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Kind regards,

Team Nexperia

# 2N7002P

60 V, 360 mA N-channel Trench MOSFET

Rev. 02 — 29 July 2010

Product data sheet

## 1. Product profile

### 1.1 General description

N-channel enhancement mode Field-Effect Transistor (FET) in a small SOT23 (TO-236AB) Surface-Mounted Device (SMD) plastic package using Trench MOSFET technology.

### 1.2 Features and benefits

- AEC-Q101 qualified
- Logic-level compatible
- Trench MOSFET technology
- Very fast switching

### 1.3 Applications

- High-speed line driver
- Low-side loadswitch
- Relay driver
- Switching circuits

### 1.4 Quick reference data

Table 1. Quick reference data

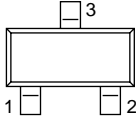
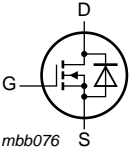
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{DS}$	drain-source voltage	$T_{amb} = 25\text{ °C}$	-	-	60	V
$V_{GS}$	gate-source voltage		-20	-	20	V
$I_D$	drain current	$V_{GS} = 10\text{ V}; T_{amb} = 25\text{ °C}$	[1]	-	360	mA
<b>Static characteristics</b>						
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 10\text{ V}; I_D = 500\text{ mA}; T_j = 25\text{ °C}; \text{pulsed}; t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.01$	-	1	1.6	$\Omega$

[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 1 cm<sup>2</sup>.



## 2. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	G	gate	 SOT23 (TO-236AB)	 mbb076
2	S	source		
3	D	drain		

## 3. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
2N7002P	TO-236AB	plastic surface-mounted package; 3 leads	SOT23

## 4. Marking

Table 4. Marking codes

Type number	Marking code <sup>[1]</sup>
2N7002P	LW%

[1] % = -: made in Hong Kong; % = p: made in Hong Kong; % = t: made in Malaysia; % = W: made in China

## 5. Limiting values

Table 5. Limiting values

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

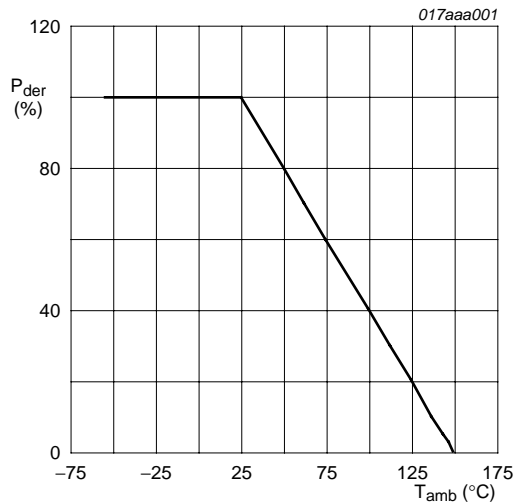
Symbol	Parameter	Conditions	Min	Max	Unit
$V_{DS}$	drain-source voltage	$T_{amb} = 25\text{ °C}$	-	60	V
$V_{GS}$	gate-source voltage		-20	20	V
$I_D$	drain current	$V_{GS} = 10\text{ V}$ ; $T_{amb} = 25\text{ °C}$	[1]	360	mA
		$V_{GS} = 10\text{ V}$ ; $T_{amb} = 100\text{ °C}$	[1]	280	mA
$I_{DM}$	peak drain current	$T_{amb} = 25\text{ °C}$ ; single pulse; $t_p \leq 10\text{ }\mu\text{s}$	-	1.2	A
$P_{tot}$	total power dissipation	$T_{amb} = 25\text{ °C}$	[2]	350	mW
			[1]	420	mW
		$T_{sp} = 25\text{ °C}$	-	1140	mW
$T_j$	junction temperature		-	150	°C
$T_{amb}$	ambient temperature		-55	150	°C
$T_{stg}$	storage temperature		-65	150	°C

### Source-drain diode

$I_S$	source current	$T_{amb} = 25\text{ °C}$	[1]	-	360	mA
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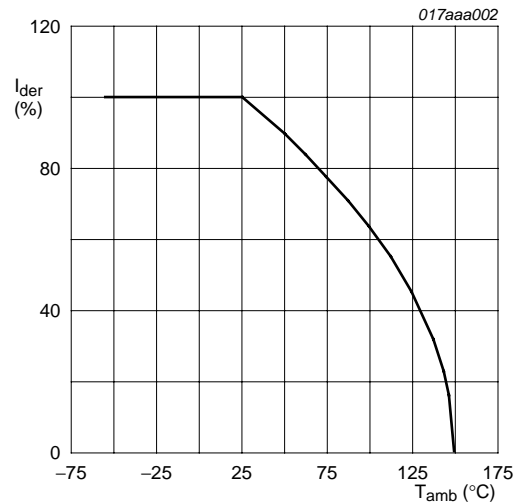
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 1 cm<sup>2</sup>.

[2] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.



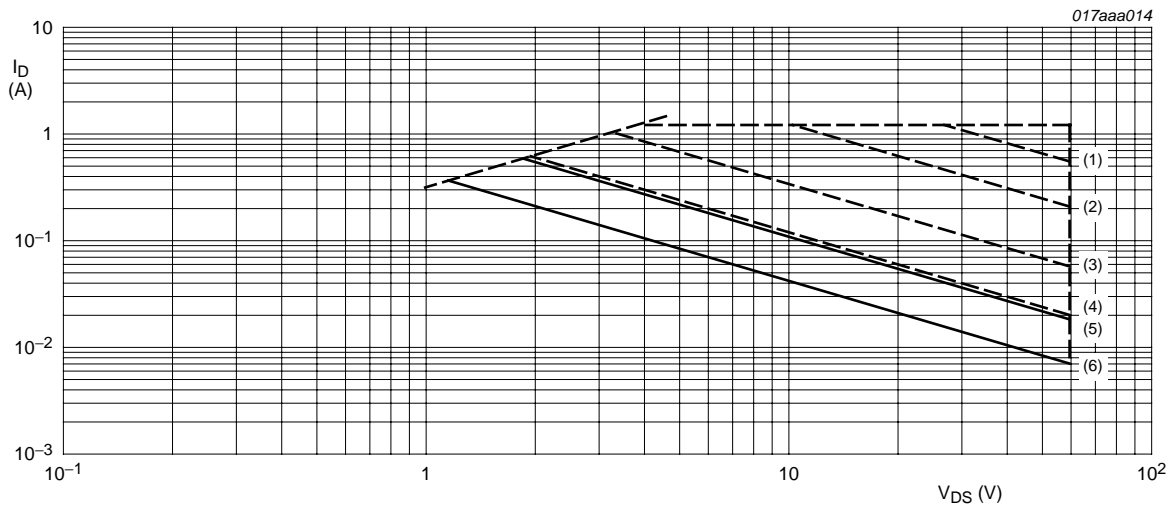
$$P_{der} = \frac{P_{tot}}{P_{tot(25^\circ\text{C})}} \times 100 \%$$

**Fig 1. Normalized total power dissipation as a function of ambient temperature**



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

**Fig 2. Normalized continuous drain current as a function of ambient temperature**



$I_{DM}$  = single pulse

(1)  $t_p = 100 \mu\text{s}$

(2)  $t_p = 1 \text{ ms}$

(3)  $t_p = 10 \text{ ms}$

(4)  $t_p = 100 \text{ ms}$

(5) DC;  $T_{sp} = 25^\circ\text{C}$

(6) DC;  $T_{amb} = 25^\circ\text{C}$ ; drain mounting pad  $1 \text{ cm}^2$

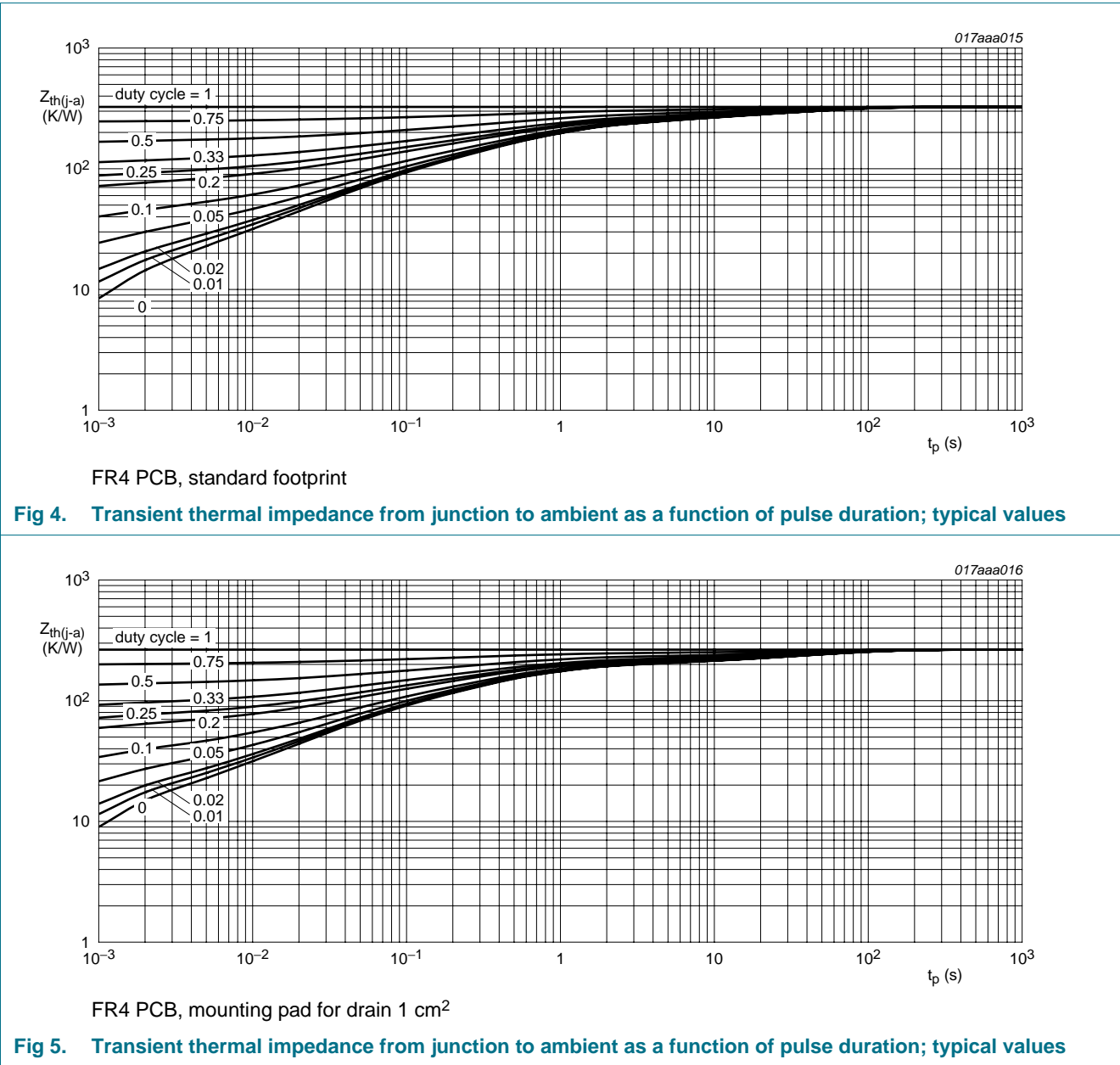
**Fig 3. Safe operating area; junction to ambient; continuous and peak drain currents as a function of drain-source voltage**

6. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	310	370 K/W
			[2]	-	260	300 K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point		-	-	115	K/W

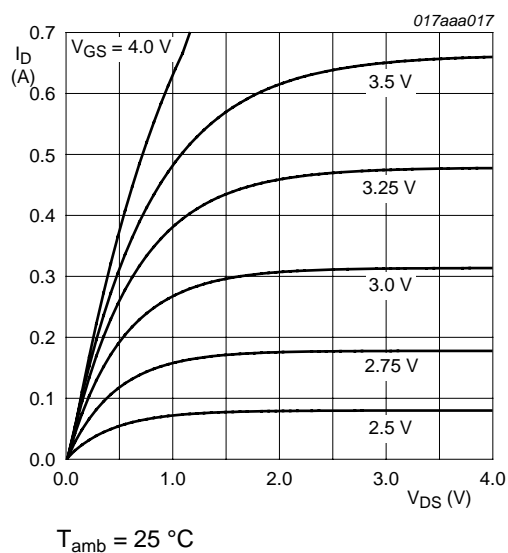
- [1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.
- [2] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 1 cm<sup>2</sup>.



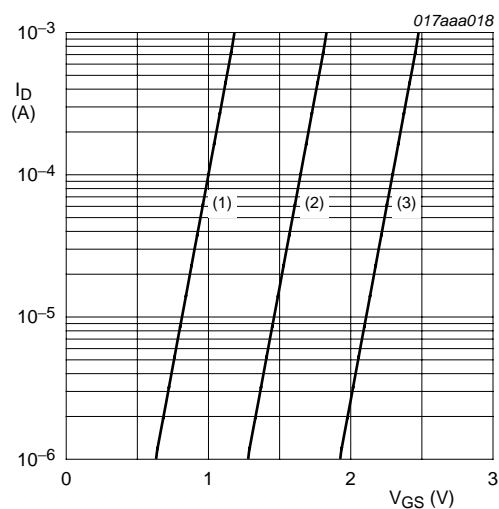
## 7. Characteristics

**Table 7. Characteristics**

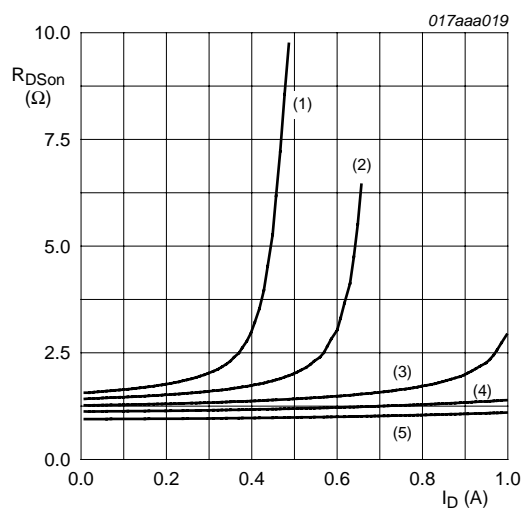
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Static characteristics						
V <sub>(BR)DSS</sub>	drain-source breakdown voltage	I <sub>D</sub> = 10 μA; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C	60	-	-	V
V <sub>GSth</sub>	gate-source threshold voltage	I <sub>D</sub> = 250 μA; V <sub>DS</sub> = V <sub>GS</sub> ; T <sub>j</sub> = 25 °C	1.1	1.75	2.4	V
I <sub>DSS</sub>	drain leakage current	V <sub>DS</sub> = 60 V; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C	-	-	1	μA
		V <sub>DS</sub> = 60 V; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 150 °C	-	-	10	μA
I <sub>GSS</sub>	gate leakage current	V <sub>GS</sub> = 20 V; V <sub>DS</sub> = 0 V; T <sub>j</sub> = 25 °C	-	-	100	nA
		V <sub>GS</sub> = -20 V; V <sub>DS</sub> = 0 V; T <sub>j</sub> = 25 °C	-	-	100	nA
R <sub>DSon</sub>	drain-source on-state resistance	V <sub>GS</sub> = 5 V; I <sub>D</sub> = 50 mA; pulsed; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.01 ; T <sub>j</sub> = 25 °C	-	1.3	2	Ω
		V <sub>GS</sub> = 10 V; I <sub>D</sub> = 500 mA; pulsed; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.01 ; T <sub>j</sub> = 25 °C	-	1	1.6	Ω
g <sub>fs</sub>	forward transconductance	V <sub>DS</sub> = 10 V; I <sub>D</sub> = 200 mA; pulsed; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.01 ; T <sub>j</sub> = 25 °C	-	400	-	mS
Dynamic characteristics						
Q <sub>G(tot)</sub>	total gate charge	I <sub>D</sub> = 300 mA; V <sub>DS</sub> = 30 V; V <sub>GS</sub> = 4.5 V; T <sub>j</sub> = 25 °C	-	0.6	0.8	nC
Q <sub>GS</sub>	gate-source charge		-	0.2	-	nC
Q <sub>GD</sub>	gate-drain charge		-	0.2	-	nC
C <sub>iss</sub>	input capacitance	V <sub>GS</sub> = 0 V; V <sub>DS</sub> = 10 V; f = 1 MHz; T <sub>j</sub> = 25 °C	-	30	50	pF
C <sub>oss</sub>	output capacitance		-	7	-	pF
C <sub>rss</sub>	reverse transfer capacitance		-	4	-	pF
t <sub>d(on)</sub>	turn-on delay time	V <sub>DS</sub> = 50 V; R <sub>L</sub> = 250 Ω; V <sub>GS</sub> = 10 V; R <sub>G(ext)</sub> = 6 Ω; T <sub>j</sub> = 25 °C	-	3	6	ns
t <sub>r</sub>	rise time		-	4	-	ns
t <sub>d(off)</sub>	turn-off delay time		-	10	20	ns
t <sub>f</sub>	fall time		-	5	-	ns
Source-drain diode						
V <sub>SD</sub>	source-drain voltage	I <sub>S</sub> = 115 mA; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C	0.47	0.75	1.1	V



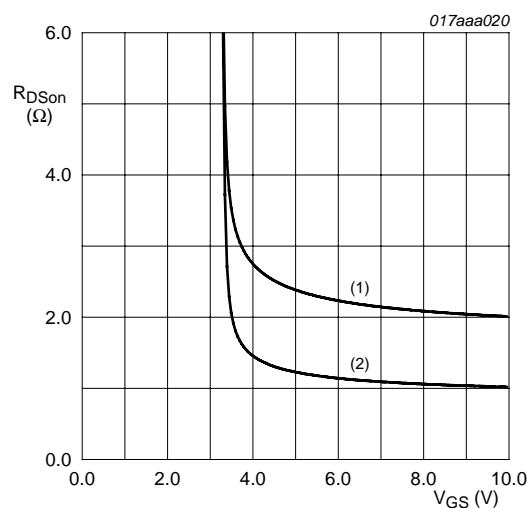
**Fig 6. Output characteristics: drain current as a function of drain-source voltage; typical values**



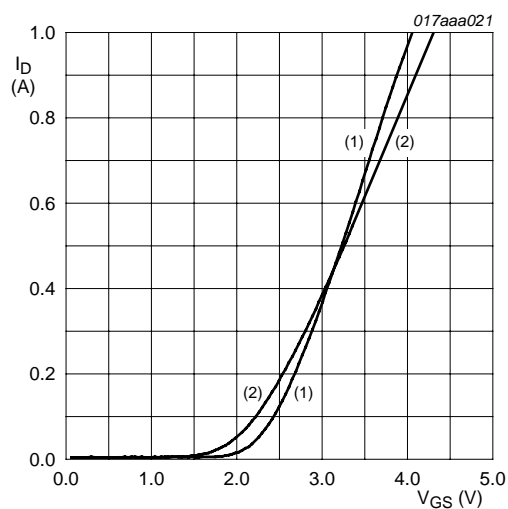
**Fig 7. Sub-threshold drain current as a function of gate-source voltage**



**Fig 8. Drain-source on-state resistance as a function of drain current; typical values**



**Fig 9. Drain-source on-state resistance as a function of gate-source voltage; typical values**

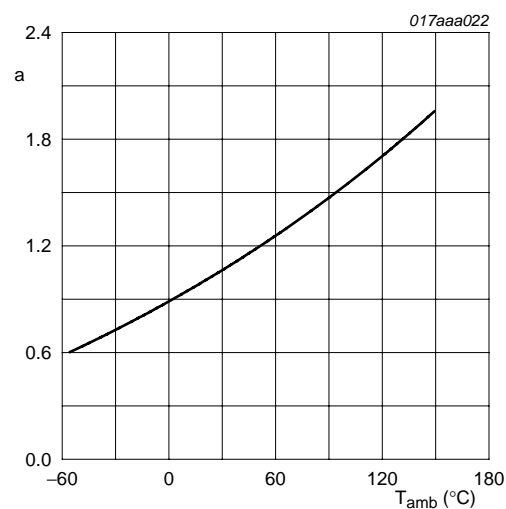


$$V_{DS} > I_D \times R_{DS(on)}$$

(1)  $T_{amb} = 25\text{ }^{\circ}\text{C}$

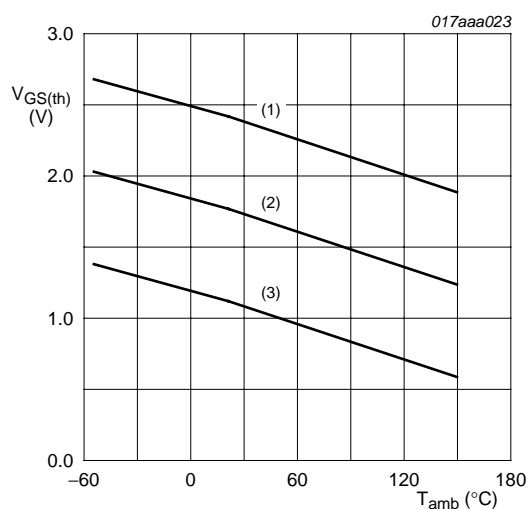
(2)  $T_{amb} = 150\text{ }^{\circ}\text{C}$

**Fig 10. 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 11. Normalized drain-source on-state resistance as a function of ambient temperature; typical values**



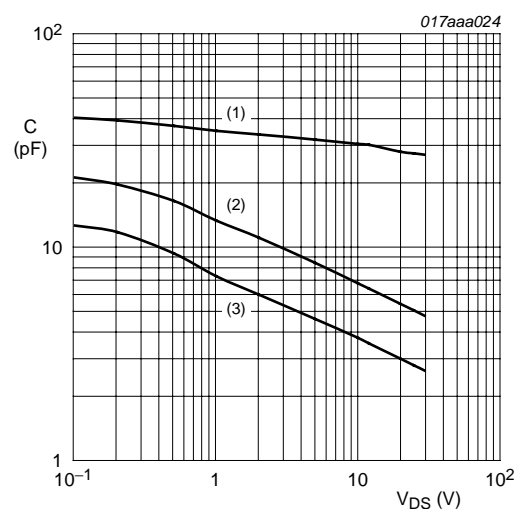
$$I_D = 0.25\text{ mA}; V_{DS} = V_{GS}$$

(1) maximum values

(2) typical values

(3) minimum values

**Fig 12. Gate-source threshold voltage as a function of ambient temperature**



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

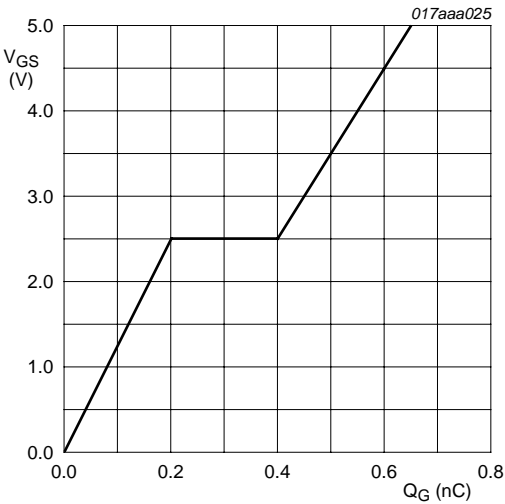
(1)  $C_{iss}$

(2)  $C_{oss}$

(3)  $C_{rss}$

**Fig 13. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values**





$I_D = 300\text{ mA}$ ;  $V_{DS} = 30\text{ V}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$

Fig 14. Gate-source voltage as a function of gate charge; typical values

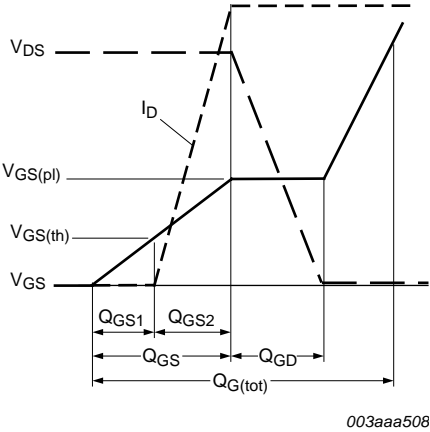
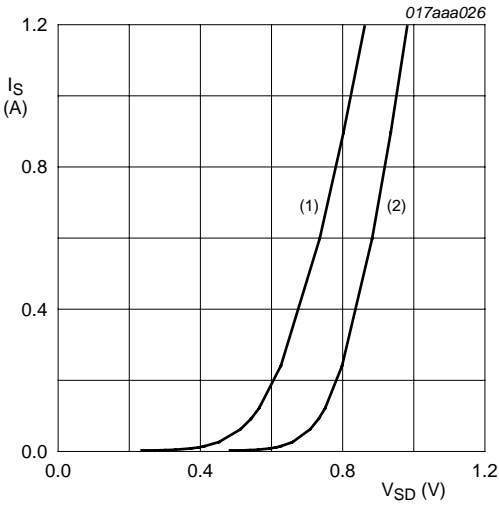


Fig 15. Gate charge waveform definitions



$V_{GS} = 0\text{ V}$   
(1)  $T_{amb} = 150\text{ }^{\circ}\text{C}$   
(2)  $T_{amb} = 25\text{ }^{\circ}\text{C}$

Fig 16. Source current as a function of source-drain voltage; typical values

## 8. Test information

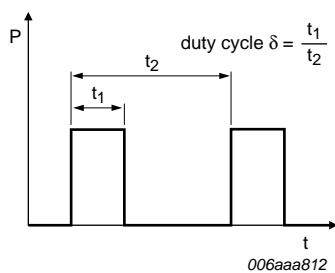


Fig 17. Duty cycle definition

9. Package outline

Plastic surface-mounted package; 3 leads

SOT23

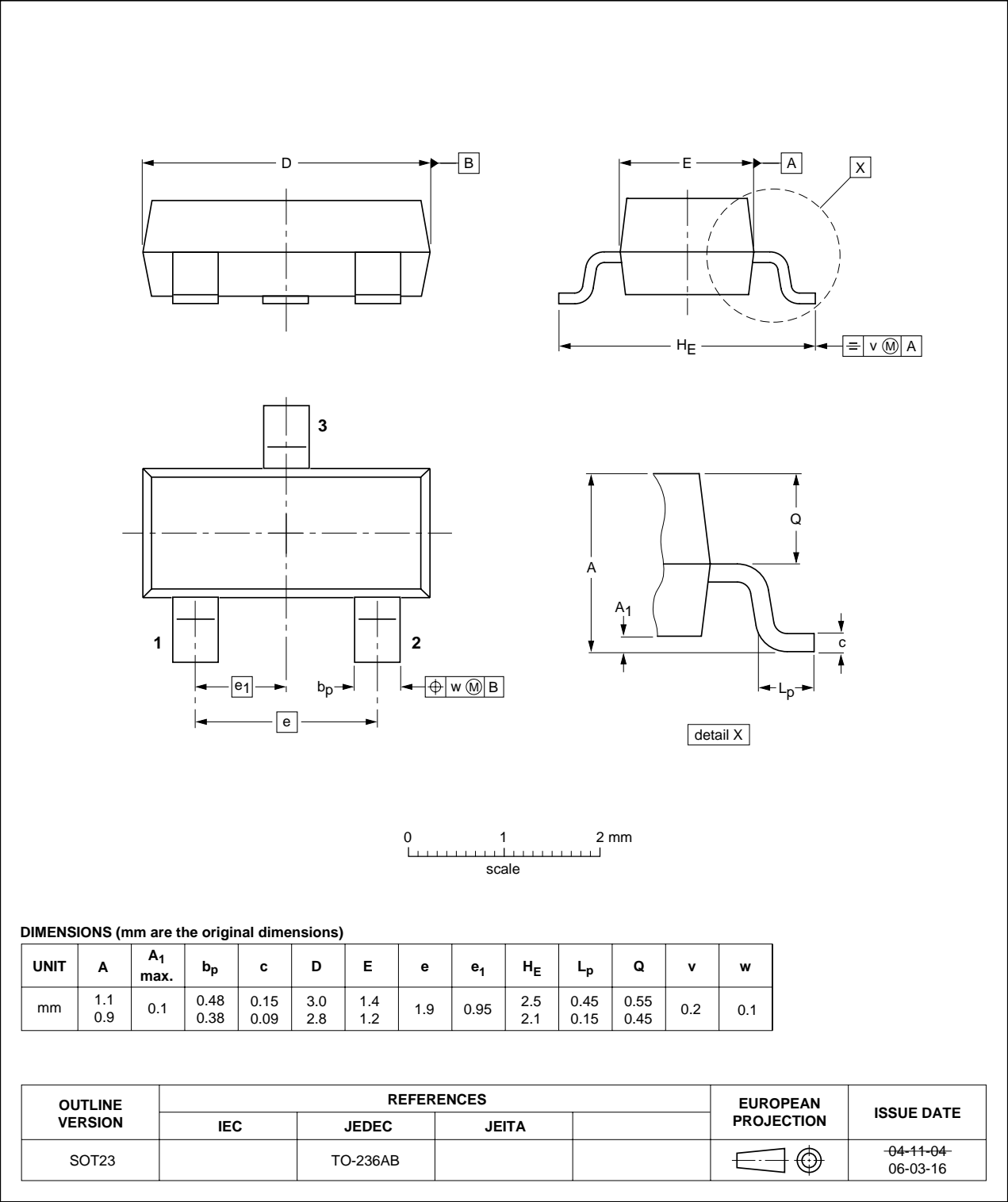


Fig 18. Package outline SOT23 (TO-236AB)

10. Soldering

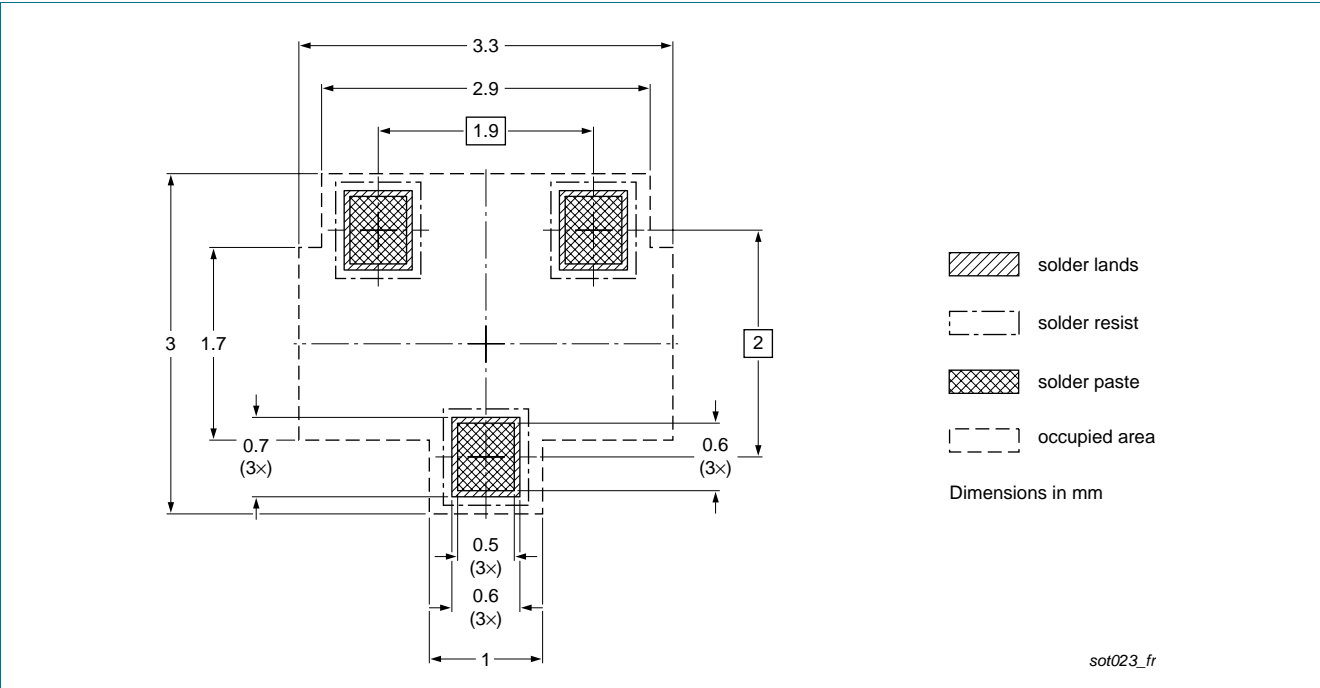


Fig 19. Reflow soldering footprint for SOT23 (TO-236AB)

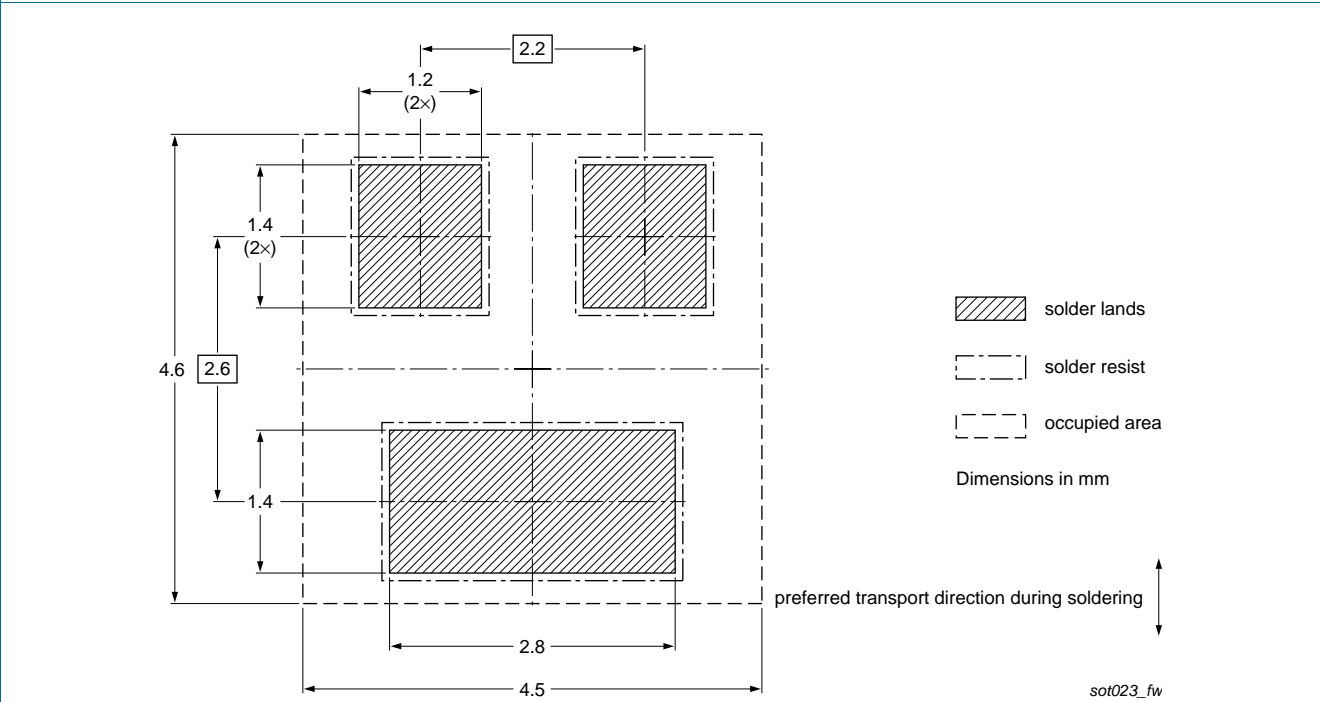


Fig 20. Wave soldering footprint for SOT23 (TO-236AB)

## 11. Revision history

Table 8. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
2N7002P v.2	20100729	Product data sheet	-	2N7002P_1
Modifications:	<ul style="list-style-type: none"><li>• Correction of thermal values.</li><li>• Correction of various characteristics values including related graphs.</li></ul>			
2N7002P_1	20100419	Product data sheet	-	-

## 12. Legal information

### 12.1 Data sheet status

Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	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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Date of release: 29 July 2010

Document identifier: 2N7002P



## Данный компонент на территории Российской Федерации

**Вы можете приобрести в компании MosChip.**

Для оперативного оформления запроса Вам необходимо перейти по данной ссылке:

<http://moschip.ru/get-element>

Вы можете разместить у нас заказ для любого Вашего проекта, будь то серийное производство или разработка единичного прибора.

В нашем ассортименте представлены ведущие мировые производители активных и пассивных электронных компонентов.

Нашей специализацией является поставка электронной компонентной базы двойного назначения, продукции таких производителей как XILINX, Intel (ex.ALTERA), Vicor, Microchip, Texas Instruments, Analog Devices, Mini-Circuits, Amphenol, Glenair.

Сотрудничество с глобальными дистрибьюторами электронных компонентов, предоставляет возможность заказывать и получать с международных складов практически любой перечень компонентов в оптимальные для Вас сроки.

На всех этапах разработки и производства наши партнеры могут получить квалифицированную поддержку опытных инженеров.

Система менеджмента качества компании отвечает требованиям в соответствии с ГОСТ Р ИСО 9001, ГОСТ РВ 0015-002 и ЭС РД 009

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