



BUK9M20-60EL

Single N-channel 60 V, 13 mOhm logic level MOSFET in LFPAK33 using Enhanced SOA technology

7 April 2022

Product data sheet

1. General description

Single, logic level, N-channel MOSFET in LFPAK33 using Application specific (ASFET) Enhanced SOA technology. This product has been designed and qualified to AEC-Q101 for use in linear mode in airbag applications.

2. Features and benefits

- Fully automotive qualified to AEC-Q101 at 175 °C
- Enhanced SOA technology for improved linear mode performance
- LFPAK copper clip package technology:
 - High robustness and current handling capability
 - Gull wing leads for easy AOI inspection and exceptional board level reliability

3. Applications

- 12 V automotive systems
- Airbag squib voltage regulator MOSFET

4. Quick reference data

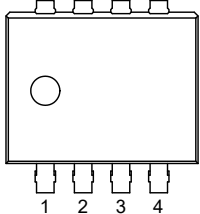
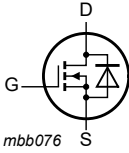
Table 1. Quick reference data

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{DS}	drain-source voltage	$25\text{ °C} \leq T_j \leq 175\text{ °C}$		-	-	60	V
I_D	drain current	$V_{GS} = 10\text{ V}; T_{mb} = 25\text{ °C};$ Fig. 2	[1]	-	-	40	A
P_{tot}	total power dissipation	$T_{mb} = 25\text{ °C};$ Fig. 1		-	-	79.4	W
Static characteristics							
R_{DSon}	drain-source on-state resistance	$V_{GS} = 10\text{ V}; I_D = 15\text{ A}; T_j = 25\text{ °C};$ Fig. 13		7.3	10.4	13	mΩ
Dynamic characteristics							
Q_{GD}	gate-drain charge	$I_D = 15\text{ A}; V_{DS} = 48\text{ V}; V_{GS} = 4.5\text{ V};$ $T_j = 25\text{ °C};$ Fig. 15; Fig. 16		-	9	18	nC

[1] 40 A 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>LFAK33 (SOT1210)</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
BUK9M20-60EL	LFAK33	Plastic, single ended surface mounted package (LFAK33); 8 leads; 0.65 mm pitch	SOT1210

7. Marking

Table 4. Marking codes

Type number	Marking code
BUK9M20-60EL	9206EL

8. Limiting values

Table 5. Limiting values

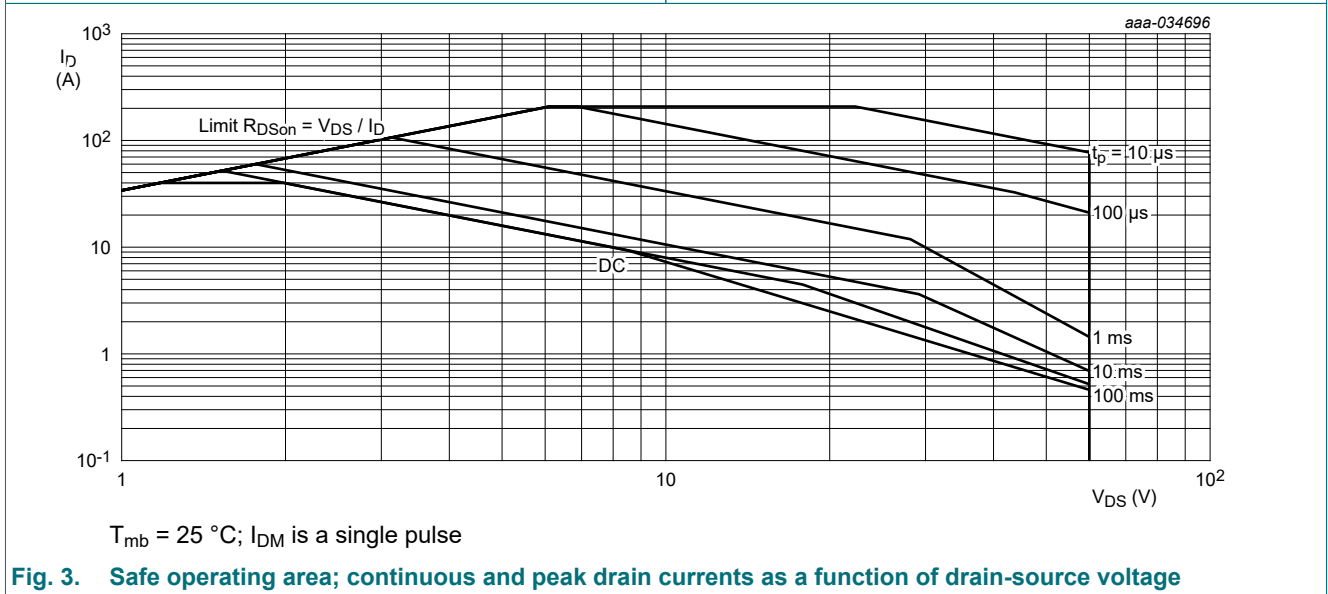
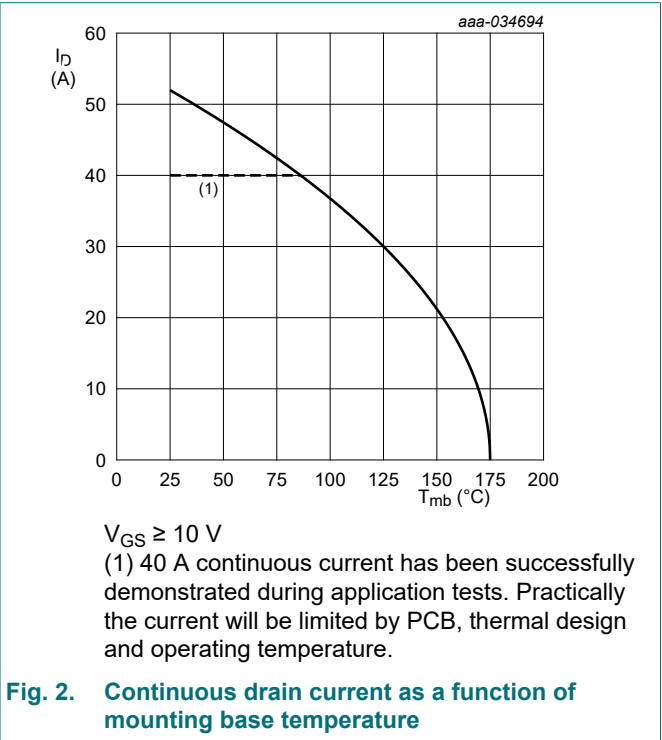
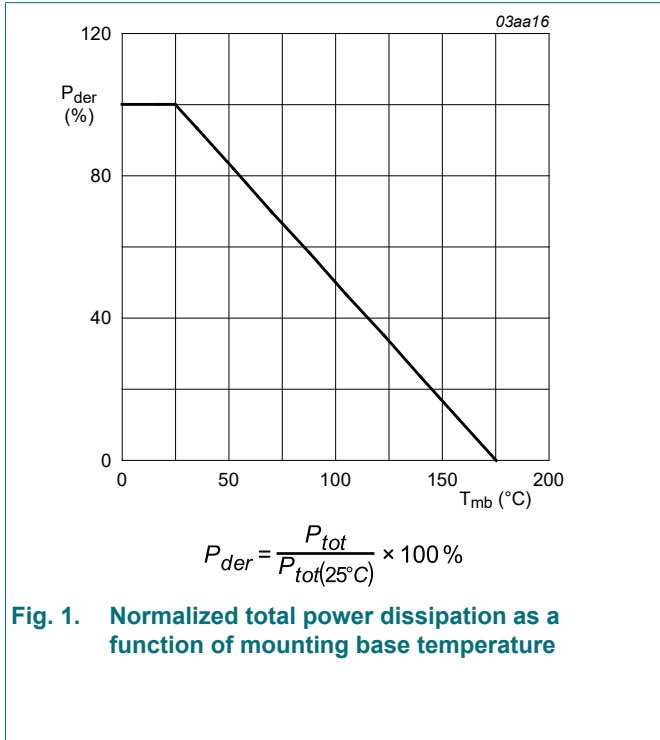
In accordance with the Absolute Maximum Rating System (IEC 60134). $T_j = 25\text{ °C}$ unless otherwise stated.

Symbol	Parameter	Conditions		Min	Max	Unit
V_{DS}	drain-source voltage	$25\text{ °C} \leq T_j \leq 175\text{ °C}$		-	60	V
V_{GS}	gate-source voltage	DC; $T_j \leq 175\text{ °C}$		-10	10	V
P_{tot}	total power dissipation	$T_{mb} = 25\text{ °C}$; Fig. 1		-	79.4	W
I_D	drain current	$V_{GS} = 10\text{ V}$; $T_{mb} = 25\text{ °C}$; Fig. 2	[1]	-	40	A
		$V_{GS} = 10\text{ V}$; $T_{mb} = 100\text{ °C}$; Fig. 2		-	37	A
I_{DM}	peak drain current	pulsed; $t_p \leq 10\text{ }\mu\text{s}$; $T_{mb} = 25\text{ °C}$; Fig. 3; Fig. 4		-	208	A
T_{stg}	storage temperature			-55	175	°C
T_j	junction temperature			-55	175	°C
Source-drain diode						
I_S	source current	$T_{mb} = 25\text{ °C}$		-	40	A
I_{SM}	peak source current	pulsed; $t_p \leq 10\text{ }\mu\text{s}$; $T_{mb} = 25\text{ °C}$		-	208	A
Avalanche ruggedness						
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$I_D = 37\text{ A}$; $V_{sup} \leq 60\text{ V}$; $R_{GS} = 50\text{ }\Omega$; $V_{GS} = 10\text{ V}$; $T_{j(init)} = 25\text{ °C}$; unclamped; $t_p = 51\text{ }\mu\text{s}$; Fig. 5	[2] [3]	-	74	mJ

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Symbol	Parameter	Conditions	Min	Max	Unit	
I_{AS}	non-repetitive avalanche current	$V_{sup} \leq 60\text{ V}$; $V_{GS} = 10\text{ V}$; $T_{j(\text{init})} = 25\text{ }^\circ\text{C}$; $R_{GS} = 50\text{ }\Omega$; Fig. 5	[2] [3] [4]	-	37	A

- [1] 40 A 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.
- [4] Protected by 100% test.



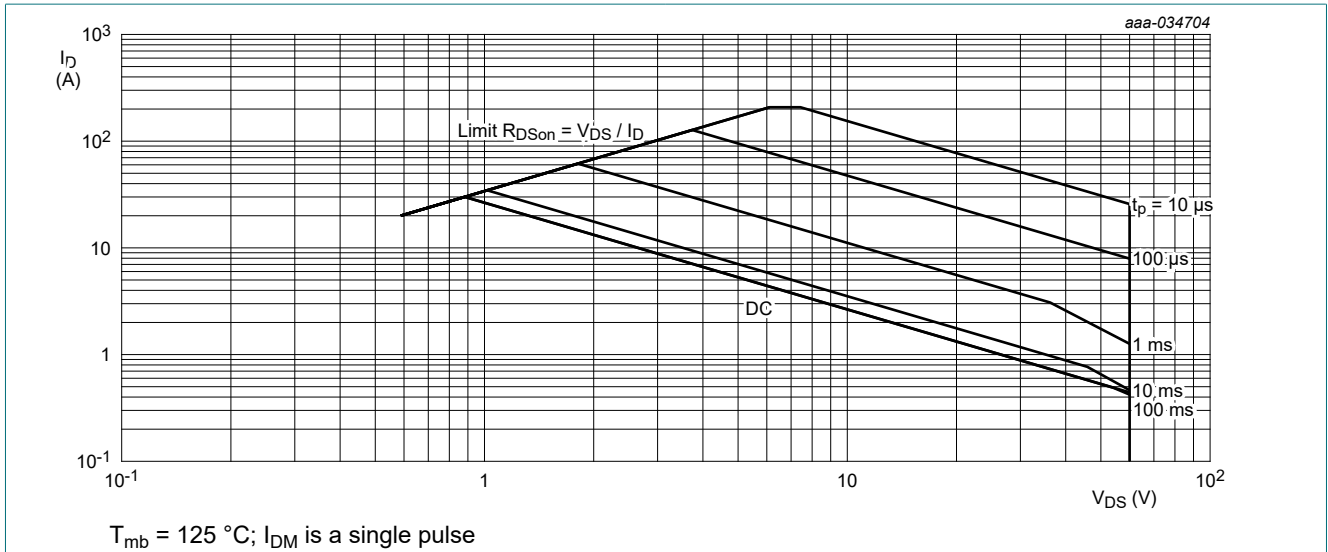


Fig. 4. Safe operating area; continuous and peak drain currents as a function of drain-source voltage

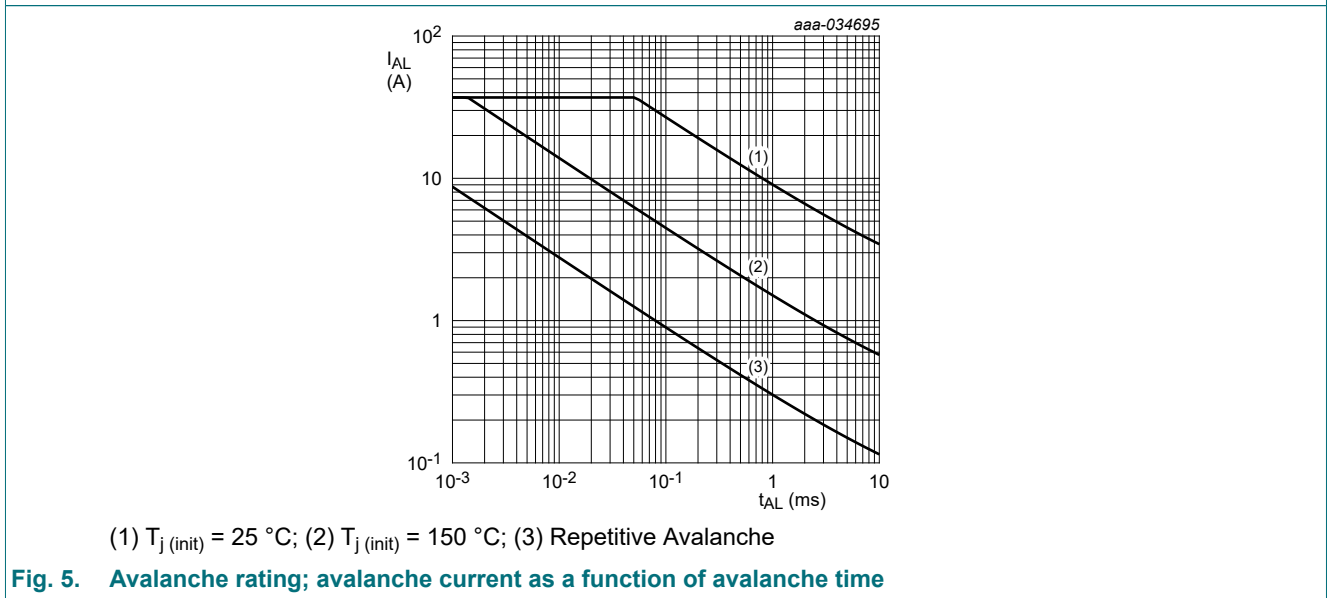


Fig. 5. Avalanche rating; avalanche current as a function of avalanche time

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. 6	-	1.58	1.89	K/W

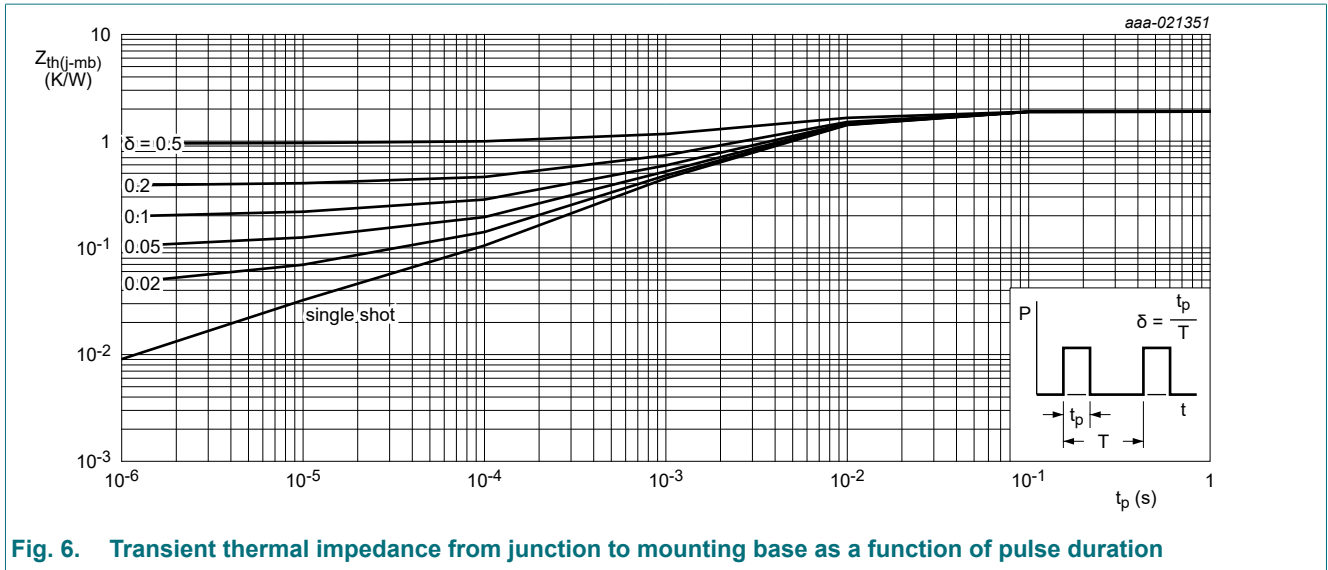


Fig. 6. Transient thermal impedance from junction to mounting base as a function of pulse duration

10. Characteristics

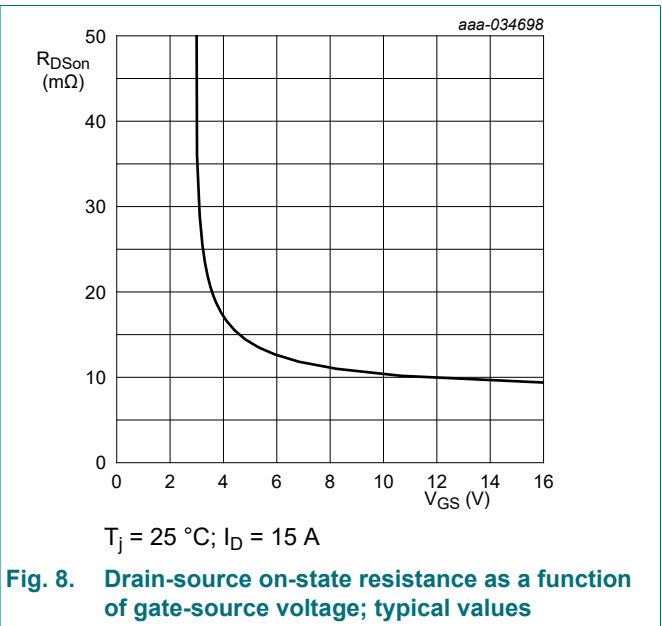
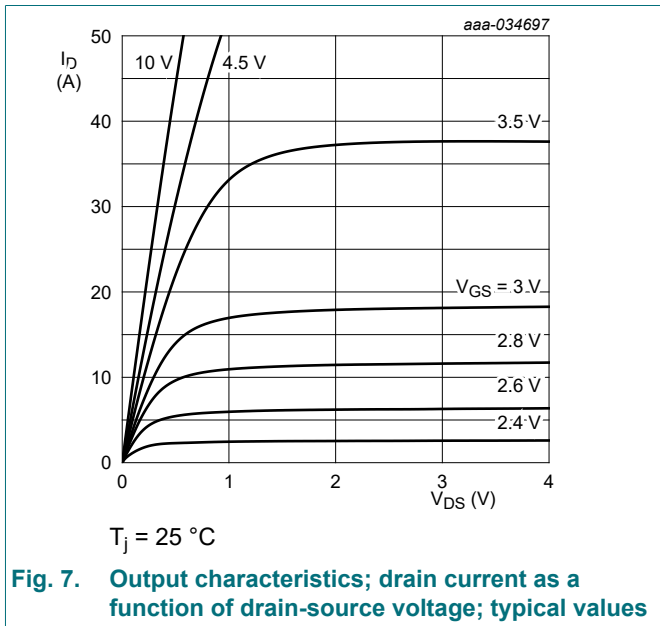
Table 7. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Static characteristics						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 250 \mu A; V_{GS} = 0 V; T_j = 25 \text{ }^\circ C$	60	66	-	V
		$I_D = 250 \mu A; V_{GS} = 0 V; T_j = -40 \text{ }^\circ C$	-	63	-	V
		$I_D = 250 \mu A; V_{GS} = 0 V; T_j = -55 \text{ }^\circ C$	54	62	-	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 1 \text{ mA}; V_{DS}=V_{GS}; T_j = 25 \text{ }^\circ C; \text{ Fig. 11}; \text{ Fig. 12}$	1.4	1.67	2.1	V
		$I_D = 1 \text{ mA}; V_{DS}=V_{GS}; T_j = -55 \text{ }^\circ C; \text{ Fig. 12}$	-	-	2.45	V
		$I_D = 1 \text{ mA}; V_{DS}=V_{GS}; T_j = 175 \text{ }^\circ C; \text{ Fig. 12}$	0.5	-	-	V
I_{DSS}	drain leakage current	$V_{DS} = 60 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ C$	-	0.01	1	μA
		$V_{DS} = 60 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 175 \text{ }^\circ C$	-	34	500	μA
I_{GSS}	gate leakage current	$V_{GS} = 10 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ C$	-	2	100	nA
		$V_{GS} = -10 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ C$	-	2	100	nA
R_{DSon}	drain-source on-state resistance	$V_{GS} = 10 \text{ V}; I_D = 15 \text{ A}; T_j = 25 \text{ }^\circ C; \text{ Fig. 13}$	7.3	10.4	13	m Ω
		$V_{GS} = 10 \text{ V}; I_D = 15 \text{ A}; T_j = 105 \text{ }^\circ C; \text{ Fig. 14}$	11	16.4	21	m Ω
		$V_{GS} = 10 \text{ V}; I_D = 15 \text{ A}; T_j = 125 \text{ }^\circ C; \text{ Fig. 14}$	12.2	18	23.4	m Ω
		$V_{GS} = 10 \text{ V}; I_D = 15 \text{ A}; T_j = 175 \text{ }^\circ C; \text{ Fig. 14}$	15	22.7	30	m Ω
		$V_{GS} = 4.5 \text{ V}; I_D = 15 \text{ A}; T_j = 25 \text{ }^\circ C; \text{ Fig. 13}$	10.5	15	20	m Ω
		$V_{GS} = 4.5 \text{ V}; I_D = 15 \text{ A}; T_j = 105 \text{ }^\circ C; \text{ Fig. 14}$	15.6	23.5	32	m Ω
		$V_{GS} = 4.5 \text{ V}; I_D = 15 \text{ A}; T_j = 125 \text{ }^\circ C; \text{ Fig. 14}$	17	26	35.3	m Ω
		$V_{GS} = 4.5 \text{ V}; I_D = 15 \text{ A}; T_j = 175 \text{ }^\circ C; \text{ Fig. 14}$	20.7	32	44.4	m Ω

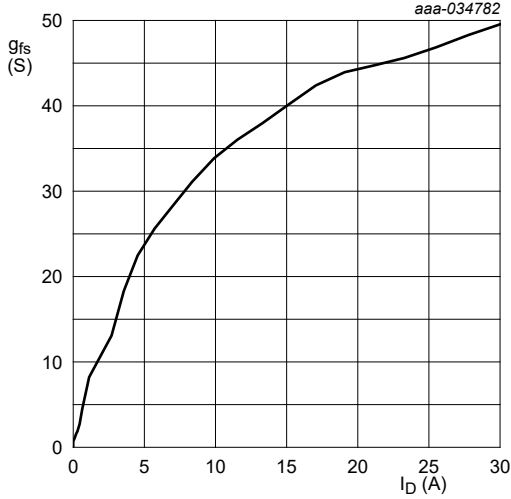
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Symbol	Parameter	Conditions	Min	Typ	Max	Unit
R_G	gate resistance	$f = 1 \text{ MHz}; T_j = 25 \text{ }^\circ\text{C}$	-	1.9	-	Ω
Dynamic characteristics						
$Q_{G(\text{tot})}$	total gate charge	$I_D = 15 \text{ A}; V_{DS} = 48 \text{ V}; V_{GS} = 10 \text{ V}; T_j = 25 \text{ }^\circ\text{C}; \text{Fig. 15}; \text{Fig. 16}$	-	40	56	nC
		$I_D = 15 \text{ A}; V_{DS} = 48 \text{ V}; V_{GS} = 4.5 \text{ V}; T_j = 25 \text{ }^\circ\text{C}; \text{Fig. 15}; \text{Fig. 16}$	-	20	28	nC
Q_{GS}	gate-source charge	$T_j = 25 \text{ }^\circ\text{C}; \text{Fig. 15}; \text{Fig. 16}$	-	5	8	nC
Q_{GD}	gate-drain charge		-	9	18	nC
C_{iss}	input capacitance	$V_{DS} = 25 \text{ V}; V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}; T_j = 25 \text{ }^\circ\text{C}; \text{Fig. 17}$	-	2101	2941	pF
C_{oss}	output capacitance		-	200	240	pF
C_{rss}	reverse transfer capacitance		-	115	158	pF
$t_{d(\text{on})}$	turn-on delay time	$V_{DS} = 48 \text{ V}; R_L = 3.2 \text{ } \Omega; V_{GS} = 5 \text{ V}; R_{G(\text{ext})} = 5 \text{ } \Omega; T_j = 25 \text{ }^\circ\text{C}$	-	11	-	ns
t_r	rise time		-	25	-	ns
$t_{d(\text{off})}$	turn-off delay time		-	25	-	ns
t_f	fall time		-	20	-	ns
g_{fs}	transfer conductance	$V_{DS} = 8 \text{ V}; I_D = 15 \text{ A}; T_j = 25 \text{ }^\circ\text{C}; \text{Fig. 9}$	-	40	-	S
Source-drain diode						
V_{SD}	source-drain voltage	$I_S = 15 \text{ A}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}; \text{Fig. 18}$	-	0.83	1	V
t_{rr}	reverse recovery time	$I_S = 15 \text{ A}; di_S/dt = -100 \text{ A}/\mu\text{s}; V_{GS} = 0 \text{ V}; V_{DS} = 30 \text{ V}; T_j = 25 \text{ }^\circ\text{C}; \text{Fig. 19}$	-	29	-	ns
Q_r	recovered charge		[1]	33	-	nC

[1] includes capacitive recovery

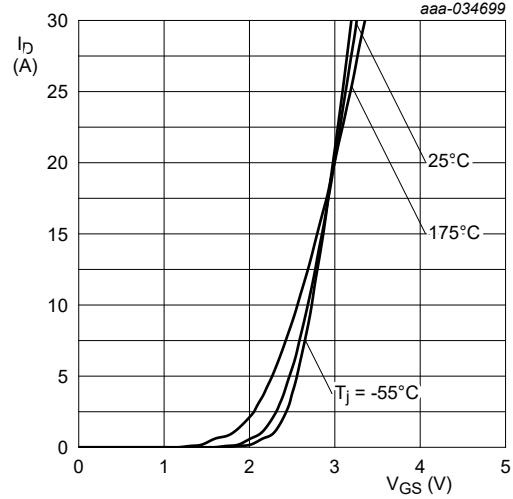


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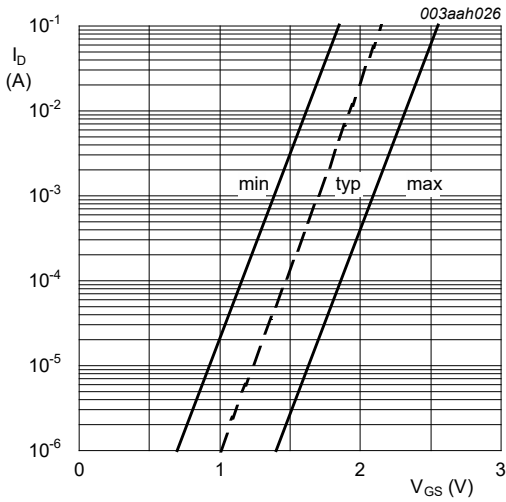
$T_j = 25\text{ °C}; V_{DS} = 8\text{ V}$

Fig. 9. Forward transconductance as a function of drain current; typical values



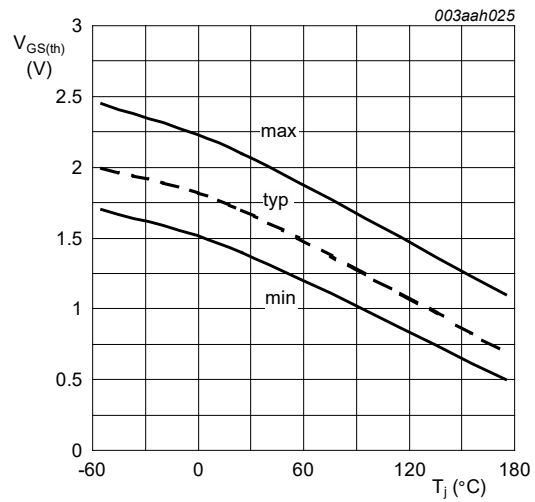
$V_{DS} = 8\text{ V}$

Fig. 10. Transfer characteristics; drain current as a function of gate-source voltage; typical values



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

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



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

Fig. 12. Gate-source threshold voltage as a function of junction temperature

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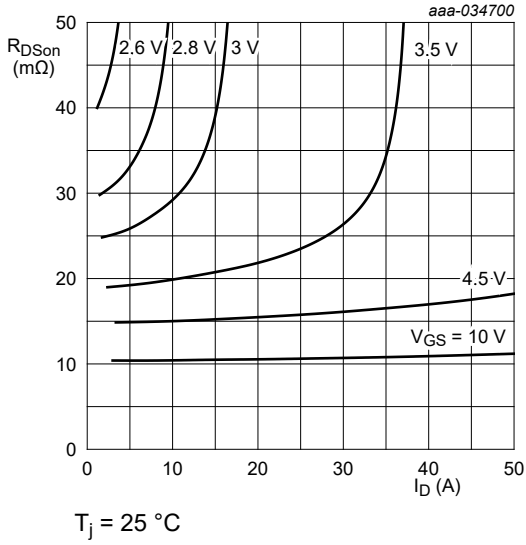
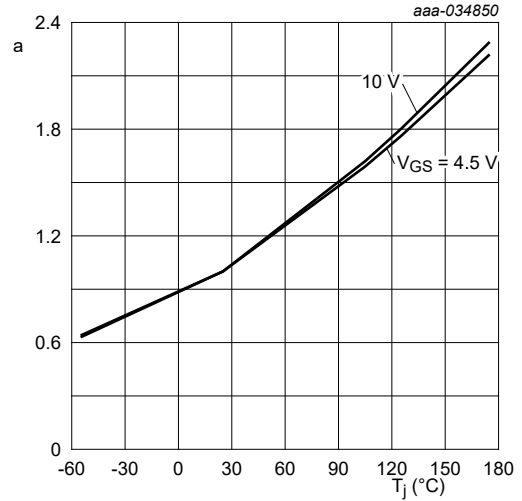


Fig. 13. Drain-source on-state resistance as a function of drain current; typical values



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

Fig. 14. Normalized drain-source on-state resistance factor as a function of junction temperature

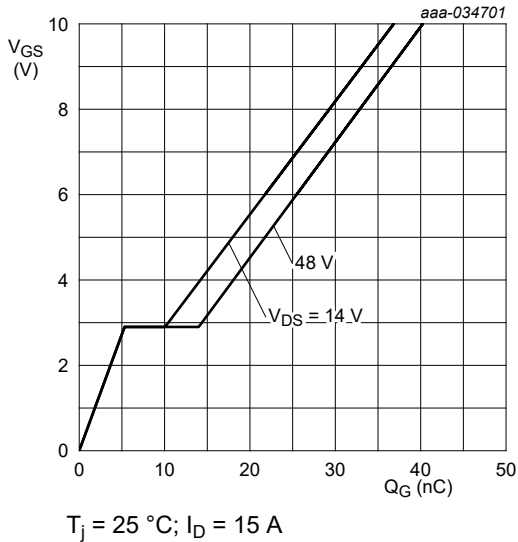


Fig. 15. Gate-source voltage as a function of gate charge; typical values

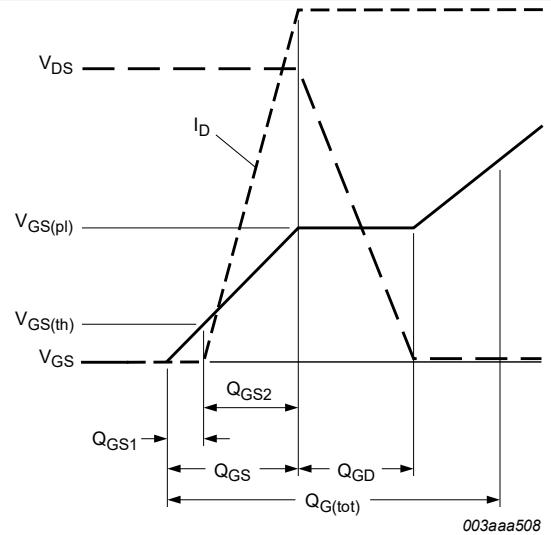
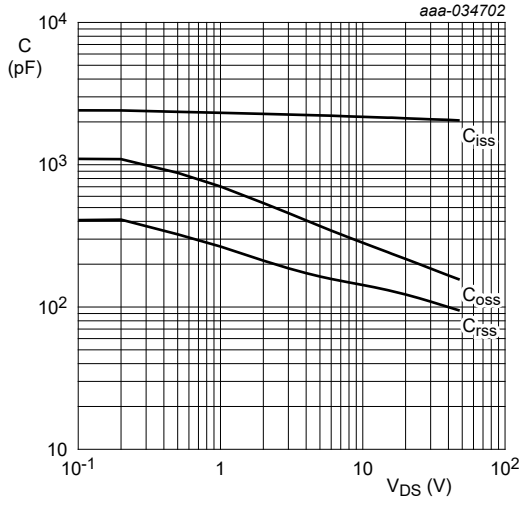


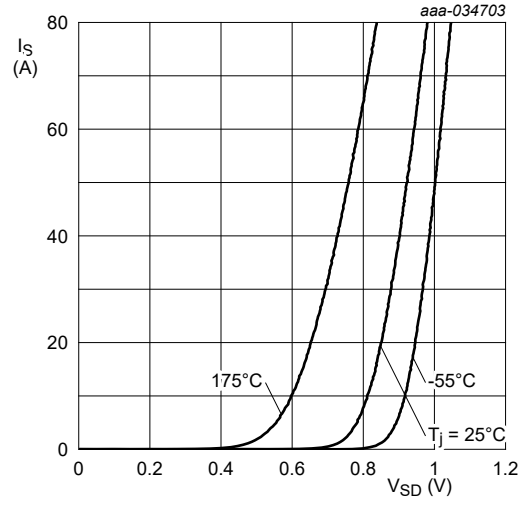
Fig. 16. Gate charge waveform definitions

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

Fig. 17. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values



$V_{GS} = 0$ V

Fig. 18. Source-drain (diode forward) current as a function of source-drain (diode forward) voltage; typical values

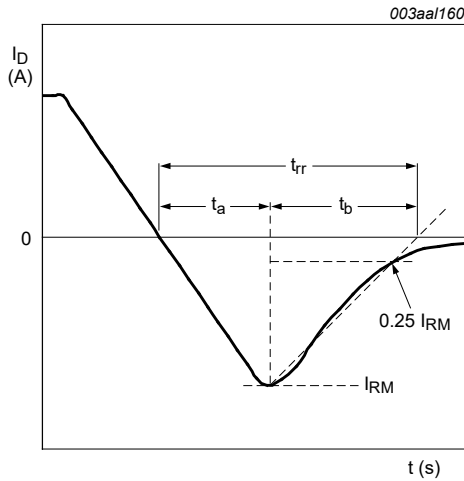


Fig. 19. Reverse recovery timing definition

11. Package outline

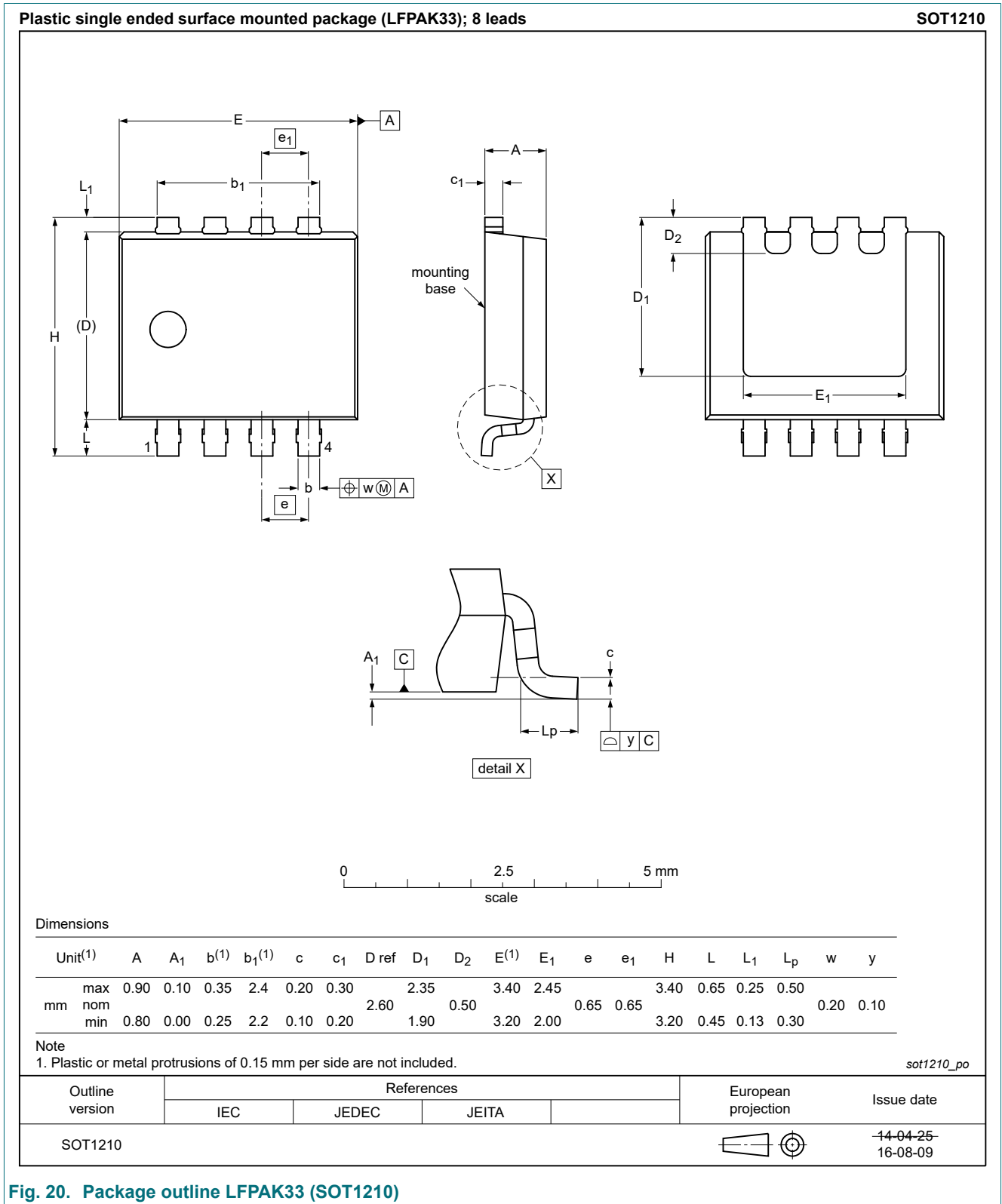


Fig. 20. Package outline LPAK33 (SOT1210)

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Document status [1][2]	Product status [3]	Definition
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[STF5N65M6](#) [IRF40H233XTMA1](#) [STU5N65M6](#) [DMN6022SSD-13](#) [DMN13M9UCA6-7](#) [DMTH10H4M6SPS-13](#) [DMN2990UFB-7B](#)
[IPB80P04P405ATMA2](#) [2N7002W-G](#) [MCAC30N06Y-TP](#) [MCQ7328-TP](#) [NTMC083NP10M5L](#) [BXP7N65D](#) [BXP4N65F](#) [AOL1454G](#)
[WMJ80N60C4](#) [BXP2N20L](#) [BXP2N65D](#) [BXT1150N10J](#) [BXT1700P06M](#) [TSM60NB380CP](#) [ROG](#) [RQ7L055BGTGR](#) [DMNH15H110SK3-13](#)
[SLF10N65ABV2](#) [BSO203SP](#) [BSO211P](#) [IPA60R230P6](#)