TECHNICAL INFORMATION

Scan Data Recording

LiDAR Localization

SICK
Sensor Intelligence.

Product described

Scan Data Recording

Manufacturer

SICK AG
Erwin-Sick-Str. 1
79183 Waldkirch
Germany

Legal notes

Original document

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1 About this document

1.1 Purpose of this document

This document provides instructions and information for recording measurement data to create maps for the localization software (e.g. NAV-LOC, LiDAR-LOC).

For contour-based localization with a 2D LiDAR, a recording of the current situation of the environment along the travel paths is required. The localization algorithm of the SICK localization software is based on a reference map, which was created on the basis of recorded scan data.

Figure 1: Deployment process of localization software

1.2 Supported hardware

NAV-LOC and LiDAR-LOC are qualified for different sensors. Please, refer to the Operation Instructions of each system for the supported sensors.

For scan data recording it is recommended to use the same sensor as for operation. However, for high quality of the scan data, we recommend these sensors.

microScan3

Protective field range 9 m (64 m warning field range):

- The sensors with 64 m measurement range are preferred over the ones with 40 m measurement range. They can be used in both configurations, 50 ms and 40 ms scan cycle time. Smaller scan cycle times allow potentially higher velocities, however, are primarily dependent on your risk assessment.

Protective field range 4 m and 5.5 m (40 m warning field range):

- When using the sensors with 40 m measurement range, the scan cycle time has to be 40 ms and not 30 ms, with corresponding 0.39° and not 0.51° resolution. A higher resolution allows the detection of smaller objects used for localization. However, the configuration is primarily dependent on your risk assessment.

Additional information on the microScan3 on mounting, installation, and commissioning can be found online at www.sick.com in the operating instructions:

- Ethernet versions: 8020200
- PROFINET versions: 8021219
- EFI-pro versions: 8021913

NAV2xx/NAV3xx

For scan data recording there are no specific limitations for the NAV2xx/NAV3xx family configurations.

2 Requirements

2.1 Required hardware

- 2D LiDAR sensor
- Laptop (host computer) with
  - 64-bit Windows operating system – Windows 7, Windows 8, or Windows 10
  - **internal** SSD
- 24 V voltage supply (for NAV310, minimum 1 A)
- Cablings
  - Voltage supply
  - Ethernet cable
- Optional: USB camera (e.g., Logitech c920)
- Optional: USB flash drive with sufficient memory for transferring measurement data

HDD problems of host computer

We would explicitly discourage you from using spinning mechanical hard drives to record measurement data. The vehicle movement can cause several seconds of measurement data loss, which can affect the mapping considerably. With a mechanical hard drive, an uneven floor can cause the disks to come into contact with the write/read head, resulting in long-term damage.

2.2 Required software

- SICK LaserView
  - Version: Customer Basic
  - Minimum version: 1.15.1
  - Download link: www.sick.com/en/en/p/p258724
- SICK SOPAS ET (only if needed for configuration of non-safety scanners)
  - Minimum version: 2018.4
  - Download link: www.sick.com/en/en/p/p367244

2.3 System requirements

- The vehicle is ready to drive in manual mode without being reliant on the position output of the localization.
- While data is being recorded, the people doing the recording must not stand within the scanning field at scan height. In addition, cables fixed to the vehicle and movable cables must be routed in such a way that they are always outside the scanning field and the scan plane

2.3.1 Requirements for the environment

Consider the following requirements for using LiDAR-LOC.

- The system is suitable for navigation in closed buildings with even floors.
- Walls, columns, and other fixed structures represented in the map must be sufficiently visible from all positions in the building.
- The surrounding ambient conditions for individual components, for example, the temperature, must comply with the data sheets.

NOTE

SICK Service can help you, assess your factory site and create a reference map.

2.3.2 Requirements for the 2D LiDAR sensor

Consider the following aspects when choosing the mounting height of the sensor.

- The sensor must be installed at a height that ensures a good field of view of the fixed elements in the facility from every location. Fixed elements include, for example, walls, columns, and fixed racks.
- The scan height must correspond exactly to the height provided for active operation.
- The angular scan range of the 2D LiDAR sensor should not be obstructed. If possible, keep the field of view > 220°.

LiDAR-LOC tolerates individual objects that move into the scan plane. This means that less than 100 % of the scan points can match the reference map. The system works even if the scan data deviates from the contour, for example, because the hall layout changes slightly or because objects move into the scan plane.

You should not install the sensor at one level with wall protrusions or other objects that can cause ambiguity when measuring the distance to the wall. Instead, install the sensor at a height above or below the protrusion to make clear which part of the building contour the sensor measures.

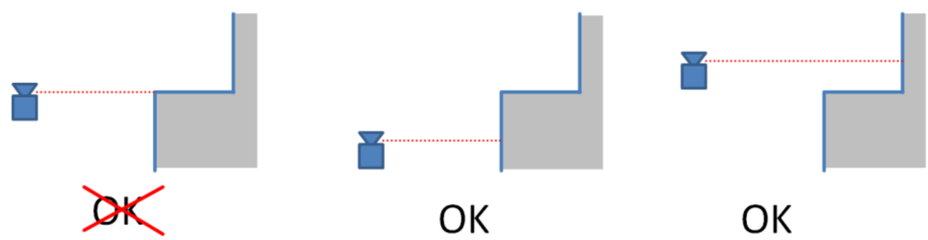


Figure 2: Sensor installation height at wall protrusions

Consider the following aspects when aligning the sensor horizontally:

- The scan plane of the sensor should run parallel to the floor surface
    - In general, at a scan height of 150 mm, the scanner should only be pitched by 0.15°.
      Note: The maximum pitch angle may increase with increased scanning height, so that ground hits are only possible from 60 m upwards.
    - As a minimum requirement, align the sensor with a spirit level.
- Align the sensor in an area with an even floor, which is intended for service work.
- Make sure that the sensor is fixated on a vehicle in such a way that the alignment of the sensor cannot be changed by accident.

SICK offers an alignment tool: Alignment Bar, part number 2101720.

This device uses an internal rechargeable lithium-ion battery and indicates the received laser beam depending on the beam size by one or more red LEDs.

3 Preparation

NOTE
While the measurement data is being recorded, the localization controller (e.g. SIM1000 or SIM2000) is not required.

3.1 Laptop network settings

- Choose the IP address (and netmask) of the laptop in such a way that communication between the 2D LiDAR sensor and laptop is possible.
- If the laptop has a firewall, this must not prevent communication with the sensor data ports (TCP port 2111 and 2112).

NOTE

Using a wired Ethernet connection between sensor and recording computer is strongly recommended.

For the case wired connection is not possible, the recording via WiFi works but one has to make sure that the signal is very good/strong the whole time and does never interrupt at any time during recording.
If the WiFi connection is not sufficiently stable, one could encounter missing packages in recording. This will significantly generate more (time consuming) difficulties to create the map or require the recording to be re-done with a more stable network configuration.

3.2 Preparing the 2D LiDAR sensor

Prerequisites:

- IP address of the sensor in the same sub network as the recording computer (e.g. Sensor 192.168.1.XX, then computer needs 192.168.1.YY, given a subnet setting of 255.255.255.0)
- Sensor connected to the recording computer (via switch or directly)
- Sensor is powered up
- The warm-up time for the 2D LiDAR sensor has ended (30 minutes)

IMPORTANT
For scan data recording the sensors measurement data output gets automatically, non-permanently reconfigured. Therefore, the vehicle cannot use the sensors measurement data for navigation and the vehicle has to be controlled in manual mode.

After the scan data recording is finished, the sensor has to be restarted to reload the configuration.

3.2.1 Non-safe sensors

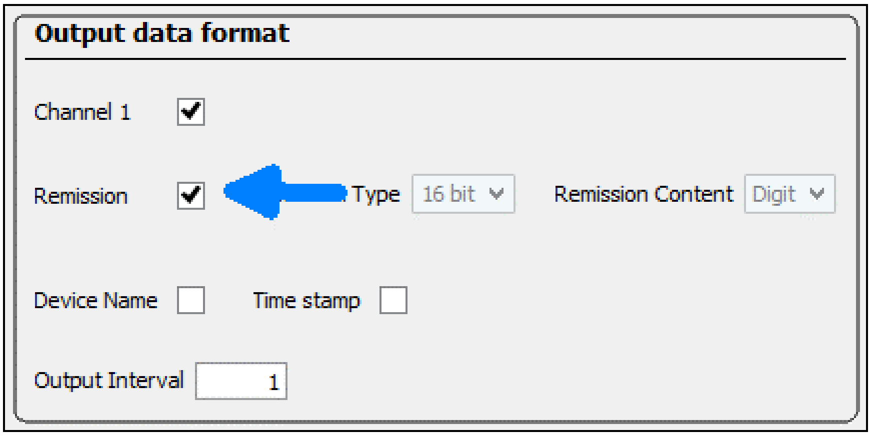
The SICK SOPAS ET software is used to change the network configuration and other settings of non-safe sensors.

You can find information on operating and setting up SOPAS ET in the specific sensor operating instructions. This publication is available at www.sick.com.

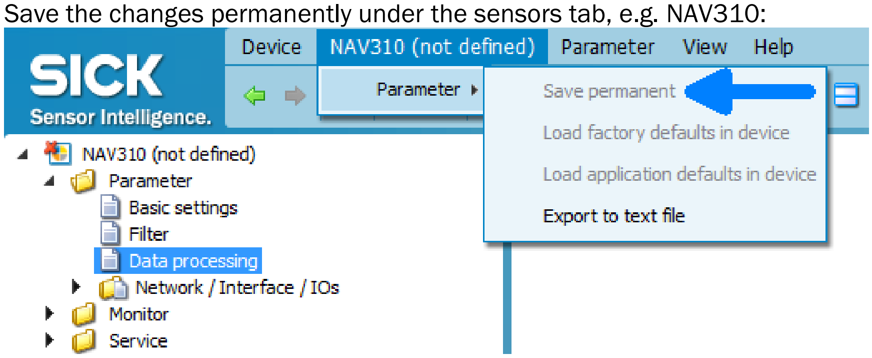
If the sensor has been converted to the *Cola B* protocol, you must convert it to the *Cola A* protocol to record data. (Cola A is the protocol on delivery.)

For a NAV310 sensor, the following configuration steps are required. For other sensor types, see the sensor's user manual for configuration settings.

1. Under [Parameter] => [Basic settings] => [Measurement], set the 2D LiDAR sensor (e.g., NAV310) to [Auto start measure].
2. Under [Parameter] => [Data processing] => [Output data format], activate the [Remission] output:



3. Save the changes permanently under the sensors tab, e.g. NAV310:



3.2.2 Safe sensors

The SICK Safety Designer software is used to change the network configuration and other settings of safe sensors.

Scan data recording for map creation does not require permanent changes to the sensor settings, but the safety-related functions of the sensor have to be fully configured. The configuration needs to be valid and verified and the sensor must not be in error mode.

When using Profinet scanners, the inputs have to be configured in the same way as the scanner is integrated. E.g. if there is an input signal configured, the input source has to be electrically applied.

4 Planning travel paths

When recording data for mapping, you must plan the travel path in advance and observe the following information in the process.

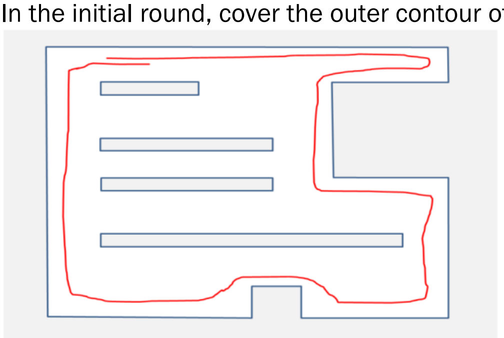
4.1 General planning of travel paths

4.1.1 Vehicle alignment before scanning

- At the start point of the measurement, the vehicle is aligned in such a way that it is ready to drive with the vehicle axis roughly aligned in the direction of one of the building axes.
- Mark the start point of the run on the ground (e.g., with adhesive tape).

4.1.2 Initial round: Outer contour

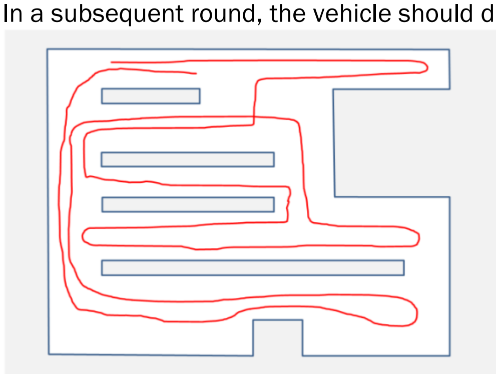
- In the initial round, cover the outer contour of the building:



- To prevent shadowing, the vehicle should get as close to the outer corners of the accessible areas as possible; otherwise, areas of the building contour will not be recorded in full.

4.1.3 Subsequent round: All aisles

- In a subsequent round, the vehicle should drive along all other aisles in the building:



- It must drive through any aisles in which localization is to be used.
- The scanning should be done in a single run.

4.1.4 Recording in halls

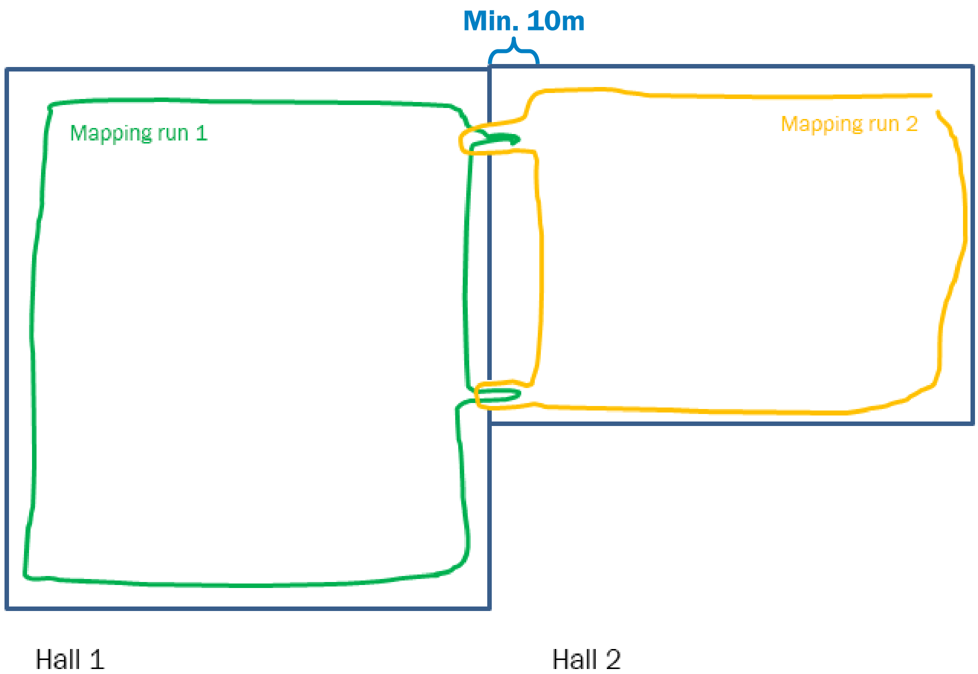
When driving around the contour, the distance from the (outer or inner) wall should not exceed 10 to 15 m if at all possible.

4.1.5 Recording several halls separately

If neighboring halls are to be mapped, their data can be recorded separately. This is particularly useful with larger plants.

The data is recorded as described for each hall.

In addition, the vehicle drives through every available passage and about 10 m into the neighboring hall on every mapping run.



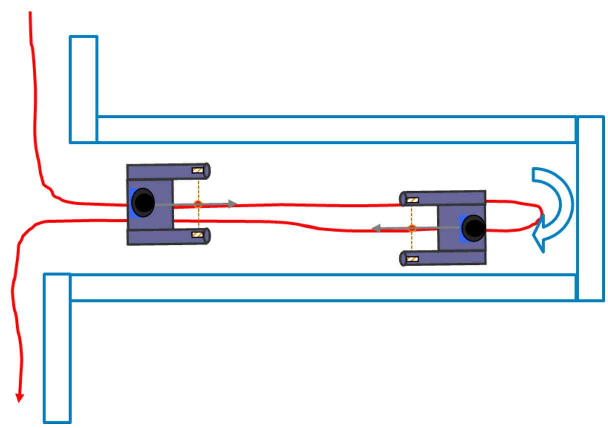
4.2 Recording with limited field of view

If a 2D LiDAR sensor with a field of view less than 360° (e.g. NAV245, microScan3 ...) is used, the steps described in this chapter have to be taken in account.

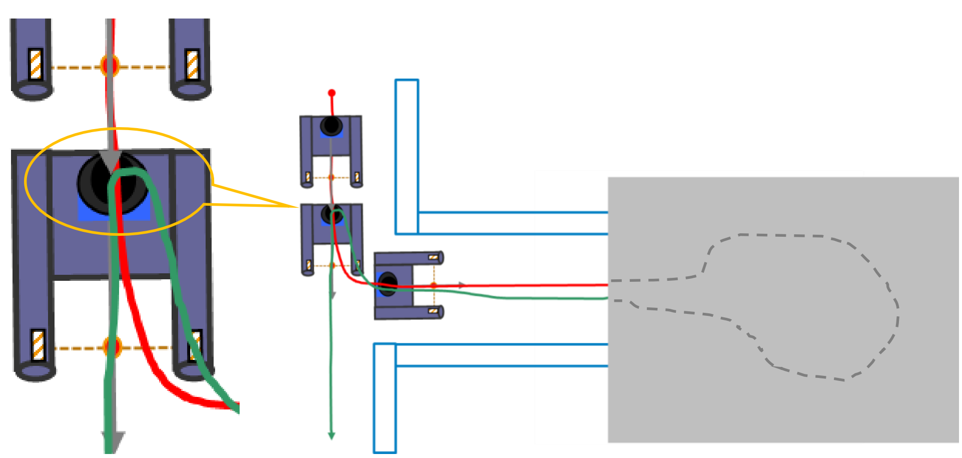
If you have questions about how to record measurement data with sensors with restricted visual range, please contact SICK Service before starting to record data.

Procedure for planning routes:

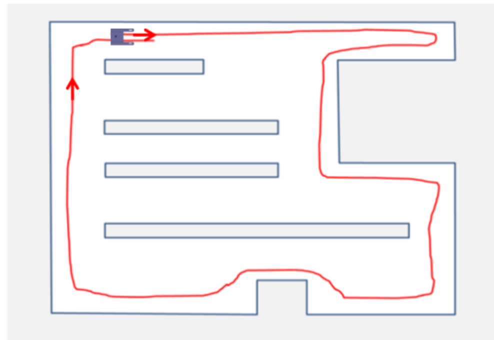
- Drive along routes in both directions.
- In areas that are driven into and out of again (e.g., recesses or side rooms), turn the vehicle so the scan data relevant for mapping is recorded in all directions. The vehicle does not have to be turned in a tight aisle if the width of the aisle means vehicles will only ever travel through it in one direction.



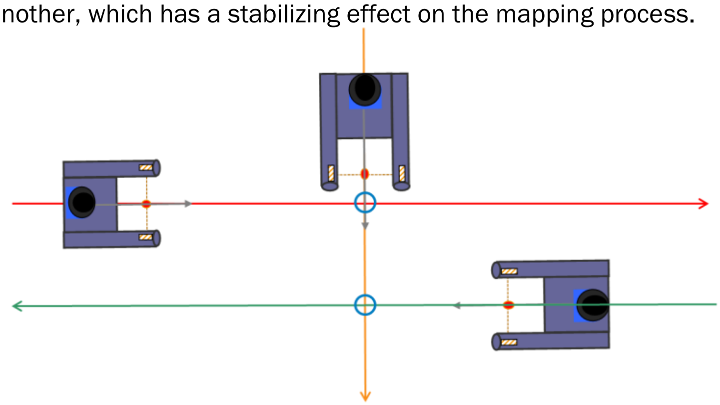
- After driving around loops (e.g., in an aisle with a dead end or in a hall), the position of and direction in which the 2D LiDAR sensor is pointing must always be restored to the same position and direction as when the vehicle entered the loop. The vehicle will usually need to be turned for this purpose.



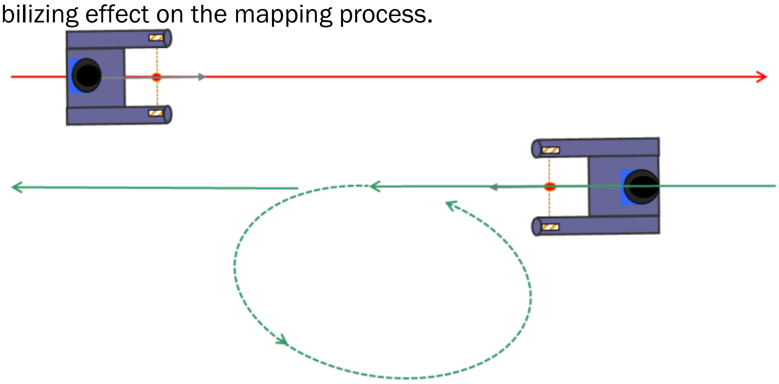
- The vehicle must be pointing in the same direction at the end position as it was at the start.



- Plan trajectories that intersect at 90° at as many suitable points as possible. This is particularly helpful if it means two trajectories running in the opposite direction can be aligned with one another, which has a stabilizing effect on the mapping process.



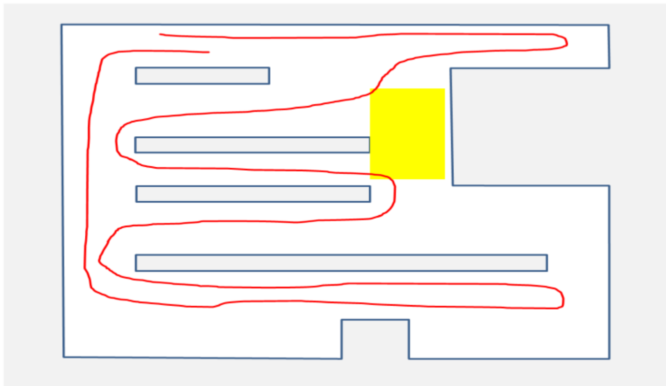
- Additionally, it can be helpful for map creation, when adding small loops while recording the opposite direction of an already recorded path. This is particularly helpful if it means two trajectories running in the opposite direction can be aligned with one another, which has a stabilizing effect on the mapping process.



4.3 Preventing missing scan data

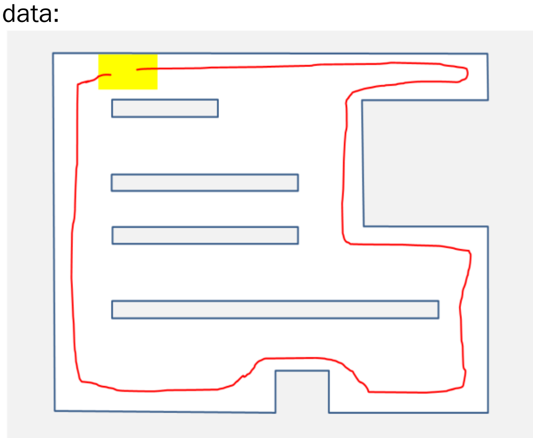
The following errors must be avoided:

- An area in which localization is supposed to work is not covered.
- No measuring distance is recorded which connects the turning points of the measurements for individual aisles.



  This can be avoided if the vehicle is driven around the outer contour of the building in a targeted manner.

- The start and end point of the measurement are not together and there is a gap in the measurement data:



  You can avoid this by aiming for the mark recommended in chapter 4.1.1 at the end of the measurement run.

- When using a sensor with a scanning angle less than 360° (all sensor except of the NAV3xx family):
  - Align the sensor in the same orientation direction at the start and end point of the trajectory
  - Align the sensors in the same orientation direction when driving out of a recess or neighboring hall, as it was when it drove in; see section 4.2
  - Ensure to have travelled all corridors in both directions
  - Keep in mind the part of the environment currently not visible to the sensor and consider performing an extra turn (section 4.2) to record scan data needed for either adding it into the map or for aligning measurement data to other segments of the driving path.

5 Recording data

5.1 Driving mode specifications

- Max. speed 1 m/s.
- For cornering, a max. vehicle yaw rate of 45°/s (i.e., a 90° turn takes at least 2 seconds; a 360° turn takes at least 8 seconds).
- Pathway travel at a constant speed is ideal for recording the measurement data.
- The measurement run should take place along the walls.
- The vehicle may stop while the data is being recorded.
- For short pauses (< 10 minutes), data recording can remain activated.
- On straight stretches, do not choose a speed which is too low; the maximum permissible speed of 1 m/s should be fully utilized.

5.2 Recording data

1. Start the LaserView software on the laptop.

NOTE
When using Windows 7, start Laserview with admin rights, if you are using a microScan3 sensor.

2. Enter the IP address of the sensor.

When using a safety laser scanner (e.g. microScan3), add "*MS3:*" in front of the IP

- Non-safe sensors: e.g. 192.168.1.10
- Safety laser scanners: e.g. MS3:192.168.1.10

For safety laser scanners, the UDP port 30178 is standard. This port has to be excluded from the fire-wall blocking. If this port is not available, one can specify an alternative port of the host computer with:

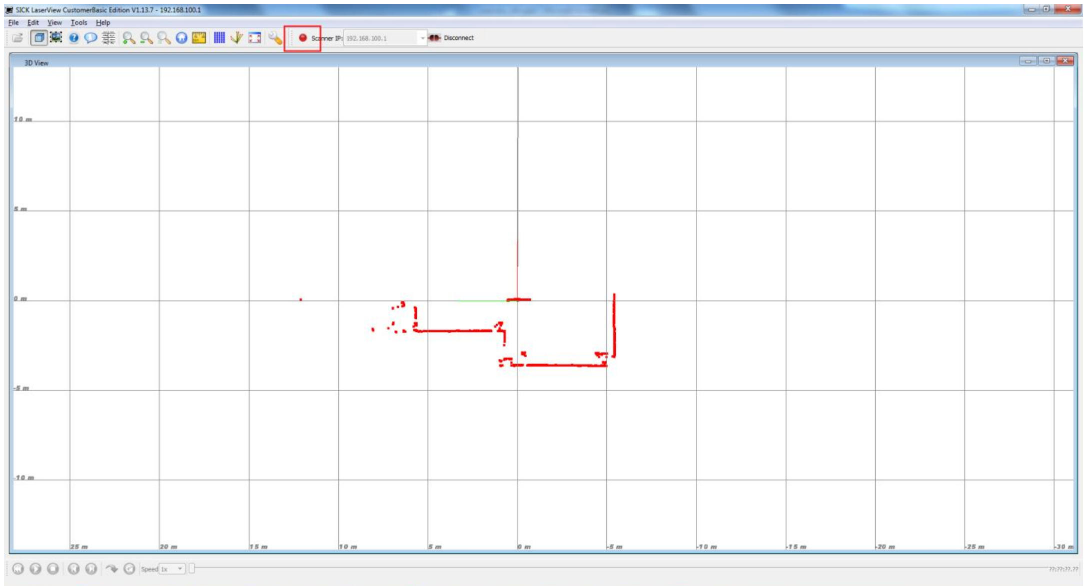
- E.g. MS3:192.168.1.10:portnumberHostComputer

This is however only for recording and does not change the port of the sensor itself.

3. Click on the [Connect] button.

Once the connection has been successfully established, scan data from the sensor is displayed.

4. Click on the [Record] button (●) and then specify a file name for the recording. Recording only starts once the file name has been confirmed



5. Click on the [Record] button (●) again to end the recording.

As the scan data is displayed during the measurement process, it can be monitored live.

The generated measurement data file can be up to 1 GB for every 10 minutes of measurement.

If several neighboring halls are being mapped, the data can be recorded separately for each hall, taking account of the information provided in chapter 4.1.5.

5.3 Recording additional video data

For additional video data, use an additional camera. This may be useful for the back office to create the map.

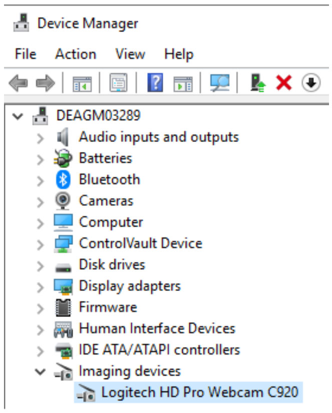
5.3.1 Supported cameras

The external USB camera Logitech c920 or c930 are supported.
(Installation of the original driver of the camera from the seller’s homepage needed)

NOTE
Other camera types including webcam of the recording computers may work, however are not fully tested.

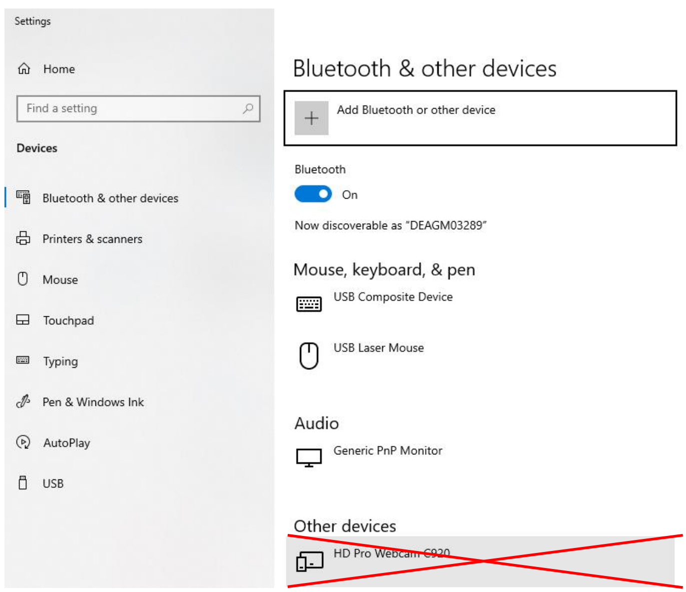
5.3.2 Approach

1. In the **Device Manager**, look-for the exact name of the camera, for example, **Logitech HD Pro Webcam C920**

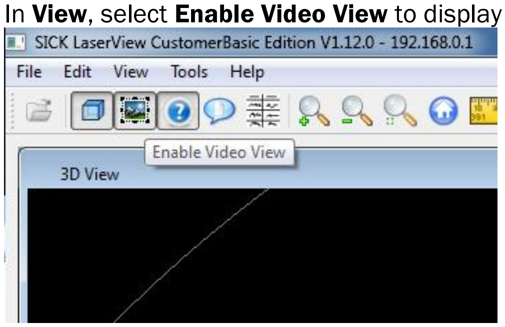


NOTE

For Windows 10, use the name shown in the Device Manager, not from the Windows 10 settings (e.g. in this case is “Logitech” is missing),



2. In **Laserview**, open the camera setting with Preference > Live Camera
3. In **General**, activate the camera with **Enable direct camera support.**
4. In **Device**, type in the exact name of the camera.
5. In **Laserview main window**, **disconnect** and **connect** again to the sensor to apply the changes.
6. In **View**, select **Enable Video View** to display the camera video



6 Troubleshooting

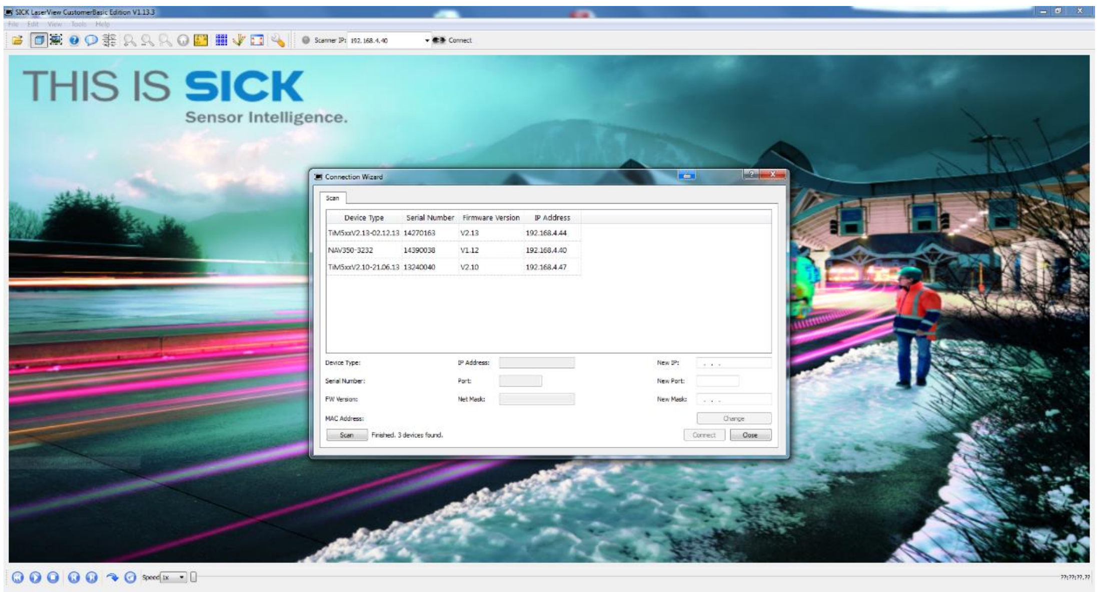
6.1 Network connection with the sensor

If an error is displayed while you are establishing a data connection between the sensor and the LaserView software, check the IP address and netmask settings of the computer and sensor.

Also check that the version of the Sick LaserView software is the one specified in section 2.2 or higher. If necessary, update the software via the download link provided there.

6.2 IP address of the sensor is not known

If the IP address of the sensor is not known but this is located in the same network segment, you can use the Connection Wizard to establish the connection. You can open this in the Start menu under [Tools], [Connection Wizard].



When using a safety sensor, you must use the Sick Safety Designer software to search for the sensor in the network to find out its IP address. Safety sensors will not be shown in the connection wizard.

When using a non-safe sensor, you can also use the Sick SOPAS ET software to search for the sensor in the network to find out its IP address.

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Australia
Phone +61 3 9457 0600
1800 334 802 – toll-free
E-mail sales@sick.com.au
Austria
Phone +43 22 36 62 28 8-0
E-mail office@sick.at
Belgium/Luxembourg
Phone +32 2 466 55 66
E-mail info@sick.be
Brazil
Phone +55 11 3215-4900
E-mail comercial@sick.com.br
Canada
Phone +1 905 771 14 44
E-mail cs.canada@sick.com
Czech Republic
Phone +420 2 57 91 18 50
E-mail sick@sick.cz
Chile
Phone +56 2 2274 7430
E-mail chile@sick.com
China
Phone +86 20 2882 3600
E-mail info.china@sick.net.cn
Denmark
Phone +45 45 82 64 00
E-mail sick@sick.dk
Finland
Phone +358-9-2515 800
E-mail sick@sick.fi
France
Phone +33 1 64 62 35 00
E-mail info@sick.fr
Germany
Phone +49 2 11 53 01-0
E-mail info@sick.de
Hong Kong
Phone +852 2153 6300
E-mail ghk@sick.com.hk
Hungary
Phone +36 1 371 2680
E-mail ertekesites@sick.hu
India
Phone +91 22 6119 8900
E-mail info@sick-india.com
Israel
Phone +972 4 6881000
E-mail info@sick-sensors.com
Italy
Phone +39 02 274341
E-mail info@sick.it
Japan
Phone +81 3 5309 2112
E-mail support@sick.jp
Malaysia
Phone +6 03 8080 7425
E-mail enquiry.my@sick.com
Mexico
Phone +52 (472) 748 9451
E-mail mexico@sick.com
Netherlands
Phone +31 30 2044 000
E-mail info@sick.nl
New Zealand
Phone +64 9 415 0459
0800 222 278 – toll-free
E-mail sales@sick.co.nz
Norway
Phone +47 67 81 50 00
E-mail sick@sick.no
Poland
Phone +48 22 539 41 00
E-mail info@sick.pl
Romania
Phone +40 356 171 120
E-mail office@sick.ro
Russia
Phone +7 495 775 05 30
E-mail info@sick.ru
Singapore
Phone +65 6744 3732
E-mail sales.gsg@sick.com
Slovakia
Phone +421 482 901201
E-mail mail@sick-sk.sk
Slovenia
Phone +386 591 788 49
E-mail office@sick.si
South Africa
Phone +27 11 472 3733
E-mail info@sickautomation.co.za
South Korea
Phone +82 2 786 6321
E-mail info@sickkorea.net
Spain
Phone +34 93 480 31 00
E-mail info@sick.es
Sweden
Phone +46 10 110 10 00
E-mail info@sick.se
Switzerland
Phone +41 41 619 29 39
E-mail contact@sick.ch
Taiwan
Phone +886 2 2375-6288
E-mail sales@sick.com.tw
Thailand
Phone +66 2645 0009
E-mail marcom.th@sick.com
Turkey
Phone +90 216 528 50 00
E-mail info@sick.com.tr
United Arab Emirates
Phone +971 4 88 65 878
E-mail info@sick.ae
United Kingdom
Phone +44 1727 831121
E-mail info@sick.co.uk
USA
Phone +1 800 325 7425
E-mail info@sick.com
Vietnam
Phone: +84 8 6292 0204
H/P +84 94545 2999
E-mail sales.gsg@sick.com

Further locations at **www.sick.com**

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