

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

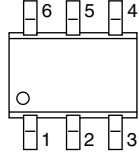
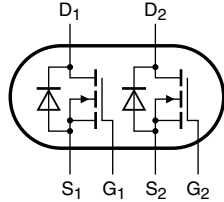
Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Per transistor						
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] -	-	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	Ω

[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated, mounting pad for drain 1 cm².

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

4. Marking

Table 4. Marking codes

Type number	Marking code ^[1]
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

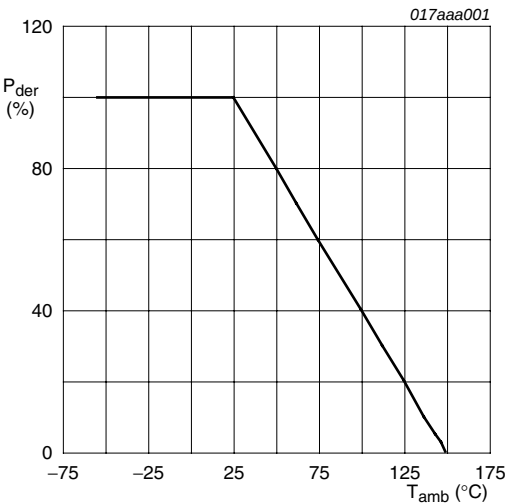
In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
Per transistor					
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).

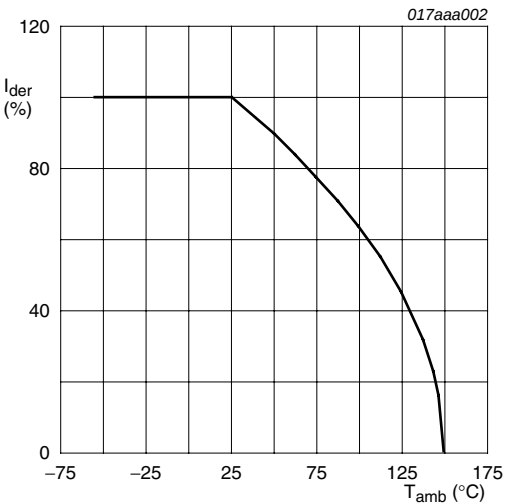
Symbol	Parameter	Conditions	Min	Max	Unit
P _{tot}	total power dissipation	T _{amb} = 25 °C	[2] -	280	mW
			[1] -	320	mW
		T _{sp} = 25 °C	-	990	mW
Source-drain diode					
I _S	source current	T _{amb} = 25 °C	[1] -	320	mA
Per device					
P _{tot}	total power dissipation	T _{amb} = 25 °C	[2] -	420	mW
T _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 cm².
[2] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and standard footprint.



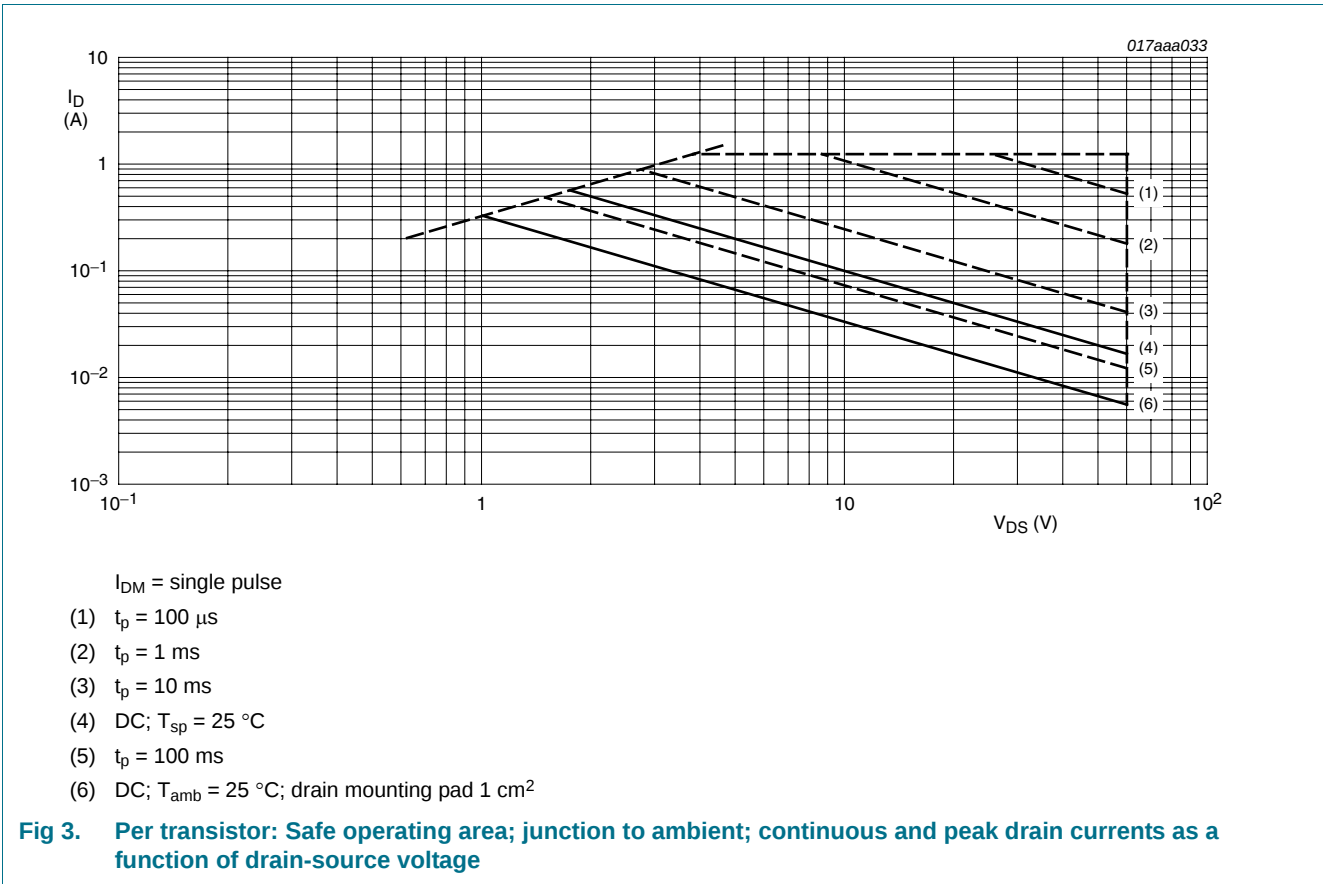
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100 \%$$

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



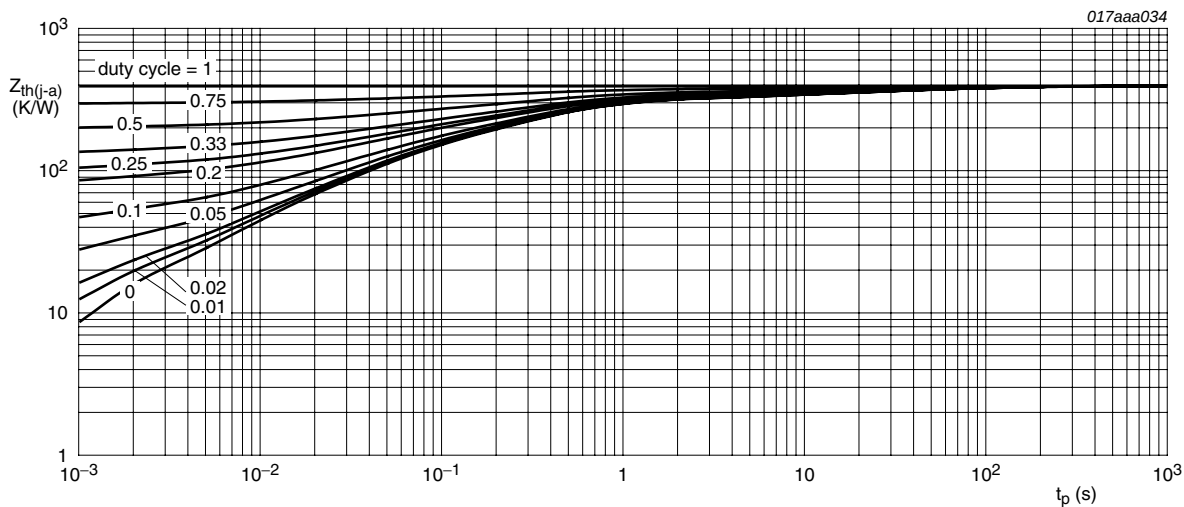
6. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Per transistor						
$R_{th(j-a)}$	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
Per device						
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1] -	-	300	K/W

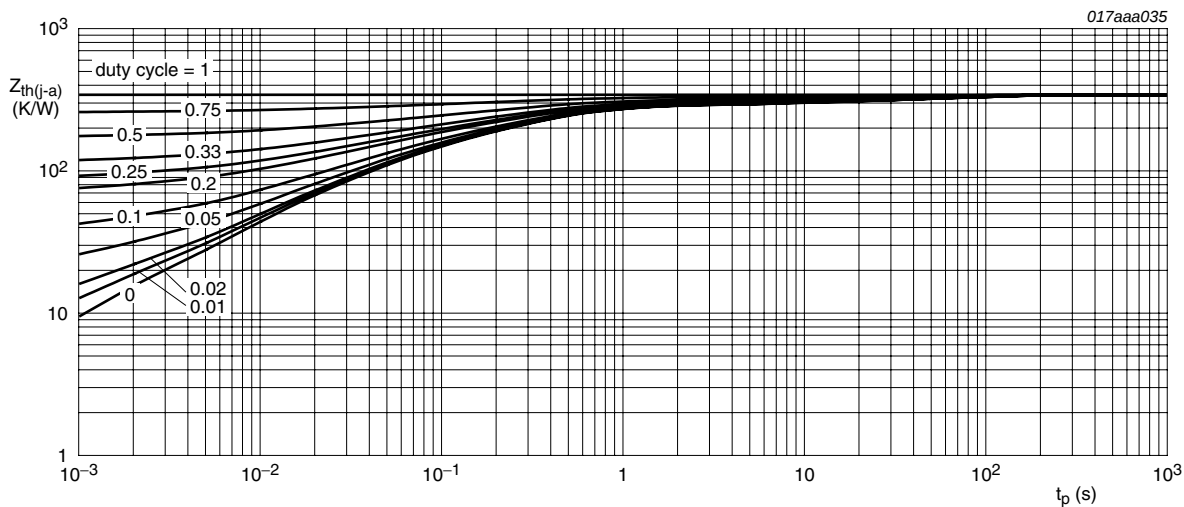
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.

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



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 cm²

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

7. Characteristics

Table 7. Characteristics

$T_j = 25\text{ }^{\circ}\text{C}$ unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Per transistor						
Static characteristics						
$V_{(BR)DSS}$	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	1.75	2.4	V
I_{DSS}	drain leakage current	$V_{DS} = 60\text{ V}$; $V_{GS} = 0\text{ V}$				
		$T_j = 25\text{ }^{\circ}\text{C}$	-	-	1	μA
		$T_j = 150\text{ }^{\circ}\text{C}$	-	-	10	μA
I_{GSS}	gate leakage current	$V_{GS} = \pm 20\text{ V}$; $V_{DS} = 0\text{ V}$	-	-	100	nA
$R_{DS(on)}$	drain-source on-state resistance	[1]				
		$V_{GS} = 5\text{ V}$; $I_D = 50\text{ mA}$	-	1.3	2	Ω
		$V_{GS} = 10\text{ V}$; $I_D = 500\text{ mA}$	-	1	1.6	Ω
g_{fs}	forward transconductance	$V_{DS} = 10\text{ V}$; $I_D = 200\text{ mA}$ [1]	-	400	-	mS
Dynamic characteristics						
$Q_{G(tot)}$	total gate charge	$I_D = 300\text{ mA}$;	-	0.6	0.8	nC
Q_{GS}	gate-source charge	$V_{DS} = 30\text{ V}$;	-	0.2	-	nC
Q_{GD}	gate-drain charge	$V_{GS} = 4.5\text{ V}$	-	0.2	-	nC
C_{iss}	input capacitance	$V_{GS} = 0\text{ V}$; $V_{DS} = 10\text{ V}$;	-	30	50	pF
C_{oss}	output capacitance	$f = 1\text{ MHz}$	-	7	-	pF
C_{rss}	reverse transfer capacitance		-	4	-	pF
$t_{d(on)}$	turn-on delay time	$V_{DD} = 50\text{ V}$;	-	3	6	ns
t_r	rise time	$R_L = 250\text{ }\Omega$;	-	4	-	ns
$t_{d(off)}$	turn-off delay time	$V_{GS} = 10\text{ V}$;	-	10	20	ns
t_f	fall time	$R_G = 6\text{ }\Omega$	-	5	-	ns
Source-drain diode						
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: $t_p \leq 300\text{ }\mu\text{s}$; $\delta \leq 0.01$.

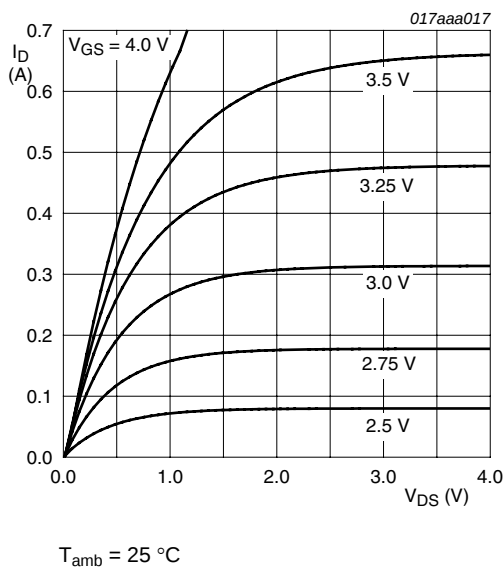


Fig 6. Per transistor: Output characteristics: drain current as a function of drain-source voltage; typical values

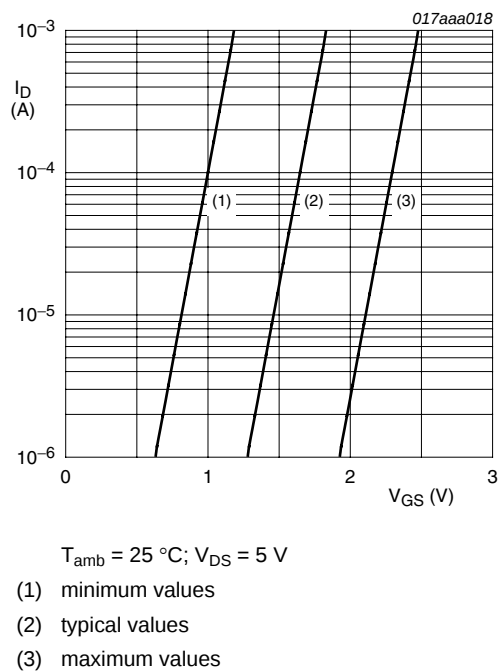


Fig 7. Per transistor: Sub-threshold drain current as a function of gate-source voltage

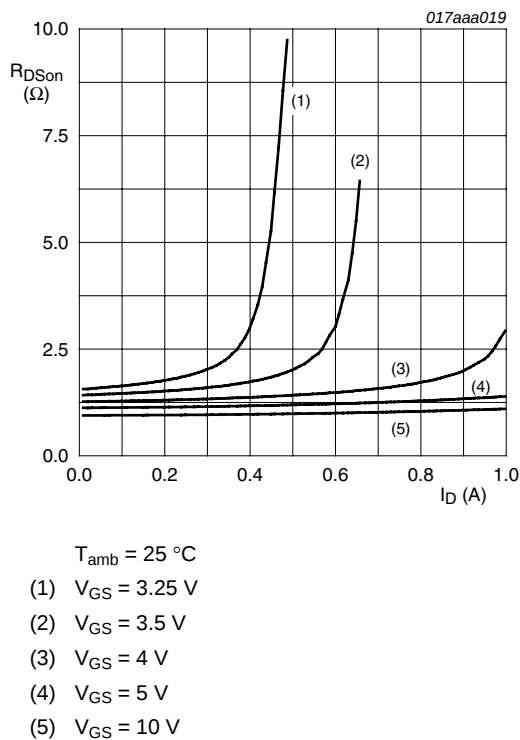


Fig 8. Per transistor: Drain-source on-state resistance as a function of drain current; typical values

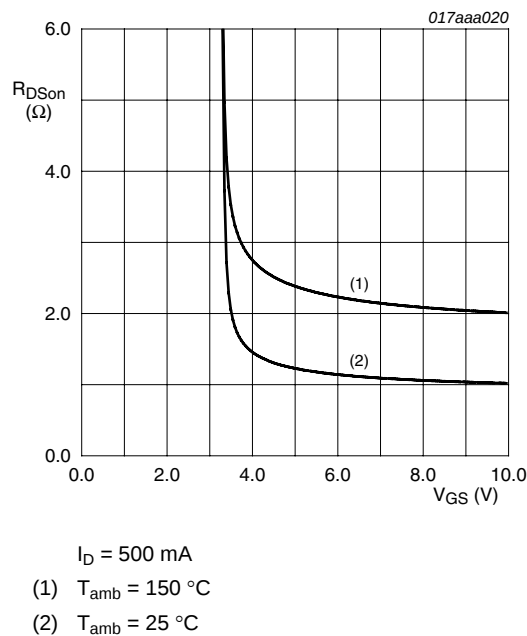
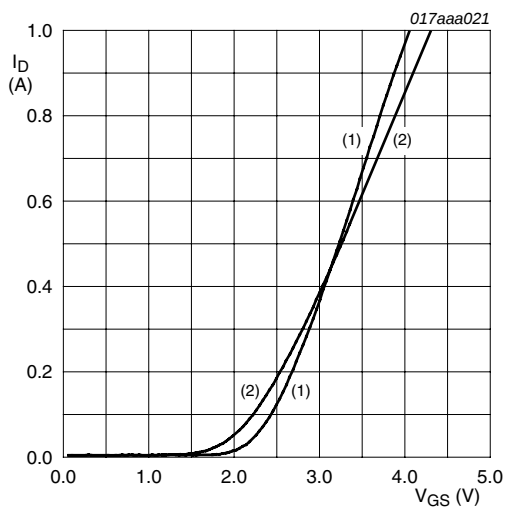


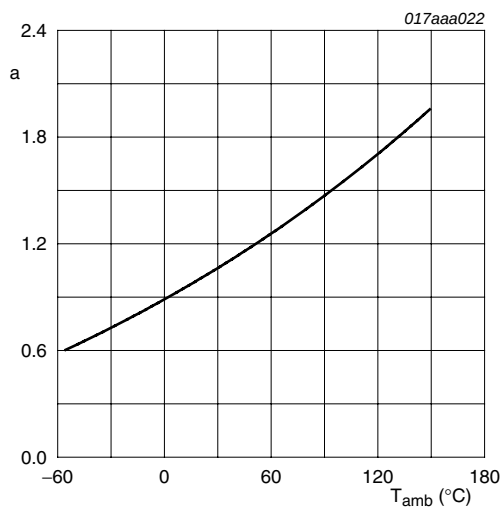
Fig 9. Per transistor: Drain-source on-state resistance as a function of gate-source voltage; typical values



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

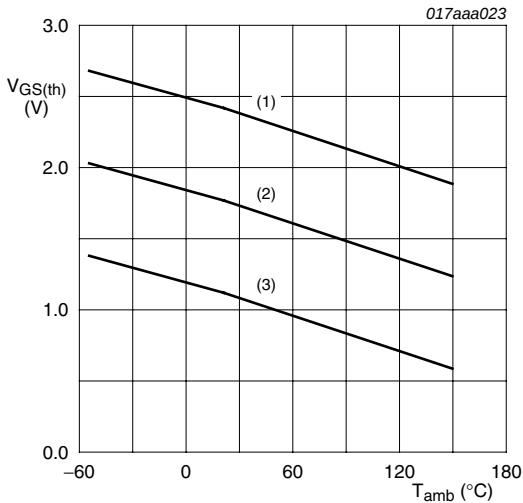
- (1) $T_{amb} = 25\text{ }^{\circ}\text{C}$
- (2) $T_{amb} = 150\text{ }^{\circ}\text{C}$

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



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

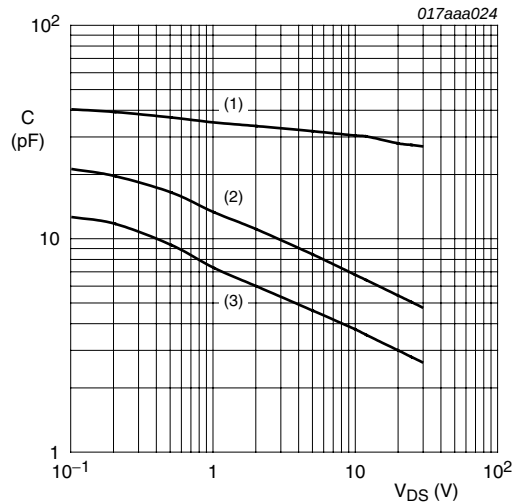
Fig 11. Per transistor: Normalized drain-source on-state resistance as a function of ambient temperature; typical values



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

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

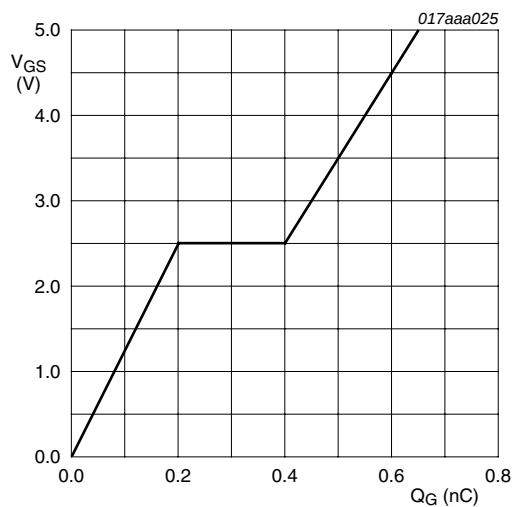
Fig 12. Per transistor: Gate-source threshold voltage as a function of ambient temperature



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

- (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

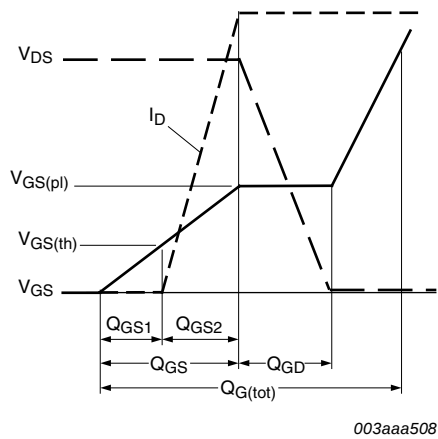
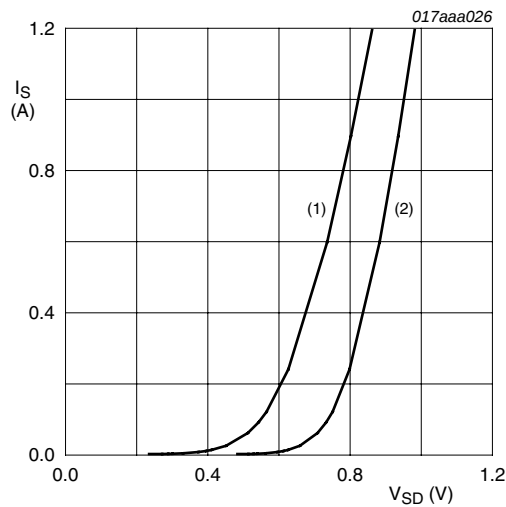


Fig 15. Per transistor: Gate charge waveform definitions



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

- (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

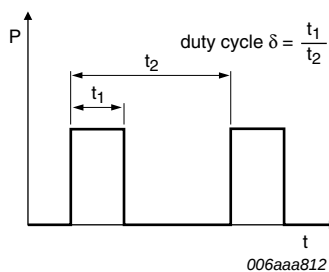


Fig 17. Duty cycle definition

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; 6 leads

SOT363

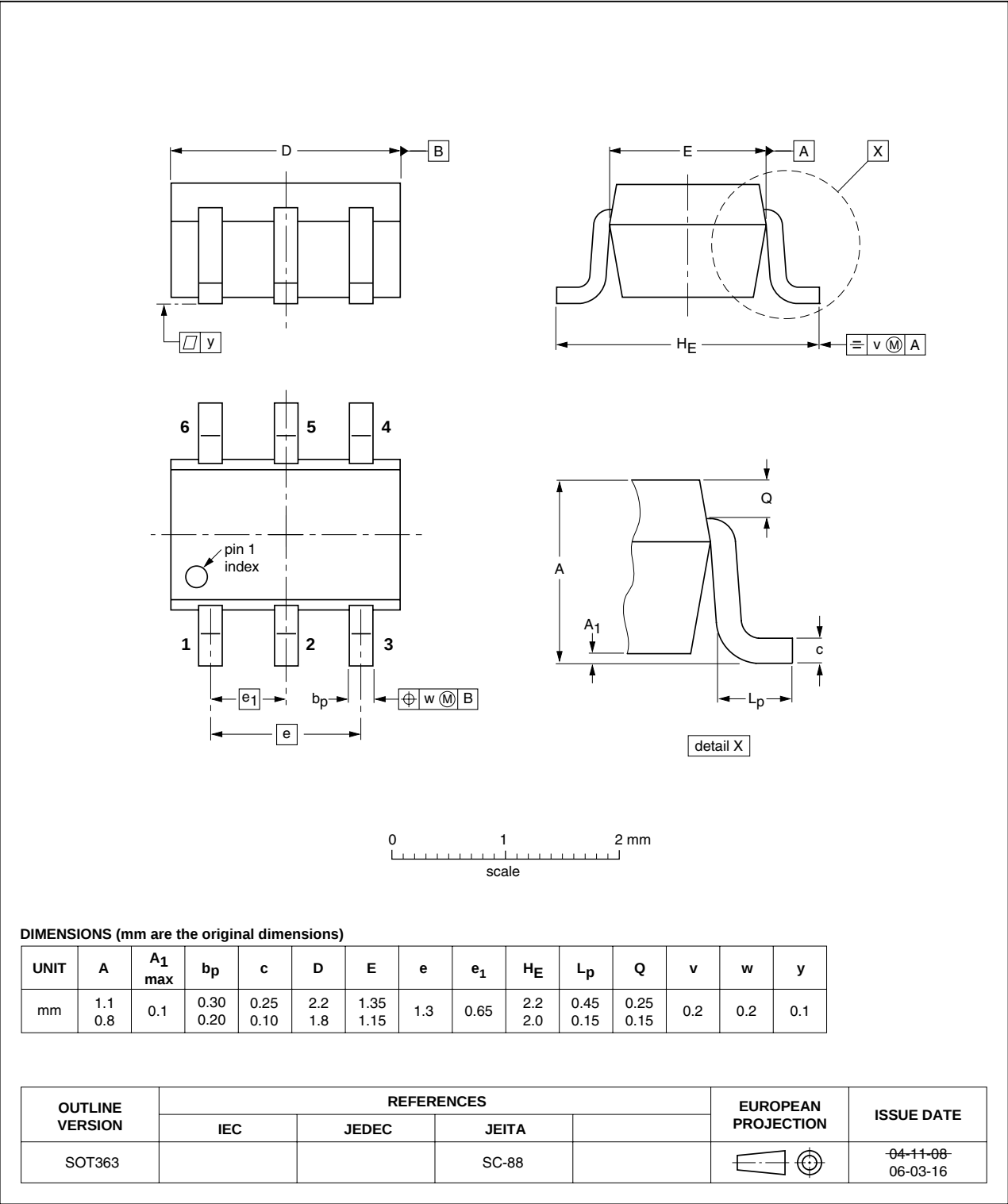


Fig 18. Package outline SOT363 (SC-88)

10. Soldering

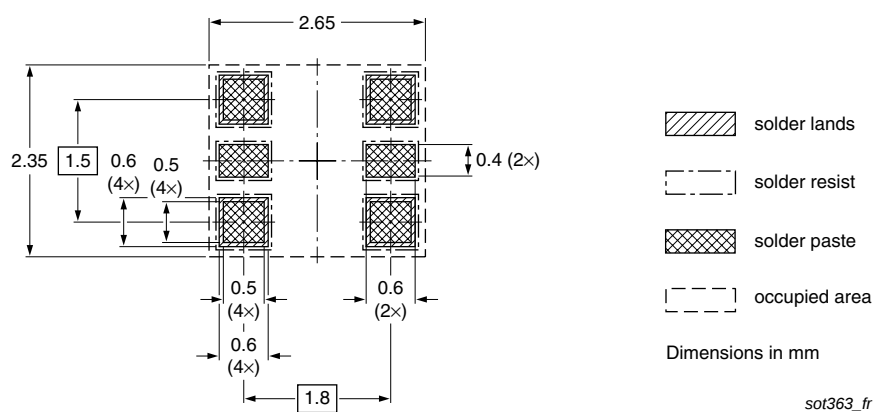


Fig 19. Reflow soldering footprint SOT363 (SC-88)

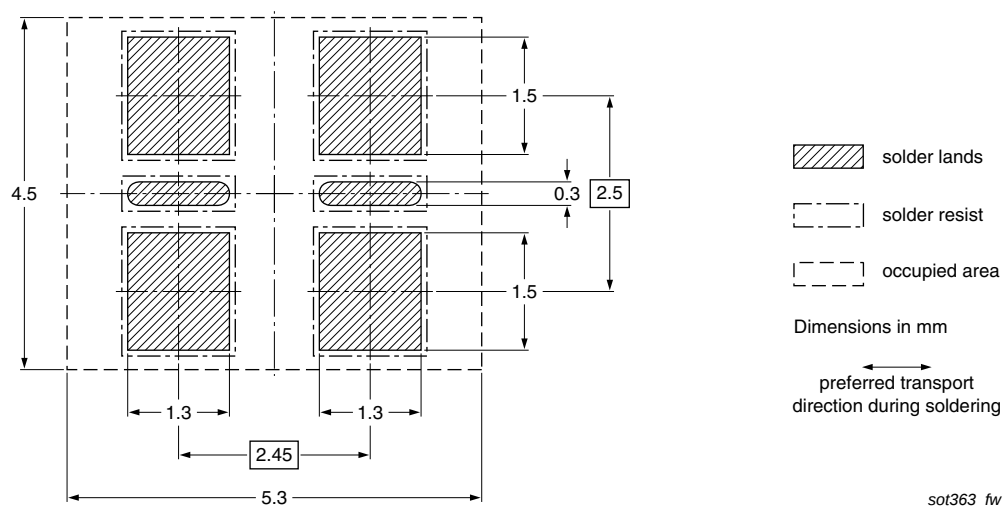


Fig 20. Wave soldering footprint SOT363 (SC-88)

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 ^{[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.
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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