



# 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

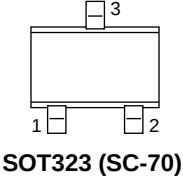
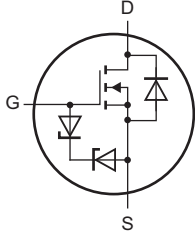
Table 1. Quick reference data

| Symbol                        | Parameter                        | Conditions                                                         | Min | Typ | Max | Unit     |
|-------------------------------|----------------------------------|--------------------------------------------------------------------|-----|-----|-----|----------|
| $V_{DS}$                      | drain-source voltage             | $T_j = 25\text{ °C}$                                               | -   | -   | 60  | V        |
| $V_{GS}$                      | gate-source voltage              |                                                                    | -20 | -   | 20  | V        |
| $I_D$                         | drain current                    | $V_{GS} = 10\text{ V}; T_{amb} = 25\text{ °C}$ <a href="#">[1]</a> | -   | -   | 320 | mA       |
| <b>Static characteristics</b> |                                  |                                                                    |     |     |     |          |
| $R_{DS(on)}$                  | 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 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   | G      | gate        | <br>SOT323 (SC-70) | <br>017aaa255 |
| 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 <sup>[1]</sup> |
|-------------|-----------------------------|
| BSS138BKW   | AD%                         |

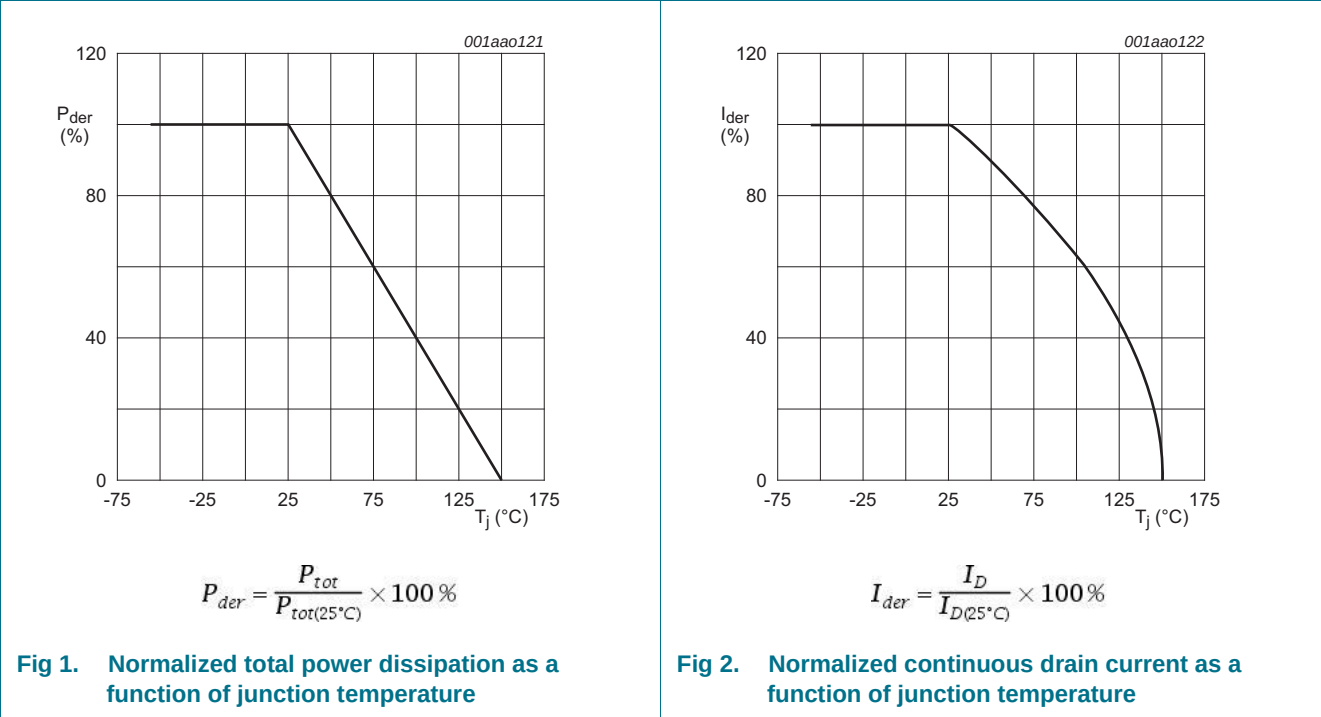
[1] % = placeholder for manufacturing site code.

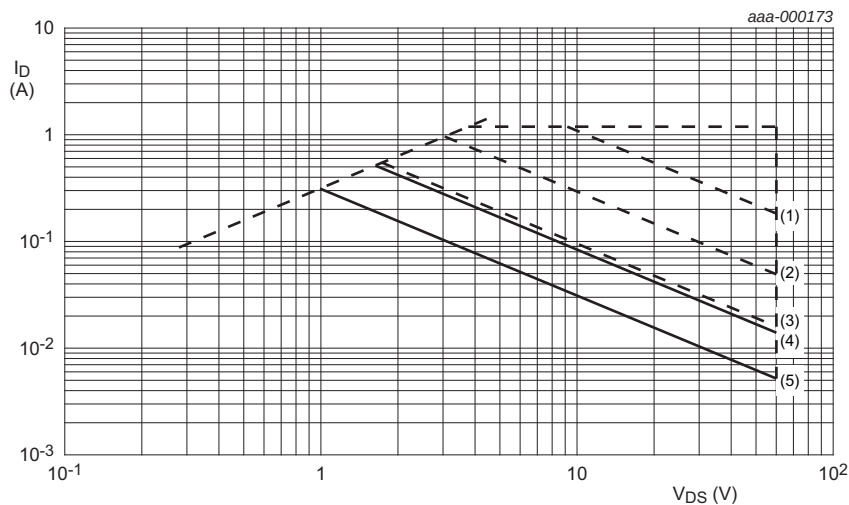
5. Limiting values

Table 5. Limiting values  
In accordance with the Absolute Maximum Rating System (IEC 60134).

| Symbol             | Parameter                       | Conditions                                                     | Min   | Max  | Unit |
|--------------------|---------------------------------|----------------------------------------------------------------|-------|------|------|
| V <sub>DS</sub>    | drain-source voltage            | T <sub>j</sub> = 25 °C                                         | -     | 60   | V    |
| V <sub>GS</sub>    | gate-source voltage             |                                                                | -20   | 20   | V    |
| I <sub>D</sub>     | drain current                   | V <sub>GS</sub> = 10 V; T <sub>amb</sub> = 25 °C               | [1] - | 320  | mA   |
|                    |                                 | V <sub>GS</sub> = 10 V; T <sub>amb</sub> = 100 °C              | [1] - | 210  | mA   |
| I <sub>DM</sub>    | peak drain current              | T <sub>amb</sub> = 25 °C; single pulse; t <sub>p</sub> ≤ 10 μs | -     | 1.2  | A    |
| P <sub>tot</sub>   | total power dissipation         | T <sub>amb</sub> = 25 °C                                       | [2] - | 260  | mW   |
|                    |                                 |                                                                | [1] - | 310  | mW   |
|                    |                                 | T <sub>sp</sub> = 25 °C                                        | -     | 830  | mW   |
| T <sub>j</sub>     | junction temperature            |                                                                | -55   | 150  | °C   |
| T <sub>amb</sub>   | ambient temperature             |                                                                | -55   | 150  | °C   |
| T <sub>stg</sub>   | storage temperature             |                                                                | -65   | 150  | °C   |
| Source-drain diode |                                 |                                                                |       |      |      |
| I <sub>S</sub>     | source current                  | T <sub>amb</sub> = 25 °C                                       | [1] - | 320  | mA   |
| ESD maximum rating |                                 |                                                                |       |      |      |
| V <sub>ESD</sub>   | 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<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.





$I_{DM}$  is a single pulse  
(1)  $t_p = 1\text{ ms}$   
(2)  $t_p = 10\text{ ms}$   
(3)  $t_p = 100\text{ ms}$   
(4) DC;  $T_{sp} = 25\text{ }^{\circ}\text{C}$   
(5) DC;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $1\text{ cm}^2$  drain mounting pad

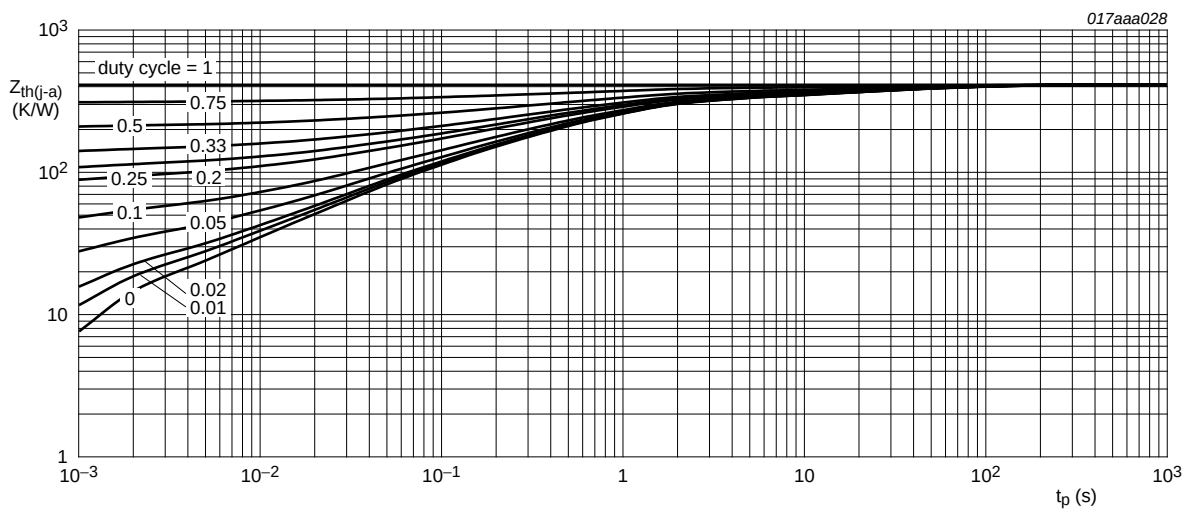
Fig 3. Safe operating area; junction to ambient; continuous and peak drain currents as a function of drain-source voltage

6. Thermal characteristics

Table 6. Thermal characteristics

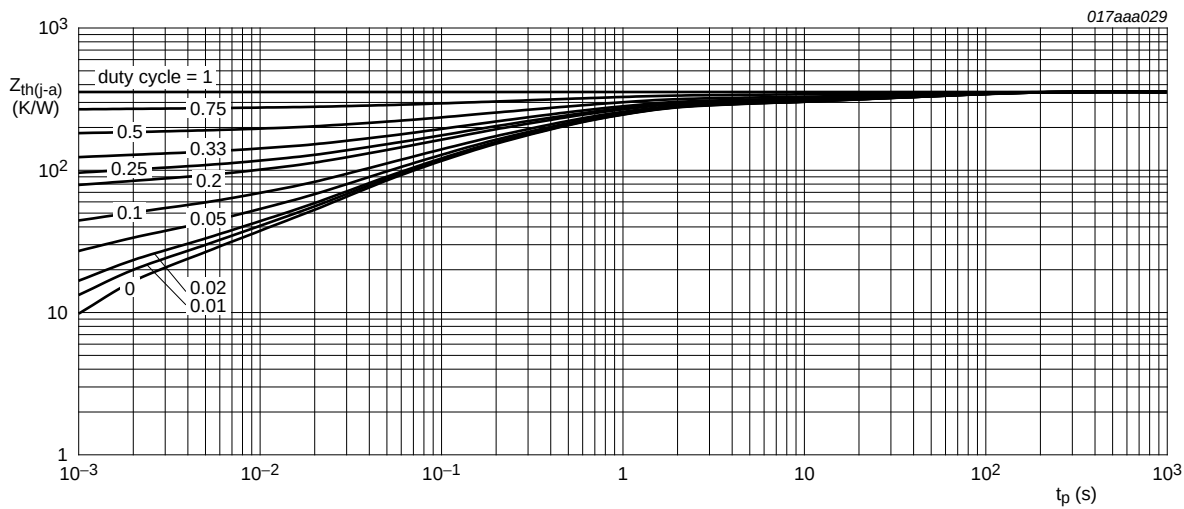
| Symbol         | Parameter                                        | Conditions  | Min | Typ | Max | Unit |
|----------------|--------------------------------------------------|-------------|-----|-----|-----|------|
| $R_{th(j-a)}$  | thermal resistance from junction to ambient      | in free air | [1] | -   | 415 | K/W  |
|                |                                                  |             | [2] | -   | 350 | 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  $1\text{ cm}^2$ .



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<sup>2</sup>

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          |
|--------------------------------|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------|------|-----|-----|---------------|
| <b>Static characteristics</b>  |                                  |                                                                                                                                    |      |     |     |               |
| $V_{(BR)DSS}$                  | drain-source breakdown voltage   | $I_D = 250\ \mu\text{A}$ ; $V_{GS} = 0\ \text{V}$ ; $T_j = 25\ ^\circ\text{C}$                                                     | 60   | -   | -   | V             |
| $V_{GSth}$                     | gate-source threshold voltage    | $I_D = 250\ \mu\text{A}$ ; $V_{DS} = V_{GS}$ ; $T_j = 25\ ^\circ\text{C}$                                                          | 0.48 | 1.1 | 1.6 | V             |
| $I_{DSS}$                      | drain leakage current            | $V_{DS} = 60\ \text{V}$ ; $V_{GS} = 0\ \text{V}$ ; $T_j = 25\ ^\circ\text{C}$                                                      | -    | -   | 1   | $\mu\text{A}$ |
|                                |                                  | $V_{DS} = 60\ \text{V}$ ; $V_{GS} = 0\ \text{V}$ ; $T_j = 150\ ^\circ\text{C}$                                                     | -    | -   | 10  | $\mu\text{A}$ |
| $I_{GSS}$                      | gate leakage current             | $V_{GS} = 20\ \text{V}$ ; $V_{DS} = 0\ \text{V}$ ; $T_j = 25\ ^\circ\text{C}$                                                      | -    | -   | 10  | $\mu\text{A}$ |
|                                |                                  | $V_{GS} = -20\ \text{V}$ ; $V_{DS} = 0\ \text{V}$ ; $T_j = 25\ ^\circ\text{C}$                                                     | -    | -   | 10  | $\mu\text{A}$ |
|                                |                                  | $V_{GS} = 10\ \text{V}$ ; $V_{DS} = 0\ \text{V}$ ; $T_j = 25\ ^\circ\text{C}$                                                      | -    | -   | 1   | $\mu\text{A}$ |
|                                |                                  | $V_{GS} = -10\ \text{V}$ ; $V_{DS} = 0\ \text{V}$ ; $T_j = 25\ ^\circ\text{C}$                                                     | -    | -   | 1   | $\mu\text{A}$ |
| $R_{DSon}$                     | drain-source on-state resistance | $V_{GS} = 10\ \text{V}$ ; $I_D = 320\ \text{mA}$ ; $T_j = 25\ ^\circ\text{C}$                                                      | -    | 1   | 1.6 | $\Omega$      |
|                                |                                  | $V_{GS} = 10\ \text{V}$ ; $I_D = 320\ \text{mA}$ ; $T_j = 150\ ^\circ\text{C}$                                                     | -    | 2   | 3.2 | $\Omega$      |
|                                |                                  | $V_{GS} = 4.5\ \text{V}$ ; $I_D = 200\ \text{mA}$ ; $T_j = 25\ ^\circ\text{C}$                                                     | -    | 1.1 | 2.2 | $\Omega$      |
|                                |                                  | $V_{GS} = 2.5\ \text{V}$ ; $I_D = 10\ \text{mA}$ ; $T_j = 25\ ^\circ\text{C}$                                                      | -    | 1.4 | 6.5 | $\Omega$      |
| $g_{fs}$                       | forward transconductance         | $V_{DS} = 10\ \text{V}$ ; $I_D = 200\ \text{mA}$ ; $T_j = 25\ ^\circ\text{C}$                                                      | -    | 700 | -   | mS            |
| <b>Dynamic characteristics</b> |                                  |                                                                                                                                    |      |     |     |               |
| $Q_{G(tot)}$                   | total gate charge                | $V_{DS} = 30\ \text{V}$ ; $I_D = 300\ \text{mA}$ ; $V_{GS} = 4.5\ \text{V}$ ;<br>$T_j = 25\ ^\circ\text{C}$                        | -    | 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                | $V_{DS} = 10\ \text{V}$ ; $f = 1\ \text{MHz}$ ; $V_{GS} = 0\ \text{V}$ ;<br>$T_j = 25\ ^\circ\text{C}$                             | -    | 42  | 56  | pF            |
| $C_{oss}$                      | output capacitance               |                                                                                                                                    | -    | 7   | -   | pF            |
| $C_{rss}$                      | reverse transfer capacitance     |                                                                                                                                    | -    | 4   | -   | pF            |
| $t_{d(on)}$                    | turn-on delay time               | $V_{DS} = 40\ \text{V}$ ; $R_L = 250\ \Omega$ ; $V_{GS} = 10\ \text{V}$ ;<br>$R_{G(ext)} = 6\ \Omega$ ; $T_j = 25\ ^\circ\text{C}$ | -    | 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</b>      |                                  |                                                                                                                                    |      |     |     |               |
| $V_{SD}$                       | source-drain voltage             | $I_S = 300\ \text{mA}$ ; $V_{GS} = 0\ \text{V}$ ; $T_j = 25\ ^\circ\text{C}$                                                       | 0.47 | 0.8 | 1.2 | V             |

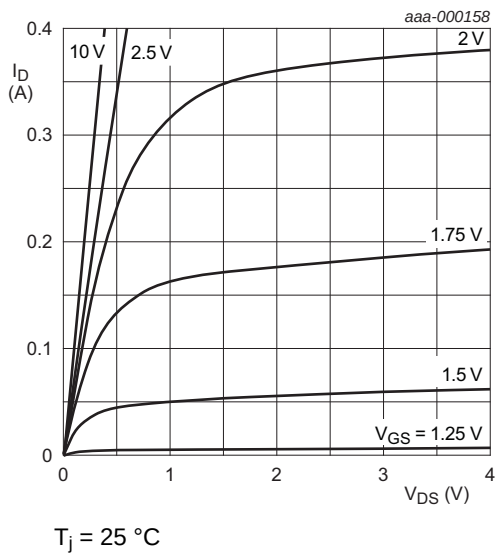


Fig 6. Output characteristics: drain current as a function of drain-source voltage; typical values

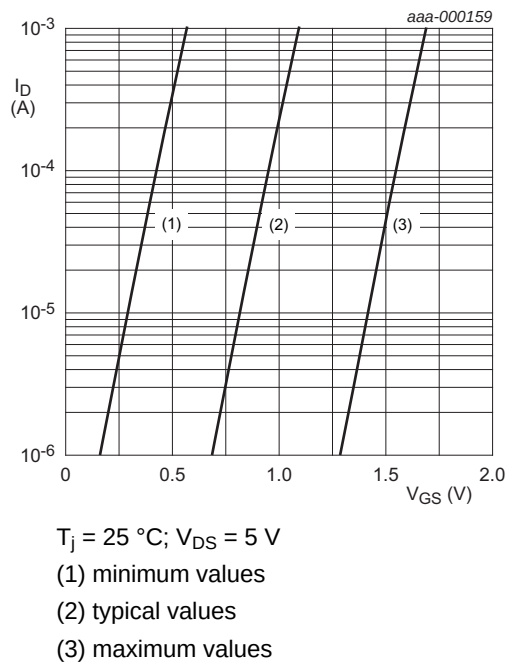


Fig 7. Sub-threshold drain current as a function of gate-source voltage

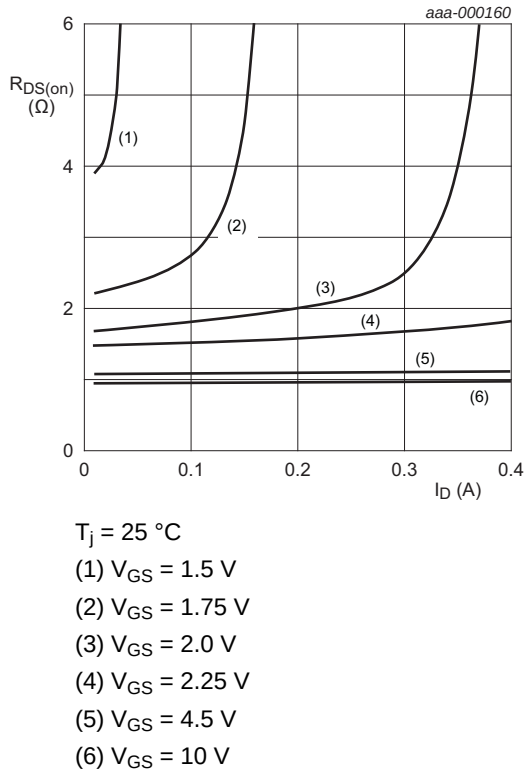


Fig 8. Drain-source on-state resistance as a function of drain current; typical values

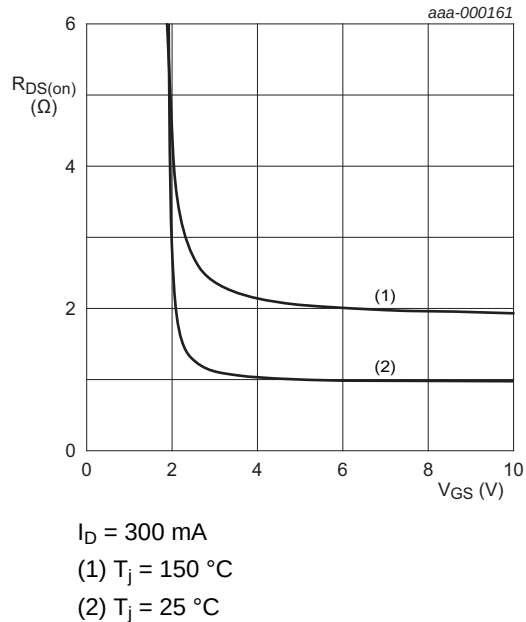
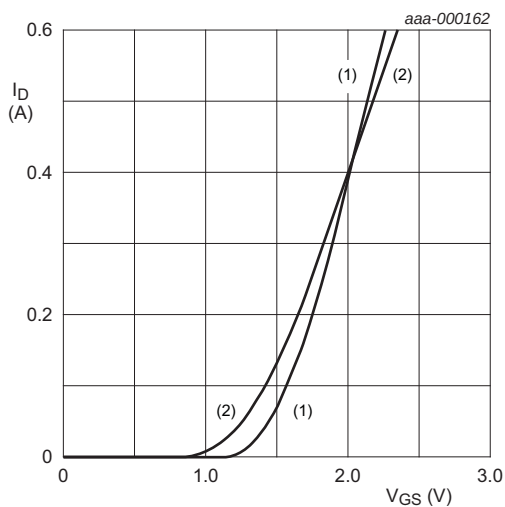
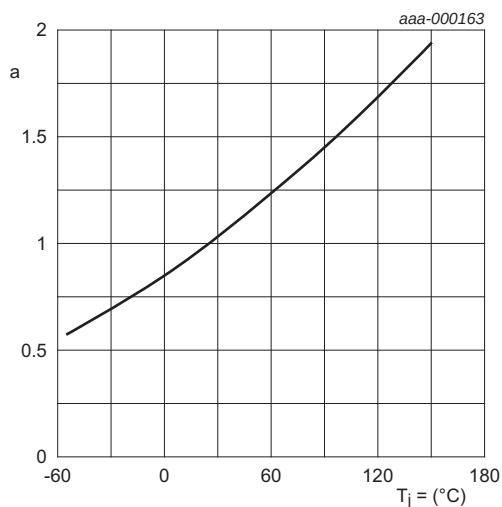


Fig 9. Drain-source on-state resistance as a function of gate-source voltage; typical values



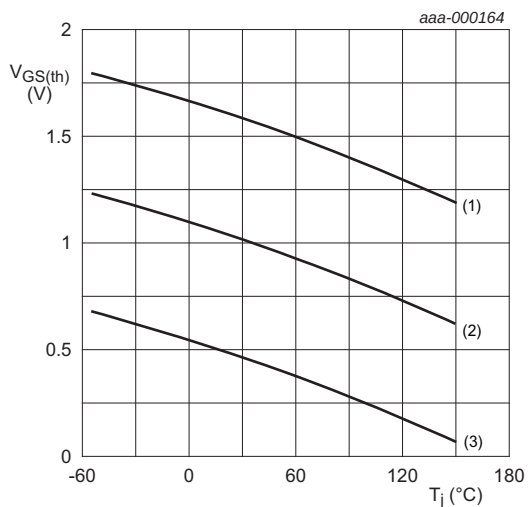
$V_{DS} > I_D \times R_{DS(on)}$   
(1)  $T_j = 25\text{ }^{\circ}\text{C}$   
(2)  $T_j = 150\text{ }^{\circ}\text{C}$

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



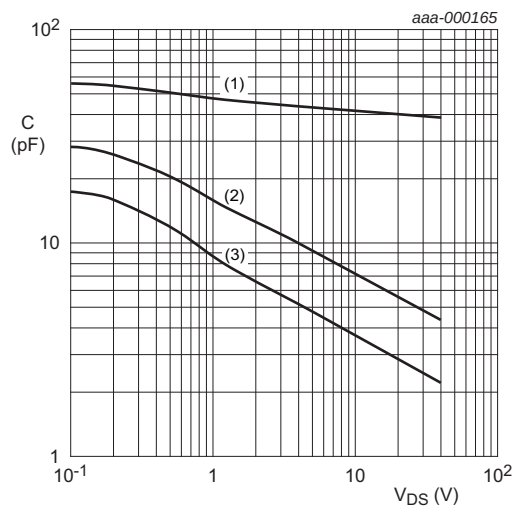
$$a = \frac{R_{DS(on)}}{R_{DS(on)(25^{\circ}\text{C})}}$$

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

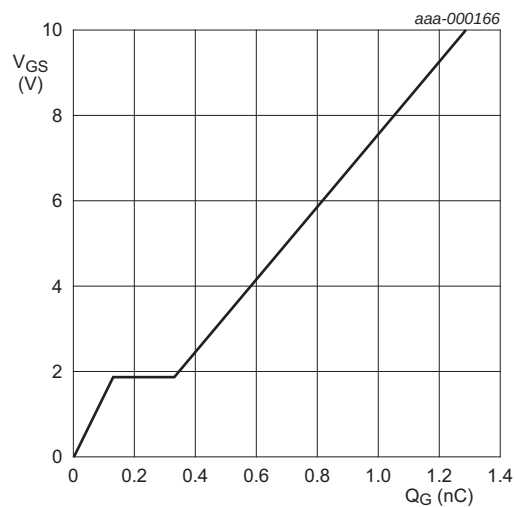
Fig 12. Gate-source threshold voltage as a function of junction temperature



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

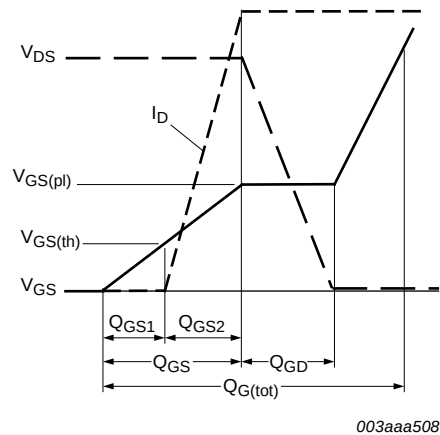
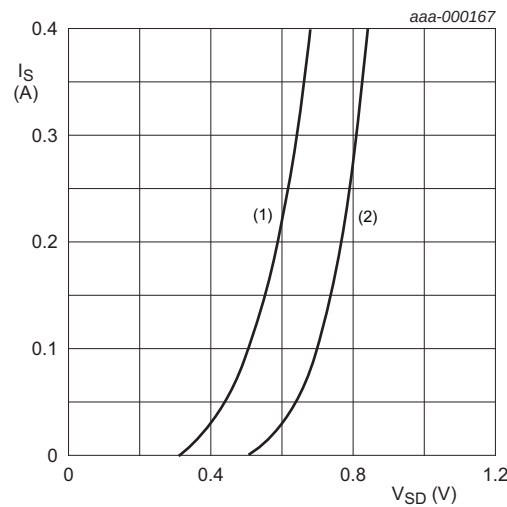


Fig 15. Gate charge waveform definitions



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

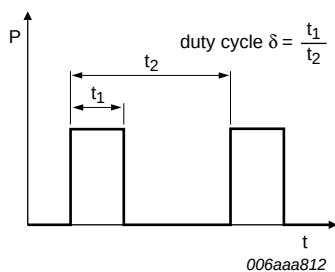


Fig 17. Duty cycle definition

### 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; 3 leads

SOT323

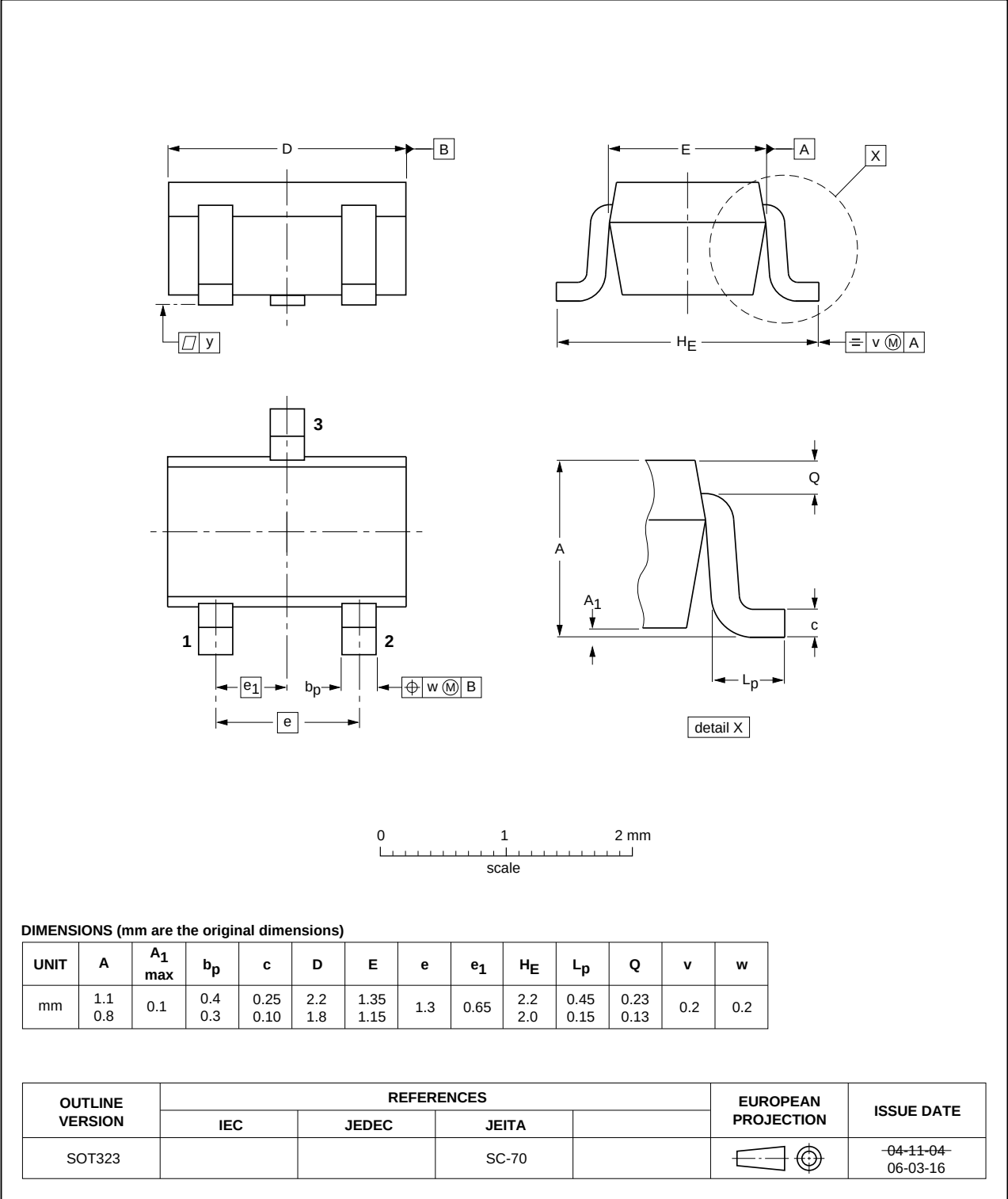
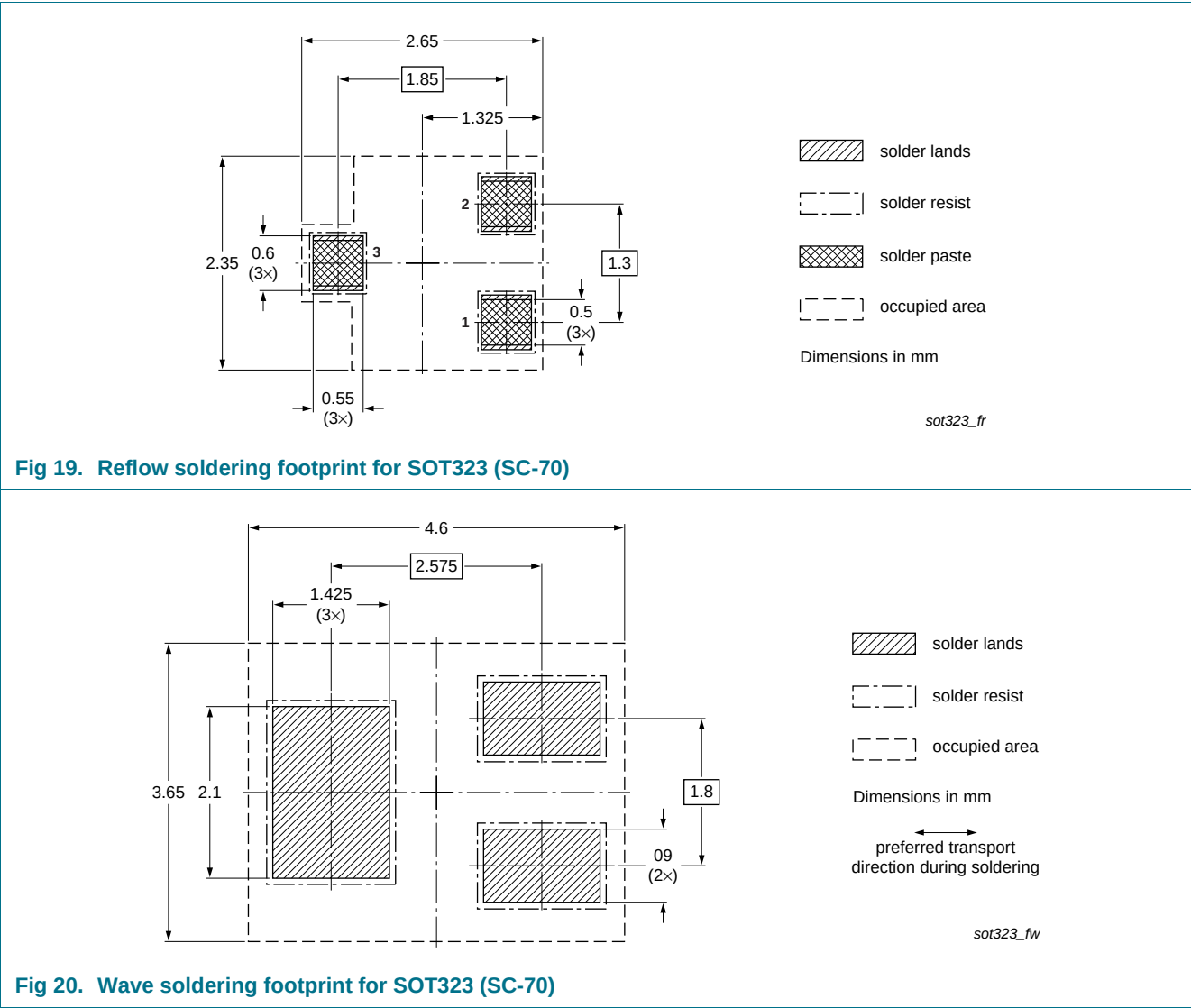


Fig 18. Package outline SOT323 (SC-70)

10. Soldering



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 <sup>[1] [2]</sup> | Product status <sup>[3]</sup> | 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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