



2N7002BK

60 V, 350 mA N-channel Trench MOSFET

Rev. 1 — 17 June 2010

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 2 kV
- AEC-Q101 qualified

1.3 Applications

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

1.4 Quick reference data

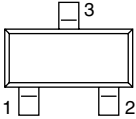
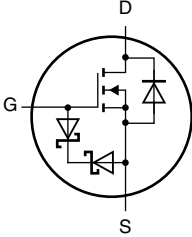
Table 1. Quick reference data

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------------|----------------------------------|---|-------|-----|-----|----------|
| V_{DS} | drain-source voltage | $T_{amb} = 25\text{ °C}$ | - | - | 60 | V |
| V_{GS} | gate-source voltage | $T_{amb} = 25\text{ °C}$ | - | - | ±20 | V |
| I_D | drain current | $T_{amb} = 25\text{ °C};$ $V_{GS} = 10\text{ V}$ | [1] - | - | 350 | mA |
| $R_{DS(on)}$ | drain-source on-state resistance | $T_j = 25\text{ °C};$ $V_{GS} = 10\text{ V};$ $I_D = 500\text{ mA}$ | - | 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

| Pin | Symbol | Description | Simplified outline | Graphic symbol |
|-----|--------|-------------|---|---|
| 1 | G | gate |  |  |
| 2 | S | source | | |
| 3 | D | drain | | |

017aaa000

3. Ordering information

Table 3. Ordering information

| Type number | Package | | |
|-------------|----------|--|---------|
| | Name | Description | Version |
| 2N7002BK | TO-236AB | plastic surface-mounted package; 3 leads | SOT23 |

4. Marking

Table 4. Marking codes

| Type number | Marking code ^[1] |
|-------------|-----------------------------|
| 2N7002BK | LN* |

- [1] * = -: made in Hong Kong
 * = p: made in Hong Kong
 * = t: made in Malaysia
 * = W: made in China

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 | $T_{amb} = 25\text{ °C}$ | - | 60 | V |
| V_{GS} | gate-source voltage | $T_{amb} = 25\text{ °C}$ | - | ±20 | V |
| I_D | drain current | $V_{GS} = 10\text{ V}$ | [1] | | |
| | | $T_{amb} = 25\text{ °C}$ | - | 350 | mA |
| | | $T_{amb} = 100\text{ °C}$ | - | 245 | mA |
| I_{DM} | peak drain current | $T_{amb} = 25\text{ °C}$; single pulse; $t_p \leq 10\text{ }\mu\text{s}$ | - | 1.2 | A |

Table 5. Limiting values ...continued

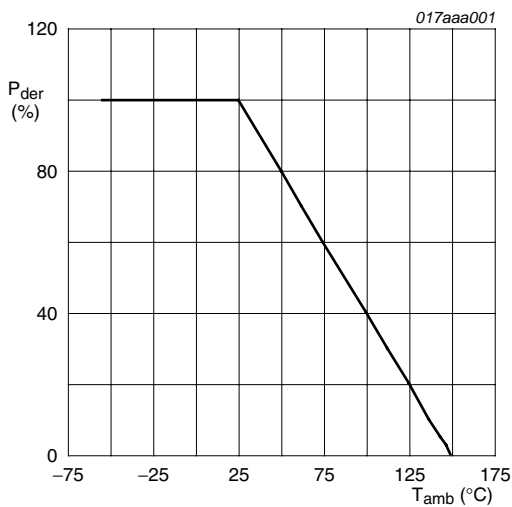
In accordance with the Absolute Maximum Rating System (IEC 60134).

| Symbol | Parameter | Conditions | Min | Max | Unit | |
|---------------------------|---------------------------------|--------------------------|-----|------|------|----|
| P _{tot} | total power dissipation | T _{amb} = 25 °C | [2] | - | 370 | mW |
| | | | [1] | - | 440 | mW |
| | | T _{sp} = 25 °C | - | 1.2 | W | |
| T _j | junction temperature | | | 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] | - | 350 | mA |
| ESD maximum rating | | | | | | |
| V _{ESD} | electrostatic discharge voltage | human body model | [3] | - | 2000 | V |

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

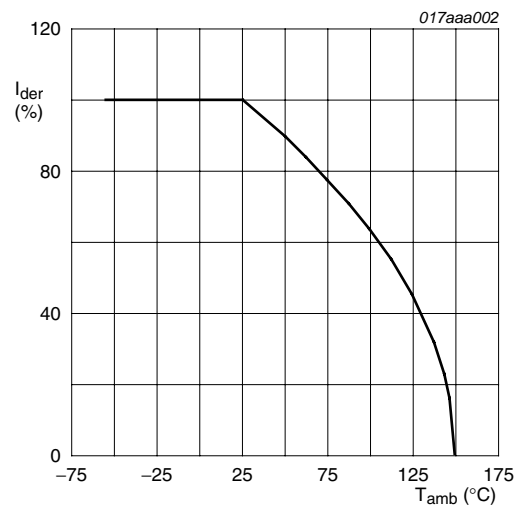
[2] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and standard footprint.

[3] Measured between all pins.



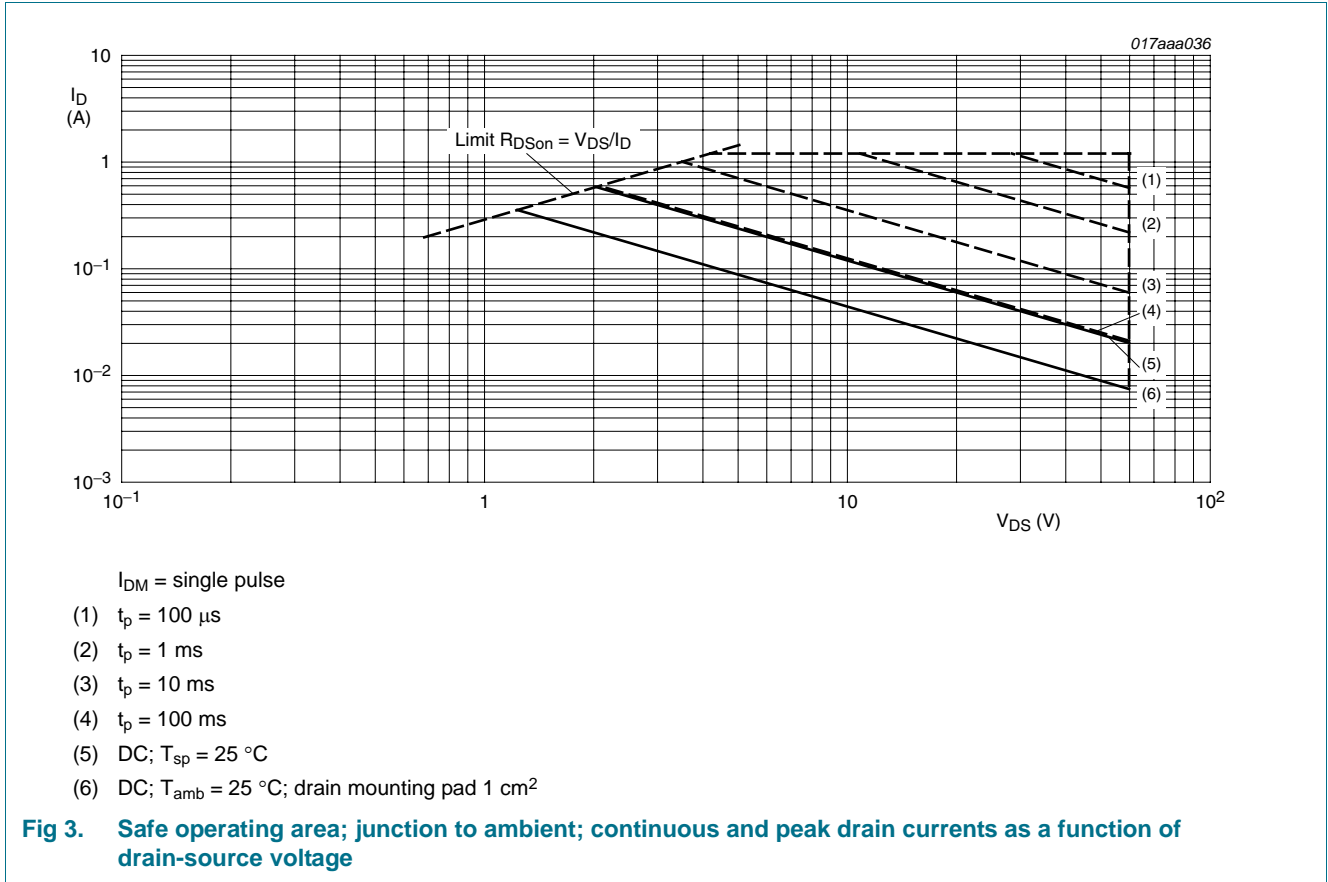
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100 \%$$

Fig 1. Normalized total power dissipation as a function of ambient temperature



$$I_{der} = \frac{I_D}{I_{D(25^{\circ}C)}} \times 100 \%$$

Fig 2. Normalized continuous drain current as a function of ambient temperature



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] | - | 295 | 340 | K/W |
| | | | [2] | - | 250 | 285 | K/W |
| $R_{th(j-sp)}$ | thermal resistance from junction to solder point | | - | - | 105 | 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 .

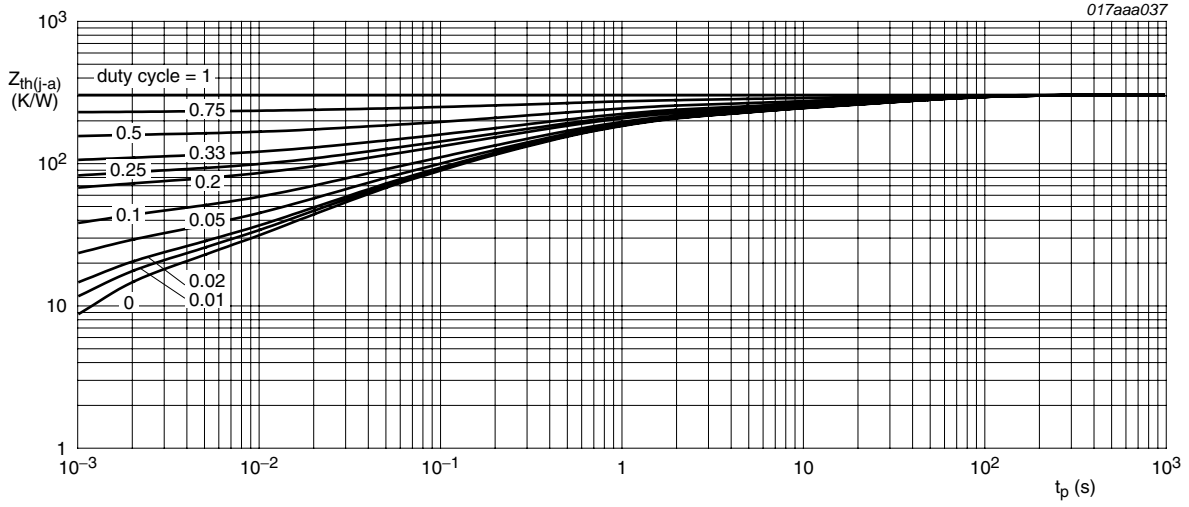


Fig 4. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

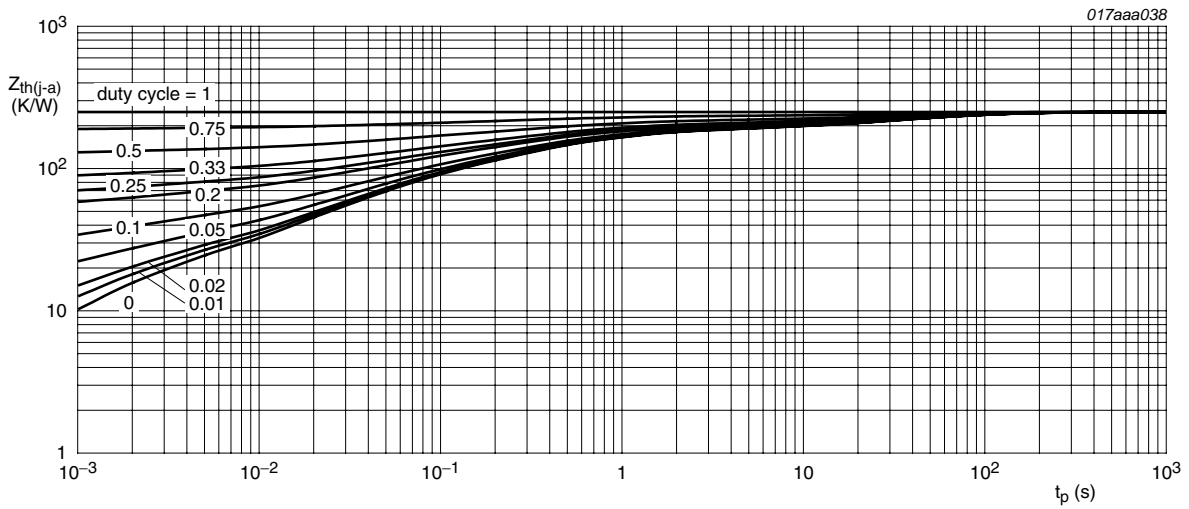


Fig 5. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

7. Characteristics

Table 7. Characteristics

$T_j = 25\text{ °C}$ unless otherwise specified.

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------------------------------|----------------------------------|---|------|------|-----|---------------|
| Static characteristics | | | | | | |
| $V_{(BR)DSS}$ | drain-source breakdown voltage | $I_D = 10\ \mu\text{A}; V_{GS} = 0\ \text{V}$ | 60 | - | - | V |
| $V_{GS(th)}$ | gate-source threshold voltage | $I_D = 250\ \mu\text{A}; V_{DS} = V_{GS}$ | 1.1 | 1.6 | 2.1 | V |
| I_{DSS} | drain leakage current | $V_{DS} = 60\ \text{V}; V_{GS} = 0\ \text{V}$ | | | | |
| | | $T_j = 25\text{ °C}$ | - | - | 1 | μA |
| | | $T_j = 150\text{ °C}$ | - | - | 10 | μA |
| I_{GSS} | gate leakage current | $V_{GS} = \pm 20\ \text{V}; V_{DS} = 0\ \text{V}$ | - | - | 10 | μA |
| $R_{DS(on)}$ | drain-source on-state resistance | | [1] | | | |
| | | $V_{GS} = 5\ \text{V}; I_D = 50\ \text{mA}$ | - | 1.3 | 2 | Ω |
| | | $V_{GS} = 10\ \text{V}; I_D = 500\ \text{mA}$ | - | 1 | 1.6 | Ω |
| g_{fs} | forward transconductance | $V_{DS} = 10\ \text{V}; I_D = 200\ \text{mA}$ | [1] | - | 550 | mS |
| Dynamic characteristics | | | | | | |
| $Q_{G(tot)}$ | total gate charge | $I_D = 300\ \text{mA};$ $V_{DS} = 30\ \text{V};$ $V_{GS} = 4.5\ \text{V}$ | - | 0.5 | 0.6 | nC |
| Q_{GS} | gate-source charge | | - | 0.2 | - | nC |
| Q_{GD} | gate-drain charge | | - | 0.1 | - | nC |
| C_{iss} | input capacitance | $V_{GS} = 0\ \text{V}; V_{DS} = 10\ \text{V};$ $f = 1\ \text{MHz}$ | - | 33 | 50 | pF |
| C_{oss} | output capacitance | | - | 7 | - | pF |
| C_{rss} | reverse transfer capacitance | | - | 4 | - | pF |
| $t_{d(on)}$ | turn-on delay time | $V_{DD} = 50\ \text{V};$ $R_L = 250\ \Omega;$ $V_{GS} = 10\ \text{V};$ $R_G = 6\ \Omega$ | - | 5 | 10 | ns |
| t_r | rise time | | - | 6 | - | ns |
| $t_{d(off)}$ | turn-off delay time | | - | 12 | 24 | ns |
| t_f | fall time | | - | 7 | - | ns |
| Source-drain diode | | | | | | |
| V_{SD} | source-drain voltage | $I_S = 115\ \text{mA}; V_{GS} = 0\ \text{V}$ | 0.47 | 0.75 | 1.1 | V |

[1] Pulse test: $t_p \leq 300\ \mu\text{s}; \delta \leq 0.01$.

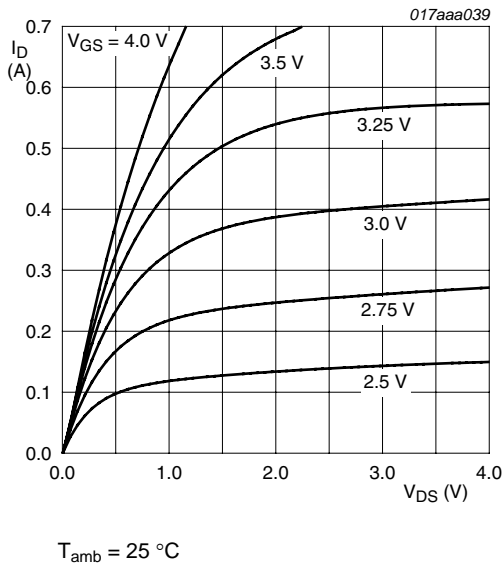


Fig 6. Output characteristics: drain current as a function of drain-source voltage; typical values

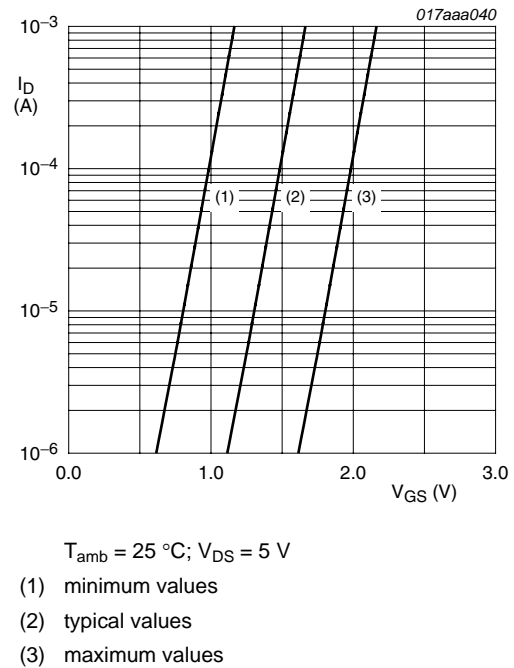


Fig 7. Sub-threshold drain current as a function of gate-source voltage

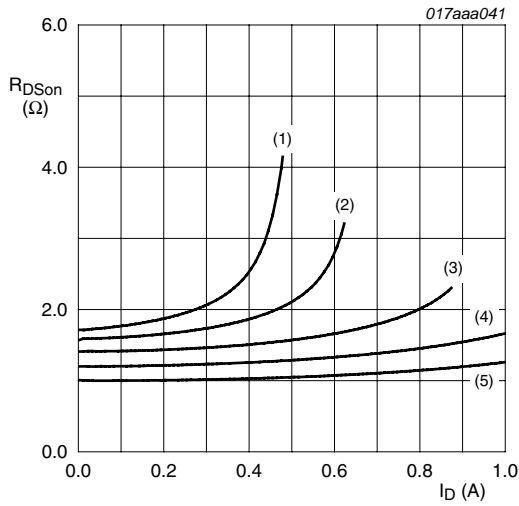


Fig 8. Drain-source on-state resistance as a function of drain current; typical values

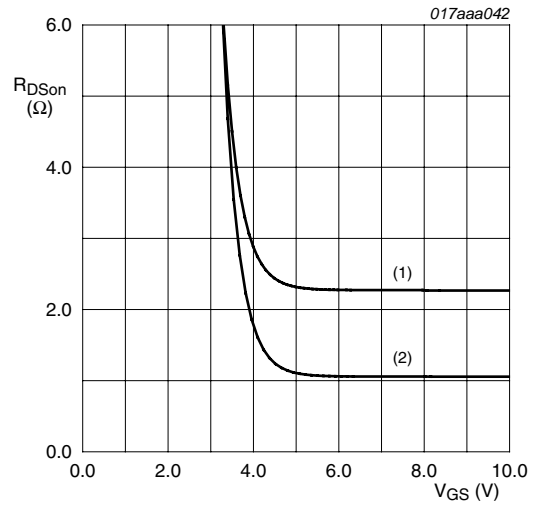
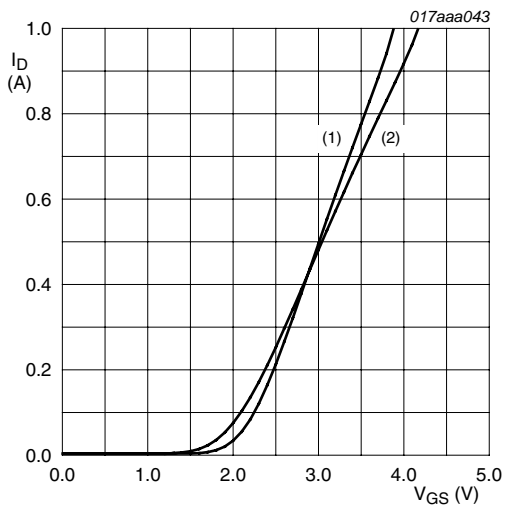
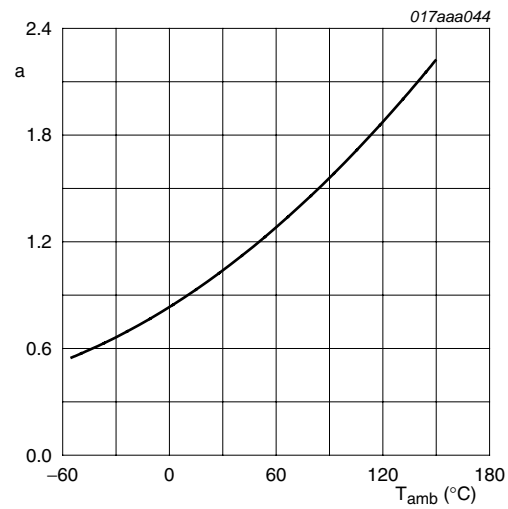


Fig 9. Drain-source on-state resistance as a function of gate-source voltage; typical values



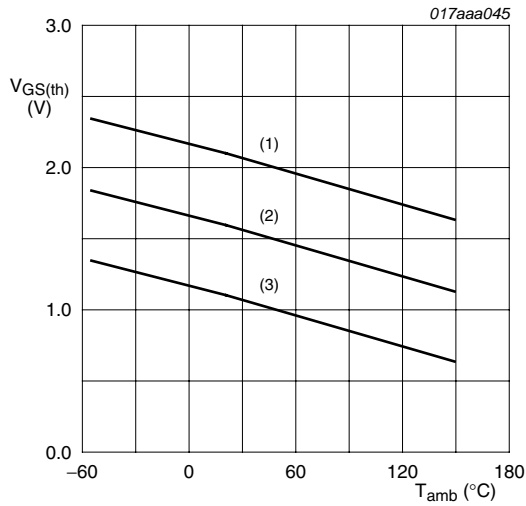
$V_{DS} > I_D \times R_{DSon}$
 (1) $T_{amb} = 25\text{ °C}$
 (2) $T_{amb} = 150\text{ °C}$

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



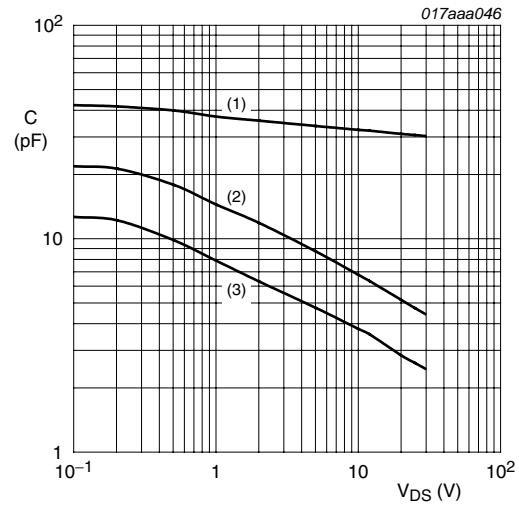
$$a = \frac{R_{DSon}}{R_{DSon(25^\circ C)}}$$

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



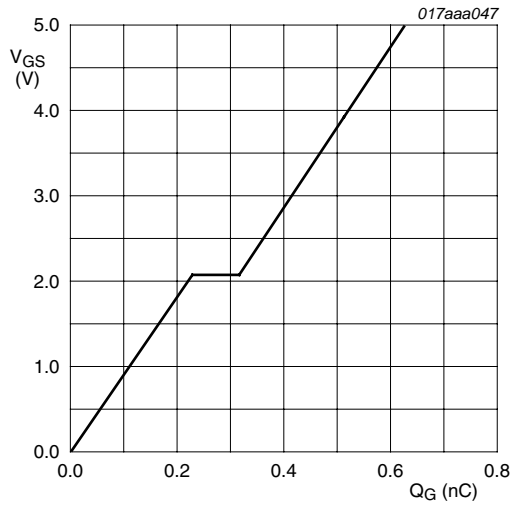
$I_D = 0.25\text{ mA}; V_{DS} = V_{GS}$
 (1) maximum values
 (2) typical values
 (3) minimum values

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



$I_D = 300 \text{ mA}$; $V_{DD} = 6 \text{ V}$; $T_{amb} = 25 \text{ }^\circ\text{C}$

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

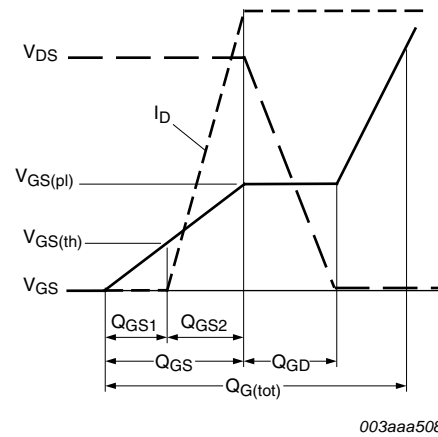
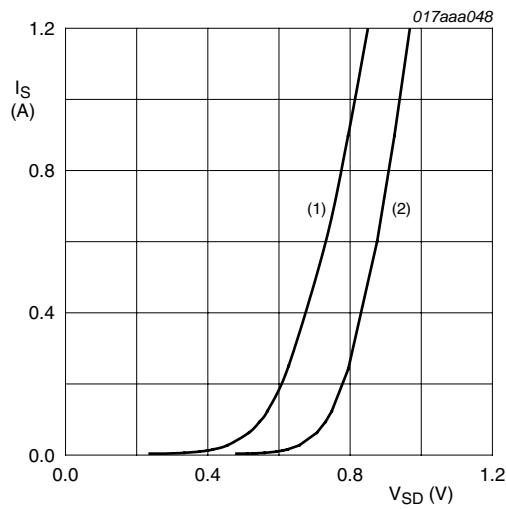


Fig 15. Gate charge waveform definitions

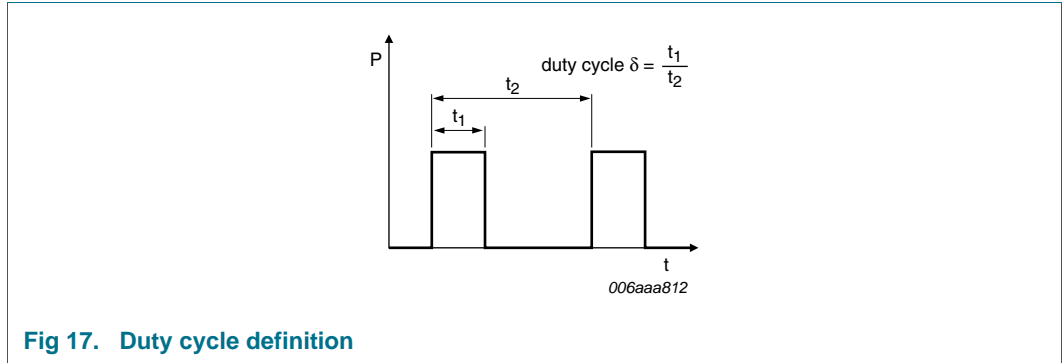


$V_{GS} = 0 \text{ V}$

- (1) $T_{amb} = 150 \text{ }^\circ\text{C}$
- (2) $T_{amb} = 25 \text{ }^\circ\text{C}$

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

8. Test information



9. Package outline

Plastic surface-mounted package; 3 leads

SOT23

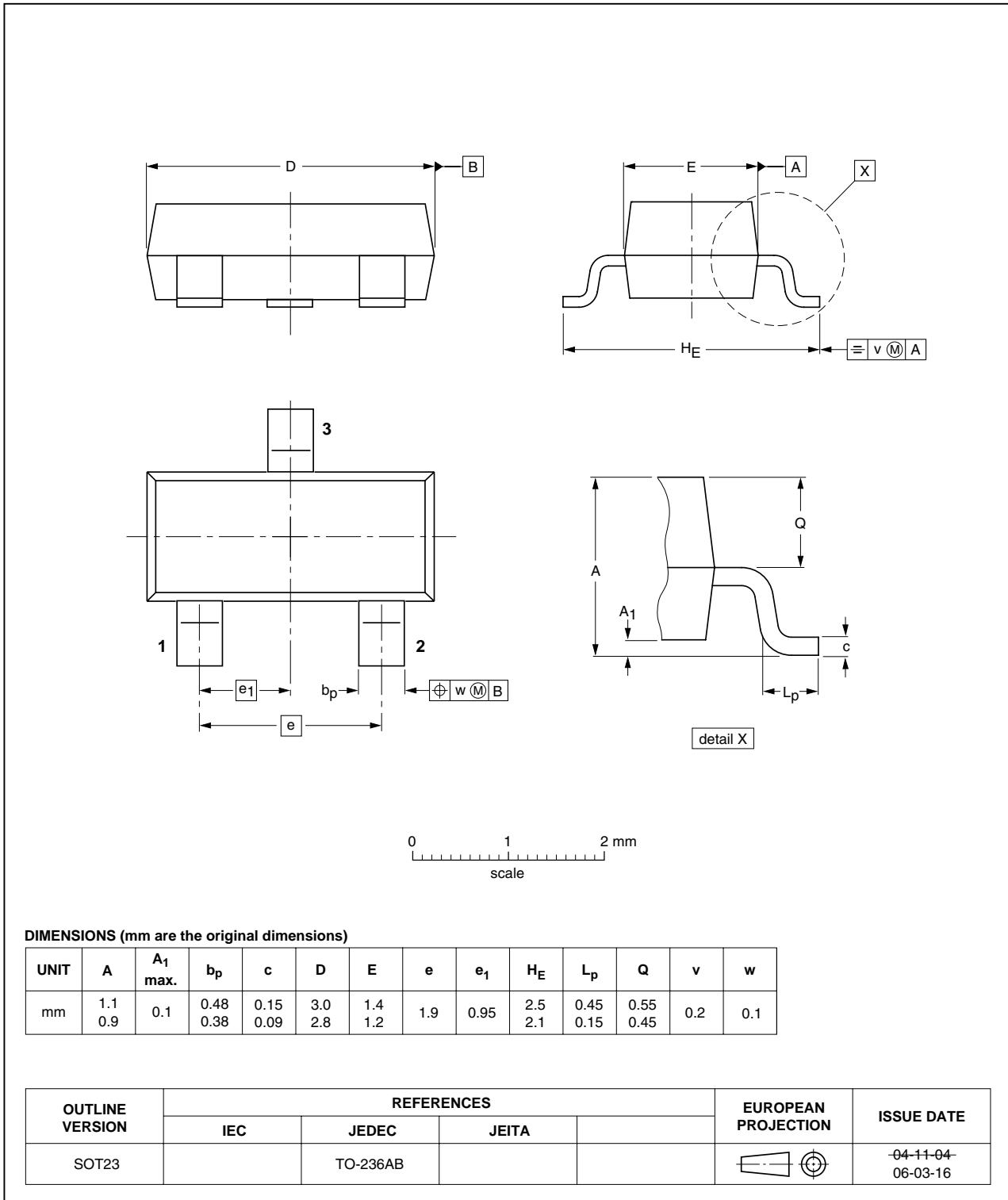


Fig 18. Package outline SOT23 (TO-236AB)

10. Soldering

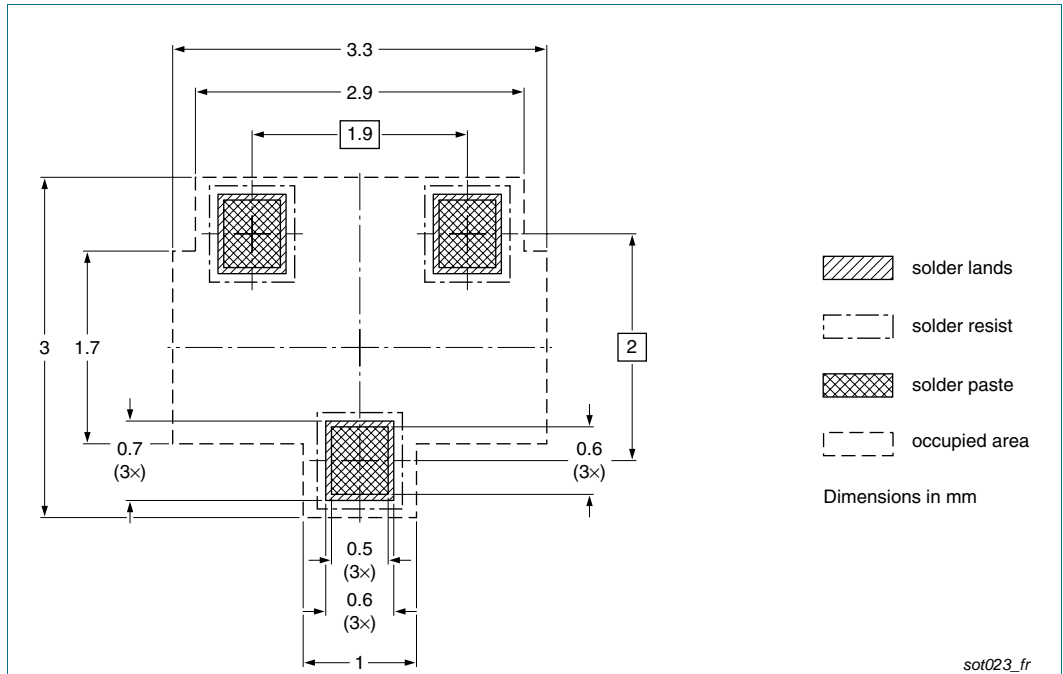


Fig 19. Reflow soldering footprint SOT23 (TO-236AB)

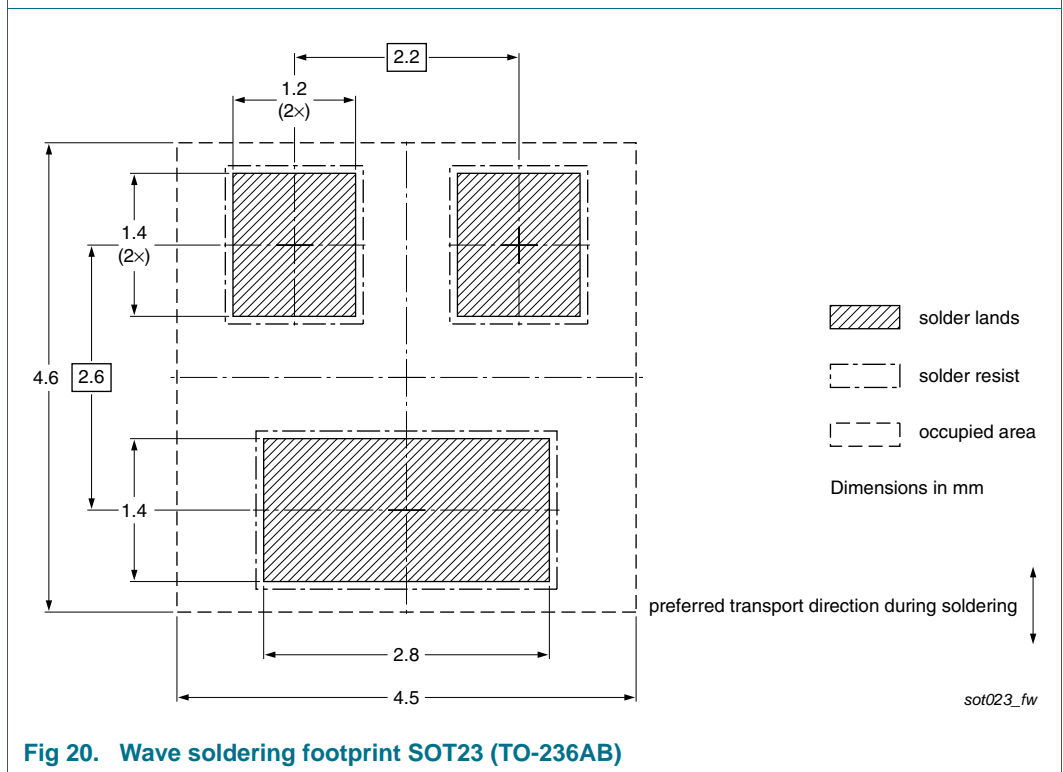


Fig 20. Wave soldering footprint SOT23 (TO-236AB)

11. Revision history

Table 8. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|--------------|--------------|--------------------|---------------|------------|
| 2N7002BK v.1 | 20100617 | 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. |

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

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