



# NX138BKS

60 V, dual N-channel Trench MOSFET

15 June 2016

Product data sheet

## 1. General description

Dual N-channel enhancement mode Field-Effect Transistor (FET) in a very small SOT363 (SC-88) Surface-Mounted Device (SMD) plastic package using Trench MOSFET technology.

## 2. Features and benefits

- Low threshold voltage
- Very fast switching
- Trench MOSFET technology
- ElectroStatic Discharge (ESD) protection > 2 kV HBM

## 3. Applications

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

## 4. Quick reference data

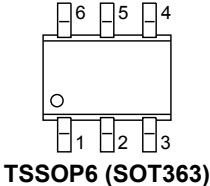
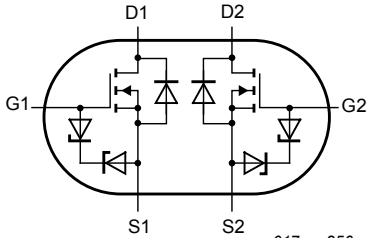
Table 1. Quick reference data

| Symbol                                         | Parameter                        | Conditions                                                      |     | Min | Typ | Max | Unit     |
|------------------------------------------------|----------------------------------|-----------------------------------------------------------------|-----|-----|-----|-----|----------|
| <b>Per transistor</b>                          |                                  |                                                                 |     |     |     |     |          |
| $V_{DS}$                                       | 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] | -   | -   | 210 | mA       |
| <b>Static characteristics (per transistor)</b> |                                  |                                                                 |     |     |     |     |          |
| $R_{DS(on)}$                                   | drain-source on-state resistance | $V_{GS} = 10\text{ V}; I_D = 200\text{ mA}; T_j = 25\text{ °C}$ |     | -   | 2.1 | 3.5 | $\Omega$ |

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

5. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description | Simplified outline                                                                                       | Graphic symbol                                                                                       |
|-----|--------|-------------|----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| 1   | S1     | source TR1  |  <p>TSSOP6 (SOT363)</p> |  <p>017aaa256</p> |
| 2   | G1     | gate TR1    |                                                                                                          |                                                                                                      |
| 3   | D2     | drain TR2   |                                                                                                          |                                                                                                      |
| 4   | S2     | source TR2  |                                                                                                          |                                                                                                      |
| 5   | G2     | gate TR2    |                                                                                                          |                                                                                                      |
| 6   | D1     | drain TR1   |                                                                                                          |                                                                                                      |

6. Ordering information

Table 3. Ordering information

| Type number | Package |                                          |         |
|-------------|---------|------------------------------------------|---------|
|             | Name    | Description                              | Version |
| NX138BKS    | TSSOP6  | plastic surface-mounted package; 6 leads | SOT363  |

## 7. Limiting values

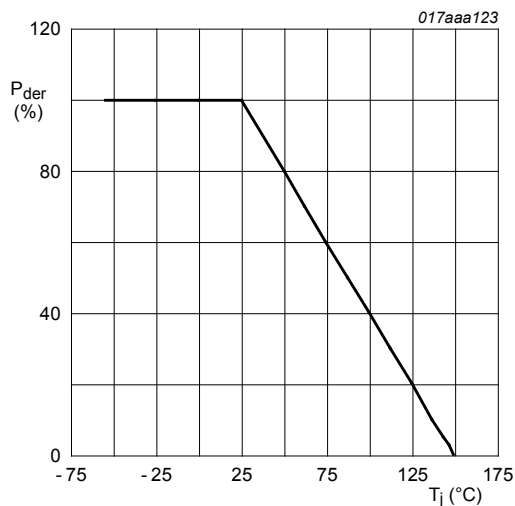
**Table 4. Limiting values**

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

| Symbol             | Parameter               | Conditions                                                     |     | Min | Max | Unit |
|--------------------|-------------------------|----------------------------------------------------------------|-----|-----|-----|------|
| Per transistor     |                         |                                                                |     |     |     |      |
| V <sub>DS</sub>    | drain-source voltage    | T <sub>J</sub> = 25 °C                                         |     | -   | 60  | V    |
| V <sub>GS</sub>    | gate-source voltage     |                                                                |     | -20 | 20  | V    |
| I <sub>D</sub>     | drain current           | V <sub>GS</sub> = 10 V; T <sub>amb</sub> = 25 °C               | [1] | -   | 210 | mA   |
|                    |                         | V <sub>GS</sub> = 10 V; T <sub>amb</sub> = 100 °C              | [1] | -   | 135 | mA   |
|                    |                         | V <sub>GS</sub> = 10 V; T <sub>sp</sub> = 25 °C                |     | -   | 330 | mA   |
| I <sub>DM</sub>    | peak drain current      | T <sub>amb</sub> = 25 °C; single pulse; t <sub>p</sub> ≤ 10 μs |     | -   | 855 | mA   |
| P <sub>tot</sub>   | total power dissipation | T <sub>amb</sub> = 25 °C                                       | [2] | -   | 285 | mW   |
|                    |                         |                                                                | [1] | -   | 320 | mW   |
|                    |                         | T <sub>sp</sub> = 25 °C                                        |     | -   | 860 | mW   |
| Per device         |                         |                                                                |     |     |     |      |
| 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] | -   | 170 | mA   |

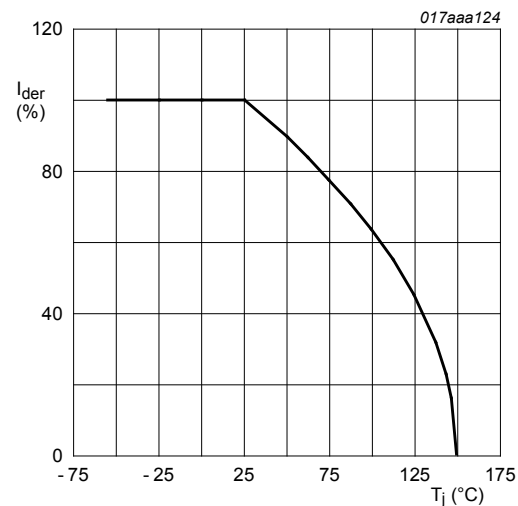
[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and mounting pad for drain 1 cm<sup>2</sup>.

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



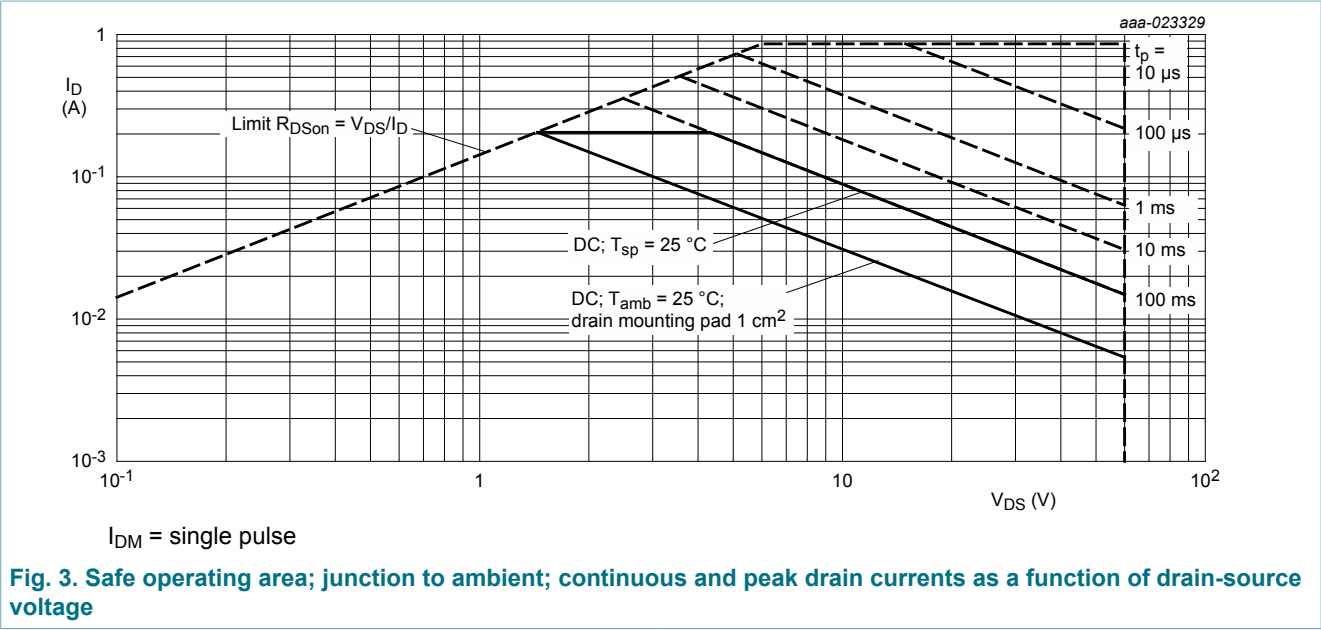
$$P_{der} = \frac{P_{tot}}{P_{tot(25^\circ\text{C})}} \times 100 \%$$

**Fig. 1. MOSFET transistor: 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. MOSFET transistor: Normalized continuous drain current as a function of junction temperature**



8. Thermal characteristics

Table 5. Thermal characteristics

| Symbol                | Parameter                                        | Conditions  |     | Min | Typ | Max | Unit |
|-----------------------|--------------------------------------------------|-------------|-----|-----|-----|-----|------|
| Per transistor        |                                                  |             |     |     |     |     |      |
| R <sub>th(j-a)</sub>  | thermal resistance from junction to ambient      | in free air | [1] | -   | 380 | 440 | K/W  |
|                       |                                                  |             | [2] | -   | 340 | 390 | K/W  |
| R <sub>th(j-sp)</sub> | thermal resistance from junction to solder point |             |     | -   | 125 | 145 | 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 cm<sup>2</sup>.

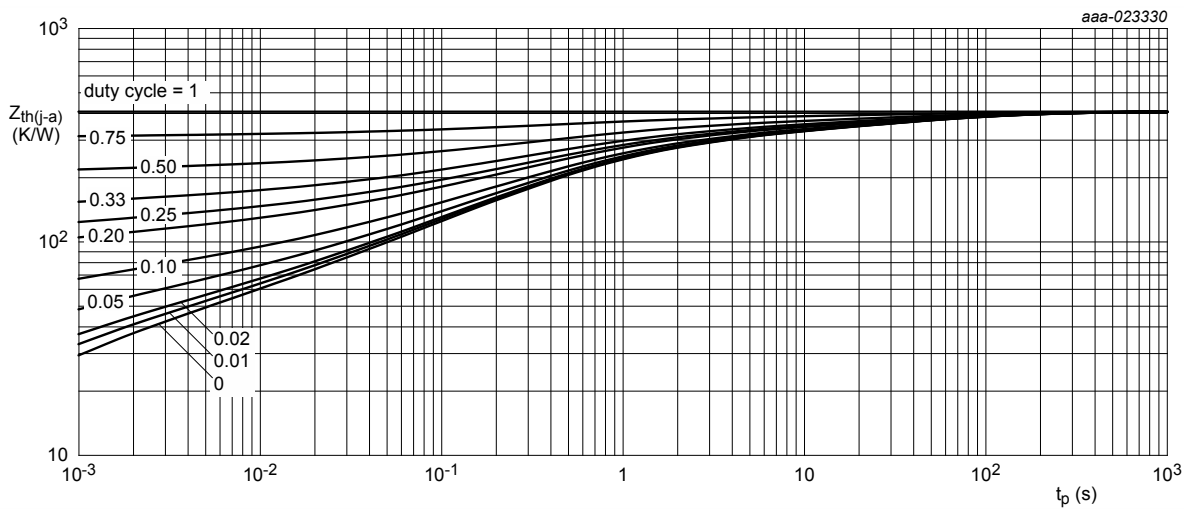


Fig. 4. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

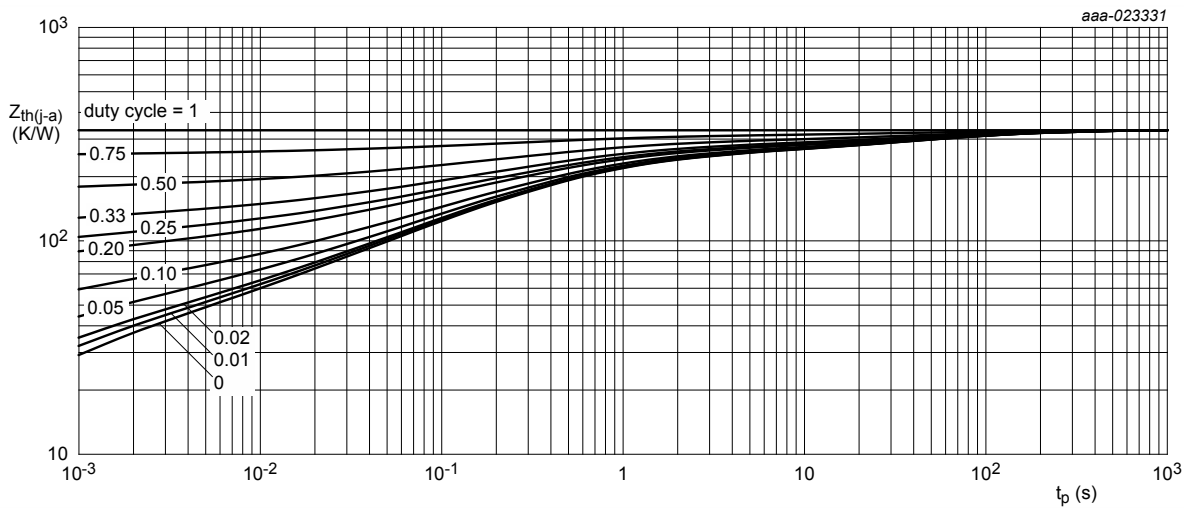


Fig. 5. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

## 9. Characteristics

Table 6. Characteristics

| Symbol                                   | Parameter                        | Conditions                                                                                                                 |  | Min | Typ  | Max  | Unit |
|------------------------------------------|----------------------------------|----------------------------------------------------------------------------------------------------------------------------|--|-----|------|------|------|
| Static characteristics (per transistor)  |                                  |                                                                                                                            |  |     |      |      |      |
| V <sub>(BR)DSS</sub>                     | drain-source breakdown voltage   | I <sub>D</sub> = 250 μA; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                     |  | 60  | -    | -    | V    |
| V <sub>GSth</sub>                        | gate-source threshold voltage    | I <sub>D</sub> = 250 μA; V <sub>DS</sub> =V <sub>GS</sub> ; T <sub>j</sub> = 25 °C                                         |  | 0.5 | 1    | 1.5  | V    |
| I <sub>DSS</sub>                         | drain leakage current            | V <sub>DS</sub> = 60 V; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                      |  | -   | -    | 1    | μA   |
| 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                                                      |  | -   | -    | 10   | μA   |
|                                          |                                  | V <sub>GS</sub> = -20 V; V <sub>DS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                     |  | -   | -    | -10  | μA   |
|                                          |                                  | V <sub>GS</sub> = 10 V; V <sub>DS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                      |  | -   | -    | 1    | μA   |
|                                          |                                  | V <sub>GS</sub> = -10 V; V <sub>DS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                     |  | -   | -    | -1   | μA   |
|                                          |                                  | V <sub>GS</sub> = 5 V; V <sub>DS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                       |  | -   | -    | 0.3  | μA   |
|                                          |                                  | V <sub>GS</sub> = -5 V; V <sub>DS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                      |  | -   | -    | -0.3 | μA   |
| R <sub>DSon</sub>                        | drain-source on-state resistance | V <sub>GS</sub> = 10 V; I <sub>D</sub> = 200 mA; T <sub>j</sub> = 25 °C                                                    |  | -   | 2.1  | 3.5  | Ω    |
|                                          |                                  | V <sub>GS</sub> = 10 V; I <sub>D</sub> = 200 mA; T <sub>j</sub> = 150 °C                                                   |  | -   | 4.3  | 7.2  | Ω    |
|                                          |                                  | V <sub>GS</sub> = 5 V; I <sub>D</sub> = 170 mA; T <sub>j</sub> = 25 °C                                                     |  | -   | 2.2  | 3.8  | Ω    |
|                                          |                                  | V <sub>GS</sub> = 2.5 V; I <sub>D</sub> = 75 mA; T <sub>j</sub> = 25 °C                                                    |  | -   | 2.6  | 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                                                    |  | -   | 0.7  | -    | S    |
| Dynamic characteristics (per transistor) |                                  |                                                                                                                            |  |     |      |      |      |
| Q <sub>G(tot)</sub>                      | total gate charge                | V <sub>DS</sub> = 30 V; I <sub>D</sub> = 200 mA; V <sub>GS</sub> = 10 V; T <sub>j</sub> = 25 °C                            |  | -   | 0.5  | 0.7  | nC   |
| Q <sub>GS</sub>                          | gate-source charge               |                                                                                                                            |  | -   | 0.12 | -    | nC   |
| Q <sub>GD</sub>                          | gate-drain charge                |                                                                                                                            |  | -   | 0.12 | -    | nC   |
| C <sub>iss</sub>                         | input capacitance                | V <sub>DS</sub> = 30 V; f = 1 MHz; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C                                           |  | -   | 20   | -    | pF   |
| C <sub>oss</sub>                         | output capacitance               |                                                                                                                            |  | -   | 3.1  | -    | pF   |
| C <sub>rss</sub>                         | reverse transfer capacitance     |                                                                                                                            |  | -   | 2    | -    | pF   |
| t <sub>d(on)</sub>                       | turn-on delay time               | V <sub>DS</sub> = 30 V; I <sub>D</sub> = 200 mA; V <sub>GS</sub> = 10 V; R <sub>G(ext)</sub> = 6 Ω; T <sub>j</sub> = 25 °C |  | -   | 8    | -    | ns   |
| t <sub>r</sub>                           | rise time                        |                                                                                                                            |  | -   | 8    | -    | ns   |
| t <sub>d(off)</sub>                      | turn-off delay time              |                                                                                                                            |  | -   | 13   | -    | ns   |
| t <sub>f</sub>                           | fall time                        |                                                                                                                            |  | -   | 5    | -    | ns   |
| Source-drain diode (per transistor)      |                                  |                                                                                                                            |  |     |      |      |      |
| V <sub>SD</sub>                          | source-drain voltage             | I <sub>S</sub> = 200 mA; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                     |  | -   | 0.9  | 1.2  | V    |

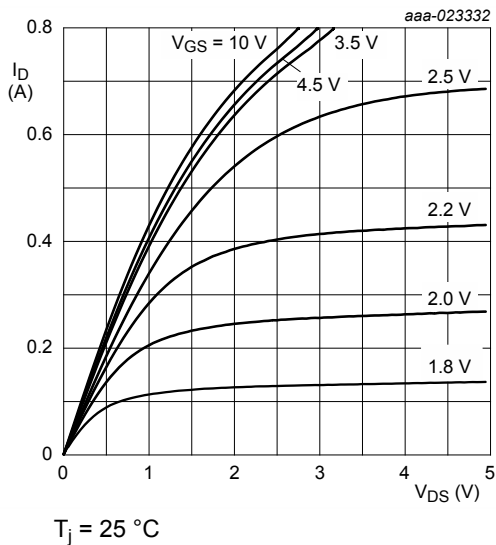


Fig. 6. Output characteristics: drain current as a function of drain-source voltage; typical values

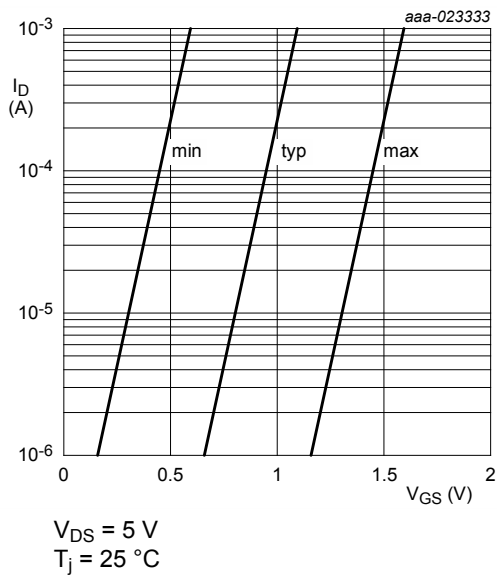


Fig. 7. Sub-threshold drain current as a function of gate-source voltage

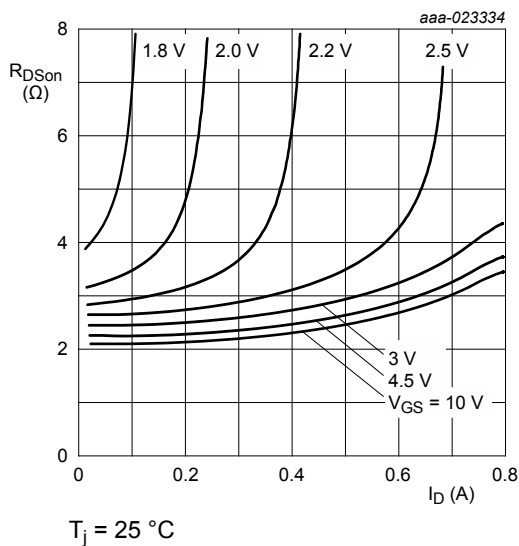


Fig. 8. Drain-source on-state resistance as a function of drain current; typical values

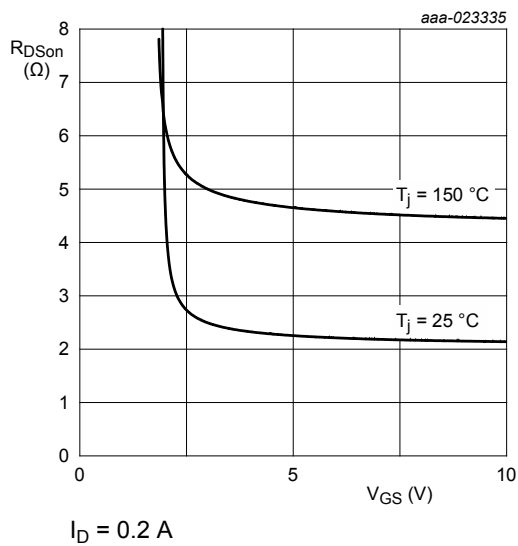


Fig. 9. Drain-source on-state resistance as a function of gate-source voltage; typical values

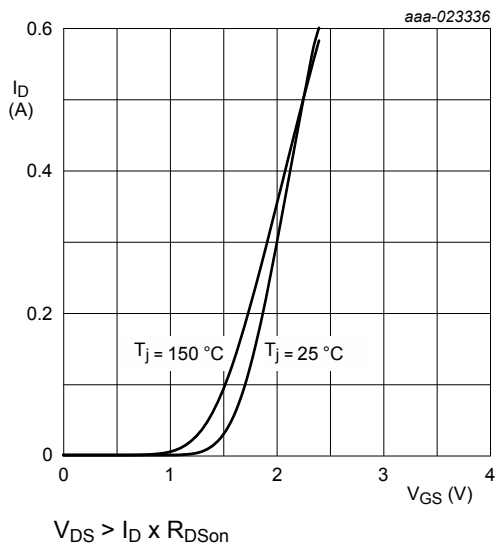


Fig. 10. Transfer characteristics: drain current as a function of gate-source voltage; typical values

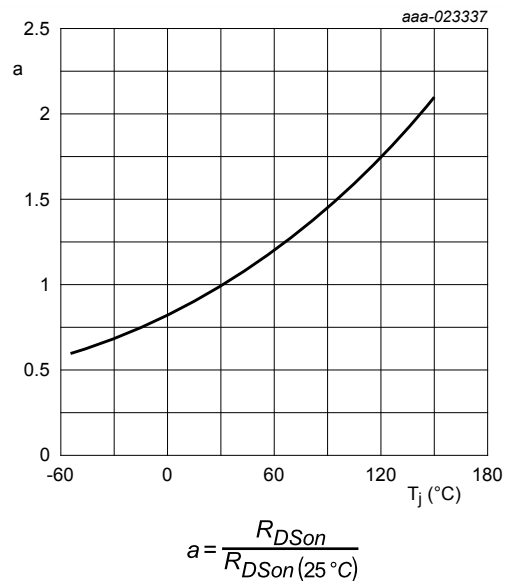


Fig. 11. Normalized drain-source on-state resistance as a function of junction temperature; typical values

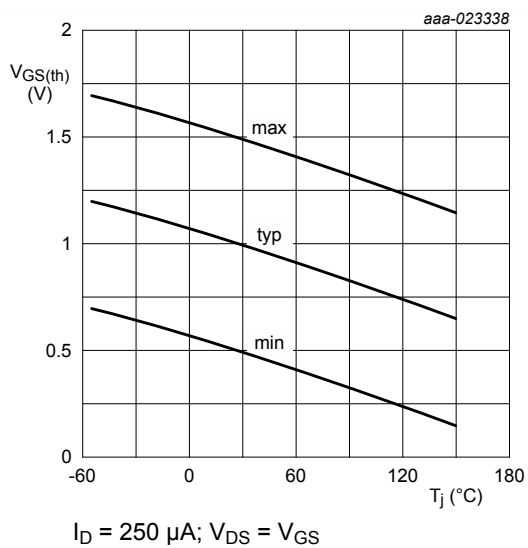


Fig. 12. Gate-source threshold voltage as a function of junction temperature

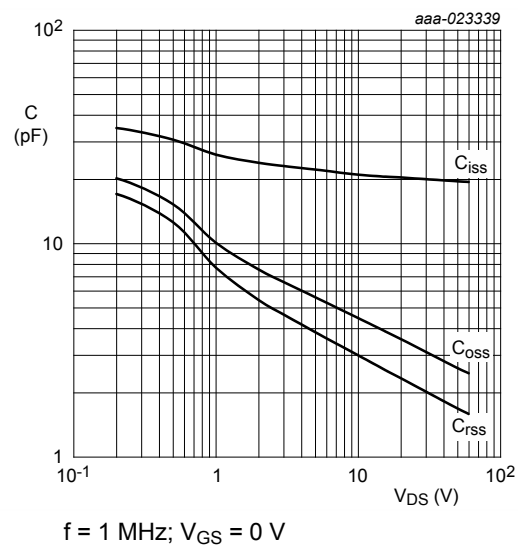


Fig. 13. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

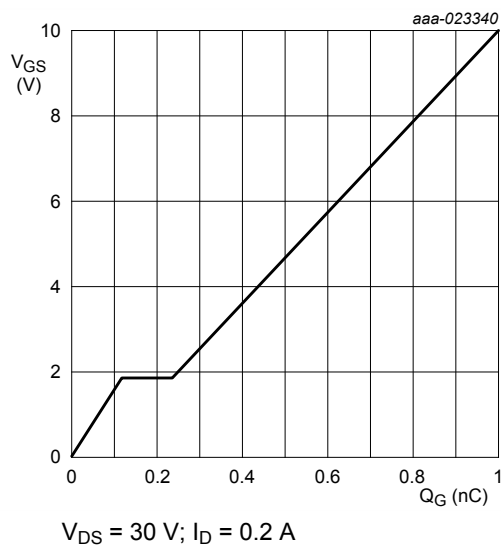


Fig. 14. Gate-source voltage as a function of gate charge; typical values

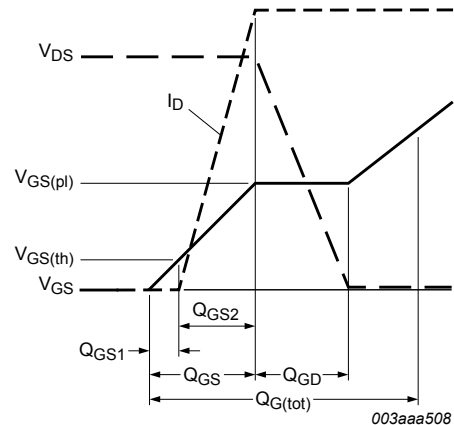


Fig. 15. MOSFET transistor: Gate charge waveform definitions

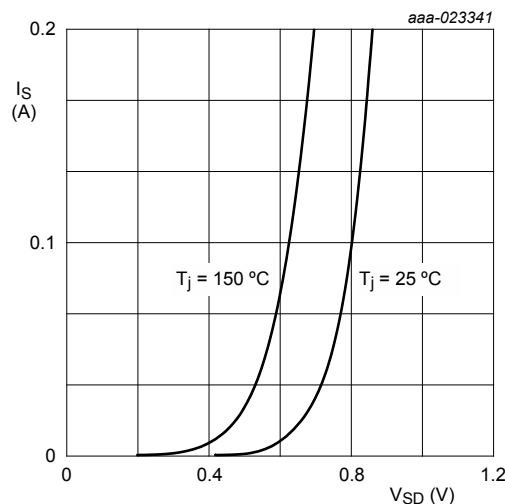


Fig. 16. Source current as a function of source-drain voltage; typical values

## 10. Test information

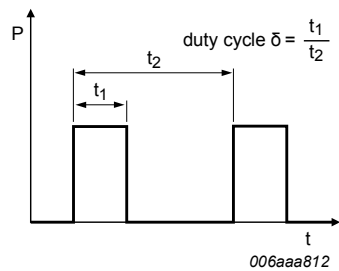
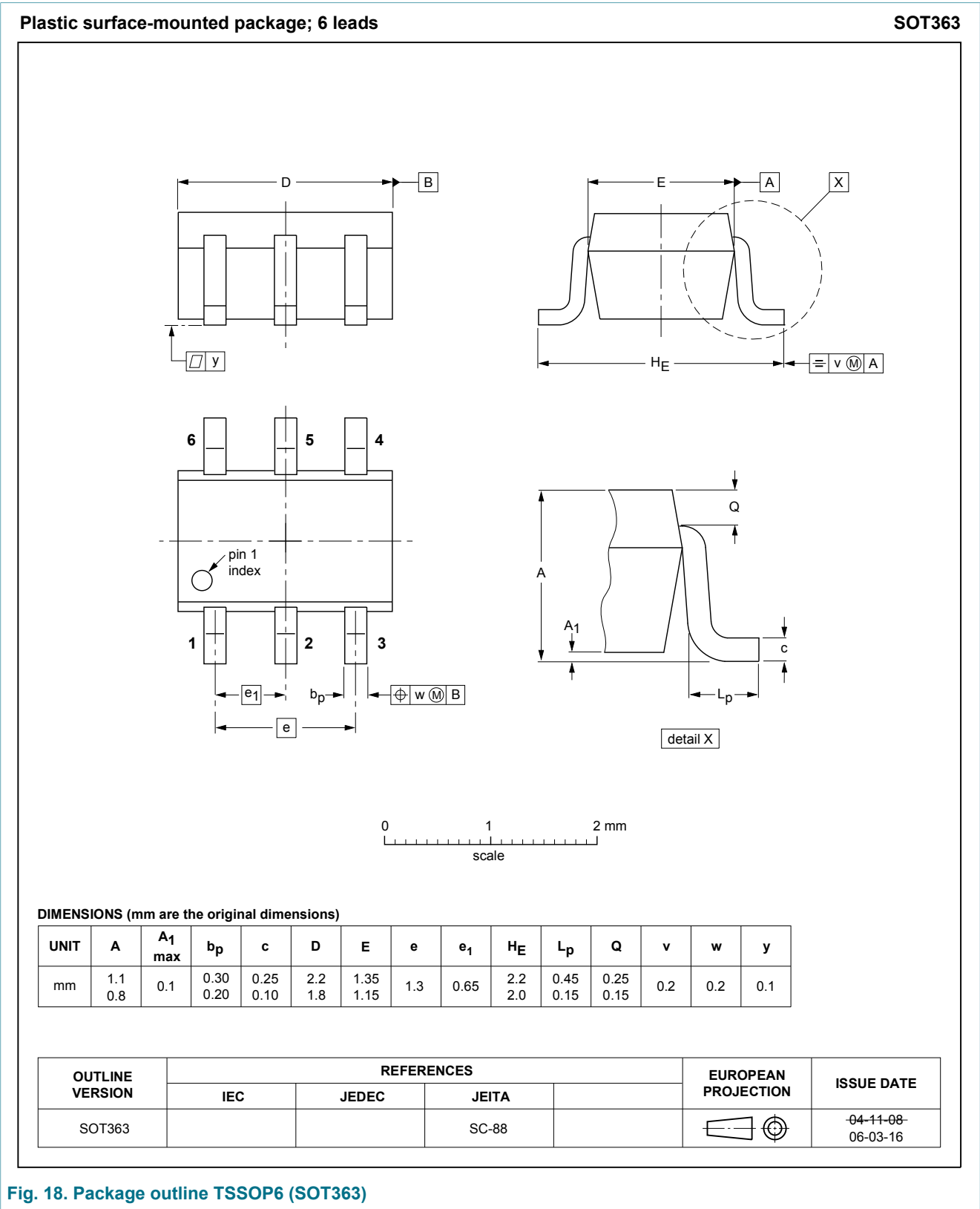


Fig. 17. Duty cycle definition

11. Package outline



12. Soldering

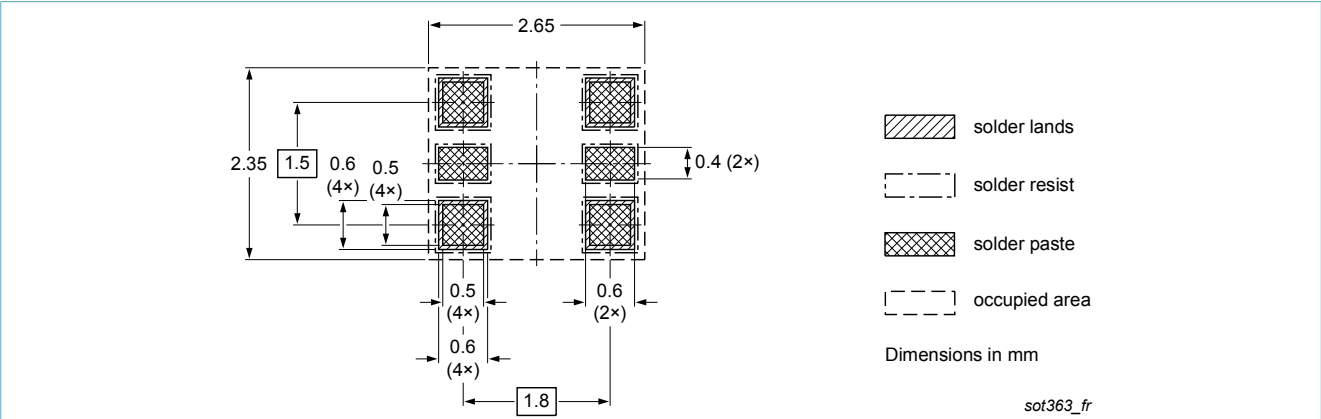


Fig. 19. Reflow soldering footprint for TSSOP6 (SOT363)

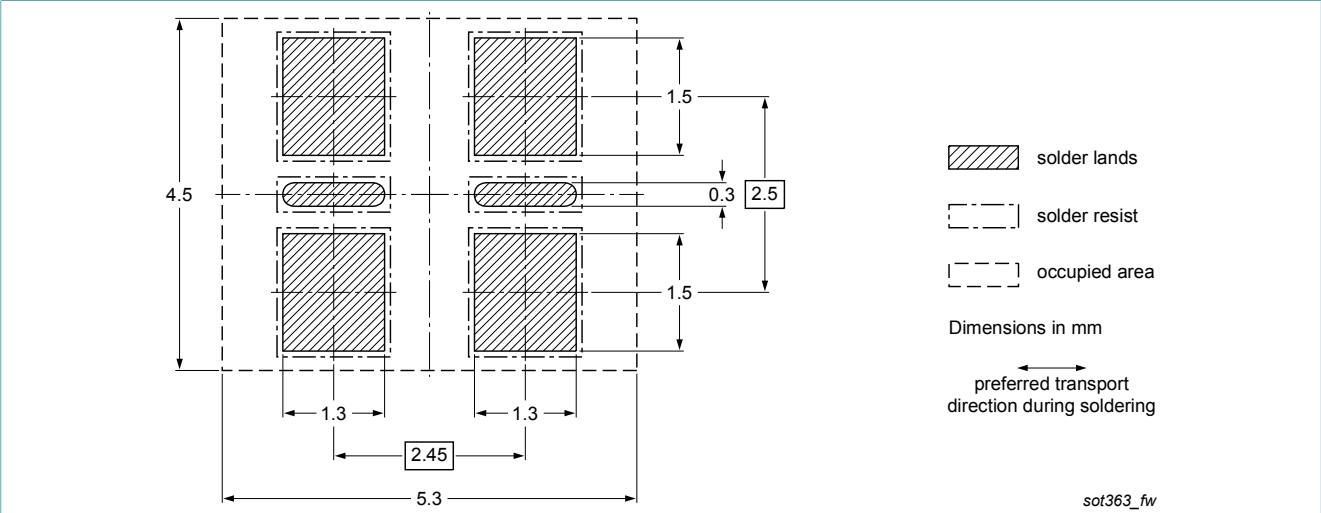


Fig. 20. Wave soldering footprint for TSSOP6 (SOT363)

### 13. Revision history

Table 7. Revision history

| Data sheet ID | Release date | Data sheet status  | Change notice | Supersedes |
|---------------|--------------|--------------------|---------------|------------|
| NX138BKS v.1  | 20160615     | Product data sheet | -             | -          |

## 14. 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.                       |
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