



# 2N7002BKS

60 V, 300 mA dual N-channel Trench MOSFET

Rev. 2 — 23 September 2010

Product data sheet

## 1. Product profile

### 1.1 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.

### 1.2 Features and benefits

- Logic-level compatible
- Very fast switching
- Trench MOSFET technology
- ESD protection up to 2 kV
- AEC-Q101 qualified

### 1.3 Applications

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

### 1.4 Quick reference data

Table 1. Quick reference data

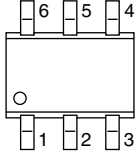
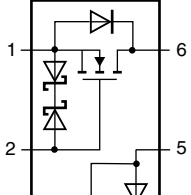
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{DS}$	drain-source voltage	$T_{amb} = 25\text{ °C}$	-	-	60	V
$V_{GS}$	gate-source voltage	$T_{amb} = 25\text{ °C}$	-	-	±20	V
$I_D$	drain current	$T_{amb} = 25\text{ °C};$ $V_{GS} = 10\text{ V}$	[1]	-	300	mA
$R_{DS(on)}$	drain-source on-state resistance	$T_j = 25\text{ °C};$ $V_{GS} = 10\text{ V};$ $I_D = 500\text{ mA}$	-	1	1.6	$\Omega$

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

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## 2. Pinning information

Table 2. Pinning

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	S1	source 1		
2	G1	gate 1		
3	D2	drain 2		
4	S2	source 2		
5	G2	gate 2		
6	D1	drain 1		

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## 3. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
2N7002BKS	SC-88	plastic surface-mounted package; 6 leads	SOT363

## 4. Marking

Table 4. Marking codes

Type number	Marking code <sup>[1]</sup>
2N7002BKS	ZT*

- [1] \* = -: made in Hong Kong  
 \* = p: made in Hong Kong  
 \* = t: made in Malaysia  
 \* = W: made in China

## 5. Limiting values

Table 5. Limiting values

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

Symbol	Parameter	Conditions	Min	Max	Unit
<b>Per transistor</b>					
$V_{DS}$	drain-source voltage	$T_{amb} = 25\text{ °C}$	-	60	V
$V_{GS}$	gate-source voltage	$T_{amb} = 25\text{ °C}$	-	±20	V
$I_D$	drain current	$V_{GS} = 10\text{ V}$	[1]		
		$T_{amb} = 25\text{ °C}$	-	300	mA
		$T_{amb} = 100\text{ °C}$	-	215	mA

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

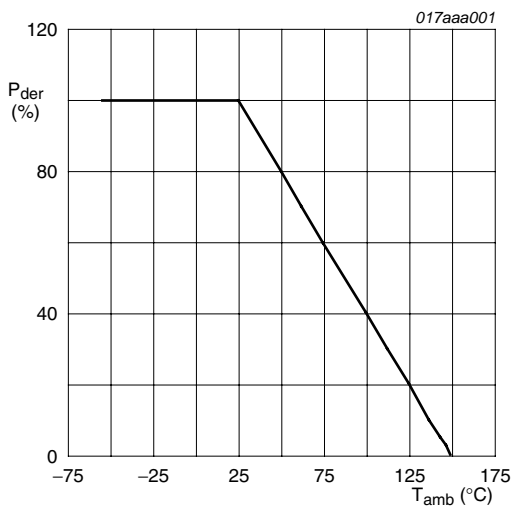
In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit	
$I_{DM}$	peak drain current	$T_{amb} = 25\text{ °C}$ ; single pulse; $t_p \leq 10\ \mu\text{s}$	-	1.2	A	
$P_{tot}$	total power dissipation	$T_{amb} = 25\text{ °C}$	[2]	-	295	mW
			[1]	-	340	mW
		$T_{sp} = 25\text{ °C}$	-	1040	mW	
<b>Source-drain diode</b>						
$I_S$	source current	$T_{amb} = 25\text{ °C}$	[1]	-	300	mA
<b>ESD maximum rating</b>						
$V_{ESD}$	electrostatic discharge voltage	human body model	[3]	-	2000	V
<b>Per device</b>						
$P_{tot}$	total power dissipation	$T_{amb} = 25\text{ °C}$	[2]	-	445	mW
$T_j$	junction temperature				150	°C
$T_{amb}$	ambient temperature		-55	+150	°C	
$T_{stg}$	storage temperature		-65	+150	°C	

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

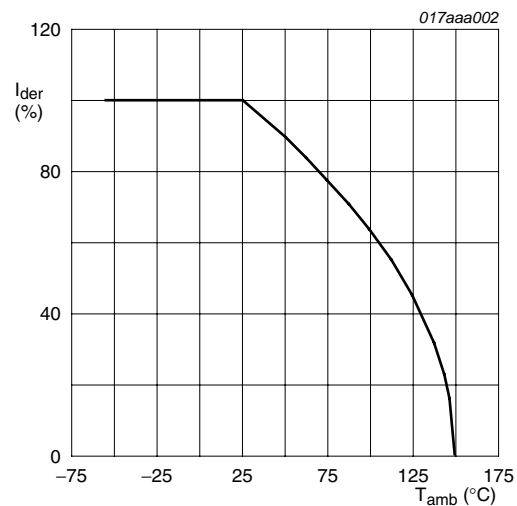
[2] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and standard footprint.

[3] Measured between all pins.



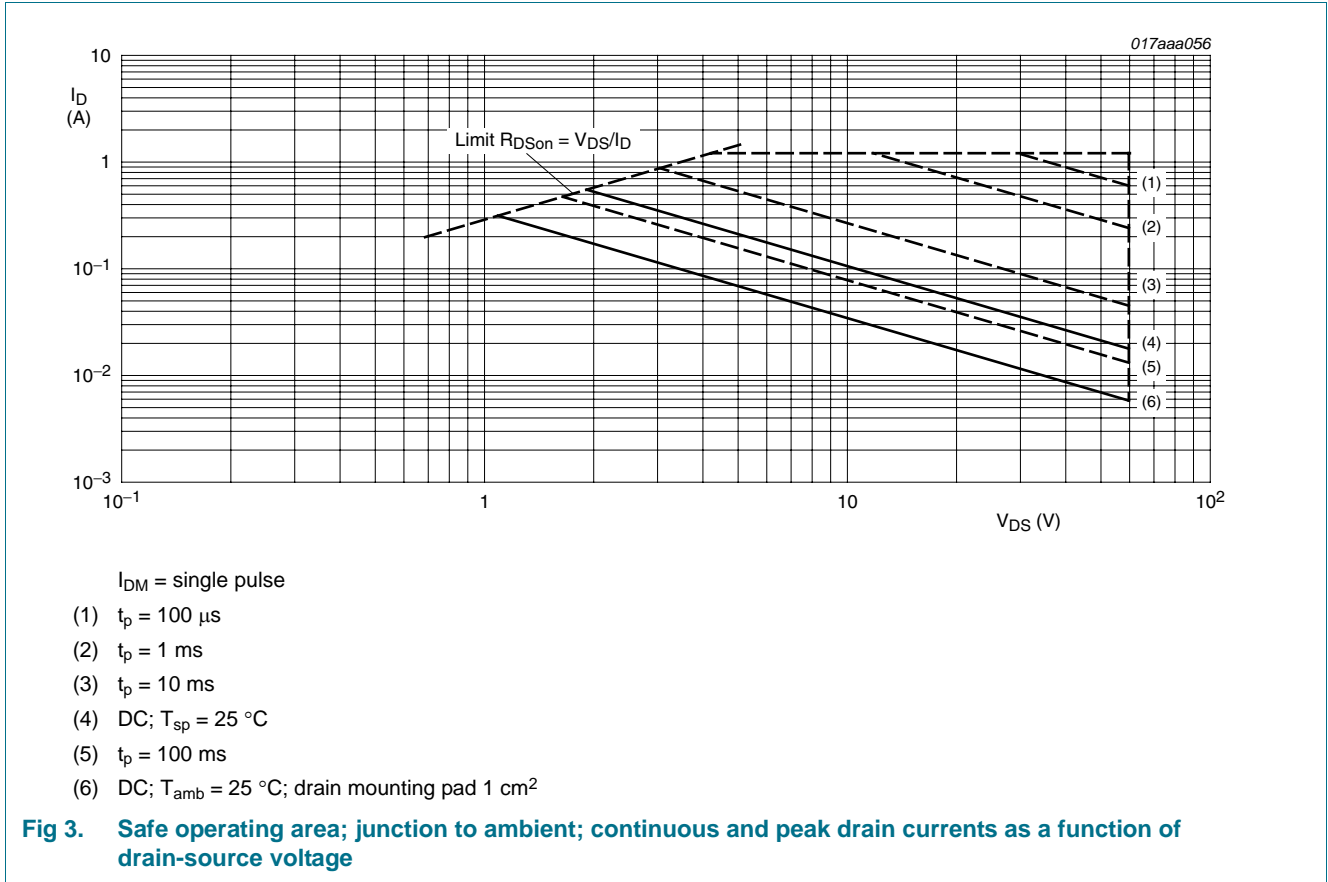
$$P_{der} = \frac{P_{tot}}{P_{tot(25\text{ °C})}} \times 100\%$$

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



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

**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
<b>Per transistor</b>						
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	370	425 K/W
			[2]	-	320	370 K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point		-	-	120	K/W
<b>Per device</b>						
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	-	275 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  $1 \text{ cm}^2$ .

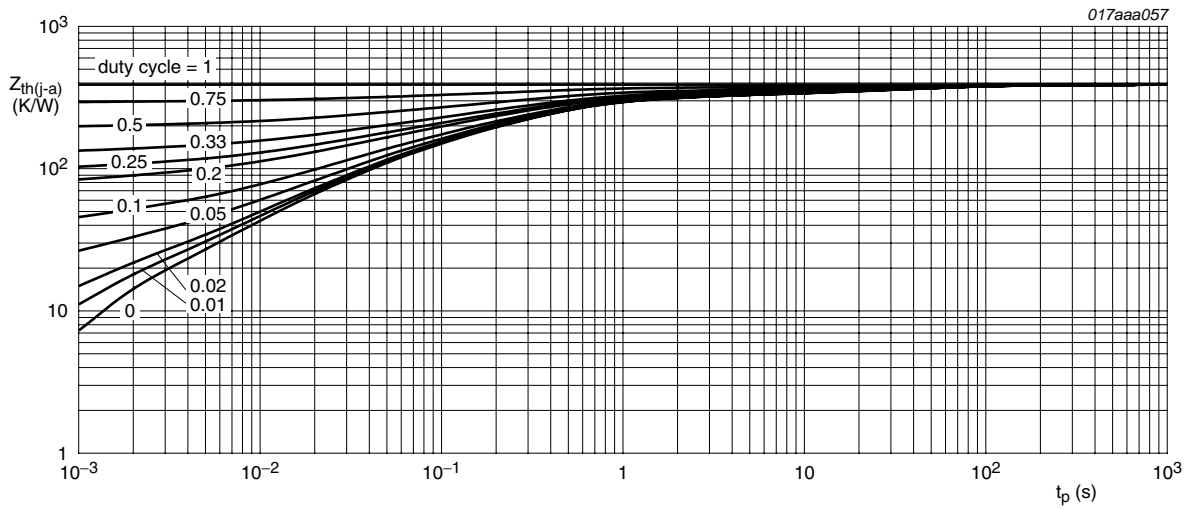


Fig 4. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

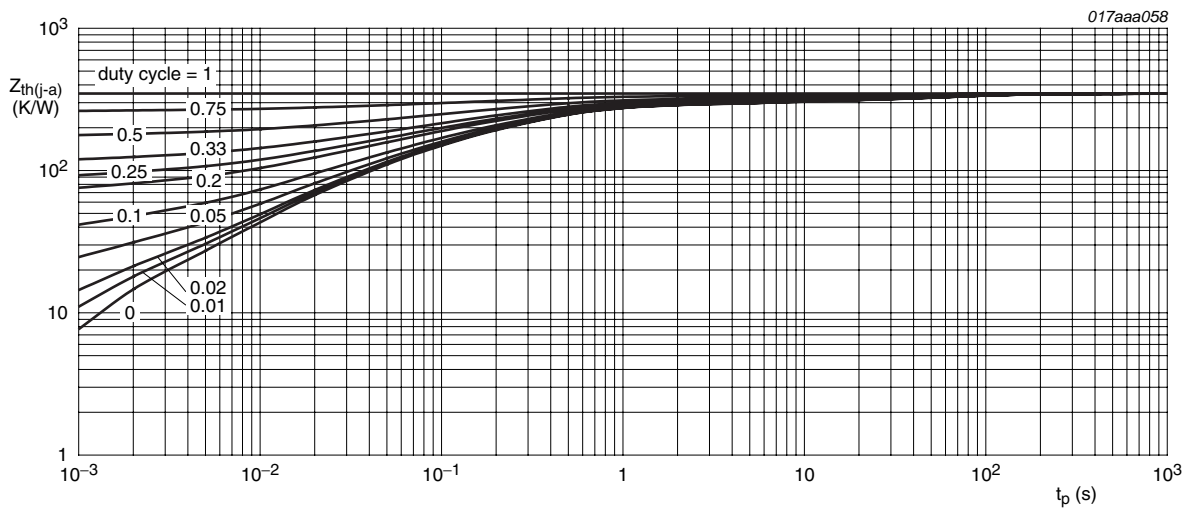


Fig 5. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

## 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	$I_D = 10\text{ }\mu\text{A}; V_{GS} = 0\text{ V}$	60	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 250\text{ }\mu\text{A}; V_{DS} = V_{GS}$	1.1	1.6	2.1	V
$I_{DSS}$	drain leakage current	$V_{DS} = 60\text{ V}; V_{GS} = 0\text{ V}$				
		$T_j = 25\text{ °C}$	-	-	1	$\mu\text{A}$
		$T_j = 150\text{ °C}$	-	-	10	$\mu\text{A}$
$I_{GSS}$	gate leakage current	$V_{GS} = \pm 20\text{ V}; V_{DS} = 0\text{ V}$	-	-	10	$\mu\text{A}$
$R_{DS(on)}$	drain-source on-state resistance		[1]			
		$V_{GS} = 5\text{ V}; I_D = 50\text{ mA}$	-	1.3	2	$\Omega$
		$V_{GS} = 10\text{ V}; I_D = 500\text{ mA}$	-	1	1.6	$\Omega$
$g_{fs}$	forward transconductance	$V_{DS} = 10\text{ V}; I_D = 200\text{ mA}$	[1]	-	550	mS
<b>Dynamic characteristics</b>						
$Q_{G(tot)}$	total gate charge	$I_D = 300\text{ mA};$ $V_{DS} = 30\text{ V};$ $V_{GS} = 4.5\text{ V}$	-	0.5	0.6	nC
$Q_{GS}$	gate-source charge		-	0.2	-	nC
$Q_{GD}$	gate-drain charge		-	0.1	-	nC
$C_{iss}$	input capacitance	$V_{GS} = 0\text{ V}; V_{DS} = 10\text{ V};$ $f = 1\text{ MHz}$	-	33	50	pF
$C_{oss}$	output capacitance		-	7	-	pF
$C_{rss}$	reverse transfer capacitance		-	4	-	pF
$t_{d(on)}$	turn-on delay time	$V_{DD} = 50\text{ V};$ $R_L = 250\text{ }\Omega;$ $V_{GS} = 10\text{ V};$ $R_G = 6\text{ }\Omega$	-	5	10	ns
$t_r$	rise time		-	6	-	ns
$t_{d(off)}$	turn-off delay time		-	12	24	ns
$t_f$	fall time		-	7	-	ns
<b>Source-drain diode</b>						
$V_{SD}$	source-drain voltage	$I_S = 115\text{ mA}; V_{GS} = 0\text{ V}$	0.47	0.75	1.1	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

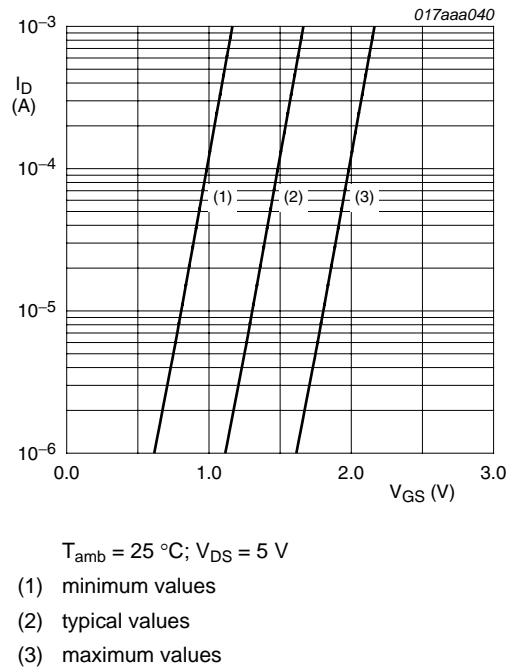


Fig 7. Sub-threshold drain current as a function of gate-source voltage



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

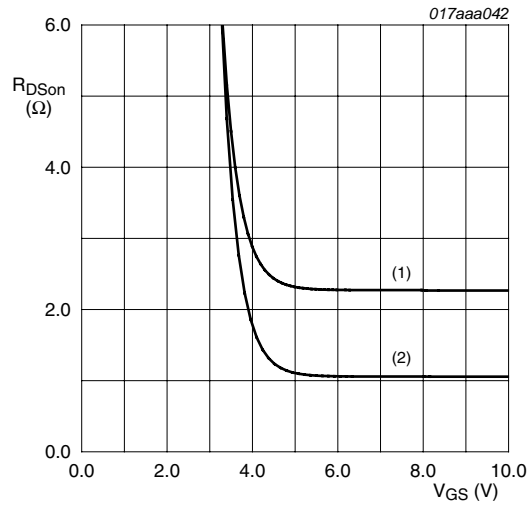
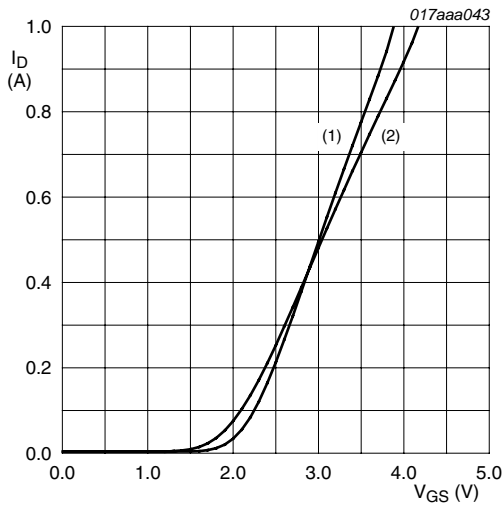
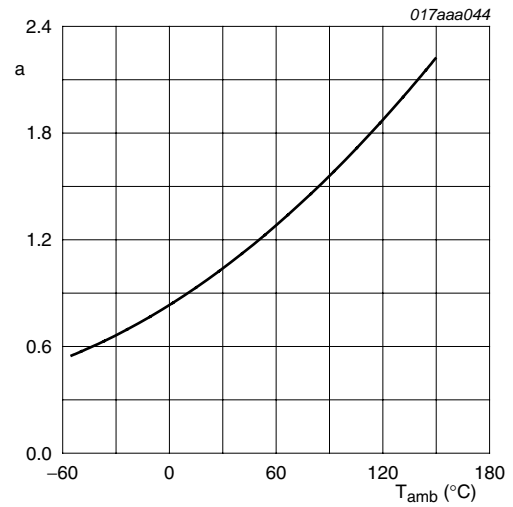


Fig 9. Drain-source on-state resistance as a function of gate-source voltage; typical values



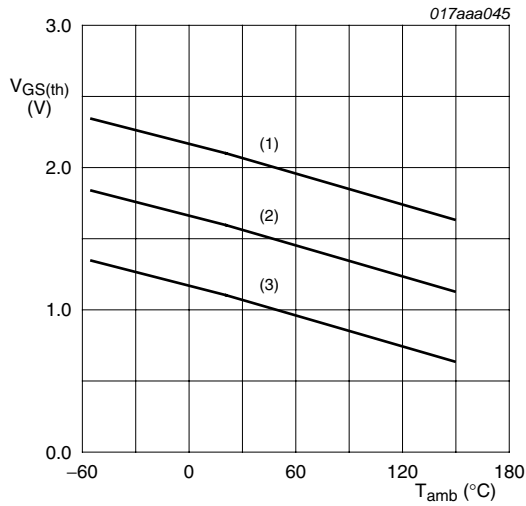
$V_{DS} > I_D \times R_{DSon}$   
 (1)  $T_{amb} = 25\text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 150\text{ }^\circ\text{C}$

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



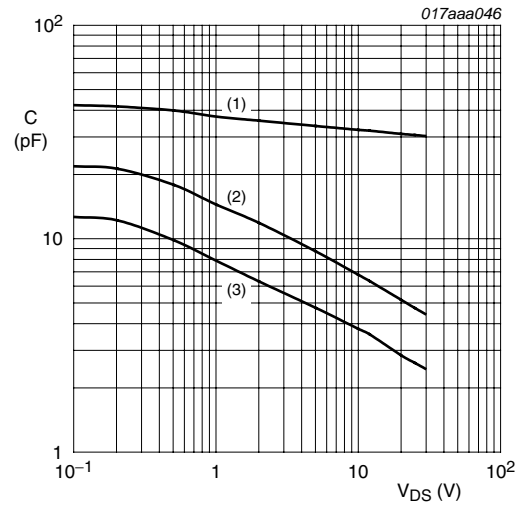
$$a = \frac{R_{DSon}}{R_{DSon(25^\circ\text{C})}}$$

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



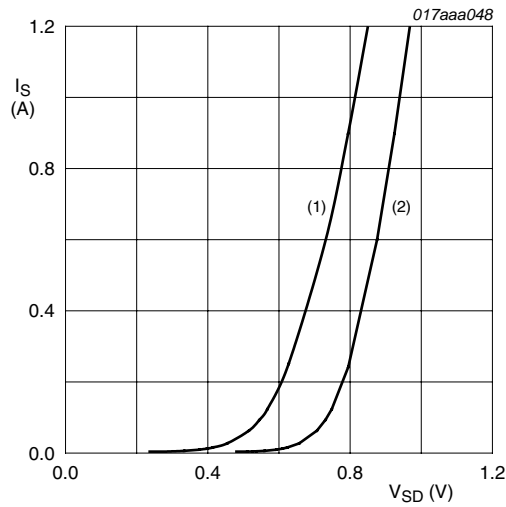


$I_D = 300 \text{ mA}$ ;  $V_{DD} = 6 \text{ V}$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$

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



**Fig 15. Gate charge waveform definitions**

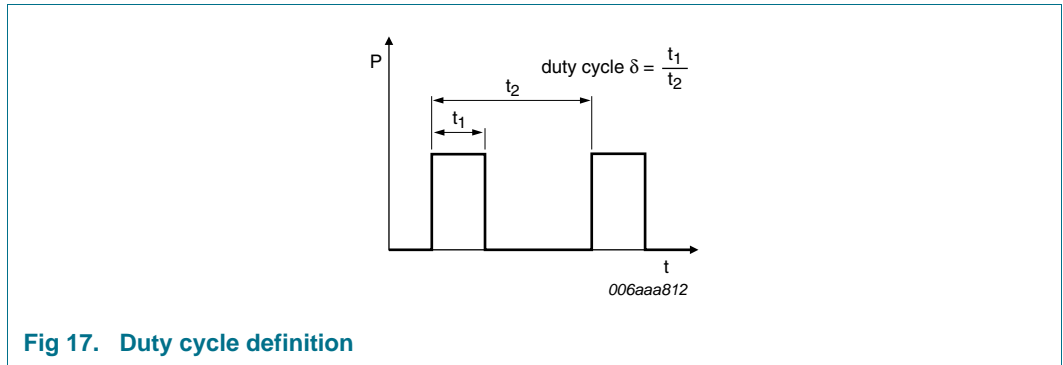


$V_{GS} = 0 \text{ V}$

- (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



9. Package outline

Plastic surface-mounted package; 6 leads

SOT363

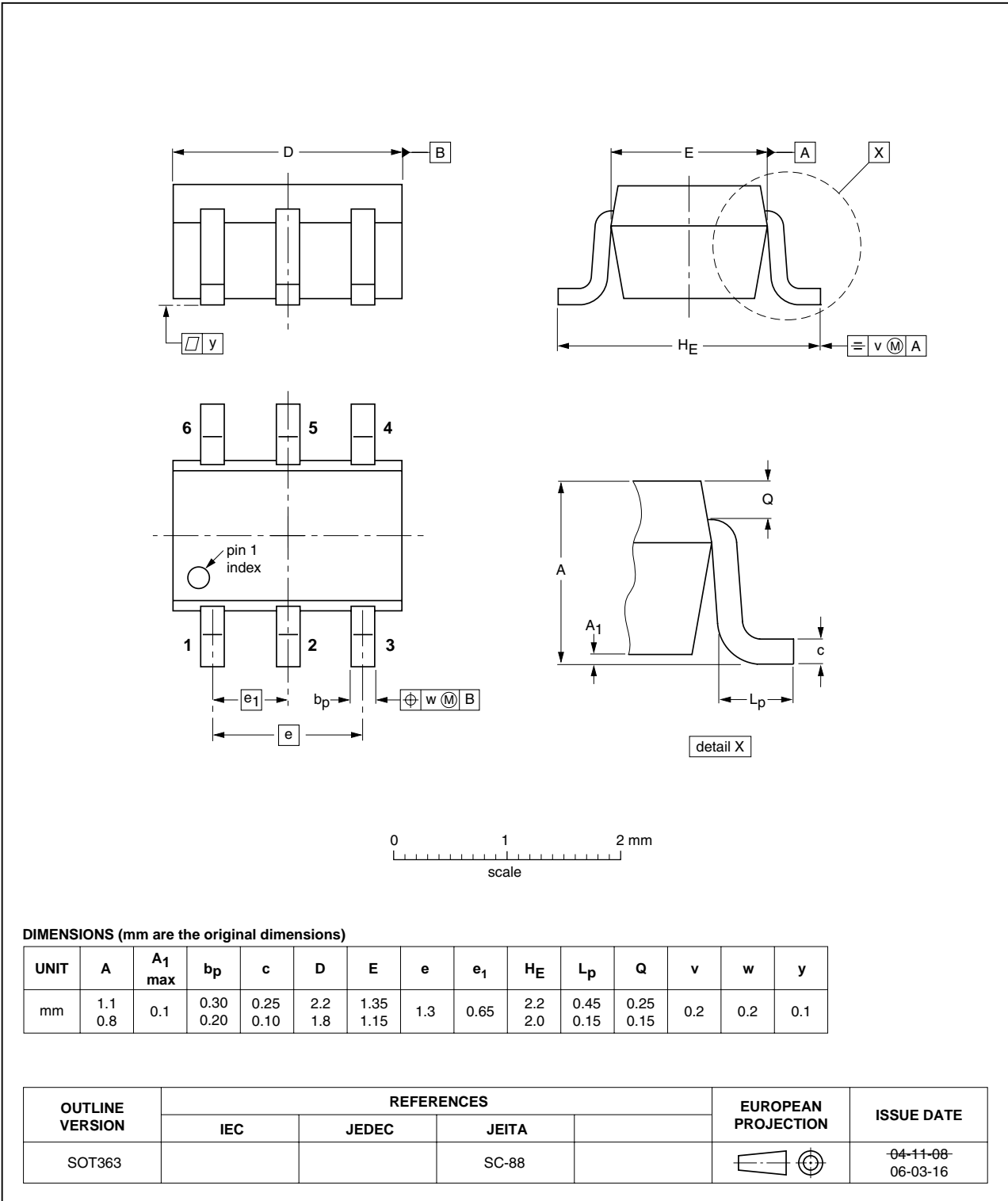


Fig 18. Package outline SOT363 (SC-88)

10. Soldering

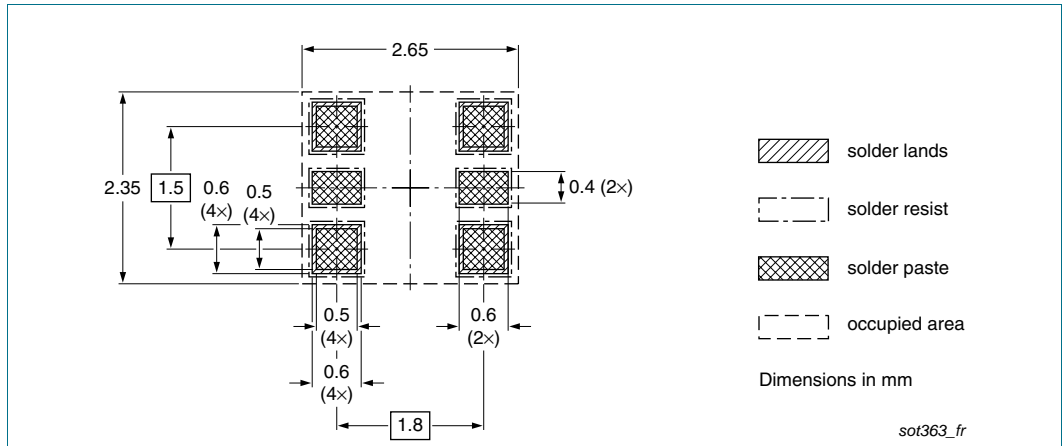


Fig 19. Reflow soldering footprint SOT363 (SC-88)

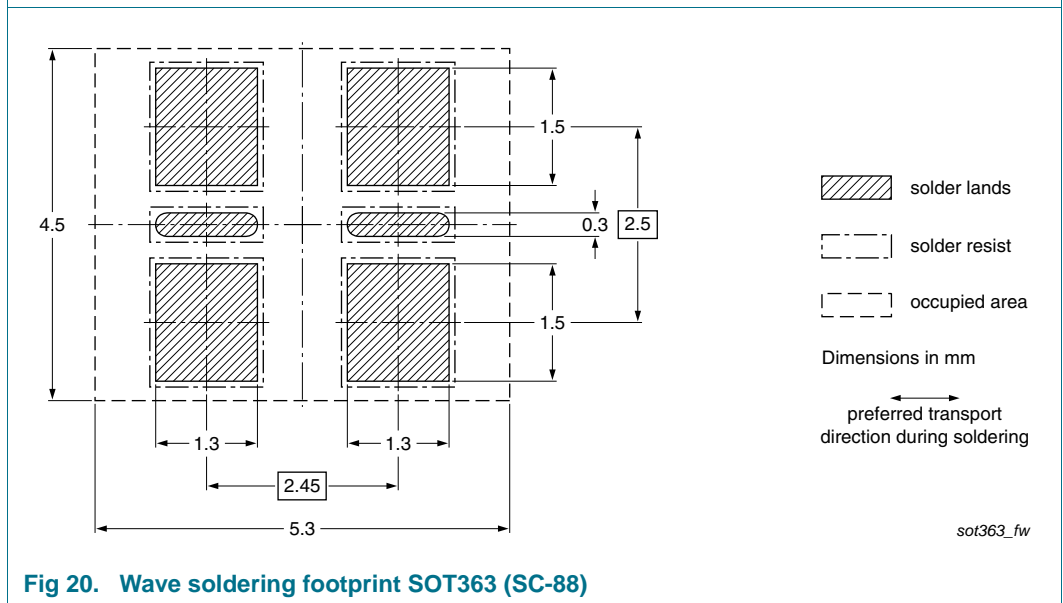


Fig 20. Wave soldering footprint SOT363 (SC-88)

## 11. Revision history

Table 8. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
2N7002BKS v.2	20100923	Product data sheet	-	2N7002BKS v.1
Modifications:	• <a href="#">Table 2 "Pinning"</a> : graphic symbol amended			
2N7002BKS v.1	20100617	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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