

PHD/PHU77NQ03T

N-channel TrenchMOS FET

Rev. 01 — 28 November 2006

Product data sheet

1. Product profile

1.1 General description

N-channel enhancement mode Field-Effect Transistor (FET) in a plastic package using TrenchMOS technology.

1.2 Features

- Fast switching
- Low thermal resistance

1.3 Applications

- DC-to-DC converters
- Computer motherboard

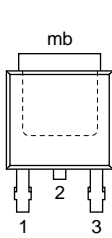
1.4 Quick reference data

- $V_{DS} \leq 25\text{ V}$
- $I_D \leq 75\text{ A}$
- $R_{DSon} \leq 9.5\text{ m}\Omega$
- $Q_{GD} = 3.2\text{ nC (typ)}$

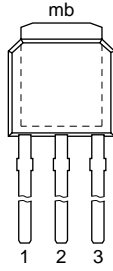
2. Pinning information

Table 1. Pinning

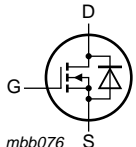
Pin	Description	Simplified outline	Symbol
1	gate (G)		
2	drain (D) [1]		
3	source (S)		
mb	mounting base; connected to drain (D)		



SOT428 (DPAK)



SOT533 (IPAK)



mbb076

[1] It is not possible to make a connection to pin 2 of the SOT428 package.

3. Ordering information

Table 2. Ordering information

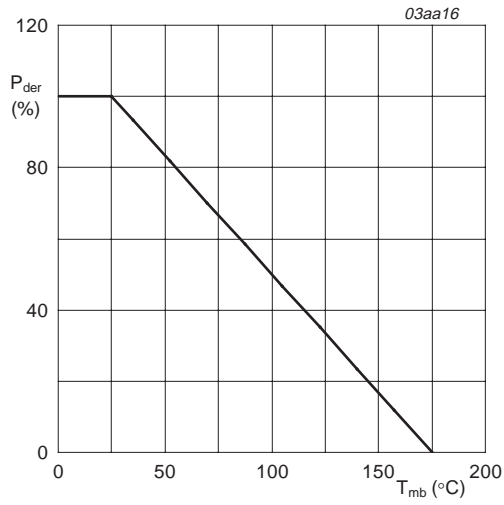
Type number	Package		Version
	Name	Description	
PHD77NQ03T	DPAK	plastic single-ended surface-mounted package; 3 leads (one lead cropped)	SOT428
PHU77NQ03T	IPAK	plastic single-ended package; 3 leads (in-line)	SOT533

4. Limiting values

Table 3. Limiting values

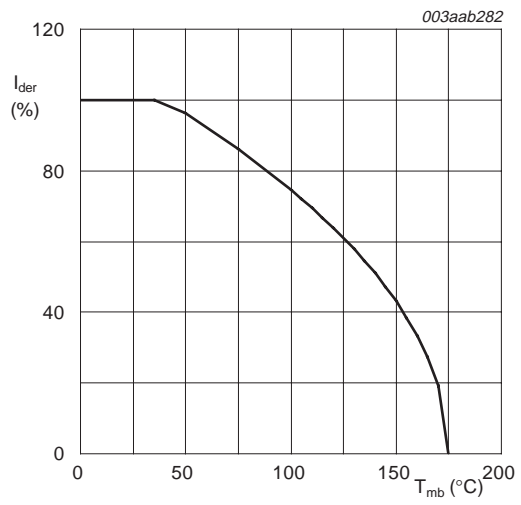
In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
V_{DS}	drain-source voltage	$25\text{ °C} \leq T_j \leq 175\text{ °C}$	-	25	V
V_{DGR}	drain-gate voltage (DC)	$25\text{ °C} \leq T_j \leq 175\text{ °C}$; $R_{GS} = 20\text{ k}\Omega$	-	25	V
V_{GS}	gate-source voltage		-	± 20	V
I_D	drain current	$T_{mb} = 25\text{ °C}$; $V_{GS} = 10\text{ V}$; see Figure 2 and 3	-	75	A
		$T_{mb} = 100\text{ °C}$; $V_{GS} = 10\text{ V}$; see Figure 2	-	55.9	A
I_{DM}	peak drain current	$T_{mb} = 25\text{ °C}$; pulsed; $t_p \leq 10\text{ }\mu\text{s}$; see Figure 3	-	240	A
P_{tot}	total power dissipation	$T_{mb} = 25\text{ °C}$; see Figure 1	-	107	W
T_{stg}	storage temperature		-55	+175	°C
T_j	junction temperature		-55	+175	°C
Source-drain diode					
I_S	source current	$T_{mb} = 25\text{ °C}$	-	75	A
I_{SM}	peak source current	$T_{mb} = 25\text{ °C}$; pulsed; $t_p \leq 10\text{ }\mu\text{s}$	-	240	A
Avalanche ruggedness					
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	unclamped inductive load; $I_D = 32\text{ A}$; $t_p = 0.17\text{ ms}$; $V_{DS} \leq 25\text{ V}$; $R_{GS} = 50\text{ }\Omega$; $V_{GS} = 10\text{ V}$; starting at $T_j = 25\text{ °C}$	-	100	mJ



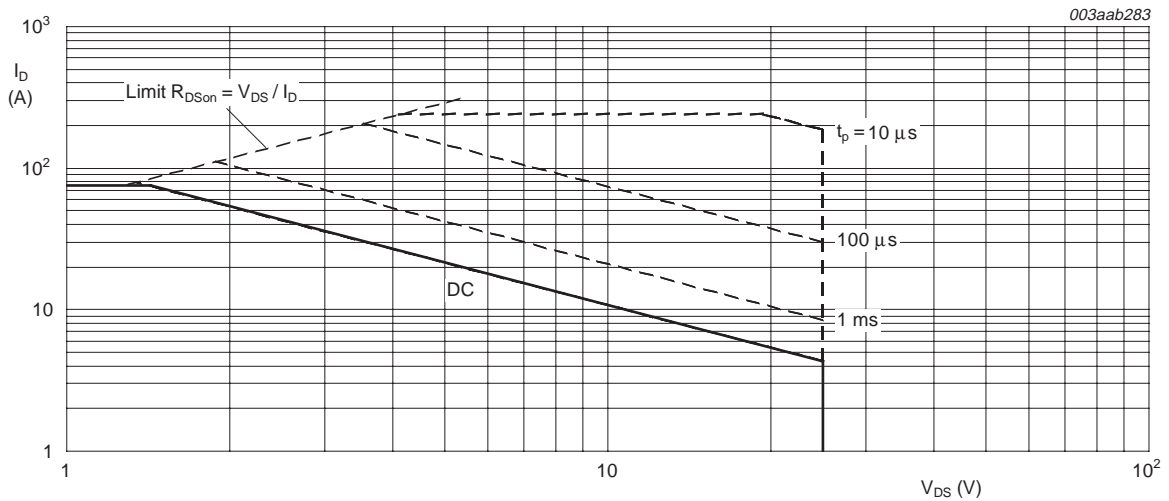
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\%$$

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



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

Fig 2. Normalized continuous drain current as a function of mounting base temperature



T_{mb} = 25 °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	see Figure 4	-	-	1.4	K/W	
$R_{th(j-a)}$	thermal resistance from junction to ambient	SOT428	minimum footprint	[1] -	75	-	K/W
			SOT404 minimum footprint	[1] -	50	-	K/W
		SOT533	vertical in free air	-	70	-	K/W

[1] Mounted on a printed-circuit board; vertical in still air.

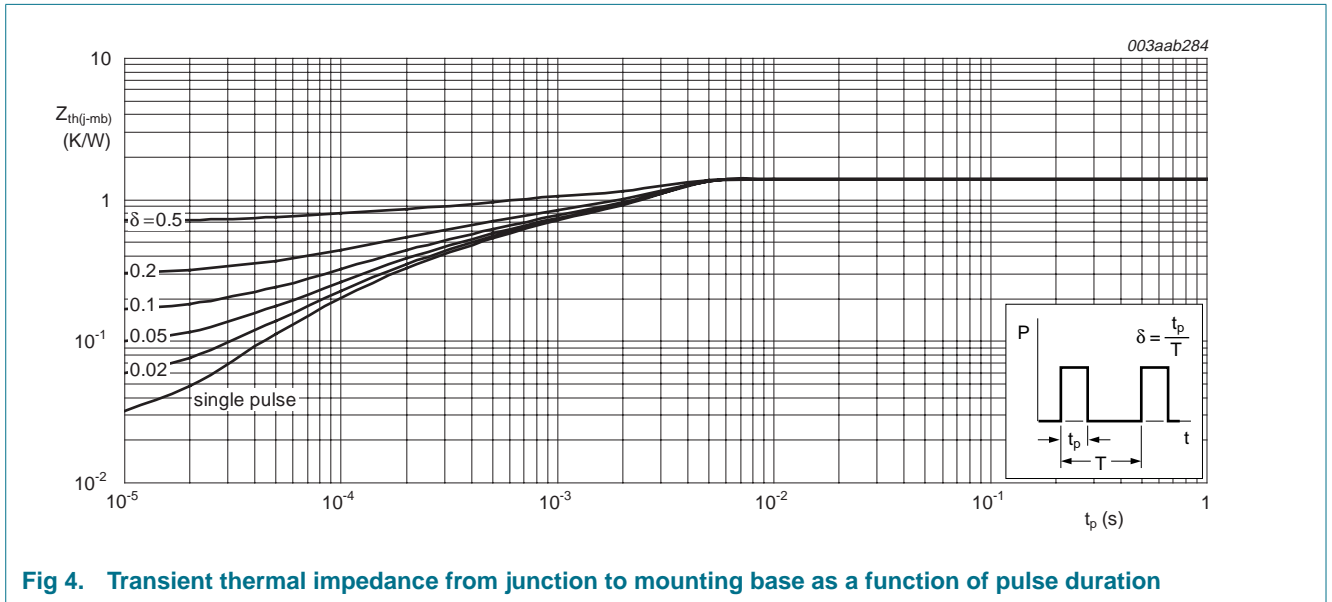
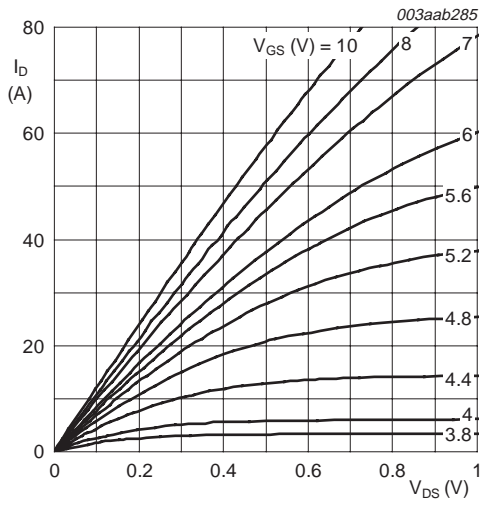


Fig 4. Transient thermal impedance from junction to mounting base as a function of pulse duration

6. Characteristics

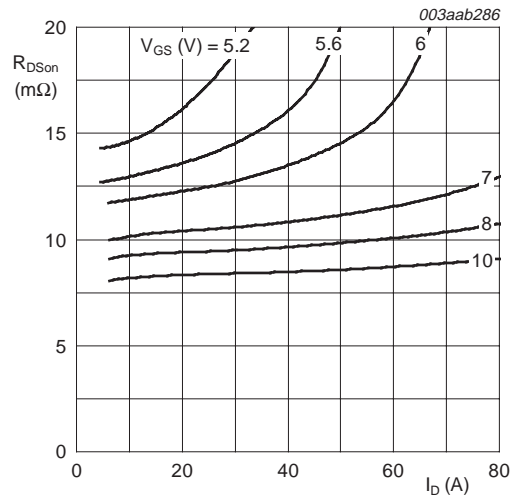
Table 5. Characteristics
T_j = 25 °C unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Static characteristics						
V _{(BR)DSS}	drain-source breakdown voltage	I _D = 250 μA; V _{GS} = 0 V T _j = 25 °C	25	-	-	V
		T _j = -55 °C	25	-	-	V
V _{GS(th)}	gate-source threshold voltage	I _D = 1 mA; V _{DS} = V _{GS} ; see Figure 9 and 10 T _j = 25 °C	2.1	2.65	3.2	V
		T _j = 175 °C	1.35	-	-	V
		T _j = -55 °C	-	-	3.65	V
I _{DSS}	drain leakage current	V _{DS} = 25 V; V _{GS} = 0 V T _j = 25 °C	-	-	10	μA
		T _j = 175 °C	-	-	500	μA
I _{GSS}	gate leakage current	V _{GS} = ±20 V; V _{DS} = 0 V	-	-	100	nA
R _G	gate resistance	f = 1 MHz	-	1.2	-	Ω
R _{DS(on)}	drain-source on-state resistance	V _{GS} = 10 V; I _D = 25 A; see Figure 6 and 8 T _j = 25 °C	-	8.3	9.5	mΩ
		T _j = 175 °C	-	15	17.1	mΩ
Dynamic characteristics						
Q _{G(tot)}	total gate charge	I _D = 25 A; V _{DS} = 12 V; V _{GS} = 10 V; see Figure 11 and 12	-	17.1	-	nC
Q _{GS}	gate-source charge		-	6	-	nC
Q _{GS1}	pre-V _{GS(th)} gate-source charge		-	3.2	-	nC
Q _{GS2}	post-V _{GS(th)} gate-source charge		-	2.8	-	nC
Q _{GD}	gate-drain charge		-	3.2	-	nC
V _{GS(pl)}	gate-source plateau voltage		-	5	-	V
Q _{G(tot)}	total gate charge	I _D = 0 A; V _{DS} = 0 V; V _{GS} = 4.5 V	-	6.2	-	nC
C _{iss}	input capacitance	V _{GS} = 0 V; V _{DS} = 12 V; f = 1 MHz; see Figure 14	-	860	-	pF
C _{oss}	output capacitance		-	400	-	pF
C _{rss}	reverse transfer capacitance		-	165	-	pF
C _{iss}	input capacitance	V _{GS} = 0 V; V _{DS} = 0 V; f = 1 MHz	-	1200	-	pF
t _{d(on)}	turn-on delay time	V _{DS} = 12 V; R _L = 0.5 Ω; V _{GS} = 10 V; R _G = 5.6 Ω	-	8.3	-	ns
t _r	rise time		-	7.6	-	ns
t _{d(off)}	turn-off delay time		-	24.8	-	ns
t _f	fall time		-	6.6	-	ns
Source-drain diode						
V _{SD}	source-drain voltage	I _S = 25 A; V _{GS} = 0 V; see Figure 13	-	0.9	1.2	V
t _{rr}	reverse recovery time	I _S = 20 A; dI _S /dt = -100 A/μs; V _{GS} = 0 V	-	34	-	ns
Q _r	recovered charge		-	12.5	-	nC



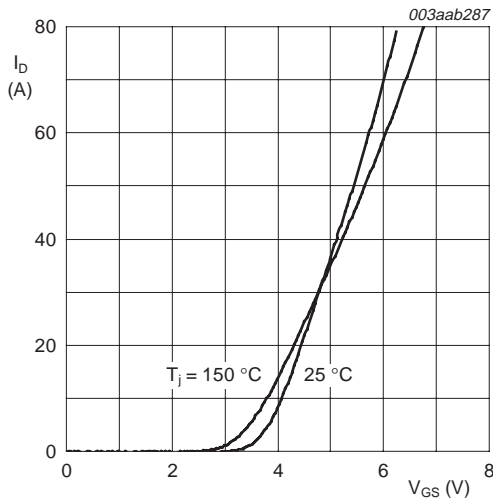
$T_j = 25\text{ }^\circ\text{C}$

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



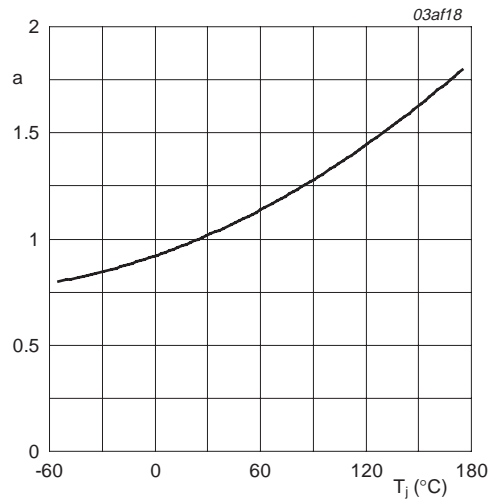
$T_j = 25\text{ }^\circ\text{C}$

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



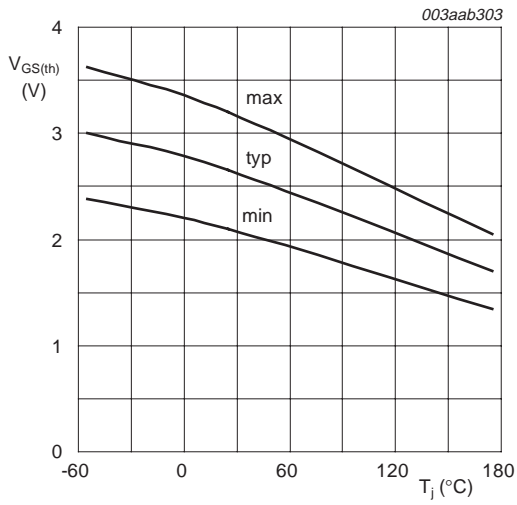
$T_j = 25\text{ }^\circ\text{C}$ and $175\text{ }^\circ\text{C}$; $V_{DS} > I_D \times R_{DS(on)}$

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



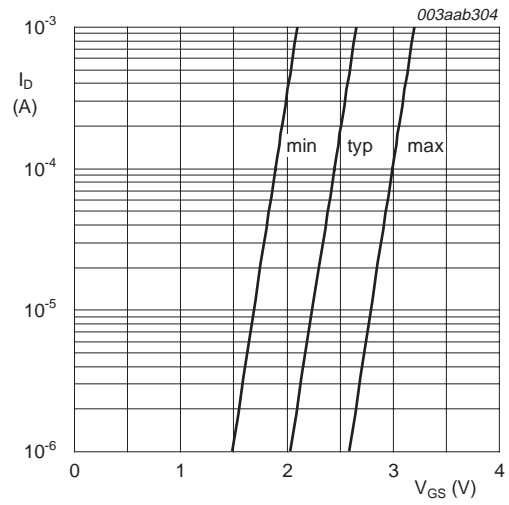
$$a = \frac{R_{DS(on)}}{R_{DS(on)(25^\circ\text{C})}}$$

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



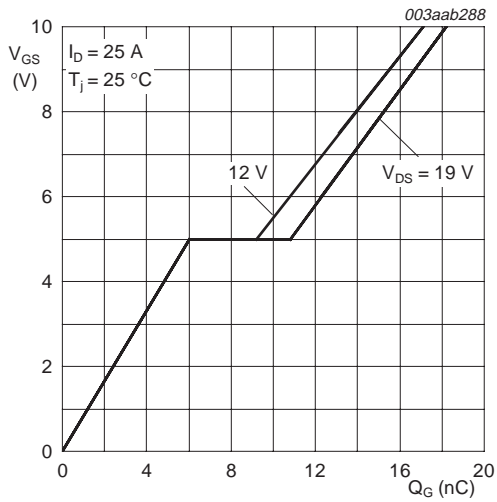
$I_D = 1 \text{ mA}; V_{DS} = V_{GS}$

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



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

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



$I_D = 25 \text{ A}; V_{DS} = 12 \text{ V and } 19 \text{ V}$

Fig 11. Gate-source voltage as a function of gate charge; typical values

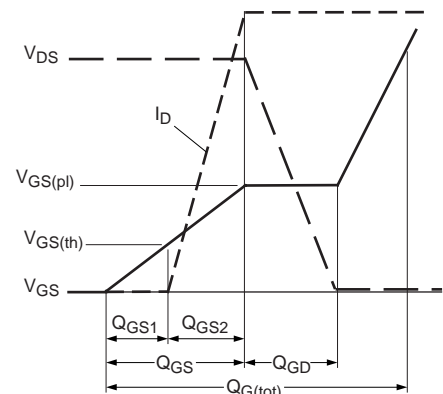
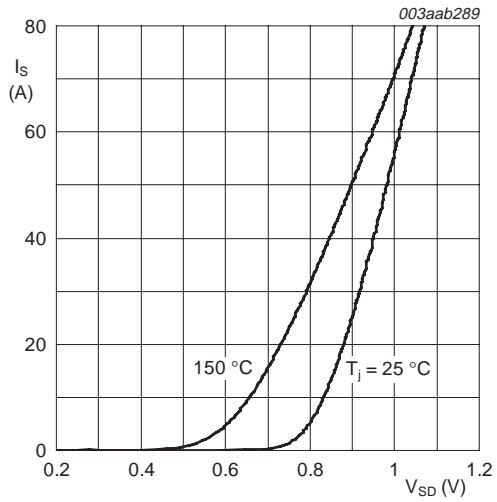
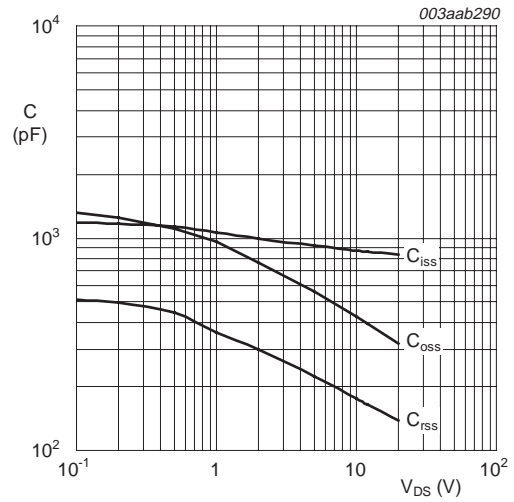


Fig 12. Gate charge waveform definitions



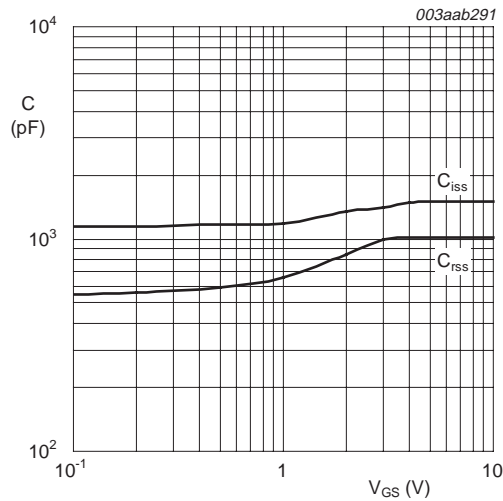
$T_j = 25\text{ °C}$ and 175 °C ; $V_{GS} = 0\text{ V}$

Fig 13. Source current as a function of source-drain voltage; 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



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

Fig 15. Input and reverse transfer capacitances as a function of gate-source voltage; typical values

7. Package outline

Plastic single-ended surface-mounted package (DPAK); 3 leads (one lead cropped)

SOT428

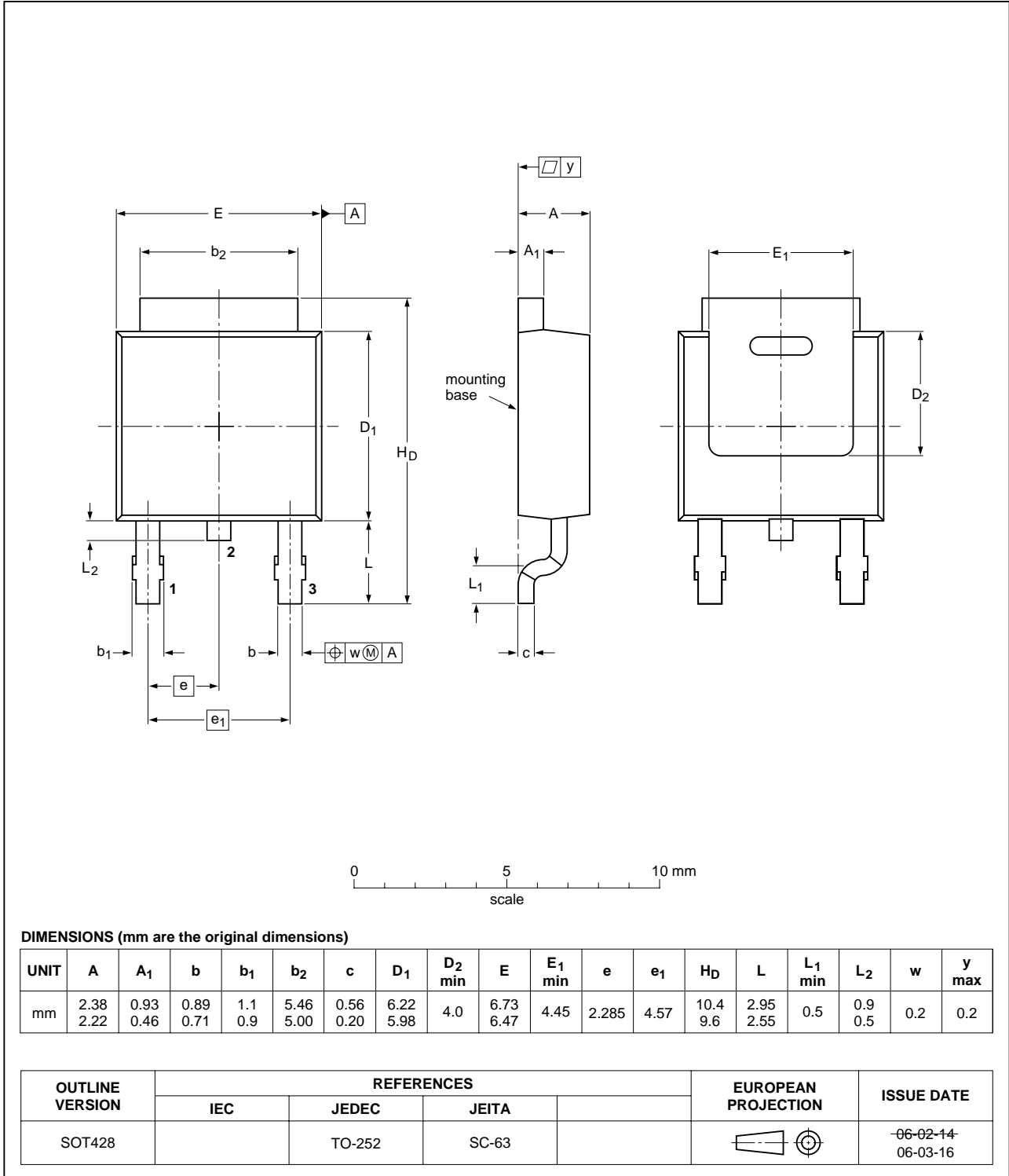
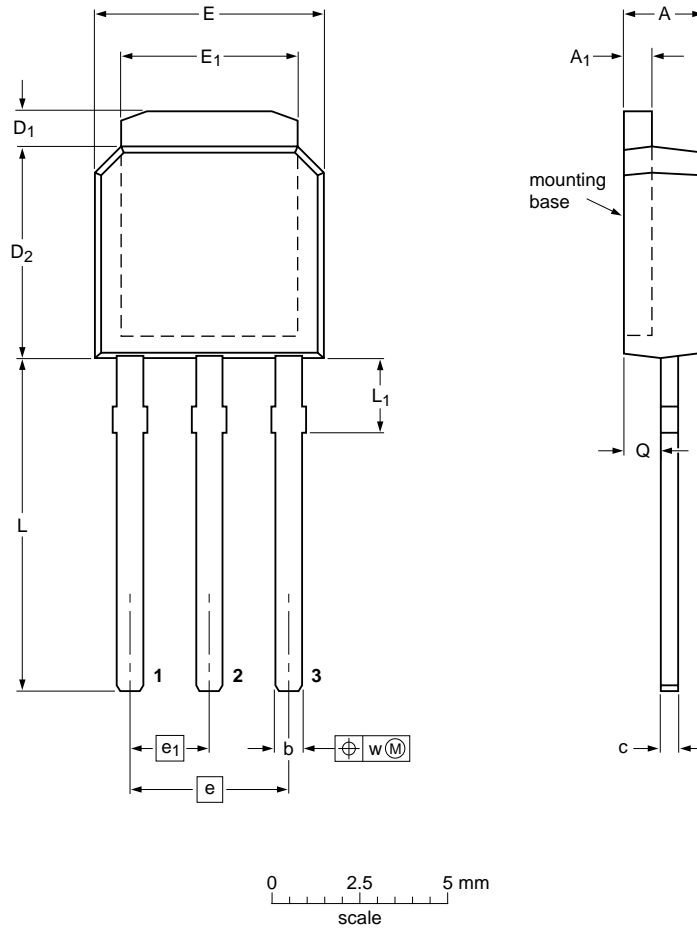


Fig 16. Package outline SOT428 (DPAK)

Plastic single-ended package (IPAK); 3 leads (in-line)

SOT533



DIMENSIONS (mm are the original dimensions)

UNIT	A	A ₁	b	c	D ₁	D ₂	E	E ₁	e	e ₁	L	L ₁ ⁽²⁾ max	Q	w
mm	2.38 2.22	0.93 0.46	0.89 0.71	0.56 0.46	1.10 0.96	6.22 5.98	6.73 6.47	5.21 5.00	4.57 BSC ⁽¹⁾	2.285 BSC ⁽¹⁾	9.6 9.2	2.7	1.1 1.0	0.3

Notes

1. Basic spacing between centers.
2. Terminal dimensions are uncontrolled within zone L₁.

OUTLINE VERSION	REFERENCES			EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA		
SOT533		TO-251			-05-02-11- 06-02-14

Fig 17. Package outline SOT533 (IPAK)

8. Revision history

Table 6. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
PHD_PHU77NQ03T_1	20061128	Product data sheet	-	-

9. Legal information

9.1 Data sheet status

Document status ^{[1][2]}	Product status ^[3]	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".

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