



NUP1301U-Q

Ultra low capacitance ESD protection array

6 May 2022

Product data sheet

1. General description

Ultra low capacitance ElectroStatic Discharge (ESD) protection array in a small SOT323 (SC-70) 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
- ESD protection up to 30 kV
- IEC 61000-4-2; level 4 (ESD)
- IEC 61000-4-5 (surge); $I_{PP} = 11$ A
- Qualified according to AEC-Q101 and recommended for use in automotive applications

3. Applications

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

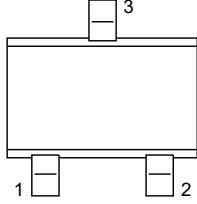
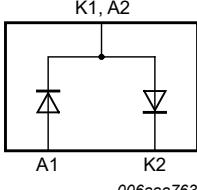
4. Quick reference data

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	 <p>SC-70 (SOT323)</p>	 <p>006aaa763</p>
2	V _{CC}	supply voltage		
3	I/O	input/output		

6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
NUP1301U-Q	SC-70	plastic, surface-mounted package; 3 leads; 1.3 mm pitch; 2 mm x 1.25 mm x 0.95 mm body	SOT323

7. Marking

Table 4. Marking codes

Type number	Marking code[1]
NUP1301U-Q	%VU

[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			-	80	V
I_F	forward current		[1]	-	215	mA
I_{FRM}	repetitive peak forward current	$t_p \leq 1 \text{ ms}$; $\delta \leq 0.25$		-	500	mA
P_{PPM}	rated peak pulse power	$t_p = 8/20 \text{ } \mu\text{s}$	[2] [3]	-	220	W
I_{PPM}	rated peak pulse current		[2] [3]	-	11	A
I_{FSM}	non-repetitive peak forward current	square wave; $t_p = 1 \text{ } \mu\text{s}$	[4]	-	4	A
		square wave; $t_p = 1 \text{ ms}$	[4]	-	1	A
		square wave; $t_p = 1 \text{ s}$	[4]	-	0.5	A
P_{tot}	total power dissipation	$T_{amb} \leq 25 \text{ } ^\circ\text{C}$	[5] [6]	-	200	mW
T_j	junction temperature			-	150	$^\circ\text{C}$
T_{amb}	ambient temperature			-55	150	$^\circ\text{C}$
T_{stg}	storage temperature			-65	150	$^\circ\text{C}$
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: $t_p \leq 300 \text{ } \mu\text{s}$; $\delta \leq 0.02$.
- [2] Non-repetitive current pulse $8/20 \text{ } \mu\text{s}$ 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] $T_j = 25 \text{ } ^\circ\text{C}$ 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.

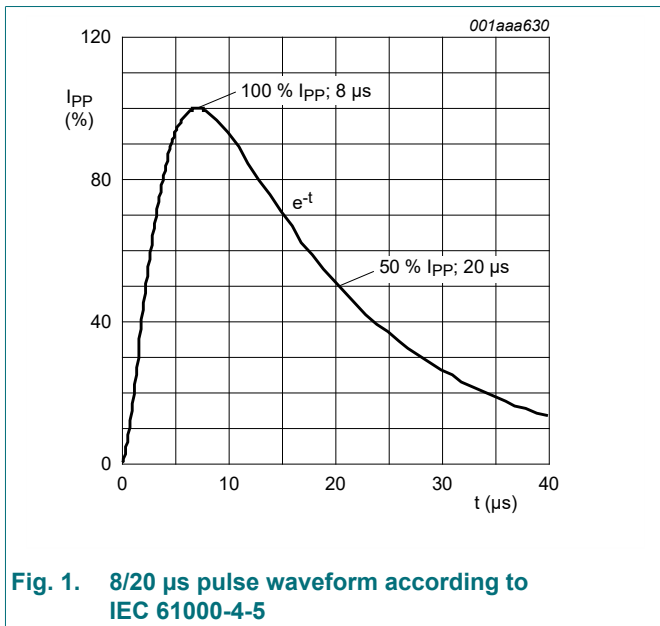


Fig. 1. 8/20 μs pulse waveform according to IEC 61000-4-5

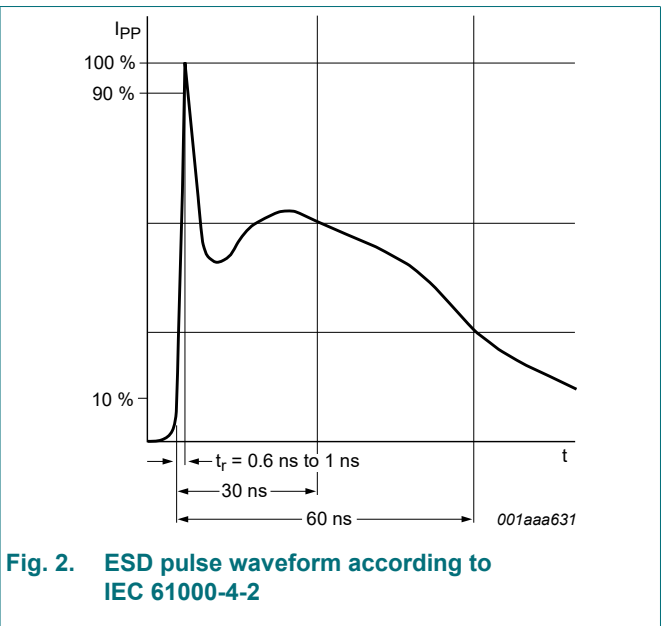


Fig. 2. ESD pulse waveform according to IEC 61000-4-2

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]	-	-	625	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point			-	-	300	K/W

[1] Single diode loaded.

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

10. Characteristics

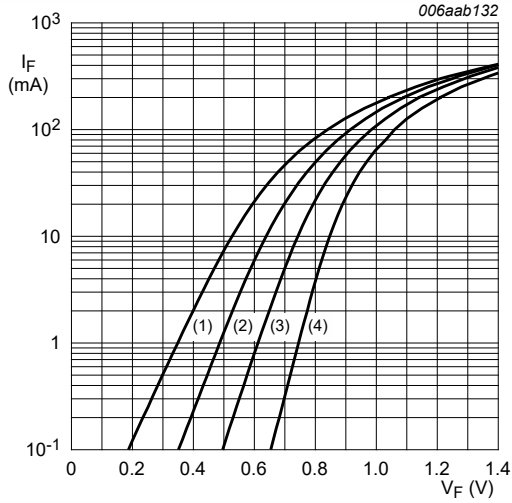
Table 7. Characteristics

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: $t_p \leq 300 \text{ } \mu\text{s}; \delta \leq 0.02$.

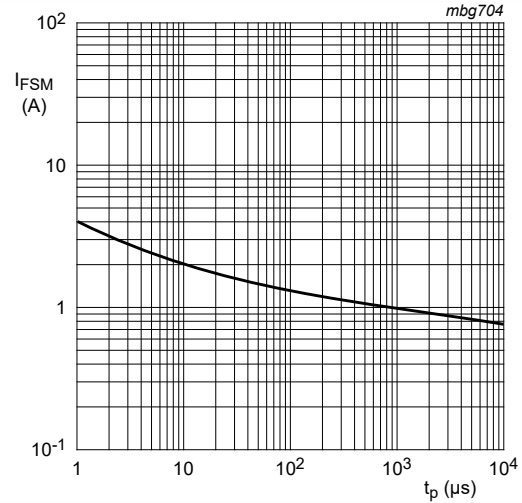
[2] Non-repetitive current pulse 8/20 μs exponential decay waveform according to IEC 61000-4-5.

[3] Measured from pin 3 to pins 1 and 2 (pins 1 and 2 are connected).



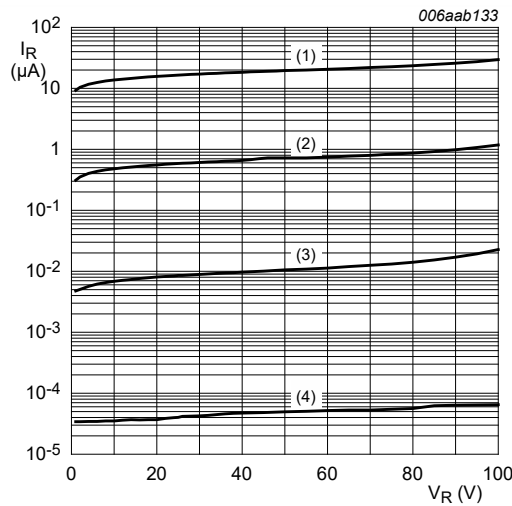
- (1) $T_{amb} = 150\text{ °C}$
- (2) $T_{amb} = 85\text{ °C}$
- (3) $T_{amb} = 25\text{ °C}$
- (4) $T_{amb} = -40\text{ °C}$

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



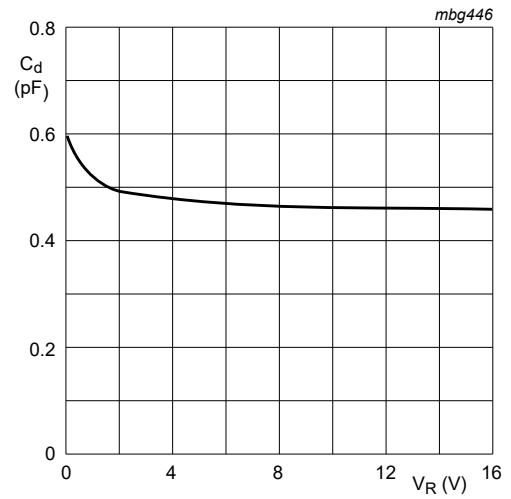
Based on square wave currents.
 $T_{j(init)} = 25\text{ °C}$

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



- (1) $T_{amb} = 150\text{ °C}$
- (2) $T_{amb} = 85\text{ °C}$
- (3) $T_{amb} = 25\text{ °C}$
- (4) $T_{amb} = -40\text{ °C}$

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



$f = 1\text{ MHz}; T_{amb} = 25\text{ °C}$

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

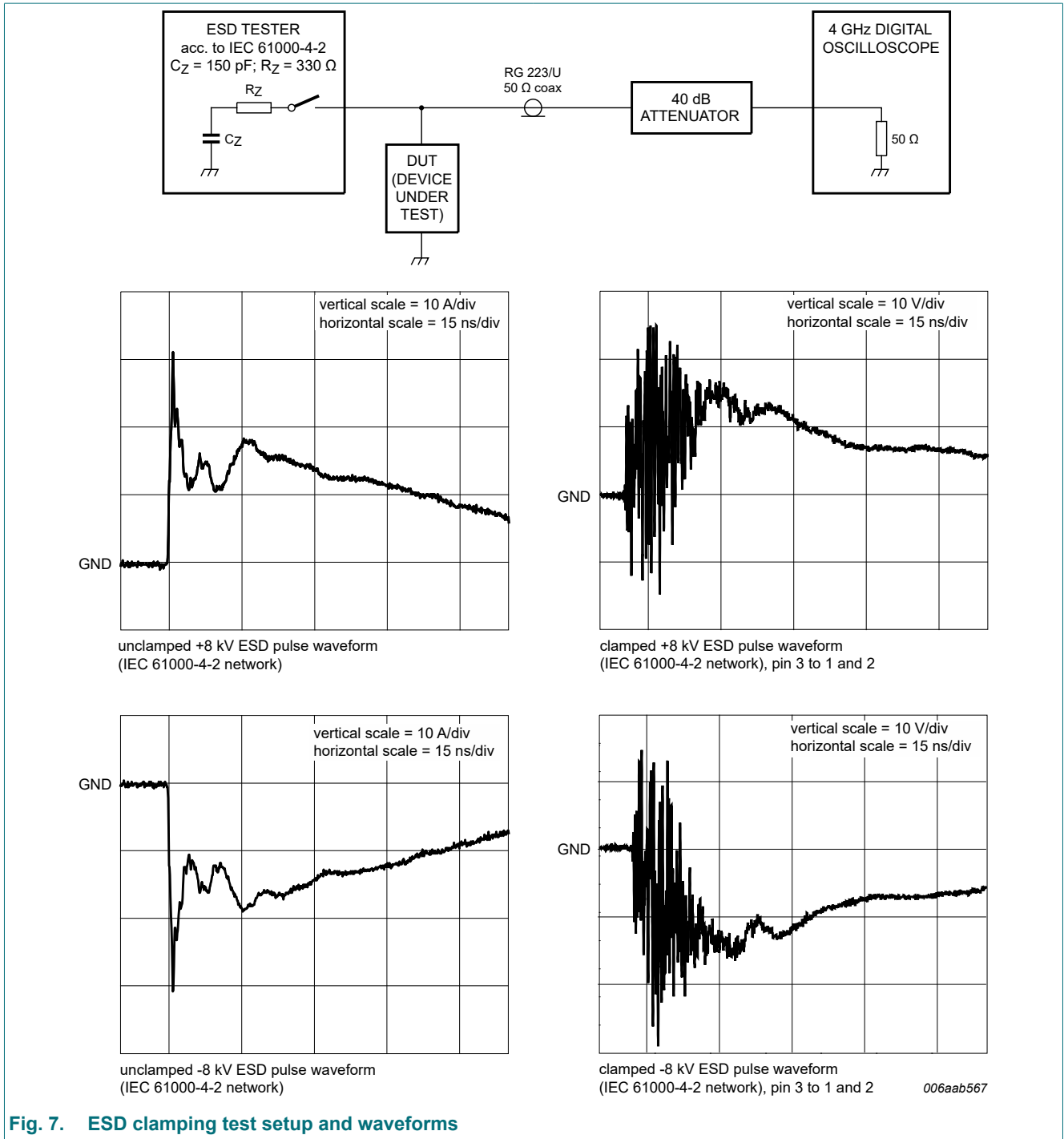


Fig. 7. ESD clamping test setup and waveforms

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.

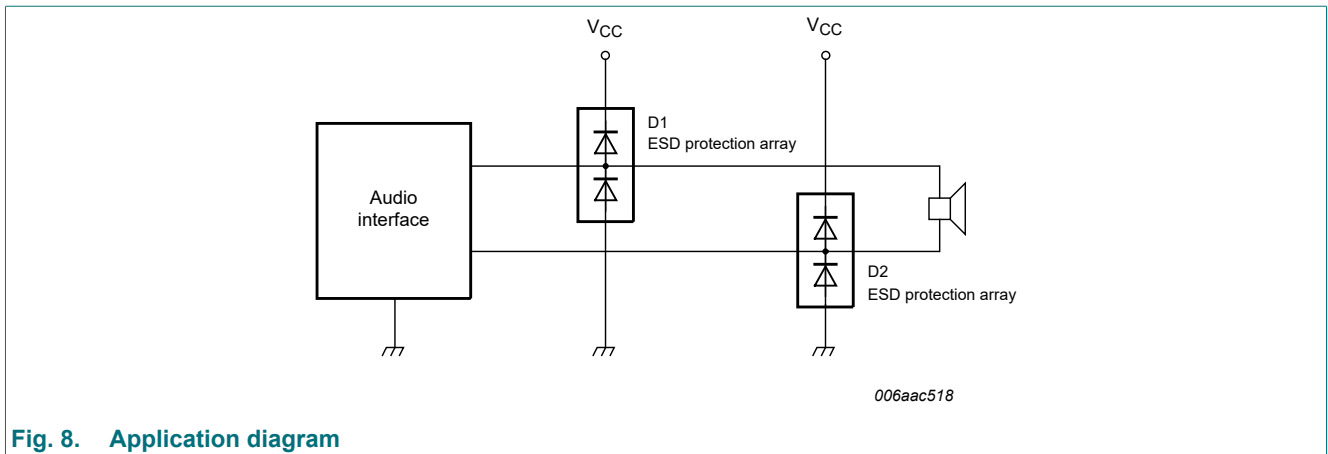


Fig. 8. Application diagram

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. Test information

Quality information

This product has been qualified in accordance with the Automotive Electronics Council (AEC) standard Q101 - *Stress test qualification for discrete semiconductors*, and is suitable for use in automotive applications.

13. Package outline

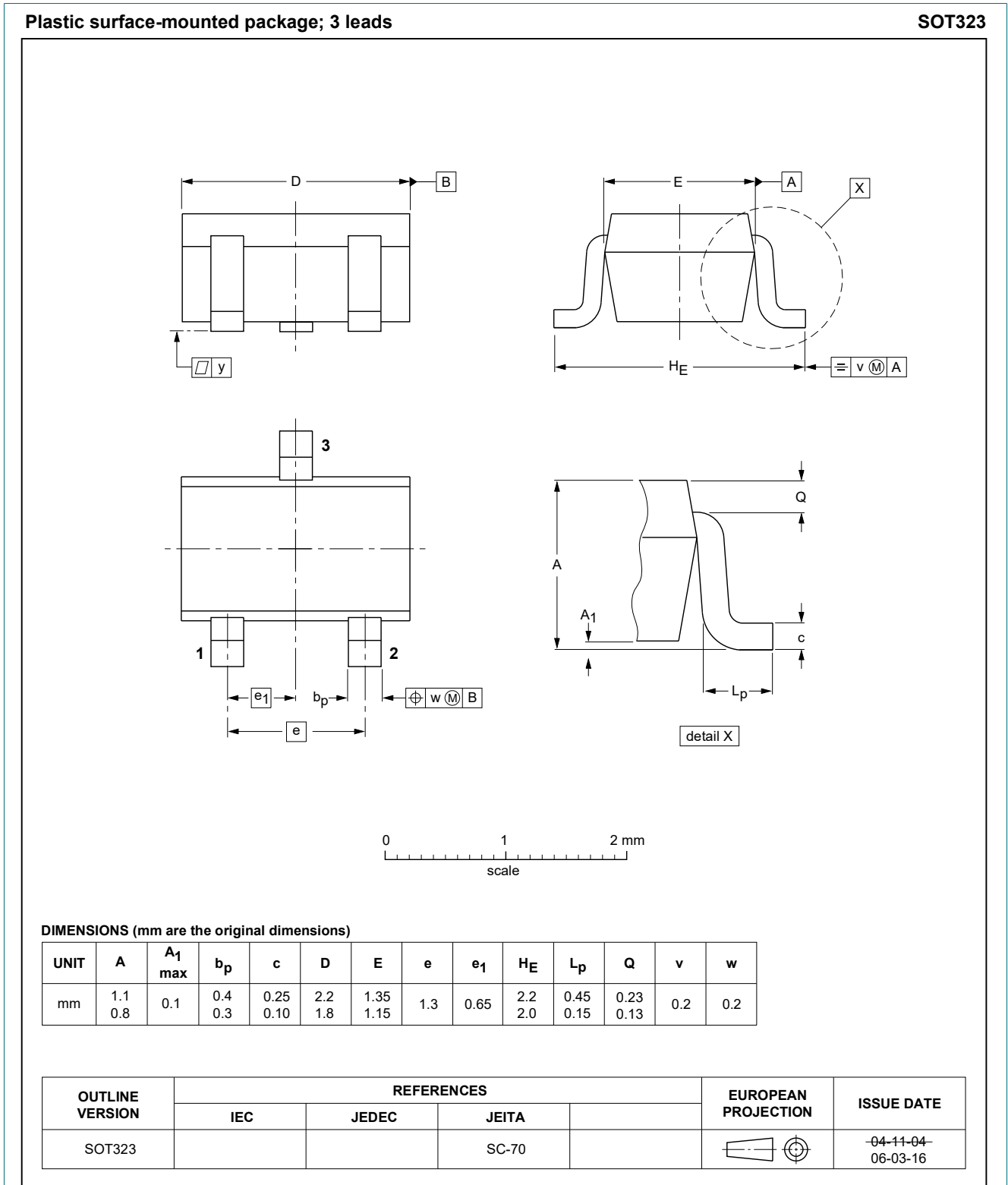


Fig. 9. Package outline SC-70 (SOT323)

14. Soldering

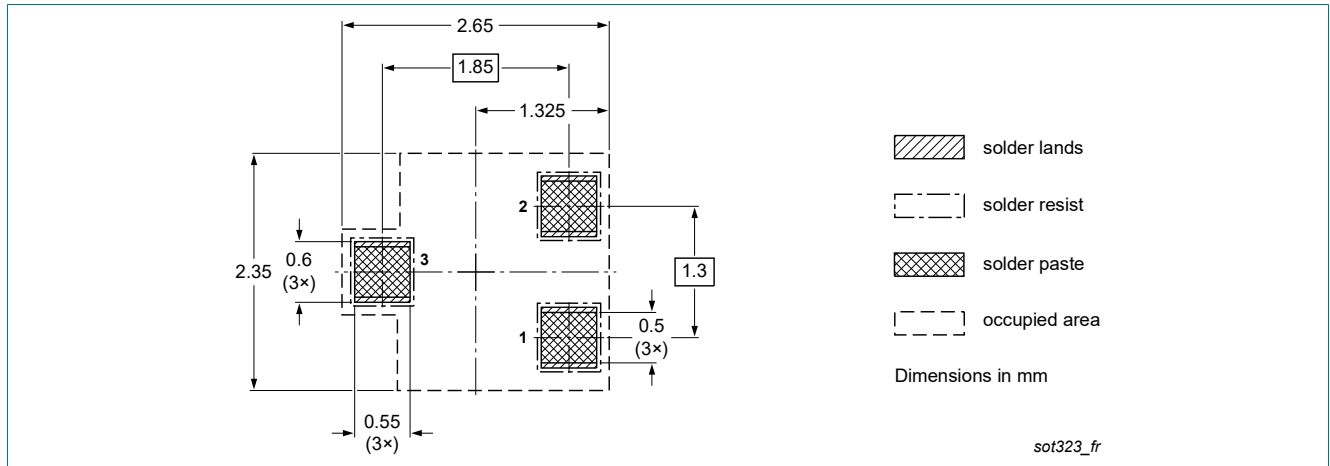


Fig. 10. Reflow soldering footprint for SC-70 (SOT323)

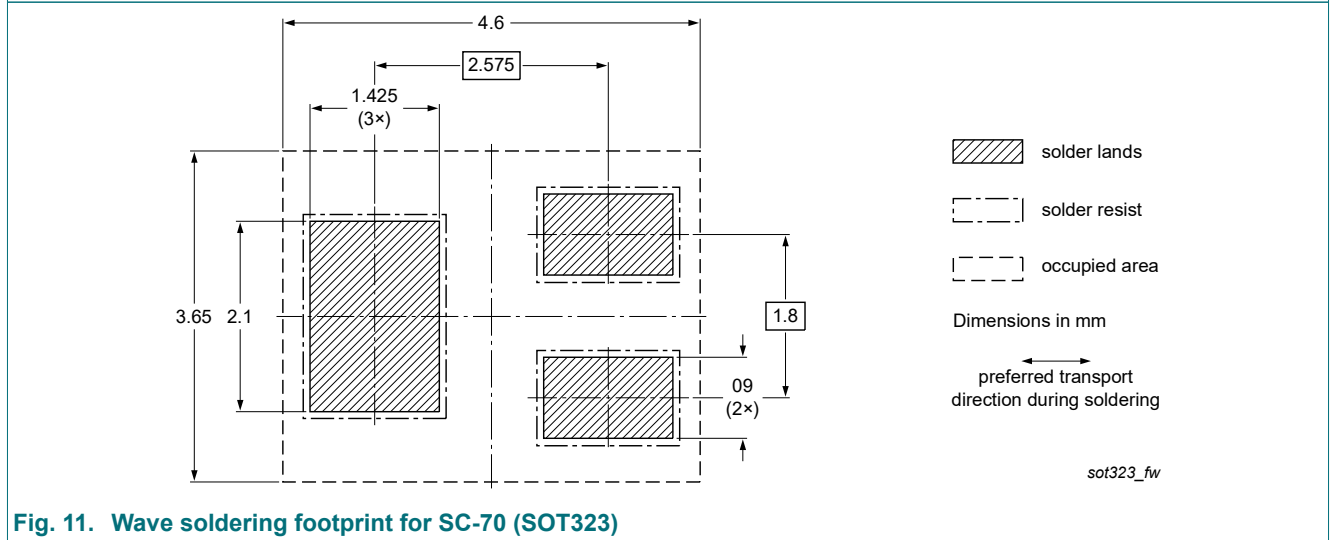


Fig. 11. Wave soldering footprint for SC-70 (SOT323)

15. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
NUP1301U-Q v.1	20220506	Product data sheet	-	-

16. 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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