



# 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

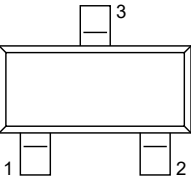
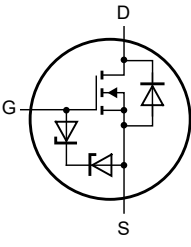
Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{DS}$	drain-source voltage	$T_j = 25\text{ °C}$	-	-	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]	-	270	mA
		$V_{GS} = 10\text{ V}; T_{sp} = 25\text{ °C}$		-	330	mA
<b>Static characteristics</b>						
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = 10\text{ V}; I_D = 200\text{ mA}; T_j = 25\text{ °C}$	-	2.2	2.8	$\Omega$

[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>.

## 5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	G	gate	 <p style="text-align: center;"><b>SOT23</b></p>	 <p style="text-align: right;"><small>017aaa255</small></p>
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

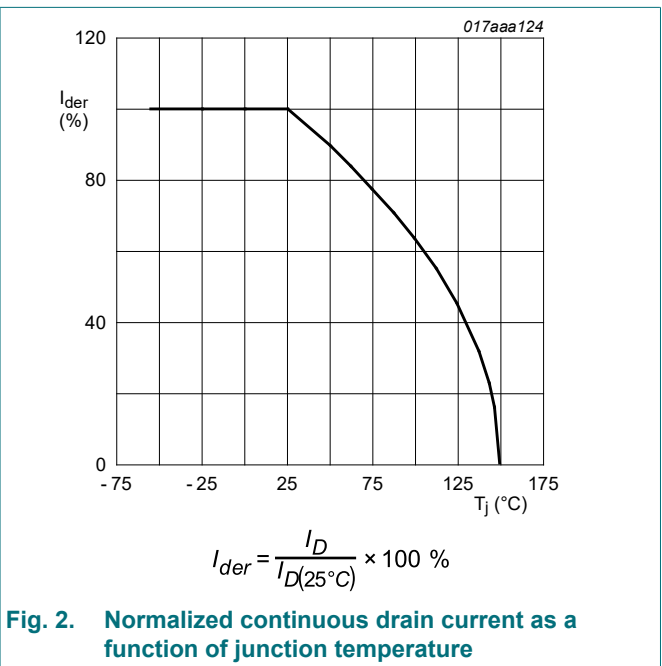
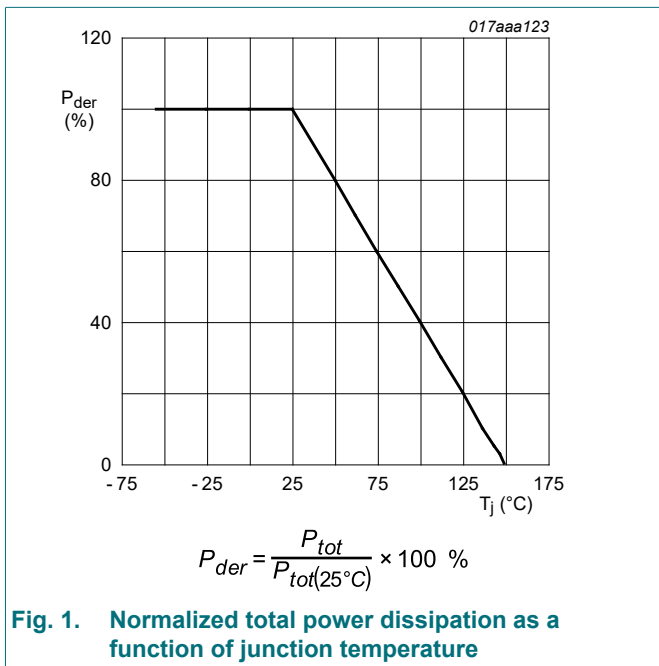
## 8. Limiting values

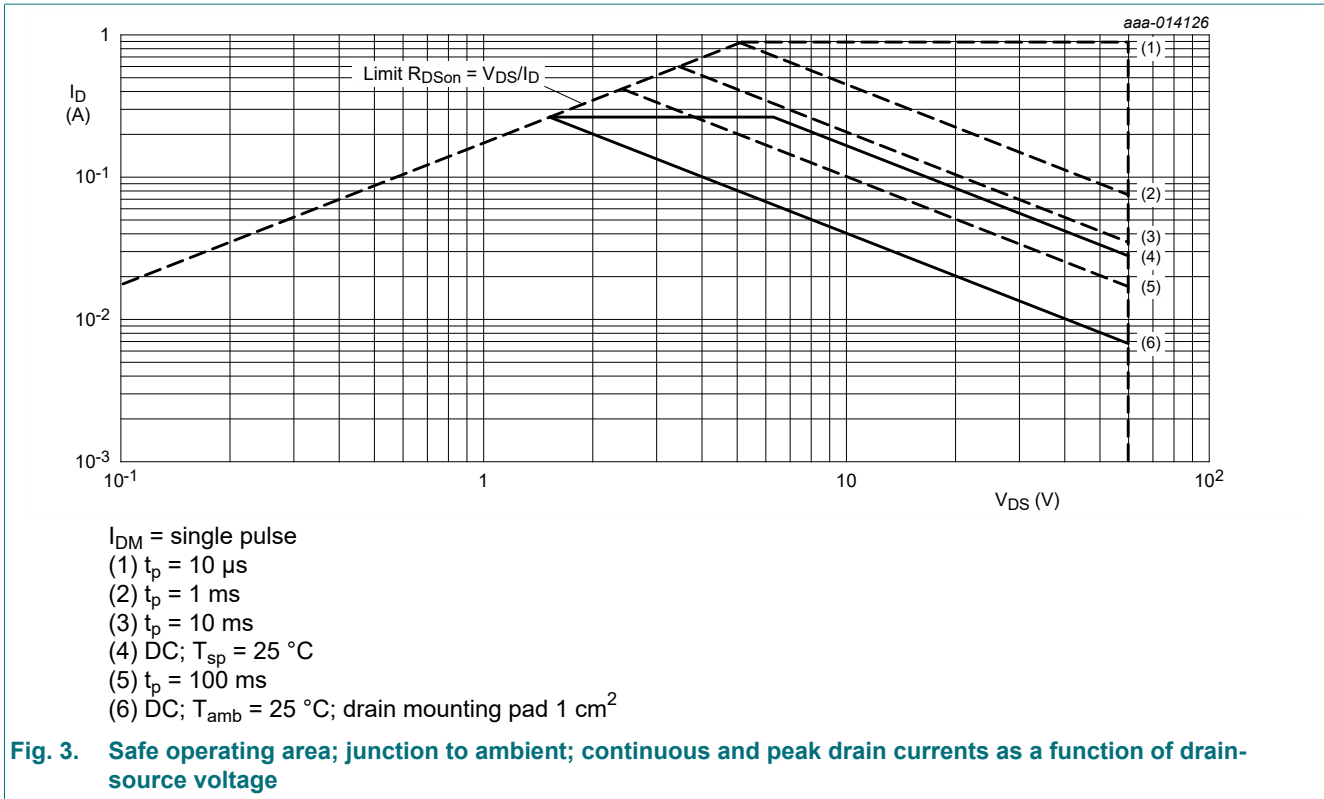
**Table 5. Limiting values**

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
<b>Source-drain diode</b>						
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.





### 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>.

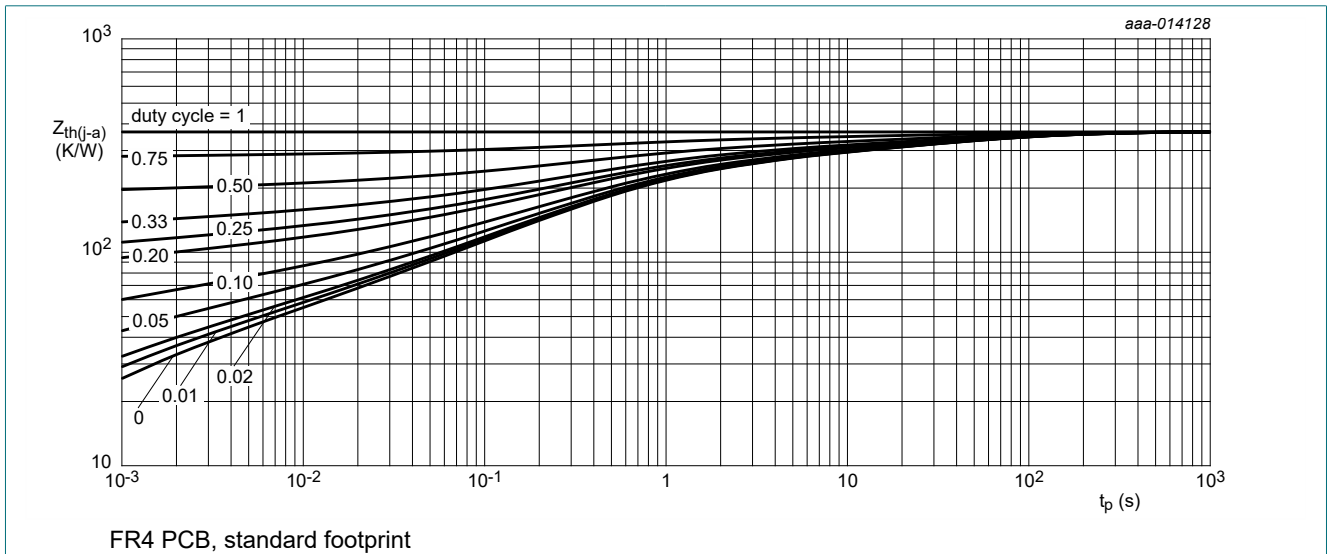


Fig. 4. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

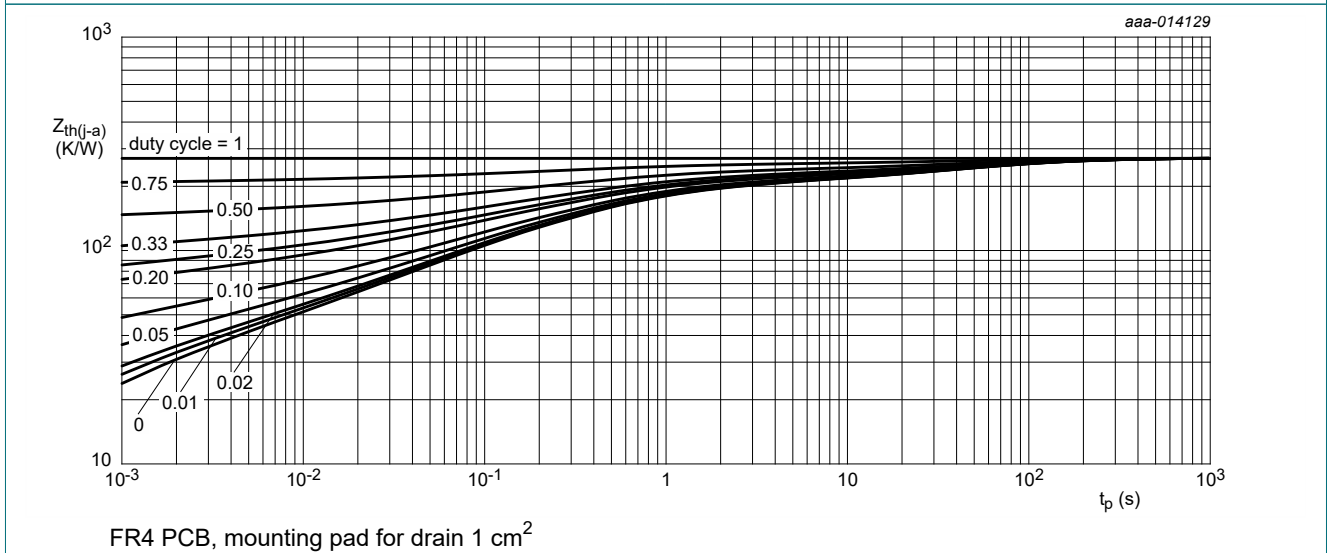
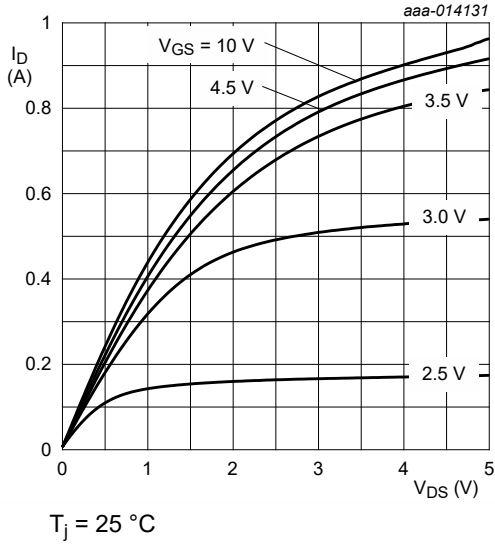


Fig. 5. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

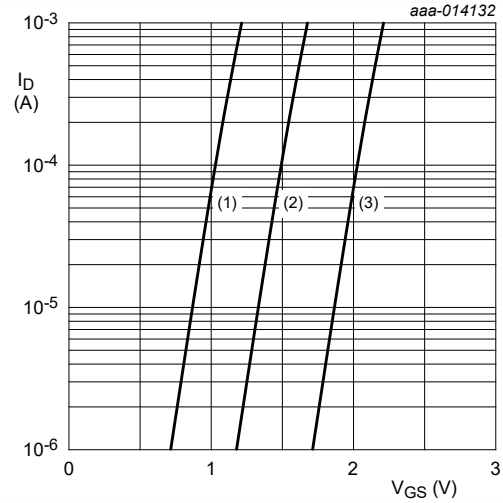
## 10. Characteristics

**Table 7. Characteristics**

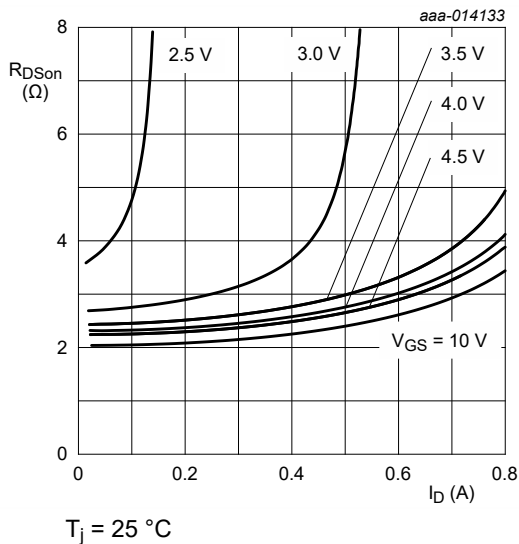
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics</b>						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 250 \mu A$ ; $V_{GS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$	60	-	-	V
$V_{GSth}$	gate-source threshold voltage	$I_D = 250 \mu A$ ; $V_{DS} = V_{GS}$ ; $T_j = 25 \text{ }^\circ C$	1.1	1.6	2.1	V
$I_{DSS}$	drain leakage current	$V_{DS} = 60 V$ ; $V_{GS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$	-	-	1	$\mu A$
$I_{GSS}$	gate leakage current	$V_{GS} = 20 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$	-	-	10	$\mu A$
		$V_{GS} = -20 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$	-	-	-10	$\mu A$
		$V_{GS} = 10 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$	-	-	1	$\mu A$
		$V_{GS} = -10 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$	-	-	-1	$\mu A$
		$V_{GS} = 5 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$	-	-	0.3	$\mu A$
		$V_{GS} = -5 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$	-	-	-0.3	$\mu A$
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = 10 V$ ; $I_D = 200 \text{ mA}$ ; $T_j = 25 \text{ }^\circ C$	-	2.2	2.8	$\Omega$
		$V_{GS} = 10 V$ ; $I_D = 100 \text{ mA}$ ; $T_j = 150 \text{ }^\circ C$	-	4.5	5.7	$\Omega$
		$V_{GS} = 5 V$ ; $I_D = 200 \text{ mA}$ ; $T_j = 25 \text{ }^\circ C$	-	2.5	3.2	$\Omega$
$g_{fs}$	forward transconductance	$V_{DS} = 10 V$ ; $I_D = 200 \text{ mA}$ ; $T_j = 25 \text{ }^\circ C$	-	600	-	mS
$R_G$	gate resistance	$f = 2.5 \text{ MHz}$	-	2.5	-	$\Omega$
<b>Dynamic characteristics</b>						
$Q_{G(tot)}$	total gate charge	$V_{DS} = 30 V$ ; $I_D = 200 \text{ mA}$ ; $V_{GS} = 10 V$ ; $T_j = 25 \text{ }^\circ C$	-	1	-	nC
$Q_{GS}$	gate-source charge		-	0.12	-	nC
$Q_{GD}$	gate-drain charge		-	0.18	-	nC
$C_{iss}$	input capacitance	$V_{DS} = 10 V$ ; $f = 1 \text{ MHz}$ ; $V_{GS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$	-	23.6	-	pF
$C_{oss}$	output capacitance		-	4.6	-	pF
$C_{rss}$	reverse transfer capacitance		-	3	-	pF
$t_{d(on)}$	turn-on delay time		$V_{DS} = 50 V$ ; $I_D = 200 \text{ mA}$ ; $V_{GS} = 10 V$ ; $R_{G(ext)} = 6 \Omega$ ; $T_j = 25 \text{ }^\circ C$	-	4.7	-
$t_r$	rise time	-		4.3	-	ns
$t_{d(off)}$	turn-off delay time	-		6.9	-	ns
$t_f$	fall time	-		2.9	-	ns
<b>Source-drain diode</b>						
$V_{SD}$	source-drain voltage	$I_S = 200 \text{ mA}$ ; $V_{GS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$	-	0.87	1.2	V



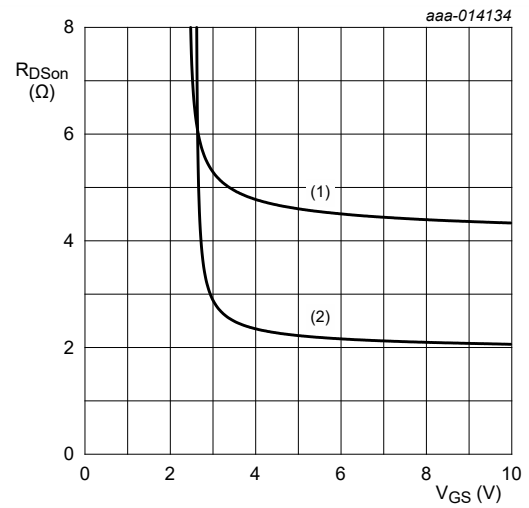
**Fig. 6. Output characteristics: drain current as a function of drain-source voltage; typical values**



**Fig. 7. Sub-threshold drain current as a function of gate-source voltage**  
 (1) minimum values  
 (2) typical values  
 (3) maximum values



**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**  
 (1)  $T_j = 150\text{ °C}$   
 (2)  $T_j = 25\text{ °C}$

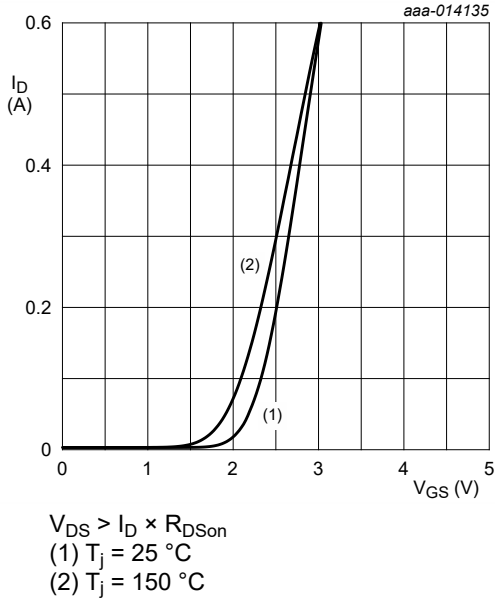


Fig. 10. Transfer characteristics: drain current as a function of gate-source voltage; typical values

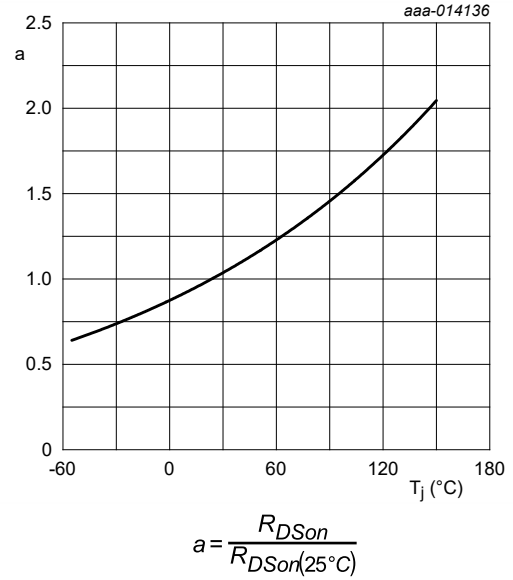


Fig. 11. Normalized drain-source on-state resistance as a function of junction temperature; typical values

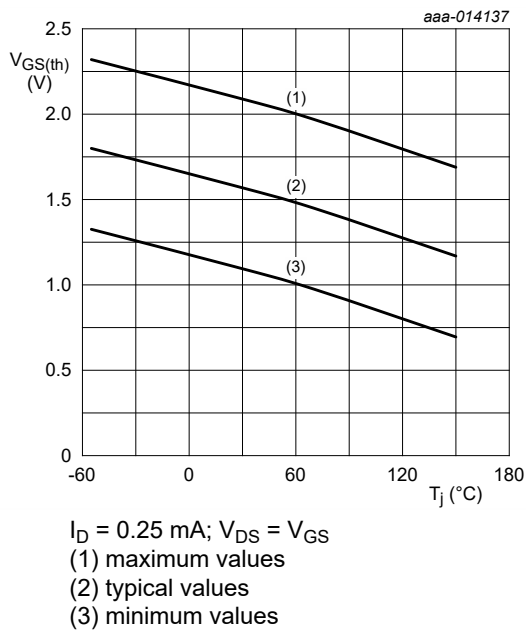


Fig. 12. Gate-source threshold voltage as a function of junction temperature

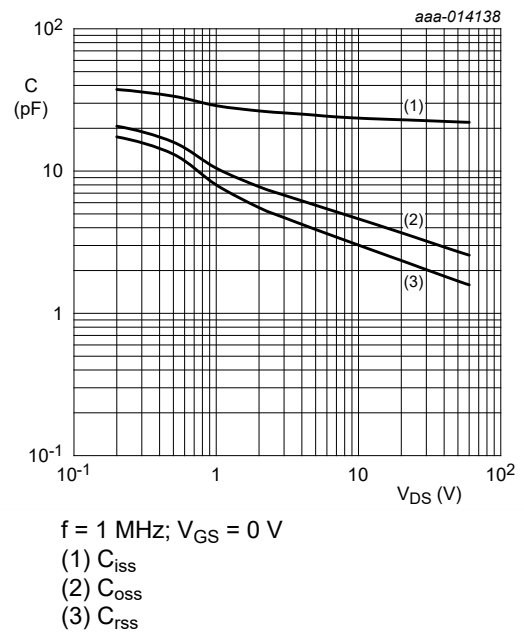
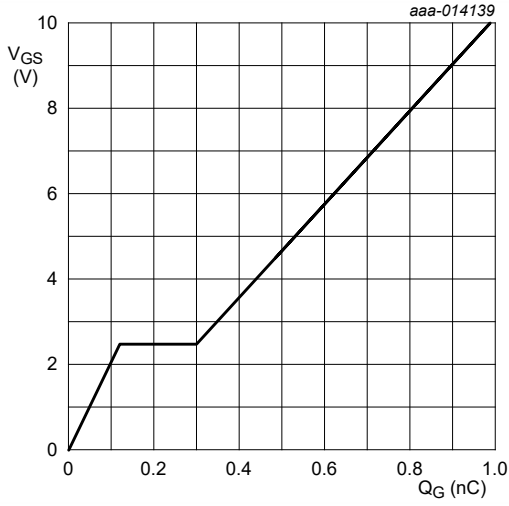


Fig. 13. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values





$I_D = 0.2$  A;  $V_{DS} = 30$  V;  $T_{amb} = 25$  °C

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

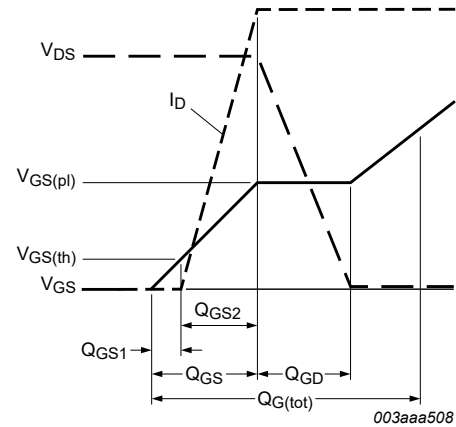
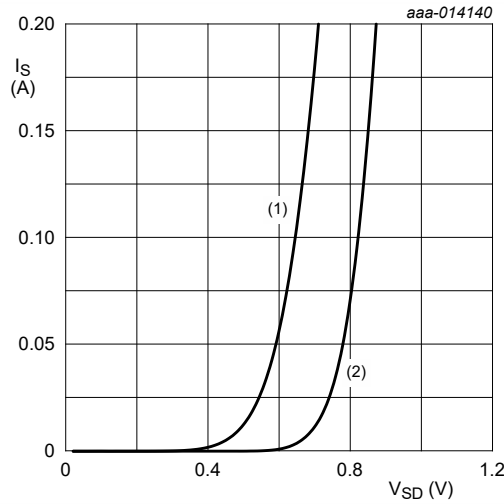


Fig. 15. Gate charge waveform definitions



$V_{GS} = 0$  V  
 (1)  $T_j = 150$  °C  
 (2)  $T_j = 25$  °C

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

### 11. Test information

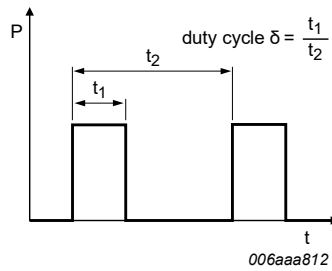


Fig. 17. Duty cycle definition

12. Package outline

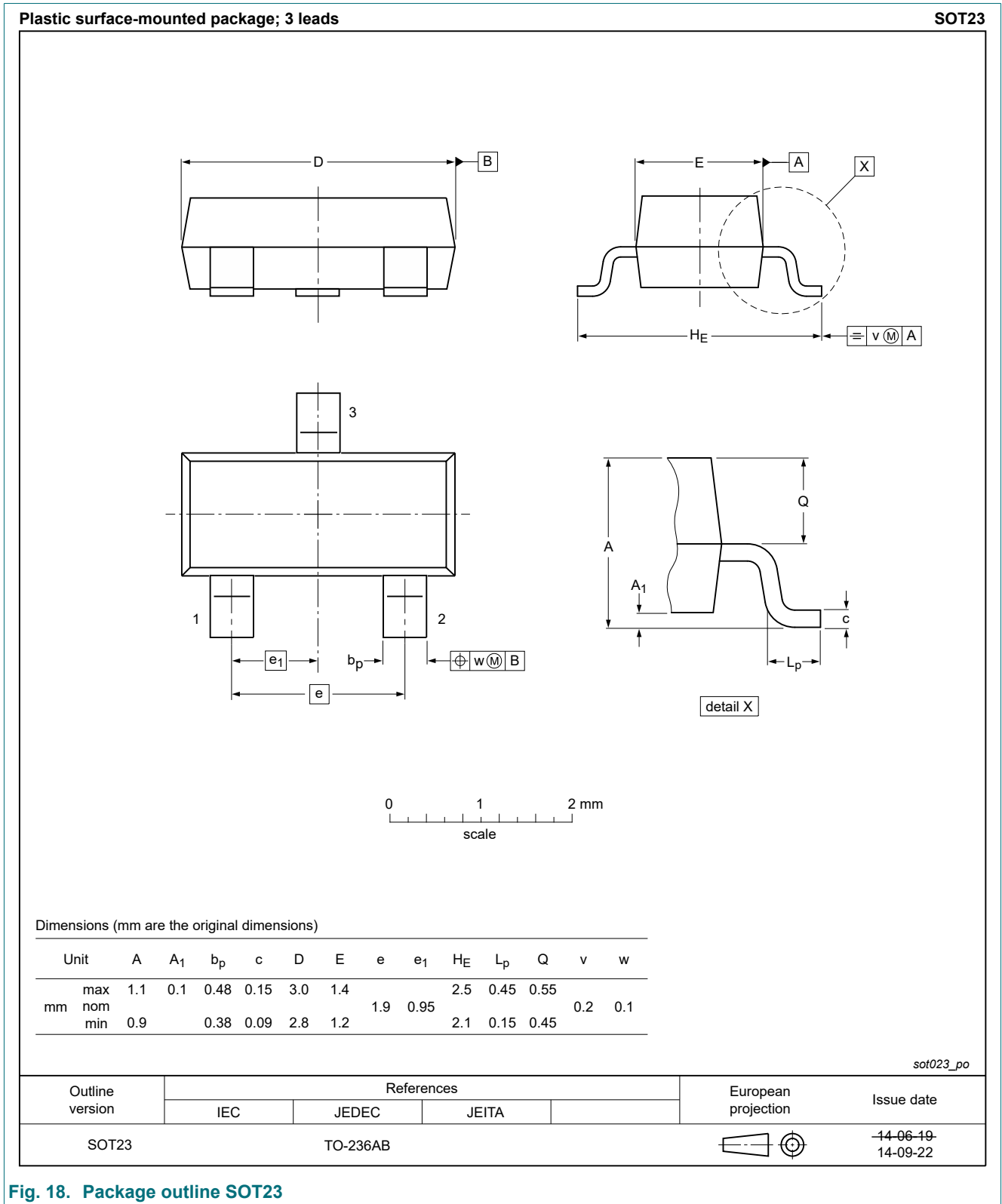


Fig. 18. Package outline SOT23

### 13. Soldering

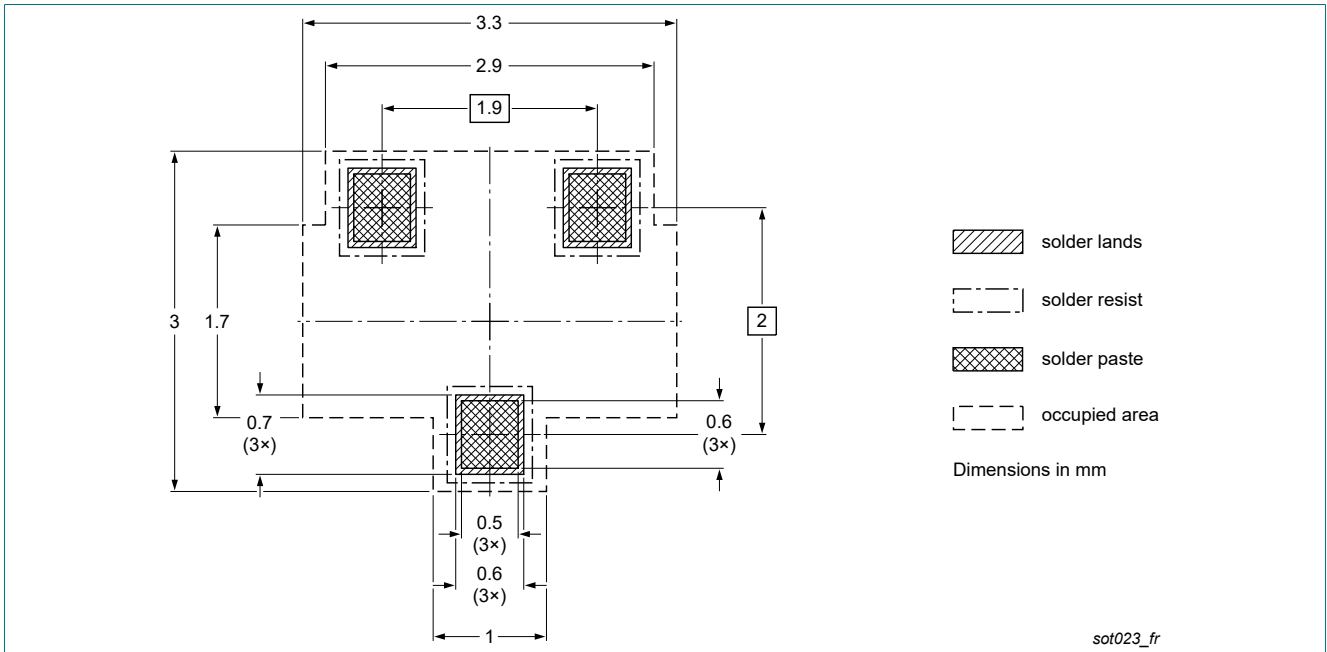


Fig. 19. Reflow soldering footprint for SOT23

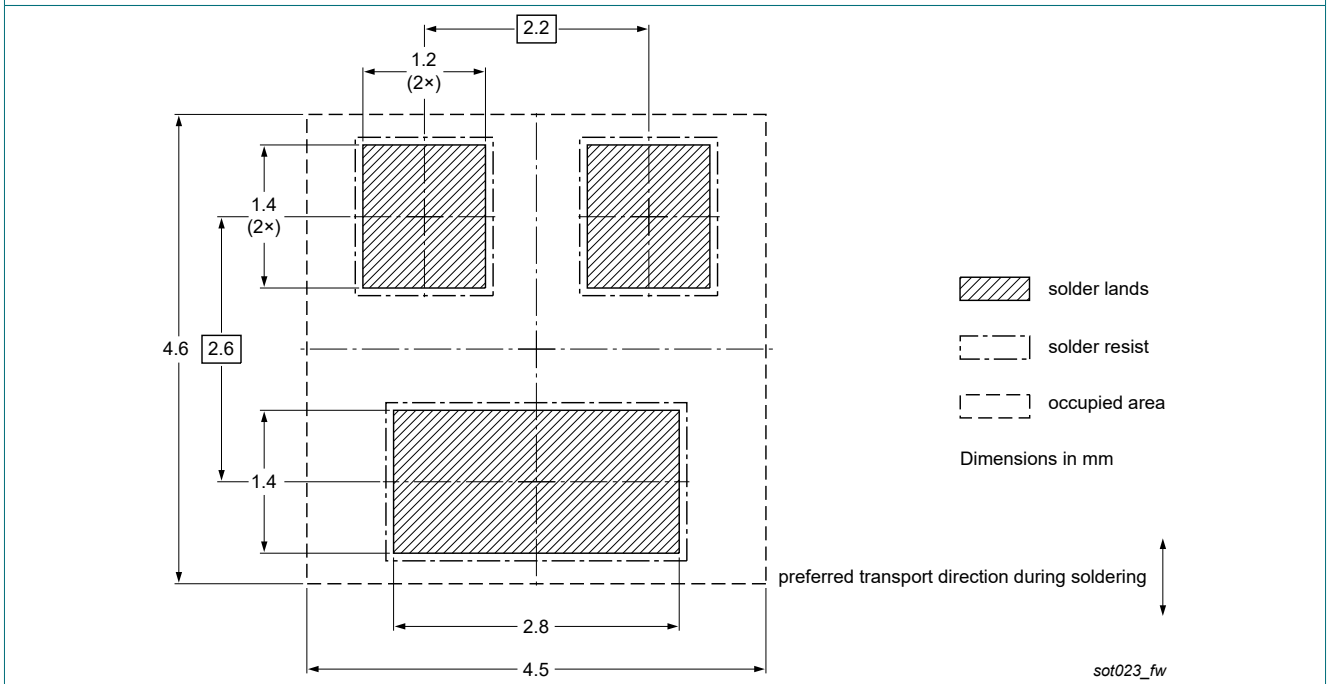


Fig. 20. Wave soldering footprint for SOT23

## 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	• Corrected the package information from SOT89 to SOT23			
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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