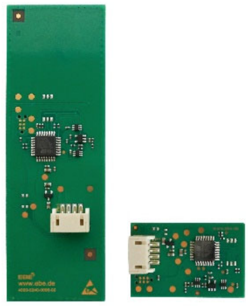
LCPB LEVEL SENSOR

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 < er < 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 I2C (open-drain), 5VDC-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
MAX. HEIGHT OVER SEALEVEL	0 – 2000 m (others on request)
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.

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!

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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.

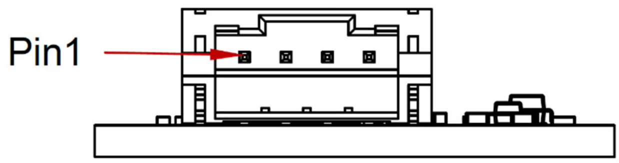
capaTEC2 measurement is generally recommended with media of a permittivity of >20 (e.g. water). For media with permittivity of less than 20, capaTEC4 may provide some advantages. EBE recommends comparing values for both capaTEC2 and capaTEC4 in the end application. This should quickly reveal the preferred 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. Molex 0510650400.

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.

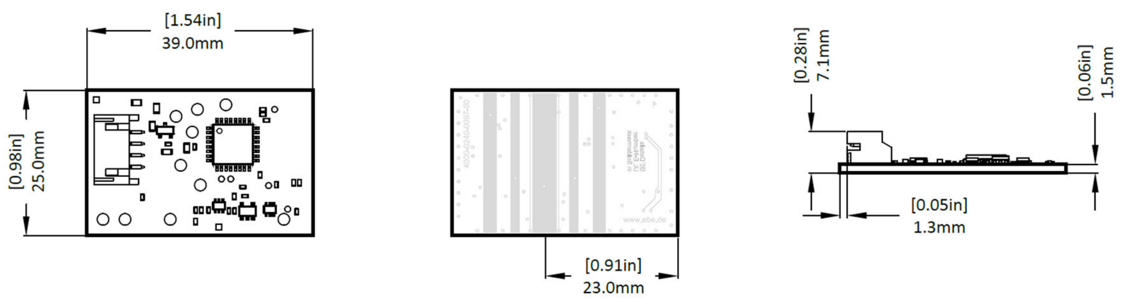
Grounding

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

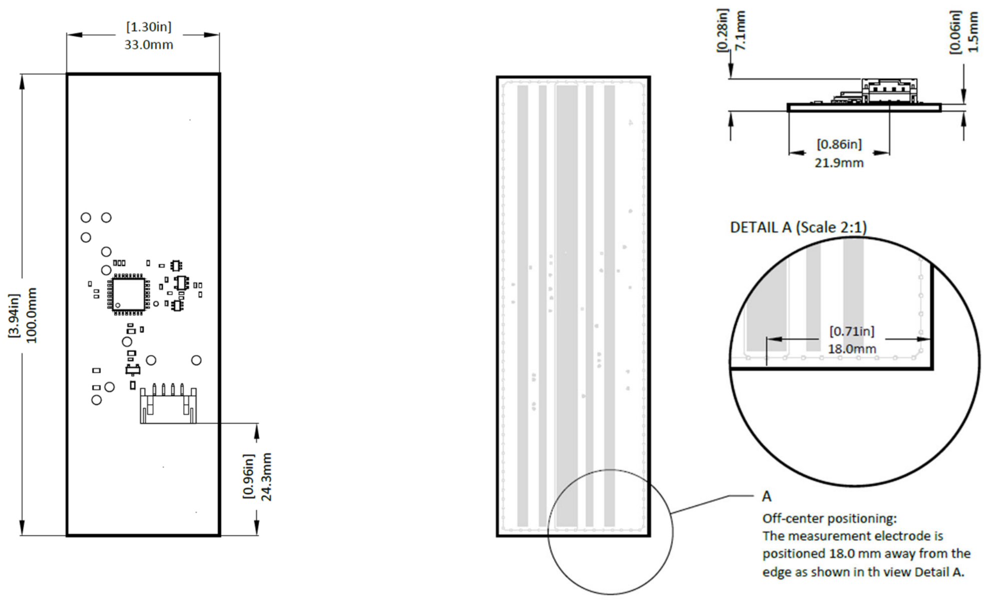
To improve robustness of the sensor, a common mode choke may be placed in the power path to reduce EMC noise level.

LCPB025D



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

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.

LCPB SENSOR COMMUNICATION PROTOCOL

A) I²C COMMUNICATION

I²C is running in standard mode with a max. clock speed of 100 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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READING FROM SENSOR VIA I2C

Start	Device address	R/W	A	Memory address	A	Start	Device address	W/R	A	Data-frame	NA	Stop

Messages from controller to target (grey)

Messages from target to controller (white)

A Acknowledge

NA Not Acknowledge

The I²C controller must at first write to the I²C sensor the virtual address from which reading should start. Then, the controller can read one or more bytes while he acknowledges every received byte (A). After all bytes of interest have been read, the controller terminates the session by sending a STOP condition.

Master	**Start**	**7-bit I²C slave address**	**R/W**	**A**	**Memory start address**	**A**	**Repeat-ing start**	**7-bit I2C slave address**	**R/W**	**A**	**Data N-Bytes*(8-bit, A)**								**Stop**
Read capaTEC4 value (int32_t)	Start	0x33	0	A	0x04	A	Start	0x33	1	A	0xXX	A	0xXX	A	0xXX	A	0xXX	NA	Stop
Read tem-perature value (uint8_t)	Start	0x33	0	A	0x04	A	Start	0x33	1	A	0xXX							NA	Stop

A Acknowledge
NA Not Acknowledge

<u>Start condition</u>
The SDA line switches from a high voltage level to a low voltage level before the SCL line switches from high to low.

<u>Stop condition</u>
The SDA line switches from a low voltage level to a high voltage level after the SCL line switches from low to high.

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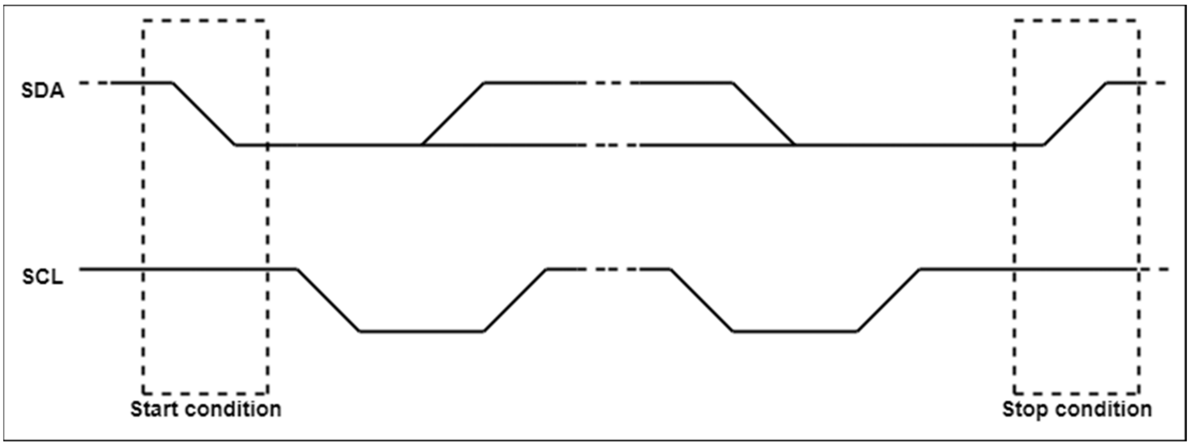
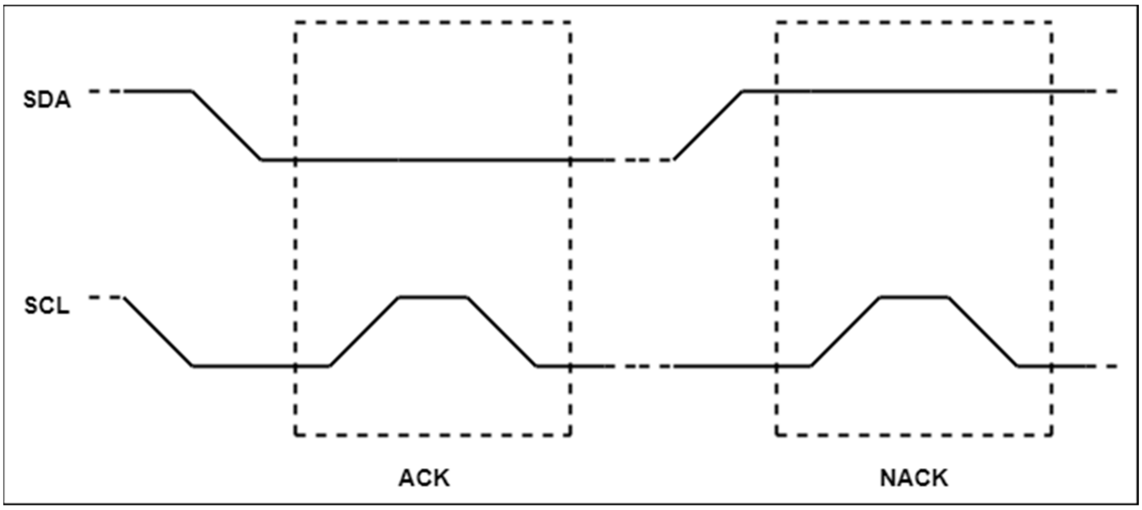


Acknowledge condition

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 con-dition	4.7	-	µs
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

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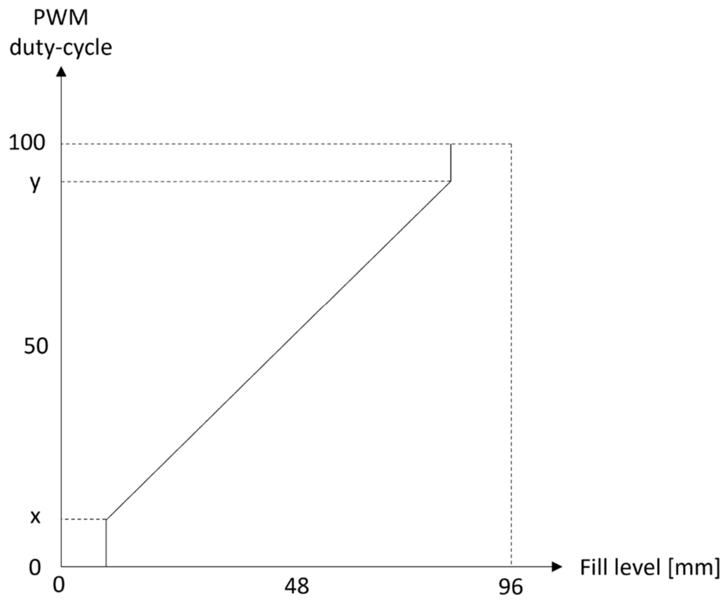
B) PWM OUTPUT

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.

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

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

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Do you like this solution?
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