



# LeddarVu

# User Guide



**LeddarTech Inc.**  
2740 Einstein Street  
Quebec, Quebec G1P 4S4  
CANADA

[www.leddartech.com](http://www.leddartech.com)

---

Copyright © 2016 LeddarTech Inc. All rights reserved.

The Company shall not be liable for any errors contained herein or for any damages arising out of or related to this document or the information contained therein, even if the Company has been advised of the possibility of such damages.

The information contained herein is the property of LeddarTech Inc., and shall not be reproduced in whole or in part without prior written approval of LeddarTech Inc. LeddarTech Inc. assumes no responsibility for any errors or omissions in this document.

Leddar is a trademark of LeddarTech Inc. All other trademarks are the property of their respective owners.

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

---

# Table of Contents

<b>1.</b>	<b>Introduction .....</b>	<b>6</b>
1.1.	Description.....	6
1.2.	Standard Board.....	8
1.3.	Enhanced Board .....	9
1.4.	Working Diagram .....	12
1.4.1.	Standard Board.....	13
1.4.2.	Enhanced Board.....	13
<b>2.</b>	<b>Underlying Principles.....</b>	<b>15</b>
<b>3.</b>	<b>Getting Started .....</b>	<b>16</b>
3.1.	Setup .....	16
3.2.	Connecting to the LeddarVu Module .....	19
<b>4.</b>	<b>Measurements and Settings.....</b>	<b>22</b>
4.1.	Distance Measurement.....	22
4.2.	Data Description .....	23
4.3.	Acquisition Settings .....	25
4.4.	Measurement Rate .....	30
4.5.	CPU Load .....	31
<b>5.</b>	<b>Communication Interfaces.....</b>	<b>33</b>
5.1.	SPI Interface .....	33
5.1.1.	SPI Basics .....	33
5.1.2.	SPI Protocol.....	34
5.1.3.	Memory Map.....	37
5.1.4.	SPI Operation .....	42
5.2.	I2C Interface .....	43
5.3.	USB Interface .....	43
5.4.	Serial Link Interface .....	44
5.5.	CAN Bus Interface .....	56

---

<b>6.</b>	<b>Leddar™ Configurator .....</b>	<b>66</b>
6.1.	Introduction to Configurator Software .....	66
6.2.	Connection Window .....	67
6.3.	Leddar™ Configurator Main Window .....	68
6.3.1.	Toolbar .....	68
6.3.2.	Fit to Window .....	68
6.3.3.	Force Equal Horizontal and Vertical Scales.....	69
6.3.4.	Zoom in.....	69
6.3.5.	Zoom out.....	69
6.3.6.	Scale.....	69
6.3.7.	Panning and Zooming .....	69
6.3.8.	Changing the LeddarVu Module Origin .....	72
6.3.9.	Changing the LeddarVu Module Orientation .....	73
6.4.	Settings.....	74
6.4.1.	Module Name.....	75
6.4.2.	Acquisition Settings .....	76
6.4.3.	Serial Port.....	77
6.4.4.	CAN Port.....	78
6.5.	Saving and Loading a Configuration .....	80
6.6.	Configuring Detection Records .....	80
6.7.	Using Detection Records.....	83
6.8.	Data Logging .....	84
6.9.	Device State.....	87
6.10.	Preferences .....	89
6.11.	Raw Detections .....	91
<b>7.</b>	<b>Specifications .....</b>	<b>95</b>
7.1.	General.....	95
7.2.	Mechanical .....	95
7.3.	Electrical.....	95
7.4.	Optical.....	96
7.5.	Performance .....	97
7.6.	Regulatory Compliancy.....	103
7.7.	Dimensions .....	103
7.7.1.	100° Module.....	104
7.7.2.	48° Module.....	105
7.7.3.	20° Module.....	106

---

<b>8. Help.....</b>	<b>107</b>
<b>Index.....</b>	<b>108</b>

---

# 1. Introduction

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

The module can be configured to be used in very simple applications or to perform more complex tasks depending on the hardware and software settings.

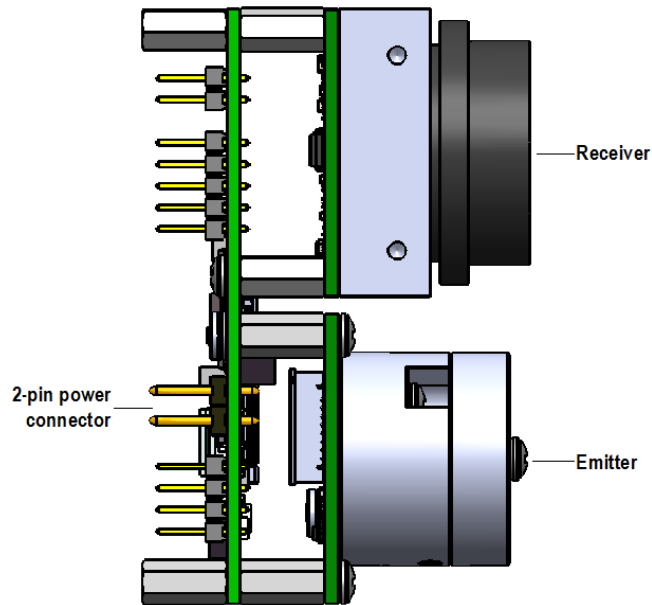
## 1.1. Description

The LeddarVu module contains the following:

- Source
- Receiver

The module comes in two configurations: standard and enhanced carrier boards. According to your configuration, they offer the following features:

- Horizontal FoV: 20°, 48°, 100°
- Vertical FoV: 0.3°, 3°
- 8 detection segments
- Real-time data acquisition and display (through SPI)
- SPI (Serial Peripheral Interface) for the direct link with the receiver (standard board)
- I2C interface to read the optional temperature sensor on the source module (standard board)
- Serial link interface: TTL, RS-232, RS-422, and RS-485 (enhanced board)
- USB interface (enhanced board)
- CAN bus interface for acquisition (enhanced board)



**Figure 1: General elements of the LeddarVu module**

#### **Receiver assembly**

The receiver assembly contains the photodetector array (8 elements), the circuit receiver, and an M7 Atmel processor (MCU).

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

#### **Emitter assembly**

The emitter assembly includes the emitter (LED, VSCSEL, and laser), the emitter driver circuit, and the temperature sensor.

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

#### **Power connection**

The power connection is a 2-pin connector that provides the module with a 12-V power source.

---

## 1.2. Standard Board

The following presents the description of the standard board.

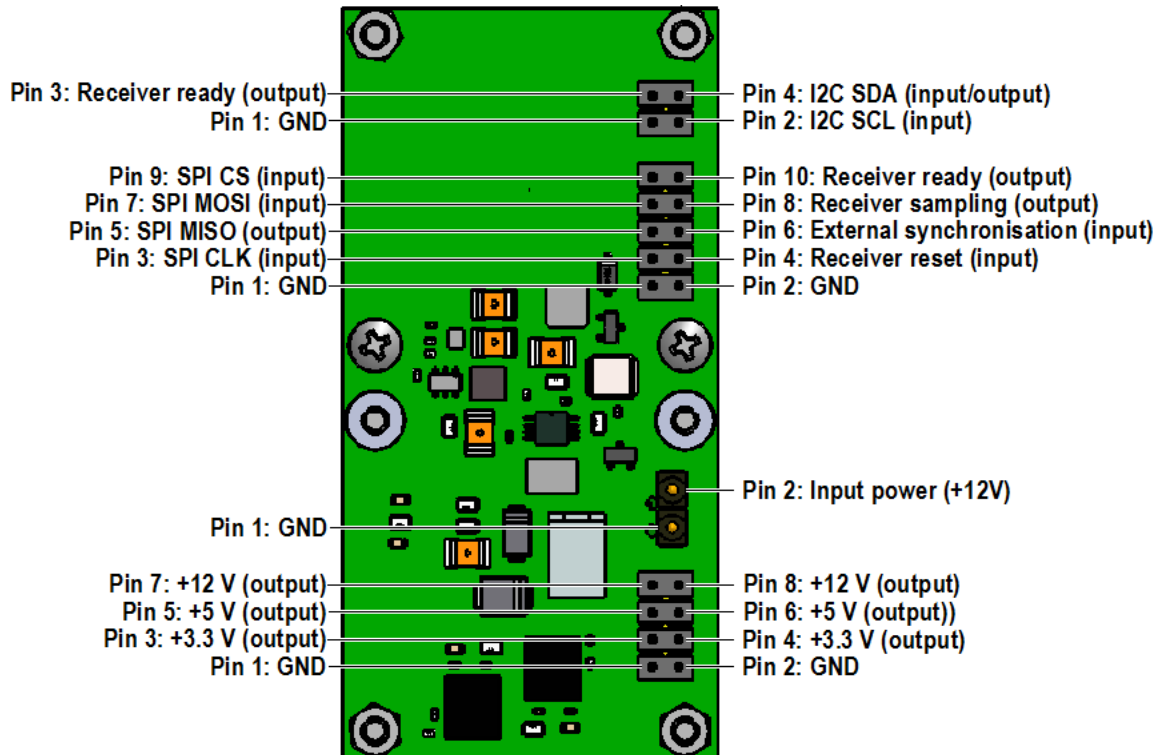


Figure 2: Board of the standard LeddarVu module



---

## 1.3. Enhanced Board

The following presents the description of the enhanced board.

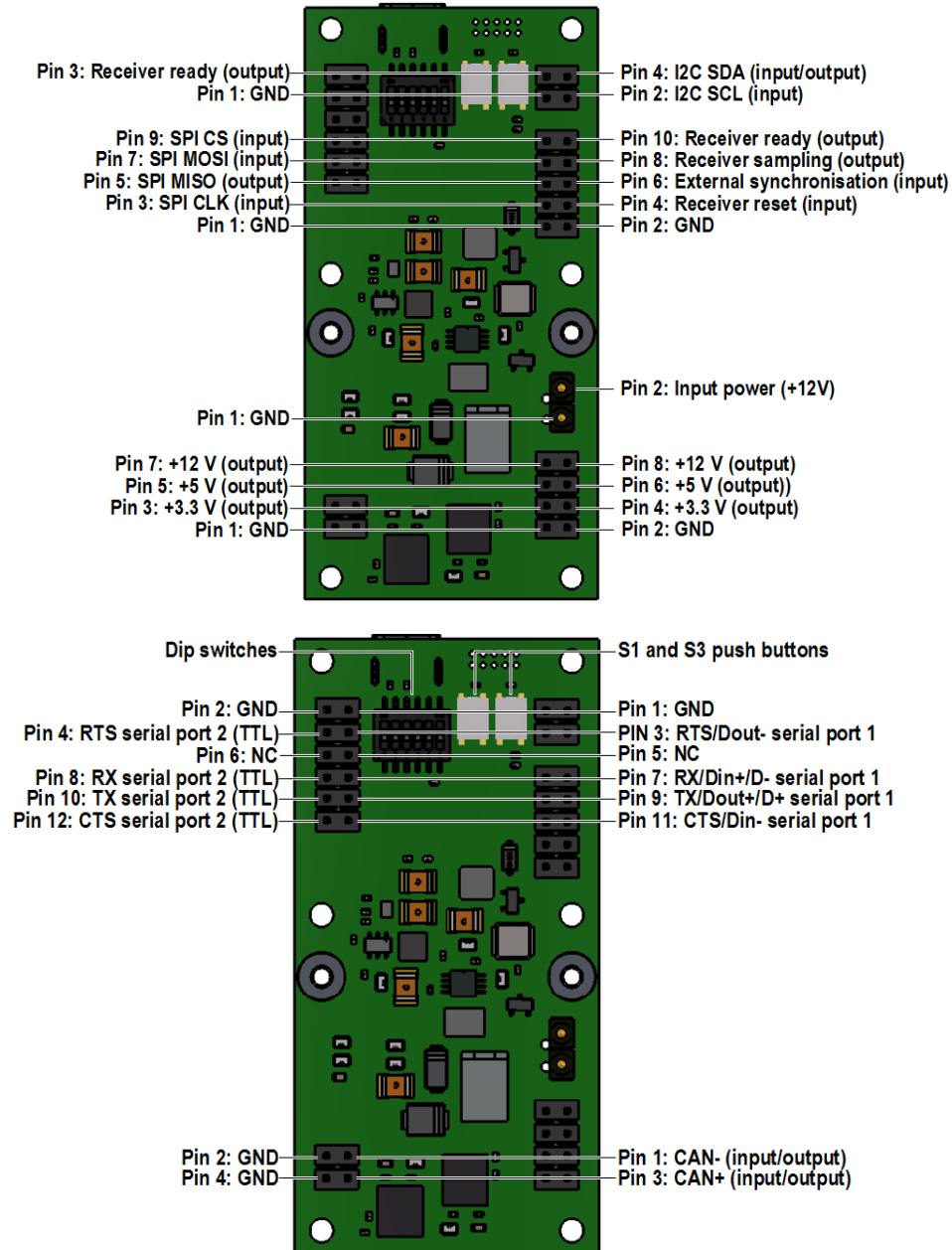


Figure 3: Board of the enhanced LeddarVu module

---

### DIP Switches

The DIP switches are used for the configuration of the serial port number 1. This port is configurable to these EIA electrical interface 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**

Interface	DIP switches position					
	1	2	3	4	5	6
<b>RS-232</b>	OFF	OFF	ON	OFF	OFF	X
<b>RS-485 two-wire configuration</b>	ON	ON	OFF	ON	ON	X
<b>RS-422 RS-485 four-wire configuration</b>	ON	OFF	ON	OFF	OFF	X

**NOTE:** On all port configuration, the module is still a half-duplex slave.

### Configurable serial link 1

Depending on the DIP switch positions, the configurable serial link pin functionalities differ (refer to Table 2).

---

**Table 2: Communication link configuration**

Pin position	Interface		
	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 -

**NOTE:** If a two-wire or four-wire differential port configuration is selected, in function of your 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 a hard reset purpose; a short press resets the module.

The S3 push button is used for special purposes (refer to Table 3).

**Table 3: The S3 push button functionalities**

Description	Action
A long press during module operation (more than 10 seconds)	<p>Resets the carrier board configuration to the default values:</p> <p>CAN port configuration</p> <ul style="list-style-type: none"><li>• 1Mbps, standard frame format</li><li>• Base Rx: 0x740</li><li>• Base Tx: 0x750</li><li>• No delay</li><li>• Distance in cm and a max. of 96 echoes</li></ul> <p>Serial link configuration</p> <ul style="list-style-type: none"><li>• 115,200 bps, 8 bits, no parity, no flow control, 1 stop bit</li><li>• Distance in cm and a max. of 40 echoes</li><li>• Modbus address: 1</li></ul>

A press (more than 2 seconds) at start up or on for a hard reset button release.	<p>Put the enhanced carrier board in the bootloader mode. This feature is used to upgrade the enhanced carrier board firmware.</p> <p>Use the LeddarTech software tool to upgrade firmware. (coming soon )</p>
--	--

## 1.4. Working Diagram

The working diagram explains how the module works in the standard and optional configurations.

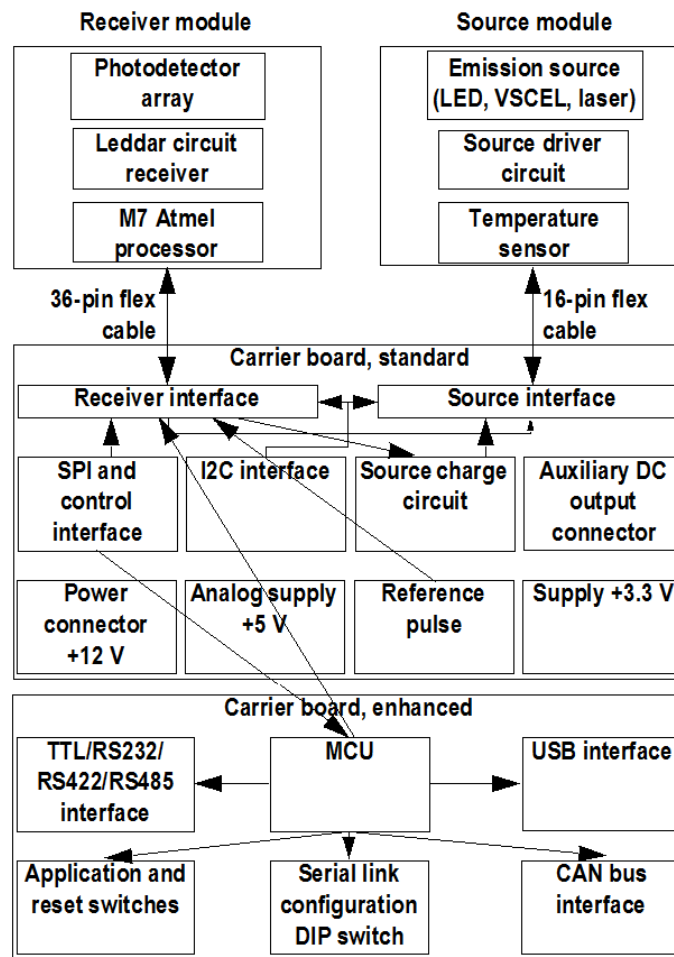


Figure 4: LeddarVu module working diagram

---

### 1.4.1. Standard Board

The standard carrier board includes the following elements:

#### **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 through 3.3 V.

**Table 4: SPI pin definition**

Pin	Function
3	CLK (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 circuit. As for the SPI, it is only intended for short distance communications. The port has a standard signal level of 0 V through 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.

#### **Reference pulse**

The reference pulse interacts with the receiver interface to set the reference segment.

### 1.4.2. Enhanced Board

The optional carrier board includes the standard elements and the following ones:

#### **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 through 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 Mbit/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-wire 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 OM 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 of them are used to configure serial link 1 (see Figure 2 and Figure 3).

#### **CAN bus interface**

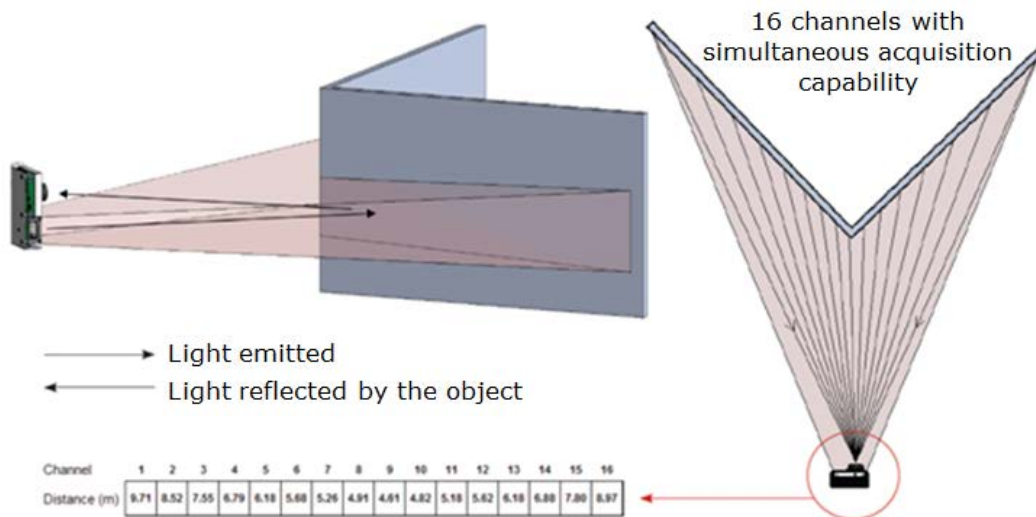
The CAN bus is implemented via a differential pair. The ISO 11898 standard describes the CAN technology. The interface has a level of 3.3 V.

---

## 2. Underlying Principles

Created by LeddarTech, LEDDAR™ (light-emitting diode detection and ranging) is a unique sensing technology based on LED illumination (infrared spectrum) and the time-of-flight of light principle. The LED emitters illuminate the area of interest (pulsed typically at 51.2 kHz for the 8-segment module) and the multichannel module receiver collects the backscatter of the emitted light and measures the time taken for the emitted light to return back to the module. An 8- or 16-channel photodetector array is used and provides multiple detection and ranging segments. Full-waveform analysis enables 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.

Figure 5 illustrates the illumination area and detection segments. In this cases, the 16 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.



**Figure 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

This chapter presents the steps to install Leddar™ Configurator and start using the M16.

### 3.1. Setup

This section presents the Leddar™ Configurator installation and the procedure to set up the LeddarVu module. All software operations are described in chapter 6.

**To install Leddar™ Configurator:**

1. In the computer CD/DVD drive, insert the software CD.

The installation software starts automatically.

OR

Download the LeddarInstaller.exe file from our Web site at (<http://support.leddartech.com/login>).

If you are a new user, fill the form and click Submit.

If you are a registered user, login by entering your e-mail address and password, and click Log In.

In the Download section, click a product and then click LeddarInstaller.exe. Double-click the file to start the installation.

2. On the computer desktop, double-click the **Leddar™ Configurator** icon.
3. In the **Welcome to the Leddar™ Software 3 Setup Wizard** dialog box, click **Next**.





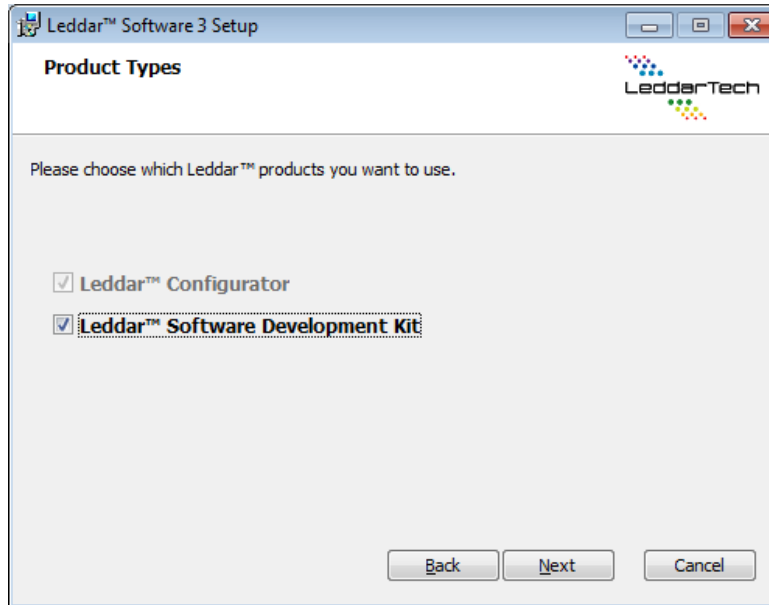
Figure 6: Welcome to the Leddar™ Software 3 Setup Wizard dialog box

4. 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, and click **Next**.



Figure 7: End-User License Agreement dialog box

- 
5. In the **Product Types** dialog box, the **Leddar™ Software Development Kit** check box is selected by default.



**Figure 8: Product Types dialog box**

6. Click **Next**.
7. In the **Destination Folder** dialog box, click **Next** to select the default destination folder.
- OR
- Click the **Change** button to choose a destination folder.
8. In the **Ready to Install Leddar™ Software 3** dialog box, click the **Install** button.
9. In the **Completed the Leddar™ Software 3 Setup Wizard** dialog box, click **Finish**.

Leddar™ Configurator creates an icon on the computer desktop.


---

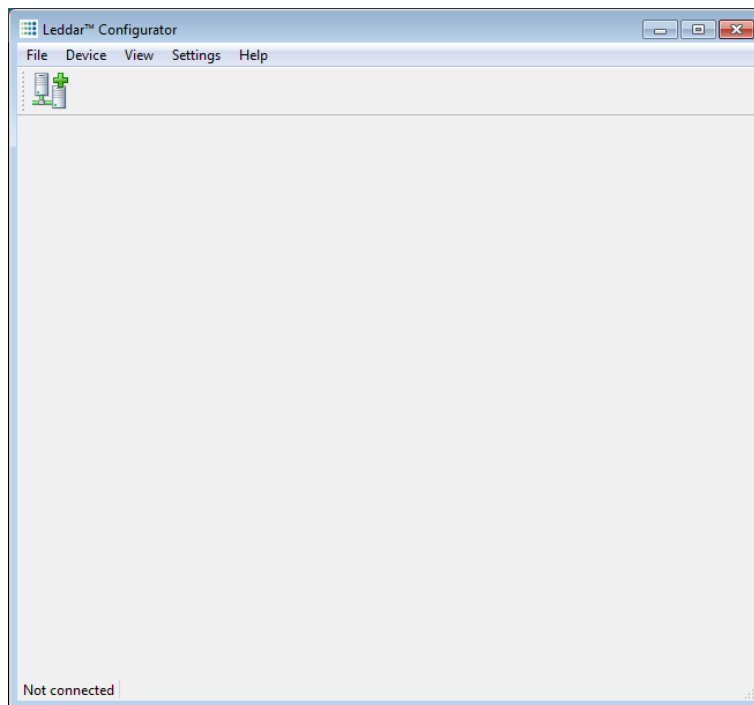
## 3.2. Connecting to the LeddarVu Module

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 LeddarVu module to create your configuration.

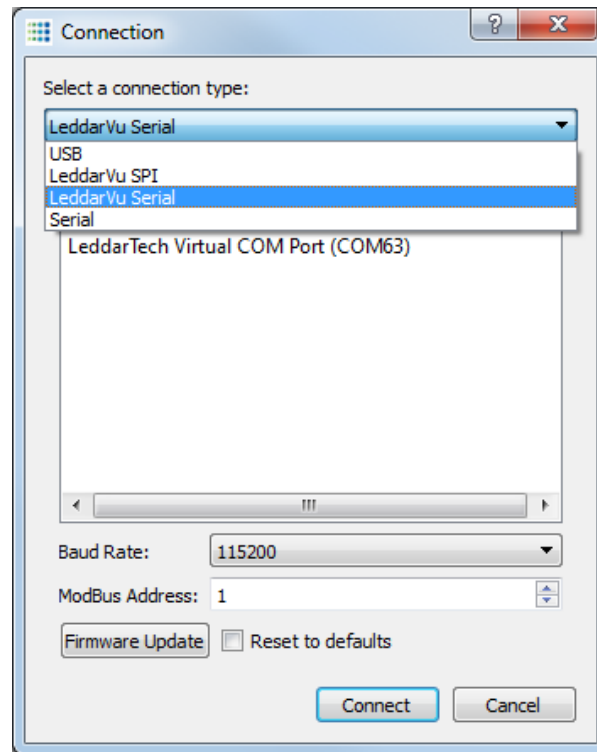
### To connect to the module:

1. Connect the power cable to the module and to a power source.
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 button (  ).



**Figure 9: Connecting to a module**

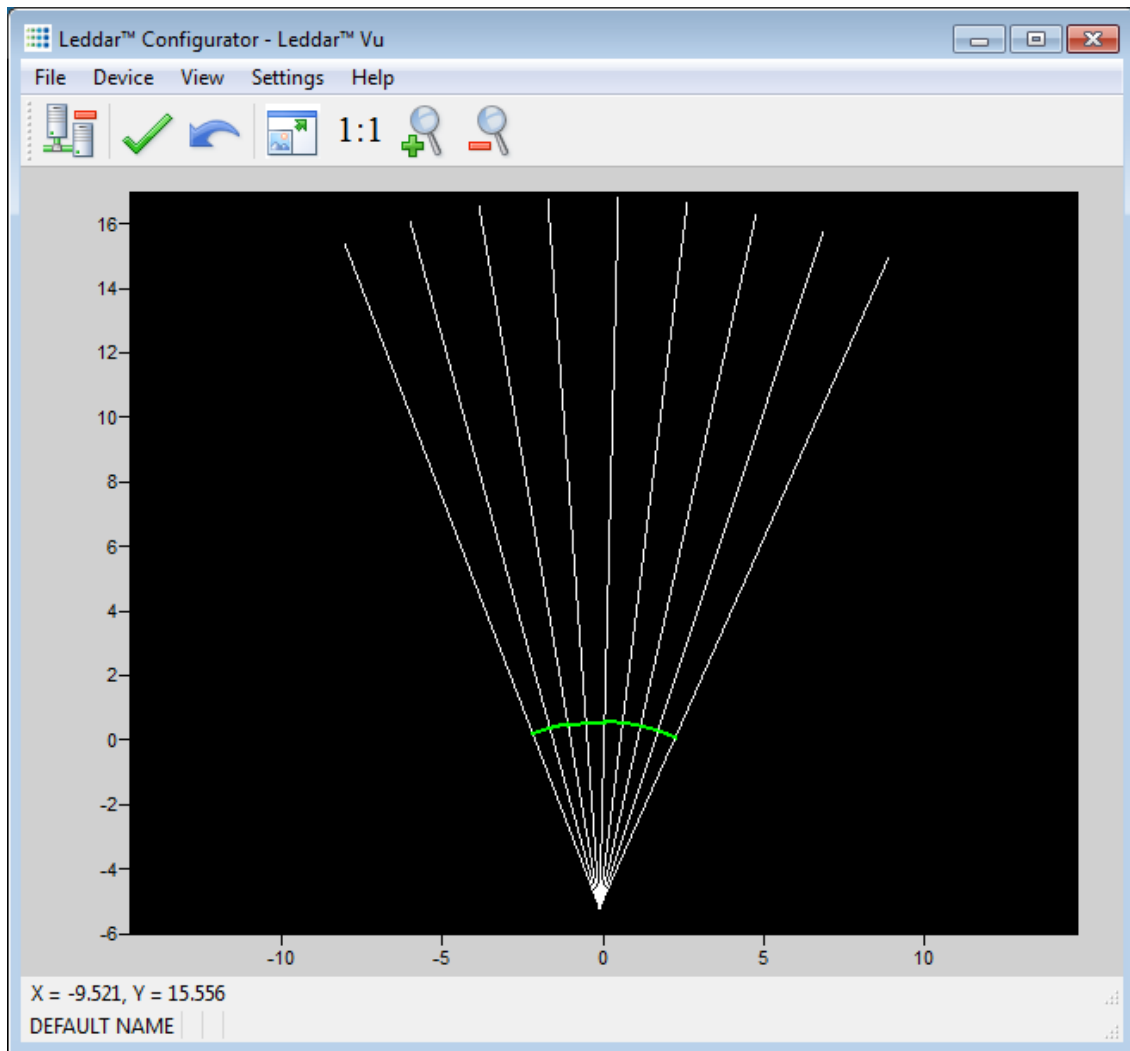
- 
5. In the **Connection** dialog box, in the **Select a connection type** list, select either **LeddarVu SPI** for a standard board or **LeddarVu Serial** for an enhanced board.



**Figure 10: Connection dialog box**

6. In the **Available ports** list, select the product and click the **Connect** button.

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



**Figure 11: Main window**

A complete description of Leddar™ Configurator features and parameters for the LeddarVu module can be found in chapter 6.

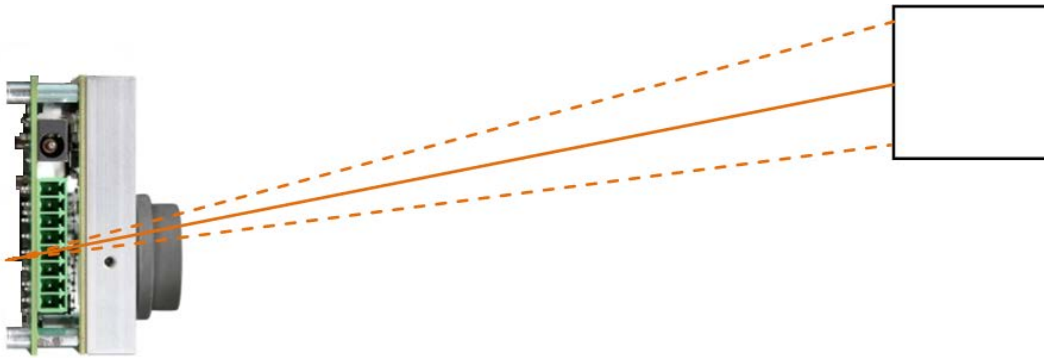
---

## 4. Measurements and Settings

This chapter presents measurements, settings, and zone definition for the LeddarVu module.

### 4.1. Distance Measurement

Distance is measured from the base of the standoffs for the LeddarVu module).



**Figure 12: Distance measurement**

The dashed lines illustrate 1 of the 8 segments and the solid line indicates the distance measured by the module in that segment.

---

## 4.2. Data Description

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

Seg	Distance	Amplitude	Flags
8	5.788	226.3	1
7	5.773	306.0	1
6	5.766	345.8	1
5	5.780	402.6	1
4	5.752	444.8	1
3	5.733	435.3	1
2	5.798	305.9	1
1	5.835	183.6	1

**Figure 13: Raw Detections dialog box**

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

**Table 5: Raw detection table 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 module.
Flags	8-bit status (bit field). See Table 6.

---

The **Flag** parameter provides the status information that indicates the measurement type.

**Table 6: Flag value description**

Bit position	Bit = 0	Bit = 1
0	Invalid measurement	Valid measurement
1	Normal measurement	Measurement is the result of demerge processing
2	Reserved	Reserved
3	Normal measurement	Received signal is above the saturation level. Measurements are valid (VALID is set) but have a lower accuracy and precision. Consider decreasing the LED intensity.
4	Reserved	Reserved
5	Reserved	Reserved
6	Reserved	Reserved
7	Reserved	Reserved
8	Reserved	Reserved
9	Reserved	Reserved

The **Flag** field provisions for 8 bits encoded as a bit field. Three bits are currently used. The following table presents the implemented decimal values of the status bit field.

**Table 7: Status value description**

Status value (decimal)	Status value (binary)	Description
1	00000001	Normal measurement (valid)
9	00001001	Saturated signal (valid)

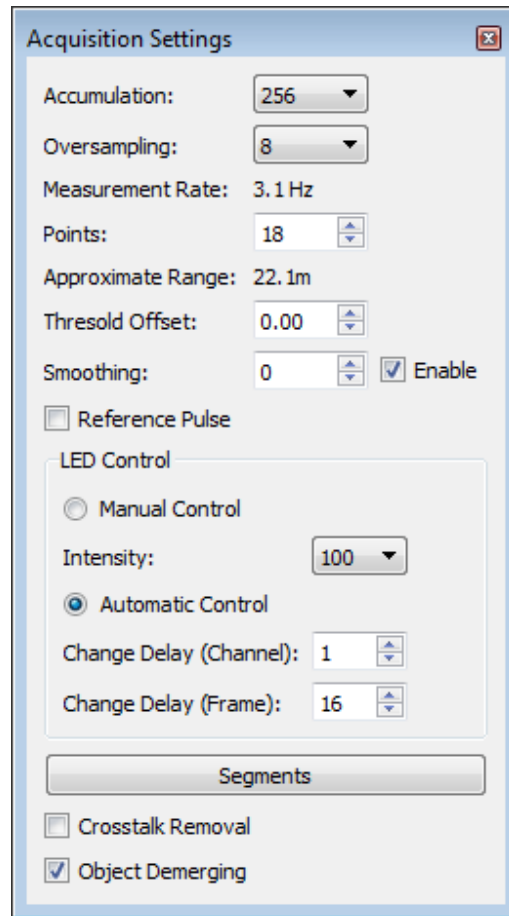


---

## 4.3. Acquisition Settings

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

To open the **Acquisition Settings** dialog box, on the **Device** menu, point to **Configuration** and click **Acquisition**.



**Figure 14: Acquisition Settings dialog box**

The numbers on a grey background are modified only by using the arrows, while the ones on a white background can additionally be modified manually by the numeric keypad of your keyboard.

To apply new acquisition settings, click the apply button (✓).

---

**Table 8: Acquisition setting description**

Parameter	Description	Effect
Accumulation	Number of accumulations	Higher values enhance the range, and reduce the measurement rate and noise.
Oversampling	Number of oversampling cycles	Higher values enhance the accuracy/precision/resolution and reduce the measurement rate.
Points	Number of base sample points	Determines the maximum detection range.
Threshold Offset	Modification to the amplitude threshold	Higher values decrease the sensitivity and reduce the range.
Smoothing	Object smoothing algorithm	<p>Smooths the LeddarVu module measurements.</p> <p>The behavior of the smoothing algorithm can be adjusted by a value ranging from -16 to 16. Higher values enhance the module precision, but reduce the module reactivity.</p> <p>The smoothing algorithm can be deactivated by clearing the <b>Enable</b> check box.</p> <p>The measurement smoothing algorithm is advised for application that need to measure slowly moving objects with a high precision.</p> <p>The application requiring to quickly track moving objects, the smoothing should be configured with a value lower than 0 or simply deactivated.</p>
LED Control	LED power control options	Selects between manual and automatic power control. In automatic, LED power is adjusted according to incoming detection amplitudes. The current LED power level is visible in the <b>Device State</b> window ( <b>View</b> menu, <b>State</b> command).
Change Delay (Channel and Frame)	Minimum delay between power changes	Smaller numbers speed up the response time of the LED power adjustment.
Crosstalk Removal	Inter-segment interference noise removal	<p>Crosstalk is a phenomenon inherent to all multiple segments 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.</p> <p>This option enables an algorithm to compensate the degradation due to crosstalk.</p> <p>This algorithm increases the computational load of the LeddarVu module microcontroller. It is recommended to disable the crosstalk removal if the module is configured to run at rates higher than 50 Hz.</p>

---

### **Accumulation**

When you increase the accumulation value, you reduce the noise as well as the measurement rate. Depending on your application, a reduction of the noise might be more important than a high measurement rate.

### **Oversampling**

When you increase the accumulation value, you increase the resolution (accuracy) but you reduce the measurement rate. Depending on your application, a higher resolution might be more important than a high measurement rate.

### **Points**

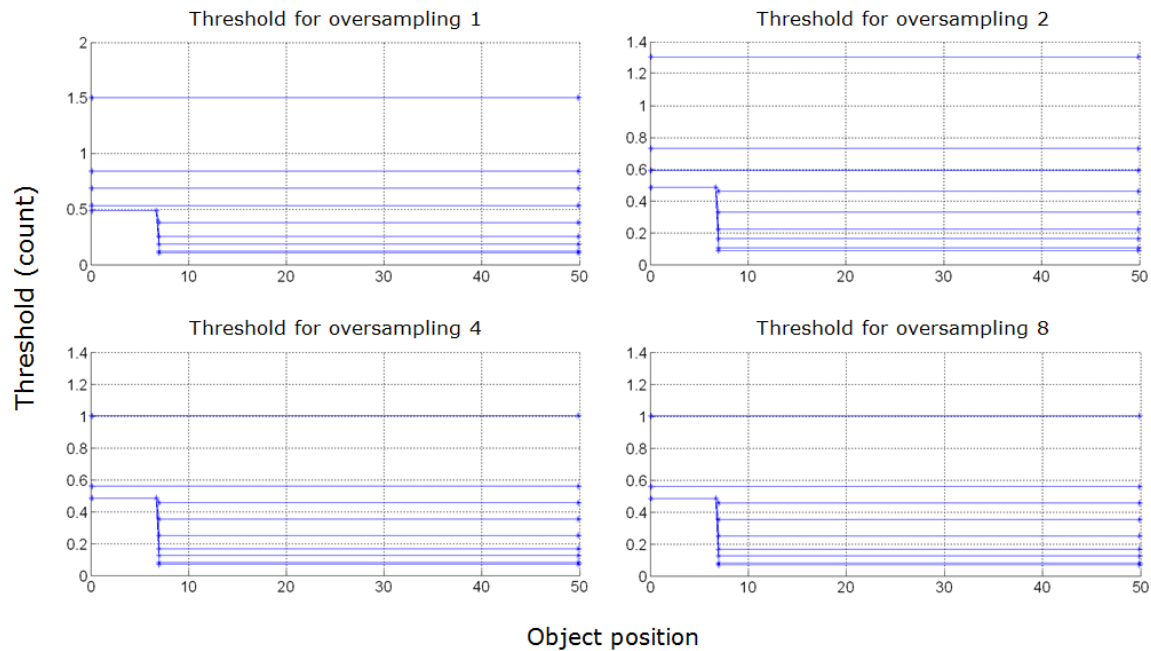
Determines the maximum detection range. It also has an impact on the processing load since it impacts the number of sample points to process for each segment.

### **Threshold offset**

The threshold offset is a value that modifies 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.

Figure 15 presents the threshold table for a LED intensity of 16. This table is effective when the threshold offset value is 0.



**Figure 15: Detection threshold example**

The multiple lines on each graph present the thresholds for numbers of 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 the sensitivity (positive value) or increasing the sensitivity (negative value) of the module. Increasing the value of the threshold offset allows ignoring (will not result in a measurement) signals with amplitude higher than the default threshold. Decreasing the value of the threshold offset allows measurements of amplitude signals lower than the default threshold.

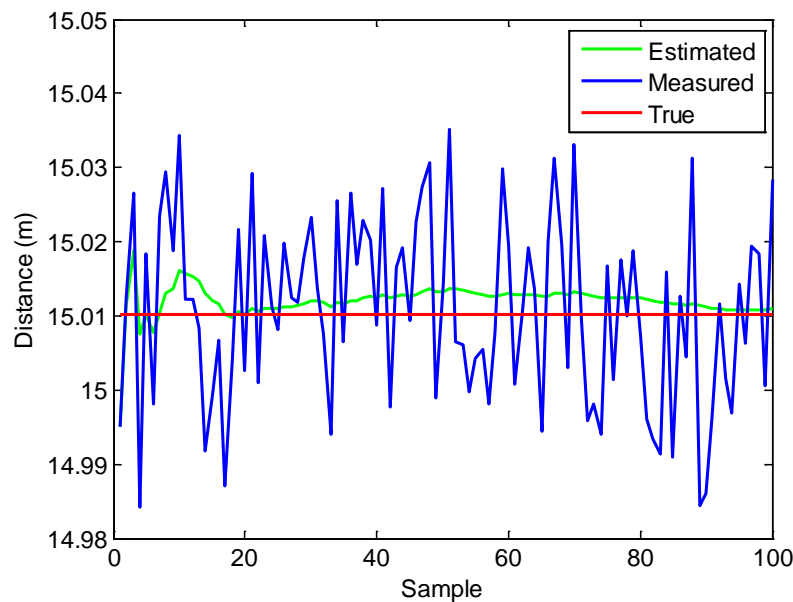
**NOTE:** The default setting (0) is selected to ensure a very low occurrence of false measurements.

False measurements are likely to occur when reducing the threshold offset (negative values). These false measurements are very random in occurrence while true measurements will be 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 LeddarVu module 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. Higher values increase the module precision, but reduce the module reactivity. An example of the behavior of the measurement smoothing algorithm is depicted in Figure 16.



**Figure 16: Measurement smoothing example**

The red line represents the true target distance; the blue curve corresponds to the target distance measured by the module without smoothing, while the green curve is the smoothed measurements. One could notice the measurement precision (standard deviation) is dramatically improved by the smoothing algorithm.

**NOTE:** *The smoothing algorithm is recommended for applications that need highly precise measurements of slowly moving objects. For application that tracks quickly moving objects, it is advised to decrease the value of the smoothing parameter or to disable the smoothing algorithm.*

---

## LED Control

There is a total of 5 LED power levels. Their approximate relative power is evenly distributed between 0 through 100%.

The change delay defines the number of measurements required before allowing the LeddarVu module to increase or decrease by one the LED power level. For example, with the same change delay, the maximum rate of change (per second) of the LED power will two times higher at 12.5 Hz than at 6.25 Hz.

**NOTE:** *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 oversampling parameters).*

Keeping the module in automatic LED power mode (default setting) ensures it adapts to varying environments. Close range objects may reflect so much light they can saturate the module, reducing the quality of the measurements. This mode will adapt the light output within the change delay setting to reach the optimal amplitude. On the other hand, low amplitudes provide lower accuracy and precision. The automatic LED power mode will select a LED intensity that provides the highest intensity that avoids the saturation condition.

**NOTE:** *When a strongly reflective or near object is present in the field of view while monitoring farther distances, the automatic adjustment will reduce the effective range of the module (reduce LED intensity) and may prevent detection of long range or low reflectivity objects. For these applications, manual mode with LED power set to 100% may be a better setting.*

## 4.4. Measurement Rate

The LeddarVu module acquires a base input waveform for each segment at a rate of 6.4 kHz. Multiple acquisitions are used to perform accumulations and oversampling, and generate a final waveform that is then processed to detect the presence of objects and measure their position.

*The final measurement rate is therefore:*

$$\text{Measurement rate} = \text{base rate} / \text{accumulations} / \text{oversampling}$$

For example, with 256 accumulations and an oversampling value of 8:

$$\text{Measurement rate} = 6400 / 256 / 8 = 3.13 \text{ Hz}$$

Table 9 presents the measurement rate for typical values of accumulations and oversampling.

---

**Table 9: Measurement rate**

<b>Accumulation</b>	<b>Oversampling</b>	<b>Measurement Rate (Hz)</b>
1024	8	0.76
512	8	1.65
256	8	3.13
128	8	6.25
64	8	12.5
32	8	25
1024	4	1.65
512	4	3.13
256	4	6.25
128	4	12.5
64	4	25
32	4	50

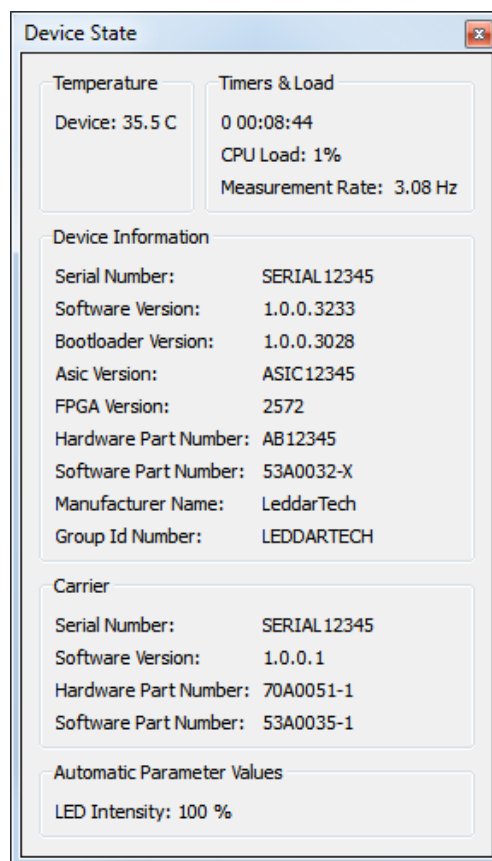
## **4.5. CPU Load**

The measurement rate varies with the accumulations and oversampling settings. The higher the rate, the higher the processing load is on the source and control assembly microcontroller. The **Point** parameter, in the **Acquisition Settings** dialog box, (**Device** menu, **Configuration > Acquisition**) also has an impact on the processing load since it impacts 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 accumulations, oversampling, and point count 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%.



**Figure 17: Device State window**



---

## 5. Communication Interfaces

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

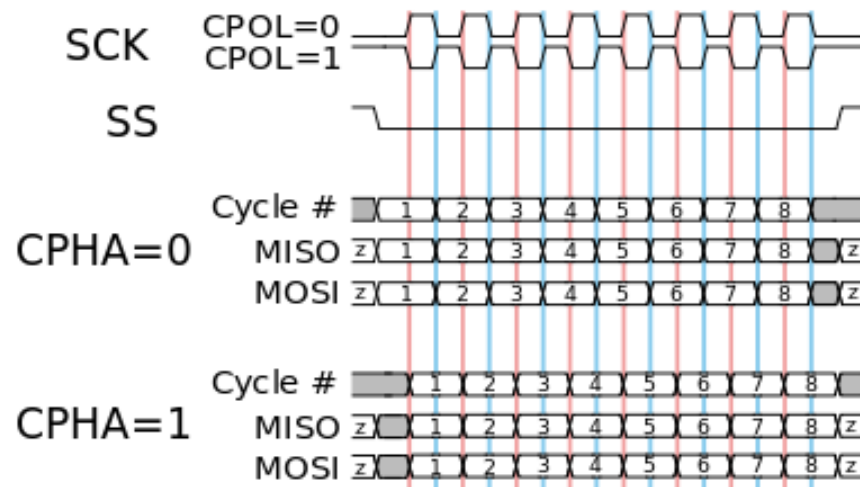
### 5.1. SPI Interface

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

The SPI interface available with the enhanced board is a port connected to MCU but not implemented for the moment.

#### 5.1.1. SPI Basics

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



**Figure 18: Standard SPI timing diagram**

The Table 10 presents the basic clock signal modes.

---

**Table 10: 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 a number of user-data bytes. The last 16 bits of the packet is the CRC16 (IBM) of both header and payload. The table below summarizes the structure of an SPI packet. It is noted that 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 11: 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 presented in Table 12.

---

**Table 12: SPI opcode commands**

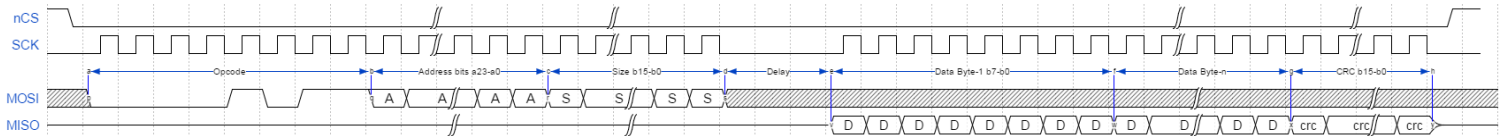
Mnemonic	Opcode	Operation	Description
READ	0x0B	Read data	The read command returns data from memory starting at the selected address. It needs a delay between the group containing the opcode, address, and size data, and the return data stream to let the receiver module to decode the request and get the 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 deassert 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 (refer to Table 4).
WREN	0x06	Write enabled	The write enabled command disables the write protection in order to modify any parameters.
WRDIS	0x04	Write disabled	The write disabled command enables the write protection to lock the module from any parameter changes.
SOFT_RST	0x99	Software reset	The software reset command resets the receiver module.

The status register and bit flags are presented in Table 13.

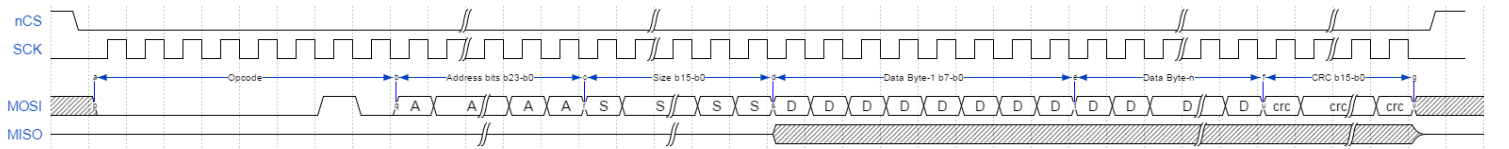
**Table 13: Status register**

Bit	Name	Access	Description
7:2	Reserved	R/W	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)

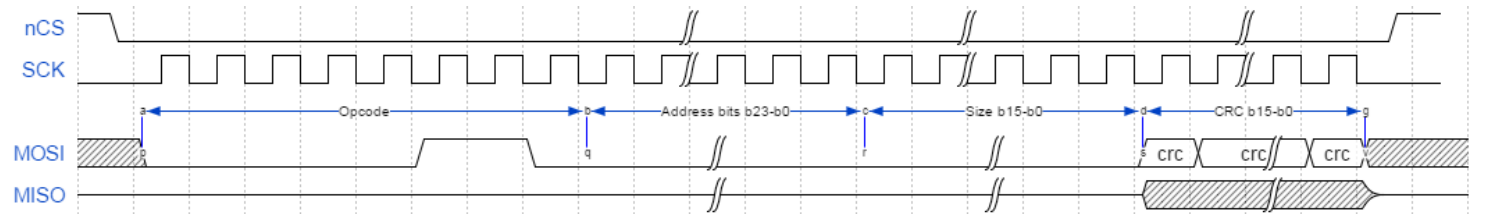
Data chronograms are represented in Figure 19 and Figure 20, and opcode and register chronograms are presented in Figure 21 and Figure 22.



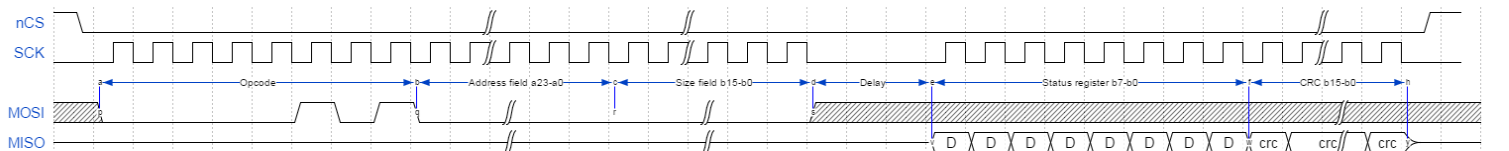
**Figure 19: Read data chronogram**



**Figure 20: Write data chronogram**



**Figure 21: Single opcode chronogram (write enabled example)**



**Figure 22: Read status register chronogram**

---

### 5.1.3. Memory Map

The memory map is divided in four memory banks. This section presents the description of the four memory banks in a table format.

**Table 14: Memory banks**

Bank Number	Start Base Address	Bank Size (KB)	Access	Description
0	0x00000000	1024	R/W	Configuration data
5	0x00400000	128	Read only	Device information and constants
13	0x00500000	1024	Read only	Detection list
19	0x00FFFB00	1	R/W	Transaction configuration

#### Configuration data

**Table 15: Configuration data bank**

Offset	length	Type	Description
0	32	chart	Module name as an ASCII string
32	1	uint8_t	Accumulation exponent
33	1	uint8_t	Oversampling exponent
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 module measurements. The behavior of the smoothing algorithm can be

---

			adjusted by a value ranging from –16 through 16.
68	1	uint8_t	Precision enabled
69	1	uint8_t	Saturation compensation enabled
70	1	uint8_t	Overshoot management enabled
71	4	int32_t	Sensitivity (detection threshold) setting expressed in a raw amplitude scale.
75	1	uint8_t	LED power
76	1	uint8_t	Auto LED power enabled
77	2	uint16_t	Auto frame average: Changes the delay in the number of measurements. This is the responsivity of the auto LED 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 LED power when using the automatic mode). This is the responsivity of the auto LED power according to the number of detections.
80	1	uint8_t	Object demerging enabled
81	1	uint8_t	Static noise removal enabled

#### Device information and constants

**Table 16: Device information and constants bank**

Offset	length	Type	Description
0	32	chart	Module part number as an ASCII string
32	32	chart	Software part number as an ASCII string
64	32	chart	Module serial number as an ASCII string
96	32	chart	Manufacturer name as an ASCII string

---

128	32	chart	Group identification number as an ASCII string
160	32	chart	Build date as an ASCII string
192	32	chart	Firmware version as an ASCII string
224	32	chart	Bootloader version as an ASCII string
256	32	chart	ASIC version as an ASCII string (optionally filled in function of the module)
288	32	chart	FPGA version as an ASCII string
320	2	uint16_t	Module type (9 for the receiver module)
322	4	uint32_t	Module options (LeddarTech 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
340	4	uint32_t	Base point sample distance
344	4	uint32_t	Reference segment mask: bit-field mask indicates the position of the reference segments.
348	2	uint16_t	Number of sample max.
350	1	uint8_t	Refresh rate scale
351	4	uint32_t	Clock frequency
355	1	uint8_t	Maximum number of detections per segment
356	4	uint32_t	Distance scale
360	1	uint8_t	Raw amplitude scale bit
361	4	uint32_t	Raw amplitude scale
365	2	int16_t	Precision min.

---

---

367	2	int16_t	Precision max.
369	4	int32_t	Sensitivity min.
373	4	int32_t	Sensitivity max.
377	1	uint8_t	LED power count
378	2	uint16_t	Auto frame average min.
380	2	uint16_t	Auto frame average max.
382	1	uint8_t	Auto LED power percent min.
383	1	uint8_t	Auto LED power percent max.
384	1	uint8_t	Auto detections average min.
385	1	uint8_t	Auto detections average max.
386	1	uint8_t	Static noise calibration source: 0 = By end-user 1 = By factory
387	4	uint32_t	CPU load scale
391	4	uint32_t	Temperature scale

### Detection list

**Table 17: Detection list bank**

Offset	length	Type	Description
0	4	uint32_t	Timestamp
4	2	uint16_t	Number of detection (N)
6	2	uint16_t	Current percentage of LED power
8	4	uint32_t	Acquisition options
12	N * detection structure size	Array of detection structure	Start of detection list array Refer to Table 18 for details.



---

**Table 18: Detection structure size**

Offset	length	Type	Description
0	4	uint32_t	Distance expressed in distance scale
4	4	uint32_t	Amplitude expressed in raw amplitude scale
8	2	uint16_t	Segment number
10	2	uint16_t	Bit-field detection flags: <ul style="list-style-type: none"><li>• Bit 0: Detection is valid (will always be set)</li><li>• Bit 1: Detection was the result of object demerging</li><li>• Bit 2: Reserved</li><li>• Bit 3: Detection is saturated</li></ul>

### Transaction configuration

**Table 19: Transaction configuration bank**

Offset	length	Type	Description
0	1	uint8_t	Secure-transaction enabled flags: 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.
1	1	uint8_t	Transaction modes: 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: <ul style="list-style-type: none"> <li>• All bits to 0: No transaction error</li> <li>• Bit-0: Access right violation</li> <li>• Bit-1: Invalid address</li> <li>• Bit-2: Command not found</li> <li>• Bit-3: Write disabled</li> <li>• Bit-4: CRC failed</li> <li>• Bit-5: Command execution error</li> <li>• Bit-6: Invalid packet</li> </ul>
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.

##### SPI port configuration

The SPI port must be configured in the 0 mode (refer to section 5.1.1 on page 33) to communicate with the receiver module. To prevent the receiver module to go into the 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.

##### 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 to 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 Figure 19 on page 36).

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

---

## Access

In order 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.

## 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.

**NOTE:** *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 standard 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 datasheet from Texas Instrument.

The I2C interface available with the enhance board is a port connected to MCU but not implemented for the moment.

## 5.3. USB Interface

The USB interface available with the enhance board is a VCP (virtual COM port) serial emulation port. This port is used as a serial link with the Modbus protocol (refer to section 5.4 Serial Link Interface). This interface can also be used to update the enhanced board firmware in the bootloader mode.

---

## 5.4. Serial Link Interface

The serial links can be of the following electric signals: TTL, RS-232, RS-422, and RS-485.

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, please visit [www.modbus.org](http://www.modbus.org).

### Report server ID (function code 0x11)

This function returns information on the LeddarVu module in the following format:

**Table 20: Report server ID messages**

Offset	Length	Description
0	1	Number of bytes of information (excluding this one). Currently 0x99 since the size of information returned is fixed.
1	32	Serial number as an ASCII string
33	1	Run status 0: OFF, 0xFF: ON. Should always return 0 FF, otherwise the module is defective.
34	32	The device name as an ASCII string
66	32	The hardware part number as an ASCII string
98	32	The software part number as an ASCII string
130	8	The full firmware version as 4 16-bit values
138	48	The full bootloader version as 4 16-bit values
146	2	The FPGA-build version
148	4	Module option flags (LeddarTech internal use)
152	2	Module identification code (9 for the module)

### 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.

---

**NOTE:** 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 five bytes (refer to Table 21).

**Table 21: Get detection messages (detection fields)**

Offset	Length	Description
0	2	The distance (little-endian). Distance unit is defined by holding register 14.
2	2	The amplitude times 64 [that is, amplitude = this field/64 (little-endian)]
4	1	3 bits are flags describing the measurement (all others are reserved): 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
5	1	Segment number

Trailing all the detections have 2 more fields (refer to Table 22).

**Table 22: Get detection messages (trailing fields)**

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

### **Read module data (function code 0x42)**

Table 23 and Table 24 present the request and answer codes for reading data. :

**Table 23: Requests**

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

---

**Table 24: Answers**

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

**Write module data (function code 0x43)**

Table 25 and Table 26 present the request and answer codes for writing data.

**Table 25: Requests**

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

**Table 26: Answers**

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

**Send opcode command (function code 0x44)**

Table 27 and Table 28 present the request and answer codes for sending the opcode.

**Table 27: Requests**

Offset	Length	Description
0	1	Opcode, supported opcodes: Read status = 0x05 Write enabled = 0x06 Write disabled = 0x04 Reset configuration = 0x C7 Soft reset = 0x99
1	1	Argument: optional value (must be set to 0x00)

---

**Table 28: 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 29, Table 30, and Table 31 present the requests and answers of the get serial port settings.

**Table 29: Requests**

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

**Table 30: Answers header field**

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

**Table 31: Answers serial port settings field**

Offset	Length	Description
0	1	Logical serial port number
1	4	Baud rate, supported rates: <ul style="list-style-type: none"><li>• 9,600</li><li>• 19,200</li><li>• 38,400</li><li>• 57,600</li><li>• 115,200</li></ul>
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 through 247
10	1	Max. echoes per transactions. Used for the Get Detection command (function code 0x41), max. of 40 echoes.
11	2	Distance resolution: <ul style="list-style-type: none"> <li>• 1 = m</li> <li>• 10 = dm</li> <li>• 100 = cm</li> <li>• 1,000 = mm</li> </ul>

**NOTE:** This answer table is repeated by the number of available serial port.

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

Table 32, Table 33, and Table 34 present the requests and answers for the set serial port settings. .

**Table 32: Requests header field**

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

**Table 33: Requests serial port setting field**

Offset	Length	Description
0	1	Settings of corresponding logical serial port number to set.
1	4	Baud rate, supported rates: <ul style="list-style-type: none"> <li>• 9,600</li> <li>• 19,200</li> <li>• 38,400</li> <li>• 57,600</li> <li>• 115,200</li> </ul>
5	1	Date size: 8 = 8-bit size
6	1	Parity: <ul style="list-style-type: none"> <li>0 = None</li> <li>1 = Odd</li> <li>2 = Even</li> </ul>

---



---

7	1	Stop bit: 1 = 1 stop bit 2 = 2 stop bits
8	1	Flow control: 0 = None
9	1	Modbus address: 1 through 247
10	1	Max. echoes per transactions. Used for the Get Detection command (function code 0x41), max. of 40 echoes.
11	2	Distance resolution: <ul style="list-style-type: none"> <li>• 1 = m</li> <li>• 10 = dm</li> <li>• 100 = cm</li> <li>• 1,000 = mm</li> </ul>

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

**Table 34: Answers**

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

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

Table 35 and Table 36 present the registers for the firmware information commands.

**Table 35: Requests**

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

**Table 36: Answers**

Offset	Length	Description
0	1	Sub-function code: 0x02
1	32	Firmware part number 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 37 and Table 38 present the registers for the carrier device information commands.

**Table 37: Requests**

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

**Table 38: Answers**

Offset	Length	Description
0	1	Sub-function code: 0x03
1	32	Hardware part number ASCII string
33	32	Hardware serial number ASCII string
65	4	Option bits. For Leddar use

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

Table 39, Table 40, and Table 41 present the requests and answers of the get CAN port settings.

**Table 39: Requests**

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

**Table 40: Answers header field**

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

---

**Table 41: Answers CAN port settings field**

Offset	Length	Description
0	1	Logical CAN port number settings
1	4	Baud rate, supported rates: <ul style="list-style-type: none"><li>• 10,000</li><li>• 20,000</li><li>• 50,000</li><li>• 100,000</li><li>• 125,000</li><li>• 250,000</li><li>• 500,000</li><li>• 1,000,000</li></ul>
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 through 96
15	2	Distance resolution: <ul style="list-style-type: none"><li>• 1 = m</li><li>• 10 = dm</li><li>• 100 = cm</li><li>• 1,000 = mm</li></ul>
17	2	Inter-message delay 0 through 65535 milliseconds
19	2	Inter-cycle delay 0 through 65535 milliseconds

**NOTE:** This answer table is repeated by the number of available CAN port.

---

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

Table 42 and Table 43 present the requests and answers for the CAN port commands.

**Table 42: Requests header field**

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

**Table 43: Requests CAN port settings field**

Offset	Length	Description
0	1	Settings of corresponding logical CAN port number to set
1	4	Baud rate, supported rates: <ul style="list-style-type: none"><li>• 10,000</li><li>• 20,000</li><li>• 50,000</li><li>• 100,000</li><li>• 125,000</li><li>• 250,000</li><li>• 500,000</li><li>• 1,000,000</li></ul>
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 through 96
15	2	Distance resolution: <ul style="list-style-type: none"><li>• 1 = m</li><li>• 10 = dm</li><li>• 100 = cm</li><li>• 1,000 = mm</li></ul>
17	2	Inter-message delay 0 through 65535 milliseconds
19	2	Inter-cycle delay 0 through 65535 milliseconds

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

---

**Table 44: Answers**

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

**Read input register (function code 0x4)**

Table 45 presents the registers for the read input commands.

**Table 45: Read input register messages**

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 LED 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 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 (that is, 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 was the result of object demerging Bit 2: Reserved Bit 3: Detection is saturated
16 + (3*N) to 16 + (4*N) - 1	Distance of the second detection for each segment

---

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 fifth detection
16 + (13*N) to 16 + (14*N) - 1	Amplitude of 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

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

**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)**

Table 46 presents the registers for these commands (see section 4.3 for a more detailed description of parameters).

---

**Table 46: Read holding register message definition**

Address	Description
0	Exponent for the number of accumulation (that is, if the content of this register is $n$ , $2^n$ accumulations are performed).
1	Exponent for the number of oversampling (that is, 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. threshold value is this register divided by 64).
5	LED power in percentage of the maximum. A value above 100 is an error. If a value is specified that is not one of the pre-defined values, the closest pre-defined value will be used. The register can be read back to know the actual value set.
6	Bit field of acquisition options: Bit-0: Automatic LED power enabled Bit-1: Demerge object enabled Bit-2: Static noise removal enabled Bit-3: Precision enabled Bit-4: Saturation compensation enabled Bit-5: Overshoot management enabled
7	Auto LED 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 LED power in automatic mode.
10	Reserved
11	Smoothing: Stabilizes the module measurements. The behavior of the smoothing algorithm can be adjusted by a value ranging from $-16$ through $16$ .
12	Low 16 bits of segment enabled: Bit-field of enabled segment
13	High 16 bits of segment enabled

**NOTE:** 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.

## 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 47: Answers**

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 48: 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 (that is, 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 49
5	Get holding data	See Table 50
6	Set holding data	See Table 51
7	Set base address	See Table 52
8	Read module data	See Table 53
9	Write module data	See Table 54
10	Send module opcode command	See Table 55

---

**Table 49: CAN bus request message (Get input data)**

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

**Table 50: CAN bus request message (Get holding data)**

<b>Holding Data Type (Byte 1)</b>	<b>Holding Data Description</b>
0	Acquisition configuration
1	Smoothing and detection threshold
2	LED 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 51: 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 accumulation (that is, if the content of this register is $n$ , $2^n$ accumulations are performed).
		Byte 3	Exponent for the number of oversampling (that is, if the content of this register is $n$ , $2^n$ oversamplings are performed).
		Byte 4	Number of base samples
1	Smoothing and detection threshold	Byte 2	Smoothing: Stabilizes the module measurements. The behavior of the smoothing algorithm can be adjusted by a value ranging from -16 to 16.
		Bytes 4 through 7	Detection threshold as a fixed-point value with a 6-bit fractional part (that is, threshold value is this register divided by 64).
2	LED power management	Byte 2	LED power in percentage of the 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. The register can be read back to know the actual value. Note that this value is ignored if the automatic LED intensity parameter is enabled.
		Byte 3	Number of echoes for saturation acceptance: the number of echoes can be saturated to avoid decreasing the led power when using the automatic mode.
		Bytes 4 and 5	Auto LED power changes the delay in number of measurements
3	Distance resolution and acquisition options	Bytes 2 and 3	Distance units: <ul style="list-style-type: none"> <li>• 1 = m</li> <li>• 10 = dm</li> <li>• 100 = cm</li> <li>• 1,000 = mm</li> </ul>

---

		Bytes 4 and 5	Bit field of acquisition options: Bit-0: Automatic LED power enabled Bit-1: Demerge object enabled Bit-2: Static noise removal enabled Bit-3: Precision enabled Bit-4: Saturation compensation enabled Bit-5: Overshoot management enabled
4	CAN port configuration 1	Byte 2	Baud rate (kbps): <ul style="list-style-type: none"> <li>0 = 1000</li> <li>1 = 500</li> <li>2 = 250</li> <li>3 = 125</li> <li>4 = 100</li> <li>5 = 50</li> <li>6 = 20</li> <li>7 = 10</li> </ul>
		Byte 3	Frame format: 0 = Standard 11 bits 1 = Extended 29 bits
		Bytes 4 through 7	Tx base ID
5	CAN port configuration 2	Bytes 4 through 7	Rx base ID
6	CAN port configuration 3	Byte 3	Maximum number of detections (measurements) returned per CAN detection message transaction: 1 through 96
		Bytes 4 and 5	Inter-message delay 0 through 65535 milliseconds
		Bytes 6 and 7	Inter-cycle delay 0 through 65535 milliseconds
7	Reserved	-	-
8	Segment enabled	Bytes 4 through 7	Bit-field of the enabled segments

---

**Table 52: CAN bus request message (Set base address)**

<b>Data Description</b>	<b>Argument</b>	<b>Argument Description</b>
Base address	Bytes 4 through 7	Base address to access (from 0x00000000 to 0x00FFFFFF)

**Table 53: CAN bus request message (Read module data)**

<b>Data Description</b>	<b>Argument</b>	<b>Argument Description</b>
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).

**Table 54: CAN bus request message (Write module data)**

<b>Data Description</b>	<b>Argument</b>	<b>Argument Description</b>
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 through 7	Data to write

**Table 55: CAN bus request message (Send module opcode command)**

<b>Data Description</b>	<b>Argument</b>	<b>Argument Description</b>
Send module opcode command	Byte 2	Opcode
	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 56: CAN bus answer message**

<b>Answer Data (Byte 0)</b>	<b>Answer Data Description</b>	<b>Additional Answer Data (Byte 1 to Byte 7)</b>
1	Answer to stop continuously sending detection requests.	Success: Return echo from the command request. Fail: All bytes, from 2 through 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 through 7, are set to 0xFF.
3	Answer to continuously sending a detection request.	Success: Return echo from the command request. Fail: All bytes, from 2 through 7, are set to 0xFF.
4	Answer to the Get input data request.	Success: See format in Table 57 Fail: All bytes, from 2 through 7, are set to 0xFF.
5	Answer to the Get holding data request.	Success: See format in  Table 51 Fail: All bytes, from 2 through 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 through 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 through 7, are set to 0xFF.
8	Answer to the Read module data request.	Success: See Table 58 Fail: All bytes, from 2 through 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 through 7, are set to 0xFF.
10	Answer to the Send module opcode request.	Success: See Table 59 Fail: All bytes, from 2 through 7, are set to 0xFF.

---

**Table 57: CAN bus answer message (Get input data)**

<b>Input Data Type (Byte 1)</b>	<b>Input Data Description</b>	<b>Argument</b>	<b>Arguments Description</b>
0	Number of segments	Bytes 2 and 3	Number of segments
1	Device identification and options	Bytes 2 and 3	Device identification code (8 for IS16)
		Bytes 4 through 7	Device option flags (LeddarTech internal use)
2	Firmware version in format A, B, C, D.	Bytes 2 and 3	The firmware build version (A)
		Bytes 4 and 5	The firmware build version (B)
		Bytes 6 and 7	The firmware build version (C)
3	Firmware version in format A, B, C, D.	Bytes 2 and 3	The firmware build version (D)
4	Bootloader version in format A, B, C, D.	Bytes 2 and 3	The bootloader build version (A)
		Bytes 4 and 5	The bootloader build version (B)
		Bytes 6 and 7	The bootloader build version (C)
5	Bootloader version in format A, B, C, D.	Bytes 2 and 3	The bootloader build version (D)
6	FPGA version	Bytes 2 and 3	The FPGA version
		Byte 6	Run status 0: OFF, 0xFF: ON. Should always return 0xFF, otherwise the module is defective.
7 through 12	Serial number	Bytes 2 through 7	Serial number as an ASCII string (max. 32 bytes)
13 through 18	Device name	Bytes 2 through 7	The device name as an ASCII string (max. 32 bytes)
19 through 24	Hardware part number	Bytes 2 through 7	The hardware part number as an ASCII string (max. 32 bytes)
25 through 30	Software part number	Bytes 2 through 7	The software part number as an ASCII string (max. 32 bytes)

---

**Table 58: 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 59: 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 indicates the number of detections that will be sent.

**Table 60: CAN bus number of detection messages**

Data	Data Return Description
Byte 0	Number of detections
Byte 1	Current LED power as a percentage of the maximum
Byte 2	Status of the bit field acquisition: Reserved
Byte 3	
Bytes 4 through 7	Timestamp of the acquisition. The timestamp is 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, which contains 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 get the amplitude (that is, 6 bits for 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 61: Flag information about measurements**

Data	Description
Bit 0	The detection is valid (always set).
Bit 1	The detection is the result of object demerging.
Bit 2	Reserved
Bit 3	The detection is saturated.
Bits 4 through 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; that is, 1874 (0x752).

For the multiple-message ID mode, detections are sent on message IDs ranging from 1874 through 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 through 1893.
- From 1874 through 1890, for a module setup with a maximum of 16 number of detections.

---

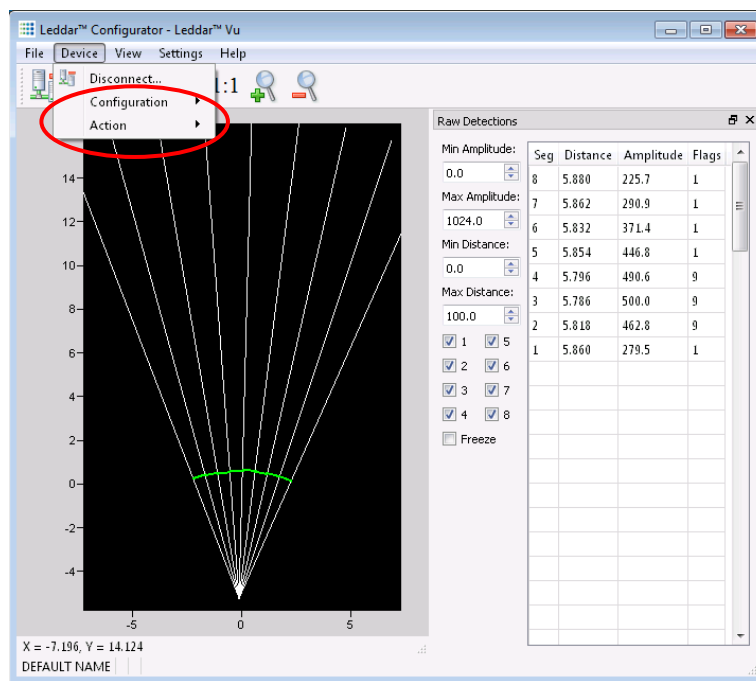
## 6. Leddar™ Configurator

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

### 6.1. Introduction to Configurator Software

The 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.



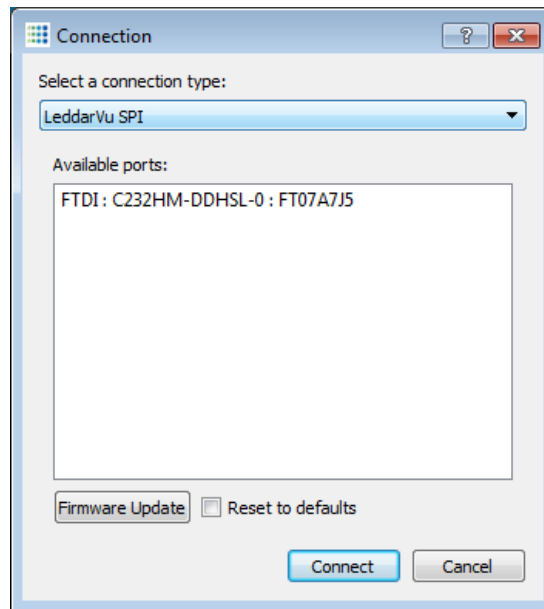
**Figure 23: Raw Detections dialog box docked on the side of the main window**

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

---

## 6.2. Connection Window

The following is a description of the information shown in the **Connection** dialog box.



**Figure 24: Connection dialog box**

### Select a connection Type

The connection type you are using.

### Available ports list

The list of available ports displays the modules currently detected.

**NOTE:** *The next descriptions apply to other connections than the SPI one. The other options include: USB, LeddarVu Serial, and Serial.*

### Name

The device name can be modified (see section “6.4.1 Module Name” on page 75).

### Serial Number

The serial number of the device as assigned by LeddarTech.

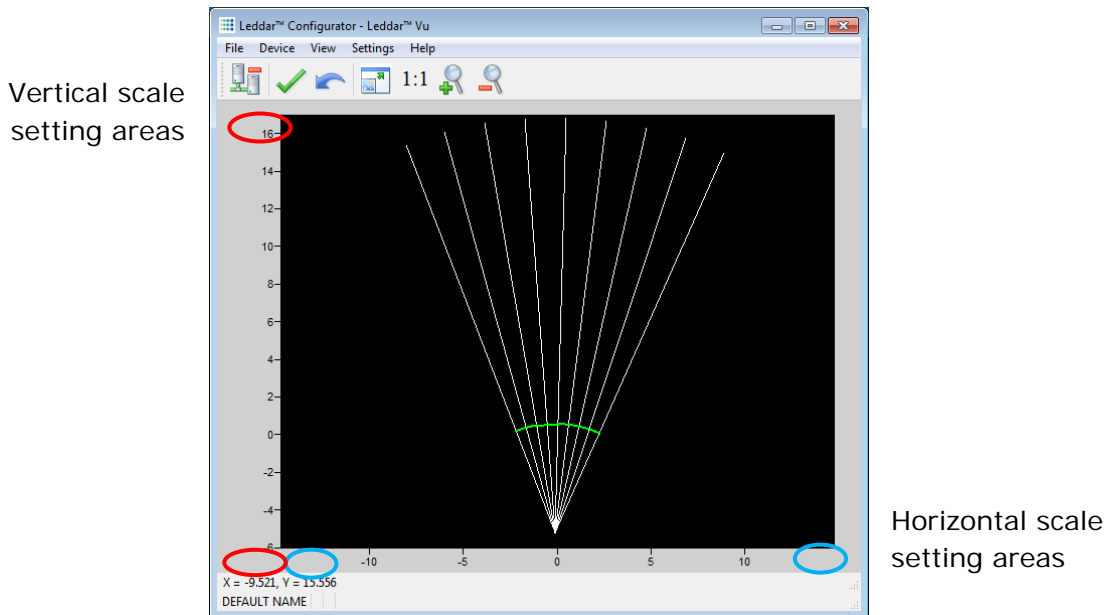
### Type

The product name.

---

## 6.3. Leddar™ Configurator Main Window

After connecting to the device, the main window opens.



**Figure 25: Leddar™ Configurator main window**


The measurements are plotted in a symbolic graph containing the 16 segments (white lines) originating from the LeddarVu module. 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 "6.11 Raw Detections" on page 91).

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

### 6.3.1. Toolbar


The toolbar includes several buttons for adjusting the view of the main window display.

### 6.3.2. Fit to Window

Click the fit-to-window button () to adjust the LeddarVu module view to the main window.

---


### 6.3.3. Force Equal Horizontal and Vertical Scales

When the equal scaling button (  ) is selected (button 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° LeddarVu module).


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

**NOTE:** *When in equal scaling mode, you cannot zoom the display horizontally or vertically, that is, 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 Figure 25 above.*

### 6.3.4. Zoom in

Click the zoom in button (  ) to zoom in vertically and horizontally around the center of the display.

### 6.3.5. Zoom out

Click the zoom out button (  ) to zoom out vertically and horizontally around the center of the display.

### 6.3.6. 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 Figure 25.

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

### 6.3.7. 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.

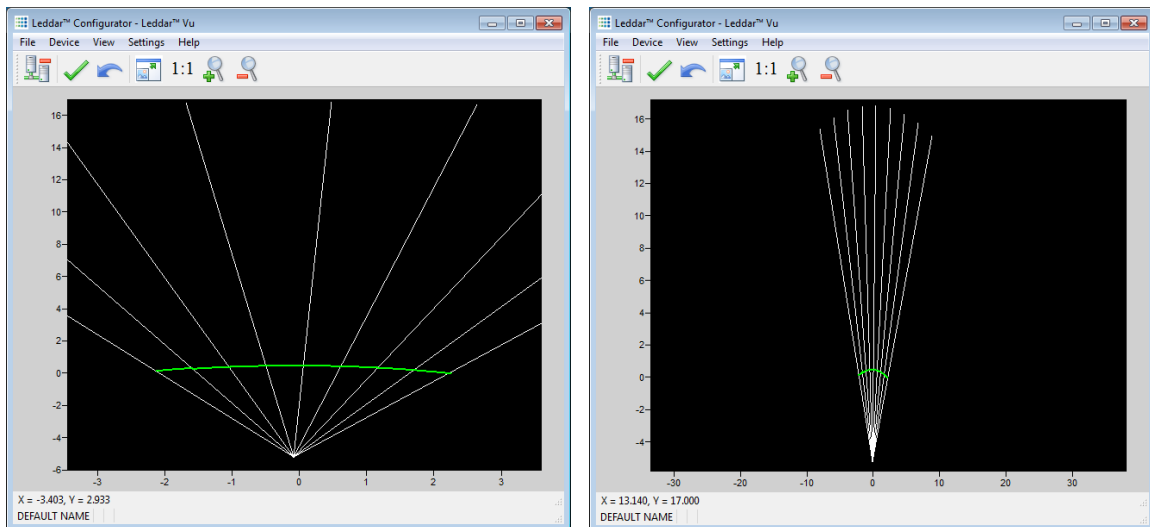
You can move up, down, and sideways by clicking and dragging the display.

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 (  ) button respectively (see sections 6.3.4 and 6.3.5).

---


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

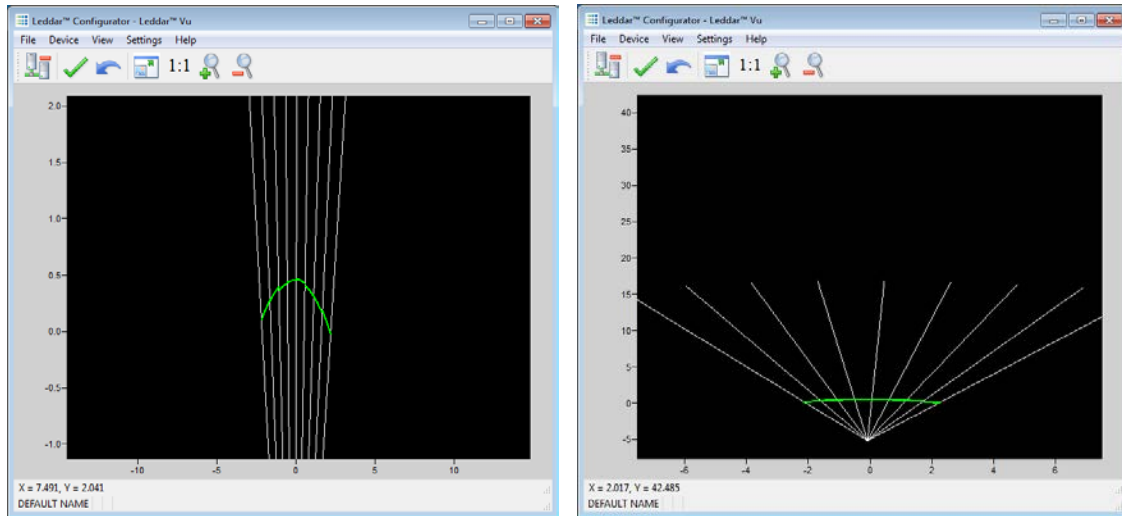
**NOTE:** The equal scaling button (  ) must be not selected (not highlighted).



**Figure 26: Zooming in (left) and out (right) horizontally**

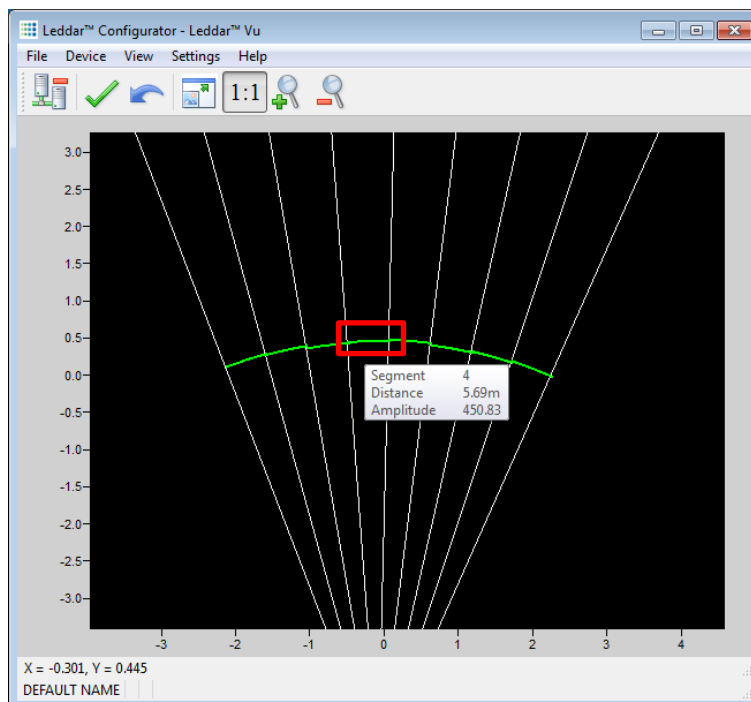
To zoom the display vertically, hold the <Shift> key down while using the mouse wheel.

**NOTE:** The equal scaling button (  ) must be not selected (not highlighted).



**Figure 27: 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.



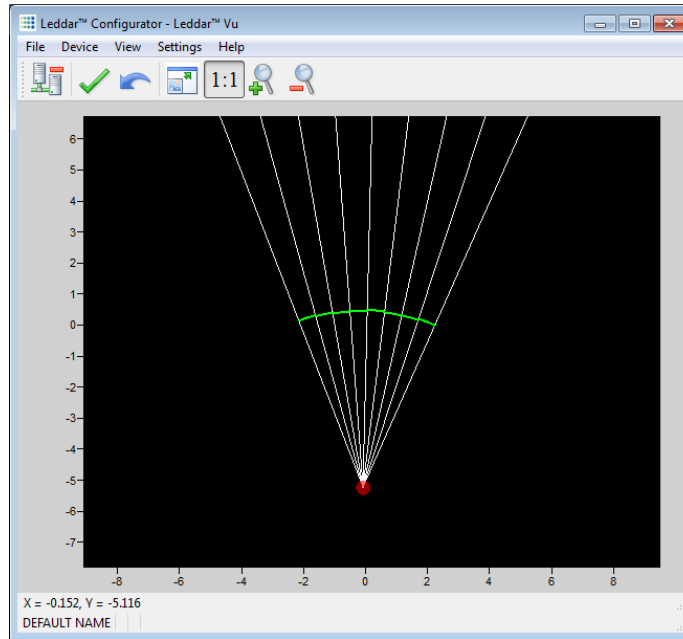
**Figure 28: Detection point coordinates**

---

### 6.3.8. Changing the LeddarVu Module Origin

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

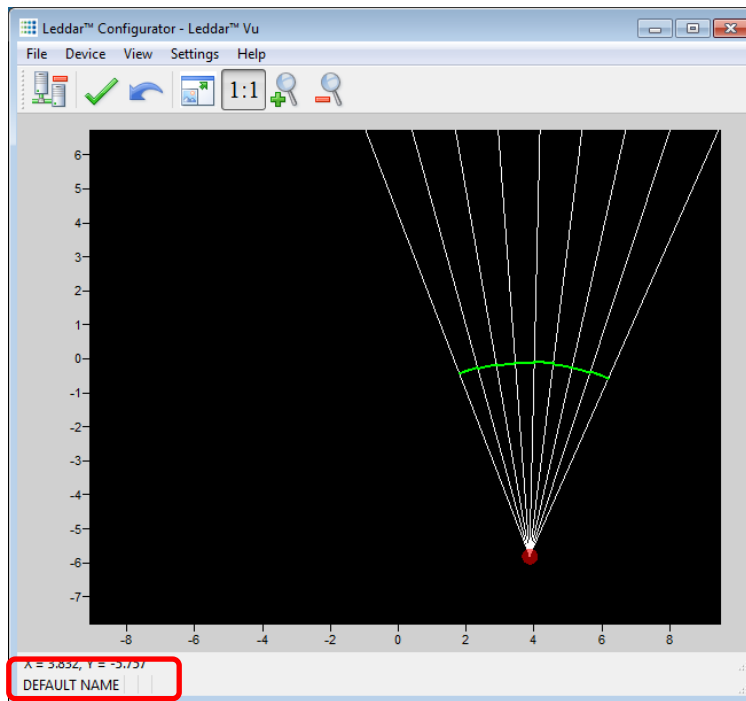
To do so, use the mouse cursor to point to the bottom of the segments (a red dot appears); click and drag it in the desired position.



**Figure 29: Dot indicator to modify the module origin**

If you click and drag the module origin, its position is displayed in the status bar as shown in Figure 30.





**Figure 30: Module position changed**

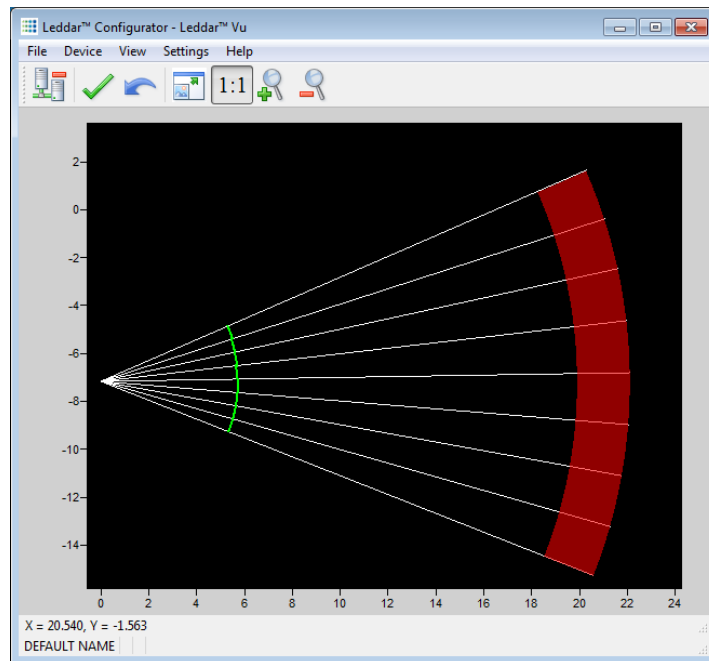
To apply the changes, click the apply button (✓).

The origin is saved in the module and it can also be modified by editing the parameters in the module position settings window.

#### 6.3.9. Changing the LeddarVu Module Orientation

The module origin may be rotated to match its physical position. 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 origin can be set to reflect its position.

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



**Figure 31: Red bar to rotate the module position**

To apply the changes, click the apply button (✓).

The module orientation is saved in the module and can also be modified by editing the parameters in the module position settings window.

## 6.4. Settings

The LeddarVu module stores a number of settings. Once saved in the module, these parameters are effective at each power up. The Leddar™ Configurator software loads these parameters upon each connection.

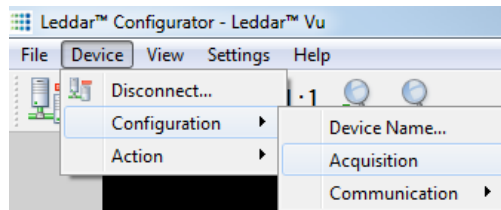
---

### 6.4.1. Module Name

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

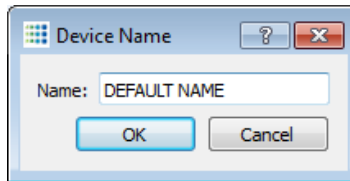
**To change the module name:**

1. Connect to a module.
2. On the **Device** menu, point to **Configuration** and click **Device Name**.



**Figure 32: Device menu and the Configuration menu items**

3. In the **Device Name** dialog box, in the **Name** field, type the new name of the module and click **OK**.



**Figure 33: Device Name dialog box**

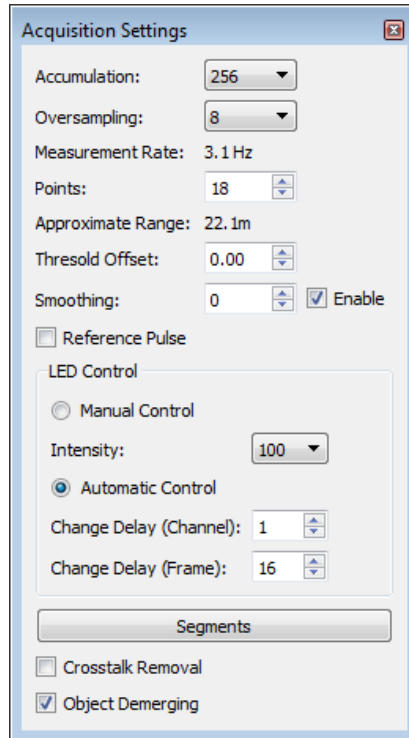
4. To apply the change, click the apply button (✓) in the Leddar™ Configurator main window.

---

### 6.4.2. Acquisition Settings

The acquisition settings allow you to define parameters to use for detection and distance measurement.

To open the **Acquisition Settings** dialog box, on the **Device** menu, point to **Configuration** and click **Acquisition**.



**Figure 34: Acquisition Settings dialog box**

The numbers on a grey background are modified only by using the arrows, while the ones on a white background can additionally be modified manually by using the numeric keypad of your keyboard.

To apply the changes, click the apply button (✓) in the main window.

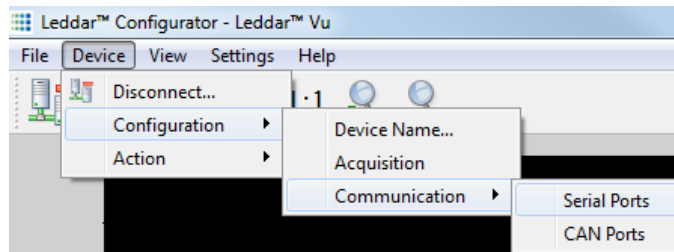
---

### 6.4.3. Serial Port

The serial port settings of the enhanced board are configurable.

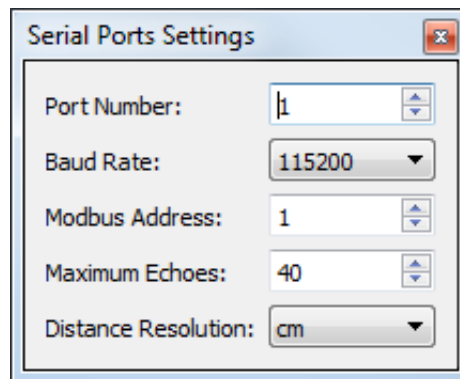
**To configure the serial port:**

1. On the **Device** menu, point to **Configuration**, point to **Communication**, and click **Serial Ports**.



**Figure 35: Device menu**

2. In the **Serial Port Setting** dialog box, use the arrows or type numbers to modify the values.



**Figure 36: Serial Port Settings dialog box**

---

Table 62 describes the serial port settings.

**Table 62: Serial port setting description**

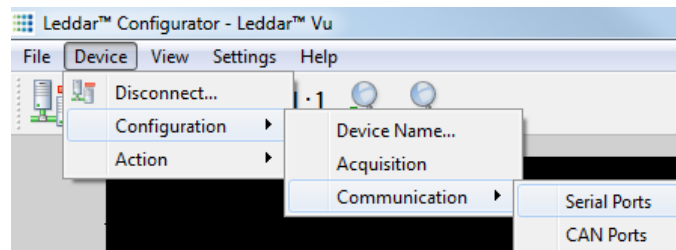
Parameter	Value
Port number	Select 1 for the configurable serial link number 1. Select 2 for the TTL serial link number 2. Select 3 for the USB VCP serial link.
Baud rate	9600, 19200, 38400, 57600, 115200 bps
Address	1 to 247
Detections	0 to 40
Distance resolution	Millimeters (mm), centimeters (cm), decimeters (dm), meters (m)

#### 6.4.4. CAN Port

The CAN port settings of the enhanced board are configurable.

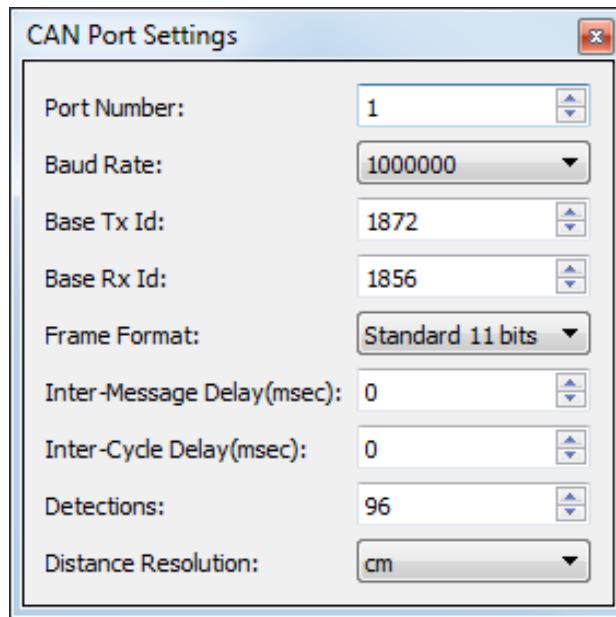
**To configure the CAN port:**

3. On the **Device** menu, point to **Configuration**, point to **Communication**, and click **CAN Ports**.



**Figure 37: Device menu**

4. In the **Serial Port Setting** dialog box, use the arrows or type numbers to modify the values.



**Figure 38: CAN Port Settings dialog box**

Table 65 describes the CAN port settings.

**Table 63: CAN port setting description**

Parameter	Value
Port number	Select 1 for CAN communication
Baud rate	10000, 20000, 50000, 100000, 125000, 250000, 500000, 1000000 bps
Base Tx ID	The base CAN arbitration ID used for data messages coming from the enhanced board to host (see the protocol documentation).
Base Rx ID	The base CAN arbitration ID used for data messages sent to the enhanced board (see the protocol documentation).
Frame format	Standard, Extended
Inter-message delay	0 to 65535 milliseconds
Inter-cycle delay	0 to 65535 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 backup settings and restore them in case of system failure or in case you want to revert to earlier settings. You can also get the configuration that was stored with a record file.

### To save a configuration:

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

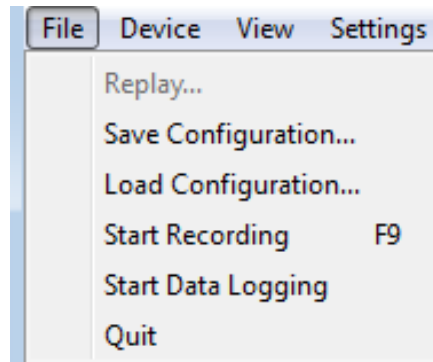


Figure 39: File menu

### To load a configuration:

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

## 6.6. Configuring Detection Records

Detection records provide a 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 \*.lrl file that can later be reloaded and replayed.

### To configure the detection record:

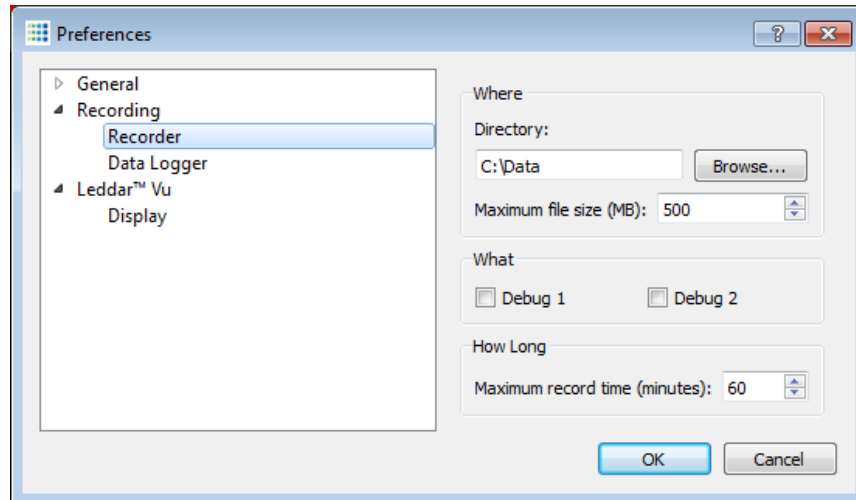
1. In Leddar™ Configurator, on the **Settings** menu, click **Preferences**.



Figure 40: Settings menu



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



**Figure 41: Preferences dialog box**

3. Under **Directory**, click the **Browse** button to select the path where you want to save the detection record file.
4. In the **Maximum file size** box, set the maximum file size by using the arrows or by entering the value manually.
5. Under **What**, select one of the **Debug** check boxes.
6. Under **How Long**, next to **Maximum record time**, determine the length of time for recording by using the arrows or by entering the value manually.

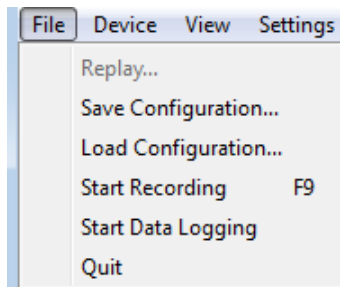
At the end of that period, recording will stop even if the file size has not reached its maximum.

7. Click **OK** to save the settings.

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

#### **To start a recording:**

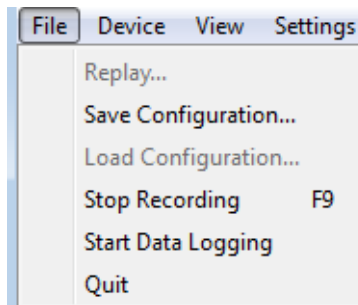
On the **File** menu, click **Start Recording**.



**Figure 42: File menu**

**To stop a recording manually:**

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



**Figure 43: File menu to stop a recording**

The following is a description of the elements available in the **Preferences** for recording 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 \*.lfl, and can only be opened and viewed with the Leddar™ Configurator software.

**Maximum file size**

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.

**Debug**

These check boxes are reserved for the use of LeddarTech technicians.

---

### Maximum record time

The value entered as the **Maximum record time** determines the length of the time for recording. At the end of that period, 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: there is 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 left.

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:

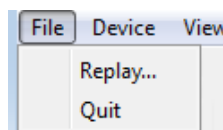
1. If you are connected to a device, disconnect from the device.

OR

Open another Leddar™ Configurator main window.

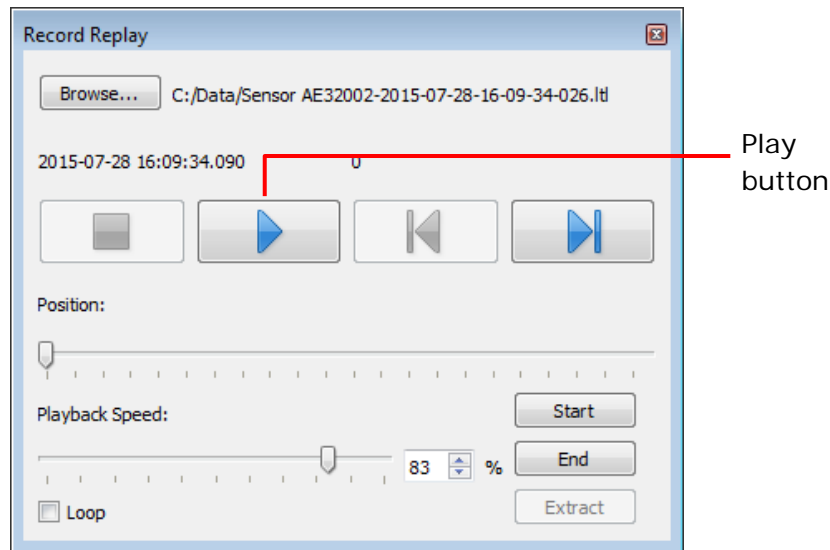
**NOTE:** *The record files can also be opened by double-clicking them.*

2. On the File menu, click Replay.



**Figure 44: File menu to open a recording**

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



**Figure 45: Record Replay dialog box**

4. Click the play button to start the playback.

**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 and then click the **Start** button; restart playing the record and stop it again at a position of interest and 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 in 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 64: Field description of the log text file**

Time (msec)	Segment [0 15]	Amplitude [0 512]	Distance (m)	Status
12735204	7	0.9	33.61	1

- The time of the detection is 12735204 milliseconds from the time the LeddarVu module was started.
- The location of the detection is segment 7 (the 8<sup>th</sup> segment).
- The amplitude of the detection is 0.09, which is very low (small, far, or dark object).
- The distance of the detection is 33.61 meters.
- The status indicates a normal measurement.

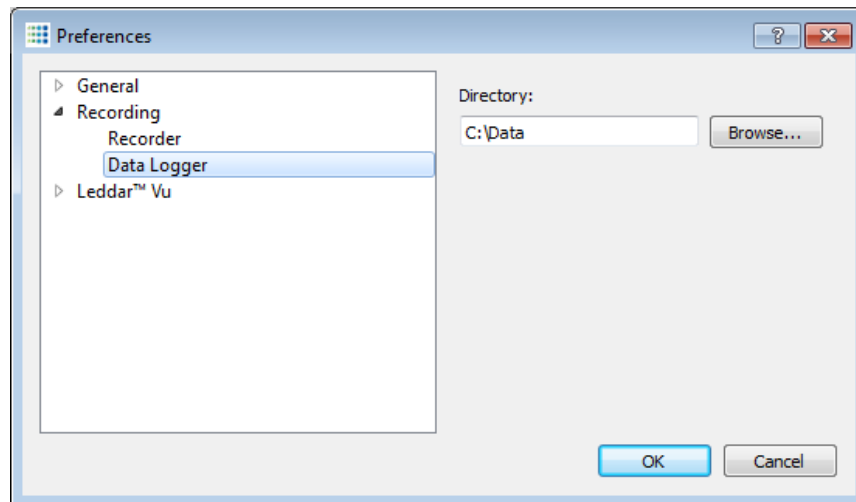
**To use the data logging function:**

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



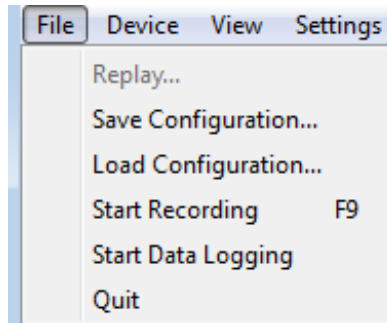
**Figure 46: Settings menu**

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



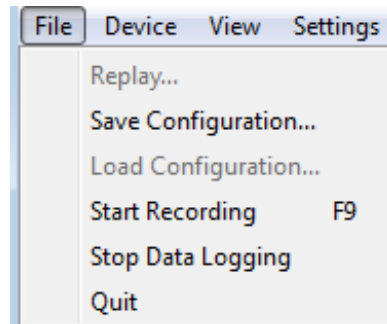
**Figure 47: Preferences dialog box for logging data**

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



**Figure 48: File menu**

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



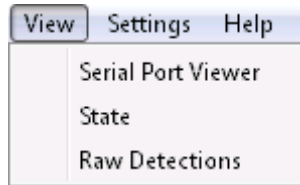
**Figure 49: File menu to stop data recording**

A .txt file is saved in the selected directory.

---

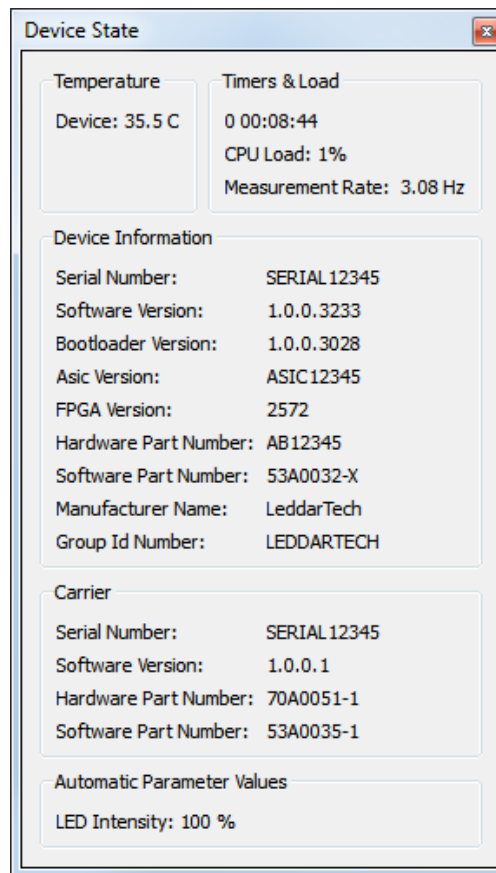
## 6.9. Device State

Information about a device is accessible when connecting to a device in the **Connection** window or by clicking the **State** command on the **View** menu.



**Figure 50: View menu**

The **Device State** window opens.



**Figure 51: Device State window**

---

## General

### **Timers & Load**

This feature gives information in days, hours, minutes, and seconds about two types of activities of a device. The first line indicates the time elapsed since the last device reset, the second since the last power cut or outage.

### **Measurement Rate**

This parameter indicates the rate at which the module measures the speed and dimension of static or moving surfaces.

### **Automatic Parameter Values**

This parameter indicates the intensity of the LED.

## Device Information

### **Serial Number**

This parameter indicates the serial number of the device as assigned by LeddarTech.

### **Software Version**

This parameter indicates the software version, which is specific to the processor of your unit.

### **Bootloader Version**

This parameter indicates the bootloader (booting instructions) version, which is specific to the processor of your unit.

### **Asic Version**

This parameter indicates the version of the application-specific integrated circuit; the microchip designed for this special application. This field is optional in function of the receiver module type.

### **FPGA Version**

This parameter indicates the field-programmable gate array circuit used in the device.

### **Hardware Part Number**

This parameter indicates the hardware part number of the device as assigned by LeddarTech.



---

### **Software Part Number**

This parameter indicates the software part number of the device as assigned by LeddarTech.

### **Manufacturer Name**

This parameter indicates the name assigned to LeddarTech.

### **Group Id Number**

This parameter indicates the end-user group unique identifier used for licencing purposes

### **Carrier**

### **Serial Number**

This parameter indicates the serial number of the enhanced carrier board as assigned by LeddarTech.

### **Software Version**

This parameter indicates the software version, which is specific to enhanced carrier board of your unit.

### **Hardware Part Number**

This parameter indicates the hardware part number of the enhanced carrier board as assigned by LeddarTech.

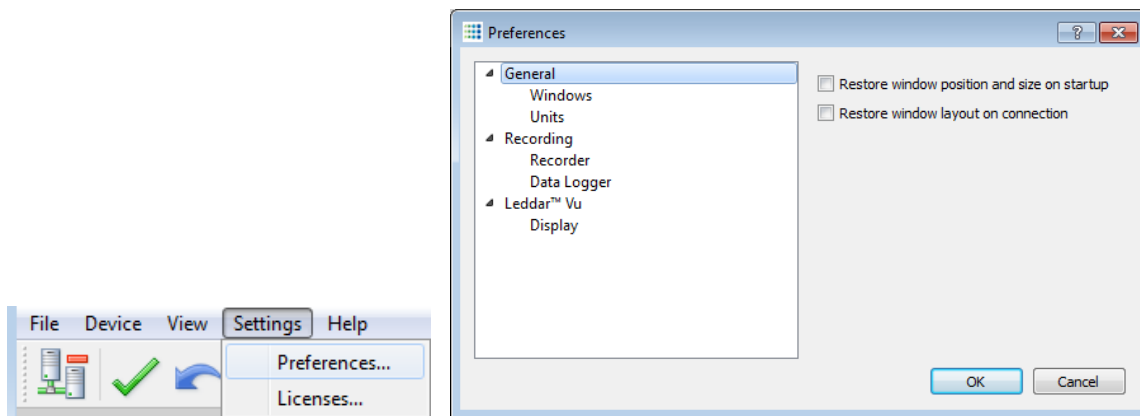
### **Software Part Number**

This parameter indicates the software part number of the enhanced carrier board as assigned by LeddarTech.

## **6.10. Preferences**

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

The **Preferences** dialog box is opened by clicking the **Preferences** command on the **Settings** menu.



**Figure 52: Settings Menu and Preferences Dialog Box**

### **Windows**

The two options allow the user to select how the content of the main window will be displayed in Leddar™ Configurator. Choices are:

- The **Restore window position and size on startup** feature 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** feature connects to the Evaluation Kit at the same size it was and with all docked dialog boxes or windows that were displayed when it was closed.

### **Distance**

The unit that is applied to distances displayed in Leddar™ Configurator.

### **Temperature**

The unit used when displaying the temperature.

### **Recording**

The **Recorder** parameter lets you choose how data files are recorded.

The **Data Logger** parameter lets you select a directory to store logs.

### **Display**

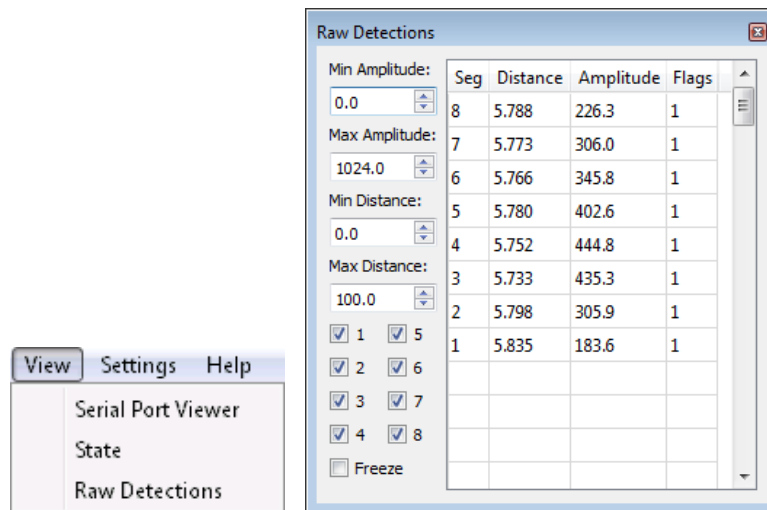
The **Detection Arc Thickness** parameter allows a user to modify the pixel width of the displayed green detections arcs in the main window.

---

## 6.11. Raw Detections

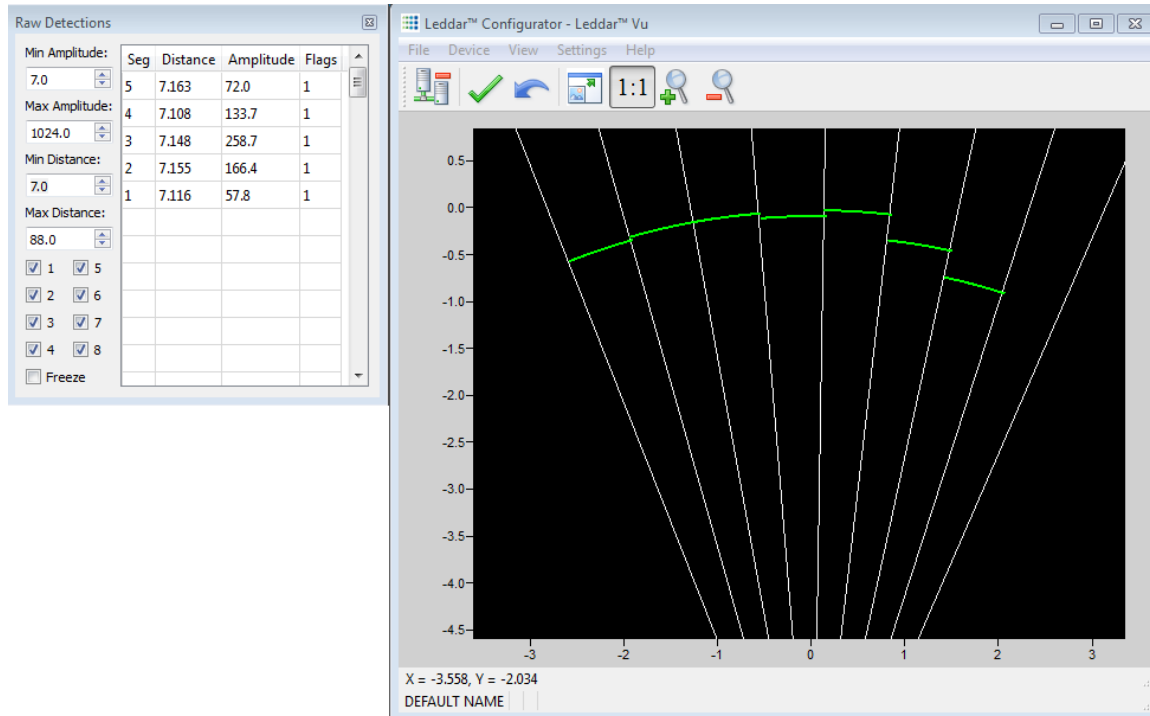
The **Raw Detections** dialog box allows you to view detection values in many ways. It provides filters to isolate segments and detection parameters..

To open the **Raw Detections** dialog box, on the **View** menu, click **Raw Detections**.



**Figure 53: View menu and Raw Detections dialog box**

Figure 54 presents an example of raw detections. When there is no detection in some segments, only the segments where a detection occurred appear in the list.



**Figure 54: Example of detection filters**

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

#### **Min and Max Amplitude**

The value entered in the **Min Amplitude** box shows only detections of amplitude higher or equal to that value. For example, if the minimum amplitude is set to 5, only the detections of amplitude 5 and more will be displayed.

The value entered in the **Max Amplitude** box will show only detections of amplitude lower or equal to that value. For example, if the maximum amplitude is set to 8, only the detections of amplitude 8 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** box will show only detections at a distance greater or equal to that value. For example, if the minimum distance is set to 10, only the detections at a distance of 10 and more will be displayed.

---

The value entered in the **Max Amplitude** box will show only detections at a distance smaller or equal to that value. For example, if the minimum distance is set to 20, only the detections at a distance of 20 and less will be displayed.

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

### **Boxes 1 to 8**

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

### **Freeze**

When selected, the **Freeze** parameter freezes 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 1.

### **Distance and Amplitude**

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

---

## Flag

The **Flag** column displays a number that represents a detection type.

**Table 65: Flag value description**

Bit position	Bit 0	Bit 1
0	Invalid measurement	Valid measurement
1	Reserved	Reserved
2	Reserved	Reserved
3	Normal measurement	Received signal is above the saturation level. Measurements are valid (VALID is set) but have a lower accuracy and precision. Consider decreasing the LED intensity.
4	Reserved	Reserved
5	Reserved	Reserved
6	Reserved	Reserved
7	Reserved	Reserved

The **Flag** parameter provisions for 8 bits encoded as a bit field. Three bits are currently used. The following table presents the implemented decimal values of the status bit field.

**Table 66: Status value description**

Status value (decimal)	Status value (binary)	Description
1	00000001	Normal measurement (valid)
9	00001001	Saturated signal (valid)

---

## 7. Specifications

This chapter presents the LeddarVu module.

### 7.1. General

**Table 67: General specifications**

LED pulse rate	51.2 kHz
Photodetector array size	1 x 8
Photodetector acquisition rate	100 MHz
Measurement rate	See Table 9 on page 31.
USB (optional)	2.0, 12 Mbits/s
CAN (optional)	10 to 1000 kbit/s, optional 120- $\Omega$ termination
Serial links (optional)	TTL, RS-232, RS-422, and RS-485. 2-wire, 4-wire, 9600 to 115200 BPS
Operating temperature	-40°C to +85°C

### 7.2. Mechanical

**Table 68: Mechanical specifications**

Assembly height	43.3 mm
Assembly width	35.2 mm

See section 7.6 for dimensions including optics.

### 7.3. Electrical

**Table 69: Electrical specifications**

Voltage	12 VDC
Power consumption (total)	2.2 W

## 7.4. Optical

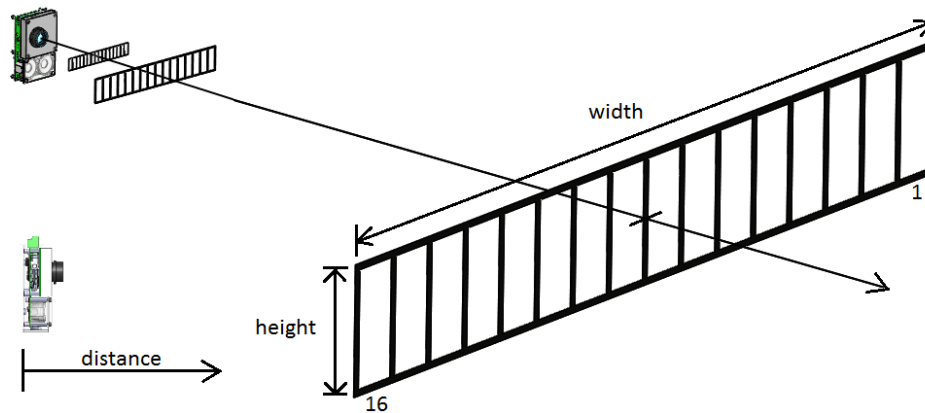
**Table 70: Optical specifications**

Wavelength	905 nm (infrared)
Laser risk group	IEC 60825-1:2014 (Third Edition); Class I laser product (certification pending)
Beam width and height	See Table 71.

**Table 71: Beam width and height**

Beam Option	Beam Width*	Beam Height*
20° x 0.3°	16.4°	0.173°
20° x 3°	16.3°	3.12°
48° x 0.3°	56.3°	0.149°
48° x 3°	57.1°	3.06°
100° x 0.3°	88.8°	0.168°
100° x 3°	58.0°	3.10°

\* These parameters present the sensitivity of the module across the beam width (segment amplitude efficiency) and height (amplitude vs. tilt). See Figure 55.



**Figure 55: Beam pattern width (*left*) and height (*right*)**



---

## 7.5. Performance

Table 72: Module performances

Performance Metrics	Values
Measurement accuracy	$\pm 5$ cm
Measurement precision	6 mm (amplitude > 15)
Resolution	1 cm
Range (maximum LED intensity)	Varies with beam optics and target properties (see amplitude vs range figures below)
Data refresh rate	Up to 100 Hz (standard board)

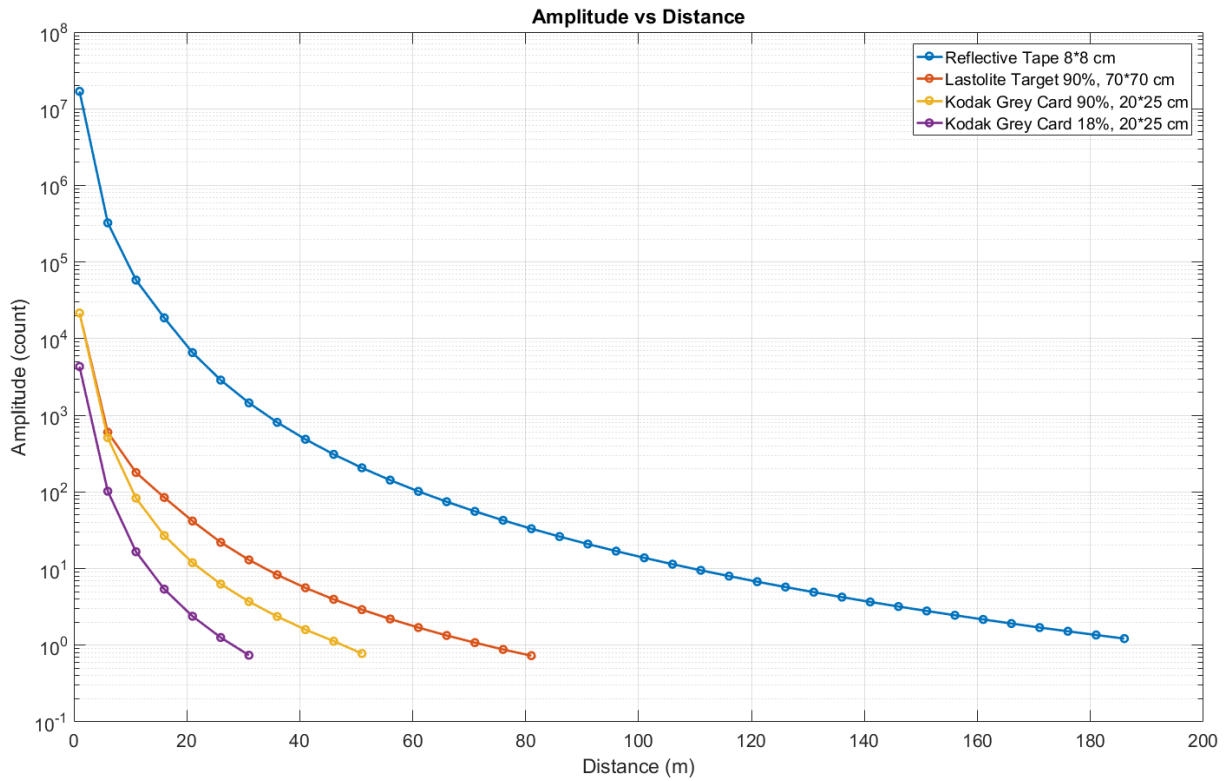
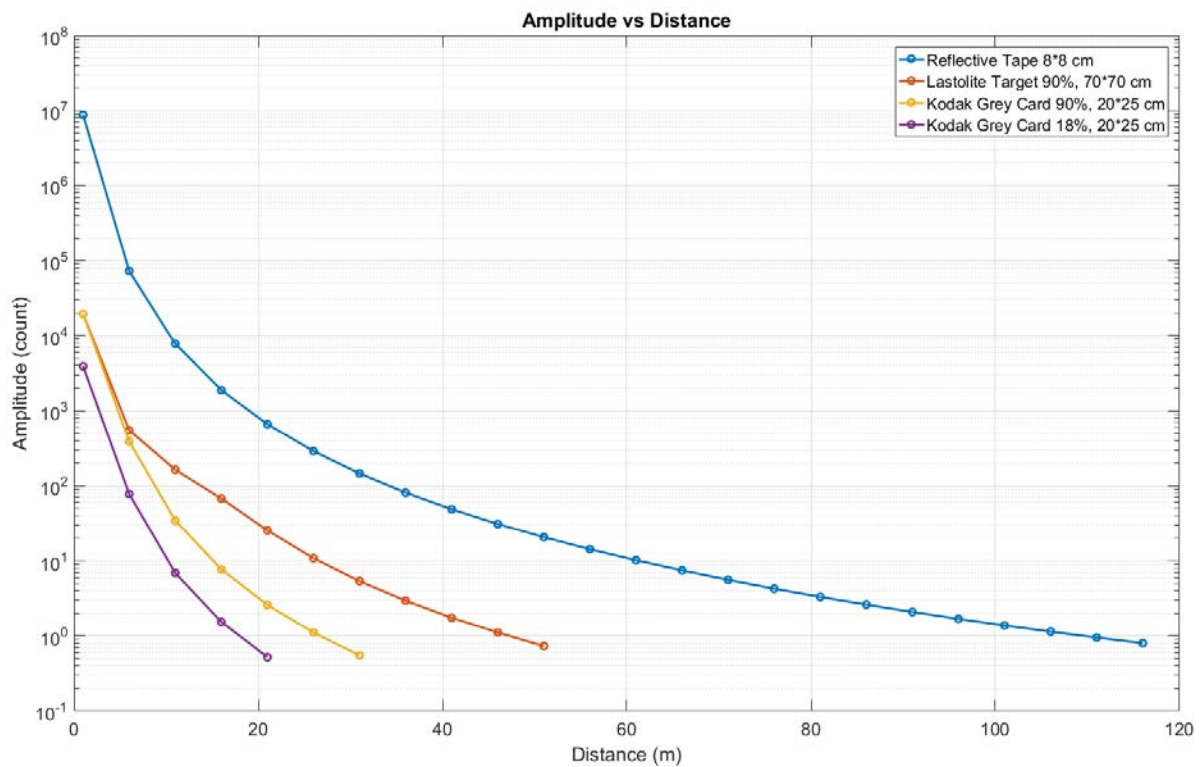
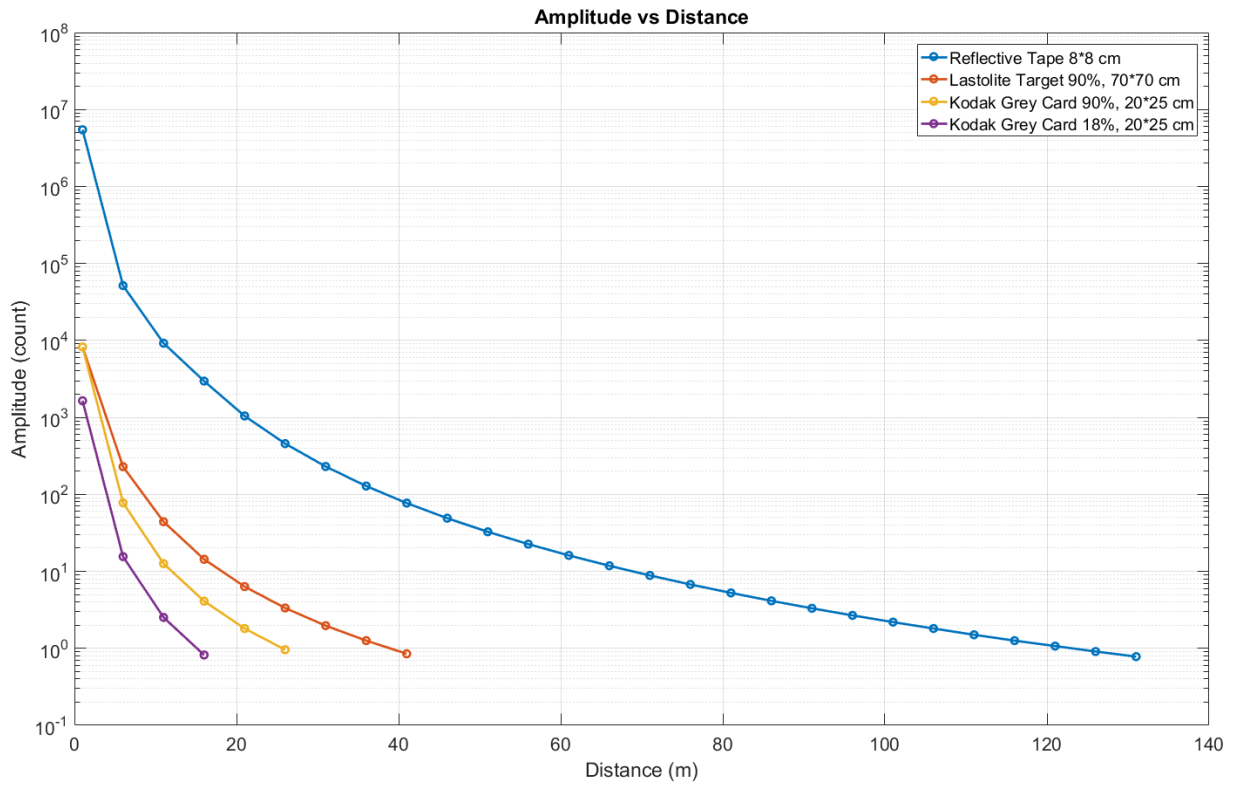


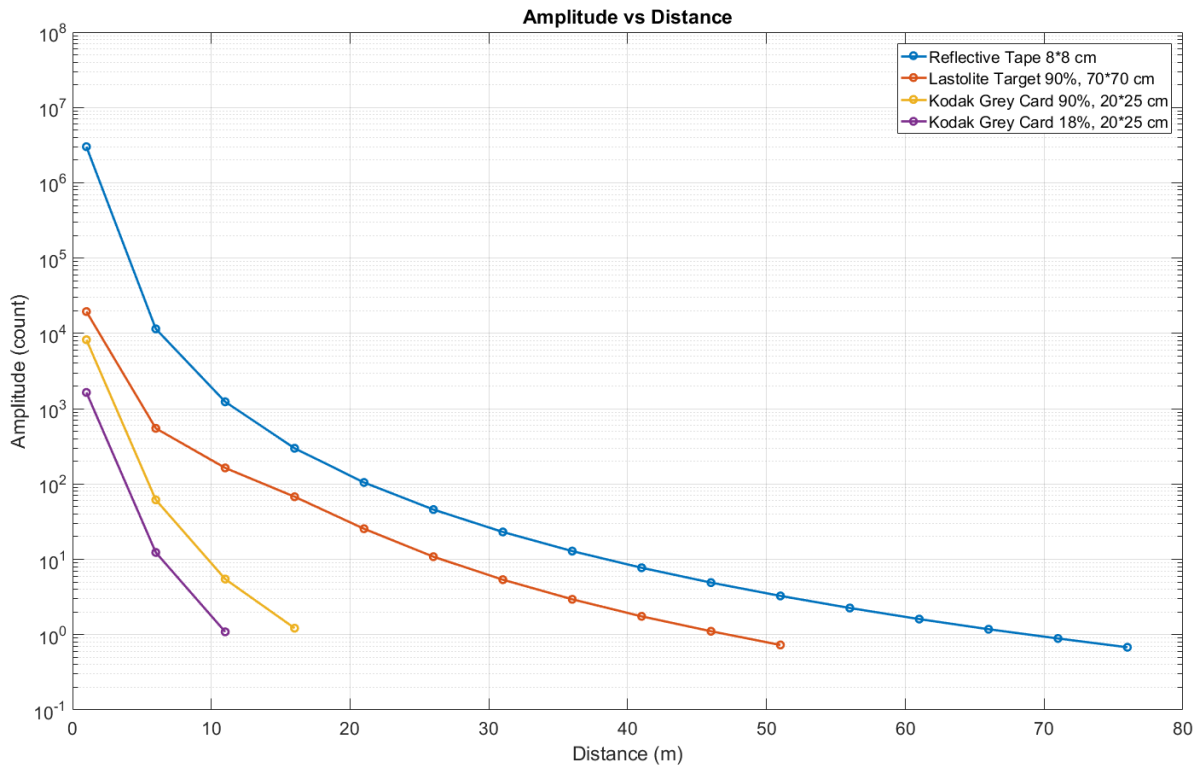
Figure 56: 20° x 0.3° (maximum intensity, 256 accumulations, and 8 oversamplings)



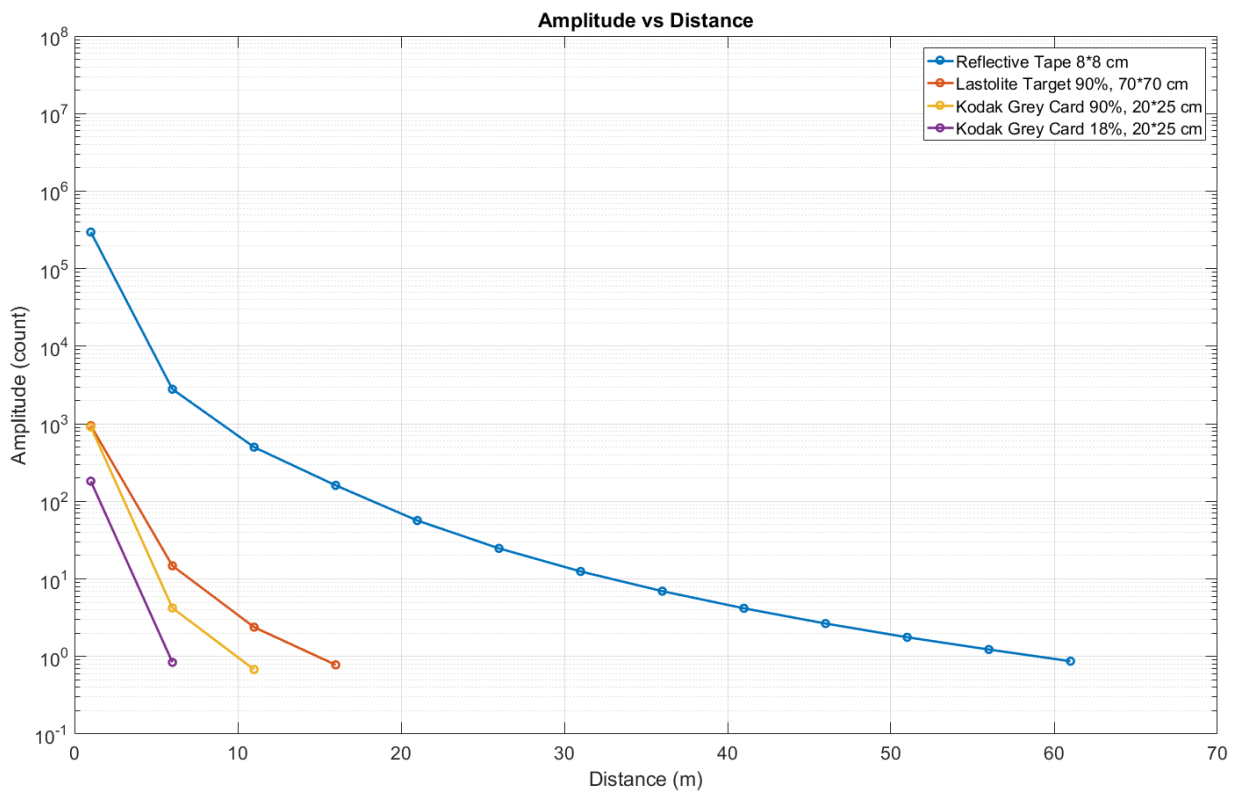
**Figure 57: 20° x 3° (maximum intensity, 256 accumulations, and 8 oversamplings)**



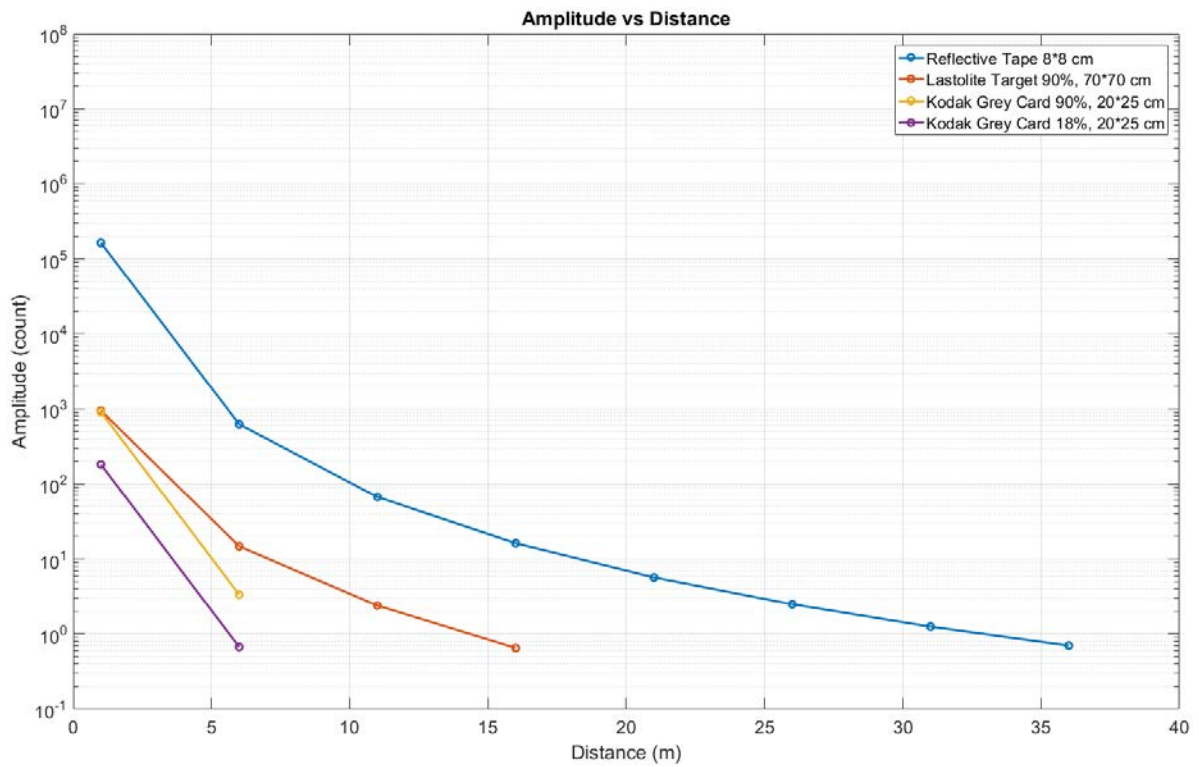
**Figure 58:  $48^\circ \times 0.3^\circ$  (maximum intensity, 256 accumulations, and 8 oversamplings)**



**Figure 59: 48° x 3° (maximum intensity, 256 accumulations, and 8 oversamplings)**



**Figure 60:  $100^\circ \times 0.3^\circ$  (maximum intensity, 256 accumulations, and 8 oversamplings)**



**Figure 61:  $100^\circ \times 3^\circ$  (maximum intensity, 256 accumulations, and 8 oversamplings)**

---

## 7.6. Regulatory Compliancy

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

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

**Table 73: Regulatory compliance**

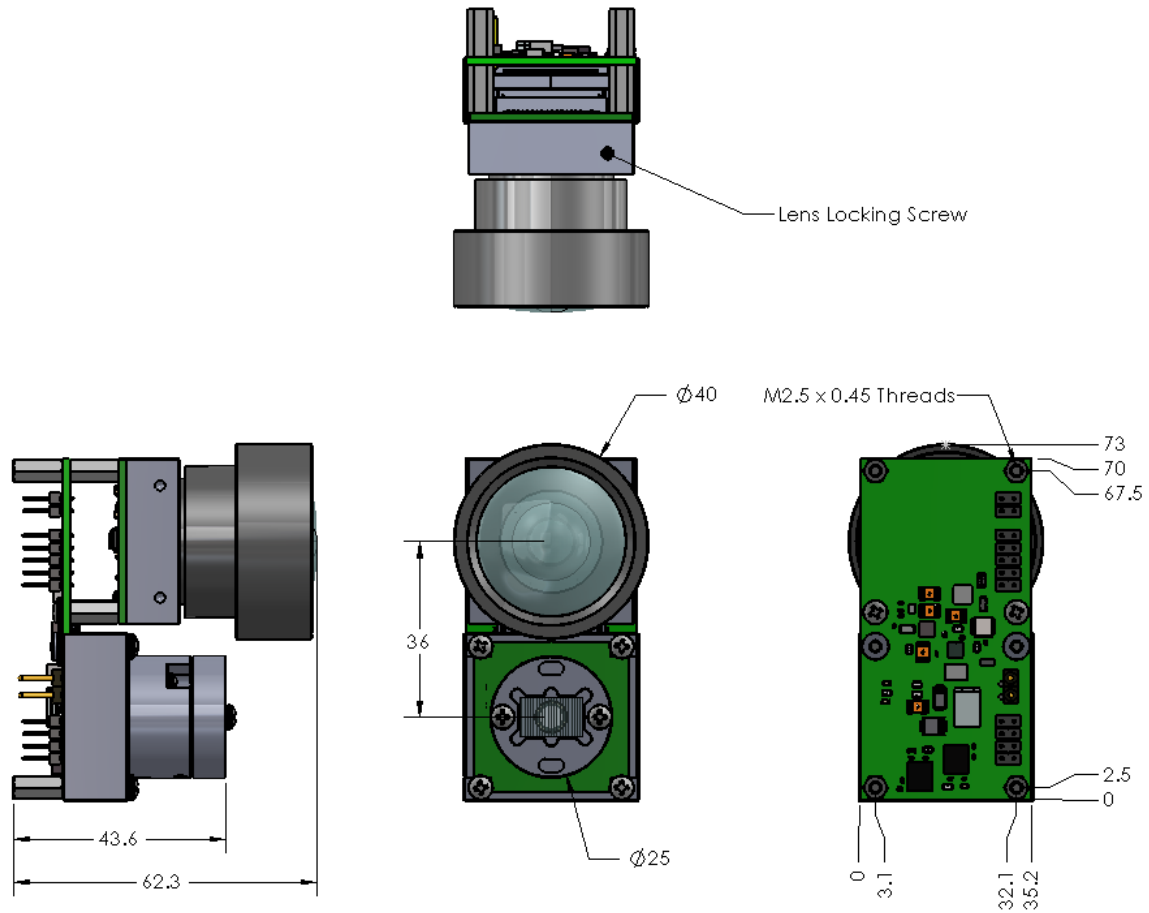
Test Name Standard	Test Specification	Performance Criterion	Result
Radiated emissions FCC part 15 (2013) subpart B	Class A 30MHz-1GHz	N/A	Pass
Radiated emissions CISPR11 (2009) A1 (2010)	Group 1 - class A 30MHz-1GHz	N/A	Pass
Radiated emissions ICES-003 (2012)	Class A 30MHz-1GHz	N/A	Pass
Electrostatic discharge immunity IEC61000-4-2 (2008)	Contact: $\pm 4$ kV Air: $\pm 8$ kV	C	Pass
Radiated electromagnetic field immunity IEC61000-4-3 (2006) A1 (2007) A2 (2010)	80 MHz-1000M Hz: 10 V/m 1.4 GHz – 2 GHz: 3 V/m 2 GHz - 2.7 GHz: 1 V/m	C	Pass

## 7.7. Dimensions

This section presents the LeddarVu module dimensions.

---

### 7.7.1. 100° Module



**Figure 62: 100° module dimensions**



---

### 7.7.2. 48° Module

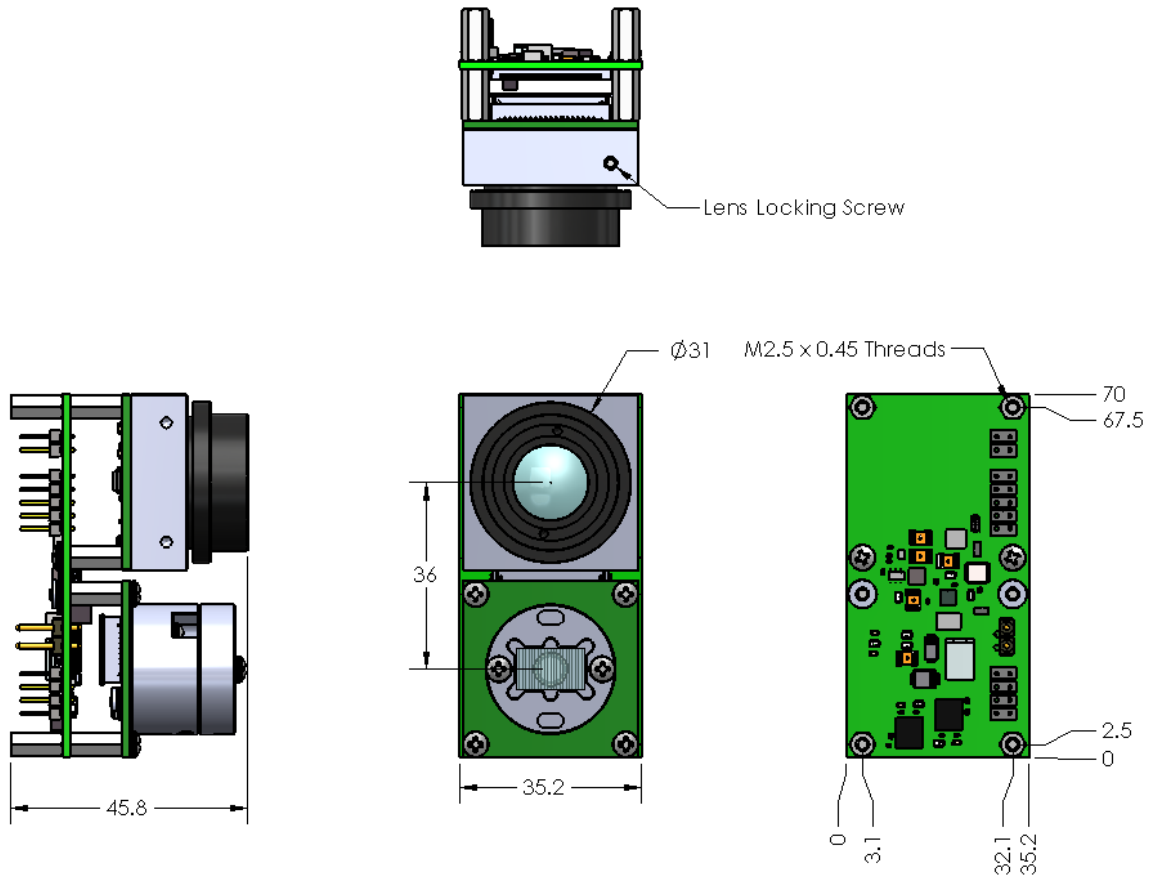
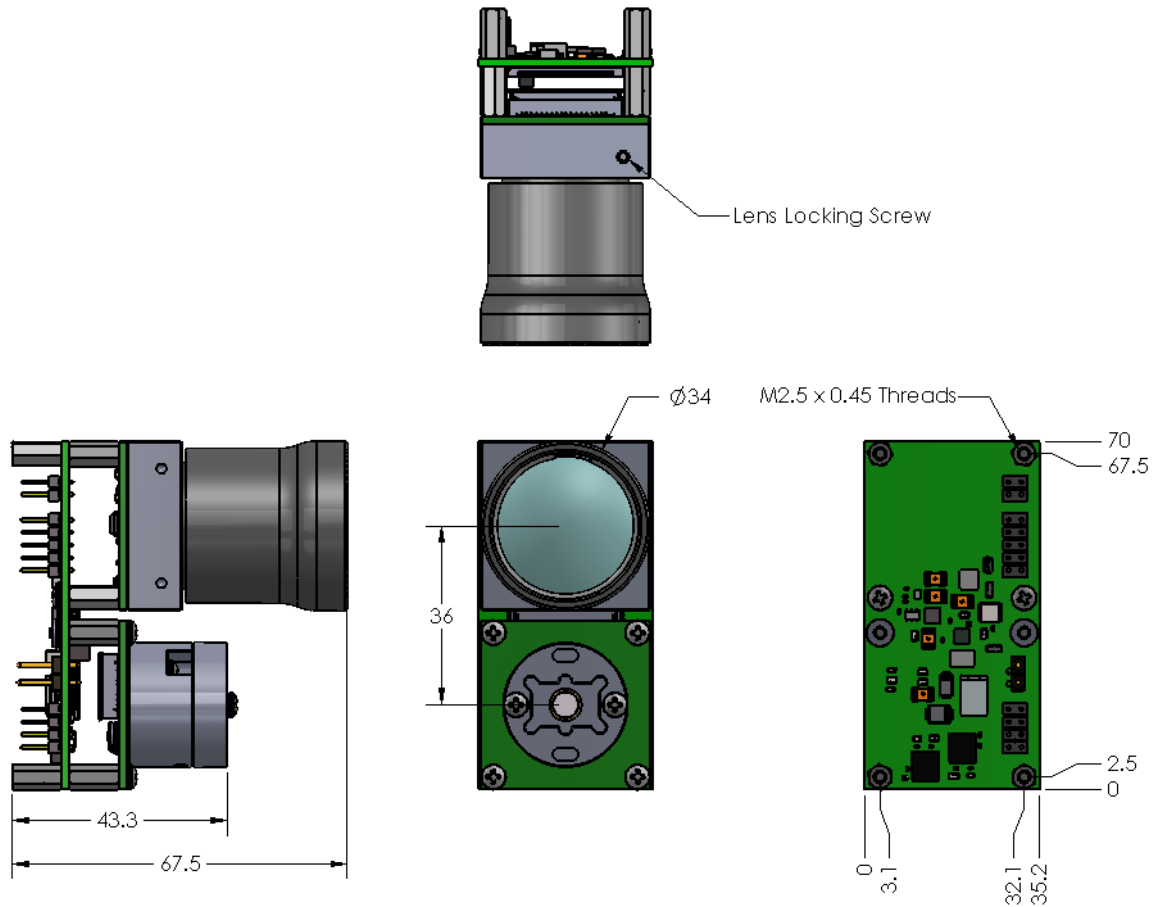


Figure 63: 48° module dimensions

---

### 7.7.3. 20° Module



**Figure 64: 20° module dimensions**

---

## 8. Help

For technical inquiries, please contact LeddarTech technical support by registering online at [www.leddartech.com/support](http://www.leddartech.com/support) to easily:

- Follow up on your requests
- Find quick answers to questions
- Get valuable updates

Or by contacting us at:

+ 1 418 653 9000

+ 1 855 865 9900

8:30 a.m. - 5:00 p.m. Eastern Standard Time

To facilitate the support, please have in hand all relevant information such as part numbers, serial numbers, etc.

### **E-mail**

[support@leddartech.com](mailto:support@leddartech.com)

### **Company address**

LeddarTech Inc.  
2740 Einstein Street  
Quebec, QC G1P 4S4  
Canada

[www.leddartech.com](http://www.leddartech.com)

---

# Index

## A

Accumulation .....	26, 27
Accuracy .....	97
Amplitude, raw detection .....	93
Asic version .....	89
Atmel processor .....	7
Automatic parameter values .....	89

## C

CAN bus .....	14, 95
CAN port settings, Get .....	51
CAN port settings, Set .....	53
Carrier device information, Get .....	51
Carrier firmware information, Get .....	50
Circuit receiver .....	7
Connection type .....	68
Control interface .....	13
Controller, pulsing .....	7
Crosstalk removal .....	26

## D

Data Logger .....	91
Data recording .....	81
Debug .....	83
Detection	
Filters, raw detection .....	91
Using records .....	81
Detection arc thickness .....	91
Detections, Get .....	44
Device	
Automatic parameter values .....	89
Enhanced carrier board firmware part number .....	90
Enhanced carrier board hardware part number .....	90
Enhanced carrier board serial number .....	90
Enhanced carrier board version, software .....	90

Firmware part number .....	89
Group ID number .....	89
Hardware part number .....	89
Manufacturer's name .....	89
Name .....	68
Power outage .....	88
Serial number .....	68, 89
Software part number .....	89
Type .....	68
Version, Asic .....	89
Version, bootloader .....	89
Version, FPGA .....	89
Version, software .....	89
DIP switches .....	10, 14
Distance .....	91
raw detection .....	93
unit .....	91

## E

Emitter assembly .....	7
Enhanced carrier board	
Firmware part number .....	90
Hardware part number .....	90
serial number .....	90
Software version .....	90

## F

File size	
Records .....	82
Records, maximum .....	83
Flag, raw detection .....	94
FPGA version .....	89
Freeze, raw detection .....	93

## H

Holding register, Read .....	56
------------------------------	----

---

<b>I</b>	
I2C .....	13
ID number, group.....	89
Input register, Read.....	54
Intensity, LED.....	30
Interface	
Control .....	13
I2C .....	13
USB .....	14

<b>L</b>	
Laser .....	7
LED .....	7
Control .....	26
intensity .....	30
Intensity .....	26
Pulse rate.....	95

<b>M</b>	
Main window.....	20
Manufacturer's name .....	89
MCU processor .....	7
MCU, microcontroller .....	14
Measurement rate .....	7, 88
Modbus protocol.....	44
Module data	
Read .....	46
Write .....	47
Module list.....	68

<b>O</b>	
Opcode command, Send.....	47
Oversampling .....	26, 27

<b>P</b>	
Part number	
Firmware .....	89
Firmware, enhanced carrier board.....	90
Hardware .....	89
Hardware, enhanced carrier board .....	90
Software .....	89
Photodetector .....	7, 95
Points .....	26, 27
Ports	
RS-232 .....	13

RS-422 .....	13
RS-485 .....	13
TTL .....	13
Power .....	13
Power outage.....	88
Precision .....	97
Preferences	
Data Logger.....	91
Display, window .....	91
Distance unit .....	91
Modifying .....	90
Recorder .....	91
Temperature unit .....	91
Protocol, Modbus.....	44
Push buttons .....	11

<b>R</b>	
Range .....	97
Raw detection	
Amplitude .....	93
Distance.....	93
Flag.....	94
Freeze .....	93
Segment .....	93
Receiver.....	7
Receiver assembly.....	7
Recorder .....	91
Recording.....	91
Recording detections.....	84
Records	
Detection (video) .....	81
Directory.....	83
File size .....	82, 83
Recording.....	81, 84
Time length, maximum .....	84
Reference pulse .....	13
Register	
Multiple, Read.....	56
Multiple, Write .....	56
Write .....	56
Report server ID .....	44
Reset.....	14
Resolution .....	97
RS-232 port.....	13
RS-422 port.....	13
RS-485 port.....	13

---

---

<b>S</b>	
Segment, raw detection .....	93
Serial number .....	68, 89
Serial number, enhanced carrier .....	90
Serial port settings, Get .....	48
Serial port settings, Set .....	49
Settings	
Accumulation .....	26
LED Intensity .....	26
Oversampling .....	26
Points .....	26
Smoothing .....	26
Threshold offset .....	26
Smoothing .....	26, 29
Source assembly .....	7
SPI .....	13
Switch, reset .....	14

<b>T</b>	
Temperature .....	91
Operating .....	95
Temperature sensor .....	7
Threshold offset .....	26, 27
Timers & Load .....	88

TTL port .....	13
----------------	----

<b>U</b>	
Units	
Distance .....	91
Temperature .....	91
USB interface .....	14
USB port .....	95

<b>V</b>	
Version	
Asic .....	89
Bootloader .....	89
FPGA .....	89
Software, enhanced carrier board .....	90
VersionSoftware .....	89
Voltage .....	95
VSCEL .....	7

<b>W</b>	
Wavelength .....	96
Window .....	91