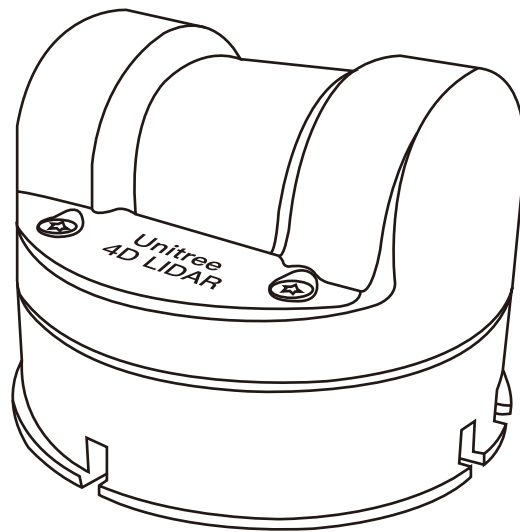# Unitree 4D LiDAR-L1

Quick Start Guide $\boxed{\text{v 1.0}}$

2023.04

Disclaimer

This product is not suitable for individuals under 16 years old. Please do not let children come into contact with this product, and be extra careful when operating in scenarios where children are present.

You should read the entire user manual and become familiar with the product's functions before operating it, while also following any relevant national and international safety regulations. This product is a laser radar ranging instrument that provides 3D laser scanning functionality when the power is working properly and all components are undamaged. This statement has an important impact on the safe use of this product and your legal rights and interests. Please read it carefully to understand your legal rights, responsibilities, and safety instructions. Failure to do so may result in property damage, safety accidents, and personal safety hazards.

The final interpretation of this document and all related documents of Unitree 4D LiDAR-L1 belongs to Unitree Technology. If there are updates, they will not be notified separately. Please visit the official website https://www.unitree.com to obtain the complete "Unitree 4D LiDAR-L1 User Manual", the latest instructions, and warnings. Hangzhou Unitree Technology Co., Ltd. (hereinafter referred to as "Unitree Technology") reserves the right to update all documents.

Once you use this product, it is deemed that you have understood, recognized, and accepted all the terms and contents of this statement. You promise to take full responsibility for using this product and any possible consequences that may arise. You promise to use this product for legitimate purposes only and agree to this clause and any relevant policies or guidelines that Unitree Technology may develop.

Unitree Technology assumes no responsibility for any losses caused by users not using the product according to this document. Users should follow all safety guidelines mentioned in this document, including but not limited to them.

Warning

1. In the case of poor air visibility (such as haze, heavy rain weather), the effective detection range of L1 will be reduced. Please be extra careful when using it. In good air visibility conditions, please refer to the parameter list for the effective detection range of L1.

2. Please make sure to install L1 on a thermally conductive metal plate such as aluminum alloy, and reserve a space of no less than 10mm around it to prevent poor air flow and affect heat dissipation.

3. Do not touch the optical window of L1 with your hands. If there are stains or dust on the L1 window, please use a lens cleaning cloth to clean it (please refer to the "Unitree 4D LiDAR-L1 User Manual" for specific cleaning methods) to avoid affecting the performance of the product.

4. To reduce the risk of electric shock and possible radiation hazards, do not disassemble or modify this product without authorization. This product does not include user-repairable parts. If after-sales service is needed, please contact Unitree Technology.

5. L1 meets the safety requirements of Class 1 laser products (IEC/EN 60825-1:2014) and can be safely used under normal conditions.

6. Damage caused by liquids is not covered by the warranty. When the usage scenario requires waterproofing, please use a waterproof protective bracket to prevent damage to L1 (please refer to the "Unitree 4D LiDAR-L1 User Manual" for examples of using waterproof protective brackets).

7. When debugging L1, please be sure to place the L1 radar on the included rubber pad and place the rubber pad on a level table to ensure stable operation of the radar.
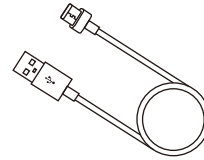
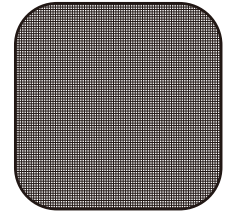8. Do not drop L1 to avoid unnecessary damage.
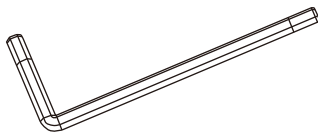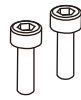
Inventory
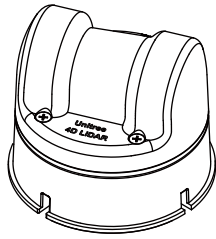
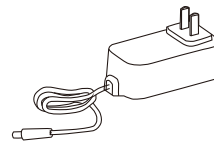Unitree 4D LiDAR-L1 x 1

Adapter Module x 1

Adapter module x 1

Rubber pad x 1

Hexagonal L-shaped wrench x 1

Screw package (M3) x 1

Data cable x 1

Introduction

Unitree 4D LiDAR-L1 is a high-performance, cost-effective, and safe 4D laser radar (3D position + 1D grayscale). It has the ability to achieve high-speed laser ranging sampling at a rate of 21,600 times per second and can be widely used in robotics, smart cities, intelligent toys, logistics and other fields. It supports functions such as mapping, positioning, recognition, obstacle avoidance, environment scanning, and 3D reconstruction. The L1 radar can detect objects as close as 0.05 meters and up to a maximum distance of 30 meters (with 90% reflectivity). The L1 radar has a 360*90 ° hemispherical ultra-wide-angle scanning capability, providing a higher point cloud coverage rate and stronger adaptability. Users can obtain real-time 3D point cloud images through the Unilidar software and develop based on the SDK to easily obtain 3D point cloud data to meet personalized application needs.
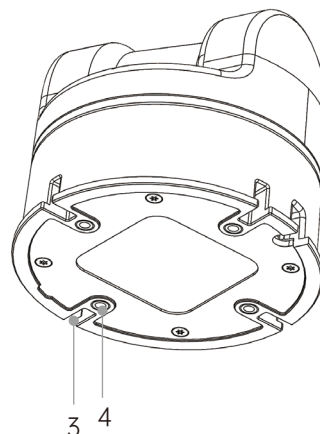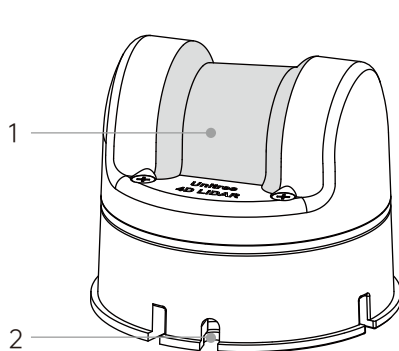
1. Optical window

2. Exit port

3. Locator slot

4. M3 mounting hole

Installation and Wiring

Effective Field of View (FOV) Range

The FOV of the Unitree 4D LiDAR-L1 is 360° horizontally and 90°[1] vertically, allowing for detection in a 360 ° three-dimensional space above the radar, as shown in the figure below. When installing the device, please be aware of the effective range of the FOV to avoid obstructing the FOV area.
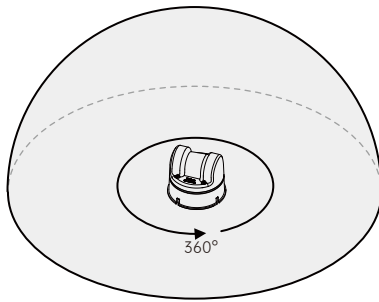
Horizontal Direction
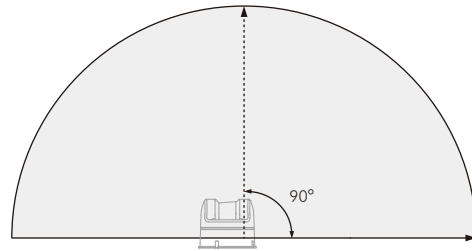
Vertical Direction

Effective FOV Range of L1

Please note that the point cloud density of the L1 varies in different FOV areas, with higher point cloud density closer to the center. Please refer to the figure below for reference.

Point Cloud Density in Different FOV Areas of L1

[1]For more detailed information, please refer to the "Unitree 4D LiDAR-L1 User Manual".

Installing L1

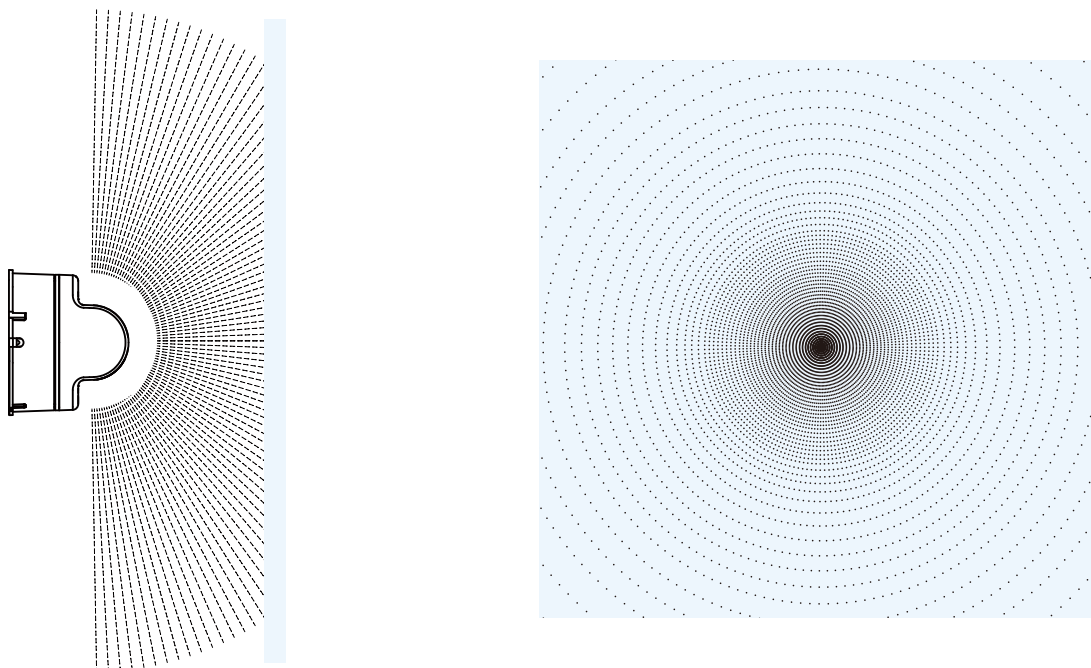Please install L1 in the appropriate position according to the size of L1 and the dimensions of the mounting holes as shown in the diagram below. The Cartesian coordinate system of L1, denoted as 0–XYZ, is defined as shown in the diagram below. O is the origin of the point cloud coordinate system, located at the bottom center position, with the +X axis pointing in the opposite direction of the outlet, and the +Y axis pointing counterclockwise 90 ° from the +X axis. O–XYZ is the point cloud coordinate system of L1(The origin and XYZ coordinate system of the IMU can be found in the L1 3D model, and its XYZ axes are parallel to the point cloud coordinate system.)

Unit: mm
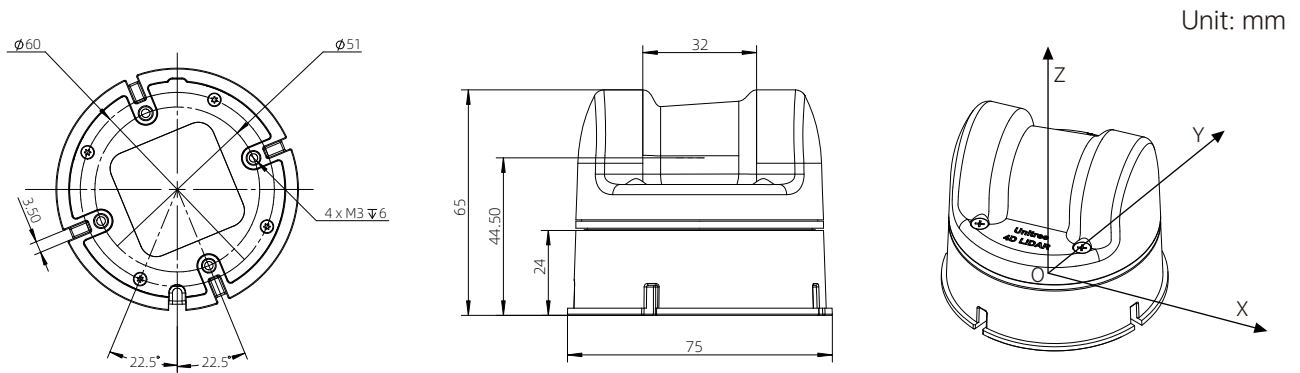
Interface Definition

The output line of the L1 is a 4-pin serial port, which can be independently developed based on the wire sequence, or can be debugged using the included adapter module, power adapter, and data cable.The specification of the serial port socket is GH1.25mm 4PIN.
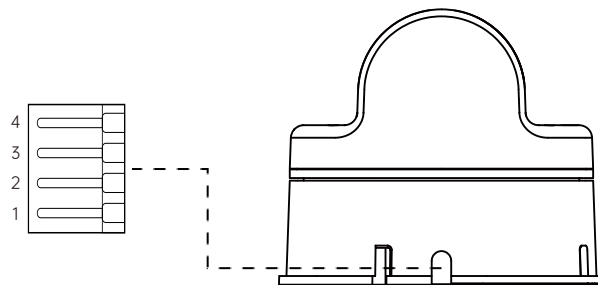
4-Pin Serial Port Diagram and Pin Numbering Diagram

The pin sequence definition of the L1's 4-pin serial port is as follows:

PIN NO.	Signal	Attribute	Description	Cable Color	Function
1	VCC	Power Supply	DC 12V power supply	Red	Power cable
2	GND	Ground	Ground	White	Power cable
3	RX	Input 3.3V	Ranging core serial port input	Green	Functional cable
4	TX	Output 3.3V	Ranging core serial port output	Black	Functional cable

Connection

It is recommended to use the included adapter module, power adapter, and data cable for temporary testing or use. The specific connection method is as follows:

a. Insert the 4-pin serial port of the L1 into the adapter module.

b. Insert the power adapter into the power port of the adapter module for power supply.

c. Insert the Type-C interface of the data cable into the data communication port of the adapter module and connect the other end to a personal computer.

Unitree4D LiDAR-L1   Adapter Module   USB to Type-C Cable   Connecting to an External Power Source
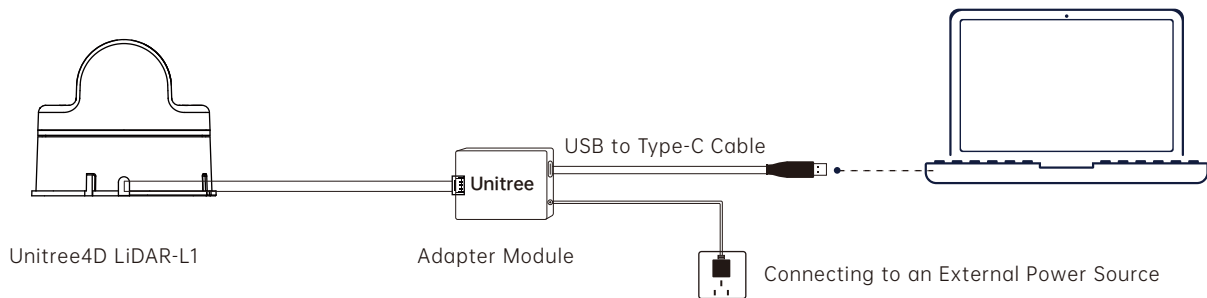
- The adapter module, power adapter, and data cable are included in the package and can be used for power supply, control signal transmission, and data transmission. Alternatively, you can use other cables according to your needs to improve usability and system protection (such as dust and waterproofing).
- When debugging, be sure to place the L1 radar on the included rubber pad and place the rubber pad on a flat surface to ensure stable operation and prevent collisions and falls.

Downloading and Installing Unilidar Software

Users can download the latest Unilidar software from the Unitree website at www.unitree.com to view the point cloud image.

Unilidar currently supports Window® (64-bit).

a. Download the Unilidar file.

b. Unzip the file and open the CP210xVCPInstaller_x64 program to install the driver in the extracted file, and run the Unilidar.exe program as an administrator.

c. The point cloud display window is on the right side, and the device management window is on the left side.

d. Click the expand serial port list on the left side of the serial port number, select the Com port with the Silicon prefix, and then click the Open Serial Port button below to connect to the device and obtain point cloud data.

e. After the connection is completed, you can view the point cloud image in the right point cloud display window.

f. The device's status information and parameter settings can be viewed and set in the device management window.

- For more detailed instructions on how to use Unilidar and a detailed explanation of each button, please refer to the "Unilidar User Manual".

Parameter Specifications

Unitree 4D LiDAR

Model	L1 PM（Precision Measurement） L1 RM（Remote Measurement）
Laser Wavelength	905nm
Eye Safety Rating [1]	Class 1(IEC60825-1:2014) Eye Safety
Max Range [2]	20M（L1 PM @90% reflectity），30M（L1 RM @90% reflectity） 10M（L1 PM @10% reflectity），15M（L1 RM @10% reflectity）
Near Blind Zone [3]	0.05m
FOV	360°* 90°
Sampling Frequency	43200 points/s
Effective Frequency	21600 points/s
Scanning Method	Contactless Brushless Mirror Scanning
4D Information	3D Position + 1D Grayscale
Horizontal Scanning Frequency	11Hz
Vertical Scanning Frequency	180Hz
Communication Interface	TTL UART
Communication Baud Rate	2000000 bps
Measurement Accuracy [4]	±2.0cm
Measurement Resolution	8 mm
IMU Sampling Rate	1kHz
IMU Reporting Frequency	250Hz
Attitude Perception Dimension	3-axis Accelerometer + 3-axis Gyroscope
LED Ring Resolution	1°
LED Ring Refresh Rate	11Hz
Anti-Strong Light Ability	100Klux
Operating Environment Temperature [5]	-10℃-60℃

Storage Environment Temperature	-20℃-60℃
Protection Level [6]	IP54
Power[7]	6W（Environment Temperature25℃）
Operating Voltage	12V DC
Size	75 (width) x 75 (depth) x 65 (height) mm
Weight	230g

[1] The instantaneous peak power of the laser is 25W, but the actual average power used will be much lower than this value, and it is driven by a pulsed method, which only emits for a very short time to ensure the safety of humans and pets and meet the Class I level laser safety standard.

[2] The typical value of reflectivity is shown here, and the actual value depends on environmental conditions and target object characteristics.

[3] The laser ranging instrument can detect and output point cloud data when the distance to the target object is 0.05m. However, due to the inability to guarantee detection accuracy, this data is for reference only.

[4] To ensure the effective detection of objects with different reflectivities within the range, there may be a slight decrease in point cloud accuracy at some locations. The test conditions are as follows: environment temperature of 25℃, target object reflectivity of 90%, and test distance of 15m.

[5] The performance of L1 will slightly decline in high and low temperature environments, strong vibration, foggy weather, etc. In addition, long-term high-temperature operation may affect product performance or even cause product damage. It is recommended to increase cooling measures to ensure that the housing temperature does not exceed 60℃. When the temperature is too high, the over-temperature protection mechanism will be triggered, and L1 will issue an over-temperature warning. When the over-temperature is severe, L1 will stop working.

[6] The protective effect of L1 varies greatly under different installation angles. Please increase external protection according to the actual installation angle. Damage caused by improper installation or external protection is not covered by the warranty.

[7] The stable power and peak power under different environments are different.

This manual will not be notified separately if updated.

You can check the latest version of the "User Manual" on the official website of Unitree.

https://www.unitree.com/en/download

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