Leddar™ Sensor Module

User Guide

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

www.leddartech.com

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1. Introduction

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

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

1.1. Description

The Leddar™ Sensor Module contains the following:

- Receiver assembly
- Source and control assembly

The Sensor Module offers the following features:

- Beam width options: 9°, 18°, 24°, 34°, 45°, 95°
- 16 detection segments
- Real-time data acquisition and display (through USB)
- RS-485 port for measurement acquisition
- CAN bus for measurement acquisition

Interfaces available for custom application development:

- RS-485
- CAN bus
- DIP switches[1] (4)
- MicroSD card slot1
- Expansion connector (UART, CAN1, SPI1, GPIO1, DAC1)

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[1] Not implemented in the current MCU firmware.

The following is a description of the main components of the Leddar™ Sensor Module.

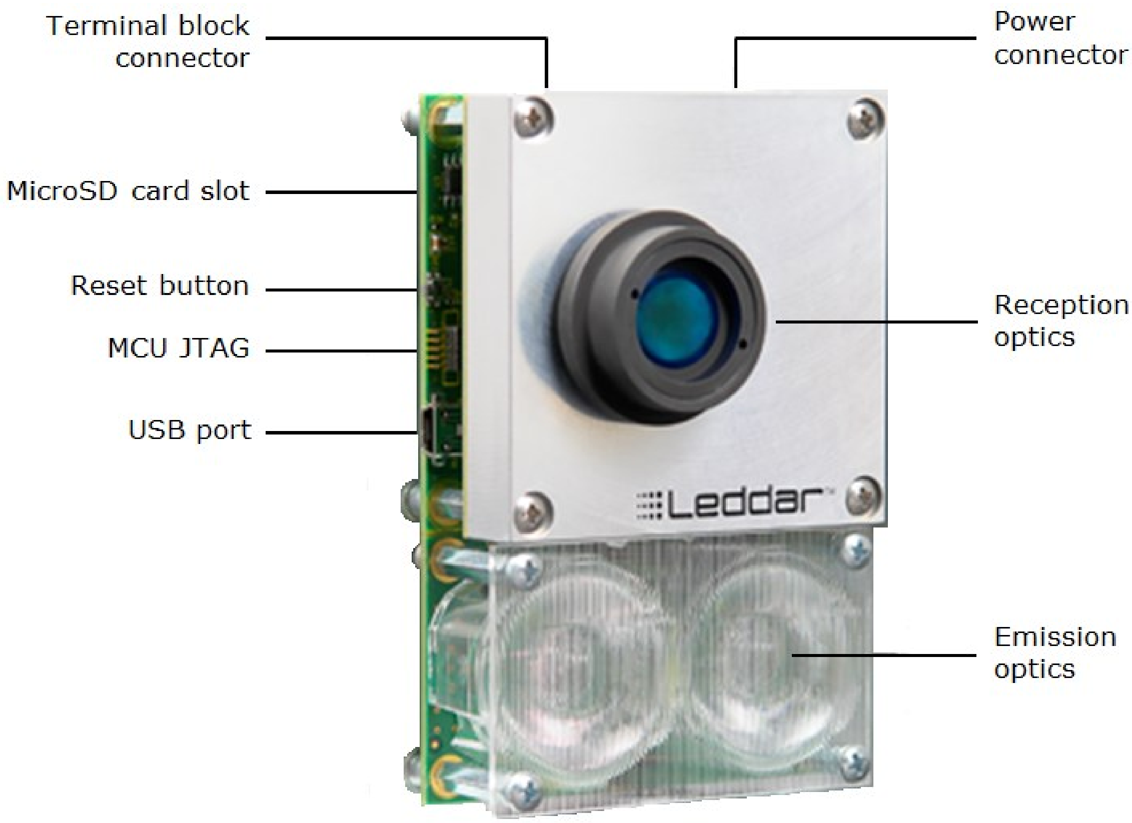


Figure 1: Leddar™ Sensor Module (45° optics)

Terminal Block

The terminal block is an 8-pin connector on top of the sensor. It provides CAN, RS-485, and power connectivity.

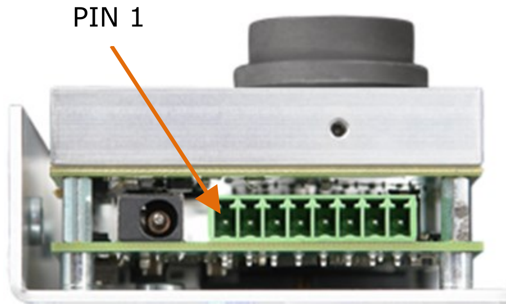


Figure 2: Terminal Block Connector

Table 1: Terminal Block Connector Pin Definition

Pin	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Function	GND	DCIN	GND	RS-485+	RS-485-	GND	CAN-H	CAN-L

Pin 2 allows the user to power the device directly through the terminal block instead of the DC connector. Ground is connected via pins 1, 3, and 6. The same conditions on jumpers P11, P13, and P15 as presented in the Power connector definition apply to power the device using 12 or 24 V.

MicroSD Card Slot

The source and control assembly is equipped with a MicroSD card reader/writer. The slot is provided for custom application development and is not implemented in the current MCU firmware. Please contact LeddarTech for future enhancements of the firmware.

Reset Button

The reset button on the right side of the sensor restarts the sensor. This can be used as an alternative to cycling the power.

MCU JTAG

The JTAG port can be used by application developers to load and debug MCU firmware.

USB Port

The USB port is a standard 2.0, 12-MBit/s port. This communication link is used by the Leddar™ Configuration software and provides a link for prototyping new applications (contact LeddarTech for the SDK).

Power Connector

The power connector provides the sensor with a 24 V power source. However, it is also possible to use a 12 V source, conditionally to changing the jumper configuration. By default, jumper P11 connects its pins 1 and 2 for the 24 V. In this case, jumper P13 is disconnected and P15 is connected. In the 12 V supply mode, connect jumper P11 on pins 2 and 3, then disconnect P15 to connect P13 instead. **WARNING!** Using the included 24 V power source while in 12 V configuration may damage your sensor.

Table 2: Jumper Configuration

	P11	**P13**	**P15**
24 V	Pins 1 and 2	Disconnected	Connected
12 V	Pins 2 and 3	Connected	Disconnected

The top image illustrates the MCU board with the 2 LEDs and the jumpers. The 2 bottom pictures show the 24 V (left) and the 12 V configurations (right). The 2 LED lenses and the receiver board have been removed for convenience on the 2 pictures, but it is not required to change the jumpers.

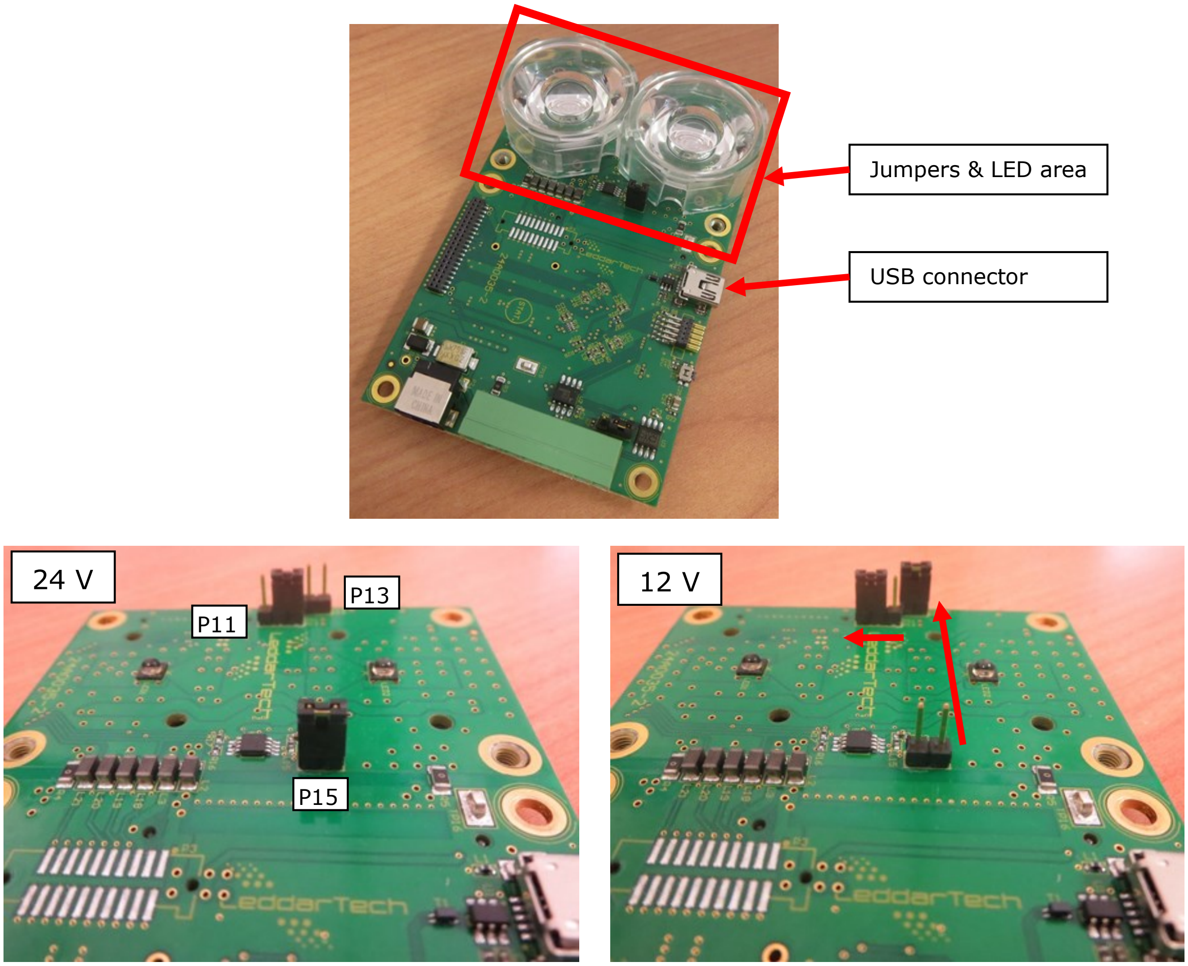


Figure 3: Jumper Configurations for 12 and 24 V supply

Receiver Assembly

The receiver assembly contains the photodetector array (16 elements) and the controller for LED pulsing and data acquisition. Data acquisition is performed at a sampling frequency of 62.5 MHz, and oversampling and accumulation is also performed on this module assembly.

The module assembly generates a full waveform per segment at the sensor measurement rate.

NOTE: *The sensor measurement rate varies according to the oversampling and accumulation settings.*

Source and Control Assembly

The source and control assembly includes the LEDs, LED drivers, MCU, and the external interfaces.

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

The MCU recovers the waveforms generated by the receiver assembly, performs full waveform analysis, and generates detection and ranging data. The data can be displayed in software after a connection has been established through the USB link.

The source and control assembly offers several external interfaces but most are provided for custom application development and are not implemented in the current MCU firmware. Please contact LeddarTech for future enhancements of the firmware.

The following diagram illustrates how the components of the sensor interact with one another.

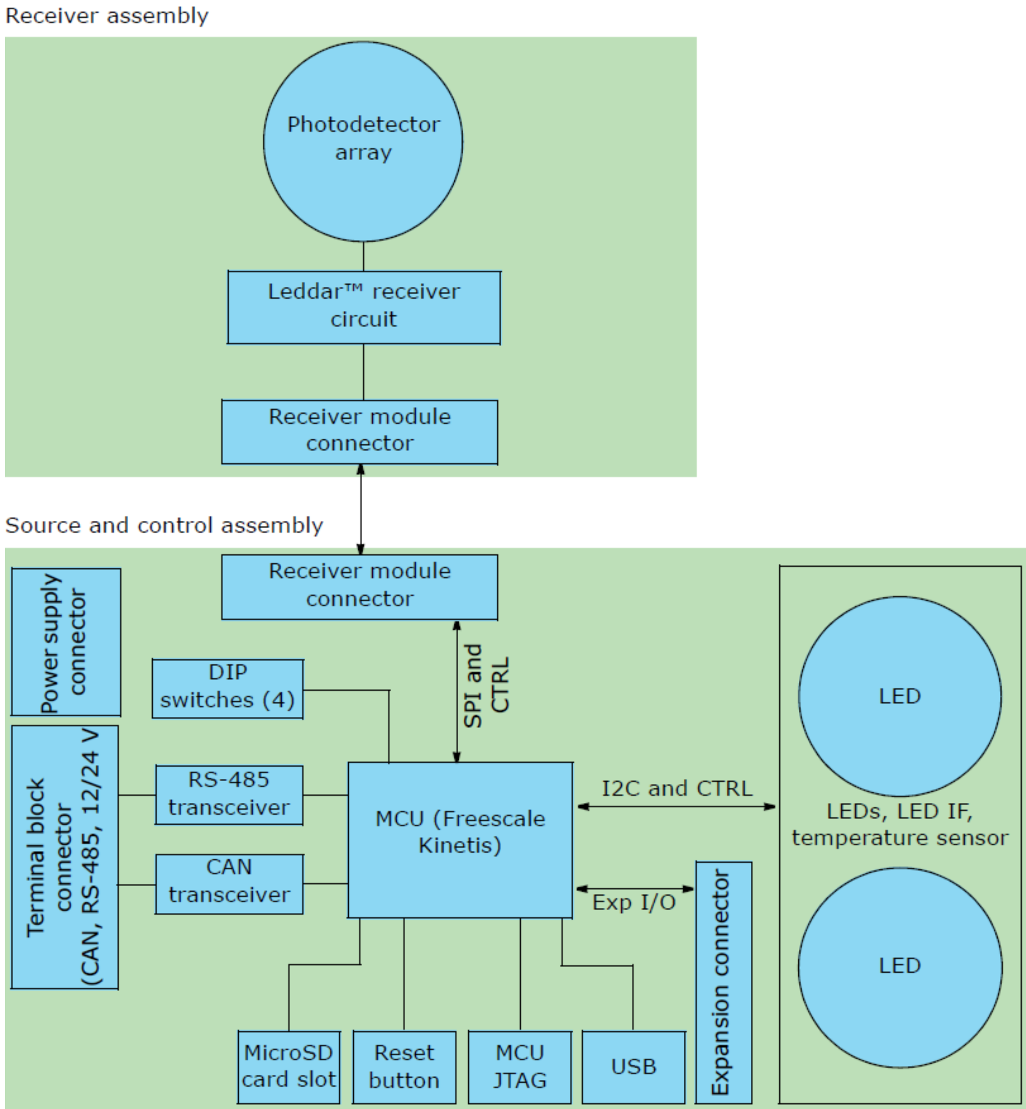


Figure 4: Leddar™ Sensor Module Working Diagram

The receiver assembly includes the reception and emission optics.

The source and control assembly includes the terminal block, the MCU, the LEDs, the LED drivers, and the external interfaces.

DIP Switches

The source and control assembly is equipped with four DIP switches. They are unused by the current design and are thus available as additional options for development of custom applications.

RS-485 Port

The RS-485 (ANSI/TIA/IEA-485) is a half-duplex differential serial communication port. It is often used in electrically noisy industrial environments. The following table provides the pin definitions compliant to RS-485 standards.

Table 3: RS-485 Pin Definition

Pin 4	B	Non-inverting	+DATA
Pin 5	A	Inverting	-DATA

CAN Bus

The CAN bus is implemented via a differential pair. Pin 7 connects to the CAN-High (CAN+) and pin 8 to CAN-Low (CAN-). Jumper P9-P10 connects the 120 Ω CAN bus termination resistor when set in position 1-2. The resistor is disconnected when in position 2-3. The ISO 11898 standard describes the CAN technology.

Expansion Connector

The expansion connector is another connectivity option that can be used for custom application development.

NOTE: *The UART link is the only option implemented in the current MCU firmware.*

All even numbered pins connect to the ground. Odd numbered pins are described below.

Table 4: Expansion Connector Pin Definition

	UART				**CAN**		**GPIO/SPI/…**								**DAC**	**+3.3 V**		**+5.4 V**		**DC**
Pin	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
	GND																			

- UART

  Pins 1, 3, 5, and 7 connect to UART2 from the MCU.

Table 5: UART Pin Definition

Pin	Function
1	TX
3	RX
5	CTS
7	RTS

- CAN

  An additional CAN bus connector is available here. Contrarily to the one on the terminal block, the designer is responsible for converting the receiver/transmitter signals to the CAN standard (CAN-High and CAN-Low).

Table 6: CAN Pin Definition

Pin	Function
9	TX
11	RX

- GPIO

  General-purpose inputs/outputs are available through pins 13, 15, 17, 19, 21, 23, 25, and 27.

- SPI

  The generic serial port interface functionality is available via pins 19, 21, 23, and 25.

Table 7: SPI Pin Definition

Pin	Function
19	MOSI
21	MISO
23	SCLK
25	CS

- DAC

  Pin 29 is a digital-to-analog output. The reference voltage is 3.3 V.

Status LEDs

There are two LEDs on this unit: one shows the activity of the microcontroller, and the other shows the USB connection status and activity.

1.2. Underlying Principles

Created by LeddarTech, LEDDAR™ (light-emitting diode detection and ranging) is a unique sensing technology based on LED illumination (infrared spectrum) and the time-of-flight of light principle. The LED emitters illuminate the area of interest (pulsed typically at 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 5 illustrates the illumination area and detection segments. The 16 segments 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.

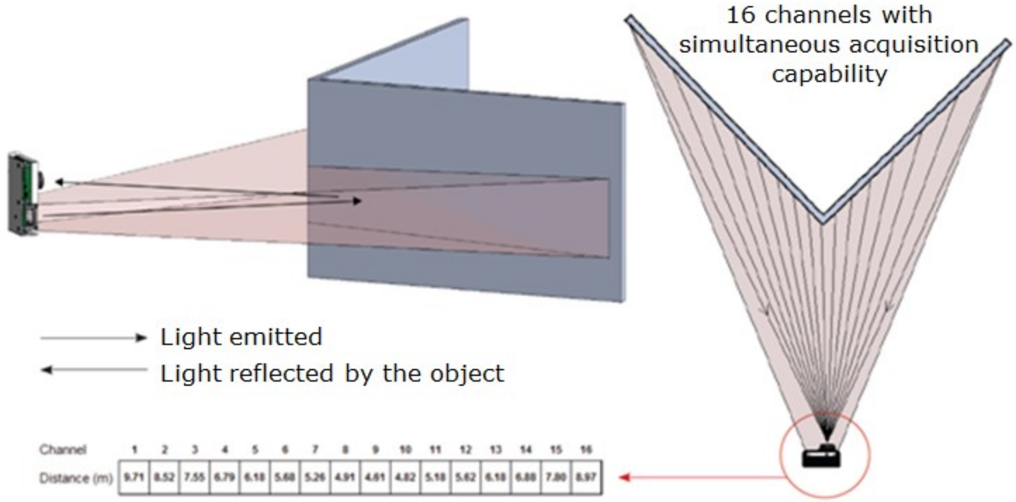


Figure 5: Illumination Area and Detection Zone

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

2. Getting Started

2.1. Setup

This section presents the Leddar™ Configuration installation and the procedure to set up the Leddar™ Sensor Module. All software operations are described in the *Leddar™ Configuration User Guide*.

To Install Leddar™ Configuration:

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

   The installation software starts automatically.

NOTE: *For 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. In the **Leddar™ Software Setup** dialog box, select the **Sensor Module** and the **Leddar™ Software Development Kit** check boxes.

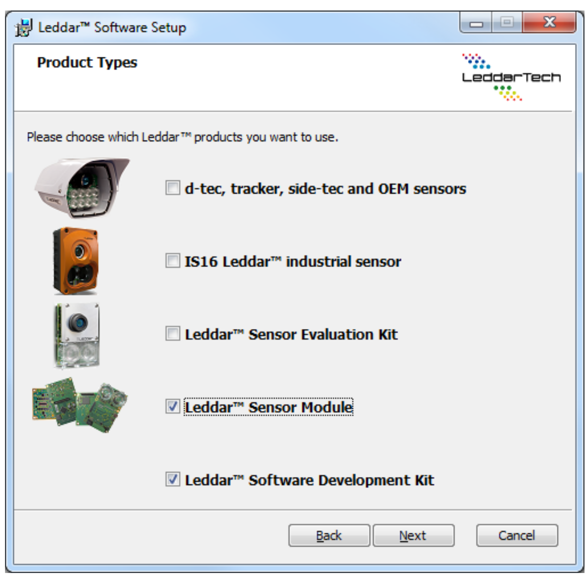


Figure 6: Leddar™ Software Setup Dialog Box

Leddar™ Configuration creates an icon on the computer desktop.

To Install the Leddar™ Sensor Module:

1. Provide power to the module.
2. Connect the USB cable to the module and to the computer.

The first time the module 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.*

2.2. Connecting to the Sensor

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

To Connect to the Sensor:

1. On the computer desktop, double-click the Leddar™ Configuration icon.
2. In Leddar™ Configuration, click the connect button ().

Figure 7: Connecting to a device

3. In the **Connection** window, select your module and click **Connect**.

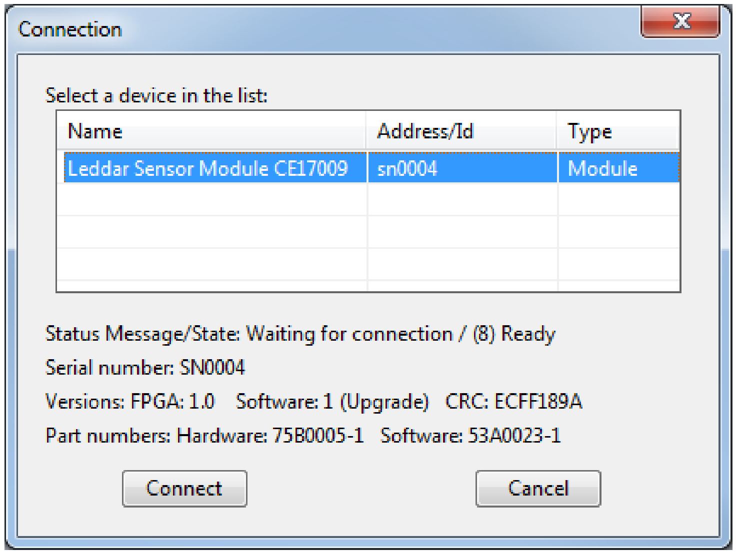


Figure 8: Connection Window

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

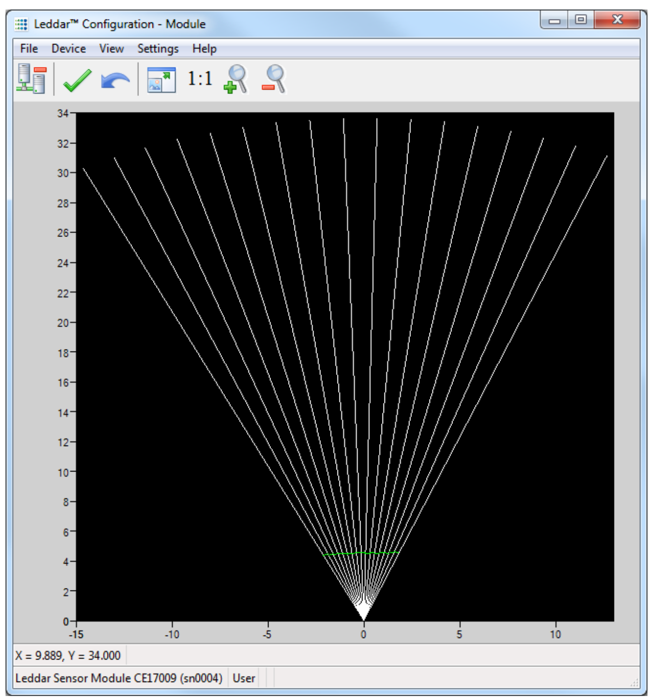


Figure 9: Main Window

A complete description of Leddar™ Configuration features and parameters for the Leddar™ Sensor Module can be found in the *Leddar™ Configuration User Guide*.

3. Measurements and Settings

3.1. Distance Measurement

Distance is measured from the base of the standoffs for the Leddar™ Sensor Module).

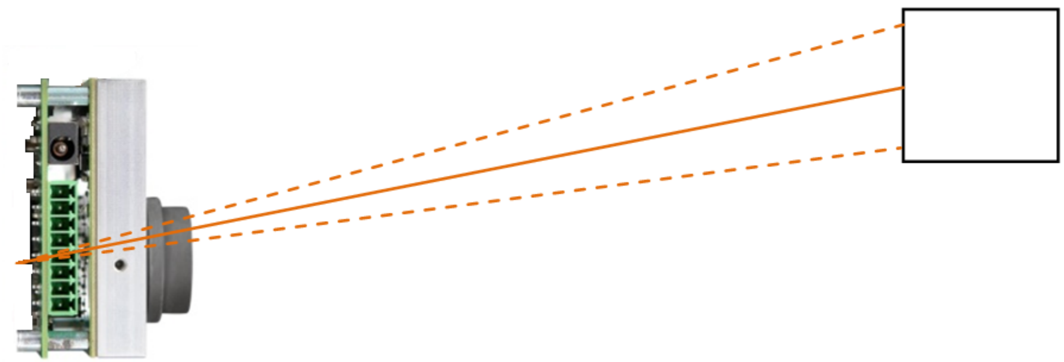


Figure 10: Distance Measurement

The dashed lines illustrate 1 of the 16 segments and the solid line indicates the distance measured by the sensor in that segment.

3.2. Data Description

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

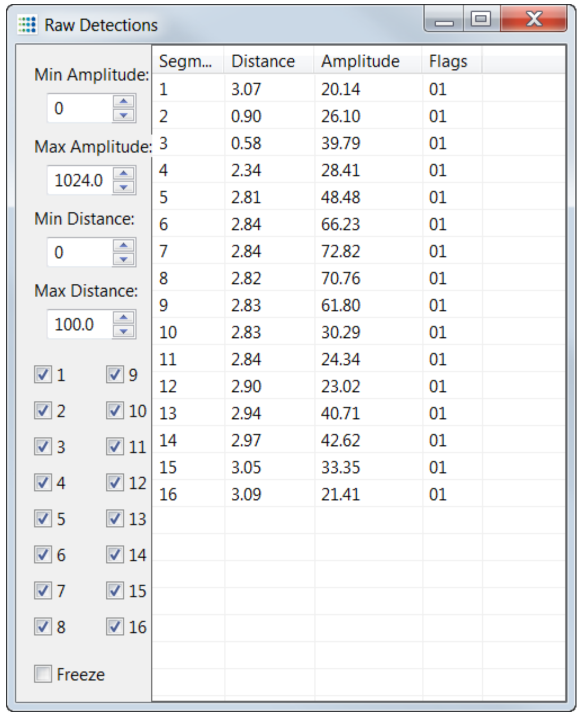


Figure 11: Raw Detections Dialog Box

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

Table 8: Raw Detection Field Description

Field	Description
Segment	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
Flag	8-bit status (bit field). See **Erreur ! Source du renvoi introuvable.**.

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

Table 9: Flag Value Description

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

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 10: Status Value Description

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

3.3. Acquisition Settings

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

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

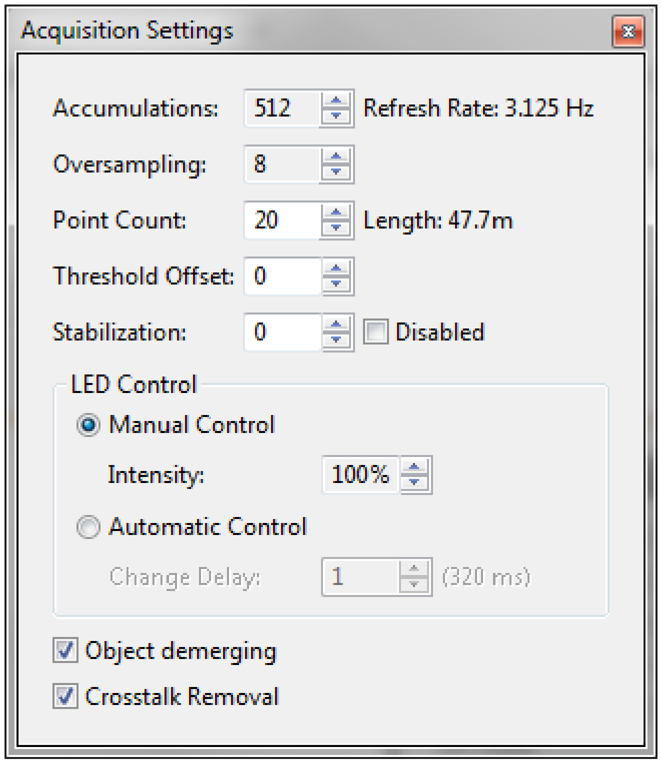


Figure 12: Acquisition Settings Dialog Box

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

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

Table 11: Acquisition Setting Description

Parameter	Description	Effect
Accumulations	Number of accumulations	Higher values enhance range, reduce measurement rate and noise.
Oversampling	Number of oversampling cycles	Higher values enhance accuracy/ precision/resolution and reduce measurement rate.
Point Count	Number of base sample points	Determines maximum detection range.

Threshold Offset	Modification to the amplitude threshold	Higher values decrease sensitivity and reduce range.
Stabilization	Object stabilization algorithm	Stabilizes the sensor measurements. The behavior of the stabilization algorithm can be adjusted by a value ranging from -16 to 16. Higher values enhance the sensor precision, but reduce the sensor reactivity. The stabilization algorithm can be deactivated by checking the "Disabled" check box. The measurement stabilization algorithm is advised for application that need to measure slowly moving objects with a high precision. The application requiring to track quickly moving objects, the stabilization should be configured with a value lower than 0 or simply deactivated.
LED Control	LED power control options	Selects between manual & automatic power control. In automatic, LED power is adjusted according to incoming detection amplitudes. The current LED power level is visible in the Device State window.
Change delay	Minimum frame delay between power changes	Smaller numbers speed up the response time of the LED power adjustment.
Object demerging	Near-objects discrimination	Eases the discrimination of multiple objects in the same segment. Object demerging is only available for measurement rates 1.5625Hz, 3.125Hz and 6.25Hz. The number of merged pulses that can be processed each frame is also limited. A status field is available in the device states window (Leddar™ Configuration) indicating if the sensor processes all merged pulses. The measurement precision of demerged objects tends to be of less quality than on usual detections.
Crosstalk removal	Inter-channel interference noise 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. This algorithm increases the computational load of the sensor microcontroller. It is recommended to disable the crosstalk removal if the sensor is configured to run at rate higher than 50Hz.

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

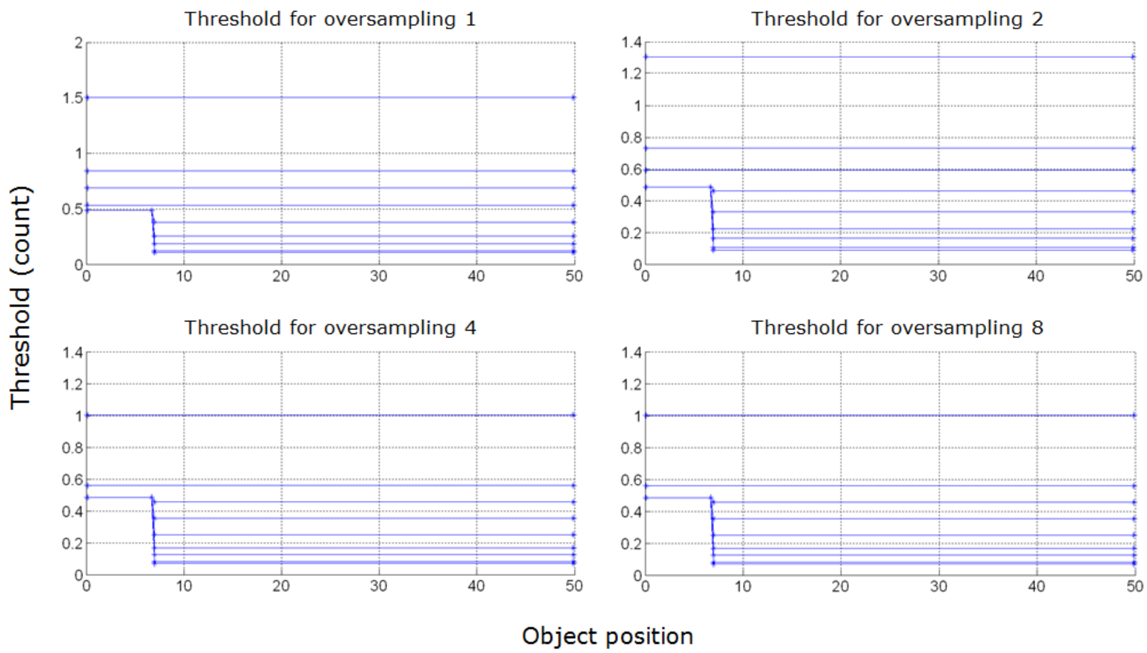


Figure 13: Detection thresholds

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: *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.

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 two times higher at 12.5 Hz than at 6.25 Hz.

NOTE: *Since the change delay parameter is a number of measurements, the delay will vary if the measurement rate is changed (through modification of the accumulation and oversampling parameters).*

Keeping the 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: *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.*

Stabilization

The stabilization algorithm increases the precision of the measurement at the cost of the sensor reactivity. The algorithm works by averaging consecutive measurements over a given time history. The history length of the filter is defined as a function of the measurement noise level. It also changes according to the oversampling and accumulation settings. The history length of the averaging filter can also be adjusted by a parameter ranging from -16 to 16. Higher values increase the sensor precision, but reduce the sensor reactivity. An example of the behavior of the measurement stabilization algorithm is depicted in Figure 14 below.

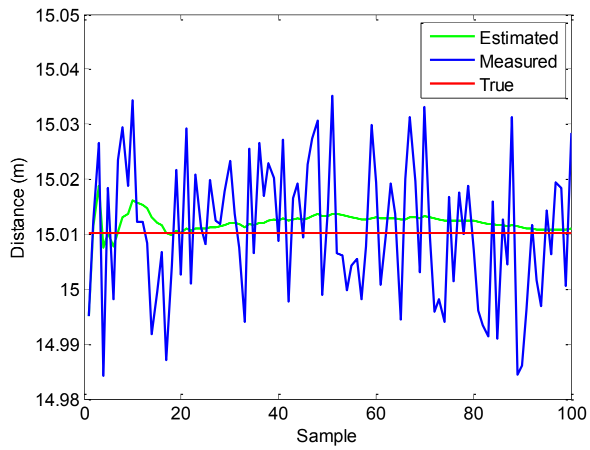


Figure 14: Measurement Stabilization Example

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

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

3.4. Measurement Rate

The sensor acquires a base input waveform for each segment at a rate of 12.8 kHz. Multiple acquisitions are used to perform accumulations and oversampling, and generate a final waveform that is then processed to detect the presence of objects and measure their position.

The final measurement rate is therefore:

Measurement rate = base rate/accumulations/oversampling

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

Measurement rate = 12800 / 256 / 8 = 6.25 Hz

Table 12 presents the measurement rate for typical values of accumulations and oversampling.

Table 12: Measurement Rate

Accumulation	Oversampling	Measurement rate (Hz)
1024	8	1.56
512	8	3.13
256	8	6.25
128	8	12.5
64	8	25
32	8	50
1024	4	3.13
512	4	6.25
256	4	12.5
128	4	25
64	4	50
32	4	100

3.1. CPU Load

The measurement rate varies with the accumulations and oversampling settings. The higher the rate, the higher the processing load is on the source and control assembly microcontroller. The point count parameter also has an impact on the processing load since it impacts the number of sample points to process for each segment.

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

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

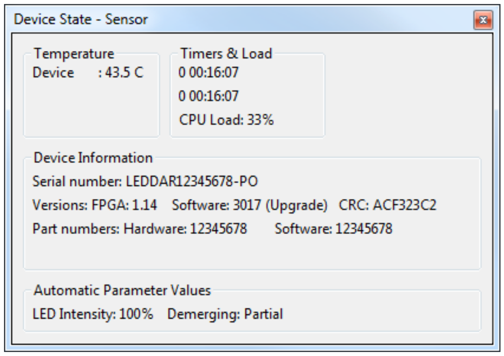


Figure 15: Device State Window

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 50Hz. The following serial port settings are configurable.

Table 13: 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

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 14: 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

3.3. CAN Port Settings

The following CAN port settings are configurable.

Table 15: CAN Port Settings

Parameter	Value
Port Number	Select 1 for the CAN port on the terminal block
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 protocol documentation).
Base Rx Id	The CAN arbitration id used for data messages TO the sensor (see protocol documentation).
Frame Format	Standard, Extended

4. Communication

4.1. Serial Port

The RS-485 port on the sensor uses the Modbus protocol. 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 16: Report Server Id Message Definition

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 (9 for sensor module)

Get Detections (function code 0x41)

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

The first byte is the number of detections in the message. Because of the limitation on a Modbus message length, a maximum of 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: *This maximum can be configured to a lower value using the Leddar Configuration software (serial port configuration) or the Write Register command described below.*

Following the first byte, each detection has five bytes:

Table 17: Get Detection Message Definition (detection fields)

Offset	Length	Description
0	2	The distance in centimeters (little-endian)
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 3 - Detection is saturated High 4 bits are the segment number.

Trailing all the detections are 2 more fields:

Table 18: Get Detection Message Definition (trailing fields)

Offset	Length	Description
0	4	Timestamp of the acquisition (little-endian). The timestamp is expressed as the number of milliseconds since the device was started.
4	1	Current LED power as a percentage of maximum.
5	1	Acquisition statuses. This is a 8-bit field with 2 bits currently defined: bit 0 indicates that automatic LED intensity is enabled if 1, bit 2 indicates that object demerging is enabled if 1.

Read Input Register (function code 0x4)

Here are the registers implemented for this command:

Table 19: Read Input Register Message Definition

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).
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
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: *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 Register (function code 0x10)

Here are the registers implemented for these commands (see section 3.3 for a more detailed description of parameters):

Table 20: Read Holding Register Message Definition

Address	Description
0	Exponent for the number of accumulation (i.e. if the content of this register is n, 2^n accumulations are performed).
1	Exponent for the number of oversampling (i.e. if the content of this register is n, 2^n oversamplings are performed).
2	Number of base samples
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 3.3 should be used. If a value is specified that is not one of the pre-defined values, the closest pre-defined value will be used. The register can be read back to know the actual value set.
6	Bit field of acquisition options with 2 bits currently defined: Bit 0 - Automatic LED intensity enabled Bit 2 – Object demerging enabled
7	Change Delay in number of measurements
8	Maximum number of detections (measurements) returned by function 0x41

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

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

4.2. CAN Bus

The CAN port uses three different message ids (these ids can be modified with the Leddar™ Configuration software):

1856 (0x740) (Rx base id): This is a 1-byte message (any extra bytes will be ignored) that the sensor listens for. It is interpreted as a command. The possible values of the data are:

Table 21: CAN Bus Message Definition

1	Send detections once
2	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).
3	Stop sending detections continuously

When sending, one 0x751 message will be sent followed by as many 0x750 messages as needed.

1873 (0x751) (Tx base id + 1): This is a 1-byte message that indicates the number of detections that will be sent.

1872 (0x750) (Tx base id): This is an 8-byte message containing two 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 centimeters.

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.

5. Specifications

5.1. General

Table 22: General Specifications

LED pulse rate	102.4 kHz
Photodetector array size	1 x 16
Photodetector acquisition rate	62.5 MHz
Measurement rate	See Table 12 on page 27.
USB	2.0, 12 MBits/s
CAN	10 to 1000 kbit/s, optional 120-Ω termination
RS-485	2-wire, half-duplex, 9600 to 115200 BPS
Operating temperature	-40°C to +55°C

5.2. Mechanical

Table 23: Mechanical Specifications

Assembly height	34.9 mm
Assembly width	66 mm

See section 5.6 for dimensions including optics.

5.3. Electrical

Table 24: Electrical Specifications

Voltage	24 VDC (or 12 VDC with alternate jumper settings)
Power consumption (total)	3.9 W

5.4. Optical

Table 25: Optical Specifications

Wavelength	940 nm (infrared)
LED risk group	IEC 62471-2006 exempt lamp classification
Beam width and height	See Table 26 below

Table 26: Beam Width and Height

Beam Option	Beam Width*	Beam Height*
95°	100°	8°
45°	48°	8°
34°	36°	5.9°
24°	26°	4.2°
18°	19°	3°
9°	10°	1.6°

* The following sections present figures illustrating the sensitivity of the sensor across beam width (segment amplitude efficiency) and height (amplitude vs tilt).

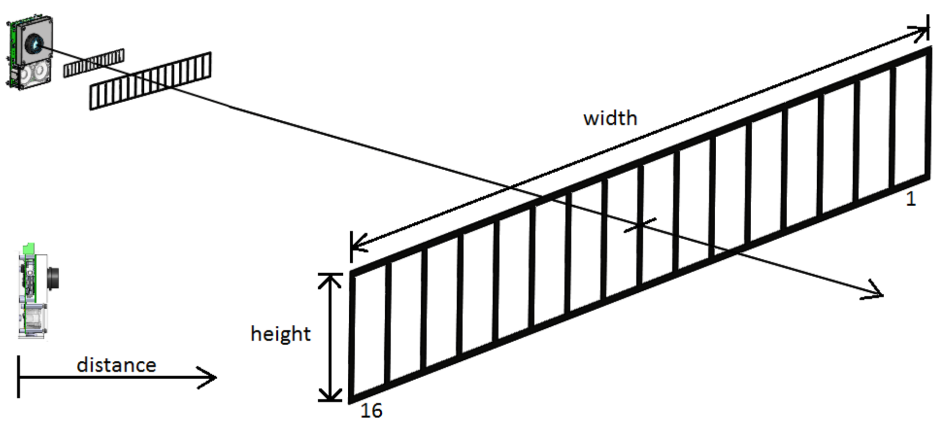


Figure 16: Beam Pattern Width (left) and Height (right)

5.4.1. 95° Module

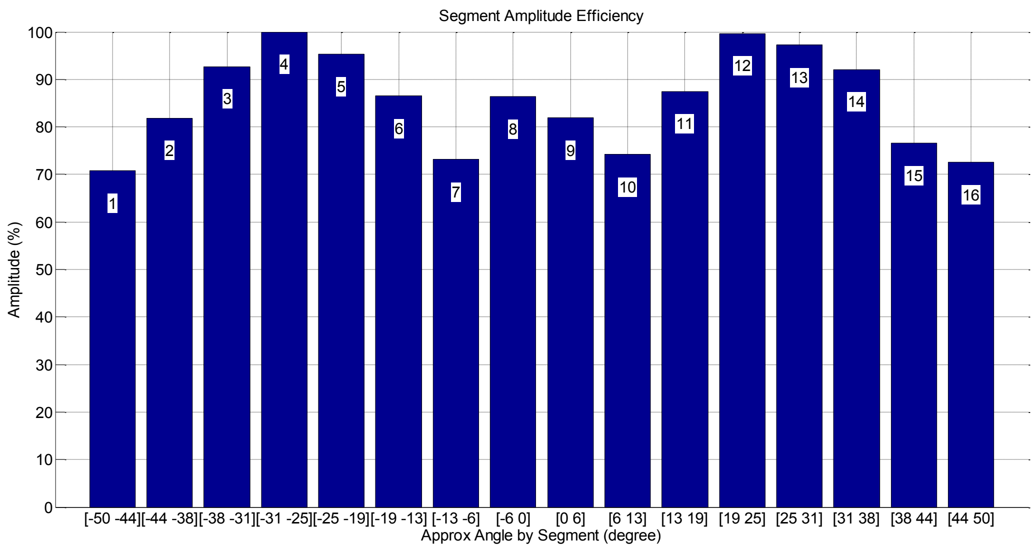


Figure 17: Detection Efficiency 95° (beam width by segment)

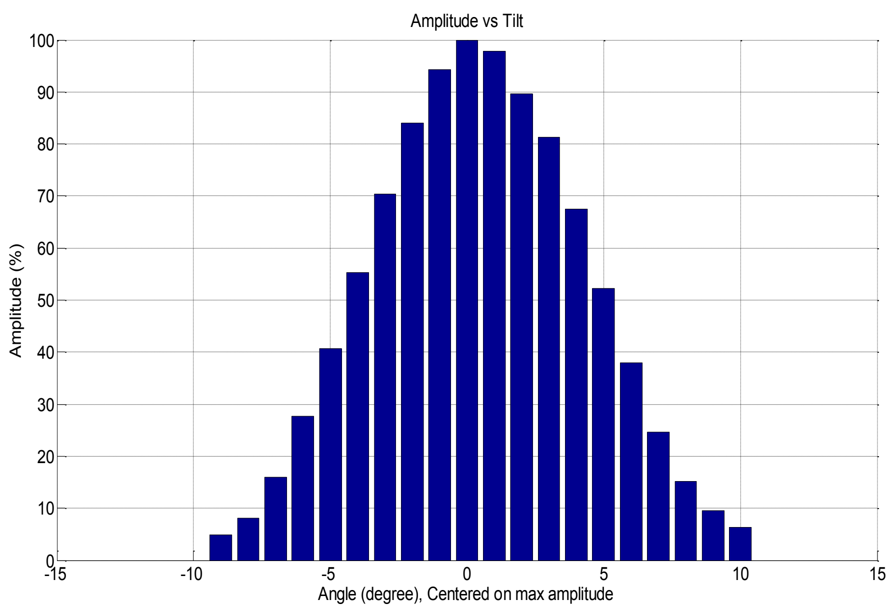


Figure 18: Detection Efficiency 95° (beam height)

5.4.2. 45° Module

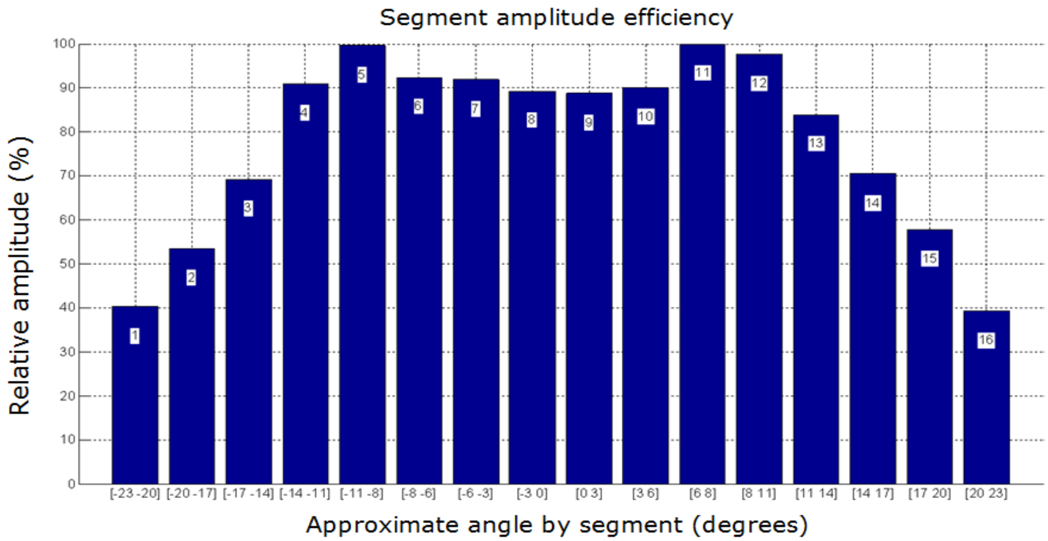


Figure 19: Detection Efficiency 45° (beam width by segment)

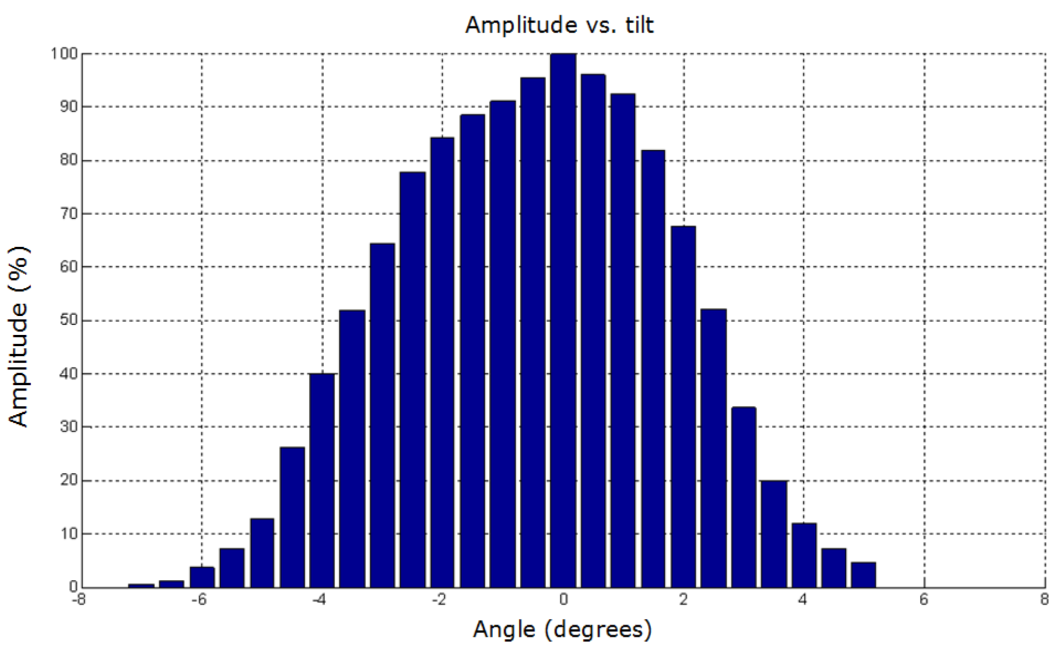


Figure 20: Detection Efficiency 45° (beam height)

5.4.3. 34° Module

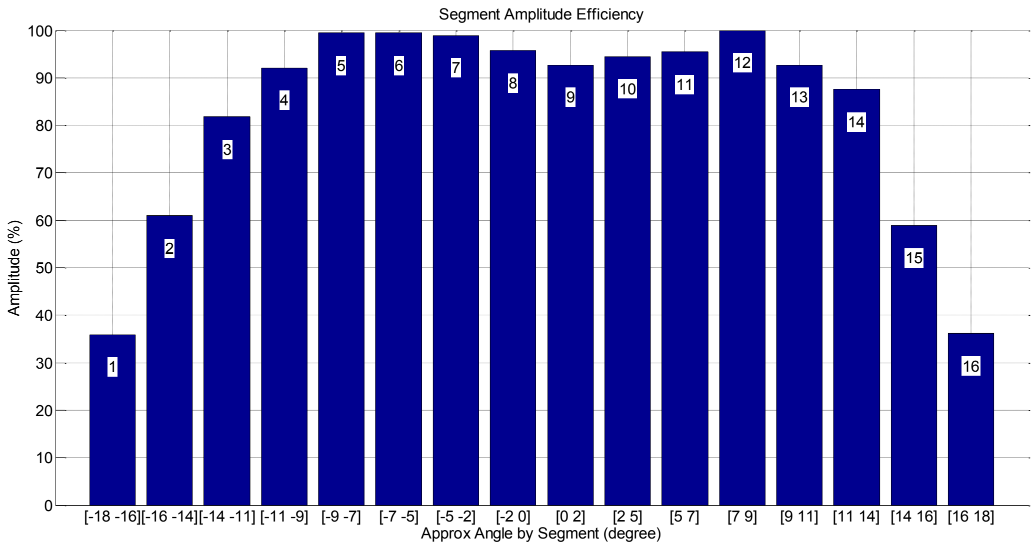


Figure 21: Detection Efficiency 34° (beam width by segment)

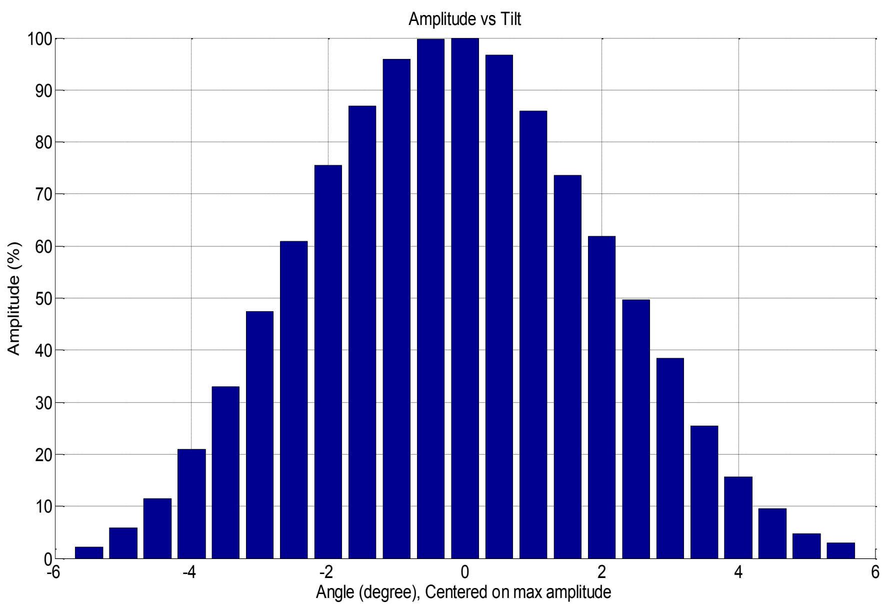


Figure 22: Detection Efficiency 34° (beam height)

5.4.4. 24°Module

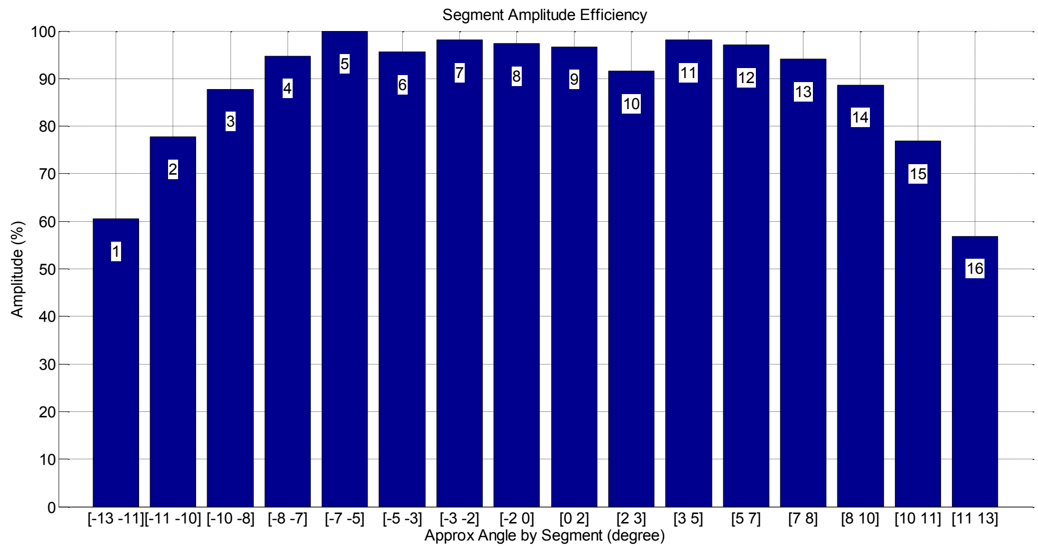


Figure 23: Detection Efficiency 24° (beam width by segment)

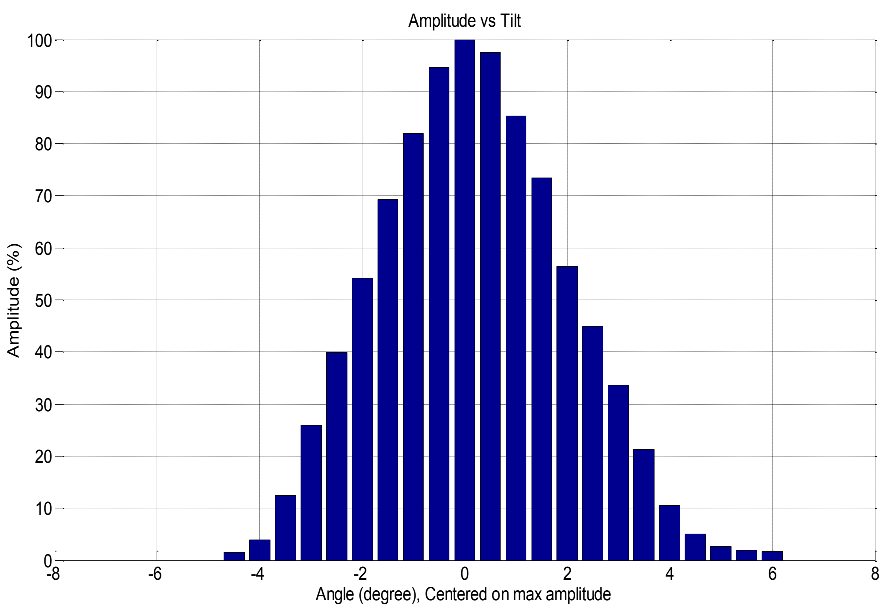


Figure 24: Detection Efficiency 24° (beam height)

5.4.5. 18° Module

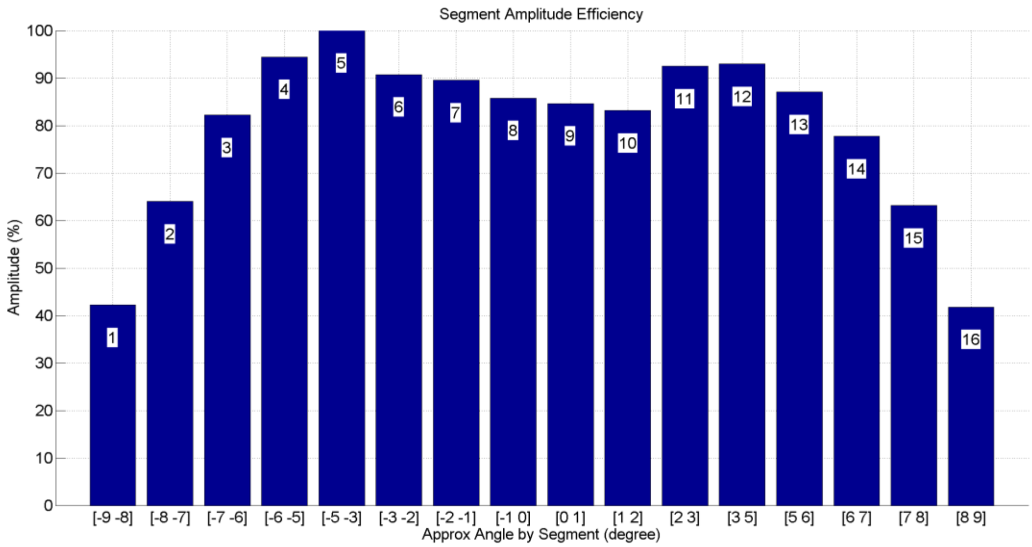


Figure 25: Detection Efficiency 18° (beam width by segment)

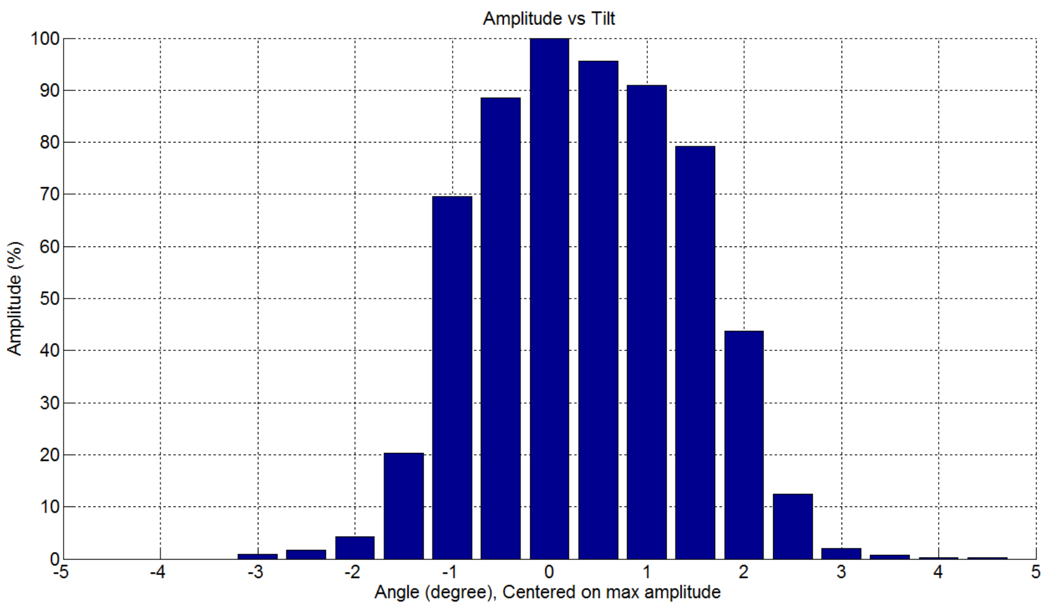


Figure 26: Detection Efficiency 18° (beam height)

5.4.6. 9° Module

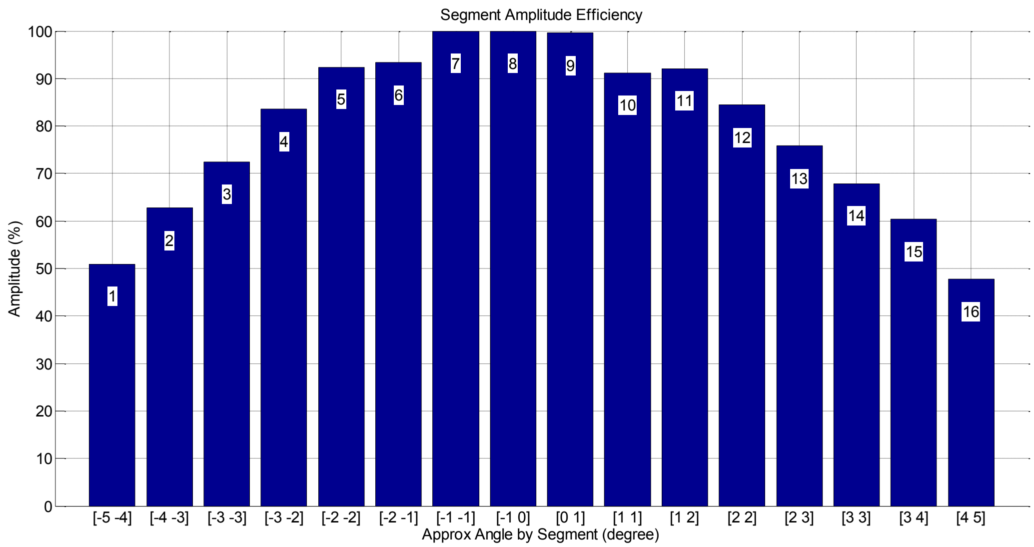


Figure 27: Detection Efficiency 9° (beam width by segment)

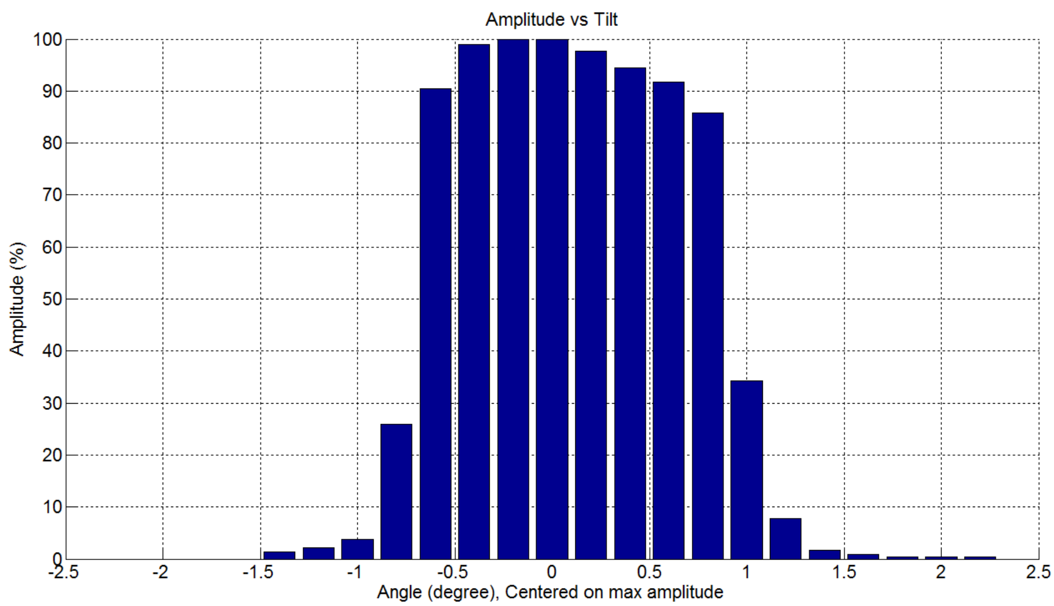


Figure 28: Detection Efficiency 9° (beam height)

5.5. Performance

Table 27: Sensor Performances

Performance Metrics	Values
Measurement accuracy	±5 cm
Measurement precision	6 mm (amplitude > 15)
Resolution	1 cm
Range (maximum LED intensity)	Varies with beam optics and target properties (see amplitude vs range figures below)

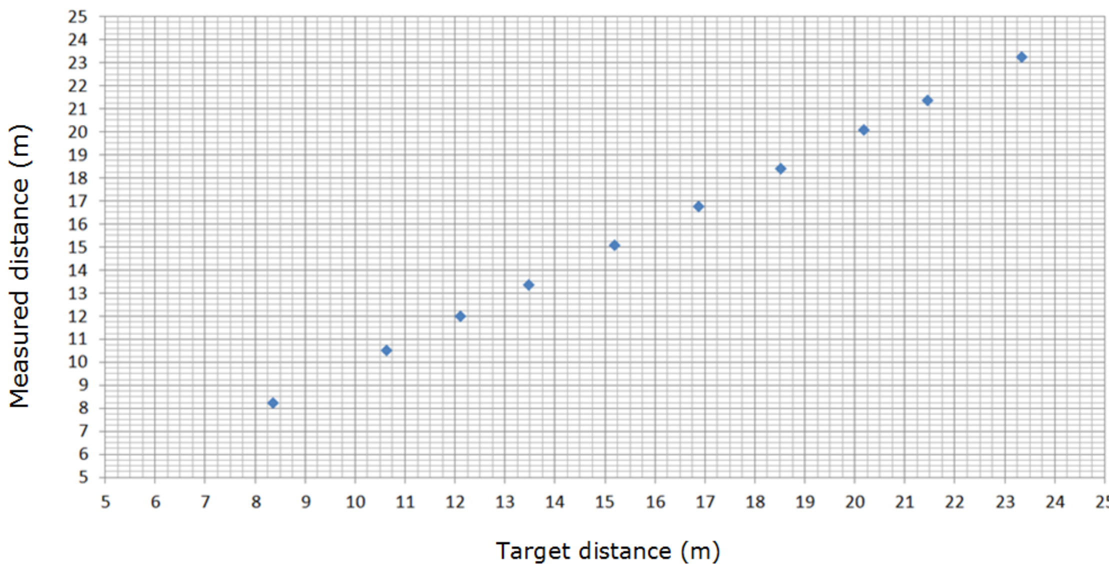


Figure 29: Accuracy vs. Distance

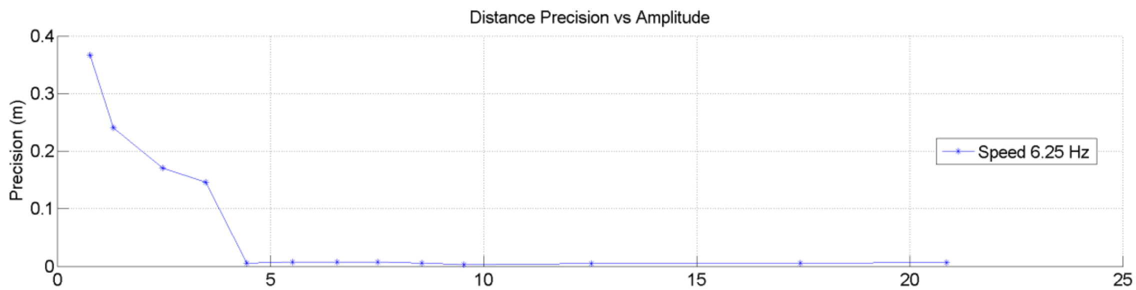


Figure 30: Precision vs. Amplitude (acc 256, ovr 8)

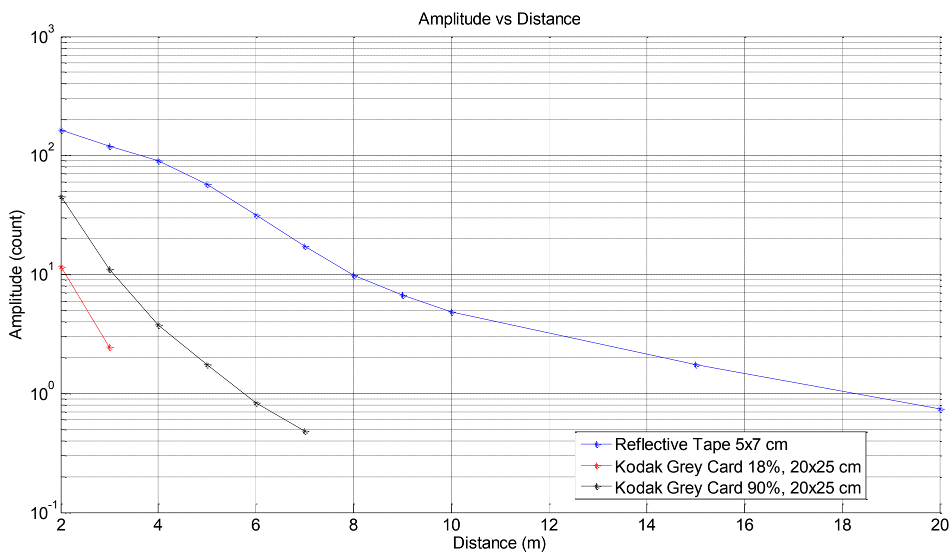


Figure 31: 95° Module Amplitude vs. Range (maximum LED intensity and 256 accumulations)

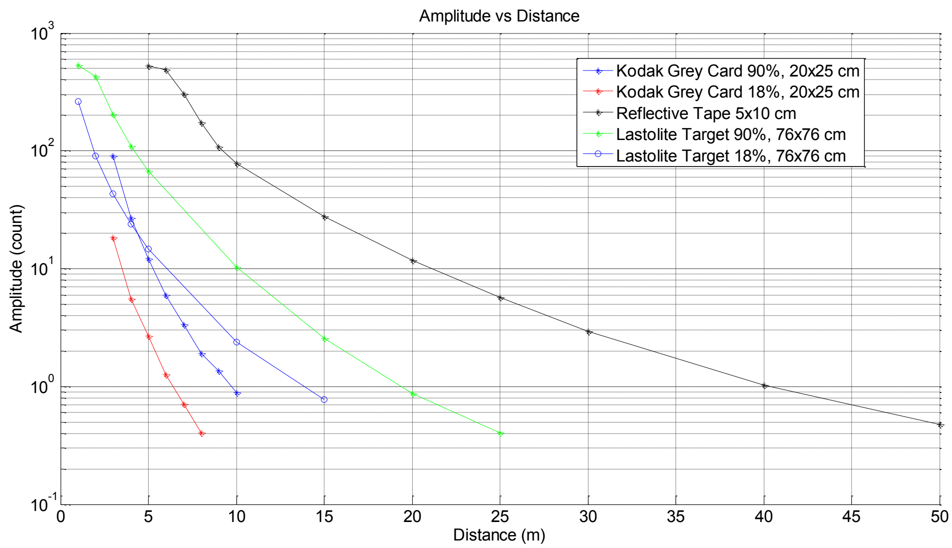


Figure 32: 45° Module Amplitude vs. Range (maximum LED intensity and 256 accumulations)

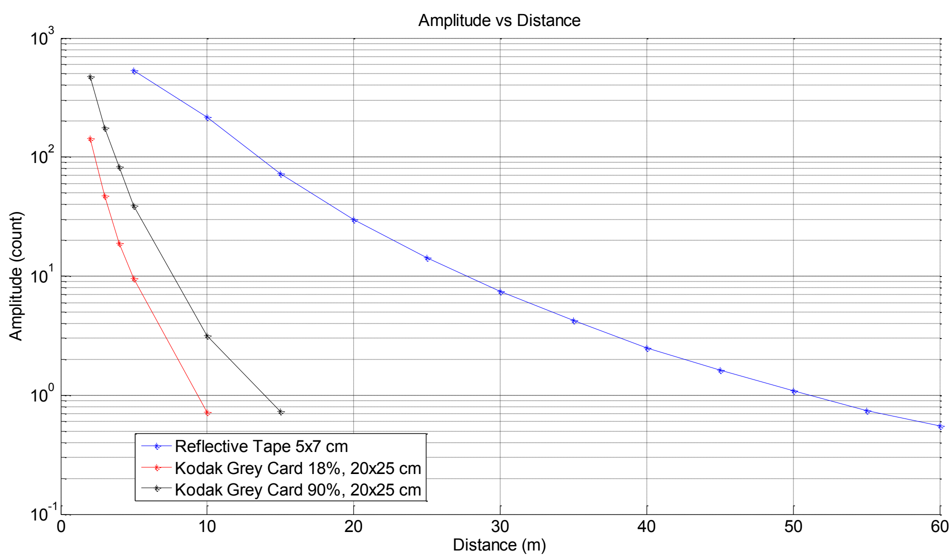


Figure 33: 34° Module Amplitude vs. Range (maximum LED intensity and 256 accumulations)

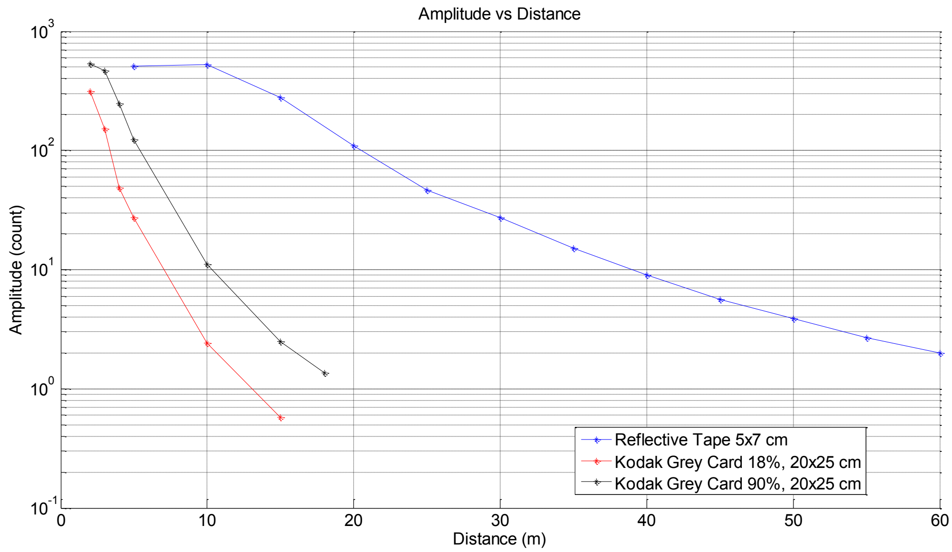


Figure 34: 24° Module Amplitude vs. Range (maximum LED intensity and 256 accumulations)

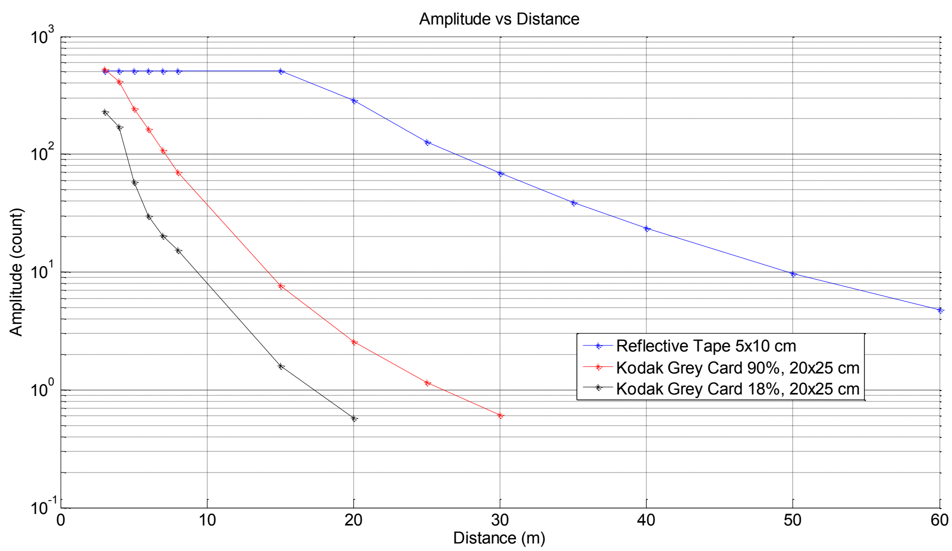


Figure 35: 18° Module Amplitude vs. Range (maximum LED intensity and 256 accumulations)

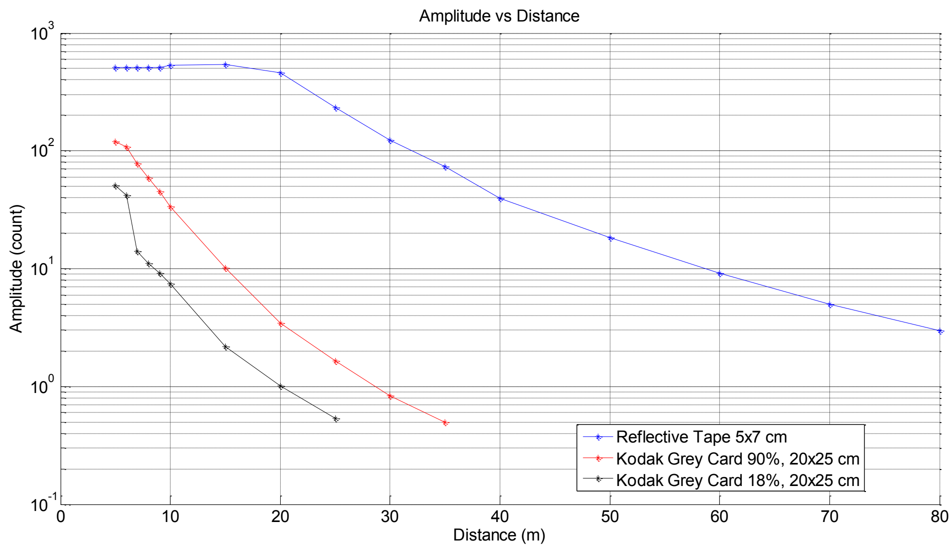


Figure 36: 9° Module Amplitude vs. Range (maximum LED intensity and 256 accumulations)

5.6. Dimensions

5.6.1. 95° Module

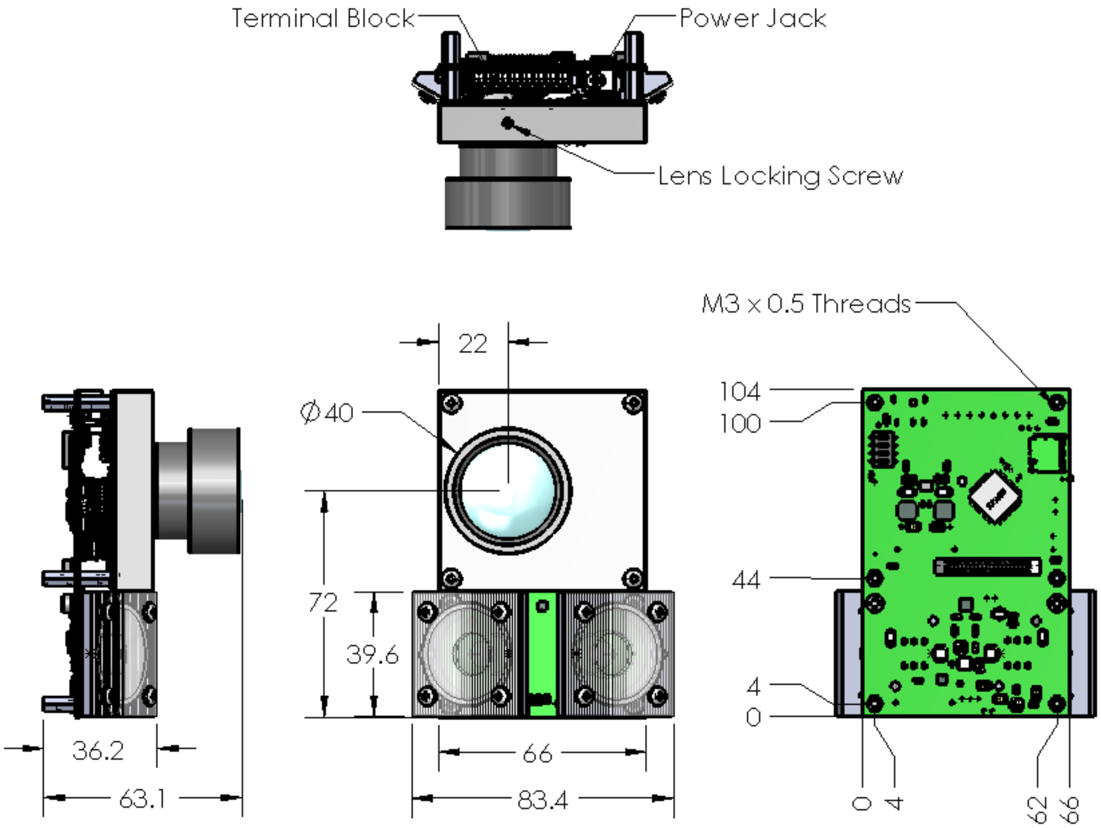


Figure 37: 95° Module Dimensions

5.6.2. 45° Module

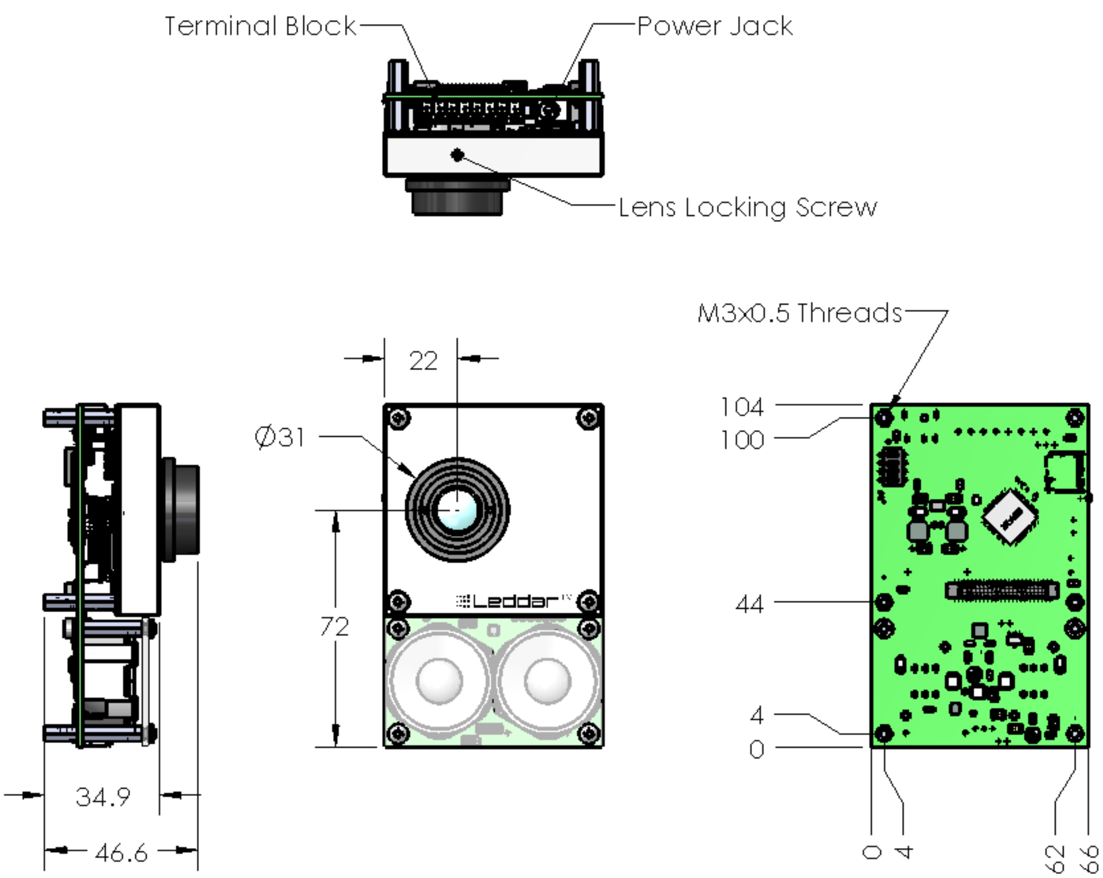


Figure 38: 45° Module Dimensions

5.6.3. 34° Module

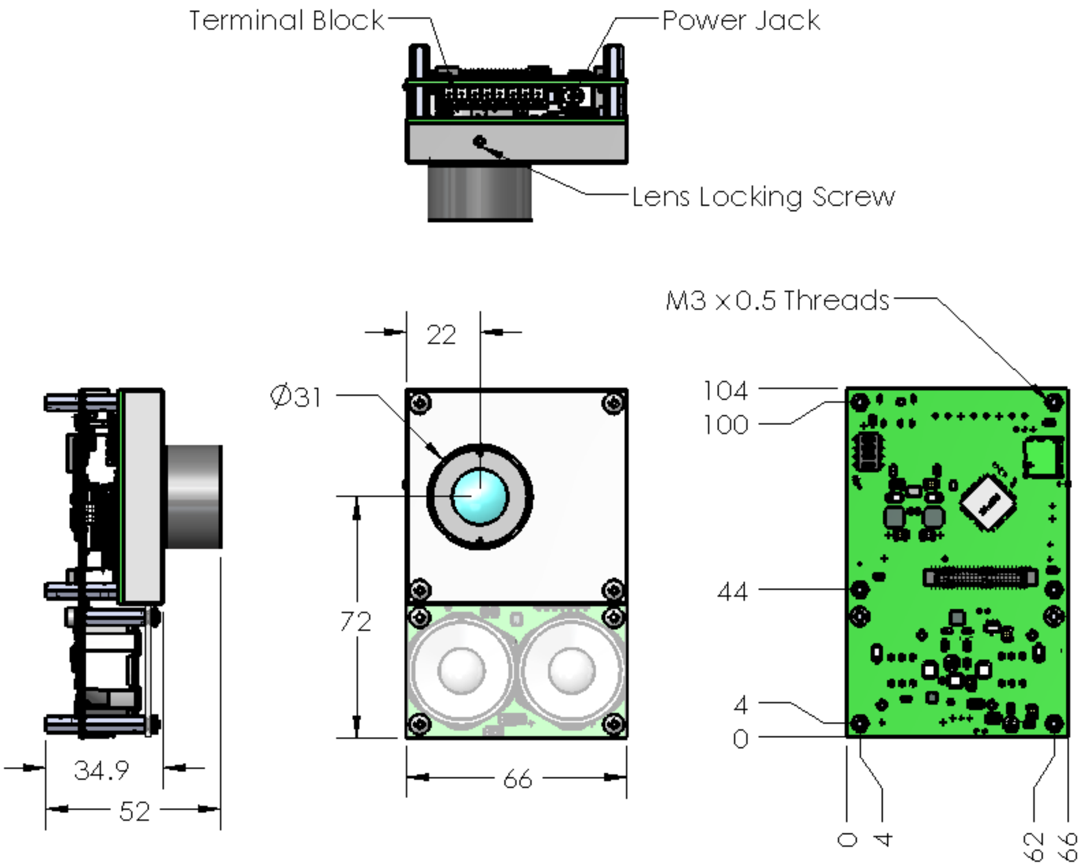


Figure 39: 34° Module Dimensions

5.6.4. 24° Module

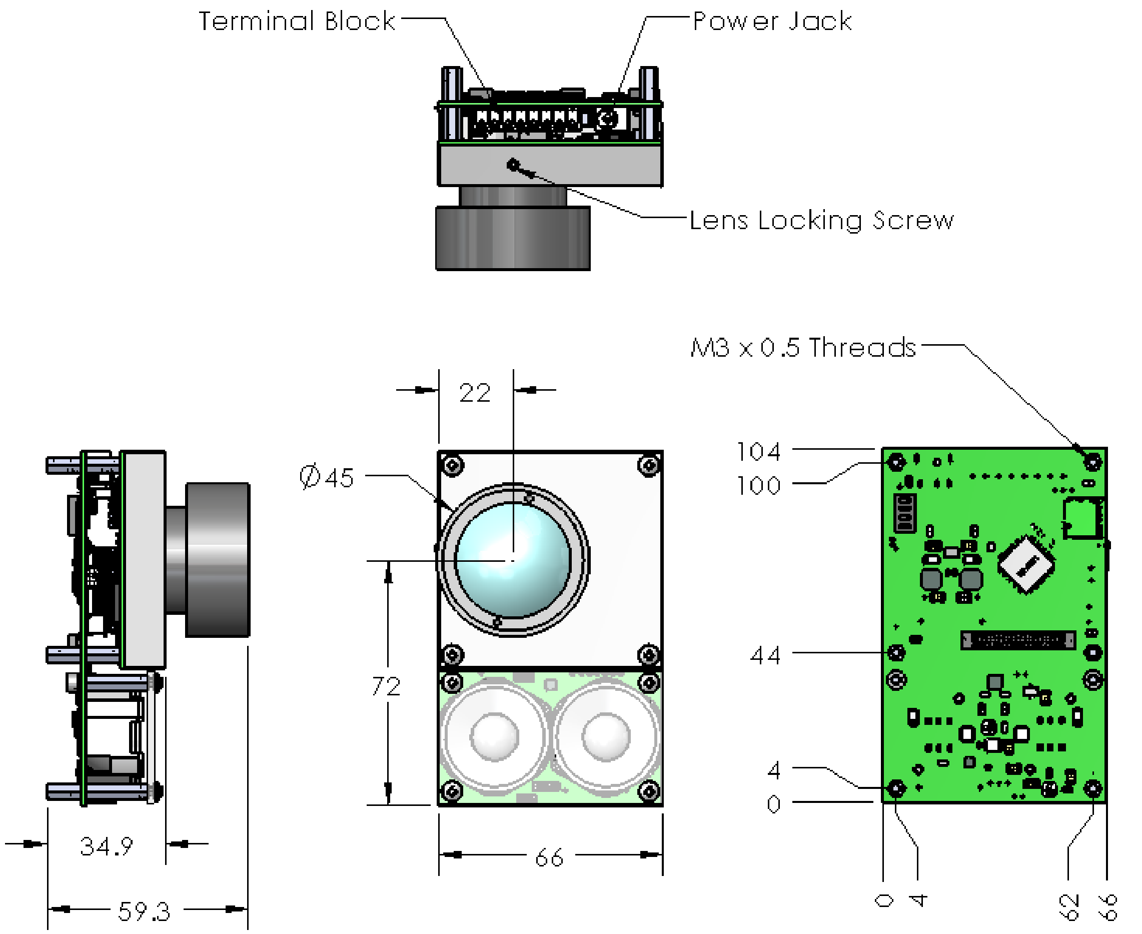
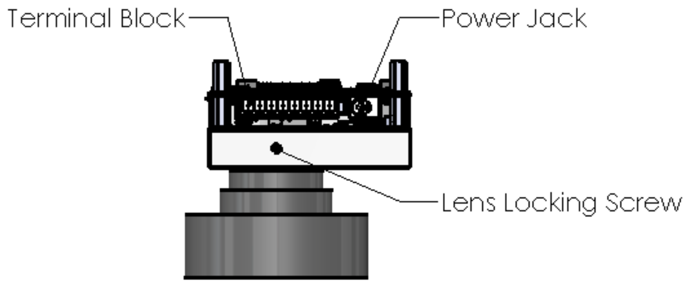


Figure 40: 24° Module Dimensions

5.6.5. 18° Module



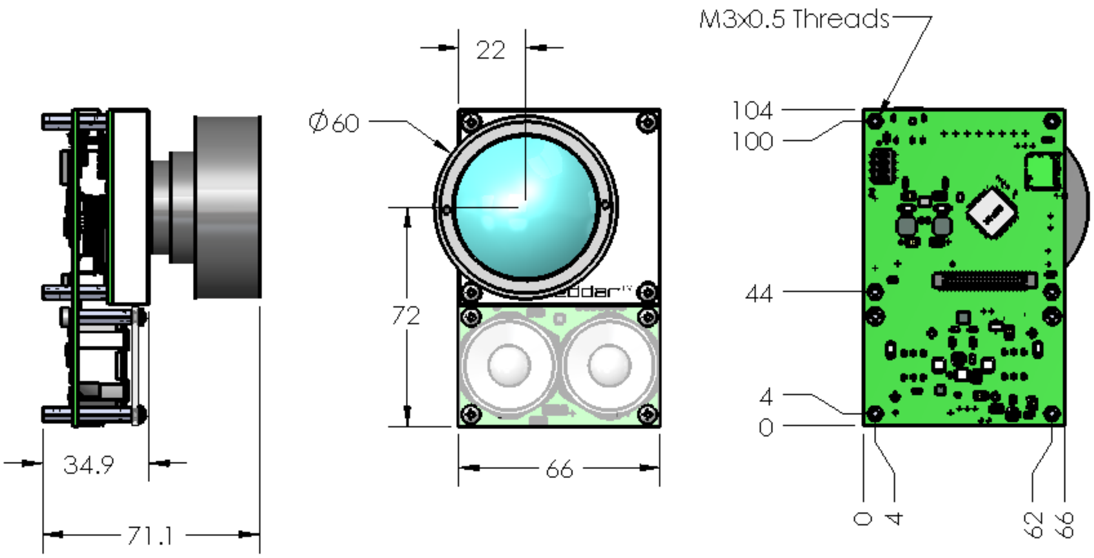


Figure 41: 18° Module Dimensions

5.6.6. 9° Module

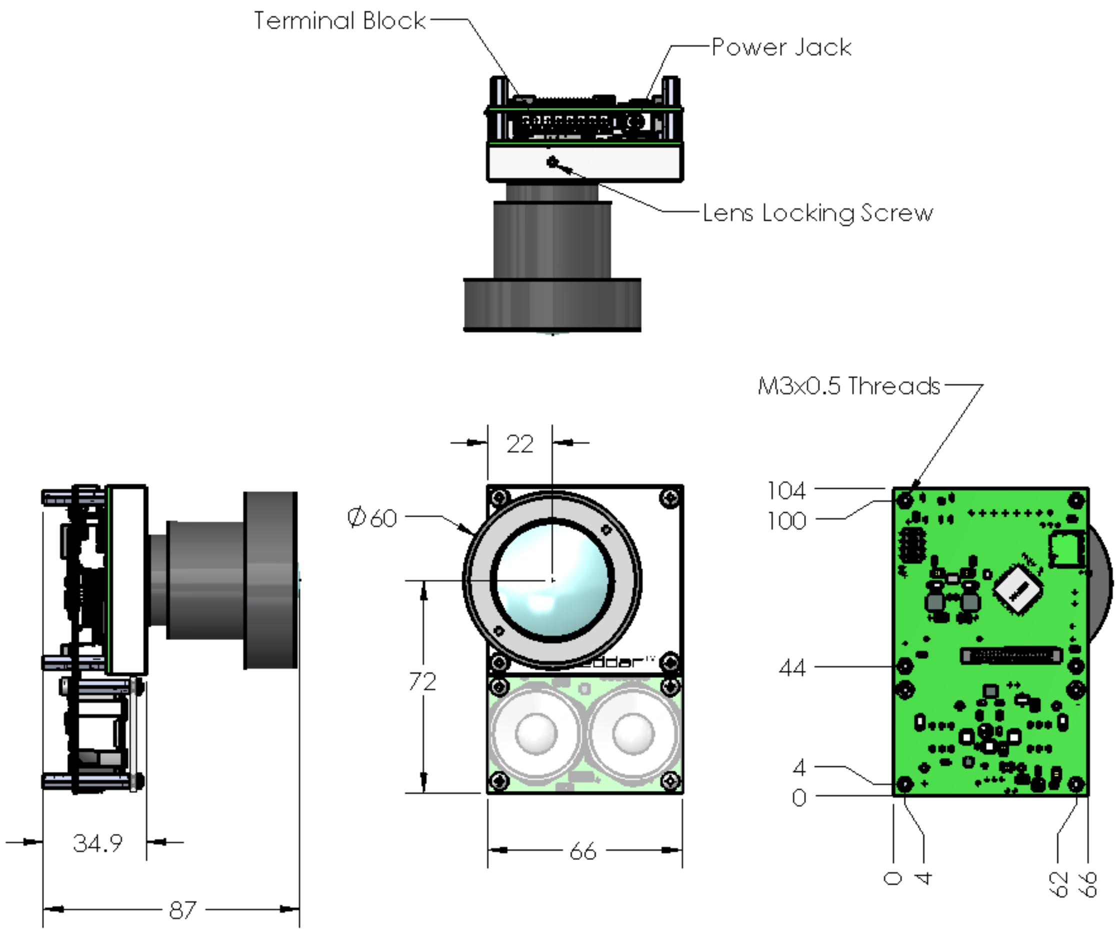


Figure 42: 9° Module Dimensions

6. 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.

E-mail

support@leddartech.com

Company address

LeddarTech Inc.

2740 Einstein Street

Quebec, QC G1P 4S4

Canada

www.leddartech.com

7. Index