



2N7002AKW-Q

60 V, N-channel Trench MOSFET

11 January 2024

Product data sheet

1. General description

N-channel enhancement mode Field-Effect Transistor (FET) in a very small SOT323 (SC70) Surface-Mounted Device (SMD) plastic package using Trench MOSFET technology.

2. Features and benefits

- Logic-level compatible
- Extended temperature range $T_j = 175\text{ °C}$
- Trench MOSFET technology
- ElectroStatic Discharge (ESD) protection
- AEC-Q101 qualified

3. Applications

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

4. Quick reference data

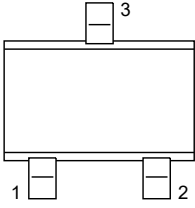
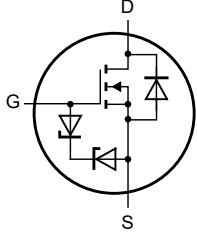
Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{DS}	drain-source voltage	$T_j = 25\text{ °C}$	-	-	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]	-	220	mA
Static characteristics						
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 10\text{ V}; I_D = 100\text{ mA}; T_j = 25\text{ °C}$	-	2.2	3	Ω

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

5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	G	gate	 <p>SC-70 (SOT323)</p>	 <p>017aaa255</p>
2	S	source		
3	D	drain		

6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
2N7002AKW-Q	SC-70	plastic, surface-mounted package; 3 leads; 1.3 mm pitch; 2 mm x 1.25 mm x 0.95 mm body	SOT323

7. Marking

Table 4. Marking codes

Type number	Marking code[1]
2N7002AKW-Q	6M%

[1] % = placeholder for manufacturing site code

8. Limiting values

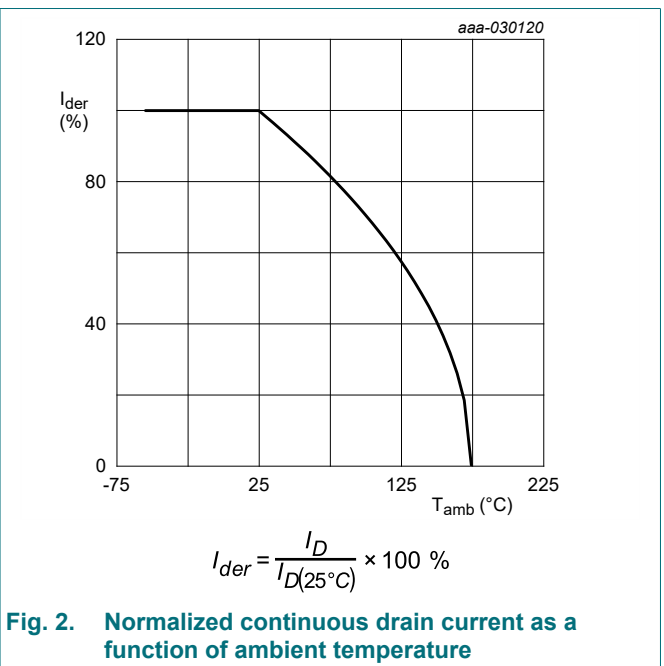
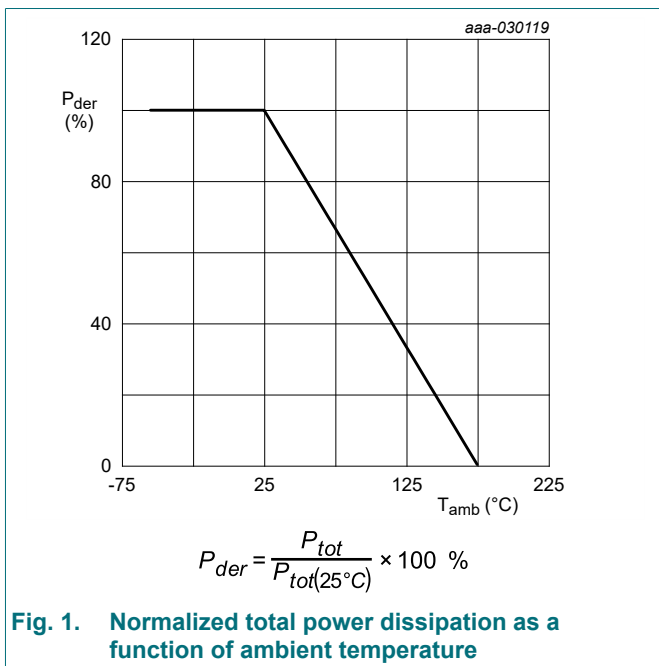
Table 5. Limiting values

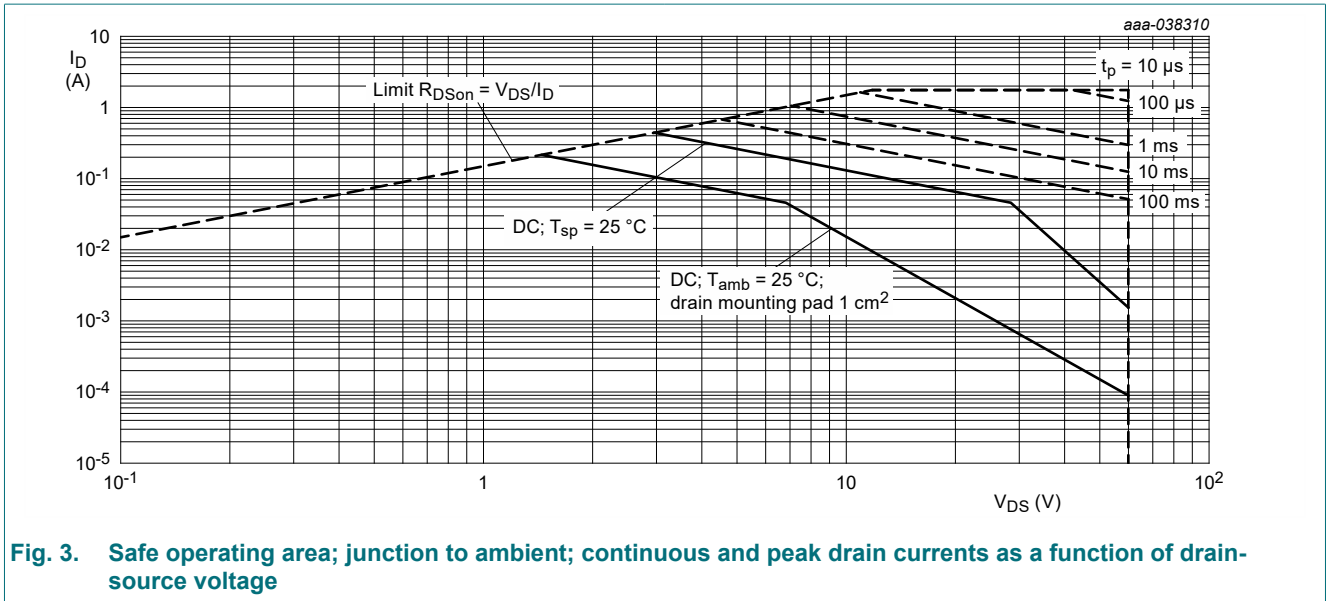
In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions		Min	Max	Unit
V _{DS}	drain-source voltage	T _j = 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]	-	220	mA
		V _{GS} = 10 V; T _{amb} = 100 °C	[1]	-	160	mA
I _{DM}	peak drain current	T _{amb} = 25 °C; single pulse; t _p ≤ 10 μs		-	1.8	A
P _{tot}	total power dissipation	T _{amb} = 25 °C	[2]	-	270	mW
			[1]	-	310	mW
		T _{sp} = 25 °C		-	1.3	W
T _j	junction temperature			-55	175	°C
T _{amb}	ambient temperature			-55	175	°C
T _{stg}	storage temperature			-65	175	°C
Source-drain diode						
I _S	source current	T _{amb} = 25 °C	[1]	-	210	mA
ESD maximum rating						
V _{ESD}	electrostatic discharge voltage	HBM		-	500	V
Avalanche ruggedness						
E _{DS(AL)S}	non-repetitive drain-source avalanche energy	T _{j(init)} = 25 °C; I _D = 20 mA; DUT in avalanche (unclamped)		-	6.6	mJ

[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.





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]	-	485	560	K/W
			[2]	-	420	480	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point			-	98	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.

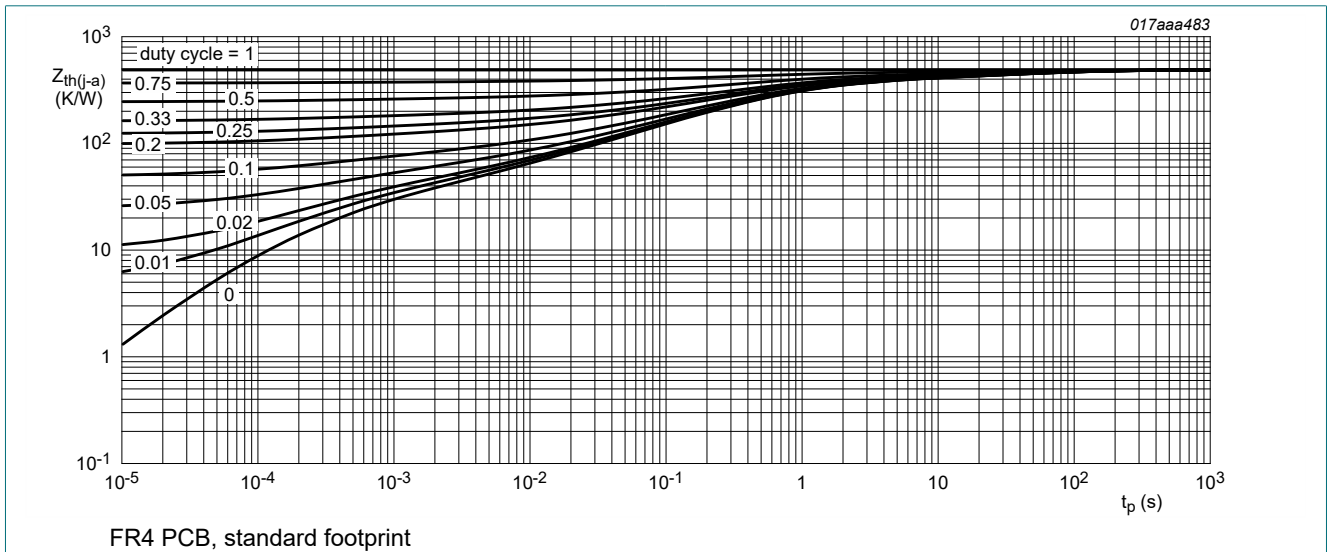


Fig. 4. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

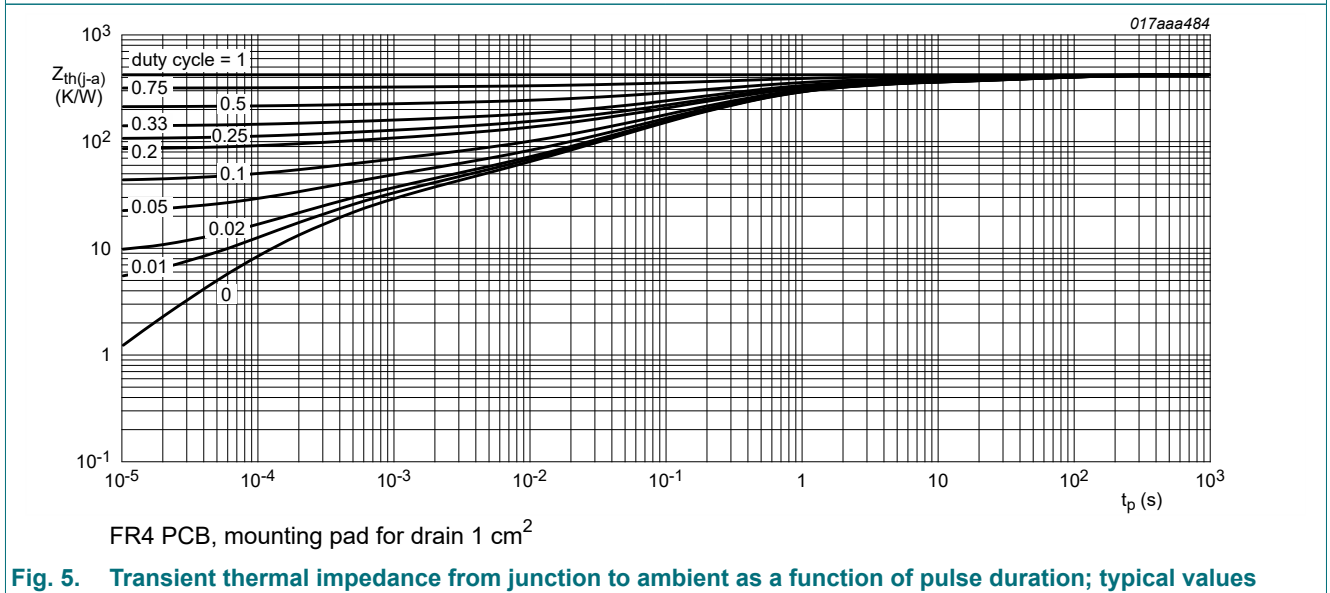


Fig. 5. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

10. Characteristics

Table 7. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Static characteristics						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 250 \mu A$; $V_{GS} = 0 V$; $T_j = 25 \text{ }^\circ C$	60	-	-	V
V_{GSth}	gate-source threshold voltage	$I_D = 250 \mu A$; $V_{DS} = V_{GS}$; $T_j = 25 \text{ }^\circ C$	1.3	1.7	2.6	V
I_{DSS}	drain leakage current	$V_{DS} = 60 V$; $V_{GS} = 0 V$; $T_j = 25 \text{ }^\circ C$	-	-	500	nA
		$V_{DS} = 60 V$; $V_{GS} = 0 V$; $T_j = 125 \text{ }^\circ C$	-	-	5	μA
I_{GSS}	gate leakage current	$V_{GS} = 20 V$; $V_{DS} = 0 V$; $T_j = 25 \text{ }^\circ C$	-	-	10	μA
		$V_{GS} = -20 V$; $V_{DS} = 0 V$; $T_j = 25 \text{ }^\circ C$	-	-	-10	μA
		$V_{GS} = 10 V$; $V_{DS} = 0 V$; $T_j = 25 \text{ }^\circ C$	-	-	1	μA
		$V_{GS} = -10 V$; $V_{DS} = 0 V$; $T_j = 25 \text{ }^\circ C$	-	-	-1	μA
		$V_{GS} = 5 V$; $V_{DS} = 0 V$; $T_j = 25 \text{ }^\circ C$	-	-	500	nA
		$V_{GS} = -5 V$; $V_{DS} = 0 V$; $T_j = 25 \text{ }^\circ C$	-	-	-500	nA
R_{DSon}	drain-source on-state resistance	$V_{GS} = 10 V$; $I_D = 100 \text{ mA}$; $T_j = 25 \text{ }^\circ C$	-	2.2	3	Ω
		$V_{GS} = 10 V$; $I_D = 100 \text{ mA}$; $T_j = 175 \text{ }^\circ C$	-	4.7	6.7	Ω
		$V_{GS} = 5 V$; $I_D = 50 \text{ mA}$; $T_j = 25 \text{ }^\circ C$	-	2.5	3.6	Ω
g_{fs}	forward transconductance	$V_{DS} = 5 V$; $I_D = 100 \text{ mA}$; $T_j = 25 \text{ }^\circ C$	-	0.3	-	S
Dynamic characteristics						
$Q_{G(tot)}$	total gate charge	$V_{DS} = 30 V$; $I_D = 100 \text{ mA}$; $V_{GS} = 10 V$; $T_j = 25 \text{ }^\circ C$	-	0.21	0.315	nC
Q_{GS}	gate-source charge		-	0.022	-	nC
Q_{GD}	gate-drain charge		-	0.051	-	nC
C_{iss}	input capacitance	$V_{DS} = 30 V$; $f = 1 \text{ MHz}$; $V_{GS} = 0 V$; $T_j = 25 \text{ }^\circ C$	-	9.2	-	pF
C_{oss}	output capacitance		-	1.6	-	pF
C_{rss}	reverse transfer capacitance		-	0.9	-	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = 30 V$; $I_D = 100 \text{ mA}$; $V_{GS} = 10 V$; $R_{G(ext)} = 6 \Omega$; $T_j = 25 \text{ }^\circ C$	-	1	-	ns
t_r	rise time		-	1	-	ns
$t_{d(off)}$	turn-off delay time		-	2	-	ns
t_f	fall time		-	6	-	ns
Source-drain diode						
V_{SD}	source-drain voltage	$I_S = 210 \text{ mA}$; $V_{GS} = 0 V$; $T_j = 25 \text{ }^\circ C$	-	1	1.6	V
t_{rr}	reverse recovery time	$I_S = 210 \text{ mA}$; $dI_S/dt = -100 \text{ A}/\mu s$; $V_{GS} = 0 V$; $V_{DS} = 30 V$; $T_j = 25 \text{ }^\circ C$	-	7	-	ns
Q_r	recovered charge		-	1	-	nC

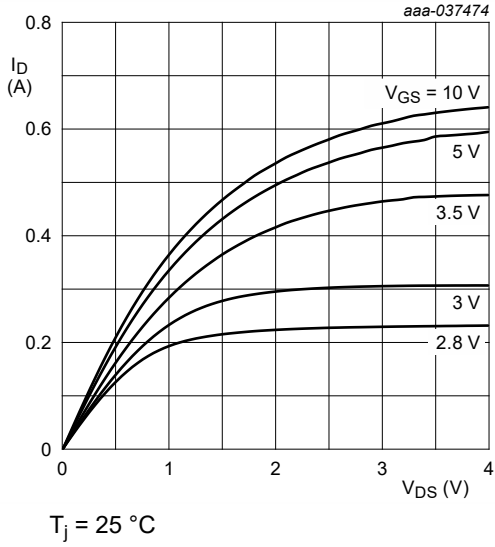


Fig. 6. Output characteristics: drain current as a function of drain-source voltage; typical values

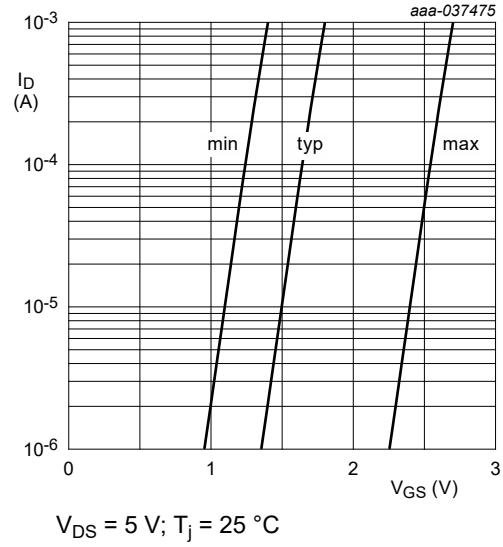


Fig. 7. Sub-threshold drain current as a function of gate-source voltage

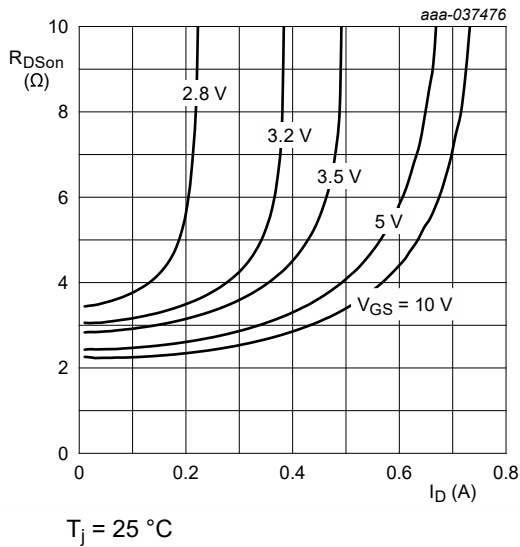


Fig. 8. Drain-source on-state resistance as a function of drain current; typical values

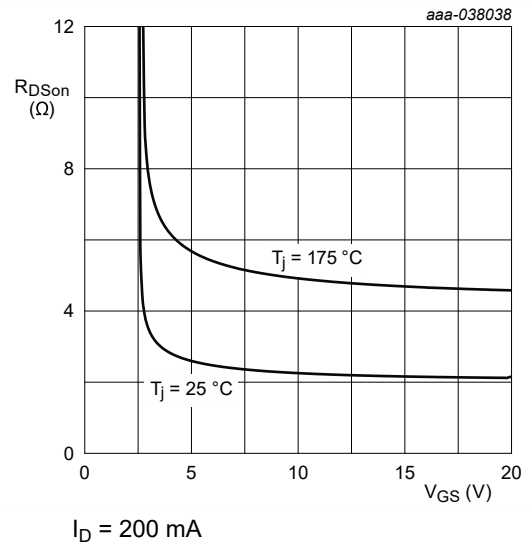


Fig. 9. Drain-source on-state resistance as a function of gate-source voltage; typical values

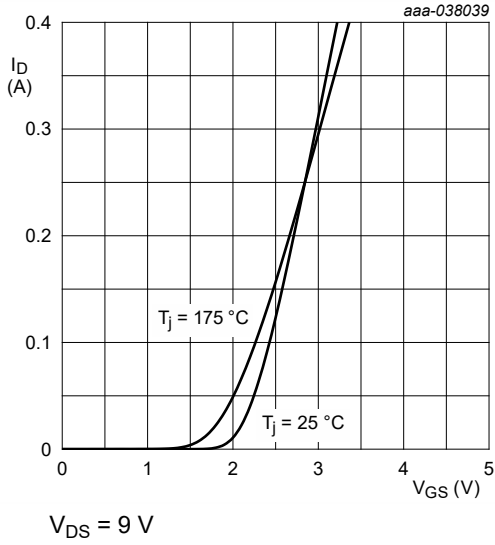
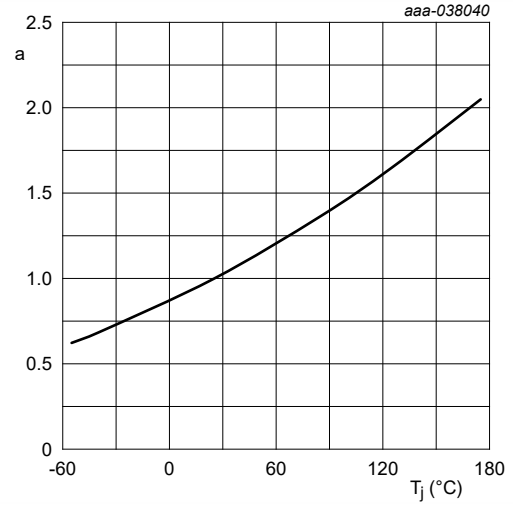


Fig. 10. Transfer characteristics: drain current as a function of gate-source voltage; typical values



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

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

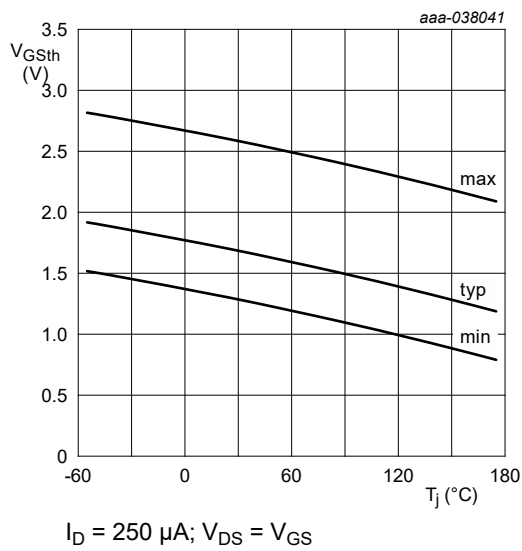


Fig. 12. Gate-source threshold voltage as a function of junction temperature

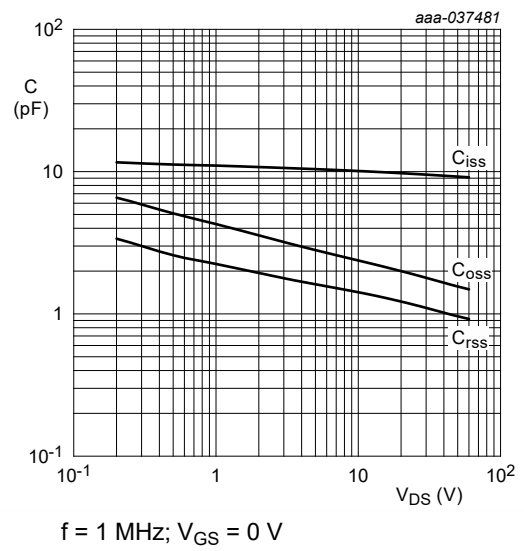
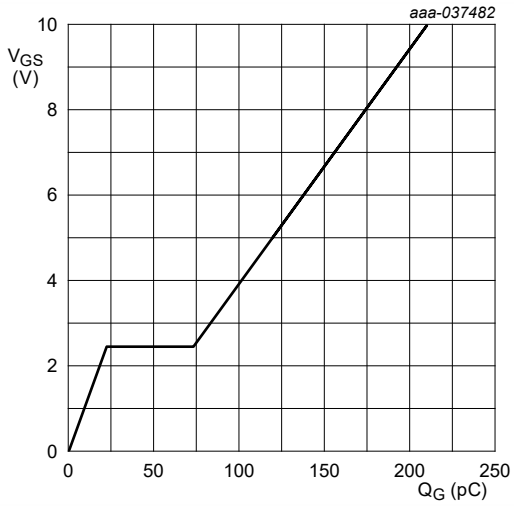


Fig. 13. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values



$I_D = 0.1 \text{ A}; V_{DS} = 30 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$

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

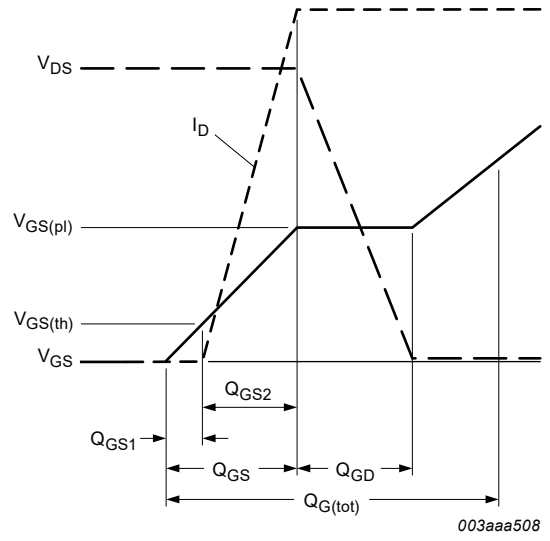
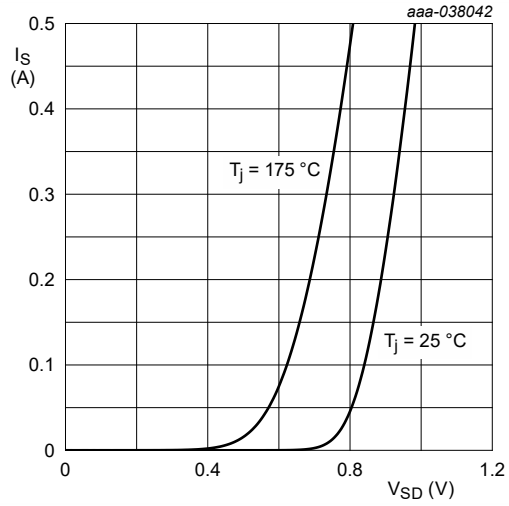


Fig. 15. Gate charge waveform definitions



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

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

11. Test information

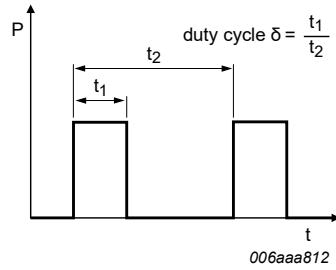


Fig. 17. Duty cycle definition

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

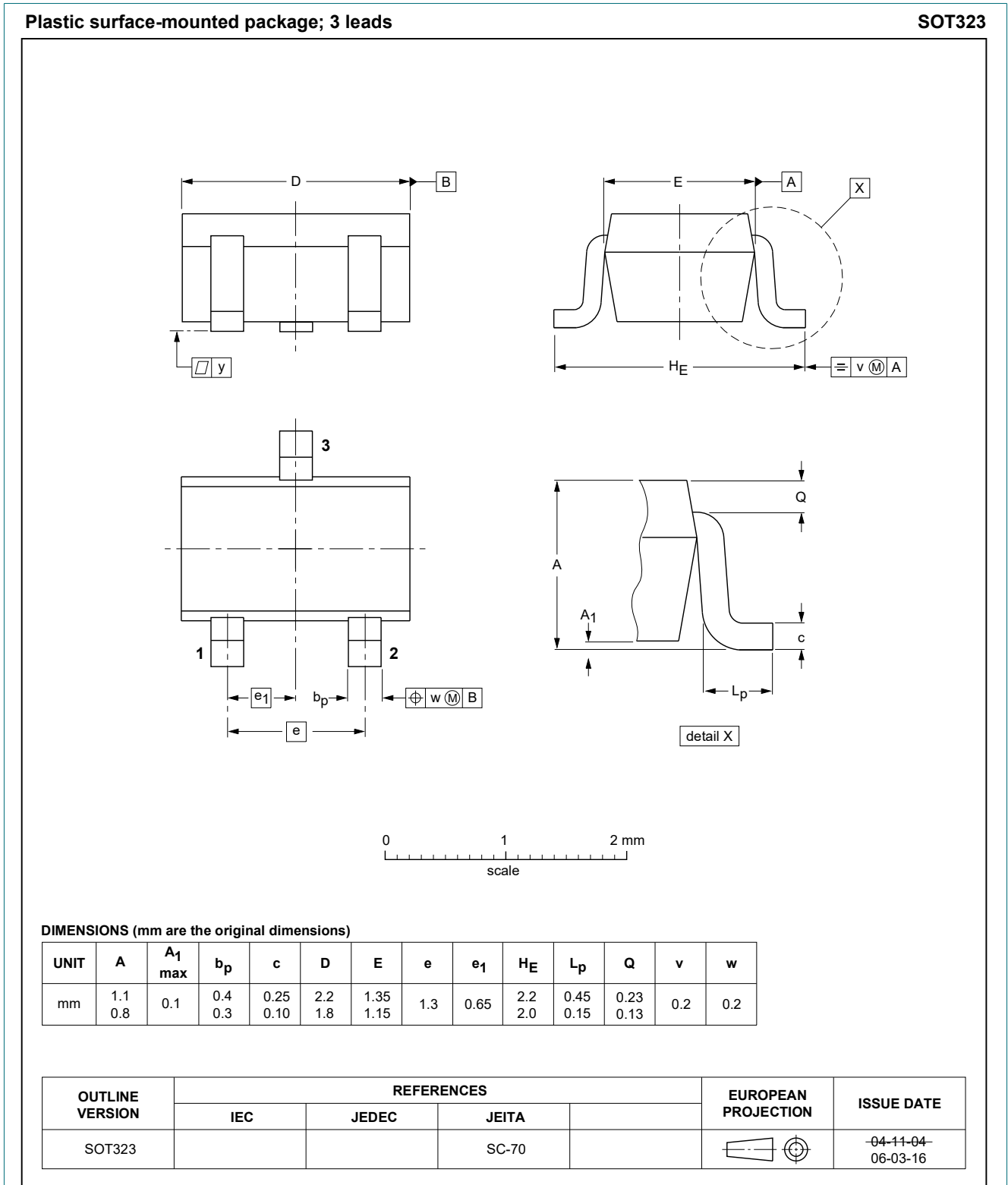


Fig. 18. Package outline SC-70 (SOT323)

13. Soldering

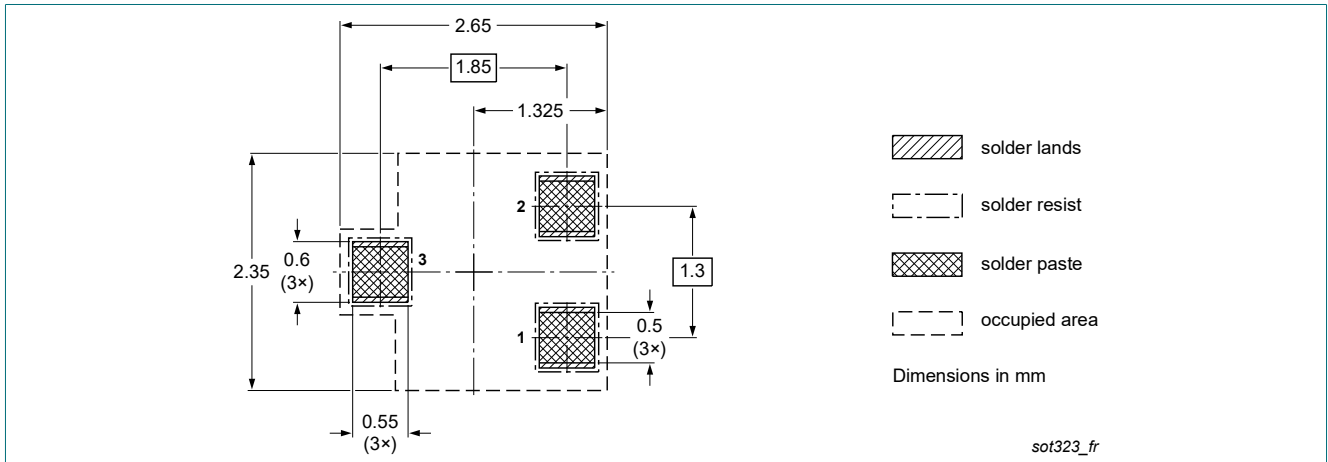


Fig. 19. Reflow soldering footprint for SC-70 (SOT323)

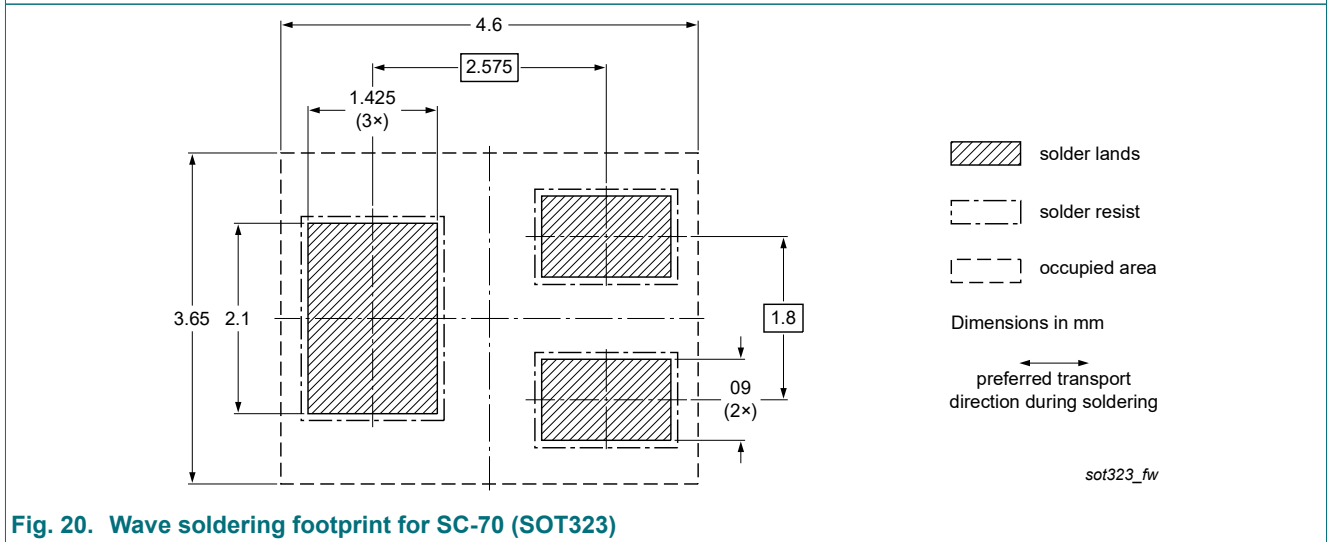


Fig. 20. Wave soldering footprint for SC-70 (SOT323)

14. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
2N7002AKW-Q v.1	20240111	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.
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Product [short] data sheet	Production	This document contains the product specification.

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