

# IP4359CX4

## Dual channel low capacitance high performance ESD protection

Rev. 1 — 6 August 2010

Product data sheet

## 1. Product profile

---

### 1.1 General description

The IP4359CX4 is a dual channel low capacitance ElectroStatic Discharge (ESD) protection device, providing protection to downstream components from ESD voltages as high as  $\pm 15$  kV contact discharge and  $> \pm 15$  kV air discharge according the IEC 61000-4-2 model, far exceeding standard level 4.

The device is optimized for protection of high speed interfaces such as Universal Serial Bus (USB) 2.0, High Definition Multimedia Interface (HDMI), Digital Visual Interface (DVI) and other interfaces requiring very low capacitance ESD protection.

The device is available in two different heights. 0.61 mm and reduced maximum height of 0.5 mm. Both versions contain identical circuits and show an identical electrical performance. Both ESD protection channels share common ground connections, but are electrically separated, thereby preventing current back drive into the adjacent channel. IP4359CX4 is fabricated using monolithic silicon technology in a single Wafer-Level Chip-Scale Package (WLCSP). These features make the IP4359CX4 ideal for use in applications requiring component miniaturization such as mobile phone handsets and other portable electronic devices.

### 1.2 Features and benefits

- Pb-free, RoHS compliant and free of halogen and antimony (Dark Green compliant)
- 2 ultra low input capacity rail-to-rail ESD protection diodes with  $C_{(I/O-GND)} = 1.3$  pF
- $R_{dyn} = 0.45 \Omega$
- Integrated ESD protection withstanding  $\pm 15$  kV contact discharge and  $> \pm 15$  kV air discharge, far exceeding IEC 61000-4-2 level 4
- Standard height version (0.61 mm) available as IP4359CX4/LF
- Reduced height version (maximum height of 0.5 mm) available as IP4359CX4/LF-H500
- $2 \times 2$  solder ball WLCSP with 0.4 mm pitch

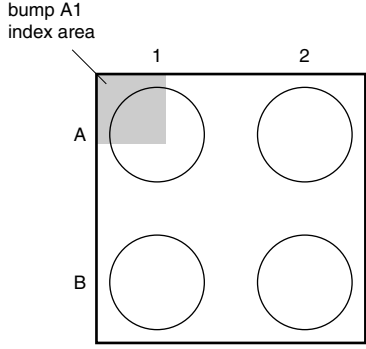
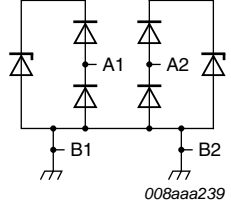
### 1.3 Applications

- High-speed interface ESD protection such as USB 2.0, HDMI, DVI etc.
- Interfaces with special requirements on low capacitive ESD protection
- Interfaces requiring separation of the positive clamping voltage/current path



## 2. Pinning information

Table 1. Pinning

Pin	Description	Simplified outline	Graphic symbol
A1 and A2	ESD protection	 <p>008aaa236</p>	 <p>008aaa239</p>
B1 and B2	ground		

transparent top view,  
solder balls facing down

## 3. Ordering information

Table 2. Ordering information

Type number	Package height	Package		
		Name	Description	Version
IP4359CX4/LF	standard <sup>[1]</sup>	WLCSP4	wafer level chip-size package; 4 bumps (2 × 2)	IP4359CX4
IP4359CX4/LF-H500	reduced <sup>[2]</sup>	WLCSP4	wafer level chip-size package; 4 bumps (2 × 2)	IP4359CX4

[1] For details see [Table 5](#).

[2] For details see [Table 6](#).

## 4. 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	pins A1 and A2 to ground (B1, B2)	-0.5	+5.5	V	
$V_{ESD}$	electrostatic discharge voltage	pins A1 and A2 to ground (B1, B2)				
		contact discharge	[1]	-15	+15	kV
		air discharge	[1]	-20	+20	kV
		IEC 61000-4-2 level 4; pins A1 and A2 to ground (B1, B2)				
		contact discharge		-8	+8	kV
	air discharge		-15	+15	kV	
$T_{stg}$	storage temperature		-55	+150	°C	
$T_{reflow(peak)}$	peak reflow temperature	10 s maximum	-	260	°C	
$T_{amb}$	ambient temperature		-35	+85	°C	

[1] Device is qualified with 1000 pulses of  $\pm 15$  kV contact discharges each, according to the IEC61000-4-2 model and far exceeds the specified level 4 (8 kV contact discharge).

## 5. Characteristics

**Table 4. Electrical characteristics**

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
$C_{(I/O-GND)}$	input/output to ground capacitance	pins A1 and A2 to ground (B1, B2); $V_I = 3.3$ V; $f = 1$ MHz	[1]	-	1.3	1.5	pF
$I_{LR}$	reverse leakage current	pins A1 and A2 to ground (B1, B2); $V_I = 3.3$ V	-	-	100	nA	
$V_{BRzd}$	Zener diode breakdown voltage	$I_{test} = 1$ mA	6	-	9	V	
$V_F$	forward voltage		-	0.7	-	V	
$R_{dyn}$	dynamic resistance	$I_{test} = 1$ A; IEC 61000-4-5					
		positive discharge	-	0.45	-	$\Omega$	
		negative discharge	-	0.45	-	$\Omega$	

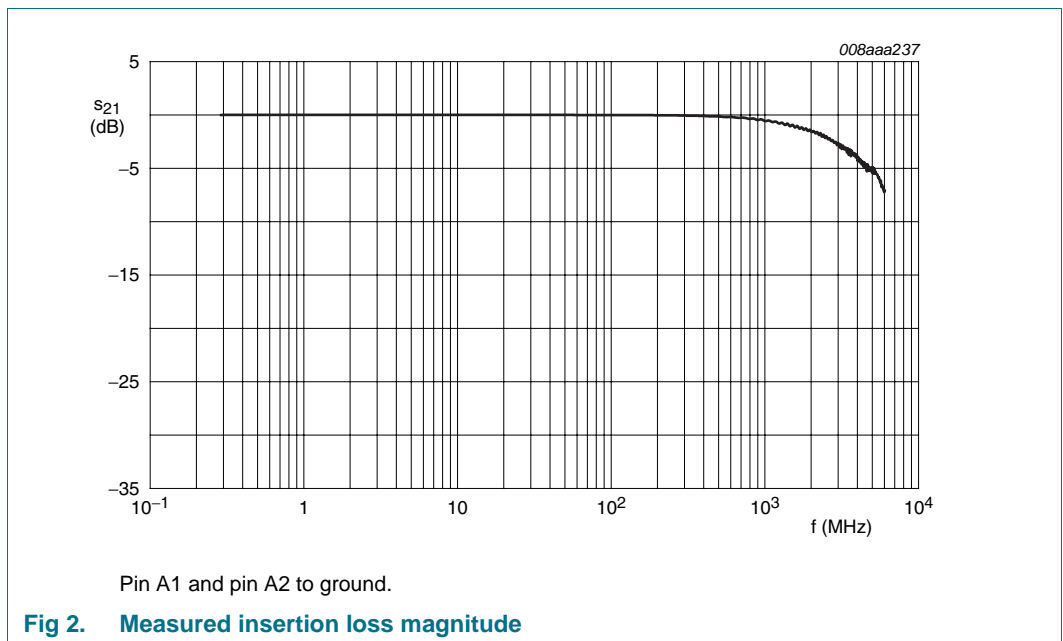
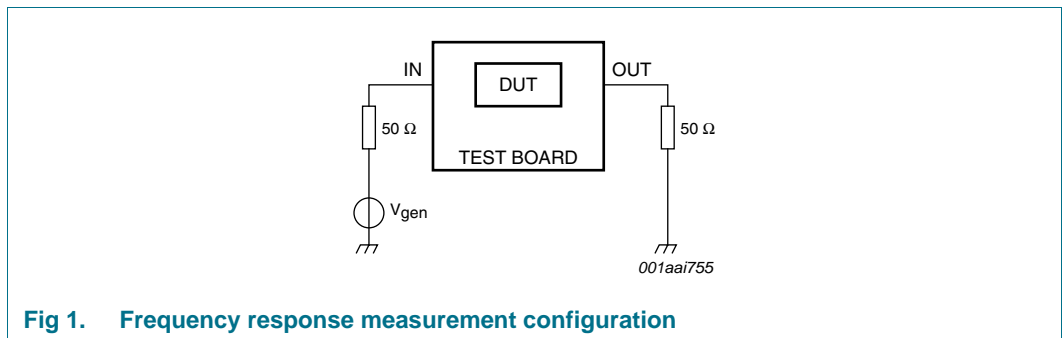
[1] Guaranteed by design.

## 6. Application information

### 6.1 Insertion loss

The IP4359CX4 is mainly designed as an ESD protection device for high speed interfaces such as USB 2.0, DVI and HDMI high speed data lines etc. The insertion loss measurement configuration of a typical 50 Ω NetWork Analyzer (NWA) system for evaluation of the IP4359CX4 is shown in [Figure 1](#).

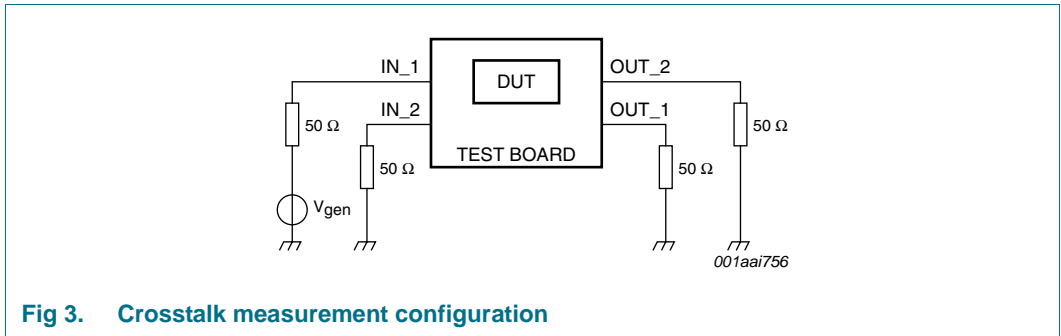
The insertion loss of IP4359CX4 is depicted in [Figure 2](#).



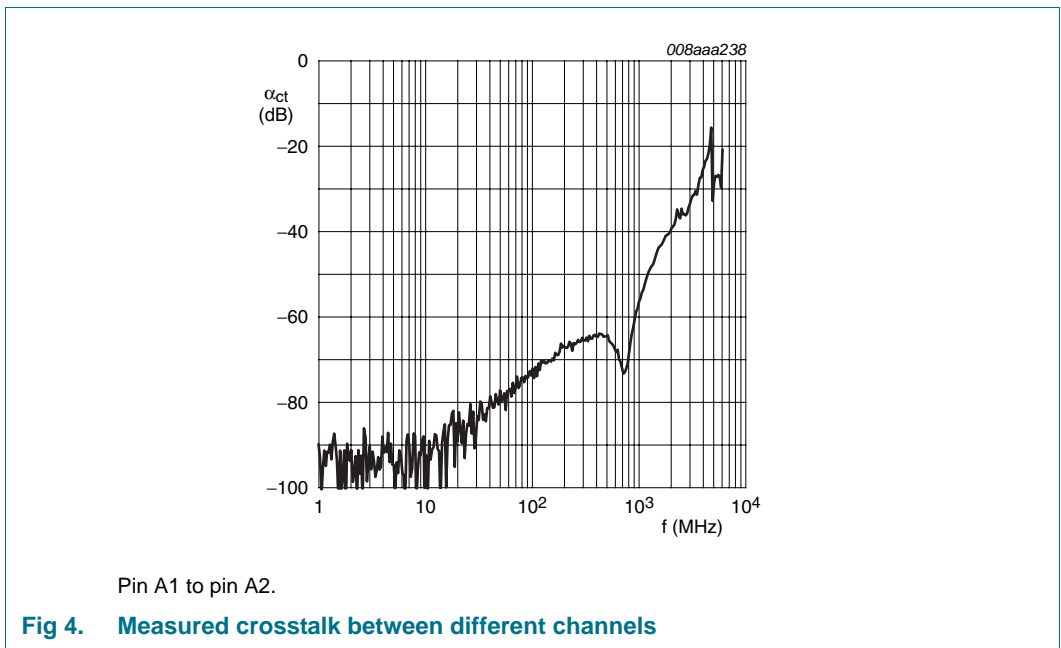
### 6.2 Crosstalk

The crosstalk measurement configuration of a typical 50 Ω NWA system for evaluation of the IP4359CX4 is shown in [Figure 3](#).

The crosstalk measurement results of IP4359CX4 are depicted in [Figure 4](#).



**Fig 3. Crosstalk measurement configuration**



**Fig 4. Measured crosstalk between different channels**

## 7. Package outline

WLCSP4: wafer level chip-size package; 4 bumps (2 x 2)

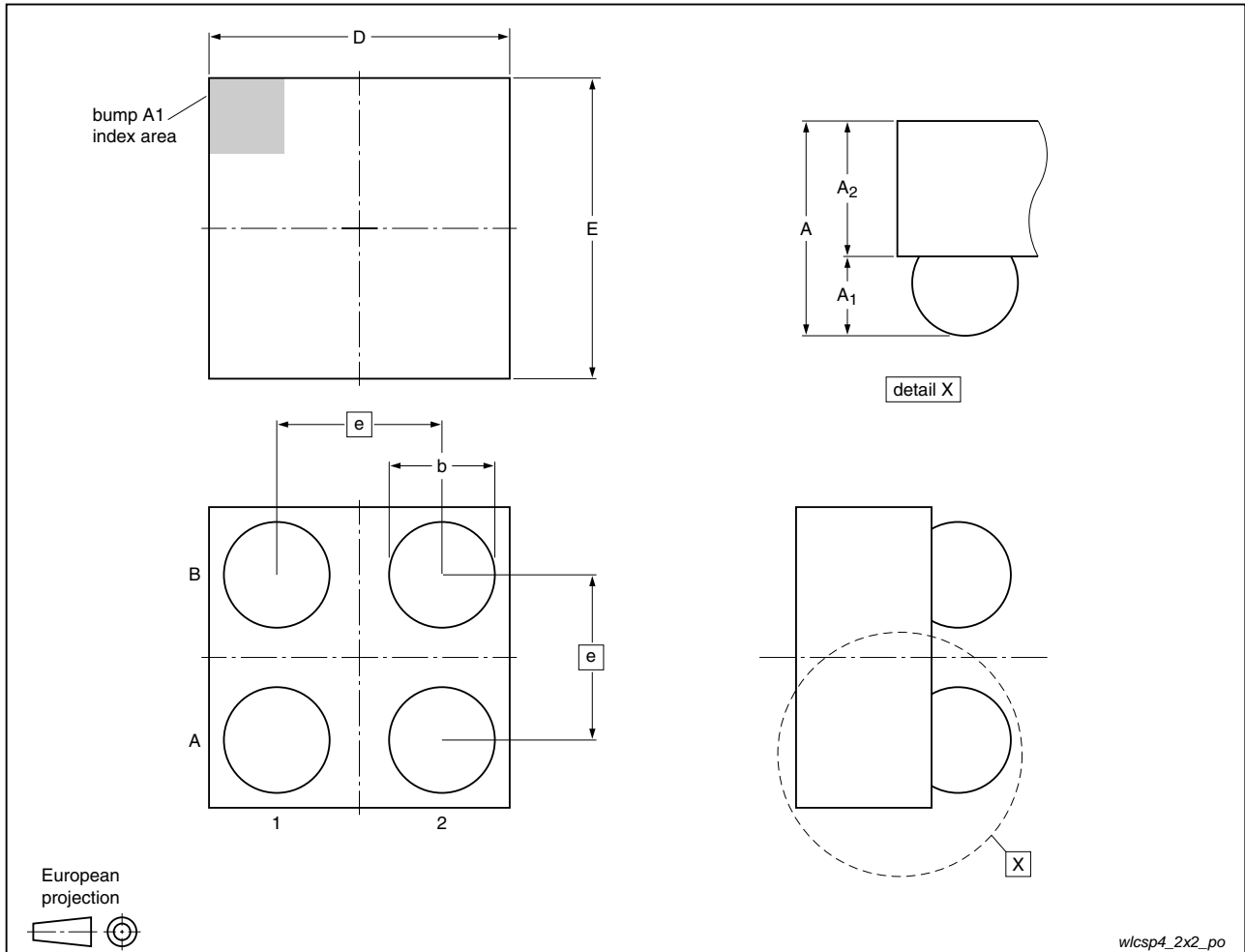


Fig 5. Package outline IP4359CX4 (WLCSP4)

Table 5. Dimensions of IP4359CX4/LF for [Figure 5](#)

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	0.71	0.76	0.81	mm
e	-	0.4	-	mm

**Table 6.** Dimensions of IP4359CX4/LF-H500 for [Figure 5](#)

Symbol	Min	Typ	Max	Unit
A	0.41	0.45	0.49	mm
A <sub>1</sub>	0.18	0.20	0.22	mm
A <sub>2</sub>	0.23	0.25	0.27	mm
b	0.21	0.26	0.31	mm
D	0.71	0.76	0.81	mm
E	0.71	0.76	0.81	mm
e	-	0.4	-	mm

## 8. Design and assembly recommendations

### 8.1 PCB design guidelines

For optimum performance it is recommended 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. For this case, refer to [Table 7](#) for the recommended PCB design parameters.

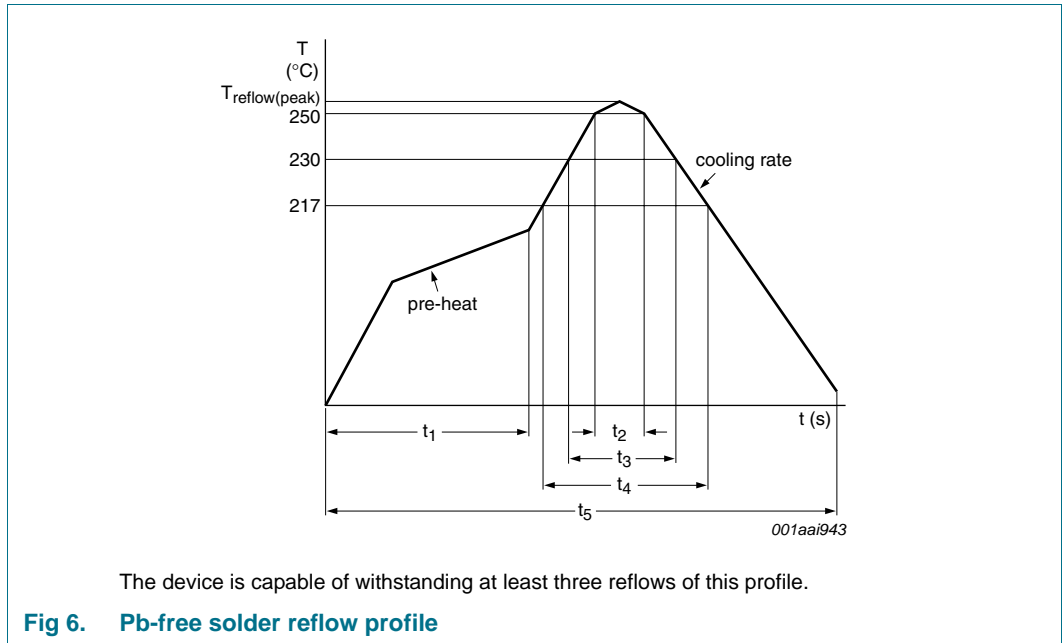
**Table 7.** Recommended PCB design parameters

Parameter	Value or specification
PCB pad diameter	250 μm
Micro-via diameter	100 μm (0.004 inch)
Solder mask aperture diameter	325 μm
Copper thickness	20 μm to 40 μm
Copper finish	AuNi or OSP
PCB material	FR4

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

**Table 8.** Assembly recommendations

Parameter	Value or specification
Solder screen aperture diameter	290 μm
Solder screen thickness	100 μm (0.004 inch)
Solder paste: Pb-free	SnAg (3 % to 4 %) Cu (0.5 % to 0.9 %)
Solder / flux ratio	50 / 50
Solder reflow profile	see <a href="#">Figure 6</a>



**Table 9. 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 $T \geq 250\text{ °C}$	-	-	30	s
$t_3$	time 3	time during $T \geq 230\text{ °C}$	10	-	50	s
$t_4$	time 4	time during $T > 217\text{ °C}$	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



## 9. Abbreviations

**Table 10. Abbreviations**

Acronym	Description
DUT	Device Under Test
DVI	Digital Visual Interface
ESD	ElectroStatic Discharge
FR4	Flame Retard 4
HDMI	High Definition Multimedia Interface
IEC	International Electrotechnical Commission
NSMD	Non-Solder Mask Defined
NWA	NetWork Analyzer
OSP	Organic Solderability Preservative
PCB	Printed-Circuit Board
RoHS	Restriction of Hazardous Substances
USB	Universal Serial Bus
WLCSP	Wafer-Level Chip-Scale Package

## 10. Revision history

**Table 11. Revision history**

Document ID	Release date	Data sheet status	Change notice	Supersedes
IP4359CX4 v.1	20100806	Product data sheet	-	-

## 11. Legal information

### 11.1 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".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL <http://www.nxp.com>.

### 11.2 Definitions

**Draft** — The document is a draft version only. The content is still under internal review and subject to formal approval, which may result in modifications or additions. NXP Semiconductors does not give any representations or warranties as to the accuracy or completeness of information included herein and shall have no liability for the consequences of use of such information.

**Short data sheet** — A short data sheet is an extract from a full data sheet with the same product type number(s) and title. A short data sheet is intended for quick reference only and should not be relied upon to contain detailed and full information. For detailed and full information see the relevant full data sheet, which is available on request via the local NXP Semiconductors sales office. In case of any inconsistency or conflict with the short data sheet, the full data sheet shall prevail.

**Product specification** — The information and data provided in a Product data sheet shall define the specification of the product as agreed between NXP Semiconductors and its customer, unless NXP Semiconductors and customer have explicitly agreed otherwise in writing. In no event however, shall an agreement be valid in which the NXP Semiconductors product is deemed to offer functions and qualities beyond those described in the Product data sheet.

### 11.3 Disclaimers

**Limited warranty and liability** — Information in this document is believed to be accurate and reliable. However, NXP Semiconductors does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information.

In no event shall NXP Semiconductors be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Notwithstanding any damages that customer might incur for any reason whatsoever, NXP Semiconductors' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the *Terms and conditions of commercial sale* of NXP Semiconductors.

**Right to make changes** — NXP Semiconductors reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

**Suitability for use** — NXP Semiconductors products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or

malfunction of an NXP Semiconductors product can reasonably be expected to result in personal injury, death or severe property or environmental damage. NXP Semiconductors accepts no liability for inclusion and/or use of NXP Semiconductors products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

**Applications** — Applications that are described herein for any of these products are for illustrative purposes only. NXP Semiconductors makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using NXP Semiconductors products, and NXP Semiconductors accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the NXP Semiconductors product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

NXP Semiconductors does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using NXP Semiconductors products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). NXP does not accept any liability in this respect.

**Limiting values** — Stress above one or more limiting values (as defined in the Absolute Maximum Ratings System of IEC 60134) will cause permanent damage to the device. Limiting values are stress ratings only and (proper) operation of the device at these or any other conditions above those given in the Recommended operating conditions section (if present) or the Characteristics sections of this document is not warranted. Constant or repeated exposure to limiting values will permanently and irreversibly affect the quality and reliability of the device.

**Terms and conditions of commercial sale** — NXP Semiconductors products are sold subject to the general terms and conditions of commercial sale, as published at <http://www.nxp.com/profile/terms>, unless otherwise agreed in a valid written individual agreement. In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. NXP Semiconductors hereby expressly objects to applying the customer's general terms and conditions with regard to the purchase of NXP Semiconductors products by customer.

**No offer to sell or license** — Nothing in this document may be interpreted or construed as an offer to sell products that is open for acceptance or the grant, conveyance or implication of any license under any copyrights, patents or other industrial or intellectual property rights.

**Export control** — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from national authorities.

**Non-automotive qualified products** — Unless this data sheet expressly states that this specific NXP Semiconductors product is automotive qualified, the product is not suitable for automotive use. It is neither qualified nor tested in accordance with automotive testing or application requirements. NXP Semiconductors accepts no liability for inclusion and/or use of non-automotive qualified products in automotive equipment or applications.

In the event that customer uses the product for design-in and use in automotive applications to automotive specifications and standards, customer (a) shall use the product without NXP Semiconductors' warranty of the product for such automotive applications, use and specifications, and (b) whenever customer uses the product for automotive applications beyond

NXP Semiconductors' specifications such use shall be solely at customer's own risk, and (c) customer fully indemnifies NXP Semiconductors for any liability, damages or failed product claims resulting from customer design and use of the product for automotive applications beyond NXP Semiconductors' standard warranty and NXP Semiconductors' product specifications.

## 11.4 Trademarks

Notice: All referenced brands, product names, service names and trademarks are the property of their respective owners.

## 12. Contact information

For more information, please visit: <http://www.nxp.com>

For sales office addresses, please send an email to: [salesaddresses@nxp.com](mailto:salesaddresses@nxp.com)

## 13. Contents

<b>1</b>	<b>Product profile</b> . . . . .	<b>1</b>
1.1	General description . . . . .	1
1.2	Features and benefits . . . . .	1
1.3	Applications . . . . .	1
<b>2</b>	<b>Pinning information</b> . . . . .	<b>2</b>
<b>3</b>	<b>Ordering information</b> . . . . .	<b>2</b>
<b>4</b>	<b>Limiting values</b> . . . . .	<b>3</b>
<b>5</b>	<b>Characteristics</b> . . . . .	<b>3</b>
<b>6</b>	<b>Application information</b> . . . . .	<b>4</b>
6.1	Insertion loss . . . . .	4
6.2	Crosstalk . . . . .	5
<b>7</b>	<b>Package outline</b> . . . . .	<b>6</b>
<b>8</b>	<b>Design and assembly recommendations</b> . . . . .	<b>7</b>
8.1	PCB design guidelines . . . . .	7
8.2	PCB assembly guidelines for Pb-free soldering . . . . .	7
<b>9</b>	<b>Abbreviations</b> . . . . .	<b>9</b>
<b>10</b>	<b>Revision history</b> . . . . .	<b>9</b>
<b>11</b>	<b>Legal information</b> . . . . .	<b>10</b>
11.1	Data sheet status . . . . .	10
11.2	Definitions . . . . .	10
11.3	Disclaimers . . . . .	10
11.4	Trademarks . . . . .	11
<b>12</b>	<b>Contact information</b> . . . . .	<b>11</b>
<b>13</b>	<b>Contents</b> . . . . .	<b>12</b>

Please be aware that important notices concerning this document and the product(s) described herein, have been included in section 'Legal information'.

© NXP B.V. 2010.

All rights reserved.

For more information, please visit: <http://www.nxp.com>

For sales office addresses, please send an email to: [salesaddresses@nxp.com](mailto:salesaddresses@nxp.com)

Date of release: 6 August 2010

Document identifier: IP4359CX4