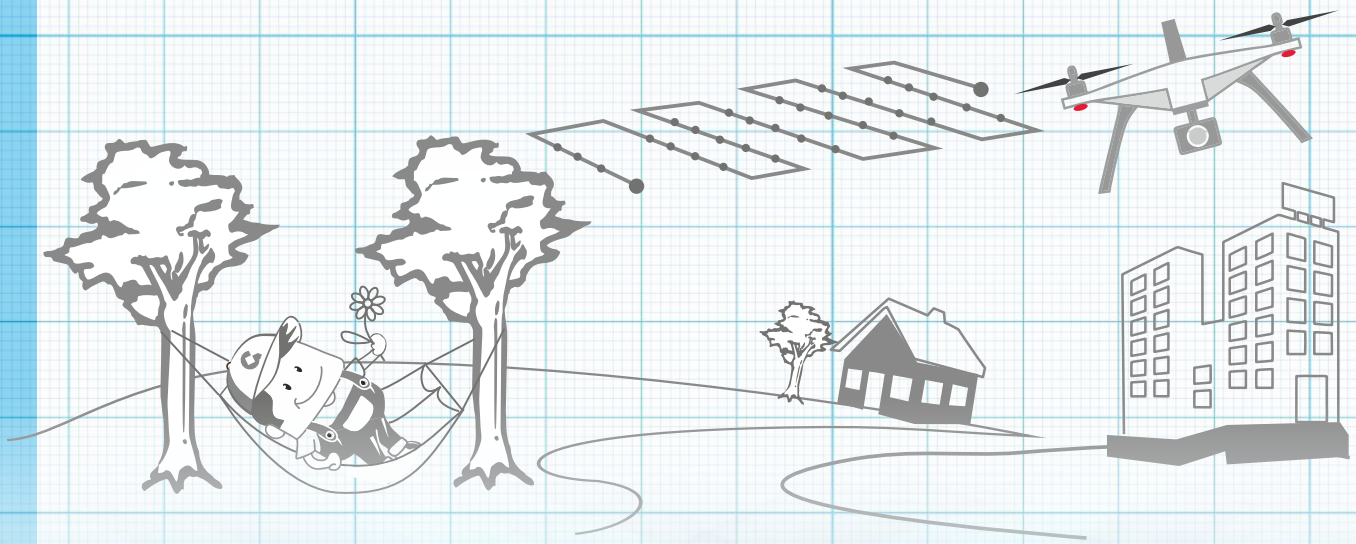
AERIAL PHOTOGRAPHY INSTRUCTIONS (APS)

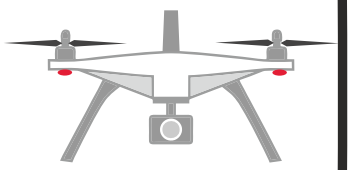
VIA PHANTOM 4
GEOBOX ONE RTK/PPK



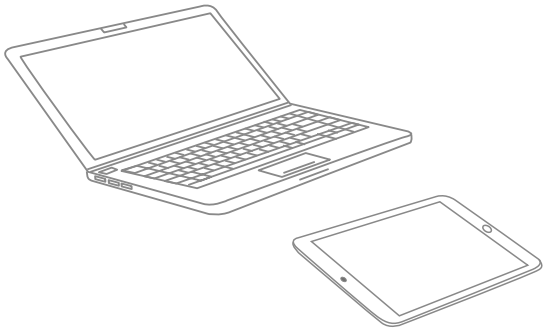
Оглавление

PLANNING THE FLIGHT ROUTE, SETTING UP THE UAV CAMERA, LAYING OUT THE MARKINGS, LAUNCHING A GEODETIC RECEIVER ON BOARD THE UAV, LAUNCHING A BASE GNSS RECEIVER AND TAKING OFF. ---------- **стр. 5**

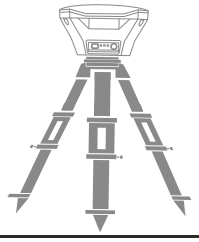
Квадрокоптер с геодезическим приемником



Планшет или компьютер с ПО для формирования полетного задания

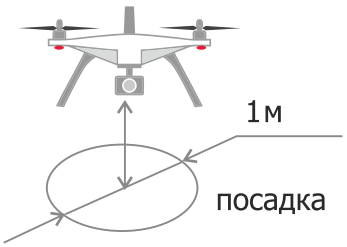


Базовая станция

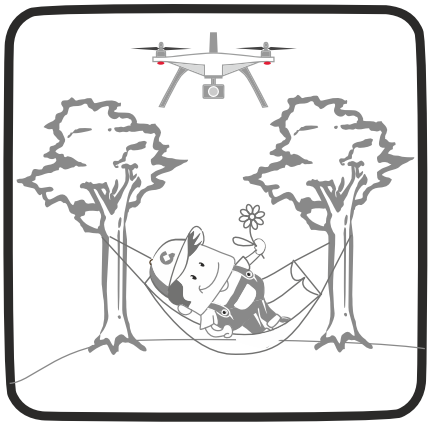


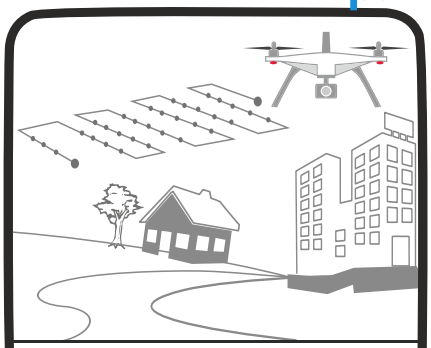
Для решения PPK нужно обеспечить референцные поправки на время полета

TAKEOFF AND LANDING OF THE UAV. ---------- **стр. 9**



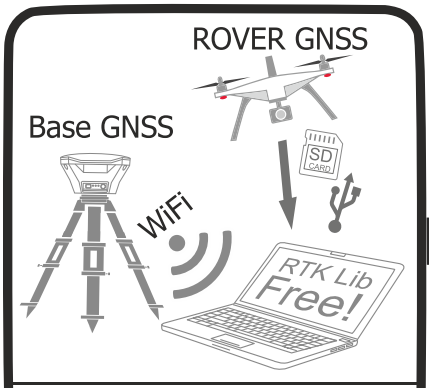
Высота полета: 60-150м





Время полета/Площадь съемки: 30 мин /40Га

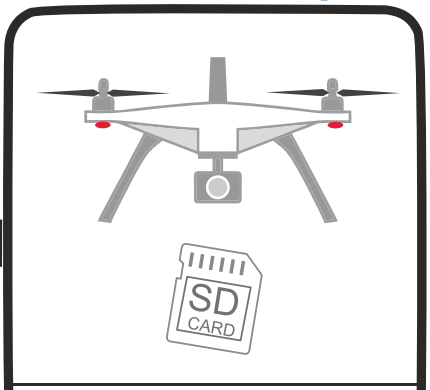
DOWNLOADING DATA FROM QUADCOPTER AND BASE STATION. ---------- **стр. 11**



Получение точных координат снимка методом PPK



Создание цифровой модели



Фотоматериалы с дрона на SD карте

POSSIBLE PROBLEMS ---------- **стр. 14**

APPENDIX 1. LIST OF THE UAV FIELD LOGBOOK FOR APS ---------- **стр. 16**

APPENDIX 1 Frequently asked questions about the tBeacon Amber UAV search beacons---------- **стр. 17**

DJI Phantom 4 GEOBOX One RTK/PPK L1/L2 Geodetic Receiver Module Specification----------стр. 19

GEOBOX®
www.geobox.pro
Geodetic accuracy for everything
@geobox
e-mail: info@geobox.pro

Attention! Work carried out with the help of UAVs is potentially dangerous and requires special attention and caution on the part of the operator.

Before starting work at the planning stage, check:

- The presence of UAV registration
- No bans on UAV flights in the field of work.
- Equipment for completeness and serviceability.
- The ability to fly based on the weather forecast.

Minimum list of required equipment:

- UAV DJI Phantom 4 Geobox RTK / PPK. Check the operation of the suspension, the condition of the motors, the condition of the contact pads of the batteries and the connector inside the case.
- U3 class memory card with a minimum of 16 GB and a maximum of 64 GB. It is advisable to have a spare.
- A charged battery or several, based on the amount of work. One battery - 17 minutes of working time or 30 hectares. Check the presence (if necessary) of the charger.
- A tablet or smartphone with sufficient battery power and a remote control cable.
- Remote control control. Check the charge level.
- Base GNSS station. Think over and solve the issue with obtaining the exact coordinates of the point of standing. Check the battery level, free space for recording the RINEX static measurement file, and sufficient accessories to install the receiver at the measurement site.

Preparation for APS

The day before working on the APS with the UAV, determine the operating time and make sure that you will have:

- **Adequate sunlight**

Determine the sunrise and sunset times. Remember that the best time for APS is around noon, when shadows from objects are minimal.
In bright light conditions, polarizing filters (CPL) and ultraviolet filters (MC UV) can be used to enhance the contrast of photographs.

Polarizing Filters (CPL) - add contrast to your photos by reducing glare, making photogrammetric processing easier. It should be borne in mind that polarizing filters slightly reduce the lens aperture (1-2 stops).

Ultraviolet filters (MC UV) – protect the camera from mechanical damage and protect photos from exposure to ultraviolet radiation. This is especially important when working in high mountain areas.

- **Good weather conditions**

When determining weather conditions, first of all, you should pay attention to two factors: visibility and wind strength.

Visibility depends on air humidity. In the event of even minimal precipitation, flights for the APS on UAVs like the DJI Phantom 4 are impossible due to the fact that the working propellers of the quadrocopter form a dense suspension of droplets in the camera area, which makes it impossible to obtain high-quality photographic material.

The maximum wind speed at which flights are recommended is 10 m/s or 36 km/h. It is better not to fly in such winds, since the UAV's speed upwind is very low, and the probability of an accident during landing or takeoff is high.

Number of visible satellites. The minimum number of visible satellites, at which it is possible to perform APS from the UAV, is 9. A smaller number can lead to the loss of the navigation solution and the need to switch to manual control mode.

A complete weather forecast before planning a flight, as well as information about the nearest airfields and prohibited places, can be obtained in the program for a tablet or smartphone - UAV Forecast (Figure 1).

As can be seen from the figure, today is unfavorable for apparently suitable satellite positions for calculating.

Users of the DJI Phantom 4 Geobox UAV in such an environment should be prepared to switch the drone from automatic to manual mode and perform a manual return.

At the time of the flight, the weather should be entered in the flight log. A sample flight log page is provided in аршешщт 1 to this manual.

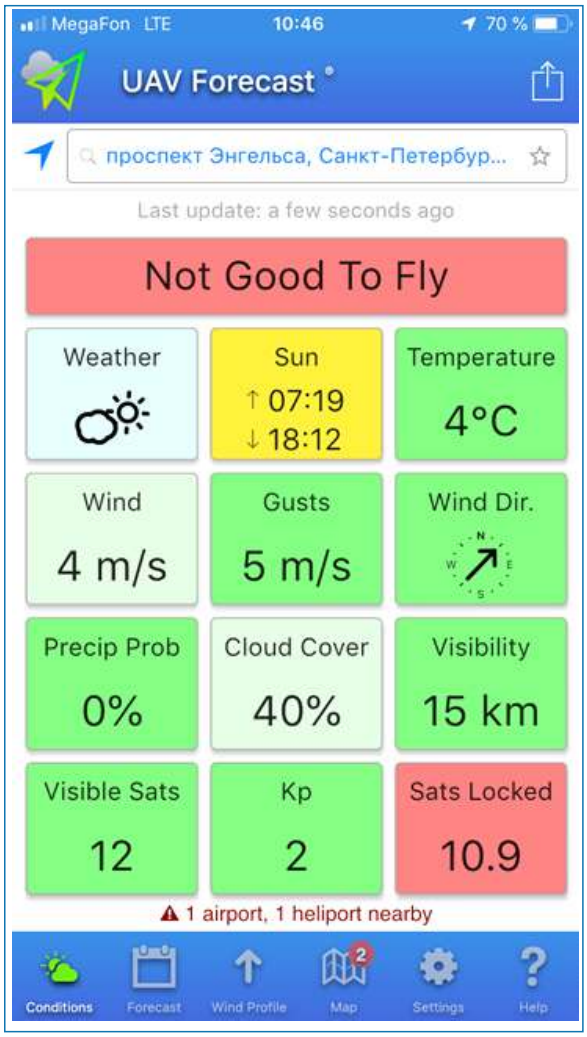


Figure 1

Planning the flight route, setting up the UAV camera, laying out the markings, launching a geodetic receiver on board the UAV, launching a base GNSS receiver and taking off.

Flight route planning

To obtain photogrammetric materials, it is required to fly over the entire survey area and collect a sufficient number of high-quality photographs with overlapping areas, sufficient for the photogrammetric program to find common points and build a digital model. To do this, you can use in different ways:

- **Flight planner program.**

When using flight planner programs, the route is built automatically. The user can change the amount of overlap, altitude and flight speed.
Examples of programs:

Pix4Dcapture, DroneDeploy, MapPilot, Atizure
Usually, programs with paid content have great functionality.
So, for example, the MapPilot flight planner, in addition to the standard functionality, offers:

- work with KML (it is convenient to highlight the area of the necessary flights);
- special shooting mode for linear objects;
- the ability to fly taking into account the relief (up to 66 latitude!).

Most programs have a free or trial mode.

We should also mention the software product **UgCS (Photogrammetry tool for land surveying).**

It is a professional product for efficient planning of flight missions. It consists of a module that is installed on the flight pad and a module that is installed on the computer.

The route is built in a module that is installed on a stationary computer or laptop. When planning a route, you can take into account the features of the relief.

When leaving for the place of work, the tablet, according to a pre-created mission, loads the mission into the UAV and provides a full interface for monitoring and controlling the flight.

- **Manual flight mode.**

This mode is often preferred by experienced pilots, as it helps to complete the mission faster. At the same time, the drone takes off, it turns on automatic mode according to the shooting time interval (usually one photo per 2 seconds) and flies to the shooting area. DJI GO 4 software shows the flight path and can be corrected to cover blind spots.

This mode can be recommended:

- experienced pilots;
- with small volumes of shooting;
- in conditions where there is a high risk of failure of the UAV navigation system.

It is also possible and effective to use non-APS flight planners such as Litchi. This type of planner does not have functions for constructing areas of overlap, but only builds a trajectory. The user himself, based on his requirements, builds parallel tacks, and the UAV flies with an automatically operating camera (from 1 frame per second to 2).

Litchi has an Internet resource where you can plan your route on a large computer. The UAV will fly along the optimal trajectory and will not stop at each turning point, but will turn in a bend, which significantly reduces flight time and provides significantly greater productivity.

Attention! The range of the camera - 1 time per second is possible only when using the additional Ashot module in the UAV./

Attention!
The optimal course for a drone-type UAV is the course at which the wind comes from the traverse (90 degrees off the course). Such a course significantly increases the flight time and reduces the risk of abnormal situations.

UAV camera setup

Adjusting camera settings is not an easy task, as there are many factors to consider that affect the quality of your images. The result is getting clear and high-quality photos. While this is easy enough to do in good light conditions, when lighting problems you have to find compromises between different settings, such as sensitivity (ISO), exposure time (Shutter), speed and altitude.

General recommendations:

- Shooting mode: S (shutter speed automatic).
- ISO: 100 to 200.
- Shutter speed: from 1/600 or less, but not less than 1/2000.

At a shutter speed of 1/2000 or less, the mechanical shutter stops working!

By focusing - it is recommended that after takeoff to the operating altitude, switch to the real image from the copter and focus the camera.
Layout of signs.

An identification mark is an element clearly visible in a photograph with a pronounced center, the coordinates of which are known. It can be of natural origin (for example, a part of road markings) or artificial (drawing with paint on a stone or ground marker Geobox OP).

Feature coordinates are usually determined using RTK. When flying with a geodetic receiver on board, solving the problem of the scale and orientation of a digital terrain model or structure is carried out by accurately determining the position of the center of the camera using satellite measurements.
However, when using UAV for APS, it is strongly recommended to use ground landmarks. In the case of a geodetic receiver on board, ground landmarks have the following functions:

- Fiscal. By determining the coordinates of the tags on the resulting model, we find out the accuracy of our model. In the case of difficult terrain, we have the opportunity to improve the accuracy of the model.
- Duplicate. In case of problems with obtaining a fixed solution using satellite measurements, we can always use ground-based landmarks to solve the scale and orientation of the model.

Signs should be laid out along the border of the site and the survey and, if possible, at points with the maximum and minimum values in height.

Launching a base GNSS receiver and rover (UAV)

The GNSS solution method used in the DJI Phantom 4 UAV is called PPK (ppk - post processing kinematic), which means “post processing kinematic processing”. That is, we launch two receivers to record Rinex files. One receiver is on the ground, at a point with known coordinates, the other is on board the UAV. After the flight, we combine these two files in the post-processing program RTKLib, TopconTools, Magnet or any other that supports this mode.
RTKlib software is free and available for download at geobox.pro.
RTKLib only works in WGS-84 coordinate system. Transition to other coordinate systems is possible in photogrammetric processing programs.

As a base receiver, you can use a GNSS station of a network of differential amendments. After the flights, you can request a Rinex file for the duration of the flight. When using **DJI Phantom 4 GEOBOX RTK/PPK L1 / L2** the distance to the base receiver from the work site should not exceed 50 km.

Working with geodetic GNSS receiver DJI Phantom 4 GEOBOX RTK PPK L1/L2

When the UAV is powered up, the receiver automatically starts recording data.
On the top of the receiver there is a connector for a helical antenna and 4 LED indicators that show the status of the receiver:

- Red LED indicates power supply
- The blue indicator may be blinking or solid. Blinking signals that the navigation solution was not received from the satellite. Continuous burning - navigation solution received and the receiver is working properly
- The green indicator signals that data is being written to the SD card
- The red indicator signals the moment when the shutter is released, which is recorded as a time mark in the Rinex file

By default the receiver is configured to accept two navigation systems - GPS and GLONAS with a recording frequency of 10 Hz.

DJI Phantom 4 GEOBOX RTK PPK GNSS Receiver Data Download

Data can be transferred from the receiver for further processing in two ways:

- Cable connection. When connected to a computer with a USB-Micro USB cable, the contents of the SD card are made available as external flash memory
- Mechanical removal of an SD card and work with it as a portable flash drive.

The **DJI Phantom 4 GEOBOX RTK/PPK L1 / L2 GNSS** receiver automatically creates folder. Folder name - date of work in the format day of month, number of month, year.
The folder contains data files. By the time the file was created, you can easily find necessary materials.

Takeoff and landing of the UAV

- Check the DJI GO 4 software interface for drone errors.
- Format the memory card.
- Perform forced calibration of the UAV magnetometer. To do this, turn on / off the flight mode change switch (P, S, A) three times and follow the instructions that will appear on the application screen.

It is better to take off the UAV from a prepared site, since the UAV during takeoff raises a suspension of earth and dust, which falls on the camera and other vulnerable parts of the geodesic quadcopter, thereby increasing wear and reducing the service life of the device.

As a takeoff platform, you can use a transport case from a **DJI Phantom 4 GEOBOX RTK/PPK** quadrocopter or a ground-based Geobox OP. It is strongly not recommended to take off from the car, as this is guaranteed to cause a failure of the UAV magnetometer.

The landing of the **DJI Phantom 4 GEOBOX RTK/PPK UAV** is comfortable and convenient to carry out in the hands, since the drone of this type is small and has legs-bases that are easy to grip by hand.
Be especially careful during takeoff and landing of the UAV.

Attention!
It is strongly recommended to carry out work on APS on a DJI Phantom 4 GEOBOX RTK/PPK UAV only if you have basic experience in piloting this type of quadcopter in manual mode!

Flight

Despite the fact that most flights take place in automatic mode, the external pilot of the UAV must fully control the process of completing the mission, not be distracted from the drone interface and, if possible, visually observe it or see the video image that it transmits.
For the convenience of work, it is recommended to fasten the control panel with the tablet with a belt and hang it around the neck: in the event of an emergency situation, the UAV operator should have his hands free.It is recommended to have on hand binoculars or a monocular with good magnification and a large viewing angle for visual control of the UAV.

After take-off, the operator must monitor and pay particular attention to the following steps:

1) Takeoff and climb.
2) Choosing the correct UAV course to the starting point of the mission (if any).
3) Change of working tacks. At the time of a tack change, the UAV is precisely centered over the pivot point while rotating. The drone's navigation system is at its maximum at this moment.
4) Landing. The final part of the landing is recommended to be performed manually and to land the drone on the hands of the operator or assistant.
5) Change of batteries. When changing the battery and taking off, pay attention to the blue status indicator of the navigation solution - the indicator should be on continuously.
6) When changing and installing batteries, pay attention to the correct installation of the battery. The battery must be in contact with the housing with a minimum clearance. When changing batteries, pay attention to the temperature of the battery contact pad - if your hand cannot tolerate touching the back of the battery, then stop flying and service the contacts.

Attention!
The maximum flight time of the DJI Phantom 4 GEOBOX RTK/PPK L1 / L2 is 30 minutes, but of which only 20 minutes are operational. Avoid discharging batteries to more than 25%. This has a bad effect on the lifespan of the elements. A weak battery can lead to abnormal landing situations, when a discharged battery will not be able to provide the necessary power to the motors and, as a consequence, the controllability of the UAV.

Downloading data from quadcopter and base station.

After the end of the flight, it is necessary to retrieve data from the quadcopter and the base station.
In total, we need to get four arrays of information to obtain the result of the APS work.

■ The most valuable and largest volume of information is photographs from the UAV. Photos are such a valuable source that often the cost of a drone does not differ much from the cost of photographs on board, so try to save photos on a computer for large volumes of work. In the UAV, photographs are recorded on a MicroSD card.

■ **DJI Phantom 4 GEOBOX RTK/PPK L1 / L2** GNSS Receiver Data Download. Data can be transferred from the receiver for further processing in two ways:

· Cable connection. When connected to a computer using a USB-Micro USB cable, the contents of the

SD card are available as an external flash memory

· Mechanical removal of an SD card and work with it as a portable flash drive. The **DJI DJI Phantom 4 GEOBOX RTK/PPK L1 / L2** GNSS receiver automatically creates a folder before starting work. Folder name - date of work in the format day of the month, number of the month,year. The folder contains data files. By the time the file was created, you can easily find the necessary materials.

■ Rinex file from base receiver. In the case of using a receiver manufactured by Emlid or any other receiver with a WEB interface, the actions are the same as in paragraph 2 of this section.
Receivers without WEB interface are connected to download the Rinex file using the method recommended by the manufacturer.
When using a differential correction network as a GNSS base receiver, you must make sure in advance that the station is active and is recording its measurements.
Most operators of differential correction networks charge access to Rinex measurement files.

Measurement processing

Offset coefficients of your quadcopter: X=0, Y=0, z=0,06

What we have:

· Aerial photography (photographs from a UAV camera) (photographs have a rough geodetic reference in the EXIF field)

· Onboard GNSS receiver data (Geobox FORA ONE) - raw data with a frequency of at least 5Hz, at least 5 GPS satellites for continuous tracking along the entire flight path)

· Basic receiver data ("raw" data in RINEX format with a recording frequency of at least 1 Hz, with a maximum distance from the place of work in ideal conditions no more than 20 km.)

It is required to get:

3D model of the object (point cloud, elevation map).
General description of actions:

■ The drone flies and takes photos of the surface with some overlap - from 50% between adjacent images and more - so that each object of the reconstructed scene is visible from at least 2 angles. In parallel, it records raw data from the GNSS receiver to obtain an accurate track of its movement. The signal from the camera shutter is registered by the GNSS receiver as an external event. It fixes hardware delays before processing. Further, these moments get their coordinates on the track using linear interpolation.

■ The data is loaded into the photogrammetric processing software. Having loaded the images, their exact coordinates, the parameters of the offset between the center of the camera and the center of the antenna, camera calibration, the program aligns the photos and builds a sparse cloud of points. The entire assessment of the accuracy of the reconstructed scene and the output results is evaluated precisely on it. After its construction, the coordinates of ground landmarks are loaded to control the accuracy on them. If necessary, they can be used for model planting as reference ones. At this stage, it is recommended to create a processing report. Then all the other necessary elements of the project are formed.

Step by step algorithm: processing

1) Data download (described in the section “Downloading data from a quadcopter and base station” on page 10 of this manual).

2) Create a folder with the name of the project (it is advisable to create folders of the same type and include information about: the date of the survey, the location of the survey, the model and serial number of the copter, the flight number in order if there are several of them - for example 2019-03-25_RUDA_DJI #### _ Fly001) with the following folders inside:

- Photos
- GNSS (drone GNSS raw data)
- Base (raw data from GNSS base)
- PVO (base coordinates, identification catalog, local system keys)
- Processing (folder with the project of photogrammetric processing software)
- Results (export results from photogrammetric processing software)

3) Download the photo from the microSD card removed from the drone to the photo folder (it is important to track that the pictures refer to this particular project by the time the files were created).

4) Download data from the quadcopter in the UBX.zip format to the GNSS folder (described in the section "Downloading data from the quadcopter and base station" of this manual).

5) Unpack «xxx.log» into GNSS folder, get UBX.

6) Convert UBX to rinex 3.03 using the RTKconv program (you can select the format by clicking the Options button, for this you need to start the RTKconv program, click the [...] button, select the UBX file, select the u-block format, then click Convert - the minimum should be formed in the GNSS folder 2 additional files with * .obs and * .nav extensions
(Latitude, Longitude, Height,) as well as the height of the antenna, if the base was used in the field.

7) Launch the GeoboxUAV program, then Rinex processing, select the type of drone (Phantom 4), select the file with tags (rinex .obs format).

8) Launch RTKPost.

- Download Rinex Rover from a copter (rinex.O) (observation).
- Download Rinex Base from the database (rinex.O) (observation).
- Load Rinex Nav from copter (rinex.N) (navigation).
- Go to Options and in the Positions section set known (well-defined) geodetic coordinates of the base Lat, Long, Heith (Latitude, Longitude, Height,) as well as the height of the antenna, if the base was used in the field.

When the settings are set, click Execute, watch the Q index.

- Fixed solution. Index Q = 1 (accuracy of solution of photographing centers - 2cm plan, 3cm height).
- Floating solution. Q = 2 (the accuracy of the solution of the photographing centers is 20-30cm plan, 20-30cm height).
- Q = 5 - a code solution that does not provide sufficient accuracy for further processing.
- Q = 0 - no solutions found at all - check the loaded data of the base and rover (UAV).

After the Execute procedure, it is necessary to press the Plot button to view the flight trajectory; by the nature of the trajectory, one can judge the quality of the processing of the "raw" data. By the color of the trajectory points, one can understand the processing quality for each point: red - a code solution (insufficient for further work), yellow - a floating solution (enough for rough processing of data with a high horizontal and vertical error from 20-40 cm, mandatory use of marks to improve accuracy), green - a fixed solution (allows you to process data with an accuracy of 3 cm to 10 cm in plan and height, it is possible not to use landmarks).

9) In the rover folder (GNSS) we find files named * .pos (full flight track) and * _events.pos (interpolated moments of photographing).10) It is necessary to match the number of photos and the number of events in the _events.pos file. To do this, open the folder with the photo and count the number of files in the folder, it is extremely important that there are NO EXTRAORDINARY FILES (SYSTEM, HIDDEN, ETC.) in the folder with photos, open the _events.pos file using a text editor that displays line numbers. If the number of photos and markers is the same, then proceed to the next step.

11) Open the GeoboxUAV program, press the second button (Create geotag list), select RTK Lib in Knd of Lib, Photos folder in Directory with photos, File with cords - _events.pos, press Create. At the output, in the GNSS folder, we get the file "filename.CSV".

For further steps, refer to the documentation for the photogrammetric software you are using. This manual briefly describes the steps in AgiSoft MetaShape as an example.

12) Open MetaShape, load photos using Processing -> Add Photos, select all photos from the Photos folder. Next, on the Binding panel, find the import button, click and select the .CSV file.

13) Then go to Tools -> Camera Calibration, go to the GPS and NS Correction tab, check the Enable snapping box, specify the values Y = 0.08, Z = 0.25, click OK.14) On the Binding panel, click the Binding parameters button, set the camera binding accuracy to 1m.
15) Next, Processing -> Align Photos.

16) We evaluate the accuracy of the binding of photographing centers - on the Binding panel, switch the mode to the View errors mode, at the bottom of the list of coordinates of the attached photographs there is a line General error in X, Y, Z.

Loading of signs.

17) To load the tags, click the Import button from the Binding panel. Then select the CSV file with the coordinates of the signs, when loading, specify the correct column separator and check the order of the Name, Latitude, Longitude, Height columns. Then click OK, and in the dialog box that appears, click "Yes, for everyone."

18) The coordinates of the markers will appear in the second list from the top (list). Right-click on one of the markers and click. Filter by markers. After that, the program leaves in the list of photos only those photos in which this (selected) marker is visible.

19) In the window with filtered photos, double-click to open the photo and correct the marker position with the mouse. This operation should be repeated with all markers.

Possible problems.

Rinex file recording missing shutter mark time.

Check the event feed from the camera to the **Emlid Reach M +** board. To do this, open the receiver's WEB interface and go to the “Camera Control” section (see Figure 6). We check the recording of events from the camera triggering. On the DJI remote control, press the "capture" button. If the drone is nearby, then we will hear the shutter click and the entry in the "Camera Events" section will be updated. If this did not happen, then it is necessary to look for the cause.

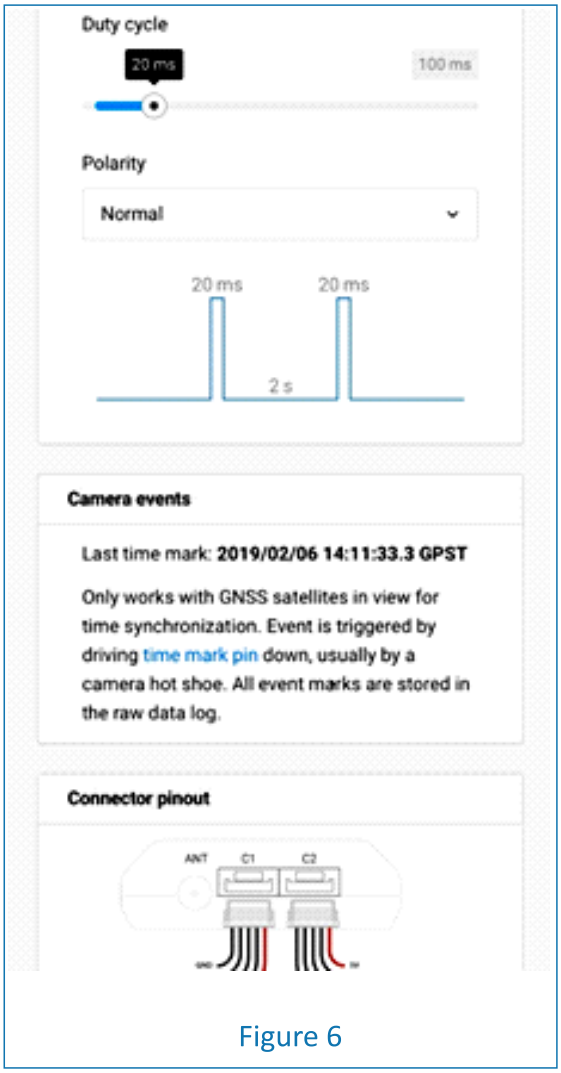


Figure 6

Possible reasons:

- Exposure costs less than 1/2000.
- In the camera menu in the "Mechanical Shutter" properties, the switch is not in the "on" position (figure 7). In the figure, it is turned on.

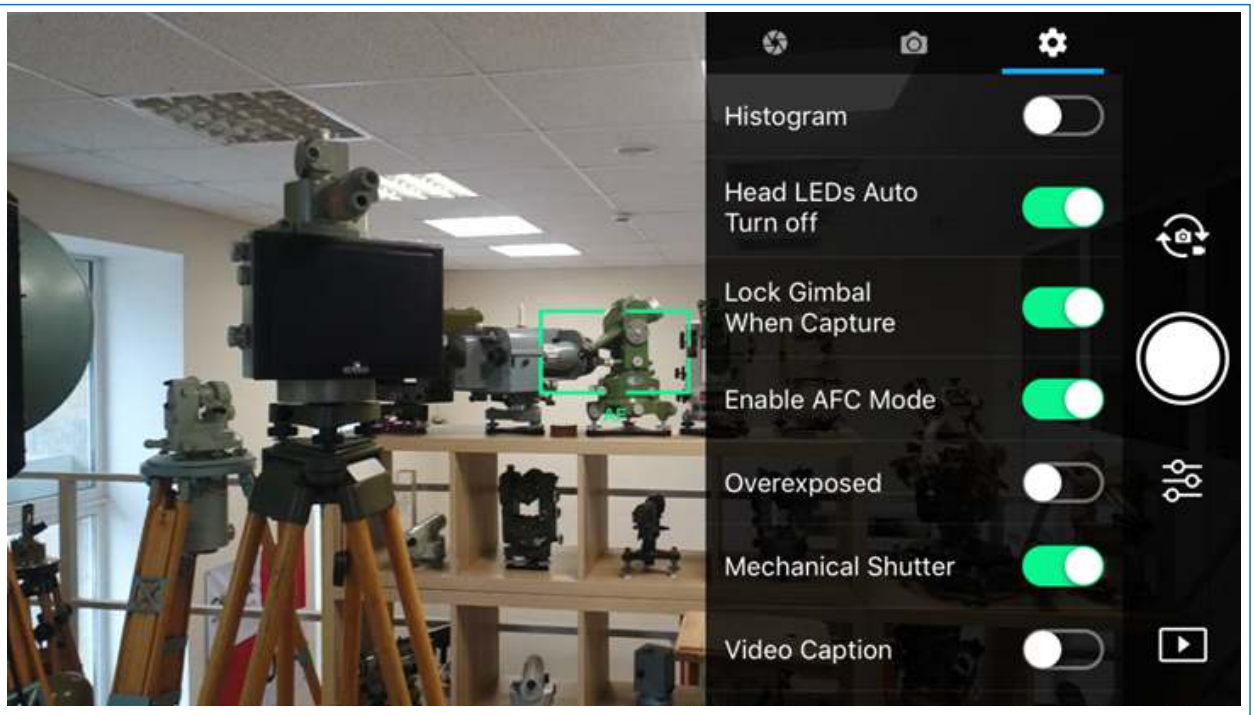


Figure 7

The Emlid Reach M + module distributes Wi-Fi, but the connection to the WEB interface does not occur.

Possible reasons:

- The module starts its operating system only when it receives the time value from the satellites. Make sure the GNSS antenna is installed and the UAV is in a location with good sky visibility.
- Sometimes the connection fails and the receiver does not connect over the Wi-Fi network correctly. In this case, on the start page of the Reach View program, we see not the network address 192.168.42.1 under the name of the receiver, but the MAC address. In this case, disconnect the Wi-Fi connection and reconnect to the receiver.

There are gaps in the Rinex UAV file - the number of events is less than the number of photos.

Possible reason:

- Check that the settings are correct in the RTK Settings section. The processor of the module may not cope with the load and make gaps if the measurement frequency is set to more than 5 Hz and more than 2 navigation systems are recorded.

Recommended settings for the central part of the Russian Federation:
Systems: GPS, Glonass.
Frequency: 5HZ

FLIGHT № | FLIGHT DATE | FLIGHT TIME

UAV NAME

CAMERA COEFFICIENTS

X

Y

Z

WEATHER FORECAST

Magnetic Activity Index

Temperature

Cloudy

Wind Strength And Direction

SOLUTION METHOD

☐ PPK

☐ RTK

☐ GCPs

Exposure ☐ 1/800 ☐ 1/1000 ☐ ☐ auto

Diaphragm ☐ 2,8 ☐ 5,6 ☐ auto ☐ num. of photos

ISO: ☐ 100 ☐ 200 ☐ 400 ☐ 800 ☐ 1000 ☐ auto

Flight Speed m/s

Snapshot stops ☐ yes ☐ no

Quantity and scheme GCPs

Scheduler software ☐ PC ☐ iOS ☐ Android

Battery level before start ☐ RMC ☐ UAV

Base Coordinates X | Y | Z

Tripod Height

File type ☐ UBX ☐ RINEX

File name

Tripod Height

Systems used

☐ GLONASS ☐ GPS ☐ Gallileo

Frequency ☐ L1 ☐ L2

Recording Frequency ☐ 5 Hz ☐ 10 Hz ☐ 1 Hz

Rover

File name

File Path

Constellation

☐ GLONASS ☐ GPS ☐ Gallileo

Frequency ☐ L1 ☐ L2

Recording Frequency ☐ 10 Hz ☐ 15 Hz

Frequently asked questions about the tBeacon Amber UAV search beacon

Question: What else do I need besides the actual beacon of the lost UAV?

Answer: To search for a beacon, you need a walkie-talkie, preferably with support for a 1750Hz ringing tone (toneburst).

Question: At what frequencies does the beacon work?

Answer: From 413M Hz to 490M Hz. This includes all authorized VHF bands: LPD, PMR, FRS / GMRS.

Question: Where does the beacon get the GPS coordinates from?
Answer: The lighthouse takes coordinates from the UAV navigation module.

Question: How to activate the beacon from the radio? What is ToneBurst?

Answer: The beacon is activated when it hears an audio tone with a frequency of 1750 Hz on the air. This tone is called ToneBurst and is intended to open up amateur radio repeaters. By default, the beacon listens to the air with an interval of 3 seconds, that is, to guarantee the activation of the beacon, you need to send a signal on air for a little more than 3 seconds.

Question: Can the beacon be activated if my radio does not support ToneBurst?

Answer: Yes. You can use a CTCSS subtone or generate a tone of the desired frequency, for example on a smartphone.

Question: How accurate are the coordinates of the beacon?

Answer: Sub-meter accuracy.
It is possible that, after a fall, the GPS antenna is turned upside down or is shaded by something, then the accuracy of the coordinates will drop, but the deviation is unlikely to exceed 10 meters. Another nuance that you should be aware of. The lighthouse does not read the coordinates all the time, but at a specified interval, by default it is 10 seconds. Those. a situation is likely when the beacon reads the coordinates in flight, and after 9 seconds the aircraft will fall to the ground and de-energize. In this case, the beacon will remember the last coordinates (in flight) and the point of incidence will be at a distance from the memorized coordinates, determined by the speed of the model.

Question: How to find a lost device with a beacon correctly?

Answer: First, you need to decide on the search area. If you are in the lowlands, move as high as possible and try to summon the beacon. If he answered, then half of the work is done, we drive the obtained coordinates into our favorite navigator and go in search. If there is no answer, then either the beacon does not hear us, or (more likely) we do not hear it. It is necessary to move either higher or closer to the intended area of the fall, or simply change the location for good luck. Eventually, you should hear the beacon and accept the coordinates. If for some reason there are no coordinates, then "fox hunting" comes to the rescue. The fact is that the three tones emitted by the beacon have different power: the first is the most powerful, the second is weaker, the third is very weak. Thus, shielding the radio with a body or improvised materials, we determine from which side the strongest (clean) signal comes. In Proximity mode the task is simplified - there is no need to determine the signal level "by eye"; the lighthouse itself communicates this by voice. Taking several bearings from different points, we build them on the map and get the point of their intersection, in which the desired item is located. Or you can act in a simple way: go where the signal is stronger. You may have to stray more, but you don't need a map or a compass.

Question: What is the range of the beacon?

Answer: If there is a line of sight, correct antennas and no interference, the range is not limited by common sense, it is tens, or even hundreds of kilometers. In practice, of course, everything is not so rosy and depends on many factors, mainly on the presence / absence of line of sight. Usually it is possible to activate and receive a beacon in the city, in the absence of line of sight, at a distance of more than 3 km. And this is with an ordinary standard antenna "sausage" and without even leaving the car. Although, of course, at the limit of audibility. The theoretical range of radio communication in ideal conditions when the lighthouse is at ground level, and the radio in the hands of an adult is about 4 km.

Question: How long does the lighthouse last?

Answer: With default settings and a 60 mAh battery, the beacon lives in standby mode for about 6-7 days. With the proper skill and willingness to make compromises, you can bring this time to a month or more. And vice versa, it can be configured so that it won't last a day, the battery life decreases with each call and is in direct proportion to the battery capacity.

DJI Phantom 4 GEOBOX One RTK/PPK L1/L2 Geodetic Receiver Module Specification

Short description:
Versatile, modular, compact, centimeter-accurate geodetic receiver. GLONASS (L1,L2), GPS/QZSS (L1,L2), BeiDou (B1,B2), Galileo (E1,E5) SBAS. Operating modes: PPK logger, static, RTK, kinematic, transmission of geo corrections. Easy integration into any system: power supply 5V USB, RS-232, USB, UART, SD card Up to 32Gb

Characteristics	Values
Receiver type	Modular
Number of channels	186
Body material	High strength plastic
Dimensions, mm	38 x 45 x 10 mm
Weight with batteries	15g
SD card slot	Yes. Up to 32Gb
Working temperature range	
Indicators and controls	
LED indicators	4 indicators: power, navigation solution, SD card recording, shutter release.
Connectors available on the case	
USB	External power connection, access to SD card in flash memory mode
UART	Multifunctional expansion connector.
High frequency connector	External helical GNSS antenna (included)
Communication	
Output formats	ASCII: NMEA-0183, NMEA2000
Binary protocol	Crescent binary
Power	
External power	Micro USB 5 B
Precision and performance	
Received signals	GPS/QZSS L1C/A, L2C, ГЛОНАСС L1OF, L2OF, BeiDou
Initialization time	Less then 10 sec
Positioning frequency	Standard up to 5 Hz to 20 Hz
Accuracy	
Statics (plan)	2,5 mm ± 0.5 mm/km
Statics (height)	5 mm ± 0.5 mm/km
Fast statics (plan)	5 mm ± 0.5 mm/km
Fast static (height)	10 mm ± 0.5 mm/km
RTK (plan)	8 mm ± 0.5 mm/km
RTK (height)	15 mm ± 0.5 mm/km
Warranty	
24 months extended warranty (free device replacement during diagnostics and repair)	

