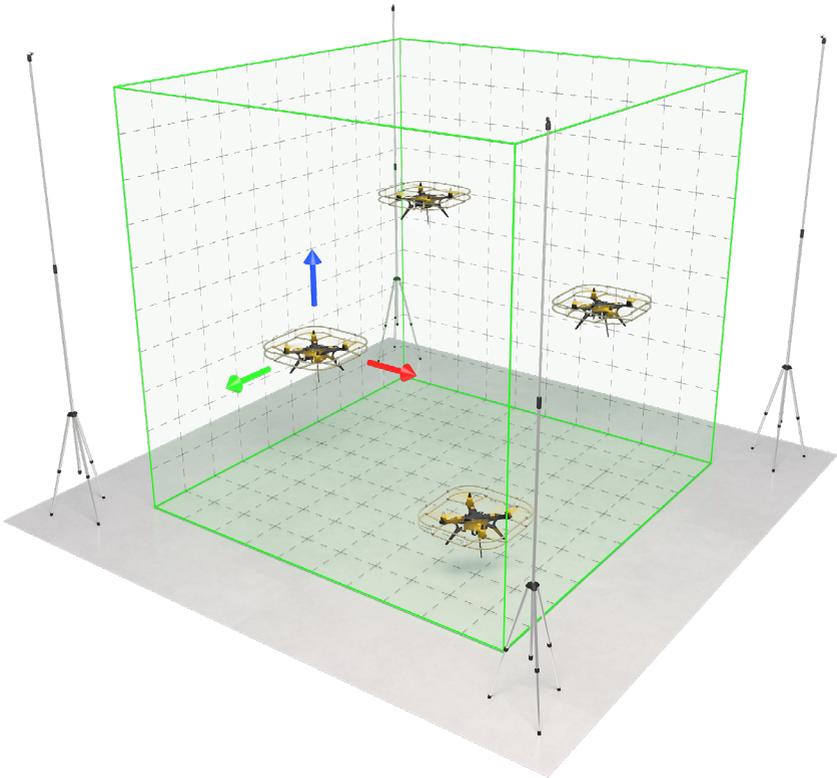
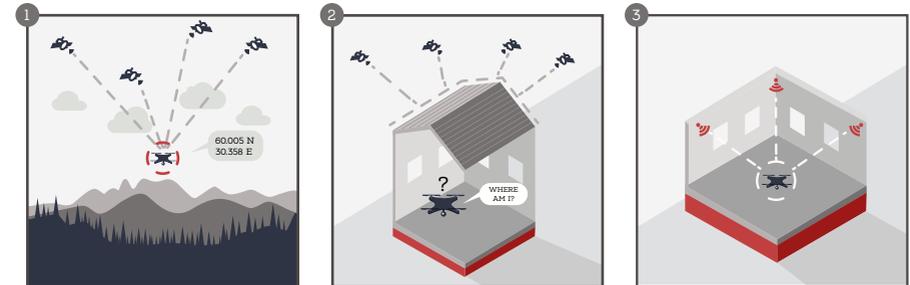


# Geoscan Locus Navigation System Operation Manual



# Purpose

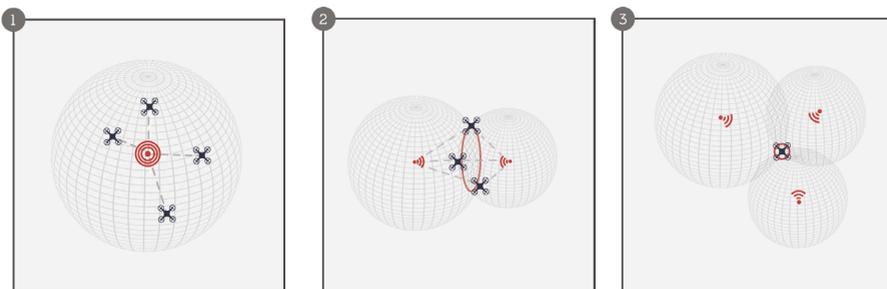
Ultrasonic local navigation system solves the problem of determining the position of an unmanned aerial vehicle, also indoors, where the signals from satellite navigation systems are unavailable.



- 1 Outdoors the quadcopter position can be determined using the signals of satellite navigation system.
- 2 Satellite signals can be unavailable indoors.
- 3 In local navigation system satellite signals are replaced by ones of ultrasonic beacons.

# Principle of operation

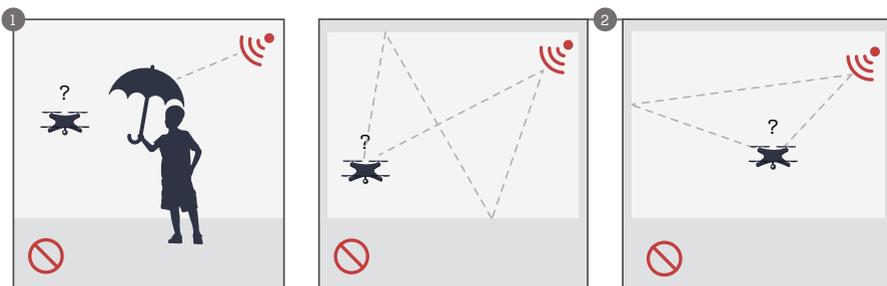
Reference points with known coordinates (“beacons”) make a basis of any positioning system. The distance from the aircraft to the beacons can be determined by measuring signal travel time from the beacon to the aircraft provided the signal propagation velocity is known. If distances to three beacons are known, the position of the aircraft can be determined as the intersection point of the three spheres, whose centers are located at beacons positions and the radii are equal to the distances from the beacon to the aircraft. This method of determining coordinates using known distances to three points with known coordinates is called trilateration.



- 1 If the distance is known for only one beacon, the quadcopter can be located at any point of the sphere whose radius is equal to the distance between the copter and the beacon.
- 2 If distances are known for two beacons, the quadcopter can be located at any point of the circle, which is the intersection of two corresponding spheres.
- 3 Known distances to three beacons allow to accurately determine the quadcopter position.

## Recommendations

The use of ultrasound imposes some restrictions on the configuration and use of the navigation system.



- 1 There should be no obstacles between the transmitter and the receiver.
- 2 The influence of reflected signals should be minimized.

The following geometrical parameters of the system are recommended.

Minimum distance between the receiver and the beacon: 1.5 m

Minimum distance between the beacons: 3 m

Minimum beacon altitude: 2 m

Minimum system operation area:  $3 \times 3 \times 2$  m

The configuration where the beacons are located at vertices of the  $5 \times 5$  m square at the height of 3.5 m is optimal.

## The system includes:

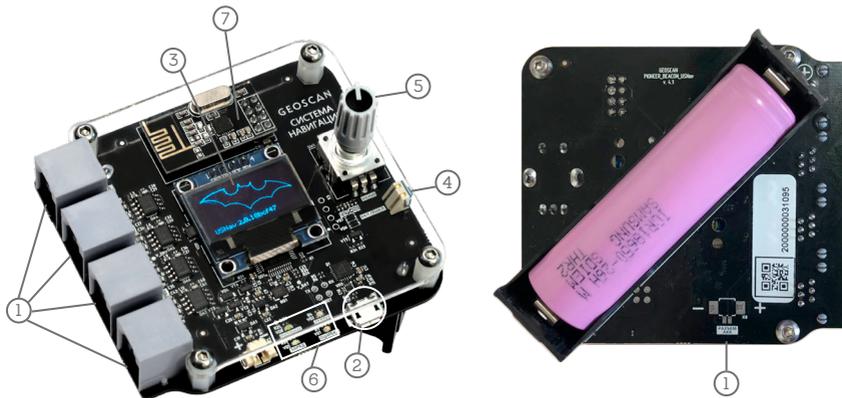


- 1 - Control unit
- 2 - Ultrasonic vibrators – 4 pc.
- 3 - Wire set for vibrators connection.
- 4 - Mounts with stickers for mounting the vibrators on the wall – 4 pc.
- 5 - Lithium-ion battery.

## Basic safety rules

Take precautions when installing beacons upstairs.  
Follow the rules for battery handling.

## Control unit



### Top view

1. Beacon connectors.
2. USB connector for connecting to the computer and battery charging.
3. Display.
4. On/Off button
5. Selector
6. LED indicators: green, red, white, blue.
7. Radio transmitter with antenna.
8. Service connectors, not used in navigation system operation.

### Bottom view

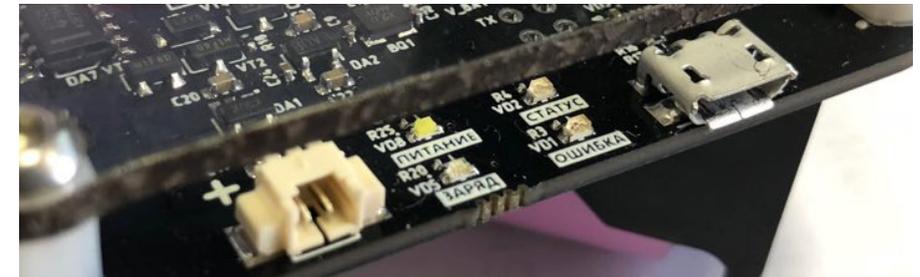
1. Battery compartment

The control unit is powered from a lithium-ion battery or via USB.

To ensure trouble-free operation of the system it is necessary to monitor battery discharge. When the battery is discharged to a voltage of 3.0 V, the Status LED starts flashing. When the battery is discharged to a voltage of 2.7 V, the operation of the system must be stopped and the battery is to be charged.

## LED indicators

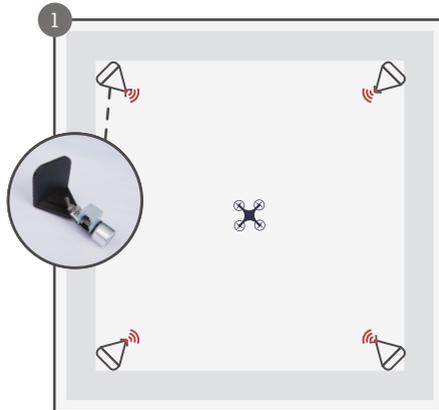
There are 4 LEDs on the navigation system control unit board.



LED indicators	Color	Status	Description
"Error"	Red	Blinking	Command start
		Permanent	Loader mode
"Status"	Green	Permanent	Normal mode operation
		Blinking	Low battery level
"Power"	White	Permanent	Power consumption
"Charge"	Blue	Permanent	Battery charging via USB/from Power Source

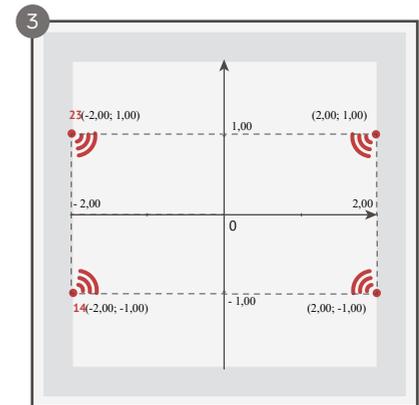
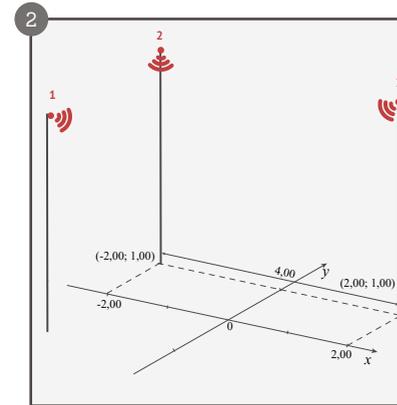
# System installation

1. Select the locations of the beacons, taking into account the possibility of wiring from the beacons to the control unit. Positioning results are optimal if the beacons are located at vertices of the 5 x 5 m square at the height of 3.5 m.
2. Fix the beacons at the mounts using screws.
3. The beacons are numbered and color-coded. The beacons 1 and 2 with black labels are to be installed at one side of flight area, the beacons 3 and 4 with white labels – at the other side.
4. Using stickers, place the mount in selected locations so that the vibrators are directed to the center of the flight area.



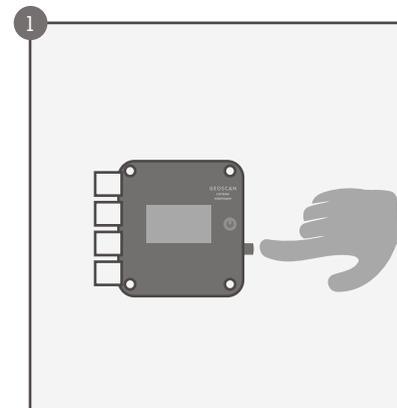
5. According to the color labels, pull the wires from the control unit to the beacons so that the wires do not fall into the flight area.
6. Secure the wires so that they do not change the position of the beacons. Connect the wires to the beacons and to the control unit. The connectors from the beacons 1 and 2 with black labels should be connected to the port 1 and 2, the connectors from the beacons 3 and 4 with white labels – to the port 3 and 4.

7. Measure the distance between the beacons with an error of no more than 5 cm, draw the map of beacon locations. It is recommended to place the origin in the center of the flight area.

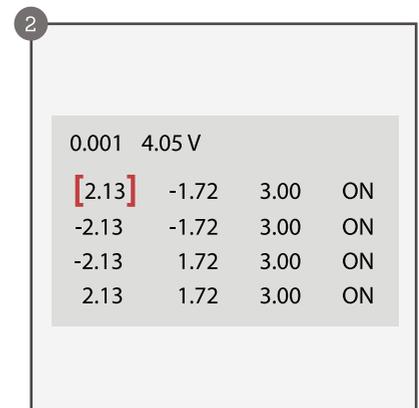


8. Record the coordinates of each beacon in selected coordinate system.

# System setup



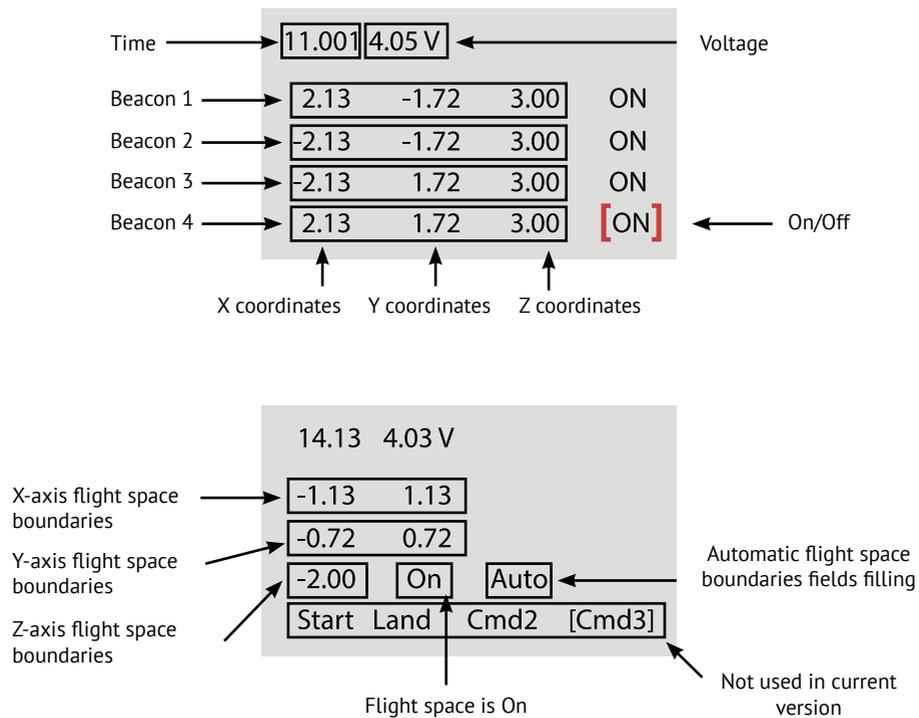
Press and release the power button.



The system is on.

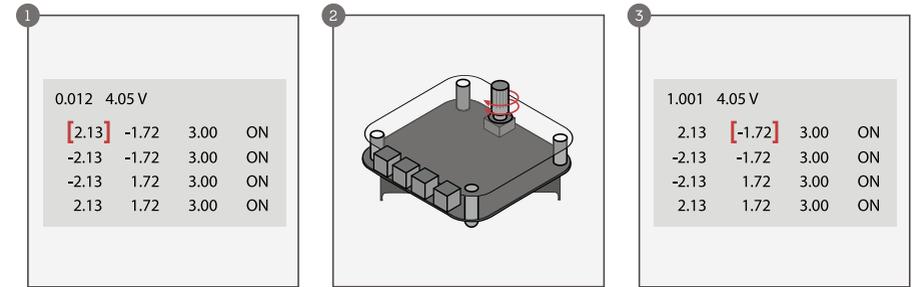
The top line of the display shows the time (seconds) since the control unit was turned on and the battery voltage (volts). This line is constantly displayed.

The four lines below show either beacons coordinates and status (on/off), or the coordinates of the boundaries of the flight space, the on/off field of the boundaries of the flight space, the field for automatically setting flight space boundaries.

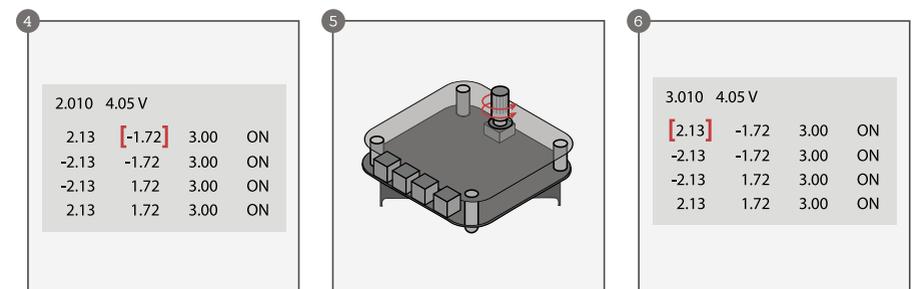


Enter the coordinates into the system. On the control unit board, the data should be entered as follows:

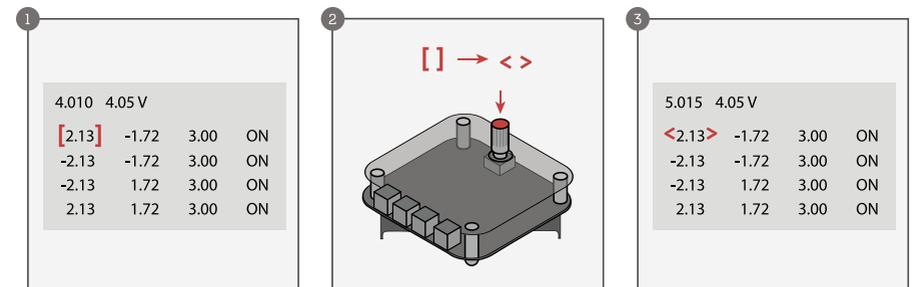
Turn the selector to select a field to set the value.



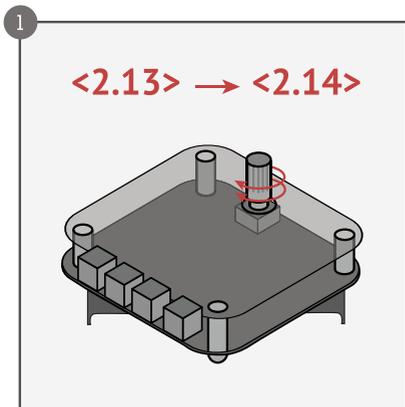
When the selector is turned clockwise, the field on the right is selected.



When the selector is turned counterclockwise, the field on the left is selected.



When the desired field is selected, press the selector. The square brackets that highlight the selected field are replaced with angular brackets, and the value in the selected field can be changed.

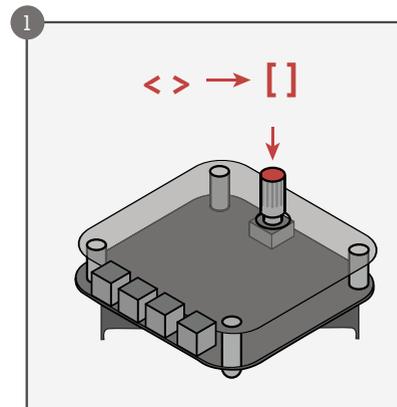


2

6.020	4.05 V		
<2.14>	-1.72	3.00	ON
-2.13	-1.72	3.00	ON
-2.13	1.72	3.00	ON
2.13	1.72	3.00	ON

To increase the value in the selected field, turn the selector clockwise.

To fix the set value and return to field selection mode, press the selector.

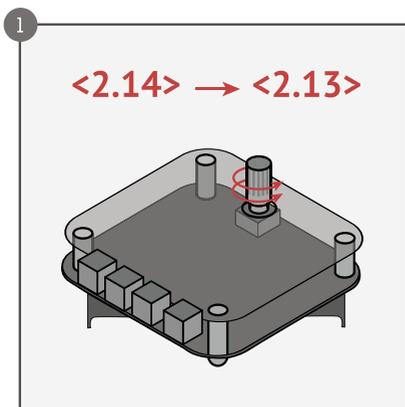


2

8.030	4.05 V		
[2.13]	-1.72	3.00	ON
-2.13	-1.72	3.00	ON
-2.13	1.72	3.00	ON
2.13	1.72	3.00	ON

The value in the selected field is recorded, angular brackets are replaced with square brackets.

In beacons ON/OFF fields, pressing the selector switches the value to the opposite.



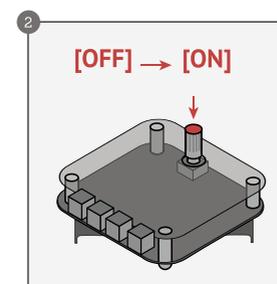
2

7.027	4.05 V		
<2.13>	-1.72	3.00	ON
-2.13	-1.72	3.00	ON
-2.13	1.72	3.00	ON
2.13	1.72	3.00	ON

Turning the selector counterclockwise decreases the value in the selected field.

1

9.035	4.05 V		
2.13	-1.72	3.00	ON
-2.13	-1.72	3.00	ON
-2.13	1.72	3.00	ON
2.13	1.72	3.00	[OFF]



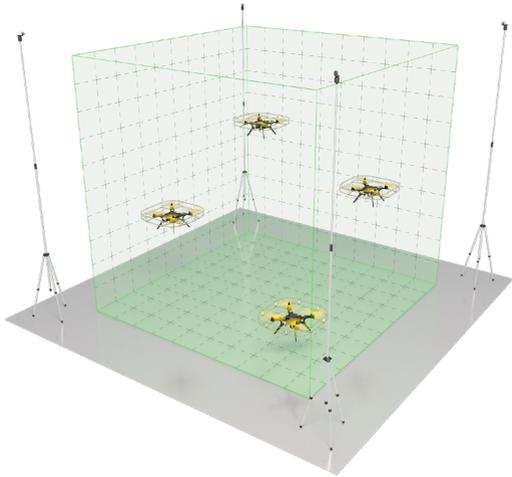
3

10.001	4.05 V		
2.13	-1.72	3.00	ON
-2.13	-1.72	3.00	ON
-2.13	1.72	3.00	ON
2.13	1.72	3.00	[ON]

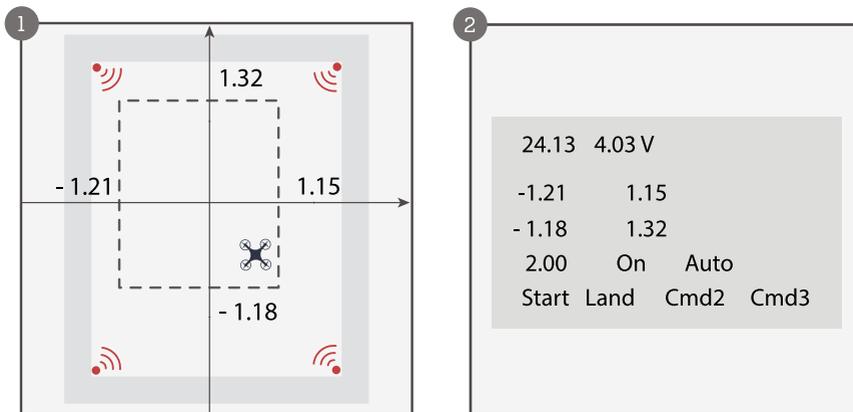
Switching the beacon ON.

# Flight space

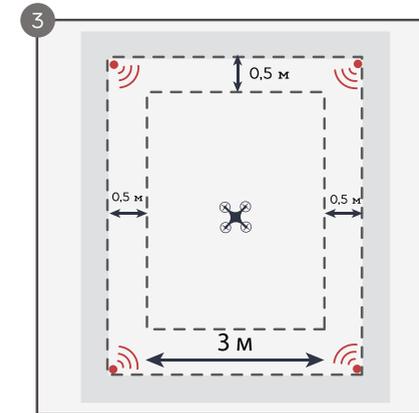
Ultrasonic navigation system allows to specify the area within which the quadcopter will remain during the flight (flight space). The flight space appears as a rectangular parallelepiped.



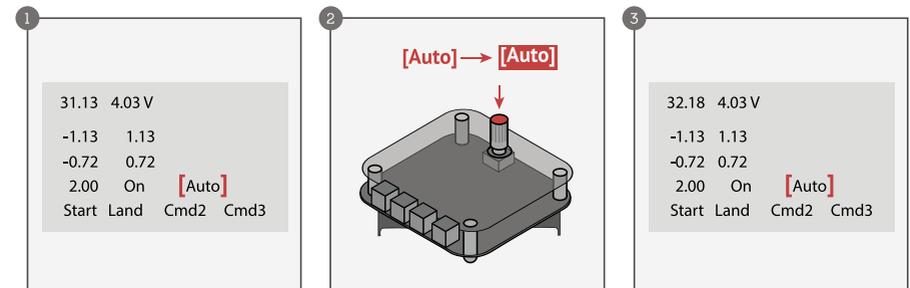
Flight space boundaries can be specified explicitly by specifying the boundary values for each of the coordinates.



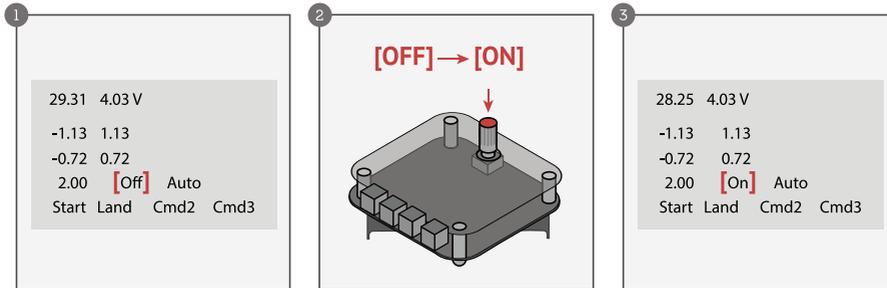
The option of automatically setting flight space boundaries also can be chosen. When automatically setting flight space boundaries, if the distance between the beacons is no more than 3 m, the boundaries will be set to 0.5 m indent from the beacons, and if the distance between the beacons exceeding 3 m, the indent is set to 1 m from the beacons.



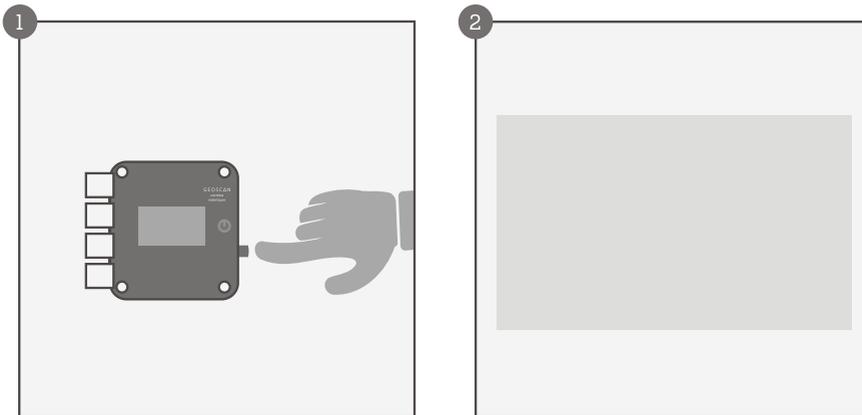
To automatically set the boundaries of the flight space, select Auto field on the screen and press the selector. At the moment of clicking the Auto field is highlighted.



To enable flight space restrictions, select the Off field and press the selector. The value in the field is changed to On, the flight space restrictions are enabled.



System turn-off.



- 1 Press ON/OFF button
- 2 The system is off.

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