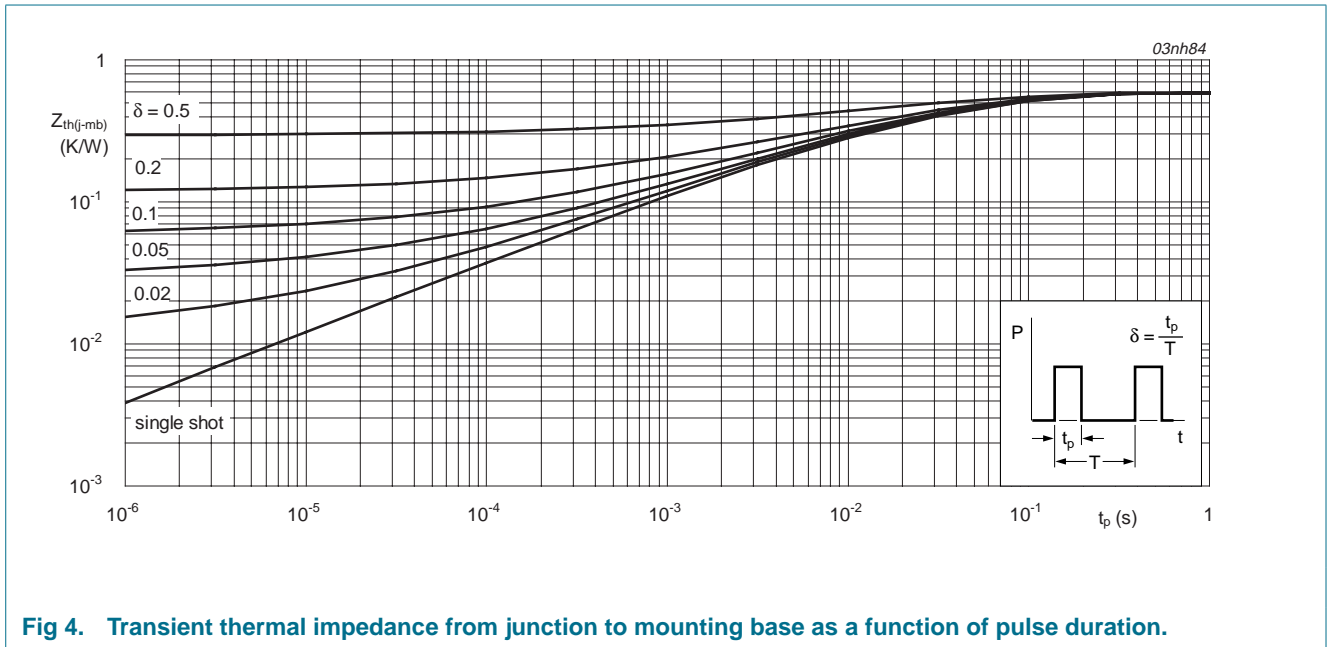
**Fig 3. Safe operating area; continuous and peak drain currents as a function of drain-source voltage.**

## 5. Thermal characteristics

**Table 4: Thermal characteristics**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$R_{th(j-mb)}$	thermal resistance from junction to mounting base	<a href="#">Figure 4</a>	-	-	0.58	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient					
	SOT78 (TO-220AB) and SOT226 (I <sup>2</sup> -PAK)	vertical in free air	-	60	-	K/W
	SOT404 (D <sup>2</sup> -PAK)	mounted on a printed-circuit board; minimum footprint; vertical in still air	-	50	-	K/W

### 5.1 Transient thermal impedance



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

## 6. Characteristics

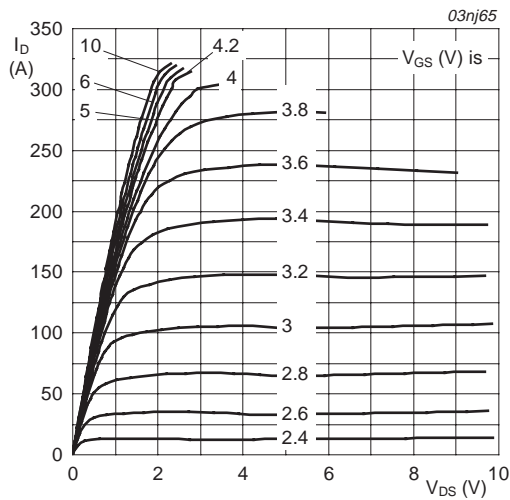
**Table 5: Characteristics**
*T<sub>j</sub> = 25 °C unless otherwise specified.*

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics</b>						
V <sub>(BR)DSS</sub>	drain-source breakdown voltage	I <sub>D</sub> = 250 μA; V <sub>GS</sub> = 0 V				
		T <sub>j</sub> = 25 °C	55	-	-	V
		T <sub>j</sub> = -55 °C	50	-	-	V
V <sub>GS(th)</sub>	gate-source threshold voltage	I <sub>D</sub> = 1 mA; V <sub>DS</sub> = V <sub>GS</sub> ; <a href="#">Figure 9</a> and <a href="#">10</a>				
		T <sub>j</sub> = 25 °C	1.1	1.5	2	V
		T <sub>j</sub> = 175 °C	0.5	-	-	V
		T <sub>j</sub> = -55 °C	-	-	2.3	V
I <sub>DSS</sub>	drain-source leakage current	V <sub>DS</sub> = 55 V; V <sub>GS</sub> = 0 V				
		T <sub>j</sub> = 25 °C	-	0.02	1	μA
		T <sub>j</sub> = 175 °C	-	-	500	μA
I <sub>GSS</sub>	gate-source leakage current	V <sub>GS</sub> = ±15 V; V <sub>DS</sub> = 0 V	-	2	100	nA
R <sub>DS(on)</sub>	drain-source on-state resistance	V <sub>GS</sub> = 5 V; I <sub>D</sub> = 25 A; <a href="#">Figure 6</a> and <a href="#">8</a>				
		T <sub>j</sub> = 25 °C	-	5.1	6.0	mΩ
		T <sub>j</sub> = 175 °C	-	-	12	mΩ
		V <sub>GS</sub> = 4.5 V; I <sub>D</sub> = 25 A; <a href="#">Figure 6</a> and <a href="#">8</a>	-	-	6.4	mΩ
		V <sub>GS</sub> = 10 V; I <sub>D</sub> = 25 A; <a href="#">Figure 6</a> and <a href="#">8</a>	-	4.8	5.4	mΩ
<b>Dynamic characteristics</b>						
Q <sub>g(tot)</sub>	total gate charge	I <sub>D</sub> = 25 A; V <sub>DD</sub> = 44 V; V <sub>GS</sub> = 5 V;	-	60	-	nC
Q <sub>gs</sub>	gate-source charge	<a href="#">Figure 14</a> and <a href="#">16</a>	-	11	-	nC
Q <sub>gd</sub>	gate-drain (Miller) charge		-	22	-	nC
V <sub>plat</sub>	plateau voltage		-	2.4	-	V
C <sub>iss</sub>	input capacitance	V <sub>GS</sub> = 0 V; V <sub>DS</sub> = 25 V; f = 1 MHz;	-	5 674	7 565	pF
C <sub>oss</sub>	output capacitance	<a href="#">Figure 12</a>	-	755	906	pF
C <sub>rss</sub>	reverse transfer capacitance		-	255	350	pF
t <sub>d(on)</sub>	turn-on delay time	V <sub>DS</sub> = 30 V; R <sub>L</sub> = 1.2 Ω;	-	37	-	ns
t <sub>r</sub>	rise time	V <sub>GS</sub> = 5 V; R <sub>G</sub> = 10 Ω	-	95	-	ns
t <sub>d(off)</sub>	turn-off delay time		-	117	-	ns
t <sub>f</sub>	fall time		-	106	-	ns
L <sub>d</sub>	internal drain inductance	from drain lead 6 mm from package to center of die	-	4.5	-	nH
		from contact screw on mounting base to center of die SOT78	-	3.5	-	nH
		from upper edge of drain mounting base to center of die SOT404/SOT226	-	2.5	-	nH
L <sub>s</sub>	internal source inductance	from source lead to source bonding pad	-	7.5	-	nH

**Table 5: Characteristics**

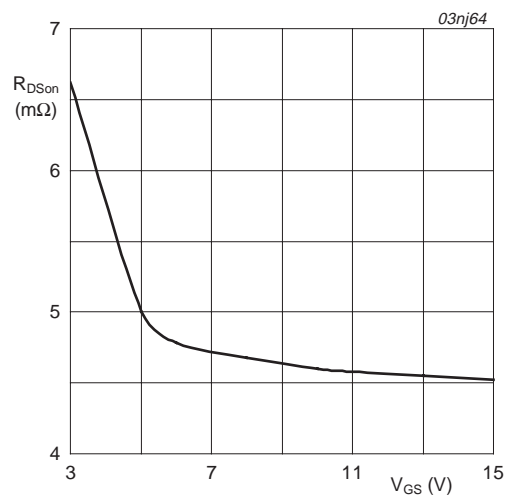
$T_j = 25\text{ }^\circ\text{C}$  unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Source-drain diode</b>						
$V_{SD}$	source-drain (diode forward) voltage	$I_S = 25\text{ A}$ ; $V_{GS} = 0\text{ V}$ ; <a href="#">Figure 15</a>	-	0.85	1.2	V
$t_{rr}$	reverse recovery time	$I_S = 20\text{ A}$ ; $dI_S/dt = -100\text{ A}/\mu\text{s}$ ;	-	64	-	ns
$Q_r$	recovered charge	$V_{GS} = 0\text{ V}$ ; $V_R = 30\text{ V}$	-	79	-	nC



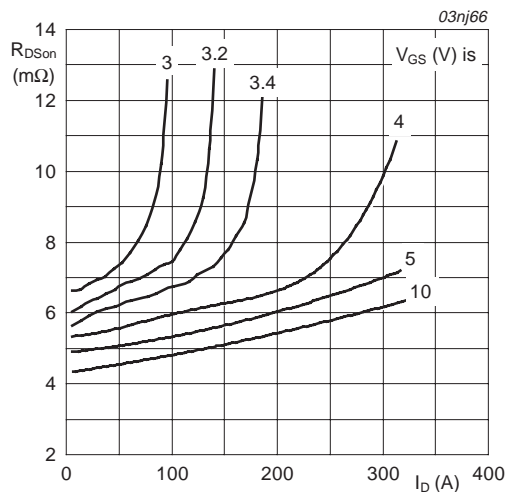
$T_j = 25\text{ }^\circ\text{C}$

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



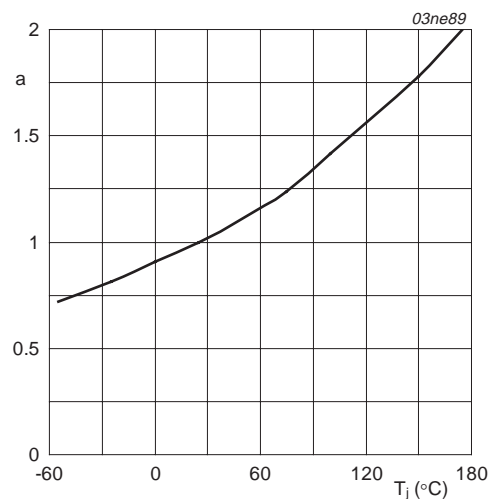
$T_j = 25\text{ }^\circ\text{C}$ ;  $I_D = 25\text{ A}$

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



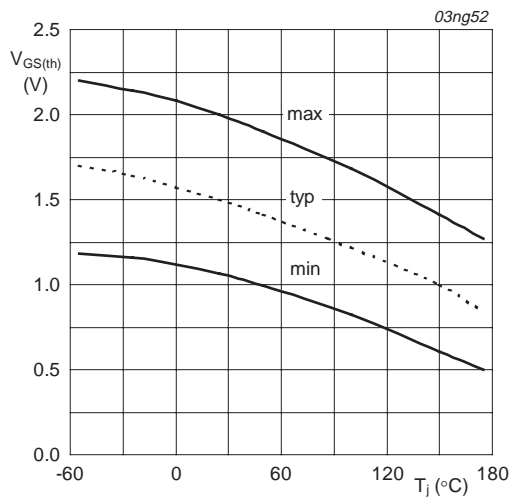
$T_j = 25\text{ }^\circ\text{C}$

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



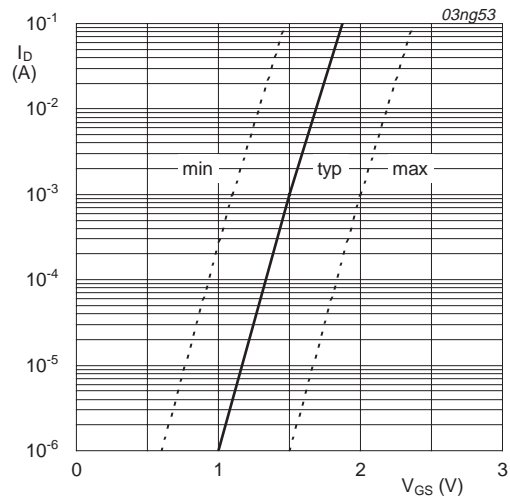
$$a = \frac{R_{DSon}}{R_{DSon}(25\text{ }^\circ\text{C})}$$

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



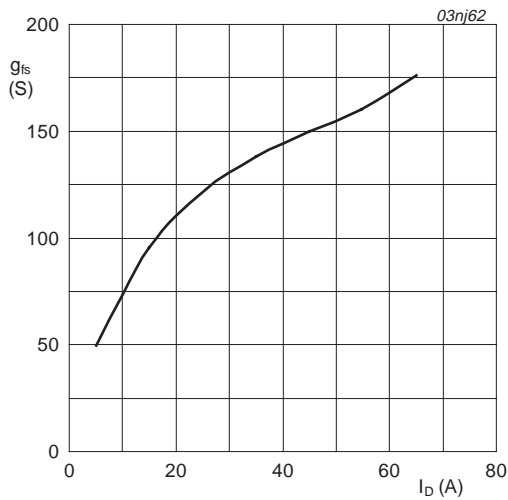
$I_D = 1 \text{ mA}; V_{DS} = V_{GS}$

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



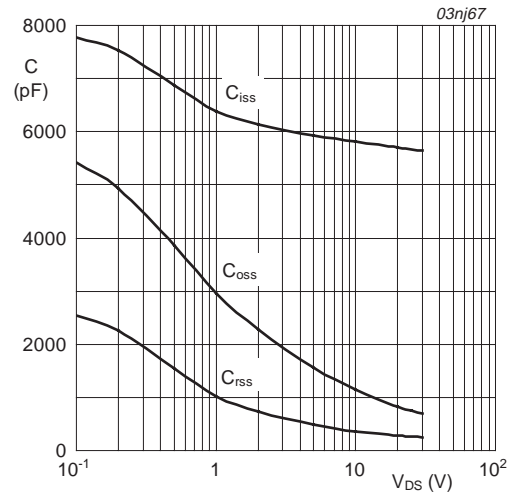
$T_j = 25 \text{ }^\circ\text{C}; V_{DS} = V_{GS}$

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



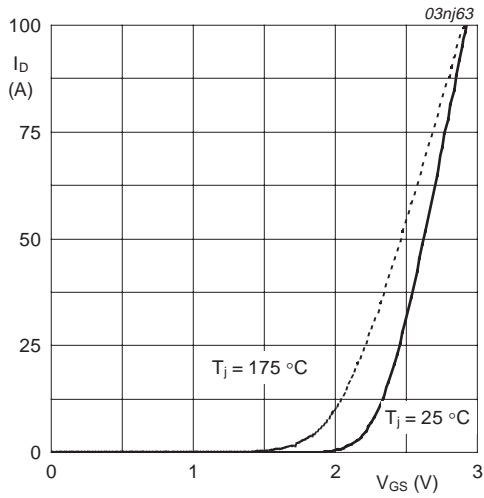
$T_j = 25 \text{ }^\circ\text{C}; V_{DS} = 25 \text{ V}$

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



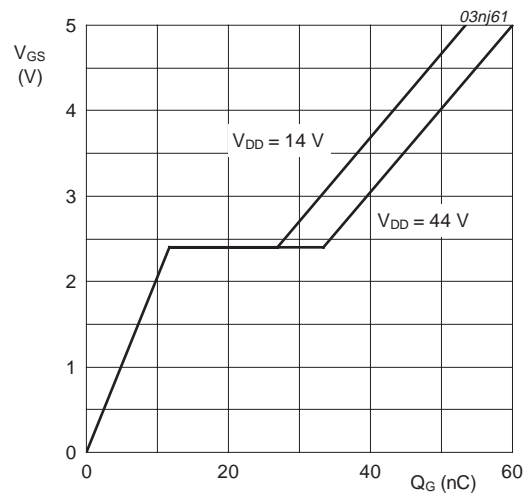
$V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$

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



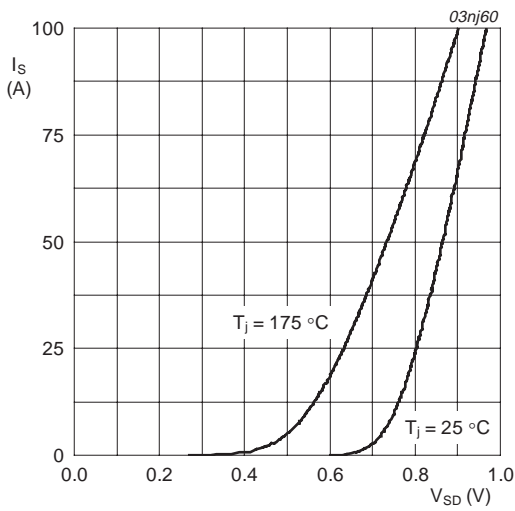
$V_{DS} = 25\text{ V}$

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



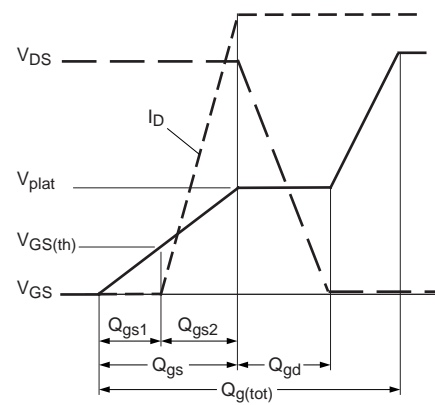
$T_j = 25\text{ °C}; I_D = 25\text{ A}$

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



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

**Fig 15. Source (diode forward) current as a function of source-drain (diode forward) voltage; typical values.**



**Fig 16. Gate charge waveform definitions.**



**7. Package outline**

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

SOT78

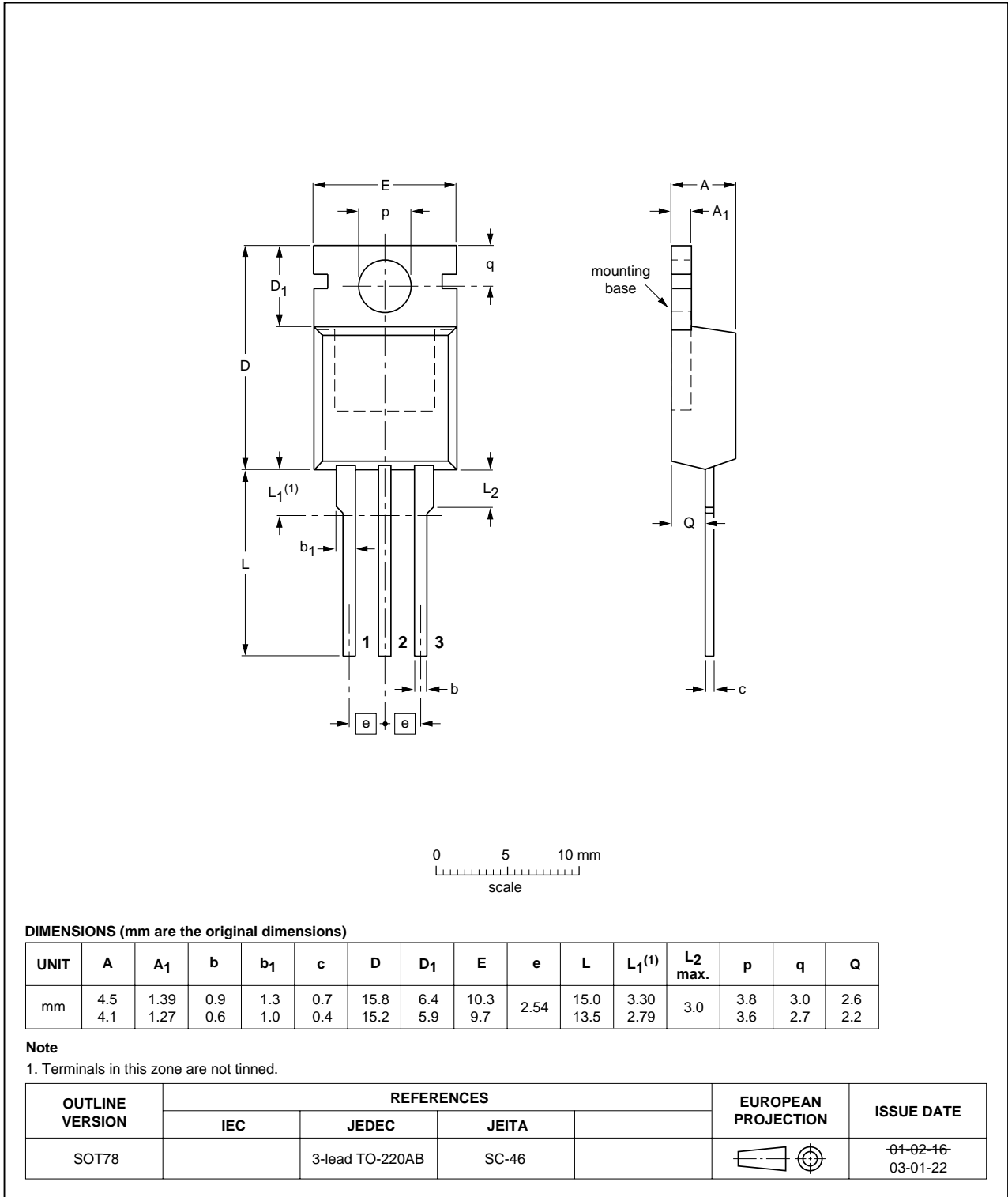
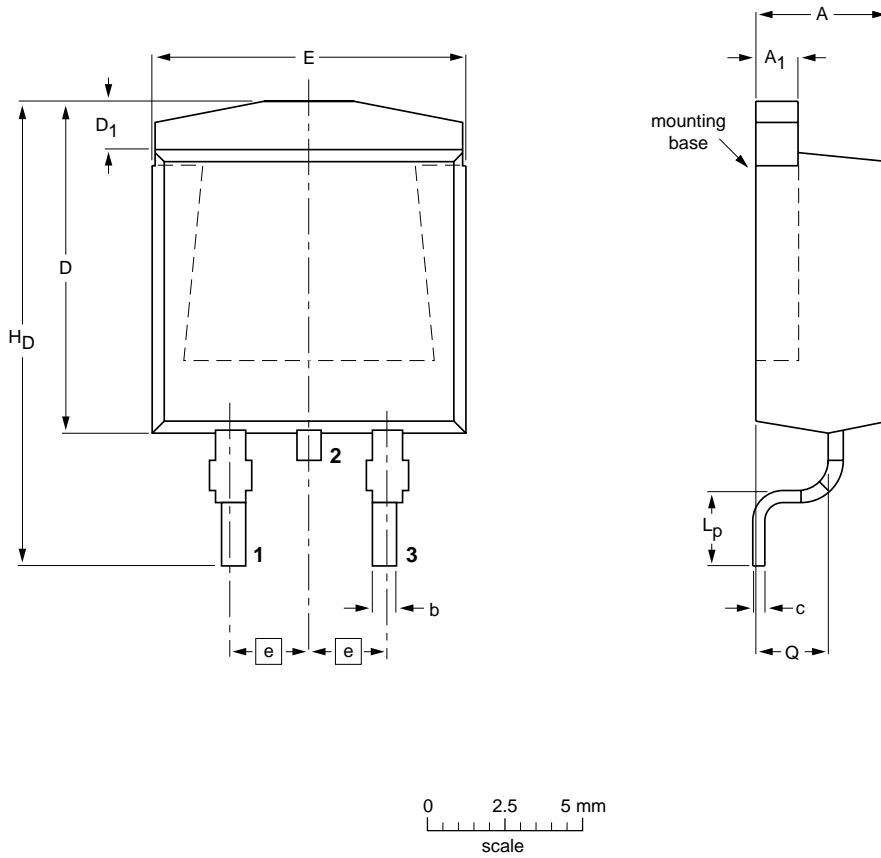


Fig 17. Package outline SOT78 (TO-220AB).

Plastic single-ended surface mounted package (D<sup>2</sup>-PAK); 3 leads (one lead cropped)

SOT404



DIMENSIONS (mm are the original dimensions)

UNIT	A	A <sub>1</sub>	b	c	D max.	D <sub>1</sub>	E	e	L <sub>p</sub>	H <sub>D</sub>	Q
mm	4.50 4.10	1.40 1.27	0.85 0.60	0.64 0.46	11	1.60 1.20	10.30 9.70	2.54	2.90 2.10	15.80 14.80	2.60 2.20

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT404						01-02-12 04-10-13

Fig 18. Package outline SOT404 (D<sup>2</sup>-PAK).

Plastic single-ended package (Philips version of I<sup>2</sup>-PAK); low-profile 3 lead TO-220AB

SOT226

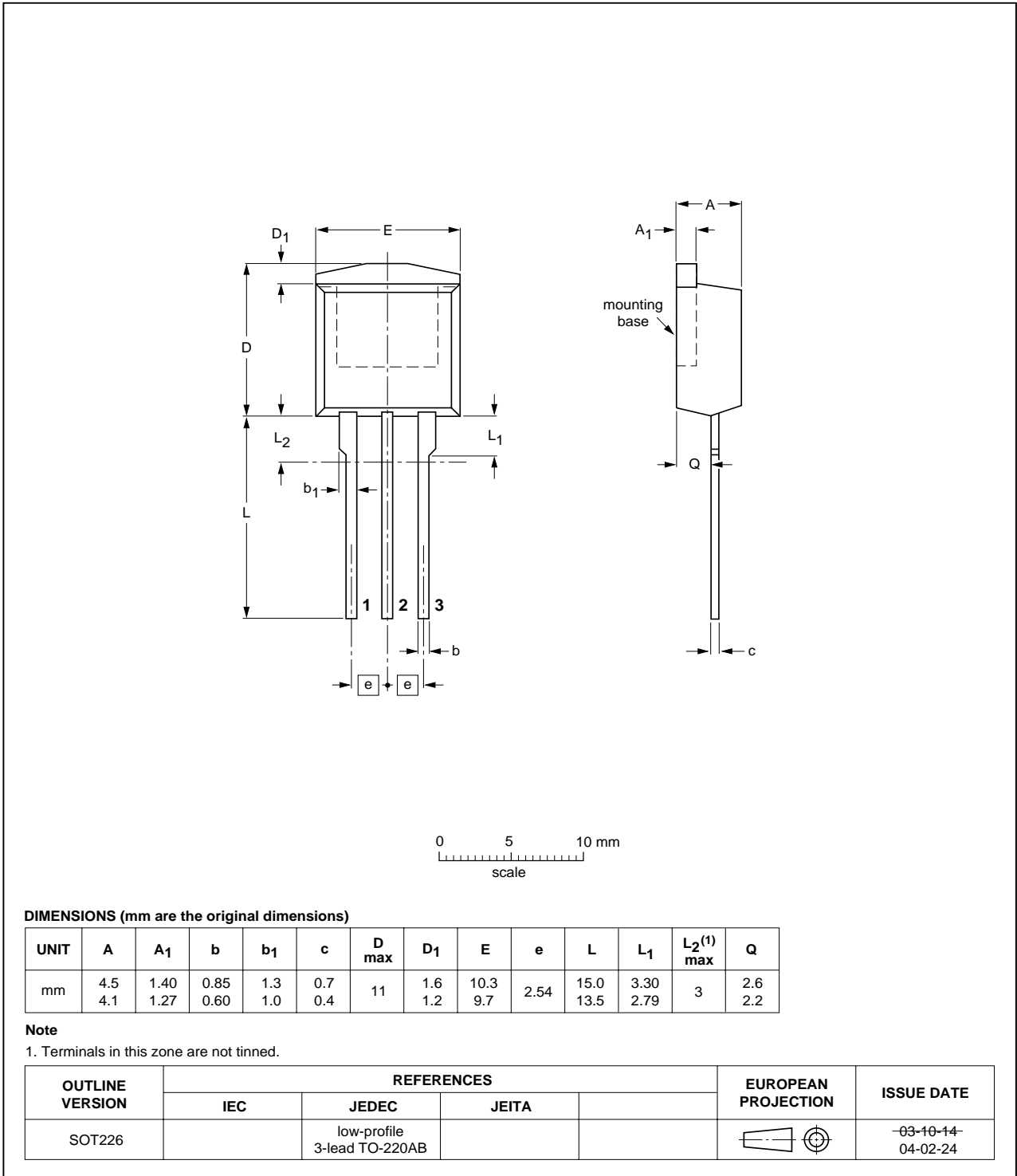
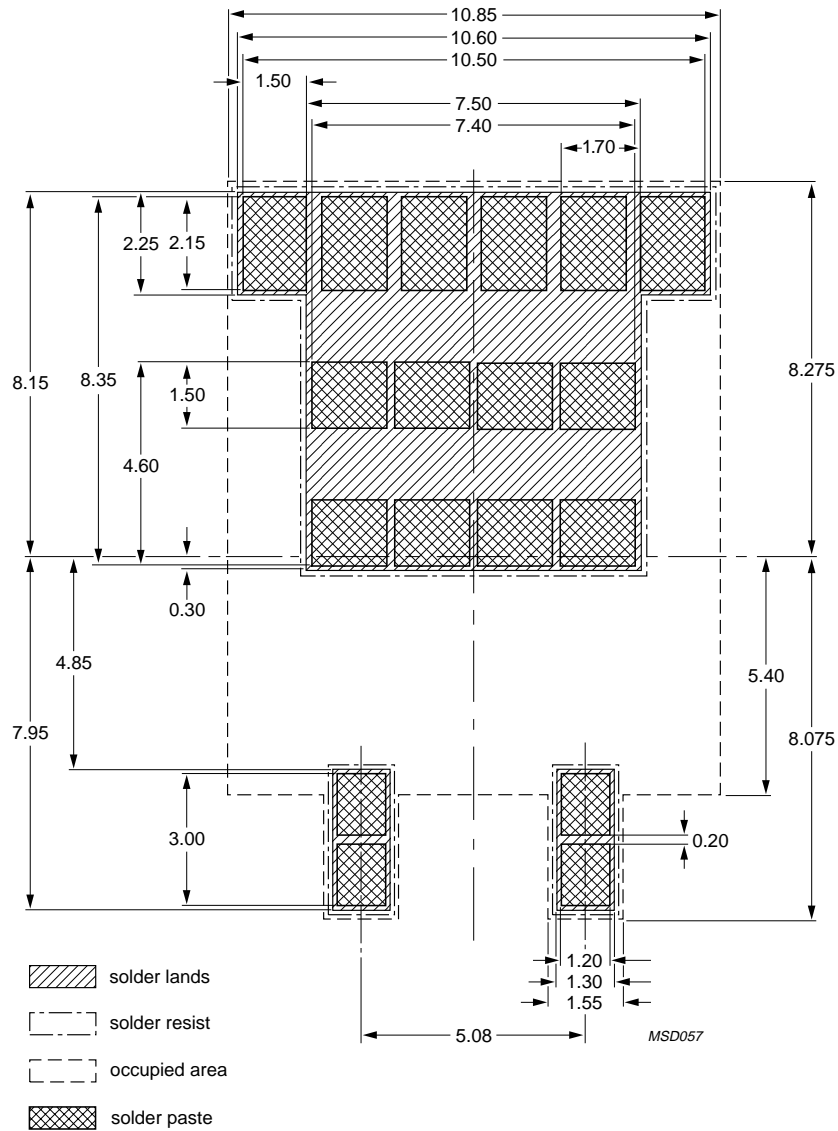


Fig 19. Package outline SOT226 (I<sup>2</sup>-PAK).

**8. Mounting**



Dimensions in mm.

**Fig 20. Reflow soldering footprint for SOT404.**

## 9. Revision history

**Table 6: Revision history**

Document ID	Release date	Data sheet status	Change notice	Doc number	Supersedes
BUK95_96_9E06_55B_3	20041130	Product data sheet	-	9397 750 13519	BUK95_96_9E06_55B_2
Modifications:			<ul style="list-style-type: none"><li>• The format of this data sheet has been redesigned to comply with the new presentation and information standard of Philips Semiconductors.</li><li>• Latest version of package outlines imported into <a href="#">Section 7</a> of data sheet.</li></ul>		
BUK95_96_9E06_55B-02	20021010	Product data sheet	-	9397 750 10474	BUK95_96_9E06_55B-01
BUK95_96_9E06_55B-01	20020813	Product data sheet	-	9397 750 09946	-

## 10. Data sheet status

Level	Data sheet status <sup>[1]</sup>	Product status <sup>[2] [3]</sup>	Definition
I	Objective data	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.
II	Preliminary data	Qualification	This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product.
III	Product data	Production	This data sheet contains data from the product specification. Philips Semiconductors reserves the right to make changes at any time in order to improve the design, manufacturing and supply. Relevant changes will be communicated via a Customer Product/Process Change Notification (CPCN).

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

[2] The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Internet at URL <http://www.semiconductors.philips.com>.

[3] For data sheets describing multiple type numbers, the highest-level product status determines the data sheet status.

## 11. Definitions

**Short-form specification** — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

**Limiting values definition** — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

**Application information** — Applications that are described herein for any of these products are for illustrative purposes only. Philips Semiconductors make no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

## 12. Disclaimers

**Life support** — These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips Semiconductors

## 14. Contact information

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## 13. Trademarks

**TrenchMOS** — is a trademark of Koninklijke Philips Electronics N.V.

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