



# IP3319CX6

Single-channel common-mode filter with integrated ESD protection network

Rev. 2 — 29 May 2013

Product data sheet

## 1. Product profile

### 1.1 General description

2-lines (one differential channel) common-mode filter with integrated ESD protection up to 15 kV contact discharge, exceeding IEC 61000-4-2, level 4. The device can eliminate efficiently common-mode noise from USB 2.0 and other high-speed interfaces with differential lines. IP3319CX6 attenuates significantly common-mode noise above 800 MHz while differential-mode signal extends out to more than 1 GHz before reaching the -3 dB point.

IP3319CX6 is designed to protect sensitive I/Os, such as USB 2.0, Ethernet, Digital Video Interface (DVI) and Low-Voltage Differential Signaling (LVDS) interfaces from destruction by ElectroStatic Discharge (ESD).

IP3319CX6 is a combination of an integrated copper-coils common-mode filter and a monolithic silicon technology-based ESD protection. It integrates two ultra-low capacitance rail-to-rail diodes plus a separated protection diode in a 0.4 mm pitch Wafer-Level Chip-Size Package (WLCSP). Due to the rail-to-rail concept, the protection is working independently from availability of a supply voltage

### 1.2 Features and benefits

- 2-lines (one differential mode) common-mode filter
- ESD protection for the USB ID line
- Extremely low clamping voltage
- ESD protection up to  $\pm 15$  kV on external contact pins
- Ultra low ESD diode capacitance
- WLCSP6 with 0.4 mm pitch

### 1.3 Applications

- USB 2.0 High-speed lines
- LVDS interfaces
- DVI

### 1.4 Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$R_{S(ch)}$	channel series resistance	single line; input to output	-	6	-	$\Omega$
$C_d$	diode capacitance	$V_1 = 0$ V; $f = 1$ MHz; pins A2, B2 to GND	[1] -	1.5	-	pF

[1] This parameter is guaranteed by design.

## 2. Pinning information

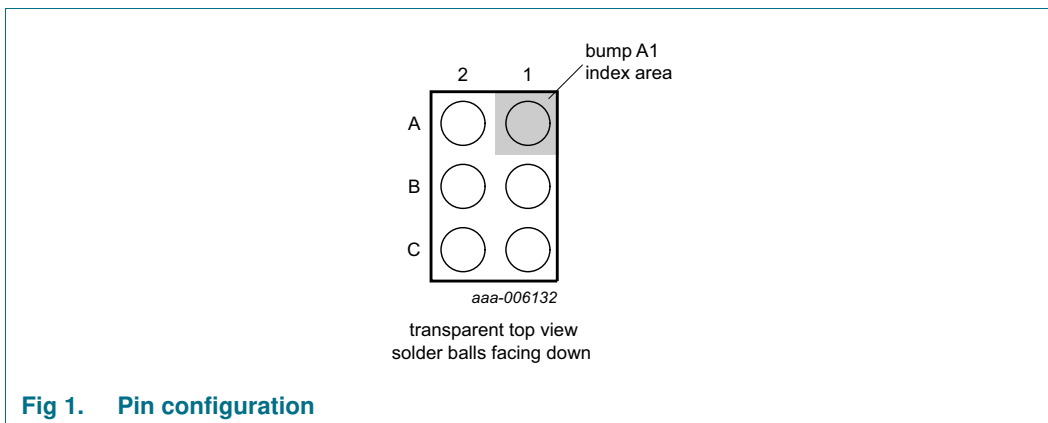


Table 2. Pinning

Pin	Symbol <a href="#">[1]</a>	Description <a href="#">[1]</a>
A1	D+_OUT	USB data D+ (host side)
A2	D+_IN	USB data D+ (connector side)
B1	D-_OUT	USB data D- (host side)
B2	D-_IN	USB data D- (connector side)
C1	GND	ground
C2	ID	USB identification

[1] D+ and D- are interchangeable.

## 3. Ordering information

Table 3. Ordering information

Type number	Package		Version
	Name	Description	
IP3319CX6	WLCSP6	wafer level chip-size package; 6 bumps (2 × 3) <a href="#">[1]</a>	IP3319CX6

[1] Size: 1.34 mm × 0.95 mm × 0.57 mm

## 4. Marking

IP3319CX6 is laser-marked with the following information (see [Figure 2](#)):

- A marker indicating the pin A1 position.
- Two lines of characters or numbers:
  - The first line (placeholder <marking code>) indicates the marking code. Mapping of product type number to marking code is given in [Table 4](#).
  - The second line (placeholder <lot ID>) indicates the production lot. This information enables tracking a device down to a particular production date.

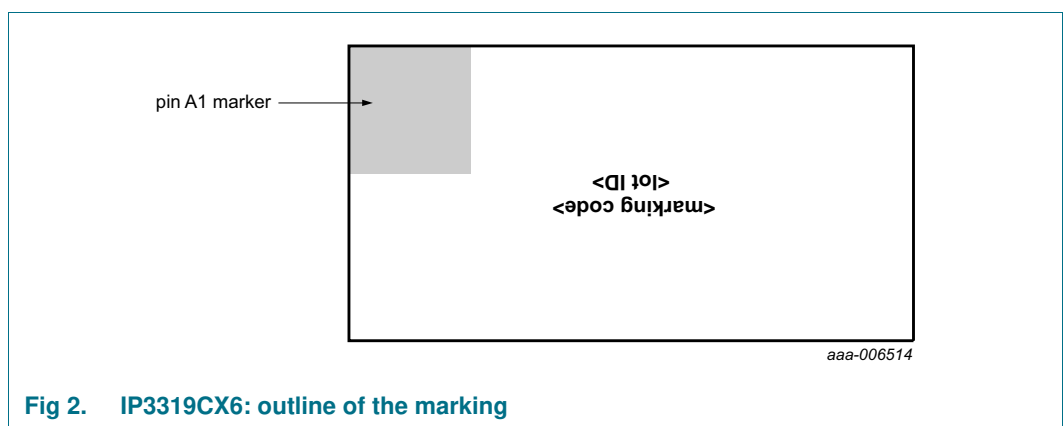


Fig 2. IP3319CX6: outline of the marking

Table 4. Marking codes

Type number	Marking code
IP3319CX6	319

## 5. Functional diagram

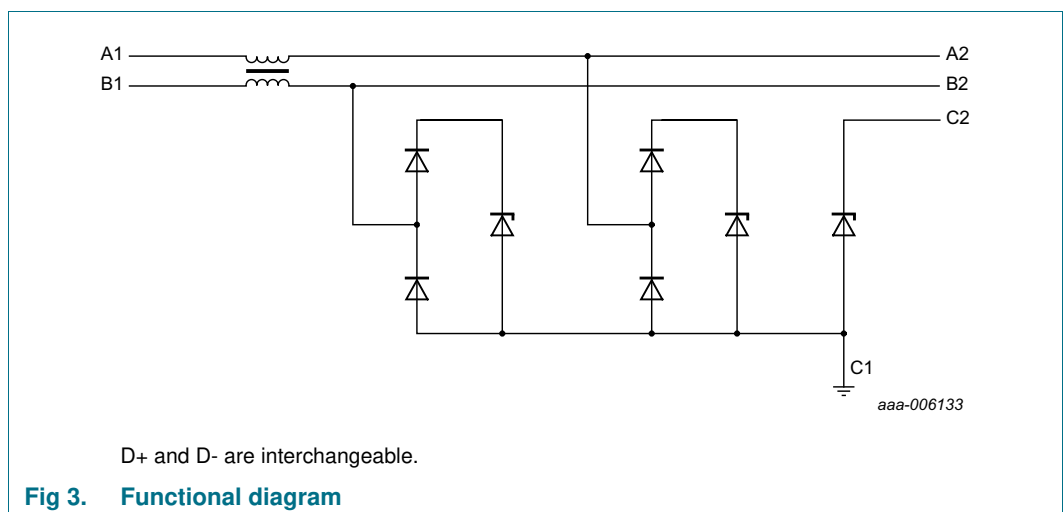


Fig 3. Functional diagram

## 6. Limiting values

**Table 5. Limiting values**

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

Symbol	Parameter	Conditions	Min	Max	Unit	
$V_I$	input voltage		0.5	5.5	V	
$V_{ESD}$	electrostatic discharge voltage	IEC 61000-4-2, level 4; pins A2, B2, C2 to GND (C1)	contact discharge	-15	+15	kV
			air discharge	-15	+15	kV
		IEC 61000-4-2, level 4; pins A1, B1 to GND (C1)	contact discharge	-2	+2	kV
			air discharge	-2	+2	kV
$T_{stg}$	storage temperature		-55	+125	°C	
$T_{amb}$	ambient temperature		-40	+85	°C	

## 7. Characteristics

### 7.1 Electrical characteristics

**Table 6. Electrical characteristics**

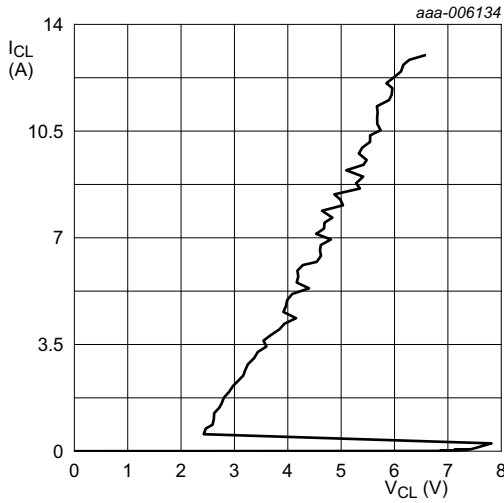
$T_{amb} = 25\text{ °C}$  unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$R_{s(ch)}$	channel series resistance	single line; input to output	-	6	-	$\Omega$
$C_d$	diode capacitance	$V_I = 0\text{ V}$ ; $f = 1\text{ MHz}$ ; pins A2, B2 to GND	[1] -	1.5	-	pF
		pin C2 to GND	[1] -	1.7	-	pF
$I_{RM}$	reverse leakage current	pins A2, B2, C2 to GND; $V_I = 3\text{ V}$	-	0.01	1	$\mu\text{A}$
$V_{BR}$	breakdown voltage	pins A2, B2, C2 to GND; $I_R = 10\text{ mA}$	6	-	10	V
$V_F$	forward voltage	$I_F = 10\text{ mA}$	-	0.7	-	V
$R_{dyn}$	dynamic resistance	TLP	[2]			
		positive transient	-	0.25	-	$\Omega$
		negative transient	-	0.20	-	$\Omega$
		surge	[3]			
		positive transient	-	0.20	-	$\Omega$
		negative transient	-	0.14	-	$\Omega$
$V_{CL}$	clamping voltage	$I_{CL} = 6\text{ A}$	[3] -	4	-	V
		$I_{CL} = -6\text{ A}$	[3] -	-2.5	-	V

[1] This parameter is guaranteed by design.

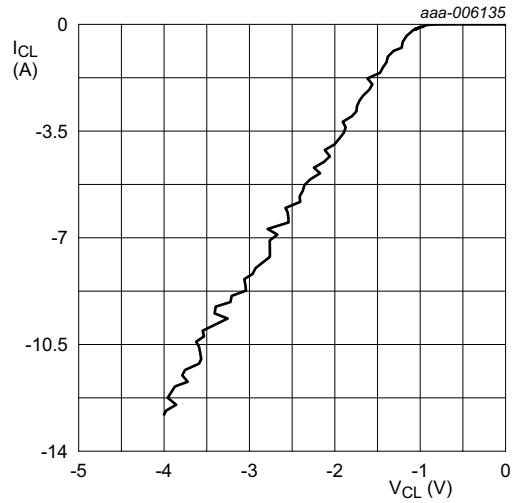
[2] 100 ns Transmission Line Pulse (TLP); 50  $\Omega$ ; pulser at 80 ns.

[3] According to IEC 61000-4-5 (8/20  $\mu\text{s}$ ).



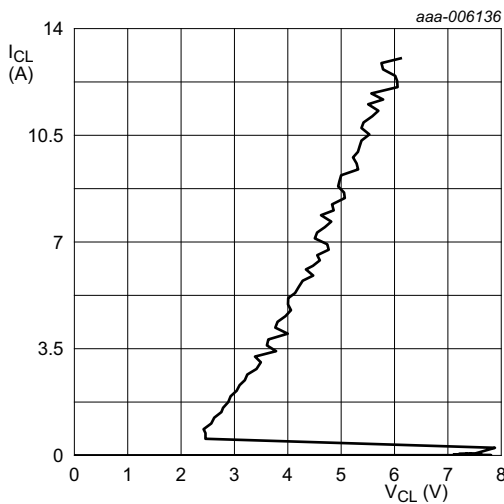
Pin A2;  $t_p = 100$  ns; Transmission Line Pulse (TLP)

**Fig 4. Dynamic resistance with positive clamping**



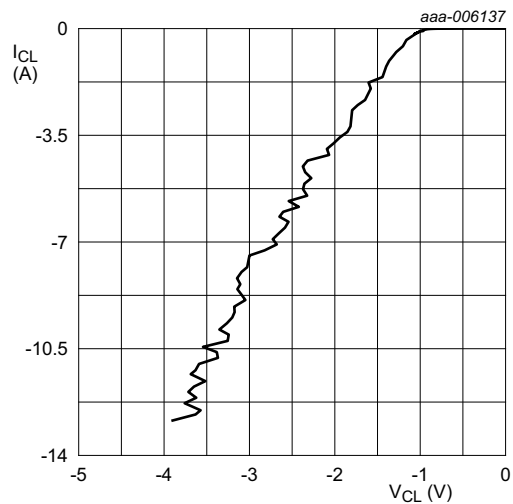
Pin A2;  $t_p = 100$  ns; Transmission Line Pulse (TLP)

**Fig 5. Dynamic resistance with negative clamping**



Pin C2;  $t_p = 100$  ns; Transmission Line Pulse (TLP)

**Fig 6. Dynamic resistance with positive clamping**



Pin C2;  $t_p = 100$  ns; Transmission Line Pulse (TLP)

**Fig 7. Dynamic resistance with negative clamping**

The device uses an advanced clamping structure showing a negative dynamic resistance. This snap-back behavior strongly reduces the clamping voltage to the system behind the ESD protection during an ESD event. Do not connect unlimited DC current sources to the data lines to avoid keeping the ESD protection device in snap-back state after exceeding breakdown voltage (due to an ESD pulse for instance).

7.2 Frequency characteristics

Table 7. Frequency characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
<b>Common mode</b>							
$\alpha_{il}$	insertion loss	S21cc; $R_{gen} = 50 \Omega$ ; $R_L = 50 \Omega$					
			$700 \text{ MHz} \leq f \leq 1.8 \text{ GHz}$	-	-	-13	dB
			$f > 1.8 \text{ GHz}$	-	-	-11	dB
<b>Differential mode</b>							
$\alpha_{il}$	insertion loss	S21dd; $R_{gen} = 50 \Omega$ ; $R_L = 50 \Omega$					
			$f = 500 \text{ MHz}$	-3	-	-	dB
			$f = 1 \text{ GHz}$	-5	-	-	dB

Figure 8 shows the common mode and differential mode attenuation measured in a 50  $\Omega$  NetWork Analyzer (NWA) system.

The 3 dB point for the differential-mode signal is above 1 GHz. The common-mode attenuation reaches a typical value of -25 dB in the GSM band.

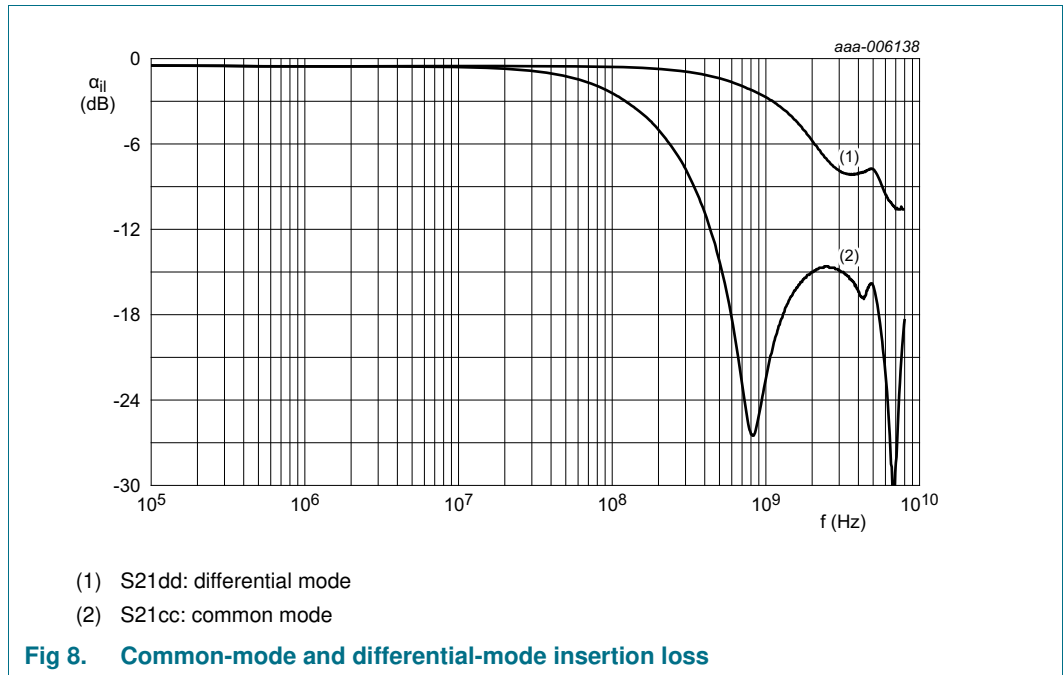
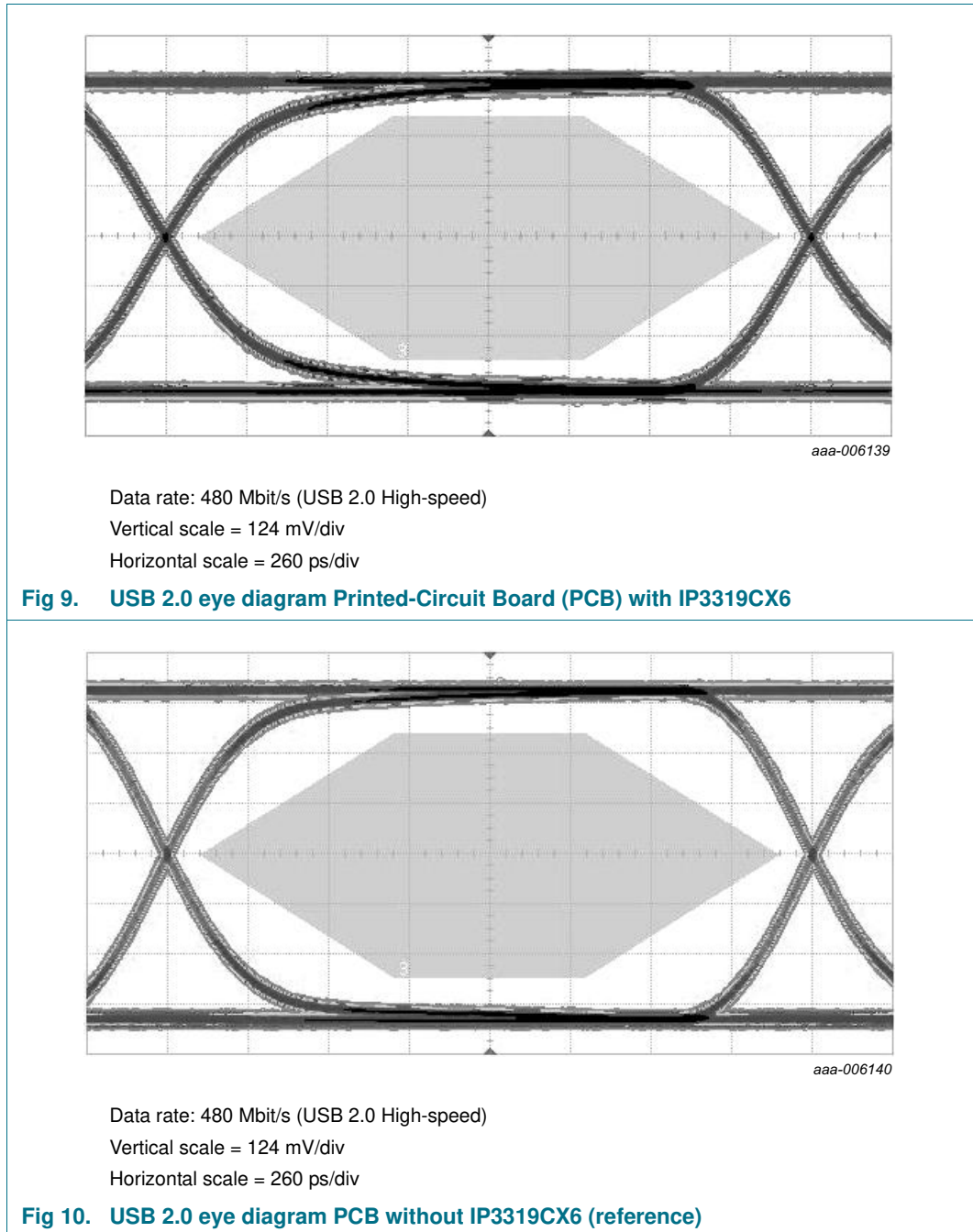


Fig 8. Common-mode and differential-mode insertion loss



## 8. Package outline

WLCSP6: wafer level chip-size package; 6 bumps (2 x 3)

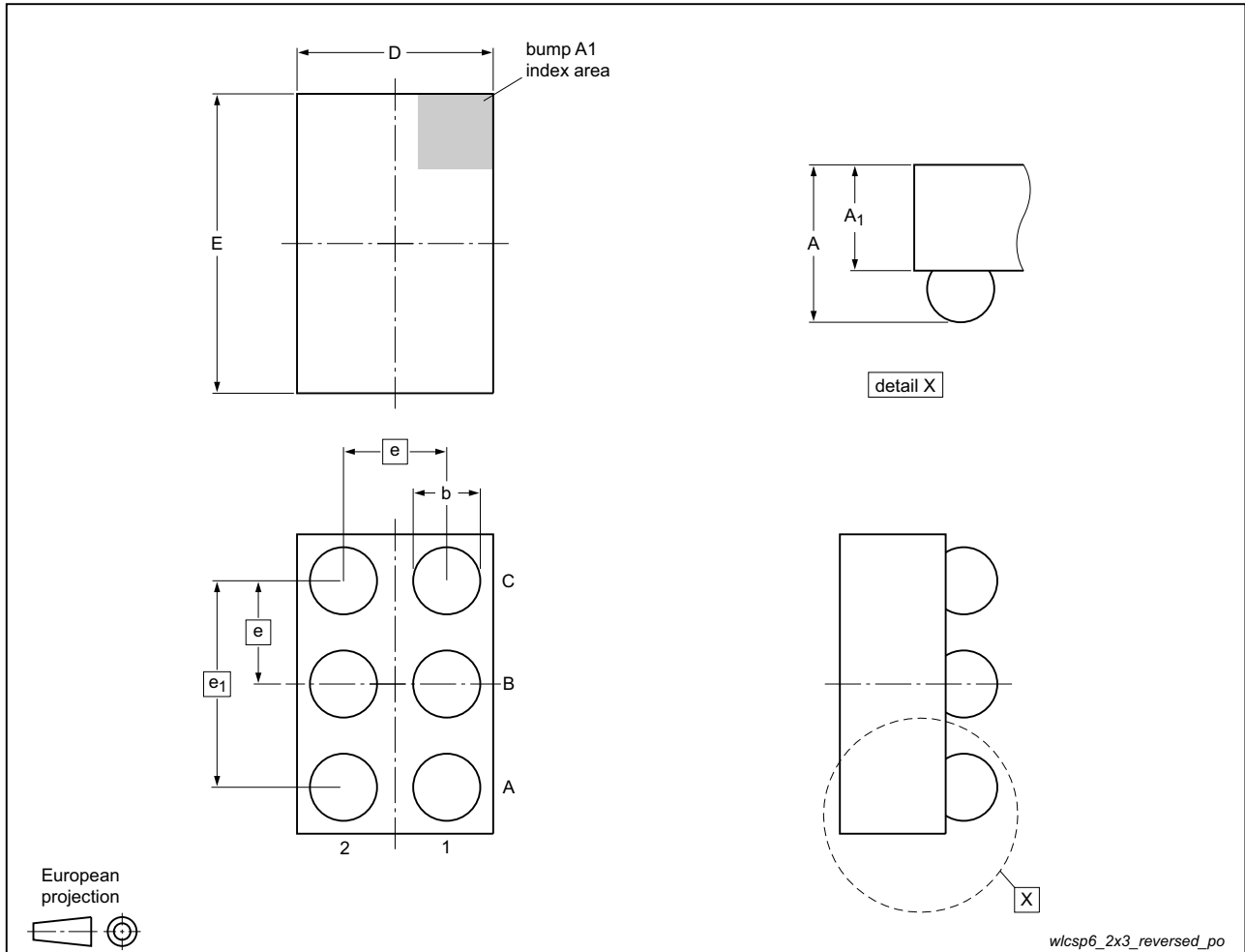


Fig 11. Package outline WLCSP6

Table 8. Package outline dimensions of WLCSP6

Symbol	Min	Typ	Max	Unit
A	0.54	0.57	0.60	mm
A <sub>1</sub>	0.36	0.37	0.38	mm
b	0.21	0.26	0.31	mm
D	0.90	0.95	1.00	mm
E	1.29	1.34	1.39	mm
e	0.38	0.40	0.42	mm
e <sub>1</sub>	0.76	0.80	0.84	mm



## 9. Packing information

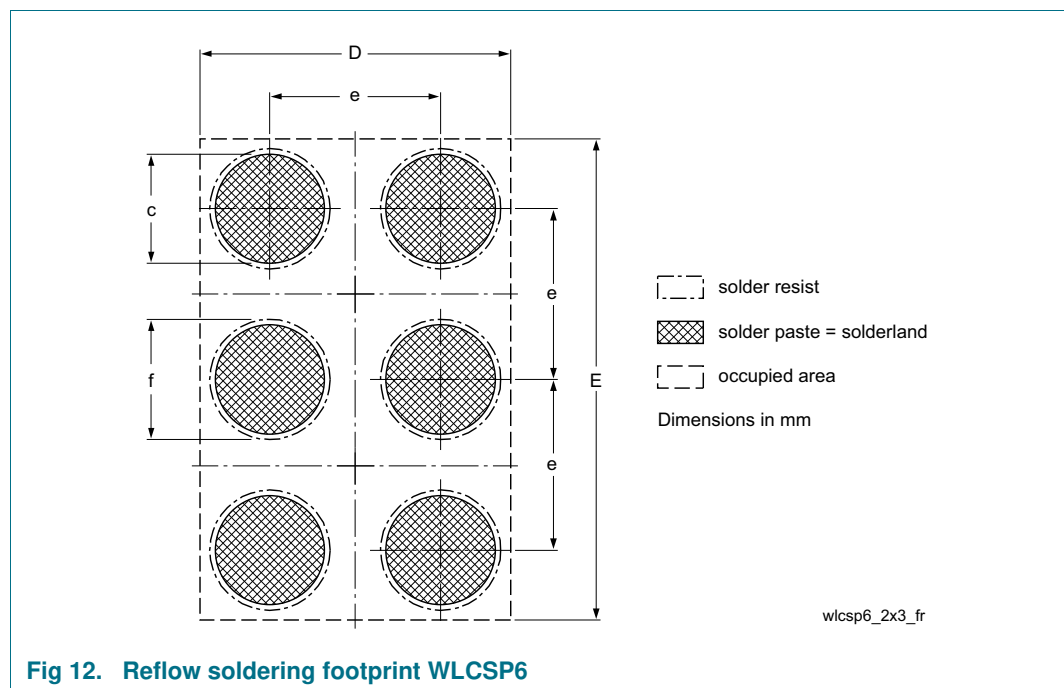
**Table 9. Packing methods**

The indicated -xxx are the last three digits of the 12NC ordering code.<sup>[1]</sup>

Type number	Package	Description	Packing quantity
			<b>4 500</b>
IP3319CX6	WLCSP6	4 mm pitch, 8 mm tape and reel	-135

[1] For further information and the availability of packing methods, see [Section 14](#).

## 10. Soldering



**Table 10. Reflow soldering dimensions of WLCSP6**

Symbol	Min	Typ	Max	Unit
c	-	0.25	-	mm
D	0.91	0.96	1.01	mm
E	1.31	1.36	1.41	mm
e	-	0.40	-	mm
f	-	0.325	-	mm

## 11. Design and assembly recommendations

### 11.1 PCB design guidelines

For optimum performance, use a Non-Solder Mask Defined (NSMD), also known as a copper-defined design, incorporating laser-drilled micro-vias connecting the ground pads to a buried ground-plane layer. This results in the lowest possible ground inductance and provides the best high frequency and ESD performance. Refer to [Table 11](#) for the recommended Printed-Circuit Board (PCB) design parameters.

**Table 11. Recommended PCB design parameters**

Parameter	Value or specification
PCB pad diameter	250 $\mu\text{m}$
Micro-via diameter	100 $\mu\text{m}$ (0.004 inch)
Solder mask aperture diameter	325 $\mu\text{m}$
Copper thickness	20 $\mu\text{m}$ to 40 $\mu\text{m}$
Copper finish	AuNi
PCB material	FR4

### 11.2 PCB assembly guidelines for Pb-free soldering

**Table 12. Assembly recommendations**

Parameter	Value or specification
Solder screen aperture diameter	290 $\mu\text{m}$
Solder screen thickness	100 $\mu\text{m}$ (0.004 inch)
Solder paste: Pb-free	SnAg (3 % to 4 %) Cu (0.5 % to 0.9 %)
Solder to flux ratio	50 : 50
Solder reflow profile	see <a href="#">Figure 13</a>

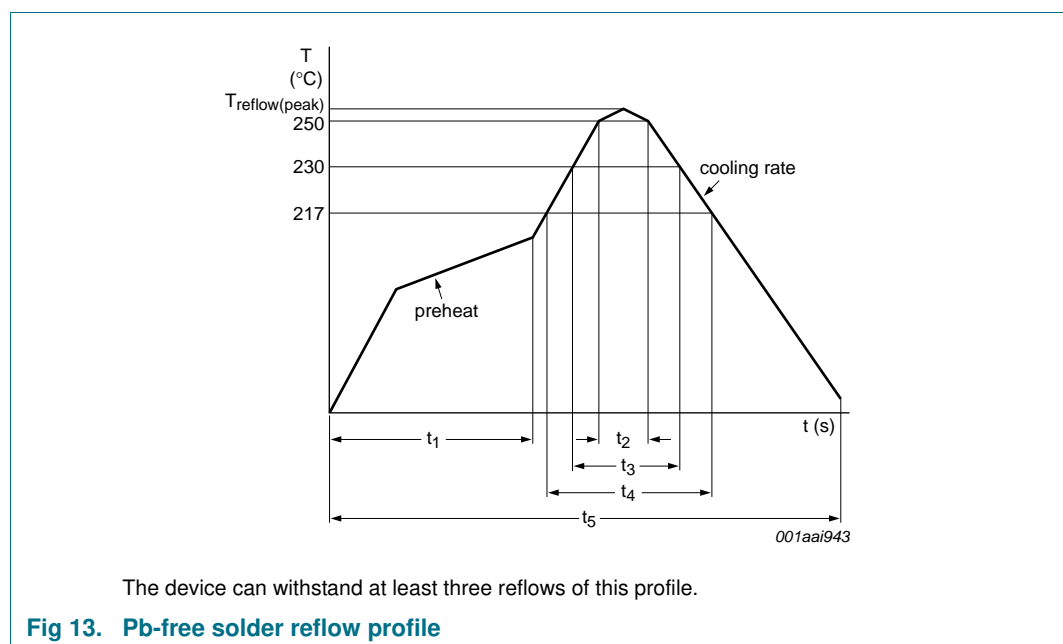


Table 13. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$T_{\text{reflow(peak)}}$	peak reflow temperature		230	-	260	°C
$t_1$	time 1	soak time	60	-	180	s
$t_2$	time 2	time during $T \geq 250$ °C	-	-	30	s
$t_3$	time 3	time during $T \geq 230$ °C	10	-	50	s
$t_4$	time 4	time during $T > 217$ °C	30	-	150	s
$t_5$	time 5		-	-	540	s
$dT/dt$	rate of change of temperature	cooling rate	-	-	-6	°C/s
		pre-heat	2.5	-	4.0	°C/s

## 12. Revision history

Table 14. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
IP3319CX6 v.2	20130529	Product data sheet	-	IP3319CX6 v.1
Modifications:		<ul style="list-style-type: none"><li>• <a href="#">Section 1.1 “General description”</a>: corrected</li><li>• <a href="#">Table 5</a>: <math>V_I</math> and <math>V_{ESD}</math> updated</li><li>• <a href="#">Table 6</a>: <math>R_{S(ch)}</math>, <math>C_d</math> and <math>V_{BR}</math> updated</li><li>• <a href="#">Section 13 “Legal information”</a>: updated</li></ul>		
IP3319CX6 v.1	20130130	Product data sheet	-	-

## 13. Legal information

### 13.1 Data sheet status

Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	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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