



2N7002NXBK

60 V, N-channel Trench MOSFET

25 July 2019

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

- Logic-level compatible
- Very fast switching
- Trench MOSFET technology
- ElectroStatic Discharge (ESD) protection > 2 kV HBM

3. Applications

- Relay driver
- High-speed line driver
- Low-side load switch
- Switching circuits

4. Quick reference data

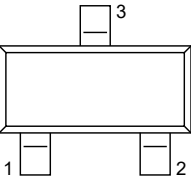
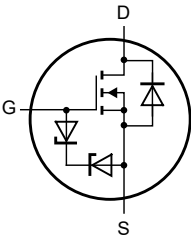
Table 1. Quick reference data

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-------------------------------|----------------------------------|---|-----|-----|-----|----------|
| V_{DS} | drain-source voltage | $T_j = 25\text{ °C}$ | - | - | 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] | - | 270 | mA |
| | | $V_{GS} = 10\text{ V}; T_{sp} = 25\text{ °C}$ | | - | 330 | mA |
| Static characteristics | | | | | | |
| R_{DSon} | drain-source on-state resistance | $V_{GS} = 10\text{ V}; I_D = 200\text{ mA}; T_j = 25\text{ °C}$ | - | 2.2 | 2.8 | Ω |

[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and mounting pad for drain 1 cm².

5. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description | Simplified outline | Graphic symbol |
|-----|--------|-------------|---|--|
| 1 | G | gate |  <p style="text-align: center;">SOT23</p> |  <p style="text-align: right;"><small>017aaa255</small></p> |
| 2 | S | source | | |
| 3 | D | drain | | |

6. Ordering information

Table 3. Ordering information

| Type number | Package | | |
|-------------|---------|--|---------|
| | Name | Description | Version |
| 2N7002NXBK | SOT23 | plastic, surface-mounted package; 3 terminals; 1.9 mm pitch; 2.9 mm x 1.3 mm x 1 mm body | SOT23 |

7. Marking

Table 4. Marking codes

| Type number | Marking code[1] |
|-------------|-----------------|
| 2N7002NXBK | %4R |

[1] % = placeholder for manufacturing site code

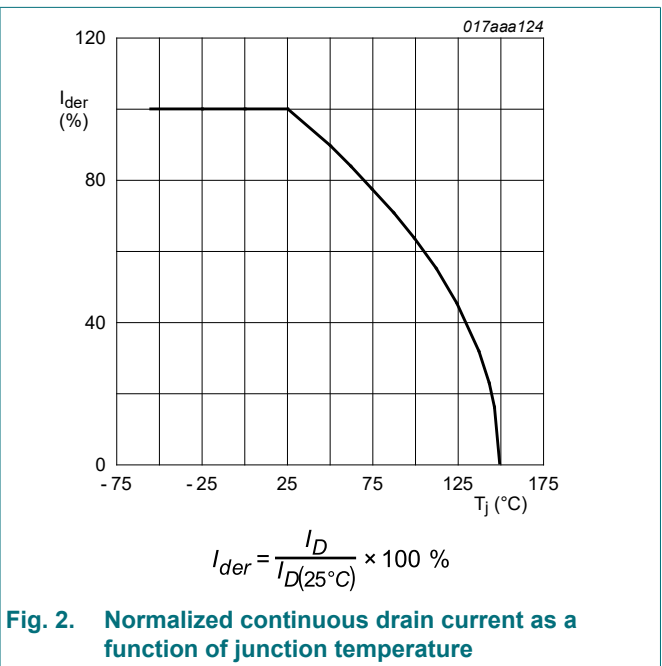
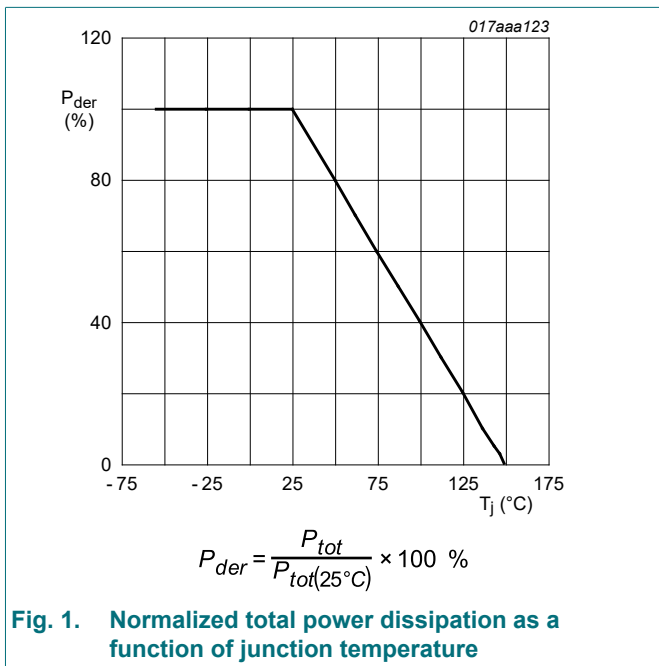
8. Limiting values

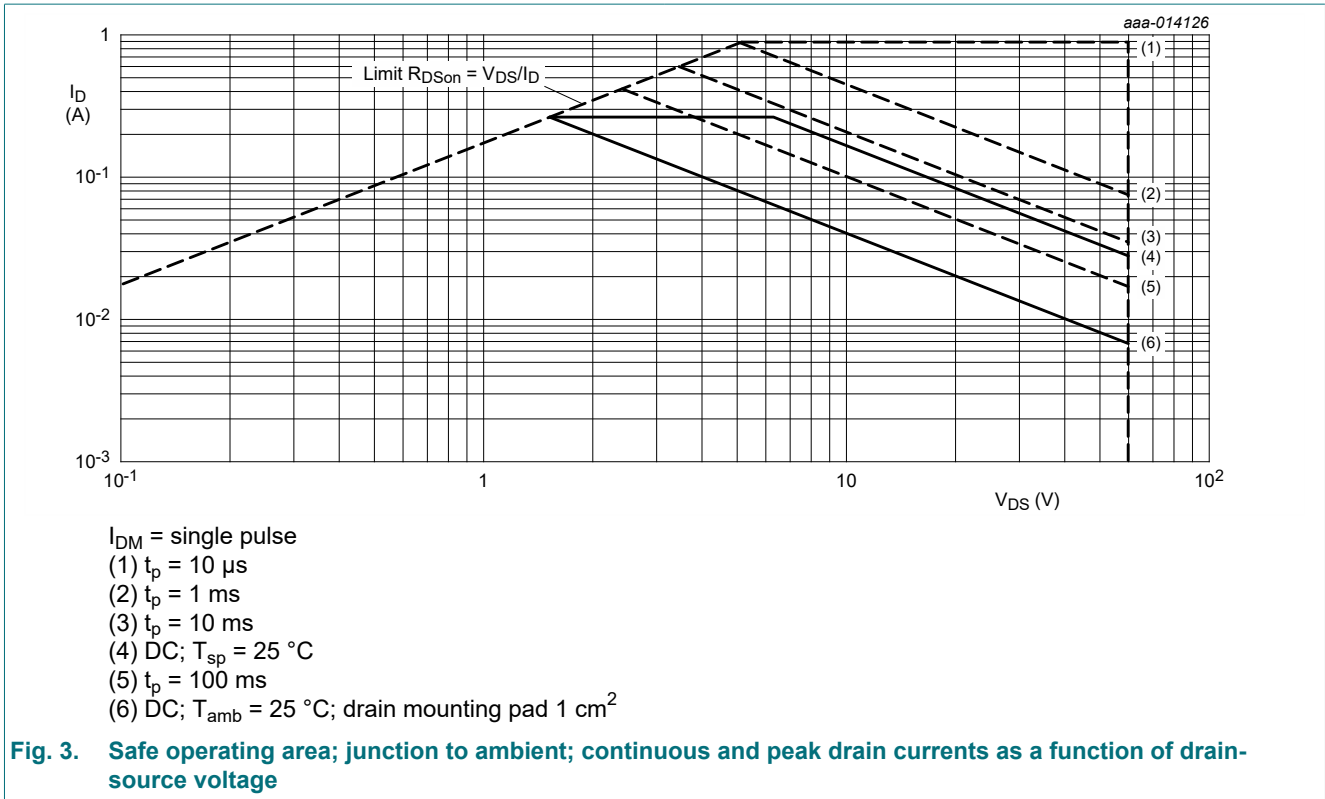
Table 5. Limiting values

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

| Symbol | Parameter | Conditions | | Min | Max | Unit |
|---------------------------|-------------------------|--|-----|-----|------|------|
| V _{DS} | drain-source voltage | T _j = 25 °C | | - | 60 | V |
| V _{GS} | gate-source voltage | | | -20 | 20 | V |
| I _D | drain current | V _{GS} = 10 V; T _{amb} = 25 °C | [1] | - | 270 | mA |
| | | V _{GS} = 10 V; T _{amb} = 100 °C | [1] | - | 170 | mA |
| | | V _{GS} = 10 V; T _{sp} = 25 °C | | - | 330 | mA |
| I _{DM} | peak drain current | T _{amb} = 25 °C; single pulse; t _p ≤ 10 μs | | - | 0.9 | A |
| P _{tot} | total power dissipation | T _{amb} = 25 °C | [2] | - | 310 | mW |
| | | | [1] | - | 400 | mW |
| | | T _{sp} = 25 °C | | - | 1670 | 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 Printed-Circuit Board (PCB), single-sided copper, tin-plated and 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 | 405 | K/W |
| | | | [2] | - | 270 | 310 | K/W |
| $R_{th(j-sp)}$ | thermal resistance from junction to solder point | | | - | 65 | 75 | 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 and mounting pad for drain 1 cm².

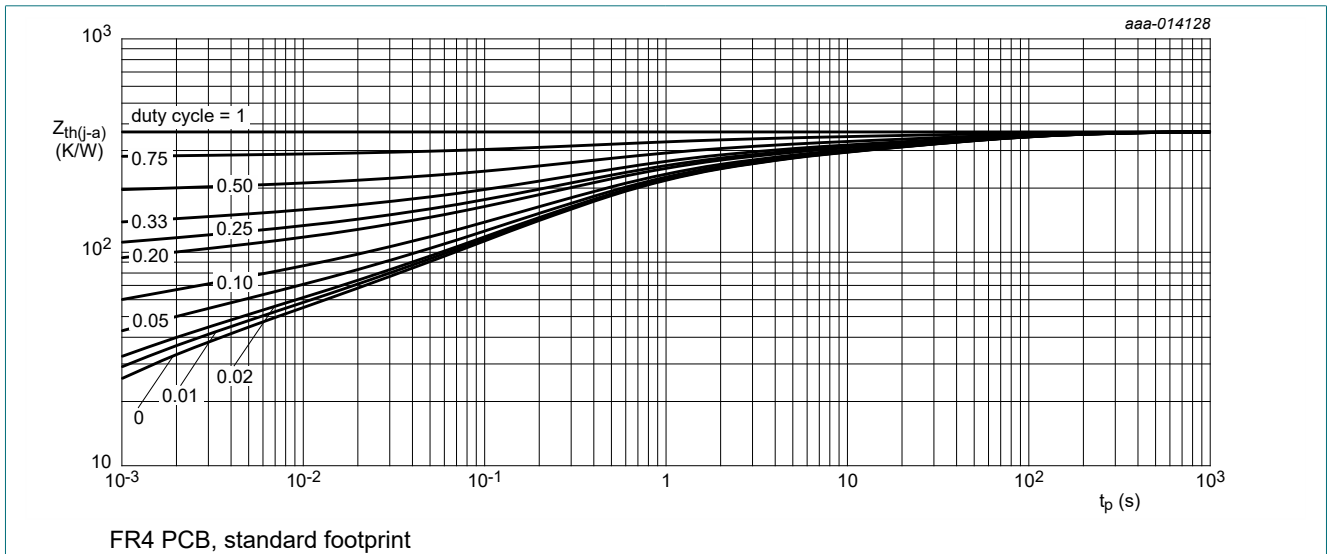


Fig. 4. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

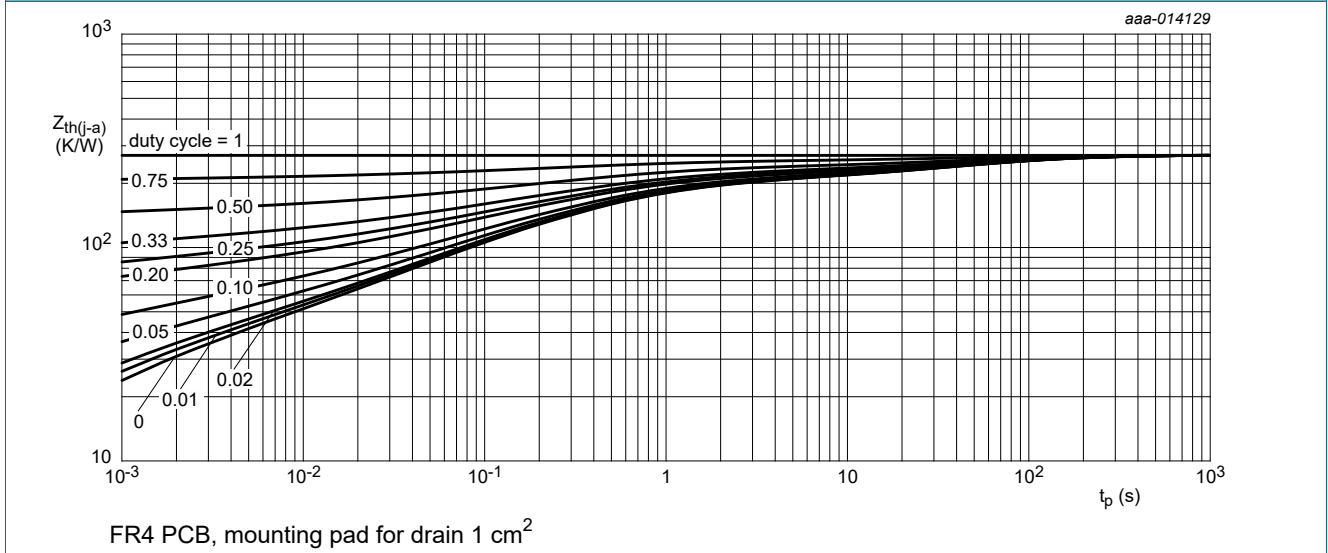


Fig. 5. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

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 | $I_D = 250 \mu A; V_{DS} = V_{GS}; T_j = 25 \text{ }^\circ C$ | 1.1 | 1.6 | 2.1 | V |
| I_{DSS} | drain leakage current | $V_{DS} = 60 V; V_{GS} = 0 V; T_j = 25 \text{ }^\circ C$ | - | - | 1 | μA |
| I_{GSS} | gate leakage current | $V_{GS} = 20 V; V_{DS} = 0 V; T_j = 25 \text{ }^\circ C$ | - | - | 10 | μA |
| | | $V_{GS} = -20 V; V_{DS} = 0 V; T_j = 25 \text{ }^\circ C$ | - | - | -10 | μA |
| | | $V_{GS} = 10 V; V_{DS} = 0 V; T_j = 25 \text{ }^\circ C$ | - | - | 1 | μA |
| | | $V_{GS} = -10 V; V_{DS} = 0 V; T_j = 25 \text{ }^\circ C$ | - | - | -1 | μA |
| | | $V_{GS} = 5 V; V_{DS} = 0 V; T_j = 25 \text{ }^\circ C$ | - | - | 0.3 | μA |
| | | $V_{GS} = -5 V; V_{DS} = 0 V; T_j = 25 \text{ }^\circ C$ | - | - | -0.3 | μA |
| R_{DSon} | drain-source on-state resistance | $V_{GS} = 10 V; I_D = 200 \text{ mA}; T_j = 25 \text{ }^\circ C$ | - | 2.2 | 2.8 | Ω |
| | | $V_{GS} = 10 V; I_D = 100 \text{ mA}; T_j = 150 \text{ }^\circ C$ | - | 4.5 | 5.7 | Ω |
| | | $V_{GS} = 5 V; I_D = 200 \text{ mA}; T_j = 25 \text{ }^\circ C$ | - | 2.5 | 3.2 | Ω |
| g_{fs} | forward transconductance | $V_{DS} = 10 V; I_D = 200 \text{ mA}; T_j = 25 \text{ }^\circ C$ | - | 600 | - | mS |
| R_G | gate resistance | $f = 2.5 \text{ MHz}$ | - | 2.5 | - | Ω |
| Dynamic characteristics | | | | | | |
| $Q_{G(tot)}$ | total gate charge | $V_{DS} = 30 V; I_D = 200 \text{ mA}; V_{GS} = 10 V; T_j = 25 \text{ }^\circ C$ | - | 1 | - | nC |
| Q_{GS} | gate-source charge | | - | 0.12 | - | nC |
| Q_{GD} | gate-drain charge | | - | 0.18 | - | nC |
| C_{iss} | input capacitance | $V_{DS} = 10 V; f = 1 \text{ MHz}; V_{GS} = 0 V; T_j = 25 \text{ }^\circ C$ | - | 23.6 | - | pF |
| C_{oss} | output capacitance | | - | 4.6 | - | pF |
| C_{rss} | reverse transfer capacitance | | - | 3 | - | pF |
| $t_{d(on)}$ | turn-on delay time | $V_{DS} = 50 V; I_D = 200 \text{ mA}; V_{GS} = 10 V; R_{G(ext)} = 6 \Omega; T_j = 25 \text{ }^\circ C$ | - | 4.7 | - | ns |
| t_r | rise time | | - | 4.3 | - | ns |
| $t_{d(off)}$ | turn-off delay time | | - | 6.9 | - | ns |
| t_f | fall time | | - | 2.9 | - | ns |
| Source-drain diode | | | | | | |
| V_{SD} | source-drain voltage | $I_S = 200 \text{ mA}; V_{GS} = 0 V; T_j = 25 \text{ }^\circ C$ | - | 0.87 | 1.2 | V |

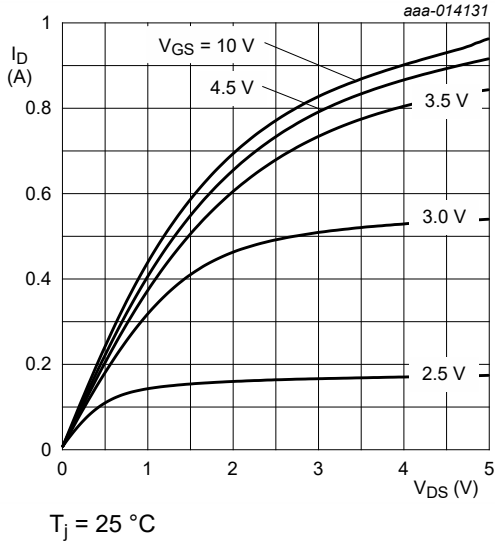


Fig. 6. Output characteristics: drain current as a function of drain-source voltage; typical values

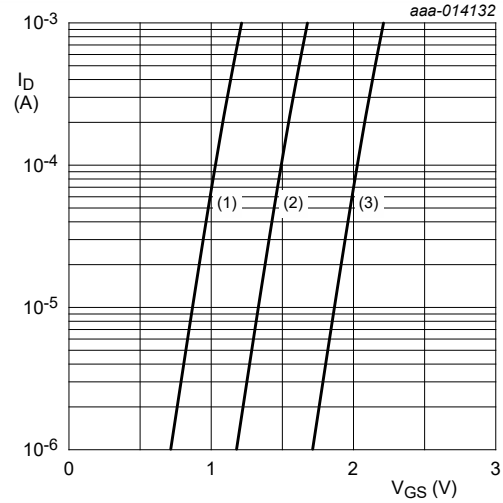


Fig. 7. Sub-threshold drain current as a function of gate-source voltage
 (1) minimum values
 (2) typical values
 (3) maximum values

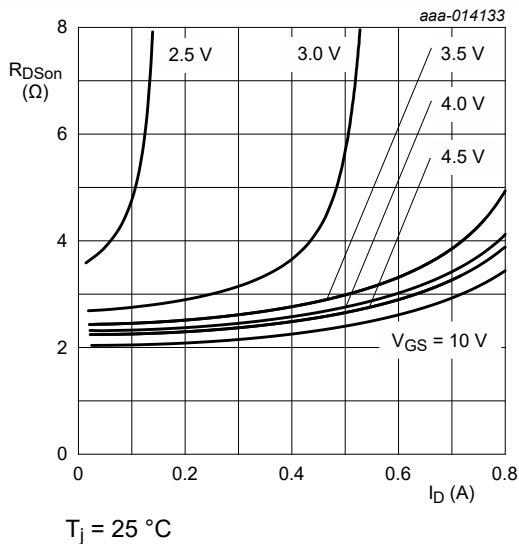


Fig. 8. Drain-source on-state resistance as a function of drain current; typical values

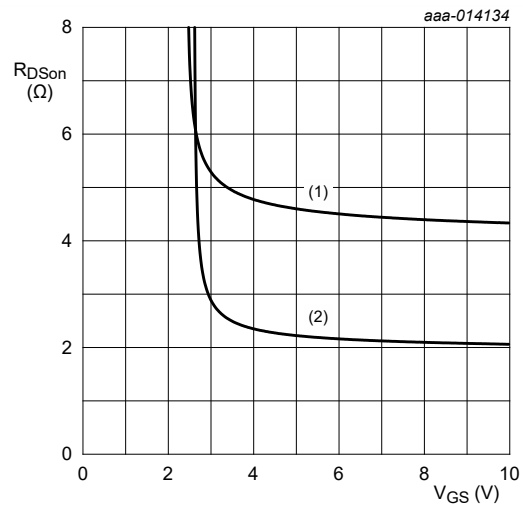


Fig. 9. Drain-source on-state resistance as a function of gate-source voltage; typical values
 (1) $T_j = 150\text{ °C}$
 (2) $T_j = 25\text{ °C}$

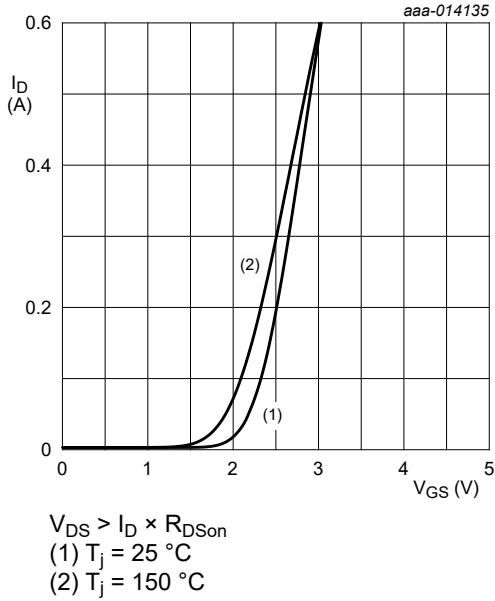


Fig. 10. Transfer characteristics: drain current as a function of gate-source voltage; typical values

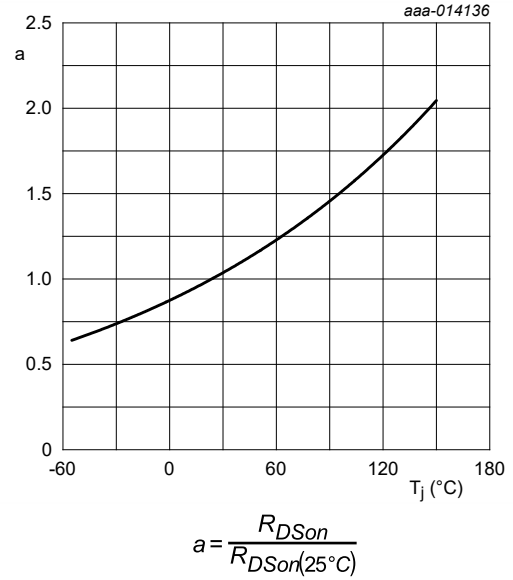


Fig. 11. Normalized drain-source on-state resistance as a function of junction temperature; typical values

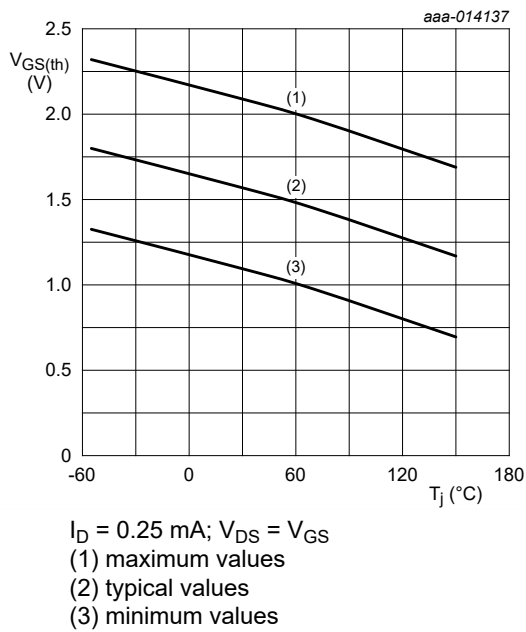


Fig. 12. Gate-source threshold voltage as a function of junction temperature

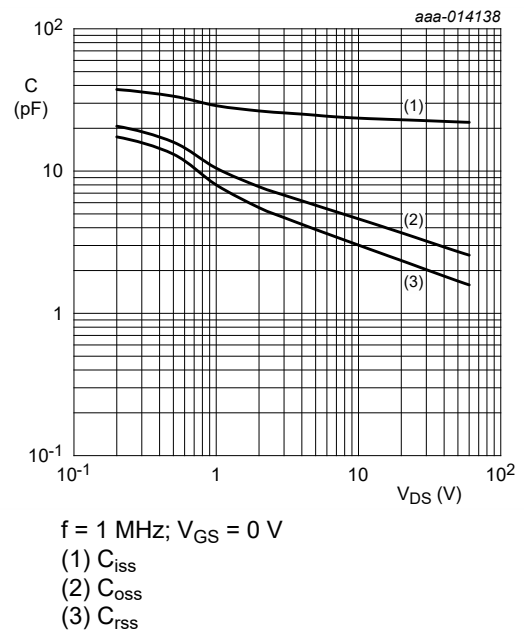
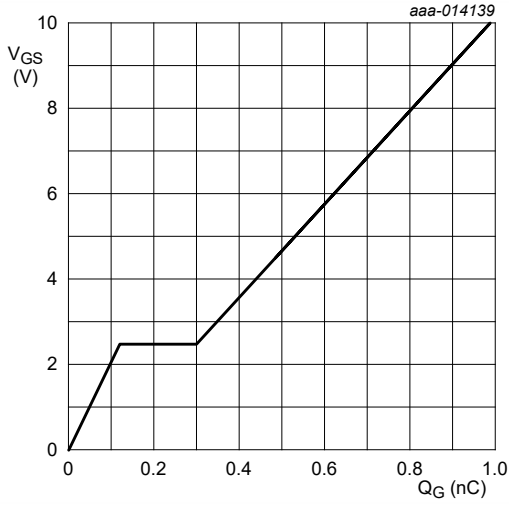


Fig. 13. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values



$I_D = 0.2$ A; $V_{DS} = 30$ V; $T_{amb} = 25$ °C

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

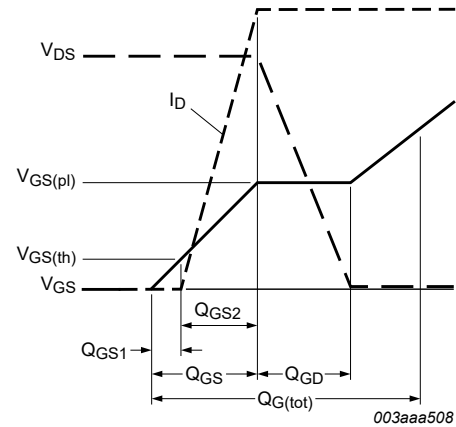
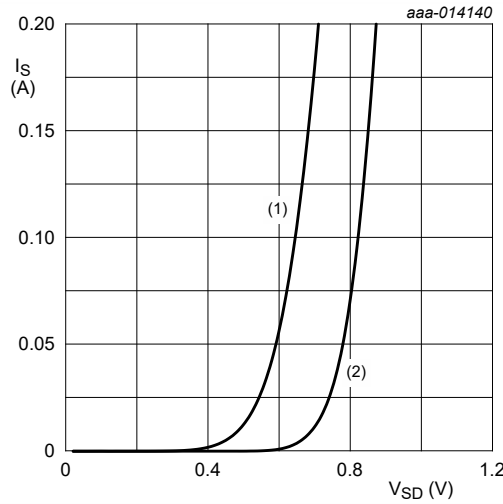


Fig. 15. Gate charge waveform definitions



$V_{GS} = 0$ V
 (1) $T_j = 150$ °C
 (2) $T_j = 25$ °C

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

11. Test information

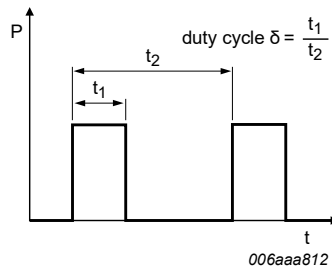


Fig. 17. Duty cycle definition

12. Package outline

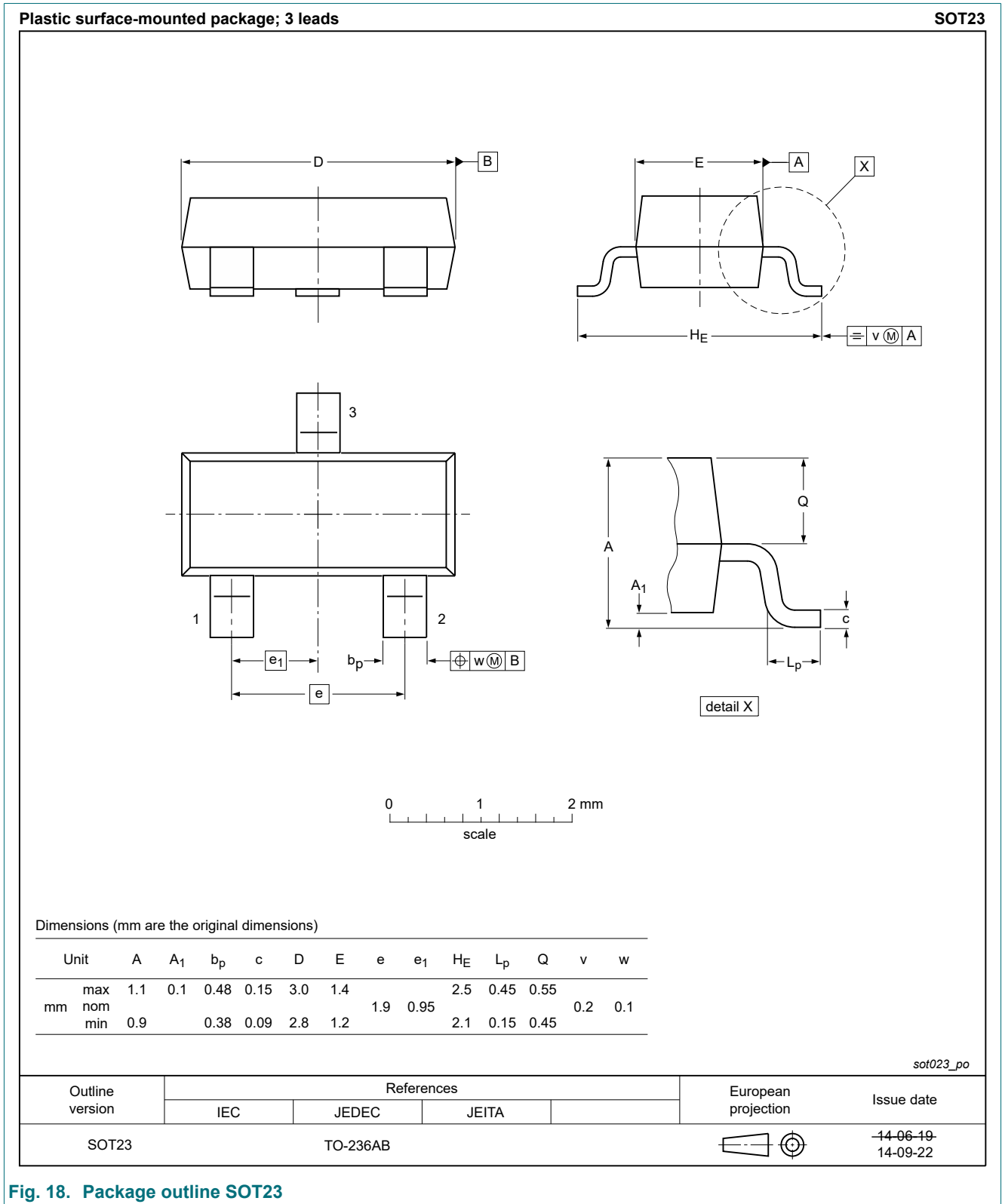


Fig. 18. Package outline SOT23

13. Soldering

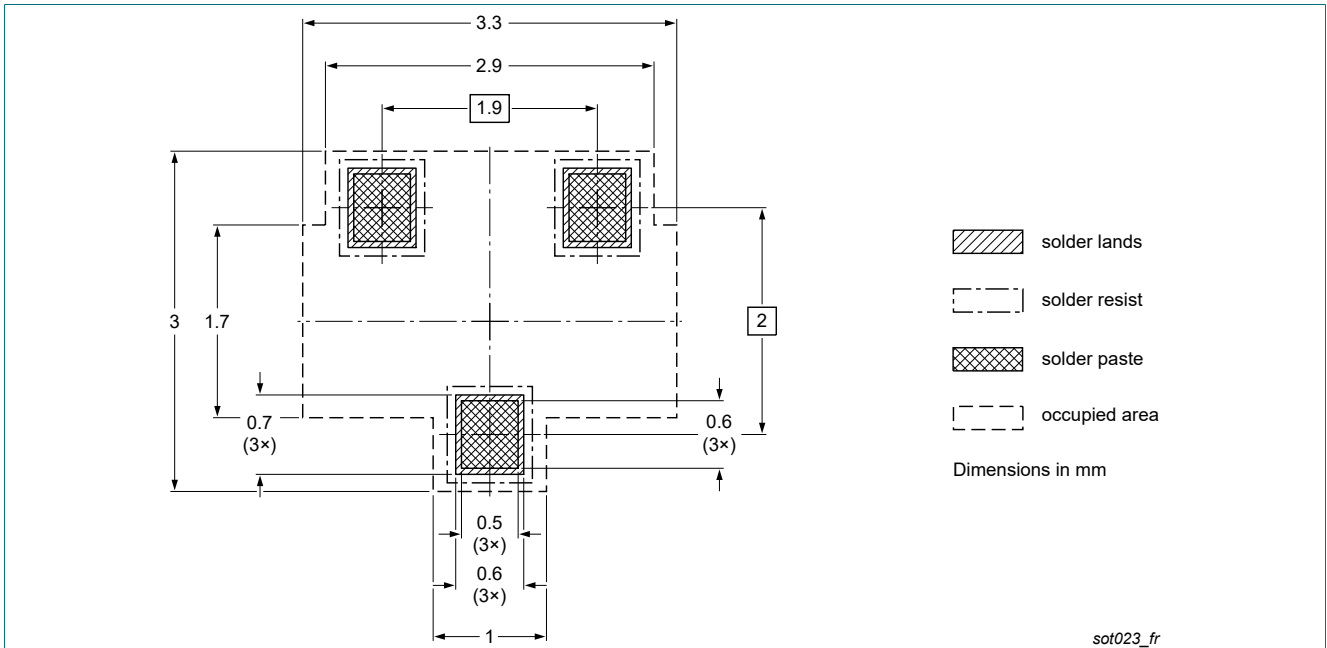


Fig. 19. Reflow soldering footprint for SOT23

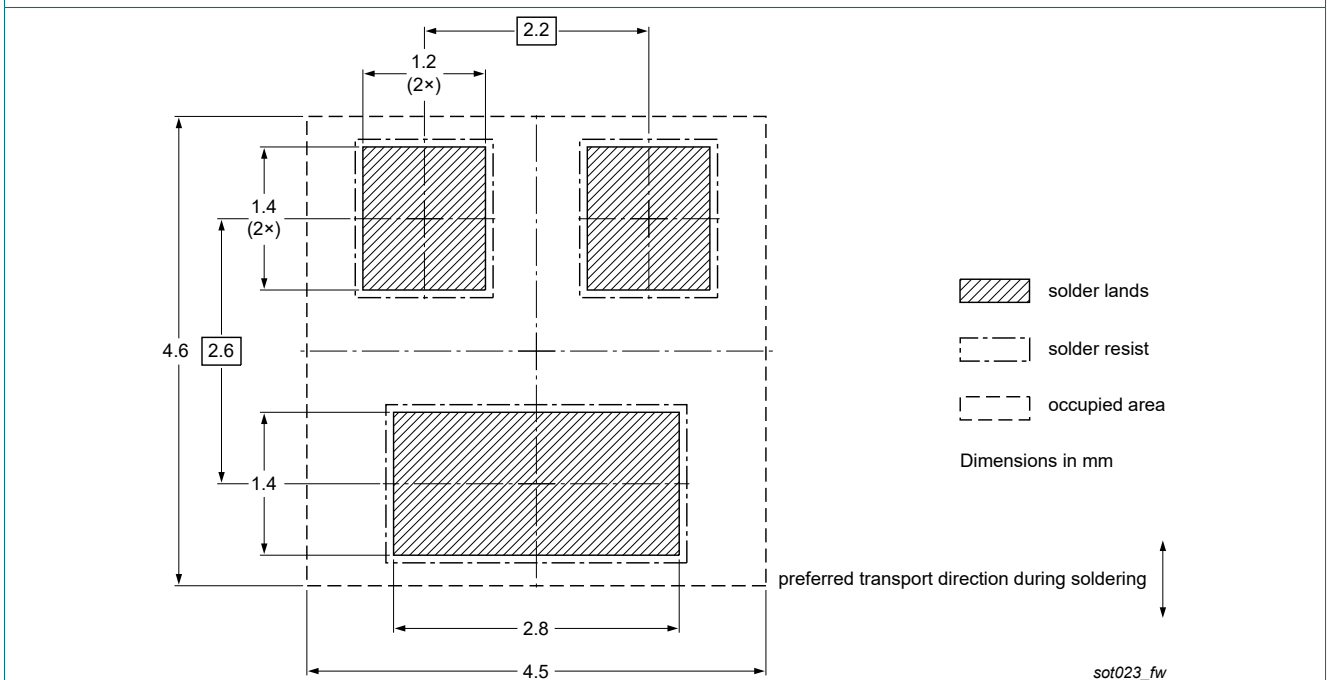


Fig. 20. Wave soldering footprint for SOT23

14. Revision history

Table 8. Revision history

| Data sheet ID | Release date | Data sheet status | Change notice | Supersedes |
|----------------|---|--------------------|---------------|----------------|
| 2N7002NXBK v.2 | 20190725 | Product data sheet | - | 2N7002NXBK v.1 |
| Modification | • Corrected the package information from SOT89 to SOT23 | | | |
| 2N7002NXBK v.1 | 20190701 | Product data sheet | - | - |

15. Legal information

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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