2N7002CK

60 V, 0.3 A N-channel Trench MOSFET

Rev. 01 — 11 September 2009 Product data sheet

1. Product profile

1.1 General description

ESD protected 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

- Logic-level compatible
- Very fast switching
- Trench MOSFET technology
- ESD protection up to 3 kV

1.3 Applications

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

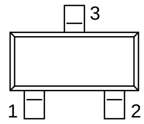
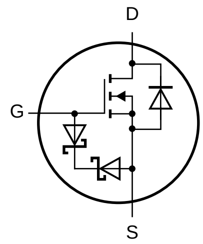
1.4 Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{DS}	drain-source voltage		-	-	60	V
I_D	drain current		-	-	300	mA
I_{DM}	peak drain current	single pulse; $t_p \leq 10$ µs	-	-	1.2	A
R_{DSon}	drain-source on-state resistance	$V_{GS} = 10$ V; $I_D = 500$ mA	-	1.1	1.6	Ω

2. Pinning information

Table 2. Pinning

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	G	gate		 017aaa000
2	S	source		
3	D	drain		

3. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
2N7002CK	TO-236AB	plastic surface-mounted package; 3 leads	SOT23

4. Marking

Table 4. Marking codes

Type number	Marking code[1]
2N7002CK	LP*

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

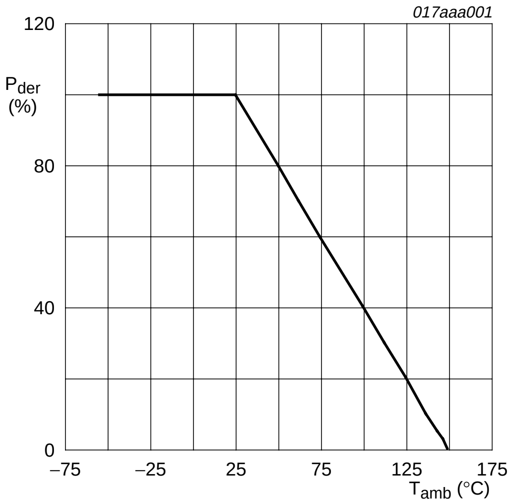
5. Limiting values

Table 5. Limiting values

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

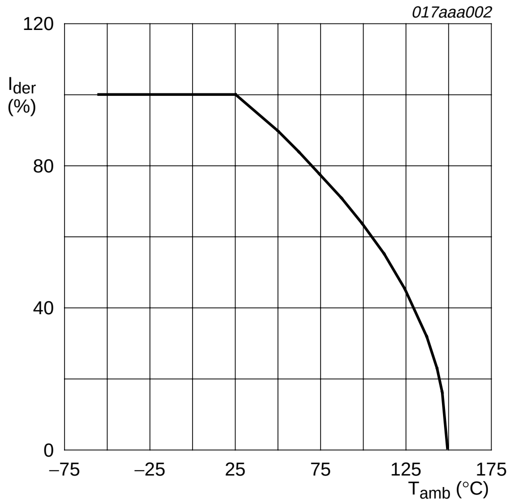
Symbol	Parameter	Conditions		Min	Max	Unit
V_{DS}	drain-source voltage	25 °C ≤ T_j ≤ 150 °C		-	60	V
V_{GS}	gate-source voltage			-	±20	V
I_D	drain current	V_{GS} = 10 V				
		T_{amb} = 25 °C		-	300	mA
		T_{amb} = 100 °C		-	190	mA
I_{DM}	peak drain current	T_{amb} = 25 °C; t_p ≤ 10 µs		-	1.2	A
P_{tot}	total power dissipation	T_{amb} = 25 °C	[1]	-	350	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 °C		-	200	mA
I_{SM}	peak source current	T_{amb} = 25 °C; t_p ≤ 10 µs		-	1.2	A
ElectroStatic Discharge (ESD)						
V_{ESD}	electrostatic discharge voltage	all pins; human body model; C = 100 pF; R = 1.5 kΩ		-	3	kV

[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated, mounting pad for drain 1 cm^2.



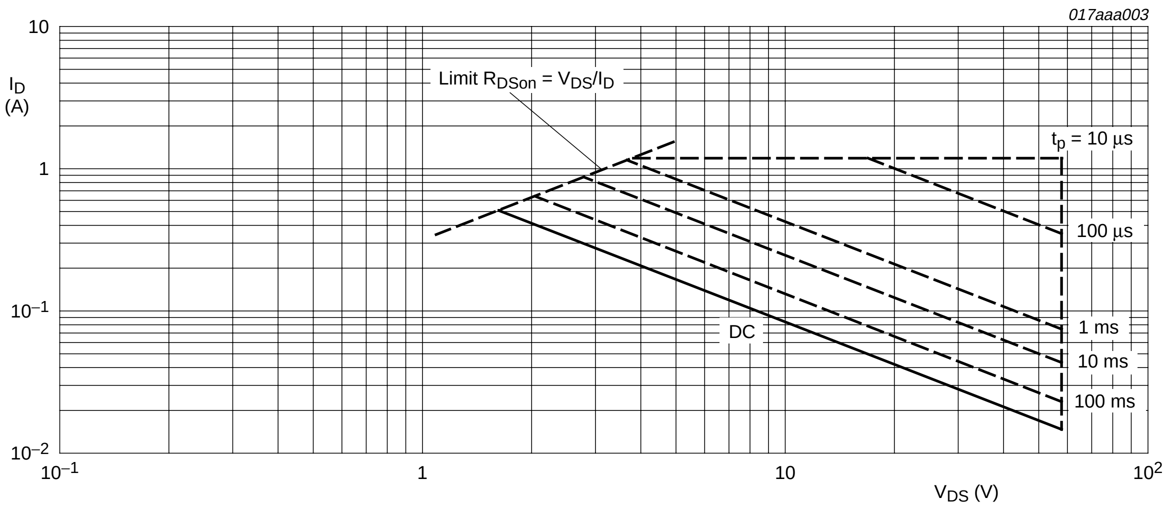
$$P_{der} = \frac{P_{tot}}{P_{tot(25°C)}} \times 100\ \%$$

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



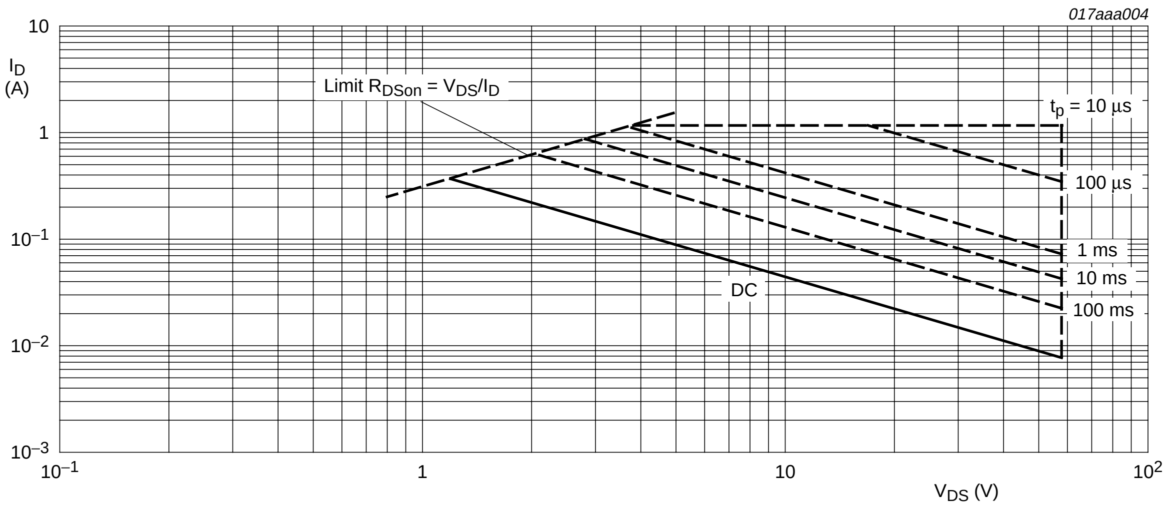
$$I_{der} = \frac{I_D}{I_{D(25°C)}} \times 100\ \%$$

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



T_{sp} = 25 °C; I_{DM} = single pulse; V_{GS} = 10 V

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



T_{amb} = 25 °C; I_{DM} = single pulse; V_{GS} = 10 V

Fig 4. 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]	-	350	500	K/W

Table 6. Thermal characteristics *...continued*

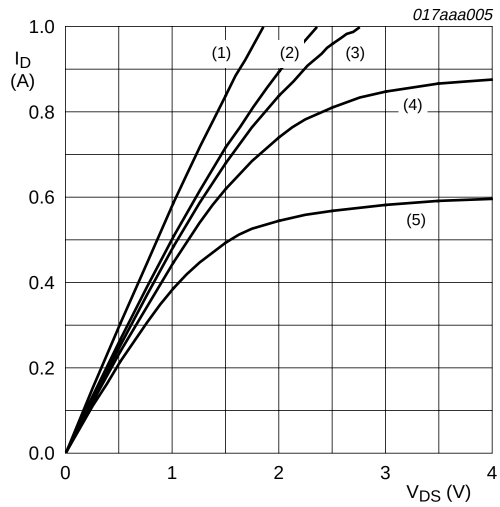
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$R_{th(j-sp)}$	thermal resistance from junction to solder point		-	-	150	K/W

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

7. Characteristics

Table 7. Characteristics
T_{amb} = 25 °C unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Static characteristics						
$V_{(BR)DSS}$	drain-source breakdown voltage	I_D = 10 µA; V_{GS} = 0 V				
		T_j = 25 °C	60	-	-	V
		T_j = –55 °C	55	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	I_D = 250 µA; V_{DS} = V_{GS}; T_j = 25 °C	1	1.75	2.5	V
I_{DSS}	drain leakage current	V_{DS} = 60 V; V_{GS} = 0 V				
		T_j = 25 °C	-	-	100	nA
		T_j = 150 °C	-	-	1	µA
I_{GSS}	gate leakage current	V_{GS} = ±20 V; V_{DS} = 0 V	-	-	5	µA
		V_{GS} = ±10 V; V_{DS} = 0 V	-	50	450	nA
		V_{GS} = ±5 V; V_{DS} = 0 V	-	-	100	nA
R_{DSon}	drain-source on-state resistance	V_{GS} = 4.5 V; I_D = 200 mA				
		T_j = 25 °C	-	1.3	3	Ω
		T_j = 150 °C	-	2.8	4.4	Ω
		V_{GS} = 10 V; I_D = 500 mA	-	1.1	1.6	Ω
Dynamic characteristics						
$Q_{G(tot)}$	total gate charge	I_D = 200 mA; V_{DS} = 10 V; V_{GS} = 4.5 V	-	1.09	1.3	nC
Q_{GS}	gate-source charge		-	0.22	-	nC
Q_{GD}	gate-drain charge		-	0.23	-	nC
C_{iss}	input capacitance	V_{GS} = 0 V; V_{DS} = 25 V; f = 1 MHz	-	47.2	55	pF
C_{oss}	output capacitance		-	11	20	pF
C_{rss}	reverse transfer capacitance		-	5	7.5	pF
$t_{d(on)}$	turn-on delay time	V_{DS} = 15 V; R_L = 15 Ω; V_{GS} = 10 V; R_G = 6 Ω	-	8	15	ns
t_r	rise time		-	8	15	ns
$t_{d(off)}$	turn-off delay time		-	38	50	ns
t_f	fall time		-	22	35	ns
Source-drain diode						
V_{SD}	source-drain voltage	I_S = 200 mA; V_{GS} = 0 V	0.47	0.79	1.1	V



T_j = 25 °C

(1) V_{GS} = 10 V

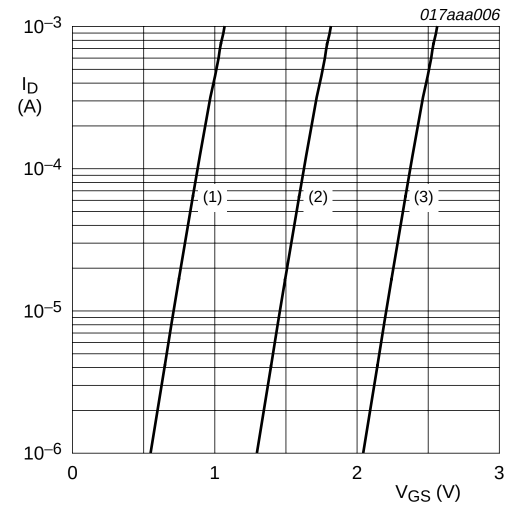
(2) V_{GS} = 5 V

(3) V_{GS} = 4.5 V

(4) V_{GS} = 4 V

(5) V_{GS} = 3.5 V

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



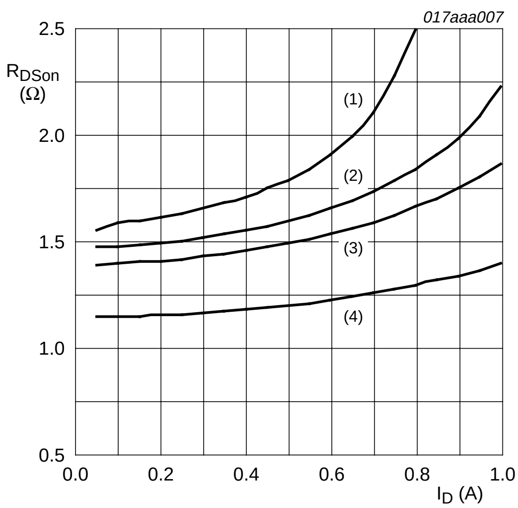
T_j = 25 °C; V_{DS} = 5 V

(1) minimum values

(2) typical values

(3) maximum values

Fig 6. Sub-threshold drain current as a function of gate-source voltage



T_j = 25 °C

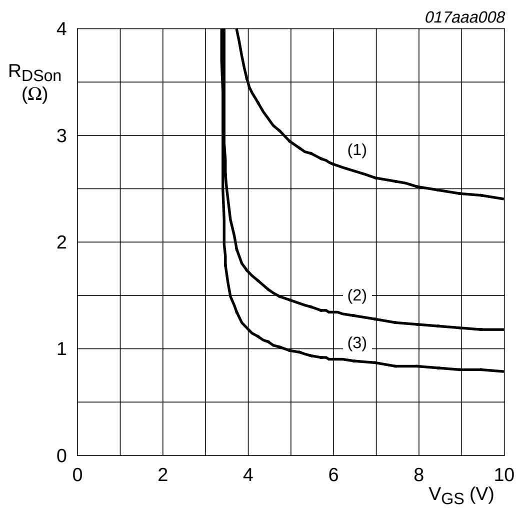
(1) V_{GS} = 4 V

(2) V_{GS} = 4.5 V

(3) V_{GS} = 5 V

(4) V_{GS} = 10 V

Fig 7. Drain-source on-state resistance as a function of drain current; typical values



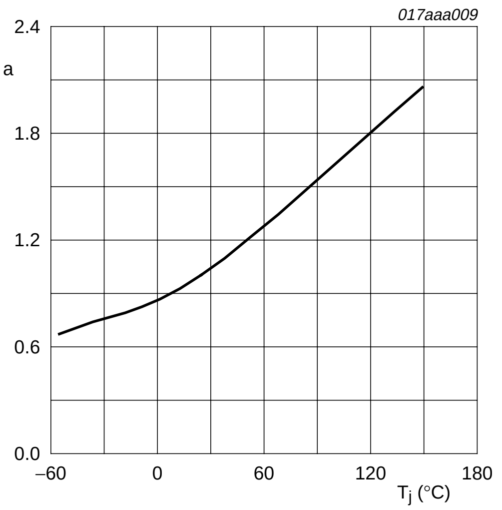
I_D = 500 mA

(1) T_j = 150 °C

(2) T_j = 25 °C

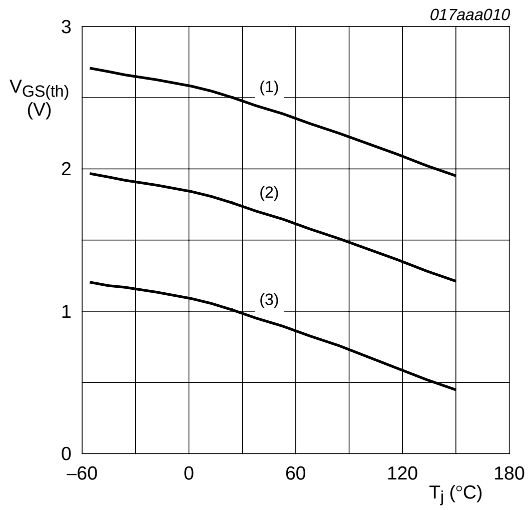
(3) T_j = −55 °C

Fig 8. Drain-source on-resistance as a function of gate-source voltage; typical values



$$a = \frac{R_{DSon}}{R_{DSon(25°C)}}$$

Fig 9. **Normalized drain-source on-state resistance factor as a function of junction temperature**



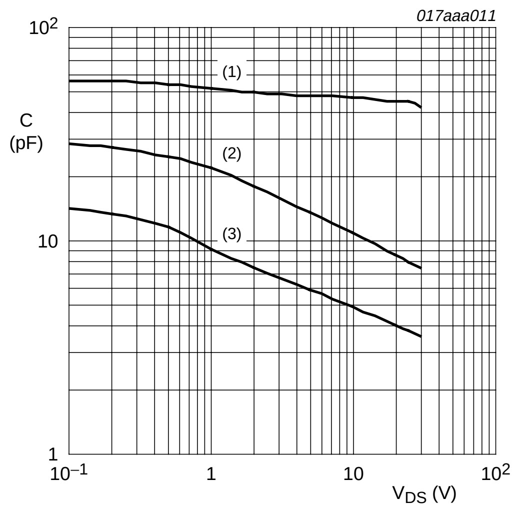
$I_D = 0.25$ mA; $V_{DS} = V_{GS}$

(1) maximum values

(2) typical values

(3) minimum values

Fig 10. **Gate-source threshold voltage as a function of junction temperature**



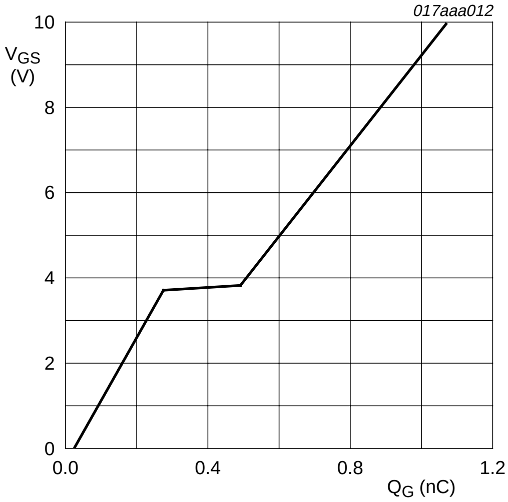
$V_{GS} = 0$ V; f = 1 MHz

(1) C_{iss}

(2) C_{oss}

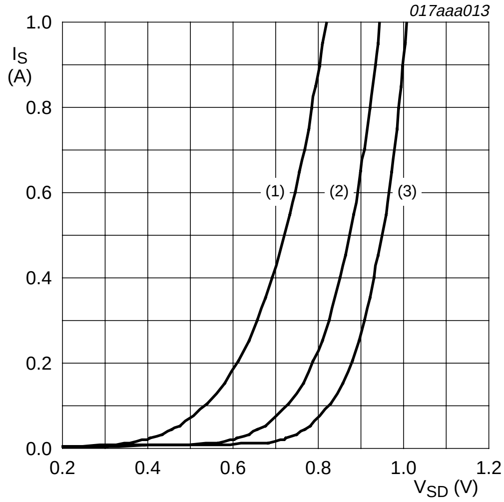
(3) C_{rss}

Fig 11. **Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values**



I_D = 200 mA; V_{DD} = 30 V; T_j = 25 °C

Fig 12. Gate-source voltage as a function of gate charge; typical values



V_{GS} = 0 V

(1) T_j = 150 °C

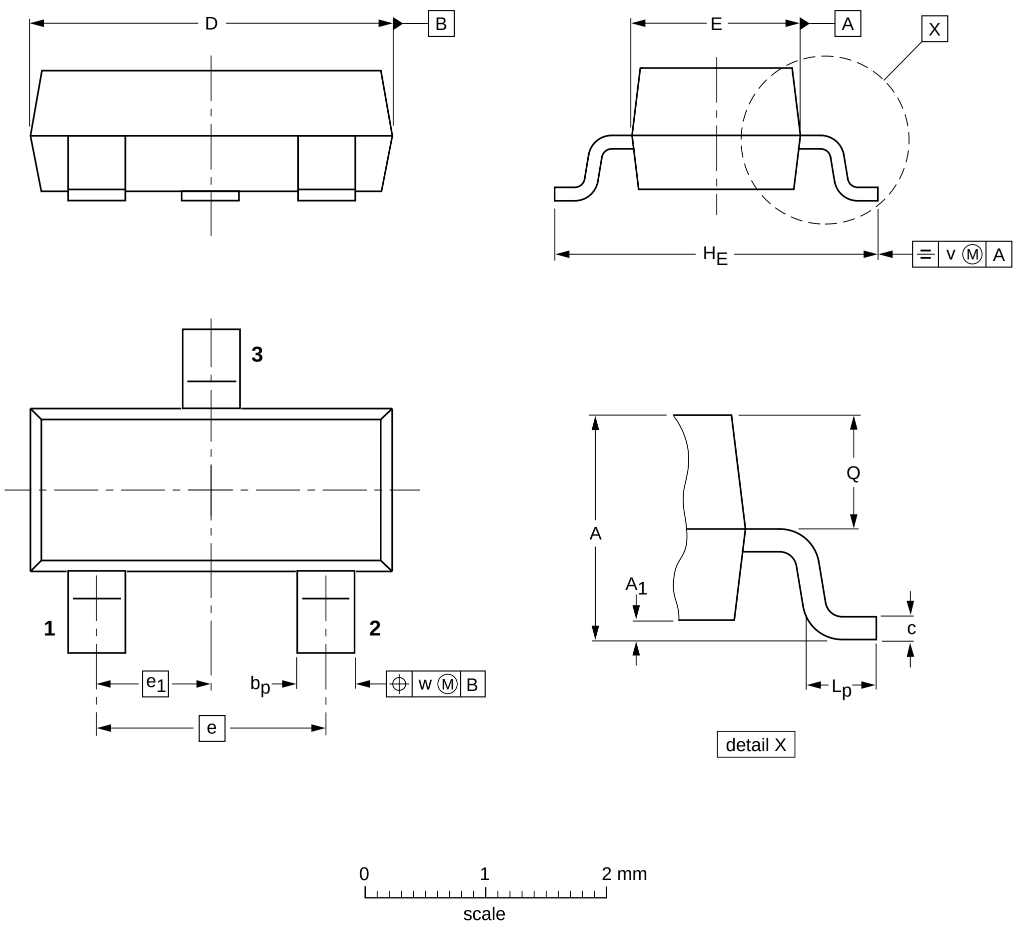
(2) T_j = 25 °C

(3) T_j = –55 °C

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

8. Package outline

Plastic surface-mounted package; 3 leads **SOT23**



DIMENSIONS (mm are the original dimensions)

UNIT	A	A_1 max.	b_p	c	D	E	e	e_1	H_E	L_p	Q	v	w
mm	1.1 0.9	0.1	0.48 0.38	0.15 0.09	3.0 2.8	1.4 1.2	1.9	0.95	2.5 2.1	0.45 0.15	0.55 0.45	0.2	0.1

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT23		TO-236AB				~~04-11-04~~ 06-03-16

Fig 14. Package outline SOT23 (TO-236AB)

9. Soldering

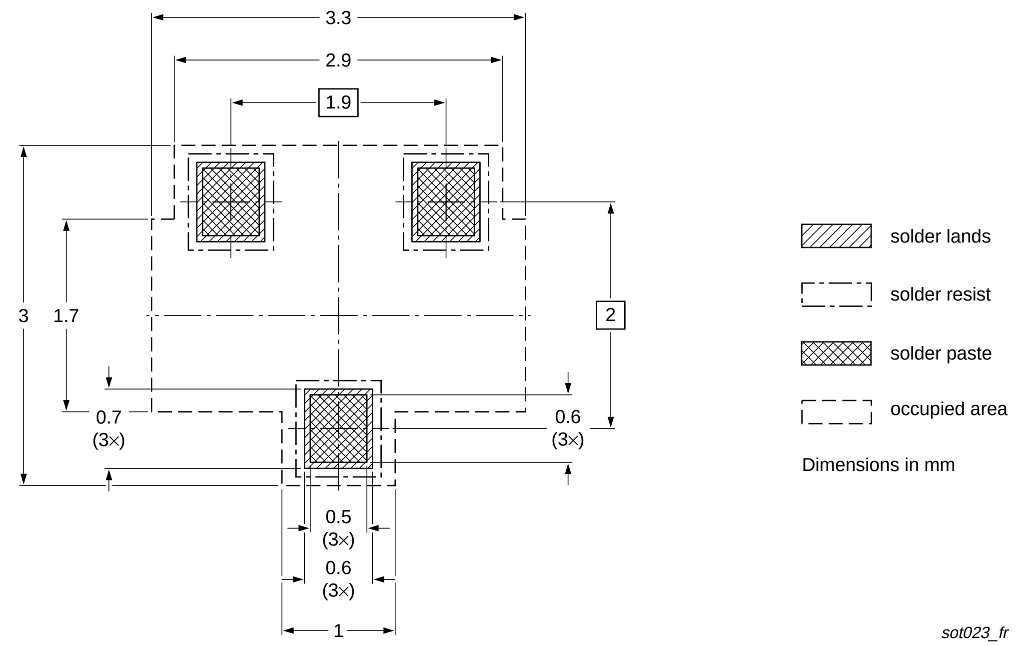


Fig 15. Reflow soldering footprint SOT23 (TO-236AB)

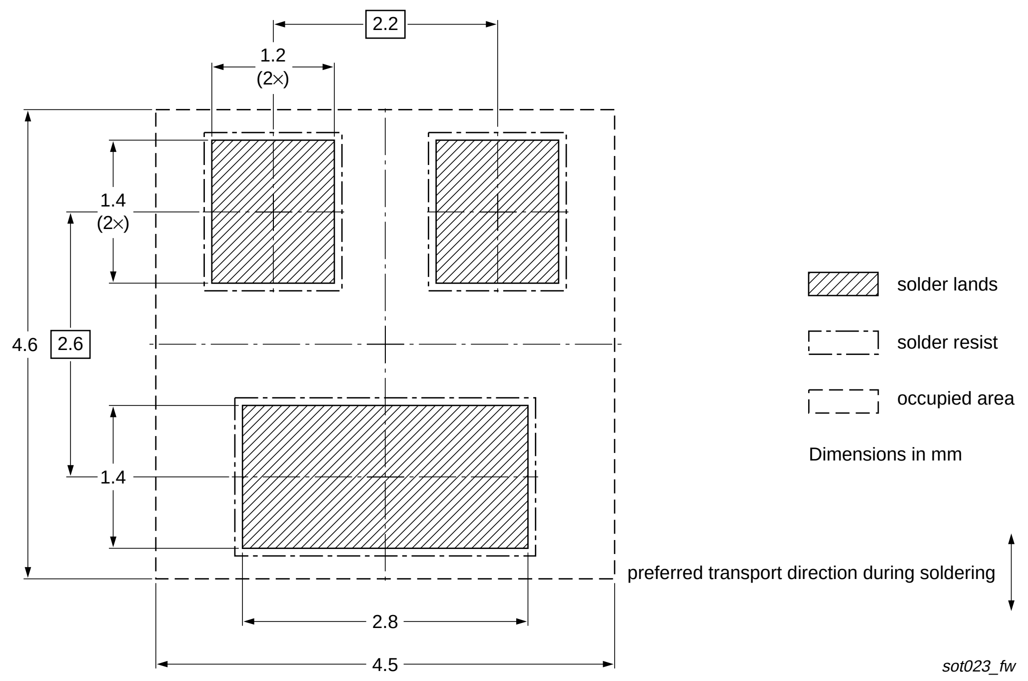


Fig 16. Wave soldering footprint SOT23 (TO-236AB)

10. Revision history

Table 8. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
2N7002CK_1	20090911	Product data sheet	-	-

11. Legal information

11.1 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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