



# PSMN9R3-60HS

N-channel 60 V, 9.3 mOhm, standard level MOSFET in LPAK56D using TrenchMOS technology

26 September 2022

Product data sheet

## 1. General description

Dual standard level N-channel MOSFET in an LPAK56D (Dual Power-SO8) package using TrenchMOS technology.

## 2. Features and benefits

- Dual MOSFET
- Repetitive avalanche rated
- High reliability LPAK56D package
- Copper-clip, solder die attach
- Qualified to 175 °C

## 3. Applications

- Brushless DC motor control
- DC-to-DC converters
- High-performance synchronous rectification
- High performance and high efficiency server power supply

## 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	$V_{GS} = 10\text{ V}$ ; $T_{mb} = 25\text{ °C}$ ; <a href="#">Fig. 2</a>	[1]	-	-	40	A
$P_{tot}$	total power dissipation	$T_{mb} = 25\text{ °C}$ ; <a href="#">Fig. 1</a>		-	-	68	W
$T_j$	junction temperature			-55	-	175	°C
<b>Static characteristics FET1 and FET2</b>							
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = 10\text{ V}$ ; $I_D = 10\text{ A}$ ; $T_j = 25\text{ °C}$ ; <a href="#">Fig. 11</a>		-	7.64	9.3	mΩ
		$V_{GS} = 10\text{ V}$ ; $I_D = 10\text{ A}$ ; $T_j = 175\text{ °C}$ ; <a href="#">Fig. 11</a> ; <a href="#">Fig. 12</a>		-	17.1	20.8	mΩ
<b>Dynamic characteristics FET1 and FET2</b>							
$Q_{GD}$	gate-drain charge	$I_D = 10\text{ A}$ ; $V_{DS} = 48\text{ V}$ ; $V_{GS} = 10\text{ V}$ ; $T_j = 25\text{ °C}$ ; <a href="#">Fig. 13</a> ; <a href="#">Fig. 14</a>		-	11	-	nC
$Q_{G(tot)}$	total gate charge			-	34.2	-	nC
<b>Avalanche ruggedness FET1 and FET2</b>							
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$I_D = 40\text{ A}$ ; $V_{sup} \leq 60\text{ V}$ ; $V_{GS} = 10\text{ V}$ ; $T_{j(init)} = 25\text{ °C}$ ; <a href="#">Fig. 4</a>	[2] [3]	-	-	103	mJ

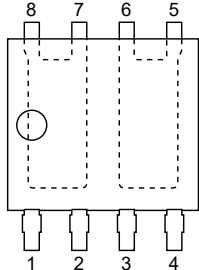
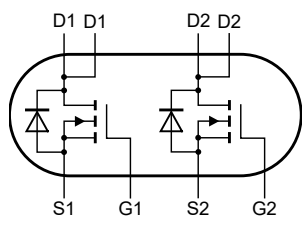
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Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Source-drain diode FET1 and FET2</b>						
Q <sub>r</sub>	recovered charge	I <sub>S</sub> = 10 A; di <sub>S</sub> /dt = -100 A/μs; V <sub>GS</sub> = 0 V; V <sub>DS</sub> = 30 V; T <sub>J</sub> = 25 °C	-	24	-	nC

- [1] Continuous current is limited by package.
- [2] Refer to application note AN10273 for further information
- [3] Single-pulse avalanche rating limited by maximum junction temperature of 175 °C

## 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		Version
	Name	Description	
PSMN9R3-60HS	LFPAK56D; Dual LFPAK	plastic, single ended surface mounted package (LFPAK56D); 8 leads	SOT1205

## 7. Marking

Table 4. Marking codes

Type number	Marking code
PSMN9R3-60HS	9R3S60H

## 8. Limiting values

Table 5. Limiting values

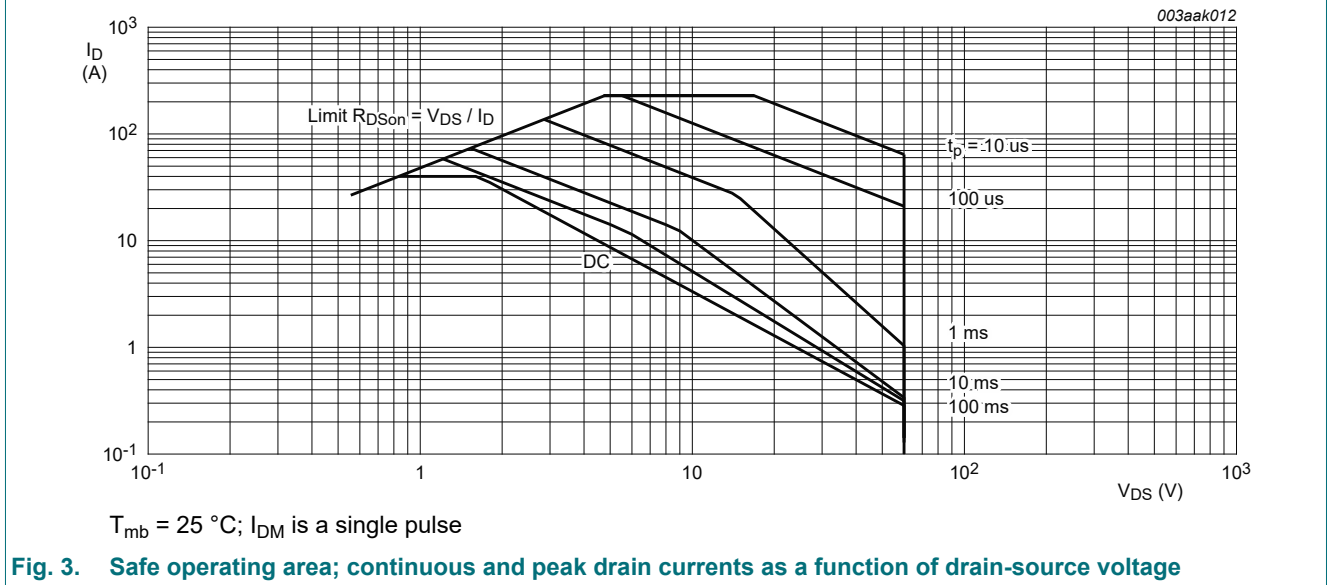
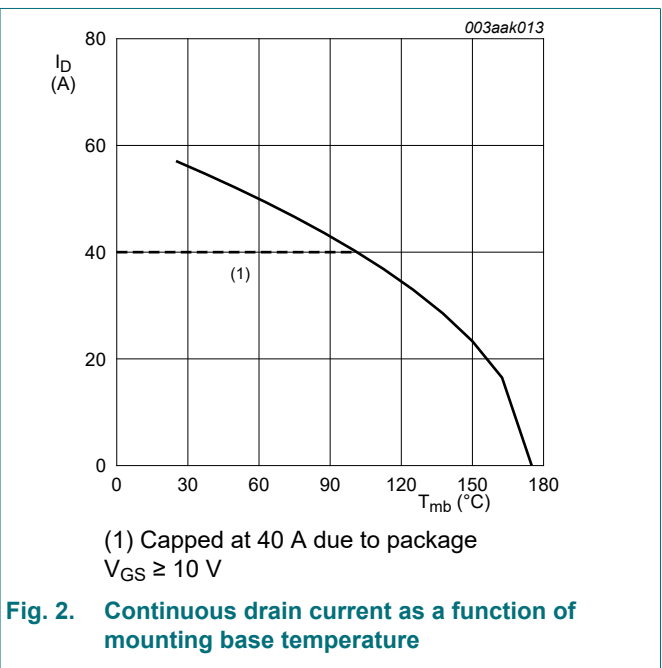
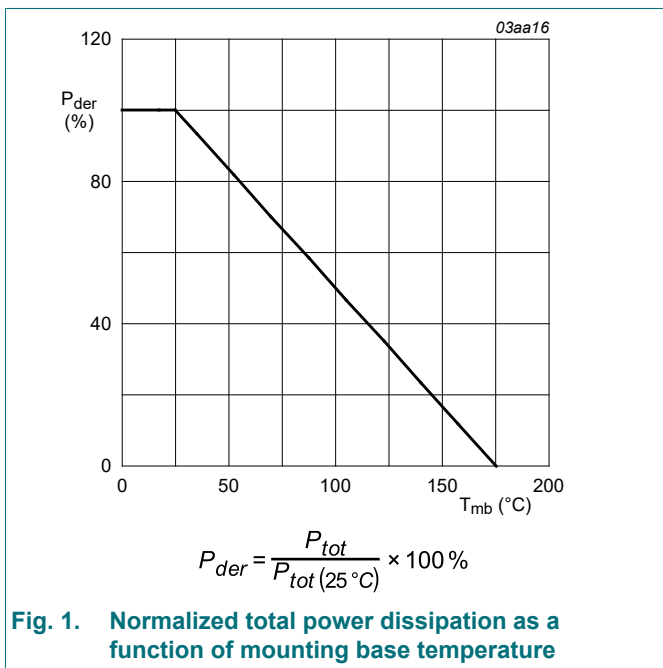
In accordance with the Absolute Maximum Rating System (IEC 60134).

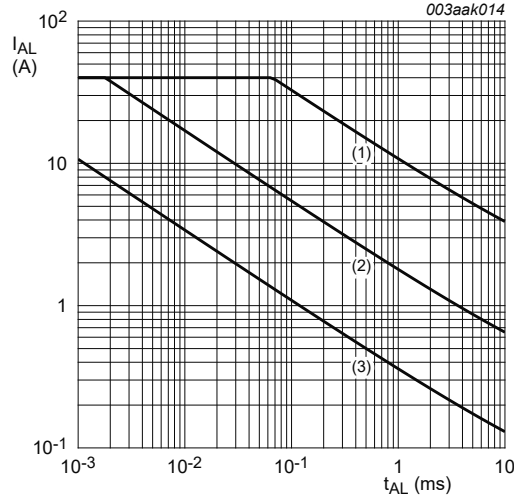
Symbol	Parameter	Conditions	Min	Max	Unit
V <sub>DS</sub>	drain-source voltage	25 °C ≤ T <sub>J</sub> ≤ 175 °C	-	60	V
V <sub>DGR</sub>	drain-gate voltage	R <sub>GS</sub> = 20 kΩ	-	60	V
V <sub>GS</sub>	gate-source voltage	DC; T <sub>J</sub> ≤ 175 °C	-20	20	V
P <sub>tot</sub>	total power dissipation	T <sub>mb</sub> = 25 °C; Fig. 1	-	68	W
I <sub>D</sub>	drain current	V <sub>GS</sub> = 10 V; T <sub>mb</sub> = 25 °C; Fig. 2	[1]	40	A
		V <sub>GS</sub> = 10 V; T <sub>mb</sub> = 100 °C; Fig. 2	[1]	40	A

N-channel 60 V, 9.3 mOhm, standard level MOSFET in LPAK56D using TrenchMOS technology

Symbol	Parameter	Conditions	Min	Max	Unit
$I_{DM}$	peak drain current	pulsed; $t_p \leq 10 \mu s$ ; $T_{mb} = 25 \text{ }^\circ\text{C}$ ; Fig. 3	-	228	A
$T_{stg}$	storage temperature		-55	175	$^\circ\text{C}$
$T_j$	junction temperature		-55	175	$^\circ\text{C}$
<b>Source-drain diode FET1 and FET2</b>					
$I_S$	source current	$T_{mb} = 25 \text{ }^\circ\text{C}$	[1]	40	A
$I_{SM}$	peak source current	pulsed; $t_p \leq 10 \mu s$ ; $T_{mb} = 25 \text{ }^\circ\text{C}$	-	228	A
<b>Avalanche ruggedness FET1 and FET2</b>					
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$I_D = 40 \text{ A}$ ; $V_{sup} \leq 60 \text{ V}$ ; $V_{GS} = 10 \text{ V}$ ; $T_{j(\text{init})} = 25 \text{ }^\circ\text{C}$ ; Fig. 4	[2] [3]	103	mJ

- [1] Continuous current is limited by package.
- [2] Refer to application note AN10273 for further information
- [3] Single-pulse avalanche rating limited by maximum junction temperature of 175  $^\circ\text{C}$





(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

### 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	-	-	2.21	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient	Minimum footprint; mounted on a printed circuit board	-	95	-	K/W

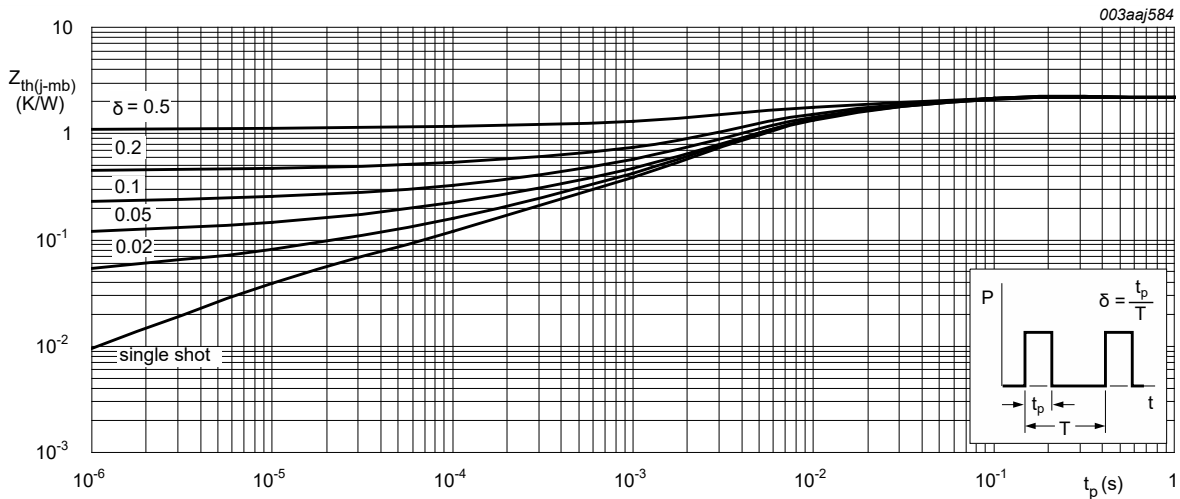


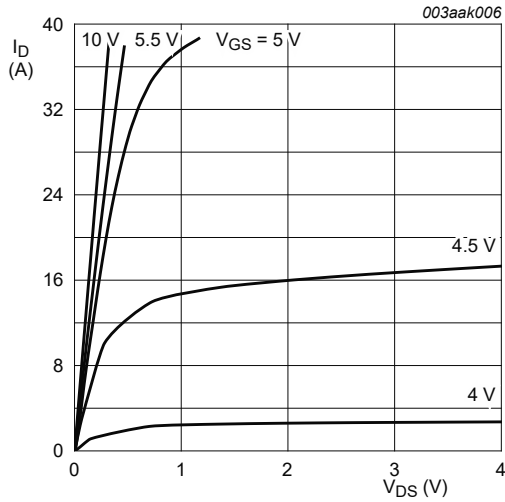
Fig. 5. Transient thermal impedance from junction to mounting base as a function of pulse duration

## 10. Characteristics

Table 7. Characteristics

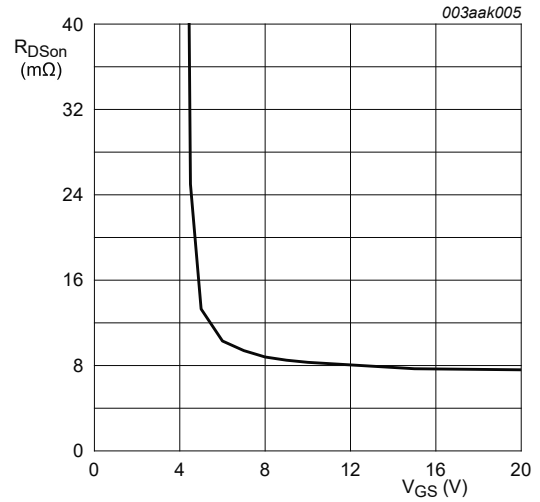
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics FET1 and FET2</b>						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 250 \mu A; V_{GS} = 0 V; T_j = -55 \text{ }^\circ C$	54	-	-	V
		$I_D = 250 \mu A; V_{GS} = 0 V; T_j = 25 \text{ }^\circ C$	60	-	-	V
$V_{GS(th)}$	gate-source 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>	2.4	3	4	V
		$I_D = 1 \text{ mA}; V_{DS}=V_{GS}; T_j = 175 \text{ }^\circ C$ ; <a href="#">Fig. 9</a> ; <a href="#">Fig. 10</a>	1	-	-	V
		$I_D = 1 \text{ mA}; V_{DS}=V_{GS}; T_j = -55 \text{ }^\circ C$ ; <a href="#">Fig. 9</a> ; <a href="#">Fig. 10</a>	-	-	4.5	V
$I_{DSS}$	drain leakage current	$V_{DS} = 60 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ C$	-	0.02	1	$\mu A$
		$V_{DS} = 60 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 175 \text{ }^\circ C$	-	-	500	$\mu A$
$I_{GSS}$	gate leakage current	$V_{GS} = -20 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ C$	-	2	100	nA
		$V_{GS} = 20 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ C$	-	2	100	nA
$R_{DS(on)}$	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>	-	7.64	9.3	m $\Omega$
		$V_{GS} = 10 \text{ V}; I_D = 10 \text{ A}; T_j = 175 \text{ }^\circ C$ ; <a href="#">Fig. 11</a> ; <a href="#">Fig. 12</a>	-	17.1	20.8	m $\Omega$
<b>Dynamic characteristics FET1 and FET2</b>						
$Q_{G(tot)}$	total gate charge	$I_D = 10 \text{ A}; V_{DS} = 48 \text{ V}; V_{GS} = 10 \text{ V}; T_j = 25 \text{ }^\circ C$ ; <a href="#">Fig. 13</a> ; <a href="#">Fig. 14</a>	-	34.2	-	nC
$Q_{GS}$	gate-source charge		-	6.7	-	nC
$Q_{GD}$	gate-drain charge		-	11	-	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>	-	1761	2348	pF
$C_{oss}$	output capacitance		-	247	297	pF
$C_{rss}$	reverse transfer capacitance		-	155	213	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = 48 \text{ V}; R_L = 5 \text{ } \Omega; V_{GS} = 10 \text{ V}; R_{G(ext)} = 5 \text{ } \Omega; T_j = 25 \text{ }^\circ C$	-	9.1	-	ns
$t_r$	rise time		-	12.5	-	ns
$t_{d(off)}$	turn-off delay time		-	23	-	ns
$t_f$	fall time		-	15	-	ns
<b>Source-drain diode FET1 and FET2</b>						
$V_{SD}$	source-drain voltage	$I_S = 10 \text{ A}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ C$ ; <a href="#">Fig. 16</a>	-	0.78	1.2	V
$t_{rr}$	reverse recovery time	$I_S = 10 \text{ A}; dI_S/dt = -100 \text{ A}/\mu s; V_{GS} = 0 \text{ V}; V_{DS} = 30 \text{ V}; T_j = 25 \text{ }^\circ C$	-	25	-	ns
$Q_r$	recovered charge		-	24	-	nC

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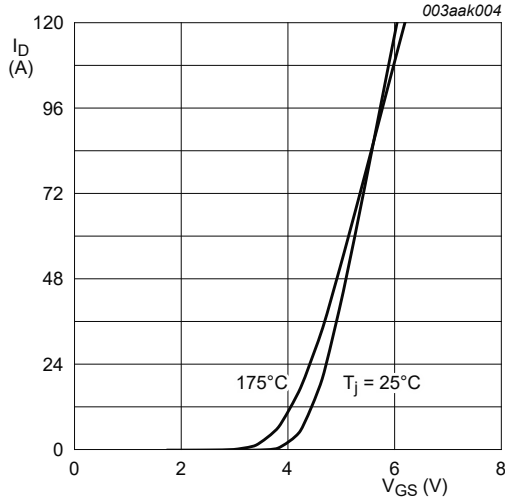
$T_j = 25\text{ }^\circ\text{C}$ ;  $t_p = 300\text{ }\mu\text{s}$

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



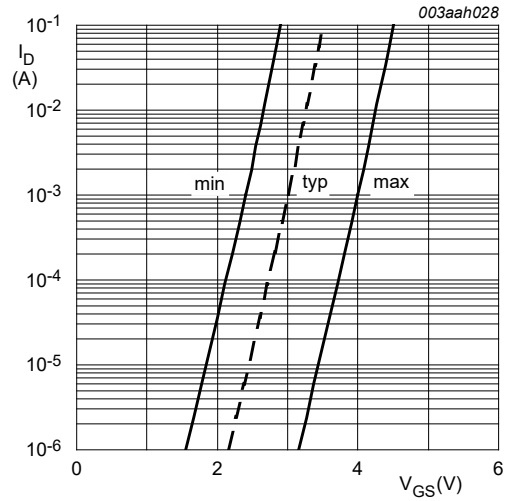
$T_j = 25\text{ }^\circ\text{C}$ ;  $I_D = 10\text{ A}$

Fig. 7. Drain-source on-state resistance as a function of gate-source voltage; typical values



$V_{DS} = 10\text{ V}$

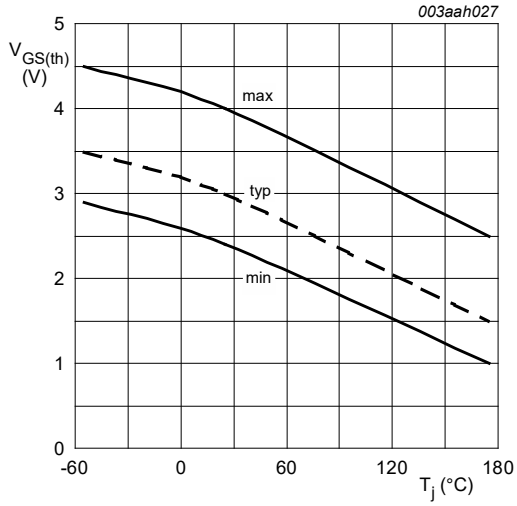
Fig. 8. Transfer characteristics; drain current as a function of gate-source voltage; typical values



$T_j = 25\text{ }^\circ\text{C}$ ;  $V_{DS} = 5\text{ V}$

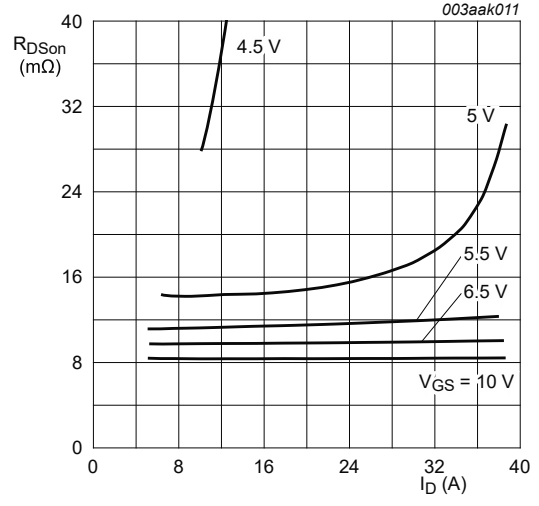
Fig. 9. Sub-threshold drain current as a function of gate-source voltage

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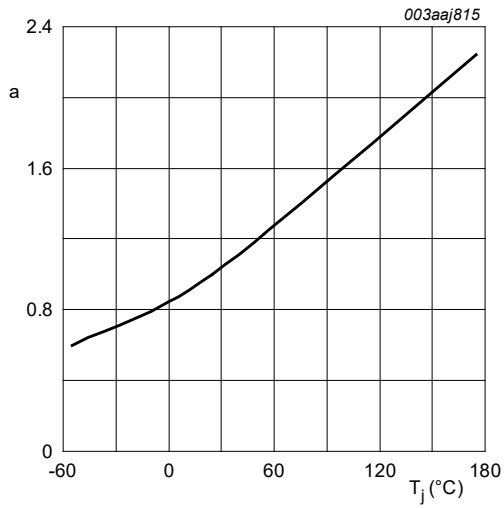
$I_D = 1 \text{ mA}; V_{DS} = V_{GS}$

Fig. 10. Gate-source threshold voltage as a function of junction temperature



$T_j = 25 \text{ °C}; t_p = 300 \text{ }\mu\text{s}$

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



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

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

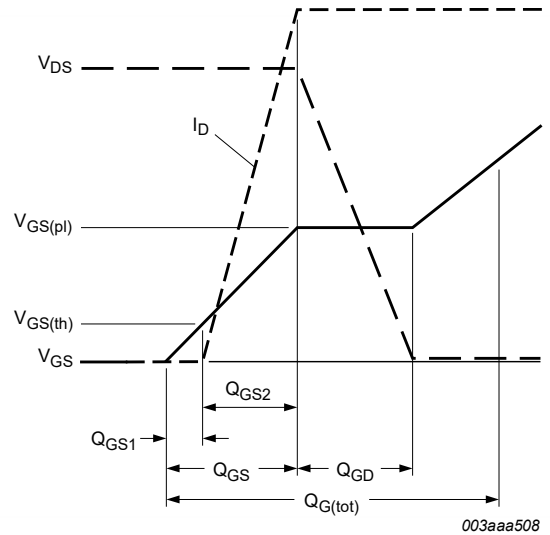
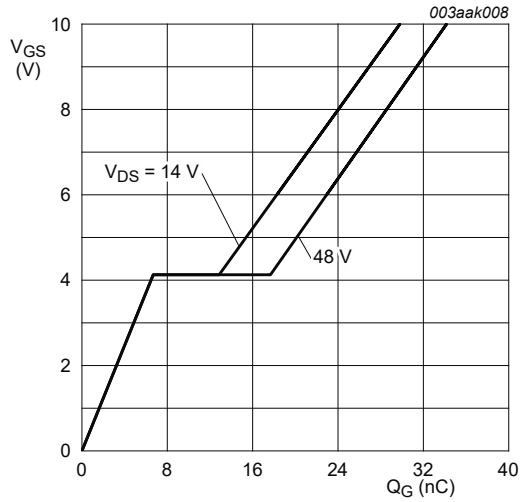


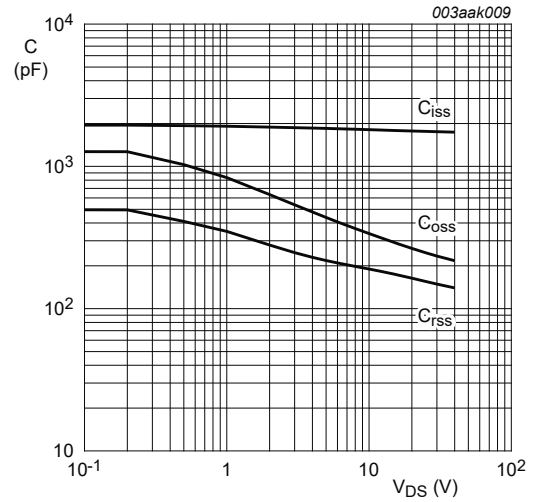
Fig. 13. Gate charge waveform definitions

N-channel 60 V, 9.3 mOhm, standard level MOSFET in LPAK56D using TrenchMOS technology



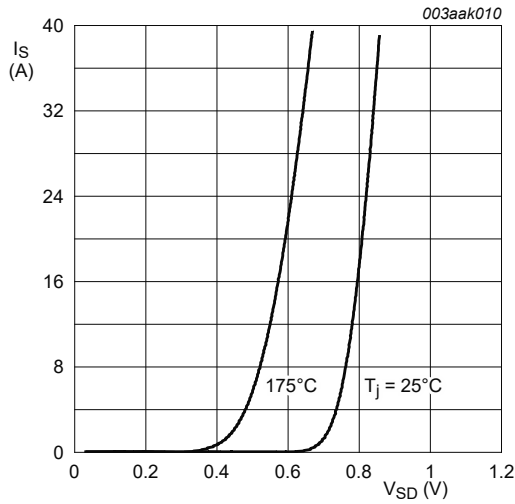
$T_j = 25\text{ }^\circ\text{C}; I_D = 10\text{ A}$

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



$V_{GS} = 0\text{ V}; I_D = 10\text{ A}$

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



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

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



### 11. Package outline

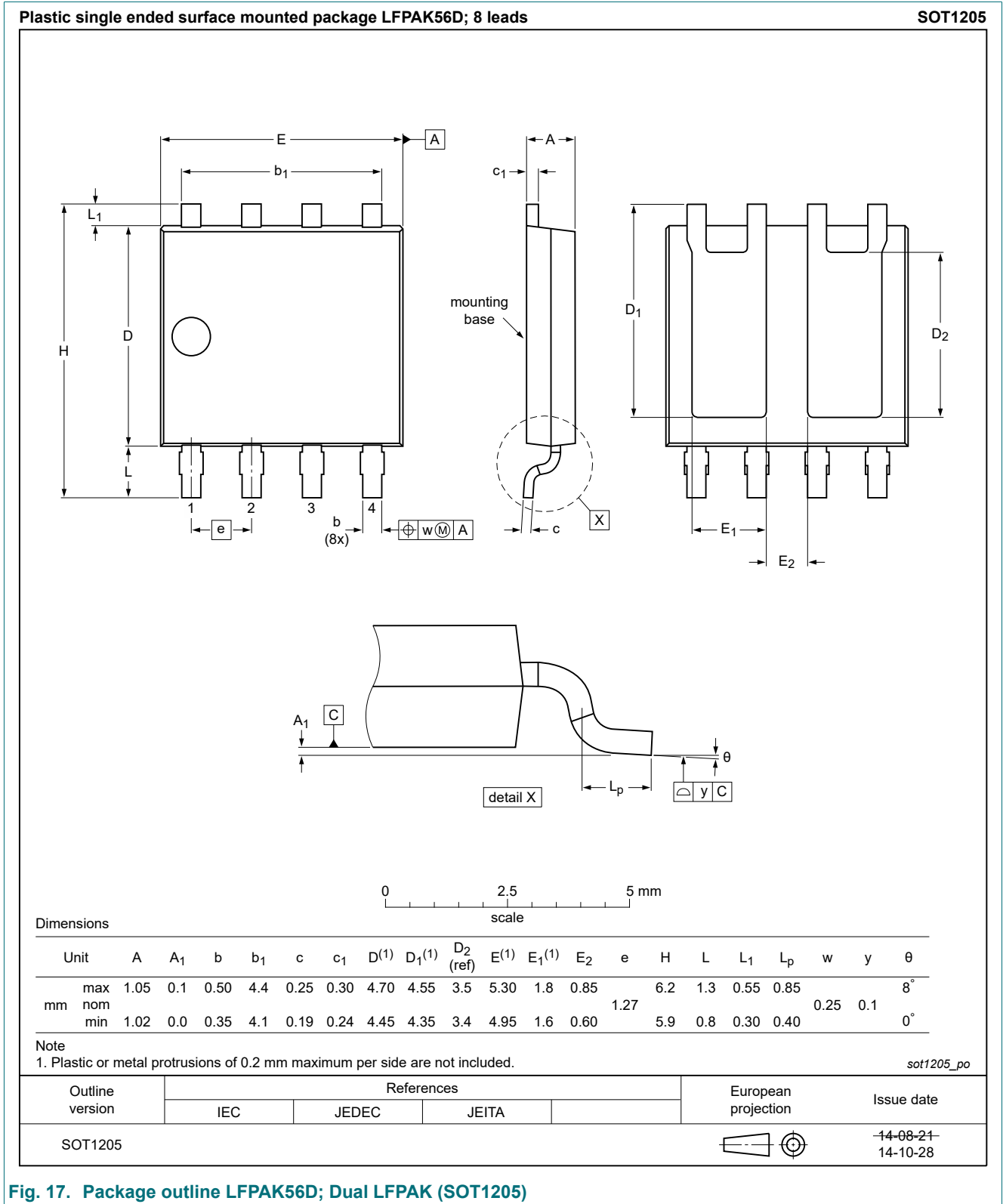


Fig. 17. Package outline LPAK56D; Dual LPAK (SOT1205)

## 12. Soldering

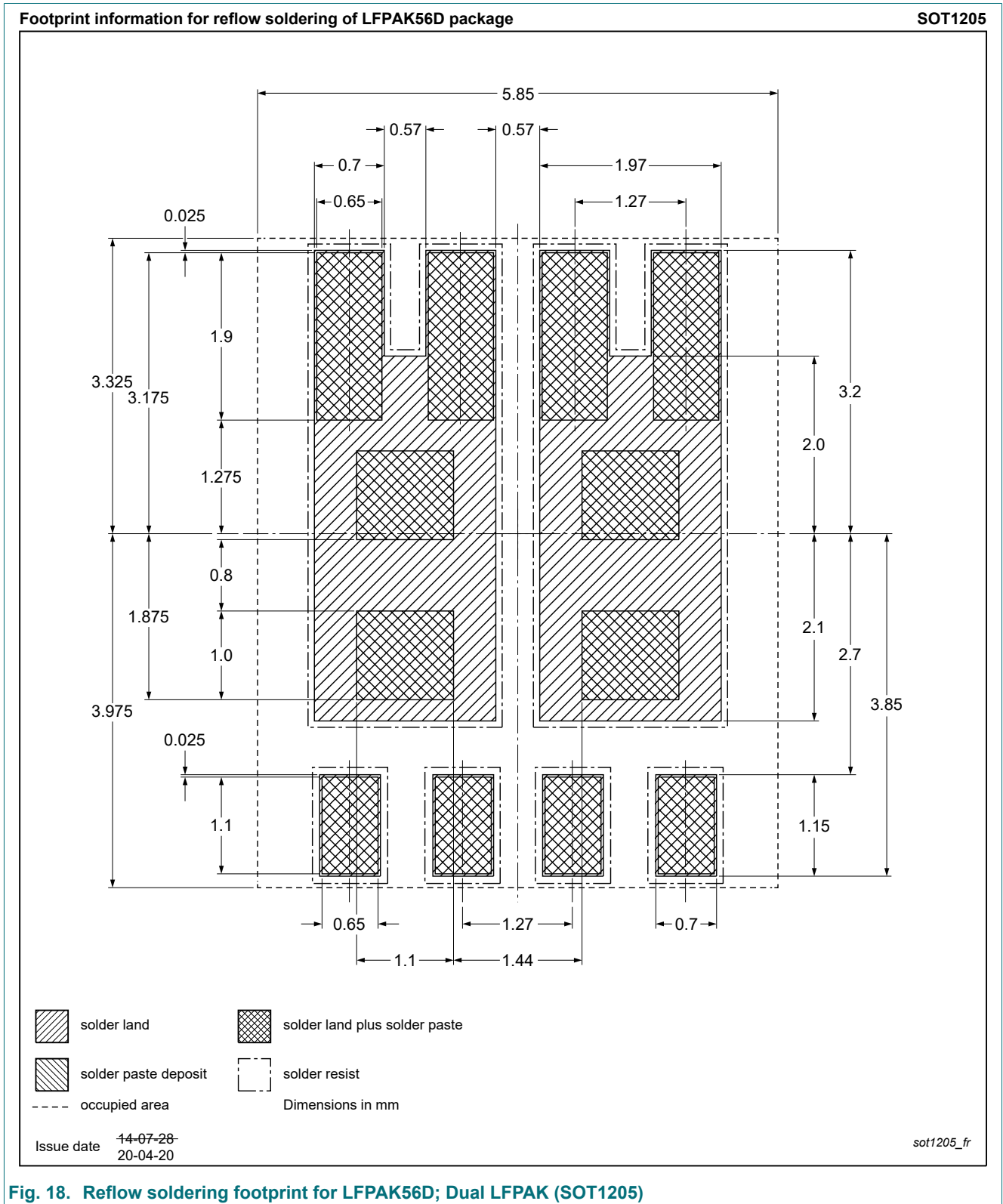


Fig. 18. Reflow soldering footprint for LPAK56D; Dual LPAK (SOT1205)

## 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.
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## Contents

---

1. General description.....	1
2. Features and benefits.....	1
3. Applications.....	1
4. Quick reference data.....	1
5. Pinning information.....	2
6. Ordering information.....	2
7. Marking.....	2
8. Limiting values.....	2
9. Thermal characteristics.....	4
10. Characteristics.....	5
11. Package outline.....	9
12. Soldering.....	10
13. Legal information.....	11

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