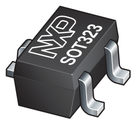



# BSS138BKW

## 60 V, 320 mA N-channel Trench MOSFET

Rev. 1 — 12 August 2011 Product data sheet

## 1. Product profile

### 1.1 General description

N-channel enhancement mode Field-Effect Transistor (FET) in a small SOT323 (SC-70) 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

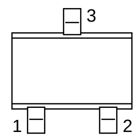
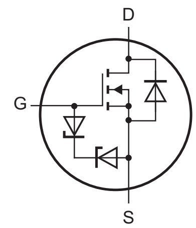
**Table 1. Quick reference data**

| 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] | - | - | 320 | mA |
| **Static characteristics** | | | | | | | |
| $R_{DSon}$ | drain-source on-state resistance | $V_{GS}$ = 10 V; $I_D$ = 320 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 | <br>**SOT323 (SC-70)** |  |
| 2 | S | source | | |
| 3 | D | drain | | |

## 3. Ordering information

**Table 3. Ordering information**

| Type number | Package | | |
|---|---|---|---|
| | Name | Description | Version |
| BSS138BKW | SC-70 | plastic surface-mounted package; 3 leads | SOT323 |

## 4. Marking

**Table 4. Marking codes**

| Type number | Marking code[1] |
|---|---|
| BSS138BKW | AD% |

[1] % = placeholder for manufacturing site code.

## 5. Limiting values

**Table 5. Limiting values**

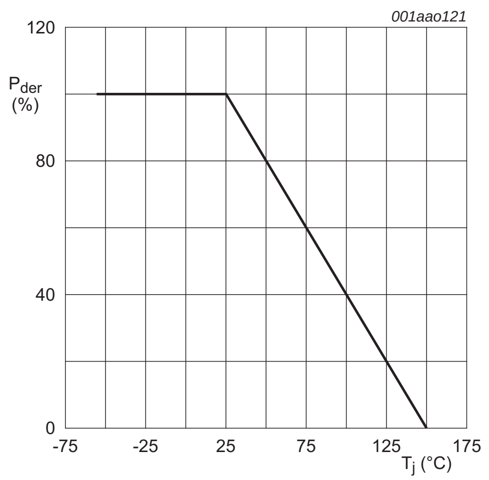
*In accordance with the Absolute Maximum Rating System (IEC 60134).*

| 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] | - | 320 | mA |
| | | $V_{GS}$ = 10 V; $T_{amb}$ = 100 °C | [1] | - | 210 | mA |
| $I_{DM}$ | peak drain current | $T_{amb}$ = 25 °C; single pulse; $t_p$ ≤ 10 µs | | - | 1.2 | A |
| $P_{tot}$ | total power dissipation | $T_{amb}$ = 25 °C | [2] | - | 260 | mW |
| | | | [1] | - | 310 | mW |
| | | $T_{sp}$ = 25 °C | | - | 830 | 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] | - | 320 | 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 $cm^2$.

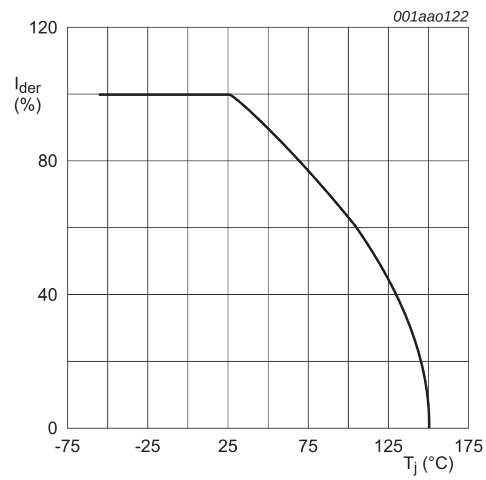
[2] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and standard footprint.

[3] Measured between all pins.



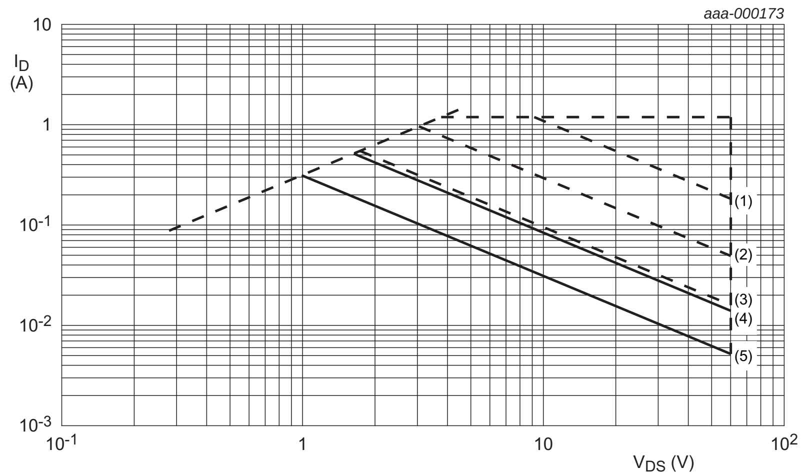

$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\,\%$$

**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**

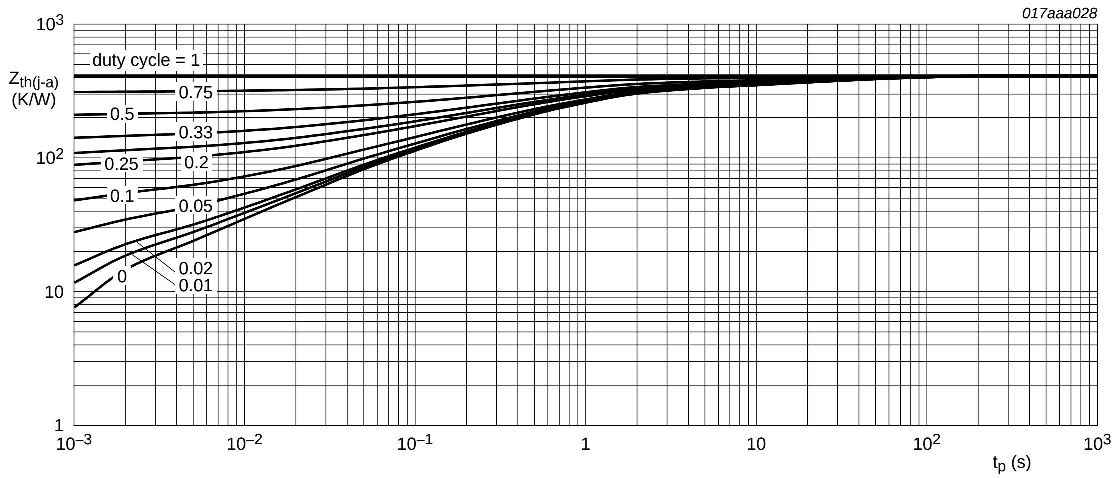
## 6. Thermal characteristics

**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] | - | 415 | 480 | K/W |
| | | | [2] | - | 350 | 400 | K/W |
| $R_{th(j-sp)}$ | thermal resistance from junction to solder point | | | - | - | 150 | K/W |

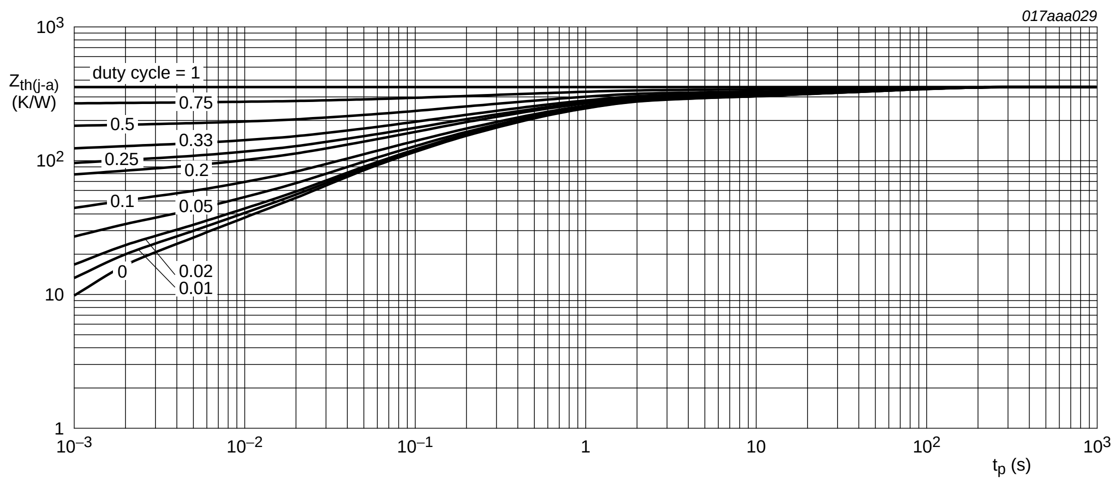
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.

[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**



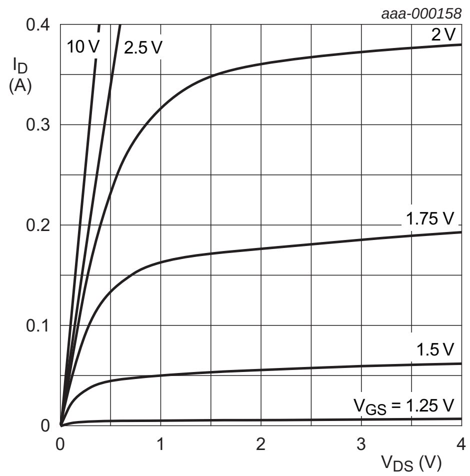

FR4 PCB, mounting pad for drain 1 $cm^2$

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

# 7. Characteristics

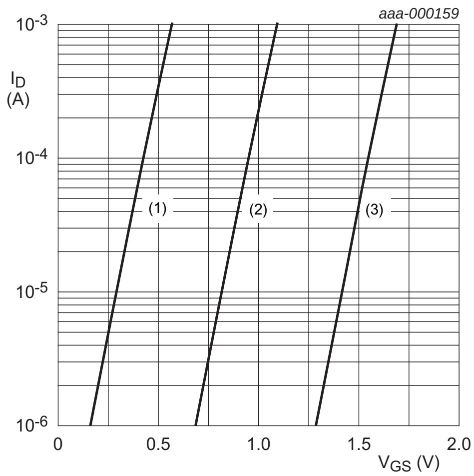
**Table 7. Characteristics**

| 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; $I_D$ = 320 mA; $T_j$ = 25 °C | - | 1 | 1.6 | Ω |
| | | $V_{GS}$ = 10 V; $I_D$ = 320 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**



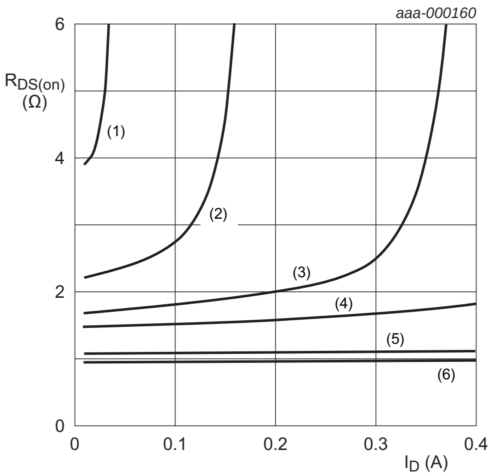

$T_j$ = 25 °C; $V_{DS}$ = 5 V

(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

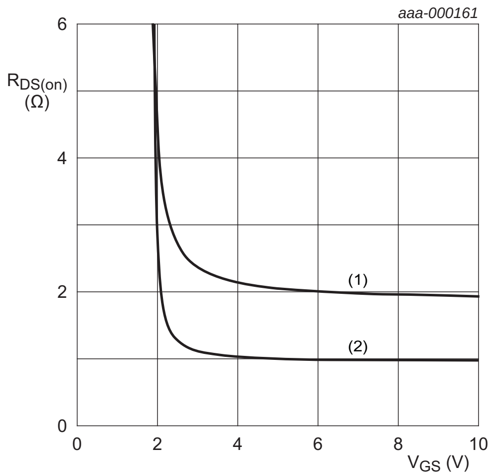
(3) $V_{GS}$ = 2.0 V

(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**

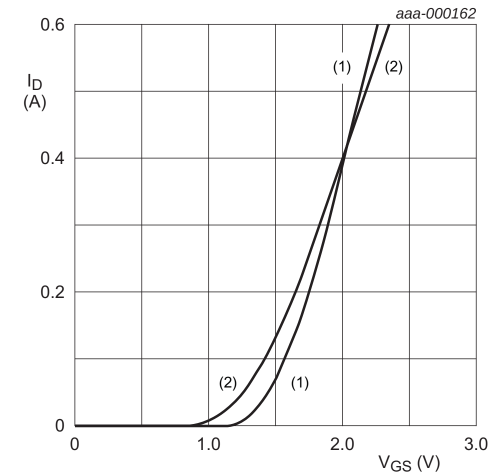



$I_D$ = 300 mA

(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**

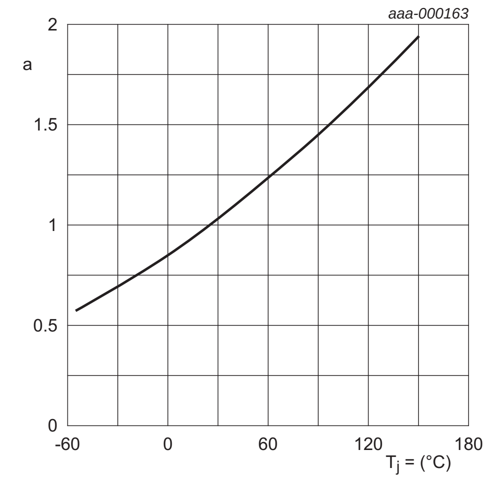



$V_{DS} > I_D \times R_{DSon}$

(1) $T_j$ = 25 °C

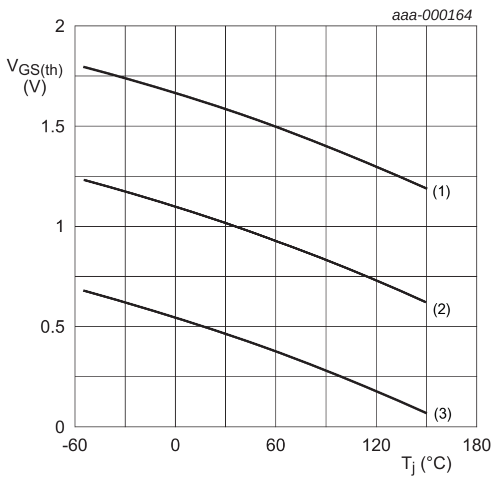
(2) $T_j$ = 150 °C

**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**



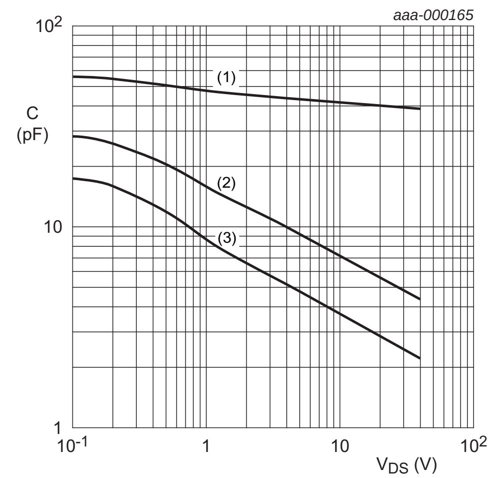

$I_D$ = 0.25 mA; $V_{DS} = V_{GS}$

(1) maximum values

(2) typical values

(3) minimum values

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



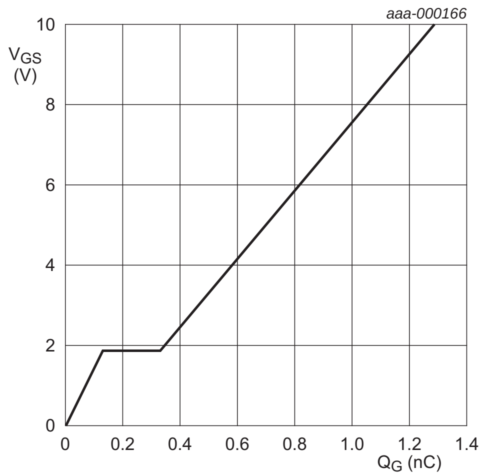

f = 1 MHz; $V_{GS}$ = 0 V

(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**

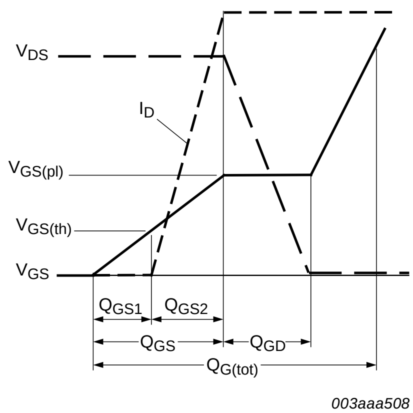
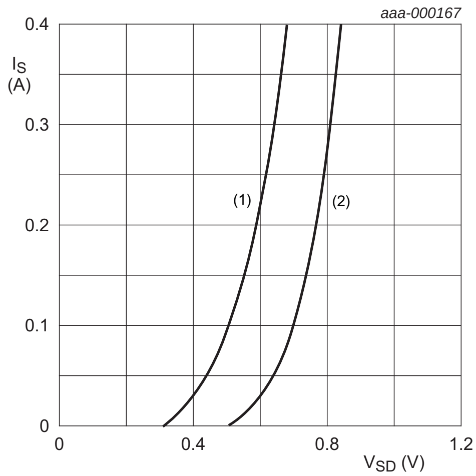



**Fig 15. Gate charge waveform definitions**




$V_{GS}$ = 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

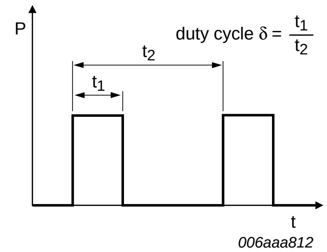


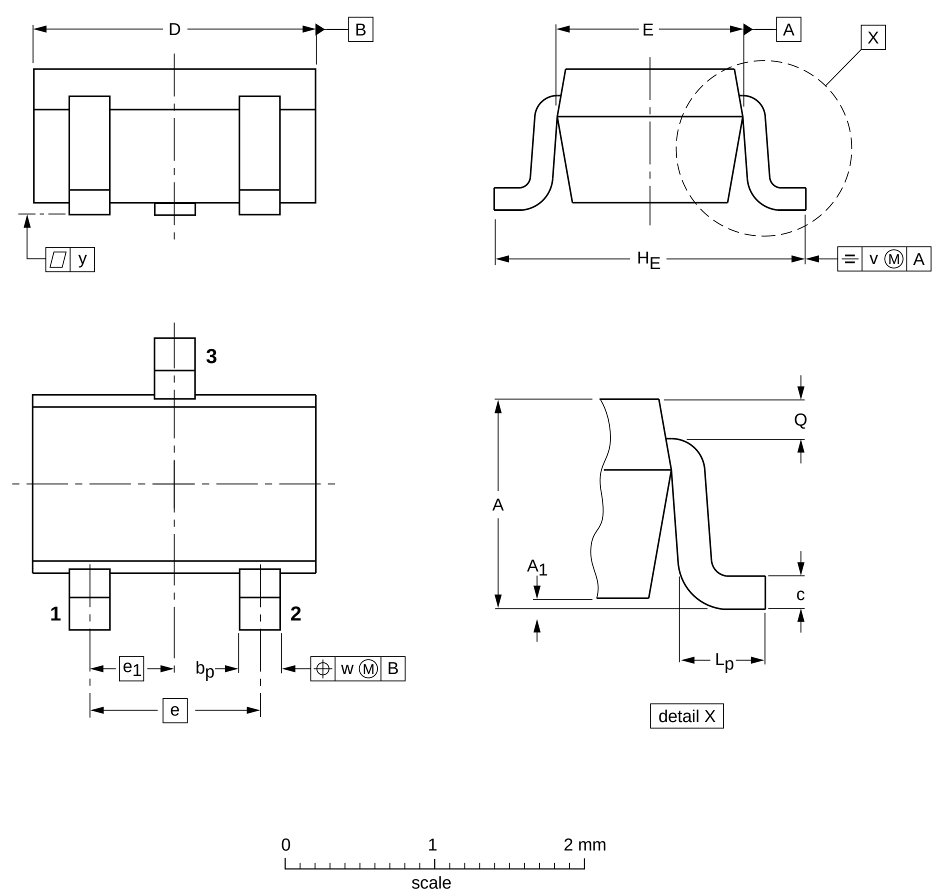

Fig 17. Duty cycle definition

## 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** **SOT323**




**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<br>0.8 | 0.1 | 0.4<br>0.3 | 0.25<br>0.10 | 2.2<br>1.8 | 1.35<br>1.15 | 1.3 | 0.65 | 2.2<br>2.0 | 0.45<br>0.15 | 0.23<br>0.13 | 0.2 | 0.2 |

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT323 | | | SC-70 | | | ~~04-11-04~~<br>06-03-16 |

Fig 18. Package outline SOT323 (SC-70)

## 10. Soldering

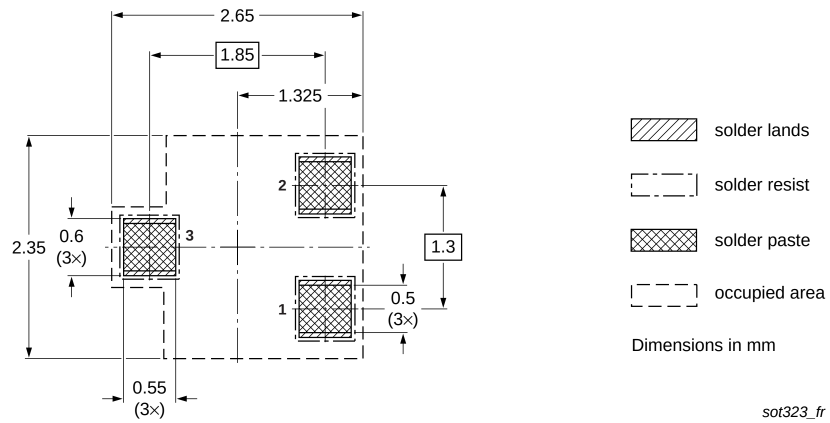



**Fig 19. Reflow soldering footprint for SOT323 (SC-70)**

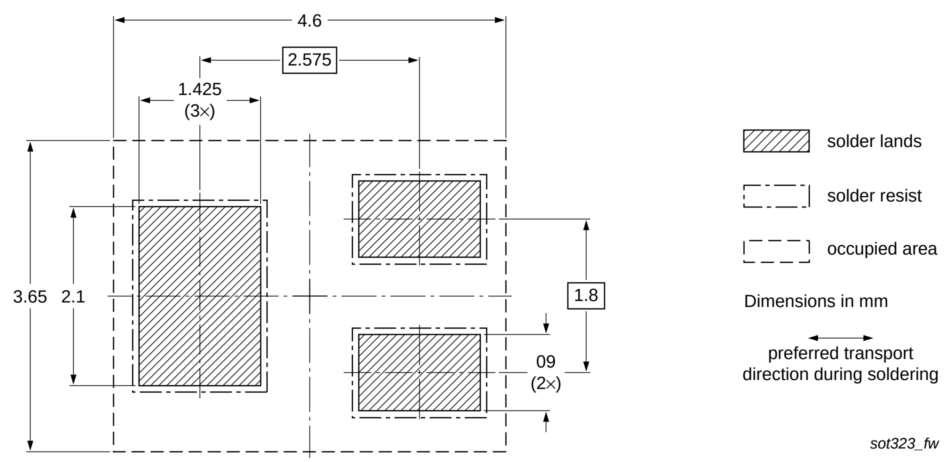



**Fig 20. Wave soldering footprint for SOT323 (SC-70)**

## 11. Revision history

**Table 8. Revision history**

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| BSS138BKW v.1 | 20110812 | 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".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.nxp.com.

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# 13. Contact information

For more information, please visit: http://www.nxp.com

For sales office addresses, please send an email to: salesaddresses@nxp.com

# 14. Contents





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