FAQ on liquid level monitoring

Introduction

This document contains a list of frequently asked questions (FAQ) on liquid level monitoring. Our Imaging expert replied to these questions during the liquid level monitoring webinar.

1 Type of sensors

1.1 General

Is it direct ToF or indirect-ToF (phase measurement)?

Sensors shown during the webinar are direct ToF.

Which sensors can be chosen for liquid level monitoring?

Other sensors than the VL53L4CD and VL53L5CX presented during the webinar can be used (VL53L0X, VL53L3CX), but performances are not as good as VL53L4CD. Example code, API, and drivers have to be adapted.

VL53L5CX gives better performances than VL53L4CD due to multizone.

Are the sensors class 1 laser devices or higher? Any regulations / safety concerns?

Yes, they are class1.

What is the wavelength of the laser light?

The wavelength is 940 nm.

Are these ToF sensors reliable?

Under normal conditions, they should work for years.

1.2 Features

What is the boot time for the sensors?

The VL53L5CX boots within a second. It is less for the VL53L4CD.

On the multichannel sensor, are all channels updated simultaneously?

Distances for all zones are measured simultaneously.

What are the min and max temperature ranging these sensors operate?

The sensors can operate from -30°C to 85°C.

VL53L4ED can operate from -40°C up to 105°C. This new sensor will be on the market by Q1'23. It works in the same way as the VL53L4CD with the same performances. The existing example code and the AN can be reused on this new ToF sensor.

Please refer to the datasheets for performance specifications at 25°C.

What type of interface do these sensors have? Can I connect multiple sensors to the same MCU interface?

The ToF sensors have I²C interface, therefore it is possible to connect multiple sensors.

Please refer to the user manuals for details on how to change the I²C address in case of multiple sensors.

Can I connect it to an I²C esp8266 board?

Yes, you can. Any MCU with an I²C interface will work.

Do the ToF sensors work in an environment with light sources with wavelengths up to 700 nm?

This is not a problem as the sensors use 940 nm IR.

Can one of the sensors measure groundwater in a 1" pipe?

No, ST does not have a sensor with this capability.

Can you retrieve signal strength from the VL53L5CX?

Yes, this is possible.

For the VL53L5CX sensor, what is the best accuracy without signal processing?

In this particular application, there is no signal processing. The best accuracy in the case of the VL53L5CX is the one given by the zone with higher signal rate.

Is there a low power mode available for the VL53L5CX?

Yes. You need to range less often and to reduce the integration time (and therefore the maximum ranging distance).

1.3 Replacement

How easy is it to replace the VL53L0X with the VL53L4CD?

As the VL53L0X and VL53L4CD are pin to pin compatible, it is an easy replacement. However, an update of the API and driver is needed.

If an older sensor is used, how do you select the SPAD that is perpendicular to the surface? You get only one measurement, not multizone.

If you are using a single zone sensor (like VL53L4CD), it is not possible to select another zone than the existing one. By default, the sensor uses the full SPAD array for a single zone device. This is why the ranging performance is slightly lower and more complex.

What are the differences between VL53L4CX and VL53L4CD. When should I use one or the other?

ST recommends you check the following link: https://community.st.com/s/article/how-to-choose-a-time-of-flight-sensor

2 Setup

2.1 General

Can I use two sensors for liquid level monitoring?

Yes, you can, but benefits will be limited.

Is it possible to place the sensor behind a protective film?

It could work if the transmittance and the haze of the product film allow the IR to go through the productive film. The closer the film is to the sensor, the better.

Is it possible to sense the bottom as well as the surface of the liquid?

No, you can sense the bottom or the surface of the liquid but not both.

Is it possible to measure the liquid inside a container from the outside of the container, provided the container is transparent?

It depends on the transparency of the container, but also the thickness of the container. Crosstalk could be important. Therefore, it is not recommended.

Can we use your technology for measuring liquid inside a container from the outside of the container, provided the container is transparent?

It depends on the transparency of the container but also from the thickness. Crosstalk could be important. Not recommended.

What about the integration in a waterproof casing?

ST sensors can be integrated in waterproof casing, but our devices are not waterproof.

Would it be possible to redirect the 940 nm laser with an IR reflective surface (like a polished copper plate) to measure around a corner?

Yes, it can work in some conditions. Some customers already use this technic to measure the distance around a corner.

2.2 Container

What is the impact of the container material?

The container's reflectance must be as low as possible to get a good ranging distance accuracy. If too reflective, the performances are degraded. It is not recommended to use a highly reflective surface.

Is it possible to measure the depth of a liquid from the bottom through a transparent tank? Is it possible to distinguish between different reflection layers in such a setup?

The bottom of the tank will cause lot of crosstalk. But it might work.

Is it possible to monitor the level of the liquid in a cup without knowing the cup size?

ST is working to propose a solution soon.

Can the sensors measure liquids in containers with an irregular form?

You get the distance between the sensor and the liquid, regardless of the shape of the container.

2.3 Contents

What is the impact of the type of liquid (consistency?) (still water, foam)?

Foam and bubbles are easier to range on as there are more reflective surfaces.

Has ST studied the effects of salt crystallization on sensors?

No, ST has not done a study on this.
Some customers are using the VL6180 to measure the size of salt crystals.

Is it safe to use these sensors to measure fuel or gas levels?

Yes. With no electrical over-stress and if the sensor is used on the condition described in the datasheet, there should not be any issue. Light IR will not generate spark when used with fuel.

Is it possible to use the ToF to sort other materials (plastic, paper glass)?

Yes, it is possible. An application note will soon be available to describe this.

Do the sensors work with none liquids (such as coffee capsules)?

The ranging ability depends on the material's reflectance, which has to be a minimum reflective to IR. For example, it is possible with rice. These are different use cases, and you have to consider if you are filling or emptying a jar.

Are the sensors applicable for powder levels and/or in ATEX proof applications?

Sensors can be used with other products than liquid. The ranging accuracy depends on the reflectance of the product. If the sensor is protected behind a cover glass, the sensor is not affected by the ATEX proof, but the sensor itself is not ATEX proof.

Do you offer support to help customers solve issues we are having?

Contact your local support or ask questions on http://community.st.com.

2.4 Minimum and maximum distances

Is there a minimum distance between the sensor and the liquid?

To avoid splashes on the sensor, it is recommended to put the sensor at least at 2 cm for the VL53L4CD and 5 cm for the VL53L5CX and to use the dust-free cover glass.

What is the minimum and maximum liquid level measurement distance?

The recommended minimum distance is 5 cm for the VL53L5CX and 2 cm for the VL53L4CD. Maximum distance is a few meters, depending on the liquid. The VL53L4CD ranges up to 1.3 m, while the VL53L5CX ranges up to 4 m in perfect conditions. In real condition, the maximum distance is reduced.

In the case of large tanks, what is the maximum ranging depth?

The best is 0 to 2 m, unless the liquid is reflective.

It is possible to have a distance sensor range 15 to 60 cm, with resolution +/- 1 mm, and sample rate over 200 Hz?

We cannot range that fast and we only have +/- 3% accuracy sensors.

In the dark, can we expect a better sensitivity, and thus a longer range? I would need around 10 m.

The range is longer in the dark, but ST sensors are not able to reach 10 m. The longest range is 4 m.

2.5 Sensor orientation

What is the impact of the sensor orientation on liquid level measurement?

Some of the light has to be perpendicular to the liquid. The more, the better. VL53L5CX is more immune to lack of perfect perpendicular orientation.

Can the sensor determine the liquid level in a tank leaning at up to 15 degrees? What if the tank is moving, and inertia is pushing the water to one side?

You have to be reasonably perpendicular to the liquid.

2.6 Temperature range

Does liquid level monitoring work with hot liquids?

Noise will be generated with steam. The less dense the steam is, the better the accuracy will be. The use of a dust free cover glass is recommended to protect the sensor from the steam and get a better accuracy. If there are drops on top of the cover glass, ranging distance can be shorter.

What temperature can it handle? We usually need to disinfect our tanks at 100°C. Would that damage the sensor?

ST does not recommend exposing the device at temperatures higher than the maximum storage temperature recommended in the datasheets.

VCSELs (vertical cavity surface emitting laser) are known to be temperature sensitive. In my measurement, the power at 50°C was only half as much as at 20°C. The range of the sensor suffers from this. What is the temperature range for the sensors? Is there any compensation for the effect?

The temperature range is -30°C to 85°C. Each time you start the sensor, a temperature calibration is done to reduce the effect of the temperature.

2.7 Calibration

Is calibration needed for liquid level monitoring?

For the VL53L5CX, no specific calibration is required when using dust-free cover glass as per our recommendations. When using the VL53L4CD, a characterization setup is needed to get precise measurement.

Will periodic calibration be required, or is the factory calibration enough for lifetime use?

In standard conditions (without drops for example), no periodic calibration is needed.

2.8 Light conditions

Will the ToF sensors work in daylight?

Yes, but maximum ranging distance will be limited if sunlight is directly hitting the sensor or the transparent tank.

Can these sensors be used in outdoor applications? For example, for the water level in a river.

ST sensors are sensitive to strong sunlight. Range during night or place a protection to measure in the shade.

Many tanks are made of plastic. In outdoor conditions, the light intensity inside the tank can be 40 klux. Do you plan to develop a ToF sensor that can cope with such conditions?

Yes. The VL53L8CX released in Q1 2023 provides higher immunity to sunlight.

2.9 Liquid movement

What is the sensitivity of liquid level monitoring to liquid surface movement?

Basically, there is no limitation.
For the VL53L4CD example code, the standard deviation limit can be configured so that the customer can determine which level of confidence is required before the measurement.

What if the liquid is flowing, like a half pipe?

You will get the height of the flowing water.

3 Cover glass

3.1 General

How to prevent environmental contamination of the sensor during its lifetime?

The sensor should be protected with a cover glass.

How sensitive are the sensors to dust or dirt? How do we clean a dirty sensor?

Use the dust free cover glass and wipe it with a cleaning cloth.

What do you recommend to limit the corrosion of sensors?

Use a protective cover glass to avoid the corrosion of the sensors (and of the PCB).

How can we waterproof the sensor?

Please use a cover glass and a waterproof enclosure.

What is the impact of the cover glass?

Dedicated calibration is needed to get rid of the effect of the cover glass. Please refer to product user manual (UM2884 for the VL53L5CX and UM2931 for the VL53L4CD) for more details.

What kind of materials can be used for a cover glass?

Polycarbonate, PMMA (acrylic) or most glass can be used.

Do we have to clean the sensor protection glass?

Yes, if possible, to ensure better accuracy.

Can you expand on immunity to cover glass crosstalk beyond 60 cm regarding the VL53L5CX? Is that a problem in the VL53L4CD?

Below 60 cm both sensors are sensitive to cover glass crosstalk. Above 60 cm; VL53L5CX is immune to crosstalk whereas the VL53L4CD is not and a cross talk compensation is done.

Can we place a protection glass in front of the sensor to protect it from moisture in an underground water tank?

Yes, you must have a cover glass. You can find details in the different application note linked to the products on st.com (AN5856 for VL53L5CX).

Can we add a lens on top of the module?

Lens should not be used as it will avoid the laser safety compliance. But the use of a cover glass is recommended.

Refer to .

3.2 Water or condensation

How is condensation on the cover glass handled?

It is recommended to use a cover glass with a barrier between the emitter and receiver. However, condensation might limit your range.

What happens if the sensor gets wet? Has a drop on it?

The use of a cover glass with a barrier between the emitter and the receptor is a must if the cover glass is going to get wet. Check st.com to get info about cover glass.

4 Algorithm

Is it possible to change the algorithm?

The algorithms are written in C. Feel free to rewrite it.

Revision history

Table 1. **Document revision history**

Date	Version	Changes
01-Feb-2023	1	Initial release

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