

# BUK9E1R6-30E

N-channel TrenchMOS logic level FET

11 September 2012

Product data sheet

## 1. Product profile

### 1.1 General description

Logic level N-channel MOSFET in a SOT226 package using TrenchMOS technology. This product has been designed and qualified to AEC Q101 standard for use in high performance automotive applications.

### 1.2 Features and benefits

- AEC Q101 compliant
- Repetitive Avalanche rated
- Suitable for thermally demanding environments due to 175 °C rating
- True Logic level gate with VGS(th) rating of greater than 0.5V at 175 °C

### 1.3 Applications

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

### 1.4 Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$V_{DS}$	drain-source voltage	$T_j \geq 25 \text{ }^\circ\text{C}; T_j \leq 175 \text{ }^\circ\text{C}$		-	-	30	V
$I_D$	drain current	$V_{GS} = 5 \text{ V}; T_{mb} = 25 \text{ }^\circ\text{C}$ ; <a href="#">Fig. 1</a>	[1]	-	-	120	A
$P_{tot}$	total power dissipation	$T_{mb} = 25 \text{ }^\circ\text{C}$ ; <a href="#">Fig. 2</a>		-	-	349	W
<b>Static characteristics</b>							
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = 5 \text{ V}; I_D = 25 \text{ A}; T_j = 25 \text{ }^\circ\text{C}$ ; <a href="#">Fig. 11</a>		-	1.4	1.6	$\text{m}\Omega$
<b>Dynamic characteristics</b>							
$Q_{GD}$	gate-drain charge	$V_{GS} = 5 \text{ V}; I_D = 25 \text{ A}; V_{DS} = 24 \text{ V}$ ; <a href="#">Fig. 13</a> ; <a href="#">Fig. 14</a>		-	39.2	-	$\text{nC}$

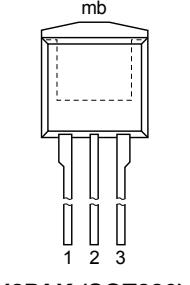
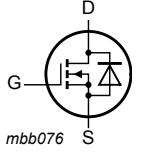
[1] Continuous current is limited by package.



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## 2. Pinning information

Table 2. Pinning information

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

## 3. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
BUK9E1R6-30E	I2PAK	plastic single-ended package (I2PAK); TO-262	SOT226

## 4. Marking

Table 4. Marking codes

Type number	Marking code
BUK9E1R6-30E	BUK9E1R6-30E

## 5. Limiting values

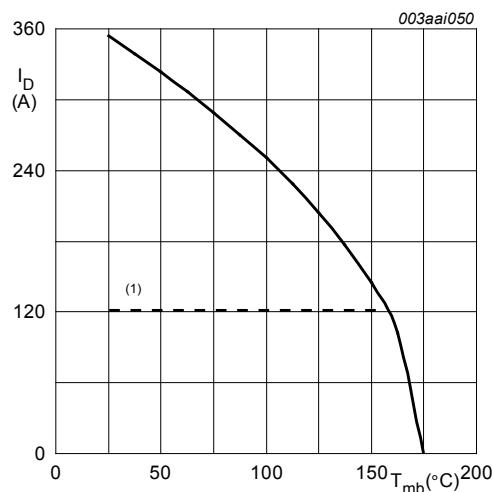
Table 5. Limiting values

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

Symbol	Parameter	Conditions		Min	Max	Unit
$V_{DS}$	drain-source voltage	$T_j \geq 25^\circ\text{C}$ ; $T_j \leq 175^\circ\text{C}$		-	30	V
$V_{DGR}$	drain-gate voltage	$R_{GS} = 20\text{ k}\Omega$		-	30	V
$V_{GS}$	gate-source voltage	$T_j \leq 175^\circ\text{C}$ ; Pulsed	<a href="#">[1]</a> <a href="#">[2]</a>	-15	15	V
		$T_j \leq 175^\circ\text{C}$ ; DC		-10	10	V
$I_D$	drain current	$T_{mb} = 25^\circ\text{C}$ ; $V_{GS} = 5\text{ V}$ ; <a href="#">Fig. 1</a>	<a href="#">[3]</a>	-	120	A
		$T_{mb} = 100^\circ\text{C}$ ; $V_{GS} = 5\text{ V}$ ; <a href="#">Fig. 1</a>		-	120	A
$I_{DM}$	peak drain current	$T_{mb} = 25^\circ\text{C}$ ; pulsed; $t_p \leq 10\text{ }\mu\text{s}$ ; <a href="#">Fig. 4</a>		-	1400	A
$P_{tot}$	total power dissipation	$T_{mb} = 25^\circ\text{C}$ ; <a href="#">Fig. 2</a>		-	349	W

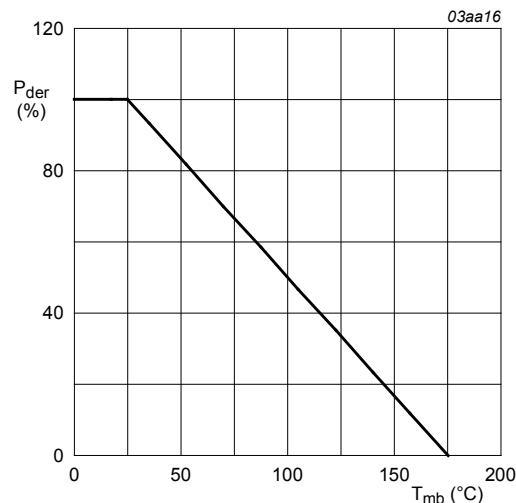
Symbol	Parameter	Conditions		Min	Max	Unit
$T_{stg}$	storage temperature			-55	175	°C
$T_j$	junction temperature			-55	175	°C
<b>Source-drain diode</b>						
$I_S$	source current	$T_{mb} = 25$ °C	[3]	-	120	A
$I_{SM}$	peak source current	pulsed; $t_p \leq 10$ µs; $T_{mb} = 25$ °C		-	1400	A
<b>Avalanche ruggedness</b>						
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$I_D = 120$ A; $V_{sup} \leq 30$ V; $R_{GS} = 50$ Ω; $V_{GS} = 5$ V; $T_{j(init)} = 25$ °C; unclamped; <a href="#">Fig. 3</a>	[4][5]	-	1405	mJ

- [1] Accumulated pulse duration up to 50 hours delivers zero defect ppm
- [2] Significantly longer life times are achieved by lowering  $T_j$  and or  $V_{GS}$
- [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. 1. Continuous drain current as a function of mounting base temperature**

$V_{GS} \geq 5$  V  
(1) Capped at 120 A due to package.



**Fig. 2. Normalized total power dissipation as a function of mounting base temperature**

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

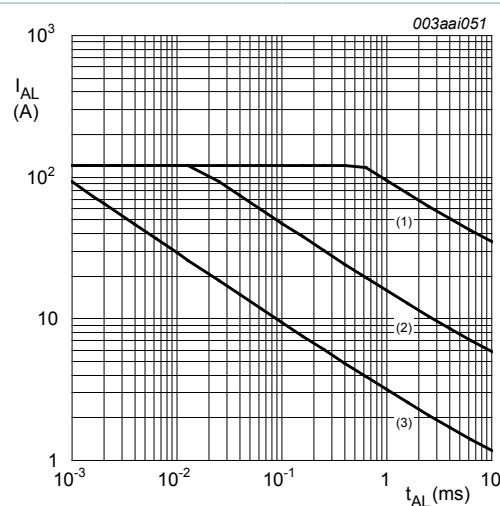


Fig. 3. Single-pulse and repetitive avalanche rating; avalanche current as a function of avalanche time

(1)  $T_j$  (int) = 25°C; (2)  $T_j$  (int) = 150°C; (3) Repetitive Avalanche

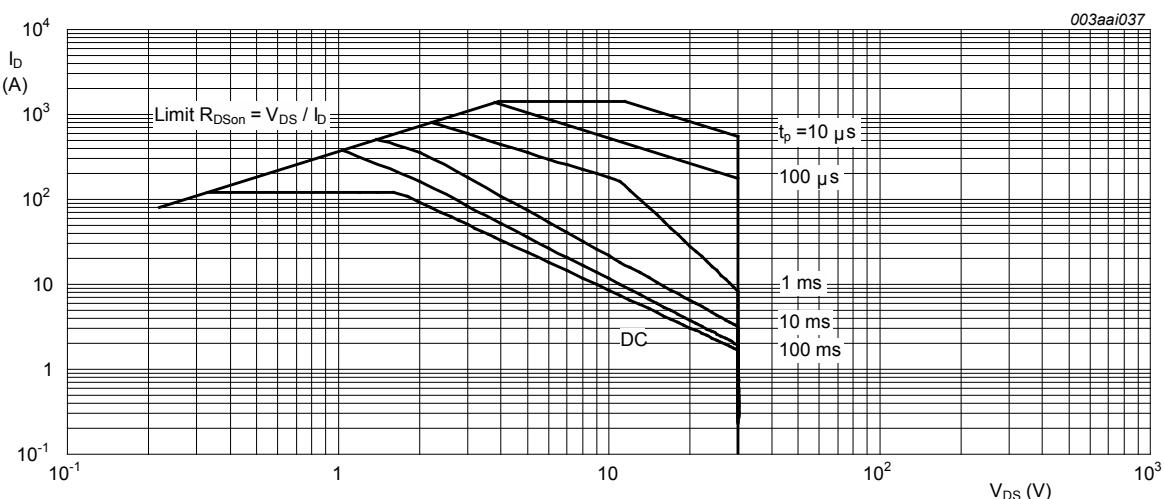


Fig. 4. Safe operating area; continuous and peak drain currents as a function of drain-source voltage

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

## 6. 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. 5</a>		-	-	0.43	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient	vertical in still air		-	65	-	K/W

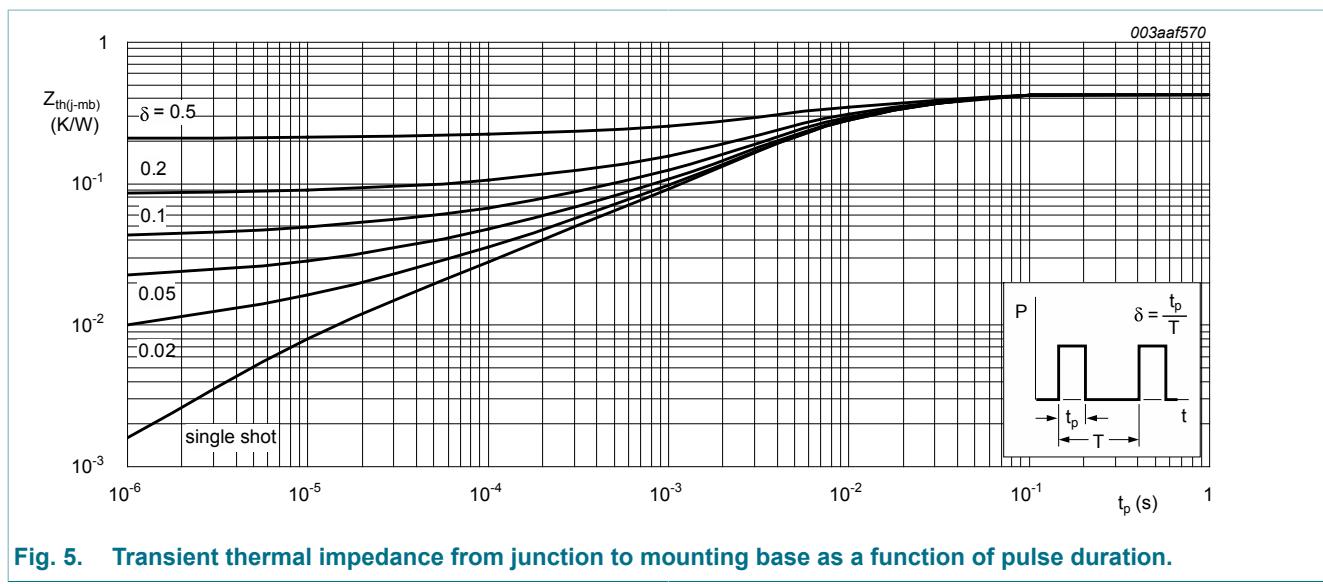


Fig. 5. Transient thermal impedance from junction to mounting base as a function of pulse duration.

## 7. Characteristics

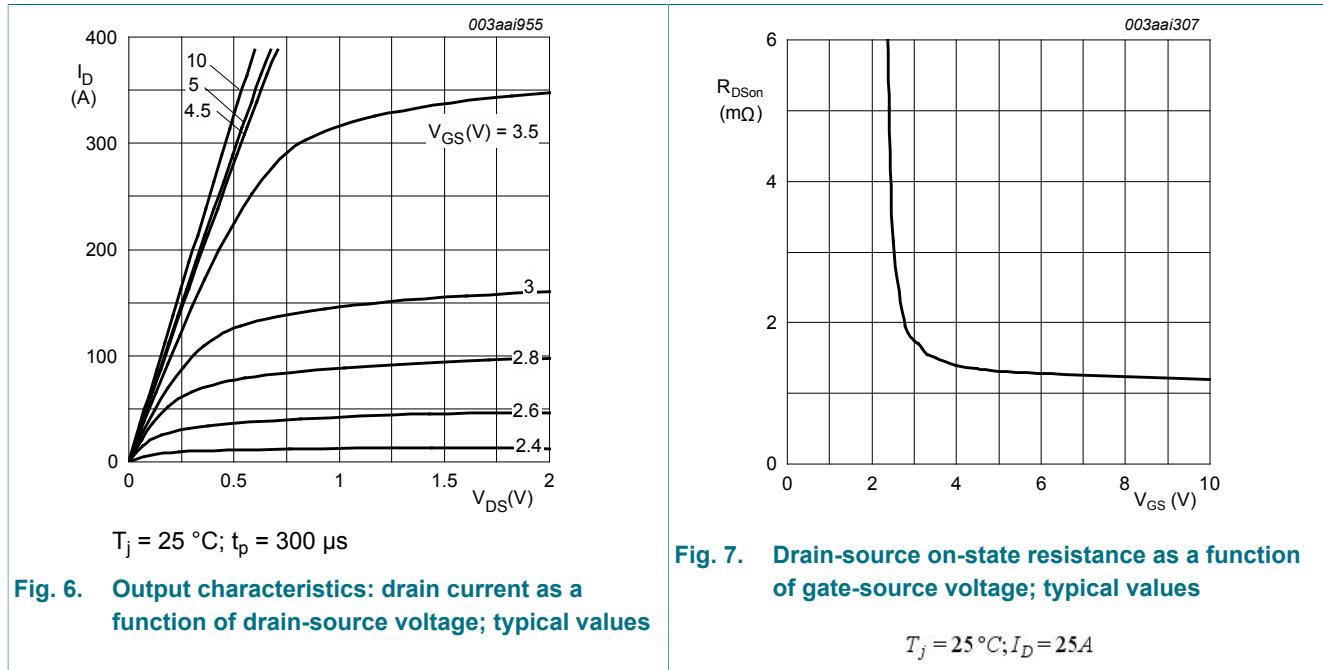
Table 7. Characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
<b>Static characteristics</b>							
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 250 \mu A; V_{GS} = 0 V; T_j = 25^\circ C$		30	-	-	V
		$I_D = 250 \mu A; V_{GS} = 0 V; T_j = -55^\circ C$		27	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 1 mA; V_{DS} = V_{GS}; T_j = 25^\circ C;$ <a href="#">Fig. 9</a> ; <a href="#">Fig. 10</a>		1.4	1.7	2.1	V
		$I_D = 1 mA; V_{DS} = V_{GS}; T_j = -55^\circ C;$ <a href="#">Fig. 10</a>		-	-	2.45	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 1 mA; V_{DS} = V_{GS}; T_j = 175^\circ C;$ <a href="#">Fig. 10</a>		0.5	-	-	V
$I_{DSS}$	drain leakage current	$V_{DS} = 30 V; V_{GS} = 0 V; T_j = 25^\circ C$		-	0.1	1	$\mu A$
		$V_{DS} = 30 V; V_{GS} = 0 V; T_j = 175^\circ C$		-	-	500	$\mu A$
$I_{GSS}$	gate leakage current	$V_{GS} = 10 V; V_{DS} = 0 V; T_j = 25^\circ C$		-	2	100	nA
		$V_{GS} = -10 V; V_{DS} = 0 V; T_j = 25^\circ C$		-	2	100	nA
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = 5 V; I_D = 25 A; T_j = 25^\circ C;$ <a href="#">Fig. 11</a>		-	1.4	1.6	$m\Omega$
		$V_{GS} = 10 V; I_D = 25 A; T_j = 25^\circ C;$ <a href="#">Fig. 11</a>		-	1.15	1.4	$m\Omega$
		$V_{GS} = 5 V; I_D = 25 A; T_j = 175^\circ C;$ <a href="#">Fig. 12</a> ; <a href="#">Fig. 11</a>		-	-	2.85	$m\Omega$
<b>Dynamic characteristics</b>							
$Q_{G(tot)}$	total gate charge	$I_D = 25 A; V_{DS} = 24 V; V_{GS} = 5 V;$ <a href="#">Fig. 13</a> ; <a href="#">Fig. 14</a>		-	113	-	nC
$Q_{GS}$	gate-source charge			-	29	-	nC

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$Q_{GD}$	gate-drain charge			-	39.2	-	nC
$C_{iss}$	input capacitance	$V_{GS} = 0 \text{ V}$ ; $V_{DS} = 25 \text{ V}$ ; $f = 1 \text{ MHz}$ ;		-	12100	16150	pF
$C_{oss}$	output capacitance	$T_j = 25 \text{ }^\circ\text{C}$ ; <a href="#">Fig. 15</a>		-	1840	2210	pF
$C_{rss}$	reverse transfer capacitance			-	898	1240	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = 25 \text{ V}$ ; $R_L = 1 \Omega$ ; $V_{GS} = 5 \text{ V}$ ;		-	71	-	ns
$t_r$	rise time	$R_{G(ext)} = 5 \Omega$		-	127	-	ns
$t_{d(off)}$	turn-off delay time			-	184	-	ns
$t_f$	fall time			-	111	-	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

**Source-drain diode**

$V_{SD}$	source-drain voltage	$I_S = 25 \text{ A}$ ; $V_{GS} = 0 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$ ; <a href="#">Fig. 16</a>		-	0.76	1.2	V
$t_{rr}$	reverse recovery time	$I_S = 20 \text{ A}$ ; $dI_S/dt = -100 \text{ A}/\mu\text{s}$ ; $V_{GS} = 0 \text{ V}$ ;		-	62	-	ns
$Q_r$	recovered charge	$V_{DS} = 25 \text{ V}$		-	112	-	nC



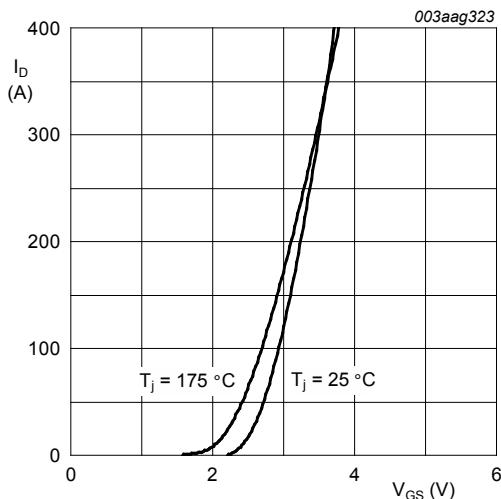


Fig. 8. Transfer characteristics: drain current as a function of gate-source voltage; typical values

$V_{DS} = 12\text{ V}$

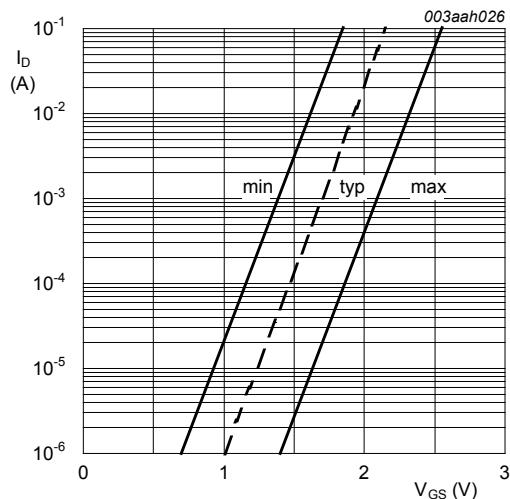


Fig. 9. Sub-threshold drain current as a function of gate-source voltage

$T_j = 25\text{ }^\circ\text{C}; V_{DS} = 5\text{ V}$

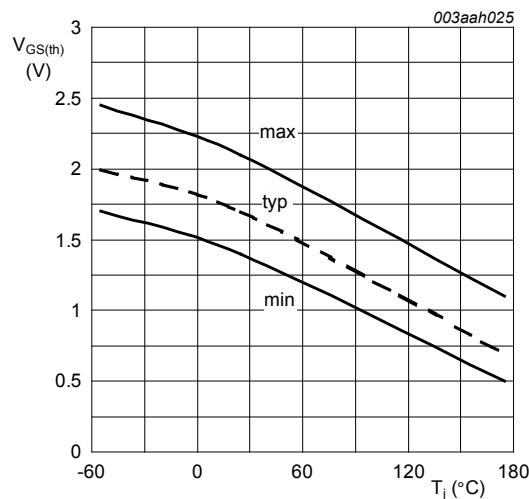
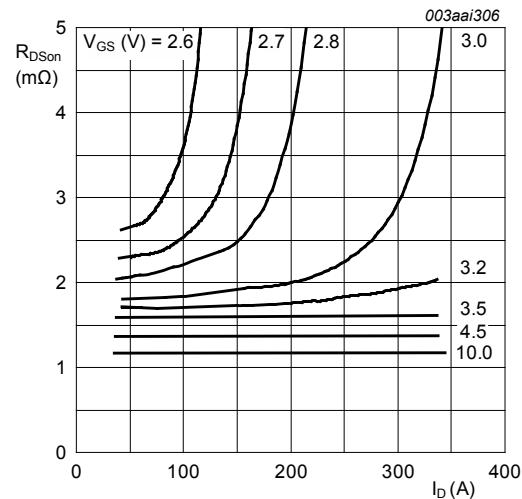


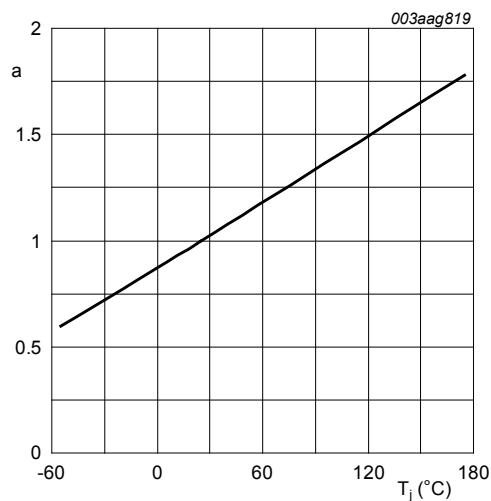
Fig. 10. Gate-source threshold voltage as a function of junction temperature

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



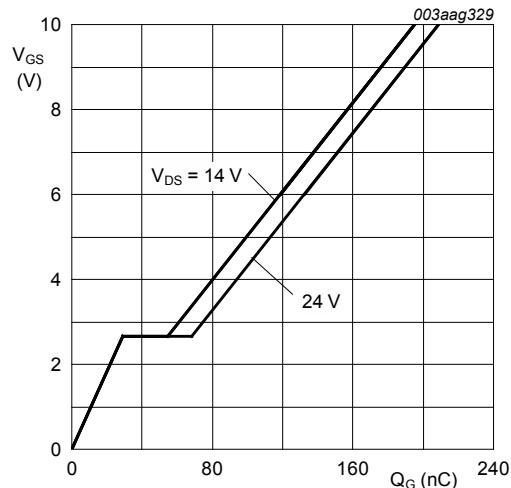
$T_j = 25\text{ }^\circ\text{C}; t_p = 300\text{ }\mu\text{s}$

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



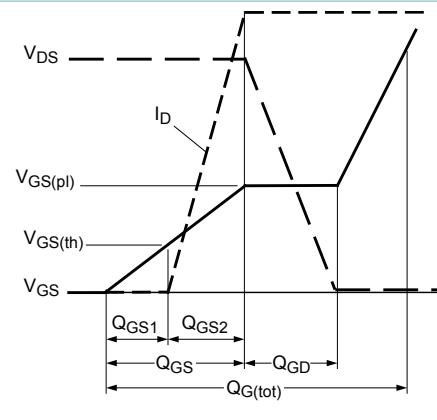
**Fig. 12. Normalized drain-source on-state resistance factor as a function of junction temperature**

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

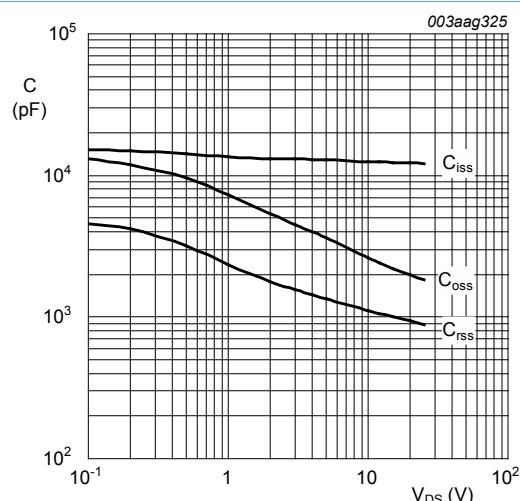


$T_j = 25\text{ }^{\circ}\text{C}$ ;  $I_D = 25\text{ A}$

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

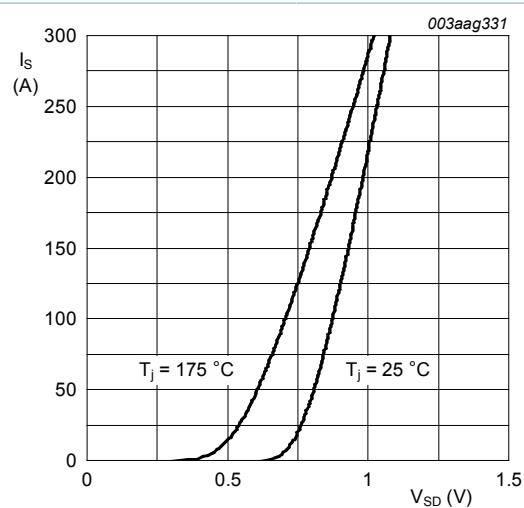


**Fig. 13. Gate charge waveform definitions**



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

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



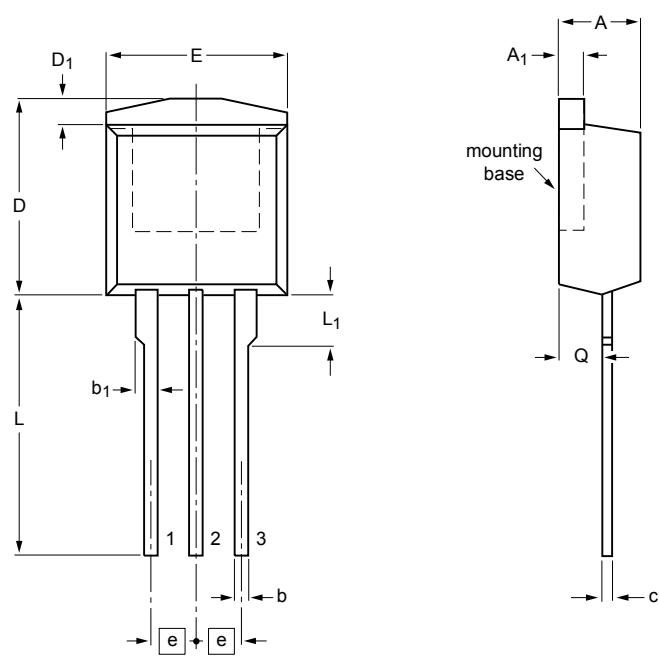
$V_{GS} = 0 \text{ V}$

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

## 8. Package outline

Plastic single-ended package (I2PAK); low-profile 3-lead TO-262

SOT226



### DIMENSIONS (mm are the original dimensions)

UNIT	A	A <sub>1</sub>	b	b <sub>1</sub>	c	D <sub>max</sub>	D <sub>1</sub>	E	e	L	L <sub>1</sub>	Q
mm	4.5 4.1	1.40 1.27	0.85 0.60	1.3 1.0	0.7 0.4	11	1.6 1.2	10.3 9.7	2.54	15.0 13.5	3.30 2.79	2.6 2.2

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT226		TO-262				-06-02-14-09-08-25

Fig. 17. Package outline I2PAK (SOT226)

## 9. Legal information

### 9.1 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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