



# BUK9M11-40H

N-channel 40 V, 11.0 mΩ logic level MOSFET in LFPAK33

29 January 2019

Product data sheet

## 1. General description

Automotive qualified logic level N-channel MOSFET in an LFPAK33 package using Trench 9 TrenchMOS technology. This product has been designed and qualified to AEC-Q101 for use in high performance automotive applications.

## 2. Features and benefits

- Fully automotive qualified to AEC-Q101 at 175 °C
- Trench 9 superjunction technology:
  - Low power losses, high power density
- LFPAK copper clip package technology:
  - High robustness and reliability
  - Gull wing leads for high manufacturability and AOI
- Repetitive avalanche rated

## 3. Applications

- 12 V automotive systems
- Powertrain, chassis, body and infotainment applications
- Medium/Low power motor drive
- DC-DC systems
- LED lighting

## 4. Quick reference data

Table 1. Quick reference data

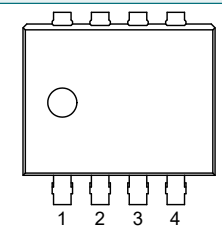
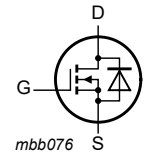
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$V_{DS}$	drain-source voltage	$25\text{ °C} \leq T_j \leq 175\text{ °C}$		-	-	40	V
$I_D$	drain current	$V_{GS} = 10\text{ V}; T_{mb} = 25\text{ °C};$ <a href="#">Fig. 2</a>	[1]	-	-	35	A
$P_{tot}$	total power dissipation	$T_{mb} = 25\text{ °C};$ <a href="#">Fig. 1</a>		-	-	50	W
<b>Static characteristics</b>							
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 10\text{ V}; I_D = 10\text{ A}; T_j = 25\text{ °C};$ <a href="#">Fig. 11</a>		6.3	9	11	mΩ
<b>Dynamic characteristics</b>							
$Q_{GD}$	gate-drain charge	$I_D = 10\text{ A}; V_{DS} = 20\text{ V}; V_{GS} = 4.5\text{ V};$ <a href="#">Fig. 13; Fig. 14</a>		-	1.6	3.2	nC
<b>Source-drain diode</b>							
$Q_r$	recovered charge	$I_S = 10\text{ A}; dI_S/dt = -100\text{ A}/\mu\text{s}; V_{GS} = 0\text{ V};$ $V_{DS} = 20\text{ V}$		-	13	-	nC

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
S	softness factor	$I_S = 10 \text{ A}$ ; $di_S/dt = -100 \text{ A}/\mu\text{s}$ ; $V_{GS} = 0 \text{ V}$ ; $V_{DS} = 20 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$ ; <a href="#">Fig. 17</a>	-	0.6	-	

[1] 35A 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>LFPAK33 (SOT1210)</p>	 <p>mbb076 S</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
BUK9M11-40H	LFPAK33	Plastic, single ended surface mounted package (LFPAK33); 8 leads; 0.65 mm pitch	SOT1210

## 7. Marking

Table 4. Marking codes

Type number	Marking code
BUK9M11-40H	91140H

## 8. Limiting values

Table 5. Limiting values

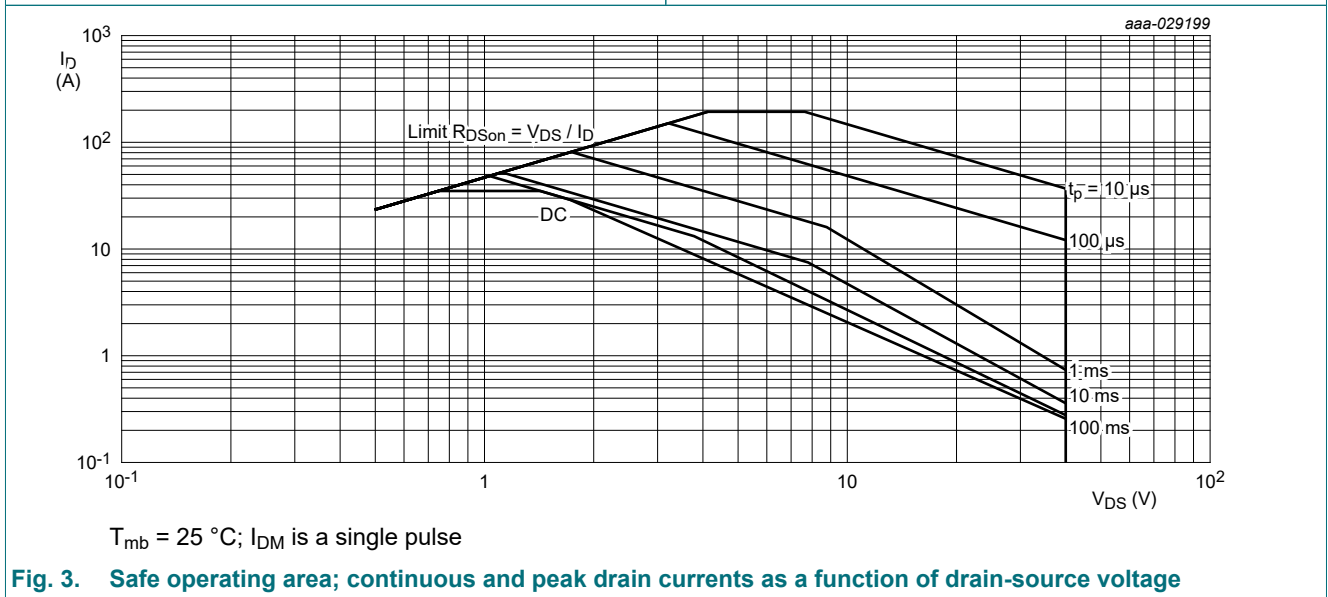
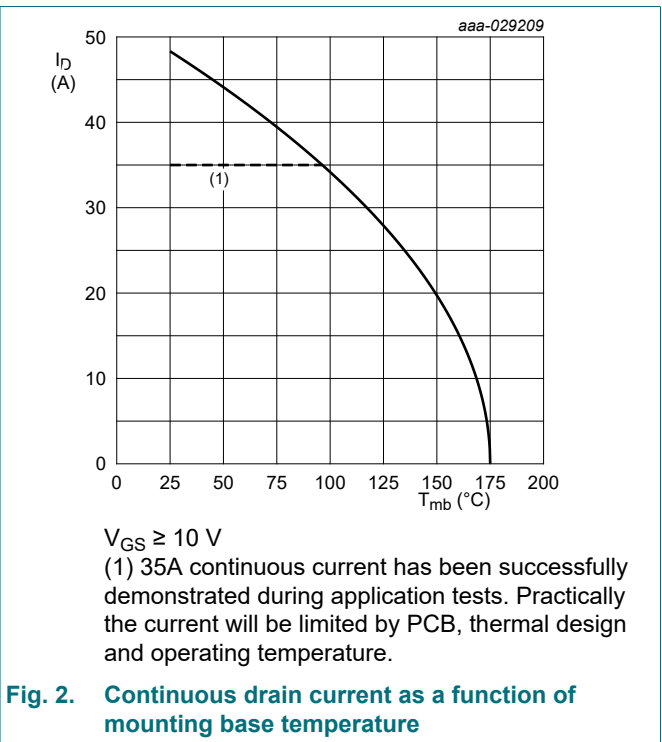
In accordance with the Absolute Maximum Rating System (IEC 60134).

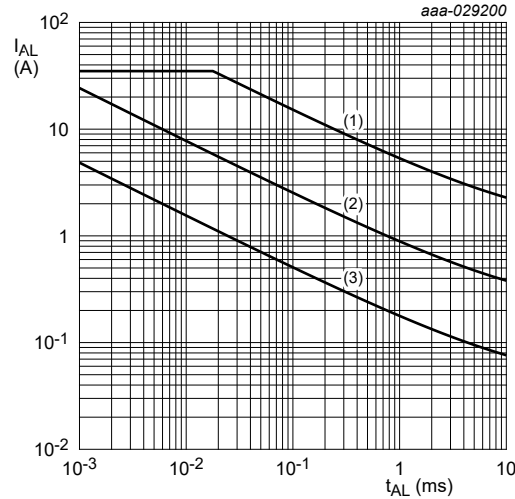
Symbol	Parameter	Conditions	Min	Max	Unit
$V_{DS}$	drain-source voltage	$25 \text{ }^\circ\text{C} \leq T_j \leq 175 \text{ }^\circ\text{C}$	-	40	V
$V_{GS}$	gate-source voltage	DC; $T_j \leq 175 \text{ }^\circ\text{C}$	-10	16	V
$P_{tot}$	total power dissipation	$T_{mb} = 25 \text{ }^\circ\text{C}$ ; <a href="#">Fig. 1</a>	-	50	W
$I_D$	drain current	$V_{GS} = 10 \text{ V}$ ; $T_{mb} = 25 \text{ }^\circ\text{C}$ ; <a href="#">Fig. 2</a>	[1]	35	A
		$V_{GS} = 10 \text{ V}$ ; $T_{mb} = 100 \text{ }^\circ\text{C}$ ; <a href="#">Fig. 2</a>	-	34	A
$I_{DM}$	peak drain current	pulsed; $t_p \leq 10 \mu\text{s}$ ; $T_{mb} = 25 \text{ }^\circ\text{C}$ ; <a href="#">Fig. 3</a>	-	193	A
$T_{stg}$	storage temperature		-55	175	$^\circ\text{C}$
$T_j$	junction temperature		-55	175	$^\circ\text{C}$

**Source-drain diode**

Symbol	Parameter	Conditions	Min	Max	Unit
$I_S$	source current	$T_{mb} = 25\text{ °C}$	-	35	A
$I_{SM}$	peak source current	pulsed; $t_p \leq 10\text{ }\mu\text{s}$ ; $T_{mb} = 25\text{ °C}$	-	193	A
<b>Avalanche ruggedness</b>					
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$I_D = 35\text{ A}$ ; $V_{sup} \leq 40\text{ V}$ ; $R_{GS} = 50\text{ }\Omega$ ; $V_{GS} = 10\text{ V}$ ; $T_{j(\text{init})} = 25\text{ °C}$ ; unclamped; <a href="#">Fig. 4</a>	[2] [3]	16	mJ

- [1] 35A 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.





(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	-	2.8	3	K/W

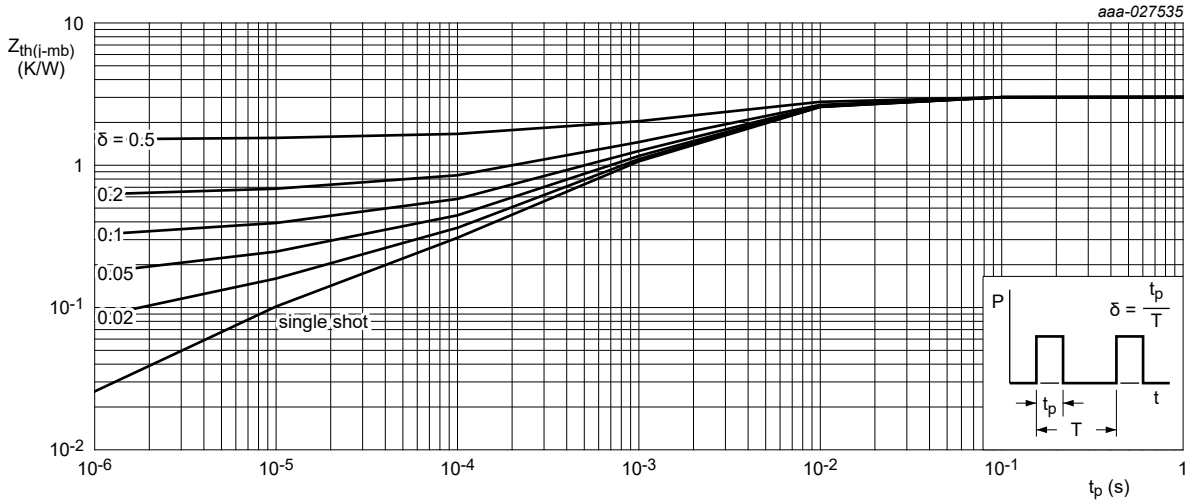


Fig. 5. Transient thermal impedance from junction to mounting base as a function of pulse duration

### 10. Characteristics

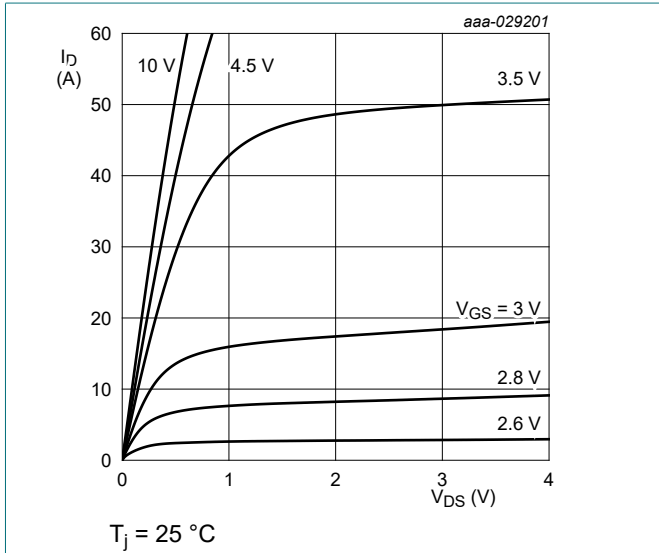
Table 7. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics</b>						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 250\text{ }\mu\text{A}; V_{GS} = 0\text{ V}; T_j = 25\text{ °C}$	40	43	-	V
		$I_D = 250\text{ }\mu\text{A}; V_{GS} = 0\text{ V}; T_j = -40\text{ °C}$	-	40.5	-	V

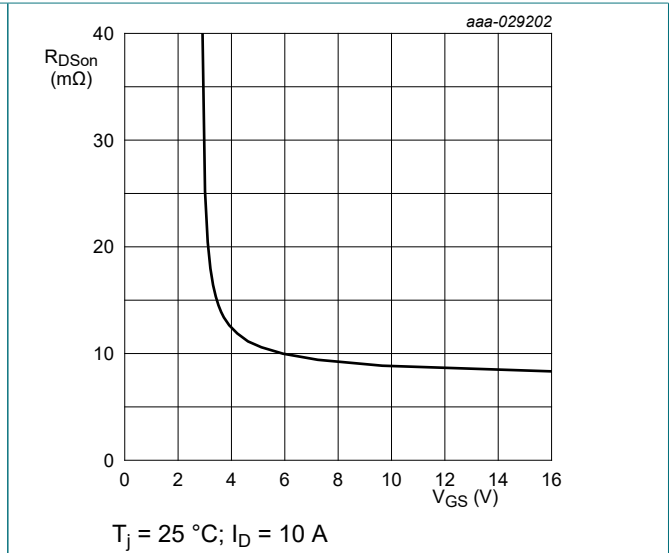
## N-channel 40 V, 11.0 mΩ logic level MOSFET in LPAK33

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
		$I_D = 250 \mu\text{A}; V_{GS} = 0 \text{ V}; T_j = -55 \text{ }^\circ\text{C}$	36	40	-	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 1 \text{ mA}; V_{DS}=V_{GS}; T_j = 25 \text{ }^\circ\text{C};$ <a href="#">Fig. 9</a> ; <a href="#">Fig. 10</a>	1.5	1.85	2.2	V
		$I_D = 1 \text{ mA}; V_{DS}=V_{GS}; T_j = -55 \text{ }^\circ\text{C};$ <a href="#">Fig. 10</a>	-	-	2.6	V
		$I_D = 1 \text{ mA}; V_{DS}=V_{GS}; T_j = 175 \text{ }^\circ\text{C};$ <a href="#">Fig. 10</a>	0.7	-	-	V
$I_{DSS}$	drain leakage current	$V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	0.01	5	$\mu\text{A}$
		$V_{DS} = 16 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 125 \text{ }^\circ\text{C}$	-	0.32	10	$\mu\text{A}$
		$V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 175 \text{ }^\circ\text{C}$	-	23	500	$\mu\text{A}$
$I_{GSS}$	gate leakage current	$V_{GS} = 16 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	2	100	nA
		$V_{GS} = -10 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	2	100	nA
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 10 \text{ V}; I_D = 10 \text{ A}; T_j = 25 \text{ }^\circ\text{C};$ <a href="#">Fig. 11</a>	6.3	9	11	mΩ
		$V_{GS} = 10 \text{ V}; I_D = 10 \text{ A}; T_j = 105 \text{ }^\circ\text{C};$ <a href="#">Fig. 12</a>	8.6	12.9	16.5	mΩ
		$V_{GS} = 10 \text{ V}; I_D = 10 \text{ A}; T_j = 125 \text{ }^\circ\text{C};$ <a href="#">Fig. 12</a>	9.5	14.1	17.7	mΩ
		$V_{GS} = 10 \text{ V}; I_D = 10 \text{ A}; T_j = 175 \text{ }^\circ\text{C};$ <a href="#">Fig. 12</a>	11.5	16.9	21.3	mΩ
		$V_{GS} = 4.5 \text{ V}; I_D = 10 \text{ A}; T_j = 25 \text{ }^\circ\text{C};$ <a href="#">Fig. 11</a>	7.9	11.3	14	mΩ
		$V_{GS} = 4.5 \text{ V}; I_D = 10 \text{ A}; T_j = 105 \text{ }^\circ\text{C};$ <a href="#">Fig. 12</a>	10.8	16.1	21	mΩ
		$V_{GS} = 4.5 \text{ V}; I_D = 10 \text{ A}; T_j = 125 \text{ }^\circ\text{C};$ <a href="#">Fig. 12</a>	11.9	17.4	22.6	mΩ
		$V_{GS} = 4.5 \text{ V}; I_D = 10 \text{ A}; T_j = 175 \text{ }^\circ\text{C};$ <a href="#">Fig. 12</a>	14.4	21	27.2	mΩ
$R_G$	gate resistance	$f = 1 \text{ MHz}; T_j = 25 \text{ }^\circ\text{C}$	0.3	0.9	2.3	Ω
<b>Dynamic characteristics</b>						
$Q_{G(tot)}$	total gate charge	$I_D = 10 \text{ A}; V_{DS} = 20 \text{ V}; V_{GS} = 10 \text{ V};$ <a href="#">Fig. 13</a> ; <a href="#">Fig. 14</a>	-	15	21	nC
		$I_D = 10 \text{ A}; V_{DS} = 20 \text{ V}; V_{GS} = 4.5 \text{ V};$ <a href="#">Fig. 13</a> ; <a href="#">Fig. 14</a>	-	6.8	9.5	nC
$Q_{GS}$	gate-source charge		-	2.7	4.1	nC
$Q_{GD}$	gate-drain charge		-	1.6	3.2	nC
$C_{iss}$	input capacitance	$V_{DS} = 25 \text{ V}; V_{GS} = 0 \text{ V}; f = 1 \text{ MHz};$ $T_j = 25 \text{ }^\circ\text{C};$ <a href="#">Fig. 15</a>	-	961	1345	pF
$C_{oss}$	output capacitance		-	273	382	pF
$C_{rss}$	reverse transfer capacitance		-	37	82	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = 20 \text{ V}; R_L = 2 \text{ } \Omega; V_{GS} = 4.5 \text{ V};$ $R_{G(ext)} = 5 \text{ } \Omega$	-	8.3	-	ns
$t_r$	rise time		-	6.5	-	ns
$t_{d(off)}$	turn-off delay time		-	9.5	-	ns
$t_f$	fall time		-	4.5	-	ns
<b>Source-drain diode</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. 16</a>	-	0.83	1.2	V
$t_{rr}$	reverse recovery time	$I_S = 10 \text{ A}; dI_S/dt = -100 \text{ A}/\mu\text{s}; V_{GS} = 0 \text{ V};$ $V_{DS} = 20 \text{ V};$ <a href="#">Fig. 17</a>	-	20	-	ns
$Q_r$	recovered charge	$I_S = 10 \text{ A}; dI_S/dt = -100 \text{ A}/\mu\text{s}; V_{GS} = 0 \text{ V};$ $V_{DS} = 20 \text{ V}$	-	13	-	nC

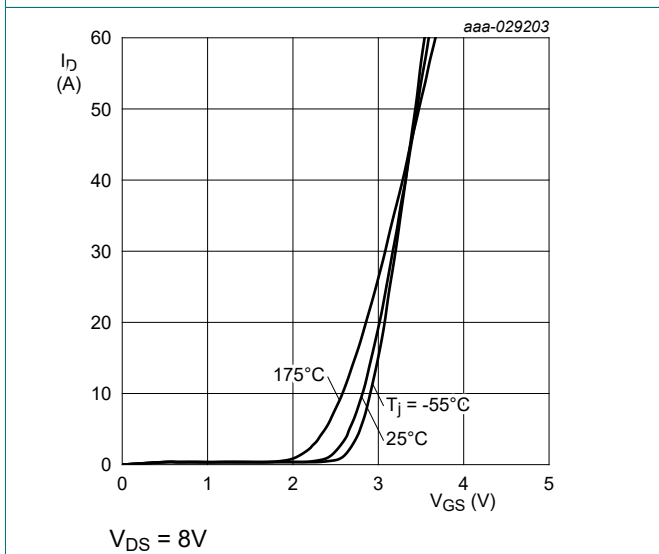
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
S	softness factor	$I_S = 10 \text{ A}$ ; $di_S/dt = -100 \text{ A}/\mu\text{s}$ ; $V_{GS} = 0 \text{ V}$ ; $V_{DS} = 20 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$ ; <a href="#">Fig. 17</a>	-	0.6	-	
		$I_S = 10 \text{ A}$ ; $di_S/dt = -500 \text{ A}/\mu\text{s}$ ; $V_{GS} = 0 \text{ V}$ ; $V_{DS} = 20 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$ ; <a href="#">Fig. 17</a>	-	0.32	-	



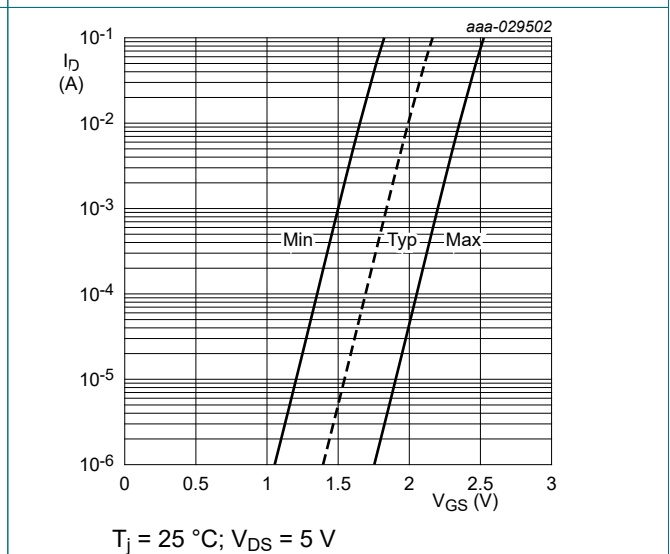
**Fig. 6. Output characteristics; drain current as a function of drain-source voltage; typical values**



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



**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**

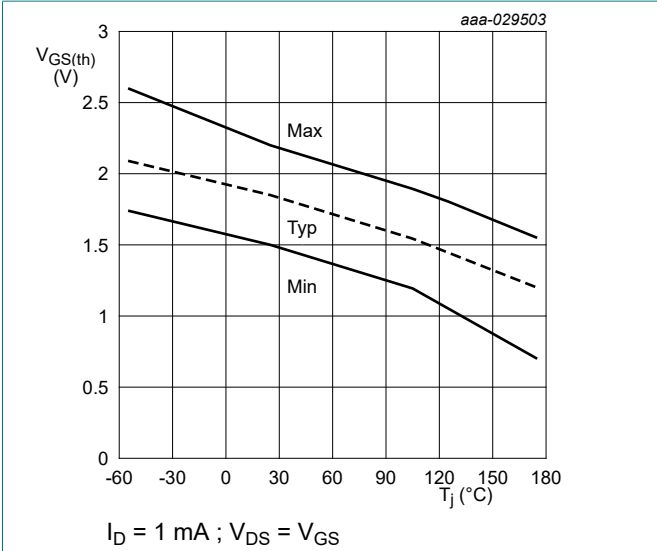


Fig. 10. Gate-source threshold voltage as a function of junction temperature

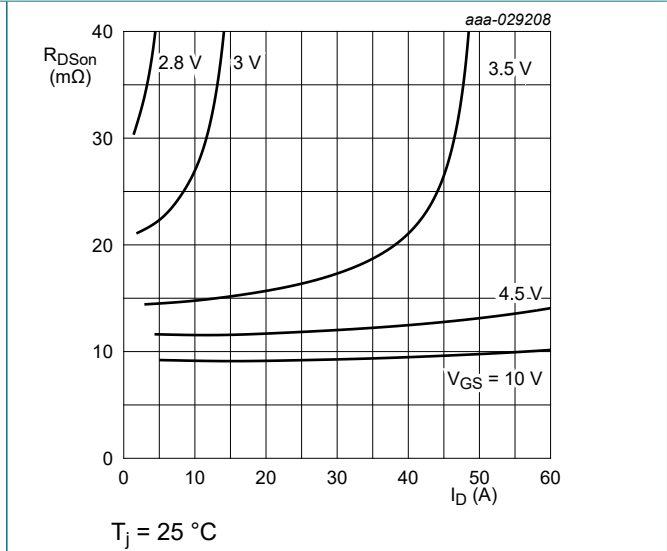


Fig. 11. Drain-source on-state resistance as a function of drain current; typical values

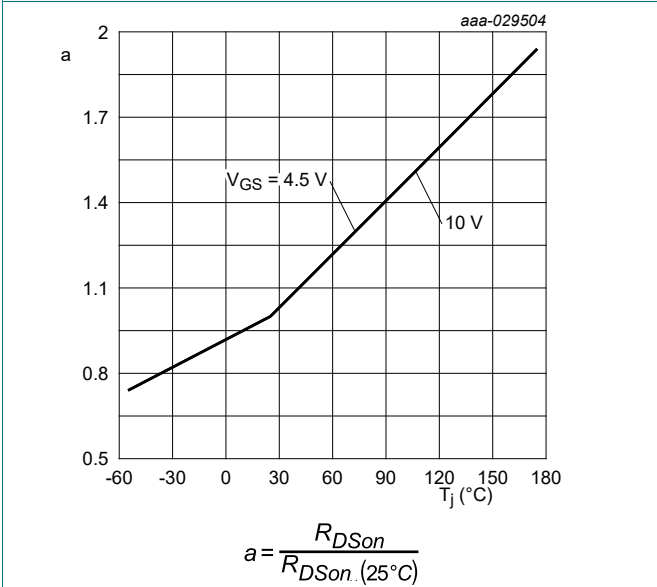


Fig. 12. Normalized drain-source on-state resistance factor as a function of junction temperature

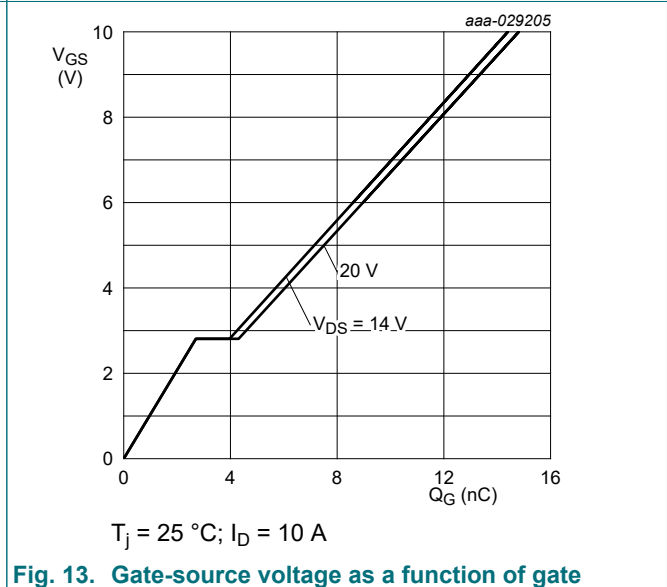


Fig. 13. Gate-source voltage as a function of gate charge; typical values

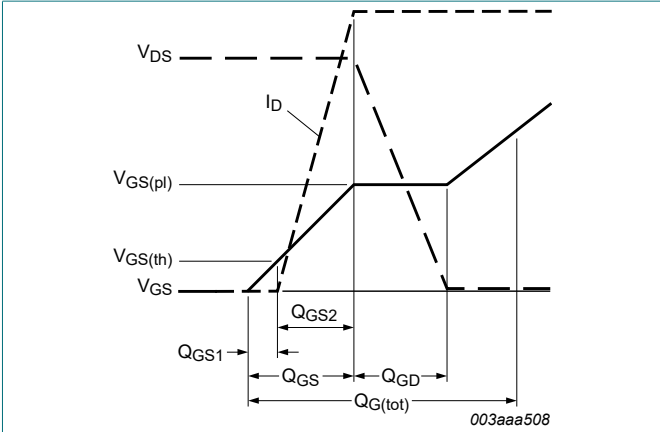


Fig. 14. Gate charge waveform definitions

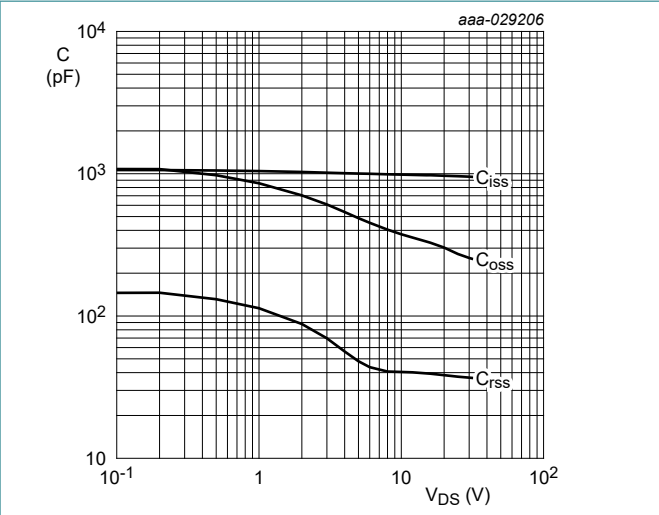


Fig. 15. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values  
 $V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$

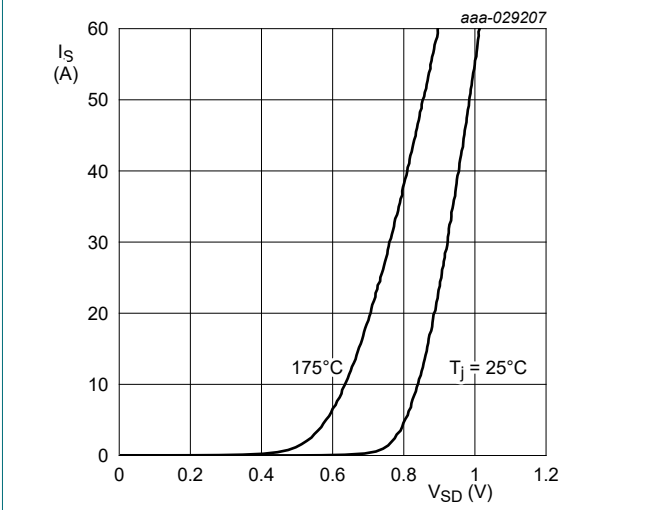


Fig. 16. Source-drain (diode forward) current as a function of source-drain (diode forward) voltage; typical values  
 $V_{GS} = 0 \text{ V}$

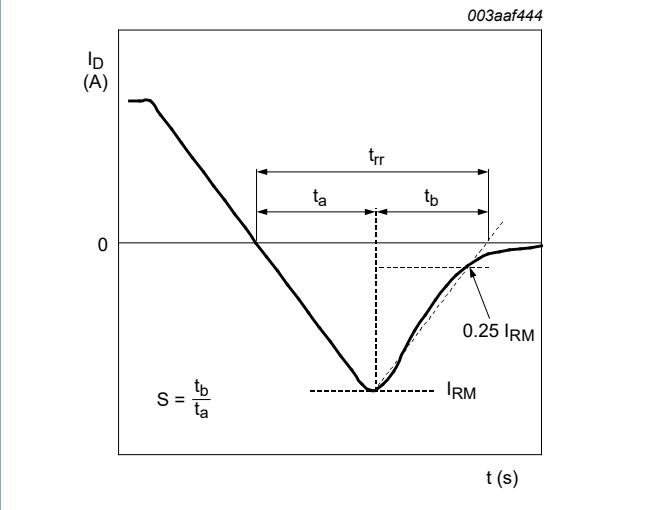


Fig. 17. Reverse recovery timing definition



11. Package outline

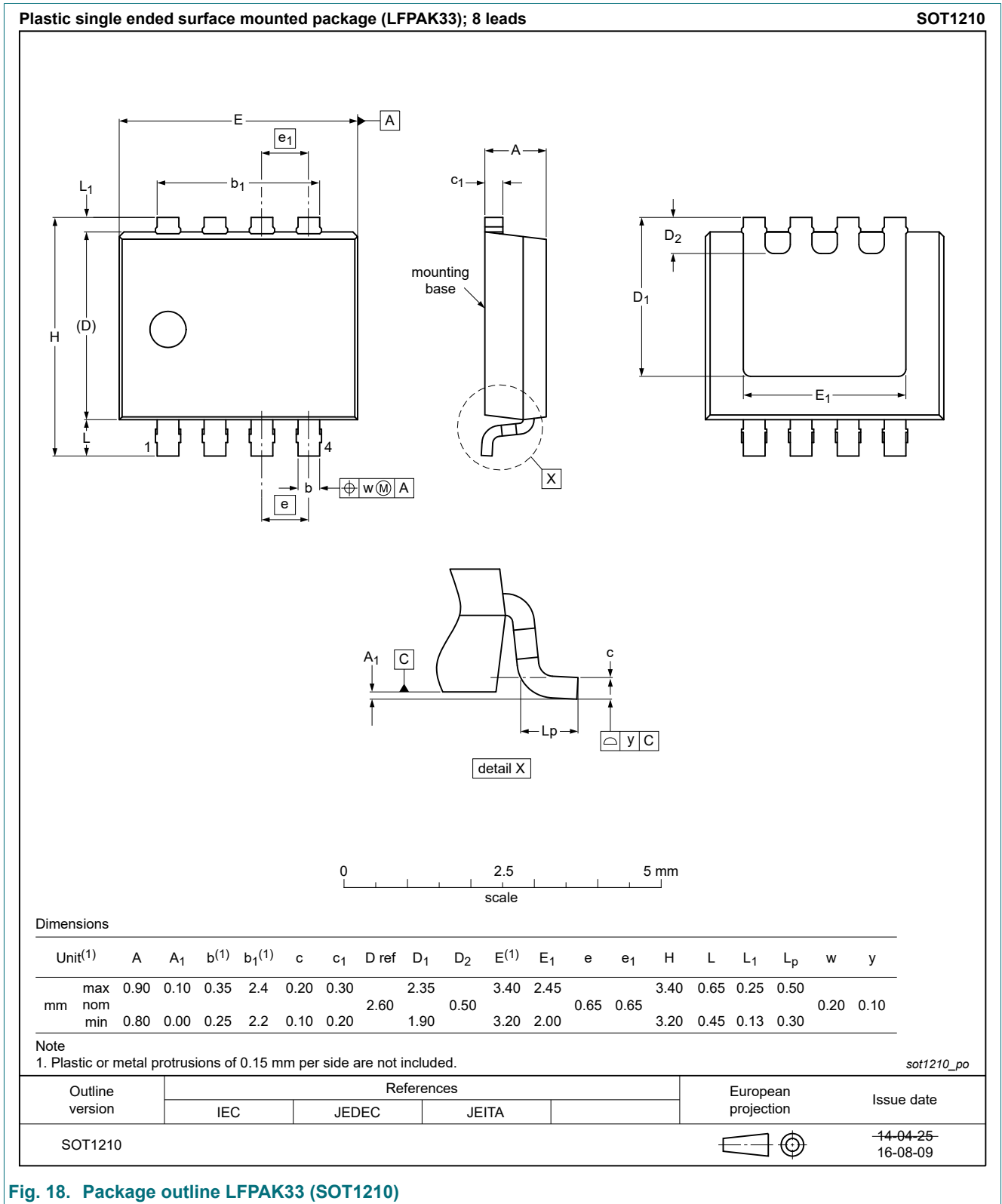


Fig. 18. Package outline LPAK33 (SOT1210)

## 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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