Geoscan 401

User Manual

Updated on September 21, 2023

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Introduction

Thank you for choosing Geoscan 401 UAV!

This manual is designed to describe UAV structure and the operating rules. We highly recommend to read the manual carefully before using UAV.

If you have any questions about UAV, technical service and repair, please contact our support: *https://www.geoscan.ru/en/support*.

We always glad to help you and answer any questions about product.

The information, specifications and pictures in this manual are relevant at the time of publication. Geoscan Group may change the UAV design or specifications without prior notice.

Do not make any changes to UAV structure by yourself. Any UAV damages or degraded specifications caused by structure changes are not covered by the warranty.

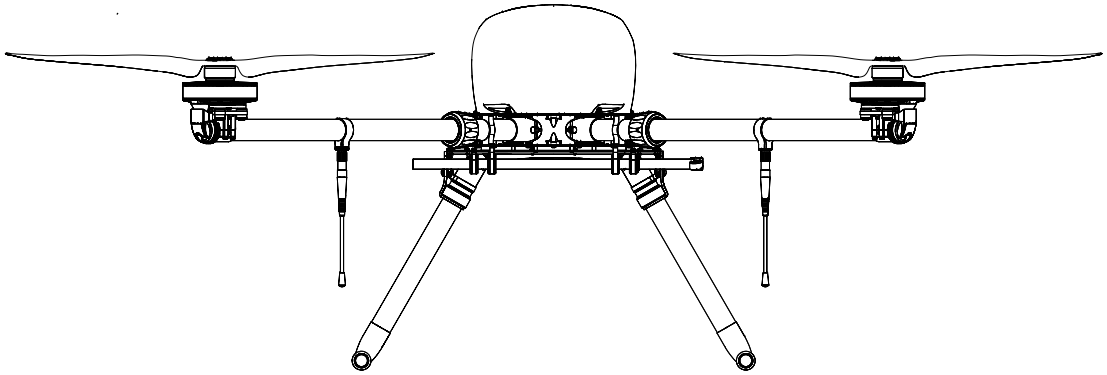
We always work to make our products better and add new features. You can always download the newest version of this manual from our website:
https://www.geoscan.ru/ru/products/401

This mark highlights important information and recommendations. It is necessary to follow these instructions for people and UAV safety.

Abbreviations

CPS	Count Per Second
GNSS	Global Navigation Satellite System
UAV	Unmanned Aerial Vehicle
USB	Universal Serial Bus

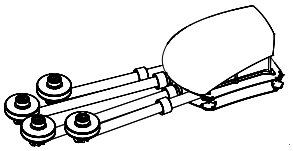
Main Information



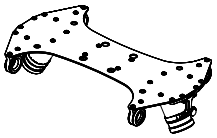
Geoscan 401 is multifuctional unmanned aerial system that included quardcopter drone with changeable payload and flight mission planning software.
Drone application depends on installed payload. The system can be used for aerial surveying, laser scanning, measuring of gamma-spectrum values, magnetic or multispectral surveying.

Kit

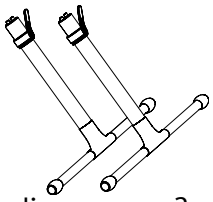
Geoscan 401 UAV



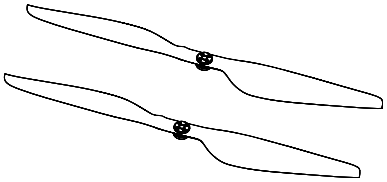
Quadcopter



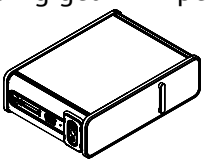
Frame of landing gears



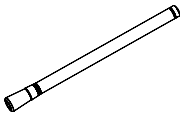
Landing gear — 2 pcs.



Propellers (pair) — 2 pcs.

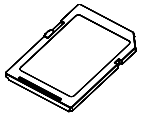


Battery



UAV antenna

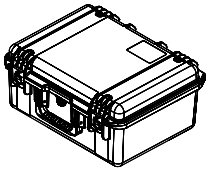
Radio modem



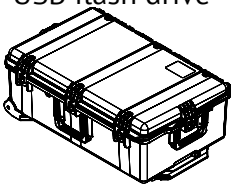
SD card

USB Cable

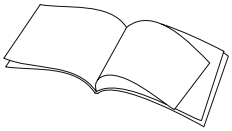
USB flash drive



Battery charger in case

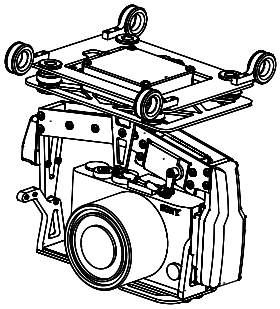


UAV transport case

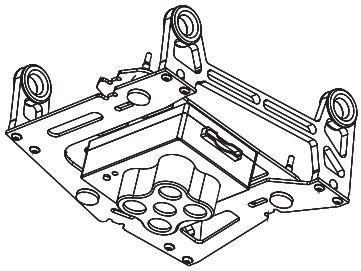


Documentation

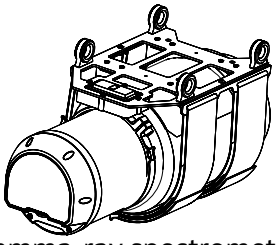
Payloads *



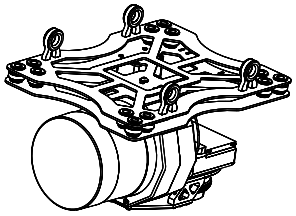
Digital camera



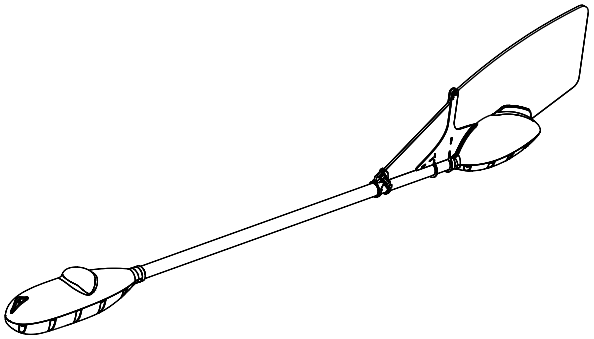
Multispectral camera



Gamma-ray spectrometer



Lidar



Quantum magnetometer

* — payload type depends on delivery kit

Maintenance Service

Visually inspect UAV for a damage after each flight.

If the propellers are damaged, you can replace them by spare parts from the kit.
If airframe or system damages are detected, please contact support.
After 80 flights we recommended to send UAV to the manufacturer for inspection and maintenance.

Storage

Geoscan 401 UAV (without the battery) should be stored in a transport case in dry room at temperature range from +5 to +25 °C and relative humidity not more than 85% without condensation.
Service life (without the battery) — 2 years.

Batteries should be stored in a cool and dry place without direct sunlight, at a temperature from +5 to +25 °C and relative humidity of 80% without condensation.
Optimum temperature range from +5 to 10 °C.
Optimal charge level for a storage: 38.5 V (see *Battery and Charger* section for details).
Battery service life — 1 year.

Safety Rules

Follow these operating instructions for safe UAV use:

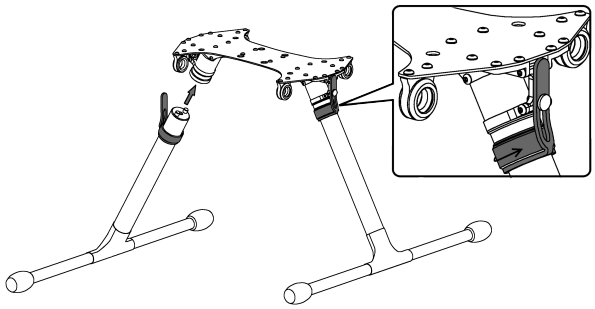
- UAV launch and maintenance can be held only by persons, who read this manual.
- Follow dealer's and/or manufacturer's recommendations and instructions for use of the equipment, as given in this manual and received during operation period.
- Carefully inspect flight area before flight and make sure that a flight path passes not less than 100 m above the terrain and high-rise objects (mountains, towers, pipes, transmission towers, etc.).
- DO NOT launch the UAV, if any damage is detected.
- DO NOT allow unauthorized persons into the UAV launch area.
- DO NOT launch or fly UAV near high power radio transmitters.
- AVOID flying above crowded places.
- DO NOT assemble or disassemble the UAV when the power is on.
- DO NOT short circuit the battery.
- Transport UAV and equipment in transport case only.
- Hold assembled UAV by quadcopter's frame arms, when you move it.
- DO NOT make any changes in UAV construction.

Operational Restrictions

- Operating temperature range without payload: from -20 to +40 °C.
  -40 to +20 °C for «Arctic» battery.
- The operating temperature ranges of payloads and other operating limits are listed in *Appendix* section.
- Max wind speed: 12 m/s.
- The aerial survey system is not designed to fly during rain, snow or other precipitation.
- UAV should be left at room temperature for 24 hours after transporting at sub-zero temperatures.

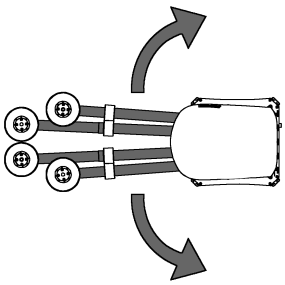
Assembly

1. Take the landing gears' base part and landing gears from transport case.
2. Put landing gears in tubes of base part.
3. Rotate landing gears' nuts to attach them to base part and lock elastic locks.



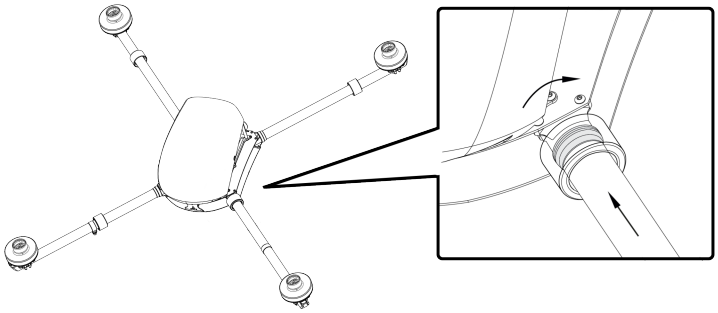
Landing gears installing

4. Take the quadcopter from transport case.
5. Remove protective transport elements.
6. Take quadcopter's frame arms out to the sides.



Quadcopter assembly

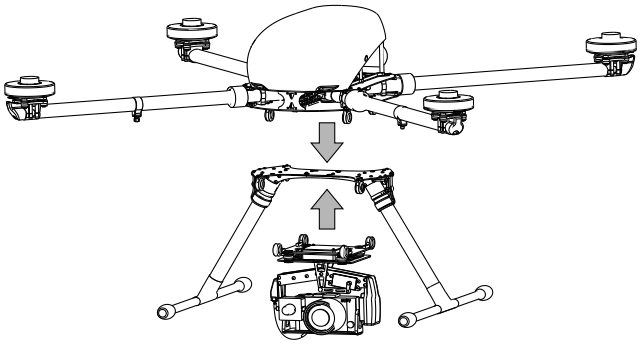
7. Move frame arms' nuts to the quadcopter's frame central part and lock it.



Lock by nuts

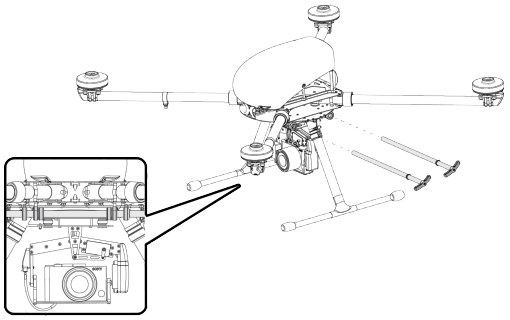
Make sure that the nuts are covered frame pins.

8. Place the quadcopter on landing gears' base part.
Frame loops must be connected with landing gear's loops.
9. Take payload cradle and position it under quadcopter's frame. The frame loops must be connected with cradle's loops. (see the picture).
The camera lens should be directed in the direction of the slope of the quadcopter fairing for camera only payloads.
Lidar payload position: place scanning cylinder in forward direction.
Gamma-spectrometer position: place scanning cylinder in rearward direction.



Example of camera payload installing

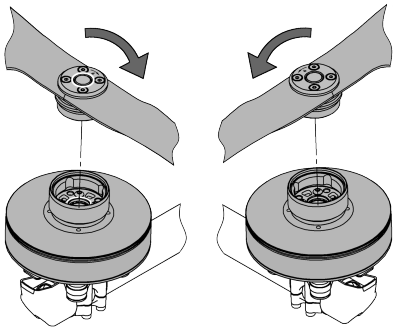
10. Put mounting rods in loops.



Mounting rods installing

Make sure that the rods are inserted as far as possible (the rings on the rods should be pushed to loops' red seals).

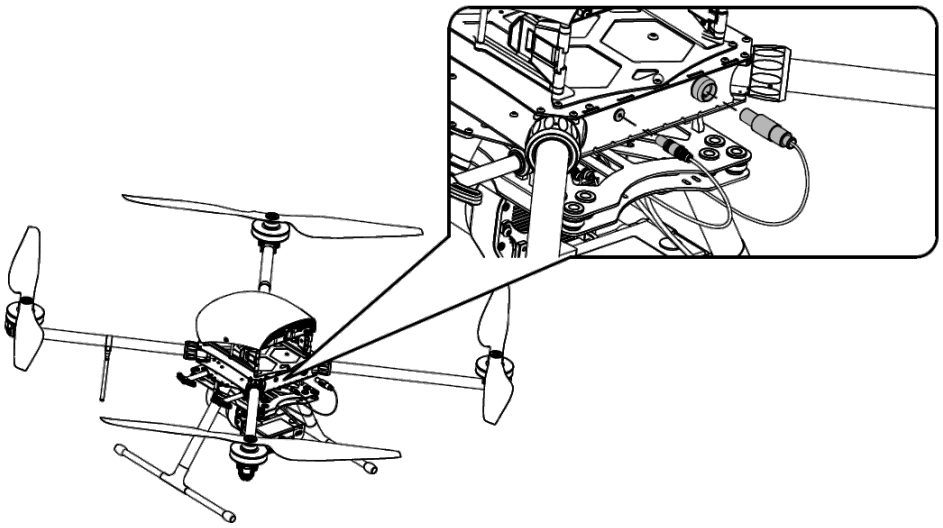
11. Attach the propellers to UAV motors.
Color marks on the propellers and motors should be in same color.
Icons on the propellers shows rotating direction for attaching.
Hold motor cover and screw each propeller.
Rotate propellers in oposite direction to deattach them.



Propellers installing

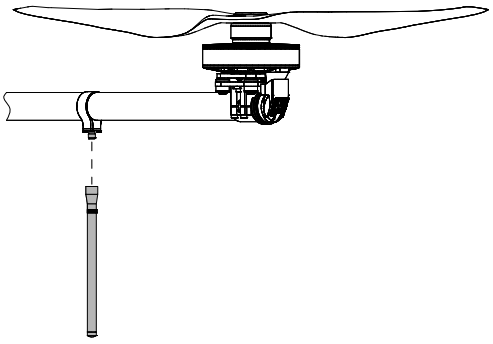
Make sure that the propellers are not damaged before each start. The propellers will should be free from a dirt and any stickers. Do not use cracked or damaged propellers.

12. Connect payload power cable (if your payload needs power from UAV battery) to UAV slot.
Connect GNSS antenna cable to UAV for payloads with in-built GNSS receiver.



Lidar connecting with 2 cables example

13. Screw UAV antenna to UAV arm.

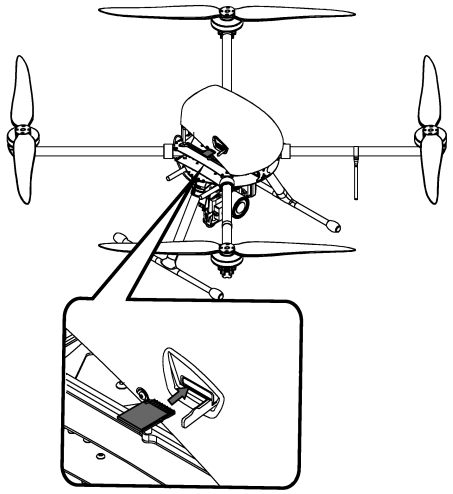


UAV antenna connecting

Make sure that the port and connector are clean. Clean it with an alcohol-moistened lint-free cloth, if it needs.

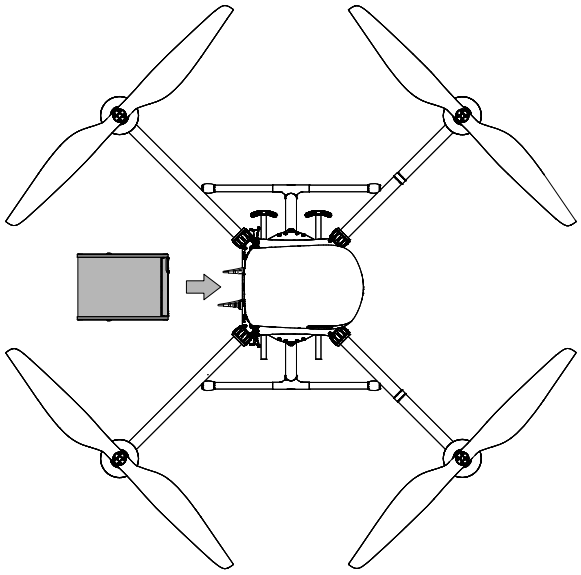
Do not turn UAV power on without antenna. It can damage in-built UAV receiver.

14. Eject SD card (-s) from payload and UAV in-built GNSS receiver (availability depends on UAV configuration), format and place in slots.



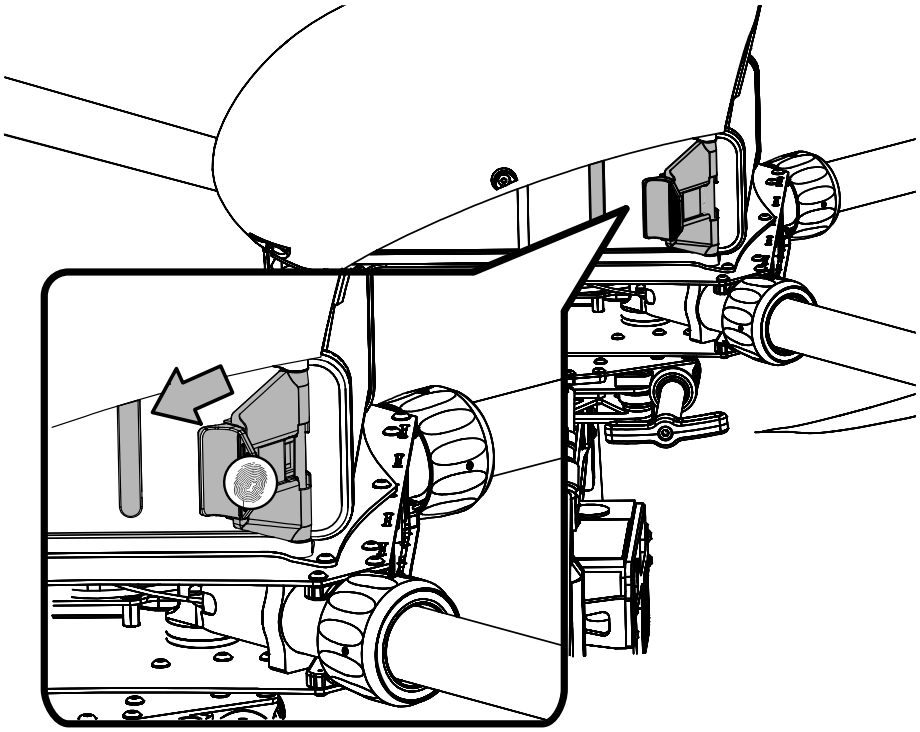
Installing SD card in GNSS receiver slot (availability depends on UAV configuration)

15. Turn UAV battery on by press control button
16. Eject the battery in UAV slot connecting pins should be on the left side.



Battery installing

16. Secure the battery by spring-loaded stops.
Press on spring-loaded parts and put it in battery slots.
On earlest Geoscan 401 UAVs the battery is secured by a velcro.



Battery securing by spring-loaded stops

Charger and Battery

Safety Rules

Battery

- DO NOT disassemble or deform the battery (do not drop and pierce).
- DO NOT allow heat the battery more than 60°C.
- DO NOT overcharge the battery (over 42 V).
- DO NOT allow the battery discharge below 30 V.
- DO NOT store fully discharged batteries. Change battery mode to **Storage** for a long storage (more than month)
- DO NOT charge battery by currents more than charge limit (no more than 100% of the capacity. We recommended to charge 50% of the capacity to extend the battery's life cycle). Current more than the limit will overheat the battery.
- Store the battery in warm place before flight at a temperatures below 0°C. When you create flight project, keep in mind the fact that LiPo batteries can lose up to 30% of capacity in cold conditions.
- Store the battery at the temperatures +5 to +20 °C without direct sunlight before flight at a temperatures more than +25°C.
- Do not charge the battery directly before flight. Wait for a battery cooldown. Charge the battery in the cool place without direct sunlight.
- Ignoring these instructions may result battery failture and fire.

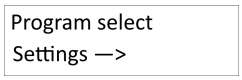
Battery Charger

- Turn on charger before connecting the battery.
- Check cables for a damage before use. Do not use damaged cables and connectors.
- DO NOT use the battery charger under direct sunlight.
- DO NOT use the battery charger without supervision.

ICharger 3010B Charger Preset

The charger is configured from the factory.
Follow the instructions to config preset, if the settings are different.
To open settings:

- On PROGRAM SELECT main screen press **Batt type/Stop** button several times until the moment, when screen will show **Settings** section.

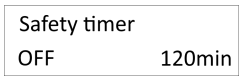


Settings section

- Press **Start/Enter** to open settings menu.

Use **Dec** and **Inc** buttons to choose parameters and **Start/Enter** to select parameters.

- Select **Safety timer** and press **Start/Enter** button.
  Use **Dec/Inc** buttons to change it to **OFF**. Press **Start/Enter** button until switcher stop blinking.

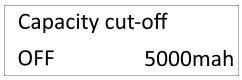


Safety timer — off

Press **Batt type/Stop** button to exit in Settings nenu.

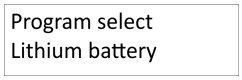
- Select **Capacity cut-off** and press **Start/Enter** button.
  Use **Dec/Inc** buttons to change it to **OFF**. Press **Start/Enter** button until stop switcher blinking.

Press **Batt type/Stop** button to exit from settings section.



Capacity cut-off — off

- On PROGRAM SELECT main screen select **Lithium battery** section and press **Start/Enter** button.

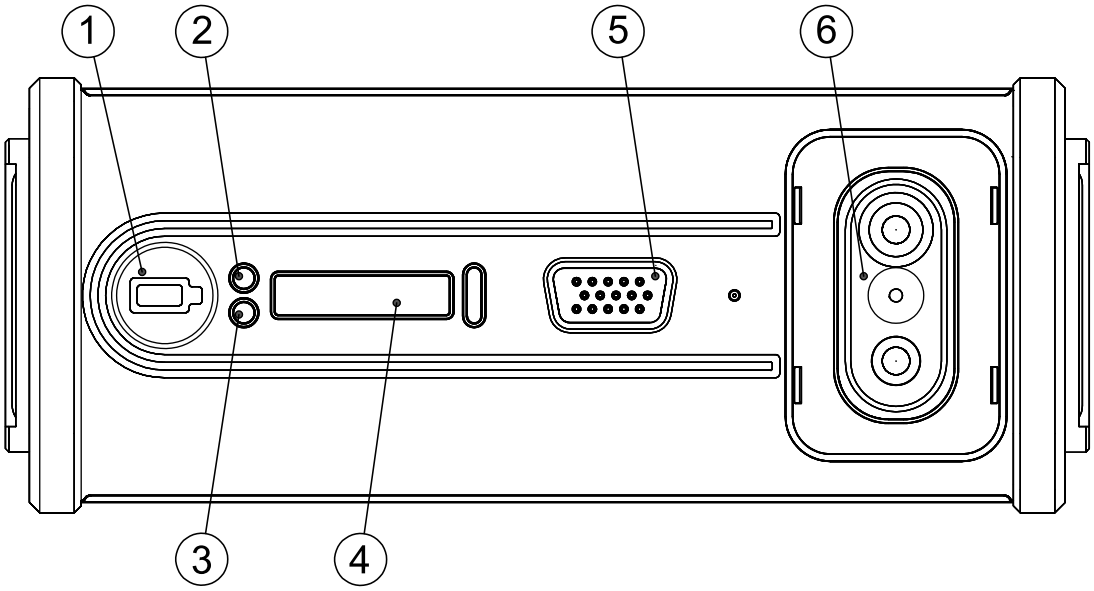


Lithium battery section

Set these parameters:

AUTO value select battery cells number (S) automatically.
Charge current: **8,0 A**.
Other settings should be default.

Battery Indication and Control



Battery LEDs and buttons

1. Control button
2. Indication LED
3. Heat indication LED («Arctic» battery)
4. LED indication bar
5. Balance connector slot
6. Connect and charge pins

Press the button (1) to check battery status.
Green LED indication bar (4) shows battery charge level. LED indication bar change color to red and show temperature inside the battery (see the table for degrees description), Green color of voltage LED (2) means that LED indication bar shows battery voltage (The battery is fully discharged, when the LED ingicators (4) are off. All LED indicators are lights, when the battery is full charged).

Red color of indication LED (2) means that LED indication bar (4) shows temperature level inside the battery.

Battery Temperature indication

LEDs	Glow mode	Temperature, °C
I (1)	flashes	<5
II (2)	flashes	5-10
III (3)	flashes	10-15
IIII (4)	lights	15-20
IIIII (5)	lights	20-25
IIIIII (6)	lights	25-30
IIIIIII (7)	flashes	30-35
IIIIIIII (8)	flashes	35-40
IIIIIIIII (9)	flashes	40-45
IIIIIIIIII (10)	flashes	>=45

The indication LED is off and indication bar LEDs are running out from right to left. It means a countdown to switch battery off. In this time you must turn on heating (for «Arctic» batteries with heating in-built system) and insert turned on battery in UAV slot.

Do not connect external power source to the battery, when indication mode is activated.

The table shows key values for the battery operation. Full battery specifications you can see in *Appendix* section.

Battery key values

Cells	Charged	Half charge level	near to discharge	Discharged	Extremely low voltage, the battery is broken
10 S	42.0 V	37.0 V	35.5 V	30.0 V	<30.0 V

The battery discharge speed is directly dependent with engines speed. The UAV use route and weather data to automatically set a optimal speed level. Set polyhons with minimum number of turns and longest tacks. Follow these recommendations to make flight projects more effectively.

The battery will start discharge faster, when the charge level drops to 35.5 V

Battery Connecting to The Charger

- Connect charge cable to charger (red cord to red + pin, black cord to black - pin).
- Connect balance cable to balance port of charger and battery slot.
- Connect red charge cord pin to the battery.
- Connect black charge cord pin to the battery.
- Start battery charging by long press **Start/Enter** button.
- Disconnect the battery from charger in reverse order.

Make sure that the engine is turned on, when you charge the battery from a car battery. A car battery will be completely discharged, if you don't check it.

Battery Heating (for «Arctic» battery)

«Arctic» batteries are marked by snowflake on the body. These batteries have temperature range from -40 to +20 °C for using in cold conditions.

Press **Control button** (1) more than 2 seconds to activate temperature holding mode for 30 minutes. **Status LED** (3) will change color to orange. LED indication bar (4) will show remaining temperature holding time (3 min for each LED). Press **Control button** (1) again to turn off temperature holding mode.

Storage and Discharge

Storage
Use Storage mode for a long (more than 14 days) battery storage.

Change charger mode **BALANCE CHG** to **STORAGE** mode, check cells number (10 Cells) and start storage balancing by long press **Start/Enter** button.

The batteries should be stored in dry cool place without direct sunlight at the temperature range from + 5 to 25 °C and a relative humidity of 80% without any condensation.

Normal storage temperature range is from +5 to +10 °C.

Normal storage voltage: 38,5 V.

Shelf period - 1 year.

Discharge
Check cells number (10S) and select **DCHG** mode to disharge the battery.
Set charge current: 1 A (Charger set optimal discharge current automaticly) and start discharge by long press **Start/Enter** button.

Battery Recycling

Do not utilize batteries with household trash. It may be dangerous for ecology. Send them to recycling points.

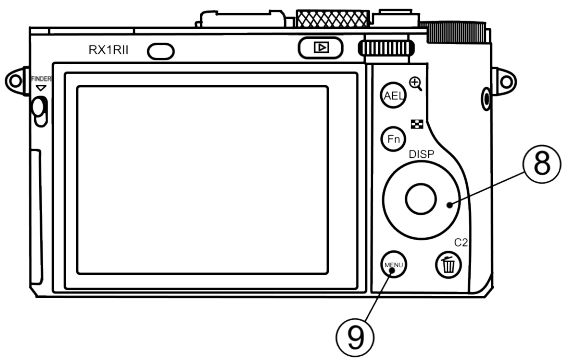
Payloads

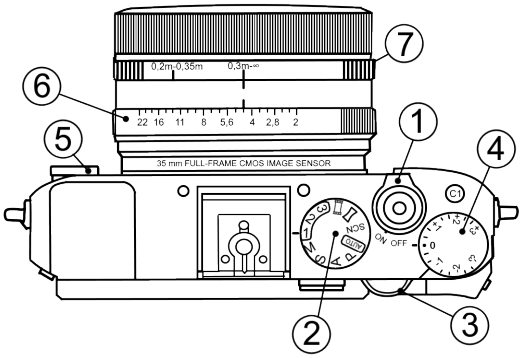
Geoscan 401 is a multifunctional platform for different payload types.
The section describes settings for payloads which can be included in set of equipment.

Sony DSC-RX1RM2 Digital Camera

Main Parts

Please, carefully read Camera Operating instructions
https://www.sony.com/electronics/support/res/manuals/4579/45798651M.pdf,
to get full information about functions and control elements before change settings.
Basic camera control elements are shown on the picture:





1. ON\OFF Switcher
2. Mode Dial
3. Control Dial
4. Exposure compensation dial
5. Focus Mode Dial
6. Aperture ring
7. Macro switching ring
8. Control Wheel
9. Menu Button

Presets

Geoscan UAVs are equipped with 2 presets for Sony DSC-RX1RM2 cameras.
Use **Mode Dial** near ON\OFF switcher to select preset for your needs.
Preset 1 serves for shooting in normal daylight conditions. The aperture value is fixed, which provides fixed aperture for better ortophoto mosaic generation.
Use these settings for this mode:

- **Mode Dial** in **«1»** position;
- **Focus Mode Dial** in **MF** position;
- **Exposure Compensation Dial** in **0** position;
- **Macro switching ring** in **0,3m-∞** position;
- **Aperture Ring** in **4,5** (first mark after 4).

Preset 2 — universal set with automatic variable aperture control (Shutter Priority).

Use these settings for this mode:

- **Mode Dial** in **«2»** position;
- **Focus mode dial** in **MF** position;
- **Exposure compensation dial** in **0** position;
- **Macro switching ring** in **0,3m-∞** position.

The aperture value is not taken into account.
Preset 3 can be used for user settings.
Select settings in menu, go to camera settings (tab 8) and select **Memory**.
Set **Mode Dial** in **«3»** position and press button in the middle of **Control Wheel**.

Presets Restoring

Settings of 1 and 2 presets can be restored, if you change them.

For preset 1 restoring:

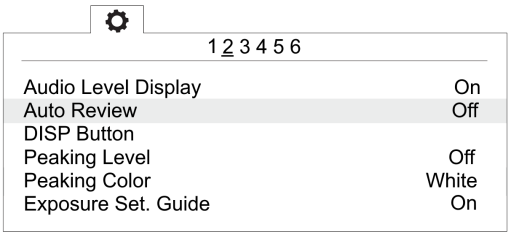
- Set **Mode Dial** in position **M** (Manual aperture control).
- Set shutter speed **1/1000** by **Control Dial**.
- Select **ISO** — **Auto** in camera menu..

Press **Menu** button, go to Camera Settings (Tab 8) and select **Memory**.
Set **Mode dial** in **«1»** position and press middle button of **Control Wheel**.
For preset 2 restoring:

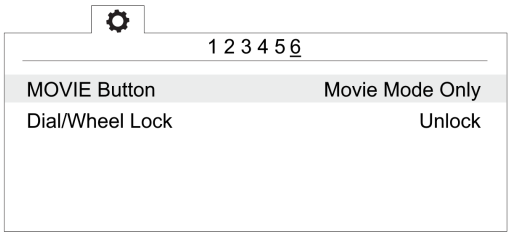
- Set **Mode Dial** in **S** (Shutter Priority) position.
- Set shutter speed **1/1000** by **Control Dial**.
- Select **ISO** — **Auto** in camera menu.

Press **Menu** button, go to Camera Settings (Tab 8) and select **Memory**.
Set **Mode dial** in **«2»** position and press middle button of **Control Wheel**.
If you change or reset settings you also need to switch off automatic photo review and shooting by MOVIE button, set max. time before power saving start and reset for file number. Change these settings:

- Switch off **Auto Review** in User Settings (tab 2) and **MOVIE Button** — **Movie Mode Only** (tab 6).

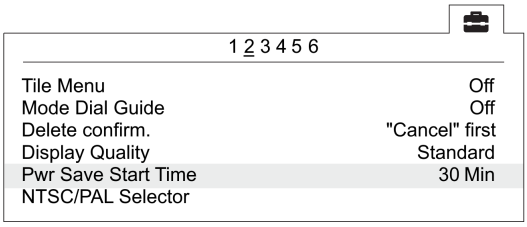


Auto review — Off

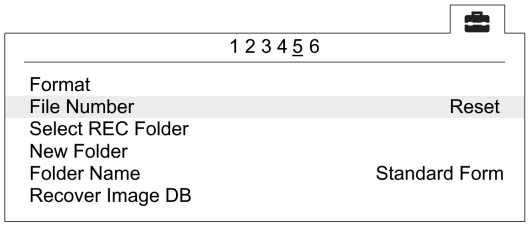


Movie mode only for MOVIE button

- In 🧰 settings section set **Power Saving Start Time** – **30 min.** (tab 2) и **File Number** – **Reset** (tab 5).



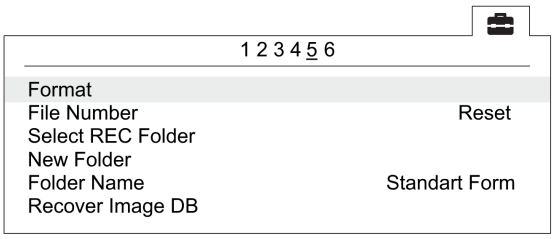
Power saving start time



File number reset

SD Card Formatting

- In 🧰 Settings menu (tab 5) select **Format**.



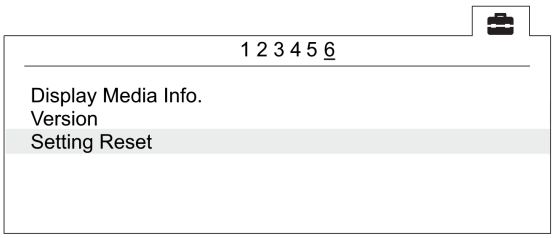
Format option

All data on SD card will be deleted!

Settings Reset

Reset of the camera will delete presets' shooting settings (Presets 1 and 2)!

- In Settings menu (tab 6) select **Setting Reset**



«Setting reset» option

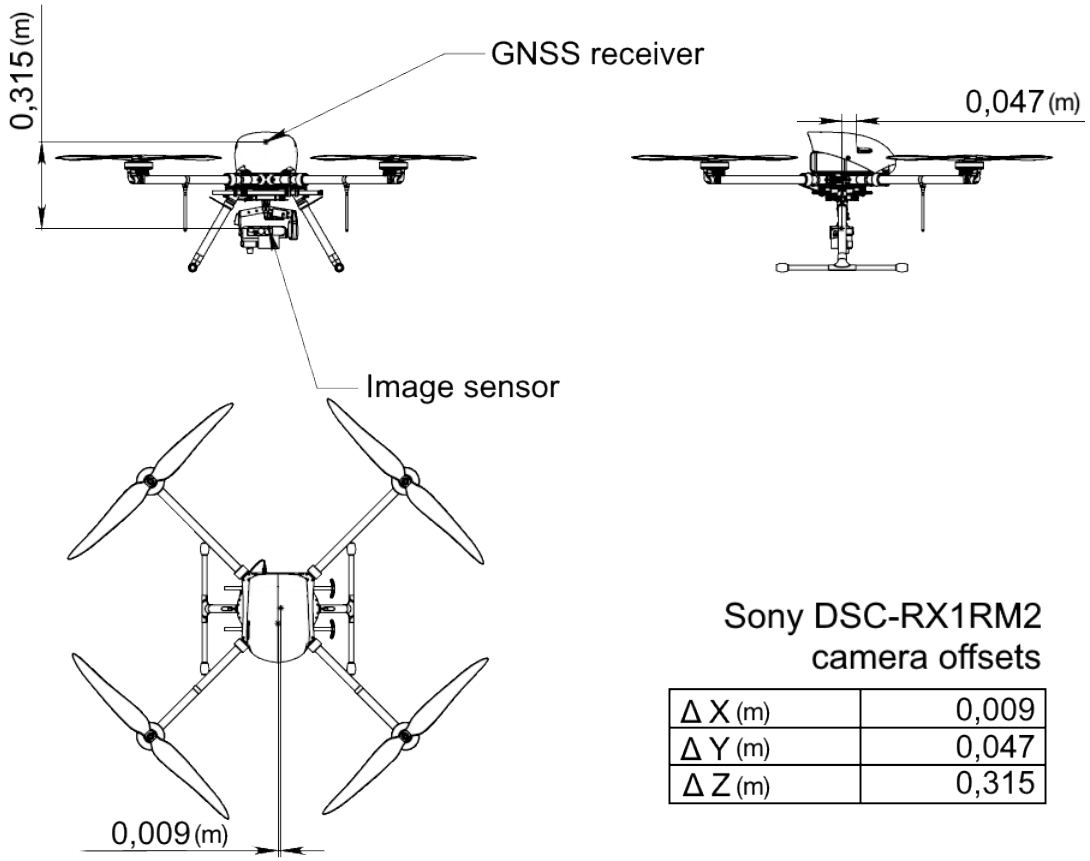
Do not remove the battery during a reset process!

- After camera reboot, you need to set **Time zone and date**, otherwise the settings will not be saved and this menu will appear at every turn on.
- Use ON/OFF switcher to turn the camera off.
- Wait 3 minutes for all settings to be saved (do not disconnect the battery or power cord).

«E:61:00» error may appear on the screen, as the camera is focused to infinity. **This message will not interfere with camera's function**.

Camera Offsets

Offset values should be taken into account when you generate ortophotomosaics and 3D models.



Sony DSC-RX1RM2
camera offsets

Δ X (m)	0,009
Δ Y (m)	0,047
Δ Z (m)	0,315

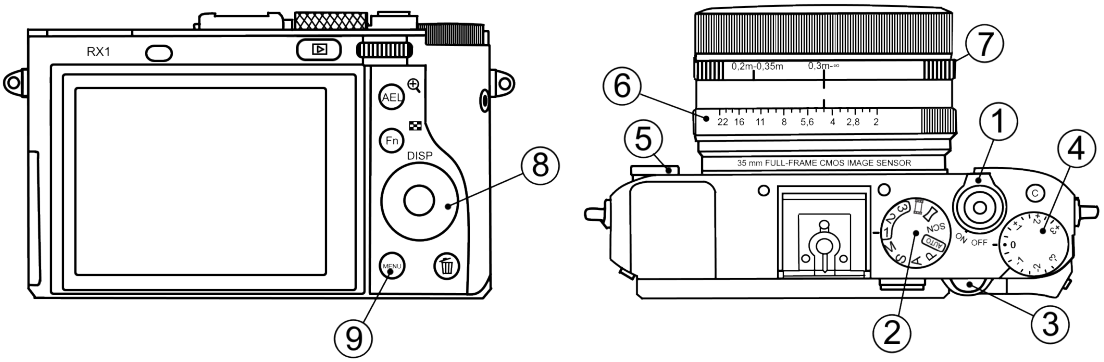
Sony DSC-RX1 offsets

Sony DSC-RX1 Digital Camera

Main Parts

Please, carefully read Camera Operating Instructions
https://www.sony.ru/electronics/support/res/manuals/4469/44695786M.pdf,
to get full information about functions and control elements before change settings.

Basic camera control elements are shown on the picture:



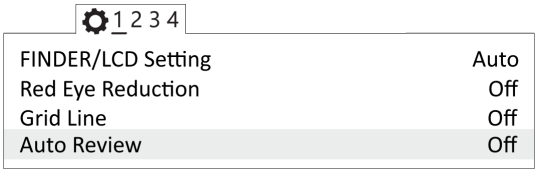
1. ON\OFF Switcher
2. Mode Dial
3. Control Dial
4. Exposure compensation dial
5. Focus Mode Dial
6. Aperture ring
7. Macro switching ring
8. Control Wheel
9. Menu Button

Camera Settings

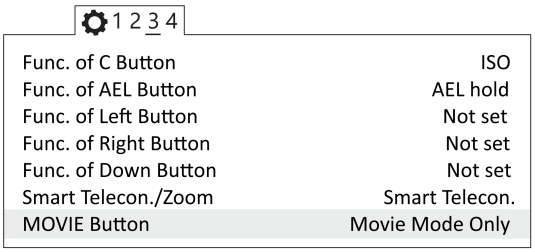
- **Mode Dial** in **«1»** position;
- **Focus Mode Dial** in **MF** position;
- **Exposure Compensation Dial** in **0** position;
- **Macro Switching Ring** in **0,3m-∞** position;
- **Aperture Ring** in **4,5** (first mark after 4).
- For normal daylight conditions switch **Mode Dial** in **M** (Manual aperture control) position and **Aperture Ring** in **4,5** (first mark after 4) position.
- For cloudy weather switch **Mode dial** in **S** (Shutter priority) position. The aperture value is not taken into account in this mode.

To set camera soft parameters, push **MENU** button, then select parameters according to the following instructions.

- In User settings menu (tab 1) turn off **Automatic preview** and set **MOVIE Button** – **Movie mode only** (tab 3).

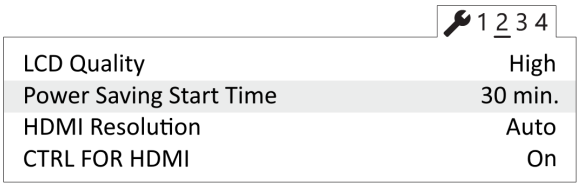


Turn off automatic preview



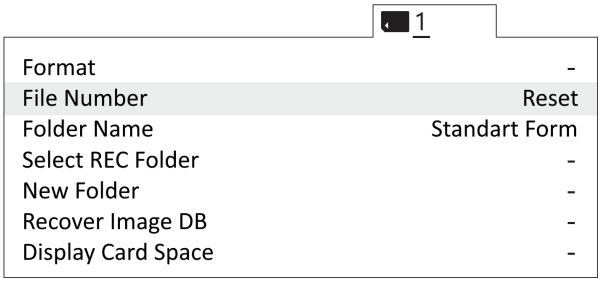
Movie mode only

- In Settings menu (tab 2) set **Power saving time** – **30 min**.



Power saving time

- In Memory Card menu set **File №** - **Clear**.



Clear file number

Other settings should not be changed from default values.

SD Card Formatting

- Select **MENU** → **[Memory card]** → **Format**

All memory card data will be deleted!

Settings Reset

Follow these steps to set default settings:

- Select **MENU** → **[Settings menu]** → **INITIALISATION** → **Reset**

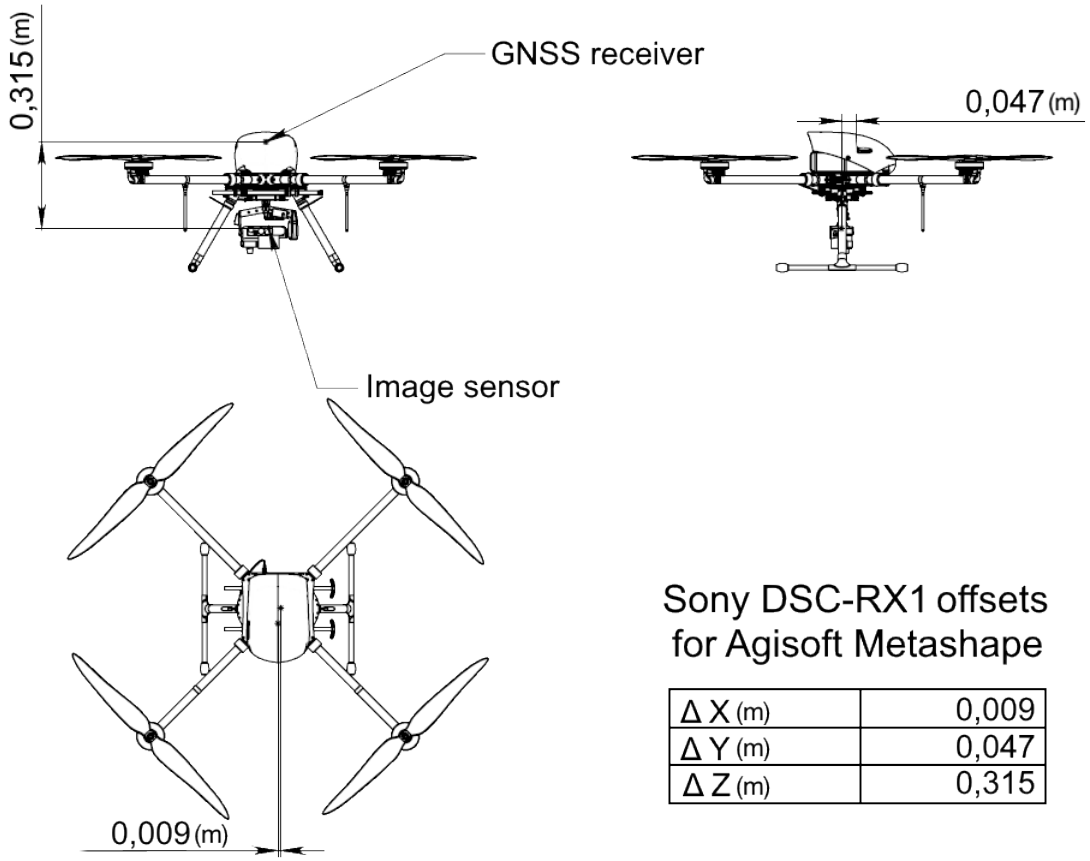
Do not remove the battery during a reset process!

- After camera reboot, you need to set **Timezone and date**, otherwise the settings will not be saved and this menu will appear at every turn on.
- Use ON/OFF switcher to turn the camera off.
- Wait 3 minutes for all settings to be saved (do not disconnect the battery or power cord).

«E:61:00» error may appear on the screen, as the camera is focused to infinity. **This message will not interfere with camera's function**.

Camera Offsets

Offset values should be taken into account when you generate ortophotomosaics and 3D models.

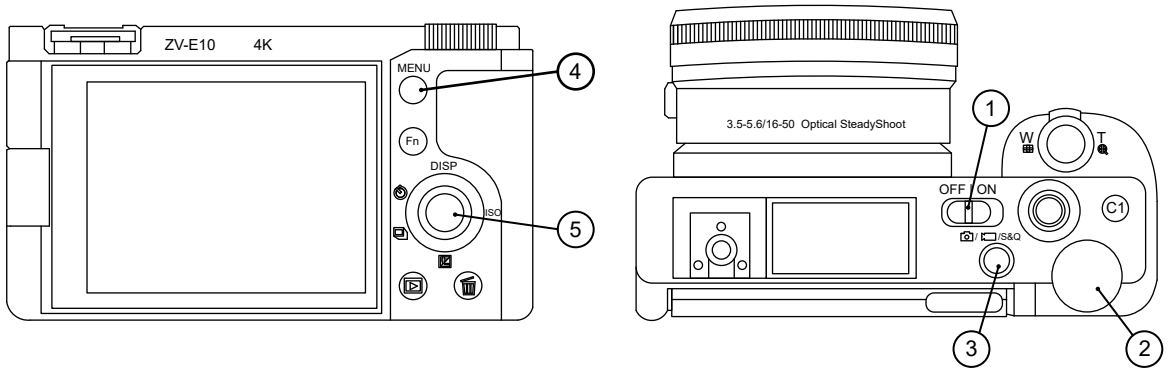


Sony DSC-RX1 offsets

Sony ZV-E10 Digital Camera

Main Parts

Please, carefully read Camera Operating Instructions *https://www.sony.com/electronics/support/res/manuals/5027/14720adf8b80e68f1cedb3d09c9ffe5b/50278353M.pdf*, to get full information about functions and control parts before make settings. Basic camera control elements are shown on the picture:

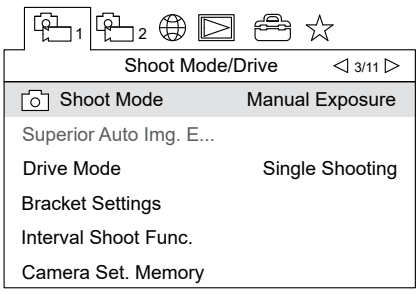


1. ON\OFF Switch
2. Control Dial
3. Photo/Video/S&Q Button
4. Menu Button
5. Control Wheel

Camera Settings

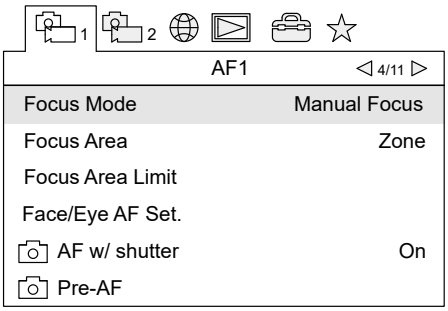
Make sure that the camera is switched to photo mode. Press **Photo/Video/S&Q** (3) button to switch mode if it needed.
Press **Menu** (4) to access Settings menu.

Press the right side of **Control Wheel** (5) in 1 Photo and Video settings 1 tab to select subsection 3 and set **Shoot Mode — Manual Exposure**.



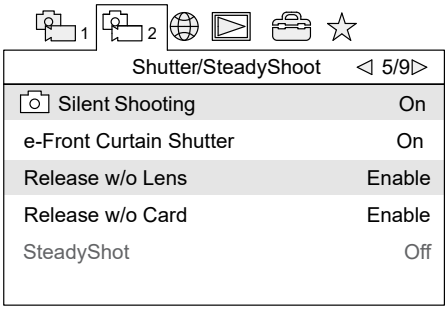
Manual Expo mode

Press the right side of control wheel to select subsection 4.
Set **Focus Mode — Manual Focus**.



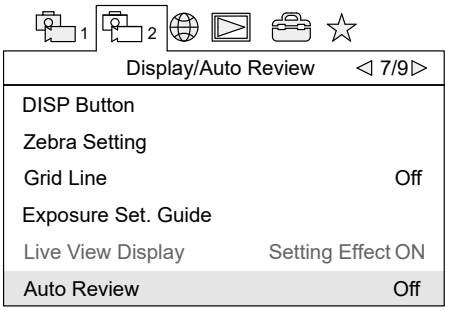
Manual Focus mode

Select subsection 5 in 2 Photo and Video settings 2 tab and turn on **Silent Shooting** and **Release without Lens** parameters.



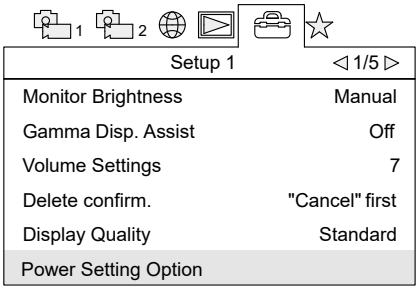
Silent Shooting and Release without Lens parameters

Press the right side of control wheel to select subsection 7.
Disable automatic reviewing by setting **Auto Review — Off**.

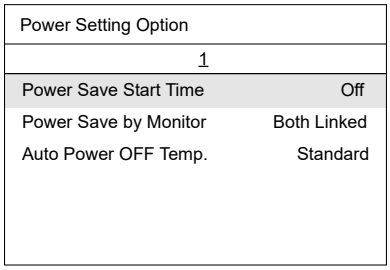


Auto Review — Off

In settings tab select **Power Setting Option** and set **Power Save Start Time — Off**.

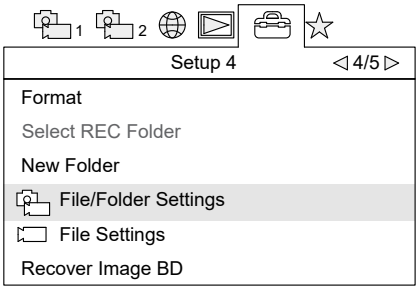


Power Setting Option

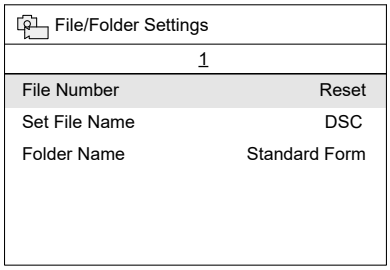


Power Save Start Time — Off

Select **File/Folder Settings** in subsection 4 and set **File Number — Reset**.



File/Folder Settings



File Number — Reset

Press **Menu** (4) button to exit from Settings menu after all sets.
Select **1/1000** exposure by rotation of **Control Wheel** (5).
Check **ISO — AUTO** parameter. Press the right side of **Control Wheel** (5) to change ISO value if it needed.

SD card Formating

Select **MENU** → (subsection 4) → **Format**

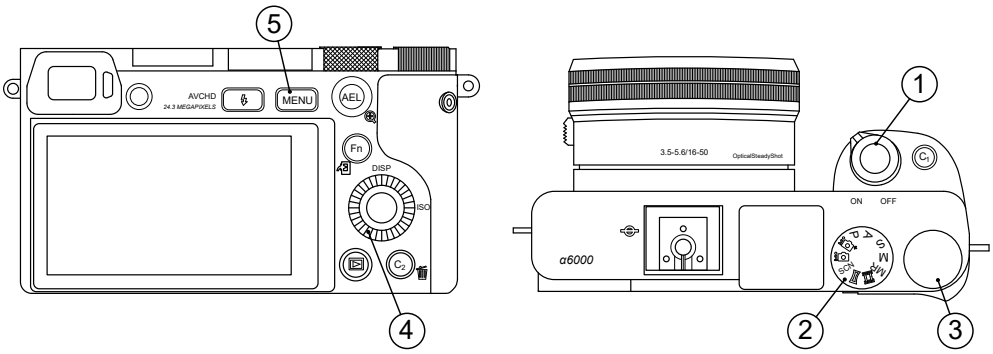
⚠ All data on SD card will be deleted!

Sony A6000 Digital Camera

Main Parts

Please, carefully read Camera Operating Instructions
https://www.sony.ru/electronics/support/res/manuals/4532/45320554M.pdf,
to get full information about functions and control parts before change settings.

Basic camera control elements are shown on the picture:

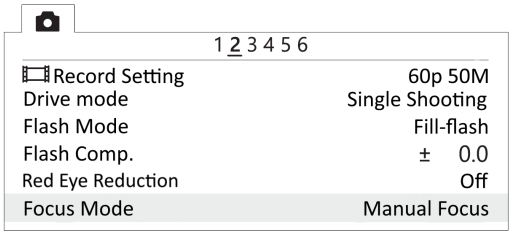


1. ON\OFF Switcher
2. Mode Dial
3. Control Dial
4. Control Wheel
5. Menu Button

Camera Settings

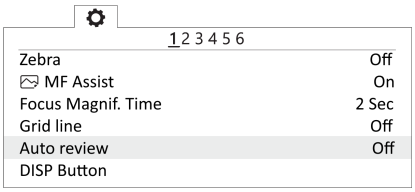
Use the control wheel to set the following parameters:

- Switch **Mode Dial** (2) in **S** (Shutter priority) position.
- Set Exposition — **1/1000** and **ISO — Auto** by **Control Wheel** (4).
- In Still Shooting menu (tab 2) set **Focus Mode** - **Manual focus**.

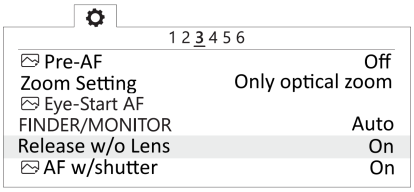


Focus Mode

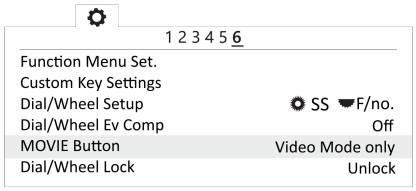
- In Custom Settings menu (tab 1) disable **Automatic preview**, turn on **Lens-less Shutter** (tab 3) and set **MOVIE** button - **Video mode only** (tab 6).



Automatic preview off

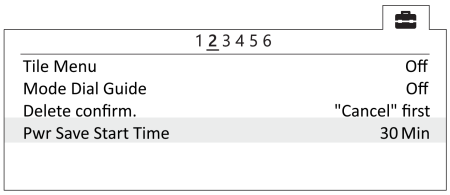


Turn on the shutter without a lens

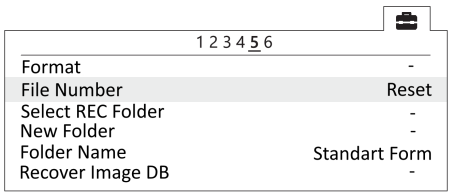


Video mode only for Movie button

- In Setup menu set **Start time energy saving** - **30 min** (tab 2) and set **File Number** - **Reset** (tab 5).



Set the time to start energy saving



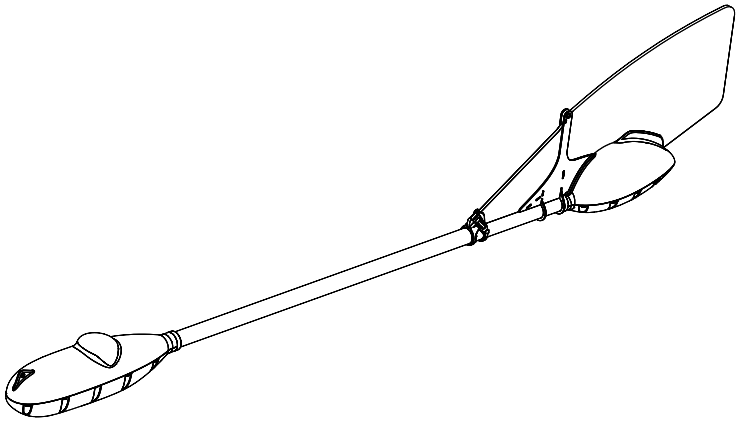
Reset file number

SD card Formatting

Select **MENU** → (tab 5) [Setup] → **Format**

All data will be deleted!

Geoshark Quantum Magnetometer



Quantum magnetometer with rubidium sensor is designed for aeromagnetic measurments at extremely low altitudes with terrain relief following.

LED Indication

A device status is showed by LEDs on electronic unit.
The table shows their meaning:

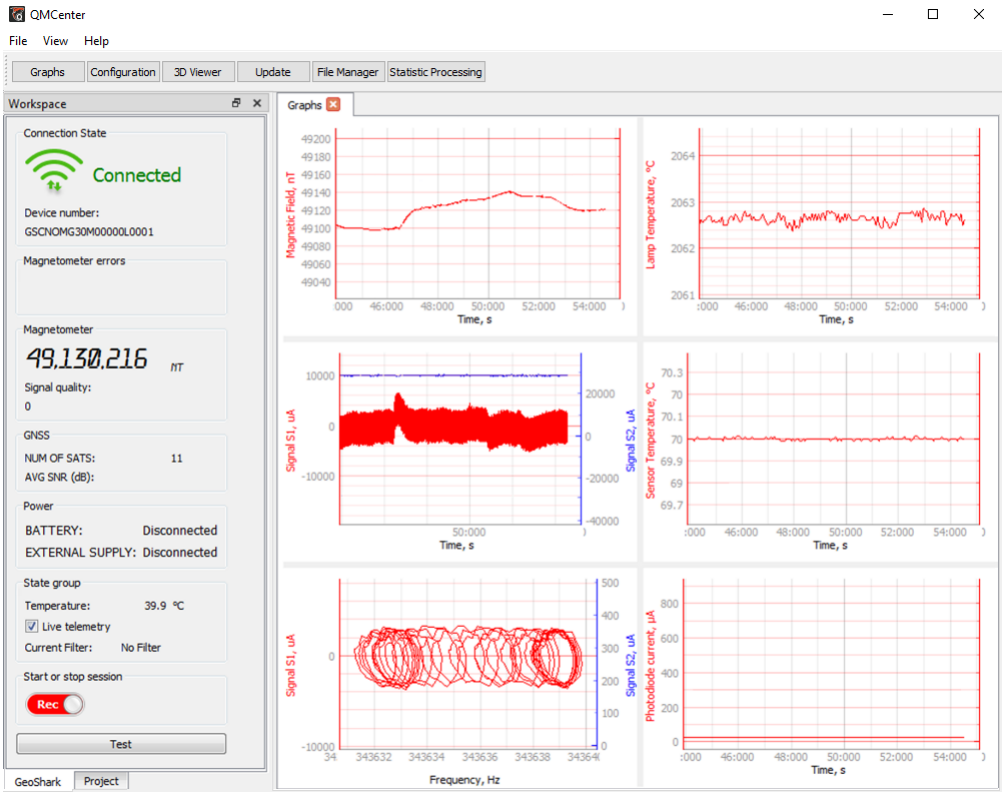
LED		Description
Power	Green flashes	Power is on
Lamp	Green lights	Device check is successful. Magnetic sensor is ready
Sensor Heater	Green lights	Rubidium sensor's temperature in operating limits
Measure	Green lights	Measurements process in progress

QMCenter Software

QMCenter is designed for real-time monitoring of magnetic variations and data post-processing.

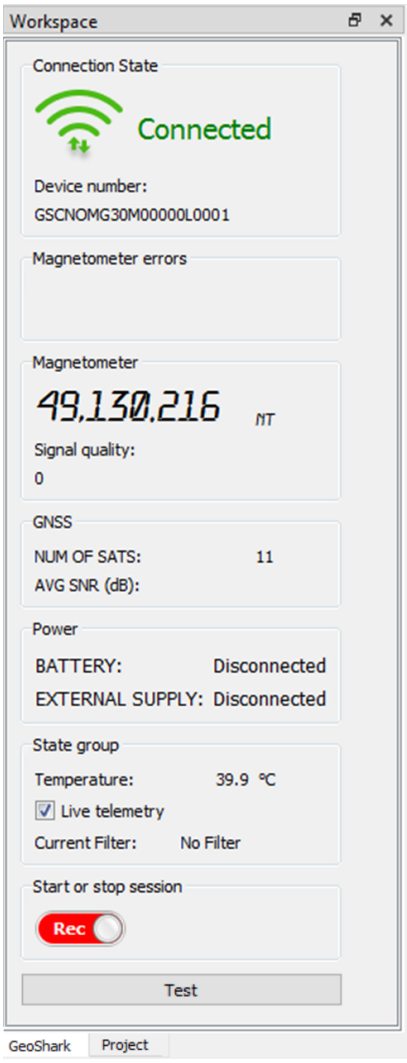
Setup and Launch

The software does not require install. Just launch QMCenter.exe file from program folder. We highly recommend QMCenter.exe run as an administrator. Otherwise the software may not work normally or not start.



Interface

Workspace field is on the left. It has two tabs: **Geoshark** and **Project**.



You can switch tabs by click on their names in the left bottom corner.
Project tab contains a project data.
Geoshark tab contains device information.
Connection State — status indicator of connection. LED lights green, when the magnetometer is connected via Wi-Fi or Ethernet.
Device number — device serial no. The serial is used to identify connected magnetometer.

Magnetometer errors — replicates **LAMP** and **SENSOR HEATER** electronic unit's indicators. Red pictograms means that the lamp is not ready and rubidium sensor is not heated.

Magnetometer — data output section for magnetic field measurements and signal quality level.

GNSS — satellite data section.

NUM OF SATS — number of captured satellites.

AVG SNR (dB) — GNSS signal level ratio.

State group — electronic unit diagnostic information.

Temperature – electronic unit temperature. Max. operating temperature is not more than +60 °C.
Live telemetry trigger activates real-time data displaying.
Start or stop session trigger activates or switch off magnetometer diagnostic log recording. Recording starts automatically when the magnetometer is turned on.

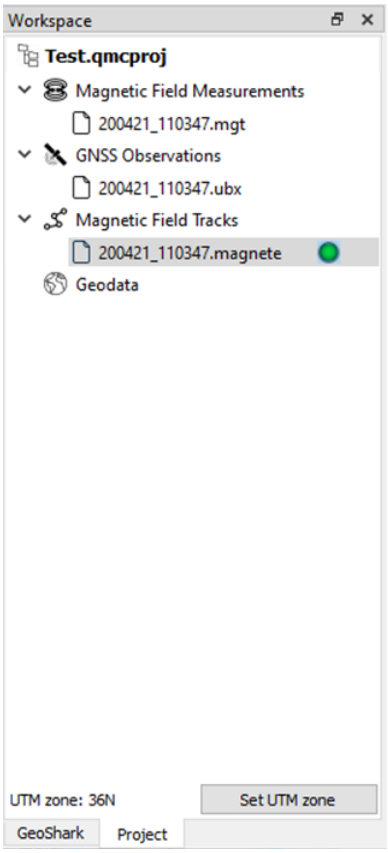
Project tab is uses to work with a project files. Here a project data is structured and processed.

Magnetic Field Measurments — section for raw *.mgt magnetic measurements data import.

GNSS Observations — section for GNSS data import (*.ubx).

Magnetic Field Tracks — section for magnetic measurements with GNSS track connection. A data can be imported from files or be generated from Magnetic Field Measurments and GNSS Observations tabs data. GNSS data and measurements file names should be same for field track generation.

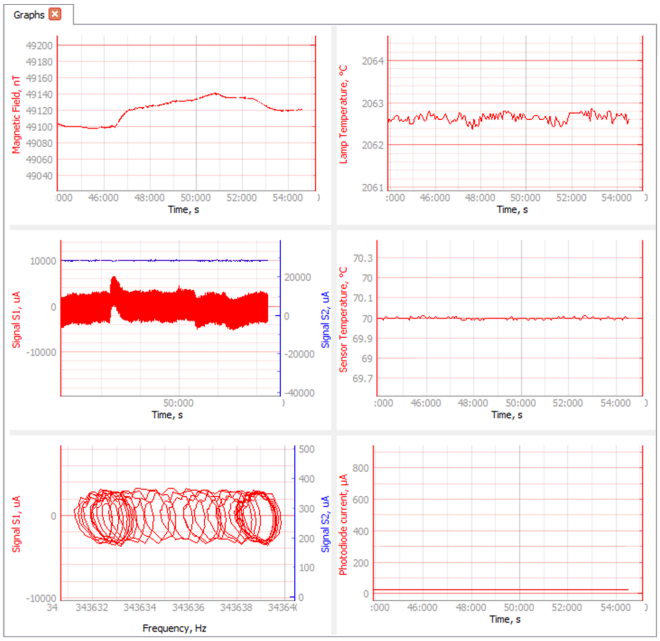
Geodata — section for a digital terrain model (*.tif) and cloud of points (*.ply) import.



Working tabs calling buttons are placed on the top of the program window.

Working tabs calling buttons

Graphs tab displays real-time measurements data.
Magnetometer should be connected via Wi-Fi or Ethernet (see *Device connecting to PC*).



Real-time measurements in Graphs tab

Configuration — service tab for device settings sync and save. Blocked for users to avoid a device damage. Changes are not permitted.

3D Viewer tab provides view of selected data. See *Magnetic Track Visualization* section for details.

Update tab is used to update a magnetometer firmware. Please contact our specialists to get latest firmware version.

Statistic Processing — service tab for device diagnostics. Geoshark magnetometer preseted by the manufacturer. Tab using is not required.

⚠ Fully charge UAV and magnetometer batteries before use!

Operations Guide

Create one or more flight projects for UAV flights by Geoscan Planner software (see *New project* section for details).
Select Geoshark magnetometer as a payload. It activates additional options for automatic flight.
Use *Precise Terrain Following* option for low altitude measurements.
1. Eject Geoshark magnetometer from transport case.
2. Attach magnetometer's fin in slot on rear part of the device. Lock it by rubber locker.
3. Unfold magnetometer's attachment cord and make sure that cord and carabiner are not damaged.
4. Turn magnetometer power on for a heating to operating temperature.
5. Assemble UAV and attach a platform with loop as payload (see *Assembly* section for details about UAV assembly).
A platform with loop placed in magnetometer's case.
6. Attach cord's carabiner to platform's loop.
7. Make sure that power LED on magnetometer's electric unit flashes and **Lamp, Sensor Heater, Measure** are lights.
8. Load created flight project in Geoscan Planner and connect UAV (see *Connecting UAV to Geoscan Planner* section for details).
8. Launch **Start Preparing Wizard** and follow the instructions on the screen.
9. Press **Start** button and approve the engines start.
UAV will lift up 15 meters altitude and will hold it.
10. Press *Semi-automatic control* button and lift UAV up to the moment, when the magnetometer will hang on the cord in air.
11. Press Semi-automatic control button again for flight mission start in automatic mode.
In the end of flight mission UAV will slow landing speed down after 20-25 meters altitude. It needs to the operator or help person can held magnetometer and shift it at 3-5 meters distance from landing point. It is necessary to avoid UAV landing directly on magnetometer.
After landing you can *download* and *post-process* measurements or use next steps for work with more than one flight project without stop.

Next steps describes how to save device operating temperature between flights for max performance.

12. Connect the device via Ethernet or Wi-Fi and download measurements data (see *Coping Data from Device Internal Storage* for details).
Do not disconnect magnetometer's battery that was used for previous flight.
Magnetometer's battery provides 1.5-2 hours of total working time.
Max. flight time of Geoscan 401 UAV is 1 hour.
Remaining battery charge should be enough to keep magnetometer sensor at operating temperature during analysis of measurements data.
13. Use QMcenter software to view measurements data and make sure that results quality is comply with data quality requirements (see *Data View and Post-Processing* section for details).
In case of deviations or anomalies change a flight route and repeat UAV launch.
14. Change UAV and magnetometer batteries.
15. Load next flight project and repeat steps 7-13.

Device connecting to PC

Connecting via Wi-Fi

1. Turn magnetometer power on.

The device will run Wi-Fi hotspot with a name **MG30M_xxx**.

Use standard OS tools for Wi-Fi connect.

Default Password is **geoshark**.

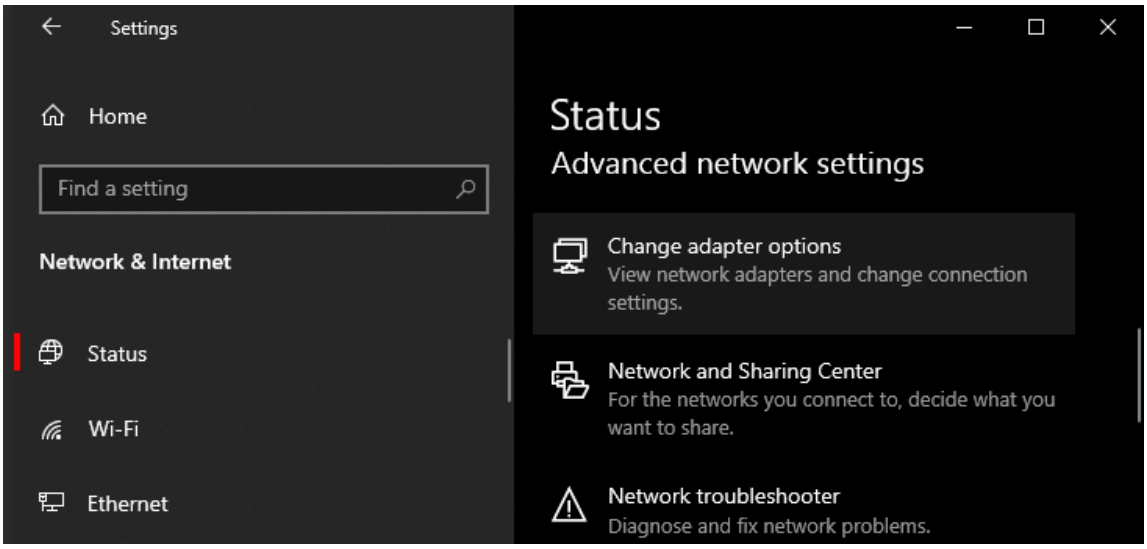
2. After successful connection in QMCenter software use (**Ctrl+I** or **File** → **Settings**) option and activate **Wi-Fi** trigger in **Connection** section.

Connection indicator will be changed to **Connected** in **Workspace** tab and real-time information about connection will be showed in **Graphs** tab.

Connecting via Ethernet

Connect settings for MS Windows 10 operating system:
1. Connect Ethernet cord to magnetometer and turn magnetometer power on.

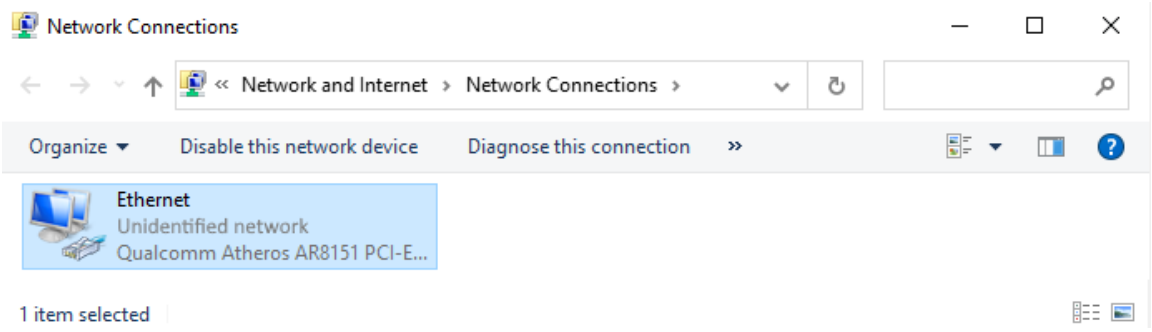
2. Press the right mouse button on **Start** button.
3. In context menu select **Network connections** option.
4. Select **Change adapter options** in Status tab.



Change adapter options

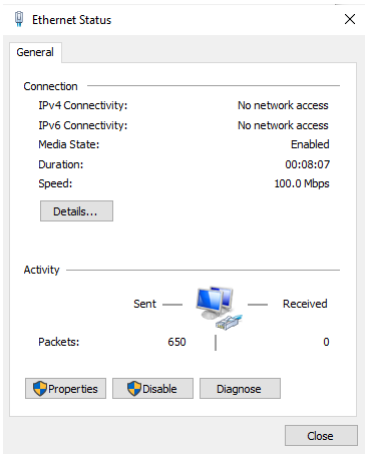
Network Connections window will be opened (for earlier Windows versions select: Control Panel → Network and Internet → Network Connections).

5. Double click on **Ethernet** icon. Ethernet Status window will be opened.

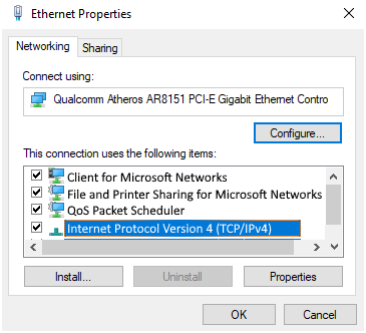


Ethernet properties

6. Press **Properties** button and select **Internet Protocol Version 4(TCP/IPv4)** connection by double mouse click.

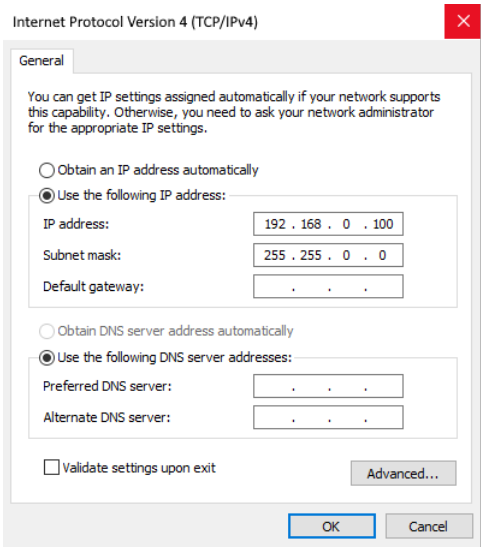


Ethernet status



Internet Protocol Version 4(TCP/IPv4)

7. Select these parameters in window:
IP address (PC): **192.168.0.100**
Subnet mask: **255.255.0.0**



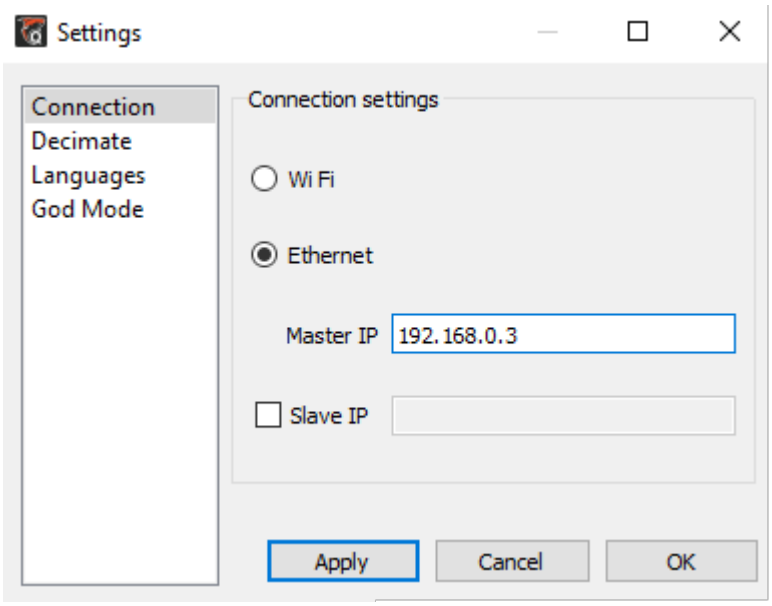
IP address of PC and subnet mask

8. Use **Ctrl+I** or **File** → **Settings** in QMCenter software and activate **Ethernet** trigger.
Set magnetometer IP in **Master IP** field.

Geoshark magnetometers has static IP address: **192.168.0.x**,
*here **x** is the end numbers of serial number on electric unit of device.*

Magnetometer with GSCNOMG3EU0000FL**0003** serial has IP address **192.168.0.3**

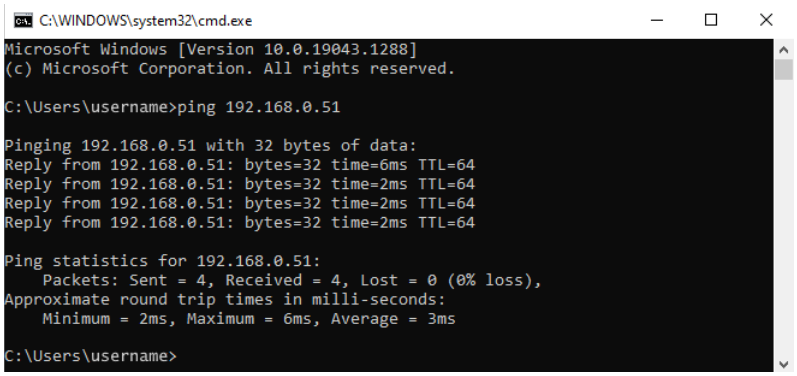
9. Approve settings by press **Apply** button and close the window by press **OK**.



Master IP in settings window

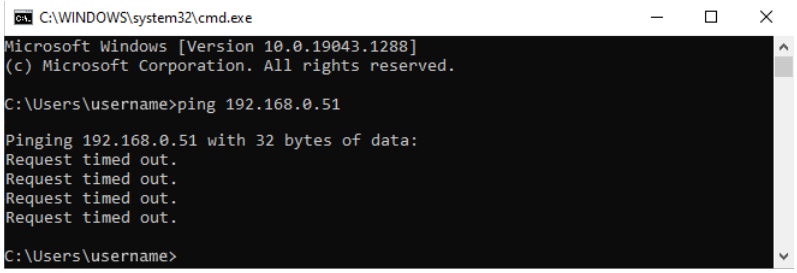
Connection Check

Check for connecting errors
Use ping command to check magnetometer connection with PC.
To do this, open **Run** field by press **Windows+R** keys.
Type **cmd** and press **OK** button.
In cmd window type **ping 192.168.0.x**
*here **x** is the end numbers of serial number on electric unit of device.*
Press Enter key.
PC will initialize 4 calls to magnetometer.
If magnetometer power is on, device is worked correctly, and network was right organized, magnetometer will answer as shown on the picture (answer for magnetometer with IP address 192.168.0.51)



Answer for right connecton

Picture blow shows answer for wrong connection:



Wrong connection

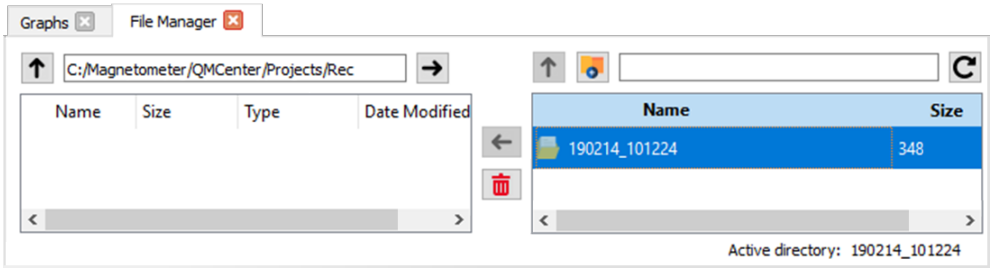
ping command can help to understand, what connection stage is wrong:

- **If ping data available, but it doesn't work**: check IP address, restart QMCenter software, restart magnetometer (load and heating processes are required a time, wait until electric unit's LEDs will show working states).
- **If ping data is not available**: check magnetometer ethernet cord state and connect. Restart the magnetometer.

Coping Data from Magnetometer Internal Storage

1. Connect magnetometer to PC via ethernet or Wi-Fi (see *Device Connecting to PC* section for details).
2. Press **File Manager** button.

Workspace tab will be changed to File Manager.



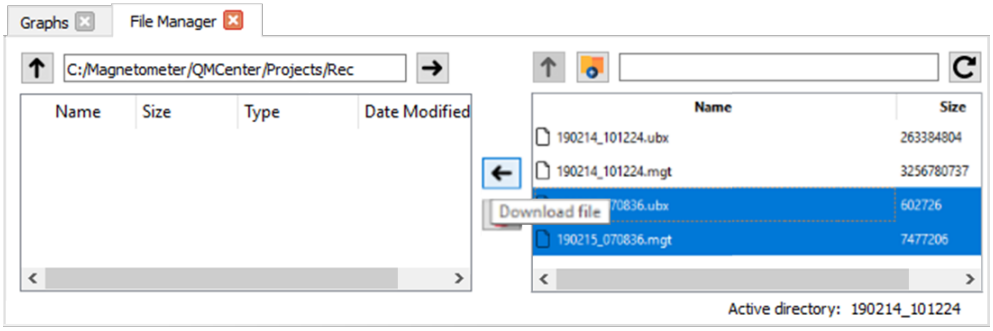
File Manager tab

Tab has two sections.
In left section you can change output folder for a data from magnetometer.
Right section (if Ethernet or Wi-Fi connection is active) shows root folder of magnetometer internal storage.

Measurements data of one session are saved in to files with same names and *.mgt and *.ubx extensions. *.mgt file is a magnetic measurements data; *.ubx is a data of GNSS tracking.

3. Select output folder in left section and required data from magnetometer storage in right section.

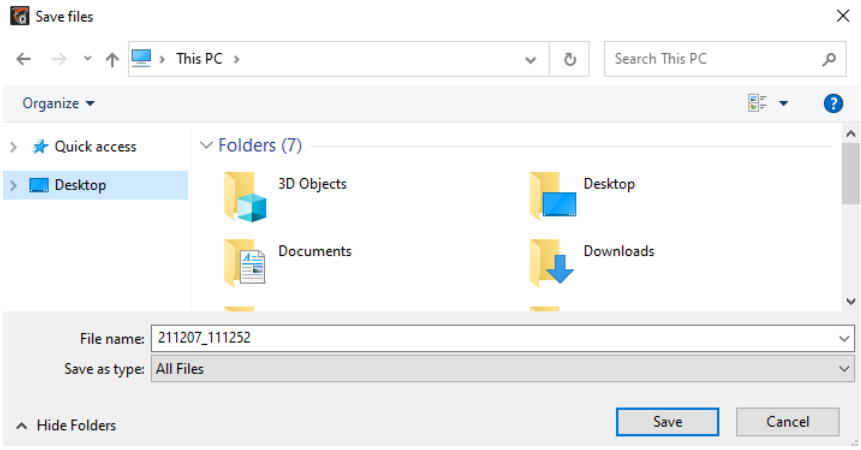
4. Press **Download file** button to download files from device to output folder.



File downloading

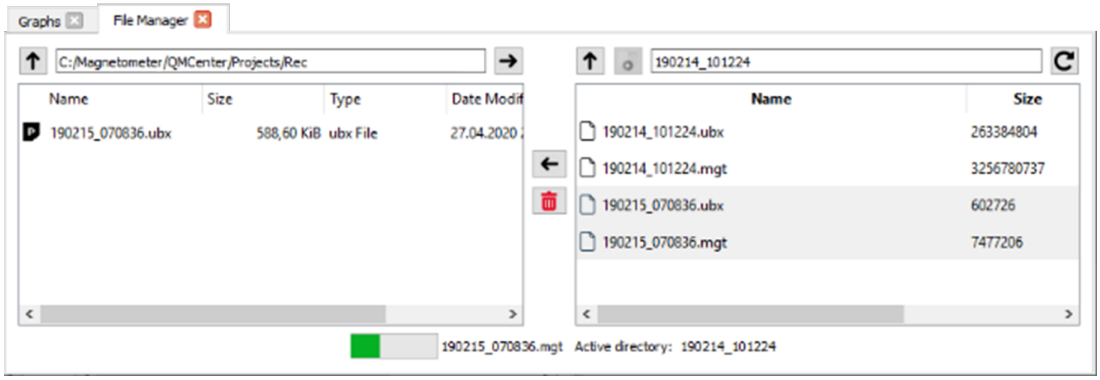
QMCenter software will ask you to change the names of coping files.

5. Change filenames, if it needs, and press **Save** button.



Save file window

Progress bar on the bottom of file manager tab shows copying state.



Copying process

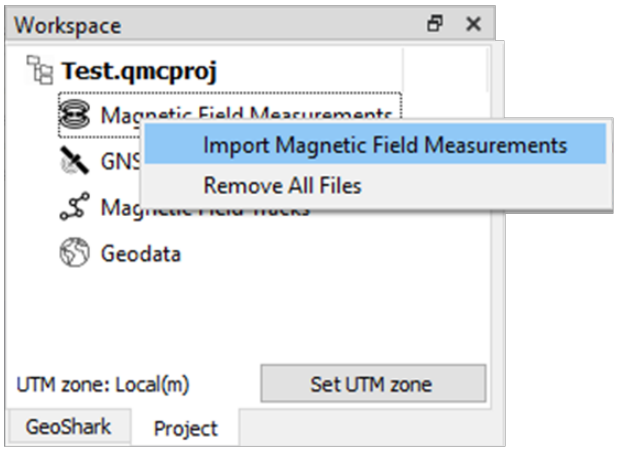
Measurements data will be shown in output folder after successful coping.

Data View and Post-Processing

Import Data in Project

Create a new project **File** → **New Project** and select a path for data saving.

Click on the right mouse button on imported data type (Magnetic Field Measurements — for *.mgt files, GNSS Observations — for *.ubx)
select **Import...** option and select data for import.



Example of magnetic measurements import (*.mgt)

Selected data will be imported in project and will be showed in data type category.

Magnetic Field Track Creating

You can generate magnetic field track based on magnetic measurements and GNSS data import.

Click on the right mouse button on *.mgt file and select **Create Magnetic Field Track** option.

It launch magnetic field track generating process. Progress bar will show a process progress.

Close progress bar window after the end of generation process (100%).

After successful generation magnetic track (*.magnete) will be shown in **Magnetic Field Tracks** section.

Magnetic Field Track Visualization

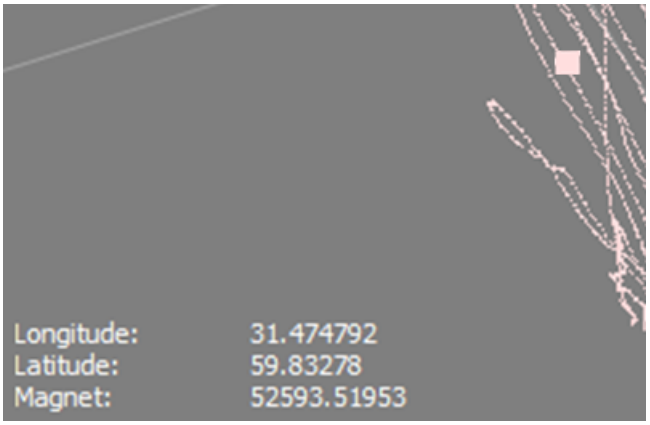
Use a generated magnetic field track file (*.magnete) to visualize tracked data.

Press **3D Viewer** button to open 3D Viewer tab.
Select a magnetic track in **Magnetic Field Tracks** section and press on gray dot near with a track name.
The dot will change color to green, and 3D track measurements data will be shown in **3D Viewer** tab.

Magnetic track selection

Use left mouse button to rotate camera view and mouse wheel for zoom.

The information about selected point (longitude, latitude, magnet) showed in left bottom corner of 3D viewer tab.



Point information

Geoscan Planner Software

Geoscan Planner software allows to configure UAV and create flight tasks for aerial survey of areas and single objects.

System Requirements

Minimum System Requirements

Operating system	MS Windows 7,8,10
CPU	Intel Core i3
RAM	4 Gb
GPU Type	Dedicated
GPU Model	Nvidia GeForce GT620M, GT630M, 710M, GT720M; AMD Radeon HD 7670M

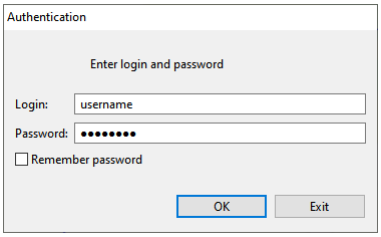
Recommended System Requirements

Operating system	MS Windows 7,8,10
CPU	Intel Core i5, i7
RAM	8 Gb
GPU Type	Dedicated
GPU Model	Nvidia GeForce GT645M, GT745M, 845M, GT720M, 940M and higher

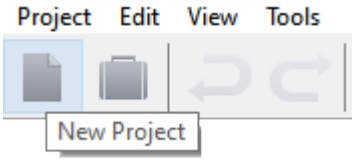
New Project

1. Install and launch **Geoscan Planner** software.

2. Enter your login/password in authentication window and create new project by press **New Project** button.

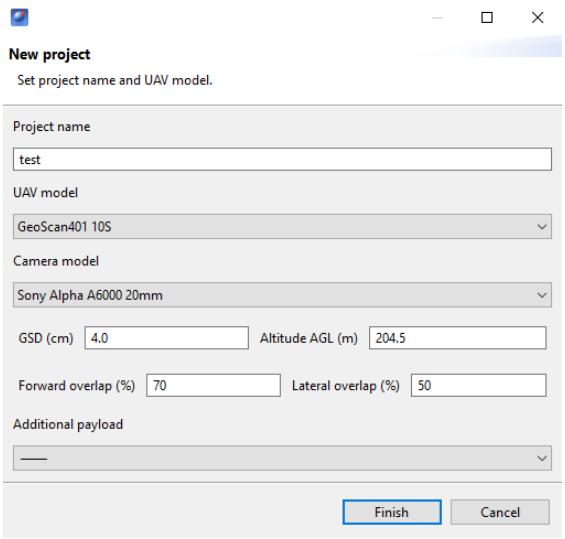


Authentication window



New Project button

3. Enter a project name and shooting parameters in the new project window.

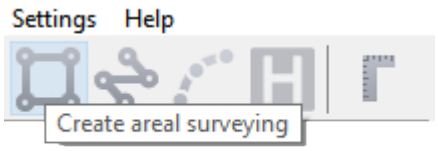


Parameters in new project window

Aerial Surveying

Aerial surveying is a polygon surveying. User sets vertices of the polygon (more than 3) and the software will automatically calculates a flight route.

1) Press **Create aerial surveying** on the toolbar.



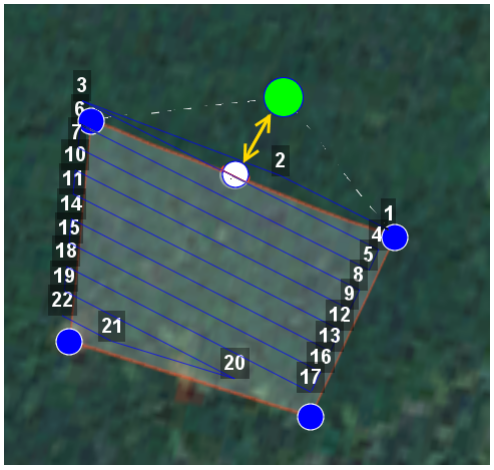
Create aerial surveying

2) Click on the map to set vertexes of aerial survey area. The program will automatically calculate the flight route.

Adding and Removing of Polygon Vertexes

You can add vertices to polygon.

1) Hold left mouse button and move middle point of a polygon side.

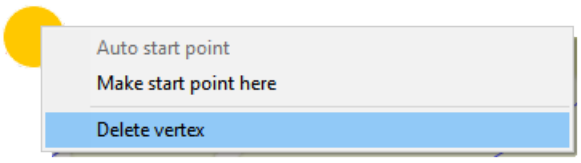


Vertex adding

The vertex will be created automatically. A floating window will display location of the vertex.

To remove the vertex:

1) right click on the vertex;
2) select *Delete vertex*.

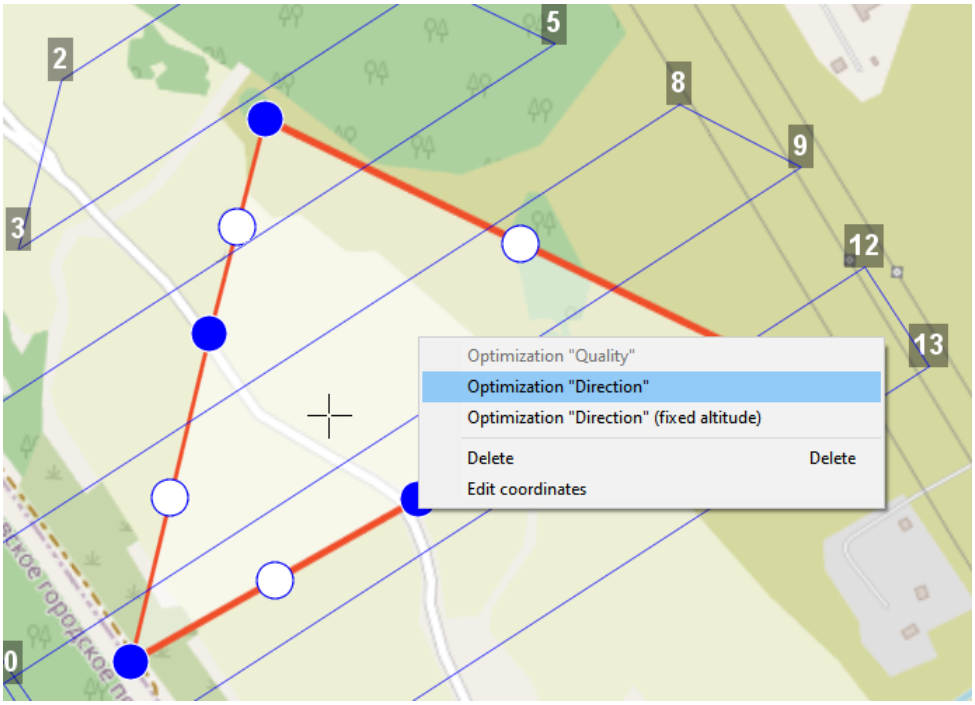


Delete vertex

Change Flight Route Direction

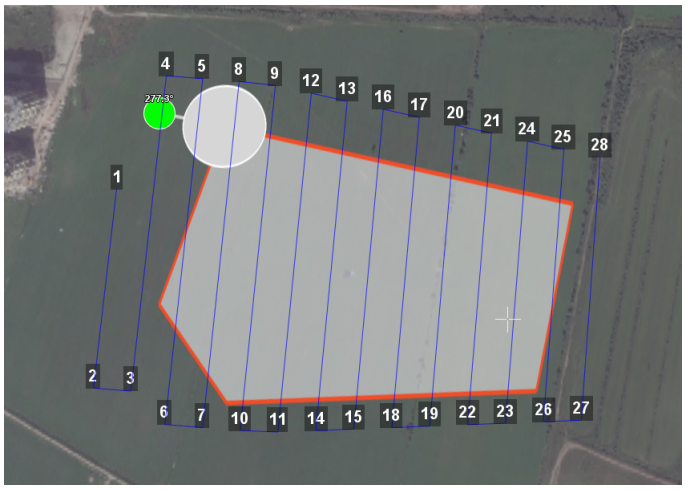
The need to change a flight route may be caused, if the force and direction of the wind are unfavorable (strong wind along the flight route of the polygon).

Right-click on the polygon and select the option *Optimization «Direction»* in context menu to change the direction of flight route.



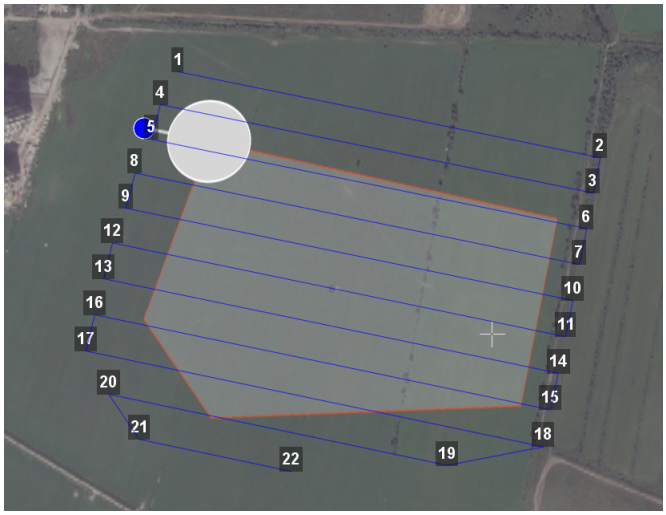
Optimization by direction

One of the vertices of the polygon will be colored gray. Use the point's slider to set the flight route direction.



Correction of the flight direction

A new flight route through the polygon in a selected direction will be generated automatically.

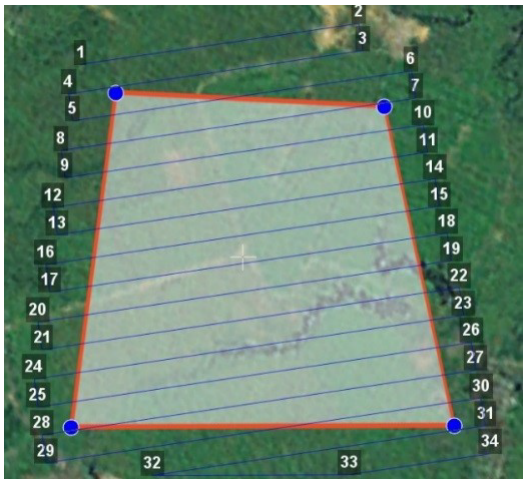


Changed flight route

Start Point Changing

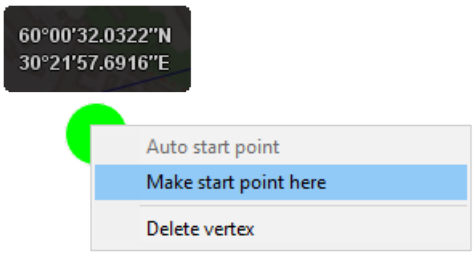
To change the polygon entry point, follow these steps:

1) Select a polygon.



Selected polygon

2) Select vertex, right click and choose *Make start point here*.



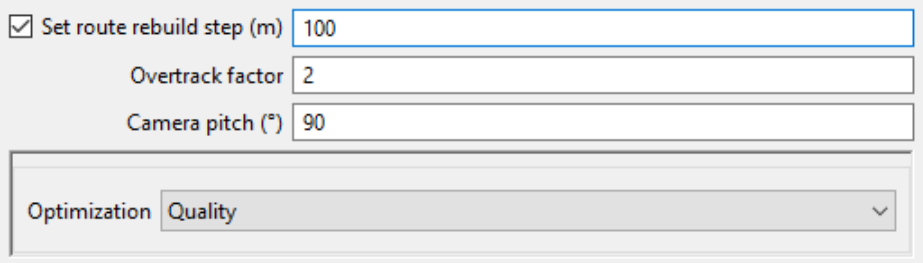
Context menu of a point

The selected point will be marked with a flag

Precise Terrain Following

Use route rebuild parameter to set rebuild step for better accuracity of results (it needs for magnetometer, lidar, gamma spectrometer and can be used for aerial survey)

To use this:
1) Create aerial surveying.
2) Change software mode to expert by press **Expert** button.
3) Activate **Set route rebuild step (m)** trigger in **Properties** tab and set a value.
Standard value for aerial survey is 100 m.
Recommended value for flights with magnetometer is 50 m.



Route rebuild step

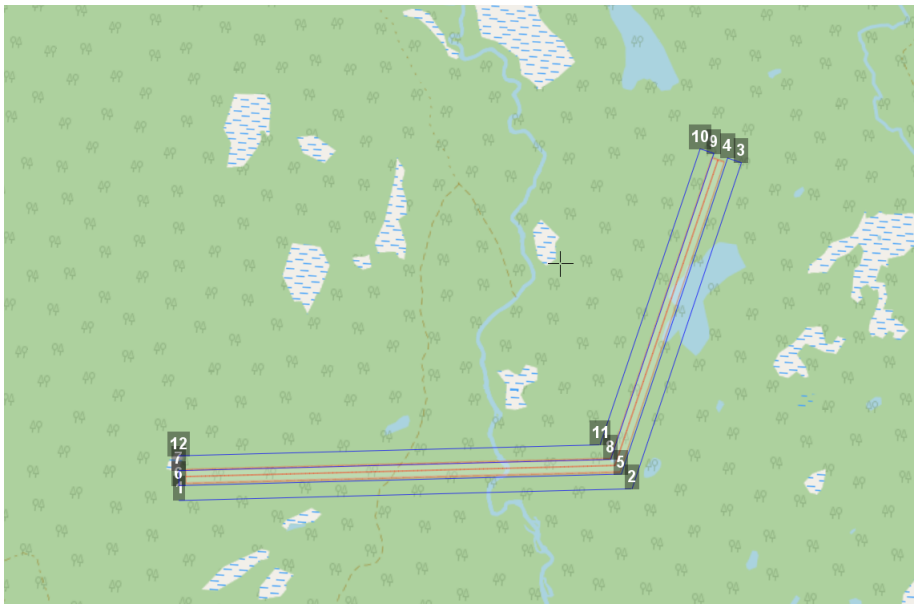
Linear Surveying

Create linear surveying tool allows to create a flight route along linear objects, such as: rivers, roads, oil pipelines, etc. .

1) Press **Create linear surveying** button on the toolbar.

Create linear surveying button

2) Single clicks to set a path around an object. The program will automatically generate flight route.

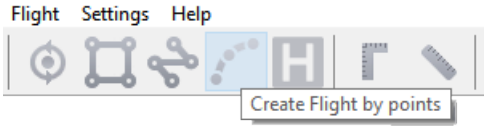


Linear survey example

Flight By Points

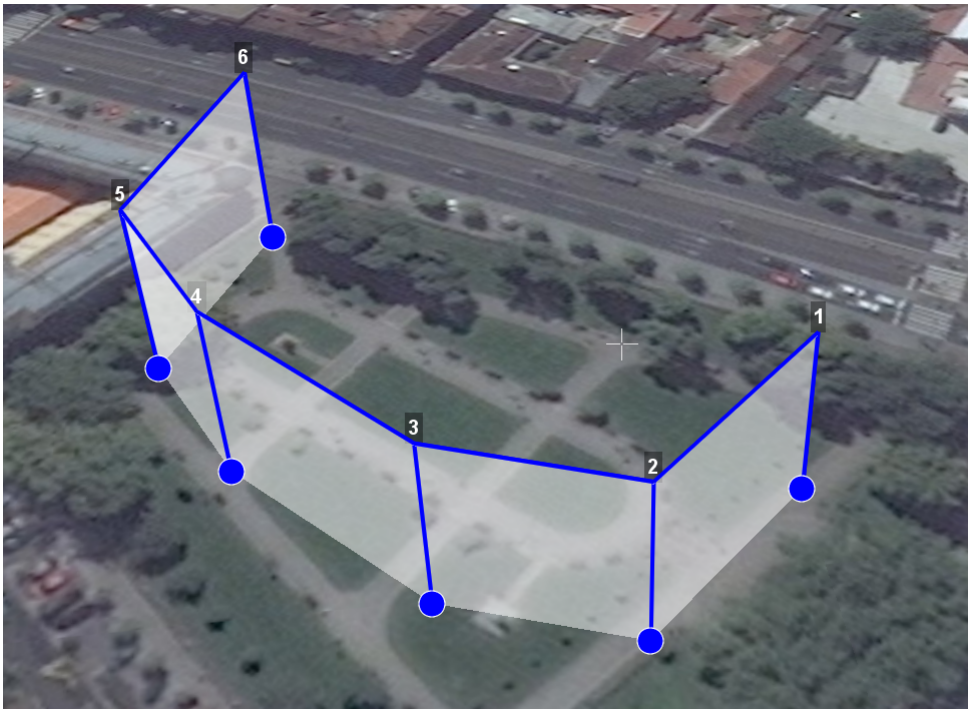
Create flight by points tool can be used for inspection of territories and overflights of high-rise objects.

1) Press **Create flight by points** button on the toolbar.



Create flight by points button

2) Single clicks to select flight route points.



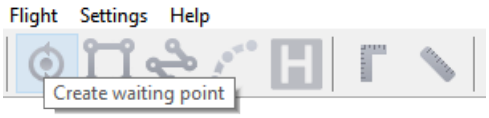
Flight by points

By default, aerial survey is not performed during the flight by points. Set up **Photo mode** in **Properties** window, if you need aerial survey photos.
Click on the right mouse button to set delay time.
Select **Set delay in point** and set time of waiting (in seconds).

Waiting Point

Create waiting point tool allows to hold UAV on selected map point.

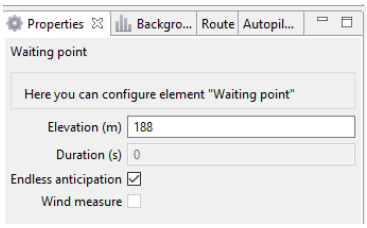
1) Press **Create waiting point** on the toolbar.



Waiting point button

2) Click mouse button on the map to set waiting point.

UAV will hold the point on the set height during the specified time, and then go back to the flight route. You can activate more options an expert mode: set delay point height, waiting time, direction, wind measurement and endless devay functions.



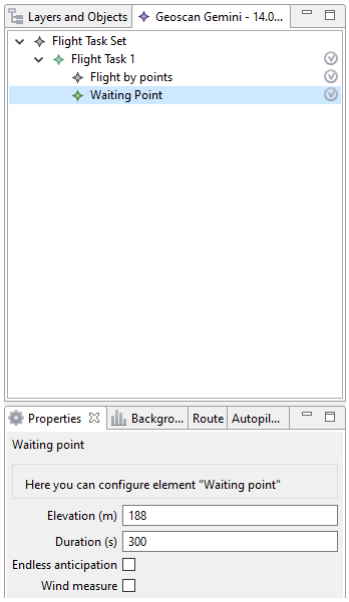
Waiting point

In **Wind measure** mode the waiting point will be colored yellow, and the duration will change to 15 seconds. UAV will take into account a wind mesurements when performing a flight task.

The waiting point option sets holding point in the air (point will be hold until the low battery charge will trigger automatic return to start point). The waiting point color will change to deep blue.

We recommend to set the waiting point with wind measurement before each flight element at the height of the flight element, especially if they are located a large distance from each other.

Geoscan UAVs are not certified instruments of wind measurement. It cannot be used as a precise tool.

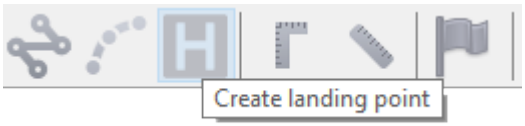


Waiting point in wind measure mode

Landing Point

Create landing point tool is used to set the UAV landing point. If there is no specified landing point, UAV will return to the starting point at the end of the flight task.

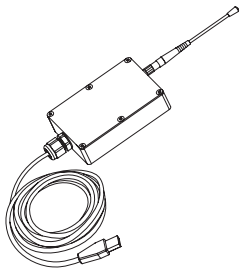
1) Press **Create landing point** button on the toolbar.



Create landing point button

2) Click on the map to select landing point for UAV.

Radio Modem Connection



The radio modem is used to load a flight task into the autopilot memory, set up and semi-automatic control the UAV flight up to 40 km using the Geoscan Planner software. This section describes how to set up wireless connection between the UAV and laptop.

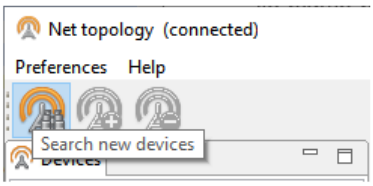
1. Connect radio modem to laptop's USB port.
2. Install **MdmDisp** and **NetTopology** software.
3. Turn the UAV power on.
4. Launch the **MdmDisp** utility.

The antenna icon and the number of connected UAVs will be displayed in a right corner of the laptop screen.

4.1 At the first time you need to configure connection with UAV.

1) Run the **NetTopology** utility.

2) Press **Search** button.

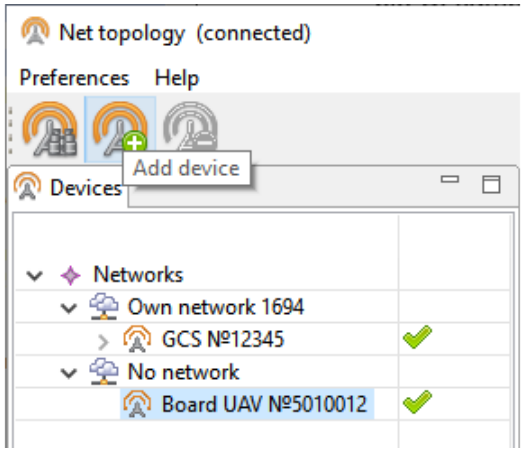


The program will show the list of detected devices. The search will continue until the **Search new devices** button will be pressed again.

3) Select UAV №501xxxx and press **Add device** button.

The utility saves the list of added devices automatically.

Before the next flights just run MdmDisp and check the successful connection.



Adding a new device

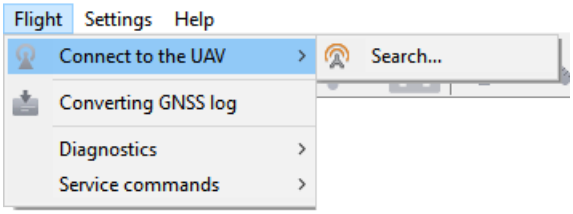
If UAV is not detected reconnect radio modem by right-click on the MdmDisp icon and select **Reconnect**. in the context menu.

If connection is failed:

- Check connection of the radio modem to laptop's USB socket.
- Check network settings in NetTopology.
- Set COM-port of the radio modem manually. Right click on the MdmDisp antenna icon and select textbfSettings in the context menu. Set **Connection type — Serial** and select COM-port of the radio modem.
- Right click to MdmDisp icon and select **Reconnect**.

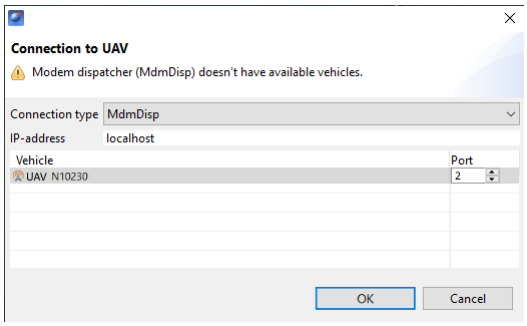
Connecting UAV to Geoscan Planner

1) Select **Connect to the UAV — Search...** in **Flight** tab.



UAV connection

2) Select connection type in **MdmDisp**.
Set *IP-adress — localhost*.
In **UAV** list set **UAV — Port 2**.



Connection settings

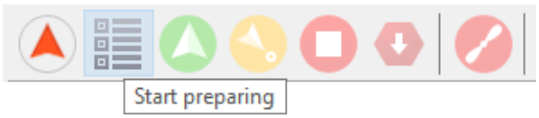
The settings will be automatically saved. At the next connections turn on the UAV power and use **Connect UAV** button on the toolbar.

Connect UAV button

The receiver will automatically detect UAV coordinates and display position on the map.

Launch Preparing

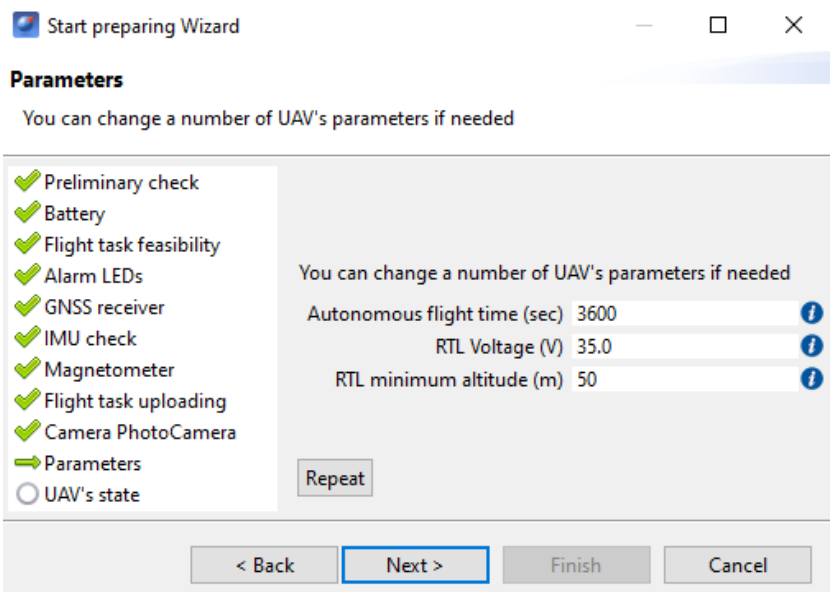
1) Press **Start preparing** button to launch preparing wizard.



Start preparing button

Follow the instructions of the Start preparing wizard (most tests are passed automatically).
On **Parameters** stage set:
Autonomous flight time (sec) – time after radio signal loss that UAV will fly in automatic mode. If the connection is not restored in this time, UAV will start retun to start point.

RTL Voltage (v) – battery voltage cut-off, that launch immediate landing. Cut-off safety range: from 33.0 to 41.5 v.
RTL minimum altitude (m) – altitude cut-off that launch immediate landing. It sets if terrain or other barriers can block return route. Safety value range: from 25 to 500 m.



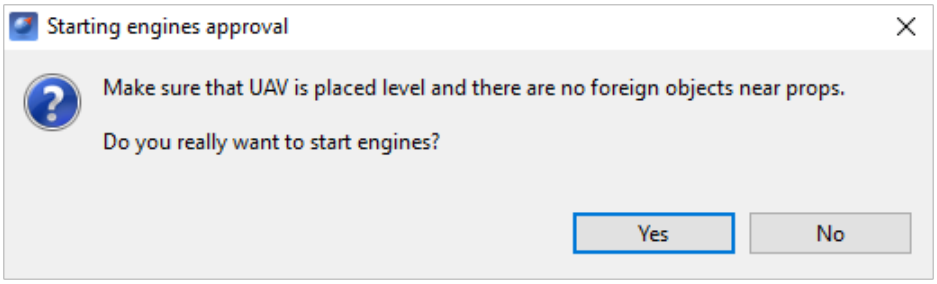
Flight mission settings

Flight

Press **Start** button.

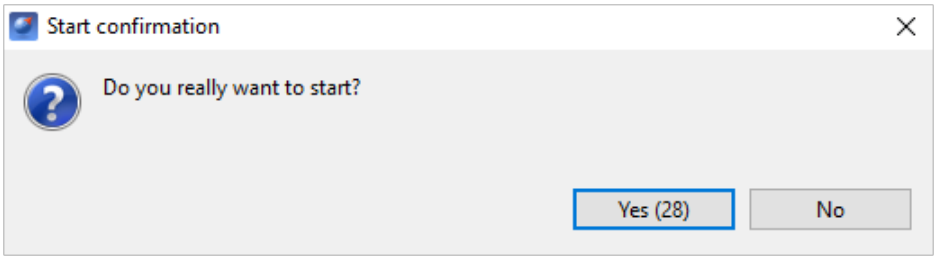
«Start» button

Make sure that nothing is block propellers and confirm engines start.



Engines start confirming window

Autopilot will check engines. Take-off confirmation window will be shown on a laptop screen. Approve the take-off.



Take-off approve

UAV will start.

UAV performs flight mission in automatic mode, but the operator should monitor flight process to aviod any deviations. All-time radio link connecton is not necessary for successful flight.

Cancel Tool

Cancel tool directs the UAV to starting point. After reaching the starting point, UAV will perform the landing.

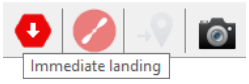
Press the **Cancel** button.

Cancel button

UAV will start flying to the starting point and will land on it.

Immediate Landing

Immediate landing tool is used to perform immediate landing on a current flight point.
Press **Immediate landing** button.



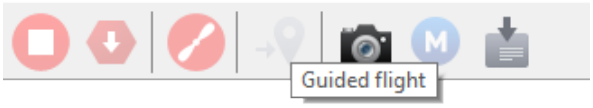
Immediate landing button

UAV will start landing.
Automatic landing is triggered by barometric height measurements. It's not recommend to land immediately at the point with the big difference in terrain compared to the takeoff point.

Guided Flight

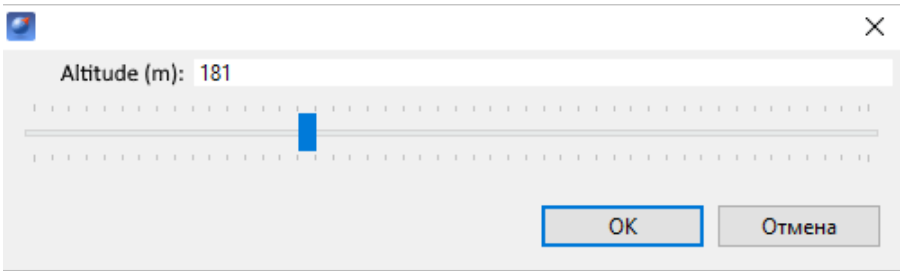
Guided flight option sets a destination point on the map and height. UAV will reach the point and start point holding until flight confirmation or until the automatic return is triggered by the battery low charge.

1) Press **Guided flight** button.



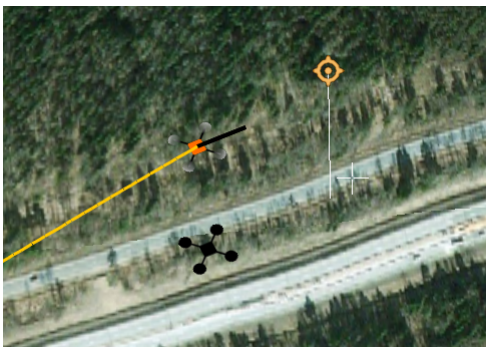
Guided flight button

2) Click a point on the map and set the flight height above the ground (Elevation).



Flight height setting

UAV will hold the point when it is reached.



Guided flight example

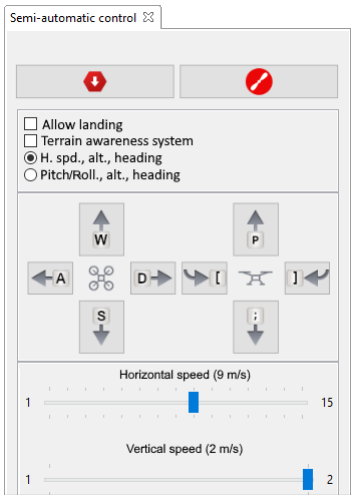
Semi-Automatic Remote Control

Semi-automatic control mode is possible after UAV pre-flight check and take-off.
Press **Semi-automatic control** button.

The UAV control will be switched to semi-automatic mode.
If the semi-automatic mode is activated, UAV autopilot will paused linear or aerial survey and will wait control commands (by screen buttons or keyboard) from UAV operator.
Immediate landing and *Stop Engines* buttons are placed on the top of semi-automatic control tab.

⚠ **Stop engines** button will trigged full motors' stop!
Make sure, that UAV is safety landed before use!

Allow landing — option provides opportunity to land UAV in manual control mode.



Terrain awareness system — higlights areas with high elevation differences on the map.

UAV can be controlled in several modes for smooth flight and better shots' quality:

H.spd.,alt.,heading — horizontal speed, altitude and heading control mode.

Pitch/Roll,alt.,heading — Pitch/Roll altitude and heading control mode.

UAV control provided by navigation keys (on the screen or keyboard).

W — Forward; **A** — Left; **S** — Back;

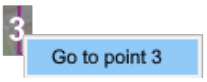
D — Right; **P** — Up; **;** — Down;

[— Left rotation; **]** — Right rotation.

Use speed settings to correct UAV speeds:

Horizontal speed — Manual control of UAV horizontal speed;
Vertical speed — Manual control of UAV vertical speed.

Press Semi-automatic control button again to turn mode off.
After you turining semi-automatic mode off, UAV will hold flight position. Set flight mission point by right mouse button click on the route point and select **Go to point** to continue flight mission from this point.



Launch

Follow these checklist to launch Geoscan 401:

1) Charge the battery and make sure it works correctly (see *Charger and battery* section for details).
2) Create flight project in Geoscan Planner software
   (see *Geoscan Planner Software* section for details).
   Save your project to load it directly before flight.
3) Assemble UAV and install payload (see *Assembly* and *Payloads* sections for details).
4) Connect payload cable(-s) to UAV.
5) Turn on payload.
   Format memory cards and check payload settings (see *Payloads* section for details).
   Remove the lens cap for a camera payload.
6) Connect radio modem to laptop and set wireless connection with UAV
   (see *Radio Modem Connection* section for details).

8) Open a flight project in Geoscan Planner.
9) Launch **Start preparing wizard**.
   Make sure that all tests are passed successfully.
10) Press **Start** button and approve engines start.

UAV will take off and start a flight mission.

UAV Disassembly

1) Unlock and eject the battery.
2) Unscrew the propellers.
3) Disconnect payload cables *
4) Unscrew UAV antenna(-s).
5) Hold payload cradle , eject mounting rods and place them in UAV transport case.
6) Unscrew the nuts of quardcopter arms and move them closer to motors for better arms folding.
7) Fold arms in front, place them in protective polypropylene block and place quardcopter in transport case.
8) Unclasp elastic stopers of landing gear and unscrew landing gears' nuts.
9) Place landing gears in transport case.

* — for payloads with UAV connect

Appendix

Specifications

UAV

UAV type	multirotor
Motors	electric brushless — 4 pcs.
Battery type	LiPo, 37 V
Take-off/landing	vertical in automatic mode from 5 meters area in diameter
Max flight time	1 hour
Max. wind resistance	up 12 m/s
Flight speed range	0-50 km/h
Min safety flight altitude	25 m
Maximum flight altitude	500 m
Max flight weight	9.3 kg
Max payload weight	2,5 kg
Dimensions (arms are folded, without landing gears)	70x25x20 cm
Dimensions (UAV is assembled)	150x150x43 cm
Max survey area per flight with accuracy 2 cm/pix	0.95 km
Max survey area per flight with accuracy 3 cm/pix	1.4 km
Max survey area per flight with accuracy 5 cm/pix	2.1 km
Operating temperature range	from -20 to +40 °C
Operating temperature range for «Arctic» battery	from -40 to +20 °C

Battery

Recommended charge current	5 A
Max charge current	8,5 A
Max voltage	42 V
Normal voltage	37 V
Lower voltage	30 V
Discharge current	<34 A
Cells	10 S
Capacity	17 000 mA·h
Weight	3 kg
Service life	1 year

Topcon B111 GNSS Receiver *

Number of channels	226 universal tracking channels
Acquisition time (hot/cold start)	<15 / <44 sec
Signals tracked	GPS: L1/L2; GLONASS: L1/L2
Positioning accuracy (PPK)	horizontal: 5 mm + 0.5 ppm × baseline length; vertical: 10 mm + 0.8 ppm × baseline length

Radio modem

Operating frequency	867.75 – 872.25 MHz
Transmitting power	<1 W
Max. bandwidth	500 kb/s
Max. delay	20 ms
Duplexing mode	TDD
Max range	40 km

Sony DSC-RX1RM2 Digital Camera *

Sensor	Full-frame CMOS Exmor R (35.9x24 mm)
Number of Pixels	43,6 MP
Shutter	Central
Aperture	f/2-22
ISO Range	100-102400
Shutter Speed	from 1/4000 to 30 sec

Sony A6000 Digital Camera *

Sensor	CMOS
Number of Pixels	24,3 MP
Shutter	Focal
Focal Length	16-50 mm
Aperture	f/3.5-22
ISO Range	100-25600

MicaSense RedEdge-MX Camera *

Max. Resolution	1280 x 960 (1.2 MP x 5 bands)
Sensor Size	4,8 x 3,6 mm
Aspect Ratio	4:3
Focal Length	5,4 mm
Field of View	Horizontal: 47,2°; Vertical: 35,4°
Accuracy of results	120 m flight altitude: up to 8 cm/pix per band; 60 m flight altitude: up to 4 cm/pix per band

* — payload type and installed GNSS receiver depends on delivery kit

Charger’s Transport Case

Dimensions	500 × 400 × 190 mm
Weight (without batteries)	7,5 kg
Protection class	IP67
Wheels	no

UAV Transport Case

Dimensions	800 × 520 × 310 mm
Weight (with equipment)	16 kg
Protection class	IP67
Wheels	yes

Geoscan Group, 2022