



BUK9D23-40E

40 V, N-channel Trench MOSFET

13 December 2017

Product data sheet

1. General description

N-channel enhancement mode Field-Effect Transistor (FET) in a medium power DFN2020MD-6 (SOT1220) Surface-Mounted Device (SMD) plastic package using Trench MOSFET technology.

2. Features and benefits

- Extended temperature range $T_j = 175\text{ °C}$
- Side wettable flanks for optical solder inspection
- Small and leadless ultra thin SMD plastic package: 2 x 2 x 0.65 mm
- Trench MOSFET technology
- AEC-Q101 qualified

3. Applications

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

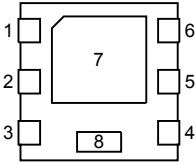
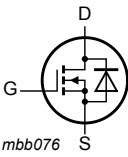
4. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{DS}	drain-source voltage	$T_j = 25\text{ °C}$		-	-	40	V
V_{GS}	gate-source voltage			-15	-	15	V
I_D	drain current	$V_{GS} = 10\text{ V}; T_{sp} = 25\text{ °C}$		-	-	19	A
P_{tot}	total power dissipation	$T_{sp} = 25\text{ °C}$		-	-	15	W
Static characteristics							
R_{DSon}	drain-source on-state resistance	$V_{GS} = 10\text{ V}; I_D = 8\text{ A}; T_j = 25\text{ °C}$		-	18	23	mΩ

5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	D	drain	 Transparent top view DFN2020MD-6 (SOT1220)	 mbb076
2	D	drain		
3	G	gate		
4	S	source		
5	D	drain		
6	D	drain		
7	D	drain		
8	S	source		

6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
BUK9D23-40E	DFN2020MD-6	DFN2020MD-6: plastic thermal enhanced ultra thin small outline package; no leads; 6 terminals	SOT1220

7. Marking

Table 4. Marking codes

Type number	Marking code ^[1]
BUK9D23-40E	%4B

[1] % = placeholder for manufacturing site code

8. Limiting values

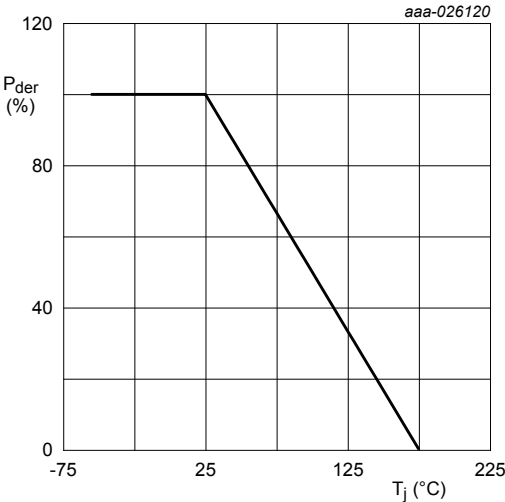
Table 5. Limiting values

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

Symbol	Parameter	Conditions		Min	Max	Unit
V_{DS}	drain-source voltage	$T_j = 25\text{ }^{\circ}\text{C}$		-	40	V
V_{GS}	gate-source voltage			-15	15	V
I_D	drain current	$V_{GS} = 10\text{ V}; T_{sp} = 25\text{ }^{\circ}\text{C}$		-	19	A
		$V_{GS} = 10\text{ V}; T_{sp} = 100\text{ }^{\circ}\text{C}$		-	12	A
		$V_{GS} = 10\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}$	[1]	-	8	A
I_{DM}	peak drain current	$T_{sp} = 25\text{ }^{\circ}\text{C}$; single pulse; $t_p \leq 10\text{ }\mu\text{s}$		-	76	A
P_{tot}	total power dissipation	$T_{sp} = 25\text{ }^{\circ}\text{C}$		-	15	W
		$T_{amb} = 25\text{ }^{\circ}\text{C}$	[1]	-	2.3	W
T_j	junction temperature			-55	175	$^{\circ}\text{C}$
T_{amb}	ambient temperature			-55	175	$^{\circ}\text{C}$
T_{stg}	storage temperature			-65	175	$^{\circ}\text{C}$
Source-drain diode						
I_S	source current	$T_{sp} = 25\text{ }^{\circ}\text{C}$		-	15	A
		$T_{amb} = 25\text{ }^{\circ}\text{C}$	[1]	-	2.3	A
I_{SM}	peak source current	single pulse; $t_p \leq 10\text{ }\mu\text{s}$; $T_{sp} = 25\text{ }^{\circ}\text{C}$		-	62	A
ESD maximum rating						
V_{ESD}	electrostatic discharge voltage	HBM	[2]	-	500	V
Avalanche ruggedness						
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$T_{j(\text{init})} = 25\text{ }^{\circ}\text{C}$; $I_D = 1.35\text{ A}$; DUT in avalanche (unclamped)		-	28.4	mJ

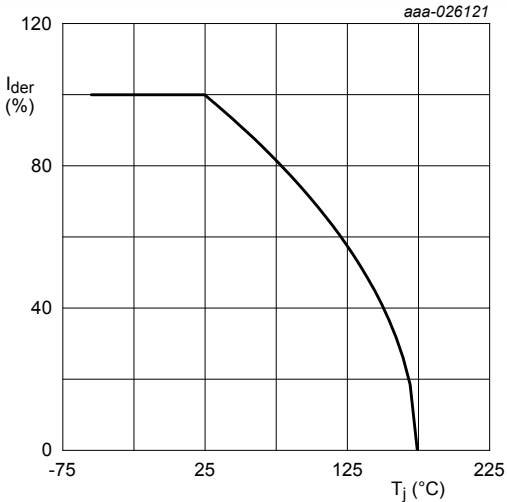
[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated, mounting pad for drain 6 cm^2 .

[2] 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 junction temperature



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

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

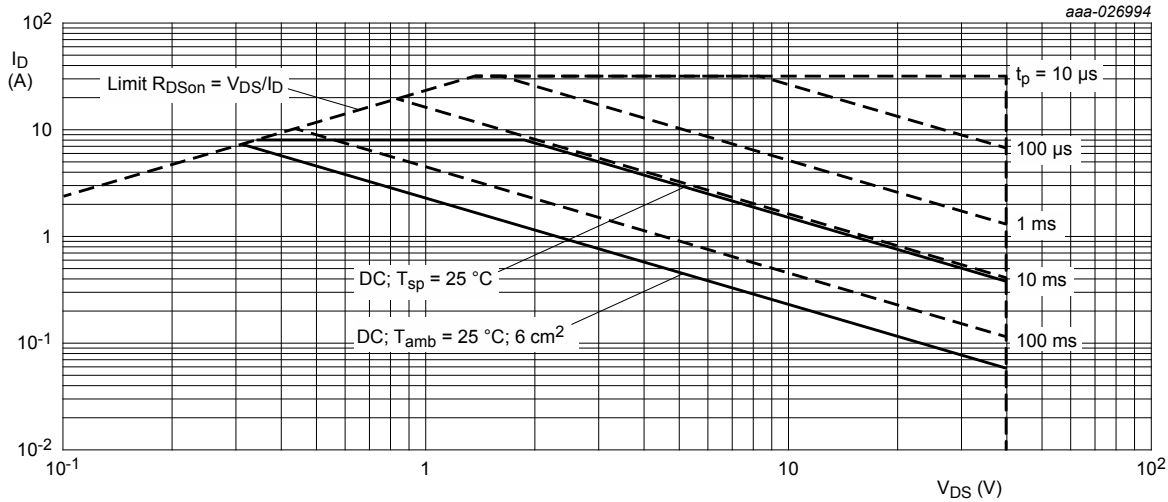


Fig. 3. Safe operating area; junction to ambient; continuous and peak drain currents as a function of drain-source voltage

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]	-	57	66	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point			-	6	10	K/W

[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 6 cm².

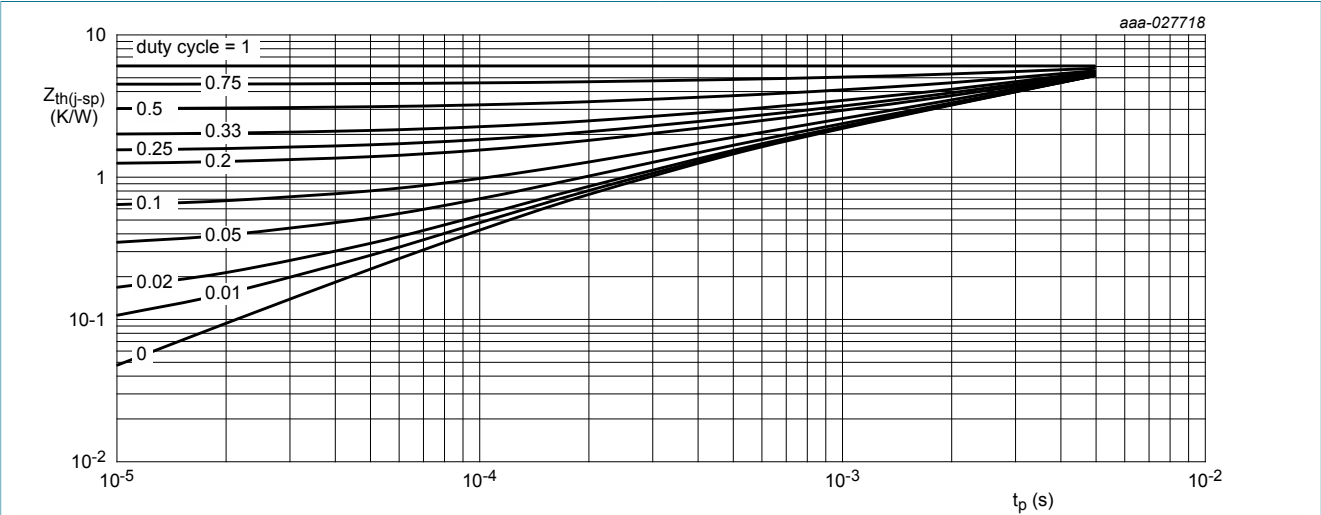
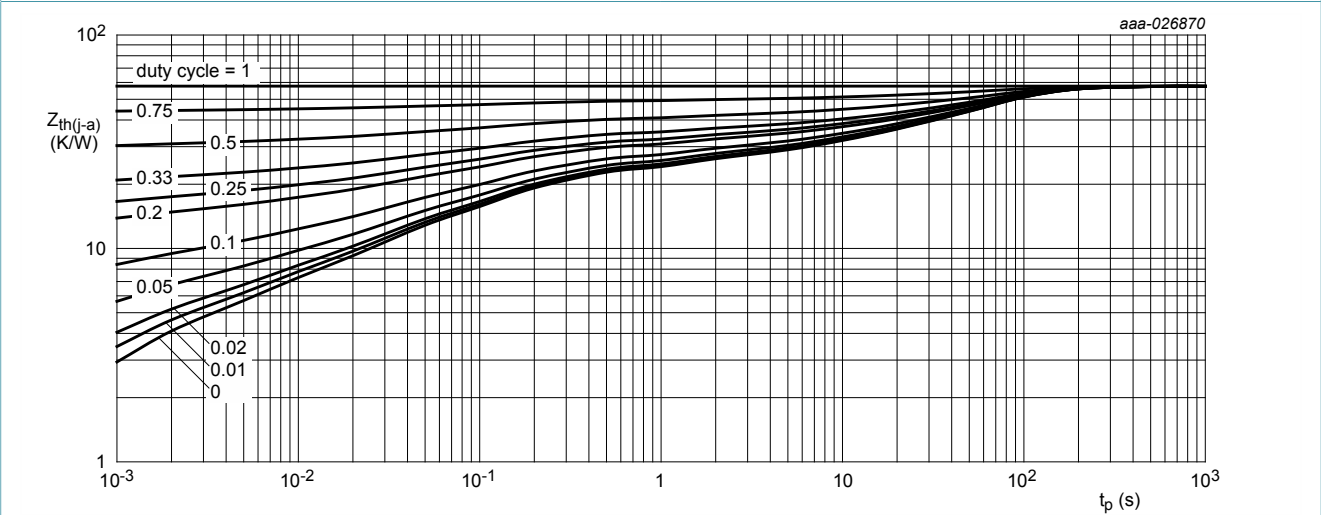


Fig. 4. Transient thermal impedance from junction to solder point as a function of pulse duration; typical values



FR4 PCB, mounting pad for drain 6 cm²

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 μA; V _{GS} = 0 V; T _j = 25 °C		40	-	-	V
V _{GSth}	gate-source threshold voltage	I _D = 250 μA; V _{DS} = V _{GS} ; T _j = 25 °C		1.4	1.7	2.1	V
I _{DSS}	drain leakage current	V _{DS} = 40 V; V _{GS} = 0 V; T _j = 25 °C		-	-	1	μA
		V _{DS} = 40 V; V _{GS} = 0 V; T _j = 175 °C		-	-	500	μA
I _{GSS}	gate leakage current	V _{GS} = 15 V; V _{DS} = 0 V; T _j = 25 °C		-	-	100	nA
		V _{GS} = -15 V; V _{DS} = 0 V; T _j = 25 °C		-	-	-100	nA
R _{DSon}	drain-source on-state resistance	V _{GS} = 10 V; I _D = 8 A; T _j = 25 °C		-	18	23	mΩ
		V _{GS} = 10 V; I _D = 8 A; T _j = 175 °C		-	33	43	mΩ
		V _{GS} = 4.5 V; I _D = 6.4 A; T _j = 25 °C		-	22	30	mΩ
g _{fs}	forward transconductance	V _{DS} = 10 V; I _D = 8 A; T _j = 25 °C		-	39	-	S
R _G	gate resistance	f = 1 MHz		-	1.8	-	Ω
Dynamic characteristics							
Q _{G(tot)}	total gate charge	V _{DS} = 20 V; I _D = 8 A; V _{GS} = 10 V; T _j = 25 °C		-	11.5	17	nC
Q _{GS}	gate-source charge			-	1.7	-	nC
Q _{GD}	gate-drain charge			-	2.1	-	nC
C _{iss}	input capacitance	V _{DS} = 20 V; f = 1 MHz; V _{GS} = 0 V; T _j = 25 °C		-	637	-	pF
C _{oss}	output capacitance			-	102	-	pF
C _{rss}	reverse transfer capacitance			-	52	-	pF
t _{d(on)}	turn-on delay time	V _{DS} = 20 V; I _D = 8 A; V _{GS} = 10 V; R _{G(ext)} = 6 Ω; T _j = 25 °C		-	2	-	ns
t _r	rise time			-	6	-	ns
t _{d(off)}	turn-off delay time			-	12	-	ns
t _f	fall time			-	4	-	ns
Source-drain diode							
V _{SD}	source-drain voltage	I _S = 2.3 A; V _{GS} = 0 V; T _j = 25 °C		-	0.8	1.2	V
t _{rr}	reverse recovery time	I _S = 2.3 A; dI _S /dt = -100 A/μs; V _{GS} = 0 V; V _{DS} = 20 V; T _j = 25 °C		-	12.9	-	ns
Q _r	recovered charge			-	5.3	-	nC

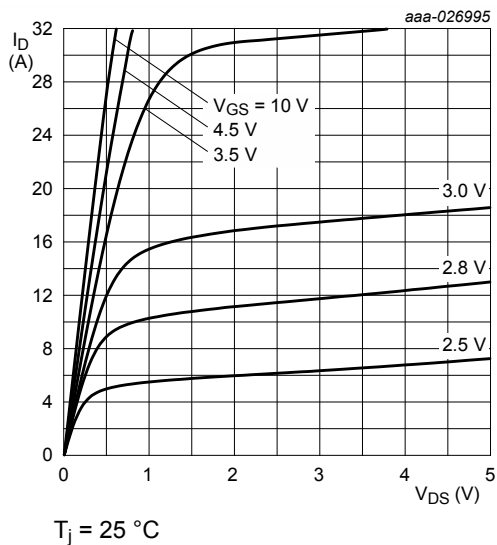


Fig. 6. Output characteristics: drain current as a function of drain-source voltage; typical values

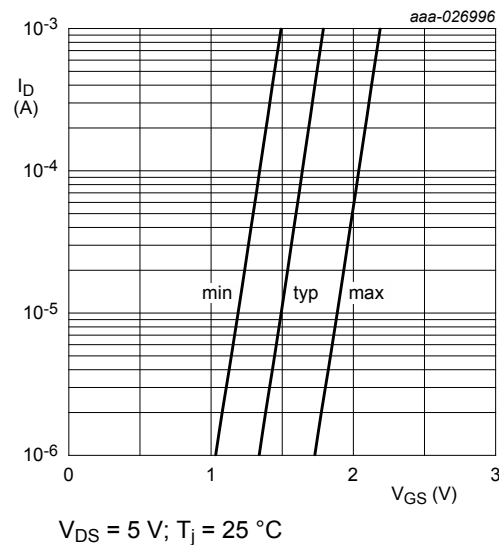


Fig. 7. Sub-threshold drain current as a function of gate-source voltage

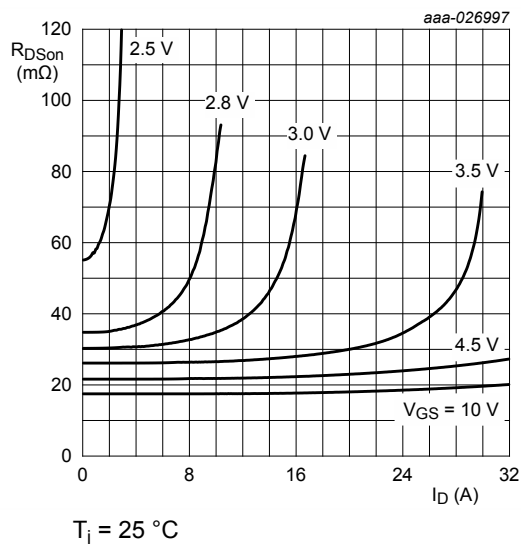


Fig. 8. Drain-source on-state resistance as a function of drain current; typical values

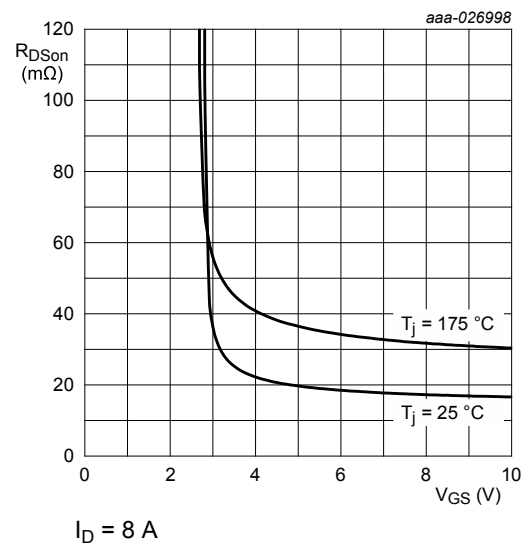


Fig. 9. Drain-source on-state resistance as a function of gate-source voltage; typical values

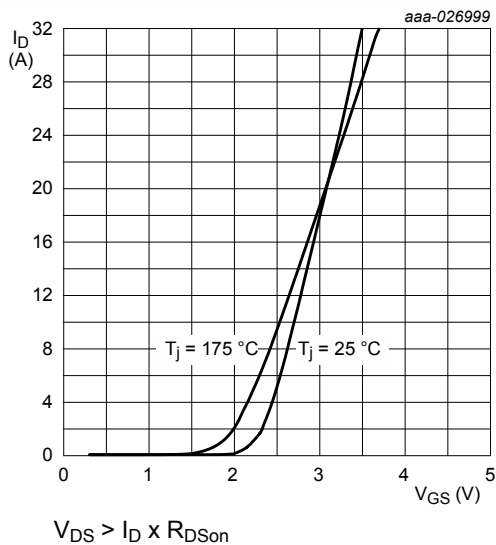


Fig. 10. Transfer characteristics: drain current as a function of gate-source voltage; typical values

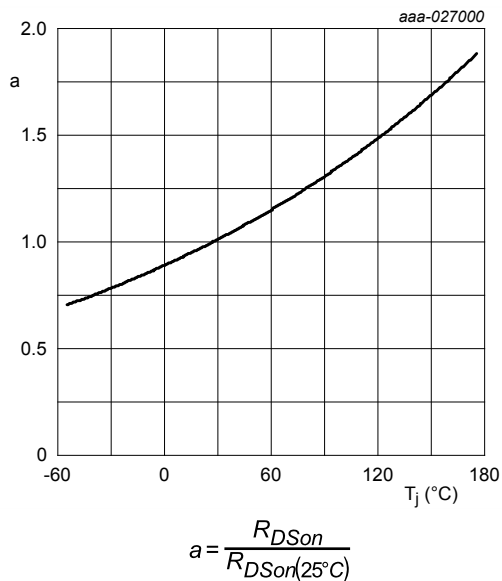


Fig. 11. Normalized drain-source on-state resistance as a function of junction temperature; typical values

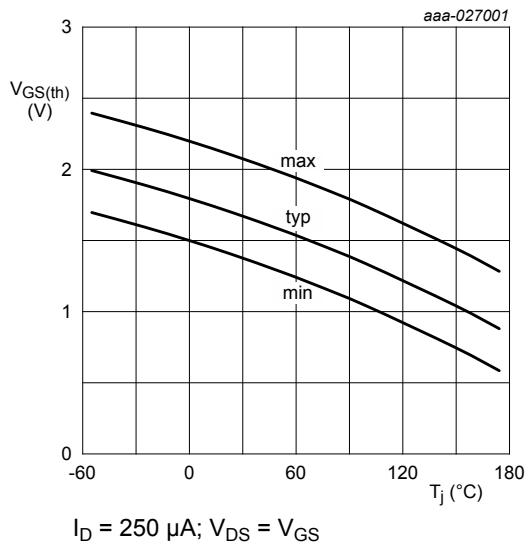


Fig. 12. Gate-source threshold voltage as a function of junction temperature

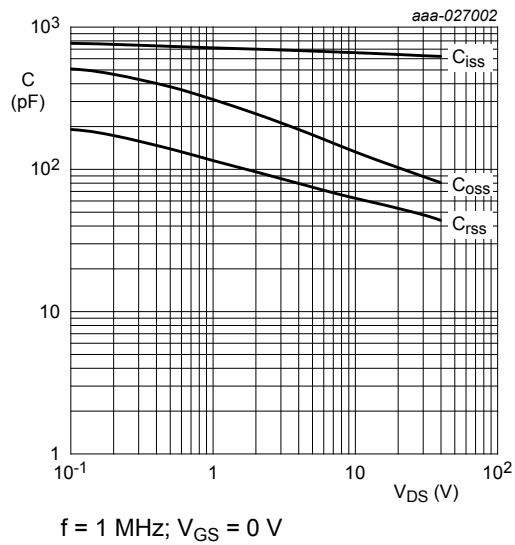
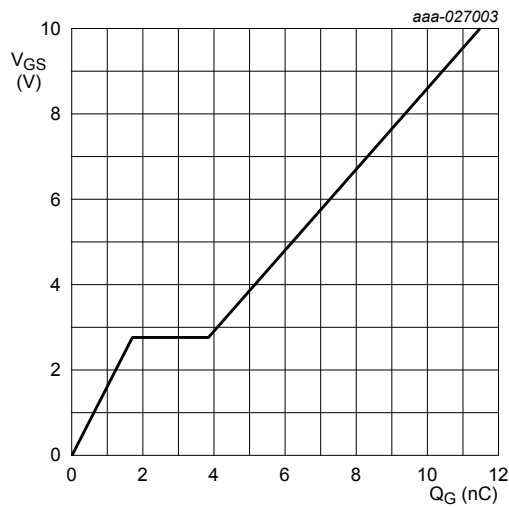


Fig. 13. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values



$V_{DS} = 20\text{ V}$; $I_D = 8\text{ A}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$

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

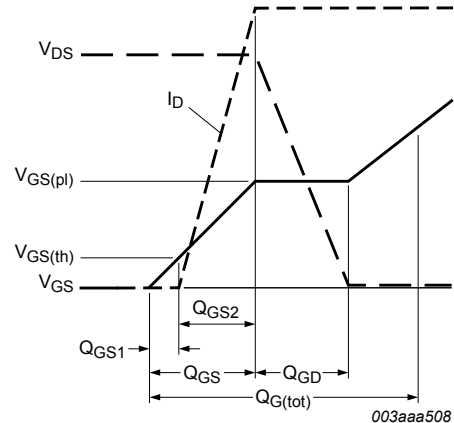
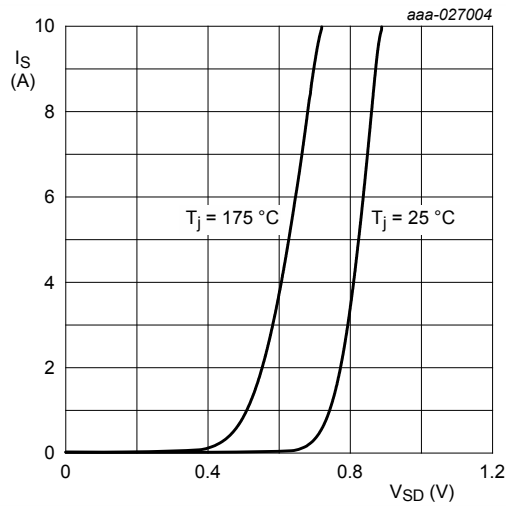


Fig. 15. Gate charge waveform definitions



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

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

11. Test information

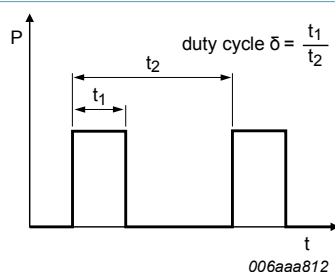


Fig. 17. Duty cycle definition

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

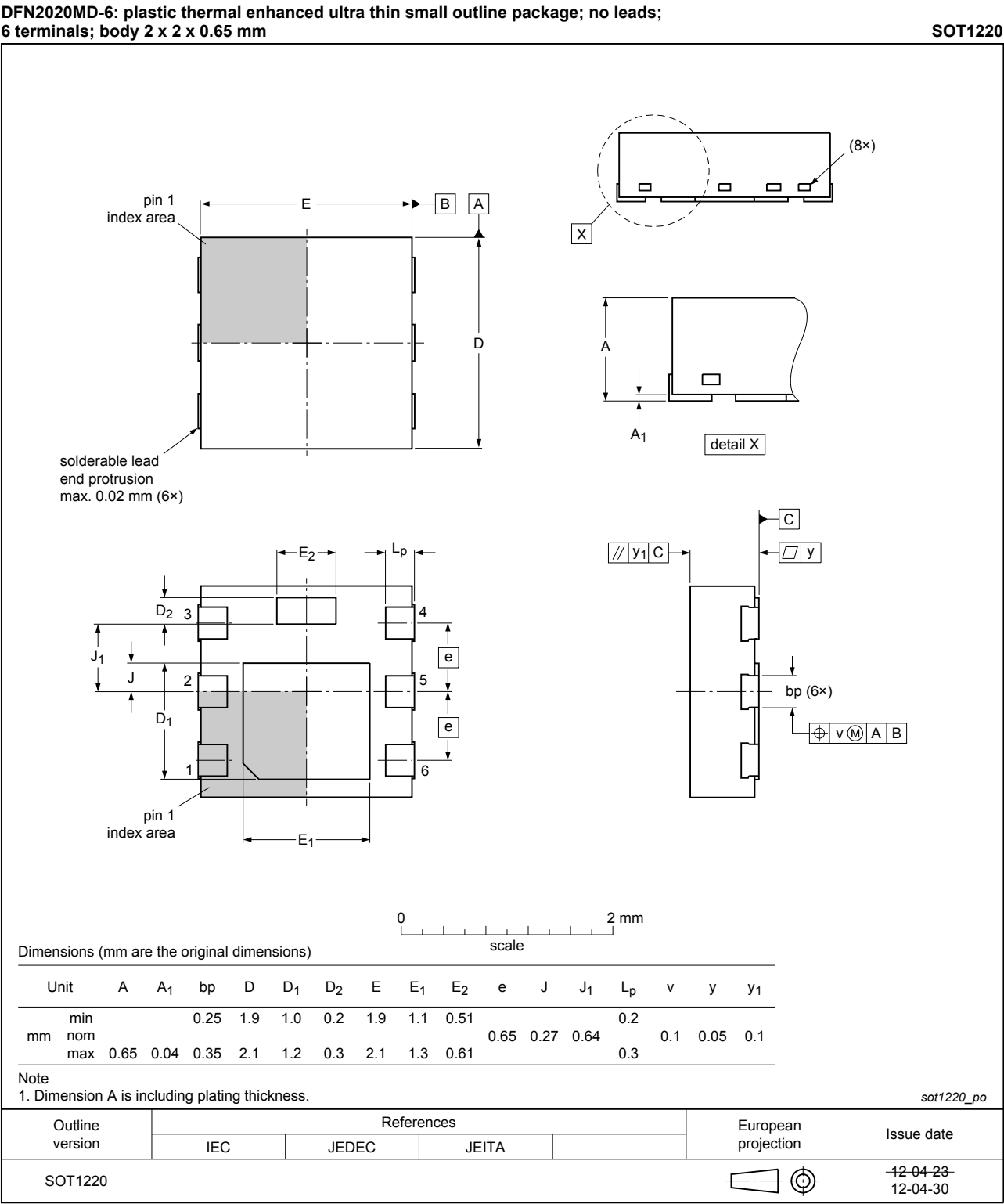


Fig. 18. Package outline DFN2020MD-6 (SOT1220)

13. Soldering

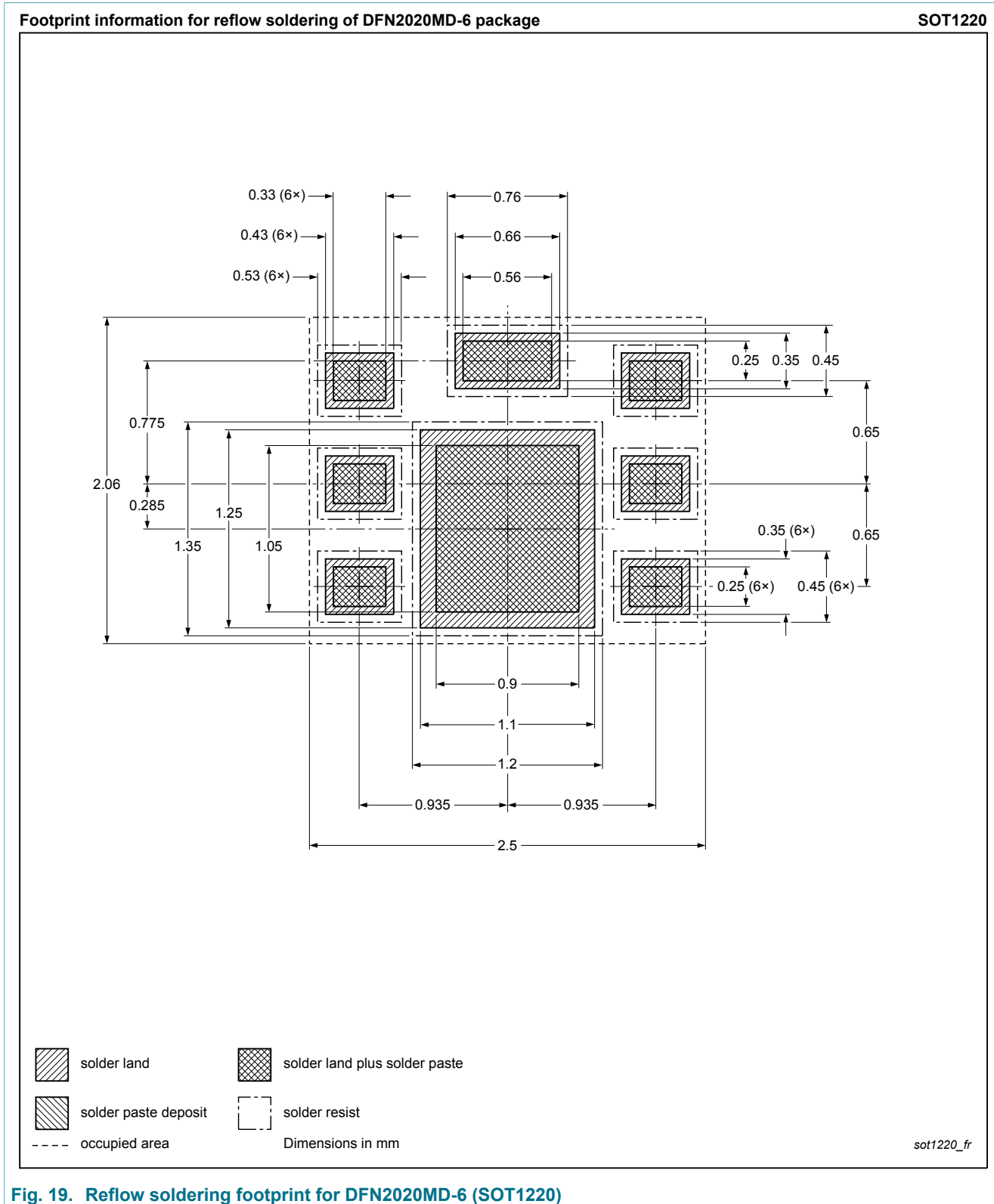


Fig. 19. Reflow soldering footprint for DFN2020MD-6 (SOT1220)

14. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
BUK9D23-40E v.1	20171213	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.

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- [2] The term 'short data sheet' is explained in section "Definitions".
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