

PHB78NQ03LT

N-channel TrenchMOS logic level FET

Rev. 05 — 13 June 2005

Product data sheet

1. Product profile

1.1 General description

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

1.2 Features

- Logic level threshold
- Fast switching

1.3 Applications

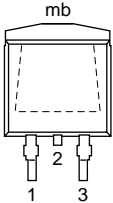
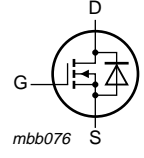
- Computer motherboards
- DC-to-DC converters

1.4 Quick reference data

- $V_{DS} \leq 25 \text{ V}$
- $I_D \leq 40 \text{ A}$
- $R_{DSon} \leq 9 \text{ m}\Omega$
- $Q_{GD} = 4 \text{ nC (typ)}$

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		

SOT404 (D2PAK)

[1] It is not possible to make a connection to pin 2.

3. Ordering information

Table 2: Ordering information

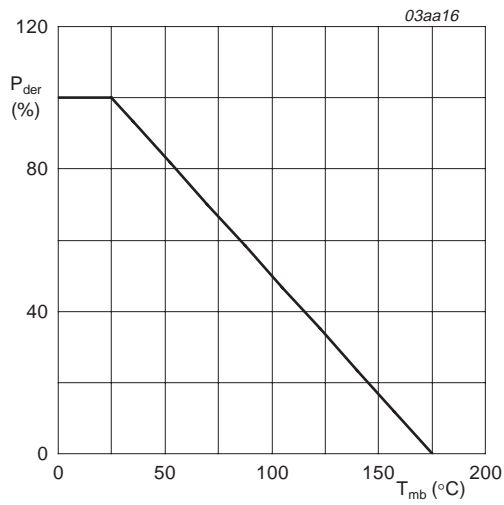
Type number	Package		Version
	Name	Description	
PHB78NQ03LT	D2PAK	plastic single-ended surface mounted package; 3 leads (one lead cropped)	SOT404

4. Limiting values

Table 3: Limiting values

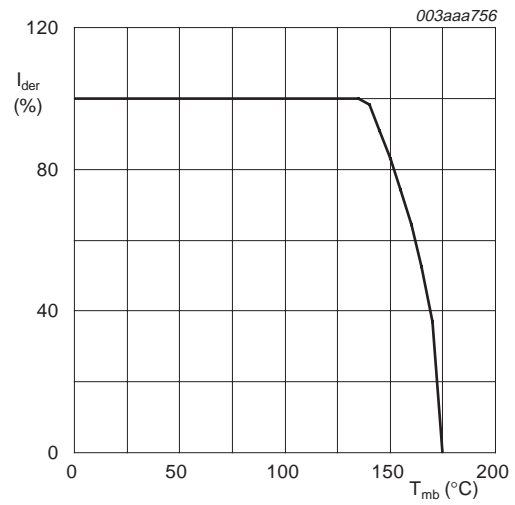
In accordance with the Absolute Maximum Rating System (IEC 60134).

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	$25\text{ °C} \leq T_j \leq 175\text{ °C}$; $R_{GS} = 20\text{ k}\Omega$	-	25	V
V_{GS}	gate-source voltage		-	± 20	V
I_D	drain current	$T_{mb} = 25\text{ °C}$; $V_{GS} = 5\text{ V}$	-	40	A
		$T_{mb} = 100\text{ °C}$; $V_{GS} = 5\text{ V}$	-	40	A
		$T_{mb} = 25\text{ °C}$; $V_{GS} = 10\text{ V}$; Figure 2 and 3	-	40	A
		$T_{mb} = 100\text{ °C}$; $V_{GS} = 10\text{ V}$; Figure 2	-	40	A
I_{DM}	peak drain current	$T_{mb} = 25\text{ °C}$; pulsed; $t_p \leq 10\text{ }\mu\text{s}$; Figure 3	-	160	A
P_{tot}	total power dissipation	$T_{mb} = 25\text{ °C}$; Figure 1	-	107	W
T_{stg}	storage temperature		-55	+175	°C
T_j	junction temperature		-55	+175	°C
Source-drain diode					
I_S	source (diode forward) current	$T_{mb} = 25\text{ °C}$	-	40	A
I_{SM}	peak source (diode forward) current	$T_{mb} = 25\text{ °C}$; pulsed; $t_p \leq 10\text{ }\mu\text{s}$	-	160	A
Avalanche ruggedness					
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	unclamped inductive load; $I_D = 32\text{ A}$; $t_p = 0.17\text{ ms}$; $V_{DD} \leq 25\text{ V}$; $R_{GS} = 50\text{ }\Omega$; $V_{GS} = 10\text{ V}$; starting at $T_j = 25\text{ °C}$	-	100	mJ



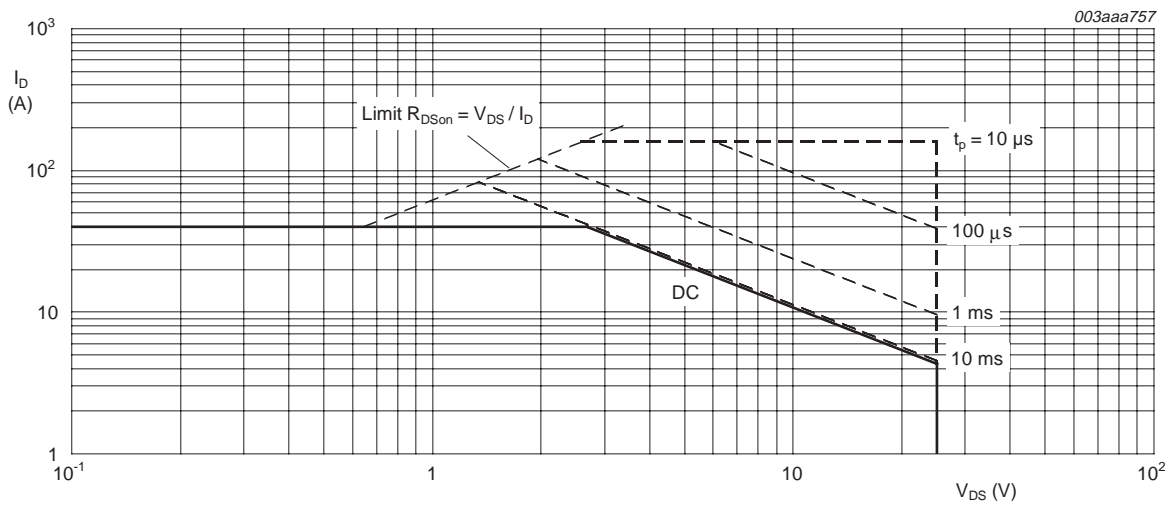
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\%$$

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



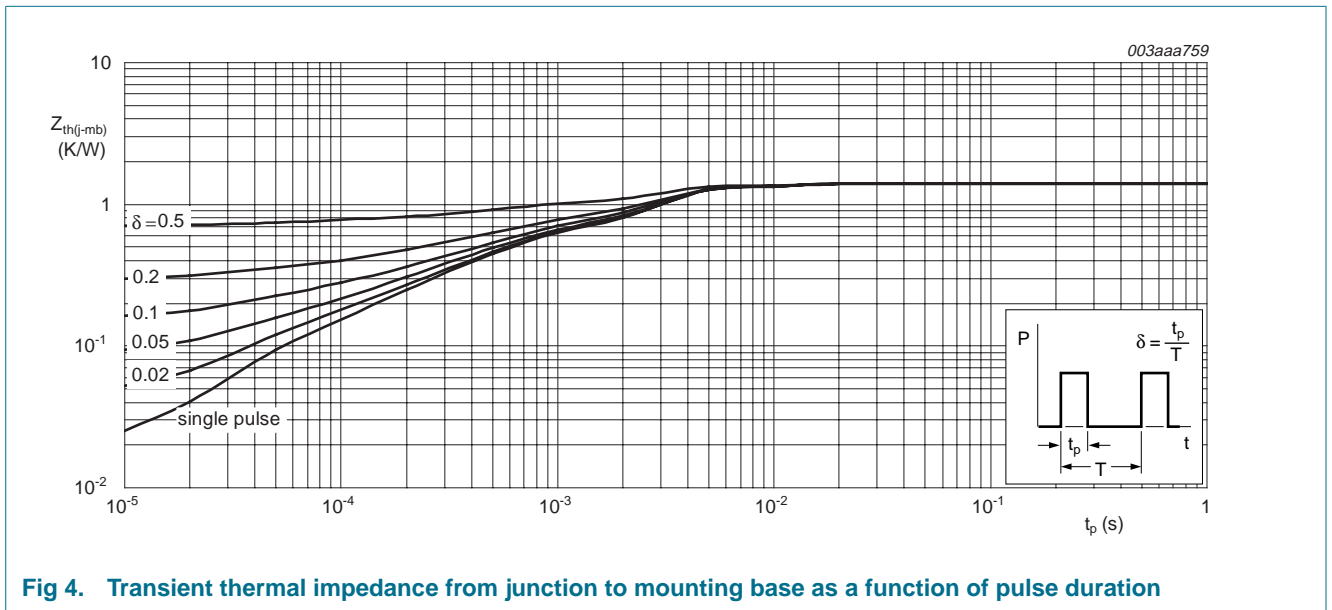
$T_{mb} = 25^{\circ}C$; I_{DM} is single pulse; $V_{GS} = 10 V$

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

5. Thermal characteristics

Table 4: Thermal characteristics

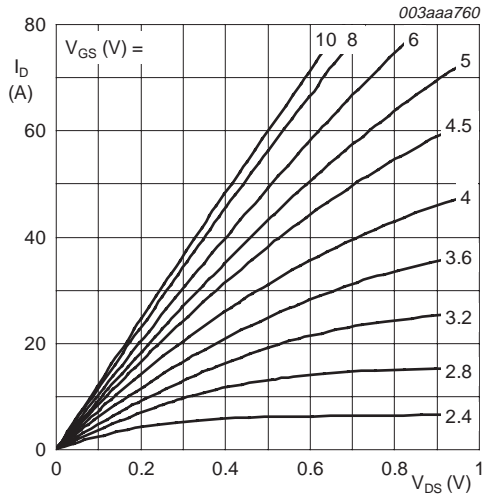
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$R_{th(j-mb)}$	thermal resistance from junction to mounting base	Figure 4	-	-	1.4	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient	mounted on a printed-circuit board; minimum footprint; vertical in still air	-	50	-	K/W



6. Characteristics

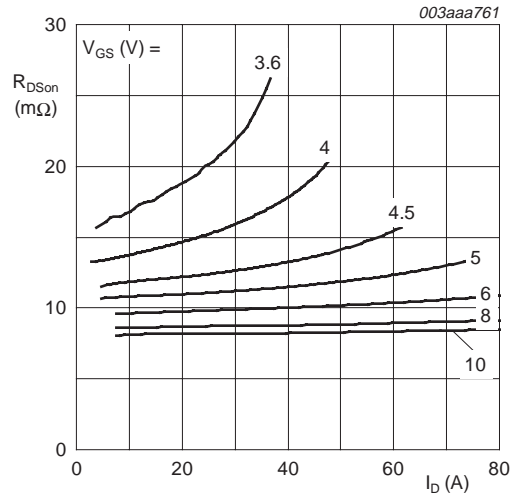
Table 5: Characteristics
 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Static characteristics						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 250\text{ }\mu\text{A}$; $V_{GS} = 0\text{ V}$ $T_j = 25\text{ }^\circ\text{C}$ $T_j = -55\text{ }^\circ\text{C}$	25 22	- -	- -	V V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 1\text{ mA}$; $V_{DS} = V_{GS}$; Figure 9 and 10 $T_j = 25\text{ }^\circ\text{C}$ $T_j = 175\text{ }^\circ\text{C}$ $T_j = -55\text{ }^\circ\text{C}$	1 0.5 -	1.5 - -	2 - 2.2	V V V
I_{DSS}	drain-source leakage current	$V_{DS} = 25\text{ V}$; $V_{GS} = 0\text{ V}$ $T_j = 25\text{ }^\circ\text{C}$ $T_j = 175\text{ }^\circ\text{C}$	- - -	- - -	1 500	μA μA
R_G	gate resistance	$f = 1\text{ MHz}$	-	1	-	Ω
I_{GSS}	gate-source leakage current	$V_{GS} = \pm 15\text{ V}$; $V_{DS} = 0\text{ V}$	-	10	100	nA
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 5\text{ V}$; $I_D = 25\text{ A}$; Figure 6 and 8 $T_j = 25\text{ }^\circ\text{C}$ $T_j = 175\text{ }^\circ\text{C}$ $V_{GS} = 10\text{ V}$; $I_D = 25\text{ A}$; Figure 6 and 8	- - -	10.5 18.9 7.65	13.5 24.3 9	m Ω m Ω m Ω
Dynamic characteristics						
$Q_{G(tot)}$	total gate charge	$I_D = 25\text{ A}$; $V_{DS} = 12\text{ V}$; $V_{GS} = 4.5\text{ V}$; Figure 11 and 12	-	11	-	nC
Q_{GS}	gate-source charge		-	3.6	-	nC
Q_{GS1}	pre- $V_{GS(th)}$ gate-source charge		-	1.8	-	nC
Q_{GS2}	post- $V_{GS(th)}$ gate-source charge		-	1.8	-	nC
Q_{GD}	gate-drain (Miller) charge		-	4	-	nC
$V_{GS(pl)}$	gate-source plateau voltage		-	3	-	V
$Q_{G(tot)}$	total gate charge	$I_D = 0\text{ A}$; $V_{DS} = 0\text{ V}$; $V_{GS} = 4.5\text{ V}$	-	8.6	-	nC
C_{iss}	input capacitance	$V_{GS} = 0\text{ V}$; $V_{DS} = 12\text{ V}$; $f = 1\text{ MHz}$; Figure 14	-	970	-	pF
C_{oss}	output capacitance		-	415	-	pF
C_{rss}	reverse transfer capacitance		-	170	-	pF
C_{iss}	input capacitance	$V_{GS} = 0\text{ V}$; $V_{DS} = 0\text{ V}$; $f = 1\text{ MHz}$	-	1460	-	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = 12\text{ V}$; $R_L = 0.5\text{ }\Omega$; $V_{GS} = 5\text{ V}$; $R_G = 5.6\text{ }\Omega$	-	13	-	ns
t_r	rise time		-	46	-	ns
$t_{d(off)}$	turn-off delay time		-	20	-	ns
t_f	fall time		-	15	-	ns
Source-drain diode						
V_{SD}	source-drain (diode forward) voltage	$I_S = 25\text{ A}$; $V_{GS} = 0\text{ V}$; Figure 13	-	0.78	1.2	V
t_{rr}	reverse recovery time	$I_S = 20\text{ A}$; $dI_S/dt = -100\text{ A}/\mu\text{s}$; $V_{GS} = 0\text{ V}$	-	35	-	ns
Q_r	recovered charge		-	20	-	nC



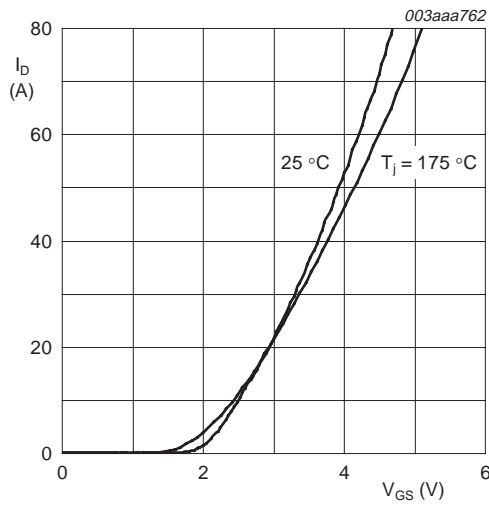
$T_j = 25\text{ }^\circ\text{C}$

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



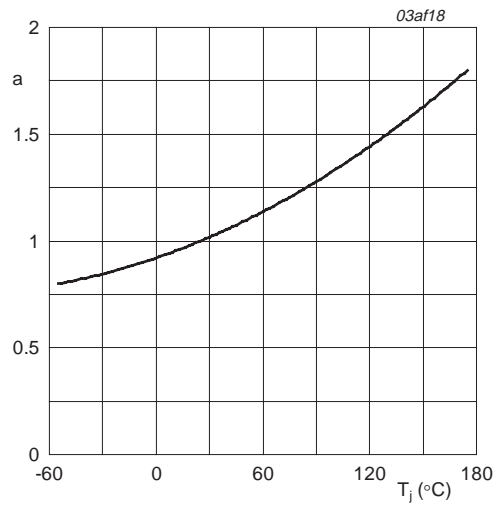
$T_j = 25\text{ }^\circ\text{C}$

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



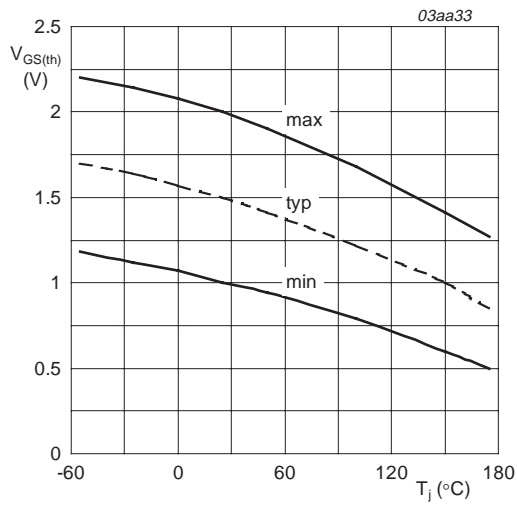
$T_j = 25\text{ }^\circ\text{C}$ and $175\text{ }^\circ\text{C}$; $V_{DS} > I_D \times R_{DS(on)}$

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



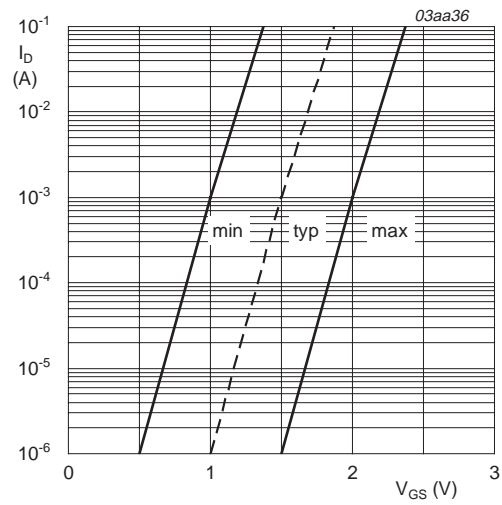
$$a = \frac{R_{DS(on)}}{R_{DS(on)(25\text{ }^\circ\text{C})}}$$

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



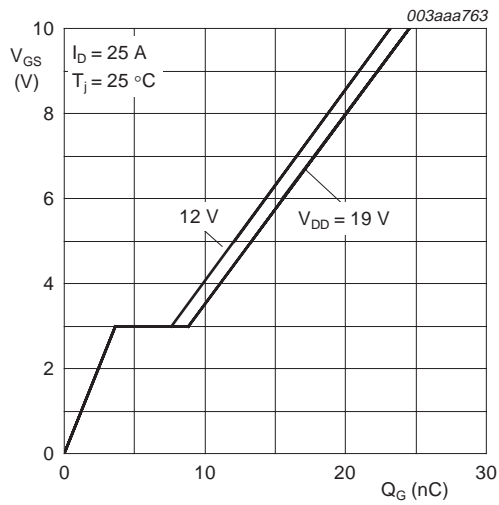
$I_D = 1 \text{ mA}; V_{DS} = V_{GS}$

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



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

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

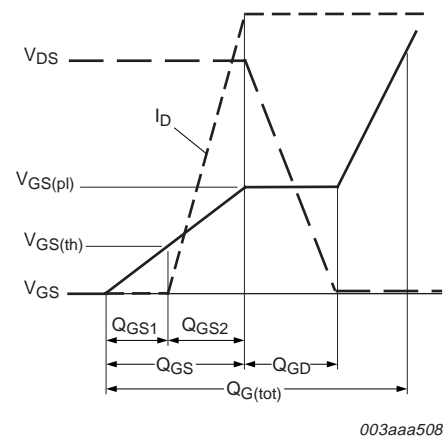
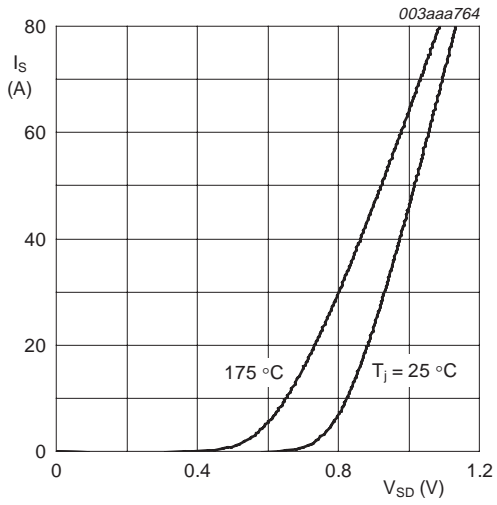
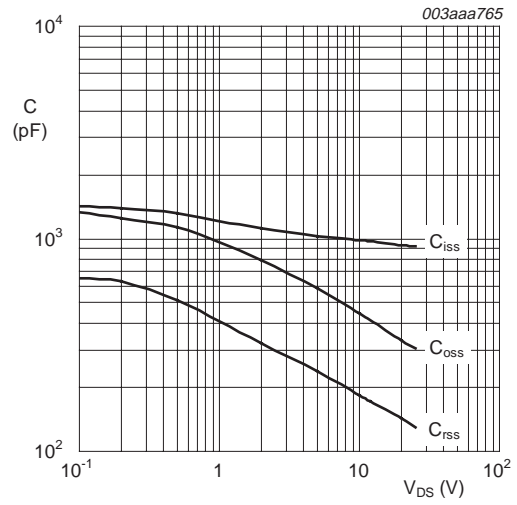


Fig 12. Gate charge waveform definitions



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

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



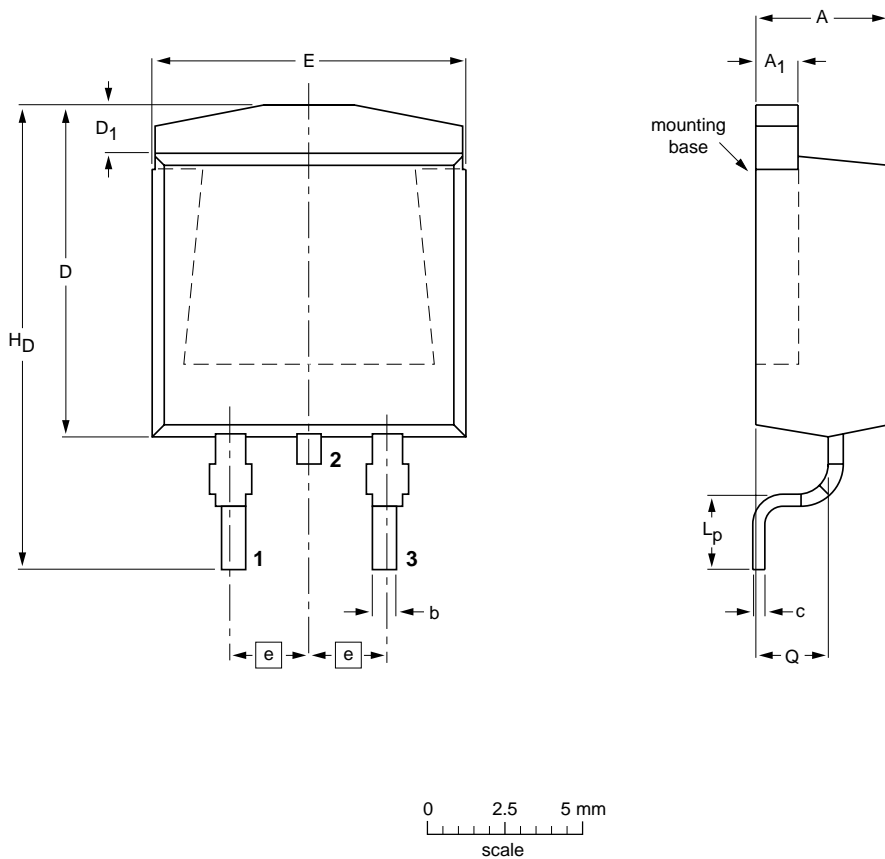
$V_{GS} = 0\text{ V}$; $f = 1\text{ MHz}$

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

7. Package outline

Plastic single-ended surface mounted package (D2PAK); 3 leads (one lead cropped)

SOT404



DIMENSIONS (mm are the original dimensions)

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

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT404						04-10-13 05-02-11

Fig 15. Package outline SOT404 (D2PAK)

8. Revision history

Table 6: Revision history

Document ID	Release date	Data sheet status	Change notice	Doc. number	Supersedes
PHB78NQ03LT_5	20050613	Product data sheet	2004070095	9397 750 15071	PHB_PHD78NQ03LT_4
Modifications: <ul style="list-style-type: none"> • The format of this data sheet has been redesigned to comply with the new presentation and information standard of Philips Semiconductors. • Removal of PHD78NQ03LT (now in separate data sheet). • Section 4 “Limiting values” I_D, I_{DM}, P_{tot}, I_S, I_{SM} and $E_{DS(AL)S}$ modified. • Section 4 “Limiting values” Figure 2 and 3 modified. • Section 5 “Thermal characteristics” $R_{th(j-mb)}$ modified. • Section 5 “Thermal characteristics” Figure 4 modified. • Section 6 “Characteristics” R_{DSon}, $Q_{G(tot)}$, Q_{GS}, Q_{GD}, C_{iss}, C_{oss}, C_{rss}, $t_{d(on)}$, t_r, $t_{d(off)}$, t_f, V_{SD}, t_{rr}, Q_f condition and/or values changed. • Section 6 “Characteristics” R_G, Q_{GS1}, Q_{GS2} and $V_{GS(pl)}$ added. • Section 6 “Characteristics” Figure 5, 6, 7, 11, 12, and 13 modified. 					
PHB_PHD78NQ03LT_4	20040726	Product data sheet	-	9397 750 13432	PHP_PHB_PHD78NQ03LT_3
PHP_PHB_PHD78NQ03LT_3	20020626	Product data sheet	-	9397 750 09667	PHP_PHB_PHD78NQ03LT_2
PHP_PHB_PHD78NQ03LT_2	20020322	Product data sheet	-	9397 750 09418	PHP_PHB_PHD78NQ03LT_1
PHP_PHB_PHD78NQ03LT_1	20011114	Product data sheet	-	9397 750 08916	-

9. Data sheet status

Level	Data sheet status ^[1]	Product status ^{[2] [3]}	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.
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[3] For data sheets describing multiple type numbers, the highest-level product status determines the data sheet status.

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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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