

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

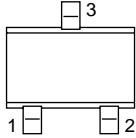
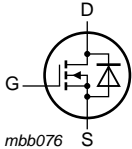
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{DS}	drain-source voltage	$T_{amb} = 25\text{ °C}$	-	-	60	V
V_{GS}	gate-source voltage		-20	-	20	V
I_D	drain current	$V_{GS} = 10\text{ V}; T_{amb} = 25\text{ °C}$	[1]	-	310	mA
Static characteristics						
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 10\text{ V}; I_D = 500\text{ mA}; T_j = 25\text{ °C}; t_p \leq 300\text{ }\mu\text{s}; \text{ pulsed}; \bar{d} \leq 0.01$	-	1	1.6	Ω

[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 1 cm².



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

4. Marking

Table 4. Marking codes

Type number	Marking code ^[1]
2N7002PW	X8%

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

5. Limiting values

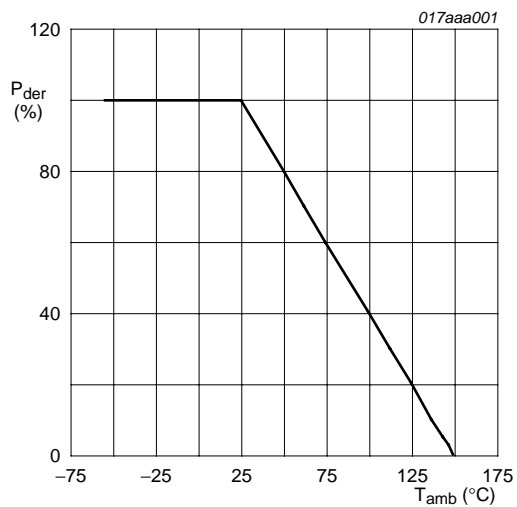
Table 5. Limiting values

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	
Source-drain diode						
I_S	source current	$T_{amb} = 25\text{ °C}$	[1]	-	310	mA

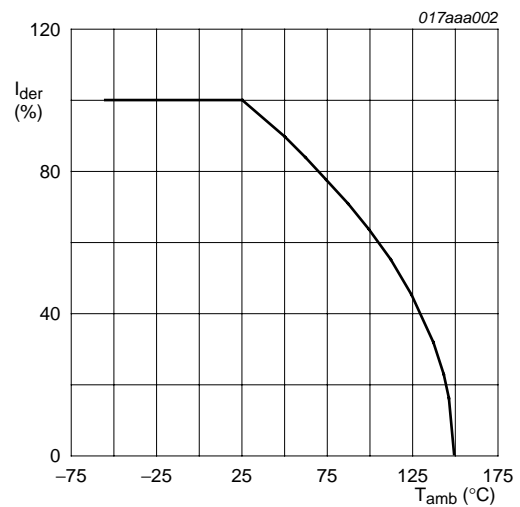
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 1 cm².

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



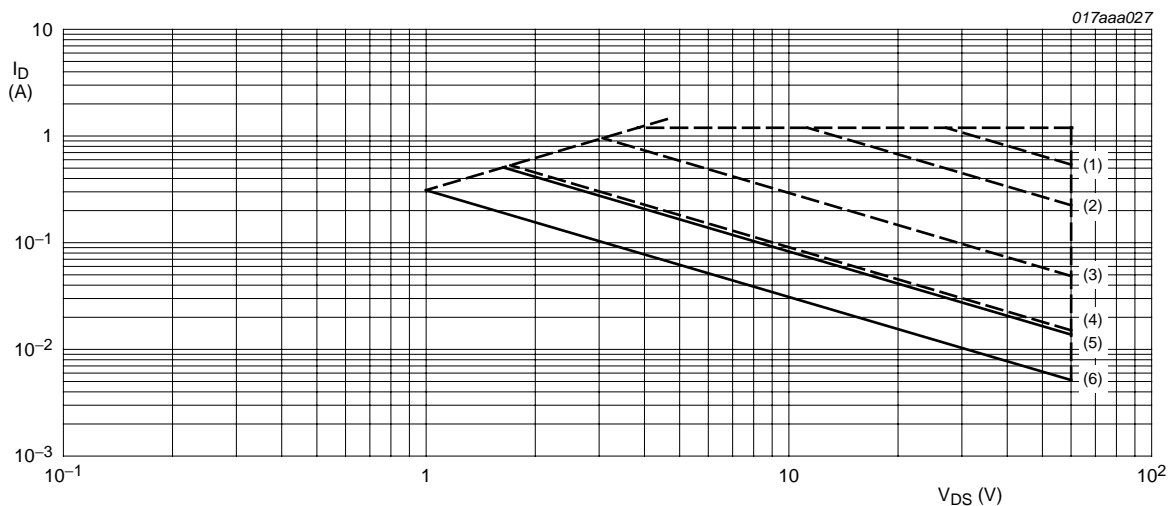
$$P_{der} = \frac{P_{tot}}{P_{tot(25^\circ\text{C})}} \times 100\%$$

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 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 cm².

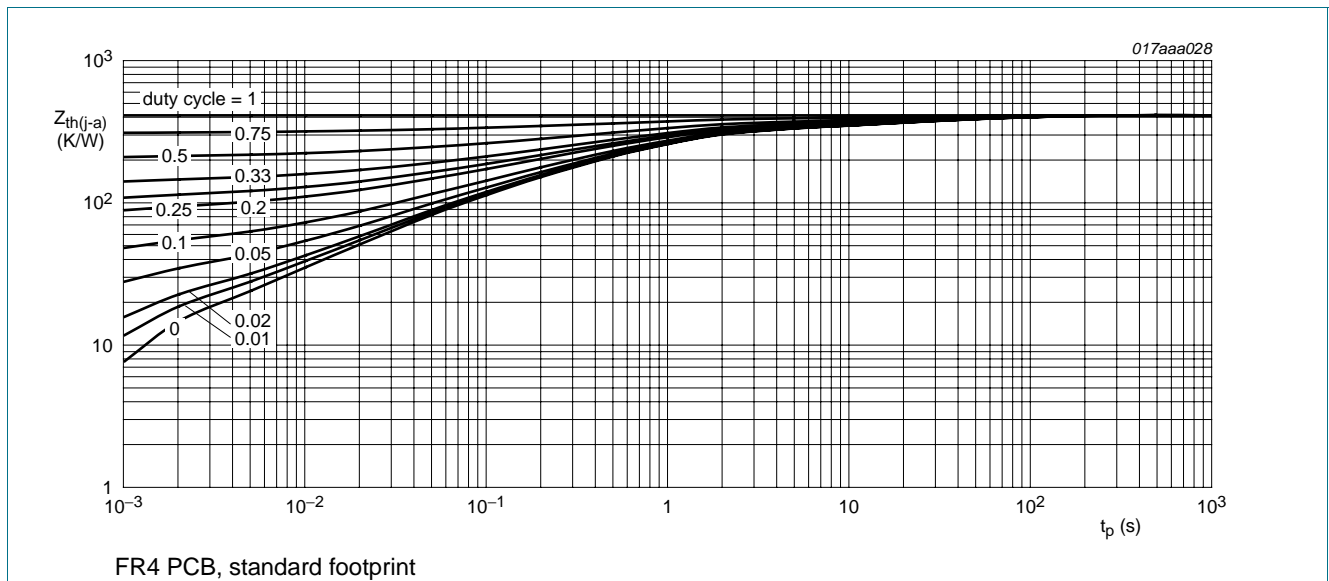


Fig 4. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

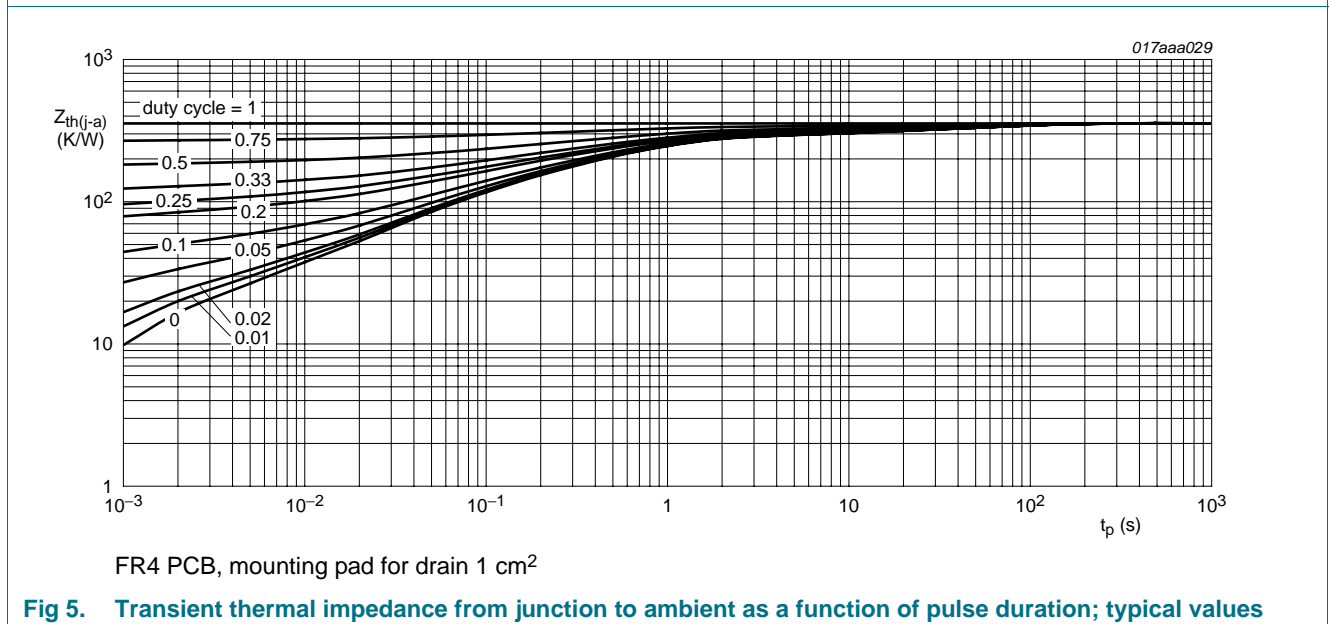


Fig 5. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

7. Characteristics

Table 7. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Static characteristics						
$V_{(BR)DSS}$	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	μA
		$V_{DS} = 60 V$; $V_{GS} = 0 V$; $T_j = 150 \text{ }^\circ C$	-	-	10	μA
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	Ω
		$V_{GS} = 10 V$; $I_D = 500 \text{ mA}$; pulsed; $t_p \leq 300 \mu s$; $\delta \leq 0.01$; $T_j = 25 \text{ }^\circ C$	-	1	1.6	Ω
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
Dynamic characteristics						
$Q_{G(tot)}$	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
Source-drain diode						
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

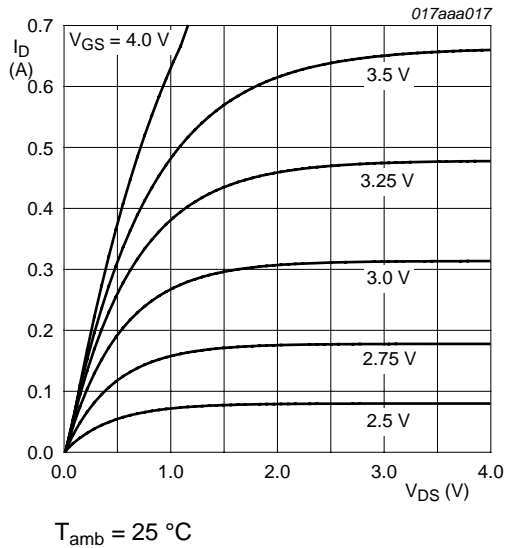


Fig 6. Output characteristics: drain current as a function of drain-source voltage; typical values

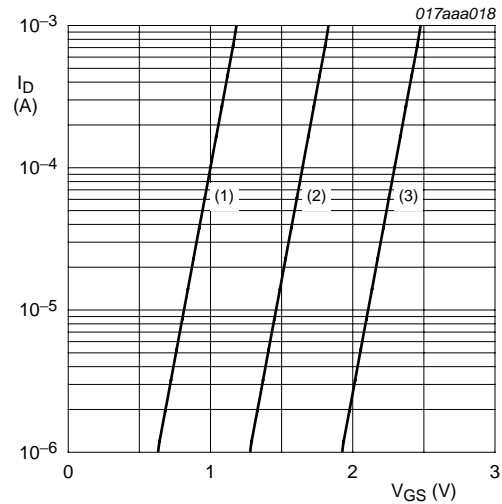
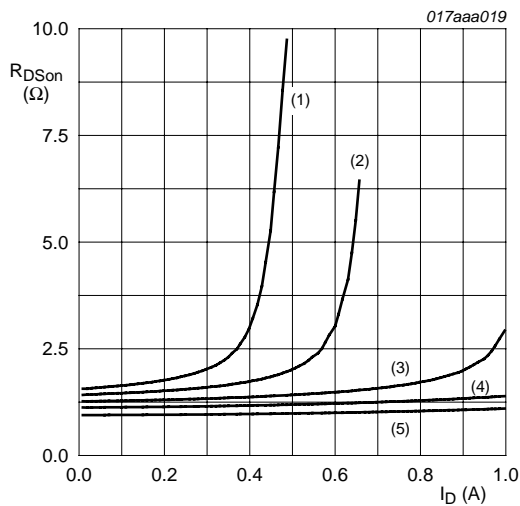
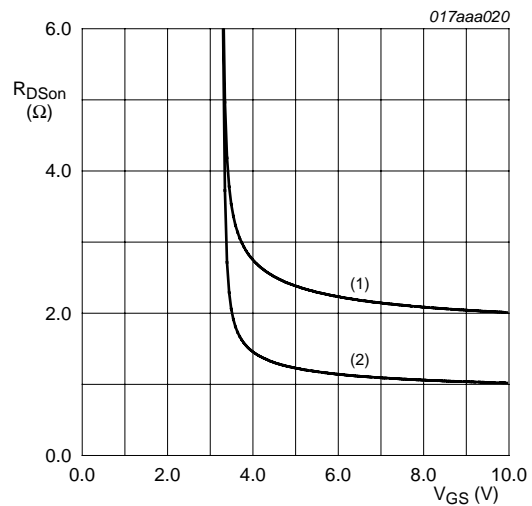


Fig 7. Sub-threshold drain current as a function of gate-source voltage



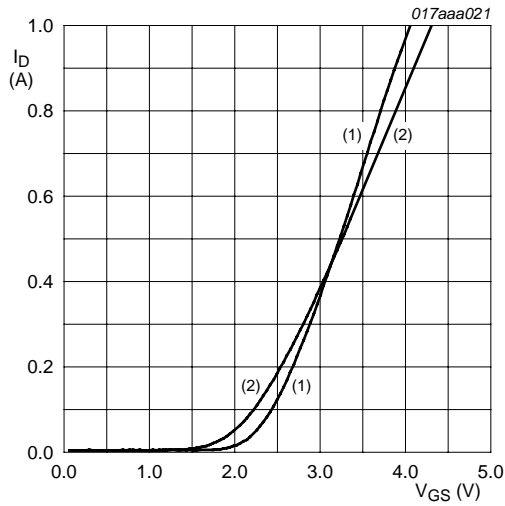
$T_{amb} = 25\text{ °C}$
 (1) $V_{GS} = 3.25\text{ V}$
 (2) $V_{GS} = 3.5\text{ V}$
 (3) $V_{GS} = 4\text{ V}$
 (4) $V_{GS} = 5\text{ V}$
 (5) $V_{GS} = 10\text{ V}$

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



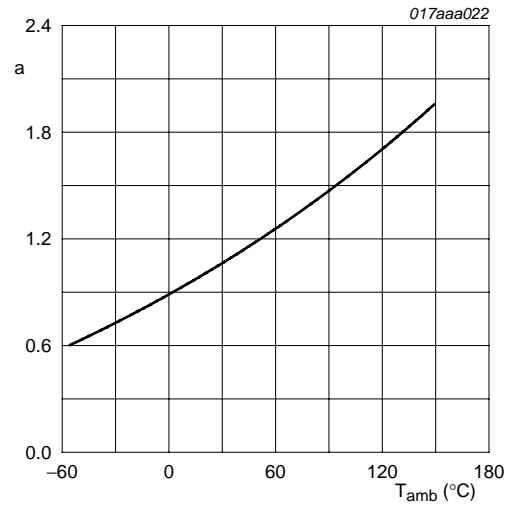
$I_D = 500\text{ mA}$
 (1) $T_{amb} = 150\text{ °C}$
 (2) $T_{amb} = 25\text{ °C}$

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



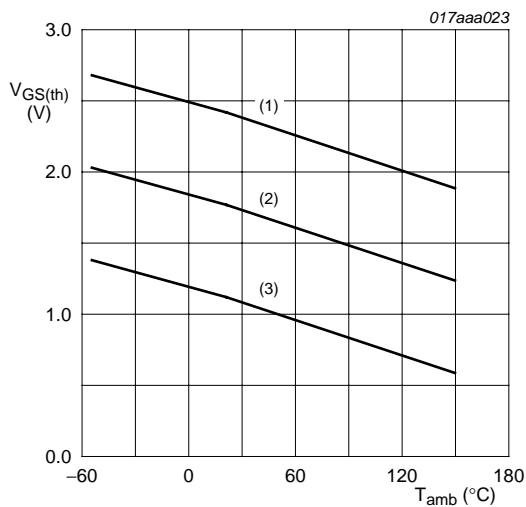
$V_{DS} > I_D \times R_{DS(on)}$
 (1) $T_{amb} = 25\text{ }^{\circ}\text{C}$
 (2) $T_{amb} = 150\text{ }^{\circ}\text{C}$

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



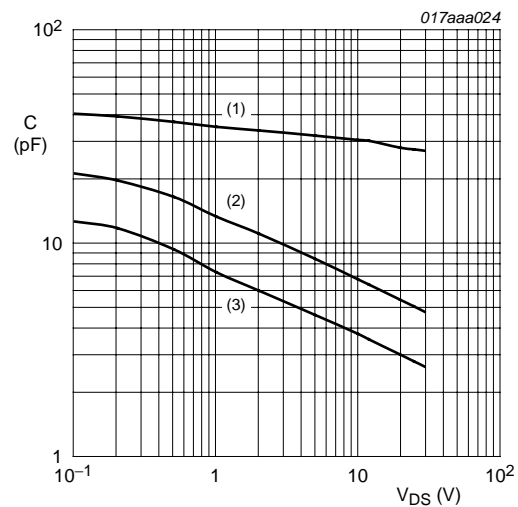
$$a = \frac{R_{DS(on)}}{R_{DS(on)25^{\circ}\text{C}}}$$

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



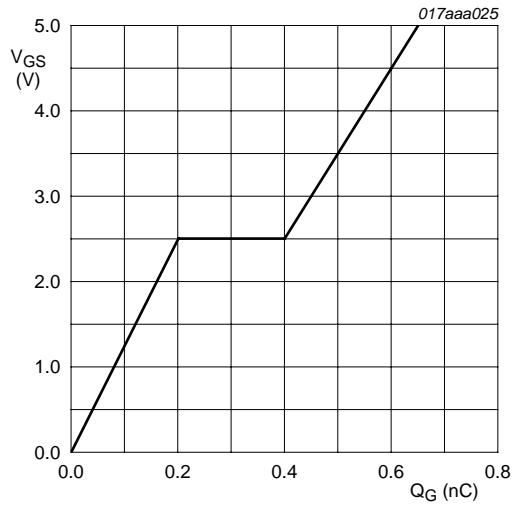
$I_D = 0.25\text{ mA}; V_{DS} = V_{GS}$
 (1) maximum values
 (2) typical values
 (3) minimum values

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

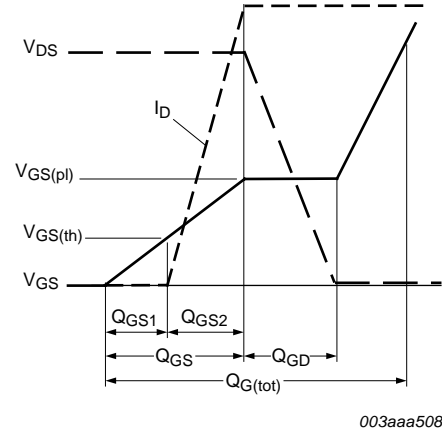
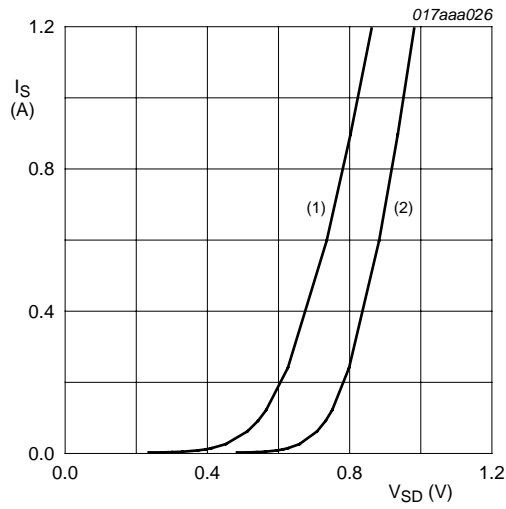


Fig 15. Gate charge waveform definitions



$V_{GS} = 0 \text{ V}$
 (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

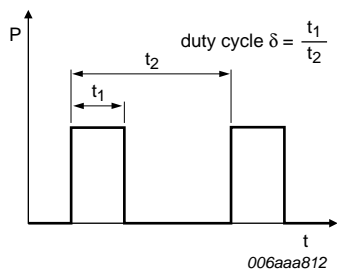


Fig 17. Duty cycle definition

9. Package outline

Plastic surface-mounted package; 3 leads

SOT323

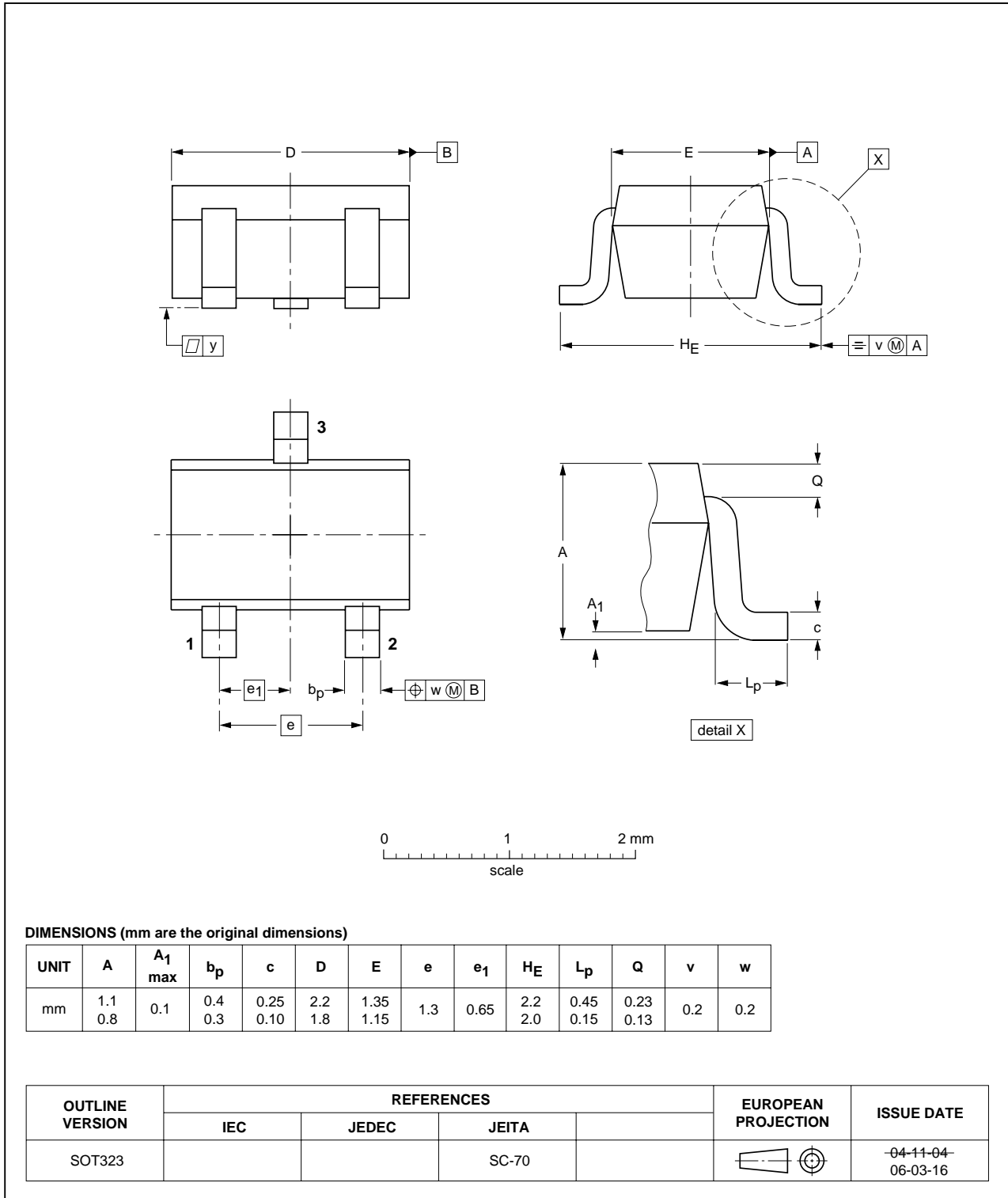


Fig 18. Package outline SOT323 (SC-70)

10. Soldering

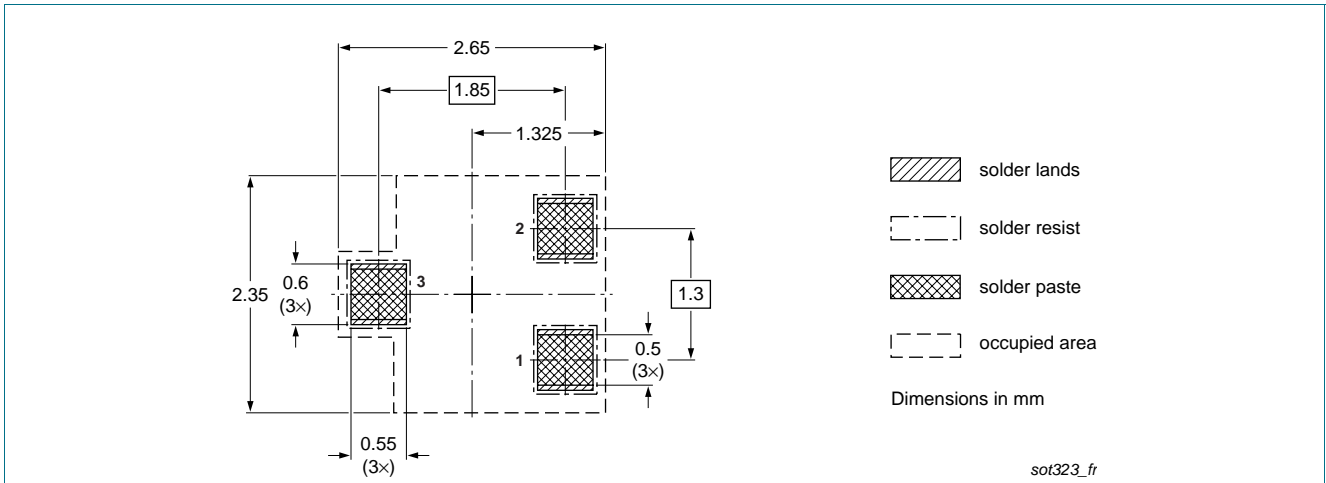


Fig 19. Reflow soldering footprint for SOT323 (SC-70)

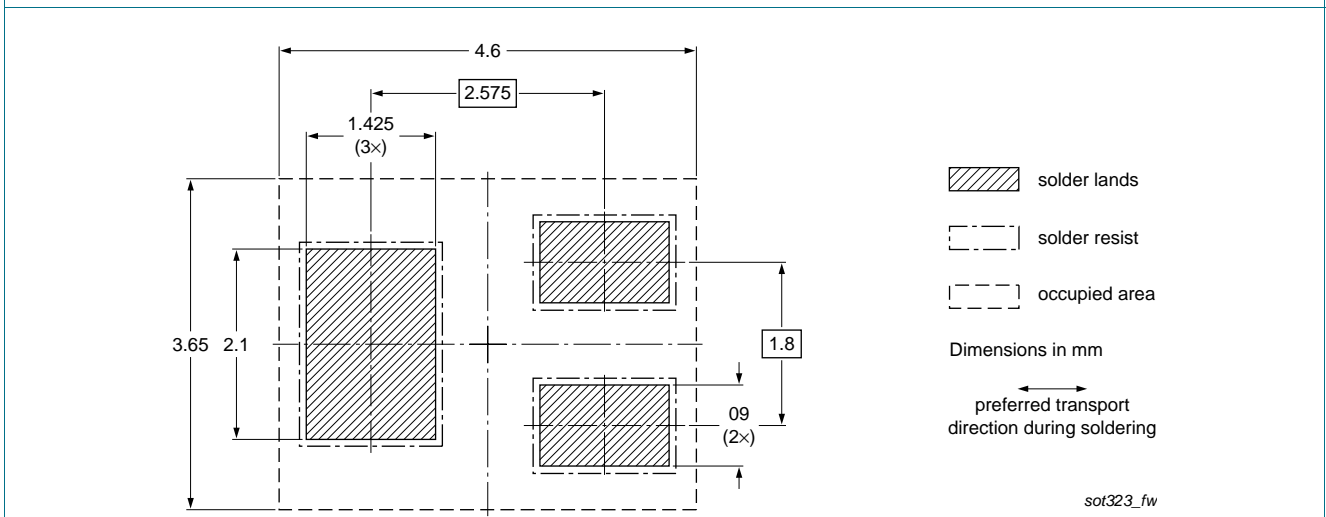


Fig 20. Wave soldering footprint for SOT323 (SC-70)

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">• Correction of thermal values.• Correction of various characteristics values including related graphs.			
2N7002PW_1	20100422	Product data sheet	-	-

12. Legal information

12.1 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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14. Contents

1	Product profile	1
1.1	General description	1
1.2	Features and benefits	1
1.3	Applications	1
1.4	Quick reference data	1
2	Pinning information	2
3	Ordering information	2
4	Marking	2
5	Limiting values	2
6	Thermal characteristics	4
7	Characteristics	5
8	Test information	9
9	Package outline	10
10	Soldering	11
11	Revision history	12
12	Legal information	13
12.1	Data sheet status	13
12.2	Definitions	13
12.3	Disclaimers	13
12.4	Trademarks	14
13	Contact information	14

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