

# IP3348CX5; IP3348CX10; IP3348CX15; IP3348CX20

Integrated multi channel LC-filter network for high-speed data interfaces with ESD protection to IEC 61000-4-2 level 4

Rev. 1.1 — 4 April 2011

Product data sheet

## 1. Product profile

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### 1.1 General description

IP3348CX5, IP3348CX10, IP3348CX15 and IP3348CX20 is a 2, 4, 6 and 8-channel LC low-pass filter network for high-speed data interfaces. It is designed to provide filtering of undesired RF signals in the 800 MHz to 3 GHz frequency band while supporting data rates up to 400 Mbit/s. In addition, IP3348CX5, IP3348CX10, IP3348CX15 and IP3348CX20 incorporates diodes to provide protection to downstream components from ElectroStatic Discharge (ESD) voltages as high as  $\pm 20$  kV contact discharge according the IEC 61000-4-2 model, far exceeding standard level 4.

The devices are fabricated using monolithic silicon technology and integrate up to 8 inductors and up to 8 pairs of back-to-back diodes in a 0.4 mm pitch Wafer-Level Chip-Scale Package (WLCSP). These features make the IP3348CX5; IP3348CX10; IP3348CX15; IP3348CX20 ideal for use in applications requiring the utmost in miniaturization such as mobile phone handsets, cordless telephones and other portable electronic devices.

### 1.2 Features and benefits

- Pb-free, RoHS compliant and free of halogen and antimony (Dark Green compliant)
- Supports data rates up to 400 Mbit/s
- Integrated ESD protection withstanding  $\pm 20$  kV contact discharge, far exceeding IEC 61000-4-2 level 4
- WLCSP with 0.4 mm pitch

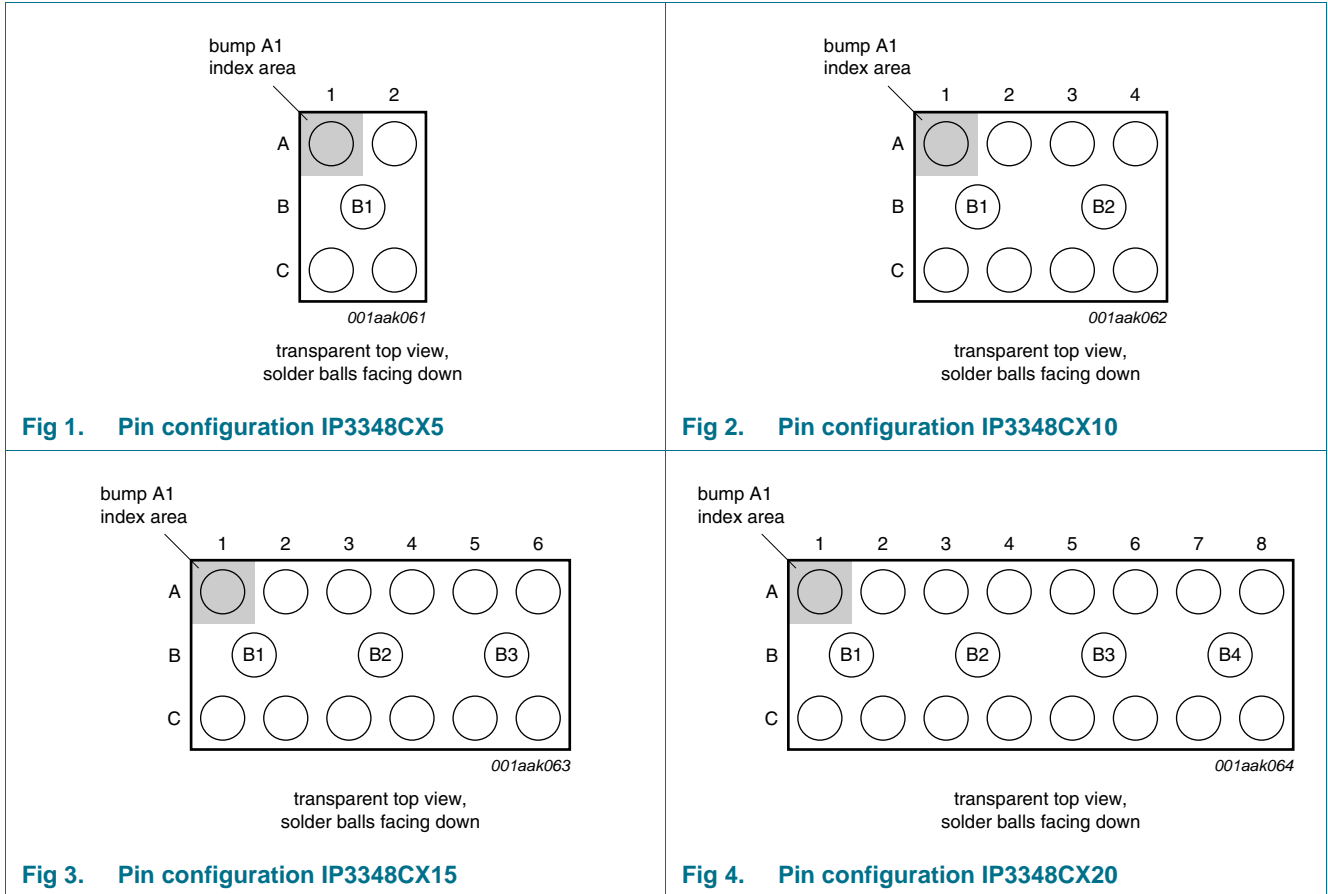
### 1.3 Applications

- ElectroMagnetic Interference (EMI) filtering and ESD protection for high-speed data interfaces like Mobile Industry Processor Interface (MIPI) and Mobile Display Digital Interface (MDDI)
- Camera imager interface
- High resolution color Liquid Crystal Display (LCD) interfaces



## 2. Pinning information

### 2.1 Pinning



### 2.2 Pin description

**Table 1. Pinning**

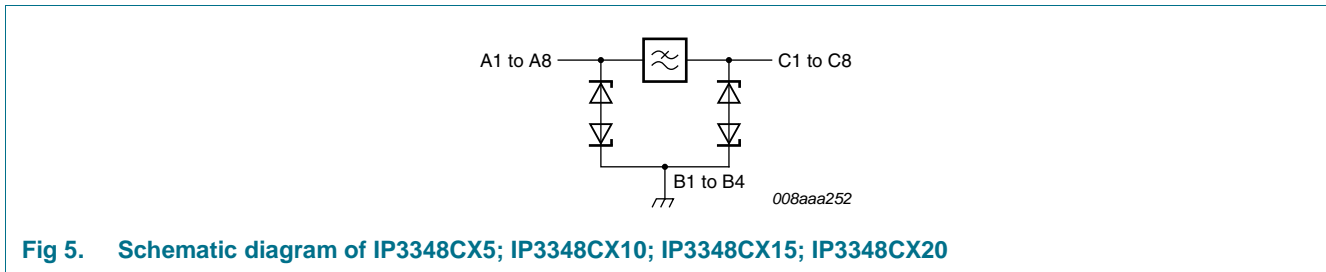
Pin	IP3348CX5	IP3348CX10	IP3348CX15	IP3348CX20	Description
A1 and C1	A1 and C1	A1 and C1	A1 and C1	A1 and C1	filter channel 1
A2 and C2	A2 and C2	A2 and C2	A2 and C2	A2 and C2	filter channel 2
-	A3 and C3	A3 and C3	A3 and C3	A3 and C3	filter channel 3
-	A4 and C4	A4 and C4	A4 and C4	A4 and C4	filter channel 4
-	-	A5 and C5	A5 and C5	A5 and C5	filter channel 5
-	-	A6 and C6	A6 and C6	A6 and C6	filter channel 6
-	-	-	A7 and C7	A7 and C7	filter channel 7
-	-	-	A8 and C8	A8 and C8	filter channel 8
B1	B1 and B2	B1, B2 and B3	B1, B2, B3 and B4	B1, B2, B3 and B4	ground

### 3. Ordering information

**Table 2. Ordering information**

Type number	Package		Version
	Name	Description	
IP3348CX5	WLCSP5	wafer level chip-size package; 5 bumps (2-1-2)	IP3348CX5
IP3348CX10	WLCSP10	wafer level chip-size package; 10 bumps (4-2-4)	IP3348CX10
IP3348CX15	WLCSP15	wafer level chip-size package; 15 bumps (6-3-6)	IP3348CX15
IP3348CX20	WLCSP20	wafer level chip-size package; 20 bumps (8-4-8)	IP3348CX20

### 4. Functional diagram



**Fig 5. Schematic diagram of IP3348CX5; IP3348CX10; IP3348CX15; IP3348CX20**

### 5. Limiting values

**Table 3. Limiting values**

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

Symbol	Parameter	Conditions	Min	Max	Unit
$V_I$	input voltage		-4	+4	V
$I_{ch}$	channel current (DC)	$T_{amb} = 85\text{ °C}$	-	20	mA
$V_{ESD}$	electrostatic discharge voltage	all pins to ground			
		contact discharge; 10 pulses <a href="#">[1]</a>	-20	+20	kV
		air discharge	-20	+20	kV
		IEC 61000-4-2 level 4; all pins to ground			
		contact discharge	-8	+8	kV
	air discharge	-15	+15	kV	
$P_{ch}$	channel power dissipation	continuous; $T_{amb} = 85\text{ °C}$	-	10	mW
$T_{stg}$	storage temperature		-55	+150	°C
$T_{reflow(peak)}$	peak reflow temperature	10 s maximum	-	260	°C
$T_{amb}$	ambient temperature		-40	+85	°C

[1] Device is qualified with 1000 pulses of  $\pm 15\text{ kV}$  contact discharges each, according to the IEC 61000-4-2 model and far exceeds the specified level 4 (8 kV contact discharge).

## 6. Characteristics

**Table 4. Channel characteristics**

$T_{amb} = 25\text{ }^{\circ}\text{C}$ ; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$R_{s(ch)}$	channel series resistance		-	10	-	$\Omega$
$L_{s(ch)}$	channel series inductance		[1]	15	-	nH
$C_{ch}$	channel capacitance	$f = 100\text{ kHz}$	[1]			
		$V_{bias(DC)} = 0\text{ V}$	-	30	-	pF
		$V_{bias(DC)} = 2.5\text{ V}$	-	25	-	pF
$V_{BR}$	breakdown voltage	$I_{test} = 1\text{ mA}$	5	-	10	V
		$I_{test} = -1\text{ mA}$	-10	-	-5	V
$I_{LR}$	reverse leakage current	per channel; $V_I = 3\text{ V}$	-	10	100	nA
		per channel; $V_I = -3\text{ V}$	-100	-10	-	nA

[1] Guaranteed by design.

**Table 5. Frequency characteristics**

$T_{amb} = 25\text{ }^{\circ}\text{C}$ ; unless otherwise specified.

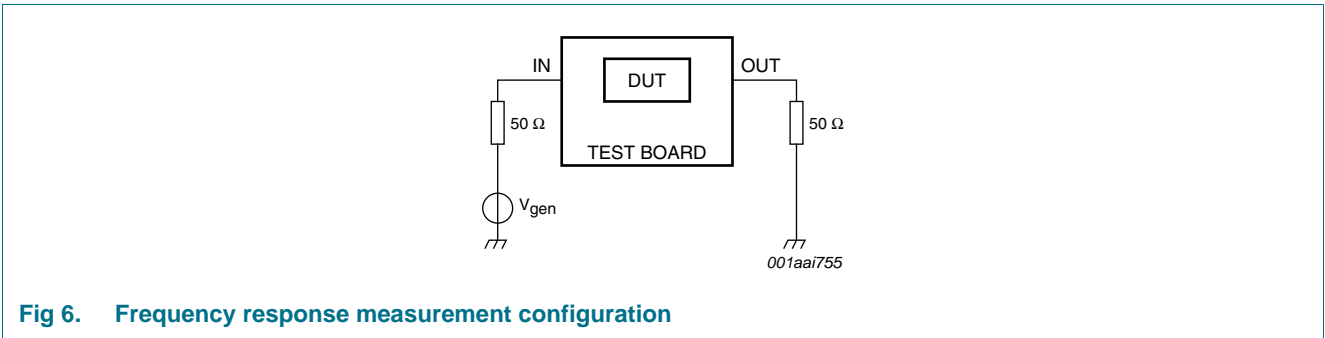
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$\alpha_{il}$	insertion loss	$R_{gen} = 50\ \Omega$ ; $R_L = 50\ \Omega$				
		$800\text{ MHz} < f_i < 1\text{ GHz}$	25	-	-	dB
		$1\text{ GHz} < f_i < 3\text{ GHz}$	30	40	-	dB
		$f_i = 0\text{ Hz}$ ; $V_{bias(DC)} = 0\text{ V}$	-	-	1	dB
$f_{-3dB}$	cut-off frequency	$R_{gen} = 50\ \Omega$ ; $R_L = 50\ \Omega$	[1]	-	350	MHz
$\alpha_{ct}$	crosstalk attenuation	$R_{gen} = 50\ \Omega$ ; $R_L = 50\ \Omega$ ; $800\text{ MHz} < f_i < 3\text{ GHz}$	35	-	-	dB

[1] Measured relative to insertion loss at DC.

## 7. Application information

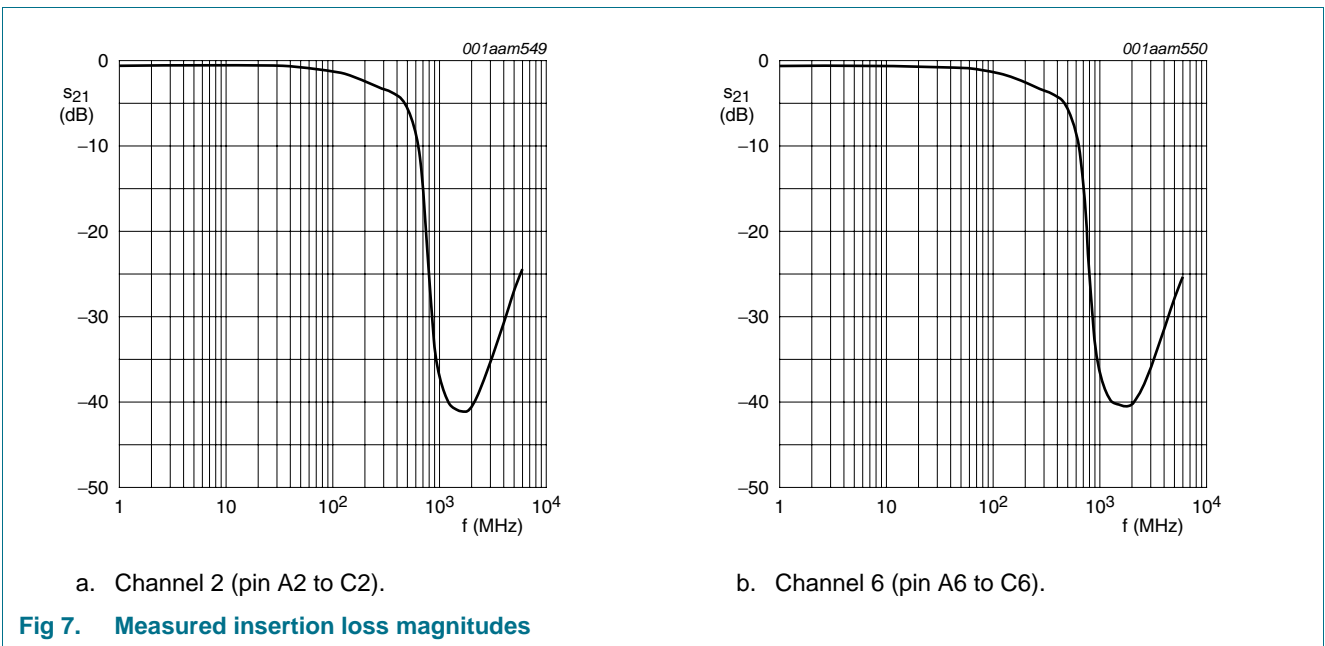
### 7.1 Insertion loss

The setup for measuring insertion loss in a 50 Ω system is shown in [Figure 6](#).



**Fig 6. Frequency response measurement configuration**

As an example, the insertion loss in a 50 Ω system for two channels of the IP3348CX15 are shown in [Figure 7](#). The insertion loss is measured directly on the wafer with coplanar probes. Unused pins are connected to ground with 50 Ω.

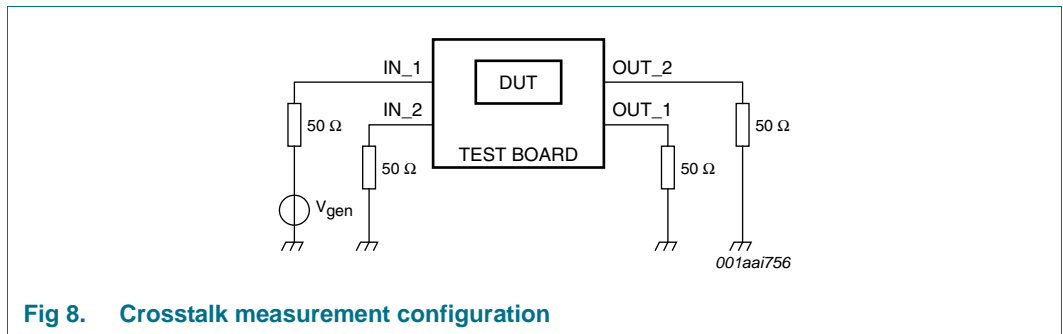


**Fig 7. Measured insertion loss magnitudes**

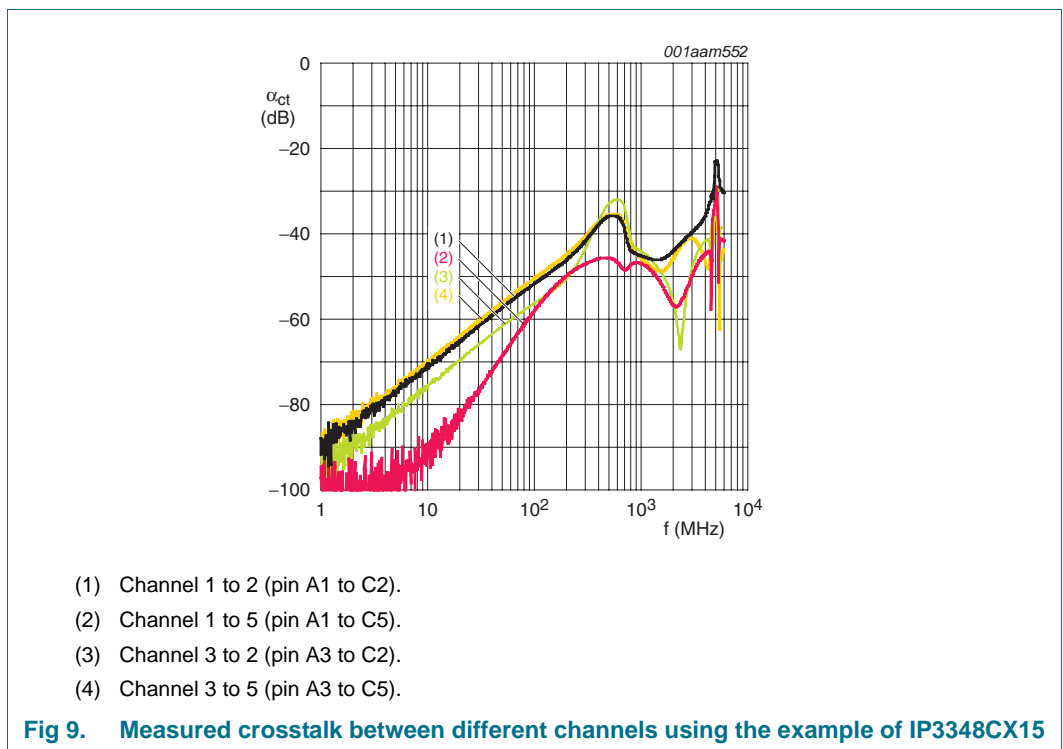
## 7.2 Crosstalk

The crosstalk measurement configuration of a typical 50 Ω NetWork Analyzer (NWA) system for evaluation of the IP3348CX5, IP3348CX10, IP3348CX15 and IP3348CX20 is shown in [Figure 8](#).

Four typical examples of crosstalk measurement results of IP3348CX15 are depicted. Unused channels are terminated with 50 Ω to ground.



**Fig 8. Crosstalk measurement configuration**



**Fig 9. Measured crosstalk between different channels using the example of IP3348CX15**

7.3 Eye diagram

The transient behavior of the IP3348CX5, IP3348CX10, IP3348CX15 and IP3348CX20 at a data rate of 400 Mbit/s is shown in [Figure 10](#) based on eye diagram measurements.

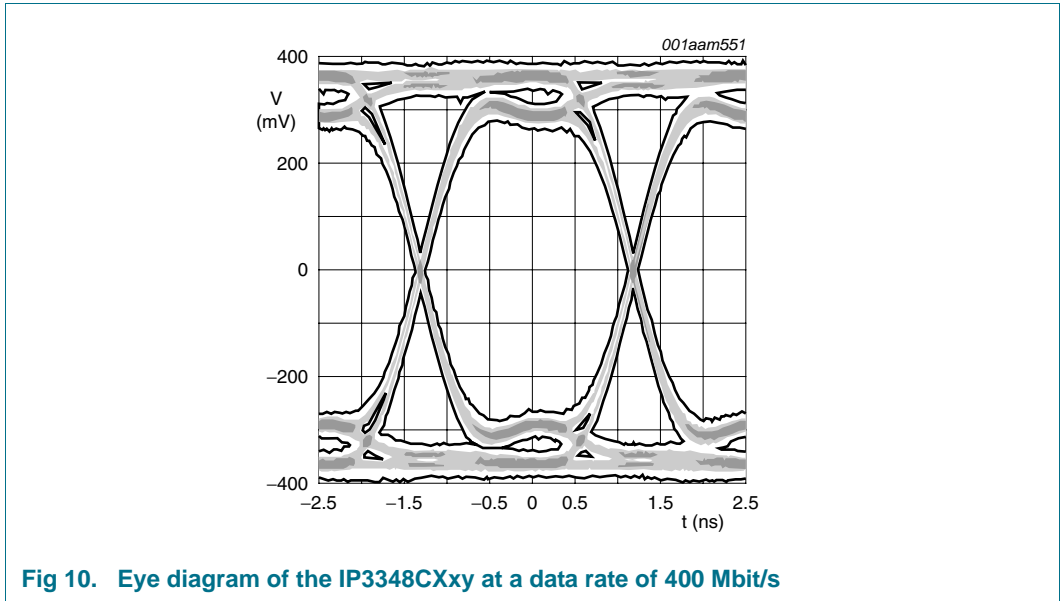


Fig 10. Eye diagram of the IP3348CXxy at a data rate of 400 Mbit/s

While [Figure 10](#) shows the eye diagram of the IP3348CXxy for a data rate of 400 Mbit/s the time characteristics for different data rates can be found in [Table 6](#).

Furthermore the percentage of time where the signal amplitude is above the MIPI receiver High-Speed (HS) mode threshold voltage of  $\pm 70$  mV is shown, too. This is a good indicator for the achievable data rate in an MIPI HS mode application.

E.g. the IP3348CXxy can be used up to a data rate of 600 Mbit/s if the receiver is able to detect bits whose amplitudes are 75 % of time above the threshold.

Table 6. Eye diagram time characteristics

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

Data rate [Mbit/s]	Period time [ns]	$\Delta t$ @ $\pm 70$ mV [ns]	Time above MIPI HS mode threshold of $\pm 70$ mV [%]
300	3.33	3.04	91.3
350	2.85	2.56	89.3
400	2.50	2.20	88.0
450	2.22	1.89	85.1
500	2.00	1.63	81.5
550	1.81	1.42	78.4
600	1.66	1.26	75.9

## 8. Package outline

WLCSP5: wafer level chip-size package; 5 bumps (2-1-2)

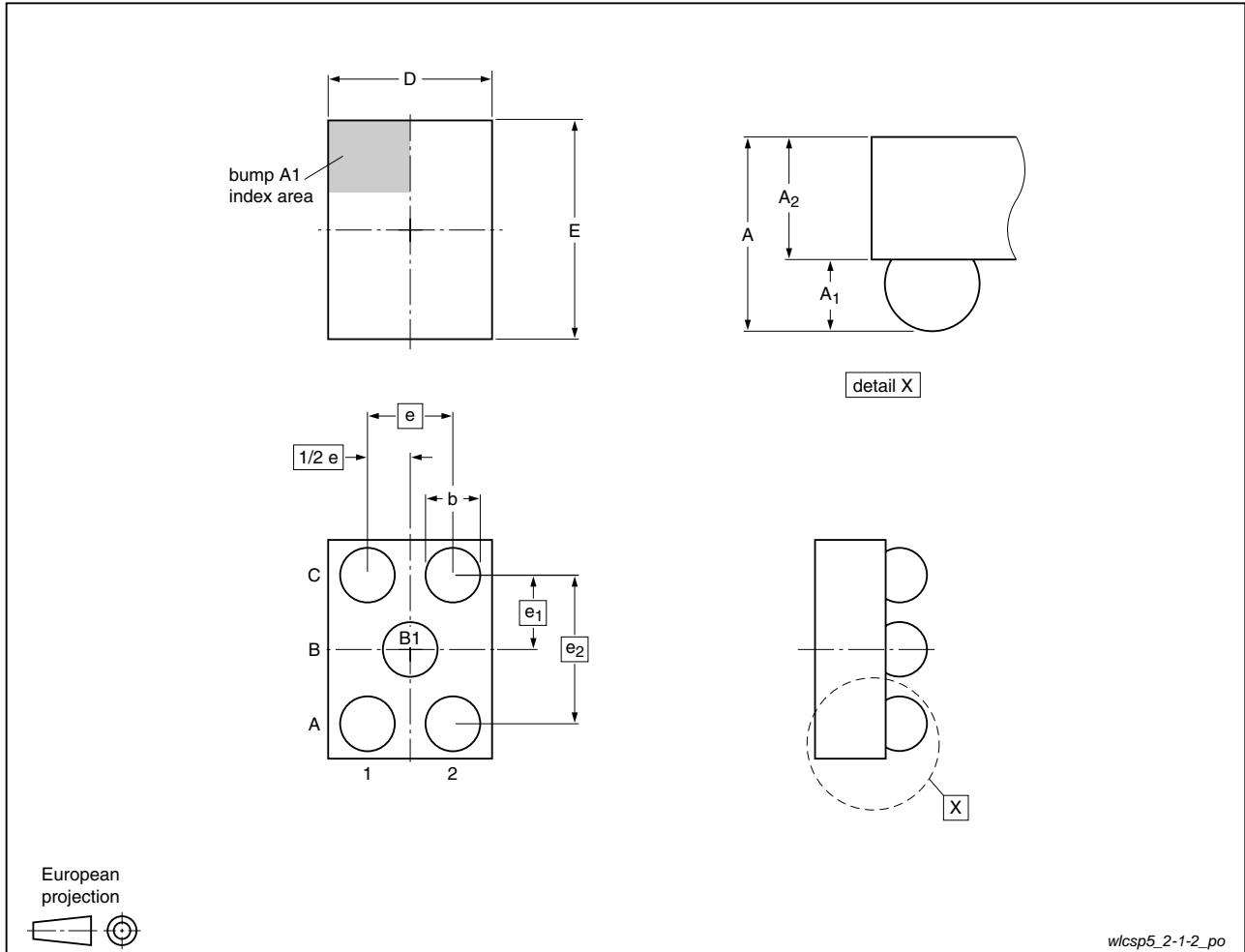


Fig 11. Package outline IP3348CX5 (WLCSP5)

Table 7. Dimensions for [Figure 11](#)

Symbol	Min	Typ	Max	Unit
A	0.57	0.61	0.65	mm
A <sub>1</sub>	0.18	0.20	0.22	mm
A <sub>2</sub>	0.39	0.41	0.43	mm
b	0.21	0.26	0.31	mm
D	0.71	0.76	0.81	mm
E	1.01	1.06	1.11	mm
e	-	0.4	-	mm
e <sub>1</sub>	-	0.346	-	mm
e <sub>2</sub>	-	0.692	-	mm







WLCSP20: wafer level chip-size package; 20 bumps (8-4-8)

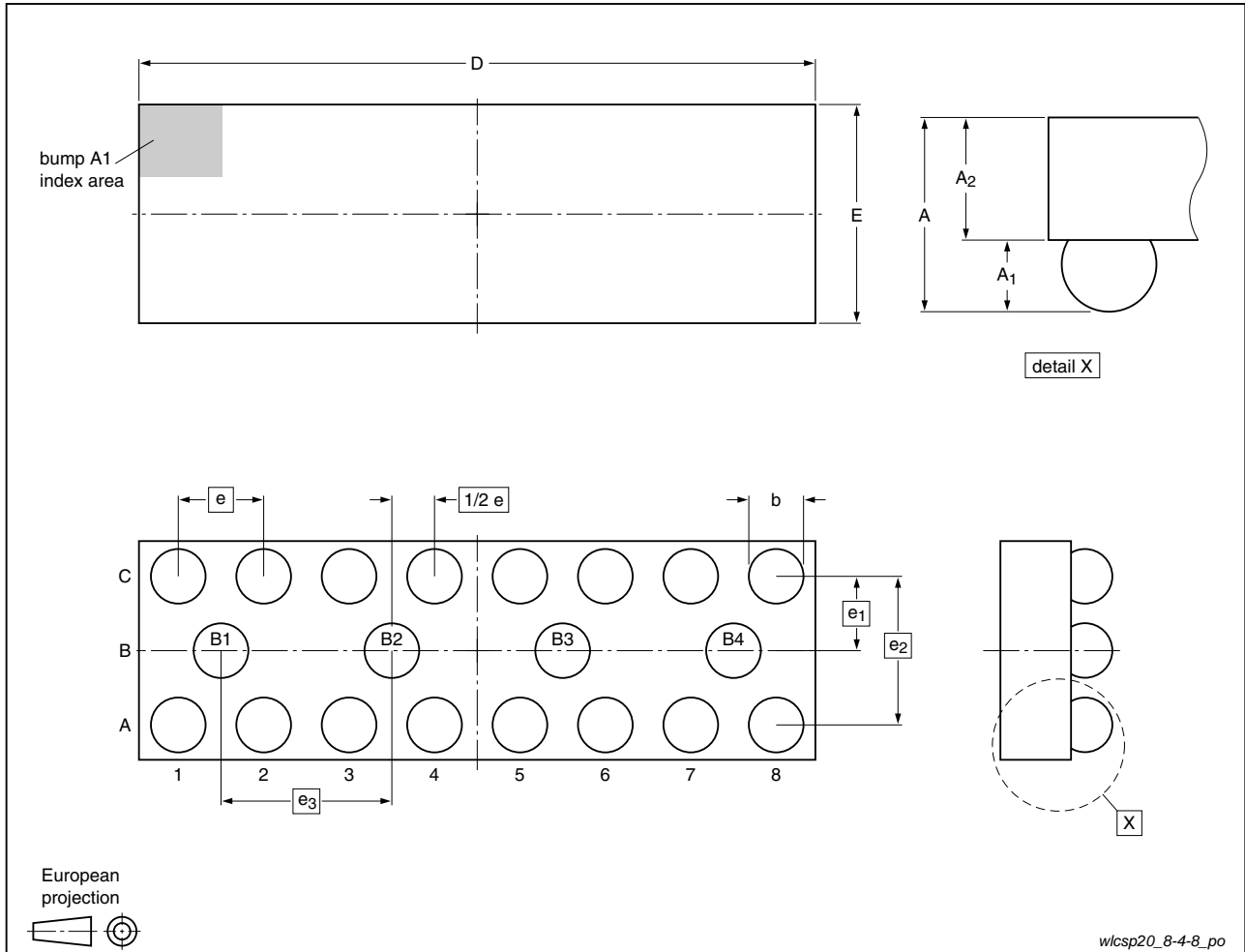


Fig 14. Package outline IP3348CX20 (WLCSP20)

Table 10. Dimensions for Figure 14

Symbol	Min	Typ	Max	Unit
A	0.57	0.61	0.65	mm
A <sub>1</sub>	0.18	0.20	0.22	mm
A <sub>2</sub>	0.39	0.41	0.43	mm
b	0.21	0.26	0.31	mm
D	3.11	3.16	3.21	mm
E	1.01	1.06	1.11	mm
e	-	0.4	-	mm
e <sub>1</sub>	-	0.346	-	mm
e <sub>2</sub>	-	0.692	-	mm
e <sub>3</sub>	-	0.8	-	mm

## 9. Design and assembly recommendations

### 9.1 PCB design guidelines

It is recommended, for optimum performance, to 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 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

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

**Table 12. Assembly recommendations**

Parameter	Value or specification
Solder screen aperture diameter	325 $\mu\text{m}$
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 15</a>

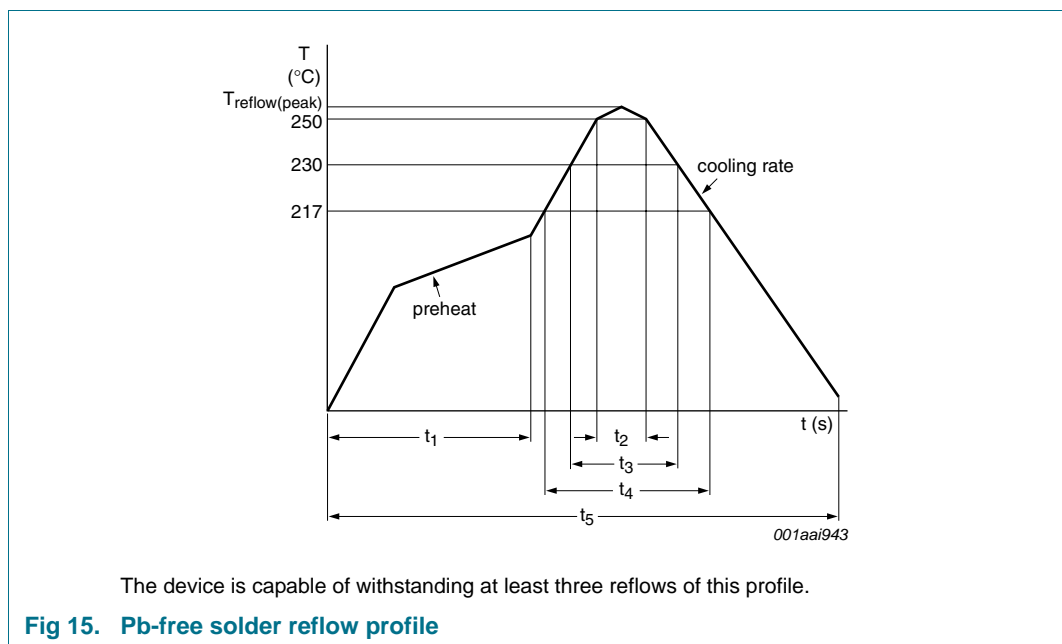


Table 13. Characteristics

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
		preheat	2.5	-	4.0	°C/s

## 10. Abbreviations

Table 14. Abbreviations

Acronym	Description
DUT	Device Under Test
EMI	ElectroMagnetic Interference
ESD	ElectroStatic Discharge
FR4	Flame Retard 4
HS	High-Speed
LCD	Liquid Crystal Display
MDDI	Mobile Display Digital Interface
MIPI	Mobile Industry Processor Interface
NSMD	Non-Solder Mask Defined
NWA	NetWork Analyzer
PCB	Printed-Circuit Board
RF	Radio Frequency
RoHS	Restriction of Hazardous Substances
WLCSP	Wafer-Level Chip-Scale Package

## 11. Revision history

Table 15. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
IP3348CX5_CX10_CX15_CX20 v.1.1	20110404	Product data sheet	-	IP3348CX5_CX10_CX15_CX20 v.1
Modifications:			• <a href="#">Section 1.3</a> : Changed MIDI to MIPI	
IP3348CX5_CX10_CX15_CX20 v.1	20101102	Product data sheet	-	-

## 12. Legal information

### 12.1 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.
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[2] The term 'short data sheet' is explained in section "Definitions".

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