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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

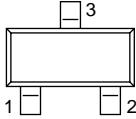
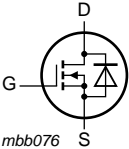
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{DS}$	drain-source voltage	$T_{amb} = 25\text{ °C}$	-	-	60	V
$V_{GS}$	gate-source voltage		-20	-	20	V
$I_D$	drain current	$V_{GS} = 10\text{ V}$ ; $T_{amb} = 25\text{ °C}$	[1]	-	360	mA
<b>Static characteristics</b>						
$R_{DS(on)}$	drain-source on-state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

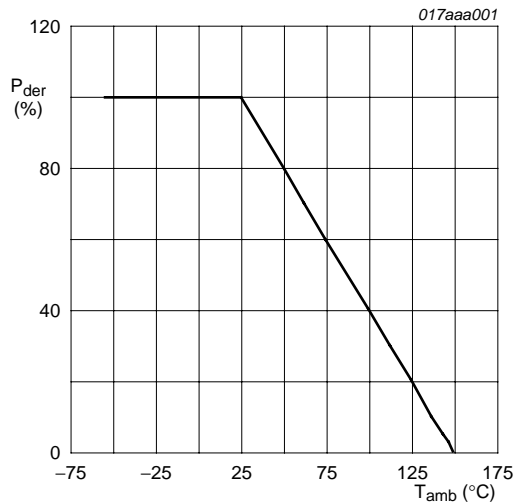
Symbol	Parameter	Conditions	Min	Max	Unit
$V_{DS}$	drain-source voltage	$T_{amb} = 25\text{ °C}$	-	60	V
$V_{GS}$	gate-source voltage		-20	20	V
$I_D$	drain current	$V_{GS} = 10\text{ V}; T_{amb} = 25\text{ °C}$	[1]	360	mA
		$V_{GS} = 10\text{ V}; T_{amb} = 100\text{ °C}$	[1]	280	mA
$I_{DM}$	peak drain current	$T_{amb} = 25\text{ °C}; \text{single pulse}; t_p \leq 10\text{ }\mu\text{s}$	-	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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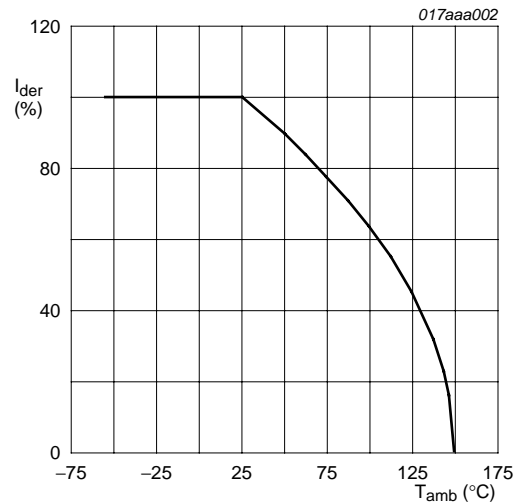
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 1 cm<sup>2</sup>.

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



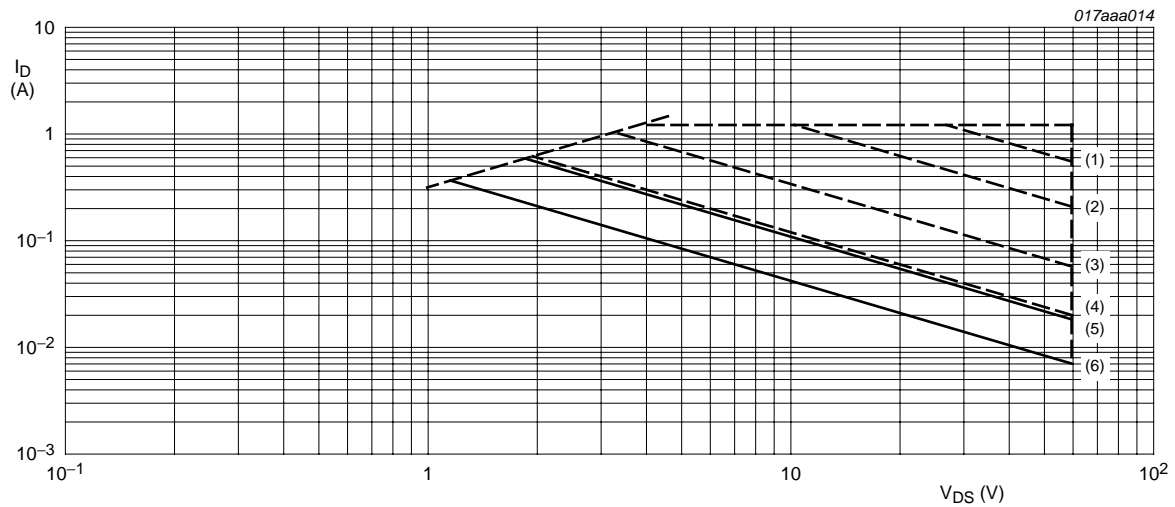
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}\text{C})}} \times 100 \%$$

**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  $1 \text{ cm}^2$

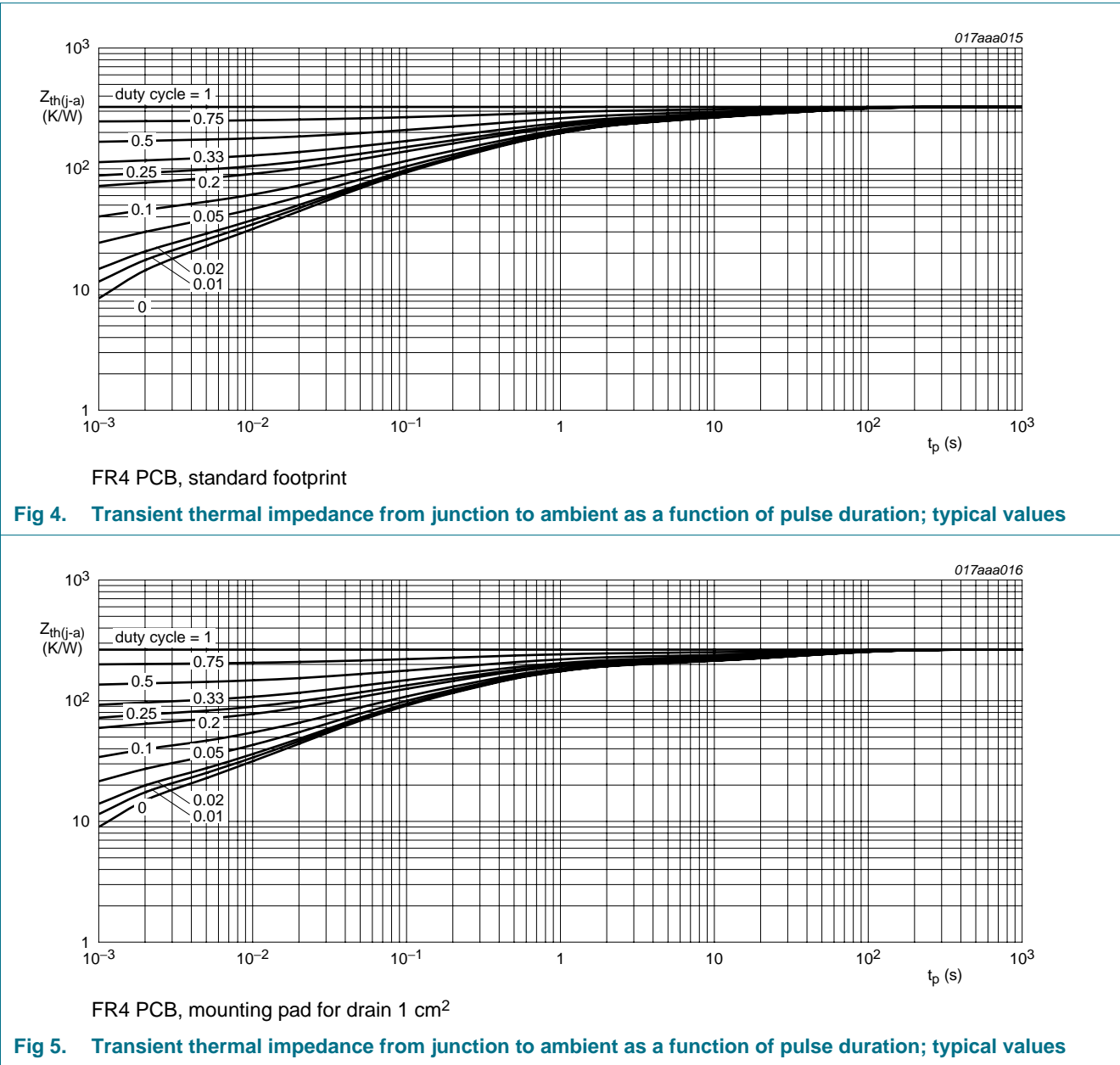
**Fig 3. Safe operating area; junction to ambient; continuous and peak drain currents as a function of drain-source voltage**

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

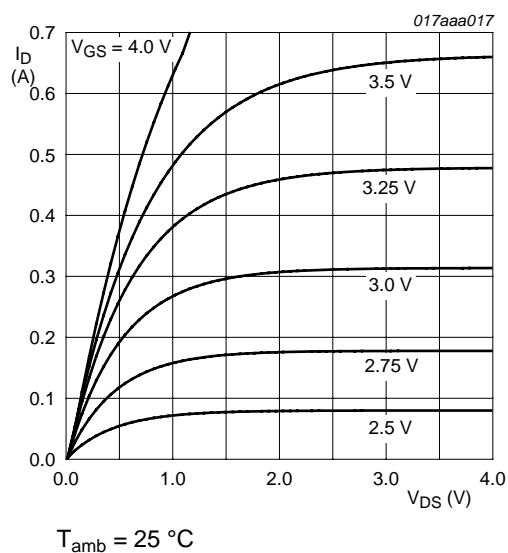
- [1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.  
[2] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 1 cm<sup>2</sup>.



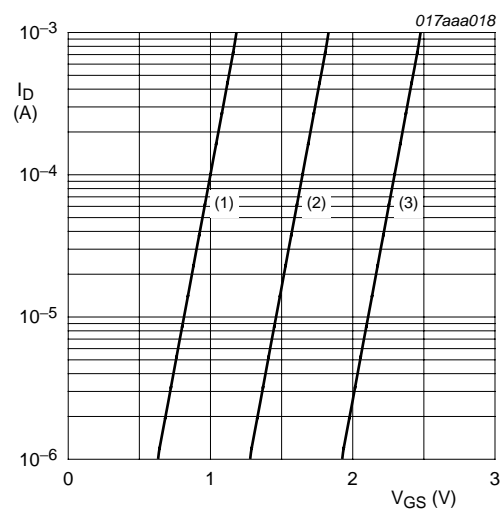
## 7. Characteristics

**Table 7. Characteristics**

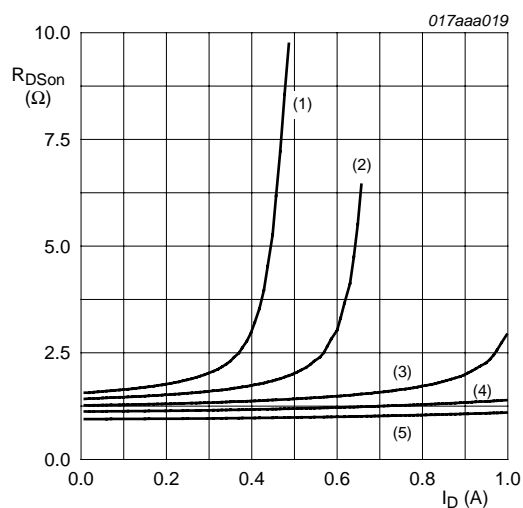
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Static characteristics						
V <sub>(BR)DSS</sub>	drain-source breakdown voltage	I <sub>D</sub> = 10 μA; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C	60	-	-	V
V <sub>GStH</sub>	gate-source threshold voltage	I <sub>D</sub> = 250 μA; V <sub>DS</sub> = V <sub>GS</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



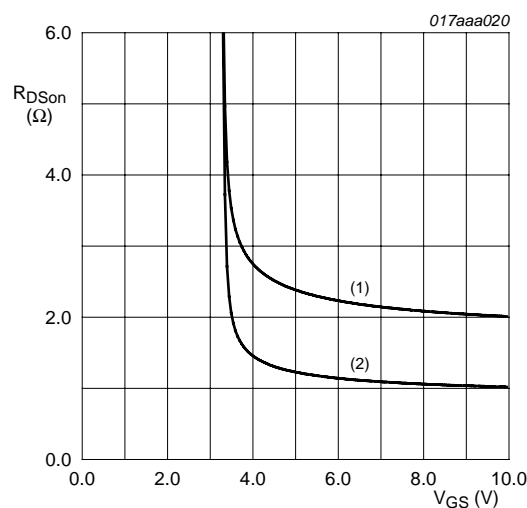
**Fig 6. Output characteristics: drain current as a function of drain-source voltage; typical values**



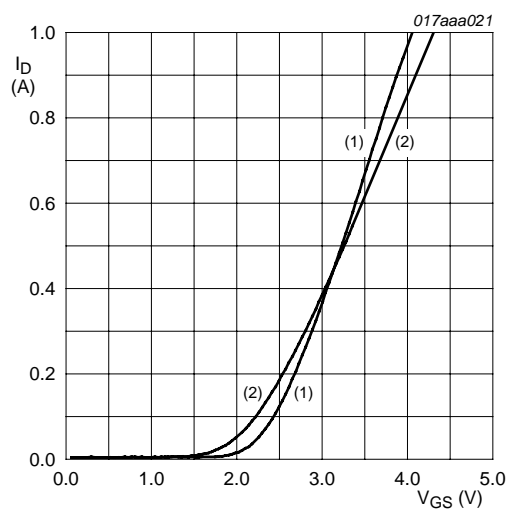
**Fig 7. Sub-threshold drain current as a function of gate-source voltage**



**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**

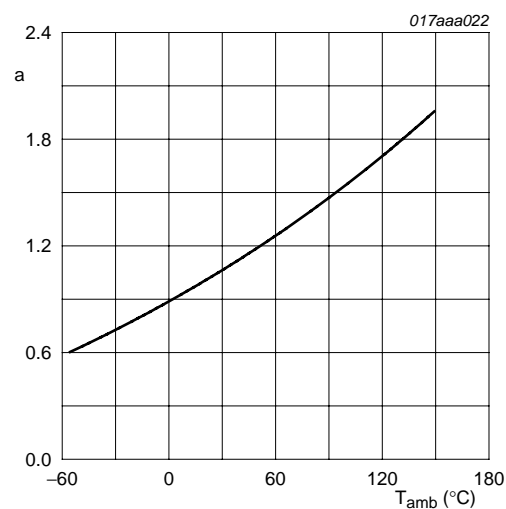


$$V_{DS} > I_D \times R_{DS(on)}$$

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

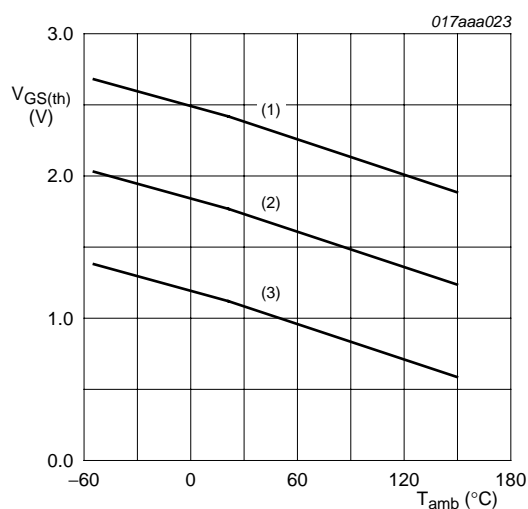
(2)  $T_{amb} = 150\text{ }^{\circ}\text{C}$

**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**



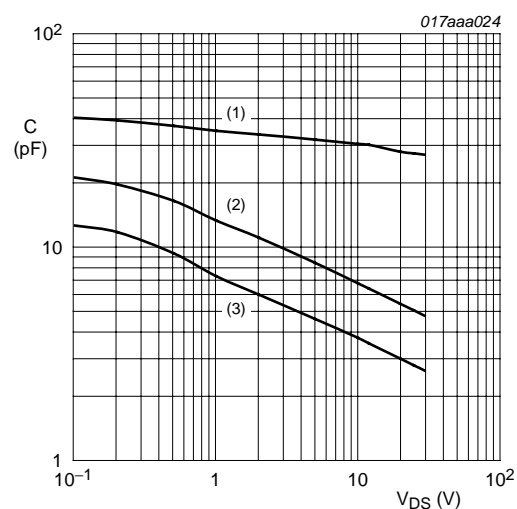
$$I_D = 0.25\text{ mA}; V_{DS} = V_{GS}$$

(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**



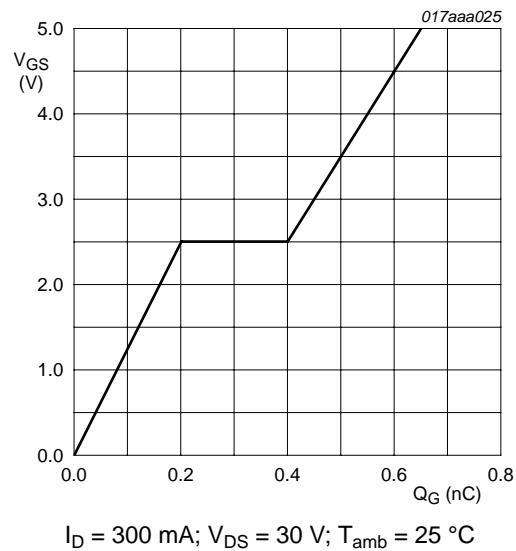


Fig 14. Gate-source voltage as a function of gate charge; typical values

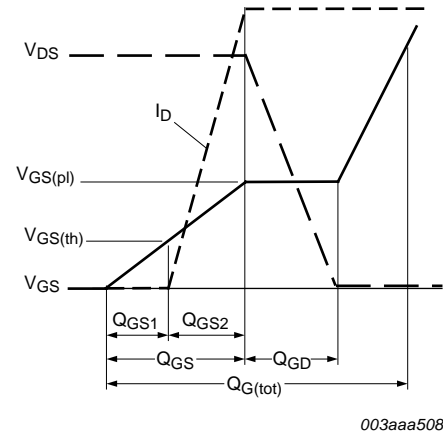


Fig 15. Gate charge waveform definitions

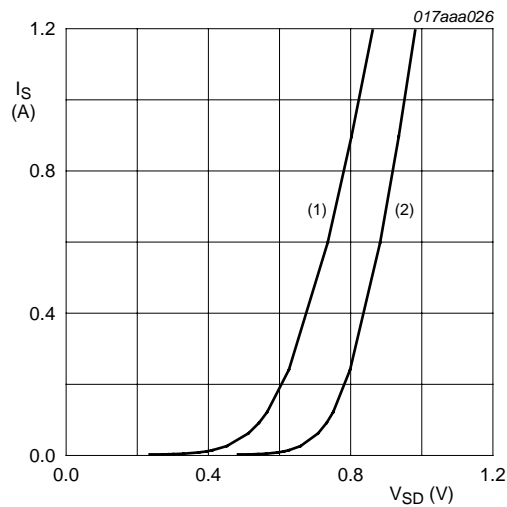


Fig 16. Source current as a function of source-drain voltage; typical values

## 8. Test information

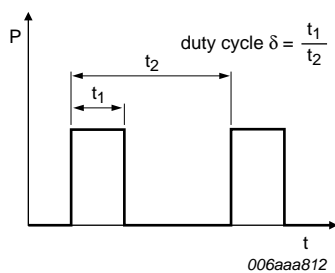


Fig 17. Duty cycle definition

9. Package outline

Plastic surface-mounted package; 3 leads

SOT23

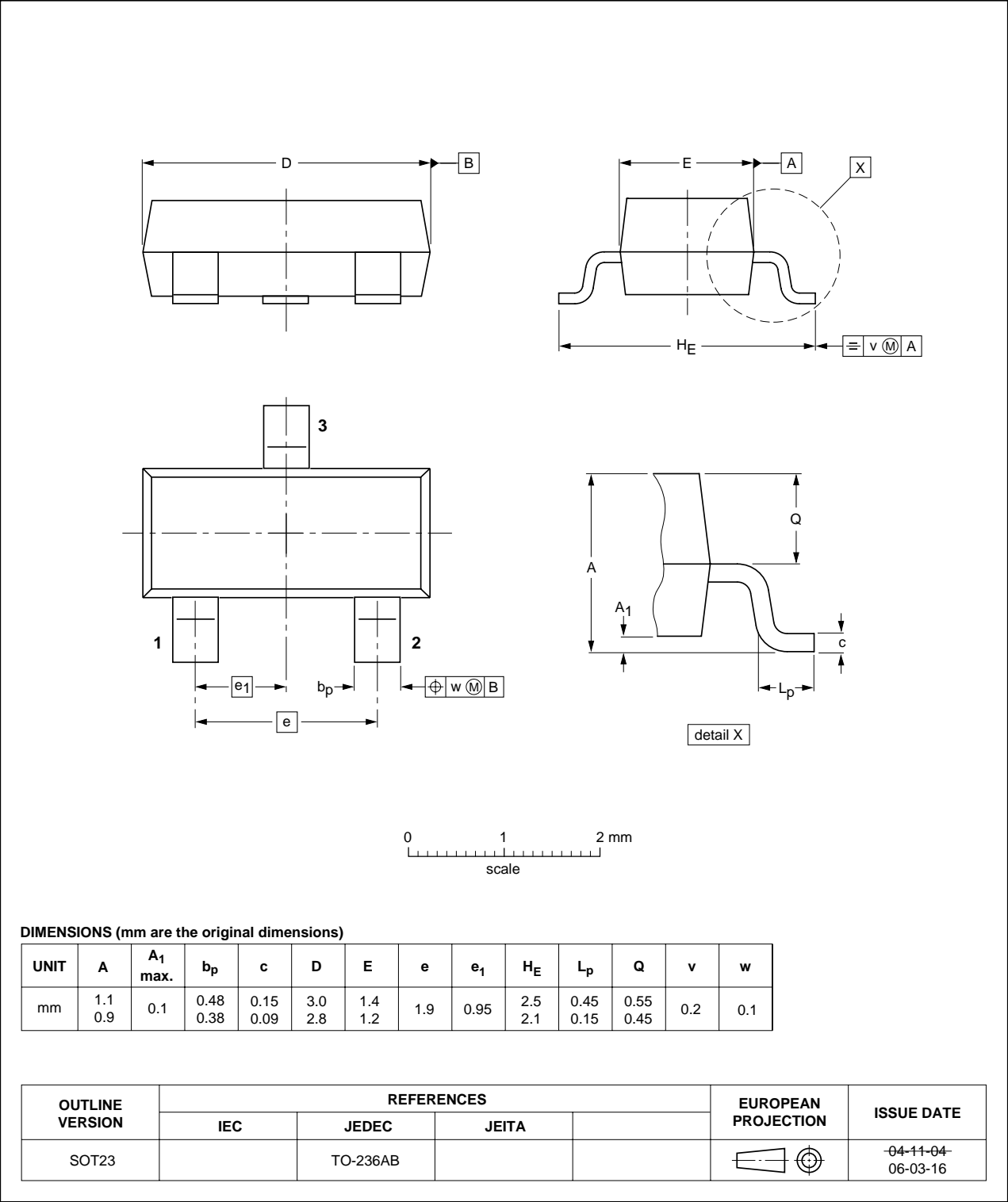


Fig 18. Package outline SOT23 (TO-236AB)

10. Soldering

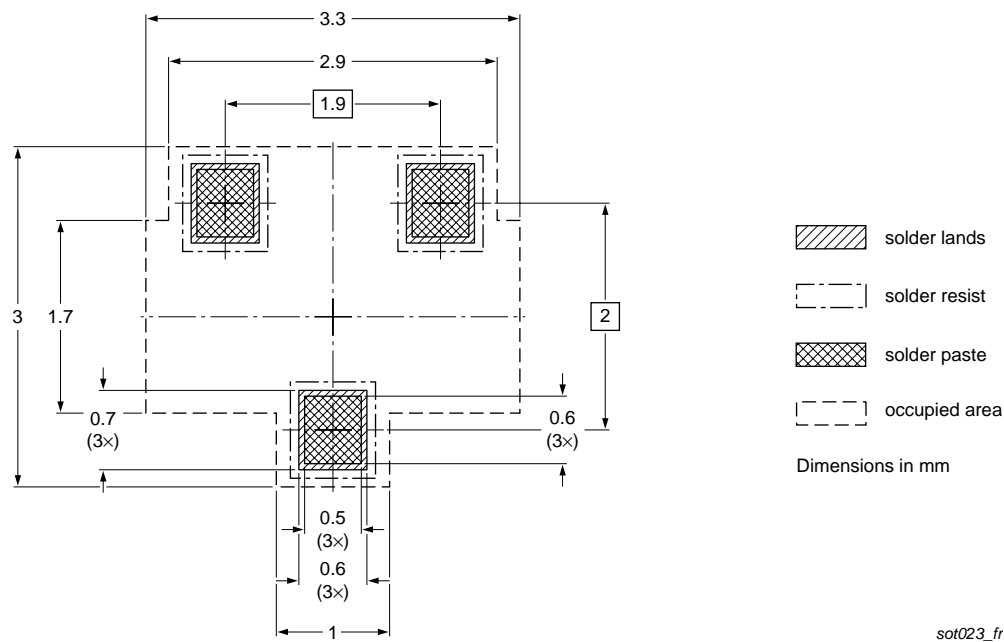


Fig 19. Reflow soldering footprint for SOT23 (TO-236AB)

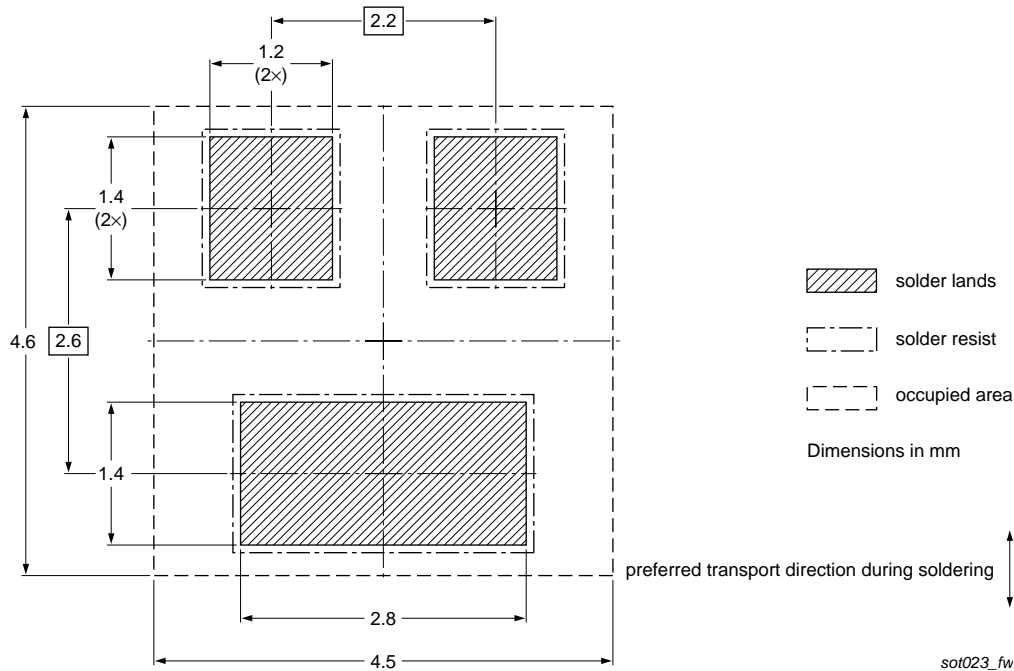


Fig 20. Wave soldering footprint for SOT23 (TO-236AB)

## 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".

[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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