



# 2N7002NXBK

60 V, N-channel Trench MOSFET

25 July 2019

Product data sheet

## 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.

## 2. Features and benefits

- Logic-level compatible
- Very fast switching
- Trench MOSFET technology
- ElectroStatic Discharge (ESD) protection > 2 kV HBM

## 3. Applications

- Relay driver
- High-speed line driver
- Low-side load switch
- Switching circuits

## 4. Quick reference data

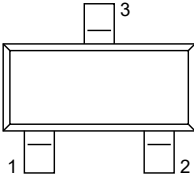
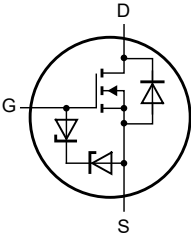
Table 1. Quick reference data

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V <sub>DS</sub>	drain-source voltage	T <sub>j</sub> = 25 °C		-	-	60	V
V <sub>GS</sub>	gate-source voltage			-20	-	20	V
I <sub>D</sub>	drain current	V <sub>GS</sub> = 10 V; T <sub>amb</sub> = 25 °C	[1]	-	-	270	mA
		V <sub>GS</sub> = 10 V; T <sub>sp</sub> = 25 °C		-	-	330	mA
Static characteristics							
R <sub>DSon</sub>	drain-source on-state resistance	V <sub>GS</sub> = 10 V; I <sub>D</sub> = 200 mA; T <sub>j</sub> = 25 °C		-	2.2	2.8	Ω

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

5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	G	gate	 SOT23	 017aaa255
2	S	source		
3	D	drain		

6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
2N7002NXBK	SOT23	plastic, surface-mounted package; 3 terminals; 1.9 mm pitch; 2.9 mm x 1.3 mm x 1 mm body	SOT23

7. Marking

Table 4. Marking codes

Type number	Marking code[1]
2N7002NXBK	%4R

[1] % = placeholder for manufacturing site code

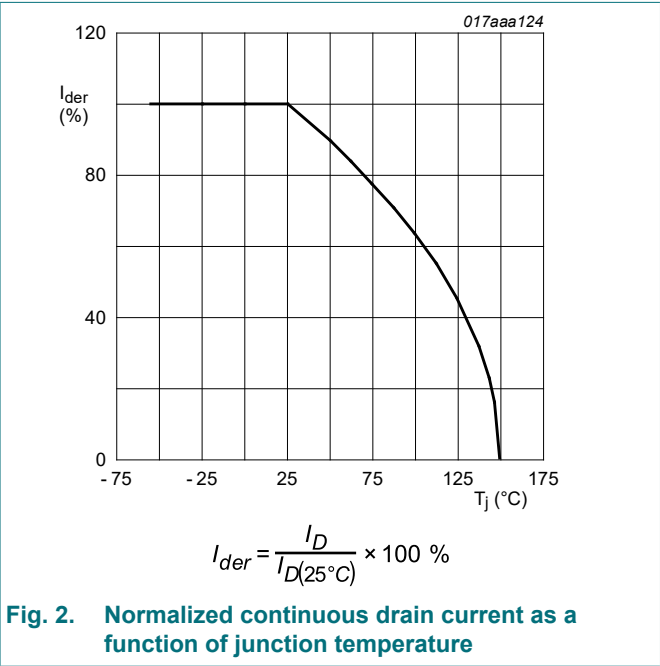
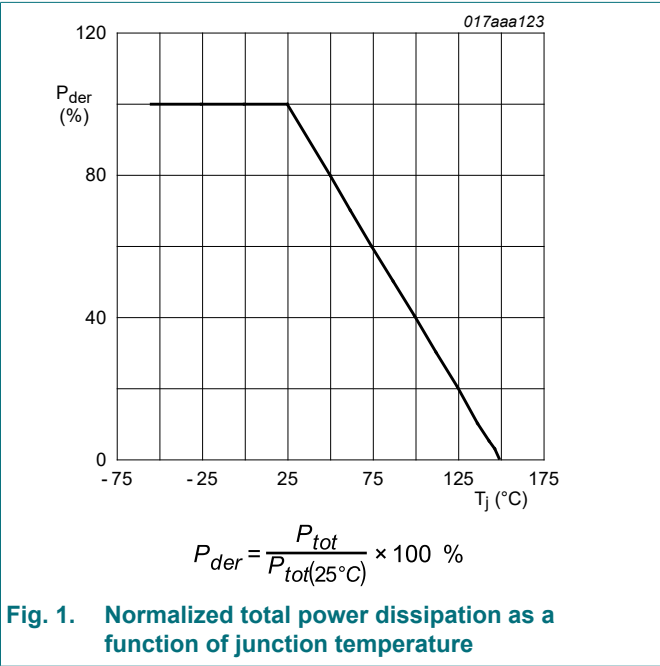
8. Limiting values

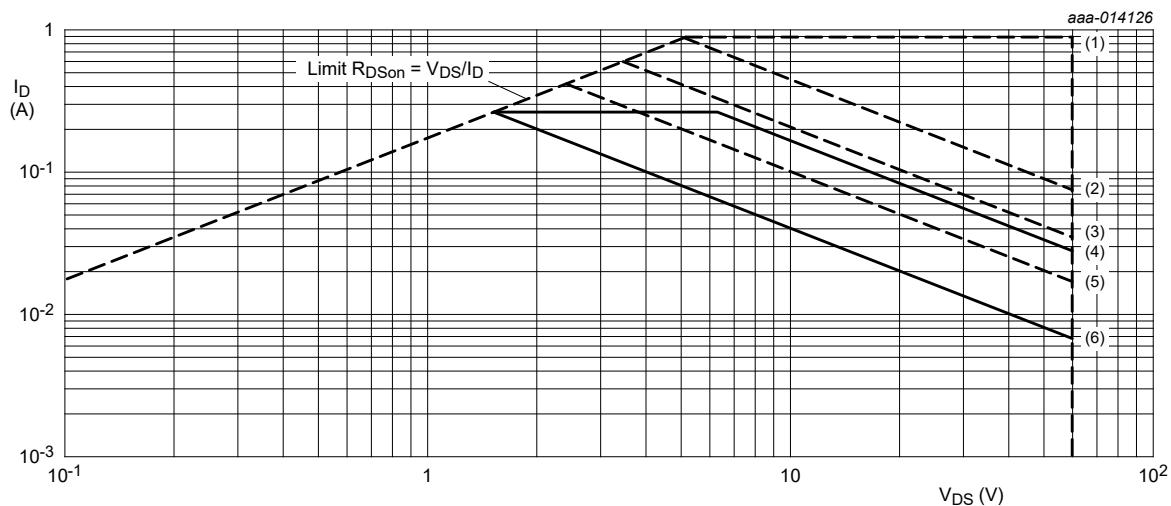
Table 5. Limiting values

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

Symbol	Parameter	Conditions		Min	Max	Unit
V <sub>DS</sub>	drain-source voltage	T <sub>j</sub> = 25 °C		-	60	V
V <sub>GS</sub>	gate-source voltage			-20	20	V
I <sub>D</sub>	drain current	V <sub>GS</sub> = 10 V; T <sub>amb</sub> = 25 °C	[1]	-	270	mA
		V <sub>GS</sub> = 10 V; T <sub>amb</sub> = 100 °C	[1]	-	170	mA
		V <sub>GS</sub> = 10 V; T <sub>sp</sub> = 25 °C		-	330	mA
I <sub>DM</sub>	peak drain current	T <sub>amb</sub> = 25 °C; single pulse; t <sub>p</sub> ≤ 10 μs		-	0.9	A
P <sub>tot</sub>	total power dissipation	T <sub>amb</sub> = 25 °C	[2]	-	310	mW
			[1]	-	400	mW
		T <sub>sp</sub> = 25 °C		-	1670	mW
T <sub>j</sub>	junction temperature			-55	150	°C
T <sub>amb</sub>	ambient temperature			-55	150	°C
T <sub>stg</sub>	storage temperature			-65	150	°C
Source-drain diode						
I <sub>S</sub>	source current	T <sub>amb</sub> = 25 °C	[1]	-	200	mA

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





$I_{DM}$  = single pulse

(1)  $t_p = 10 \mu s$

(2)  $t_p = 1 ms$

(3)  $t_p = 10 ms$

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

(5)  $t_p = 100 ms$

(6) DC;  $T_{amb} = 25^\circ C$ ; 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

9. 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	405	K/W
			[2]	-	270	310	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point			-	65	75	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 and mounting pad for drain 1 cm<sup>2</sup>.

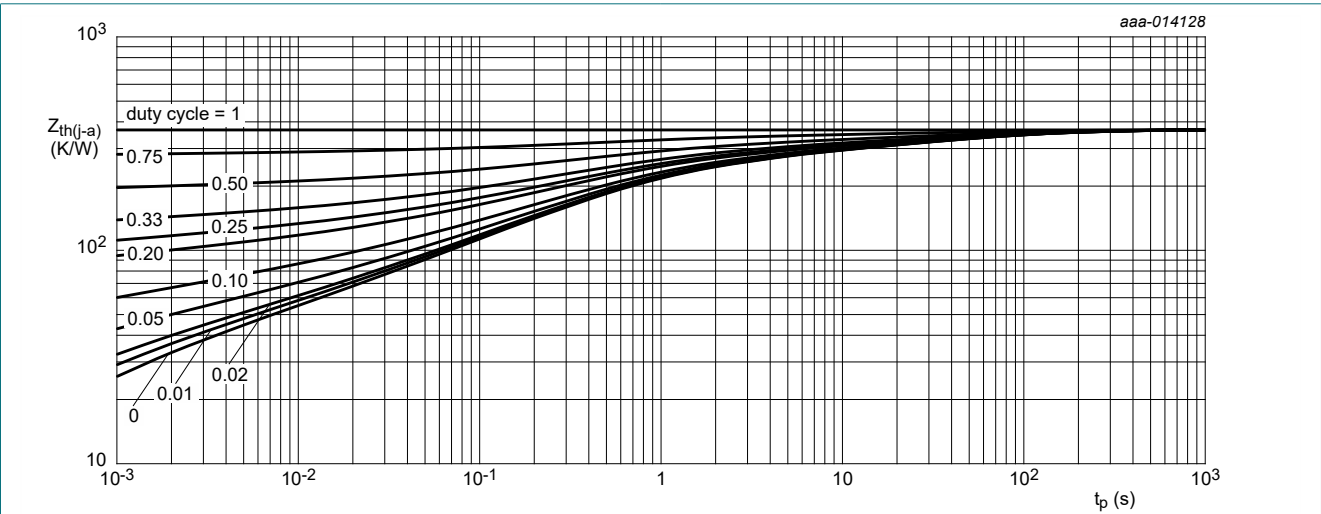


Fig. 4. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

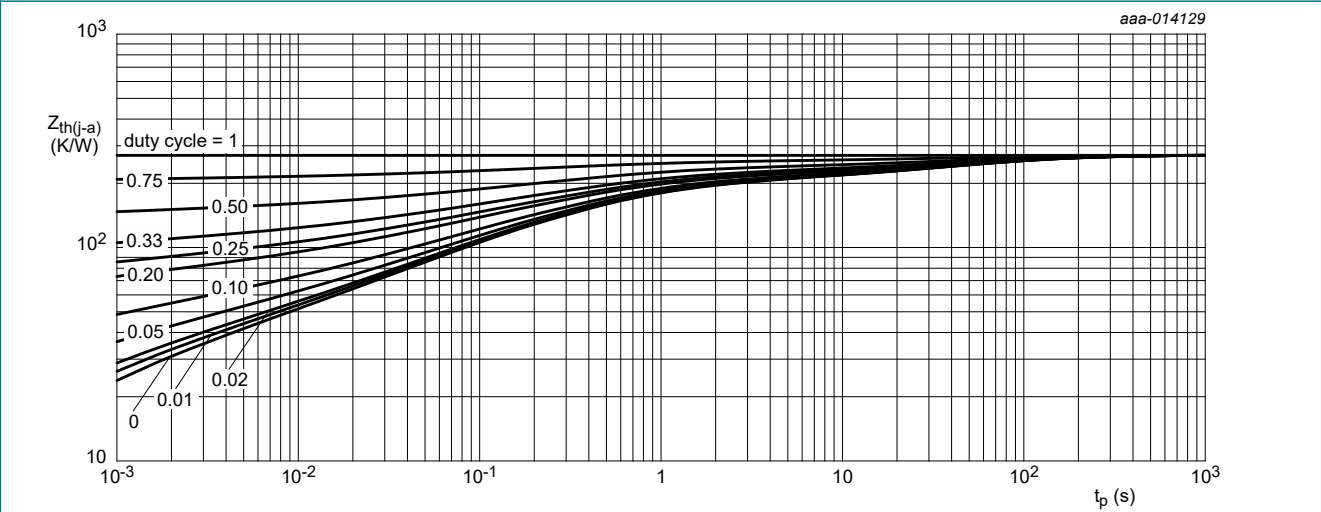


Fig. 5. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

## 10. 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> = 250 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	1.6	2.1	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
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		-	-	10	μA
		V <sub>GS</sub> = -20 V; V <sub>DS</sub> = 0 V; T <sub>J</sub> = 25 °C		-	-	-10	μA
		V <sub>GS</sub> = 10 V; V <sub>DS</sub> = 0 V; T <sub>J</sub> = 25 °C		-	-	1	μA
		V <sub>GS</sub> = -10 V; V <sub>DS</sub> = 0 V; T <sub>J</sub> = 25 °C		-	-	-1	μA
		V <sub>GS</sub> = 5 V; V <sub>DS</sub> = 0 V; T <sub>J</sub> = 25 °C		-	-	0.3	μA
		V <sub>GS</sub> = -5 V; V <sub>DS</sub> = 0 V; T <sub>J</sub> = 25 °C		-	-	-0.3	μA
R <sub>DSon</sub>	drain-source on-state resistance	V <sub>GS</sub> = 10 V; I <sub>D</sub> = 200 mA; T <sub>J</sub> = 25 °C		-	2.2	2.8	Ω
		V <sub>GS</sub> = 10 V; I <sub>D</sub> = 100 mA; T <sub>J</sub> = 150 °C		-	4.5	5.7	Ω
		V <sub>GS</sub> = 5 V; I <sub>D</sub> = 200 mA; T <sub>J</sub> = 25 °C		-	2.5	3.2	Ω
g <sub>fs</sub>	forward transconductance	V <sub>DS</sub> = 10 V; I <sub>D</sub> = 200 mA; T <sub>J</sub> = 25 °C		-	600	-	mS
R <sub>G</sub>	gate resistance	f = 2.5 MHz		-	2.5	-	Ω
Dynamic characteristics							
Q <sub>G(tot)</sub>	total gate charge	V <sub>DS</sub> = 30 V; I <sub>D</sub> = 200 mA; V <sub>GS</sub> = 10 V; T <sub>J</sub> = 25 °C		-	1	-	nC
Q <sub>GS</sub>	gate-source charge			-	0.12	-	nC
Q <sub>GD</sub>	gate-drain charge			-	0.18	-	nC
C <sub>iss</sub>	input capacitance	V <sub>DS</sub> = 10 V; f = 1 MHz; V <sub>GS</sub> = 0 V; T <sub>J</sub> = 25 °C		-	23.6	-	pF
C <sub>oss</sub>	output capacitance			-	4.6	-	pF
C <sub>rss</sub>	reverse transfer capacitance			-	3	-	pF
t <sub>d(on)</sub>	turn-on delay time	V <sub>DS</sub> = 50 V; I <sub>D</sub> = 200 mA; V <sub>GS</sub> = 10 V; R <sub>G(ext)</sub> = 6 Ω; T <sub>J</sub> = 25 °C		-	4.7	-	ns
t <sub>r</sub>	rise time			-	4.3	-	ns
t <sub>d(off)</sub>	turn-off delay time			-	6.9	-	ns
t <sub>f</sub>	fall time			-	2.9	-	ns
Source-drain diode							
V <sub>SD</sub>	source-drain voltage	I <sub>S</sub> = 200 mA; V <sub>GS</sub> = 0 V; T <sub>J</sub> = 25 °C		-	0.87	1.2	V

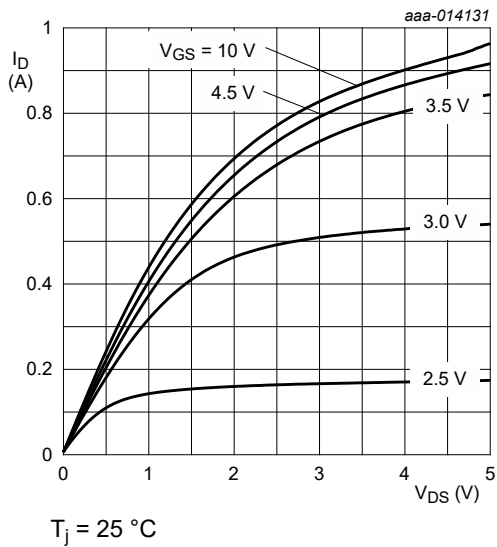


Fig. 6. Output characteristics: drain current as a function of drain-source voltage; typical values

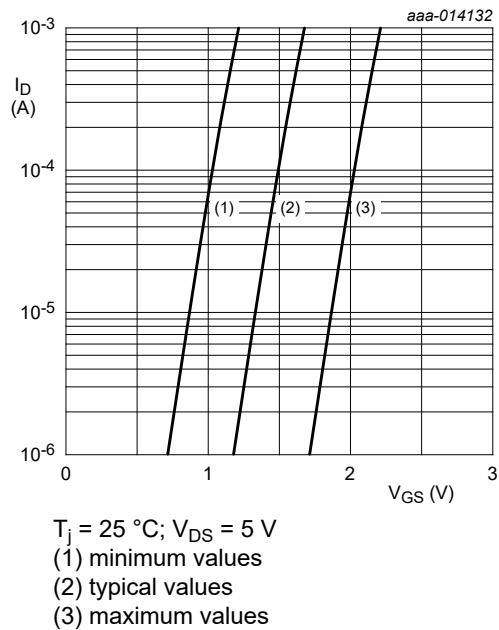


Fig. 7. Sub-threshold drain current as a function of gate-source voltage

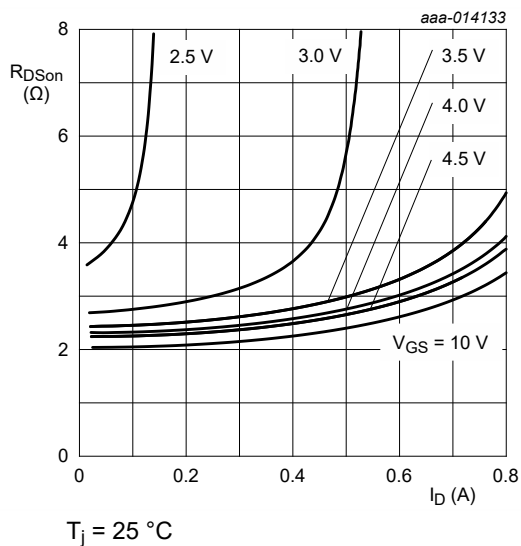


Fig. 8. Drain-source on-state resistance as a function of drain current; typical values

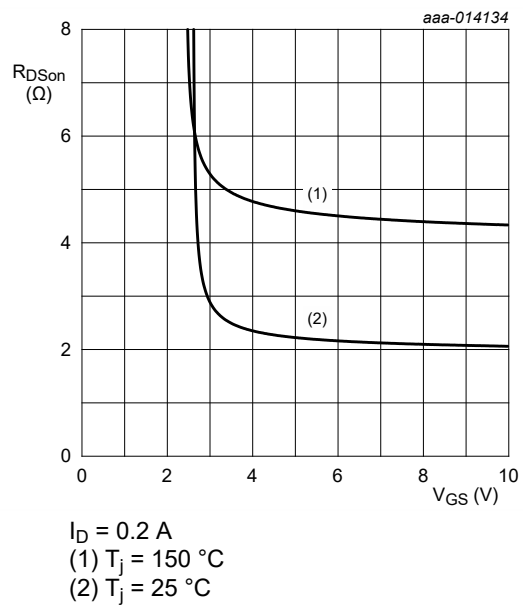


Fig. 9. Drain-source on-state resistance as a function of gate-source voltage; typical values

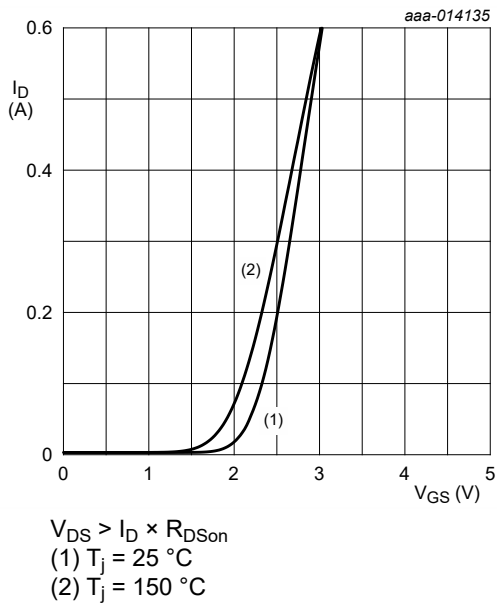


Fig. 10. Transfer characteristics: drain current as a function of gate-source voltage; typical values

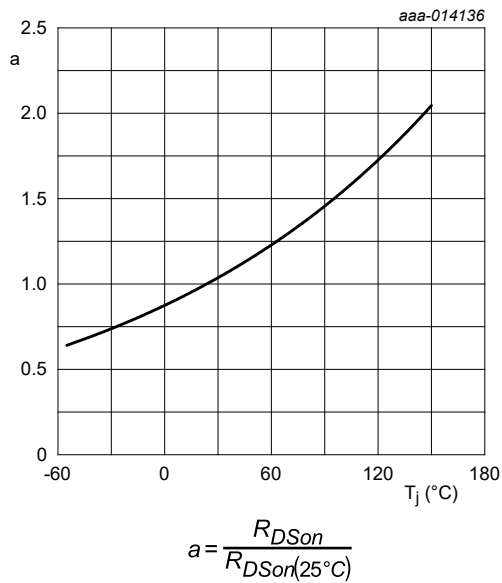


Fig. 11. Normalized drain-source on-state resistance as a function of junction temperature; typical values

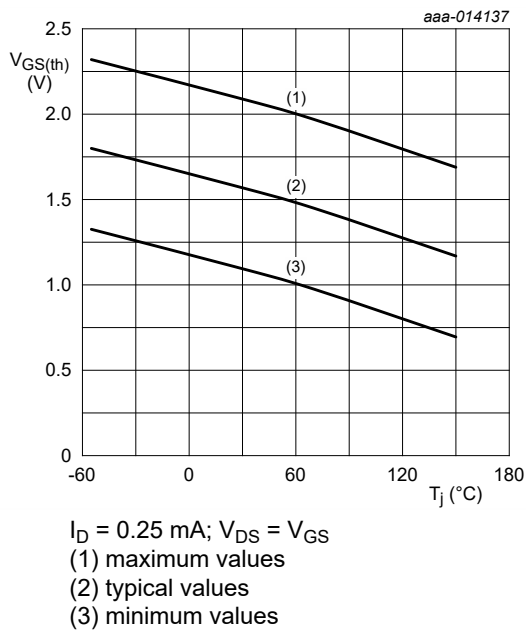


Fig. 12. Gate-source threshold voltage as a function of junction temperature

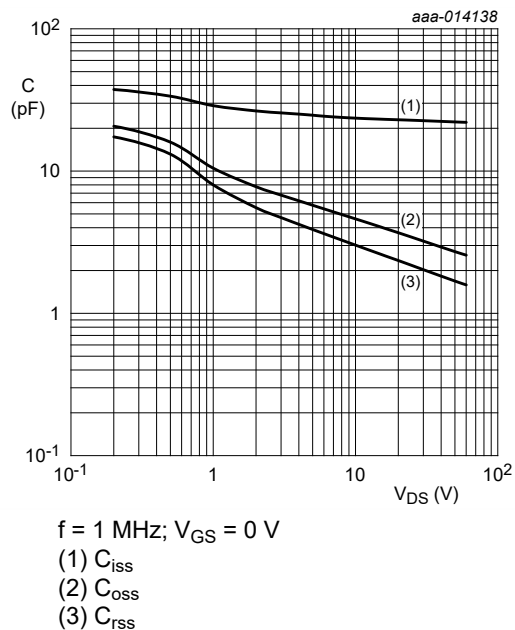


Fig. 13. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values



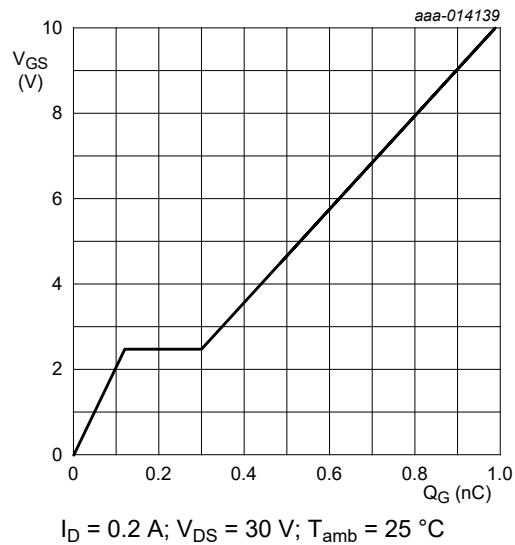


Fig. 14. Gate-source voltage as a function of gate charge; typical values

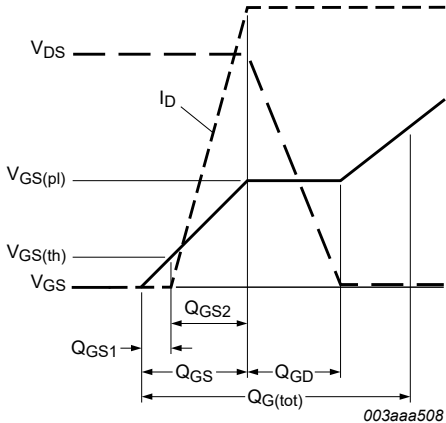


Fig. 15. Gate charge waveform definitions

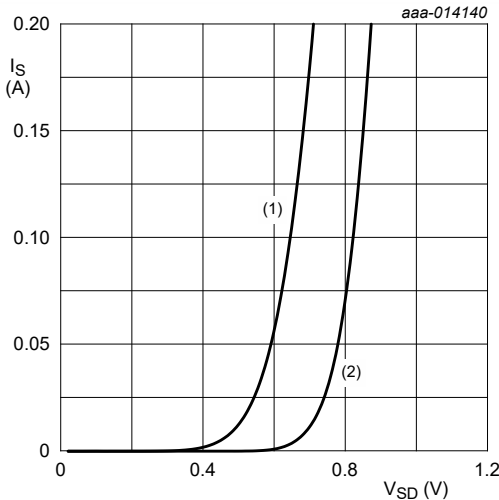


Fig. 16. Source current as a function of source-drain voltage; typical values

11. Test information

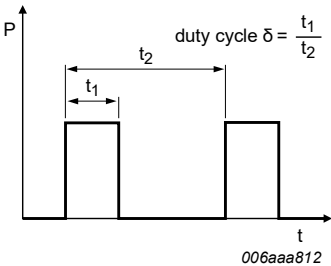
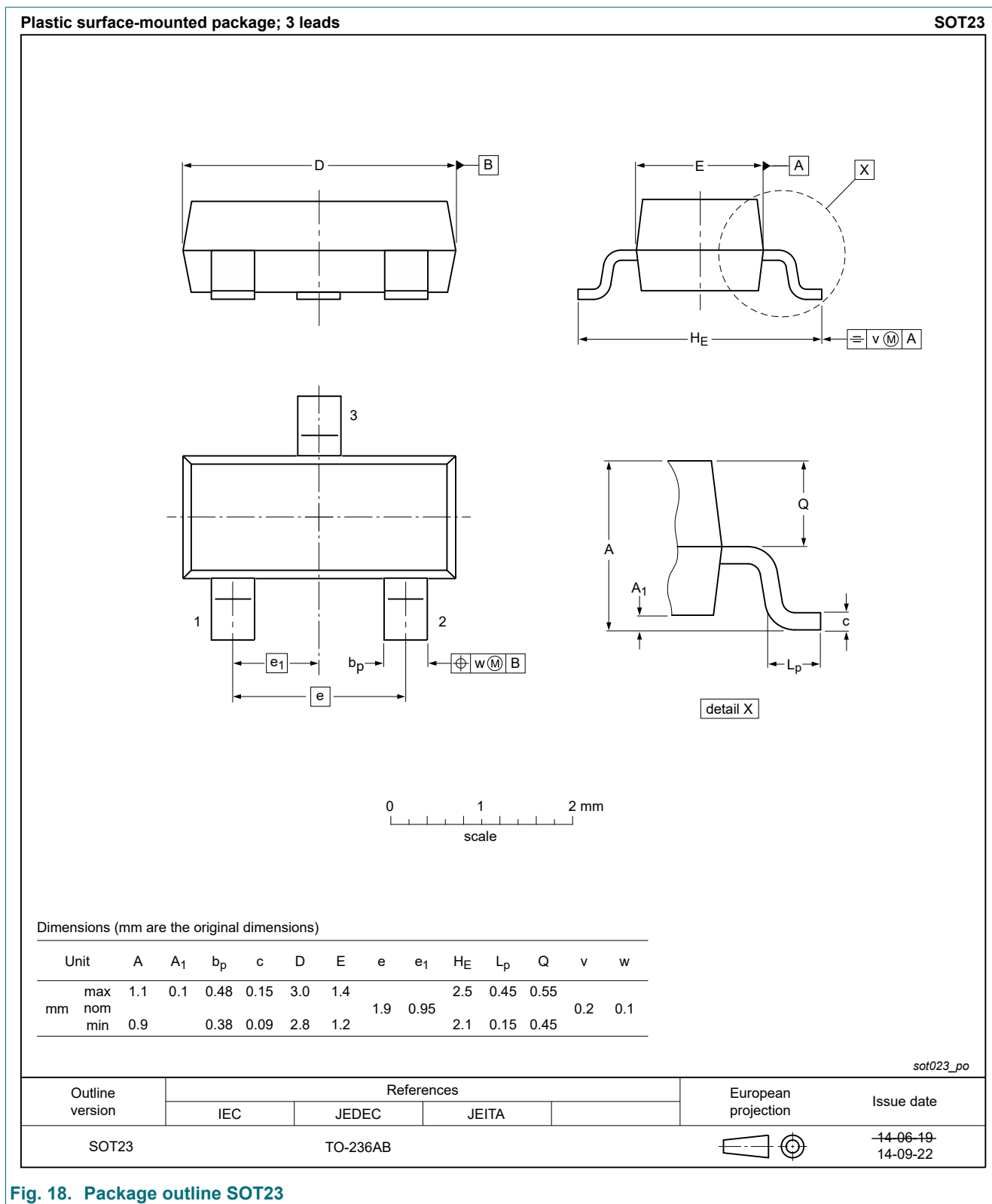


Fig. 17. Duty cycle definition

## 12. Package outline



13. Soldering

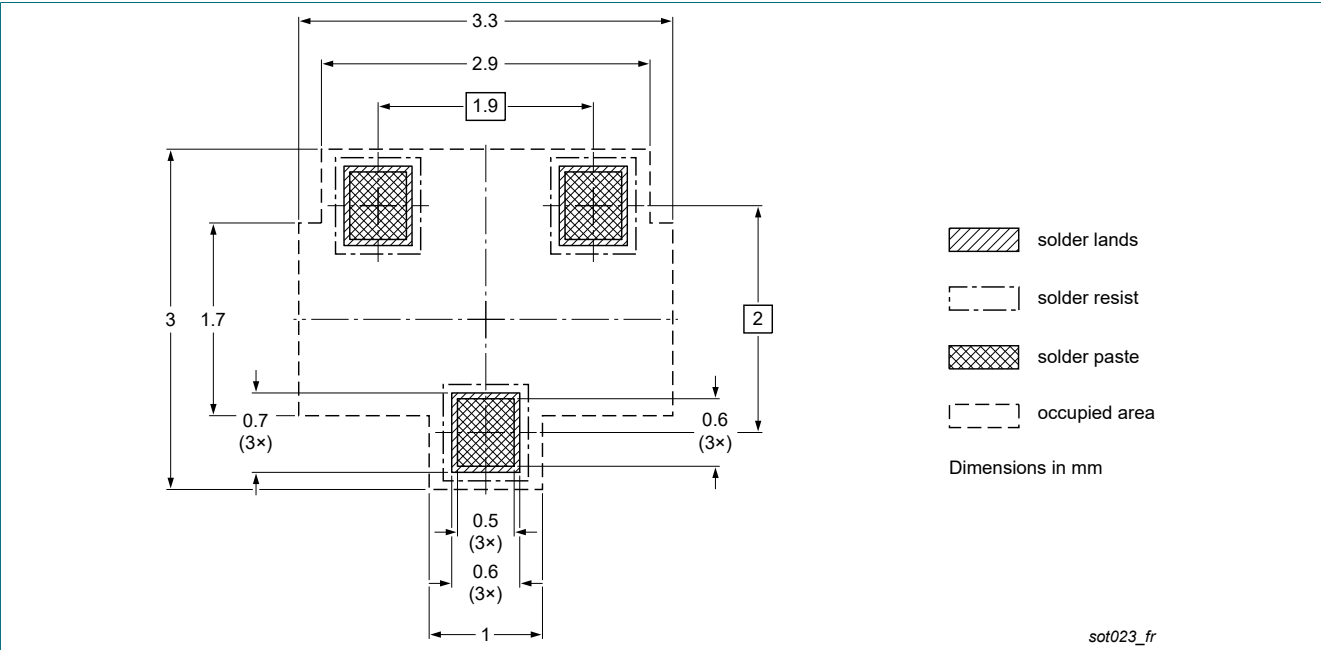


Fig. 19. Reflow soldering footprint for SOT23

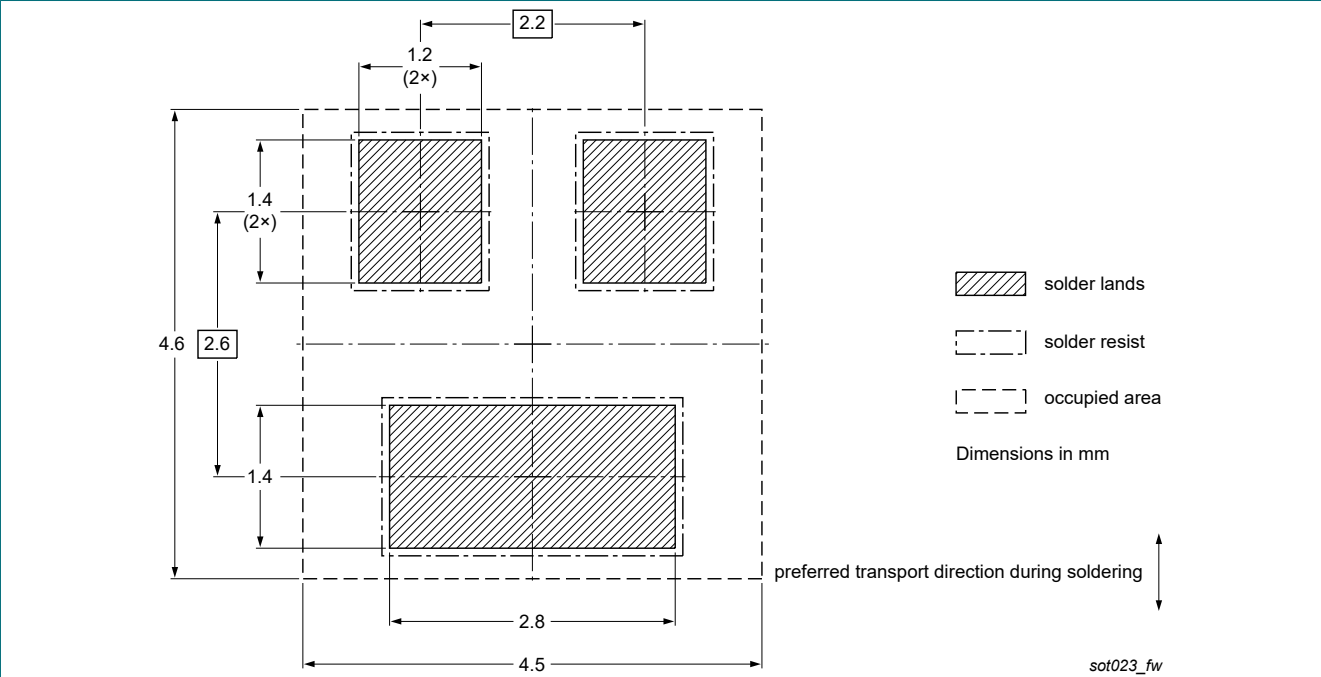


Fig. 20. Wave soldering footprint for SOT23

## 14. Revision history

**Table 8. Revision history**

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
2N7002NXBK v.2	20190725	Product data sheet	-	2N7002NXBK v.1
Modification	<ul style="list-style-type: none"><li>Corrected the package information from SOT89 to SOT23</li></ul>			
2N7002NXBK v.1	20190701	Product data sheet	-	-

## 15. Legal information

### 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.

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- [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 <https://www.nexperia.com>.

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Contents

1. General description..... 1

2. Features and benefits..... 1

3. Applications..... 1

4. Quick reference data..... 1

5. Pinning information.....2

6. Ordering information.....2

7. Marking.....2

8. Limiting values..... 3

9. Thermal characteristics..... 5

10. Characteristics.....6

11. Test information.....9

12. Package outline..... 10

13. Soldering..... 11

14. Revision history.....12

15. Legal information.....13

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