

# PHD20N06T

N-channel TrenchMOS™ transistor

Rev. 01 — 22 February 2001

Product specification

## 1. Description

N-channel enhancement mode field-effect power transistor in a plastic package using TrenchMOS™<sup>1</sup> technology.

Product availability:

PHD20N06T in SOT428 (D-PAK).

## 2. Features

- TrenchMOS™ technology
- Low on-state resistance
- Fast switching.

## 3. Applications

- Switched mode power supplies
- DC to DC converters
- General purpose switch.

## 4. Pinning information

Table 1: Pinning - SOT428 (D-PAK), simplified outline and symbol

Pin	Description	Simplified outline	Symbol
1	gate (g)	<p>Top view MBK091</p> <p><b>SOT428 (D-PAK)</b></p>	<p>MBB076</p>
2	drain (d)		
3	source (s)		
mb	drain (d)		

1. TrenchMOS is a trademark of Royal Philips Electronics.



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## 5. Quick reference data

**Table 2: Quick reference data**

Symbol	Parameter	Conditions	Typ	Max	Unit
$V_{DS}$	drain-source voltage (DC)		–	55	V
$I_D$	drain current (DC)	$T_{mb} = 25\text{ °C}; V_{GS} = 10\text{ V}$	–	18	A
$P_{tot}$	total power dissipation	$T_{mb} = 25\text{ °C}$	–	51	W
$T_j$	junction temperature		–	175	°C
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = 10\text{ V}; I_D = 10\text{ A}$			
		$T_j = 25\text{ °C}$	65	77	mΩ
		$T_j = 175\text{ °C}$	–	154	mΩ

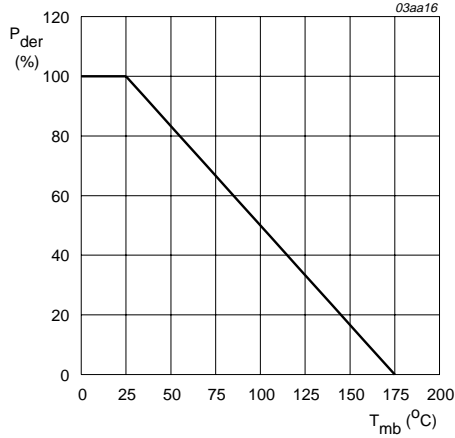
## 6. Limiting values

**Table 3: Limiting values**

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

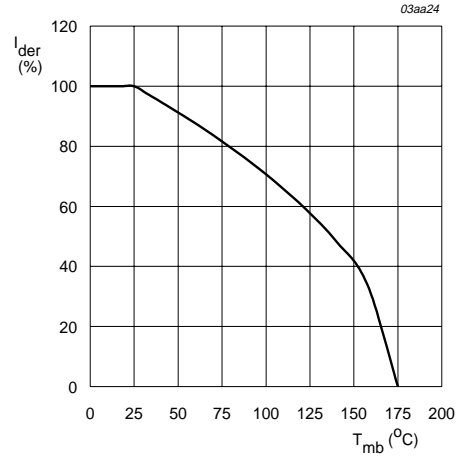
Symbol	Parameter	Conditions	Min	Max	Unit
$V_{DS}$	drain-source voltage (DC)		–	55	V
$V_{DGR}$	drain-gate voltage (DC)	$R_{GS} = 20\text{ k}\Omega$	–	55	V
$V_{GS}$	gate-source voltage (DC)		–	±20	V
$I_D$	drain current (DC)	$T_{mb} = 25\text{ °C}; V_{GS} = 10\text{ V};$ <b>Figure 2 and 3</b>	–	18	A
		$T_{mb} = 100\text{ °C}; V_{GS} = 10\text{ V};$ <b>Figure 2</b>	–	13	A
$I_{DM}$	peak drain current	$T_{mb} = 25\text{ °C};$ pulsed; $t_p \leq 10\text{ }\mu\text{s};$ <b>Figure 3</b>	[1]	73	A
$P_{tot}$	total power dissipation	$T_{mb} = 25\text{ °C};$ <b>Figure 1</b>	–	51	W
$T_{stg}$	storage temperature		–55	+175	°C
$T_j$	operating junction temperature		–55	+175	°C
<b>Source-drain diode</b>					
$I_{DR}$	reverse drain current (DC)	$T_{mb} = 25\text{ °C}$	–	18	A
$I_{DRM}$	pulsed reverse drain current	$T_{mb} = 25\text{ °C};$ pulsed; $t_p \leq 10\text{ }\mu\text{s}$	–	73	A
<b>Avalanche ruggedness</b>					
$W_{DSS}$	non-repetitive avalanche energy	unclamped inductive load; $I_D = 6\text{ A};$ $V_{DS} \leq 55\text{ V}; V_{GS} = 10\text{ V}; R_{GS} = 50\text{ }\Omega;$ starting $T_j = 25\text{ °C}$	–	36	mJ

[1]  $I_{DM}$  is limited by chip, not package.



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

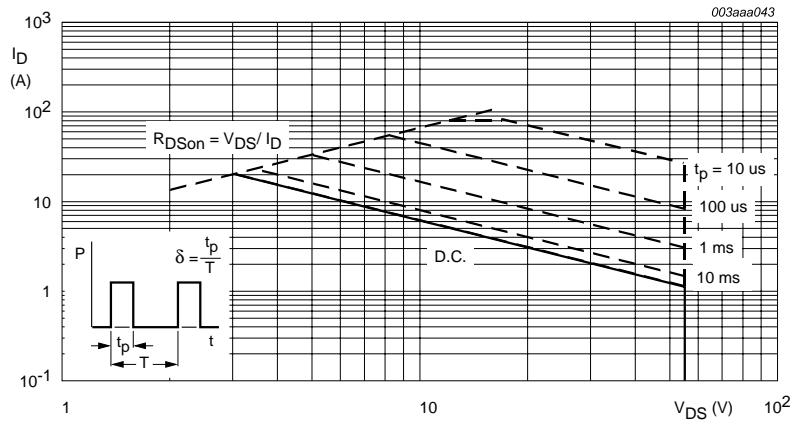
Fig 1. Normalized total power dissipation as a function of mounting base temperature.



$$V_{GS} \geq 4.5 \text{ V}$$

$$I_{der} = \frac{I_D}{I_{D(25^{\circ}C)}} \times 100\%$$

Fig 2. Normalized 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.

## 7. Thermal characteristics

Table 4: Thermal characteristics

Symbol	Parameter	Conditions	Value	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	minimum footprint, FR4 board	71.4	K/W
$R_{th(j-mb)}$	thermal resistance from junction to mounting base	Figure 4	2.9	K/W

### 7.1 Transient thermal impedance

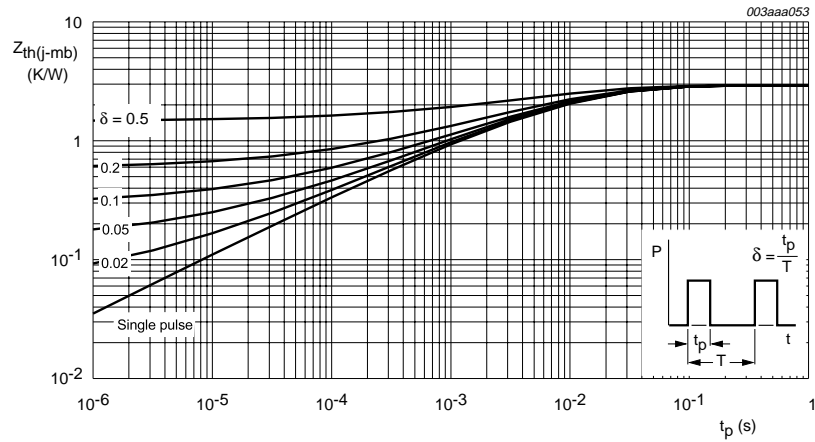


Fig 4. Transient thermal impedance from junction to mounting base as a function of pulse duration.

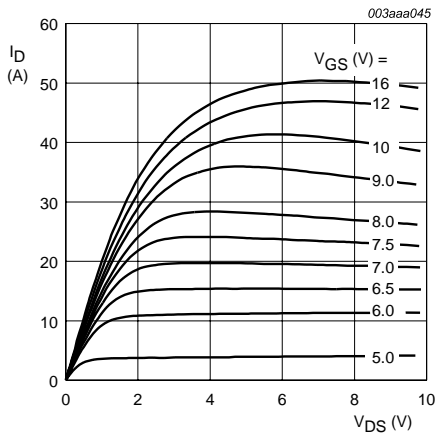
## 8. Characteristics

**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> = 0.25 mA; 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> ; Figure 9				
		T <sub>j</sub> = 25 °C	2	3	4	V
		T <sub>j</sub> = 175 °C	1	–	–	V
		T <sub>j</sub> = –55 °C	–	–	4.4	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	–	0.05	10	μA
		T <sub>j</sub> = 175 °C	–	–	500	μA
I <sub>GSS</sub>	gate-source leakage current	V <sub>GS</sub> = ±20 V; V <sub>DS</sub> = 0 V	–	2	100	nA
R <sub>DS(on)</sub>	drain-source on-state resistance	V <sub>GS</sub> = 10 V; I <sub>D</sub> = 10 A; Figure 7 and 8				
		T <sub>j</sub> = 25 °C	–	65	77	mΩ
		T <sub>j</sub> = 175 °C	–	–	154	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;	–	11	–	nC
Q <sub>gs</sub>	gate-source charge	V <sub>GS</sub> = 10 V; Figure 14	–	3	–	nC
Q <sub>gd</sub>	gate-drain (Miller) charge		–	6	–	nC
C <sub>iss</sub>	input capacitance	V <sub>GS</sub> = 0 V; V <sub>DS</sub> = 25 V;	–	316	422	pF
C <sub>oss</sub>	output capacitance	f = 1 MHz; Figure 12	–	92	110	pF
C <sub>rss</sub>	reverse transfer capacitance		–	64	87	pF
t <sub>d(on)</sub>	turn-on delay time	V <sub>DD</sub> = 30 V; R <sub>L</sub> = 1.2 Ω;	–	10	–	ns
t <sub>r</sub>	rise time	V <sub>GS</sub> = 10 V; R <sub>G</sub> = 10 Ω;	–	50	–	ns
t <sub>d(off)</sub>	turn-off delay time		–	70	–	ns
t <sub>f</sub>	fall time		–	40	–	ns
L <sub>d</sub>	internal drain inductance	measured from drain lead from package to centre of die	–	2.5	–	nH
L <sub>s</sub>	internal source inductance	measured from source lead from package to source bond pad	–	7.5	–	nH

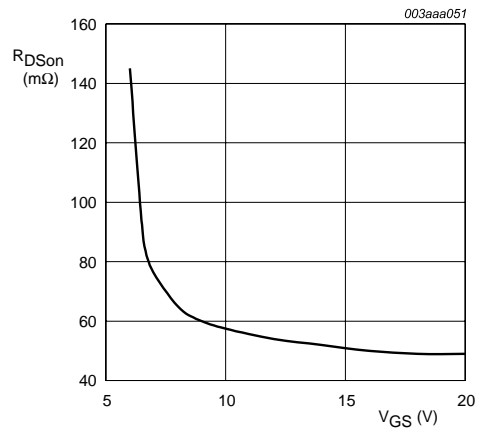
**Table 5: Characteristics...continued**  
*T<sub>j</sub> = 25 °C unless otherwise specified*

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Source-drain diode</b>						
V <sub>SD</sub>	source-drain (diode forward) voltage	I <sub>S</sub> = 10 A; V <sub>GS</sub> = 0 V; Figure 15	–	0.85	1.2	V
t <sub>rr</sub>	reverse recovery time	I <sub>S</sub> = 20 A; dI <sub>S</sub> /dt = –100 A/μs;	–	32	–	ns
Q <sub>r</sub>	recovered charge	V <sub>GS</sub> = –10 V; V <sub>DS</sub> = 30 V	–	120	–	nC



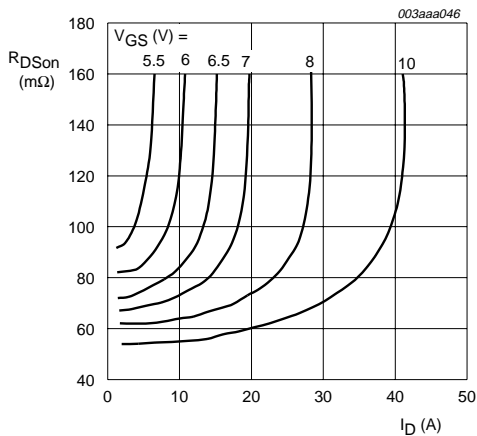
T<sub>j</sub> = 25 °C

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



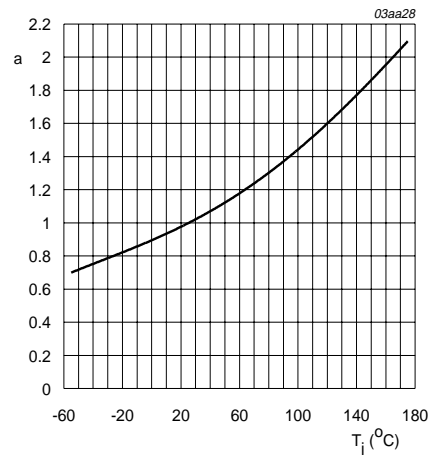
T<sub>j</sub> = 25 °C; I<sub>D</sub> = 10 A

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



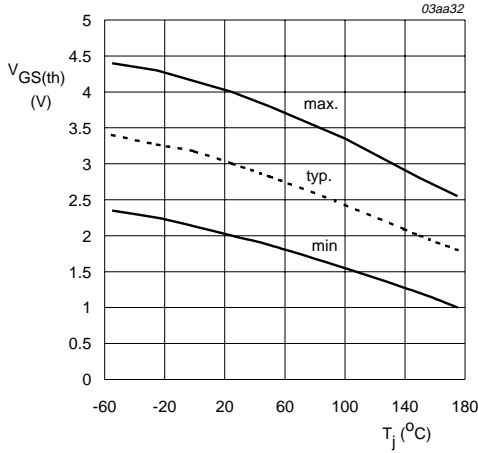
T<sub>j</sub> = 25 °C

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



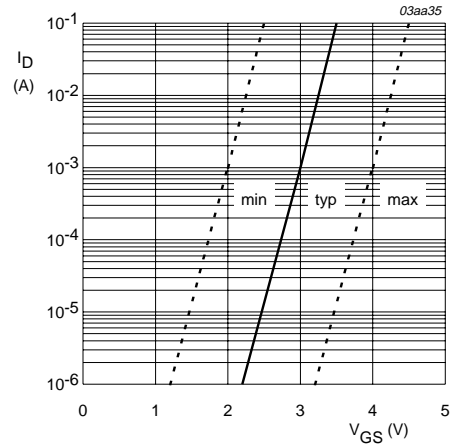
$$a = \frac{R_{DSon}}{R_{DSon(25^{\circ}C)}}$$

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



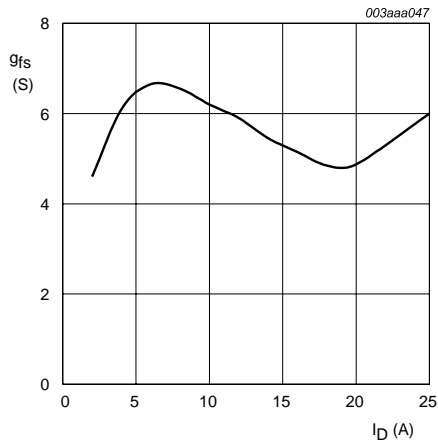
$I_D = 1 \text{ mA}; V_{DS} = V_{GS}$

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



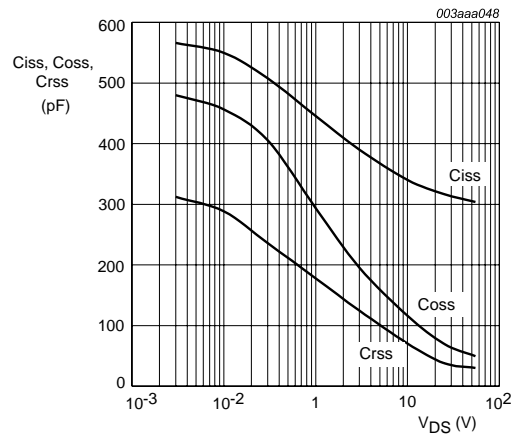
$T_j = 25 \text{ °C}; V_{DS} = V_{GS}$

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



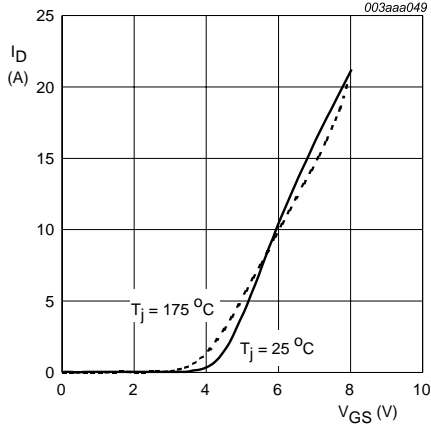
$T_j = 25 \text{ °C}; V_{DS} = 25 \text{ V}$

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



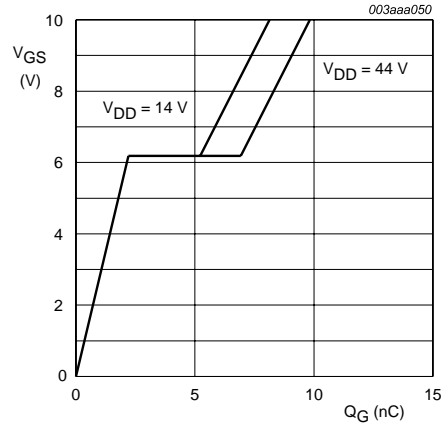
$V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$

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



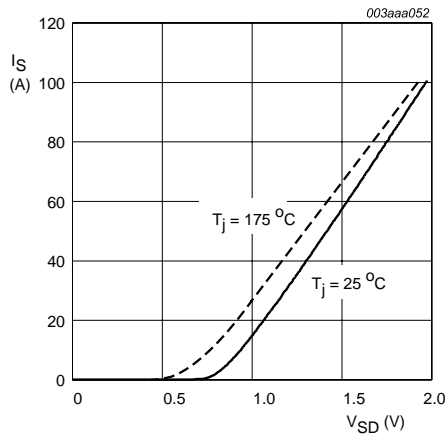
$V_{DS} = 25 \text{ V}$

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



$T_j = 25 \text{ °C}; I_D = 10 \text{ A}$

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.



9. Package outline

Plastic single-ended surface mounted package (Philips version of D-PAK); 3 leads  
(one lead cropped)

SOT428

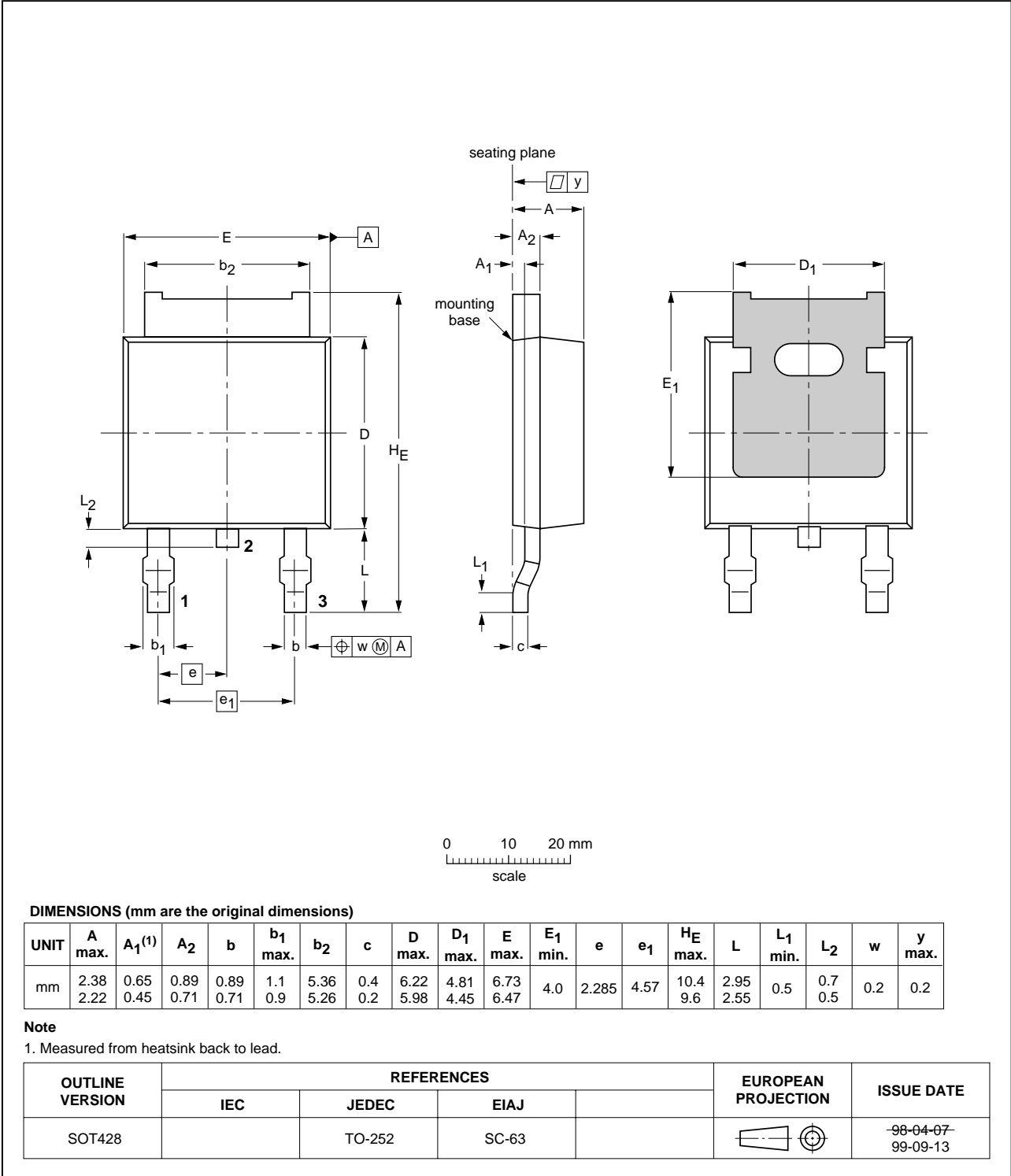


Fig 16. SOT428 (D-PAK).

## 10. Revision history

Table 6: Revision history

Rev	Date	CPCN	Description
01	20010222	-	Product specification; initial version.

## 11. Data sheet status

Datasheet status	Product status	Definition <sup>[1]</sup>
Objective specification	Development	This data sheet contains the design target or goal specifications for product development. Specification may change in any manner without notice.
Preliminary specification	Qualification	This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
Product specification	Production	This data sheet contains final specifications. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.

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

## 12. 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.

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## Contents

1	Description . . . . .	1
2	Features . . . . .	1
3	Applications . . . . .	1
4	Pinning information . . . . .	1
5	Quick reference data . . . . .	2
6	Limiting values . . . . .	2
7	Thermal characteristics . . . . .	4
7.1	Transient thermal impedance . . . . .	4
8	Characteristics . . . . .	5
9	Package outline . . . . .	9
10	Revision history . . . . .	10
11	Data sheet status . . . . .	11
12	Definitions . . . . .	11
13	Disclaimers . . . . .	11



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