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Kind regards,

Team Nexperia



# BUK9E1R9-40E

N-channel 40 V, 1.9 mΩ logic level MOSFET in I<sup>2</sup>PAK

5 June 2013

Product data sheet

## 1. General description

Logic level N-channel MOSFET in a I<sup>2</sup>PAK package using TrenchMOS technology. This product has been designed and qualified to AEC Q101 standard for use in high performance automotive applications.

## 2. Features and benefits

- AEC Q101 compliant
- Repetitive avalanche rated
- Suitable for thermally demanding environments due to 175 °C rating
- True logic level gate with  $V_{GS(th)}$  rating of greater than 0.5 V at 175 °C

## 3. Applications

- 12 V Automotive systems
- Motors, lamps and solenoid control
- Power Steering
- Fan 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	$T_j \geq 25\text{ °C}; T_j \leq 175\text{ °C}$		-	-	40	V
$I_D$	drain current	$V_{GS} = 5\text{ V}; T_{mb} = 25\text{ °C};$ <a href="#">Fig. 1</a>	[1]	-	-	120	A
$P_{tot}$	total power dissipation	$T_{mb} = 25\text{ °C};$ <a href="#">Fig. 2</a>		-	-	349	W
<b>Static characteristics</b>							
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 5\text{ V}; I_D = 25\text{ A}; T_j = 25\text{ °C};$ <a href="#">Fig. 11</a>		-	1.6	1.93	mΩ
<b>Dynamic characteristics</b>							
$Q_{GD}$	gate-drain charge	$V_{GS} = 5\text{ V}; I_D = 25\text{ A}; V_{DS} = 32\text{ V};$ <a href="#">Fig. 13; Fig. 14</a>		-	40.9	-	nC

[1] Continuous current is limited by package.

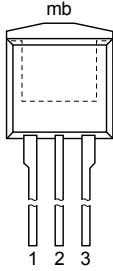
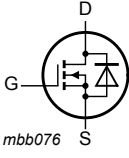


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## 5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	G	gate	 <p>I<sup>2</sup>PAK (SOT226)</p>	 <p>mbb076</p>
2	D	drain		
3	S	source		
mb	D	mounting base; connected to drain		

## 6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
BUK9E1R9-40E	I <sup>2</sup> PAK	plastic single-ended package (I <sup>2</sup> PAK); TO-262	SOT226

## 7. Marking

Table 4. Marking codes

Type number	Marking code
BUK9E1R9-40E	BUK9E1R9-40E

## 8. Limiting values

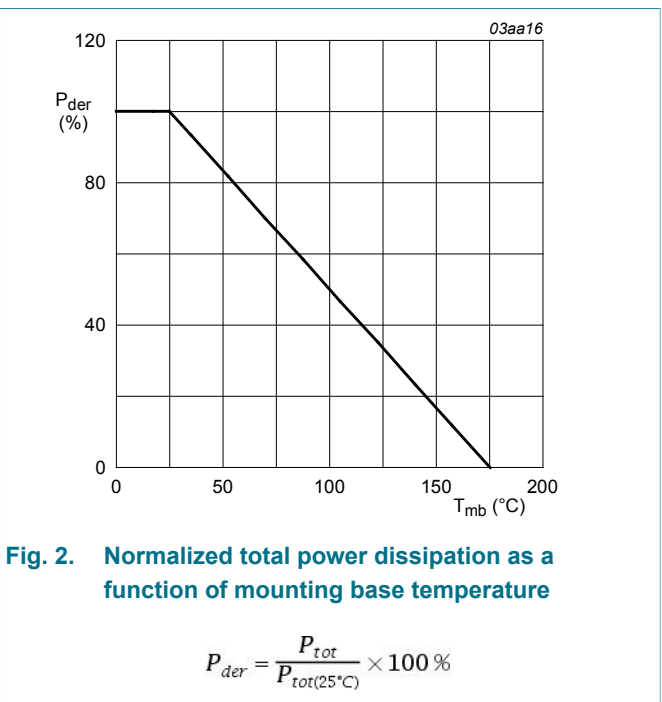
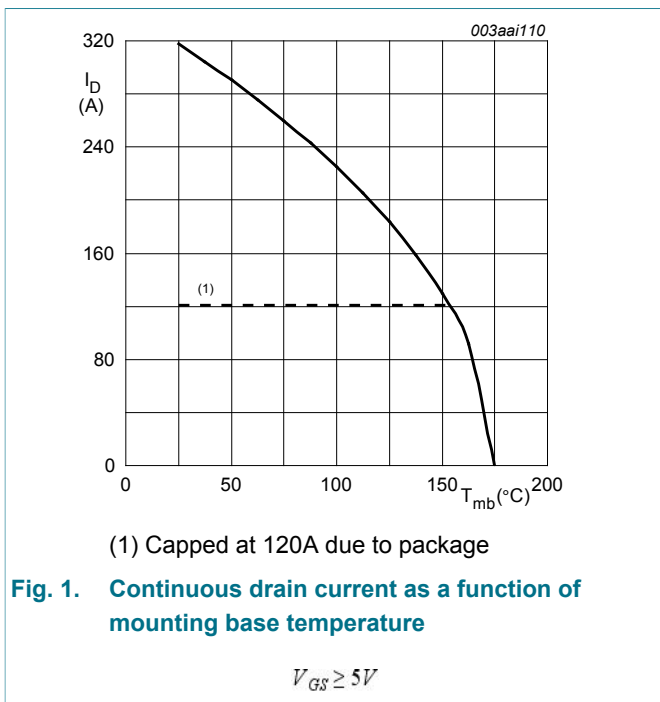
Table 5. Limiting values

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

Symbol	Parameter	Conditions	Min	Max	Unit	
V <sub>DS</sub>	drain-source voltage	T <sub>j</sub> ≥ 25 °C; T <sub>j</sub> ≤ 175 °C	-	40	V	
V <sub>DGR</sub>	drain-gate voltage	R <sub>GS</sub> = 20 kΩ	-	40	V	
V <sub>GS</sub>	gate-source voltage	T <sub>j</sub> ≤ 175 °C; Pulsed	[1][2]	-15	15	V
		T <sub>j</sub> ≤ 175 °C; DC		-10	10	V
I <sub>D</sub>	drain current	T <sub>mb</sub> = 25 °C; V <sub>GS</sub> = 5 V; Fig. 1	[3]	-	120	A
		T <sub>mb</sub> = 100 °C; V <sub>GS</sub> = 5 V; Fig. 1	[3]	-	120	A
I <sub>DM</sub>	peak drain current	T <sub>mb</sub> = 25 °C; pulsed; t <sub>p</sub> ≤ 10 μs; Fig. 4		-	1228	A
P <sub>tot</sub>	total power dissipation	T <sub>mb</sub> = 25 °C; Fig. 2		-	349	W

Symbol	Parameter	Conditions		Min	Max	Unit
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	[3]	-	120	A
I <sub>SM</sub>	peak source current	pulsed; t <sub>p</sub> ≤ 10 μs; T <sub>mb</sub> = 25 °C		-	1228	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> = 5 V; T <sub>j(init)</sub> = 25 °C; unclamped; <a href="#">Fig. 3</a>	[4][5]	-	1008	mJ

- [1] Accumulated pulse duration up to 50 hours delivers zero defect ppm
- [2] Significantly longer life times are achieved by lowering T<sub>j</sub> and or V<sub>GS</sub>
- [3] Continuous current is limited by package.
- [4] Single-pulse avalanche rating limited by maximum junction temperature of 175 °C.
- [5] Refer to application note AN10273 for further information.



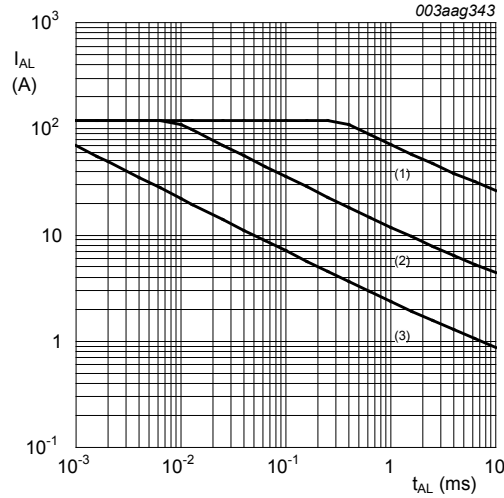


Fig. 3. Single-pulse and repetitive avalanche rating; avalanche current as a function of avalanche time

(1)  $T_{j (init)} = 25^\circ C$ ; (2)  $T_{j (init)} = 150^\circ C$ ; (3) Repetitive Avalanche

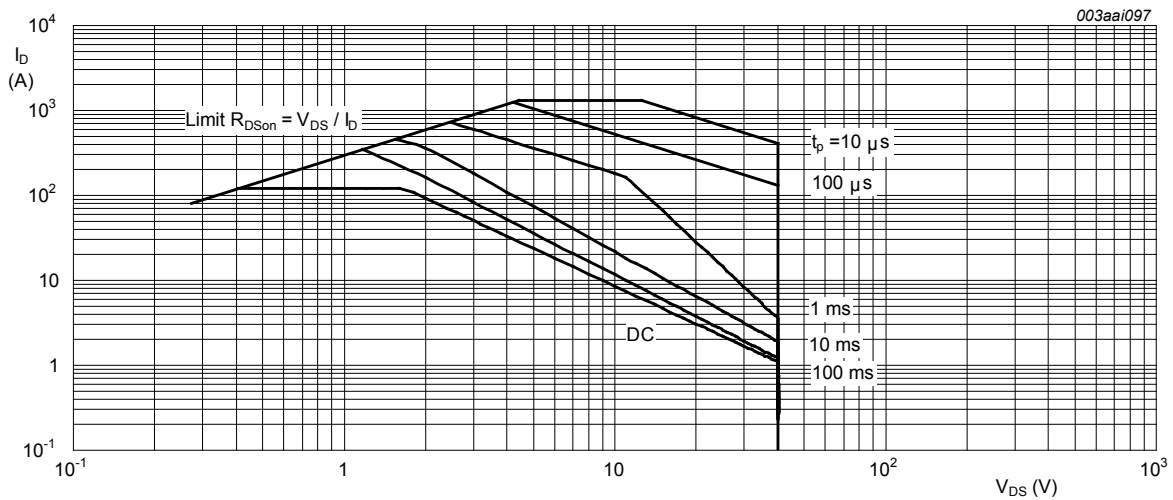


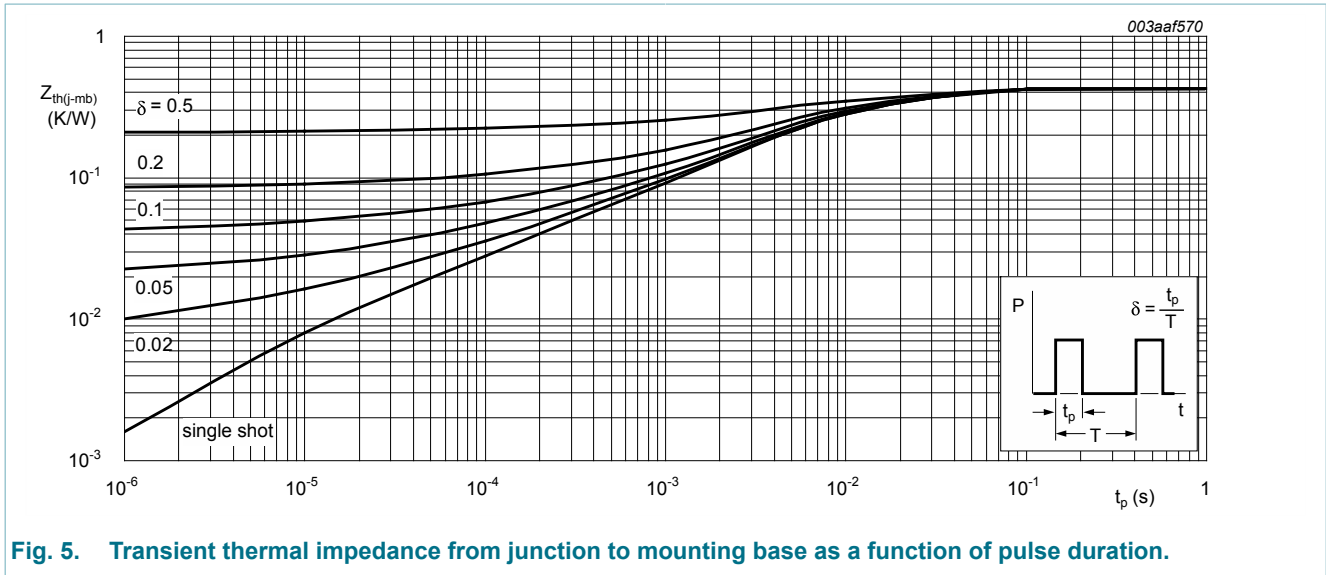
Fig. 4. Safe operating area; continuous and peak drain currents as a function of drain-source voltage

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

## 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	-	-	0.43	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient	vertical in still air	-	65	-	K/W



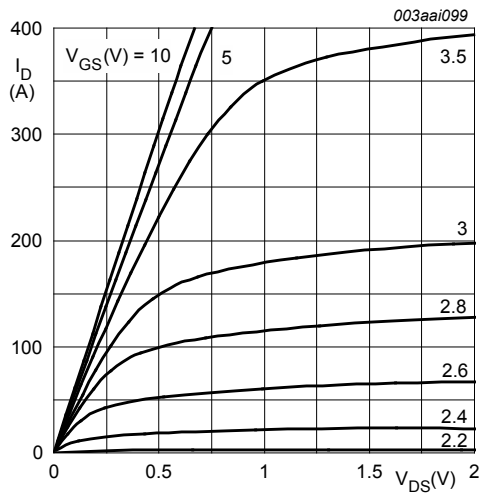
**Fig. 5. Transient thermal impedance from junction to mounting base as a function of pulse duration.**

## 10. Characteristics

**Table 7. Characteristics**

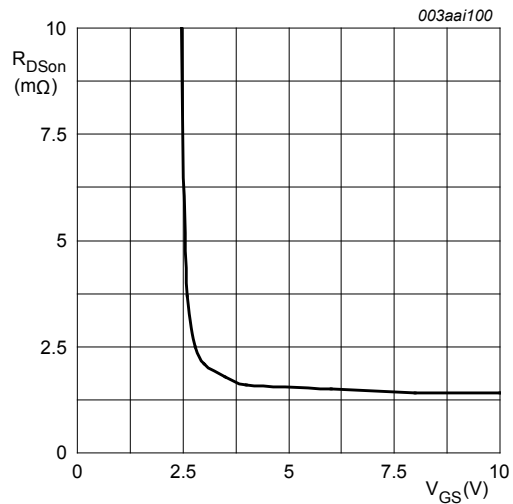
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics</b>						
V <sub>(BR)DSS</sub>	drain-source breakdown voltage	I <sub>D</sub> = 250 μA; V <sub>GS</sub> = 0 V; T <sub>J</sub> = 25 °C	40	-	-	V
		I <sub>D</sub> = 250 μA; V <sub>GS</sub> = 0 V; T <sub>J</sub> = -55 °C	36	-	-	V
V <sub>GS(th)</sub>	gate-source threshold voltage	I <sub>D</sub> = 1 mA; V <sub>DS</sub> = V <sub>GS</sub> ; T <sub>J</sub> = 25 °C; <a href="#">Fig. 9</a> ; <a href="#">Fig. 10</a>	1.4	1.7	2.1	V
		I <sub>D</sub> = 1 mA; V <sub>DS</sub> = V <sub>GS</sub> ; T <sub>J</sub> = -55 °C; <a href="#">Fig. 9</a>	-	-	2.45	V
		I <sub>D</sub> = 1 mA; V <sub>DS</sub> = V <sub>GS</sub> ; T <sub>J</sub> = 175 °C; <a href="#">Fig. 9</a>	0.5	-	-	V
I <sub>DSS</sub>	drain leakage current	V <sub>DS</sub> = 40 V; V <sub>GS</sub> = 0 V; T <sub>J</sub> = 25 °C	-	0.13	1	μA
		V <sub>DS</sub> = 40 V; V <sub>GS</sub> = 0 V; T <sub>J</sub> = 175 °C	-	-	500	μA
I <sub>GSS</sub>	gate leakage current	V <sub>GS</sub> = 10 V; V <sub>DS</sub> = 0 V; T <sub>J</sub> = 25 °C	-	2	100	nA
		V <sub>GS</sub> = -10 V; V <sub>DS</sub> = 0 V; T <sub>J</sub> = 25 °C	-	2	100	nA
R <sub>DSon</sub>	drain-source on-state resistance	V <sub>GS</sub> = 5 V; I <sub>D</sub> = 25 A; T <sub>J</sub> = 25 °C; <a href="#">Fig. 11</a>	-	1.6	1.93	mΩ
		V <sub>GS</sub> = 10 V; I <sub>D</sub> = 25 A; T <sub>J</sub> = 25 °C; <a href="#">Fig. 11</a>	-	1.4	1.7	mΩ
		V <sub>GS</sub> = 5 V; I <sub>D</sub> = 25 A; T <sub>J</sub> = 175 °C; <a href="#">Fig. 12</a> ; <a href="#">Fig. 11</a>	-	-	3.7	mΩ
<b>Dynamic characteristics</b>						
Q <sub>G(tot)</sub>	total gate charge	I <sub>D</sub> = 25 A; V <sub>DS</sub> = 32 V; V <sub>GS</sub> = 5 V; <a href="#">Fig. 13</a> ; <a href="#">Fig. 14</a>	-	120	-	nC
Q <sub>GS</sub>	gate-source charge		-	26.9	-	nC

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$Q_{GD}$	gate-drain charge		-	40.9	-	nC
$C_{iss}$	input capacitance	$V_{GS} = 0\text{ V}; V_{DS} = 25\text{ V}; f = 1\text{ MHz};$	-	12300	16400	pF
$C_{oss}$	output capacitance	$T_j = 25\text{ }^\circ\text{C}; \text{Fig. 15}$	-	1530	1840	pF
$C_{rss}$	reverse transfer capacitance		-	740	1020	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = 30\text{ V}; R_L = 1.2\text{ } \Omega; V_{GS} = 5\text{ V};$	-	95	-	ns
$t_r$	rise time	$R_{G(ext)} = 5\text{ } \Omega$	-	118	-	ns
$t_{d(off)}$	turn-off delay time		-	195	-	ns
$t_f$	fall time		-	119	-	ns
$L_D$	internal drain inductance	from upper edge of drain mounting base to center of die	-	2.5	-	nH
		from drain lead 6mm from package to centre of die	-	4.5	-	nH
$L_S$	internal source inductance	from source lead to source bonding pad	-	7.5	-	nH
<b>Source-drain diode</b>						
$V_{SD}$	source-drain voltage	$I_S = 25\text{ A}; V_{GS} = 0\text{ V}; T_j = 25\text{ }^\circ\text{C}; \text{Fig. 16}$	-	0.77	1.2	V
$t_{rr}$	reverse recovery time	$I_S = 20\text{ A}; di_S/dt = -100\text{ A}/\mu\text{s}; V_{GS} = 0\text{ V};$	-	57	-	ns
$Q_r$	recovered charge	$V_{DS} = 25\text{ V}$	-	97	-	nC



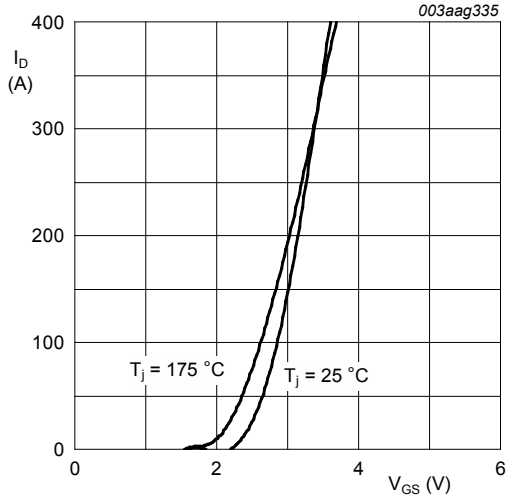
$T_j = 25\text{ }^\circ\text{C}; t_p = 300\text{ } \mu\text{s}$

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



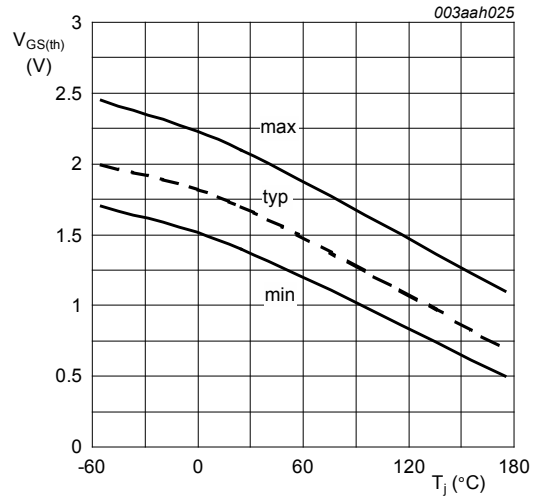
**Fig. 7. Drain-source on-state resistance as a function of gate-source voltage; typical values**

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



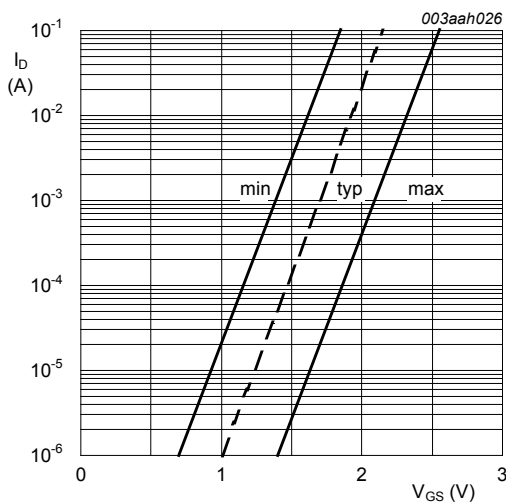
**Fig. 8. Transfer characteristics: drain current as a function of gate-source voltage; typical values**

$V_{DS} = 12 V$



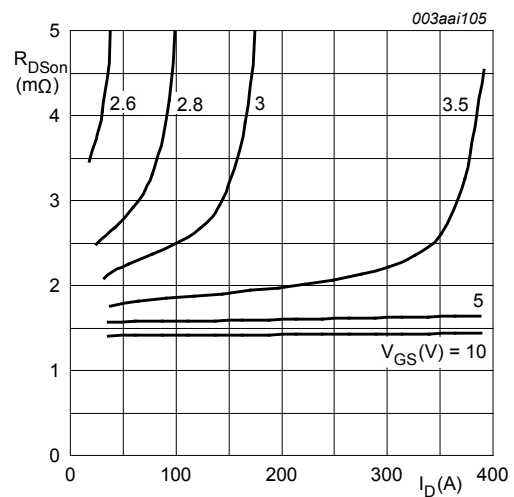
**Fig. 9. Gate-source threshold voltage as a function of junction temperature**

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



**Fig. 10. Sub-threshold drain current as a function of gate-source voltage**

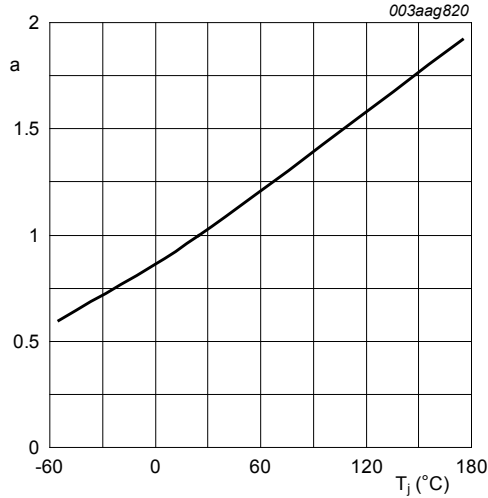
$T_j = 25 \text{ °C}; V_{DS} = 5 V$



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

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



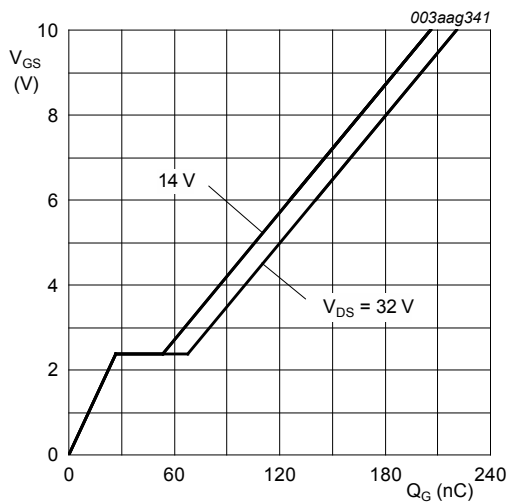


**Fig. 12. Normalized drain-source on-state resistance factor as a function of junction temperature**

$$a = \frac{R_{DS(on)}}{R_{DS(on)(25\text{ }^\circ\text{C})}}$$

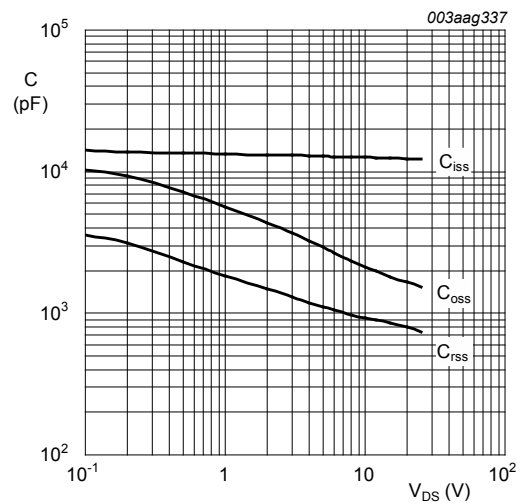


**Fig. 13. Gate charge waveform definitions**



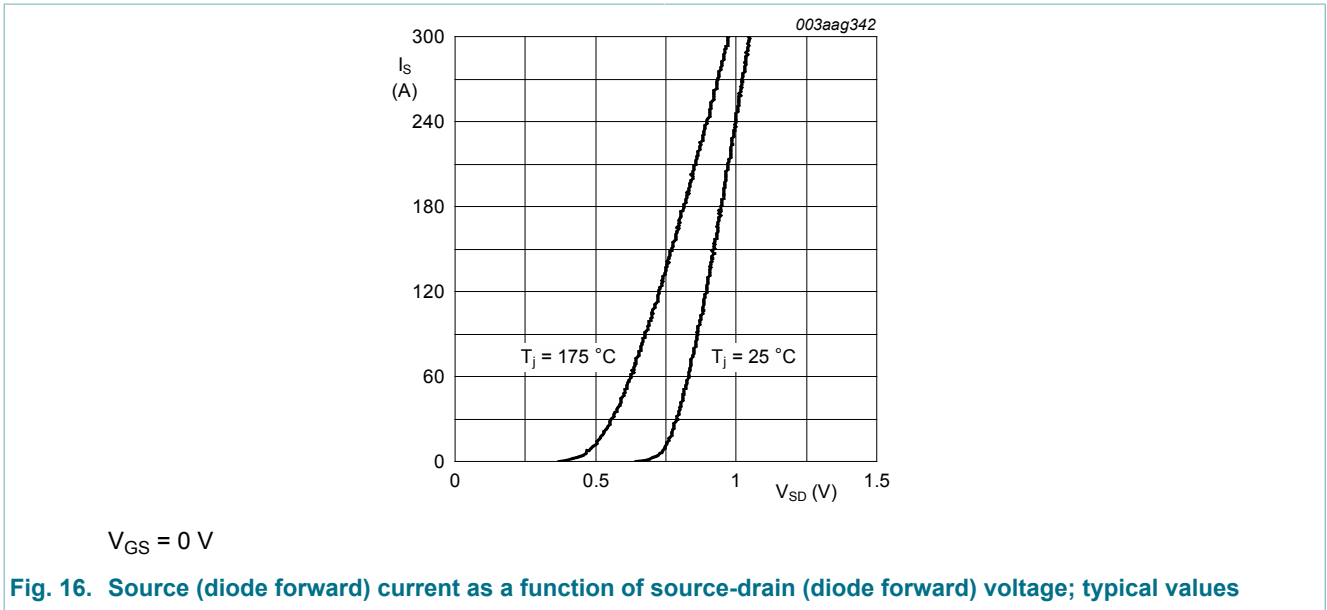
$T_j = 25\text{ }^\circ\text{C}; I_D = 25\text{ A}$

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



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

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



### 11. Package outline

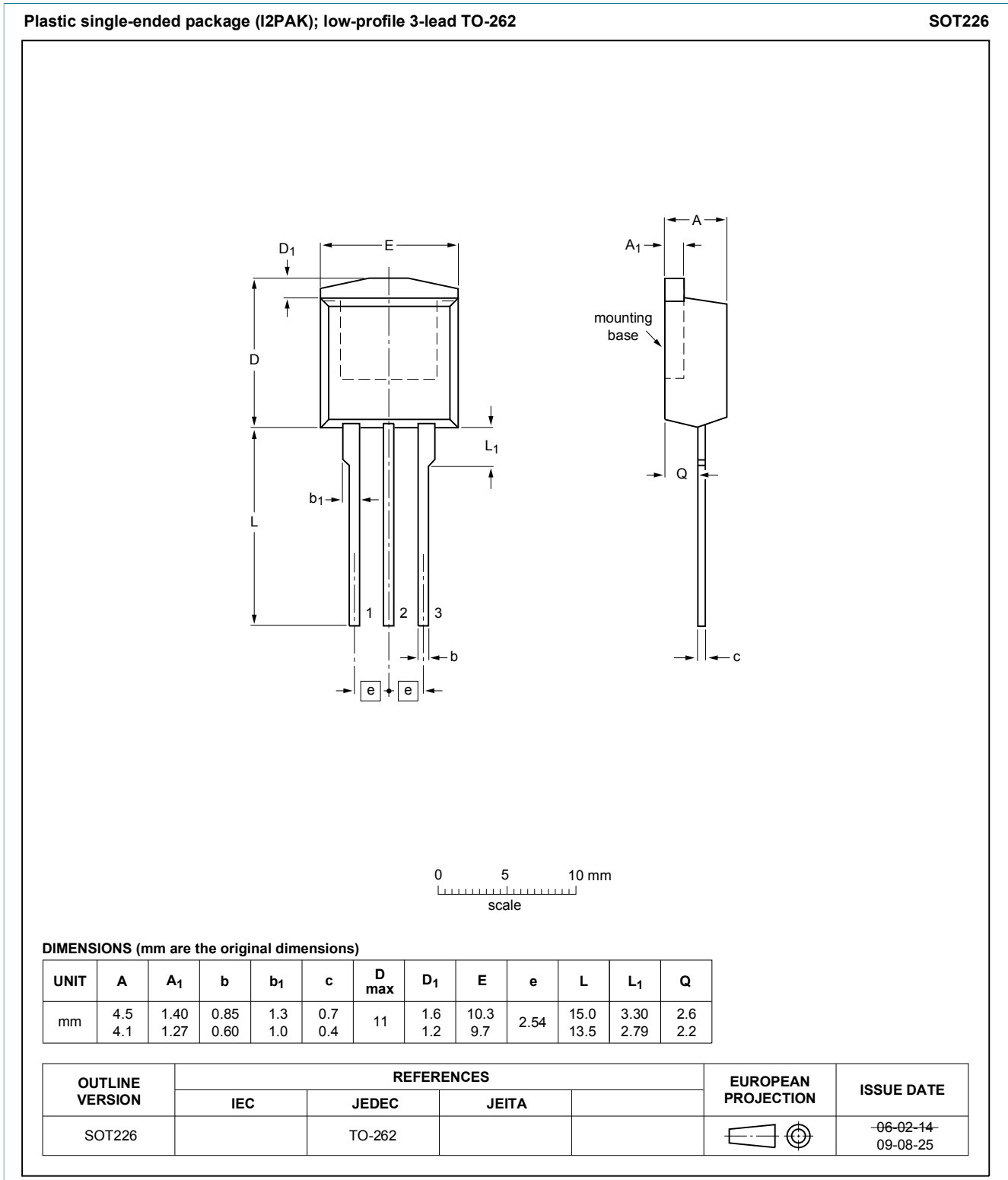


Fig. 17. Package outline I<sup>2</sup>PAK (SOT226)

## 12. Legal information

### 12.1 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.
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## 13. Contents

<b>1</b>	<b>General description .....</b>	<b>1</b>
<b>2</b>	<b>Features and benefits .....</b>	<b>1</b>
<b>3</b>	<b>Applications .....</b>	<b>1</b>
<b>4</b>	<b>Quick reference data .....</b>	<b>1</b>
<b>5</b>	<b>Pinning information .....</b>	<b>2</b>
<b>6</b>	<b>Ordering information .....</b>	<b>2</b>
<b>7</b>	<b>Marking .....</b>	<b>2</b>
<b>8</b>	<b>Limiting values .....</b>	<b>2</b>
<b>9</b>	<b>Thermal characteristics .....</b>	<b>4</b>
<b>10</b>	<b>Characteristics .....</b>	<b>5</b>
<b>11</b>	<b>Package outline .....</b>	<b>10</b>
<b>12</b>	<b>Legal information .....</b>	<b>11</b>
12.1	Data sheet status .....	11
12.2	Definitions .....	11
12.3	Disclaimers .....	11
12.4	Trademarks .....	12

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