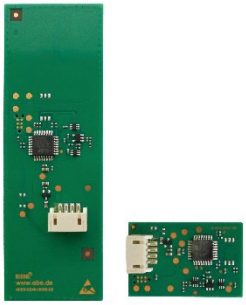
LCPB LEVEL SENSOR

FEATURES

- Continuous, contact-free level monitoring over wide measurement ranges
- Immune to almost any interference from the outside
- Capacitive measurement of many liquids and solids
- Small sized, easily mountable outside of container
- Accurate measurement even with air gaps between sensor and container, allowing operation e.g. with exchangeable tanks
- Various custom options available



TECHNICAL DATA

DIMENSION/MEASURING RANGE	see outline drawing (others on request)
MEASUREMENT TYPE	capaTEC®
PERMITTIVITY OF THE MEDIUM	$4 < \varepsilon_r < 82$
WALLTHICKNESS	typ. up to 5mm[1] (e.g. glas, PE, PP, ABS, others)
AIR GAP	typ. up to 3mm[1]
ACCURACY	typ. ± 2mm[1]
RESOLUTION	typ. 11 bit
RESPONSE TIME	typ. 100 ms
POWER SUPPLY	5 VDC, max. 30 mA
OUTPUT	I^2C, PWM on request[2]
OUTPUT BUS VOLTAGE	3.3 – 5.0 VDC I^2C (open-drain), 5 VDC-tolerant 3.3 VDC PWM (push-pull)
OPERATING TEMPERATURE RANGE	-25°C to +85°C / -13°F to 185°F
STORAGE TEMPERATURE	-40°C to +100°C / -40°F to 212°F
HUMIDITY	max. 95% r.H., non-condensing[4]
MAX. HEIGHT OVER SEALEVEL	0 – 2000 m (others on request)
MTBF	typ. > 10 years[3]
PROTECTION CLASS	IP 20

[1] Sensors measures capacitance. Accuracy of level reading is function of number of parameters including container material, wall thickness, air gaps, media and others. Typical values refer to a random water tank setting.
[2] EBE offers sensor interface boxes including software to allow PWM outputs to be set and adjusted.
[3] MTBF with a component temperature of 60°C; ground fixed; uncontrolled environment
[4] Deviation of output values may occur starting from about 80% r.H.

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Note
Sensor output is calibrated and temperature compensated. To compensate for the application environment, an one-point calibration after mounting in the end application is generally recommended. Capacitive sensors are for use with non-metallic container material only!

capaTEC2 vs. capaTEC4
capaTEC2 and capaTEC4 are different EBE measurement methods to determine the capacitive value (and level therefore). Both measurement methods have their specific advantages and disadvantages.

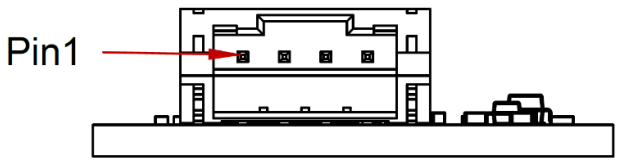
capaTEC2 measurement is generally recommended with media of a permittivity of >20 (e.g. water). For media with permittivity of less than 20, capaTEC4 may provide some advantages. EBE recommends comparing values for both capaTEC2 and capaTEC4 in the end application. This should quickly reveal the preferred method. In case of any question, please contact EBE.

ELECTRICAL CONNECTION

A 2mm (0.079”) 4-pole shrouded SMT header is assembled on the sensor PCB. To avoid mechanical stress on the connector, a cable fixation shall be used to avoid damaging the sensor.

PIN	I²C	PWM[1)]
1	VCC	VCC
2	SDA	PWM
3	SCL	n/a
4	Ground	Ground

[1)] EBE offers sensor interface boxes including software to allow PWM outputs to be set and adjusted.



Possible connectors (female crimp housing 4-pole) for LCPB include e.g. JST PH connector (PHR-4, crimp contact SPH-002T-P0.5S); TE AMP HPI 2.0 (440129-4, crimp contact 1735801-1); Würth Elektronik WR-WTB 2.00mm (620004113322, crimp contact 62000113722 / 62000113722DEC). Other compatible connectors are possible a well.

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MOUNTING & OUTLINE DRAWINGS

To get best sensor performance, please ensure the following mounting guidelines:

- Do not use metal screws or any metallic object to fix the sensor onto your container. Plastic mounting clips are therefore recommended.
- Gluing tape should be used only outside the sensing area, possible tape includes e.g. 3M 4910F or Tesa 4965.
- Keep air-distance between sensor and container wall as small as possible.
- If condensation could occur during operation, placing silicone-based grease may be an option to avoid droplets due to condensation between container wall and sensing area.

Grounding

No special grounding to PE (protective earth) is necessary for this sensor. Based on the sensor's design, the level sensor is decoupled from PE. To get best results, a stable power supply with reduced ripple noise or additional filter is recommended.

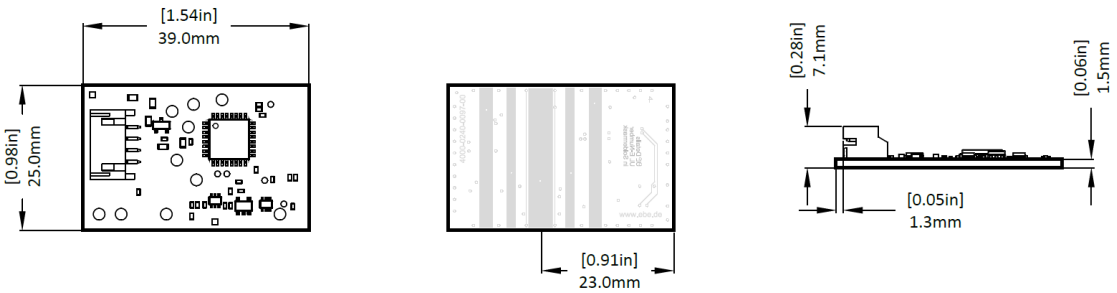
EMC

To improve robustness of the sensor, a common mode choke may be placed in the power path to reduce EMC noise level.

Orientation

The alignment of the electrodes has to be perpendicular to the fill level. Please note that LCPB025D and LCPB096D have a different orientation in respect to the longer side of the sensor PCB.

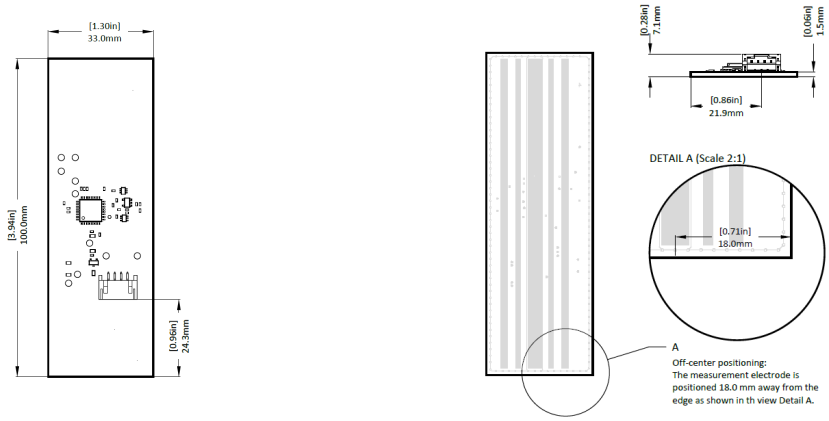
LCPB025D



Off-center positioning:
The measurement electrode is positioned 23.0 mm away from the edge as shown.

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LCPB096D



The active sensing area of the sensor is on the bottom side of the PCBA. To avoid influences on the capacitive measurement system, keep area free of metallic surfaces or mounting components e.g. metal screws (> 5 mm distance to the outer bounds of the active sensing area).

LCPB sensors are REACH/RoHS compliant (EU). For UL compliance please contact EBE.

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LCPB SENSOR COMMUNICATION PROTOCOL

A) I²C COMMUNICATION

I²C is running in standard mode with a max. clock speed up to 400 kHz. Standard I²C device address of LCPB sensors is 0x33.

VIRTUAL REGISTER TABLE

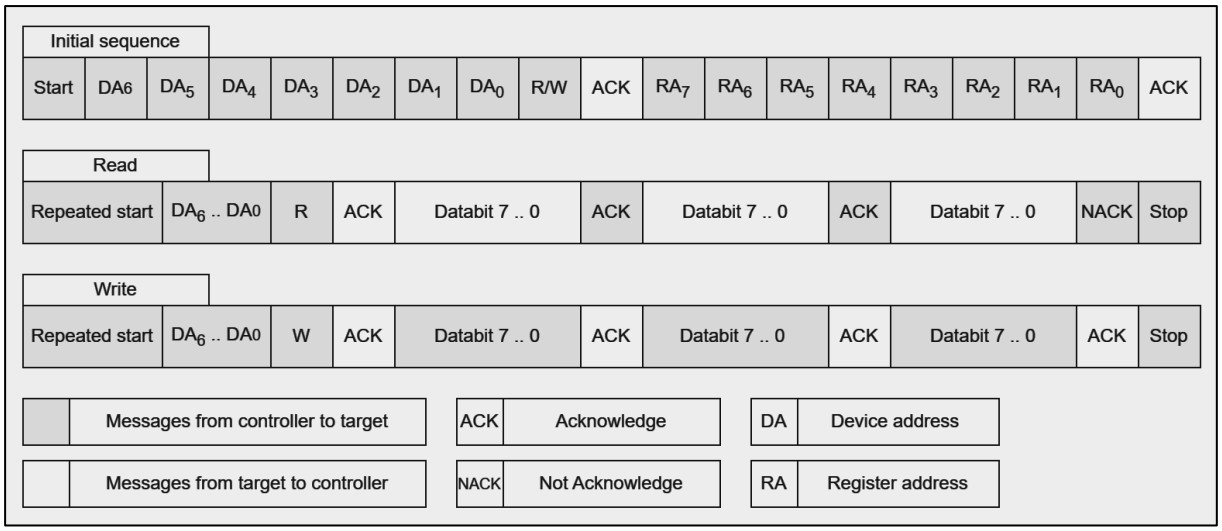
ALL VALUES ARE 8 BIT VALUES FOR R/W ACCESS

REGISTER (HEX)	READ/WRITE	DATA TYPE	DESCRIPTION
0x00	read	32 bit signed	capaTEC2 value
0x04	read	32 bit signed	capaTEC4 value
0x10	read	8 bit unsigned	temperature, 1 degree resolution
0x11	read	8 bit unsigned	Sensor type 0x01 LCPB096D 0x02 LCPB025D 0x04 Custom specific sensor
0x12	read/write	8 bit unsigned	device address, standard: 0x33
0x14	read	16 bit unsigned	Hardware version (X.Y), X=bit 7..0
0x16	read	16 bit unsigned	Software version (X.Y), X=bit 7..0
0x20	read/write	64-bit	Customer offset capaTEC2, 8-Byte character array with signed integer, sign at fixed byte position 0. Example “+0000057“ in Hex: “2B 30 30 30 30 30 35 37”
0x30	read/write	64-bit	Customer offset capaTEC4, 8-Byte character array with signed integer, sign at fixed byte position 0. Example “-0000057“ in Hex: “2D 30 30 30 30 30 35 37”

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COMMUNICATION BETWEEN SENSOR AND CONTROLLER

For I²C communication between controller and target the combined format is used. Therefore, an initial sequence followed with a different sequence depending on a reading or writing operation is applied which is shown in the following picture.



Initial sequence

The initial sequence begins with a start operation from the controller followed by the 7-bit long device address to whom the controller wants to communicate with. For the 8th-bit the controller transmits a “0” for a writing communication and “1” for a reading communication.
The target device sends an acknowledge bit (ACK) afterwards if the message is transmitted correctly – a not acknowledge bit (NACK) otherwise.
At the end of the initial sequence the controller sends the 8-bit long register address which is acknowledge by the target.

Read/Write sequence

The combined format applies another start condition. This allows the I²C bus to transmit several bytes of data without closing the connection between the controller and the target.
Followed by the device address and the equivalent read/write bit from the controller, the target acknowledges and the data transmission can be done.
Depending on a read or write communication, controller and target interplay 8-bit data followed by an ACK-bit. This can be done for several bytes.
The transmission ends when the controller sends a stop condition.

Note: The controller sends an NACK-bit after the last byte of data to end the transmission.

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Start and repeated start condition

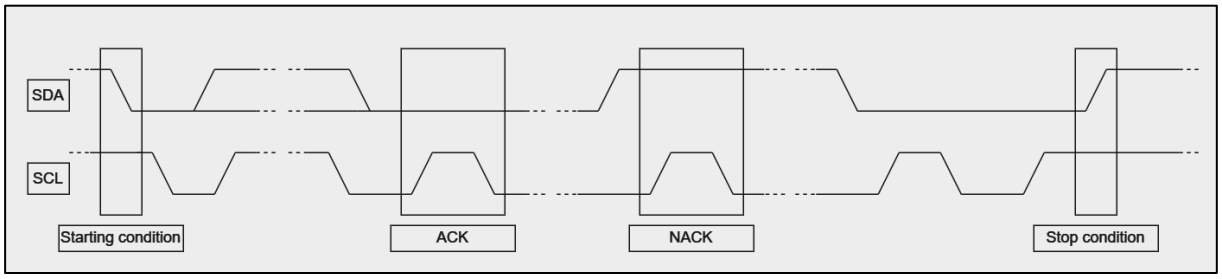
The SDA line switches from a high voltage level to a low voltage level before the SCL line switches from high to low.

Stop condition

The SDA line switches from a low voltage level to a high voltage level after the SCL line switches from low to high.

Acknowledge condition

After the transmission of every byte the target responds to the controller with the ninth bit whether the transmission was successful (ACK) or not (NACK).
The SDA line switches from a high voltage level to a low voltage level for an ACK.
The SDA line stays on a high voltage level for a NACK.



TIMING CHARACTERISTICS

SYMBOL	PARAMETER	VALUE		UNIT
		MIN	MAX	
fSCL	SCL clock frequency	-	100	kHz
tLOW	SCL clock LOW time	4.7	-	µs
tHIGH	SCL clock time period	4.0	-	µs
tHD:STA	Hold time (repeated) START condition	4.0	-	µs
tSU:STA	Set-up time for a repeated START condition	4.7	-	µs

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SYMBOL	PARAMETER	VALUE		UNIT
		MIN	MAX	
tHD:DAT	SDA Data hold time	0	-	µs
tVD:DAT	SDA Data valid time	-	3.45	µs
tSU:DAT	SDA Data set-up time	250	-	ns
tRSDA	Rise time of SDA signals	-	1000	ns
tRSCL	Rise time of SCL signals	-	1000	ns
tFSDA	Fall time of SDA signals	-	300	ns
tFSCL	Falls time of SCL signals	-	300	ns
tSU:STO	Set-up time for STOP condition	4.0	-	µs
tBUF	Bus free time between a STOP and START condition	4.7	-	µs
CBL	Capacitive load for each bus line	-	400	pF

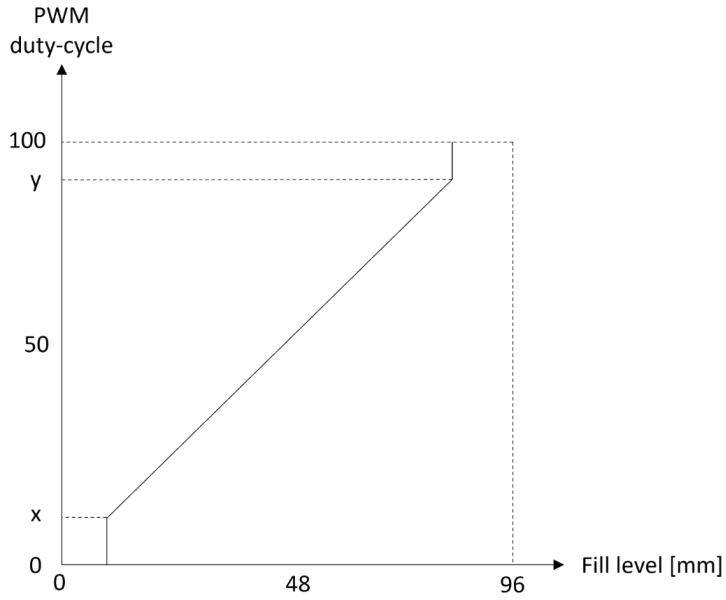
B) PWM OUTPUT

In PWM operational mode*, the sensor PWM output is a linear function on the fill level, varying the duty-cycle proportional to the fill level state. Depending on the application, integration of an offset in the linear mapping function can bring advantages due to hiding e.g. edge effects.

* EBE offers sensor interface boxes including software to allow PWM outputs to be set and adjusted.

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Typical output signal graph (depending on application setting):



When fill level exceeds the active sensing area, the mapping function will get non-linear.

Note

The linear transfer function of the PWM duty cycle has an upper and lower boundary of capacitive values which are output. Due to the limited form of representation via the PWM duty cycle for some applications the set boundaries do not match the application at hand and do not deliver meaningful measurement readings. The sensor output might be low in output amplitude or even have no output change at all. In this case the boundaries have to be changed manually, to match the application (e.g. a certain air gap).
The default mapping is set for conditions of 0 mm air gap, 2 mm tank wall thickness and PP tank material. By default the capaTEC2 value is used to generate the duty cycle.

Duty Cycle	**25 mm Sensor capaTEC2 values [digits]**	**96 mm Sensor capaTEC2 value [digits]**
10%	→ 8192	→ 22938
90%	→ 1638	→ 6553

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SAFETY AND WARNING NOTES

The components are solely for use by technically qualified, professional electronics experts who are familiar to the dangers and application risks associated with handling electrical mechanical components, systems and subsystems. User assumes all responsibility and liability for proper and safe handling and use and agrees with the restrictions and disclaimer at the end of this document.

DISCLAIMER

The information contained in this document is for general guidance only. The user is responsible for determining the suitability of the technical information referred herein for his application. On delivery of the component, EBE is only obliged to implement those properties set out and agreed upon in this document. Further properties are not included. No guarantee is given. The component has been designed for installation in our customer's products. Manufacturer of the resulting product and consequent liability according to the Product Liability Act lies with the customer. Warranty is limited to below mentioned extent.

The component is not intended for installation in end products for medical, life-saving, or safety-related applications. The use of the component is also not permitted and expressly prohibited in vehicles of any kind (including trailers and watercraft), as a component in aerospace products (including radio transmitter for aerospace purposes), or in offshore structures.

User assumes all responsibility and liability to determine whether the component is subject to any applicable international, federal, state, or local laws and regulations related to user's handling and use of the component and, if applicable, user assumes all responsibility and liability for compliance in all respects with such laws and regulations.

Disclaimer for improper use
The manufacturer accepts no liability for damage resulting from improper, inappropriate, or non-compliant use of the component. Any liability for direct or indirect damage, consequential damage or loss resulting from improper use is excluded. The Customer (user) is obliged to use the component exclusively in accordance with the instructions and information given in this document.

The limitation of liability described above does not apply in the case of mandatory statutory liability such as under the German Product Liability Act (Produkthaftungsgesetz) or in the case that a guarantee is given or in the case of willful deceit or fraudulent misrepresentation or with regard to claims for an injury of the life or limb or health or in the case of intentional or grossly negligent breach of fundamental contractual duties (“wesentliche Vertragspflichten”).

REVISION

REVISION	DATE	DESCRIPTION
1.2	05.05.2026	Update legal notices

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