



# BUK6D120-60P

60 V, P-channel Trench MOSFET

3 April 2018

Product data sheet

## 1. General description

P-channel enhancement mode Field-Effect Transistor (FET) in a leadless 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
- High-side load switch
- Switching circuits

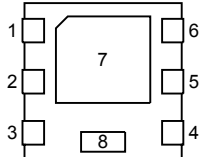
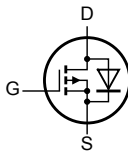
## 4. Quick reference data

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	$V_{GS} = -10\text{ V}; T_{sp} = 25\text{ °C}$	-	-	-8	A
$P_{tot}$	total power dissipation	$T_{sp} = 25\text{ °C}$	-	-	15	W
<b>Static characteristics</b>						
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = -10\text{ V}; I_D = -3\text{ A}; T_j = 25\text{ °C}$	-	95	120	m $\Omega$

## 5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	D	drain	 <p>Transparent top view <b>DFN2020MD-6 (SOT1220)</b></p>	 <p>017aaa094</p>
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
BUK6D120-60P	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
BUK6D120-60P	4S

## 8. Limiting values

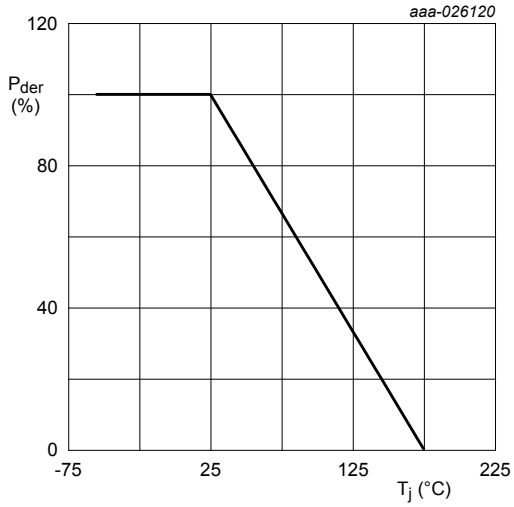
**Table 5. Limiting values**

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

Symbol	Parameter	Conditions		Min	Max	Unit
$V_{DS}$	drain-source voltage	$T_j = 25\text{ °C}$		-	-60	V
$V_{GS}$	gate-source voltage			-20	20	V
$I_D$	drain current	$V_{GS} = -10\text{ V}; T_{sp} = 25\text{ °C}$		-	-8	A
		$V_{GS} = -10\text{ V}; T_{sp} = 100\text{ °C}$		-	-5.1	A
		$V_{GS} = -10\text{ V}; T_{amb} = 25\text{ °C}$	[1]	-	-3	A
$I_{DM}$	peak drain current	$T_{sp} = 25\text{ °C};$ single pulse; $t_p \leq 10\text{ }\mu\text{s}$		-	-32	A
$P_{tot}$	total power dissipation	$T_{sp} = 25\text{ °C}$		-	15	W
		$T_{amb} = 25\text{ °C}$	[1]	-	2.3	W
$T_j$	junction temperature			-55	175	°C
$T_{amb}$	ambient temperature			-55	175	°C
$T_{stg}$	storage temperature			-65	175	°C
<b>Source-drain diode</b>						
$I_S$	source current	$T_{sp} = 25\text{ °C}$		-	-8	A
		$T_{amb} = 25\text{ °C}$	[1]	-	-2.3	A
$I_{SM}$	peak source current	single pulse; $t_p \leq 10\text{ }\mu\text{s}; T_{sp} = 25\text{ °C}$		-	-32	A
<b>ESD maximum rating</b>						
$V_{ESD}$	electrostatic discharge voltage	HBM	[2]	-	500	V
<b>Avalanche ruggedness</b>						
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$T_{j(\text{init})} = 25\text{ °C}; I_D = -0.85\text{ A};$ DUT in avalanche (unclamped)		-	28	mJ

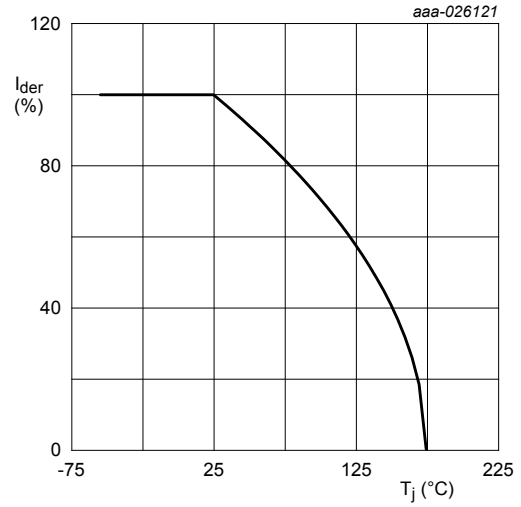
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and mounting pad for drain 6 cm<sup>2</sup>.

[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

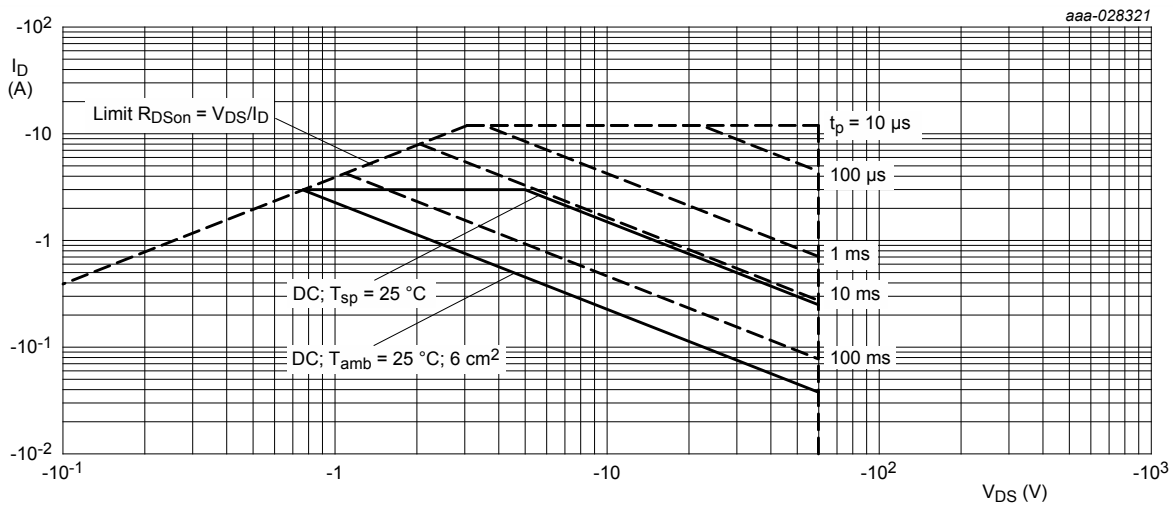


Fig. 3. Safe operating area; junction to ambient; continuous and peak drain currents as a function of drain-source voltage

## 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 and mounting pad for drain 6 cm<sup>2</sup>.

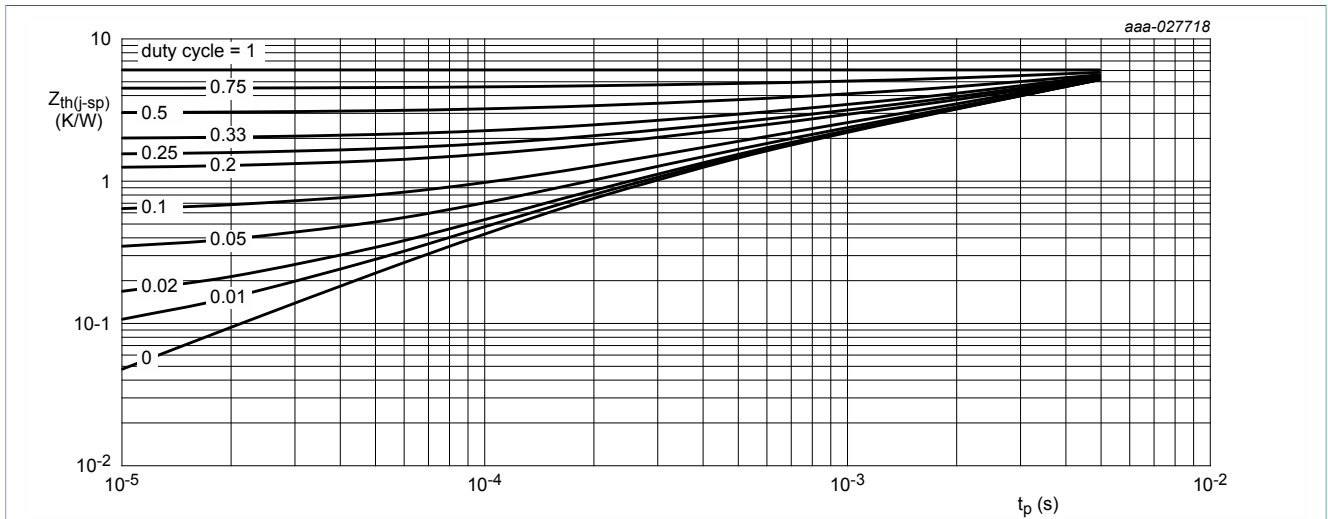
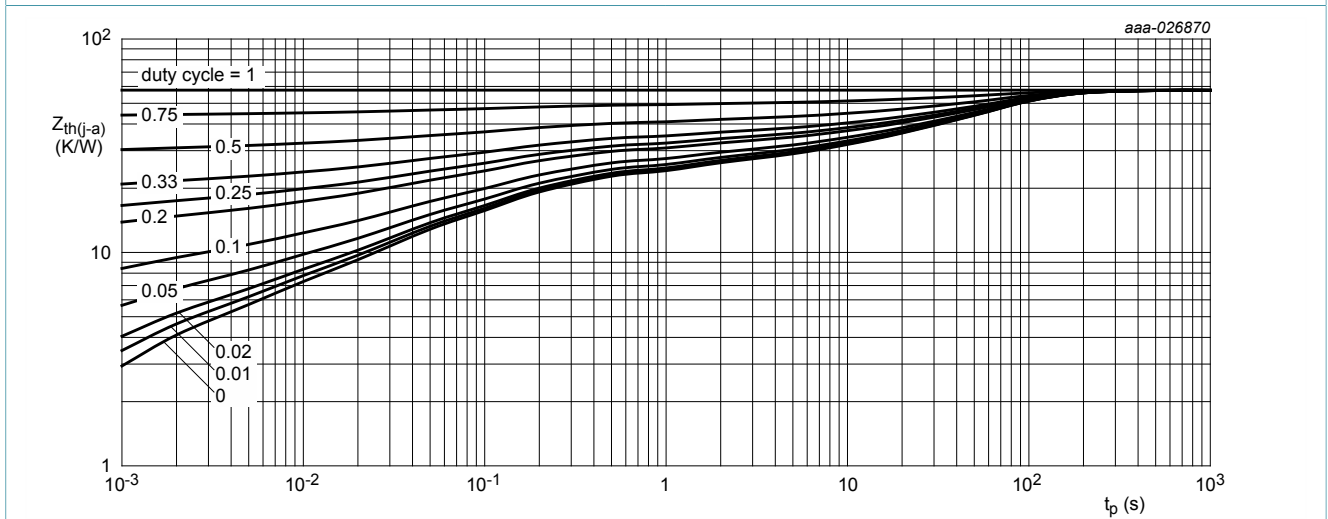


Fig. 4. Transient thermal impedance from junction to solder point as a function of pulse duration; typical values



FR4 PCB, mounting pad for drain 6 cm<sup>2</sup>

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

## 10. 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	$I_D = -250\ \mu\text{A}$ ; $V_{GS} = 0\ \text{V}$	-60	-	-	V
$V_{GSth}$	gate-source threshold voltage	$I_D = -250\ \mu\text{A}$ ; $V_{DS} = V_{GS}$ ; $T_j = 25\text{ °C}$	-1.9	-2.5	-3.2	V
$I_{DSS}$	drain leakage current	$V_{DS} = -60\ \text{V}$ ; $V_{GS} = 0\ \text{V}$ ; $T_j = 25\text{ °C}$	-	-	-1	$\mu\text{A}$
		$V_{DS} = -60\ \text{V}$ ; $V_{GS} = 0\ \text{V}$ ; $T_j = 175\text{ °C}$	-	-	-500	$\mu\text{A}$
$I_{GSS}$	gate leakage current	$V_{GS} = -20\ \text{V}$ ; $V_{DS} = 0\ \text{V}$	-	-	-100	nA
		$V_{GS} = 20\ \text{V}$ ; $V_{DS} = 0\ \text{V}$	-	-	100	nA
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = -10\ \text{V}$ ; $I_D = -3\ \text{A}$ ; $T_j = 25\text{ °C}$	-	95	120	m $\Omega$
		$V_{GS} = -10\ \text{V}$ ; $I_D = -3\ \text{A}$ ; $T_j = 175\text{ °C}$	-	202	256	m $\Omega$
		$V_{GS} = -4.5\ \text{V}$ ; $I_D = -2.5\ \text{A}$	-	125	170	m $\Omega$
$g_{fs}$	forward transconductance	$V_{DS} = -10\ \text{V}$ ; $I_D = -3\ \text{A}$	-	13	-	S
$R_G$	gate resistance	$f = 1\ \text{MHz}$	-	8	-	$\Omega$
<b>Dynamic characteristics</b>						
$Q_{G(tot)}$	total gate charge	$V_{DS} = -30\ \text{V}$ ; $I_D = -3\ \text{A}$ ; $V_{GS} = -10\ \text{V}$	-	12	18	nC
$Q_{GS}$	gate-source charge		-	2.6	-	nC
$Q_{GD}$	gate-drain charge		-	2.6	-	nC
$C_{iss}$	input capacitance	$V_{DS} = -30\ \text{V}$ ; $f = 1\ \text{MHz}$ ; $V_{GS} = 0\ \text{V}$	-	724	-	pF
$C_{oss}$	output capacitance		-	55	-	pF
$C_{rss}$	reverse transfer capacitance		-	30	-	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = -30\ \text{V}$ ; $I_D = -3\ \text{A}$ ; $V_{GS} = -10\ \text{V}$ ; $R_{G(ext)} = 6\ \Omega$	-	9	-	ns
$t_r$	rise time		-	10	-	ns
$t_{d(off)}$	turn-off delay time		-	24	-	ns
$t_f$	fall time		-	18	-	ns
<b>Source-drain diode</b>						
$V_{SD}$	source-drain voltage	$I_S = -2.3\ \text{A}$ ; $V_{GS} = 0\ \text{V}$	-	-0.8	-1.2	V
$t_{rr}$	reverse recovery time	$I_S = -2.3\ \text{A}$ ; $dI_S/dt = 100\ \text{A}/\mu\text{s}$ ; $V_{GS} = 0\ \text{V}$ ; $V_{DS} = -30\ \text{V}$ ; $T_j = 25\text{ °C}$	-	24	-	ns
$Q_r$	recovered charge		-	24	-	nC

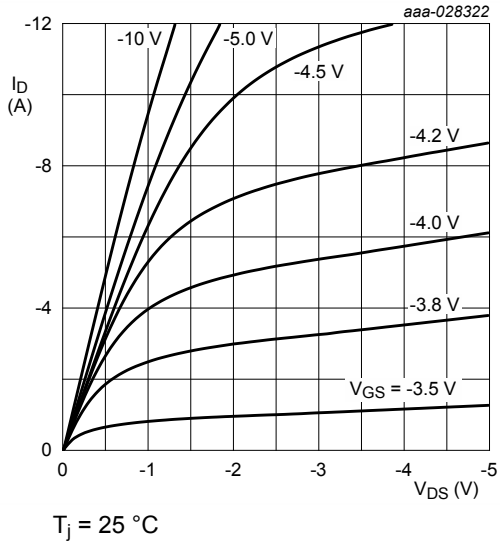


Fig. 6. Output characteristics: drain current as a function of drain-source voltage; typical values

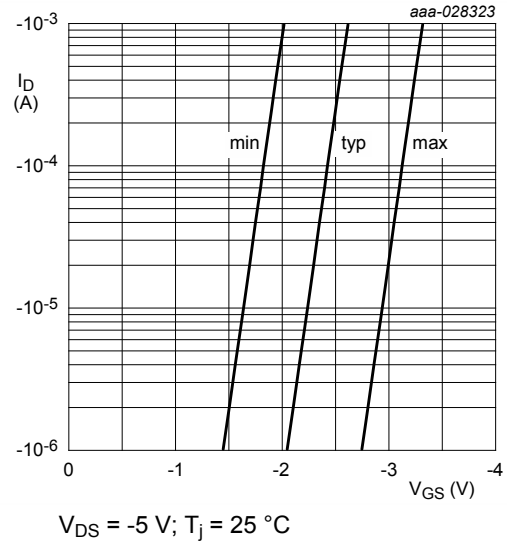


Fig. 7. Sub-threshold drain current as a function of gate-source voltage

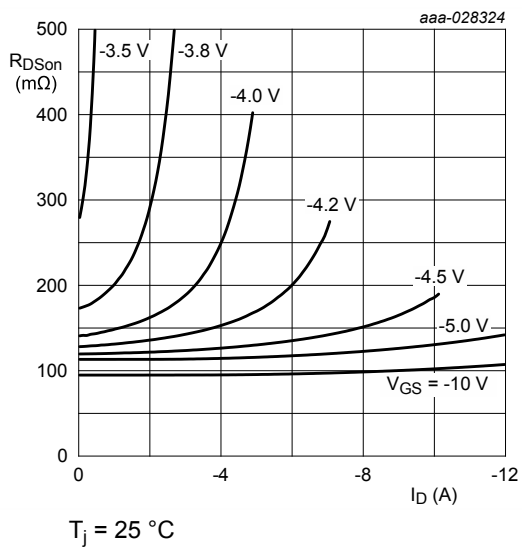


Fig. 8. Drain-source on-state resistance as a function of drain current; typical values

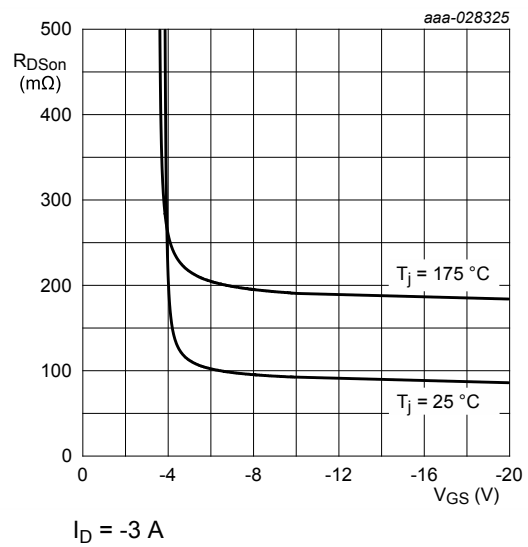
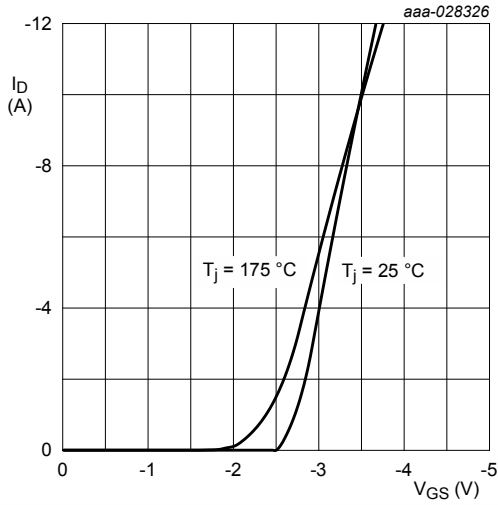
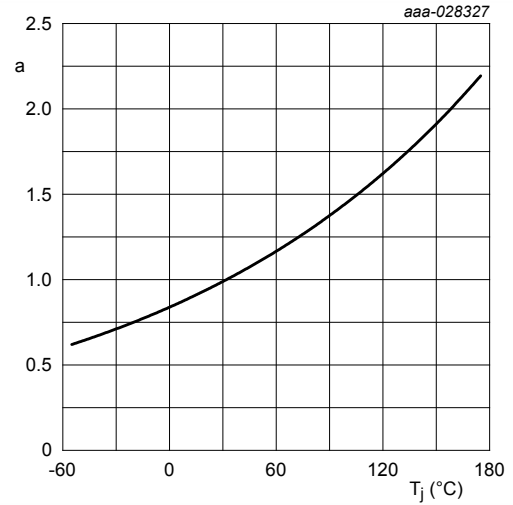


Fig. 9. Drain-source on-state resistance as a function of gate-source voltage; typical values



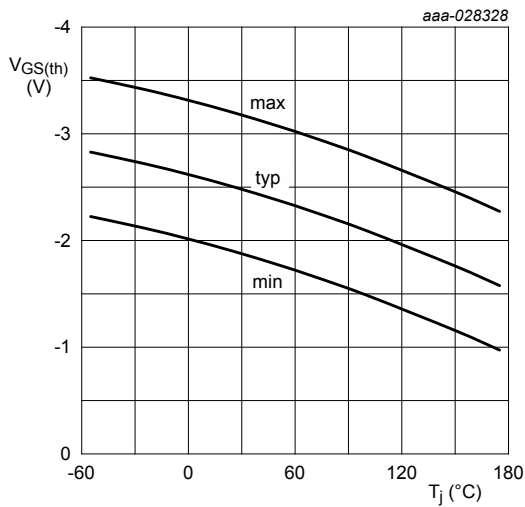
$$V_{DS} > I_D \times R_{DSon}$$

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



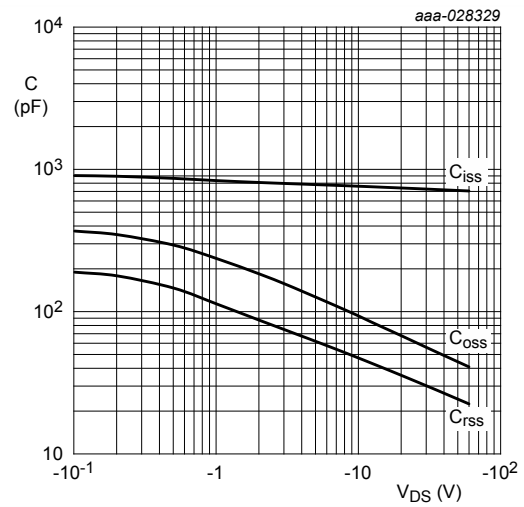
$$a = \frac{R_{DSon}}{R_{DSon(25^\circ C)}}$$

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



$$I_D = -250 \mu A; V_{DS} = V_{GS}$$

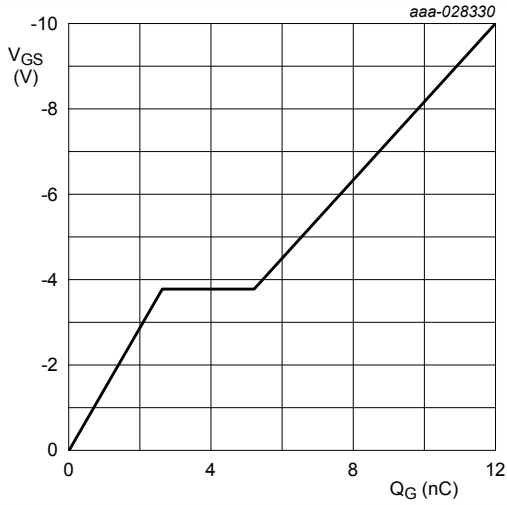
**Fig. 12. Gate-source threshold voltage as a function of junction temperature**



$$f = 1 \text{ MHz}; V_{GS} = 0 \text{ V}$$

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





$V_{DS} = -30\text{ V}$ ;  $I_D = -3\text{ A}$ ;  $T_{amb} = 25\text{ }^\circ\text{C}$

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

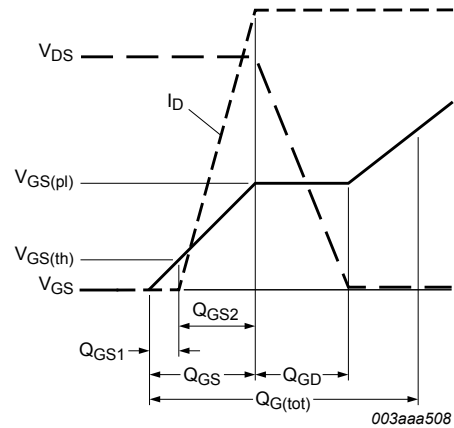
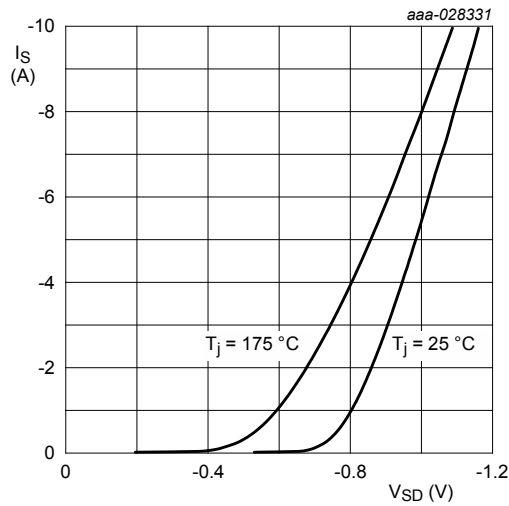


Fig. 15. Gate charge waveform definitions



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

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

## 11. Test information

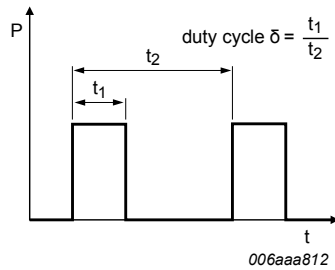


Fig. 17. Duty cycle definition

### 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

DFN2020MD-6: plastic thermal enhanced ultra thin small outline package; no leads;  
6 terminals; body 2 x 2 x 0.65 mm

SOT1220

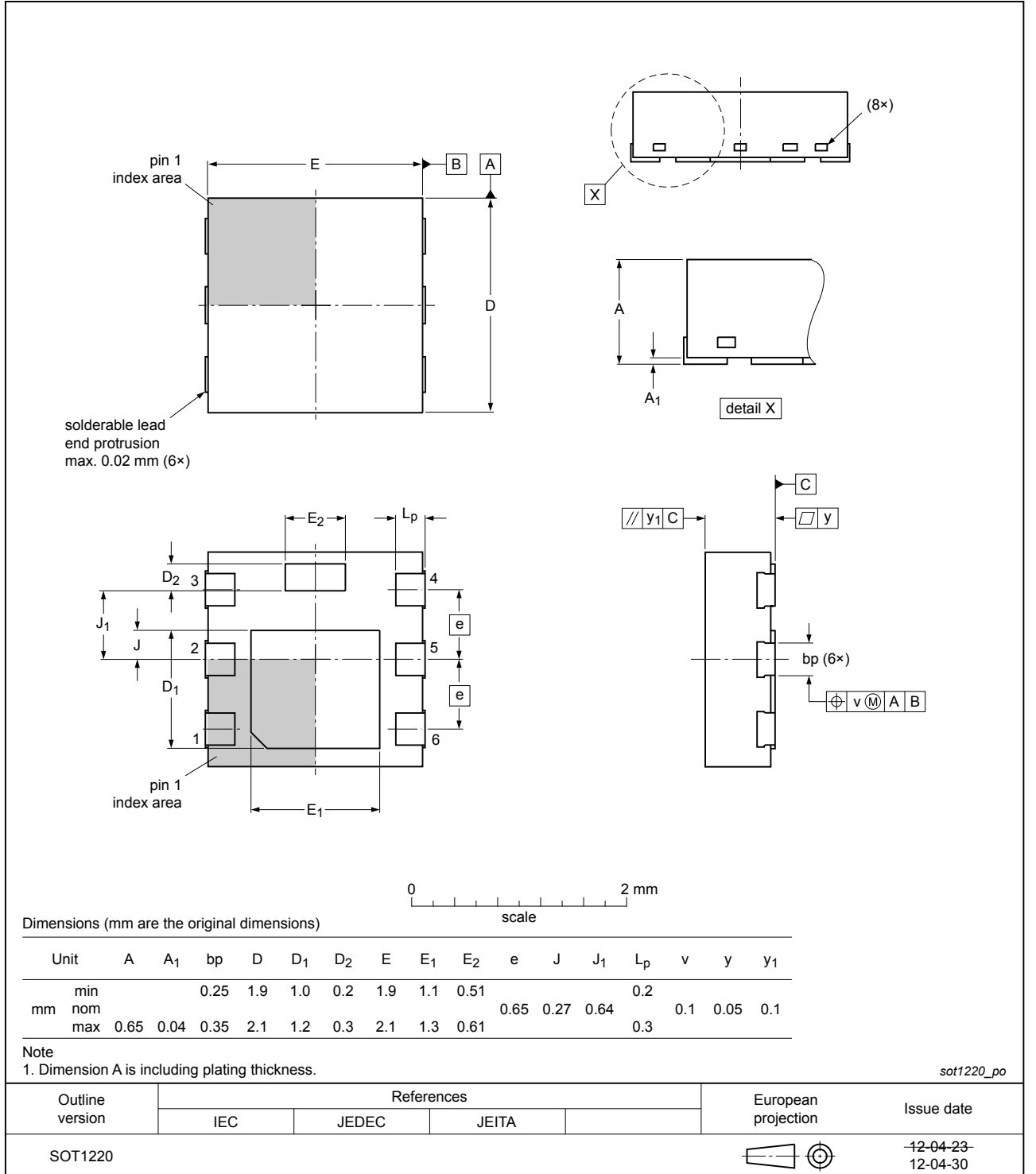
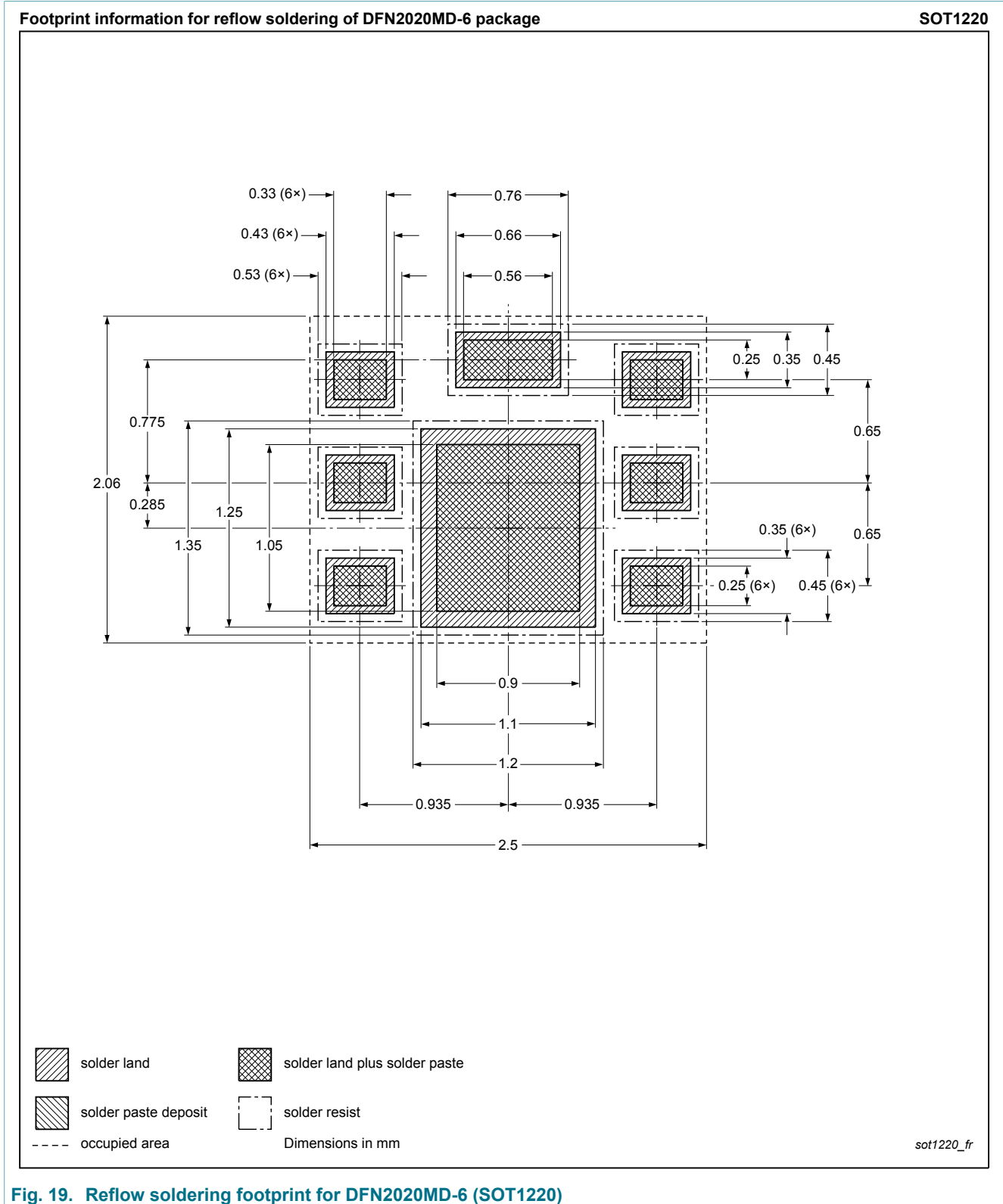


Fig. 18. Package outline DFN2020MD-6 (SOT1220)

### 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
BUK6D120-60P v.1	20180403	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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