

# 2N7002PS

60 V, 320 mA N-channel Trench MOSFET

Rev. 1 — 1 July 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
- AEC-Q101 qualified

### 1.3 Applications

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

### 1.4 Quick reference data

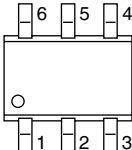
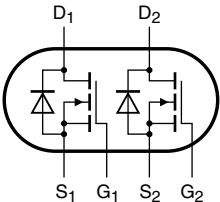
Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Per transistor</b>						
$V_{DS}$	drain-source voltage	$T_{amb} = 25\text{ °C}$	-	-	60	V
$V_{GS}$	gate-source voltage	$T_{amb} = 25\text{ °C}$	-	-	$\pm 20$	V
$I_D$	drain current	$T_{amb} = 25\text{ °C};$ $V_{GS} = 10\text{ V}$	[1]	-	320	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 Printed-Circuit Board (PCB), single-sided copper, tin-plated, mounting pad for drain 1 cm<sup>2</sup>.

## 2. Pinning information

Table 2. Pinning

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	S1	source1		
2	G1	gate1		
3	D2	drain2		
4	S2	source2		
5	G2	gate2		
6	D1	drain1		

*msd901*

## 3. Ordering information

Table 3. Ordering information

Type number	Package		Version
	Name	Description	
2N7002PS	SC-88	plastic surface-mounted package; 6 leads	SOT363

## 4. Marking

Table 4. Marking codes

Type number	Marking code <sup>[1]</sup>
2N7002PS	M8*

- [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]		
		$T_{amb} = 25\text{ °C}$	-	320	mA
		$T_{amb} = 100\text{ °C}$	-	240	mA
$I_{DM}$	peak drain current	$T_{amb} = 25\text{ °C}$ ; single pulse; $t_p \leq 10\text{ }\mu\text{s}$	-	1.2	A

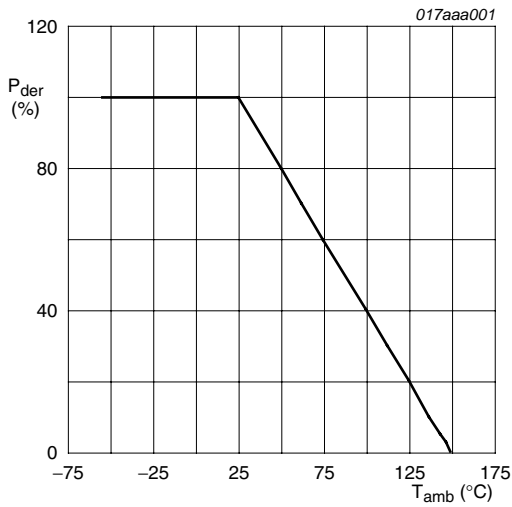
**Table 5. Limiting values ...continued**

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]	-	280	mW
			[1]	-	320	mW
		T <sub>sp</sub> = 25 °C	-	990	mW	
<b>Source-drain diode</b>						
I <sub>S</sub>	source current	T <sub>amb</sub> = 25 °C	[1]	-	320	mA
<b>Per device</b>						
P <sub>tot</sub>	total power dissipation	T <sub>amb</sub> = 25 °C	[2]	-	420	mW
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	

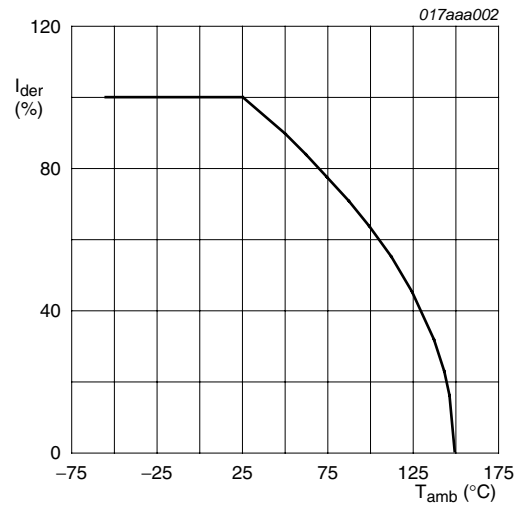
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 1 cm<sup>2</sup>.

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



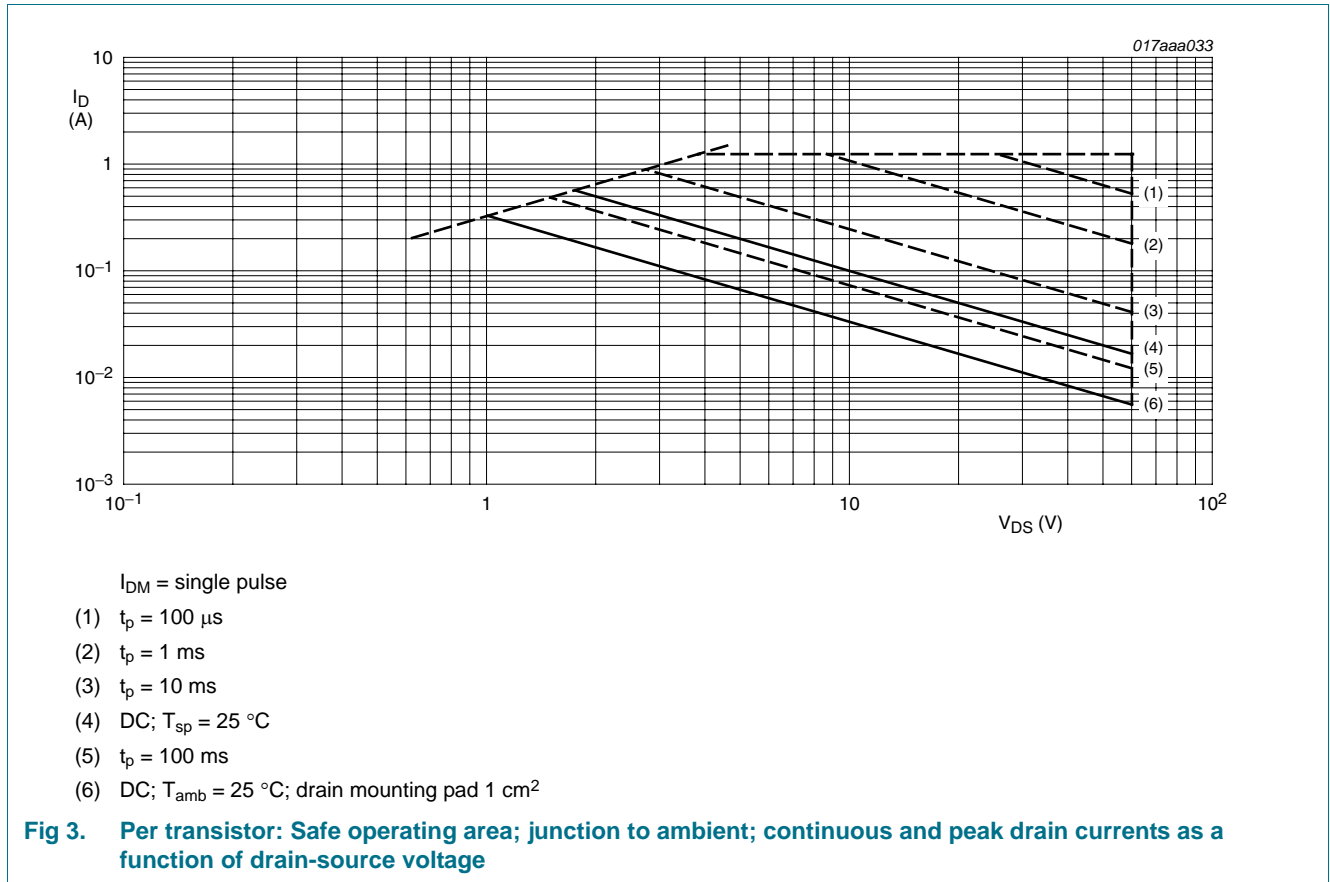
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\%$$

**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**



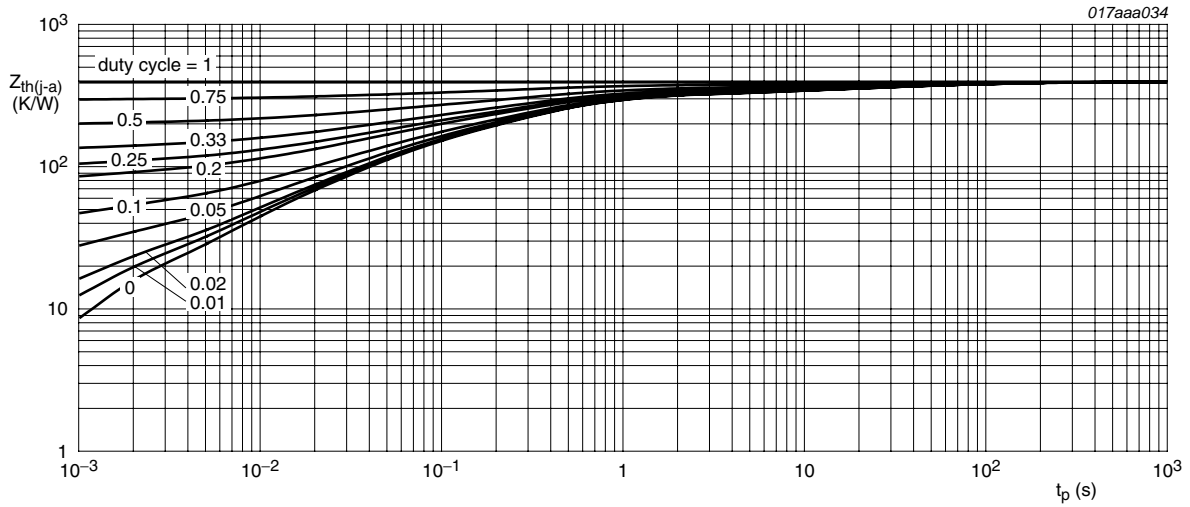
## 6. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Per transistor</b>						
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	390	445 K/W
			[2]	-	340	390 K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point		-	-	130	K/W
<b>Per device</b>						
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	-	300 K/W

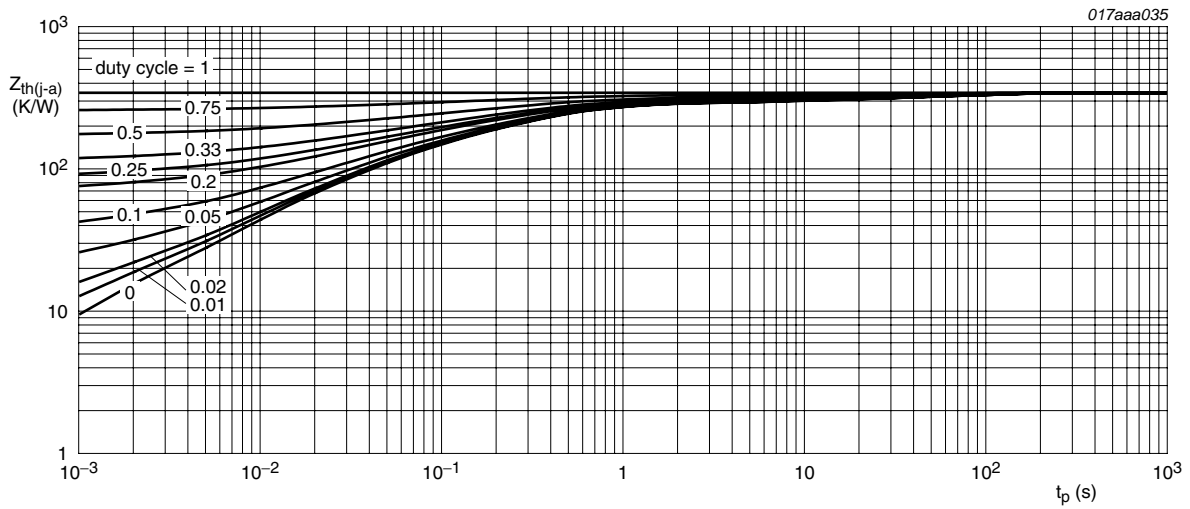
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.

[2] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain  $1 \text{ cm}^2$ .



FR4 PCB, standard footprint

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



FR4 PCB, mounting pad for drain 1 cm<sup>2</sup>

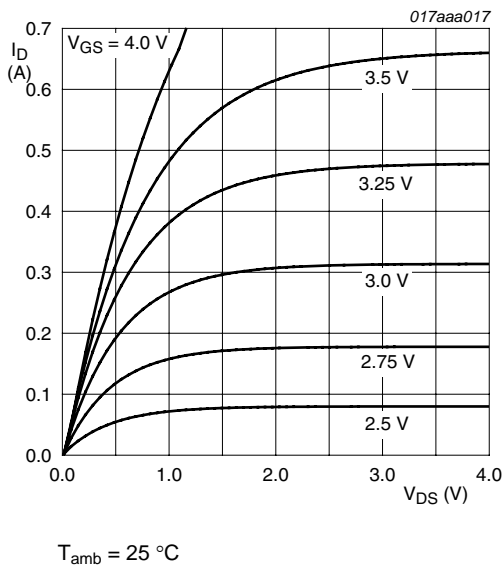
**Fig 5. Per transistor: Transient thermal impedance from junction to ambient as a function of pulse duration; typical values**

## 7. Characteristics

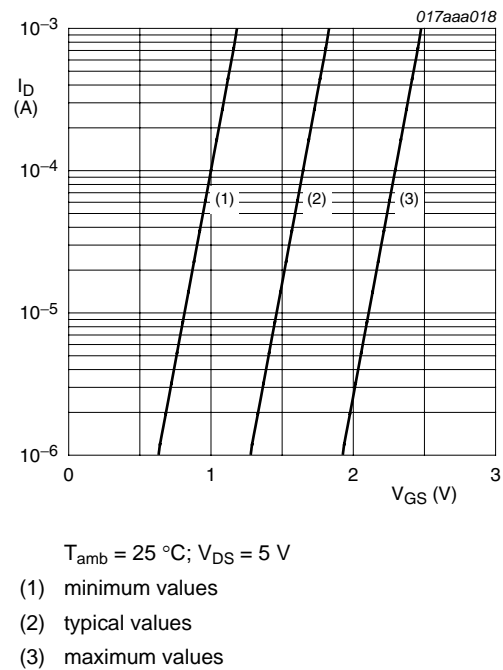
**Table 7. Characteristics**
*T<sub>j</sub> = 25 °C unless otherwise specified.*

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Per transistor</b>						
<b>Static characteristics</b>						
V <sub>(BR)DSS</sub>	drain-source breakdown voltage	I <sub>D</sub> = 10 μA; V <sub>GS</sub> = 0 V	60	-	-	V
V <sub>GS(th)</sub>	gate-source threshold voltage	I <sub>D</sub> = 250 μA; V <sub>DS</sub> = V <sub>GS</sub>	1.1	1.75	2.4	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
		T <sub>j</sub> = 150 °C	-	-	10	μA
I <sub>GSS</sub>	gate leakage current	V <sub>GS</sub> = ±20 V; V <sub>DS</sub> = 0 V	-	-	100	nA
R <sub>DS(on)</sub>	drain-source on-state resistance		[1]			
		V <sub>GS</sub> = 5 V; I <sub>D</sub> = 50 mA	-	1.3	2	Ω
		V <sub>GS</sub> = 10 V; I <sub>D</sub> = 500 mA	-	1	1.6	Ω
g <sub>fs</sub>	forward transconductance	V <sub>DS</sub> = 10 V; I <sub>D</sub> = 200 mA	[1]	400	-	mS
<b>Dynamic characteristics</b>						
Q <sub>G(tot)</sub>	total gate charge	I <sub>D</sub> = 300 mA;	-	0.6	0.8	nC
Q <sub>GS</sub>	gate-source charge	V <sub>DS</sub> = 30 V;	-	0.2	-	nC
Q <sub>GD</sub>	gate-drain charge	V <sub>GS</sub> = 4.5 V	-	0.2	-	nC
C <sub>iss</sub>	input capacitance	V <sub>GS</sub> = 0 V; V <sub>DS</sub> = 10 V;	-	30	50	pF
C <sub>oss</sub>	output capacitance	f = 1 MHz	-	7	-	pF
C <sub>rss</sub>	reverse transfer capacitance		-	4	-	pF
t <sub>d(on)</sub>	turn-on delay time	V <sub>DD</sub> = 50 V;	-	3	6	ns
t <sub>r</sub>	rise time	R <sub>L</sub> = 250 Ω;	-	4	-	ns
t <sub>d(off)</sub>	turn-off delay time	V <sub>GS</sub> = 10 V;	-	10	20	ns
t <sub>f</sub>	fall time	R <sub>G</sub> = 6 Ω	-	5	-	ns
<b>Source-drain diode</b>						
V <sub>SD</sub>	source-drain voltage	I <sub>S</sub> = 115 mA; V <sub>GS</sub> = 0 V	0.47	0.75	1.1	V

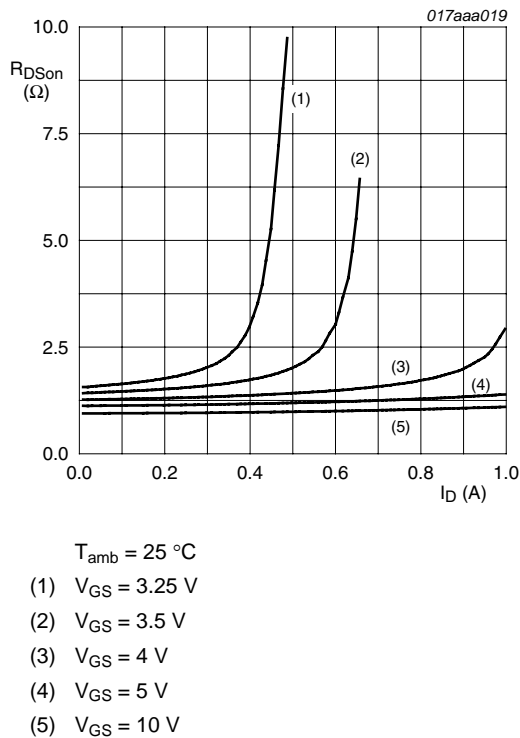
 [1] Pulse test: t<sub>p</sub> ≤ 300 μs; δ ≤ 0.01.



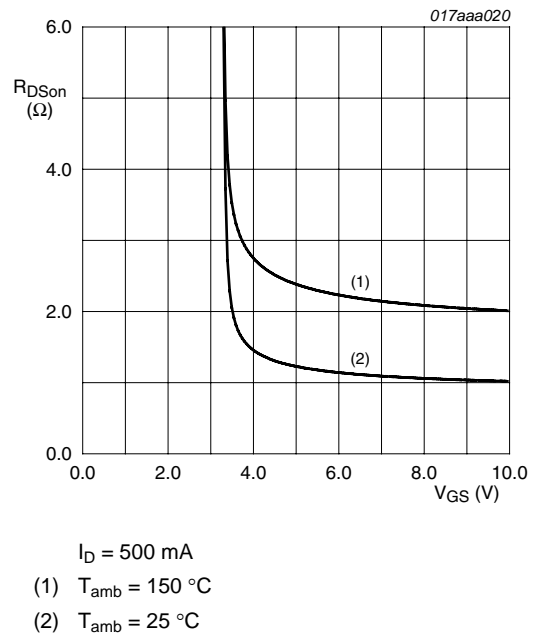
**Fig 6. Per transistor: Output characteristics: drain current as a function of drain-source voltage; typical values**



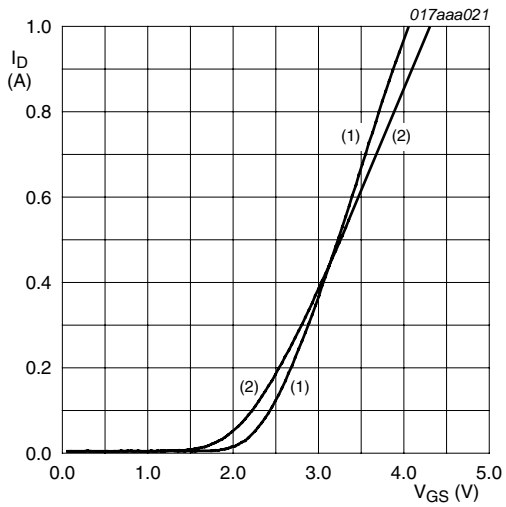
**Fig 7. Per transistor: Sub-threshold drain current as a function of gate-source voltage**



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

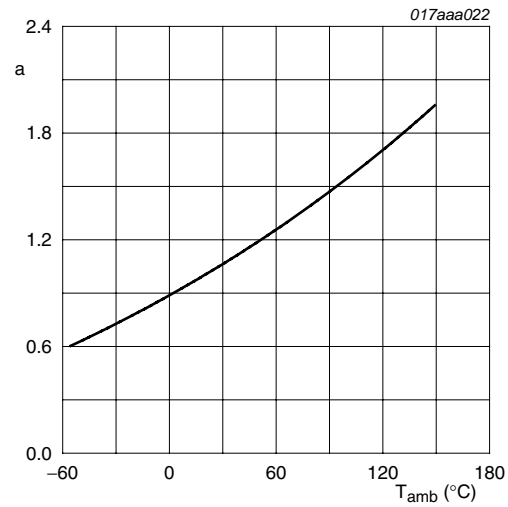


**Fig 9. Per transistor: Drain-source on-state resistance as a function of gate-source voltage; typical values**



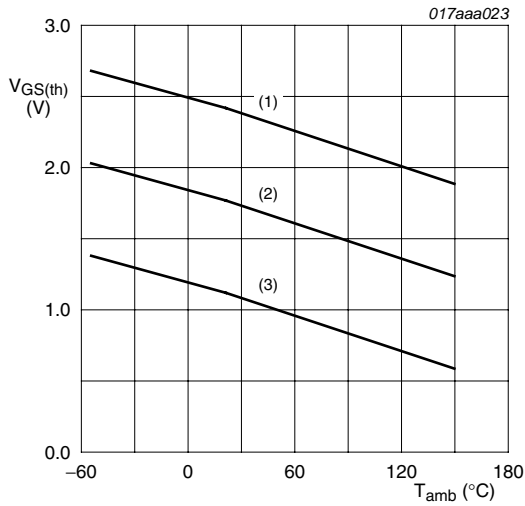
$V_{DS} > I_D \times R_{DS(on)}$   
 (1)  $T_{amb} = 25\text{ °C}$   
 (2)  $T_{amb} = 150\text{ °C}$

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



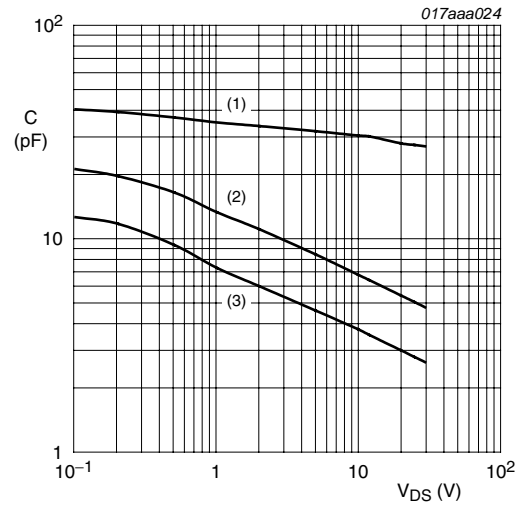
$$a = \frac{R_{DS(on)}}{R_{DS(on)(25^\circ C)}}$$

**Fig 11. Per transistor: 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

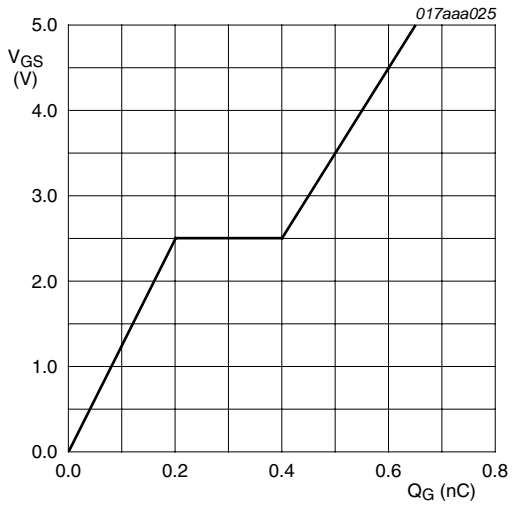
**Fig 12. Per transistor: Gate-source threshold voltage as a function of ambient temperature**



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

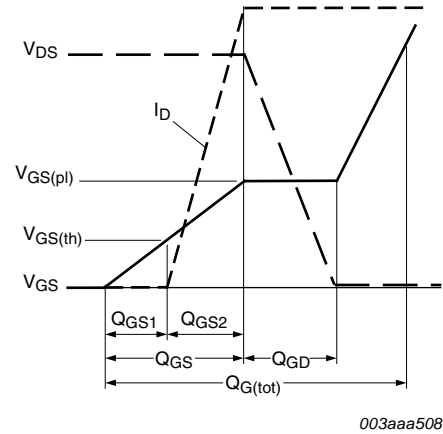
**Fig 13. Per transistor: Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values**



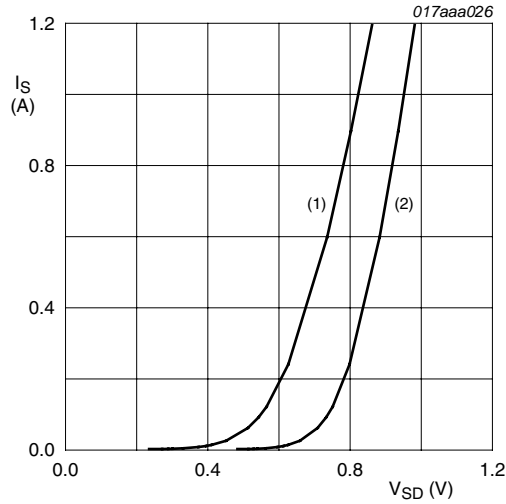


$I_D = 300 \text{ mA}$ ;  $V_{DS} = 30 \text{ V}$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$

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



**Fig 15. Per transistor: Gate charge waveform definitions**

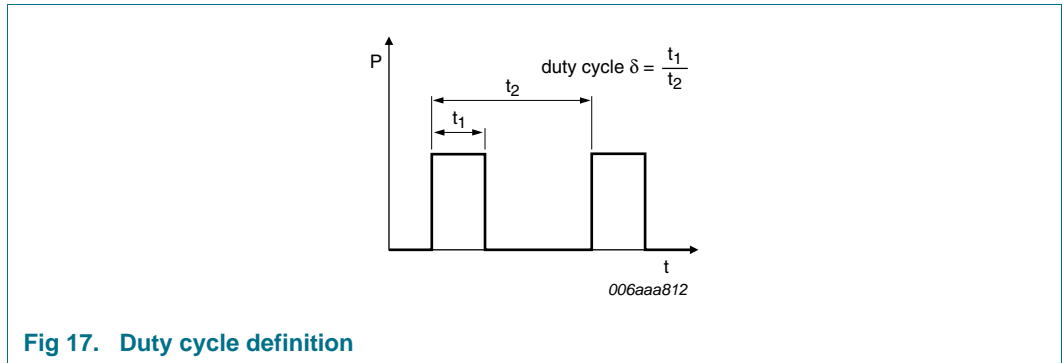


$V_{GS} = 0 \text{ V}$

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

**Fig 16. Per transistor: 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; 6 leads

SOT363

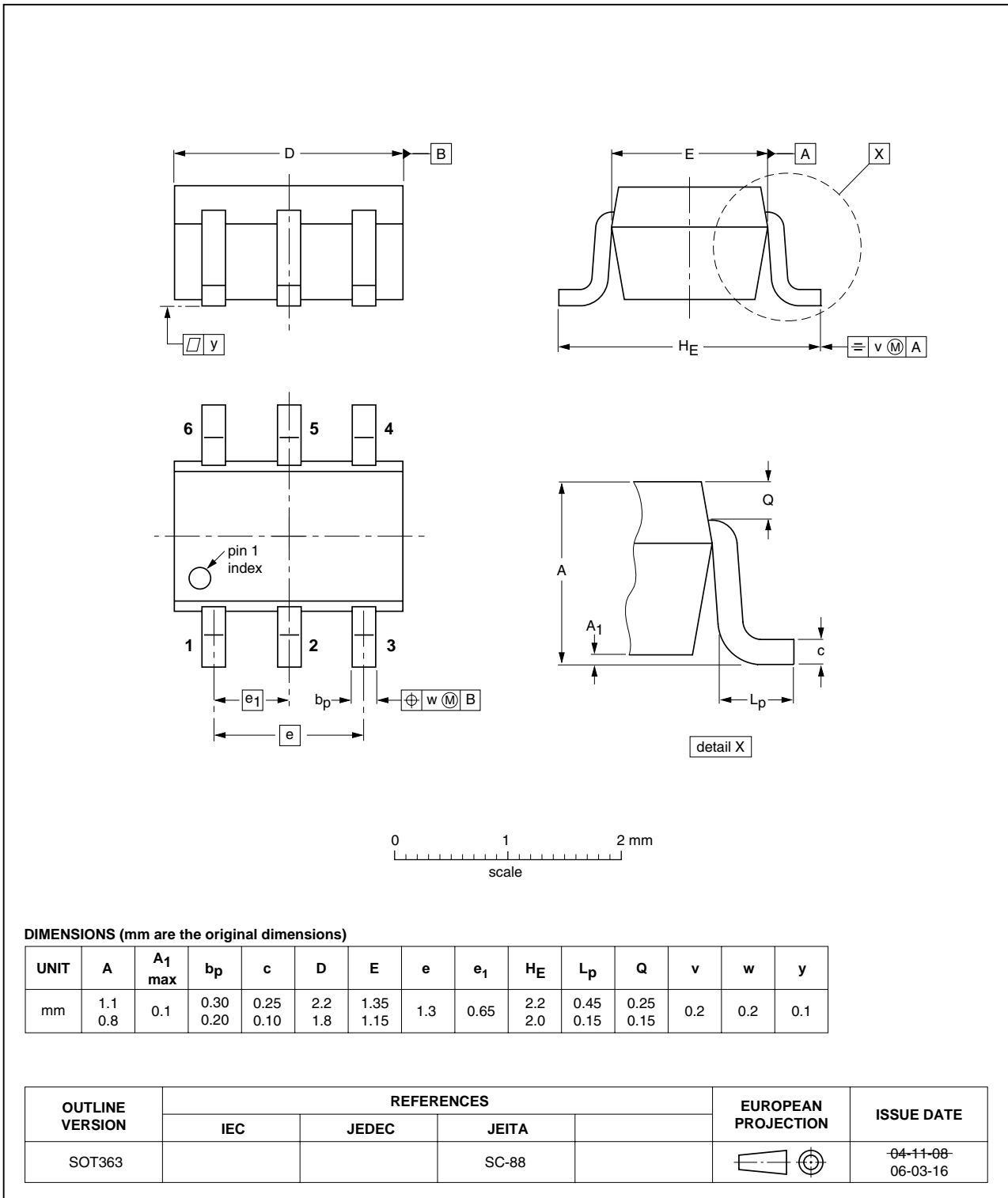


Fig 18. Package outline SOT363 (SC-88)

### 10. Soldering

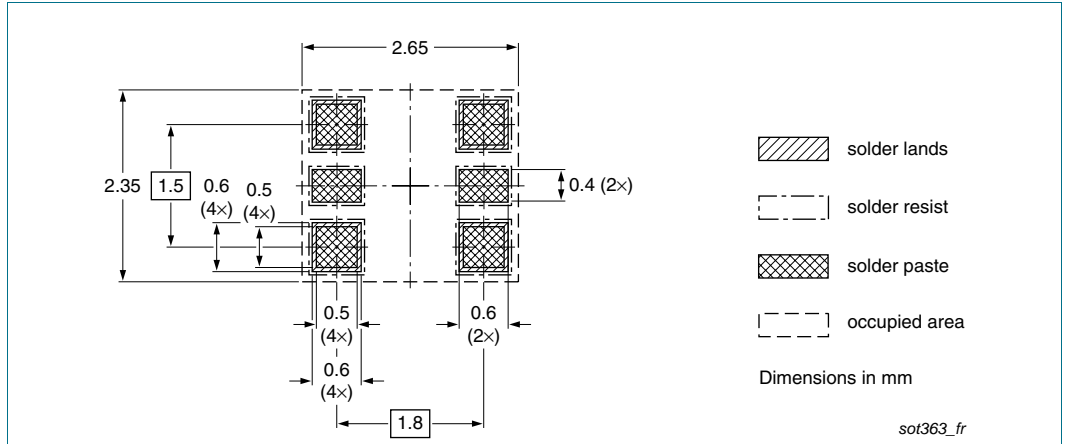


Fig 19. Reflow soldering footprint SOT363 (SC-88)

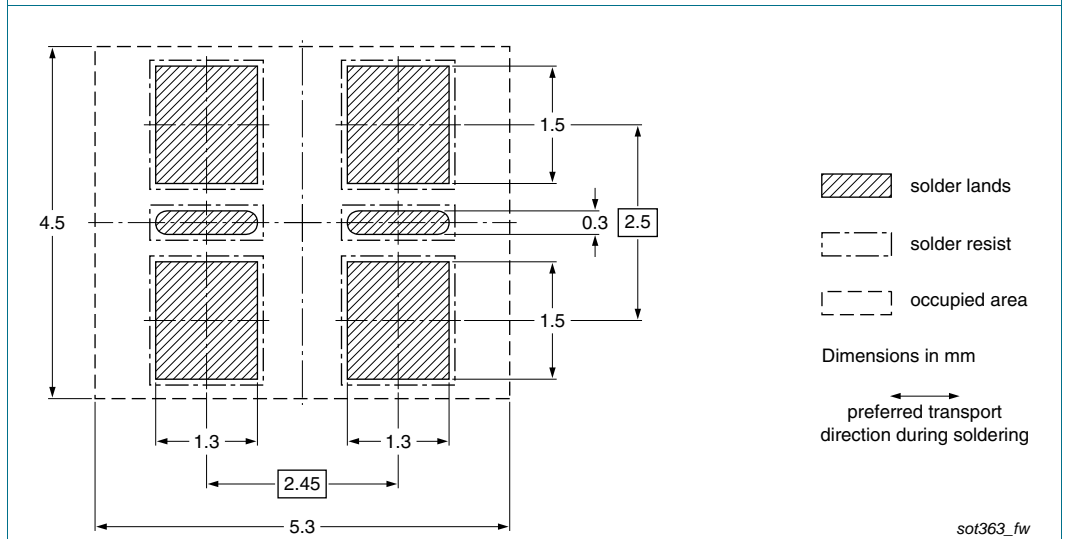


Fig 20. Wave soldering footprint SOT363 (SC-88)

## 11. Revision history

Table 8. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
2N7002PS v.1	20100701	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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