

# 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  $R_{DS(on)}$  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
$R_{DS(on)}$	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 $\Omega$

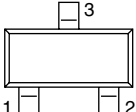
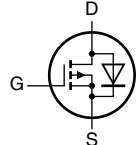
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 6 cm<sup>2</sup>,  $t \leq 5\text{ s}$ .

[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

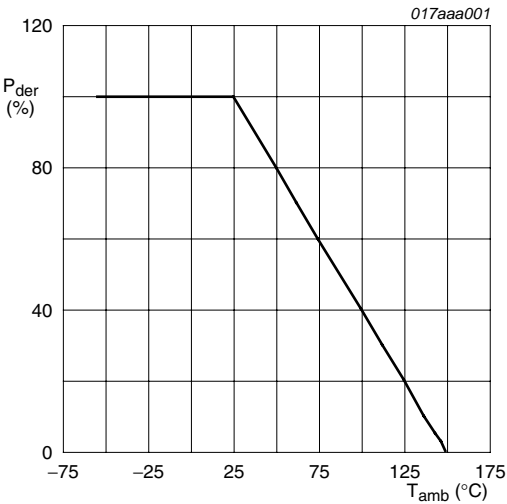
In accordance with the Absolute Maximum Rating System (IEC 60134).

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).*

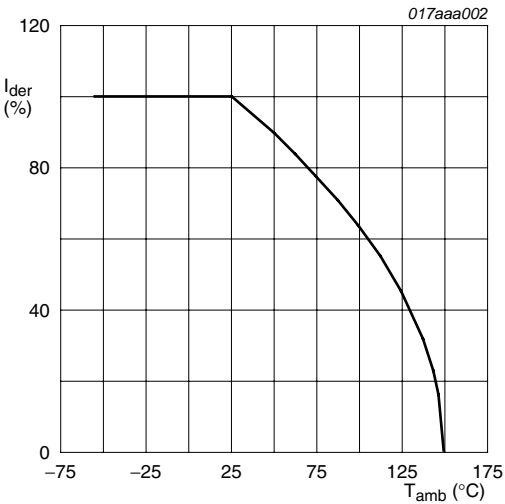
Symbol	Parameter	Conditions	Min	Max	Unit
P <sub>tot</sub>	total power dissipation	T <sub>amb</sub> = 25 °C	[2] -	400	mW
			[1] -	710	mW
		T <sub>sp</sub> = 25 °C	-	2.8	W
T <sub>j</sub>	junction temperature			150	°C
T <sub>amb</sub>	ambient temperature		-55	+150	°C
T <sub>stg</sub>	storage temperature		-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.



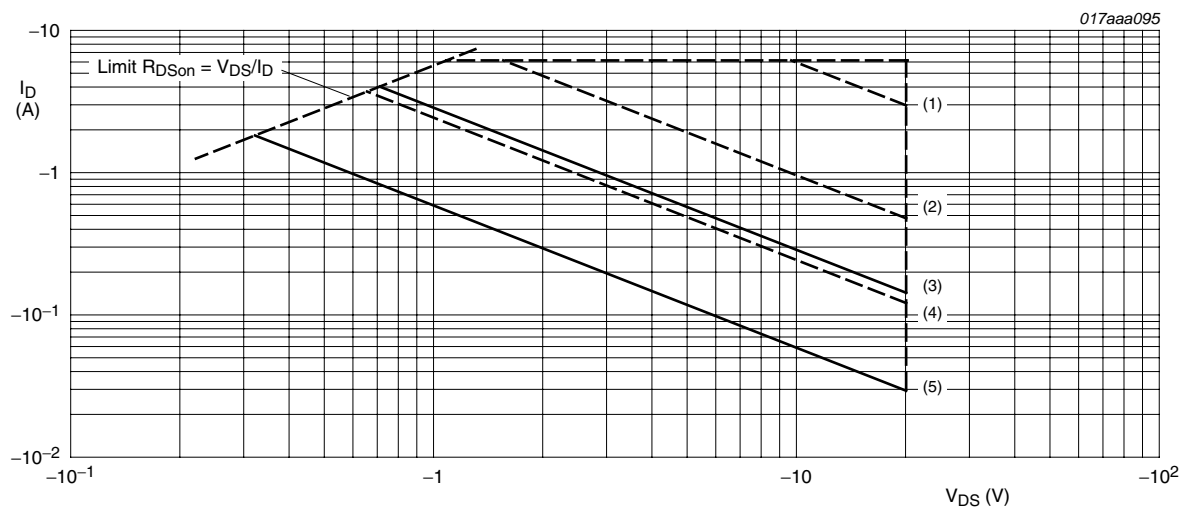
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100 \%$$

**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**



- $I_{DM}$  = single pulse
- (1)  $t_p = 1$  ms
  - (2)  $t_p = 10$  ms
  - (3) DC;  $T_{sp} = 25$  °C
  - (4)  $t_p = 100$  ms
  - (5) DC;  $T_{amb} = 25$  °C; drain mounting pad 6 cm<sup>2</sup>

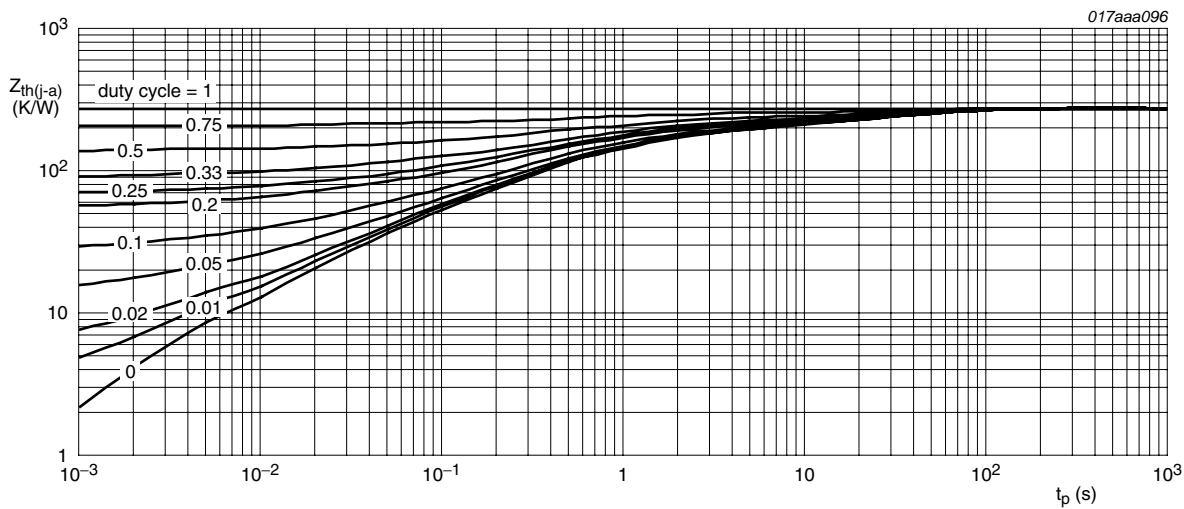
Fig 3. Safe operating area; junction to ambient; continuous and peak drain currents as a function of drain-source voltage

## 6. Thermal characteristics

Table 6. Thermal characteristics

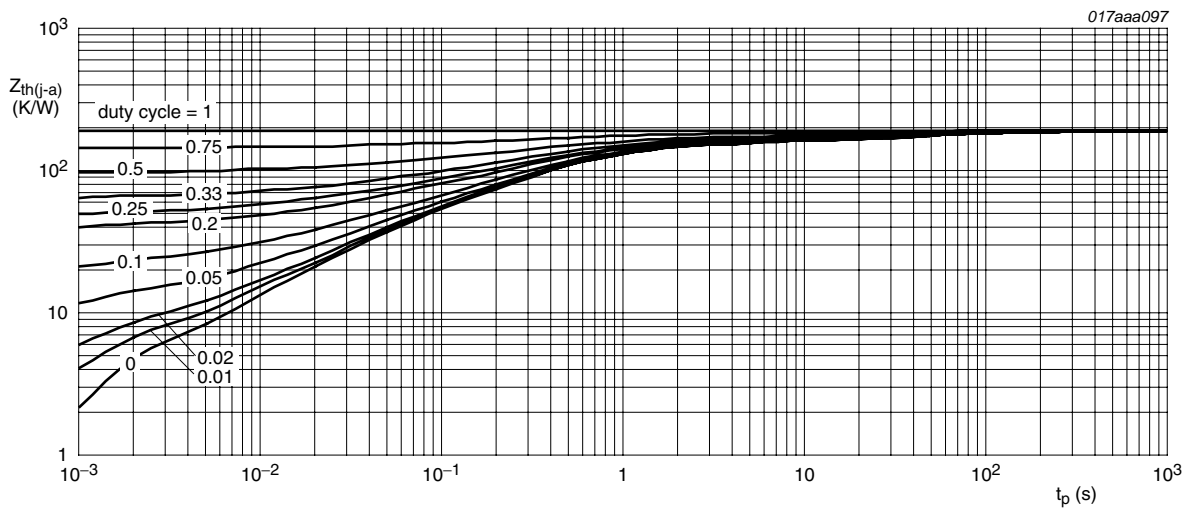
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	-	315 K/W
			[2]	-	-	175 K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point		-	-	45	K/W

- [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 cm²

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:  $t_p \leq 300\text{ }\mu\text{s}$ ;  $\delta \leq 0.01$ .

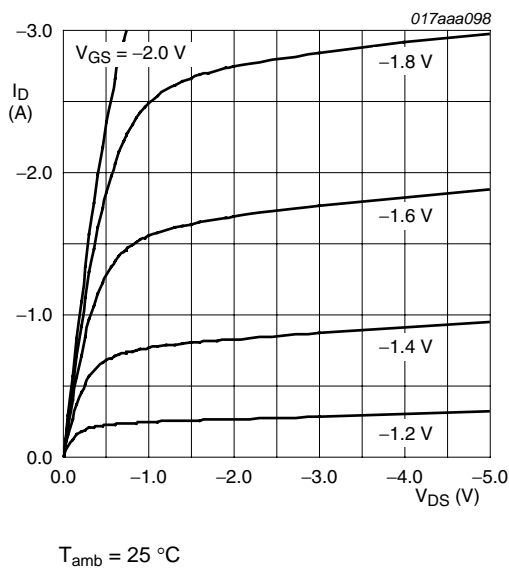


Fig 6. Output characteristics: drain current as a function of drain-source voltage; typical values

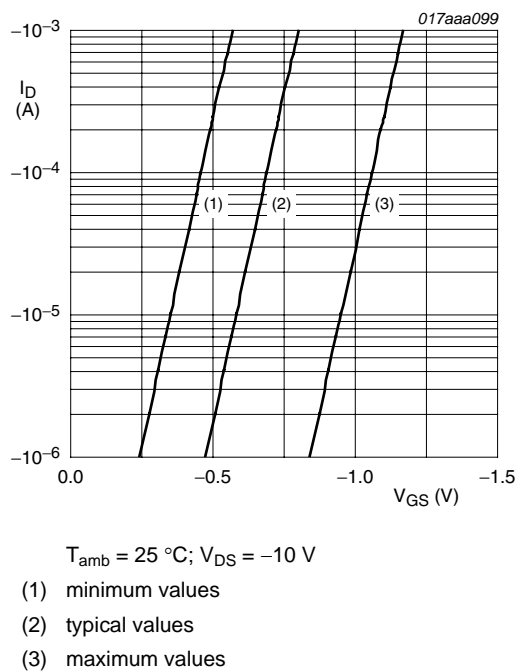


Fig 7. Sub-threshold drain current as a function of gate-source voltage

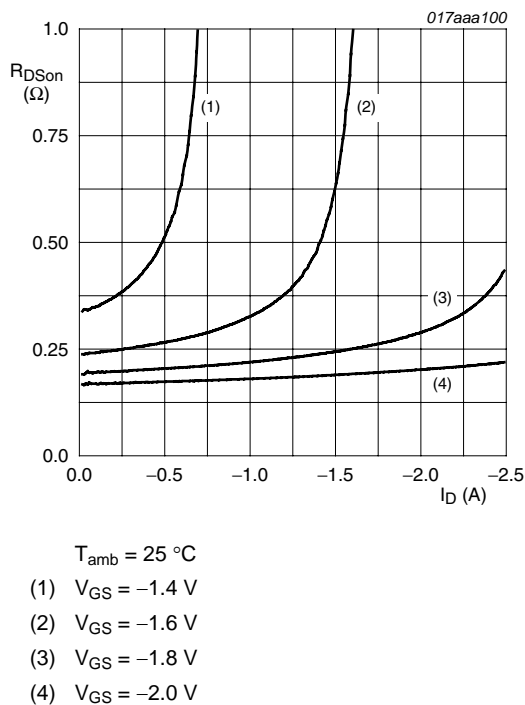


Fig 8. Drain-source on-state resistance as a function of drain current; typical values

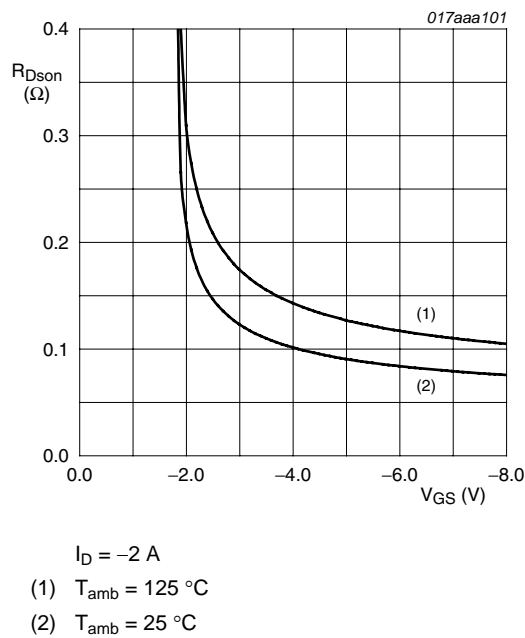
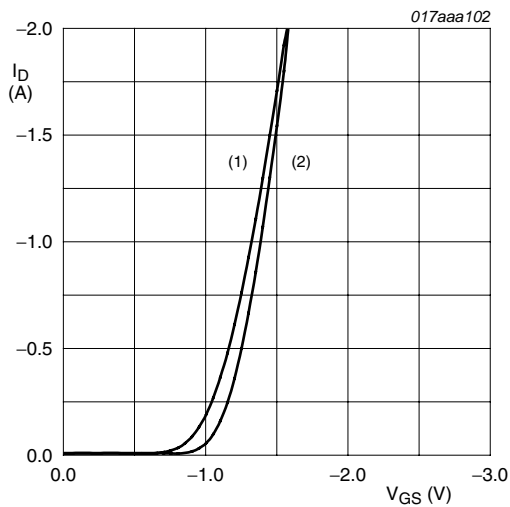


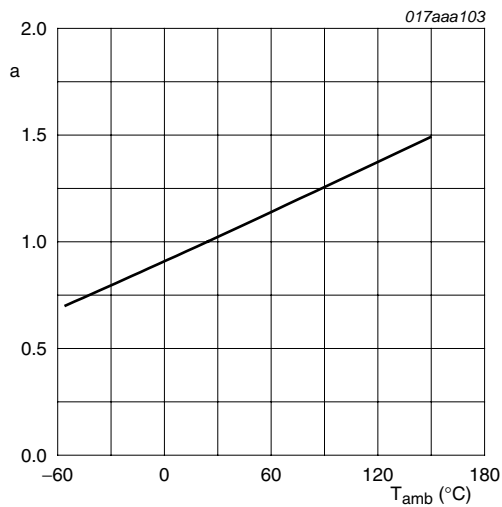
Fig 9. Drain-source on-state resistance as a function of gate-source voltage; typical values



$V_{DS} > I_D \times R_{DSon}$

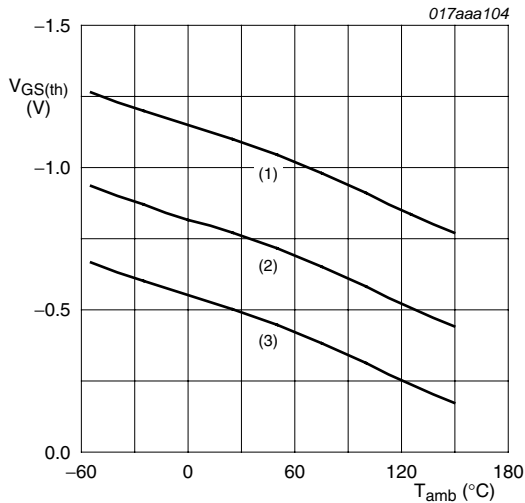
- (1)  $T_{amb} = 150\text{ }^{\circ}\text{C}$
- (2)  $T_{amb} = 25\text{ }^{\circ}\text{C}$

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



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

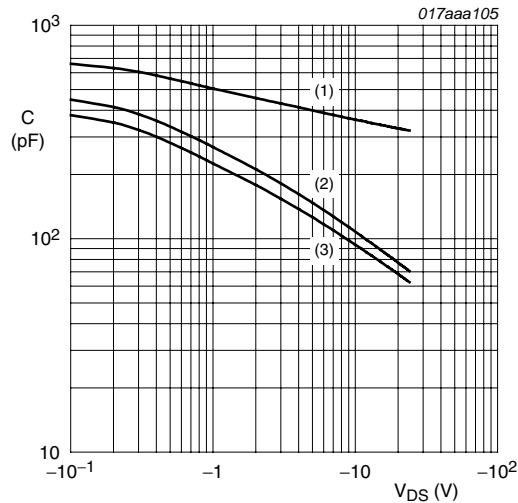
**Fig 11. Normalized drain-source on-state resistance as a function of ambient temperature; typical values**



$I_D = -0.25\text{ mA}; V_{DS} = V_{GS}$

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

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

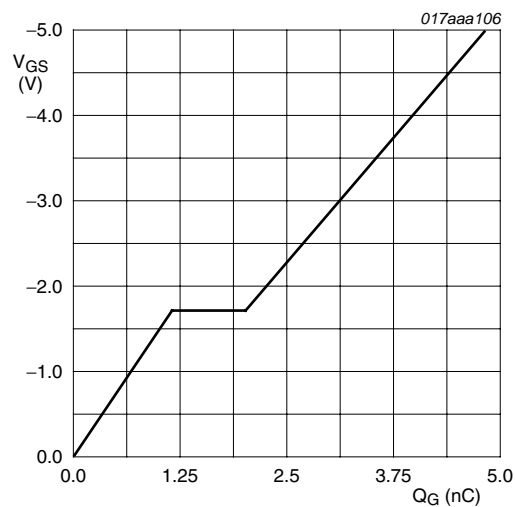


$f = 1\text{ MHz}; V_{GS} = 0\text{ V}$

- (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

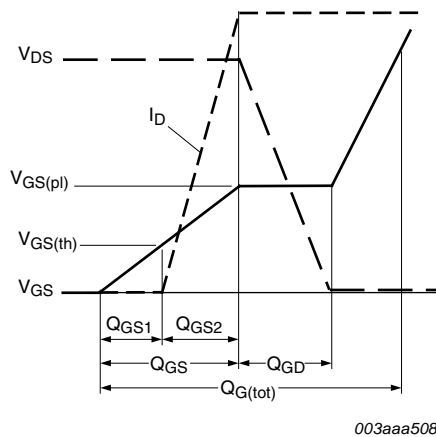
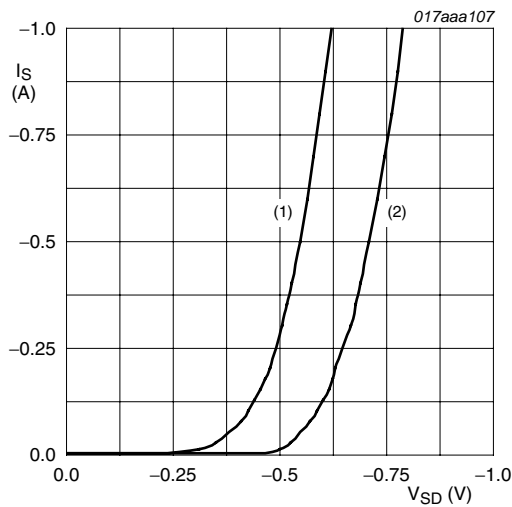


Fig 15. Gate charge waveform definitions



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

- (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

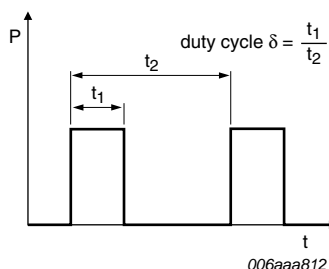


Fig 17. Duty cycle definition

### 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 leadsSOT23

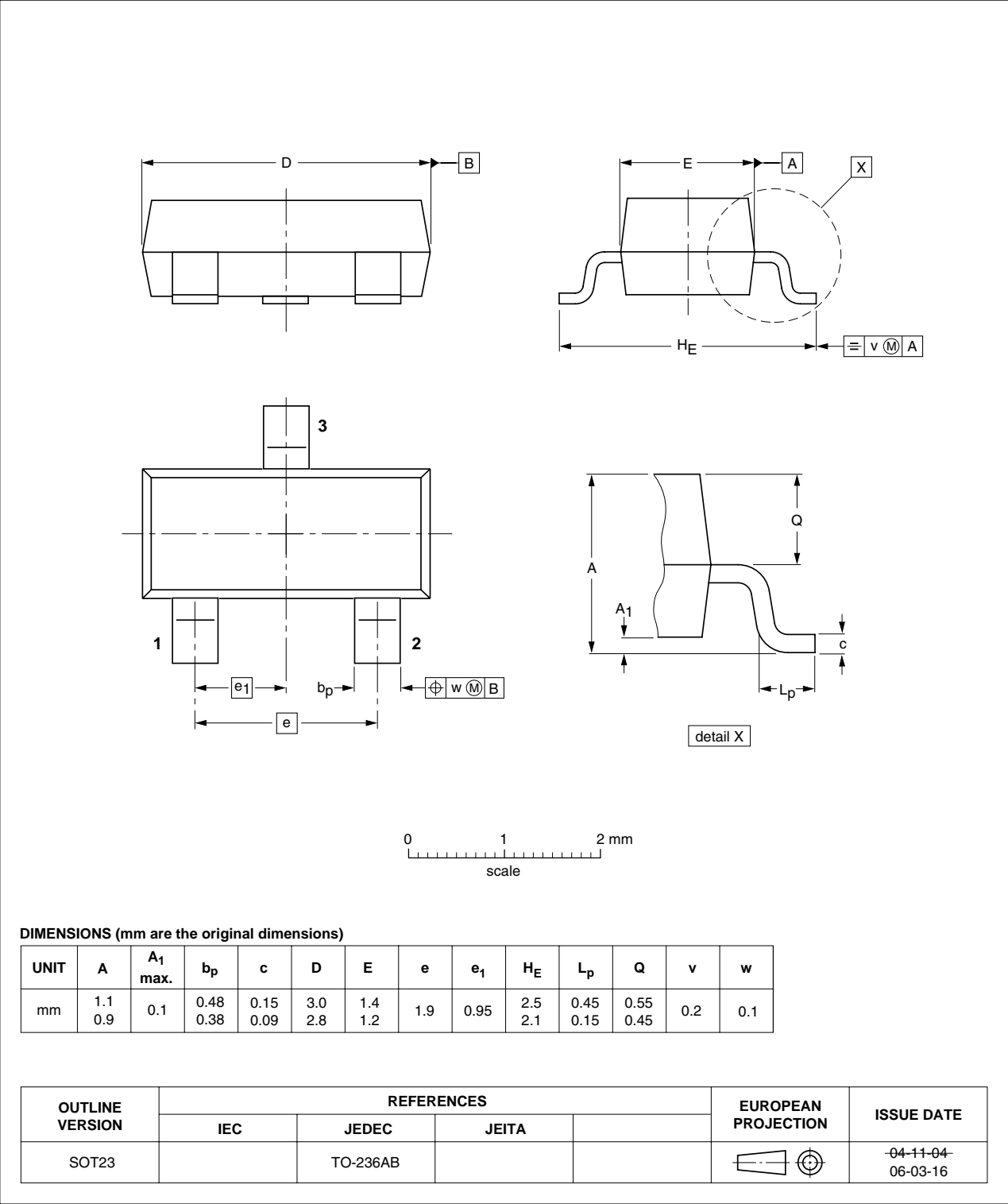


Fig 18. Package outline SOT23 (TO-236AB)

10. Soldering

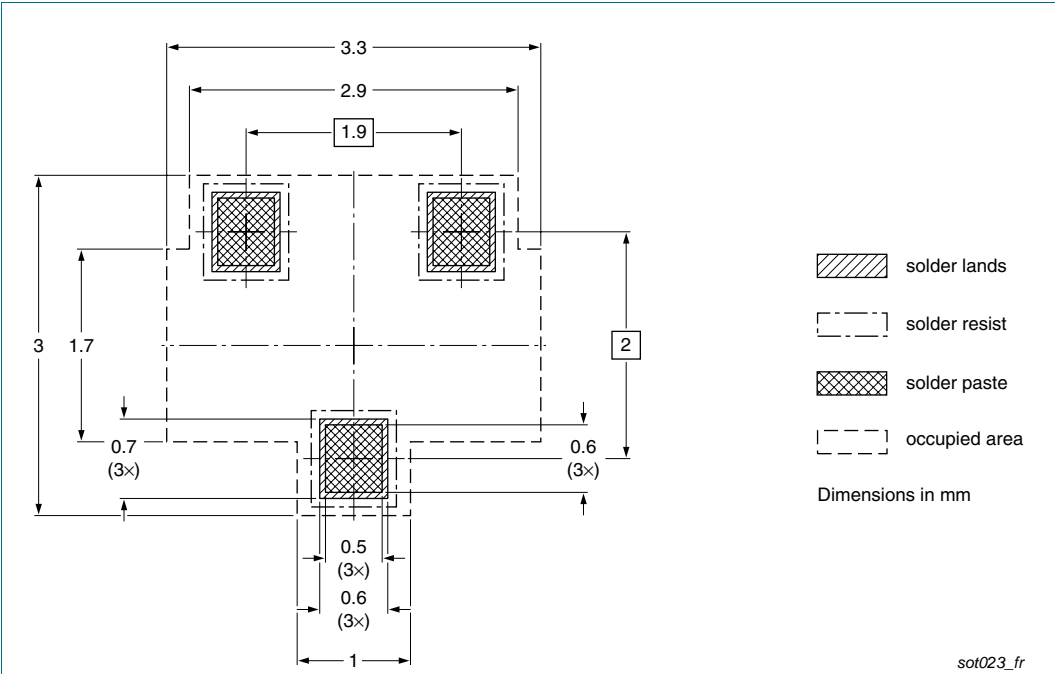


Fig 19. Reflow soldering footprint SOT23 (TO-236AB)

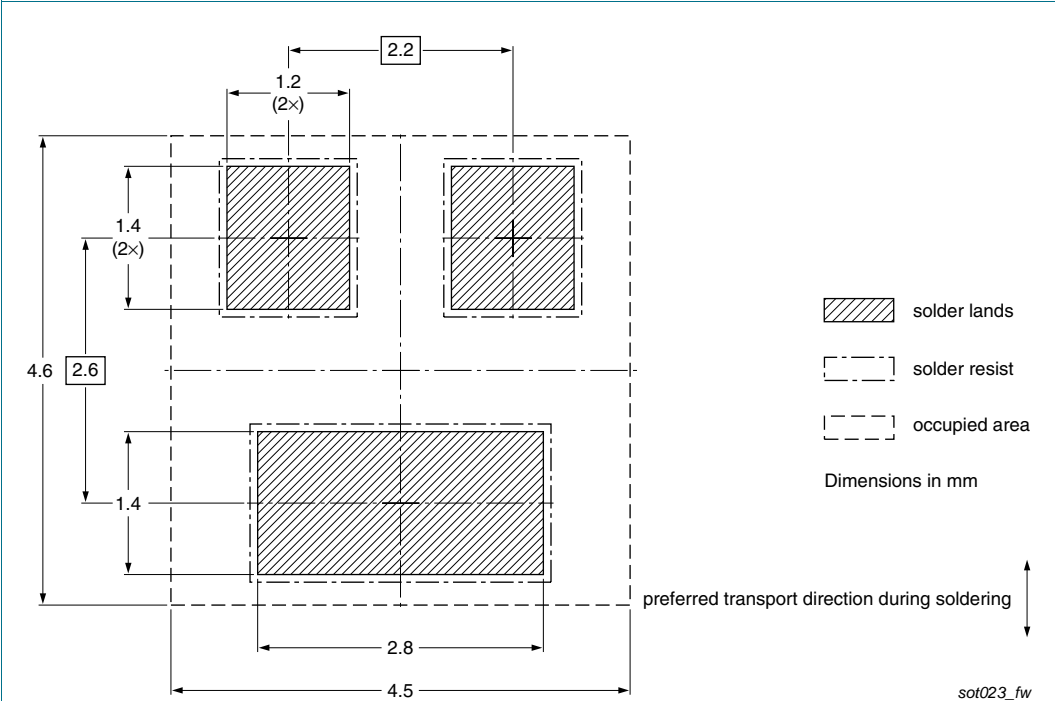


Fig 20. Wave soldering footprint SOT23 (TO-236AB)

## 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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Date of release: 26 October 2010

Document identifier: NX2301P