



NUP1301

Ultra low capacitance ESD protection array

14 April 2023

Product data sheet

1. General description

Ultra low capacitance ElectroStatic Discharge (ESD) protection array in a small SOT23 (TO-236AB) Surface-Mounted Device (SMD) plastic package designed to protect one signal line in rail-to-rail configuration from the damage caused by ESD and other transients.

2. Features and benefits

- ESD protection of one signal line (rail-to-rail configuration)
- Ultra low diode capacitance: $C_d = 0.6$ pF
- Very low reverse leakage current: ≤ 30 nA
- ESD protection up to 30 kV
- IEC 61000-4-2; level 4 (ESD)
- IEC 61000-4-5 (surge); $I_{PPM} = 11$ A at $t_p = 8/20$ μ s

3. Applications

- Telecommunication networks
- Video line protection
- Microcontroller protection
- I²C-bus protection
- Antenna power supply
- Analog audio
- Class-D amplifier

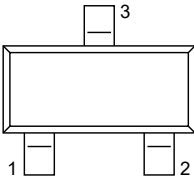
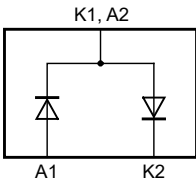
4. Quick reference data

Table 1. Quick reference data

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-----------|---------------------------------|---|-----|-----|------|------|
| V_{RRM} | repetitive peak reverse voltage | | - | - | 80 | V |
| C_d | diode capacitance | $f = 1$ MHz; $V_R = 0$ V; $T_{amb} = 25$ °C | - | 0.6 | 0.75 | pF |
| I_R | reverse current | $V_R = 80$ V; $T_{amb} = 25$ °C | - | - | 100 | nA |

5. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description | Simplified outline | Graphic symbol |
|-----|-----------------|----------------|--|--|
| 1 | GND | ground |  SOT23 |  006aaa763 |
| 2 | V _{CC} | supply voltage | | |
| 3 | I/O | input/output | | |

6. Ordering information

Table 3. Ordering information

| Type number | Package | | |
|-------------|---------|--|---------|
| | Name | Description | Version |
| NUP1301 | 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] |
|-------------|-----------------------------|
| NUP1301 | LJ% |

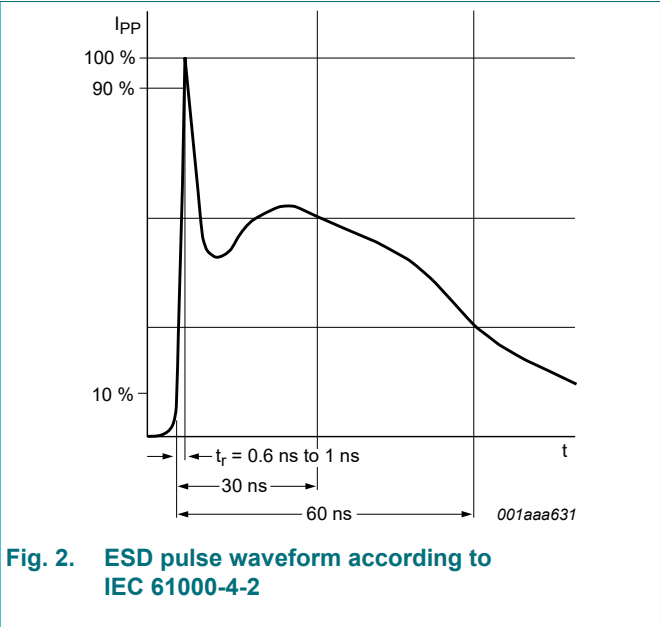
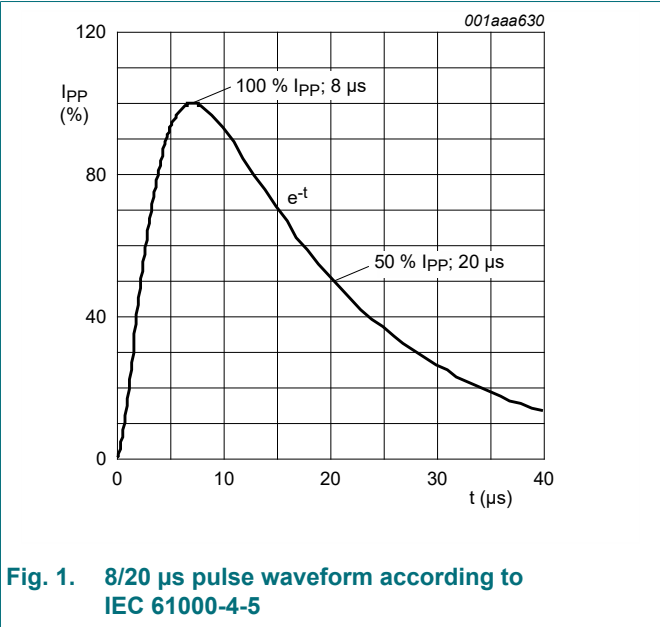
[1] % = placeholder for manufacturing site code

8. Limiting values

Table 5. Limiting values
In accordance with the Absolute Maximum Rating System (IEC 60134).

| Symbol | Parameter | Conditions | | Min | Max | Unit |
|---------------------|-------------------------------------|---|---------|-----|-----|------|
| V _{RRM} | repetitive peak reverse voltage | | | - | 80 | V |
| V _R | reverse voltage | T _{amb} = 25 °C | | - | 80 | V |
| I _F | forward current | | [1] | - | 215 | mA |
| I _{FRM} | repetitive peak forward current | t _p ≤ 1 ms; δ ≤ 0.25; T _j = 25 °C | | - | 500 | mA |
| P _{PPM} | rated peak pulse power | t _p = 8/20 μs | [2] [3] | - | 220 | W |
| I _{PPM} | rated peak pulse current | t _p = 8/20 μs | [2] [3] | - | 11 | A |
| I _{FSM} | non-repetitive peak forward current | square wave; t _p = 1 μs | [4] | - | 4 | A |
| | | square wave; t _p = 1 ms | [4] | - | 1 | A |
| | | square wave; t _p = 1 s | [4] | - | 0.5 | A |
| P _{tot} | total power dissipation | T _{amb} = 25 °C | [5] [6] | - | 250 | mW |
| T _j | junction temperature | | | - | 150 | °C |
| T _{amb} | ambient temperature | | | -55 | 150 | °C |
| T _{stg} | storage temperature | | | -65 | 150 | °C |
| ESD maximum ratings | | | | | | |
| V _{ESD} | electrostatic discharge voltage | IEC 61000-4-2 (contact discharge) | [3] [7] | - | 30 | kV |
| | | machine model | | - | 400 | V |
| | | MIL-STD-883 (human body model) | | - | 10 | kV |

- [1] Pulse test: t_p ≤ 300 μs; δ ≤ 0.02.
[2] Non-repetitive current pulse 8/20 μs exponential decay waveform according to IEC 61000-4-5.
[3] Measured from pin 3 to pins 1 and 2 (pins 1 and 2 are connected).
[4] T_j = 25 °C prior to surge.
[5] Single diode loaded.
[6] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and standard footprint.
[7] Device stressed with ten non-repetitive ESD pulses.



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] [2] | - | - | 500 | K/W |
| $R_{th(j-sp)}$ | thermal resistance from junction to solder point | | | - | - | 360 | K/W |

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

10. Characteristics

Table 7. Characteristics

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|----------|-------------------|--|---------|-----|-----|------|---------------|
| V_F | forward voltage | $I_F = 1\text{ mA}; T_{amb} = 25\text{ }^{\circ}\text{C}$ | [1] | - | - | 715 | mV |
| | | $I_F = 10\text{ mA}; T_{amb} = 25\text{ }^{\circ}\text{C}$ | [1] | - | - | 855 | mV |
| | | $I_F = 50\text{ mA}; T_{amb} = 25\text{ }^{\circ}\text{C}$ | [1] | - | - | 1 | V |
| | | $I_F = 150\text{ mA}; T_{amb} = 25\text{ }^{\circ}\text{C}$ | [1] | - | - | 1.25 | V |
| V_{BR} | breakdown voltage | $I_R = 100\text{ }\mu\text{A}; T_{amb} = 25\text{ }^{\circ}\text{C}$ | | 100 | - | - | V |
| I_R | reverse current | $V_R = 25\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}$ | | - | - | 30 | nA |
| | | $V_R = 80\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}$ | | - | - | 100 | nA |
| | | $V_R = 25\text{ V}; T_j = 150\text{ }^{\circ}\text{C}$ | | - | - | 25 | μA |
| | | $V_R = 80\text{ V}; T_j = 150\text{ }^{\circ}\text{C}$ | | - | - | 35 | μA |
| C_d | diode capacitance | $f = 1\text{ MHz}; V_R = 0\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}$ | | - | 0.6 | 0.75 | pF |
| V_{CL} | clamping voltage | $I_{PP} = 1\text{ A}; T_{amb} = 25\text{ }^{\circ}\text{C}$ | [2] [3] | - | - | 3 | V |
| | | $I_{PPM} = 11\text{ A}; T_{amb} = 25\text{ }^{\circ}\text{C}$ | [2] [3] | - | - | 20 | V |

[1] Pulse test: $t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.02$.
[2] Non-repetitive current pulse 8/20 μs exponential decay waveform according to IEC 61000-4-5.
[3] Measured from pin 3 to pins 1 and 2 (pins 1 and 2 are connected).

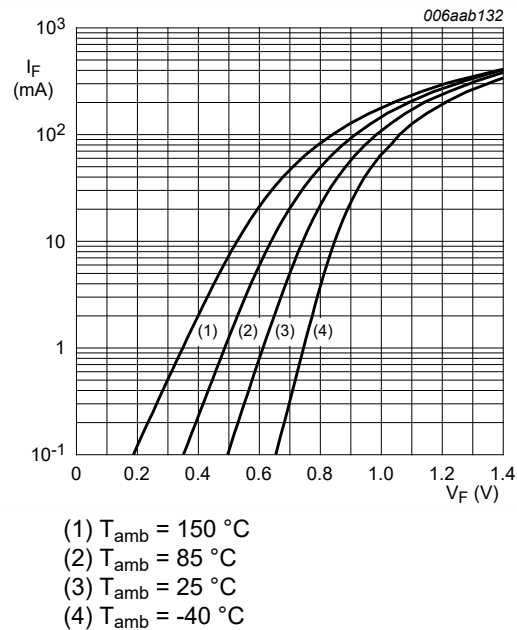


Fig. 3. Forward current as a function of forward voltage; typical values

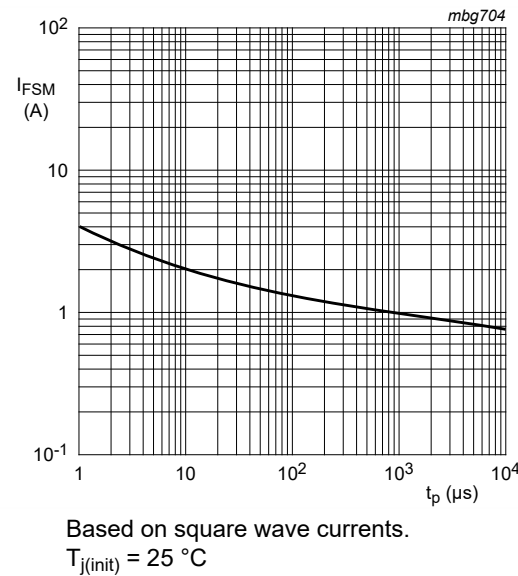


Fig. 4. Non-repetitive peak forward current as a function of pulse duration; typical values

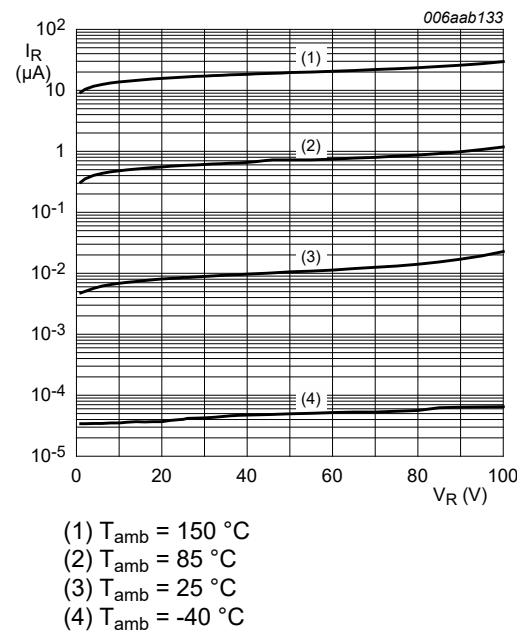


Fig. 5. Reverse current as a function of reverse voltage; typical values

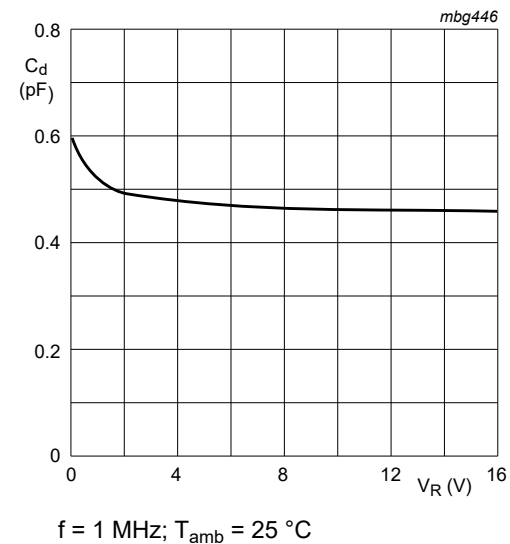
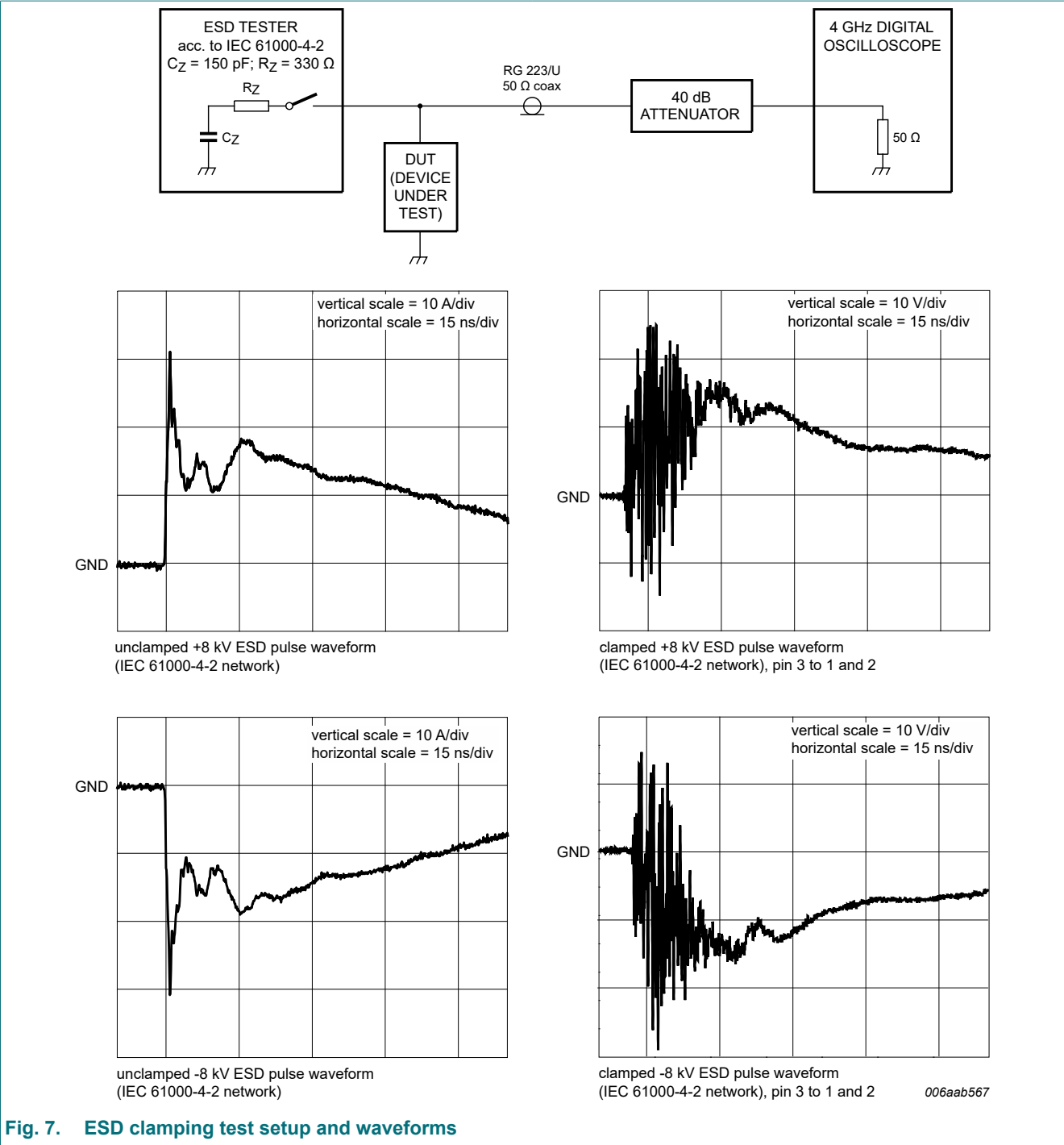


Fig. 6. Diode capacitance as a function of reverse voltage; typical values



11. Application information

Protection of a single (high-speed) data line in rail-to-rail configuration. The protected data line is connected to pin 3. Pin 1 is connected to ground (GND) and pin 2 is connected to the supply rail (supply voltage V_{CC} .) When the transient voltage exceeds the forward voltage drop of one diode, the transient is directed either to the supply rail or to GND. The advantages of these solutions are: low line capacitance (0.6 pF typically), fast response time, and low clamping voltage.

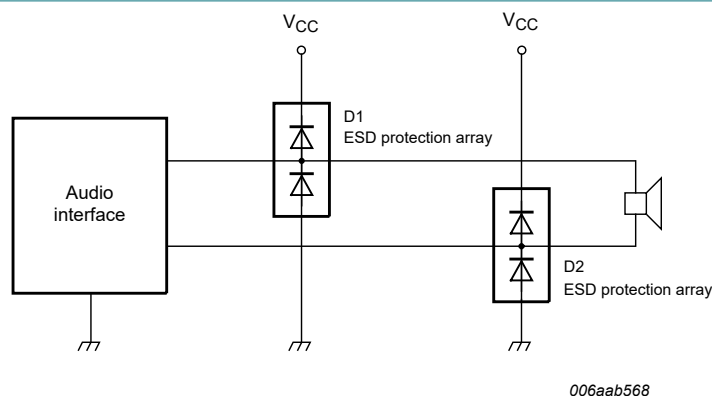


Fig. 8. Typical application for the protection of one signal line

Circuit board layout and protection device placement

Circuit board layout is critical for the suppression of ESD, Electrical Fast Transient (EFT) and surge transients. The following guidelines are recommended:

1. Place the device as close to the input terminal or connector as possible.
2. Minimize the path length between the device and the protected line.
3. Keep parallel signal paths to a minimum.
4. Avoid running protected conductors in parallel with unprotected conductors.
5. Minimize all Printed-Circuit Board (PCB) conductive loops including power and ground loops.
6. Minimize the length of the transient return path to ground.
7. Avoid using shared transient return paths to a common ground point.
8. Use ground planes whenever possible. For multilayer PCBs, use ground vias.

12. Package outline

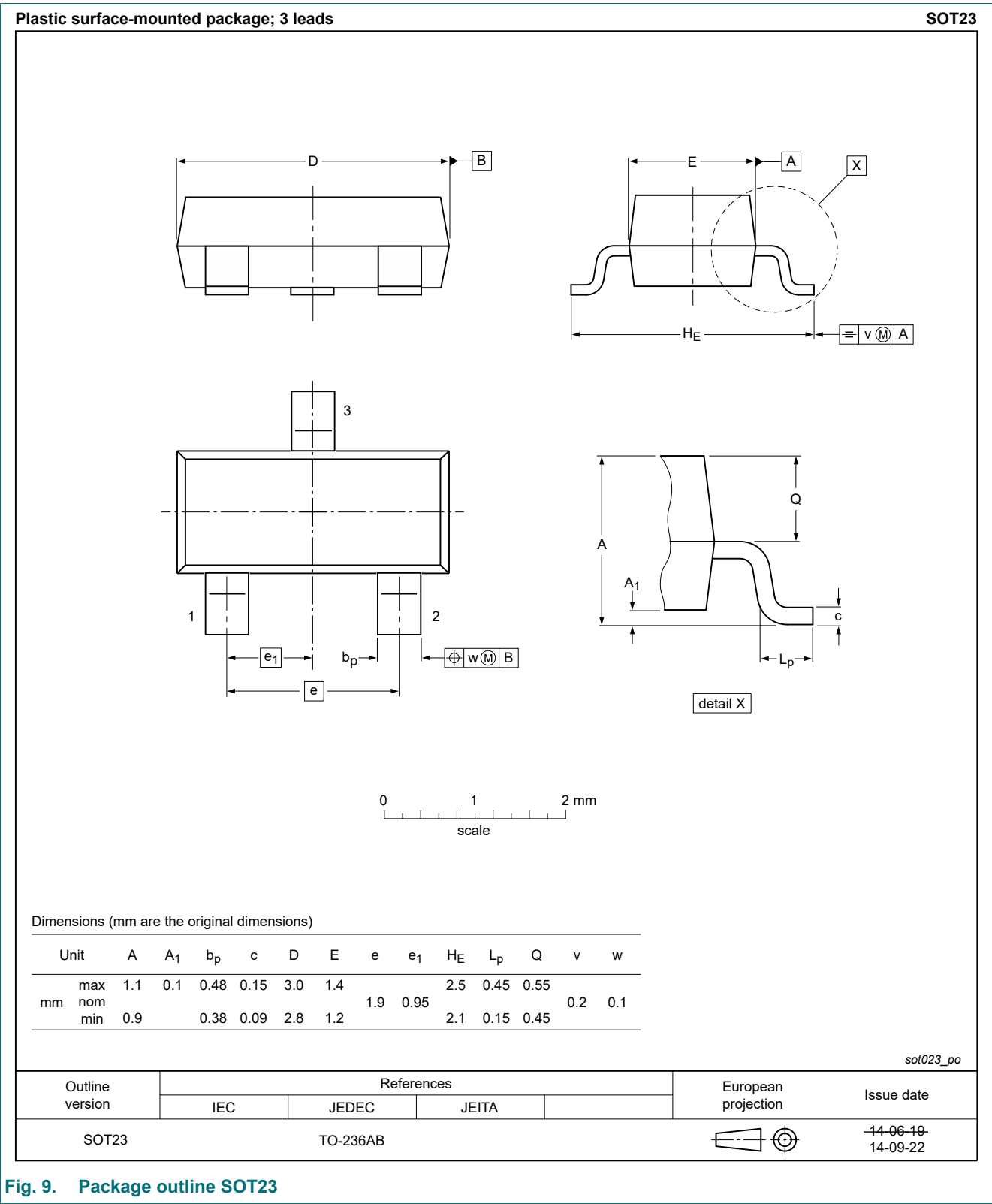


Fig. 9. Package outline SOT23

13. Soldering



Fig. 10. Reflow soldering footprint for SOT23

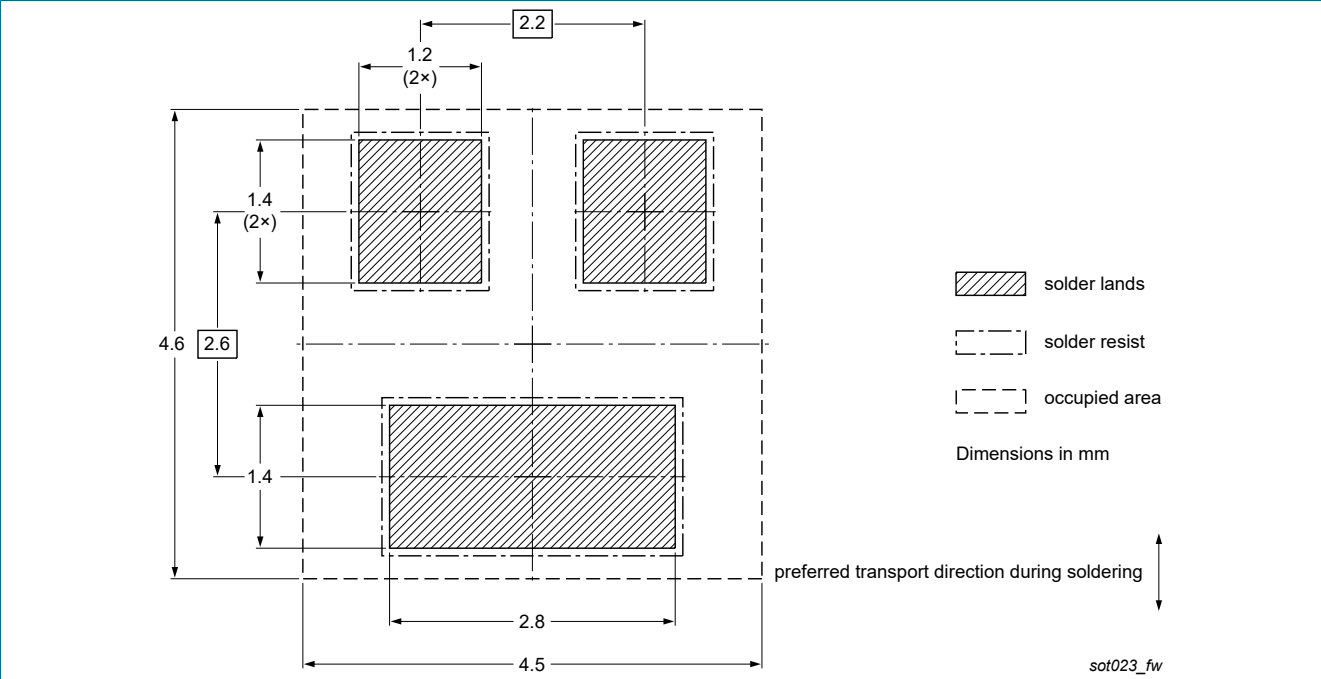


Fig. 11. Wave soldering footprint for SOT23

14. Revision history

Table 8. Revision history

| Data sheet ID | Release date | Data sheet status | Change notice | Supersedes |
|----------------|---|--------------------|---------------|-------------|
| NUP1301 v.2 | 20230414 | Product data sheet | - | NUP1301 v.1 |
| Modifications: | <ul style="list-style-type: none">• The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia• Legal texts have been adapted to the new company name where appropriate• Removed table "ESD standards compliance"• Product changed to non-automotive qualification. Please refer to nexperia.com for automotive (-Q) product alternative(s). | | | |
| NUP1301 v.1 | 20090511 | 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. |

- [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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Contents

1. General description..... 1

2. Features and benefits..... 1

3. Applications..... 1

4. Quick reference data..... 1

5. Pinning information.....2

6. Ordering information.....2

7. Marking.....2

8. Limiting values..... 3

9. Thermal characteristics..... 4

10. Characteristics.....4

11. Application information.....7

12. Package outline..... 8

13. Soldering..... 9

14. Revision history.....10

15. Legal information.....11

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