

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

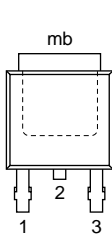
1.4 Quick reference data

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

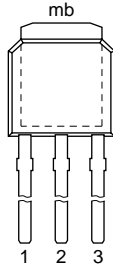
2. Pinning information

Table 1. Pinning

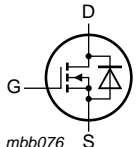
Pin	Description	Simplified outline	Symbol
1	gate (G)		
2	drain (D) [1]		
3	source (S)		
mb	mounting base; connected to drain (D)		



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

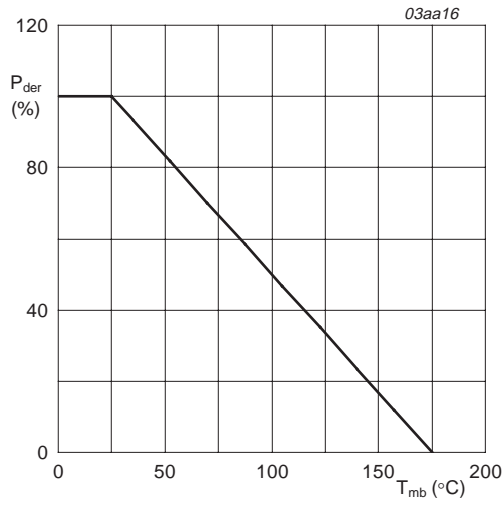
Type number	Package		Version
	Name	Description	
PHD77NQ03T	DPAK	plastic single-ended surface-mounted package; 3 leads (one lead cropped)	SOT428
PHU77NQ03T	IPAK	plastic single-ended package; 3 leads (in-line)	SOT533

4. Limiting values

Table 3. Limiting values

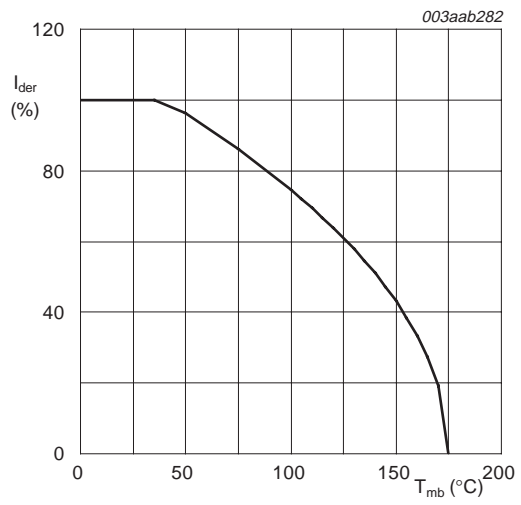
In accordance with the Absolute Maximum Rating System (IEC 60134).

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



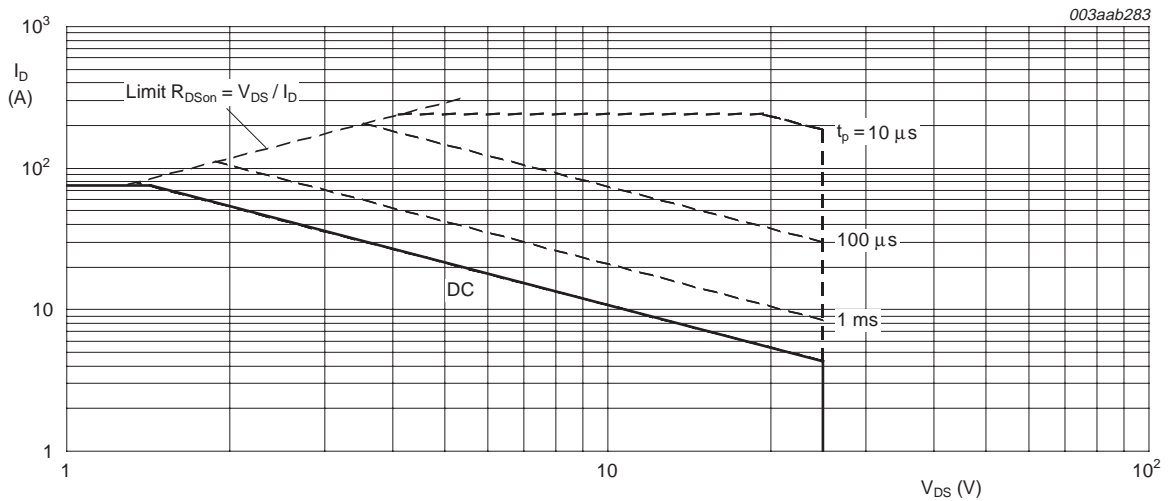
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\%$$

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.

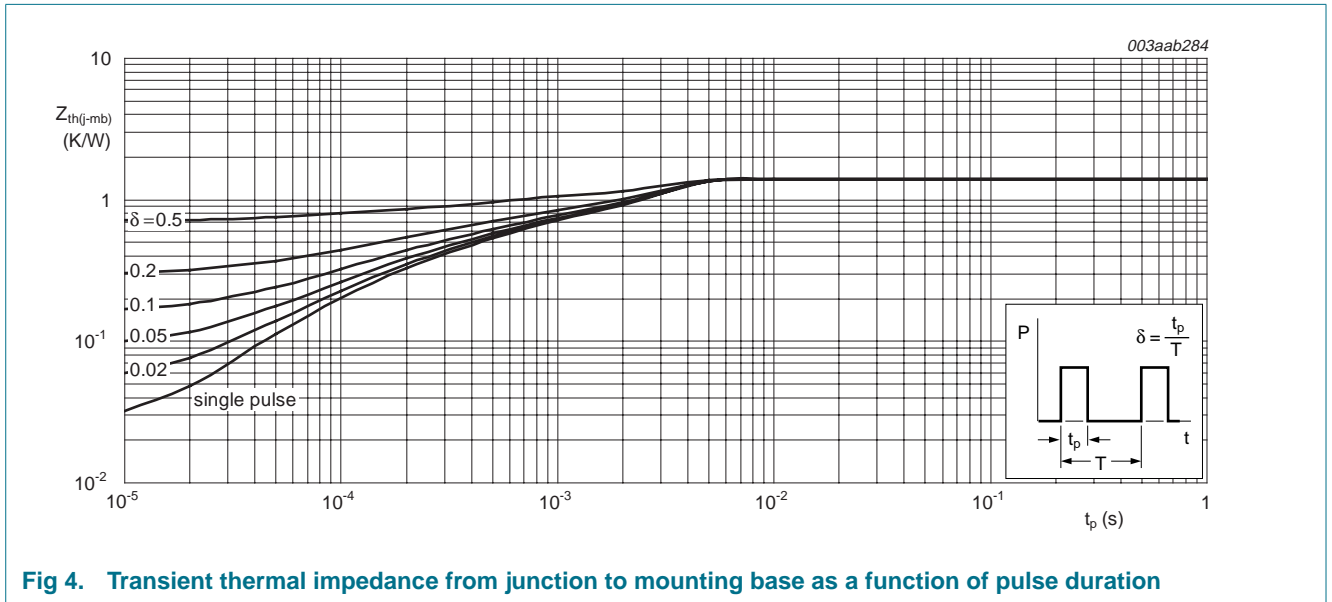


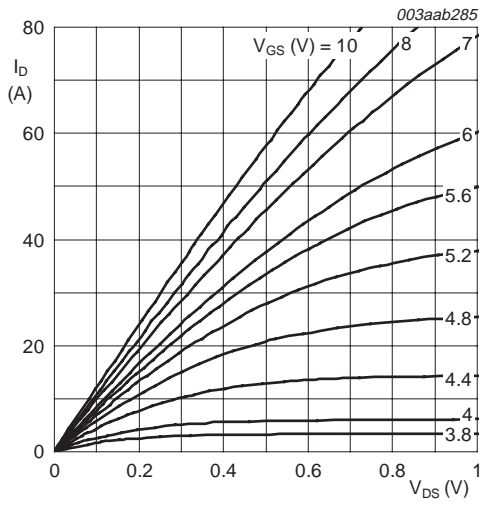
Fig 4. Transient thermal impedance from junction to mounting base as a function of pulse duration

6. Characteristics

Table 5. Characteristics

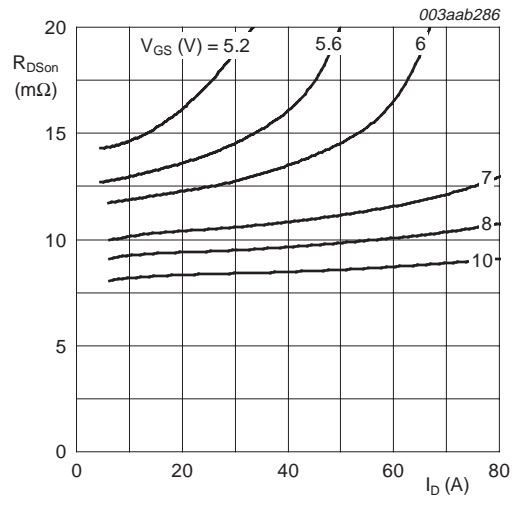
$T_j = 25\text{ °C}$ unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Static characteristics						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 250\text{ }\mu\text{A}$; $V_{GS} = 0\text{ V}$				
		$T_j = 25\text{ °C}$	25	-	-	V
		$T_j = -55\text{ °C}$	25	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 1\text{ mA}$; $V_{DS} = V_{GS}$; see Figure 9 and 10				
		$T_j = 25\text{ °C}$	2.1	2.65	3.2	V
		$T_j = 175\text{ °C}$	1.35	-	-	V
		$T_j = -55\text{ °C}$	-	-	3.65	V
I_{DSS}	drain leakage current	$V_{DS} = 25\text{ V}$; $V_{GS} = 0\text{ V}$				
		$T_j = 25\text{ °C}$	-	-	10	μA
		$T_j = 175\text{ °C}$	-	-	500	μA
I_{GSS}	gate leakage current	$V_{GS} = \pm 20\text{ V}$; $V_{DS} = 0\text{ V}$	-	-	100	nA
R_G	gate resistance	$f = 1\text{ MHz}$	-	1.2	-	Ω
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 10\text{ V}$; $I_D = 25\text{ A}$; see Figure 6 and 8				
		$T_j = 25\text{ °C}$	-	8.3	9.5	m Ω
		$T_j = 175\text{ °C}$	-	15	17.1	m Ω
Dynamic characteristics						
$Q_{G(tot)}$	total gate charge	$I_D = 25\text{ A}$; $V_{DS} = 12\text{ V}$; $V_{GS} = 10\text{ V}$; 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	$I_D = 0\text{ A}$; $V_{DS} = 0\text{ V}$; $V_{GS} = 4.5\text{ V}$	-	6.2	-	nC
C_{iss}	input capacitance	$V_{GS} = 0\text{ V}$; $V_{DS} = 12\text{ V}$; $f = 1\text{ MHz}$; see Figure 14	-	860	-	pF
C_{oss}	output capacitance		-	400	-	pF
C_{rss}	reverse transfer capacitance		-	165	-	pF
C_{iss}	input capacitance	$V_{GS} = 0\text{ V}$; $V_{DS} = 0\text{ V}$; $f = 1\text{ MHz}$	-	1200	-	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = 12\text{ V}$; $R_L = 0.5\text{ }\Omega$; $V_{GS} = 10\text{ V}$; $R_G = 5.6\text{ }\Omega$	-	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	$I_S = 25\text{ A}$; $V_{GS} = 0\text{ V}$; see Figure 13	-	0.9	1.2	V
t_{rr}	reverse recovery time	$I_S = 20\text{ A}$; $dI_S/dt = -100\text{ A}/\mu\text{s}$; $V_{GS} = 0\text{ V}$	-	34	-	ns
Q_r	recovered charge		-	12.5	-	nC



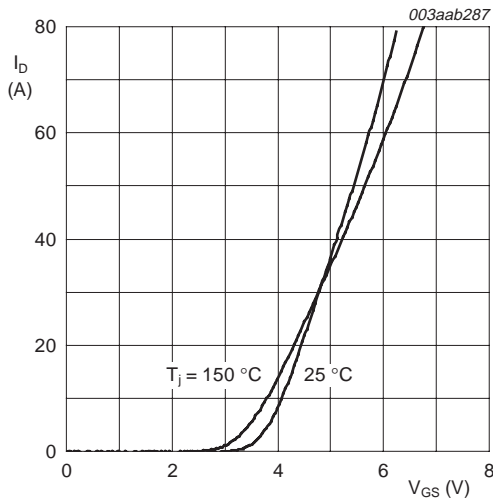
$T_j = 25\text{ }^\circ\text{C}$

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



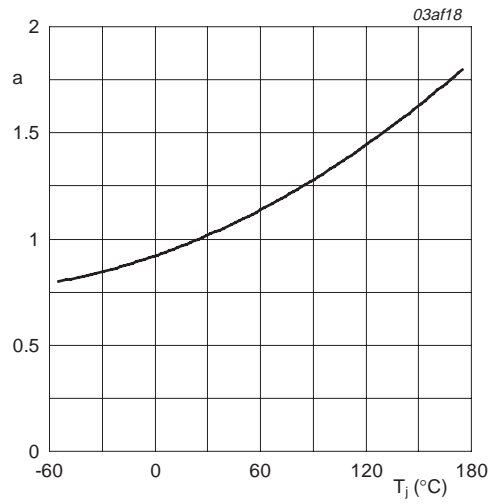
$T_j = 25\text{ }^\circ\text{C}$

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



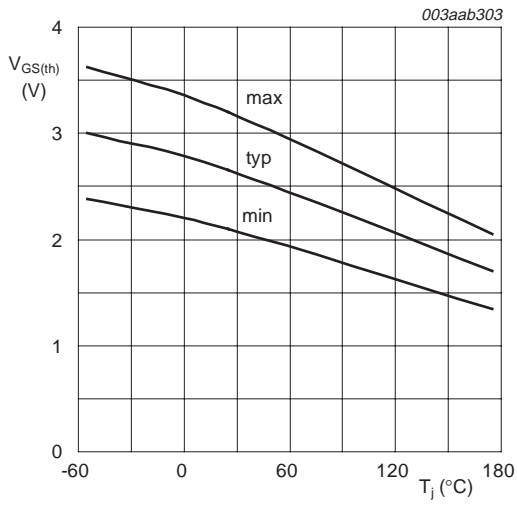
$T_j = 25\text{ }^\circ\text{C}$ and $175\text{ }^\circ\text{C}$; $V_{DS} > I_D \times R_{DS(on)}$

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



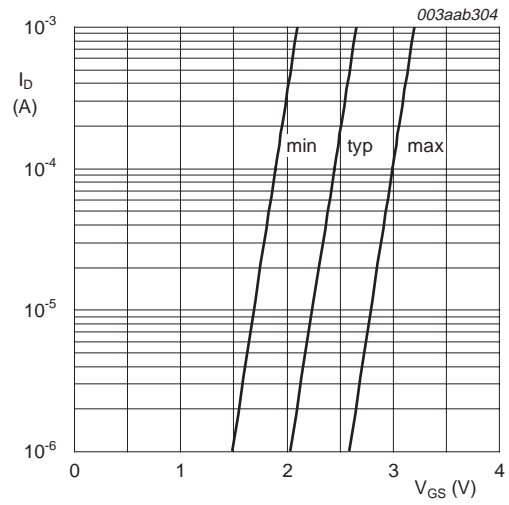
$$a = \frac{R_{DS(on)}}{R_{DS(on)(25^\circ\text{C})}}$$

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



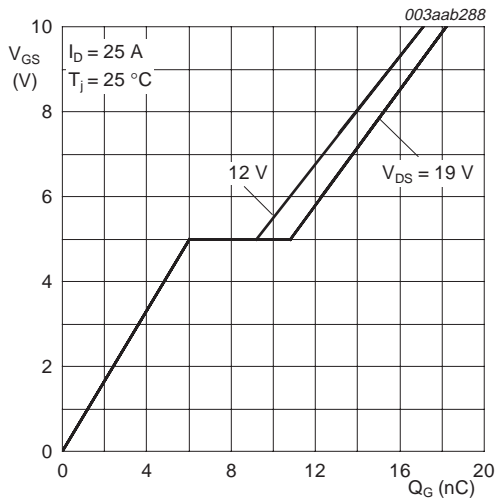
$I_D = 1 \text{ mA}; V_{DS} = V_{GS}$

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

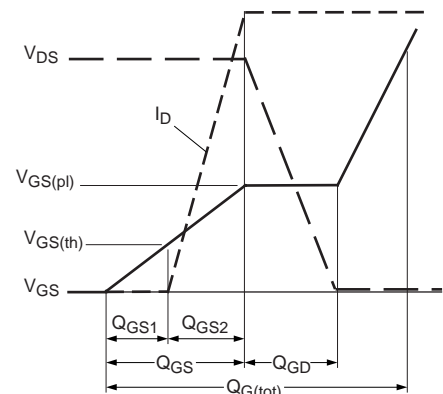
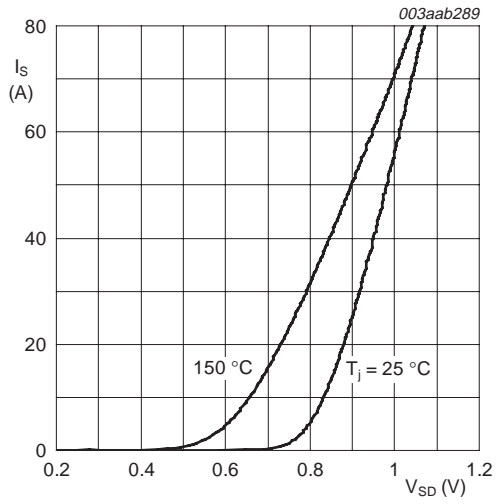
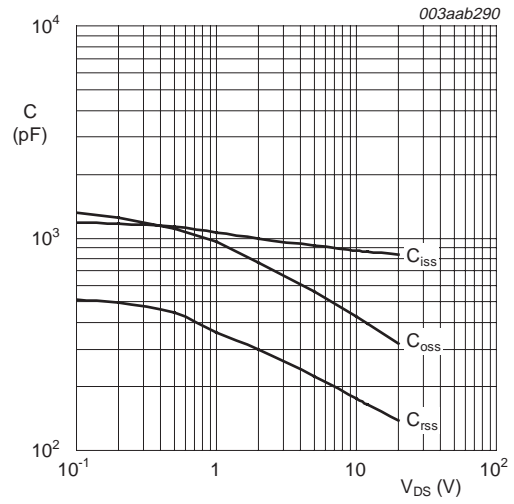


Fig 12. Gate charge waveform definitions



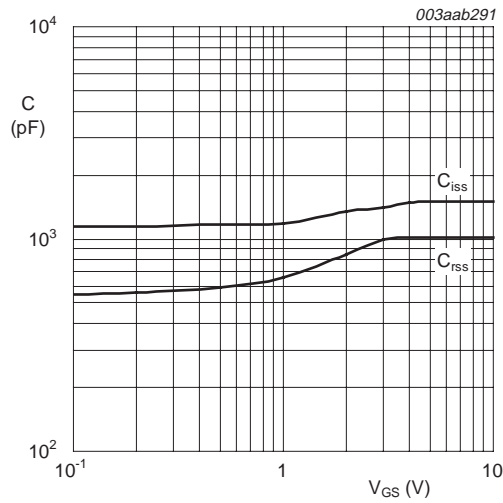
$T_j = 25\text{ °C}$ and 175 °C ; $V_{GS} = 0\text{ V}$

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



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

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

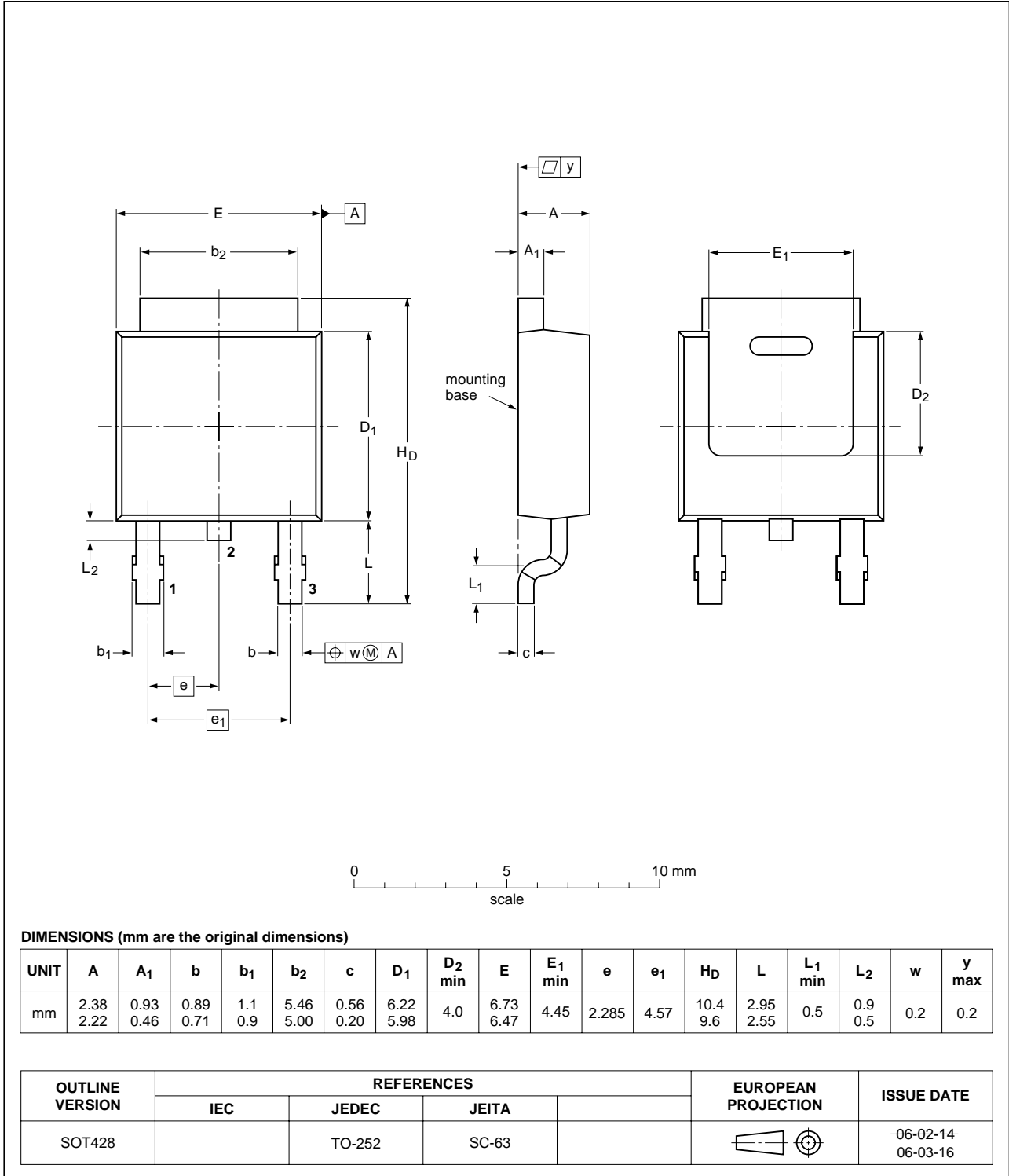
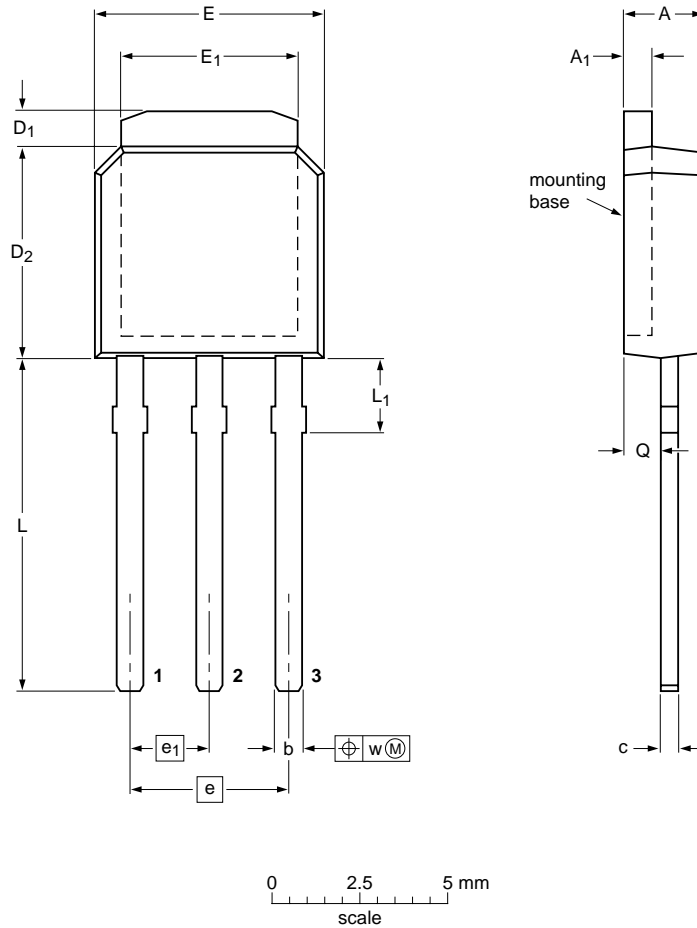


Fig 16. Package outline SOT428 (DPAK)

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".

[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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