



BSS138AKA

60 V, single N-channel Trench MOSFET

6 February 2013

Product data sheet

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.

2. Features and benefits

- Very fast switching
- Trench MOSFET technology
- ESD protection
- Low threshold voltage
- AEC-Q101 qualified

3. Applications

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

4. Quick reference data

Table 1. Quick reference data

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-------------------------------|----------------------------------|---|-----|-----|-----|----------|
| V_{DS} | drain-source voltage | $T_j = 25\text{ }^\circ\text{C}$ | - | - | 60 | V |
| V_{GS} | gate-source voltage | | -20 | - | 20 | V |
| I_D | drain current | $V_{GS} = 10\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}$ | [1] | - | 200 | mA |
| Static characteristics | | | | | | |
| $R_{DS(on)}$ | drain-source on-state resistance | $V_{GS} = 10\text{ V}; I_D = 100\text{ mA};$ pulsed; $t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.02; T_j = 25\text{ }^\circ\text{C}$ | - | 2.7 | 4.5 | Ω |

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

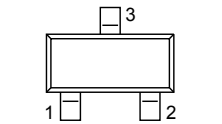
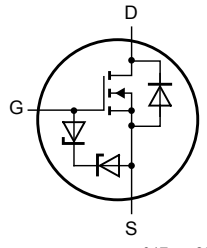


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5. Pinning information

Table 2. Pinning information

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

6. Ordering information

Table 3. Ordering information

| Type number | Package | | |
|-------------|----------|--|---------|
| | Name | Description | Version |
| BSS138AKA | TO-236AB | plastic surface-mounted package; 3 leads | SOT23 |

7. Marking

Table 4. Marking codes

| Type number | Marking code |
|-------------|--------------|
| BSS138AKA | %JL |

[1] % = placeholder for manufacturing site code

8. Limiting values

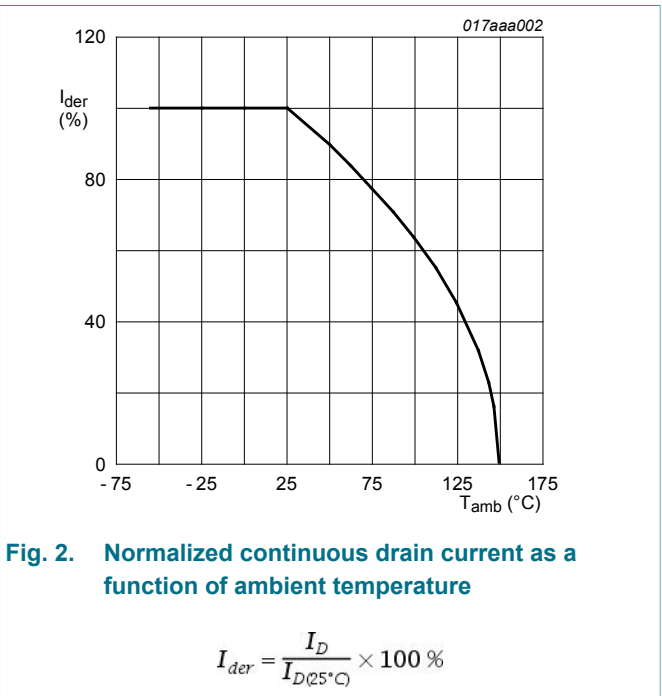
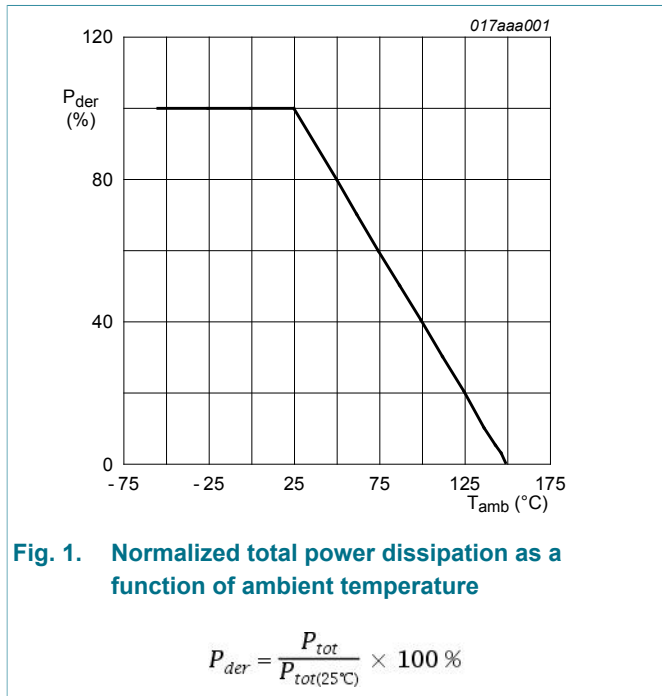
Table 5. Limiting values

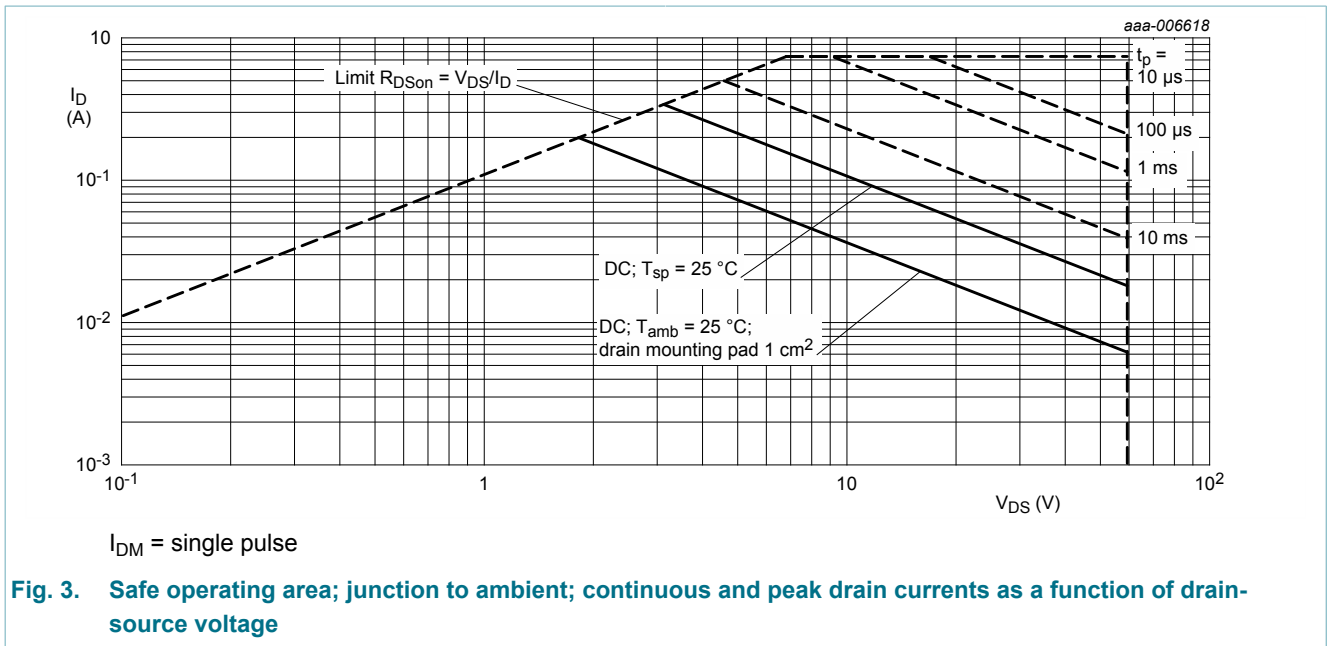
In accordance with the Absolute Maximum Rating System (IEC 60134).

| Symbol | Parameter | Conditions | | Min | Max | Unit |
|-----------|-------------------------|---|-----|-----|-----|------|
| V_{DS} | drain-source voltage | $T_j = 25\text{ }^\circ\text{C}$ | | - | 60 | V |
| V_{GS} | gate-source voltage | | | -20 | 20 | V |
| I_D | drain current | $V_{GS} = 10\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}$ | [1] | - | 200 | mA |
| | | $V_{GS} = 10\text{ V}; T_{amb} = 100\text{ }^\circ\text{C}$ | [1] | - | 125 | mA |
| I_{DM} | peak drain current | $T_{amb} = 25\text{ }^\circ\text{C}; \text{single pulse}; t_p \leq 10\text{ }\mu\text{s}$ | | - | 800 | mA |
| P_{tot} | total power dissipation | $T_{amb} = 25\text{ }^\circ\text{C}$ | [2] | - | 300 | mW |
| | | | [1] | - | 360 | mW |

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---------------------------|----------------------|--------------------------|-----|------|------|
| | | T _{sp} = 25 °C | - | 1060 | 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] | 200 | mA |

- [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.





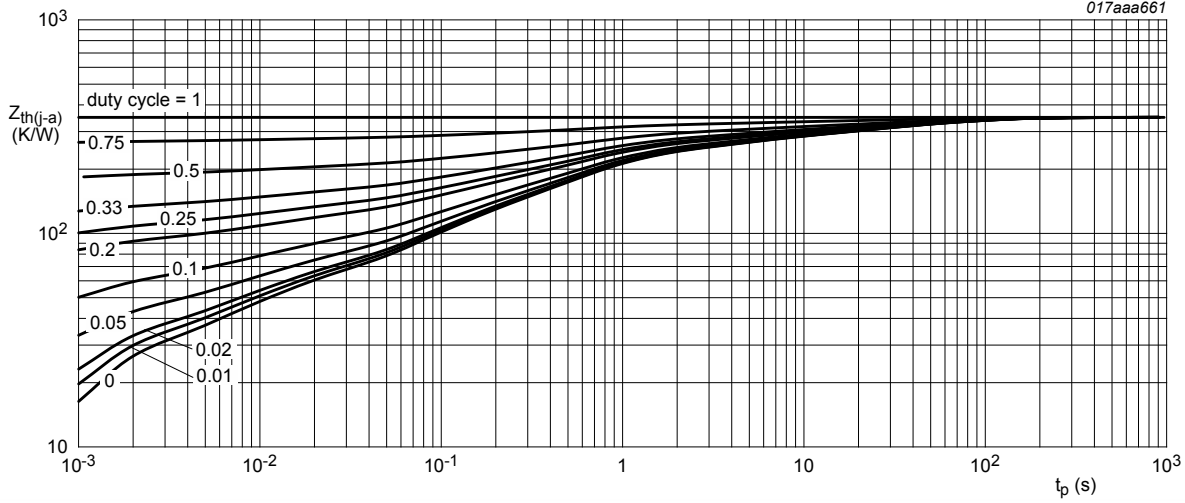
9. Thermal characteristics

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] | - | 350 | 400 | K/W |
| | | | [2] | - | 300 | 340 | K/W |
| $R_{th(j-sp)}$ | thermal resistance from junction to solder point | | | - | - | 115 | K/W |

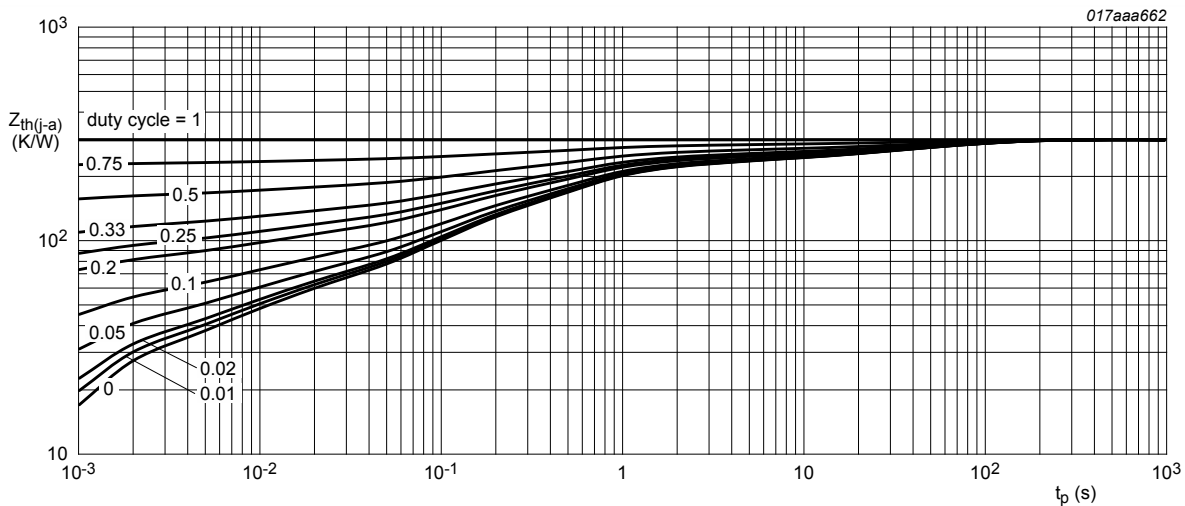
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.

[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

10. Characteristics

Table 7. Characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-------------------------------|--------------------------------|--|-----|-----|-----|---------|
| Static characteristics | | | | | | |
| $V_{(BR)DSS}$ | drain-source breakdown voltage | $I_D = 250 \mu A; V_{GS} = 0 V; T_j = 25 \text{ }^\circ C$ | 60 | - | - | V |
| V_{GSth} | gate-source threshold voltage | $I_D = 250 A; V_{DS} = V_{GS}; T_j = 25 \text{ }^\circ C$ | 0.8 | 1.2 | 1.5 | V |
| I_{DSS} | drain leakage current | $V_{DS} = 60 V; V_{GS} = 0 V; T_j = 25 \text{ }^\circ C$ | - | - | 1 | μA |
| | | $V_{DS} = 60 V; V_{GS} = 0 V; T_j = 150 \text{ }^\circ C$ | - | - | 10 | μA |

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------------------------------|----------------------------------|---|------|------|------|------|
| I _{GSS} | gate leakage current | V _{GS} = 20 V; V _{DS} = 0 V; T _j = 25 °C | - | - | 3.5 | μA |
| | | V _{GS} = -20 V; V _{DS} = 0 V; T _j = 25 °C | - | - | -3.5 | 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 |
| | | V _{GS} = 4.5 V; V _{DS} = 0 V; T _j = 25 °C | - | - | 0.5 | μA |
| | | V _{GS} = -4.5 V; V _{DS} = 0 V; T _j = 25 °C | - | - | -0.5 | μA |
| R _{DSon} | drain-source on-state resistance | V _{GS} = 10 V; I _D = 100 mA; pulsed; t _p ≤ 300 μs; δ ≤ 0.02; T _j = 25 °C | - | 2.7 | 4.5 | Ω |
| | | V _{GS} = 10 V; I _D = 100 mA; pulsed; t _p ≤ 300 μs; δ ≤ 0.02; T _j = 150 °C | - | 5.5 | 9.2 | Ω |
| | | V _{GS} = 4.5 V; I _D = 100 mA; pulsed; t _p ≤ 300 μs; δ ≤ 0.02; T _j = 25 °C | - | 3 | 5.2 | Ω |
| | | V _{GS} = 2.5 V; I _D = 10 mA; pulsed; t _p ≤ 300 μs; δ ≤ 0.02; T _j = 25 °C | - | 4 | 13 | Ω |
| g _{fs} | forward transconductance | V _{DS} = 10 V; I _D = 150 mA; pulsed; t _p ≤ 300 μs; δ ≤ 0.02; T _j = 25 °C | 320 | - | - | mS |
| Dynamic characteristics | | | | | | |
| Q _{G(tot)} | total gate charge | V _{DS} = 30 V; I _D = 150 mA; V _{GS} = 4.5 V; T _j = 25 °C | - | 0.39 | 0.51 | nC |
| Q _{GS} | gate-source charge | | - | 0.1 | - | nC |
| Q _{GD} | gate-drain charge | | - | 0.1 | - | nC |
| C _{iSS} | input capacitance | V _{DS} = 30 V; f = 1 MHz; V _{GS} = 0 V; T _j = 25 °C | - | 31 | 47 | pF |
| C _{oSS} | output capacitance | | - | 21 | - | pF |
| C _{rSS} | reverse transfer capacitance | | - | 16 | - | 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 | | - | 6 | - | ns |
| t _{d(off)} | turn-off delay time | | - | 36 | 72 | ns |
| t _f | fall time | | - | 22 | - | ns |
| Source-drain diode | | | | | | |
| V _{SD} | source-drain voltage | I _S = 115 mA; V _{GS} = 0 V; T _j = 25 °C | 0.47 | 0.7 | 1.2 | V |

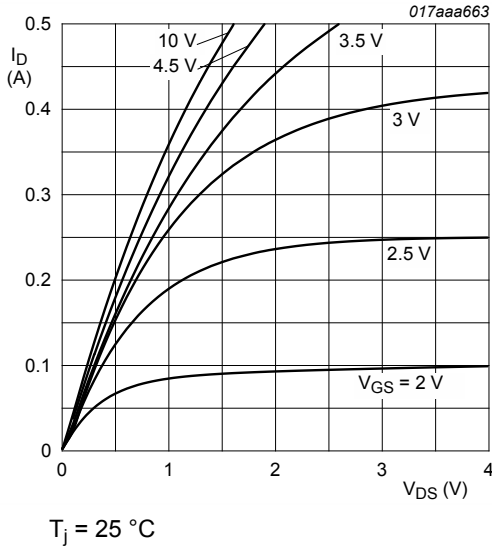


Fig. 6. Output characteristics: drain current as a function of drain-source voltage; typical values

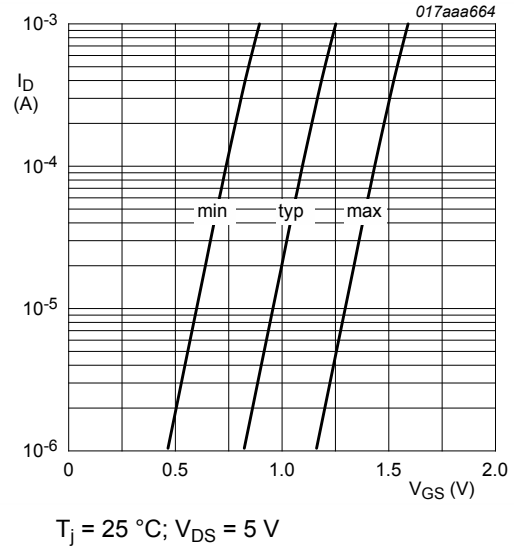


Fig. 7. Sub-threshold drain current as a function of gate-source voltage

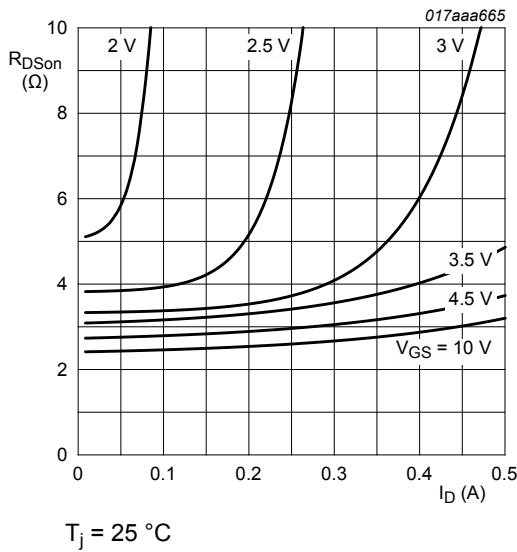


Fig. 8. Drain-source on-state resistance as a function of drain current; typical values

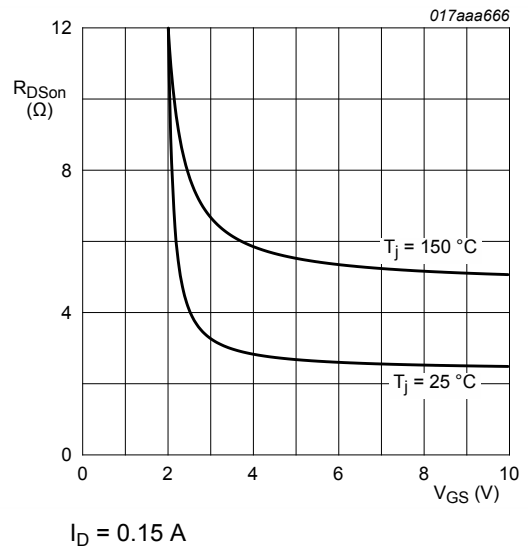
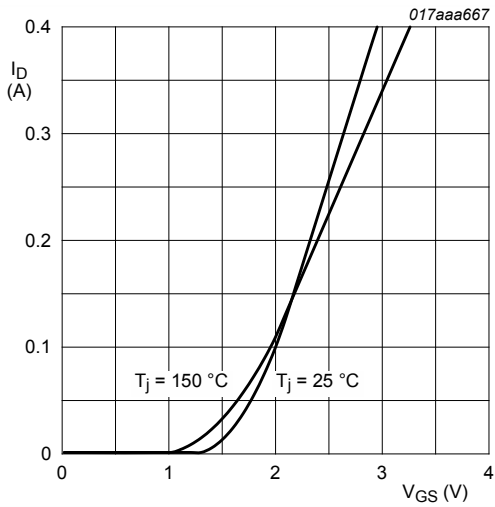


Fig. 9. Drain-source on-state resistance as a function of gate-source voltage; typical values



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

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

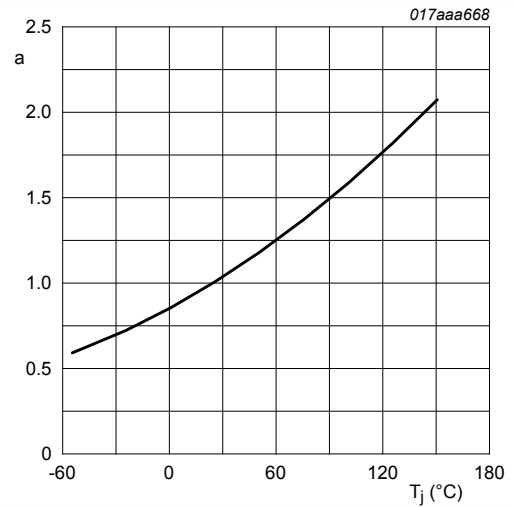
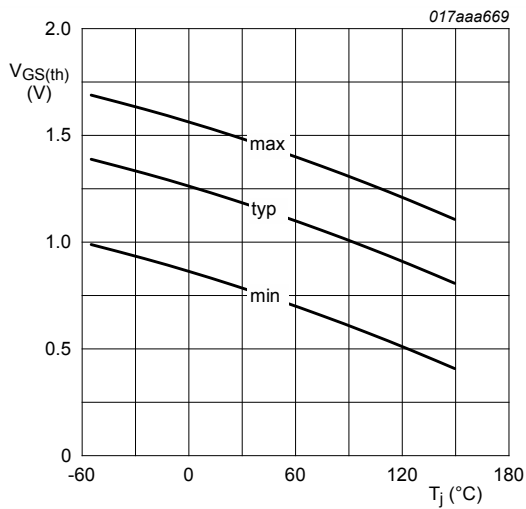


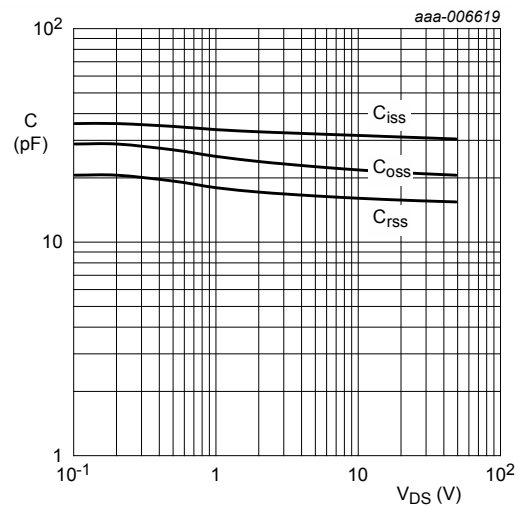
Fig. 11. Normalized drain-source on-state resistance as a function of junction temperature; typical values

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



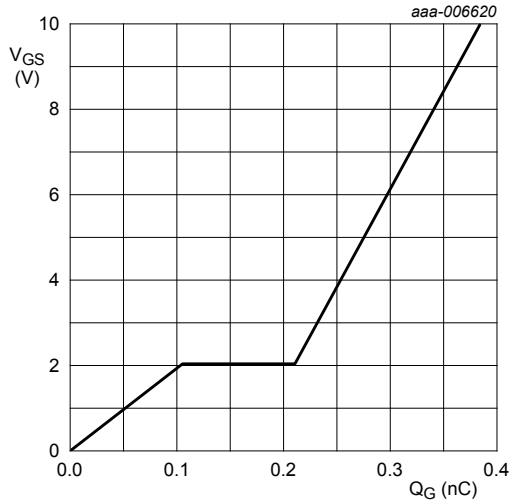
$$I_D = 0.25 \text{ mA}; V_{DS} = V_{GS}$$

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



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

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



$I_D = 150 \text{ mA}; V_{DS} = 30 \text{ V}; T_{amb} = 25 \text{ }^\circ\text{C}$

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

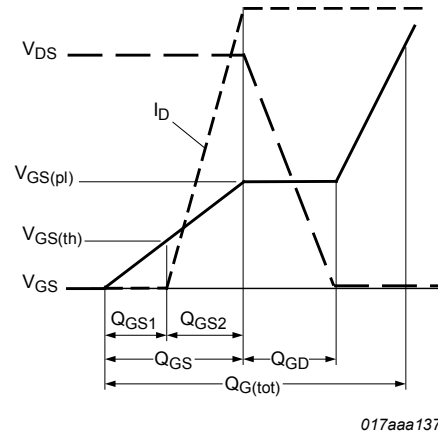
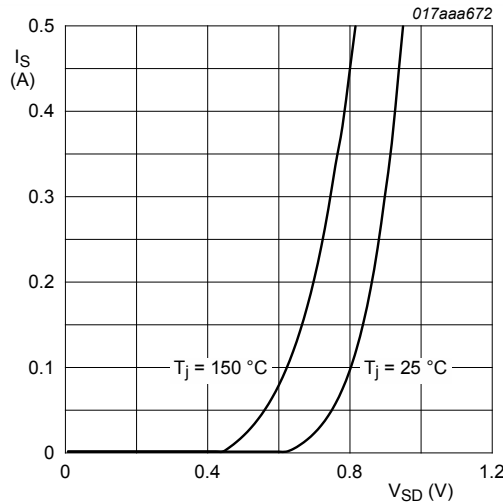


Fig. 15. Gate charge waveform definitions



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

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

11. Test information

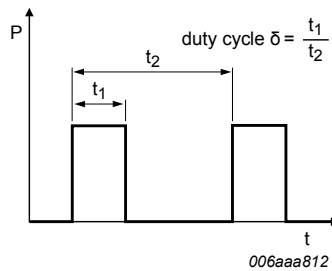


Fig. 17. Duty cycle definition

11.1 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.

12. Package outline

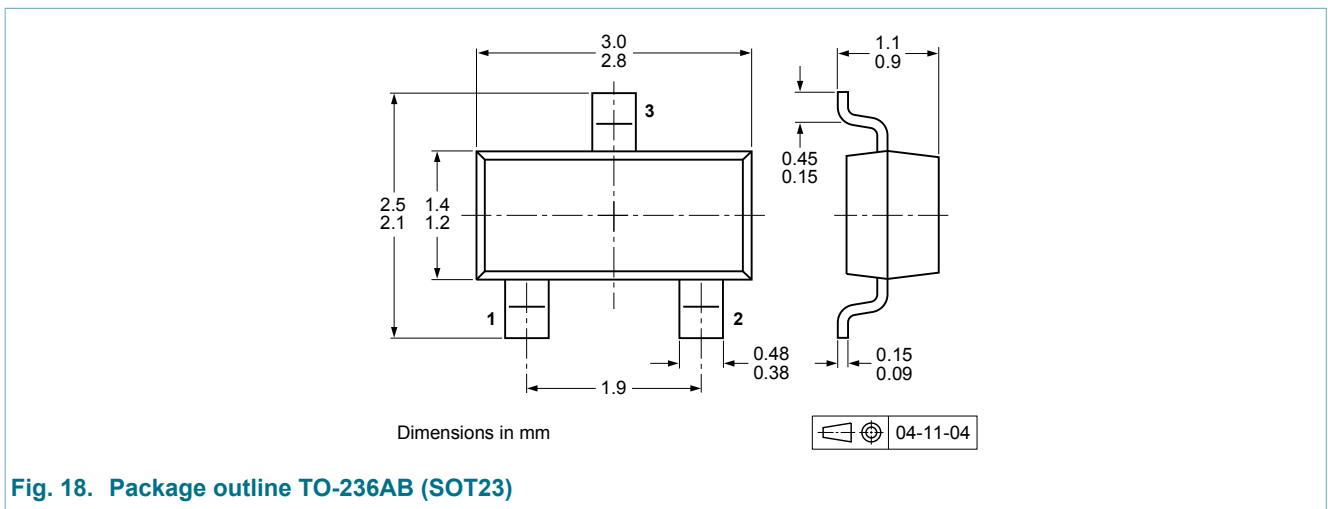


Fig. 18. Package outline TO-236AB (SOT23)

13. Soldering

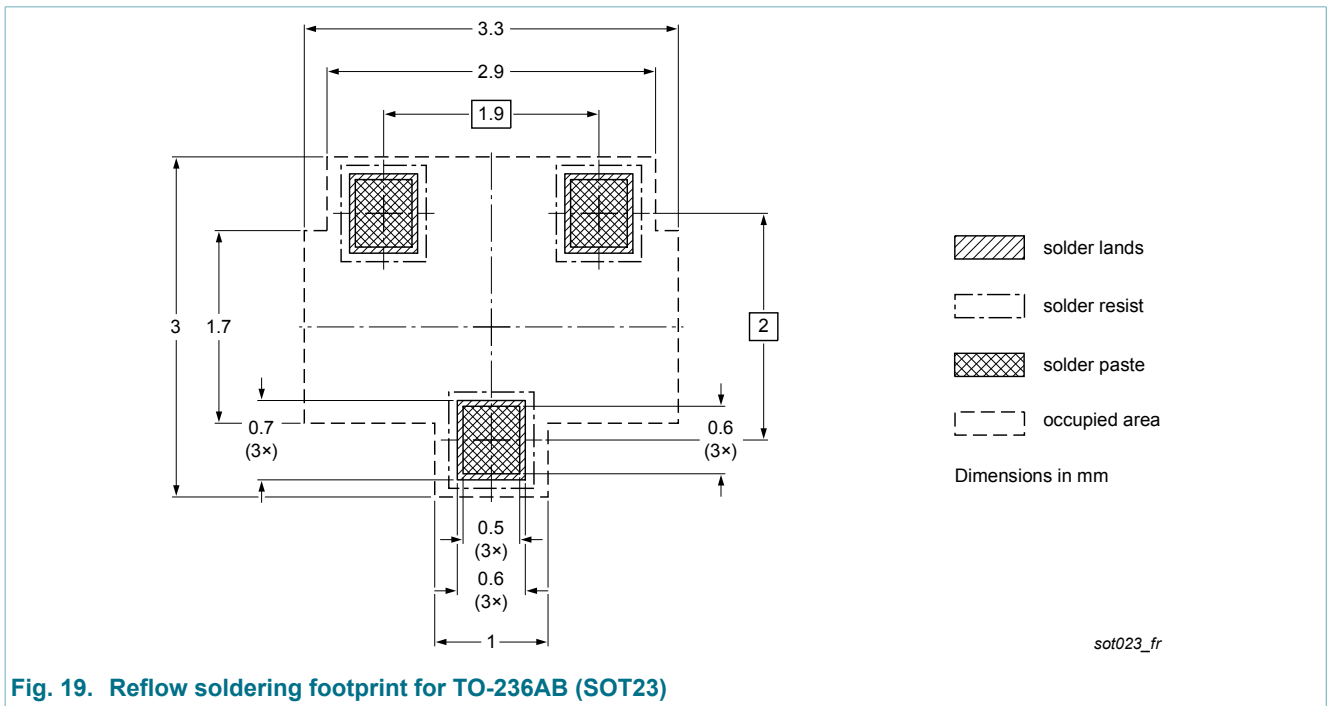


Fig. 19. Reflow soldering footprint for TO-236AB (SOT23)

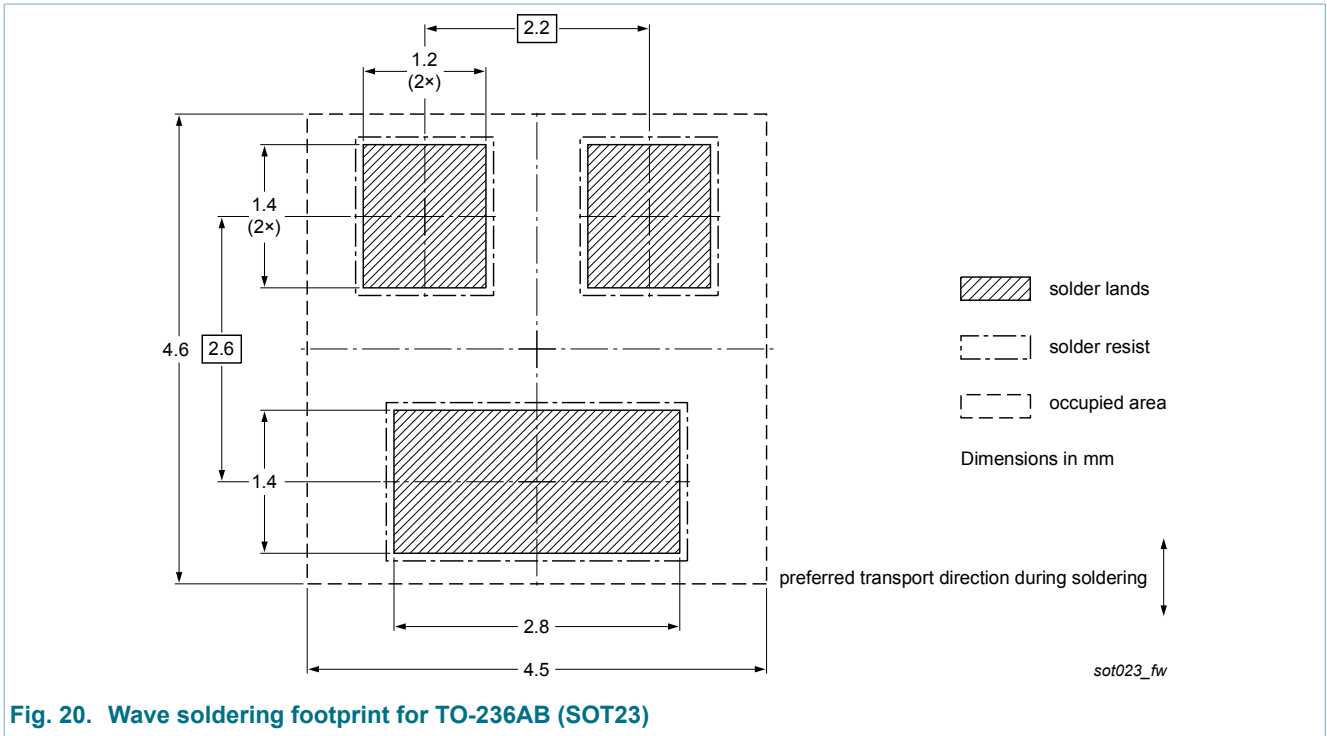


Fig. 20. Wave soldering footprint for TO-236AB (SOT23)

14. Revision history

Table 8. Revision history

| Data sheet ID | Release date | Data sheet status | Change notice | Supersedes |
|---------------|--------------|--------------------|---------------|------------|
| BSS138AKA v.1 | 20130206 | Product data sheet | - | - |

15. Legal information

15.1 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. |

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