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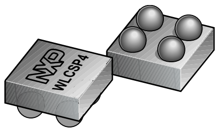


IP4085CX4; IP4385CX4; IP4386CX4; IP4387CX4

Integrated high-performance ESD protection diodes

Rev. 2 — 14 December 2012 **Product data sheet**

1. Product profile

1.1 General description

Integrated high-performance protection diodes protecting appliances against ElectroStatic Discharge (ESD) of ±30 kV, far exceeding IEC 61000-4-2 level 4 standard, overvoltage and wrong polarity.

Each device includes one high-level ESD protection diode in a 4-channel 0.4 mm (IP438xCX4) or 0.5 mm (IP4085CX4) pitch Wafer Level Chip-Size Package (WLCSP). The anode and the cathode of ESD protection diode are each connected to two solder balls.

1.2 Features and benefits

- 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, level 4
- Small 2 × 2 solder ball WLCSP package with 0.4 mm or 0.5 mm pitch

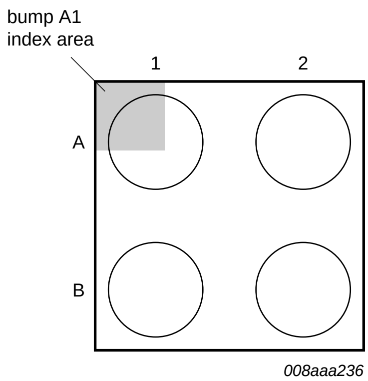
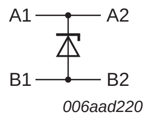
1.3 Applications

General-purpose ESD protection such as for charger interfaces in:

- Mobile handsets
- Portable devices
- Wireless data systems

2. Pinning information

Table 1. Pinning

Pin	Description	Simplified outline	Graphic symbol
A1 and A2	cathode	 transparent top view, solder balls facing down	
B1 and B2	anode		

3. Ordering information

Table 2. Ordering information

Type number	Package		
	Name	Description	Version
IP4085CX4/LF/P	WLCSP4	wafer level chip-size package: 4 bumps (2 × 2)[1]	IP4085CX4/LF/P
IP4385CX4/LF		wafer level chip-size package: 4 bumps (2 × 2)[2]	IP4385CX4/LF
IP4386CX4/P			IP4386CX4/P
IP4387CX4/P			IP4387CX4/P

[1] Size: 0.91 × 0.91 × 0.65 mm

[2] Size: 0.76 × 0.76 × 0.61 mm

4. Limiting values

Table 3. Limiting values

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

Symbol	Parameter	Conditions		Min	Max	Unit
V_{RWM}	reverse standoff voltage	IP4085CX4; IP4386CX4		–0.5	+14	V
		IP4385CX4		–0.5	+5.5	V
		IP4387CX4		–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
T_{stg}	storage temperature			–55	+150	°C
$T_{reflow(peak)}$	peak reflow temperature	$t_p \leq 10$ s		-	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 Printed-Circuit Board (PCB) to prevent the device from de-soldering. For ambient temperature 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.

5. 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	[1]	130	K/W

[1] Depends on details of PCB layout.

6. 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}	clamping voltage	I_R = 1 A; $T_{amb} \leq$ 85 °C at surge peak pulse, according to IEC 61000-4-5					
		IP4085CX4		-	-	20	V
		IP4385CX4		-	-	10	V
		IP4386CX4		-	-	20	V
		IP4387CX4		-	-	13	V
I_{RM}	reverse leakage current						
		IP4085CX4; IP4385CX4 V_R = +5 V		-	-	200	nA
		IP4386CX4; V_R = +14 V		-	-	200	nA
		IP4387CX4; V_R = +8 V		-	-	800	nA
C_d	diode capacitance	V_R = 0 V; f = 1 MHz					
		IP4085CX4		-	180	-	pF
		IP4385CX4		-	450	-	pF
		IP4386CX4		-	160	-	pF
		IP4387CX4		-	290	-	pF
V_F	forward voltage	I_F = 850 mA					
		IP4085CX4	[1]	-	-	1.15	V
			[2]	-	-	1.3	V
		IP4385CX4	[1]	-	-	1.0	V
			[2]	-	-	1.1	V
		IP4386CX4	[1]	-	-	1.15	V
			[2]	-	-	1.3	V
		IP4387CX4	[1]	-	-	1.10	V
			[2]	-	-	1.25	V

[1] $T_{amb} \geq$ +25 °C

[2] −30 °C $\leq T_{amb} \leq$ +85 °C

7. Application information

7.1 Forward current DC clamping voltage

The forward current DC clamping voltage is an indicator of protection level of circuit from voltage sources with the wrong polarity. Figure 1 shows basic measurement setup.

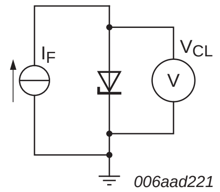
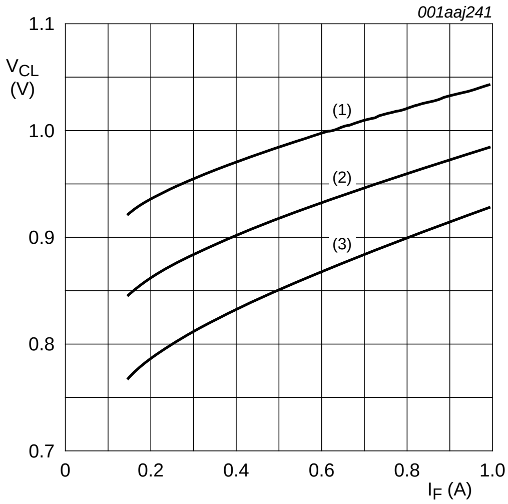


Fig 1. Measuring DC clamping voltage with forward current

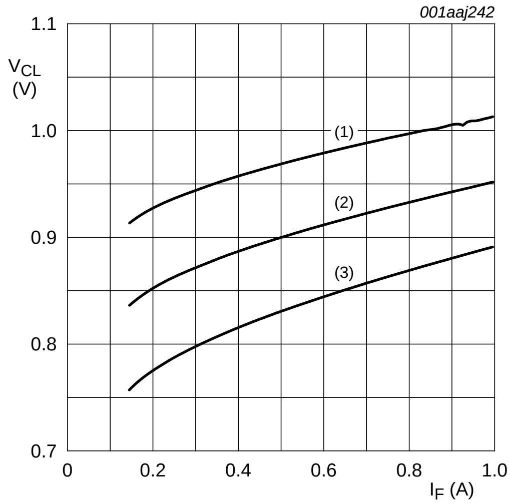


(1) T_{amb} = +25 °C

(2) T_{amb} = +85 °C

(3) T_{amb} = −30 °C

Fig 2. IP4085CX4: DC clamping voltage as a function of forward current

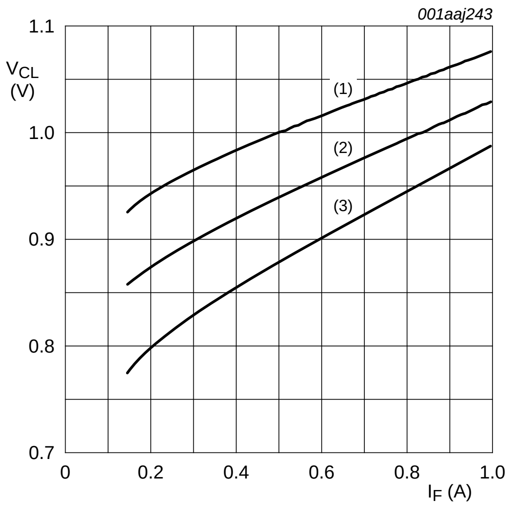


(1) T_{amb} = +25 °C

(2) T_{amb} = +85 °C

(3) T_{amb} = −30 °C

Fig 3. IP4385CX4: DC clamping voltage as a function of forward current

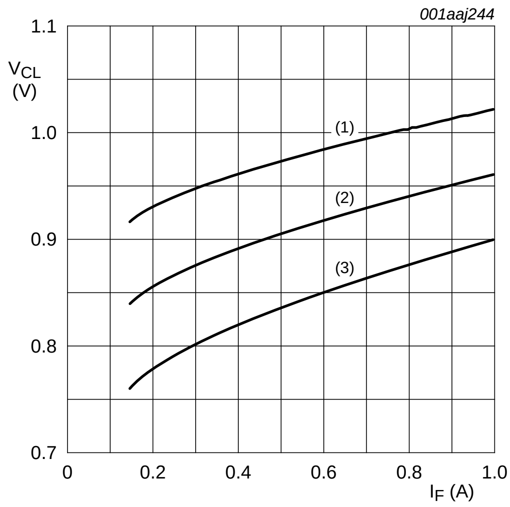


(1) T_{amb} = +25 °C

(2) T_{amb} = +85 °C

(3) T_{amb} = −30 °C

Fig 4. IP4386CX4: DC clamping voltage as a function of forward current



(1) T_{amb} = +25 °C

(2) T_{amb} = +85 °C

(3) T_{amb} = −30 °C

Fig 5. IP4387CX4: DC clamping voltage as a function of forward current

7.2 Peak clamping voltage

The peak clamping voltage for forward and reverse current pulses of 8/20 µs (IEC 61000-4-5) is an indicator of protection level of circuits from power surges due to voltage discharges. The current pulse shape over time is shown in Figure 7. The basic measurement setup for forward current and reverse current pulses respectively are shown in Figure 6 and Figure 12.

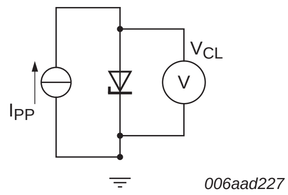


Fig 6. Measuring peak clamping voltage with forward current

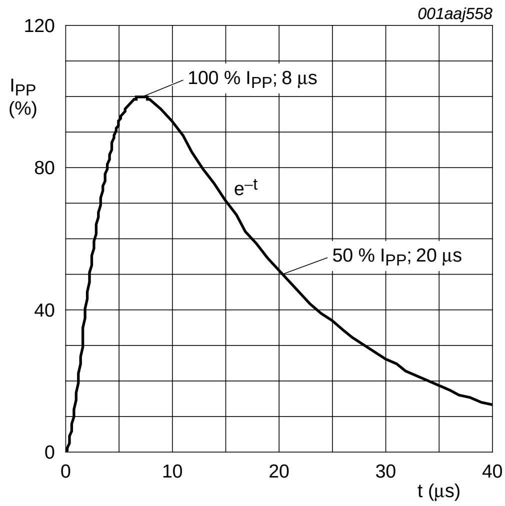
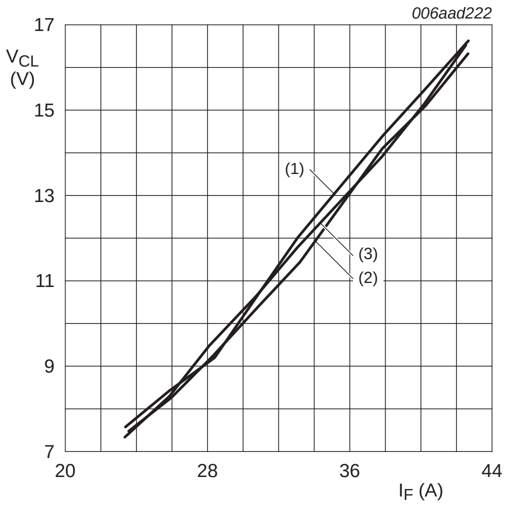
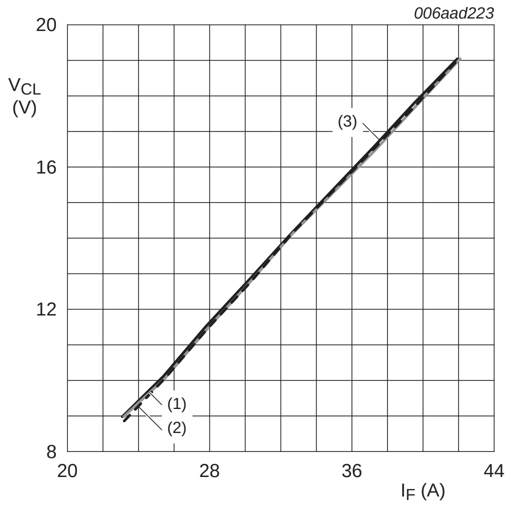


Fig 7. 8/20 µs current pulse waveform according to IEC 61000-4-5



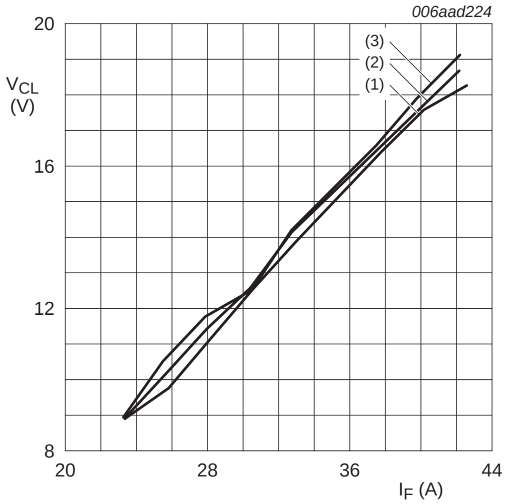
(1) T_{amb} = +25 °C
(2) T_{amb} = +85 °C
(3) T_{amb} = −30 °C

Fig 8. IP4085CX4: peak clamping voltage as a function of forward current



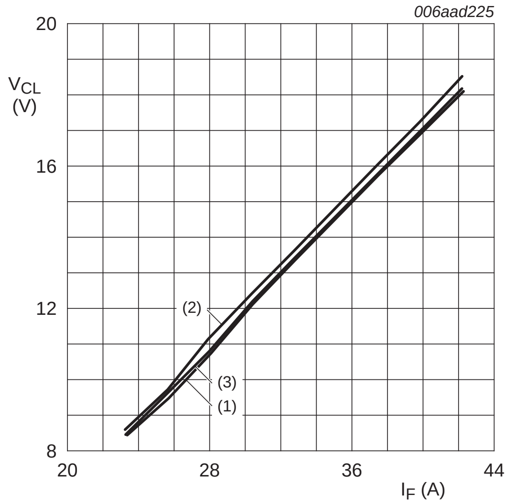
(1) T_{amb} = +25 °C
(2) T_{amb} = +85 °C
(3) T_{amb} = −30 °C

Fig 9. IP4385CX4: peak clamping voltage as a function of forward current



(1) T_{amb} = +25 °C
(2) T_{amb} = +85 °C
(3) T_{amb} = −30 °C

Fig 10. IP4386CX4: peak clamping voltage as a function of forward current



(1) T_{amb} = +25 °C
(2) T_{amb} = +85 °C
(3) T_{amb} = −30 °C

Fig 11. IP4387CX4: peak clamping voltage as a function of forward current

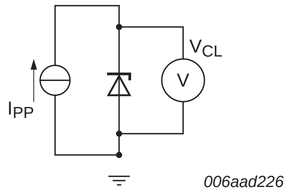
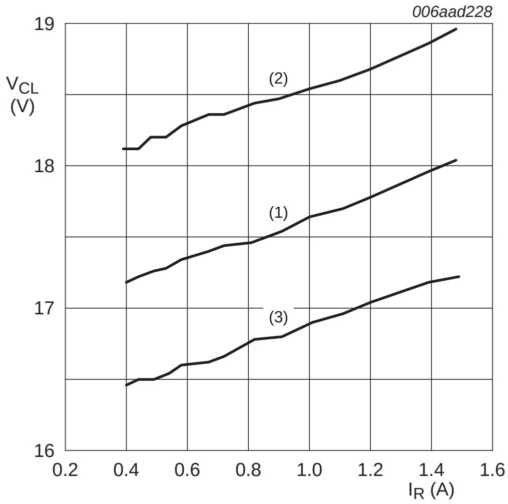


Fig 12. Measuring peak clamping voltage with reverse current

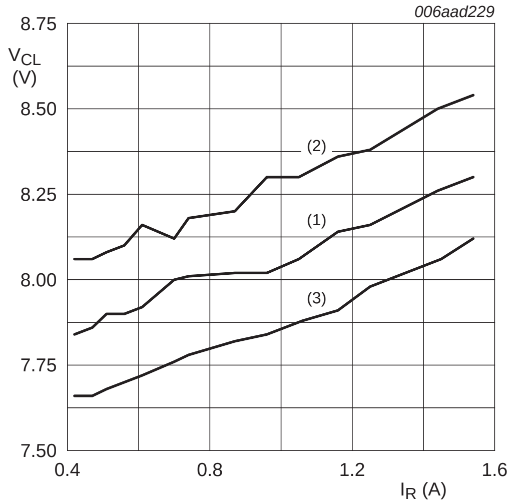


(1) T_{amb} = +25 °C

(2) T_{amb} = +85 °C

(3) T_{amb} = −30 °C

Fig 13. IP4085CX4: peak clamping voltage as a function of reverse current

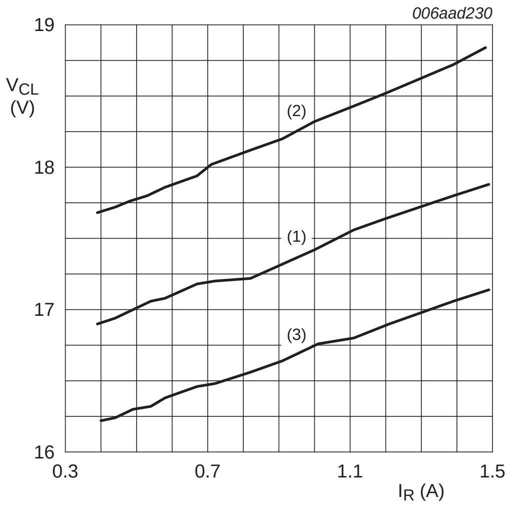


(1) T_{amb} = +25 °C

(2) T_{amb} = +85 °C

(3) T_{amb} = −30 °C

Fig 14. IP4385CX4: peak clamping voltage as a function of reverse current

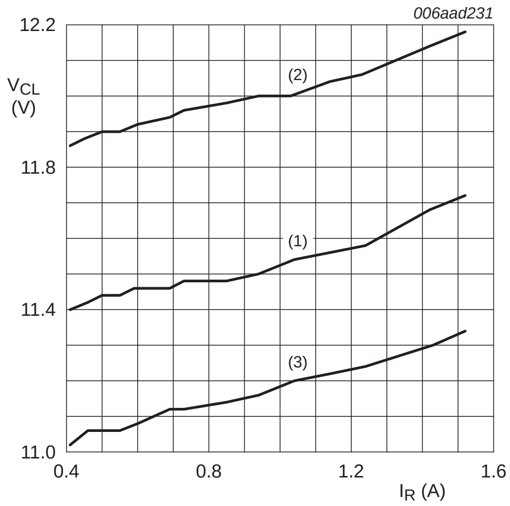


(1) T_{amb} = +25 °C.

(2) T_{amb} = +85 °C.

(3) T_{amb} = −30 °C.

Fig 15. IP4386CX4: peak clamping voltage as a function of reverse current



(1) T_{amb} = +25 °C.

(2) T_{amb} = +85 °C.

(3) T_{amb} = −30 °C.

Fig 16. IP4387CX4: peak clamping voltage as a function of reverse current

Measurements are done on a heat-dissipation optimized PCB with massive copper area under the Device Under Test (DUT).

8. Package outline

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

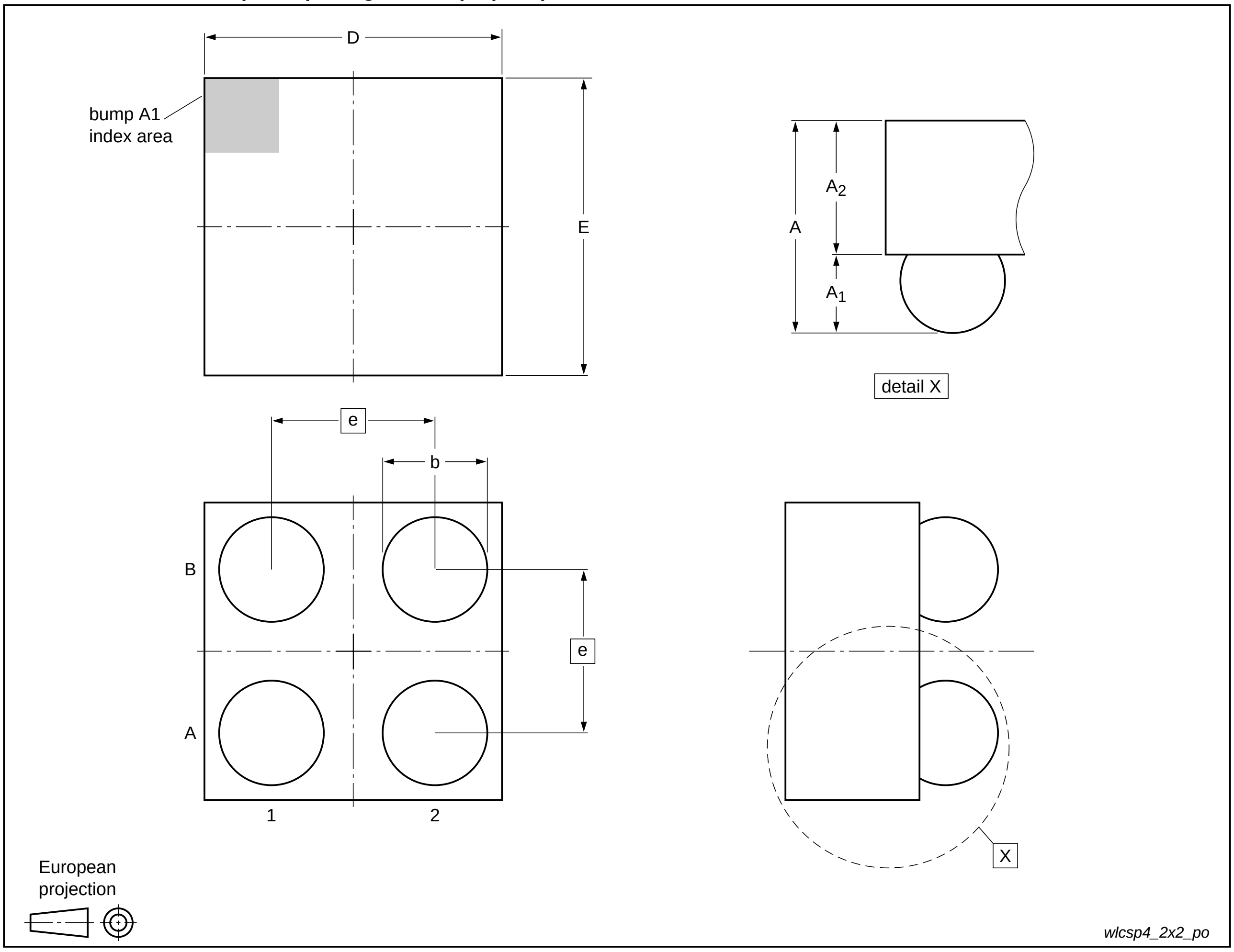


Fig 17. Package outline WLCSP4

Table 6. Package outline dimensions of IP4085CX4 (WLCSP4)

Symbol	Min	Typ	Max	Unit
A	0.60	0.65	0.70	mm
A_1	0.22	0.24	0.26	mm
A_2	0.38	0.41	0.44	mm
b	0.27	0.32	0.37	mm
D	0.86	0.91	0.96	mm
E	0.86	0.91	0.96	mm
e	0.5	0.5	0.5	mm

Table 7. Package outline dimensions of IP438xCX4 (WLCSP4)

Symbol	Min	Typ	Max	Unit
A	0.56	0.61	0.66	mm
A_1	0.18	0.20	0.22	mm
A_2	0.38	0.41	0.44	mm
b	0.21	0.26	0.31	mm
D	0.71	0.76	0.76	mm
E	0.71	0.76	0.81	mm
e	0.4	0.4	0.4	mm

9. Design and assembly recommendations

9.1 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 8 for the recommended PCB design parameters.

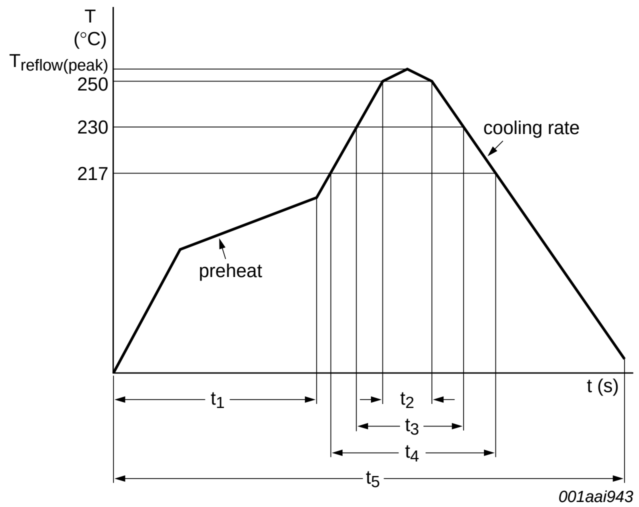
Table 8. Recommended PCB design parameters

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

9.2 PCB assembly guidelines for Pb-free soldering

Table 9. 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 to flux ratio	50 : 50
Solder reflow profile	see Figure 18



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

Fig 18. Pb-free solder reflow profile

Table 10. 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

10. Soldering

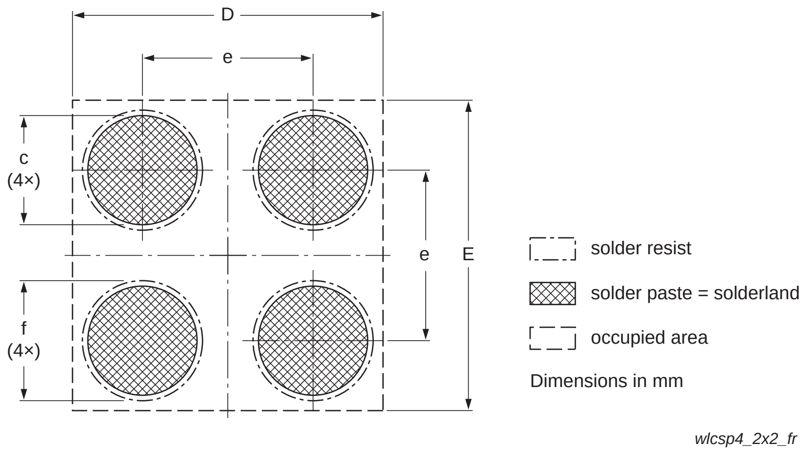


Fig 19. Reflow soldering footprint WLCSP4

Table 11. Soldering dimensions of IP4085CX4 (WLCSP4)

Symbol	Min	Typ	Max	Unit
c	-	0.31	-	mm
D	0.86	0.91	0.96	mm
E	0.86	0.91	0.96	mm
e	-	0.5	-	mm
f	-	0.385	-	mm

Table 12. Soldering dimensions of IP438xCX4 (WLCSP4)

Symbol	Min	Typ	Max	Unit
c	-	0.25	-	mm
D	0.71	0.76	0.81	mm
E	0.71	0.76	0.81	mm
e	-	0.4	-	mm
f	-	0.325	-	mm

11. Revision history

Table 13. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
IP4085_4385_4386_4387_CX4 v.2	20121214	Product data sheet	-	IP4085_4385_4386_4387_CX4 v.1
Modifications:	• Basic type IP4085CX4/LF removed • Section 1 "Product profile": updated • Section 2 "Pinning information": updated • Functional diagram: removed • Table 3 "Limiting values": updated • Table 5 "Electrical characteristics". updated • Section 7 "Application information". updated • Figure 1, 6, 8 to 16: updated • Marking: removed • Section 8 "Package outline": updated • Section 10 "Soldering": added • Section 12 "Legal information": updated			
IP4085_4385_4386_4387_CX4 v.1	20090326	Product data sheet	-	-

12. Legal information

12.1 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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13. Contact information

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

For sales office addresses, please send an email to: **salesaddresses@nxp.com**

14. Contents

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