



2N7002P

60 V, 360 mA N-channel Trench MOSFET

23 November 2020

Product data sheet

1. General description

N-channel enhancement mode Field-Effect Transistor (FET) in a small SOT23 (TO-236AB) Surface-Mounted Device (SMD) plastic package using Trench MOSFET technology.

2. Features and benefits

- Logic-level compatible
- Very fast switching
- Trench MOSFET technology
- AEC-Q101 qualified

3. Applications

- Relay driver
- High-speed line driver
- Low-side load switch
- Switching circuits

4. Quick reference data

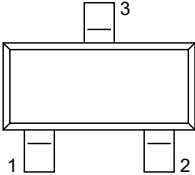
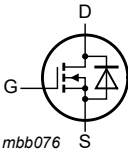
Table 1. Quick reference data

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{DS}	drain-source voltage	$T_{amb} = 25\text{ °C}$		-	-	60	V
V_{GS}	gate-source voltage			-20	-	20	V
I_D	drain current	$V_{GS} = 10\text{ V}; T_{amb} = 25\text{ °C}$	[1]	-	-	360	mA
Static characteristics							
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 10\text{ V}; I_D = 500\text{ mA}; \text{pulsed}; t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.01; T_j = 25\text{ °C}$		-	1	1.6	Ω

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

5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	G	gate	 SOT23	 mbb076
2	S	source		
3	D	drain		

6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
2N7002P	SOT23	plastic, surface-mounted package; 3 terminals; 1.9 mm pitch; 2.9 mm x 1.3 mm x 1 mm body	SOT23

7. Marking

Table 4. Marking codes

Type number	Marking code[1]
2N7002P	LW%

[1] % = placeholder for manufacturing site code

8. Limiting values

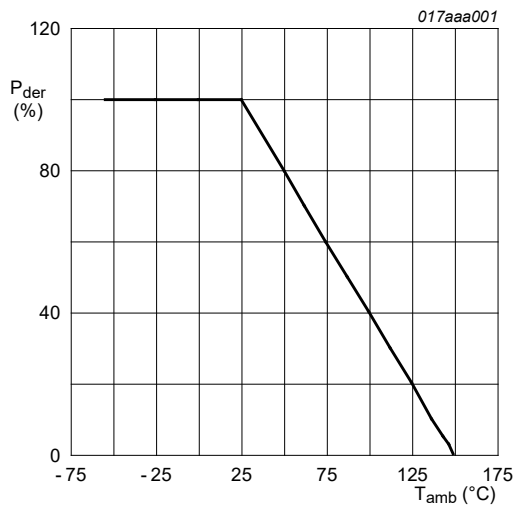
Table 5. Limiting values

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

Symbol	Parameter	Conditions		Min	Max	Unit
V _{DS}	drain-source voltage	T _{amb} = 25 °C		-	60	V
V _{GS}	gate-source voltage			-20	20	V
I _D	drain current	V _{GS} = 10 V; T _{amb} = 25 °C	[1]	-	360	mA
		V _{GS} = 10 V; T _{amb} = 100 °C	[1]	-	280	mA
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]	-	350	mW
			[1]	-	420	mW
		T _{sp} = 25 °C		-	1140	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]	-	360	mA

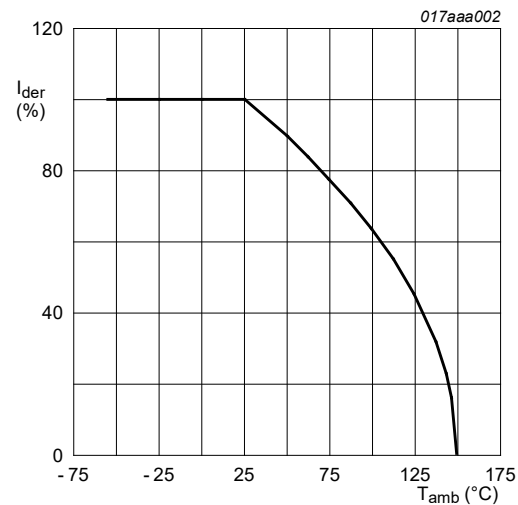
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 1 cm².

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



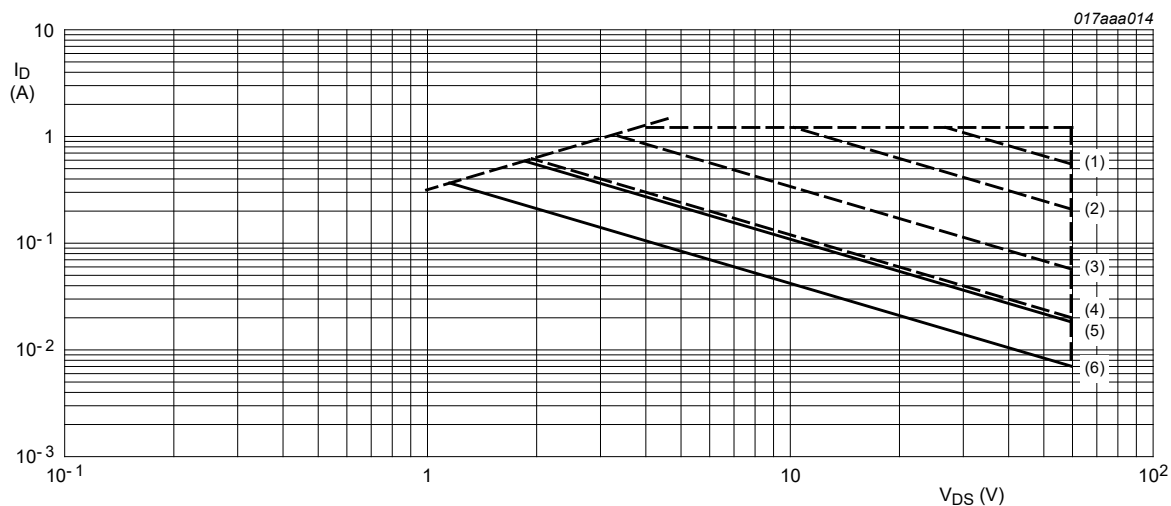
$$P_{der} = \frac{P_{tot}}{P_{tot(25^\circ\text{C})}} \times 100 \%$$

Fig. 1. Normalized total power dissipation as a function of ambient temperature



$$I_{der} = \frac{I_D}{I_{D(25^\circ\text{C})}} \times 100 \%$$

Fig. 2. Normalized continuous drain current as a function of ambient temperature



I_{DM} = single pulse

(1) $t_p = 100 \mu s$

(2) $t_p = 1 ms$

(3) $t_p = 10 ms$

(4) $t_p = 100 ms$

(5) DC; $T_{sp} = 25 \text{ }^\circ\text{C}$

(6) DC; $T_{amb} = 25 \text{ }^\circ\text{C}$; drain mounting pad 1 cm^2

Fig. 3. Safe operating area; junction to ambient; continuous and peak drain currents as a function of drain-source voltage

9. 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]	-	310	370	K/W
			[2]	-	260	300	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point			-	-	115	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 cm².

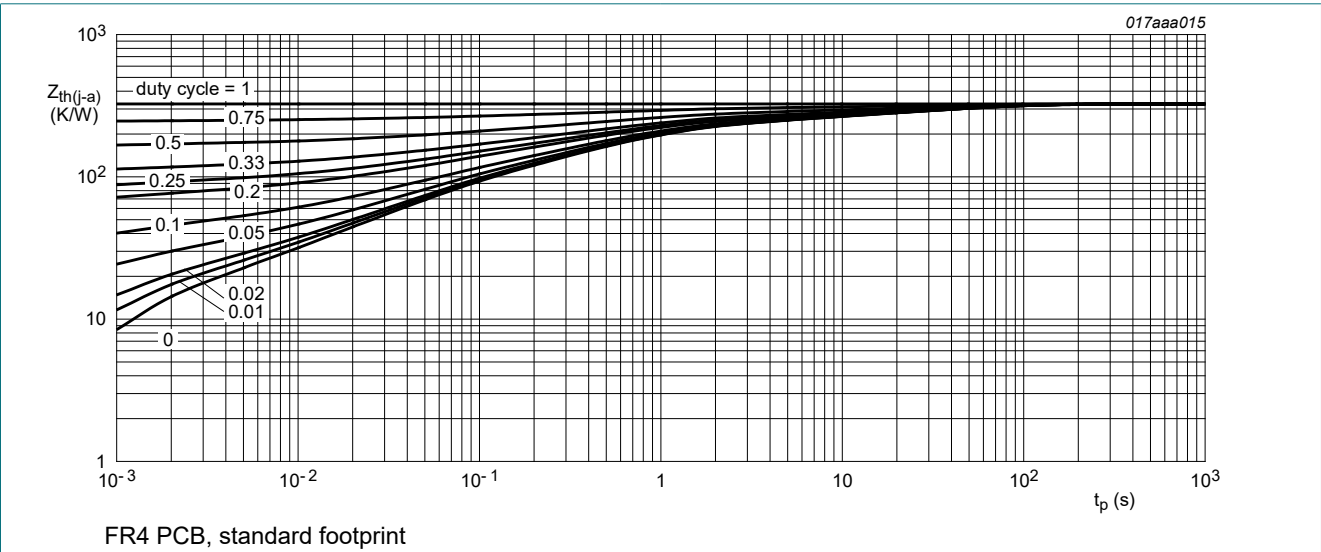


Fig. 4. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

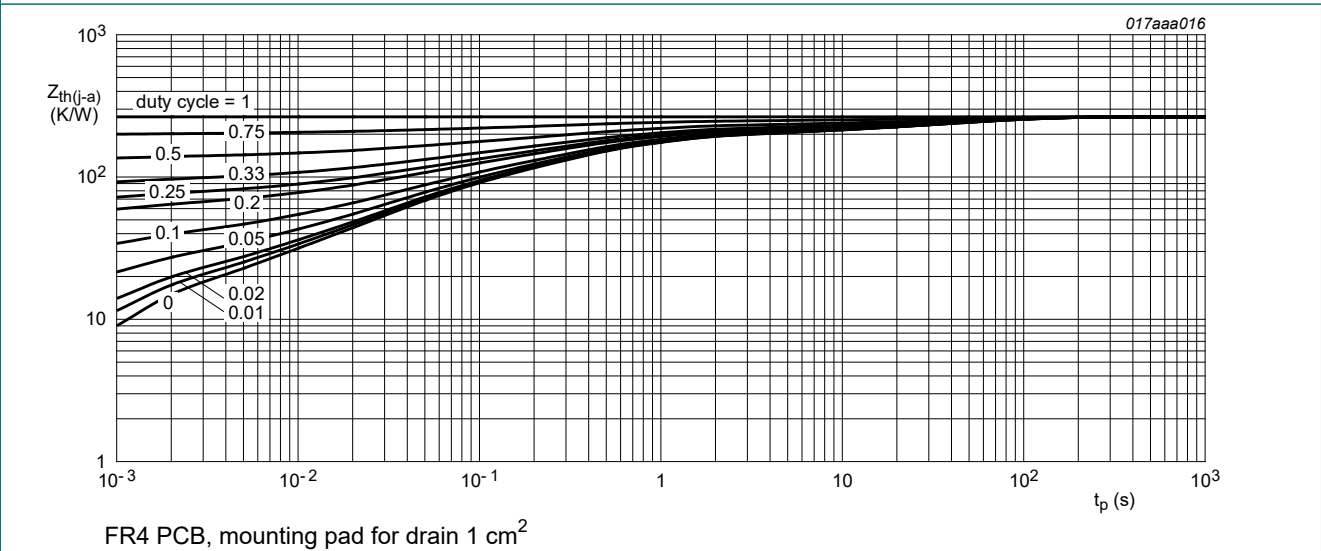


Fig. 5. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

10. Characteristics

Table 7. Characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Static characteristics							
V _{(BR)DSS}	drain-source breakdown voltage	I _D = 10 μA; V _{GS} = 0 V; T _j = 25 °C		60	-	-	V
V _{GSth}	gate-source threshold voltage	I _D = 250 μA; V _{DS} =V _{GS} ; T _j = 25 °C		1.1	1.75	2.4	V
I _{DSS}	drain leakage current	V _{DS} = 60 V; V _{GS} = 0 V; T _j = 25 °C		-	-	1	μA
		V _{DS} = 60 V; V _{GS} = 0 V; T _j = 150 °C		-	-	10	μA
I _{GSS}	gate leakage current	V _{GS} = 20 V; V _{DS} = 0 V; T _j = 25 °C		-	-	100	nA
		V _{GS} = -20 V; V _{DS} = 0 V; T _j = 25 °C		-	-	-100	nA
R _{DSon}	drain-source on-state resistance	V _{GS} = 5 V; I _D = 50 mA; pulsed; t _p ≤ 300 μs; δ ≤ 0.01; T _j = 25 °C		-	1.3	2	Ω
		V _{GS} = 10 V; I _D = 500 mA; pulsed; t _p ≤ 300 μs; δ ≤ 0.01; T _j = 25 °C		-	1	1.6	Ω
g _{fs}	forward transconductance	V _{DS} = 10 V; I _D = 200 mA; pulsed; t _p ≤ 300 μs; δ ≤ 0.01; T _j = 25 °C		-	400	-	mS
Dynamic characteristics							
Q _{G(tot)}	total gate charge	V _{DS} = 30 V; I _D = 300 mA; V _{GS} = 4.5 V; T _j = 25 °C		-	0.6	0.8	nC
Q _{GS}	gate-source charge			-	0.2	-	nC
Q _{GD}	gate-drain charge			-	0.2	-	nC
C _{iss}	input capacitance	V _{DS} = 10 V; f = 1 MHz; V _{GS} = 0 V; T _j = 25 °C		-	30	50	pF
C _{oss}	output capacitance			-	7	-	pF
C _{rss}	reverse transfer capacitance			-	4	-	pF
t _{d(on)}	turn-on delay time	V _{DS} = 50 V; R _L = 250 Ω; V _{GS} = 10 V; R _{G(ext)} = 6 Ω; T _j = 25 °C		-	3	6	ns
t _r	rise time			-	4	-	ns
t _{d(off)}	turn-off delay time			-	10	20	ns
t _f	fall time			-	5	-	ns
Source-drain diode							
V _{SD}	source-drain voltage	I _S = 115 mA; V _{GS} = 0 V; T _j = 25 °C		0.47	0.75	1.1	V

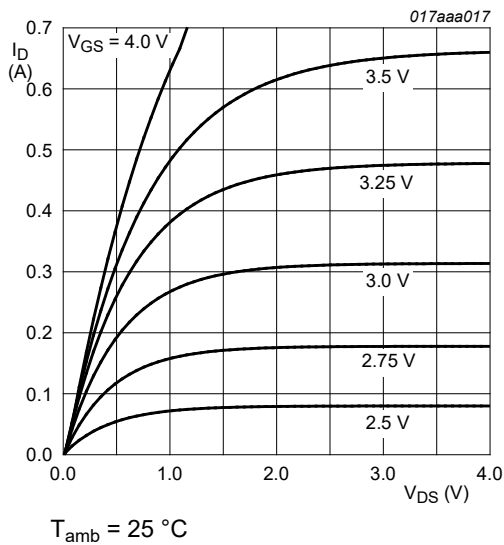


Fig. 6. Output characteristics: drain current as a function of drain-source voltage; typical values

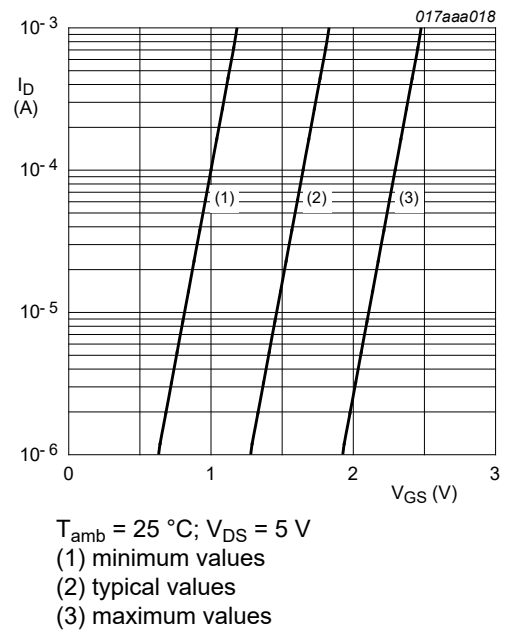


Fig. 7. Sub-threshold drain current as a function of gate-source voltage

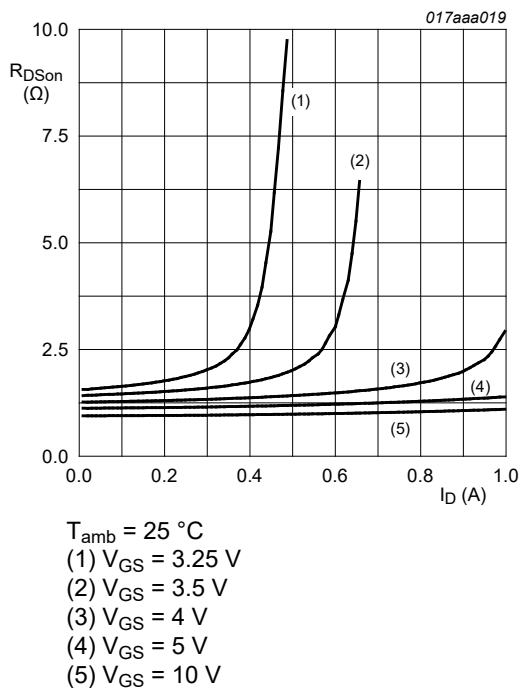


Fig. 8. Drain-source on-state resistance as a function of drain current; typical values

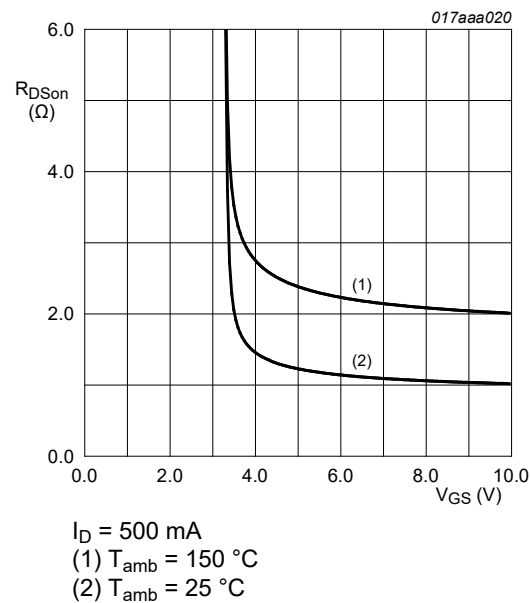


Fig. 9. Drain-source on-state resistance as a function of gate-source voltage; typical values

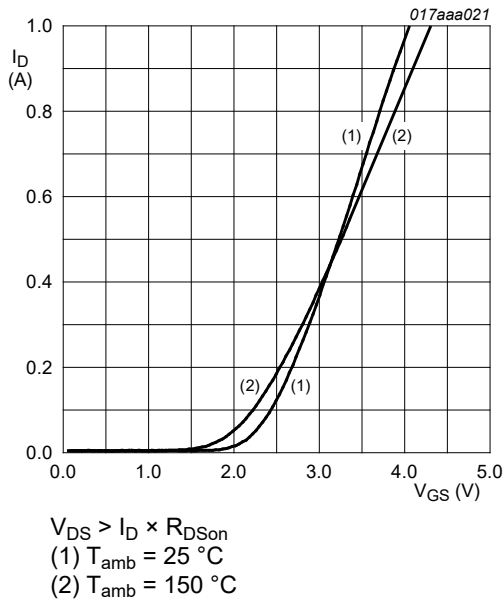


Fig. 10. Transfer characteristics: drain current as a function of gate-source voltage; typical values

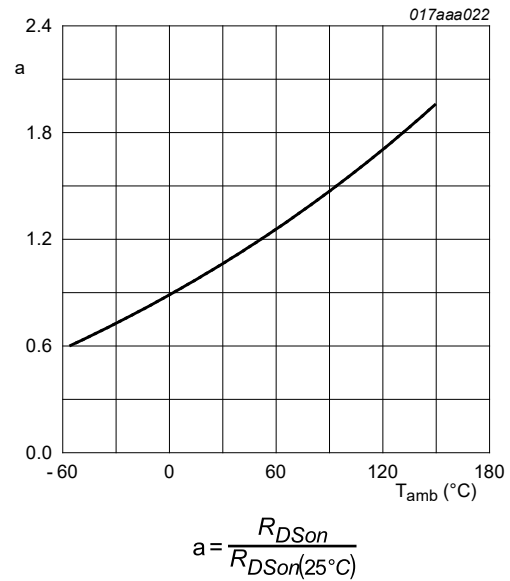


Fig. 11. Normalized drain-source on-state resistance as a function of ambient temperature; typical values

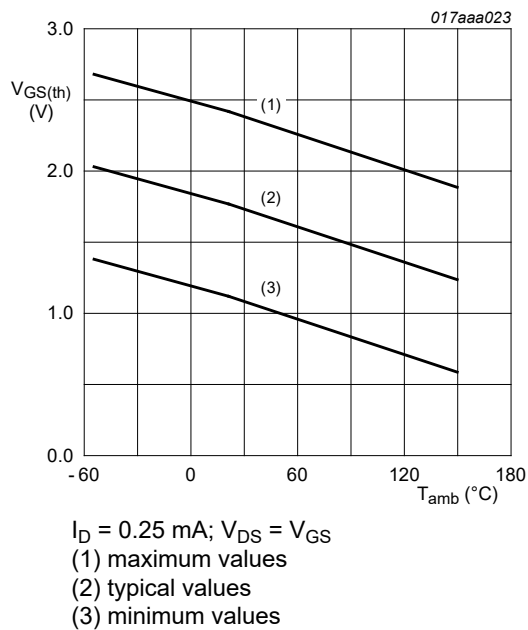


Fig. 12. Gate-source threshold voltage as a function of ambient temperature

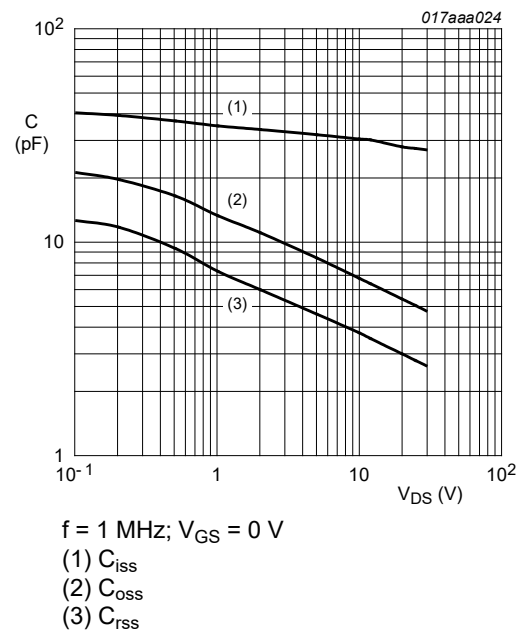


Fig. 13. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

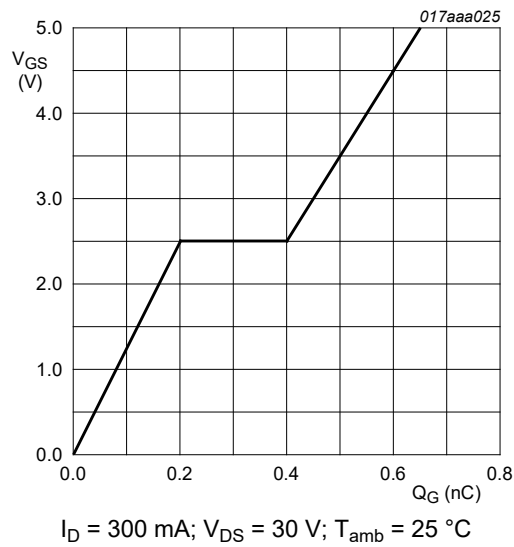


Fig. 14. Gate-source voltage as a function of gate charge; typical values

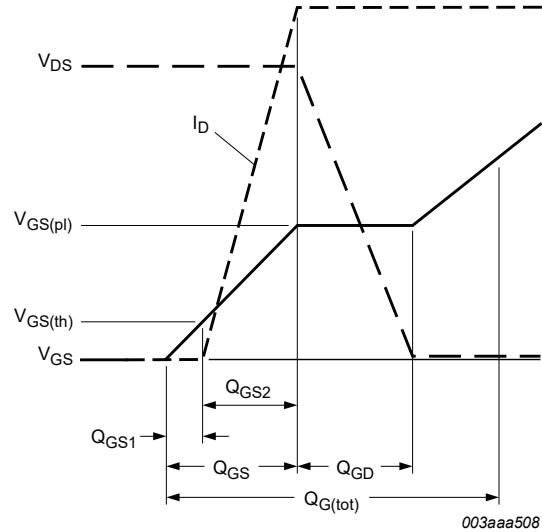


Fig. 15. Gate charge waveform definitions

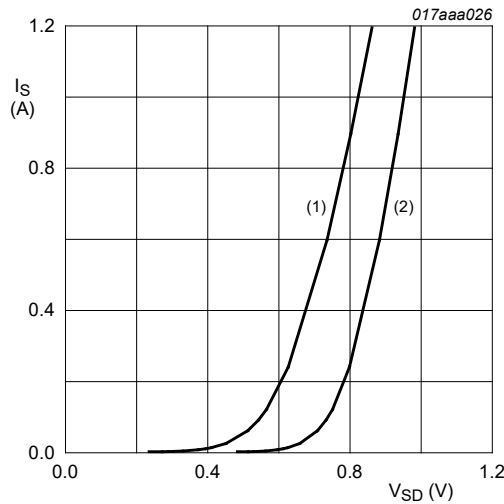


Fig. 16. Source current as a function of source-drain voltage; typical values

11. Test information

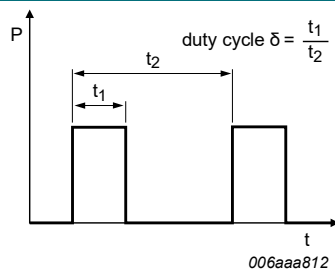


Fig. 17. Duty cycle definition

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.

12. Package outline

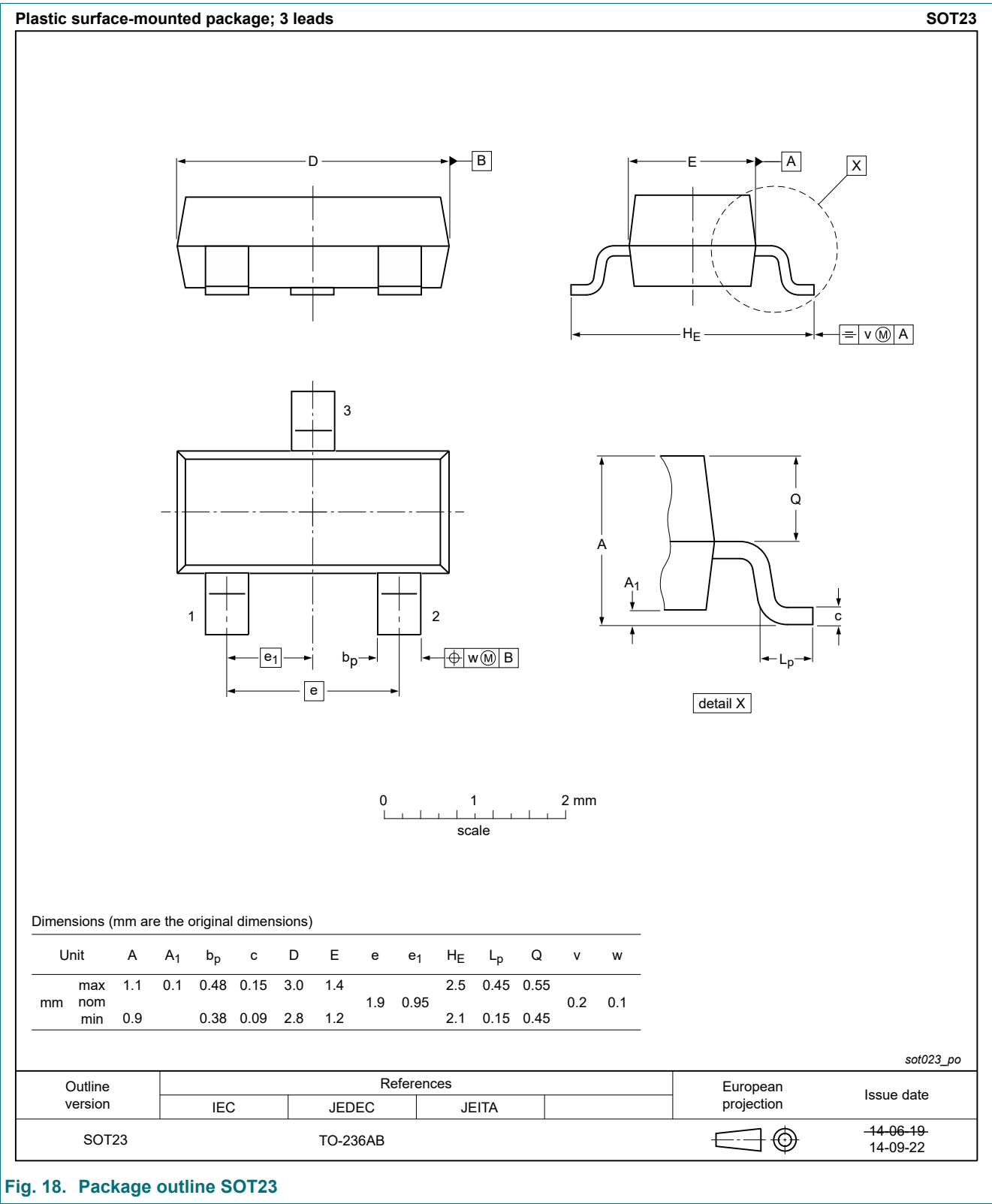
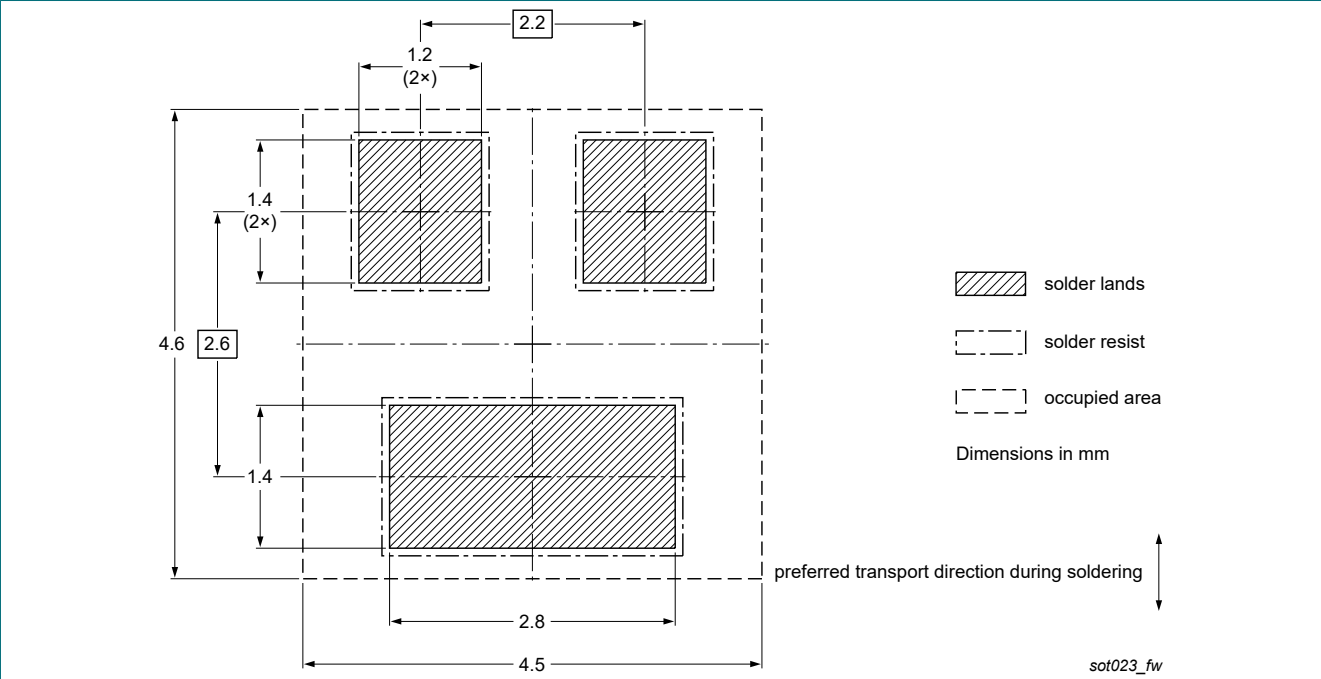
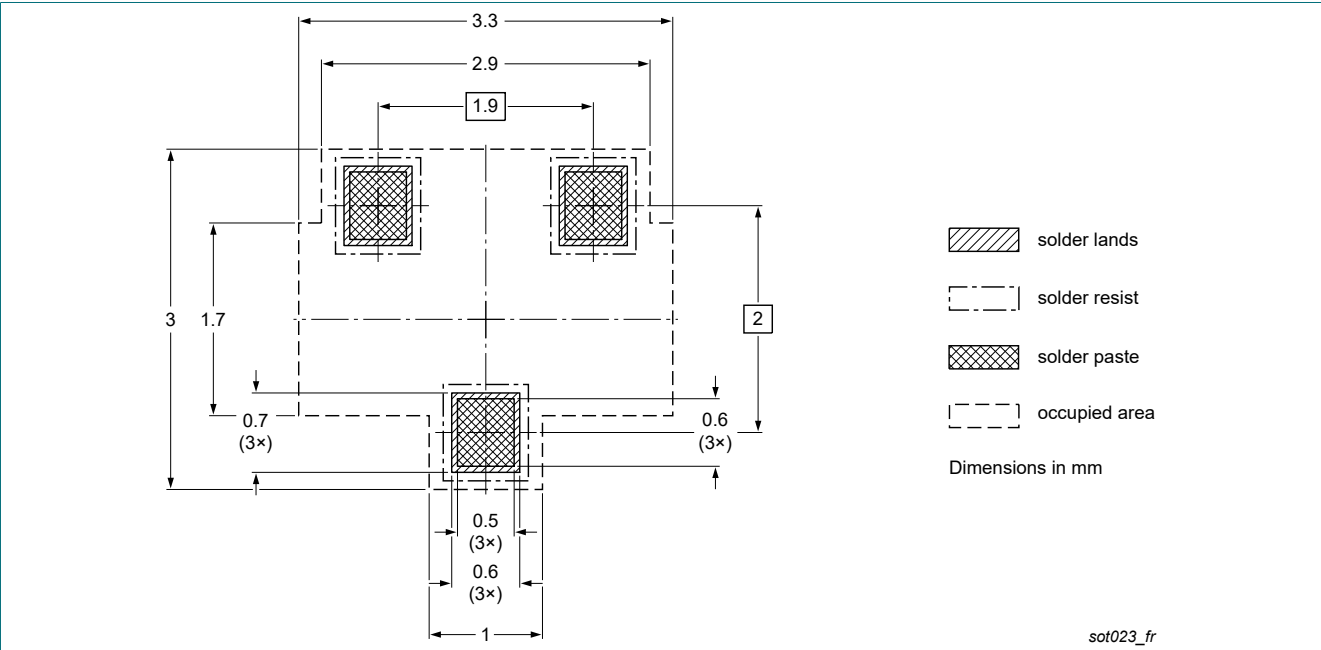


Fig. 18. Package outline SOT23

13. Soldering



14. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
2N7002P v.3	20201123	Product data sheet	-	2N7002P v.2
Modifications:	• The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia. • Legal texts have been adapted to the new company name where appropriate. • Chapter "Characteristics": Typo correction for I_{GSS}.			
2N7002P v.2	20100729	Product data sheet	-	2N7002P v.1
2N7002P v.1	20100419	Product data sheet	-	-

15. Legal information

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".
- [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 <https://www.nexperia.com>.

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