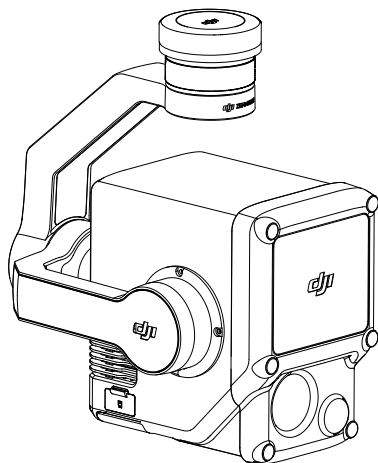


ZENMUSE L1

User Manual v1.2

2021.09



Searching for Keywords

Search for keywords such as “battery” and “install” to find a topic. If you are using Adobe Acrobat Reader to read this document, press Ctrl+F on Windows or Command+F on Mac to begin a search.

Navigating to a Topic

View a complete list of topics in the table of contents. Click on a topic to navigate to that section.


Printing this Document

This document supports high resolution printing.

Using This Manual

Legends

 Important

 Hints and Tips

 Reference

Caution

1. The L1 is a precision instrument. DO NOT drop the L1 and handle with care.
2. If highly accurate point cloud data is required, it is not recommended to use the L1 in low visibility conditions such as foggy or rainy weather. Otherwise, the detection range may be reduced resulting in point cloud noise being produced.
3. DO NOT touch the optical window of the L1. Dust and stains on the optical window can negatively affect the performance. Use compressed air or a wet lens cloth to clean the optical window correctly. Refer to the [Storage, Transportation, and Maintenance](#) section for more information on how to clean optical windows.
4. DO NOT touch the surface of the lens with your hand. Be careful to avoid scratching the surface of the lens with sharp objects. Otherwise, the quality of images may be affected. Clean the surface of the camera lens with a soft, dry, clean cloth. DO NOT use substances containing alcohol, benzene, thinners, other flammable substances, or alkaline detergents to clean or maintain the RGB Mapping Camera or Auxiliary Positioning Vision Sensor.
5. When not in use, store the L1 in the storage case and replace the desiccant packet as necessary to prevent fogging the lenses due to excessive ambient humidity. If the lenses fog up, the water vapor will usually dissipate after powering on the device for a while. It is recommended to store the L1 in an environment with a relative humidity of less than 40% and temperature of $20\pm 5^{\circ}\text{C}$.
6. DO NOT place the product under direct sunlight, in areas with poor ventilation, or near a heat source such as a heater.
7. DO NOT repeatedly power the product on or off. After powering off, wait at least 30 seconds before powering back on. Otherwise, the product life will be affected.
8. Under stable laboratory conditions, the L1 achieves an IP54 protection rating by IEC 60529 standards. The protection rating is not permanent, however, and may reduce over an extended period.
9. Make sure there is no liquid on the surface or in the port of the gimbal.
10. Make sure the gimbal is securely installed on the aircraft and the microSD card slot cover is closed properly.
11. Make sure the surface of the gimbal is dry before opening the microSD card slot cover.
12. DO NOT remove or insert the microSD card when taking a photo or recording a video.

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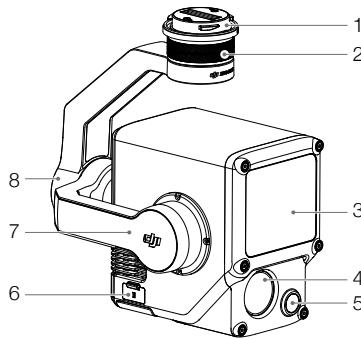
Product Profile

Introduction

The ZENMUSE™ L1 integrates a LIVOX™ LiDAR module, a high-accuracy IMU, and an RGB mapping camera on a 3-axis stabilized gimbal. When used with compatible DJI aircraft and DJI TERRA™, the L1 offers a complete solution that gives real-time 3D data throughout the day, which effectively captures the details of complex structures and delivers highly accurate reconstructed models.

Overview

1. Gimbal Connector
2. Pan Motor
3. LiDAR Sensor
4. RGB Mapping Camera
5. Auxiliary Positioning Vision Sensor
6. microSD Card Slot
7. Tilt Motor
8. Roll Motor



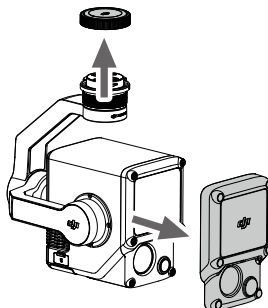
Installation

Supported Aircraft

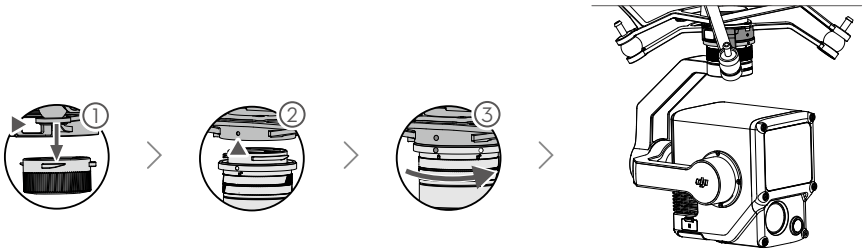
MATRICE™ 300 RTK


Installing on Aircraft

1. Remove the gimbal cap and lens protector.



2. Press the button on the aircraft used for detaching the gimbal and camera. Rotate the gimbal cap on the aircraft to remove.
3. Align the white dot on the gimbal with the red dot on the aircraft and insert the gimbal.
4. Rotate the gimbal lock to the locked position by aligning the red dots.



-
-  • Make sure the gimbal connector on the aircraft is positioned correctly when mounting. Otherwise, the L1 cannot be mounted.
- Only remove the L1 after powering off the aircraft.
 - Remove the L1 by pressing the button on the aircraft to detach the gimbal and camera.
 - Make sure the microSD card slot cover is firmly in place to prevent dust or moisture entering while using or during transportation. Failure to close the microSD card slot cover may cause the gimbal motor to overload during usage.
 - To avoid burns, DO NOT directly touch the camera case when powering on.
 - Detach the gimbal from the aircraft during transportation or storage. Otherwise, the service life of the gimbal dampers may be shortened or they may even be damaged.
-

Remote Controller Controls

The Matrice 300 RTK remote controller is used as an example below. Adjust the tilt of the gimbal using the left dial and adjust the pan using the right dial. Press the shutter button or record button to take photos or record video. Toggle the 5D button to adjust the EV value. The customizable C1 button can be used to recenter the gimbal and the customizable C2 button can be used to switch between the main and auxiliary screen.

1. Left Dial

Turn to adjust the tilt of the gimbal.

2. Record Button

Press to start or stop recording video.

3. Shutter Button

Press to take a photo. The photo mode can be set to single or interval in DJI Pilot. Single photos can also be taken during video recording.

4. Right Dial

Turn to adjust the pan of the gimbal.

5. 5D Button

The default configuration is listed below. The configuration can be adjusted in DJI Pilot.

Left: Decrease EV value

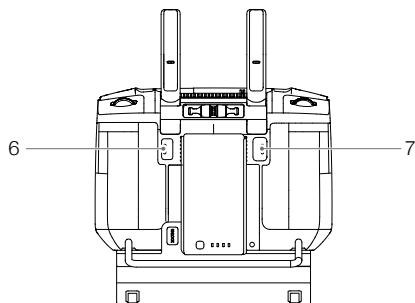
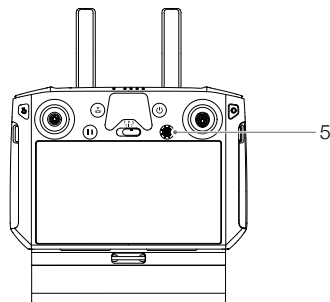
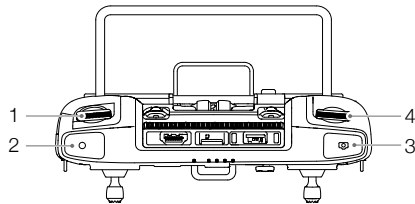
Right: Increase EV value

6. Customizable C2 Button

The default function is to switch between the main and auxiliary screen. The function for this button can be customized in DJI Pilot.

7. Customizable C1 Button

The default function is to recenter the gimbal. The function for this button can be customized in DJI Pilot.

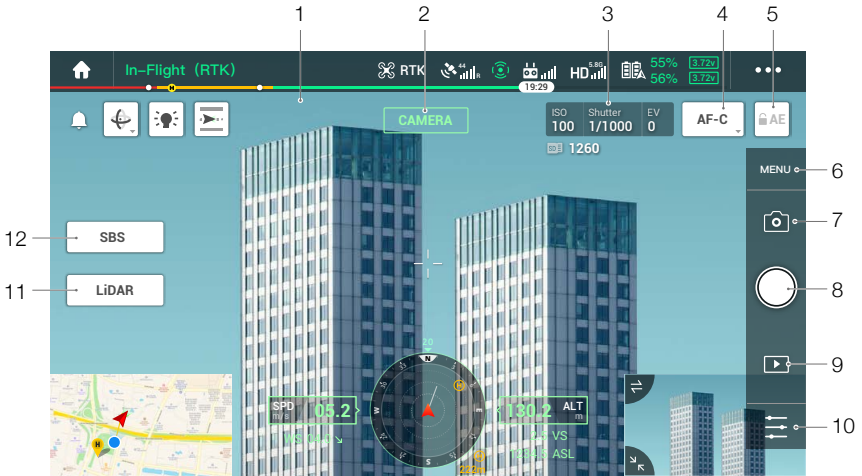


DJI Pilot App Controls





The touch interface can be used for capturing photos, recording videos, and viewing playback. Users can create a flight mission to record point cloud data in DJI Pilot.

Basic Features

The touch interface can display a HD live view and offers professional photography configurations.



The interface may need to be updated. Make sure to update to the latest firmware.

- 1. Live HD Video**
Displays the current camera view.
- 2. Camera Type**
Displays the current camera type including camera view, point cloud view, and side-by-side view.
- 3. Camera Parameters**
Displays the current camera parameters.
- 4. Focus Mode**
Tap to switch between MF, AF-C, and AF-S focus mode.
- 5. Auto Exposure Lock**
Tap to lock the exposure value.
- 6. Camera Settings**
Tap to enter the photo and video settings. Tap  to configure photo settings such as photo mode and image format. Tap  to configure video settings such as video size and format. Tap  to configure point cloud settings. Tap  to configure video subtitles, grid, and smart LED settings. The settings may vary according to different camera models.

7. **Recording Mode (Shutter/Video Record/Point Cloud Record)**
Tap to switch between photo, video, and point cloud recording modes.
8. **Shooting Button (Shutter/Video Record/Point Cloud Record)**
Tap to take photos or start or stop recording video or point cloud data. The shutter and record buttons can also be used to take a photo and record video.
9. **Playback**
Tap to enter and preview photos and videos as soon as they are captured.
10. **Parameter Settings**
Tap to set ISO, shutter, exposure values, and other parameters.
11. **Camera/Point Cloud Toggle**
Tap to switch the main screen to the camera view or point cloud view.
12. **Single/Dual View Toggle**
Tap to switch the main screen to single or dual view.

Point Cloud Recording View



13. IMU Calibration Button

Tap to perform a IMU Calibration to calibrate the LiDAR's inertial navigation system and increase accuracy of reconstruction. Tap STOP to stop a IMU Calibration. IMU Calibration should be performed at both the start and end of a flight. Make sure there are no obstacles within a 30m radius of the start and end points.

14. Color Palette

Tap to select a rendering mode including reflectivity, height, distance, and RGB.

15. Model Preview Button

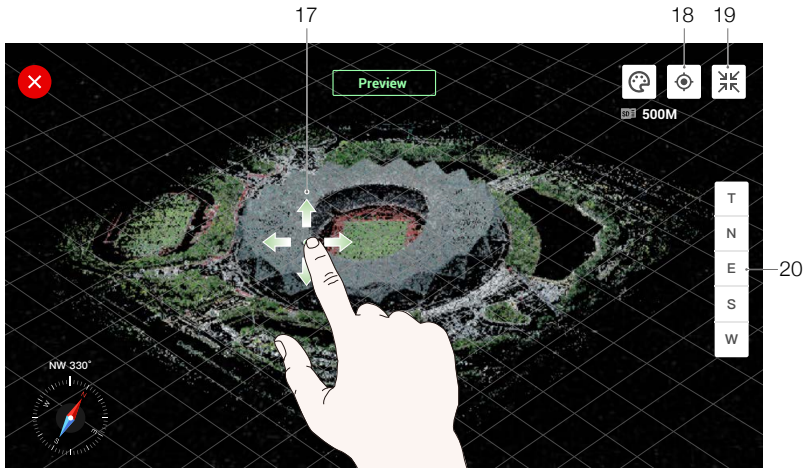
Refer to the [Point Cloud Model Preview](#) section for more information.

16. Pause Button

Tap to pause point cloud recording and tap again to resume.

Point Cloud Model Preview

Tap to view the current point cloud model from different perspectives.



17. Use one finger to drag the point cloud model and use two fingers to rotate or zoom in or out on the point cloud model.

18. Tap to view the point cloud model beneath the aircraft.

19. Tap and the point cloud model will recenter and zoom in or out to display the whole model.

20. Tap to view the point cloud model from the top, north, east, south, or west.


Field Data Collection

Users can create a flight mission to record point cloud data in DJI Pilot and import the recorded data into DJI Terra for high-precision model reconstruction.


Preparation

1. Make sure the L1 is installed correctly on the aircraft and that the aircraft and remote controller are linked after powering on.
2. Go to camera view in DJI Pilot, select ●●●, then RTK, choose the RTK service type, and make sure that the status of RTK positioning and heading both display FIX. Refer to the [Base Station Satellite Data Acquisition](#) section for more information on data processing if the network or remote controller video transmission signal is poor.
3. Before recording data, it is recommended to warm up the L1 for 3 to 5 minutes after powering on. Wait until a prompt appears in the app stating that the payload INS IMU is warmed up.

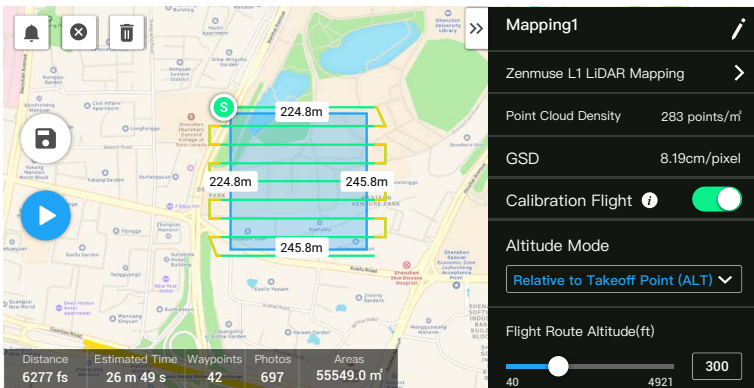
Setting Camera Parameters

1. Go to the camera view in DJI Pilot and select .
2. Select  to adjust the camera parameters according to the surroundings. Make sure the photo will be well exposed.

Mapping Mission

Enter the mission flight screen in DJI Pilot, select Create a Route, and then  to choose a Mapping mission.



1. Tap and drag on the map to adjust the area that will be scanned.




2. Edit the parameters for a LiDAR Mapping mission or Photogrammetry mission.
 - A. LiDAR Mapping mission:
 - a. Select Zenmuse L1 and then LiDAR Mapping.
 - b. Set the advanced settings, payload settings, and other parameters. It is recommended to

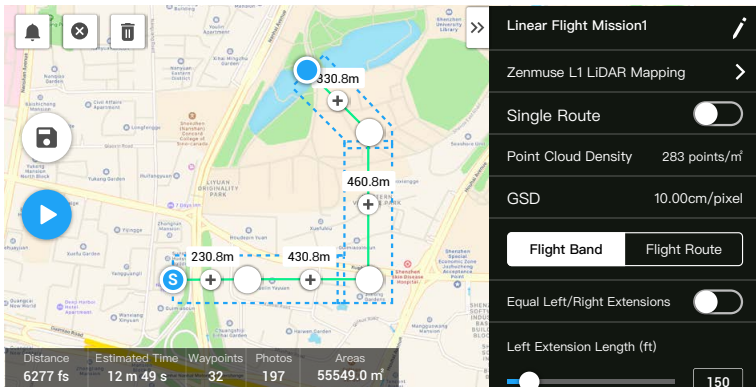
set the Side Overlap (LiDAR) to 50% or above, the Scanning Mode to Repetitive, the altitude to 50-100 m, the flight speed to 8-12 m/s, and enable IMU Calibration.



B. Photogrammetry mission:

- a. Select Zenmuse L1 and then Photogrammetry.
 - b. Set the advanced settings, payload settings, and other parameters. It is recommended to disable Dewarping and set Forward Overlap (Visible) and Side Overlap (Visible) to default parameters.
3. Select  to save the flight mission and select  to upload and execute the flight mission.
 4. Power off the aircraft after the mission is completed and remove the microSD card from the L1. Connect it to a computer and check the point cloud data, photos, and other files in the DCIM folder.

Linear Flight Mission

1. Enter the mission flight screen in DJI Pilot, select Create a Route, and then  to choose a Linear Flight mission.
2. Tap and drag on the map to adjust the area that will be scanned.



3. Edit the parameters for a LiDAR Mapping mission or Photogrammetry mission.
 - A. LiDAR Mapping mission:
 - a. Select Zenmuse L1 and then LiDAR Mapping.
 - b. Set the advanced settings, payload, flight band, flight route, and other parameters. It is recommended to set the altitude to 50-100 m, the flight speed to 8-12 m/s, and adjust the extension length to cover the area to be scanned.
 - B. Photogrammetry mission:
 - a. Select Zenmuse L1 and then Photogrammetry.
 - b. Set the advanced settings, payload settings, and other parameters. It is recommended to disable Dewarping and set Forward Overlap (Visible) and Side Overlap (Visible) to default parameters.
4. Select  to save the flight mission and select  to upload and execute the flight mission.

- Power off the aircraft after the mission is completed and remove the microSD card from the L1. Connect it to a computer and check the point cloud data, photos, and other files in the DCIM folder.


Terrain Follow

To perform a precise Terrain Follow flight, enable Terrain Follow in Mapping mission and import the DSM file including the altitude information.

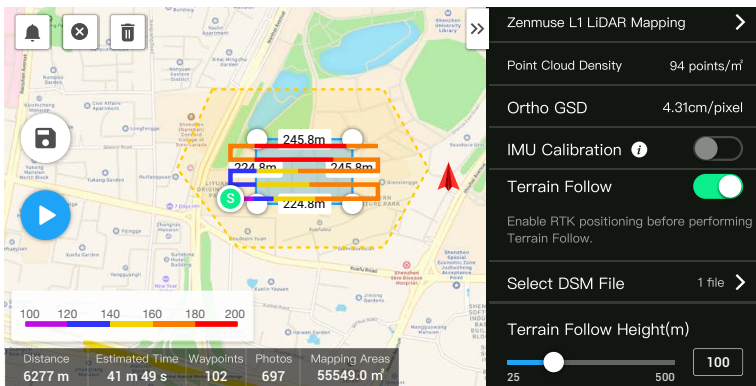
Preparing Files

The DSM files of the measurement area can be obtained through the following two methods:

- Collect the 2D data of the mapping area and perform a 2D reconstruction through DJI Terra by selecting Fruit Tree. A .tif file will be generated and can be imported to the microSD card of the remote controller.
- Download the terrain mapping data from a geobrowser and import to the microSD card of the remote controller.

 Make sure that the DSM file is a geographic coordinate system file, and not a projected coordinate system file. Otherwise, the imported file may not be recognized. It is recommended that the resolution of the imported file should be no more than 10 meters.



Importing Files





- Enable Terrain Follow in Mapping mission.
- Tap Select DSM File. Tap +, select and import the file from the microSD card of the remote controller, and wait for the file to be imported.
- The imported files will be displayed in the list.

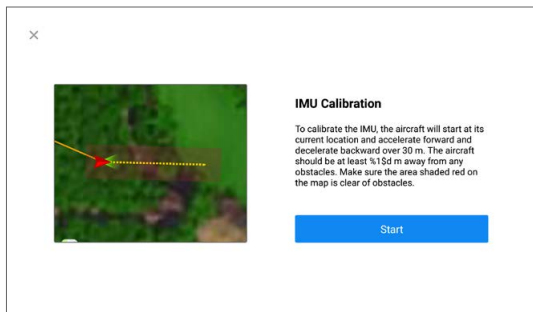
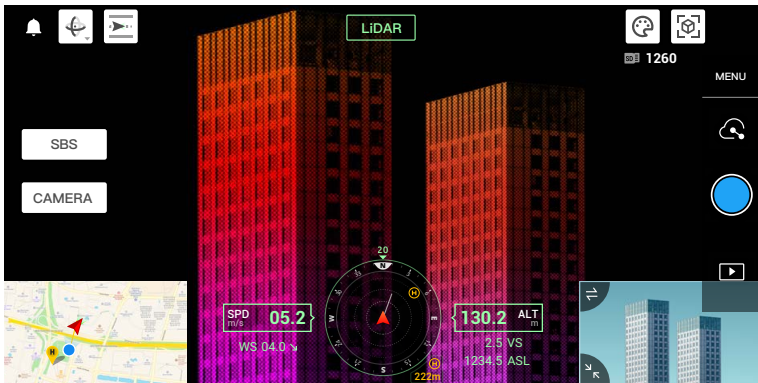
Planning a Flight Route



- Enable Terrain Follow in Mapping mission and select a file from the Select DSM File screen.
- Edit the parameters in Mapping mission:
 - Set the terrain follow height.

- B. Set the takeoff speed, route speed, and action upon completion.
 - C. In Advanced Settings, set the Side Overlap (LiDAR), Course Angle, Margin, and photo mode.
 - D. In Payload Settings, set the Return Mode, Sampling Rate, Scanning Mode, and RGB Coloring.
3. Select  to save the mission and select  to upload and execute the flight mission.
 4. Power off the aircraft after the mission is completed and remove the microSD card from the L1. Connect the microSD card to a computer and check the point cloud data, photos, and other files in the DCIM folder.

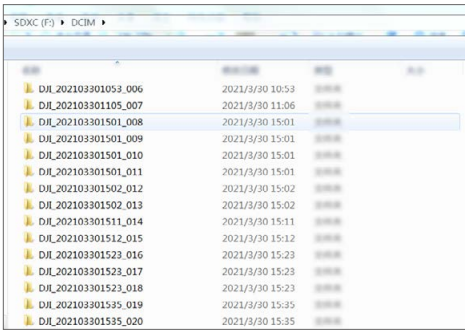
Manual Flight

1. Fly the aircraft to an appropriate height. It is recommended that the target be 5 to 100 meters away from the L1 and to perform a IMU Calibration. Tap , and , and follow the prompts to finish the calibration. To ensure flight safety, enable obstacle sensing and make sure the area shaded red on the map is clear of obstacles.
2. Fly the aircraft to the target you wish to record and use the camera view to adjust the gimbal to a suitable angle for recording point cloud data. Tap to enter point cloud view. Tap  to start point cloud recording.

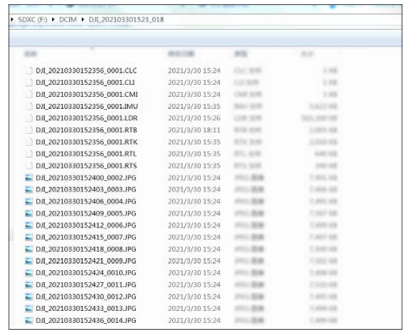


- Perform the flight mission to record point cloud data. Tap  to view the point cloud model recorded in real time during flight.
- Return to the point cloud view and tap  to finish recording.
- It is recommended to perform another IMU Calibration after recording the point cloud data.
- Power off the aircraft after the mission is completed and remove the microSD card from the L1. Connect it to a computer and check the point cloud data, photos, and other files in the DCIM folder.

Point Cloud Data File Description



文件名	日期	时间	大小
DJI_202103301053_006	2021/3/30	10:53	1.00 MB
DJI_202103301105_007	2021/3/30	11:06	1.00 MB
DJI_202103301501_008	2021/3/30	15:01	1.00 MB
DJI_202103301501_009	2021/3/30	15:01	1.00 MB
DJI_202103301501_010	2021/3/30	15:01	1.00 MB
DJI_202103301501_011	2021/3/30	15:01	1.00 MB
DJI_202103301502_012	2021/3/30	15:02	1.00 MB
DJI_202103301502_013	2021/3/30	15:02	1.00 MB
DJI_202103301511_014	2021/3/30	15:11	1.00 MB
DJI_202103301512_015	2021/3/30	15:12	1.00 MB
DJI_202103301523_016	2021/3/30	15:23	1.00 MB
DJI_202103301523_017	2021/3/30	15:23	1.00 MB
DJI_202103301523_018	2021/3/30	15:23	1.00 MB
DJI_202103301535_019	2021/3/30	15:35	1.00 MB
DJI_202103301535_020	2021/3/30	15:35	1.00 MB



文件名	日期	时间	大小
DJI_20210330152356_0001.CLG	2021/3/30	15:24	1.00 MB
DJI_20210330152356_0001.CLI	2021/3/30	15:24	1.00 MB
DJI_20210330152356_0001.CMI	2021/3/30	15:24	1.00 MB
DJI_20210330152356_0001.LDR	2021/3/30	15:26	1.00 MB
DJI_20210330152356_0001.RTB	2021/3/30	18:11	1.00 MB
DJI_20210330152356_0001.RTK	2021/3/30	15:35	1.00 MB
DJI_20210330152356_0001.RTL	2021/3/30	15:35	1.00 MB
DJI_20210330152356_0001.RTS	2021/3/30	15:35	1.00 MB
DJI_20210330154006_0002.JPG	2021/3/30	15:24	1.00 MB
DJI_20210330154001_0003.JPG	2021/3/30	15:24	1.00 MB
DJI_20210330154006_0004.JPG	2021/3/30	15:24	1.00 MB
DJI_20210330154009_0005.JPG	2021/3/30	15:24	1.00 MB
DJI_20210330154121_0006.JPG	2021/3/30	15:24	1.00 MB
DJI_20210330154151_0007.JPG	2021/3/30	15:24	1.00 MB
DJI_20210330154128_0008.JPG	2021/3/30	15:24	1.00 MB
DJI_20210330154242_0009.JPG	2021/3/30	15:24	1.00 MB
DJI_20210330154244_0010.JPG	2021/3/30	15:24	1.00 MB
DJI_20210330154247_0011.JPG	2021/3/30	15:24	1.00 MB
DJI_20210330154306_0012.JPG	2021/3/30	15:24	1.00 MB
DJI_20210330154303_0013.JPG	2021/3/30	15:24	1.00 MB
DJI_20210330154306_0014.JPG	2021/3/30	15:24	1.00 MB

- The recorded point cloud data is stored in the microSD card. The storage directory is microSD: DCIM/DJI_YYYYMMDDHHMM_NO_XXX (XXX can be edited by the user).
- The folder contains not only photos taken during the flight but also files with the suffix CLG, CLI, CMI, IMU, LDR, RTB, RTK, RTL, and RTS.



Chinese characters cannot be used to rename any of the files.

Base Station Satellite Data Acquisition

When the mobile network or remote controller video transmission signal is poor, use the RTCM data of the D-RTK 2 Mobile Station or a third-party RTK base station to assist the L1 for data post-processing. Follow the steps below:

- Check the local operation time from the point cloud data file directory stored in the microSD card.
- Search for .DAT RTCM files with the same timestamp as the stored files of the D-RTK 2 Mobile Station or third-party RTK base station and follow the steps below:
 - If using the D-RTK 2 Mobile Station, copy the .DAT file with the same timestamp in the rtmcrw folder to the folder of the point cloud data file directory.
 - If using a third-party RTK base station, .oem/.ubx/.obs/.rtcm files are supported. Rename the file the same as the .RTB file in the point cloud data file directory by following the name format in the table below and copy the renamed file to the folder of the point cloud data file directory. DJI Terra will prioritize files in the following order: .oem > .ubx > .obs > .rtcm.

Protocol Type	Protocol Version	Message Type	Name Format
OEM	OEM4, OEM6	RANGE	DJI_YYYYMMDDHHMM_XXX.oem
UBX	--	RAWX	DJI_YYYYMMDDHHMM_XXX.ubx
RINEX	v2.1x, v3.0x	--	DJI_YYYYMMDDHHMM_XXX.obs
RTCM	v3.0	1003, 1004, 1012, 1014	DJI_YYYYMMDDHHMM_XXX.rtcn
	v3.20	MSM4, MSM5, MSM6, MSM7	



- Note that the RTCM file stored in the D-RTK 2 Mobile Station is in UTC time format.
- If using the D-RTK 2 Mobile Station, users can also directly copy all the base station data files from that day and DJI Terra will automatically merge them.
- When setting up a third-party RTK base station, follow the steps to set the coordinates of the origin for the RTK base station (using Renix format as an example):
 1. Erect the RTK base station to a point with known coordinates and record the XYZ coordinates in ECEF format (use a third-party software for format conversion if necessary).
 2. Use Notepad to open the Renix file with the O. file and modify the "APPROX POSITION XYZ" coordinates of the O. file to the coordinates recorded in Step 1.
- Read the D-RTK 2 Mobile Station User Guide for more information.

Office Data Processing

Users can import the recorded point cloud data into DJI Terra for high-precision model reconstruction. Read the DJI Terra User Manual for more information.

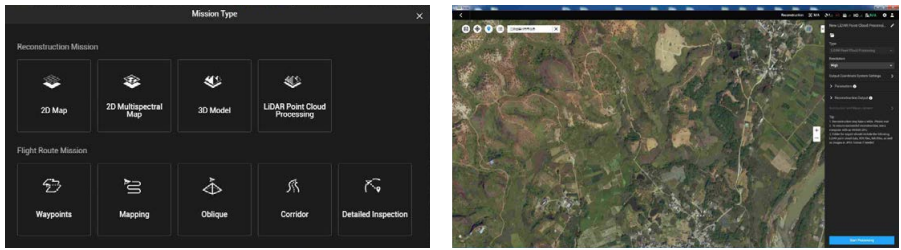
Downloading DJI Terra


DJI Terra is required for data processing. Read the DJI Terra User Manual for more information about how to configure DJI Terra and use reconstruction.

Visit <https://www.dji.com/dji-terra/downloads> to download and install DJI Terra.

Reconstruction Procedures

Follow the steps below to reconstruct point cloud data in DJI Terra.

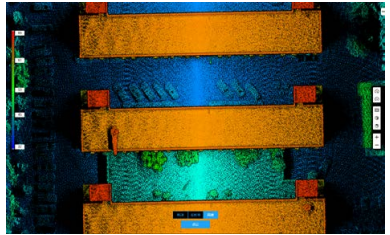


1. Launch DJI Terra, select New Mission, and create and save a point cloud processing mission.
2. Select  on the mission editing page and import the folder from the microSD card. The folder will be named according to the time the point cloud data was recorded. The folder contains files with the suffix CLC, CLI, CMI, IMU, LDR, RTB, RTK, RTL, and RTS.
3. Configure the point cloud density and output coordinate system settings.
4. Click to start reconstruction and wait until it is completed.
5. In the reconstruction page, the current mission folder can be opened by pressing “Ctrl+Alt+F” to find the file and check the result of the reconstruction.
6. Read the DJI Terra User Manual for more information about how to process data such as optimizing point cloud data accuracy.

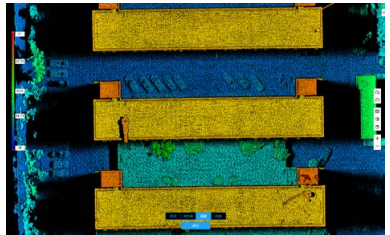
LiDAR Point Cloud Description

The L1 features two point cloud scanning methods. Users can choose between non-repetitive and repetitive scanning methods.

- A. The non-repetitive scanning method is the L1's unique LiDAR technology. It provides a near-circular FOV with a scanning density that is denser in the center of the FOV compared to the surrounding area, resulting in a more comprehensive point cloud model.



- B. The repetitive scanning method provides a flat FOV, which is similar to traditional mechanical scanning methods. It can obtain more uniform and precise scanning results compared to traditional mechanical scanning methods.

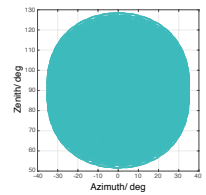
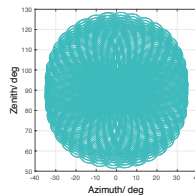
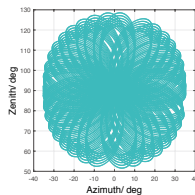
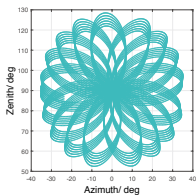


Non-Repetitive Scanning Method

Typical Point Cloud Patterns

For the non-repetitive scanning method, the L1 has a vertical FOV of 77.2° and a horizontal FOV of 70.4°. The figure below displays the typical point cloud patterns of the L1 after 0.1 s, 0.2 s, 0.5 s, and 1 s.

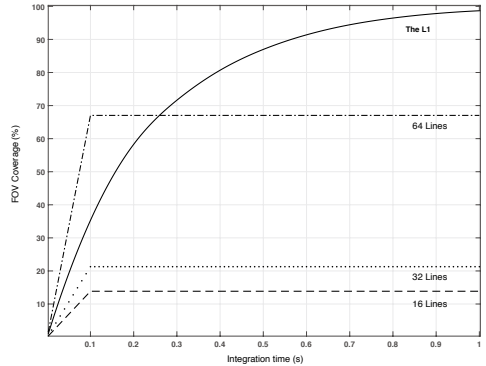
- A. Within a radius of 10° of the center of the FOV, the point cloud density rivals traditional 32-line LiDAR sensors within 0.1 s.
- B. Within a radius of 10° of the center of the FOV, the point cloud density rivals traditional 64-line LiDAR sensors within 0.2 s. The point cloud density in the rest of the FOV rivals traditional 32-line LiDAR sensors within the same time.
- C. Over time, the point cloud density and coverage inside the FOV increase significantly and reveal more detailed information of the surroundings.



FOV Coverage

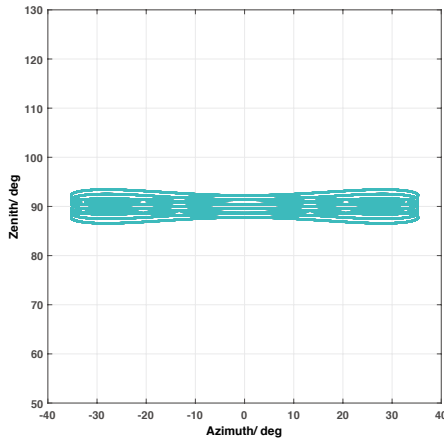
The figure below shows the FOV coverage of the L1 compared with non-L1 LiDAR sensors that use traditional mechanical scanning methods.

- A. When the integration time is less than 0.3 s, the 70% FOV coverage of the L1 is slightly better than a 64-line LiDAR sensor.
- B. As the integration time increases, however, the FOV coverage of the L1 increases significantly. After 0.8 s, almost all areas are illuminated by laser beams as the FOV coverage approaches 100%.



Repetitive Scanning Patterns

For the repetitive scanning method of L1, the scanning repeats approximately every 0.1 s, the horizontal FOV is 70.4°, the vertical FOV is 4.5°, and the vertical angular resolution is slightly better than traditional 32-line LiDAR sensors.



- Close Proximity Blind Zone: the L1 LiDAR sensor cannot precisely detect objects that are less than 1 meter away. The point cloud data may be distorted to a varying extent when the target object is within a range of 1 to 3 meters.
- The range accuracy of L1 LiDAR is 2 cm tested in an environment at a temperature of 25° C (77° F) with a target object that has a reflectivity of 80% and is 20 meters away from the L1. The actual environment may differ from the testing environment. The figure listed is for reference only.

Maintenance

Exporting Log

Go to the camera view in DJI Pilot, select ●●●, and Export Zenmuse L1 Log to export the camera log to the microSD card of the L1.

Firmware Update

Using DJI Pilot

1. Make sure that the L1 is securely mounted onto the aircraft, that there is a strong connection between the aircraft and remote controller and other DJI devices used with the aircraft, and that all devices are powered on.
2. Go to HMS in DJI Pilot, select Firmware Update, then Zenmuse L1, and follow the on-screen instructions to update the firmware. Select Update All to update all available devices simultaneously.

Using microSD Card

1. Make sure that the L1 is securely mounted onto the aircraft and the aircraft is powered off. Check that there is enough free space on the microSD card and the Intelligent Flight Batteries are fully charged.
2. Visit the Zenmuse L1 product page on the DJI official website and go to Downloads.
3. Download the latest firmware.
4. Once downloaded, copy the firmware file to the root directory of the microSD card.
5. Insert the microSD card into the microSD card slot of the L1.
6. Power on the aircraft. The gimbal and camera perform an auto-check and will start to update automatically. The gimbal will beep to indicate the status of the firmware update.
7. Restart the device after the firmware update is complete.

Update Status Alarm

Alarm	Descriptions
1 short beep	Firmware update detected. Preparing to update
4 short beeps	Updating firmware. Do not stop update
1 long beep followed by 2 short beeps	Firmware update successful
Continuous long beep	Firmware update failed. Try again and contact DJI Support if the problem persists



- Make sure that there is only one firmware update file on the microSD card.
- Do not power off the aircraft or detach the gimbal and camera while updating the firmware. It is recommended to delete the firmware update file on the microSD card once the firmware is updated.

Zenmuse L1 Calibration

Major calibration errors may result in issues such as layered point clouds and inaccurate color rendering. Select to calibrate Zenmuse L1. The L1 firmware should be v03.00.01.00 or later.

Re-calibrating the Internal and External Parameters of the L1

1. Collecting Calibration Data

Make sure that there is a facade of the building in the measurement area. Use Mapping to create a route of about 5 minutes, and enable IMU Calibration, Elevation Optimization, RGB Coloring, Single return and Repetitive scanning, and set the side overlap to 50%. Then perform the flight to collect the data.

2. Using DJI Terra to Export Calibration File

Use DJI Terra (v3.1.0 or later) to create a LiDAR Point Cloud Processing task, import the calibration data collected in step 1, and select the Scenarios as "Zenmuse L1 Calibration". Click "Export Calibration File" after the processing task is completed. The generated calibration file is the .tar file in the project folder lidars/terra_L1_cali.

It is recommended to check if the point cloud is with issues such as layered point clouds and inaccurate color rendering, go to step 3 if no; otherwise, operate step 1 and 2 again.

3. Calibrating the L1

Copy the calibration file to the root directory of the microSD card, insert the microSD card into the L1 that needs to be calibrated, install the L1 onto the M300 RTK and power on the aircraft, wait about 5 minutes to complete the calibration.

4. Checking the Result

After the calibration completed, remove the microSD card from the L1. Connect it to a computer and check the .txt format log file. If it displays all succeeded, the calibration is successful. Users can also record the point cloud data to check whether the time parameter of the .CLI file is updated.

Restoring the L1 Internal and External Parameters to Default Settings

Once the Zenmuse L1 Calibration results are not satisfied, user can also restore the L1 internal and external parameters to default settings by following below steps.

1. Create a new .txt text file, and name it as reset_cali_user. Open the file and write the SN serial number of the L1 that needs to be reset, with the format of "SN number: XXXXXXXXXXXXXXX" (find the SN serial number in the .CLI file or view in the device version information in App).

```

DJI_ZENMUSE_L1_CALIBRATION_2024_1028
INFO: [0:00] [0:00] [0:00] [0:00]
lidar calibration result: lidar to imu
version: 1.0.0.7
Sat May 25 11:01:40 2021
Headerframe:
time:
childframe:
lidar:
Obrv: x, y, z:
[0.01505077 0.99915658 0.00091147 0.00402433]
Rpy = a, unit: mm/s
[0.08 16.36 -46.44]
Roll-Pitch-Yaw (Sequence: ZYX, unit: deg):
[176.7812 -0.4601 0.0241]
RMS value of dYaw after boreight not optimization (meaning: self evaluation for optimization, unit: none, threshold: [0.6050, 0.0500]:
0.0461
RMS value for lidar plumb YZ projection detection error (meaning: lidar detection error for line direction, unit: deg, threshold: +0.07 deg):
0.0382
RMS value for gravity YZ projection evaluation (meaning: extrinsic rotation angle error, unit: deg, threshold: +0.12 deg):
0.0397
SN number: 3FCDJ5R004P198
  
```

```

reset_cali_user - 2024-10-28
SN number: 3FCDJ5R004P198
  
```

2. Copy the .txt text file to the root directory of the microSD card, insert the microSD card into the L1

that needs to be calibrated, install the L1 onto the M300 RTK and power on the aircraft, wait about 5 minutes to complete the calibration.

3. Record the point cloud data, remove the microSD card from the L1. Connect it to a computer and check the .txt format log file. If it displays all succeeded, the reset is successful. Users can also check whether the time parameter of the .CLI file is restored to the factory time.

Storage, Transportation, and Maintenance

Storage

The storage temperature range for the L1 LiDAR is from -40° to 85° C (-40° to 185° F). Keep L1 LiDAR sensors in a dry and dust-free environment.

1. Make sure the L1 LiDAR sensors are not exposed to environments containing poisonous or corrosive gases or materials.
2. DO NOT drop the L1 LiDAR sensors and be careful when placing in or taking out of storage.

Transportation

1. Before transportation, place the L1 in a suitable box for transportation and make sure it is secure. Make sure to place foam inside the transportation box and that the box is clean and dry.
2. DO NOT drop the L1 and be careful when carrying it.

Maintenance

1. Under normal circumstances, the only maintenance required for the L1 is to clean the optical window of the LiDAR sensor. Dust and stains on the optical window can negatively affect the performance of the LiDAR sensor. Make sure to regularly clean the optical window to prevent this from happening.
2. First, check the surface of the optical window to see if cleaning is necessary. If it is necessary to clean it, follow the steps below:
 - A. Use compressed or canned air. DO NOT wipe a dusty optical window as it will only cause more damage. Clean the optical window with compressed or canned air before wiping the optical window. It is not necessary to use a wipe if there is no visible stains on the optical window afterward.
 - B. Wipe the stains: DO NOT wipe using a dry lens tissue as it will scratch the surface of the optical window. Use a wet lens tissue. Wipe slowly to remove the dirt instead of redistributing it on the surface of the optical window. If the optical window is still dirty, a mild soap solution can be used to gently wash the window. Repeat Step B to remove any remaining soap residue.

Specifications

General	
Product name	ZENMUSE L1
Dimensions	152×110×169 mm
Weight	930±10 g
Power	Typical: 30 W; Max: 60 W
IP Rating	IP54
Supported Aircraft	Matrice 300 RTK
Operating Temperature Range	-20° to 50° C (-4° to 122° F) when using RGB mapping camera: 0° to 50° C (32° to 122° F)
Storage Temperature Range	-20° to 60° C (-4° to 140° F)
System Performance	
Detection Range	450 m @ 80% reflectivity, 0 klx 190 m @ 10% reflectivity, 100 klx
Point Rate	Single return: max. 240,000 pts/s Multiple return: max. 480,000 pts/s
System Accuracy (RMS 1σ)*	Horizontal: 10 cm @ 50 m Vertical: 5 cm @ 50 m
Real-Time Point Cloud Coloring Coding	Reflectivity, Height, Distance, RGB
LIDAR	
Laser Wavelength	905 nm
Beam Divergence	0.03° (Horizontal) × 0.28° (Vertical)
Ranging Accuracy (RMS 1σ)**	3 cm @ 100 m
Maximum Returns Supported	3
Scan Modes	Non-repetitive scanning pattern, Repetitive scanning pattern
FOV	Non-repetitive scanning pattern: 70.4° (horizontal) × 77.2° (vertical) Repetitive scanning pattern: 70.4° (horizontal) × 4.5° (vertical)
Laser Safety	Class 1 (IEC 60825-1:2014) (Eye Safety)
Inertial Navigation System	
IMU Update Frequency	200 Hz
Accelerometer Range	±8 g
Angular Velocity Meter Range	±2000 dps
Yaw Accuracy (RMS 1σ)*	Real-time: 0.3°, Post-processing: 0.15°
Pitch/Roll Accuracy (RMS 1σ)*	Real-time: 0.05°, Post-processing: 0.025°
Auxiliary Positioning Vision Sensor	
Resolution	1280×960
FOV	95°
RGB Mapping Camera	
Sensor Size	1 in
Effective Pixels	20 MP

Photo Size	5472×3078 (16:9), 4864×3648 (4:3), 5472×3648 (3:2)
Focal Length	8.8/24 mm (equivalent)
Shutter Speed	Mechanical shutter speed: 1/2000-8 s Electronic shutter speed: 1/8000-8 s
ISO	Video: 100-3200 (auto), 100-6400 (manual) Photo: 100-3200 (auto), 100-12800 (manual)
Aperture Range	f/2.8 - f/11
Supported File System	FAT (≤32 GB); exFAT (>32 GB)
Photo Format	JPEG
Video Format	MOV, MP4
Video Resolution	H.264, 4K: 3840×2160 30p
Gimbal	
Stabilized System	3-axis (tilt, roll, pan)
Angular Vibration Range	±0.01°
Mount	Detachable DJI SKYPORT
Controllable Range	Tilt: -120° to +30°, Pan: ±320°
Operation Modes	Follow/Free/Re-center
Data Storage	
Raw Data Storage	Photo/IMU/Point cloud/GNSS/Calibration files
Supported microSD Cards	microSD: Sequential writing speed 50 MB/s or above and UHS-I Speed Grade 3 rating or above; Max capacity: 256 GB
Recommended microSD Cards***	SanDisk Extreme 128GB UHS-I Speed Grade 3 SanDisk Extreme 64GB UHS-I Speed Grade 3 SanDisk Extreme 32GB UHS-I Speed Grade 3 SanDisk Extreme 16GB UHS-I Speed Grade 3 Lexar 1066x 128GB U3 Samsung EVO Plus 128GB
Post-Processing Software	
Supported Software	DJI Terra
Data Format	DJI Terra supports exporting standard format point cloud models: Point cloud format: PNTS/LAS/Ply/PCD/S3MB

* The accuracy was measured under the following conditions in a DJI laboratory environment: after a 5-minute warm up, using Mapping Mission with IMU Calibration enabled in DJI Pilot, and with the RTK in FIX status. The relative altitude was set to 50 m, flight speed to 10 m/s, gimbal pitch to -90°, and each straight segment of the flight route was less than 1000 m. DJI Terra was used for post-processing.

** Measured in an environment of 25° C (77° F) with a target of 80% reflectivity at a distance of 100 meters. Results may vary depending on test conditions.

*** The recommended microSD cards may be updated in future. Visit the DJI official website for the latest information.



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