

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

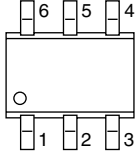
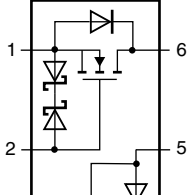
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{DS}	drain-source voltage	$T_{amb} = 25\text{ °C}$	-	-	60	V
V_{GS}	gate-source voltage	$T_{amb} = 25\text{ °C}$	-	-	± 20	V
I_D	drain current	$T_{amb} = 25\text{ °C};$ $V_{GS} = 10\text{ V}$	[1] -	-	300	mA
$R_{DS(on)}$	drain-source on-state resistance	$T_j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

[1] Device mounted on an FR4 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	source 1		
2	G1	gate 1		
3	D2	drain 2		
4	S2	source 2		
5	G2	gate 2		
6	D1	drain 1		

017aaa055

3. Ordering information

Table 3. Ordering information

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

4. Marking

Table 4. Marking codes

Type number	Marking code ^[1]
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
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]		
		$T_{amb} = 25\text{ °C}$	-	300	mA
		$T_{amb} = 100\text{ °C}$	-	215	mA

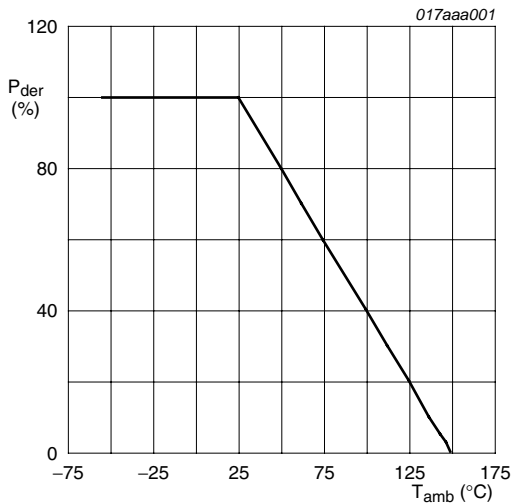
Table 5. Limiting values ...continued
 In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
I _{DM}	peak drain current	T _{amb} = 25 °C; single pulse; t _p ≤ 10 μs	-	1.2	A
P _{tot}	total power dissipation	T _{amb} = 25 °C	[2] -	295	mW
			[1] -	340	mW
		T _{sp} = 25 °C	-	1040	mW
Source-drain diode					
I _S	source current	T _{amb} = 25 °C	[1] -	300	mA
ESD maximum rating					
V _{ESD}	electrostatic discharge voltage	human body model	[3] -	2000	V
Per device					
P _{tot}	total power dissipation	T _{amb} = 25 °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 cm².

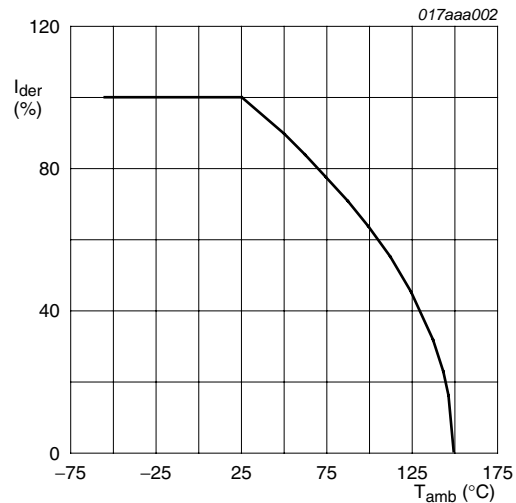
[2] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and standard footprint.

[3] Measured between all pins.



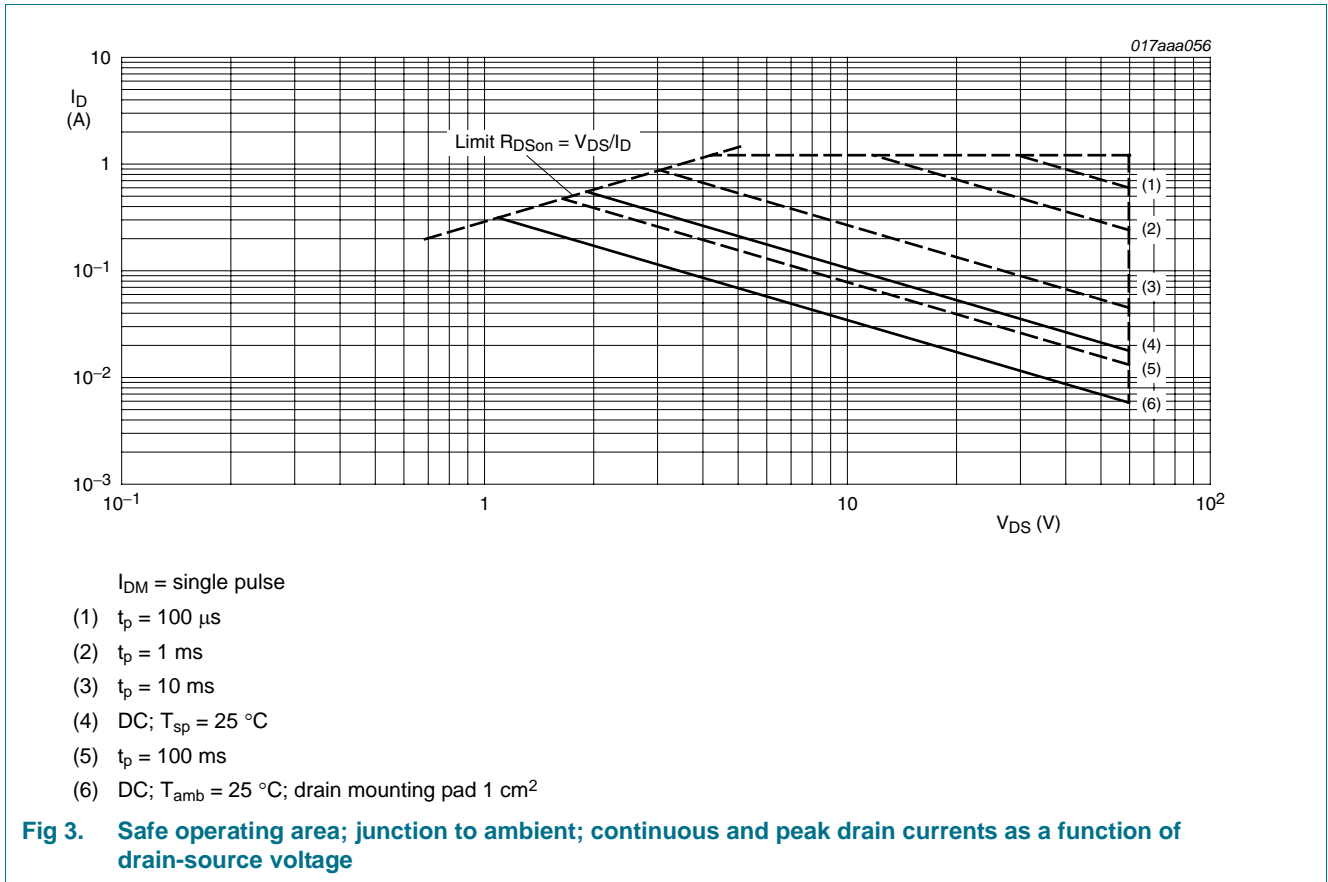
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\%$$

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



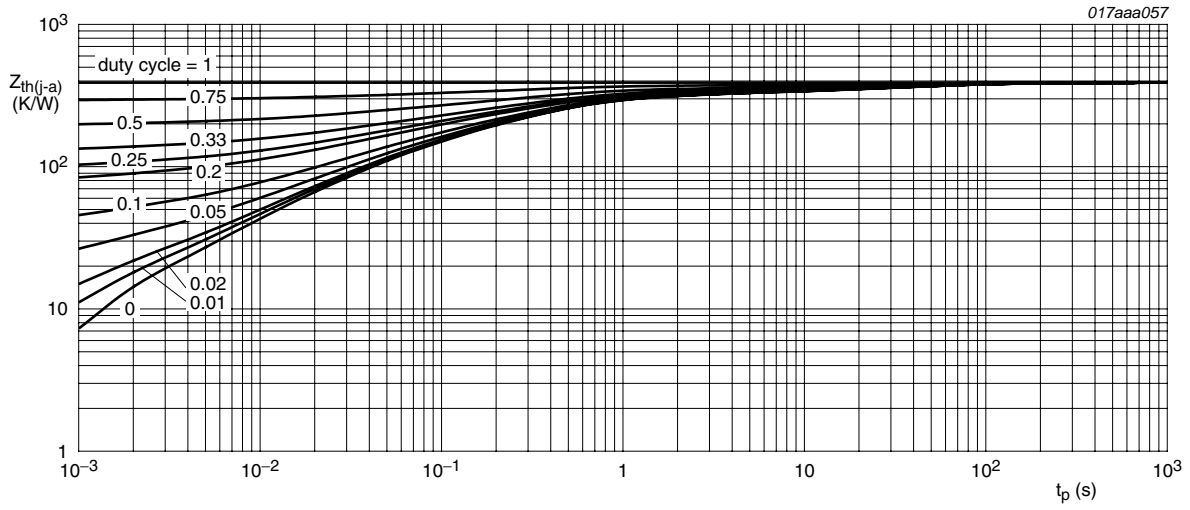
6. Thermal characteristics

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]	-	370	425 K/W
			[2]	-	320	370 K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point		-	-	120	K/W
Per device						
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	-	275 K/W

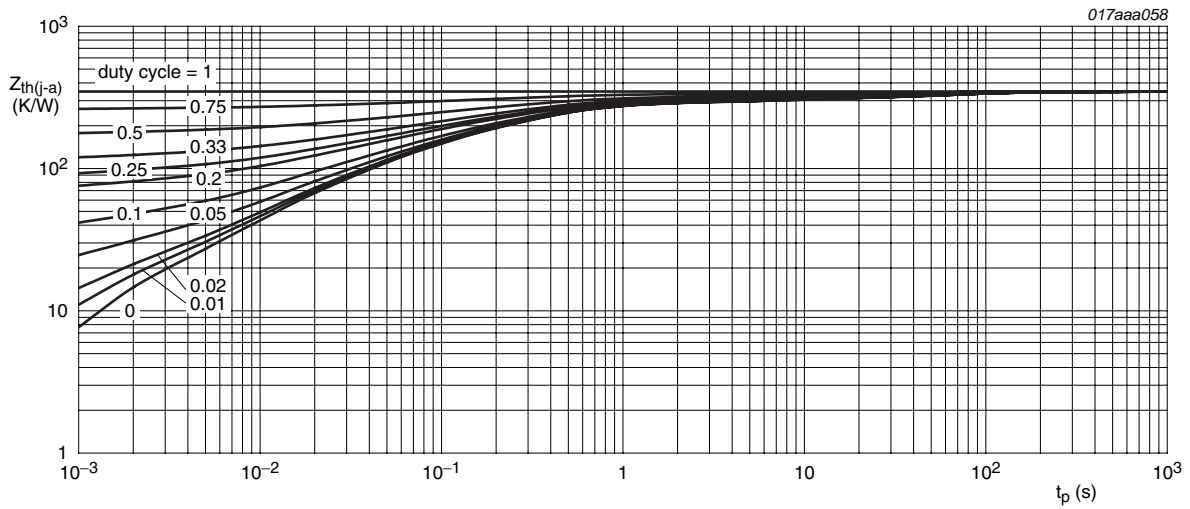
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.

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



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 1 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 °C unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Static characteristics						
V _{(BR)DSS}	drain-source breakdown voltage	I _D = 10 μA; V _{GS} = 0 V	60	-	-	V
V _{GS(th)}	gate-source threshold voltage	I _D = 250 μA; V _{DS} = V _{GS}	1.1	1.6	2.1	V
I _{DSS}	drain leakage current	V _{DS} = 60 V; V _{GS} = 0 V				
		T _j = 25 °C	-	-	1	μA
		T _j = 150 °C	-	-	10	μA
I _{GSS}	gate leakage current	V _{GS} = ±20 V; V _{DS} = 0 V	-	-	10	μA
R _{DS(on)}	drain-source on-state resistance		[1]			
		V _{GS} = 5 V; I _D = 50 mA	-	1.3	2	Ω
		V _{GS} = 10 V; I _D = 500 mA	-	1	1.6	Ω
g _{fs}	forward transconductance	V _{DS} = 10 V; I _D = 200 mA	[1]	-	550	mS
Dynamic characteristics						
Q _{G(tot)}	total gate charge	I _D = 300 mA;	-	0.5	0.6	nC
Q _{GS}	gate-source charge	V _{DS} = 30 V;	-	0.2	-	nC
Q _{GD}	gate-drain charge	V _{GS} = 4.5 V	-	0.1	-	nC
C _{iss}	input capacitance	V _{GS} = 0 V; V _{DS} = 10 V;	-	33	50	pF
C _{oss}	output capacitance	f = 1 MHz	-	7	-	pF
C _{rss}	reverse transfer capacitance		-	4	-	pF
t _{d(on)}	turn-on delay time	V _{DD} = 50 V;	-	5	10	ns
t _r	rise time	R _L = 250 Ω;	-	6	-	ns
t _{d(off)}	turn-off delay time	V _{GS} = 10 V;	-	12	24	ns
t _f	fall time	R _G = 6 Ω	-	7	-	ns
Source-drain diode						
V _{SD}	source-drain voltage	I _S = 115 mA; V _{GS} = 0 V	0.47	0.75	1.1	V

 [1] Pulse test: t_p ≤ 300 μs; δ ≤ 0.01.

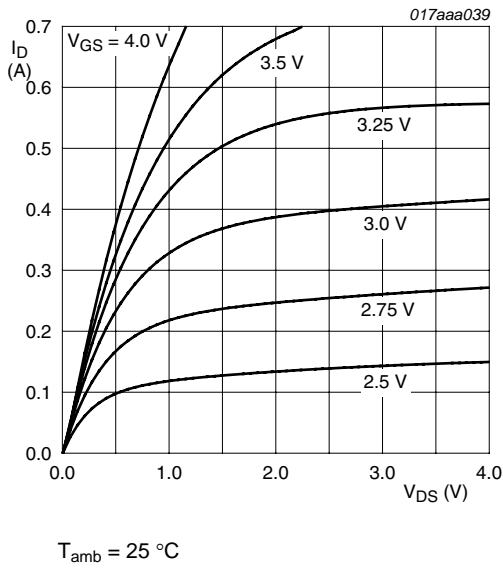


Fig 6. Output characteristics: drain current as a function of drain-source voltage; typical values

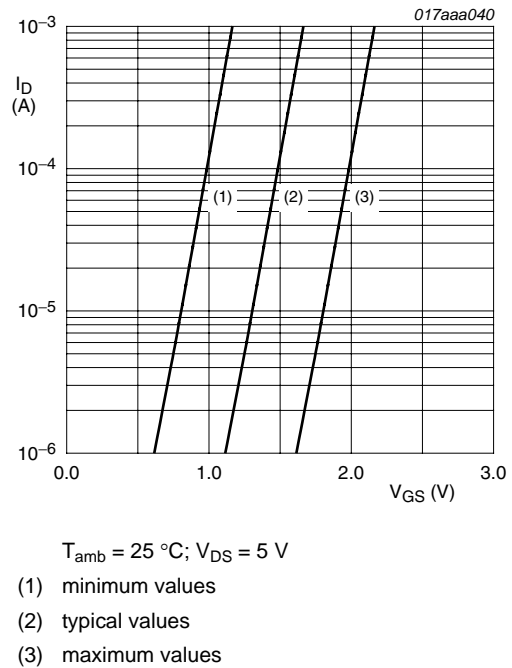


Fig 7. Sub-threshold drain current as a function of gate-source voltage

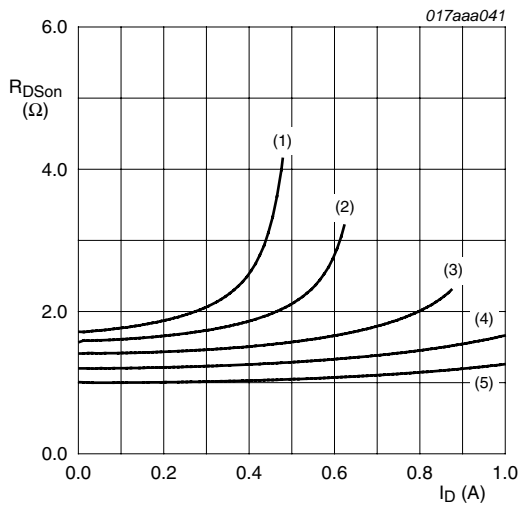


Fig 8. Drain-source on-state resistance as a function of drain current; typical values

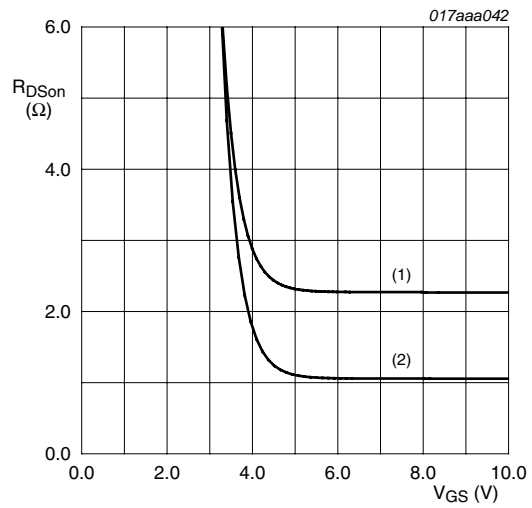
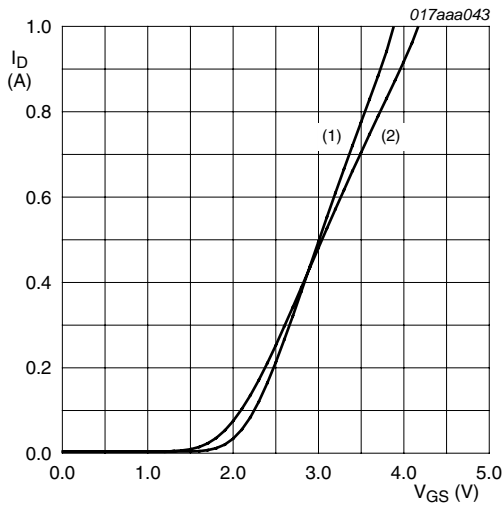
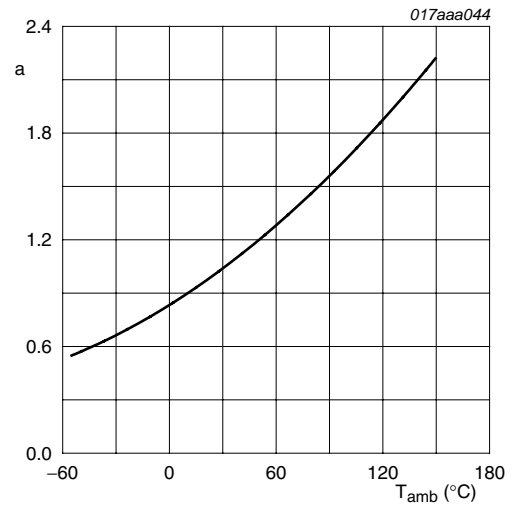


Fig 9. Drain-source on-state resistance as a function of gate-source voltage; typical values



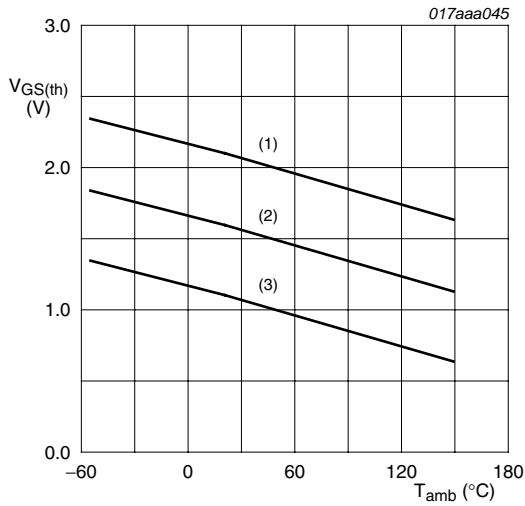
$V_{DS} > I_D \times R_{DSon}$
 (1) $T_{amb} = 25\text{ °C}$
 (2) $T_{amb} = 150\text{ °C}$

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



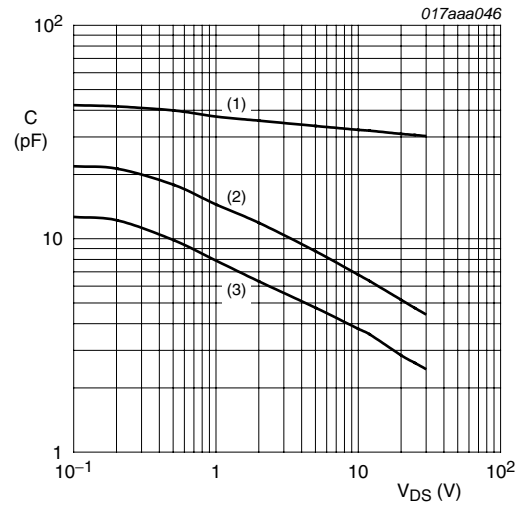
$$a = \frac{R_{DSon}}{R_{DSon(25\text{ °C})}}$$

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



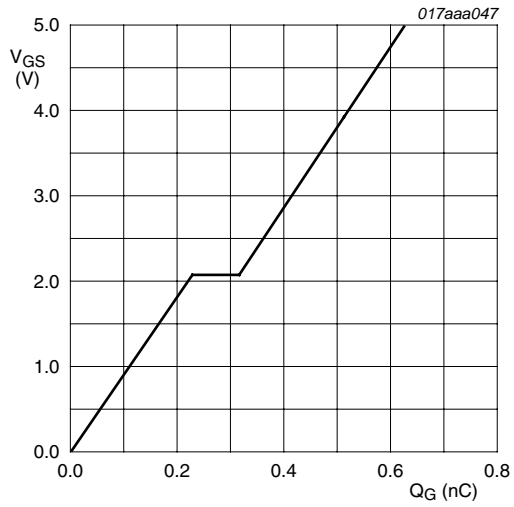
$I_D = 0.25\text{ mA}$; $V_{DS} = V_{GS}$
 (1) maximum values
 (2) typical values
 (3) minimum values

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

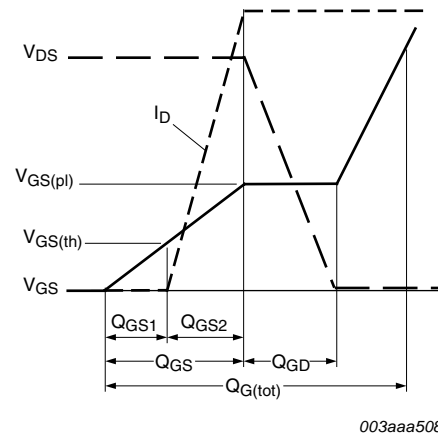
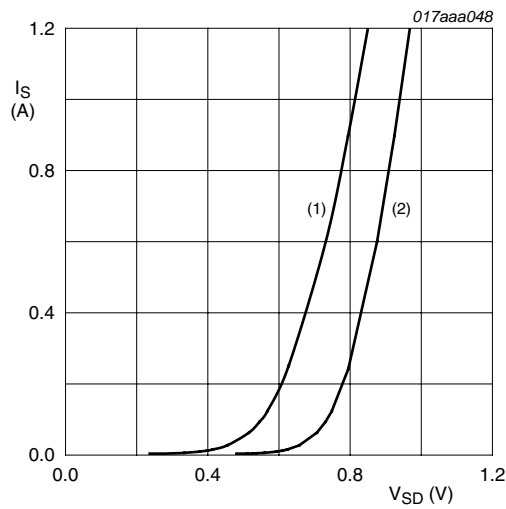


Fig 15. Gate charge waveform definitions



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

- (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

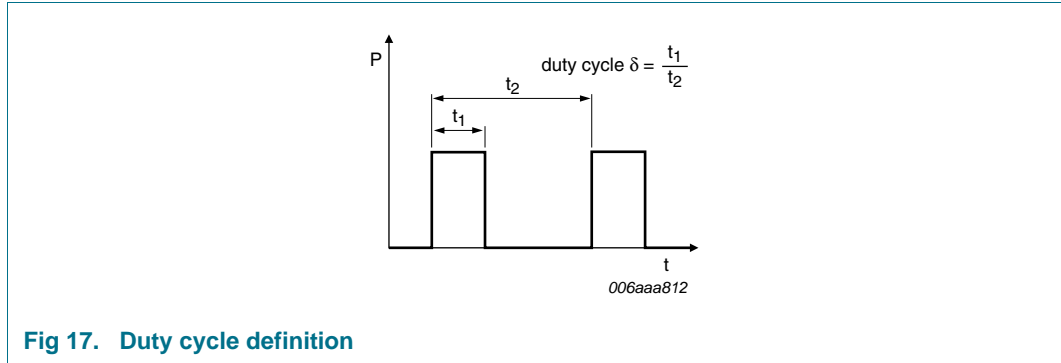


Fig 17. Duty cycle definition

9. Package outline

Plastic surface-mounted package; 6 leads

SOT363

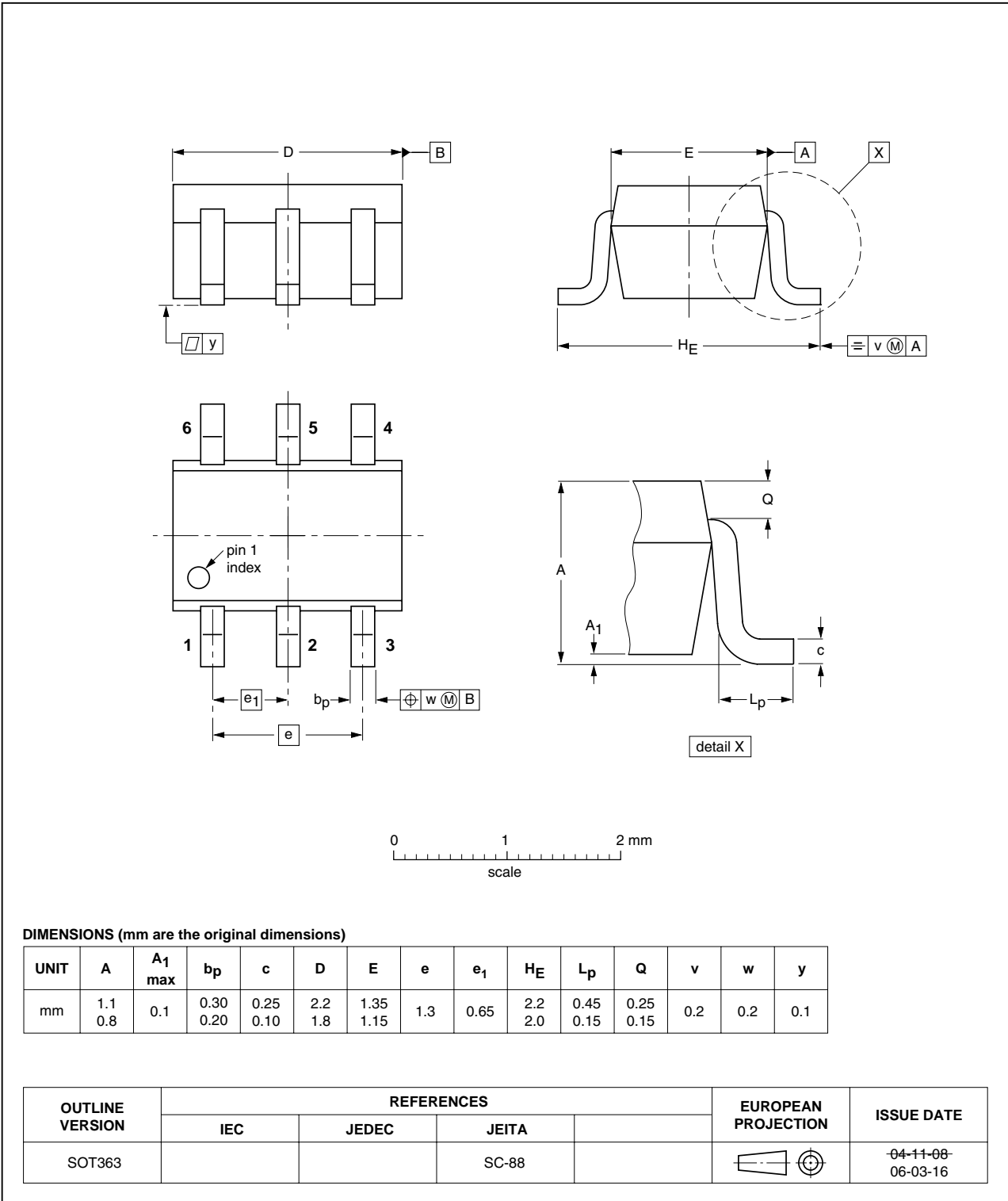


Fig 18. Package outline SOT363 (SC-88)

10. Soldering

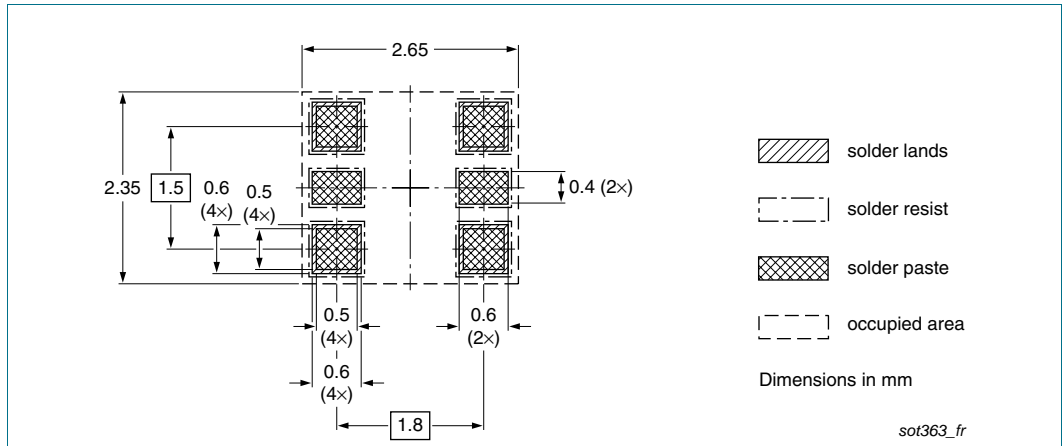


Fig 19. Reflow soldering footprint SOT363 (SC-88)

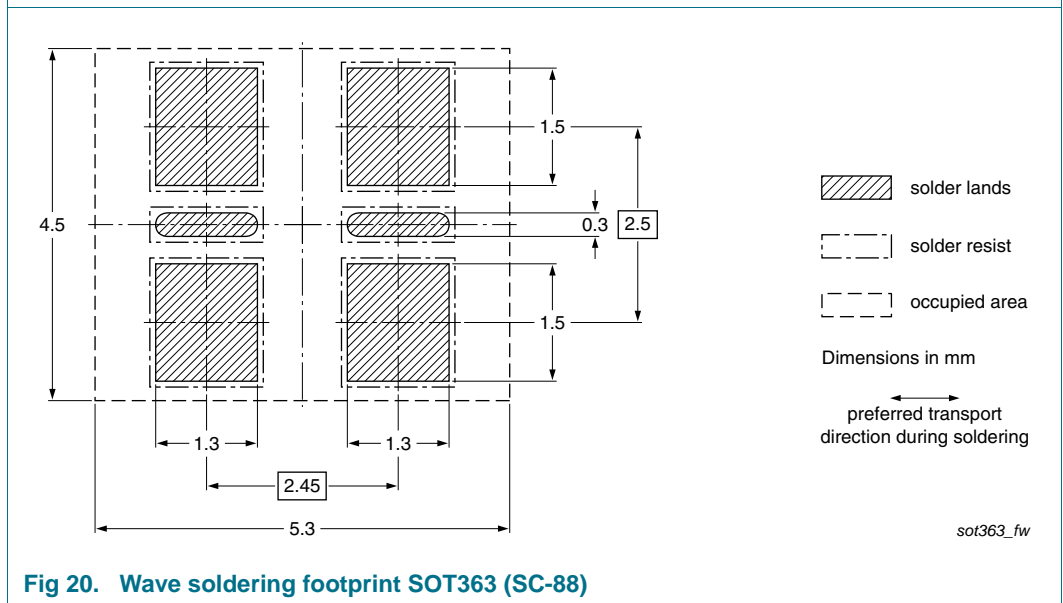


Fig 20. Wave soldering footprint SOT363 (SC-88)

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:	• Table 2 "Pinning" : graphic symbol amended			
2N7002BKS v.1	20100617	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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