



# 2N7002BKV

60 V, 340 mA dual N-channel Trench MOSFET

Rev. 2 — 22 September 2010

Product data sheet

## 1. Product profile

### 1.1 General description

Dual N-channel enhancement mode Field-Effect Transistor (FET) in an ultra small SOT666 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

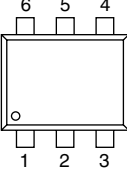
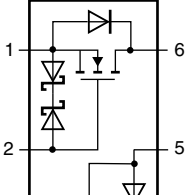
Table 1. Quick reference data

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]	-	340	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>.

## 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
2N7002BKV	-	plastic surface-mounted package; 6 leads	SOT666

## 4. Marking

Table 4. Marking codes

Type number	Marking code
2N7002BKV	ZG

## 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]		
		$T_{amb} = 25\text{ °C}$	-	340	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**

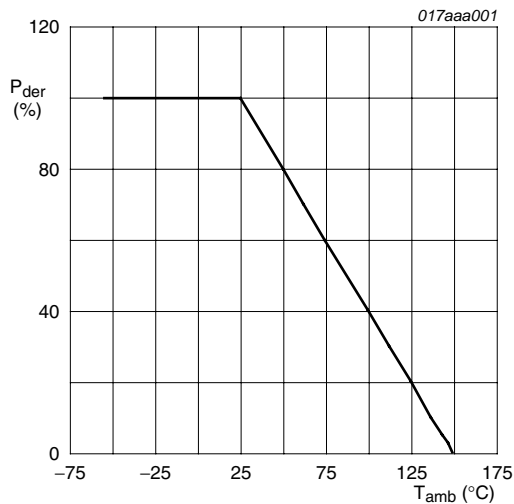
In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit	
P <sub>tot</sub>	total power dissipation	T <sub>amb</sub> = 25 °C	[2]	-	350	mW
			[1]	-	410	mW
		T <sub>sp</sub> = 25 °C	-	1140	mW	
<b>Source-drain diode</b>						
I <sub>S</sub>	source current	T <sub>amb</sub> = 25 °C	[1]	-	340	mA
<b>ESD maximum rating</b>						
V <sub>ESD</sub>	electrostatic discharge voltage	human body model	[3]	-	2000	V
<b>Per device</b>						
P <sub>tot</sub>	total power dissipation	T <sub>amb</sub> = 25 °C	[2]	-	525	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>.

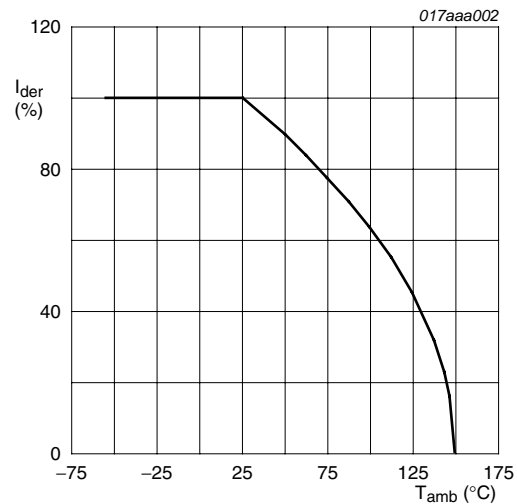
[2] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and standard footprint.

[3] Measured between all pins.



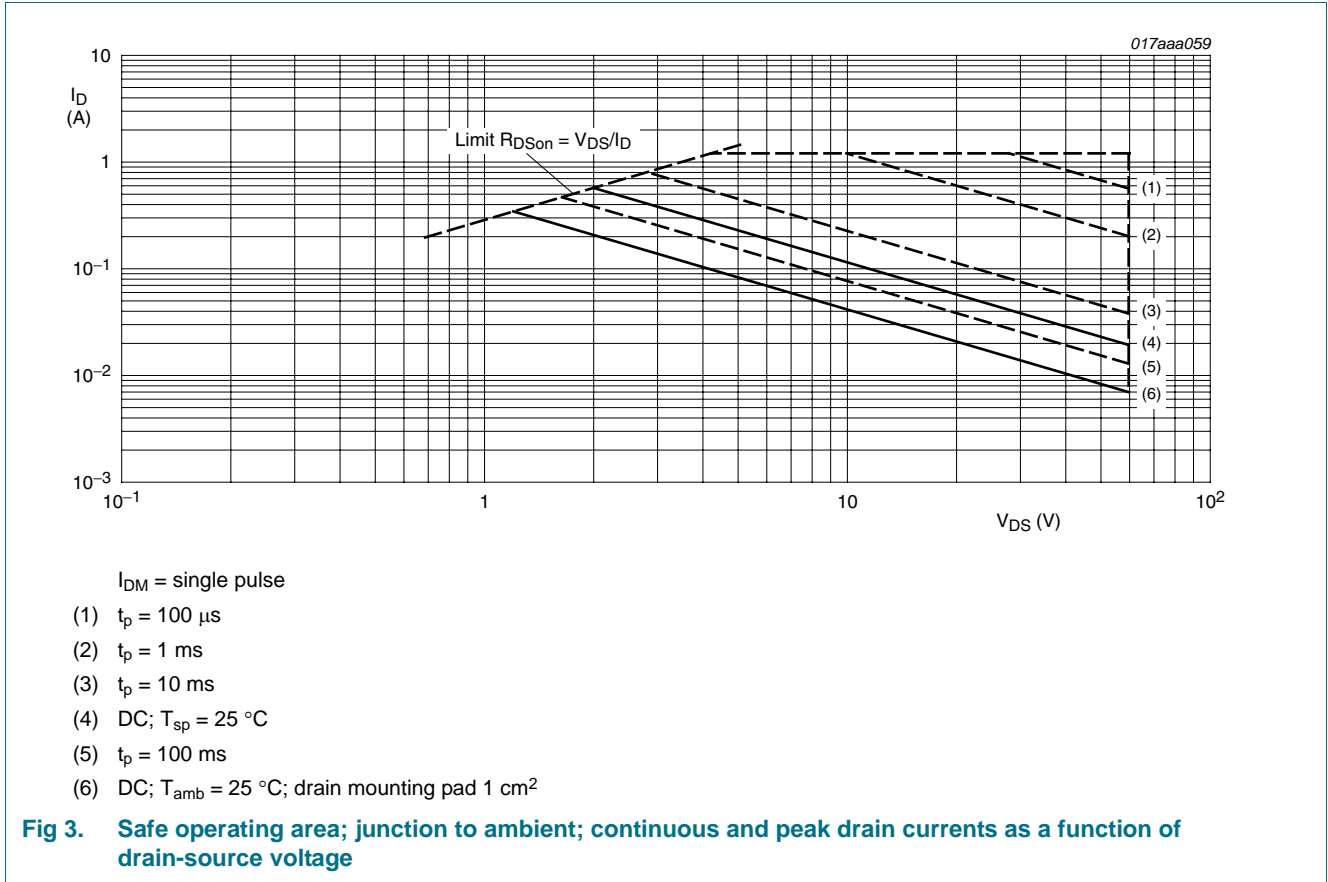
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100 \%$$

**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**



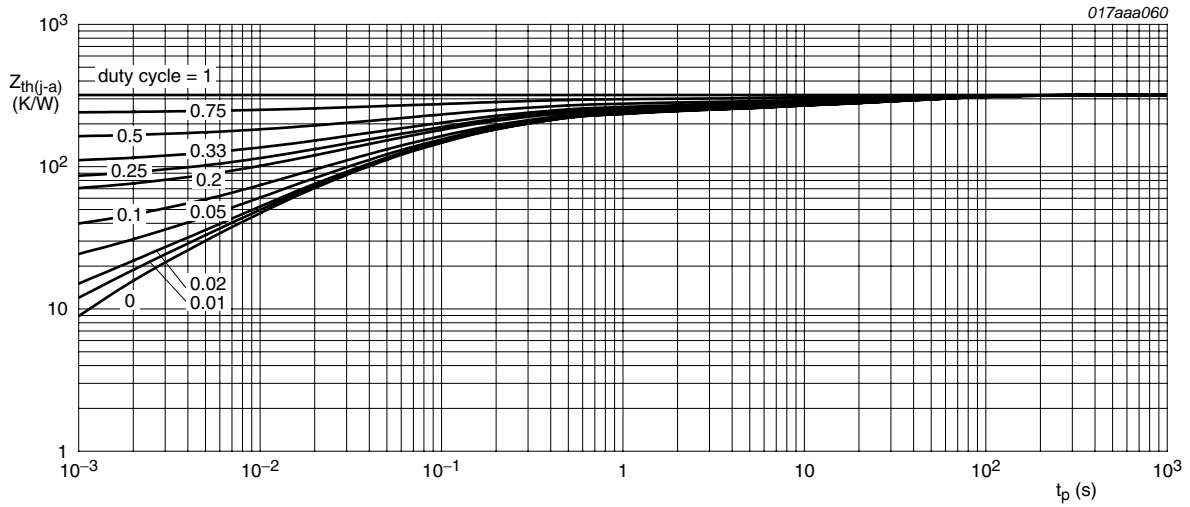
## 6. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
<b>Per transistor</b>							
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	315	360	K/W
			[2]	-	265	305	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point		-	-	110	K/W	
<b>Per device</b>							
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	-	240	K/W

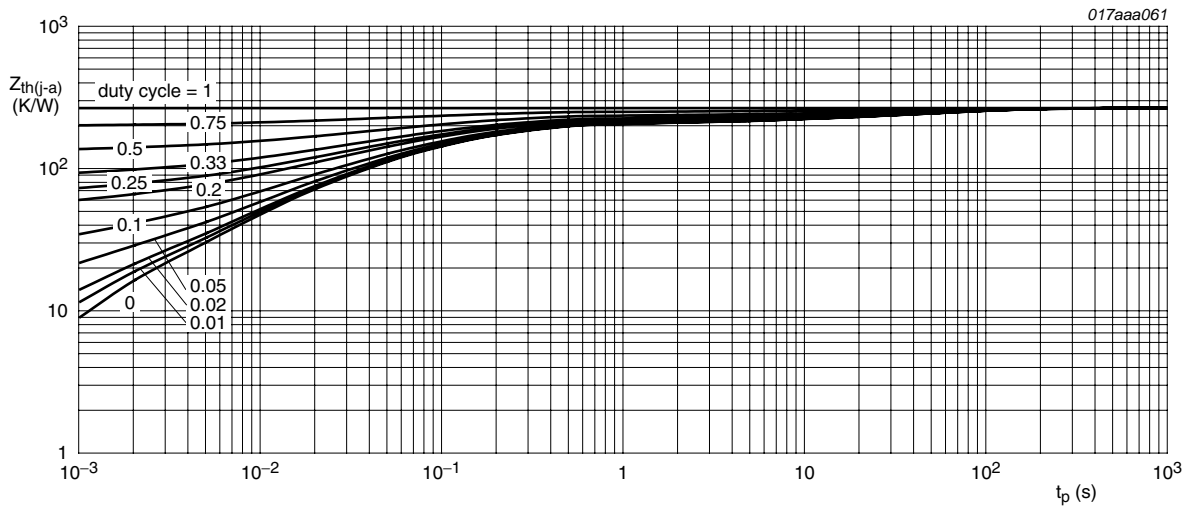
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.

[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. 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. 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:  $t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.01$ .

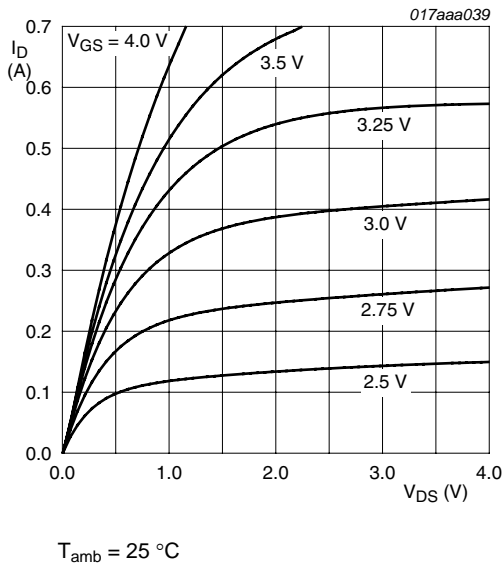


Fig 6. Output characteristics: drain current as a function of drain-source voltage; typical values

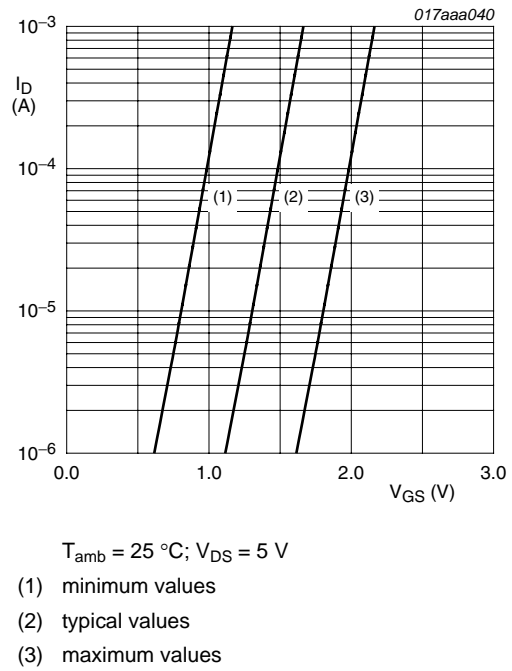


Fig 7. Sub-threshold drain current as a function of gate-source voltage

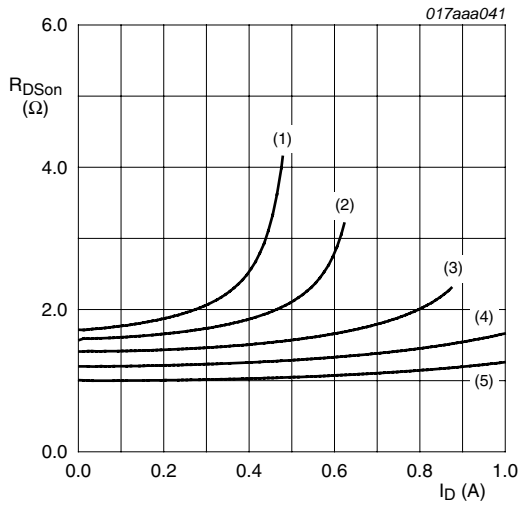


Fig 8. Drain-source on-state resistance as a function of drain current; typical values

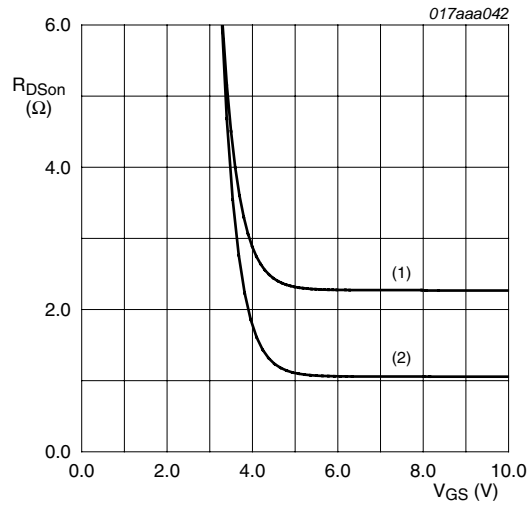
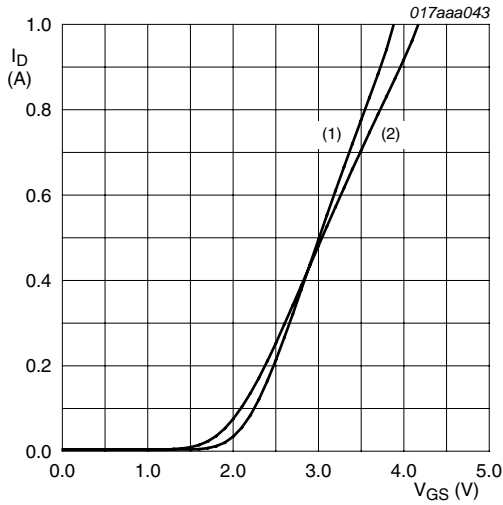
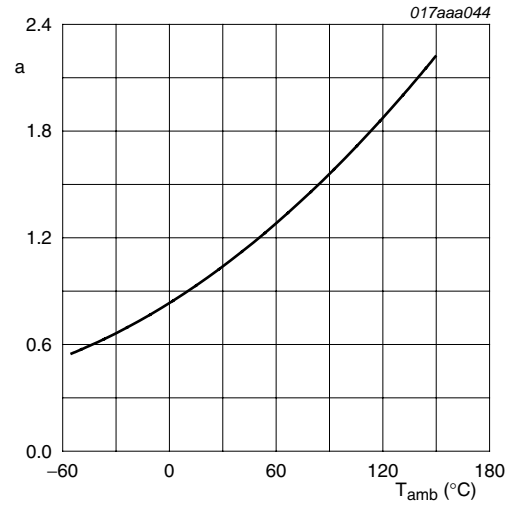


Fig 9. Drain-source on-state resistance as a function of gate-source voltage; typical values



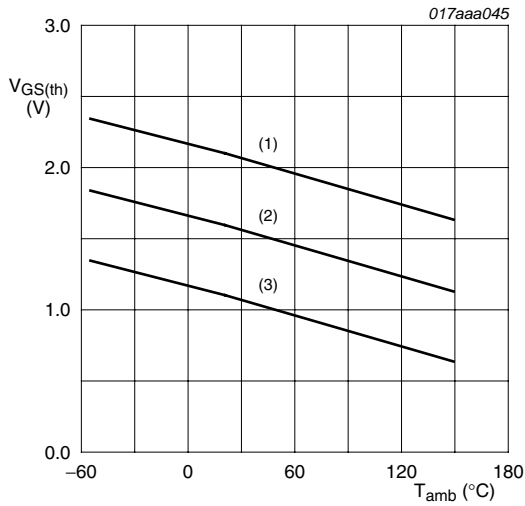
$V_{DS} > I_D \times R_{DSon}$   
 (1)  $T_{amb} = 25\text{ °C}$   
 (2)  $T_{amb} = 150\text{ °C}$

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



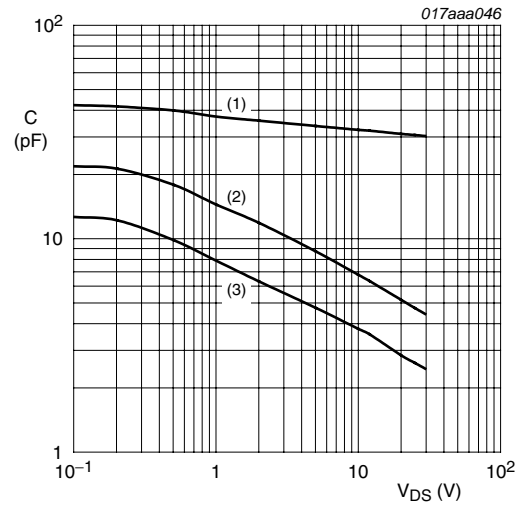
$$a = \frac{R_{DSon}}{R_{DSon(25^\circ C)}}$$

**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

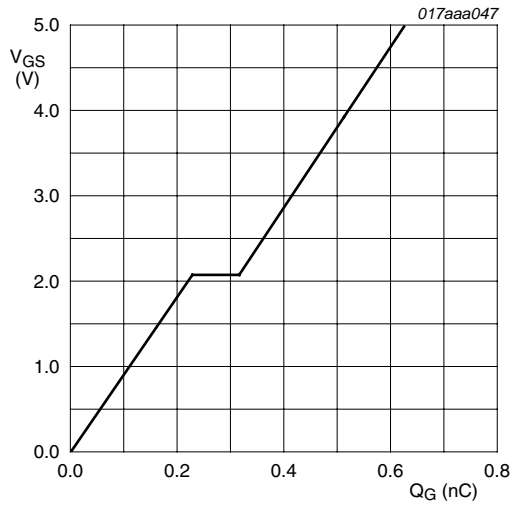
**Fig 12. Gate-source threshold voltage as a function of ambient temperature**



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

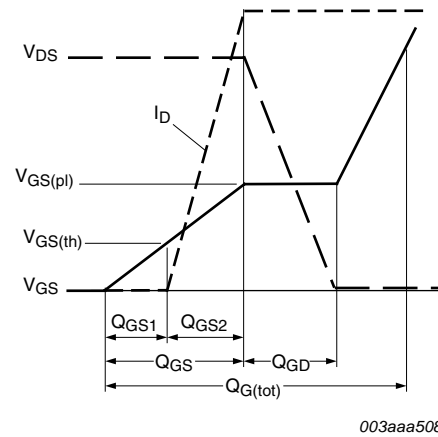
**Fig 13. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values**



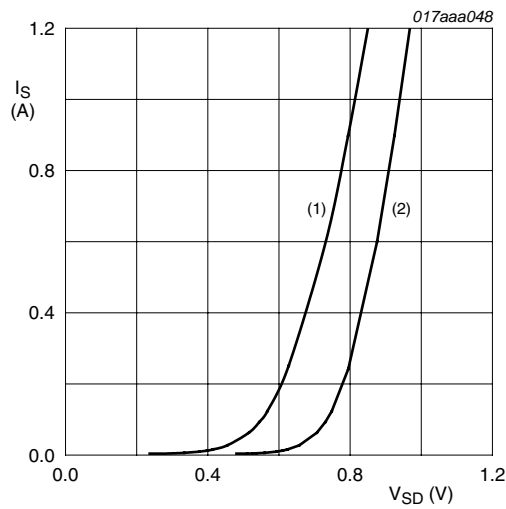


$I_D = 300 \text{ mA}$ ;  $V_{DD} = 6 \text{ V}$ ;  $T_{amb} = 25 \text{ }^\circ\text{C}$

**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

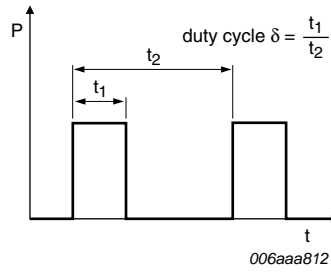


Fig 17. Duty cycle definition

9. Package outline

Plastic surface-mounted package; 6 leads

SOT666

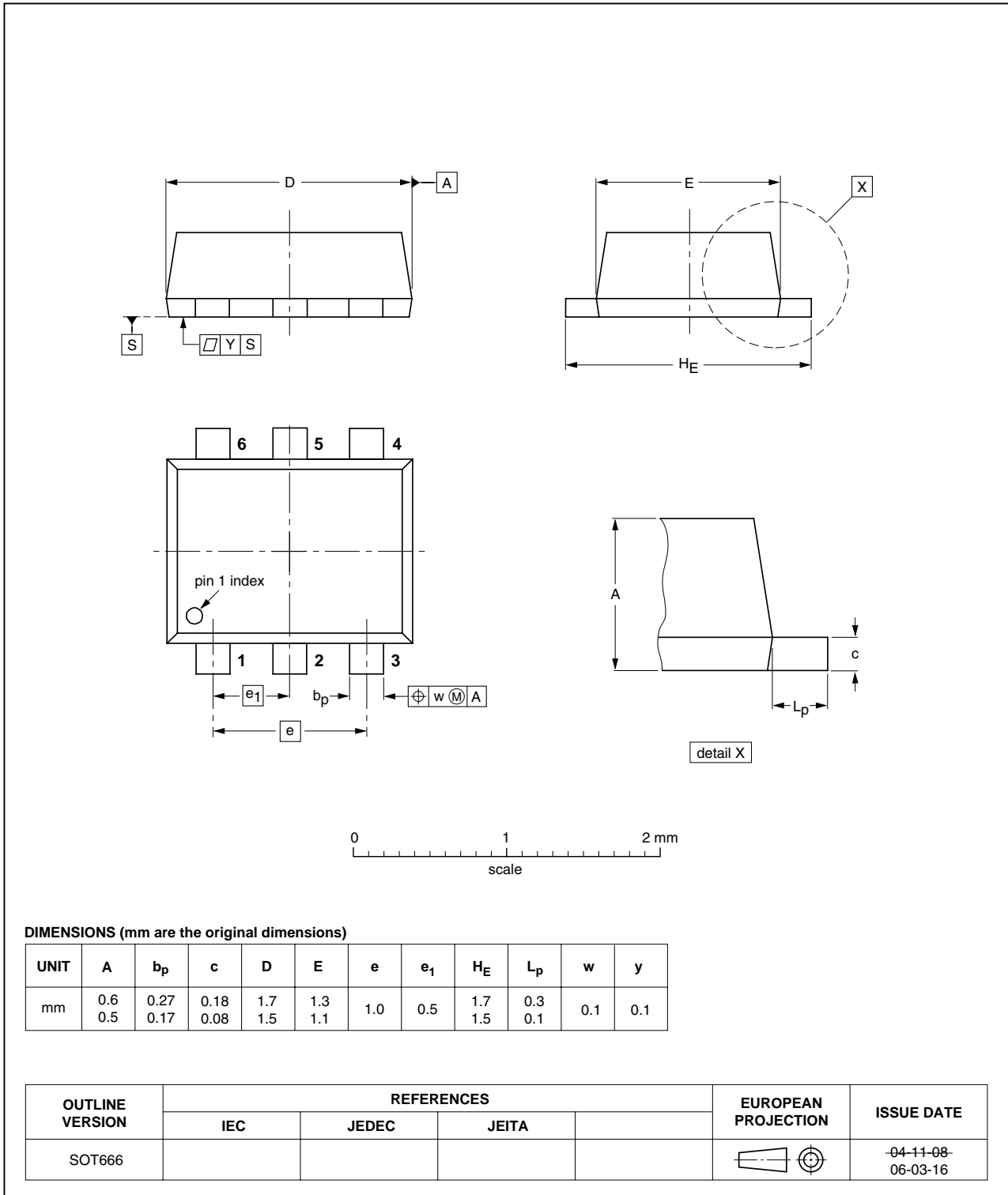
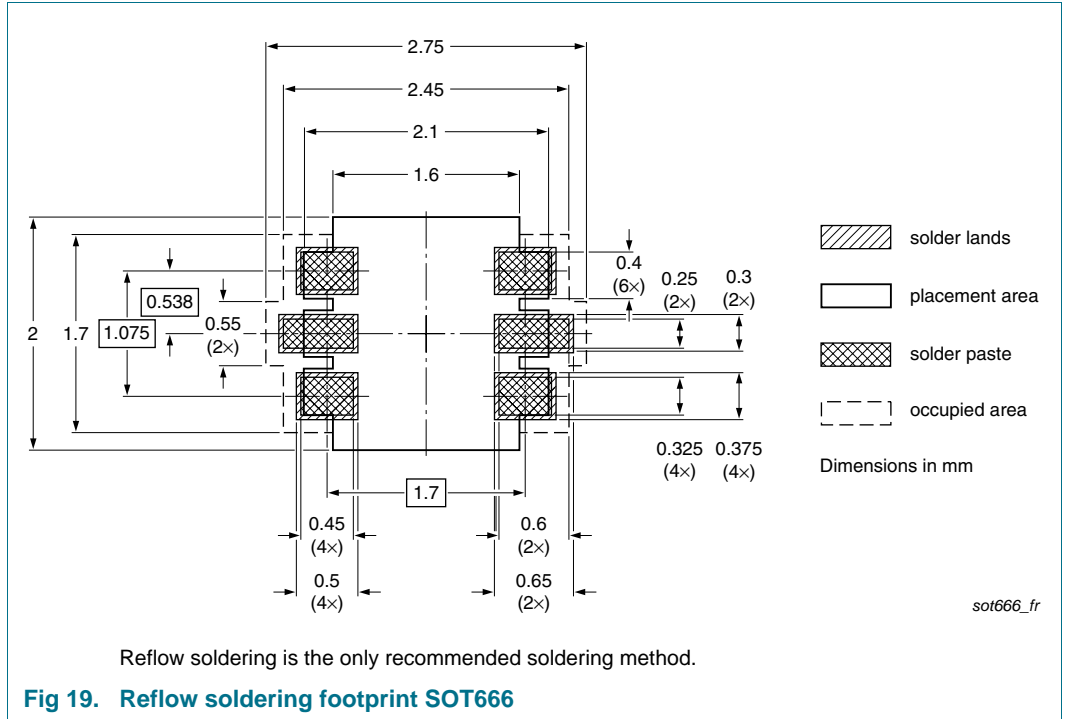


Fig 18. Package outline SOT666

**10. Soldering**



## 11. Revision history

Table 8. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
2N7002BKV v.2	20100922	Product data sheet	-	2N7002BKV v.1
Modifications:		<ul style="list-style-type: none"><li>• <a href="#">Table 2 “Pinning”</a>: graphic symbol amended</li><li>• <a href="#">Table 6 “Thermal characteristics”</a>: typo for <math>R_{th(j-sp)}</math> maximum value per transistor amended</li><li>• <a href="#">Table 6 “Thermal characteristics”</a>: typo for <math>R_{th(j-a)}</math> maximum value per device amended</li></ul>		
2N7002BKV v.1	20100610	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.nexperia.com>.

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