General Description

The epc300-330 family products are high-sensitive photodiode arrays for light-barrier, light-curtain and the like applications. The photodiodes 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 epc300-330 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 photodiodes.

Also, other mechanical dimensions are available upon request. It is be possible to manufacture photodiodes arrays of up to 15x15 mm or even bigger. Such a 15x15 mm device would then contain 450 individual photodiodes, 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 30V 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
- Customer specific wavelength filter upon request

Applications

- Linear photodiode arrays
- Differential photodiode
- Light-barriers and light-curtains ranging from millimeters to tens of meters
- Smoke detectors, liquid detectors, level detectors
- Heartbeat monitors
- Position detection (linear, rotary, angle, etc.)
- IR remote control of Hi-Fi, TV sets and other equipment
- Leveling instruments

Product range overview

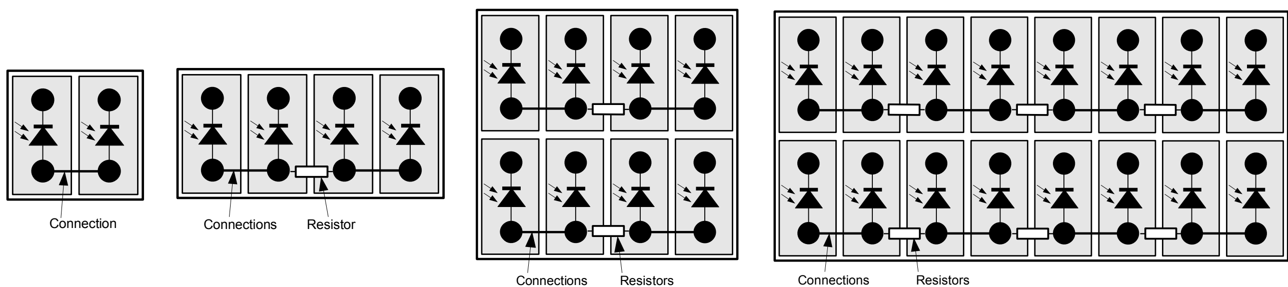

Figure 1: Array configurations epc300, epc310, epc320, epc330
Note: Resistors are referenced in section "Electrical isolation between individual diodes"

Model	No. of photodiodes	Diode length [mm]	Diode width [mm]	Total active area [mm²]	Typ. dark current at 20°C [pA]	Ideal bias voltage [V]	Wavelength [nm]	Footprint
Single diode	1	1.0	0.5	0.43	40	5	400 - 1050	---
epc300	2	1.0	1.0	0.86	80	5	400 - 1050	CSP4
epc310	4	2.0	1.0	1.71	160	5	400 - 1050	CSP8
epc320	8	2.0	2.0	3.42	320	5	400 - 1050	CSP16
epc330	16	4.0	2.0	6.84	640	5	400 - 1050	CSP32

Table 1: Type specific characteristics (all diodes of the array are connected in parallel)

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1. Electrical, optical and timing characteristics

All characteristics are at typical operational ratings, V_R = 5.0 V, R_L = 50 Ω, -40°C < T_A < +85°C, unless otherwise stated

1.1. General characteristics and operating conditions

Parameter	Description	Conditions/Comments	Min.	Typ.	Max.	Units
V_R	Reverse voltage		1.5	5	20	V
λ_S max.	Wavelength	At max. sensitivity		850		nm
λ	Wavelength range	S = 20 % of S_{max}	400		1'030	nm
S_λ	Spectral sensitivity	For epc300 at λ = 850 nm, V_R = 5V, I_e = 1 mW/cm²		0.6		A/W
η	Quantum efficiency	For epc300 at λ = 850 nm, V_R = 5V, I_e = 1 mW/cm²		90		%
φ	Half angle			±75		°
V_O	Open circuit voltage	I_e = 0.5 mW/cm²		300		mV
TC_V	Temperature coefficient of I_{SC}			0.15		%/K
TC_O	Temperature coefficient of V_O			-3.0		mV/K

Table 2: General characteristics

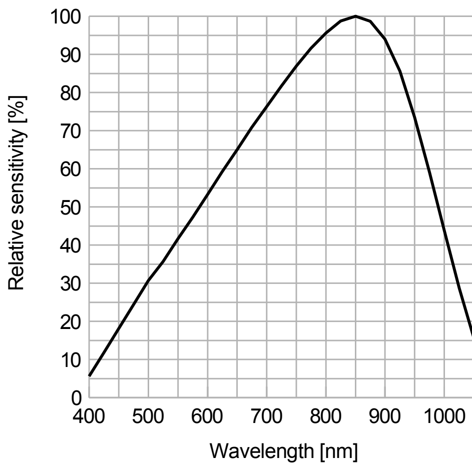

Figure 2: Relative spectral sensitivity (Sλ) vs. wavelength

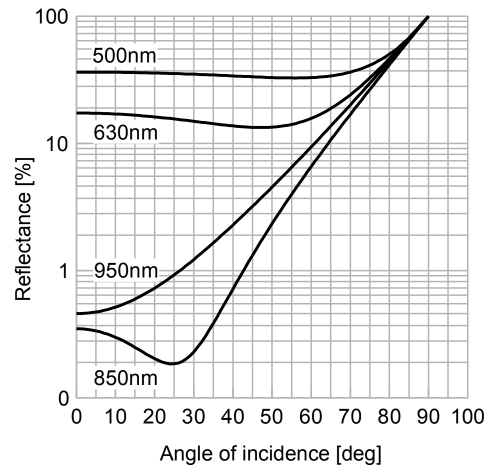

Figure 3: Reflectance vs. illumination angle (AOI)

1.2. Type specific characteristics

All diodes of the array are connected in parallel

Parameter	Description	Conditions/Comments	Type	Min.	Typ.	Max.	Units
I_P	Photocurrent	V_R = 5V, I_e = 1 mW/cm², λ = 850 nm. Refer to Figure 4.	per diode		2.5		µA
			epc300		5		
			epc310		10		
			epc320		20		
			epc330		40		
I_R	Dark Current	V_R = 5 V, T_A= 20°C. Selected types available upon request.	per diode		40 pA	2.5 nA	
			epc300		80 pA	5 nA	
			epc310		160 pA	10 nA	
			epc320		320 pA	20 nA	
			epc330		640 pA	40nA	
I_{SC}	Short-circuit current	λ = 850 nm, I_e = 1 mW/cm²	per diode		2.5		µA
			epc300		5		
			epc310		10		
			epc320		20		
			epc330		40		

Table 3: Type specific characteristics

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Parameter	Description	Conditions/Comments	Type	Min.	Typ.	Max.	Units
t_r / t_f	Rise / fall time	all types, Photocurrent I_P = 200 µA at R_L = 50 Ω , λ = 850 nm. Refer to Figure 5.	V_R = +1.5 V		300		ns
			V_R = +5.0 V		150		
			V_R = +10.0 V		90		
C_O	Capacitance	V_R = +5V, ƒ = 100kHz, E = 0	per diode		5		pF
			epc300		10		
			epc310		20		
			epc320		40		
			epc330		80		
NEP	Noise equivalent power	V_R = +5V	per diode		4.2×10^{-15}		W/√Hz
			epc300		6.0×10^{-15}		
			epc310		8.4×10^{-15}		
			epc320		12×10^{-15}		
			epc330		17×10^{-15}		
C_T	Cross-talk suppression	For voltage difference V_{diff} < 100 mV between cathodes of the photodiodes. Refer to Figure 6.	epc320 epc330		50		dB

Table 3 Cont.: Type specific characteristics

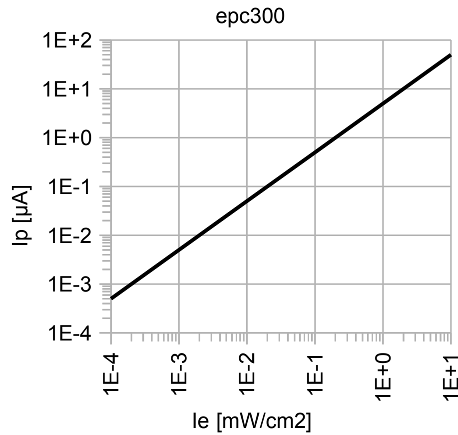


Figure 4: Photocurrent I_P = ƒ(I_e), V_R = 5 V, λ = 850nm

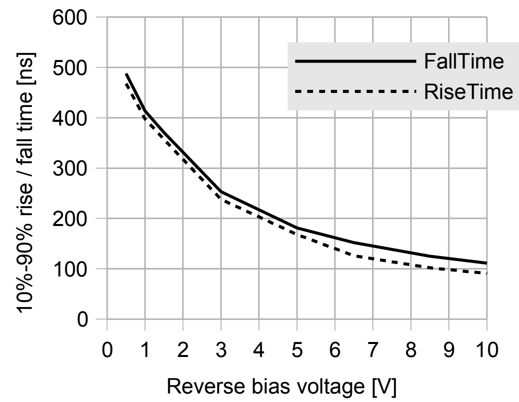


Figure 5: Rise / fall time versus reverse bias voltage

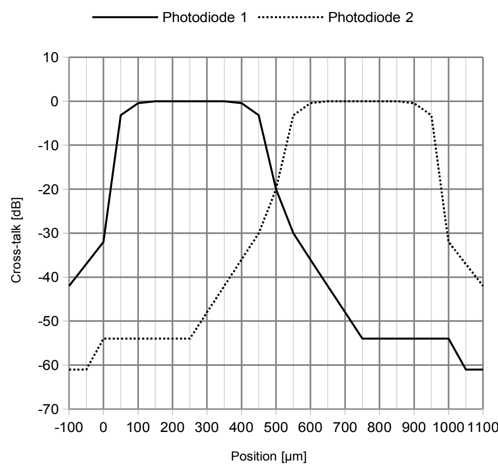


Figure 6: Cross-talk between a pair of photodiodes

1.3. Absolute maximum ratings

Parameter	Conditions
Reverse voltage V_R	30 V
Breakdown voltage between diodes	10 V
ESD rating	JEDEC HBM class 2 (2kV to < 4kV)
Operating temperature range (T_a)	-40°C to +85°C
Storage temperature range (T_S)	-40°C to +85°C
Relative humidity	0 ... 95%, non-condensing

2. Pin-out

NOTE:
Always two photodiodes are paired and have shorted anodes as shown in Figure 7. It is the same for all diodes on epc310, epc320 and epc330.

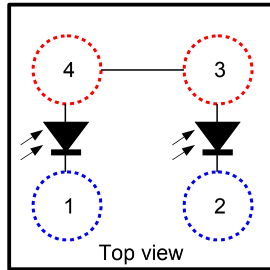


Figure 7: epc300

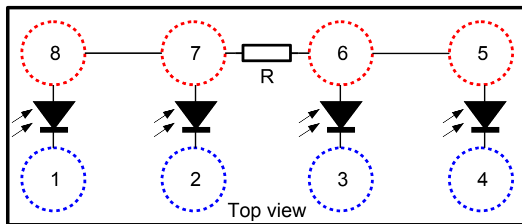


Figure 8: epc310

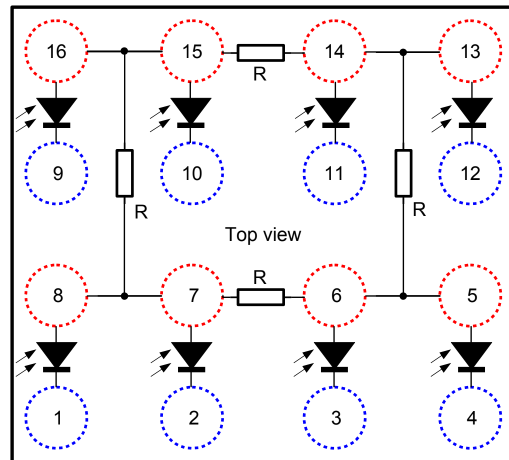


Figure 9: epc320

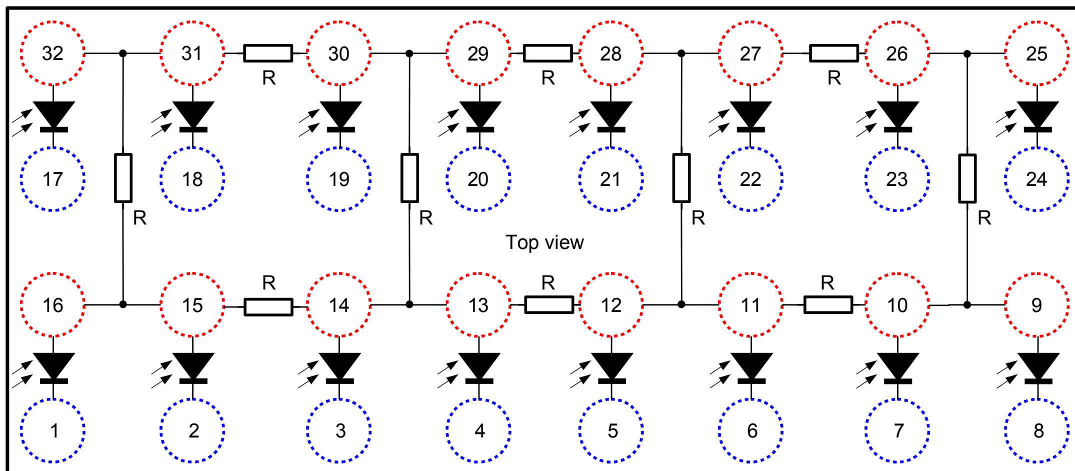


Figure 10: epc330

NOTE: R is referenced in section “Electrical isolation between individual diodes”

3. Packaging and layout information

3.1. Mechanical dimensions

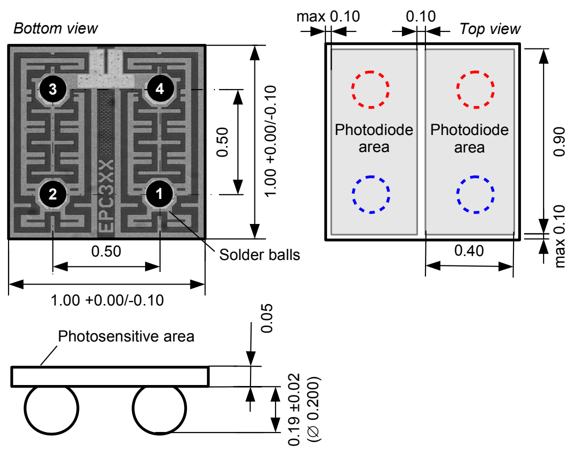


Figure 11: epc300-CSP4

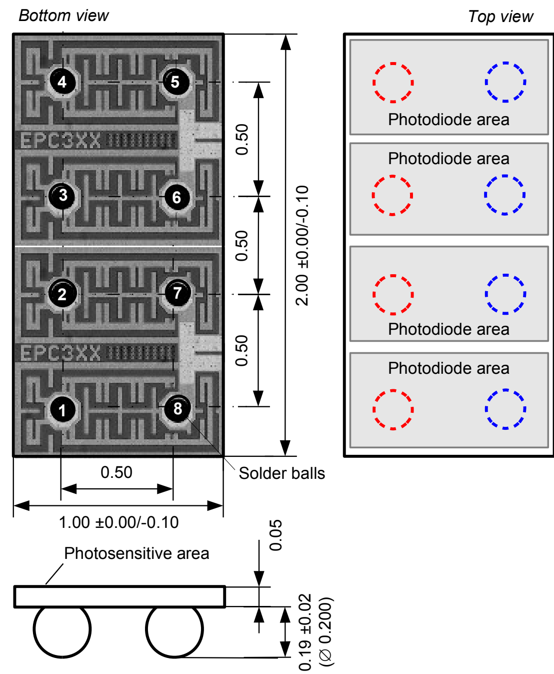


Figure 12: epc310-CSP8

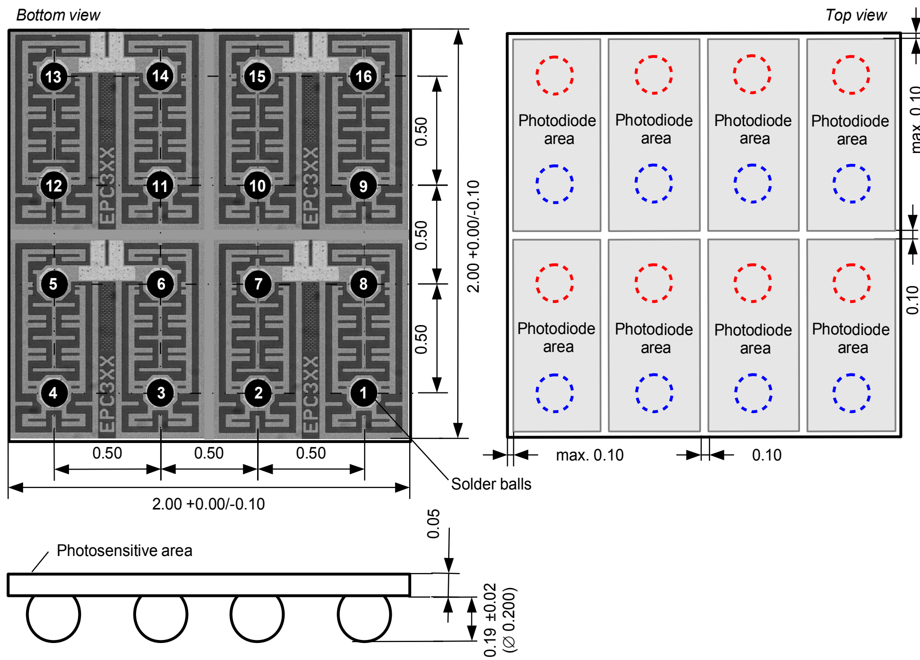
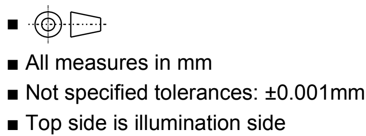


Figure 13: epc320-CSP16

Notes:

- 
- All measures in mm
- Not specified tolerances: ±0.001mm
- Top side is illumination side

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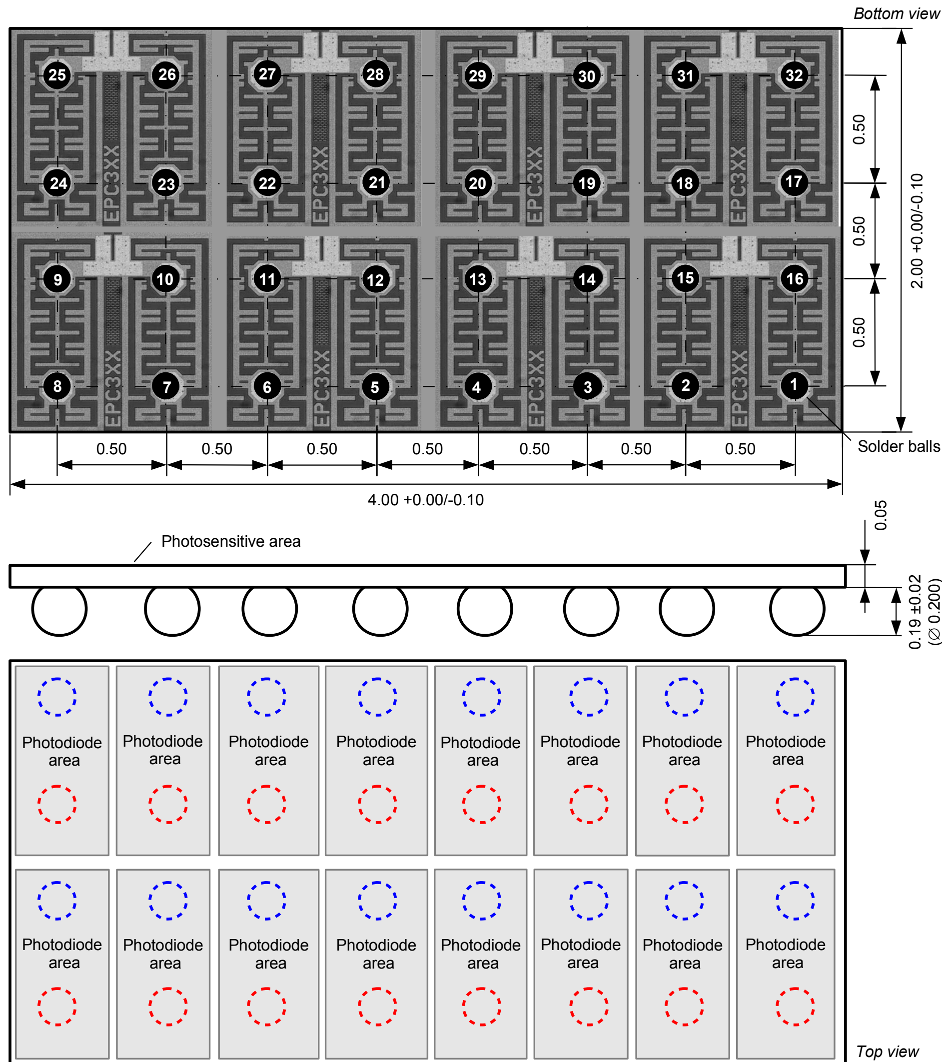


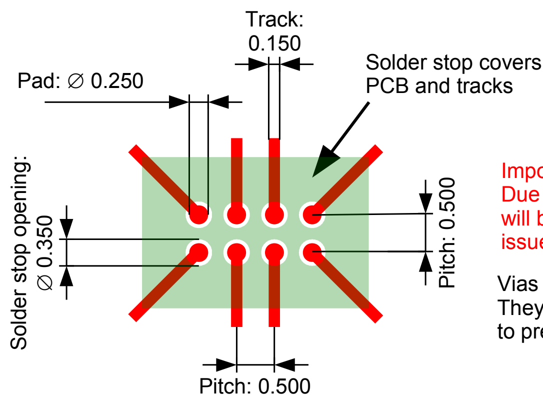
Figure 14: epc330-CSP32

3.2. Location of the photosensitive area

The photosensitive area are not marked (neither on the front nor on the backside of the IC). As a visible reference, the metal rings of the IC can be used. They are visible from the solder ball side. They can be seen also from the front side (photosensitive area) with a camera which is sensitive in the near infrared wavelength domain (950 .. 1'150nm).

3.3. PCB design and SMD manufacturing process considerations

As the epc300, epc310, epc320 and epc330 chips come in chip scale packages with only 50µm thickness, the PCB layout should be made with special care. In addition, careful handling during the assembly process shall be assured in order to avoid mechanical damage during the assembly process.



Important note:
Due to the thin chip substrate, unevenness of the substrate surface will be visible on the top surface of the chip. This may cause optical issues and has to be considered carefully.

Vias underneath the chip:
They must be filled solid, covered by a solder pad or solder mask to prevent drain of solder or underfill into or through the vias

Figure 15: Recommended PCB layout (all measures in mm), e.g. epc310

Because the silicon chip is small and light weight compared to the solder balls, it is highly recommended that all tracks to the chip should come straight from the side (Figure 15). A symmetrical design is highly recommended to achieve high production yield. The pads and the tracks should also have exactly the same width at least for 1mm from the pad. They shall be covered by a solder resist mask in order to avoid drain of the solder tin alloy to the track.

IMPORTANT NOTES:

- Connect all anode pins to the same voltage level. This is on one side due to the metallic, pairwise on-chip connection, otherwise due to the bulk resistance between these pairs. See also chapter 5.1.
- All pins of the diode array should be connected electrical-wise for ESD reasons.
- The biasing of the cathodes can be individual. Their voltage levels should be equal best match.

Underfill of the components reduces stress to the solder pads caused by e.g. temperature cycling or mechanical bending. Furthermore the thermal and mechanical fatigue will be reduced and the longterm reliability will be increased. Underfill material and underfill selection is application specific. It shall follow JEDEC-STD JEP150: Stress-Test-Driven Qualification of and Failure Mechanisms Associated with Assembled Solid State Surface-Mount Components. Refer also to the application note AN08 Process-Rules CSP Assembly which can be downloaded from the ESPROS website at www.espros.com/downloads. Obeying these recommendations a high manufacturing yield can be achieved.

3.4. 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 datasheet 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.

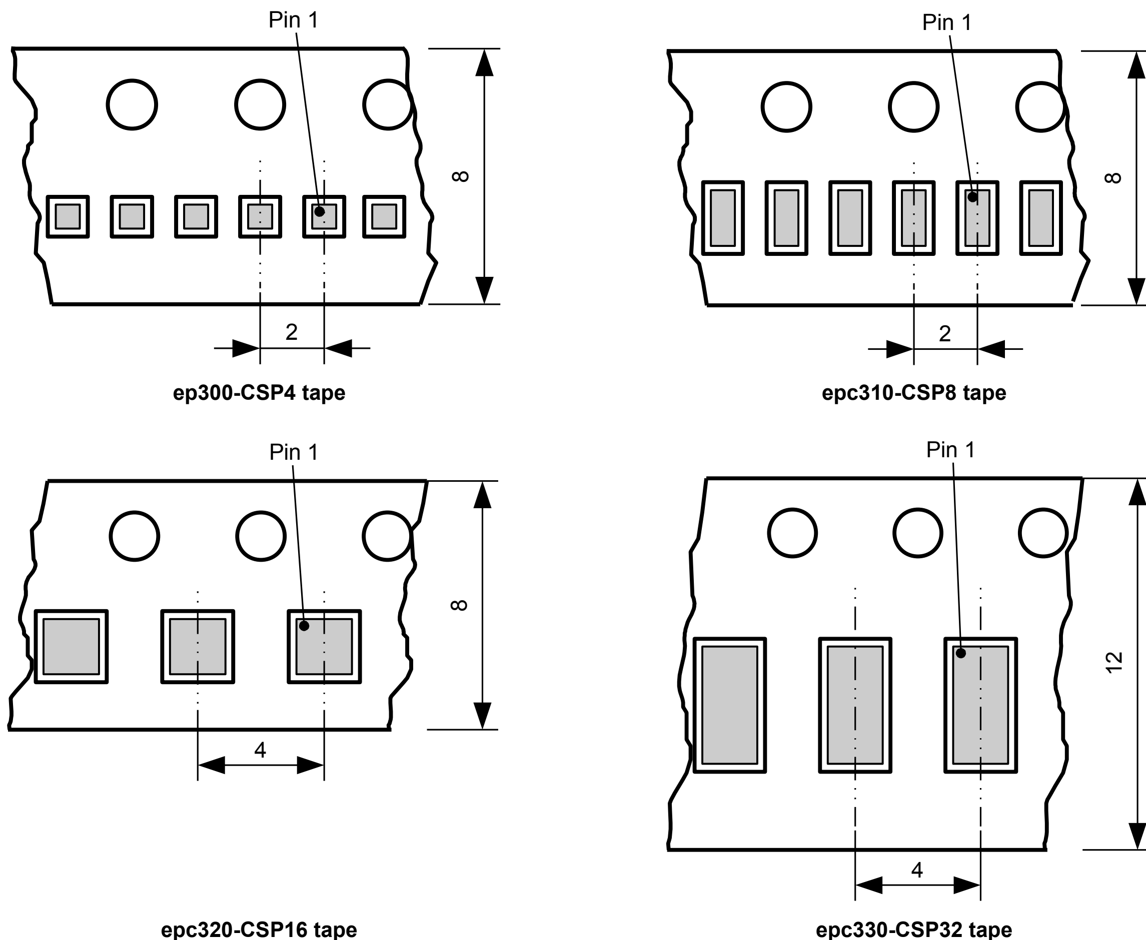


Figure 16: Tape dimensions (all measures in mm)

ESPROS does not guarantee that there are no empty cavities. Thus, the pick-and-place machine should check the presence of a chip during picking.

4. Ordering information

Part Number	Part Name	Package	RoHS compliance
P100 049	epc300-CSP4	CSP4	Yes
P100 050	epc310-CSP8	CSP8	Yes
P100 051	epc320-CSP16	CSP16	Yes
P100 052	epc330-CSP32	CSP32	Yes

Table 4: Ordering Information

4.1. Notes to various chip releases

The supplied chip version can be identified by reading the extension -XXX of the part name on the packaging labels or delivery papers e.g. epc300-CSP4-XXX.

Chip version -000: Solder ball height is 0.26 ±0.04mm. Solder ball diameter is 300µm.

5. Application information

5.1. Electrical isolation between individual diodes

The individual diodes are located on a monolithic silicon chip. Thus, the electrical isolation between the 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.

5.2. Spectral sensitivity

These photodiode arrays contain 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.

5.3. Light-barrier application

The following circuit uses an epc3xx photodiode array as a single photodiode in combination with an epc13x PD amplifier chip. This circuit offers a very high AC photocurrent sensitivity and a tremendous DC backlight suppression.

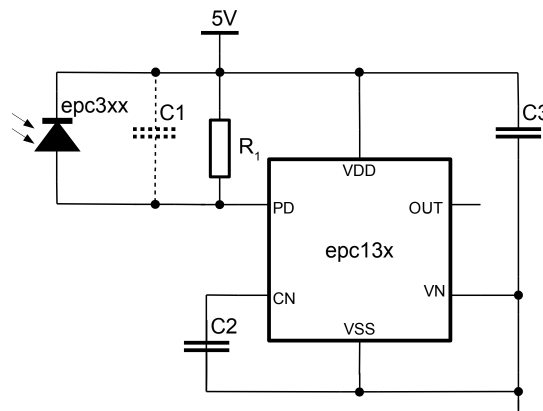


Figure 17: Typical schematic using an epc13x PD amplifier

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 datasheet).
C2: 33nF (DC input current filter capacitor)
C3: 100nF or more (power supply filter capacitor)

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