

2N7002BKW

60 V, 310 mA N-channel Trench MOSFET

Rev. 1 — 17 June 2010

Product data sheet

1. Product profile

1.1 General description

N-channel enhancement mode Field-Effect Transistor (FET) in a small SOT323 (SC-70) 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

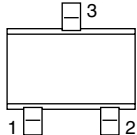
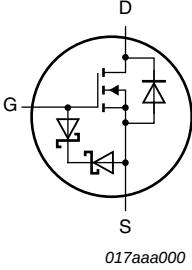
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{DS}	drain-source voltage	$T_{amb} = 25\text{ }^{\circ}\text{C}$	-	-	60	V
V_{GS}	gate-source voltage	$T_{amb} = 25\text{ }^{\circ}\text{C}$	-	-	± 20	V
I_D	drain current	$T_{amb} = 25\text{ }^{\circ}\text{C};$ $V_{GS} = 10\text{ V}$	[1] -	-	310	mA
$R_{DS(on)}$	drain-source on-state resistance	$T_j = 25\text{ }^{\circ}\text{C};$ $V_{GS} = 10\text{ V};$ $I_D = 500\text{ mA}$	-	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	G	gate		
2	S	source		
3	D	drain		

3. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
2N7002BKW	SC-70	plastic surface-mounted package; 3 leads	SOT323

4. Marking

Table 4. Marking codes

Type number	Marking code ^[1]
2N7002BKW	X9*

- [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

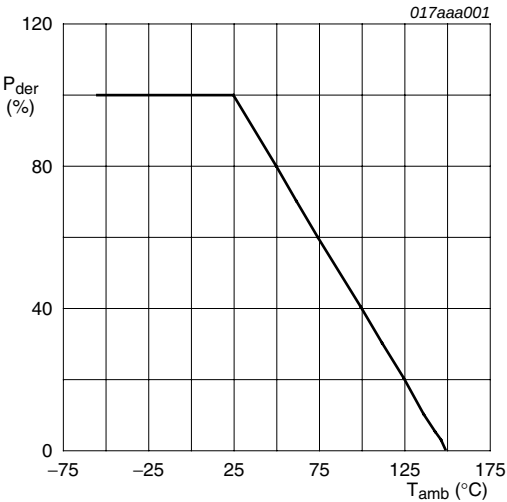
In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
V_{DS}	drain-source voltage	$T_{amb} = 25\text{ }^{\circ}\text{C}$	-	60	V
V_{GS}	gate-source voltage	$T_{amb} = 25\text{ }^{\circ}\text{C}$	-	± 20	V
I_D	drain current	$V_{GS} = 10\text{ V}$	[1]		
		$T_{amb} = 25\text{ }^{\circ}\text{C}$	-	310	mA
		$T_{amb} = 100\text{ }^{\circ}\text{C}$	-	215	mA
I_{DM}	peak drain current	$T_{amb} = 25\text{ }^{\circ}\text{C}$; 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).

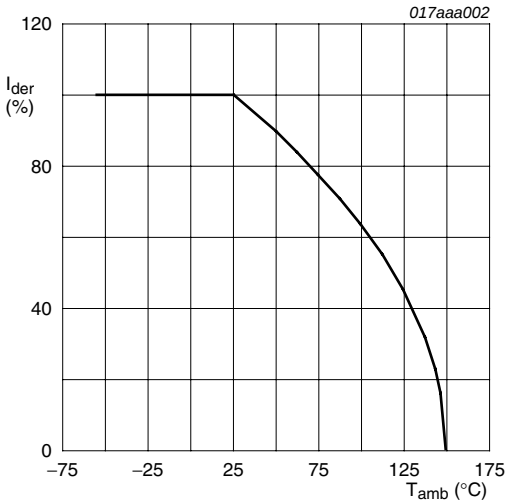
Symbol	Parameter	Conditions	Min	Max	Unit
P _{tot}	total power dissipation	T _{amb} = 25 °C	[2] -	275	mW
			[1] -	330	mW
		T _{sp} = 25 °C	-	880	mW
T _j	junction temperature			150	°C
T _{amb}	ambient temperature		-55	+150	°C
T _{stg}	storage temperature		-65	+150	°C
Source-drain diode					
I _S	source current	T _{amb} = 25 °C	[1] -	310	mA
ESD maximum rating					
V _{ESD}	electrostatic discharge voltage	human body model	[3] -	2000	V

- [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.



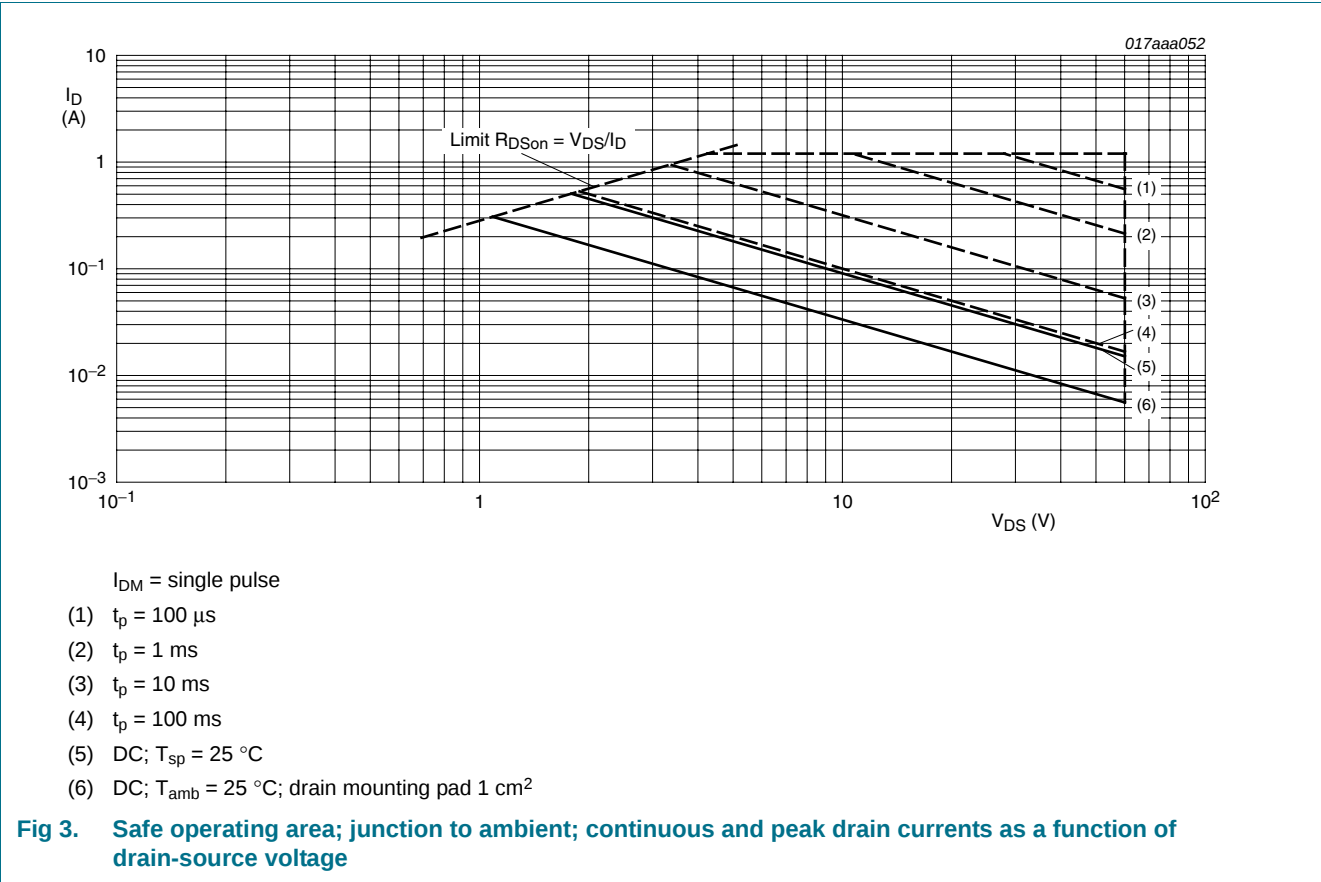
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100 \%$$

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



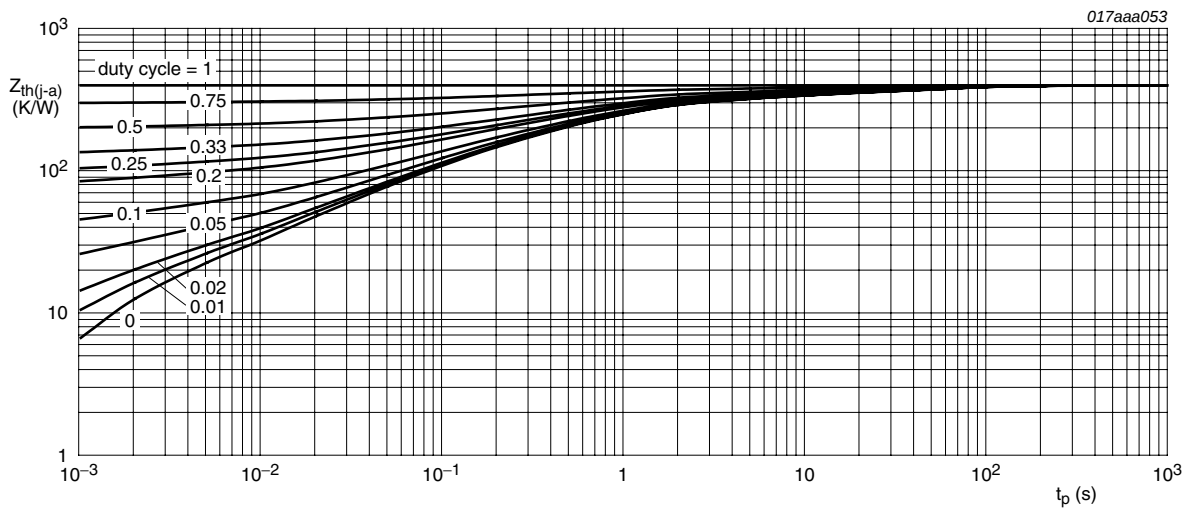
6. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1] -	395	455	K/W
			[2] -	330	380	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point		-	-	140	K/W

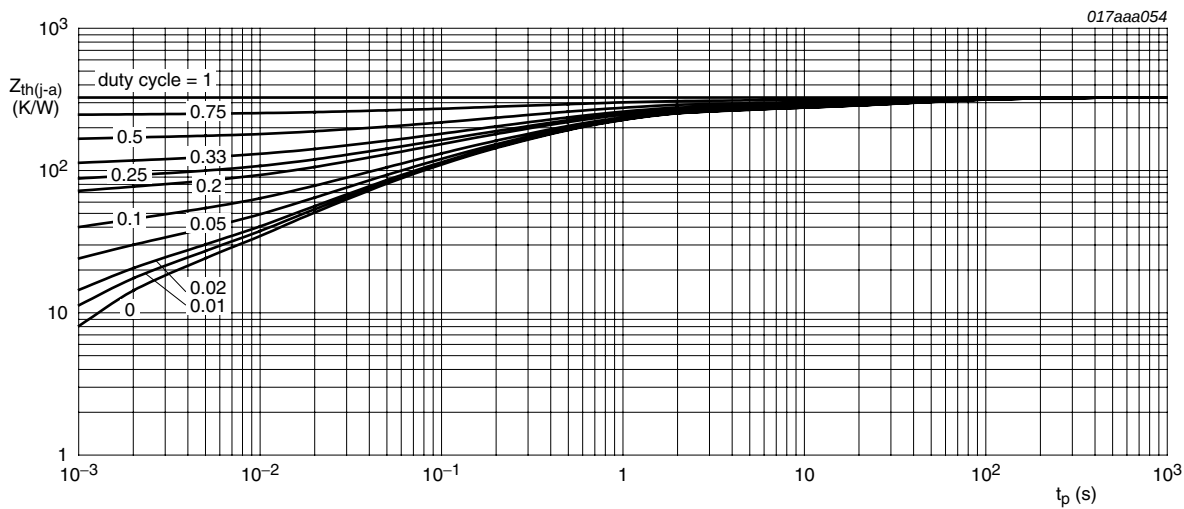
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.

[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

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
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	1.6	2.1	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	$V_{GS} = \pm 20\text{ V}$; $V_{DS} = 0\text{ V}$	-	-	10	μA
$R_{DS(on)}$	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]	-	550	-	mS
Dynamic characteristics						
$Q_{G(tot)}$	total gate charge	$I_D = 300\text{ mA}$;	-	0.5	0.6	nC
Q_{GS}	gate-source charge	$V_{DS} = 30\text{ V}$;	-	0.2	-	nC
Q_{GD}	gate-drain charge	$V_{GS} = 4.5\text{ V}$	-	0.1	-	nC
C_{iss}	input capacitance	$V_{GS} = 0\text{ V}$; $V_{DS} = 10\text{ V}$;	-	33	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	$V_{DD} = 50\text{ V}$;	-	5	10	ns
t_r	rise time	$R_L = 250\text{ }\Omega$;	-	6	-	ns
$t_{d(off)}$	turn-off delay time	$V_{GS} = 10\text{ V}$;	-	12	24	ns
t_f	fall time	$R_G = 6\text{ }\Omega$	-	7	-	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: $t_p \leq 300\text{ }\mu\text{s}$; $\delta \leq 0.01$.

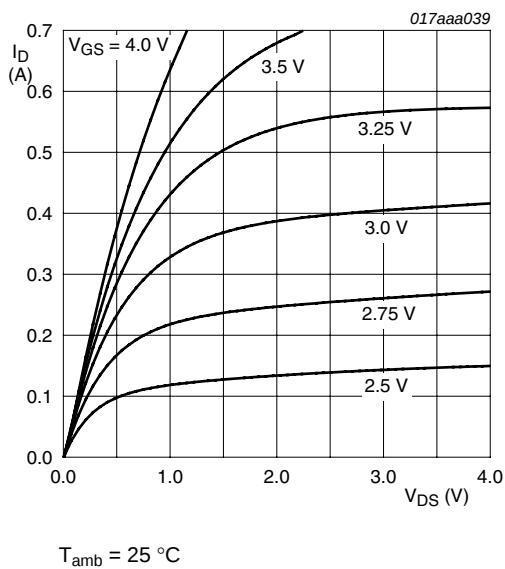


Fig 6. Output characteristics: drain current as a function of drain-source voltage; typical values

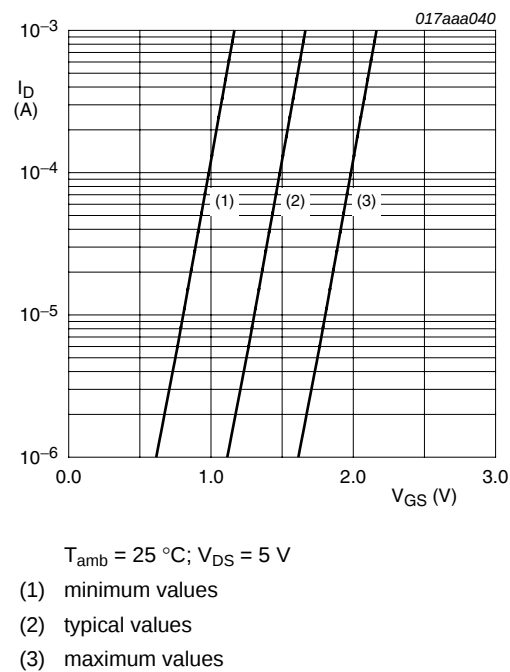


Fig 7. Sub-threshold drain current as a function of gate-source voltage

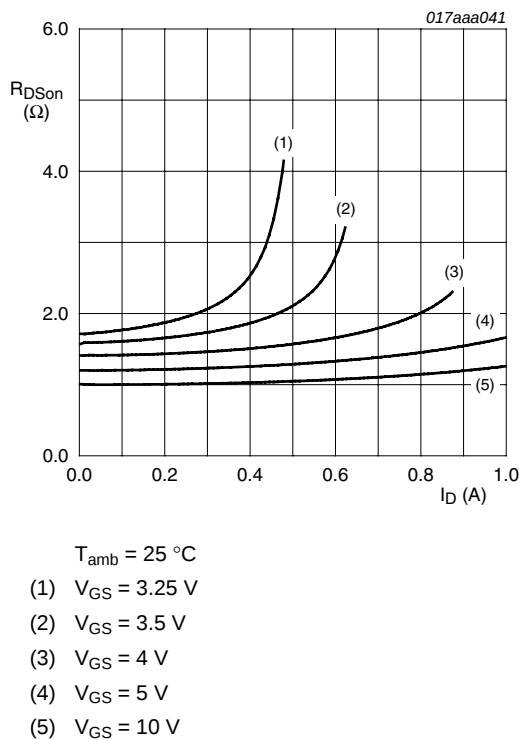


Fig 8. Drain-source on-state resistance as a function of drain current; typical values

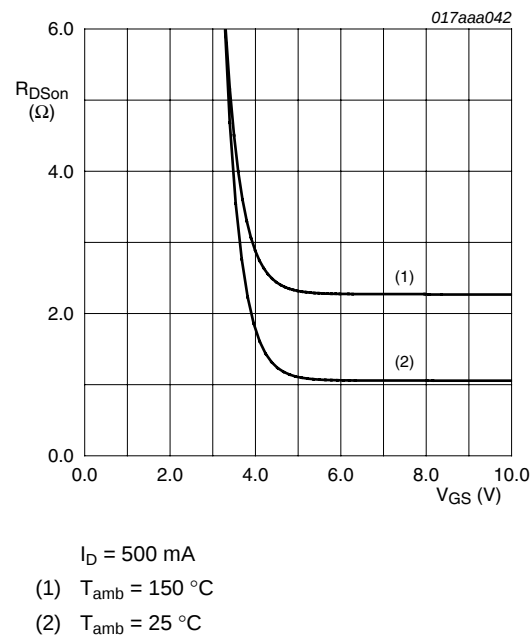
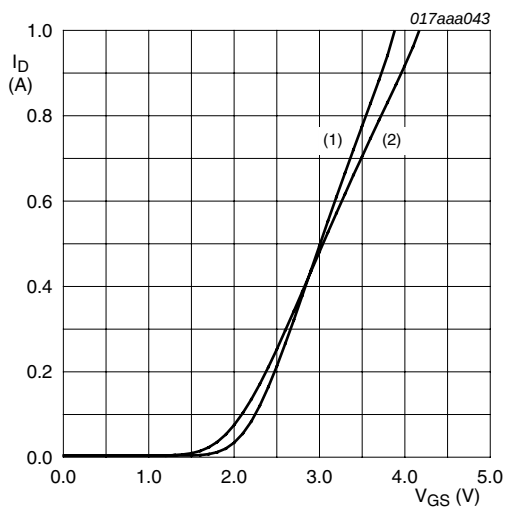
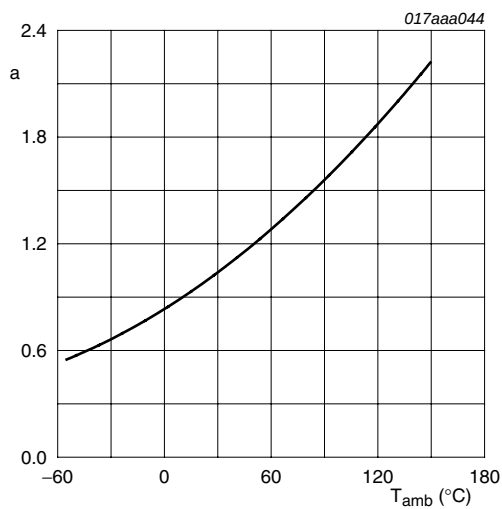


Fig 9. Drain-source on-state resistance as a function of gate-source voltage; typical values



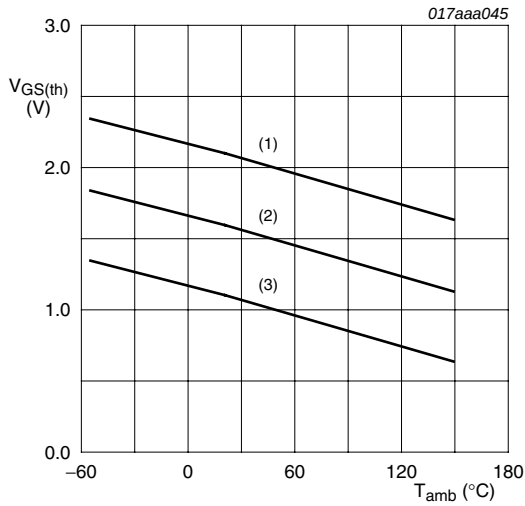
$V_{DS} > I_D \times R_{DSon}$
(1) $T_{amb} = 25\text{ }^{\circ}\text{C}$
(2) $T_{amb} = 150\text{ }^{\circ}\text{C}$

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



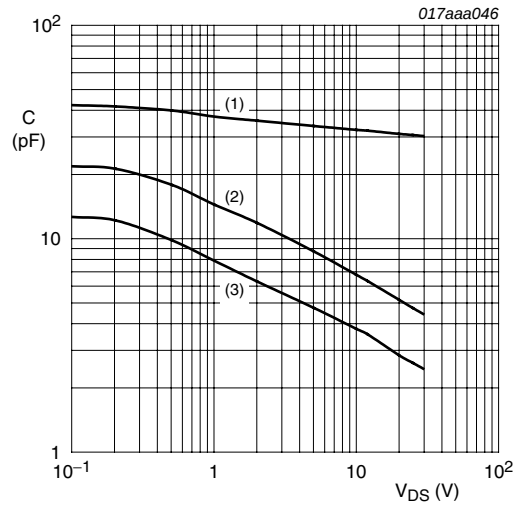
$$a = \frac{R_{DSon}}{R_{DSon(25^{\circ}\text{C})}}$$

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



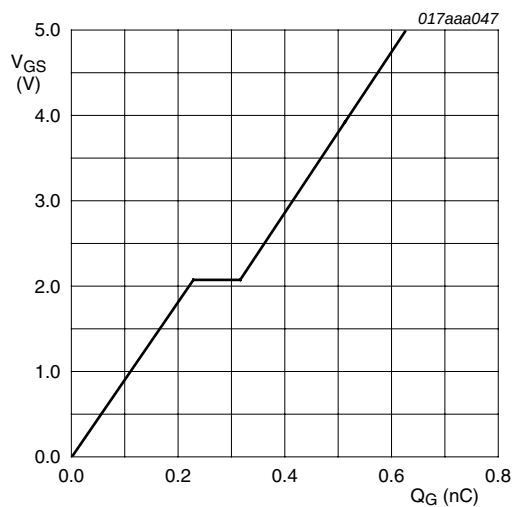
$I_D = 0.25\text{ mA}; V_{DS} = V_{GS}$
(1) maximum values
(2) typical values
(3) minimum values

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

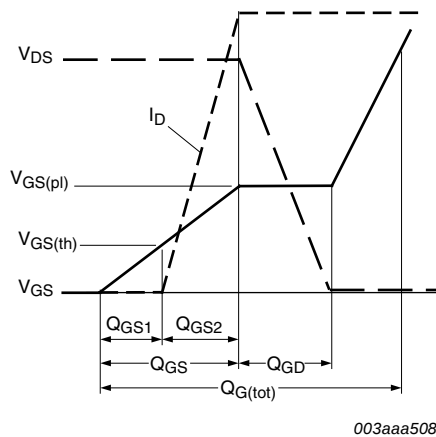
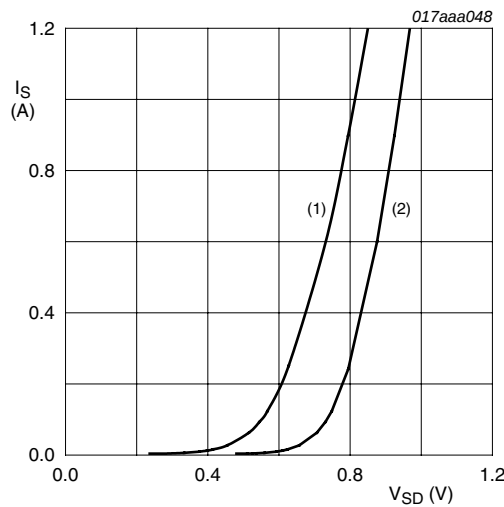


Fig 15. Gate charge waveform definitions



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

- (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

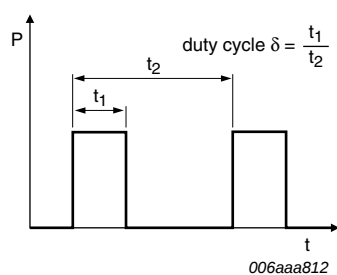


Fig 17. Duty cycle definition

9. Package outline

Plastic surface-mounted package; 3 leads

SOT323

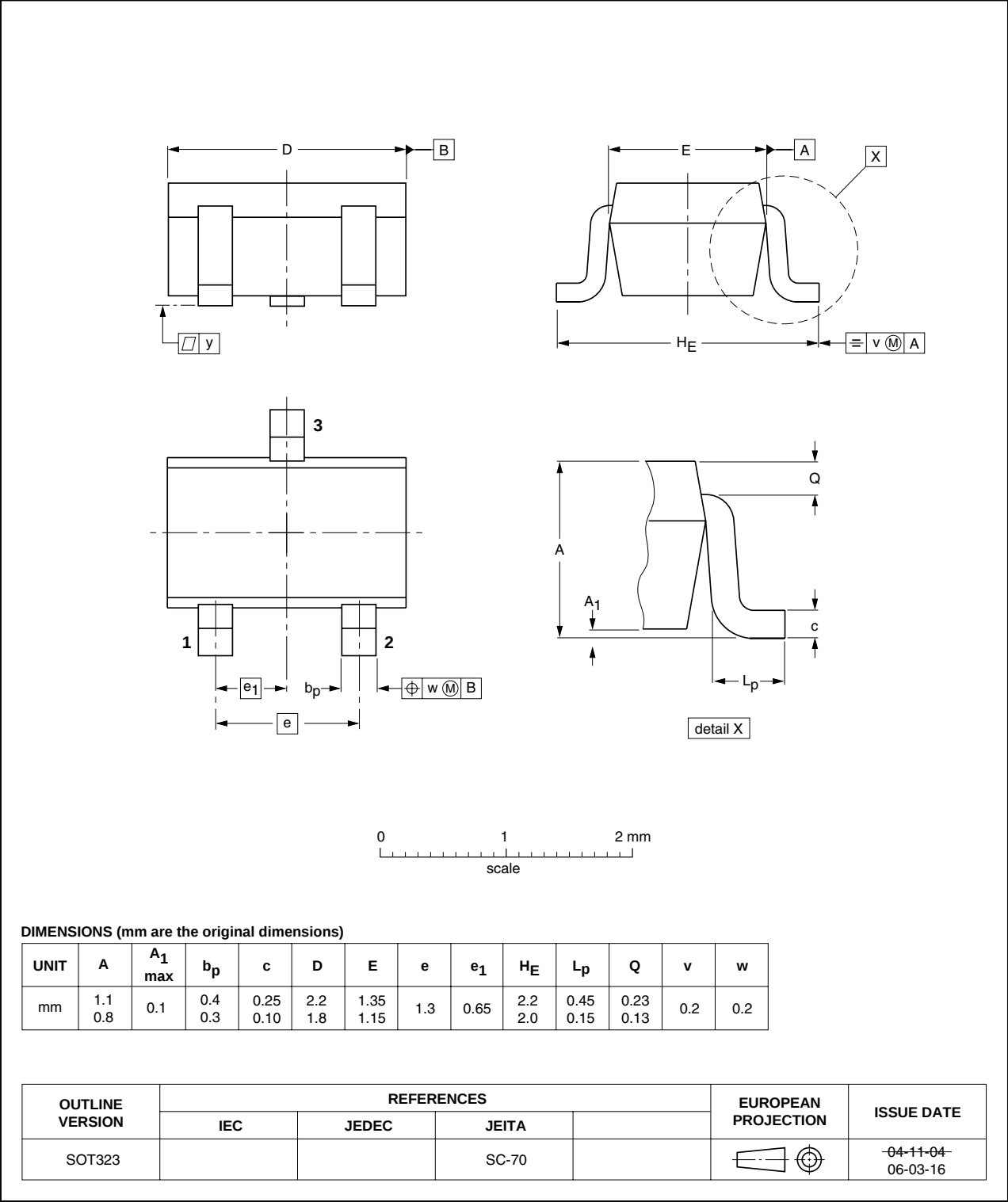
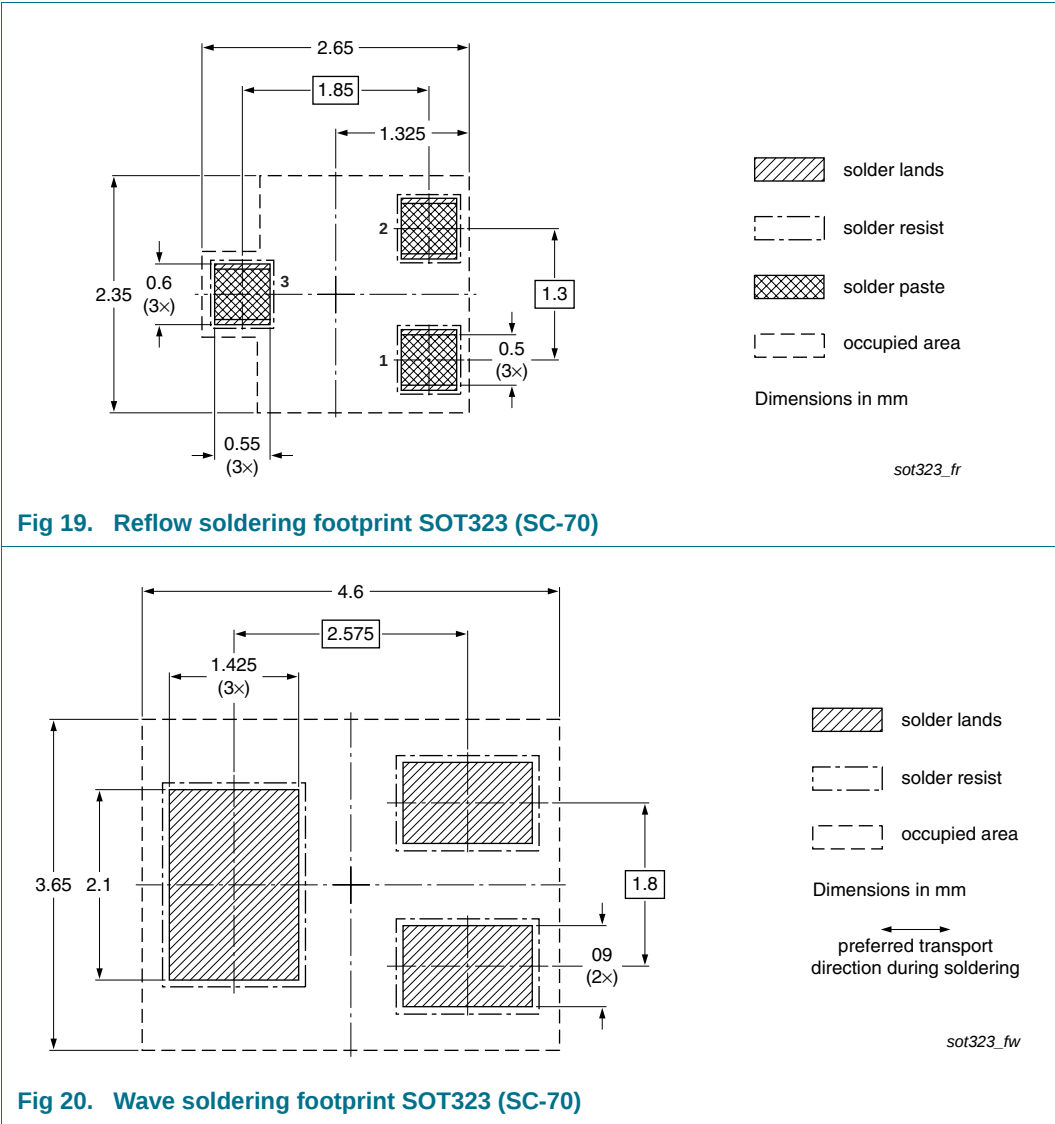


Fig 18. Package outline SOT323 (SC-70)

10. Soldering



11. Revision history

Table 8. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
2N7002BKW 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.
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[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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14. Contents

1	Product profile	1
1.1	General description	1
1.2	Features and benefits	1
1.3	Applications	1
1.4	Quick reference data	1
2	Pinning information	2
3	Ordering information	2
4	Marking	2
5	Limiting values	2
6	Thermal characteristics	4
7	Characteristics	6
8	Test information	10
9	Package outline	11
10	Soldering	12
11	Revision history	13
12	Legal information	14
12.1	Data sheet status	14
12.2	Definitions	14
12.3	Disclaimers	14
12.4	Trademarks	15
13	Contact information	15
14	Contents	16

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