



BUK9J0R9-40H

N-channel 40 V, 0.9 mΩ logic level MOSFET in LPAK56E

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 an enhanced LPAK56E 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
- LPAK 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
- LPAK 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

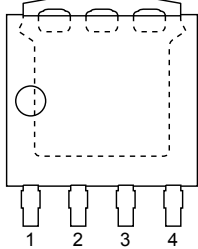
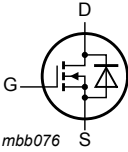
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{DS}	drain-source voltage	$25\text{ °C} \leq T_j \leq 175\text{ °C}$		-	-	40	V
I_D	drain current	$V_{GS} = 10\text{ V}$; $T_{mb} = 25\text{ °C}$; Fig. 2	[1]	-	-	220	A
P_{tot}	total power dissipation	$T_{mb} = 25\text{ °C}$; Fig. 1		-	-	500	W

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Static characteristics						
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 10\text{ V}$; $I_D = 25\text{ A}$; $T_J = 25\text{ }^\circ\text{C}$; Fig. 11	0.53	0.76	0.9	mΩ
Dynamic characteristics						
Q_{GD}	gate-drain charge	$I_D = 25\text{ A}$; $V_{DS} = 20\text{ V}$; $V_{GS} = 4.5\text{ V}$; Fig. 13 ; Fig. 14	-	12.7	25.3	nC
Source-drain diode						
Q_r	recovered charge	$I_S = 25\text{ A}$; $di_S/dt = -100\text{ A}/\mu\text{s}$; $V_{GS} = 0\text{ V}$; $V_{DS} = 20\text{ V}$; $T_J = 25\text{ }^\circ\text{C}$	-	52.6	-	nC
S	softness factor	$I_S = 25\text{ A}$; $di_S/dt = -100\text{ A}/\mu\text{s}$; $V_{GS} = 0\text{ V}$; $V_{DS} = 20\text{ V}$; $T_J = 25\text{ }^\circ\text{C}$; Fig. 17	-	0.77	-	

[1] 220A 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	 LPAK56E; Power-SO8 (SOT1023)	 mbb076
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
BUK9J0R9-40H	LPAK56E; Power-SO8	plastic, single-ended surface-mounted package (LPAK56); 4 leads; 1.27 mm pitch	SOT1023

7. Marking

Table 4. Marking codes

Type number	Marking code
BUK9J0R9-40H	90H940E

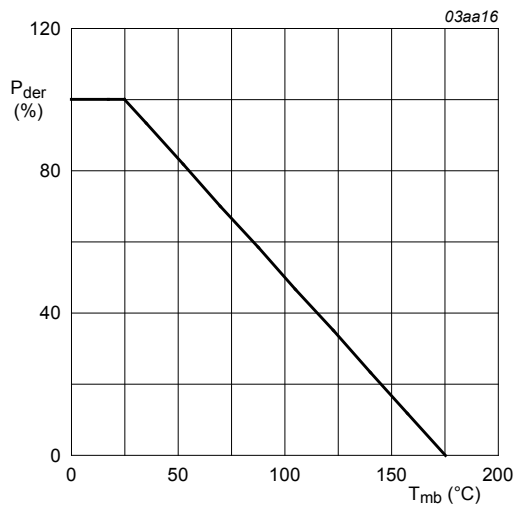
8. Limiting values

Table 5. Limiting values

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

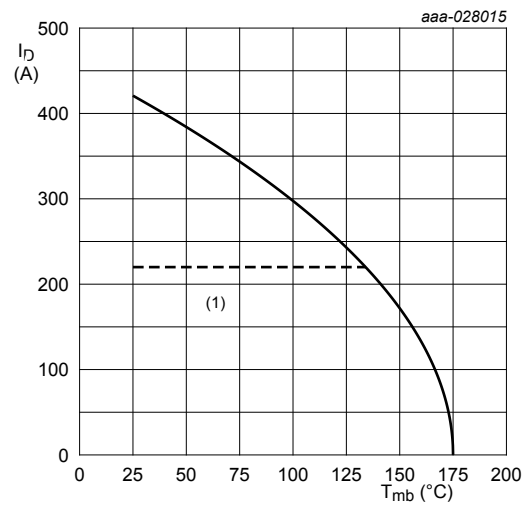
Symbol	Parameter	Conditions		Min	Max	Unit
V_{DS}	drain-source voltage	$25\text{ °C} \leq T_j \leq 175\text{ °C}$		-	40	V
V_{GS}	gate-source voltage	DC; $T_j \leq 175\text{ °C}$		-10	16	V
P_{tot}	total power dissipation	$T_{mb} = 25\text{ °C}$; Fig. 1		-	500	W
I_D	drain current	$V_{GS} = 10\text{ V}$; $T_{mb} = 25\text{ °C}$; Fig. 2	[1]	-	220	A
		$V_{GS} = 10\text{ V}$; $T_{mb} = 100\text{ °C}$; Fig. 2	[1]	-	220	A
I_{DM}	peak drain current	pulsed; $t_p \leq 10\text{ }\mu\text{s}$; $T_{mb} = 25\text{ °C}$; Fig. 3		-	600	A
T_{stg}	storage temperature			-55	175	°C
T_j	junction temperature			-55	175	°C
Source-drain diode						
I_S	source current	$T_{mb} = 25\text{ °C}$	[2]	-	165	A
I_{SM}	peak source current	pulsed; $t_p \leq 10\text{ }\mu\text{s}$; $T_{mb} = 25\text{ °C}$		-	600	A
Avalanche ruggedness						
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$I_D = 160\text{ A}$; $V_{sup} \leq 40\text{ V}$; $R_{GS} = 50\text{ }\Omega$; $V_{GS} = 10\text{ V}$; $T_{j(init)} = 25\text{ °C}$; unclamped; Fig. 4	[3] [4]	-	290	mJ

- [1] 220A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature.
- [2] 165A continuous current has been successfully demonstrated during application tests. 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.



$$P_{der} = \frac{P_{tot}}{P_{tot(25^\circ\text{C})}} \times 100\%$$

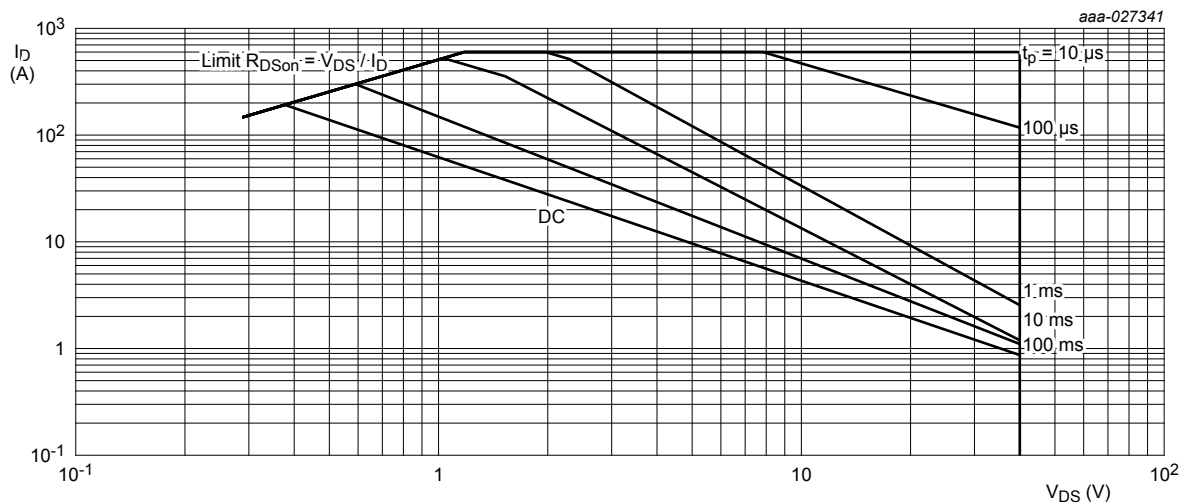
Fig. 1. Normalized total power dissipation as a function of mounting base temperature



$V_{GS} \geq 10\text{ V}$

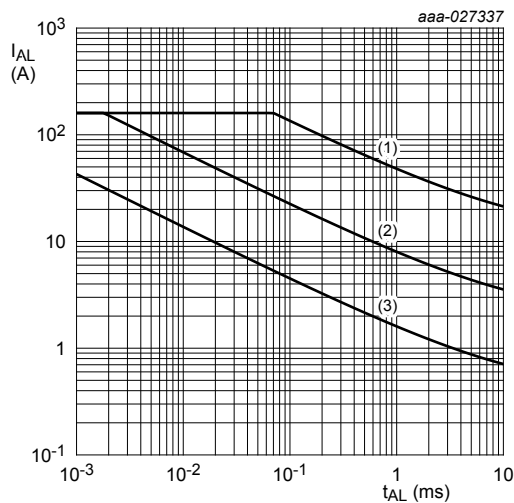
(1) 220A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature.

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



$T_{mb} = 25^\circ\text{C}$; I_{DM} is a single pulse

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



(1) $T_{j\text{ (init)}} = 25\text{ °C}$; (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	-	0.21	0.3	K/W

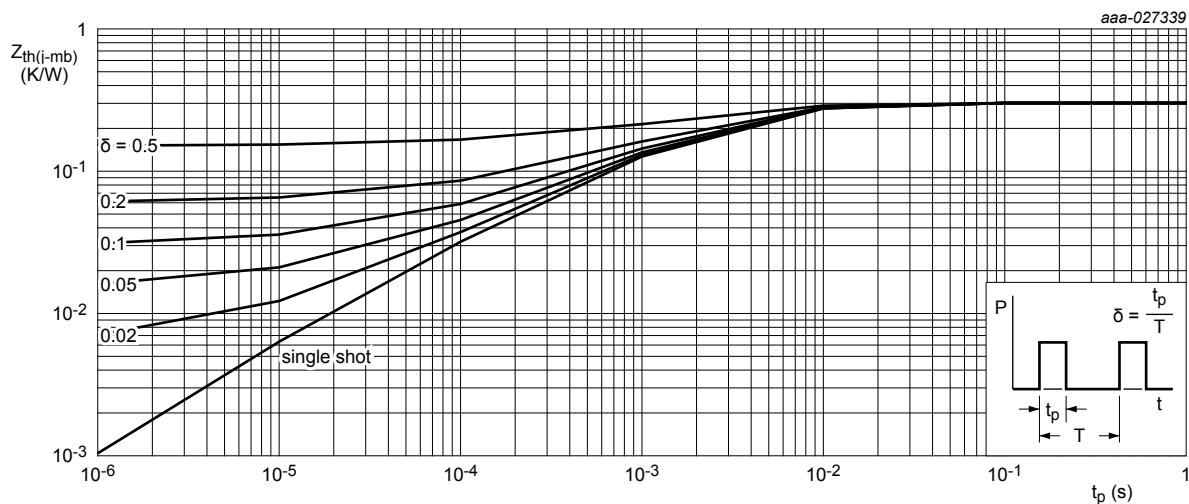


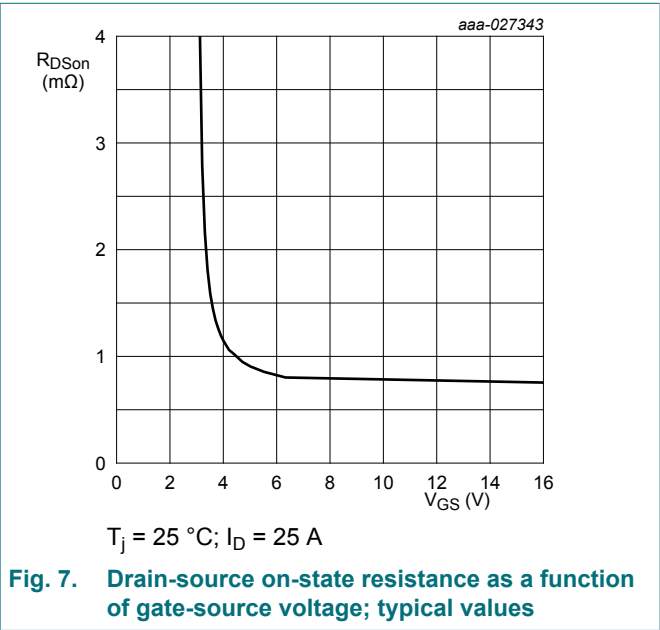
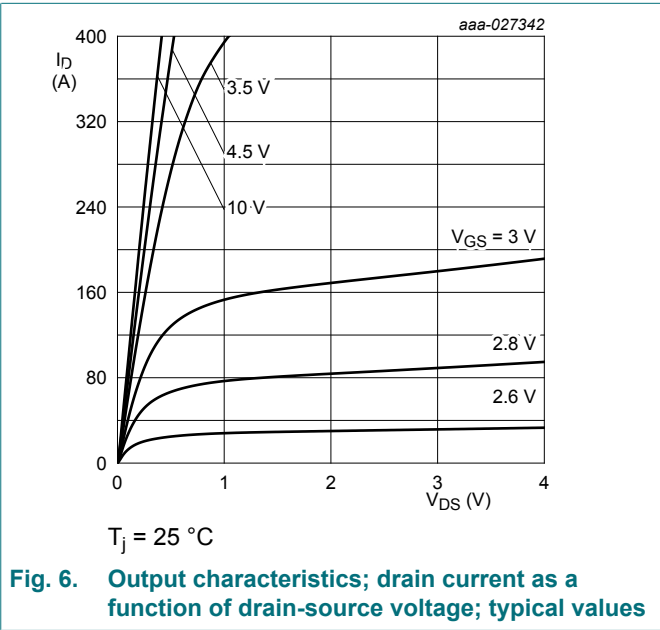
Fig. 5. Transient thermal impedance from junction to mounting base as a function of pulse duration

10. Characteristics

Table 7. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Static characteristics						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 250\ \mu\text{A}$; $V_{GS} = 0\ \text{V}$; $T_J = 25\ ^\circ\text{C}$	40	43	-	V
		$I_D = 250\ \mu\text{A}$; $V_{GS} = 0\ \text{V}$; $T_J = -40\ ^\circ\text{C}$	-	40.5	-	V
		$I_D = 250\ \mu\text{A}$; $V_{GS} = 0\ \text{V}$; $T_J = -55\ ^\circ\text{C}$	36	40	-	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 1\ \text{mA}$; $V_{DS}=V_{GS}$; $T_J = 25\ ^\circ\text{C}$; Fig. 9 ; Fig. 10	1.35	1.66	2.05	V
		$I_D = 1\ \text{mA}$; $V_{DS}=V_{GS}$; $T_J = 175\ ^\circ\text{C}$; Fig. 10	0.6	-	-	V
		$I_D = 1\ \text{mA}$; $V_{DS}=V_{GS}$; $T_J = -55\ ^\circ\text{C}$; Fig. 10	-	-	2.5	V
I_{DSS}	drain leakage current	$V_{DS} = 40\ \text{V}$; $V_{GS} = 0\ \text{V}$; $T_J = 25\ ^\circ\text{C}$	-	0.4	5	μA
		$V_{DS} = 16\ \text{V}$; $V_{GS} = 0\ \text{V}$; $T_J = 125\ ^\circ\text{C}$	-	3.2	25	μA
		$V_{DS} = 40\ \text{V}$; $V_{GS} = 0\ \text{V}$; $T_J = 175\ ^\circ\text{C}$	-	405	1000	μA
I_{GSS}	gate leakage current	$V_{GS} = 16\ \text{V}$; $V_{DS} = 0\ \text{V}$; $T_J = 25\ ^\circ\text{C}$	-	2	100	nA
		$V_{GS} = -10\ \text{V}$; $V_{DS} = 0\ \text{V}$; $T_J = 25\ ^\circ\text{C}$	-	2	100	nA
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 10\ \text{V}$; $I_D = 25\ \text{A}$; $T_J = 25\ ^\circ\text{C}$; Fig. 11	0.53	0.76	0.9	mΩ
		$V_{GS} = 10\ \text{V}$; $I_D = 25\ \text{A}$; $T_J = 105\ ^\circ\text{C}$; Fig. 12	0.79	1.17	1.41	mΩ
		$V_{GS} = 10\ \text{V}$; $I_D = 25\ \text{A}$; $T_J = 125\ ^\circ\text{C}$; Fig. 12	0.87	1.29	1.57	mΩ
		$V_{GS} = 10\ \text{V}$; $I_D = 25\ \text{A}$; $T_J = 175\ ^\circ\text{C}$; Fig. 12	1.1	1.63	1.96	mΩ
		$V_{GS} = 4.5\ \text{V}$; $I_D = 25\ \text{A}$; $T_J = 25\ ^\circ\text{C}$; Fig. 11	0.68	0.97	1.2	mΩ
		$V_{GS} = 4.5\ \text{V}$; $I_D = 25\ \text{A}$; $T_J = 105\ ^\circ\text{C}$; Fig. 12	1	1.47	1.9	mΩ
		$V_{GS} = 4.5\ \text{V}$; $I_D = 25\ \text{A}$; $T_J = 125\ ^\circ\text{C}$; Fig. 12	1.1	1.62	2.1	mΩ
		$V_{GS} = 4.5\ \text{V}$; $I_D = 25\ \text{A}$; $T_J = 175\ ^\circ\text{C}$; Fig. 12	1.4	2.03	2.6	mΩ
R_G	gate resistance	$f = 1\ \text{MHz}$; $T_J = 25\ ^\circ\text{C}$	0.42	1.04	2.6	mΩ
Dynamic characteristics						
$Q_{G(tot)}$	total gate charge	$I_D = 25\ \text{A}$; $V_{DS} = 20\ \text{V}$; $V_{GS} = 10\ \text{V}$; Fig. 13 ; Fig. 14	-	120	168	nC
		$I_D = 25\ \text{A}$; $V_{DS} = 20\ \text{V}$; $V_{GS} = 4.5\ \text{V}$; Fig. 13 ; Fig. 14	-	54.2	76	nC
Q_{GS}	gate-source charge		-	20.2	30.2	nC
Q_{GD}	gate-drain charge		-	12.7	25.3	nC

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
C _{iss}	input capacitance	V _{DS} = 25 V; V _{GS} = 0 V; f = 1 MHz; T _J = 25 °C; Fig. 15		-	8977	12568	pF
C _{oss}	output capacitance			-	1549	2168	pF
C _{rss}	reverse transfer capacitance			-	346	760	pF
t _{d(on)}	turn-on delay time	V _{DS} = 20 V; R _L = 0.8 Ω; V _{GS} = 4.5 V; R _{G(ext)} = 5 Ω		-	45.4	-	ns
t _r	rise time			-	46.2	-	ns
t _{d(off)}	turn-off delay time			-	59.2	-	ns
t _f	fall time			-	32.6	-	ns
Source-drain diode							
V _{SD}	source-drain voltage	I _S = 25 A; V _{GS} = 0 V; T _J = 25 °C; Fig. 16		-	0.76	1.2	V
t _{rr}	reverse recovery time	I _S = 25 A; dI _S /dt = -100 A/μs; V _{GS} = 0 V; V _{DS} = 20 V; T _J = 25 °C		-	44.6	-	ns
Q _r	recovered charge			-	52.6	-	nC
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; Fig. 17		-	0.77	-	
		I _S = 25 A; dI _S /dt = -500 A/μs; V _{GS} = 0 V; V _{DS} = 20 V; T _J = 25 °C; Fig. 17		-	0.67	-	



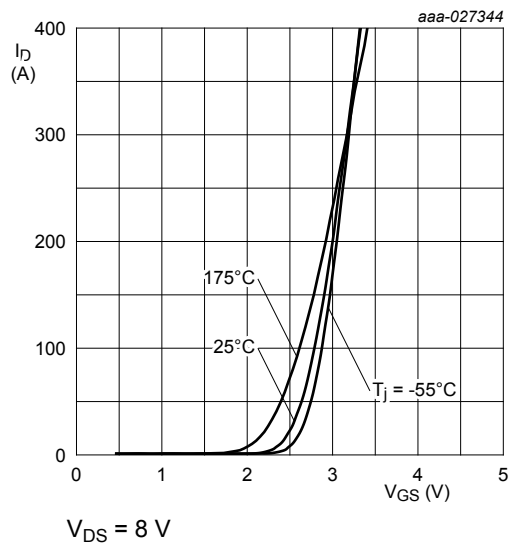


Fig. 8. Transfer characteristics; drain current as a function of gate-source voltage; typical values

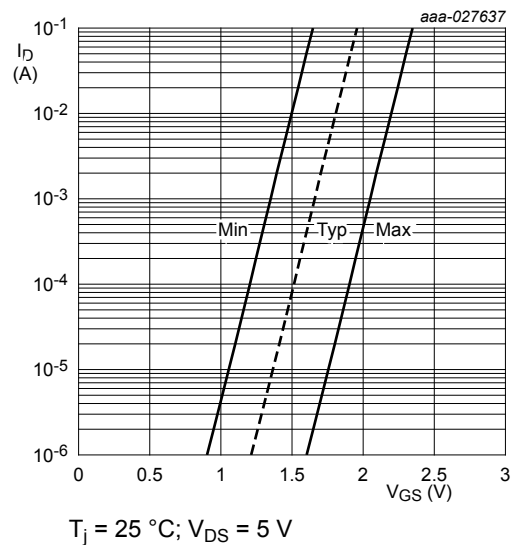


Fig. 9. Sub-threshold drain current as a function of gate-source voltage

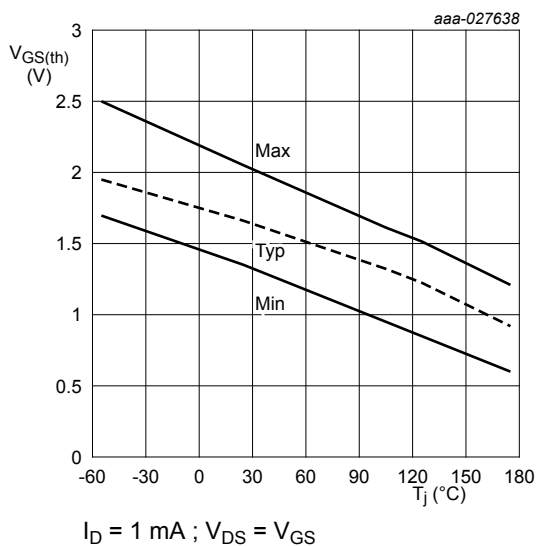


Fig. 10. Gate-source threshold voltage as a function of junction temperature

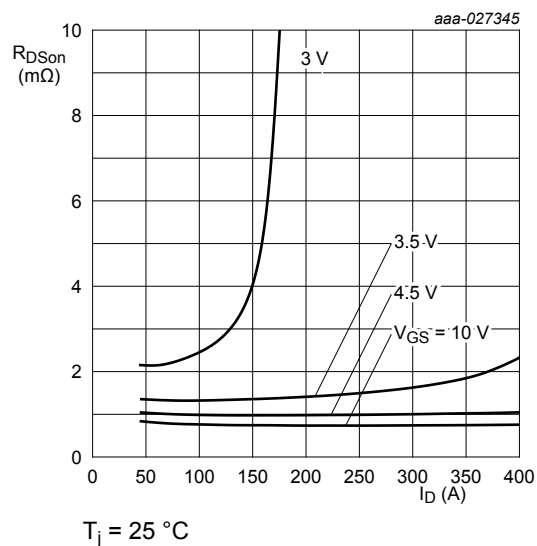


Fig. 11. Drain-source on-state resistance as a function of drain current; typical values

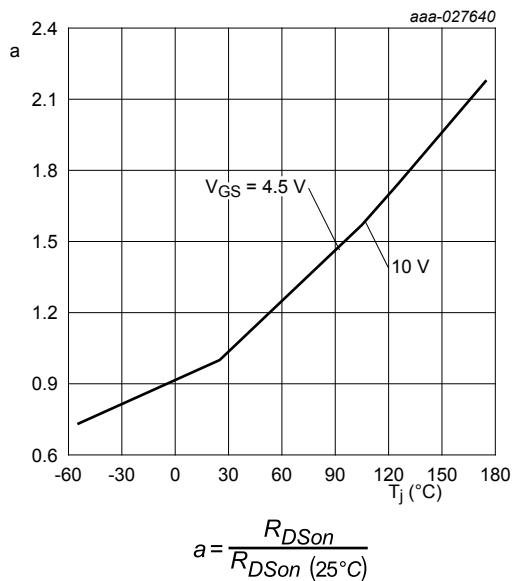


Fig. 12. Normalized drain-source on-state resistance factor as a function of junction temperature

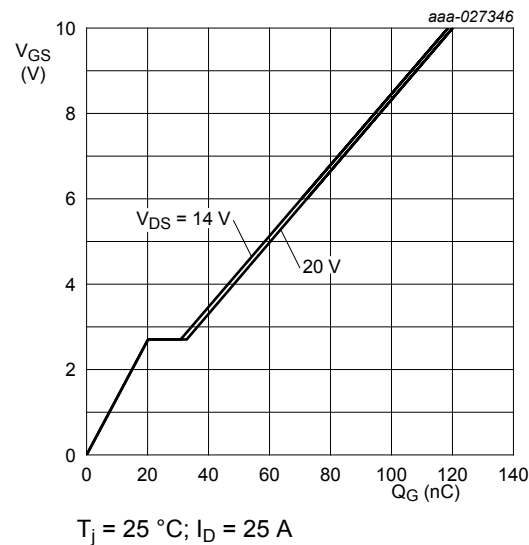


Fig. 13. Gate-source voltage as a function of gate charge; typical values

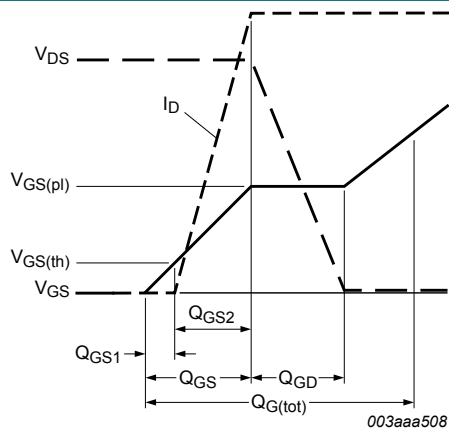


Fig. 14. Gate charge waveform definitions

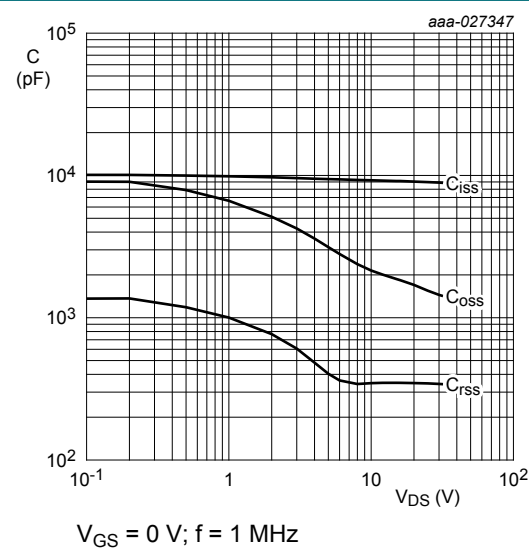


Fig. 15. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

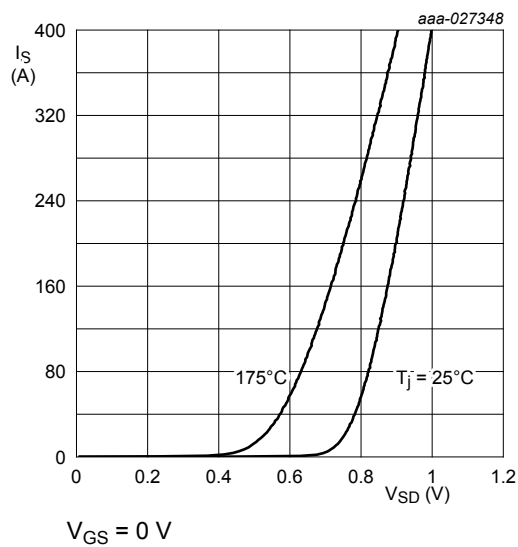


Fig. 16. Source-drain (diode forward) current as a function of source-drain (diode forward) voltage; typical values

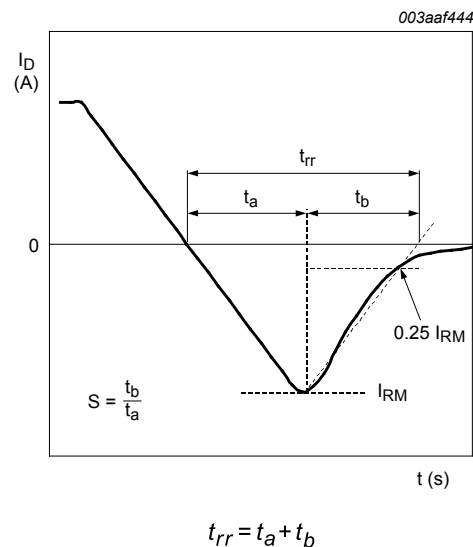


Fig. 17. Reverse recovery waveform definitions

11. Package outline

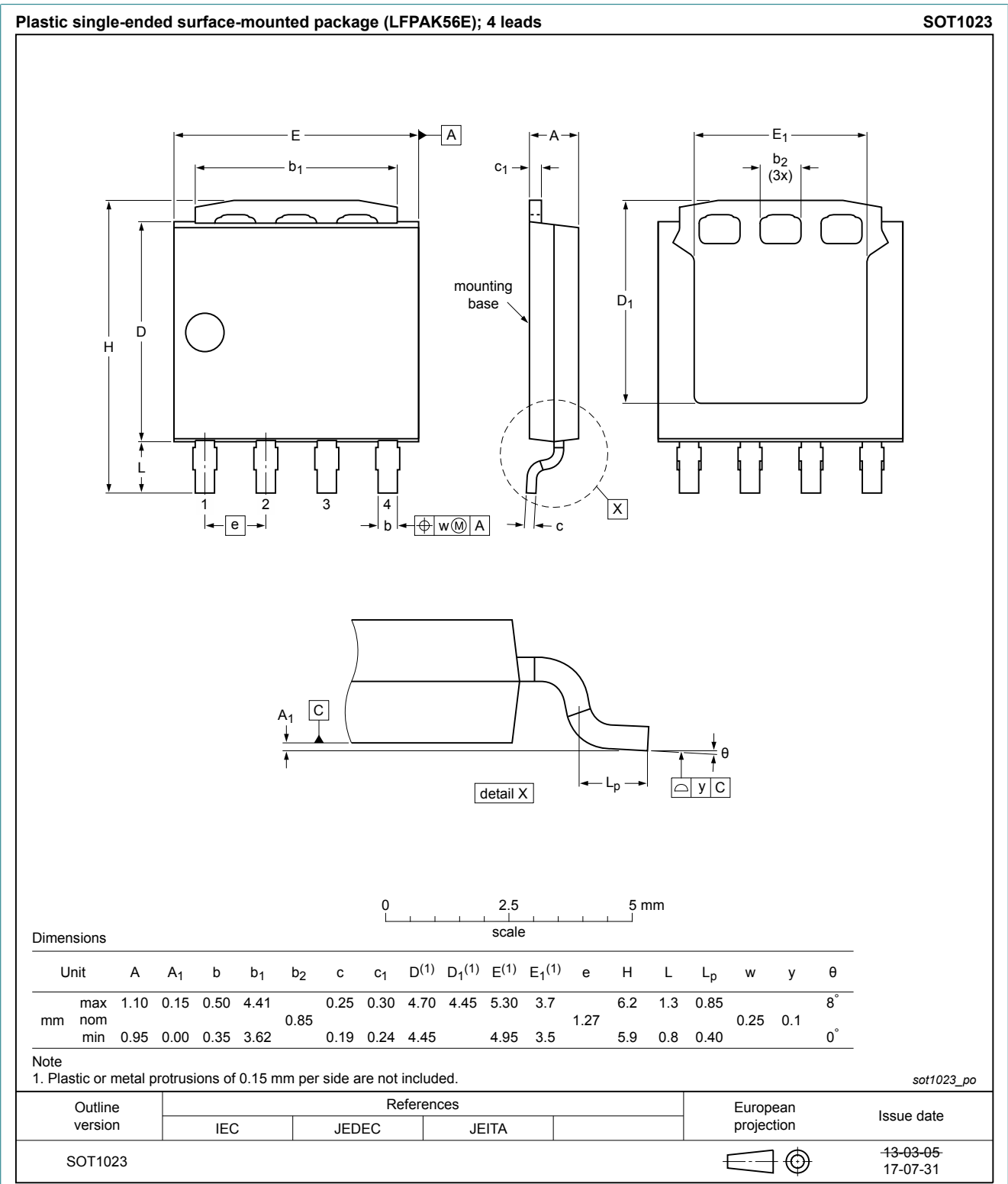


Fig. 18. Package outline LPAK56E; Power-SO8 (SOT1023)

12. Legal information

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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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