



**THE DATASHEET OF  
NX2301P,215**





# NX2301P

20 V, 2 A P-channel Trench MOSFET

Rev. 1 — 26 October 2010

Product data sheet

## 1. Product profile

### 1.1 General description

P-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 and benefits

- 1.8 V  $R_{DSon}$  rated for Low Voltage Gate Drive
- Very fast switching
- Trench MOSFET technology
- AEC-Q101 qualified

### 1.3 Applications

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

### 1.4 Quick reference data

Table 1. Quick reference data

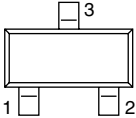
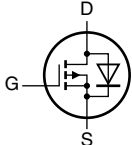
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{DS}$	drain-source voltage	$T_{amb} = 25\text{ °C}$	-	-	-20	V
$V_{GS}$	gate-source voltage	$T_{amb} = 25\text{ °C}$	-	-	$\pm 8$	V
$I_D$	drain current	$T_{amb} = 25\text{ °C};$ $V_{GS} = -4.5\text{ V}$	[1] -	-	-2	A
$R_{DSon}$	drain-source on-state resistance	$T_j = 25\text{ °C};$ $V_{GS} = -4.5\text{ V};$ $I_D = -1\text{ A}$	[2] -	100	120	m $\Omega$

[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 6 cm<sup>2</sup>,  $t \leq 5\text{ s}$ .

[2] Pulse test:  $t_p \leq 300\text{ }\mu\text{s}$ ;  $\delta \leq 0.01$ .

## 2. Pinning information

Table 2. Pinning

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

017aaa094

## 3. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
NX2301P	TO-236AB	plastic surface-mounted package; 3 leads	SOT23

## 4. Marking

Table 4. Marking codes

Type number	Marking code <sup>[1]</sup>
NX2301P	MG*

[1] \* = placeholder for manufacturing site code

## 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	$T_{amb} = 25\text{ °C}$	-	-20	V
$V_{GS}$	gate-source voltage	$T_{amb} = 25\text{ °C}$	-	±8	V
$I_D$	drain current	$V_{GS} = -4.5\text{ V}$	[1]		
		$T_{amb} = 25\text{ °C}$	-	-2	A
		$T_{amb} = 100\text{ °C}$	-	-1.2	A
$I_{DM}$	peak drain current	$T_{amb} = 25\text{ °C}$ ; single pulse; $t_p \leq 10\text{ }\mu\text{s}$	-	-6	A

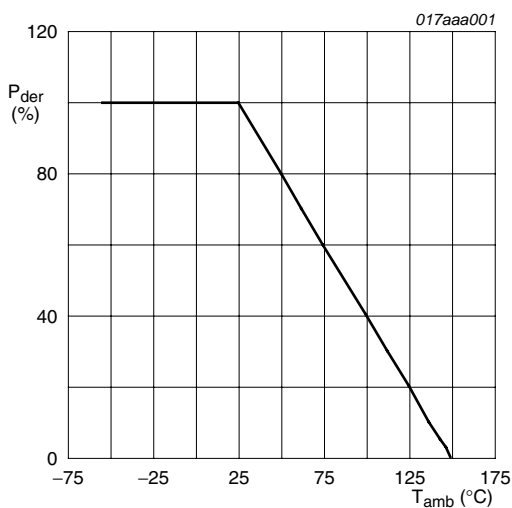
**Table 5. Limiting values ...continued**

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

Symbol	Parameter	Conditions	Min	Max	Unit	
P <sub>tot</sub>	total power dissipation	T <sub>amb</sub> = 25 °C	[2]	-	400	mW
			[1]	-	710	mW
		T <sub>sp</sub> = 25 °C	-	2.8	W	
T <sub>j</sub>	junction temperature			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]	-	-0.7	A

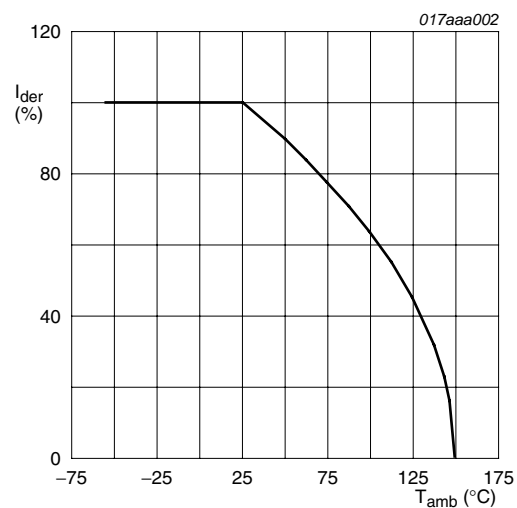
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 6 cm<sup>2</sup>, t ≤ 5 s.

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



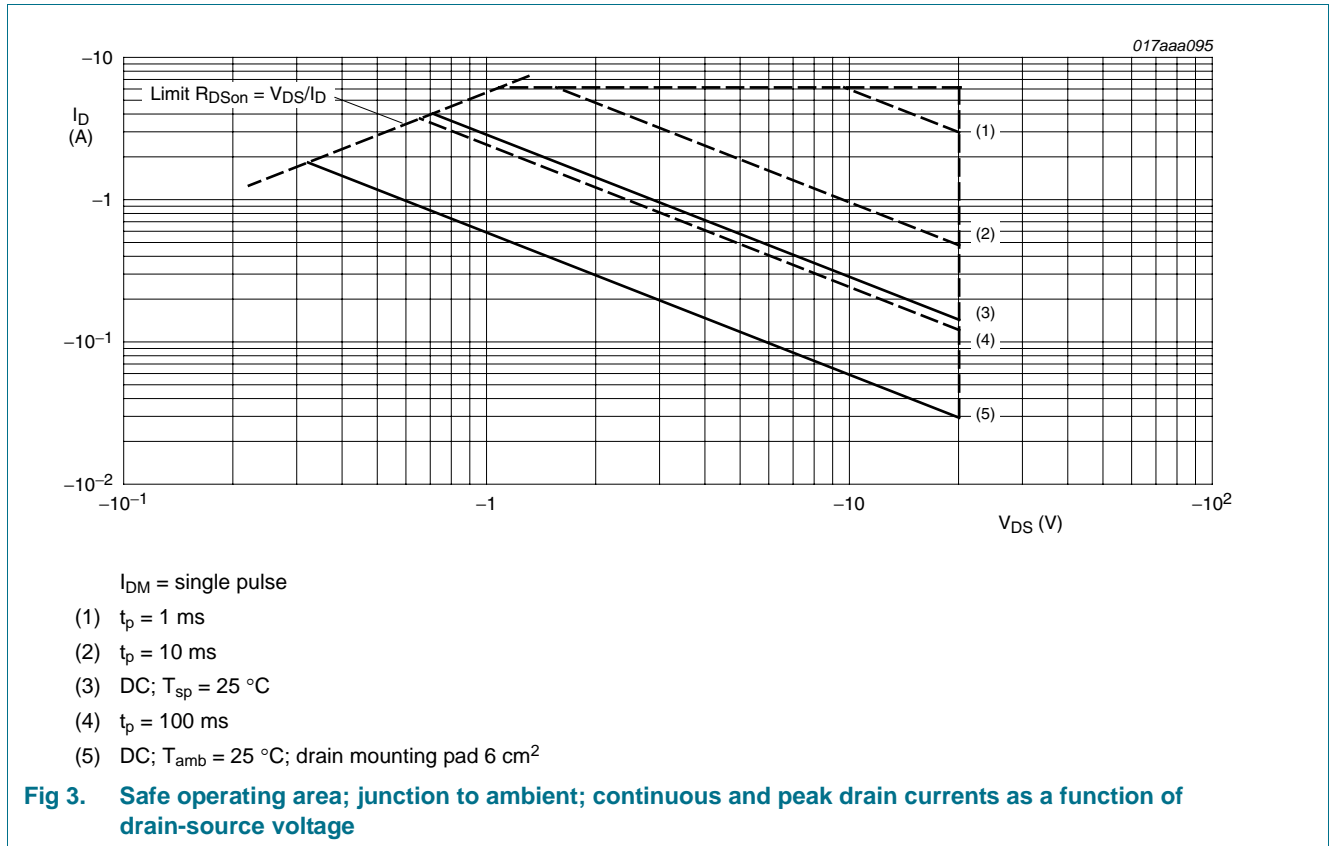
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\%$$

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



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

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



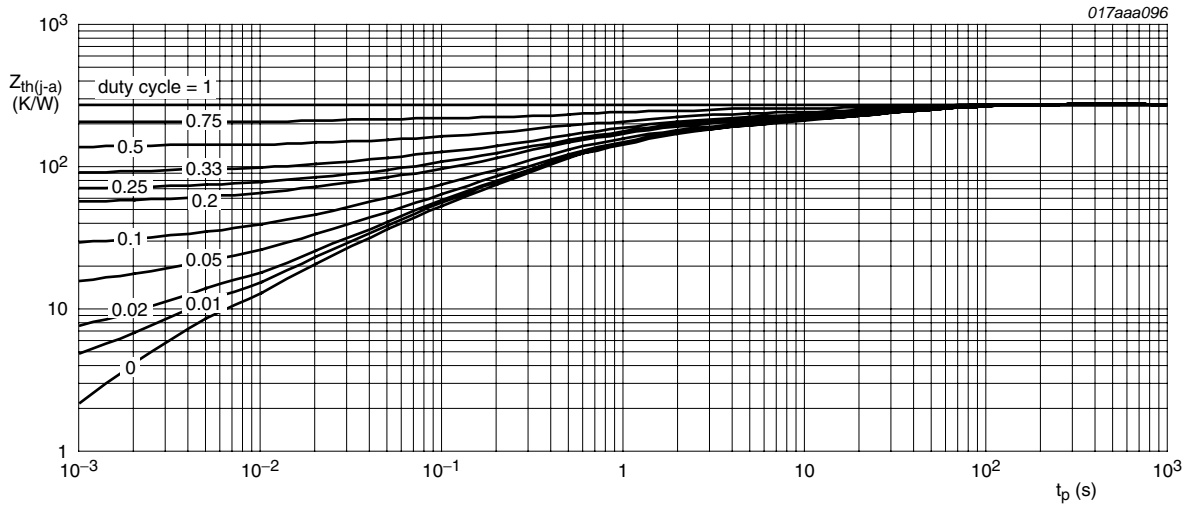
## 6. Thermal characteristics

**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]	-	315	K/W
			[2]	-	175	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point		-	-	45	K/W

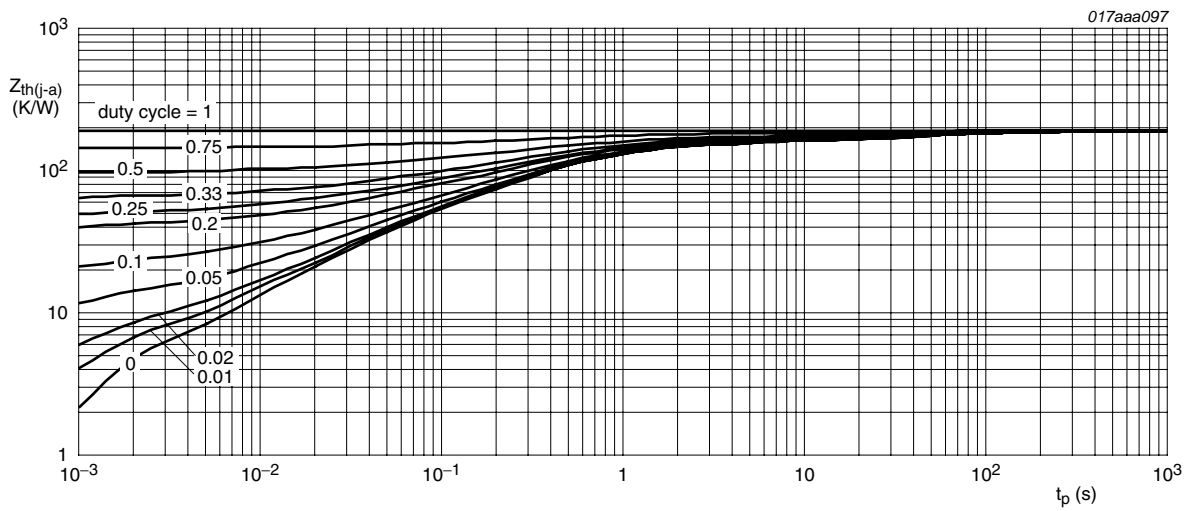
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.

[2] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain  $6$  cm<sup>2</sup>,  $t \leq 5$  s.



FR4 PCB, standard footprint

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



FR4 PCB, mounting pad for drain 6 cm<sup>2</sup>

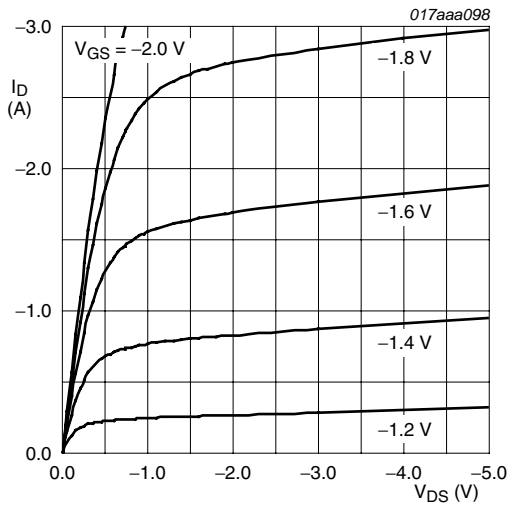
Fig 5. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

## 7. Characteristics

**Table 7. Characteristics**
 $T_j = 25\text{ °C}$  unless otherwise specified.

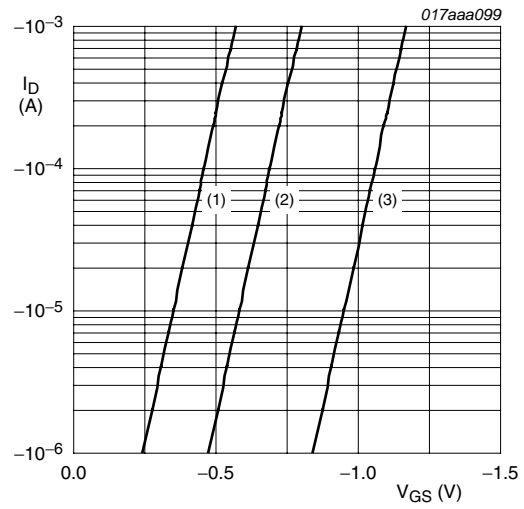
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics</b>						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = -250\ \mu\text{A}$ ; $V_{GS} = 0\ \text{V}$	-20	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = -250\ \mu\text{A}$ ; $V_{DS} = V_{GS}$	-0.5	-0.75	-1.1	V
$I_{DSS}$	drain leakage current	$V_{DS} = -20\ \text{V}$ ; $V_{GS} = 0\ \text{V}$	-	-	-1	$\mu\text{A}$
$I_{GSS}$	gate leakage current	$V_{GS} = \pm 8\ \text{V}$ ; $V_{DS} = 0\ \text{V}$	-	-	$\pm 100$	nA
$R_{DS(on)}$	drain-source on-state resistance		[1]			
		$V_{GS} = -4.5\ \text{V}$ ; $I_D = -1\ \text{A}$				
		$T_j = 25\text{ °C}$		100	120	m $\Omega$
		$T_j = 150\text{ °C}$		-	180	m $\Omega$
		$V_{GS} = -2.5\ \text{V}$ ; $I_D = -1\ \text{A}$	-	155	190	m $\Omega$
	$V_{GS} = -1.8\ \text{V}$ ; $I_D = -0.2\ \text{A}$	-	210	270	m $\Omega$	
$g_{fs}$	forward transconductance	$V_{DS} = -5\ \text{V}$ ; $I_D = -2\ \text{A}$	[1]	4.7	-	S
<b>Dynamic characteristics</b>						
$Q_{G(tot)}$	total gate charge	$I_D = -2.2\ \text{A}$ ; $V_{DS} = -6\ \text{V}$ ; $V_{GS} = -4.5\ \text{V}$	-	4.5	6	nC
$Q_{GS}$	gate-source charge		-	1.1	-	nC
$Q_{GD}$	gate-drain charge		-	0.9	-	nC
$C_{iss}$	input capacitance	$V_{GS} = 0\ \text{V}$ ; $V_{DS} = -6\ \text{V}$ ; $f = 1\ \text{MHz}$	-	380	-	pF
$C_{oss}$	output capacitance		-	135	-	pF
$C_{rss}$	reverse transfer capacitance		-	115	-	pF
$t_{d(on)}$	turn-on delay time	$V_{DD} = -6\ \text{V}$ ; $R_L = 6\ \Omega$ ;	-	7	-	ns
$t_r$	rise time	$V_{GS} = -4.5\ \text{V}$ ;	-	15	-	ns
$t_{d(off)}$	turn-off delay time	$R_G = 6\ \Omega$	-	50	-	ns
$t_f$	fall time		-	25	-	ns
<b>Source-drain diode</b>						
$V_{SD}$	source-drain voltage	$I_S = -1\ \text{A}$ ; $V_{GS} = 0\ \text{V}$	[1]	-0.8	-1.0	V

[1] Pulse test:  $t_p \leq 300\ \mu\text{s}$ ;  $\delta \leq 0.01$ .



$T_{amb} = 25\text{ }^\circ\text{C}$

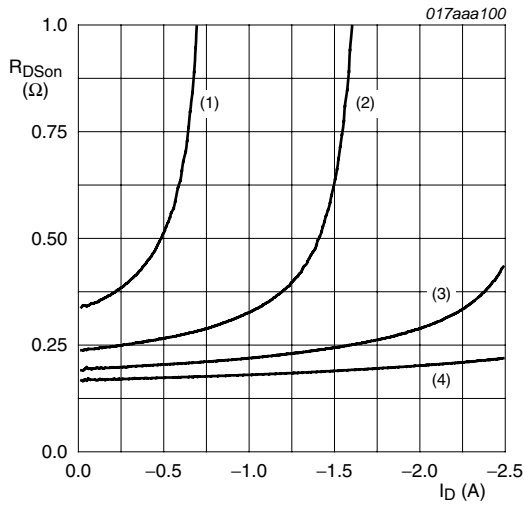
**Fig 6. Output characteristics: drain current as a function of drain-source voltage; typical values**



$T_{amb} = 25\text{ }^\circ\text{C}; V_{DS} = -10\text{ V}$

- (1) minimum values
- (2) typical values
- (3) maximum values

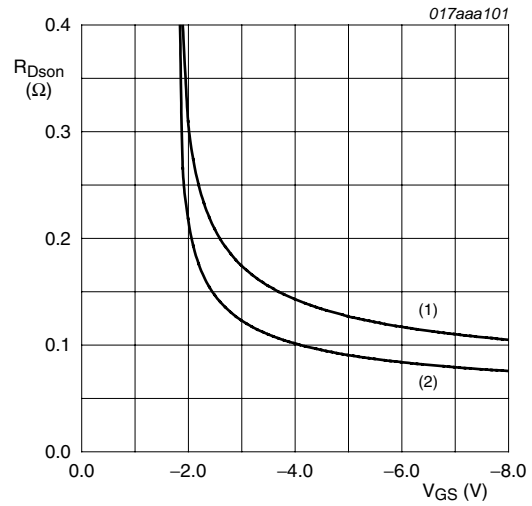
**Fig 7. Sub-threshold drain current as a function of gate-source voltage**



$T_{amb} = 25\text{ }^\circ\text{C}$

- (1)  $V_{GS} = -1.4\text{ V}$
- (2)  $V_{GS} = -1.6\text{ V}$
- (3)  $V_{GS} = -1.8\text{ V}$
- (4)  $V_{GS} = -2.0\text{ V}$

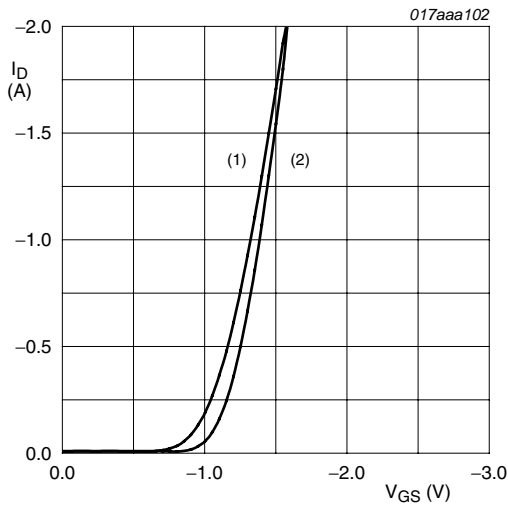
**Fig 8. Drain-source on-state resistance as a function of drain current; typical values**



$I_D = -2\text{ A}$

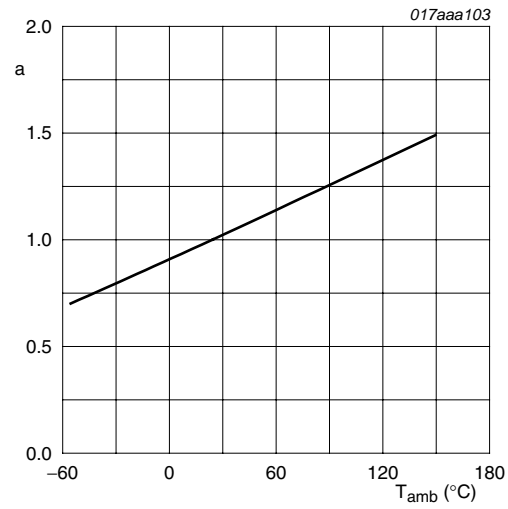
- (1)  $T_{amb} = 125\text{ }^\circ\text{C}$
- (2)  $T_{amb} = 25\text{ }^\circ\text{C}$

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



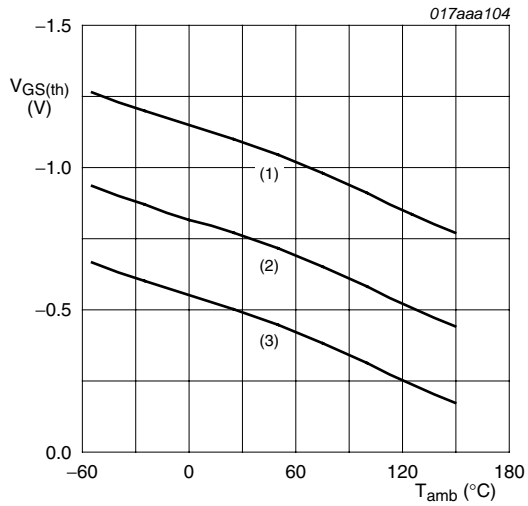
$V_{DS} > I_D \times R_{DSon}$   
 (1)  $T_{amb} = 150\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$

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



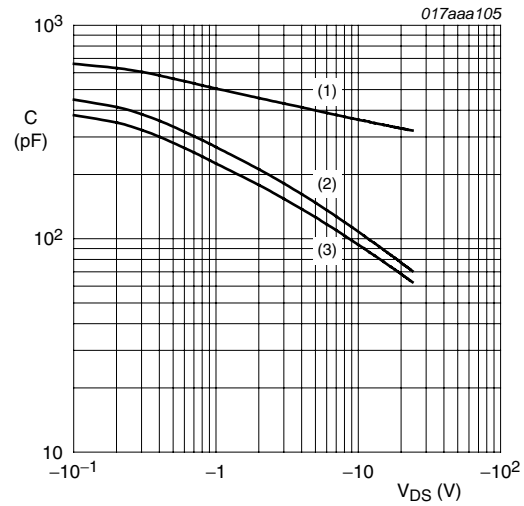
$$a = \frac{R_{DSon}}{R_{DSon(25^\circ C)}}$$

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



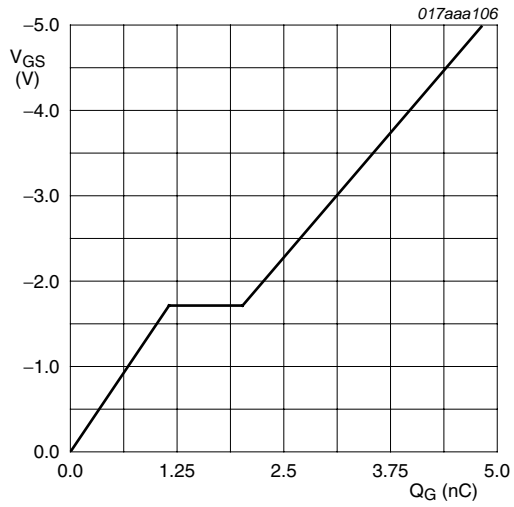
$I_D = -0.25\text{ mA}; V_{DS} = V_{GS}$   
 (1) maximum values  
 (2) typical values  
 (3) minimum values

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



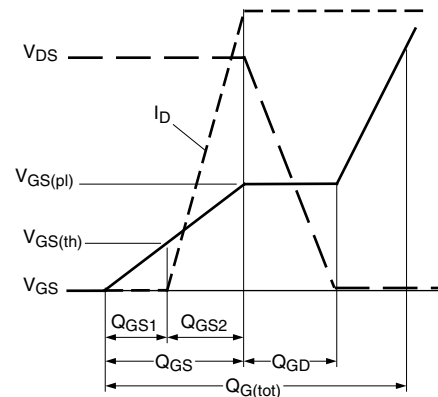
$f = 1\text{ MHz}; V_{GS} = 0\text{ V}$   
 (1)  $C_{iss}$   
 (2)  $C_{oss}$   
 (3)  $C_{rss}$

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

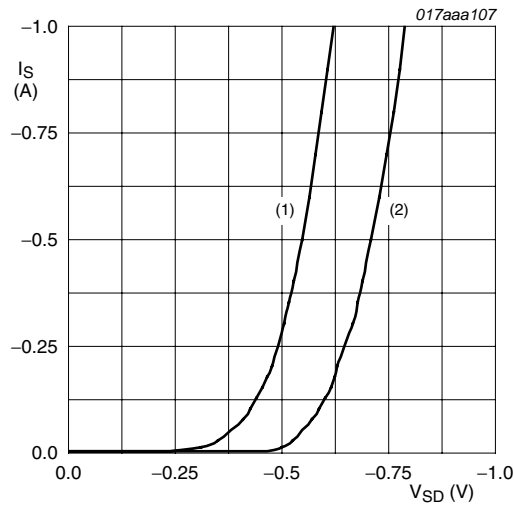


$I_D = -2 \text{ A}$ ;  $V_{DS} = -6 \text{ V}$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$

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



**Fig 15. Gate charge waveform definitions**

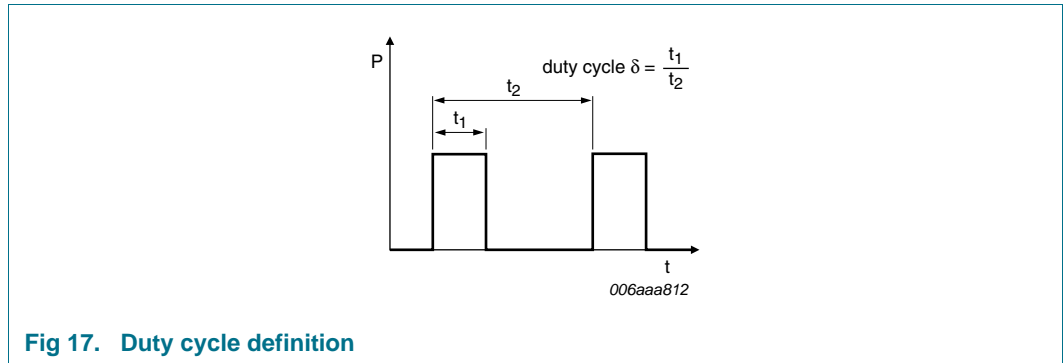


$V_{GS} = 0 \text{ V}$

- (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



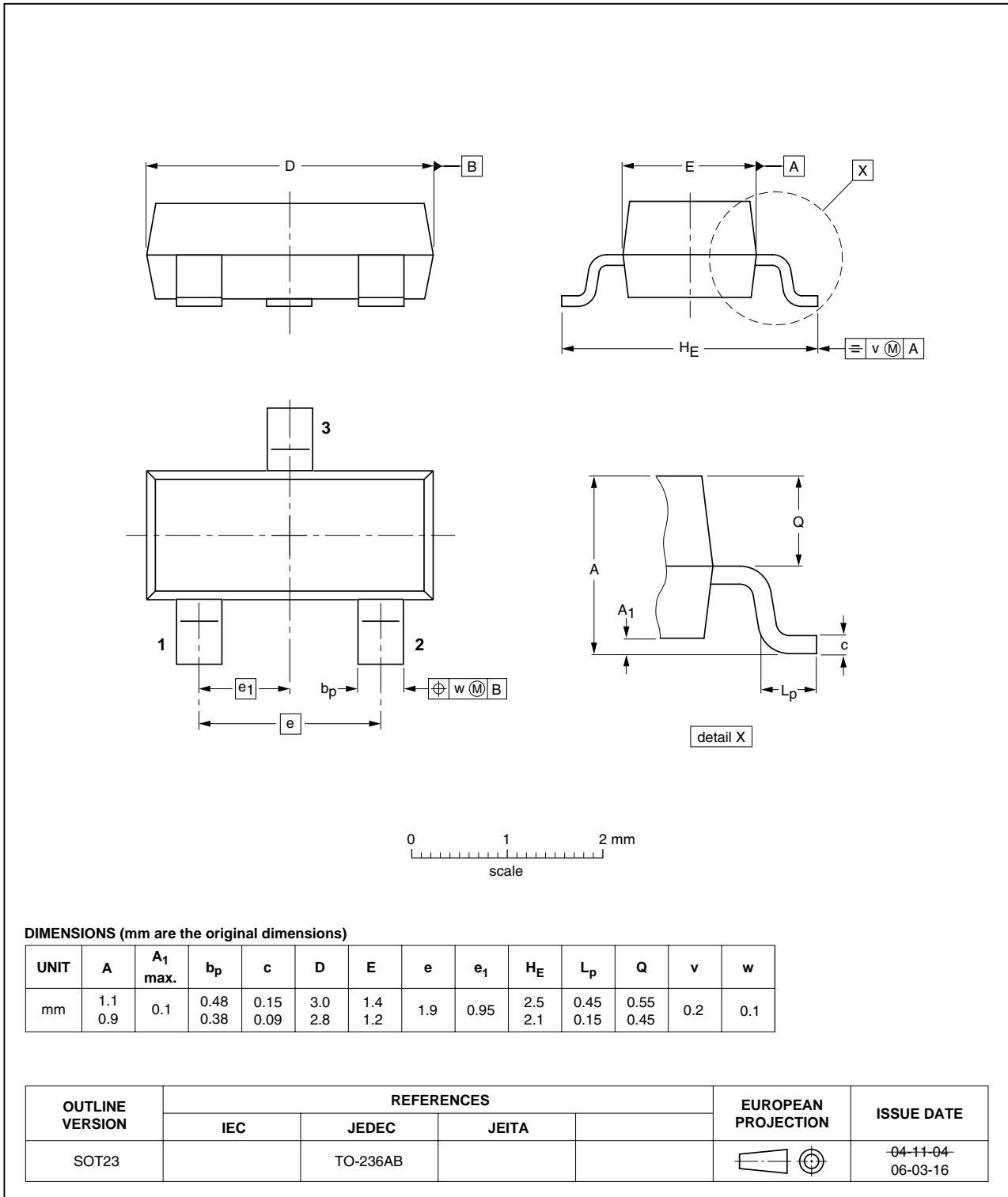
### 8.1 Quality information

This product has been qualified in accordance with the Automotive Electronics Council (AEC) standard Q101 - *Stress test qualification for discrete semiconductors*, and is suitable for use in automotive applications.

**9. Package outline**

Plastic surface-mounted package; 3 leads

SOT23



**Fig 18. Package outline SOT23 (TO-236AB)**

10. Soldering

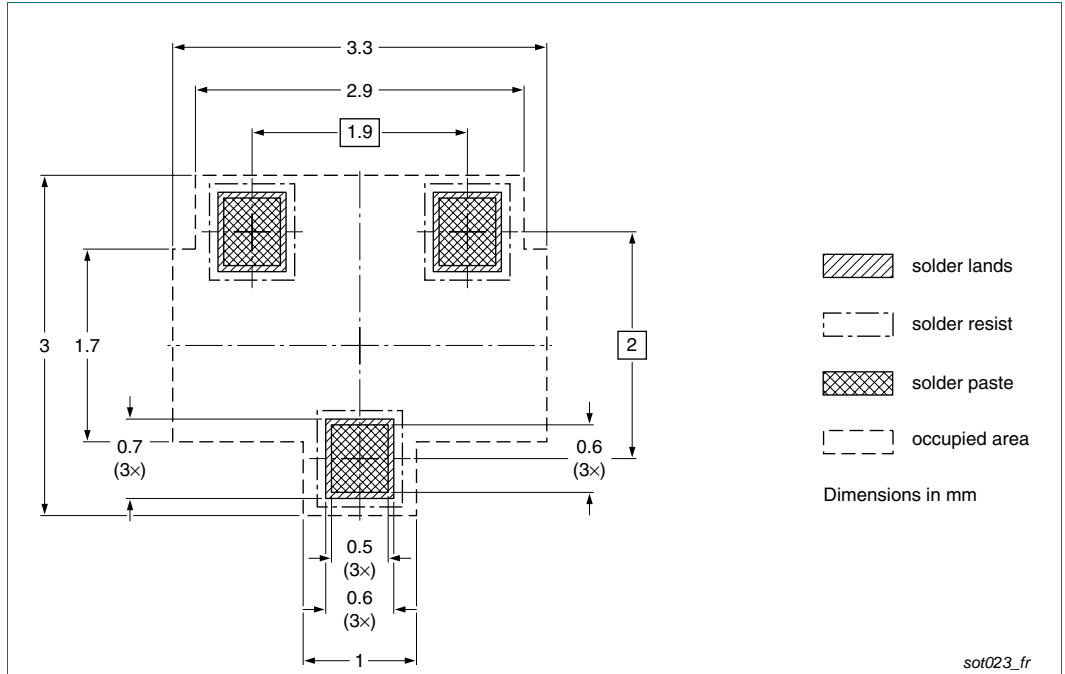


Fig 19. Reflow soldering footprint SOT23 (TO-236AB)

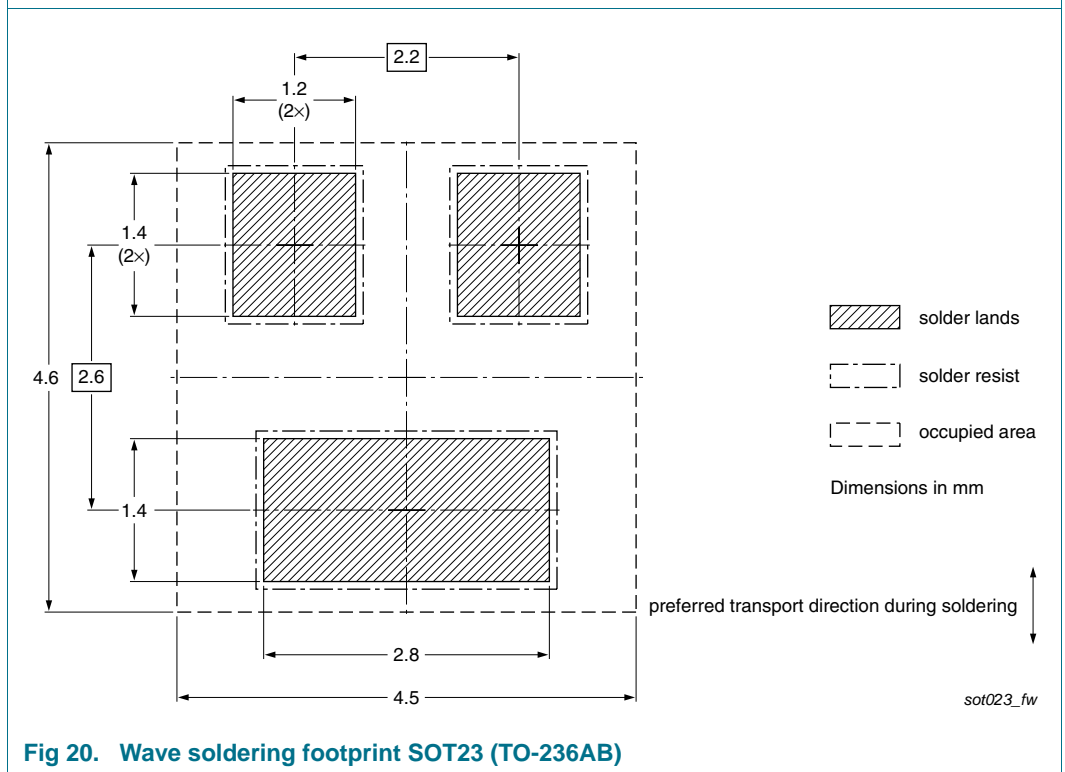


Fig 20. Wave soldering footprint SOT23 (TO-236AB)

## 11. Revision history

Table 8. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
NX2301P v.1	20101026	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.

[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

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<b>1</b>	<b>Product profile</b> . . . . .	<b>1</b>
1.1	General description . . . . .	1
1.2	Features and benefits . . . . .	1
1.3	Applications . . . . .	1
1.4	Quick reference data . . . . .	1
<b>2</b>	<b>Pinning information</b> . . . . .	<b>2</b>
<b>3</b>	<b>Ordering information</b> . . . . .	<b>2</b>
<b>4</b>	<b>Marking</b> . . . . .	<b>2</b>
<b>5</b>	<b>Limiting values</b> . . . . .	<b>2</b>
<b>6</b>	<b>Thermal characteristics</b> . . . . .	<b>4</b>
<b>7</b>	<b>Characteristics</b> . . . . .	<b>6</b>
<b>8</b>	<b>Test information</b> . . . . .	<b>10</b>
8.1	Quality information . . . . .	10
<b>9</b>	<b>Package outline</b> . . . . .	<b>11</b>
<b>10</b>	<b>Soldering</b> . . . . .	<b>12</b>
<b>11</b>	<b>Revision history</b> . . . . .	<b>13</b>
<b>12</b>	<b>Legal information</b> . . . . .	<b>14</b>
12.1	Data sheet status . . . . .	14
12.2	Definitions . . . . .	14
12.3	Disclaimers . . . . .	14
12.4	Trademarks . . . . .	15
<b>13</b>	<b>Contact information</b> . . . . .	<b>15</b>
<b>14</b>	<b>Contents</b> . . . . .	<b>16</b>

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