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

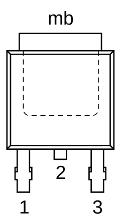
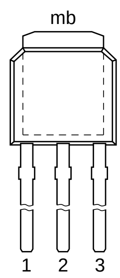
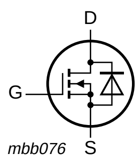
- DC-to-DC converters
- Computer motherboard

1.4 Quick reference data

- $V_{DS} \leq 25$ V
- $R_{DSon} \leq 9.5$ mΩ
- $I_D \leq 75$ A
- $Q_{GD} = 3.2$ 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)	

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

3. Ordering information

Table 2. Ordering information

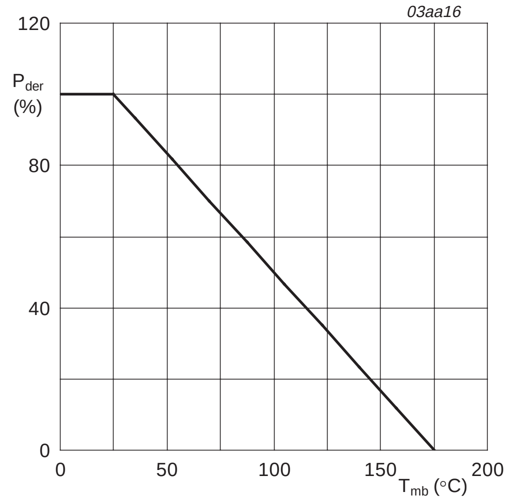
Type number	Package		
	Name	Description	Version
PHD77NQ03T	DPAK	plastic single-ended surface-mounted package; 3 leads (one lead cropped)	SOT428
PHU77NQ03T	IPAK	plastic single-ended package; 3 leads (in-line)	SOT533

4. Limiting values

Table 3. Limiting values

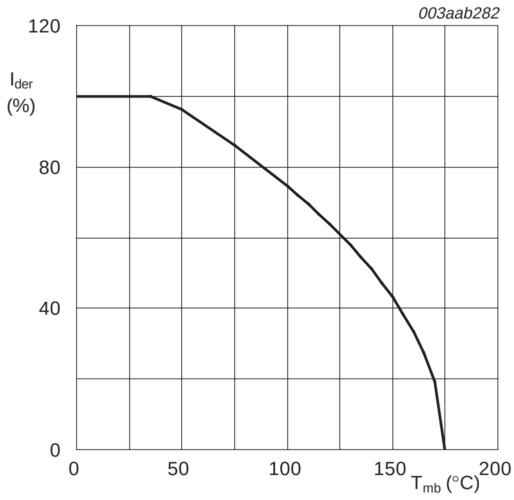
In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
V_{DS}	drain-source voltage	25 °C ≤ T_j ≤ 175 °C	-	25	V
V_{DGR}	drain-gate voltage (DC)	25 °C ≤ T_j ≤ 175 °C; R_{GS} = 20 kΩ	-	25	V
V_{GS}	gate-source voltage		-	±20	V
I_D	drain current	T_{mb} = 25 °C; V_{GS} = 10 V; see Figure 2 and 3	-	75	A
		T_{mb} = 100 °C; V_{GS} = 10 V; see Figure 2	-	55.9	A
I_{DM}	peak drain current	T_{mb} = 25 °C; pulsed; t_p ≤ 10 µs; see Figure 3	-	240	A
P_{tot}	total power dissipation	T_{mb} = 25 °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 °C	-	75	A
I_{SM}	peak source current	T_{mb} = 25 °C; pulsed; t_p ≤ 10 µs	-	240	A
Avalanche ruggedness					
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	unclamped inductive load; I_D = 32 A; t_p = 0.17 ms; V_{DS} ≤ 25 V; R_{GS} = 50 Ω; V_{GS} = 10 V; starting at T_j = 25 °C	-	100	mJ



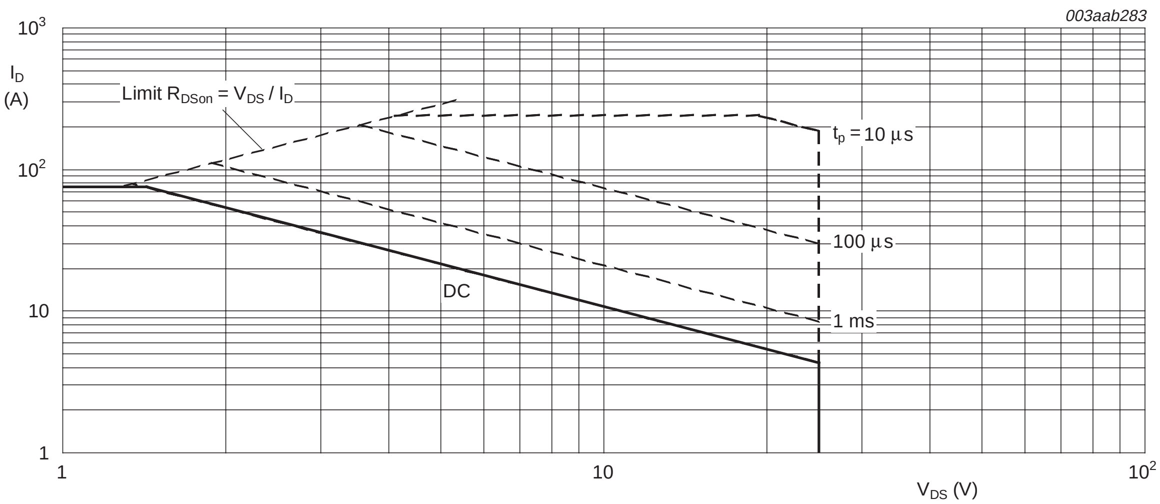
$$P_{der} = \frac{P_{tot}}{P_{tot(25°C)}} \times 100\ \%$$

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



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

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.

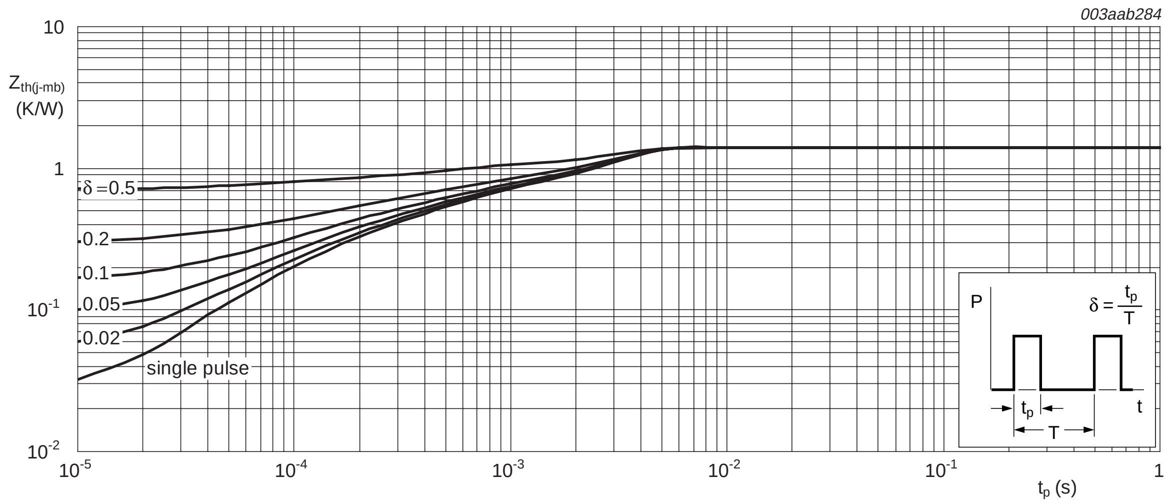


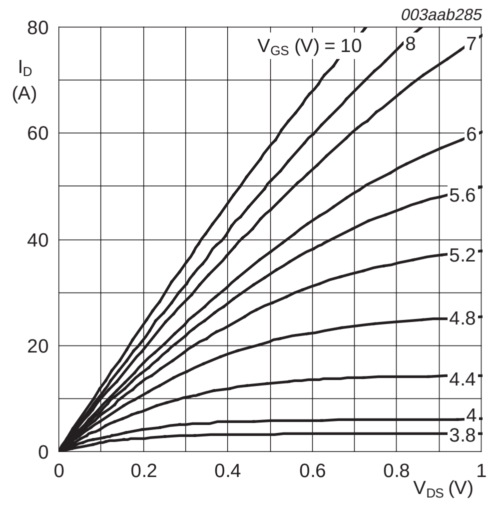
Fig 4. Transient thermal impedance from junction to mounting base as a function of pulse duration

6. Characteristics

Table 5. Characteristics

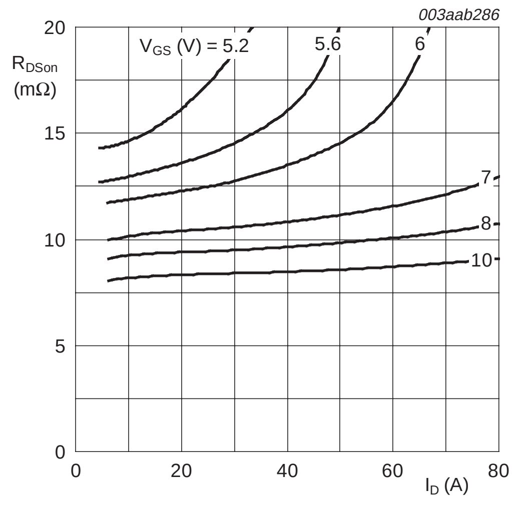
T_j = 25 °C unless otherwise specified.

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_{DSon}	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



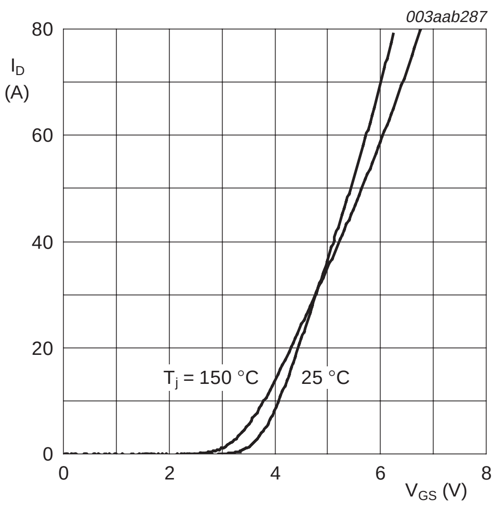
T_j = 25 °C

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



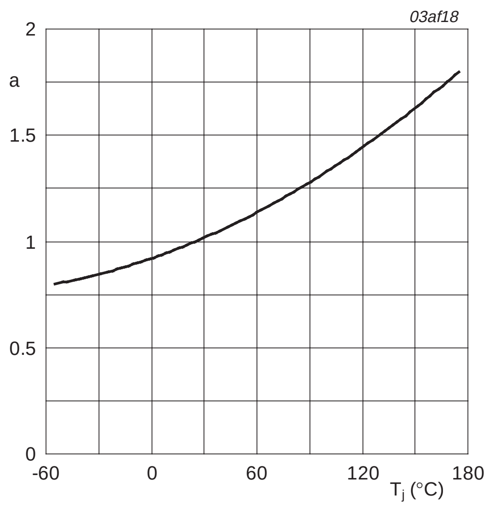
T_j = 25 °C

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



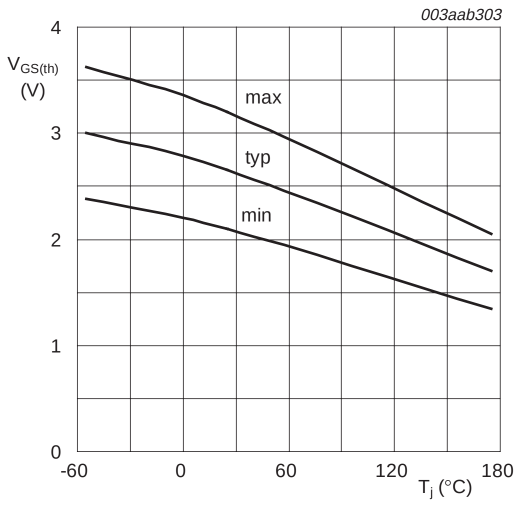
T_j = 25 °C and 175 °C; $V_{DS} > I_D \times R_{DSon}$

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



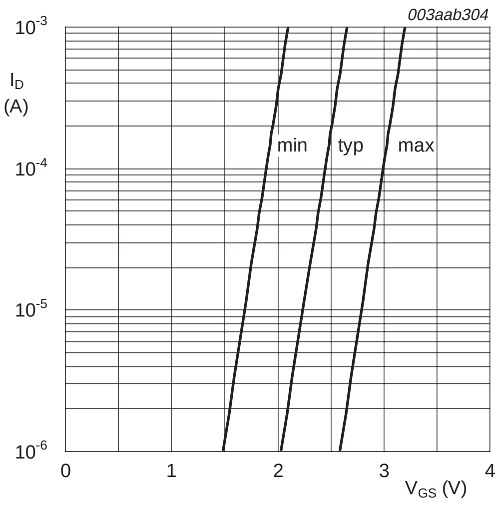
$$a = \frac{R_{DSon}}{R_{DSon(25°C)}}$$

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



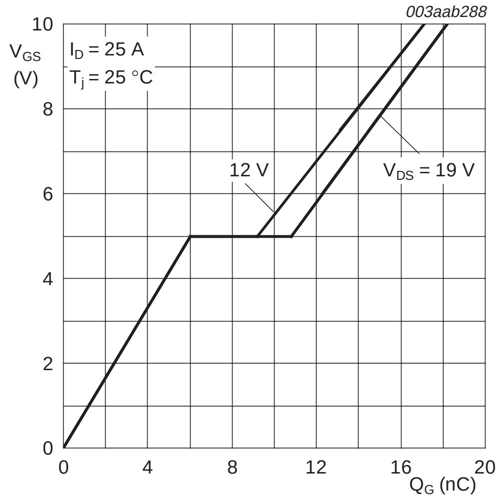
I_D = 1 mA; $V_{DS} = V_{GS}$

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



T_j = 25 °C; V_{DS} = 5 V

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



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

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

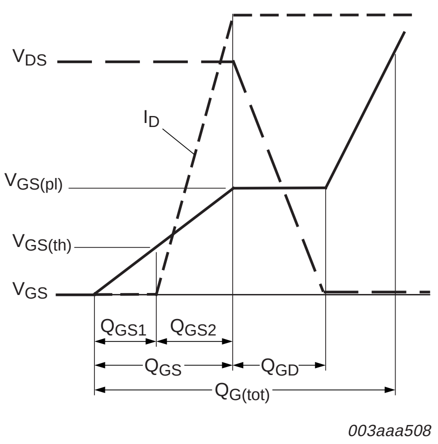
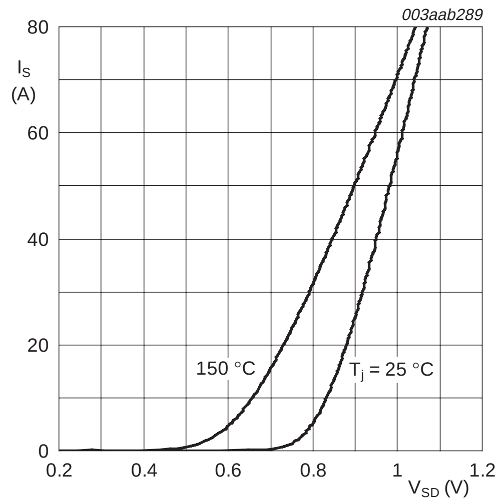
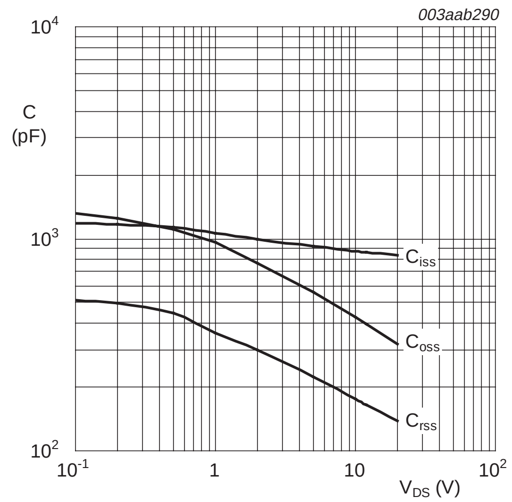


Fig 12. Gate charge waveform definitions



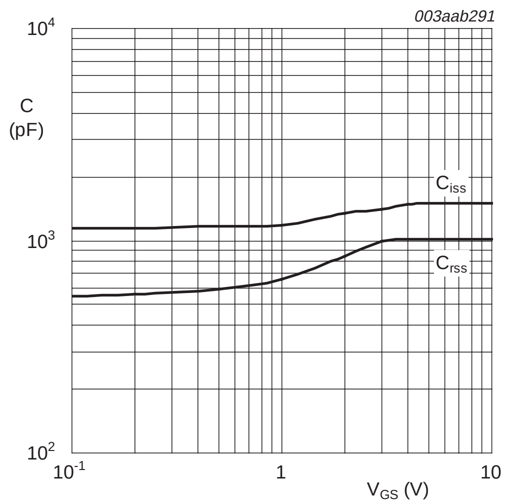
T_j = 25 °C and 175 °C; V_{GS} = 0 V

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



V_{GS} = 0 V; f = 1 MHz

Fig 14. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

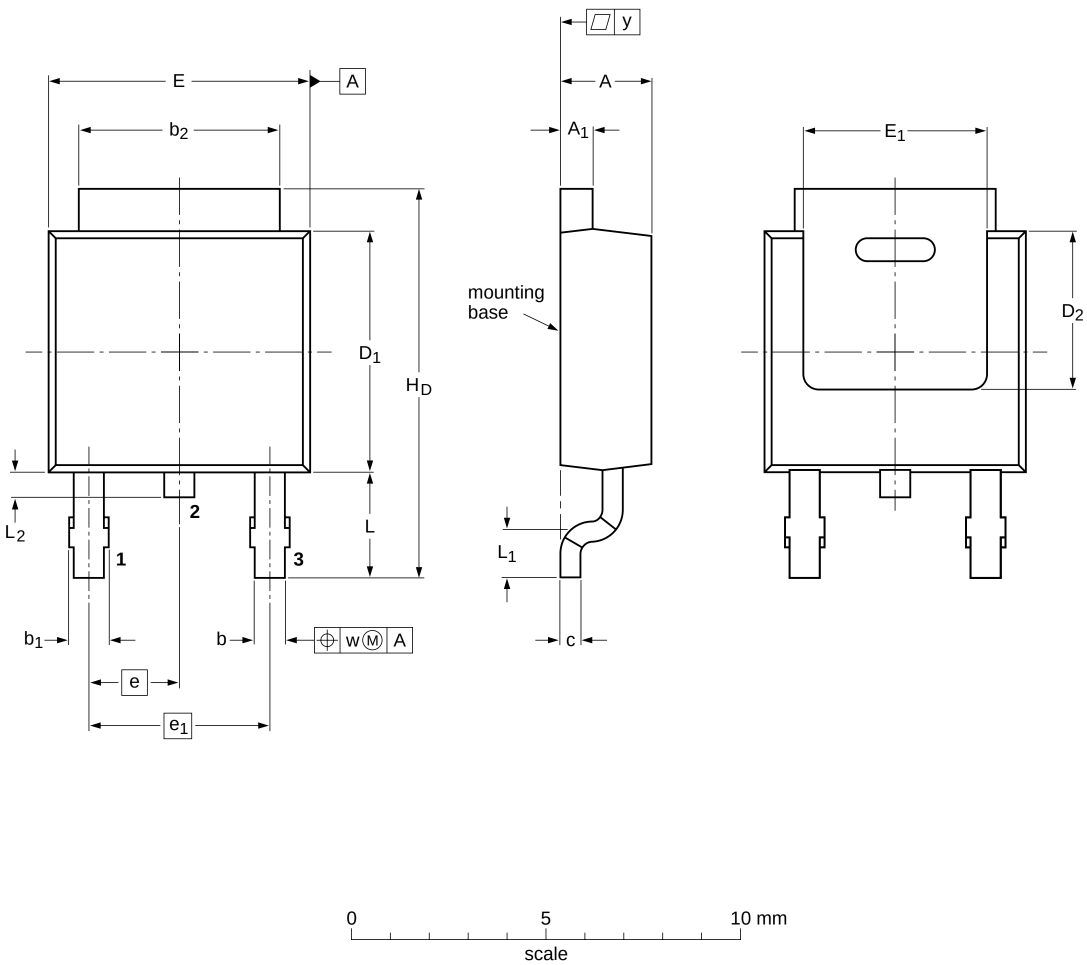


V_{GS} = 0 V; f = 1 MHz

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**



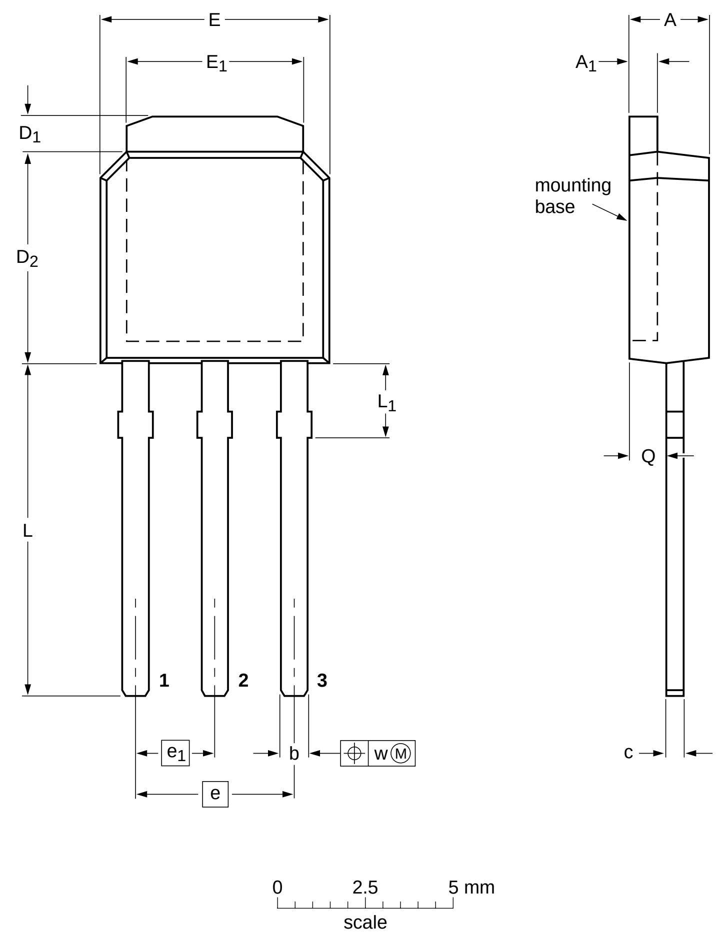
DIMENSIONS (mm are the original dimensions)

UNIT	A	A_1	b	b_1	b_2	c	D_1	D_2 min	E	E_1 min	e	e_1	H_D	L	L_1 min	L_2	w	y max
mm	2.38 2.22	0.93 0.46	0.89 0.71	1.1 0.9	5.46 5.00	0.56 0.20	6.22 5.98	4.0	6.73 6.47	4.45	2.285	4.57	10.4 9.6	2.95 2.55	0.5	0.9 0.5	0.2	0.2

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT428		TO-252	SC-63			~~06-02-14~~ 06-03-16

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 L_1.

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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11. Contents

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