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Kind regards,

Team Nexperia



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

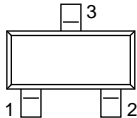
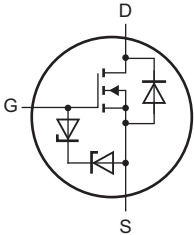
| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-------------------------------|----------------------------------|---|-------|-----|-----|----------|
| V_{DS} | drain-source voltage | $T_j = 25\text{ °C}$ | - | - | 60 | V |
| V_{GS} | gate-source voltage | | -20 | - | 20 | V |
| I_D | drain current | $V_{GS} = 10\text{ V}; T_{amb} = 25\text{ °C}$ | [1] - | - | 360 | mA |
| Static characteristics | | | | | | |
| $R_{DS(on)}$ | drain-source on-state resistance | $V_{GS} = 10\text{ V}; I_D = 350\text{ mA}; T_j = 25\text{ °C}$ | - | 1 | 1.6 | Ω |

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



2. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description | Simplified outline | Graphic symbol |
|-----|--------|-------------|---|--|
| 1 | G | gate |  <p>SOT23 (TO-236AB)</p> |  <p>017aaa255</p> |
| 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.

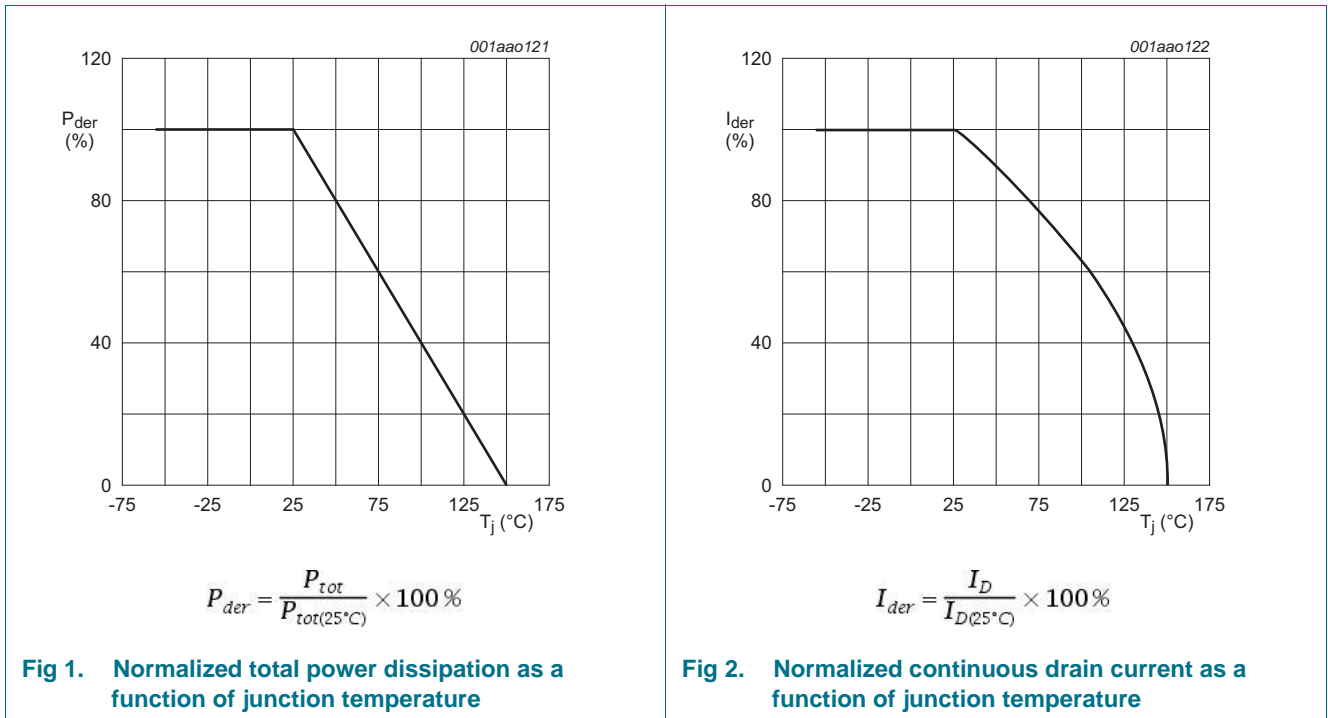
5. Limiting values

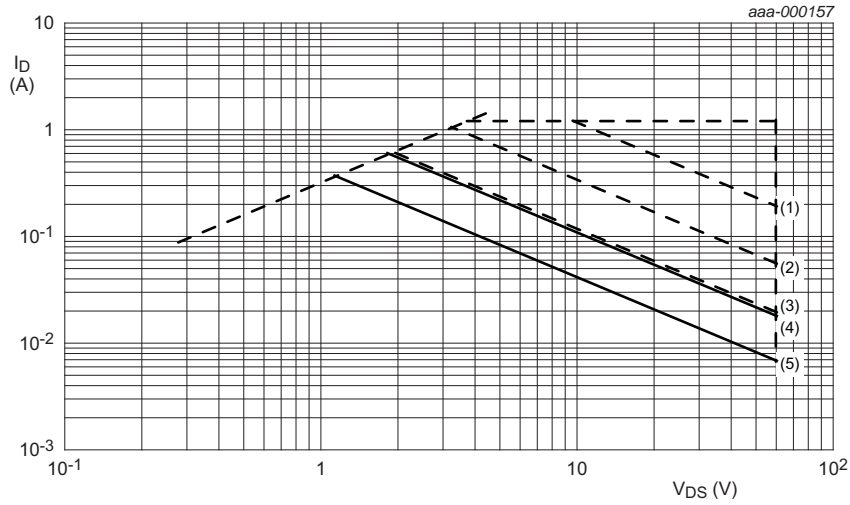
Table 5. Limiting values

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 ≤ 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 cm².
- [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 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

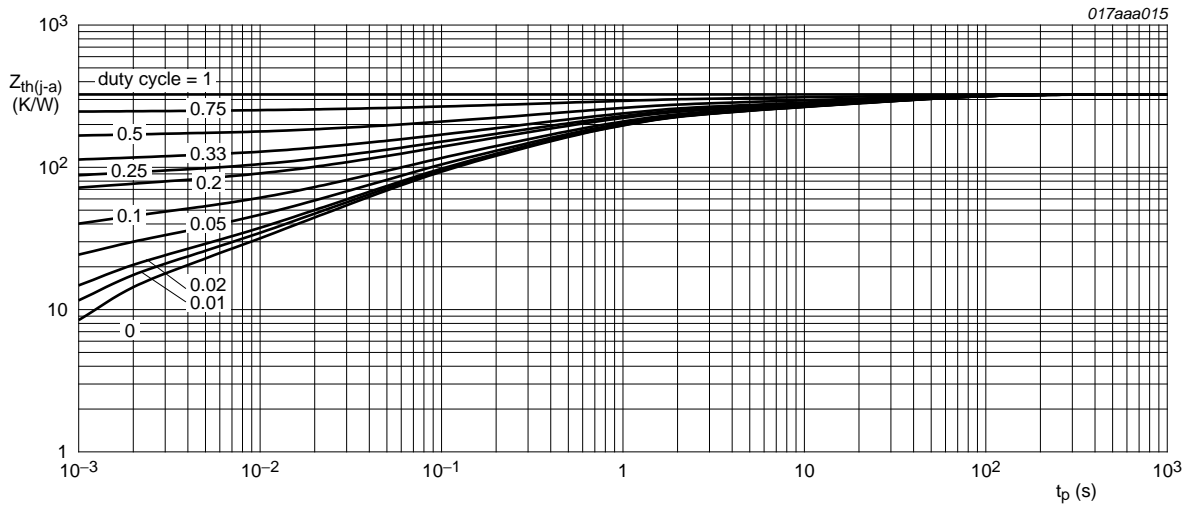
6. Thermal characteristics

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 | |

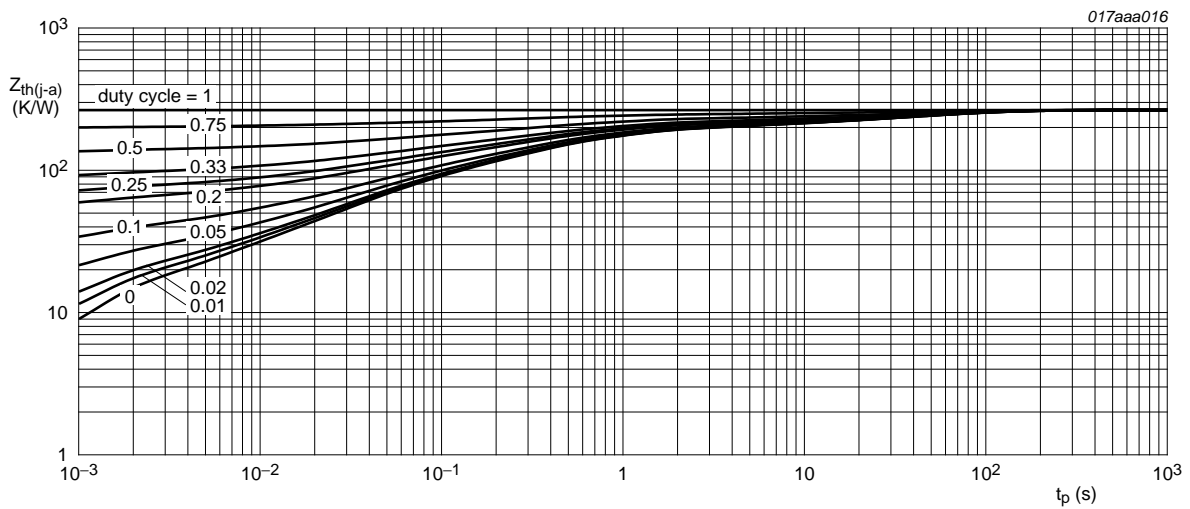
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.

[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 cm²

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 | $I_D = 250 \mu\text{A}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$ | 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 | μA |
| | | $V_{DS} = 60 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 150 \text{ }^\circ\text{C}$ | - | - | 10 | μA |
| I_{GSS} | gate leakage current | $V_{GS} = 20 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$ | - | - | 10 | μA |
| | | $V_{GS} = -20 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$ | - | - | 10 | μA |
| | | $V_{GS} = 10 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$ | - | - | 1 | μA |
| | | $V_{GS} = -10 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$ | - | - | 1 | μA |
| | | $V_{GS} = 10 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 150 \text{ }^\circ\text{C}$ | - | - | 1 | μA |
| R_{DSon} | drain-source on-state resistance | $V_{GS} = 10 \text{ V}; I_D = 350 \text{ mA}; T_j = 25 \text{ }^\circ\text{C}$ | - | 1 | 1.6 | Ω |
| | | $V_{GS} = 10 \text{ V}; I_D = 350 \text{ mA}; T_j = 150 \text{ }^\circ\text{C}$ | - | 2 | 3.2 | Ω |
| | | $V_{GS} = 4.5 \text{ V}; I_D = 200 \text{ mA}; T_j = 25 \text{ }^\circ\text{C}$ | - | 1.1 | 2.2 | Ω |
| | | $V_{GS} = 2.5 \text{ V}; I_D = 10 \text{ mA}; T_j = 25 \text{ }^\circ\text{C}$ | - | 1.4 | 6.5 | Ω |
| g_{fs} | forward transconductance | $V_{DS} = 10 \text{ V}; I_D = 200 \text{ mA}; T_j = 25 \text{ }^\circ\text{C}$ | - | 700 | - | mS |
| Dynamic characteristics | | | | | | |
| $Q_{G(tot)}$ | 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 |
| Source-drain diode | | | | | | |
| V_{SD} | source-drain voltage | $I_S = 300 \text{ mA}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$ | 0.47 | 0.8 | 1.2 | V |

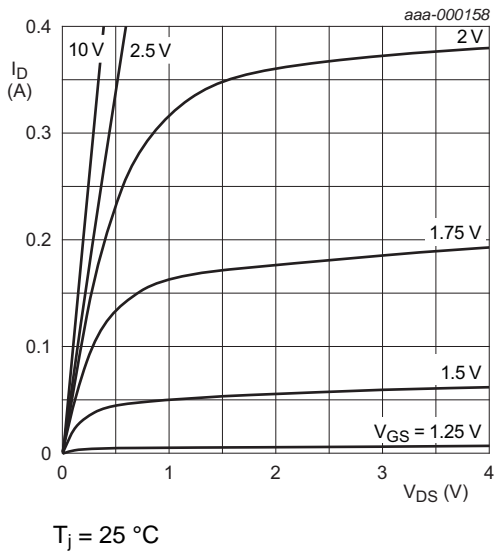


Fig 6. Output characteristics: drain current as a function of drain-source voltage; typical values

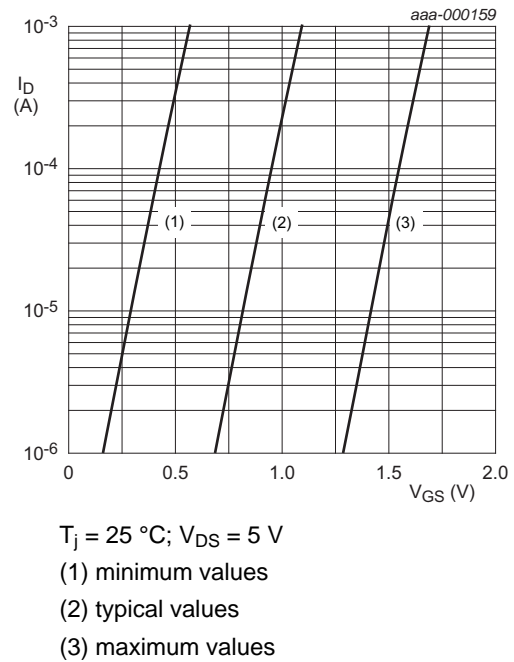
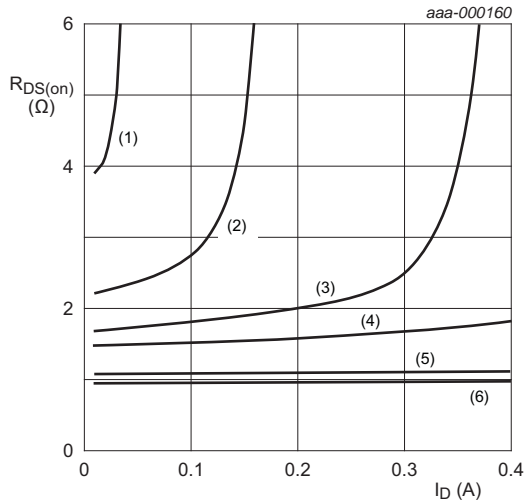
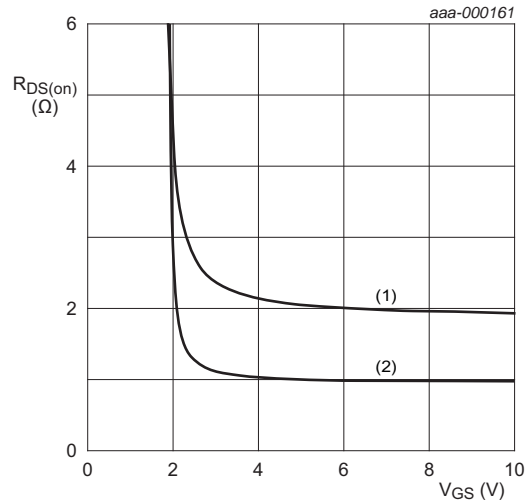


Fig 7. Sub-threshold drain current as a function of gate-source voltage



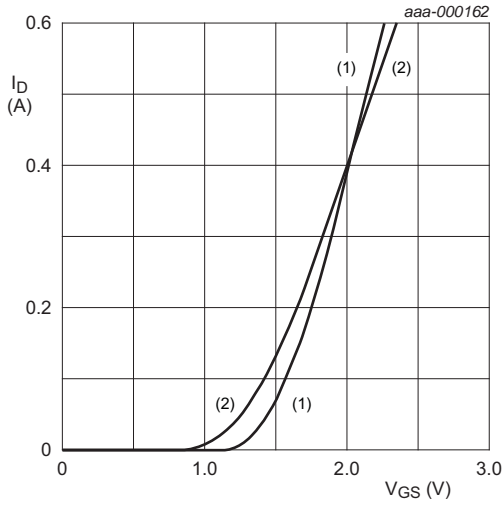
$T_j = 25\text{ }^\circ\text{C}$
 (1) $V_{GS} = 1.5\text{ V}$
 (2) $V_{GS} = 1.75\text{ V}$
 (3) $V_{GS} = 2.0\text{ V}$
 (4) $V_{GS} = 2.25\text{ V}$
 (5) $V_{GS} = 4.5\text{ V}$
 (6) $V_{GS} = 10\text{ V}$

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



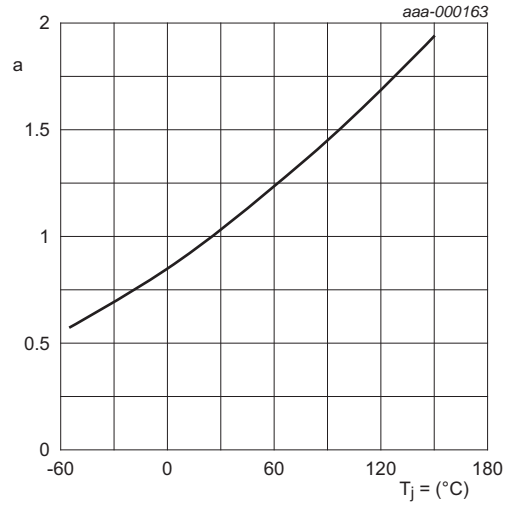
$I_D = 300\text{ mA}$
 (1) $T_j = 150\text{ }^\circ\text{C}$
 (2) $T_j = 25\text{ }^\circ\text{C}$

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



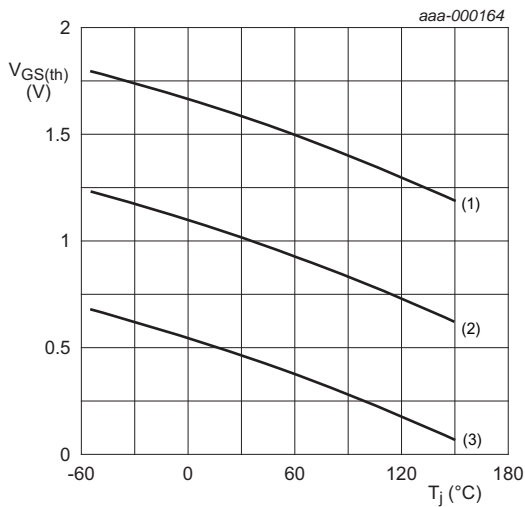
$V_{DS} > I_D \times R_{DS(on)}$
 (1) $T_j = 25\text{ °C}$
 (2) $T_j = 150\text{ °C}$

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



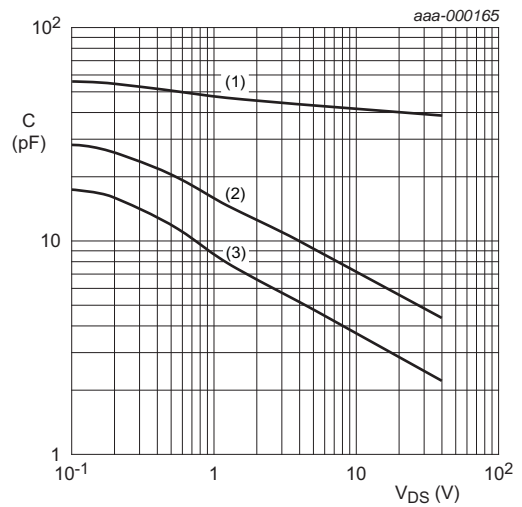
$$a = \frac{R_{DS(on)}}{R_{DS(on)@25^\circ\text{C}}}$$

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



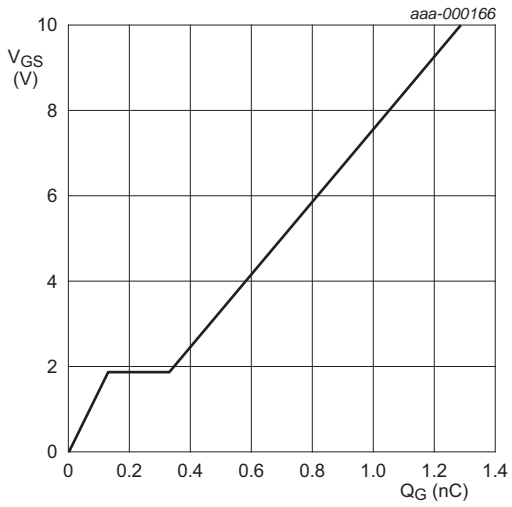
$I_D = 0.25\text{ mA}; V_{DS} = V_{GS}$
 (1) maximum values
 (2) typical values
 (3) minimum values

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



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

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

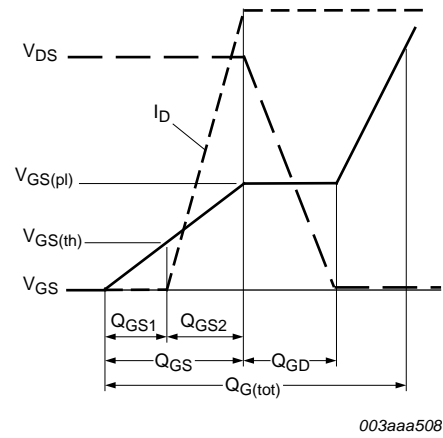
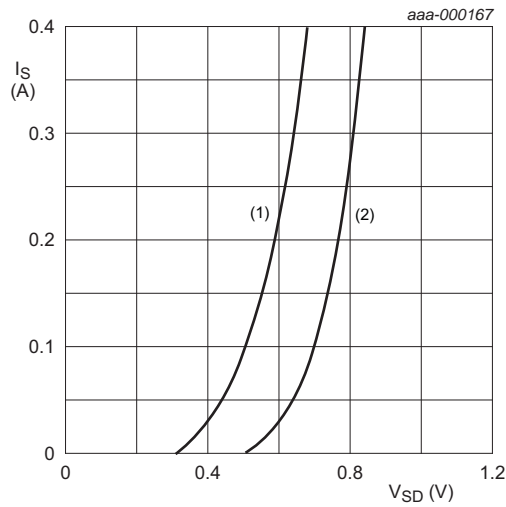


Fig 15. Gate charge waveform definitions



$V_{GS} = 0$ 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

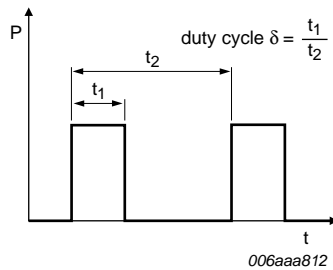


Fig 17. Duty cycle definition

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

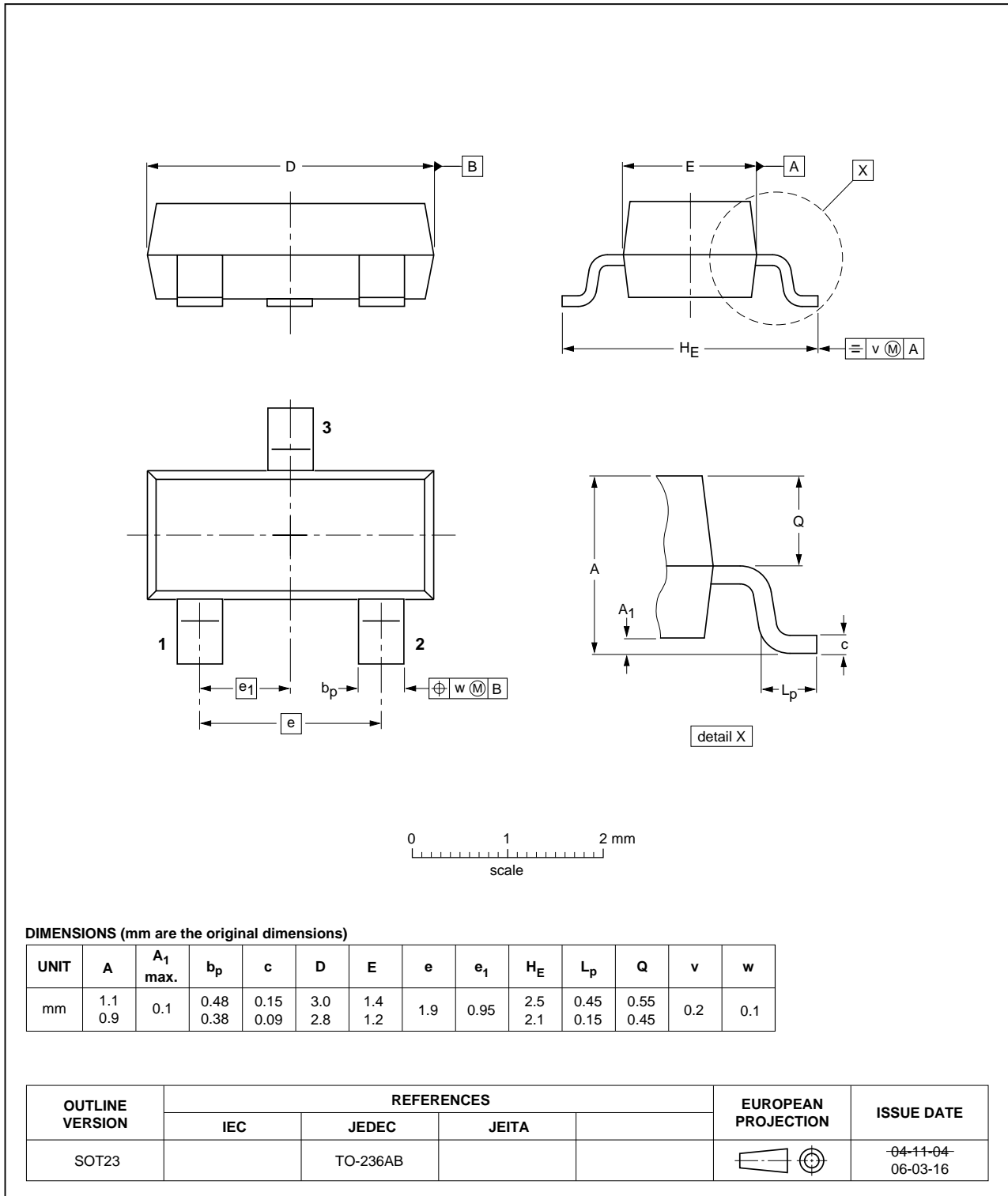


Fig 18. Package outline SOT23 (TO-236AB)

10. Soldering

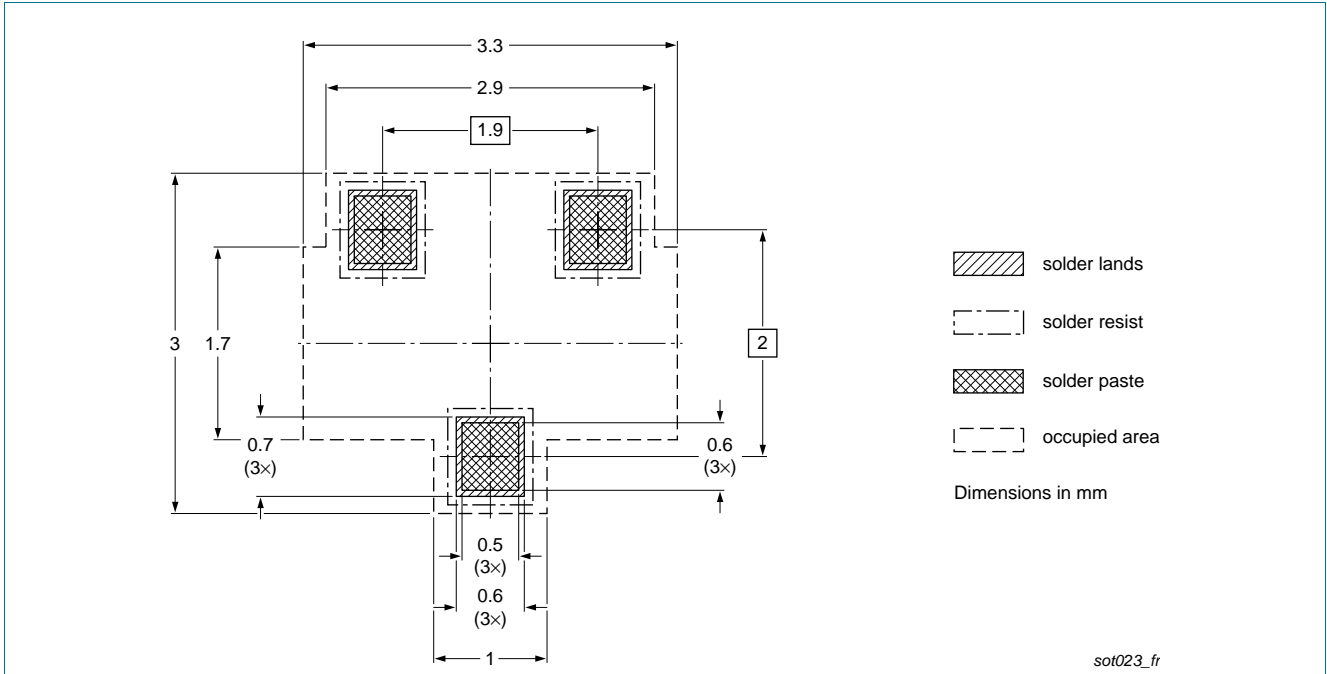


Fig 19. Reflow soldering footprint for SOT23 (TO-236AB)

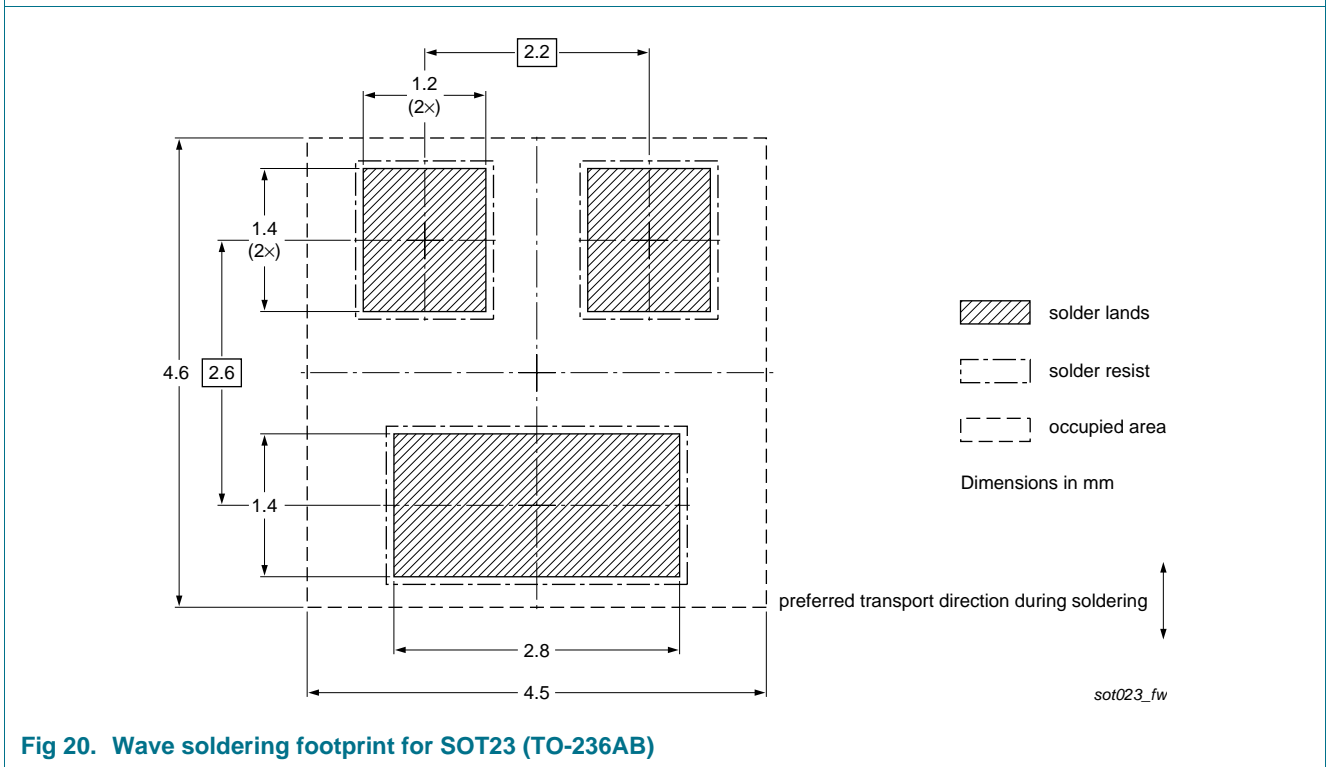


Fig 20. Wave soldering footprint for SOT23 (TO-236AB)

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. |
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