SPH Engineering

SkyHub

User Manual

Revision 10
June 2023

Revision History

REVISION	DATE	DESCRIPTION
10	30.08.2023	• TX Frequency configuration for RadSys zGPR • ROS support plugin configuration was changed • Skyhub cable LEDs behavior desctiption • QuSpin Gen-2 magnetometer configuration • Lightware SF-30D configuration update • US-D1 configuration update
9	14.11.2022	• Update Echo sounder settings description • Added the BDUS Bridge (ROS 2 framework) support description • ROS based driver for altimeter SF-30D description • ROS based driver for altimeter US-D1 descrtiption • Updated Navigation parameters description • Navigation tuning guideline
8	08.07.2022	• Added the PPS Sync description • Updated the Assembling section • Updated setup instructions for Geonics EM-61 • Changed the `MAV/BAUD_RATE` default value from 57600 to 230400
7	20.05.2022	• Added the Target Altitude limit of TTF and Grasshopper modes above water for laser altimeter • Added the Warnings section • Added the RadSys zGPR description • Added new parameters to Geonics EM-61 settings • Updated the Update Firmware section • Updated parameters in the NAV config section • Changed the `OUTPUT_GPS/FREQUENCY_HZ` default value from 1 Hz to 5 Hz • Removed the `START_DELAY_S` parameter from payloads configuration connected via UART/RS-232
6	09.02.2022	• Added UgCS SkyHub 3 • Added the Supported Sensors section • Added the Lightware SF30/D altimeter description • Changed the Description section • Removed the Attollo WASP-200 altimeter description • Removed the Lightware SF11/C altimeter description • Removed the UgCS SkyHub Device section • Removed the Kits section

REVISION	DATE	DESCRIPTION
5	13.01.2022	• Added the DJI M300 RTK description • Added the ArduPilot/PX4 based drone description • Added the DJI Obstacle Sensors Disabling • Added the Position Log description • Added the Obstacle Avoidance Mode description • Added the Echologger ECT D052/D032 description • Added the sound speed value to ECT400 Echosounder specification • Added the FT Technologies FT742-SM description • Added the Nanoradar MR72 radar obstacle detector description • Added the Geonics EM-38MK2 conductivity meter description • Added the RadSys Zond Aero GPR description • Added the Remote Water Sampling description • Added the GPS Output description • Added the Emlid Reach M2 description • Changed the DJI Flight Controller Activation description • Changed the Grasshopper Mode description • Changed the True Terrain Following description • Changed the *PERGAM_FALCON/FREQUENCY_HZ* description • Changed the *PERGAM_LMM/FREQUENCY_HZ* description • Removed the RadSys Zond Lite support • Removed support of 12 ns and 25 ns time range for RadSys Zond GPR • Removed Default DJI Credentials (Recommended) section
4	05.11.2020	• Added the True Terrain Following v2.0 settings • Added the resuming and pausing TTF from UgCS-CPM description • Added the Geonics EM-61 metal detector description • Added the *IGNORE_ERRORS* to common altimeter settings • Added the SEG-Y Postprocessing Tool description • Changed the *MAV/COMPONENT_ID* default value • Changed the default DJI flight mode for Grasshopper • Updated the minimum required UgCS-CPM version • Updated the table of contents • Removed the *MAX_FLIGHT_SPEED_MPS* config parameter

REVISION	DATE	DESCRIPTION
3	03.09.2020	• Added the ArduPilot connection description • Added the Grasshopper Mode • Added the firmware uninstalling description • Added the payload plugin start delay description • Added the Lighware SF11/C laser altimeter description • Changed default Payload and Autopilot plugins loading settings to `false` • Updated the RadSys Zond description related to the new Lite version • Updated the desktop application using description • Updated the configuration description
2	29.05.2020	• Added the Gas detector kit description • Added the Echosounder kit description • Fixed typos
1	20.04.2020	• Initial release

TABLE OF CONTENTS

1 • DESCRIPTION

The SkyHub solution is a hardware and software set designed to enhance commercial-off-the-shelf UAVs capabilities for industrial purposes and to support integration of diverse sensors.

SkyHub solution functions:

- Data collection from sensors like GPR, methane detector, echosounder, etc. which do not have internal data logger. Data recorded in CSV format as well in the formats compatible with specialized software for sensor data processing and analysis (SEG-Y, NMEA-0183, etc.).
- Data fusion from the payload and UAV telemetry. Data without coordinates (non-geotagged) is in most cases useless. SkyHub uses the positioning information from the drone to geotag sensor data.
- SkyHub can supply NMEA coordinate stream to the external sensor. Some sensors have internal data recorders but require an external GPS receiver. SkyHub can act as such an additional GPS receiver by providing the UAV coordinates to sensors.
- Support for True Terrain Following for DJI drones to automatically keep constant elevation over the surface using real-time data from a radar or laser altimeter.
- Support for Grasshopper mode for DJI drones. The mode provides the flight between waypoints at a safe altitude and descends in waypoints to the set altitude to make measurements (using NDT sensor, echo sounder, etc.) or to drop a parcel or seismic sensor.
- Support for an external detector of obstacles to interrupt the flight and save the UAV, especially if the weather conditions or payload configuration interfere with the built-in sensors on the UAV or the UAV does not have such sensors.

Compatible drones

- DJI M300 RTK
- DJI M600 / M600 Pro
- DJI M210 / M210 V2 / M210 V2 RTK
- Custom frames based on DJI A3 flight controller
- Drones based on Pixhawk autopilot with ArduCopter or PX4 firmware.

Interaction diagrams with drones

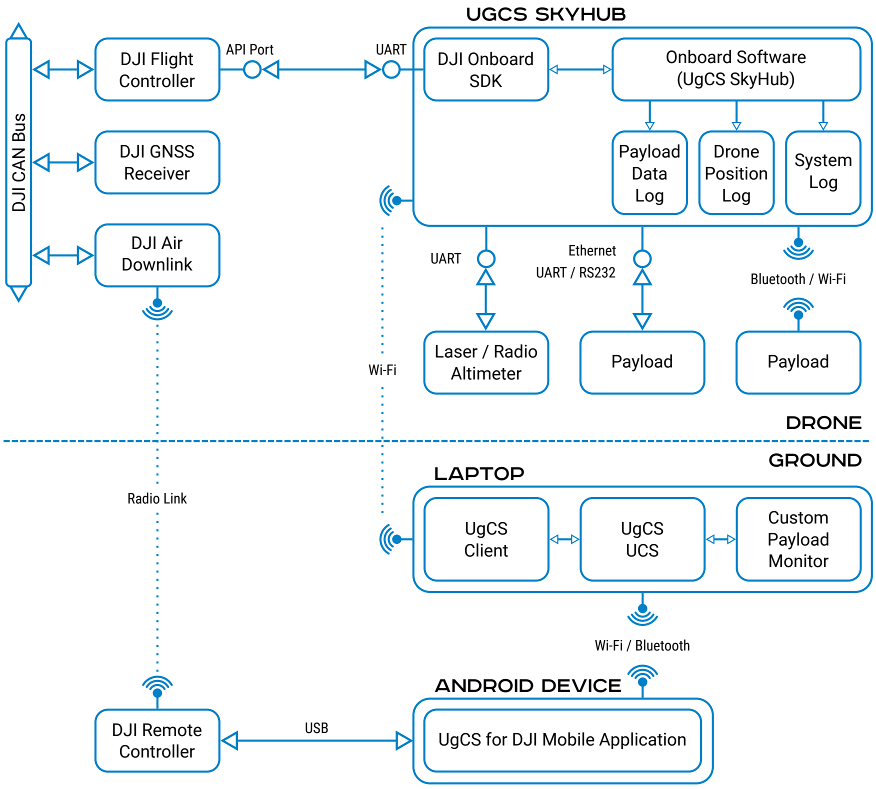

Figure 1.1 — DJI SDK drone interaction diagram

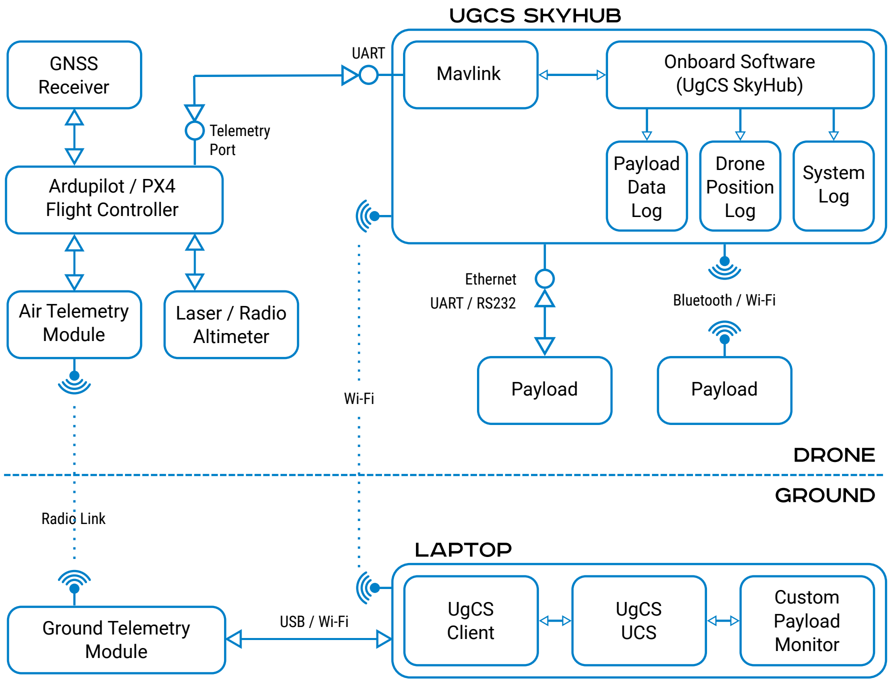

Figure 1.2 — Pixhawk autopilot based drone interaction diagram

Supported sensors

MANUFACTURER	SENSOR NAME	DATA LOGGING ON UGCS SKYHUB	DATA / CONTROL INTERFACE	POWER FEED FROM UGCS SKYHUB	NOTES
Altimeter (used for flight control in True Terraion-Following (TTF) and Grasshopper (GH) flight modes)					
Nanoradar	NRA24	YES	UART	YES	Max range: 50 m
LightWare Lidar	SF30/D	YES	UART	YES	Max range: 200 m
LightWare Lidar	SF11/C	YES	UART / I²C	YES	Obsolete
Attollo Engineering	WASP-200	YES	UART	YES	Obsolete
Ground-Penetrating Radar (GPR)					
Radar System	Zond Aero 500	YES	Ethernet	YES	
Radar System	Zond Aero 1000	YES	Ethernet	YES	
Radar System	Zond Aero LF	YES	Ethernet	YES	
Radar System	Zond-12e Drone 500A	YES	Ethernet	YES	
Radar System	Zond-12e Drone 1000A	YES	Ethernet	YES	
Radar System	Zond-12e Dual 1000a	YES	Ethernet	YES	
Radar System	Zond-12e Drone LF	YES	Ethernet	YES	

MANUFACTURER	SENSOR NAME	DATA LOGGING ON UGCS SKYHUB	DATA / CONTROL INTERFACE	POWER FEED FROM UGCS SKYHUB	NOTES
Radarteam	Cobra Plug-In	YES	Bluetooth	YES	
Radarteam	Cobra CBD	YES	Bluetooth	YES	
Magnetometer					
SENSYS	MagDrone R3 / R4	-	-	YES	GPR feed (GPS-out) from UgCS Skyhub
Geometrics	MagArrow / MagArrow-SX	-	-	-	Tested for compatibility with TTF
GEM Systems	GSMP-35U / 25U	-	-	-	Tested for compatibility with TTF
Echosounders					
Echologger	ECT400	YES	RS-232	YES	Optionally USB
Echologger	ECT D052	YES	RS-232	YES	Optionally USB
Echologger	ECT D032	YES	RS-232	YES	Optionally USB
Methane detector					
Pergam	Laser Falcon	YES	USB	YES	
Pergam	LMm	YES	UART	YES	Obsolete
Metal detector					
Geonics	EM61Lite	YES	RS-232	YES	
Conductivity meter					
Geonics	EM38-MK2	YES	RS-232 / Bluetooth	YES	

MANUFACTURER	SENSOR NAME	DATA LOGGING ON UGCS SKYHUB	DATA / CONTROL INTERFACE	POWER FEED FROM UGCS SKYHUB	NOTES
Other sensors and devices					
FT Technologies	FT742-SM anemometer	YES	UART	YES	
Nanoradar	MR72 obstacles detector	YES	UART	YES	
Emlid	Reach M2	YES	UART / USB	-	
SPH Engineering	Water sampler messenger release device	-	GPIO / PWM	YES	Tested with Ruttner water sampler

2 • WARNINGS

⚠ Read this user manual carefully before you use the appliance and save it for future reference.

⚠ In order to avoid damage to components, all connections to the SkyHub device must be made with the device unpowered.

3 • ASSEMBLING

Instructions on how to mount UgCS SkyHub and an altimeter are published on the webpage How to install UgCS SkyHub.

Power-on checks

The cable connecting SkyHub and DJI M300 RTK drones has built-in LED indicators. You may check the connection condition by their examination:

Figure 3.1 — Numbered LEDs on cable

- LED1 lights up when the power is coming from the drone.
- LED2 is blinking when there is a communication from the drone.
- LED3 is blinking when there is a communication from SkyHub.
- LED2 lights up fully when the connection is established.

4 • PREPARATION

Prerequisites

Required desktop software:

- UgCS v4.3 or higher (referred below as **UgCS**)
- UgCS Custom Payload Monitor v3.17 (referred below as **UgCS-CPM**)
- Putty SSH Client
- WinSCP

Required desktop software for DJI drones:

- DJI Assistant 2 for A3 Autopilot, DJI Assistant 2 for Matrice (M210) or DJI Assistant 2 for Enterprize (M300, M600)

Required desktop software for PX4 based drones:

- QGroundControl

Required desktop software for ArduPilot based drones:

- Mission Planner

Required mobile software for DJI drones:

- For DJI A3 / M600 / M600 Pro: DJI GO
- For DJI M210 / M210 V2 / M300 RTK: DJI Pilot
- UgCS for DJI v2.36 or higher (referred below as **UgCS for DJI**)

Connect to SkyHub Using Wi-Fi

Important: It is strongly recommended to switch on a remote controller before any operations with the SkyHub Wi-Fi.

After powering on the SkyHub operates as Wi-Fi access point with following credentials:

- SSID: `UgCS-SkyHub-******` (where `******` is the SkyHub serial number)
- Passphrase: `12341234`

Note: Windows users might be suggested to enter PIN the first time. Please, switch to security key mode before entering the passphrase.

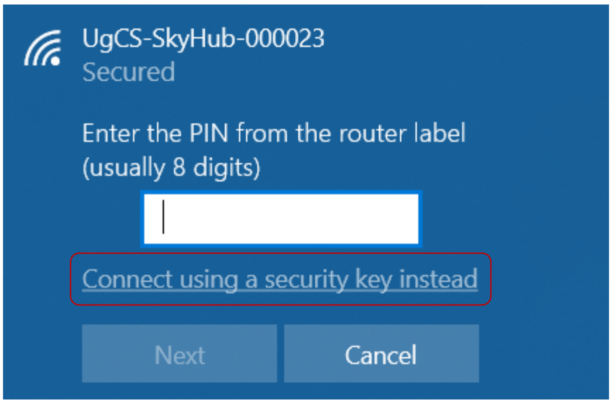

Figure 4.1 — Windows Wi-Fi connection dialog. PIN mode

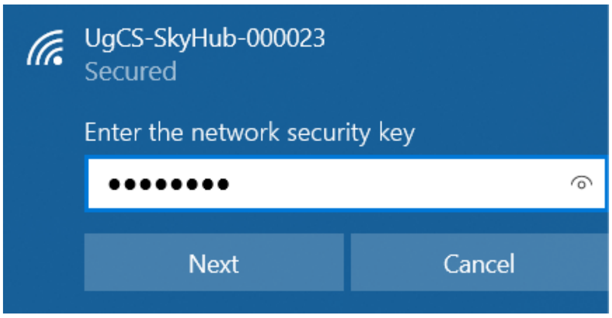

Figure 4.2 — Windows Wi-Fi connection dialog. Security key mode.

One may connect to SkyHub via SSH protocol (e.g. using PuTTY or WinSCP).

- IP address: `10.1.0.1`
- Port: 22
- Username: `root`
- Password: *<empty>*

Connect to SkyHub Using Ethernet

Parameters for wired connection are:

- IP address: `10.2.0.1`
- Port: 22
- Username: `root`
- Password: *<empty>*

SkyHub runs DHCP service onboard, therefore, the PC's IP address will be assigned automatically after connection.

Access to Onboard File System

One may use any SCP client to access the SkyHub file system. For example, one may use WinSCP.

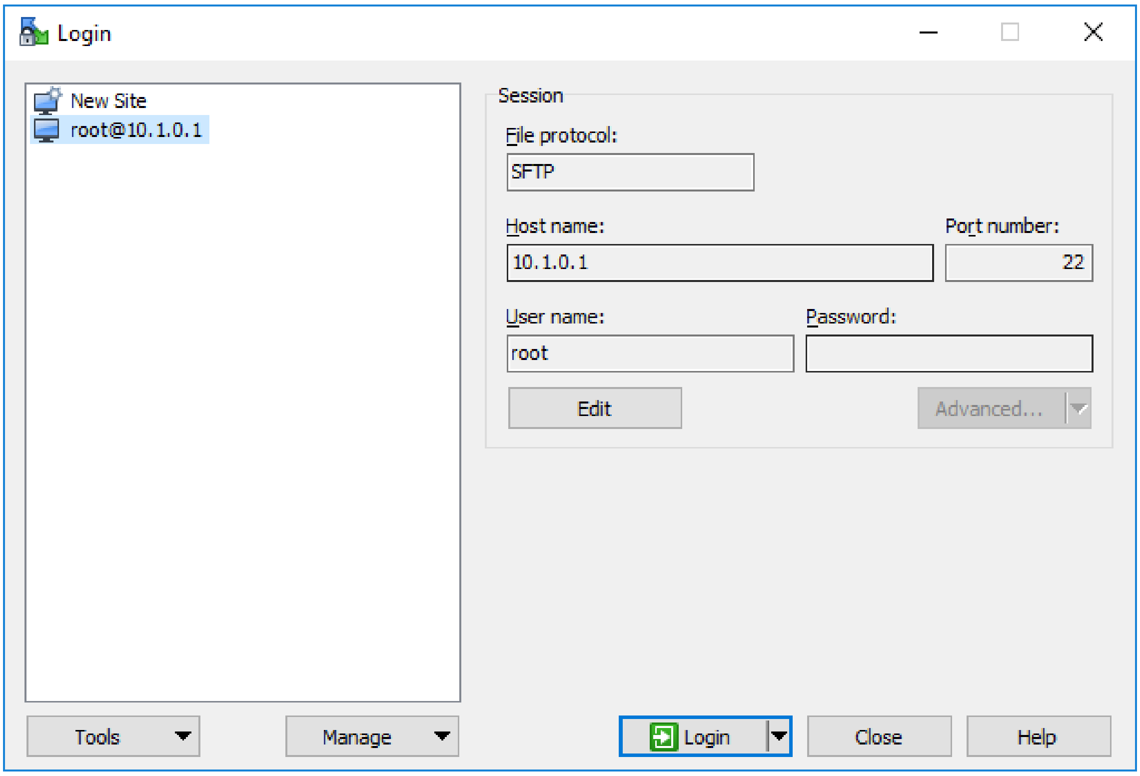

Figure 4.3 — WinSCP settings

While pressing the Login button one may choose between login via SCP (to have access to the file system) or opening with PuTTY (for SSH access).

Table 4.1 — Onboard File System

	UGCS SKYHUB 2	UGCS SKYHUB 3
Home directory for root user	`/home/root/`	`/root/`
MicroSD root	`/run/media/mmcblk1p1/`	
Configuration file	`/etc/skyhub/skyhub.conf`	`/etc/skyhub/skyhub.conf`
Logs directory	`/run/media/mmcblk1p1/skyhub_logs/`	`/data/skyhub_logs/`

Setup Interface to DJI Autopilot

To allow the SkyHub to connect to the DJI autopilot, one should activate and setup the Onboard SDK for its device, and setup the UgCS for DJI mobile application.

DJI User's Credentials Registration

One needs to create and use own credentials for the DJI flight controller activating. Please, follow the steps described below.

1. Create an account on https://developer.dji.com/ then enter to Apps tab in the developer area.
2. Choose the ONBOARD SDK option from the drop-down list and press the CREATE APP button.

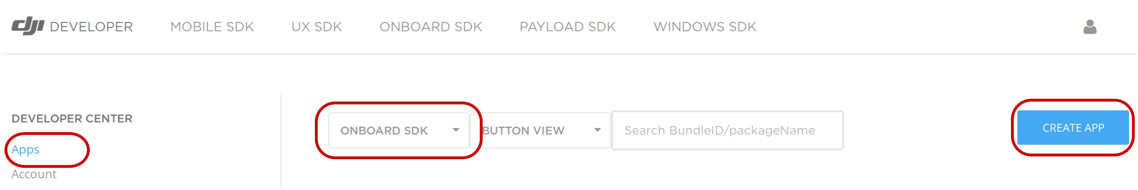

Figure 4.4 — DJI Developer area

3. Enter corresponding information and press the CREATE button.

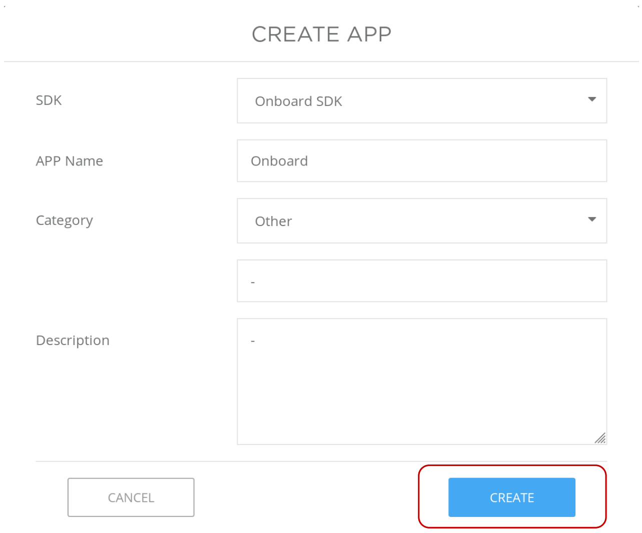

Figure 4.5 — Create app

4. Follow steps from received activation e-mail.
5. Return to the DJI Developer area and open app details. Remember **APP ID** and **App Key** values.

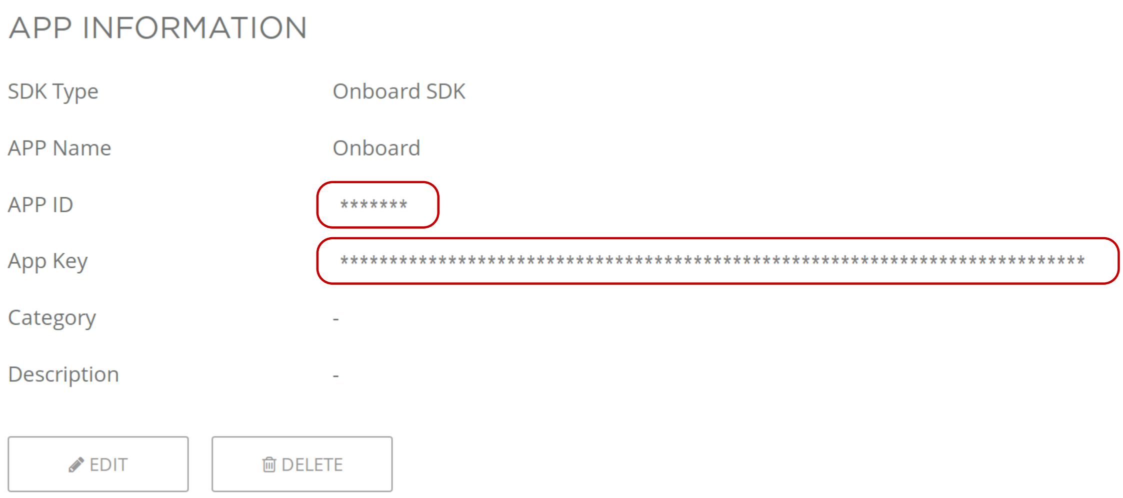

Figure 4.6 — Getting App ID and Key from App Information

6. Write these values to corresponding configuration fields in `skyhub.conf` (`APP_ID` and `APP_KEY` accordingly in `[DJI]` or [DJI_M] section) as described in Setup the SkyHub Device. Do not forget to restart the SkyHub after changing parameters.

DJI Flight Controller Activation

The following steps are described for the DJI A3 flight controller but may be applied to another DJI product with a minor difference.

1. Run the DJI Assistant 2 and check settings that at least `DJI account information` and `Onboard SDK APP ID` options are enabled. Otherwise, Onboard SDK access to the flight controller can't be activated.

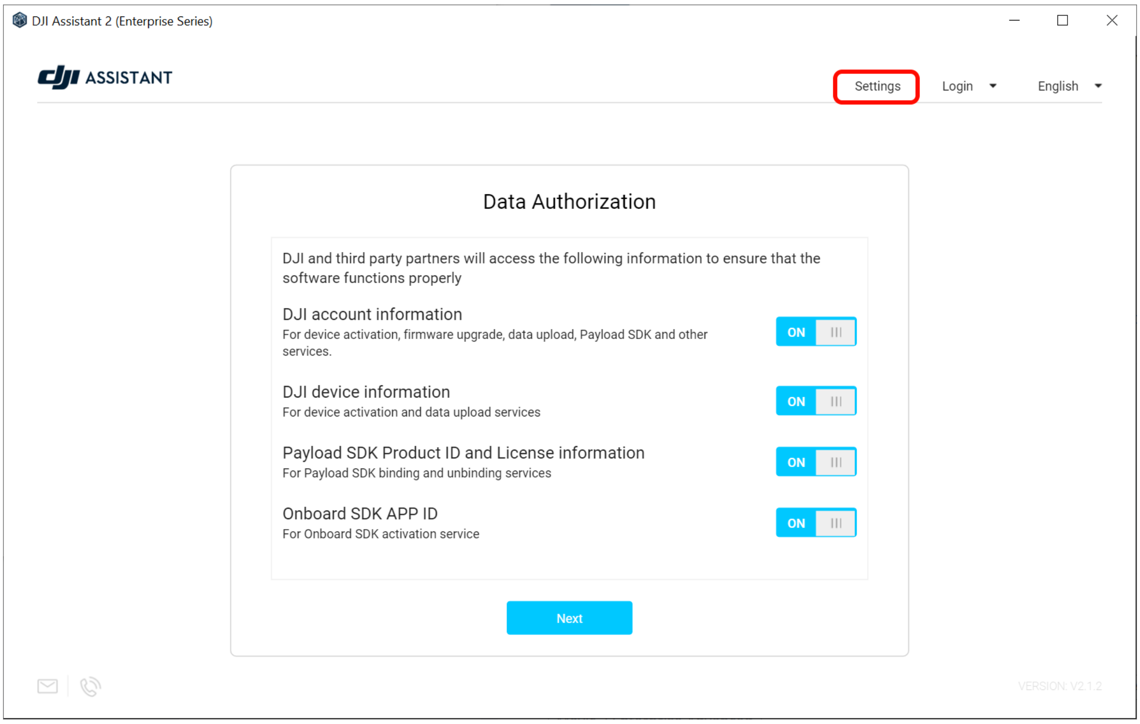

Figure 4.7 — DJI Assistant 2 start window

2. Connect the DJI flight controller to the PC and press the `Login` button.

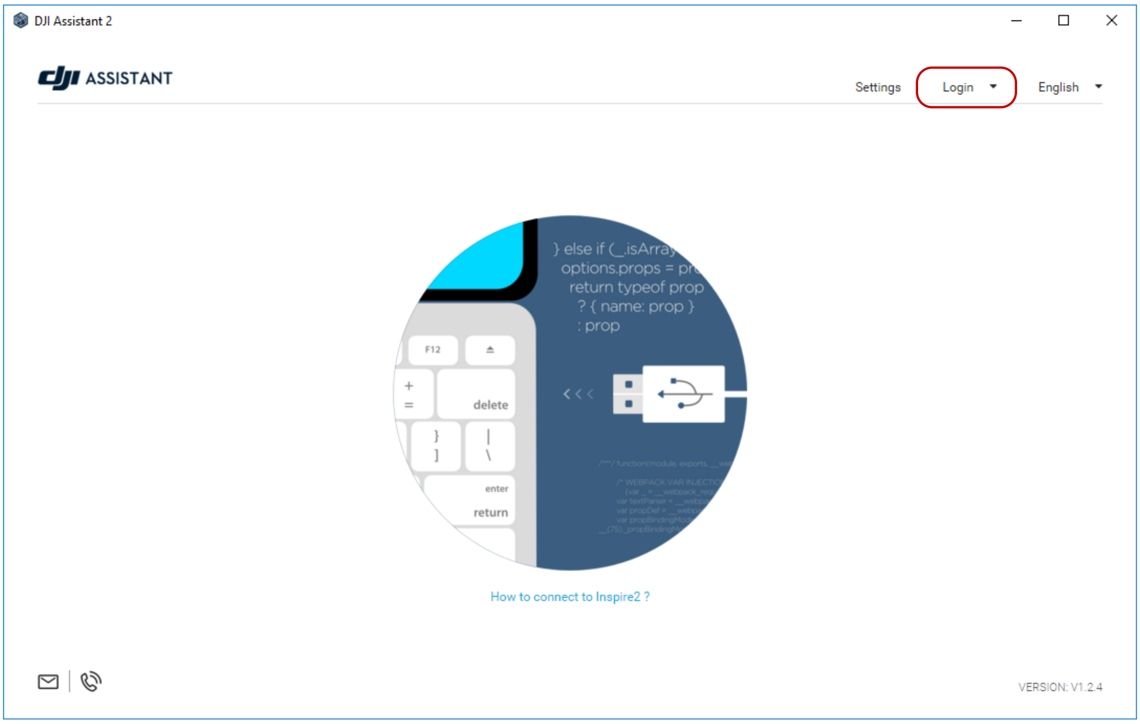

Figure 4.8 — DJI Assistant 2 start window

3. Enter User's DJI credentials created during DJI User's Credentials Registration and press `Sign in` button.

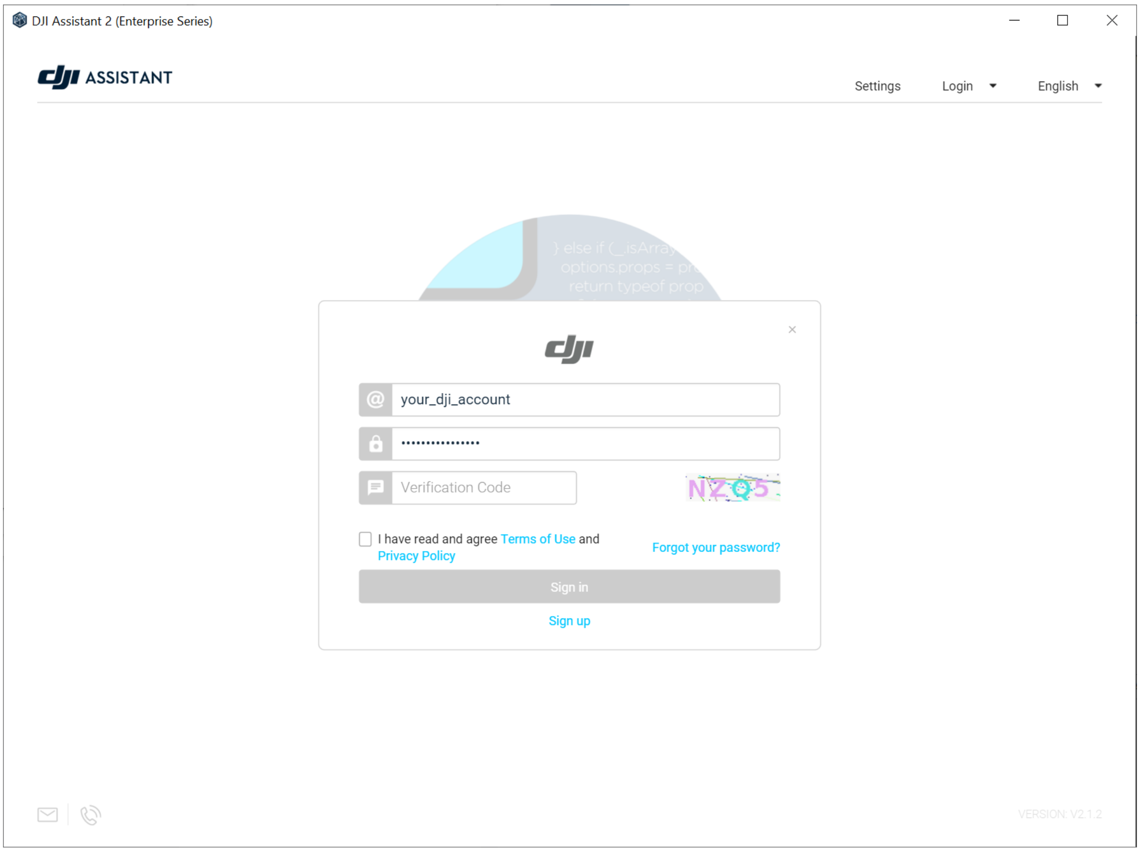

Figure 4.9 — DJI Assistant 2 login window

4. Switch on the drone, wait for the device to appear, open the main window, then choose the `SDK/Onboard SDK` tab and check `Enable API Control`, `Ground Station Status` and `Enable SDK Failsafe Actions` checkboxes.

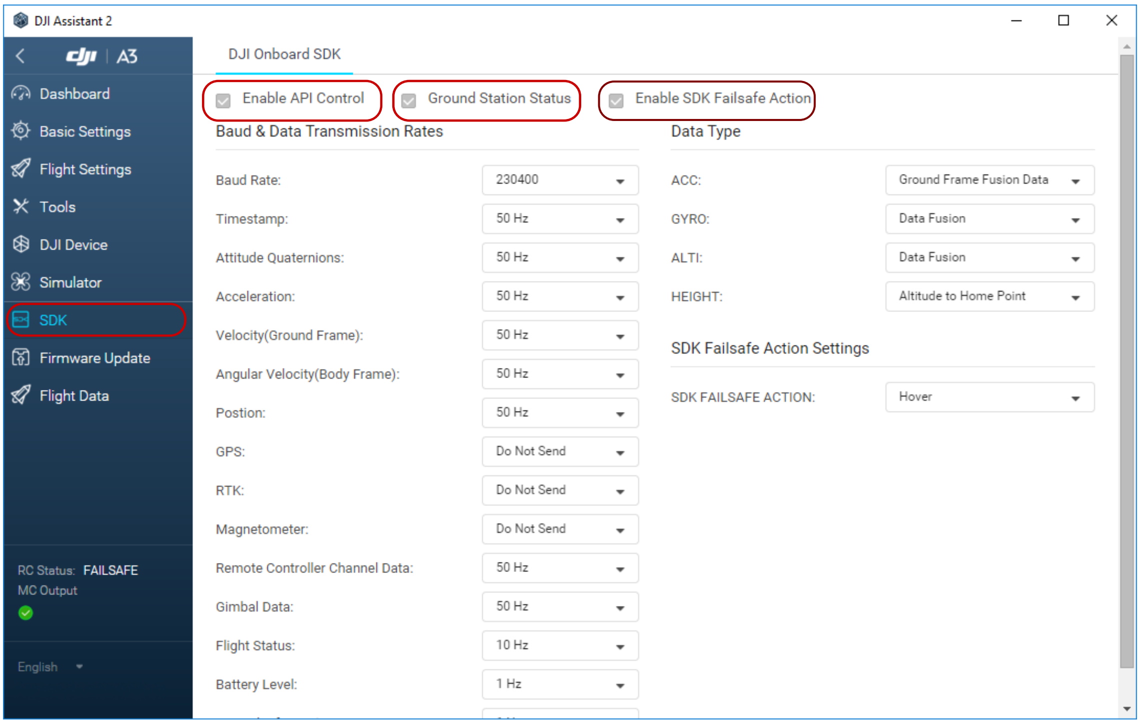

Figure 4.10 — Enable API control in DJI Assistant 2

5. **When available:** Choose the Basic Settings > Remote Controller tab, check the Enable Multiple Flight Mode checkbox, and configure the flight mode switch to be in P-mode for left and right positions while being in A-mode for the middle position.

   An alternative way to activate the Multiple Flight Mode is using the DJI GO/Pilot app (see step 9 below).

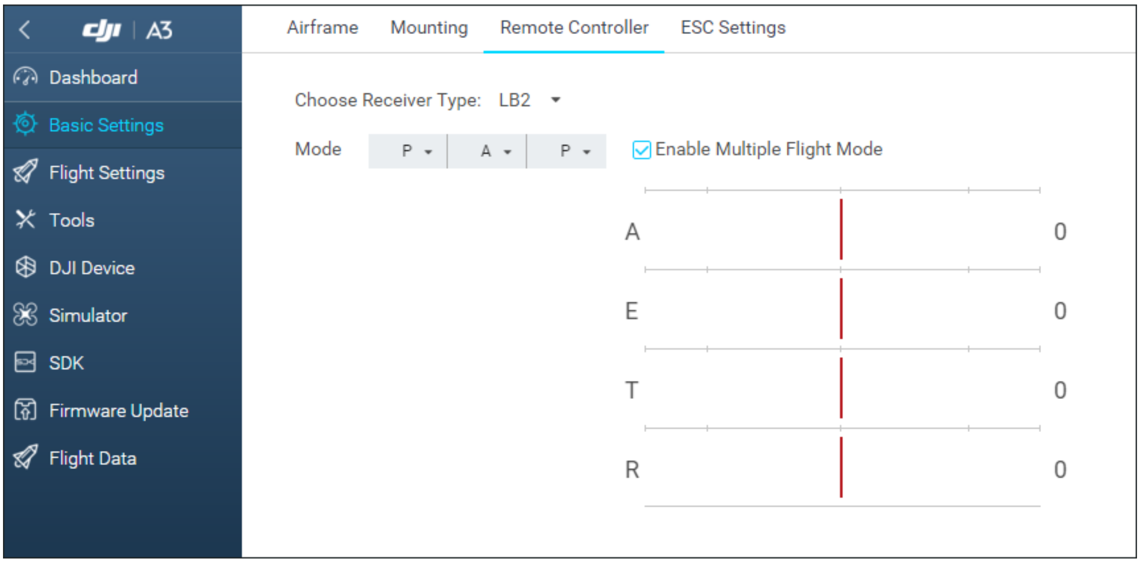

Figure 4.11 — Enable API control in DJI Assistant 2

6. Switch on the DJI Remote Controller, run DJI GO (DJI Pilot), choose the `Me` tab, press the `Login` button.
7. Enter User's DJI credentials created during DJI User's Credentials Registration and press the `Sign in` button.
8. Choose the `Equipment` tab, wait for A3 / M600 / M600 Pro / M210 / M210 V2 / M300, then press `Camera` button.

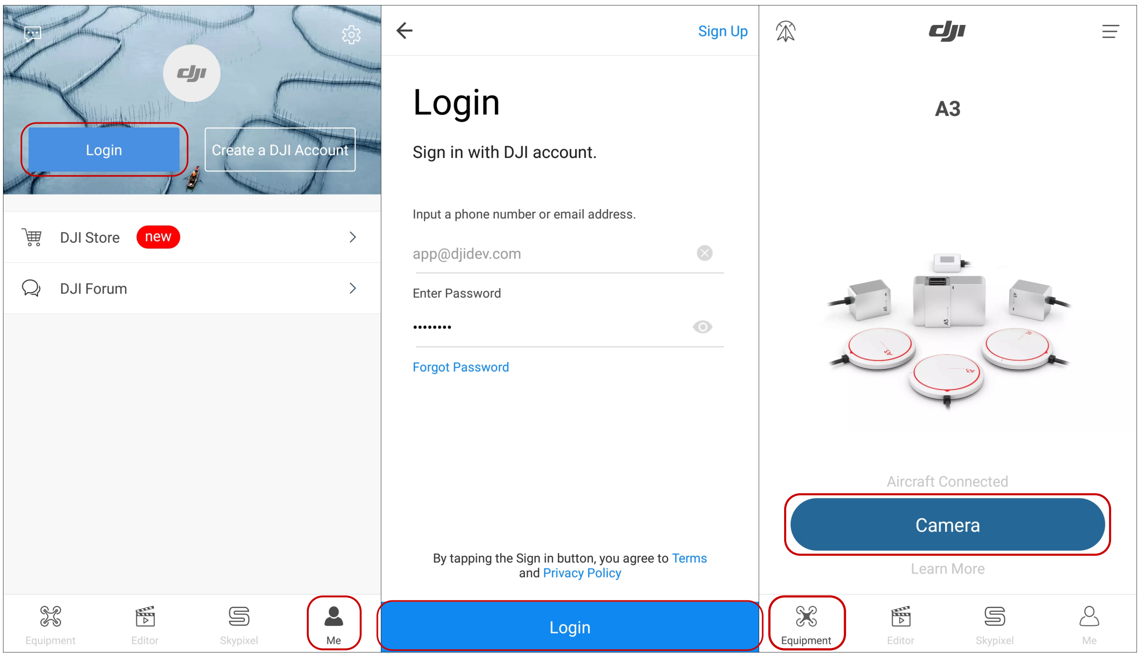

Figure 4.12 — DJI GO screens

9. An alternative way to activate the Multiple Flight Mode. Go to the DJI GO/Pilot app > Camera View/Manual Flight > Menu > [aircraft icon] > Enable Multiple Flight Mode.

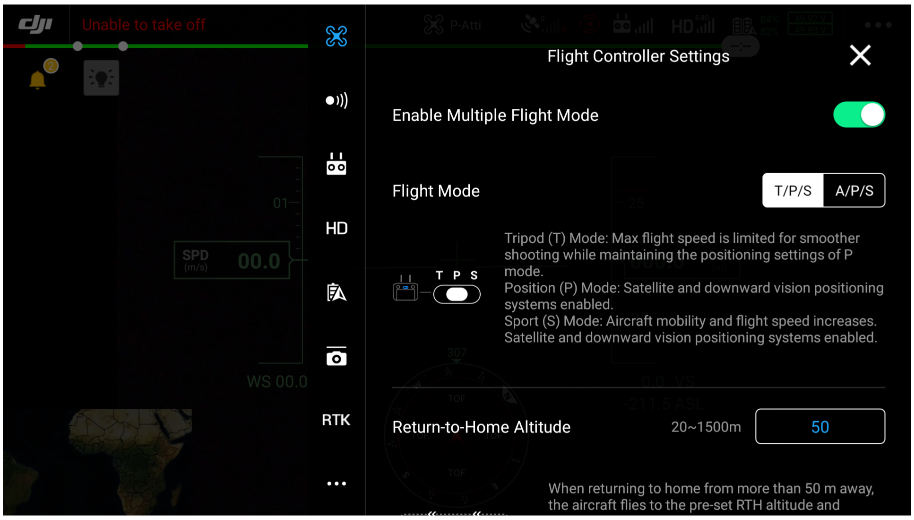

Figure 4.13 — Enabling Multiple Flight Mode

10. **Note:** If DJI M210 is used, should be set to enable M210 Power Supply and OSDK Communication Ports in the DJI Pilot application for the first time.

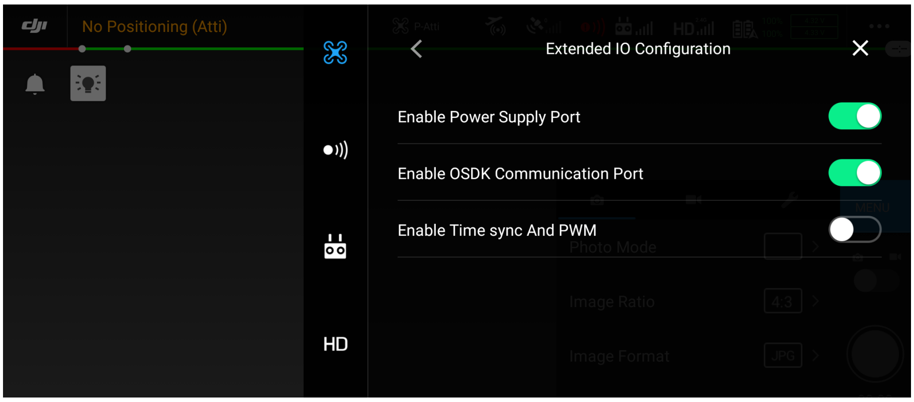

Figure 4.14 — DJI Pilot screen. Additional setups for DJI M210

11. Restart the drone by a power cycle. The SkyHub device should be properly connected to the flight controller.
12. Wait for the SkyHub firmware loads and starts. The DJI mobile application may request you about additional permissions for the Onboard SDK. Confirm all of them allowing the SkyHub to access the DJI autopilot.

Now the flight controller is ready to be connected via Onboard SDK. Please don't forget to move User's DJI App ID and Key to the `skyhub.conf` configuraiton file.

Important: The DJI flight controller may not activate from the first attempt. If there is no connection with flight controller after full system setup, try to logout and login several times with the drone power cycling.

DJI Obstacle Sensors Disabling

Depending on the used payload, downwards obstacle sensors may need to be disabled (actual for DJI M300 RTK and DJI M210). Should use DJI Pilot to disable them according to the screenshots below.

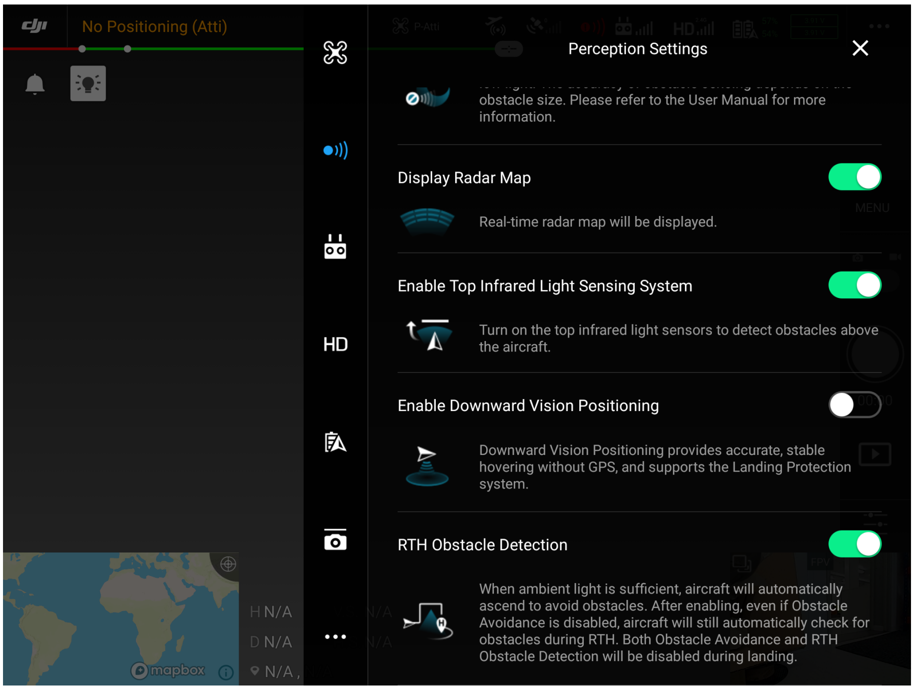

Figure 4.15 — M210 DJI Pilot screens

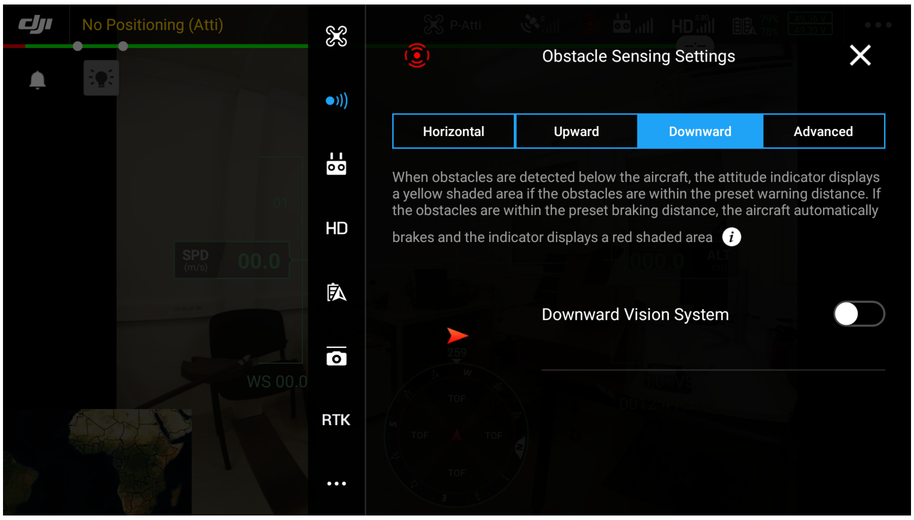

Figure 4.16 — M300 RTK DJI Pilot screens

Setup the UgCS for DJI Mobile Application

One should enable custom payload support in the UgCS for DJI mobile application. After starting the application go to Menu > Drone Specific Settings and enable the corresponding checkbox.

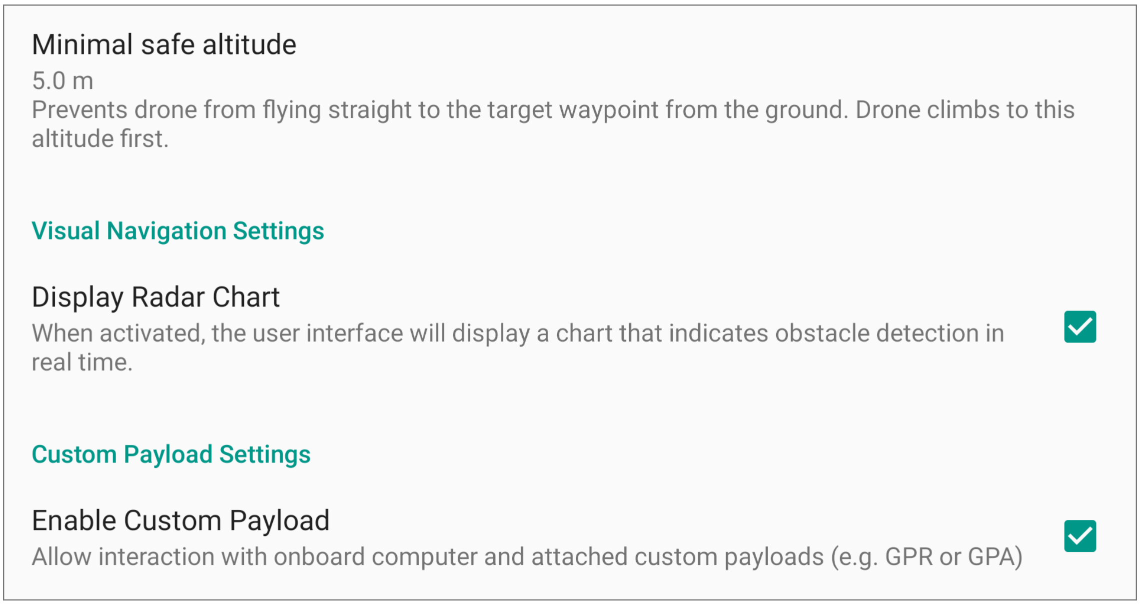

Figure 4.17 — Enable Custom Payload checkbox

Setup Interface to ArduPilot

SkyHub can be connected to the flight controller flashed with the ArduPilot 4.x.x firmware.

1. Make sure UgCS version 4.3 or higher is used (download links can be found in Prerequisites section) and VSM for ArduPilot vehicles is installed.

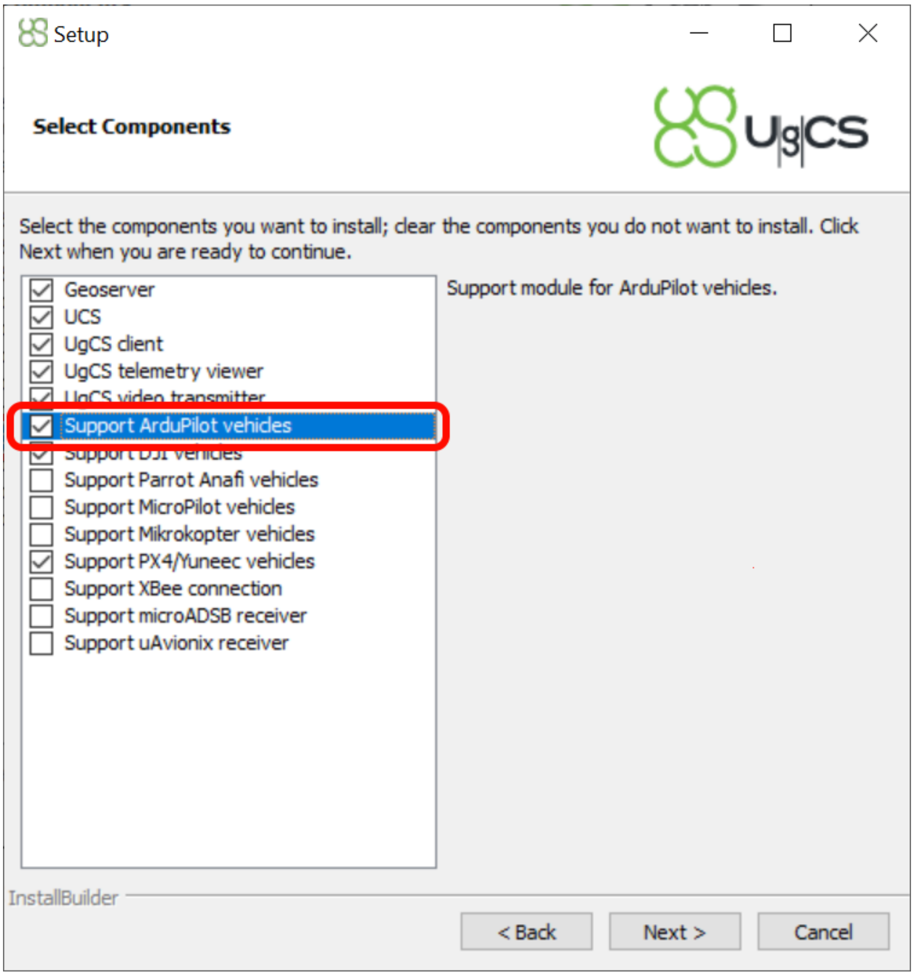

Figure 4.18 — UgCS installation Support for ArduPilot vehicles

2. Configure UgCS `Ardupilot VSM`. Open `vsm-ardupilot.conf` in text editor with administrator privileges. The file is located in the UgCS installation folder (default path `C:\Program Files (x86)\UgCS\bin`). Find, uncomment and adjust the following settings if needed.

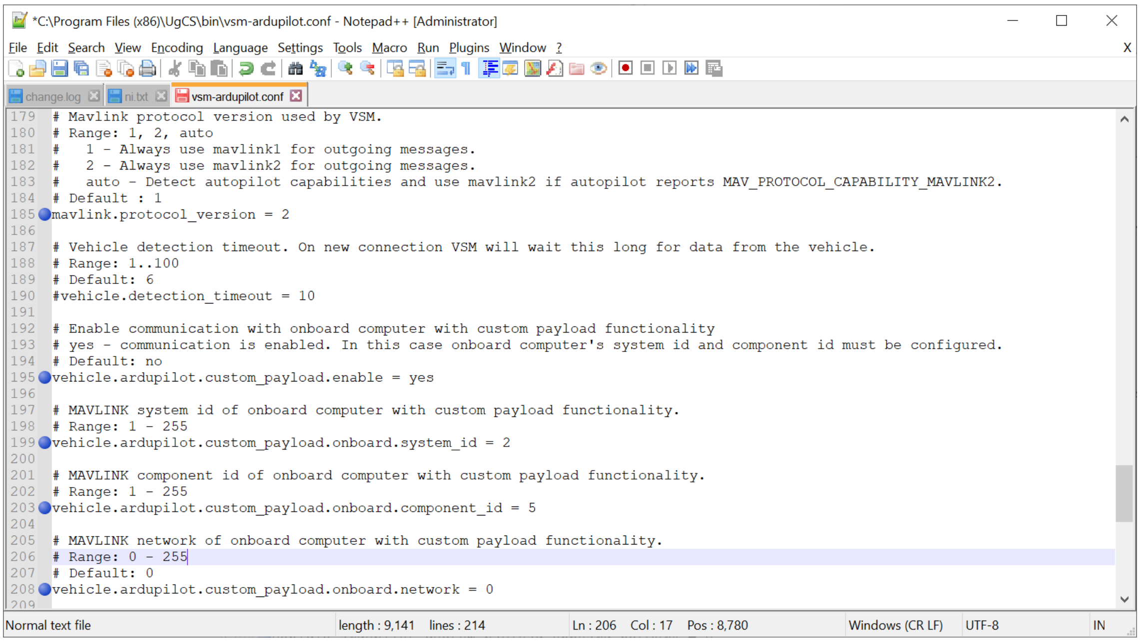

Figure 4.19 — ArduPilot VSM configuration file

3. Within `[AUTOPILOT]` section set to `true` for the only `MAVPILOT` parameter and `false` for others:

```
[AUTOPILOTS]
DJI=false
DJI_M=false
MAVPILOT=true
```

4. Restart SkyHub
5. Make sure that UgCS ArduPilot VSM parameter `vehicle.ardupilot.custom_payload.onboard.component_id` is equal to the `COMPONENT_ID` value in the `[MAV]` section of the SkyHub config. Make sure that V2_EXTENSION parameter is set to TRUE in the [MAV] section of the UgCS SkyHub config. See ArduPilot/PX4 Configuration to find all available settings with default values and descriptions.
6. Open application Mission Planner, connect it to the vehicle autopilot and check serial port settings used for SkyHub communication. Check port configured baud rate. Speed should be the same as configured at SkyHub side in the `[MAV]` section of the SkyHub config (recommended *230400*). If adjustment is needed don't forget write them and restart autopilot.
7. Check communication between SkyHub and autopilot. Using Mission Planner open Setup -> Advanced -> MAVLink inspector.

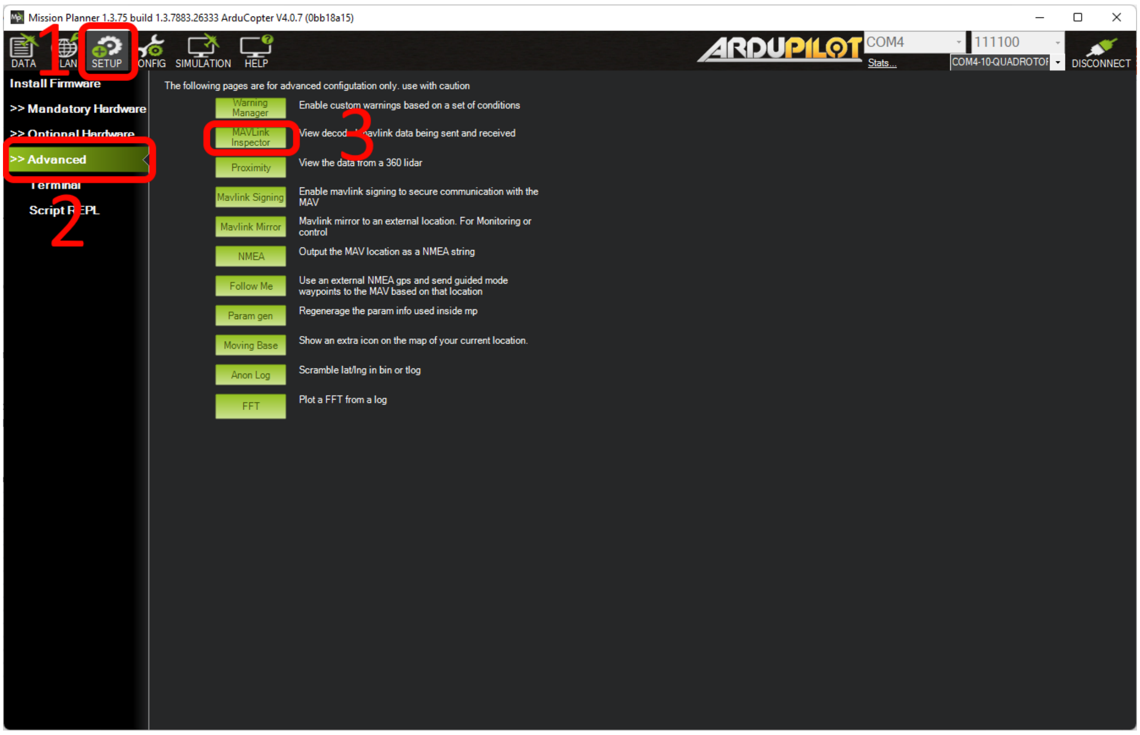

Figure 4.20 — Mission Planner MAVlink inspector

8. In case of correct connection and configuration MAVLink, inspector shows communication between SkyHub and autopilot.

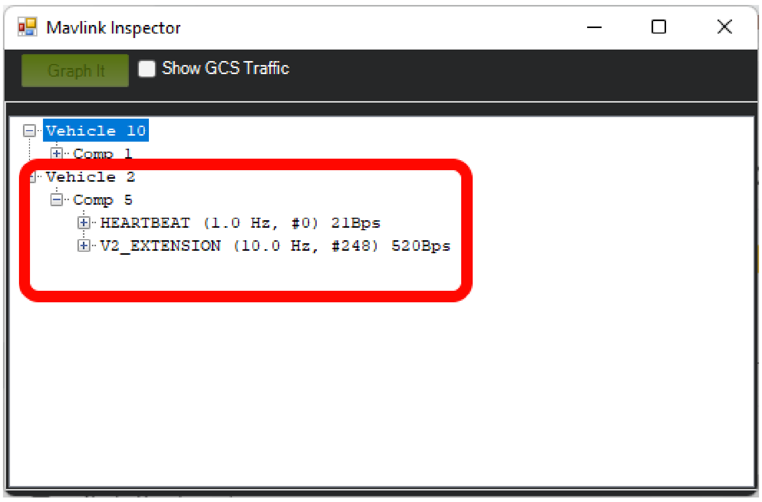

Figure 4.21 — Mission Planner MAVlink inspector data

Vehicle 2 and Comp 5 correspond to configured at SkyHub System (2) and Component (5) ID.

9. In case of correct Autopilot, UgCS and SkyHub configuration, *Payload data b64* is displayed at drone telemetry in UgCS.

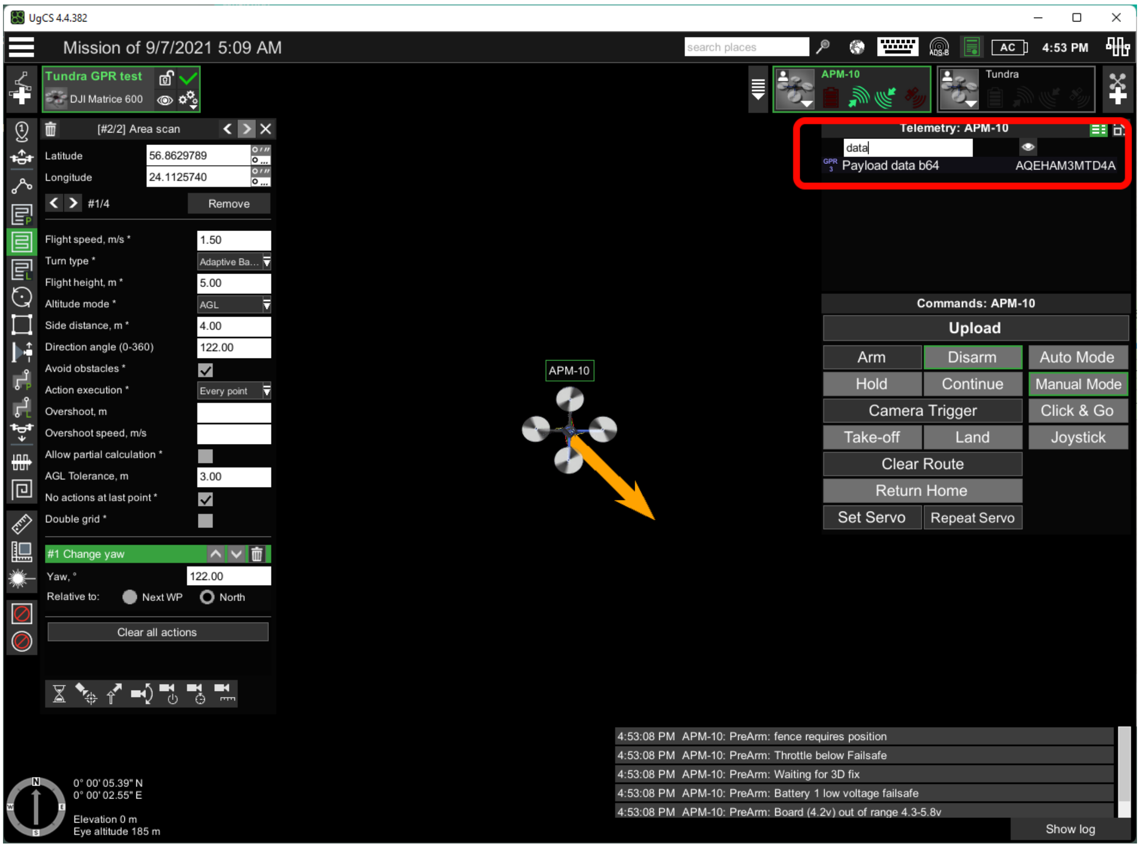

Figure 4.22 — UgCS, drone telemetry

Setup Interface to PX4

SkyHub can be connected to the flight controller flashed with the PX4 1.10.x or higher firmware.

1. Make sure UgCS version 4.3 or higher is used (download links can be found in Prerequisites section) and VSM for PX4 vehicles is installed.

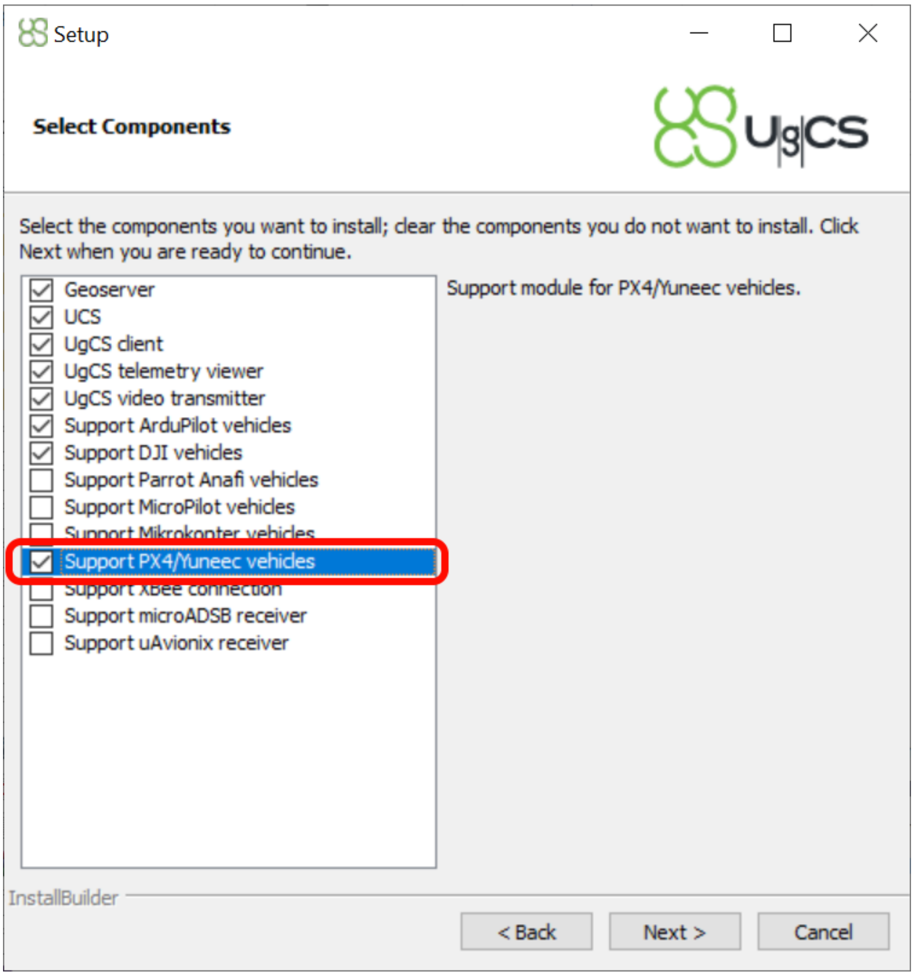

Figure 4.23 — UgCS installation Support for PX4 based vehicles

2. Configure `UgCS PX4 VSM`. Open `vsm-px4.conf` in text editor with administrator privileges. The file is located in the UgCS installation folder (default path `C:\Program Files (x86)\UgCS\bin`). Find, uncomment and adjust the following settings if needed.

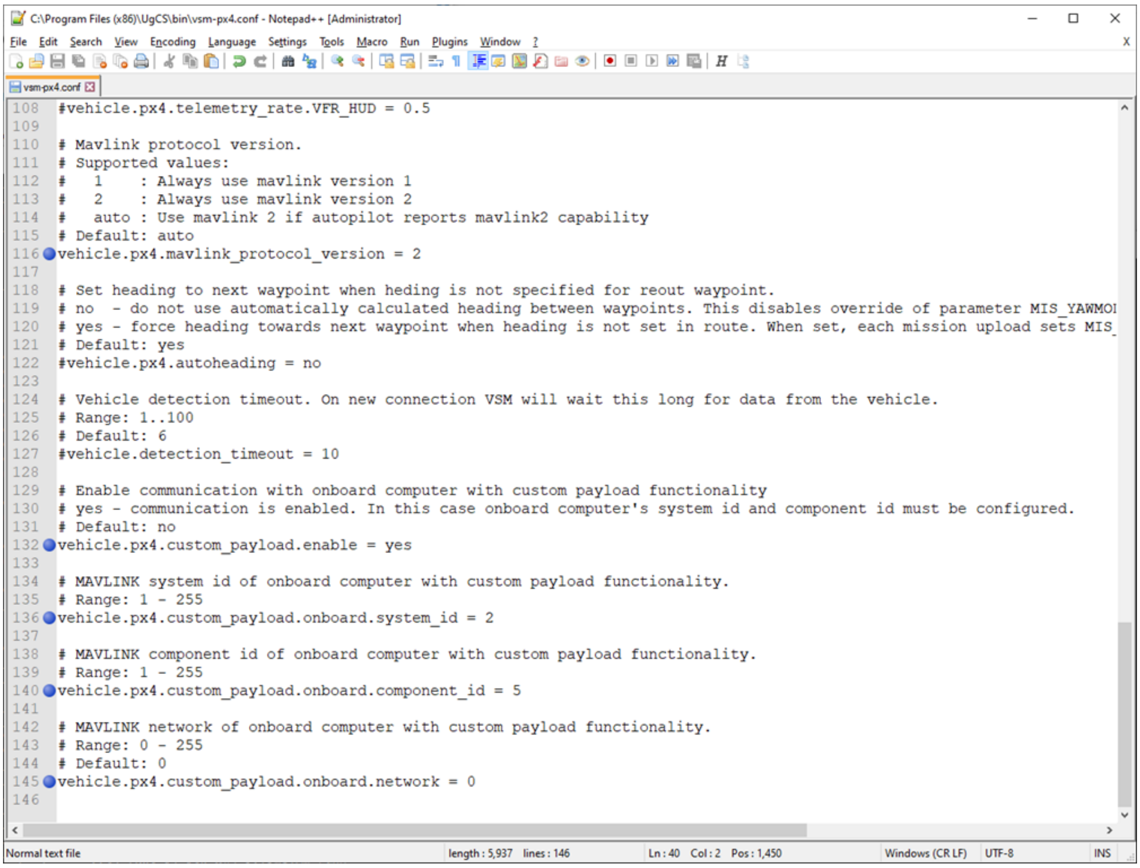

Figure 4.24 — PX4 VSM configuration file

3. Within `[AUTOPILOT]` section set to `true` for the only `MAVPILOT` parameter and `false` for others:

```
[AUTOPILOTS]
DJI=false
DJI_M=false
MAVPILOT=true
```

4. Restart SkyHub

5. Make sure that UgCS PX4 VSM parameter `vehicle.px4.custom_payload.onboard.component_id` is equal to the `COMPONENT_ID` value in the `[MAV]` section of the SkyHub config. Make sure that V2_EXTENSION parameter is set to TRUE in the [MAV] section of the UgCS SkyHub config. See ArduPilot/PX4 Configuration to find all available settings with default values and descriptions.

6. If SkyHub is connected to telemetry port 2, open application QGroundControl, then go to Parameters -> MAVLink and set parameter `MAV_1_CONFIG` to `TELEM2`.

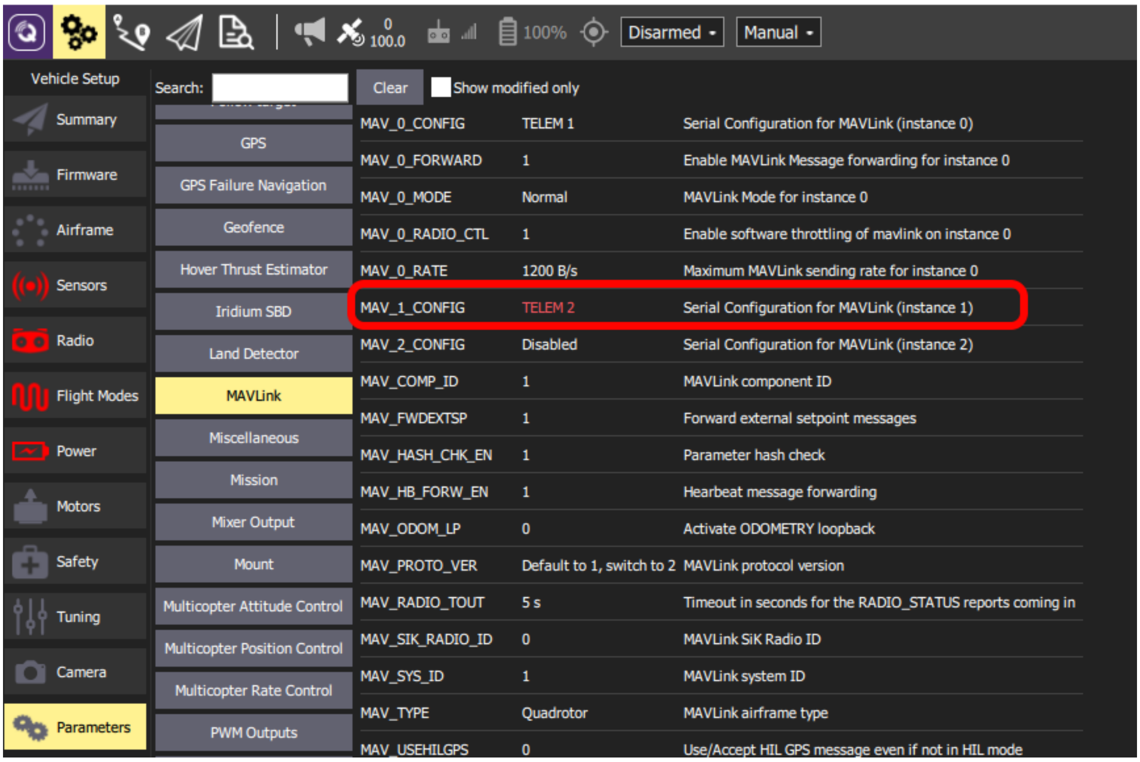

Figure 4.25 — SkyHub PX4 TELEM2 port configuration

7. Restart autopilot.
8. After restart data forwarding for TELEM2 autopilot telemetry ports should be enabled, set to 1 parameter `MAV_1_FORWARD`.

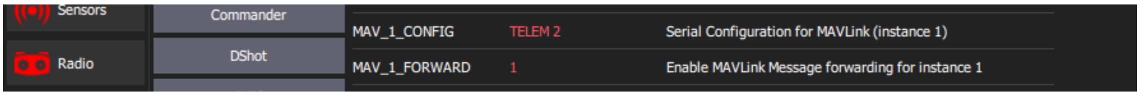

Figure 4.26 — SkyHub PX4 TELEM2 port data forwarding configuration

9. Change baudrate for the TELEM2 Serial Port (recommended *230400*). Speed should be the same as configured at SkyHub side in the `[MAV]` section of the SkyHub config.

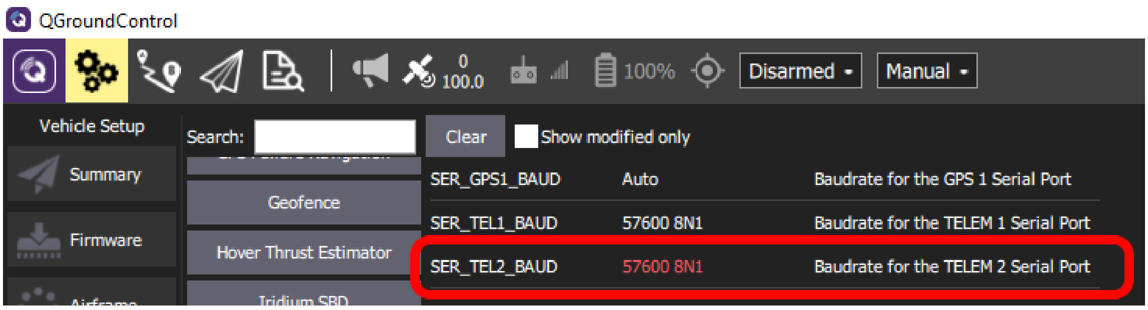

Figure 4.27 — SkyHub PX4 TELEM2 port baudrate configuration

Note: SkyHub subscribes to the following MAVLink messages with telemetry rate defined by the `TELEMETRY_RATE` parameter in the `MAV` section in SkyHub config file:

```
GPS2_RAW
GPS_RAW_INT
GLOBAL_POSITION_INT
ATTITUDE
SYSTEM_TIME
HEARTBEAT
DISTANCE_SENSOR
```

Setup the SkyHub Device

In order to configure the SkyHub software one should edit `skyhub.conf` file located in `/etc/skyhub/` directory. This configuration file has a widely used INI like file format. The default configuration file created automatically if the configuration file doesn't exist.

The first step is to enable the only used autopilot and disable others. Go to `[AUTOPILOTS]` sections and set the corresponding field to `true`. For example, when using the solution with drones:

DJI M600/M600Pro/M210:

```
[AUTOPILOTS]
DJI=true
DJI_M=false
MAVPILOT=false
```

The second important step is to configure used autopilot and payloads. Pay attention that related section will be available for configuration only after it enabling and SkyHub restart. For example, DJI autopilot related parameters are collected within the `[DJI]` section:

```
[DJI]
APP_ID=1071019
APP_KEY=42873...30b25
BAUD_RATE=230400
RESPONSE_TIMEOUT_S=1
SENDING_PERIOD_MS=20
SERIAL_DEVICE=/dev/ttymxc3
```

ArduPilot / PX4 autopilot related parameters are collected within the `[MAV]` section:

```
[MAV]
BAUD_RATE=230400
COMPONENT_ID=5
CONNECTION_TYPE=UART
SENDING_PERIOD_MS=20
SERIAL_DEVICE=/dev/ttymxc3
SYSTEM_ID=2
V2_EXTENSION=false
```

Within `[PAYLOADS]` section set to `true` for the only used payloads and `false` for the unused ones. For example, when using the high frequency GPR with the radar altimeter:

```
[PAYLOADS]
DROP_MESSENGER=false
ECHOLOGGER_DUAL=false
```

```
ECHOLOGGER_ECT=false
FTTECHNOLOGIES_FT742_SM=false
GEONICS_EM_38_MK2=false
GEONICS_EM_61=false
GNSS=false
LIGHTWARE_SF30=false
NANORADAR_MR=false
NANORADAR_NRA=true
PAYLOAD_EXAMPLE=false
PERGAM_FALCON=false
PERGAM_LMM=false
RADARTEAM_COBRA=false
RADSYS_ZGPR=false
RADSYS_ZOND=true
```

Within `[OUTPUTS]` section set to `true` for the only used outputs and `false` for the unused ones. For example, when using the GPS output:

```
[OUTPUTS]
OUTPUT_GPS=true
PPS_SYNC=false
```

For a more detailed description of the configuration file, see Configuration Parameters.

5 • PAYLOADS SETUP

Choose the usage scenario below:

- **Altimeter Setup**
  - Nanoradar NRA24 Altimeter Setup
  - Lightware SF30/D Altimeter Setup
- **Ground-Penetrating Radar Setup**
  - Low Frequency GPR Setup
  - High Frequency GPR Setup
  - RadSys zGPR Setup
- **Echosounder Setup**
  - Echologger ECT400 Setup
  - Echologger ECT D052/D032 Setup
- **Gas Detector Setup**
  - Pergam Laser Falcon Setup
  - Pergam LMm Setup
- **Metal Detector Setup**
  - Geonics EM-61 Setup
- **Conductivity Meter Setup**
  - Geonics EM38-MK2 Setup
- **Remote Water Sampling Setup**
  - Drop Messenger Setup
- **Anemometer Setup**
  - FT Technologies FT742-SM Setup
- **Obstacle Detector Setup**
  - Nanoradar MR72 Setup
- **Outputs Setup**
  - GPS Output Setup
  - PPS Sync Setup

Altimeter Setup

There are common altimeter settings in the `[ALTIMETER]` section. Check whether minimum and maximum values correspond to your needs:

```
[ALTIMETER]
MIN_ALTITUDE_M=0.5
MAX_ALTITUDE_M=20
```

These values are used to bound valid drone altitude values. When the drone flies out of the limits, the operator will be notified. Also, while flying in TF mode, descending below `MIN_ALTITUDE_M` or ascending above `MAX_ALTITUDE_M` make the drone hover and go to the safe altitude.

Another parameter to be set is the sensor's zero-level above ground when the drone stands at the surface:

```
[ALTIMETER]
ZERO_LEVEL_M=0.4
```

The `ZERO_LEVEL_M` value will be subtracted from the distance reported by the rangefinder resulting in the true drone's altitude above ground level.

Nanoradar NRA24 Altimeter Setup

1. Set `NANORADAR_NRA` item to `true` in `[PAYLOADS]` section:

    ```
    [PAYLOADS]
    NANORADAR_NRA=true
    ```

2. Choose the appropriate `SERIAL_DEVICE` in the `[NANORADAR_NRA]` section depending on which connector it is connected to. Set it to `/dev/ttymxc5` when connecting to the 5-pin Lemo connector or to `/dev/ttymxc1` when connecting to the 4-pin Lemo connector for SkyHub 2 or set it to one of UARTs, e.g. to `/dev/ttyS0`, for SkyHub 3:

    ```
    [NANORADAR_NRA]
    SERIAL_DEVICE=/dev/ttymxc5
    ; or
    SERIAL_DEVICE=/dev/ttymxc1
    ; or
    SERIAL_DEVICE=/dev/ttyS0
    ```

Important: Nanoradar NRA24 radar altimeter doesn't detect any reflection from the ground when there is no motion due to technological limitations. Therefore, it starts to measure the altitude only after takeoff. Move the drone by hands before a flight to be sure the altimeter operates well.

See the Nanoradar NRA24 Altimeter Configuration section to find all available settings with default values and descriptions.

Lightware SF30/D Altimeter Setup

1. Set `LIGHTWARE_SF30` item to `true` in `[PAYLOADS]` section:

```
[PAYLOADS]
LIGHTWARE_SF30=true
```

2. Choose the appropriate `UART_SERIAL_DEVICE` in the `[LIGHTWARE_SF30]` section depending on which connector it is connected to:

```
[LIGHTWARE_SF30]
UART_SERIAL_DEVICE=/dev/ttyS0
```

See Lightware SF30/D Altimeter Configuration to find all available settings with default values and descriptions.

ROS-based Lightware SF30/D Altimeter Setup

Started from version 2.14 SkyHub supports new driver for SD30/D altimeter based on ROS framework design.

1. Set `LIGHTWARE_SF30` item to `false` in `[PAYLOADS]` section to disable old version of driver:

```
[PAYLOADS]
LIGHTWARE_SF30=false
```

2. Set `LIGHTWARE_SF30` item to `true` in `[ROS_PAYLOADS]` section to enable new version of driver. See ROS-based Lightware SF30/D Altimeter Configuration for details.

   [ROS_PAYLOADS] LIGHTWARE_SF30=true

ROS-based Ainteins US-D1 Altimeter Setup

Started from version 2.14 SkyHub supports Ainteins US-D1 altimeter payload based on ROS framework design.

Set `AINSTEIN_US_D1` item to `true` in `[ROS_PAYLOADS]` section to enable the driver. See ROS-based Ainteins US-D1 Altimeter Configuration for details.

[ROS_PAYLOADS] AINSTEIN_US_D1=true

Ground-Penetrating Radar Setup

Low Frequency GPR Setup

1. Set `RADARTEAM_COBRA` item to `true` in `[PAYLOADS]` section:

   ```
   [PAYLOADS]
   RADARTEAM_COBRA=true
   ```

2. Set `MODEL` and `TIME_RANGE` parameters in the `[RADARTEAM_COBRA]` section according to concrete GPR model used:

   ```
   [RADARTEAM_COBRA]
   MODEL=SE-150
   TIME_RANGE_NS=800
   ```

See Low Frequency GPR Configuration to find all available settings with default values and descriptions.

High Frequency GPR Setup

1. Every new device is to be calibrated before using. One should find the appropriate values of the pulse delay. Connect the GPR to the PC, run the Prism 2 software, and find the required pulse delay while using the desired mode, time range, sample count.

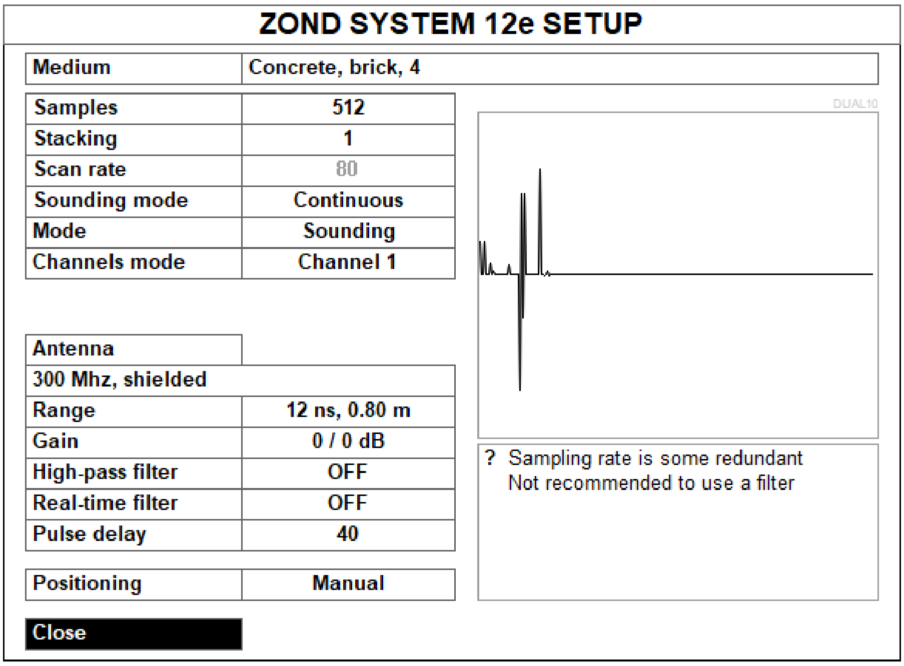

Figure 5.1 — Prism 2 setup window

2. While using dual-channel GPR model one may choose either single-channel or dual-channel mode by setting the `MODE` parameter in the `[RADSYS_ZOND]` section:

```
[RADSYS_ZOND]
MODE=CHANNEL_1 ; Single-channel
; or
MODE=TWO_CHANNELS ; Dual-channel
```

3. Set the trace time range, sample count, pulse delay, and filter in the corresponding fields in the [RADSYS_ZOND] section:

```
[RADSYS_ZOND]
FILTER_1=OFF
FILTER_2=OFF
MODE=TWO_CHANNELS
PULSE_DELAY_1=297
PULSE_DELAY_2=301
SAMPLE_COUNT=256
TIME_RANGE_NS_1=300
TIME_RANGE_NS_2=300
```

Note: When using the Aero version of RadSys Zond radar, all fields are ignored apart PULSE_DELAY_1 and TIME_RANGE_NS_1.

4. While using dual-channel mode one may setup the antenna offsets in the corresponding fields:

```
[RADSYS_ZOND]
OFFSET_FORWARD_M_1=0.1 ; 10 cm alongside the heading line
OFFSET_FORWARD_M_2=0.1
OFFSET_RIGHT_M_1=0.25 ; 25 cm alongside the traverse line
OFFSET_RIGHT_M_2=-0.25 ; -25 cm alongside the traverse line (left offset)
```

See High Frequency GPR Configuration to find all available settings with default values and descriptions.

RadSys zGPR Setup

1. Every new device is to be calibrated before using. One should find the appropriate values of the pulse delay. Connect the GPR to the PC, run the Prism 2 software, and find the required pulse delay and TX frequency while using the desired mode, time range, sample count.

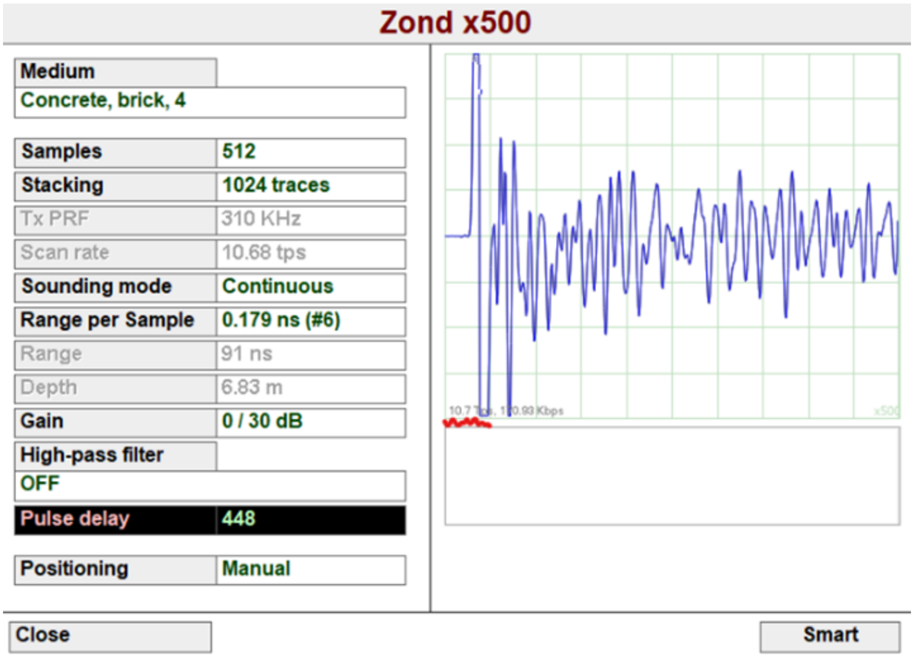

Figure 5.2 — Prism 2 setup window

2. Set `RADSYS_ZGPR` item to `true` in `[PAYLOADS]` section:

```
[PAYLOADS]
RADSYS_ZGPR=true
```

3. Set the code of trace time range per sample, sample count, pulse delay, and stacking fields in the `[RADSYS_ZGPR]` section:

```
[RADSYS_ZGPR]
PULSE_DELAY=174
SAMPLE_COUNT=512
STACKING=128
TIME_RANGE_PER_SAMPLE=7
TX_FREQUENCY_KHZ=300
```

See RadSys zGPR Configuration to find all available settings with default values and descriptions.

Echosounder Setup

There are common echosounder settings in the `[ECHOSOUNDER]` section. Check whether minimum and maximum values correspond to your needs:

```
[ECHOSOUNDER]
MIN_DEPTH_M=0.5
MAX_DEPTH_M=20
```

These values are used to bound valid echosounder depth values. When the depth value is out of the limits, the operator will be notified.

Another parameter to be set is the length of the echosounder cable:

```
[ECHOSOUNDER]
CABLE_LENGTH_M=0
```

This parameter is set to zero by default. If set to the value greater than zero, it is used to determine whether the echosounder is immersed in water. When the drone altitude becomes lower than the cable length, it means the echosounder is immersed in water.

Also, the cable length parameter is used to find the *True Depth* value. *True Depth* is a calculated value of depth from the surface resulting from the echosounder's value and the current altitude using the specified cable length parameter.

The *True Depth* value is recorded as a separate column in the position log file and echosounder NMEA log (see About Log Files). Also, this data is sent to the PC application.

The first samples of the trace in SEG-Y log (see About Log Files) are set to zero if the echosounder is immersed in water. Zeros number (N) is defined from the difference between the *True Depth* value (TDepth, m) and the depth measured with the echosounder (Depth, m) taking into account the speed of sound (1500 m/s) and set sampling rate (Rate, Hz) by the formula:

```
N = 2 × (TDepth - Depth) × Rate / 1500
```

Echologger ECT400 Setup

1. Set `ECHOLOGGER_ECT` item to `true` in `[PAYLOADS]` section:

   ```
   [PAYLOADS]
   ECHOLOGGER_ECT=true
   ```

2. Set the `MAX_SENSOR_ANGLE_DEG` parameter in the `[ECHOLOGGER_ECT]` section for data filtering by echosounder tilt while recording. Set to 90 degrees for disabling.

3. Set the `MIN_SENSOR_DEPTH_M` parameter in the `[ECHOLOGGER_ECT]` section for data filtering by echosounder depth value while recording. Set to zero for disabling:

```
[ECHOLOGGER_ECT]
MAX_SENSOR_ANGLE_DEG=10
MIN_SENSOR_DEPTH_M=0.1
```

4. Set the `RANGE_M`, the `DEADZONE_MM` parameters in the `[ECHOLOGGER_ECT]` section according to the water body to be explored:

```
[ECHOLOGGER_ECT]
DEADZONE_MM=300
RANGE_M=10
```

5. One may choose the output data format for Echologger ECT400. The `NMEA` value is useful when only NMEA log file should be recorded. The `ECHOSOUNDER` mode is used to record both NMEA and SEG-Y logs:

```
[ECHOLOGGER_ECT]
MODE=NMEA
; or
MODE=ECHOSOUNDER
```

Note the data rate in the `ECHOSOUNDER` mode is significantly lower than in the `NMEA` one.

Table 5.1 — Maximum measure interval against range in NMEA and Echosounder mode for Echologger ECT400

RANGE	NMEA MODE	ECHOSOUNDER MODE
2 m	0.1 sec	0.25 sec
10 m	0.1 sec	0.5 sec
20 m		1 sec
40 m	0.2 sec	
80 m	0.25 sec	2 sec
100 m	0.33 sec	0.25 sec

See Echologger ECT400 Configuration to find all available settings with default values and descriptions.

Echologger ECT D052/D032 Setup

1. Set ECHOLOGGER_DUAL item to `true` in [PAYLOADS] section:

```
[PAYLOADS]
ECHOLOGGER_DUAL=true
```

2. Set the MAX_SENSOR_ANGLE_DEG parameter in the [ECHOLOGGER_DUAL] section for data filtering by echosounder tilt while recording. Set to 90 degrees for disabling.
3. Set the MIN_SENSOR_DEPTH_M parameter in the [ECHOLOGGER_DUAL] section for data filtering by echosounder depth value while recording. Set to zero for disabling:

```
[ECHOLOGGER_DUAL]
MAX_SENSOR_ANGLE_DEG=10
MIN_SENSOR_DEPTH_M=0.1
```

4. Set the RANGE_HIGH_M, the RANGE_LOW_M, the DEADZONE_HIGH_MM, and the DEADZONE_LOW_MM parameters in the [ECHOLOGGER_DUAL] section according to the water body to be explored:

```
[ECHOLOGGER_DUAL]
DEADZONE_HIGH_MM=500
DEADZONE_LOW_MM=1000
RANGE_HIGH_M=10
RANGE_LOW_M=10
```

5. Set the `FREQUENCY_HIGH_HZ` and the `FREQUENCY_LOW_HZ` parameters in the `[ECHOLOGGER_DUAL]` section.

   FREQUENCY_HIGH_HZ/FREQUENCY_LOW_HZ should be set according to the model of echo sounder as below:

   D032:

```
[ECHOLOGGER_DUAL]
FREQUENCY_HIGH_HZ=200000
FREQUENCY_LOW_HZ=30000
```

   D052:

```
[ECHOLOGGER_DUAL]
FREQUENCY_HIGH_HZ=200000
FREQUENCY_LOW_HZ=50000
```

Please note that these parameters are not used to change frequency of echosounder because frequencies are fixed for a particular model. They are utilized for correct echosounder data handling.

6. One may choose the output data format for Echologger ECT D052/D032. The `NMEA` value is useful when only NMEA log file should be recorded. The `ECHOSOUNDER` mode is used to record both NMEA and SEG-Y logs:

```
[ECHOLOGGER_DUAL]
MODE=NMEA
; or
MODE=ECHOSOUNDER
```

Note the data rate in the `ECHOSOUNDER` mode is significantly lower than in the `NMEA` one. Strongly recommended to set the `INTERVAL_S` value in the `ECHOLOGGER_DUAL` section according to the table:

Table 5.2 — Maximum measure interval against range in NMEA and Echosounder mode for Echologger ECT D052/D032

RANGE	NMEA MODE	ECHOSOUNDER MODE
1 m	0.1 sec	0.25 sec

RANGE	NMEA MODE	ECHOSOUNDER MODE
2 m	0.1 sec	0.33 sec
5 m	0.1 sec	0.5 sec
10 m	0.1 sec	1 sec
20 m	0.125 sec	2 sec
50 m	0.2 sec	4 sec
100 m	0.33 sec	4 sec
150 m	0.5 sec	4 sec
200 m	1 sec	4 sec

7. Set the `SAMPLING_RATE_HZ` parameter in the `[ECHOLOGGER_DUAL]` section according to the table below. The `SAMPLING_RATE_HZ` is relevant only for the ECHOSOUNDER mode.

Table 5.3 — Sampling rate depending on the range in Echosounder mode for Echologger ECT D052/D032

RANGE	SAMPLING RATE
1 ~ 50 m	100000 Hz
60 ~ 100 m	50000 Hz
120 ~ 200 m	25000 Hz

Important: if the improper value of sampling rate sets for a certain range, Echologger ECT D052/D032 can reset continuously until the proper value is set.

See Echologger ECT D052/D032 Configuration to find all available settings with default values and descriptions.

Gas Detector Setup

There are common gas detector settings in the `[GAS_DETECTOR]` section. Check whether minimum and maximum values correspond to your needs:

```
[GAS_DETECTOR]
MIN_CONCENTRATION_PPM=0
MAX_CONCENTRATION_PPM=1000
```

These values are used to bound valid gas detector values. When the gas concentration is out of the limits, the operator will be notified.

Another parameter to be set is the sensor's background value:

```
[GAS_DETECTOR]
ZERO_LEVEL_PPM=0
```

The `ZERO_LEVEL_PPM` value will be subtracted from the gas concentration reported by the gas detector resulting in the true gas concentration.

Pergam Laser Falcon Setup

1. Set `PERGAM_FALCON` item to `true` in `[PAYLOADS]` section:

    ```
    [PAYLOADS]
    PERGAM_FALCON=true
    ```

2. Choose the appropriate `SERIAL_DEVICE` in the `[PERGAM_FALCON]` section:

    ```
    [PERGAM_FALCON]
    SERIAL_DEVICE=/dev/ttyUSB0
    ```

See Pergam Laser Falcon Configuration to find all available settings with default values and descriptions.

Pergam LMm Setup

1. Set `PERGAM_LMM` item to `true` in `[PAYLOADS]` section:

    ```
    [PAYLOADS]
    PERGAM_LMM=true
    ```

2. Choose the appropriate SERIAL_DEVICE in the [PERGAM_LMM] section depending on which connector it is connected to. Set it to /dev/ttymxc5 when connecting to the 5-pin Lemo connector or to /dev/ttymxc1 when connecting to the 4-pin Lemo connector for SkyHub 2 or set it to one of UARTs, e.g. to /dev/ttyAMA1, for SkyHub 3:

```
[PERGAM_LMM]
SERIAL_DEVICE=/dev/ttymxc5
; or
SERIAL_DEVICE=/dev/ttymxc1
; or
SERIAL_DEVICE=/dev/ttyAMA1
```

See Pergam LMm Configuration to find all available settings with default values and descriptions.

Metal Detector Setup

There are common metal detector settings in the [METAL_DETECTOR] section. Check whether minimum and maximum values correspond to your needs:

```
[METAL_DETECTOR]
MIN_OUTPUT_VALUE_MV=0
MAX_OUTPUT_VALUE_MV=1000
```

These values are used to bound valid metal detector values. When the output value is out of the limits, the operator will be notified.

Geonics EM-61 Setup

1. Set GEONICS_EM_61 item to true in [PAYLOADS] section:

```
[PAYLOADS]
GEONICS_EM_61=true
```

2. Choose the appropriate CONNECTION_TYPE in the [GEONICS_EM_61] section:

```
[GEONICS_EM_61]
CONNECTION_TYPE=BLUETOOTH ; connection through bluetooth (preferable)
; or
CONNECTION_TYPE=RS232 ; connection through RS232
```

3. While using RS232 connection choose the appropriate SERIAL_DEVICE in the [GEONICS_EM_61] section. Set it to /dev/ttymxc1 when the onboard RS232 connection is used or to /dev/ttyUSB0 when the USB-RS232 connection is used for SkyHub 2 or set it to one of UARTs, e.g. to /dev/ttyAMA3, for SkyHub 3:

```
[GEONICS_EM_61]
SERIAL_DEVICE=/dev/ttymxc1
; or
SERIAL_DEVICE=/dev/ttyUSB0
; or
SERIAL_DEVICE=/dev/ttyAMA3
```

See Geonics EM-61 Configuration to find all available settings with default values and descriptions.

Conductivity Meter Setup

There are common conductivity meter settings in the [CONDUCTIVITY_METER] section. Check whether minimum and maximum values correspond to your needs:

```
[CONDUCTIVITY_METER]
MIN_OUTPUT_VALUE_MS_M=0
MAX_OUTPUT_VALUE_MS_M=500
```

These values are used to bound valid conductivity values. When the conductivity is out of the limits, the operator will be notified.

Geonics EM38-MK2 Setup

1. Set GEONICS_EM_38_MK2 item to true in [PAYLOADS] section:

```
[PAYLOADS]
GEONICS_EM_38_MK2=true
```

2. Choose the appropriate CONNECTION_TYPE in the [GEONICS_EM_38_MK2] section:

```
[GEONICS_EM_38_MK2]
CONNECTION_TYPE=BLUETOOTH ; connection through bluetooth
; or
CONNECTION_TYPE=RS232 ; connection through RS232
```

3. Choose the appropriate CHANNEL_NUMBER in the [GEONICS_EM_38_MK2] section to display the desired value on the Conductivity Meter widget in UgCS-CPM. For example, to display the conductivity for 1.0 m set channel to 3:

```
[GEONICS_EM_38_MK2]
CHANNEL_NUMBER=3
```

See Geonics EM38-MK2 Configuration to find all available settings with default values and descriptions.

Important: to connect through RS232 should use the USB-UART adapter.

Important: should calibrate the conductivity meter before using it according to the manufacture documentation.

Remote Water Sampling Setup

Drop Messenger Setup

1. Set DROP_MESSENGER item to true in [PAYLOADS] section:

```
[PAYLOADS]
DROP_MESSENGER=true
```

2. Set PAYLOAD_POWER_ON item to false in [APP] section:

```
[APP]
PAYLOAD_POWER_ON=false
```

3. DROP_MESSENGER plugin has only one purpose is to drop messenger to close Ruttner water sampler. UgCS SkyHub drops the messenger using magnetic holder. To release holder its power supply must be flipped for some time (power cycle). By default, it uses the following settings:

```
[DROP_MESSENGER]
POWER_CYCLE_S=0.5
```

See Drop Messenger Configuration to find details and descriptions.

Anemometer Setup

There are common anemometer settings in the `[ANEMOMETER]` section. Check whether minimum and maximum values correspond to your needs:

```
[ANEMOMETER]
MIN_WIND_SPEED_MPS=0
MAX_WIND_SPEED_MPS=10
```

These values are used to bound valid wind speed values. When the wind speed is out of the limits, the operator will be notified.

FT Technologies FT742-SM Setup

1. Set `FTTECHNOLOGIES_FT742_SM` item to `true` in `[PAYLOADS]` section:

```
[PAYLOADS]
FTTECHNOLOGIES_FT742_SM=true
```

See FT Technologies FT742-SM Configuration to find all available settings with default values and descriptions.

Obstacle Detector Setup

Nanoradar MR72 Setup

1. Set `NANORADAR_MR` item to `true` in `[PAYLOADS]` section:

```
[PAYLOADS]
NANORADAR_MR=true
```

2. Choose the appropriate `IGNORE_SIDE_SECTORS` in the `[NANORADAR_MR]` section to ignore or to take into account side sections during the distance to an obstacle definition.
3. To monitor the distance to obstacles in UgCS-CPM, add the Payload Example widget by clicking the plus button and set Payload Message ID equals 195 by clicking the settings button.

See the Nanoradar MR72 Configuration section to find all available settings with default values and descriptions.

GPS Receiver Setup

GNSS plugin supports GPS receivers with NMEA output data and connection through USB or UART. GNSS plugin supports parsing for ZDA and GGA sentences of NMEA format.

Emlid Reach M2 Setup

1. Connection to SkyHub has two options. Using micro-USB cable or UART S1 port on Emlid Reach M2. Due to high peak power consumption, should get additional power supply for the Emlid Reach M2.
2. Should decide how to power Emlid Reach M2. It could be done over USB or one of it S1, S2, C1, or C2 ports. Emlid Reach M2 requires up to 3 A current @ 5.2 V to power up properly, 600 mA for regular power consumption, and 3 A for peaks.

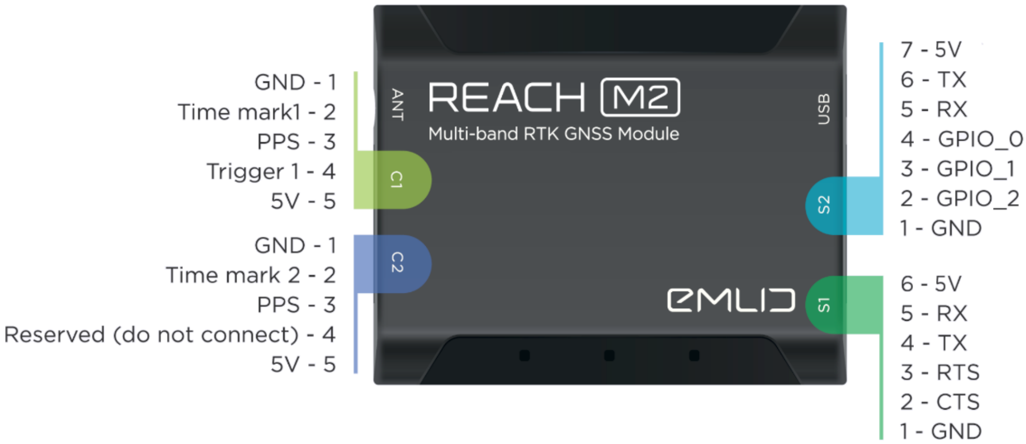

Figure 5.3 — Emlid Reach M2 Port Pinouts

3. If USB connection is used, USB cable +5 wire should be isolated from SkyHub. Make sure that there is a stable power source for Emlid Reach M2, only the red LED lights up when the receiver lacks power.

Important: Do not plug two power supplies at the same time as it may damage the device.

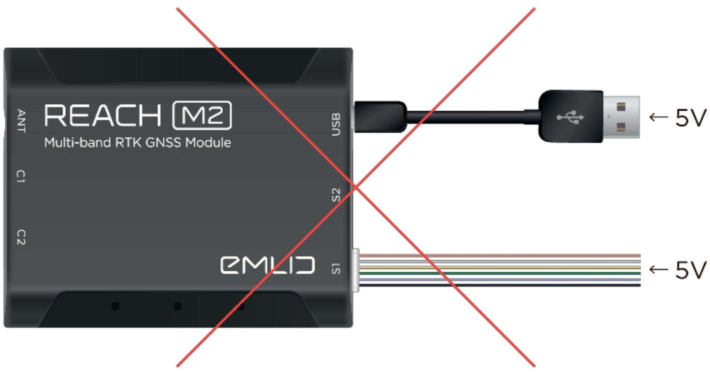

Figure 5.4 — Wrong power supply for Emlid Reach M2

4. When Emlid Reach M2 is powered on, connect to its Wi-Fi. Adjust the receiver using the special app from the manufacture or the internet browser. Should set Output 1/Serial to ON on the Position Output Settings Page.
5. Select output interface according to connection type to SkyHub, USB or UART.
6. Select the baud rate and NMEA format. Save settings.
7. Then should change skyhub configuration. Set GNSS item to `true` in `[PAYLOADS]` section:

```
[PAYLOADS]
GNSS=true
```

Important: GPS Receiver loads settings from separate config file. The file location: `/etc/skyhub/gnss.conf`. File format: `INI` (https://en.wikipedia.org/wiki/INI_file)

8. Check parameters in `gnss.config` file. Set `SERIAL_DEVICE` to `/dev/ttymxc1` when the UART connection is used with SkyHub 2 or to `/dev/ttyUSBX` (X is the USB port number) when the USB connection is used with SkyHub of both generations:

```
[GNSS]
BAUD_RATE=115200 ; equals selected on step 6
PAYLOAD_ID=193
SERIAL_DEVICE=/dev/ttymxc1 ; UART connection
or
SERIAL_DEVICE=/dev/ttyUSBX ; USB connection
```

See GPS Receiver Configuration to find all available settings with default values and descriptions.

9. To check correct Emlid Reach M2 connection to SkyHub, use the Payload Example Widget in UgCS-CPM and set `Payload Message ID` to `GNSS/PAYLOAD_ID` value from GNSS configuration file. There will be a satellite count on the Payload Example Widget if all settings are right.

Magnetometer Setup

QuSpin GEN2 Setup

Magnetometer module relies on the ROS subsystem. So, the first steps are ROS Bridge setup and ROS Bridge Configuration.

Then set `QSPIN_G2` to true in `[ROS_PAYLOADS]` section:

```
[ROS_PAYLOADS]
QSPIN_G2=true
```

Restart the Skyhub and add such section for every QuSpin device instance:

```
[ROS_MAGNETOMETER_QUSPINGEN2_0]
ALTITUDE_SOURCE=v1:altimeter::0
BAUD_RATE=230400
DATALOG_DIR=/data/skyhub_logs
FILTER=OFF
MAGNETIC_ENVIRONMENT=AVERAGE
MASTER_MODE=OFF
OFFSET_FORWARD_M=0.05
OFFSET_RIGHT_M=0.5
PAYLOAD_ID=192
SENSOR_DATA_RATE_MS=2
SERIAL_DEVICE=/dev/ttyXRUSB0
SLAVE_MODE=OFF
VECTOR_MODE=OFF
```

Replace _0 with device instance number (starting from 0). Specify the correct device name with `SERIAL_DEVICE` parameter. Use `PAYLOAD_ID` to distinguish payloads in Custom Payload Monitor. Use values in range 192-200.

See QuSpin GEN2 Configuration to find all available settings with default values and descriptions.

Outputs Setup

GPS Output Setup

GPS Output sends to defined address messages contained ZDA and GGA sentences in NMEA format. Coordinates, date, time, and other information for NMEA sentences are received from an drone (UAV).

1. Set `OUTPUT_GPS` item to `true` in `[OUTPUTS]` section:

   ```
   [OUTPUTS]
   OUTPUT_GPS=true
   ```

2. Choose the appropriate `ADDRESS` in the `[OUTPUT_GPS]` section. `ADDRESS` has to match with connected serial device name which the GPS output sends messages to.
3. Choose the appropriate `FREQUENCY_HZ` and `BAUD_RATE` in the `[OUTPUT_GPS]` section.

See the GPS Output Configuration section to find all available settings with default values and descriptions.

PPS Sync Setup

PPS Sync provides transmitting PPS signal from the source (for ex, from an autopilot) to the consumer (any payload). To support PPS Sync, should implement a support for special pins in the cable connecting a payload with the SkyHub device.

Set `PPS_SYNC` item to `true` in `[OUTPUTS]` section:

```
[OUTPUTS]
PPS_SYNC=true
```

By default, SkyHub supports the connector 2 as the PPS signal source and the connector 5 as output for the PPS signal consumer.

Note: Please, contact our support team if PPS Sync configuration changes are required.

ROS Bridge Setup

ROS Bridge plugin is a key component for interaction with ROS framework. All ROS-based payload drivers use this module to interact with core SkyHub services (ground software connections, log files, flight controller data acquisition).

Set `ROS_BRIDGE` item to `true` in `[OUTPUTS]` section:

```
[OUTPUTS]
ROS_BRIDGE=true
```

Restart SkyHub after this. Then reboot is complete with enabled ROS_BRIDGE plugin, new sections `ROS_BRIDGE` and `ROS_PAYLOADS` will appear. You may use default values of change them for your needs.

See the ROS Bridge Configuration section to find all available settings with default values and descriptions.

Note: Please, contact our support team if ROS integration configuration changes are required.

6 • GETTING STARTED

It is strongly recommended to verify any usage scenario using the simulator before starting the real flight. There is a dedicated simulator mode in the UgCS for DJI mobile application. Go to Menu > Simulator to enable or disable it.

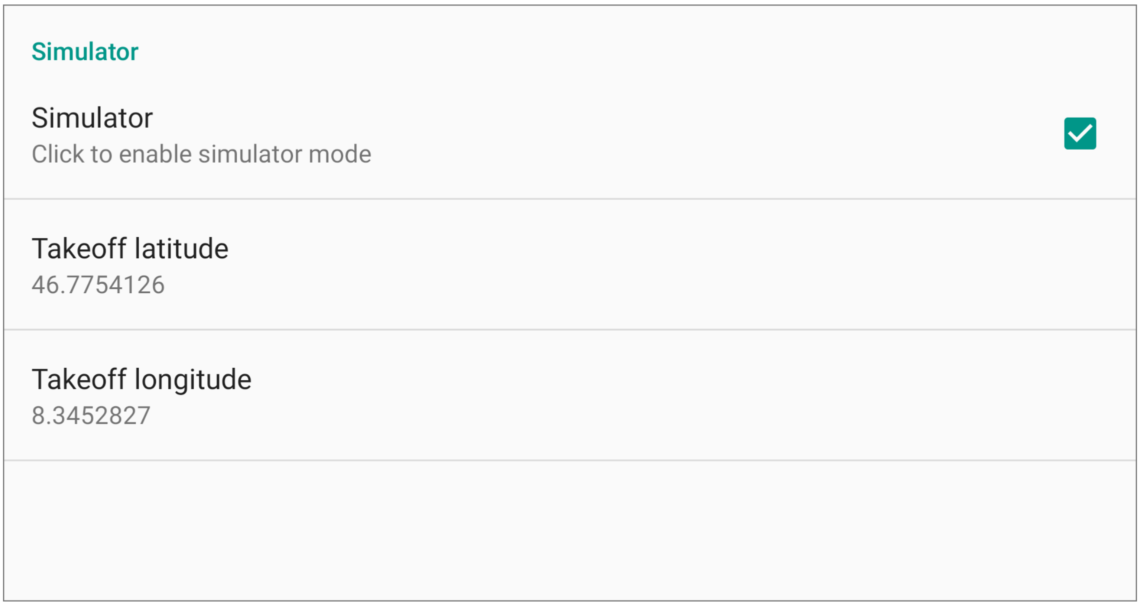

Figure 6.1 — Enable Simulator mode

True Terrain Following

Simulator Mode

1. Start the PC and connect it to the Wi-Fi network. Start the UgCS and plan a mission for the drone.
2. Turn on the drone, the payload, and SkyHub device.
3. Connect the mobile device to the same Wi-Fi network as the PC. Turn on the DJI Remote Controller. Be sure that the flight mode switch on the DJI Remote Controller is in the P-mode. Run the UgCS for DJI mobile application. Wait for the application shows the main window and connects to the UgCS. UCS connection indicator in the UgCS for DJI should become green.
4. Click Menu, choose Simulator, and enable the Simulator checkbox.
5. Make sure that the drone with a correct profile appears in the UgCS on the PC and all drone indicators (battery, uplink, downlink, satellites) are green. Select the drone and the mission.

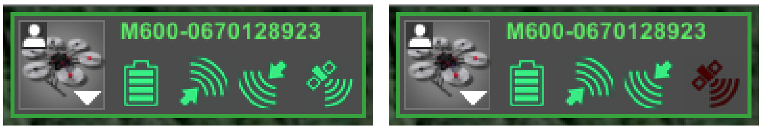

Figure 6.2 — Good (left) and bad (right) vehicle state in UgCS

7. Start the UgCS-CPM application and connect to UgCS with default credentials. Check the UgCS, Drone, and SkyHub indicators are green. Add the Terrain Following widget and other widgets related to connected payloads by clicking the plus button.

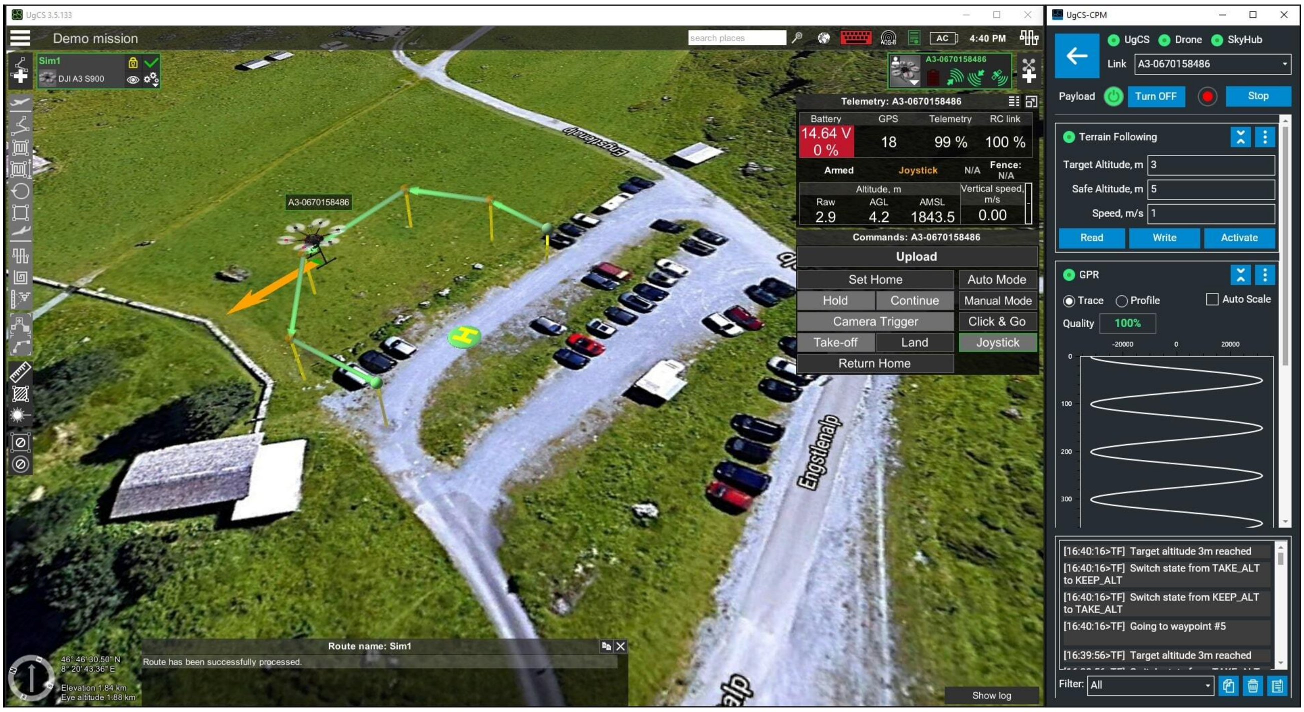

Figure 6.3 — UgCS and UgCS-CPM application open side-by-side

8. Upload the route to the drone. After that, click the Read button in the Terrain Following widget (UgCS-CPM), then click Configure and make sure the `Terrain Following ENABLED` message appears in the UgCS-CPM log window at the bottom side. If not, toggle the flight mode switch to A-mode (S-mode for DJI M300 RTK) and back it to P-mode, then try again to press the Configure button.
9. Arm the drone using the DJI Remote Controller then take off at the valid altitude (see Altimeter Setup for details).
10. Click the Activate button in the Terrain Following widget to activate the Terrain Following Flight mode. Check the drone simulator has started a mission.
11. Make sure the data from connected payloads are displayed in UgCS-CPM. Try to move the UAV and check the sensors' response.
12. Land the drone simulator after the mission has been completed and try to download log files (see Log Files Management below). Check the log files for validity.
13. Erase all log files.

Flight

Configuration steps to be done before the real flight are similar to ones described above for simulator mode. Use the checklist below:

1. Check the altitude limits `MIN_ALTITUDE_M` and `MAX_ALTITUDE_M` in the `[ALTIMETER]` section.
2. Set the `ZERO_LEVEL_M` value in the `[ALTIMETER]` section according to the real position of the altimeter.
3. Make sure the only used payloads are `true` in the `[PAYLOADS]` section. Every payload should be properly configured (see Payloads Setup).
4. Erase old log files if they are not more needed (see Log Files Management below for details).
5. Connect both the PC and the mobile device to the same Wi-Fi network.
6. Switch on the drone and the DJI Remote Controller. Make sure the flight mode switch is in P-mode. Run UgCS, UgCS for DJI, and make sure the drone has a good status in UgCS.
7. Run UgCS-CPM, wait for all indicators become green, and press the Start button.
8. Check the Altimeter widget for it displays the altimeter data. Note that there is no data from the radar altimeter until the drone is moving. Gently shake the drone by hand until the altitude starts to change. Note the altitude limits may be changed in Settings > Altimeter window.
9. Upload the route to the drone using UgCS.
10. Go to the Terrain Following widget, press Read to read current TTF settings.
11. Set the `Target Altitude` and Safe Altitude to desired values.

Attention: It is strongly recommended not to set `Target Altitude` more than **10 meters** for the laser altimeter **above water**

13. Press the Configure button. Wait for the `Terrain Following ENABLED` message.
14. If there is no message mentioned above, change the flight mode switch to A-mode (S-mode for DJI M300 RTK) and back it to P-mode, then try again to press the Configure button.
15. Take off using the DJI Remote Controller or from the UgCS and rise up to the appropriate altitude (see limits from step 2).
16. Press the Activate button in the Terrain Following widget to start the flight in terrain-following mode. The alternative way to activate it is to move the flight mode switch to A-Mode then to F-mode. The alternative way doesn't support with M210/M300 series DJI of drones.

17. You may interrupt the flight by moving the flight mode switch to A-Mode (S-mode for for DJI M300 RTK) then to P-mode or by pressing the Pause button in the Terrain Following widget (UgCS-CPM).

    The flight can be resumed by moving the flight mode switch to A-mode then to F-mode or by pressing the Resume button in the Terrain Following widget (UgCS-CPM). Resuming using the DJI Remote Controller don't support with M210/M300 series DJI of drones.

    During pause you may manually control the drone, for example fly around an obstacle. In this case the drone returns to the nearest point on the route by the shortest way after resuming.

Attention: the flight mode on the DJI Remote Controller must be obligatory switched back to **P-mode** before manually control. Otherwise, the drone returns to an unexpected resuming point.

18. If the drone descends below the minimum allowed altitude or ascends above the maximum allowed altitude (see step 2), it stops then climbs to increase its altitude to value configured at step 12. You may manually correct drone position and resume the flight according to recommendations at step 17.
19. After the mission has been completed the drone stops at the last waypoint then climbs to increase its altitude to value configured at step 12.
20. Move the flight mode switch to P-Mode to take control, then return the drone to the desired landing position, and land. If the flight has been ended over the desired landing point, press the Land button in UgCS.
21. Download log files (see Log Files Management).

TTF with new altimeter drivers

To use new (ROS based) altimeter drivers for TTF mode additional modules must be configured. There are two modules:

1. Altimeter monitor is responsible for sending altimeter telemetery to the Ground Software.
2. TTF feeder is responsible for accurate altitude data supply for True Terrain Following.

The configuration of TTF using the new drivers includes these steps:

1. Configure new driver as described before. For example, see ROS-based Ainteins US-D1 Altimeter Setup.
2. Configure TTF for Simulation or real Flight mode as was shown above.

3. Enable Altimeter monitor payload in skyhub.conf file.
4. Enable TTF feeder node payload in skyhub.conf file.
5. Restart the skyhub.
6. Configure [ROS_MONITOR_ALTIMETERS_0] section parameters (see Configure Altimeter Monitor).
7. Configure [ROS_MONITOR_TTF_0] section parameters (see Configure TTF Feeder).

Grasshopper Mode

Route requirements

Grasshopper action is executed only on waypoints with turn type **Stop & turn** and **Wait action** assigned. Route may consist of mixed type of waypoints (Adaptive bank turn and Stop & turn), to navigate drone to survey area, and for survey have waypoints with turn type **Stop & turn and** and **Wait action**.

Simulator Mode

1. Start the PC and connect it to the Wi-Fi network. Start the UgCS and plan a mission for the drone. The descent points must be set as `wait` action, the wait duration defines waiting time in the descent point.
2. Turn on the drone, the payload, and SkyHub device.
3. Connect the mobile device to the same Wi-Fi network as the PC. Turn on the DJI Remote Controller. Be sure that the flight mode switch on the DJI Remote Controller is in the P-mode. Run the UgCS for DJI mobile application. Wait for the application shows the main window and connects to the UgCS. UCS connection indicator in the UgCS for DJI should become green.
4. Click Menu, choose Simulator and enable the Simulator checkbox.
5. Make sure that the drone with a correct profile appears in the UgCS on the PC and all drone indicators (battery, uplink, downlink, satellites) are green. Select the drone and the mission.
6. Start the UgCS-CPM application and connect to UgCS with default credentials. Check the UgCS, Drone, and SkyHub indicators are green. Add the Grasshopper widget and other widgets related to connected payloads by clicking the plus button.
7. Upload the route to the drone. After that, click the Read button in the Grasshopper widget (UgCS-CPM), then click Configure and make sure the `Grasshopper` ENABLED message appears in the UgCS-CPM log window at the bottom side. If not, toggle the flight mode switch to A-mode (S-mode for DJI M300 RTK) and back it to P-mode, then try again to press the Configure button.
8. Arm the drone using the DJI Remote Controller then take off at the valid altitude (see Altimeter Setup for details).

9. Click the Activate button in the Grasshopper widget (UgCS-CPM) to activate the Grasshopper Flight mode. Check the drone simulator has started a mission.
10. Make sure the data from connected payloads are displayed in UgCS-CPM and payloads send data.
11. Land the drone simulator after the mission has been completed and try to download log files (see Log Files Management below). Check the log files for validity.
12. Erase all log files.

Flight

Configuration steps to be done before the real flight are similar to ones described above for simulator mode. Use the checklist below:

1. Check the altitude limits `MIN_ALTITUDE_M` and `MAX_ALTITUDE_M` in the `[ALTIMETER]` section.
2. Set the `ZERO_LEVEL_M` value in the `[ALTIMETER]` section according to the real position of the altimeter.
3. Make sure the only used payloads are `true` in the `[PAYLOADS]` section. Every payload should be properly configured (see Payloads Setup).
4. Erase old log files if they are not more needed (see Log Files Management below for details).
5. Connect both the PC and the mobile device to the same Wi-Fi network.
6. Switch on the drone and the DJI Remote Controller. Make sure the flight mode switch is in P-mode. Run UgCS, UgCS for DJI, and make sure the drone has a good status in UgCS.
7. Run UgCS-CPM, wait for all indicators become green, and press the Start button.
8. Check the Altimeter widget for it displays the altimeter data. Note that there is no data from the radar altimeter until the drone is moving. Gently shake the drone by hand until the altitude starts to change. Note the altitude limits may be changed in Settings > Altimeter window.
9. Upload the route to the drone using UgCS.
10. Go to the Grasshopper widget, press Read to read current GH settings.
11. Set `Target Altitude` in order to follow terrain, set `Descent To` to desired values.

Attention: It is strongly recommended not to set `Target Altitude` more than **10 meters** for the laser altimeter **above water**

13. Press the Configure button. Wait for the `Grasshopper ENABLED` message.

14. If there is no message mentioned above, change the flight mode switch to A-mode (S-mode for DJI M300 RTK) and back it to P-Mode, then try again to press the Configure button.
15. Take off using the DJI Remote Controller or from the UgCS and rise up to the appropriate altitude (see limits from step 2).
16. Press the Activate button in the Grasshopper widget to start the flight in grasshopper mode. The alternative way to activate it is to move the flight mode switch to A-Mode then to F-mode. The alternative way doesn't support with M210/M300 series DJI of drones.
17. You may interrupt the flight by moving the flight mode switch to A-Mode (S-mode for DJI M300 RTK) then to P-mode or by pressing the Pause button in the Grasshopper widget (UgCS-CPM).

    The flight can be resumed by moving the flight mode switch to A-mode then to F-mode or by pressing the Resume button in the Grasshopper widget (UgCS-CPM). Resuming using the DJI Remote Controller don't support with M210/M300 series DJI of drones.

    During pause you may manually control the drone, for example fly around an obstacle. In this case the drone returns to the nearest point on the route by the shortest way after resuming.

Attention: the flight mode on the DJI Remote Controller must be obligatory switched back to **P-mode** before manually control. Otherwise, the drone returns to an unexpected resuming point.

18. If the drone descends below the minimum allowed altitude or ascends above the maximum allowed altitude (see step 2), it stops then climbs to increase its altitude to value defined the `FAIL_SAFE_ALTITUDE_M` parameter in the `[GH]` section in config and then the route pauses. You may manually correct drone position and resume the flight according to recommendations in the step 17.
19. After the mission has been completed the drone stops at the last waypoint then climbs to increase its altitude to value defined the `FAIL_SAFE_ALTITUDE_M` parameter in the `[GH]` section in config.
20. Return the drone to the desired landing position, and land. If the flight has been ended over the desired landing point, press the Land button in UgCS.
21. Download log files (see Log Files Management).

Obstacle Avoidance Mode

Obstacle Avoidance mode enables to prevent collision of the drone (UAV) with obstacles during the flight. The mode is available for neither manual/auto flights and TTF/GH flight modes. Obstacle Avoidance mode is enabled for all supported DJI drones.

Description

The mode can be activated by pressing the Activate button on the Obstacle Avoidance widget in UgCS-CPM. The activation status is kept in config (see the `ACTIVATED` parameter in the `[OA]` section in config Obstacle Avoidance Configuration) so if the previous SkyHub session was finished with activated mode, SkyHub restores activation status in the new session. In this case UgCS-CPM contains the Deactivate button.

Obstacle Avoidance mode, when it's activated, has two possible states:

- `DISARMED`: not all conditions are executed, the distance to obstacles isn't controlled.
- `ARMED`: the distance to obstacles is controlled.

Conditions of auto switching to ARMED state are defined with parameters `ACTIVATION_ALTITUDE_M` and `ACTIVATION_SPEED_MPS` in the `[OA]` section in config. If the drone (UAV) takes the altitude above `ACTIVATION_ALTITUDE_M` and the speed above `ACTIVATION_SPEED_MPS`, Obstacle Avoidance becomes ARMED, otherwise becomes DISARMED. The UgCS-CPM displays the *Obstacle Avoidance ARMED* or *Obstacle Avoidance DISARMED* message. `ACTIVATION_ALTITUDE_M` is optional parameter, if the `ALTITUDE_SOURCE` sets to `ALTIMETER` but the kit doesn't include the altimeter, `ACTIVATION_ALTITUDE_M` is ignored.

Obstacle detection is based on data received from the special collision detector or from a connected altimeter. Obstacle distance source sets in the `SAFETY_DISTANCE_SOURCE` in the `[OA]` section (see details in Obstacle Avoidance Configuration). Safe distance to an obstacle is configured on the Obstacle Avoidance widget in UgCS-CPM. When Obstacle Avoidance is in ARMED state and the distance to an obstacle is less than configured value, Obstacle Avoidance executes the safety action. Default safety action is returning home, see other safety actions in Obstacle Avoidance Configuration. UgCS-CPM shows current safety action on the Obstacle Avoidance widget.

Embedded sensors

To use obstacle aviodance mode with DJI drone embedded sensors set `EMBEDDED_SENSORS`. You should list required sensors: by default all embedded sensors are used.

Usage

1. Connect to SkyHub (see Connect to SkyHub Using Wi-Fi or Connect to SkyHub Using Ethernet) and set desired parameter values in the `[OA]` section (see details in Obstacle Avoidance Configuration). Disconnect from the SkyHub.
2. Start the PC and connect it to the Wi-Fi network. Start the UgCS and plan a mission for the drone.
3. Turn on the drone, payloads, and SkyHub device.

4. Connect the mobile device to the same Wi-Fi network as the PC. Turn on the DJI Remote Controller. Run the UgCS for DJI mobile application. Wait for the application shows the main window and connects to the UgCS. UCS connection indicator in the UgCS for DJI should become green.
5. Make sure that the drone with a correct profile appears in the UgCS on the PC and all drone indicators (battery, uplink, downlink, satellites) are green. Select the drone and the mission.
6. Start the UgCS-CPM application and connect to UgCS with default credentials. Check UgCS, Drone, and SkyHub indicators are green.
7. Add the Obstacle Avoidance widget and other widgets related to connected payloads by clicking the plus button. To monitor the distance to obstacles using the special obstacle detector, add the Payload Example widget by clicking the plus button and set Payload Message ID equals 195 by clicking the settings button.
8. Go to the Obstacle Avoidance widget, click the Read button to read current OA settings.
9. Set the Safe Distance to Obstacle to desired value. Make sure the Safety Action shows desired action.
10. Press the Configure button. Wait for the `Safety Distance to Obstacle CHANGED` message.
11. Press the Activate button, if the mode is deactivated. Wait for the `Obstacle Avoidance ACTIVATED` message.
12. Upload the route to the drone using UgCS, launch auto, TTF, or Grasshopper Flight mode or start manual flight.
13. If the distance to obstacles drops below the Safe Distance (see step 9), the safety action will be activated.
14. You may interrupt the safety action using the DJI Remote Controller, then click the Deactivate button. To activate Obstacle Avoidance mode again press the Activate button on the Obstacle Avoidance widget.
15. Reconfiguring of Obstacle Avoidance mode is available any time.
16. After flights has been completed, return the drone to the desired landing position, and land. Press the Deactivate button on the Obstacle Avoidance widget.

About Log Files

Logs are stored in the `skyhub_logs` folder on the microSD card.

There are two types of obligatory log files:

- Position log: `*-position.csv`
- System log: `*-system.log`

Position logs (`-position.csv` suffix) contain drone position data (GPS coordinates, attitude, altitude, etc.) followed with the payload's specific parameters, if any. For more details, see Position Log.

System logs (`-system.log` extension) is a journal of various system events. Please keep it while contacting our support team.

Also, depending on the concrete payload used one may get following log files:

- GPR data log in SEG-Y format: `*-gpr.sgy`
- Echosounder data log in SEG-Y format: `*-echo.sgy`
- Echosounder data log in NMEA format: `*-nmea.txt`
- Gas detector data log in NMEA format: `*-pergam-*.log`

GPR data logs (`-gpr.sgy` suffix) contain radar trace data in SEG-Y format. These files can be analyzed in PC applications such as Prism2 or similar software capable to read and process GPR data in SEG-Y format.

Echosounder data logs in SEG-Y format (`-echo.sgy` suffix) contain sounding trace data. These file can also be analyzed in the SEG-Y data processing software.

Echosounder data logs in NMEA 0183 format (`-nmea.txt` suffix) contain bathymetric data. These files can be processed in any software capable of handling data in NMEA 0183 format (e.g. ReefMaster).

Gas detector data logs in mixed NMEA 0183 + raw messages format (`-pergam.txt` suffix) contain measured concentration data. These files can be processed in Pergam's proprietary software.

The filename contains the sequential numbers (*000001*, *000002*, etc.) before the time synchronization and date/time (in *YEAR-MONTH-DAY-HOUR-MIN-SEC* format) after the synchronization with the GPS. The time is UTC.

Logging (except system log) is started only by command from UgCS-CPM (using the Record/Stop button) or automatically after taking off. The system log begins after onboard software is started.

The logs with the same file names have been created simultaneously. When the filename is to be changed (e.g. after the time synchronization) a new set of logs is created.

The logs can be automatically divided by file size, time, trace count (GPR or echosounder only), and waypoints. This option is turned off by default. To enable it, set corresponding parameters to values greater than zero in the `[APP]` section. More than one parameter can be set simultaneously, in this case splitting will be fulfilled when the first of selected conditions occurs:

```
[APP]
LOG_SPLIT_SIZE_MB=0 ; megabytes
LOG_SPLIT_TIME_S=0 ; seconds
```

```
LOG_SPLIT_TRACES=0
LOG_SPLIT_WAYPOINTS=0 ; 0 or 1
```

When LOG_SPLIT_WAYPOINTS is set to 1 or another value greater than zero, each log file will contain one flight line with two waypoints.

There are two ways to download log files:

- Using UgCS-CPM (see Log Files Management)
- With any web browser via HTTP protocol (supported for SkyHub 2 only)

When the second way is chosen, open http://10.1.0.1 (Wi-Fi) or http://192.168.0.33 (Ethernet) in your browser and choose the required log file from a list of all recorded ones.

Position Log

Position logs contain common parameter group and the payload's specific parameters if any. Common parameter columns fill in with the latest received value. Specific parameter columns fill in at the moment when the payloads received data, excluding altimeters, its columns write as common parameters

If payloads don't receive data during doubled period sets in the APP/POSITION_LOG_PERIOD_MS configuration parameter, Position Log starts logging only common parameters with given period.

Table 6.1 — Position Log. Common Columns Description

COLUNM NAME	UNIT	DESCRIPTION
Common		
Elapsed	ms	Time elapsed since launch
Date		Date received from the drone. Format: yyyy/MM/dd
Time		Time received from the drone. Format: hh:mm:ss.ms
Pitch	deg	Pitch angle received from the drone
Roll	deg	Roll angle received from the drone
Yaw	deg	Yaw angle received from the drone
Latitude	deg	Latitude received from the drone in GPS system

COLUNM NAME	UNIT	DESCRIPTION
Longitude	deg	Longitude received from the drone in GPS system
Altitude	m	Altitude relative to take-off point
Velocity	m/s	Horizontal velocity
RTK Status		• **ON**: RTK used • **OFF**: RTK not used
Latitude RTK	deg	Latitude received from the drone using RTK station
Longitude RTK	deg	Longitude received from the drone using RTK station
Altitude RTK	m	Altitude AMSL received from the drone using RTK station

Table 6.2 — Position Log. Anemometer Columns Description

COLUNM NAME	UNIT	DESCRIPTION
Anemometer		
AIR:Speed	m/s	Measured wind speed
AIR:Direction	deg	Measured wind direction relative to magnetic north

Table 6.3 — Position Log. Altimeter Columns Description

COLUNM NAME	UNIT	DESCRIPTION
Altimeter		
ALT:Altitude	m	Measured altitude
ALT:Filtered Altitude	m	Altitude after applying LPF, see Altimeter Configuration

Table 6.4 — Position Log. Conductivity Meter Columns Description

COLUNM NAME	UNIT	DESCRIPTION
Conductivity Meter		

COLUNM NAME	UNIT	DESCRIPTION
CM:CV0.5	mS/m	Measured conductivity for 0.5 m
CM:IV0.5	ppt	Measured inphase for 0.5 m
CM:CV1.0	mS/m	Measured conductivity for 1.0 m
CM:IV1.0	ppt	Measured inphase for 1.0 m

Table 6.5 — Position Log. Echosounder Columns Description

COLUNM NAME	UNIT	DESCRIPTION
Echosounder		
ECHO:Depth	m	Measured depth
ECHO:Depth Hi	m	Measured depth on high acoustic frequency. Support for dual frequency echosounder
ECHO:Depth Lo	m	Measured depth on low acoustic frequency. Support for dual frequency echosounder
ECHO:True Depth	m	Depth with taking into account sensor position relative to the waterline. True Depth calculates using `ALT:Altitude` value and the `ECHOSOUNDER/CABLE_LENGTH_M` configuration paramater.
ECHO:True Depth Hi	m	Depth on high acoustic frequency with taking into account sensor position relative to the waterline. True Depth Hi calculates using `ALT:Altitude` value and the `ECHOSOUNDER/CABLE_LENGTH_M` configuration paramater. Support for dual frequency echosounder

COLUNM NAME	UNIT	DESCRIPTION
ECHO:True Depth Lo	m	Depth on low acoustic frequency with taking into account sensor position relative to the waterline. True Depth Hi calculates using `ALT:Altitude` value and the `ECHOSOUNDER/CABLE_LENGTH_M` configuration paramater. Support for dual frequency echosounder
ECHO:Temperature	°C	Temperature in degrees Celsius
ECHO:Trace		Trace number in SEG-Y file
ECHO:Trace Hi		Trace number in SEG-Y file for high acoustic frequency. Support for dual frequency echosounder
ECHO:Trace Lo		Trace number in SEG-Y file for low acoustic frequency. Support for dual frequency echosounder
ECHO:Pitch	deg	Pitch angle received from the payload
ECHO:Roll	deg	Roll angle received from the payload

Table 6.6 — Position Log. Gas Detector Columns Description

COLUNM NAME	UNIT	DESCRIPTION
Gas Detector		
GAS:Methane	ppm × m	Measured concentration in ppm (parts per million) per meter

COLUNM NAME	UNIT	DESCRIPTION
GAS:Status		Specific status for the payload • **0**: on measuring (but the intensity is low, measure value is not accurate as 1) • **1**: on measuring (with good intensity level) • **2-4**: N/A • **5**: not enough reflection (very low intensity, value is not accurate) • **6**: too much reflection (high density gas) • **7**: too much reflection (not able to measure by interfering of sunlight, etc…) • **8**: N/A • **9**: stop, no measuring

Table 6.7 — Position Log. GPS Receiver Columns Description

COLUNM NAME	UNIT	DESCRIPTION
GPS Receiver		
GNSS:Date		Date
GNSS:Time		Time
GNSS:Latitude	deg	Latitude
GNSS:Longitude	deg	Longitude
GNSS:Altitude	m	Altitude above/below mean-sea-level (geoid)

COLUNM NAME	UNIT	DESCRIPTION
GNSS:Quality Indicator		GPS Quality Indicator • **0**: fix not available • **1**: GPS fix • **2**: Differential GPS fix • **3**: PPS fix • **4**: RTK • **5**: float RTK • **6**: estimated (dead reckoning) • **7**: manual input mode • **8**: simulation mode
GNSS:Satellites		Number of satellites in use
GNSS:HDOP	m	Horizontal dilution of precision
GNSS:Undulation	m	Geoidal separation, the difference between the WGS-84 earth ellipsoid and mean-sea-level (geoid). Negative value means mean-sea-level below ellipsoid

Table 6.8 — Position Log. Ground-Penetrating Radar Columns Description

COLUNM NAME	UNIT	DESCRIPTION
Ground-Penetrating Radar		
GPR:Trace		Trace number in SEG-Y file

Table 6.9 — Position Log. Metal Detector Columns Description

COLUNM NAME	UNIT	DESCRIPTION
Metal Detector		
MD:Channel 1	mV	Measured response in channel 1
MD:Channel 2	mV	Measured response in channel 2
MD:Channel 3	mV	Measured response in channel 3
MD:Channel 4	mV	Measured response in channel 4
MD:Top Channel	mV	Measured response in top channel

Table 6.10 — Position Log. Obstacle Detector Columns Description

COLUNM NAME	UNIT	DESCRIPTION
Obstacle Detector		
OBS:Sector1	m	Distance to the nearest obstacle in the sector 1
OBS:Sector2	m	Distance to the nearest obstacle in the sector 2 (central sector)
OBS:Sector3	m	Distance to the nearest obstacle in the sector 3

Table 6.11 — Position Log. Lightware SF30/D Altimeter Description

COLUNM NAME	UNIT	DESCRIPTION
Lightware SF30/D		
SF:RawF	m	First return raw
SF:FiltF	m	First return filtered
SF:SgthF	%	First return strength
SF:RawL	m	Last return raw
SF:FiltL	m	Last return filtered
SF:SgthL	%	Last return strength
SF:Noise		Background noise
SF:Temp	°C	Temperature in degrees Celsius

Log Files Management

1. Connect the PC to the SkyHub using Wi-Fi (see Connect to SkyHub Using Wi-Fi) or by wire (see Connect to SkyHub Using Ethernet).
2. Go to Settings > SkyHub and make sure the IP-address corresponds to the connection way.
3. Open UgCS-CPM and go to Tools > Manage Logs.
4. Press the Browse button to choose the destination folder for log files.
5. Use the date and file extension filters to choose log files to be downloaded.
6. You can write custom extension if needed in the corresponding textbox.

7. Press the Download button and wait for downloading has been finished.
8. After the log files are not more needed you may delete them all using the Erase All button.
9. If you need to delete only certain files you may set the date and file extension filters then press the Erase button.
10. You also have 2 options for downloading and deleting depending on logs creation date: All dates and Today.
11. Note, if you choose Today, UgCS-CPM will work not only with today's logs but with yesterday's and tomorrow's. The reason is the possible difference between local date and the UTC one used in log file names.

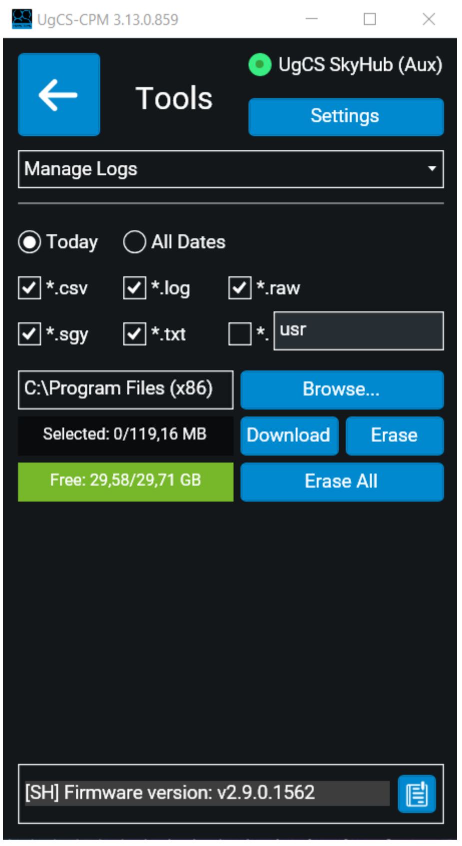

Figure 6.4 — UgCS-CPM. Manage Logs window

Update Firmware

1. Connect the PC to the SkyHub using Wi-Fi (see Connect to SkyHub Using Wi-Fi) or by wire (see Connect to SkyHub Using Ethernet).
2. Open UgCS-CPM and go to Tools > Manage SkyHub
3. The SkyHub (Aux) indicator is green when there is the connection to the SkyHub device via Ethernet or Wi-Fi and red otherwise.

4. Since UgCS-CPM v3.15 this supports two hardware versions of UgCS SkyHub device. The `Device` line on the `Manage UgCS SkyHub` page displays the version of the connected device.
5. The latest SkyHub firmware compatible with the installed UgCS-CPM is located in `UgCS-CPM/firmware` folder. Also, the latest SkyHub firmware is available by the link https://integrated.ugcs.com/dl/s/skyhub-armhf for the `UgCS SkyHub v2` device and by the link https://integrated.ugcs.com/dl/s/skyhub-arm64 for the `UgCS SkyHub v3` device.
6. Click the Browse button and choose the firmware archive file. If the device version is `UgCS SkyHub v2`, should choose the file named as `skyhub-v2-*.tar.gz`. If the device version is `UgCS SkyHub v3`, should choose the `skyhub-v3-*.tar.gz` file. Then press the Upgrade button.
7. Wait for the progress bar becomes filled and check the firmware version after it appears.
8. Click the Back button to return on the main UgCS-CPM page. Wait for the UgCS SkyHub device reboots and click the Reconnect button.

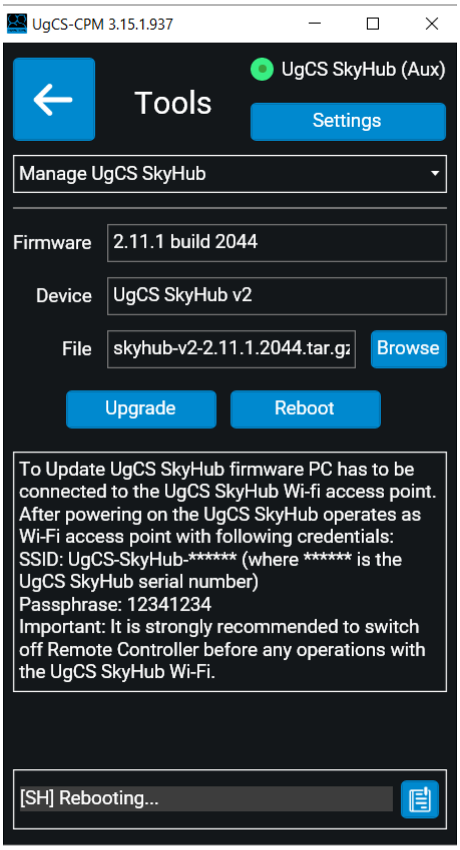

Figure 6.5 — UgCS-CPM. Manage SkyHub window

Uninstall Firmware

Important: This article is intended for advanced users only.

1. Connect the PC to the SkyHub using Wi-Fi (see Connect to SkyHub Using Wi-Fi) or by wire (see Connect to SkyHub Using Ethernet).

   To uninstall the firmware on the SkyHub 3 device, launch the command:

   ```
   $ dpkg -r ugcs-skyhub
   ```

   The configuration file and log files are kept.

The following steps describe the uninstall procedure for the SkyHub 2.

2. Download the latest firmware from our website: https://integrated.ugcs.com/dl/s/skyhub-armhf
3. Upload manually the firmware to MicroSD root (path: `/run/media/mmcblk1p1`) by FTP/SCP client.
4. Connect to SkyHub via ssh and move to the MicroSD root.
5. Unpack the firmware package and manually run the script to uninstall the SkyHub firmware from the device:

   ```
   $ tar -xvf skyhub-*.tar.gz
   $ skyhub-*/uninstall.sh
   ```

If the firmware is uninstalled, the configuration file is also deleted, but log files in the folder `/run/media/mmcblk1p1/skyhub_logs/` are kept.

7 • CONFIGURATION PARAMETERS

- Configuration file location: `/etc/skyhub/skyhub.conf`
- File format: `INI` (https://en.wikipedia.org/wiki/INI_file)

Important: The SkyHub device should be restarted after any change in the configuration file by reboot command or by power cycling.

SkyHub Configuration

Table 7.1 — SkyHub settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[APP]		
DISABLE_WIFI_IN_AIR	false	Disable Wi-Fi when the drone is in air. Set to `true` for Wi-Fi stops working after takeoff.
LOG_SPLIT_SIZE_MB	0	Log splitting by file size, MB
LOG_SPLIT_TIME_S	0	Period of log splitting, s
LOG_SPLIT_TRACES	0	Log splitting by trace number (applicable to GPR and echosounder only)
LOG_SPLIT_WAYPOINTS	0	Log splitting by waypoint count. When set to 1, each log will contain one line with two waypoints.
MIN_FREE_SPACE_MB	300	Minimum allowable free space on the microSD card, MB
PAYLOAD_START_DELAY_S	5	Start payload plugins delay, s
POSITION_LOG_PERIOD_MS	100	Period of writing to position log, ms
STATUS_PERIOD_MS	500	Period of payload status sending to ground, ms
TELEMETRY_PERIOD_MS	200	Telemetry data refresh period, ms
[AUTOPILOTS]		

PARAMETER	DEFAULT VALUE	DESCRIPTION
DJI	false	Using the DJI autopilot except for support for DJI M300 RTK. Set to `true` if DJI drone is used.
DJI_M	false	Using the DJI autopilot to support DJI M300 RTK. Set to `true` if DJI M300 RTK drone is used.
MAVPILOT	false	Using the MAVLink-based autopilot. Set to `true` if ArduPilot / PX4 based drone is used.
[PAYLOADS]		
DROP_MESSENGER	false	Using the Ruttner water sampler. Set to `true` if used.
ECHOLOGGER_DUAL	false	Using the Echologger ECT D052/D032 echosounder. Set to `true` if used.
ECHOLOGGER_ECT	false	Using the Echologger ECT400 echosounder. Set to `true` if used.
FTTECHNOLOGIES_FT742_SM	false	Using the FT Technologies FT742-SM anemometer. Set to `true` if used.
GEONICS_EM_38_MK2	false	Using the Geonics EM38-MK2 conductivity meter. Set to `true` if used.
GEONICS_EM_61	false	Using the Geonics EM-61 metal detector. Set to `true` if used.
GNSS	false	Using the Emlid Reach M2 GPS receiver. Set to `true` if used.
LIGHTWARE_SF30	false	Using the Lightware SF30/D laser altimeter. Set to `true` if used.

PARAMETER	DEFAULT VALUE	DESCRIPTION
NANORADAR_MR	false	Using the Nanoradar MR72 radar obstacle detector. Set to `true` if used.
NANORADAR_NRA	false	Using the Nanoradar NRA24 radar altimeter. Set to `true` if used.
PERGAM_FALCON	false	Using the Pergam Laser Falcon gas detector. Set to `true` if used.
PERGAM_LMM	false	Using the Pergam LMM gas detector. Set to `true` if used.
RADARTEAM_COBRA	false	Using the Radarteam Cobra low frequency GPR. Set to `true` if used.
RADSYS_ZOND	false	Using the RadSys Zond-12e high frequency GPR. Set to `true` if used.

Table 7.2 — SkyHub advanced settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[APP]		
SYSINFO_LOG	false	Log the system info such as CPU temperature, CPU frequencies, and CPU usage (used for debugging only)
VERBOSE	false	Log the debug info to the system log (used for debugging only)
[PAYLOADS]		
PAYLOAD_EXAMPLE	false	Using the custom payload. Set to `true` if used.

Autopilot Configuration

DJI Autopilot Configuration

Table 7.3 — DJI autopilot settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[DJI]		
APP_ID	1071019	DJI App ID
APP_KEY	42873…30b25	DJI App Key
BAUD_RATE	230400	UART baud rate, bps
RESPONSE_TIMEOUT_S	1	DJI response timeout, s
SENDING_PERIOD_MS	20	Period of data sending to ground, ms
SERIAL_DEVICE	**UgCS SkyHub 2**: /dev/ttymxc3 **UgCS SkyHub 3**: /dev/ttyAMA1	UART serial device. Default value depends on the UgCS SkyHub generation

ArduPilot/PX4 Configuration

Table 7.4 — ArduPilot/PX4 connection settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[MAV]		
BAUD_RATE	230400	UART baud rate, bps
CONNECTION_TYPE	UART	Connection type: • **UART**: to connect through UART • **TCP**: to connect through Ethernet
COMPONENT_ID	5	MAVLink component Id of UgCS SkyHub
SENDING_PERIOD_MS	20	Delay between sends of sensor data from internal queue to the ground station.

PARAMETER	DEFAULT VALUE	DESCRIPTION
SERIAL_DEVICE	**UgCS SkyHub 2**: /dev/ttymxc3 **UgCS SkyHub 3**: /dev/ttyAMA1	UART serial device. Default value depends on the UgCS SkyHub generation
SYSTEM_ID	2	MAVLink system Id of UgCS SkyHub
TELEMETRY_RATE	10	Telemetry frequency, Hz
V2_EXTENSION	false	Using MAVLink V2_EXTENSION messages. Set to `true` to enable it.

Flight Control Mode Configuration

True Terrain Following Configuration

Table 7.5 — TTF settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[TF]		
FAIL_SAFE_ALTITUDE_M	20	Fail safe altitude, m
TARGET_ALTITUDE_M	3	Target flight altitude, m

Grasshopper Configuration

Table 7.6 — GH settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[GH]		
DESCENT_ALTITUDE_M	3	Target descending altitude, m
DESCENT_SPEED_MPS	1	Descent rate, m/s
FAIL_SAFE_ALTITUDE_M	5	Fail safe altitude, m
TARGET_ALTITUDE_M	5	Target flight altitude, m

Obstacle Avoidance Configuration

Table 7.7 — OA settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[OA]		
ACTION	RETURN_TO_HOME	Safety action if the obstacle detected • **RETURN_TO_HOME**: Activate return to home function • **STOP_AND_HOVER**: Go to safe altitude and await • **WARNING**: Show warning message • **NOTHING**: Do nothing
ACTIVATED	false	Activate or deactivate Obstacle Avoidance mode
ACTIVATION_ALTITUDE_M	10	Altitude above which Obstacle Avoidance mode switches to *ARMED*, m
ACTIVATION_SPEED_MPS	0.2	Speed (relative to the ground) above which Obstacle Avoidance mode switches to *ARMED*, m/s
ALTITUDE_SOURCE	ALTIMETER	• **ALTIMETER**: Use external altimeter as altitude source • **AUTOPILOT**: Use autopilot as altitude source. **Attention!** Be careful using *AUTOPILOT*, the altitude calculates as difference between current AMSL and AMSL of the latest taking off.
SAFETY_DISTANCE_LIMIT_M	5	Distance less which safety action activates, m
SAFETY_DISTANCE_SOURCE	OBSTACLE_DETECTOR	• **OBSTACLE_DETECTOR**: Use external or embedded obstacle detector as a source • **ALTIMETER**: Use external altimeter as obstacle distance source

PARAMETER	DEFAULT VALUE	DESCRIPTION
EMBEDDED_SENSORS	FRONT BACK LEFT RIGHT UP DOWN	List of embedded sensors used for obstacle detection. Remove list members to disable corresponding sensors. If list is empty embedded sensors are not used.

Navigation Configuration

See the Guidelines for navigation values choosing section for tips on tuning.

Table 7.8 – Navigation settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[NAV]		
ACCEPTANCE_RADIUS_M	0.5 m Permissible range: 0.01 – 10 m	The distance to the waypoint after which the waypoint is considered reached.
HORIZONTAL_ACCEL_MSS	1 m/s2 Permissible range: 0 - 10 m/s2	Acceleration in the horizontal plane (XY). The trajectory will be built in such a way that the drone's acceleration does not exceed the specified value. The trajectory will also be built when turning, and the radius of curvature depends on this acceleration when performing the BankTurn maneuver.
MAX_CLIMB_SPEED_MS	5 m/s Permissible range: 0 - 10 m/s	Maximum vertical **climbing** speed. Specifies a constraint when calculating the trajectory. The device will not exceed this speed when moving along the route and when avoiding obstacles.
MAX_DESCENT_SPEED_MS	5 m/s Permissible range: 0 - 10 m/s	Maximum vertical **descend** speed. Specifies a constraint then calculating the trajectory. The device will not exceed this speed when moving along the route and when avoiding obstacles.
MAX_JERK	0.1 m/s3 Permissible range: 0.1 – 1 m/s3	The maximum rate of change of acceleration during the calculation of the trajectory. The trajectory is calculated based on the constraint that the vehicle cannot change acceleration faster than the parameter value. While following the route, the value is ignored and not checked.

PARAMETER	DEFAULT VALUE	DESCRIPTION
POS_P	0.5 Permissible range: 0.1 – 1	The proportional component of the PID controller for calculating the speed from the position error in the horizontal plane.
POS_Z_P	0.5 Permissible range: 0.1 – 1	The proportional component of the PID controller for calculating the speed from the position error in the vertical plane. Responsible for maintaining the vertical component of speed by the autopilot.
VELOCITY_FEED_FORWARD	0 m/s Permissible range: 0 – 1.9	An experimental parameter for the delay compensation between transmitting the target horizontal speed and receiving the actual value from the flight controller.
VELOCITY_Z_FEED_FORWARD	0 m/s Permissible range: 0 – 1.9	An experimental parameter for the delay compensation between transmitting the target vertical speed and receiving the actual value from the flight controller.
VERTICAL_ACCEL_MSS	0.5 m/s2	The acceleration the drone will perform vertical maneuvers (along the Z axis).
YAW_RATE_DS	40 deg/sec	The turn rate in the horizontal plane (XY) at waypoints. Recomended range from 15 to 60 deg/sec
DEBUG_LOG	false Acceptable values: false, true	Enable debug mode. In case of unexpected situations that require the collection and analysis of work logs, this value can be set to “true”. The debug log will record controller operation events for further analisys of the processing logic.

Configure TTF Feeder

You should edit /etc/skyhub/skyhub.conf and enable this option:

```
[ROS_PAYLOADS]
TTF_FEEDER=true
```

This node works as a single instance. You should provide the only section of monitor paramenters for all configured altimenter instances:

```
[ROS_MONITOR_TTF_0]
SOURCE=v1:altimeter:Lightware_SF30D:0
```

Table 7.9 — ROS-based TTF Feeder settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[ROS_MONITOR_TTF_0]		
SOURCE	v1:altimeter::	Mask to select altimeneter as TTF source

Altimeter Configuration

Table 7.10 — Common altimeter settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[ALTIMETER]		
MAX_ALTITUDE_M	20	Max altitude value, m
MIN_ALTITUDE_M	0.5	Min altitude value, m
ZERO_LEVEL_M	0	Altimeter position above ground level, m
IGNORE_ERRORS	0	Maximum number of ignoring fails received in a row
FILTER_TYPE	NONE	Type of filtering used for altimeter data • **NONE**: no filtering be applied • **LP**: low-pass filter • **EF**: estimator filter
EF_FILTER_GATE	3	Innovation consistency gate size (STD). Determines how many standard deviations can me accepted before mesurments may be considered as invalid. Available values: 1.0-10.0

PARAMETER	DEFAULT VALUE	DESCRIPTION
EF_FILTER_PROC_NOISE	0.5	Process noise for terrain offset, m/s. Less values will softer result greater. Range 0.1 - 1.0
EF_FILTER_RNG_NOISE	0.2	Altimeter noise. Less values for more precise sensor, m. Range 0.01 - 0.4
EF_FILTER_TERR_GRAD	0.1	Expected terrain gradient, m/m. Less value for more flat surfaces. Range 0.0 - 1
LP_FILTER_LENGTH	0	(experimental option) Low-pass filter length. Available options are: 0 (filter disabled), 8, 12, 16, 20, 24, 28, 32

Nanoradar NRA24 Altimeter Configuration

Table 7.11 — Nanoradar NRA24 altimeter settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[NANORADAR_NRA]		
AVERAGING	2	Averaging factor. The more is the smoother but rarer.
BAUD_RATE	115200	UART baud rate, bps
SERIAL_DEVICE	**UgCS SkyHub 2**: /dev/ttymxc5 **UgCS SkyHub 3**: /dev/ttyS0	UART serial device. Default value depends on the UgCS SkyHub generation

Lightware SF30/D Altimeter Configuration

Table 7.12 — Lightware SF30/D altimeter settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[LIGHTWARE_SF30]		

PARAMETER	DEFAULT VALUE	DESCRIPTION
EXTENDED_CSV_LOG	false	Log extended data to CSV position log with prefix SF. See details in Position Log
RATE_HZ	39	Data sampling update rate. Only fixed values are available: 20010, 10005, 5002, 2501, 1250, 625, 312, 156, 78, 39
TTF_IS_FILTERED	true	Defines the distance for TTF or GH mode • **true**: filtered distance is used • **false**: raw distance is used
TTF_RETURN_MODE	LAST	Defines the return for TTF or GH mode • **FIRST**: first return is used • **LAST**: last return is used
TTF_SUPPORT	true	Defines whether Lightware SF30/D is used as the altimeter for TTF or GH mode
UART_BAUD_RATE	115200	UART baud rate, bps
UART_SERIAL_DEVICE	/dev/ttyS0	UART serial device

ROS-based Lightware SF30/D Altimeter Configuration

This driver supports multiple instances of SD30D altimeters connected to the same SkyHub device. You should provide additional section for every configured instance (zero-base):

```
[ROS_ALTIMETER_LIGHTWARESF30D_0]
IS_FILTERED=false
RATE_HZ=39
RETURN_MODE=LAST
UART_BAUD_RATE=115200
UART_SERIAL_DEVICE=/dev/ttyS0
```

Table 7.13 — ROS-based Lightware SF30/D altimeter settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[ROS_LIGHTWARE_SF30]		

PARAMETER	DEFAULT VALUE	DESCRIPTION
RATE_HZ	39	Data sampling update rate. Only fixed values are available: 20010, 10005, 5002, 2501, 1250, 625, 312, 156, 78, 39
IS_FILTERED	true	Defines the distance for TTF or GH mode • **true**: filtered distance is used • **false**: raw distance is used
RETURN_MODE	LAST	Defines the return for TTF or GH mode • **FIRST**: first return is used • **LAST**: last return is used
UART_BAUD_RATE	115200	UART baud rate, bps
UART_SERIAL_DEVICE	/dev/ttyS0	UART serial device

ROS-based Ainteins US-D1 Altimeter Configuration

This driver supports multiple instances of US-D1 altimeters connected to the same SkyHub device. You should provide additional section for every configured instance (zero-base):

```
[ROS_ALTIMETER_AINSTEINUSD1_0]
UART_BAUD_RATE=115200
UART_SERIAL_DEVICE=/dev/ttyS0
```

Table 7.14 — ROS-based Ainteins US-D1 altimeter settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[ROS_US_D1]		
UART_BAUD_RATE	115200	UART baud rate, bps
UART_SERIAL_DEVICE	/dev/ttyS0	UART serial device

Configure Altimeter Monitor

You should edit /etc/skyhub/skyhub.conf and enable this payload:

```
[ROS_PAYLOADS]
ALTIMETERS_MONITOR=true
```

This node works as a single instance. You should provide the only section of monitor paramenters for all configured altimenter instances:

```
[ROS_MONITOR_ALTIMETERS_0]
DATALOG=25376e65-2866-40b4-bbdf-7dfd08fb7c32
SOURCE=v1:altimeter::
```

Table 7.15 — ROS-based Altimeter monitor settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[ROS_MONITOR_ALTIMETERS_0]		
DATALOG		Datalog ID to write altimeter values
SOURCE	v1:altimeter::	Mask to select altimeneters to monitor

GPR Configuration

Low Frequency GPR Configuration

Table 7.16 — Low Frequency GPR settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[RADARTEAM_COBRA]		
BLUETOOTH_NAME	RT[0-9]+	Bluetooth name of GPR device. May be a regular expression.
MODEL	SE-150	GPR model. Added to the SEG-Y log header.
TELEMETRY_PERIOD_MS	2000	Telemetry data refresh rate, ms
TIME_RANGE_NS	800	Trace time range, ns: • **800** for newer devices • **1600** for older devices

High Frequency GPR Configuration

Table 7.17 — High Frequency GPR settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[RADSYS_ZOND]		
FILTER_1	OFF	High pass filter for the first channel: • **OFF**: High pass filter is off • **WEAK**: Weak high pass filter • **STRONG**: Strong high pass filter • **SUPER_STRONG**: Super strong high pass filter This parameter is also applicable in single-channel mode.
FILTER_2	OFF	High pass filter for the second channel. See `FILTER_1` values.
IP_ADDRESS	192.168.0.10	IP-address of the GPR
MODE	CHANNEL_1	GPR channel mode: • **CHANNEL_1**: Single-channel, the first channel is active • **CHANNEL_2**: Single-channel, the second channel is active • **TWO_CHANNELS**: Dual-channel, both channels are active • **TX1_RX2**: The first channel transmitter to the second channel receiver • **TX2_RX1**: The second channel transmitter to the first channel receiver • **CIRCLE**: Circle mode
OFFSET_FORWARD_M_1	0	Offset of the first antenna alongside the heading line, m
OFFSET_FORWARD_M_2	0	Offset of the second antenna alongside the heading line, m
OFFSET_RIGHT_M_1	0	Offset of the first antenna alongside the traverse line, m

PARAMETER	DEFAULT VALUE	DESCRIPTION
OFFSET_RIGHT_M_2	0	Offset of the second antenna alongside the traverse line, m
PORT	23	TCP-port of the GPR
PULSE_DELAY_1	0	Pulse delay for the first channel. Should be set up during the calibration. From **0** to **1023**. This parameter is also applicable in single-channel mode and with the `Aero` version.
PULSE_DELAY_2	0	Pulse delay for the second channel. See `PULSE_DELAY_1` values.
RAW_LOG	false	Log the raw data from echosounder (used for debugging only)
SOUNDING_MODE	SOUNDING	Possible values are: • **SOUNDING**: Normal operation mode • **CALIBRATION**: Sine wave with frequency 20 MHz • **TEST**: Sine wave with constant period for any settings
SAMPLE_COUNT	256	Sample count per trace: **128, 256, 512, 1024**
TELEMETRY_PERIOD_MS	2000	Telemetry data refresh rate, ms
TIME_RANGE_NS_1	300	Trace time range for the first channel, ns: **50, 100, 200, 300, 500, 800, 1200, 2000**. This parameter is also applicable in single-channel mode and with the `Aero` version. Trace time range for the `Aero` version, ns: **50, 100, 200, 300, 500**.
TIME_RANGE_NS_2	300	Trace time range for the second channel, ns. See `TIME_RANGE_1` values.

Note: When using the `Aero` version of RadSys Zond radar, all fields are ignored apart `PULSE_DELAY_1` and `TIME_RANGE_NS_1`.

RadSys zGPR Configuration

Table 7.18 — RadSys zGPR settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[RADSYS_ZGPR]		
IP_ADDRESS	192.168.0.10	IP-address of the zGPR
PORT	23	TCP-port of the GPR
PULSE_DELAY	174	Pulse delay should be set up during the calibration. From **0** to **7000**
SAMPLE_COUNT	512	Sample count per trace. From **32** to **8192**
STACKING	128	Defines how many traces are stacked. From **1** to **65535**
TELEMETRY_PERIOD_MS	2000	Telemetry data refresh rate, ms
TX_FREQUENCY_KHZ	300	Transmission frequency, khz [1-310]
TIME_RANGE_PER_SAMPLE	7	Encodes the trace time range per sample. From **0** to **14**: **0**: 17.857 ps **1**: 35.714 ps **2**: 71.429 ps **3**: 89.286 ps **4**: 125.000 ps **5**: 142.857 ps **6**: 178.571 ps **7**: 250.000 ps **8**: 357.143 ps **9**: 500.000 ps **10**: 625.000 ps **11**: 714.286 ps **12**: 1.00 ns **13**: 1.25 ns **14**: 2.50 ns

Echosounder Configuration

Table 7.19 — Common echosounder settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[ECHOSOUNDER]		
CABLE_LENGTH_M	0	Echosounder cable length, m
MAX_DEPTH_M	20	Max depth value, m
MIN_DEPTH_M	0.5	Min depth value, m

Echologger ECT400 Configuration

Table 7.20 — Echologger ECT400 settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[ECHOLOGGER_ECT]		
ALT_THRESHOLD_PCT	10	Altimeter threshold in percents of a full scale
BAUD_RATE	115200	UART baud rate, bps
DEADZONE_MM	300	Near field zone where detection is ignored, mm
INTERVAL_S	0.1	Time between measures, sec
GAIN_DB	0	Amplifying gain, dB
MAX_SENSOR_ANGLE_DEG	10	Data filtering by tilt. The data are not recorded if the sensor tilt value is greater than the specified value, degree.

PARAMETER	DEFAULT VALUE	DESCRIPTION
MIN_SENSOR_DEPTH_M	0.1	Data filtering by sensor dept in the water. Sensor depth is calculated as a difference between the length of the cable (set by CABLE_LENGTH_M parameter in the ECHOSOUNDER section) and current altitude. The data are not recorded if the sensor depth is lower than specified value, m.
MODE	NMEA	• **NMEA**: Ouptut data in NMEA format only • **ECHOSOUNDER**: Output data in NMEA and SEG-Y formats
RANGE_M	8	Measuring range, m
RAW_LOG	false	Log the raw data from echosounder (used for debugging only)
SERIAL_DEVICE	**UgCS SkyHub 2**: /dev/ttymxc1 **UgCS SkyHub 3**: /dev/ttyAMA3	Serial device name. Default value depends on the UgCS SkyHub generation
TXLENGTH_US	50	Transmitted pulse length, micro second. The value is automatically increased if it is less than the required value.

Echologger ECT D052/D032 Configuration

Table 7.21 — Echologger ECT D052/D032 settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[ECHOLOGGER_DUAL]		
ALT_THRESHOLD_HIGH_PCT	10	Altimeter threshold in percents of a full scale for high acoustic frequency
ALT_THRESHOLD_LOW_PCT	10	Altimeter threshold in percents of a full scale for low acoustic frequency

PARAMETER	DEFAULT VALUE	DESCRIPTION
BAUD_RATE	115200	UART baud rate, bps
DEADZONE_HIGH_MM	500	Near field zone where detection is ignored for high acoustic frequency, mm
DEADZONE_LOW_MM	1000	Near field zone where detection is ignored for low acoustic frequency, mm. To support D032 model recommend changing the value to 1500 mm.
INTERVAL_S	0.1	Time between measures, sec
FREQUENCY_HIGH_HZ	200000	High acoustic frequency, Hz
FREQUENCY_LOW_HZ	50000	Low acoustic frequency, Hz. To support D032 model change the value to 30000 Hz.
GAIN_HIGH_DB	0	Amplifying gain for high acoustic frequency, dB
GAIN_LOW_DB	0	Amplifying gain for low acoustic frequency, dB
MAX_SENSOR_ANGLE_DEG	10	Data filtering by tilt. The data are not recorded if the sensor tilt value is greater than the specified value, degree.
MIN_SENSOR_DEPTH_M	0.1	Data filtering by sensor dept in the water. Sensor depth is calculated as a difference between the length of the cable (set by CABLE_LENGTH_M parameter in the ECHOSOUNDER section) and current altitude. The data are not recorded if the sensor depth is lower than specified value, m.
MODE	NMEA	• **NMEA**: Ouptut data in NMEA format only • **ECHOSOUNDER**: Output data in NMEA and SEG-Y formats

PARAMETER	DEFAULT VALUE	DESCRIPTION
RANGE_HIGH_M	10	Measuring range for high acoustic frequency, m. Only fixed ranges are available: 1, 1.5, 2, 3, 5, 10, 15, 20, 30, 40, 50, 60, 70, 80, 90, 100, 120, 150, 200 meters
RANGE_LOW_M	10	Measuring range for low acoustic frequency, m. Only fixed ranges are available: 1, 1.5, 2, 3, 5, 10, 15, 20, 30, 40, 50, 60, 70, 80, 90, 100, 120, 150, 200 meters
RAW_LOG	false	Log the raw data from echosounder (used for debugging only)
SAMPLING_RATE_HZ	100000	Internal ADC sampling frequency, Hz. The sampling rate is relevant only for the ECHOSOUNDER mode. Only fixed ranges are available: 100000, 50000, 25000, 12500, 6250 Hz
SERIAL_DEVICE	**UgCS SkyHub 2**: /dev/ttymxc1 **UgCS SkyHub 3**: /dev/ttyAMA3	Serial device name. Default value depends on the UgCS SkyHub generation
TXLENGTH_HIGH_US	50	Transmitted pulse length for high acoustic frequency, microsecond
TXLENGTH_LOW_US	50	Transmitted pulse length for low acoustic frequency, microsecond

Gas Detector Configuration

Table 7.22 – Common gas detector settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[GAS_DETECTOR]		
MAX_CONCENTRATION_PPM	1000	Max gas concentration, PPM
MIN_CONCENTRATION_PPM	0	Min gas concentration, PPM
ZERO_LEVEL_PPM	0	Background gas concentration value to be subtracted, PPM

Pergam Laser Falcon Configuration

Table 7.23 – Pergam Laser Falcon settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[PERGAM_FALCON]		
FREQUENCY_HZ	2	Measuring frequency, Hz. Available values: 2 Hz, 1 Hz, or lower (see **Note** under the table)
SERIAL_DEVICE	/dev/ttyUSB0	UART serial device. The built-in Pergam Laser Falcon UART adapter is used.

Note: The Pergam Laser Falcon measures the methane concentration every 100ms, and a series of 5 measurements are combined into an average. The average and intermediate measurements are stored on the Pergam Laser Falcon board and can be sent upon request. The stored information is updated every 500 ms. The FREQUENCY_HZ parameter only sets the frequency of requests from SkyHub to the Pergam Laser Falcon, while the Pergam Laser Falcon continues to work according to its scheme.

Pergam LMm Configuration

Table 7.24 — Pergam LMm settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[PERGAM_LMM]		
FREQUENCY_HZ	2	Measuring frequency, Hz. Available values: 2 Hz, 1 Hz, or lower.
SERIAL_DEVICE	**UgCS SkyHub 2**: /dev/ttymxc5 **UgCS SkyHub 3**: /dev/ttyAMA1	UART serial device. Default value depends on the UgCS SkyHub generation

Metal Detector Configuration

Table 7.25 — Common metal detector settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[METAL_DETECTOR]		
MAX_OUTPUT_VALUE_MV	1000	Max output metal detector value, mV
MIN_OUTPUT_VALUE_MV	0	Min output metal detector value, mV

Geonics EM-61 Configuration

Table 7.26 — Geonics EM-61 settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[GEONICS_EM_61]		
BAUD_RATE	9600	RS232 baud rate, bps
BLUETOOTH_NAME	EM61MK2[^*]+	Bluetooth name of the device. May be a regular expression.

PARAMETER	DEFAULT VALUE	DESCRIPTION
CONNECTION_TYPE	RS232	Connection type: • **BLUETOOTH**: to connect through bluetooth • **RS232**: to connect through UART
EXTENDED_CSV_LOG	false	Log extended raw data to CSV position log with prefix `MD`
GAIN	HIGH	Defines the gain: • **HIGH**: High gain • **LOW**: Low gain
RAW_LOG	false	Log the raw data from metal detector (used for debugging only)
SERIAL_DEVICE	**UgCS SkyHub 2**: /dev/ttymxc1 **UgCS SkyHub 3**: /dev/ttyAMA3	RS232 serial device. Default value depends on the UgCS SkyHub generation

Conductivity Meter Configuration

Table 7.27 — Common conductivity meter settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[CONDUCTIVITY_METER]		
MAX_OUTPUT_VALUE_MS_M	500	Max altitude value, mS/m
MIN_OUTPUT_VALUE_MS_M	0	Min altitude value, mS/m

Geonics EM38-MK2 Configuration

Table 7.28 — Geonics EM38-MK2 settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[GEONICS_EM_38_MK2]		
BAUD_RATE	19200	UART baud rate, bps
BLUETOOTH_NAME	em38mk2[^*]+	Bluetooth name of the device. May be a regular expression.
CHANNEL_NUMBER	3	Channel number to display on the Conductivity widget in UgCS-CPM. Available values: 1-4. • **1**: conductivity (for 0.5 m in mS/m) • **2**: inphase (for 0.5 m in ppt) • **3**: conductivity (for 1.0 m in mS/m) • **4**: inphase (for 1.0 m in ppt)
CONNECTION_TYPE	RS232	Connection type: • **BLUETOOTH**: to connect through bluetooth • **RS232**: to connect through UART
SERIAL_DEVICE	**UgCS SkyHub 2**: /dev/ttymxc1 **UgCS SkyHub 3**: /dev/ttyAMA3	UART serial device. The USB-UART adapter is used. Default value depends on the UgCS SkyHub generation

Drop Messenger Configuration

Table 7.29 — Pergam Laser Falcon settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[DROP_MESSENGER]		
POWER_CYCLE_S	0.5	Flip payload power for time to release holder, sec.

Anemometer Configuration

Table 7.30 — Common anemometer settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[ANEMOMETER]		
MAX_WIND_SPEED_MPS	10	Max wind speed value, m
MIN_WIND_SPEED_MPS	0	Min wind speed value, m

FT Technologies FT742-SM Configuration

Table 7.31 — FT Technologies FT742-SM settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[FTTECHNOLOGIES_FT742_SM]		
BAUD_RATE	38400	UART baud rate, bps
SERIAL_DEVICE	/dev/ttyACM0	UART serial device. The USB-UART adapter is used.

Obstacle Detector Configuration

Nanoradar MR72 Configuration

Table 7.32 — Nanoradar MR72 settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[NANORADAR_MR]		
BAUD_RATE	115200	UART baud rate, bps
IGNORE_SIDE_SECTORS	false	Ignore side sectors during distance to obstacle definition
SERIAL_DEVICE	**UgCS SkyHub 2**: /dev/ttymxc1 **UgCS SkyHub 3**: /dev/ttyAMA3	UART serial device. Default value depends on the UgCS SkyHub generation

Magnetometer Configuration

QuSpin GEN2 Configuration

Table 7.33 — Magnetometer QuSpin GEN2 settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[ROS_MAGNETOMETER_QUSPINGEN2_0]		
ALTITUDE_SOURCE	v1:altimeter::0	ROS node choosen as an altitude source. The first connected altimeter will be used with the default value
BAUD_RATE	230400	UART baud rate, bps
DATALOG_DIR	/data/skyhub_logs	Where to create datalog file in filesystem
FILTER	OFF	Apply hardware filtration: ON or OFF
MAGNETIC_ENVIRONMENT	AVERAGE	Backgound magnetic noise level: LOW, AVERAGE or HIGH

PARAMETER	DEFAULT VALUE	DESCRIPTION
MASTER_MODE	OFF	Syncronize other QuSpin instances with this device. OFF for standalone or slave nodes. Only one device should be in master mode.
OFFSET_FORWARD_M	0	Coordinates correction based on sensor location. Offset from GNSS receiver.
OFFSET_RIGHT_M	0	Coordinates correction based on sensor location. Offset from GNSS receiver.
PAYLOAD_ID	192	Payload ID to show in Custom Payload Monitor widget.
SENSOR_DATA_RATE_MS	200	Samples rate in ms between samples.
SERIAL_DEVICE	/dev/ttyAMA3	Serial device name. Default value depends on the UgCS SkyHub generation
SLAVE_MODE	OFF	Syncronize this QuSpin instances with other device. OFF for standalone or master device. Multiple slaves may be guided by the single master.
VECTOR_MODE	OFF	Turn On or OFF vector mode of data reading.

GPS Receiver Configuration

Table 7.34 – GPS Receiver settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[GNSS]		
BAUD_RATE	115200	UART baud rate, bps

PARAMETER	DEFAULT VALUE	DESCRIPTION
DATE_FORMAT	yyyy/MM/dd	Data format in Position Log
PAYLOAD_ID	193	Payload ID to display value on the UgCS-CPM widget
SERIAL_DEVICE	**UgCS SkyHub 2**: /dev/ttymxc1 **UgCS SkyHub 3**: /dev/ttyAMA3	Device name. Default value depends on the UgCS SkyHub generation
TIME_FORMAT	HH:mm:ss.zzz	Time format in Position Log

Important: GPS Receiver loads settings from separate config file. See details in GPS Receiver Setup.

Outputs Configuration

GPS Output Configuration

Table 7.35 — GPS Output settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[OUTPUT_GPS]		
ADDRESS	**UgCS SkyHub 2**: /dev/ttymxc1 **UgCS SkyHub 3**: /dev/ttyAMA4	UART serial device. Default value depends on the UgCS SkyHub generation
BAUD_RATE	57600	UART baud rate, bps
FREQUENCY_HZ	5	Frequency of message sending. Only fixed ranges are available: 1, 2, 3, 4, 5 Hz.

ROS Bridge Configuration

Table 7.36 — ROS Bridge settings

PARAMETER	DEFAULT VALUE	DESCRIPTION
[ROS_BRIDGE]		

PARAMETER	DEFAULT VALUE	DESCRIPTION
LAUNCH	/etc/skyhub/default.launch	ROS launch script to start up nodes
LOGS_LEVEL	info	Detail level of log messages: INFO, ERROR, WARN, DEBUG
LOGS_PATH	/var/skyhub/logs	Where to create logs
ROS_ENV	/opt/ugcs/ros/galactic	Where to look for installed ROS framework
SDK_PATH	/opt/ugcs/skyhub-ros	Where to look for installed Skyhub SDK
MODULES_PATH	/var/skyhub/modules	Where to look for ROS packages for payloads
GROUND_LOG_MS	100	Threshold interval to send message to CPM
UI_MESSAGES	default	Which messages send to CPM UI. “all” or “important” only or “default” for all except unimportant

Guidelines for navigation values choosing

Skyhub provides a number of parameters that allow you to adjust the flight algorithms. This section provides a description of the expected impact of the provided parameters, but the specific values are entirely dependent on the user’s task and the actual conditions: wind speed, altitude, acceptable accuracy and required speed.

HORIZONTAL_ACCEL_MSS parameter

If the drone is heavy and it is important to maintain smoothness during acceleration and deceleration, it is better to set a value not exceeding 1 m/s2 at the waypoints. At the same time, long acceleration and deceleration can increase the total flight time, which will negatively affect the work productivity. The maximum value is 10 m/s2, but there is a possibility to run into the limitations of the autopilot/drone, as it may not be able to provide the specified speed and acceleration. That is, the target point will move ahead of the current position and the drone will have to catch up with it, exceeding the specified speed on the route. This is also true for stopping at a point: the drone can fly over it (overshoot).

VERTICAL_ACCEL_MSS parameter

There are two considerations of choosing the values of this parameter. First, the trajectories (smooth and continuous functions of time, twice differentiable) will be built based on the restriction on the allowable acceleration. Those, if the drone, while following the route, must descend or climb at the speed specified in the mission, then the speed will change smoothly according to this parameter. Secondly, the sudden change of the ground level in the Terrain Following flight mode will be smoothed out so that the acceleration does not exceed this value. This is an important point: if the acceleration is low, the drone can smooth out the trajectory too much before or after the obstacle. Therefore, for flying over water and a smooth surface, the acceleration value should be made in the region of 0.5 - 1 m/s2, and for flying over a relief surface, it is worth increasing the value of the parameter - up to about 2-3 m/s2. The exact value should be selected empirically.

YAW_RATE_DS parameter

The turn rate (Yaw) is smoothed by the PID controller before being passed to the flight controller. The value specified in this parameter will be close to the targeted, but may be less at the beginning and end of the turn maneuver.

VELOCITY_FEED_FORWARD parameter

Due to technical limitations, it is not possible to explicitly set the controller with exact acceleration value to decelerate or accelerate: to compensate, a value is transmitted slightly more or less than the targeted speeds so that the controller has time to provide more accurate trajectory following. With a well-performing autopilot (reacting quickly and clearly following speed targets), the value of the VELOCITY_FEED_FORWARD parameter should be close to or equal to 0. In some cases, it allows you to compensate for the drop in altitude during descent.

POS_P parameter

The higher the value, the more accurately the device follows the trajectory, but the higher the probability of oscillations. Horizontal oscillations look like pecks in the direction of flight. If the value is small, then the device moves unsteadily in a straight line or can serpentine or overshoot waypoints during StopAndTurn maneuvers.

POS_Z_P parameter

Higher values allow you to follow the target trajectory more closely, but may cause vertical oscillation. Vertical oscillations while descending look like fading and jumps with a characteristic sound (Bzz - bzzz - bzzz…). If the value is small, then the speed changes sluggishly and the obstacles avoiding can be very smooth and with a noticeable delay.

ACCEPTANCE_RADIUS_M parameter

If the distance between the current position of the drone and the target waypoint is less than the specified parameter, then the waypoint is considered reached. At the moment of reaching the notification of this event will be sent to the ground control station and the device can proceed to build a trajectory to the next point. If the reached point was the last one, then the device will keep the position inside the ball with the given radius.

LEAN_COMPENSATION parameter

The influence of the parameter increases with flight altitude increasing. At low altitudes, the difference lies within the altitude hold error.

Note: Please, contact our support team if additional informantion is required.

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