



# BSS138BKS

60 V, 320 mA dual N-channel Trench MOSFET

Rev. 1 — 12 August 2011

Product data sheet

## 1. Product profile

### 1.1 General description

Dual N-channel enhancement mode Field-Effect Transistor (FET) in a very small SOT363 (SC-88) 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

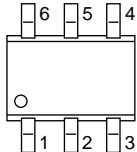
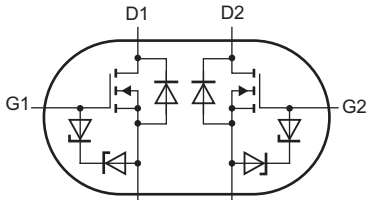
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Per transistor</b>						
$V_{DS}$	drain-source voltage	$T_j = 25\text{ °C}$	-	-	60	V
$V_{GS}$	gate-source voltage		-20	-	20	V
$I_D$	drain current	$V_{GS} = 10\text{ V};$ $T_{amb} = 25\text{ °C}$	[1]	-	320	mA
<b>Static characteristics (per transistor)</b>						
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = 10\text{ V};$ $I_D = 320\text{ mA}; T_j = 25\text{ °C}$	-	1	1.6	$\Omega$

[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated, mounting pad for drain 1 cm<sup>2</sup>.



## 2. Pinning information

**Table 2. Pinning information**

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	S1	source TR1	 <p><b>SOT363 (TSSOP6)</b></p>	 <p>017aaa256</p>
2	G1	gate TR1		
3	D2	drain TR2		
4	S2	source TR2		
5	G2	gate TR2		
6	D1	drain TR1		

## 3. Ordering information

**Table 3. Ordering information**

Type number	Package		Version
	Name	Description	
BSS138BKS	TSSOP6	plastic surface-mounted package; 6 leads	SOT363

## 4. Marking

**Table 4. Marking codes**

Type number	Marking code <sup>[1]</sup>
BSS138BKS	LG%

[1] % = placeholder for manufacturing site code.

## 5. Limiting values

**Table 5. Limiting values**

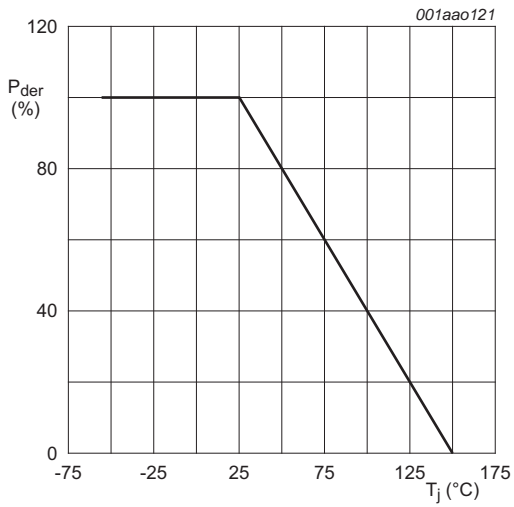
In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit	
<b>Per transistor</b>						
$V_{DS}$	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]	-	320	mA
		$V_{GS} = 10\text{ V}; T_{amb} = 100\text{ °C}$	[1]	-	210	mA
$I_{DM}$	peak drain current	$T_{amb} = 25\text{ °C};$ single pulse; $t_p \leq 10\text{ }\mu\text{s}$	-	1.2	A	
$P_{tot}$	total power dissipation	$T_{amb} = 25\text{ °C}$	[2]	-	280	mW
			[1]	-	320	mW
		$T_{sp} = 25\text{ °C}$	-	-	990	mW
<b>Per device</b>						
$P_{tot}$	total power dissipation	$T_{amb} = 25\text{ °C}$	[2]	-	445	mW
$T_j$	junction temperature		-55	150	°C	
$T_{amb}$	ambient temperature		-55	150	°C	
$T_{stg}$	storage temperature		-65	150	°C	
<b>Source-drain diode</b>						
$I_S$	source current	$T_{amb} = 25\text{ °C}$	[1]	-	320	mA
<b>ESD maximum rating</b>						
$V_{ESD}$	electrostatic discharge voltage	HBM	[3]	-	1500	V

[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated, mounting pad for drain 1 cm<sup>2</sup>.

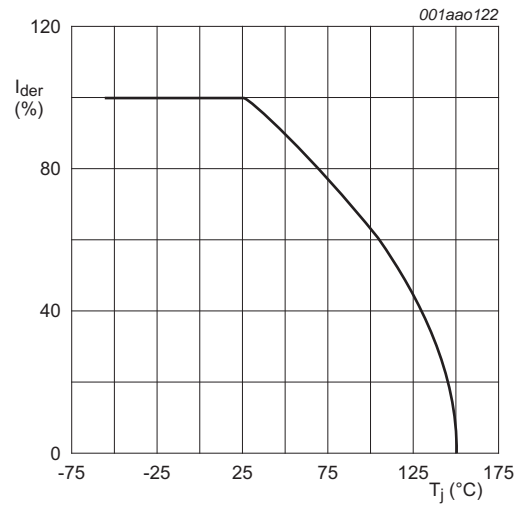
[2] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and standard footprint.

[3] Measured between all pins.



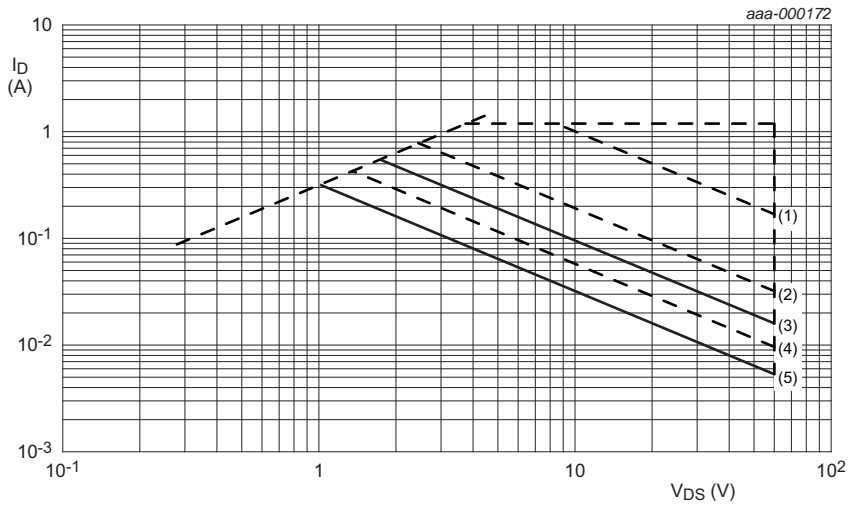
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\%$$

**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)  $t_p = 1 \text{ ms}$
- (2)  $t_p = 10 \text{ ms}$
- (3) DC;  $T_{sp} = 25^{\circ}C$
- (4)  $t_p = 100 \text{ ms}$
- (5) DC;  $T_{amb} = 25^{\circ}C$ ;  $1 \text{ cm}^2$  drain mounting pad

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

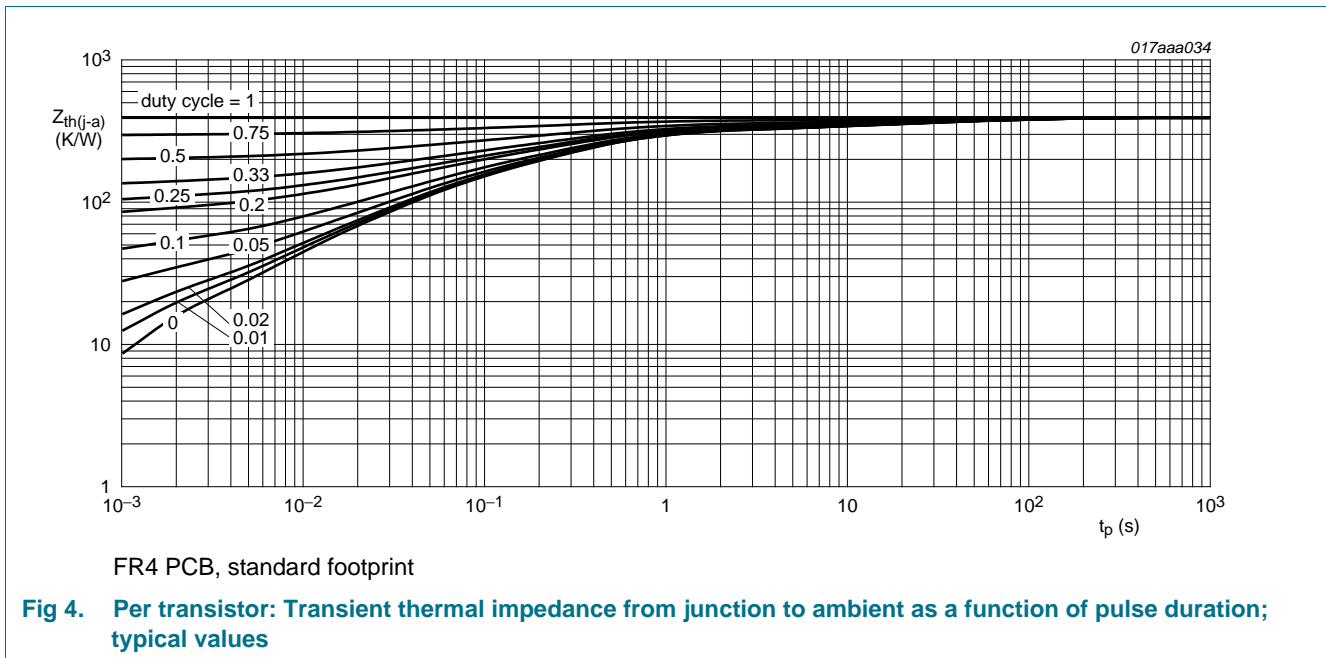
## 6. Thermal characteristics

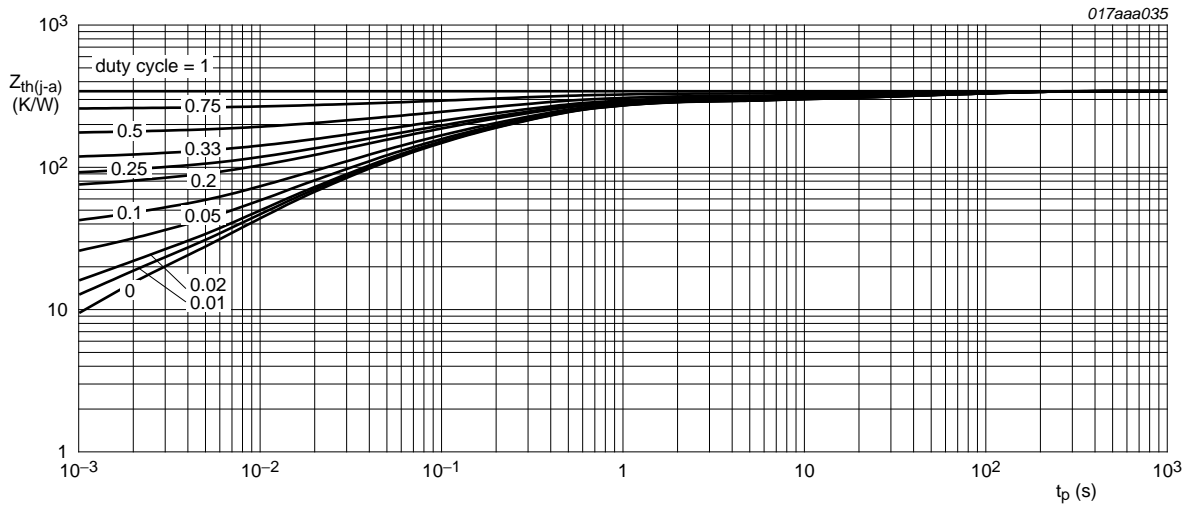
**Table 6. Thermal characteristics**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
<b>Per transistor</b>							
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	390	445	K/W
			[2]	-	340	390	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point		-	-	130	K/W	
<b>Per device</b>							
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	-	300	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<sup>2</sup>.





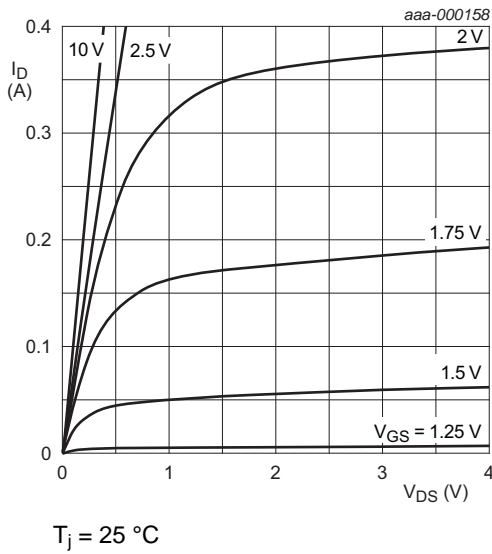
FR4 PCB, mounting pad for drain 1 cm<sup>2</sup>

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

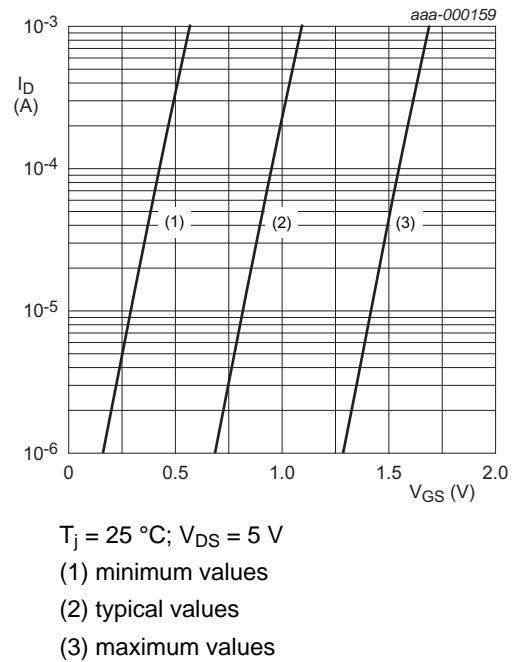
## 7. Characteristics

Table 7. Characteristics

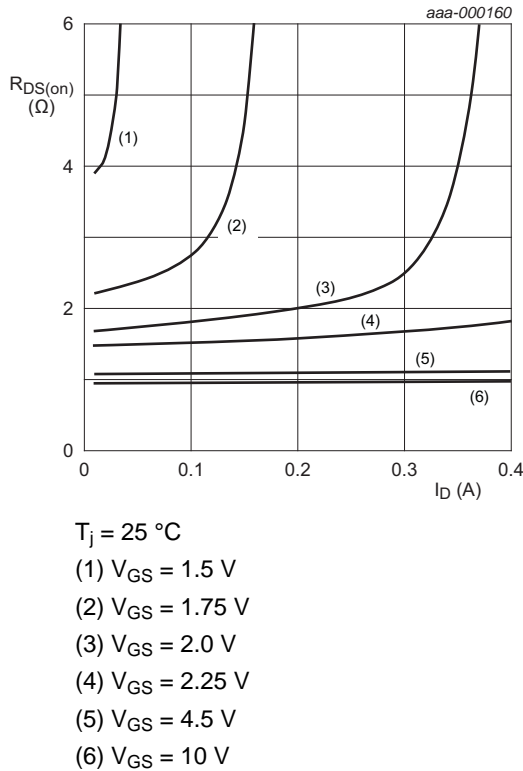
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics (per transistor)</b>						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 250 \mu\text{A}$ ; $V_{GS} = 0 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$	60	-	-	V
$V_{GSth}$	gate-source threshold voltage	$I_D = 250 \mu\text{A}$ ; $V_{DS} = V_{GS}$ ; $T_j = 25 \text{ }^\circ\text{C}$	0.48	1.1	1.6	V
$I_{DSS}$	drain leakage current	$V_{DS} = 60 \text{ V}$ ; $V_{GS} = 0 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	-	1	$\mu\text{A}$
		$V_{DS} = 60 \text{ V}$ ; $V_{GS} = 0 \text{ V}$ ; $T_j = 150 \text{ }^\circ\text{C}$	-	-	10	$\mu\text{A}$
$I_{GSS}$	gate leakage current	$V_{GS} = 20 \text{ V}$ ; $V_{DS} = 0 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	-	10	$\mu\text{A}$
		$V_{GS} = -20 \text{ V}$ ; $V_{DS} = 0 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	-	10	$\mu\text{A}$
		$V_{GS} = 10 \text{ V}$ ; $V_{DS} = 0 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	-	1	$\mu\text{A}$
		$V_{GS} = -10 \text{ V}$ ; $V_{DS} = 0 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	-	1	$\mu\text{A}$
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = 10 \text{ V}$ ; $I_D = 320 \text{ mA}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	1	1.6	$\Omega$
		$V_{GS} = 10 \text{ V}$ ; $I_D = 320 \text{ mA}$ ; $T_j = 150 \text{ }^\circ\text{C}$	-	2	3.2	$\Omega$
		$V_{GS} = 4.5 \text{ V}$ ; $I_D = 200 \text{ mA}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	1.1	2.2	$\Omega$
		$V_{GS} = 2.5 \text{ V}$ ; $I_D = 10 \text{ mA}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	1.4	6.5	$\Omega$
$g_{fs}$	forward transconductance	$V_{DS} = 10 \text{ V}$ ; $I_D = 200 \text{ mA}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	700	-	mS
<b>Dynamic characteristics (per transistor)</b>						
$Q_{G(tot)}$	total gate charge	$V_{DS} = 30 \text{ V}$ ; $I_D = 300 \text{ mA}$ ; $V_{GS} = 4.5 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	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	$V_{DS} = 10 \text{ V}$ ; $f = 1 \text{ MHz}$ ; $V_{GS} = 0 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	42	56	pF
$C_{oss}$	output capacitance		-	7	-	pF
$C_{rss}$	reverse transfer capacitance		-	4	-	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = 40 \text{ V}$ ; $R_L = 250 \Omega$ ; $V_{GS} = 10 \text{ V}$ ; $R_{G(ext)} = 6 \Omega$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	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
<b>Source-drain diode (per transistor)</b>						
$V_{SD}$	source-drain voltage	$I_S = 300 \text{ mA}$ ; $V_{GS} = 0 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$	0.7	0.8	1.2	V



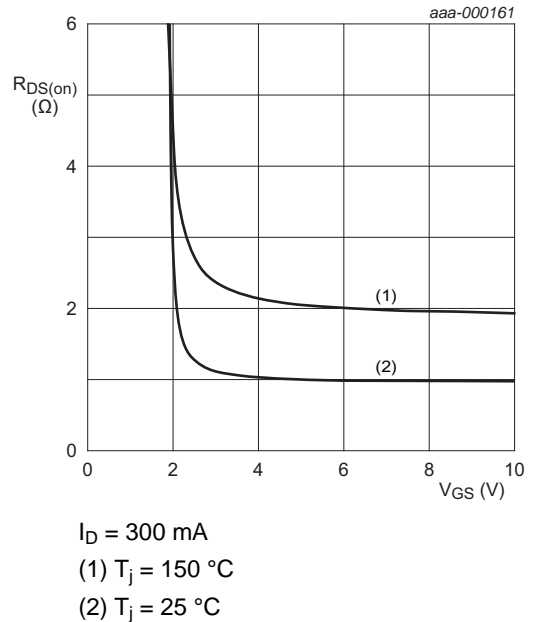
**Fig 6. Output characteristics: drain current as a function of drain-source voltage; typical values**



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

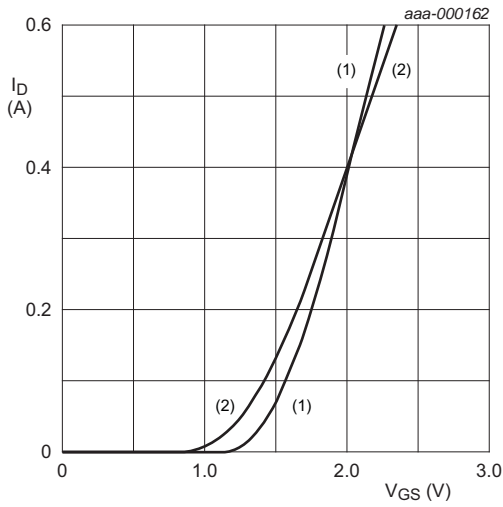


**Fig 8. Drain-source on-state resistance as a function of drain current; typical values**



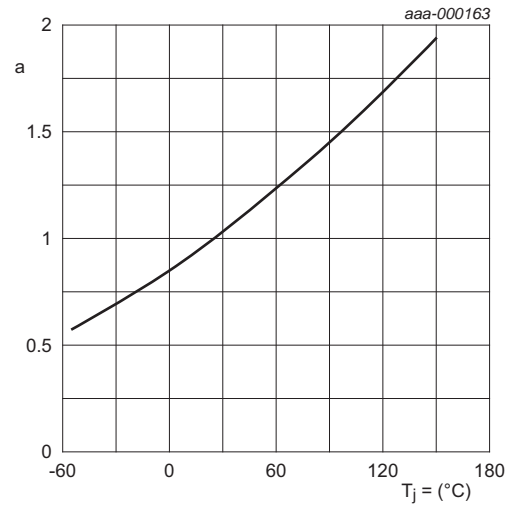
**Fig 9. Drain-source on-state resistance as a function of gate-source voltage; typical values**





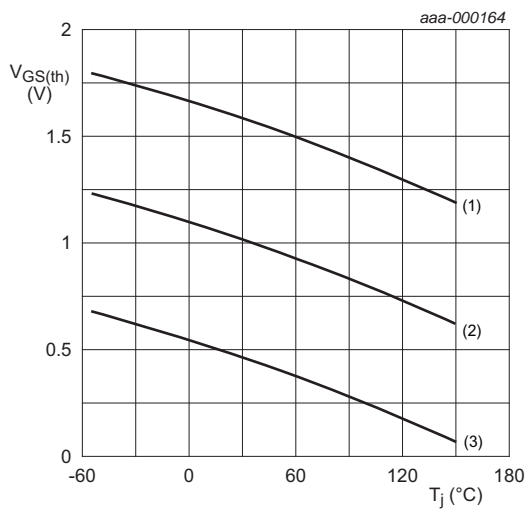
$V_{DS} > I_D \times R_{DS(on)}$   
 (1)  $T_j = 25\text{ °C}$   
 (2)  $T_j = 150\text{ °C}$

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



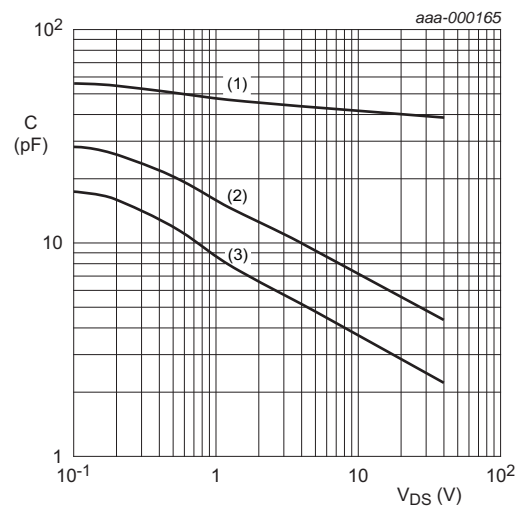
$$a = \frac{R_{DS(on)}}{R_{DS(on)@25^\circ\text{C}}}$$

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



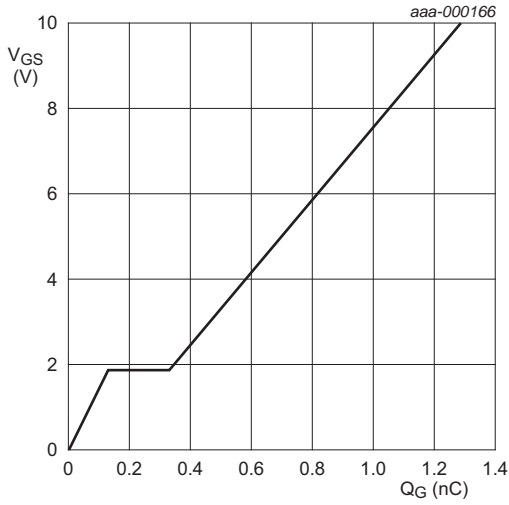
$I_D = 0.25\text{ mA}; V_{DS} = V_{GS}$   
 (1) maximum values  
 (2) typical values  
 (3) minimum values

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



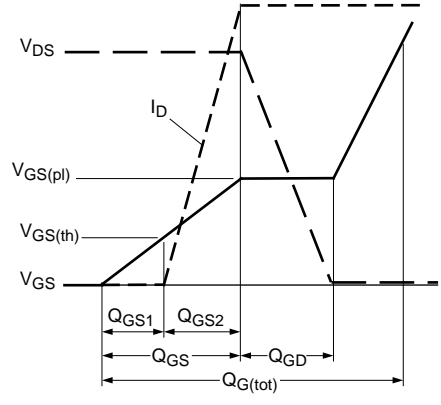
$f = 1\text{ MHz}; V_{GS} = 0\text{ V}$   
 (1)  $C_{iss}$   
 (2)  $C_{oss}$   
 (3)  $C_{rss}$

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

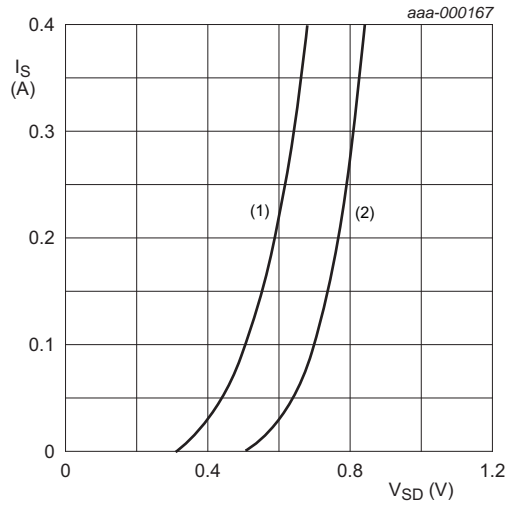


$I_D = 0.3 \text{ A}; V_{DS} = 30 \text{ V}; T_{amb} = 25 \text{ }^\circ\text{C}$

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



**Fig 15. Gate charge waveform definitions**



$V_{GS} = 0 \text{ V}$   
 (1)  $T_j = 150 \text{ }^\circ\text{C}$   
 (2)  $T_j = 25 \text{ }^\circ\text{C}$

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

## 8. Test information

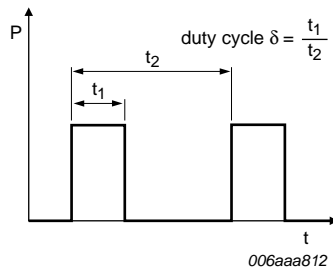


Fig 17. Duty cycle definition

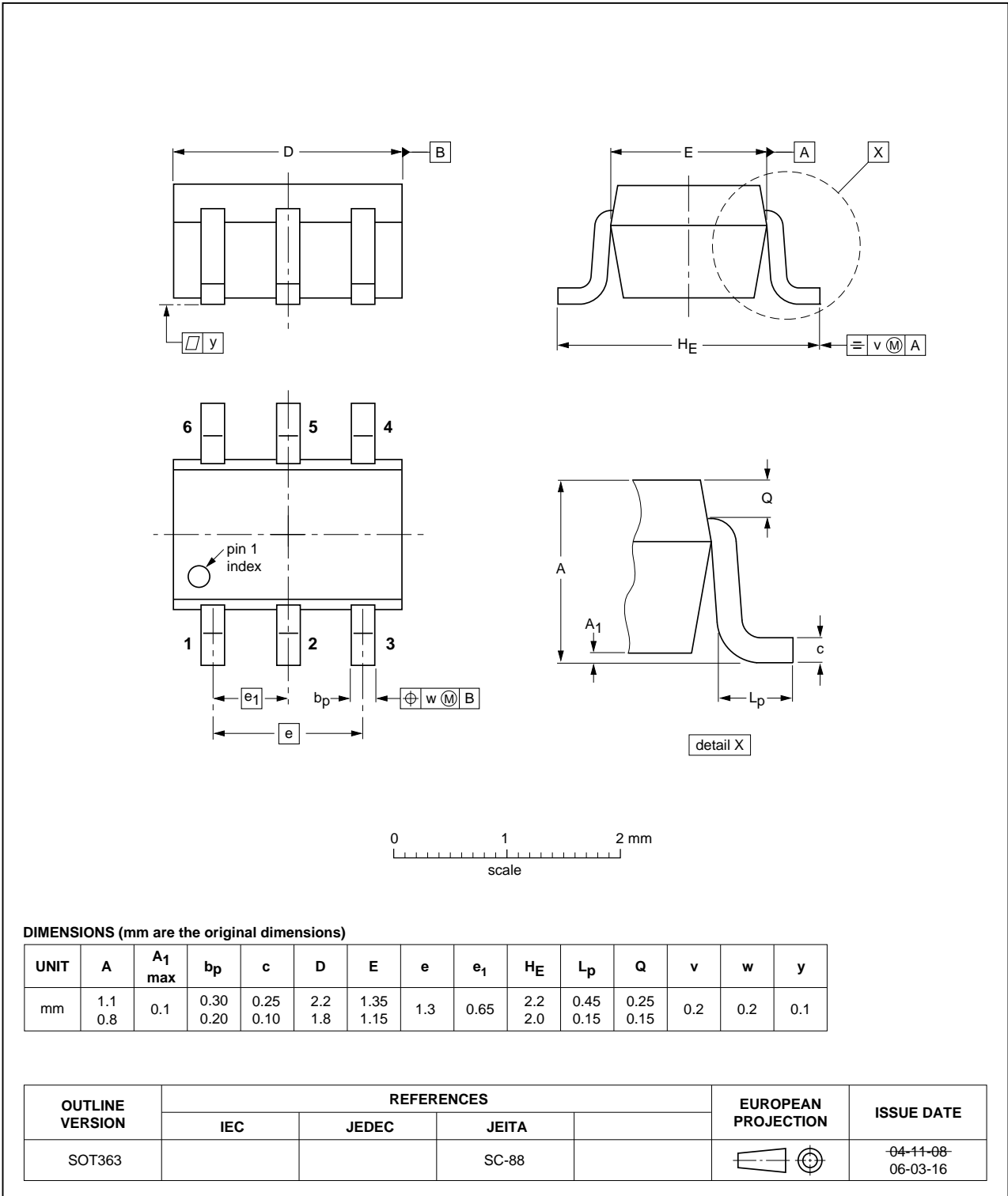
### 8.1 Quality information

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**

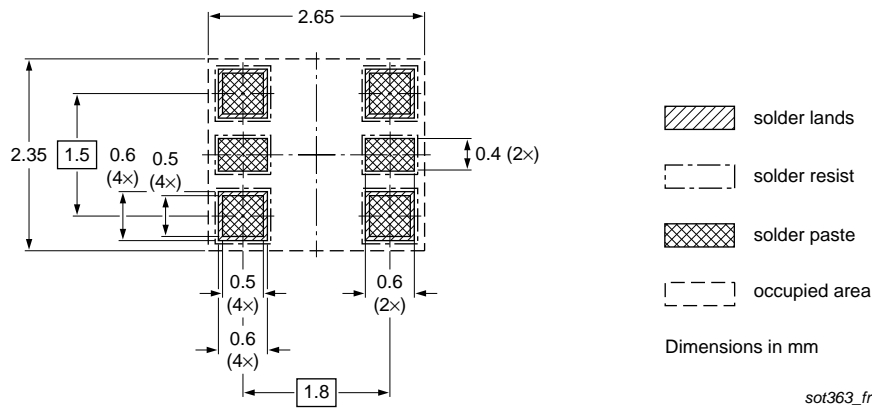
Plastic surface-mounted package; 6 leads

SOT363

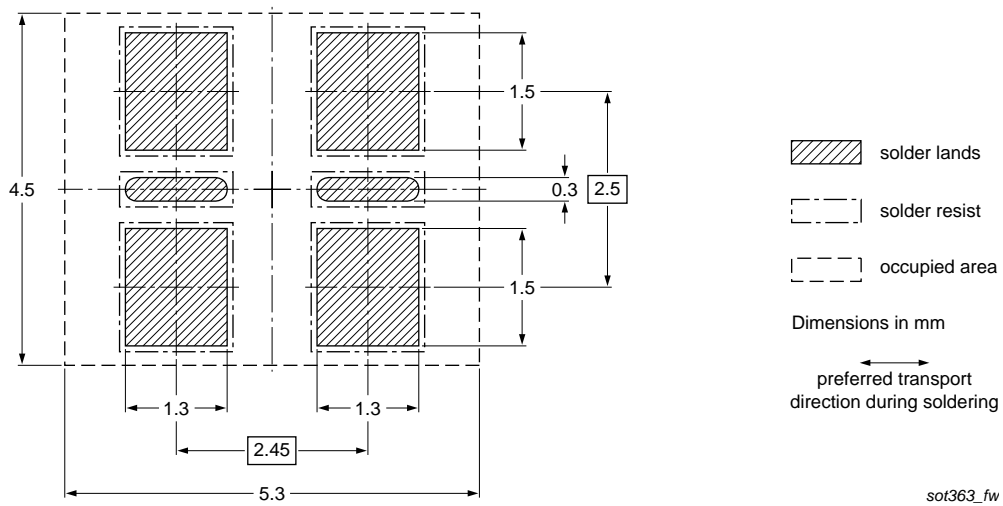


**Fig 18. Package outline SOT363 (TSSOP6)**

**10. Soldering**



**Fig 19. Reflow soldering footprint for SOT363 (TSSOP6)**



**Fig 20. Wave soldering footprint for SOT363 (TSSOP6)**

## 11. Revision history

**Table 8.** Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BSS138BKS v.1	20110812	Product data sheet	-	-

## 12. Legal information

### 12.1 Data sheet status

Document status <a href="#">[1]</a> <a href="#">[2]</a>	Product status <a href="#">[3]</a>	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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## 14. Contents

<b>1</b>	<b>Product profile</b> . . . . .	<b>1</b>
1.1	General description . . . . .	1
1.2	Features and benefits . . . . .	1
1.3	Applications . . . . .	1
1.4	Quick reference data . . . . .	1
<b>2</b>	<b>Pinning information</b> . . . . .	<b>2</b>
<b>3</b>	<b>Ordering information</b> . . . . .	<b>2</b>
<b>4</b>	<b>Marking</b> . . . . .	<b>2</b>
<b>5</b>	<b>Limiting values</b> . . . . .	<b>3</b>
<b>6</b>	<b>Thermal characteristics</b> . . . . .	<b>5</b>
<b>7</b>	<b>Characteristics</b> . . . . .	<b>7</b>
<b>8</b>	<b>Test information</b> . . . . .	<b>11</b>
8.1	Quality information . . . . .	11
<b>9</b>	<b>Package outline</b> . . . . .	<b>12</b>
<b>10</b>	<b>Soldering</b> . . . . .	<b>13</b>
<b>11</b>	<b>Revision history</b> . . . . .	<b>14</b>
<b>12</b>	<b>Legal information</b> . . . . .	<b>15</b>
12.1	Data sheet status . . . . .	15
12.2	Definitions . . . . .	15
12.3	Disclaimers . . . . .	15
12.4	Trademarks . . . . .	16
<b>13</b>	<b>Contact information</b> . . . . .	<b>16</b>

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