BSS138BK

60 V, 360 mA N-channel Trench MOSFET

Rev. 1 — 4 August 2011 Product data sheet

1. Product profile

1.1 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.

1.2 Features and benefits

- Logic-level compatible
- Very fast switching
- Trench MOSFET technology
- ESD protection up to 1.5 kV
- AEC-Q101 qualified

1.3 Applications

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

1.4 Quick reference data

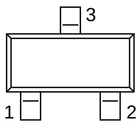
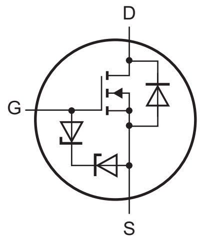
Table 1. Quick reference data

Symbol	Parameter	Conditions		Min	Typ	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]	-	-	360	mA
Static characteristics							
R_{DSon}	drain-source on-state resistance	V_{GS} = 10 V; I_D = 350 mA; T_j = 25 °C		-	1	1.6	Ω

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

2. Pinning information

Table 2. Pinning information

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

3. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
BSS138BK	TO-236AB	plastic surface-mounted package; 3 leads	SOT23

4. Marking

Table 4. Marking codes

Type number	Marking code[1]
BSS138BK	%SB

[1] % = placeholder for manufacturing site code.

5. Limiting values

Table 5. Limiting values

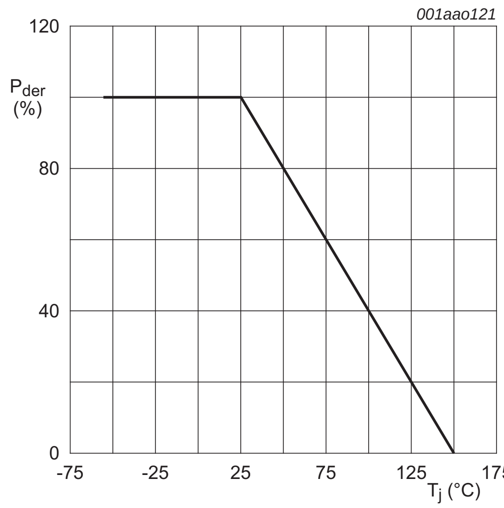
In accordance with the Absolute Maximum Rating System (IEC 60134).

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]	-	360	mA
		V_{GS} = 10 V; T_{amb} = 100 °C	[1]	-	230	mA
I_{DM}	peak drain current	T_{amb} = 25 °C; single pulse; $t_p \leq 10$ µs		-	1.2	A
P_{tot}	total power dissipation	T_{amb} = 25 °C	[2]	-	350	mW
			[1]	-	420	mW
		T_{sp} = 25 °C		-	1140	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]	-	360	mA
ESD maximum rating						
V_{ESD}	electrostatic discharge voltage	HBM	[3]	-	1500	V

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

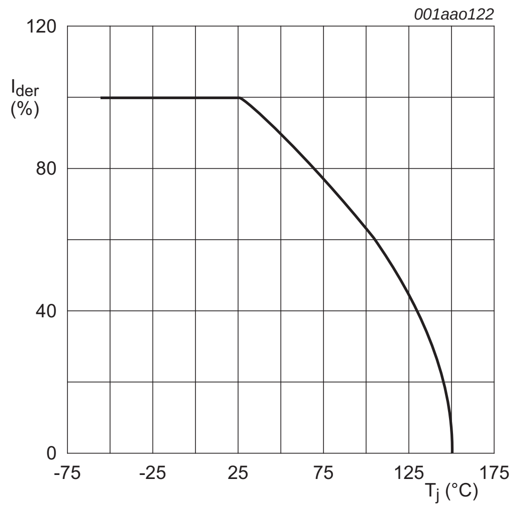
[2] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and standard footprint.

[3] Measured between all pins.



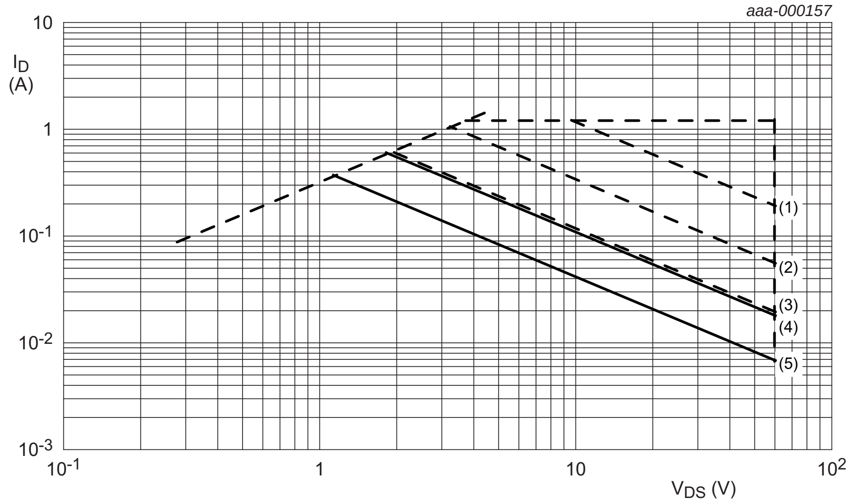
$$P_{der} = \frac{P_{tot}}{P_{tot(25^\circ C)}} \times 100\,\%$$

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



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

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



I_{DM} is a single pulse

(1) t_p = 1 ms

(2) t_p = 10 ms

(3) t_p = 100 ms

(4) DC; T_{sp} = 25 °C

(5) DC; T_{amb} = 25 °C; 1 cm^2 drain mounting pad

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

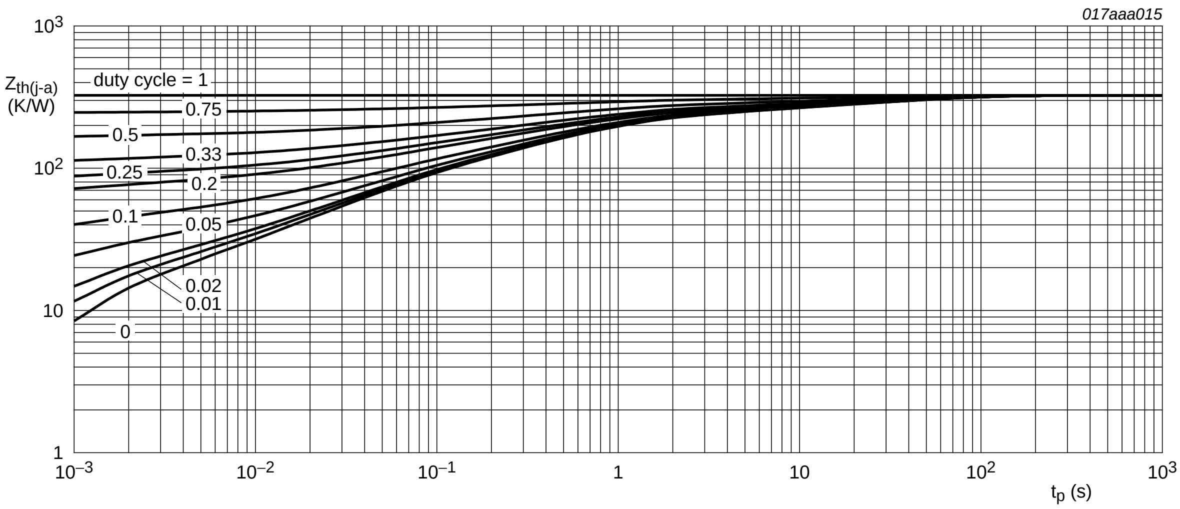
6. Thermal characteristics

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]	-	310	370	K/W
			[2]	-	260	300	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point			-	-	115	K/W

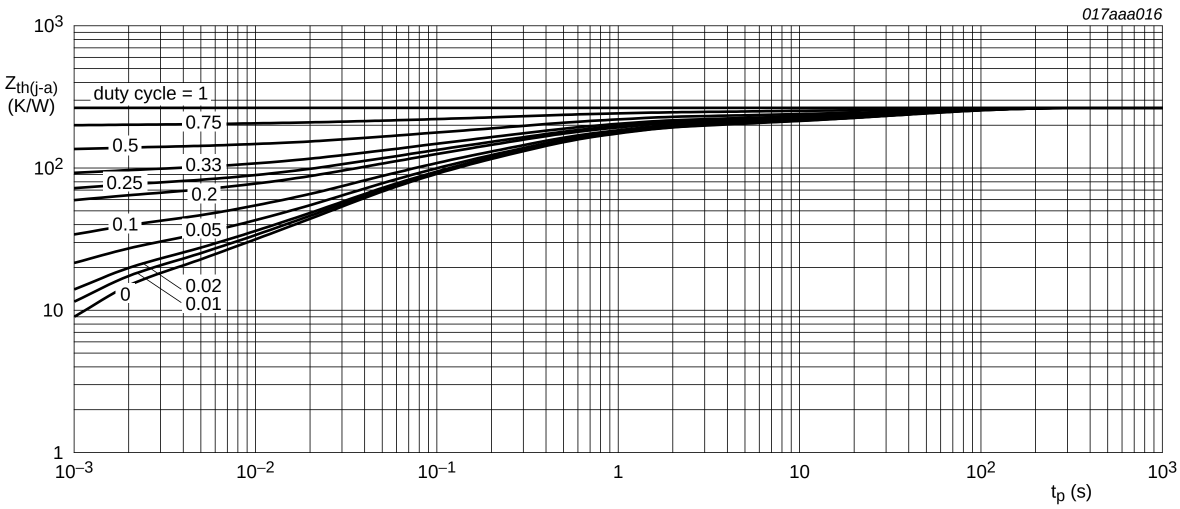
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.

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



FR4 PCB, standard footprint

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



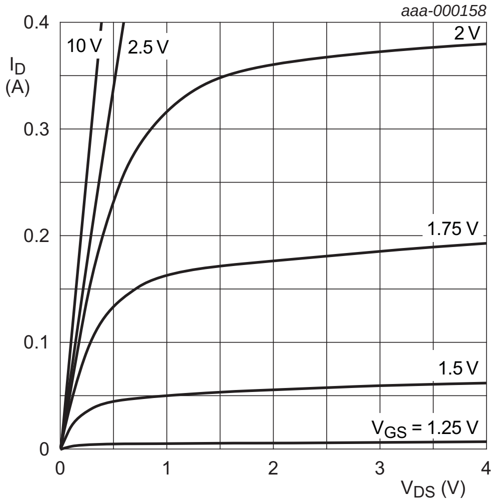
FR4 PCB, mounting pad for drain 1 cm^2

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

7. Characteristics

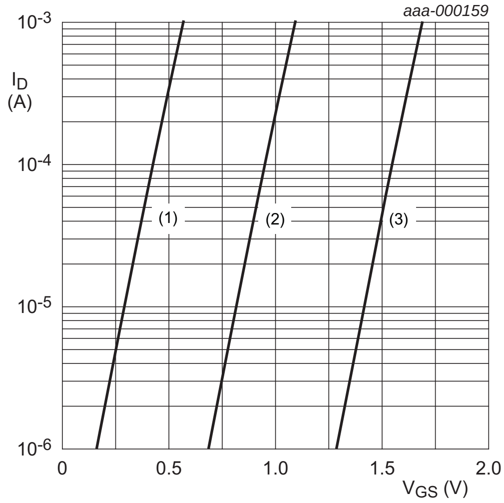
Table 7. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Static characteristics						
$V_{(BR)DSS}$	drain-source breakdown voltage	I_D = 250 µA; V_{GS} = 0 V; T_j = 25 °C	60	-	-	V
V_{GSth}	gate-source threshold voltage	I_D = 250 µA; V_{DS} = V_{GS}; T_j = 25 °C	0.48	1.1	1.6	V
I_{DSS}	drain leakage current	V_{DS} = 60 V; V_{GS} = 0 V; T_j = 25 °C	-	-	1	µA
		V_{DS} = 60 V; V_{GS} = 0 V; T_j = 150 °C	-	-	10	µA
I_{GSS}	gate leakage current	V_{GS} = 20 V; V_{DS} = 0 V; T_j = 25 °C	-	-	10	µA
		V_{GS} = -20 V; V_{DS} = 0 V; T_j = 25 °C	-	-	10	µA
		V_{GS} = 10 V; V_{DS} = 0 V; T_j = 25 °C	-	-	1	µA
		V_{GS} = -10 V; V_{DS} = 0 V; T_j = 25 °C	-	-	1	µA
R_{DSon}	drain-source on-state resistance	V_{GS} = 10 V; I_D = 350 mA; T_j = 25 °C	-	1	1.6	Ω
		V_{GS} = 10 V; I_D = 350 mA; T_j = 150 °C	-	2	3.2	Ω
		V_{GS} = 4.5 V; I_D = 200 mA; T_j = 25 °C	-	1.1	2.2	Ω
		V_{GS} = 2.5 V; I_D = 10 mA; T_j = 25 °C	-	1.4	6.5	Ω
g_{fs}	forward transconductance	V_{DS} = 10 V; I_D = 200 mA; T_j = 25 °C	-	700	-	mS
Dynamic characteristics						
$Q_{G(tot)}$	total gate charge	V_{DS} = 30 V; I_D = 300 mA; V_{GS} = 4.5 V; T_j = 25 °C	-	0.6	0.7	nC
Q_{GS}	gate-source charge		-	0.1	-	nC
Q_{GD}	gate-drain charge		-	0.2	-	nC
C_{iss}	input capacitance	V_{DS} = 10 V; f = 1 MHz; V_{GS} = 0 V; T_j = 25 °C	-	42	56	pF
C_{oss}	output capacitance		-	7	-	pF
C_{rss}	reverse transfer capacitance		-	4	-	pF
$t_{d(on)}$	turn-on delay time	V_{DS} = 40 V; R_L = 250 Ω; V_{GS} = 10 V; $R_{G(ext)}$ = 6 Ω; T_j = 25 °C	-	5	10	ns
t_r	rise time		-	5	-	ns
$t_{d(off)}$	turn-off delay time		-	38	76	ns
t_f	fall time		-	20	-	ns
Source-drain diode						
V_{SD}	source-drain voltage	I_S = 300 mA; V_{GS} = 0 V; T_j = 25 °C	0.47	0.8	1.2	V



T_j = 25 °C

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



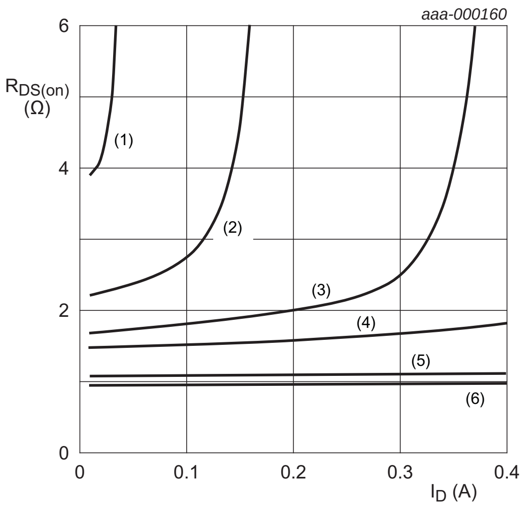
T_j = 25 °C; V_{DS} = 5 V

(1) minimum values

(2) typical values

(3) maximum values

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



T_j = 25 °C

(1) V_{GS} = 1.5 V

(2) V_{GS} = 1.75 V

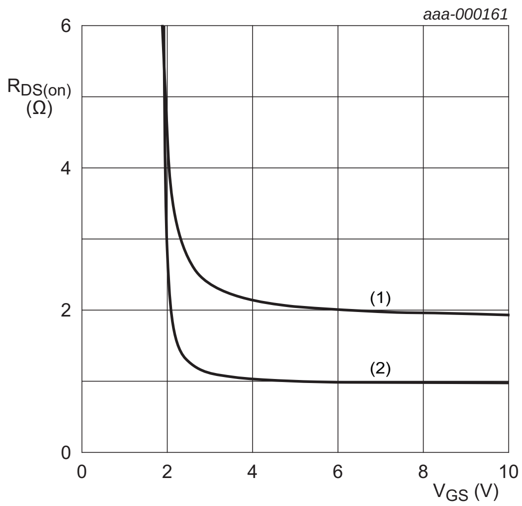
(3) V_{GS} = 2.0 V

(4) V_{GS} = 2.25 V

(5) V_{GS} = 4.5 V

(6) V_{GS} = 10 V

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

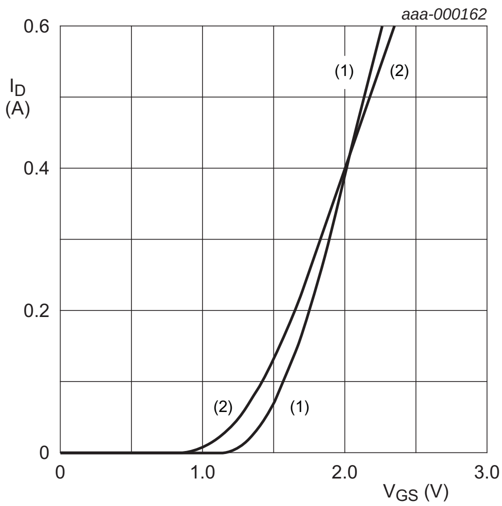


I_D = 300 mA

(1) T_j = 150 °C

(2) T_j = 25 °C

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

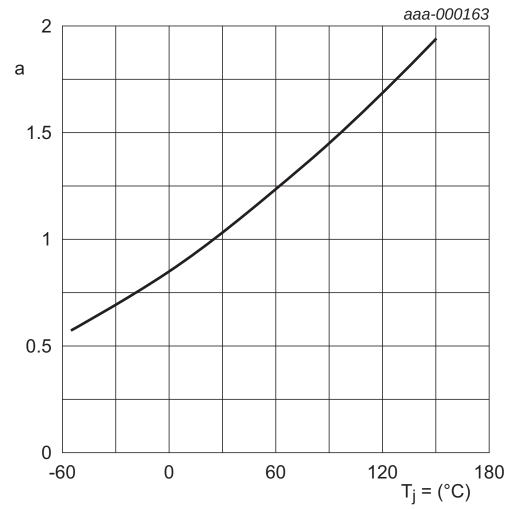


$V_{DS} > I_D \times R_{DSon}$

(1) T_j = 25 °C

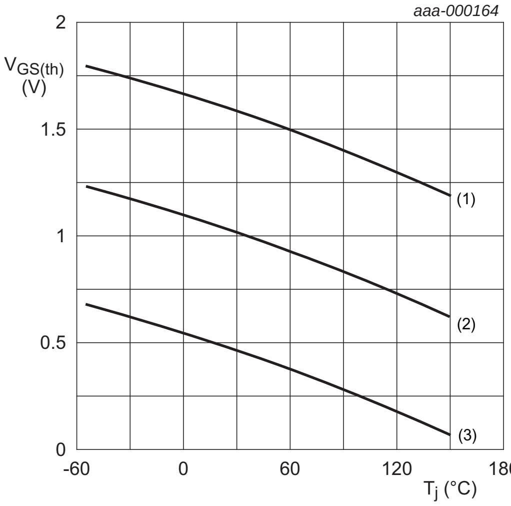
(2) T_j = 150 °C

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



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

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



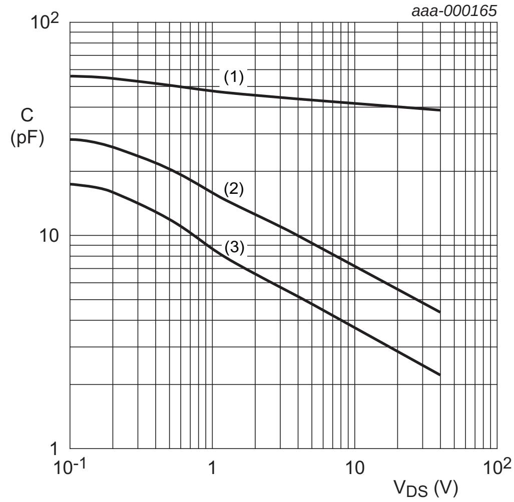
I_D = 0.25 mA; $V_{DS} = V_{GS}$

(1) maximum values

(2) typical values

(3) minimum values

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



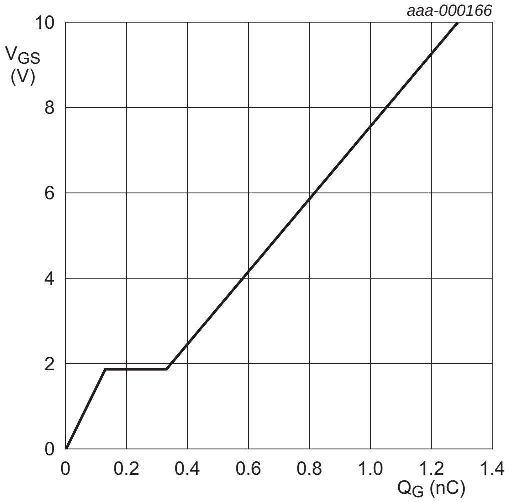
f = 1 MHz; V_{GS} = 0 V

(1) C_{iss}

(2) C_{oss}

(3) C_{rss}

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



I_D = 0.3 A; V_{DS} = 30 V; T_{amb} = 25 °C

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

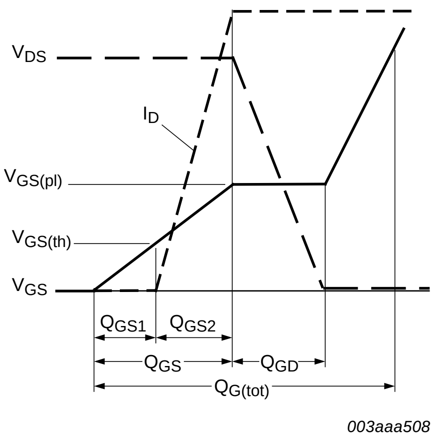
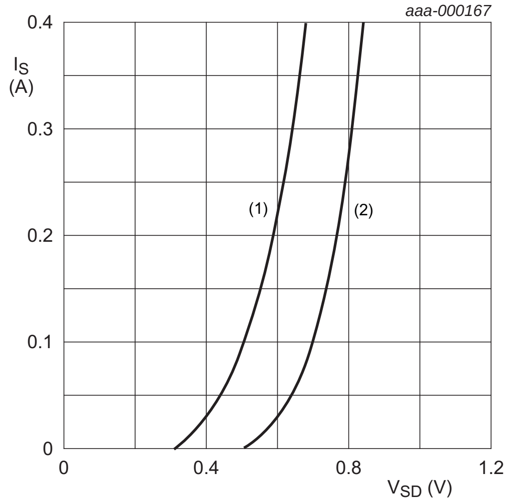


Fig 15. Gate charge waveform definitions



V_{GS} = 0 V

(1) T_j = 150 °C

(2) T_j = 25 °C

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

8. Test information

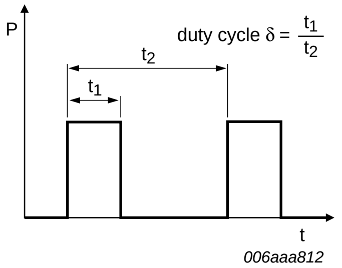


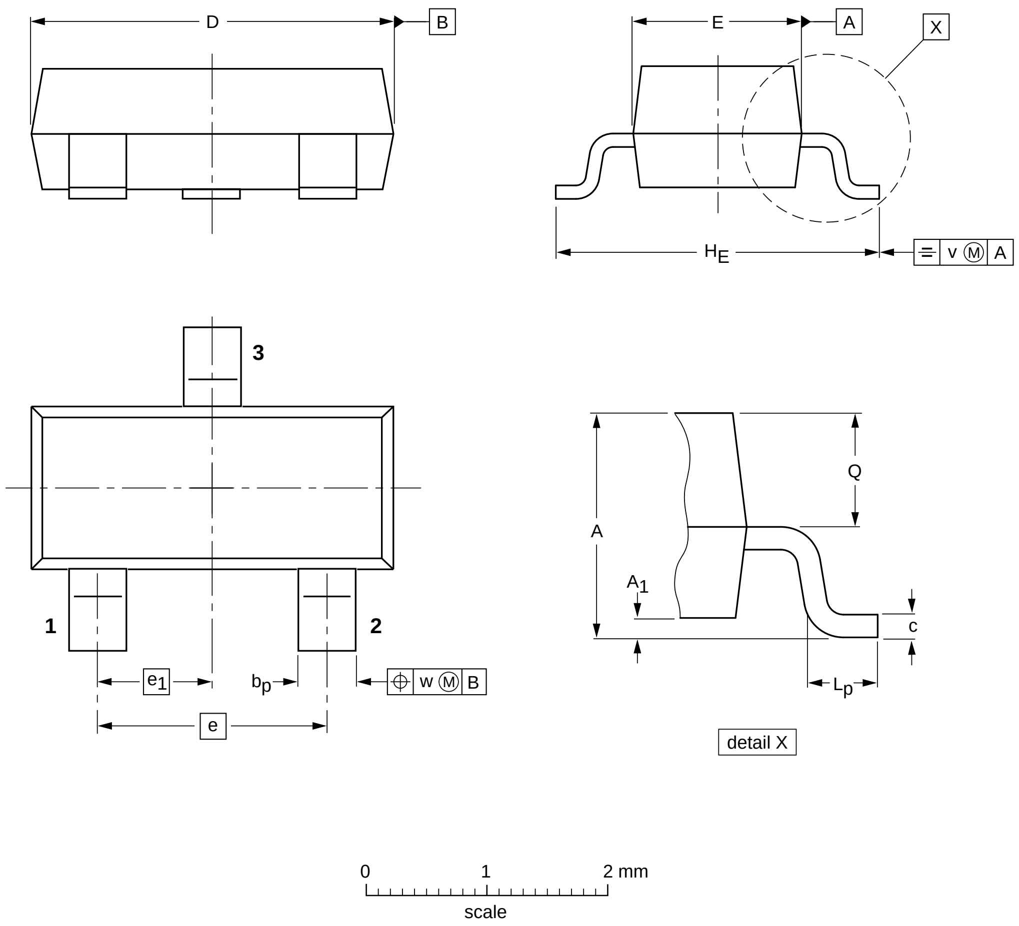
Fig 17. Duty cycle definition

8.1 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.

9. Package outline

Plastic surface-mounted package; 3 leads **SOT23**



DIMENSIONS (mm are the original dimensions)

UNIT	A	A_1 max.	b_p	c	D	E	e	e_1	H_E	L_p	Q	v	w
mm	1.1 0.9	0.1	0.48 0.38	0.15 0.09	3.0 2.8	1.4 1.2	1.9	0.95	2.5 2.1	0.45 0.15	0.55 0.45	0.2	0.1

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT23		TO-236AB				~~04-11-04~~ 06-03-16

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

10. Soldering

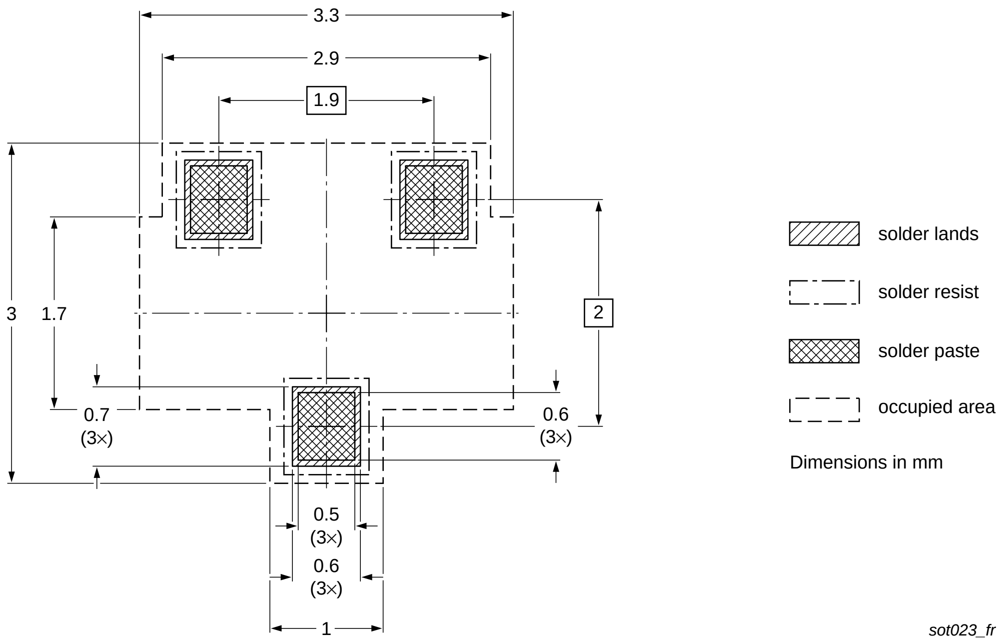


Fig 19. Reflow soldering footprint for SOT23 (TO-236AB)

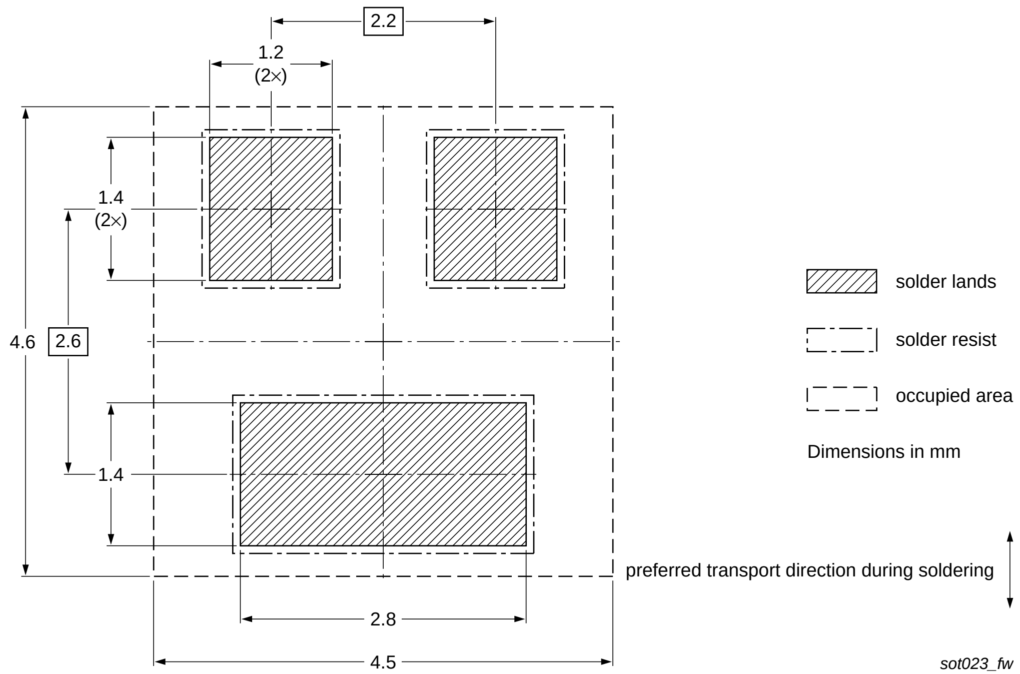


Fig 20. Wave soldering footprint for SOT23 (TO-236AB)

11. Revision history

Table 8. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BSS138BK v.1	20110804	Product data sheet	-	-

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.

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

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14. Contents

Date of release: 04 August 2011