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1. General

The XQ-L Series Lidar sensors create a virtual 2D surface in which multiple detection areas ("Activation zones") can be defined. The sensor detects when an object enters or exits an Activation zone. With this functionality, a broad variety of applications can be created, such as Lift&Learn, interactive videowalls and Approach&Learn. This document provides explanation of the available functionalities and instructions on how to install and integrate the sensor into your digital signage installation.

The information in this document is created for users who are familiar with the Nexmosphere API and are able to control a basic setup with a Nexmosphere API controller. If this is not the case yet, please read the general documentation on the Nexmosphere serial API first.

2. Product overview

The XQ-L series Lidar sensors are available in 2 different models, the **XQ-L2** and **XQ-L5**. The sensor specifications are as follows:

	XQ-L2	XQ-L5
Field of View angle	360°	360°
Field of View radius	5 meter	10 meter
Max. number of Activation zones	24	24
Lifetime (hours)	10K	45K

XQ-L2

XQ-L5

The XQ-L series Lidar sensors consists out of 2 parts: the Lidar sensor itself and the sensor interface.

sensor interface   *lidar sensor*
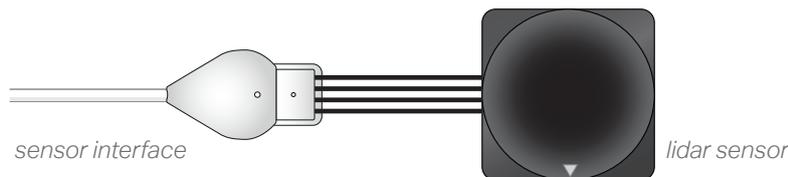
Internally, the **Lidar sensor** has a fast-rotating Infrared laser component which generates a high volume of distance data samples through Time-of-Flight measurements. With this internal data, the **sensor interface** creates a 2D view of the sensor environment and can accurately determine if an object enters or exits a specific area within it's detection field, based on X-Y coordinates.

3. Functionalities and API commands

The XQ-L sensors provide the following functionalities:

1. **Define Field of Interest** - define the area of interest in which your Activation zones will be located
2. **Define Activation zones** - define the Activation zones in which you want to detect the presence of an object
3. **Activation zone triggers** - receive API commands when an object enters or exits an Activation zone

The following sections will cover each of these functionalities in detail. Please note that for each API example in this document, X-talk interface address 001 is used (X001). When the sensor is connected to another X-talk channel, replace the "001" with the applicable X-talk address.

3.1 - Define Field of Interest

The XQ-L sensor has a large Field of View, which generates a significant amount of data. In order to optimize the functionality of the sensor, the first step in applying the sensor is to define your Field of Interest. This is the area within the sensor's full Field of View, in which you want to detect objects. Out of the box, this sensor has been equipped with a default FoI, more on this below. The Field of Interest can be adjusted by sending commands which contain the coordinates of the corner points of your Field of Interest. A minimum of 3 and a maximmum of 10 corners can be defined by sending API commands with the following format:
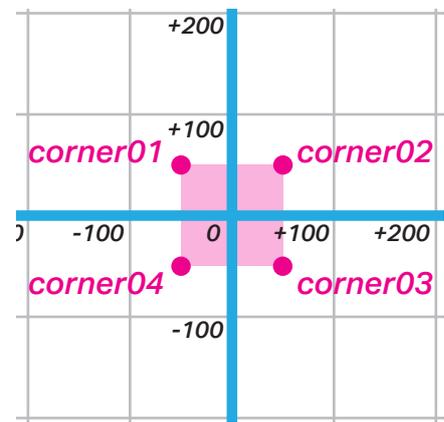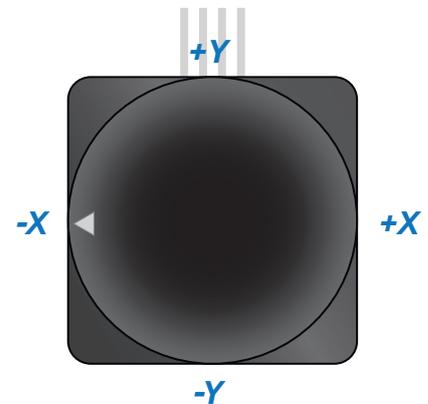
`X001B[FOICORNER**=±XXX,±YYY]`

*Define a corner of the **Field of Interest***
*** = Corner number **01-10***
±XXX = X-coordinate of corner in cm
±YYY = Y-coordinate of corner in cm

Once all corner coordinates are send to the sensor, the following command must be send to the sensor to recalculate it's FoI:

`X001B[RECALCULATEFOI]`

Calculate and store Field of Interest

When defining the Field of Interest, consider the following:

*   The orientation of the sensor in relation to the X and Y coordinates is shown in the illustration on the right. **The arrow on the sensor points to the -X direction.**
*   The FoI corner command must be send in numerical order, starting at corner 01.
*   The FoI is stored in the sensors memory and therefore only needs to be set once.
*   Examples of FoI command sequences are available on page 3.
*   The default Field of Interest is indicated on the bottom right of this page.
*   The currently set FoI corners can be requested at any time by sending the following data request command:
    `X001B[FOI?]`
*   When sending the calculate-FoI command, the sensor generates a list of 360 coordinates. Together, these coordinates form the outer line of the Field of Interest. Upon request, a tool is available to visualize the Field of Interest utilizing this data list.
*   The 360 FoI values can be requested at any time by sending the following data request command:
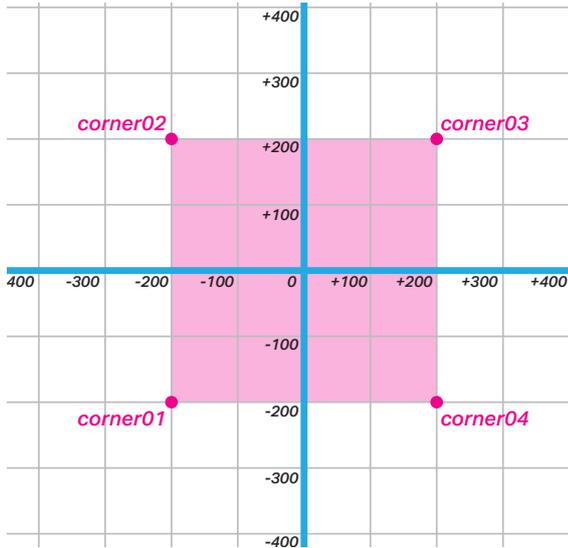   `X001B[FOIVALUES?]`

Default Field of Interest

Example commands - Define Field of Interest
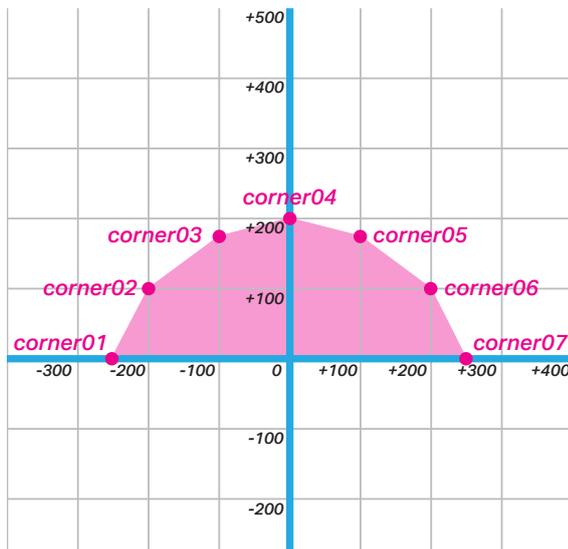
```
X001B[FOICORNER01=-200,-200]
X001B[FOICORNER02=-200,+200]
X001B[FOICORNER03=+200,+200]
X001B[FOICORNER04=+200,-200]
X001B[RECALCULATEFOI]
```

```
X001B[FOICORNER01=+000,+000]
X001B[FOICORNER02=+000,+150]
X001B[FOICORNER03=+075,+200]
X001B[FOICORNER04=+200,+075]
X001B[FOICORNER04=+150,+000]
X001B[RECALCULATEFOI]
```
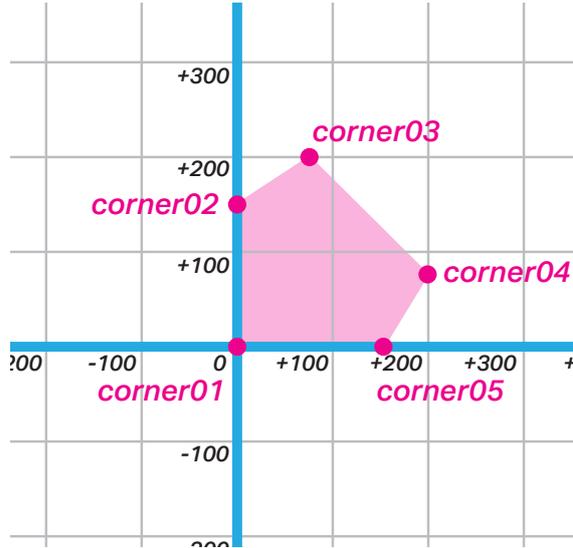


```
X001B[FOICORNER01=-250,+000]
X001B[FOICORNER02=-200,+100]
X001B[FOICORNER03=-100,+175]
X001B[FOICORNER04=+000,+200]
X001B[FOICORNER05=+100,+175]
X001B[FOICORNER06=+200,-100]
X001B[FOICORNER07=+250,+000]
X001B[RECALCULATEFOI]
```

```
X001B[FOICORNER01=-100,-240]
X001B[FOICORNER02=-240,-100]
X001B[FOICORNER03=-240,+100]
X001B[FOICORNER04=-100,+240]
X001B[FOICORNER05=+100,+240]
X001B[FOICORNER06=+240,+100]
X001B[FOICORNER07=+240,-100]
X001B[FOICORNER08=+100,-240]
X001B[RECALCULATEFOI]
```
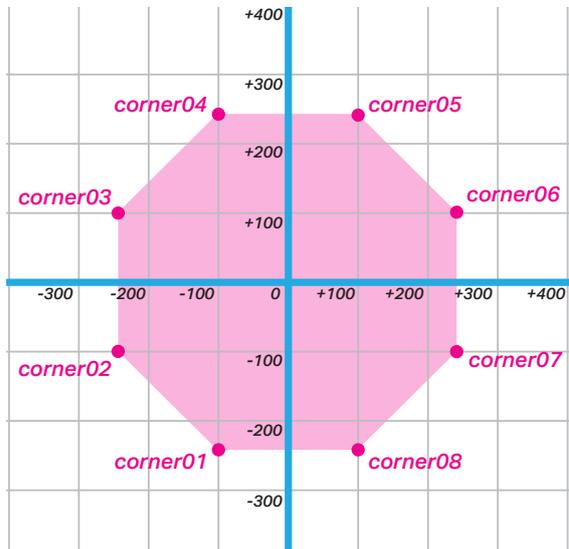
3.2 - Define Activation zones

Within the Field of Interest, Activation zones can be defined. These are the individual zones within your Field of Interest in which you want to detect the presence of an object or person. The Activation zones can be defined by sending commands which contain the coordinates and dimensions of the desired area. A maximum of 24 Activation zones can be defined by sending API commands with the following format:

```
X001B[ZONE**=±XXX,±YYY,WWW,HHH]
```

*Define an **Activation zone***
*** = Zone number 01-24*
±XXX = X-coordinate of bottom left corner in cm
±YYY = Y-coordinate of bottom left corner in cm
WWW = width in cm (max 250)
HHH = height in cm (max 250)

When defining the Activation zones, consider the following:

*   The orientation of the sensor in relation to the X and Y coordinates is shown in the illustration on the right. **The arrow on the sensor points to the -X direction The cable exit points to the +Y direction.**
*   The Activation zones must be located within the Field of Interest.
*   The origin point (coordinates) of an Activation zone is the left bottom corner.
*   Activation zone can only be set in a rectangular shape.
*   The default Activation zones are indicated on the bottom right of this page.
*   Multiple parameter can be set to adjust the object detection behaviour of the sensor. For more information please see page 7.
*   The current set Activation zones can be requested at any time by sending the following data request command:

```
X001B[ZONES?]
```
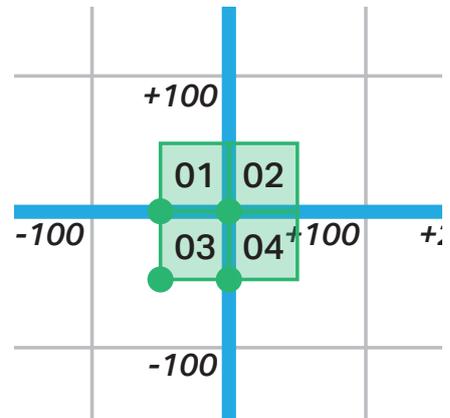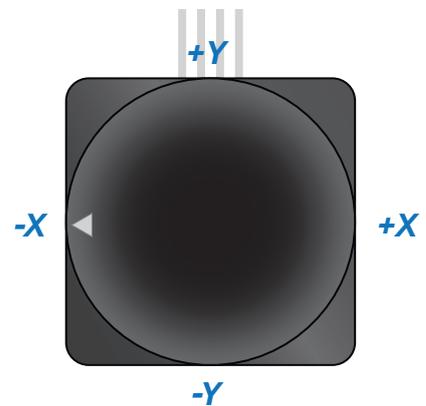

Default Activation zones

Example commands - Activation zones

```
X001B[ZONE01=-200,+100,100,100]
X001B[ZONE02=+100,+100,100,100]
X001B[ZONE03=-200,-200,100,100]
X001B[ZONE04=+100,-200,100,100]
```
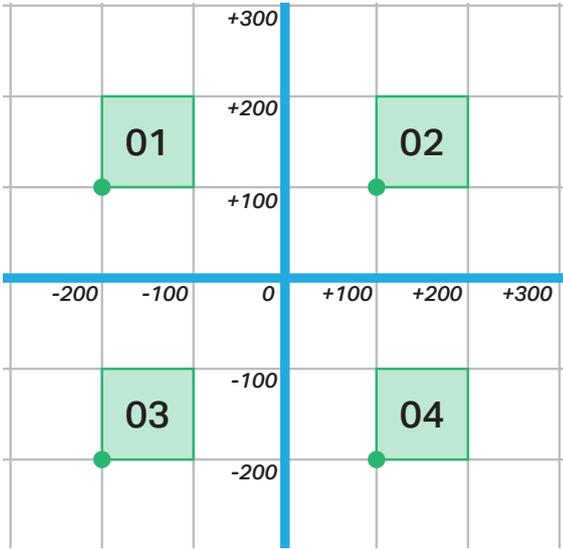


```
X001B[ZONE01=+000,+000,100,100]
X001B[ZONE02=+100,+000,050,100]
X001B[ZONE03=+000,+100,100,050]
```
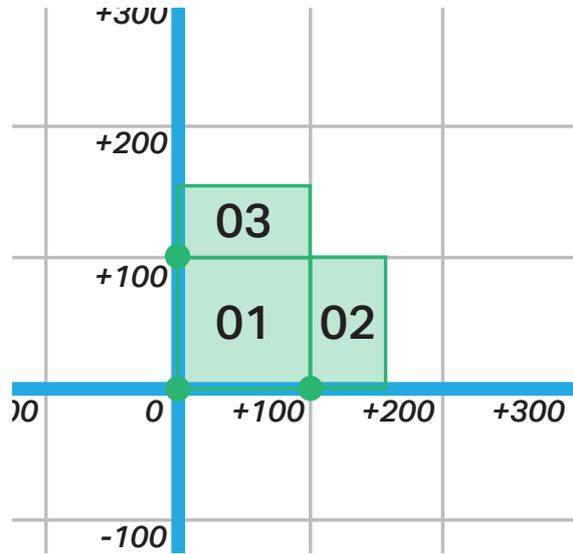


```
X001B[ZONE01=-100,+050,200,050]
X001B[ZONE02=-100,+100,200,075]
X001B[ZONE03=-200,+050,100,050]
X001B[ZONE04=+100,+050,100,050]
```
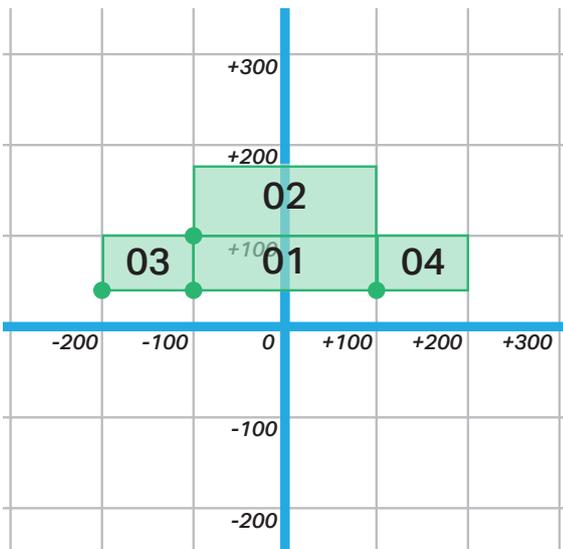


```
X001B[ZONE17=-025,-025,050,050]
X001B[ZONE09=-075,-075,150,150]
X001B[ZONE24=-125,-125,250,250]
```
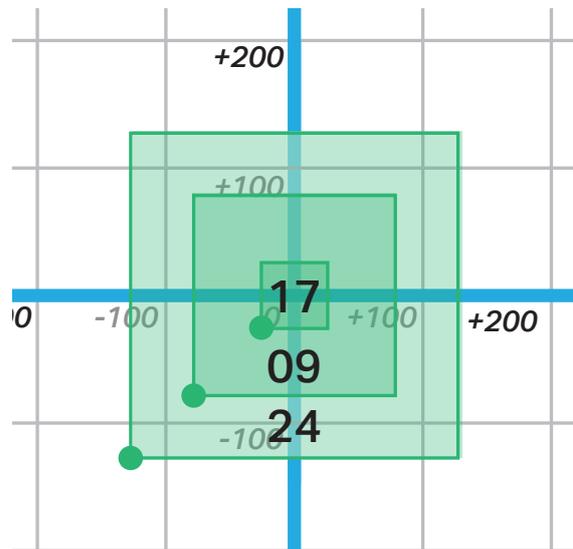
3.3 - Activation zone triggers

The XZ Lidar sensor detects when an object enters or exits an activation zone. Per default, each time this happens, the sensor sends an API message with the following format:

X001B[ZONE**=ENTER]	Object entered Activation zone	**= zone number	01-24
X001B[ZONE**=EXIT]	Object exited Activation zone	**= zone number	01-24

When implementing Activation zone triggers, consider the following:

- In case an object already entered an Activation zone, and a second object enters, a new Enter message will only be send if the second object is not adjoining the first object, *from the perspective of the sensor*.
- In case of overlapping Activation zones, it is possible that an object enters or exits multiple Activation zones simultaneously. For each activation zone, a separate API message is send.
- Multiple parameter can be set to adjust the object detection behaviour of the sensor. For more information please see page 7.

Example commands

Object entered Activation zone 03 on the sensor connected to X-talk interface 001

X001B[ZONE03=ENTER]

Object exited Activation zone 24 on the sensor connected to X-talk interface 006

X006B[ZONE24=EXIT]

Object entered Activation zone 17 and 09 on the sensor connected to X-talk interface 002

X002B[ZONE09=ENTER]
X002B[ZONE17=ENTER]

The Lidar sensor can also keep track of the number of objects which are currently in a zone, and can indicate this with every Enter and Exit message. To enable this functionality, the output mode of the sensor must be adjusted by sending the following setting command:

`X001S[4:3]` Activation zone triggers with count

In this output mode, the API messages have the following format:

X001B[ZONE**=ENTER:*XX*]	Object entered	**= zone number	01-24	XX = objects in zone	00-99
X001B[ZONE**=EXIT:*XX*]	Object exited	**= zone number	01-24	XX = objects in zone	00-99

When implementing Activation zone triggers with count, consider the following:

- In case an object already entered an Activation zone, and a second object enters, a new Enter message will only be send if the second object is not adjoining the first object, *from the perspective of the sensor*.
- With an Enter command, the object which has entered is included in the count number.
- With an Exit command, the object which has exited is excluded in the count number.
- Multiple parameter can be set to adjust the object detection behaviour of the sensor. For more information please see page 7.

Example commands

On the lidar sensor connected to X-talk interface 001, an object entered Activation zone 07 as the 3rd object currently in that zone:

X001B[ZONE07=ENTER:03]

On the lidar sensor connected to X-talk interface 004, an object exited Activation zone 02, after which no objects were currently left in that zone:

X004B[ZONE02=EXIT:00]

The current number of objects in an Activation zone can be requested by sending the following data request command:

`X001B[ZONE**OBJECTS?]` **= zone number 01-24

The reply will have the following format:

X001B[ZONE**OBJECTS=*XX*]	**= zone number	01-24	XX = objects in zone	00-99

Multiple parameter can be set to adjust the object detection behaviour of the sensor

`X001B[ZONE**DELAY=TT]`

Set the time an object needs to be in the Activation zone to trigger and Enter command

* *= Activation zone   **01** *to* **24** *(nr)*
TT= time in zone   **0** *to* **99** *(frames/sensor rotations)*
XQ-L2: 1 frame = ~140mS   *XQ-L5: 1 frame = ~100mS*

`X001B[ZONE**MINSIZE=SS]`

Set the minimum size which an object needs to be to trigger an Enter command

* *= Activation zone   **01** *to* **24** *(nr)*
SS= Minimum size   **01** *to* **50** *(cm)*

`X001B[ZONE**MAXSIZE=SSS]`

Set the maximum size which an object can be to trigger an Enter command

* *= Activation zone   **01** *to* **24** *(nr)*
SSS= Maximum size   **005** *to* **250** *(cm)*

Activation zone parameters example commands

Set the time an object needs to be in Activation zone 03 to trigger an Enter command on the XQ-L sensor to 280mS.

`X001B[ZONE03DELAY=02]`

Set the minimum size for an object in Activation zone 09 to trigger an Enter command to 12cm.

`X001B[ZONE09MINSIZE=12]`

Set the maximum size for an object in Activation zone 01 to trigger an Enter command to 31cm.

`X001B[ZONE01MAXSIZE=031]`

The following control commands can be used to clear all Activation zone parameters. This will clear the coordinate and dimension values, and will set the delay, minimum size and maximum size to the default values.

`X001B[ZONE**=CLEAR]`

Clear all parameters for a specific Activation zone
* *= Activation zone   **01** *to* **24** *(nr)*

`X001B[CLEARALLZONES]`

Clear all parameters for all Activation zones

4 - Installation requirements and guidelines

When integrating an XQ-L Series Lidar sensor into your digital signage installation, several installation requirements and guidelines need to be taken into account in order for the sensor to perform optimal and operate stable.

4.1 Laser safety considerations

The XQ-L Series Lidar sensor contains a laser emitter and corresponding drive circuitry. The laser output is designed to remain within Class 1 laser safety limits under all reasonably foreseeable conditions including single faults in compliance with IEC 60825-1:2014 (third edition). The laser output power must not be increased by any means and no optics should be used with the intention of focusing the laser beam.

Caution: Use of controls or adjustments or performance of procedures other than those specified in this document may result into hazardous radiation exposure.

4.2 Connection Diagrams

The XQ-L Series Lidar sensor can be connected to any X-talk interface and is therefore compatible with all Xperience controllers. Make sure the sensor is connected to the X-talk interface before powering the Xperience controller. Otherwise, it will not be recognized by the Xperience controller and no sensor output will be provided.
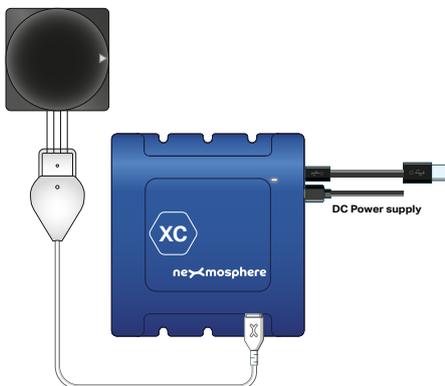
Example connection to XC Controller
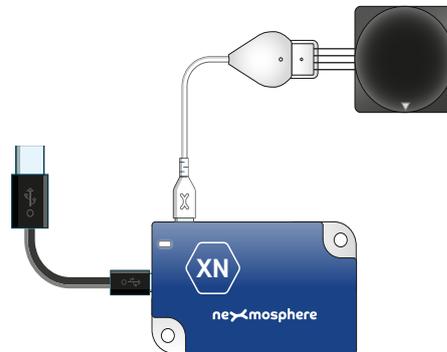
Example connection to XN Controller

The sensors require a high peak current at start-up. Due to this, only 1 lidar sensor can be connected to an XN controller. To an XC controller 2 Lidar sensors can be connected.

4.3 Hardware integration guidelines

Field of View

The XQ-L Series Lidar sensors have a 2D 360° Field of View. Please take this into consideration when designing your setup and determining the position of the sensor.

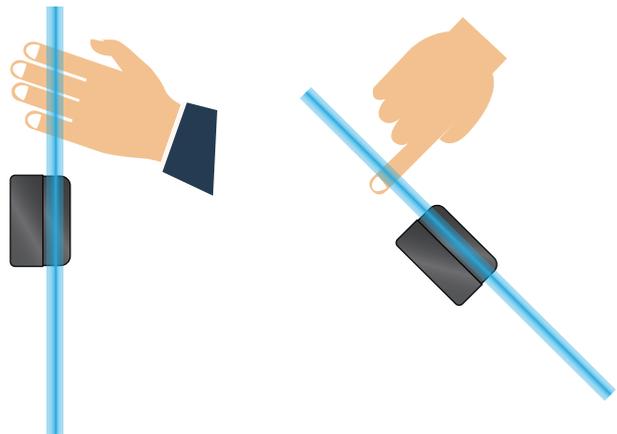*Side view*

Top view

Installation orientation

The sensor can be installed in any orientation, offering the ability to create a horizontal, vertical or diagonal detection surface. This makes the sensor suitable for a variety of applications. Below several examples are provided:

Vertical or Diagonal orientation

This orientation can for example be applied to detect when a person's hand or arm crosses an Activation zone. When the sensor is installed on the edge of a shelf, this information can be used to detect if a person reaches for a specific product.

Another option is to create interactive touchpoints on any surfacet, for example in combination with projected content.

Horizontal orientation

This orientation can for example be applied to detect if a person enters or exits a specific Activation zone. This can be used to detected the presence of multiple persons simultaneously. With this data, information such as footfall, traffic and dwell time can be generated.

Another option is to create interactive touchpoints on any surface, for example in combination with projected content.
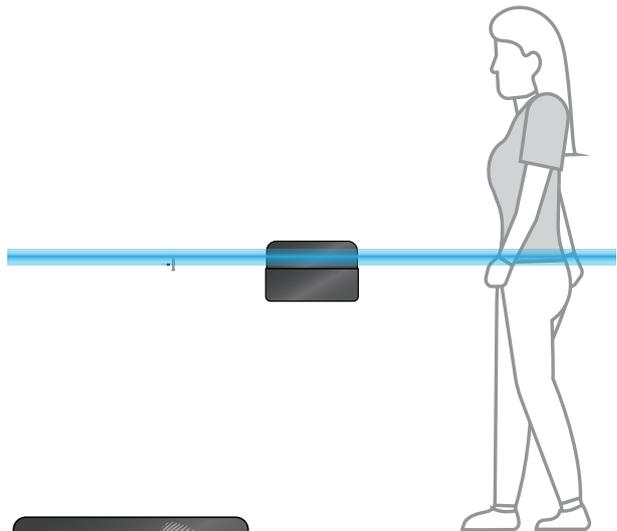
Smudge and dust on sensor

In case there is smudge or heavy dust on the sensor, the sensor readings may become less accurate and unstable. Please make sure the top (circular) sensor casing is clean.

5.1 - Settings

The XQ-L Series Lidar sensor has multiple settings which determine the behaviour and output of the sensor. The settings can be adjusted by sending X-talk setting commands via the API. After a power cycle, the settings always return back to default.

Setting 1: Status LED behaviour

1. LED on	`X001S[1:1]`
2. LED off	`X001S[1:2]`
3. LED on, blink at trigger (default)	`X001S[1:3]`
4. LED off, blink at trigger	`X001S[1:4]`

Setting 4: Output mode

1. Activation zones single detection	`X001S[4:1]`
2. Activation zones multi detection (d)	`X001S[4:2]`
3. Activation zones with count	`X001S[4:3]`

Per default, the sensor can detect multiple objects in an Activation zone, and will send a new API message each time an object enters or exits a zone. This can be adjusted to only detect one object simultaneously per zone (setting 4:1). In this case, no new API message will be send when a second object enters a zone.

The sensor can also be set to count the number of objects in a zone (setting 4:3). For more information, please see section 3.3, page 6.

Setting 7: Hysteresis for Actication zones

Set hysteresis threshold `X001S[7:X]`

X is a value between **1-10** and its default value is **2**. It indicates the hysteresis threshold in centimetres for a new API message to be triggered when an object is moving from one Activation zone to another. This setting can avoid an overload of API messages jumping back and forth between two adjacent Activation zones when an object is located at the edge of two Activation zones.

Setting 8: Minimum signal intensity (advanced)

Set minimum signal intensity level `X001S[8:X]`

X is a value between **1-250** and its default value is **10**. It determines the minimum internal signal level for a measurement to be considered valid. The higher the minimum signal level, the better the signal needs to be for a measurement to be considered valid.

For dark objects, the signal level typically will be lower, and for light objects, it will be higher.

Setting 9: Multi-object threshold (advanced)

Set multi-object threshold `X001S[9:X]`

X is a value between **1-100** and its default value is **10**. It determines the difference which two internal measurement samples need to have for them to be considered two separate objects.

The lower the threshold, the closer objects can be placed together and still be distinguished. In this case, an object with sharp shape variation might also be detected as two objects instead of one.

6. Quick test

In order to test if the XQ-L Series Lidar sensor is installed correctly, please follow the test procedure below:

Step 1 - Setup

First, connect the Lidar sensor to an Xperience controller. Secondly, power the Xperience controller.

The green status LED of the lidar sensor should go on. The status LED of the controller will start to blink and once power-up is completed will be lit continuously
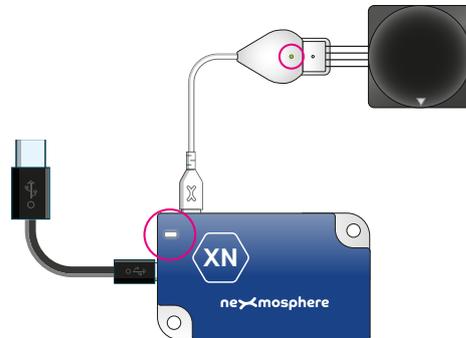
Step 2 - Test Activation zone detection

Place an object (e.g. your hand) in one of the Activation zones. Per default, this would be anywhere within the a 50cm radius of the sensor.

Both the green status LED of the sensor and the status LED of the controller should blink.

Remove the object from the Activation zone

Both the green status LED of the sensor and the status LED of the controller should blink.

LED BLINK

LED BLINK
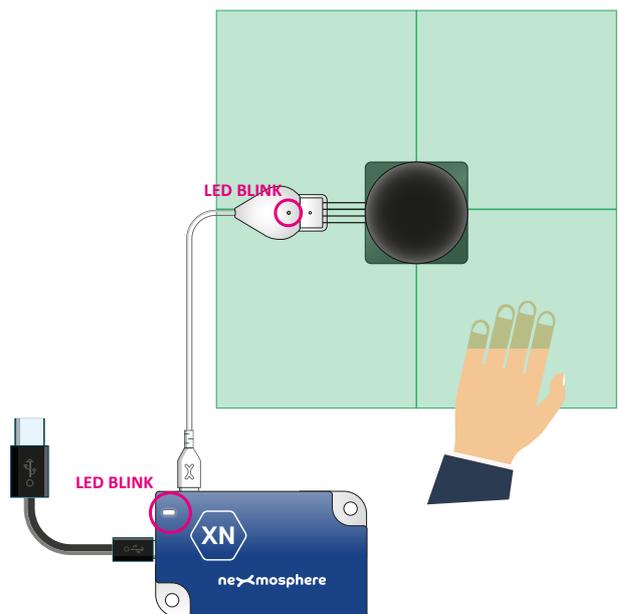
In case any of the steps above does not provide the expected result, please check the installation guidelines in this document.

For a full test we recommend to connect the setup to a mediaplayer or PC and test all API commands listed in this document (see section 3, page 2-3). For more information on how to setup a test for your controller, please see the Quick Start Guide of the Xperience controller you are using. These are available on nexmosphere.com/support-documentation

Please contact support@nexmosphere.com for any support questions you may have.