



# NX138BKS

60 V, dual N-channel Trench MOSFET

15 June 2016

Product data sheet

## 1. General description

Dual N-channel enhancement mode Field-Effect Transistor (FET) in a very small SOT363 (SC-88) Surface-Mounted Device (SMD) plastic package using Trench MOSFET technology.

## 2. Features and benefits

- Low threshold voltage
- Very fast switching
- Trench MOSFET technology
- ElectroStatic Discharge (ESD) protection > 2 kV HBM

## 3. Applications

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

## 4. Quick reference data

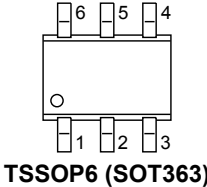
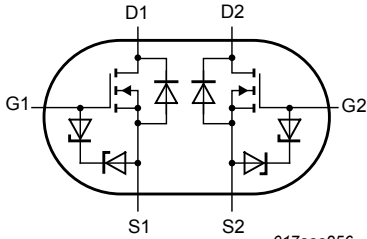
Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Per transistor</b>						
$V_{DS}$	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]	-	210	mA
<b>Static characteristics (per transistor)</b>						
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 10\text{ V}; I_D = 200\text{ mA}; T_j = 25\text{ °C}$	-	2.1	3.5	$\Omega$

[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	S1	source TR1	 <p>TSSOP6 (SOT363)</p>	 <p>017aaa256</p>
2	G1	gate TR1		
3	D2	drain TR2		
4	S2	source TR2		
5	G2	gate TR2		
6	D1	drain TR1		

6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
NX138BKS	TSSOP6	plastic surface-mounted package; 6 leads	SOT363

## 7. Limiting values

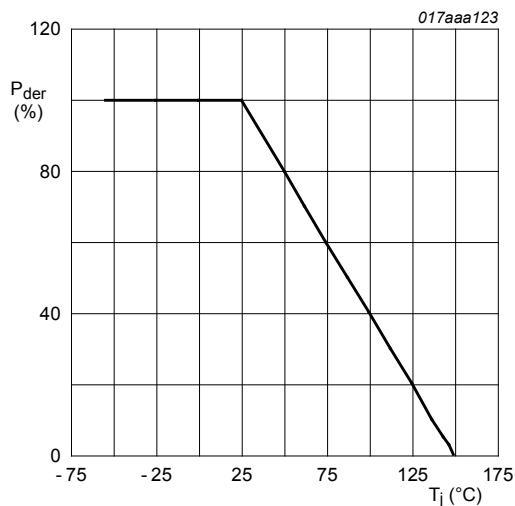
**Table 4. Limiting values**

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

Symbol	Parameter	Conditions		Min	Max	Unit
Per transistor						
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]	-	210	mA
		V <sub>GS</sub> = 10 V; T <sub>amb</sub> = 100 °C	[1]	-	135	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		-	855	mA
P <sub>tot</sub>	total power dissipation	T <sub>amb</sub> = 25 °C	[2]	-	285	mW
			[1]	-	320	mW
		T <sub>sp</sub> = 25 °C		-	860	mW
Per device						
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]	-	170	mA

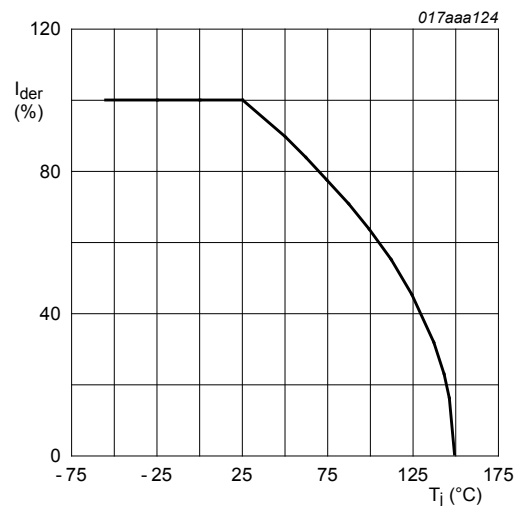
[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and mounting pad for drain 1 cm<sup>2</sup>.

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



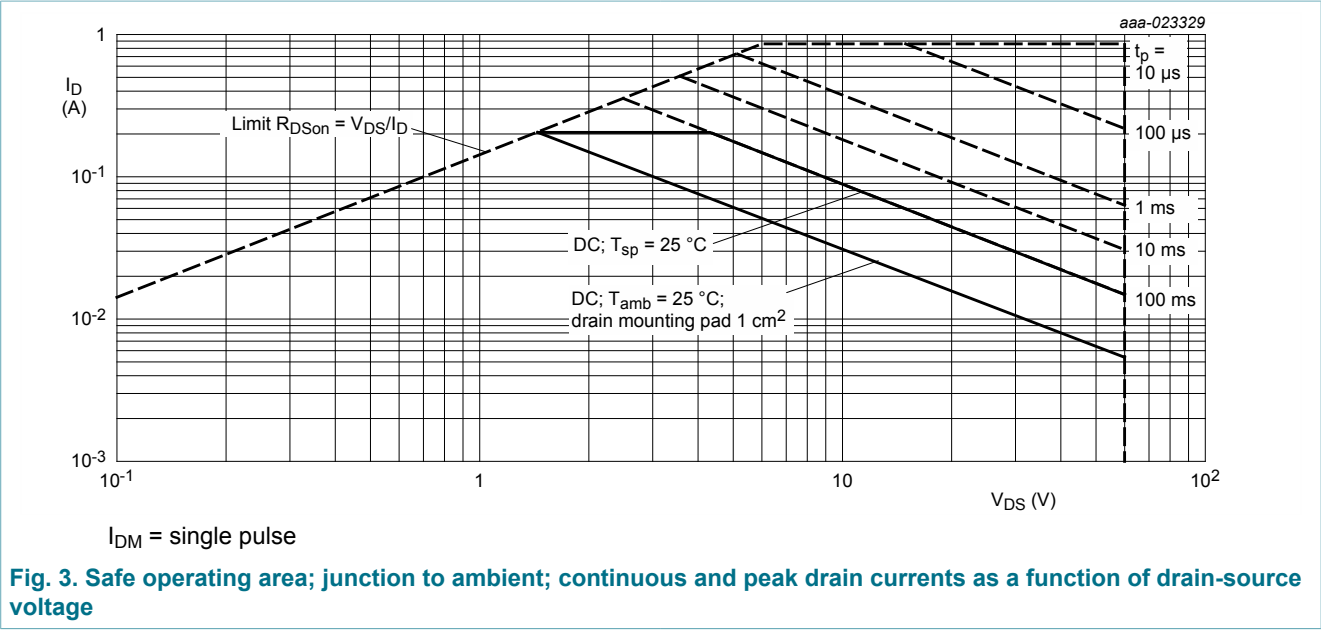
$$P_{der} = \frac{P_{tot}}{P_{tot(25^\circ\text{C})}} \times 100 \%$$

**Fig. 1. MOSFET transistor: Normalized total power dissipation as a function of junction temperature**



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

**Fig. 2. MOSFET transistor: Normalized continuous drain current as a function of junction temperature**



8. Thermal characteristics

Table 5. Thermal characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Per transistor							
R <sub>th(j-a)</sub>	thermal resistance from junction to ambient	in free air	[1]	-	380	440	K/W
			[2]	-	340	390	K/W
R <sub>th(j-sp)</sub>	thermal resistance from junction to solder point			-	125	145	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>.

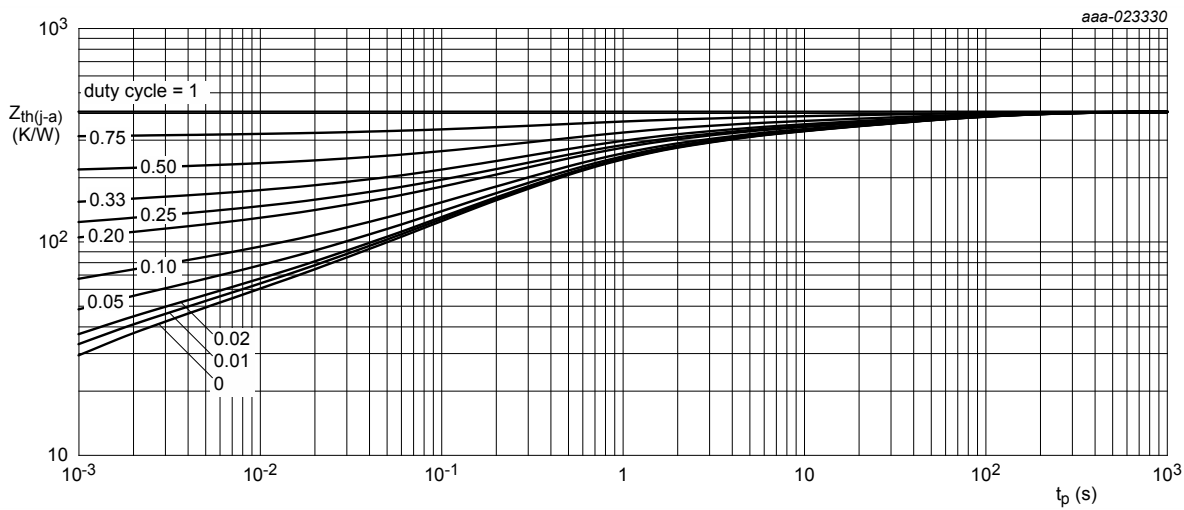


Fig. 4. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

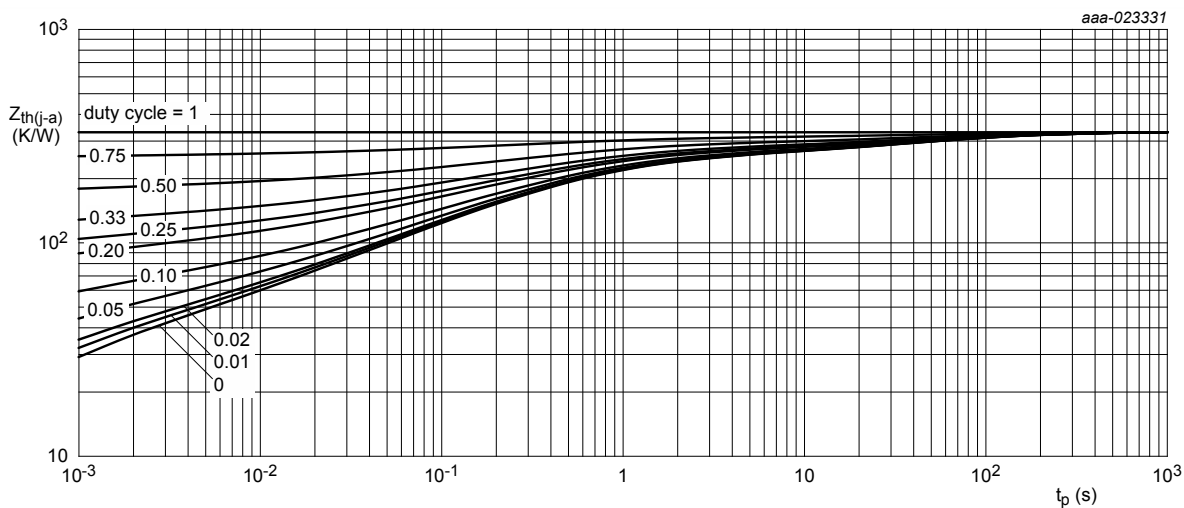


Fig. 5. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

## 9. Characteristics

Table 6. Characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Static characteristics (per transistor)							
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		0.5	1	1.5	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		-	2.1	3.5	Ω
		V <sub>GS</sub> = 10 V; I <sub>D</sub> = 200 mA; T <sub>j</sub> = 150 °C		-	4.3	7.2	Ω
		V <sub>GS</sub> = 5 V; I <sub>D</sub> = 170 mA; T <sub>j</sub> = 25 °C		-	2.2	3.8	Ω
		V <sub>GS</sub> = 2.5 V; I <sub>D</sub> = 75 mA; T <sub>j</sub> = 25 °C		-	2.6	5	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		-	0.7	-	S
Dynamic characteristics (per transistor)							
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		-	0.5	0.7	nC
Q <sub>GS</sub>	gate-source charge			-	0.12	-	nC
Q <sub>GD</sub>	gate-drain charge			-	0.12	-	nC
C <sub>iss</sub>	input capacitance	V <sub>DS</sub> = 30 V; f = 1 MHz; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C		-	20	-	pF
C <sub>oss</sub>	output capacitance			-	3.1	-	pF
C <sub>rss</sub>	reverse transfer capacitance			-	2	-	pF
t <sub>d(on)</sub>	turn-on delay time	V <sub>DS</sub> = 30 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		-	8	-	ns
t <sub>r</sub>	rise time			-	8	-	ns
t <sub>d(off)</sub>	turn-off delay time			-	13	-	ns
t <sub>f</sub>	fall time			-	5	-	ns
Source-drain diode (per transistor)							
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		-	0.9	1.2	V

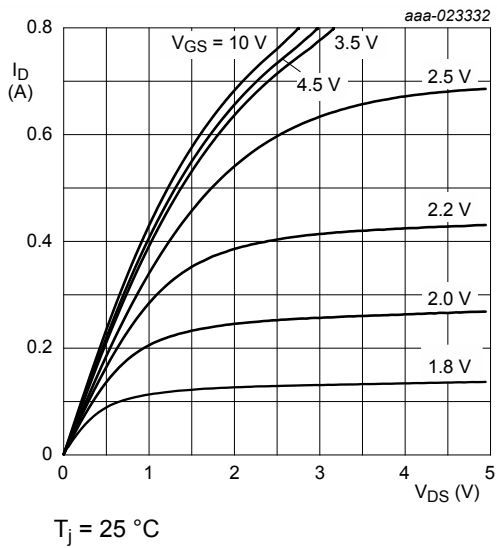


Fig. 6. Output characteristics: drain current as a function of drain-source voltage; typical values

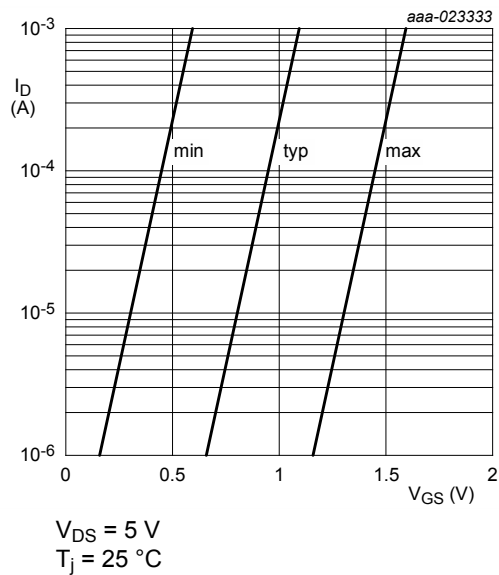


Fig. 7. Sub-threshold drain current as a function of gate-source voltage

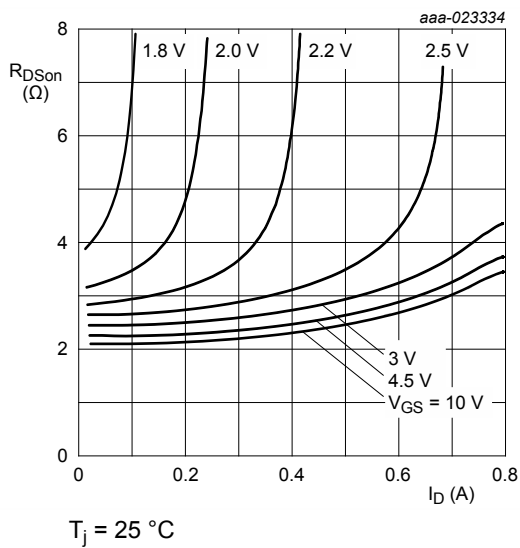


Fig. 8. Drain-source on-state resistance as a function of drain current; typical values

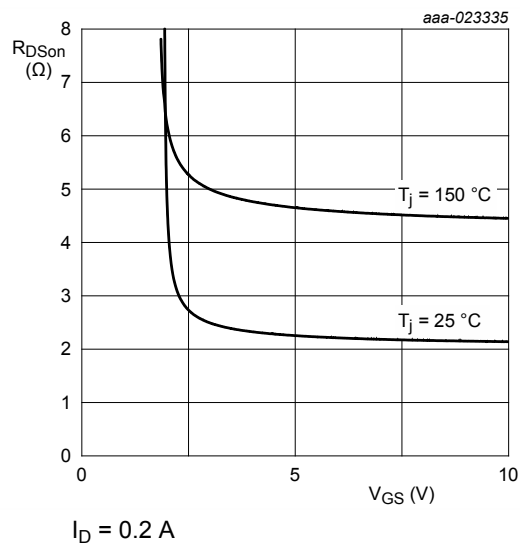


Fig. 9. Drain-source on-state resistance as a function of gate-source voltage; typical values

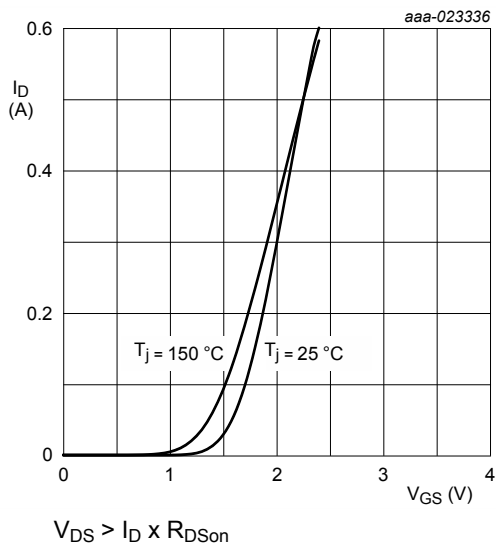


Fig. 10. Transfer characteristics: drain current as a function of gate-source voltage; typical values

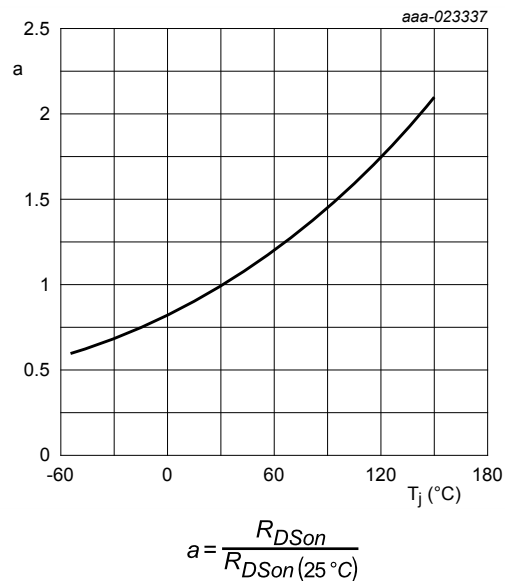


Fig. 11. Normalized drain-source on-state resistance as a function of junction temperature; typical values

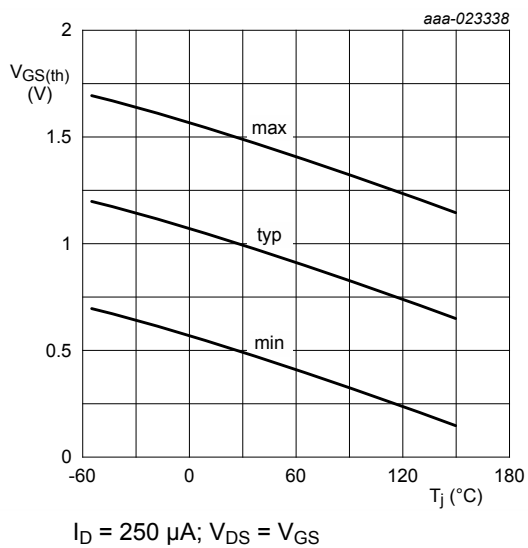


Fig. 12. Gate-source threshold voltage as a function of junction temperature

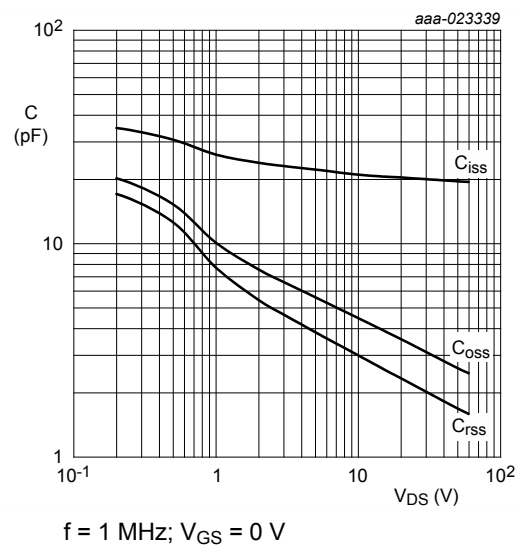


Fig. 13. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

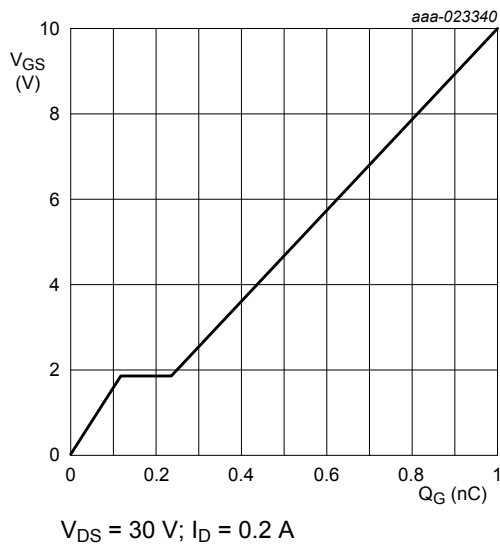


Fig. 14. Gate-source voltage as a function of gate charge; typical values

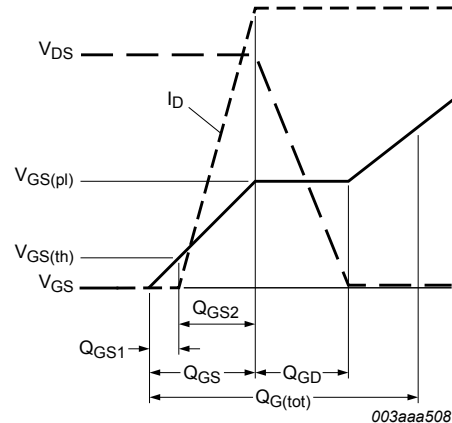


Fig. 15. MOSFET transistor: Gate charge waveform definitions

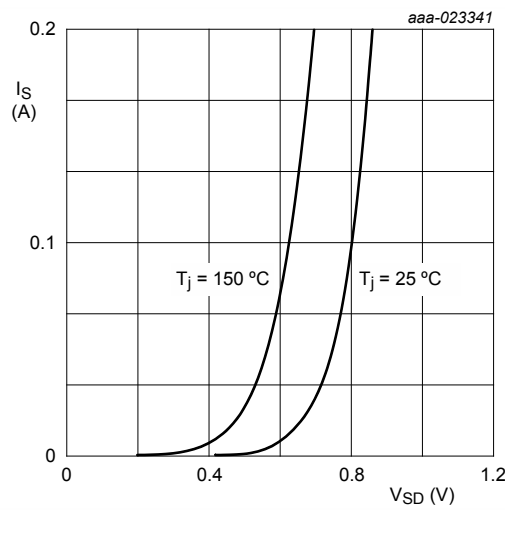


Fig. 16. Source current as a function of source-drain voltage; typical values

## 10. Test information

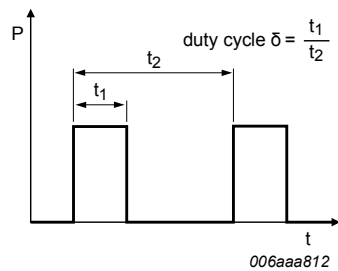
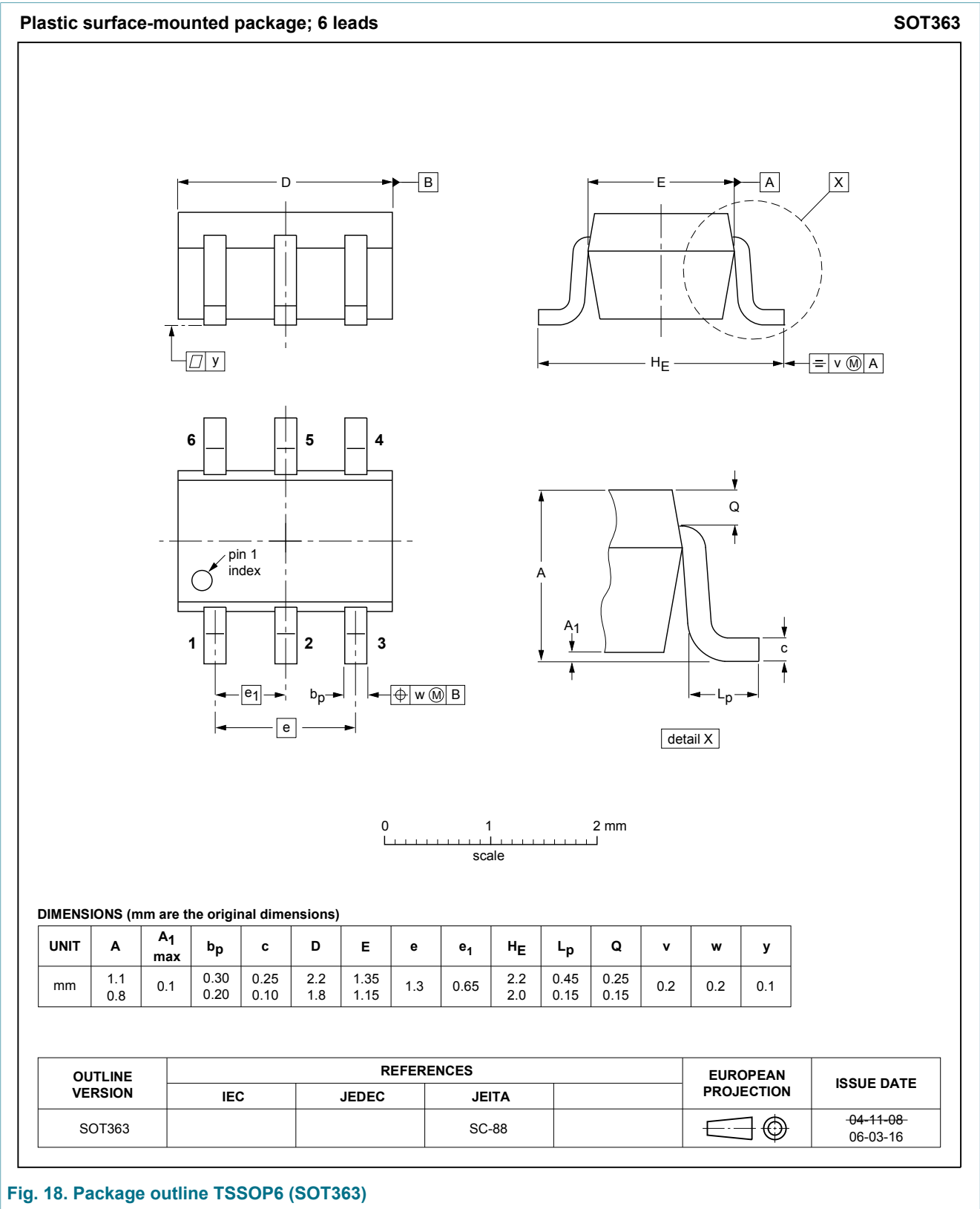


Fig. 17. Duty cycle definition

11. Package outline



12. Soldering

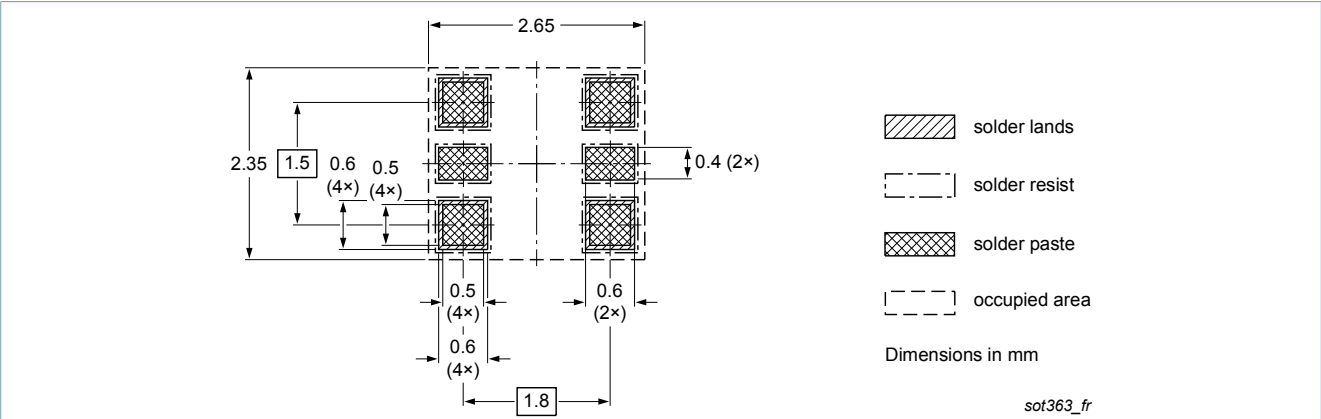


Fig. 19. Reflow soldering footprint for TSSOP6 (SOT363)

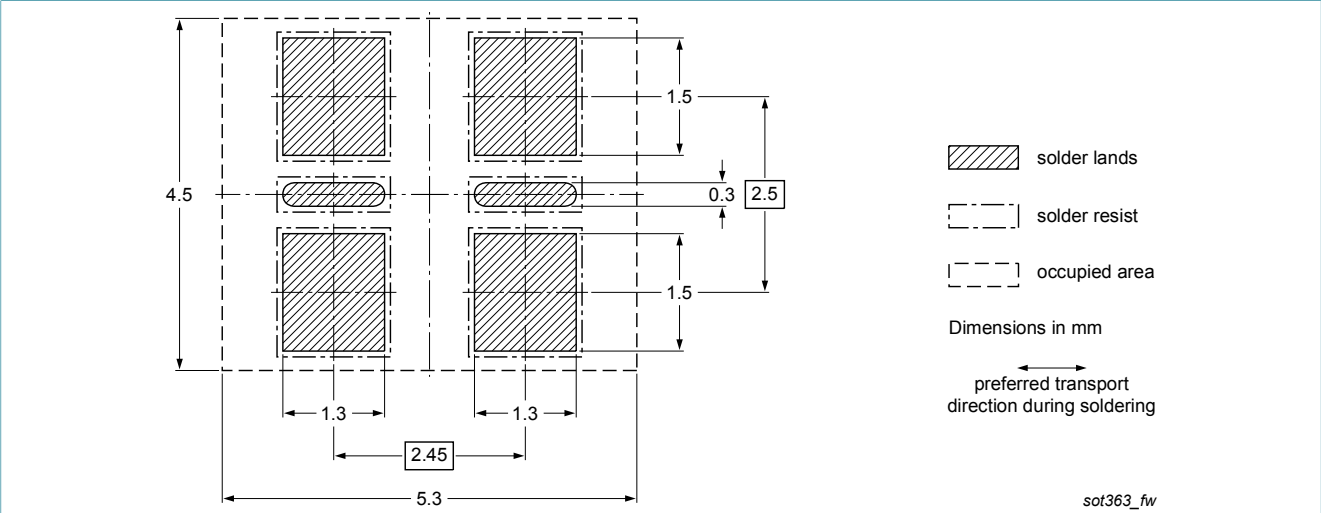


Fig. 20. Wave soldering footprint for TSSOP6 (SOT363)

### 13. Revision history

Table 7. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
NX138BKS v.1	20160615	Product data sheet	-	-

## 14. 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.
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15. 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. Limiting values..... 3

8. Thermal characteristics..... 4

9. Characteristics..... 6

10. Test information..... 9

11. Package outline..... 10

12. Soldering..... 11

13. Revision history.....12

14. Legal information..... 13

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Date of release: 15 June 2016