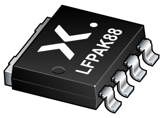


BUK7S1R2-40H

N-channel 40 V, 1.2 mΩ standard level MOSFET in LFPAK88

28 September 2022 **Product data sheet**

1. General description

Automotive qualified N-channel MOSFET using the latest Trench 9 low ohmic superjunction technology, housed in a copper-clip LFPAK88 package. This product has been fully designed and qualified to meet beyond AEC-Q101 requirements delivering high performance and reliability.

2. Features and benefits

- Fully automotive qualified to beyond AEC-Q101:
  - -55 °C to +175 °C rating suitable for thermally demanding environments
- LFPAK88 package:
  - Designed for smaller footprint and improved power density over older wire bond packages such as D²PAK for today's space constrained high power automotive applications
  - Thin package and copper clip enables LFPAK88 to be highly efficient thermally
- LFPAK copper clip technology enabling improvements over wire bond packages by:
  - Increased maximum current capability and excellent current spreading
  - Improved R_{DSon}
  - Low source inductance
  - Low thermal resistance R_{th}
- LFPAK Gull Wing leads:
  - Flexible leads enabling high Board Level Reliability absorbing mechanical and thermal cycling stress, unlike traditional QFN packages
  - Visual (AOI) soldering inspection, no need for expensive x-ray equipment
  - Easy solder wetting for good mechanical solder joint
- Unique 40 V Trench 9 superjunction technology:
  - Reduced cell pitch and superjunction platform enables lower R_{DSon} in the same footprint
  - Improved SOA and avalanche capability compared to standard TrenchMOS
  - Tight $V_{GS(th)}$ limits enable easy paralleling of MOSFETs

3. Applications

- 12 V automotive systems
- 48 V DC/DC systems (on 12 V secondary side)
- Higher power motors, lamps and solenoid control
- Reverse polarity protection
- LED lighting
- Ultra high performance power switching

4. Quick reference data

Table 1. Quick reference data

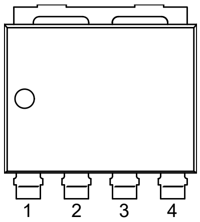
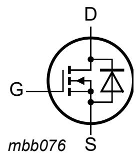
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{DS}	drain-source voltage	25 °C ≤ T_j ≤ 175 °C		-	-	40	V
I_D	drain current	V_{GS} = 10 V; T_{mb} = 25 °C; Fig. 2	[1]	-	-	300	A
P_{tot}	total power dissipation	T_{mb} = 25 °C; Fig. 1		-	-	294	W

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
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. 11		0.74	1.06	1.2	mΩ
		V_{GS} = 10 V; I_D = 25 A; T_j = 105 °C; Fig. 12		1.05	1.59	1.9	mΩ
Dynamic characteristics							
Q_{GD}	gate-drain charge	I_D = 25 A; V_{DS} = 32 V; V_{GS} = 10 V; Fig. 13; Fig. 14		-	14	28	nC
$Q_{G(tot)}$	total gate charge			-	80	112	nC
Avalanche ruggedness							
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	I_D = 120 A; V_{sup} ≤ 40 V; R_{GS} = 50 Ω; V_{GS} = 10 V; $T_{j(init)}$ = 25 °C; unclamped; Fig. 4	[2] [3]	-	-	277	mJ
Source-drain diode							
Q_r	recovered charge	I_S = 25 A; dI_S/dt = -100 A/µs; V_{GS} = 0 V; V_{DS} = 20 V	[4]	-	38	-	nC

[1] 300A continuous current has been successfully demonstrated during application. Practically the current will be limited by PCB, thermal design and operating emperature.
[2] Single-pulse avalanche rating limited by maximum junction temperature of 175 °C.
[3] Refer to application note AN10273 for further information.
[4] includes capacitive recovery

5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	G	gate	 LFPAK88 (SOT1235)	
2	S	source		
3	S	source		
4	S	source		
mb	D	mounting base; connected to drain		

6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
BUK7S1R2-40H	LFPAK88	plastic, single-ended surface-mounted package (LFPAK88); 4 leads; 2 mm pitch; 8 mm x 8 mm x 1.6 mm body	SOT1235
BUK7S1R2-40H/A002	LFPAK88	plastic, single-ended surface-mounted package (LFPAK88); 4 leads; 2 mm pitch; 8 mm x 8 mm x 1.6 mm body	SOT1235

7. Marking

Table 4. Marking codes

Type number	Marking code
BUK7S1R2-40H	7S1R240H
BUK7S1R2-40H/A002	7S1R240H

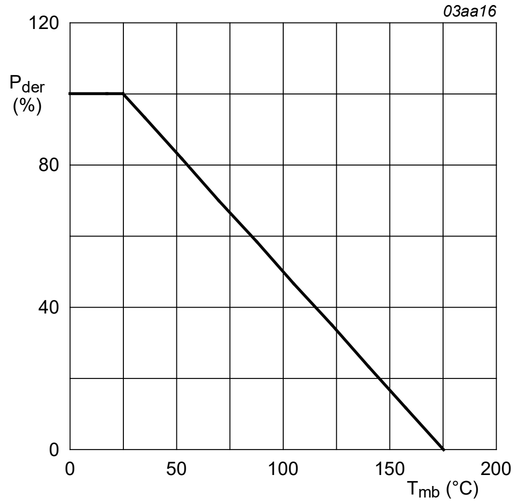
8. Limiting values

Table 5. Limiting values

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

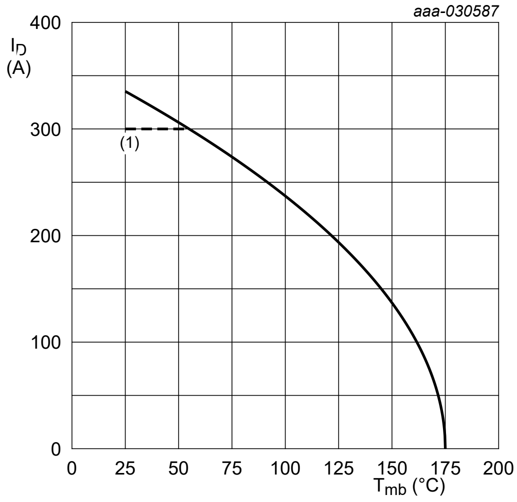
Symbol	Parameter	Conditions		Min	Max	Unit
V_{DS}	drain-source voltage	25 °C ≤ T_j ≤ 175 °C		-	40	V
V_{GS}	gate-source voltage	DC; T_j ≤ 175 °C		-10	20	V
P_{tot}	total power dissipation	T_{mb} = 25 °C; Fig. 1		-	294	W
I_D	drain current	V_{GS} = 10 V; T_{mb} = 25 °C; Fig. 2	[1]	-	300	A
I_{DM}	peak drain current	pulsed; t_p ≤ 10 µs; T_{mb} = 25 °C; Fig. 3		-	1341	A
T_{stg}	storage temperature			-55	175	°C
T_j	junction temperature			-55	175	°C
Source-drain diode						
I_S	source current	T_{mb} = 25 °C	[2]	-	294	A
I_{SM}	peak source current	pulsed; t_p ≤ 10 µs; T_{mb} = 25 °C		-	1341	A
Avalanche ruggedness						
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	I_D = 120 A; V_{sup} ≤ 40 V; R_{GS} = 50 Ω; V_{GS} = 10 V; $T_{j(init)}$ = 25 °C; unclamped; Fig. 4	[3] [4]	-	277	mJ
I_{AS}	non-repetitive avalanche current	V_{sup} ≤ 40 V; V_{GS} = 10 V; $T_{j(init)}$ = 25 °C; R_{GS} = 50 Ω; Fig. 4	[5]	-	199	A

[1] 300A continuous current has been successfully demonstrated during application. Practically the current will be limited by PCB, thermal design and operating emperature.
[2] 294A continuous current has been successfully demonstrated during application. Practically the current will be limited by PCB, thermal design and operating temperature.
[3] Single-pulse avalanche rating limited by maximum junction temperature of 175 °C.
[4] Refer to application note AN10273 for further information.
[5] Protected by 100% test.



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

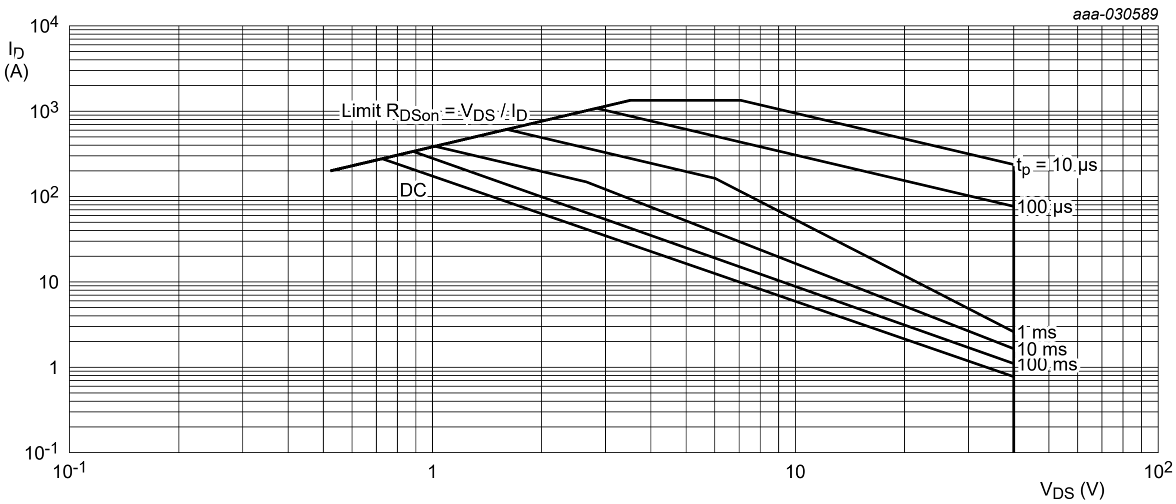
Fig. 1. Normalized total power dissipation as a function of mounting base temperature



$V_{GS} \geq 10$ V

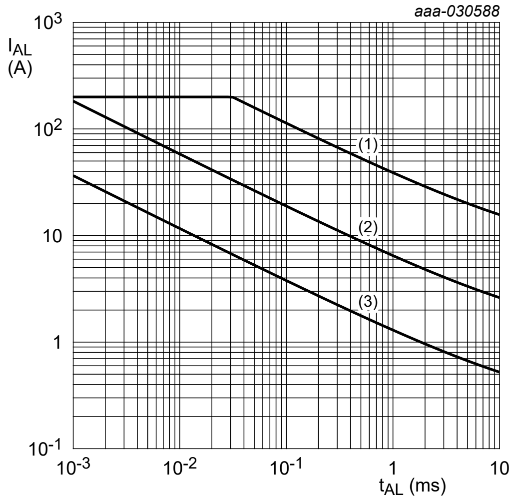
(1) 300A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature.

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



T_{mb} = 25 °C; I_{DM} is a single pulse

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



(1) $T_{j\,(init)}$ = 25 °C; (2) $T_{j\,(init)}$ = 150 °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		-	0.45	0.51	K/W

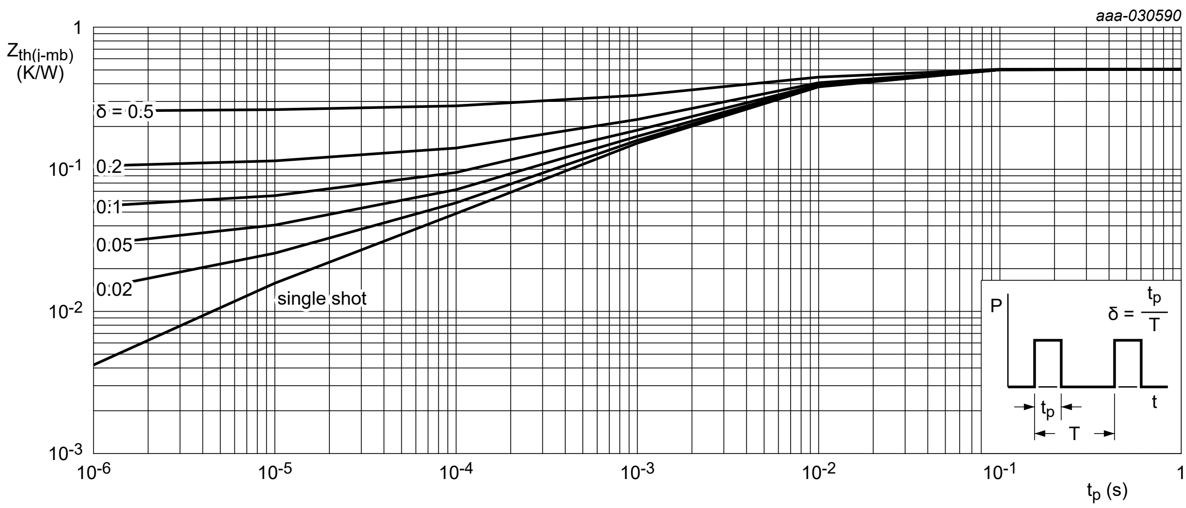


Fig. 5. Transient thermal impedance from junction to mounting base as a function of pulse duration

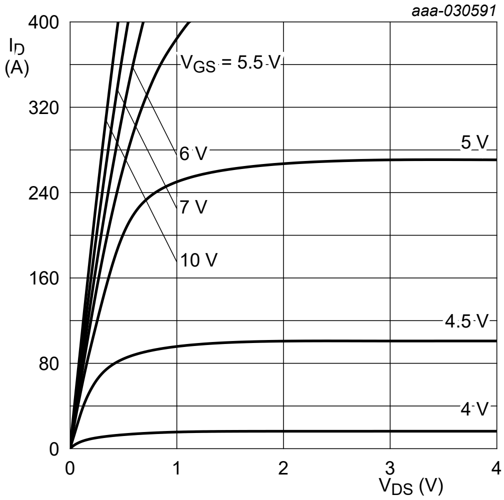
10. Characteristics

Table 7. Characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Static characteristics							
$V_{(BR)DSS}$	drain-source breakdown voltage	I_D = 250 µA; V_{GS} = 0 V; T_j = 25 °C		40	43	-	V
		I_D = 250 µA; V_{GS} = 0 V; T_j = -40 °C		-	40.5	-	V
		I_D = 250 µA; V_{GS} = 0 V; T_j = -55 °C		36	40	-	V
$V_{GS(th)}$	gate-source threshold voltage	I_D = 1 mA; V_{DS}=V_{GS}; T_j = 25 °C; Fig. 9; Fig. 10		2.4	3	3.6	V
		I_D = 1 mA; V_{DS}=V_{GS}; T_j = -55 °C; Fig. 10		-	-	4.3	V
		I_D = 1 mA; V_{DS}=V_{GS}; T_j = 175 °C; Fig. 10		1	-	-	V
I_{DSS}	drain leakage current	V_{DS} = 40 V; V_{GS} = 0 V; T_j = 25 °C		-	0.06	1.2	µA
		V_{DS} = 16 V; V_{GS} = 0 V; T_j = 125 °C		-	1.6	25	µA
		V_{DS} = 40 V; V_{GS} = 0 V; T_j = 175 °C		-	180	500	µA
I_{GSS}	gate leakage current	V_{GS} = 20 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} = 10 V; I_D = 25 A; T_j = 25 °C; Fig. 11		0.74	1.06	1.2	mΩ
		V_{GS} = 10 V; I_D = 25 A; T_j = 105 °C; Fig. 12		1.05	1.59	1.9	mΩ
		V_{GS} = 10 V; I_D = 25 A; T_j = 125 °C; Fig. 12		1.16	1.76	2.1	mΩ
		V_{GS} = 10 V; I_D = 25 A; T_j = 175 °C; Fig. 12		1.46	2.21	2.6	mΩ
R_G	gate resistance	f = 1 MHz; T_j = 25 °C		0.4	1.05	2.6	Ω
Dynamic characteristics							
$Q_{G(tot)}$	total gate charge	I_D = 25 A; V_{DS} = 32 V; V_{GS} = 10 V; Fig. 13; Fig. 14		-	80	112	nC
Q_{GS}	gate-source charge			-	22	33	nC
Q_{GD}	gate-drain charge			-	14	28	nC
C_{iss}	input capacitance	V_{DS} = 25 V; V_{GS} = 0 V; f = 1 MHz; T_j = 25 °C; Fig. 15		-	6014	8420	pF
C_{oss}	output capacitance			-	1352	1893	pF
C_{rss}	reverse transfer capacitance			-	244	537	pF
$t_{d(on)}$	turn-on delay time	V_{DS} = 30 V; R_L = 1.2 Ω; V_{GS} = 10 V; $R_{G(ext)}$ = 5 Ω		-	19	-	ns
t_r	rise time			-	16	-	ns
$t_{d(off)}$	turn-off delay time			-	50	-	ns
t_f	fall time			-	22	-	ns
Source-drain diode							
V_{SD}	source-drain voltage	I_S = 25 A; V_{GS} = 0 V; T_j = 25 °C; Fig. 16		-	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} = 20 V		-	39	-	ns
Q_r	recovered charge		[1]	-	38	-	nC

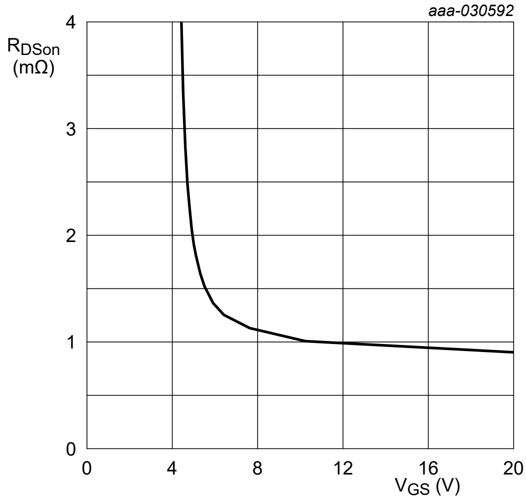
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
S	softness factor	I_S = 25 A; dI_S/dt = -100 A/µs; V_{GS} = 0 V; V_{DS} = 20 V; T_j = 25 °C		-	0.82	-	
		I_S = 25 A; dI_S/dt = -500 A/µs; V_{GS} = 0 V; V_{DS} = 20 V; T_j = 25 °C		-	0.73	-	

[1] includes capacitive recovery



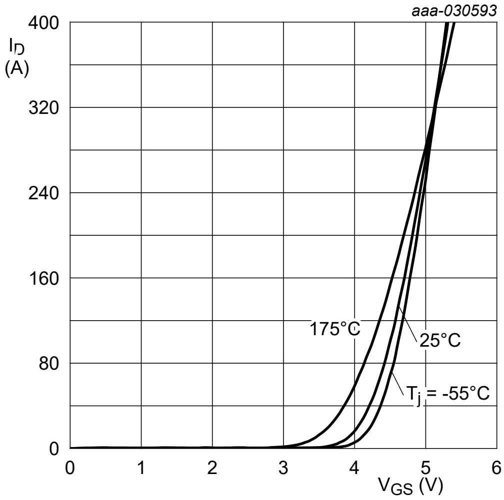
T_j = 25 °C

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



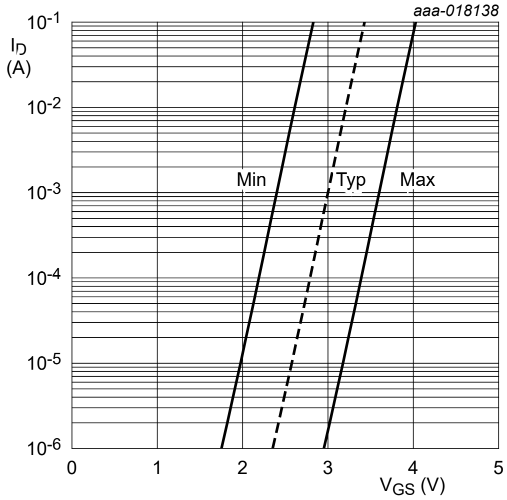
T_j = 25 °C; I_D = 25 A

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



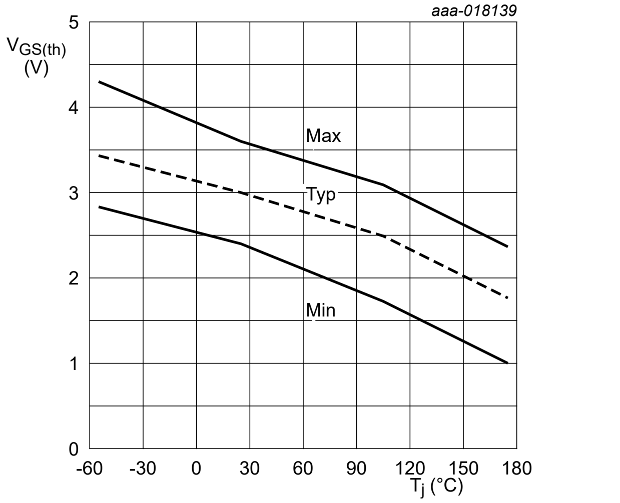
V_{DS} = 8 V

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



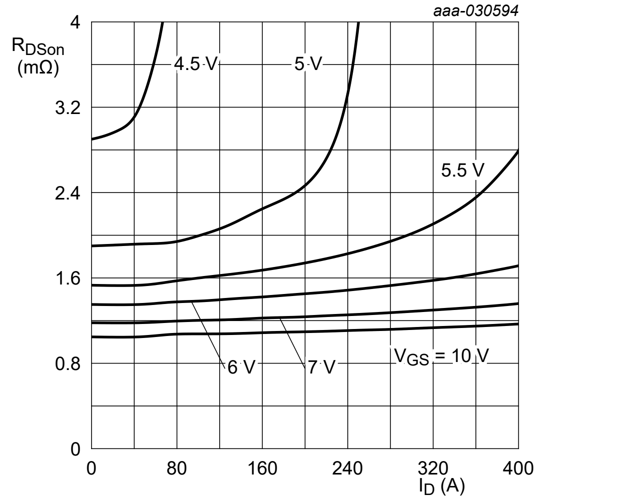
T_j = 25 °C; V_{DS} = 5 V

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



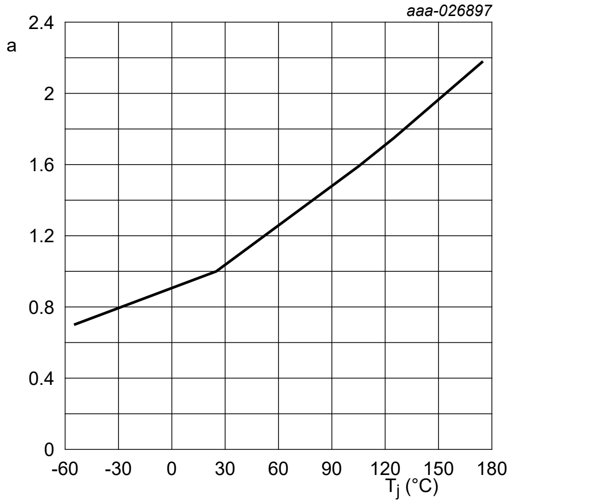
I_D = 1 mA ; V_{DS} = V_{GS}

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



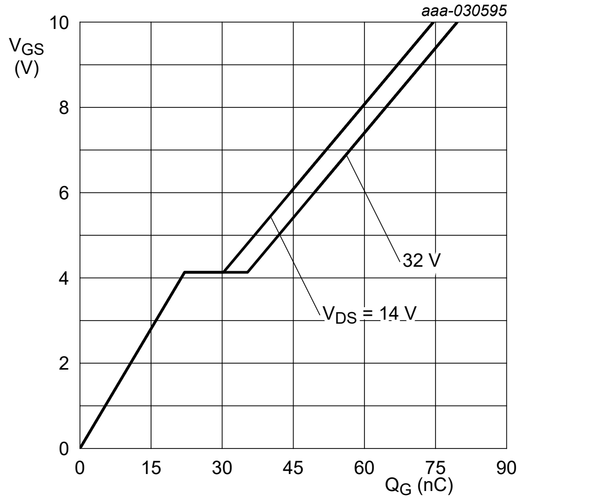
T_j = 25 °C

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



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

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



T_j = 25 °C; I_D = 25 A

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

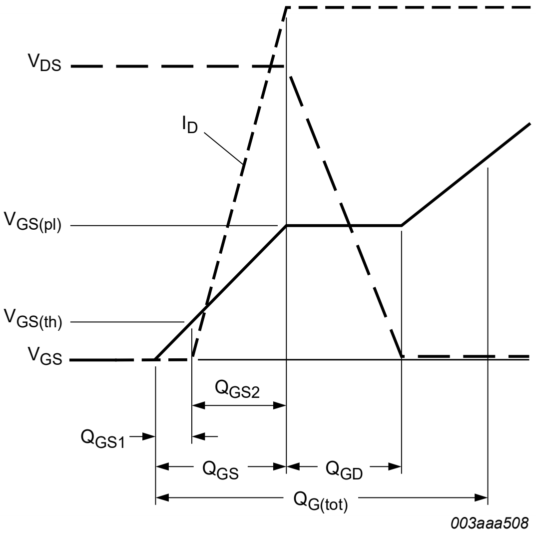
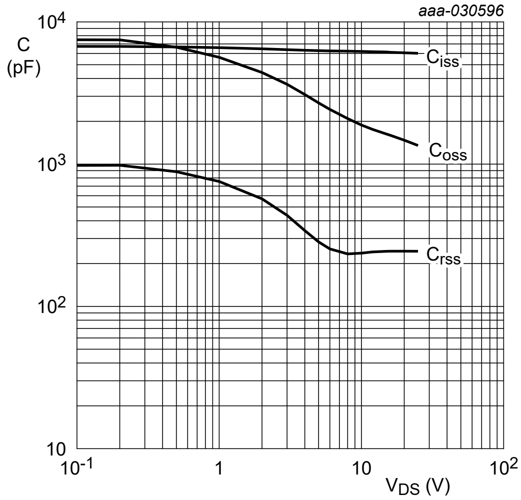
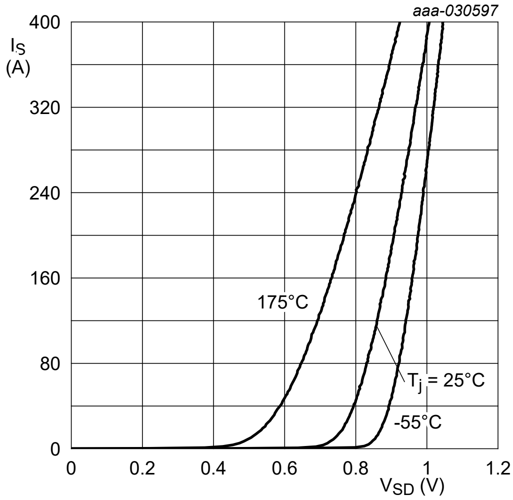


Fig. 14. Gate charge waveform definitions



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

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

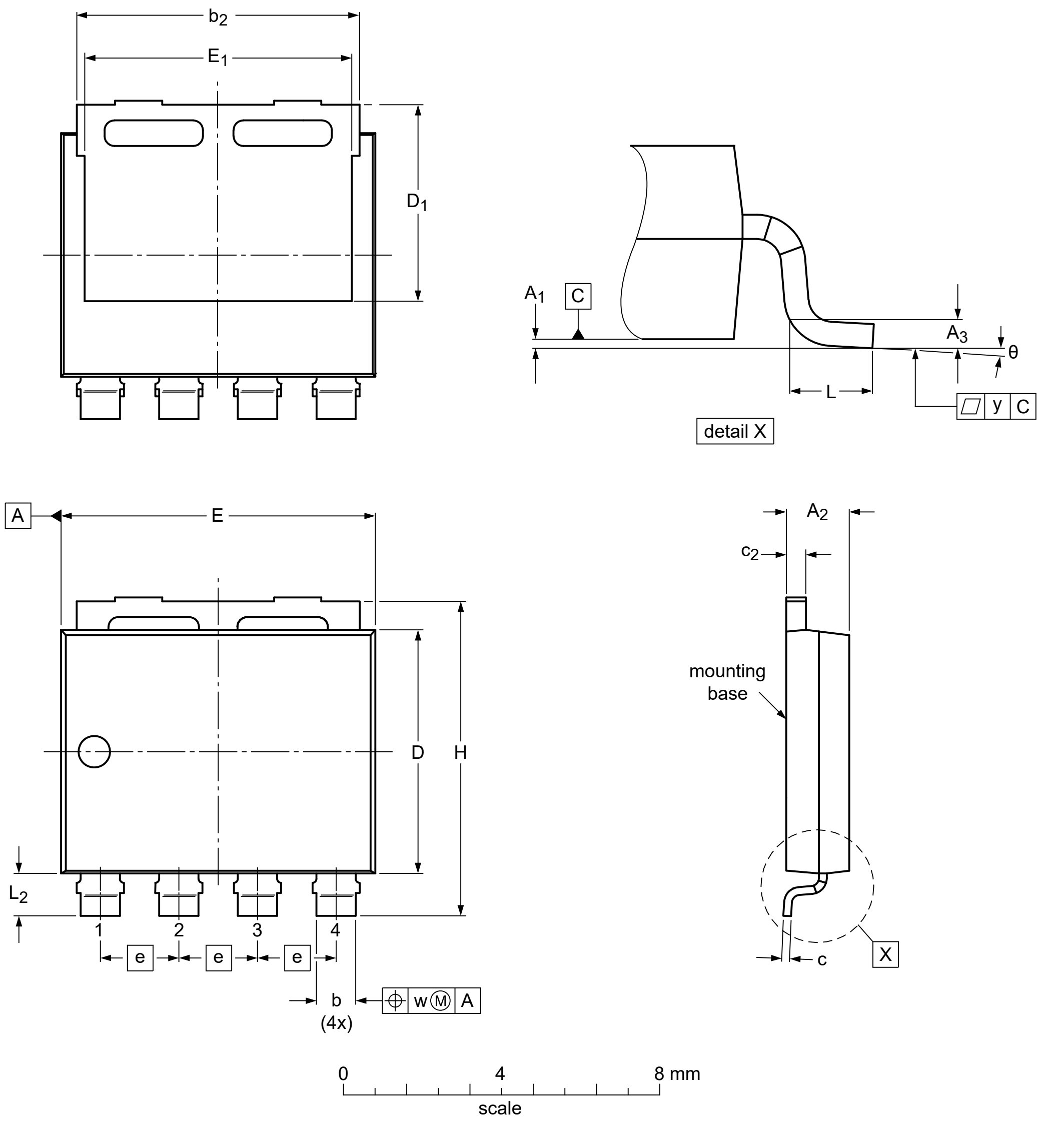


V_{GS} = 0 V

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

11. Package outline

Plastic single-ended surface-mounted package (LFPAK88); 4 leads **SOT1235**



Dimensions (mm are the original dimensions)

Unit		A_1	A_2	A_3	b	b_2	c	c_2	D(1)	D_1(1)	E(1)	E_1(1)	e	H(1)	L	L_2	w	y	θ
mm	max	0.15	1.7		1.1	7.3	0.24	0.55	6.3	5.1	8.1	6.9		8.1	0.8	1.3			8°
	nom			0.25									2.0				0.25	0.10	
	min	0.00	1.5		0.9	7.1	0.18	0.45	6.1	4.9	7.9	6.7		7.8	0.6	0.9			0°

Note
1. Plastic or metal protrusions of 0.2 mm maximum per side are not included.

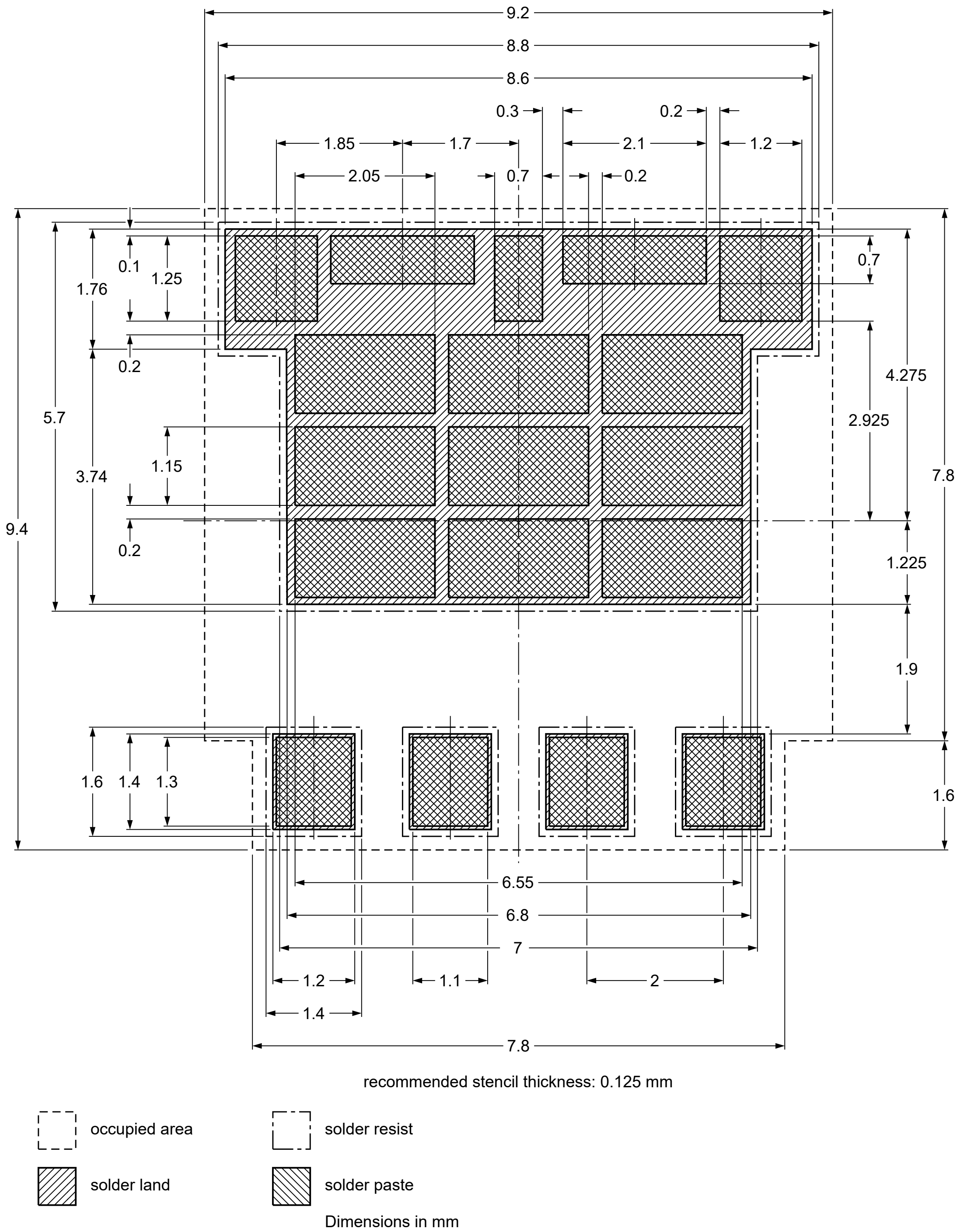
sot1235_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT1235						~~17-08-02~~ 17-08-07

Fig. 17. Package outline LFPAK88 (SOT1235)

12. Soldering

Footprint information for reflow soldering of LFPAK88 package **SOT1235**



Issue date ~~18-12-12~~ 18-12-13

sot1235_fr

Fig. 18. Reflow soldering footprint for LFPAK88 (SOT1235)

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".
[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the internet at https://www.nexperia.com.

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Contents

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Date of release: 28 September 2022