

# 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 $\Omega$

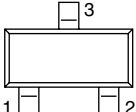
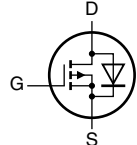
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 6 cm<sup>2</sup>,  $t \leq 5\text{ s}$ .

[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

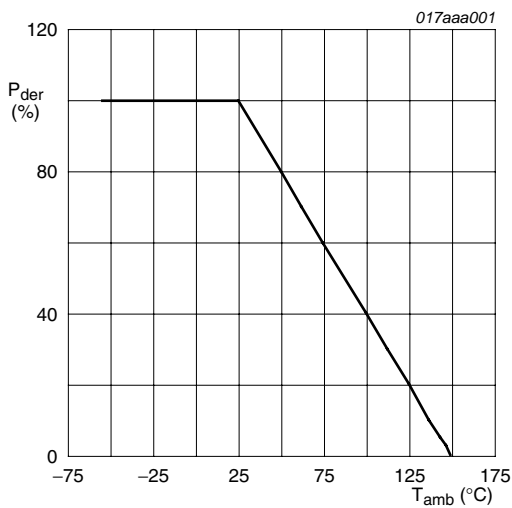
**Table 5. Limiting values ...continued**

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

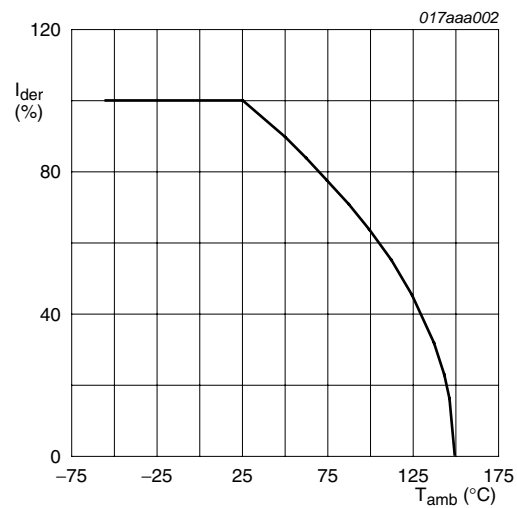
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 6 cm<sup>2</sup>, t ≤ 5 s.

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



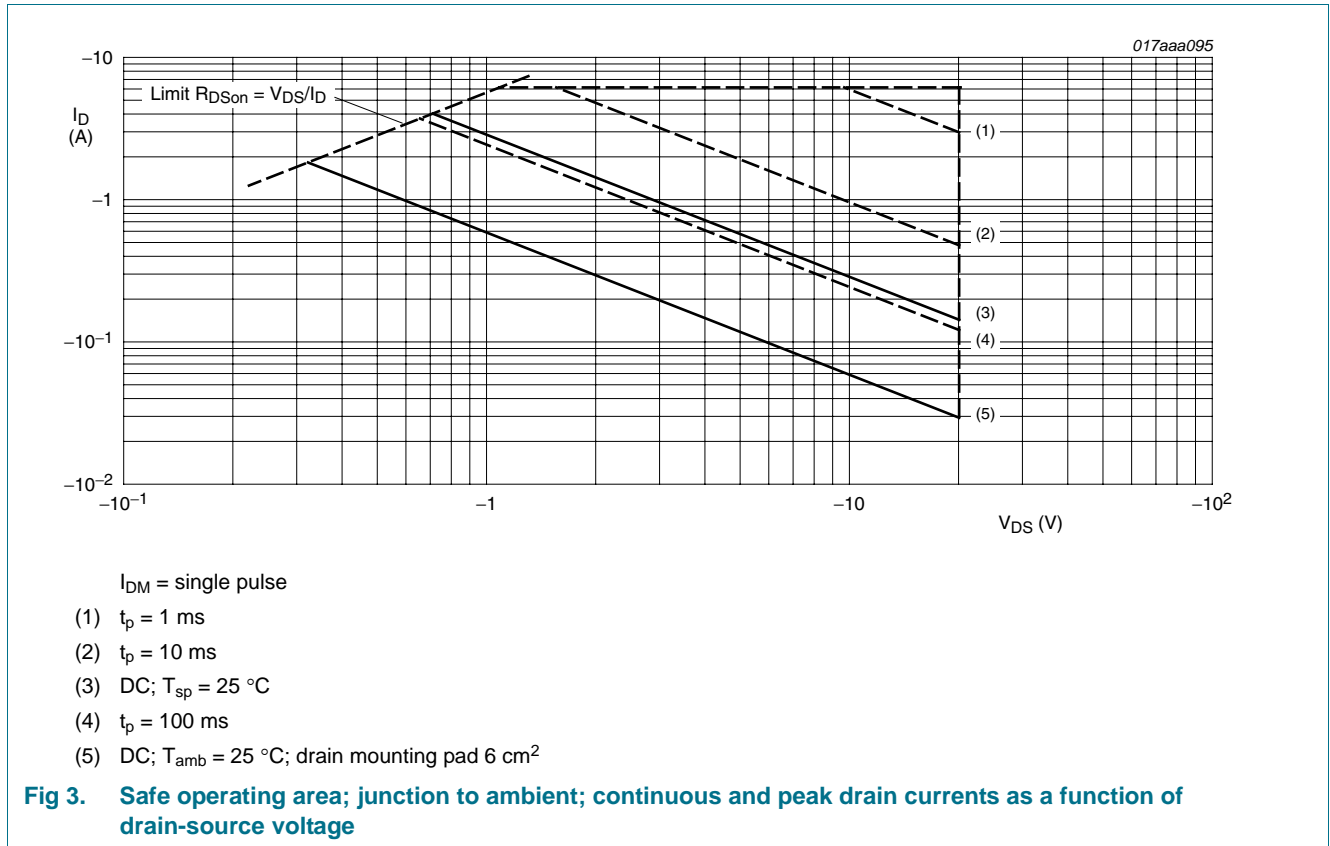
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\%$$

**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**



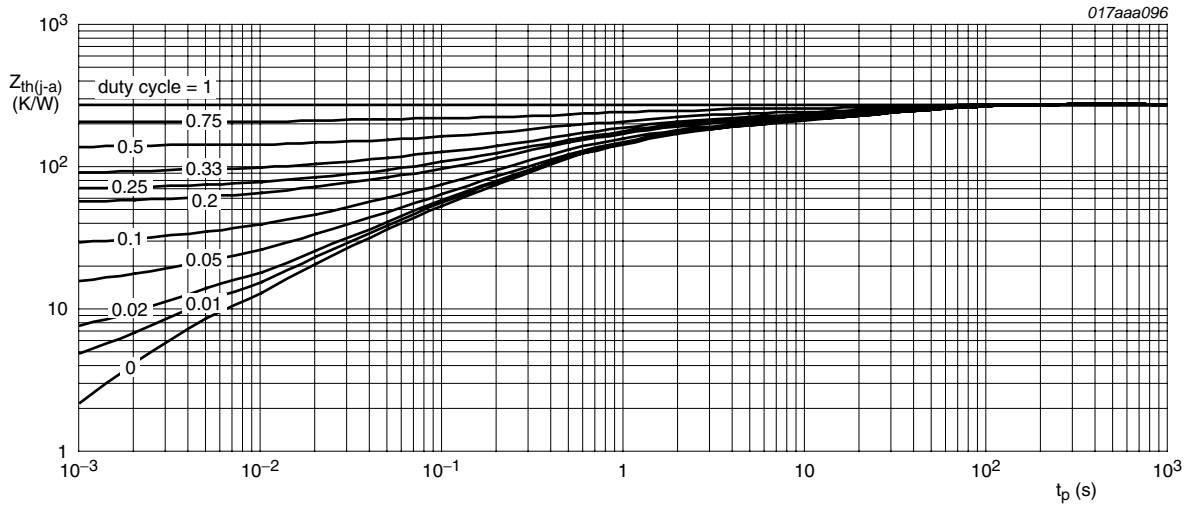
## 6. Thermal characteristics

**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

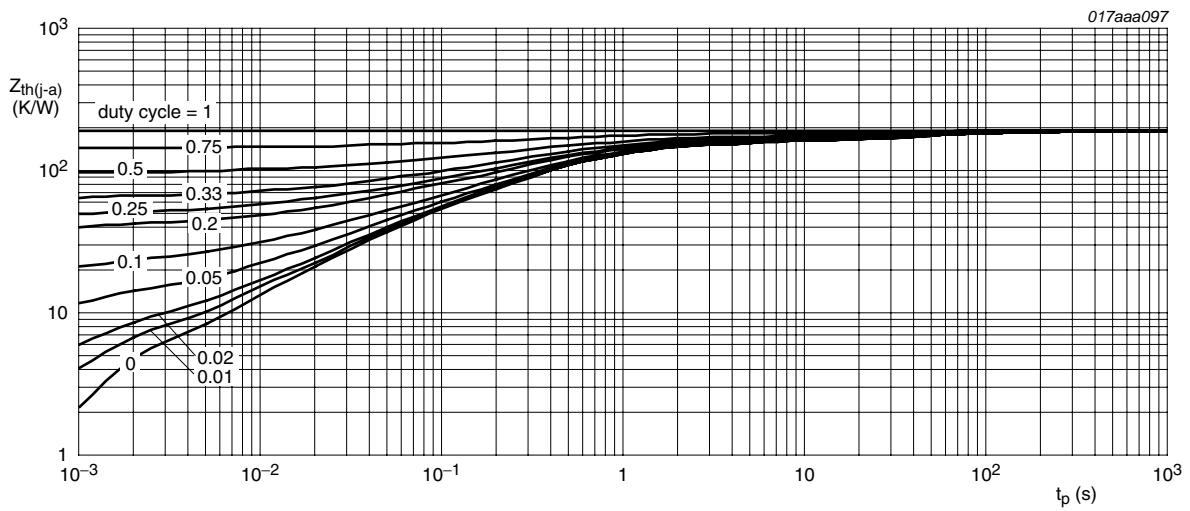
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.

[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>

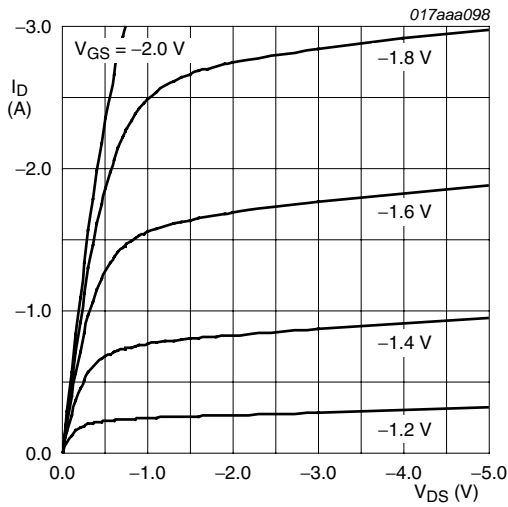
Fig 5. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

## 7. Characteristics

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

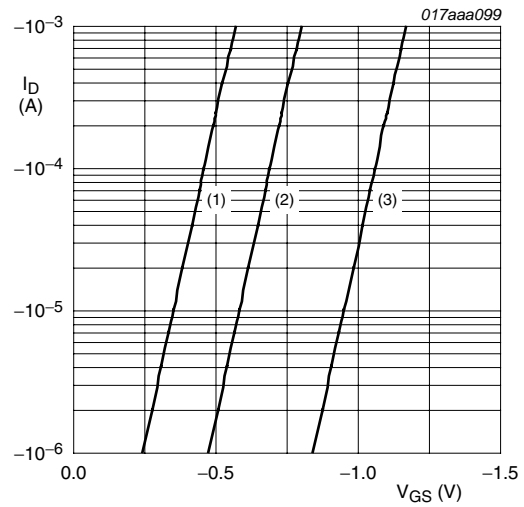
Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
<b>Static characteristics</b>							
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = -250\text{ }\mu\text{A}$ ; $V_{GS} = 0\text{ V}$	-20	-	-	V	
$V_{GS(th)}$	gate-source threshold voltage	$I_D = -250\text{ }\mu\text{A}$ ; $V_{DS} = V_{GS}$	-0.5	-0.75	-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]				
		$V_{GS} = -4.5\text{ V}$ ; $I_D = -1\text{ A}$					
		$T_j = 25\text{ }^\circ\text{C}$		100	120	m $\Omega$	
		$T_j = 150\text{ }^\circ\text{C}$		-	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	$V_{DD} = -6\text{ V}$ ; $R_L = 6\text{ }\Omega$ ;	-	7	-	ns	
$t_r$	rise time	$V_{GS} = -4.5\text{ V}$ ;	-	15	-	ns	
$t_{d(off)}$	turn-off delay time	$R_G = 6\text{ }\Omega$	-	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:  $t_p \leq 300\text{ }\mu\text{s}$ ;  $\delta \leq 0.01$ .



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

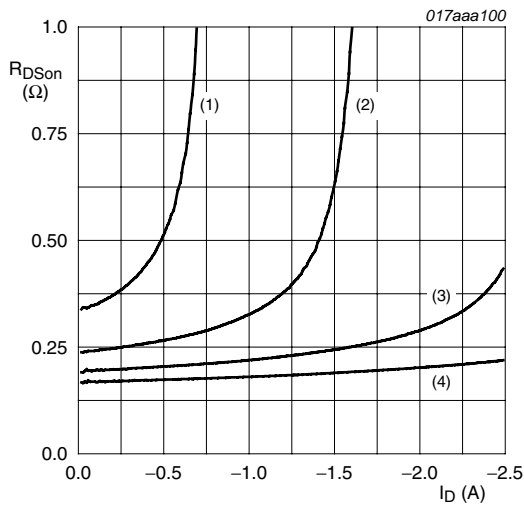
**Fig 6. Output characteristics: drain current as a function of drain-source voltage; typical values**



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

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

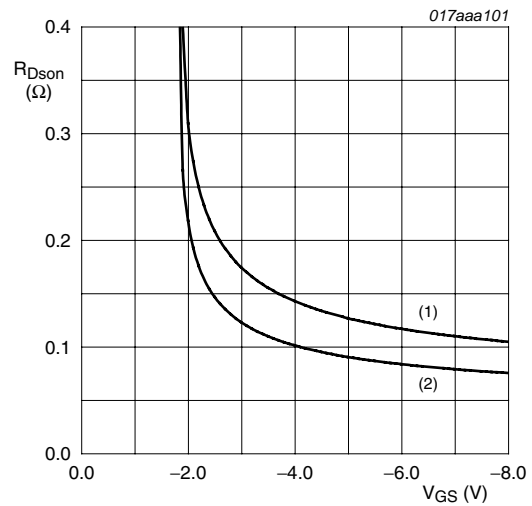
**Fig 7. Sub-threshold drain current as a function of gate-source voltage**



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

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

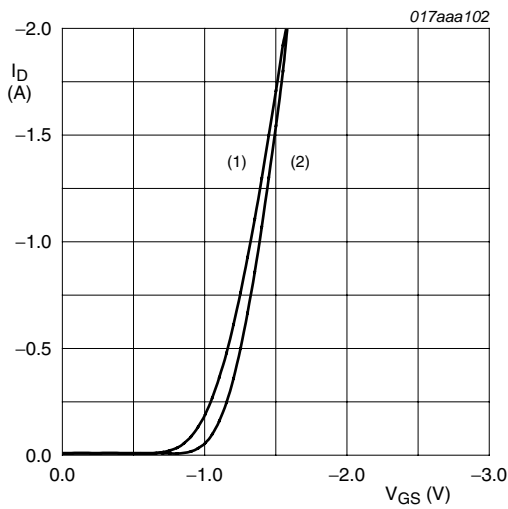
**Fig 8. Drain-source on-state resistance as a function of drain current; typical values**



$I_D = -2\text{ A}$

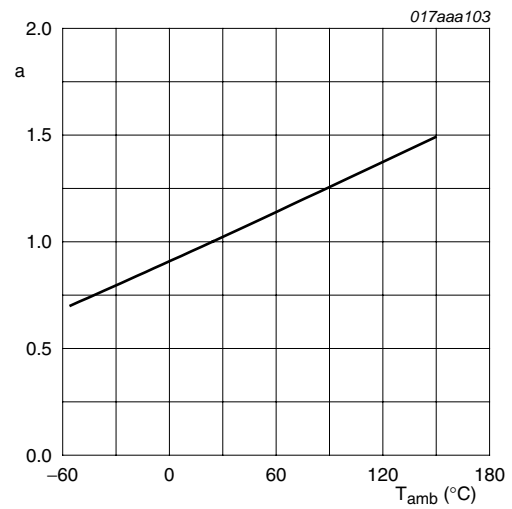
- (1)  $T_{amb} = 125\text{ }^{\circ}\text{C}$
- (2)  $T_{amb} = 25\text{ }^{\circ}\text{C}$

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



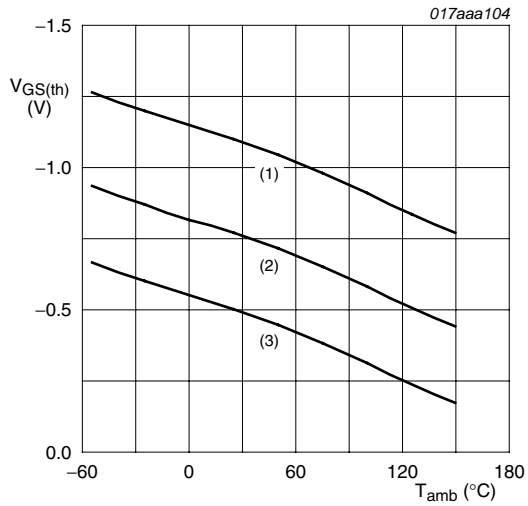
$V_{DS} > I_D \times R_{DSon}$   
 (1)  $T_{amb} = 150\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$

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



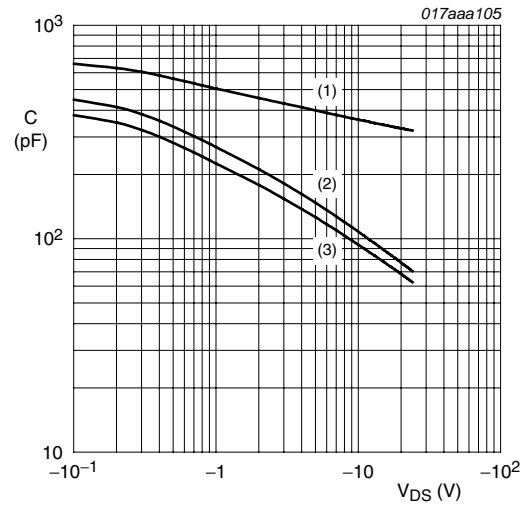
$$a = \frac{R_{DSon}}{R_{DSon(25^\circ C)}}$$

**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

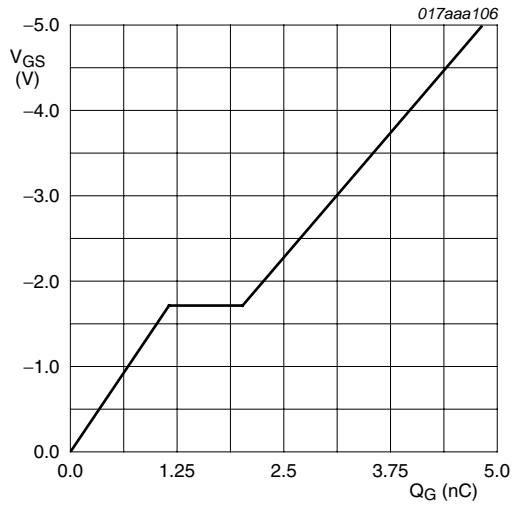
**Fig 12. Gate-source threshold voltage as a function of ambient temperature**



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

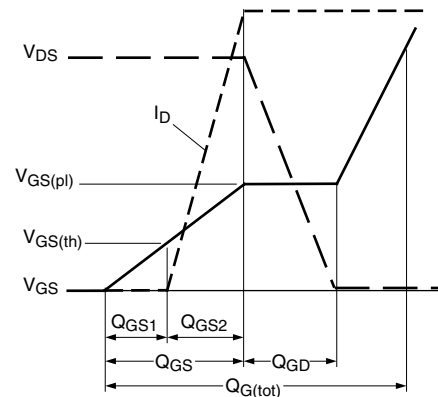
**Fig 13. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values**



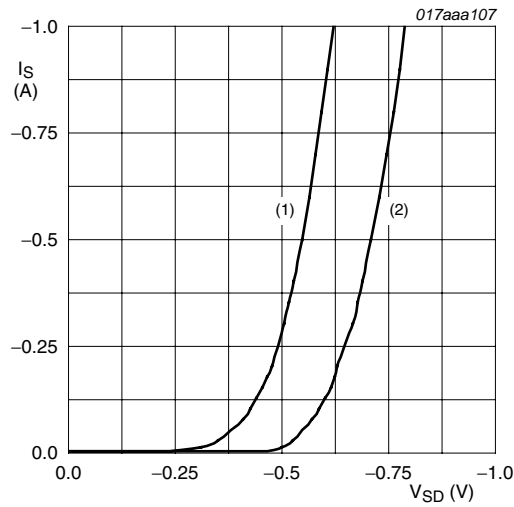


$I_D = -2 \text{ A}; V_{DS} = -6 \text{ V}; T_{amb} = 25 \text{ }^\circ\text{C}$

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



**Fig 15. Gate charge waveform definitions**

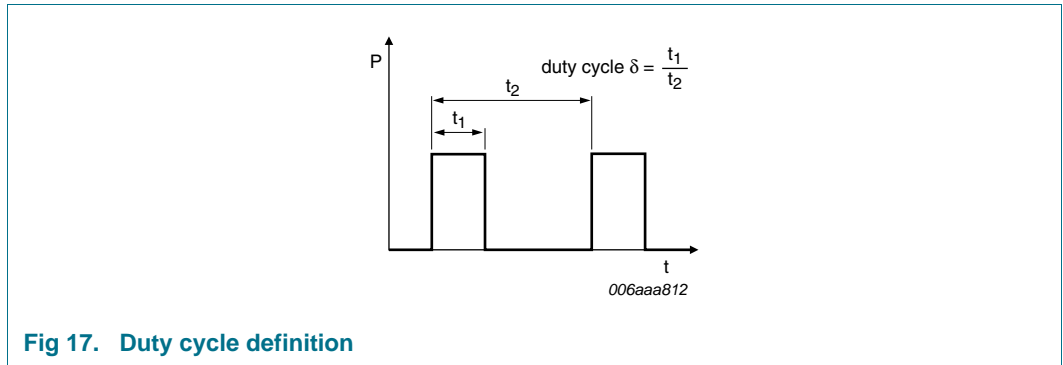


$V_{GS} = 0 \text{ V}$

- (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

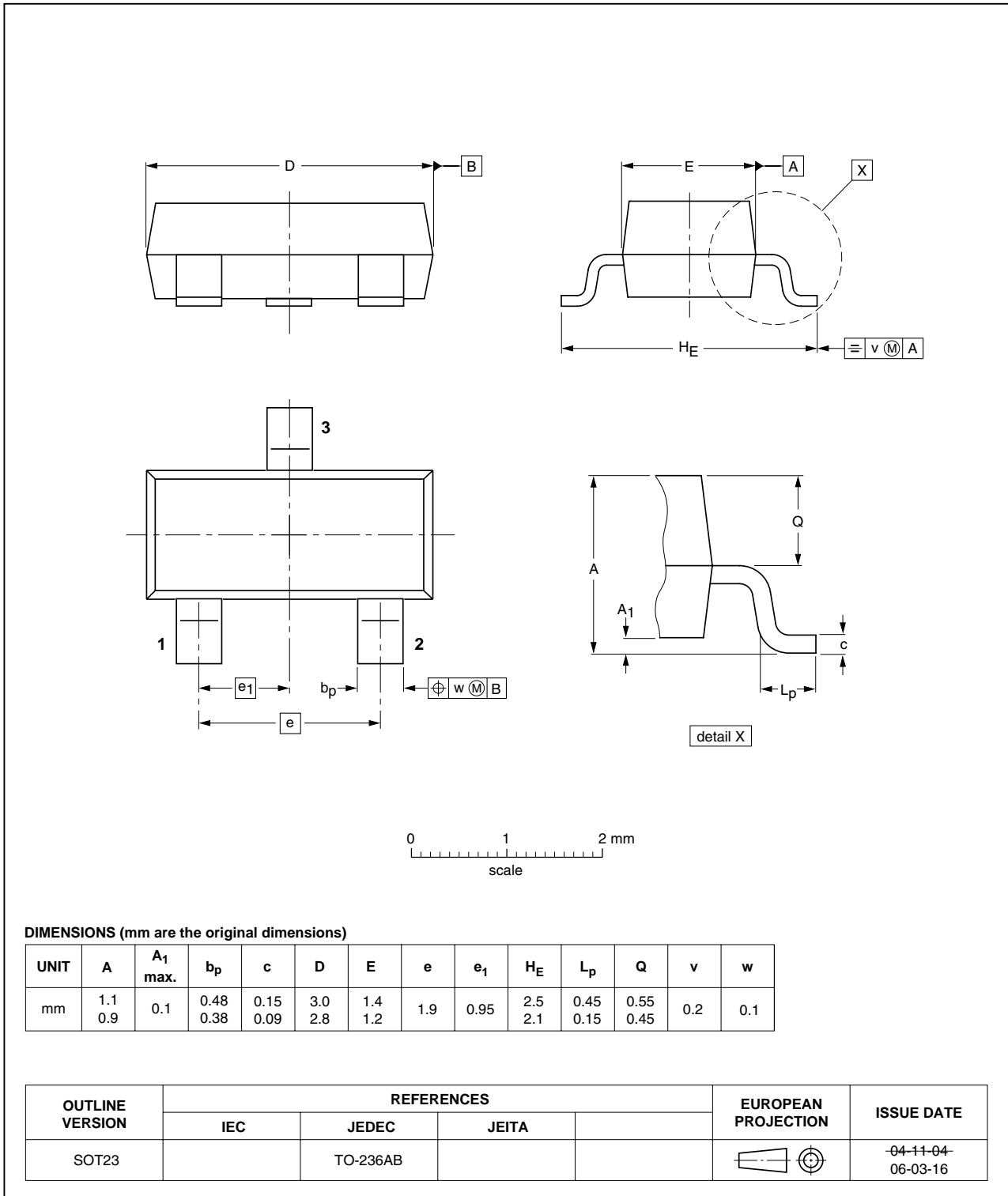
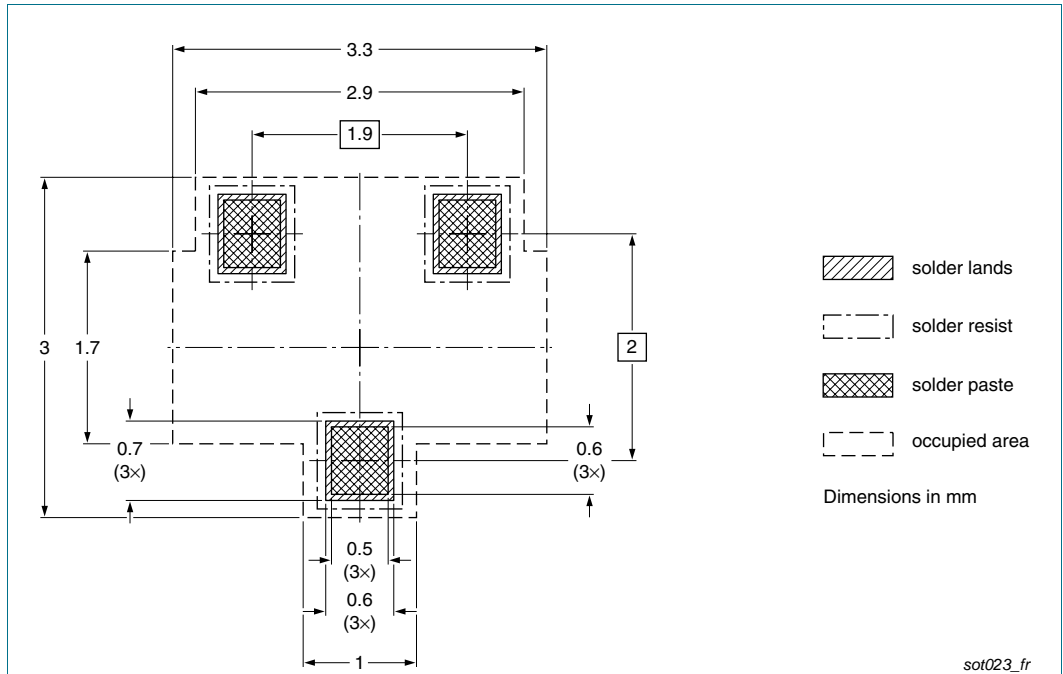
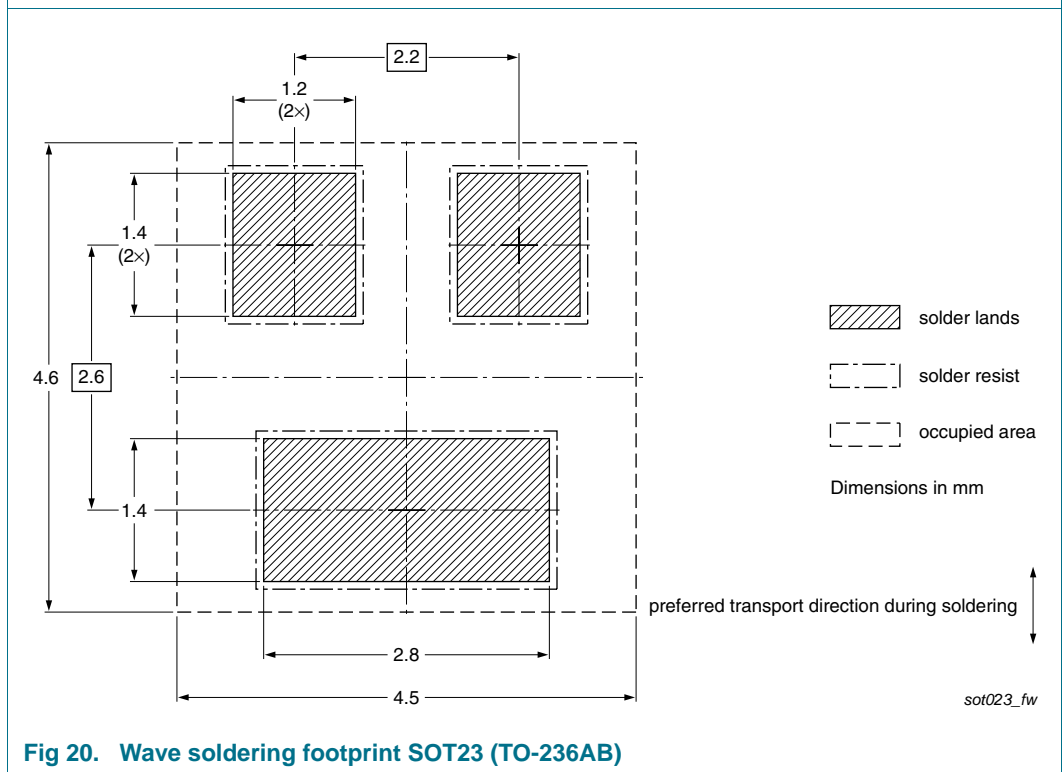


Fig 18. Package outline SOT23 (TO-236AB)

**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".

[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 URL <http://www.nxp.com>.

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