IP4085CX4; IP4385CX4; IP4386CX4; IP4387CX4

Integrated high-performance ESD-protection diodes to IEC61000-4-2, level 4

Rev. 01 — 26 March 2009 Product data sheet

1. Product profile

1.1 General description

IP4085CX4, IP4385CX4, IP4386CX4 and IP4387CX4 are designed to protect appliances from destruction by either:

- ElectroStatic Discharges (ESD) of ±30 kV, far exceeding IEC 61000-4-2 standard, level 4
- overvoltage
- wrong polarity

Each device has a single high-performance ESD-protection diode with the anode and cathode each connected to two solder balls. The IP4085CX4, IP4385CX4, IP4386CX4 and IP4387CX4 are fabricated using monolithic silicon technology in a Wafer-Level Chip-Scale Package (WLCSP) with a pitch of 0.4 mm (IP438xCX4) or 0.5 mm (IP4085CX4).

1.2 Features

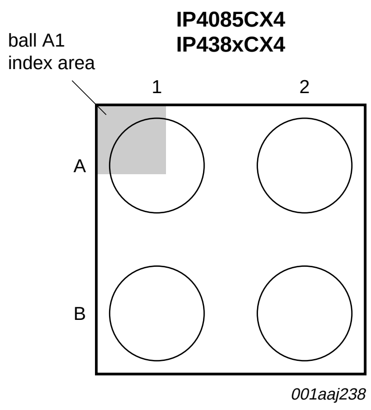
- Pb-free, RoHS and Dark Green compliant
- Single integrated high-performance ESD-protection diode
- Surge immunity according to IEC 61000-4-5 (8/20 μs) up to 60 A (IP4085CX4)
- ESD protection of >30 kV contact discharge, far exceeding IEC 61000-4-2 standard, level 4
- Small 2 × 2 solder ball WLCSP package with 0.4 mm or 0.5 mm pitch

1.3 Applications

- General purpose ESD-protection such as for charger interfaces in:
    - Cellular and PCS mobile handsets
    - Cordless telephones
    - Wireless data (WAN/LAN) systems

founded by Philips

2. Pinning information



Transparent top view

Fig 1. Pin configuration IP4085CX4; IP4385CX4; IP4386CX4; IP4387CX4

Table 1. Pinning

Pin	Description
A1 and A2	diode cathode
B1 and B2	diode anode

3. Ordering information

Table 2. Ordering information

Type number	Package		
	Name	Description	Version
IP4085CX4/LF	WLCSP4	wafer level chip-size package: 4 bumps; 0.91 × 0.91 × 0.65 mm	IP4085CX4/LF
IP4385CX4/LF	WLCSP4	wafer level chip-size package: 4 bumps; 0.76 × 0.76 × 0.61 mm	IP438xCX4/LF
IP4386CX4/LF	WLCSP4	wafer level chip-size package: 4 bumps; 0.76 × 0.76 × 0.61 mm	IP438xCX4/LF
IP4387CX4/LF	WLCSP4	wafer level chip-size package: 4 bumps; 0.76 × 0.76 × 0.61 mm	IP438xCX4/LF

4. Functional diagram

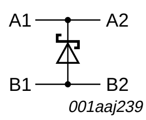


Fig 2. Schematic diagram IP4085CX4; IP4385CX4; IP4386CX4; IP4387CX4

5. Limiting values

Table 3. Limiting values

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

Symbol	Parameter	Conditions		Min	Max	Unit
V_{CC}	supply voltage	IP4085CX4/LF; IP4386CX4/LF		–0.5	+14	V
		IP4385CX4/LF		–0.5	+5.5	V
		IP4387CX4/LF		–0.5	+8.0	V
V_{ESD}	electrostatic discharge voltage	all pins to ground				
		contact discharge	[1]	–30	+30	kV
		air discharge	[1]	–15	+15	kV
		IEC 61000-4-2, level 4; all pins to ground				
		contact discharge		–8	+8	kV
		air discharge		–15	+15	kV
I_{PP}	peak pulse current	IEC 61000-4-5; t_p = 8/20 µs				
		IP4085CX4		60	-	A
		IP4385CX4; IP4387CX4		33	-	A
		IP4386CX4		28	-	A
I_{FSM}	non-repetitive peak forward current	10 pulses; 1 pulse per second				
		IP4085CX4; IP4386CX4; t_p = 2 ms		10	-	A
		IP4085CX4; IP4386CX4; t_p = 5 ms		8.5	-	A
		IP4085CX4; IP4386CX4; t_p = 100 ms		3.5	-	A
		IP4385CX4; IP4387CX4; t_p = 2 ms		11	-	A
		IP4385CX4; IP4387CX4; t_p = 5 ms		9	-	A
		IP4385CX4; IP4387CX4; t_p = 100 ms		5	-	A
P_{tot}	total power dissipation	forward conducting	[2]			
		IP4085CX4	[3]	-	1	W
		IP4385CX4; IP4386CX4; IP4387CX4	[3]	-	0.7	W

Table 3. Limiting values *...continued*

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

Symbol	Parameter	Conditions	Min	Max	Unit
T_{stg}	storage temperature		–55	+150	°C
$T_{reflow(peak)}$	peak reflow temperature	10 s maximum	-	260	°C
T_{amb}	ambient temperature		–30	+85	°C

[1] Device tested with over 1000 pulses of ±30 kV contact discharges, according to the IEC 61000-4-2 model.

[2] Severe self-heating demands a heat-dissipation optimized PCB to prevent the device from de-soldering. For ambient temperatures above 50 °C, the guaranteed life time is 48 hours at 0.7 W, assuming R_{th} to be 130 K/W as specified in Table 4.

[3] Permanent operation at maximum power dissipation and above maximum junction temperature will result in a reduced life time.

6. Thermal characteristics

Table 4. Thermal characteristics

Symbol	Parameter	Conditions		Typ	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	on a 2-layer PCB		-	
		IP4085CX4; IP4385CX4; IP4386CX4; IP4387CX4	[1]	130	K/W

[1] Depends on details of layout.

7. Characteristics

Table 5. Electrical characteristics

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{BR}	breakdown voltage	I_R = 15 mA				
		IP4085CX4; IP4386CX4	16	-	-	V
		IP4385CX4	7.0	-	-	V
		IP4387CX4	10	-	-	V
$V_{CL(trt)}$	transient clamping voltage	I_R = 1 A; $T_{amb} \leq 85$ °C at surge peak pulse according to IEC 61000-4-5				
		IP4085CX4	-	-	20.0	V
		IP4385CX4	-	-	10.0	V
		IP4386CX4	-	-	20.0	V
		IP4387CX4	-	-	13.0	V
I_{LR}	reverse leakage current					
	IP4085CX4; IP4385CX4	V_R = +5.0 V	-	-	200	nA
	IP4386CX4	V_R = +14.0 V	-	-	200	nA
	IP4387CX4	V_R = +8.0 V	-	-	800	nA

Table 5. Electrical characteristics *...continued*

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
C_d	diode capacitance	DC bias V_R = 0 V; f = 1 MHz				
	IP4085CX4		-	180	-	pF
	IP4385CX4		-	450	-	pF
	IP4386CX4		-	160	-	pF
	IP4387CX4		-	290	-	pF
V_{Fd}	diode forward voltage	I_F = 850 mA				
	IP4085CX4	$T_{amb} \geq$ +25 °C	-	-	1.15	V
		−30 °C $\leq T_{amb} \leq$ +85 °C	-	-	1.3	V
	IP4385CX4	$T_{amb} \geq$ +25 °C	-	-	1.0	V
		−30 °C $\leq T_{amb} \leq$ +85 °C	-	-	1.1	V
	IP4386CX4	$T_{amb} \geq$ +25 °C	-	-	1.15	V
		−30 °C $\leq T_{amb} \leq$ +85 °C	-	-	1.3	V
	IP4387CX4	$T_{amb} \geq$ +25 °C	-	-	1.10	V
		−30 °C $\leq T_{amb} \leq$ +85 °C	-	-	1.25	V

8. Application information

8.1 Forward current DC clamping voltage

The forward current DC clamping voltage is of interest when protecting circuits from voltage sources with the wrong polarity. Figure 3 shows the basic measurement setup.

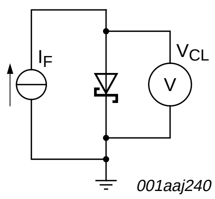
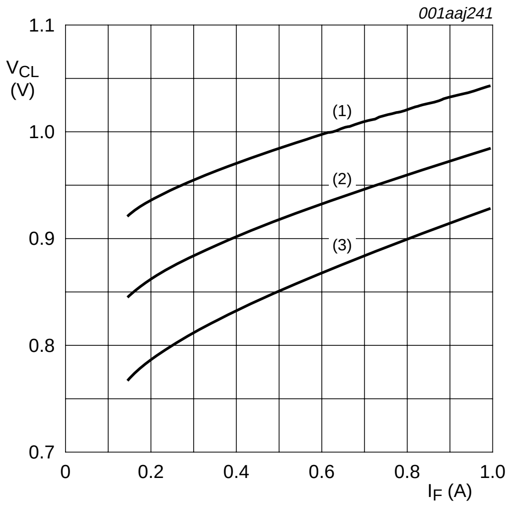


Fig 3. Measuring DC clamping voltage with forward current

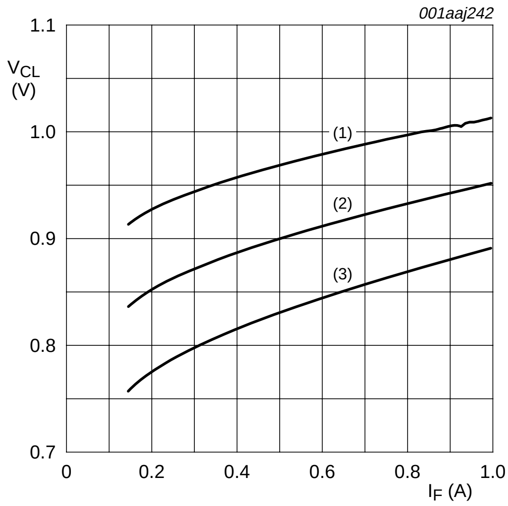


(1) T_{amb} = +25 °C.

(2) T_{amb} = +85 °C.

(3) T_{amb} = −30 °C.

Fig 4. DC clamping voltage as a function of forward current; IP4085CX4

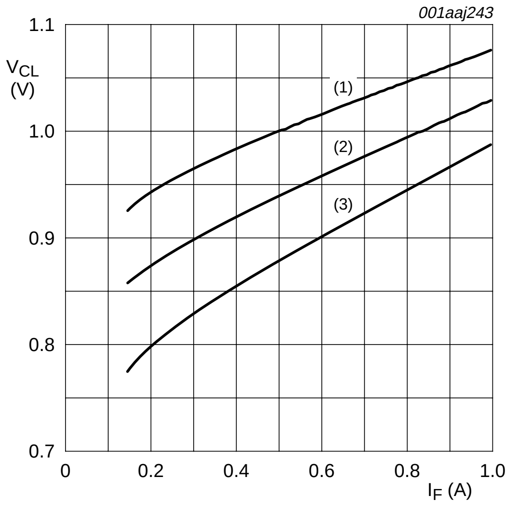


(1) T_{amb} = +25 °C.

(2) T_{amb} = +85 °C.

(3) T_{amb} = −30 °C.

Fig 5. DC clamping voltage as a function of forward current; IP4385CX4

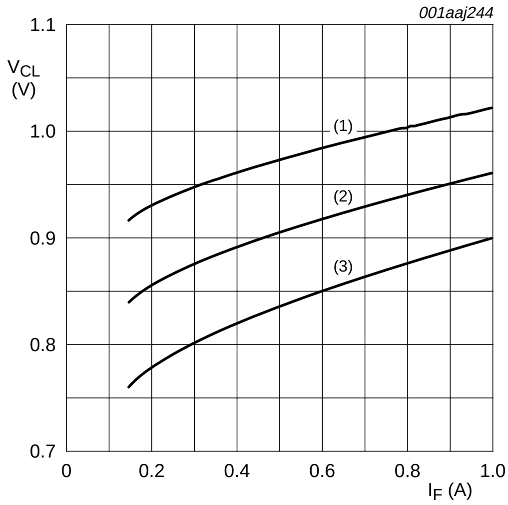


(1) T_{amb} = +25 °C.

(2) T_{amb} = +85 °C.

(3) T_{amb} = −30 °C.

Fig 6. DC clamping voltage as a function of forward current; IP4386CX4



(1) T_{amb} = +25 °C.

(2) T_{amb} = +85 °C.

(3) T_{amb} = −30 °C.

Fig 7. DC clamping voltage as a function of forward current; IP4387CX4

8.2 Peak clamping voltage

The peak clamping voltage for forward and reverse current pulses of 8/20 µs (IEC 61000-4-5) is significant when protecting circuits from power surges due to voltage discharges. The current pulse shape over time is shown in Figure 9. The basic measurement setup for forward current and reverse current pulses respectively are shown in Figure 8 and Figure 14.

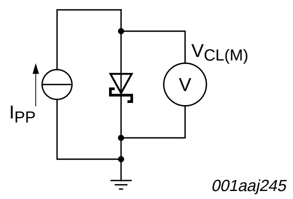


Fig 8. Measuring peak clamping voltage with forward current

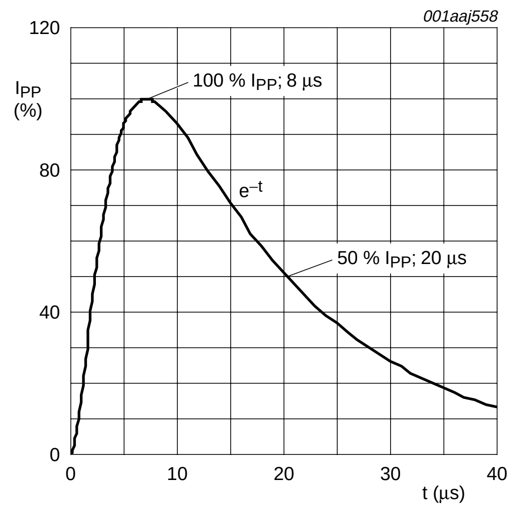
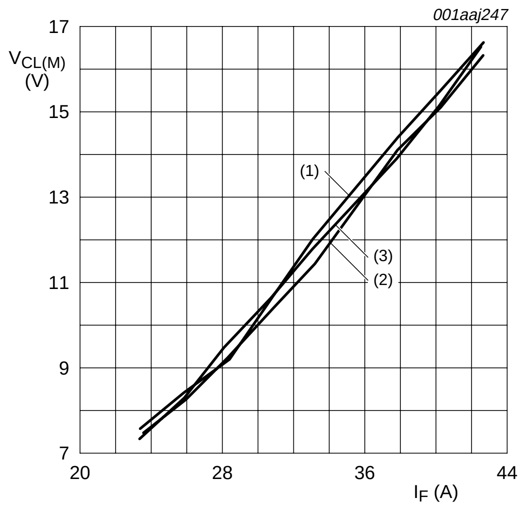


Fig 9. 8/20 µs current pulse waveform according to IEC 61000-4-5

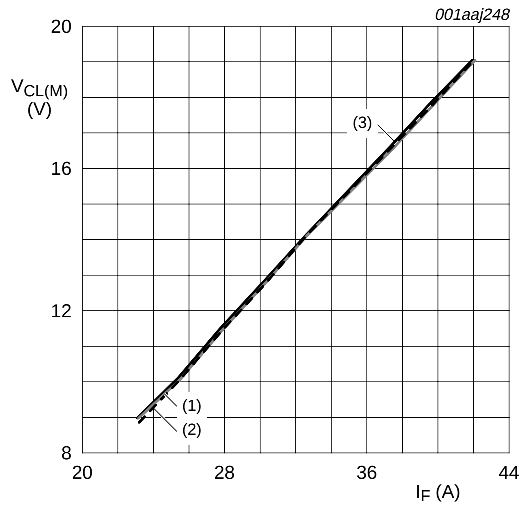


(1) T_{amb} = +25 °C.

(2) T_{amb} = +85 °C.

(3) T_{amb} = −30 °C.

Fig 10. Peak clamping voltage as a function of forward current; IP4085CX4

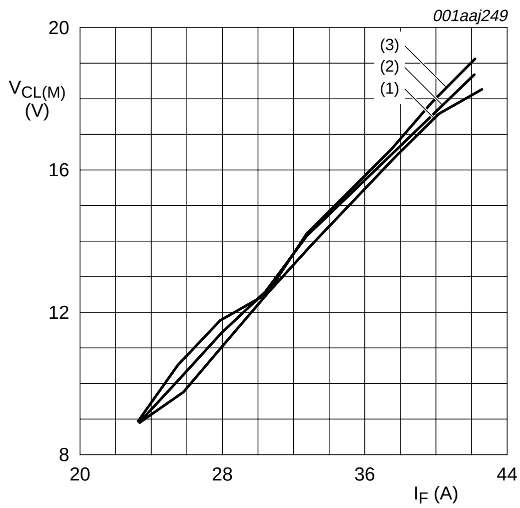


(1) T_{amb} = +25 °C.

(2) T_{amb} = +85 °C.

(3) T_{amb} = −30 °C.

Fig 11. Peak clamping voltage as a function of forward current; IP4385CX4

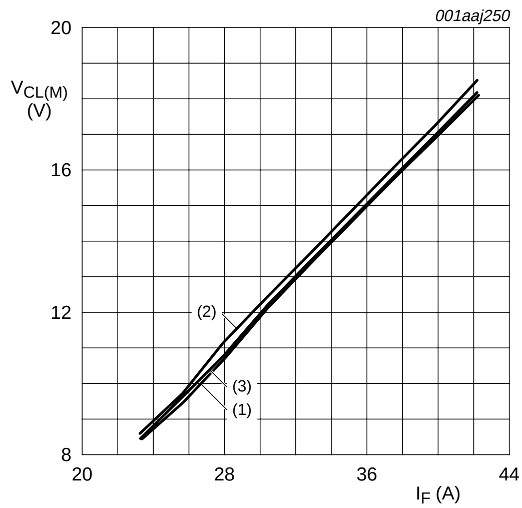


(1) T_{amb} = +25 °C.

(2) T_{amb} = +85 °C.

(3) T_{amb} = −30 °C.

Fig 12. Peak clamping voltage as a function of forward current; IP4386CX4



(1) T_{amb} = +25 °C.

(2) T_{amb} = +85 °C.

(3) T_{amb} = −30 °C.

Fig 13. Peak clamping voltage as a function of forward current; IP4387CX4

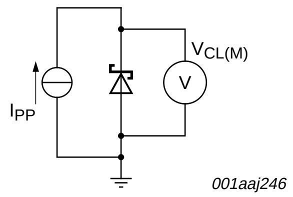
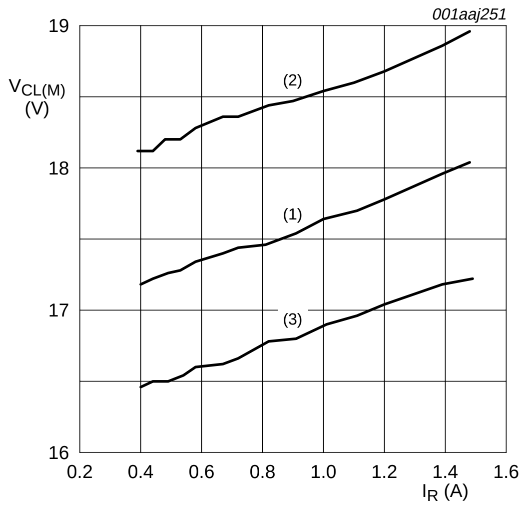


Fig 14. Measuring peak clamping voltage with reverse current

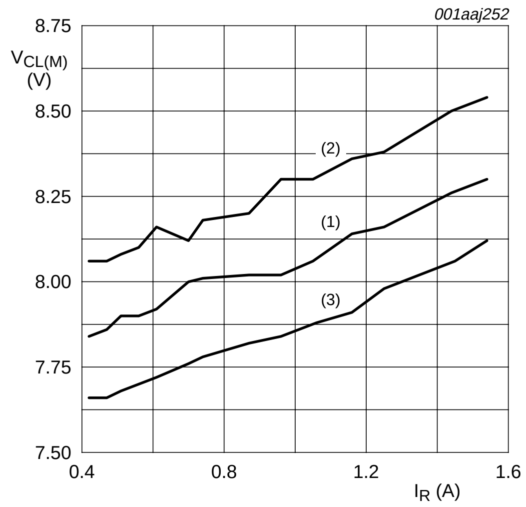


(1) T_{amb} = +25 °C.

(2) T_{amb} = +85 °C.

(3) T_{amb} = −30 °C.

Fig 15. Peak clamping voltage as a function of reverse current; IP4085CX4

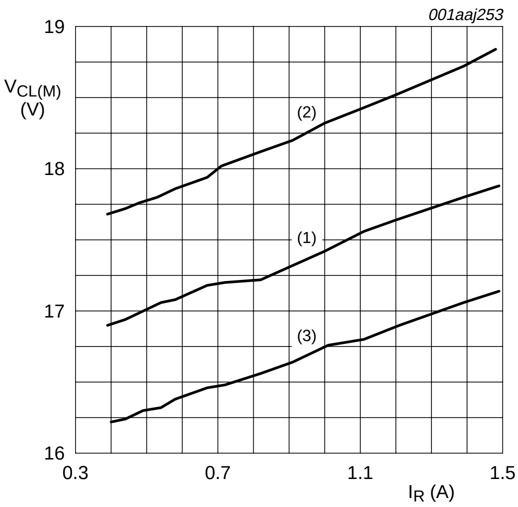


(1) T_{amb} = +25 °C.

(2) T_{amb} = +85 °C.

(3) T_{amb} = −30 °C.

Fig 16. Peak clamping voltage as a function of reverse current; IP4385CX4

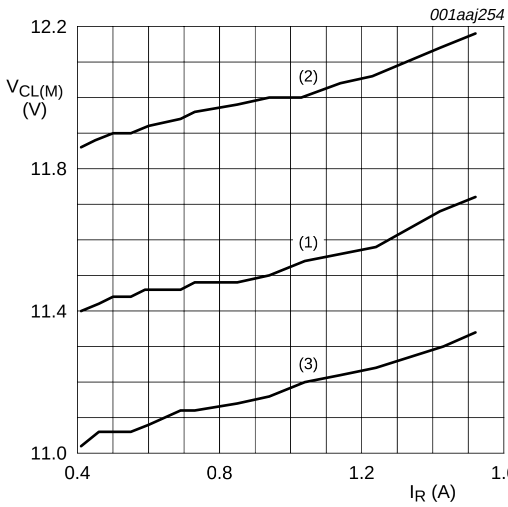


(1) T_{amb} = +25 °C.

(2) T_{amb} = +85 °C.

(3) T_{amb} = −30 °C.

Fig 17. Peak clamping voltage as a function of reverse current; IP4386CX4



(1) T_{amb} = +25 °C.

(2) T_{amb} = +85 °C.

(3) T_{amb} = −30 °C.

Fig 18. Peak clamping voltage as a function of reverse current; IP4387CX4

Remark: Measurements done on a heat-dissipation optimized PCB with massive copper area under the DUT.

9. Marking

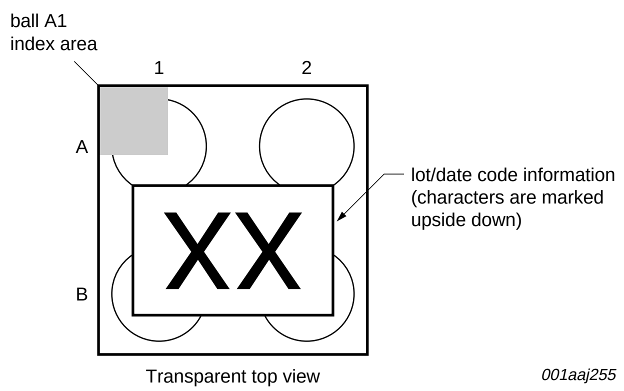
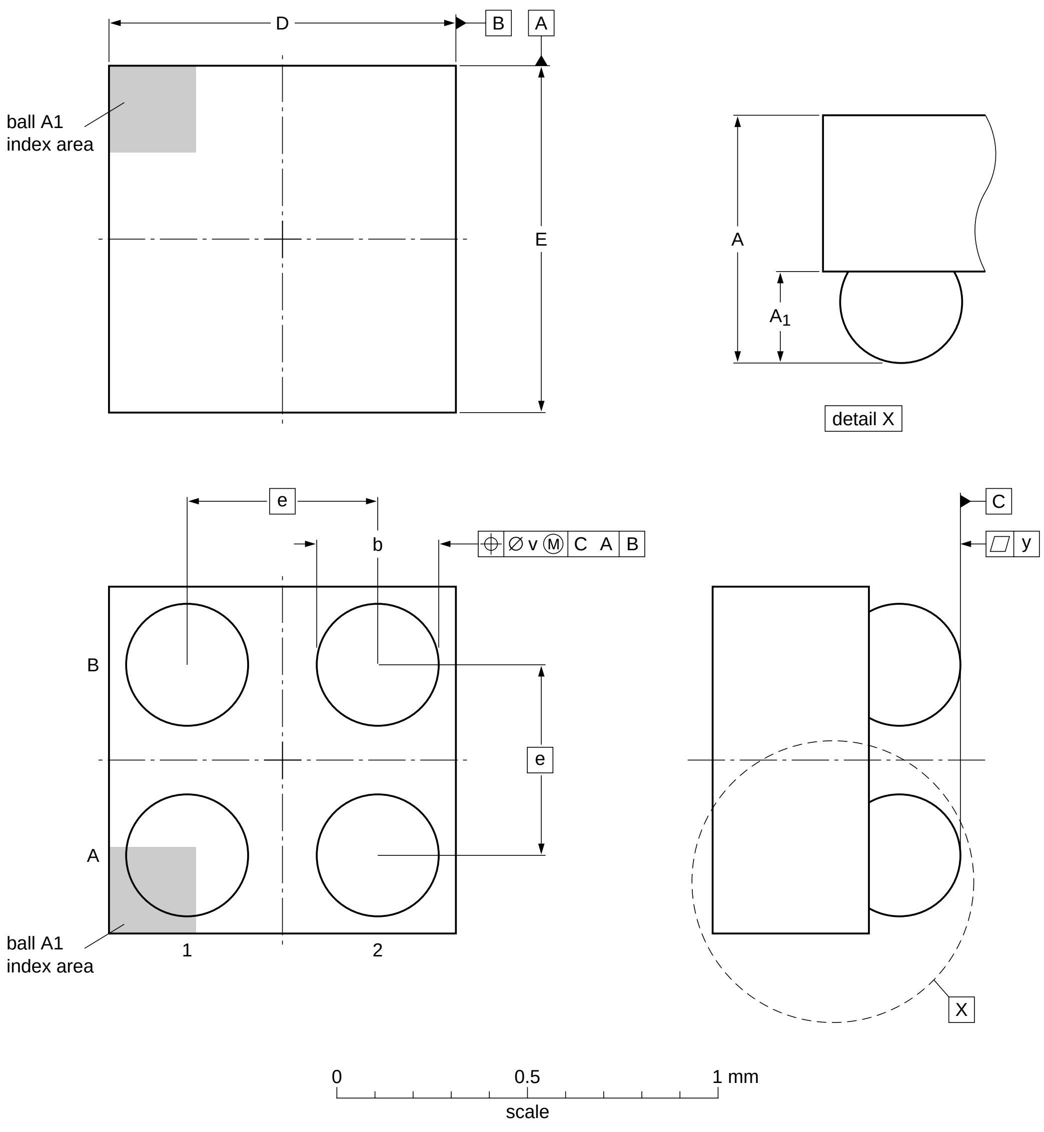


Fig 19. Marking of IP4085CX4, IP4385CX4, IP4386CX4 and IP4387CX4

10. Package outline

WLCSP4: wafer level chip-size package; 4 bumps; 0.91 x 0.91 x 0.65 mm **IP4085CX4/LF**



Dimensions

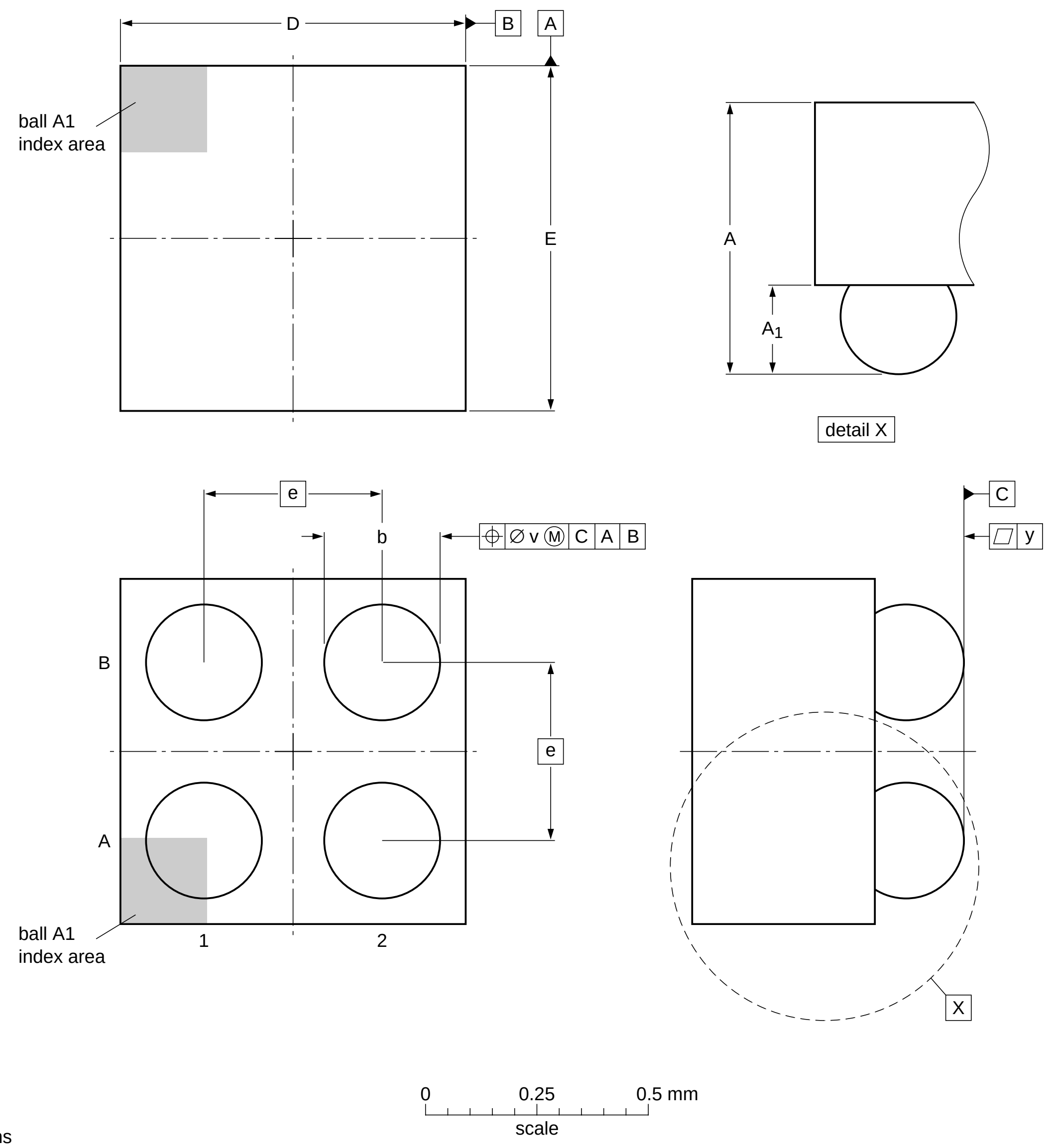
Unit		A	A_1	b	D	E	e	v	y
mm	max	0.70	0.26	0.37	0.96	0.96			
	nom	0.65	0.24	0.32	0.91	0.91	0.5	0.005	0.02
	min	0.60	0.22	0.27	0.86	0.86			

ip4085cx4_lf_po

Outline version	References IEC	References JEDEC	References JEITA		European projection	Issue date
IP4085CX4/LF						08-12-04

Fig 20. Package outline IP4085CX4/LF (WLCSP4)

WLCSP4: wafer level chip-size package; 4 bumps; 0.76 x 0.76 x 0.61 mm **IP438xCX4/LF**



Dimensions

Unit		A	A_1	b	D	E	e	v	y
mm	max	0.66	0.22	0.31	0.81	0.81			
	nom	0.61	0.20	0.26	0.76	0.76	0.4	0.005	0.02
	min	0.56	0.18	0.21	0.71	0.71			

ip438xcx4_lf_po

Outline version	References IEC	References JEDEC	References JEITA		European projection	Issue date
IP438xCX4/LF						08-12-04

Fig 21. Package outline IP438xCX4/LF (WLCSP4)

11. Design and assembly recommendations

11.1 PCB design guidelines

For optimum performance it is recommended to use a Non-Solder Mask PCB Design (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 6 for the recommended PCB design parameters.

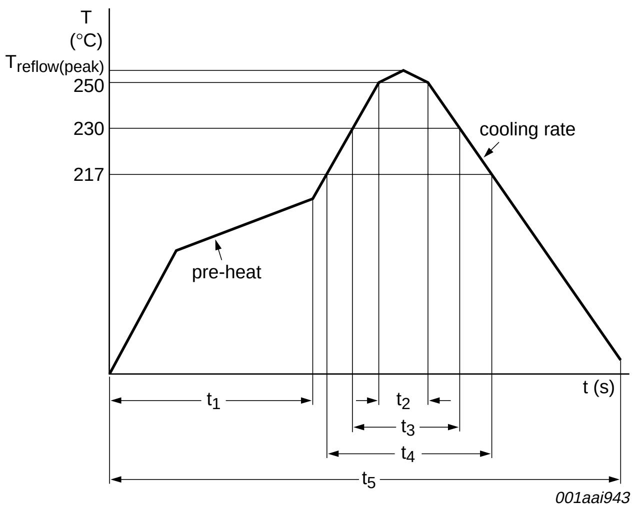
Table 6. Recommended PCB design parameters

Parameter	Value or Specification
PCB pad diameter	200 µm
Micro-via diameter	100 µm (0.004 inch)
Solder mask aperture diameter	370 µm
Copper thickness	20 µm to 40 µm
Copper finish	AuNi
PCB material	FR4

11.2 PCB assembly guidelines for Pb-free soldering

Table 7. Assembly recommendations

Parameter	Value or Specification
Solder screen aperture diameter	330 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 Figure 22



The device is capable of withstanding at least three reflows of this profile.

Fig 22. Pb-free solder reflow profile

Table 8. Reflow soldering process characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$T_{reflow(peak)}$	peak reflow temperature		230	-	260	°C
t_1	time 1	soak time	60	-	180	s
t_2	time 2	time during T ≥ 250 °C	-	-	30	s
t_3	time 3	time during T ≥ 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. Abbreviations

Table 9. Abbreviations

Acronym	Description
DUT	Device Under Test
FR4	Flame Retard 4
LAN	Local Area Network
PCB	Printed-Circuit Board
PCS	Personal Communication System
RoHS	Restriction of Hazardous Substances
WAN	Wide Area Network
WLCSP	Wafer-Level Chip-Scale Package

13. Revision history

Table 10. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
IP4085_4385_4386_4387_CX4_1	20090326	Product data sheet	-	-

14. Legal information

14.1 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".

[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.

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16. Contents

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