High sensitive photodiodes

General Description

The epc3xx family products are high-sensitive photo diodes for light-barrier, light-curtain, and the like applications. These photo diodes are designed to be used in a reverse-bias mode.

This device allows the design of short to long range light barriers from a few millimeters up to tens of meters.

Using chips from the epc3xx product line, linear or two dimensional arrays can be formed for any application, be it triangulation, spot location, angle measurement, rotary encoders, or similar. Also, spectral sensitive detectors can easily be designed by applying color filters in front of the photo diodes.

Also, other mechanical dimensions are available upon request. It is be possible to manufacture photo diodes of up to 15x15 mm or even bigger. Such a 15x15 mm device then would contain 450 individual photo diodes, each of them individually accessible. All diodes feature a very high quantum efficiency of 90% in the near IR range, a reverse breakdown voltage of up to 30 Volts and a response time down to less than 100ns. All devices are available upon request with optical bandpass filters.

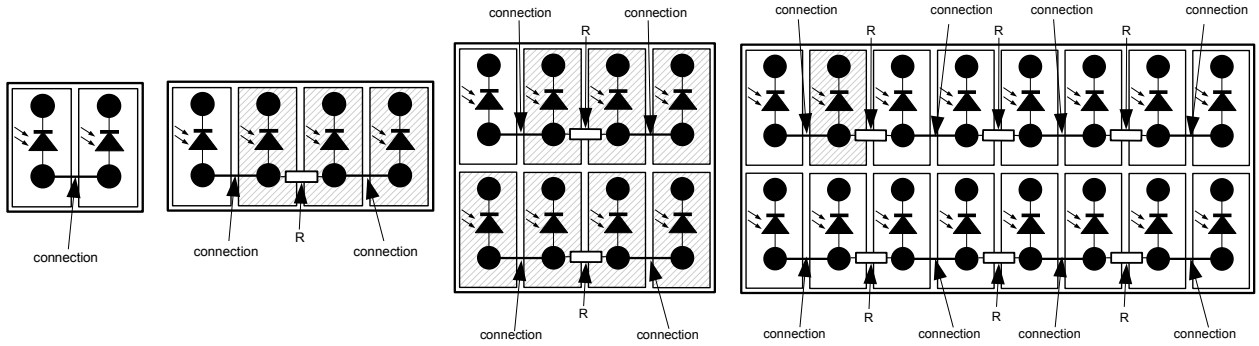
Features

- Low dark current
- High quantum efficiency
- High dynamic range
- Diodes can be used in parallel
- CSP package with very small footprint
- Near infrared and visible version available
- Customer specific wavelength filter upon request

Applications

- Light barriers ranging from millimeters to tens of meters
- Light curtains
- Smoke detectors
- Liquid detectors
- Heart beat monitors
- Position detection (rotary, linear, angle, etc.)
- IR remote control of Hi-Fi, TV sets and other equipment
- Leveling instruments
- Differential measurement
- Linear photo diode arrays

Product Range Overview



R : refer to chapter “Electrical isolation between individual diodes”

Model	No. of Photo Diodes	Diode Length (mm)	Diode Width (mm)	Total Active Area (mm^2)	Typ. Dark Current at 20°C (pA)	Ideal Bias Voltage (V)	Wavelength (nm)	Footprint
Single diode	1	1.0	0.5	0.43	20	5	400 - 1050	---
epc300	2	1.0	1.0	0.86	40	5	400 - 1050	CSP4
epc310	4	2.0	1.0	1.71	80	5	400 - 1050	CSP8
epc320	8	2.0	2.0	3.42	160	5	400 - 1050	CSP16
epc330	16	4.0	2.0	6.84	320	5	400 - 1050	CSP32

Type specific characteristics (all diodes of the array connected in parallel)

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Absolute Maximum Ratings (Notes 1, 2)

Reverse Voltage V_R	30.0 V
Breakdown Voltage between Diodes	10.0 V
Storage Temperature Range (T_S)	-40°C to +85°C
Lead Temperature solder, 4 sec. (T_L)	+260°C

Recommended Operating Conditions

	Min.	Max.	Units
Reverse Voltage (V_R)	1.5	20.0	V
Operating Temperature (T_A)	-40	+85	°C
Relative Humidity (non-condensing)	+5	+95	%

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Recommended operating conditions indicate conditions for which the device is intended to be functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see Electrical Characteristics.

Note 2: This device is a highly sensitive CMOS photodiodes with an ESD rating of JEDEC HBM class 2 (<2kV). Handling and assembly of this device should only be done at ESD protected workstations.

Note 3: Unless otherwise stated, measuring parameters are V_R = 5.0 V, -40°C < T_A < +85°C, R_L = 50 Ω

Note 4: Unless otherwise stated, measurement data apply for individual photo diodes in multi diode chips

General Characteristics (Notes 3, 4)

Symbol	Parameter	Conditions/Comments	Values			Units
			Min.	Typ.	Max.	
$\lambda_{S\,max.}$	Wavelength	max. Sensitivity		850		nm
λ	Wavelength Range	S = 20 % of S_{max}	400		1030	nm
S_λ	Spectral Sensitivity	λ = 850nm, V_R = 5V, I_e = 1 mW/cm², type epc300		0.6		A/W
η	Quantum Efficiency	λ = 850nm, V_R = 5V, I_e = 1 mW/cm², type epc300		90		%
φ	Half angle			±60		°
V_O	Open Circuit Voltage	I_e = 0.5 mW/cm²		300		mV
TC_V	Temperature Coefficient of I_{SC}			0.38		%/K
TC_O	Temperature Coefficient of V_O			-3.0		mV/K

Type Specific Characteristics @ +25°C (all diodes of the array connected in parallel)

Symbol	Parameter		Conditions/Comments	Values			Units
				Min.	Typ.	Max.	
I_P	Photo Current	per diode	V_R = 5V, I_e = 1 mW/cm², λ = 850 nm (NIR filter centered on 850nm)		2.5		µA
		epc300			5		
		epc310			10		
		epc320			20		
		epc330			40		
I_R	Dark Current *	per diode	V_R = 5 V, T_A = 20°C		20	250	pA
		epc300			40	500	
		epc310			80	1000	
		epc320			160	2000	
		epc330			320	4000	
I_{SC}	Short-circuit Current	per diode	I_e = 1 mW/cm²		2.5		µA
		epc300			5		
		epc310			10		
		epc320			20		
		epc330			40		

* selected types available upon request

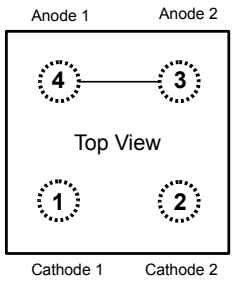
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Symbol	Parameter		Conditions/Comments	Values			Units
				Min.	Typ.	Max.	
t_r	Rise/Fall Time	all types	photo current measured at R_L = 50 Ω , λ = 850 nm, I_P = 200 µA				ns
			V_R = +1.5 V		300		
			V_R = +5.0 V		150		
			V_R = +10.0 V		90		
C_O	Capacitance	per diode	V_R = +5V, f = 100kHz, E = 0		5		pF
		epc300			10		
		epc310			20		
		epc320			40		
		epc330			80		
NEP	Noise Equivalent Power	per diode	V_R = 5 V		$4.2x10^{-15}$		W/√Hz
		epc300			$6.0x10^{-15}$		
		epc310			$8.4x10^{-15}$		
		epc320			$1.2x10^{-14}$		
		epc330			$1.7x10^{-14}$		
C_T	Cross Talk Suppression	epc320 epc330	between individual photo diodes on the same chip, if the voltage difference V_{diff} is <100mV between individual diodes (cathodes)		50		dB

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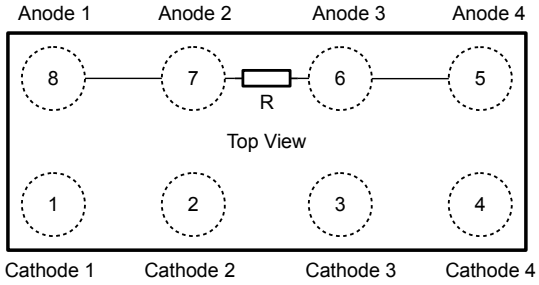
Connection Diagrams

epc300

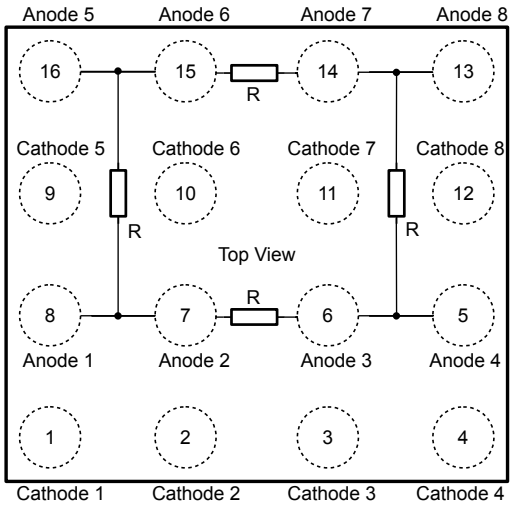


The structure of the diodes shown in the figure to the left is the same for all individual diodes on the chip also for the models epc310, epc320, and epc330. Always two photo diodes are paired and have shorted anodes as shown in the figure.
R: refer to chapter “Electrical isolation between individual diodes”

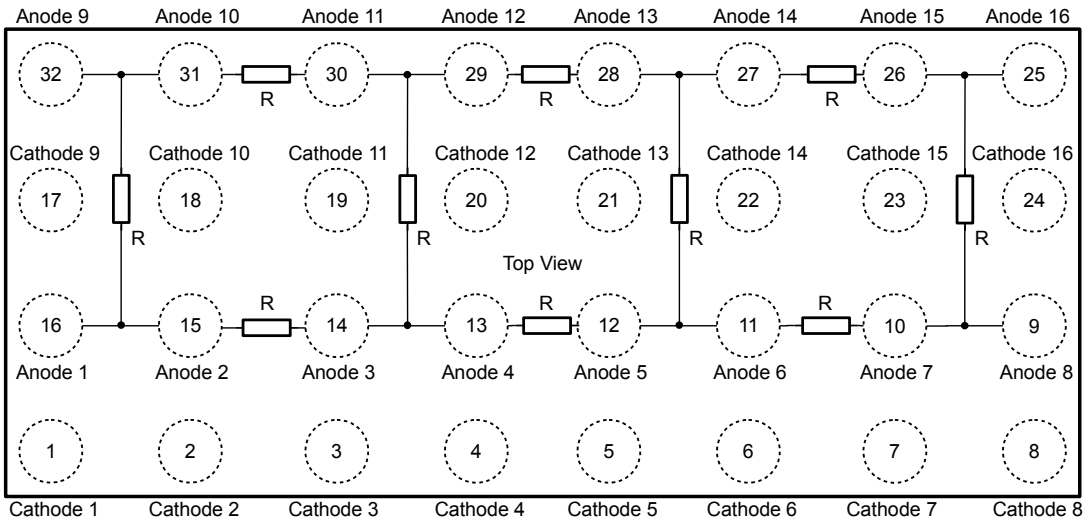
epc310



epc320



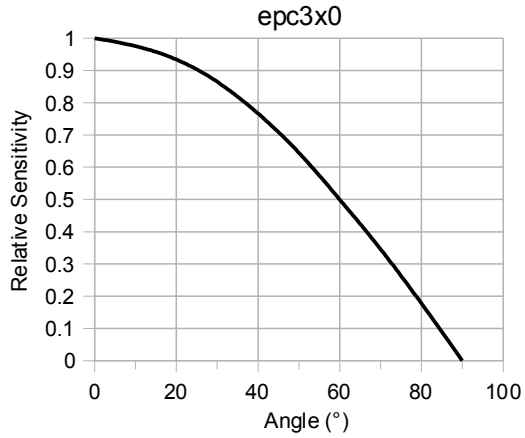
epc330



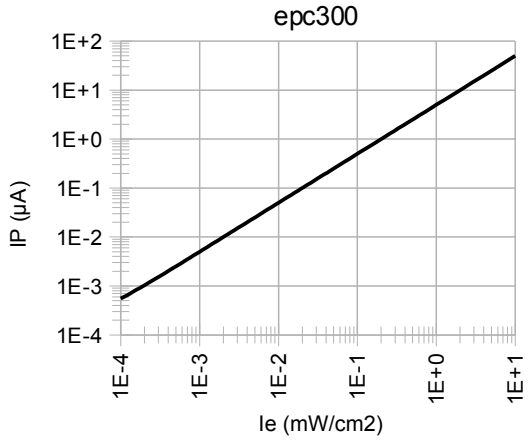
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Other Parameters

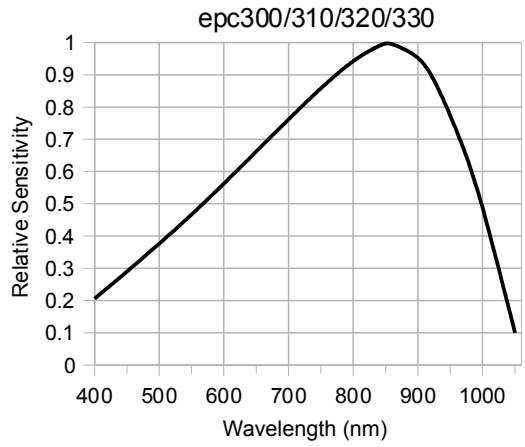
(typical values, T_{amb} = 25°C, V_{DD} = 5.0V, I_{PD}=0mA)



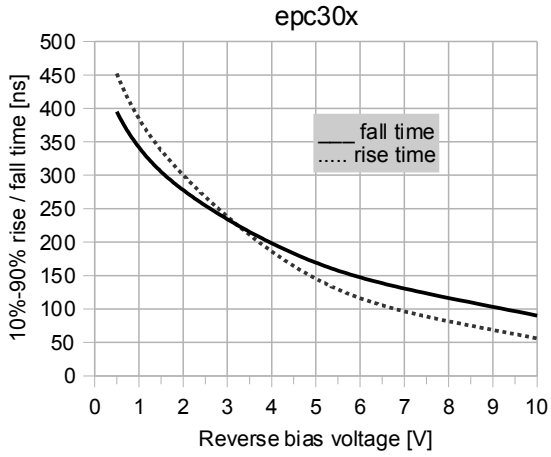
Relative sensitivity vs. illumination angle



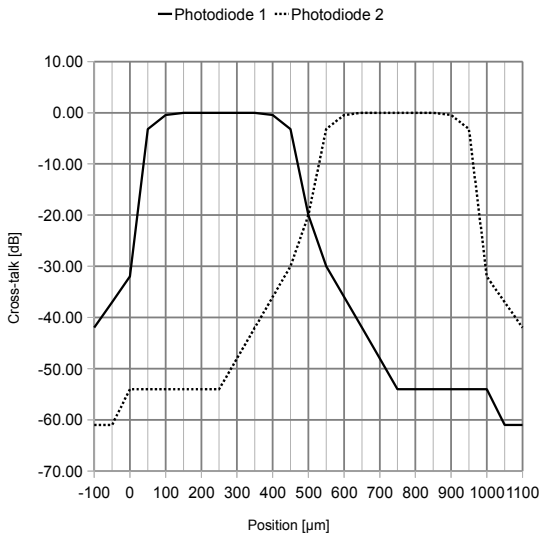
Photocurrent $I_P = f(I_e)$, V_R = 5 V, λ=850nm



Relative spectral sensitivity



Rise/ fall time versus reverse bias voltage



Cross-talk between a pair of photodiodes

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Application Information

Light Barrier Application
The following circuit uses an epc3xx photo diode with an epc13x PD amplifier chip. This circuit offers a very high AC photo current sensitivity and a tremendous DC backlight suppression.

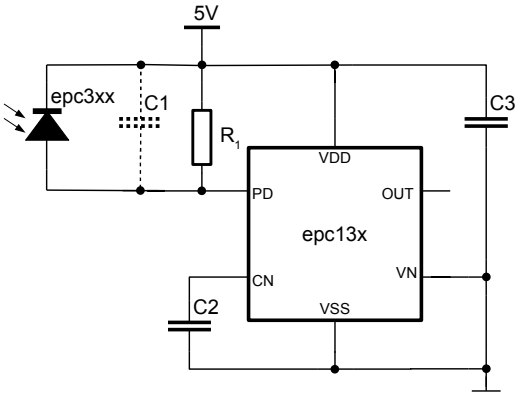


Figure 1: Typical schematic circuit using an epc13x PD amplifier

Recommended Components Values
R1: 27k (bias resistor). Sensitivity can be reduced by the reduction of this resistor.
C1: Usually not needed. May be up to 100 pF (refer to the epc13x data sheet).
C2: 33nF (DC input current filter capacitor)
C3: 100nF or more (power supply filter capacitor)

Spectral Sensitivity
This photo diode contains an anti-reflection coating on the photosensitive surface. Standard versions have no optical filter in order to allow applications from the near UV to the near IR range. However, optical filters deposited on the photosensitive surface are available upon request. The filter parameters can be adjusted in a wide range according to specific customer requirements.

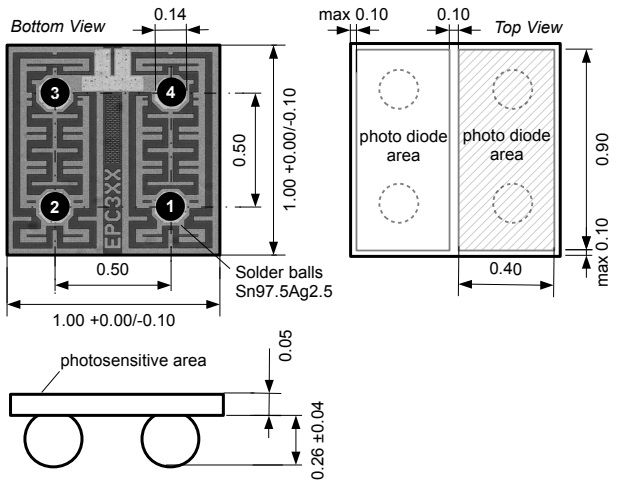
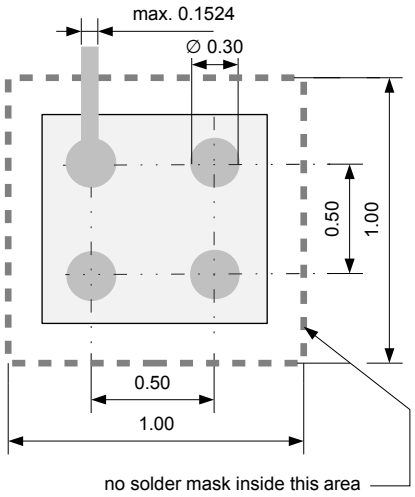
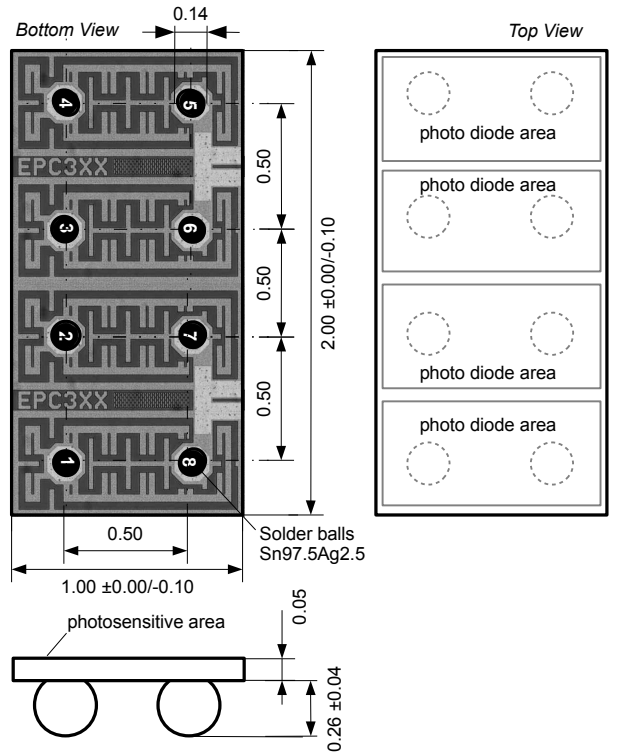
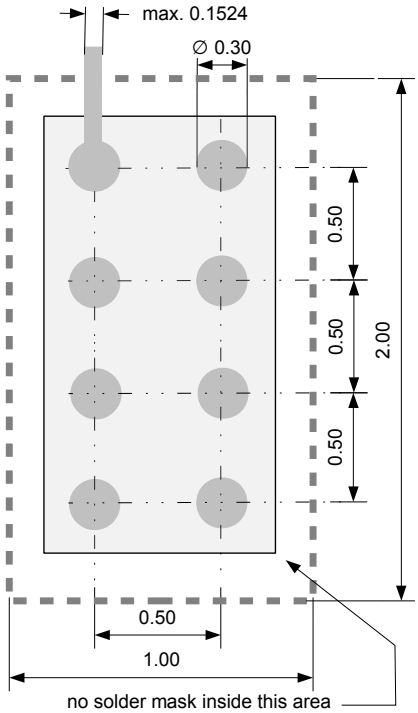
Electrical Isolation between individual Diodes
The individual diodes are located on a monolithic silicon chip. Thus, the electrical isolation between the individual diodes is not as good as with diodes on separate substrates. The substrate is conductive in x and y direction between all anodes, e.g. indicated in schematics by “R”. In x direction between the anode pairs ca. 20kΩ is a typical value. They must not be used as resistor components.

Design rules
On chip are the anodes metallic connect together by pairs. The user has to take care, that all anode pins are connected to the same voltage level (refer to above section).
All pins of the diode array should be connected electrical-wise.
The biasing of the cathodes can be individual.Their voltage levels should be equal best match.

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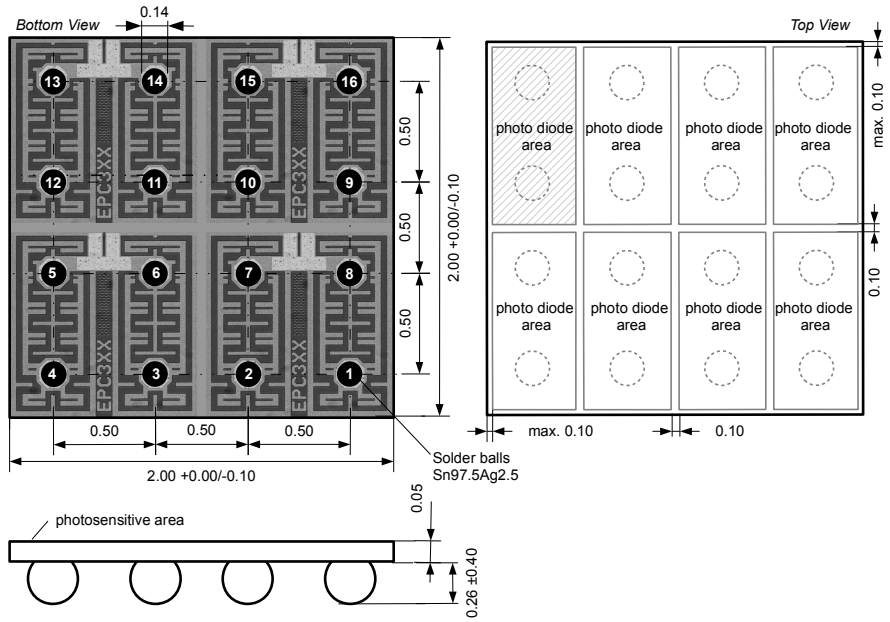
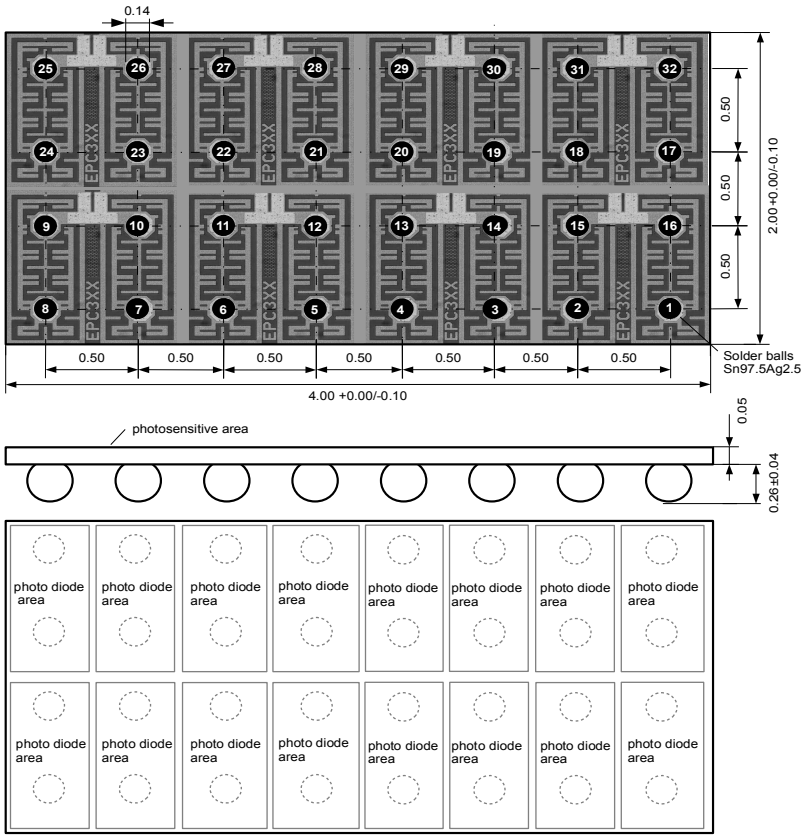
Layout Information

(all measures in mm,)

Package	Mechanical Dimensions	Layout Recommendations
CSP4		
CSP8		

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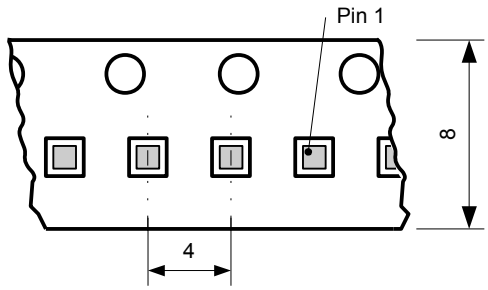
Layout Information (Cont.)

Package	Mechanical Dimensions
CSP16	
CSP32	

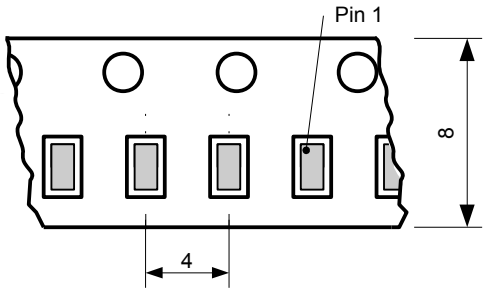
Packaging Information

(all measures in mm)

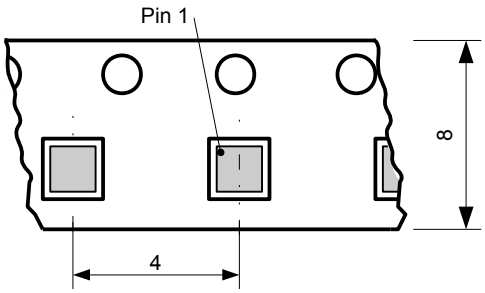
CSP4 Tape



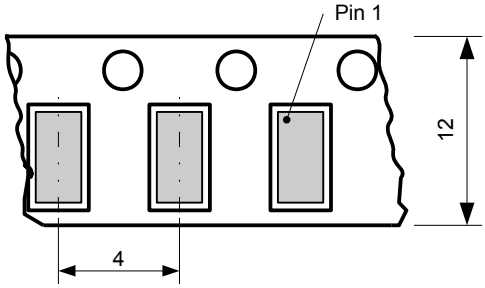
CSP8 Tape



CSP16 Tape



CSP32 Tape



Tape & Reel Information

The devices are mounted on embossed tape for automatic placement systems. The tape is wound on 178 mm (7 inch) or 330 mm (13 inch) reels and individually packaged for shipment. General tape-and-reel specification data are available in a separate data sheet and indicate the tape sizes for various package types. Further tape-and-reel specifications can be found in the Electronic Industries Association (EIA) standard 481-1, 481-2, 481-3.

epc does not guarantee non-empty cavities. Thus, pick-and-place machines should check the presence of a chip during picking.

It is highly recommended to use underfill after assembly of the chips to the PCB.

Ordering Information

Part Name	Package	RoHS compliance	Packaging Method
epc300-CSP4	CSP4	Yes	Reel
epc310-CSP8	CSP8	Yes	Reel
epc320-CSP16	CSP16	Yes	Reel
epc330-CSP32	CSP32	Yes	Reel

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