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Kind regards,

Team Nexperia



BSS138AKA

60 V, single N-channel Trench MOSFET

29 April 2015

Product data sheet

1. General description

N-channel enhancement mode Field-Effect Transistor (FET) in a small SOT23 (TO-236AB) Surface-Mounted Device (SMD) plastic package using Trench MOSFET technology.

2. Features and benefits

- Very fast switching
- Trench MOSFET technology
- ESD protection
- Low threshold voltage
- AEC-Q101 qualified

3. Applications

- Relay driver
- High-speed line driver
- Low-side loadswitch
- Switching circuits

4. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{DS}	drain-source voltage	$T_j = 25\text{ °C}$	-	-	60	V
V_{GS}	gate-source voltage		-20	-	20	V
I_D	drain current	$V_{GS} = 10\text{ V}; T_{amb} = 25\text{ °C}$	[1]	-	200	mA
Static characteristics						
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 10\text{ V}; I_D = 100\text{ mA};$ pulsed; $t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.02; T_j = 25\text{ °C}$	-	2.7	4.5	Ω

[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 1 cm².

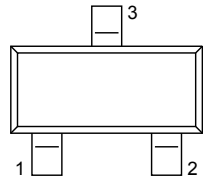
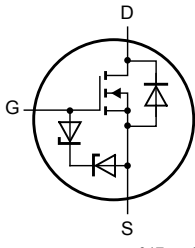


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5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	G	gate	 <p>TO-236AB (SOT23)</p>	 <p>017aaa255</p>
2	S	source		
3	D	drain		

6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
BSS138AKA	TO-236AB	plastic surface-mounted package; 3 leads	SOT23

7. Marking

Table 4. Marking codes

Type number	Marking code
BSS138AKA	%JL

[1] % = placeholder for manufacturing site code

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 = 25 °C		-	60	V
V _{GS}	gate-source voltage			-20	20	V
I _D	drain current	V _{GS} = 10 V; T _{amb} = 25 °C	[1]	-	200	mA
		V _{GS} = 10 V; T _{amb} = 100 °C	[1]	-	125	mA
I _{DM}	peak drain current	T _{amb} = 25 °C; single pulse; t _p ≤ 10 μs		-	800	mA
P _{tot}	total power dissipation	T _{amb} = 25 °C	[2]	-	300	mW
			[1]	-	360	mW
		T _{sp} = 25 °C		-	1060	mW
T _j	junction temperature			-55	150	°C
T _{amb}	ambient temperature			-55	150	°C
T _{stg}	storage temperature			-65	150	°C
Source-drain diode						
I _S	source current	T _{amb} = 25 °C	[1]	-	200	mA

[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 1 cm².

[2] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and standard footprint.

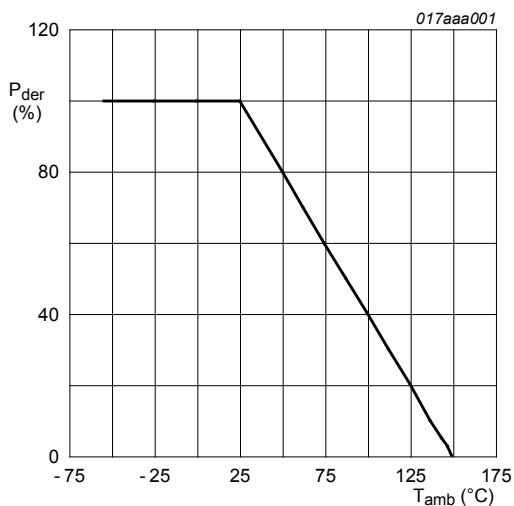


Fig. 1. Normalized total power dissipation as a function of ambient temperature

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

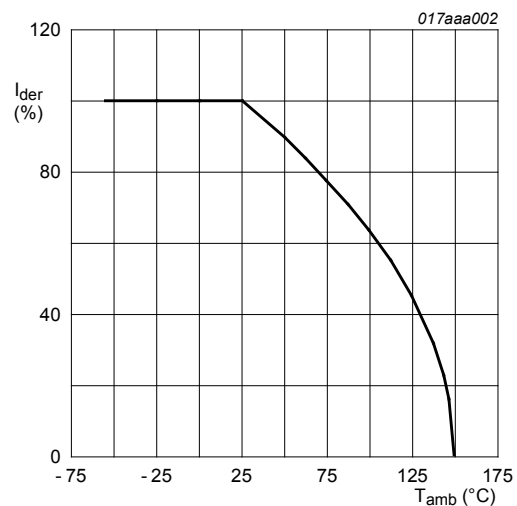
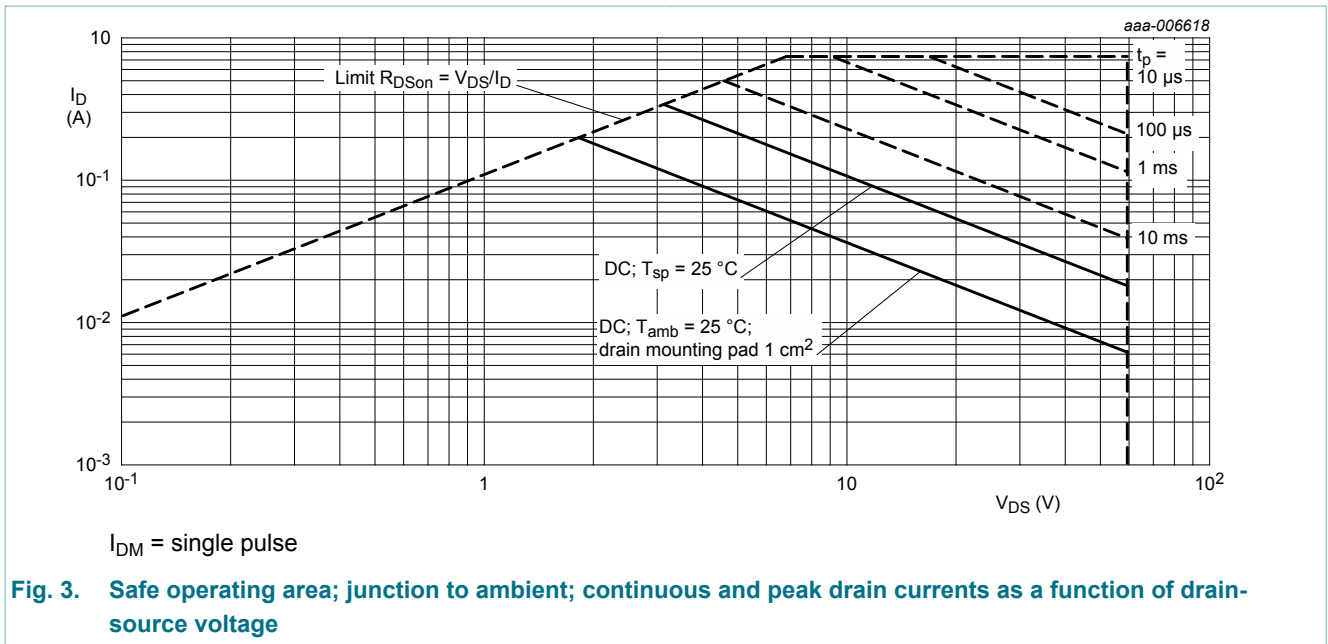


Fig. 2. Normalized continuous drain current as a function of ambient temperature

$$I_{der} = \frac{I_D}{I_{D(25^\circ\text{C})}} \times 100\%$$



9. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	350	400	K/W
			[2]	-	300	340	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point			-	-	115	K/W

[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.

[2] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 1 cm^2 .

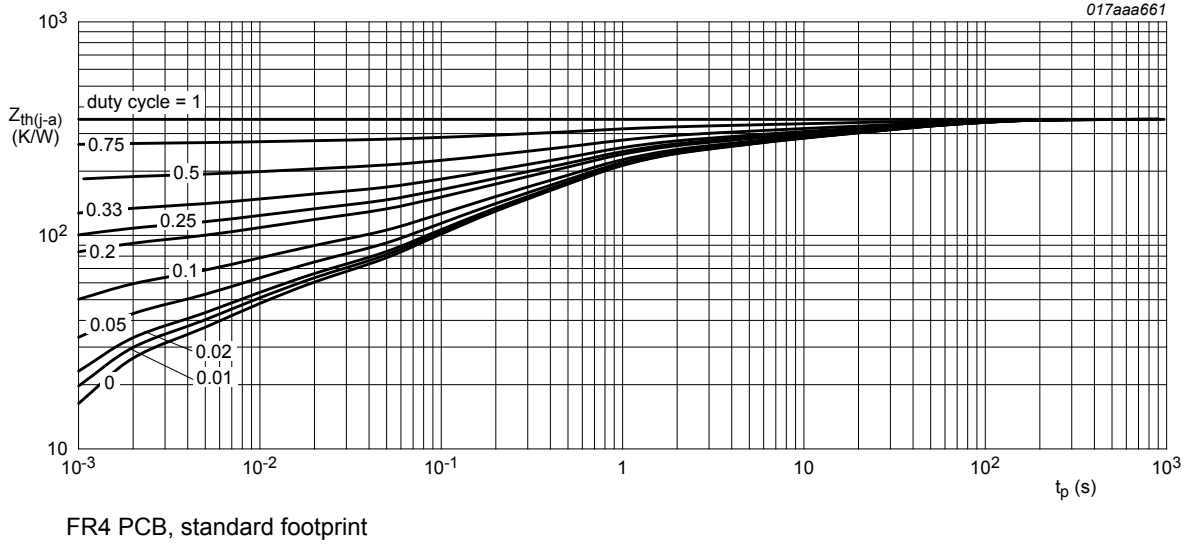


Fig. 4. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

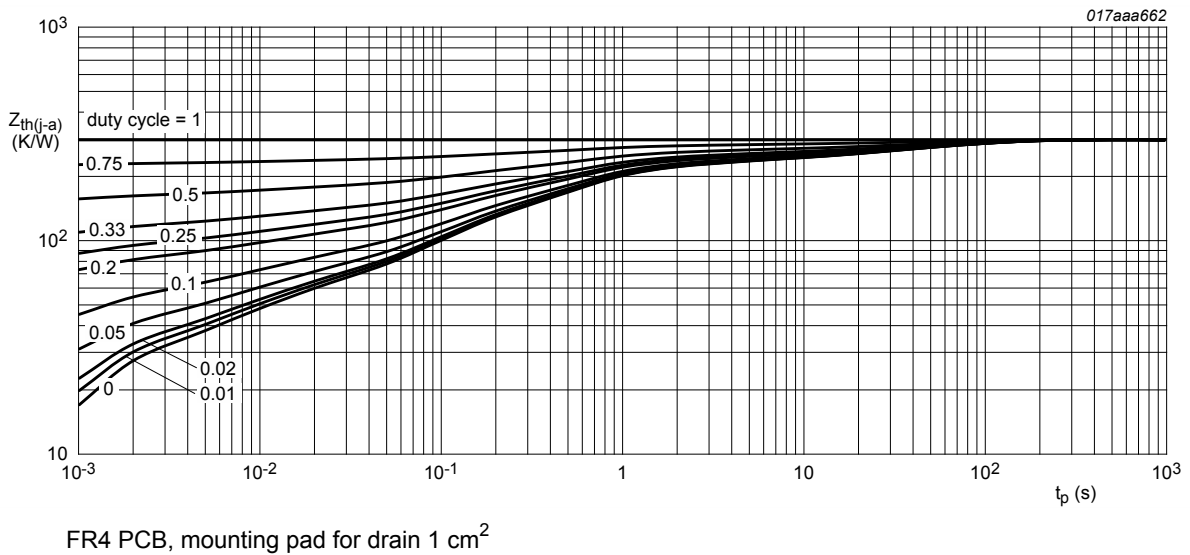


Fig. 5. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

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
V_{GSth}	gate-source threshold voltage	$I_D = 250 A; V_{DS} = V_{GS}; T_j = 25 \text{ }^\circ C$	0.8	1.2	1.5	V
I_{DSS}	drain leakage current	$V_{DS} = 60 V; V_{GS} = 0 V; T_j = 25 \text{ }^\circ C$	-	-	1	μA
		$V_{DS} = 60 V; V_{GS} = 0 V; T_j = 150 \text{ }^\circ C$	-	-	10	μA
I_{GSS}	gate leakage current	$V_{GS} = 20 V; V_{DS} = 0 V; T_j = 25 \text{ }^\circ C$	-	-	3.5	μA
		$V_{GS} = -20 V; V_{DS} = 0 V; T_j = 25 \text{ }^\circ C$	-	-	-3.5	μA
		$V_{GS} = 10 V; V_{DS} = 0 V; T_j = 25 \text{ }^\circ C$	-	-	1	μA
		$V_{GS} = -10 V; V_{DS} = 0 V; T_j = 25 \text{ }^\circ C$	-	-	-1	μA
		$V_{GS} = 4.5 V; V_{DS} = 0 V; T_j = 25 \text{ }^\circ C$	-	-	0.5	μA
		$V_{GS} = -4.5 V; V_{DS} = 0 V; T_j = 25 \text{ }^\circ C$	-	-	-0.5	μA
		R_{DSon}	drain-source on-state resistance	$V_{GS} = 10 V; I_D = 100 \text{ mA};$ pulsed; $t_p \leq 300 \mu s; \delta \leq 0.02; T_j = 25 \text{ }^\circ C$	-	2.7
$V_{GS} = 10 V; I_D = 100 \text{ mA};$ pulsed; $t_p \leq 300 \mu s; \delta \leq 0.02; T_j = 150 \text{ }^\circ C$	-	5.5		9.2	Ω	
$V_{GS} = 4.5 V; I_D = 100 \text{ mA};$ pulsed; $t_p \leq 300 \mu s; \delta \leq 0.02; T_j = 25 \text{ }^\circ C$	-	3		5.2	Ω	
$V_{GS} = 2.5 V; I_D = 10 \text{ mA};$ pulsed; $t_p \leq 300 \mu s; \delta \leq 0.02; T_j = 25 \text{ }^\circ C$	-	4		13	Ω	
g_{fs}	forward transconductance	$V_{DS} = 10 V; I_D = 150 \text{ mA};$ pulsed; $t_p \leq 300 \mu s; \delta \leq 0.02; T_j = 25 \text{ }^\circ C$	320	-	-	mS
Dynamic characteristics						
$Q_{G(tot)}$	total gate charge	$V_{DS} = 30 V; I_D = 150 \text{ mA}; V_{GS} = 4.5 V;$ $T_j = 25 \text{ }^\circ C$	-	0.39	0.51	nC
Q_{GS}	gate-source charge		-	0.1	-	nC
Q_{GD}	gate-drain charge		-	0.1	-	nC
C_{iss}	input capacitance	$V_{DS} = 30 V; f = 1 \text{ MHz}; V_{GS} = 0 V;$ $T_j = 25 \text{ }^\circ C$	-	13	20	pF
C_{oss}	output capacitance		-	2.6	-	pF
C_{rss}	reverse transfer capacitance		-	1.1	-	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = 40 V; R_L = 250 \Omega; V_{GS} = 10 V;$ $R_{G(ext)} = 6 \Omega; T_j = 25 \text{ }^\circ C$	-	5	10	ns
t_r	rise time		-	6	-	ns
$t_{d(off)}$	turn-off delay time		-	36	72	ns

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
t_f	fall time		-	22	-	ns
Source-drain diode						
V_{SD}	source-drain voltage	$I_S = 115 \text{ mA}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	0.47	0.7	1.2	V

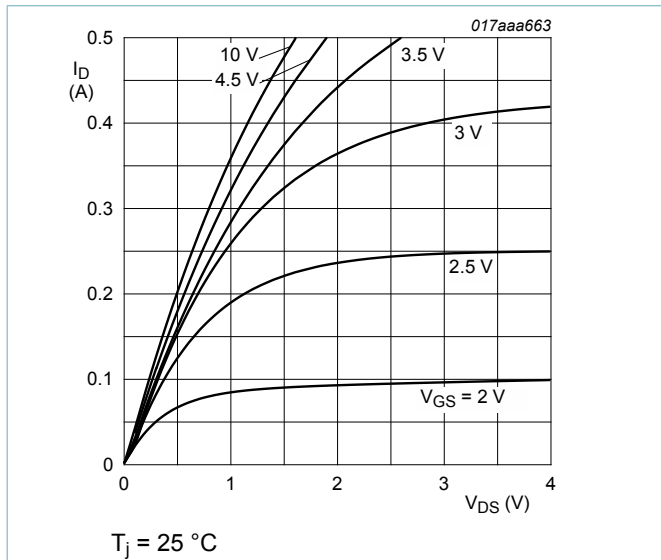


Fig. 6. Output characteristics: drain current as a function of drain-source voltage; typical values

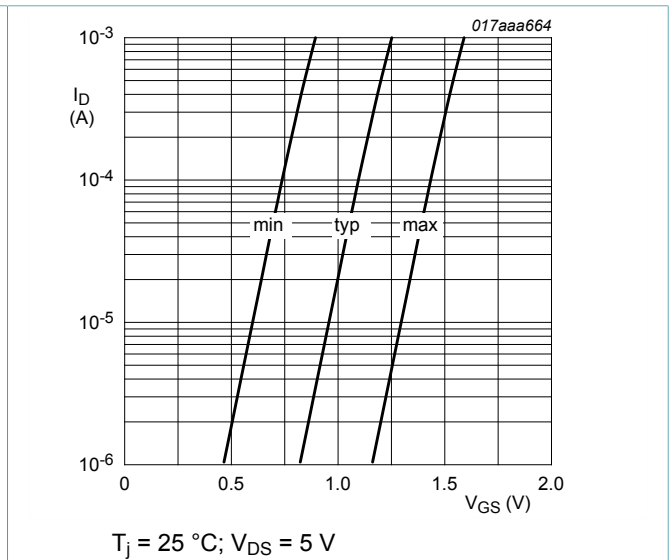


Fig. 7. Sub-threshold drain current as a function of gate-source voltage

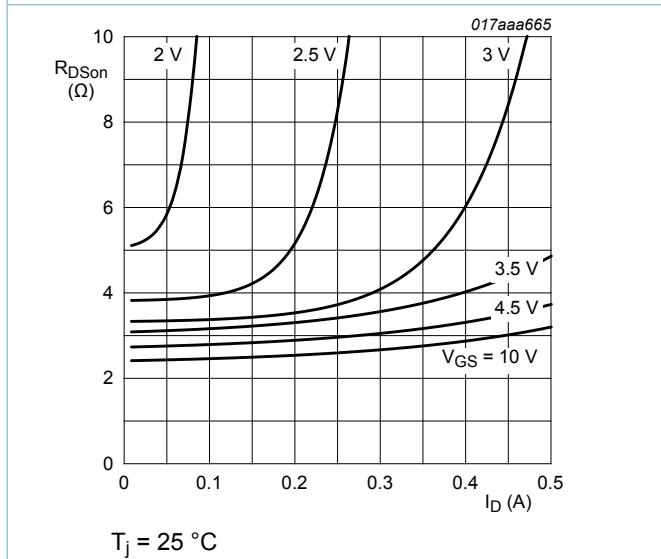


Fig. 8. Drain-source on-state resistance as a function of drain current; typical values

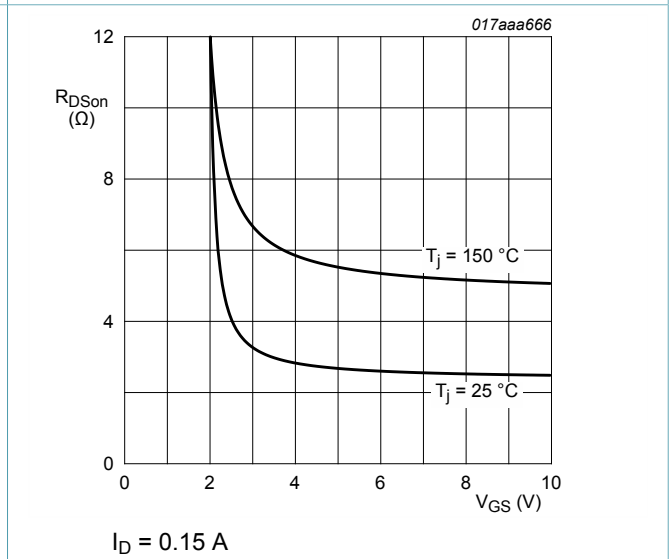
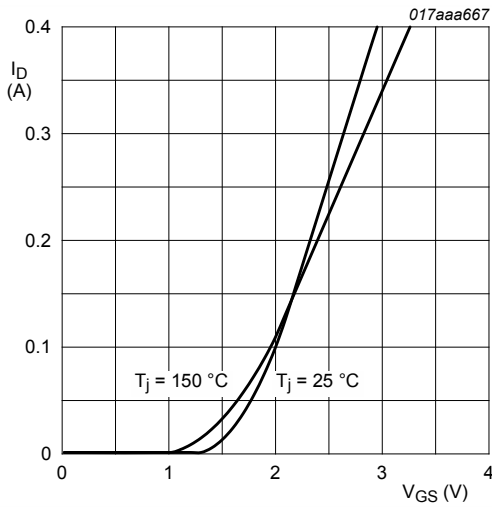


Fig. 9. Drain-source on-state resistance as a function of gate-source voltage; typical values



$$V_{DS} > I_D \times R_{DSon}$$

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

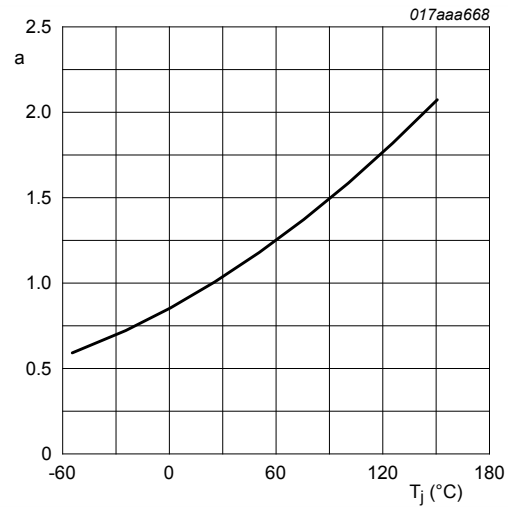
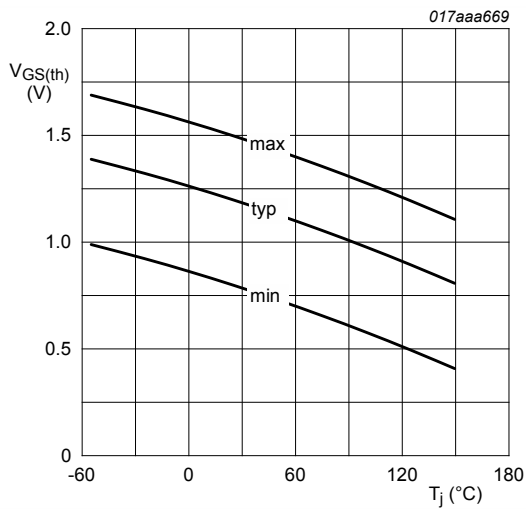


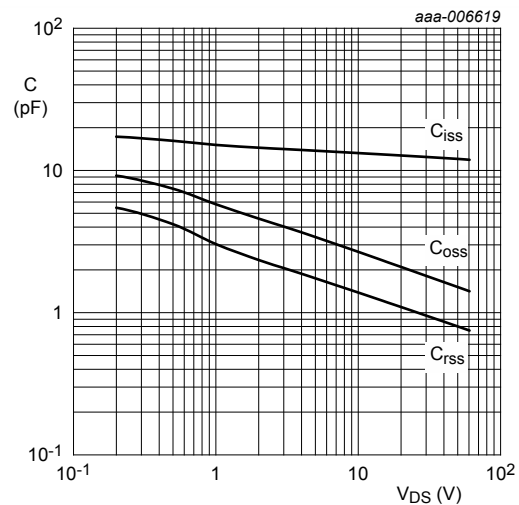
Fig. 11. Normalized drain-source on-state resistance as a function of junction temperature; typical values

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



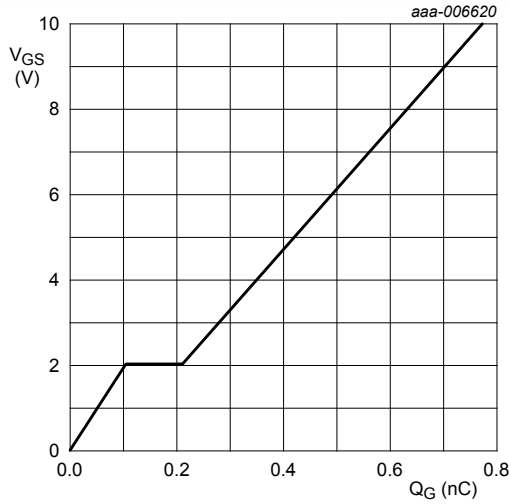
$$I_D = 0.25 \text{ mA}; V_{DS} = V_{GS}$$

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



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

Fig. 13. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values



$I_D = 150 \text{ mA}; V_{DS} = 30 \text{ V}; T_{amb} = 25 \text{ }^\circ\text{C}$

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

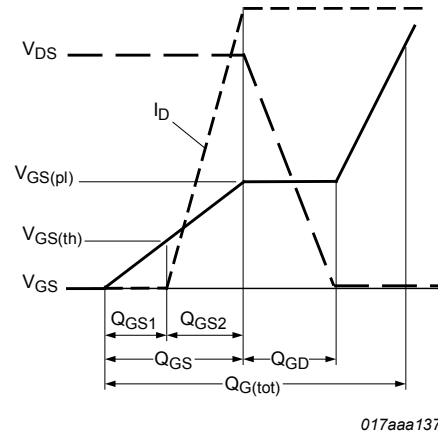
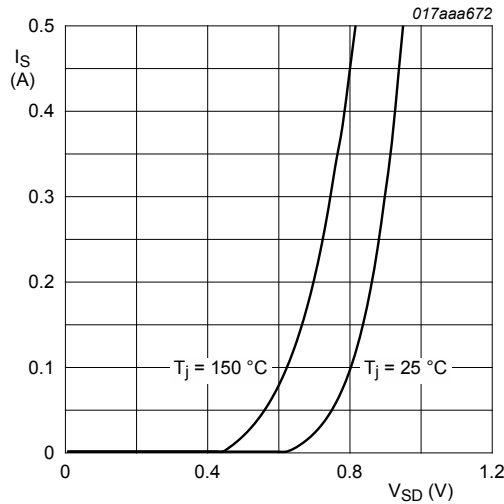


Fig. 15. Gate charge waveform definitions



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

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

11. Test information

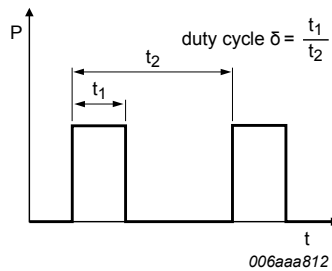


Fig. 17. Duty cycle definition

11.1 Quality information

This product has been qualified in accordance with the Automotive Electronics Council (AEC) standard Q101 - Stress test qualification for discrete semiconductors, and is suitable for use in automotive applications.

12. Package outline

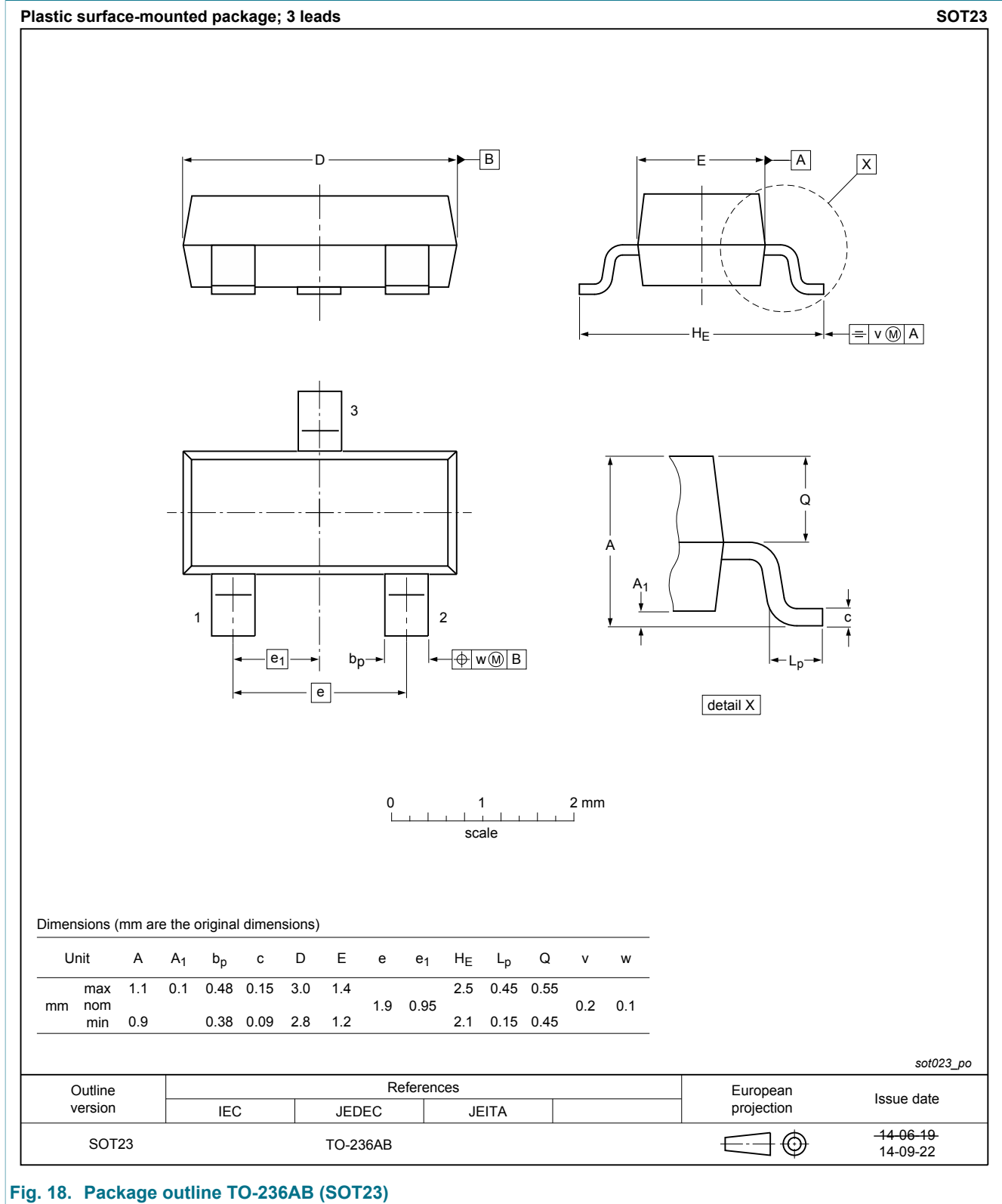


Fig. 18. Package outline TO-236AB (SOT23)

13. Soldering

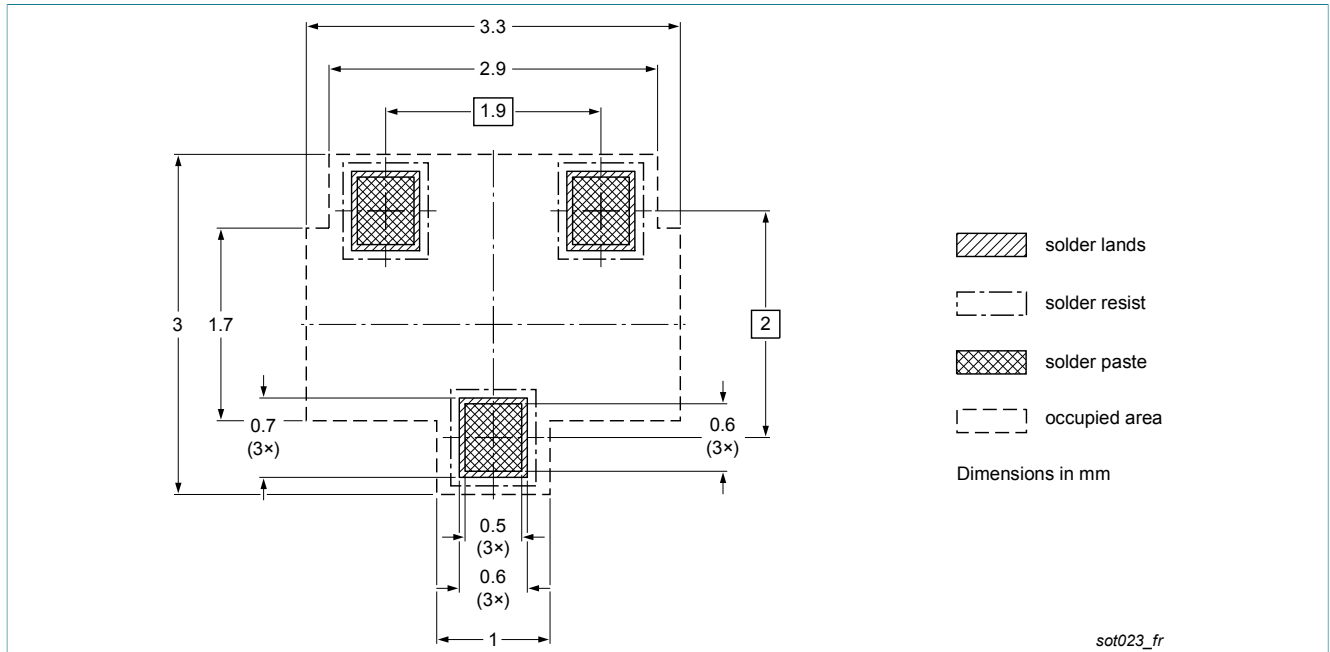


Fig. 19. Reflow soldering footprint for TO-236AB (SOT23)

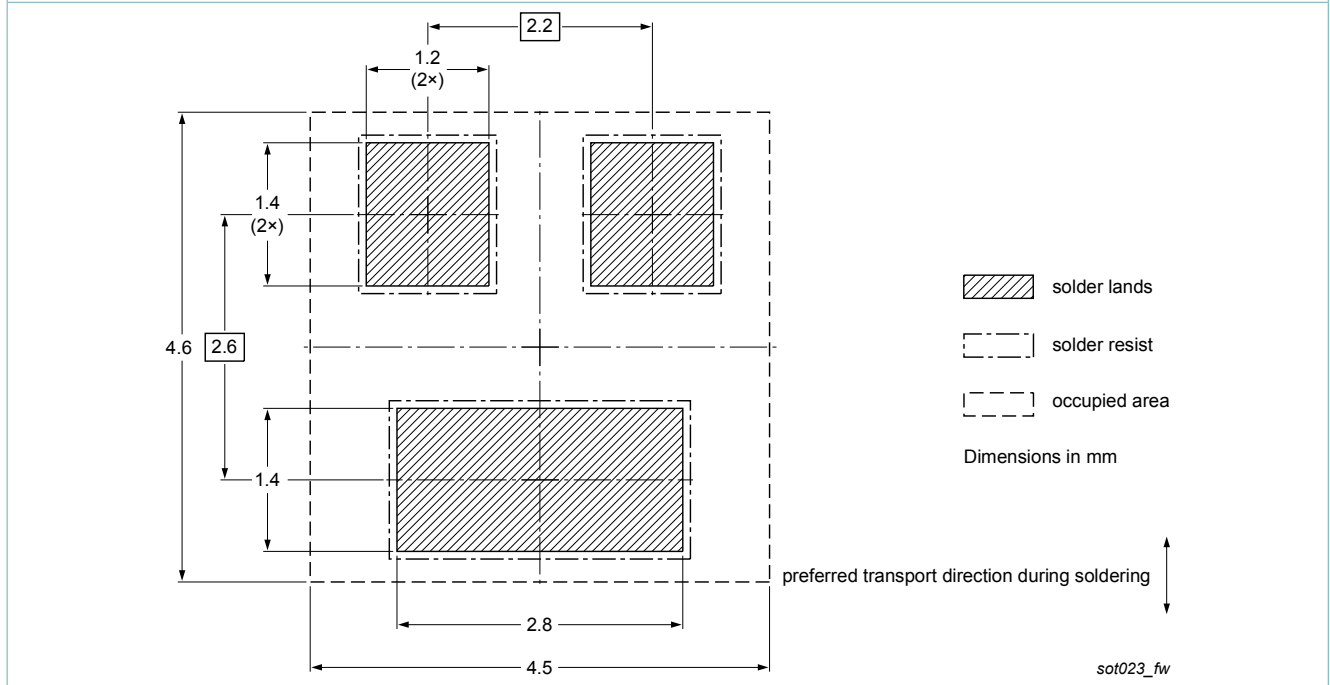


Fig. 20. Wave soldering footprint for TO-236AB (SOT23)

14. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
BSS138AKA v.3	20150429	Product data sheet	-	BSS138AKA v.2
Modifications:	<ul style="list-style-type: none">Figure 14: x-axis scale corrected			
BSS138AKA v.2	20141103	Product data sheet	-	BSS138AKA v.1
BSS138AKA v.1	20130206	Product data sheet	-	-

15. Legal information

15.1 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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