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 photo diode is shorted.

Refer to the separate Data Sheet of the epc100 receiver chip and to the Reference Manual epc10x for implementation, usage and configuration information.

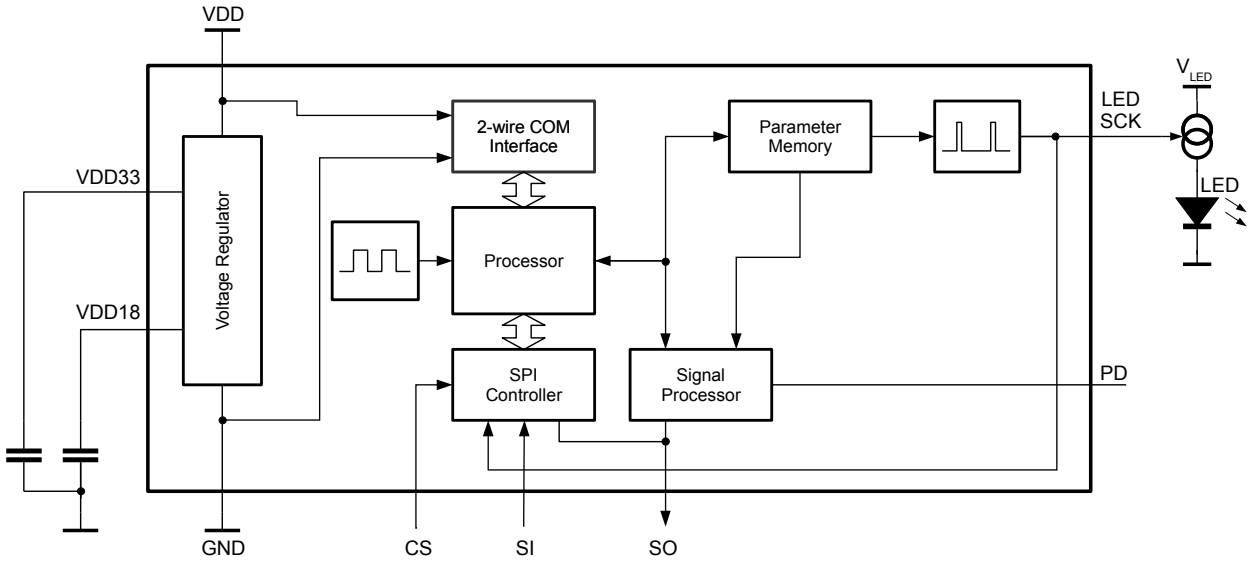
Feature

- Light pulse transmitter
- Universal LED controller
- Scan period down to 30 µs
- 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)

Voltage to any pin except V_{DD}	-0.3V to VDD+0.3 V
Supply Voltage on 2-wire bus V_{DD}	-0.3V to +8.0V
Programming Voltage on 2-wire bus V_{DD}	-0.3V to +8.0V
Input current at any pin except LED	-6mA to +6mA
Power consumption with maximum load	125mW
Storage Temperature Range (T_S)	-55°C to +155°C
Lead Temperature solder, 4 sec. (T_L)	+260°C

Recommended Operating Conditions

	Min.	Max.	Units
Operating Voltage on 2-wire bus V_{DD}	4.5	5.5	V
Programming Voltage on V_{DD}	7.0	8.0	V
Operating Temperature (T_O)	-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.

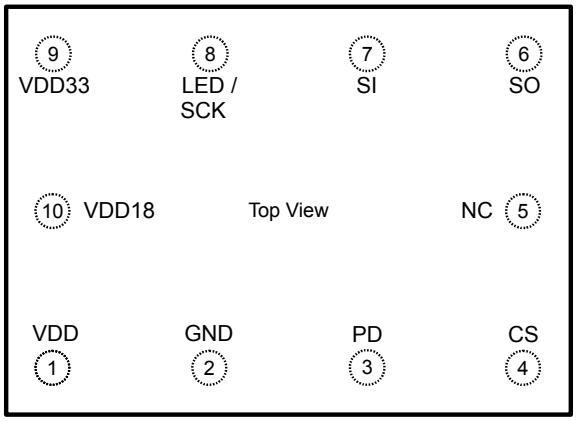
Note 2: This device is a highly sensitive CMOS ac current amplifier with an ESD rating of JEDEC HBM class 0 (<250V). Handling and assembly of this device should only be done at ESD protected workstations.

Electrical Characteristics

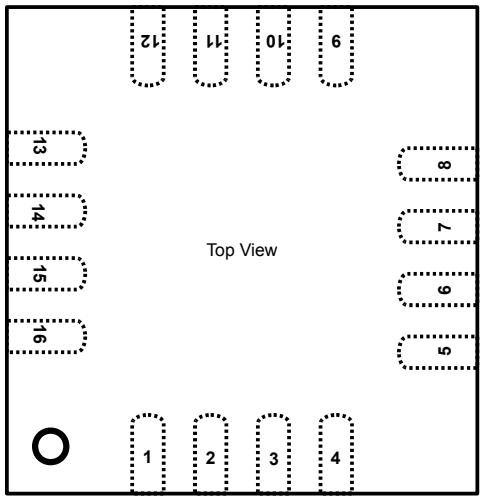
V_{DD} = 5.0 V, -40°C < T_A < +85°C, if not otherwise specified

Symbol	Parameter	Conditions/Comments		Values			Units
				Min.	Typ.	Max.	
V_{PP}	Ripple on supply voltage, peak to peak		2-wire interface V_{det}				
			50mV			25	mV
			100mV			50	mV
			200mV			100	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	mA
V_{det}	Detection level for 2-wire interface			80		120	mV
I_{MOD}	Modulation current for 2-wire interface	for the recommended setting. Refer to C2X.		6.4	8.0	9.8	mA
T_{pulse}	LED pulse length	configurable		1		8	µs
f_{clk}	Reference clock	Internal oscillator			1		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/LED		V_{DD}- 0.5			V
V_{OHLED}	Output high voltage SCK	@ 0.1mA sink current at pin LED		V_{DD}- 0.5			V
V_{OL}	Output low voltage	@ 4mA source				0.5	V
$I_{SCK/LED}$	Source current	@ pin SCK/LED		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	Address programming input. Refer to section “Quasi Daisy Chain for address Programming.
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 Output	SPI Interface: Serial input
8	14	LED/SCK	Digital Out Digital In	LED output SPI Interface: Shift Clock
9	12	VDD33	Power supply Decoupling	Positive power supply for analog and digital circuitry. If the the device is supplied by V_{DD33}, a power supply filter capacitor is connected to this pin. This is not a supply pin for external components → for test purpose only!!
10	10	VDD18	Analog Out	1.8 V regulator output → This is not a supply pin for external components. For test purpose only!
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.

Overview Functional Description

Light Curtain – Transmitter

Figure 1shows a typical schematic circuit of a light curtain emitter edge. A microcontroller manages the transmitters in the edge via an interface chip (epc100) to the 2-wire power and communication bus. Since the LEDs draw a very high peak current when enabled, huge noise on he 2-wire bus would interfere with the communication protocol on the bus. Thus, the LEDs are connected to a separate 2-wire power bus.

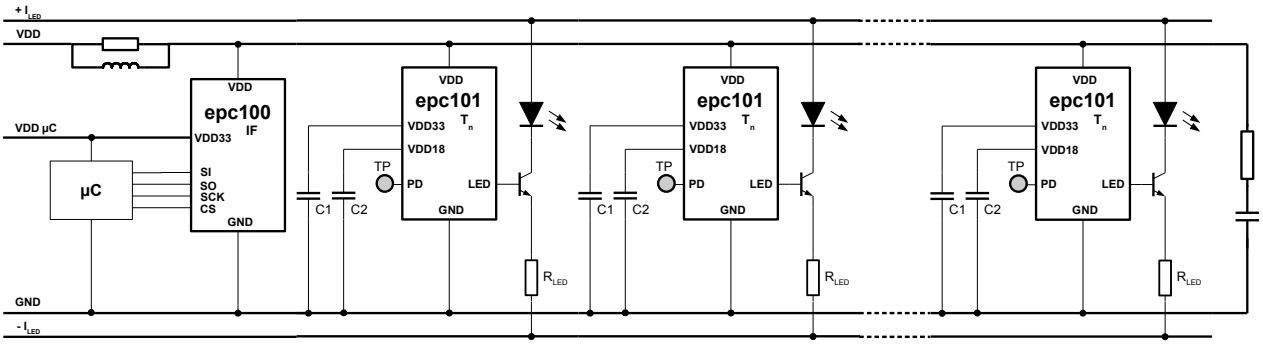


Figure 1: Light curtain transmitter with up to 300mA pulse current through the LED

In Figure 1, the LED current is defined by a common current source. The resistor R_{LED}, which is typically 2.2 Ohms, is not needed in non-safety applications. If this resistor is inserted, a failure mode will be detected if more than one LED is active due to a short circuit or a failure in the epc101. It is also possible to have a common voltage supply and to control the LED current by a series resistor.

In order to allow a stable operation of the transmitter nodes, two voltage supply decoupling capacitors are needed: C1 should be of 100nF and C2 4.7nF, both ceramic types.

For long range applications, a LED current of up to 1A is needed. Such a high pulse current can be switched by using a darlington stage according to Figure 2. Resistor R_{LED} is typically 2.2 Ohms. The resistors R_{DEC1} and R_{DEC2} decoupling the LED driving current from the GND. The approximative values for these resistors are: R_{DEC1} = 22 kOhm and R_{DEC2} = 390 Ohm. Possible transistors are for T1 BC846B and for T2 BC817-40.

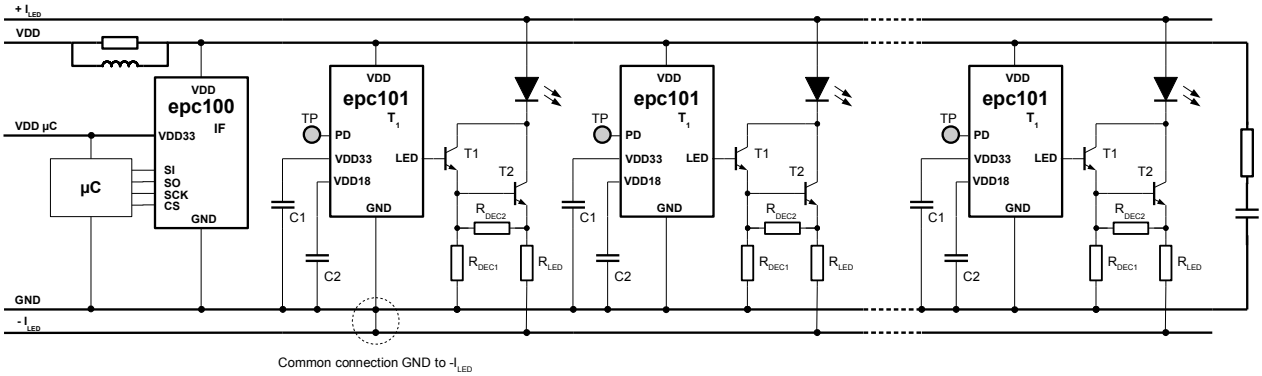


Figure 2: Light curtain transmitter with more then 300mA pulse current through the LED

Quasi Daisy Chain for Address Programming

Each device needs his own unique device address, which has to be programmed during the production process. This address can be set in different ways in the epc101 chip:

- by a single device programming with the SPI interface.
- by a single device programming by stimulation with a LED as photo-receiver or with a voltage pulse to the pin PD. Refer for details to the instruction “VTHRLED” in the Reference Manual epc10x.
- as a barrel with a quasi Daisy Chain programming sequence using the the voltage pulse mode of “VTHRLED”.

The general description of the address programming procedure is explained in detail in the Reference Manual epc10x, chapter 7.

The circuit of Figure 3 demonstrates, that with a few additional components the address programming of the epc101 transmitter can easily be done with a quasi Daisy Chain sequence. The principle is simple to understand: Always the last programmed device stimulates the pulse for the next element in the chain. Once an address is programmed in the epc101 device, it is possible to send an individual command to the chip. This allows to generate the pulse for the next element in the chain. The first pulse of the chain is created by a port of the microprocessor to start the sequence. The circuit allows also, to program the addresses of replaced elements.

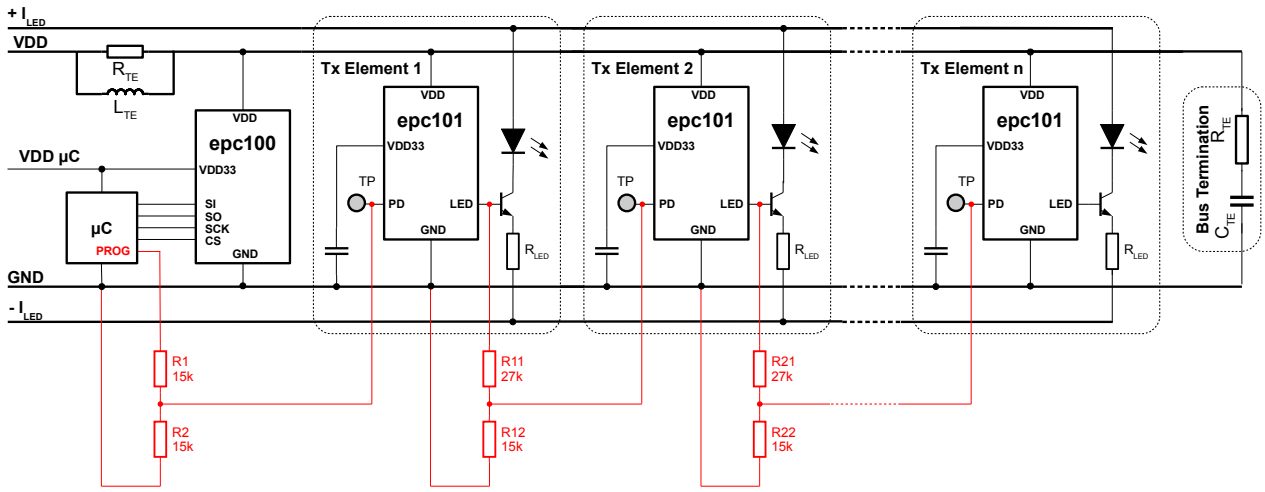
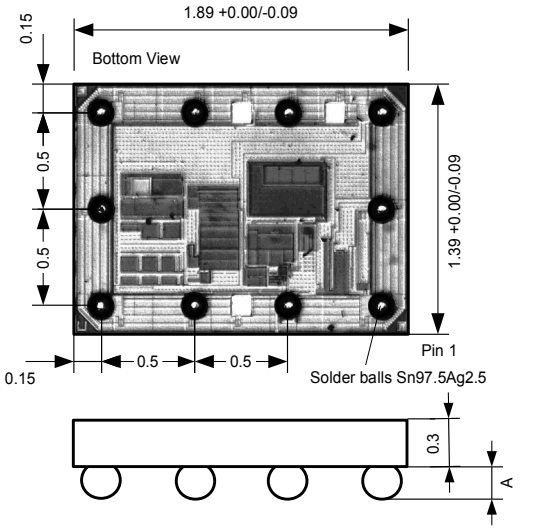


Figure 3: Light curtain transmitter with more then 300mA pulse current through the LED

Layout Information (all measures in mm, ···⊙▷···**)**

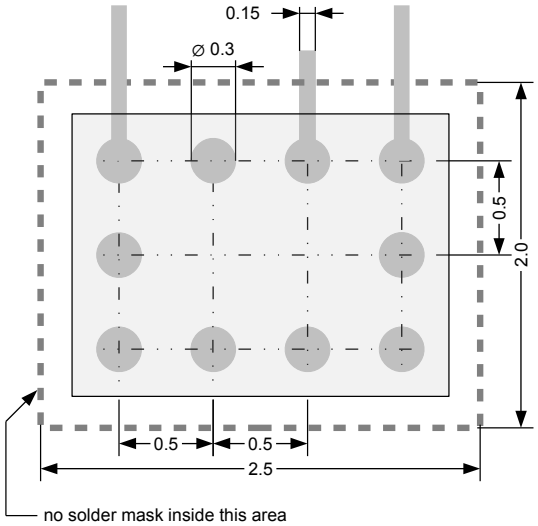
CSP-10 Package

Mechanical Dimensions



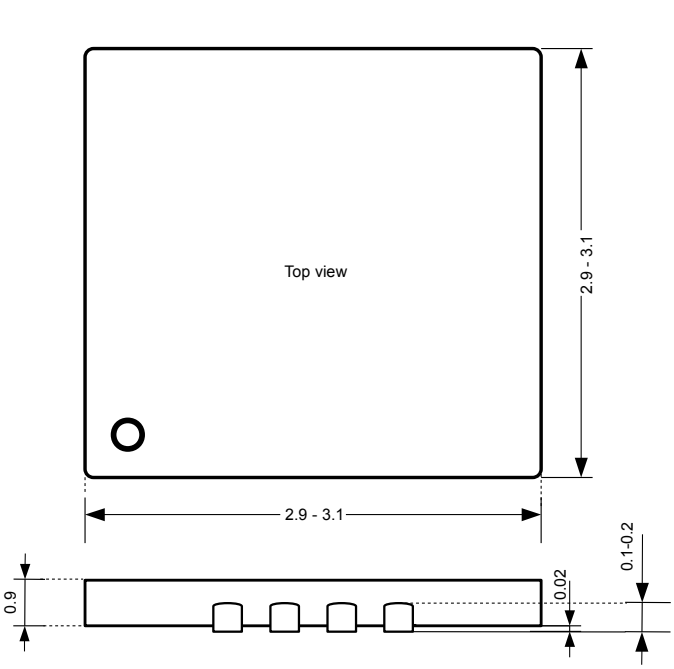
Revision:	-	A
Dimension A:	0.12 ±0.02	0.15 ±0.02

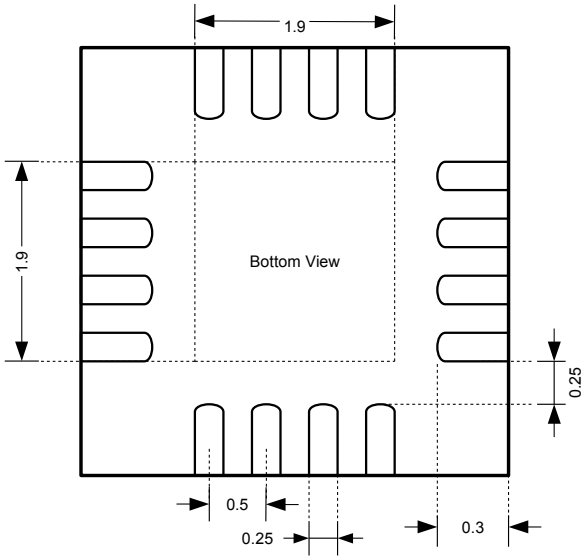
Layout Recommendations



QFN-16 Package

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





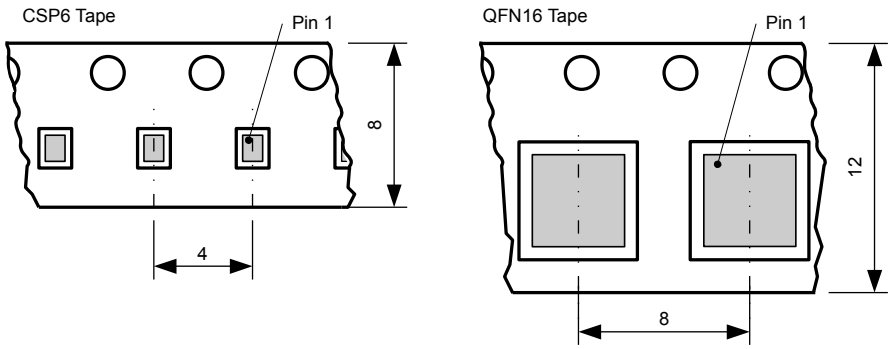
Reflow Solder Profile

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 t emperature (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.

Order 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

IMPORTANT NOTICE

ESPROS Photonics AG and its subsidiaries (epc) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to epc's terms and conditions of sale supplied at the time of order acknowledgment.

epc warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with epc's standard warranty. Testing and other quality control techniques are used to the extent epc deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

epc assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using epc components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

epc does not warrant or represent that any license, either express or implied, is granted under any epc patent right, copyright, mask work right, or other epc intellectual property right relating to any combination, machine, or process in which epc products or services are used. Information published by epc regarding third-party products or services does not constitute a license from epc to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from epc under the patents or other intellectual property of epc.

Resale of epc products or services with statements different from or beyond the parameters stated by epc for that product or service voids all express and any implied warranties for the associated epc product or service. epc is not responsible or liable for any such statements.

epc products are not authorized for use in safety-critical applications (such as life support) where a failure of the epc product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of epc products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by epc. Further, Buyers must fully indemnify epc and its representatives against any damages arising out of the use of epc products in such safety-critical applications.

epc products are neither designed nor intended for use in military/aerospace applications or environments unless the epc products are specifically designated by epc as military-grade or "enhanced plastic." Only products designated by epc as military-grade meet military specifications. Buyers acknowledge and agree that any such use of epc products which epc has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

epc products are neither designed nor intended for use in automotive applications or environments unless the specific epc products are designated by epc as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, epc will not be responsible for any failure to meet such requirements.

Polytec
POLYTEC GmbH **Polytec-Platz 1 - 7** **D -76337 Waldbronn** **GERMANY**
Tel: +49 (72 43) 604 1730 **Fax: +49 (72 43) 6 99 44** **E-Mail: oek@polytec.de** **www.polytec.de**