Unitree 4D LiDAR-L2 From Robotics To Infrastructure User Manual

Unitree
4D LiDAR-L2
User Manual v 1.1
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Contents

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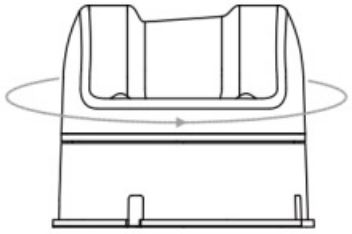
https://github.com/unitreerobotics/unilidar_sdk

Product Overview

Introduction
The Unitree 4D LiDAR – L2 is a cost – effective, safe and reliable 4D laser radar (3D position + 1D gray level), which has the ability to sample high – speed laser ranging 64000 times per second and can be widely used in robots, smart cities, intelligent toys, logistics and other fields, supporting the realization of functions such as mapping, positioning, recognition, obstacle avoidance, environmental scanning, 3D reconstruction, etc.
The L2 radar can detect objects with a minimum distance of 0.05 meters and a maximum distance of 30 meters (90% reflectivity).
The L2 whole machine is small and lightweight, weighing only 230 grams, suitable for general robot environmental scanning, positioning, mapping, navigation and obstacle avoidance.
The L2 has excellent ultra – wide – angle scanning capabilities, with the field of view (FOV) expanded to 360 ° horizontally and 90 ° vertically, enabling three – dimensional space detection with a hemispherical field of view, and the application range can be expanded to more commercial scenarios. In addition, the L2 also supports a negative angle mode, in which the field of view will be further expanded to 360 ° horizontally and 96 ° vertically, and the farthest measurement distance in the range corresponding to the expanded 6° field of view will be slightly closer.
The L2 has an IMU module with 3 – axis acceleration and 3 – axis gyroscope built – in, supporting a sampling frequency of 1 kHz and a reporting frequency of 500 Hz.
The L2 has a circumferential scanning frequency of 5.55 Hz, a vertical scanning frequency of 216 Hz, and an effective sampling frequency of 64000 points per second. The L2 not only has excellent performance but also high reliability, meeting the working environment temperature range of – 10° C to 50°C and the IEC – 60825 Class 1 eye safety level.
L2 supports controlling 3D Mode/2D Mode, Normal Mode/NEGA Mode, IMU Enable/IMU Disable, TTL UART output/ENET UDP output, Self Start/CMD Start, and Gray ON/Gray OFF. The factory default parameters are: 3D Mode, NEGA Mode, IMU Disable, ENET, SELF START, and GRAY ON.
Working Principle
The L2 radar mainly includes a laser emission and ranging core, a reflecting mirror, a high – speed rotating motor, and a low – speed rotating motor. In the working state, according to the illustrated perspective, the rotation directions of the high – speed rotating motor and the low – speed rotating motor are as follows.

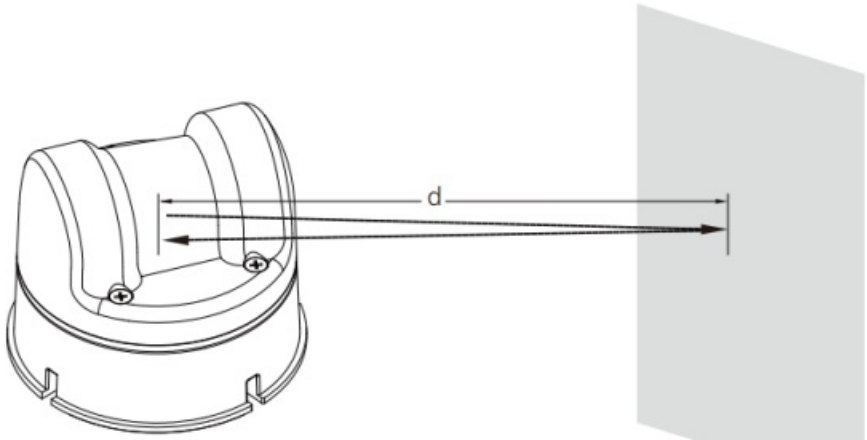
High-speed motor rotation direction



Low speed motor rotation direction

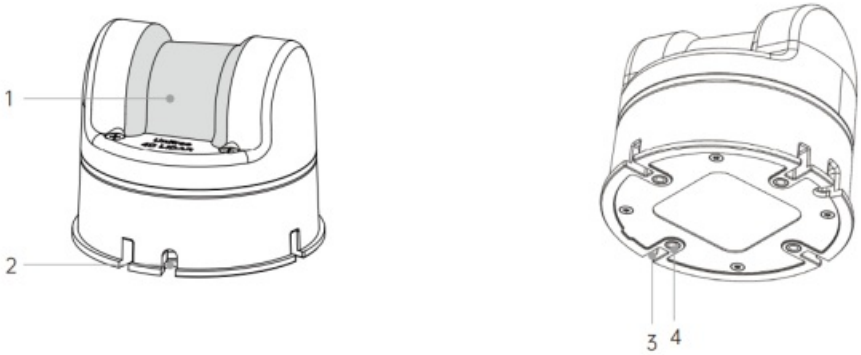
The L2 communication supports ENET UDP and TTL UART. When using ENET UDP communication, connect the L2 network port and power port. When using TTL UART, it can be connected through the provided adapter module, connect the Type – C port in the adapter module and the power port in the cable, or it can also directly connect to the TTL UART serial port socket according to the wire sequence in the “Interface Definition” to use. The L2 is equipped with an adapter module, a power adapter and a data cable for users, eliminating the need to provide a complex power supply system and debugging cables, reducing the use cost.

The L2 adopts the laser flight time ranging technique and, in cooperation with a high – speed laser acquisition and processing mechanism, can achieve 64,000 ranging actions per second. For each ranging action, the L2 emits an infrared laser signal in the form of a narrow pulse at the ns level. The light reflected after this laser signal irradiates the target object will be received by the laser acquisition system of the radar. After being analyzed and processed by the processor, the distance value between the target object irradiated and the L2 as well as the current included angle and other information will be output from the communication interface.



Working Principle Schematic Diagram

Component Description



1. Optical Window

   The laser beam emitted through the optical window can scan objects within the field of view (FOV).

2. Outlet

   The L2 has three terminals for its outlet, namely a DC3.5 – 1.35 power supply, an RJ45 receptacle (network port), and a GH1.25 – 4Y plug (serial port). For detailed wire sequences, please refer to the Interface Definition section.

3. Positioning Slots

   There are 4 positioning slots in total. When designing a fixed bracket, the positioning slots can be used to improve the positioning accuracy of the whole machine. For specific dimensions, please refer to the Installation Dimensions section.

4. M3 Installation Holes

   There are 4 installation holes in total. The L2 can be fixed in an appropriate position using M3 screws.

Interface Definition

One – out – Three Cable

The L2 has three terminals for its outlet, namely a DC3.5 – 1.35 power supply head (power port), an RJ45 receptacle (network port), and a GH1.25 – 4Y plug (serial port). Users can connect to the L2 through the provided power adapter, serial port adapter module, data cable or network cable to achieve power connection, control signal transmission and data transmission, etc., or they can also customize and use materials suitable for the scene requirements to replace the adapter module to improve the overall protection ability (such as dust and water resistance). The specification of the serial port seat is GH1.25mm 4PIN.

The wire sequence definition of the L2 cable is as follows:

Outlet Interface	Pin Number	Pin Number	1 Wire Color	Function
DC3 4-1.35 Power Supply	Positive	Power Positive	Red	Power Cable
	Negative	Power Negative	Black	Power Cable
RJ45 Receptacle	1	ETHTX+	White Orange	Data Cable
	2	ETHTX-	Orange	Data Cable
	3	ETHRX+	White Green	Data Cable
	6	ETHRX-	Green	Data Cable
GH1.25-4Y Plug	2	UART GND	Pink	Data Cable
	3	UART RX	White	Data Cable
	4	UART TX	Brown	Data Cable
	1	–	–	–

Installation

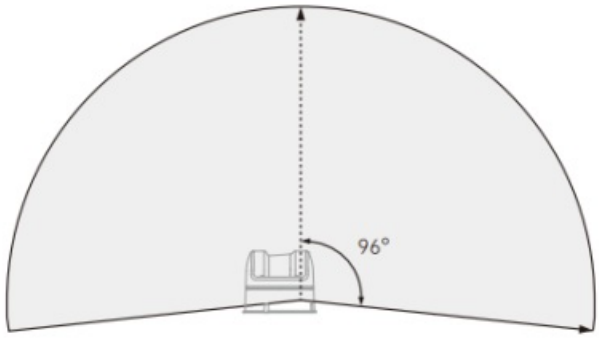
Effective Field of View (FOV) Range

The L2 contains a high – speed motor and a low – speed motor inside. The high – speed motor drives the reflecting mirror to rotate, achieving a measurement range of 180 ° in the vertical direction, and then the low – speed rotating motor drives the measurement core part to rotate 360 ° to achieve a 360 * 90 ° hemispherical ultra – wide – angle scan, which can measure the three – dimensional space above the radar, as shown in the following

figure. Please pay attention to the effective range of the FOV during installation to avoid blocking the FOV area.

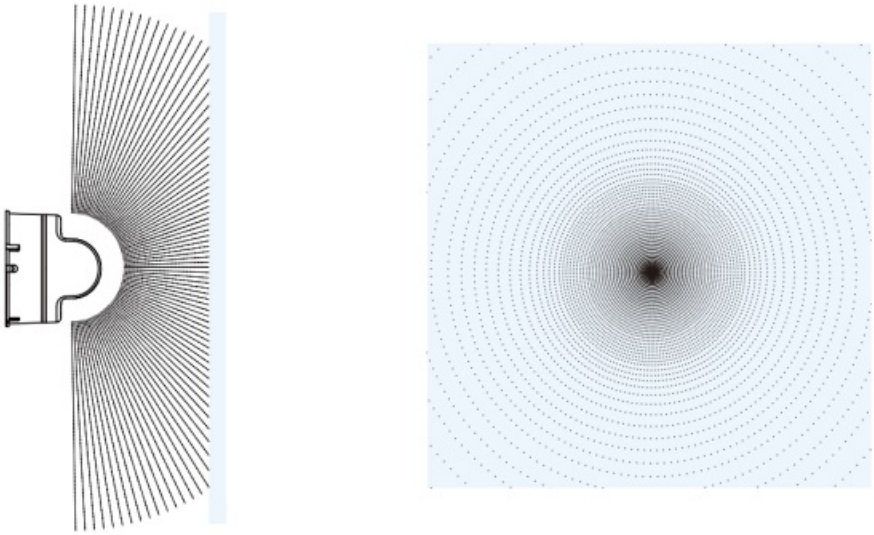
L2 Effective FOV range

L2 supports a negative angle mode, in which the horizontal direction field of view remains unchanged and the vertical direction field of view expands to 96° in the negative angle mode. In the negative angle mode, the farthest measurement distance in the range corresponding to the expanded 6° field of view will be slightly closer.



Negative Angle Mode Vertical Direction Field of View Figure

Please note that the point cloud density of the L2 is different in different FOV regions, and the point cloud density is larger near the center, as shown in the following figure.



The range of view directly above L2 is the furthest. In addition, there will be an extremely small angle area of vision deficiency directly above L2, which is a normal phenomenon after algorithm correction.

Installation Precautions

Before formally installing the L2, please be sure to read the following precautions carefully:

1. Clean the optical window with alcohol or a clean cloth before installation. Also ensure the clean-liness of the

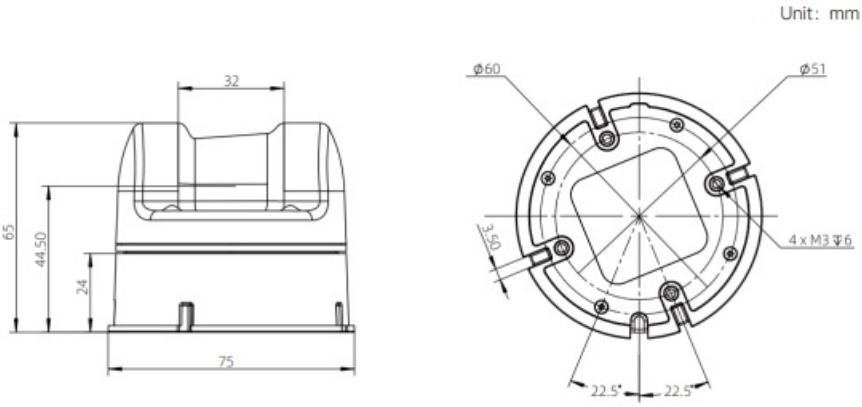
optical window during use. Dust or other dirt may affect the scanning effect of the L2.

2. During installation, do not block its FOV. Even installing a transparent glass plate on the optical window will affect the performance of L2.
3. The L2 can be installed in any direction through the bottom installation holes.
4. The installation structure of L2 can only ensure its own reliability, and the body cannot bear ad-ditional loads.
5. Leave a certain amount of space on all four sides during installation to prevent poor air flow from affecting the heat dissipation effect.
6. When the application scenario requires water resistance, the L2 needs to be equipped with a water protection device. The water protection diagrams for normal installation and upside -down installation are as follows:

Installation Water Protection Diagram

Installation Dimensions

The bottom of the L2 has 4 M3 installation holes with a depth of 6mm. Please install the L2 in an appropriate position according to the L2 mechanical dimensions and installation hole position dimensions shown in the following figure.



L2 Mechanical Dimensions

L2 Weight and Dimensions

Weight	230g
Dimensions	75 (width) x75 (depth) x65 (height)mm

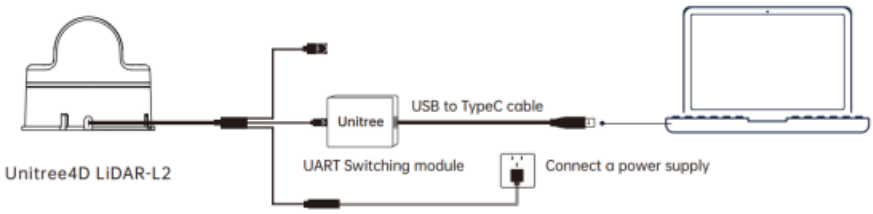
Use

Connection

UART TTL Connection

The 4PIN plug of the L2 can provide data transmission but not power. For specific wire sequences, please refer to

the Interface Definition section. If you need to temporarily test or use L2, it is recommended to use the adapter module, power adapter and data cable provided in the package. The connection and use methods are as follows: a.Insert the 4PIN serial port of the L2 into the adapter module. b.Insert the power adapter into the power supply port of the cable to supply power. 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.

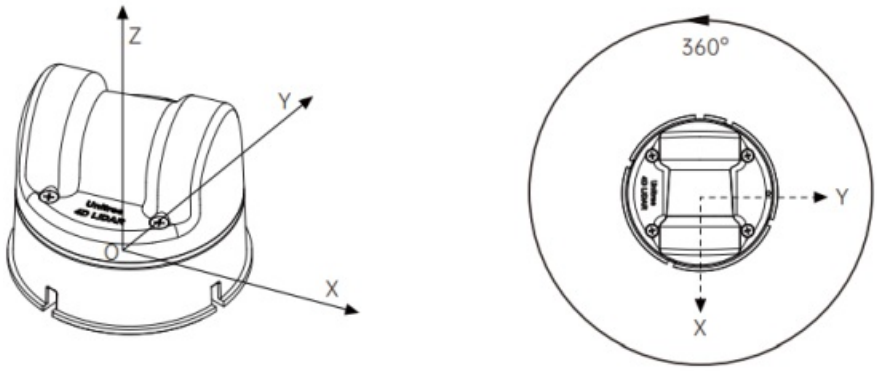


ENET UDP Connection

The L2 supports network UDP data transmission. Connect the network port and power port of the cable to use. The L2's network port can be directly used for data transmission. When using, insert the network port into a switch or computer, and insert the power adapter into the power supply port of the cable to use. The default configuration information of the L2 is: IP: 192.168.1.62, Gateway: 192.168.1.1, Subnet Mask: 255.255.255.0, Default Destination Server IP Address for Sending Data is 192.168.1.2. The UDP port for sending data by the radar is 6101, and the receiving port of the destination server is 6201. When using for the first time, please note that the address of the destination server and the IP of the L2 do not conflict. If you need to modify the configuration information, you can do so through an upper computer or SDK. · The adapter module, power adapter and data cable are all provided with the package, which can achieve power connection, control signal transmission and data transmission, etc., or you can use other materials according to your own needs to replace them, improving the use convenience and system protection ability (such as dust and water resistance). · When debugging, please place the L2 radar on the provided rubber pad and place the rubber pad on a horizontal table to ensure the radar works stably and avoid knocking and falling.

Coordinate System

The definition of the right – angled coordinate system O – XYZ of L2 is as shown in the following figure. O is the origin of the point cloud coordinate system, located at the bottom center position, +X is the opposite direction of the outlet, +Y is the direction 90 ° counterclockwise from +X, and O – XYZ is the point cloud coordinate system of L2 (the origin and XYZ coordinate system of the IMU are seen in the L2 3D model, and its XYZ axes are relatively parallel to the XYZ axes of the point cloud coordinate system).



Unitree4D LiDAR – L2 Coordinate Definition

Point Cloud Data

The L2 can only choose one way to output data from ENET UDP and TTL UART, which can be selected through Unilidar 2 or SDK.

By default, the L2 starts to output point cloud data after being powered on. The point cloud data includes distance values, angles, reflectivity, IMU data and working status data. The point cloud data is the synthesis of all point clouds detected on the surface of the measured object within the field of view by the laser detection rangefinder. Each point cloud data mainly contains the following information:

Distance value: The actual distance between sampling points, in millimeters. Angle: The angle of the sampling point relative to the orientation of the L2 itself, in degrees. Reflectivity: The reflectivity of the detected object. IMU data: Data of 3 – axis accelerometer and 3 – axis gyroscope. Working status data: The current rotational speed,

voltage, temperature, etc. of the laser detection rangefinder.

Working Status and Working Mode

The working status of the L2 refers to the current working status of the laser detection rangefinder, and the working mode refers to the target working status set by the user.

Description of Working Status:

The working status of the L2 includes sampling status, standby status, and interference status, as detailed in the following table.

Working	Description
Sampling Status	The laser detection rangefinder has been started and is working normally (emitting laser beams).
Standby Status	After setting the standby mode, it enters the standby state. In this state, the power consumption is less than 1W, the LED light is off, the high – speed motor stops rotating, the low – speed motor stops rotating, and only IMU data is output.
Interference Status	After being forced to stop rotating by an external force, the point cloud cannot be used. When the external force is released, the L2 will automatically resume rotation and point cloud data.

Description of Working Mode:

The working mode refers to the target working status set by the user. There are two working modes that can be set by the user for the L2: normal mode (Normal mode) and standby mode (Standby mode). The user can set different working modes through Unilidar 2 or SDK. When using the L2 for the first time, the default mode is the normal mode. When the L2 is powered off and then powered on again, it will return to the default normal mode.

In addition, the L2 can also be set to enable 3D/2D mode, negative angle mode, and power – on self – start, and these settings will take effect after saving the parameters and restarting the radar. In 3D mode, the high – speed motor and the low – speed motor of the radar work normally, providing three – dimensional point cloud data. In 2D mode, only the height motor of the radar works normally, the low – speed motor pauses working, and only two – dimensional point cloud data is provided. The L2 defaults to 3D mode.

In the negative angle mode, the field of view of the radar is 360 ° ×96 ° , and the farthest measurement distance in the range corresponding to the expanded 6 ° field of view will be slightly closer.

The L2 defaults not to open the negative angle mode.

When power – on self – start is enabled, the radar starts working immediately after being powered on. When power – on self – start is disabled and saved and then restarted, the radar will not work every time it is powered on but will wait for a start command. The L2 defaults to power – on self – start.

LED Mode

The LED of the L2 does not support configuration and has three states:

6 – segment light ring in normal mode, 3 – segment light ring in negative angle mode, and the light ring blinks slowly in 2D mode.

Unilidar 2

Unilidar 2 is an operating software used by the L2 that can display and analyze three – dimensional point clouds in real time and supports advanced functions such as product settings and external parameter adjustment. Using the Unilidar 2 software, users can perform simple graphical debugging.

Unilidar

2 currently supports Window® (64 – bit). Windows users: Run the Unilidar 2.exe program as an administrator after downloading. For more detailed usage methods of Unilidar 2, please visit the official website **www.unitree.com**, download and consult the Unilidar 2 User Manual for more information. Unilidar SDK 2

In addition to using Unilidar 2 to view real – time point cloud data, users can also obtain point cloud data through the Unilidar SDK software package and apply the point cloud data to various scenarios.

This software package can provide the following functions: ·Parse the original data transmitted from the laser radar and convert it into point cloud and IMU data ·Obtain point cloud data ·Obtain IMU data ·Configure and query relevant parameters and status information Visit **https://www.unitree.com/download** to view more detailed information about the Unilidar SDK documentation.

Storage, Transportation and Maintenance

Storage

- The storage temperature of the L2 is – 20° C to 60° C. Please store it in a dry, ventilated and dust – free environment.
- Avoid placing it with corrosive, flammable and explosive items.
- Handle it carefully when storing to avoid damaging the equipment.
- For equipment stored for a long time, please check and maintain it regularly.

Transport

- Before transporting, fix the equipment and confirm that it is installed in place before packing.
- Use special packing boxes or packing buffer materials to achieve the necessary protection effect.
- Avoid being affected by impacts, vibrations and frictions during transportation to avoid mechanical damage.

Maintenance

The L2 has good reliability and stability. During normal use, only the optical window needs to be regularly inspected and cleaned. If the optical window area is polluted (such as by dust, mud, etc.), it may affect the quality of the data generated after the radar scans an object. At this time, the radar needs to be cleaned. Preferably, use a clean cleaning cloth to gently wipe the optical window to remove surface dirt. When cleaning, wipe gently to avoid scratching the surface of the optical window with excessive force and affecting its performance. If there are still visible stains on the optical window, use a cleaning cloth dipped in a small amount of alcohol and then wipe the window.

Troubleshooting

If problems occur during use, please check the following table for solutions. If the problem still cannot be solved, please contact Unitree or an authorized dealer of Unitree.

Problem	Solution
Unable to obtain L2 data through TTL UART method	·Confirm that all wires are correctly connected. ·Confirm that the adapter is suitable. The power supply requirement of the L 2 is 12V, 1A. ·Confirm that the radar data output is selected as TTL UART output. After confirming the above, if the serial port connected to the L2 still cannot be detected, try restarting the L2 and Unilidar 2 software.
Unable to obtain L2 data through ENET UDP method	·Confirm that all wires are correctly connected. ·Confirm that the adapter is suitable. The power supply requirement of the L 2 is 12V, 1A. ·Confirm that the L2 and the target server's IP configurations are correct an d do not conflict. ·Check the network configuration and confirm that the network is smooth. ·Confirm that the port for receiving data on the target server is not occupied or isolated, and the default is udp6201. ·Confirm that the radar data output is ENET UDP output.
Unable to confirm the IP paramet er information of the L2	·Connect the L2 by serial port, modify the IP parameter information through an upper computer or SDK, and save and restart.
Can detect the serial port connec ted to the L2, but cannot open the serial port / or cannot start sa mpling	·Confirm that all wires are correctly connected. ·Confirm that the adapter is suitable. The power supply requirement of the L 2 is 12V, 1A. If the problem still exists, try restarting the L2 and Unilidar 2 sof tware.
After being forced by an external force, the L2 stops rotating	·Usually, when the external force is released, the L2 will automatically resum e rotation. ·Try restarting the L2.

After – sales Warranty Information

Visit **https://www.unitree.com/terms** to learn more about the warranty information of Unitree 4D Lidar – L2.

Parameter Specifications

Unitree 4D LiDAR

Model	L2
Laser Wavelengths	905nm
Eye Safety Rating «1	Class 1(IEC60825-1:2014) Eye Safety
Max Range	30M(@90% reflectity) 15M(@10% reflectity)
Near Blind Zone -:	0.05m
FOV	360** 90°/360°°96° (NAGE Mode)
Sampling Frequency	128000 points /s
Effective Frequency	64000 points /s
Scanning Method	Contactless Brushless Mirror Scanning
4D Information	30 Position +10 Grayscale(Support 20 Mode) (41
Horizontal Scanning Frequency	5.55Hz
Vertical Scanning Frequency	216Hz
Communication interface	ENET UDP. TTL UART
Communication Baud Rate	4000000 bps (TTL UART)
Measurement Accuracy =!	=2.0em
Angular Resolution	0.64°
Measurement Resolution	4.5mm
IMU Sampling Rate	kHz
IMU Reporting Frequency	S500Hz
Attitude Perception Dimension	3-axis Accelerometer + 3-axis Gyroscope
LED Ring Resolution	60°
LED Ring Refresh Rate	5.55HzZ
Anti-Strong Light Ability	100Klux
Operating Environment Temperature i	-10°C-59°C
Storage Environment Temperature	-20°C-60°C
Protection Level [7]	IP54
Power [8]	10W Environment Temperature 25°C
Operating Voltage	12V DC
Size	75 width x75 depth x65 height mm
Weight	230g

1. The instantaneous peak power of the loser 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. In 2D mode, the angle range is 180° or 192° (in NEGA Mode), and the effective frequency is still 64,000 points per second.
5. To ensure the effective detection of objects with diferent defectivities within the range, there may be a slight decrease in point-cloud accuracy at some locutions. The test conditions are os folows: environment temperature of 259c, target object reflectivity 90%, and test distance of 15m.
6. In environments such as high and low temperatures, strong vibrations, and heavy fog, the performance of L2 will decrease slightly. In addition, long-term operation at high temperatures may affect the product performance and even cause damage to the product. It is recommended that users increase heat dissipation measures to ensure that the temperature of the bottom cover does not exceed 85 ° C. If the temperature is too high, the over-temperature protection mechanism will be triggered, and L2 will issue an over-temperature warning. When the temperature is severely exceeded, L2 will stop running.
7. The protection effect of L2 varies greatly under different installation angles. Please increase external protection according to the actual installation angle on your own; damage caused by improper installation or external protection is not covered by the warranty.
8. The stable power and peak power are different in different environments. When the environmental temperature range is from -10 ° C to 30 ° C, L2 will automatically operate in the self-heating mode and will not output point clouds until the temperature meets the requirements, and the peak power can reach 13W at this time. Please design the power supply reasonably to ensure the normal operation of the equipment.

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

Documents / Resources

	Unitree 4D LiDAR-L2 From Robotics To Infrastructure [pdf] User Manual 4D LiDAR-L2 From Robotics To Infrastructure, 4D LiDAR-L2, From Robotics To Infrastructure, To Infrastructure

References

- Unitree Robotics | Robot Dog_Quadruped_Humanoid Robotics Company
- GitHub - unitreerobotics/unilidar_sdk: SDK for Unitree L1 LiDAR
- Download Center Go1 - Unitree Robotics
- Download Center Go1 - Unitree Robotics
- Terms & Policies - Unitree Robotics
- User Manual