



BUK9K35-60RA

Dual N-channel 60 V, 35 mOhm logic level MOSFET in LPAK56D using Repetitive Avalanche technology

2 December 2020

Product data sheet

1. General description

Dual, logic level N-channel MOSFET in an LPAK56D package, using Application Specific (ASFET) repetitive avalanche silicon technology. This product has been designed and qualified to AEC-Q101 for use in repetitive avalanche applications.

2. Features and benefits

- Fully automotive qualified to AEC-Q101 at 175 °C
- Repetitive Avalanche rated to 30 °C T_j rise:
 - Tested to 1 Bn avalanche events
- LPAK copper clip package technology:
 - High robustness and reliability
 - Gull wing leads for high manufacturability and AOI

3. Applications

- 12 V, 24 V and 48 V automotive systems
- Repetitive avalanche topologies
- Engine control
- Transmission control
- Actuator and auxiliary loads

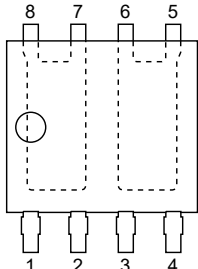
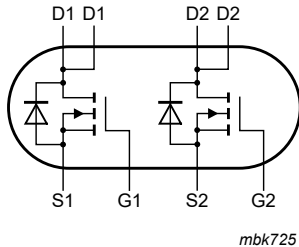
4. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{DS}	drain-source voltage	$25\text{ °C} \leq T_j \leq 175\text{ °C}$	-	-	60	V
I_D	drain current	$V_{GS} = 5\text{ V}$; $T_{mb} = 25\text{ °C}$; Fig. 2	-	-	22	A
P_{tot}	total power dissipation	$T_{mb} = 25\text{ °C}$; Fig. 1	-	-	38	W
Static characteristics FET1 and FET2						
R_{DSon}	drain-source on-state resistance	$V_{GS} = 5\text{ V}$; $I_D = 5\text{ A}$; $T_j = 25\text{ °C}$; Fig. 15	17	30.5	35	mΩ
Dynamic characteristics FET1 and FET2						
Q_{GD}	gate-drain charge	$I_D = 5\text{ A}$; $V_{DS} = 48\text{ V}$; $V_{GS} = 5\text{ V}$; $T_j = 25\text{ °C}$; Fig. 17 ; Fig. 18	-	3	-	nC

5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	S1	source1	 LFPAK56D; Dual LPAK (SOT1205)	 mbk725
2	G1	gate1		
3	S2	source2		
4	G2	gate2		
5	D2	drain2		
6	D2	drain2		
7	D1	drain1		
8	D1	drain1		

6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
BUK9K35-60RA	LFPAK56D; Dual LPAK	plastic, single ended surface mounted package (LFPAK56D); 8 leads	SOT1205

7. Marking

Table 4. Marking codes

Type number	Marking code
BUK9K35-60RA	93560RA

8. Limiting values

Table 5. Limiting values

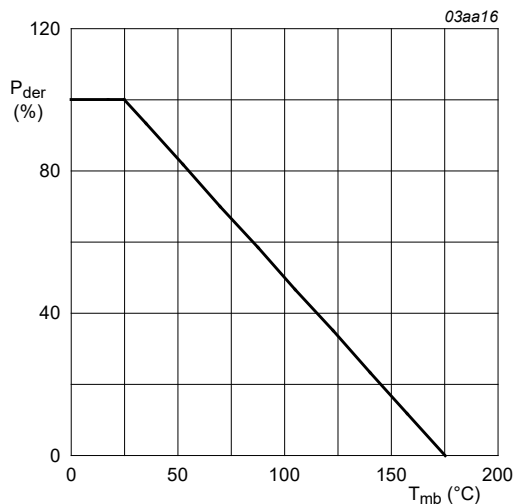
In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
V_{DS}	drain-source voltage	$25\text{ °C} \leq T_j \leq 175\text{ °C}$	-	60	V
V_{DGR}	drain-gate voltage	$25\text{ °C} \leq T_j \leq 175\text{ °C}$; $R_{GS} = 20\text{ k}\Omega$	-	60	V
V_{GS}	gate-source voltage	DC; $T_j \leq 175\text{ °C}$	-10	10	V
		$T_j \leq 175\text{ °C}$	[1] [2] -15	15	V
P_{tot}	total power dissipation	$T_{mb} = 25\text{ °C}$; Fig. 1	-	38	W
I_D	drain current	$V_{GS} = 5\text{ V}$; $T_{mb} = 25\text{ °C}$; Fig. 2	-	22	A
		$V_{GS} = 5\text{ V}$; $T_{mb} = 100\text{ °C}$; Fig. 2	-	16	A
I_{DM}	peak drain current	pulsed; $t_p \leq 10\text{ }\mu\text{s}$; $T_{mb} = 25\text{ °C}$; Fig. 3	-	90	A
T_{stg}	storage temperature		-55	175	°C
T_j	junction temperature		-55	175	°C
$T_{sld(M)}$	peak soldering temperature		-	260	°C

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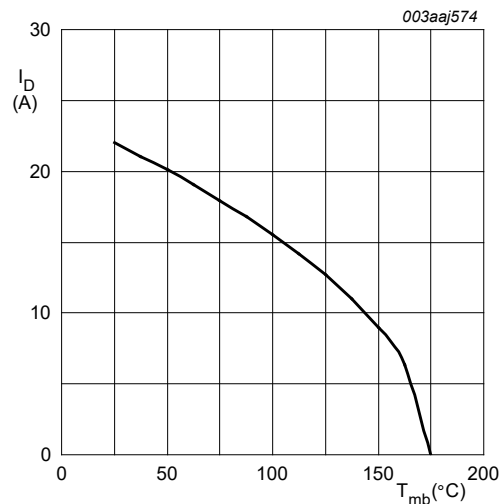
Symbol	Parameter	Conditions		Min	Max	Unit
Source-drain diode FET1 and FET2						
I_S	source current	$T_{mb} = 25\text{ °C}$		-	22	A
I_{SM}	peak source current	pulsed; $t_p \leq 10\text{ }\mu\text{s}$; $T_{mb} = 25\text{ °C}$		-	90	A
Avalanche ruggedness						
$E_{DS(AL)R}$	repetitive drain-source avalanche energy	$I_D = 0.73\text{ A}$; $V_{sup} \leq 60\text{ V}$; $R_{GS} = 10\text{ }\Omega$; $V_{GS} = 10\text{ V}$; $T_{j(rise)} \leq 30\text{ °C}$; unclamped; Fig. 4; Fig. 5; Fig. 6	[3] [4] [5]	-	28.6	mJ
Avalanche ruggedness FET1 and FET2						
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$I_D = 22\text{ A}$; $V_{sup} \leq 60\text{ V}$; $V_{GS} = 5\text{ V}$; $T_{j(init)} = 25\text{ °C}$; Fig. 7	[6] [7]	-	19.5	mJ

- [1] Accumulated Pulse duration up to 50 hours delivers zero defect ppm.
 [2] Significantly longer life times are achieved by lowering T_j and or V_{GS}
 [3] Repetitive avalanche rating is limited by maximum junction temperature of 175 °C and junction rise of 30 °C
 [4] Refer to Fig. 5 for the limiting number of avalanche events
 [5] Refer to Fig. 6 R_{dson} at $V_{GS}=5V$ will increase as a function of repetitive avalanche cycles
 [6] Refer to application note AN10273 for further information
 [7] Single-pulse avalanche rating limited by maximum junction temperature of 175 °C



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

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



$V_{GS} \geq 5\text{ V}$

Fig. 2. Continuous drain current as a function of mounting base temperature

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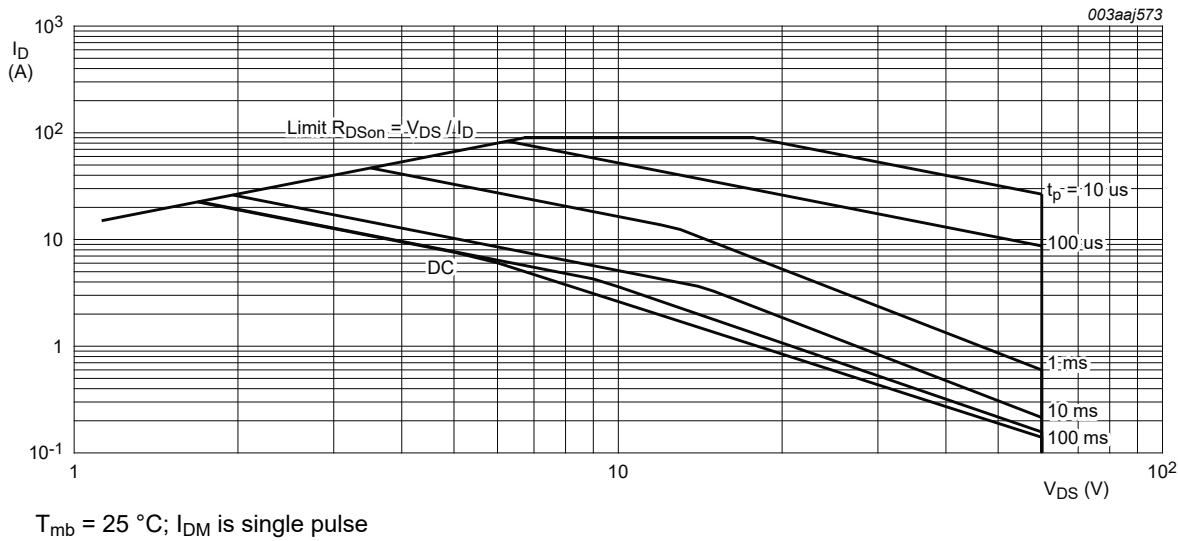


Fig. 3. Safe operating area; continuous and peak drain current as a function of drain-source voltage

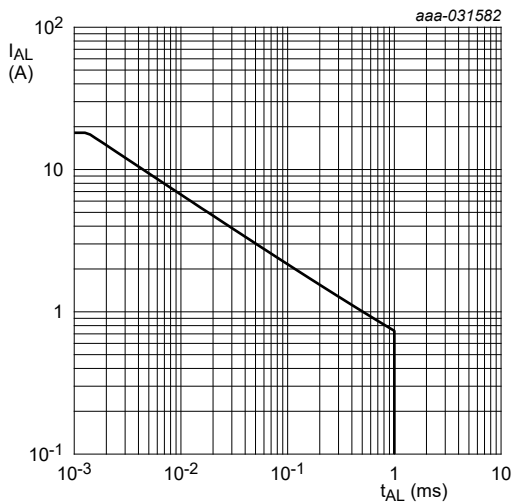


Fig. 4. Repetitive avalanche rating; avalanche current as a function of avalanche time

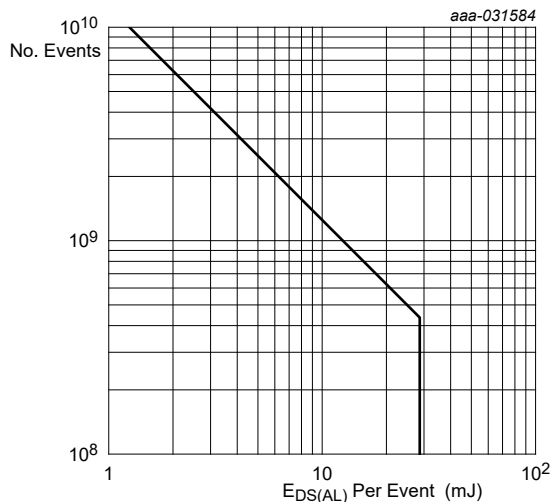


Fig. 5. Repetitive avalanche rating; maximum number of avalanche events as a function of avalanche energy

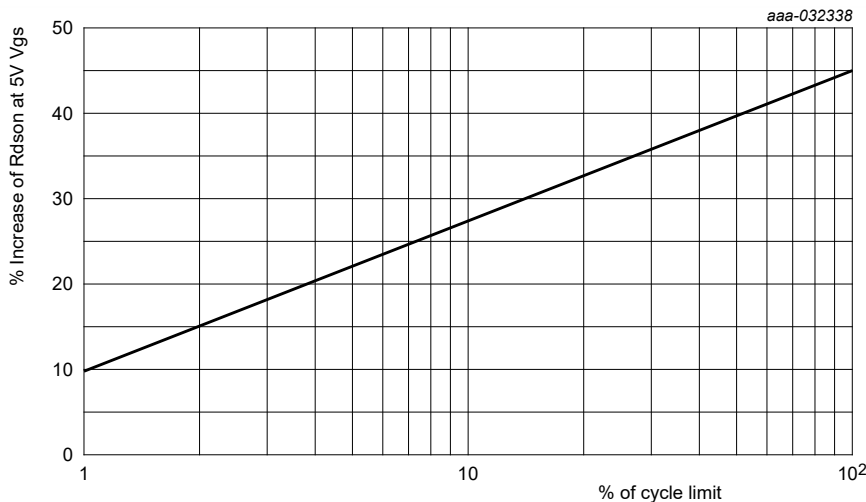
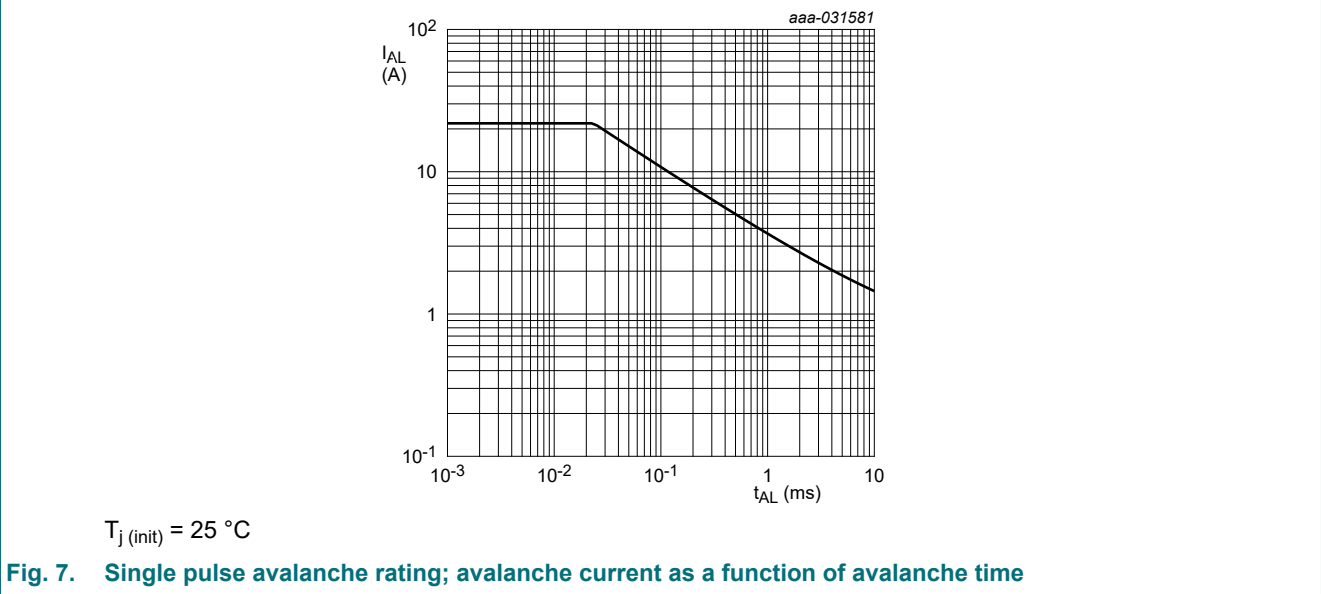


Fig. 6. Percentage $R_{DS(on)}$ at 5V increase as a function of avalanche cycles

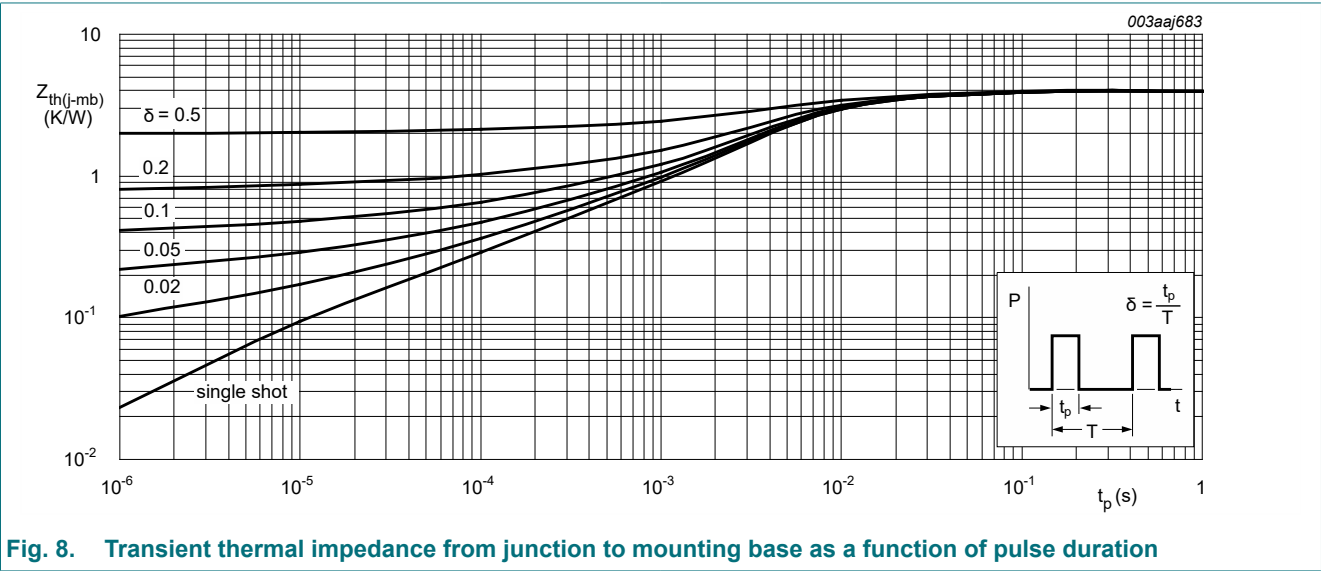
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9. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$R_{th(j-mb)}$	thermal resistance from junction to mounting base	Fig. 8	-	-	3.96	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient	Minimum footprint; mounted on a printed circuit board	-	95	-	K/W



10. Characteristics

Table 7. Characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Static characteristics FET1 and FET2							
V _{(BR)DSS}	drain-source breakdown voltage	I _D = 250 μA; V _{GS} = 0 V; T _j = -55 °C		54	-	-	V
		I _D = 250 μA; V _{GS} = 0 V; T _j = 25 °C		60	-	-	V
V _{GS(th)}	gate-source threshold voltage	I _D = 1 mA; V _{DS} =V _{GS} ; T _j = 25 °C; Fig. 13 ; Fig. 14		1.4	1.7	2.1	V
		I _D = 1 mA; V _{DS} =V _{GS} ; T _j = 175 °C; Fig. 13 ; Fig. 14		0.5	-	-	V
		I _D = 1 mA; V _{DS} =V _{GS} ; T _j = -55 °C; Fig. 13 ; Fig. 14		-	-	2.45	V
I _{DSS}	drain leakage current	V _{DS} = 60 V; V _{GS} = 0 V; T _j = 175 °C		-	-	500	μA
		V _{DS} = 60 V; V _{GS} = 0 V; T _j = 25 °C		-	0.02	1	μA
I _{GSS}	gate leakage current	V _{GS} = -10 V; V _{DS} = 0 V; T _j = 25 °C		-	2	100	nA
		V _{GS} = 10 V; V _{DS} = 0 V; T _j = 25 °C		-	2	100	nA
R _{DSon}	drain-source on-state resistance	V _{GS} = 5 V; I _D = 5 A; T _j = 25 °C; Fig. 15		17	30.5	35	mΩ
		V _{GS} = 5 V; I _D = 5 A; T _j = 175 °C; Fig. 15 ; Fig. 16		-	65.27	79	mΩ
		V _{GS} = 10 V; I _D = 5 A; T _j = 25 °C; Fig. 15		15.5	26.8	32	mΩ
Dynamic characteristics FET1 and FET2							
Q _{G(tot)}	total gate charge	I _D = 5 A; V _{DS} = 48 V; V _{GS} = 5 V; T _j = 25 °C; Fig. 17 ; Fig. 18		-	7.8	-	nC
Q _{GS}	gate-source charge			-	1.2	-	nC
Q _{GD}	gate-drain charge			-	3	-	nC
C _{iss}	input capacitance	V _{DS} = 25 V; V _{GS} = 0 V; f = 1 MHz; T _j = 25 °C; Fig. 19		-	811	1081	pF
C _{oss}	output capacitance			-	98	118	pF
C _{rss}	reverse transfer capacitance			-	51	70	pF
t _{d(on)}	turn-on delay time	V _{DS} = 48 V; R _L = 10 Ω; V _{GS} = 5 V; R _{G(ext)} = 5 Ω; T _j = 25 °C		-	7.1	-	ns
t _r	rise time			-	11.3	-	ns
t _{d(off)}	turn-off delay time			-	14.9	-	ns
t _f	fall time			-	10.6	-	ns
Source-drain diode FET1 and FET2							
V _{SD}	source-drain voltage	I _S = 5 A; V _{GS} = 0 V; T _j = 25 °C; Fig. 20		-	0.78	1.2	V
t _{rr}	reverse recovery time	I _S = 5 A; dI _S /dt = -100 A/μs; V _{GS} = 0 V; V _{DS} = 30 V; T _j = 25 °C		-	17.6	-	ns
Q _r	recovered charge			-	12.1	-	nC

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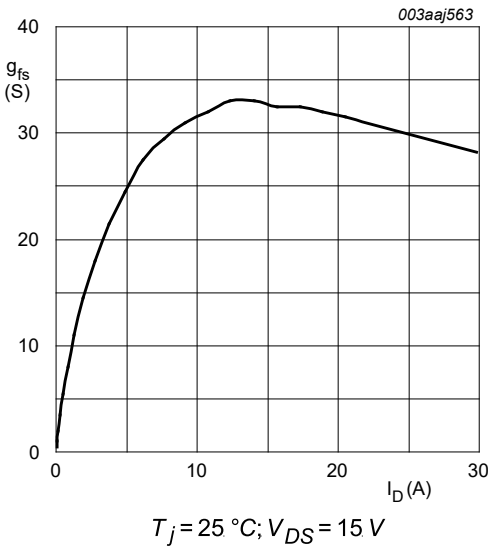


Fig. 9. Forward transconductance as a function of drain current; typical values

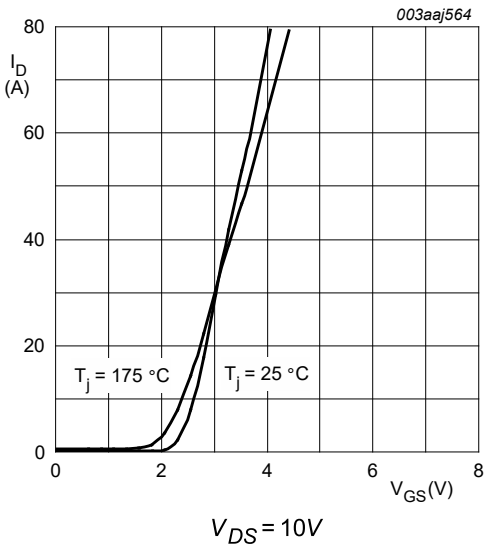


Fig. 10. Transfer Characteristic: drain current as a function of gate-source voltage; typical values

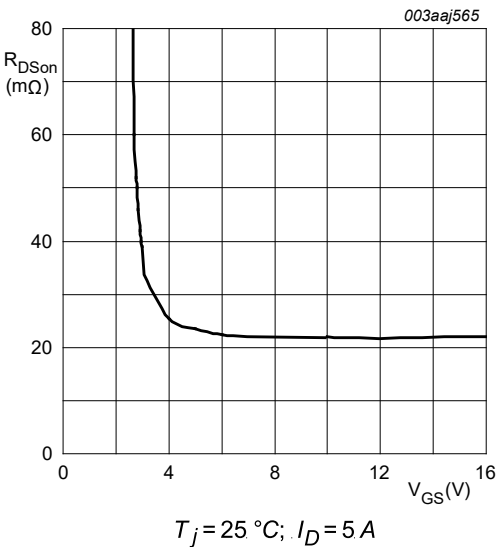


Fig. 11. Drain-source on-state resistance as a function of gate-source voltage; typical values

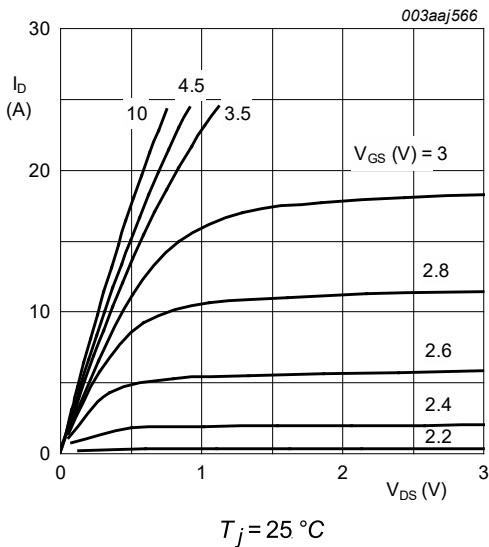


Fig. 12. Output characteristics: drain current as a function of drain-source voltage; typical values

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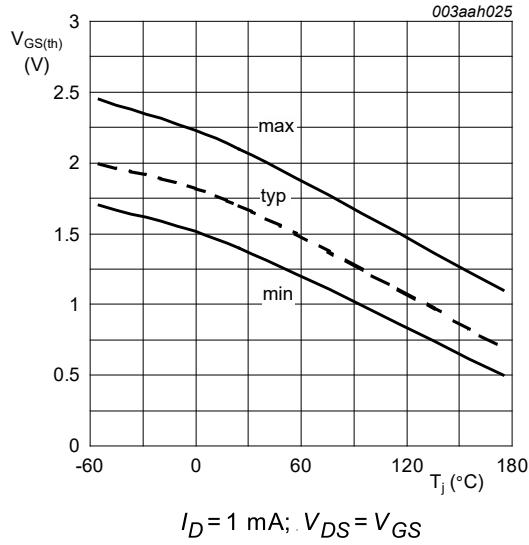


Fig. 13. Gate-source threshold voltage as a function of junction temperature

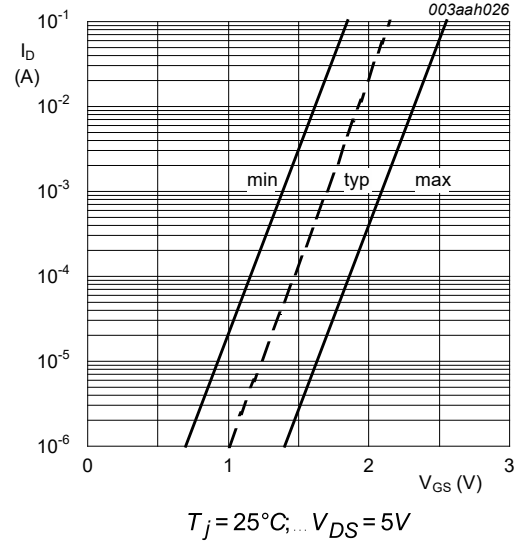


Fig. 14. Sub-threshold drain current as a function of gate-source voltage

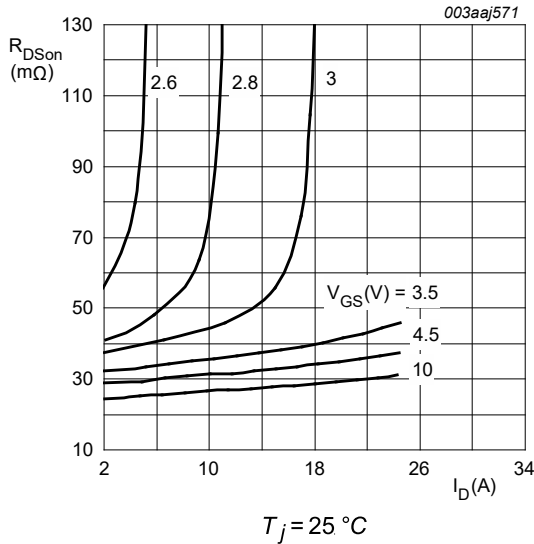


Fig. 15. Drain-source on-state resistance as a function of drain current; typical values

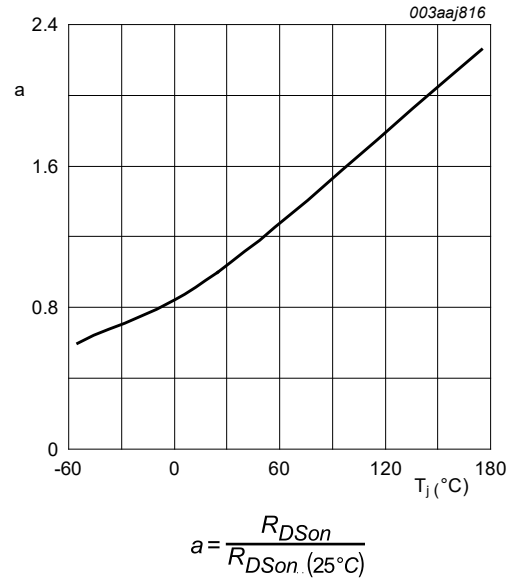


Fig. 16. Normalized drain-source on-state resistance factor as a function of junction temperature

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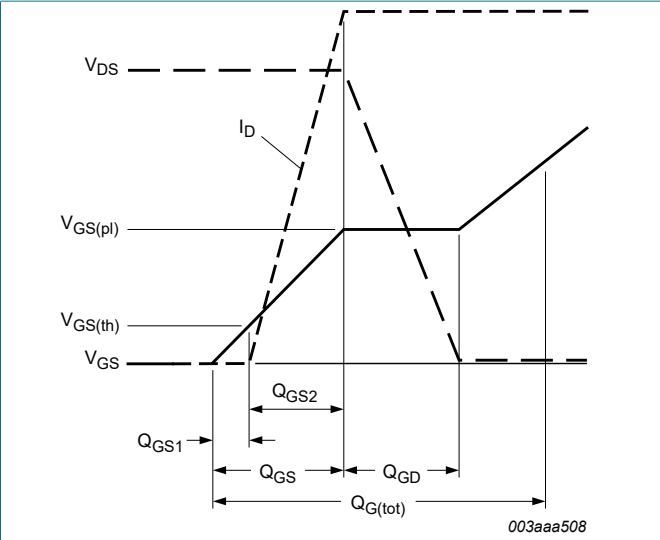


Fig. 17. Gate charge waveform definitions

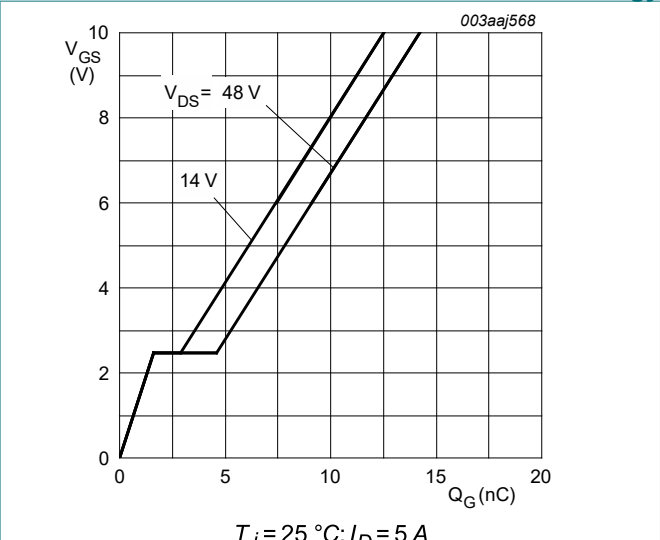


Fig. 18. Gate-source voltage as a function of gate charge; typical values

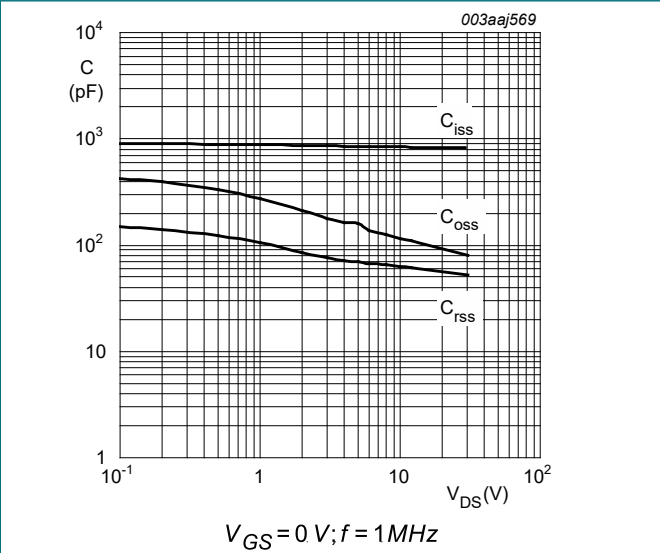


Fig. 19. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

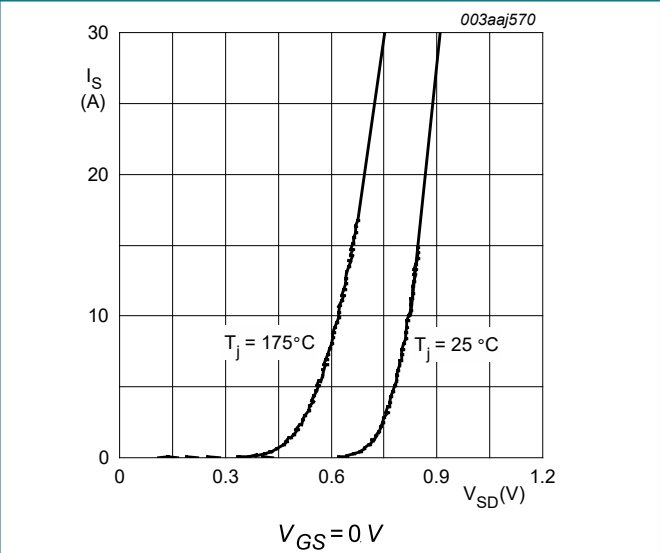


Fig. 20. Source current as a function of source-drain voltage; typical values

11. Package outline

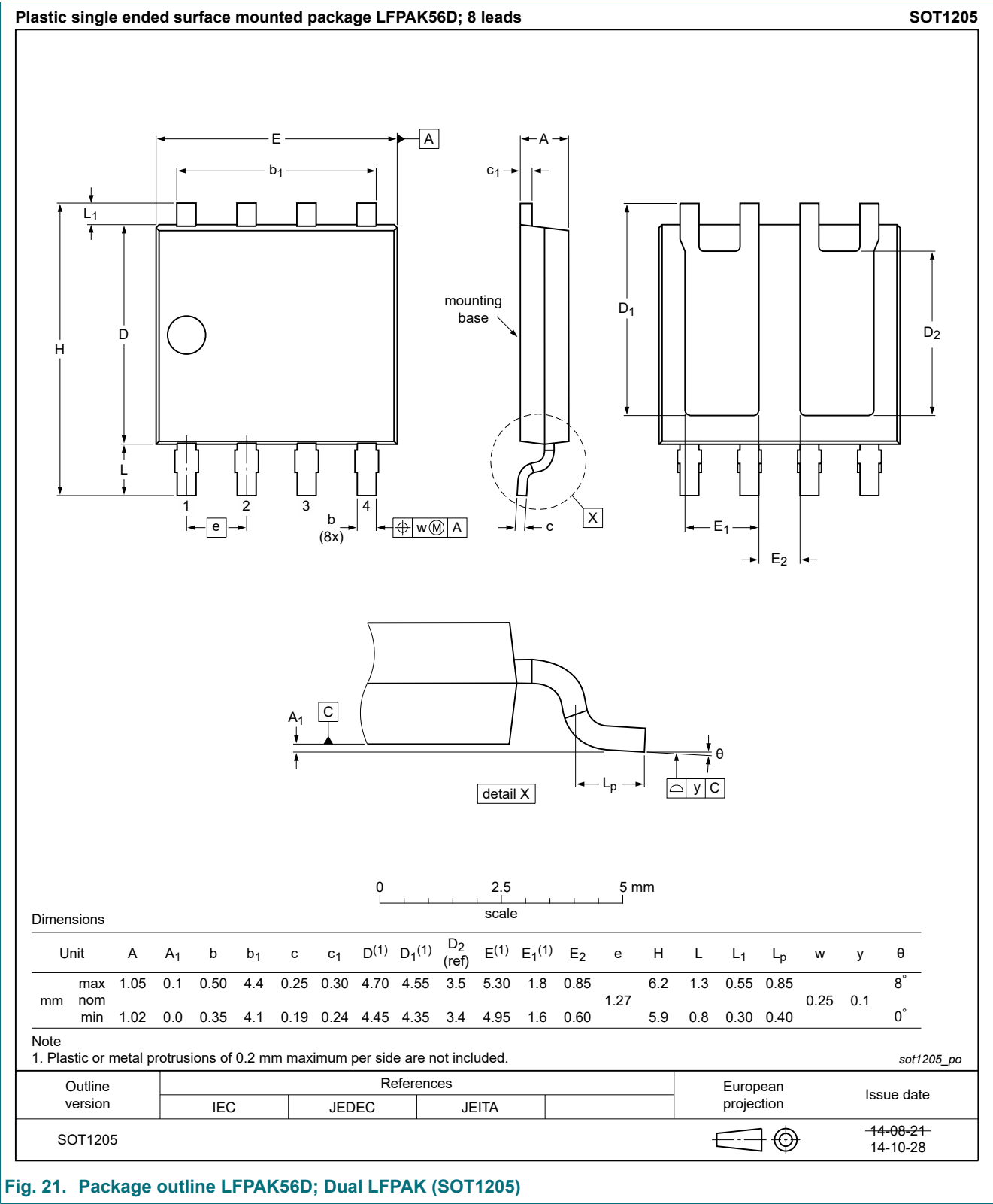


Fig. 21. Package outline LPAK56D; Dual LPAK (SOT1205)

12. Soldering

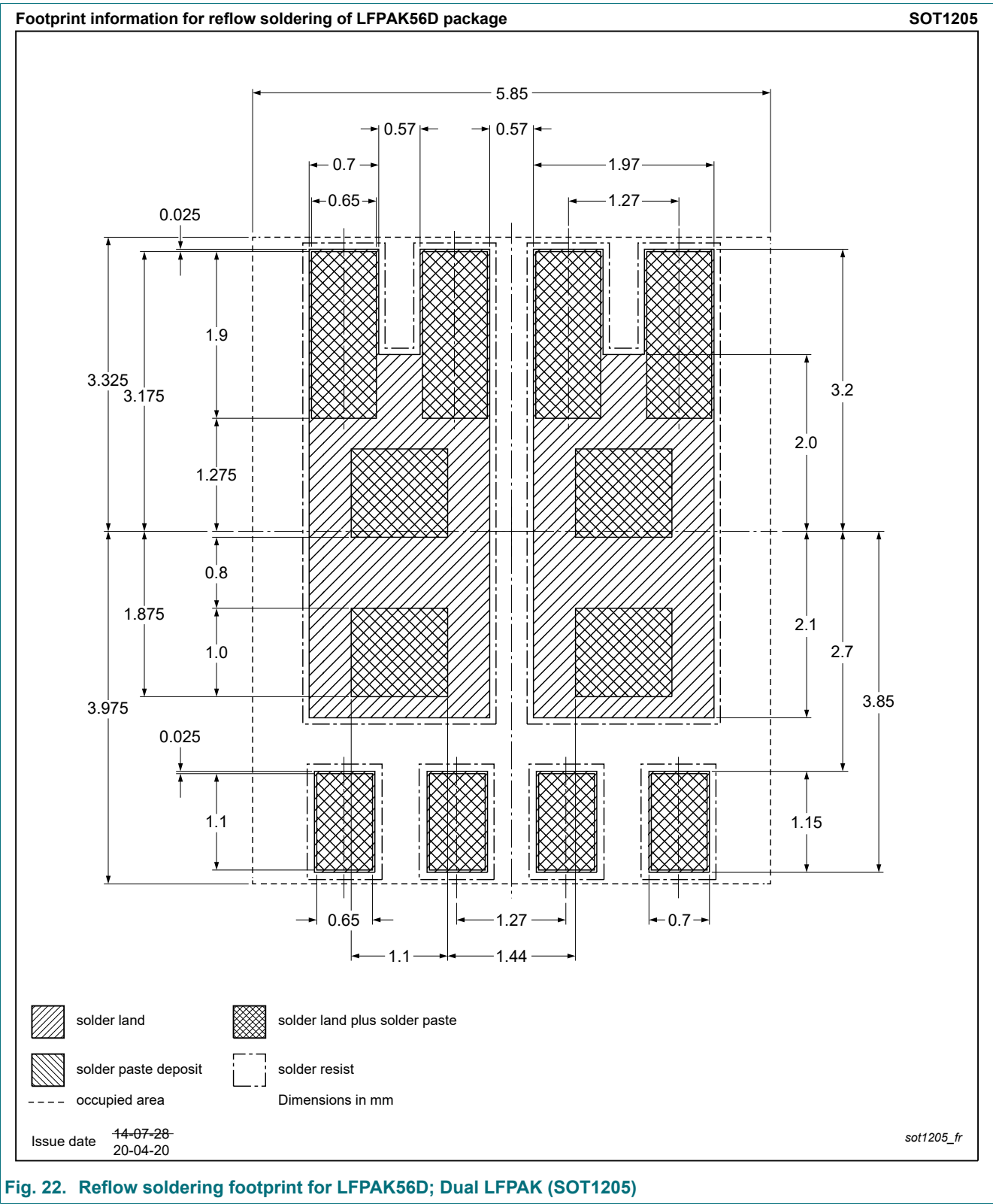


Fig. 22. Reflow soldering footprint for LPAK56D; Dual LPAK (SOT1205)

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13. 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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