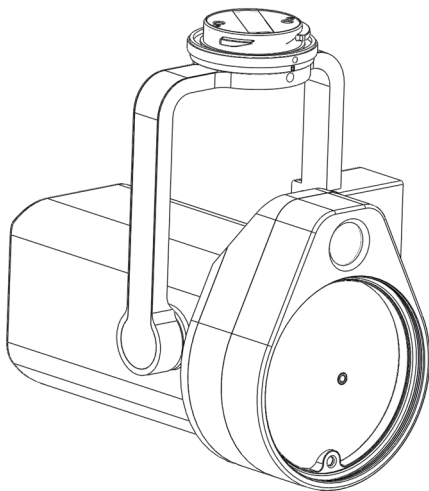




User Manual

UAV Based Laser
Methane Leakage
Detector



1

READ FIRST

Safety precautions, measuring principle, technical parameter

1.1 Safety Warning

Please read the following carefully before using this product and make sure it is operated correctly.

DANGER

When the device is turned on, do not look directly or use an optical instrument (such as a telescope or magnifying glass) to observe the laser on the front of the instrument to avoid burning your eyes!

DANGER

When the device is turned on, do not point the laser at the eyes of other people or animals. This action may cause accidental injury or damage!

DANGER

The structure of the equipment is specially designed to connect with DJI unmanned aerial vehicle. Please connect the equipment to the aircraft reliably before take-off to avoid the danger caused by accidental falling off of the equipment.



Detection Laser

LASER RADIATION
DO NOT STARE INTO BEAM
CLASS IIIR LASER PRODUCT

CAUTION

Do not attempt to repair or replace the instrument parts yourself! When the instrument does not work properly or prompts an error message, please refer to the relevant description of this manual for repair operations, or contact the manufacturer's technical staff.

CAUTION

When the device is not powered, the pitching portion can be rotated at will. When the device is powered up, it is strictly forbidden to forcibly turn the pitching part to avoid damage.

1.2 Functional Description

UAV Based Laser Methane Leakage Detector (U10) is a gas detection device for remotely measuring methane gas using a drone as a carrier. The device emits a laser, an invisible infrared laser that measures the concentration per unit (ppm.m) of methane gas present at a long distance.

1.3 Measuring Principle

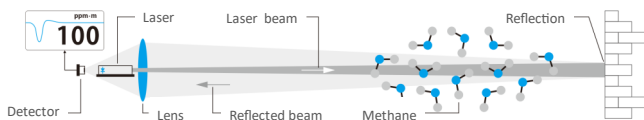
“Methane molecules absorb light of a specific wavelength”

—— Molecular Absorption Spectroscopy

“The amount of light absorbed by a transparent medium (methane gas mass) is proportional to the thickness of the air mass and the concentration of the air mass”

—— Bill Lambert's law

According to the principle, a beam of a specific wavelength can be used to penetrate the leaked methane air mass. According to the degree of weakening of the beam, the concentration of methane passing through the air mass can be measured, and only the methane is responsive (the only choice).



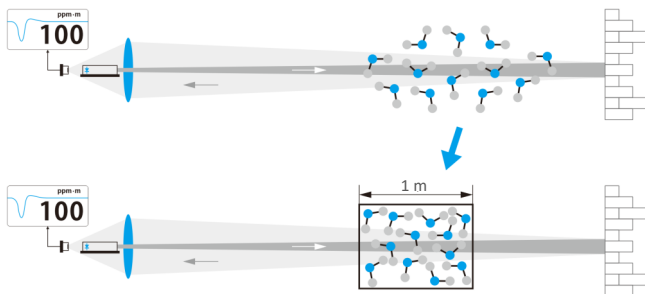
In the telemetry test, after the emitted beam passes through the leaked methane air mass, it must be reflected by the reflecting surface, and then passed through the air mass and returned to the detector, so that the instrument can complete the measurement and output the unit concentration value.

Because the leaked methane air mass drifts with the wind, it is constantly changing and unevenly distributed in space and time; the distance from the instrument to the reflector is uncertain, and the thickness of the methane gas mass is also uncertain. In order to be able to express the concentration values in this case, the concept of unit concentration (ppm.m) is commonly used in the industry to mean: methane concentration (ppm) x standard thickness (1 m).

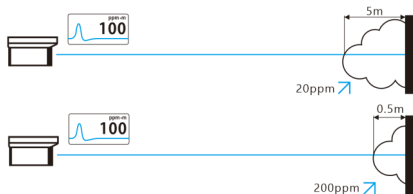
1.4 Unit Concentration (ppm.m)

“ The meaning of 100 ppm.m : to uniformly distribute 100 ppm of methane gas on a gas mass of 1 m thickness. ”

It can be approximated that the unit concentration is the concentration after the methane molecules on the straight line (laser detection line) between the telemeter and the reflection target are uniformly "compressed" or "expanded" into a region of 1 m thickness.



The instrument has a measured value of 100 ppm.m for a methane agglomerate with a thickness of 5 m and a concentration of 20 ppm on the test line, which corresponds to the air mass being "compressed" to a thickness of 1 m and a concentration of 100 ppm.



1.5 Parameters

Model	U10
Measurement object	methane (CH ₄)
Measuring principle	Laser absorption spectroscopy
Detection laser	Class IIIR
Static detection limit ^{*1}	5 ppm.m
Sampling frequency	500KHz
Response time	0.025s
Measuring range	0 ~ 50,000 ppm.m
Maximum distance ^{*2}	100m
Working temperature	-20 ~ 50 °C
Operating humidity	< 90% RH (no condensation)
Volume	L155 × W 90 × H 100mm
Weight	520 g
Image sensor	720P, 1/2.8", 12mm

*1 The static detection limit test condition is: 20 m gypsum reflection surface, static measurement.

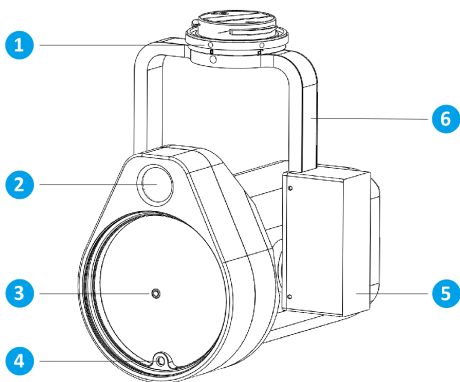
*2 The detection distance is closely related to the reflection condition. The value given here is the detection distance in the general inspection environment.

2

Composition & Maintenance

Equipment composition
and maintenance method

2.1 Equipment Composition



[1] DJI SkyPort

[2] Alignment camera

[3] Detecting laser output

[4] NC

[5] Pitch adjustment

[6] Support

2.2 Preparation Before Use

Check the integrity of the equipment and check the appearance of the equipment for damage, contamination and missing. When the equipment is not in use, it can be stored in a protective box and stored in an environment that is non-corrosive, has no strong vibration, temperature $0 \sim +40^{\circ}\text{C}$, and relative humidity is not more than 90%.

2.3 Maintenance

2.3.1 Routine Maintenance

In order to ensure the good working condition of the equipment, please follow the recommendations below for routine maintenance.

- [1] Cleaning the outer surface
 When necessary
- [2] Use special tools to clean the lens
 When polluted or periodically
- [3] Clean the Sky Port connector
 When the equipment is connected to the plane abnormally
- [4] Stored in a protective box
 Long-term use
- [5] Calibration
 Device prompt or regular

2.3.2 Optical Lens Maintenance

To clean the optical lens, first use the air blow in the maintenance tool (do not use the mouth to blow) to clean the surface dust, and then wipe it with a soft cloth cleaning cloth; if the pollution is serious, you can wipe it with an optical wipe first, then wipe it. Wipe the mirror cloth, but do not leave water stains.

Do not wipe hard when there is dust on the lens to avoid scratching the lens or damaging the optical lens.

3

Operation

Operation steps of the
device and one

3.1 Preparation

Install the U10 to the SKYPORT interface of the aircraft. If the M210 is equipped with a dual pylon, the U10 is installed to the I platform, and the IOS device is connected to the remote control via the data cable to start the aircraft and the remote control.

3.2 Disclaimer

iPad™、iPhone™ and iOS™ are products of Apple Inc. of the United States. They are supported by Apple Inc. of the United States. For instructions, please refer to the information and documentation provided by Apple Inc. of the United States.

M200 series aircraft is the product of Shenzhen DJI Innovation Technology Co., Ltd., and is supported by DJI Innovation. For instructions, please refer to the materials and documents provided by DJI Innovation.

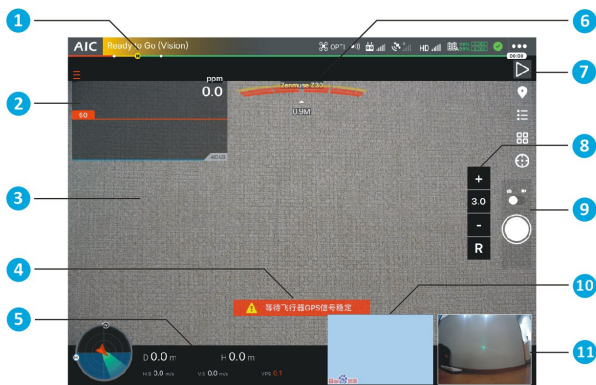
Alpha (Shandong) Instruments is an Apple-certified application provider that provides one applications based on the iOS platform.

3.3 Operation Interface

one acquires the real-time status, equipment configuration and real-time concentration of the equipment (unmanned aerial vehicle and detection equipment) through connection with the inspection equipment.

αone supports real-time drawing of the inspection route, starting with the identification as "start point"  and ending the identification as "end point" . The application automatically adds an "alarm point"  when an alarm occurs; it supports manual addition of the "attention point"  for locations that require attention. It can also attach photos and text records to alarms and events of interest.

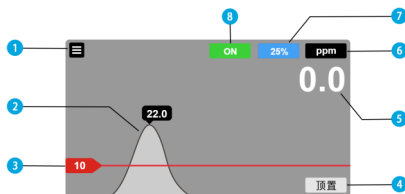
The function buttons contain functions commonly used during the inspection: "Start Patrol" , "End Patrol" , "Add Focus" , "Alarm List Edit" , "Setup" , "Back to Current Position" . With the "autonomous cruise" .



Operation interface:

- [1] UAV status bar
UAV connection status, error information, etc.
- [2] Detection data display, setting area
Gas concentration display, alarm limit setting
- [3] Main camera screen display
HD camera screen display
- [4] System message bar
System message prompt and error code display
- [5] Flight data
Show current flight altitude, speed, etc.
- [6] Forward obstacle avoidance display
Obstacle avoidance prompt and forward distance display
- [7] Inspection function
Start, end inspection, inspection report and settings, etc.
- [8] Main camera focus adjustment
Step focus adjustment
- [9] Main camera control area
Switch / turn on / end camera and video
- [10] Map display area
Display/record flight path, display alarm points
- [11] Patrol camera display
Patrol equipment comes with camera image display

3.3.1 Concentration Window



- | | | |
|-------|-------------------------|---------------------------------------|
| [1] | Basic Settings | Set alarm line |
| [2] | Concentration Curve | Historical curve, and maximum value |
| [3] | Alarm Limit | User set alarm threshold |
| [4] | Equipment Type | Display the type of connected device |
| [5] | Real-time Concentration | Display the real-time concentration |
| [6] | Unit | ppm or ppm.m |
| [7] | Laser Intensity | Display the real-time laser intensity |
| [8] | NC | |

3.3.2 Basic Settings



The back of the concentration window is the basic setting of the device, including alarm limit settings, and so on.

3.3.3 System Information

The system message contains two types of message class and alarm class. The message class prompts the current system status, and the alarm class prompts the device to make an error.

Please refer to "Appendix 1" of this manual for details.

3.3.4 Function buttons

The function buttons contain functions that are commonly used during the inspection:

- [1]  [Start Inspection](#)
Click to start recording routes and alarm points
- [2]  [End Inspection](#)
Click to end this inspection
- [3]  [Add attention](#)
Add attention point, add building detection
- [4]  [Alarm list editing](#)
Hide/show alarm point list, edit list information
- [5]  [System Configuration](#)
configuration, inspection history, offline map, etc.
- [6]  [Back to current location](#)
Navigate to the current location
- [7]  [Autonomous cruise](#)
Set autonomous cruise path and start autonomous cruise

3.4 Start

3.4.1 Login

Enter the inspector's name in the User Name box and click the "Login".

3.4.2 Start / End Inspection

After ensuring that the app is properly connected to the device, click the "Start Patrol"  to start the inspection. The system automatically adds a start identifier  to the current location.

Click the "End Patrol"  to end the inspection. The system automatically adds the end marker.

CAUTION

You must click the "Start Patrol"  to record the path and perform a concentration overrun alarm.

3.4.3 Alarm and attention

During the inspection, when an alarm event occurs, the system automatically adds an alarm flag and records the maximum value of the alarm.

If you encounter other hidden dangers, or manually determine the events to be recorded, you can click the "Add Focus" , the application will add the attention mark in the current geographic location.

3.4.4 System Configuration

Click the "System Configuration"  to open the settings menu, including software settings, system messages, inspection routes, inspection reports, offline maps, and software information. (PART 4)

3.4.5 Alarm list editing

The start point , end point , alarm point  and attention point  in the current inspection route are displayed in the alarm list. Click the “Alarm List”  to hide and display the alarm point list.

If the added point is confirmed as a serious alarm point, the left slip is set to "star point"; if it is confirmed as invalid point, the right slide is set to "invalid point" (invalid point will not be generated in the inspection report) .

Click on the corresponding point item to edit, the application will automatically locate the corresponding position of the logo and open the "information box", you can take photos / add pictures, shortcut labels, text notes.

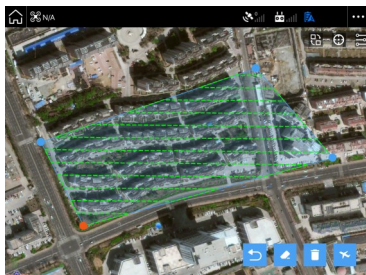


3.4.6 Autonomous cruise

one supports user-defined cruise paths, which are divided into two types of route modes: "waypoint flight" and "block scan".

Block scan mode:

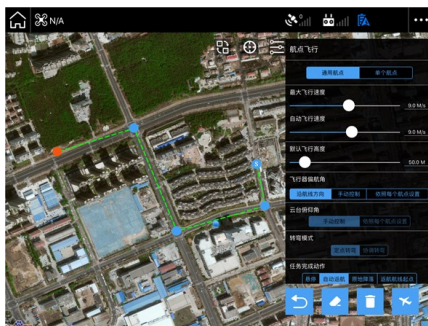
By clicking on the location of the block on the map, long press and drag the four corners to select the area. The overall parameters of the route can be set.



Waypoint flight mode:

For waypoint positioning on the map, the right setting bar can set the general properties of the entire segment or the properties of the single waypoint.

The top three button functions are "Switch Map", "My Location", "Route Edit", and the four button functions below are "return route mode", delete all waypoints, "delete the previous waypoint", "Start flying."



4

Application Settings

Introduce application settings, inspection records

4.1 Software Settings

Software settings include "alarm area", "interval", "interval distance", "alarm type customization" and so on.

[1] Alarm area

In the alarm area, if there are multiple alarms, the report only records the highest point information in the area, and the setting ranges 0m~100m.

[2] Time interval

The setting range is 0min~120min

[3] Distance interval

The setting range is 0km~5km, reconnect within the set interval time and interval, automatically continue the last inspection

[4] Alarm type

Alarm type quick classification label can be customized

[5] Other settings

Do not change the equipment for the engineer

The screenshot displays a settings menu with a dark background and white text. It includes five main sections: '报警区域' (Alarm Area) with a range of (0~100) 20 m and a description about recording the highest point; '时间间隔' (Time Interval) with a range of (0~120) 15 min; '间隔距离' (Distance Interval) with a range of (0~5) 2 km and a description about reconnecting; '报警类型自定义' (Alarm Type Customization) with a list of five categories: '误报' (False Alarm), '下水道' (Sewer), '闪光灯' (Flashlight), 'CNG汽车' (CNG Vehicle), and '施工' (Construction), each with a minus and plus button; and a footer note about the limit of 20 types and 10 additions.

报警区域	(0~100) 20 m
在设置的报警区域内, 若有多次报警, 报告只记录该区域内最高点的信息	
时间间隔	(0~120) 15 min
间隔距离	(0~5) 2 km
设备在设置的间隔时间和间隔距离内重新连接, 自动继续上次巡检	
报警类型自定义	
误报	- +
下水道	- +
闪光灯	- +
CNG汽车	- +
施工	- +

自定义常用报警类型, 类型描述字数限制为20, 最多可添加10条

4.2 Device Settings

The device settings include the "serial number", "version number", "internal parameters" of the connected device, start calibration, and so on.

4.3 System Information

The system message list is used to record important event messages that occur during system operation. For the error message processing method, please refer to "Appendix 1" of this manual.

4.4 Inspection route

The inspection route records the inspection records within one month and can be edited again before the report is generated. After the editing is completed, click "Generate Report", the system will generate a PDF inspection report for the inspection route and alarm information.

A red flag indicates that the route has not generated a patrol report. You can select multiple patrol records to generate a "patrol report".



4.5 Generate Report

Click the “Generate Report” button under “Inspection Route” to generate a report of the inspection record of the current route. In order to get accurate location information when generating a report, be sure to connect your iOS device to the Internet. After the inspection report is generated, the application will automatically jump to the preview report page.

CAUTION

Connect your iOS device to the available Internet and click Generate Report. It takes 10 to 20 seconds to generate a report. When the Internet connection is unstable or there are more reports, the time will be longer.

4.6 Inspection Report

Click “Public Inspection Report” to open the report list. The report list on the right is sorted by time. The report content is previewed on the left side. You can also output the report by e-mail or print, and delete the report.



4.6.1 Inspection Report

A typical inspection report contains the following sections

- [1] Inspection route map
 [Inspection information, equipment information and inspection map](#)
- [2] Route important alarm point
 [Details of star point, attention point, and notes on the inspection route](#)
- [3] Route alarm point
 [General alarm point information on the inspection route](#)

4.6.2 Output Report

Print the report, select the available printers correctly in the pop-up print dialog and click the "Print" button.

Before sending the report, please make sure that you have connected to the Internet. In the pop-up email sending dialog box, fill in the recipient's email address correctly and click the "Send" button. If the system prompts "The current device settings do not support sending mail", you need to first add a mail account in iOS.

4.7 Offline Map

Find the city you want to download and click to download.

Click the "Download Management" button to view the download progress or delete unwanted offline maps.

If there is an "updatable" prompt in the download management page, click to update the map of the corresponding city.

Appendix 1: Error Code

The device has a self-diagnosis function. If an error occurs, the application will give an audible prompt. At this time, an error code similar to "E001" will be displayed on the APP. The meaning of the code, device behavior and recommended disposal methods are as follows:

[E001] Ambient temperature is out of range

1. Shut down and move the device to room temperature (0 ~ 30) for 1 hour.
2. Reboot, if you repeat the error, please contact after sales

[E003] Laser intensity is too weak

1. Errors caused by foreign object occlusion will automatically recover after abnormal exclusion
2. If the error persists, please check the lens for contamination and damage; if so, please clean the lens
3. If this error occurs repeatedly, please contact after sales

[E004] Laser intensity is too strong

1. Errors caused by sudden exposure to high surface surfaces such as mirrors and glass will automatically recover after abnormal exclusion
2. If this error occurs repeatedly, please contact after sales

[E005 / E006 / E202] Temperature control is not stable

1. Shut down and move the device to room temperature (0 ~ 30) for 1 hour.
2. Reboot, if the error occurs repeatedly, please contact after sales
3. Shut down, reboot, if the error occurs repeatedly, please contact after sales

[E200] No standard gas pool detected

1. Place the standard gas cell in the upper left corner of the equipment box and re-calibrate

[E201 / E203 / E204] Configuration error

1. Shut down, reboot, if the error occurs repeatedly, please contact after sales

[E205] Calibration error

1. Shut down, reboot, if the error occurs repeatedly, please contact after sales

