



# BUK9K13-40H

Dual N-channel 40 V, 13 mOhm logic level MOSFET in LPAK56D

11 February 2021

Product data sheet

## 1. General description

Dual, Logic level N-channel MOSFET in an LPAK56D package, using Trench 9 TrenchMOS technology. This product has been designed and qualified to AEC-Q101 for use in high performance automotive applications

## 2. Features and benefits

- Fully automotive qualified to AEC-Q101 at 175 °C
- Trench 9 superjunction technology:
  - Low power losses, high power density
- LPAK copper clip package technology:
  - High robustness and reliability
  - Gull wing leads for high manufacturability and AOI
- Repetitive avalanche rated

## 3. Applications

- 12 V, 24 V and 48 V automotive systems
- Motors, lamps and solenoid control
- Transmission control
- DC-to-DC conversion

## 4. Quick reference data

Table 1. Quick reference data

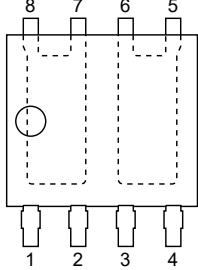
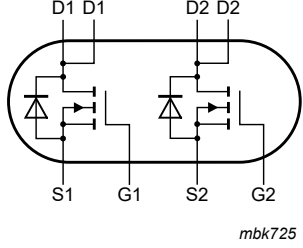
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$V_{DS}$	drain-source voltage	$25\text{ °C} \leq T_j \leq 175\text{ °C}$		-	-	40	V
$I_D$	drain current	$V_{GS} = 10\text{ V}; T_{mb} = 25\text{ °C};$ <a href="#">Fig. 2</a>	[1]	-	-	42	A
$P_{tot}$	total power dissipation	$T_{mb} = 25\text{ °C};$ <a href="#">Fig. 1</a>		-	-	46	W
<b>Static characteristics FET1 and FET2</b>							
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = 4.5\text{ V}; I_D = 10\text{ A}; T_j = 25\text{ °C};$ <a href="#">Fig. 11</a>		9.8	14.1	16.9	mΩ
<b>Dynamic characteristics FET1 and FET2</b>							
$Q_{GD}$	gate-drain charge	$I_D = 10\text{ A}; V_{DS} = 32\text{ V}; V_{GS} = 5\text{ V};$ $T_j = 25\text{ °C};$ <a href="#">Fig. 13</a> ; <a href="#">Fig. 14</a>		-	1.8	4.2	nC
<b>Source-drain diode FET1 and FET2</b>							
$Q_r$	recovered charge	$I_S = 10\text{ A}; di_S/dt = -100\text{ A}/\mu\text{s}; V_{GS} = 0\text{ V};$ <a href="#">[2]</a> $V_{DS} = 20\text{ V}; T_j = 25\text{ °C}$		-	16.2	-	nC

[1] 42A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature.

[2] Includes capacitive recovery

## 5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	S1	source1	 <p>LFPAK56D; Dual LFPAK (SOT1205)</p>	 <p>mbk725</p>
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
BUK9K13-40H	LFPAK56D; Dual LFPAK	plastic, single ended surface mounted package (LFPAK56D); 8 leads	SOT1205

## 7. Marking

Table 4. Marking codes

Type number	Marking code
BUK9K13-40H	91340HK

## 8. Limiting values

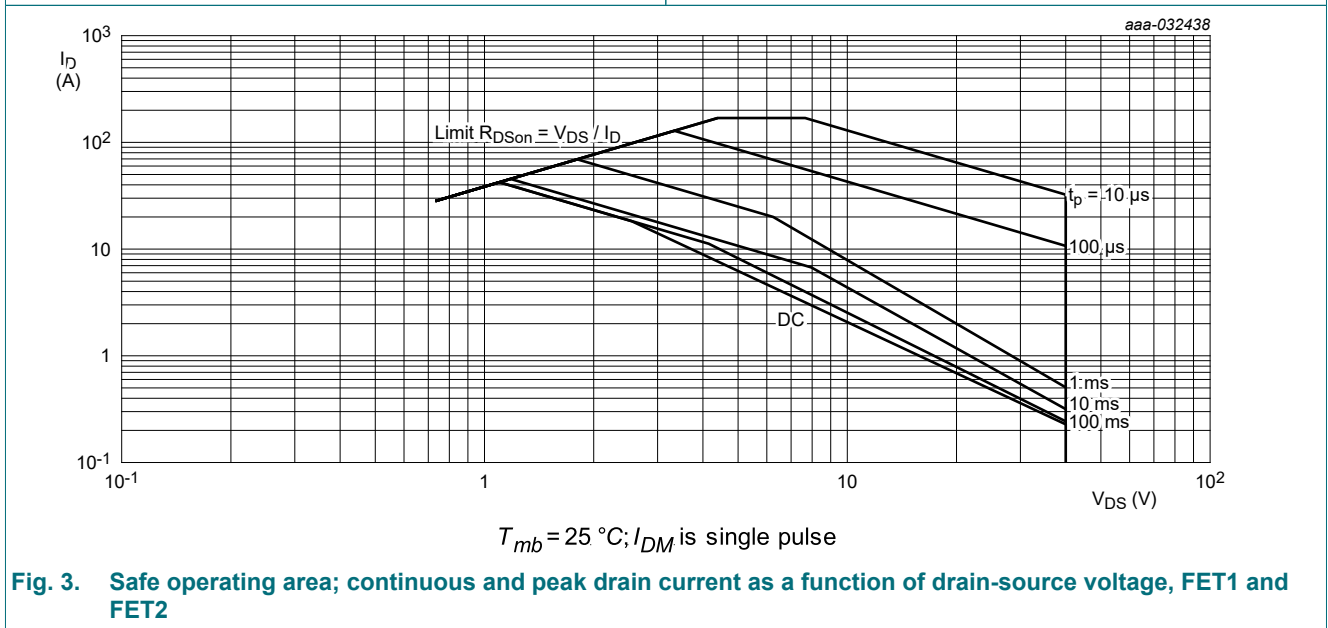
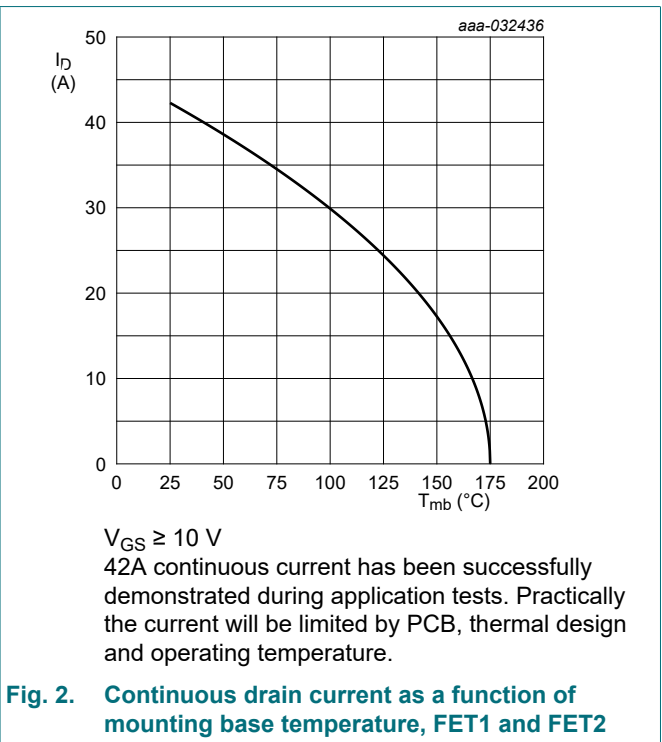
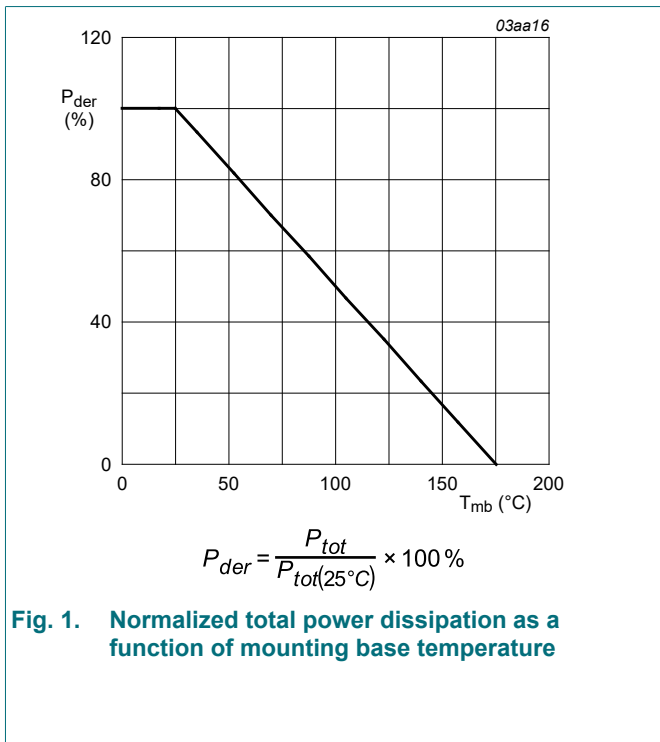
Table 5. Limiting values

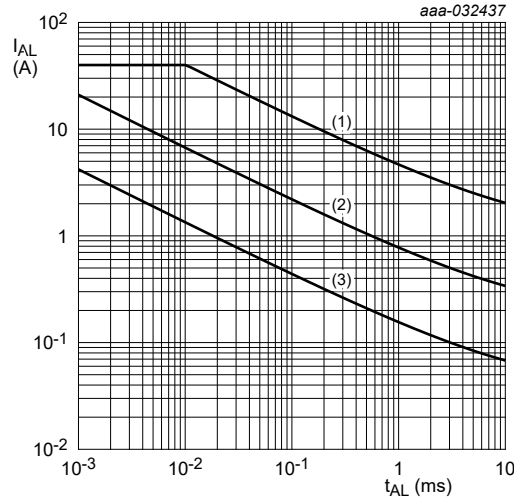
In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit	
$V_{DS}$	drain-source voltage	$25\text{ °C} \leq T_j \leq 175\text{ °C}$	-	40	V	
$V_{GS}$	gate-source voltage	DC; $T_j = 25\text{ °C}$	-20	20	V	
$P_{tot}$	total power dissipation	$T_{mb} = 25\text{ °C}$ ; Fig. 1	-	46	W	
$I_D$	drain current	$V_{GS} = 10\text{ V}$ ; $T_{mb} = 25\text{ °C}$ ; Fig. 2	[1]	-	42	A
		$V_{GS} = 10\text{ V}$ ; $T_{mb} = 100\text{ °C}$ ; Fig. 2		-	30	A
$I_{DM}$	peak drain current	pulsed; $t_p \leq 10\text{ }\mu\text{s}$ ; $T_{mb} = 25\text{ °C}$ ; Fig. 3	-	169	A	
$T_{stg}$	storage temperature		-55	175	°C	
$T_j$	junction temperature		-55	175	°C	
<b>Source-drain diode FET1 and FET2</b>						
$I_S$	source current	$T_{mb} = 25\text{ °C}$	-	42	A	
$I_{SM}$	peak source current	pulsed; $t_p \leq 10\text{ }\mu\text{s}$ ; $T_{mb} = 25\text{ °C}$	-	169	A	

Symbol	Parameter	Conditions	Min	Max	Unit	
<b>Avalanche Ruggedness FET1 and FET2</b>						
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$I_D = 39.9 \text{ A}$ ; $V_{sup} \leq 40 \text{ V}$ ; $R_{GS} = 50 \Omega$ ; $V_{GS} = 10 \text{ V}$ ; $T_{j(\text{init})} = 25 \text{ }^\circ\text{C}$ ; Fig. 4	[2] [3]	-	10.6	mJ
$I_{AS}$	non-repetitive avalanche current	$V_{sup} = 40 \text{ V}$ ; $V_{GS} = 10 \text{ V}$ ; $T_{j(\text{init})} = 25 \text{ }^\circ\text{C}$ ; $R_{GS} = 50 \Omega$ ; Fig. 4	[4]	-	39.9	A

- [1] 42A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature.
- [2] Single-pulse avalanche rating limited by maximum junction temperature of 175 °C.
- [3] Refer to application note AN10273 for further information.
- [4] Protected by 100% test





(1)  $T_{j\text{(init)}} = 25\text{ °C}$ ; (2)  $T_{j\text{(init)}} = 150\text{ °C}$ ; (3) Repetitive Avalanche

Fig. 4. Avalanche rating; avalanche current as a function of avalanche time, FET1 and FET2

### 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. 5	-	3	3.23	K/W

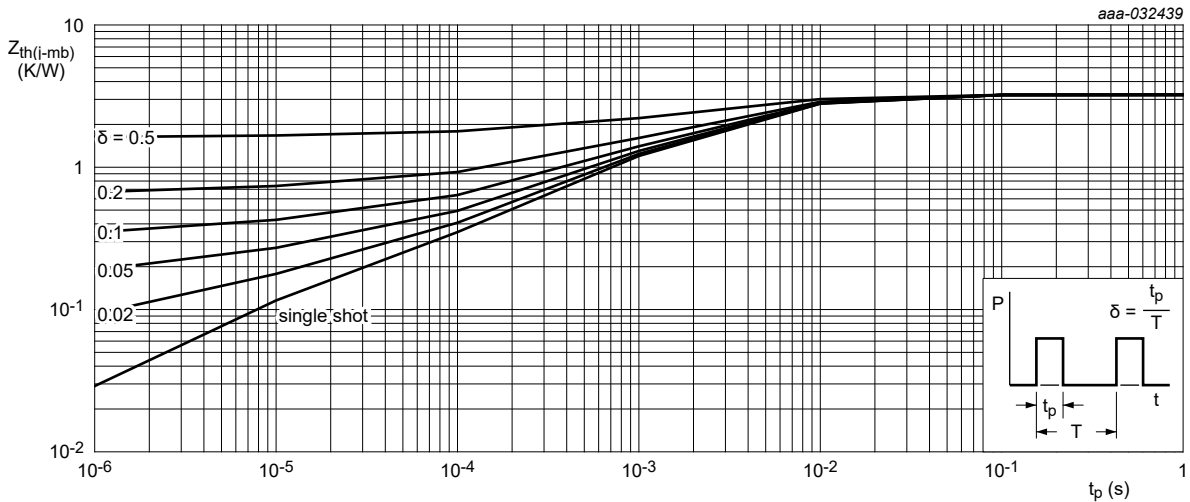


Fig. 5. Transient thermal impedance from junction to mounting base as a function of pulse duration, FET1 and FET2

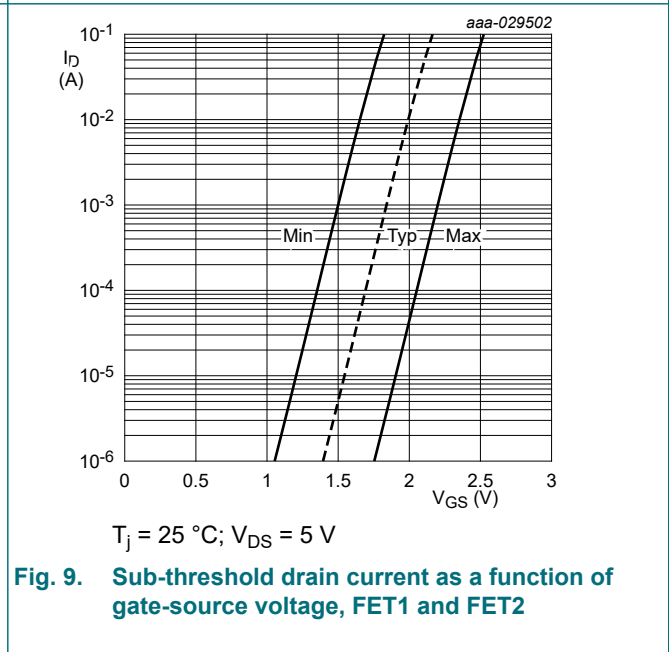
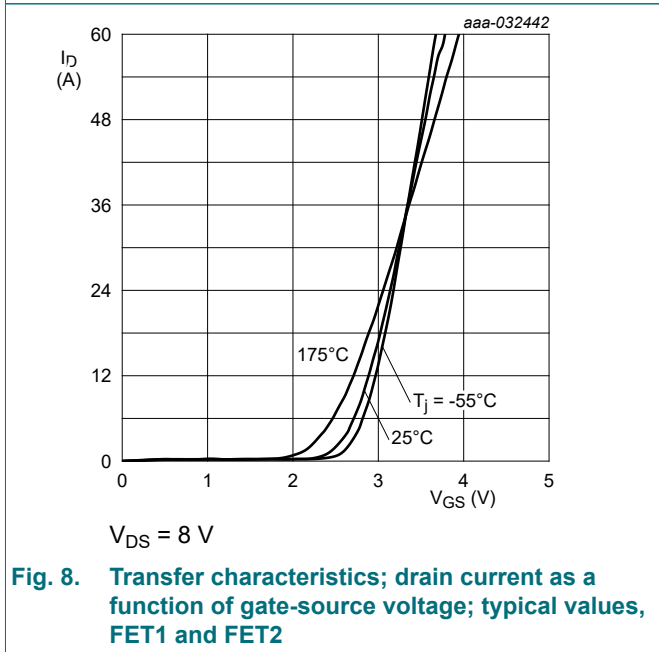
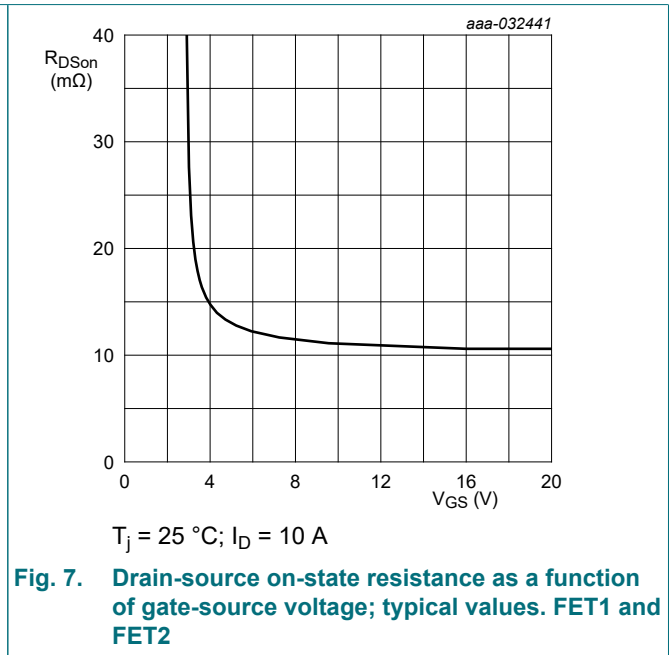
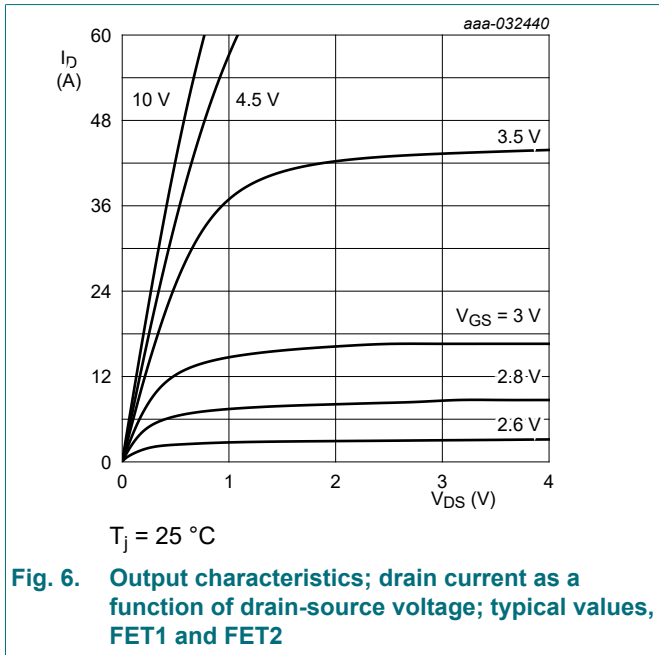
## 10. Characteristics

Table 7. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics FET1 and FET2</b>						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 250 \mu A; V_{GS} = 0 V; T_j = 25 \text{ }^\circ C$	40	43	-	V
		$I_D = 250 \mu A; V_{GS} = 0 V; T_j = -40 \text{ }^\circ C$	-	40.5	-	V
		$I_D = 250 \mu A; V_{GS} = 0 V; T_j = -55 \text{ }^\circ C$	36	40	-	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 1 \text{ mA}; V_{DS}=V_{GS}; T_j = 25 \text{ }^\circ C$ ; <a href="#">Fig. 9</a> ; <a href="#">Fig. 10</a>	1.5	1.85	2.2	V
		$I_D = 1 \text{ mA}; V_{DS}=V_{GS}; T_j = 175 \text{ }^\circ C$ ; <a href="#">Fig. 10</a>	0.7	-	-	V
		$I_D = 1 \text{ mA}; V_{DS}=V_{GS}; T_j = -55 \text{ }^\circ C$ ; <a href="#">Fig. 10</a>	-	-	2.6	V
$I_{DSS}$	drain leakage current	$V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ C$	-	0.01	5	$\mu A$
		$V_{DS} = 16 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 125 \text{ }^\circ C$	-	0.14	10	$\mu A$
		$V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 175 \text{ }^\circ C$	-	26	500	$\mu A$
$I_{GSS}$	gate leakage current	$V_{GS} = -10 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ C$	-	2	100	nA
		$V_{GS} = 16 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ C$	-	2	100	nA
$R_{Dson}$	drain-source on-state resistance	$V_{GS} = 10 \text{ V}; I_D = 10 \text{ A}; T_j = 25 \text{ }^\circ C$ ; <a href="#">Fig. 11</a>	7.9	11.4	13.6	m $\Omega$
		$V_{GS} = 10 \text{ V}; I_D = 10 \text{ A}; T_j = 105 \text{ }^\circ C$ ; <a href="#">Fig. 12</a>	10.9	16	20.4	m $\Omega$
		$V_{GS} = 10 \text{ V}; I_D = 10 \text{ A}; T_j = 125 \text{ }^\circ C$ ; <a href="#">Fig. 12</a>	12	17.4	21.9	m $\Omega$
		$V_{GS} = 10 \text{ V}; I_D = 10 \text{ A}; T_j = 175 \text{ }^\circ C$ ; <a href="#">Fig. 12</a>	14.5	20.9	26.4	m $\Omega$
		$V_{GS} = 4.5 \text{ V}; I_D = 10 \text{ A}; T_j = 25 \text{ }^\circ C$ ; <a href="#">Fig. 11</a>	9.8	14.1	16.9	m $\Omega$
		$V_{GS} = 4.5 \text{ V}; I_D = 10 \text{ A}; T_j = 105 \text{ }^\circ C$ ; <a href="#">Fig. 12</a>	13.5	20	25.4	m $\Omega$
		$V_{GS} = 4.5 \text{ V}; I_D = 10 \text{ A}; T_j = 125 \text{ }^\circ C$ ; <a href="#">Fig. 12</a>	14.8	21.6	27.2	m $\Omega$
		$V_{GS} = 4.5 \text{ V}; I_D = 10 \text{ A}; T_j = 175 \text{ }^\circ C$ ; <a href="#">Fig. 12</a>	18	26.6	32.8	m $\Omega$
$R_G$	gate resistance	$f = 1 \text{ MHz}; T_j = 25 \text{ }^\circ C$	0.7	1.8	4.2	$\Omega$
<b>Dynamic characteristics FET1 and FET2</b>						
$Q_{G(tot)}$	total gate charge	$I_D = 10 \text{ A}; V_{DS} = 32 \text{ V}; V_{GS} = 10 \text{ V}; T_j = 25 \text{ }^\circ C$ ; <a href="#">Fig. 13</a> ; <a href="#">Fig. 14</a>	-	13	19.4	nC
		$I_D = 10 \text{ A}; V_{DS} = 32 \text{ V}; V_{GS} = 5 \text{ V}; T_j = 25 \text{ }^\circ C$ ; <a href="#">Fig. 13</a> ; <a href="#">Fig. 14</a>	-	6.8	10.2	nC
$Q_{GS}$	gate-source charge		-	2.3	3.8	nC
$Q_{GD}$	gate-drain charge		-	1.8	4.2	nC
$C_{iss}$	input capacitance	$V_{DS} = 25 \text{ V}; V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}; T_j = 25 \text{ }^\circ C$ ; <a href="#">Fig. 15</a>	-	848	1160	pF
$C_{oss}$	output capacitance		-	280	420	pF
$C_{rss}$	reverse transfer capacitance		-	39	84	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = 32 \text{ V}; R_L = 3.2 \text{ } \Omega; V_{GS} = 5 \text{ V}; R_{G(ext)} = 5 \text{ } \Omega; T_j = 25 \text{ }^\circ C$	-	6.5	-	ns
$t_r$	rise time		-	9.7	-	ns
$t_{d(off)}$	turn-off delay time		-	10.1	-	ns

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$t_f$	fall time		-	7.8	-	ns
<b>Source-drain diode FET1 and FET2</b>						
$V_{SD}$	source-drain voltage	$I_S = 10\text{ A}$ ; $V_{GS} = 0\text{ V}$ ; $T_j = 25\text{ }^\circ\text{C}$ ; Fig. 16	-	0.81	1	V
$t_{rr}$	reverse recovery time	$I_S = 10\text{ A}$ ; $di_S/dt = -100\text{ A}/\mu\text{s}$ ; $V_{GS} = 0\text{ V}$ ;	-	21.5	-	ns
$Q_r$	recovered charge	$V_{DS} = 20\text{ V}$ ; $T_j = 25\text{ }^\circ\text{C}$	[1]	16.2	-	nC

[1] Includes capacitive recovery



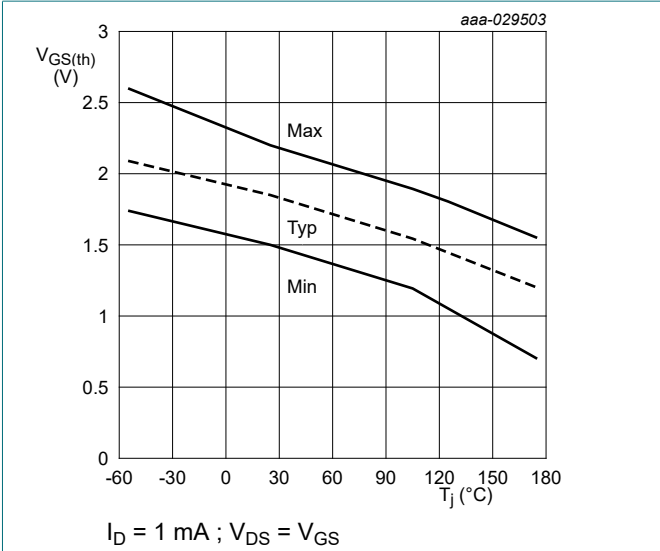


Fig. 10. Gate-source threshold voltage as a function of junction temperature, FET1 and FET2

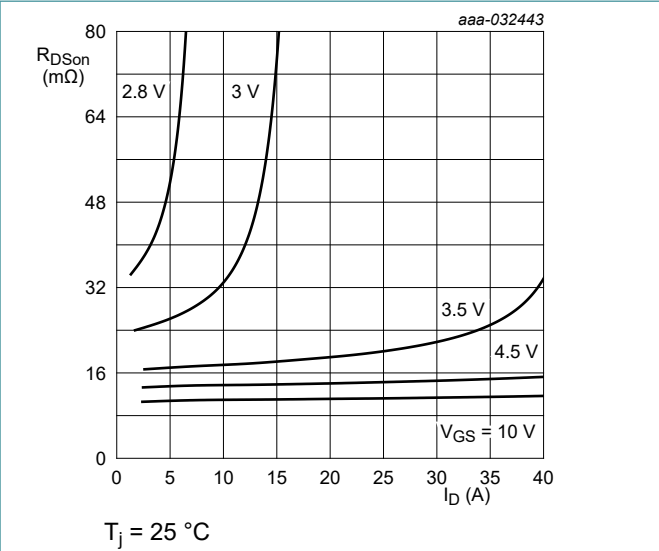


Fig. 11. Drain-source on-state resistance as a function of drain current; typical values, FET1 and FET2

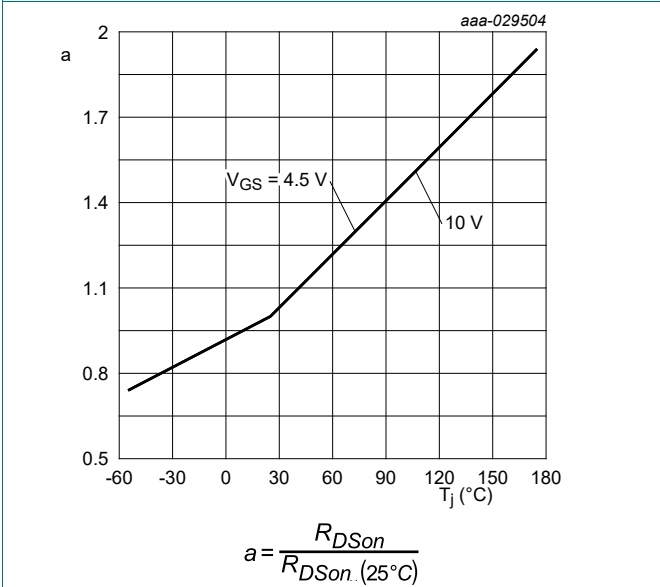


Fig. 12. Normalized drain-source on-state resistance factor as a function of junction temperature, FET1 and FET2

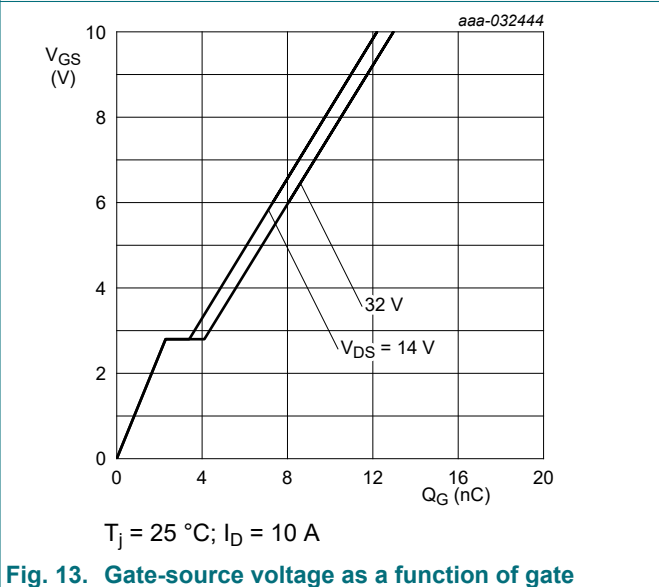
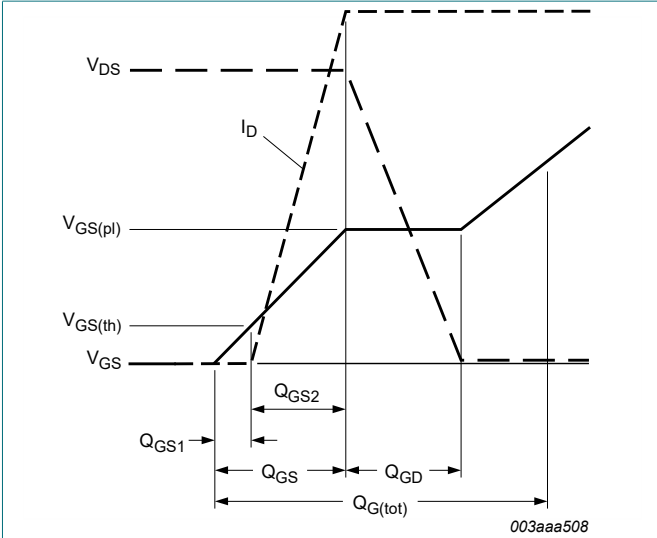
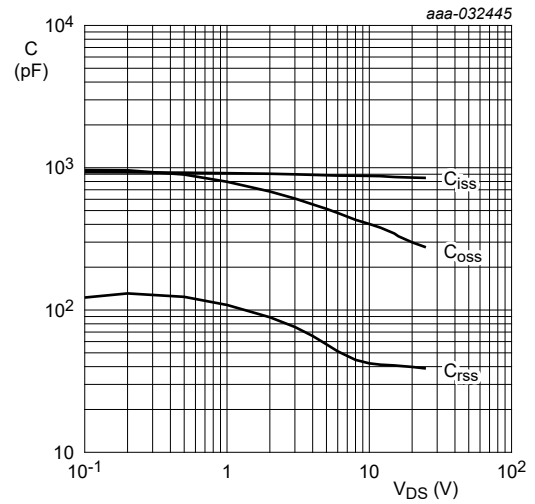


Fig. 13. Gate-source voltage as a function of gate charge; typical values, FET1 and FET2

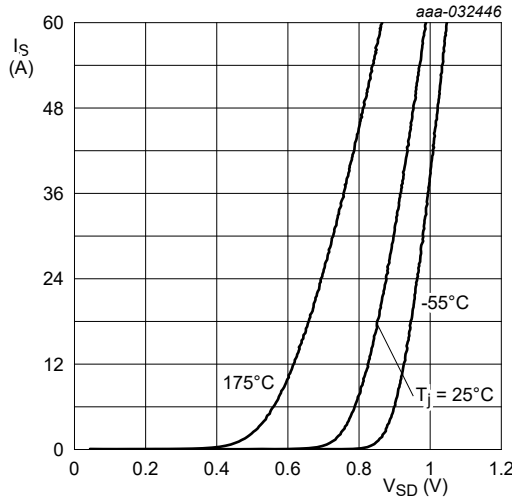


**Fig. 14. Gate charge waveform definitions**



**Fig. 15. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values, FET1 and FET2**

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



$V_{GS} = 0V$

**Fig. 16. Source-drain (diode forward) current as a function of source-drain (diode forward) voltage; typical values FET1 and FET2**



11. Package outline

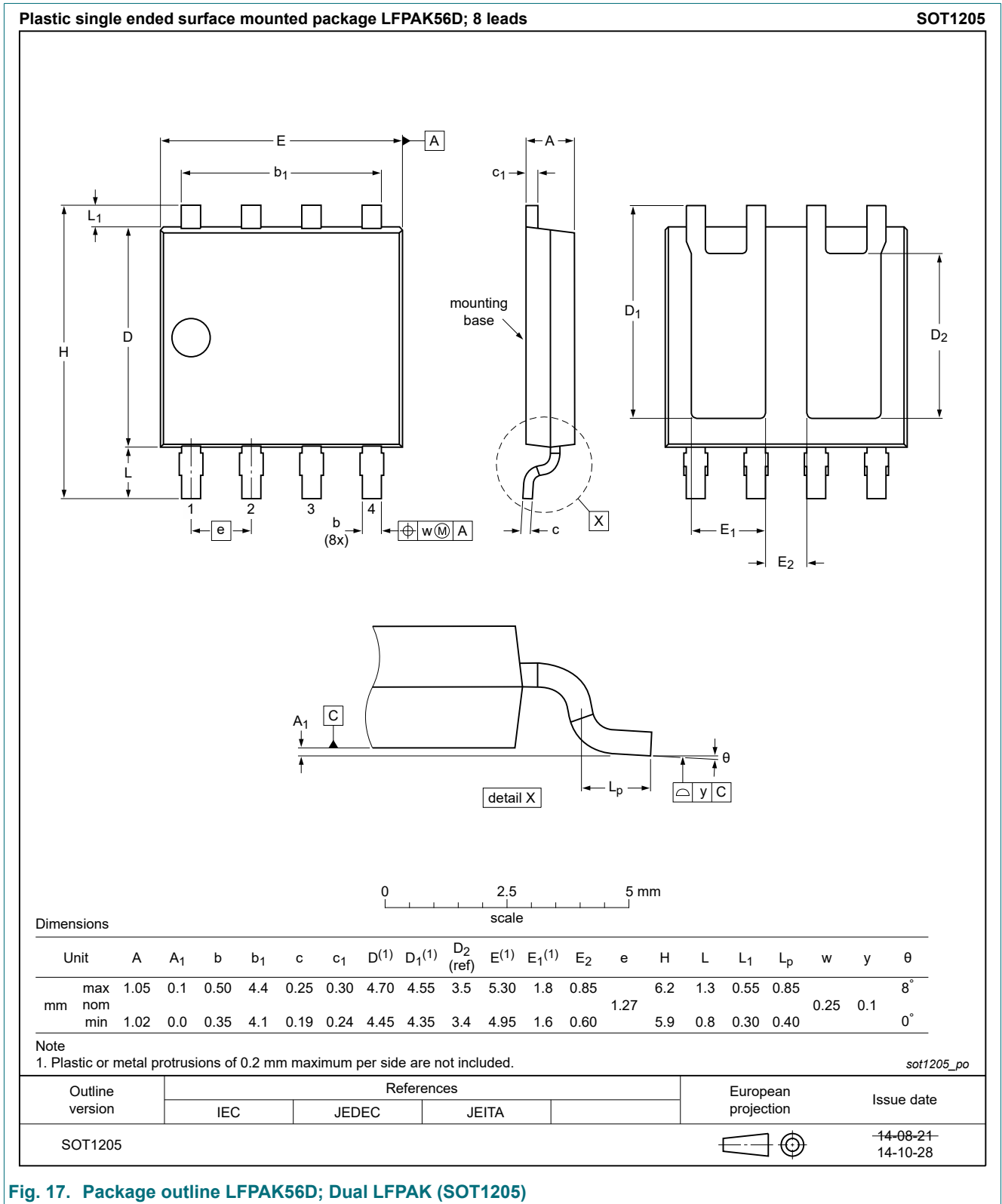
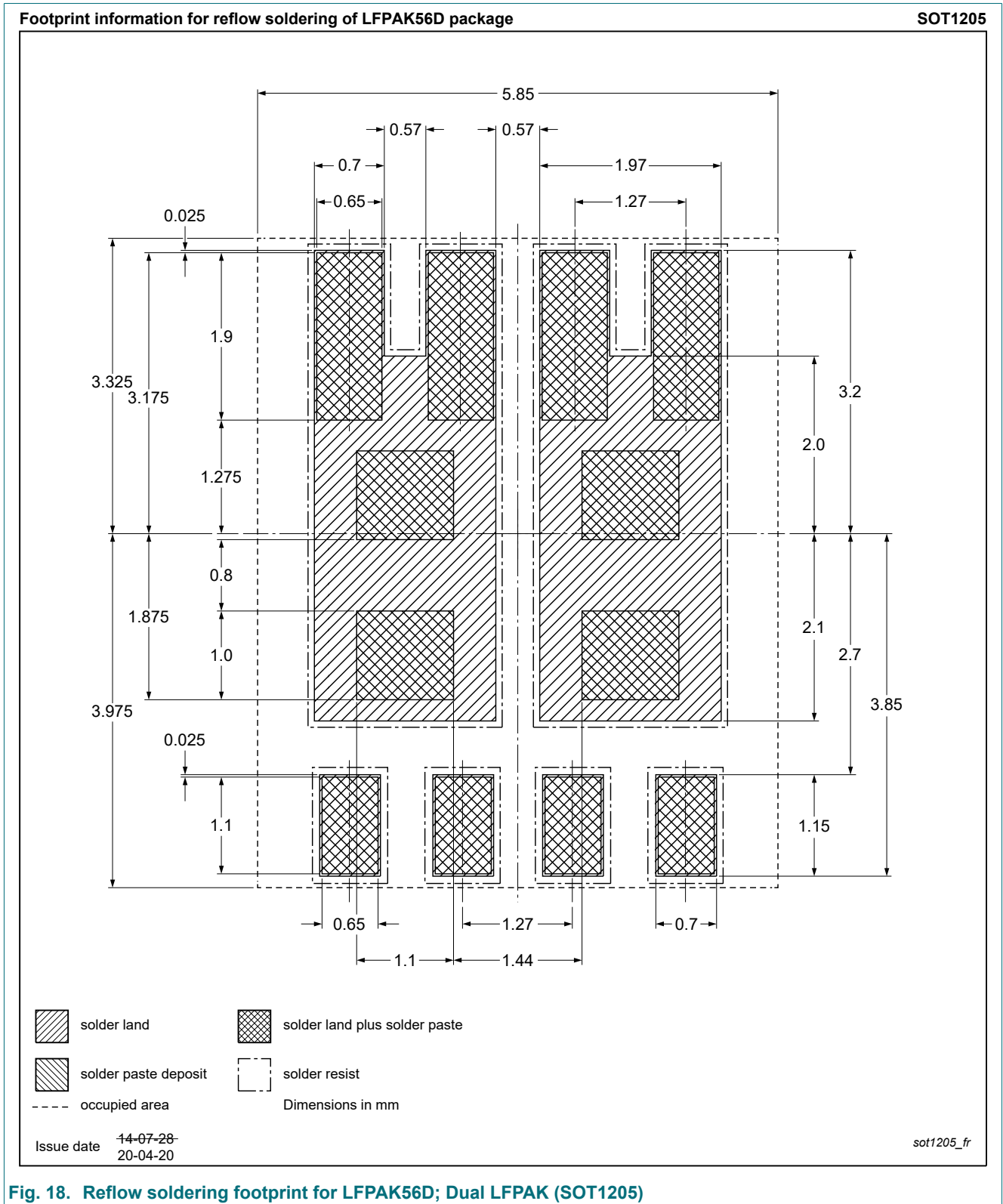


Fig. 17. Package outline LPAK56D; Dual LPAK (SOT1205)

## 12. Soldering



**Fig. 18. Reflow soldering footprint for LPAK56D; Dual LPAK (SOT1205)**

## 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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