



Light-Curtain Device with 2-Wire Bus Interface

General Description

The epc10x chip set is a general purpose CMOS integrated circuit for light-curtain applications. epc100 is used on the receiver side (Rx) whereas epc 101 is on the emitter side (Tx). Up to 1023 devices may be connected to two respectively four wires in parallel. Each device can be individually addressed by an epc100 chip which acts as the interface between a microcontroller and the 2-wire bus. It manages the bus traffic between the microcontroller and the individual Rx and Tx elements. Programmable fuses i.e. for the address, sensitivity, LED light pulse width, etc. allow the device to be parametrized in the final system (OTP memory).

Each chip can be put into 'standby mode' or 'operating mode' to reduce power consumption. During 'standby mode', power consumption is reduced and the photodiode is shorted.

Refer to the separate Data Sheet of the epc101 transmitter chip and to the Reference Manual epc10x for implementation, usage and configuration information.

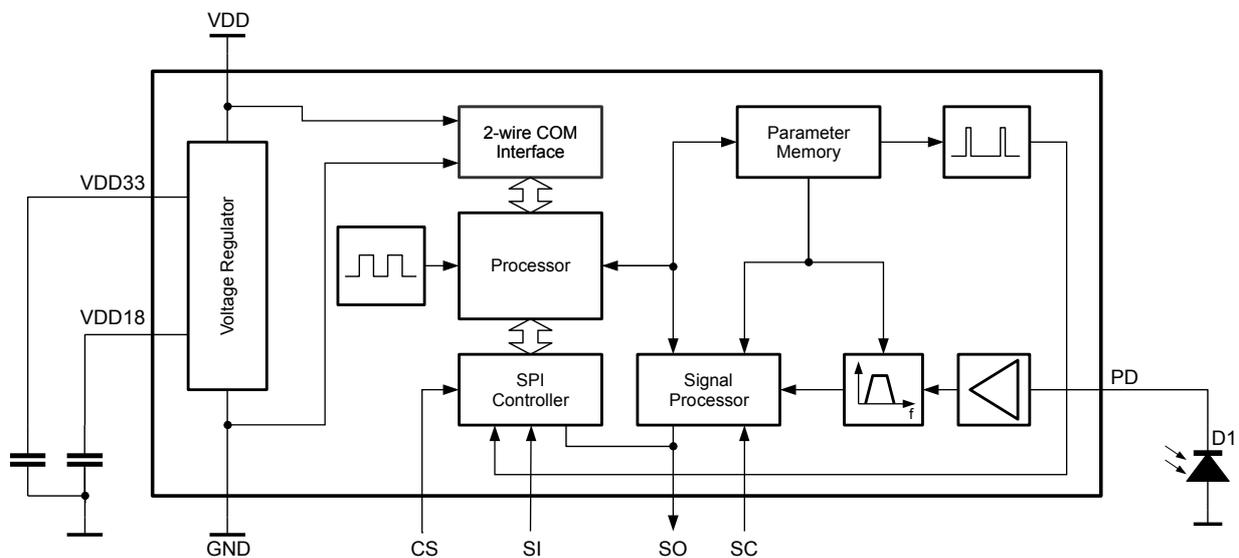
Feature

- Light pulse receiver
- Bus transceiver
- Advantageous wiring by communication over the power-supply lines
- High sensitive input for photodiode current signals, typ. 60nA
- Scan period down to 30 μ s
- integrated clock generator
- CSP10 package with very small footprint.

Applications

- Light barriers ranging from millimeters to tens of meters
- Light curtains
- Smoke detectors
- Liquid detectors

Functional Block Diagram



Absolute Maximum Ratings (Notes 1, 2)		Recommended Operating Conditions			
Voltage to any pin except V _{DD}	-0.3V to VDD+0.3 V	Min.	Max.	Units	
Supply Voltage on 2-wire bus V _{DD}	-0.3V to +8.0V	Operating Voltage on 2-wire bus V _{DD}	4.5	5.5	V
Programming Voltage on 2-wire bus V _{DD}	-0.3V to +8.0V	Programming Voltage on V _{DD}	7.0	8.0	V
Power Supply Voltage V _{DD33}	-0.3V to +5.5V	Operating Supply Voltage V _{DD33}	3.0	3.6	V
Input current at any pin except SCK	-6mA to +6mA				
Power consumption with maximum load	125mW				
Storage Temperature Range (T _s)	-55°C to +155°C	Operating Temperature (T _o)	-40°	+85	°C
Lead Temperature solder, 4 sec. (T _L)	+260°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.

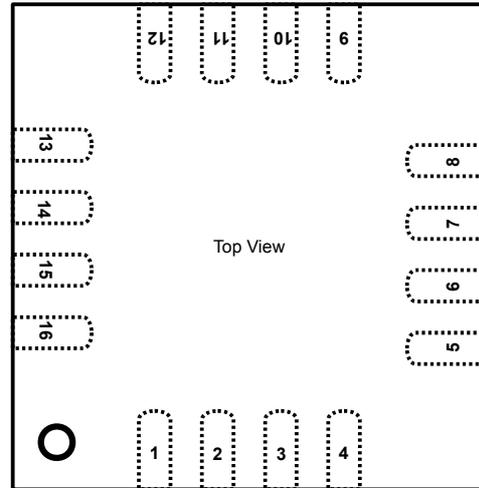
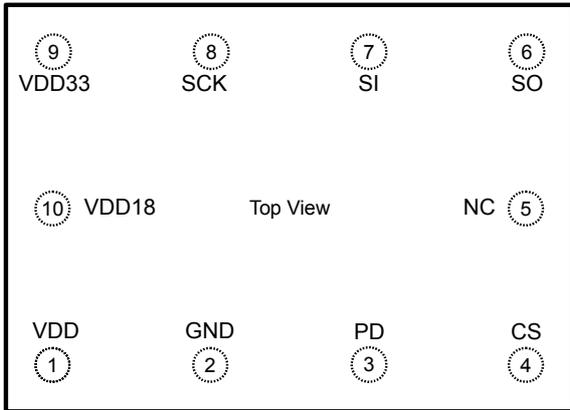
Note 2: This device is a highly sensitive CMOS ac current amplifier with an ESD rating of JEDEC HBM class 0 (<250V). Handling and assembly of this device should only be done at ESD protected workstations.

Electrical Characteristics

V_{DD} = 5.0 V, -40°C < T_A < +85°C, if not otherwise specified

Symbol	Parameter	Conditions/Comments	Values			Units
			Min.	Typ.	Max.	
V _{PP}	Ripple on supply voltage, peak to peak	2-wire interface V _{det}				
		---			70	mV
		50mV			150	mV
		100mV			350	mV
		200mV			600	mV
I _{DD_IDLE}	Current consumption	in idle mode			1.4	mA
I _{DD_OP}	Current consumption	in operation mode I _{PD} = 0 mA			2.0	mA
V _{det}	Detection level for 2-wire interface		50		200	mV
I _{MOD}	Modulation current for 2-wire interface	for the recommended setting. Refer to C2X.	6.4	8.0	9.8	mA
I _{PDCC}	DC Photodiode Current	generated by ambient light			2	mA
I _{PD_NST}	Input Pulse Threshold (Photo Current Sensitivity)	Photodiode current pulse to generate an output signal (only OUT=1), configurable (refer to the Reference Manual epc10x)	24		108	nA
I _{PD_RST}	Input Pulse Threshold (Photo Current Sensitivity)	Photodiode current pulse to generate an output signal (OUT=1 & OUTH=1)		90		nA
I _{Pulse}	Maximum Input Pulse Current	If the input current is above this level, the T _{Relax} is undefined (refer to section 'Other Parameters')			100	µA
T _{Pulse}	LED pulse length		1		10	µs
T _{Relax}	Relaxation time	After a strong current pulse (I _{pulse} = 100µA)			50	µs
I _{N_Imin}	Input related noise	@ I _{PDCC} = 0		7	15	nA _{RMS}
I _{N_Imax}	Input related noise	@ I _{PDCC} = I _{PDCC} Max			20	nA _{RMS}
f _{clk}	Reference clock	Internal oscillator		32		MHz
df _{clk}	Temperature drift of the oscillator			7		%
V _{PUP}	Power-up Threshold Voltage	The voltage at VDD33 when the device starts up	2.4		3	V
V _{IH}	High level input voltage		0.7 * V _{DD}		V _{DD}	V
V _{IL}	Low level input voltage		GND		0.3 * V _{DD}	V
I _{LEAKD}	Input leakage current				10	µA
V _{OH}	Output high voltage	@ 4mA sink except pin SCK	V _{DD} - 0.5			V
V _{OHSCK}	Output high voltage SCK	@ 0.1mA sink current at pin SCK	V _{DD} - 0.5			V
V _{OL}	Output low voltage	@ 4mA source			0.5	V
I _{SCK}	Source current	@ pin SCK	0.7		1.3	mA
V _{Hist}	Schmitt Trigger Hysteresis		0.1			V
R _{PU}	Pull-Up Resistor		30		200	kΩ

Connection Diagrams



10-Pin Chip Scale Package (CSP)

16-Pin QFN Package

Note: For sampling only. Limited quantities. Please inquire.

10-Pin CSP	16-Pin QFN	PIN Name	Type	Description
1	9	VDD	Power supply	Positive power supply for regulator and positive terminal of the 2-wire interface.
2	7	GND	Power supply	Negative power supply pin.
3	6	PD	Analog Input	Photodiode input.
4	4	CS	Digital Input	SPI Interface: Chip Select. Active low, with pull up
5	2	NC	Analog Out	Not used. For CSP soldering connect this pin only to a test point; not to a signal or GND.
6	1	SO	Digital Output	SPI Interface: Serial out
7	15	SI	Digital Input	SPI Interface: Serial input
8	14	SCK	Digital Input	SPI Interface: Shift Clock
9	12	VDD33	Power supply Decoupling	Positive power supply for analog and digital. If the the device is supplied by V_{DDR} , a power supply filter capacitor is connected to this pin.
10	10	VDD18	Analog Out	1.8 V regulator output. Do not use this pin, except for a decoupling capacitor.
n/a	3	NC		Not connected. Connect this pin to GND.
n/a	5	NC		Not connected. Connect this pin to GND.
n/a	8	NC		Not connected. Connect this pin to GND.
n/a	11	NC		Not connected. Connect this pin to GND.
n/a	13	NC		Not connected. Connect this pin to GND.
n/a	16	NC		Not connected. Connect this pin to GND.

Other Parameters

(typical values, $T_{amb} = 25^{\circ}C$, $V_{DD} = 5.0V$)

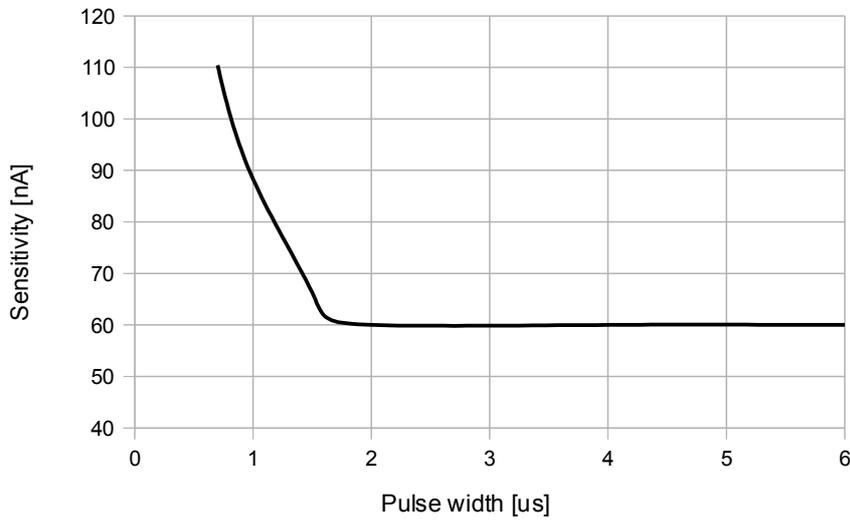


Figure 1: Input Sensitivity vs. LED pulse length

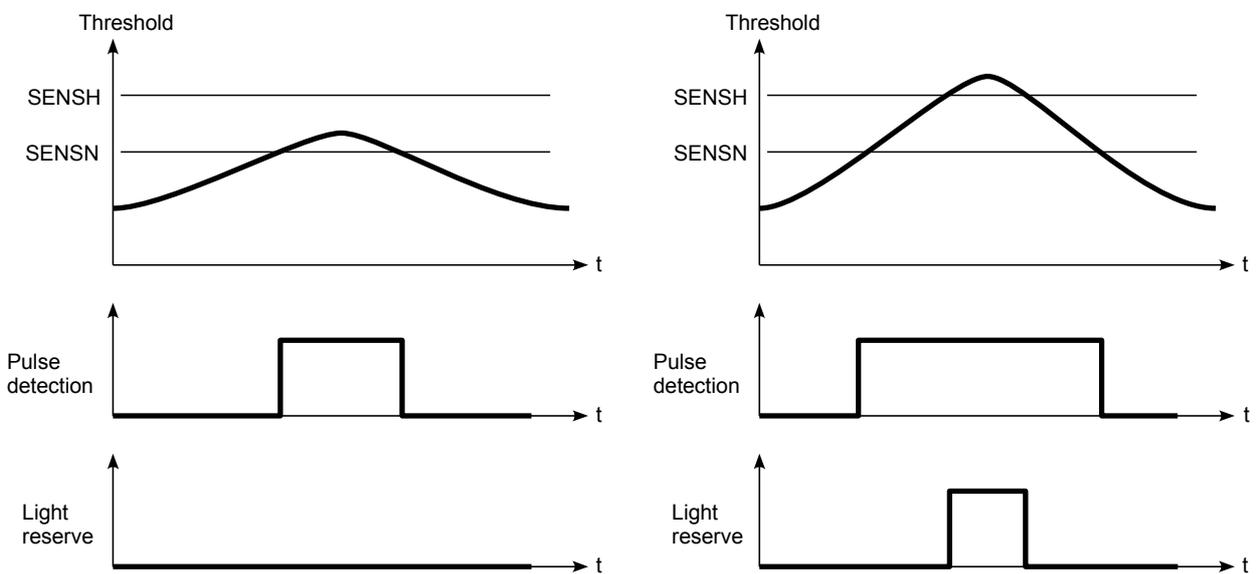


Figure 2: Pulse detection and light reserve threshold operation (*SENS*, *SENS_H*)

Overview Functional Description

Light Curtain Receiver in a 2-Wire Configuration

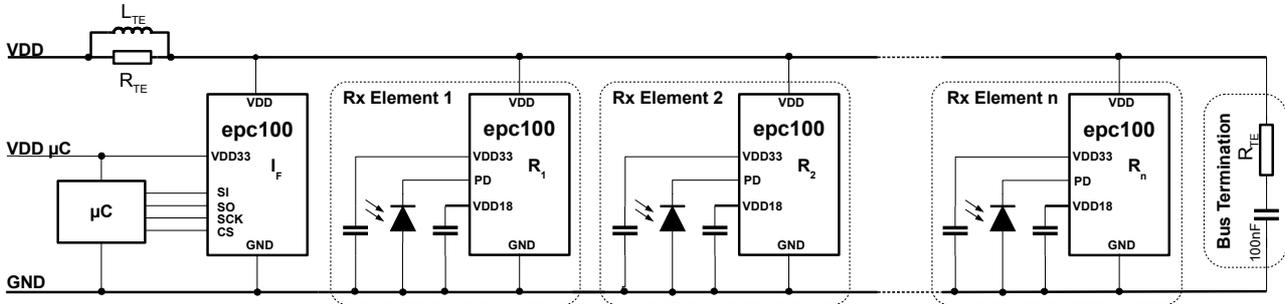


Figure 3: Typical light curtain receiver edge circuit (principal schematic)

The epc100 device can be operated in two different modes:

a) Photo Current Receivers

It detects current pulses of the photodiode generated by light pulses and transmits the information using the 2-wire bus to a central controller, i.e. a microcontroller. The devices operating as this photo current receivers are designated in the schematic diagram above as R_1 to R_n .

b) 2-Wire Bus Interface of the Central Controller

It manages the 2-wire bus traffic between the microcontroller and the individual photo current receivers. The device operating as the interface unit is designated as I_F .

From the point of view of the microcontroller, the whole system looks like a single device with several addressable photodiodes. The microcontroller activates one photodiode and fetches the results after a predefined time. Each sensor device has two different operation modes: A standby and an operating mode. During the standby mode the power consumption is reduced and the DC current generated in the photodiode is shorted. During the operation mode, the microcontroller addresses one device after the other and fetches the result. The result contains the information whether a light pulse has been received in a predefined receive window or not. It also contains the time point when the light pulse has been received in respect to the receive window.

The receiver channel detects current pulses which are generated by light pulses in the photodiodes. The detection circuitry has two trigger levels, hereinafter called thresholds, which form a digital signal from the analog current change. The lower threshold is called SENSN (normal, pulse detection) whereas the upper level is called SENSH (high, light reserve). Both trigger thresholds can be configured individually per chip. Please refer to Figure 2 and to the Reference Manual epc10x which contains the configuration information.

Application Information

Schematic Circuit of one Node

Figure 4 shows the schematic circuit of one node on a light curtain system. A node consists of four components only: The receiver chip epc100, a photodiode and two supply voltage decoupling capacitors.

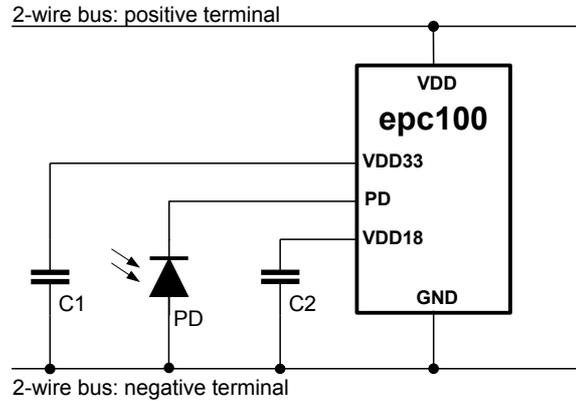


Figure 4: Schematic circuit of one node

Recommended Components Values

PD: PIN photodiode, i.e., epc300, epc310, epc320, epc330 (refer to the separate available data sheet epc3xx), or similar

C1: 100nF ceramic capacitor

C2: 4.7nF ceramic capacitor

Schematic Circuit of the Interface SPI to 2-wire Bus and Bus Termination

An epc100 chip is used as the interface to access the 2-wire bus by the SPI interface of the microcontroller. This chip is solely used for this function. The circuit around the interface needs to be designed carefully to get the 2-wire bus properly working. The circuit in Figure 5 shows the decoupling of the VDD33 supply from the microprocessor supply. The Schottky diode D prevents of the reverse supply of VDD33 during the address programming. In the last step of the interface chip programming, the internal voltage regulator has to be switched "OFF" (SOFF=1).

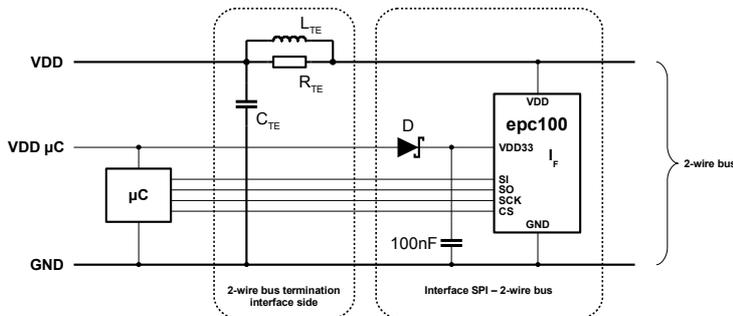


Figure 5: Schematic of the interface circuit (begin of the 2-wire bus)

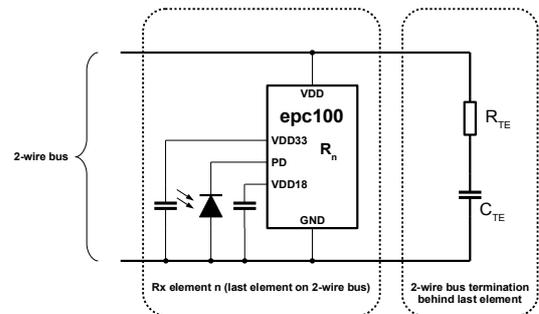
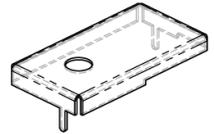


Figure 6: Termination at the end of the 2-wire bus

The termination of the 2-wire bus, see Figure 5 and Figure 6, is in detail described in the "Reference Manual epc100 / epc101."

Design Precautions

The sensitivity at pin PD is very high in order to achieve a long operation range of light curtains even without lenses in front of the IR LED and/or the photodiode. Thus, the pin PD is very sensitive to EMI. Special care should be taken to keep the PCB track at pin PD to the photodiode as short as possible (a few mm only!). This track should be kept away from sources emitting electromagnetic noise which may induce unwanted signals. It is strongly recommended to cover the chip and the photodiode with a metal shield. A recommended part is shown in Figure 7.



*Figure 7:
Recommended EMC
shield*

The pins at the bottom are to solder the shield to the PCB with electrical connection to GND. The hole in the front is the opening window for the photodiode. The back side of the PCB below the sensitive area (PD, epc100) shall be a polygon connected to GND to shield the circuit from the back side. The capacitors shall be of high mechanical stability (no piezoelectric effect) in order to avoid unwanted voltage modulation by mechanical shock or vibration.

Ambient Light

Photodiode DC current is generated by ambient light, e.g. sun light. DC currents at pin PD do not generate an output signal. However, if I_{PDDC} is above the stated value, the input is saturated which blocks the detection of AC current pulses.

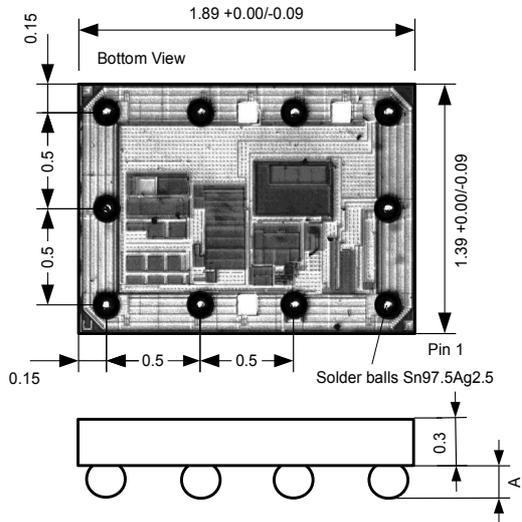
Photodiode Capacitance

If the photodiode capacitance is below the specified value, the system becomes more sensitive to power supply ripple voltage at higher frequencies (>200kHz). This sensitivity can be reduced by a parallel capacitor to the photodiode. However, this measure reduces the detection sensitivity. If the photodiode capacity is above the specified value, a lower detection sensitivity and a higher sensitivity spread results.

Layout Information (all measures in mm, )

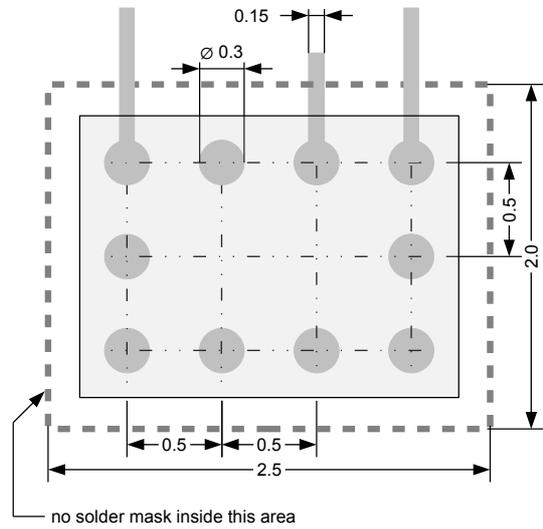
CSP-10 Package

Mechanical Dimensions



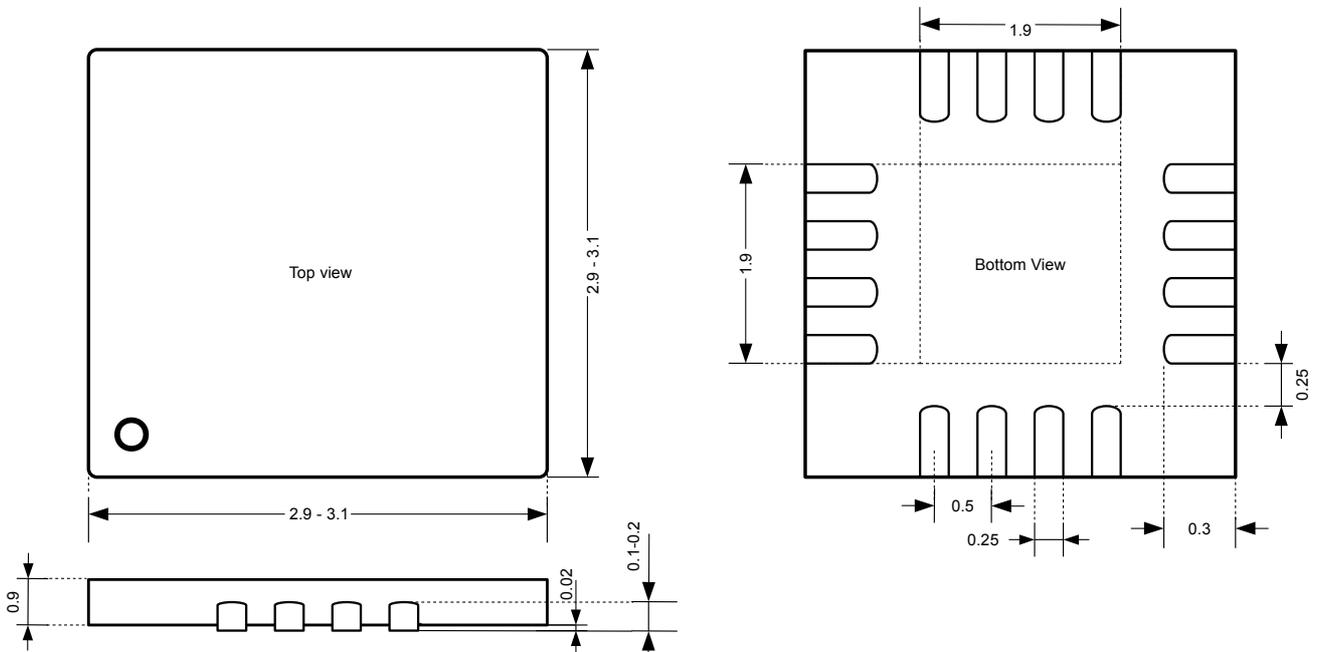
Revision:	-	A
Dimension A:	0.12 ±0.02	0.15 ±0.02

Layout Recommendations



QFN-16 Package

Note: For sampling only. Limited quantities. Please inquire.



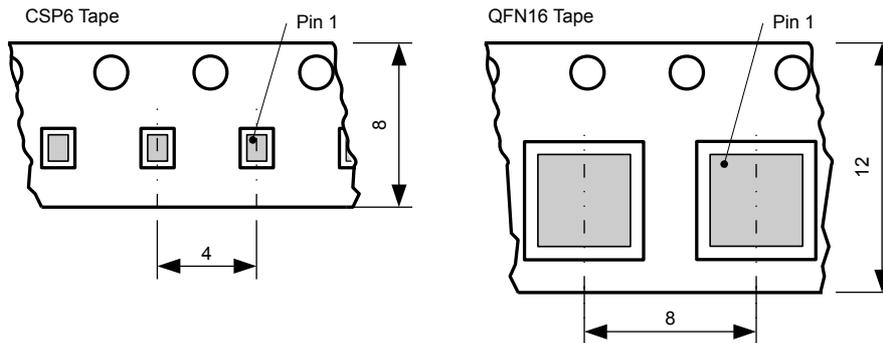
Reflow Solder Profile

For infrared or conventional soldering the solder profile has to follow the recommendations of IPC/JEDEC J-STD-020C (min. revision C) for Pb-free assembly for both types of packages. The peak soldering temperature (T_L) should not exceed +260°C for a maximum of 4 sec.

Packaging Information (all measures in mm)

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 that there are no empty cavities.
Thus, the pick-and-place machine should do check the presence of a chip during picking.

Ordering Information

Standard products:

Part Number	Package	RoHS compliance	Packaging Method
epc100-CSP10	CSP10	Yes	Reel
epc101-CSP10	CSP10	Yes	Reel

For sampling only. Limited quantities. Please inquire.

Part Number	Package	RoHS compliance	Packaging Method
epc100-QFN16	QFN16	Yes	Reel
epc101-QFN16	QFN16	Yes	Reel

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