



# BUK9Y1R6-40H

N-channel 40 V, 1.6 mΩ logic level MOSFET in LFPAK56

31 May 2018

Product data sheet

## 1. General description

Automotive qualified N-channel MOSFET using the latest Trench 9 low ohmic superjunction technology, housed in a robust LFPAK56 package. This product has been fully designed and qualified to meet AEC-Q101 requirements delivering high performance and endurance.

## 2. Features and benefits

- Fully automotive qualified to AEC-Q101:
  - 175 °C rating suitable for thermally demanding environments
- Trench 9 Superjunction technology:
  - Reduced cell pitch enables enhanced power density and efficiency with lower  $R_{DSon}$  in same footprint
  - Improved SOA and avalanche capability compared to standard TrenchMOS
  - Tight  $V_{GS(th)}$  limits enable easy paralleling of MOSFETs
- LFPAK Gull Wing leads:
  - High Board Level Reliability absorbing mechanical stress during thermal cycling, unlike traditional QFN packages
  - Visual (AOI) soldering inspection, no need for expensive x-ray equipment
  - Easy solder wetting for good mechanical solder joint
- LFPAK copper clip technology:
  - Improved reliability, with reduced  $R_{th}$  and  $R_{DSon}$
  - Increases maximum current capability and improved current spreading

## 3. Applications

- 12 V automotive systems
- Motors, lamps and solenoid control
- Start-Stop micro-hybrid applications
- Transmission control
- Ultra high performance power switching

## 4. Quick reference data

Table 1. Quick reference data

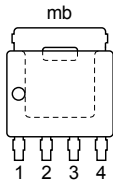
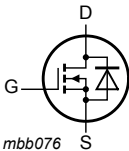
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$V_{DS}$	drain-source voltage	$25\text{ °C} \leq T_j \leq 175\text{ °C}$		-	-	40	V
$I_D$	drain current	$V_{GS} = 10\text{ V}; T_{mb} = 25\text{ °C}$	[1]	-	-	120	A
$P_{tot}$	total power dissipation	$T_{mb} = 25\text{ °C}; \text{Fig. 1}$		-	-	294	W

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics</b>						
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 10\text{ V}$ ; $I_D = 25\text{ A}$ ; $T_j = 25\text{ °C}$ ; <a href="#">Fig. 10</a>	0.86	1.23	1.6	mΩ
<b>Dynamic characteristics</b>						
$Q_{GD}$	gate-drain charge	$I_D = 25\text{ A}$ ; $V_{DS} = 20\text{ V}$ ; $V_{GS} = 4.5\text{ V}$ ; <a href="#">Fig. 12</a> ; <a href="#">Fig. 13</a>	-	8.3	16.6	nC
<b>Source-drain diode</b>						
$Q_r$	recovered charge	$I_S = 25\text{ A}$ ; $di_S/dt = -100\text{ A}/\mu\text{s}$ ; $V_{GS} = 0\text{ V}$ ;	-	30.6	-	nC
S	softness factor	$V_{DS} = 20\text{ V}$ ; $T_j = 25\text{ °C}$ ; <a href="#">Fig. 16</a>	-	0.84	-	

[1] 120A 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	 <p><b>LFAK56; Power-SO8 (SOT669)</b></p>	 <p><i>mbb076</i></p>
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
BUK9Y1R6-40H	LFAK56; Power-SO8	plastic, single-ended surface-mounted package; 4 terminals	SOT669

## 7. Marking

Table 4. Marking codes

Type number	Marking code
BUK9Y1R6-40H	91H640

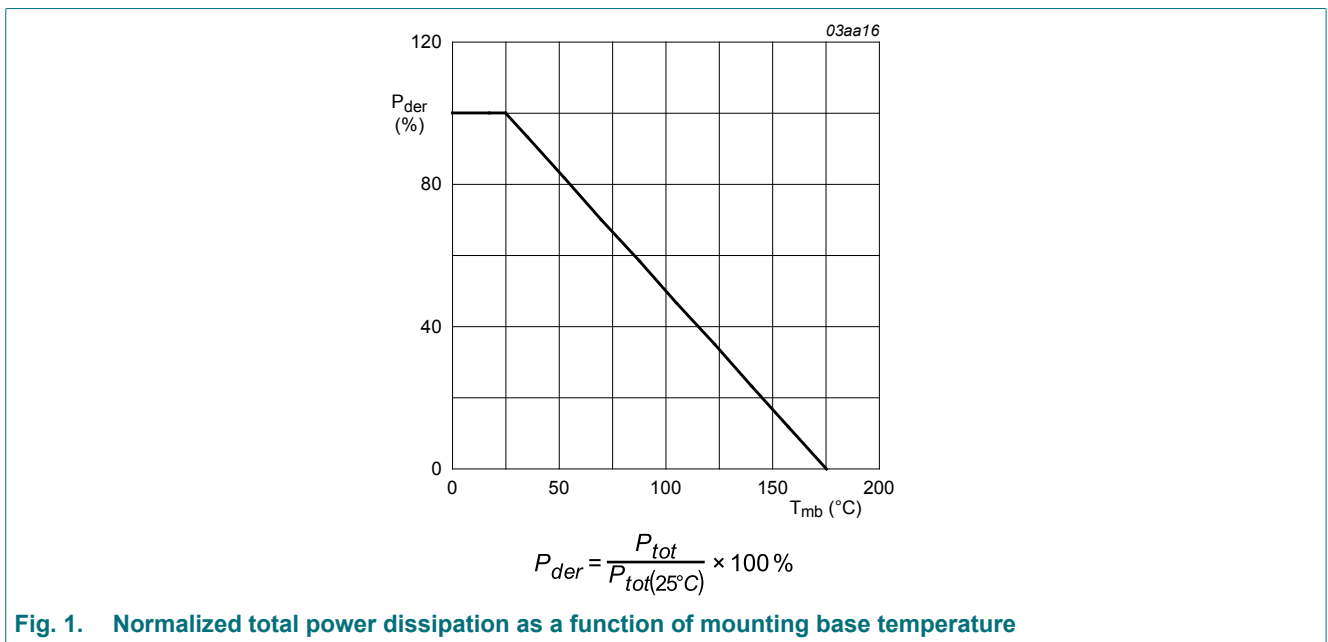
## 8. Limiting values

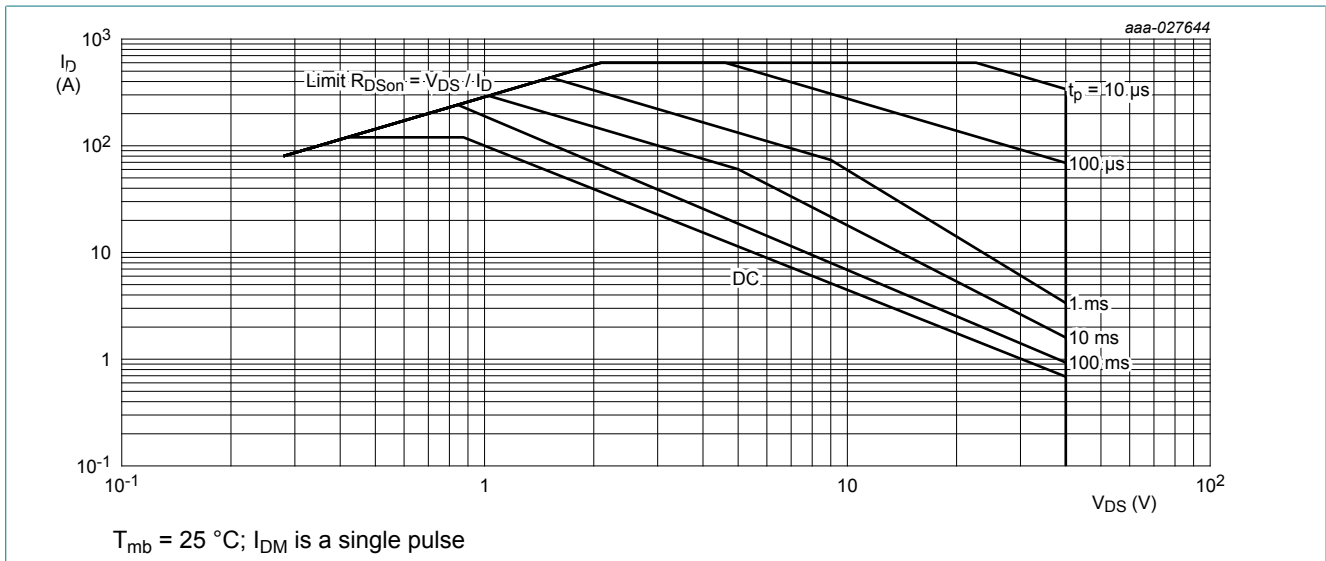
Table 5. Limiting values

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

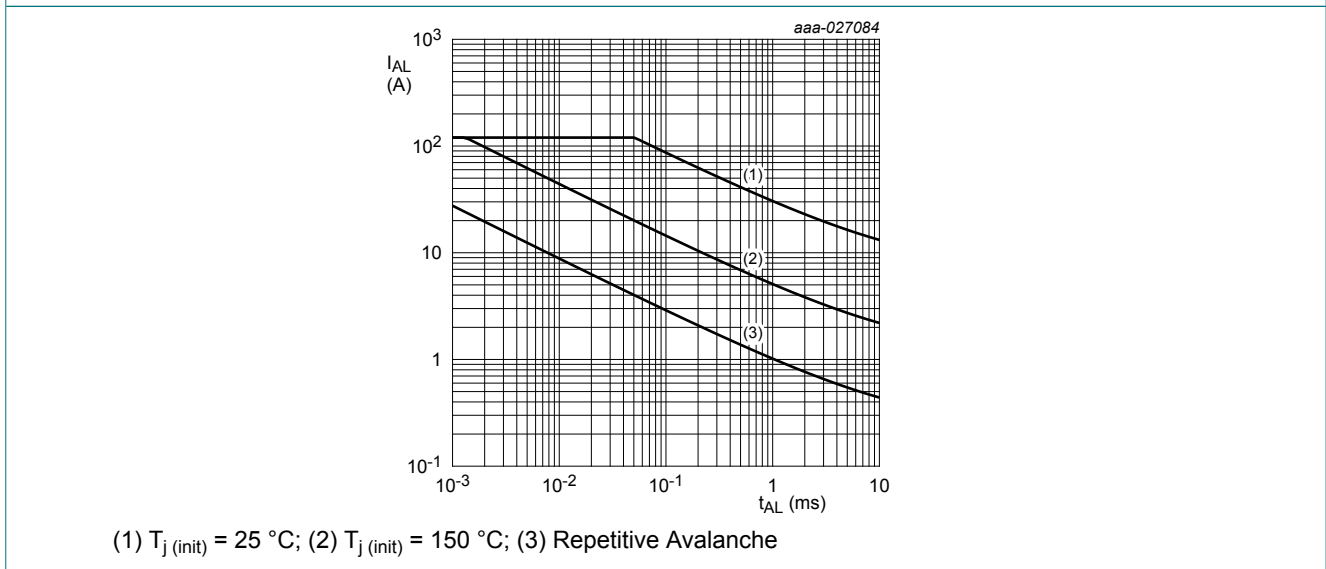
Symbol	Parameter	Conditions		Min	Max	Unit
V <sub>DS</sub>	drain-source voltage	25 °C ≤ T <sub>j</sub> ≤ 175 °C		-	40	V
V <sub>GS</sub>	gate-source voltage	DC; T <sub>j</sub> ≤ 175 °C		-10	16	V
P <sub>tot</sub>	total power dissipation	T <sub>mb</sub> = 25 °C; <a href="#">Fig. 1</a>		-	294	W
I <sub>D</sub>	drain current	V <sub>GS</sub> = 10 V; T <sub>mb</sub> = 25 °C	<a href="#">[1]</a>	-	120	A
I <sub>DM</sub>	peak drain current	pulsed; t <sub>p</sub> ≤ 10 μs; T <sub>mb</sub> = 25 °C; <a href="#">Fig. 2</a>		-	600	A
T <sub>stg</sub>	storage temperature			-55	175	°C
T <sub>j</sub>	junction temperature			-55	175	°C
<b>Source-drain diode</b>						
I <sub>S</sub>	source current	T <sub>mb</sub> = 25 °C	<a href="#">[1]</a>	-	120	A
I <sub>SM</sub>	peak source current	pulsed; t <sub>p</sub> ≤ 10 μs; T <sub>mb</sub> = 25 °C		-	600	A
<b>Avalanche ruggedness</b>						
E <sub>DS(AL)S</sub>	non-repetitive drain-source avalanche energy	I <sub>D</sub> = 120 A; V <sub>sup</sub> ≤ 40 V; R <sub>GS</sub> = 50 Ω; V <sub>GS</sub> = 10 V; T <sub>j(init)</sub> = 25 °C; unclamped; <a href="#">Fig. 3</a>	<a href="#">[2]</a> <a href="#">[3]</a>	-	158	mJ

- [1] 120A 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





**Fig. 2. Safe operating area; continuous and peak drain currents as a function of drain-source voltage**

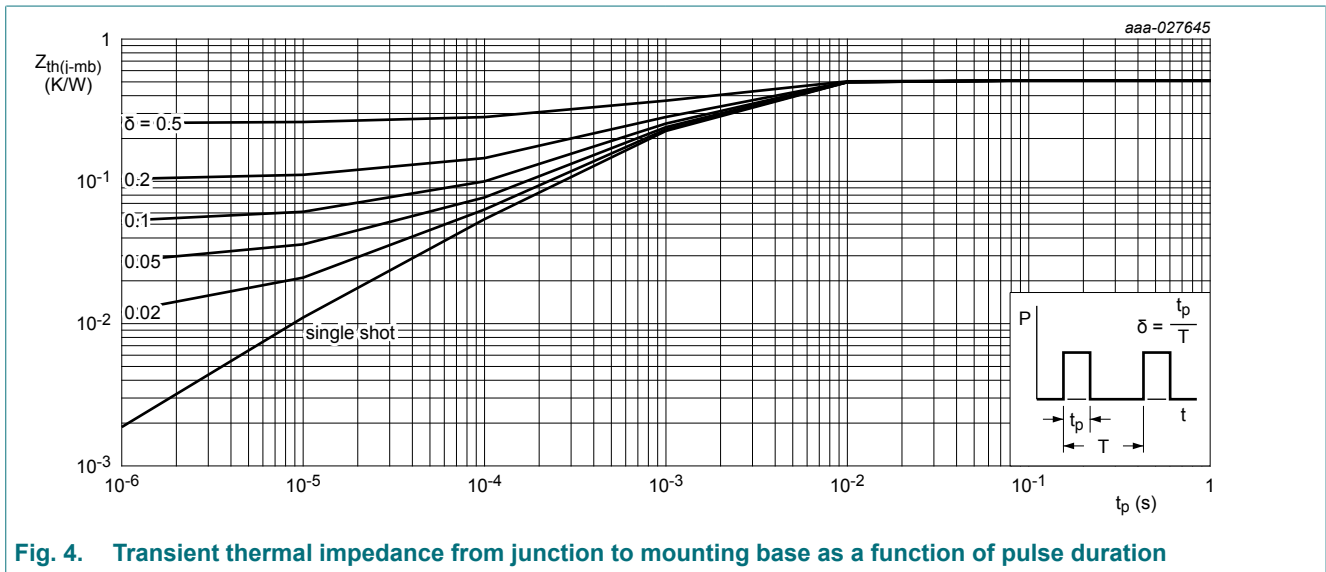


**Fig. 3. Avalanche rating; avalanche current as a function of avalanche time**

## 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	<a href="#">Fig. 4</a>	-	0.39	0.51	K/W



## 10. Characteristics

Table 7. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics</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. 8</a> ; <a href="#">Fig. 9</a>	1.35	1.62	2.05	V
		$I_D = 1 \text{ mA}; V_{DS}=V_{GS}; T_j = 175 \text{ }^\circ C$ ; <a href="#">Fig. 9</a>	0.6	-	-	V
		$I_D = 1 \text{ mA}; V_{DS}=V_{GS}; T_j = -55 \text{ }^\circ C$ ; <a href="#">Fig. 9</a>	-	-	2.5	V
$I_{DSS}$	drain leakage current	$V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ C$	-	0.11	5	$\mu A$
		$V_{DS} = 16 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 125 \text{ }^\circ C$	-	1.8	10	$\mu A$
		$V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 175 \text{ }^\circ C$	-	220	500	$\mu A$
$I_{GSS}$	gate leakage current	$V_{GS} = 16 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ C$	-	2	100	nA
		$V_{GS} = -10 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ C$	-	2	100	nA

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
R <sub>DSon</sub>	drain-source on-state resistance	V <sub>GS</sub> = 10 V; I <sub>D</sub> = 25 A; T <sub>j</sub> = 25 °C; <a href="#">Fig. 10</a>	0.86	1.23	1.6	mΩ
		V <sub>GS</sub> = 10 V; I <sub>D</sub> = 25 A; T <sub>j</sub> = 105 °C; <a href="#">Fig. 11</a>	1.3	1.89	2.5	mΩ
		V <sub>GS</sub> = 10 V; I <sub>D</sub> = 25 A; T <sub>j</sub> = 125 °C; <a href="#">Fig. 11</a>	1.4	2.08	2.8	mΩ
		V <sub>GS</sub> = 10 V; I <sub>D</sub> = 25 A; T <sub>j</sub> = 175 °C; <a href="#">Fig. 11</a>	1.8	2.62	3.5	mΩ
		V <sub>GS</sub> = 4.5 V; I <sub>D</sub> = 25 A; T <sub>j</sub> = 25 °C; <a href="#">Fig. 10</a>	1.1	1.55	2.2	mΩ
		V <sub>GS</sub> = 4.5 V; I <sub>D</sub> = 25 A; T <sub>j</sub> = 105 °C; <a href="#">Fig. 11</a>	1.6	2.34	3.5	mΩ
		V <sub>GS</sub> = 4.5 V; I <sub>D</sub> = 25 A; T <sub>j</sub> = 125 °C; <a href="#">Fig. 11</a>	1.8	2.57	3.8	mΩ
		V <sub>GS</sub> = 4.5 V; I <sub>D</sub> = 25 A; T <sub>j</sub> = 175 °C; <a href="#">Fig. 11</a>	2.3	3.21	4.8	mΩ
R <sub>G</sub>	gate resistance	f = 1 MHz; T <sub>j</sub> = 25 °C	0.36	0.9	2.25	Ω
<b>Dynamic characteristics</b>						
Q <sub>G(tot)</sub>	total gate charge	I <sub>D</sub> = 25 A; V <sub>DS</sub> = 20 V; V <sub>GS</sub> = 10 V; <a href="#">Fig. 12</a> ; <a href="#">Fig. 13</a>	-	77	107.8	nC
		I <sub>D</sub> = 25 A; V <sub>DS</sub> = 20 V; V <sub>GS</sub> = 4.5 V; <a href="#">Fig. 12</a> ; <a href="#">Fig. 13</a>	-	34.9	48.9	nC
Q <sub>GS</sub>	gate-source charge		-	12.4	18.6	nC
Q <sub>GD</sub>	gate-drain charge		-	8.3	16.6	nC
C <sub>iss</sub>	input capacitance	V <sub>DS</sub> = 25 V; V <sub>GS</sub> = 0 V; f = 1 MHz; T <sub>j</sub> = 25 °C; <a href="#">Fig. 14</a>	-	5402	7563	pF
C <sub>oss</sub>	output capacitance		-	1022	1431	pF
C <sub>rss</sub>	reverse transfer capacitance		-	208	458	pF
t <sub>d(on)</sub>	turn-on delay time	V <sub>DS</sub> = 20 V; R <sub>L</sub> = 0.8 Ω; V <sub>GS</sub> = 4.5 V; R <sub>G(ext)</sub> = 5 Ω	-	27.6	-	ns
t <sub>r</sub>	rise time		-	30.3	-	ns
t <sub>d(off)</sub>	turn-off delay time		-	39.4	-	ns
t <sub>f</sub>	fall time		-	22.9	-	ns
<b>Source-drain diode</b>						
V <sub>SD</sub>	source-drain voltage	I <sub>S</sub> = 25 A; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C; <a href="#">Fig. 15</a>	-	0.8	1.2	V
t <sub>rr</sub>	reverse recovery time	I <sub>S</sub> = 25 A; dI <sub>S</sub> /dt = -100 A/μs; V <sub>GS</sub> = 0 V; V <sub>DS</sub> = 20 V; T <sub>j</sub> = 25 °C; <a href="#">Fig. 16</a>	-	34.7	-	ns
Q <sub>r</sub>	recovered charge		-	30.6	-	nC
S	softness factor		I <sub>S</sub> = 25 A; dI <sub>S</sub> /dt = -500 A/μs; V <sub>GS</sub> = 0 V; V <sub>DS</sub> = 20 V; T <sub>j</sub> = 25 °C; <a href="#">Fig. 16</a>	-	0.84	-
			-	0.66	-	

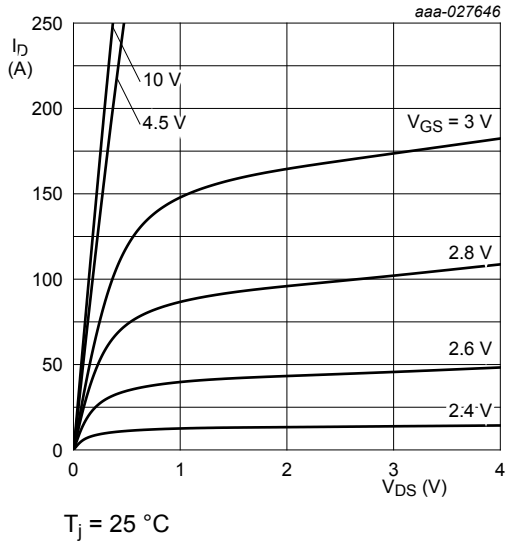


Fig. 5. Output characteristics; drain current as a function of drain-source voltage; typical values

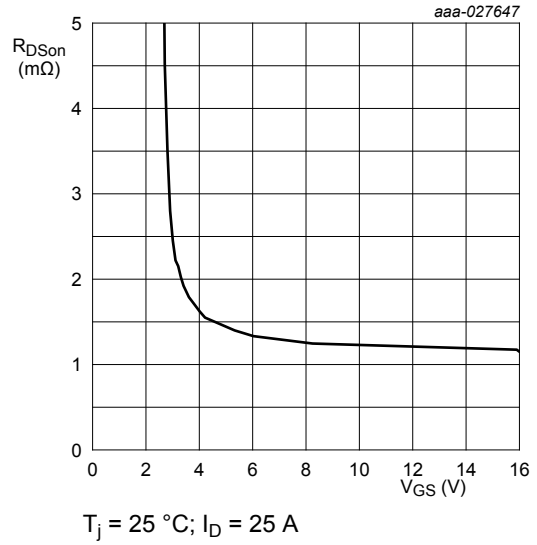


Fig. 6. Drain-source on-state resistance as a function of gate-source voltage; typical values

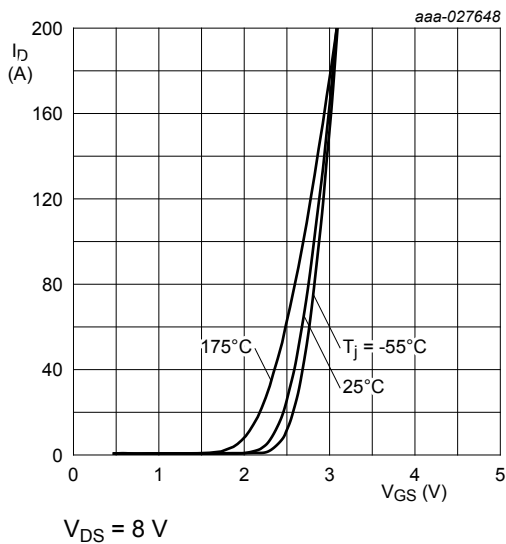


Fig. 7. Transfer characteristics; drain current as a function of gate-source voltage; typical values

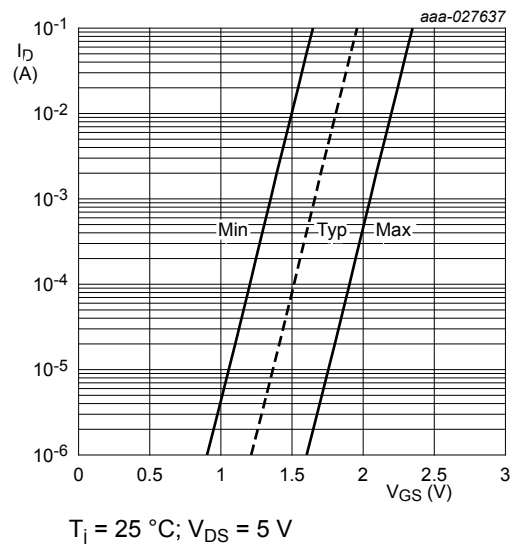
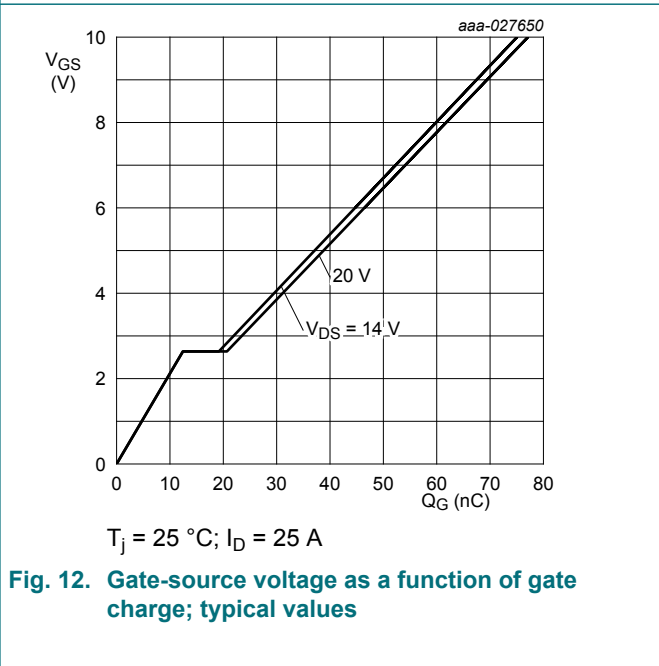
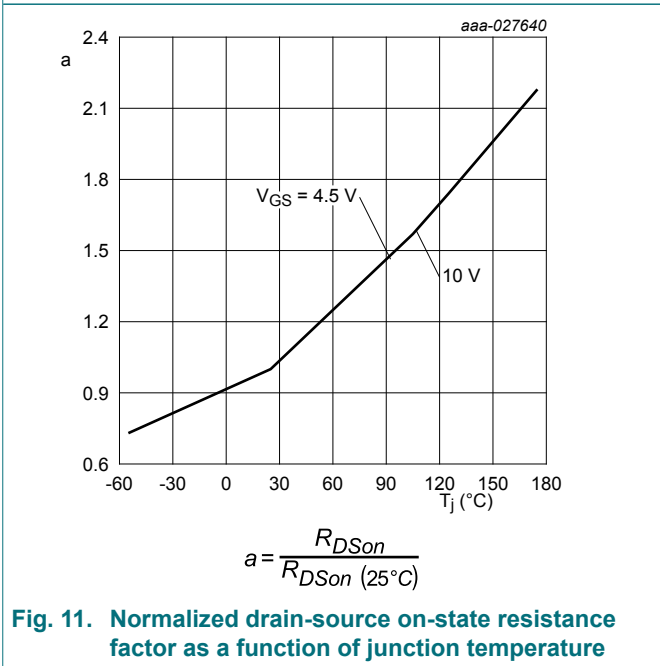
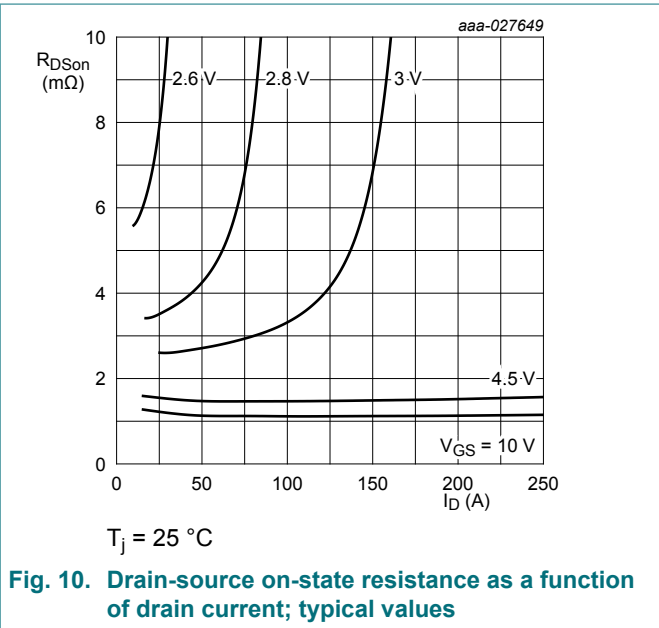
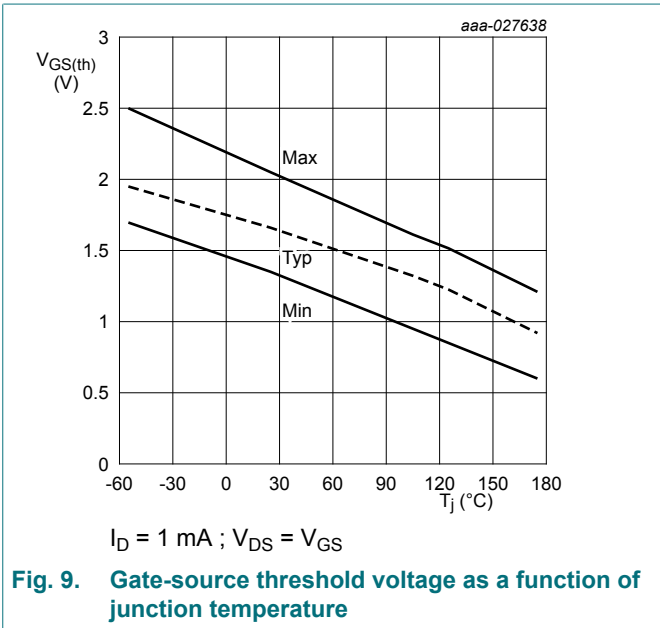
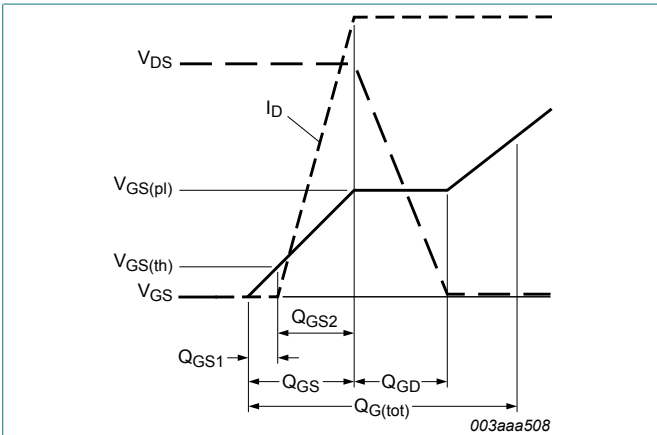


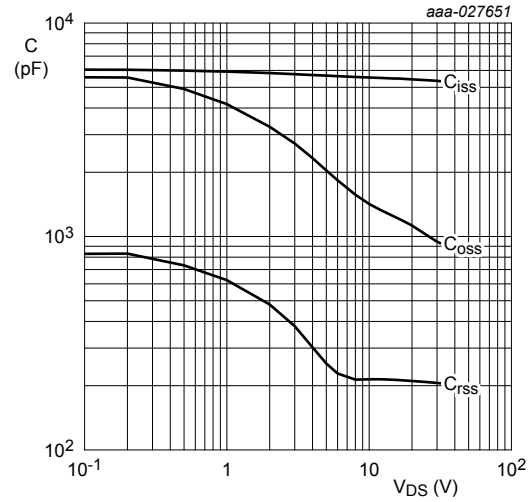
Fig. 8. Sub-threshold drain current as a function of gate-source voltage





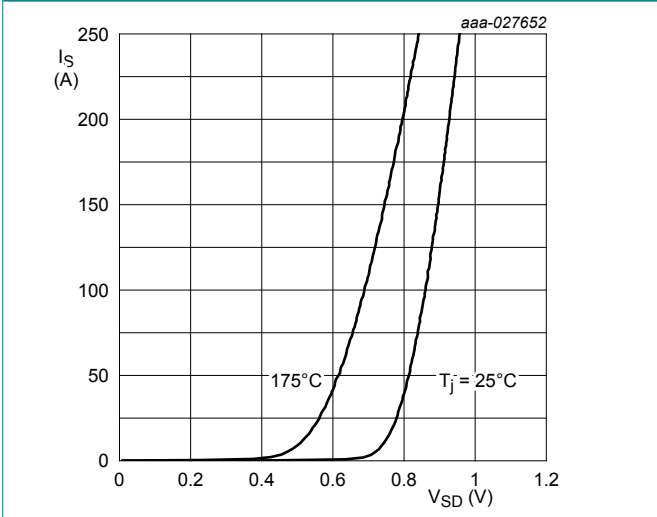


**Fig. 13. Gate charge waveform definitions**



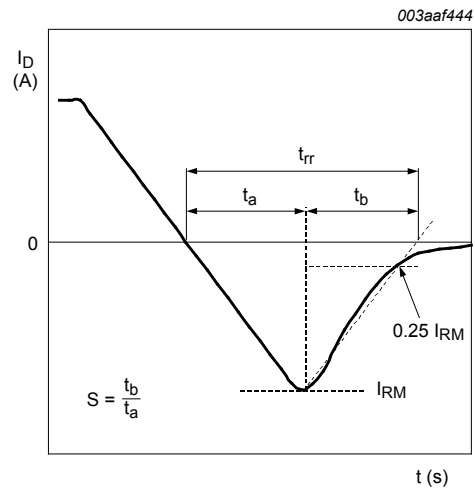
$V_{GS} = 0$  V;  $f = 1$  MHz

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



$V_{GS} = 0$  V

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



$$t_{rr} = t_a + t_b$$

**Fig. 16. Reverse recovery waveform definitions**

### 11. Package outline

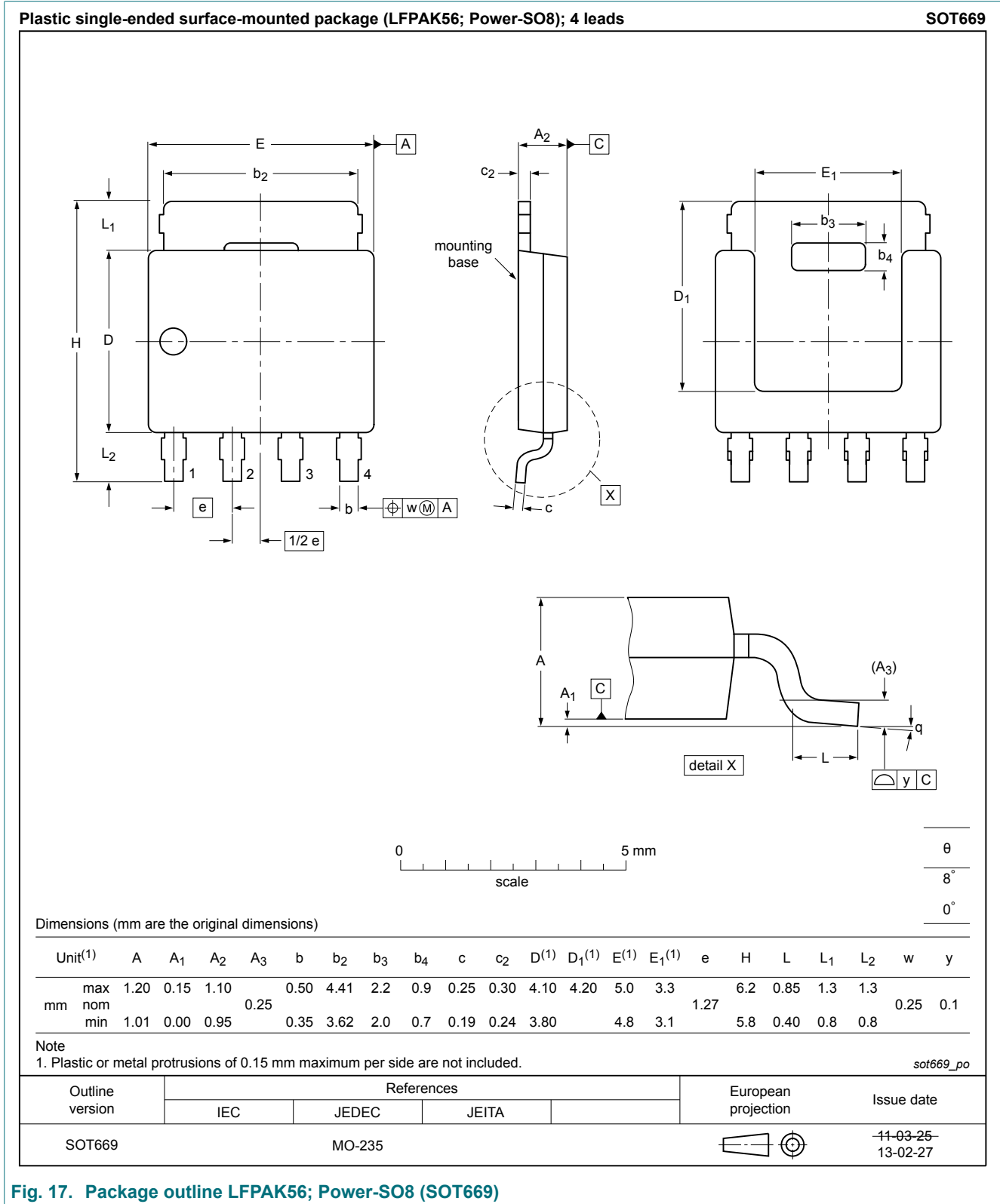


Fig. 17. Package outline LPAK56; Power-SO8 (SOT669)

## 12. 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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