SF45/B microLiDAR® sensor

The world's smallest and lightest scanning microLiDAR®

Disclaimer

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Welcome to LightWare

Thank you for selecting LightWare as your **partner** in distance sensing technology.

LightWare is a pioneer in microLiDAR® distance sensors, drawing upon **four decades** of expertise in LiDAR technology to develop application-specific products renowned for their **accuracy, reliability, and durability**. LightWare's assembly process involves meticulous handling of sensors and optics, creating microLiDAR® sensors of world class quality. Our production methods benchmark the **ISO 9001:2015** standards at scale, with manufacturing capabilities reaching up to **45,000 units annually**, with each microLiDAR® unit crafted to the same exacting standards. Unsurprisingly, leading companies worldwide trust LightWare as their **preferred LiDAR partner**.

We are dedicated to ensuring **your success** when using LightWare microLiDAR® sensors to address your unique distance measuring and geospatial challenges.

Beyond this comprehensive product guide, our website's **resource center** (https://lightwarelidar.com/) offers a wealth of supplementary information, **including APIs, CAD drawings, and FAQs**.

Our dedicated technical support desk is at your service if you require assistance with integration or technical queries. Reach out to them at support@lightwarelidar.com.

LightWare products come with a **24-month limited warranty**, covering any defects in material or workmanship under normal use. For detailed warranty information, please refer to our website at https://lightwarelidar.com/terms-and-conditions/. We're here to support you on your journey — sensing your world with LightWare LiDAR.

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1 Overview

This product guide is a comprehensive companion to your LightWare SF45/B microLiDAR® - the world's smallest and lightest scanning microLiDAR®.

The LightWare SF45/B is engineered for high-performance applications in UAVs, robotics, and industrial automation. Weighing just 58 grams, this compact sensor delivers ranging capabilities from 0.2 m up to 50 m in a minimal footprint, making it highly suitable for weight-sensitive platforms.

The SF45/B's scanning Field of View (FoV) that can be adjusted from a few degrees up to 320 degrees to adapt to your sensing needs. The configurable scanning angle of the SF45/B enables the operator to only scan the area of interest in rapid succession.

The small form factor of only 51 mm x 48 mm x 44 mm makes the SF45/B appropriate to almost every application, while the update rate of up to 5000 measurements per second provides a high volume of point data. This makes the SF45/B applicable for a variety of unmanned ground vehicle (UGV), unmanned aerial vehicle (UAV) or robot where size and weight are critical to the system design.

The SF45/B is tolerant to changes in background lighting conditions, wind and noise which makes the SF45/B an excellent LiDAR for applications such as collision avoidance, navigation, ground surveying, obstacle detection, and terrain following.

The SF45/B is equipped with two alarm zones, that allows the user to select the distance, as well as the direction that an alarm output should be generated. This functionality is ideal for object avoidance and safety applications.

The sensor supports first and last pulse detection, which enhances its ability to distinguish between multiple objects in cluttered environments. It integrates easily with various systems through USB, UART, and I²C interfaces and is compatible with popular platforms such as ArduPilot, ROS, Arduino, Raspberry Pi, and PX4.

The SF45/B's combination of performance, versatility, and affordability makes it a valuable tool for developers and engineers seeking advanced LiDAR capabilities in a minimal form factor.

2 Safety

Always adhere to these product safety precautions and operate the sensor strictly in accordance with the guidelines outlined in this product guide. LightWare bears no responsibility or liability for any damage or injury, whether direct or indirect, arising from a failure to comply with these stipulations. Non-compliance with the precautions or warnings provided in this product guide constitutes a breach of safety standards intended for the proper use of the sensor.

2.1 Laser eye safety

LightWare LiDAR sensors comply with the United States Food and Drug Administration (FDA) laser eye safety regulations for safe use around humans and animals, based on the international standard IEC 60825-1 and utilizing LaserSafe PC Professional for the computations.

Caution: The sensor contains a laser and should never be aimed at a person or animal. Do not view the laser with magnifying optics such as microscopes or telescopes.

This laser product emits non-ionizing laser radiation. It is classified as Class 1M, indicating that the laser beam is safe to look at with the naked eye during normal use. However, avoid viewing it through magnifying optics such as binoculars, microscopes, telescopes, etc. Despite the safety rating, refrain from looking into the beam, switch off the device when in the vicinity, and never stare directly into the lens from less than half a meter.

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

Warning: Risk of permanent eye damage

- Class 1M lasers are **not safe** if viewed through **magnifying optics such as microscopes, binoculars, or telescopes from a distance less than the NOHD**.
- The laser eye safety rating of the sensor depends on the mechanical integrity of the optics and electronics. It must **not be disassembled or modified in any way**.
- **If the sensor is damaged, do not continue using it**.
- The sensor should be mounted using the mounting holes or product-specific brackets. **Do not attach to or clamp the lens tubes** as this may cause damage and adversely affect the laser safety rating.
- There are **no user-serviceable parts**, and maintenance or repair must only be done by the manufacturer or a qualified service agent.
- No regular maintenance is required, but if the lenses start collecting dust, they may be wiped with suitable lens-cleaning materials. Ensure that the device is switched off before looking into the lenses.

2.2 Labeling

Figure 1: SF45/B laser warning label

Important note: It is a legal requirement to display the laser warning label on your final product or system

2.3 Laser radiation information

Table 1: Laser radiation information

Specification	Value
LightWare product	SF45/B microLiDAR®
LiDAR type	Articulating single beam
Eye safety classification	Class 1M
Laser wavelength	905 nm
Pulse width	16 ns
Pulse frequency	20 kHz
Average laser power	<2.5 mW
Maximum energy per pulse	90 nJ
Extended Nominal ocular hazard distance (Extended NOHD)*	0.5m

* Distance beyond which binoculars may be safely used.

Approximate values only. Please contact LightWare LiDAR if further information is required.

3 Key technical specifications

Table 2: SF45/B microLiDAR® key technical specifications

SF45/B microLiDAR® key technical specifications	
Performance	
Range	0.2 to 50m / 0.6 to 164ft (70% albedo in sunlight conditions, 0.9 x 0.9 m target size)
Update rate	50 to 5,000 readings per second (customizable to suit application) and up to 5 sweeps per second
Resolution	1 cm / 0.4 in
Accuracy	± 5 cm / ± 2 in for update rates lower than 500 readings/s ± 10 cm / ± 4 in for update rates higher than 500 readings/s
Connections	
Power supply voltage	5 to 5.5 V
Power supply current	300mA typical, <450mA on startup
Outputs and interfaces	Serial UART and I^2C (3.3 V TTL, 5 V tolerant). USB for setup and configuration.
Form factor	
Dimensions	51 mm x 48 mm x 44 mm / 2 in x 1.9 in x 1.7 in
Weight	59 g / 2.08 oz (excluding cables)
Optical	
Approvals	FDA: 1710193-000 (2020/09) CE certified ROHS3 Compliant REACH undefined NDAA compliant (Section 848) Blue UAS ready
Laser safety	Class 1M (Please refer to the eye safety section of this user guide, above)
Optical aperture	12.7 mm / 0.5 in
Beam divergence	< 0.5°
Environmental	
Operating temperature	-10 to 50°C / 14 to 122°F
Storage temperature	–40 to 80 °C / -40 to 176 °F
Enclosure rating	Full unit is IP30
Accessories	
Communication cable	CAB_195
USB cable for SF11/ SF30 / SF20	AE10418-ND
DroneCAN Adaptor	ACC_DroneCAN
Default settings	
Serial port settings	Baud rate 115200, 8 data bits, 1 stop bit, no parity, no handshaking
I^2C address	0x66 (Hex+469+6\]'), 102 (Dec)
Update rate	50 readings per second

4 Accessories

To support configuration and integration, the following accessories are available for purchase from the LightWare website:

4.1 Communication cable

Each SF45/B is supplied with a communication and power cable. Additional cables are available for purchase from our online store.

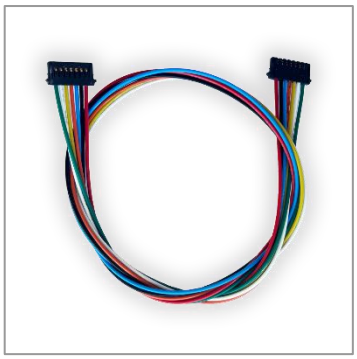

Figure 2: CAB_195 - Communication cable for SF11/SF30

4.2 USB cable

An optional USB Type A to USB Type B Micro cable is available to connect the SF45/B to your computer using the micro-USB interface on the SF45/B.

Figure 3: AE10418-ND - USB cable for SF11/ SF30 / SF20

4.3 DroneCAN adapter

A DroneCAN adapter is available to seamlessly integrate the LightWare LiDAR rangefinder with DroneCAN enabled flight controllers.

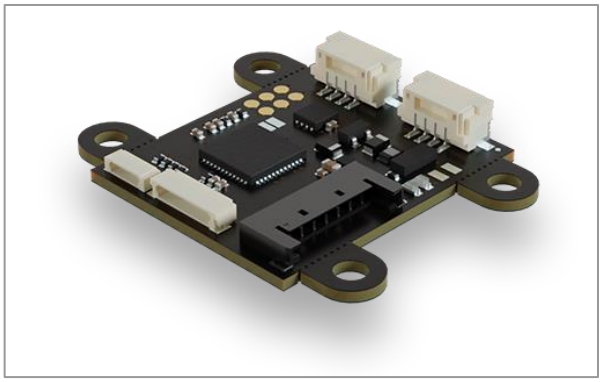

Figure 4: ACC_DroneCAN – DroneCAN adapter

5 Getting started

LightWare Studio is a free application (available for Windows, macOS, and Linux) and is the gateway to configuring your microLiDAR® sensor and visualizing your data. This software empowers you to customize settings, fine-tune sensor parameters, and easily analyze data. It also facilitates firmware upgrades and in-field diagnostics and support.

Detailed step-by-step videos are available on LightWare's YouTube channel: https://www.youtube.com/@LightWareLiDAR/videos

Follow these easy steps to get going with your LightWare microLiDAR®:

1. Download and install the version of LightWare Studio compatible with your operating system from the Resource section of LightWare's website at https://lightwarelidar.com/. You can safely install over an existing version of LightWare Studio if you are upgrading.

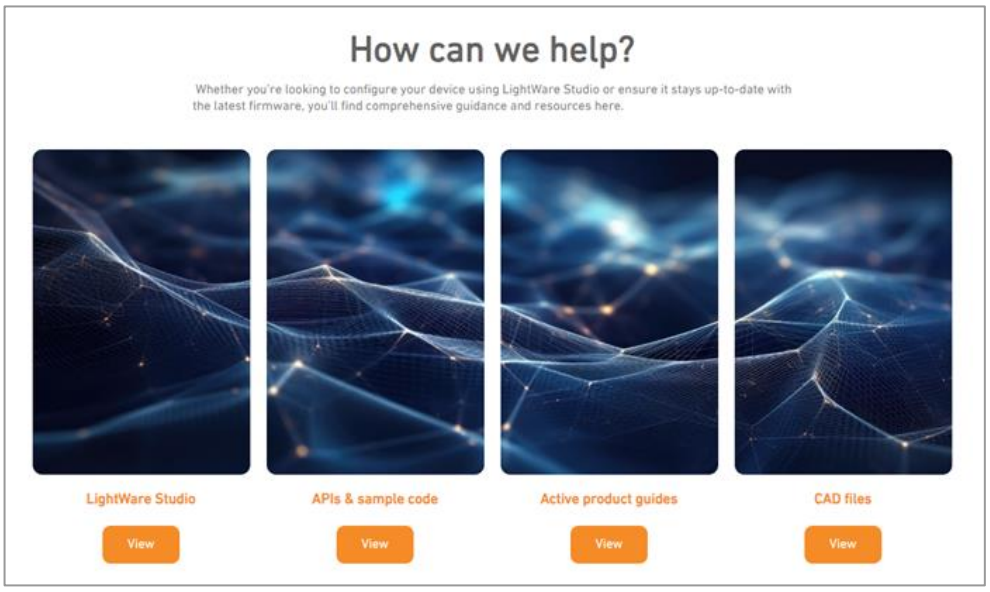

Figure 5: LightWare Studio website download page

2. Once the installation is complete, the *Welcome to LightWare Studio* page will open, prompting you to attach a device to your computer.

3. Carefully connect your SF45/B to your PC via a standard MicroUSB cable.

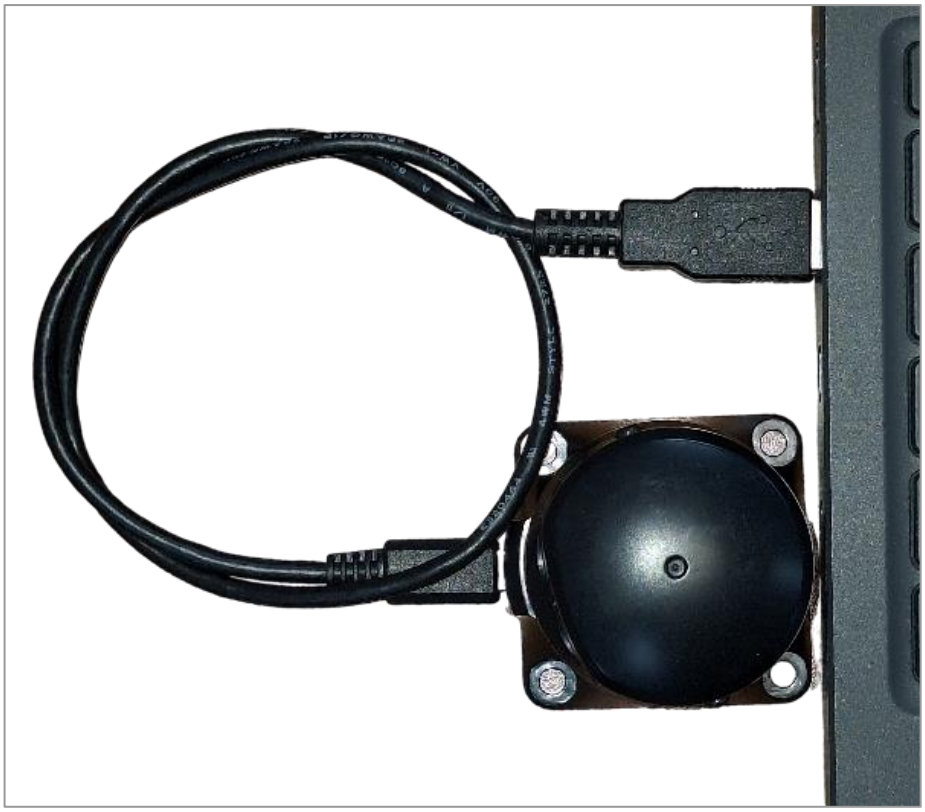

Figure 6: SF45/B connection to a PC via microUSB cable

Caution: To avoid the risk of shorting the high voltage lines on the sensor circuit board, connect the USB cable to the sensor first before connecting it to the computer.

4. When connecting the sensor for the first time, Windows users may experience a brief delay as the operating system installs the necessary generic communication driver. Please allow the installation process to complete.

5. LightWare Studio will automatically detect the device and present it for selection on the Welcome page. The Welcome page may show other communications ports on your computer. Select the LightWare SF45/B sensor.

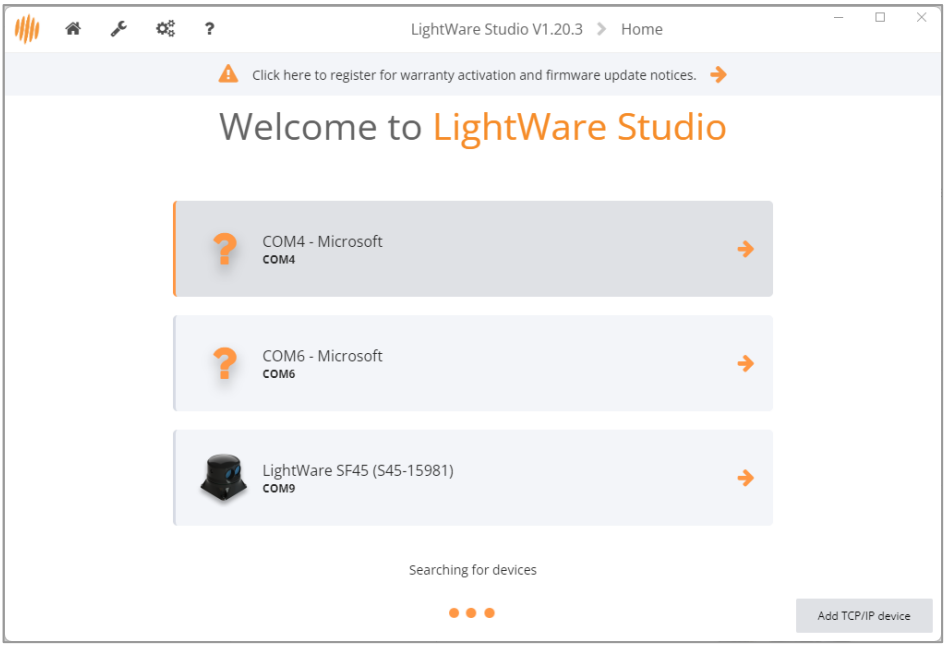

Figure 7: Connection established with the SF45/B

6. LightWare Studio will start on the device's Info page, indicating the serial number, hardware version and firmware version of your device.

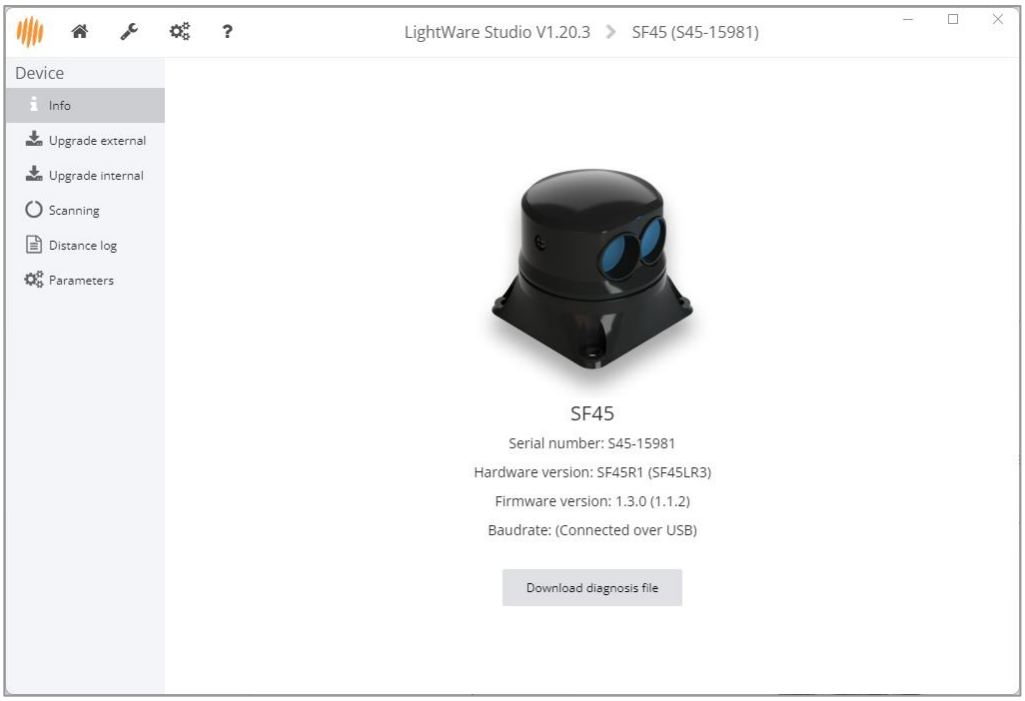

Figure 8: LightWare Studio device information page

7. Navigate to the *Scanning* tool from the left panel. This shows a graphical representation of the scanned field

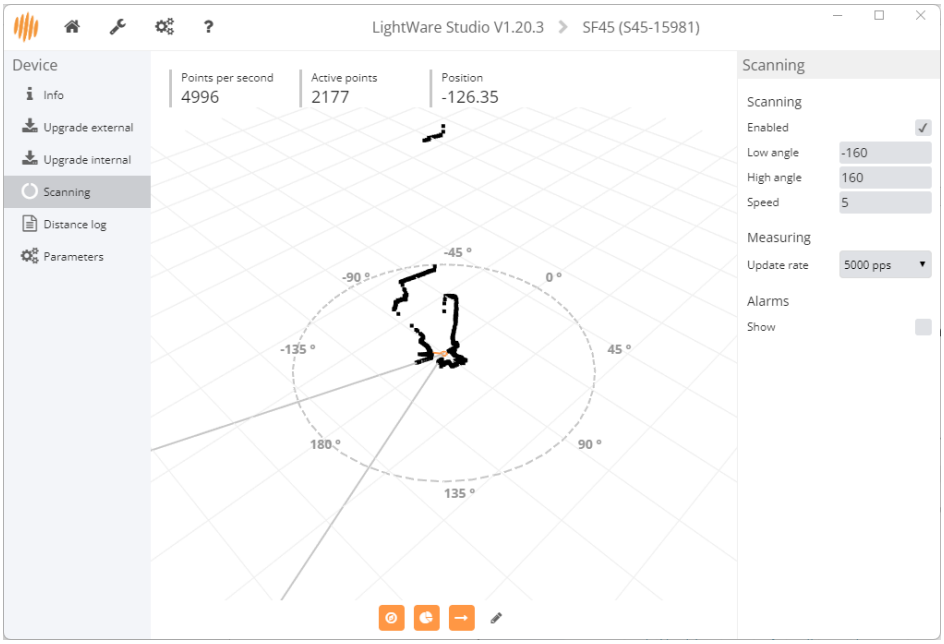

Figure 9: LightWare Studio SF45/B Scanning page

8. Navigate to the *Distance log* tool from the left panel. This tool streams live distance data in meters as it is scanned by the sensor, together with the angle that the measurement was taken. Toggle the parameters on the right to stop or start the streaming, add line numbers or time stamps, or switch on different data types.

9. Data can be downloaded and saved using the *save* icon above the data.

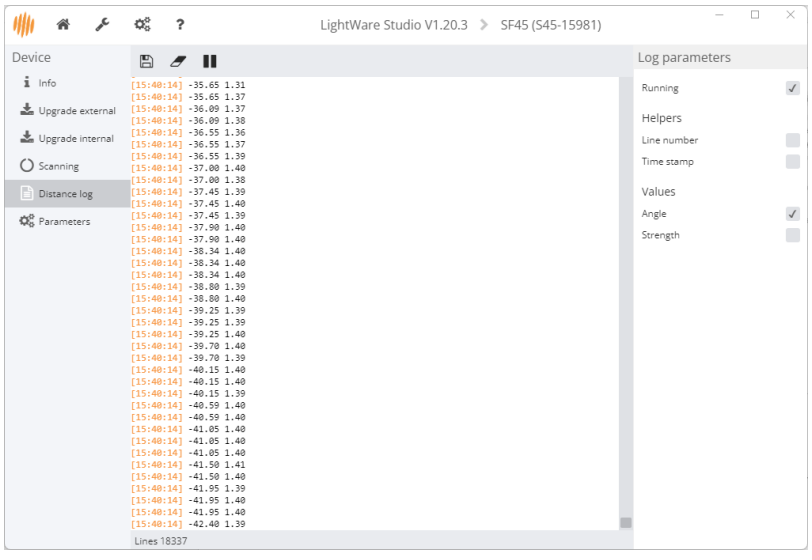

Figure 10: LightWare Studio SF45/B distance log page showing measurements

6 Parameters, settings, and tools

6.1 Setting the device parameters

Your LightWare SF45/B microLiDAR® sensor can be configured via LightWare Studio or from a host controller using the product commands through the serial UART or I²C communication interfaces.

To set the device parameters using LightWare Studio:

1. In the left panel, click on *Parameters* to open the detailed parameters page.

2. The scroll-down list of adjustable parameters will be displayed, with explanatory notes and dropdown options.

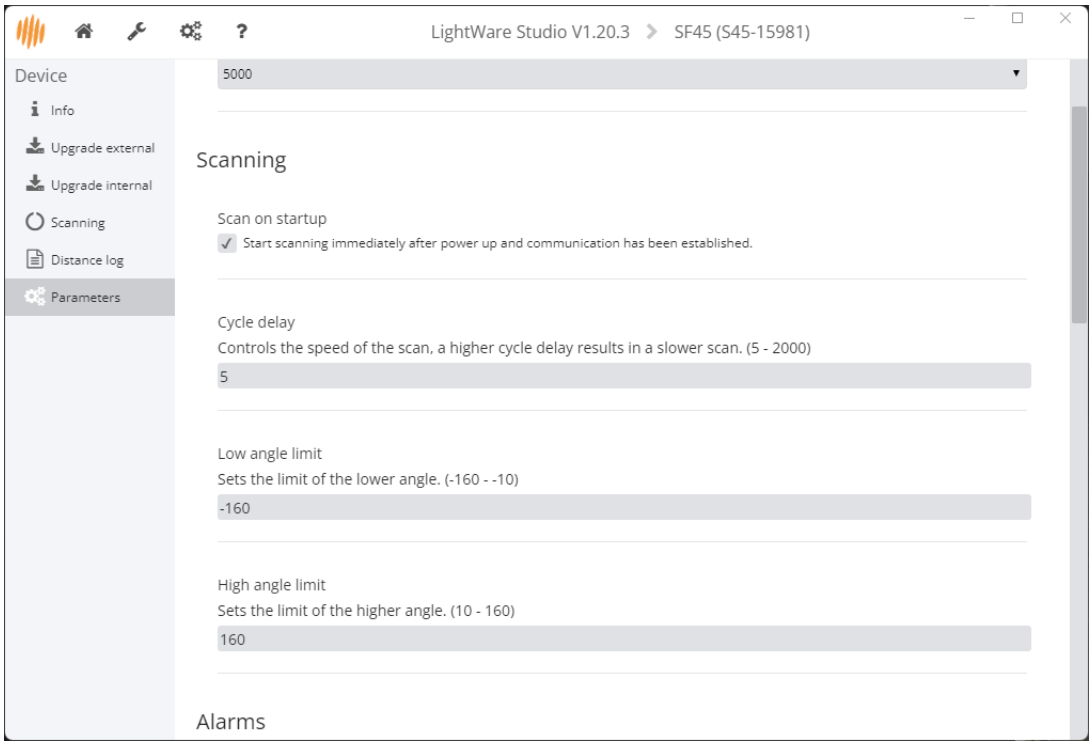

Figure 11: LightWare Studio SF45/B detailed parameters page

3. Set your device parameters according to your requirements. Refer to the table below for more information.

Table 3: SF45/B adjustable parameters

Parameter	Explanation	Options/range
Measurement:		
Update rate	Controls number of measurements taken per second.	50 to 5000
Scanning:		
Scan on startup	Start scanning immediately after power up and communication has been established.	Select/Deselect
Cycle delay	Controls the speed of the scan. A higher cycle delay results in a slower scan.	5-2000
Low angle limit	Sets the limit of the lower angle (at what angle should scanning start)	-160 to -10
High angle limit	Sets the limit of the higher angle (at what angle should scanning start)	10 to 160
Alarms		
Alarm hysteresis	The amount by which distance reading must decrease below the alarm distance before the alarm is cleared. Used to prevent alarm chatter. (In meters, up to two decimal places.)	0 to 10 meters
Alarm A distance	Warn when an object is detected closer than this user-set alarm distance. (In meters, up to two decimal places.) When scanning is activated, the object must also be between the left and right alarm angles.	0 to 100
Alarm A low angle	Angle in degrees (must be lower than Alarm A high angle)	-180 to 180
Alarm A high angle	Angle in degrees (must be higher than Alarm A low angle)	-180 to 180
Alarm B distance	Warn when an object is detected closer than this user-set alarm distance. (In meters, up to two decimal places.) When scanning is activated, the object must also be between the left and right alarm angles.	0 to 100
Alarm B low angle	Angle in degrees (must be lower than Alarm B high angle)	-180 to 180
Alarm B high angle	Angle in degrees (must be higher than Alarm B low angle)	-180 to 180
Communication		
Serial UART baud rate	Select the serial UART interface baud rate, (in bps).	9 600 to 921600
I2C address	The address used when communicating over the I^2C interface. A whole number in decimal.	0 to 127

6.2 Settings and tools

Additional application **settings** are available by clicking on the *gears* icon in the top menu:

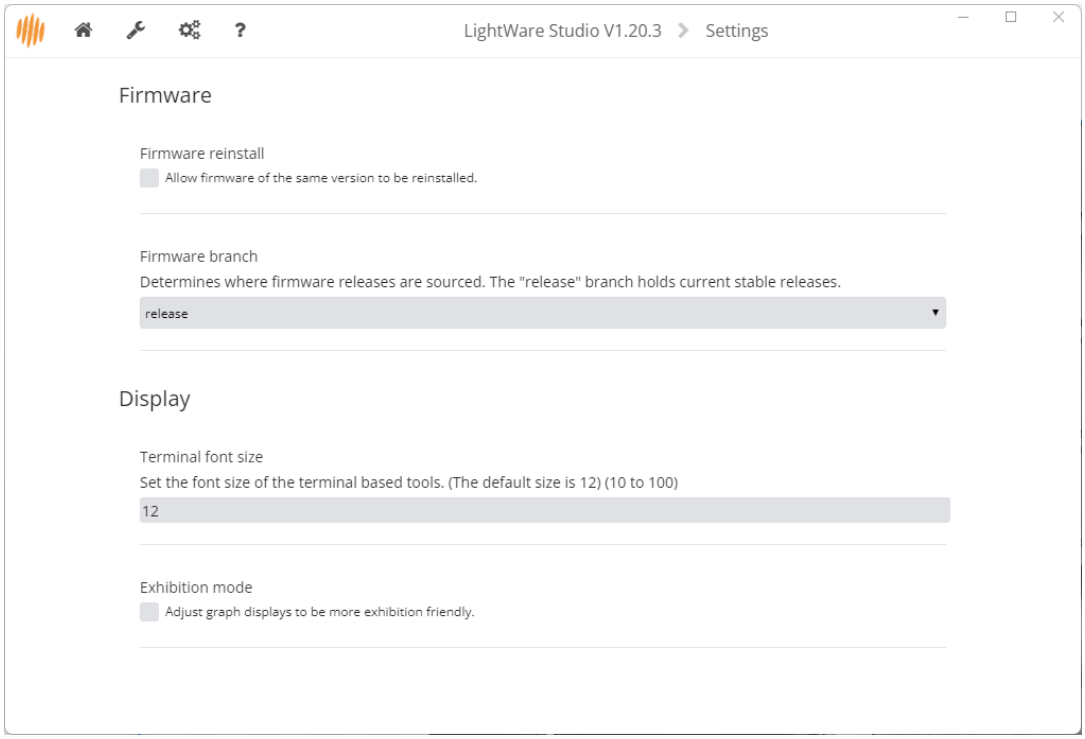

Figure 12: LightWare Studio application settings page

You can access the **specialized device tools page** by clicking on the *wrench* icon in the top menu, including a traditional terminal if needed:

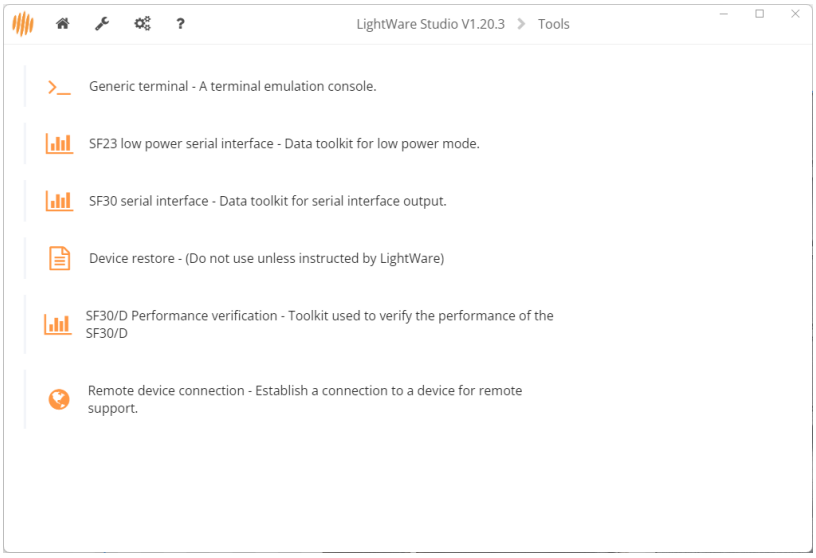

Figure 13: LightWare Studio specialized tools page

7 Installation, mounting, and cabling

7.1 Mechanical interface

For detailed CAD files, please refer to the LightWare resource center at https://lightwarelidar.com/.

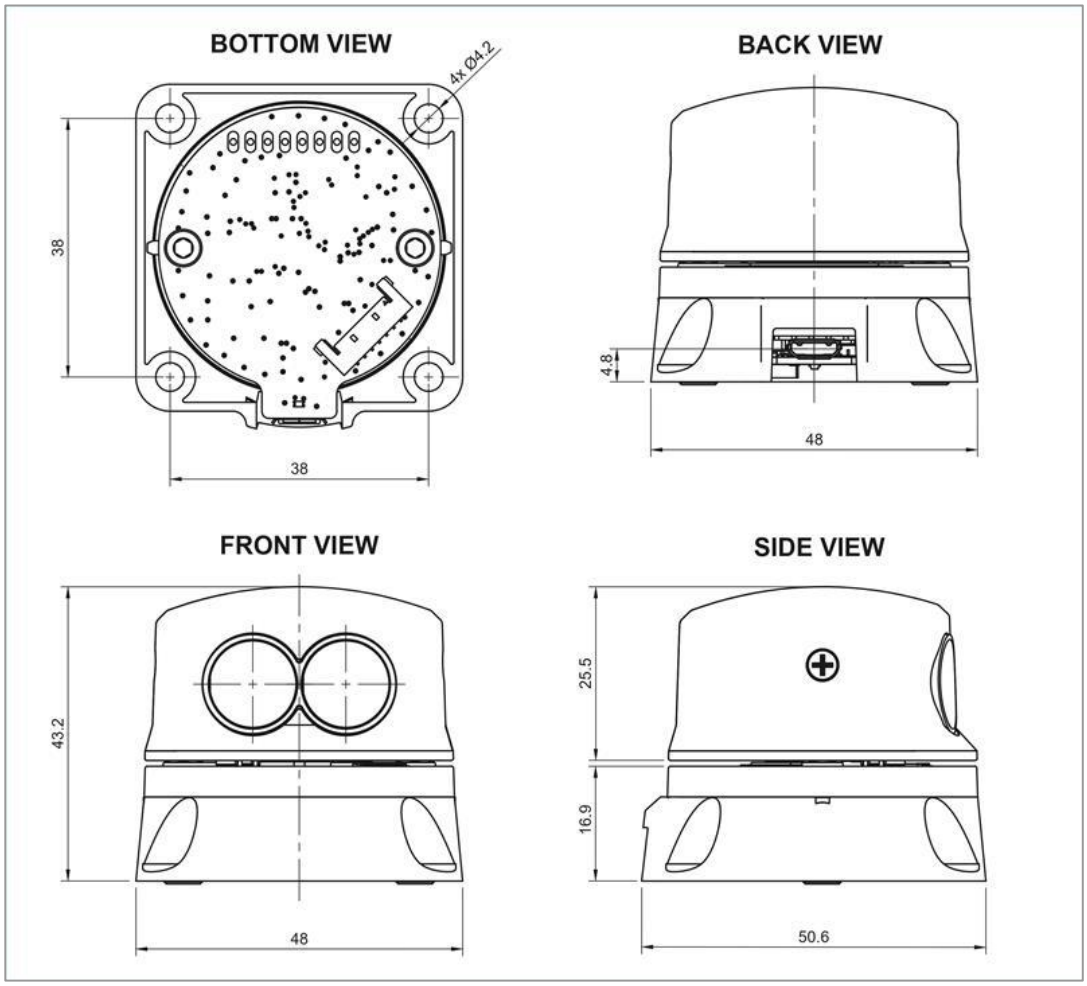

Figure 14: SF45/B dimensions

Caution: This sensor is an OEM module that requires appropriate heat dissipation and EMI shielding.

7.2 Mounting and alignment instructions

Take careful note of the following points when mounting the sensor:

- When choosing a position, ensure that there is **nothing in the path** of the laser beam and that there are **no shiny or highly reflective surfaces near the beam path** that could result in false signals.
- Do not mount the sensor recessed within a cavity of the airframe.
- Make sure the sensor is securely mounted to prevent false readings or damage.
- The LightWare microLiDAR® sensor is designed for installation with exposed lenses. If it is to be mounted behind glass, ensure use of non-reflective glass and mount the sensor flush with the glass to prevent false readings. The glass must have good transmission at 905 nm wavelength, with an anti-reflective coating optimized for this wavelength.
- Ensure adequate heat dissipation and EMI shielding is provided to the sensor.
- Secure the communication cable to prevent it from pulling on the connection port.
- Measuring short ranges (<20 m), towards a high reflective surface, illuminated by direct sunlight (e.g. sunlight illuminating a road sign post) can cause high noise to the sensor. This will result in an out-of-range result being returned. Consider reducing the update rate.
- When measuring at longer ranges and the target reflectivity is extremely poor (asphalt/tar), this would result in laser light absorption. In such cases a larger error (between 7cm and 15cm) and multiple out-of-range signals will be returned. Consider reducing the update rate.

7.3 Orientation

The sensor requires a clear line-of-sight to measure distance to a target surface. It can be mounted horizontally or vertically.

It can be mounted in a downward facing, angled, or forward-facing orientation, depending on your application.

7.4 Communication and power cable

The SF45/B is supplied with an LW 000_135 communication cable. This cable carries the power supply, communications signals, and servo driver signals, and connects to the SF45/B through an eight-position receptacle connector.

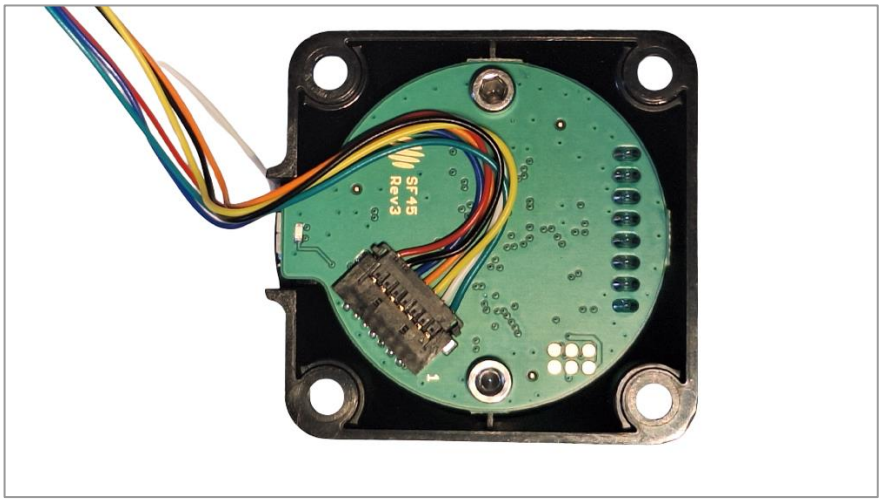

Figure 26: SF45/B communication cable connection

Table 4: SF45/B pinout table

Connector Pin	Wire	Serial Function	I²C Function
1	Green	Do not connect	
2	White	Do not connect	
3	Yellow	TXD, transmit data for serial connections	SDA
4	Orange	RXD, receive data for serial connections	SCL
5	Blue	GND	
6	Black	GND	
7	Red	VIN, +5 V power supply positive	

Note: The serial UART, I²C, and servo interfaces use 3.3 V TTL logic, (5 V tolerant). The 5-volt power supply should be sized appropriately for startup power.

8 Advanced features

8.1 Alarms

The alarm feature on the LightWare SF45/B microLiDAR® measures and reports distances of potentially hazardous conditions. This feature allows for the creation of two independent alarm zones to support safety, security, or obstacle detection applications.

8.1.1 Configuring Alarm A & Alarm B

Alarm A and Alarm B provides separate warnings when the ground (or another object) is detected closer than their user-set alarm distances. Each time a distance measurement is taken, the data is analyzed internally by the sensor and the alarm statuses are updated in real time.

To configure the Alarms:

- Connect your SF45/B to LightWare Studio via a USB cable and your laptop.
- Click on Scanning in the left menu panel. Your SF45/B should now be scanning its surroundings and plotting a point cloud on LightWare Studio.
- On the right panel tick the Show button at the bottom to open the Alarm configuration menu. You will see configuration options for both Alarm A and B.
- Each Alarm can be set for:
    - Distance - the measuring range for the alarm, from 0.0 to 50.0 meters;
    - Low angle – the left boundary in degrees, from -160.0 to +160.0 degrees, but cannot be higher than the High angle; and
    - High angle – the right boundary in degrees, from -160.0 to +160.0 degrees, but cannot be lower than the Low angle.

Alarm zones are indicated as sectors on the LightWare Studio Scanning page. Triggered alarm zones are indicated in red, while unset alarm zones are indicated in green.

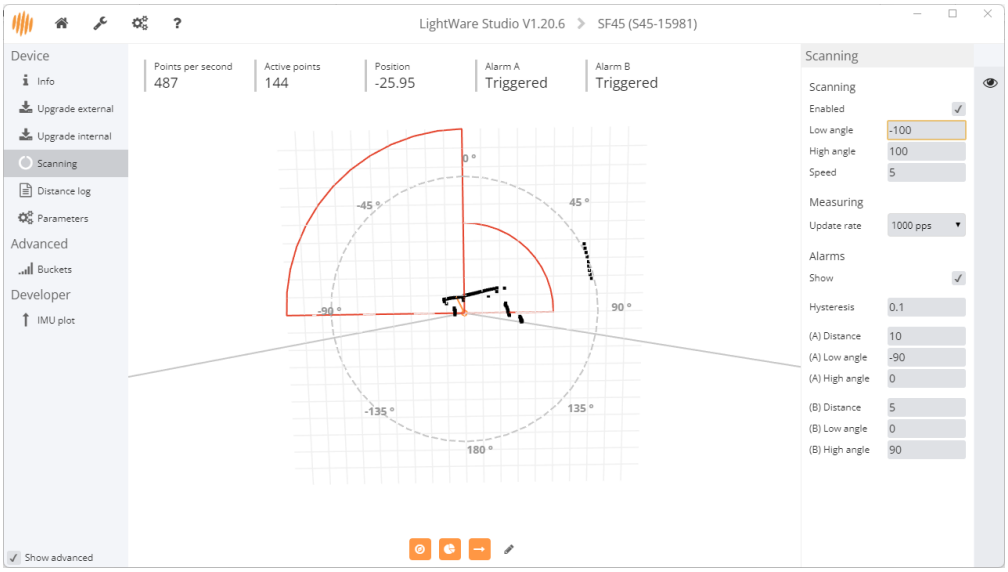

Figure 15: Alarm sectors on LightWare Studio showing Alarm A and B

8.1.2 Alarm hysteresis

Hysteresis prevents the alarms from switching rapidly between states when the target surface is at the activation distance. Activation occurs at the set distance minus the hysteresis distance and deactivation occurs at the set distance plus the hysteresis distance. Hysteresis can be set from 0.0 to 10.0 meters.

These alarm parameters (including hysteresis) can be set using the LightWare Studio parameters page or by using commands through your host controller.

9 Communication interfaces

The LightWare microLiDAR® sensor can be connected to a host controller, transmitting results and receiving commands with a serial UART or an I²C communication interface.

- The one-to-one serial UART interface allows one sensor to communicate with a single host controller.
- The configurable address of the I²C communication interface allows multiple sensors to be connected to one host controller on a common bus.

Once a sensor is connected to a host controller, the first command from the host controller will inform it which of the two communication interfaces is being used. Subsequent commands sent from the host controller to the sensor will request values, change settings, or alter the sensor's performance. The sensor will reply to a single command with a single reply, although the streaming command allows the sensor to continuously update the reply without the host resending the command. Note that streaming data is only available through the serial UART interface. The complete command list is contained in this product guide.

We suggest using LightWare's pre-built APIs wherever possible, which are available via the LightWare website resource center. If you require more control or do not find a suitable pre-built API, you can use the information below to build a compatible system. The packet-based binary protocol is compatible with higher-level APIs like C, Python, and JavaScript. Please contact LightWare for assistance with APIs or programming if required.

9.1 Serial UART interface

For serial UART communication, the sensor uses encapsulated packets to send and receive data. A packet sent **to** the sensor is a request. A correctly formatted request will always be **replied** to with a response. Streaming is available through the serial UART interface. In this case, the sensor sends request streaming packets without a direct request from the host, and they do not require a response from the host.

Requests are made using one of the sensor commands. The complete command list is contained in this product guide. Commands are flagged as either read or write. When a read request is issued, the response will contain the requested data. When a write request is issued, the contents of the response will vary depending on the command.

Default serial UART interface properties:

- Baud rate: 115200 (configurable)
- Data: 8 bit
- Parity: none
- Stop: 1 bit
- Flow control: none

9.2 I²C interface

For I²C communication, the sensor will always be the slave on the I²C interface and only transmit data when requested by the master.

Multiple sensors can be connected to an I²C bus. The I²C serial bus configurable address allows connecting multiple devices on a common bus. Default I²C interface Address: 0x66 or 102. The sensor's I²C interface SDA and SCL pins use 3.3 V logic levels with a 3.3kΩ pull-up resistors, but are also 5 V tolerant.

Requests are made using one of the sensor commands. The complete command list is contained below in this product guide. When a read request is issued the response will contain the requested data. When a write request is issued there is no response generated.

10 Commands

Your LightWare microLiDAR® use the packet-based binary communication protocols for both serial UART and I²C communications. The packet-based binary protocol is a register-based protocol that is compatible with higher-level APIs like C, Python, and JavaScript. This is LightWare's recommended protocol as it allows for various data streaming from a single request.

The first command sent by the host to the sensor after powerup will be used to detect whether serial UART or I²C mode is in use. The sensor will not return a response to the first command. Subsequently, for each command sent by the host controller, a single reply will be returned by the sensor.

To initialize the communication with the sensor, send the command to request the Product name. It is advisable to send the command to query the Product name twice in succession shortly after powerup. As described above the first request will not return a response, however the second request will return the product name, indicating that the sensor has indeed initialized successfully, and a handshake has been successfully established with the sensor.

The streaming ($) command can be used to command the sensor to continuously update the reply without waiting for the host controller to resend the command

10.1 Binary protocol

10.1.1 Binary protocol - Command structure

Both request and response **packets** are composed of the following bytes:

Table 5: Packet composition

	Header			Payload		Checksum	
Byte	start	flags low	flags high	ID	data	CRC low	CRC high

Table 6: Header Flag byte explanation

Byte	**Flags high**								**Flags low**							
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	Payload length (0 to 1023)								Reserved							Write

- The **start** byte is always 0xAA and indicates the beginning of a packet.
- The **flags** bytes form a 16-bit integer representing the packet's payload length and read/write status.
- The **payload** includes the ID byte, the data bytes, and the write bit. Its length is between 1 and 1023 bytes, inclusive depending on the command type.
- The **ID** byte indicates which command the request/response relates to.
- The **command list** is contained later in this product guide.
- The **write** bit is 1 to indicate write mode, or 0 to indicate read mode.
- The **CRC** bytes form a 16-bit/2-byte checksum value used to validate the integrity of the packet data. The sensor will not accept and process a packet if the CRC is not correctly formed. Every byte in the packet except for the CRC itself is included in the checksum calculation.

10.1.2 Binary protocol - Checksum algorithm

The **checksum** algorithm is CRC-16-CCITT 0x1021. Below are two CRC calculation examples:

Table 7: Checksum algorithm

C/C++	JavaScript

uint16_t createCRC(uint8_t* Data, uint16_t Size)
{
  uint16_t crc = 0;
 	
  for (uint32_t i = 0; i < Size; ++i)
  {
  uint16_t code = crc >> 8;
  code ^= Data[i];
  code ^= code >> 4;
  crc = crc << 8;
  crc ^= code;
  code = code << 5;
  crc ^= code;
  code = code << 7;
  crc ^= code;
  }
 	
  return crc;
}
	function createCRC(data, size) {
	  let crc = 0;
	
	  for (let i = 0; i < size; ++i) {
	  let code = crc >>> 8 & 0xFF;
	  code ^= data[i] & 0xFF;
	  code ^= code >>> 4;
	  crc = crc << 8 & 0xFFFF;
	  crc ^= code;
	  code = code << 5 & 0xFFFF;
	  crc ^= code;
	  code = code << 7 & 0xFFFF;
	  crc ^= code;
	  }
	
	  return crc;
	}

10.1.3 Binary protocol – Reading bytes

Once a packet is successfully read it can be processed based on its command ID. It is vital to **verify the payload length and checksum** before processing.

If either of the following errors are received, “invalid packet length” or “checksum is invalid”, please roll the incoming stream back to one byte after where the start byte was detected.

Below is the process for reading the raw serial byte stream and identifying packets:

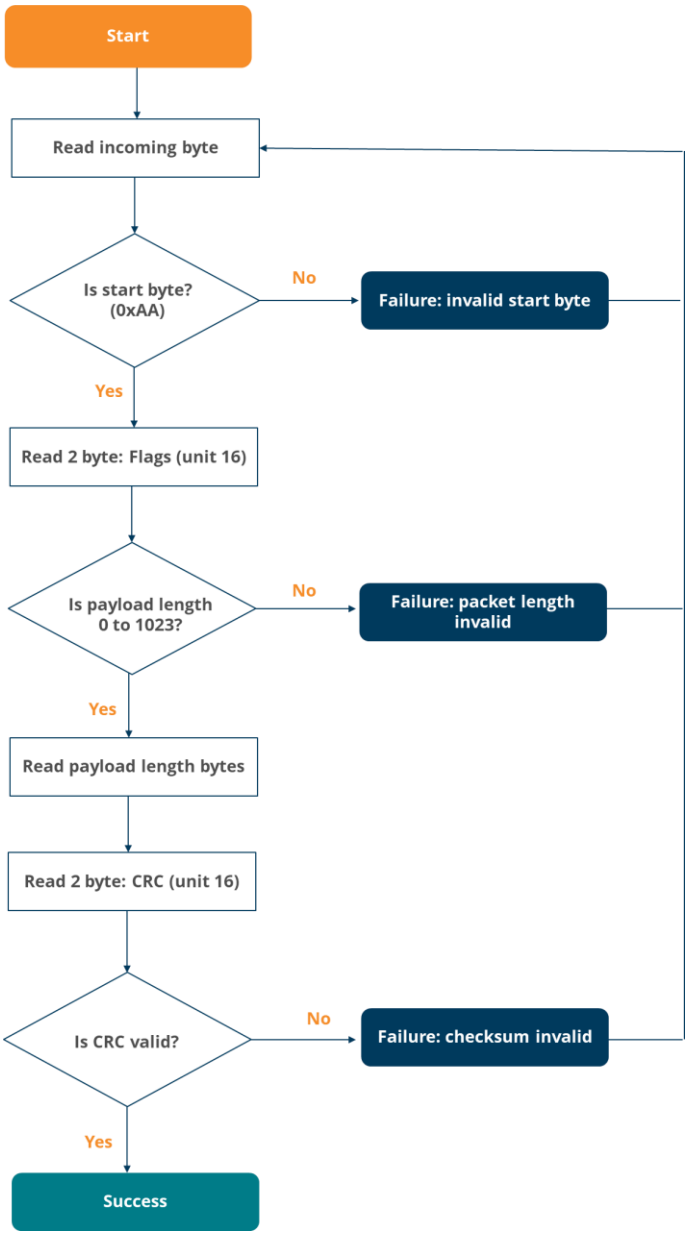

Figure 16: Process flow for reading bytes

10.1.4 Binary protocol - Sending commands

Every request sent to the sensor will receive a response. The response also confirms that the request was received and processed. The timeout value and number of retries should be optimized for the specific application.

Below is the process for sending a command request and reading the response:

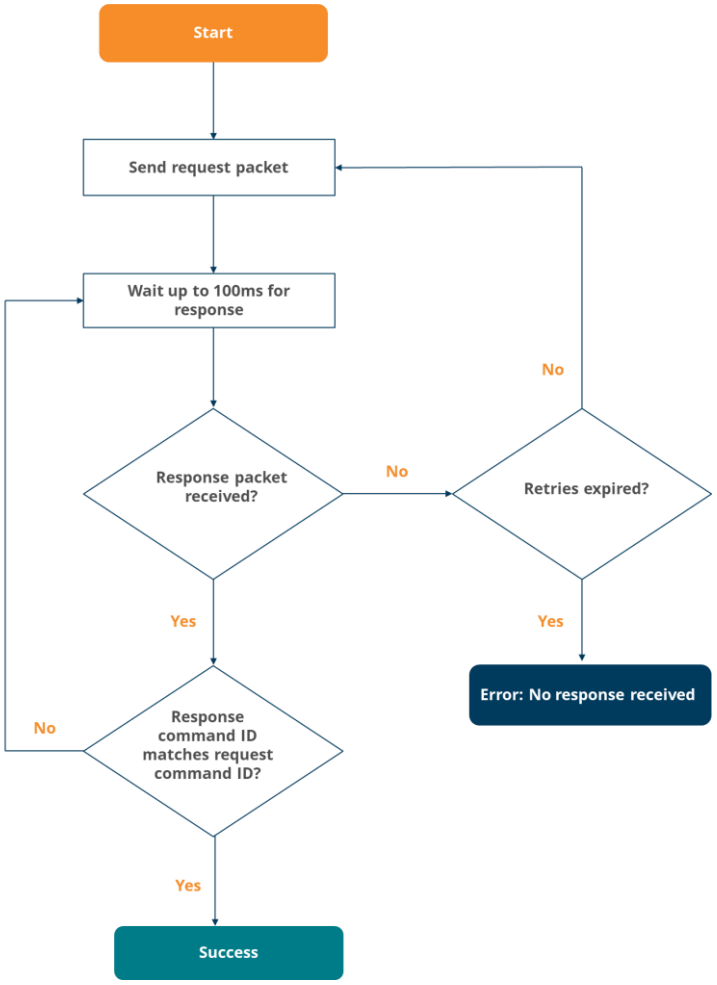

Figure 17: Process flow for sending commands

10.1.5 Binary protocol - Saving

Parameters listed in the command list below, and indicated to persists across power cycles, must be saved to onboard flash once changed.

To save the parameters, the Token (ID 10) must be read from the unit by sending a read command. The value received must then be sent as the data in the Save Parameters command (ID 12) to the unit.

The Token expires every time after use and consecutive save commands will require the request of a new token prior to the save commands sent.

10.1.6 Binary protocol – Command list

Table 8: Binary protocol command list

<table>
<tr><th>ID</th><th>Name</th><th>RW</th><th>Read bytes</th><th>Write bytes</th><th>Persists</th><th>Description</th></tr>
<tr><td>0</td><td>Product name</td><td>R</td><td>16</td><td>-</td><td>-</td><td>A 16-byte string indicating product model name.
Always SF45/B followed by a null terminator.
Use to verify the SF45/B is connected and operational over the selected interface.</td></tr>
<tr><td>1</td><td>Hardware version</td><td>R</td><td>4/ uint32</td><td>-</td><td>-</td><td>The hardware revision number as a uint32.</td></tr>
<tr><td>2</td><td>Firmware version</td><td>R</td><td>4</td><td>-</td><td>-</td><td>The currently installed firmware version as 4 bytes.
Used to identify the product for API compatibility.
<table>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><td>Patch</td><td>Minor</td><td>Major</td><td>Reserved</td></tr>
</table></td></tr>
<tr><td>3</td><td>Serial number</td><td>R</td><td>16</td><td>-</td><td>-</td><td>A 16-byte string (null-terminated) of the serial identifier assigned during production.</td></tr>
<tr><td>9</td><td>User data</td><td>RW</td><td>16</td><td>16</td><td>Yes</td><td>16 bytes of user data stored and read for any purpose.</td></tr>
<tr><td>10</td><td>Token</td><td>R</td><td>2 / unit16</td><td>-</td><td>-</td><td>Next usable safety token / Current safety token.
Once used, it will expire, and a new token will be created.</td></tr>
<tr><td>12</td><td>Save parameters</td><td>W</td><td>-</td><td>2/ uint16</td><td>-</td><td>Commands written to, that must be stored and persist across power cycles will be saved to flash memory on the receipt of the latest Token (ID 10) value sent to this command.
The safety token prevents unintentional writes.
The token expires once a successful save has completed.</td></tr>
<tr><td>14</td><td>Reset</td><td>W</td><td>-</td><td>2/ uint16</td><td>-</td><td>Writing the safety token to this command will restart the sensor.</td></tr>
<tr><td>27</td><td>Distance output</td><td>RW</td><td>4/ uint32</td><td>4/ uint32</td><td>No</td><td>Configures the (44) distance data command data output. Each bit toggles the output of specified data.
<table>
<tr><th>Bit</th><th>Output</th></tr>
<tr><td>0</td><td>First return raw</td></tr>
<tr><td>1</td><td>First return filter</td></tr>
<tr><td>2</td><td>First return strength</td></tr>
<tr><td>3</td><td>Last return raw</td></tr>
<tr><td>4</td><td>Last return filter</td></tr>
<tr><td>5</td><td>Last return strength</td></tr>
<tr><td>6</td><td>Background noise</td></tr>
<tr><td>7</td><td>Temperature</td></tr>
<tr><td>8</td><td>Yaw angle</td></tr>
</table></td></tr>
<tr><td>30</td><td>Stream</td><td>RW</td><td>4/ uint32</td><td>4/ uint32</td><td>No</td><td>Serial and USB interface only.
(If used on I²C, the data will not be retrievable.)
Reading from the stream command will indicate what type of data is currently being streamed.
Writing to the stream command will set the type of data to be streamed.
<table>
<tr><th>Value</th><th>Streamed data</th></tr>
<tr><td>0</td><td>disabled</td></tr>
<tr><td>5</td><td>(44) Distance data cm</td></tr>
<tr><td>6</td><td>(45) Distance data cm</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>ID</th><th>Name</th><th>RW</th><th>Read bytes</th><th>Write bytes</th><th>Persists</th><th>Description</th></tr>
<tr><td>44</td><td>Distance data in cm</td><td>R</td><td>varies</td><td>-</td><td>-</td><td>This command contains distance data as measured by the SF45/B. The data included will vary based on the configuration of the 27. Distance output command.

This command can be read at any time however if 30. Stream is set to 5 then this command will automatically output at the measurement update rate.

The data will be packed in order based on the bits set in the Distance output parameter.
<table>
<tr><th>Data output bit</th><th>Description</th><th>Size</th></tr>
<tr><td>0</td><td>First return raw [cm]</td><td>int16</td></tr>
<tr><td>1</td><td>First return filtered [cm]</td><td>int16</td></tr>
<tr><td>2</td><td>First return strength [%]</td><td>int16</td></tr>
<tr><td>3</td><td>Last return raw [cm]</td><td>int16</td></tr>
<tr><td>4</td><td>Last return filtered [cm]</td><td>int16</td></tr>
<tr><td>5</td><td>Last return strength [%]</td><td>int16</td></tr>
<tr><td>6</td><td>Background noise</td><td>int16</td></tr>
<tr><td>7</td><td>Temperature [1/100 degC]</td><td>int16</td></tr>
<tr><td>8</td><td>Yaw angle [1/100 deg]</td><td>int16</td></tr>
</table></td></tr>
<tr><td>45</td><td>Distance data in mm</td><td>R</td><td>varies</td><td>-</td><td>-</td><td>This command contains distance data as measured by the SF45/B. The data included will vary based on the configuration of the 27. Distance output command.

The data will be packed in order based on the bits set in the Distance output parameter.
<table>
<tr><th>Data output bit</th><th>Description</th><th>Size</th></tr>
<tr><td>0</td><td>First return raw (mm)</td><td>int32</td></tr>
<tr><td>1</td><td>First return filtered (mm)</td><td>int32</td></tr>
<tr><td>2</td><td>First return strength (%)</td><td>int32</td></tr>
<tr><td>3</td><td>Last return raw (mm)</td><td>int32</td></tr>
<tr><td>4</td><td>Last return filtered (mm)</td><td>int32</td></tr>
<tr><td>5</td><td>Last return strength (%)</td><td>int32</td></tr>
<tr><td>6</td><td>Background noise</td><td>int32</td></tr>
<tr><td>7</td><td>Temperature [1/100 degC]</td><td>int32</td></tr>
<tr><td>8</td><td>Yaw angle [1/100 deg]</td><td>int32</td></tr>
</table></td></tr>
<tr><td>50</td><td>LED</td><td>RW</td><td>1/ uint8</td><td>1/ uint8</td><td>No</td><td>Reading this command will indicate the current LED state. Writing to this command will enable or disable the LED.
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0</td><td>Disabled</td></tr>
<tr><td>1</td><td>Enabled</td></tr>
</table></td></tr>
<tr><td>60</td><td>Alarm state</td><td>R</td><td>2/ uint16</td><td>-</td><td>-</td><td>Reading this command will return the current state of all alarms. Byte 0 represents the status of Alarm A and byte 2 that of Alarm B. A value of 1 as the status represents a triggered state and 0 a not triggered state
<table>
<tr><th>Byte</th><th>Description</th></tr>
<tr><td>0</td><td>Alarm A</td></tr>
<tr><td>1</td><td>Alarm B</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>ID</th><th>Name</th><th>RW</th><th>Read bytes</th><th>Write bytes</th><th>Persists</th><th>Description</th></tr>
<tr><td>61</td><td>Alarm A distance</td><td>RW</td><td>4/float32</td><td>4/float32</td><td>Yes</td><td>This command read and write the distance setting for Alarm A. This distance set-point will generate a Trigger condition for Alarm A when a distance shorter than the set value is measured by the LiDAR. This value can be adjusted with a resolution of 0.01m.</td></tr>
<tr><td>62</td><td>Alarm B distance</td><td>RW</td><td>4/float32</td><td>4/float32</td><td>Yes</td><td>This command read and write the distance setting for Alarm B. This distance set-point will generate a Trigger condition for Alarm B when a distance shorter than the set value is measured by the LiDAR. This value can be adjusted with a resolution of 0.01m.</td></tr>
<tr><td>63</td><td>Alarm hysteresis</td><td>R</td><td>4/float32</td><td>4/float32</td><td>Yes</td><td>This command read and write the hysteresis setting for both Alarm A and Alarm B. A trigger condition will be generated when the measured distance is less than the alarm set-point distance by the alarm hysteresis value. The triggered state will clear when the measured distance exceeds the alarm set-point value by the hysteresis value. This value can be adjusted with a resolution of 0.01m.</td></tr>
<tr><td>66</td><td>Update rate</td><td>RW</td><td>1/ uint8</td><td>1/ uint8</td><td>Yes</td><td>Controls the SF45/B's sampling update rate.
Reading this command will return the current update rate.
Writing this command will set the update rate.
<table>
<tr><th>Command value</th><th>Update rate samples/second</th></tr>
<tr><td>1</td><td>50</td></tr>
<tr><td>2</td><td>100</td></tr>
<tr><td>3</td><td>200</td></tr>
<tr><td>4</td><td>400</td></tr>
<tr><td>5</td><td>500</td></tr>
<tr><td>6</td><td>625</td></tr>
<tr><td>7</td><td>1000</td></tr>
<tr><td>8</td><td>1250</td></tr>
<tr><td>9</td><td>1538</td></tr>
<tr><td>10</td><td>2000</td></tr>
<tr><td>11</td><td>2500</td></tr>
<tr><td>12</td><td>5000</td></tr>
</table></td></tr>
<tr><td>79</td><td>Baud rate</td><td>RW</td><td>1/ uint8</td><td>1/ uint8</td><td>Yes</td><td>The serial baud rate used by the serial interface.
This parameter only takes effect when the serial interface is first enabled after power-up or restart.
Reading this command will return the baud rate.
Writing to this command will set the baud rate.
<table>
<tr><th>Value</th><th>Baud rate (bps)</th></tr>
<tr><td>0</td><td>9600</td></tr>
<tr><td>1</td><td>19200</td></tr>
<tr><td>2</td><td>38400</td></tr>
<tr><td>3</td><td>57600</td></tr>
<tr><td>4</td><td>115200</td></tr>
<tr><td>5</td><td>230400</td></tr>
<tr><td>6</td><td>460800</td></tr>
<tr><td>7</td><td>921600</td></tr>
</table></td></tr>
<tr><td>80</td><td>I2C address</td><td>RW</td><td>1/ uint8</td><td>1/ uint8</td><td>Yes</td><td>The I²C address value is in decimal.
Reading this command will return the I²C address.
Writing this command will set the I²C address.</td></tr>
</table>

<table>
<tr><th>ID</th><th>Name</th><th>RW</th><th>Read bytes</th><th>Write bytes</th><th>Persists</th><th>Description</th></tr>
<tr><td>85</td><td>Scan speed</td><td>RW</td><td>2/
uint16</td><td>2/
uint16</td><td>Yes</td><td>The scan speed controls the delay between each scan position. A higher value will cause the scan to take longer. A value of 5 to 2000 can be used.

Reading this command will return the scan speed. Writing this command will set the scan speed.</td></tr>
<tr><td>88</td><td>Alarm A low</td><td>RW</td><td>4/float32</td><td>4/float32</td><td>Yes</td><td>This command reads and writes the starting angle setting for Alarm A. A trigger condition for Alarm A is only possible for distances measured between the low angle and the high angle. This value can be adjusted with a resolution of 0.01deg.</td></tr>
<tr><td>89</td><td>Alarm A high</td><td>RW</td><td>4/float32</td><td>4/float32</td><td>Yes</td><td>This command reads and writes the end angle setting for Alarm A. A trigger condition for Alarm A is only possible for distances measured between the low angle and the high angle. This value can be adjusted with a resolution of 0.01deg.</td></tr>
<tr><td>90</td><td>Alarm B low</td><td>RW</td><td>4/float32</td><td>4/float32</td><td>Yes</td><td>This command reads and writes the starting angle setting for Alarm B. A trigger condition for Alarm B is only possible for distances measured between the low angle and the high angle. This value can be adjusted with a resolution of 0.01deg.</td></tr>
<tr><td>91</td><td>Alarm B high</td><td>RW</td><td>4/float32</td><td>4/float32</td><td>Yes</td><td>This command reads and writes the end angle setting for Alarm B. A trigger condition for Alarm B is only possible for distances measured between the low angle and the high angle. This value can be adjusted with a resolution of 0.01deg.</td></tr>
<tr><td>93</td><td>Stepper status</td><td>R</td><td>1/
uint8</td><td></td><td></td><td>This status feedback will indicate the current status of the stepper motor driver and scanning position status.
<table>
<tr><th>Bit nr</th><th>Description</th></tr>
<tr><td>0</td><td>Stepper Enable(1) or Disable(0)</td></tr>
<tr><td>1</td><td>Stepper Driver healthy (1) or failure(0)</td></tr>
<tr><td>2</td><td>Center Position Zero detected(1) or not(0)</td></tr>
<tr><td>3</td><td>Position accuracy lost(1) or normal(0)</td></tr>
<tr><td>4</td><td>Motor failure(1) or normal (0)</td></tr>
</table></td></tr>
<tr><td>94</td><td>Scan on startup</td><td>RW</td><td>1/
uint8</td><td>1/
uint8</td><td>Yes</td><td>This will enable(1)/disable(0) the scanning at the startup of the unit. With this enabled, the unit will automatically start scanning after startup.</td></tr>
<tr><td>96</td><td>Scan enabled</td><td>RW</td><td>1/
Uint16</td><td>1/
Uint16</td><td>No</td><td>This will enable(1)/disable(0) the scanning. With this command the scanning can be stopped and started at any time.</td></tr>
<tr><td>97</td><td>Scan position</td><td>RW</td><td>4/
uint32</td><td>4/
uint32</td><td>No</td><td>This command, when read, will indicate the current scan angle position. When the scanning is disabled with command 96. Scan enable, the angle position of the SF45/B can be changed by writing the required angle to this command.</td></tr>
<tr><td>98</td><td>Scan low angle</td><td>RW</td><td>4/
uint32</td><td>4/
uint32</td><td>Yes</td><td>This command will set the low scanning angle (counter clockwise). This value must be between -170° and -5°</td></tr>
<tr><td>99</td><td>Scan high angle</td><td>RW</td><td>4/
uint32</td><td>4/
uint32</td><td>Yes</td><td>This command will set the high scanning angle (clockwise). This value must be between 5° and 170°</td></tr>
<tr><td>150</td><td>Laser firing</td><td>RW</td><td>1/
uint8</td><td>1/
uint8</td><td>No</td><td>Reading this command will indicate the current laser firing state. Writing to this command will enable or disable laser firing.
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0</td><td>Disabled</td></tr>
<tr><td>1</td><td>Enabled</td></tr>
</table></td></tr>
<tr><td>157</td><td>Temperature</td><td>R</td><td>4/
uint32</td><td>-</td><td>-</td><td>Reading this command will return the measured temperature in 0.01 of a degree.</td></tr>
</table>

ID	Name	RW	Read bytes	Write bytes	Persists	Description
185	**Noise**	R	4/ uint32	-	-	Reading this command will return the level of measured background noise.
194	**Zero offset**	RW	4/ uint32	4/ uint32	Yes	Changing this offset value will change the Zero distance position for the output. This value is written and read in mm.
195	**Lost signal counter**	RW	1/ uint8	1/ uint8	Yes	The lost signal counter is used to determine the number of lost signal returns that needs to be generated before a lost signal indication is output on the distance value. The lost signal indication on the distance output value is -1000.

11 Firmware updates

Occasionally, LightWare will release new firmware for your sensor, to address bug fixes or introduce additional features. All registered customers will receive an email notification when new firmware is released for their LightWare sensor.

Caution: LightWare strongly advises that all LightWare sensors are kept up to date with their latest firmware revision.

You can check whether your sensor is equipped with the latest firmware and access updates directly through LightWare Studio as follows:

1. Select *Upgrade external* from the left panel.

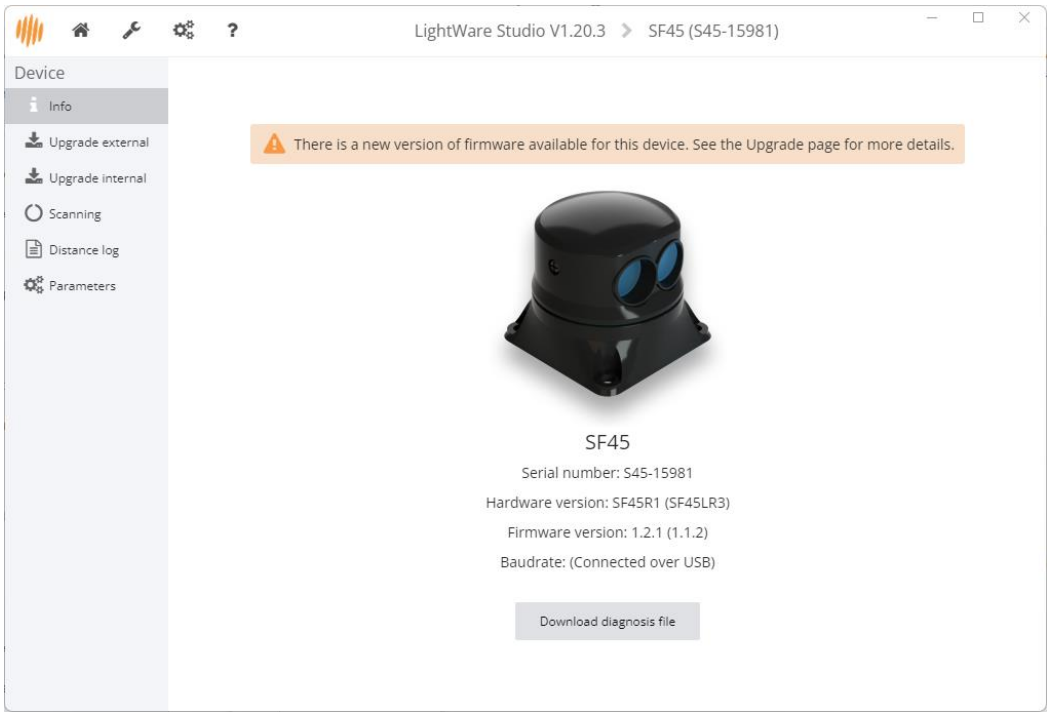

Figure 18: LightWare Studio device information page

2. The page will display the firmware version currently installed on the sensor and indicate whether any recent upgrades are available for download.

3. If you need to upgrade, click the *Install* button, and follow the instructions.

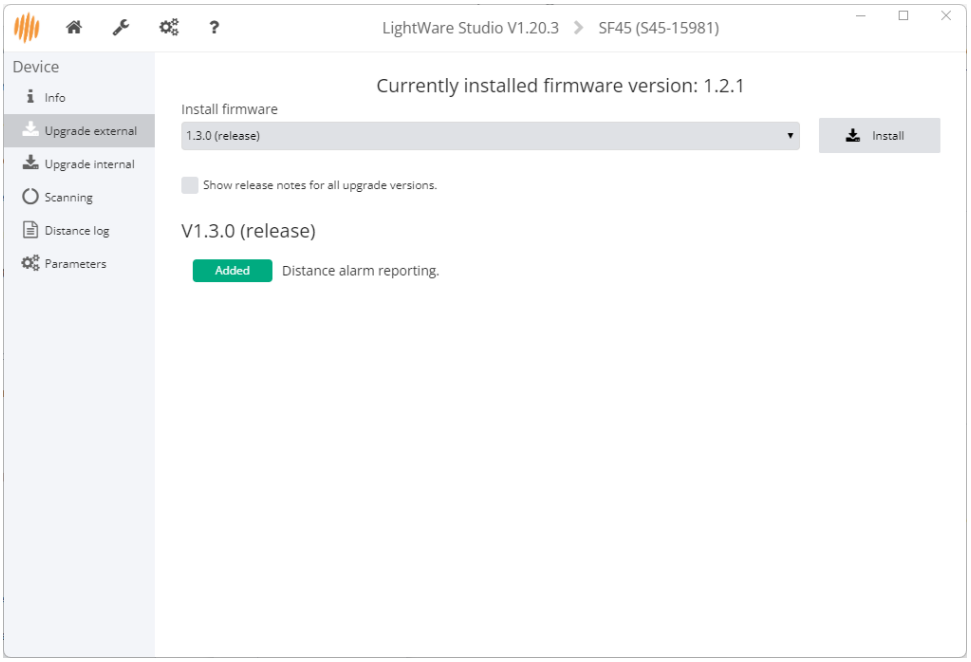

Figure 19: LightWare Studio firmware upgrade page

4. The page will display the currently installed firmware version on the sensor, and it will indicate whether any recent upgrades are available for download.

5. After selecting Install, a prompt will request permission to proceed

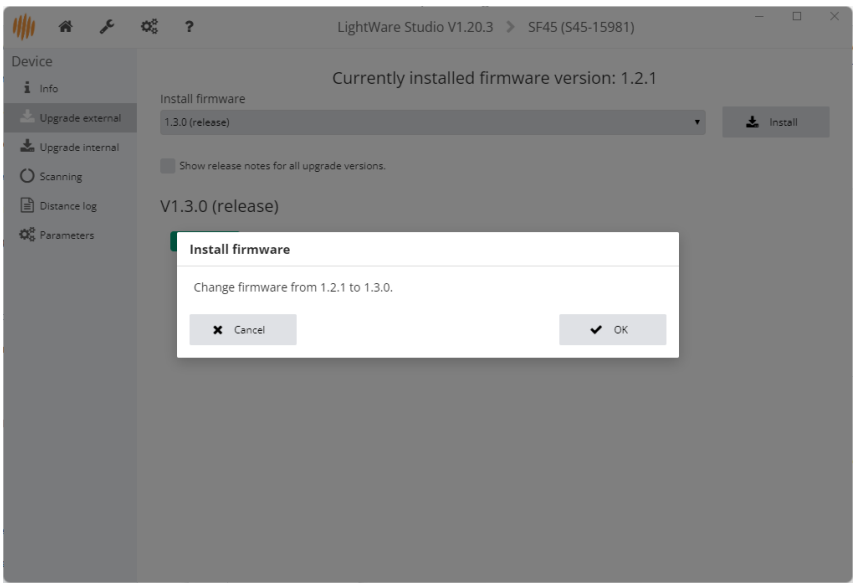

Figure 20: Confirmation of firmware upgrade

6. The firmware will be installed to your device, and the device will automatically reboot.

12 Troubleshooting

Table 13: SF45/B troubleshooting

Problem	Solution
1. Sensor outputs a short distance reading or distorted distance reading	• The sensor is receiving a signal caused by scattered light from a close-by object in the vicinity of the beam, such as a desk surface, landing gear, pole, or highly reflective object. Relocate your sensor or the object and test again.
2. Sensor outputs -1 / 230	• This is an out-of-range condition. There is no measurable object within the sensor's range.
3. Sensor is not communicating with the serial UART controller at all.	• Ensure that the sensor's baud rate is compatible with the controller. • Ensure that the sensor's TXD and RXD lines are connected to the controller's RXD and TXD lines, respectively. • If using ArduPilot or PX4, ensure that the correct parameters for sensor integration have been set. • Ensure that the sensor supply voltage is within the specified range and is not dropping below the specified minimum level. If using a separate power supply, ensure a common ground.
4. Sensor is not communicating with the I²C controller at all.	• Ensure that the sensor SDA and SCL lines are connected to the controller SDA and SCL lines, respectively. • If using ArduPilot or PX4, ensure that the correct parameters for sensor integration have been set. • Ensure that the sensor supply voltage is within the specified range and is not dropping below the specified minimum level. • If using a separate power supply, ensure a common ground.
5. Unit not rotating	• Ensure "Scan on startup" is enabled in LightWare Studio. • Ensure that the supply voltage is suffiecient. This unit has a higher current draw on startup and some USB ports may not support it.
6. Alarms not visible	• Check alarm zone distances are set correctly • Ensure that GPIO mode is set to output either alarm A or alarm B • Alarm takes time to reset, check "GPIO alarm confirmation count"
7. Sensor stops communicating during flight	• Check the power supply to the sensor. Ensure all cable connections are properly seated and secured. Check communicaton cable for any breaks
8. The sensor is running hot	• Ensure adequate ventilation and heat sinking to prevent heat build-up.
9. Motor movements are erratic	• Check that there are no obstructions preventing the required movements. • Check that the incoming power voltage is stable and not dropping below 5V

For issues not covered above, refer to the FAQs in the LightWare website resource center or contact LightWare's dedicated technical support team for assistance with remote testing of your LightWare sensor.

13 Repair and maintenance

13.1 Maintenance and calibration

The LightWare microLiDAR® sensor contains no moving parts, and **no regular maintenance** is required. The sensor **does not need regular calibration** and will remain true to specification throughout its lifespan if used as directed.

13.2 Cleaning

If the LightWare microLiDAR® lenses collect dust, use a clean, soft cloth or air compressor to remove it. The lenses are coated with an anti-reflective, non-scratch coating. Only appropriate lens cleaning materials should be used to avoid scratching the sensor's lens or damaging the coating. Keep the device free from moisture in accordance with its IP rating.

13.3 Electrical safety

- Check all electrical connections are isolated and that there are no exposed wires.
- Ensure the power supplied to the device does not exceed the maximum rated voltages specified in the technical specifications section.
- Keep the device free from moisture in accordance with the IP rating.

13.4 Service and repairs

If you experience any problems with your sensor, please contact the LightWare technical support desk for in-field diagnostics before sending the unit to LightWare. During in-field support, you may be requested to supply the device's diagnostics file, which can be downloaded from LightWare Studio from the device *Info* page.

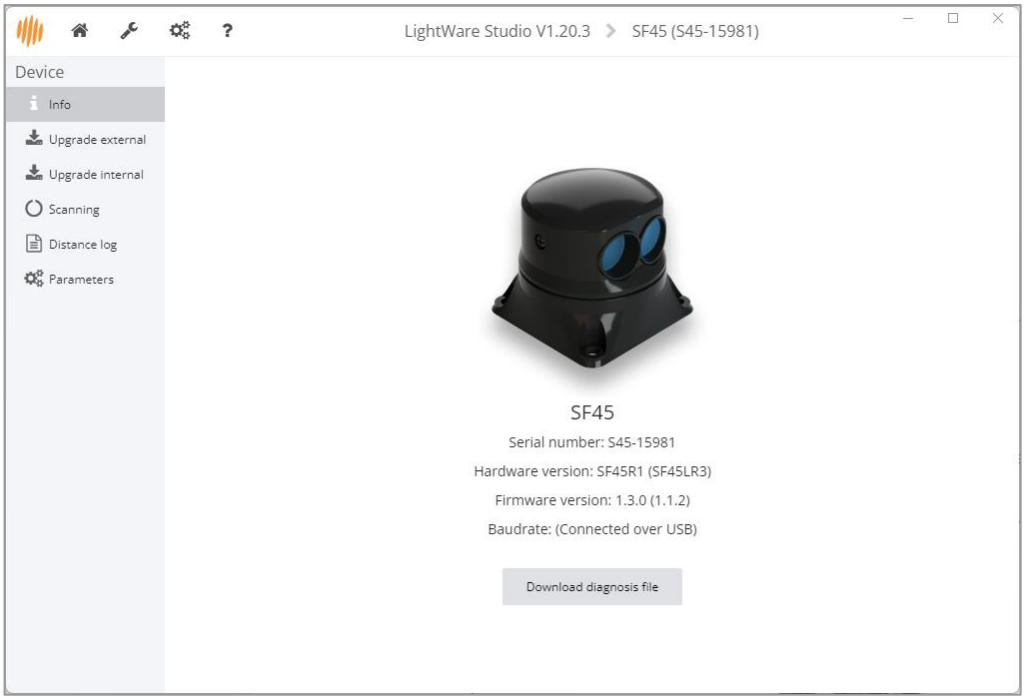

Figure 21: LightWare Studio device information page

If the unit needs to be returned to LightWare for repairs, LightWare support will assist you with the Return Merchandise Authorization (RMA) procedure.

14 End-of-life safe disposal

At LightWare, we are committed to protecting the environment and ensuring that our products have minimal impact on the planet at the end of their lifecycle. As your device reaches the end of its operational life, we encourage you to dispose of it in a responsible and environmentally friendly manner.

Please do not dispose of LightWare sensors with general household or commercial waste.

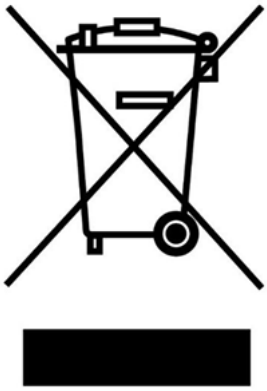

Figure 22: End-of-life disposal

LightWare sensors consist of ABS and other plastics, acrylic, and glass components, which are widely recyclable. The electronic PC board assembly should be disposed of through a reputable electronic waste recycler in your area. Alternatively, return your device to LightWare for safe disposal.

15 Document revision history

Table 14: Revision history

Revision	Date	Comments
Rev 3.1	2026/03/16	Replace figure 2 image and updated the image caption
Rev 3	2025/06/20	Major rework of the Product Guide
Rev 2	2021/07/02	Add "40. Full Speed Distance in cm" stream data
Rev 1	2020/04/14	Fix "44. Distance data in cm" links
Rev 0	2020/02/06	First edition