



BUK9M12-60E

N-channel 60 V, 12 mΩ logic level MOSFET in LFPAK33

19 September 2016

Product data sheet

1. General description

Logic level N-channel MOSFET in an LFPAK33 (Power33) 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 $V_{GS(th)}$ rating of greater than 0.5 V at 175 °C

3. Applications

- 12 V automotive systems
- Motors, lamps and solenoid control
- Transmission control
- Ultra high performance power switching

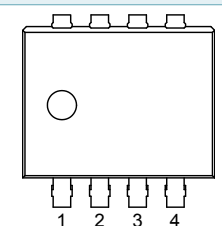
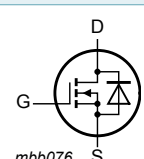
4. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{DS}	drain-source voltage	$25\text{ °C} \leq T_j \leq 175\text{ °C}$	-	-	60	V
I_D	drain current	$V_{GS} = 5\text{ V}$; $T_{mb} = 25\text{ °C}$; Fig. 2	-	-	54	A
P_{tot}	total power dissipation	$T_{mb} = 25\text{ °C}$; Fig. 1	-	-	79	W
Static characteristics						
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 5\text{ V}$; $I_D = 15\text{ A}$; $T_j = 25\text{ °C}$; Fig. 11	-	10	12	mΩ
Dynamic characteristics						
Q_{GD}	gate-drain charge	$I_D = 15\text{ A}$; $V_{DS} = 48\text{ V}$; $V_{GS} = 5\text{ V}$; $T_j = 25\text{ °C}$; Fig. 13 ; Fig. 14	-	7.9	-	nC

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
BUK9M12-60E	LFAK33	Plastic single ended surface mounted package (LFAK33); 8 leads	SOT1210

7. Marking

Table 4. Marking codes

Type number	Marking code
BUK9M12-60E	91260E

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	$25\text{ °C} \leq T_j \leq 175\text{ °C}$	-	60	V
V_{DGR}	drain-gate voltage	$R_{GS} = 20\text{ k}\Omega$	-	60	V
V_{GS}	gate-source voltage	DC; $T_j \leq 175\text{ °C}$	-10	10	V
		Pulsed; $T_j \leq 175\text{ °C}$	[1][2]	-15	15
P_{tot}	total power dissipation	$T_{mb} = 25\text{ °C}$; Fig. 1	-	79	W
I_D	drain current	$V_{GS} = 5\text{ V}$; $T_{mb} = 25\text{ °C}$; Fig. 2	-	54	A
		$V_{GS} = 5\text{ V}$; $T_{mb} = 100\text{ °C}$; Fig. 2	-	38	A
I_{DM}	peak drain current	pulsed; $t_p \leq 10\text{ }\mu\text{s}$; $T_{mb} = 25\text{ °C}$; Fig. 3	-	216	A

Symbol	Parameter	Conditions	Min	Max	Unit
T _{stg}	storage temperature		-55	175	°C
T _j	junction temperature		-55	175	°C
Source-drain diode					
I _S	source current	T _{mb} = 25 °C	-	54	A
I _{SM}	peak source current	pulsed; t _p ≤ 10 μs; T _{mb} = 25 °C	-	216	A
Avalanche ruggedness					
E _{DS(AL)S}	non-repetitive drain-source avalanche energy	I _D = 54 A; V _{sup} ≤ 60 V; R _{GS} = 50 Ω; V _{GS} = 5 V; T _{j(init)} = 25 °C; unclamped; Fig. 4	[3][4]	-	50.5 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] Single-pulse avalanche rating limited by maximum junction temperature of 175 °C.
- [4] Refer to application note AN10273 for further information.

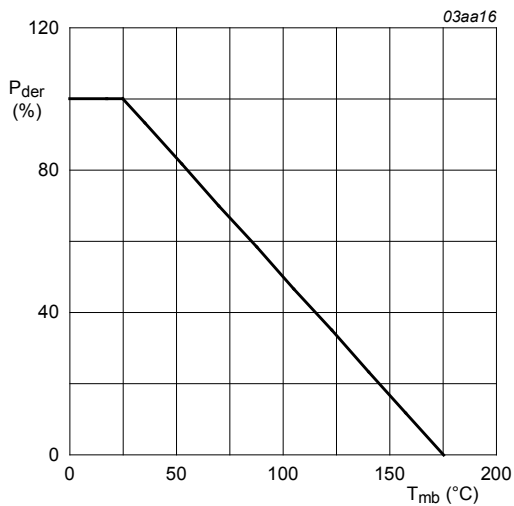
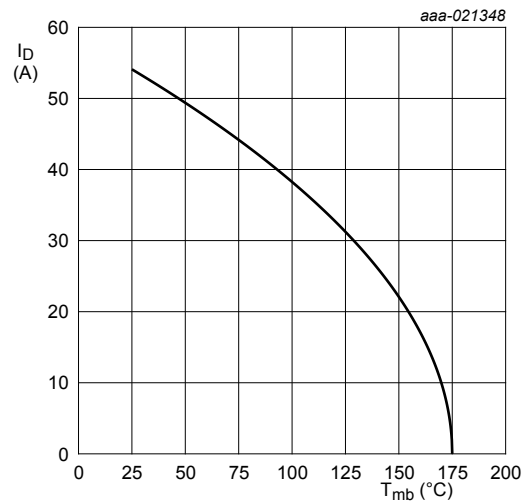


Fig. 1. Normalized total power dissipation as a function of mounting base temperature

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



V_{GS} ≥ 5 V

Fig. 2. Continuous drain current as a function of mounting base temperature

$$I_D = 54 \times \sqrt{\frac{175^{\circ}\text{C} - T_{mb}}{150^{\circ}\text{C}}} \quad \text{for } T_{mb} \geq 25^{\circ}\text{C}$$

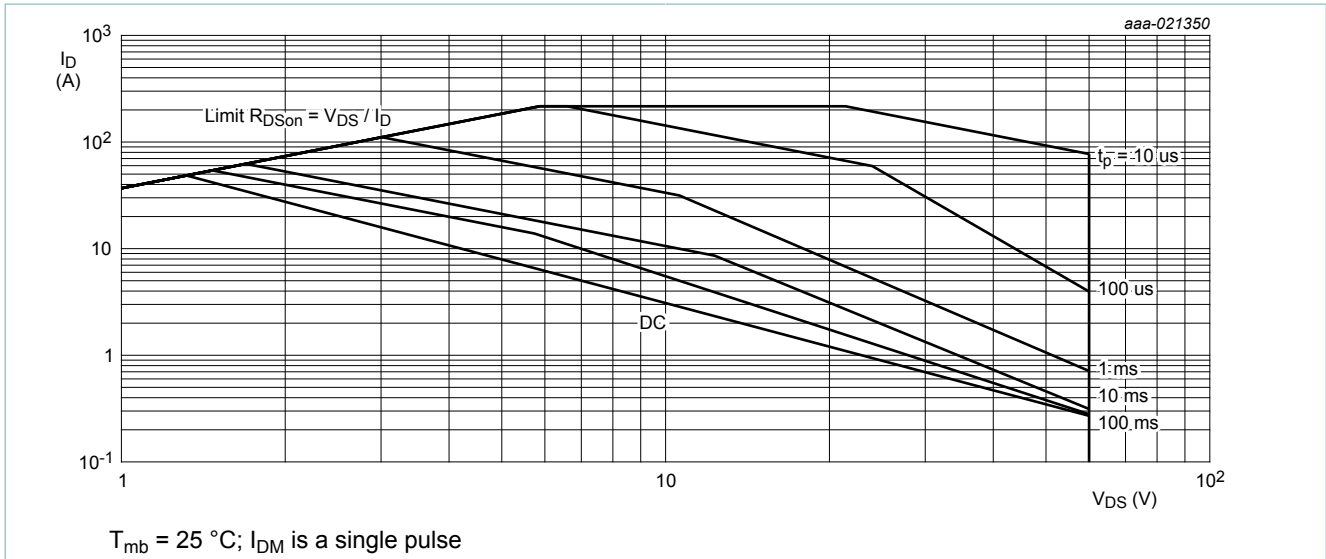


Fig. 3. Safe operating area; continuous and peak drain currents as a function of drain-source voltage

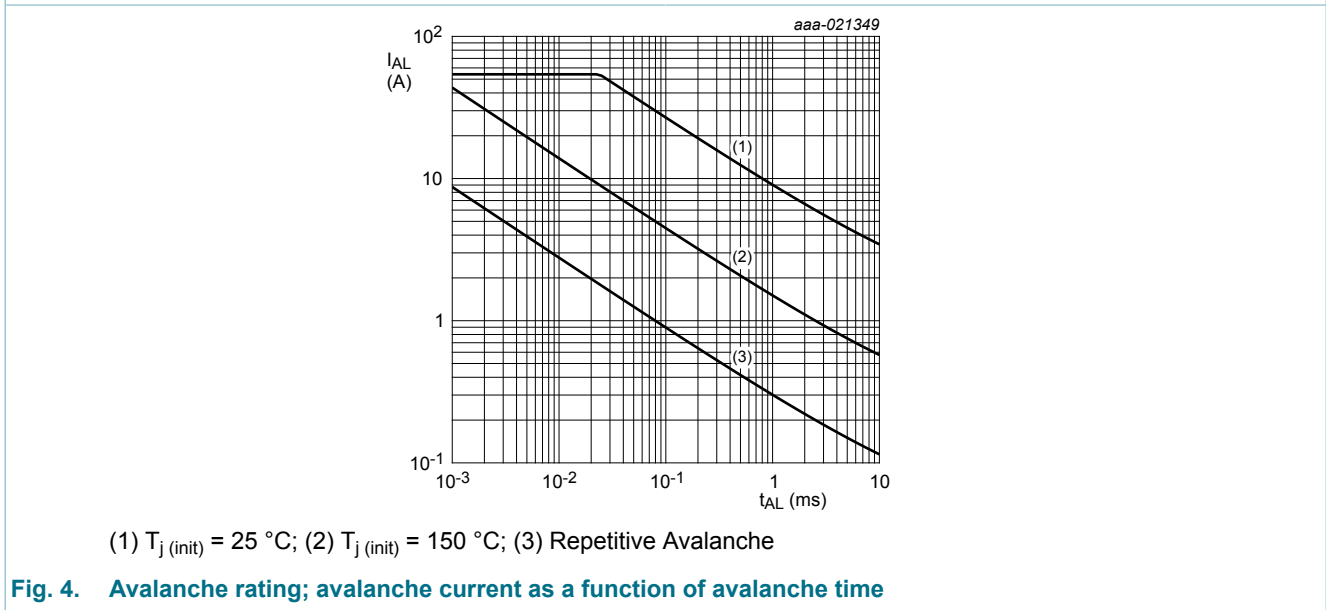


Fig. 4. Avalanche rating; avalanche current as a function of avalanche time

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	-	1.58	1.89	K/W

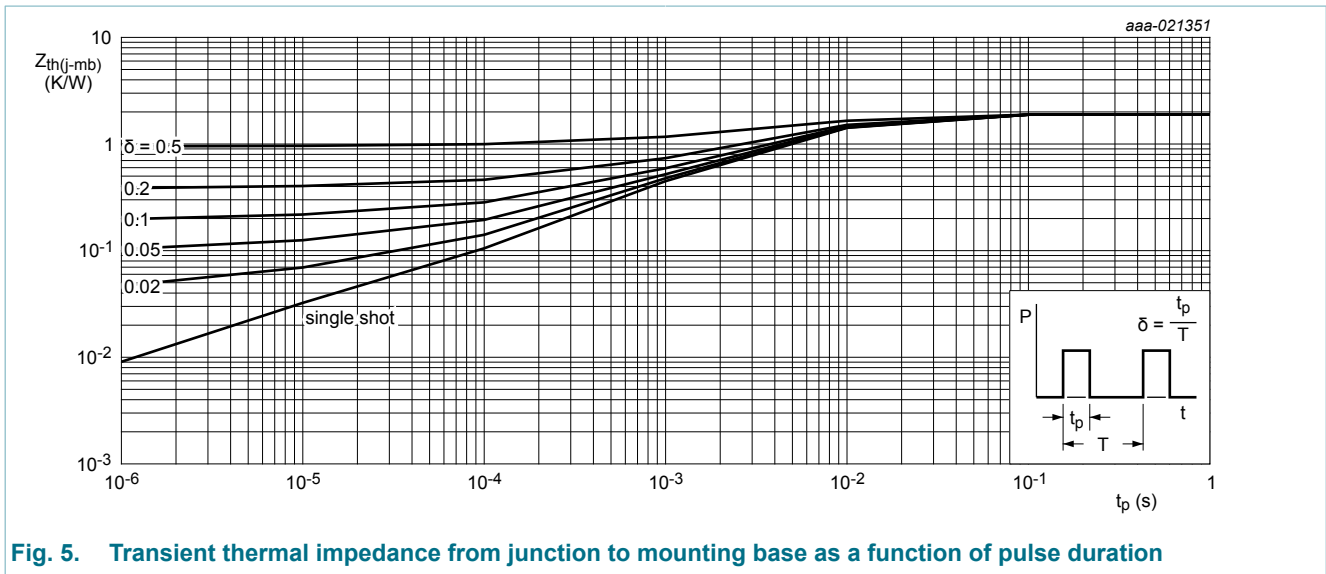


Fig. 5. Transient thermal impedance from junction to mounting base as a function of pulse duration

10. Characteristics

Table 7. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
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	-	-	V
		$I_D = 250 \mu A; V_{GS} = 0 V; T_j = -55 \text{ }^\circ C$	54	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 25 \text{ }^\circ C;$ Fig. 9; Fig. 10	1.4	1.7	2.1	V
		$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = -55 \text{ }^\circ C;$ Fig. 10	-	-	2.45	V
		$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 175 \text{ }^\circ C;$ Fig. 10	0.5	-	-	V
I_{DSS}	drain leakage current	$V_{DS} = 60 V; V_{GS} = 0 V; T_j = 25 \text{ }^\circ C$	-	0.02	1	μA
		$V_{DS} = 60 V; V_{GS} = 0 V; T_j = 175 \text{ }^\circ C$	-	-	500	μA
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	$V_{GS} = 5 V; I_D = 15 A; T_j = 25 \text{ }^\circ C;$ Fig. 11	-	10	12	mΩ
		$V_{GS} = 10 V; I_D = 15 A; T_j = 25 \text{ }^\circ C;$ Fig. 11	-	9	11	mΩ
		$V_{GS} = 5 V; I_D = 15 A; T_j = 175 \text{ }^\circ C;$ Fig. 12	-	-	27	mΩ
Dynamic characteristics						
$Q_{G(tot)}$	total gate charge	$I_D = 15 A; V_{DS} = 48 V; V_{GS} = 5 V;$ $T_j = 25 \text{ }^\circ C;$ Fig. 13; Fig. 14	-	21	-	nC
Q_{GS}	gate-source charge		-	5.4	-	nC

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Q_{GD}	gate-drain charge		-	7.9	-	nC
C_{iss}	input capacitance	$V_{DS} = 25\text{ V}; V_{GS} = 0\text{ V}; f = 1\text{ MHz}; T_j = 25\text{ }^\circ\text{C};$ Fig. 15	-	2082	2769	pF
C_{oss}	output capacitance		-	195	234	pF
C_{rss}	reverse transfer capacitance		-	101	138	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = 45\text{ V}; R_L = 3\text{ }\Omega; V_{GS} = 5\text{ V}; R_{G(ext)} = 5\text{ }\Omega; T_j = 25\text{ }^\circ\text{C}$	-	12.1	-	ns
t_r	rise time		-	21.3	-	ns
$t_{d(off)}$	turn-off delay time		-	26.5	-	ns
t_f	fall time		-	17.4	-	ns
Source-drain diode						
V_{SD}	source-drain voltage	$I_S = 15\text{ A}; V_{GS} = 0\text{ V}; T_j = 25\text{ }^\circ\text{C};$ Fig. 16	-	0.82	1.2	V
t_{rr}	reverse recovery time	$I_S = 15\text{ A}; di_S/dt = -100\text{ A}/\mu\text{s}; V_{GS} = 0\text{ V}; V_{DS} = 25\text{ V}; T_j = 25\text{ }^\circ\text{C}$	-	20.1	-	ns
Q_r	recovered charge		-	16.5	-	nC

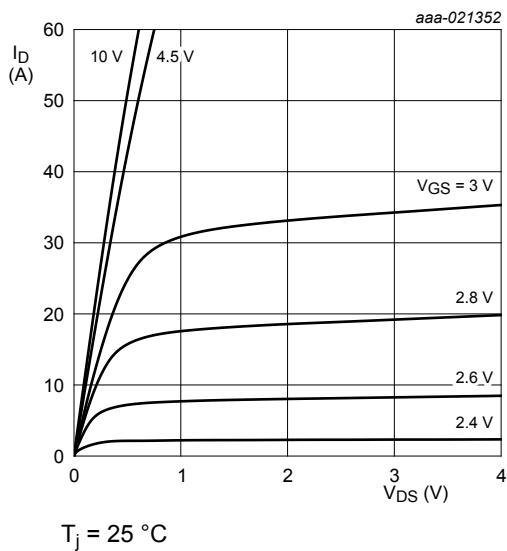


Fig. 6. Output characteristics; drain current as a function of drain-source voltage; typical values

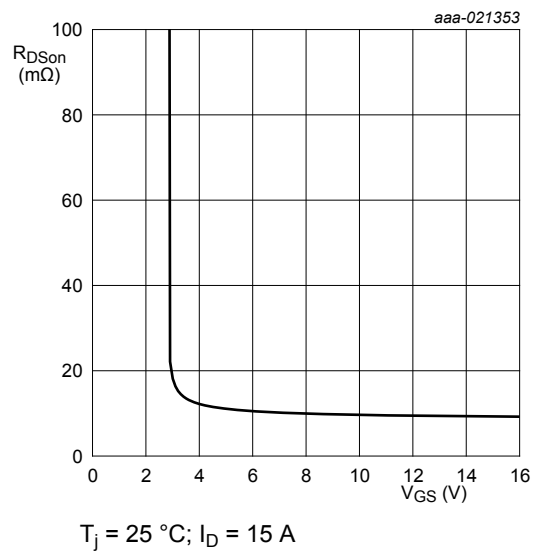


Fig. 7. Drain-source on-state resistance as a function of gate-source voltage; typical values

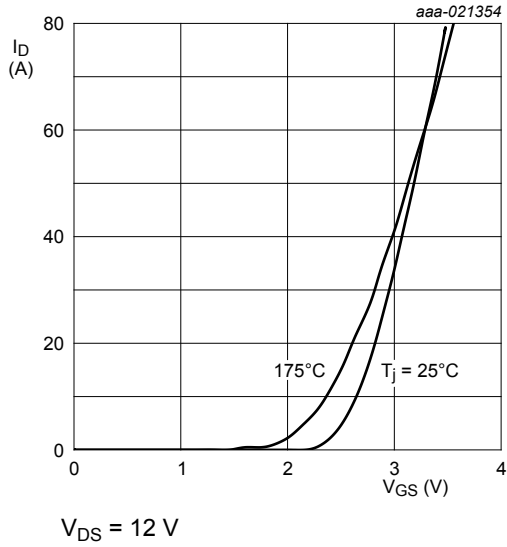


Fig. 8. Transfer characteristics; drain current as a function of gate-source voltage; typical values

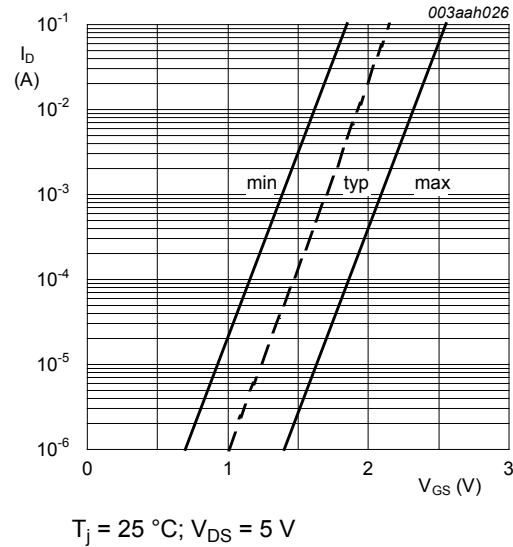


Fig. 9. Sub-threshold drain current as a function of gate-source voltage

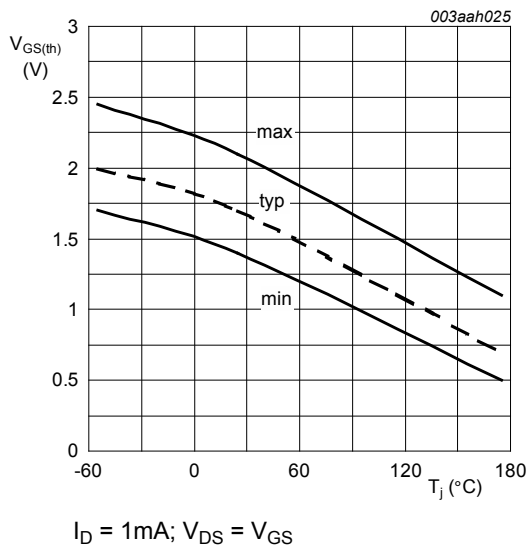


Fig. 10. Gate-source threshold voltage as a function of junction temperature

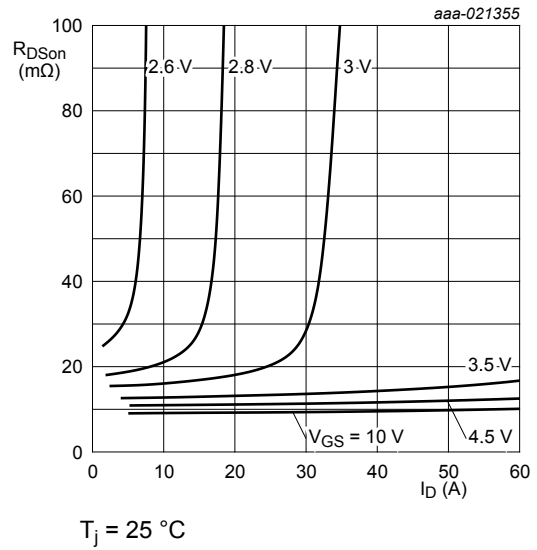


Fig. 11. Drain-source on-state resistance as a function of drain current; typical values

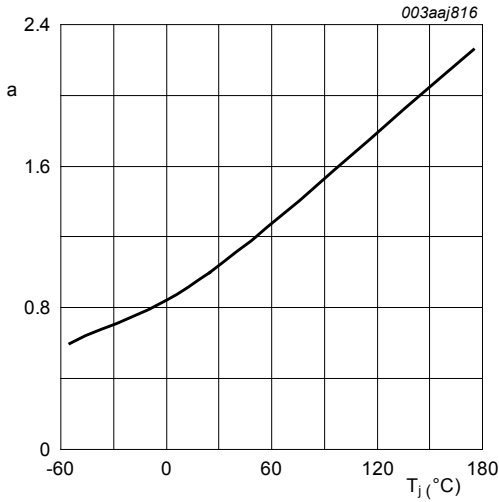
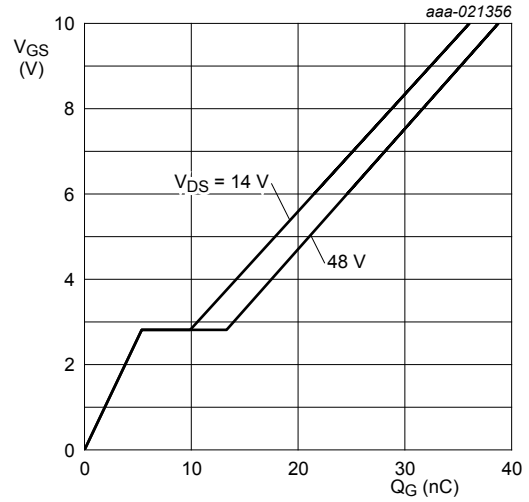


Fig. 12. Normalized drain-source on-state resistance factor as a function of junction temperature

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



$T_j = 25^{\circ}C; I_D = 15 A$

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

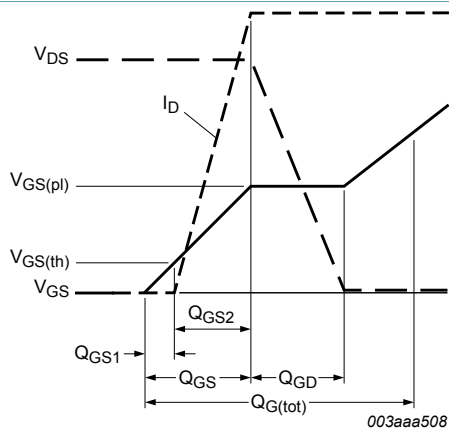
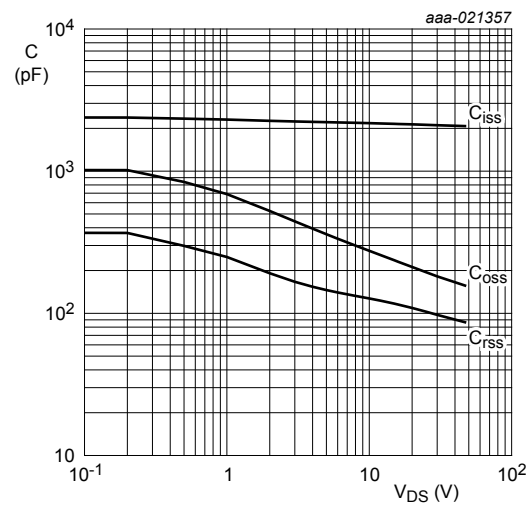
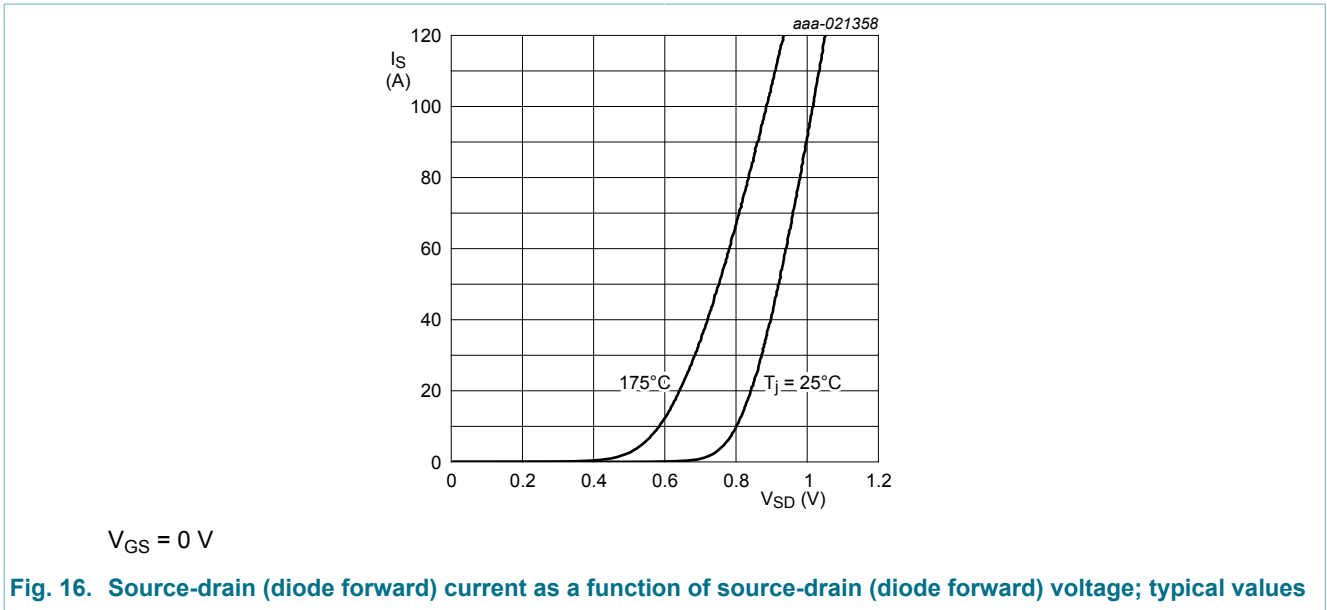


Fig. 14. Gate charge waveform definitions



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

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



11. Application information

For guidance on how to use and understand this datasheet, please refer to application note [AN11158](#) "Understanding power MOSFET datasheet parameters".

12. Package outline

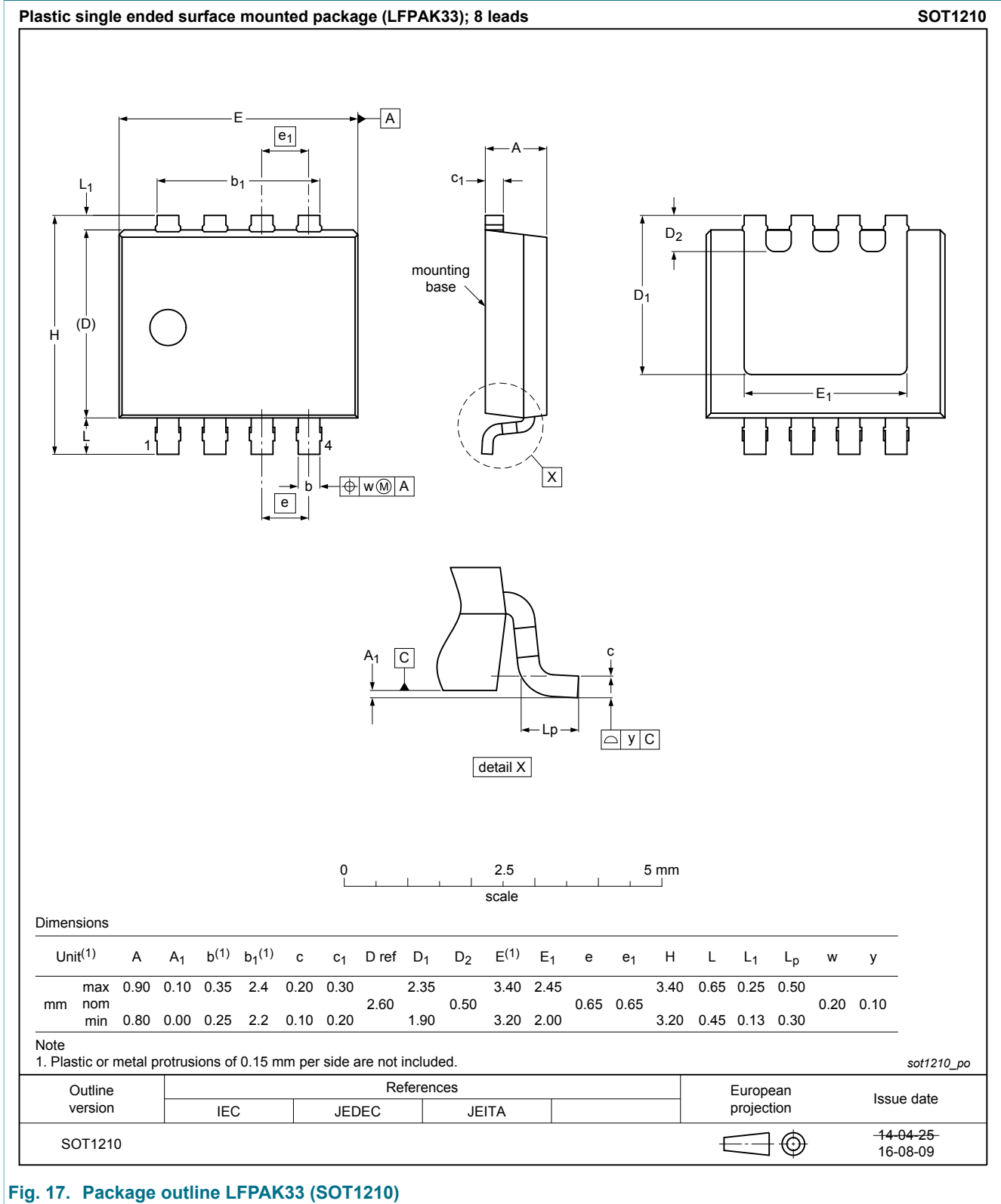


Fig. 17. Package outline LFPAK33 (SOT1210)

13. Legal information

13.1 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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