

# 2N7002PW

60 V, 310 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 very small SOT323 (SC-70) 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

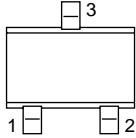
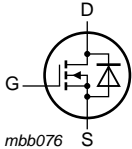
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{DS}$	drain-source voltage	$T_{amb} = 25\text{ °C}$	-	-	60	V
$V_{GS}$	gate-source voltage		-20	-	20	V
$I_D$	drain current	$V_{GS} = 10\text{ V}; T_{amb} = 25\text{ °C}$	[1]	-	310	mA
<b>Static characteristics</b>						
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 10\text{ V}; I_D = 500\text{ mA}; T_j = 25\text{ °C}; t_p \leq 300\text{ }\mu\text{s}; \text{ pulsed}; \delta \leq 0.01$	-	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		
2	S	source		
3	D	drain		

**SOT323 (SC-70)**

## 3. Ordering information

Table 3. Ordering information

Type number	Package		Version
	Name	Description	
2N7002PW	SC-70	plastic surface-mounted package; 3 leads	SOT323

## 4. Marking

Table 4. Marking codes

Type number	Marking code <sup>[1]</sup>
2N7002PW	X8%

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

## 5. Limiting values

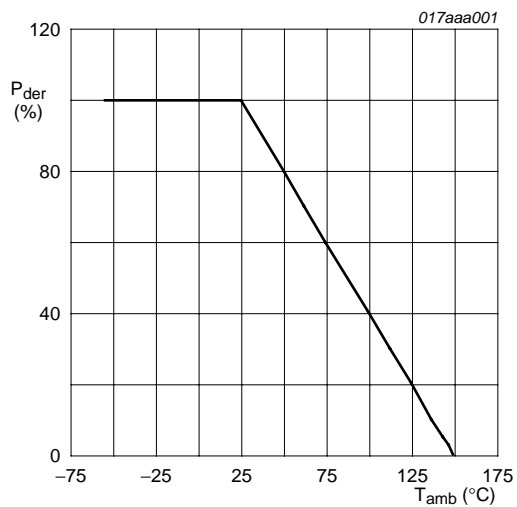
Table 5. Limiting values

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]	-	310	mA
		$V_{GS} = 10\text{ V}; T_{amb} = 100\text{ °C}$	[1]	-	240	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]	-	260	mW
			[1]	-	310	mW
		$T_{sp} = 25\text{ °C}$		-	830	mW
$T_j$	junction temperature		-	150	°C	
$T_{amb}$	ambient temperature		-55	150	°C	
$T_{stg}$	storage temperature		-65	150	°C	
<b>Source-drain diode</b>						
$I_S$	source current	$T_{amb} = 25\text{ °C}$	[1]	-	310	mA

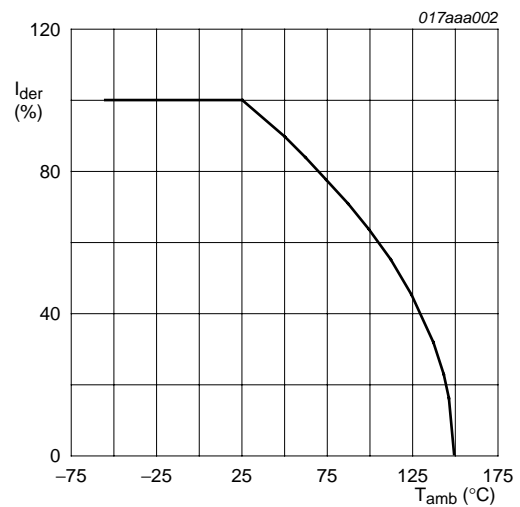
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 1 cm<sup>2</sup>.

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



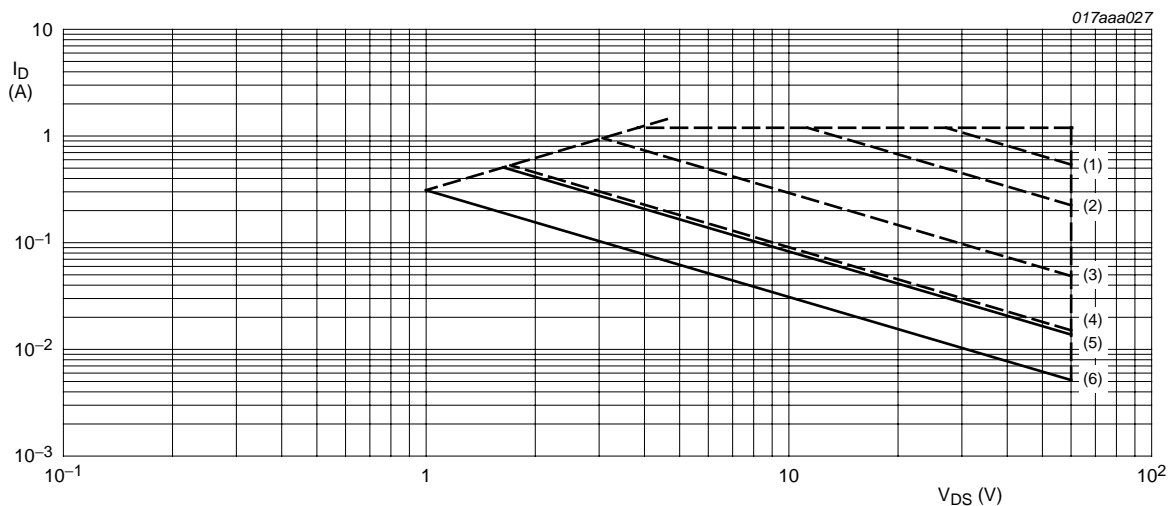
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}\text{C})}} \times 100\%$$

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

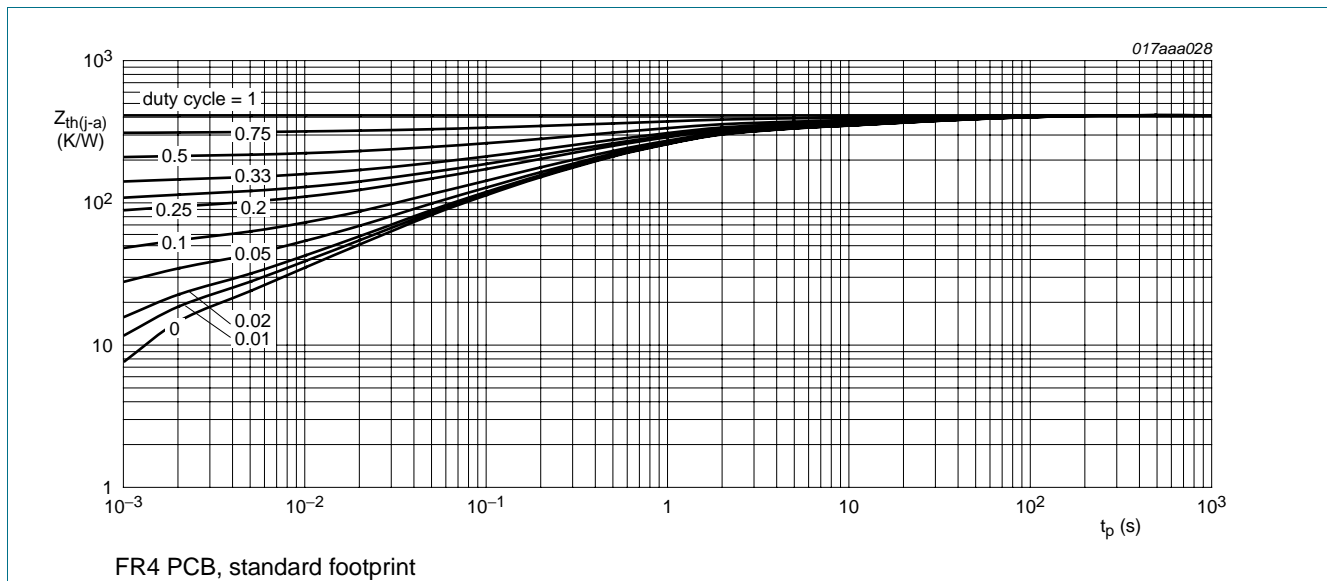
## 6. Thermal characteristics

**Table 6. Thermal characteristics**

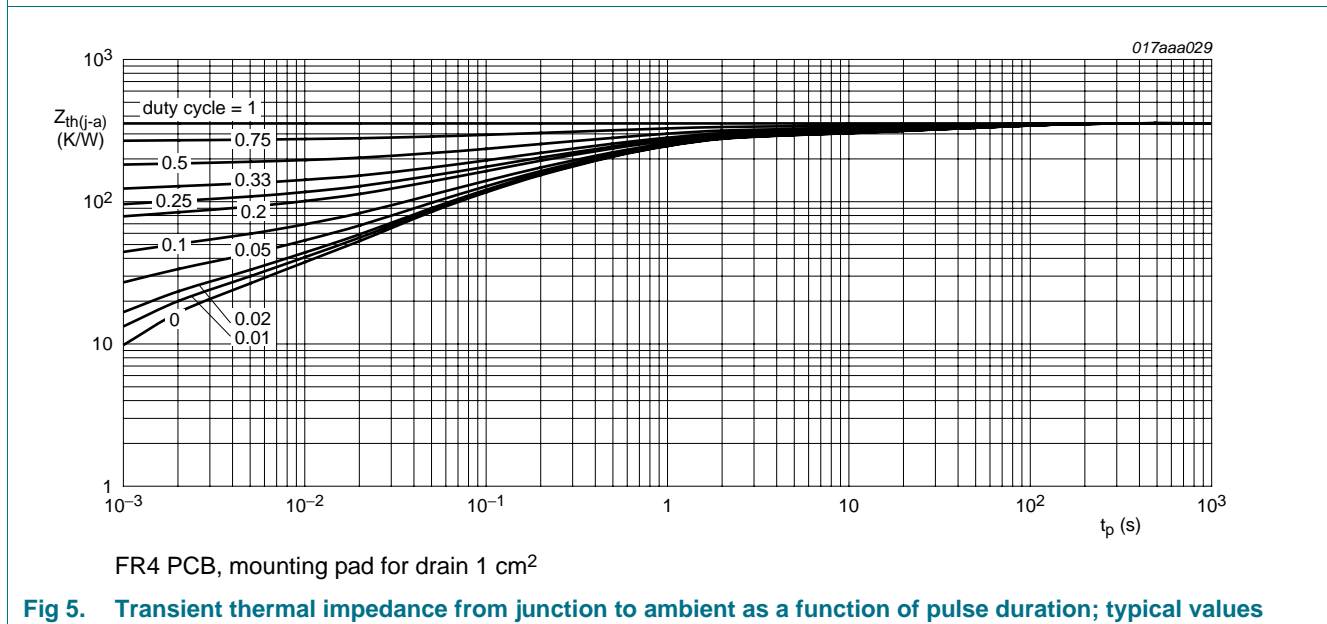
Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	415	480	K/W
			[2]	-	350	400	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point		-	-	150	K/W	

[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>.



**Fig 4. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values**

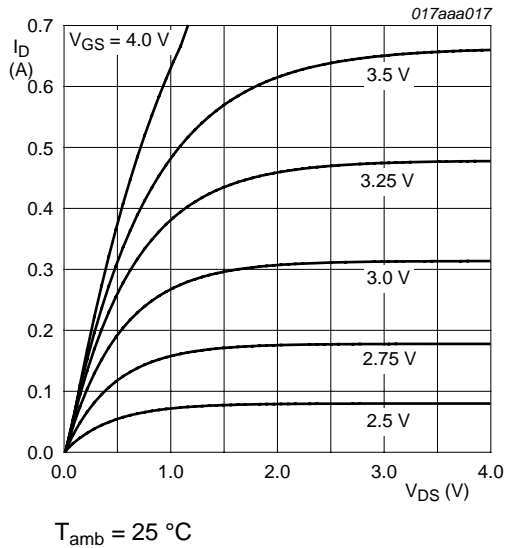


**Fig 5. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values**

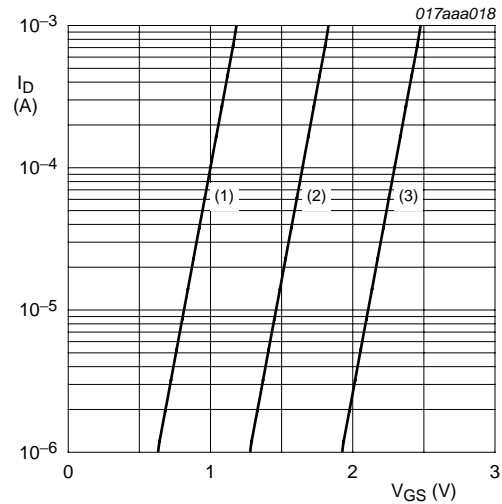
## 7. Characteristics

**Table 7. Characteristics**

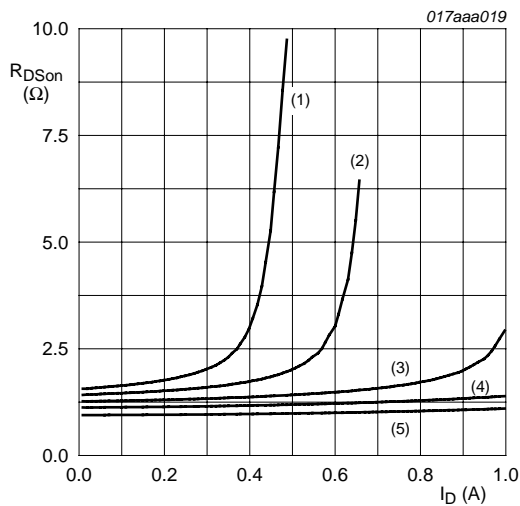
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics</b>						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 10 \mu A$ ; $V_{GS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$	60	-	-	V
$V_{GSth}$	gate-source threshold voltage	$I_D = 250 \mu A$ ; $V_{DS} = V_{GS}$ ; $T_j = 25 \text{ }^\circ C$	1.1	1.75	2.4	V
$I_{DSS}$	drain leakage current	$V_{DS} = 60 V$ ; $V_{GS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$	-	-	1	$\mu A$
		$V_{DS} = 60 V$ ; $V_{GS} = 0 V$ ; $T_j = 150 \text{ }^\circ C$	-	-	10	$\mu A$
$I_{GSS}$	gate leakage current	$V_{GS} = 20 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$	-	-	100	nA
		$V_{GS} = -20 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$	-	-	100	nA
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = 5 V$ ; $I_D = 50 \text{ mA}$ ; pulsed; $t_p \leq 300 \mu s$ ; $\delta \leq 0.01$ ; $T_j = 25 \text{ }^\circ C$	-	1.3	2	$\Omega$
		$V_{GS} = 10 V$ ; $I_D = 500 \text{ mA}$ ; pulsed; $t_p \leq 300 \mu s$ ; $\delta \leq 0.01$ ; $T_j = 25 \text{ }^\circ C$	-	1	1.6	$\Omega$
$g_{fs}$	forward transconductance	$V_{DS} = 10 V$ ; $I_D = 200 \text{ mA}$ ; pulsed; $t_p \leq 300 \mu s$ ; $\delta \leq 0.01$ ; $T_j = 25 \text{ }^\circ C$	-	400	-	mS
<b>Dynamic characteristics</b>						
$Q_{G(tot)}$	total gate charge	$I_D = 300 \text{ mA}$ ; $V_{DS} = 30 V$ ; $V_{GS} = 4.5 V$ ; $T_j = 25 \text{ }^\circ C$	-	0.6	0.8	nC
$Q_{GS}$	gate-source charge		-	0.2	-	nC
$Q_{GD}$	gate-drain charge		-	0.2	-	nC
$C_{iss}$	input capacitance	$V_{GS} = 0 V$ ; $V_{DS} = 10 V$ ; $f = 1 \text{ MHz}$ ; $T_j = 25 \text{ }^\circ C$	-	30	50	pF
$C_{oss}$	output capacitance		-	7	-	pF
$C_{rss}$	reverse transfer capacitance		-	4	-	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = 50 V$ ; $R_L = 250 \Omega$ ; $V_{GS} = 10 V$ ; $R_{G(ext)} = 6 \Omega$ ; $T_j = 25 \text{ }^\circ C$	-	3	6	ns
$t_r$	rise time		-	4	-	ns
$t_{d(off)}$	turn-off delay time		-	10	20	ns
$t_f$	fall time		-	5	-	ns
<b>Source-drain diode</b>						
$V_{SD}$	source-drain voltage	$I_S = 115 \text{ mA}$ ; $V_{GS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$	0.47	0.75	1.1	V



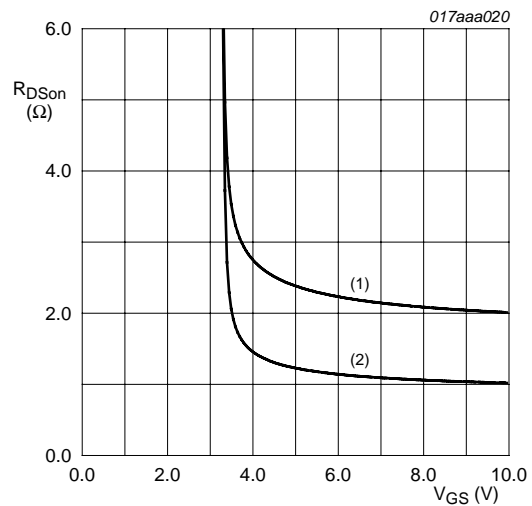
**Fig 6. Output characteristics: drain current as a function of drain-source voltage; typical values**



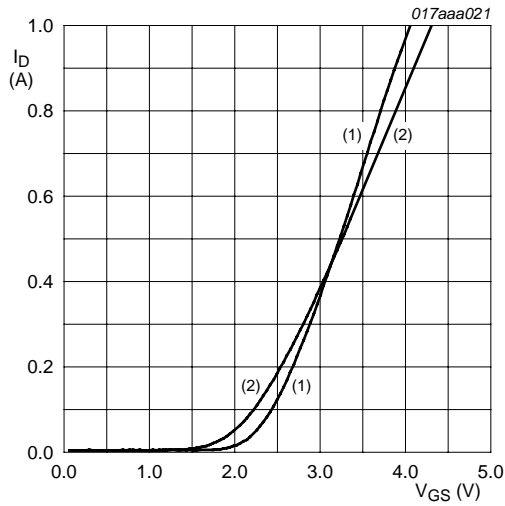
**Fig 7. Sub-threshold drain current as a function of gate-source voltage**



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

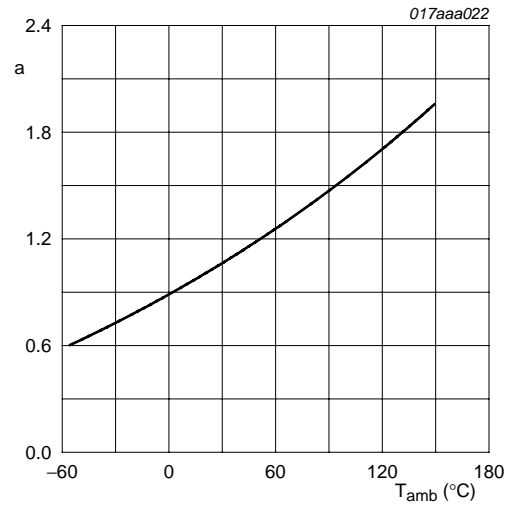


**Fig 9. Drain-source on-state resistance as a function of gate-source voltage; typical values**



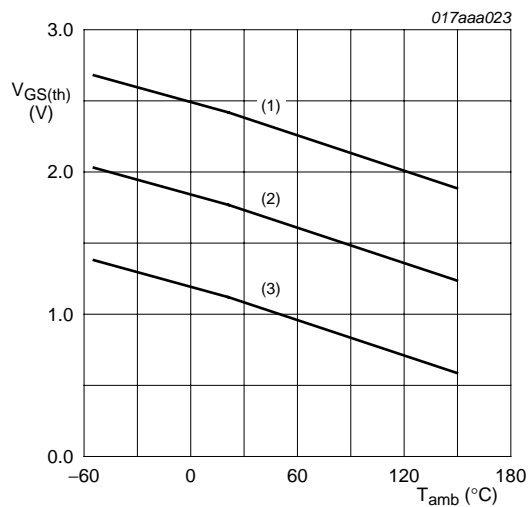
$V_{DS} > I_D \times R_{DS(on)}$   
 (1)  $T_{amb} = 25\text{ °C}$   
 (2)  $T_{amb} = 150\text{ °C}$

Fig 10. Transfer characteristics: drain current as a function of gate-source voltage; typical values



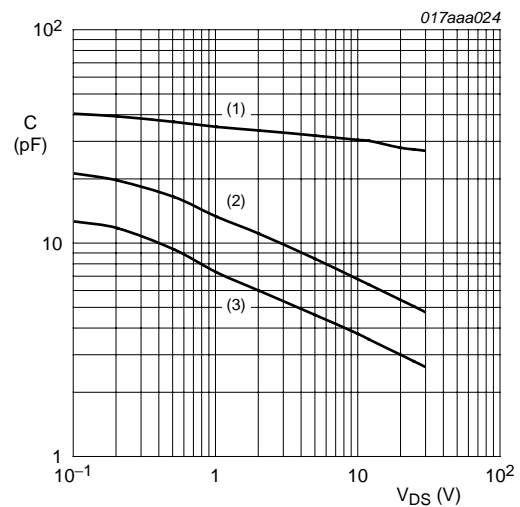
$$a = \frac{R_{DS(on)}}{R_{DS(on)25\text{°C}}}$$

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



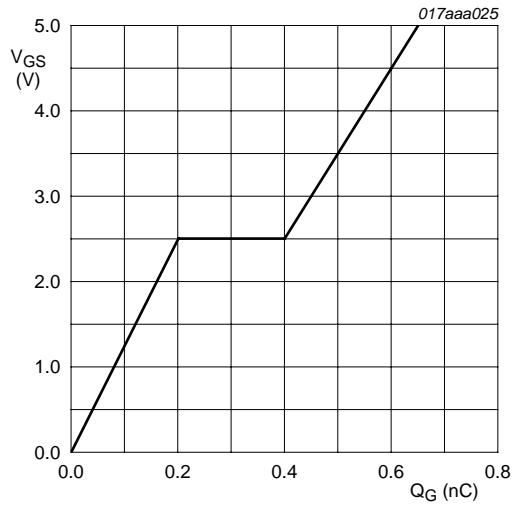
$I_D = 0.25\text{ mA}; V_{DS} = V_{GS}$   
 (1) maximum values  
 (2) typical values  
 (3) minimum values

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



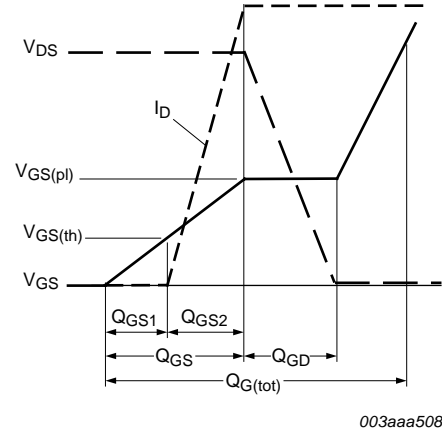
$f = 1\text{ MHz}; V_{GS} = 0\text{ V}$   
 (1)  $C_{iss}$   
 (2)  $C_{oss}$   
 (3)  $C_{rss}$

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

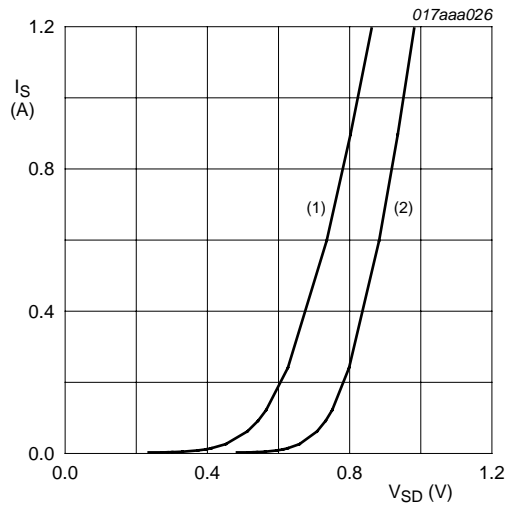


$I_D = 300 \text{ mA}; V_{DS} = 30 \text{ V}; T_{amb} = 25 \text{ }^\circ\text{C}$

**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

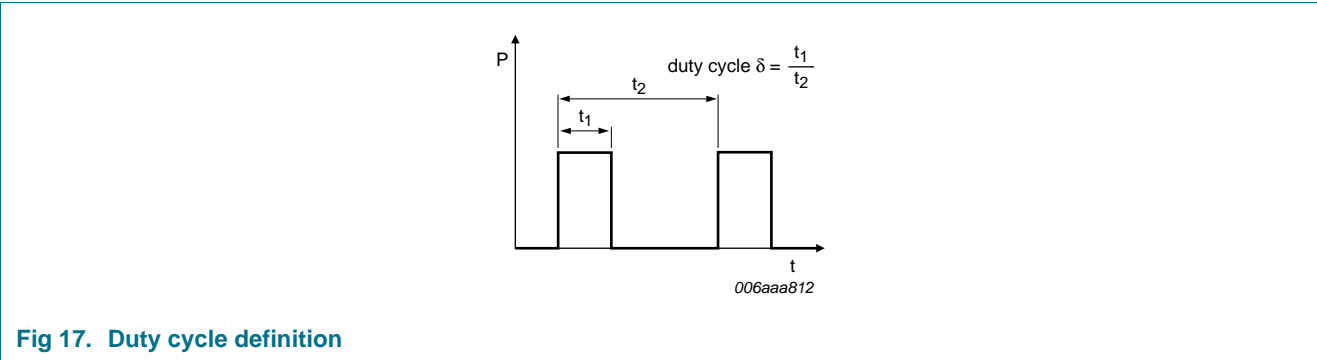


Fig 17. Duty cycle definition

9. Package outline

Plastic surface-mounted package; 3 leads

SOT323

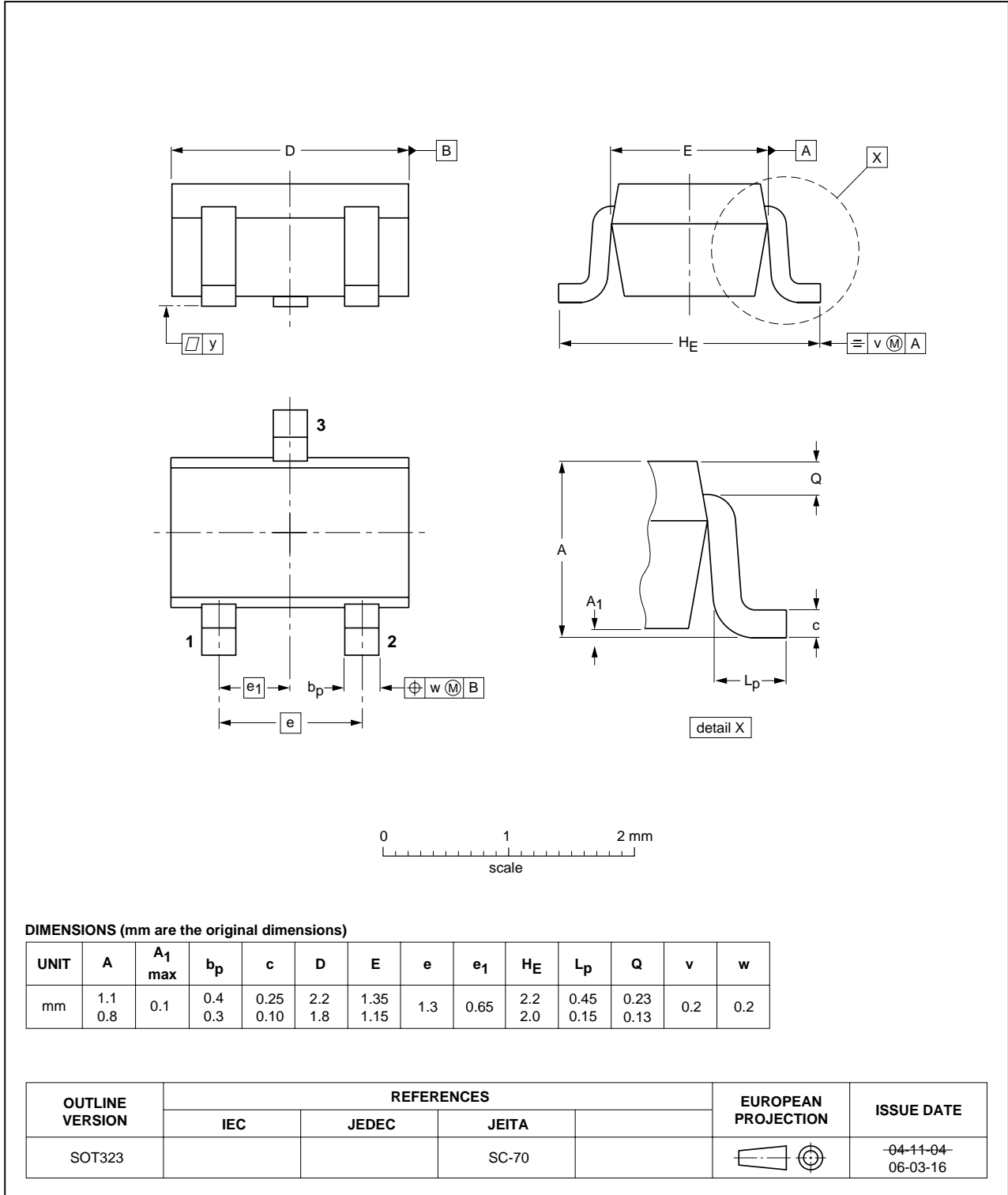


Fig 18. Package outline SOT323 (SC-70)

### 10. Soldering

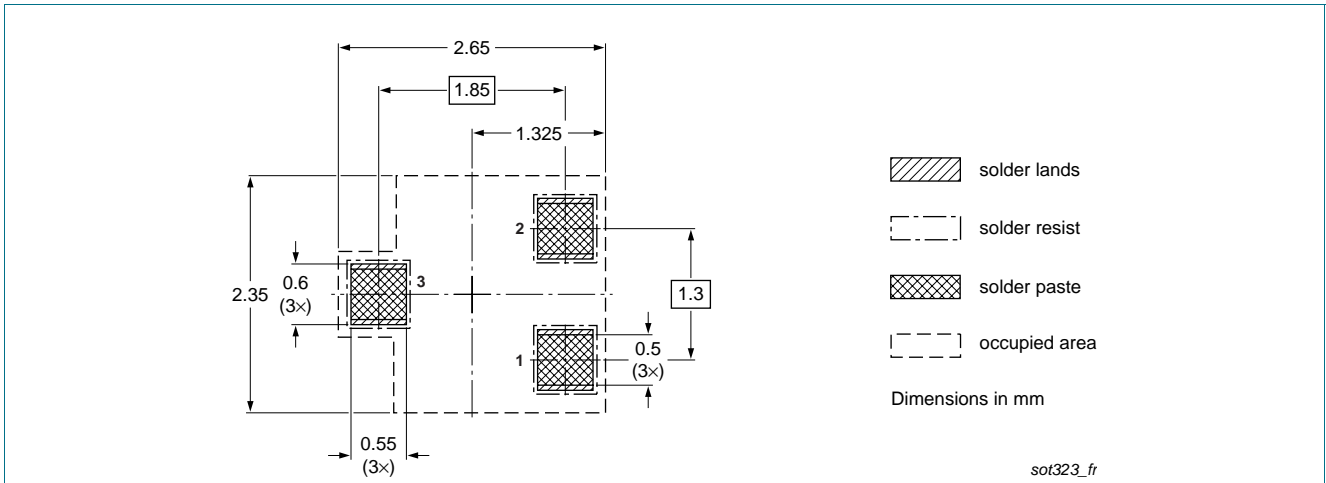


Fig 19. Reflow soldering footprint for SOT323 (SC-70)

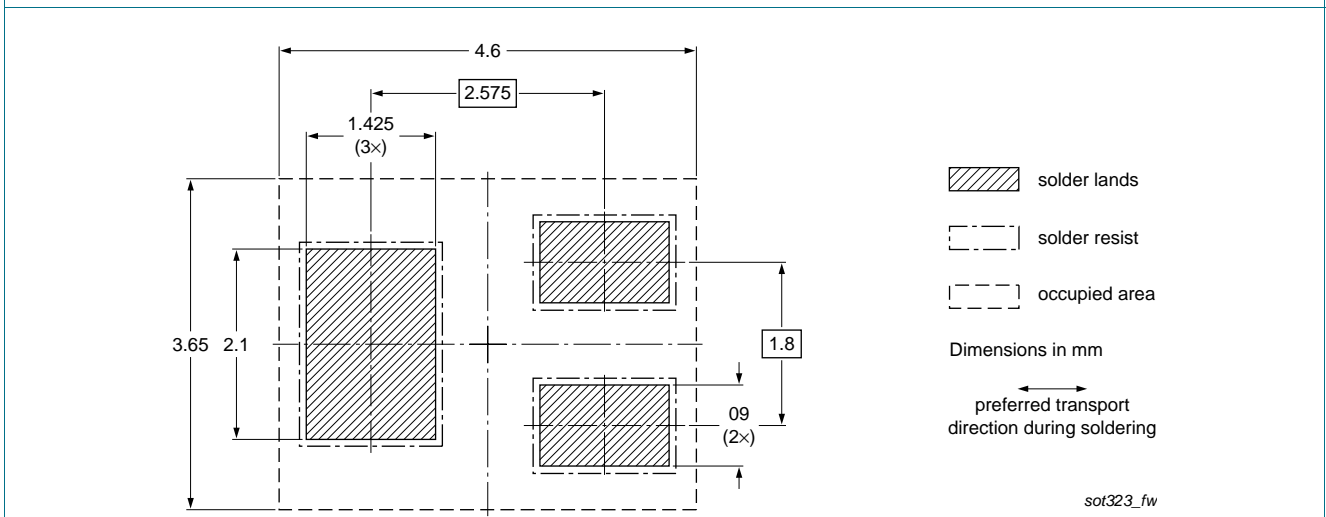


Fig 20. Wave soldering footprint for SOT323 (SC-70)

## 11. Revision history

Table 8. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
2N7002PW v.2	20100729	Product data sheet	-	2N7002PW_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>			
2N7002PW_1	20100422	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.

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[2] The term 'short data sheet' is explained in section "Definitions".

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Date of release: 29 July 2010

Document identifier: 2N7002PW

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