

# NXS7002AK

60 V, single N-channel Trench MOSFET

25 September 2012

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

- Very fast switching
- Trench MOSFET technology
- ESD protected up to 400 V

### 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             | $T_{amb} = 25\text{ }^{\circ}\text{C}$                                        |     | -   | -   | 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] | -   | -   | 190 | mA       |
| <b>Static characteristics</b> |                                  |                                                                               |     |     |     |     |          |
| $R_{DS(on)}$                  | drain-source on-state resistance | $V_{GS} = 10\text{ V}; I_D = 100\text{ mA}; T_j = 25\text{ }^{\circ}\text{C}$ |     | -   | 3   | 5   | $\Omega$ |

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

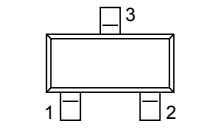
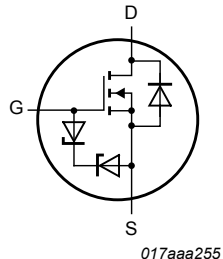


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## 2. Pinning information

Table 2. Pinning information

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

## 3. Ordering information

Table 3. Ordering information

| Type number | Package  |                                          |         |
|-------------|----------|------------------------------------------|---------|
|             | Name     | Description                              | Version |
| NXS7002AK   | TO-236AB | plastic surface-mounted package; 3 leads | SOT23   |

## 4. Marking

Table 4. Marking codes

| Type number | Marking code |
|-------------|--------------|
| NXS7002AK   | %JH          |

[1] % = placeholder for manufacturing site code

## 5. Limiting values

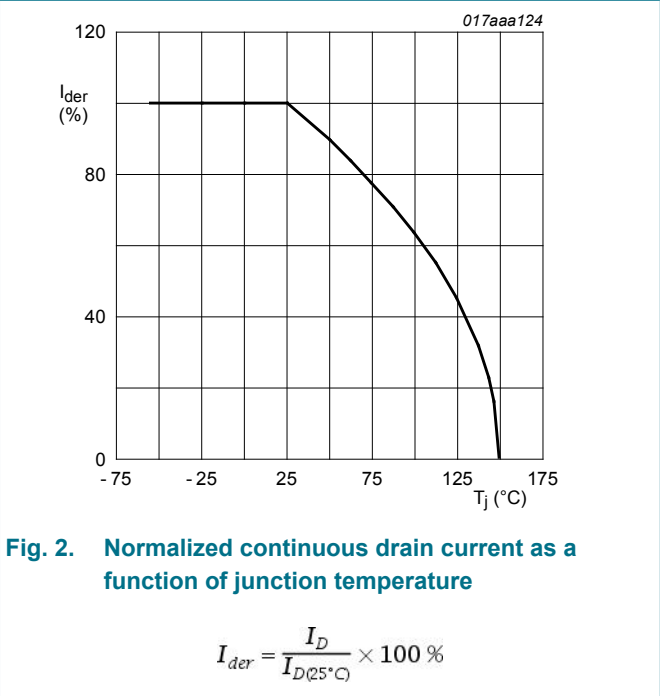
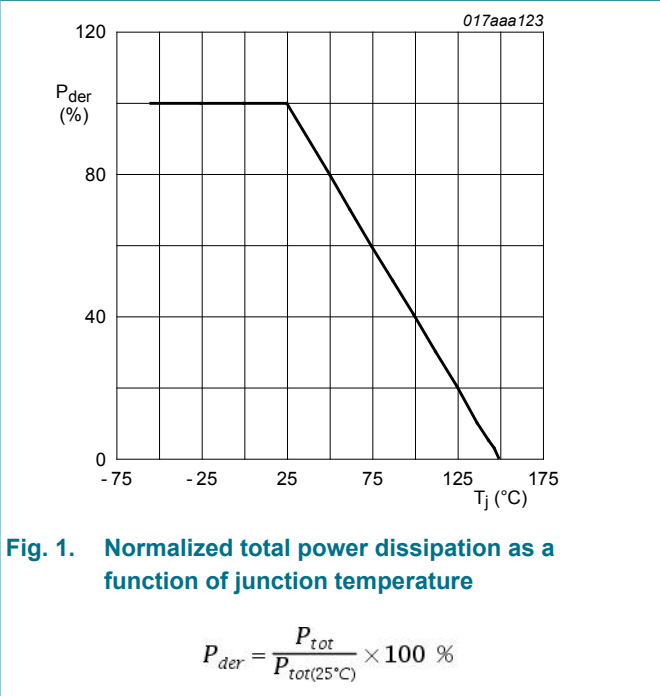
Table 5. Limiting values

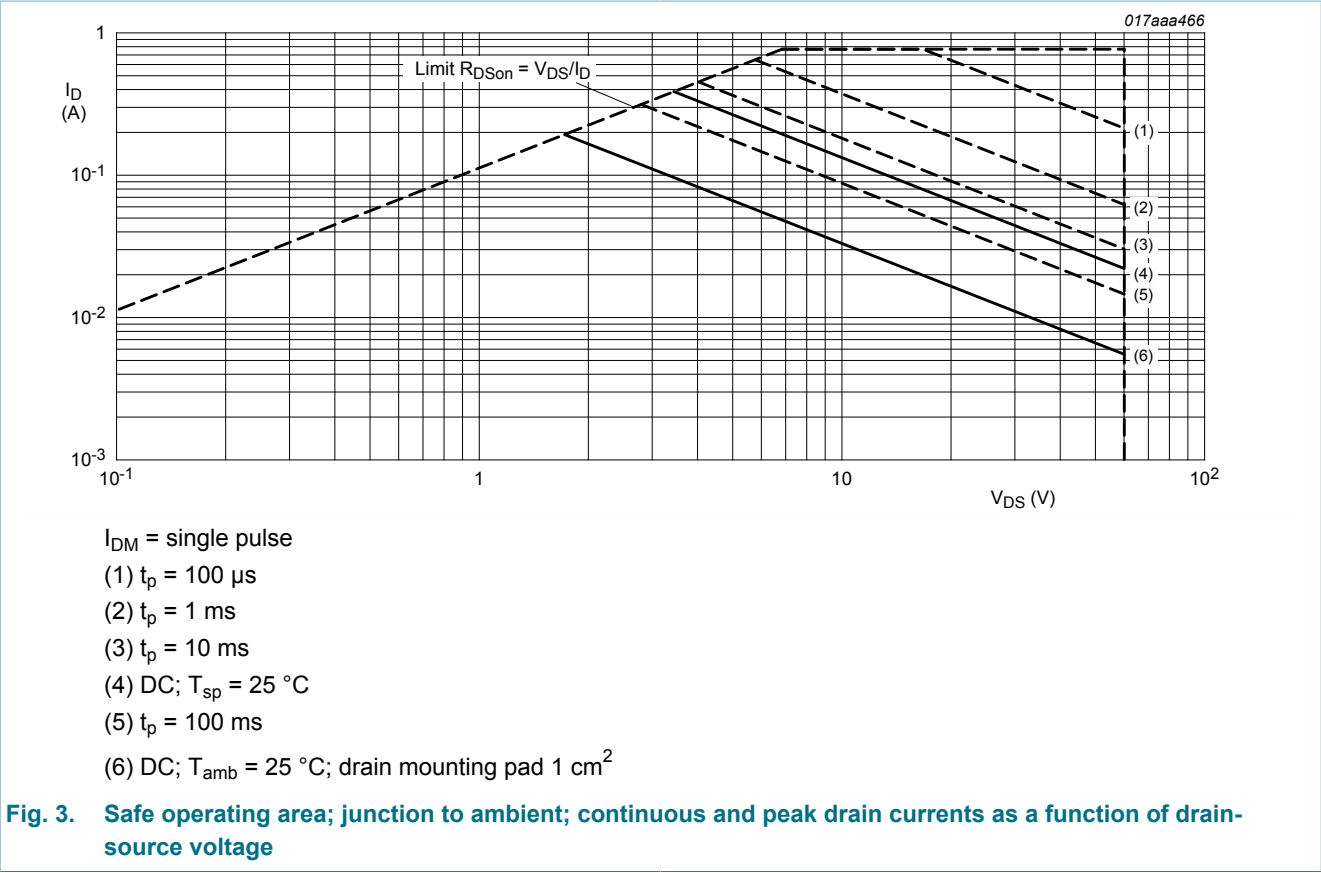
In accordance with the Absolute Maximum Rating System (IEC 60134).

| Symbol    | Parameter               | Conditions                                                                              |     | Min | Max | Unit |
|-----------|-------------------------|-----------------------------------------------------------------------------------------|-----|-----|-----|------|
| $V_{DS}$  | drain-source voltage    | $T_{amb} = 25\text{ }^{\circ}\text{C}$                                                  |     | -   | 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] | -   | 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; $t_p \leq 10\text{ }\mu\text{s}$ |     | -   | 800 | mA   |
| $P_{tot}$ | total power dissipation | $T_{amb} = 25\text{ }^{\circ}\text{C}$                                                  | [2] | -   | 265 | mW   |
|           |                         |                                                                                         | [1] | -   | 325 | mW   |

| Symbol             | Parameter            | Conditions               |     | Min | Max  | Unit |
|--------------------|----------------------|--------------------------|-----|-----|------|------|
|                    |                      | T <sub>sp</sub> = 25 °C  |     | -   | 1330 | mW   |
| T <sub>j</sub>     | junction temperature |                          |     | -55 | 150  | °C   |
| T <sub>amb</sub>   | ambient temperature  |                          |     | -55 | 150  | °C   |
| T <sub>stg</sub>   | storage temperature  |                          |     | -65 | 150  | °C   |
| Source-drain diode |                      |                          |     |     |      |      |
| I <sub>S</sub>     | source current       | T <sub>amb</sub> = 25 °C | [1] | -   | 190  | mA   |

- [1] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 1 cm<sup>2</sup>.
- [2] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and standard footprint.





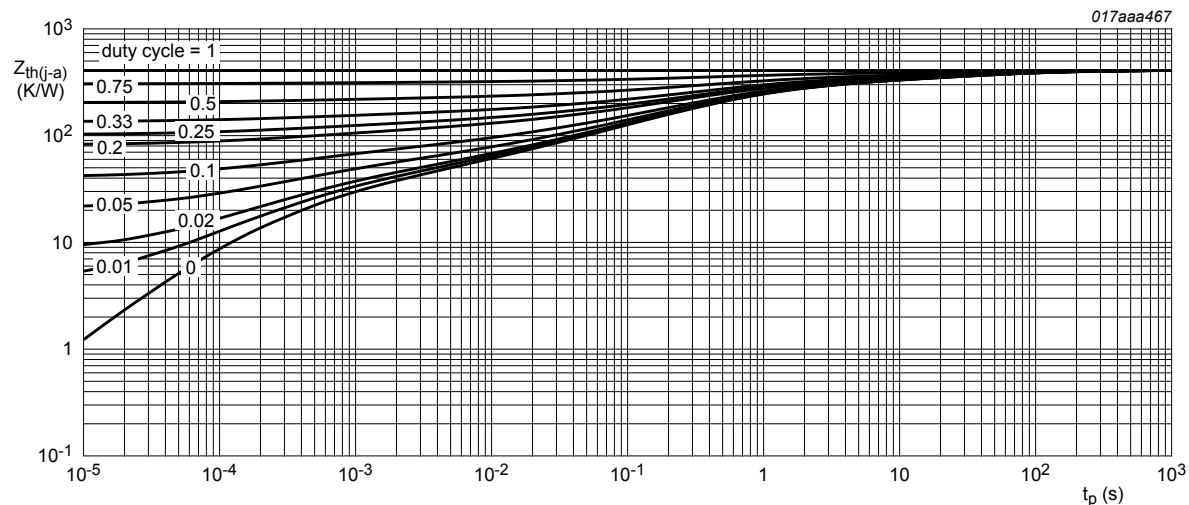
## 6. Thermal characteristics

Table 6. Thermal characteristics

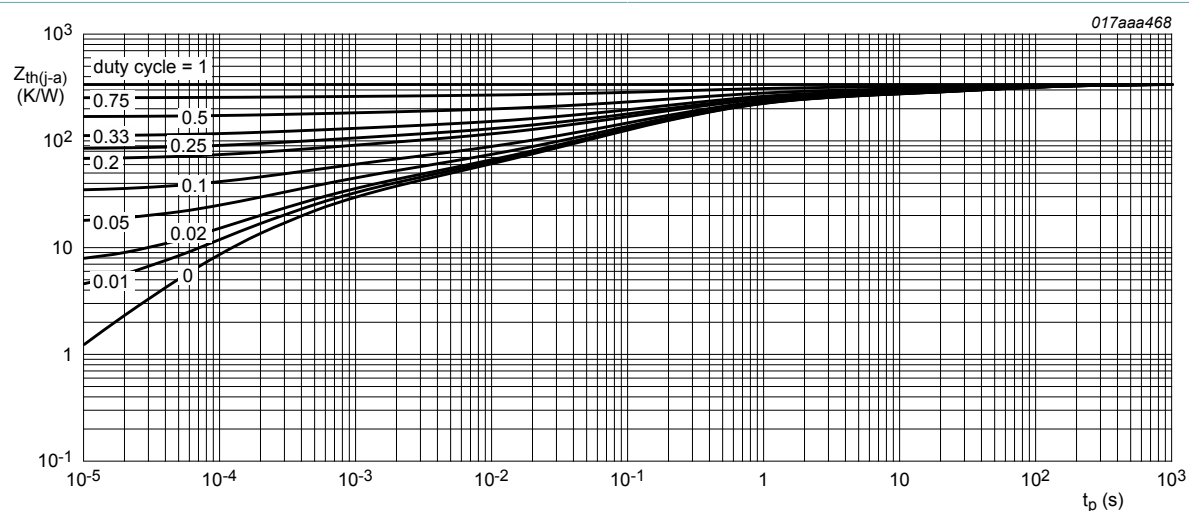
| Symbol         | Parameter                                        | Conditions  |     | Min | Typ | Max | Unit |
|----------------|--------------------------------------------------|-------------|-----|-----|-----|-----|------|
| $R_{th(j-a)}$  | thermal resistance from junction to ambient      | in free air | [1] | -   | 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  $1 cm^2$ .



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 cm<sup>2</sup>
**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    |
|-------------------------------|--------------------------------|-------------------------------------------------------------|-----|-----|-----|---------|
| <b>Static characteristics</b> |                                |                                                             |     |     |     |         |
| $V_{(BR)DSS}$                 | drain-source breakdown voltage | $I_D = 250 \mu A$ ; $V_{GS} = 0 V$ ; $T_j = 25 ^\circ C$    | 60  | -   | -   | V       |
| $V_{GSth}$                    | gate-source threshold voltage  | $I_D = 250 \mu A$ ; $V_{DS} = V_{GS}$ ; $T_j = 25 ^\circ C$ | 1.1 | 1.6 | 2.5 | V       |
| $I_{DSS}$                     | drain leakage current          | $V_{DS} = 60 V$ ; $V_{GS} = 0 V$ ; $T_j = 25 ^\circ C$      | -   | -   | 1   | $\mu A$ |
|                               |                                | $V_{DS} = 60 V$ ; $V_{GS} = 0 V$ ; $T_j = 150 ^\circ C$     | -   | -   | 10  | $\mu A$ |

| Symbol                  | Parameter                        | Conditions                                                                                                                |  | Min  | Typ  | Max  | Unit |
|-------------------------|----------------------------------|---------------------------------------------------------------------------------------------------------------------------|--|------|------|------|------|
| I <sub>GSS</sub>        | gate leakage current             | V <sub>GS</sub> = 20 V; V <sub>DS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                     |  | -    | -    | 2    | μA   |
|                         |                                  | V <sub>GS</sub> = -20 V; V <sub>DS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                    |  | -    | -    | 2    | μA   |
|                         |                                  | V <sub>GS</sub> = 10 V; V <sub>DS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                     |  | -    | -    | 0.5  | μA   |
|                         |                                  | V <sub>GS</sub> = -10 V; V <sub>DS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                    |  | -    | -    | 0.5  | μA   |
|                         |                                  | V <sub>GS</sub> = 5 V; V <sub>DS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                      |  | -    | -    | 100  | nA   |
|                         |                                  | V <sub>GS</sub> = -5 V; V <sub>DS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                     |  | -    | -    | 100  | nA   |
| R <sub>DSon</sub>       | drain-source on-state resistance | V <sub>GS</sub> = 10 V; I <sub>D</sub> = 100 mA; T <sub>j</sub> = 25 °C                                                   |  | -    | 3    | 5    | Ω    |
|                         |                                  | V <sub>GS</sub> = 10 V; I <sub>D</sub> = 100 mA; T <sub>j</sub> = 150 °C                                                  |  | -    | 6.2  | 9.2  | Ω    |
|                         |                                  | V <sub>GS</sub> = 5 V; I <sub>D</sub> = 100 mA; T <sub>j</sub> = 25 °C                                                    |  | -    | 3.7  | 5    | Ω    |
| g <sub>fs</sub>         | forward transconductance         | V <sub>DS</sub> = 10 V; I <sub>D</sub> = 200 mA; T <sub>j</sub> = 25 °C                                                   |  | 80   | 230  | -    | mS   |
| Dynamic characteristics |                                  |                                                                                                                           |  |      |      |      |      |
| Q <sub>G(tot)</sub>     | total gate charge                | V <sub>DS</sub> = 30 V; I <sub>D</sub> = 200 mA; V <sub>GS</sub> = 4.5 V; T <sub>j</sub> = 25 °C                          |  | -    | 0.33 | 0.43 | nC   |
| Q <sub>GS</sub>         | gate-source charge               |                                                                                                                           |  | -    | 0.12 | -    | nC   |
| Q <sub>GD</sub>         | gate-drain charge                |                                                                                                                           |  | -    | 0.09 | -    | nC   |
| C <sub>iss</sub>        | input capacitance                | V <sub>DS</sub> = 10 V; f = 1 MHz; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C                                          |  | -    | -    | 22   | pF   |
| C <sub>oss</sub>        | output capacitance               |                                                                                                                           |  | -    | -    | 11   | pF   |
| C <sub>rss</sub>        | reverse transfer capacitance     |                                                                                                                           |  | -    | -    | 2    | pF   |
| t <sub>d(on)</sub>      | turn-on delay time               | V <sub>DS</sub> = 40 V; R <sub>L</sub> = 250 Ω; V <sub>GS</sub> = 10 V; R <sub>G(ext)</sub> = 6 Ω; T <sub>j</sub> = 25 °C |  | -    | 6    | 12   | ns   |
| t <sub>r</sub>          | rise time                        |                                                                                                                           |  | -    | 7    | -    | ns   |
| t <sub>d(off)</sub>     | turn-off delay time              |                                                                                                                           |  | -    | 20   | 40   | ns   |
| t <sub>f</sub>          | fall time                        |                                                                                                                           |  | -    | 14   | -    | ns   |
| Source-drain diode      |                                  |                                                                                                                           |  |      |      |      |      |
| V <sub>SD</sub>         | source-drain voltage             | I <sub>S</sub> = 115 mA; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                    |  | 0.47 | 0.7  | 1.2  | V    |

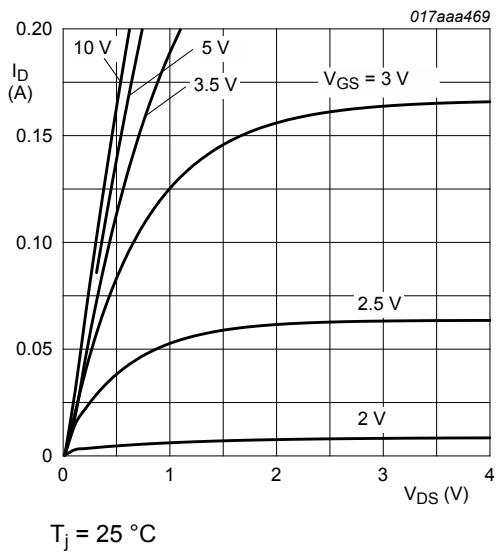


Fig. 6. Output characteristics: drain current as a function of drain-source voltage; typical values

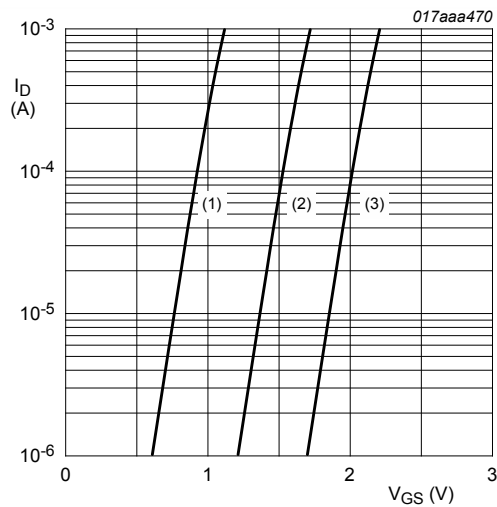


Fig. 7. Sub-threshold drain current as a function of gate-source voltage

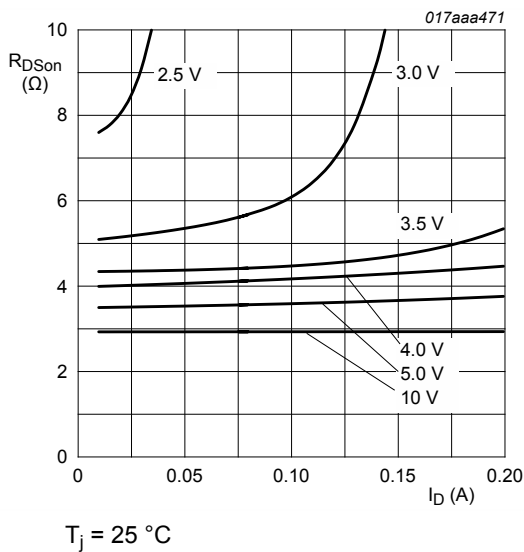


Fig. 8. Drain-source on-state resistance as a function of drain current; typical values

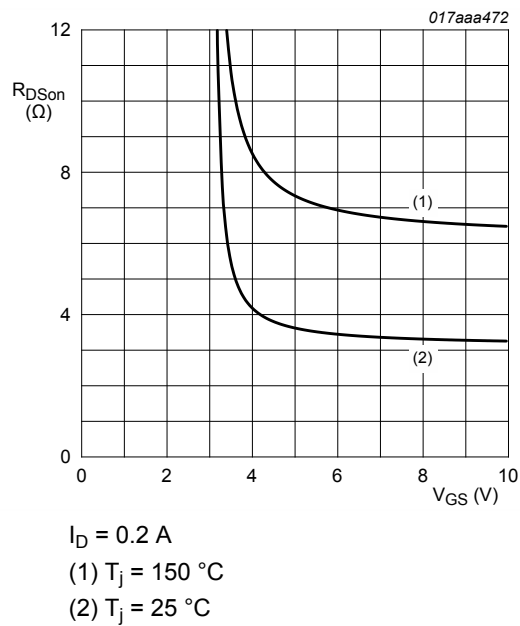
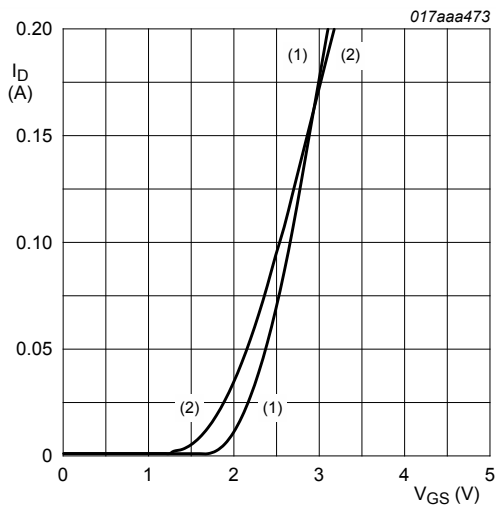


Fig. 9. Drain-source on-state resistance as a function of gate-source voltage; typical values



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

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

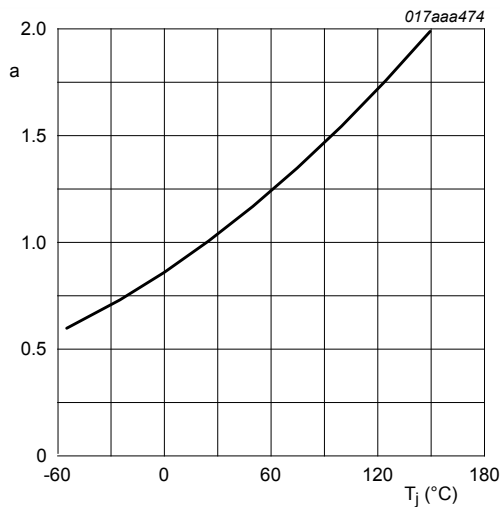
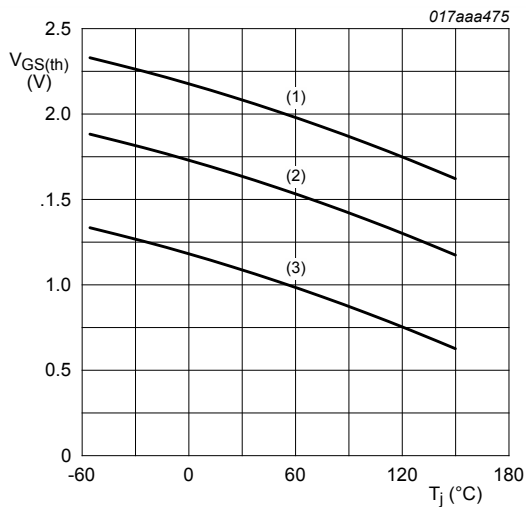


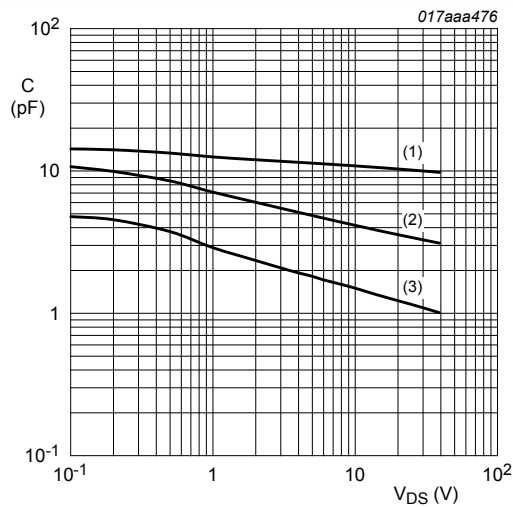
Fig. 11. Normalized drain-source on-state resistance as a function of junction temperature; typical values

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



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

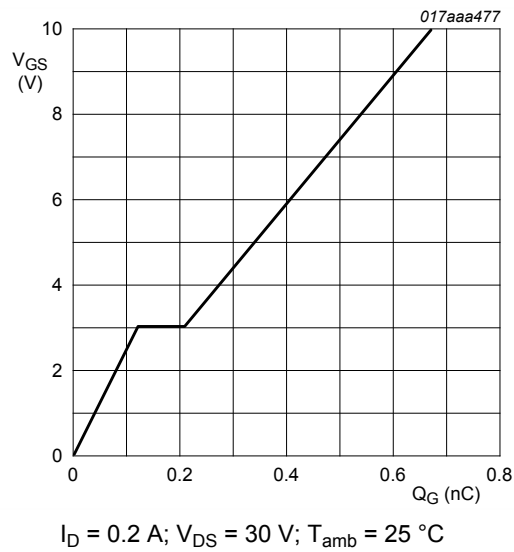


Fig. 14. Gate-source voltage as a function of gate charge; typical values

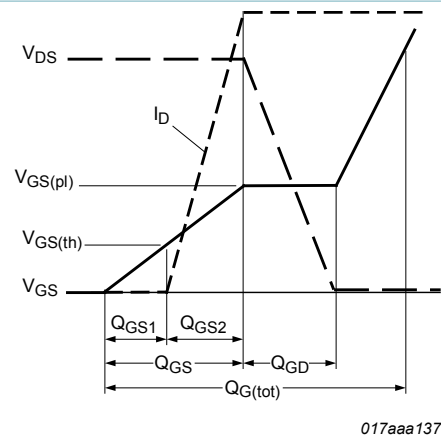
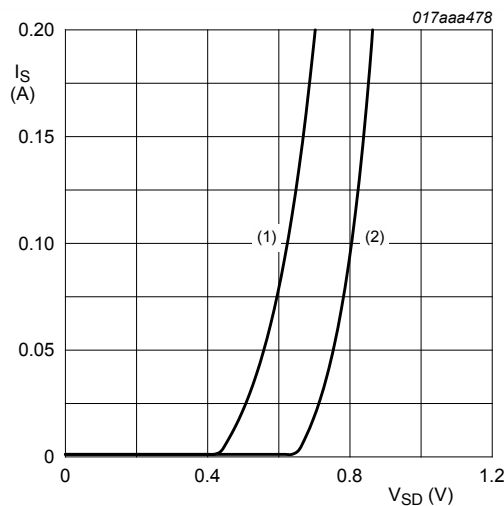


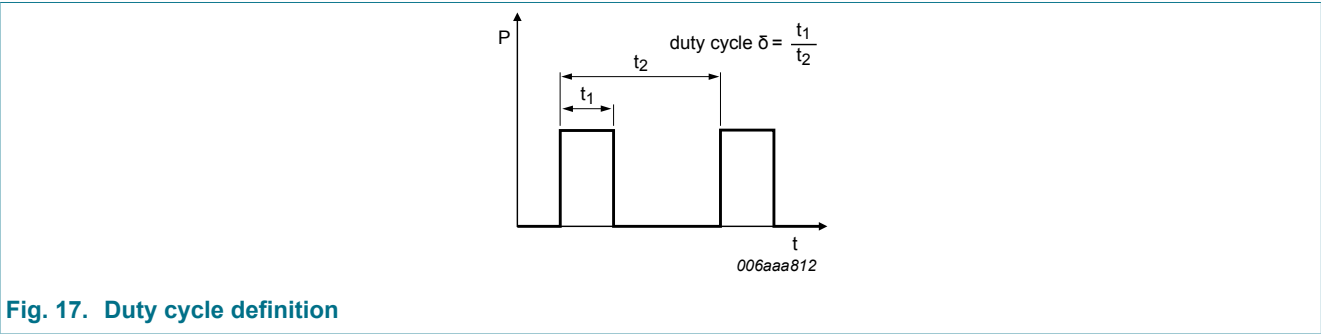
Fig. 15. Gate charge waveform definitions



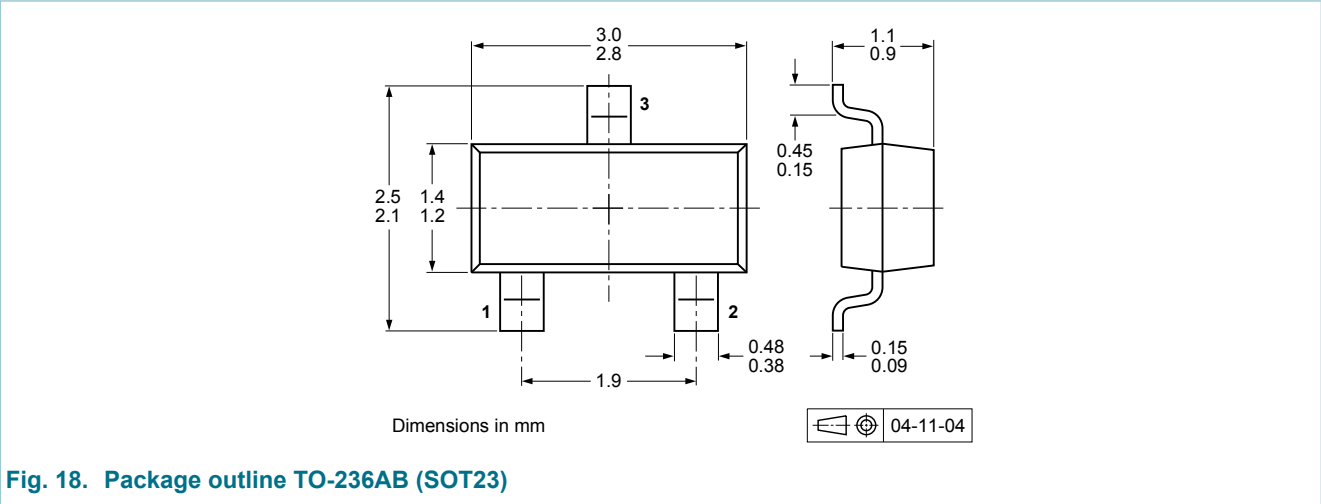
$V_{GS} = 0\text{ V}$   
(1)  $T_j = 150\text{ }^{\circ}\text{C}$   
(2)  $T_j = 25\text{ }^{\circ}\text{C}$

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

8. Test information



9. Package outline



10. Soldering

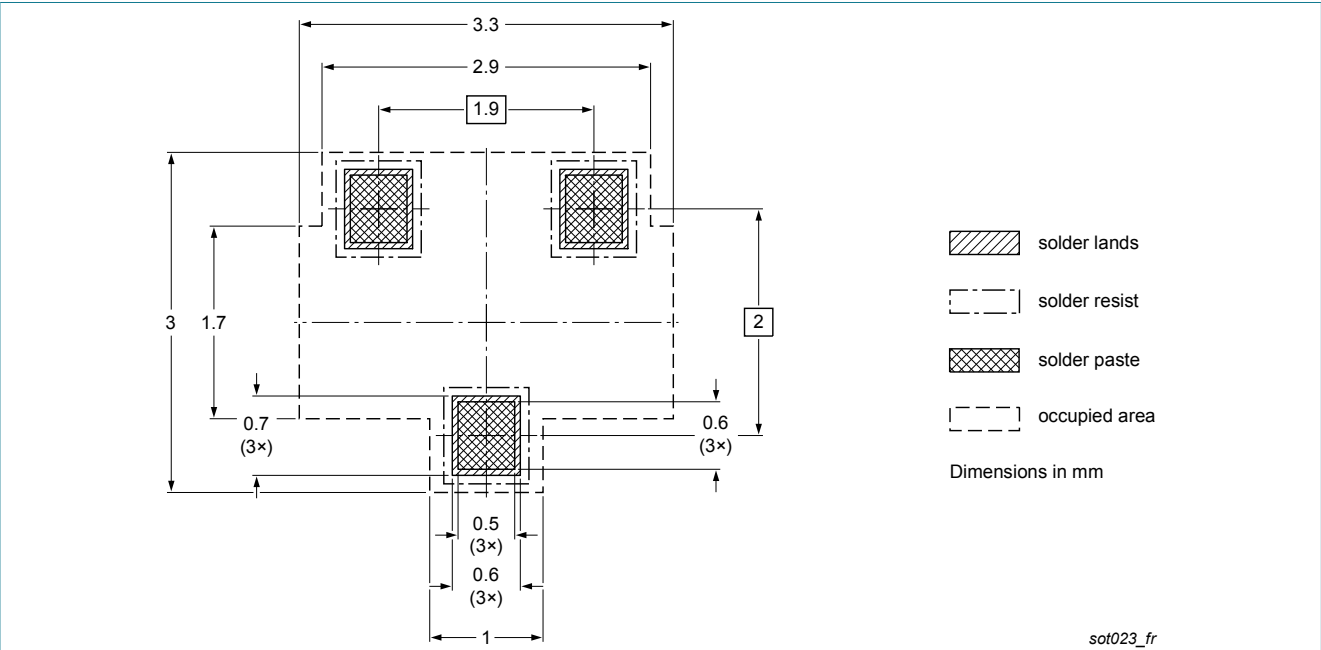


Fig. 19. Reflow soldering footprint for TO-236AB (SOT23)

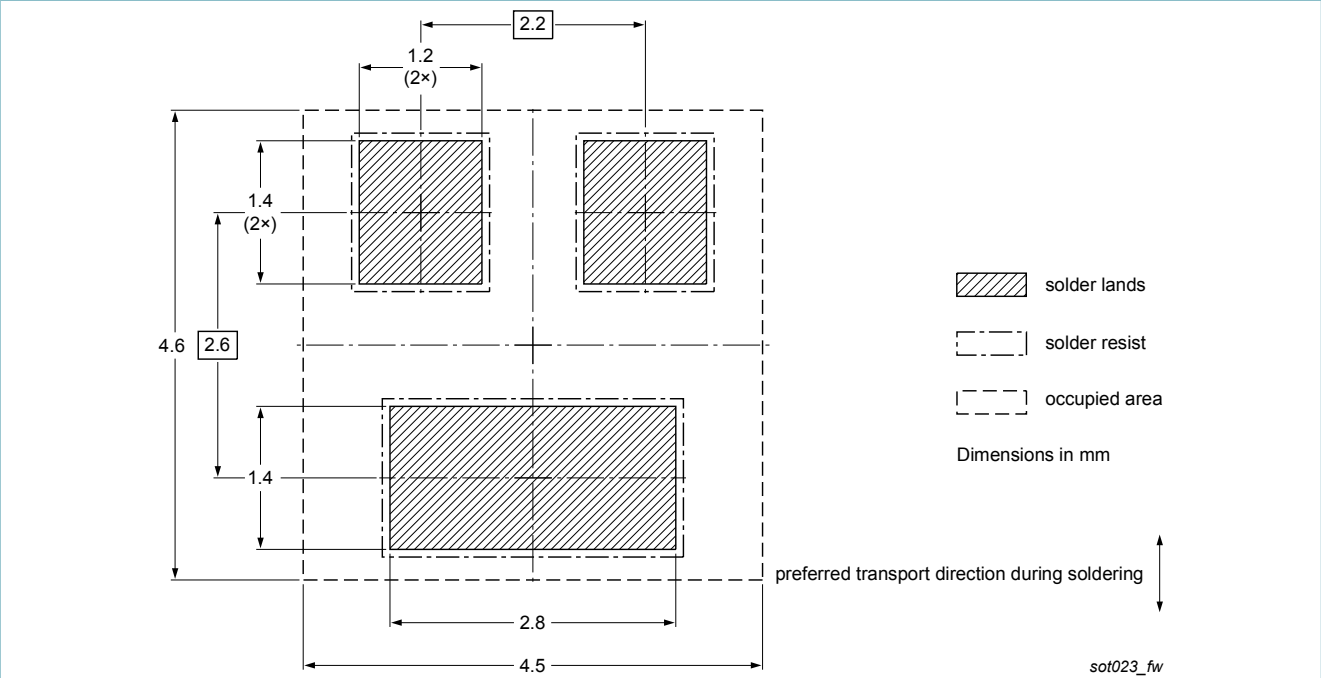


Fig. 20. Wave soldering footprint for TO-236AB (SOT23)

## 11. Revision history

Table 8. Revision history

| Data sheet ID | Release date | Data sheet status  | Change notice | Supersedes |
|---------------|--------------|--------------------|---------------|------------|
| NXS7002AK v.1 | 20120925     | 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.                                     |

- [1] Please consult the most recently issued document before initiating or completing a design.
- [2] The term 'short data sheet' is explained in section "Definitions".
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## 13. Contents

|           |                                      |           |
|-----------|--------------------------------------|-----------|
| <b>1</b>  | <b>Product profile .....</b>         | <b>1</b>  |
| 1.1       | General description .....            | 1         |
| 1.2       | Features and benefits .....          | 1         |
| 1.3       | Applications .....                   | 1         |
| 1.4       | Quick reference data .....           | 1         |
| <b>2</b>  | <b>Pinning information .....</b>     | <b>2</b>  |
| <b>3</b>  | <b>Ordering information .....</b>    | <b>2</b>  |
| <b>4</b>  | <b>Marking .....</b>                 | <b>2</b>  |
| <b>5</b>  | <b>Limiting values .....</b>         | <b>2</b>  |
| <b>6</b>  | <b>Thermal characteristics .....</b> | <b>4</b>  |
| <b>7</b>  | <b>Characteristics .....</b>         | <b>5</b>  |
| <b>8</b>  | <b>Test information .....</b>        | <b>10</b> |
| <b>9</b>  | <b>Package outline .....</b>         | <b>10</b> |
| <b>10</b> | <b>Soldering .....</b>               | <b>11</b> |
| <b>11</b> | <b>Revision history .....</b>        | <b>12</b> |
| <b>12</b> | <b>Legal information .....</b>       | <b>13</b> |
| 12.1      | Data sheet status .....              | 13        |
| 12.2      | Definitions .....                    | 13        |
| 12.3      | Disclaimers .....                    | 13        |
| 12.4      | Trademarks .....                     | 14        |

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