



## G2 LiDAR Sensor Product Information Guide

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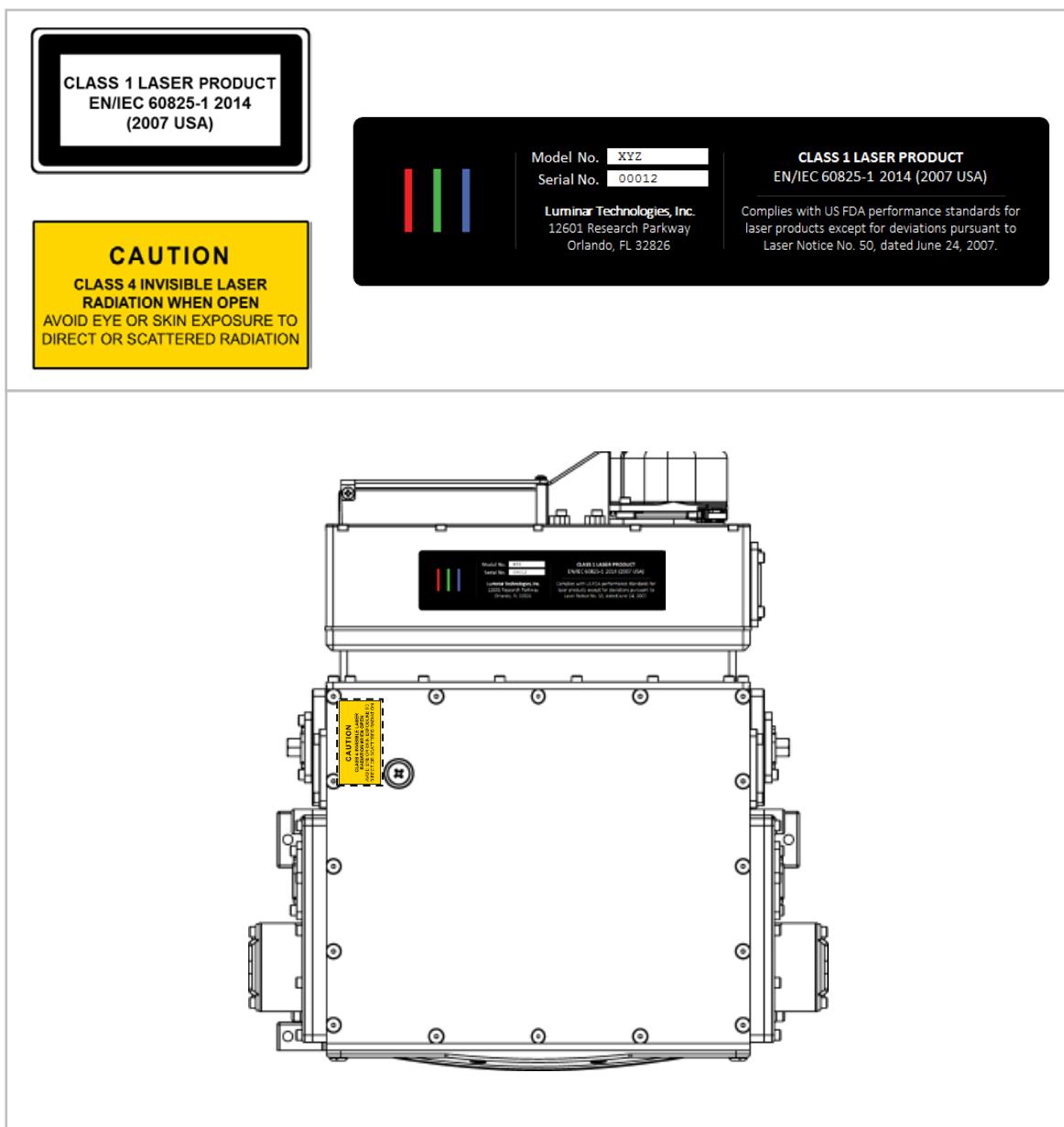
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## Safety Warnings & Labels

**⚠ Caution:** The exclamation point symbol is intended to alert the user to the presence of important operating instructions in the literature accompanying the product.

- **Read Instructions:** All safety and operating instructions should be read before the product is operated.
- **Retain Instructions:** The safety and operating instructions should be retained for reference.
- **Heed Warnings:** All warnings on the product and in the product information guide should be adhered to.
- **Follow Instructions:** All operating instructions should be followed.





# Chapter 1

# Laser Compliance &

# Handling Information

## Prototype Product

The Model G2 system is a prototype and not yet released for consumer use. The Model G2 system is for the testing and evaluation only by businesses and related personnel accustomed and trained in the proper use, handling and storage of such LiDAR systems, and any vehicle or vehicle system into which the unit may be assembled. Customer must ensure that all handling, storage, testing and evaluation of the Model G2 is in adherence to all applicable laws and regulations and industry standards and practice. The customer must take all reasonable and appropriate precautions in the testing and evaluation of the Model G2 as installed in or part of any vehicle or vehicle system deployed or operated in any manner.

 **Warning:** Misuse or mishandling of the Model G2 may result in death, substantial physical harm, radiation exposure, and property damage.

 **Warning:** Operation of the Model G2 if there is damage to the unit housing including any broken seals, damage or holes to the housing, or damage to the optical sensor head aperture window, may result in exposure to Class 4 radiation which may result in death, substantial physical harm, and property damage.

### 1.1 Laser Compliance

#### 1.1.1 Laser Product Operation

IEC has defined standards for laser safety. For a LiDAR or any other laser system to be considered safe during use under these standards, it must not emit laser radiation above the Accessible Emission Limit ("AEL") or otherwise produce an exposure above the Maximum Permissible Exposure ("MPE").

The IEC 60825 standard defines a category of laser products called "Class 1" laser products that are deemed safe during use by the IEC. The standard defines these Class 1 laser products as:

Laser products that are safe during use, including long-term direct intrabeam viewing, even when exposure occurs while using telescopic optics. Class 1 also includes high power lasers that are fully enclosed so that no potentially

hazardous radiation is accessible during use (embedded laser product). Intrabeam viewing of Class 1 laser products which emit visible radiant energy may still produce dazzling visual effects, particularly in low ambient light. The term "eye-safe" may only be used for Class 1 laser products. The term "eye-safe laser" should not be used to describe a laser, based solely on its output wavelength being greater than 1400 nm. Lasers of any wavelength with sufficient output power can cause injury.

The Luminar Technologies, Inc. G2 LiDAR systems have undergone design, analysis and testing to meet the IEC requirements for Class 1 laser products. To ensure that the Class 1 compliance features are maintained, the user must follow all installation and operating instructions as well as ensuring system integrity.

The Class 1 compliance features of the G2 LiDAR systems fall into four general categories:

- Power limiting design features
- Scanner failure features
- Protective housing features
- Design verification testing

### **1.1.2 Analysis and Classification**

Luminar has determined that the Luminar G2 LiDAR system complies with the Class 1 requirements. This classification is determined through analysis and calculations to show that the human exposure in the scanned Field of Regard ("FoR") is below the Class 1 AEL. The calculations were performed in accordance with IEC 60825-1:2007 ed.3 and filed with the FDA Center for Devices and Radiological Health as part of the system's registration with the FDA.

There are also other requirements that must be met to be Class 1. The features of the Luminar G2 LiDAR system directed to Class 1 compliance are described in more detail in the following paragraphs.

### **1.1.3 Power Limiting Design Features**

While the Luminar G2 LiDAR system gives the user the ability to adjust the laser power between 0-100% there are 3 layers of power control and checking that limit the total power delivered into the scanned FoR that keep the emitted power below the Class 1

AEL. These features are generally command checking and power control circuits and algorithms.

#### **1.1.4 Scanner Failure Features**

The Luminar G2 LiDAR system incorporates redundant scan failure detection on all scan channels. This is necessary to ensure that the emitted light within the specified exposure area stays below the AEL. Should any part of the scanning system fail the laser will be shut off before the AEL is reached, thus preventing an exposure above the Class 1 limit.

#### **1.1.5 Protective Housing Features**

Another important feature of the system that provides safety is the Enclosure. Under normal operating conditions, the user is prevented from accessing any radiation above the Class 1 AEL by the enclosure. For this reason, it is vitally important that the user DOES NOT ATTEMPT to open, alter or otherwise access the interior of the G2 scanner head. Likewise, should the front window become cracked or broken, the system should be immediately turned off and returned to Luminar for repair. In the case of a broken window for example, the scanners will likely be compromised, the scan failure detection system will sense this problem and prevent the laser from operating.

#### **1.1.6 Design Verification Testing**

The Luminar G2 LiDAR system has undergone extensive design and analysis to ensure the highest level of laser safety possible. To verify that these features work correctly, each G2 delivered is tested and certified. The total emitted power is measured, the scan failure detection system is tested by inducing a failure and the shutdown time is measured. The power limiting software and circuits are tested to demonstrate that the commanded power can never exceed the predetermined maximum output that would exceed the Class 1 AEL.

### **1.2 Handling**

Handle your G2 System with care. It is made of metal, glass, and sensitive electronic components. Operate your G2 System attached on a solid, and stable surface that allows for adequate air circulation above and around the sensor and control box.

#### **1.2.1 Connectors and Ports**

Never force a connector into a port. When connecting the device, make sure the port is free of debris, that the connector matches the port, and that you have positioned the connector correctly in relation to the port.

### **1.2.2 Window Cleaning and Care**

Keep the optical window of your G2 system clean and dry. Dry the window of the G2 system thoroughly with a nonabrasive, lint-free cloth, if the surface is exposed to fresh water. If the window is in contact with sand, salt, or with liquids other than fresh water, clean using fresh water followed by ethylene alcohol applied with a nonabrasive, lint-free cloth.

### **1.2.3 Operating Temperature**

The G2 system is designed to work best in ambient temperatures between 32° and 104° F (0° and 40° C). The G2 system can be damaged and the operating life shortened if operated outside of these temperature ranges. Avoid exposing the G2 system to dramatic changes in temperature or humidity.

### **1.2.4 Installation and Operation**

- Do not disconnect any cable while the system is powered. Doing so may damage the system.
- Always reduce laser power to zero before turning off the Model G2 Control Box.
- Always visually inspect the Model G2 unit prior to any operation. Never operate the unit if there are observed any broken seals, damage/holes in the housing, or damage of any kind to the optical sensor head aperture window.

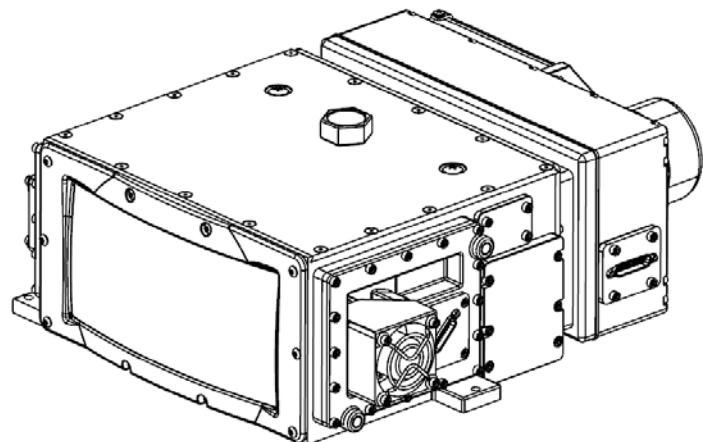
## **1.3 Service and Modification**

There are no user-serviceable parts in the G2 system. Nor are there any user adjustments required on the hardware. Therefore, do not open or disassemble the G2 system, in any manner, or attempt any service or repair. Similarly, do not make any modifications or alterations to the unit in any manner including to the protective housing. Please consult the Purchase Agreement regarding service or repair by Luminar.

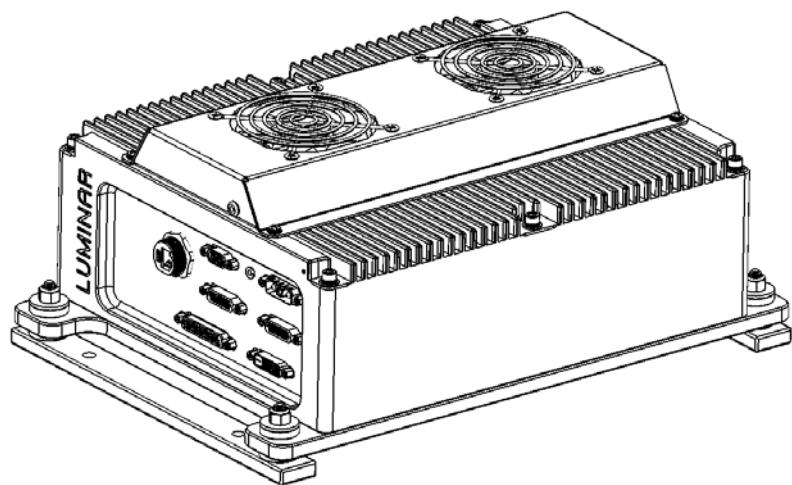


## Chapter 2

# What's in the Box



G2 SENSOR

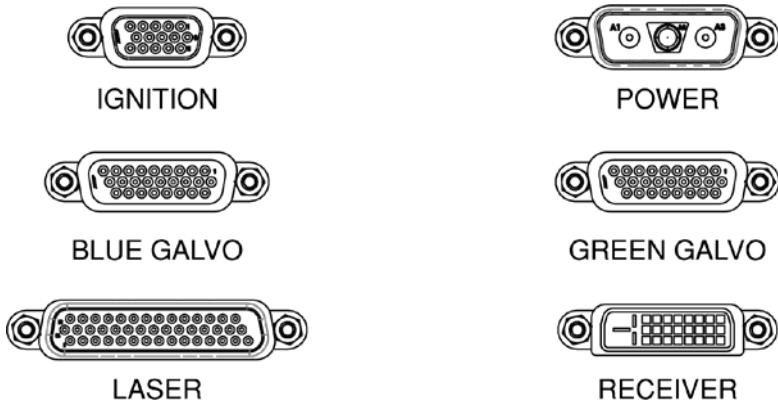


CONTROL MODULE

What's in the box

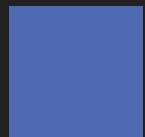


## DOCUMENTATION



## CABLES - CONTROL MODULE SIDE

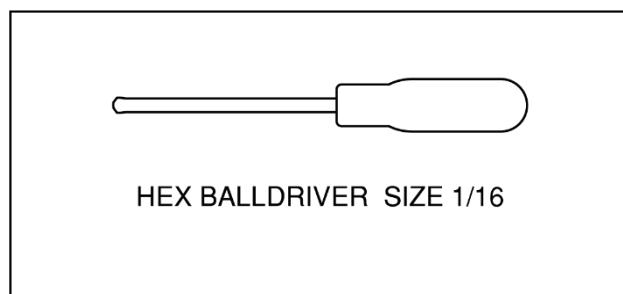
What's in the box



# Chapter 3

# Product Assembly

### 3.1 Tools Needed

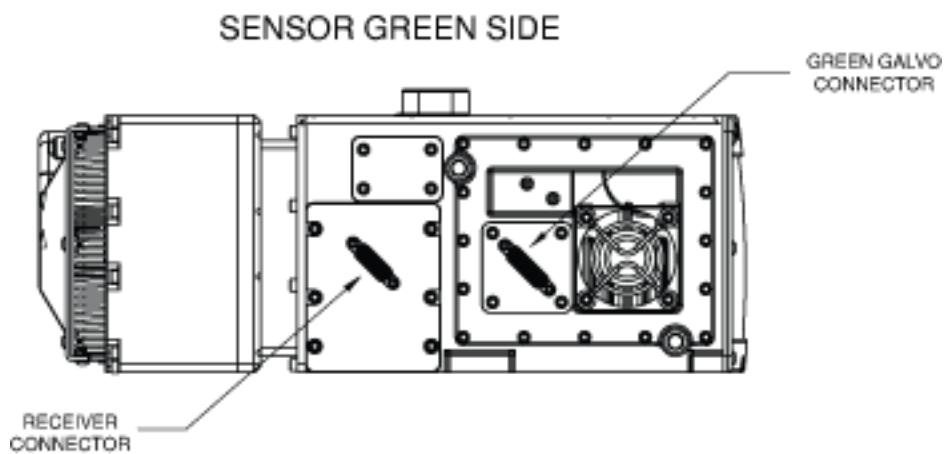


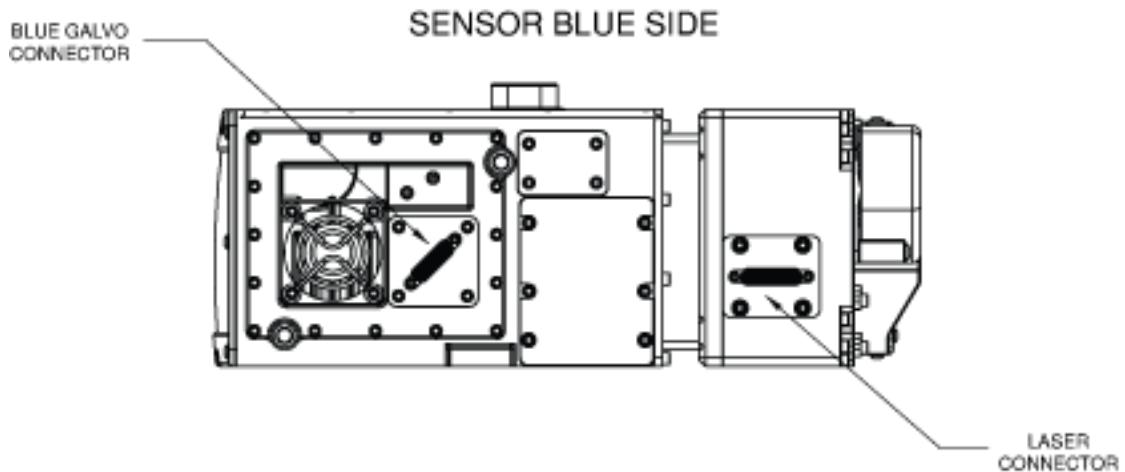
### 3.2 Unboxing

The G2 system is designed to set it up quickly and start using it right away. Take components carefully out of the shipping case using correct lifting techniques. Position your G2 system so that:

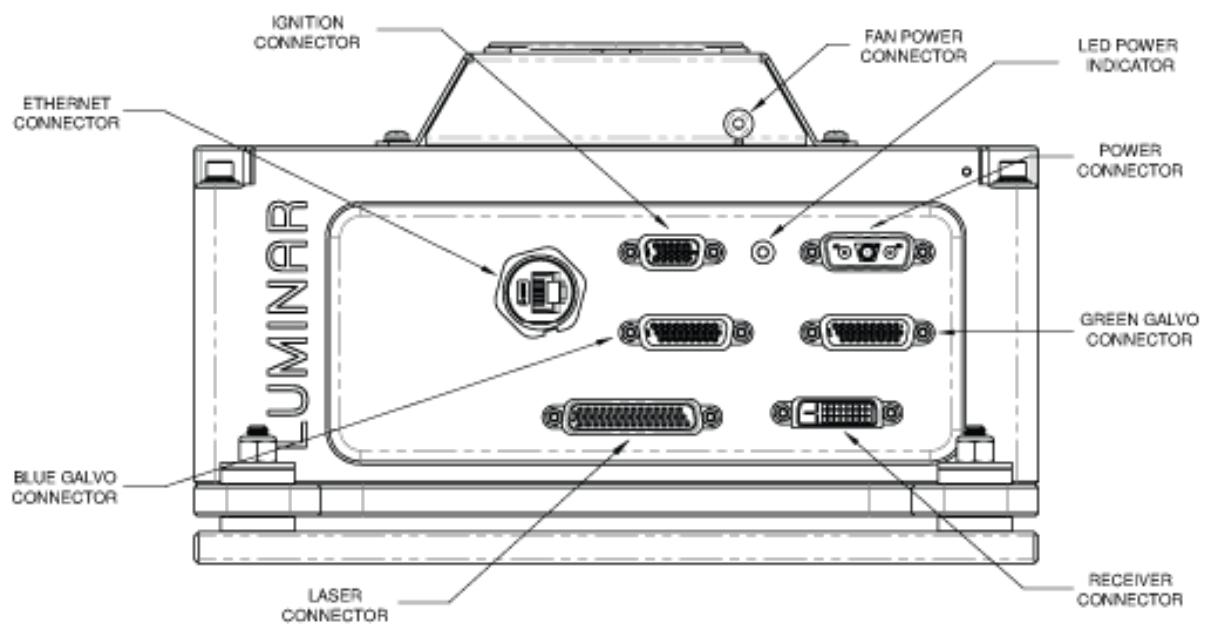
- It is either attached to or placed on a sturdy, flat surface.
- Connectors and cables are not pressed or pinched against other objects.
- The airflow is not obstructed. The G2 sensor head has fans on the sides and back. The Control Box has fans on the top that should not be obstructed.

### 3.3 Identifying Connectors

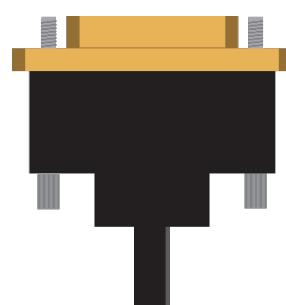




CONTROL MODULE FRONT VIEW



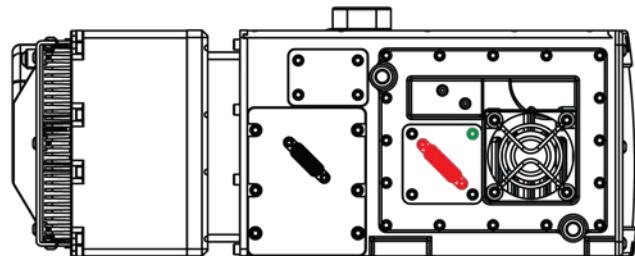
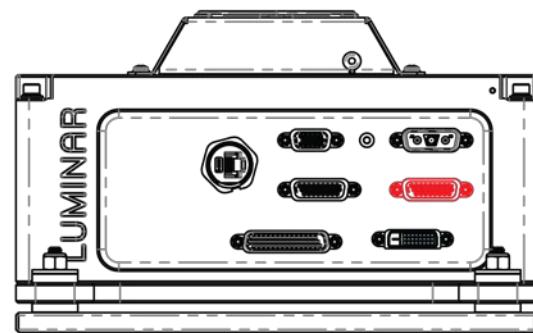
### 3.4 Connecting Cables

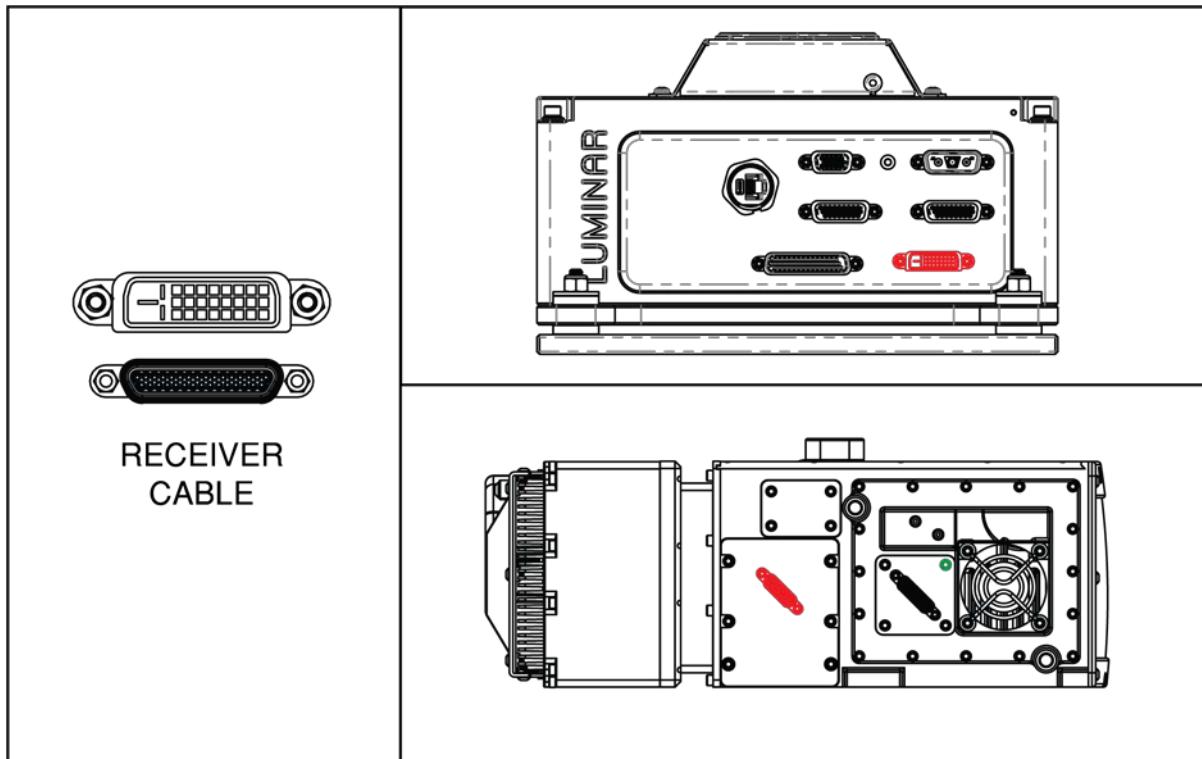
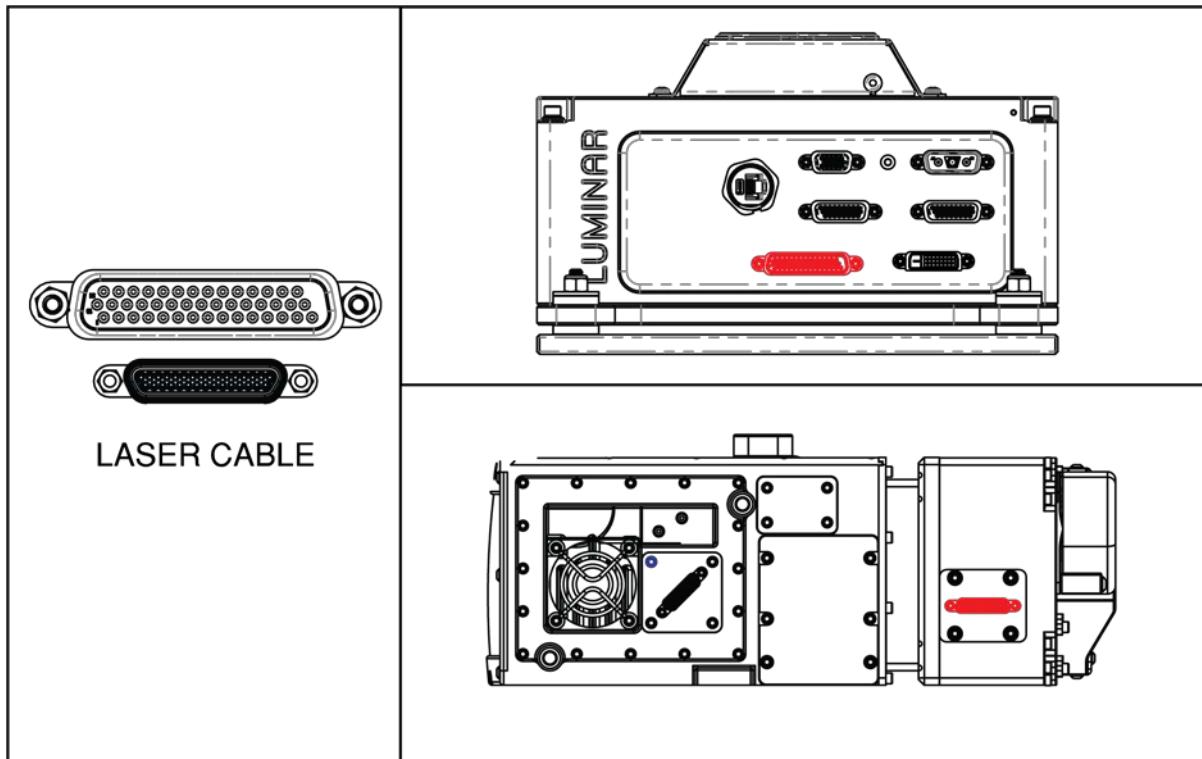


**⚠ Warning:** When attaching all connectors, make sure to fasten the connector attachment screws to the device using two-turn increments, alternating between the two screws. Failure to do so could result in improper seating of the connector, thus resulting in the malfunction of the system or loss of data connectivity.

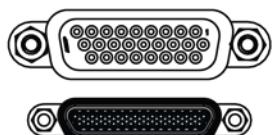
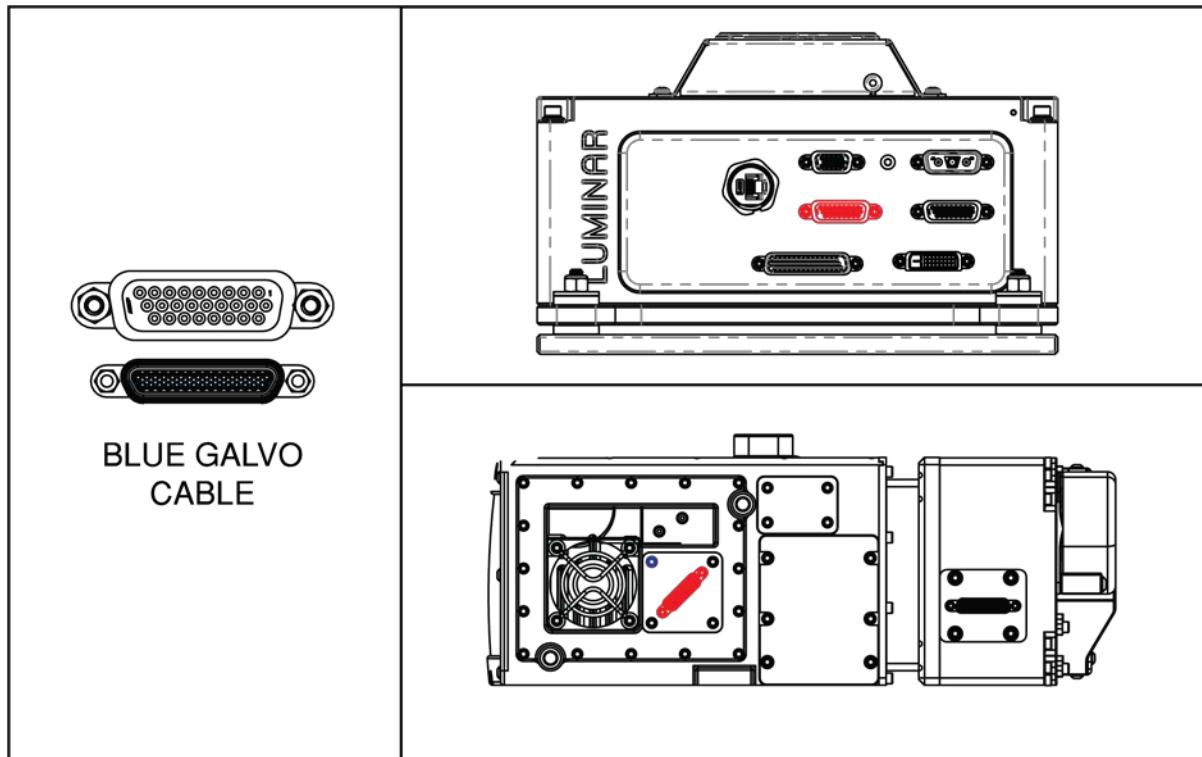


GREEN GALVO  
CABLE

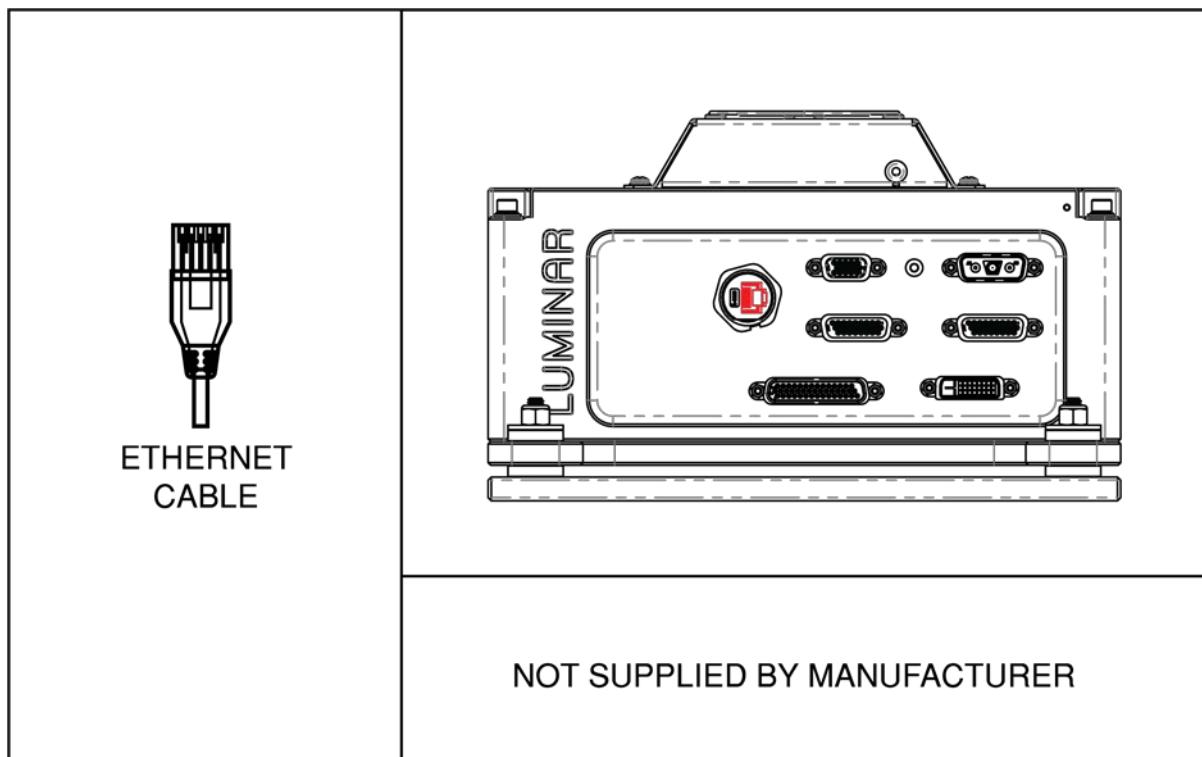




Assembly

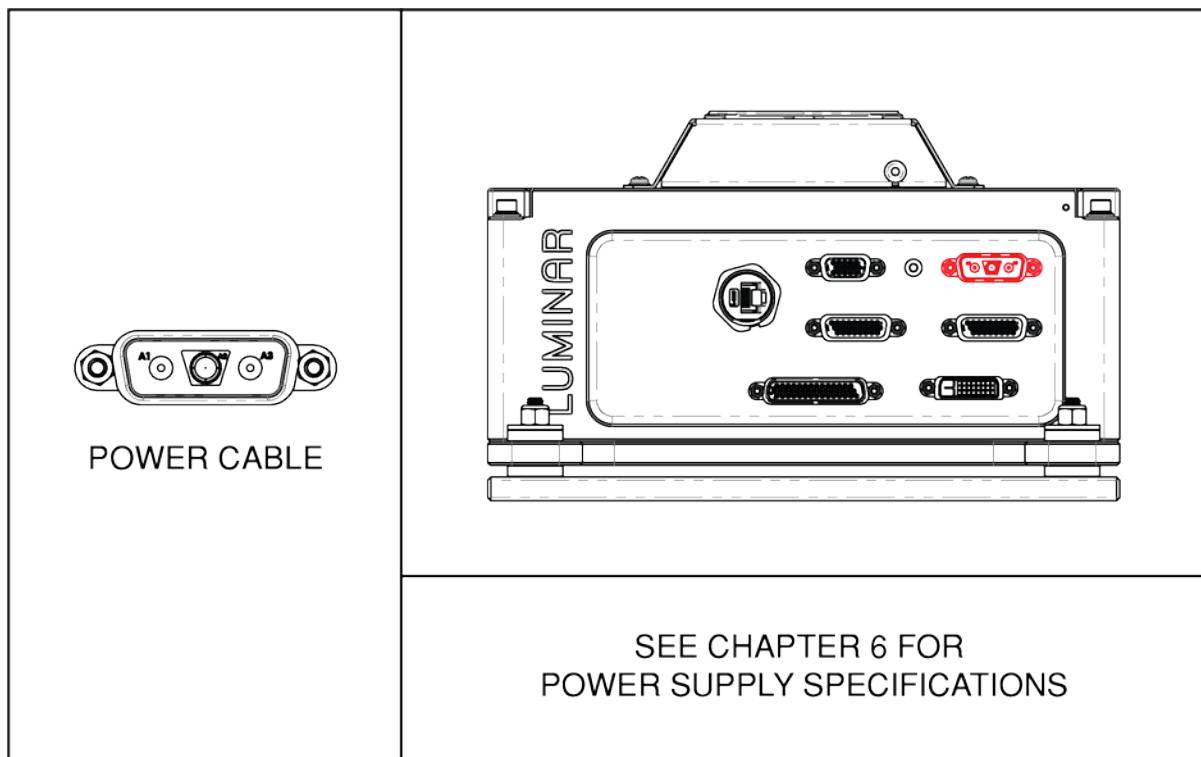
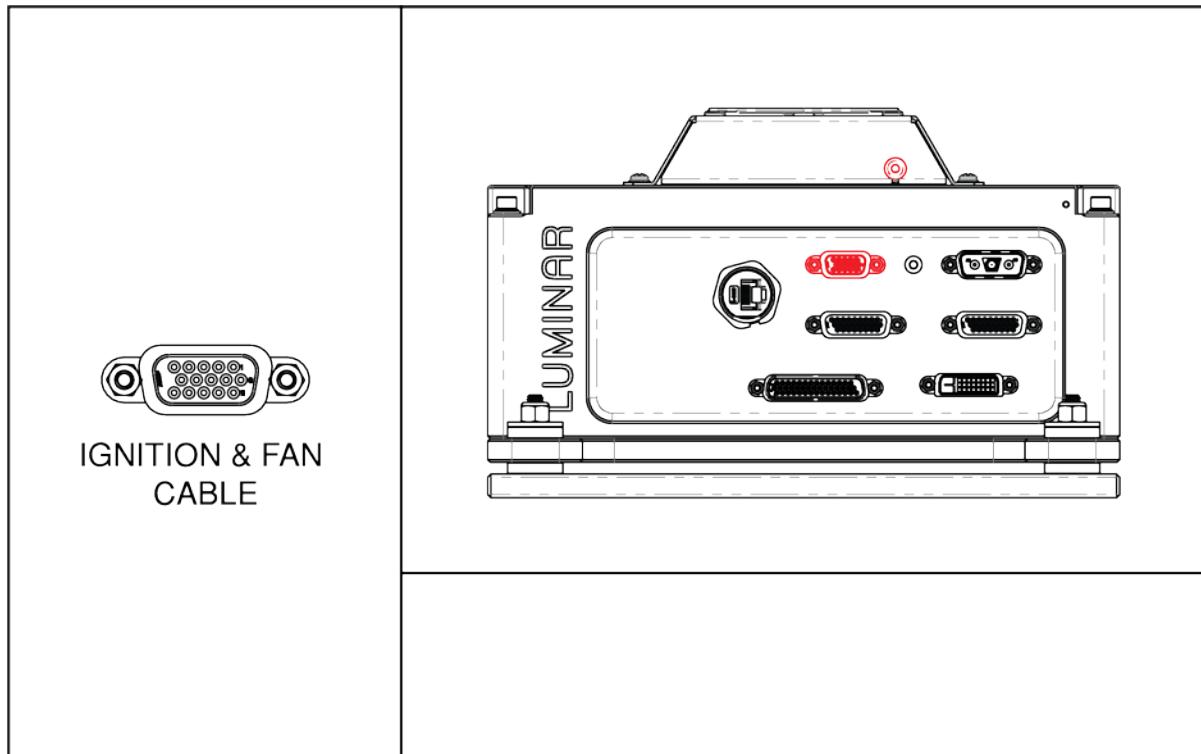


BLUE GALVO  
CABLE



ETHERNET  
CABLE

NOT SUPPLIED BY MANUFACTURER





# Chapter 4

# Installation &

# Operation

## 4.1 Installation

Mounting and positioning of the Model G2 Sensor and Control Box may be performed by the user. This section will provide the details necessary to perform the appropriate mounting and positioning of the Sensor and Control Box.

**i Note:** To avoid damage to the unit, use care when installing, handling and operating the Model G2 LiDAR System:

- During handling and installation, avoid getting fingerprints or other contaminates on the front window of the Sensor.
- Power to the Control Box should be clean, steady and continuous.
- Air flow for both the Control Box vent and the Sensor rear heat sink should not be encumbered at install and operation to ensure stable thermal operation. For optimal performance, the gap between the intake and nearby obstructions should be at least equal or greater to the fans' diameter.

### 4.1.1 Placement of the Sensor

The Sensor must be installed in an area with sufficient room for the Sensor and electrical cable assemblies. An exact model of the Sensor shell has been provided to the client, its dimensions may be seen in Chapter 5. There are three mounting points on the bottom surface of the Sensor. Please refer to the Sensor shell model in Chapter 5 for exact placement.

The electrical cable lengths will limit the physical separation and relative orientations of the Sensor and Control Box. Consideration should also be given to ensure that sufficient access is available to secure the electrical cables, as the electrical cables require sufficient torque and grip to secure to the Sensor Head.

### 4.1.2 Placement of the Control Box

The Control Box should be given the same consideration and care as a desktop computer. Allow two (2) inches of room on each side of the box for air flow and do not obstruct the blower fan on the top of the Control Box. Do not expose the Control Box to excess vibration or extreme temperatures. The Control Box must be connected to the Sensor Head using the provided electrical cable assemblies.

A 12V DC Power Source that can supply up 25A is recommended to use to operate the system. Connect the positive terminal of the Control Box power to the positive terminal of the DC Power Source and the negative terminal of the Control Box to the negative terminal of the DC Power Source. Note that the DC Power Source needs to be used when deciding on where to connect the control box.

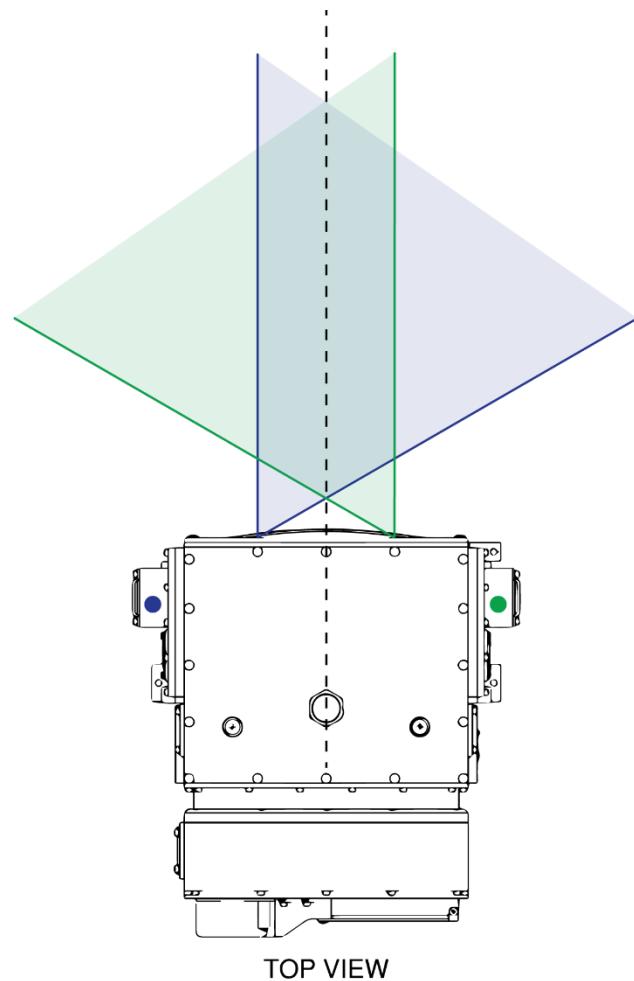
The G2 System can interface with any computer that can run the LumSDK by connecting the Control Box to the computer via a Cat 5e Ethernet cable.

## 4.2 Operation

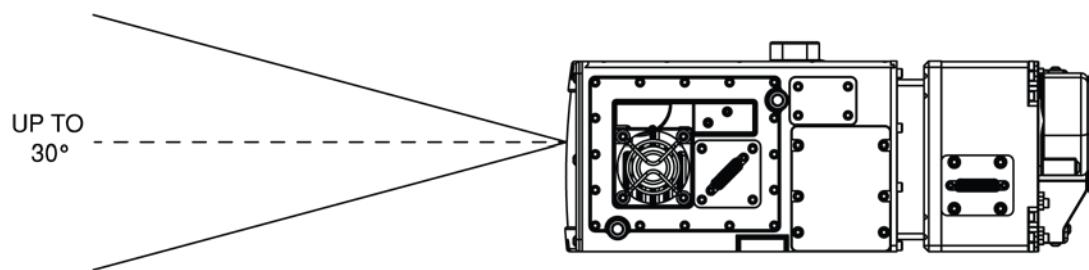
To turn on the system connect the ignition wire to a power supply. After turning the unit on, the Luminar sensor data is available directly on the ethernet interface. LumSDK can be used to interface with the device but is not required. We provide documentation for the Ethernet-based interface in the next chapter. In addition, a sample viewer application is available upon request.

### 4.2.1 Optical Overview

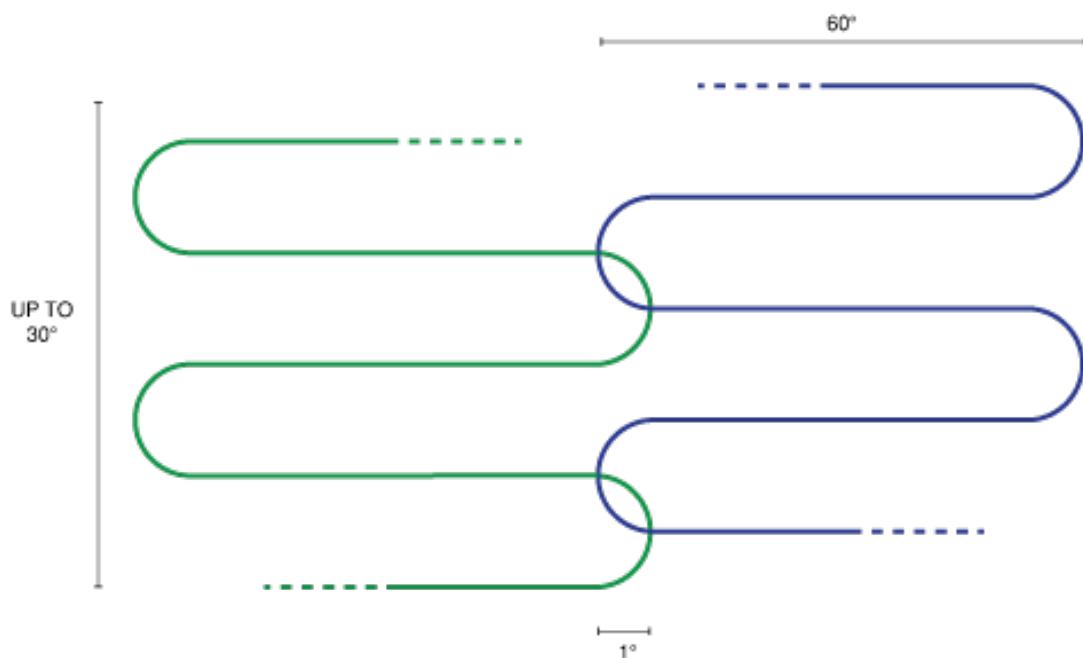
The G2 Sensor is a dual-scanning optical system with a resolution of 2000 x 64 pixels sampling at 10Hz. The two independent scanning mechanisms work together to achieve a Horizontal Field of View (HFOV) of one hundred and twenty degrees (120°), sixty degrees (60°) each. The HFOV achieved is described in the figure below:

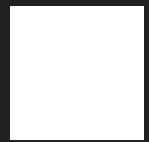


Each individual scanning system can achieve up to thirty degrees ( $30^\circ$ ) vertical field of view (VFOV). The system allows the user to modify the VFOV, from the maximum of  $30^\circ$  down to a minimum of around  $11^\circ$ . A graphical description can be seen below:



The resulting scan pattern that is achieved by the convolution of both scan patterns can be observed in the figure below





# Chapter 5

# Luminar SDK

The Luminar SDK is sample code demonstrating how to communicate with the Luminar Model G-series firmware. This chapter provides introductory documentation, but further documentation is available in Doxygen HTML format. The main HTML file generated by Doxygen is docs/html/index.html in the Luminar SDK.

## 5.1 Default Settings

The sensor by default has the following IP address (but is configurable by sending a "Set IP Address" packet): **10.42.0.37**

The sensor has the following UDP port, which is unchangeable: **5117**

Multicast is not supported at this time.

## 5.2 Basic Packet Structure

The communication between the Luminar G2 system and client machine occurs over UDP.

UDP datagrams contain a common, 12-byte header before the payload:

Byte	1	2	3	4	5	6	7	8	9	10
	ed	fe	f3	a1	ef	be	34	12	Type Low	Type Hi (0)

```
#define LUM_MAGIC_NUMBER \
    (0x1234L << 48 | 0xbeefL << 32 | 0xa1f3L << 16 | \
    0xfeedL)
struct lum_packet_header {
    uint64_t magic_number_long; // must equal
    LUM_MAGIC_NUMBER uint32_t packet_type;
};
```

The first 8 bytes of the datagram are a unique identifier to signify that this is a Luminar packet. This is a check to minimize the chances of another packet being misinterpreted, given the connectionless nature of UDP. Any packet whose first 8 bytes are not equal to LUM\_MAGIC\_NUMBER are ignored.

The next 4 bytes are for the packet type. The packet type indicates how to interpret the remaining bytes of the payload. See the table header Packet Types to see the appropriate values for various packet types.

## 5.3 Packet Types

There are several UDP packet types in the current version of the Luminar interface. Each has a defined interaction mode; importantly, they do not all receive an acknowledgment packet.

**① Note:** Lidar Sensor and server are used interchangeably in this document. The document uses C structs to document the packet formats. Some structs end in a char array member of size 1 (e.g., “char payload[1]”). This denotes a flexible array, since the payload of the packet past that point is not a fixed size. We use a 1-sized array rather than the more conventional 0-sized array because the latter is not C++-compliant.

In addition to this document, sample source code is provided demonstrating usage of these packets in simple C and C++ programs, including a visualizer using Robot Operating System’s rviz application. The following table documents the appropriate values for the packet\_type field. Each type of packet is described in the following section:

Packet Type	Value in packet_type field of header
Set IP Address Packet	5
Timestamp Packet	6
TLV Packet	7
Heartbeat Packet	8

### 5.3.1 IP Address Packet

The Set IP Address Packet is sent by the client to the server only.

- The IP Address Packet is a non-responsive packet type.
- The Sensor will immediately try to change IP address if the packet is valid.
- No acknowledgement packet is sent, since receiving packets from the new address should provide acknowledgement.
- The client should then communicate with the new IP address to verify the IP address was changed.
- The client must know the server’s initial IP address in order to set its IP address.
- Because the sensor always boots up with 10.42.0.37 as its default IP address, packets can be directly sent to the default IP address.
- Setting the IP address via UDP broadcast packets is not supported at this time.

- This can be maneuvered around via Linux's virtual network interfaces, in case your network is not a 10.x.x.x subnet.

```
struct address_packet_struct
{
    char      packetType;
    char      reserved[3];
    uint32_t newIPAddress;
};
```

### 5.3.2 Timestamp Packet

The Timestamp Packets are sent by both the client and the LIDAR.

- The timestamp packet is used to inform the client the difference between the sensor's clock and the client's clock.
- When a client sends a Timestamp Pack packet to the LIDAR, the value of the sent timestamp field is ignored.
- The response packet has the same sequence number as the request packet, but with the timestamp field set to a 32-bit timestamp since bootup when the packet entered the server's receive queue.
- Note that since this value is a 32 bit unsigned integer, it will reset to zero about every 71 minutes.
- The purpose of the sequence number is to account for possible reordering of UDP packets.

```
struct timestamp_packet_struct
{
    char      packetType;      char
reserved1[3];          uint32_t sequenceNum;
    uint32_t timeStamp; // In microseconds
};
```

### 5.3.3 TLV Packets

TLV's are the primary method for status and command communication with the G2 System. The client uses the TLV to send command packets to the G2 Control Box via the flexible array payload field, while the G2 Control Box uses it to communicate debug output.

The payload of a UDP packet can contain one or more TLV commands. TLV stands for Type-Length-Vector, a general format where Vector is the payload, Type is an identifier indicating how to interpret the payload, and length is how large the payload is.

LUM\_TLV\_PACKET::tlvs contains an array of LUM\_TLV objects, each of which represents one TLV command. The reason that it is not typed as a LUM\_TLV array is because LUM\_TLV is a flexible struct (it doesn't have a fixed size).

Every LUM\_TLV\_PACKET received by the lidar will cause another LUM\_TLV\_PACKET to be returned back to the sender, containing the same LUM\_TLV\_PACKET::sequence number, for bookkeeping purposes. Documentation of possible TLV's is contained in

```
include/fpga firmware/sw/lum_tlv_eth_protocol.h.
```

### 5.3.4 Heartbeat Packet

The heartbeat packet serves two primary purposes:

- The first is to set the destination IP address and UDP port where the sensor will send LIDAR data packets.
- The second is for safety - if a heartbeat packet is not received for a period of 3 seconds, the Luminar LIDAR will shut off the laser. This is primarily to provide a safe shutdown in the event of malfunction.

It is a good idea to send a heartbeat packet several times a second to ensure the timer is not tripped. This packet does not get an acknowledgement packet, but will result in LIDAR data packets being sent to the sender of the packet if successfully received.

```
struct packet_acquire_enable_struct
{
    char    packet_type; // LUM_MULTI_DISTANCE_PACKET_TYPE
    char    reserved[3];
};
```

### 5.3.5 Multi-Return Packet

LIDAR data is sent to the client in groups of points; there are 1000 points in a line per Eye. Each line is transmitted as a group of UDP packets, the lum\_group\_header contains the information necessary to identify a line. The lum\_group\_packet contains a header and a payload, either angle or range data.

Angle payloads are transmitted in groups of (334, 334, 332) samples for the rising edges of the blue and green eyes.

Angle are transmitted 16 bit signed fixed-point values which must be converted to degrees or radians. Within the angle packet header, the values of line, num\_samples, and first\_sample\_index allow you to index an angle value within a frame.

Ranges are transmitted as 32 bit signed integers. Along with the line and num\_samples values from the header, some bits of the 32 allow you to index the range data within a frame. The multi-return packet format is documented below. Note: the return index is not given, to determine the index of a return within the total number of requested returns, you must count up from 0th return, 1st, ...

Data values for multi-return data are formatted as follows:

- b31-12 == Range time value
- b11 == 0
- b10 == Rising flag
- B9-0 == X position

Data values immediately follow the header (lum\_group\_header). There may be multiple returns for one pixel. Multiple X return pixels will never cross a packet boundary. All samples in a packet are contained on a single line.

```
typedef struct
{
    uint8_t tag; // 2=angle data, 3=range distance data
    uint8_t eye; // 0 for green rise, 1 for blue rise, 2 for
                 green drop, 3 for blue drop
    uint16_t line;// horizontal scan line # for first sample
    uint16_t num_samples;// number of samples      uint16_t
    first_sample_index;// index of first sample (angle data only)
    uint32_t first_timestamp_us;// Timestamp of first angle sample
                                in microseconds since bootup (not for range data)
}
lum_group_header;
```

## 5.4 Calibration Methods

This section outlines the basic calibration values needed for each G2 sensor. The G2 Sensor consists of 3 main components: a laser timing system, an azimuth angle galvanometer, and an elevation angle galvanometer. Each of these has calibration values that need to be set to produce correct 3D points.

The laser timing system gives Time-Of-Flight (TOF) measurements. An offset value is automatically added to the time measurement values to compensate for optical and electrical path delays. An additional constant may be added to the TOF value to further compensate for system to system variations.

The azimuth and elevation systems both have true zero positions, and angle widths. For elevation, this is parameterized in terms of a minimum and maximum angle. These need to be calibrated for each eye. Typical values are as follows:

- Highest elevation angle: 3 degrees
- Lowest elevation angle: -17 degrees
- Azimuth angle width: 60 degrees
- Azimuth angle center: 0 degrees

Along with the sample code, a sample calibration file is provided in a yaml format. These are loaded into a parameter server on software startup. `lumsdk\_node.cpp` demonstrates how to use the calibration parameters to undiscretize and correct the raw data, in the process of transforming raw data into point clouds. Calibration is currently implemented as post-processing in software; it therefore does not affect raw data coming from the FPGA. Users are therefore not bound to implement our set of calibration parameters, and can choose a separate set to better fit their needs.

## 5.5 Key Files

- Documentation of packet format for raw data, addresses, timestamps:  
`include/fpga-firmware/sw/lum\_eth\_protocol.h`:
- Documentation of packet format for TLV's:  
`include/fpgafirmware/sw/lum\_tlv\_eth\_protocol.h`
- Demonstrates how to undiscretize the raw data: `include/conversions.hpp` and `src/conversions.cpp`
- Demonstrates how to send heartbeat packets, and parse raw data packets:  
`include/fpga\_client3.hpp` and `src/fpga\_client3.cpp`

- Demonstrates how to send/receive TLV packets. Sample functions for generating yscan distributions:
- `include/tlv/\*` and `src/tlv\*`
- Sample ROS Node that produces point clouds from the raw data and sends TLV's for sample commands:  
`lumsdk\_node.cpp`

The lumsdk\_node provides a sample terminal for commanding the sensor.

## 5.6 Command Type Example Payload

Sensor Characteristic	Value	Command
Laser State	On	u
	Off	d
Laser Power	0 to 100	"value"p
Threshold Value Green	0 to 100	"value"g
Threshold Value Blue	0 to 100	"value"b
Change Line Mode	640 lines	0f
	64 lines	1f
Uniform Y Scan	<fov> centered on horizon	15y
FPGA Holdoff Delay	150 to 250; intervals of 10	"value"h
Galvo/ADC Offset Value Green	0 to 30	"value"G
Galvo/ADC Offset Value Blue	0 to 30	"value"B

**i Note:** It can often take several seconds for the laser to come fully up.

### Prerequisites

- Robot Operating System (for visualization)
- A network interface on a subnet containing IPv4 address 10.42.0.37
- Curl to download sensor firmware

## 5.7 Initial Setup

**i Note:** This is already done for you on delivery of a visualization computer.

**ⓘ Note:** If running on a system not provided by Luminar, you may need to replace enp0s31f6 in install\_deps.sh with the name of your Ethernet network interface. This can be found by running ifconfig. This script installs prerequisites and sets up the network interface.

```
1 cd <path-to-lumsdk-dir>
2 ./install_deps.sh
```

### 5.7.1 Build SDK

**ⓘ Note:** this is already done for you on delivery of a visualization computer.

```
1 cd <path-to-lumsdk-dir>
2 catkin_make
```

### 5.7.2 Documentation

Open docs/html/index.html to view documentation.

## 5.8 LuminView

- LuminView is a custom point cloud visualization tool which provides improved image quality over other tools such as rviz. It also features angle smoothing which reduces noise in the point cloud.
- LuminView provides a return index selector and rising/falling edge toggle button, which allows for quick navigation between viewing different sets of returns.
- In LuminView, rotating the camera is done by left clicking and dragging in the direction of desired rotation. The arrow keys are used to zoom (no modifier key), pan (shift pressed down), or orbit the camera (ctrl pressed down) in a particular direction.

```
1 cd <path-to-lumsdk-dir>
2 source devel/setup.bash
3 roslaunch luminar_point_cloud luminview.launch
```

## 5.9 Standard Visualizer (rviz)

```
1 cd <path-to-lumsdk-dir>
2 source devel/setup.bash
3 roslaunch luminar_point_cloud release.launch
```

## 5.10 Update Sensor Firmware

When updates to sensor firmware become available, we are distributing an executable to flash new firmware onto your device. Our flashing script will download the latest firmware from our firmware server, and program your device over Ethernet.

- This tool, named 'lumsdk\_flash', can be used to upload new firmware onto the Luminar Model G.
- The tool is found in the tools directory inside of the lumsdk directory.
- New firmware can be downloaded via the Luminar web server.
- To run newly flashed firmware on the FPGA, power cycle the system.

```
1 #First, make sure communication is established with  
the sensor.  
2 ping 10.42.0.37  
3  
4 cd <path-to-lumsdk-dir>/tools  
5 ./fla  
sh
```

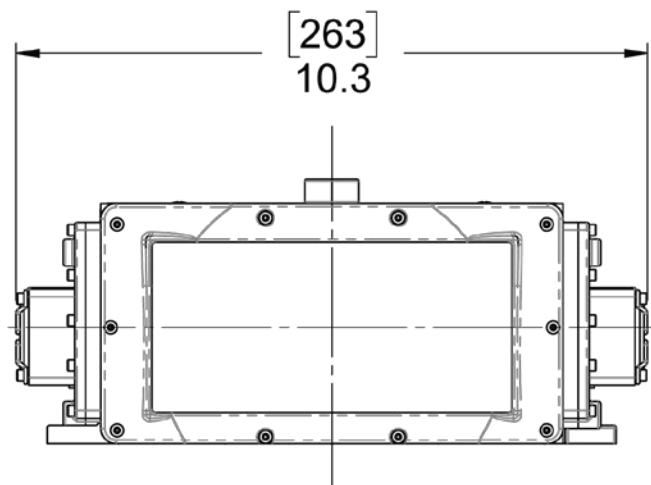


# Chapter 6

# Specifications

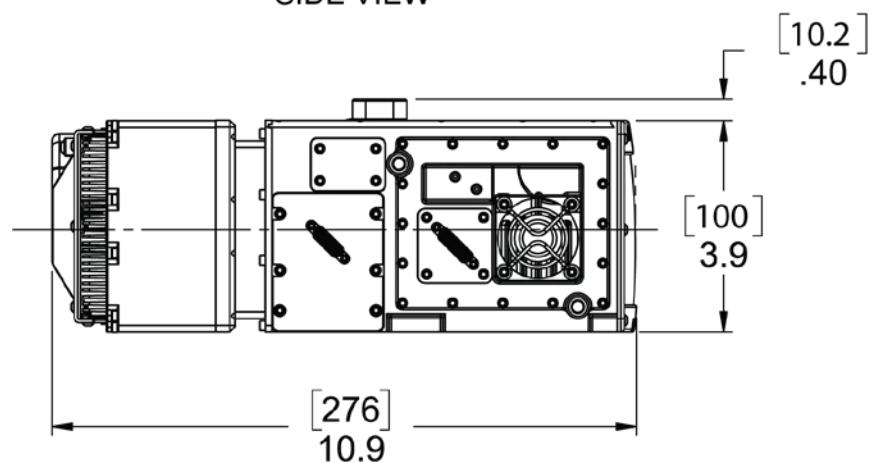
# & Dimensions

FRONT VIEW



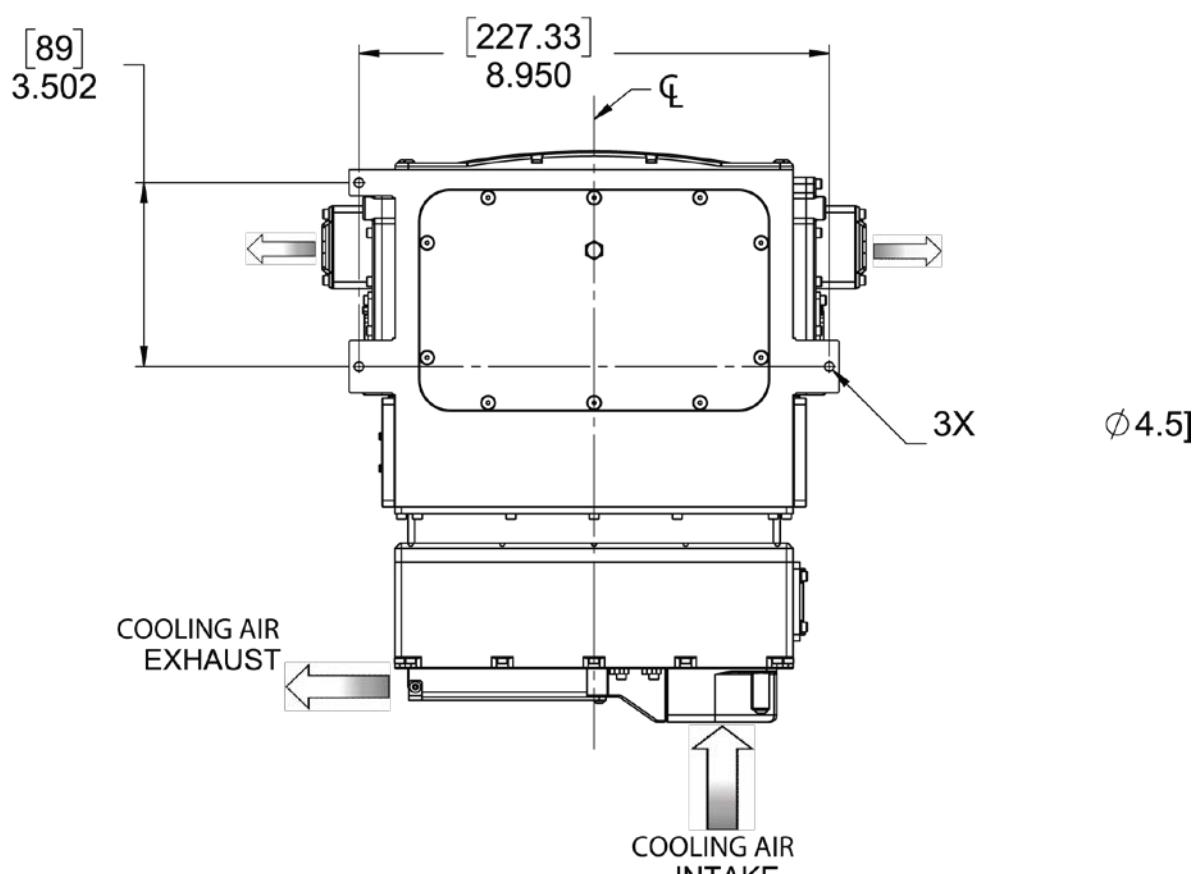
UNITS: INCHES [mm]

SIDE VIEW



UNITS: INCHES [mm]

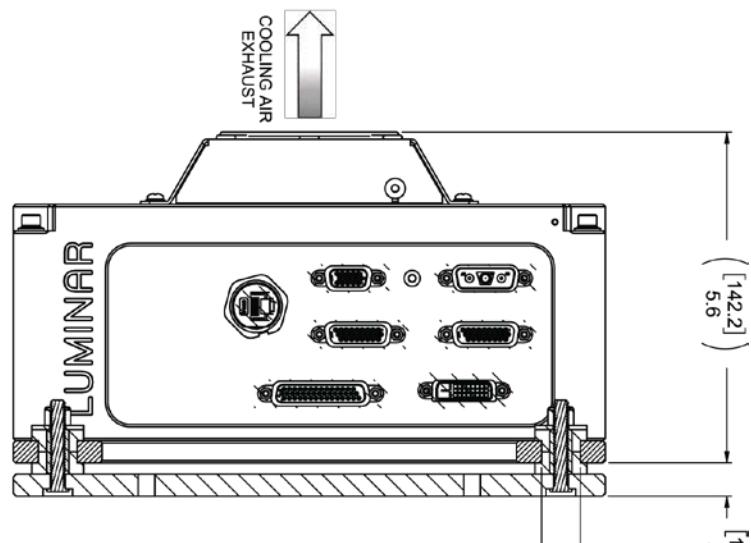
BOTTOM VIEW



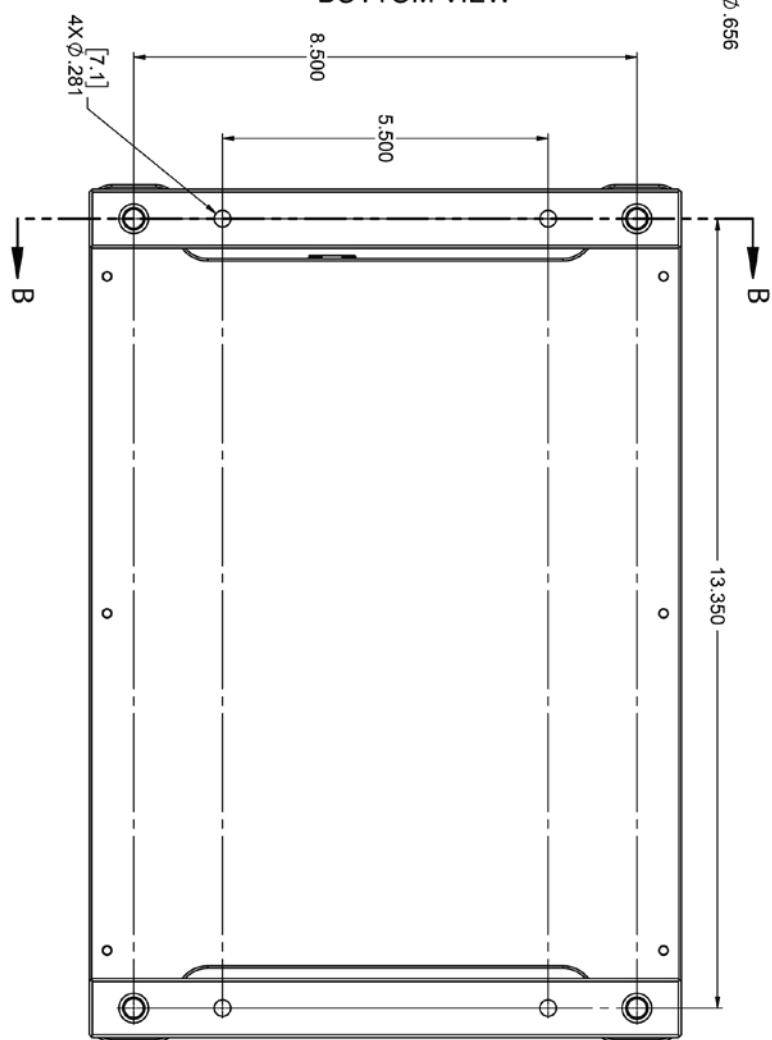
UNITS: INCHES [mm]

## LUMINAR CONFIDENTIAL

## FRONT VIEW



## BOTTOM VIEW



UNITS: INCHES [mm]

## Specifications &amp; Dimensions

## 6.1 System Specifications

Specification	Value	Notes
Horizontal Points	2000	
Vertical Points	64	
Frame Rate (Hz)	10	
Range returns per pixel	Up to 7	Rising and falling edge
Horizontal Field of View	120°	
Vertical Field of View	30°	Configurable (11°–30°)
Maximum Range (m)	>200	
Minimum Range (m)	4m	
Range Resolution (mm)	± ~1	
Range Precision (cm)	± ~1.25	(25m, 10%) Precision dependent on proximity/reflectivity

## 6.2 Laser Parameters

Pulse or CW	High frequency repetition pulse
Center Wavelength (nm)	1550
Pulse Width (ns)	1 - 10
Maximum Pulse Energy per Output (μJ)	≤1.25

## 6.3 Power & Operating Conditions

Specification	Min	Typ	Max
Input Voltage (V)	9.6	12	30
RMS Current (A)	-	20.2	30
Pk-Pk Current (A)	-	57	60
Average Input Power (W)	-	242.4	290
Operating Temperature (°C)	0	25	40

LUMINAR

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