IS16 Industrial Leddar^{TM} Sensor

User Guide

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

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1. Introduction

At the heart of the IS16 industrial Leddar™ sensor lies a patented Leddar™ Technology, designed to detect, locate and measure all types of objects that are either solid or liquid. The IS16 industrial Leddar™ sensor provides both distance and angular positioning while performing continuous analysis of the area. Specifically designed for the industrial market, this unique sensor is optimized for 0 to 50 meter detection and ranging applications.

Based on time-of-flight measurements using pulses from infrared LEDs, combined with 16 independent active segments, the IS16 industrial Leddar™ sensor provides fast, accurate and non-stop detection and ranging. The 45-degree beam, produced by diffused light pulses and processed through innovative algorithms, allows for the detection of a wide range of objects under various environmental conditions. And with its LCD display option, configuring and monitoring ongoing operations is a snap.

Presence detection mode (full configuration only)

This sensor integrates a *Presence Detection Mode* where the PNP/NPN outputs indicate the presence of objects within the configured zones (two zones, one per output).

Using *Teach mode* configuration, the sensor uses the perimeter of its surroundings as a detection zone.

In *Quick mode*, a near limit and a far limit are set to quickly define zones.

In Advanced mode, near and far limits can be set for each segment and unwanted segments can be deactivated.

WARNING! The IS16 industrial Leddar™ sensor does NOT include self-checking redundant circuitry required for use in personnel safety applications. A sensor failure or malfunction can result in OPEN or CLOSED state on the PNP/NPN outputs. Never use this product as a sensing device for personnel safety. Their use as safety devices may create an unsafe condition which could lead to injury or death.

Raw measurements mode

The IS16 industrial Leddar™ sensor provides the capabilities to acquire all measurements, from all segments— in real time— through the RS-485 link or the CAN bus. Each measurement provides the distance of the detected object, the index of the segment it was detected in, and the intensity of the measurement (indication of how much light was reflected off the object and captured by the sensor).

1.1. Overview

The IS16 industrial Leddar™ sensor is offered in many configurations.

The full configuration option includes all features of the presence detection mode and the raw measurement mode.

The raw measurement configuration option provides only the distance of the detected object, the index of the segment it was detected in, and the intensity of the measurement. No digital output and LCD are provided for this option.

The LCD option is offered only for the full configuration option. The presence of the LCD in the control panel provides advanced configuration setting directly on the sensor. When the LCD is not present, the advanced configuration settings are done using the Leddar™ Configurator software.

Each configuration if offered with the RS-485 or the CAN bus interface.

The IS16 industrial Leddar™ sensor package contains everything needed to get started:

- Sensor
- Quick reference guide
- Software CD

Figure 1: IS16 Industrial Leddar™ sensor

The sensor[1] offers the following features:

- 0 to 50 meter (165 ft) detection
- Rapid measurement rate – up to 50 Hz
- Beam width 45°, height 7.5°
- 16 detection segments (width 2.8°, height 7.5°)
- 2 NPN/PNP outputs (1 per detection zone)
- Control panel for on-site configuration
- LCD display option for on-site monitoring
- IP67 weather-resistant enclosure
- RS-485 or CAN bus for configuration and measurement acquisition
- USB port for configuration and measurement acquisition
- Software for configuration and monitoring (USB)
- SDK and code examples (RS-485, USB, Windows, Linux)

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[1] The sensor model described in this document is a 45° sensor. Please contact LeddarTech for other available beam options.

1.2. Underlying Principles

Created by LeddarTech, LEDDAR™ (light-emitting diode detection and ranging) is a unique sensing technology based on LED illumination (in either the visible or the infrared spectrum) and the time-of-flight of light principle. The LED emitters illuminate the area of interest (pulsed typically at 100 kHz) and the multichannel sensor receiver collects the backscatter of the emitted light and measures the time taken for the emitted light to return back to the sensor. A 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 2 illustrates the illumination area and detection segments of the evaluation kit. The 16 channels provide a profile of the object in the beam. In other installations, the 16 channels can be used to locate and track one or multiple objects in the beam.

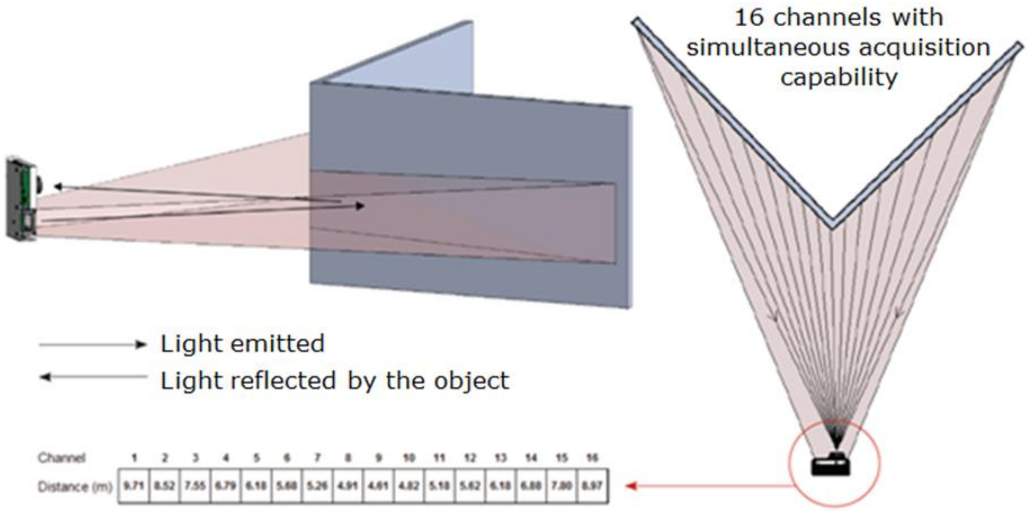


Figure 2: Illumination area and detection zone

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.

1.3. Beam Pattern

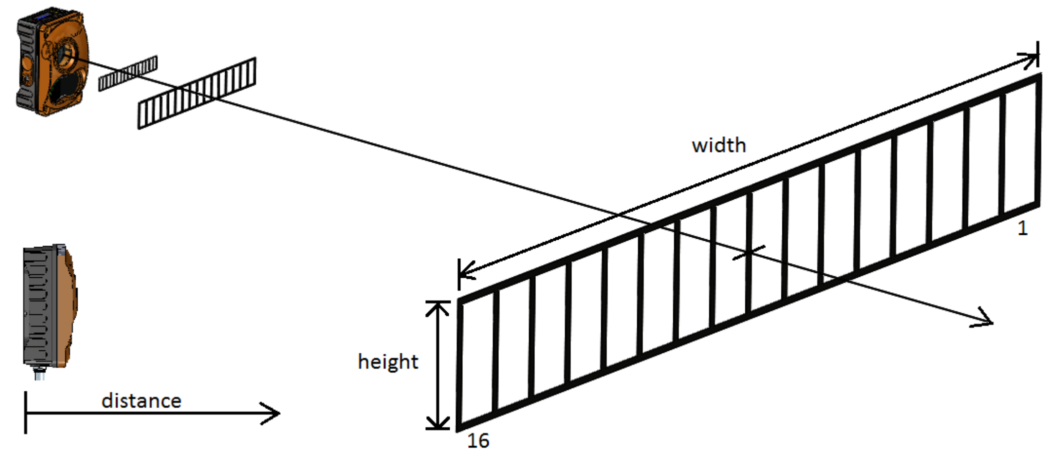


Figure 3: Beam and distance measurement reference position

The LEDs and emission optics create a diffused light beam to illuminate the scene while the reception lens collects the backscatter of light from objects in the beam onto a multi-element photo detector.

The lens specifications and photo detector geometry result in a beam with 48° width (w) and 8° height (h). Note that the detection sensitivity varies within the beam and limits that are not clear cut at 48° and 8°. Figure 68 and Figure 69 illustrate how the sensitivity varies within the cross-section of the beam (width and height). For example, Figure 69 indicates that the sensitivity drops to less than half of the maximum outside of an optimal 6° range.

Figure 3 illustrates various cross-sections of the beam (at 5m, 10m and 50m) and how the beam is segmented (16 segments). The following equations can be used to approximate the beam cross-section dimensions at a given distance (d) from the sensor.

Beam width = d x 0.8905

Beam Height = d x 0.1402

Each segment has a width 1/16th of the beam width and the same height as the beam. The following table provides beam cross-section dimensions for various distances from the sensor.

Table 1: Beam cross-section dimensions vs. distance

Distance	Beam Width	Beam Height	Segment Width	Segment Height
0.5	0.45	0.07	0.03	0.07
1	0.89	0.14	0.06	0.14
2	1.78	0.28	0.11	0.28
5	4.45	0.70	0.28	0.70
10	8.91	1.40	0.56	1.40
15	13.36	2.10	0.83	2.10
20	17.81	2.80	1.11	2.80
25	22.26	3.51	1.39	3.51
30	26.72	4.21	1.67	4.21
35	31.17	4.91	1.95	4.91
40	35.62	5.61	2.23	5.61
45	40.07	6.31	2.50	6.31
50	44.53	7.01	2.78	7.01

2. Installation

This chapter presents the mechanical and electrical installation information.

2.1. Mechanical

SHCS M4, M5, 8-32 or 10-24 screws are recommended for installing the IS16 industrial Leddar™ sensor.

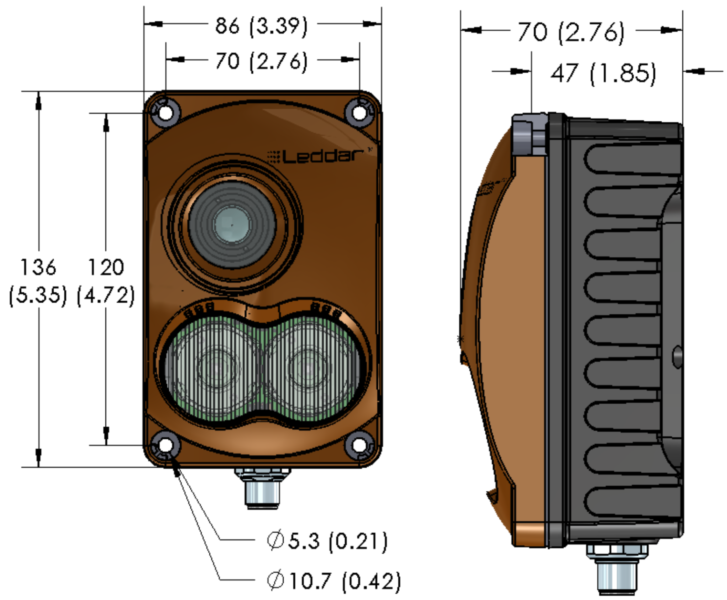


Figure 4: Mechanical dimensions

2.2. Electrical

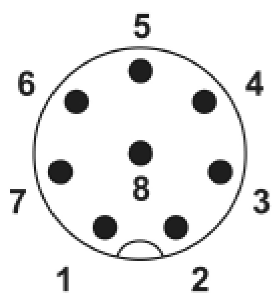
2.2.1. Supply and Load Specifications

Table 2: Supply and load specifications

DC supply voltage	12-30 V
PNP/NPN output load current (max)	100 mA

2.2.2. M12 Connector Pinout

Table 3: M12 Connector pinout

Pinout	**Pin #**	**Full Configuration**	**Raw Measurement Configuration**
	1	RS-485- / CAN_L	RS-485- / CAN_L
	2	DC SUPPLY	DC SUPPLY
	3	ANALOG OUT (4-20mA, 0-10V)*	No connect
	4	PNP/NPN OUT1 (ZONE 1)	No connect
	5	PNP/NPN OUT2 (ZONE 2)	No connect
	6	RS-485+ / CAN_H	RS-485+ / CAN_H
	7	GND	GND
	8	INPUT*	No connect

***** Provision for future use

2.2.3. NPN Connection Diagram

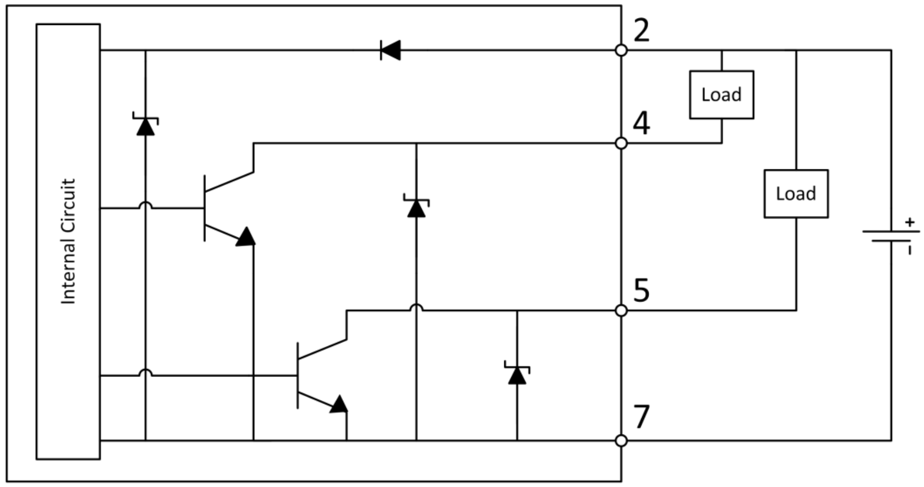


Figure 5: NPN Connection diagram

2.2.4. PNP Connection Diagram

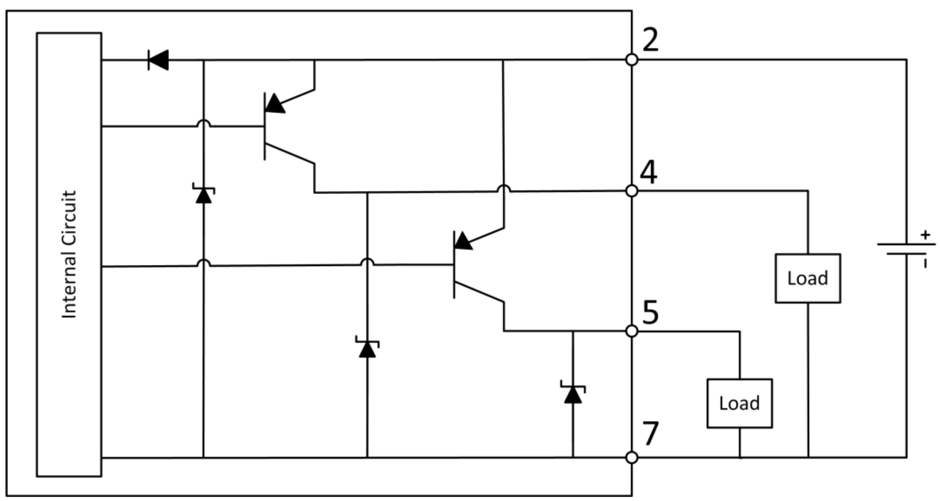


Figure 6: PNP Connection diagram

3. Control Panel

This section explains the functionality of the control panel with a LCD display. For the control panel without the LCD display, the buttons and the output LED are inactive and reserved for future use. The Power LED keeps the same functionality and the Signal LED informs the presence of an object in its detection range.

3.1. Description (with LCD Option)

The control panel provides several buttons and indicators and a display used to navigate through the menu for sensor configuration.

Figure 7: Control panel

Table 4: Control panel indicator functions

Indicator	Function
Power	On when the sensor has power
Signal	• During normal operation, it is on when no objects are detected. • During the teach operation, it is on if an object is not detected in all segments (use to warn the far limit will be set to the limit of the beam).
Out 1	On when zone 1 is activated (objet detected in the zone).
Out 2	On when zone 2 is activated (objet detected in the zone).

Table 5: Control panel pushbutton functions

Key	Function
 Backspace	• Move back in the menu or move to the previous digit. • Hold 2 seconds to exit changes.
 Arrows	• Move up/down in menu. • Modify settings and digits.
 Enter	• Move forward in menu or next digit. • Apply changes.

3.2. Menu

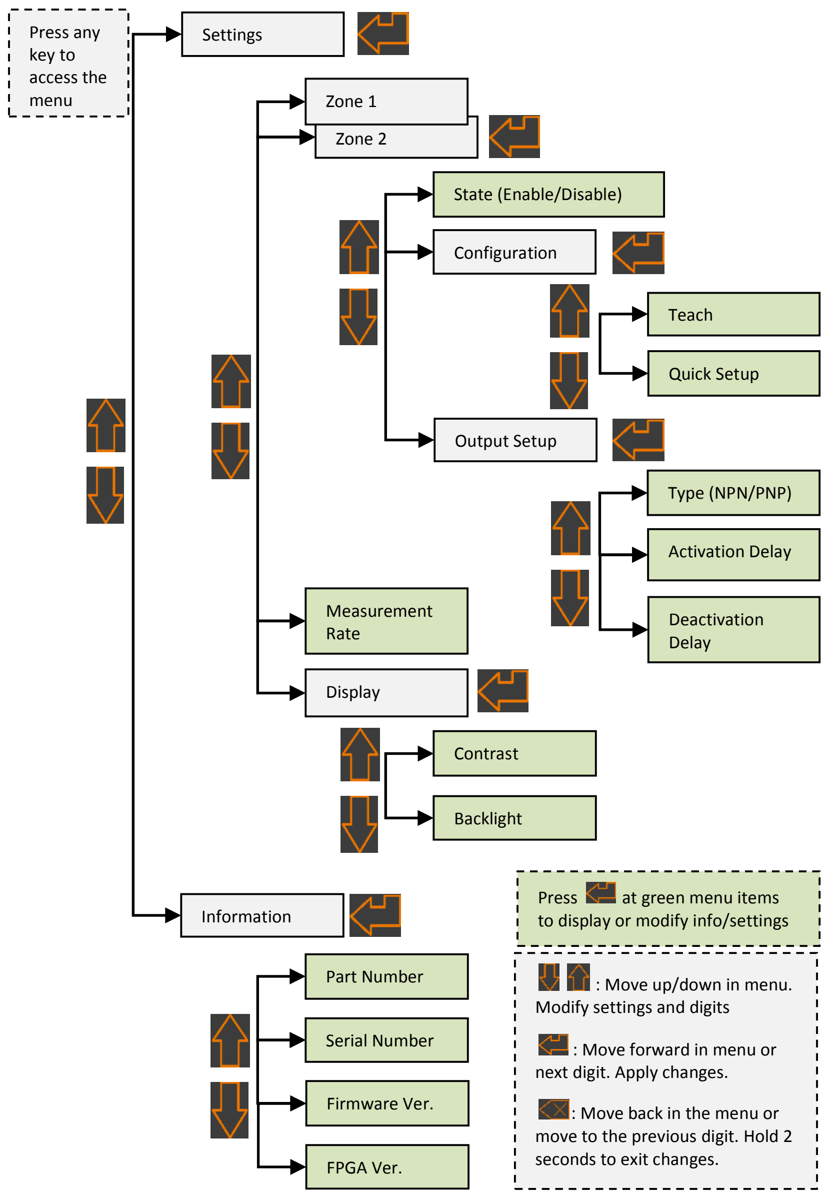


Figure 8: Control panel menu

4. Installing Leddar™ Configurator

This chapter presents the steps to install Leddar™ Configurator and start using the IS16.

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.

NOTE*: For Microsoft Windows® XP, an upgrade of Microsoft components and a restart may be required. Follow the instructions and do not remove the installation CD from the CD/DVD drive. Installation will automatically resume after restarting the computer.*

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 9: 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 10: End-User License Agreement dialog box

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

***NOTE**: If you do not want to install the development kit, clear the check box.*

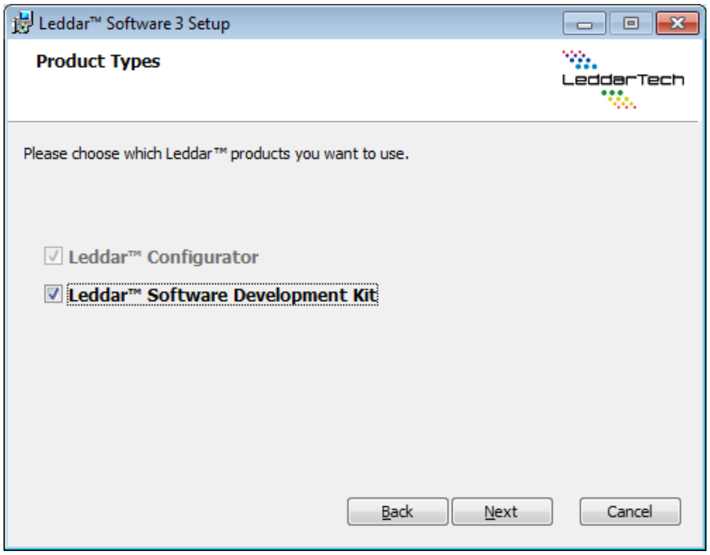


Figure 11: Product Types dialog box

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.

Connecting to the Sensor

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

***NOTE**: For Windows™ XP, you may be prompted for installation instructions upon detection of the sensor. Accept the default or recommended settings.*

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

To connect to the sensor:

1. Connect the power cord to the sensor and to a power outlet.
2. Connect the USB cable to the sensor and to the computer.

3. On the computer desktop, double-click the Leddar™ Configurator icon.
4. In the Configurator main window, click the connect button ().

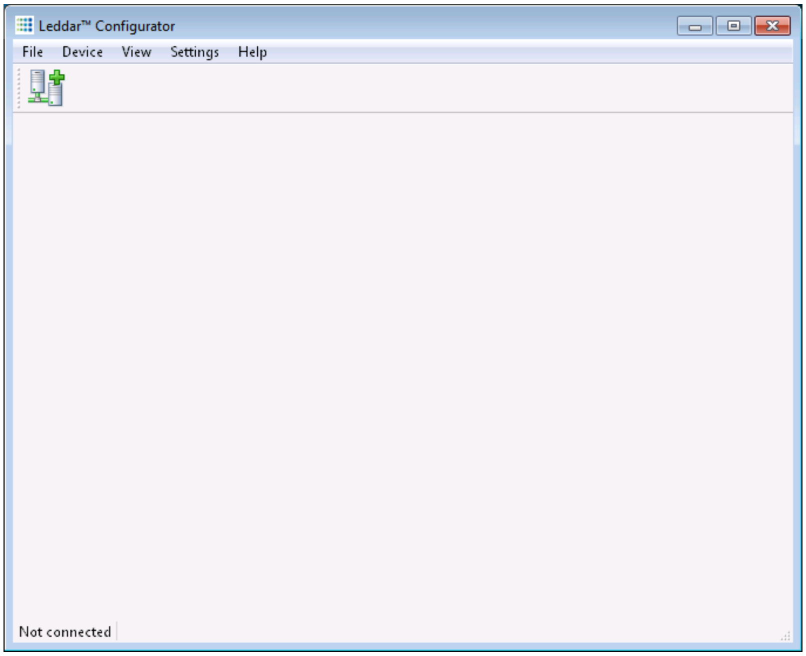


Figure 12: Connecting to a sensor

5. In the **Connection** dialog box, in the **Select a connection type** list, select the USB connection.

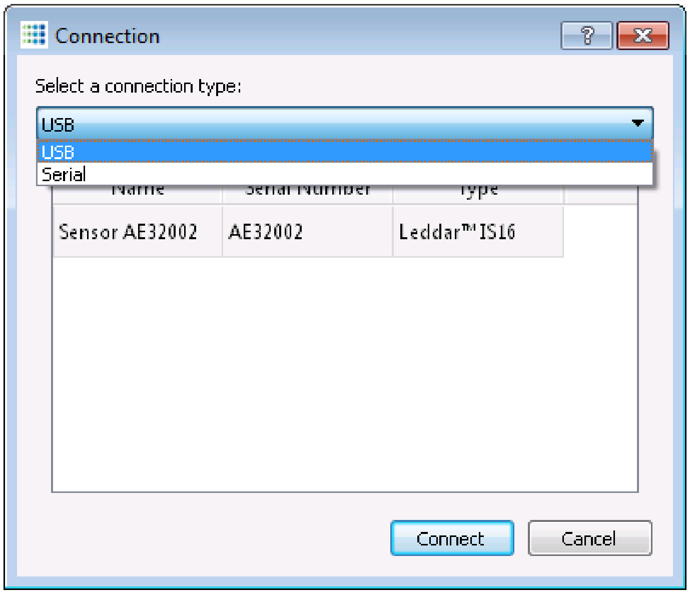


Figure 13: Connection dialog box

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

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

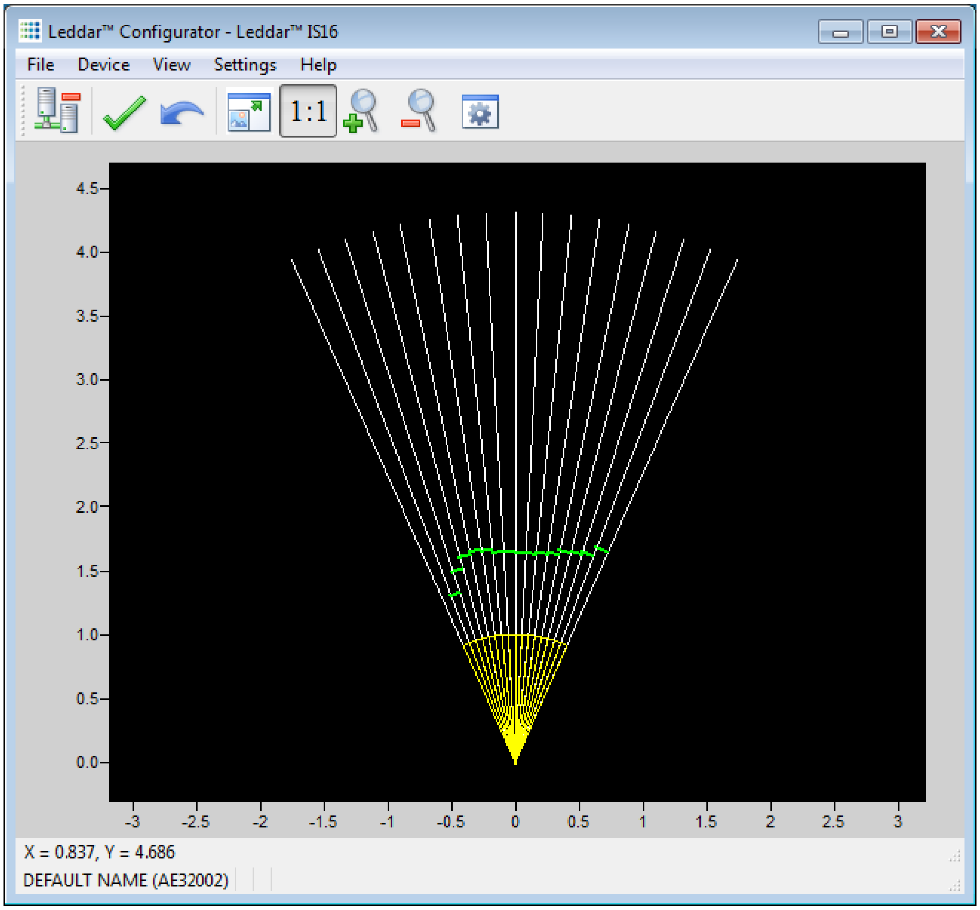


Figure 14: Main window

A complete description of Leddar™ Configurator features and parameters is presented in Chapter 8.

5. Presence Mode

NOTE*: This chapter applies for the full configuration only.*

5.1. Overview

In presence mode, user-defined zones in the sensor beam are used to activate the NPN/PNP outputs when an object is present within a zone.

Two zones can be configured, one for each output.

Each output can be separately enabled and configured as NPN or PNP. The outputs can also be configured to be "CLOSED" (source/sink current) on object presence or "OPEN" on object presence.

NOTE: *On power loss, the outputs will be in OPEN state, regardless of the output configuration.*

WARNING! The IS16 industrial Leddar™ sensor does NOT include self-checking redundant circuitry required for use in personnel safety applications. A sensor failure or malfunction can result in OPEN or CLOSED state on the PNP/NPN outputs. Never use this product as a sensing device for personnel safety. Their use as safety devices may create an unsafe condition which could lead to injury or death.

A zone is defined by near and far limits for each segment in the sensor beam (16 segments) and can be configured in different ways.

5.2. Configuration Steps

To use the sensor in presence detection mode, at least the following steps are required:

1. Configure the zones (using Teach, Quick, or Advanced)
2. Configure and enable the outputs.

Optimal performance may require adjustment of other parameters such as the measurement rate and output activation and deactivation delays. Note that other advanced parameters (detection threshold offset, useful range, LED power, object demerging) are only adjustable with Leddar™ Configurator.

5.3. Teach Mode

With the Teach mode, the sensor sets the near limit of each segment to 0 and sets the far limit of each segment to the closest object detected in each segment minus the gap setting. Figure 15 shows an example zone obtained through teach configuration. The gap in each segment is visible between the green line (the detected object position) and the orange line (far limit).

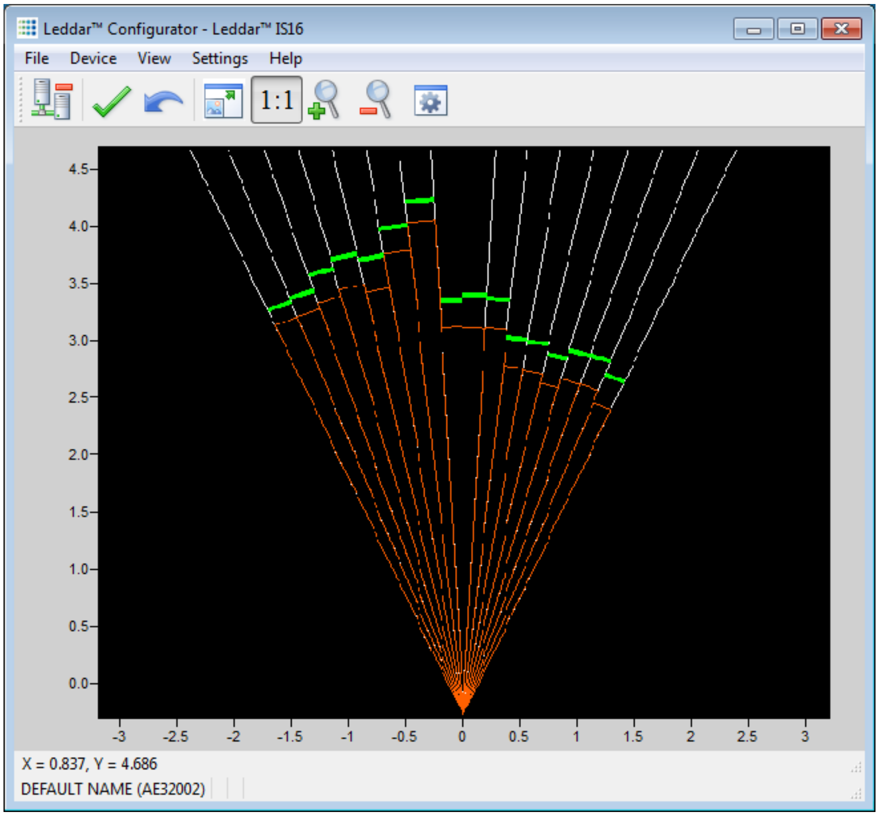


Figure 15: Teach zone example

5.3.1. Using the Teach Mode

Control panel (with LCD option)

Enter the Teach items (see Figure 8). The gap setting will be requested (in meters). Use the enter/back buttons to move across digits and the up/down buttons to modify the digit values.

Make sure nothing is blocking the sensor and that nothing is moving within the desired zone.

Press the enter button on the last digit to start the Teach configuration.

A countdown appears (to clear the sensor) then the Teach configuration starts. The SIGNAL LED will light if the Teach fails (see section 5.3.2). The result will also be indicated on the display. In the Teach mode, the sensor sets the near limit of each segment to 0 and sets the far limit of each segment to the closest object detected in each segment minus the gap setting. Figure 15 shows an example of a zone obtained using the Teach configuration. The gap in each segment is visible between the green line (the detected object position) and the orange line (far limit).

Leddar™ Configurator software

The software provides a **Detection Zones** dialog box for zone configuration.

To open it, click the **Device** menu, point to **Configuration**, and click **Detection Zones**.

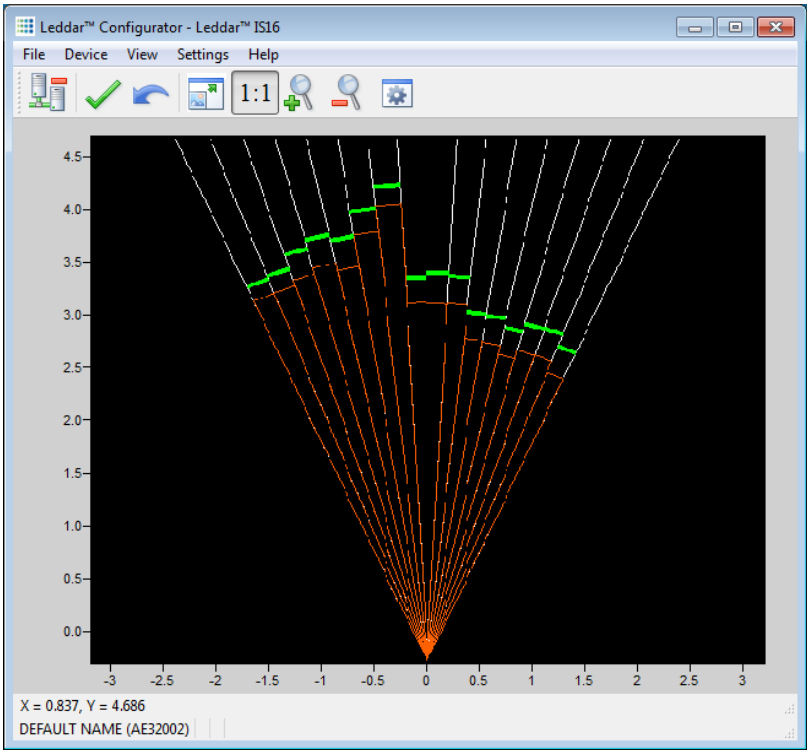


Figure 16: Teach mode example

To configure the zone in Teach mode, select the desired zone, select the Teach configuration mode, adjust the gap setting, and click the **Teach** button.

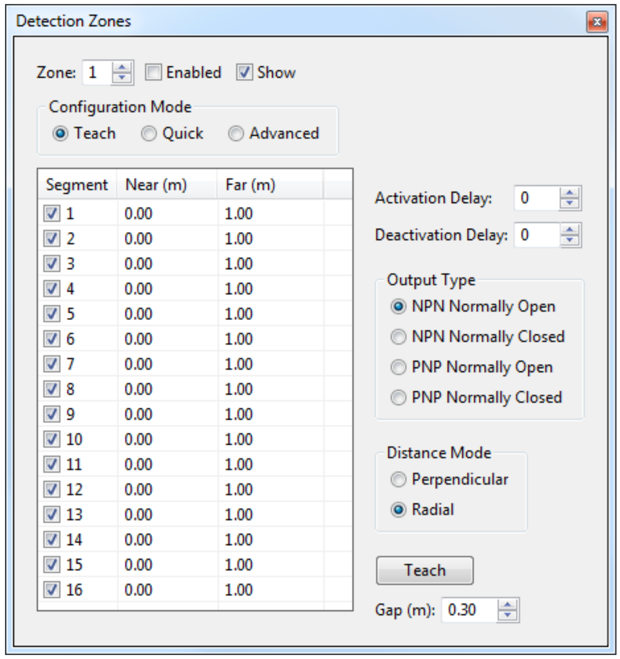


Figure 17: Detection Zones dialog box (Teach mode)

5.3.2. Optimal Installation

The Teach mode will operate most effectively if the following conditions are met:

- Every segment has a detected object as part of the sensor perimeter. If not, the far limit of empty segments will be set to the beam limit. The Quick or Advanced mode should be considered for these installations.
- The zone is delimited with a static perimeter (for example, wall, floor). Dynamic changes to the perimeter may result in false zone activation.

5.4. Quick Mode

5.4.1. Description

In Quick mode, a zone is created with all segments configured with the same near and far limits. Two near and far limit distance types are available, radial and perpendicular. Figure 18 illustrates 2 example of zones created with the Quick mode for each distance type.

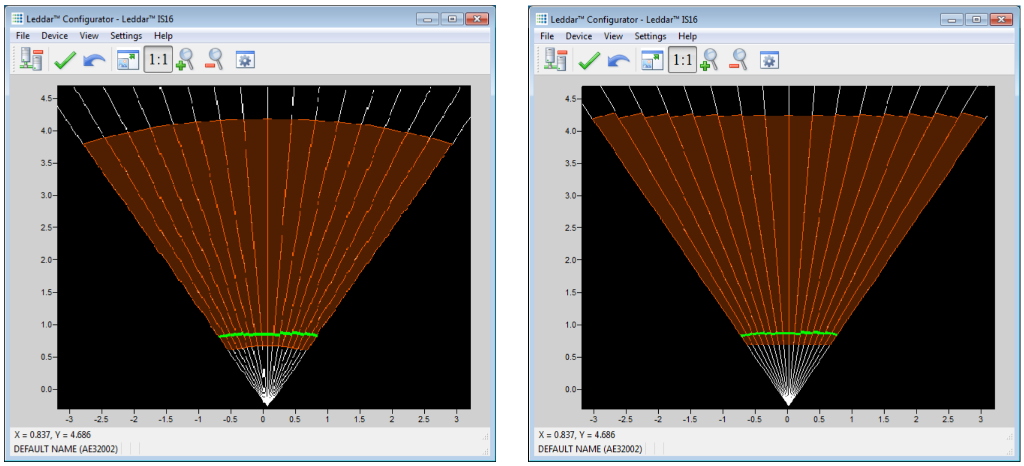


Figure 18: Quick mode examples (radial and perpendicular)

5.4.2. Using the Quick Mode

Control panel (with LCD option)

Enter the Quick mode menu item (see Figure 8). The near and far settings will be requested (in meters). Use the enter/back buttons to move across digits and the up/down buttons to modify the digit values. Press the enter button on the last digit to move forward in the setup steps.

The mode will be requested as well. Choose radial or perpendicular and press enter to complete the quick mode configuration.

Leddar™ Configurator software

The software **Detection Zones** dialog box provides a button to select the Quick mode configuration.

To open it, on the **Device** menu, point to **Configuration** and click **Detection Zones**.

To configure the zone in Quick mode, select the desired zone, select **Quick**, adjust the near and far limits, and click the **Apply** button (green check mark). Note that the near and far limits are adjustable graphically in the main window by clicking the limit line and dragging it closer or farther from the sensor.

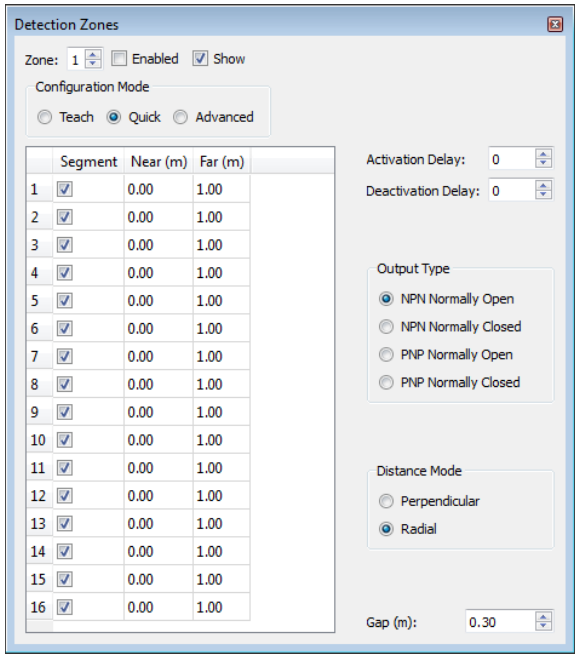


Figure 19: Detection Zones dialog box (quick mode)

5.5. Advanced Mode

5.5.1. Description

In Advanced mode, the near and far limit of each segment is configurable and unwanted segments can be disabled. This mode provides the highest flexibility to create custom zones.

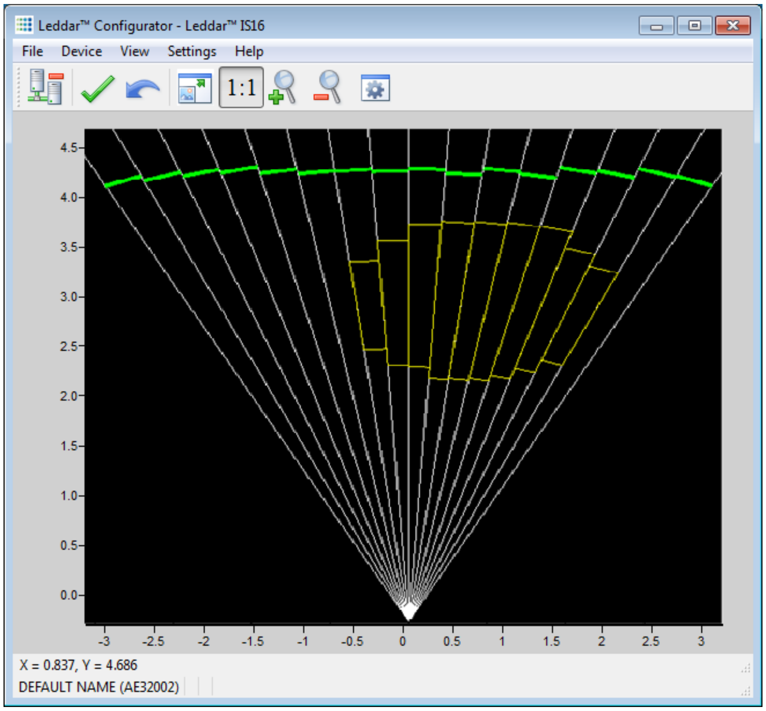


Figure 20: Advanced mode zone example

5.5.2. Using the Advanced Mode

The Advanced mode is only available using Leddar™ Configurator. The software provides a **Detection Zones** dialog box for zone configuration.

To open it, on the **Device** menu, point to **Configuration**, and click **Detection Zones**.

To configure the zone in Advance mode, select the desired zone, select **Advanced**, clear the check boxes of unwanted segments and set the near and far limits for each active segment. Note that each segment near and far limits are adjustable graphically in the main window by clicking the limit line and dragging it closer to or farther from the sensor.

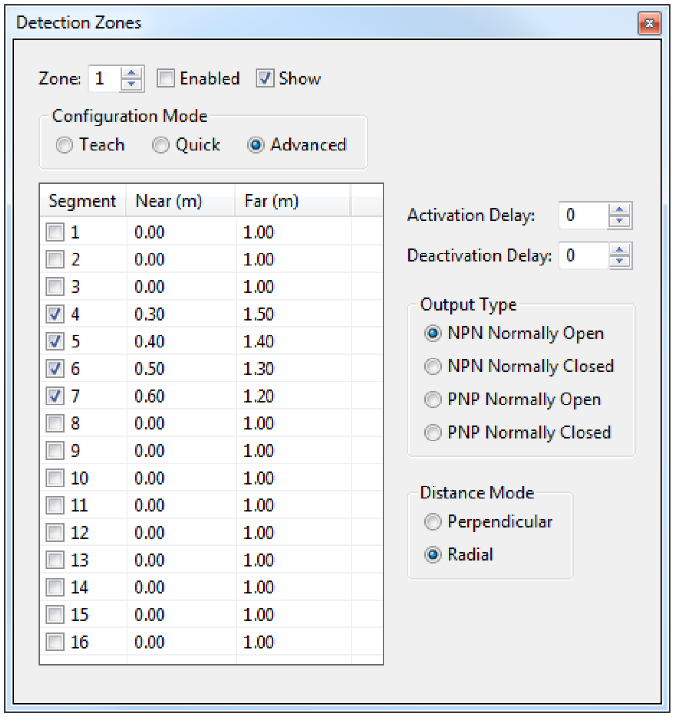


Figure 21: Detection Zones dialog box (Advanced mode)

5.6. Outputs Configuration

The outputs can be configured through the control panel (see Figure 8) or the Leddar™ Configurator software (in the zone configuration window).

5.6.1. Type

The sensor outputs may be configured to one of these settings:

- NPN, normally OPEN (open when no presence in the zone)
- NPN, normally CLOSED (closed when no presence in the zone)
- PNP, normally OPEN
- PNP, normally CLOSED

NOTE: *On power loss, the outputs will be in the OPEN state, regardless of the output type configuration.*

5.6.2. Activation Delay

The activation delay is used to set a minimum number of consecutive measurements with an object in the zone before switching the output to the “presence” state.

NOTE: *Since the parameter is a number of measurements, the delay will vary if the measurement rate is changed.*

5.6.3. Deactivation Delay

The deactivation delay is used to set a minimum number of consecutive measurements without an object in the zone before switching the output to the inactive zone state.

NOTE: *Since the parameter is a number of measurements, the delay will vary if the measurement rate is changed.*

5.7. Additional Settings

The following settings may be adjusted to optimize operation of the sensor in presence mode.

These settings are found in the **Acquisition Settings** dialog box. To open it, on the **Device** menu, point to **Configuration** and click **Acquisition**.

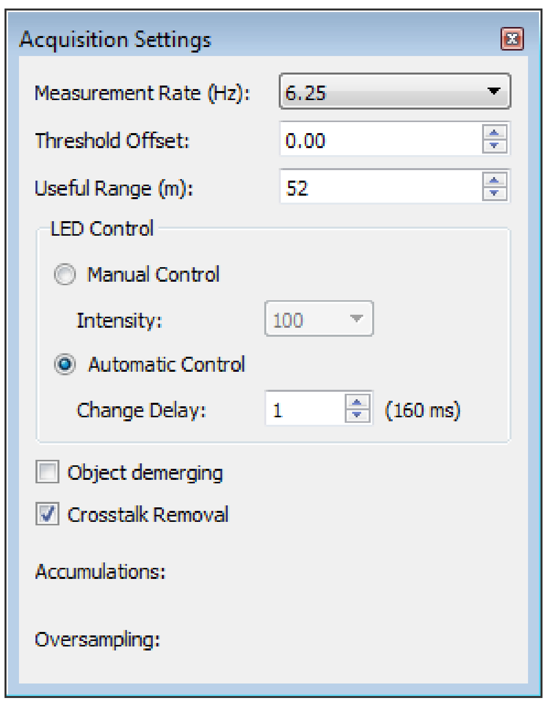


Figure 22: Acquisition Settings dialog box (Advanced mode)

Table 6: Acquisition setting description

Setting	Effect	More Information
Measurement Rate	Decreasing improves precision and range. Increasing improves zone activation response time	Section 7.1
Threshold Offset	Increasing reduces sensitivity and range. This can help filter out secondary objects in the scene.	Section 7.2
Useful Range	Decreasing reduces the maximum distance the sensor will detect objects.	Section 7.3
LED Control	Provides manual control of the LED intensity (automatic by default).	Section 7.4
Object demerge	Improves discrimination of 2 close objects in the same segment. Available at measurement rates 1.5625, 3.125 and 6.25Hz.	Section 7.5
Crosstalk Removal	Inter-channel interference noise removal	Section 7.6

6. Raw Measurements Mode

This chapter applies only for both the advanced detection and the raw measurement configurations.

6.1. Overview

The raw measurements mode refers to use of the sensor with acquisition of the object detection and distance measurement data. The data available in raw measurement can be displayed in the Leddar™ Configurator from the **View** menu by clicking the **Raw Detections** command. Data can be collected through the serial link [RS-485 link (Modbus protocol)/CAN bus] or USB link (SDK).

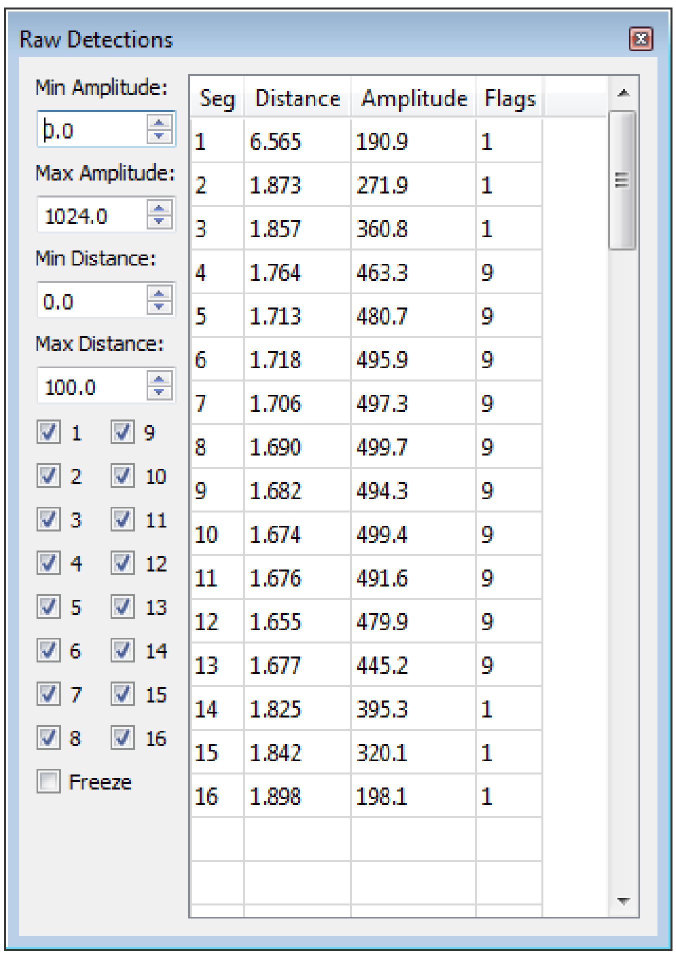


Figure 23: Raw Detections dialog box

6.2. Measurements Description

An object crossing the beam of the sensor is detected and measured. It is qualified by its distance, segment position, and amplitude. The quantity of light reflected back and captured by the sensor determines the amplitude.

Table 7: Raw detection field description

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

The **Flags** parameter provides the status information that indicates the measurement type. Table 8 presents the flag definitions for data transferred through the USB link. See section 0 for the description of flags available through the RS-485 link.

Table 8: Flag value description

Bit position	Bit = 0	Bit = 1
0	Invalid measurement	Valid measurement
1	Normal measurement	Measurement is the result of demerge processing (see section 7.5).
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 **Flags** field provisions for 8 bits encoded as a bit field. Three bits are currently used. The following table presents the example decimal values of the status bit field.

Table 9: Status value description

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

6.3. Configuration

6.3.1. Acquisition Settings

The acquisition settings can be adjusted to optimize the sensor for high measurement rate, precision or range. These settings are described in detail in section 7.

6.3.2. Serial Port Settings

A number of serial port settings are available to adjust data acquisition through the RS-485 link. Typical serial port settings such as baud rate and start/stop bit can be configured to the desired values.

A baud rate of 115200 is recommended to provide the best data transfer rate and measurement rate up to 50 Hz. The following serial port settings are configurable.

Table 10: Serial port settings description

Parameter	Value
Baud rate	9600, 19200, 38400, 57600, 115200 bps
Parity	None, odd, even
Stop bits	1, 2
Address	1 to 247
Detections	0 to 48

The **Detections** parameter is the maximum number of detections to output in Modbus data transfers (Get detections – function code 0x41). This can be used to match the data transfer rate to the sensor measurement rate (the sensor will drop measurements if the measurement rate exceeds the data transfer rate).

In order to give an equal chance to each segment, the sensor parses all segments to output their nearest measurement and then pass to the second nearest, etc. until either there are no more detections to output, or the configured number of detections is reached.

The following table lists the theoretical maximum number of detections that can be transferred for different baud rates and measurement rates. This assumes the host can sustain the resulting data transfer rate.

Table 11: Maximum detections per Baud rate/Measurement rate settings

Baud\Hz	1.5625	3.125	6.25	12.5	25	50
115200	48	48	48	48	48	32
57600	48	48	48	32	32	14
38400	48	48	48	44	20	8
19200	48	48	44	20	8	2
9600	48	44	20	8	2	2

6.3.3. CAN Port Settings

The CAN port settings are available to adjust data acquisition through the CAN link. Typical CAN port settings such as baud rate, Tx and Rx ID, frame format, inter-message and inter-cycle delay, flag information, maximum number of detection to output, and the message mode can be configured.

The following CAN port settings are available.

Table 12: CAN port settings

Parameter	Value
Baud Rate	10, 20, 50, 100, 125, 250, 500, 1000 kbps
Base Tx ID	The CAN arbitration ID used for data messages. From the sensor containing the detections. The arbitration ID of the messages containing the number of detections will be this value plus one (see the protocol documentation).
Base Rx ID	The CAN arbitration ID used for data messages To the evaluation kit (see the protocol documentation).
Frame Format	Standard, Extended
Inter-Message Delay	0 to 65535 milliseconds

Inter-Cycle Delay	0 to 65535 milliseconds
Flag Information	Enable, Disable (standard detection message)
Detection	1 to 96
Message Mode	Single or multiple

The CAN port supports two frame format standards: the standard 11 identifier bits and the extended 29 identifier bits.

For a CAN host device that uses limited resource, it is possible to slow down the CAN data transmission by adding configurable delays from 0 to 65535 milliseconds:

The **Inter-Message Delay** parameter is a delay to add between two CAN messages.

The **Inter-Cycle Delay** parameter is a delay to add between two acquisition cycles message block. It is especially used to send detection in continuous mode.

The **Flag Information** parameter, when activated, gives an 8-bit field additional information of measurement.

The **Detections** parameters is the maximum number of detections to output in the CAN bus. This can be used to limit the range of message ID used in multiple-message mode. In order to give an equal chance to each segment, the sensor parses all segments to output their nearest measurement and then move to the next nearest, and so on until either there are no more detections to output or the configured number of detections is reached.

The **Message Mode** parameter is the type of transmission data on the CAN link. Two message modes are available. Please refer to section 6.5 for more information.

6.4. Modbus Protocol

The RS-485 port on the sensor uses 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.

Report server ID (function code 0x11)

This function returns information on the sensor in the following format:

Table 13: Report server ID message

Offset	Length	Description
0	1	Number of bytes of information (excluding this one). Currently 0x95 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 0xFF, otherwise the sensor is defective.
34	64	The device name as a Unicode string
98	16	The software part number as an ASCII string
114	16	The hardware part number as an ASCII string
130	8	The full firmware version as 4 16-bit values
138	4	The firmware 32-bit CRC
142	2	The firmware type (LeddarTech internal use)
144	2	The FPGA version
146	4	Device option flags (LeddarTech internal use)
150	2	Device identification code (8 for IS16)

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 48 detections will be returned. This is not a problem as it is very unlikely to have more than 48 detections in a real-world application. Note that this maximum can be configured to a lower value using Leddar™ Configurator (serial port configuration) or the Write Register command described below.

Following the first byte, each detection entry has five bytes:

Table 14: Get detection message (detection fields)

Offset	Length	Description
0	2	The distance in centimeters (little-endian). Distance unit is defined by holding register 14.
2	2	The amplitude times 64 (i.e., amplitude = this field/64) (little-endian)
4	1	Low 4 bits are flags describing the measurement: 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 High 4 bits are the segment number.

Trailing all the detections are some more fields:

Table 15: Get detection message (trailing fields)

Offset	Length	Description
0	4	Timestamp of the acquisition (little-endian). The timestamp is expressed as the number of milliseconds since the sensor was started.
4	1	Current LED power as a percentage of maximum.
5	1	Current acquisition statuses. This is an 8-bit field with 1 bit currently defined (all others are reserved): Bit 1 - Object demerging is completed if 1 when this function is activated.

Read input register (function code 0x4)

Here are the registers implemented for this command:

Table 16: Read input register message

Address	Description
0	Sensor temperature in degree Celsius. Fixed point value with an 8-bit fractional part (that is, temperature is the register value divided by 256).
1	Detection status for polling mode: 0 = Detections not ready. 1 = Detections ready: this register is reset to 0 on reading input registers from addresses 13 to 207 or on execution of “get detections” function (code 0x41).

13	Least significant byte is the current LED power as a percentage of maximum. Most significant byte is acquisition statuses: bit 0 indicates that automatic LED intensity is enabled if 1, bit 2 indicates that object demerging is enabled if 1.
14	Low 16 bits of timestamp (number of milliseconds since the sensor was started)
15	High 16 bits of timestamp
16-31	Distance in centimeters of first detection for each segment, zero if no detection in a segment. Distance unit is defined by holding register 14.
32-47	Amplitude of first detection for each segment times 64 (i.e., amplitude = this register/64), zero if no detection in a segment
48-63	Distance of second detection for each segment
64-79	Amplitude of second detection for each segment
80-95	Distance of third detection
96-111	Amplitude of third detection
112-127	Distance of fourth detection
128-143	Amplitude of fourth detection
144-159	Distance of fifth detection
160-175	Amplitude of fifth detection
176-191	Distance of sixth detection
192-207	Amplitude of sixth detection

Note that as per the Modbus protocol, register values are returned in big-endian format.

Read holding register (function code 0x3), write register (function code 0x6) and write multiple registers (function code 0x10)

Here are the registers implemented for these commands (see section 7 for a more detailed description of parameters).

Table 17: Read holding, write register, and write multiple register definition

Address	Description
0 to 2	Reserved
3	Measurement rate in Hz. The value of this register is n in the following

4	Detection threshold as a fixed-point value with an 8-bit fractional part (i.e. threshold value is this register divided by 256).
5	LED power in percentage of the maximum. A value above 100 is an error. Only the LED intensity values defined in section 7.4 should be used. 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 set. Note that this value is ignored if Automatic LED intensity is enabled.
6	Bit field of acquisition options with 3 bits currently defined (all others are reserved): Bit 0 – Automatic LED intensity enabled Bit 2 – Object demerging enabled Bit 3 – Crosstalk removal disabled (disabled if 1)
7	Change delay in number of measurements
8	Maximum number of detections (measurements) returned by function 0x41
9 and 10	Reserved
11	Smoothing: Stabilizes the sensor measurements. The behavior of the smoothing algorithm can be adjusted by a value ranging from −16 to 16.
12 and 13	Reserved
14	Distance units: mm = 1000 cm = 100 dm = 10 m = 1
15	Channel activation: Bits field of selected channel to activate
16 to 26	Reserved
27	Port configuration stop bits: Set to 1 or 2.
28	Port configuration parity: 0 = none 1 = odd 2 = even
29	Port configuration Baud rate: 0 = 9600 bps 1 = 19200 bps 2 = 38400 bps 3 = 57600 bps 4 = 115200 bps

30	Port configuration Modbus sensor address: Set from 1 to 247.

To setup the port configuration, it is recommended to do the "read holding registers" and "write multiple register" commands for the entire range of Modbus holding register address from 27 to 30 inclusively.

The "write register" and "write multiple register" commands execution will fail if this sensor is USB connected to a host device: the error code 4 will be returned.

Note that 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.

6.5. CAN Bus

The CAN port in single message mode uses the 1872 (0x750) base ID to send all detection message. When sending detection, one 0x751 message will be sent followed by as many 1872 (0x750) base ID messages as needed.

The CAN port in multiple message mode uses a maximum range from 1874 (0x752) ID to 1922 (0x782) of standard message or a maximum range from 1874 (0x752) ID to 1970 (0x7B2) of message with detection flag information. When sending detection, one 0x751 message will be sent followed by messages on ID range from 1874 (0x752) to as needed in multiple message mode.

Four different message ids are available (these IDs can be modified with the Leddar™ Configurator software):

1856 (0x740) (Rx base ID)

This is an 8-byte message length for command request that the sensor listens for: the first byte (Byte 0) describe the main function and rest of message bytes are used as arguments. Undescribed bytes are reserved and must be set to 0.

Table 18: CAN bus request message

Function Request (Byte 0)	Function Request Description	Function Arguments (Byte 1)
1	Legacy: Send detections once	-

2	Legacy: Start sending detections continuously (the sensor will send a new set of detections each time they are ready without waiting for a request).	-
3	Stop sending detections continuously	-
4	Send detection once	Bit field of operation mode (this override CAN Operation Mode field in CAN port configuration 3): Bit-0: 0 = return detection in single message mode, 1 = return detection in multiple message mode Bit-1: reserved Bit-2: reserved Bit-3: detection flag message activation
5	Start sending detections continuously (i.e., the sensor will send a new set of detections each time they are ready without waiting for a request).	Bit field of operation mode (this override CAN Operation Mode field in CAN port configuration 3): Bit-0: 0 = return detection in single message mode, 1 = return detection in multiple message mode Bit-1: reserved Bit-2: reserved Bit-3: detection flag message activation
6	GET input data (read only)	See Table 19
7	GET holding data	See Table 20
8	SET holding data	See Table 21

NOTE: *The GET and SET function messages always return an answer message on the 1873 (0x751) base ID, see section below.*

Table 19: CAN bus request message (GET input data)

Input Data Type (Byte 1)	Input Data Description
0	Temperature

Table 20: CAN bus request message (GET holding data)

Holding Data Type (Byte 1)	Holding Data Description
0	Reserved
1	Measurement rate
2	Detection threshold
3	LED power percent (%)
4	Acquisition option
5	Auto acquisition average frames
6	Smoothing
7	Distance resolution
8	Selected channel
9	CAN port configuration 1
10	CAN port configuration 2
11	CAN port configuration 3

Table 21: CAN bus request message (SET holding data)

Holding Data Type (Byte 1)	Holding Data Description	Arguments	Arguments Description
0	Reserved		
1	Measurement rate	Byte 2	Measurement rate in Hz. Value of this field is expressed by n in this following formula $12800/2^n$ and must be: 8 = 50 Hz 9 = 25 Hz 10 = 12.5 Hz 11 = 6.25 Hz 12 = 3.125 Hz

			13 = 1.5625 Hz
2	Detection threshold	Byte 4 Byte 5 Byte 6 Byte 7	Detection threshold as a fixed-point value with a 16-bit fractional part (that is, threshold value is this register divided by 65536).
3	LED power percent (%)	Byte 2	LED power in percentage of the maximum. A value above 100 is an error. Only the LED intensity values defined in section 7.2 should be used. 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 set. Note that this value is ignored if Automatic LED intensity is enabled.
4	Acquisition option	Byte 2 Byte 3	Bit field of acquisition options with 3 bits currently defined (all others are reserved): Bit 0 – Automatic LED intensity enabled Bit 2 – Object demerging enabled Bit 3 – Crosstalk removal disable (disable if 1)
5	Auto acquisition average frames	Byte 2 Byte 3	Change delay in number of measurements
6	Smoothing	Byte 2	Smoothing: stabilizes the sensor measurements. The behavior of the smoothing algorithm can be adjusted by a value ranging from -16 to 16.
7	Distance units	Byte 2 Byte 3	Distance units: mm = 1000 cm = 100 dm = 10 m = 1
8	Channel activation	Byte 2 Byte 3	Bits field of activated channel
9	CAN port configuration 1	Byte 2	Baud rate: 0 = 1000 kbps 1 = 500 kbps 2 = 250 kbps 3 = 125 kbps 4 = 100 kbps 5 = 50 kbps 6 = 20 kbps 7 = 10 kbps

		Byte 3	Frame format: 0 = standard 11 bits 1 = extended 29 bits
		Byte 4	Tx base ID
		Byte 5	
		Byte 6	
		Byte 7	
10	CAN port configuration 2	Byte 4	Rx base ID
		Byte 5	
		Byte 6	
		Byte 7	
11	CAN port configuration 3	Byte 2	CAN Operation Mode bits field: Bit-0: 0 = return detection in single message mode, 1 = return detection in multiple message mode Bit-1: inter-message delay activation Bit-2: inter-cycle delay activation Bit-3: detection flag message activation
		Byte 3	Maximum number of detections (measurements) returned per CAN detection message transaction: 1 to 96
		Byte 4	Inter-message delay 0 to 65535 milliseconds
		Byte 5	
		Byte 6	Inter-cycle delay 0 to 65535 milliseconds
		Byte 7	

NOTE: *The SET command execution will fail if this sensor is USB connected to a host device: an error answer message will be returned.*

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

This is an 8-byte message that indicates: the number of detections that will be sent or the answer to the GET and SET command requests.

Table 22: CAN bus answer message

Answer Data (Byte 0)	Answer Data Description	Additional Answer Data (Byte 1 to Byte 7)

Equal or less than 96	Number of detections	See Table 23
128 + 6	Answer to GET input data request	Success: See format in Table 24 Fail: All byte 2 to byte 7 are set to 0xFF
128 + 7	Answer to GET holding data request	Success: See format in Table 21 Fail: All byte 2 to byte 7 are set to 0xFF
128 + 8	Answer to SET holding data request	Success: Return echo of the SET command request. Fail: All byte 2 to byte 7 are set to 0xFF

Table 23: CAN bus number of detection message

Data	Data Return Description
Byte 0	Number of detections
Byte 1	Reserved
Byte 2	Current LED power as a percentage of maximum
Byte 3	Current acquisition statuses. This is an 8-bit field with 1 bit currently defined (all others are reserved): Bit 1 - Object demerging is completed if set to 1 when this function is activated.
Byte 4	Timestamp of the acquisition. The timestamp is expressed as the number of milliseconds since the sensor was started.
Byte 5	
Byte 6	
Byte 7	

Table 24: CAN bus answer message (GET input data)

Input Data Type (Byte 1)	Input Data Description	Arguments	Arguments Description
0	Temperature	Byte 4	Temperature as a fixed-point value with a 16-bits fractional part (that is, temperature value is this register divided by 65536).
		Byte 5	
		Byte 6	
		Byte 7	

1872 (0x750) (Tx base ID)

This is an 8-byte message containing detection(s) use in single message mode. Two (2) types of message are supported: standard detection message and detection message with flag information.

The standard detection message containing two (2) detections: if the number of detections is odd, the last message will be 0 filled in the last 4 bytes. The message is separated in two parts with the same format:

Data bytes 0 and 1 contain the distance in units defined by “distance units” holding data.

Data byte 2 and the 4 LSBs of byte 3 contain the amplitude as a 12-bit value. This value must be divided by 4 to get the amplitude (i.e., 2 bits for fractional part).

The 4 MSBs of byte 3 contain the segment number.

Table 25: Standard CAN bus detection message

<table>
<tr><th colspan="2">Byte 7</th><th>Byte 6</th><th>Byte 5</th><th>Byte 4</th><th colspan="2">Byte 3</th><th>Byte 2</th><th>Byte 1</th><th>Byte 0</th></tr>
<tr><td>Segment (n+1)</td><td colspan="2">Amplitude (n+1)</td><td colspan="2">Distance (n+1)</td><td>Segment (n)</td><td colspan="2">Amplitude (n)</td><td colspan="2">Distance (n)</td></tr>
</table>

The detection message with flag information containing only one (1) detection and the format is as below:

Data bytes 0 and 1 contain the distance in units defined by “distance units” holding data.

Data bytes 2 and 3 contain the amplitude. This value must be divided by 64 to get the amplitude (i.e., 6 bits for fractional part).

The byte 4 contains the flag information as described in Table 26.

Table 26: Flag information of measurement

Bit 0	Detection is valid (will always be set)
Bit 1	Detection was the result of object demerging
Bit 2	Reserved
Bit 3	Detection is saturated
Bits 4-7	Reserved

The byte 5 contains the segment number.

Data bytes 6 and 7 are reserved.

Table 27: CAN bus detection message definition with flag information

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte 0
-	-	Segment (n)	Flag (n)	Amplitude (n)		Distance (n)	

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

This is an 8-byte message for multiple message mode using the same format as 0x750 message (see above). Detections are send on a message ID range from 1874 to [1874 + (number of detection / 2) + (number of detection MODULO 2)] in standard detection message and send on a message ID range from 1874 to [1874 + number of detection] in detection message with flag information. The range of message ID can be limited by the maximum number of detection to output to CAN port.

Example: Sensor with 1874 base ID: 19 detections are sent.

- From 1874 to 1884 message ID in standard detection message.
- From 1874 to 1882 message ID in standard detection message on a sensor setup of 16 maximum number of detection.
- From 1874 to 1893 message ID in detection message with flag information.
- From 1874 to 1890 message ID in detection message with flag information on a sensor setup of 16 maximum number of detection.

6.6. SDK

The Leddar™ SDK (software development kit) is a set of interfaces to allow programmers to integrate the IS16 industrial Leddar™ sensor in their products.

Windows and Linux sample code is provided to get started quickly on the RS-485 link Modbus protocol.

Development through the USB link is possible with interfaces provided for C and .NET which should allow easy integration with most Windows environments.

The C interface allows low level integration in C, C++, or any other languages that easily interface with C functions.

The .NET interface allows easy usage in .NET languages like C# and Visual Basic but also in environments that support .NET integration like MATLAB™ or LabVIEW™.

To help developers get started quickly, sample code consisting of example applications in Visual Studio and integration examples in MATLAB™ and LabVIEW™ are provided.

NOTE*:* *Complete SDK documentation is available from the Start menu (the SDK must be selected during installation of Leddar™ Configurator software).*

7. Acquisition Settings

7.1. Measurement Rate

The measurement rate determines the speed of detection.

The choices are: 1.5625 Hz, 3.125 Hz, 6.25 Hz, 12.5 Hz, 25 Hz, and 50 Hz.

Lower measurement rates provide the highest range, accuracy, and precision. It is recommended to use the lowest measurement rate required.

NOTE: *Changing the rate will modify the duration of the output activation/deactivation delay and the automatic LED intensity mode change delay settings.*

7.2. 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 24 presents the threshold table for a LED intensity of 16. This table is effective when the threshold offset value is 0.

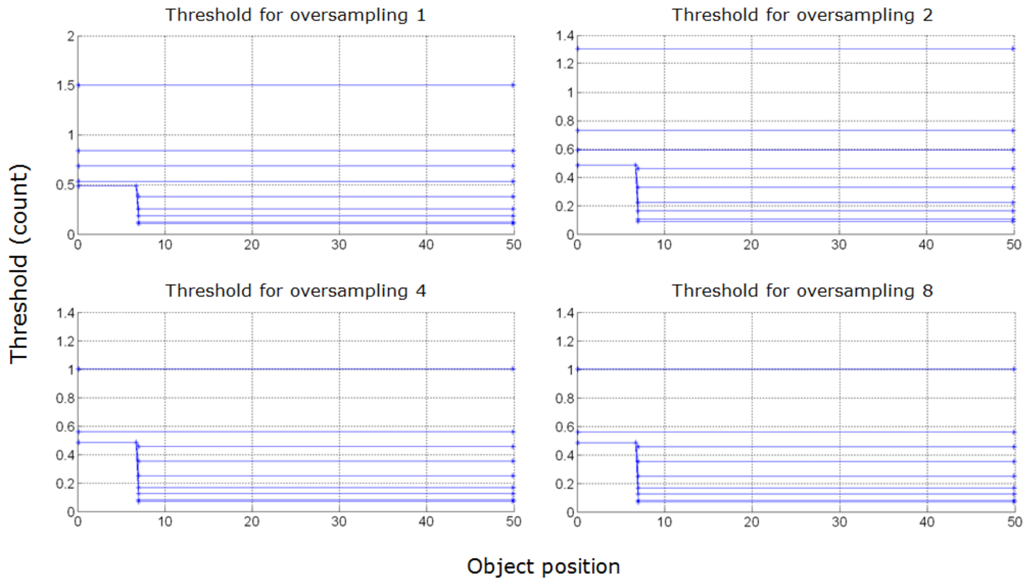


Figure 24: Detection thresholds

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 sensor. 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 that 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.

7.3. Useful Range

The sensor range capacity depends on the LED intensity and the acquisition parameters; mostly the measurement rate. The slower the rate, the more light the sensor can collect from objects, increasing the sensor range.

The useful range parameter does not impact the range capacity, it simply specifies in which range the sensor will operate and report objects.

This parameter can serve the following purposes:

- Minimize data throughput over the RS-485 or CAN link by avoiding detection of objects beyond the application range.
- Minimize application level data processing by avoiding detections beyond the application range.
- Improve data viewing in Leddar™ Configurator by avoiding detections beyond the application range and by limiting the beam in the main window to display the useful range only.

7.4. LED Intensity

There are a total of 8 supported LED power levels. Their approximate relative power is as follows: 10%, 20%, 35%, 50%, 65%, 80%, 90% and 100%.

The change delay defines the number of measurements required before allowing the sensor 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 be 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.*

Keeping the sensor 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 sensor, 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 that 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 sensor (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.

7.5. Object Demerging

One advantage of Leddar™ sensors is the capacity to detect multiple objects in the same segment. This is possible when an object in a segment does not occupy the full cross section of that segment. Objects behind will still be illuminated and may be detected if enough light is reflected back and captured by the sensor. The sensor performs full waveform analysis of the input signal and will detect all objects.

However, if 2 objects are separated by less than 5 to 6 m, the straightforward analysis will not discriminate the 2 signals since the pulses analyzed are "merged".

Object demerging is an advanced signal processing method developed by LeddarTech that extracts measurements from merged pulses characteristic of close objects.

Note that the precision and resolution of demerged objects are lower than typical single object detections. Object demerging is available for measurement rates 1.5625 Hz, 3.125 Hz, and 6.25 Hz and the number of merged pulses that can be processed each frame is limited. A status field is available in the device states window (Leddar™ Configurator) indicating if the sensor processes all merged pulses.

7.6. Cross Talk Removal

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.

This option enables an algorithm to compensate the degradation due to crosstalk.

8. Leddar™ Configurator

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

8.1. Introduction

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.

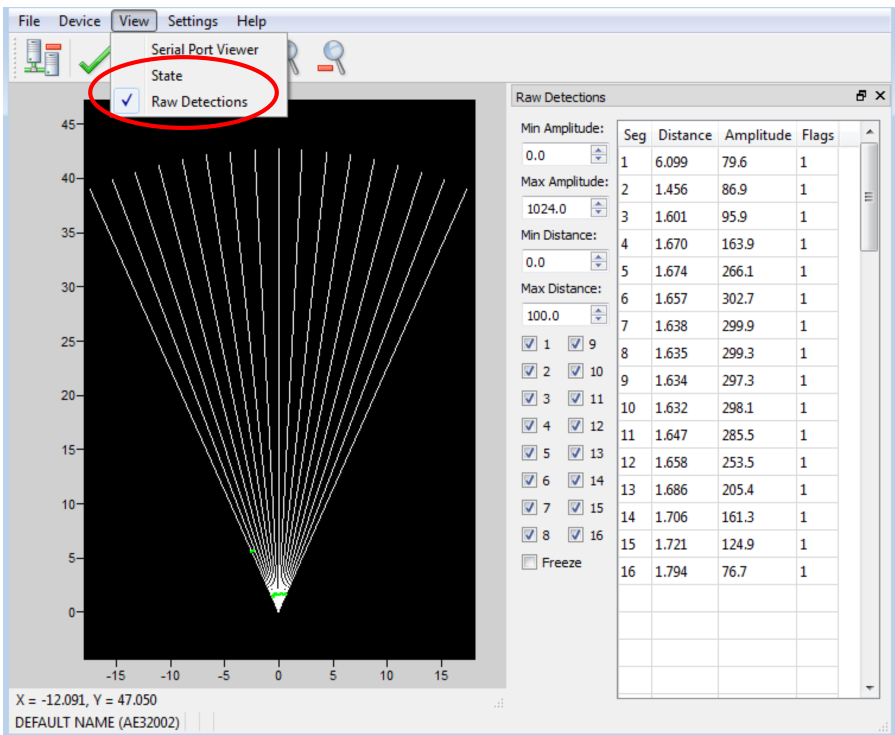


Figure 25: Raw Detections dialog box docked on the side of the main window

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

8.2. Connection Window

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

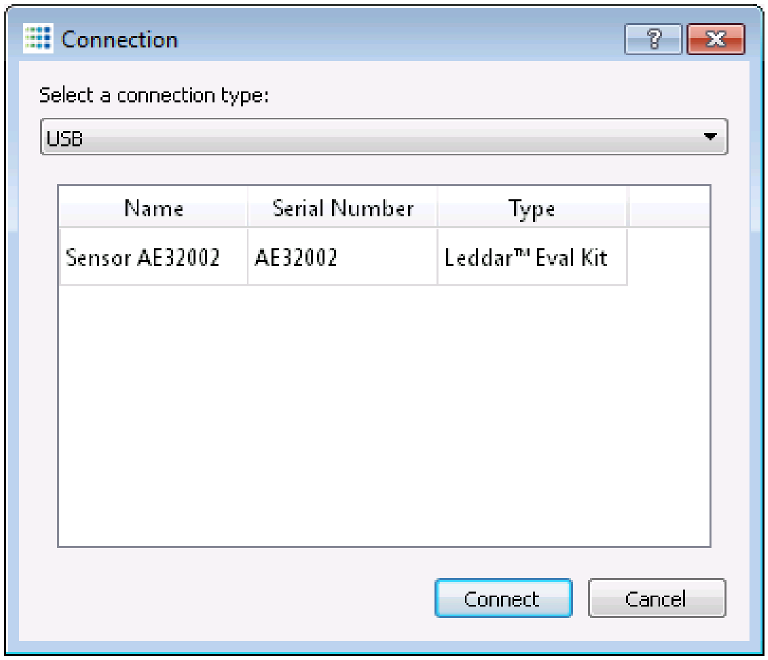


Figure 26: Connection dialog box

Select a connection Type

The connection type you are using; either USB or serial.

Device list

The device list displays the device currently detected.

Name

The device name can be modified (see section “8.3.1 Device Name” on page 62).

Serial Number

The serial number of the device as assigned by LeddarTech

Type

The product name

Leddar™ Configurator Main Window

After connecting to the device, the main window opens.

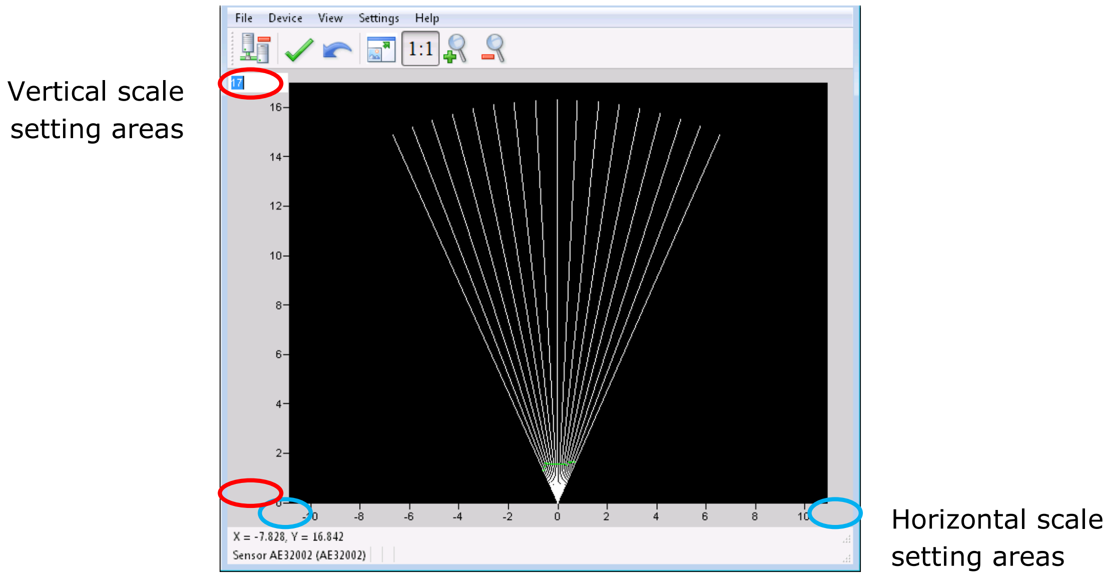


Figure 27: Leddar™ Configurator main window

The measurements are plotted in a symbolic graph containing the 16 segments (white lines) originating from the sensor. Detections are drawn as arcs in their corresponding segments. Only valid measurements are displayed. A more detailed description of the measurements can be obtained in the **Raw Detections** dialog box (see section “8.10 Raw Detections” on page 81).

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

8.2.1. Toolbar Display Controls

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

Fit to window

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

Force equal horizontal and vertical scales

When the equal scaling button (1:1) 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 45° beam for a 45° sensor).

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 27 above.*

Zoom in

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

Zoom out

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

8.2.2. 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 27 above.

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

8.2.3. 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 0 and 0).

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

NOTE: *The equal scaling button (* 1:1 *) must be not selected (not highlighted).*

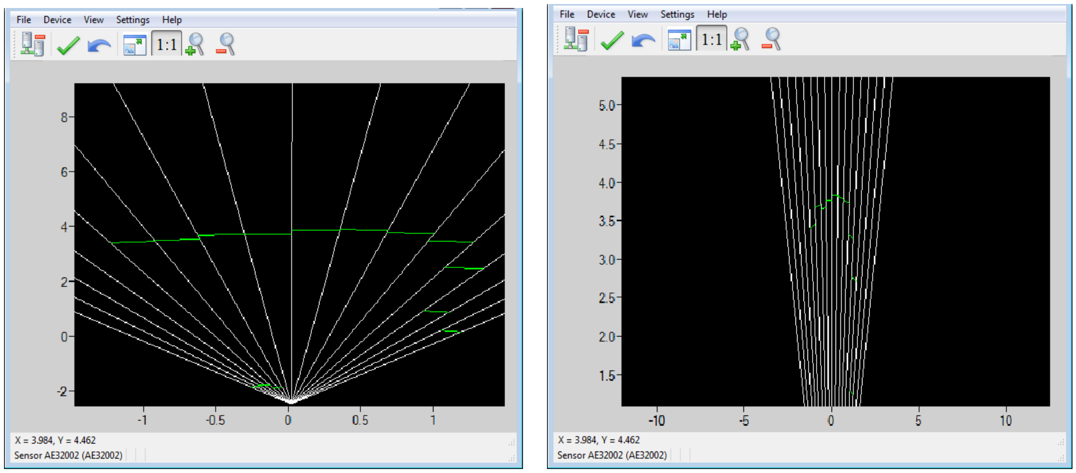


Figure 28: Zooming in *(left)* and out *(right)* horizontally

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

NOTE: *The equal scaling button (* 1:1 *) must be not selected (not highlighted).*

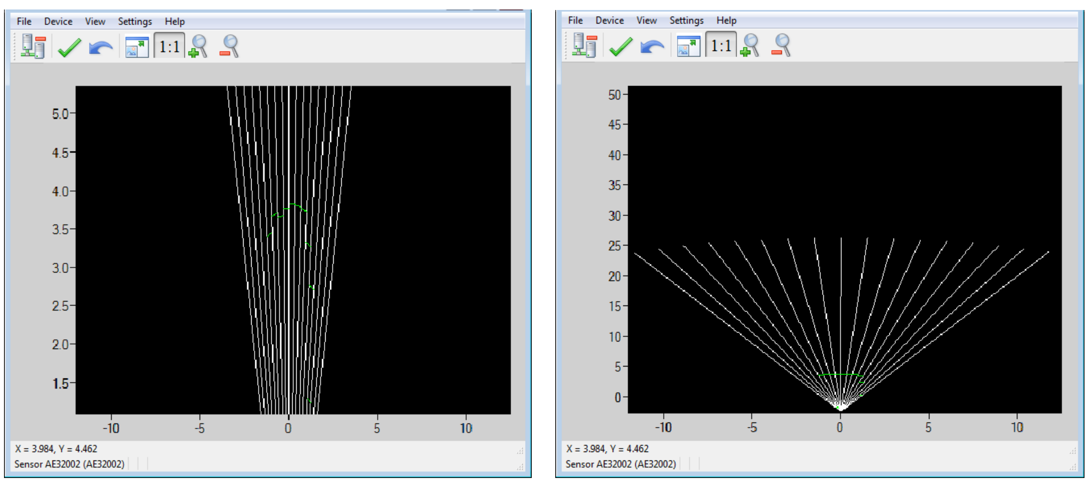


Figure 29: Zooming in *(left)* and out *(right)* vertically

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.

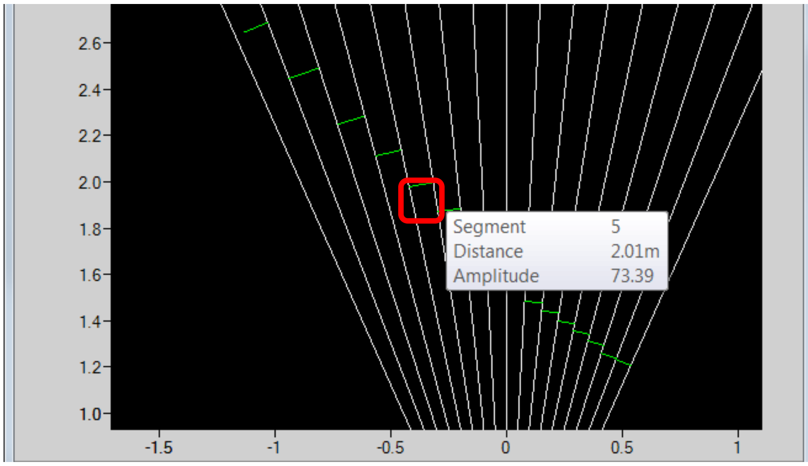


Figure 30: Detection point coordinates

8.2.4. Changing the Sensor Origin

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

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

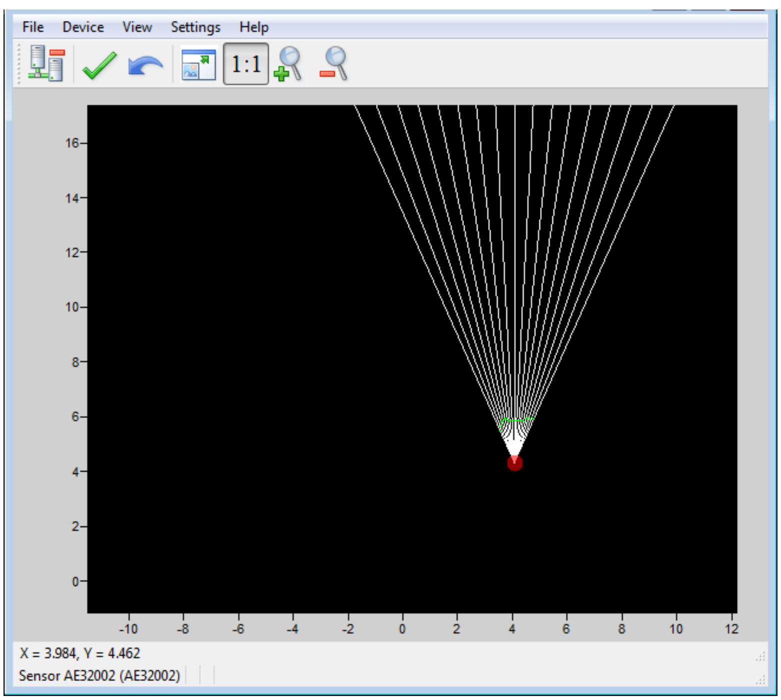


Figure 31: Dot indicator to modify the sensor origin

If you click and drag the sensor origin, the sensor position is displayed in the status bar as shown in Figure 32 below.

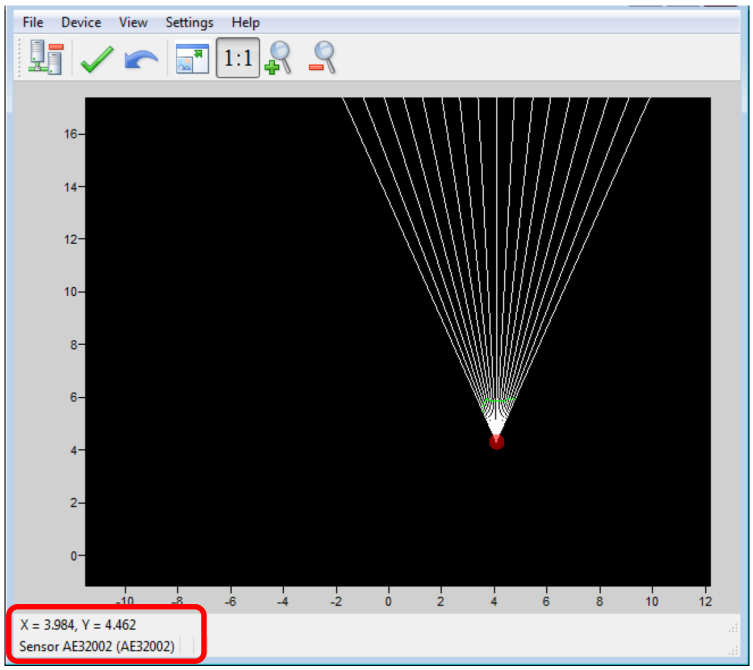


Figure 32: Sensor position display

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

The sensor origin is saved in the sensor and can also be modified by editing the parameters in the sensor position settings window (see section "8.3.3 Sensor Position" on page 64).

8.2.5. Changing the Sensor Orientation

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

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

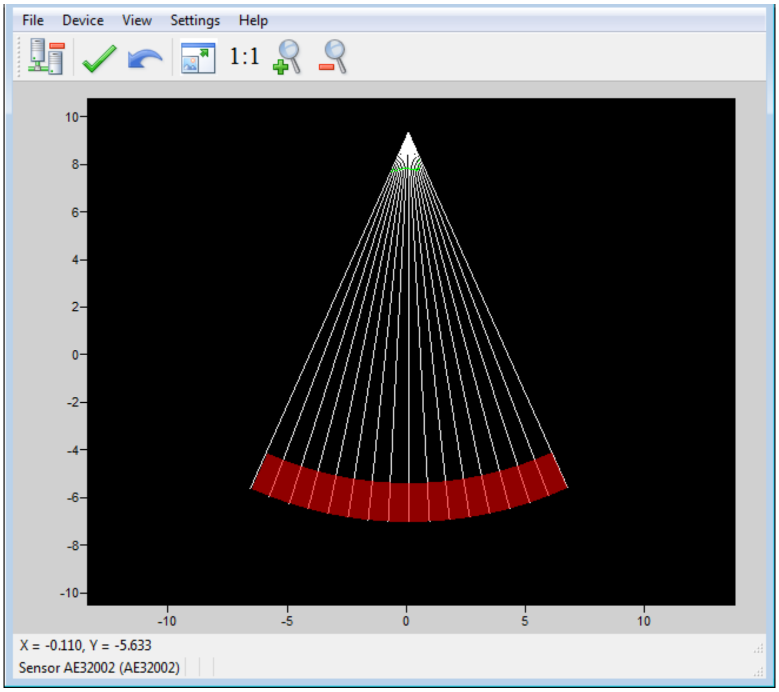


Figure 33: Red bar to rotate the sensor position

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

The sensor orientation is saved in the sensor and can also be modified by editing the parameters in the sensor position settings window (see section "8.3.3 Sensor Position" on page 64).

8.3. Settings

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

8.3.1. Device Name

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

To change the device name:

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

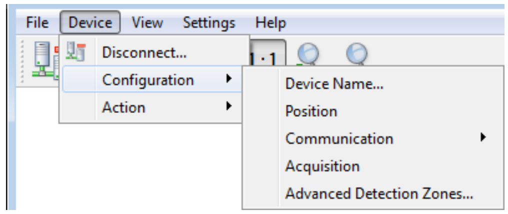


Figure 34: Device menu and The Configuration menu items

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

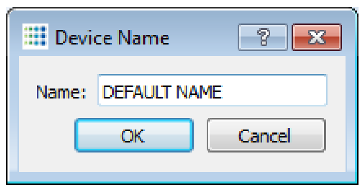


Figure 35: Device Name dialog box

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

8.3.2. 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**.

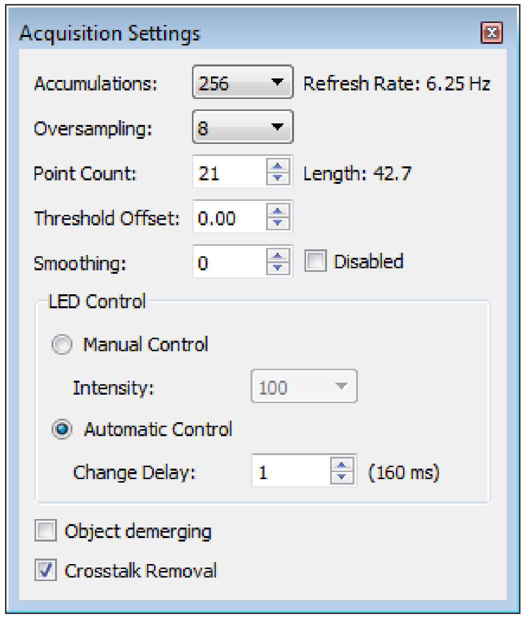


Figure 36: Acquisition Settings dialog box

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.

8.3.3. Sensor Position

The sensor position allows you to define the sensor position with respect to the reference of the system it is used in. See sections 8.2.4 and 8.2.5 for more information.

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

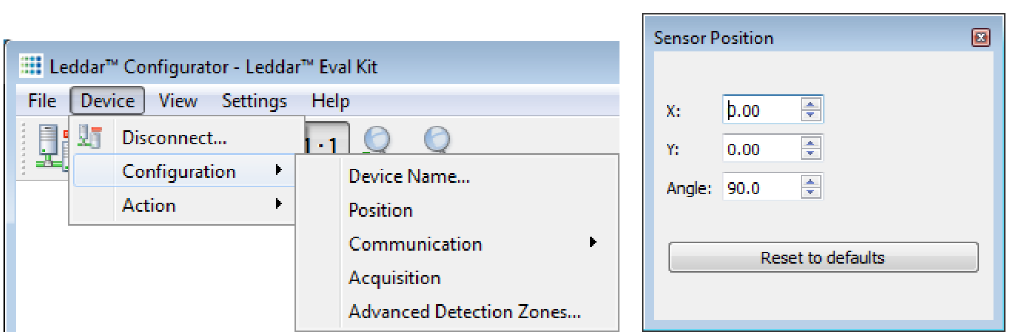


Figure 37: Device menu and Sensor Position dialog box

The numbers are modified either by using the arrows or by entering the value manually.

The Reset to defaults button replaces the segments to their original manufacturing positions.

8.3.4. General

The sensor **General** communication settings are configurable.

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

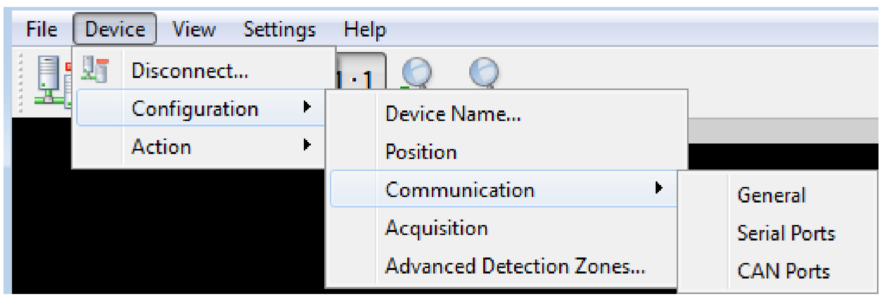


Figure 38: Device menu, and the Configuration and Communication menu items

In the **General Setting** dialog box, in the **Distance Units** list, select the units with which you want to work.

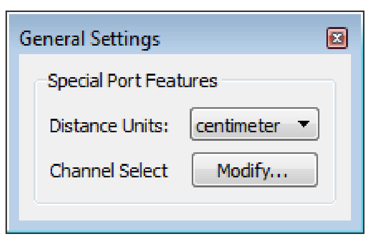


Figure 39: General Settings dialog box

The number of channels used is set to 16 by default but you can remove some of them to suit your application through the **LeddarHots** dialog box. Next to **Channel Select**, click **Modify** and clear the desired check boxes.

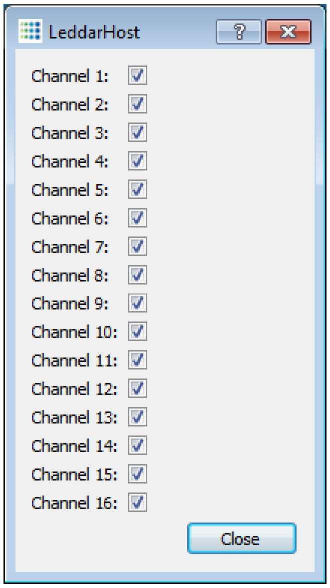


Figure 40: LeddarHots dialog box

8.3.5. Serial Ports

The sensor serial port settings are configurable.

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

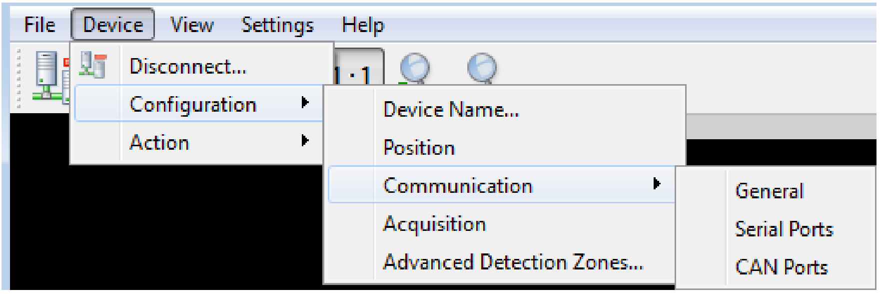


Figure 41: Device menu, and the Configuration and Communication menu items

In the **Serial Port Setting** dialog box, the numbers are modified by using the arrows or by entering the value manually.

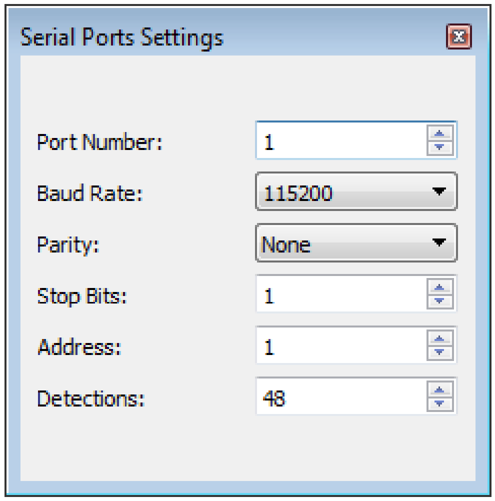


Figure 42: Serial Ports Settings dialog box

The following table describes the serial port settings.

Table 28: Serial port settings description

Parameter	Value
Port Number	Select 1 for the RS-485 port on the terminal block
Baud Rate	9600, 19200, 38400, 57600, 115200 bps
Parity	None, odd, even
Stop Bits	1, 2
Address	1 to 247
Detections	0 to 48

8.3.6. CAN Ports

The sensor CAN port settings are configurable.

To open the **CAN Port Settings** dialog box, on the **Device** menu, point to **Configuration**, point to **Communication**, and click **CAN Ports**.

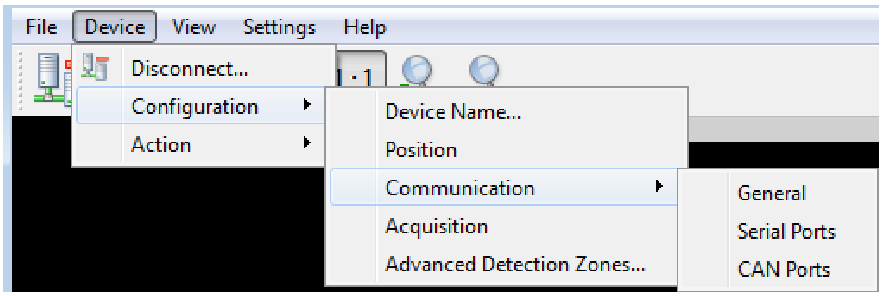


Figure 43: Device menu, and the Configuration and Communication menu items

In the **CAN Port Setting** dialog box, the numbers are modified by using the arrows or by entering the value manually.

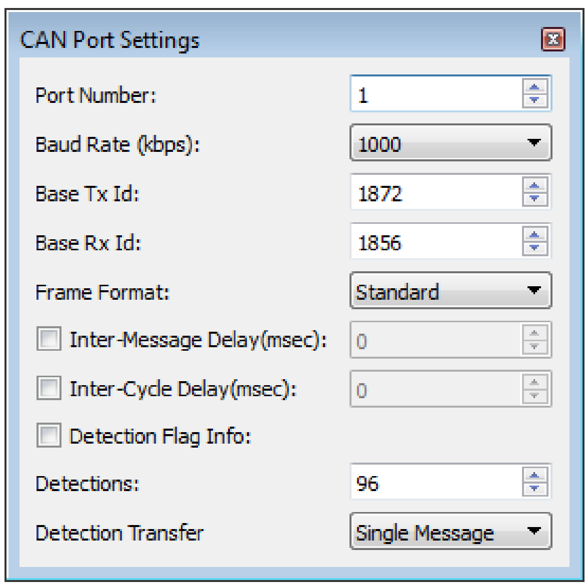


Figure 44: CAN Port Settings dialog box

The following table describes the CAN port settings.

Table 29: CAN port settings description

Parameter	Value
Port Number	Select 1 for CAN communication
Baud Rate	10, 20, 50, 100, 125, 250, 500, 1000 kbps
Base Tx Id	The CAN arbitration ID used for data messages coming from the evaluation kit containing the detections. The arbitration ID of the messages containing the number of detections will be this value plus one (see the protocol documentation).
Base Rx Id	The CAN arbitration ID used for data messages sent to the evaluation kit (see the protocol documentation).
Frame Format	Standard, Extended
Inter-Message Delay	0 to 65535 milliseconds
Inter-Cycle Delay	0 to 65535 milliseconds
Detection Flag Info	The information on the detection flag is displayed in the main window.
Detections	1 to 96
Detection Transfer	Single or multiple messages

8.3.7. Advanced Zone Detection

To open the **Advanced Zone Detection** dialog box, on the **Device** menu, point to **Configuration**, and click **Advanced Detection Zones**.

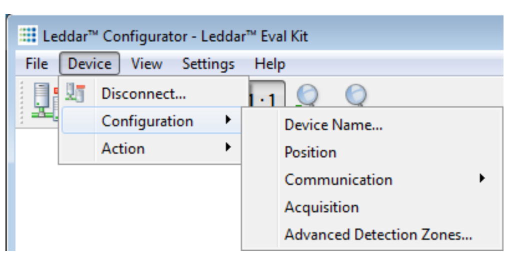


Figure 45: Device menu and The Configuration menu items

When the **Enable Advanced Zone Detection** check box is selected, a red dot appears at the bottom corner of the main window.

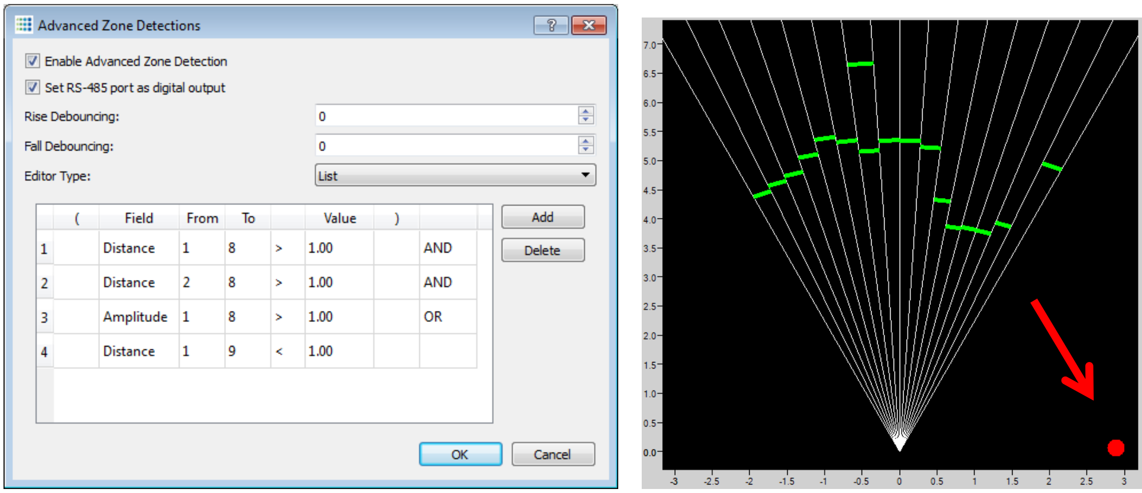


Figure 46: Advanced Zone Detection dialog box (*left*) and the and the Enable Advanced Zone Detection selected example (*right*)

When both **Set RS-485 port as digital output** and **Enable Advanced Zone Detection** check boxes are selected, the output becomes differential instead of an RS-485 communication port.

The **Rise Debouncing** and **Fall Debouncing** values are used to add a delay before rising ON and falling OFF.

This is used to eliminating the rapid signal fluctuations which characteristically accompany a change of state in mechanical switches. In the boxes, enter the number of consecutive frames required ON (or OFF) before really turning ON (or OFF).

The **Editor Type** list lets the user choose to view the detection zones as a list or as a tree.

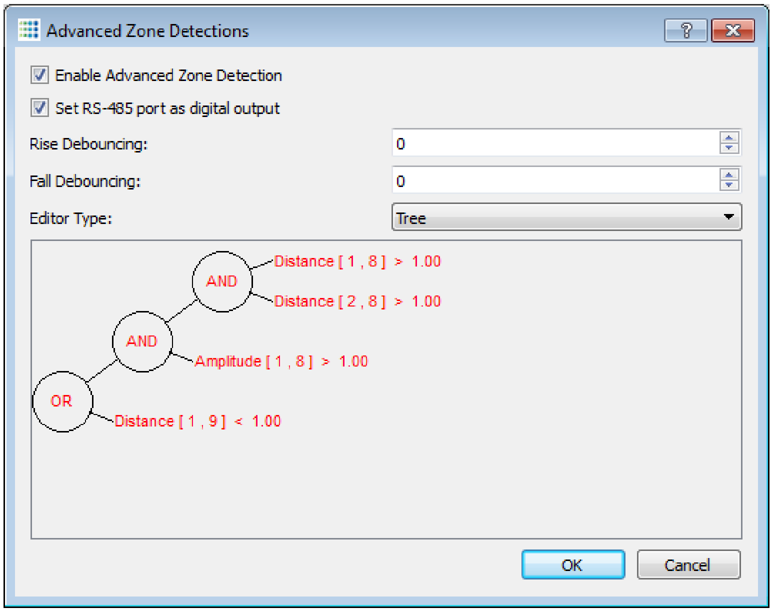


Figure 47: Detection zone tree

8.4. 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**.

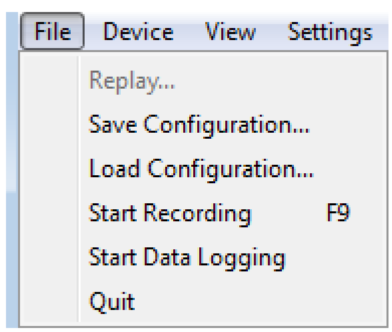


Figure 48: File menu

To load a configuration:

On the File menu, click Load Configuration.

8.5. 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 *.ltl file that can later be reloaded and replayed.

To configure the detection record:

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

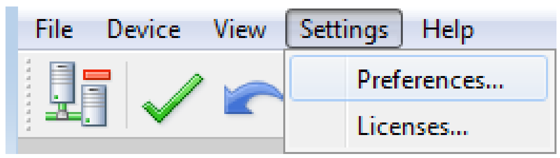


Figure 49: Settings menu

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

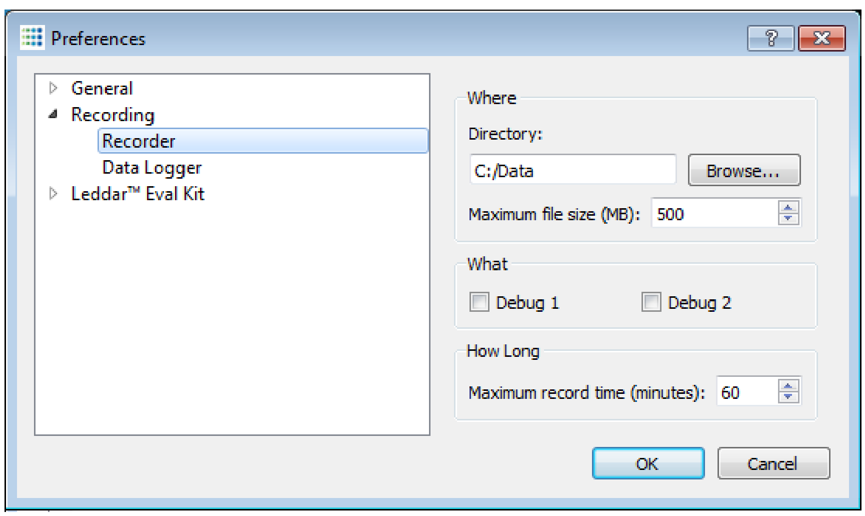


Figure 50: Preferences dialog box

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**.

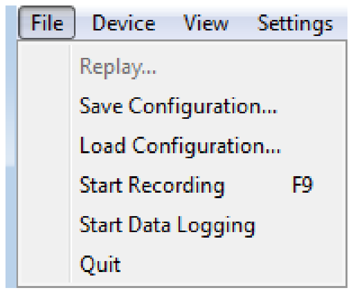


Figure 51: File menu

To stop a recording manually:

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

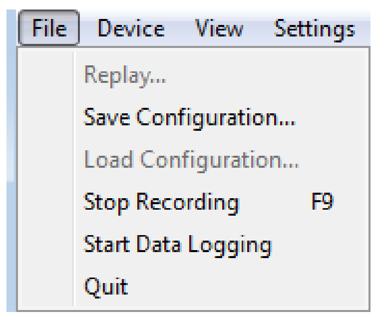


Figure 52: File menu to stop a recording

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 *.ltl, 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.

8.6. 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**.

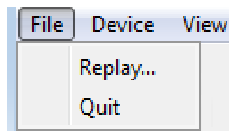


Figure 53: File menu to open a recording

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

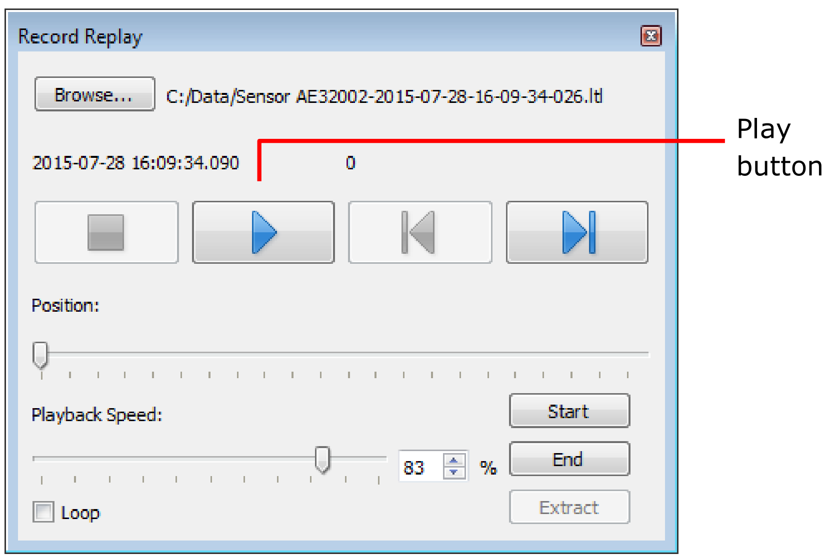


Figure 54: Record Replay dialog box

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.

8.7. 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 30: 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 sensor was started.
- The location of the detection is segment 7 (the 8th 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**.

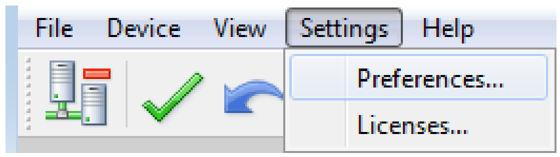


Figure 55: Settings menu

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

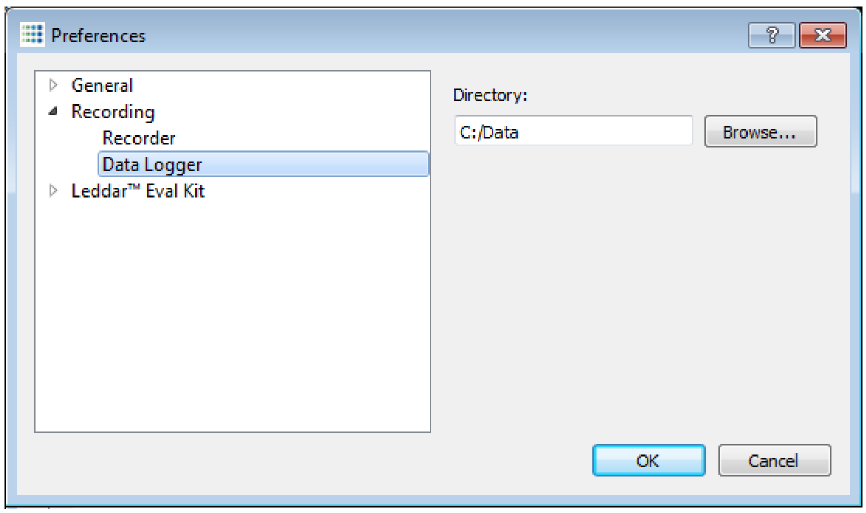


Figure 56: Preferences dialog box for logging data

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.

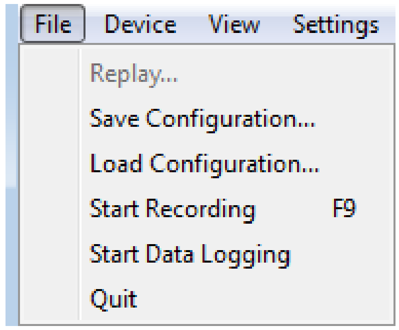


Figure 57: File menu

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

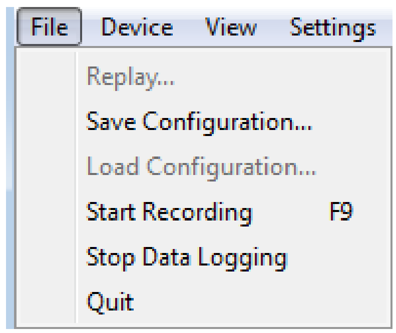


Figure 58: File menu to stop data recording

A .txt file is saved in the selected directory.

8.8. 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.

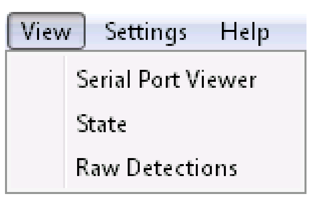


Figure 59: View menu

The **Device State** window opens.

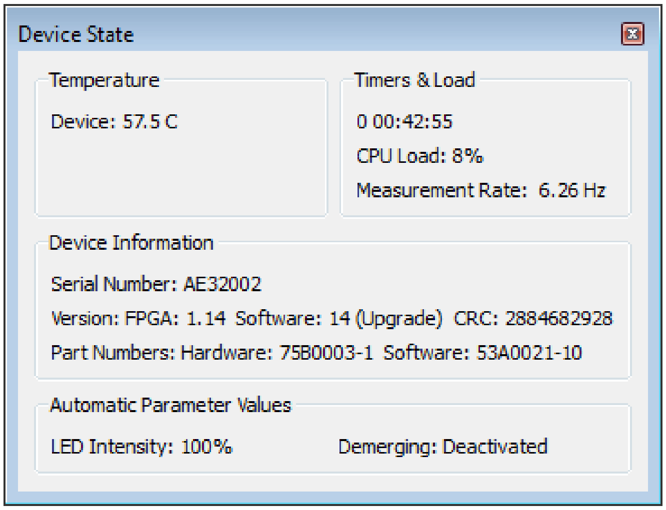


Figure 60: Device State window

Temperature

This section indicates the temperature of the device.

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.

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

The **Measurement Rate** indicates the rate at which the sensor measures the speed and dimension of static or moving surfaces.

Device Information

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

The **Version** includes the following:

- FPGA: The firmware version of the device.
- Software: The software version of the device.
- CRC: Indicates the firmware version to ensure that it is authentic.

The **Part Numbers** provide the hardware and software part numbers of a device as assigned by LeddarTech.

The LED Intensity is the current LED power in use by the sensor. It automatically adapts to too strong/too weak detections when properly activated in the acquisition settings window.

The **Demerging** indicates the current object demerging status, when activated in the acquisition settings. It may be:

- Partial: when the demerge sensor didn't process all pulses characteristic of merged objects.
- Completed: when the sensor processed all pulses characteristic of merged objects.

8.9. 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.

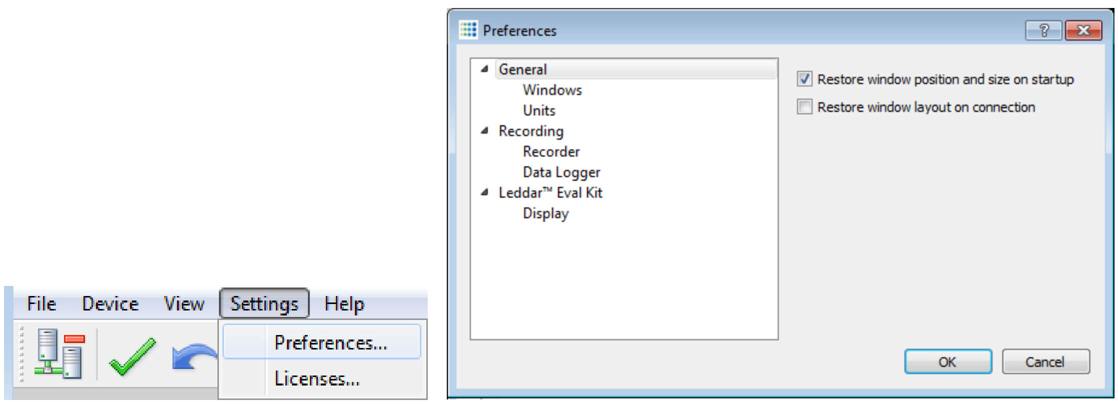


Figure 61: Settings Menu and Preferences Dialog Box

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 Leaddar™ 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.

Units

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

The Temperature is the unit used when displaying temperatures.

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.

8.10. 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**.

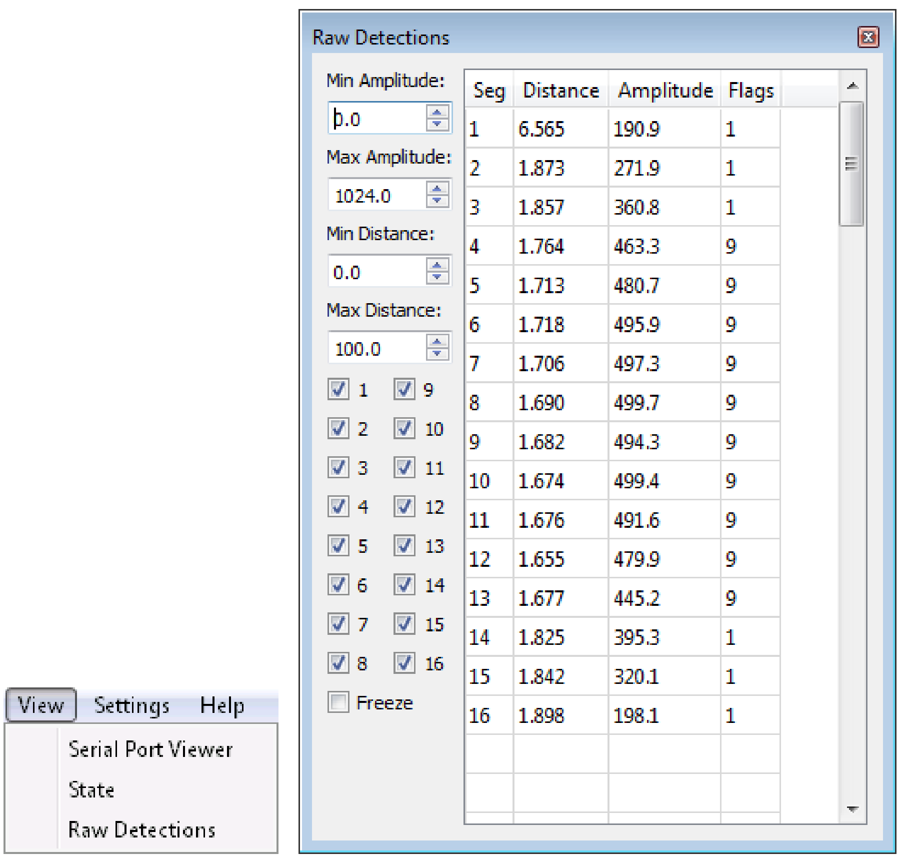


Figure 62: View menu and Raw Detections dialog box

Figure 63 presents an example of raw detections. When there is no detection in some segments, only the segments where detection occurred appear in the list.

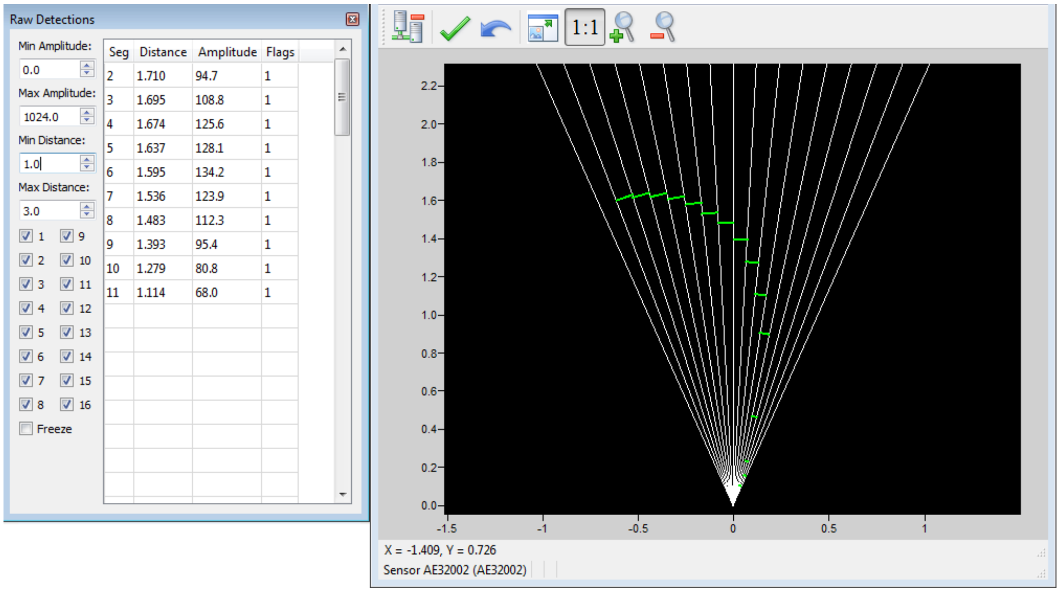


Figure 63: Example of detection filters

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 16

Check boxes 1 to 16 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 31: 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** 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 32: Status value description

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

8.11. View Serial Port Data

When using a device through a serial port (for example, using an RS-485 to USB adapter cable), it is possible to establish a connection to the sensor and display the sensor measurements in Leddar™ Configurator.

To view the serial port data:

1. On the View menu, click Serial Port Viewer.

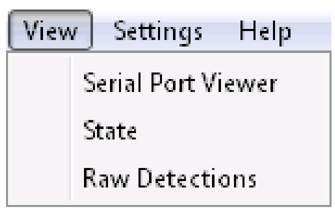


Figure 64: View menu

2. I the **Serial Port Viewer** dialog box. In the **Port** list, select the serial port of the connected sensor.

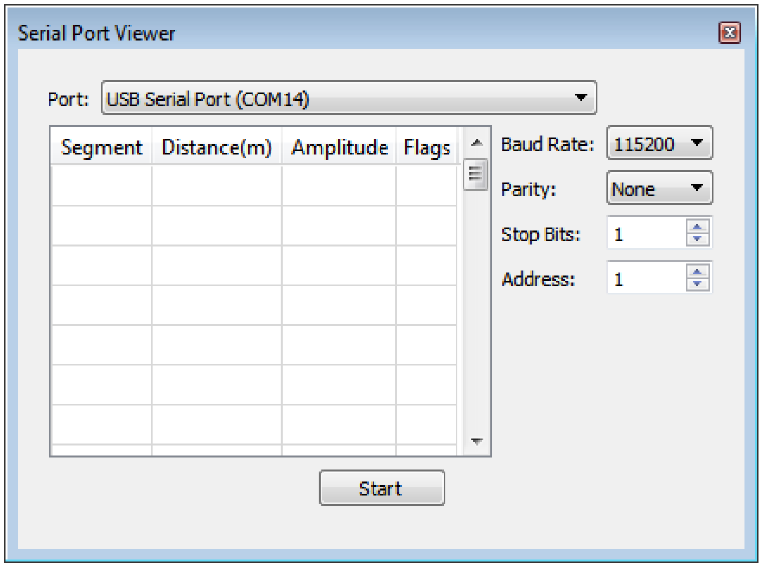


Figure 65: Serial Port Viewer dialog box

3. Click the **Start** button to establish connection and display the measurements.

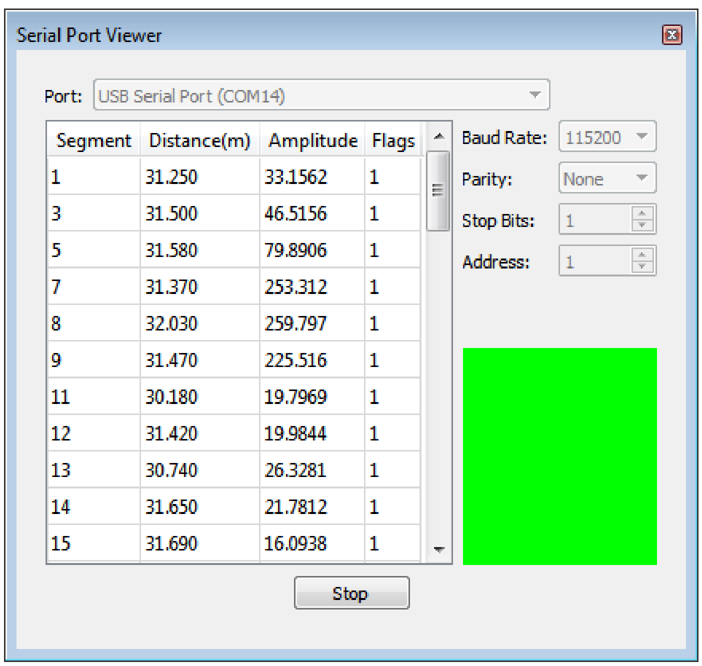


Figure 66: Serial port measurement

9. Specifications

9.1. General

Table 33: General specifications

LED pulse rate	102.4 kHz
Photodetector array size	1 x 16
Measurement rate	1.5625, 3.125, 6.25, 12.5, 25, 50 Hz.
USB	2.0, 12 MBits/s
RS-485	2-wire, half-duplex, 9600 to 115200 BPS
Operating temperature	-40°C to +50°C

9.2. Mechanical

Table 34: Mechanical specifications

Height	136 mm
Width	86 mm
Depth	70 mm
Weight	430 g

9.3. Electrical

Table 35: Electrical specifications

DC supply voltage	12-30 V
PNP/NPN output load current (max)	100 mA
Power consumption	5.6 W

9.4. Optical

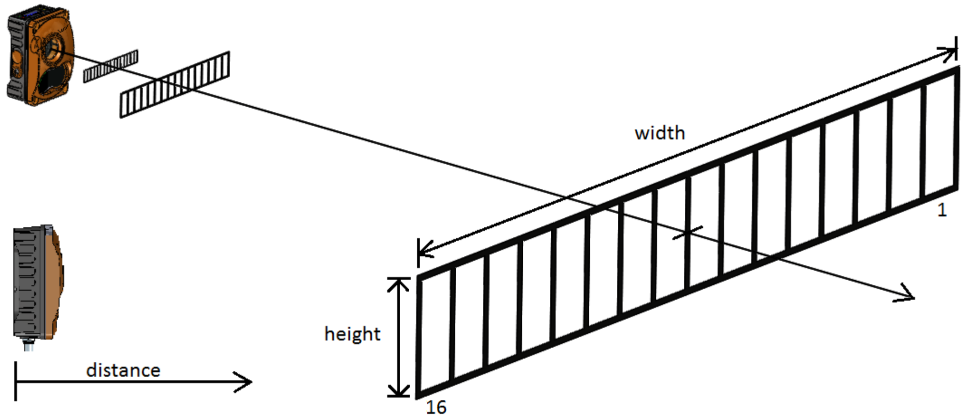


Figure 67: Beam pattern

Beam width	48°
Beam height	8°
Wavelength	940 nm (infrared)
LED risk group	IEC 62471-2006 exempt lamp classification

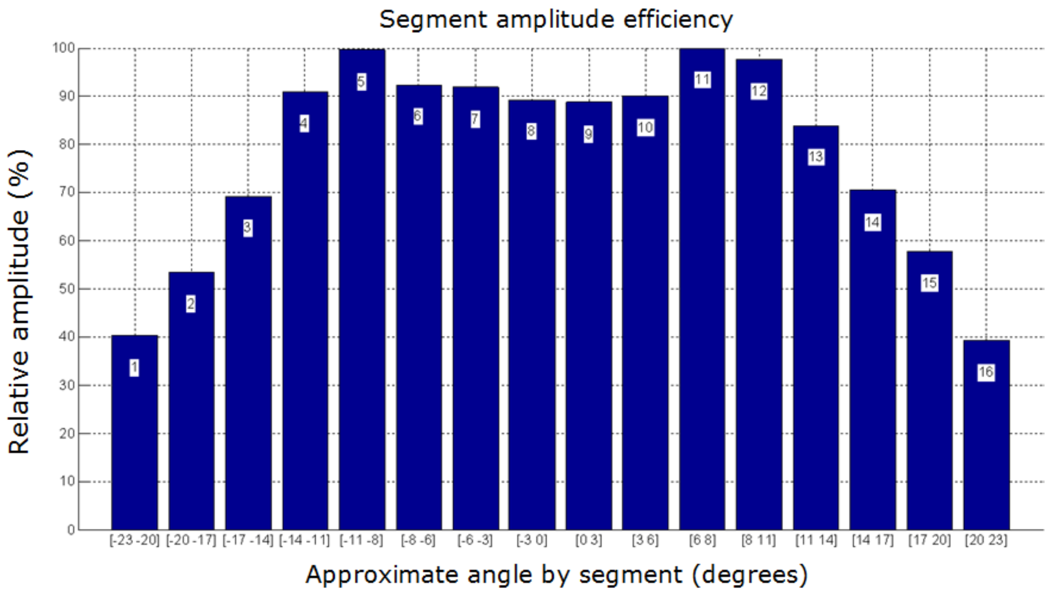


Figure 68: Detection efficiency (beam width by segment)

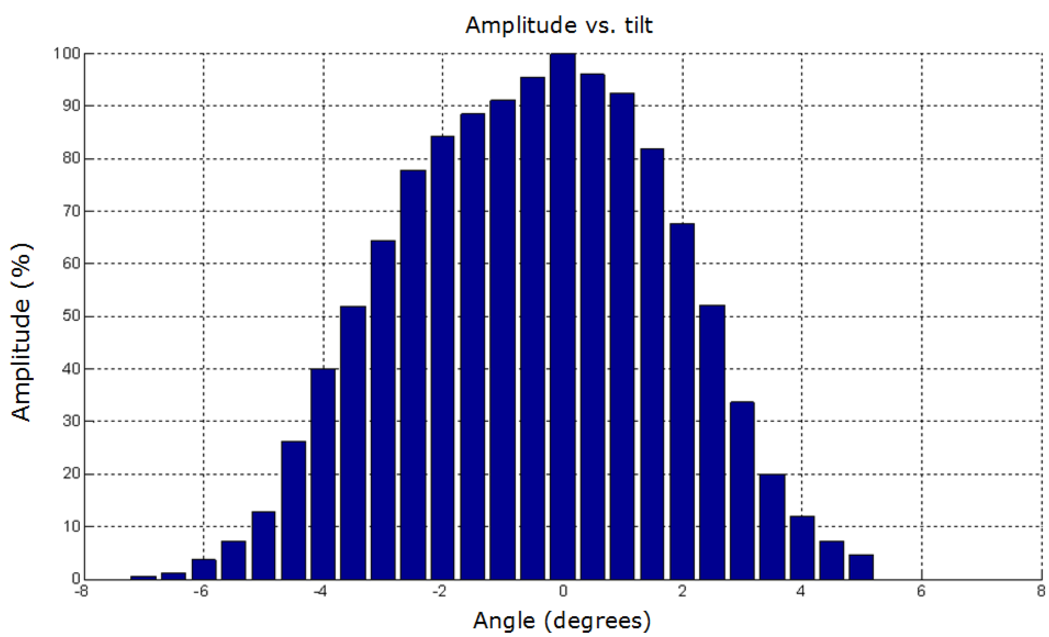


Figure 69: Detection efficiency (beam height)

9.5. Performance

Table 36: Sensor performances

Measurement accuracy	±5 cm
Measurement precision	6 mm (amplitude > 15)
Resolution	1 cm
Range (maximum LED intensity)	See Figure 72

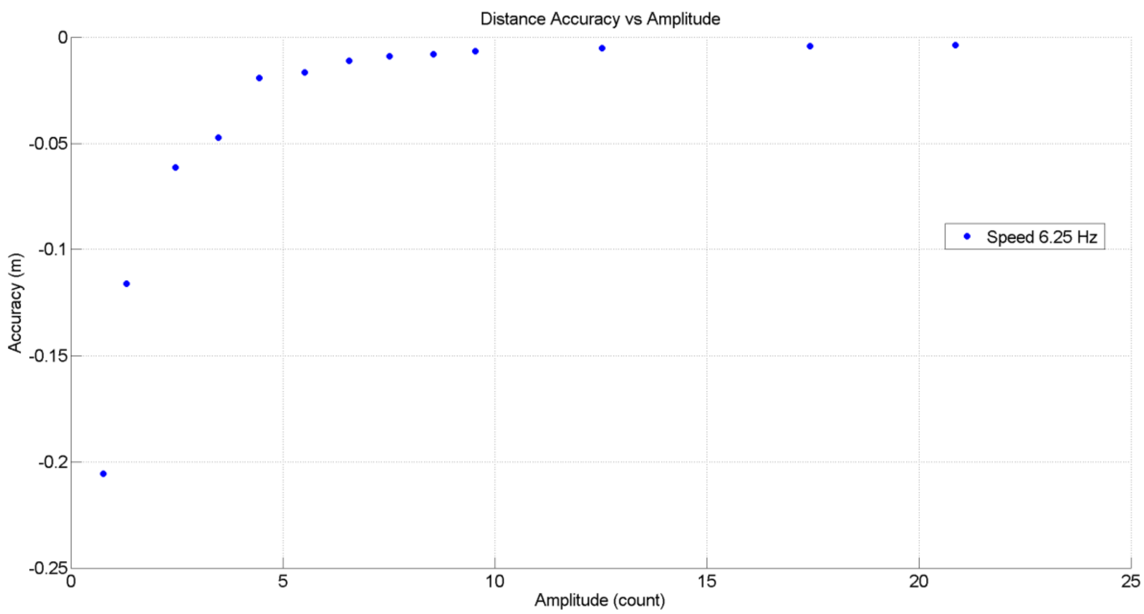


Figure 70: Accuracy vs. amplitude

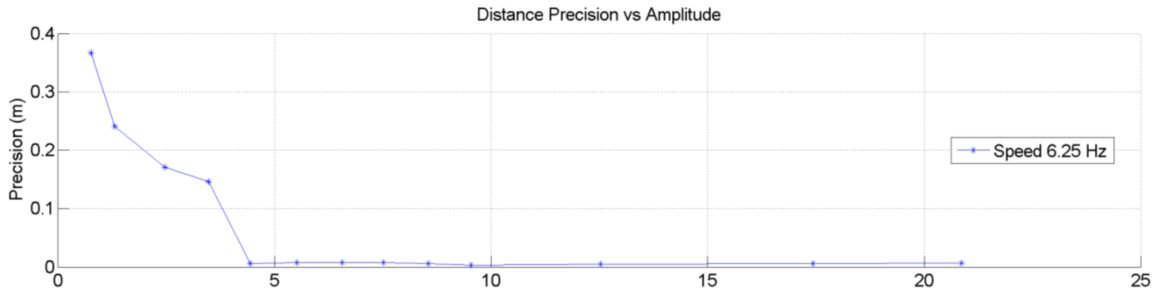


Figure 71: Precision vs. amplitude

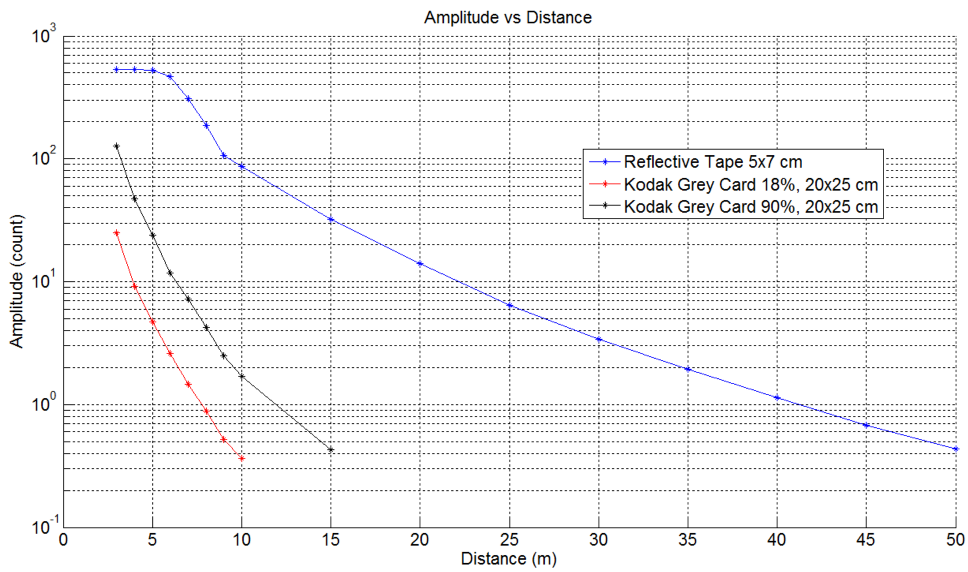


Figure 72: Amplitude vs. distance

9.6. Dimensions

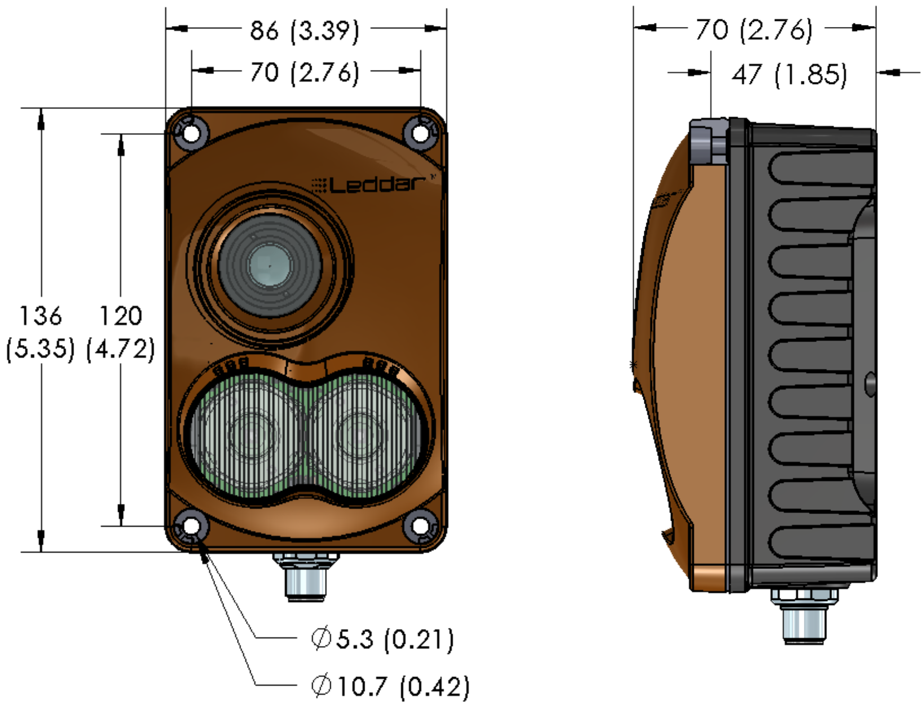


Figure 73: Casing dimensions

9.7. Compliance to Standards

This device complies with:

Table 37: Compliance to standards

Sinusoidal vibration	IEC 60068-2-6
Mechanical shocks	IEC 60068-2-27
Thermal shock	IEC 60068-2-14
Protection against ingress of water	IEC 60529 Code IPX7
Protection against ingress of dust	IEC 60529 Code IP6X
Protection against ingress of solid objects	IEC 60529 Code IP6X

10. Help

For technical inquiries, please contact LeddarTech technical support by registering online at 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.

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