PSMNR56-25YLE

N-channel 25 V, 0.63 mOhm, ASFET for hotswap with enhanced SOA in LFPAK56E

10 November 2022 Product data sheet

1. General description

N-channel enhancement mode ASFET for hotswap with enhanced SOA in LFPAK56E package optimized for low R_{DSon} and strong safe operating area, optimized for hot-swap, inrush and linear-mode applications.

2. Features and benefits

- Fully optimized Safe Operating Area (SOA) for superior linear mode operation
- Optimized for low R_{DSon} / low I^2R conduction losses
- LFPAK56E package for applications that demand the highest performance and reliability in a 30 mm^2 footprint
- Low leakage <1 µA at 25 °C
- Copper-clip for low parasitic inductance and resistance
- High reliability LFPAK package, qualified to 175 °C

3. Applications

- Hot swap in 12 V - 20 V applications
- e-Fuse
- DC switch
- Load switch
- Battery protection

4. Quick reference data

Table 1. Quick reference data

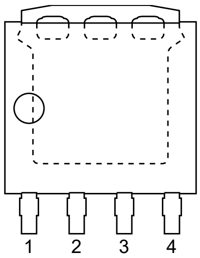
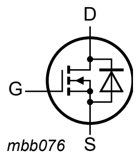
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{DS}	drain-source voltage	25 °C ≤ T_j ≤ 175 °C		-	-	25	V
I_D	drain current	V_{GS} = 10 V; T_{mb} = 25 °C; Fig. 2	[1]	-	-	320	A
P_{tot}	total power dissipation	T_{mb} = 25 °C; Fig. 1		-	-	333	W
T_j	junction temperature			-55	-	175	°C
Static characteristics							
R_{DSon}	drain-source on-state resistance	V_{GS} = 10 V; I_D = 25 A; T_j = 25 °C; Fig. 10		-	0.5	0.63	mΩ
		V_{GS} = 7 V; I_D = 25 A; T_j = 25 °C; Fig. 10		-	0.65	0.92	mΩ
Dynamic characteristics							
Q_{GD}	gate-drain charge	I_D = 25 A; V_{DS} = 12 V; V_{GS} = 4.5 V; T_j = 25 °C; Fig. 12; Fig. 13		2.7	15	30	nC
$Q_{G(tot)}$	total gate charge			24	54	89	nC

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Source-drain diode							
S	softness factor	I_S = 25 A; dI_S/dt = -100 A/µs; V_{GS} = 0 V; V_{DS} = 12 V; T_j = 25 °C; Fig. 16		-	0.92	-	

[1] 320 A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature.

5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	S	source	 **LFPAK56E; Power-SO8 (SOT1023)**	
2	S	source		
3	S	source		
4	G	gate		
mb	D	mounting base; connected to drain		

6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
PSMNR56-25YLE	LFPAK56E; Power-SO8	plastic, single-ended surface-mounted package (LFPAK56); 4 leads; 1.27 mm pitch	SOT1023

7. Marking

Table 4. Marking codes

Type number	Marking code
PSMNR56-25YLE	E56L25J

8. Limiting values

Table 5. Limiting values

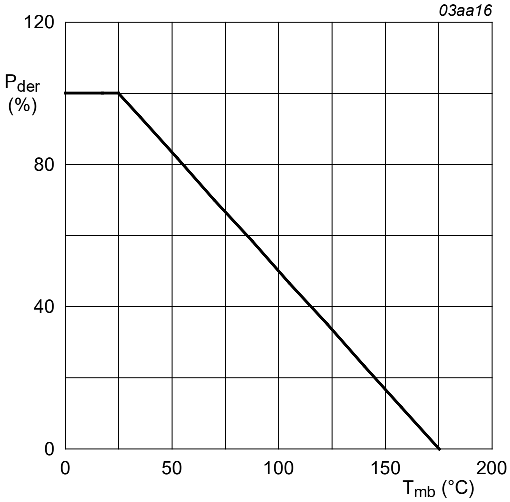
In accordance with the Absolute Maximum Rating System (IEC 60134). Tj = 25 °C unless otherwise stated.

Symbol	Parameter	Conditions		Min	Max	Unit
V_{DS}	drain-source voltage	25 °C ≤ T_j ≤ 175 °C		-	25	V
V_{DGR}	drain-gate voltage	25 °C ≤ T_j ≤ 175 °C; R_{GS} = 20 kΩ		-	25	V
V_{GS}	gate-source voltage			-20	20	V
P_{tot}	total power dissipation	T_{mb} = 25 °C; Fig. 1		-	333	W
I_D	drain current	V_{GS} = 10 V; T_{mb} = 25 °C; Fig. 2	[1]	-	320	A
		V_{GS} = 10 V; T_{mb} = 100 °C; Fig. 2		-	320	A
I_{DM}	peak drain current	pulsed; t_p ≤ 10 µs; T_{mb} = 25 °C; Fig. 3		-	2068	A

Symbol	Parameter	Conditions		Min	Max	Unit
T_{stg}	storage temperature			-55	175	°C
T_j	junction temperature			-55	175	°C
$T_{sld(M)}$	peak soldering temperature			-	260	°C
Source-drain diode						
I_S	source current	T_{mb} = 25 °C		-	320	A
I_{SM}	peak source current	pulsed; t_p ≤ 10 µs; T_{mb} = 25 °C		-	2068	A
Avalanche ruggedness						
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	I_D = 25 A; V_{sup} ≤ 25 V; R_{GS} = 50 Ω; V_{GS} = 10 V; $T_{j(init)}$ = 25 °C; unclamped; t_p = 18 ms	[2]	-	7.2	J
I_{AS}	non-repetitive avalanche current	V_{sup} ≤ 25 V; V_{GS} = 10 V; $T_{j(init)}$ = 25 °C; R_{GS} = 50 Ω	[2]	-	190	A

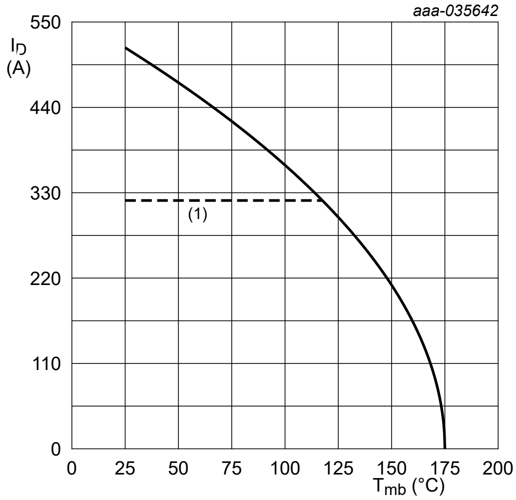
[1] 320 A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature.

[2] Protected by 100% test.



$$P_{der} = \frac{P_{tot}}{P_{tot(25°C)}} \times 100\,\%$$

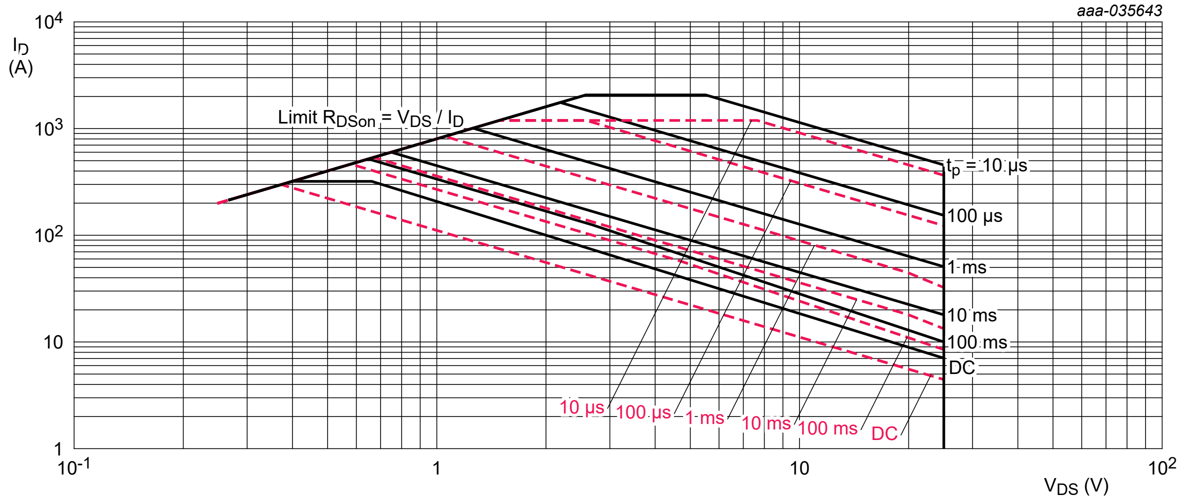
Fig. 1. Normalized total power dissipation as a function of mounting base temperature



V_{GS} ≥ 10 V

(1) 320 A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature.

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



T_{mb} = 25 °C (solid black line);T_{mb} = 125 °C (red dashed line); I_{DM} is a single pulse

Fig. 3. Safe operating area; 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
$R_{th(j-mb)}$	thermal resistance from junction to mounting base	Fig. 4		-	0.35	0.45	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient	Fig. 5		-	42	-	K/W
		Fig. 6		-	85	-	K/W

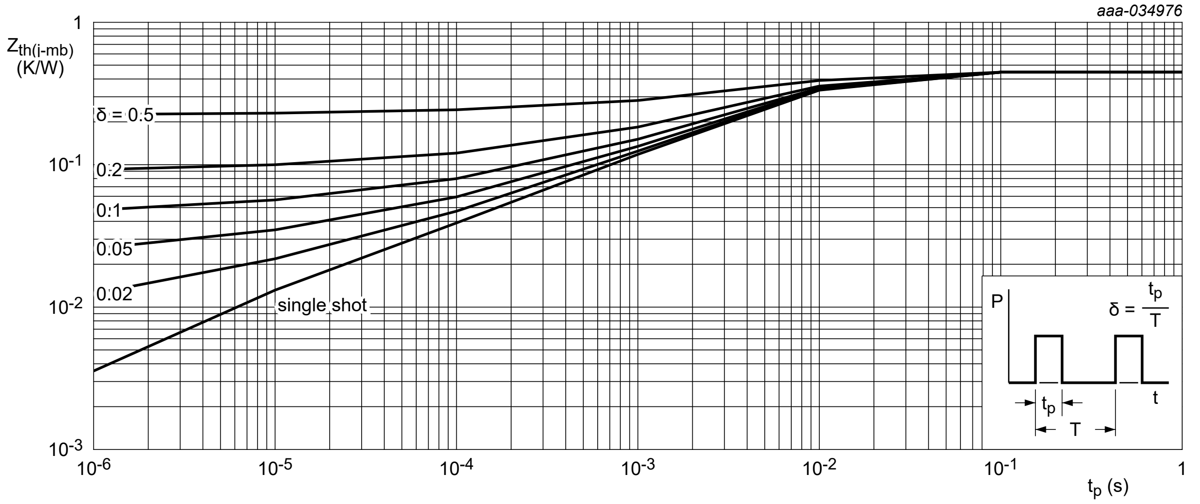
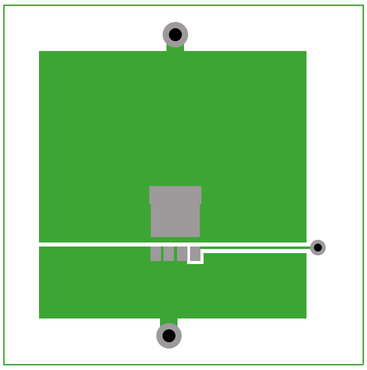


Fig. 4. Transient thermal impedance from junction to mounting base as a function of pulse duration



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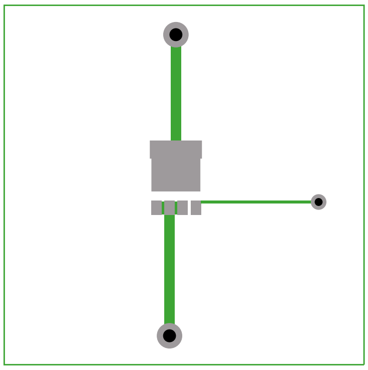
Copper area 25.4 mm square; 70 µm thick on FR4 board

Fig. 5. PCB layout for thermal resistance from junction to ambient



aaa-027935

70 µm thick copper on FR4 board

Fig. 6. PCB layout with minimum footprint for thermal resistance from junction to ambient

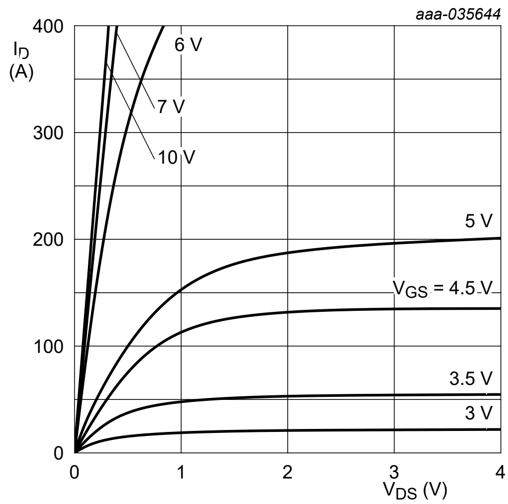
10. Characteristics

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		25	-	-	V
		I_D = 250 µA; V_{GS} = 0 V; T_j = -55 °C		22.5	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	I_D = 2 mA; V_{DS}=V_{GS}; T_j = 25 °C		1.2	1.84	2.2	V
$\Delta V_{GS(th)}/\Delta T$	gate-source threshold voltage variation with temperature	25 °C ≤ T_j ≤ 150 °C		-	-4	-	mV/K
I_{DSS}	drain leakage current	V_{DS} = 20 V; V_{GS} = 0 V; T_j = 25 °C		-	-	1	µA
		V_{DS} = 20 V; V_{GS} = 0 V; T_j = 125 °C		-	11.8	-	µA
I_{GSS}	gate leakage current	V_{GS} = 16 V; V_{DS} = 0 V; T_j = 25 °C		-	-	100	nA
		V_{GS} = -16 V; V_{DS} = 0 V; T_j = 25 °C		-	-	100	nA
R_{DSon}	drain-source on-state resistance	V_{GS} = 10 V; I_D = 25 A; T_j = 25 °C; Fig. 10		-	0.5	0.63	mΩ
		V_{GS} = 10 V; I_D = 25 A; T_j = 150 °C; Fig. 11		-	-	1.1	mΩ
		V_{GS} = 7 V; I_D = 25 A; T_j = 25 °C; Fig. 10		-	0.65	0.92	mΩ
		V_{GS} = 7 V; I_D = 25 A; T_j = 150 °C; Fig. 11		-	-	1.6	mΩ
R_G	gate resistance	f = 1 MHz; T_j = 25 °C		1.4	3.6	9	Ω
Dynamic characteristics							
$Q_{G(tot)}$	total gate charge	I_D = 25 A; V_{DS} = 12 V; V_{GS} = 4.5 V; T_j = 25 °C; Fig. 12; Fig. 13		24	54	89	nC
		I_D = 25 A; V_{DS} = 12 V; V_{GS} = 10 V; T_j = 25 °C; Fig. 12; Fig. 13		51	115	190	nC
		I_D = 0 A; V_{DS} = 0 V; V_{GS} = 10 V; T_j = 25 °C		-	59	-	nC

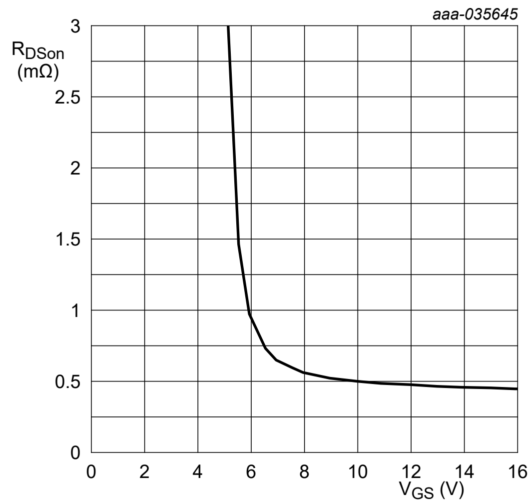
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Q_{GS}	gate-source charge	I_D = 25 A; V_{DS} = 12 V; V_{GS} = 4.5 V; T_j = 25 °C; Fig. 12; Fig. 13		6	23	44	nC
$Q_{GS(th)}$	pre-threshold gate-source charge			3.2	12	23	nC
$Q_{GS(th-pl)}$	post-threshold gate-source charge			3	11	21	nC
Q_{GD}	gate-drain charge			2.7	15	30	nC
$V_{GS(pl)}$	gate-source plateau voltage	I_D = 25 A; V_{DS} = 12 V; T_j = 25 °C; Fig. 12; Fig. 13		-	3.2	-	V
C_{iss}	input capacitance	V_{DS} = 12 V; V_{GS} = 0 V; f = 1 MHz; T_j = 25 °C; Fig. 14		4855	8091	12137	pF
C_{oss}	output capacitance			1865	3109	4664	pF
C_{rss}	reverse transfer capacitance			183	677	1625	pF
$t_{d(on)}$	turn-on delay time	V_{DS} = 12 V; R_L = 0.5 Ω; V_{GS} = 4.5 V; $R_{G(ext)}$ = 5 Ω; T_j = 25 °C		-	65	-	ns
t_r	rise time			-	150	-	ns
$t_{d(off)}$	turn-off delay time			-	51	-	ns
t_f	fall time			-	64	-	ns
Q_{oss}	output charge	V_{GS} = 0 V; V_{DS} = 12 V; f = 1 MHz; T_j = 25 °C		-	57	-	nC
Source-drain diode							
V_{SD}	source-drain voltage	I_S = 25 A; V_{GS} = 0 V; T_j = 25 °C; Fig. 15		-	0.77	1	V
t_{rr}	reverse recovery time	I_S = 25 A; dI_S/dt = -100 A/µs; V_{GS} = 0 V; V_{DS} = 12 V; T_j = 25 °C; Fig. 16		-	43	-	ns
Q_r	recovered charge		[1]	-	44	-	nC
t_a	reverse recovery rise time			-	22.2	-	ns
t_b	reverse recovery fall time			-	20.5	-	ns
S	softness factor			-	0.92	-	

[1] includes capacitive recovery



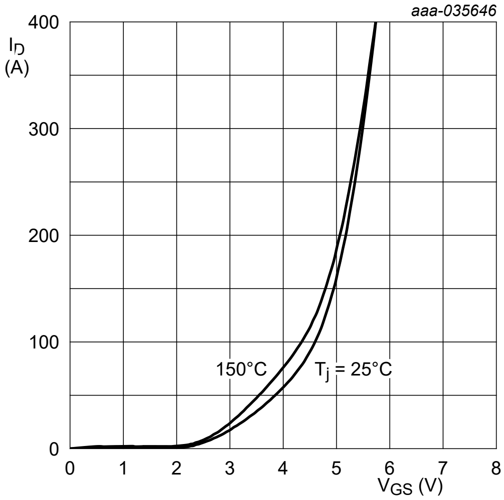
T_j = 25 °C

Fig. 7. Output characteristics; drain current as a function of drain-source voltage; typical values



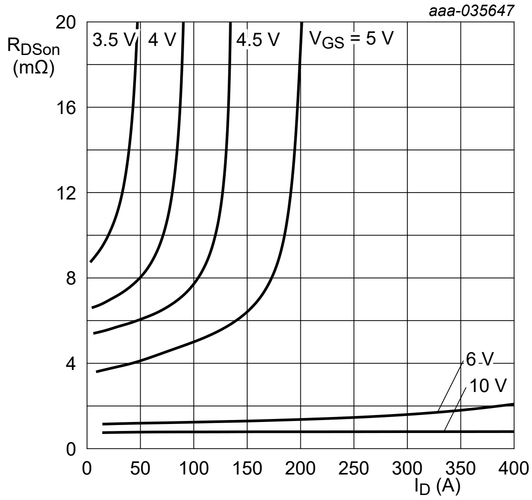
T_j = 25 °C; I_D = 25 A

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



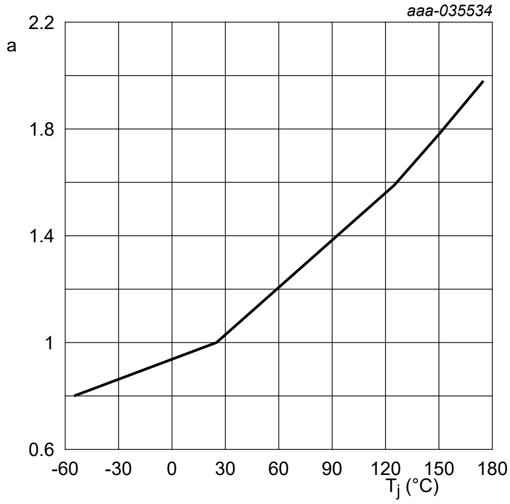
V_{DS} = 8 V

Fig. 9. Transfer characteristics; drain current as a function of gate-source voltage; typical values



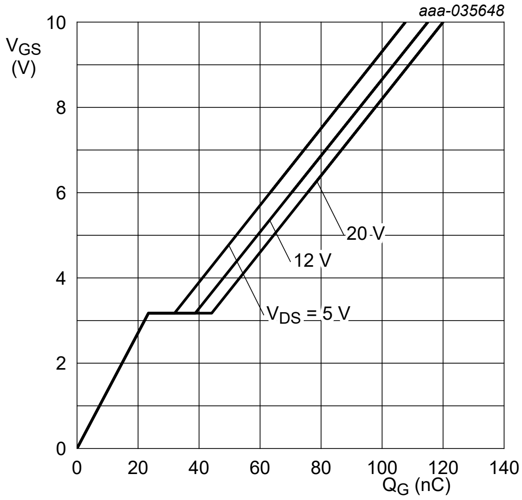
T_j = 25 °C

Fig. 10. Drain-source on-state resistance as a function of drain current; typical values



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

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



T_j = 25 °C; I_D = 25 A

Fig. 12. Gate-source voltage as a function of gate charge; typical values

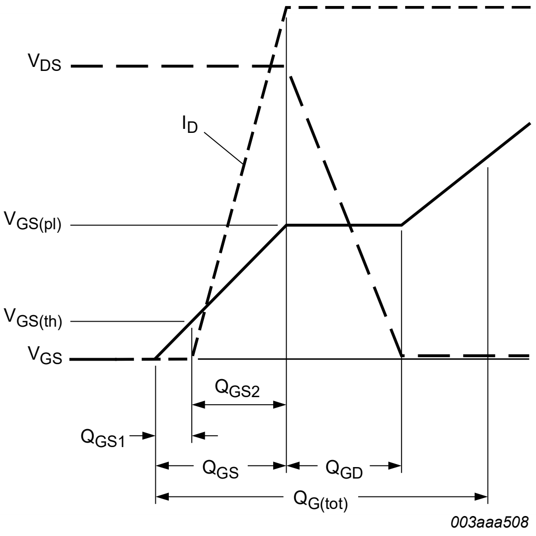


Fig. 13. Gate charge waveform definitions

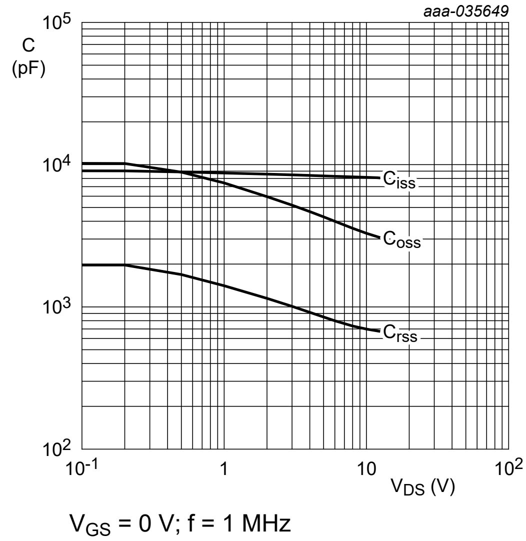


Fig. 14. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

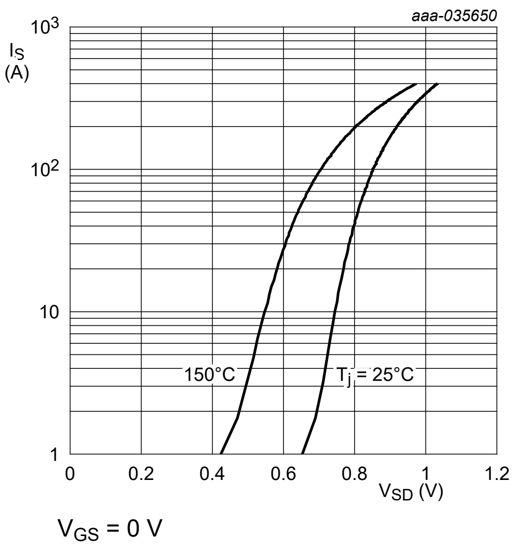


Fig. 15. Source-drain (diode forward) current as a function of source-drain (diode forward) voltage; typical values

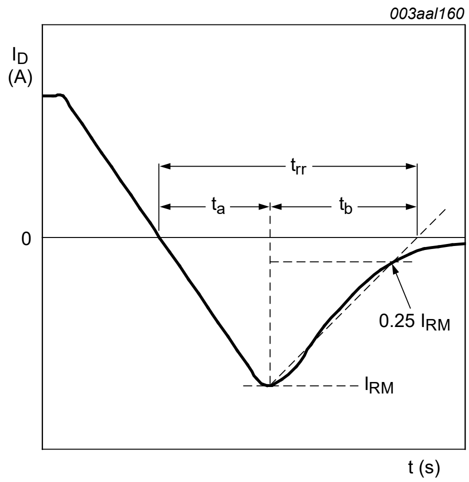
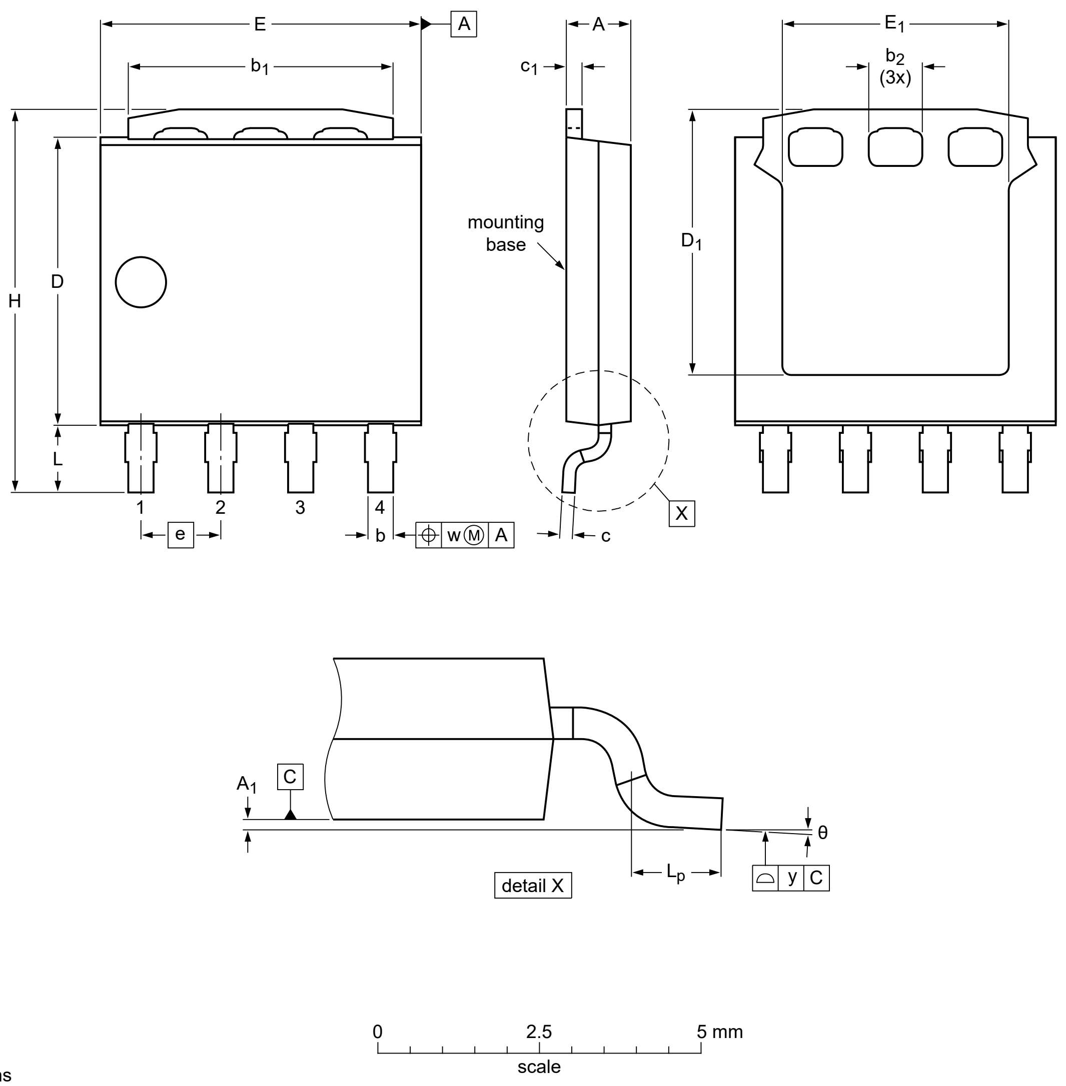


Fig. 16. Reverse recovery timing definition

11. Package outline

Plastic single-ended surface-mounted package (LFPAK56E); 4 leads **SOT1023**



Dimensions

Unit		A	A_1	b	b_1	b_2	c	c_1	$D^{(1)}$	$D_1^{(1)}$	$E^{(1)}$	$E_1^{(1)}$	e	H	L	L_p	w	y	θ
mm	max	1.10	0.15	0.50	4.41		0.25	0.30	4.70	4.45	5.30	3.7		6.2	1.3	0.85			8°
	nom					0.85							1.27				0.25	0.1	
	min	0.95	0.00	0.35	3.62		0.19	0.24	4.45		4.95	3.5		5.9	0.8	0.40			0°

Note

1. Plastic or metal protrusions of 0.15 mm per side are not included.

sot1023_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT1023						~~13-03-05~~ 17-07-31

Fig. 17. Package outline LFPAK56E; Power-SO8 (SOT1023)

12. Soldering

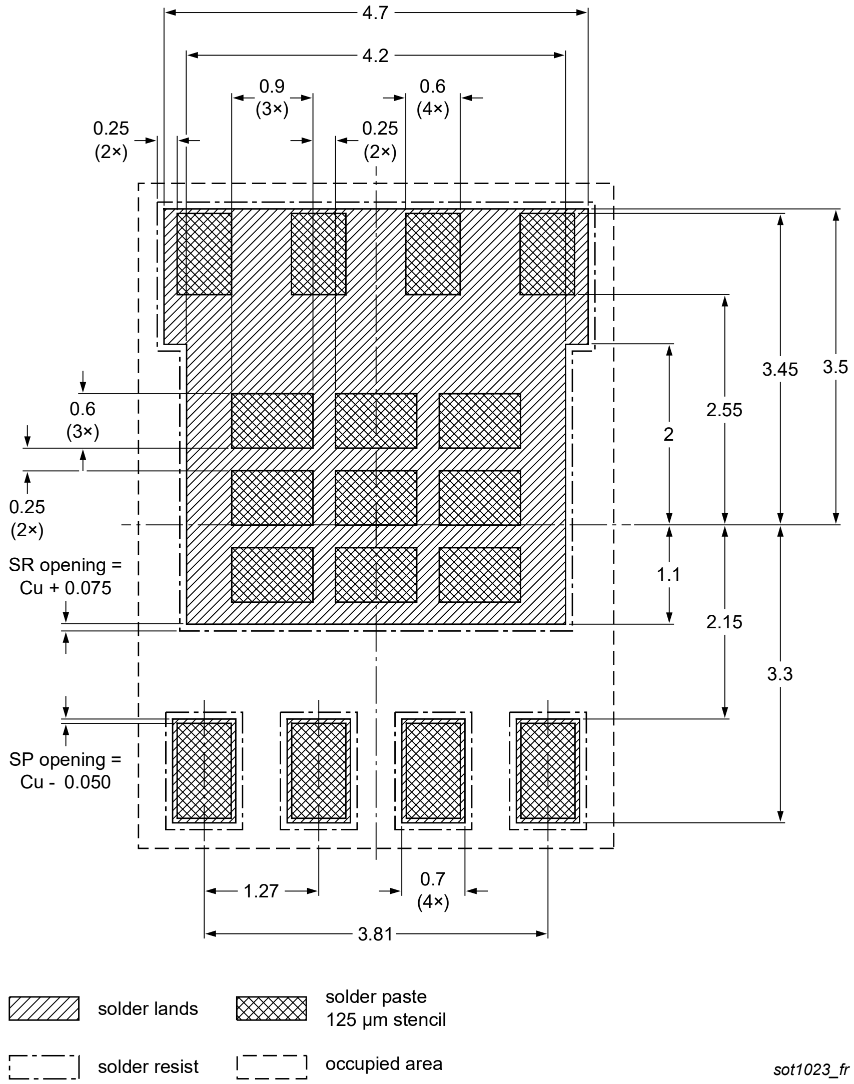


Fig. 18. Reflow soldering footprint for LFPAK56E; Power-SO8 (SOT1023)

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.

[1] Please consult the most recently issued document before initiating or completing a design.
[2] The term 'short data sheet' is explained in section "Definitions".
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