



2N7002NXAK

60 V, single N-channel Trench MOSFET

1 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

- Very fast switching
- Trench MOSFET technology
- ESD protected

3. Applications

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

4. Quick reference data

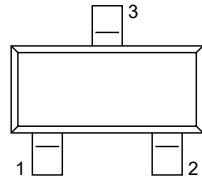
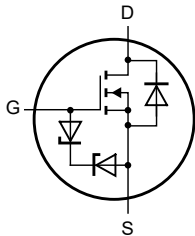
Table 1. Quick reference data

| 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 | $V_{GS} = 10\text{ V}; T_{sp} = 25\text{ °C}$ | - | - | 300 | mA |
| | | $V_{GS} = 10\text{ V}; T_{amb} = 25\text{ °C}$ [1] | - | - | 190 | mA |
| Static characteristics | | | | | | |
| R_{DSon} | drain-source on-state resistance | $V_{GS} = 10\text{ V}; I_D = 100\text{ mA}; T_j = 25\text{ °C}$ | - | 3 | 4.5 | Ω |

[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 1 cm^2 .

5. Pinning information

Table 2. Pinning information

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

6. Ordering information

Table 3. Ordering information

| Type number | Package | | |
|-------------|----------|--|---------|
| | Name | Description | Version |
| 2N7002NXAK | TO-236AB | plastic surface-mounted package; 3 leads | SOT23 |

7. Marking

Table 4. Marking codes

| Type number | Marking code[1] |
|-------------|-----------------|
| 2N7002NXAK | %CM |

[1] % = placeholder for manufacturing site code

8. Limiting values

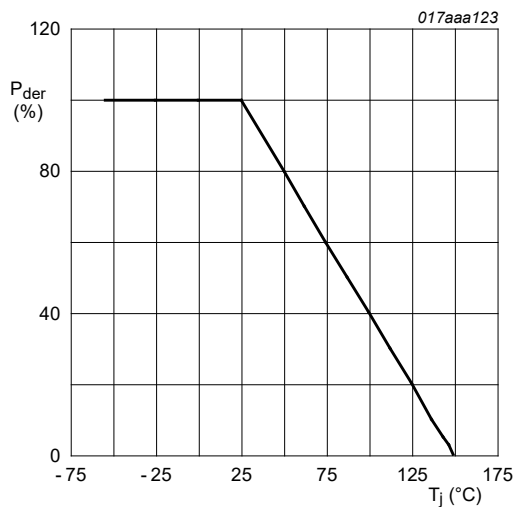
Table 5. Limiting values

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 | $V_{GS} = 10\text{ V}; T_{sp} = 25\text{ }^{\circ}\text{C}$ | | - | 300 | mA |
| | | $V_{GS} = 10\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}$ | [1] | - | 190 | mA |
| | | $V_{GS} = 10\text{ V}; T_{amb} = 100\text{ }^{\circ}\text{C}$ | [1] | - | 120 | mA |
| I_{DM} | peak drain current | $T_{amb} = 25\text{ }^{\circ}\text{C}$; single pulse; $t_p \leq 10\text{ }\mu\text{s}$ | | - | 760 | mA |
| P_{tot} | total power dissipation | $T_{amb} = 25\text{ }^{\circ}\text{C}$ | [2] | - | 265 | mW |
| | | | [1] | - | 325 | mW |
| | | $T_{sp} = 25\text{ }^{\circ}\text{C}$ | | - | 1330 | mW |
| T_j | junction temperature | | | -55 | 150 | $^{\circ}\text{C}$ |
| T_{amb} | ambient temperature | | | -55 | 150 | $^{\circ}\text{C}$ |
| T_{stg} | storage temperature | | | -65 | 150 | $^{\circ}\text{C}$ |
| Source-drain diode | | | | | | |
| I_S | source current | $T_{amb} = 25\text{ }^{\circ}\text{C}$ | [1] | - | 190 | mA |

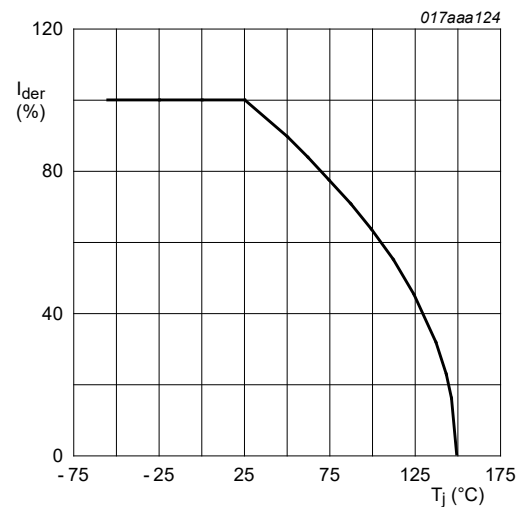
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 1 cm^2 .

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



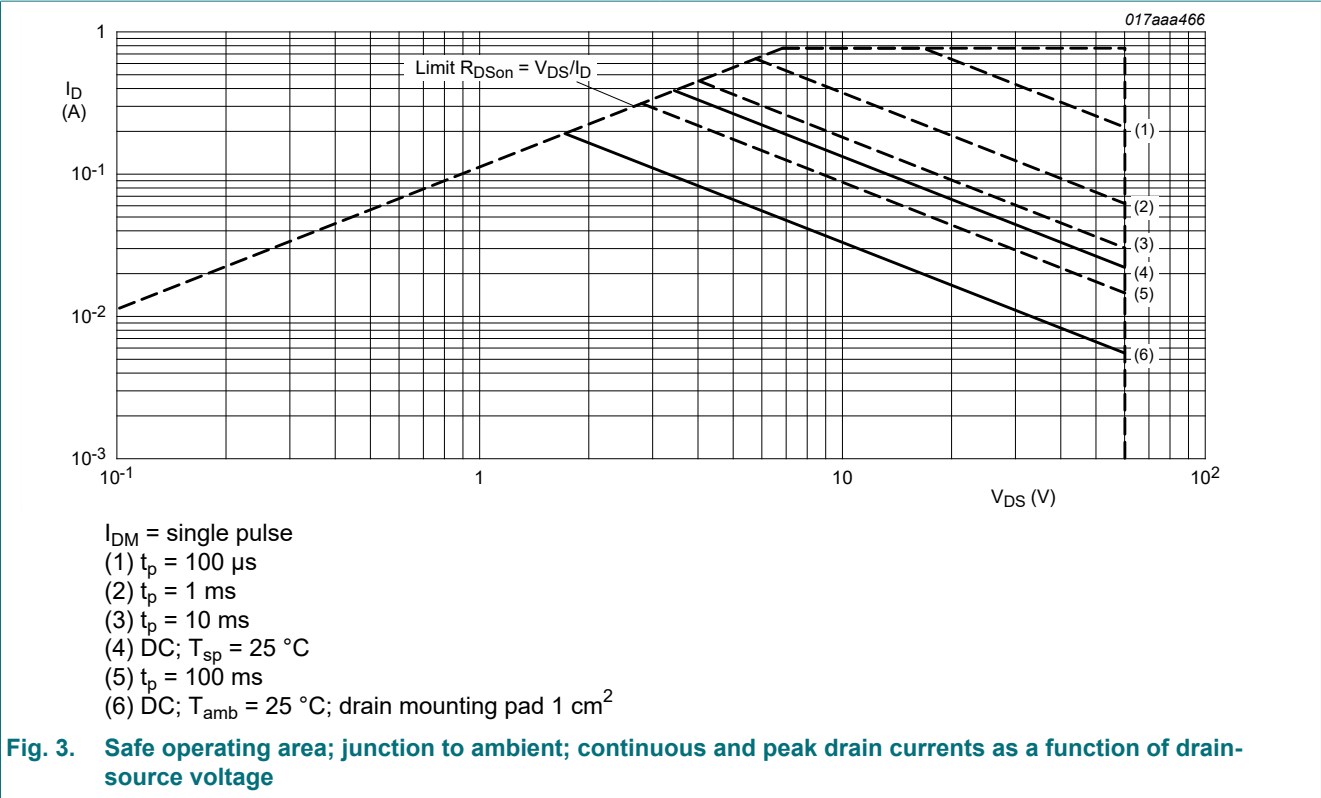
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}\text{C})}} \times 100\%$$

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



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

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



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] | - | 410 | 470 | K/W |
| | | | [2] | - | 330 | 380 | K/W |
| $R_{th(j-sp)}$ | thermal resistance from junction to solder point | | | - | - | 95 | 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 .

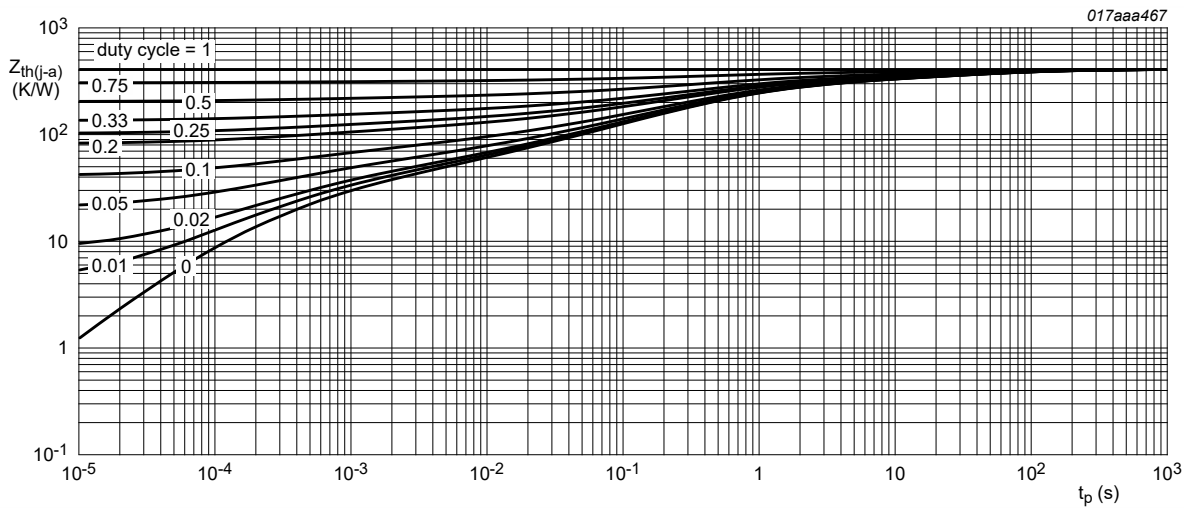


Fig. 4. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

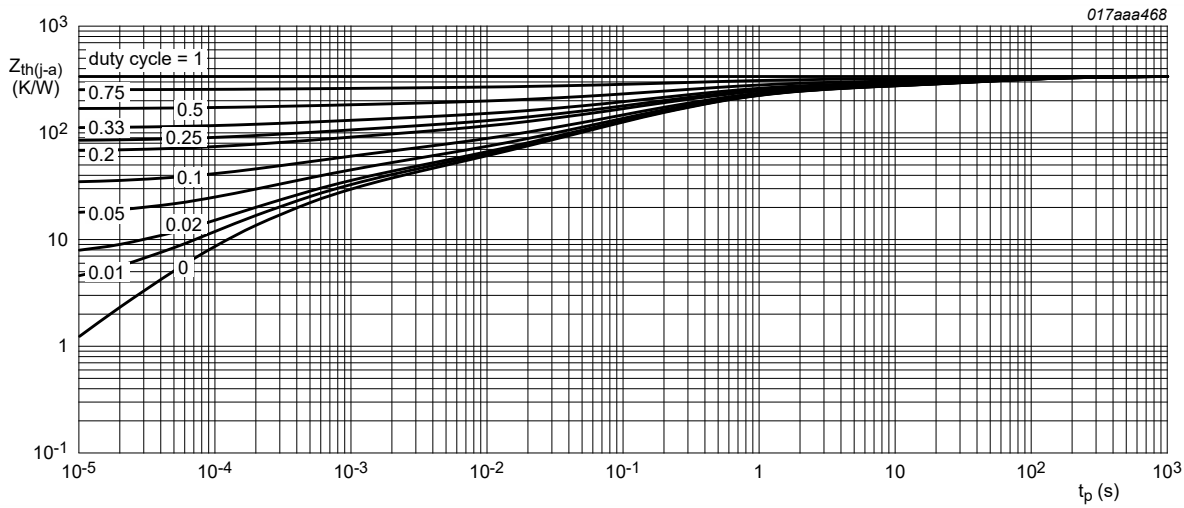


Fig. 5. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

10. Characteristics

Table 7. Characteristics

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|--|--------------------------------|---|----------------------------------|---|------|------|------|
| Static characteristics | | | | | | | |
| V _{(BR)DSS} | drain-source breakdown voltage | I _D = 250 μA; V _{GS} = 0 V; T _j = 25 °C | | 60 | - | - | V |
| V _{GSth} | gate-source threshold voltage | I _D = 250 μA; V _{DS} =V _{GS} ; T _j = 25 °C | | 1.1 | 1.6 | 2.1 | V |
| I _{DSS} | drain leakage current | V _{DS} = 60 V; V _{GS} = 0 V; T _j = 25 °C | | - | - | 1 | μA |
| | | V _{DS} = 60 V; V _{GS} = 0 V; T _j = 150 °C | | - | - | 10 | μA |
| I _{GSS} | gate leakage current | V _{GS} = 20 V; V _{DS} = 0 V; T _j = 25 °C | | - | - | 2 | μA |
| | | V _{GS} = -20 V; V _{DS} = 0 V; T _j = 25 °C | | - | - | -2 | μA |
| | | V _{GS} = 10 V; V _{DS} = 0 V; T _j = 25 °C | | - | - | 0.5 | μA |
| | | V _{GS} = -10 V; V _{DS} = 0 V; T _j = 25 °C | | - | - | -0.5 | μA |
| | | V _{GS} = 5 V; V _{DS} = 0 V; T _j = 25 °C | | - | - | 100 | nA |
| | | V _{GS} = -5 V; V _{DS} = 0 V; T _j = 25 °C | | - | - | -100 | nA |
| | | R _{DSon} | drain-source on-state resistance | V _{GS} = 10 V; I _D = 100 mA; T _j = 25 °C | | - | 3 |
| V _{GS} = 10 V; I _D = 100 mA; T _j = 150 °C | | - | | 6.2 | 9.2 | Ω | |
| V _{GS} = 5 V; I _D = 100 mA; T _j = 25 °C | | - | | 3.7 | 5.2 | Ω | |
| g _{fs} | forward transconductance | V _{DS} = 10 V; I _D = 200 mA; T _j = 25 °C | | - | 500 | - | mS |
| Dynamic characteristics | | | | | | | |
| Q _{G(tot)} | total gate charge | V _{DS} = 30 V; I _D = 200 mA; V _{GS} = 4.5 V; T _j = 25 °C | | - | 0.33 | 0.43 | nC |
| Q _{GS} | gate-source charge | | | - | 0.12 | - | nC |
| Q _{GD} | gate-drain charge | | | - | 0.09 | - | nC |
| C _{iss} | input capacitance | V _{DS} = 10 V; f = 1 MHz; V _{GS} = 0 V; T _j = 25 °C | | - | 15 | 20 | pF |
| C _{oss} | output capacitance | | | - | 3.4 | - | pF |
| C _{rss} | reverse transfer capacitance | | | - | 2 | - | 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 | | - | 6 | 12 | ns |
| t _r | rise time | | | - | 7 | - | ns |
| t _{d(off)} | turn-off delay time | | | - | 11 | 20 | ns |
| t _f | fall time | | | - | 5 | - | ns |
| Source-drain diode | | | | | | | |
| V _{SD} | source-drain voltage | I _S = 115 mA; V _{GS} = 0 V; T _j = 25 °C | | 0.47 | 0.8 | 1.2 | V |

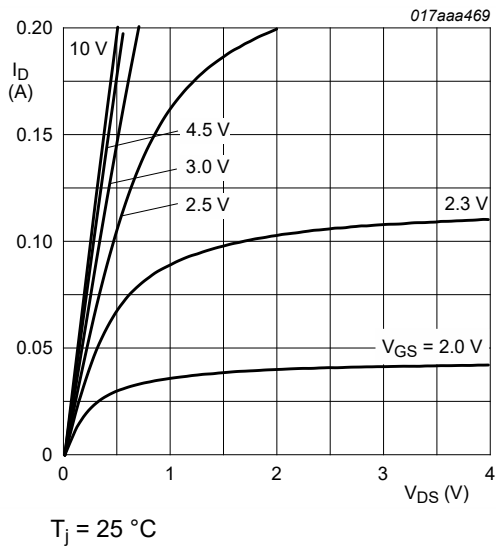


Fig. 6. Output characteristics: drain current as a function of drain-source voltage; typical values

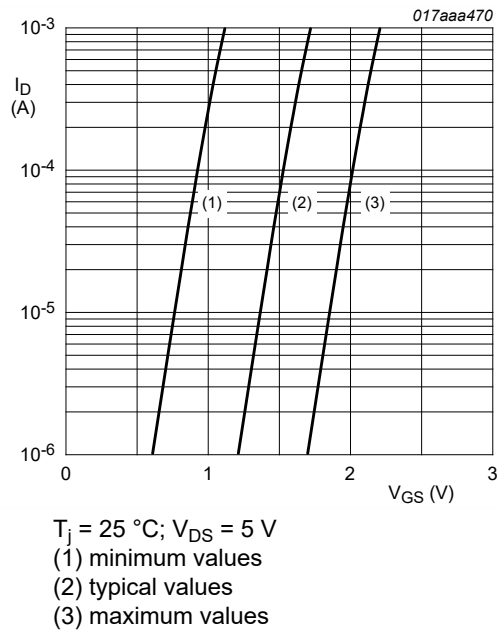


Fig. 7. Sub-threshold drain current as a function of gate-source voltage

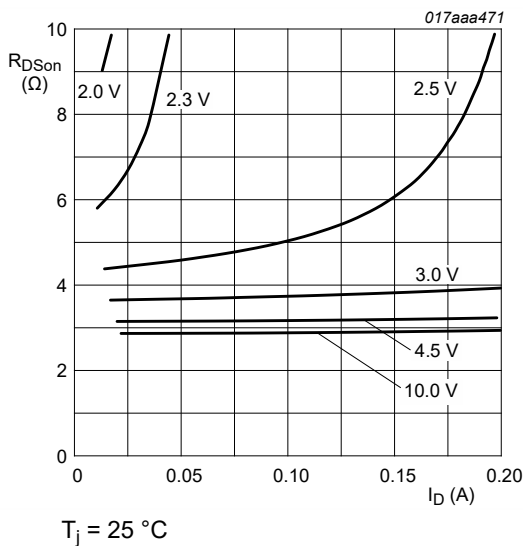


Fig. 8. Drain-source on-state resistance as a function of drain current; typical values

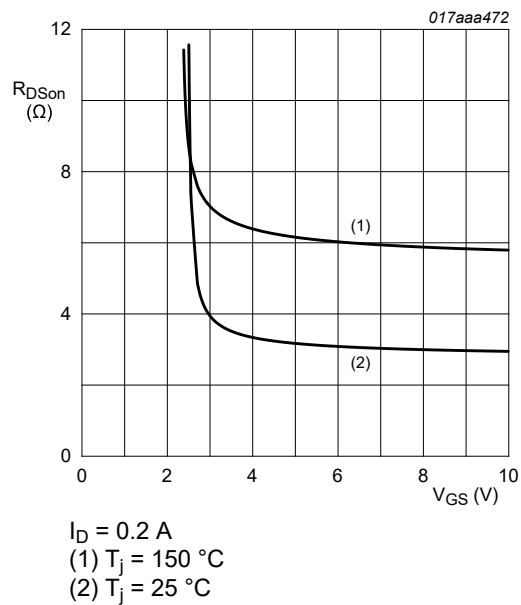


Fig. 9. Drain-source on-state resistance as a function of gate-source voltage; typical values

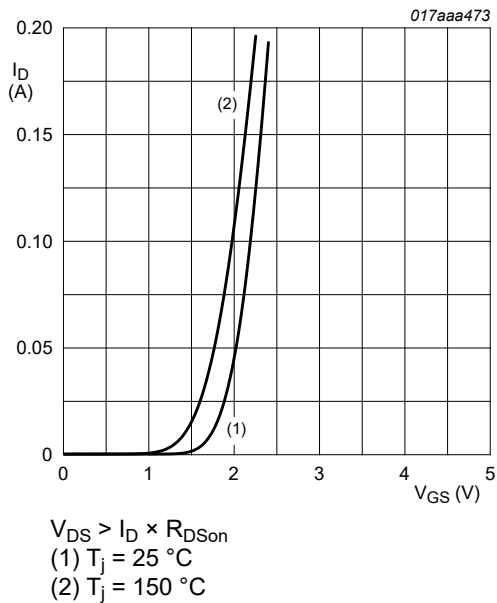


Fig. 10. Transfer characteristics: drain current as a function of gate-source voltage; typical values

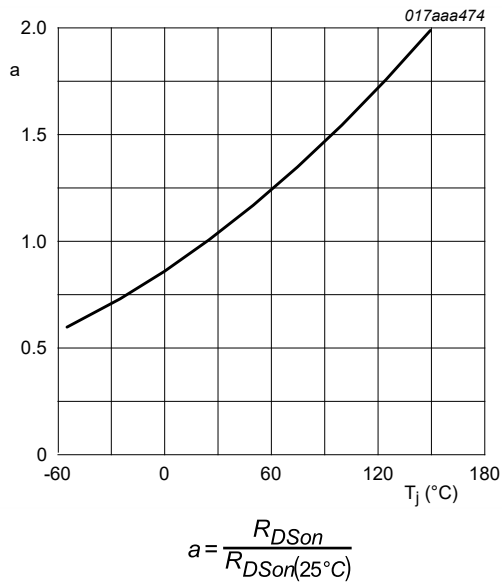


Fig. 11. Normalized drain-source on-state resistance as a function of junction temperature; typical values

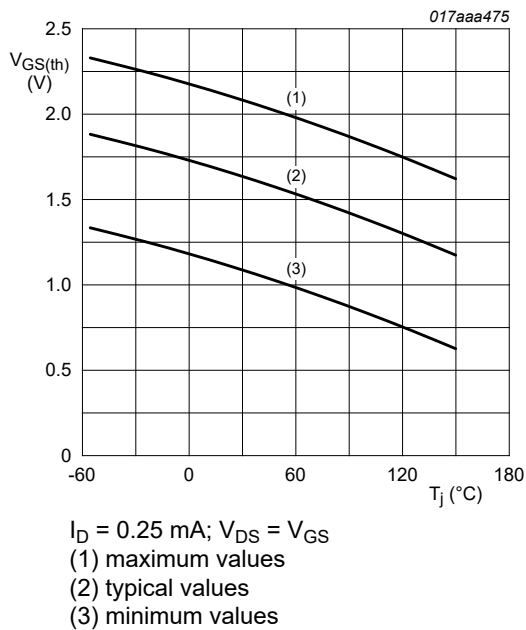


Fig. 12. Gate-source threshold voltage as a function of junction temperature

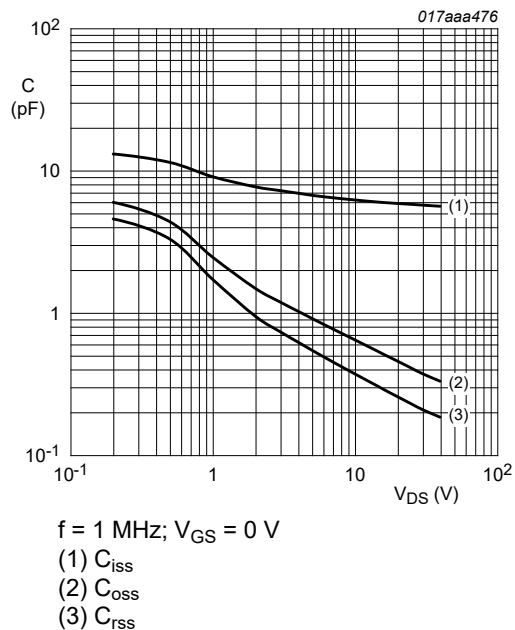


Fig. 13. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

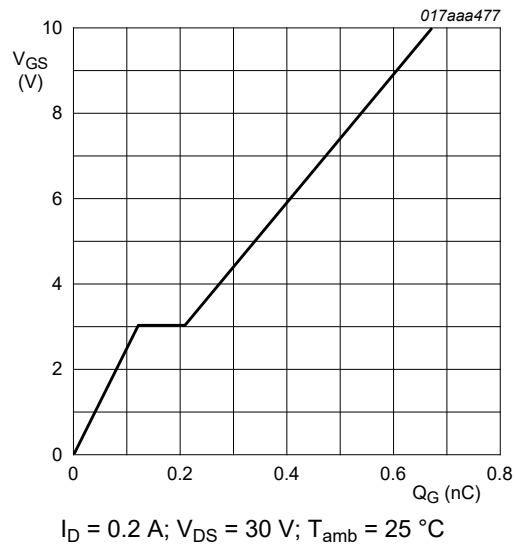


Fig. 14. Gate-source voltage as a function of gate charge; typical values

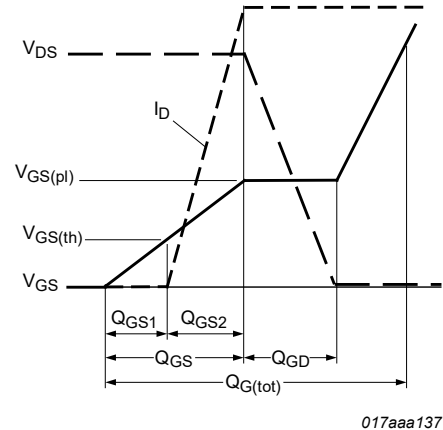
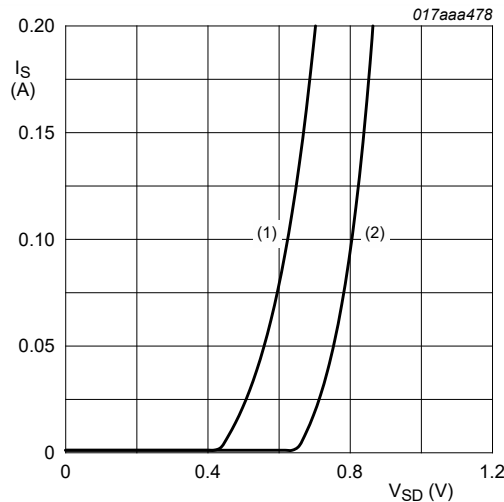


Fig. 15. MOSFET transistor: Gate charge waveform definitions



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

11. Test information

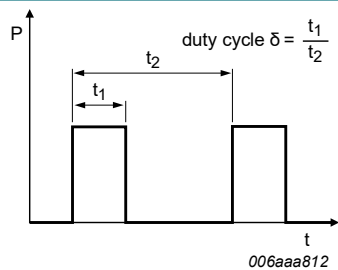
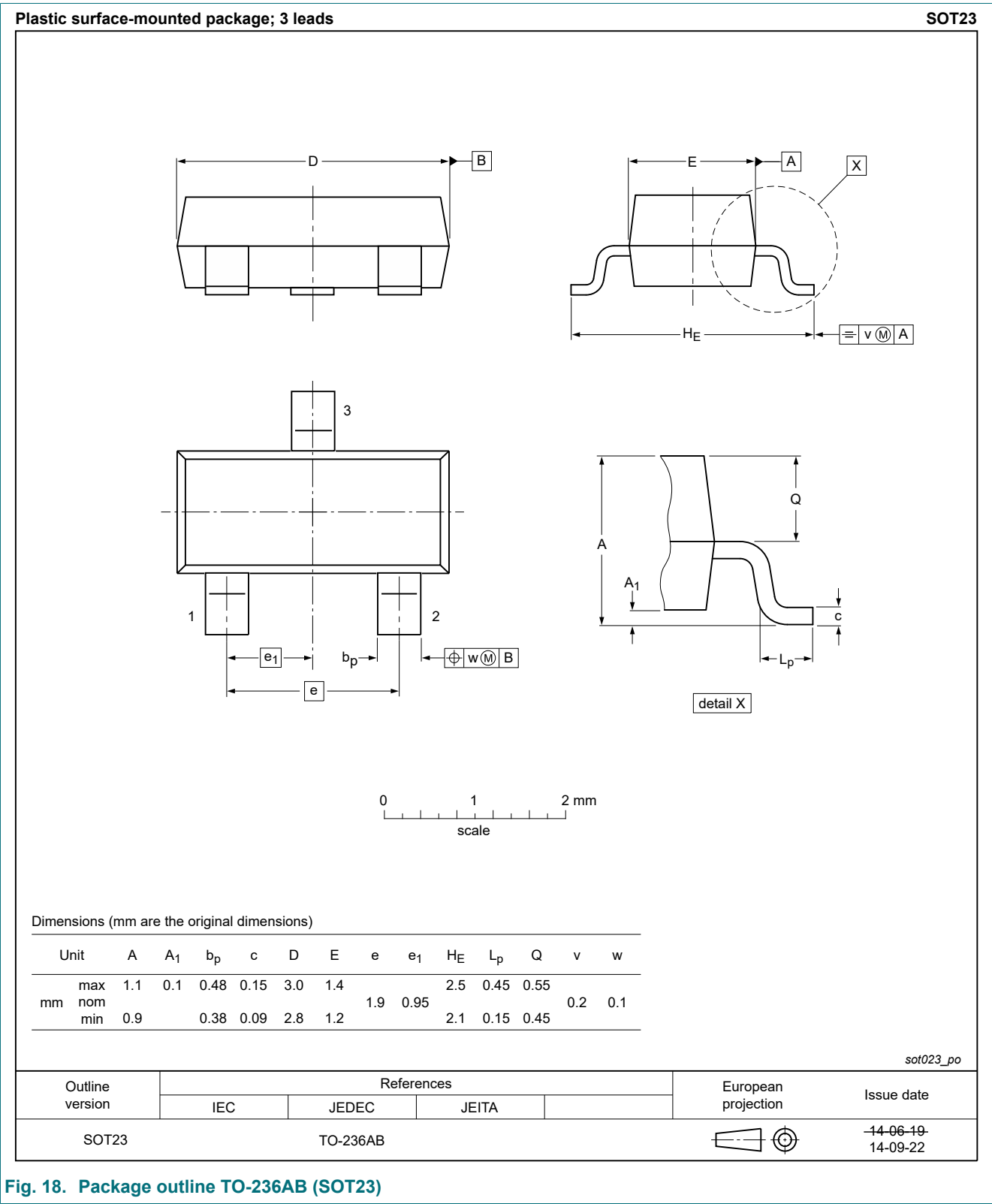


Fig. 17. Duty cycle definition

12. Package outline



13. Soldering

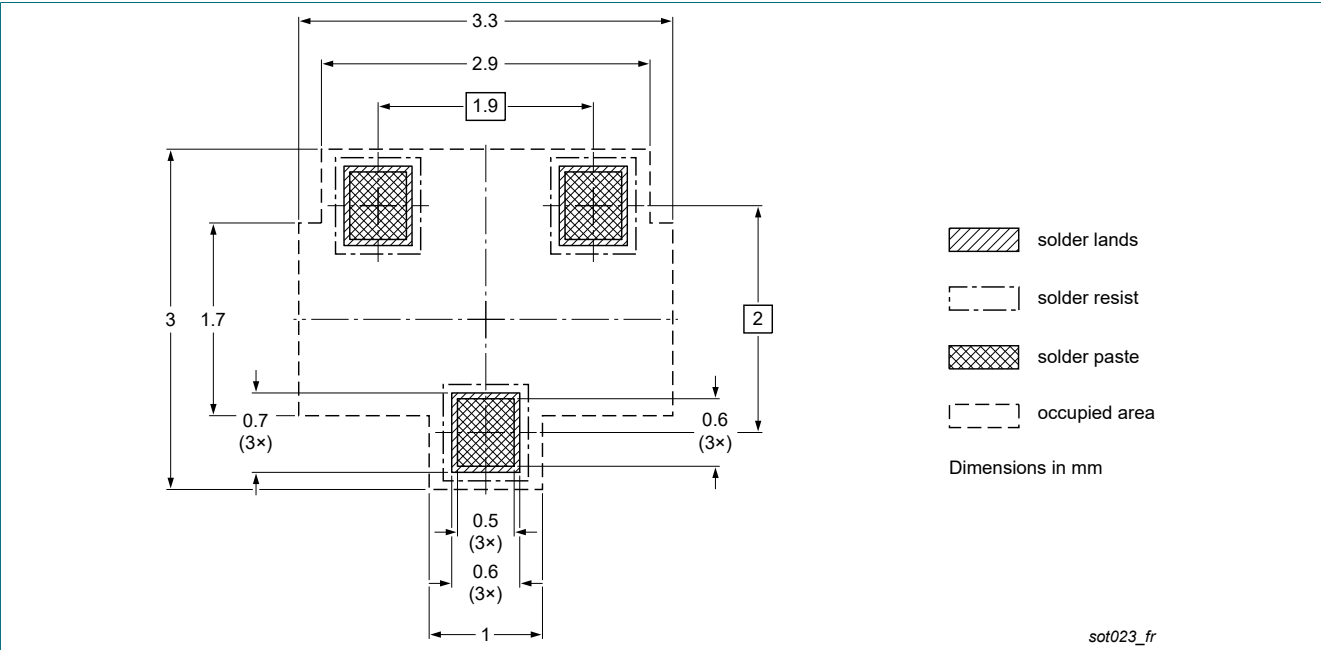


Fig. 19. Reflow soldering footprint for TO-236AB (SOT23)

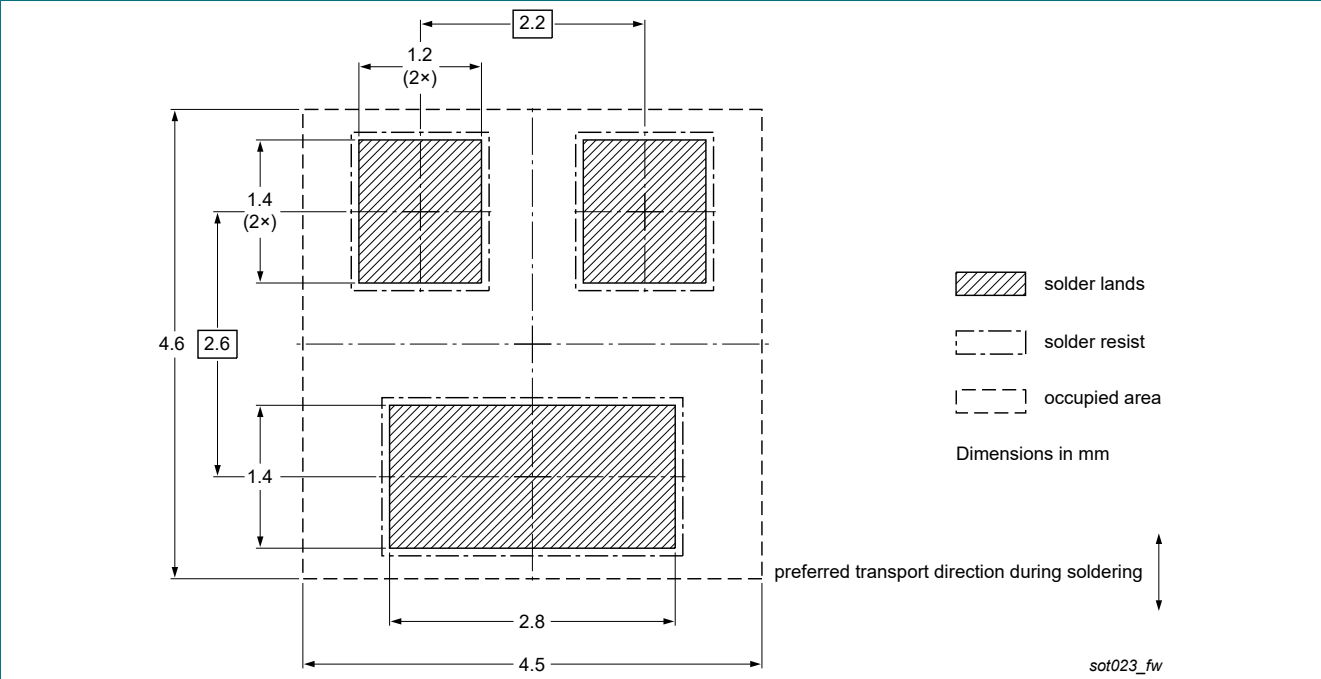


Fig. 20. Wave soldering footprint for TO-236AB (SOT23)

14. Revision history

Table 8. Revision history

| Data sheet ID | Release date | Data sheet status | Change notice | Supersedes |
|----------------|--------------|--------------------|---------------|------------|
| 2N7002NXAK 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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- [2] The term 'short data sheet' is explained in section "Definitions".
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Date of release: 1 July 2019

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