LeddarTech®

SOLVING CRITICAL SENSING, FUSION AND PERCEPTION CHALLENGES

Leddar™ Vu8

8 Segment Solid-State LiDAR Sensor Module

USER GUIDE

TF ID 013728

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Leddar™ Configurator software: this software is based in part on the work of the Independent JPEG Group.

Keep this User Guide for future reference.

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Version History

Version	Description	Date (YYYY-MM-DD)
54A0028_V7.0_EN	Updated Disclaimer information	2021-05-04
54A0028_V8.0_EN	• Updated to new User Guide template with corrections throughout the text, including for consistency • Complete reorganization of the document contents • Updated all screenshots as per latest software version • Added following sections: "6.13 Reset" "6.14 Serial Port Viewer" "6.15 Help" "8. Troubleshooting" "9. Maintenance" "10. Disposal"	2021-10-20

Contact Information

	LeddarTech Inc.	
Address	**Head Office**	**Production & Shipping**
	4535, boulevard Wilfrid-Hamel, **Suite 240** Québec (Québec) G1P 2J7, Canada	4535, boulevard Wilfrid-Hamel, **Suite 140** Québec (Québec) G1P 2J7, Canada
Phone	+ 1-418-653-9000 1-855-865-9900 8:30 a.m. – 5:00 p.m. EST	
Fax	+ 1-418-653-9099	
Support	support@leddartech.com	
Website	www.leddartech.com	

Document Conventions

This document uses the following conventions:

Name of menu > **name of the window**	Shows the access path to menus under each section of the Leddar™ Configurator software.
Arial bold	The names of buttons, menus, dialog boxes and the elements of the interface are in **bold type**.
	***Note:*** *Contains helpful suggestions and references to information included within this User Guide.*
	***Warning:*** *Refers to a warning or important information to follow.*

This document uses the metric system (SI).

1. Introduction

The Leddar Vu8 module enables developers and integrators to make the most of Leddar™ technology through integration in detection and ranging systems. The purpose of the Leddar Vu8 module is to be easily and rapidly integrated into various applications.

The Leddar Vu8 can be configured for elementary applications or perform more complex tasks depending on the hardware and software settings.

1.1. Description

The Leddar Vu8 module contains the following:

- Source and control assembly
- Receiver assembly

The module comes in two configurations:

1. SPI

2. USB, CAN and serial

Depending on the configuration, they offer the following features:

- Horizontal field of view (HFoV): 16°, 48° and 99°
- Vertical field of view (VFoV): 0.3°, 2° and 3°
- Eight detection segments
- Real-time data acquisition and display (through SPI)
- SPI (serial peripheral interface) for the direct link with the receiver (SPI carrier board)
- I2C interface to read the optional temperature sensor on the source module (SPI carrier board)
- Serial link interface: TTL, RS-232, RS-422 and RS-485 (USB, CAN and serial carrier board)
- USB interface (USB, CAN and serial carrier board)
- CAN bus interface for acquisition (USB, CAN and serial carrier board)

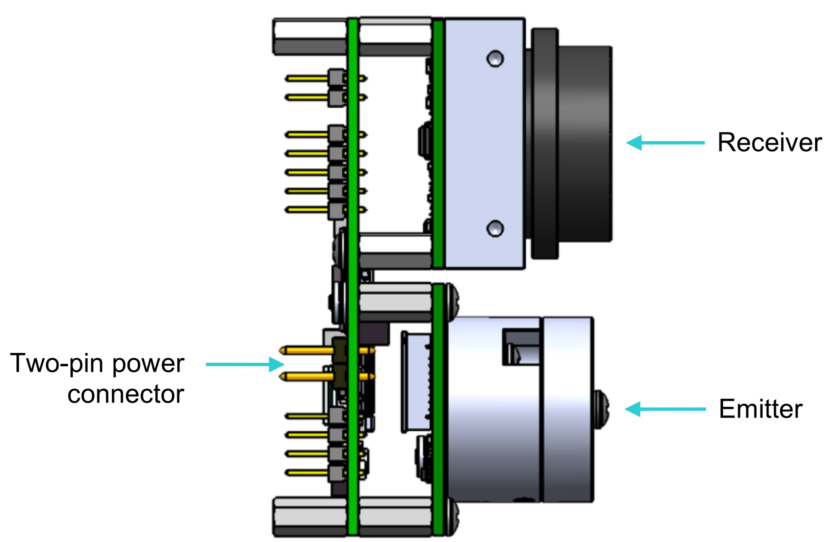

Fig. 1: Leddar Vu8 general elements

Receiver assembly

The receiver assembly contains the photodetector array (eight elements), the circuit receiver and a processor (MCU).

The module generates a full waveform per segment at its measurement rate.

	Lens coating color for 48° configuration may change from one sample to another from greenish to bluish, but the inherent properties of the lens are not affected in the field of application of this product.

Emitter assembly

The emitter assembly includes the emitter, the emitter driver circuit and the temperature sensor.

Light source pulsing is controlled by the receiver assembly since the receiver data acquisition must be synchronized with the light source pulses. The temperature sensor, located near the light source, is used to implement temperature compensation on the ranging results.

Power connection

The power connection is a two-pin connector that provides the module with a 12 V power source.

1.2. SPI Carrier Board

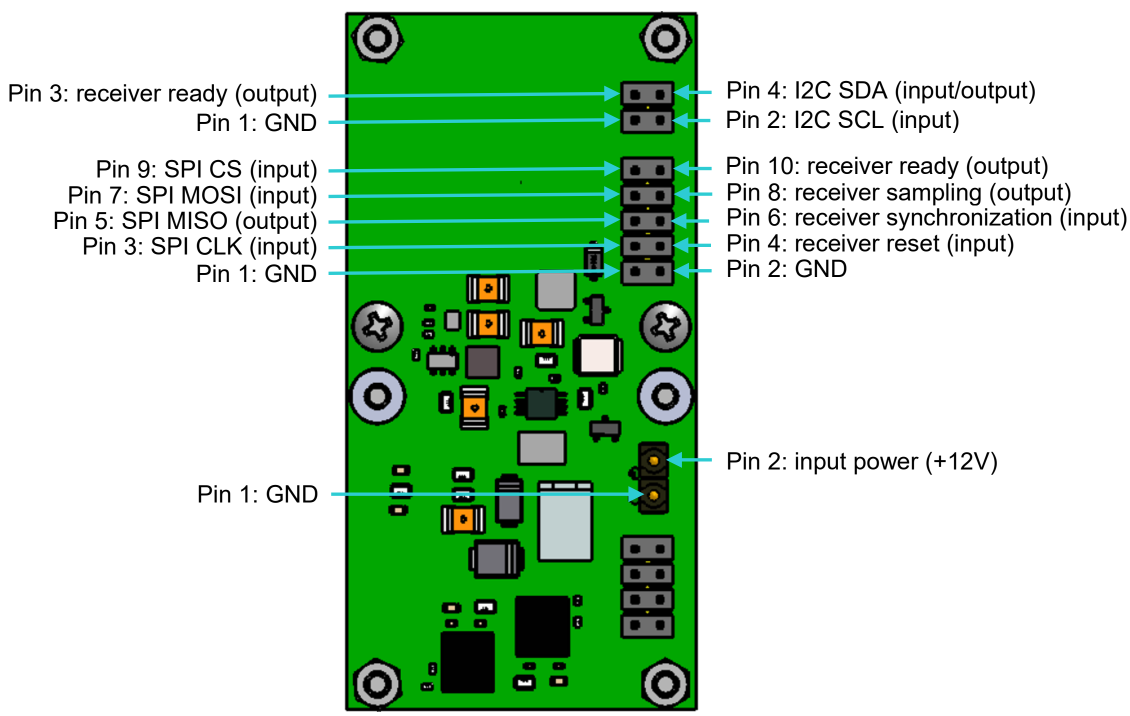

Fig. 2: Leddar Vu8 SPI carrier board

	Power outputs can supply up to 15 mA.

1.3. USB, CAN and Serial Carrier Board

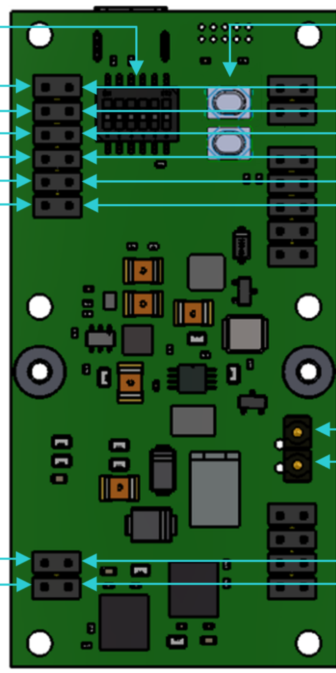

Fig. 3: Leddar Vu8 USB, CAN and serial carrier board

Power outputs can supply up to 15 mA.

DIP switches

The DIP switches are used for the configuration of serial port number 1. This port is configurable to these EIA electrical interfaces for the following standard serial communication ports:

- RS-232
- RS-485 two-wire configuration
- RS-422/RS-485 four-wire configuration

Table 1: Communication port configuration (six-position DIP switch)

Interface	DIP Switch Position					
	1	2	3	4	5	6
RS-232	OFF	OFF	ON	OFF	OFF	X
RS-485 two-wire configuration	ON	ON	OFF	ON	ON	X
RS-422/RS-485 four-wire config-uration	ON	OFF	ON	OFF	OFF	X

On all port configurations, the module is still a half-duplex slave.

Table 2: Communication port configuration (eight-position DIP switch)

Interface	DIP Switch Position							
	1	2	3	4	5	6	7	8
RS-232	OFF	ON	OFF	OFF	OFF	X	X	X
RS-485 two-wire configuration	ON	OFF	ON	ON	ON	X	X	X
RS-422/RS-485 four-wire configuration	ON	ON	OFF	OFF	OFF	X	X	X

*DIP switch position 6 on **ON** position enables a 121 Ω termination resistor to RS-485 two-wire configuration only (must be kept on OFF position in any other configuration).*

*DIP switch position 8 on **ON** position enables a 121 Ω termination resistor to CAN port.*

Configurable serial link 1

Depending on the DIP switch positions, the configurable serial link pin functionalities differ (see Table 3).

Table 3: Communication link configuration

	Interface		
Pin Position	RS-232	RS-485 two-wire configuration	RS-422/RS-485 four-wire configuration
1	GND	GND	GND
3	RTS	D-	Dout-
5	NC	NC	NC
7	Rx	D-	Din+
9	Tx	D+	Dout+
11	CTS	D-	Din-

If a two- or four-wire differential port configuration is selected, depending on the network configuration, you should put bias resistors on transmitter or receiver lines to maintain the proper idle voltage and force the line to the idle condition.

Push buttons

The S1 push button is used for hard reset purposes; a short press resets the module.

The S3 push button is used for special purposes (see Table 4).

Table 4: S3 push button functionalities

Description	Action
Long press during module operation (longer than 10 seconds)	Resets the carrier board configuration to the default values: **CAN port configuration** • 1 Mbps, standard frame format • Base Rx: 0x740 • Base Tx: 0x750 • No delay • Distance in cm and a max. of 96 echoes **Serial link configuration** • 115 200 bps, 8 bits, no parity, no flow control, 1 stop bit • Distance in cm and a max. of 40 echoes • Modbus address: 1
S3 button pressed for more than 2 seconds during startup (or after a hard reset)	Set the USB, CAN and serial carrier board to bootloader mode. This feature is used to upgrade the USB, CAN and serial carrier board firmware. Use the LeddarTech software tool to upgrade the firmware.

1.4. Working Diagram

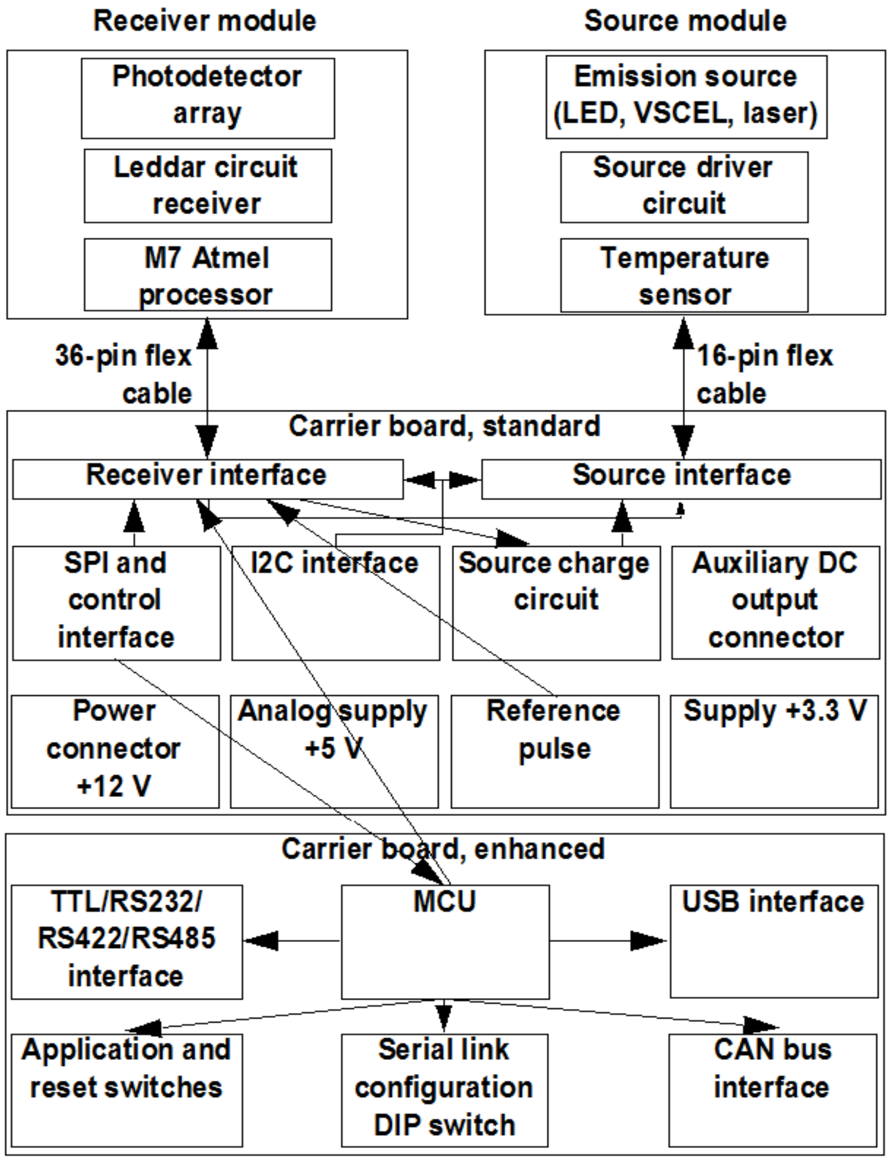

Fig. 4: Leddar Vu8 working diagram

1.4.1. SPI Carrier Board

SPI and control interface

The SPI serial port functionalities are available via pins 3, 5, 7 and 9. The port has a standard signal level of 0 V to 3.3 V.

Table 5: SPI pin definition

Pin	Function
3	CLK (input)
4	Hard reset (input)
5	MISO (output)
7	MOSI (input)
9	CS (input)

I2C interface

The Integrated Circuit (I2C) protocol is intended to allow multiple slave digital circuits to communicate with one or more master circuits. As for the SPI, it is only intended for short-distance communications. The port has a standard signal level of 0 V to 3.3 V.

Power supply

The power source includes the source, the auxiliary DC output connection, the +12 V connection, the +5 V analog supply and the +3.3 V supply.

1.4.2. USB, CAN and Serial Carrier Board

The optional carrier board includes the following:

Serial ports (TTL, RS-232, RS-422 and RS-485)

The TTL port is used for the short-range transmission of data. The port has a standard signal level of 0 V to 3.3 V.

The RS-232 is used for the transmission of data. It defines the signals connection between the data terminal equipment (such as a computer) and the data circuit-terminating equipment (such as a modem).

The RS-422 (ANSI/TIA/EIA-422-B), a four-wire configuration, specifies the electrical characteristics of the digital signaling circuit. It can transmit data at rates as high as 10 Mbits/s or may be sent on cables as long as 1500 meters. Some systems directly interconnect and may be used to extend the range of an RS-232 connection.

The RS-485 (ANSI/TIA/IEA-485) is a two- or four-wire differential serial communication port. It is often used in electrically noisy environments.

Microcontroller MCU

The source and control assembly is equipped with an MCU on the carrier board. It is provided to transmit data from the receiver module through the communication ports.

USB interface

The USB interface is a compatible 2.0, full-speed 12-Mbit/s port. This interface emulates a VCP (virtual COM port) used as a serial port.

Application and Reset switch

The Reset switch restarts the module. This can be used as an alternative to cycling the power.

Serial link configuration DIP switches

The source and control assembly is equipped with ten DIP switches. Five are used to configure serial link 1 (see Fig. 2 and Fig. 3).

CAN bus interface

The CAN bus is implemented via a differential pair. The ISO 11898 standard describes the CAN technology. The interface has a level of 3.3 V.

2. Underlying Principles

Created by LeddarTech, Leddar™ (light-emitting diode detection and ranging) is a unique sensing technology based on the laser illumination (infrared spectrum) and the time-of-flight of light principle. The light source illuminates the area of interest (pulsed typically at 10 kHz for the 48° Leddar Vu8 module) and the multichannel module receiver collects the backscattered light and measures the time taken for the light to return to the module.

An eight-channel photodetector array is used and provides multiple detections and ranging segments. Full-waveform analysis enables the detection and distance measurement of multiple objects in each segment, provided that foreground objects do not fully obscure objects behind them. Oversampling and accumulation techniques are used to provide extended resolution and range.

Fig. 5 illustrates the illumination area and detection segments. In this case, the eight segments provide a profile of the object in the beam. In other installations, the channels can be used to locate and track one or multiple objects in the beam.

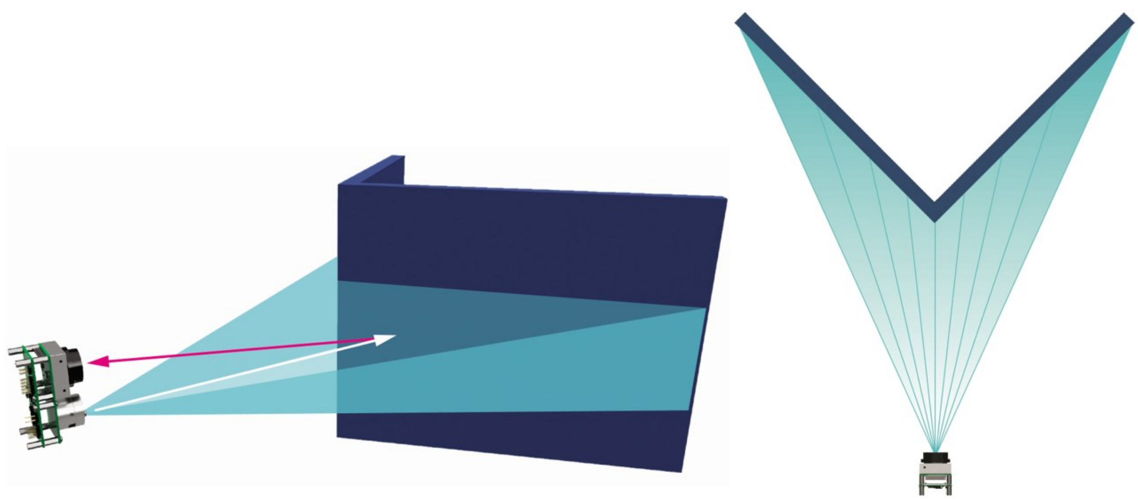

Fig. 5: Illumination area and detection zone

The core of Leddar™ sensing is the pulsing of diffused light, collection of reflected light (including oversampling and accumulation) and full-waveform analysis. The light source type, the number of light sources, the illumination and reception beam and the number of photodetectors can all be tailored to fit specific application requirements such as detection range, beam and spatial resolution.

3. Getting Started

3.1. Power Supply (Optional)

The power supply included with the Starter Kit version of the Leddar Vu8 has a pluggable terminal block that connects to the 12 V header connector of the Leddar Vu8 module. See Fig. 2 or Fig. 3 for the location of the 12 V header pin.

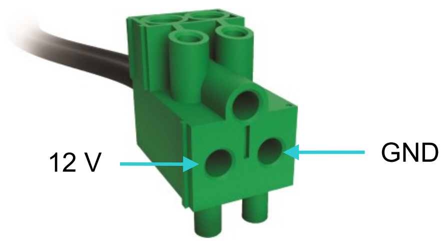

Fig. 6: Optional power supply terminal block

3.2. SPI Cable (Optional)

Table 6 below shows the pinout of the optional SPI cable sold by LeddarTech. See Fig. 2 for connection information.

Table 6: Optional SPI cable pinout

Wire Color	Function
Black	Ground
Blue	Reset_N
Orange	SCLK
Green	MISO
Yellow	MOSI
Brown	CS#

3.3. Setup

This section presents the Leddar™ Configurator installation and the procedure to set up the Leddar Vu8 module. All software operations are described in section “6. Leddar Configurator” on page 71.

To install Leddar™ Configurator:

1. Download the LeddarInstaller.exe file from our web site at www.leddartech.com/resources/#product-download/.
   a. If you are a new user, fill the form and click **Submit**.
   b. If you are a registered user, log in by entering your email address and password, then click **Log In**.
2. In the **Software Download** section, select a product, then click **LeddarInstaller.exe**. Double-click the file to start the installation.
3. On your computer desktop, double-click the **Leddar Configurator** icon.

4. In the **Welcome to the Leddar™ Software Setup Wizard** dialog box, click **Next**.

Fig. 7: Welcome dialog box

5. In the **End-User License Agreement** dialog box, read the terms of the agreement, select the **I accept the terms in the License Agreement** check box, then click **Next**.

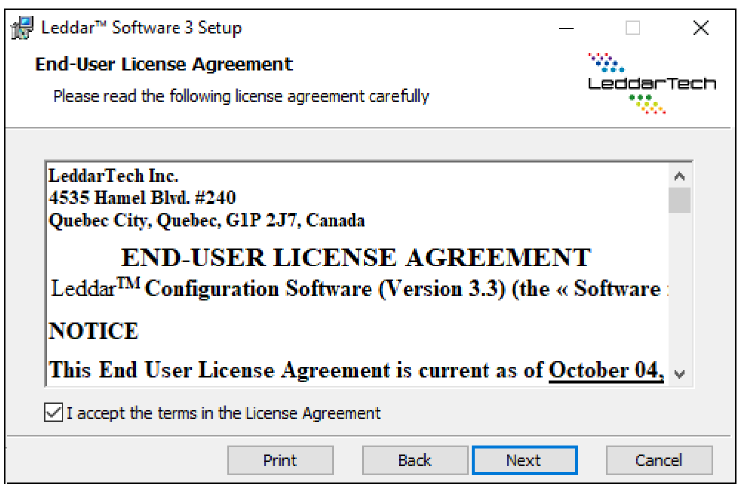

Fig. 8: End-User License Agreement dialog box

6. In the **Product Types** dialog box, the **Leddar™ Configurator** check box is selected by default.

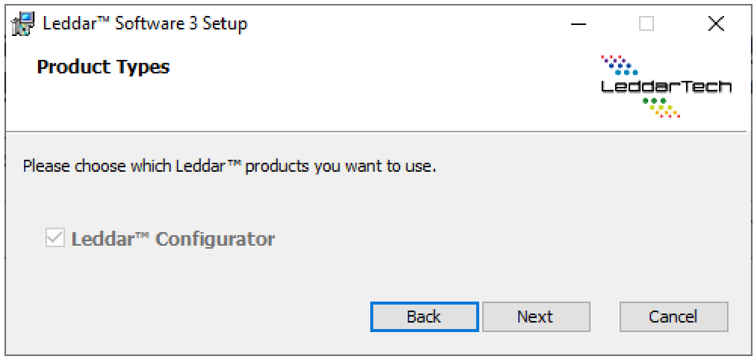

Fig. 9: Product Types dialog box

7. Click **Next**.
8. In the **Destination Folder** dialog box, click **Next** to select the default destination folder.

   OR

   Click the **Change…** button to choose a destination folder.

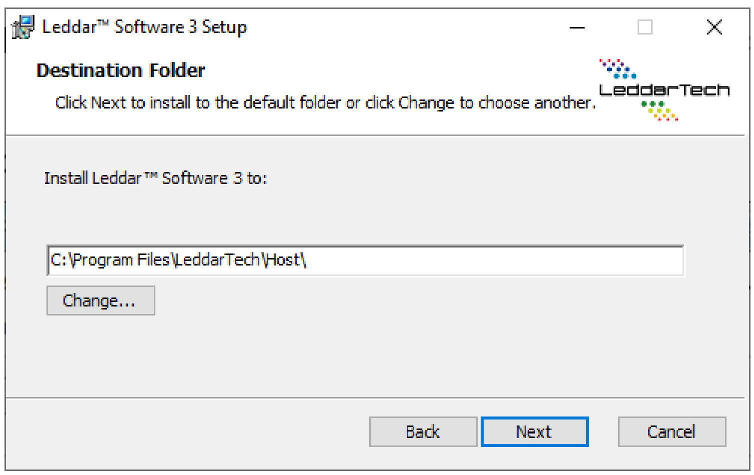

Fig. 10: Destination Folder dialog box

9. In the **Ready to Install Leddar™ Software** dialog box, click the **Install** button.

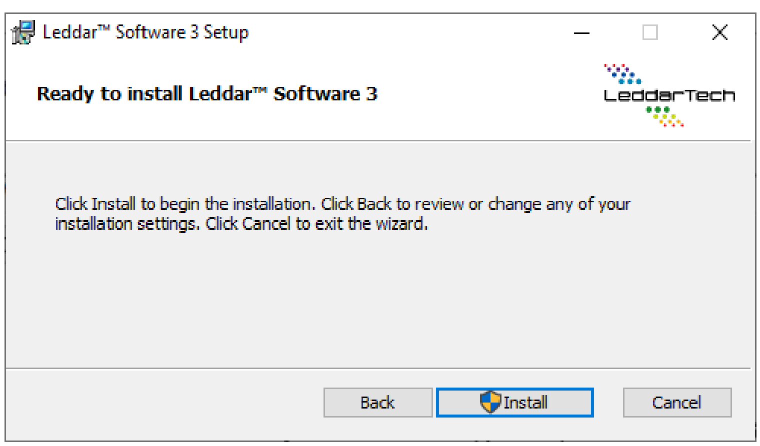

Fig. 11: Installation dialog box

10. In the **Leddar™ Setup Wizard Completed** dialog box, click **Finish**.

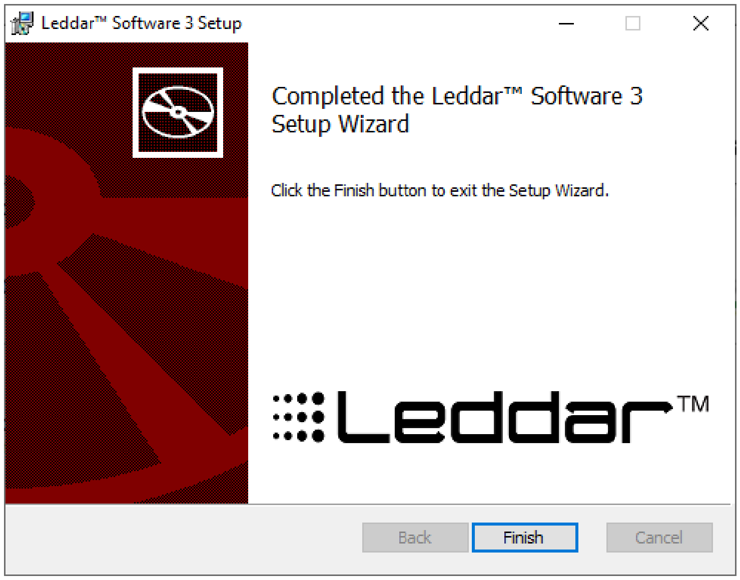

Fig. 12: Completing the installation

Leddar Configurator creates an icon on the computer desktop.

3.4. Connecting to the Module

The first time the module is connected to a computer, a few seconds are required for Windows™ to detect it and complete the installation.

Once the installation is completed, you can connect to the module.

To connect to the module:

1. Connect the power cord to the module and to a power outlet.
2. Connect the USB cable to the module and to the computer.
3. On the computer desktop, double-click the **Leddar™ Configurator** icon.
4. In Leddar Configurator, click the **Connect** icon.

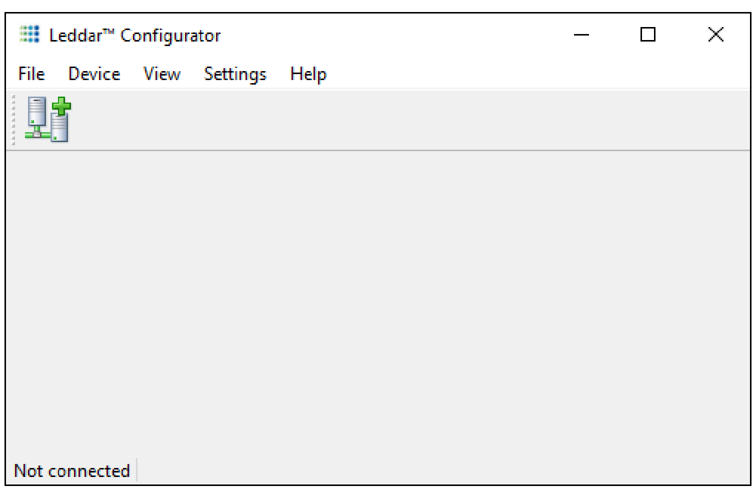

Fig. 13: Connecting to a module

5. In the **Select a connection type** list of the **Connection** dialog box, select either **Leddar Vu8 SPI** for a standard board or **Leddar Vu8 USB/Serial** for a USB, CAN and serial.

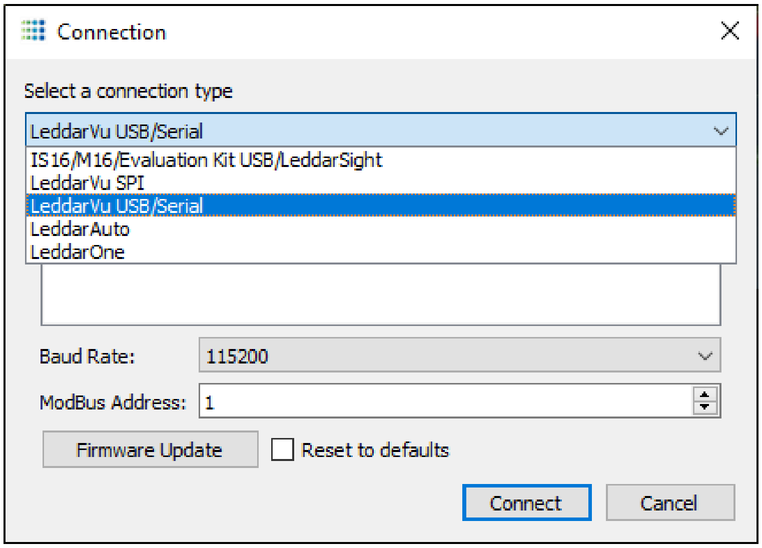

Fig. 14: Connection dialog box

6. Select the appropriate device and click the **Connect** button.

   The main window displays the detections (green lines) in the segments (white lines).

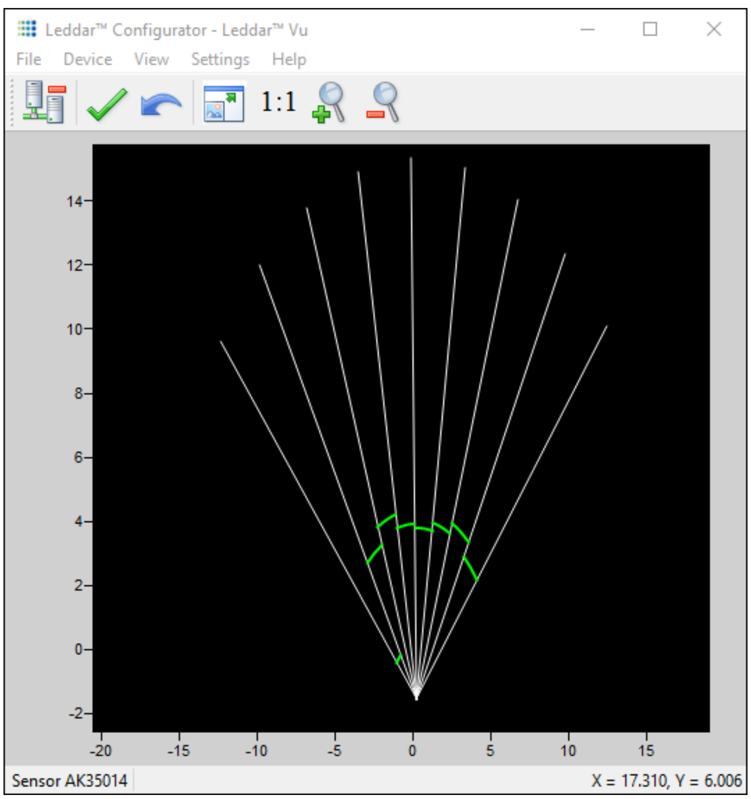

Fig. 15: Main window

A complete description of Leddar Configurator features and parameters for the Leddar Vu8 module can be found in section “6. Leddar Configurator.”

4. Measurements and Settings

4.1. Distance Measurement

Distance is measured from the base of the standoffs for the Leddar Vu8 module.

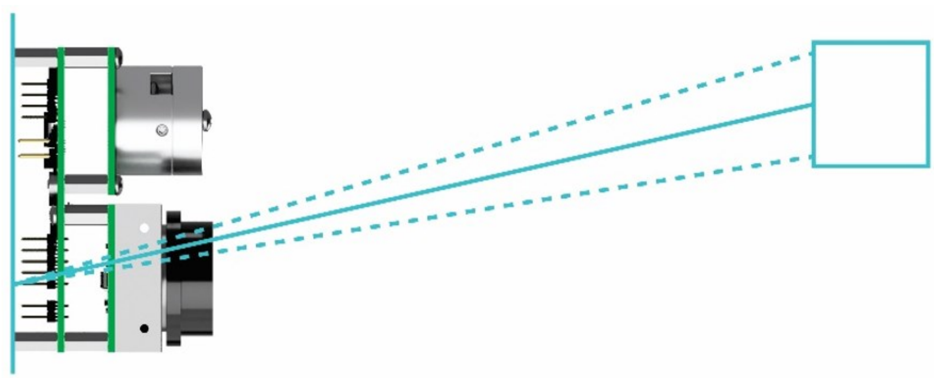

Fig. 16: Distance measurement

The dashed lines illustrate one of the eight segments and the solid line indicates the distance measured by the sensor in that segment.

4.2. Data Description

Data displayed in the **Raw Detections** dialog box allow you to precisely define the desired detection parameters (**View** menu > **Raw Detections**).

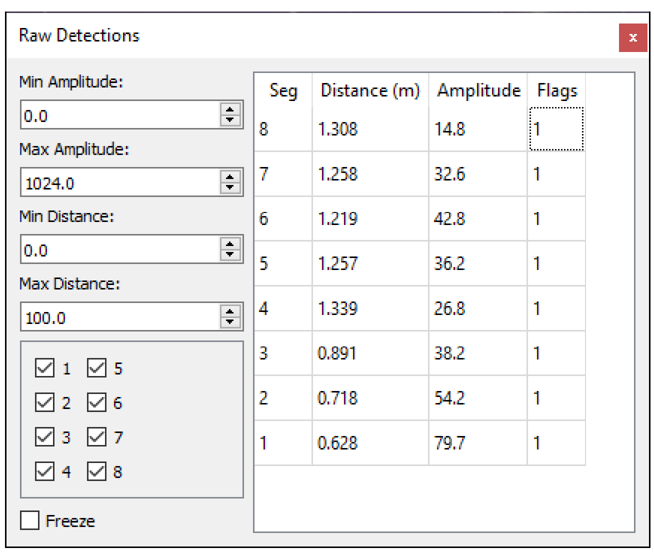

Fig. 17: Raw Detections dialog box

An object crossing the beam of the sensor is detected and measured. It is qualified by its distance, segment position and amplitude. The quantity of light reflected to the module by the object generates the amplitude. The bigger the reflection, the higher the amplitude will be.

The amplitude is expressed in counts. A count is the unit value of the used ADC in the receiver. The fractional of counts is caused by the accumulation to achieve more precision.

Table 7: Raw Detections field description

Field	Description
Segment (Seg)	Beam segment in which the object is detected
Distance	Position of the detected object
Amplitude	Quantity of light reflected by the object and measured by the sensor
Flags	8-bit status (bit field). See Table 8.

The **Flags** field provides the status information that indicates the measurement type.

Table 8: Flag value description

Bit position	Bit = 0	Bit = 1
0	Invalid measurement	Valid measurement
1	Normal measurement	Measurement is the result of demerging processing.
2	Reserved	Reserved
3	Normal measurement	Received signal is above the saturation level. Measurements are valid (VALID is set) but have lower accuracy and precision. Consider decreasing the light source Intensity value.
4	Reserved	Reserved
5	Reserved	Reserved
6	Reserved	Reserved
7	Reserved	Reserved

The **Flags** field provisions for eight bits encoded as a bit field. Three bits are currently used. The following table lists the implemented decimal values of the status bit field.

Table 9: Status value description

Status Value (Decimal)	Status Value (Binary)	Description
1	00000001	Normal measurement (valid)
9	00001001	Saturated signal (valid)

4.3. Acquisition Settings

Acquisition settings allow you to define parameters to use for detection.

To open the **Acquisition Settings** dialog box, select **Device**, then **Configuration**, then click **Acquisition**.

4.3.1. General Settings

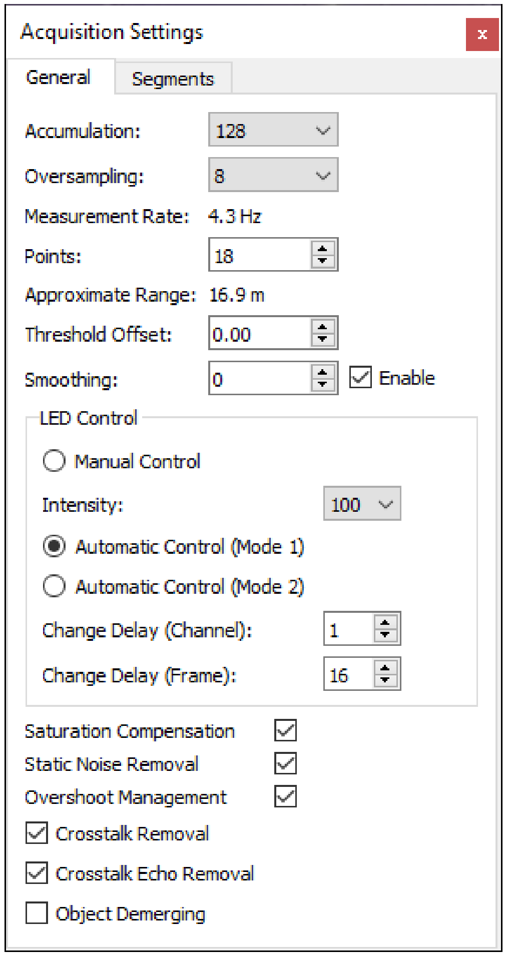

Fig. 18: Acquisition Settings dialog box – General tab

To apply new acquisition settings, click the  **Apply** icon in the main window.

Table 10: Acquisition settings description

Parameter	Description	Range
Accumulation	Number of accumulations Higher values enhance range and reduce measurement rate and noise. When you increase the accumulation value, you reduce the noise as well as the measurement rate. Depending on the application, a reduction of the noise might be more important than a high measurement rate.	1 2 4 8 16 32 64 128 256 512 1024
Oversampling[1]	Number of oversampling cycles Higher values enhance resolution (accuracy) and reduce the measurement rate. When you increase the oversampling value, you increase the resolution (accuracy) but reduce the measurement rate. Depending on the application, a higher resolution might be more important than a high measurement rate.	1 2 4 8 16 32
Points	Number of base sample points Determines the maximum detection range. The more points there are, the more they have an impact on the processing load since it impacts the number of sample points to process for each segment.	2 to 128
Threshold Offset	Modification to the amplitude threshold Higher values decrease the sensitivity and reduce the range. See below for more details.	−50.00 to 500.00
Smoothing	Object smoothing algorithm. Smooths the sensor measurements. The behavior of the smoothing algorithm can be adjusted by a value ranging from −16 to 16. Higher values enhance the sensor precision but reduce its reactivity. The smoothing algorithm can be deactivated by clearing the **Enable** check box. The measurement smoothing algorithm is advised for applications that need to measure slowly moving objects with high precision. For applications requiring to quickly track moving objects, the smoothing should be configured with a value lower than 0 or simply deactivated. See below for more details.	−16 to 16

[1] Oversampling of 1 and 2 might lead to accuracy below specification.

Parameter	Description	Range
Light Source Control	Light source power control options Allow you to select between Manual and Automatic modes. In Automatic mode, the light source power is adjusted according to incoming detection amplitudes. The current light source power level is visible in the **View** > **State** > **Device State** window. See below for more details.	100% 81% 53% 28% 6%
Change Delay (**Channel** and **Frame**)	Minimum frame delay between power changes Smaller values speed up the response time of the light source power adjustment.	Channel: 0 to 8 Frame: varies
Saturation Compensation	When selected, this parameter allows you to activate the advanced distance computation algorithm for very strong (saturated) signals. This computation uses slightly more computing power to enhance the quality of the distance measurements of saturated light pulses. The algorithm classifies the detected pulses based on their shape. The sensor determines which pulses are saturated and which have a normal shape. Saturated pulse occurs when the signal backscattered by the object is so strong that the full-waveform signal is clipped. If not treated, this phenomenon creates an important degradation of the distance measurement accuracy.	Enabled Disabled
Static Noise Removal	When selected, this parameter allows you to enhance measurements by subtracting the constant electronic noise present at the beginning of signals.	Enabled Disabled
Overshoot Management	When selected, this parameter allows you to improve the detection of false measurements caused by specific signal shapes. For example, this may occur when strongly reflecting objects are present in the field of view.	Enabled Disabled
Crosstalk Removal	Inter-channel interference noise mitigation Crosstalk is a phenomenon inherent to all multiple-segment time-of-flight sensors. It causes a degradation of the distance measurement accuracy of an object when one or more objects with significantly higher reflectivity are detected in other segments at a similar distance. This option enables an algorithm to compensate for the degradation due to crosstalk. This algorithm increases the computational load of the sensor microcontroller. It is recommended to disable the **Crosstalk Removal** option if the module is configured to run at a rate higher than 50 Hz.	Enabled Disabled
Crosstalk Echo Removal	When selected, this parameter can further increase accuracy by removing secondary echoes that might still be present in adjacent segments after applying the first stage of crosstalk removal.	Enabled Disabled

Parameter	Description	Range
Object Demerging	Near-object discrimination Allows you to ease the discrimination of multiple objects in the same segment. Object demerging is only available for measurement rates under 5.0 Hz. Also, the accumulation value must be 64 and the over-sampling value 8. The number of merged pulses that can be processed for each frame is also limited. A status field is available in the **Device State** window, indicating if the sensor processes all merged pulses. The measurement of demerged objects tends to be of lower quality than on usual detections.	Enabled Disabled

Threshold Offset

The Threshold Offset value allows you to modify the detection amplitude threshold.

A default detection threshold table was determined to provide robust detection and minimize false detections caused by noise in the input signal.

Fig. 19 presents the threshold table for a light source Intensity value of 16. This table is effective when the Threshold Offset value is 0.

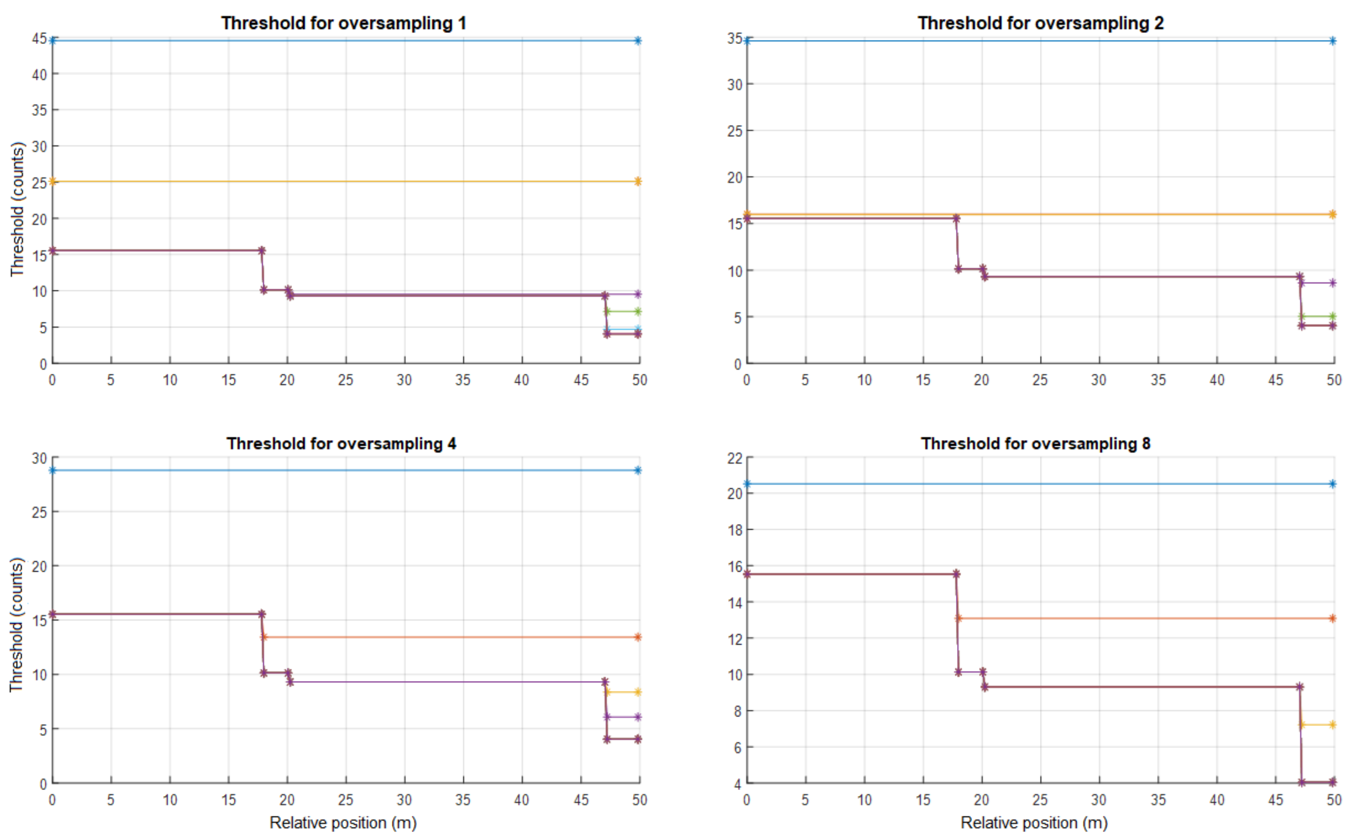

Fig. 19: Detection threshold examples

The multiple lines in each graph present the thresholds for a few accumulations of 1 (top curve), 2, 4, 8, 16, 32, 64, 128 and 256 (bottom curve). Accumulations of 512 and 1024 are also available, although not shown (provide the lowest thresholds).

The **Threshold Offset** parameter has the effect of offsetting each value in the threshold table by the selected value. This provides a means of reducing (positive value) or increasing (negative value) the sensor's sensitivity. Increasing the Threshold Offset value allows ignoring (will not result in a measurement) signals with amplitude higher than the default threshold. Decreasing the Threshold Offset value allows measurements of amplitude signals lower than the default threshold.

The default setting (0) is selected to ensure a very low occurrence of false measurements.

False measurements are likely to occur when reducing the Threshold Offset (negative values). These false measurements are very random in occurrence, while true measurements are repeatable. For this reason, it may be useful in some applications to use a higher sensitivity and filter out the false measurements at the application level. For example, this can be useful in applications that require long detection ranges or detection of small or low-reflectivity targets.

Smoothing

The smoothing algorithm increases the precision of the measurement at the cost of the sensor reactivity. The algorithm works by averaging consecutive measurements over a given time history. The history length of the filter is defined as a function of the measurement noise level. It also changes according to the oversampling and accumulation settings. The history length of the averaging filter can also be adjusted by a parameter ranging from −16 to 16. Clear the **Enable** check box to disable smoothing. Higher values increase the sensor precision but reduce its reactivity. An example of the behavior of the measurement smoothing algorithm is shown in Fig. 20 below.

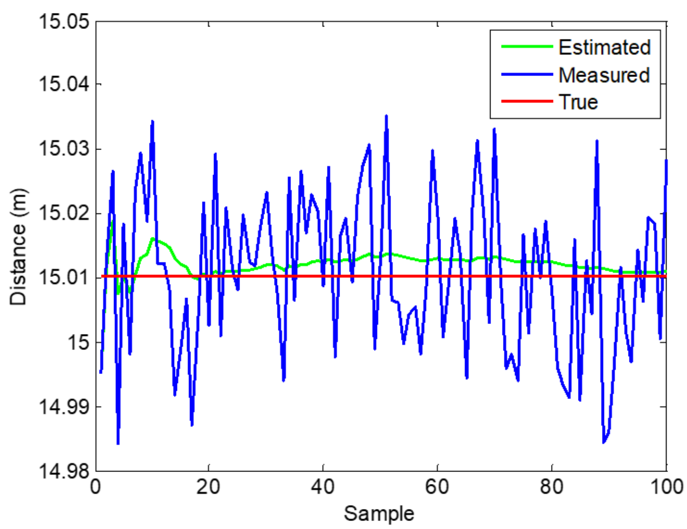

Fig. 20: Measurement smoothing example

The red line represents the true target distance, the blue curve corresponds to the target distance measured by the sensor without smoothing and the green curve denotes the smoothed measurements. Noteworthy is that the smoothing algorithm dramatically improves the measurement precision (standard deviation).

*The smoothing algorithm is recommended for applications that require highly precise measurements of slowly moving objects. For applications that track quickly moving objects, it is advised to decrease the **Smoothing** parameter's value or disable the smoothing algorithm. Clear the **Enable** check box to disable smoothing.*

Light Source Control

There are a total of five supported light source power levels. Their approximate relative power is evenly distributed between 0 and 100%.

There are three power control modes:

- Manual
- Automatic mode 1
- Automatic mode 2

With the Manual mode, the light power source of the sensor is set to a fixed value. This mode can be used in a controlled environment of sensor FoV.

For Automatic mode, the **Change Delay** parameter allows you to define the number of measurements required before allowing the sensor to increase or decrease the light source power level by one. For example, with the same Change Delay, the maximum rate of changes (per second) of the light source power will be twice higher at 12.5 Hz than at 6.25 Hz. The Change Delay can be set by the number of detection frames and the number of saturated segments that can be tolerated (Automatic mode 1 only).

> *Since the **Change Delay** parameter is a number of measurements, the delay will vary if the measurement rate is changed (through modification of the accumulation and over-sampling parameters).*

Keeping the sensor in Automatic power mode (default setting) ensures it adapts to varying environments. Close-range objects may reflect so much light that they will saturate the sensor, reducing the quality of the measurements. This mode will adapt the light output within the Change Delay setting (**Channel** and **Frame** parameters) to reach the optimal amplitude. On the other hand, low amplitudes provide lower accuracy and precision. The Automatic power mode will select a laser intensity that provides the highest intensity to avoid the saturation condition.

Automatic mode 2 will adapt the light output within the Change Delay (**Frame** parameter only) to reach at least one or more segments in saturation condition to provide the highest detection range. This mode is useful to keep the highest detection range into non-saturated segments when a strongly reflective object is detected.

> *When a strongly reflective or nearby object is present in the field of view while monitoring farther distances, the automatic adjustment will reduce the effective range of the sensor (reduced light source Intensity value) and may prevent detection of long-range or low-reflectivity objects. For these applications, Automatic mode 2 may be a better setting.*

4.3.2. Enabling and Disabling Segments

To open the **Acquisition Settings** dialog box, select **Device**, then **Configuration**, then click **Acquisition**.

Segments are enabled by default. Deactivating a segment can target what needs to be identified in a field of view. This has an impact on the measurement rate, which will be faster.

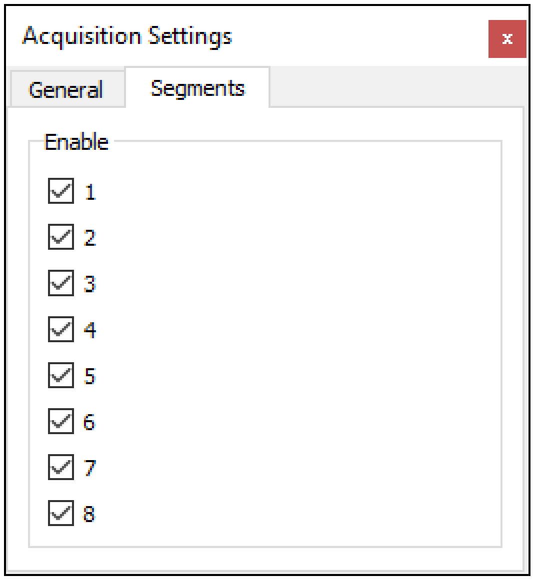

Fig. 21: Acquisition Settings dialog box – Segments tab

The corresponding segments will appear with gray square lines in the main window when you deselect segments, as shown below.

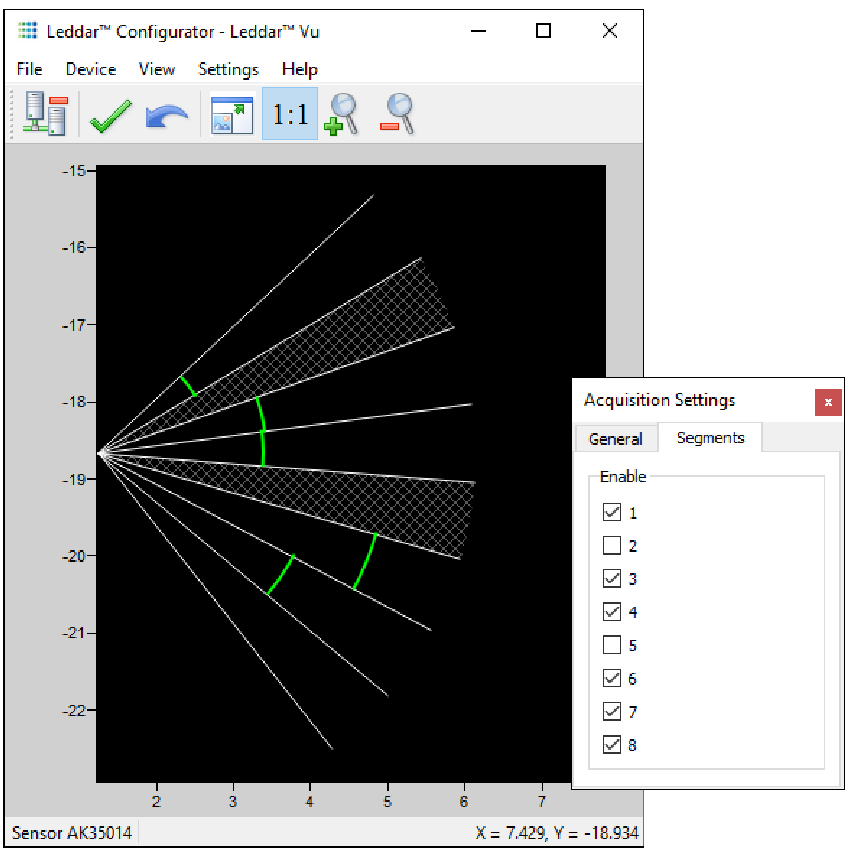

Fig. 22: Disabled segments example

To apply new acquisition settings, click the  **Apply** icon in the main window.

4.4. Measurement Rate

The Leddar Vu8 sensor acquires a base input waveform for each segment at a rate between 10 kHz and 40 kHz, depending on the sensor field of view (see Table 11).

Table 11: Base acquisition rate based on the field of view

Leddar Vu8 FoV	Base Acquisition Rate
16°	10 kHz
48°	20 kHz
99°	40 kHz

Multiple acquisitions are used to perform accumulations and oversamplings and generate a final waveform that is then processed to detect the presence of objects and measure their position.

The theoretical measurement rate is, therefore:

$$Measurement\ rate = \frac{Base\ rate}{(Number\ of\ segments\ enabled + 1) * accumulations * oversamplings}$$

For example, for a 16° Leddar Vu8 with 256 accumulations and an oversampling value of 8:

$$Measurement\ rate = \frac{10000}{(8+1) * 256 * 8} = 0.5425\ \mathrm{Hz}$$

The data processing time is not taken into account in this calculation. Hence, the actual measurement will almost always be lower than the theoretical value. The actual measurement rate depends on the complexity of the scene, and the algorithms enabled.

Refer to section “4.3.2 Enabling and Disabling Segments” on page 37 for more details.

Table 12 below shows the measurement rate for typical accumulation and oversampling values.

Table 12: Theoretical measurement rate for Leddar Vu8

Accumulation	Oversampling	Measurement Rate (Hz)		
		16° FoV	48° FoV	99° FoV
1024	8	0.1356	0.2713	0.5425
512	8	0.2713	0.5425	1.0851
256	8	0.5425	1.0851	2.1701
128	8	1.0851	2.1701	4.3403
64	8	2.1701	4.3403	8.6806
32	8	4.3403	8.6806	17.3611
1024	4	0.2713	0.5425	1.0851
512	4	0.5425	1.0851	2.1701
256	4	1.0851	2.1701	4.3403
128	4	2.1701	4.3403	8.6806
64	4	4.3403	8.6806	17.3611
32	4	8.6806	17.3611	34.7222

4.5. CPU Load

The measurement rate varies with the accumulation and oversampling settings. The higher the rate, the higher the processing load is on the source and control assembly microcontroller. The **Points** parameter, in the **Acquisition Settings** dialog box (**Device** menu, **Configuration** > **Acquisition**), also has an impact on the processing load since it affects the number of sample points to process for each segment.

Given the high flexibility of parameter settings, it is possible to create a processing load that exceeds the capacity of the microcontroller. When the microcontroller load is exceeded, the theoretical measurement rate will not be obtained.

The load (**CPU Load**) is displayed in the **Device State** window (**View** menu > **State**). It is recommended to verify the load when modifying the **Accumulation**, **Oversampling** and **Points** parameters. The measurement rate will be lower than the calculated rate, and the measurement period may be irregular when the load nears or reaches 100%.

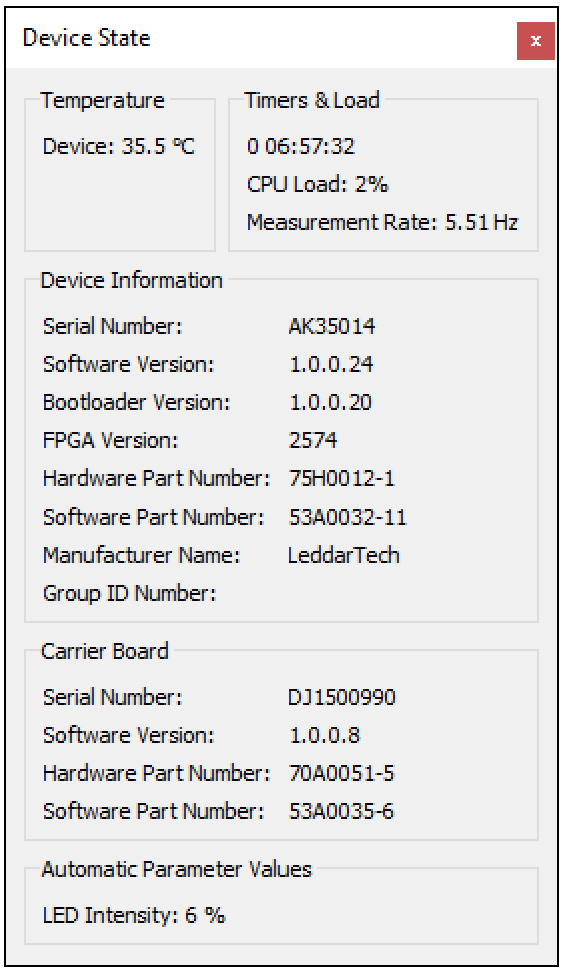

Fig. 23: Device State window

5. Communication Interfaces

The interfaces and links are optional and are implemented depending on the configuration.

5.1. SPI Interface

The SPI interface on the SPI board is a direct link to the receiver module.

The SPI interface available with the USB, CAN and serial board is a port connected to the MCU but currently not implemented.

5.1.1. SPI Basics

The SPI interface uses Configuration mode 0, where data is captured on the rising edge of the clock signal and output on the falling.

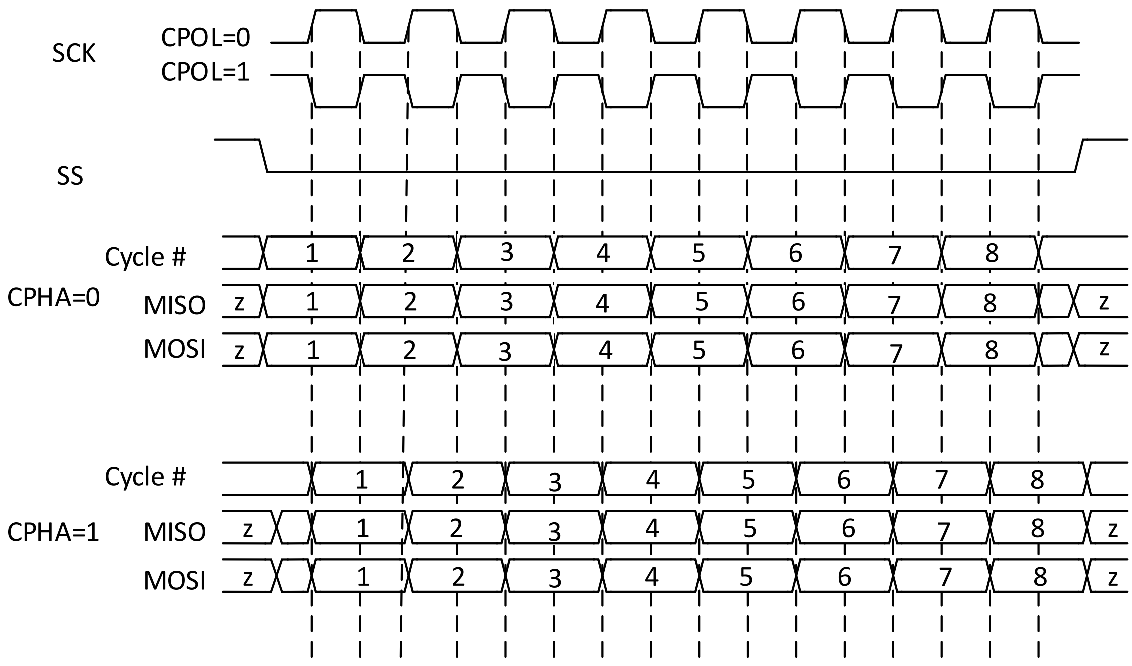

Fig. 24: Standard SPI timing diagram

Table 13 below lists the basic clock signal modes.

Table 13: Basic modes

Mode	Clock Polarity (CPOL)	Clock Phase (CPHA)
0	0	0
1	0	1
2	1	0
3	1	1

5.1.2. SPI Protocol

The universal SPI protocol uses a combination of standard commands for flash and SRAM memories.

Each SPI packet contains a header, a payload and a cyclic redundancy check (CRC).

The first byte of the header corresponds to an instruction opcode. It is followed by a 24-bit address and the 16-bit size of the payload. The payload contains several user data bytes. The last 16 bits of the packet are the CRC16 (IBM) of both the header and payload. Table 14 below summarizes the structure of an SPI packet. Noteworthy is that the address and the CRC are packed with the most significant byte first, while the first byte of data corresponds to the least significant byte.

Table 14: Byte offsets

Field	Opcode	Address			Size		Data			CRC16	
Byte offset	1	2	3	4	5	6	7	…	7 + n	8 + n	9 + n

The supported opcodes are listed in Table 15 below.

Table 15: SPI opcode commands

Mnemonic	Opcode	Operation	Description
READ	0x0B	Read data	The “Read” command returns data from memory starting at the selected address. It needs a delay between the group containing the opcode, address and size data, and the return data stream to let the receiver module decode the request and get the ready data to the clock.
WRITE	0x02	Write data	The “Write” command writes data to memory starting at the selected address and is limited to a page of 1 to 512 bytes.
CE	0xC7	Reset configuration	The “Reset” command resets the module to the default configuration. The process is started on de-assert of nCS and the write-enable flag in the status register must be asserted.
RDSR	0x05	Read status register	The “Read status” command returns a byte of the status register and bit-field flags (see Table 16).
WREN	0x06	Write enabled	The “Write enabled” command disables the write protection to modify any parameters.
WRDIS	0x04	Write disabled	The “Write disabled” command enables the write protection to lock the module from any parameter changes.
SOFTRST	0x99	Software reset	The “Software reset” command resets the receiver module.

The status register and bit flags are listed in Table 16 below.

Table 16: Status register

Bit	Name	Access	Description
7:2	Reserved	R/W	Reserved for future use
1	Write enable latch	R	0 = Write disabled 1 = Write enabled
0	Module ready	R	0 = Module ready 1 = Module busy (programming, erasing)

Data chronograms are shown in Fig. 25 and Fig. 26 below, while opcode and register chronograms are shown in Fig. 27 and Fig. 28.

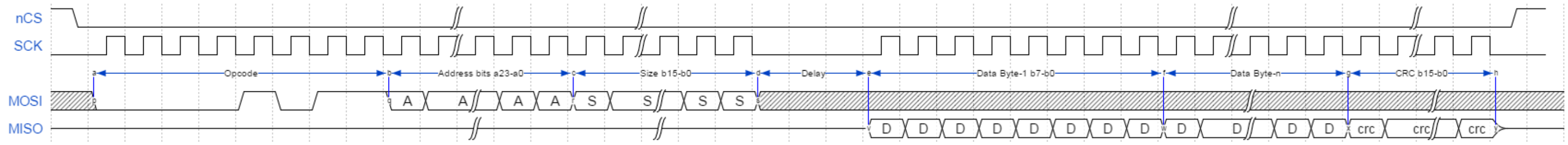

Fig. 25: Read-data chronogram

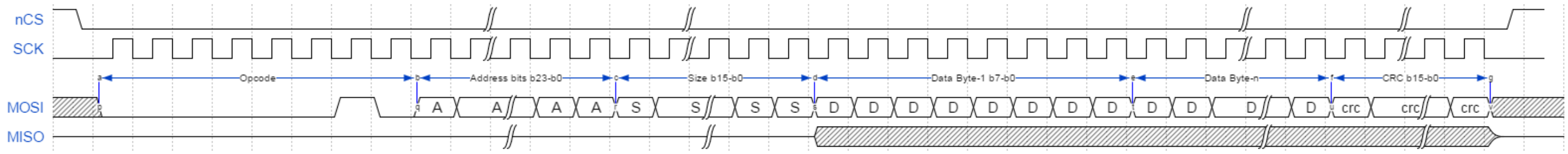

Fig. 26: Write-data chronogram

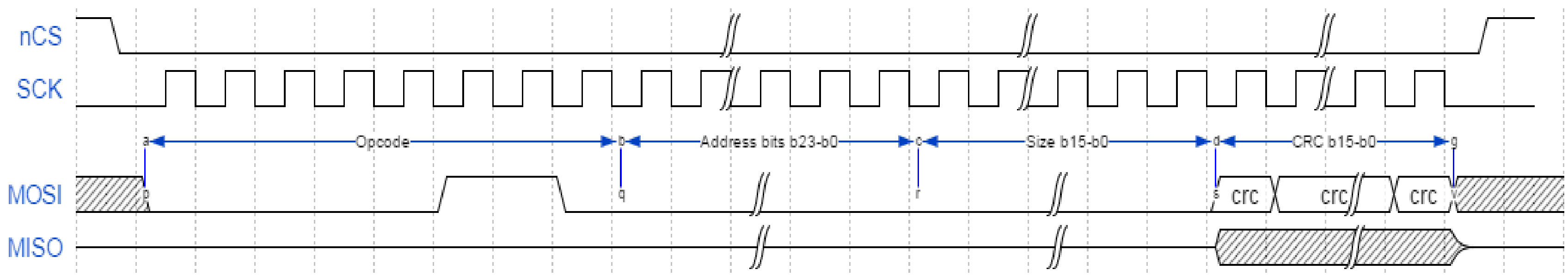

Fig. 27: Single-opcode chronogram (write-enabled example)

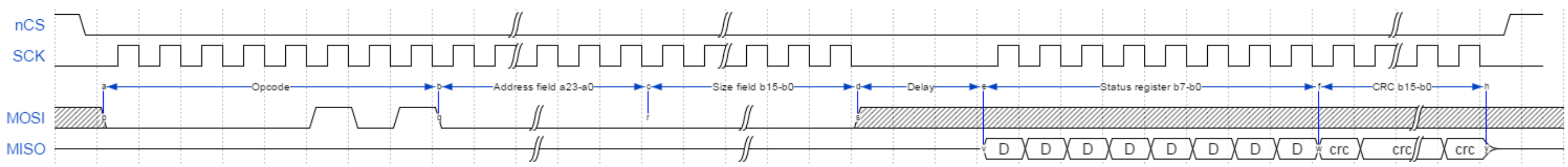

Fig. 28: Read status register chronogram

5.1.3. Memory Map

The memory map is divided into four memory banks. This section describes the four memory banks in a table format.

Table 17: Memory banks

Bank Number	Start Base Address	Bank Size (kB)	Access	Description
0	0x00000000	1024	R/W	Configuration data
2	0x00200000	512	R/W	Configuration data
6	0x00400000	128	Read-only	General device information and constants
10	0x00480000	128	R/W	General status
12	0x004C0000	128	R/W	Leddar Vu8 status
14	0x00500000	1024	Read-only	Detection list
21	0x00FFFB00	1	R/W	Transaction configuration

Configuration data

Table 18: Configuration data bank

Offset	Length	Type	Description
0	32	char	Module name as an ASCII string
32	1	uint8_t	Accumulation exponent: for example, $3 = 2^3 = 8$
33	1	uint8_t	Oversampling exponent: for example, $3 = 2^3 = 8$
34	1	uint8_t	Base point sample
35	4	uint32_t	Bit field of segment enabled
39	4	uint32_t	Acquisition rate of the reference pulse
43	4	float	Yaw angle of the module
47	4	float	Pitch angle of the module
51	4	float	Roll angle of the module
55	4	float	X-axis position of the module
59	4	float	Y-axis position of the module
63	4	float	Z-axis position of the module
67	1	int8_t	Precision (smoothing): stabilizes the sensor measurements. The behavior of the smoothing algorithm can be adjusted by a value ranging from –16 to 16.
68	1	uint8_t	Precision enabled
69	1	uint8_t	Saturation compensation enabled
70	1	uint8_t	Overshoot management enabled

Offset	Length	Type	Description
71	4	int32_t	Sensitivity (detection threshold) setting expressed in a raw amplitude scale
75	1	uint8_t	Light source power (0 to 100)
76	1	uint8_t	Auto light source power: 0 = Disabled 1 = Mode 1 2 = Mode 2
77	2	uint16_t	Auto frame average: changes the delay in the number of measurements. This is the responsivity of the auto light source power according to the number of frames.
79	1	uint8_t	Auto detections average: number of detections for saturation acceptance (the number of detections can be saturated to avoid decreasing the light source power when using the Automatic mode). This is the responsivity of the auto light source power according to the number of detections.
80	1	uint8_t	Object demerging enabled
81	1	uint8_t	Static noise removal enabled

Product configuration

Table 19: Product configuration data bank

Offset	Length	Type	Description
0	1	uint8_t	Crosstalk removal enabled
1	1	uint8_t	Crosstalk echo removal enabled

Device information and constants

Table 20: Device information and constants bank

Offset	Length	Type	Description
0	32	char	Module part number as an ASCII string
32	32	char	Software part number as an ASCII string
64	32	char	Module serial number as an ASCII string
96	32	char	Manufacturer name as an ASCII string
128	32	char	Group identification number as an ASCII string
160	32	char	Build date as an ASCII string
192	32	char	Firmware version as an ASCII string
224	32	char	Bootloader version as an ASCII string
256	32	char	ASIC version as an ASCII string (optionally filled according to the module)
288	32	char	FPGA version as an ASCII string

Offset	Length	Type	Description
320	2	uint16_t	Module type: 0x00000000 = Invalid device 0x00000007 = M16 Evaluation Kit 0x00000008 = IS16 0x00000009 = M16 0x0000000A = LeddarOne 0x0000000D = Leddar Vu8
322	4	uint32_t	Internal use
326	1	uint8_t	Accumulation exponent min.
327	1	uint8_t	Accumulation exponent max.
328	1	uint8_t	Oversampling exponent min.
329	1	uint8_t	Oversampling exponent max.
330	1	uint8_t	Base point sample min.
331	1	uint8_t	Base point sample max.
332	2	uint16_t	Number of vertical segments
334	2	uint16_t	Number of horizontal segments
336	2	uint16_t	Number of reference segments
338	4	uint32_t	Base point sample distance
342	4	uint32_t	Reference segment mask: bit-field mask indicates the position of the reference segments.
346	2	uint16_t	Number of samples max.
348	1	uint8_t	Internal use
349	4	uint32_t	Clock frequency
353	1	uint8_t	Maximum number of detections per segment
354	4	uint32_t	Distance scale
358	1	uint8_t	Raw amplitude scale bit, to which 0xd must be added (amplitude scale given in bitshift). I.e., raw amplitude << (scale bit + 0x0d).
359	4	uint32_t	Raw amplitude scale, to which the value 8192 must be added.
363	2	int16_t	Precision min.
365	2	int16_t	Precision max.
367	4	int32_t	Sensitivity min.
371	4	int32_t	Sensitivity max.
375	1	uint8_t	Current light source power count (max. 16)
376	2	uint16_t	Auto frame average min.
378	2	uint16_t	Auto frame average max.
380	1	uint8_t	Auto light source power percent min.

Offset	Length	Type	Description
381	1	uint8_t	Auto light source power percent max.
382	1	uint8_t	Auto detections average min.
383	1	uint8_t	Auto detections average max.
384	1	uint8_t	Static noise calibration source: 0 = By end user 1 = By factory
385	4	uint32_t	CPU load scale
389	4	uint32_t	Temperature scale

Leddar Vu8 device information and constants

Table 21: Device information and constants

Offset	Length	Type	Description
0	1	uint8_t	Sensor temperature scale exponent Sensor temperature scale = 2^ contents of this register

General status

Table 22: General status

Offset	Length	Type	Description
0	1	uint8_t	Detection ready flag: for Polling mode, detections are ready to be read if set to 1.
37	4	uint32_t	CPU load %CPU load = contents of this register / CPU load scale
75	4	uint32_t	Binary CRC32

Leddar Vu8 status

Table 23: Leddar Vu8 status

Offset	Length	Type	Description
0	4	uint32_t	Sensor temperature Temperature = contents of this register / (2^ sensor temperature scale exponent)

Detection list

Table 24: Detection list bank

Offset	Length	Type	Description
0	4	uint32_t	Timestamp in ms since power-up
4	2	uint16_t	Number of detections (N)

Offset	Length	Type	Description
6	2	uint16_t	Current percentage of light source power
8	4	uint32_t	Acquisition options
12	N* detection structure size	Array of detection structure	Start of detection list array See Table 25 for details.

Detection structure size

Table 25: Detection structure size

Offset	Length	Type	Description
0	4	uint32_t	Distance expressed in distance scale To convert to meters, the distance must be divided by the distance scale.
4	4	uint32_t	Amplitude expressed in raw amplitude scale To convert the amplitude to counts, it must be divided by the amplitude scale. Amplitude = contents of this register / (amplitude scale register + 8192)
8	2	uint16_t	Segment number
10	2	uint16_t	Bit-field detection flag: Bit 0: Detection is valid (will always be set) Bit 1: Detection is the result of object demerging Bit 2: Reserved Bit 3: Detection is saturated Bit 4: Reserved Bit 5: Reserved Bit 6: Detection is within the crosstalk zone Bit 7: Reserved

Transaction configuration

Table 26: Transaction configuration bank

Offset	Length	Type	Description
0	1	uint8_t	Secure-transaction enabled flag: 1 = Enables the CRC calculation and validation on any transaction. This flag is enabled by default. 0 = No CRC validation. The CRC field is still required in SPI protocol but can be set to any value.

Offset	Length	Type	Description
1	1	uint8_t	Transaction mode: 0 = Free run. The READY pin is asserted on each ready detection frame. The host must be able to read data on time. 1 = Blocking read. On the READY pin assertion, host must read all data from traces or detections bank (data transaction control source configuration) to continue acquisition. 2 = Partial blocking read. On the READY pin assertion, host can read all data from traces of the detection bank and the acquisition is still running. Possible loss of detection frames if the host reading data is very long.
2	2	uint16_t	CRC of the last transaction
4	2	uint16_t	Bit-field information of last transactions: All bits to 0: No transaction error Bit 0: Access right violation Bit 1: Invalid address Bit 2: Command not found Bit 3: Write disabled Bit 4: CRC failed Bit 5: Command execution error Bit 6: Invalid packet
6	1	uint8_t	Data transaction control source: 0 = On trace 1 = On detections This register determines which data type will control the READY pin and manage the transaction mode.

5.1.4. SPI Operation

The SPI operation includes four parameters: SPI port configuration, speed and timing, access and modification.

5.1.4.1. SPI Port Configuration

The SPI port must be configured in the 0 mode (see section “5.1.1 SPI Basics” on page 41) to communicate with the receiver module.

5.1.4.2. Sensor Hard Reset

A hard-reset pin is available to reboot the sensor. The standard hard reset chronogram is shown in Fig. 29 below: the nCS must not be asserted during this reset sequence. The minimum reset state time (Trst) is 1 millisecond. The minimum wait time after reset state release (Twait) is 100 milliseconds.

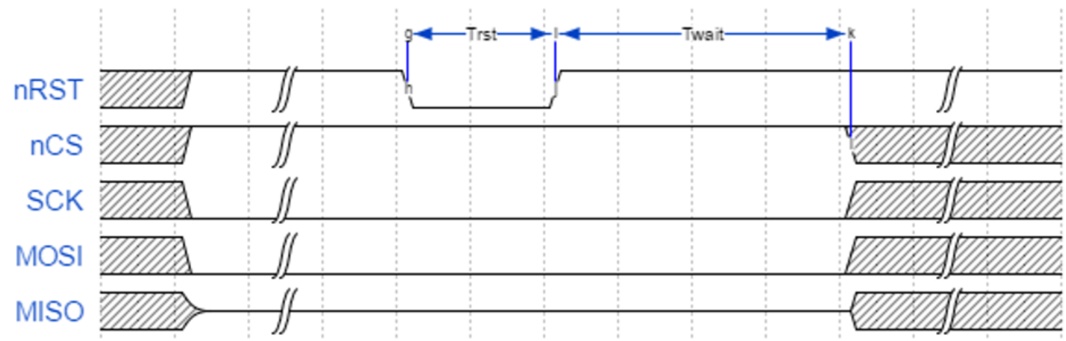

Fig. 29: Standard hard reset chronogram

To prevent the receiver module to go into bootloader mode, the port must never have all SPI input pins (nCS, MOSI and CLK) set to the low level for more than 100 milliseconds at power-up or when performing a hard reset.

5.1.4.3. Speed and Timing

For the read operation, a delay is needed between the header (group containing the opcode, address and size data) and the return data stream to let the receiver module decode the request and get the ready data to the clock. This delay can be set to 1 millisecond. During this delay, the SPI clock must be halted and the nCS must be staying asserted (see Fig. 25).

The SPI clock frequency can be in the range between 500 kHz and 25 MHz.

5.1.4.4. Access

To access a parameter, you need to add a parameter offset to the associated bank start base address. Use the parameter length to get or set the whole parameter field.

5.1.4.5. Modification

To modify a parameter:

1. Disable the write protection of the module by sending the “Write enabled” command.
2. Poll the status register to get the ready state and write enabled flag asserted.
3. Send the new parameter value.
4. Poll the status register to get the ready state.
5. Send the “Write disabled” command (write protection) to prevent any unwanted parameter change.

To prevent any data corruption or loss after modifying a parameter or a firmware update, the module must be in the ready state before shutting it down or doing a hard reset.

5.2. I2C Interface

The I2C interface on the SPI board is a direct link to the receiver and source modules. For the moment, only the temperature sensor is accessible. Refer to the LM75BIMM-3/NOPB temperature sensor data sheet from Texas Instruments.

The I2C interface available with the enhanced board is a port connected to the MCU but currently not implemented.

5.3. USB Interface

The USB interface available with the USB, CAN and serial board is a VCP (virtual COM port) serial emulation port. This port is used as a serial link with the Modbus protocol (see section 5.4 below). This interface can also be used to update the USB, CAN and serial board firmware in bootloader mode.

5.4. Serial Link Interface

The serial links can be of the following electric signals: TTL, RS-232, RS-422 and RS485.

The serial link ports use the Modbus protocol using the RTU transmission mode only. This section describes the commands that are implemented.

For more information on the Modbus protocol, go to www.modbus.org.

Read input register (function code 0x4)

The following table lists the registers for the "Read input" commands.

Table 27: Read input register message

Address	Description
1	Detection status for Polling mode: 0 = Detections not ready 1 = Detections ready: this status flag is reset to 0 after reading this register
2	Number of segments (N)
11	Number of detections
12	Current percentage of light source power
13	Bit field of acquisition status: Reserved.
14	Low 16 bits of timestamp (number of milliseconds since the module was started)
15	High 16 bits of timestamp
16 to 16 + N-1	Distance of the first detection for each segment, zero if no detection in a segment. The distance unit is defined by the serial port parameters.
16 + N to 16 + (2*N) – 1	Amplitude of first detection for each segment times 64 (i.e., amplitude = this register / 64), zero if no detection in a segment
16 + (2*N) to 16 + (3*N) – 1	Flag of the first detection for each segment: Bit 0: Detection is valid (will always be set) Bit 1: Detection is the result of object demerging Bit 2: Reserved Bit 3: Detection is saturated Bit 4: Reserved Bit 5: Reserved Bit 6: Detection is within the crosstalk zone Bit 7: Reserved
16 + (3*N) to 16 + (4*N) – 1	Distance of the second detection for each segment

Address	Description
16 + (4*N) to 16 + (5*N) – 1	Amplitude of the second detection for each segment
16 + (5*N) to 16 + (6*N) – 1	Flag of the second detection for each segment
16 + (6*N) to 16 + (7*N) – 1	Distance of the third detection
16 + (7*N) to 16 + (8*N) – 1	Amplitude of the third detection
16 + (8*N) to 16 + (9*N) – 1	Flag of the third detection
16 + (9*N) to 16 + (10*N) – 1	Distance of the fourth detection
16 + (10*N) to 16 + (11*N) – 1	Amplitude of the fourth detection
16 + (11*N) to 16 + (12*N) – 1	Flag of the fourth detection
16 + (12*N) to 16 + (13*N) – 1	Distance of the fifth detection
16 + (13*N) to 16 + (14*N) – 1	Distance of the fifth detection
16 + (14*N) to 16 + (15*N) – 1	Flag of the fifth detection
16 + (15*N) to 16 + (16*N) – 1	Distance of the sixth detection
16 + (16*N) to 16 + (17*N) – 1	Amplitude of the sixth detection
16 + (17*N) to 16 + (18*N) – 1	Flag of the sixth detection

As per the Modbus protocol, register values are returned in big-endian format.

For an example of a 0x04 Modbus function (read input register), refer to Appendix A on page 104.

Read holding register (function code 0x3), write register (function code 0x6), write multiple register (function code 0x10) and read/write multiple register (function code 0x17)

The following table lists the registers for these commands (see section 4.3 for a more detailed description of parameters).

Table 28: Read holding register message definition

Address	Description
0	Exponent for the number of accumulations (i.e., if the content of this register is n, 2^n accumulations are performed)
1	Exponent for the number of oversamplings (i.e., if the content of this register is n, 2^n oversamplings are performed)
2	Number of base samples
3	Reserved
4	Detection threshold as a fixed-point value with a 6-bit fractional part (i.e., the threshold value is this register divided by 64)

Address	Description
5	Light source power as a percentage of maximum. A value above 100 is an error. If a value is specified that is not one of the predefined values, the closest predefined value will be used. Refer to the detection reading to verify the light source Intensity value as shown in Table 27 and Table 31.
6	Bit field of acquisition options: Bit 0: Automatic light source power enabled Bit 1: Object demerging enabled Bit 2: Static noise removal enabled Bit 3: Precision (smoothing) enabled Bit 4: Saturation compensation enabled Bit 5: Overshoot management enabled Bit 6: Automatic light source power mode: 0 = Mode 1 1 = Mode 2 Bit 7: Crosstalk removal enabled Bit 8: Crosstalk echo removal enabled
7	Auto light source power change delay in number of measurements
8	Reserved
9	Number of echoes for saturation acceptance: the number of echoes can be saturated to avoid decreasing the light source power in Automatic mode.
10	**Operation mode** Write mode: 0 = Stop (stop acquisition) 1 = Continuous 2 = Single (acquisition of a single detection frame) Read mode: 10 = Stopped (sensor is stopped) 11 = Continuous acquisition mode 12 = Single frame busy (acquisition in progress) 13 = Sensor is busy
11	Smoothing: stabilizes the sensor measurements. The behavior of the smoothing algorithm can be adjusted by a value ranging from –16 to 16.
12	Low 16 bits of segment enabled: bit field of enabled segment
13	High 16 bits of segment enabled

As per the Modbus protocol, register values are returned in big-endian format.

A request for a register that does not exist will return error code “2.” Trying to set a register to an invalid value will return error code “3.” If an error occurs while trying to execute the function, error code “4” will be returned.

Report server ID (function code 0x11)

This function returns information on the Leddar Vu8 module in the following format:

Table 29: Report server ID message

Offset	Length	Description
0	1	Number of bytes of information (excluding this one). Currently 0x99 since the size of the information returned is fixed.
1	32	Serial number as an ASCII string
33	1	Run status 0: OFF, 0xFF: ON. Should always return 0xFF, otherwise the module is defective.
34	32	Device name as an ASCII string
66	32	Hardware part number as an ASCII string
98	32	Software part number as an ASCII string
130	8	Full firmware version as four 16-bit values
138	48	Full bootloader version as four 16-bit values
146	2	FPGA build version
148	4	Internal use
152	2	Device identification code (13 for Leddar Vu8)

Get detections (function code 0x41)

This function returns the detections/measurements in the following format:

The first byte is the number of detections in the message. Because of the limitation on a Modbus message length, a maximum of 40 detections will be returned.

This maximum can be configured to a lower value using the Leddar Configurator software (serial port configuration) or the Write Register command described below.

Following the first byte, each detection has six bytes (see Table 30).

Table 30: Get detection message (detection fields)

Offset	Length	Description
0	2	The distance (little-endian). Distance unit is defined by serial port parameters.
2	2	The amplitude times 64 [i.e., amplitude = this field / 64 (little-endian)]
4	1	Four bits are flags describing the measurement (all others are reserved): Bit 0: Detection is valid (will always be set) Bit 1: Detection is the result of object demerging Bit 3: Detection is saturated Bit 6: Detection is within the crosstalk zone
5	1	Segment number

Three more data fields follow the detection list:

Table 31: Get detection message (trailing fields)

Offset	Length	Description
0	4	Timestamp of the acquisition (little-endian), expressed as the number of milliseconds since the device was started
4	1	Current light source power as a percentage of maximum
5	2	Bit-field acquisition. Reserved.

For an example of a 0x41 Modbus function, refer to Appendix B on page 106.

Read module data (function code 0x42)

Table 32 and Table 33 list the request and answer codes for reading data. This function is an encapsulation of the SPI protocol. See section “5.1.3 Memory Map” above.

Table 32: Requests

Offset	Length	Description
0	4	Base address: 0x00000000 to 0x00FFFFFF (little-endian)
4	1	Number of bytes to read: 1 to 247.

Table 33: Answers

Offset	Length	Description
0	4	Base address: 0x00000000 to 0x00FFFFFF (little-endian)
4	1	Number of bytes read: 1 to 247.
5	Nb * 1 byte	Data

Write module data (function code 0x43)

Table 34 and Table 35 list the request and answer codes for writing data. This function is an encapsulation of the SPI protocol. See section “5.1.3 Memory Map.”

Table 34: Requests

Offset	Length	Description
0	4	Base address: 0x00000000 to 0x00FFFFFF
4	1	Number of bytes written: 1 to 247.
5	Nb * 1 byte	Data

Table 35: Answers

Offset	Length	Description
0	4	Base address: 0x00000000 to 0x00FFFFFF
4	1	Number of bytes written: 1 to 247.

Send opcode command (function code 0x44)

Table 36 and Table 37 list the request and answer codes for sending the opcode. This function is an encapsulation of the SPI protocol. See section "5.1.3 Memory Map."

Table 36: Requests

Offset	Length	Description
0	1	Opcode. Supported opcodes: Read status = 0x05 Write enabled = 0x06 Write disabled = 0x04 Reset configuration = 0xC7 Soft reset = 0x99
1	1	Argument: optional value (must be set to 0x00)

Table 37: Answers

Offset	Length	Description
0	1	Opcode
1	1	Return value: optional return value (Read status opcode = Status value)

Get serial port settings (function code 0x45, 0x00)

Table 38, Table 39 and Table 40 list the requests and answers of the Get serial port settings.

Table 38: Requests

Offset	Length	Description
0	1	Sub-function code: 0x00

Table 39: Answers header field

Offset	Length	Description
0	1	Sub-function code: 0x00
1	1	Number of serial ports
2	1	Current logical serial port number (current logical serial number connected to the host used for this transaction)

Table 40: Answers serial port settings field

Offset	Length	Description
0	1	Logical serial port number
1	4	Baud rate. Supported rates: 9 600 19 200 38 400 57 600 115 200
5	1	Date size: 8 = 8-bit size
6	1	Parity: 0 = None 1 = Odd 2 = Even
7	1	Stop bit: 1 = 1 stop bit 2 = 2 stop bits
8	1	Flow control: 0 = None
9	1	Modbus address: 1 to 247.
10	1	Max. echoes per transaction. Used for the Get Detection command (function code 0x41), max. 40 echoes.
11	2	Distance resolution: 1 = m 10 = dm 100 = cm 1 000 = mm

This answer table is repeated by the number of available serial ports.

Set serial port settings (function code 0x45, 0x01)

Table 41, Table 42 and Table 43 list the requests and answers for the Set serial port settings.

Table 41: Requests header field

Offset	Length	Description
0	1	Sub-function code: 0x01

Table 42: Requests serial port setting field

Offset	Length	Description
0	1	Settings of the corresponding logical serial port number to set
1	4	Baud rate. Supported rates: 9 600 19 200 38 400 57 600 115 200
5	1	Date size: 8 = 8-bit size
6	1	Parity: 0 = None 1 = Odd 2 = Even
7	1	Stop bit: 1 = 1 stop bit 2 = 2 stop bits
8	1	Flow control: 0 = None
9	1	Modbus address: 1 to 247.
10	1	Max. echoes per transaction. Used for the Get Detection command (function code 0x41), max. 40 echoes.
11	2	Distance resolution: 1 = m 10 = dm 100 = cm 1 000 = mm

This request table can be repeated by the number of available serial ports (by using the corresponding logical port number).

Table 43: Answers

Offset	Length	Description
0	1	Sub-function code: 0x01

Get carrier firmware information (function code 0x45, 0x02)

Table 44 and Table 45 list the registers for the Firmware information commands.

Table 44: Requests

Offset	Length	Description
0	1	Sub-function code: 0x02

Table 45: Answers

Offset	Length	Description
0	1	Sub-function code: 0x02
1	32	Firmware part number as an ASCII string
33	8	Firmware version in four units for format A, B, C and D.

Get carrier device information (function code 0x45, 0x03)

Table 46 and Table 47 list the registers for the Carrier device information commands.

Table 46: Requests

Offset	Length	Description
0	1	Sub-function code: 0x03

Table 47: Answers

Offset	Length	Description
0	1	Sub-function code: 0x03
1	32	Hardware part number as an ASCII string
33	32	Hardware serial number as an ASCII string
65	4	Option bits. Reserved for LeddarTech use.

Get CAN port settings (function code 0x45, 0x04)

Table 48, Table 49 and Table 50 list the requests and answers of the Get CAN port settings.

Table 48: Requests

Offset	Length	Description
0	1	Sub-function code: 0x04

Table 49: Answers header field

Offset	Length	Description
0	1	Sub-function code: 0x04
1	1	Number of CAN ports

Table 50: Answers CAN port settings field

Offset	Length	Description
0	1	Logical CAN port number settings
1	4	Baud rate. Supported rates: 10 000 20 000 50 000 100 000 125 000 250 000 500 000 1 000 000
5	1	Frame format: 0 = Standard 11 bits 1 = Extended 29 bits
6	4	Tx base ID
10	4	Rx base ID
14	1	Maximum number of detections (measurements) returned per CAN detection message transaction: 1 to 96.
15	2	Distance resolution: 1 = m 10 = dm 100 = cm 1 000 = mm
17	2	Inter-message delay (0 to 65 535 milliseconds)
19	2	Inter-cycle delay (0 to 65 535 milliseconds)

This answer table is repeated by the number of available CAN ports.

Set CAN port settings (function code 0x45, 0x05)

Table 51 and Table 52 list the requests and answers for the CAN port commands.

Table 51: Requests header field

Offset	Length	Description
0	1	Sub-function code: 0x05

Table 52: Requests CAN port settings field

Offset	Length	Description
0	1	Settings of the corresponding logical CAN port number to set
1	4	Baud rate. Supported rates: 10 000 20 000 50 000 100 000 125 000 250 000 500 000 1 000 000
5	1	Frame format: 0 = Standard 11 bits 1 = Extended 29 bits
6	4	Tx base ID
10	4	Rx base ID
14	1	Maximum number of detections (measurements) returned per CAN detection message transaction: 1 to 96.
15	2	Distance resolution: 1 = m 10 = dm 100 = cm 1 000 = mm
17	2	Inter-message delay (0 to 65 535 milliseconds)
19	2	Inter-cycle delay (0 to 65 535 milliseconds)

This request table can be repeated by the number of available CAN ports (by using the corresponding logical port number).

Table 53: Answers

Offset	Length	Description
0	1	Sub-function code: 0x05

5.5. CAN Bus Interface

The CAN bus interface uses two default message IDs that can be modified by the user: 1856 (0x740) and 1872 (0x750).

Four message IDs are available:

Table 54: CAN message IDs

Message ID	Direction	Data Type
0x740	Rx	Request from a host
0x750	Tx	Answer to a host request
0x751	Tx	Number of detection messages
0x752 and over	Tx	Detection messages

1856 (0x740) (Rx base ID)

These are 8-byte length messages for command requests that the module monitors: the first byte (byte 0) describes the main function and the rest of the message bytes are used as arguments. Undescribed bytes are reserved and must be set to 0.

The module answer messages are described in section 1872 (0x750) (Tx base ID).

Table 55: CAN bus request message

Function Request (Byte 0)	Function Request Description	Function Arguments (Byte 1)
1	Stop sending detections continuously	--
2	Send detection once	Bit field of operation mode Bit 0: 0 = Return detection in single-message mode 1 = Return detection in multiple-message mode
3	Start sending detections continuously (i.e., the module will send a new set of detections each time they are ready without waiting for a request)	Bit field of operation mode Bit 0: 0 = Return detection in single-message mode 1 = Return detection in multiple-message mode
4	Get input data (read-only)	See Table 56.
5	Get holding data	See Table 57.
6	Set holding data	See Table 58.
7	Set base address	See Table 59.
8	Read module data	See Table 60.
9	Write module data	See Table 61.
10	Send module opcode command	See Table 62.

Table 56: CAN bus request message (Get input data)

Input Data Type (Byte 1)	Input Data Description
0	Number of segments
1	Device identification and option
2 and 3	Firmware version
4 and 5	Bootloader version
6	FPGA version
7 to 12	Serial number
13 to 18	Device name
19 to 24	Hardware part number
25 to 30	Software part number

Table 57: CAN bus request message (Get holding data)

Holding Data Type (Byte 1)	Holding Data Description
0	Acquisition configuration
1	Smoothing and detection threshold
2	Light source power management
3	Distance resolution and acquisition options
4	CAN port configuration 1
5	CAN port configuration 2
6	CAN port configuration 3
7	Reserved
8	Segment enabled

Table 58: CAN bus request message (Set holding data)

Holding Data Type (Byte 1)	Holding Data Description	Argument	Argument Description
0	Acquisition configuration	Byte 2	Exponent for the number of accumulations (i.e., if the content of this register is n, 2^n accumulations are performed)
		Byte 3	Exponent for the number of oversamplings (i.e., if the content of this register is n, 2^n oversamplings are performed)
		Byte 4	Number of base samples

Holding Data Type (Byte 1)	Holding Data Description	Argument	Argument Description
1	Smoothing and detection threshold	Byte 2	Smoothing: stabilizes the sensor measurements. The behavior of the smoothing algorithm can be adjusted by a value ranging from −16 to 16. Clear the **Enable** check box to disable smoothing.
		Bytes 4 to 7	Detection threshold as a fixed-point value with a 6-bit fractional part (i.e., threshold value is this register divided by 64)
2	Light source power management	Byte 2	Light source power as a percentage of maximum. A value above 100 is an error. If a value is specified that is not one of the predefined values, the closest predefined value will be used. Refer to the detection reading to verify the light source Intensity value as shown in Table 55 and Table 67. Note that this value is ignored if the Automatic light source power is enabled.
		Byte 3	Number of echoes for saturation acceptance: the number of echoes can be saturated to avoid decreasing the light source power when using the Automatic mode.
		Bytes 4 and 5	Auto light source power changes the delay in number of measurements.
3	Distance resolution and acquisition options	Bytes 2 and 3	Distance unit: 1 = m 10 = dm 100 = cm 1 000 = mm
		Bytes 4 and 5	Bit field of acquisition options: Bit 0: Automatic light source power enabled Bit 1: Object demerging enabled Bit 2: Static noise removal enabled Bit 3: Precision (smoothing) enabled Bit 4: Saturation compensation enabled Bit 5: Overshoot management enabled Bit 6: Automatic light source power mode: 0 = Mode 1 1 = Mode 2 Bit 7: Crosstalk removal enabled Bit 8: Crosstalk echo removal enabled

Holding Data Type (Byte 1)	Holding Data Description	Argument	Argument Description
4	CAN port configuration 1	Byte 2	Baud rate (kbps): 0 = 1 000 1 = 500 2 = 250 3 = 125 4 = 100 5 = 50 6 = 20 7 = 10
		Byte 3	Frame format: 0 = Standard 11 bits 1 = Extended 29 bits
		Bytes 4 to 7	Tx base ID
5	CAN port configuration 2	Bytes 4 to 7	Rx base ID
6	CAN port configuration 3	Byte 3	Maximum number of detections (measurements) returned per CAN detection message transaction: 1 to 96.
		Bytes 4 and 5	Inter-message delay (0 to 65 535 milliseconds)
		Bytes 6 and 7	Inter-cycle delay (0 to 65 535 milliseconds)
7	Reserved	--	--
8	Segment enabled	Bytes 4 to 7	Bit field of the enabled segments

Table 59: CAN bus request message (Set base address)

Data Description	Argument	Argument Description
Base address	Bytes 4 to 7	Base address to access the Read module date and Write module date commands (from 0x00000000 to 0x00FFFFFF)

Table 60: CAN bus request message (Read module data)

Data Description	Argument	Argument Description
Read module data	Byte 1	Data length (1, 2 or 4)
	Bytes 2 and 3	Offset from 0x0000 to 0xFFFF (final address to access is the result of the base address plus this offset). This function is an encapsulation of the SPI protocol. See section “5.1.3 Memory Map.”

Table 61: CAN bus request message (Write module data)

Data Description	Argument	Argument Description
Write module data	Byte 1	Data length (1, 2 or 4)
	Bytes 2 and 3	Offset from 0x0000 to 0xFFFF (final address to access is the result of the base address plus this offset).
	Bytes 4 to 7	Data to write This function is an encapsulation of the SPI protocol. See section "5.1.3 Memory Map."

Table 62: CAN bus request message (Send module opcode command)

Data Description	Argument	Argument Description
Send module opcode command	Byte 2	Opcode This function is an encapsulation of the SPI protocol. See section "5.1.2 SPI Protocol."
	Byte 3	Optional argument (must be set to 0x00)

1872 (0x750) (Tx base ID)

These are 8-byte answer messages to the host command requests.

Table 63: CAN bus answer message

Answer Data (Byte 0)	Answer Data Description	Additional Answer Data (Byte 1 to Byte 7)
1	Answer to stop continuously sending detection requests	Success: return echo from the command request. Fail: all bytes from 2 to 7 are set to 0xFF.
2	Answer to send once a detection request	Success: return echo from the command request. Fail: all bytes from 2 to 7 are set to 0xFF.
3	Answer to continuously send a detection request	Success: return echo from the command request. Fail: all bytes from 2 to 7 are set to 0xFF.
4	Answer to the Get input data request	Success: see format in Table 64. Fail: all bytes from 2 to 7 are set to 0xFF.
5	Answer to the Get holding data request	Success: see format in Table 58. Fail: all bytes from 2 to 7 are set to 0xFF.
6	Answer to the Set holding data request	Success: return echo of the command request. Fail: all bytes from 2 to 7 are set to 0xFF.
7	Answer to the Set base address request	Success: return echo of the command request. Fail: all bytes from 2 to 7 are set to 0xFF.
8	Answer to the Read module data request	Success: see Table 65. Fail: all bytes from 2 to 7 are set to 0xFF.
9	Answer to the Write module data request	Success: return echo of the command request. Fail: all bytes from 2 to 7 are set to 0xFF.

Answer Data (Byte 0)	Answer Data Description	Additional Answer Data (Byte 1 to Byte 7)
10	Answer to the Send module opcode request	Success: see Table 66. Fail: all bytes from 2 to 7 are set to 0xFF.

Table 64: CAN bus answer message (Get input data)

Input Data Type (Byte 1)	Input Data Description	Argument	Argument Description
0	Number of segments	Bytes 2 and 3	Number of segments
1	Device identification and options	Bytes 2 and 3	Device identification code (13 for Leddar Vu8)
		Bytes 4 to 7	Module option flags (LeddarTech internal use)
2	Firmware version in format A, B, C, D	Bytes 2 and 3	Firmware build version (A)
		Bytes 4 and 5	Firmware build version (B)
		Bytes 6 and 7	Firmware build version (C)
3	Firmware version in format A, B, C, D	Bytes 2 and 3	Firmware build version (D)
4	Bootloader version in format A, B, C, D	Bytes 2 and 3	Bootloader build version (A)
		Bytes 4 and 5	Bootloader build version (B)
		Bytes 6 and 7	Bootloader build version (C)
5	Bootloader version in format A, B, C, D	Bytes 2 and 3	Bootloader build version (D)
6	FPGA version	Bytes 2 and 3	FPGA version
		Byte 6	Run status 0: OFF, 0xFF: ON. Should always return 0xFF, otherwise the module is defective.
7 to 12	Serial number	Bytes 2 to 7	Serial number as an ASCII string (max. 32 bytes)
13 to 18	Device name	Bytes 2 to 7	Device name as an ASCII string (max. 32 bytes)
19 to 24	Hardware part number	Bytes 2 to 7	Hardware part number as an ASCII string (max. 32 bytes)
25 to 30	Software part number	Bytes 2 to 7	Software part number as an ASCII string (max. 32 bytes)

Table 65: CAN bus answer message (Read module data)

Data Description	Argument	Argument Description
Read module opcode command	Byte 1	Data length (1, 2 or 4)
	Byte 2	Offset
	Byte 3	
	Byte 4	Data to read
	Byte 5	
	Byte 6	
	Byte 7	

Table 66: CAN bus answer message (Send module opcode request)

Data Description	Argument	Argument Description
Send module opcode command	Byte 2	Opcode
	Byte 3	Optional argument
	Byte 4	Optional return value

1873 (0x751) (Tx base ID + 1)

These are 8-byte messages that indicate the number of detections that will be sent.

Table 67: CAN bus number of detection messages

Data	Data Return Description
Byte 0	Number of detections
Byte 1	Current light source power as a percentage of maximum
Byte 2	Status of the bit-field acquisition: Reserved.
Byte 3	
Bytes 4 to 7	Timestamp of the acquisition, expressed as the number of milliseconds since the module was started.

1874 (0x752) (Tx base ID + 2)

These are the detection messages with flag information, containing one detection presented in the following format:

- Data bytes 0 and 1 contain the distance in units defined by the distance-units holding data.
- Data bytes 2 and 3 contain the amplitude. This value must be divided by 64 to provide the amplitude (i.e., 6 bits for the fractional part).
- Data bytes 4 and 5 contain the flag information as described in the table below.
- Bytes 6 and 7 contain the segment number.

Table 68: Flag information of measurement

Data	Description
Bit 0	Detection is valid (will always be set).
Bit 1	Detection was the result of object demerging.
Bit 2	Reserved
Bit 3	Detection is saturated.
Bits 4-5	Reserved
Bit 6	Detection is within the crosstalk zone.
Bit 7-15	Reserved

Detection messages can be sent in two modes: as a single-message ID or a multiple-message ID.

For the single-message ID mode, all detection messages are sequentially sent on the same message ID; i.e., 1874 (0x752).

For the multiple-message ID mode, detections are sent on message IDs ranging from 1874 to the number of detections (1874 + number of detections). The range of message IDs can be limited by the maximum number of detections to output to the CAN port (defined in CAN configuration 3 holding data for a maximum configurable of 96 detections).

The following are examples of message IDs for the 1874 base (with a 19-detection frame):

- From 1874 to 1893
- From 1874 to 1890, for a module setup with a maximum number of 16 detections.

For an example of a Leddar Vu8 CAN bus, refer to Appendix C on page108.

6. Leddar Configurator

The Leddar™ Configurator provides configuration parameters and operation functionalities for Leddar™ products.

6.1. Introduction

The Leddar Configurator interface can be resized manually or set to full-screen view.

All dialog boxes that do not include a selection of action buttons at the bottom, such as **Connect**, **OK**, **Cancel**, etc., are dockable at the top, the bottom or on the right side of the main window.

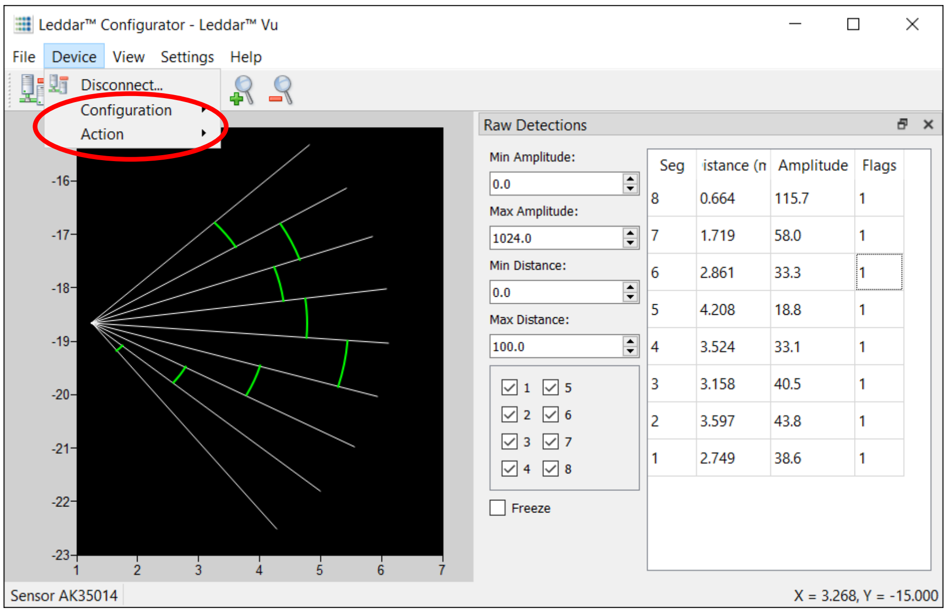

Fig. 30: Raw Detections dialog box docked on the side of the main window

When a dialog box or a window is already open, a check mark appears next to the command on the menu.

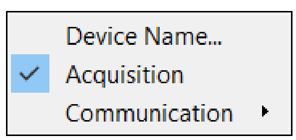

Fig. 31: Command check mark

6.2. Connection Window

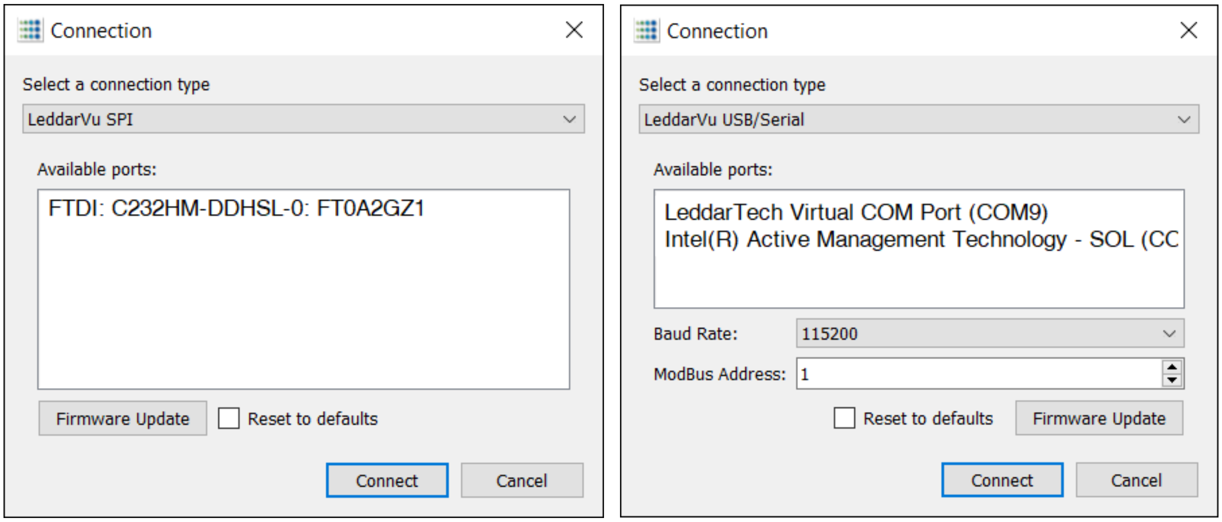

Fig. 32: USB (left) and SPI (right) connection dialog box

Select a connection type

The connection type you are using. There are five connection types:

1. IS16/M16/Evaluation Kit USB/Leddar Sight
2. Leddar Vu8 SPI
3. Leddar Vu8 USB/Serial
4. LeddarAuto
5. LeddarOne

Available ports

The list of available ports displays the modules currently detected.

	The descriptions below apply to the Leddar Vu8 USB/Serial connection type.

6.3. Leddar Configurator Main Window

After connecting to the device, the main window opens.

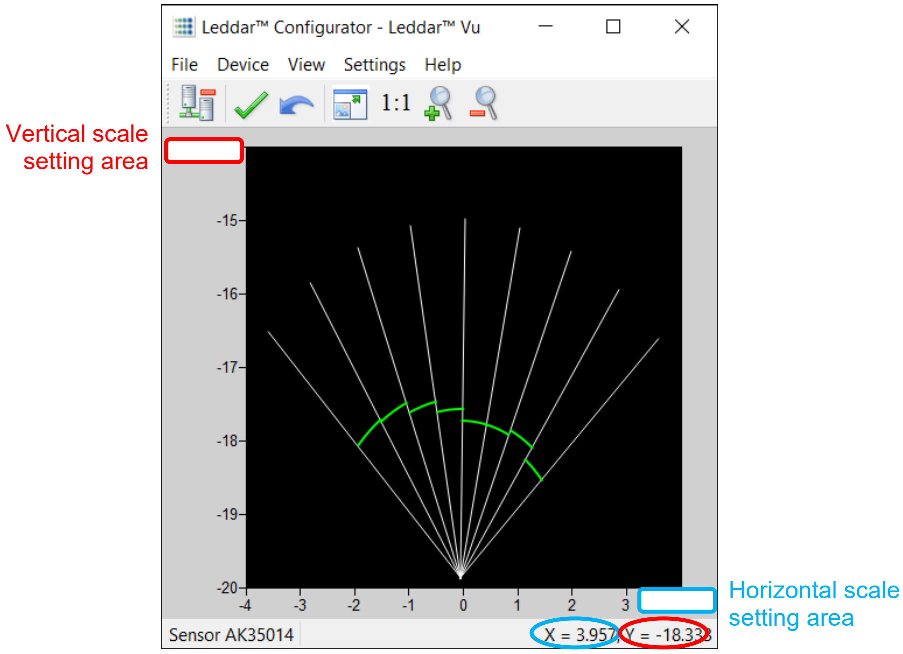

Fig. 33: Leddar Configurator main window

The measurements are plotted in a symbolic graph containing the eight segments (white lines) originating from the sensor. Detections are drawn as arcs in their corresponding segments. Only valid measurements are displayed. A more detailed description of the measurements can be obtained in the **Raw Detections** dialog box (see section “6.12 Raw Detections” on page 91).

The numbers X and Y displayed at the bottom are the mouse cursor position coordinates.

Display Controls

Several options are available for adjusting the main window display.

6.3.1. Fit to Window

The  **Fit to Window** icon allows you to expand the display to fit the dimensions of the computer screen.

6.3.2. Force Equal Horizontal and Vertical Scales

When the 

Equal Scaling icon is selected (icon highlighted), the original ratio of the display is kept or restored. The horizontal and vertical scales will be set to the same values, and the beam will be displayed in accordance with the beam properties (for example, the display will show a 48° beam for a 48° Leddar Vu8 module).

Click the icon again to change the vertical and horizontal scales independently.

	*When in equal scaling mode, you cannot zoom the display horizontally or vertically, i.e., holding the **<Control>** or **<Shift>** key down while zooming in or out will have no effect. The scales cannot then be modified by entering values in the fields shown in Fig. 33 above.*

6.3.3. Zoom In

Click the **Zoom In** icon to zoom in vertically and horizontally around the center of the display.

6.3.4. Zoom Out

Click the **Zoom Out** icon to zoom out vertically and horizontally around the center of the display.

6.3.5. Scale

The window opens with the default scale setting. The horizontal and vertical scales can be changed manually by entering new values in the fields accessible by clicking the areas shown in Fig. 33.

To apply the changes, click anywhere in the main window.

6.3.6. Panning and Zooming

The display in the main window can be panned and zoomed in different ways. Panning and zooming is done relative to the mouse cursor position.

You can move up, down and sideways by clicking and dragging the display.

To zoom the display in and out, use the mouse wheel alone. This has the same effect as clicking the **Zoom In** or **Zoom Out** icon respectively (see sections 6.3.3 and 6.3.4 above).

To zoom the display horizontally, hold down the **<Control>** key of the computer keyboard while using the mouse wheel.

*The 1:1 **Equal Scaling** icon must be not selected (not highlighted).*

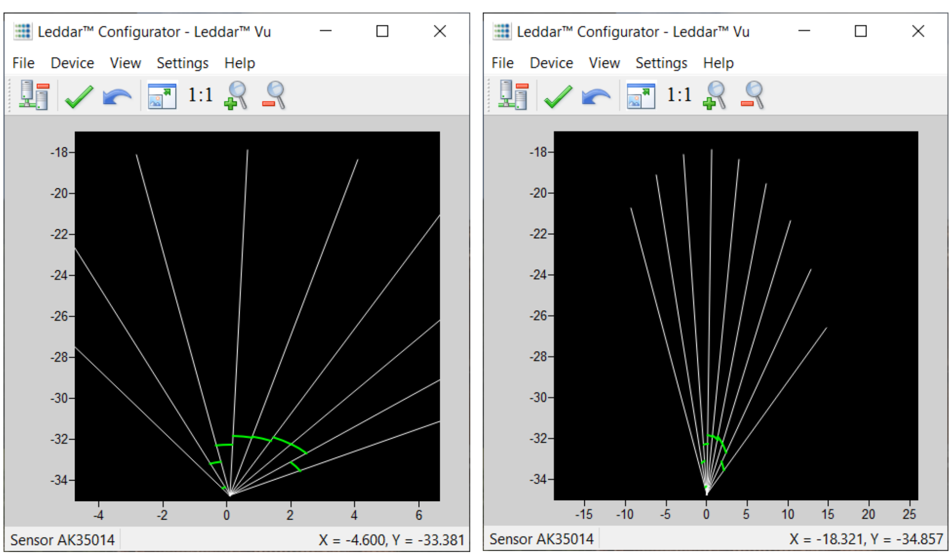

Fig. 34: Zooming in (left) and out (right) horizontally

To zoom the display vertically, hold the **<Shift>** key down while using the mouse wheel.

	The 1:1 ***Equal Scaling*** *icon must be not selected (not highlighted).*

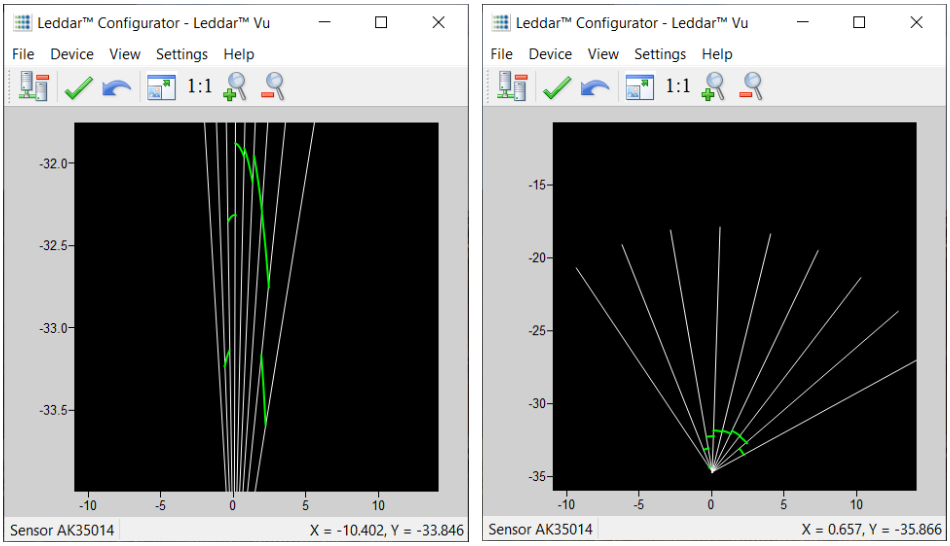

Fig. 35: Zooming in (left) and out (right) vertically

The measurements of a detection point appear as a pop-up when you point to it with the mouse cursor for a more accurate assessment of the detection. Detection points are shown in the form of green lines (arcs) in the main window for visibility reasons.

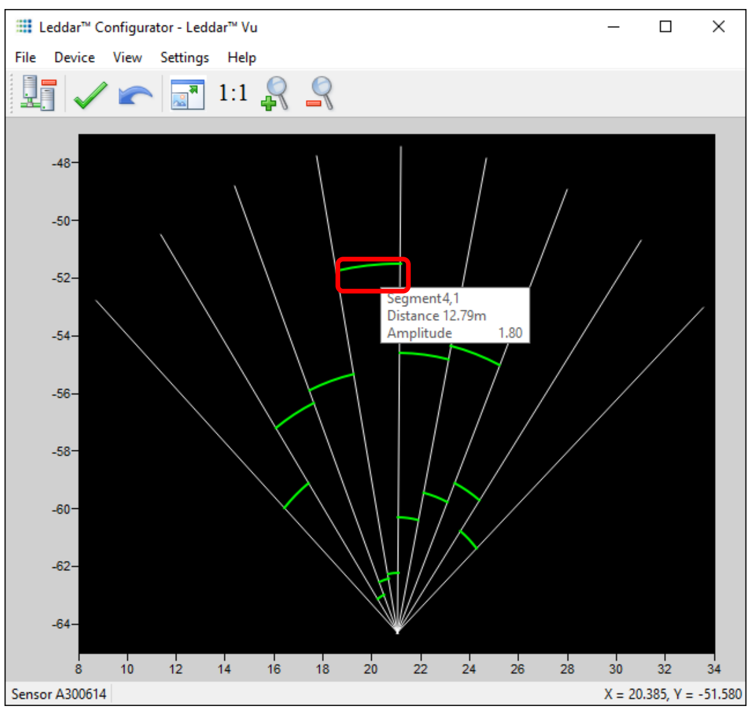

Fig. 36: Detection point coordinates

6.3.7. Changing the Sensor Origin

The sensor origin can be modified by clicking the sensor origin at the bottom of the segments.

To do so, use the mouse cursor to point to the bottom of the segments (a red dot appears), then click and drag it to the desired position.

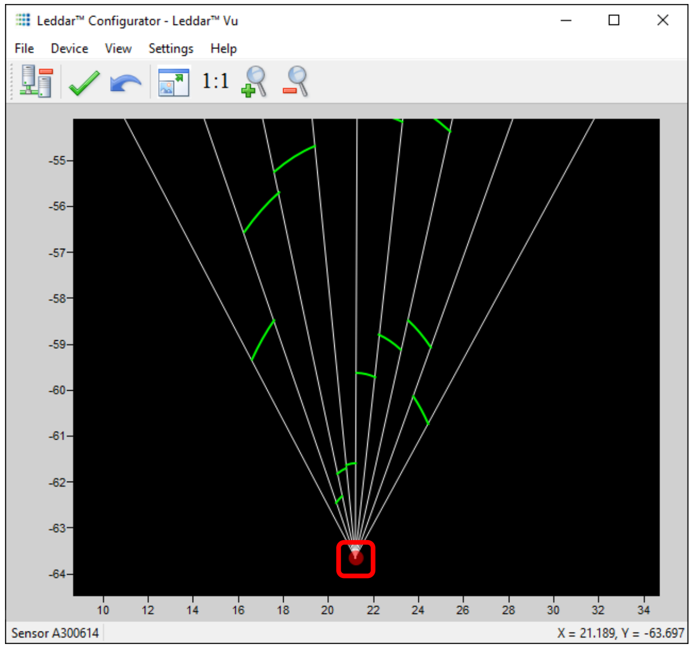

Fig. 37: Changing the sensor origin

If you click and drag the sensor origin, its position is displayed in the status bar, as shown in Fig. 38 below.

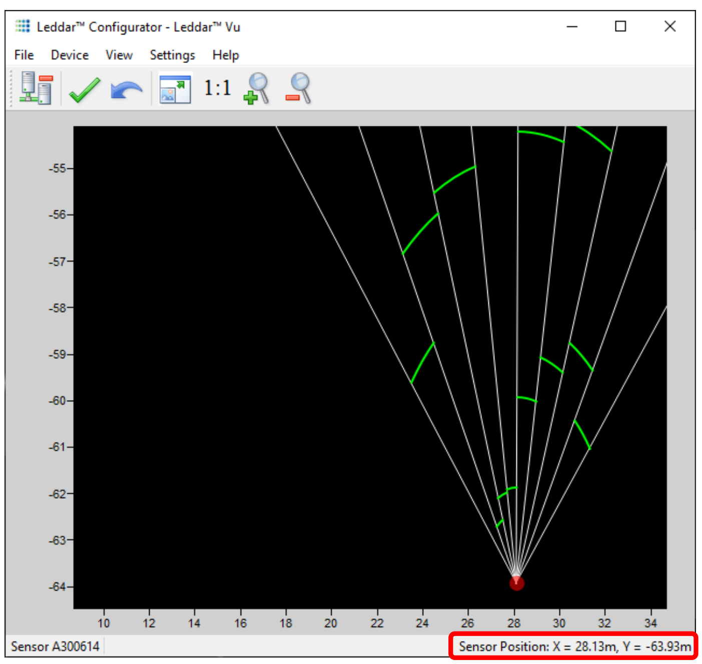

Fig. 38: Sensor position display

To apply the changes, click the  **Apply** icon. The sensor origin is saved in the module.

6.3.8. Changing the Sensor Orientation

The sensor orientation may be changed to match the physical position of the module. If you do so, the main window display can better match the physical installation of the module. For example, if the module is installed above the ground, the sensor origin can be set to reflect its position.

Use the mouse cursor to point to the top of the segments (the top turns red), then click and drag it to the desired position.

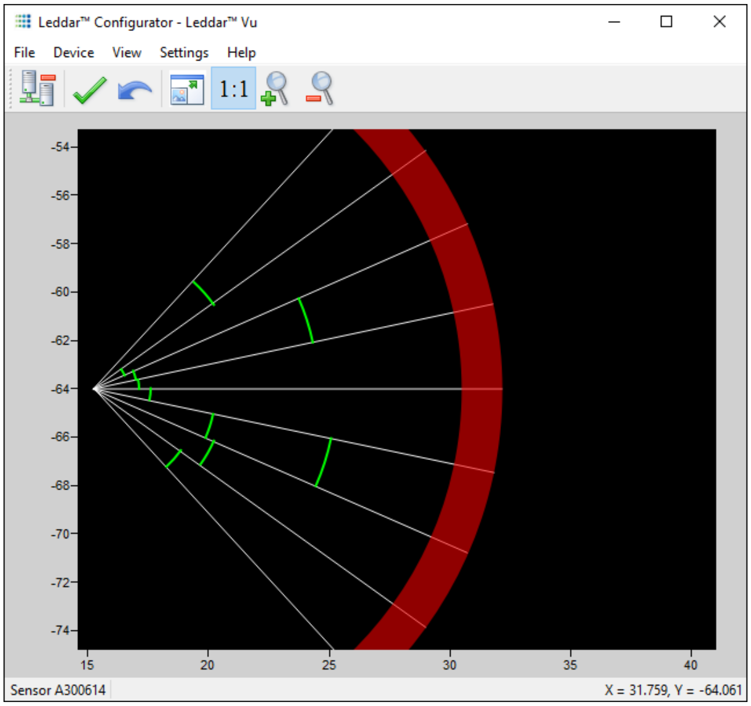

Fig. 39: Changing the sensor orientation

To apply the changes, click the **Apply** icon. The sensor orientation is saved in the module.

6.4. Settings

The Leddar Vu8 stores many settings. Once saved in the module, these parameters are effective at each power-up. The Leddar Configurator software loads these parameters upon each connection.

6.4.1. Device Name

When you connect to a Leddar Vu8 module for the first time, it has a default name. You can change that name at any time.

To change the device name:

1. Connect to the device.

2. In the **Device** menu, select **Configuration**, then click **Device Name...**.

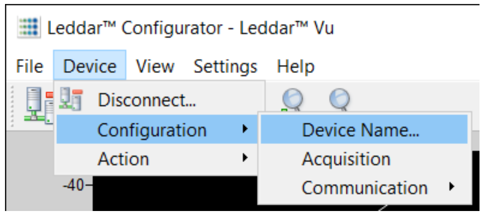

Fig. 40: Device menu – Changing the device name

3. In the **Name** field of the **Device Name** dialog box, enter the new name of the device and click **OK**.

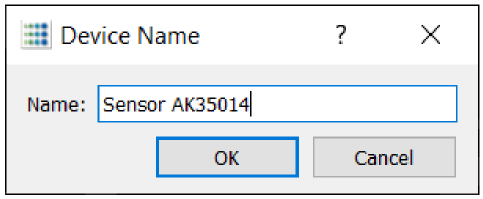

Fig. 41: Device Name dialog box

4. Click the **Apply** icon in the Leddar Configurator main window to apply the change.

6.4.2. Acquisition Settings

The Acquisition Settings function allows you to define parameters to use for detection and distance measurement.

To open the **Acquisition Settings** dialog box, select **Device**, then **Configuration**, then click **Acquisition**.

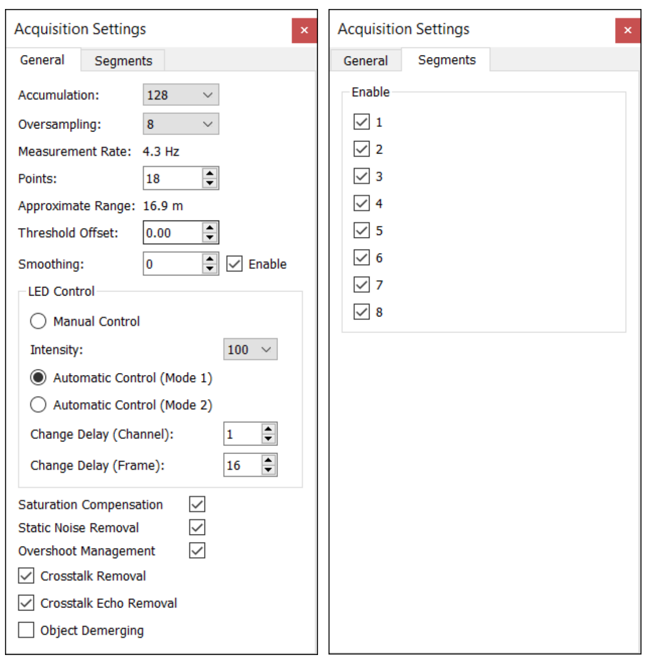

Fig. 42: Acquisition Settings dialog boxes

To apply the changes, click the **Apply** icon in the main window.

Refer to section 4.3 on page 32 for more details on all the parameters.

6.4.3. Serial Ports

The serial port settings of the USB, CAN and serial board are configurable.

To configure the serial port:

1. In the **Device** menu, select **Configuration**, then **Communication**, then click **Serial Ports**.

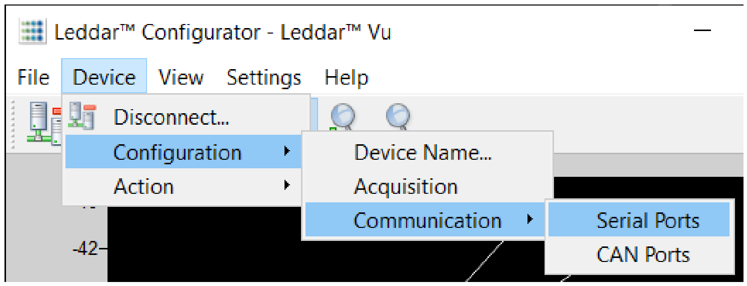

Fig. 43: Device menu – Serial ports

2. In the **Serial Ports Settings** dialog box, you can change the numbers using the arrows or by entering the value manually.

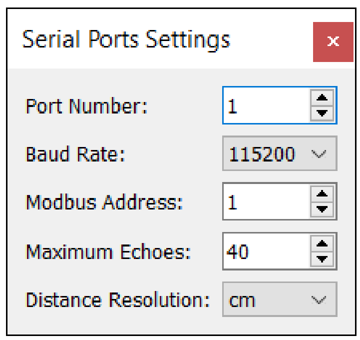

Fig. 44: Serial Ports Settings dialog box

Table 69: Serial port settings description

Parameter	Value
Port Number	Select **1** for the configurable serial link number 1. Select **2** for the TTL serial link number 2. Select **3** for the USB VCP serial link.
Baud Rate (bps)	9 600 19 200 38 400 57 600 115 200
Modbus Address	1 to 247
Maximum Echoes	0 to 40

Parameter	Value
Distance Resolution	Millimeters (mm) Centimeters (cm) Decimeters (dm) Meters (m)

6.4.4. CAN Ports

The CAN port settings of the USB, CAN and serial board are configurable.

To configure the CAN port:

1. In the **Device** menu, select **Configuration**, then **Communication**, then click **CAN Ports**.

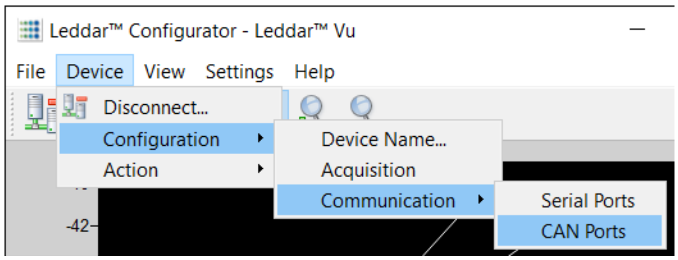

Fig. 45: Device menu – CAN ports

2. In the **CAN Port Settings** dialog box, you can change the numbers using the arrows or by entering the value manually.

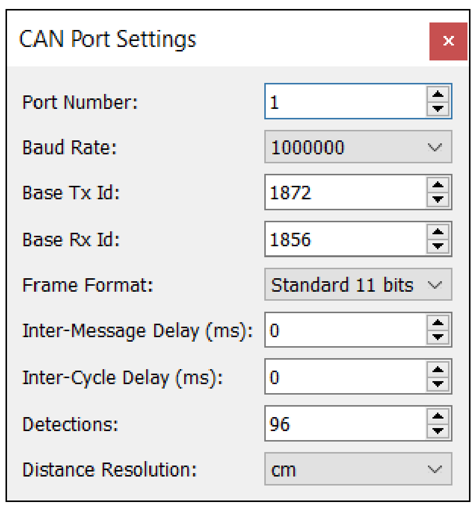

Fig. 46: CAN Port Settings dialog box

Table 70: CAN port settings description

Parameter	Value
Port Number	Select **1** for CAN communication.

Parameter	Value
Baud Rate (bps)	10 000 20 000 50 000 100 000 125 000 250 000 500 000 1 000 000
Base Tx ID	The base CAN arbitration ID used for data messages coming from the USB, CAN and serial board to the host. The arbitration ID of the messages containing the number of detections will be this value plus one (see the protocol documentation).
Base Rx ID	The base CAN arbitration ID used for data messages sent to the USB, CAN and serial board (see the protocol documentation).
Frame Format	Standard 11 bits Extended 29 bits
Inter-Message Delay	0 to 65 535 milliseconds
Inter-Cycle Delay	0 to 65 535 milliseconds
Detections	1 to 96
Distance Resolution	Millimeters (mm) Centimeters (cm) Decimeters (dm) Meters (m)

6.5. Saving and Loading a Configuration

The software configuration for a device can be saved to a file. This enables you to back up settings and restore them in case of system failure or in case you want to revert to earlier settings. You can also retrieve the configuration that was stored with a record file.

To save a configuration:

In the **File** menu, click **Save Configuration...**.

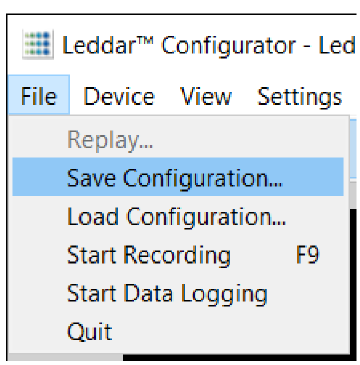

Fig. 47: File menu – Saving a configuration

To load a configuration:

In the **File** menu, click **Load Configuration...**.

6.6. Configuring Detection Records

Detection records provide playback of detections recorded by a device. This visual information can be useful for verification, troubleshooting or training purposes. Detection records allow for a full data playback stored in a *.ltl file that can later be reloaded and replayed.

To configure the detection record:

1. In the **Settings** menu, click **Preferences...**.

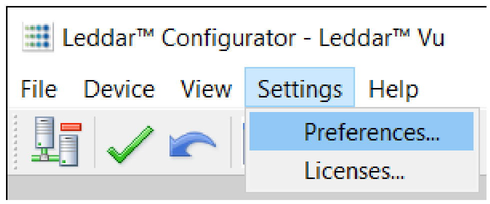

Fig. 48: Settings menu – Preferences

2. In the **Preferences** dialog box, click **Recording**, then **Recorder**.

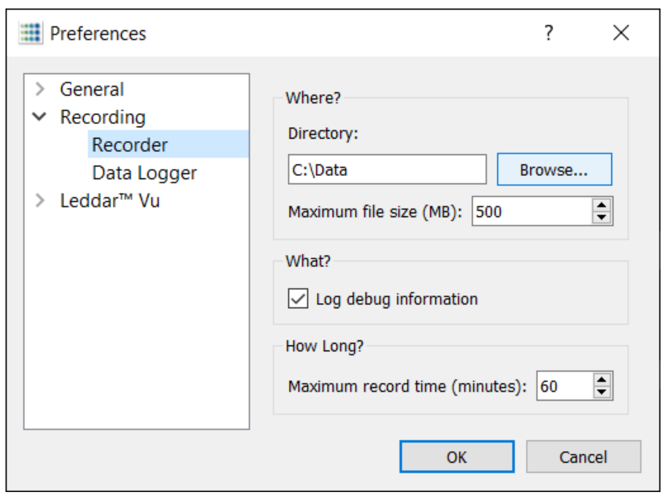

Fig. 49: Preferences dialog box – Recorder

3. Under **Directory**, click the **Browse…** button to select the path to save the detection record file.
4. In the **Maximum file size (MB)** box, set the maximum file size using the arrows or by entering the value manually.
5. Under **What?** select the **Log debug information** check box.
6. Under **How Long?** next to **Maximum record time (minutes)**, set the length of time for recording using the arrows or by entering the value manually. At the end of that period, the recording will stop even if the file size has not reached its maximum.
7. Click **OK** to save the settings.

A complete description of the elements found in the recording **Preferences** dialog box follows the next two procedures.

To start a recording:

In the **File** menu, click **Start Recording**.

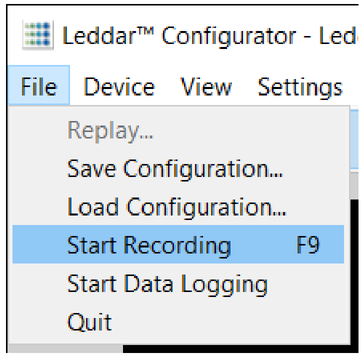

Fig. 50: File menu – Starting a recording

To stop a recording manually:

In the **File** menu, click **Stop Recording**.

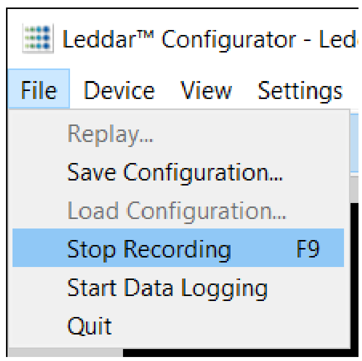

Fig. 51: File menu – Stopping a recording

The following is a description of the elements available in the recording **Preferences** dialog box.

Record directory

The record directory is the folder in which all record files will be saved. These files are in a proprietary format, with the extension *.ltl, and can only be opened and viewed with the Leddar Configurator software.

Maximum file size (MB)

Record files can be quite large. Set the maximum file size as needed. The recording stops for the current file once it reaches the maximum file size and automatically switches the recording to another file. This is to keep record files of manageable sizes.

Log debug information

This check box is reserved for the use of LeddarTech for debug purposes.

Maximum record time (minutes)

The value entered as the **Maximum record time** defines the length of the time for recording. At the end of that period, the recording will stop even if the file size has not reached its maximum.

6.7. Using Detection Records

Once you have completed a recording, you can review it and extract part of the recording.

The **Record Replay** dialog box offers the same functions as a regular video player, providing a Stop button, a Play button and frame-by-frame Forward and Backward buttons.

The **Position** slider lets you move directly to a desired position.

The **Playback Speed** slider lets you adjust the speed of the recording playback; faster is to the right.

The **Start**, **End** and **Extract** buttons allow you to select a portion of the recording and extract it for further reference or analysis.

To play a record:

1. If you are connected to a device, disconnect from it.

   OR

   Open another Leddar Configurator main window.

	The record files can also be opened by double-clicking them.

2. In the **File** menu, click **Replay...**.

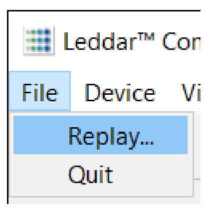

Fig. 52: File menu – Replay option

3. In the **Record Replay** dialog box, click the **Browse…** button to select a file.

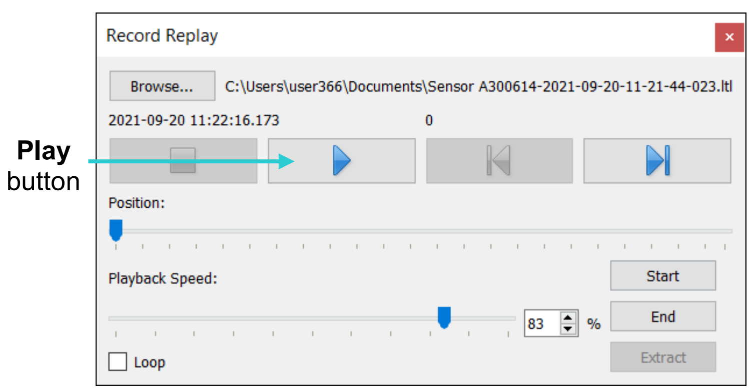

Fig. 53: Record Replay dialog box

4. Click the **Play** button to start the playback.
5. Select the **Loop** check box to repeat the playback continuously.

To extract a record file segment:

1. Set the **Position** slider to the position where you want the file segment to start and click the **Start** button.
2. Set the **Position** slider to the position where you want the file segment to stop and click the **End** button.

   OR

   Play the record and stop it at a position of interest, then click the **Start** button; restart playing the record, stop it again at a position of interest and then click the **Stop** button.
3. Click the **Extract** button to extract and save that file segment.

6.8. Data Logging

The Data Logging function is used to output the data to a .txt file. This file can be imported to a software application (such as Microsoft Excel) for offline analysis.

The duration of the record is indicated in the status bar.

Each line of the generated text file contains the information related to a single detection.

Table 71: Field description of the log text file

Time (msec)	Segment [1 8]	Amplitude [0 512]	Distance (m)	Status
12735204	7	0.9	33.61	1

In this table:

- **Time** indicates the timestamp of the detection from when the sensor was connected to the power supply.
- **Segment** refers to the location of the detection (line, column).
- **Amplitude** of the detection indicates the strength of the returned signal.
- **Distance** indicates the distance of the detection in meters or feet depending on the distance unit configured in **Settings** > **Preferences…** > **General** > **Units**.
- **Status** corresponds to a flag value. Refer to section “6.12 Raw Detections” for more details.

To use the Data Logging function:

1. In the **Settings** menu of Leddar Configurator, click **Preferences...**.

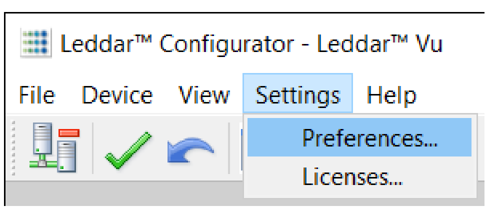

Fig. 54: Settings menu – Preferences

2. In the **Preferences** dialog box, select **Recording**, then click **Data Logger**.

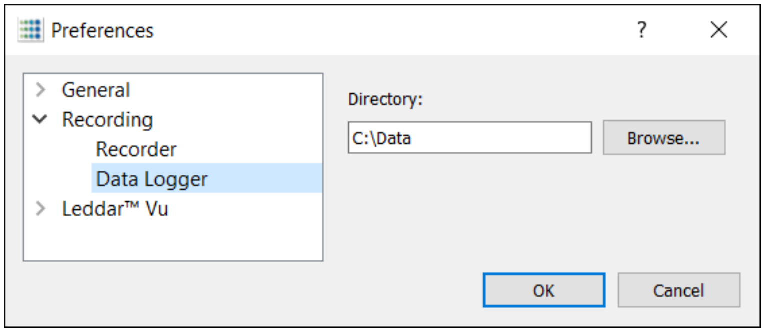

Fig. 55: Preferences dialog box – Logging data

3. Under **Directory**, click the **Browse…** button to select the path where you want to save the log and click **OK**.
4. In the **File** menu, click **Start Data Logging**.

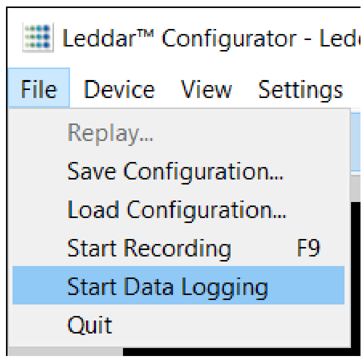

Fig. 56: File menu – Starting data logging

5. To stop recording, click **Stop Data Logging** in the **File** menu.

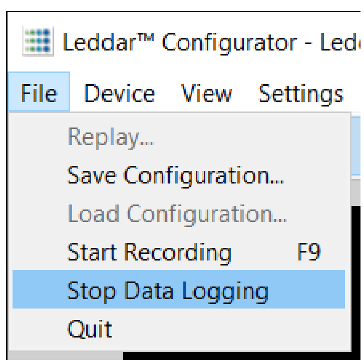

Fig. 57: File menu – Stopping data logging

A .txt file is saved in the selected directory.

6.9. Firmware Update

1. Connect the Leddar Vu8 to its power supply and to the computer through USB or SPI.
2. Launch Leddar Configurator and connect to the sensor.
3. A prompt is displayed, indicating that the carrier board firmware is outdated.

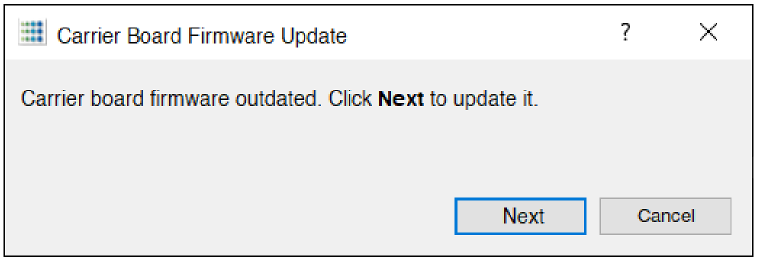

Fig. 58: Carrier Board Firmware Update dialog box

4. Follow the instructions to perform the firmware update.

	*It is very important that you follow ESD protection rules when updating the firmware to avoid any risk of damage to the sensor circuitry.*

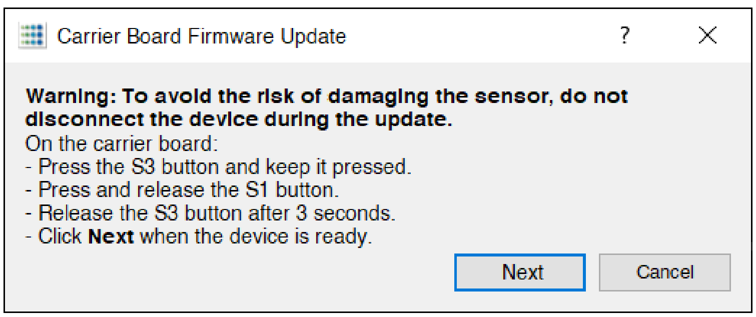

Fig. 59: Carrier Board Firmware Update warning

	*Remember to keep the S3 button pressed while you press S1. See below for the locations of the buttons.*

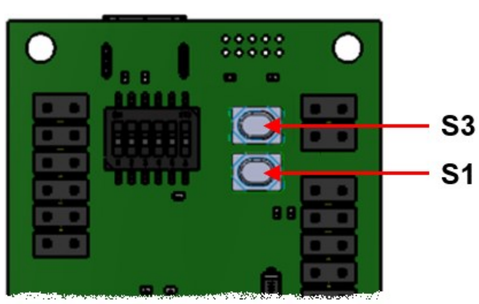

Fig. 60: Carrier board – S3 and S1 buttons

5. At the end of the update, you will need to power-cycle the module and reconnect.

6. Upon the second connection, a prompt will be displayed, specifying that the software is not up to date.

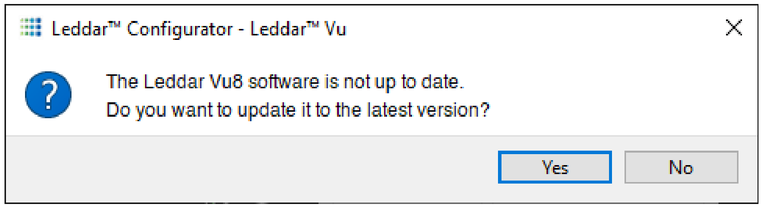

Fig. 61: Software update dialog box

7. Perform the second phase of the update and power-cycle the module again.

To verify the update, click **State** in the **View** menu. The **Device State** window opens, allowing you to verify the following information.

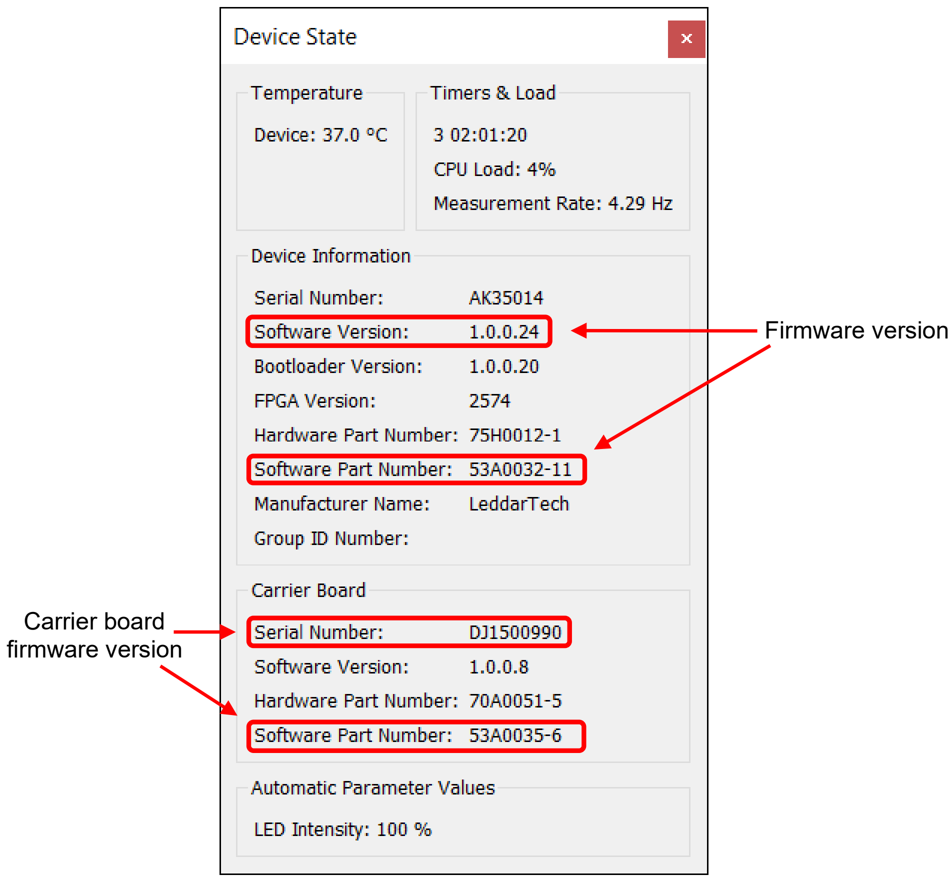

Fig. 62: Device State window

6.10. Device State

Information about a device is accessible by selecting the **State** option in the **View** menu.

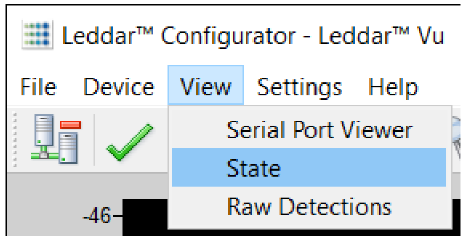

Fig. 63: View menu – State

The **Device State** window opens.

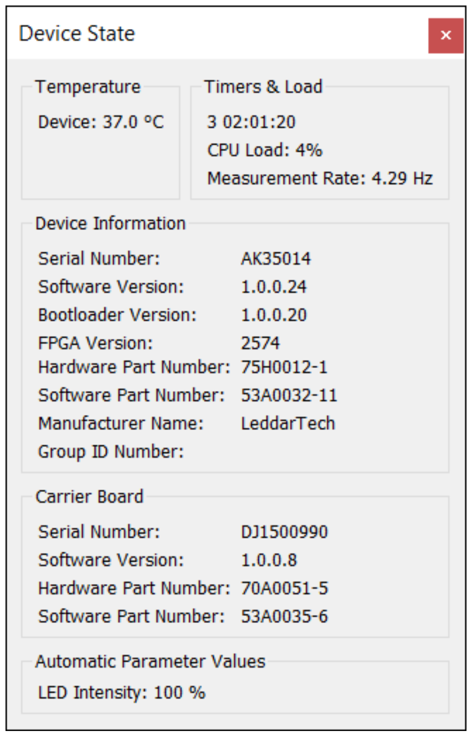

Fig. 64: Device State window

Temperature

The **Device** parameter indicates the temperature of the device.

Timers & Load

This section provides information on the time elapsed since the last sensor reset in days, hours, minutes and seconds.

The **CPU Load** indicates how much of the sensor processor capacity is in use. When the load reaches nearly 100%, the processor may no longer be able to process all the data. The effective frame rate may be impacted.

The **Measurement Rate** indicates the rate at which the sensor measures the speed and dimension of static or moving objects. A **Measurement Rate** in red indicates a significant difference between the optimum and current measurement rates.

Device Information

The **Serial Number** is the serial number of the device as assigned by LeddarTech.

The **Software Version** is the software version specific to the processor of the unit.

The **Bootloader Version** is the bootloader (booting instructions) version specific to the processor of the unit.

The **FPGA Version** is the field-programmable gate array circuit used in the device.

The **Hardware Part Number** is the hardware part number of the device as assigned by LeddarTech.

The **Software Part Number** is the software part number of the device as assigned by LeddarTech.

The **Manufacturer Name** is the name assigned to LeddarTech.

The **Group ID Number** is the end-user group unique identifier used for licensing purposes.

Carrier Board

The **Serial Number** is the serial number of the USB, CAN and serial carrier board as assigned by LeddarTech.

The **Software Version** is the software version specific to the USB, CAN and serial carrier board of the unit.

The **Hardware Part Number** is the hardware part number of the USB, CAN and serial carrier board as assigned by LeddarTech.

The **Software Part Number** is the software part number of the USB, CAN and serial carrier board as assigned by LeddarTech.

Automatic Parameter Values

The **Light Source Intensity** indicates the intensity of the laser.

6.11. Preferences

Preferences are used to change various settings related to the display of Leddar Configurator.

Open the **Preferences** dialog box by clicking the **Preferences…** option in the **Settings** menu.

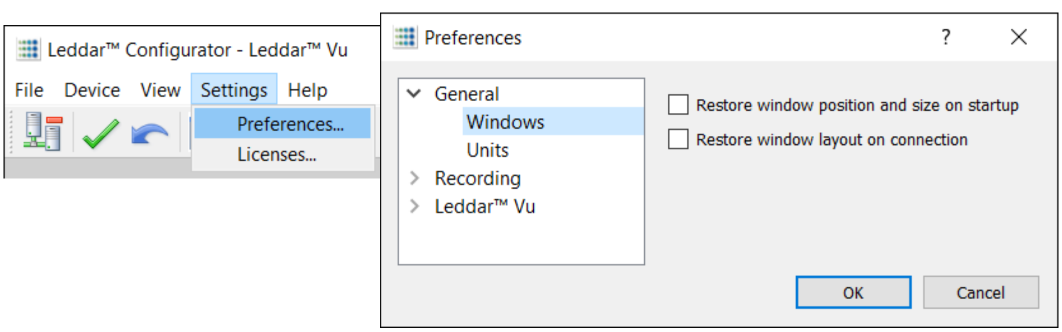

Fig. 65: Preferences dialog box – Windows

Windows

The two options allow you to select how the content of the main window will be displayed in Leddar Configurator.

- The **Restore window position and size on startup** option starts Leddar Configurator at the same place on the computer desktop and at the same size it was when it was closed.
- The **Restore window layout on connection** option connects at the same size it was and with all docked dialog boxes or windows that were displayed when it was closed.

Units

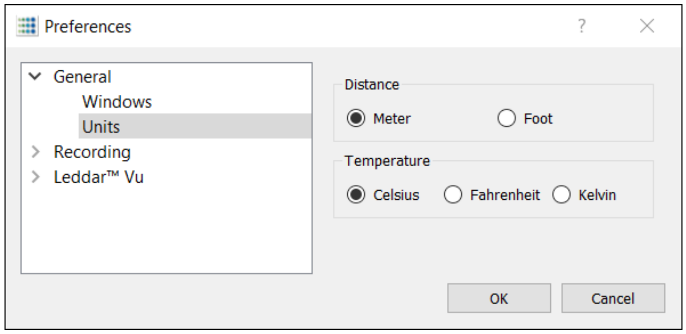

Fig. 66: Preferences dialog box – Units

The unit that is applied to the **distances** and to the sensor **temperature** displayed in Leddar Configurator.

Recording

The **Recorder** settings let you choose how data files are recorded (see Fig. 49 on page 82).

The **Data Logger** setting lets you select a directory to store logs (see Fig. 55 on page 86).

Display

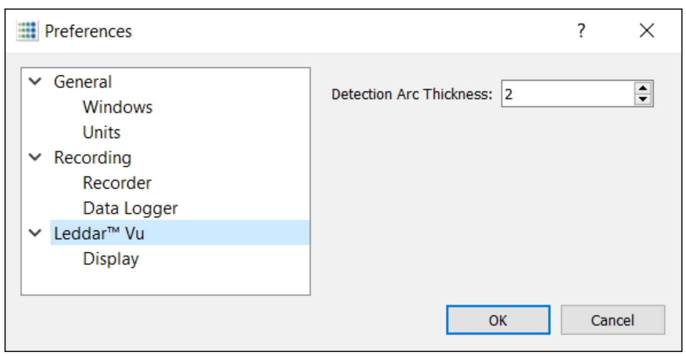

Fig. 67: Preferences dialog box – Display

The **Detection Arc Thickness** parameter allows you to modify the pixel width of the green detection arcs displayed in the main window. You can select a value between 0 and 10.

6.12. Raw Detections

The **Raw Detections** dialog box allows you to view detection values in many ways. It provides filters to isolate segments and detection parameters.

To open the **Raw Detections** dialog box, select **Raw Detections** in the **View** menu.

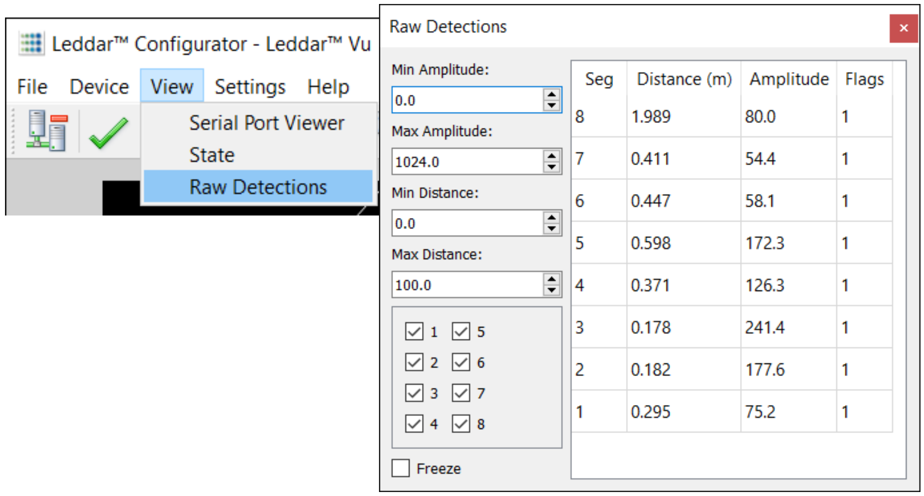

Fig. 68: View menu – Raw Detections dialog box

Fig. 69 shows an example of raw detections. When there is no detection in some segments, only the segments where detection occurred appear in the list.

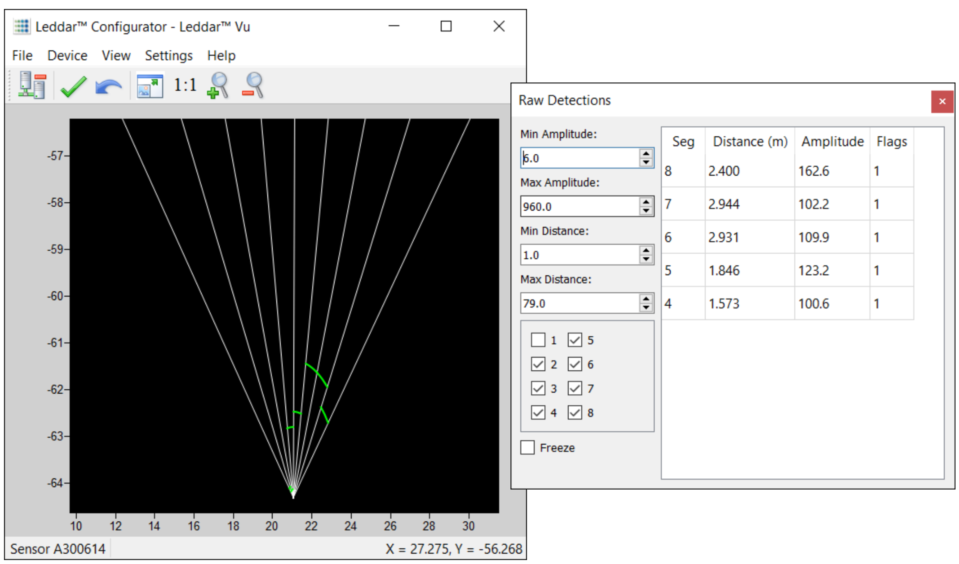

Fig. 69: Filtering detections in the Raw Detections dialog box

The following is a description of the parameters in the **Raw Detections** dialog box.

Min and **Max Amplitude**

The value entered in the **Min Amplitude** field shows only detections of amplitude higher than or equal to that value. For example, if the minimum amplitude is set to 5.0, only the detections of amplitude 5.0 and higher will be displayed.

The value entered in the **Max Amplitude** field will show only detections of amplitude lower than or equal to that value. For example, if the maximum amplitude is set to 8.0, only the detections of amplitude 8.0 and lower will be displayed.

Setting a value in both fields will result in a range of amplitude to display.

Min and **Max Distance**

The value entered in the **Min Distance** field will show only detections at a distance greater than or equal to that value. For example, if the minimum distance is set to 10.0, only the detections at a distance of 10.0 and more will be displayed.

The value entered in the **Max Distance** field will show only detections at a distance smaller than or equal to that value. For example, if the minimum distance is set to 20.0, only the detections at a distance of 20.0 and less will be displayed.

Setting a value in both fields will result in a range of distance to display.

Check boxes 1 to 8

Check boxes 1 to 8 allow you to select which segments to display.

Freeze

When selected, the **Freeze** option allows you to freeze the values displayed in the **Raw Detections** dialog box. To return to the live display, clear the check box.

Seg

The **Seg** column lists the segment for which there is a detection according to the filters used. The segment numbers are read from left to right, starting at 8.

Distance and **Amplitude**

The **Distance** column displays the distance of the detection, and the **Amplitude** column displays its amplitude.

Flags

The **Flags** column displays a number that represents a detection type. See Table 8 in section 4.2.

6.13. Reset

The Reset option allows you to reset the module its default settings.

In the **Device** menu, select **Action**, then click **Reset to factory default configuration...**.

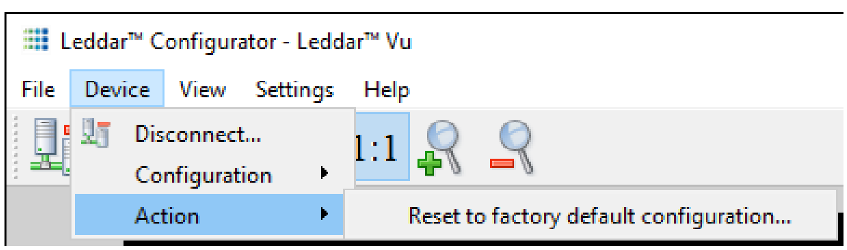

Fig. 70: Device menu – Reset

You will be prompted for confirmation, as the Reset action cannot be undone.

6.14. Serial Port Viewer

The **Serial Port Viewer** function allows you to monitor serial port communication data (**View** menu > **Serial Port Viewer**).

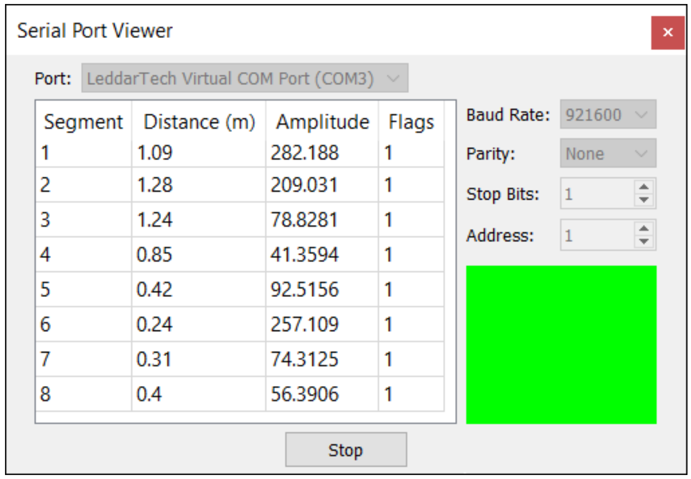

Fig. 71: Serial Port Viewer

6.15. Help

6.15.1. User Guide

In the **Help** menu, select **User Guide…**.

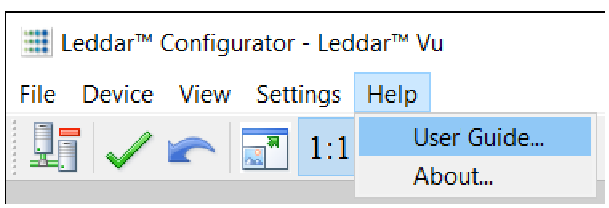

Fig. 72: Help menu – Accessing the User Guide

This option allows you to access a PDF version of the Leddar Vu8 User Guide directly from Leddar Configurator.

6.15.2. About

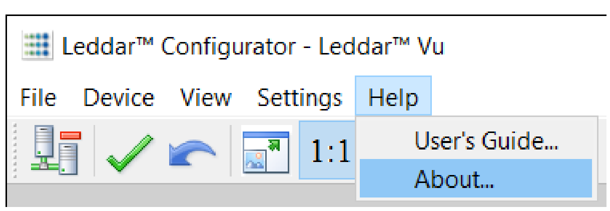

Fig. 73: Help menu – Accessing the About window

In the **Help** menu, select **About…**.

This option allows you to know which dynamic link libraries are currently used in the Vu8 module and the software part number. This information is useful when contacting LeddarTech support.

7. Specifications

7.1. General

Table 72: General specifications

Description	Value
Light source pulse rate	51.2 kHz
Photodetector array size	1 x 8
Photodetector acquisition rate	100 MHz
Measurement rate	See Table 12 on page 39.
USB (optional)	2.0, 12 Mbits/s
CAN (optional)	10 to 1 000 kbits/s, optional 120-Ω termination
Serial links (optional)	TTL, RS-232, RS-422 and RS-485. Two-wire, four-wire, 9 600 to 115 200 bps
Operating temperature	−40 °C to +85 °C

7.2. Regulatory Compliance

The Leddar Vu8 module complies with FDA performance standards for laser products except for deviations pursuant to Laser Notice No. 50 dated June 24, 2007.

Testing results are valid for a cable length shorter than 3 meters.

Table 73: Regulatory compliance information

Standard	Test Specification	Certification	Result
Radiated Emissions **FCC Part 15 (2013), Subpart B**	Class A 30 MHz – 1 GHz	N/A	Pass
Radiated Emissions **CISPR11 (2009) A1 (2010)**	Group 1 – Class A 30 MHz – 1 GHz	N/A	Pass
Radiated Emissions **ICES-003 (2012)**	Class A 30 MHz – 1 GHz	N/A	Pass
Electrostatic Discharge Immunity **IEC61000-4-2 (2008)**	Contact: ±4 kV Air: ±8 kV	Class C	Pass
Radiated Electromagnetic Field Immunity **IEC61000-4-3 (2006)** **A1 (2007) A2 (2010)**	80 MHz – 1 000 MHz: 10 V/m 1.4 GHz – 2 GHz: 3 V/m 2 GHz – 2.7 GHz: 1 V/m	Class C	Pass

7.3. Electrical

Table 74: Electrical specifications

Description	Value
Voltage	12 VDC ±0.6 V
Power consumption (total)	<2.2 W
Power output maximum current	15 mA

7.4. Optical

Table 75: Optical specifications

Description	Value
Wavelength	905 nm (infrared)
Laser risk group	IEC 60825-1:2014 (Third Edition); Class I laser product
Beam width and height (HFoV and VFoV)	See Table 76 below.

Table 76: HFoV and VFoV

Horizontal FoV[2]	Vertical FoV[2]
16° ± 1°	0.3° ± 0.2°
16° ± 1°	2° ± 0.6°
48° ± 3.5°	0.3° ± 0.15°
48° ± 3.5°	3° ± 0.6°
99° ± 5°	0.3° ± 0.15°
99° ± 5°	3° ± 0.25°

[2] Sensitivity of the module across the horizontal FoV (segment amplitude efficiency) and vertical FoV (amplitude vs. tilt). See Fig. 74.

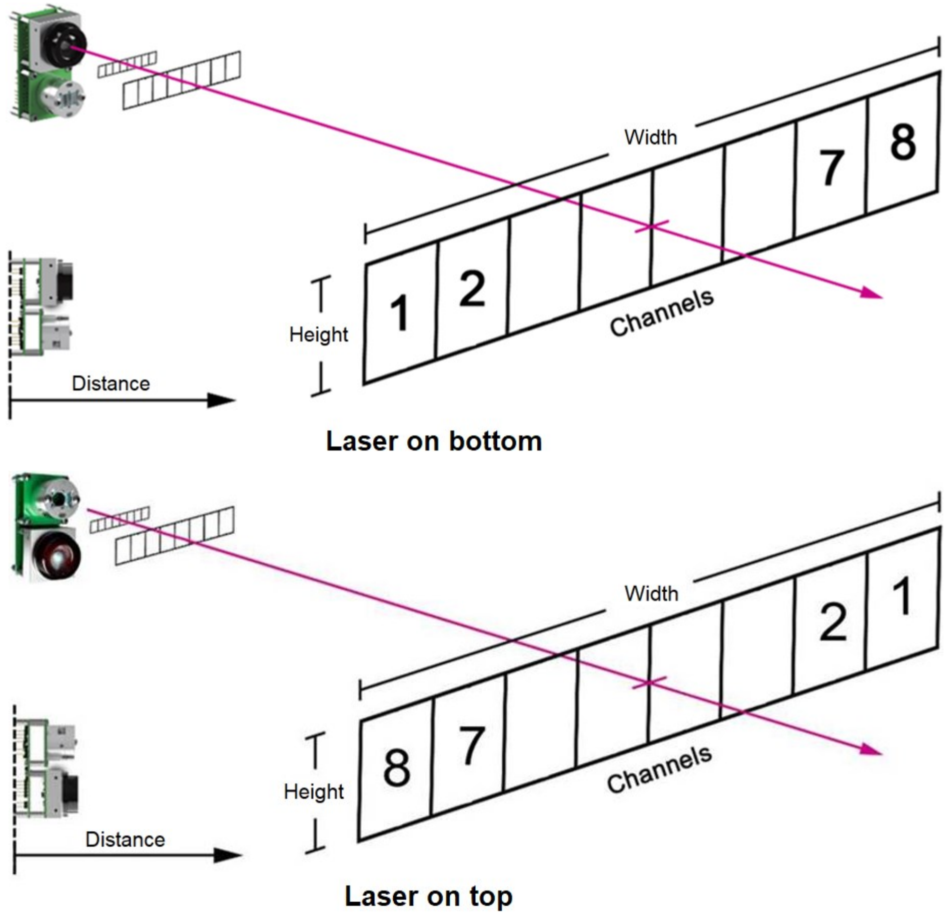

Fig. 74: Horizontal field of view (HFoV) and vertical field of view (VFoV)

7.5. Performance

Table 77: Module performances

Performance Metric	Value
Measurement accuracy[3]	±5 cm
Measurement precision	6 mm (amplitude >15)
Resolution	1 cm
Range (maximum light source intensity)	Varies with beam optics and target properties (see amplitude vs. range figures below).
Data refresh rate	Up to 100 Hz (standard board)

[3] For oversampling of 4 and more.

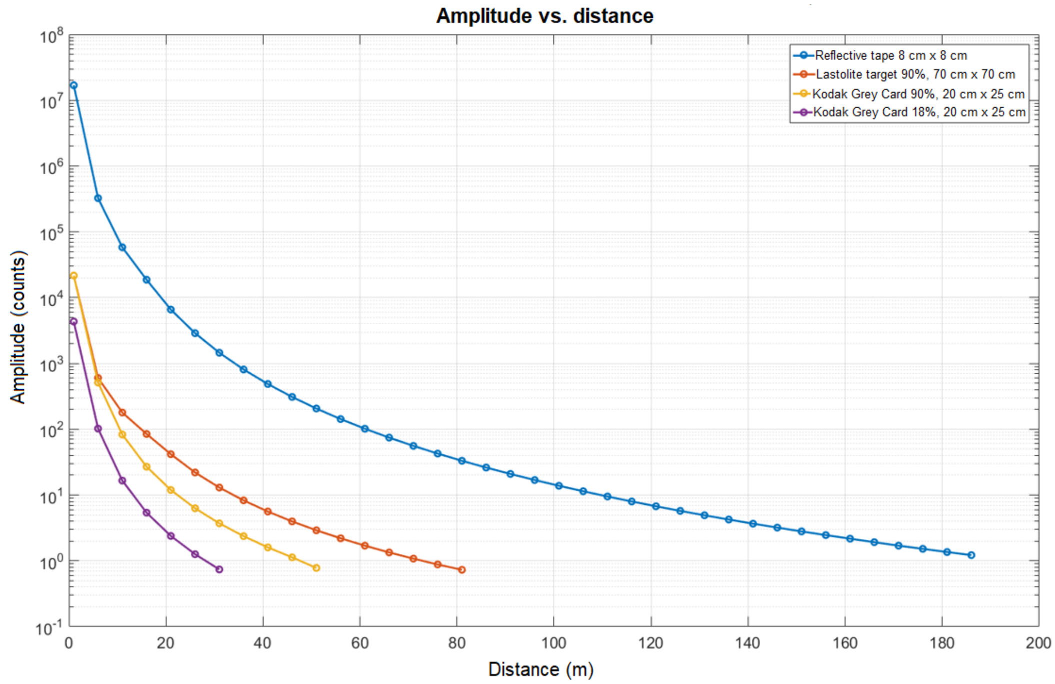

Fig. 75: 16° x 0.3°
(Maximum intensity, accumulation = 256, oversampling = 8)

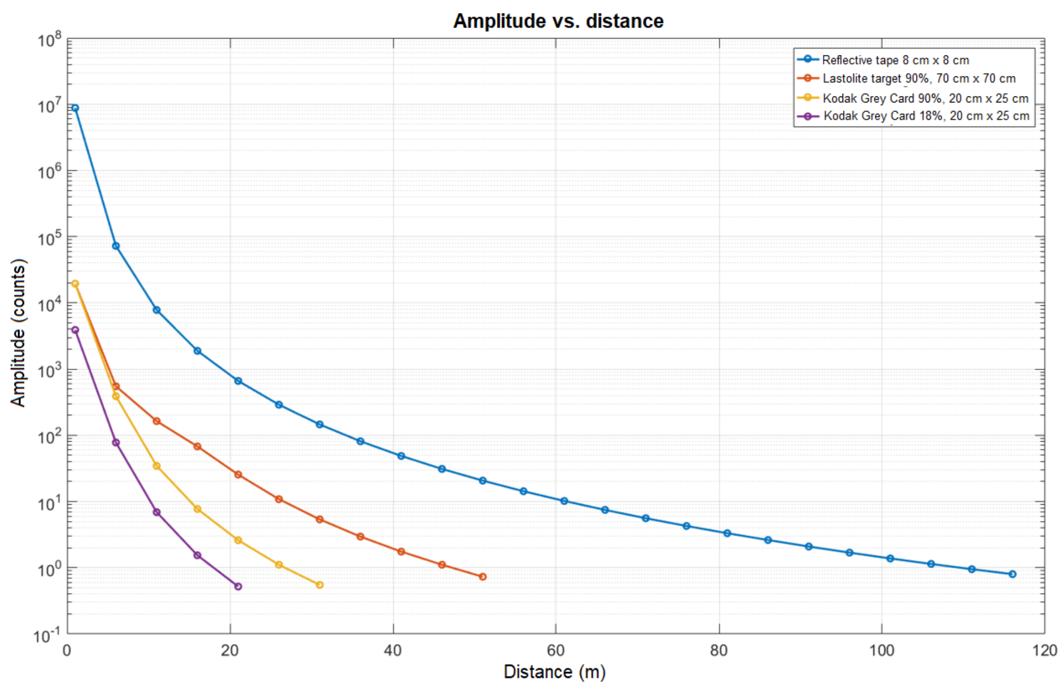

Fig. 76: 16° x 2°
(Maximum intensity, accumulation = 256, oversampling = 8)

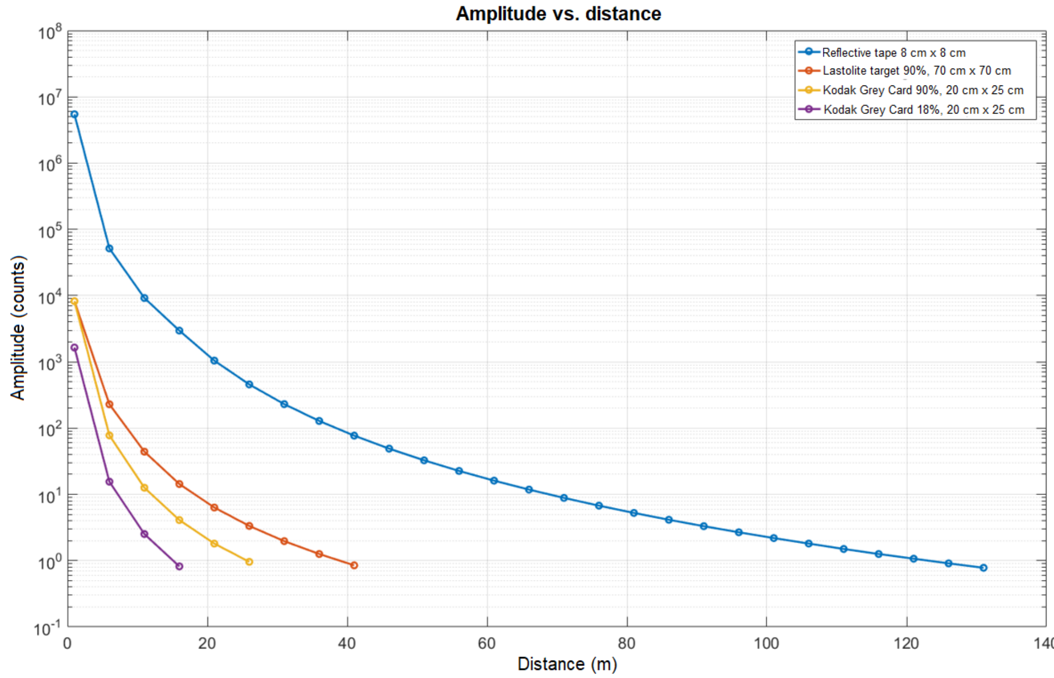

Fig. 77: 48° x 0.3°
(Maximum intensity, accumulation = 256, oversampling = 8)

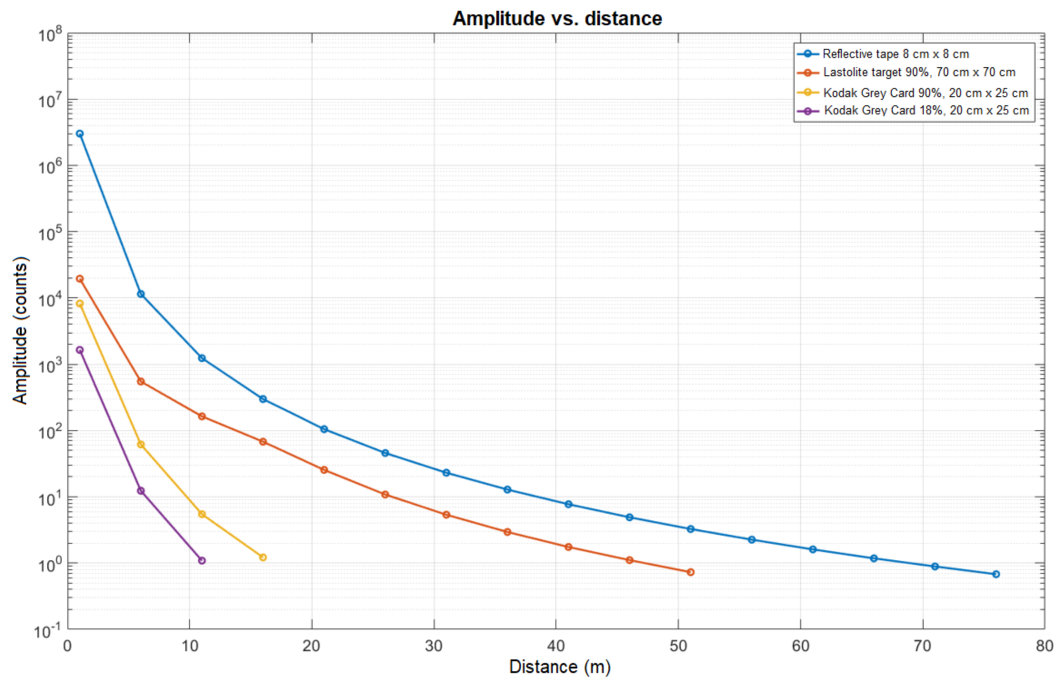

Fig. 78: 48° x 3°
(Maximum intensity, accumulation = 256, oversampling = 8)

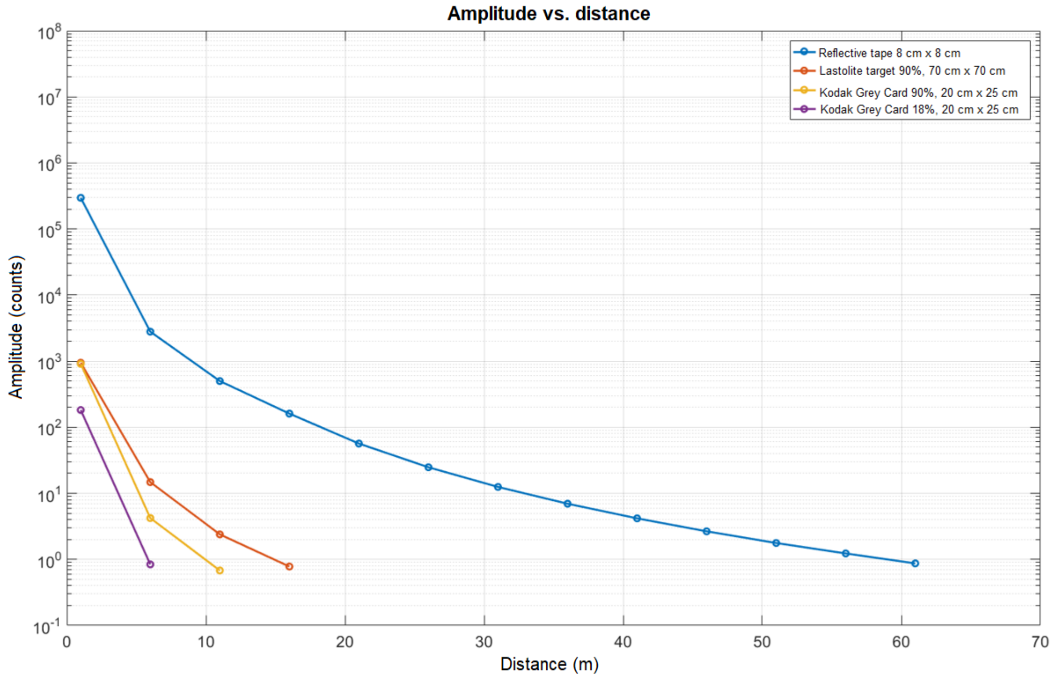

Fig. 79: 99°x 0.3°
(Maximum intensity, accumulation = 256, oversampling = 8)

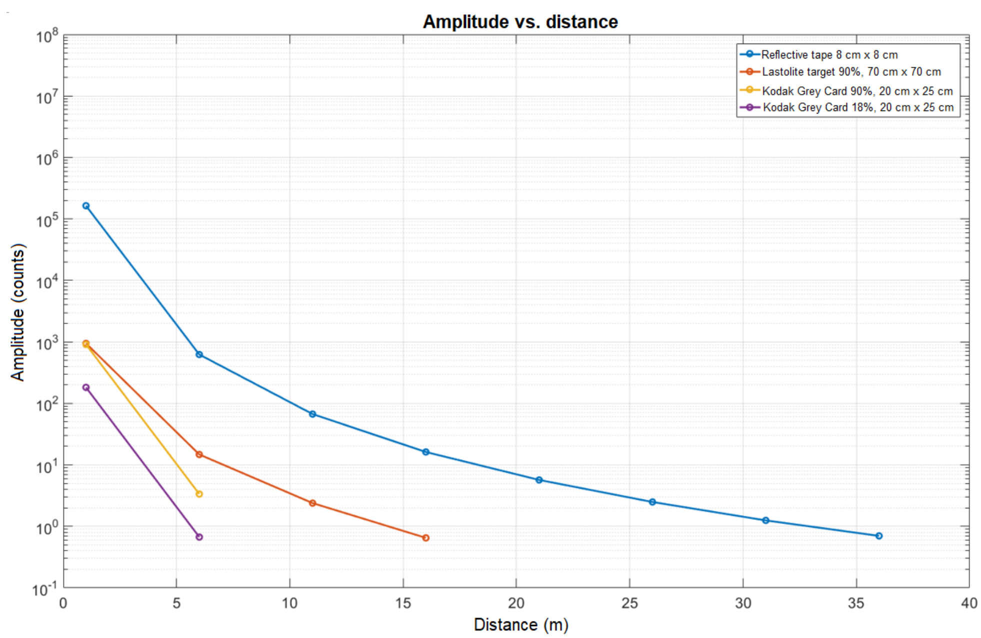

Fig. 80: 99° x 3°
(Maximum intensity, accumulation = 256, oversampling = 8)

7.6. Dimensions

7.6.1. 99° Module

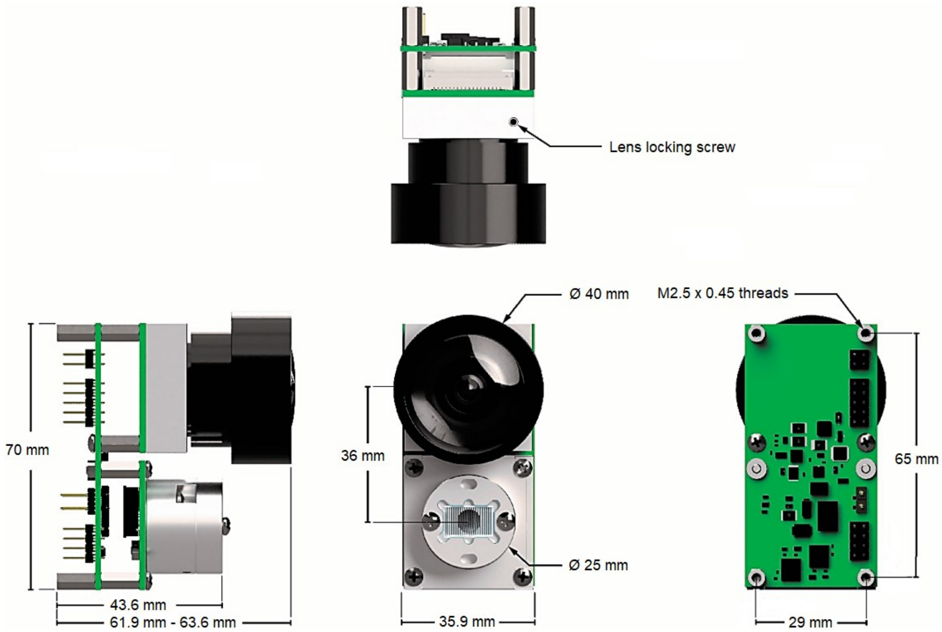

Fig. 81: 99° module dimensions

7.6.2. 48° Module

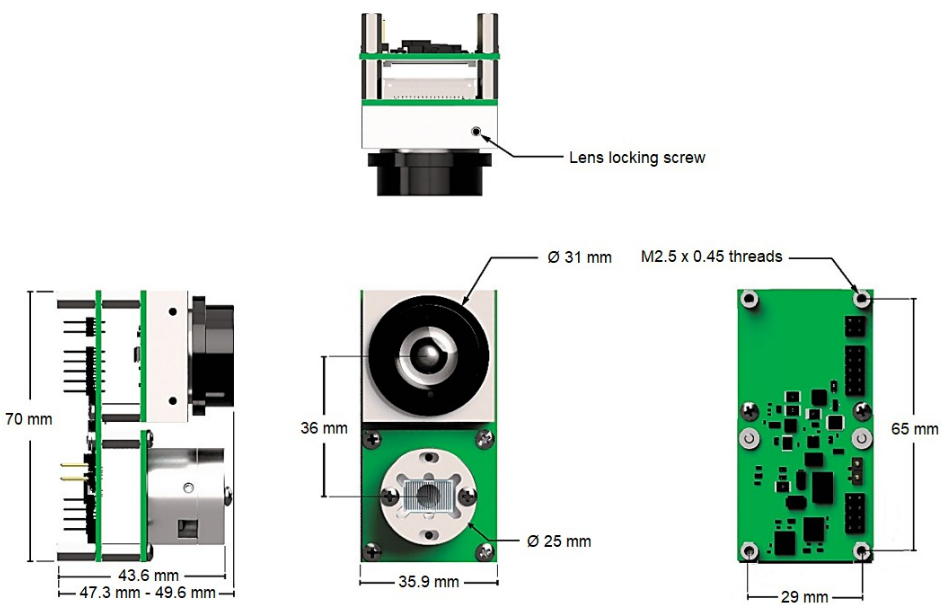

Fig. 82: 48° module dimensions

7.6.3. 16° Module

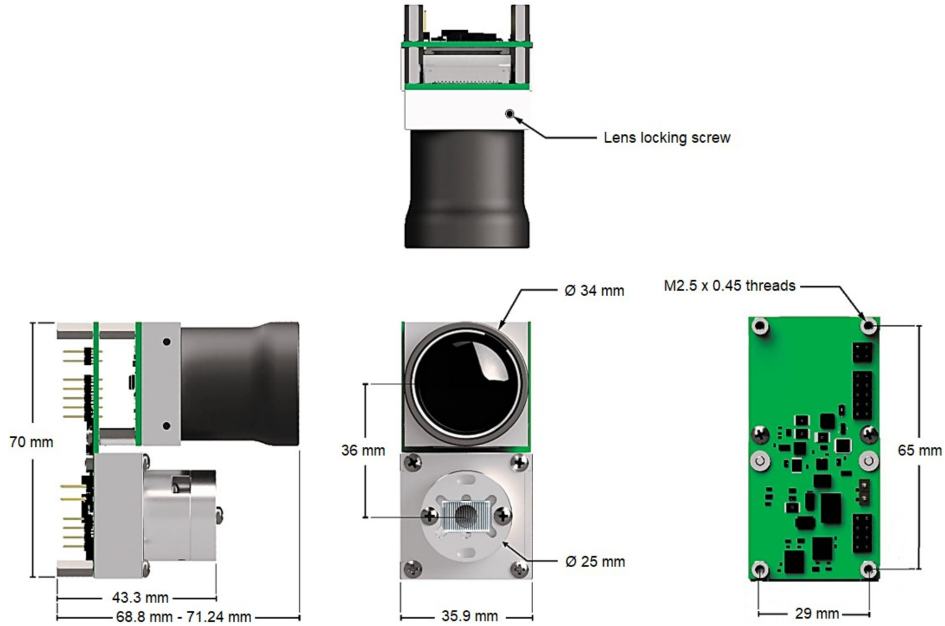

Fig. 83: 16° module dimensions

8. Troubleshooting

Contact LeddarTech for troubleshooting information concerning the Leddar Vu8 module.

9. Maintenance

Manipulation	⚠ *Avoid touching the optical surfaces as fingerprints can permanently damage the optical coatings.*
Cleaning the optical surfaces	• Blow off dust using compressed air. • Clean the optical surfaces with premium-grade optical tissues only. ⚠ *Do not use cotton-tipped applicators. If needed, clean the optical surfaces with isopropyl alcohol instead.*

For any questions or concerns on how to safely perform maintenance operations on the Leddar Vu8 module, contact LeddarTech support at support@leddartech.com.

10. Disposal

Like any electronic equipment, the Leddar Vu8 module contains environmentally unsustainable components. Dispose of in an environmentally responsible manner.

11. Technical Support

For technical enquiries, contact LeddarTech technical support at support@leddartech.com to easily:

- follow up on your requests
- find quick answers to questions
- get valuable updates

Also, see the contact information at the end of this document.

Please have all relevant information such as part numbers, serial numbers and pictures to facilitate support.

Appendix A. Example of a 0x04 Function (Read Input Register)

Transmitted message

01 04 00 01 00 27 E1 D0

Use the 0x04 command to read 39 consecutive registers starting at address 01. On device with Modbus address 01, using the CRC D0 E1.

Received message

01 04 4E 00 01 00 08 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 08 00 64 00 00 B0 F7 00 00 00 0F 00 0E 00 0C 00 0D 00 0E 00 12 00 16 00 19 5A E3 5B F5 5E 26 62 29 63 92 75 13 7C 2B 5B 66 00 01 00 01 00 01 00 01 00 01 00 09 00 09 00 01 66 6F

1, 8, 0, 0, 0, 0, 0, 0, 0, 0, 8, 100, 0, 45303, 0, 15, 14, 12, 13, 14, 18, 22, 25, 23267, 23541, 24102, 25129, 25490, 29971, 31787, 23398, 1, 1, 1, 1, 1, 9, 9, 1

Header: 1, 8, 0, 0, 0, 0, 0, 0, 0, 0, 8, 100, 0, 45303, 0

(Address 1) Status for Polling mode: 1 = Detections ready

(2) Number of segments: 8 = 8 segments

(11) Number of detection: 8 = 8 detections

(12) Light source power: 100 = 100%

(14&15) Timestamp: 45303 = 45303 ms

Distance (first detection only): 15, 14, 12, 13, 14, 18, 22, 25

(Address 16) Segment #8 = 15 cm

(17) Segment #7 = 14 cm

(18) Segment #6 = 12 cm

(19) Segment #5 = 13 cm

(20) Segment #4 = 14 cm

(21) Segment #3 = 18 cm

(22) Segment #2 = 22 cm

(23) Segment #1 = 25 cm

Amplitude (first detection only): 23267, 23541, 24102, 25129, 25490, 29971, 31787, 23398

(Address 24) Segment #8 = 23267 / 64 = 363.55 counts

(25) Segment #7 = 23541 / 64 = 367.83 counts

(26) Segment #6 = 24102 / 64 = 376.59 counts

(27) Segment #5 = 25129 / 64 = 392.64 counts

(28) Segment #4 = 25490 / 64 = 398.28 counts

(29) Segment #3 = 29971 / 64 = 468.30 counts

(30) Segment #2 = 31787 / 64 = 496.67 counts

(31) Segment #1 = 23398 / 64 = 365.59 counts

Flag (first detection only): 1, 1, 1, 1, 1, 9, 9, 1

(Address 32) Segment #8 = 1 = Valid

(33) Segment #7 = 1 = Valid

(34) Segment #6 = 1 = Valid

(35) Segment #5 = 1 = Valid

(36) Segment #4 = 1 = Valid

(37) Segment #3 = 9 = Saturation

(38) Segment #2 = 9 = Saturation

(39) Segment #1 = 1 = Valid

Appendix B. Example of a 0x41 Modbus Function

Transmitted data stream message

01 41 C0 10

Use the 0x41 command to read on device Modbus address # 01, using the CRC 10 C0.

Received data stream message

01 41 08 25 00 52 81 09 07 25 00 49 81 09 06 24 00 4F 81 09 05 25 00 05 81 09 04 29 00 A9 7D 09 03 2E 00 96 66 01 02 35 00 CC 47 01 01 39 00 64 33 01 00 F0 4C 1A 00 64 00 00 D2 EE

Get detection messages (first byte)

Modbus address: 01 hex = 1 = Address#1

Function code: 0x41 hex = 65 = function 0x41

Number of detections: 08 hex = 8 = 8 detections

Get detection messages (detection fields)

(1) 25 00 52 81 09 07:
Distance (cm): 00 25 hex = 37 cm = 0.37 m

Amplitude (count): 81 52 hex = 33106 / 64 = 517.28 counts

Flag: 09 hex = 9 (Saturation)

Segment #: 07 hex = 7 (Segment #8)

(2) 25 00 49 81 09 06:
Distance (cm): 00 25 hex = 37 cm = 0.37 m

Amplitude (count): 81 49 hex = 33097 / 64 = 517.14 counts

Flag: 09 hex = 9 (Saturation)

Segment #: 06 hex = 6 (Segment #7)

(3) 24 00 4F 81 09 05:
Distance (cm): 00 24 hex = 36 cm = 0.36 m

Amplitude (count): 81 4F hex = 33103 / 64 = 517.23 counts

Flag: 09 hex = 9 (Saturation)

Segment #: 05 hex = 5 (Segment #6)

(4) 25 00 05 81 09 04:
Distance (cm): 00 25 hex = 37 cm = 0.37 m

Amplitude (count): 81 05 hex = 33029 / 64 = 516.08 counts

Flag: 09 hex = 9 (Saturation)

Segment #: 04 hex = 4 (Segment #5)

(5) 29 00 A9 7D 09 03:
Distance (cm): 00 29 hex = 41 cm = 0.41 m

Amplitude (count): 7D A9 hex = 32169 / 64 = 502.64 counts

Flag: 09 hex = 9 (Saturation)

Segment #: 03 hex = 3 (Segment #4)

(6) 2E 00 96 66 01 02:
Distance (cm): 00 2E hex = 46 cm = 0.46 m

Amplitude (count): 66 96 hex = 26262 / 64 = 410.34 counts

Flag: 01 hex = 1 (Valid)

Segment #: 02 hex = 2 (Segment #3)

(7) 35 00 CC 47 01 01:
Distance (cm): 00 35 hex = 53 cm = 0.53 m

Amplitude (count): 47 CC hex = 18380 / 64 = 287.19 counts

Flag: 01 hex = 1 (Valid)

Segment #: 01 hex = 1 (Segment #2)

(8) 39 00 64 33 01 00:
Distance (cm): 00 39 hex = 57 cm = 0.57 m

Amplitude (count): 33 64 hex = 13156/ 64 = 205.56 counts

Flag: 01 hex = 1 (Valid)

Segment #: 00 hex = 0 (Segment #1)

Get detection messages (trailing fields)

(1) F0 4C 1A 00 64 00 00:
TimeStamp (ms): 00 1A 4C F0 hex = 1 723 632 ms = 1723 s

Light source POWER (%): 64 hex = 100 = 100%

Bit field acq. (reserved): 00 00 hex = 0

CRC (16bits Modbus) = EE D2

Appendix C. Example of a Leddar Vu8 CAN Bus Detection Request

A request is sent to the sensor; this request is an 8-byte message that is addressed to the message ID 0x740. The sensor then replies with multiple 8-byte messages addressed to the message ID 0x750 +.

There are two possible modes:

1. For example, to obtain a detection frame (polling), in the **multiple message** mode, send this request: 0x740: 02, 01, 00, 00, 00, 00, 00, 00

   The sensor will then answer with the following sequence:

   0x750: 02 01 00 00 00 00 00 00: echo of the successful request

   0x751: 08 64 00 00 41 8D 26 00: number of detections (8), LED power (100%), timestamp (2526529 msec)

   0x752: 77 05 8F 00 01 00 07 00: detection of channel #7, distance (0x0577 = 1399 cm), amplitude (0x008F = 143/64 = 2.2344 counts), flag info (0x0001 = valid)

   0x753: 0E 05 D3 00 01 00 06 00: detection of channel #6

   0x754: 05 05 EC 00 01 00 05 00: detection of channel #5

   0x755: 03 05 F9 00 01 00 04 00: detection of channel #4

   0x756: 0D 05 F2 00 01 00 03 00: detection of channel #3

   0x757: 1B 05 ED 00 01 00 02 00: detection of channel #2

   0x758: 2D 05 B9 00 01 00 01 00: detection of channel #1

   0x759: 97 05 9F 00 01 00 00 00: detection of channel #0

2. For the sensor to send data streaming in the **simple message** mode, initiate the communication with the request:

   0x740: 03, 00, 00, 00, 00, 00, 00, 00

   The sensor will then answer with the following sequence:

   0x750: 03 00 00 00 00 00 00 00: echo of the successful request

   0x751: 08 64 00 00 41 8D 26 00: detection frame N: number of detections (8), LED power (100%), timestamp (2526529 msec)

   0x752: 77 05 8F 00 01 00 07 00: detection of channel #7, distance (0x0577 = 1399 cm), amplitude (0x008F = 143/64 = 2.2344 counts), flag info (0x0001 = valid)

   0x752: 0E 05 D3 00 01 00 06 00: detection of channel #6

   0x752: 05 05 EC 00 01 00 05 00: detection of channel #5

   0x752: 03 05 F9 00 01 00 04 00: detection of channel #4

   0x752: 0D 05 F2 00 01 00 03 00: detection of channel #3

   0x752: 1B 05 ED 00 01 00 02 00: detection of channel #2

   0x752: 2D 05 B9 00 01 00 01 00: detection of channel #1

   0x752: 97 05 9F 00 01 00 00 00: detection of channel #0

   0x751: 08 64 00 00 41 8D 26 00: detection frame N+1

   0x752: 77 05 8F 00 01 00 07 00

0x752: 0E 05 D3 00 01 00 06 00

0x752: 05 05 EC 00 01 00 05 00

0x752: 03 05 F9 00 01 00 04 00

0x752: 0D 05 F2 00 01 00 03 00

0x752: 1B 05 ED 00 01 00 02 00

0x752: 2D 05 B9 00 01 00 01 00

0x752: 97 05 9F 00 01 00 00 00

0x751: 08 64 00 00 41 8D 26 00: detection frame N+2

0x752: 77 05 8F 00 01 00 07 00

0x752: 0E 05 D3 00 01 00 06 00

0x752: 05 05 EC 00 01 00 05 00

0x752: 03 05 F9 00 01 00 04 00

0x752: 0D 05 F2 00 01 00 03 00

0x752: 1B 05 ED 00 01 00 02 00

0x752: 2D 05 B9 00 01 00 01 00

0x752: 97 05 9F 00 01 00 00 00

To stop the data streaming, send the request:

0x740: 01, 00, 00, 00, 00, 00, 00, 00

The sensor the responds with the following message:

0x750: 01 00 00 00 00 00 00 00: echo of the successful request

LEDDARTECH INC.

www.leddartech.com

HEADQUARTERS

4535, boulevard Wilfrid-Hamel, Suite 240

Québec (Québec) G1P 2J7, Canada

Phone: + 1-418-653-9000

Canada or USA (toll-free): 1-855-865-9900

support@leddartech.com

sales@leddartech.com

CANADA – USA – AUSTRIA – FRANCE – GERMANY – ITALY – ISRAEL – HONG KONG – CHINA

More information on our offices worldwide can be found at: leddartech.com/contact-us