

# BUK9K35-60E

Dual N-channel TrenchMOS logic level FET

23 April 2013

Product data sheet

## 1. General description

Dual logic level N-channel MOSFET in a LFAK56D 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

- Q101 compliant
- Repetitive avalanche rated
- Suitable for thermally demanding environments due to 175 °C rating
- True logic level gate with  $V_{GS(th)} > 0.5 \text{ V @ } 175 \text{ °C}$

## 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	$T_j \geq 25 \text{ °C}; T_j \leq 175 \text{ °C}$	-	-	60	V
$I_D$	drain current	$V_{GS} = 5 \text{ V}; T_{mb} = 25 \text{ °C}; \text{Fig. 1}$	-	-	22	A
$P_{tot}$	total power dissipation	$T_{mb} = 25 \text{ °C}; \text{Fig. 2}$	-	-	38	W
<b>Static characteristics FET1 and FET2</b>						
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 5 \text{ V}; I_D = 5 \text{ A}; T_j = 25 \text{ °C}; \text{Fig. 12}$	-	30.5	35	mΩ
<b>Dynamic characteristics FET1 and FET2</b>						
$Q_{GD}$	gate-drain charge	$I_D = 5 \text{ A}; V_{DS} = 48 \text{ V}; V_{GS} = 10 \text{ V}; T_j = 25 \text{ °C}; \text{Fig. 14}; \text{Fig. 15}$	-	3	-	nC

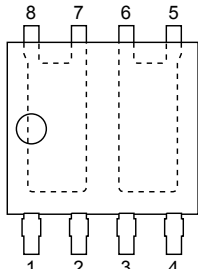
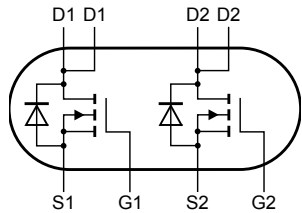


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## 5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	S1	source1	 <p><b>LFPAK56D (SOT1205)</b></p>	 <p><i>mbk725</i></p>
2	G1	gate1		
3	S2	source2		
4	G2	gate2		
5	D2	drain2		
6	D2	drain2		
7	D1	drain1		
8	D1	drain1		

## 6. Ordering information

Table 3. Ordering information

Type number	Package		Version
	Name	Description	
BUK9K35-60E	LFPAK56D	Plastic single ended surface mounted package (LFPAK56D); 8 leads	SOT1205

## 7. Marking

Table 4. Marking codes

Type number	Marking code
BUK9K35-60E	9356E

## 8. Limiting values

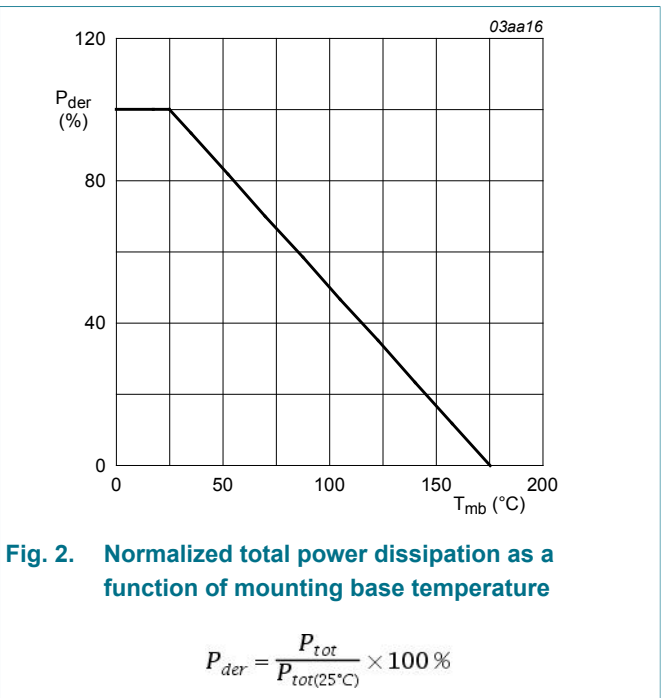
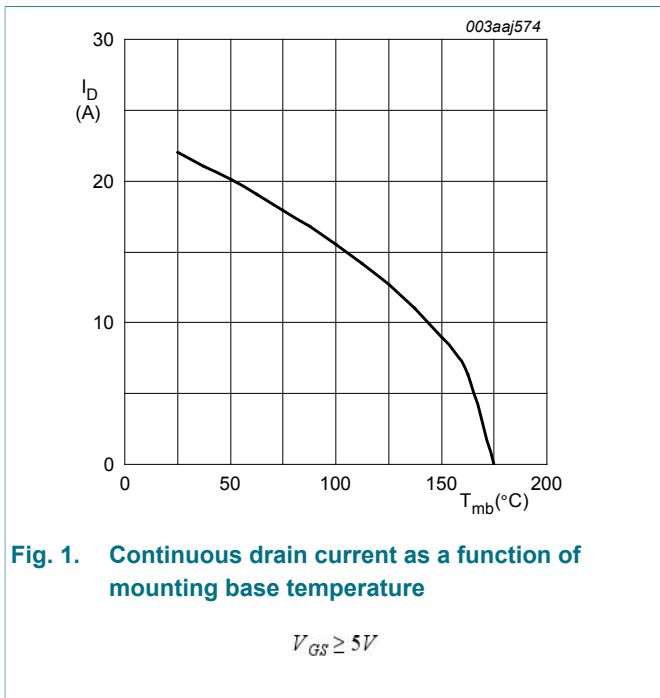
Table 5. Limiting values

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

Symbol	Parameter	Conditions	Min	Max	Unit
$V_{DS}$	drain-source voltage	$T_j \geq 25\text{ }^\circ\text{C}$ ; $T_j \leq 175\text{ }^\circ\text{C}$	-	60	V
$V_{DGR}$	drain-gate voltage	$R_{GS} = 20\text{ k}\Omega$ ; $T_j \geq 25\text{ }^\circ\text{C}$ ; $T_j \leq 175\text{ }^\circ\text{C}$	-	60	V
$V_{GS}$	gate-source voltage	$T_j \leq 175\text{ }^\circ\text{C}$ ; DC	-10	10	V
		$T_j \leq 175\text{ }^\circ\text{C}$	[1][2] -15	15	V
$I_D$	drain current	$T_{mb} = 25\text{ }^\circ\text{C}$ ; $V_{GS} = 5\text{ V}$ ; Fig. 1	-	22	A
		$T_{mb} = 100\text{ }^\circ\text{C}$ ; $V_{GS} = 5\text{ V}$ ; Fig. 1	-	16	A
$I_{DM}$	peak drain current	$T_{mb} = 25\text{ }^\circ\text{C}$ ; pulsed; $t_p \leq 10\text{ }\mu\text{s}$ ; Fig. 4	-	90	A

Symbol	Parameter	Conditions	Min	Max	Unit
$P_{tot}$	total power dissipation	$T_{mb} = 25\text{ °C}$ ; <a href="#">Fig. 2</a>	-	38	W
$T_{stg}$	storage temperature		-55	175	°C
$T_j$	junction temperature		-55	175	°C
$T_{sld(M)}$	peak soldering temperature		-	260	°C
<b>Source-drain diode FET1 and FET2</b>					
$I_S$	source current	$T_{mb} = 25\text{ °C}$	-	22	A
$I_{SM}$	peak source current	pulsed; $t_p \leq 10\text{ }\mu\text{s}$ ; $T_{mb} = 25\text{ °C}$	-	90	A
<b>Avalanche Ruggedness FET1 and FET2</b>					
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$I_D = 22\text{ A}$ ; $V_{sup} \leq 60\text{ V}$ ; $V_{GS} = 5\text{ V}$ ; $T_{j(init)} = 25\text{ °C}$ ; <a href="#">Fig. 3</a>	<a href="#">[3][4]</a>	-	19.5 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] Refer to application note AN10273 for further information
- [4] Single-pulse avalanche rating limited by maximum junction temperature of 175 °C



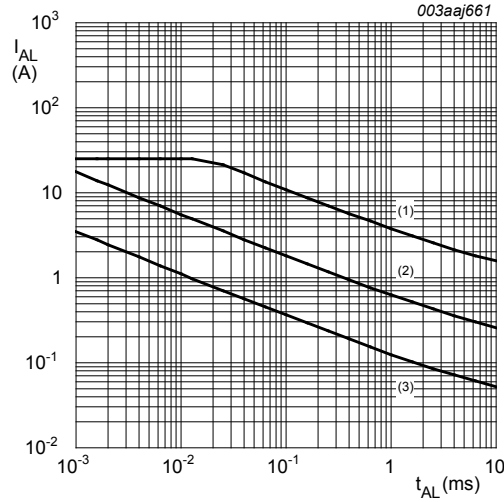


Fig. 3. Single-pulse and repetitive avalanche rating; avalanche current as a function of avalanche time, FET1 and FET2

- (1) Single-pulse;  $T_j = 25\text{ }^\circ\text{C}$ .
- (2) Single-pulse;  $T_j = 150\text{ }^\circ\text{C}$ .
- (3) Repetitive.

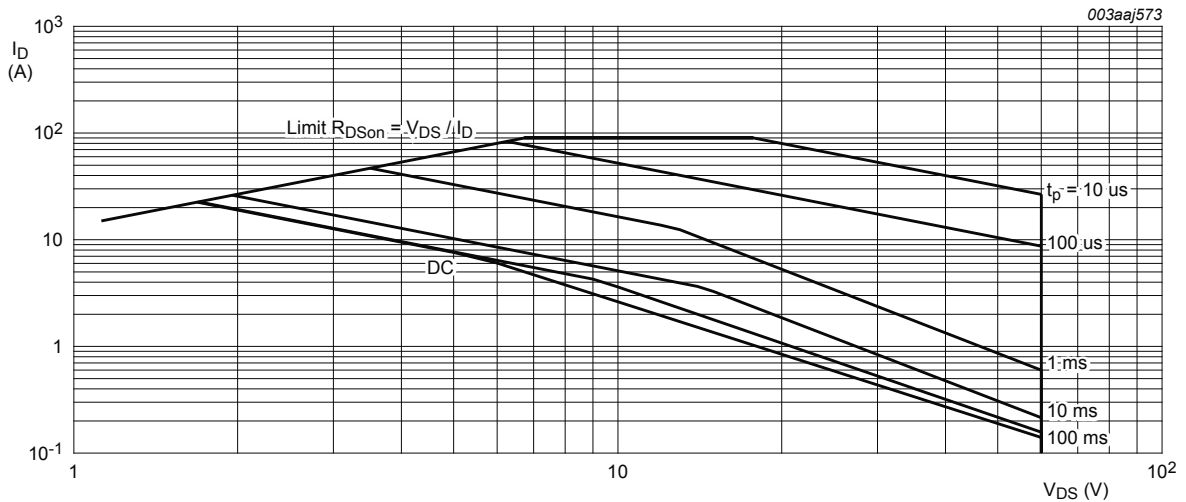


Fig. 4. Safe operating area; continuous and peak drain current as a function of drain-source voltage

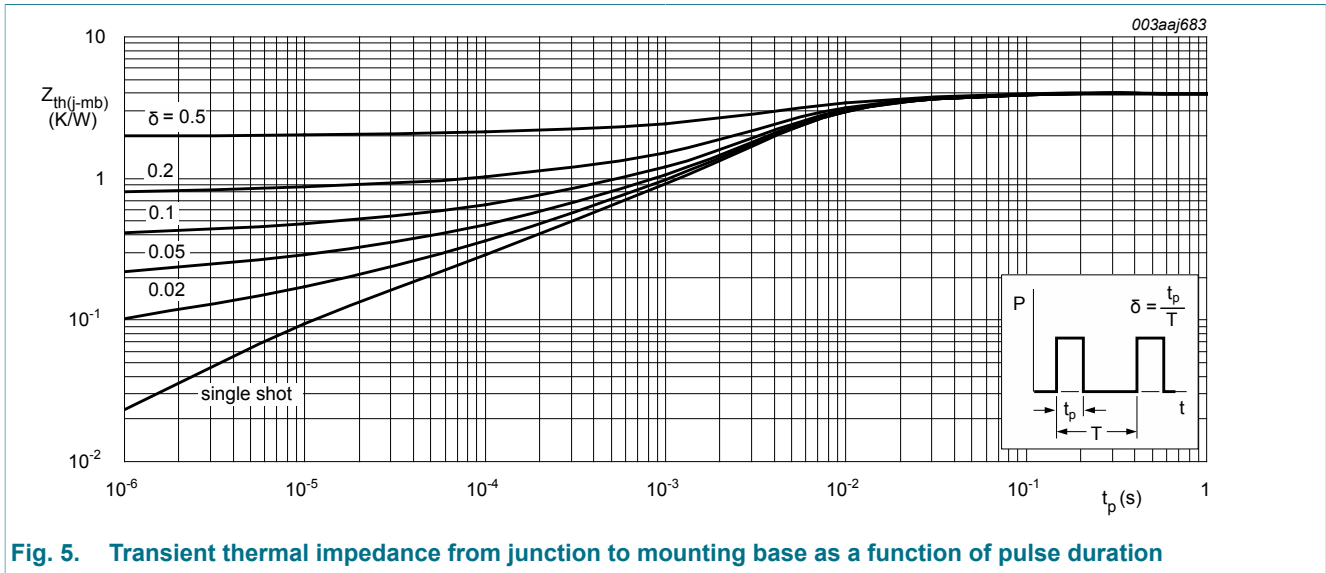
$T_{mb} = 25\text{ }^\circ\text{C}$ ;  $I_{DM}$  is single pulse

## 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	-	-	3.96	K/W

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	Minimum footprint; mounted on a printed circuit board	-	95	-	K/W

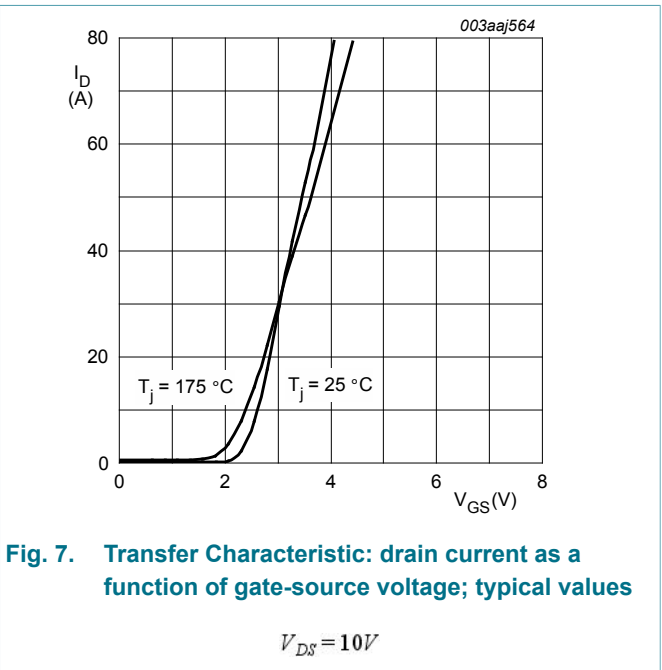
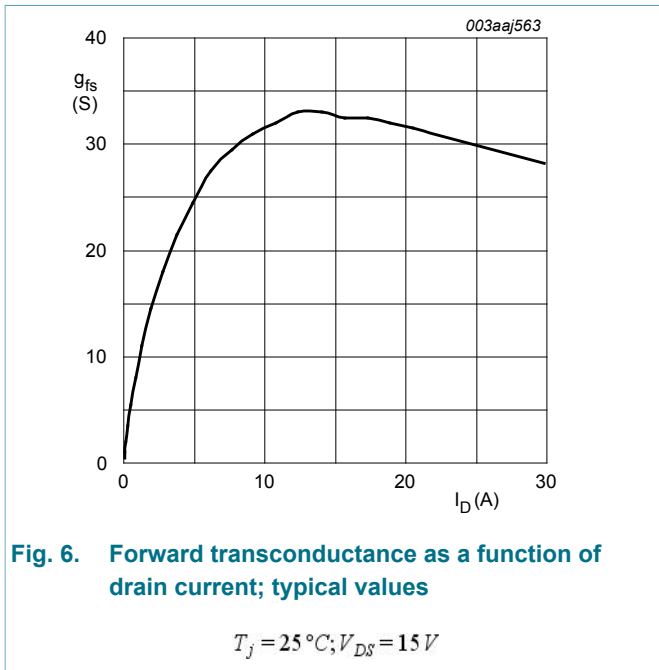


## 10. Characteristics

Table 7. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics FET1 and FET2</b>						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 250 \mu A; V_{GS} = 0 V; T_j = -55 \text{ }^\circ C$	54	-	-	V
		$I_D = 250 \mu A; V_{GS} = 0 V; T_j = 25 \text{ }^\circ C$	60	-	-	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. 10; Fig. 11</a>	1.4	1.7	2.1	V
		$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 175 \text{ }^\circ C;$ <a href="#">Fig. 10; Fig. 11</a>	0.5	-	-	V
		$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = -55 \text{ }^\circ C;$ <a href="#">Fig. 10; Fig. 11</a>	-	-	2.45	V
$I_{DSS}$	drain leakage current	$V_{DS} = 60 V; V_{GS} = 0 V; T_j = 175 \text{ }^\circ C$	-	-	500	$\mu A$
		$V_{DS} = 60 V; V_{GS} = 0 V; T_j = 25 \text{ }^\circ C$	-	0.02	1	$\mu A$
$I_{GSS}$	gate leakage current	$V_{GS} = -10 V; V_{DS} = 0 V; T_j = 25 \text{ }^\circ C$	-	2	100	nA
		$V_{GS} = 10 V; V_{DS} = 0 V; T_j = 25 \text{ }^\circ C$	-	2	100	nA
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = 5 V; I_D = 5 A; T_j = 25 \text{ }^\circ C;$ <a href="#">Fig. 12</a>	-	30.5	35	m $\Omega$
		$V_{GS} = 5 V; I_D = 5 A; T_j = 175 \text{ }^\circ C;$ <a href="#">Fig. 12; Fig. 13</a>	-	65.27	79	m $\Omega$
		$V_{GS} = 10 V; I_D = 5 A; T_j = 25 \text{ }^\circ C;$ <a href="#">Fig. 12</a>	-	26.8	32	m $\Omega$

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Dynamic characteristics FET1 and FET2</b>						
$Q_{G(tot)}$	total gate charge	$I_D = 5\text{ A}; V_{DS} = 48\text{ V}; V_{GS} = 10\text{ V};$ $T_j = 25\text{ }^\circ\text{C};$ <a href="#">Fig. 14</a> ; <a href="#">Fig. 15</a>	-	14.2	-	nC
$Q_{GS}$	gate-source charge		-	1.2	-	nC
$Q_{GD}$	gate-drain charge		-	3	-	nC
$C_{iss}$	input capacitance	$V_{GS} = 0\text{ V}; V_{DS} = 25\text{ V}; f = 1\text{ MHz};$ $T_j = 25\text{ }^\circ\text{C};$ <a href="#">Fig. 16</a>	-	811	1081	pF
$C_{oss}$	output capacitance		-	83	100	pF
$C_{rss}$	reverse transfer capacitance		-	51	70	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = 48\text{ V}; R_L = 10\text{ }\Omega; V_{GS} = 10\text{ V};$ $R_{G(ext)} = 5\text{ }\Omega; T_j = 25\text{ }^\circ\text{C}; I_D = 5\text{ A}$	-	3.9	-	ns
$t_r$	rise time		-	3.7	-	ns
$t_{d(off)}$	turn-off delay time		-	20.5	-	ns
$t_f$	fall time		-	10	-	ns
<b>Source-drain diode FET1 and FET2</b>						
$V_{SD}$	source-drain voltage	$I_S = 10\text{ A}; V_{GS} = 0\text{ V}; T_j = 25\text{ }^\circ\text{C};$ <a href="#">Fig. 17</a>	-	0.78	1.2	V
$t_{rr}$	reverse recovery time	$I_S = 5\text{ A}; dI_S/dt = -100\text{ A}/\mu\text{s}; V_{GS} = 0\text{ V};$	-	17.6	-	ns
$Q_r$	recovered charge	$V_{DS} = 30\text{ V}; T_j = 25\text{ }^\circ\text{C}$	-	12.1	-	nC



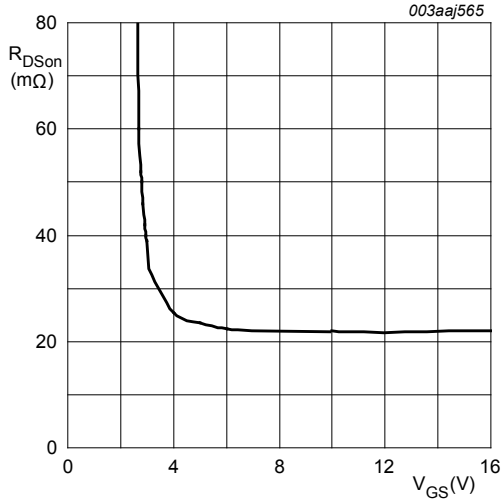


Fig. 8. Drain-source on-state resistance as a function of gate-source voltage; typical values

$T_j = 25^\circ\text{C}; I_D = 5\text{ A}$

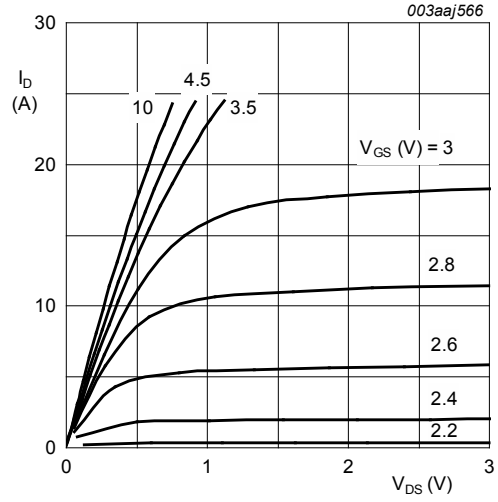


Fig. 9. Output characteristics: drain current as a function of drain-source voltage; typical values

$T_j = 25^\circ\text{C}$

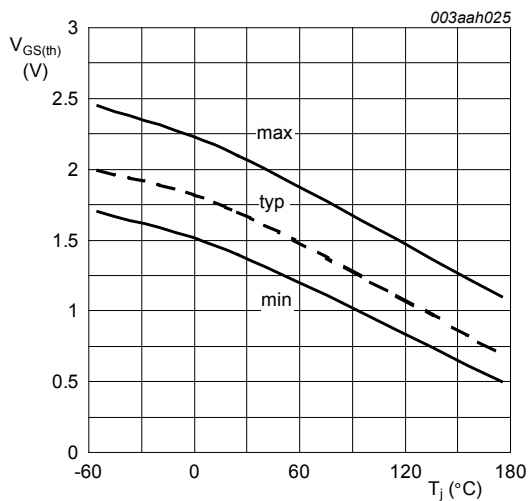


Fig. 10. Gate-source threshold voltage as a function of junction temperature

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

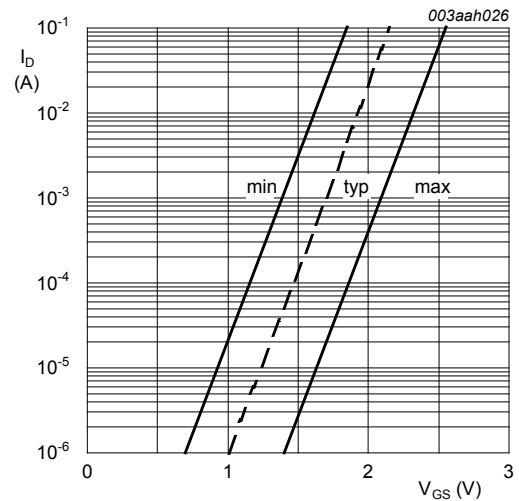


Fig. 11. Sub-threshold drain current as a function of gate-source voltage

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

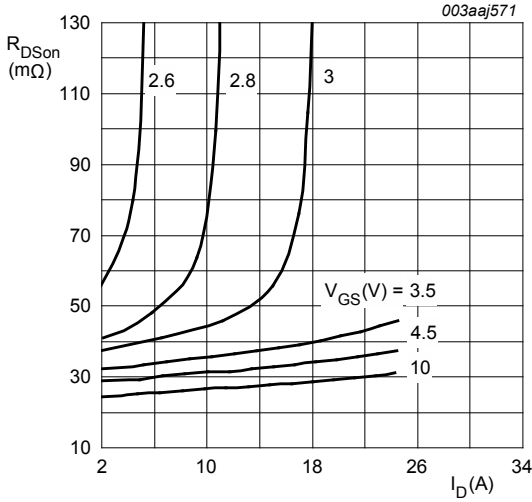


Fig. 12. Drain-source on-state resistance as a function of drain current; typical values

$T_j = 25^\circ\text{C}$

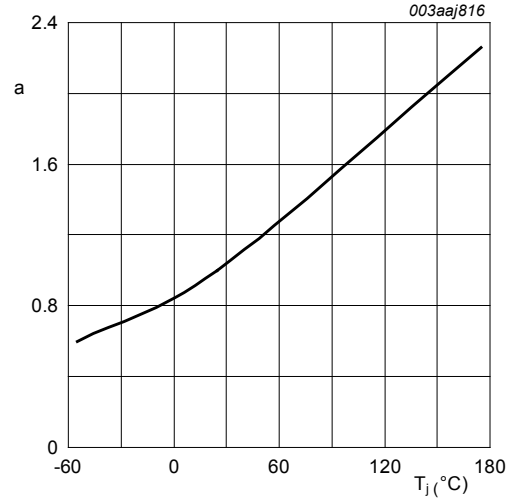


Fig. 13. Normalized drain-source on-state resistance factor as a function of junction temperature

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

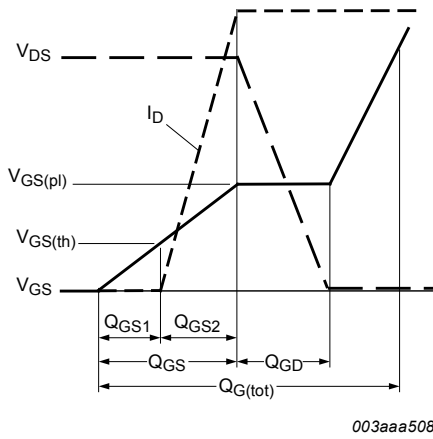


Fig. 14. Gate charge waveform definitions

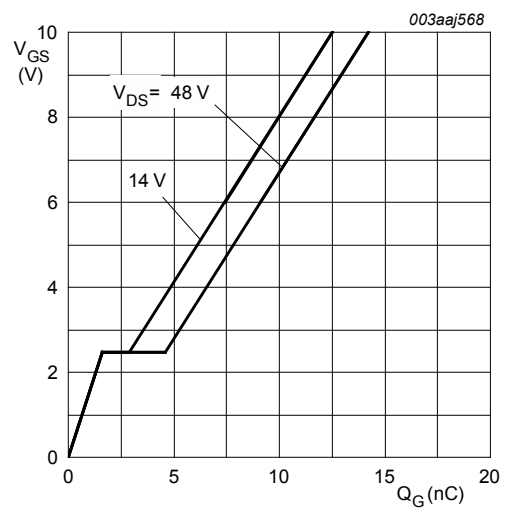
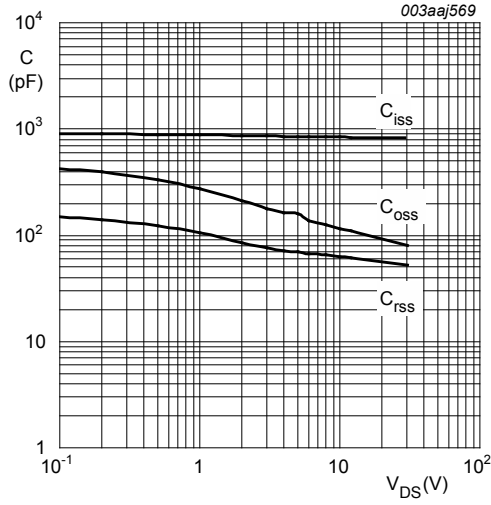


Fig. 15. Gate-source voltage as a function of gate charge; typical values

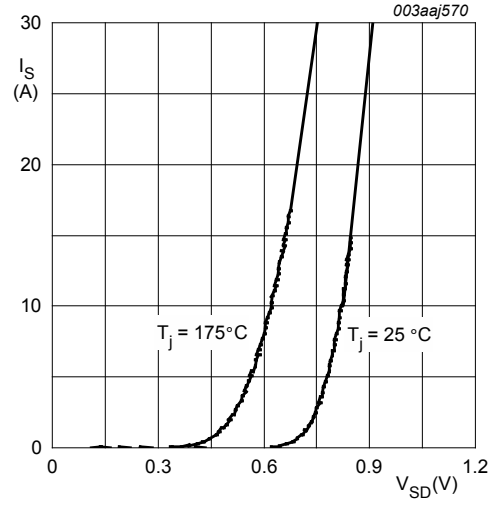
$T_j = 25^\circ\text{C}; I_D = 5\text{ A}$





**Fig. 16. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values**

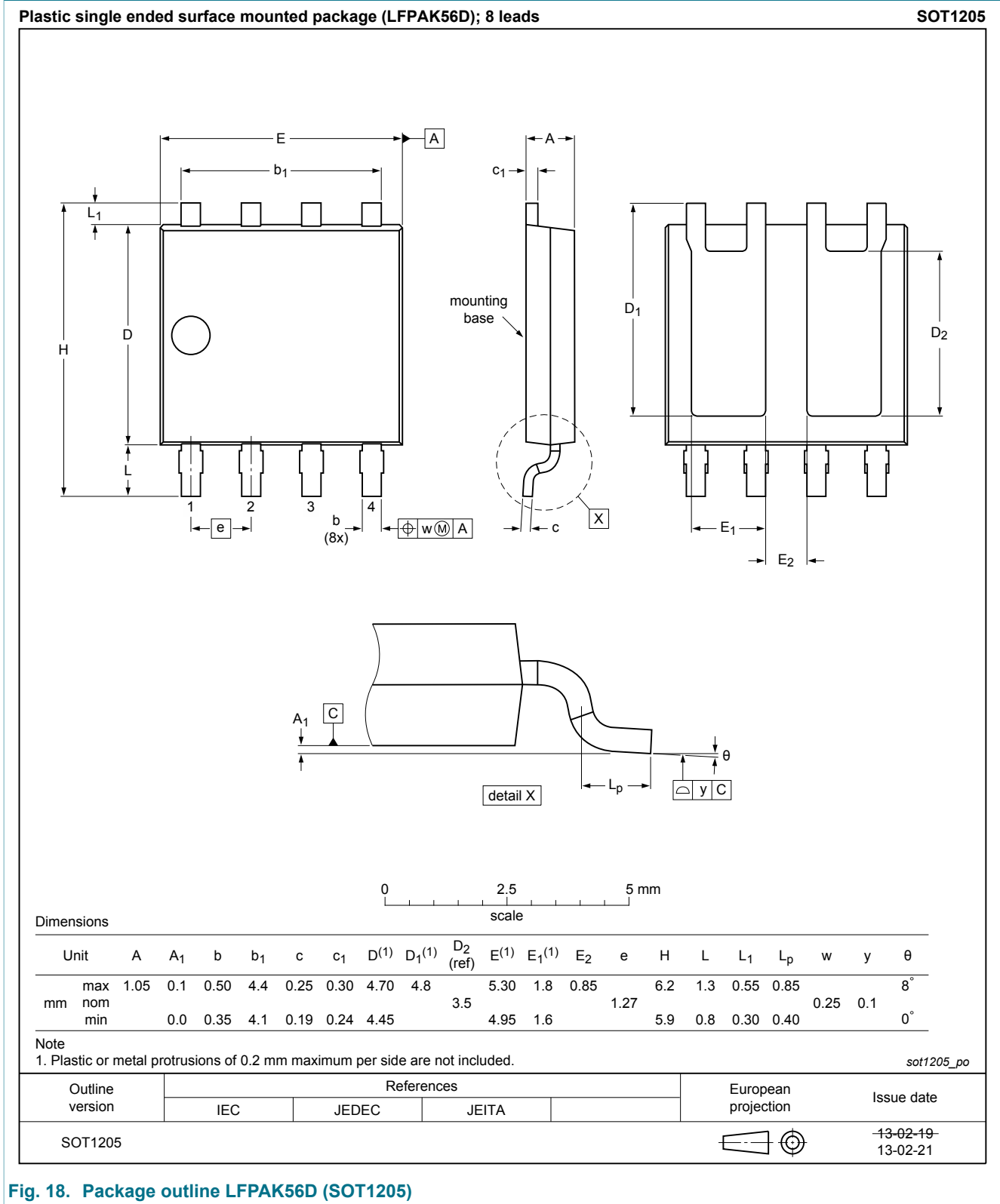
$$V_{GS} = 0V; f = 1MHz$$



**Fig. 17. Source current as a function of source-drain voltage; typical values**

$$V_{GS} = 0V$$

### 11. Package outline



**Fig. 18. Package outline LPAK56D (SOT1205)**

## 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.
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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