Vector™ & Scorpion™ Skynode™

User Manual

CONTENT

1. GENERAL INFORMATION 5
1.1 Abbreviations ... 7

2. SAFETY INTRUCTIONS 9
2.1 Operation ... 10
2.2 Battery Safety ... 11
2.2.1 Battery Handling ... 11
2.2.2 Battery Charging ... 11
2.2.3 Battery Storage ... 11
2.3 Disposal ... 12

3. CONTAINED COMPONENTS 13

4. SYSTEM OVERVIEW 19
4. System Overview ... 20

5. UNBOXING & TRANSPORT 21
5.1 Vector Backpack ... 22
5.2 Scorpion Backpack ... 24

6. ASSEMBLY, DISASSEMBLY & CHARGING 25
6.1 2-in-1 System ... 26
6.2 Smart Battery Setup ... 27
6.2.1 Smart Battery 120 ... 27
6.2.2 Smart Battery 180 ... 30
6.2.3 Pelicharger ... 32
6.2.4 Smart Battery: Buttons and functions ... 33
6.2.5 Multicharger ... 33
6.3 Vector ... 36
6.3.1 Balance Weight ... 37
6.4 Scorpion ... 38
6.5 Ground Control Station (GCS) ... 39
6.5.1 Silvus Handheld Setup ... 39
6.5.2 Silvus Stationary Setup ... 41
6.6 Ground Control Station ... 43
6.6.1 Connect to GCS ... 43
6.6.2 GCS Toughbook ... 44
6.7 Ground Control Station (GCS) ... 45
6.7.1 Add-On QS-Switch ... 45
6.7.2 Add-On Extension Cable 12 m ... 47
6.7.3 Video and KML Sharing ... 48

7. FLIGHT OPERATION 49
7.1 Vector ... 50
7.1.1 Take-off & Transition ... 51
7.1.2 Manual & Automatic Take-off Abort Scenarios ... 52
7.1.3 Mission, Emergency & Mission Commands ... 53
7.1.4 Warning Messages ... 54
7.1.5 Retransition & Landing ... 55
7.1.6 Hover Commands ... 56
7.1.7 Maximum Hover Time ... 57
7.1.8 GNSS denied mode ... 58
7.2 Scorpion ... 64
7.2.1 Take-off ... 64
7.2.2 Mission, Emergency & Mission Commands ... 65
7.2.3 Automatic Mission Coming Home ... 66
7.2.4 Landing ... 67
7.2.5 GNSS denied mode ... 68

8. MISSION OPERATION 69
8.1 User Interface ... 70
8.1.1 Main Menu ... 70
8.1.2 Header ... 72
8.1.3 Map Screen ... 74
8.1.4 Sensor Screen ... 76
8.2 Controlling the UAV and the Sensor ... 78
8.2.1 Overview ... 78
8.2.2 Controlling the UAV via Map ... 81
8.2.3 Controlling the UAV via Mission ... 81
8.2.4 Adjusting the time of the manual flight ... 93
8.2.5 Sensor settings ... 94
8.2.6 Controlling the UAV via Sensor Guidance ... 95
8.2.7 Controlling the Sensor via Joystick ... 96
8.2.8 Sensor via FPV Mode ... 96
8.2.9 Controlling the Sensor via Geo-Lock ... 97
8.2.10 Controlling the Sensor via Tracking ... 97
8.2.11 Multi-Pilot Control ... 97
8.3 Point of Interest (POI) ... 98
8.4 Integration into Battle Management System (BMS) ... 101
8.4.1 Kropya Plugin ... 102
8.4.2 Palantir Plugin ... 109

9. DATA-LINK HANDLING 111
9.1 Radio Frequency (RF) basics ... 112
9.2 General Knowledge Silvus Streamcaster ... 117
9.3 Establish a Datalink Connection ... 121
9.4 Solving Connection problems ... 127
9.5 Advanced Silvus Settings ... 128
9.6 Non standard connection possibilities ... 132

10. UPDATES, SETTINGS & POST-FLIGHT 135
10.1 Updating QBase ... 136
10.2 VS Ground Connection ... 136
10.3 Description of QOS ... 136
10.4 Updating QOS ... 137
10.4.1 Updating QOS via QBase ... 137
10.4.2 Updating QOS via Browser Interface ... 137
10.5 FlyLogs Download ... 139
10.5.1 Logging ... 140
10.6 Recordings Download ... 141
10.6.1 GCS Recordings Download ... 141
10.6.2 On-Board Recordings Download ... 142
10.7 Updating the Raptor Payload ... 144
10.7.1 TRIP2 Update Instructions ... 144
10.7.2 Raptor Camera Update Instructions ... 145
10.8 Updating the Smart Battery ... 148
10.9 VS Calibration ... 149
10.9.1 Calibrating the Magnetometer ... 149
10.9.2 Calibrating the Accelerometer ... 150
10.10 Exceptional Updating Procedures ... 151
10.10.2 Updating the ESC Firmware ... 152
10.10.3 Updating the PDB Firmware ... 153
10.10.4 Updating the PMBV Firmware ... 154

11. FAIL SAFE PROCEDURES 155
11.1 Barometric Failure ... 156
11.2 GNSS signal loss ... 156
11.3 Gyroscopic IMU Failure ... 156

11.4 Magnetomer Failure 157
11.5 Propulsion Stops 157

12. TROUBLESHOOTING 159
12.1 Error Messages & Notifications in QBase 160
12.2 Troubleshooting 166
12.2.1 Data Link Connection Troubleshooting 166

13. TECHNICAL SPECIFICATIONS 169
13.1 Vector (equipped with Smart Battery 120) 170
13.2 Vector (equipped with Smart Battery 180) 170
13.4 Scorpion 171
13.3 Gimbaled Sensor 171
13.5 Skynav Ground Control system 172
13.6 Toughbook Ground Control System 172
13.7 Data Link Handheld 172
13.8 Silvus Stationary 172
13.9 Smart Battery 120 172
13.10 Smart Battery 180 172

1. GENERAL INFORMATION

1.1 Abbreviations

Please read and follow these instructions carefully. All Quantum-Systems products are made for professional use only.

With the purchase of a Quantum-Systems product you agree with the terms and conditions. The applicable terms and conditions can be found at www.quantum-systems.com. These terms and conditions include regulations about liability and warranty.

Quantum-Systems GmbH reserves the right to make changes to specifications and product descriptions presented in this manual at any time without notice.

Applicable regulations
When using Quantum-Systems products always follow local aviation regulations. Regulations can vary depending on the country and the region where the product is operated. Inform yourself about the applicable laws before using a Quantum-Systems product.
"Beyond Visual Line of Sight" (BVLOS) operations might be prohibited depending on the country or area. In some areas, the use of UAVs is completely prohibited. Inform yourself about the privacy laws concerning the use of Quantum-Systems products equipped with cameras. The use of the products and the compliance of the regional laws is the operator's sole responsibility.

Technical support
For technical support please contact your sales agent.

C
Quantum-Systems GmbH declares that the products: Vector & Scorpion UAV are in conformity with the CE regulations.

Address
Quantum-Systems GmbH
Zeppelinstraße 18
82205 Gilching
Germany
www.quantum-systems.com

Document number: QS_VS_Skynode_UserManual_A5_V03
Release date: October 30th, 2023

Please always consider the current version of the digital manual. The applicability of this manual is restricted to the Skynode Vector, please msake sure this is the product in use. To check what version of the Vector is operated, check the sticker in Main.

1.1 Abbreviations

ACC	Acceleration
ADP	Air Data Probe
ADS-B	Automatic Dependent Surveillance–Broadcast
AGL	Altitude Above Ground Level
ALT	Altitude
ATO	Altitude Above Take-off
BFT	Beaufort Scale
BVLOS	Beyond Visual Line of Sight
ELV	Elevation (hight of ground above mean sea level)
EO	Electro-Optical (Visible Light)
ESC	Electronic Speed Controler
EVTOL	Electric Vertical Take-off and Landing
FLT	Flight Time
FPV	First Person View
GCS	Ground Control Station
GPS	Global Positioning System
ID	Identification
IMU	Inertial Measurement Units
Incl	Including
IR	Infra-Red
LAT	Latitude
LED	Light-Emitting Diode
LON	Longitude
MAG	Magnetometer
MSL	Altitude Above Mean Sea Level
PDB	Power Distribution Board
PMB	Payload Management Board
POI	Point of Interest
POS	Position Mode
RC	Remote Control
REEST	Reestablishing
RNG	Ground Range (Distance on Ground)
RTR	Retransition Waypoint
SBP	Smart Battery Pack
SR	Slant Range (Direct Distance)
STBY	Standby
QOS	Quantum Operating System
UAS	Unmanned Aerial System
UAV	Unmanned Aerial Vehicle
UDP	User Datagram Protocol
VTOL	Vertical Take-off and Landing

2. SAFETY INTRUCTIONS

2.1 Operation
2.2 Battery Safety
    2.2.1 Battery Handling
    2.2.2 Battery Charging
    2.2.3 Battery Storage
2.3 Disposal

2.1 Operation

1. Always follow the manual when using the system.
2. It is the user's responsibility to follow the laws that regulate the operation of UAS in the desired flying area. Flying out of the operator's sight might be prohibited depending on the local laws, please inform yourself.
3. Please always keep a safe distance from spinning rotors of at least 10 m (33 ft) to avoid risk of injury and damage of property.
4. Please keep a safe distance between the UAV and humans at any time to avoid any personal injury in the event of a crash.
5. In case of an emergency the user must be able to manually fly the UAV.
6. Do not fly or take off close to objects generating magnetic/electromagnetic fields (power lines, generators, antennas, transformers, etc.) as it may cause malfunction of the GPS and/or the magnetic field sensors.
7. Do not fly or take off close to objects containing large amounts of metal or carbon fiber (parking decks, buildings of reinforced concrete, ships, cars or other machines) as it may cause malfunction of the GPS and/or the magnetic field sensors.
8. Always ensure proper GPS coverage of the UAV. Do not fly in narrow canyons as it may cause malfunction of the GPS and/or the magnetic field sensors.
9. Make sure no large obstacles (buildings, trees, mountains, etc.) or objects generating or blocking electro-magnetic radiation (antennas, fences, power lines, etc.) are between the transmitter / GCS and the UAV during the whole time of operation.
10. The aircraft must not be operated
- at temperatures below -12 °C (10.4 °F) and above 50 °C (122 °F).
- in heavy rain or snowfall.
- In Icing-conditions
- at windspeeds above 12 m/s (23.3 kn) (See chapter 3.1.). Please note that the wind speed on the ground is always less than the wind speed at flight altitude.

11. Transportation of the system is recommended in the original Quantum-Systems transportation box.
12. The use of third party products, such as batteries, chargers, ground modems, ground control stations, which were not provided by Quantum-Systems, is prohibited. Any modification to the system is prohibited unless expressly authorized by Quantum-Systems or an authorized reseller.
13. Due to the risk of an electric shock, do not disassemble any Quantum-Systems products. For repair and maintenance work always contact your sales agent.
14. Each operator is responsible for ensuring the airworthiness of the UAV.
15. The UAV does not detect and avoid obstacles. Every operator is responsible to plan a flight path that is free of obstacles.
16. Do not fly with detached gimbaled sensor.
17. The equipment is for professional use only. It must not be operated by children.
18. Use only those batteries specified by Quantum-Systems
19. The UAV and its ground-equipment must be stored inside its transport box when not in use. The safety of the vehicle is not affected by UV radiation within the usual exposure time when handled accordingly.

2.2 Battery Safety

To avoid fire, serious injury and property damage observe the following safety guidelines when using, charging or storing the UAV battery packs.

2.2.1 Battery Handling

1. Do not take-off with State of Charge below 50 %.
2. Do not use or charge swollen, leaky, or damaged batteries.
3. Do not use a battery that was involved in a crash or any kind of heavy impact.
4. The temperature of the battery pack must be within the operating temperature range: 20 – 40 °C (68 – 104 °F). Initiate the self-heating function by pressing and holding the button for 5 seconds.
5. Do not expose the battery pack to direct sunlight. Temperatures over 70 °C (158 °F) may damage the battery pack. To prevent malfunction of the battery, never fly the UAV in strong electrostatic or electromagnetic environments.
6. Do not expose the battery to water. Replace the battery pack if exposed to water.
7. If your eyes or skin make contact with any battery chemicals, immediately wash the affected area with clean running water for at least 15 minutes. See a doctor immediately.
8. Do not place the UAV battery packs in a microwave, dryer, oven or in a pressurized container. Do not solder on or close to a UAV battery pack. Do not place the battery pack near a cooking surface, iron or radiator.
9. Do not drop the battery pack. Do not step on it.
10. Never open or modify the battery pack. Do not short circuit the battery.
11. The battery life may be reduced if it is not used regularly.
12. Avoid touching the battery pack surface directly after the flight. HOT! RISK OF BURNS!
13. Never disassemble, puncture, shock, incinerate, or heat the battery pack over 70°C (158 °F).

2.2.2 Battery Charging

1. To charge the battery follow the guideline as described in this manual.
2. Always use the original battery charger to charge the battery packs. Quantum-Systems is not responsible or liable for damages caused by charging the battery with a third-party charger.
3. **Only charge the batteries at ambient temperatures of 5 °C to 30 °C (41 °F - 86 °F).**
4. Never connect the battery packs to a wall socket or to car charger outlets directly.
5. The battery must be charged under supervision. Never charge the battery pack close to flammable materials or on flammable surfaces.
6. Disconnect the battery when it is fully charged.
7. Do not clean the charger with flammable liquids like denatured alcohol.
8. Never use a damaged charger.

2.2.3 Battery Storage

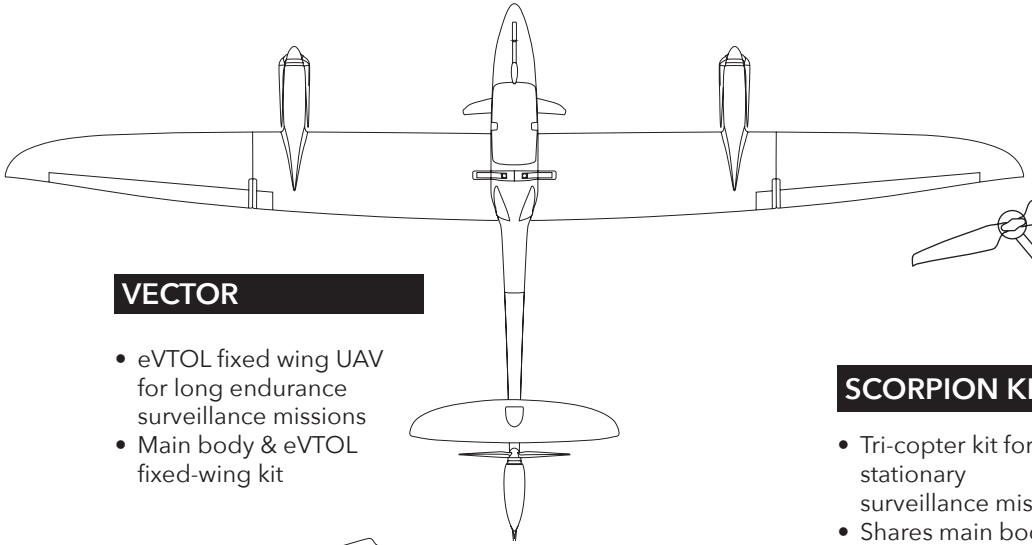
1. Keep the battery out of reach of children and animals. Do not leave the battery near heat sources such as furnaces or heaters.
2. **Always store the battery at proper ambient temperature: Storage less than 3 months: -20 °C to 45 °C (-4 °F to 113 °F) Storage more than 3 months: 22 °C to 28 °C (72 °F to 82 °F).**
3. Always keep the battery dry. Do not expose the battery to water.
4. Never attempt to travel with or transport a damaged battery or a battery with a power level higher than 25 %.
5. Do not store the battery completely discharged.
6. Always remove the battery from the UAV when it is not in use.
7. Always apply the contacts protection cap if the battery pack is not in use.

2.3 Disposal

For the disposal of the battery packs, follow the local regulations for the recycling of Li-Ion batteries. Do not dispose the battery pack with the normal trash. Make sure the battery is completely discharged before the disposal.

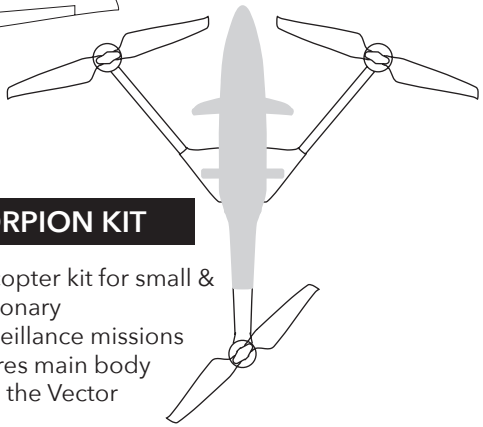
Before disposal apply the protection caps to the contacts. Never put the battery pack into fire due to the risk of an explosion. The battery can also be sent back to an official reseller or to Quantum-Systems. Dispose all Quantum-Systems products according to the local regulations for the recycling of electronic or electrical devices. The outer wings and the elevator of the UAV can be disposed along with plastic waste.

3. CONTAINED COMPONENTS



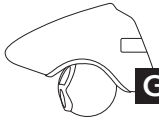
VECTOR

- eVTOL fixed wing UAV for long endurance surveillance missions
- Main body & eVTOL fixed-wing kit



SCORPION KIT

- Tri-copter kit for small & stationary surveillance missions
- Shares main body with the Vector



GIMBALED SENSOR

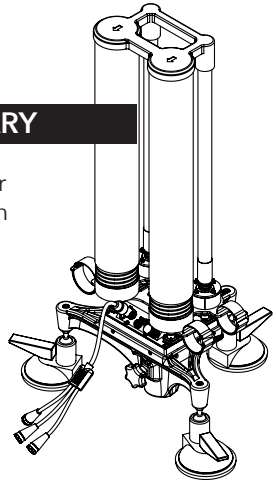
Gimbaled sensors
- Option 1: HD40-LV
- Option 2: Raptor

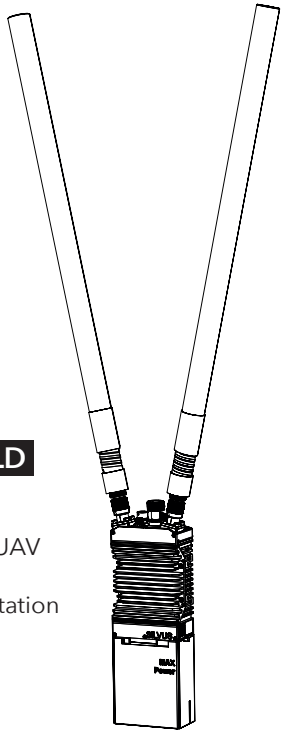
SKYNAV GROUND CONTROL DEVICE AND/OR RUGGED LAPTOP

- Incl. QBase Tactical software for mission planning & mission controlling
- Incl. power cable
- Incl. connection Cable

SILVUS STATIONARY

- Stationary modem for 35 km range between data link & the UAS
- Incl. power cable

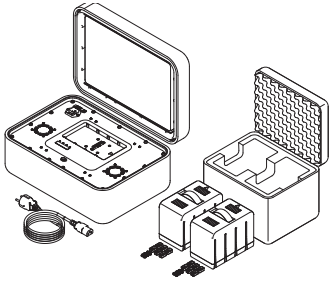




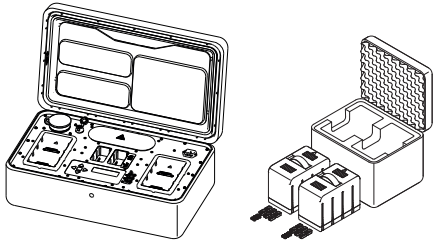
DATA LINK HANDHELD

- Modem for 15 km range between data link & the UAV
- Incl. connection Cable
- Incl. battery & charging station

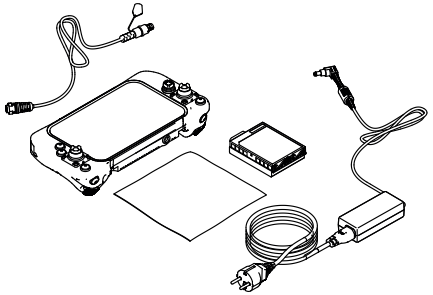
SMART BATTERY STARTER SET 120



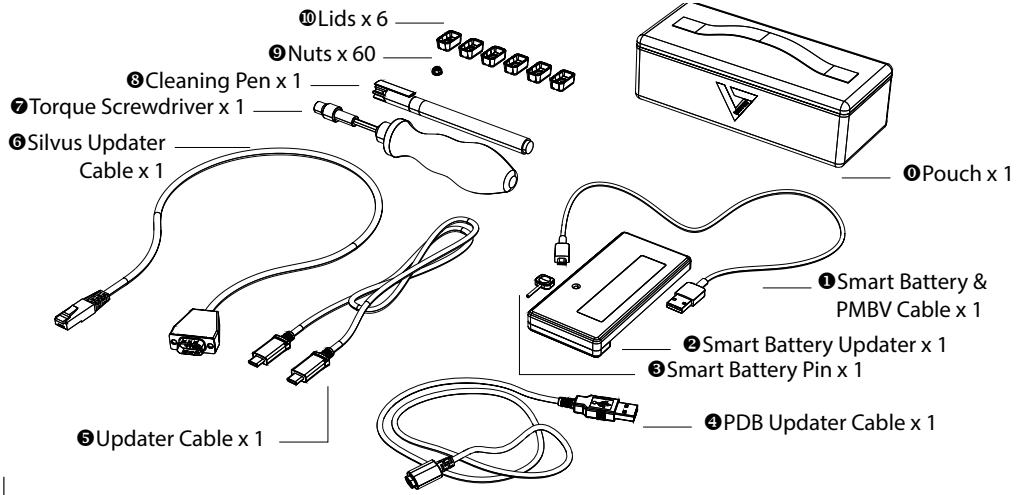
SMART BATTERY STARTER SET 180



SKYNAV GROUND CONTROL SET

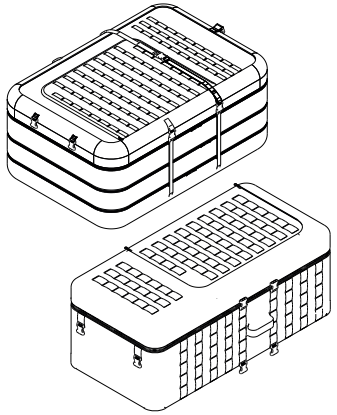


STANDARD ACCESSORIES KIT



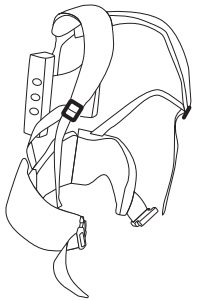
TRANSPORT CASE

- Available for Vector & Scorpion



ADD-ONS

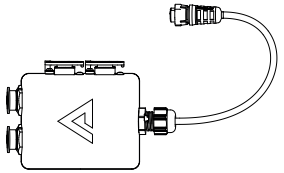
BACKPACK STRAPS



DIRECT CONNECTION SKYNAV TO HANDHELD

DATALINK EXTENSION CABLE

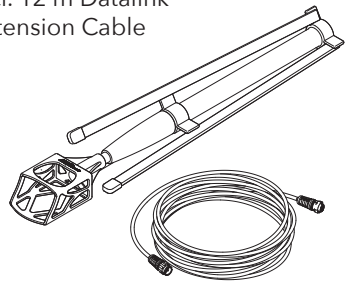
RUGGED DATALINK SWITCH



SILVUS HANDHELD MOUNT

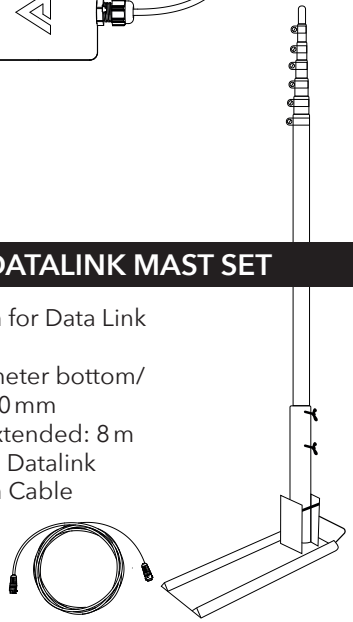
SILVUS HANDHELD TRIPOD

- Compatible with silvus Handheld only
- Incl. 12 m Datalink Extension Cable



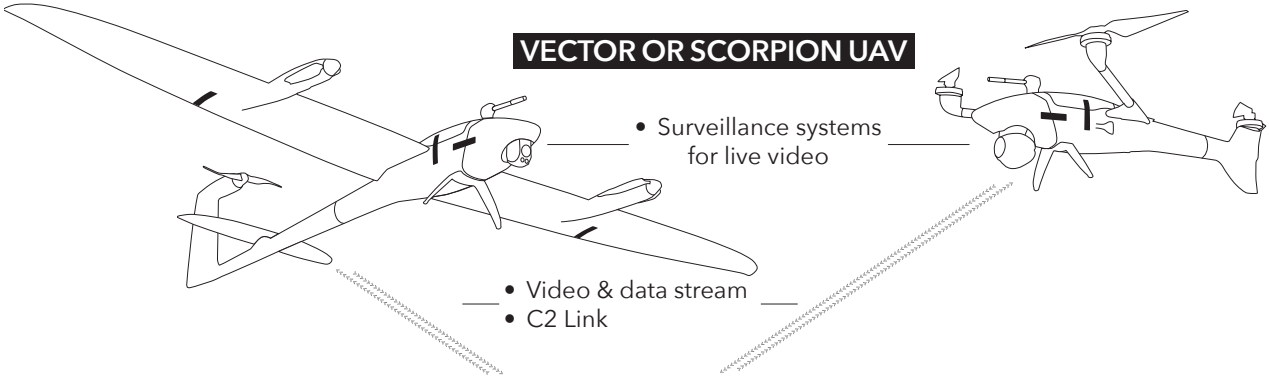
SILVUS DATALINK MAST SET

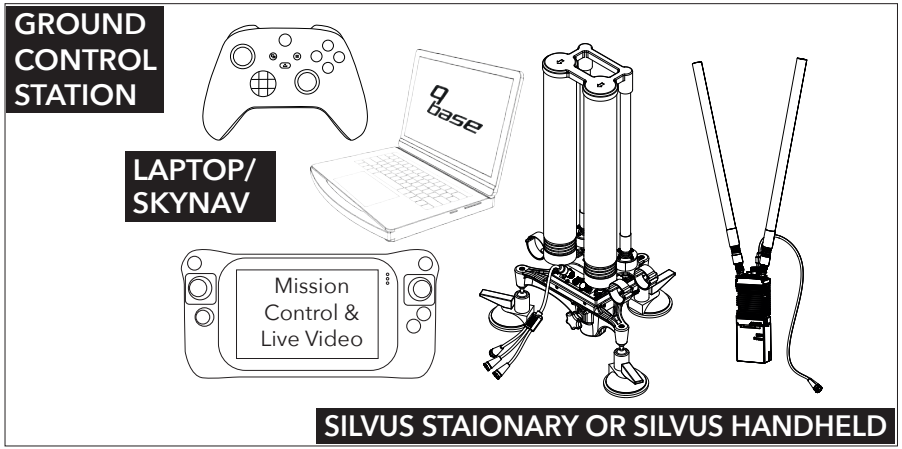
- Extension for Data Link Station
- Pipe diameter bottom/ top: 60/40 mm
- Length extended: 8 m
- Incl. 12 m Datalink Extension Cable



4. SYSTEM OVERVIEW

4. System Overview





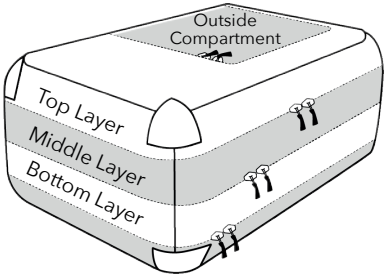
5. UNBOXING & TRANSPORT

5.1 Vector Backpack
5.2 Scorpion Backpack

5.1 Vector Backpack

The backpack is suitable for transporting all components that are required for a flight. The battery packs must be carried in an extra bag.
Please unpack in the following order.

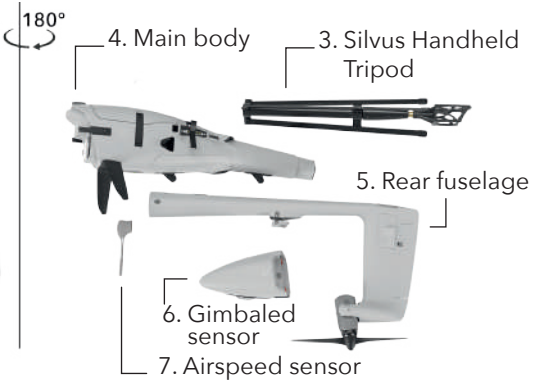
Layer Overview



Outside Compartment

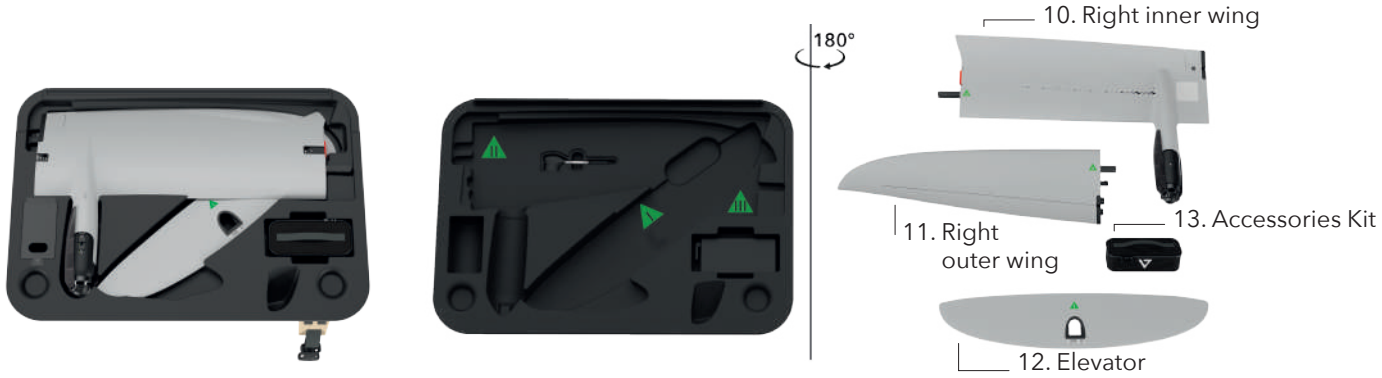
1. Skynav Ground Control device / Toughbook & Controller
2. Silvus Handheld

Middle Layer



Top Layer

Bottom Layer

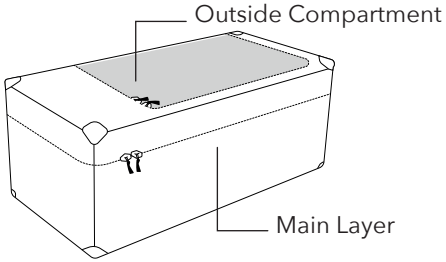


Please follow the reverse order for packing and note that each part has a symbol corresponding to the symbol in the transportation box.

5.2 Scorpion Backpack

The backpack is suitable for transporting all components that are required for a flight.
The battery packs must be carried in an extra bag.
Please unpack in the following order.

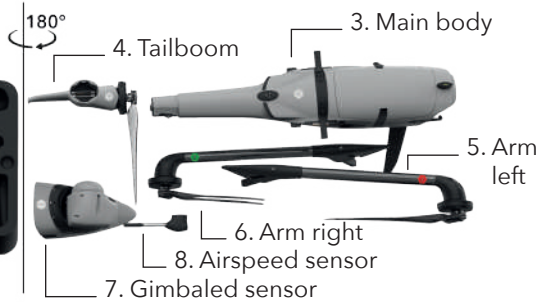
Layer Overview



Outside Compartment

1. Skynav Ground Control device
2. Silvus Handheld

Main Layer



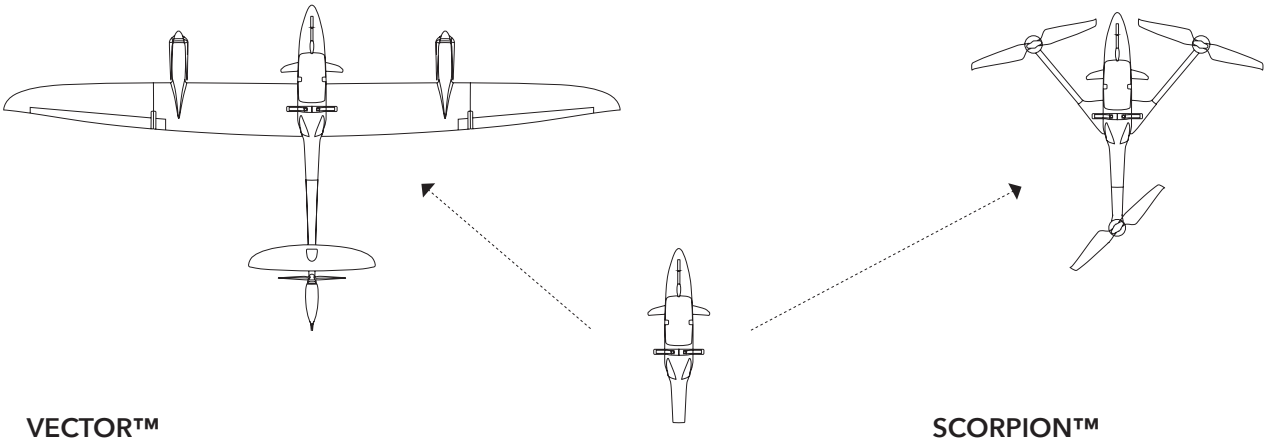
Please follow the reverse order for packing and note that each part has a symbol corresponding to the symbol in the transportation box.

6. ASSEMBLY, DISASSEMBLY & CHARGING

6

6.1 2-in-1 System
6.2 Battery Setup
    6.2.1 Smart Battery 120
    6.2.2 Smart Battery 180
    6.2.3 Pelicharger
    6.2.4 Smart Battery: Buttons and functions
    6.2.5 Multicharger
6.3 Vector
6.4 Scorpion
6.5 Ground Setup
    6.5.1 Silvus Handheld Setup
    6.5.2 Silvus Stationary Setup
6.6 Ground Control Station
    6.6.1 GCS Skynav
    6.6.2 GCS Toughbook
6.7 Ground Network Extensions
    6.7.1 Add-On QS-Switch
    6.7.2 Add-On Extension Cable 12 m
    6.7.3 Video and KML Sharing

6.1 2-in-1 System



VECTOR™

- Take-off weight: 8.5 kg / 18.7 lb
- Wingspan: 2.80 m / 9.2 ft
- Lenght: 1.50 m / 4.9 ft

CENTERPIECE
(Main body)

- EO / IR gimbal
- Mesh IP encrypted data link
- Quantum-Skynode

SCORPION™

- Take-off weight: < 8 kg / 17.6 lb
- Wingspan: 1.37 m / 4.5 ft

6.2 Smart Battery Setup

6.2.1 Smart Battery 120

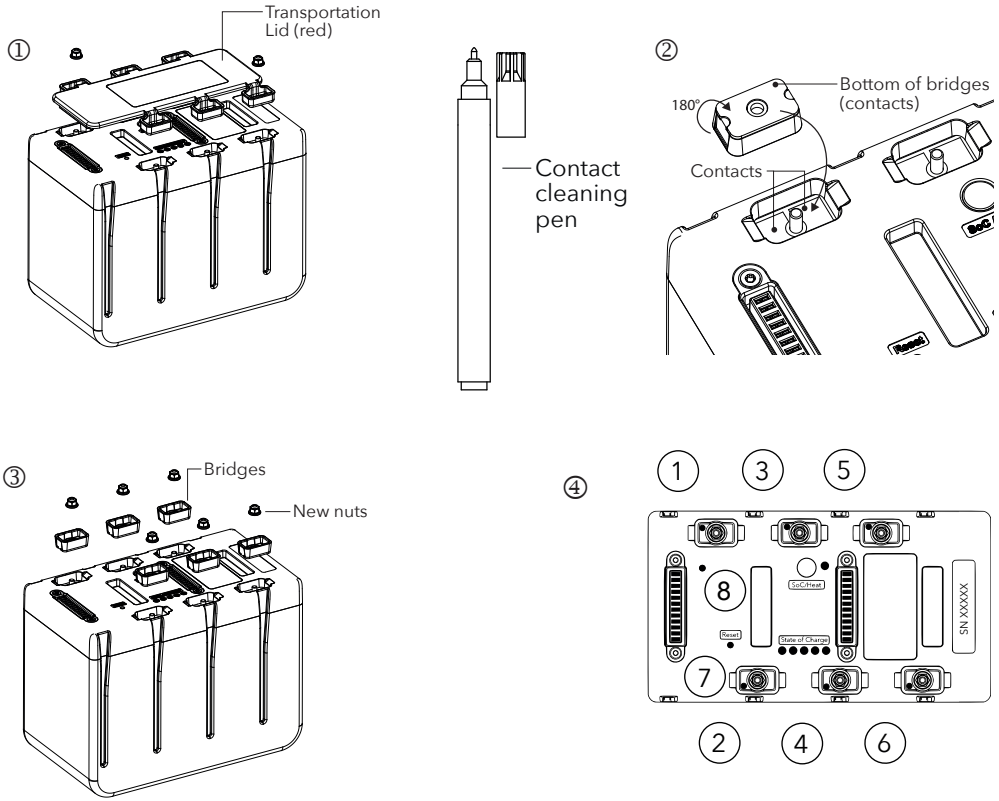
The QS Smart Battery 120 is a Vector/Scorpion custom designed Li-Ion power source. It will enable you to maximize the performance and safety of your Vector/Scorpion missions with up to 120 min. of flight time for Vector.

Transport configuration and operational mode
You will receive your Smart Battery in transport configuration. This ensures the battery can travel safely and follow transport regulations by physically splitting it into modules of less than 100 Wh.

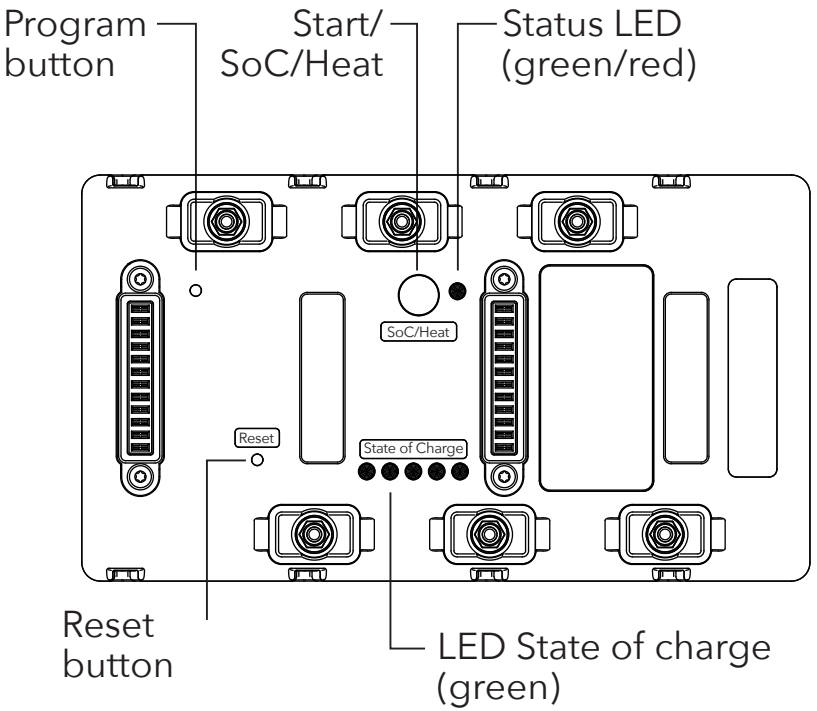
To be able to use the Smart Battery it must be set to operational mode:
1. Unscrew the 2 nuts and remove the red Transportation Lid ①.
The self-locking nuts may not be used twice!
2. Use the contact cleaning pen to clean the contacts of the six bridges and the contacts of the battery ②.
3. Insert the 6 Smart Battery bridges into the slots. Use new nuts to screw the bridges back on ③ (use the included 0.9 Nm torque wrench).
4. When assembling the bridges, follow the order on ④.
5. Press the reset button and the program button on the bottom of the battery with the reset pin.
6. The Status LED will start flashing for 60 seconds.
7. Press the Start-Button before inserting the battery into the aircraft. The battery will turn off after 60 seconds if not installed.

Note: If you are planning to send a Smart Battery simply remove the bridges, re-install the red Transportation Lid and do not forget to send the bridges in the package.

The Vector package includes 60 self-locking nuts to ensure 10 Smart Battery bridge assembly/disassembly cycles.
The self-locking nuts must not be used twice!
The cleaning process is always necessary after removing the red Transportation Lid and before assembling the bridges.



Note: When using the 120 version, pleas insert the 120 Trim Weight into the Rear as described in chapter 6.3.1.


Program button
Start/ SoC/Heat
Status LED (green/red)
SoC/Heat
Reset
State of Charge
Reset button
LED State of charge (green)

6.2.2 Smart Battery 180

The QS Smart Battery 180 is a Vector/Scorpion custom designed LiPo power source. It will enable you to maximize the performance and safety of your Vector/Scorpion missions with up to 180 min of flight time for Vector.

Note: The Smart Battery 180 does not comply with IATA regulations on the 100-Wh limit in civil aviation.

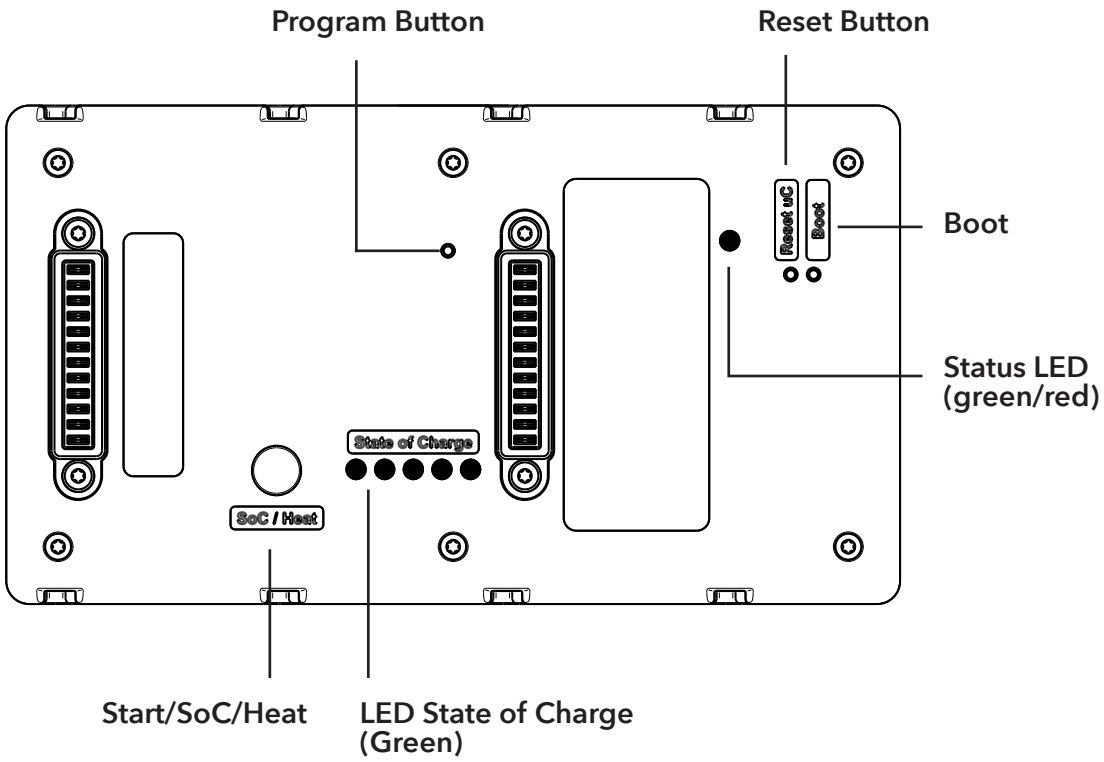
Operational procedures:

1. Press "SoC/HEAT" button to "wake-up" the battery pack.
2. "Status Led" blinking green/red: battery is "awake".
3. "5-LED State of charge" static lights: shows the SoC.
4. If one LED of the "5-LED State of charge" is blinking: SoC very low.
5. Insert into the battery tray of the main body after "wake-up" to be ready to flight.

Note: when using the 180 version, please insert the 180 Balance Weight into the Rear as described in chapter 6.3.1.

Heating:

1. If the "SoC/HEAT" button is pressed and held for >2 seconds, the battery will heat the cells to 30° C.
2. "5-LED State of charge" running light: displays heating in progress.


Program Button
Reset Button
Reset uC
Boot
Boot
Status LED
(green/red)
State of Charge
SoC / Heat
Start/SoC/Heat
LED State of Charge
(Green)

6.2.4 Smart Battery: Buttons and functions

State of Charge (SoC) Indicator

5 LEDs with 20 % increments show the SoC of the SMP from 0 – 100 %.
Press the Start/SoC/Heat button on the bottom of the battery and a SoC will light up.

Current battery level					
LED 5	LED 4	LED 3	LED 2	LED 1	Status
○	○	○	○	●	20 %
○	○	○	●	●	40 %
○	○	●	●	●	60 %
○	●	●	●	●	80 %
●	●	●	●	●	100 %

Legend	
Symbol	Explanation
○	LED is off
●	green LED is permanently lit

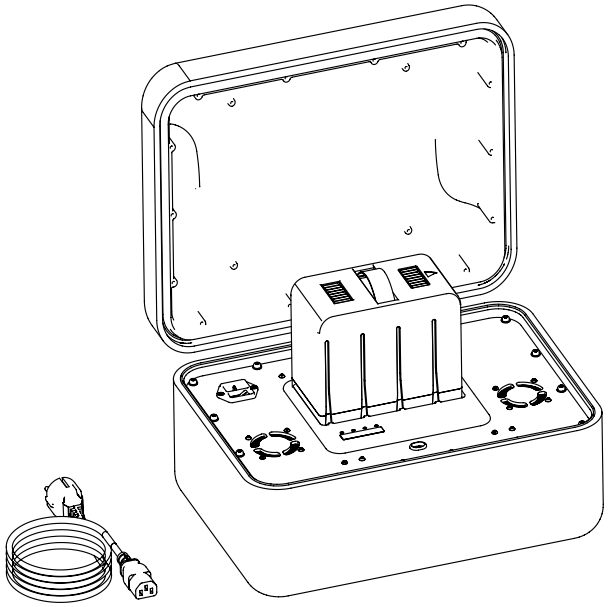
Manual pre-heating function

The Smart Battery automatically heats up as soon as it is connected to the UAV. As it is safety relevant the UAV will not allow the preflight check if the battery temperature is below its operational temperature.
In order to reduce the automatic on-site heating time it is recommended to pre-heat the battery when flying at ambient temperatures below 16 °C (61 °F).
1. Press and hold down the button on the bottom of the battery for more than 8 seconds (>2 sec for SBP 180).
2. The SoC LEDs will flash alternated with a red one until the battery reaches optimal operation temperature.
3. The heating will stop automatically (LEDs will stop flashing).

6.2.3 Pelicharger

1. Connect the Pelicharger to a power source (110 – 230 V AC).
2. Flip the power switch to turn on the charger. Three LEDs will light up indicating the charger is trying to detect a battery to charge. A green LED indicates the charger is powered. A yellow LED (Charging) and a green LED (Full) are flashing alternately.
3. Press the Start/SoC-button to activate the battery.
4. Insert the Smart Battery into the charging mount, matching the arrow direction of the battery and the charging station. The yellow flashing LED indicates the battery is charging.
5. Once the yellow flashing switches to permanently green the charging is completed. Charging time: 1 – 1.5 hours.
6. The battery can be removed by pulling the handle and the station can be turned off.

NOTE: If the charger is powered for too long without a battery, a red (error) light will flash. If this is the case turn off the charger, wait 20 seconds, turn it back on and repeat from step 2.



6.2.5 Multicharger

The Multicharger unit is capable of charging all the equipment required for a Vector mission.
It features:

- 2 Smart Battery charging slots (compatible with both SmartBattery 120 and SmartBattery 180)
- 2 Silvus battery charging slots
- 2 USB ports for charging of mobile devices
- 1 Toughbook charging cable.

Charging process of the Smart Batteries
To charge the Smart Batteries, the steps to be followed are:

1. Connect Multicharger by either a NATO socket or a standard wall plug (230V or 110V).
2. Power on Multicharger using the switch on the top left.
3. Insert the batteries. If multiple batteries are connected, the battery with the higher charging level will be charged first.
4. When a battery is charging, it is possible to interrupt the charging process by either disconnecting the battery, or by pressing the button. To restart the charging process, simply press the button.
5. When a battery is fully charged, an audible notification sound will be played to indicate completion of the charging process, and the status on the display will indicate “Full”.
6. Disconnect the battery.

Display interface

-Charge:
The CHARGE display shows the state of charge of the batteries, charging current and charging status.

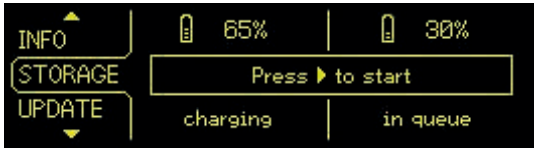
-Info:
The INFO display shows battery details of all connected batteries, such as the serial number, firmware version, charging cycles, cell voltages and temperature.

-Setup:
Brightness.

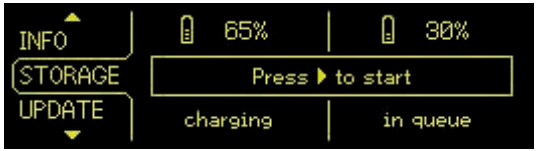
Volume

Stealth Mode, When stealth mode is enabled, it will become active after next Multicharger startup. Very basic interface with minimal light and sound emission that only allows battery charging

Press any button to quit stealth mode.



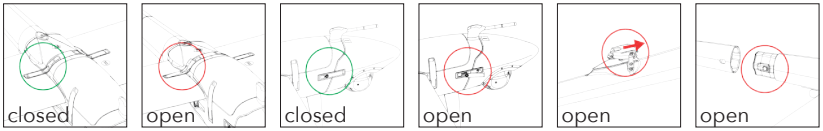
-Storage:
Storage mode (dis)charges batteries to recommended storage voltage to comply with international air transport regulations.



-Logging:
Export the charging logs to a USB drive.

6.3 Vector

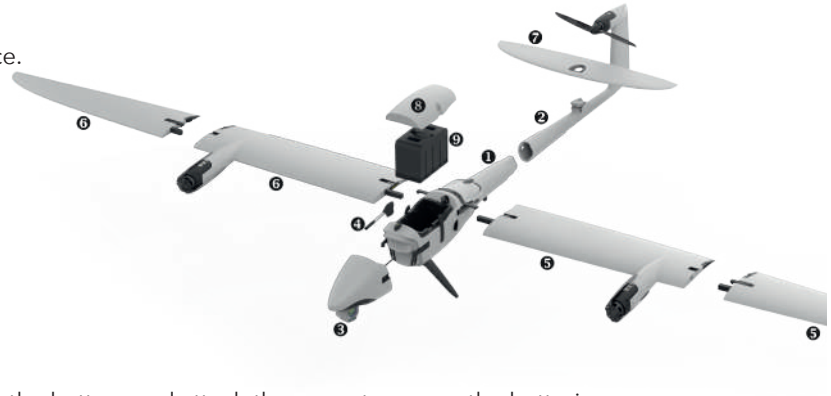
Lock Mechanism
All connections between the UAV parts are secured by the Vector/Scorpion lock mechanism. When connecting please make sure that the lock mechanism is in place.



1. Open the connector by gently pushing the shown button.
2. Connect the two parts and insert the connection hook into the corresponding mount.
3. Secure the connection by locking the mechanism. An audible click is noteable when the mechanism is in place.
4. If the elevator or the rear is not connected correctly, this will be indicated on the QBase and the take-off will be interrupted.

Assemble/Disassemble

Backpack Middle Layer
❶ Place the main body on a level and stable surface.
❷ Attach the rear fuselage.
❸ Attach the gimbaled sensor.
❹ Attach the air data probe.



Backpack Top Layer
❺ Attach the left inner- and outer-wing.

Backpack Bottom Layer
❻ Attach the right inner- and outer-wing.
❼ Attach the elevator.
❽ Remove the battery cover.
❾ Press the Start Button of the Smart Battery. Insert the battery and attach the cover to secure the batteries. The Vector will power automatically.

6.3.1 Balance Weight

The Balance Weight in the Rear of the Vector is necessary for adjusting the centre of gravity with different payloads or batteries.

Check before each flight if the corresponding Balance Weight for battery and payload is inside.

Change of the Balance Weight:

1. Push the small lever of the Balance Weight to unlock it and pull it out of the insert.
2. Choose one Balance Weight depending on the Battery and Sensor setup chosen for the mission. Please compare with the configurations table.
3. Compare the writing of the Balance Weight with the selected setup of payload and battery.
4. Slide the corresponding Balance Weight into the slot until you hear a "click".

Note: if the Balance Weight is wrong or missing, the launch will not be possible a notification will be displayed in QBase as listed in chapter 12.1.

	SMART BATTERY 120	SMART BATTERY 180
Sensor Raptor	Balance Weight 120	Balance Weight 180
Sensor HD40-LV		

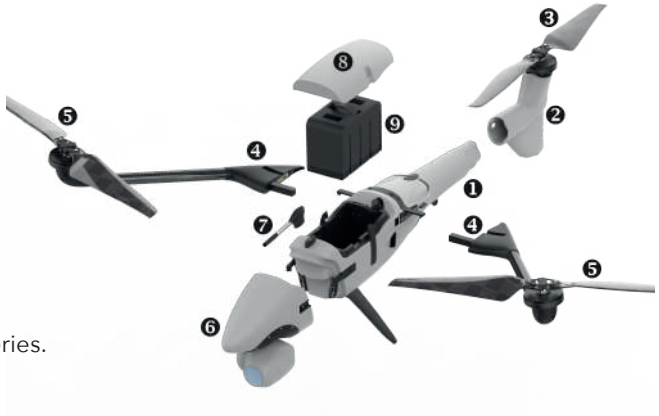
6.4 Scorpion

Lock Mechanism

All connections between the UAV parts are secured by the Vector/Scorpion lock mechanism.
When connecting please make sure that the lock mechanism is locked properly. An audible click is noteable when the mechanism is in place.
For detailed description see 6.3.

Assemble/Disassemble

❶ Place the main body on a level and stable surface.
❷ Attach the rear fuselage.
❸ Unfold the propellers until they are in line.
❹ Attach the arms left and right.
❺ Unfold the propellers until they are in line.
❻ Attach the gimbaled sensor.
❼ Attach the air data probe.
❽ Remove the battery cover.
❾ Press the Start-Button of the Smart Battery.
Insert the Smart Battery and attach the cover to secure the batteries.
The Scorpion will power on automatically.



6.5 Ground Control Station (GCS)

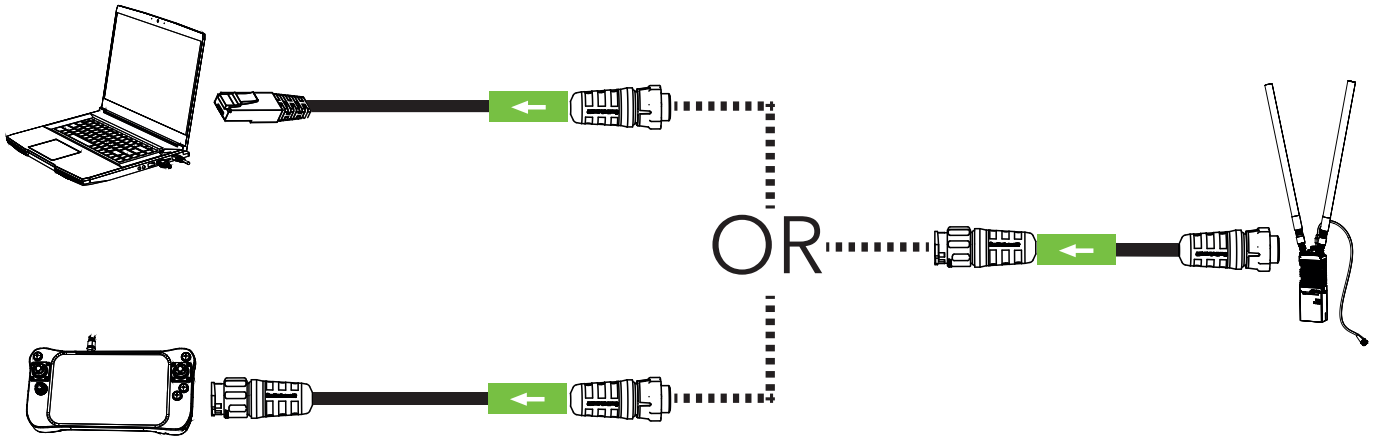
The ground setup is composed by GCS and Datalink. There are different configurations how they can be connected, depending on the situation and the needs of the mission. Every GCS and Datalink delivered by Quantum Systems has its own connection cable. All these are compatible with each other since the same port is always used. The connector is called Switchcraft and allows to connect different Add-Ons in between to extend the functionalities of the system.

Ground Wiring Rule

All connection cables for the ground setup have at least one Switchcraft connector, that is highlighted with a white/green arrow label. To connect the cables just follow the arrow! The arrows are always going from the Datalink to the GCS as illustrated above.

6.5.1 Silvus Handheld Setup

Connect to Datalink



1. Connect the Silvus Handheld Cable to the Silvus Handheld Streamcaster by aligning the two red dots of the connectors (A).
2. Connect the Switchcraft connectors by aligning the arrows as shown in the illustration.

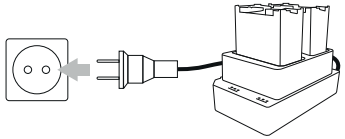
Note: Either the Laptop or the Skynav cable can be connected.

3. Connect the GCS cable to the GCS.
4. Power the GCS and start QBase Tactical.
5. Power the Silvus Handheld by turning the switching the Mode Switch on the top of it on the same channel selected on the Mode Switch of the Main and follow chapter 9.1.1.

Tip: When controlling/monitoring the UAV without tripod it is possible to insert the Handheld into the corresponding slot on the top of the backpack.

Charging

1. Make sure the battery is disconnected from the Handheld main part.
2. Connect the power supply to the charger.
3. Connect the power cord to the power supply and to a wall socket.
4. Insert up to two batteries into the charger.
5. The charging process will start automatically.
6. The successful charging process is indicated by permanently lit green LEDs.

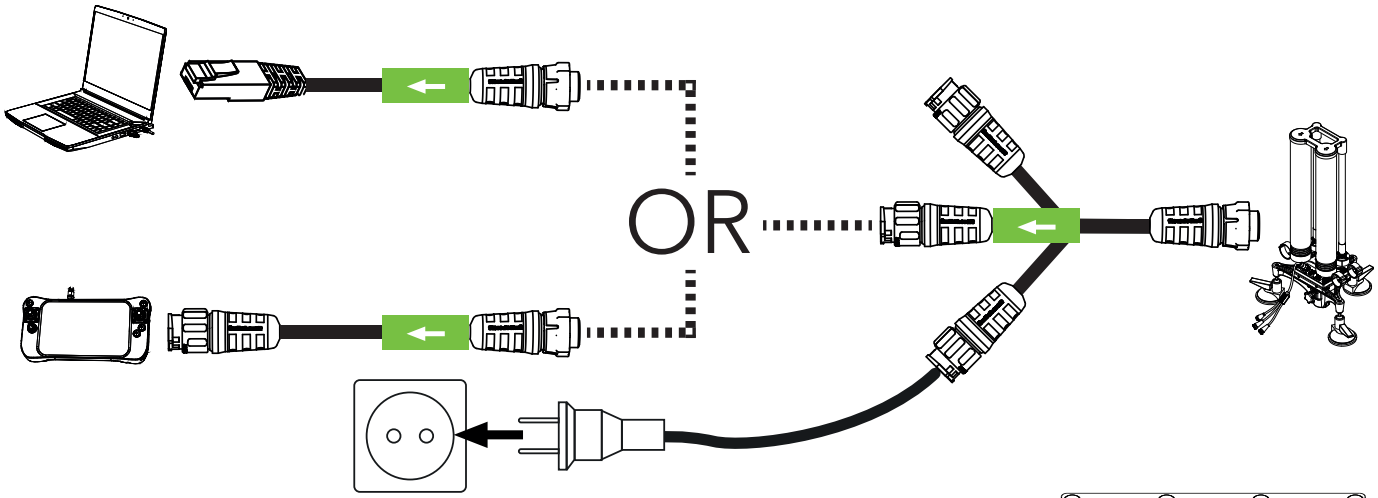


Assemble/Disassemble

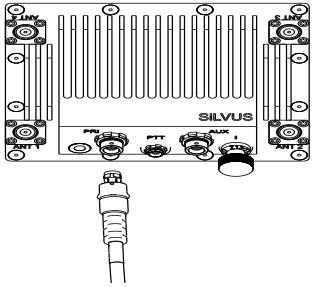
If the Handheld is not already assembled please follow these steps:
1. Remove the (yellow) caps from the antenna connectors on the top side of the main part.
2. Connect both antennas to the Handheld main part. Lock them with the screw –lock mechanism.
3. Connect the battery to the Handheld main parts. Lock it by the twist–lock mechanism.

6.5.2 Silvus Stationary Setup

Connect to Datalink



1.Connect the Silvus Stationary Cable to the Silvus Stationary Streamcaster by aligning the two red dots of the connectors.

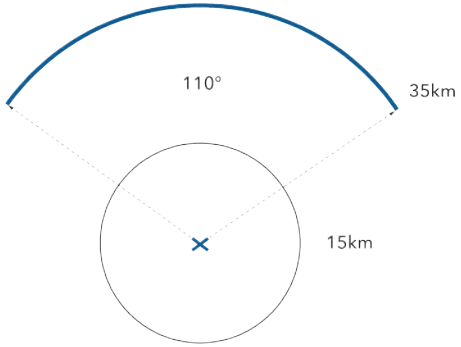


2. Connect the Switchcraft connectors by aligning the arrows as shown in the illustration.

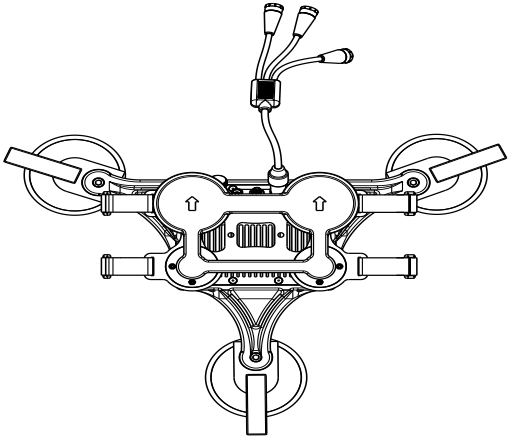
Note: Either the Laptop or the Skynav cable can be connected.

3. Connect the GCS cable to the GCS.
4. Power the GCS and start QBase Tactical.
5. Connect the Power Supply connector of the 3-Split Cable of the Stationary to the power supply.
6. Connect the Power Supply to a power outlet.
7. Power the Silvus Stationary by turning the switching the Mode Switch on the top of it on the same channel selected on the Mode Switch of the Main and follow chapter 9.1.1.

Note: For maximum range, please turn the arrows on top of the antennas towards the flight area. The two larger antennas with the arrows are directional antennas with an antenna sector of 110°. The two smaller antennas are omnidirectional antennas to ensure good link coverage in the vicinity.



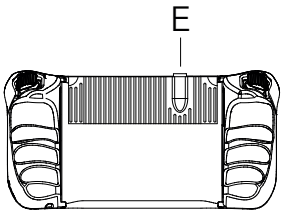
*Line of sight, 500m AGL,
no objects in fresnel zone



Assemble/Disassemble

The Silvus Stationary is preassembled and ready-to-use. It is not powered by batteries but needs to be connected to a power socket. It is recommended to set it up on a smooth surface (e.g. car roof) or on the Quantum Systems Mast Set.

6.6 Ground Control Station



The Setup on the Ground is described in chapter 6.5. To connect and use properly the GCS please follow the following chapters. The use of the QBase Tactical C2 software is the same on all GCS of Quantum Systems.

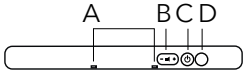
6.6.1 Connect to GCS

Turn on and first configuration

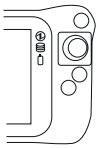
1. Connect the wirings as described in chapter 6.5.
2. Connect the Skynav Cable connector to the Skynav by aligning the two red dots of the connectors (E).
3. Turn on the Skynav by pressing and holding the power button (C) until the power indicator (icon) lights up.

Charging

1. Conect the power cord to the Skynav.
2. Connect the power cord to a power outlet.
3. The charging process will start automatically.



A: Microphone
B: Volume button
C: Power button
D: Rotation Lock button



LED indicators
Power indicator
off: Power off
green: Power on,
flashing green: sleep.
Drive status
Battery status

6.6.2 GCS Toughbook

Connect to GCS

1. Connect the wirings as described in chapter 6.5.
2. Connect the Laptop Cable to the ethernet port of the laptop.
3. Turn on the Laptop by pressing the power button under the screen.
4. Open QBase Tactical and connect the Controller via USB cable.

Charging

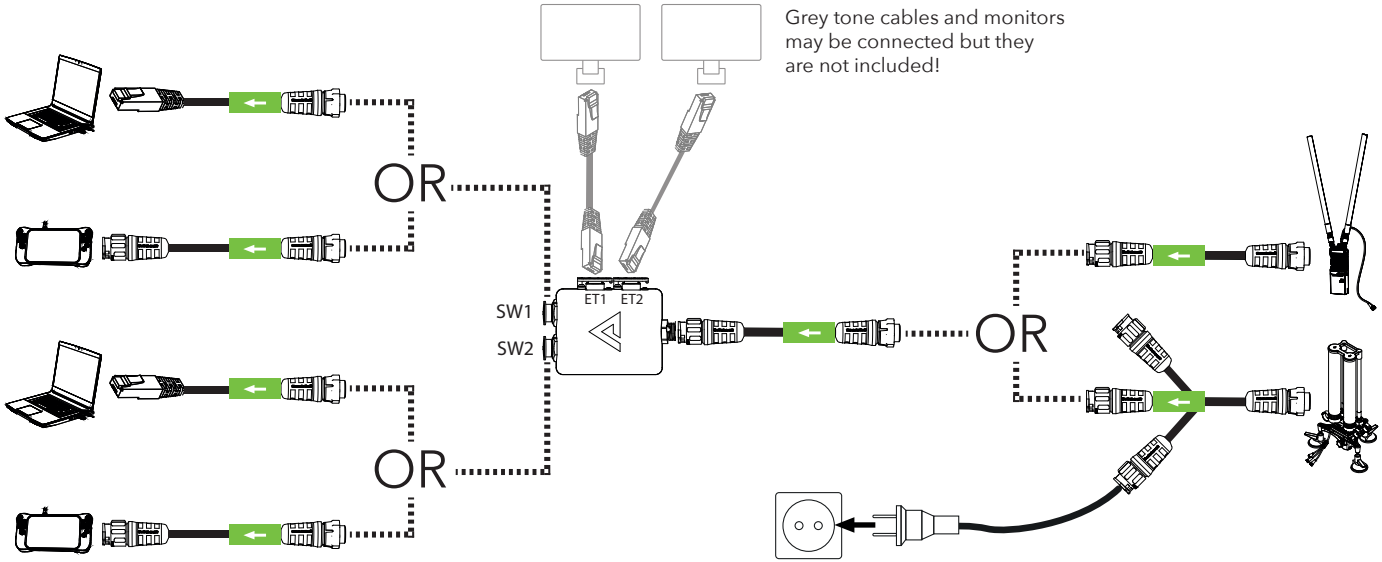
1. Connect the power cord to the Laptop.
2. Connect the power cord to a power outlet.
3. The charging process will start automatically.

6.7 Ground Control Station (GCS)

6.7.1 Add-On QS-Switch

The QS-Switch is an in-house produced rugged switch from Quantum Systems. It allows to connect more GCS simultaneously in all conditions. Perfect for two operator missions or headquarters setups by sharing the mission information into the tactical network.

As described in chapter 6.5 always follow the white/green arrows from the Datalink to the GCS to connect the wiring system.



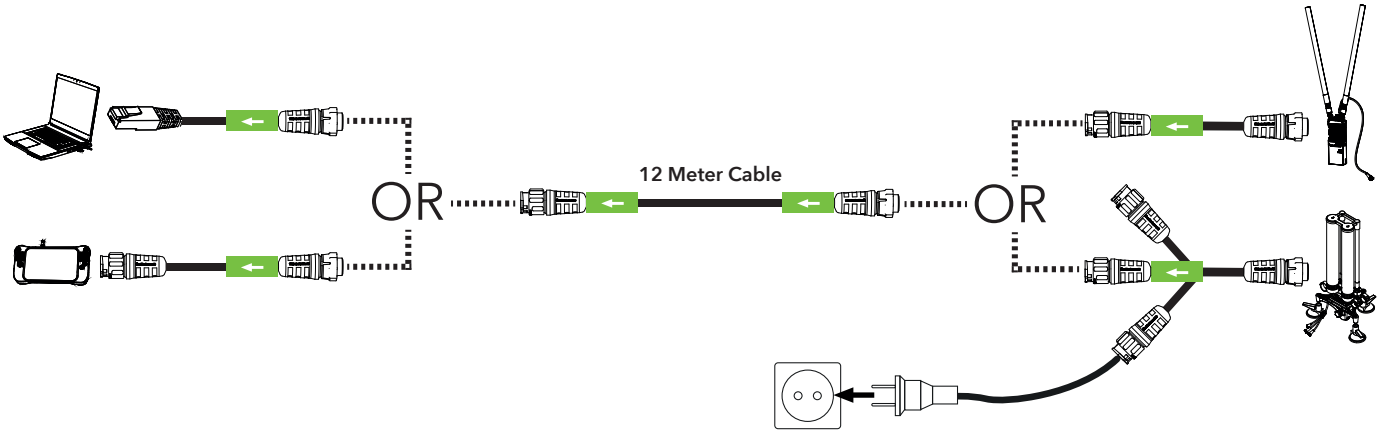
How to connect:

1. Connect the Datalink cable by following the white/green arrow, (on the right of the Switch). As it is always the same Switchcraft connector, it is indifferent whether it is the Stationary or the Handheld.
2. Connect one GCS Cable, indifferently whether the Skynav or Laptop, to the first SW1 port (on the left of the Switch).
3. Connect the second GCS Cable, indifferently whether the Skynav or Laptop, to the first SW2 port (on the left of the Switch).
4. Turn on the two GCS and follow chapter 9.1.1.
5. Two GCS can be used simultaneously.

Attention: The two operators must be in constant communication or have agreed in advance. Using QBase Tactical simultaneously on two GCSs on the same aircraft allows continuous exchange of aircraft control hold.
Note: The QS-Switch has two additional Ethernet ports that allow either two more GCSs to be connected or the video and KML stream to be shared with the tactical network. For this purpose, additional third-party Ethernet cables will be required.

6.7.2 Add-On Extension Cable 12 m

The Extension Cable 12 m is delivered with all mast or tripods sets offered by Quantum Systems or can be add separately. It allows to extend the distance between GCS and Datalink by 12 m, essential for some situations.



1. Connect the Datalink cable by following the white/green arrow, (on the right of the Extension Cable). As it is always the same Switchcraft connector, it is indifferent whether it is the Stationary or the Handheld.
2. Connect the GCS Cable, indifferently whether the Skynav or Laptop, to the second connector (on the left of the Extension Cable).
3. Turn on the GCS and follow chapter 9.1.1.

Tip: it can be connected in between of every Switchcraft connector couple, by following the white/green arrows as described in chapter 6.5. For example, between the QS-Switch and one Datalink positioned on the Mast, so that the ports of the Switch are on the ground and the Datalink can stay on the preferred high position.

6.7.3 Video and KML Sharing

To access the video stream and the KMLs from the network you can connect in two ways: by cable or via Silvus data link.
Cable connection:

1. Connect the Switch with GCS and datalink as in chapter 6.7.1.
2. Connect an ethernet cable (which is not included in the delivery) to the ethernet port of the Switch.
3. Connect the other ethernet connector to the computer on which the stream and the KMLs should run.

Silvus connection:
1. Another Silvus data link must be established for this. All S-Band Silvus devices can be used for this.
2. Set the Silvus to the same channel of the Silvus device of the GCS by turning the channel selector on the Silvus to the same number as the main Silvus.
3. Connect the Silvus device to the computer using the cables provided (as explained in chapter 6.5).
In both cases, open the browser of the computer and enter the IP of the sensors in the search bar. This will look like this:

This can be read in the inner area of the payload.
The stream can now be viewed via VLC by selecting "Open Network Stream" from the "Media" menu and entering the address as (notice the @ symbol):

Remark: VLC adds a delay of 1 second for buffering
Depending on the battle management software used, video-stream and KMLs can be accessed on it and quickly integrated.

7. FLIGHT OPERATION

7.1 Vector
- 7.1.1 Take-off & Transition
- 7.1.2 Manual & Automatic Take-off Abort Scenarios
- 7.1.3 Mission & Emergency Commands
- 7.1.4 Automatic Mission Coming Home
- 7.1.5 Retransition & Landing
- 7.1.6 Commands
- 7.1.7 Maximum Hover Time
- 7.1.8 GNSS denied mode

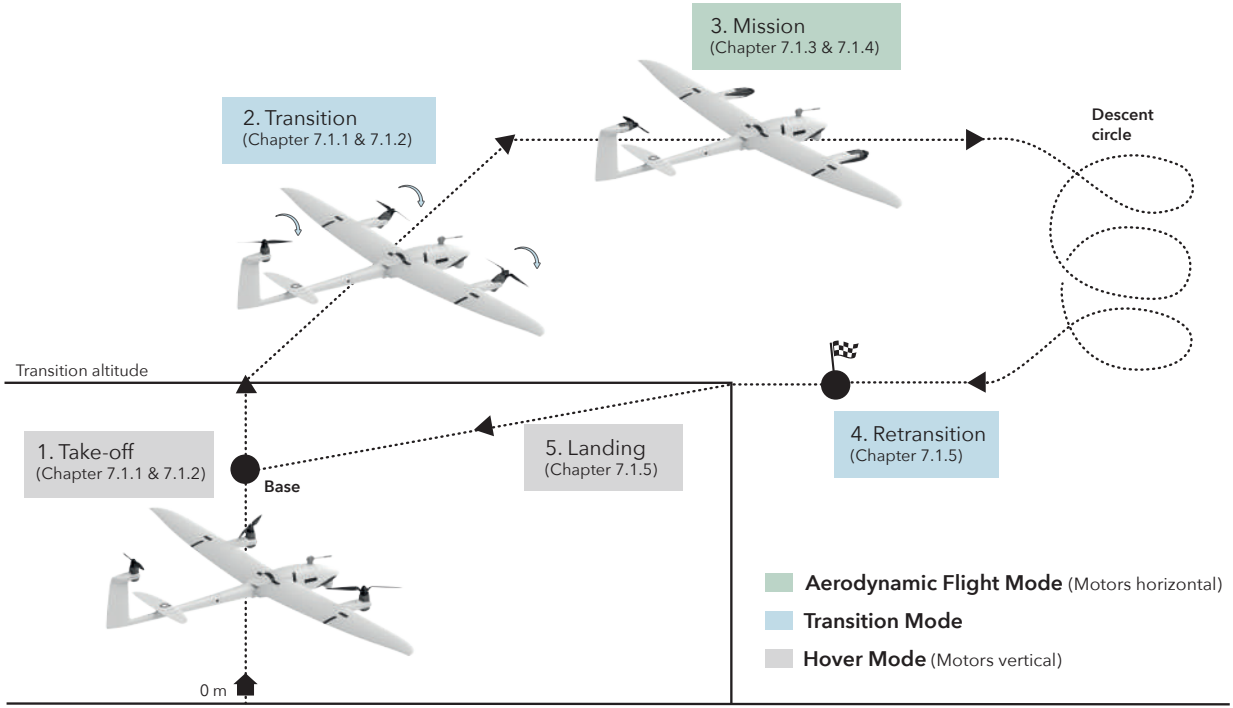
7.2 Scorpion
- 7.2.1 Take-off & Mission
- 7.2.2 Mission & Emergency Commands
- 7.2.3 Automatic Mission Coming Home
- 7.2.4 Landing
- 7.2.5 GNSS denied mode

7.3 Smart Battery: Buttons and functions

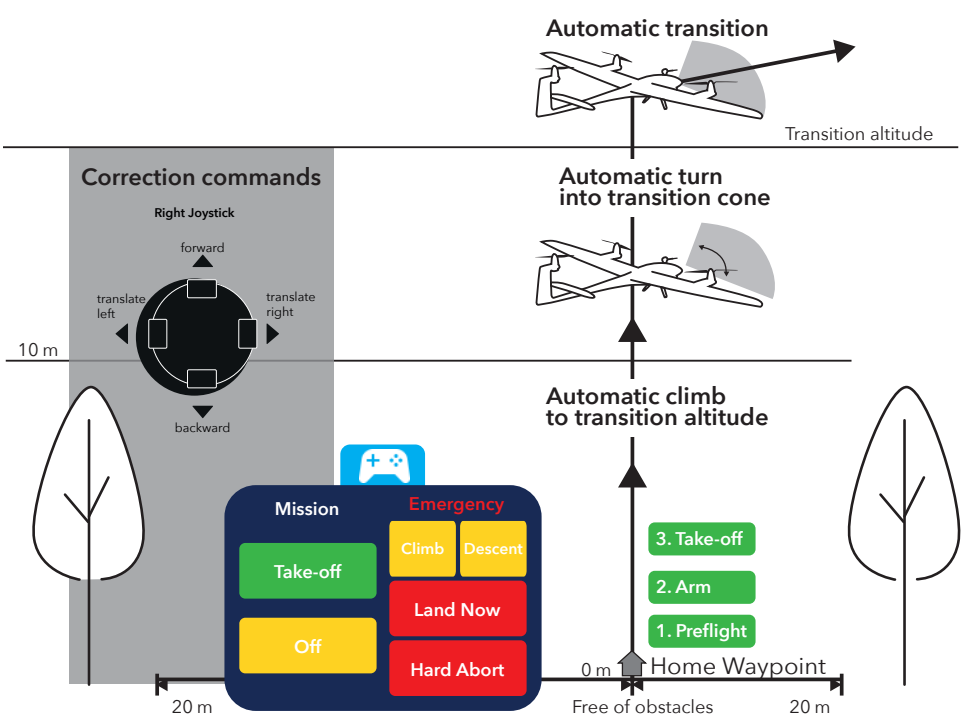
7.1 Vector

This chapter describes the general flight operation of the Vector incl. the take-off, transition, mission, retransition and landing. During every flight phase the operator has the possibility to intervene or to abort the flight.

Furthermore, the Vector is equipped with safety features that initiate an automatic coming home in case of an emergency.



7.1.1 Take-off & Transition



Preflight Checks: 1. Check the position heading and that it is the same as in the QBase 2.Check the correct movement of control surfaces upon manual command.

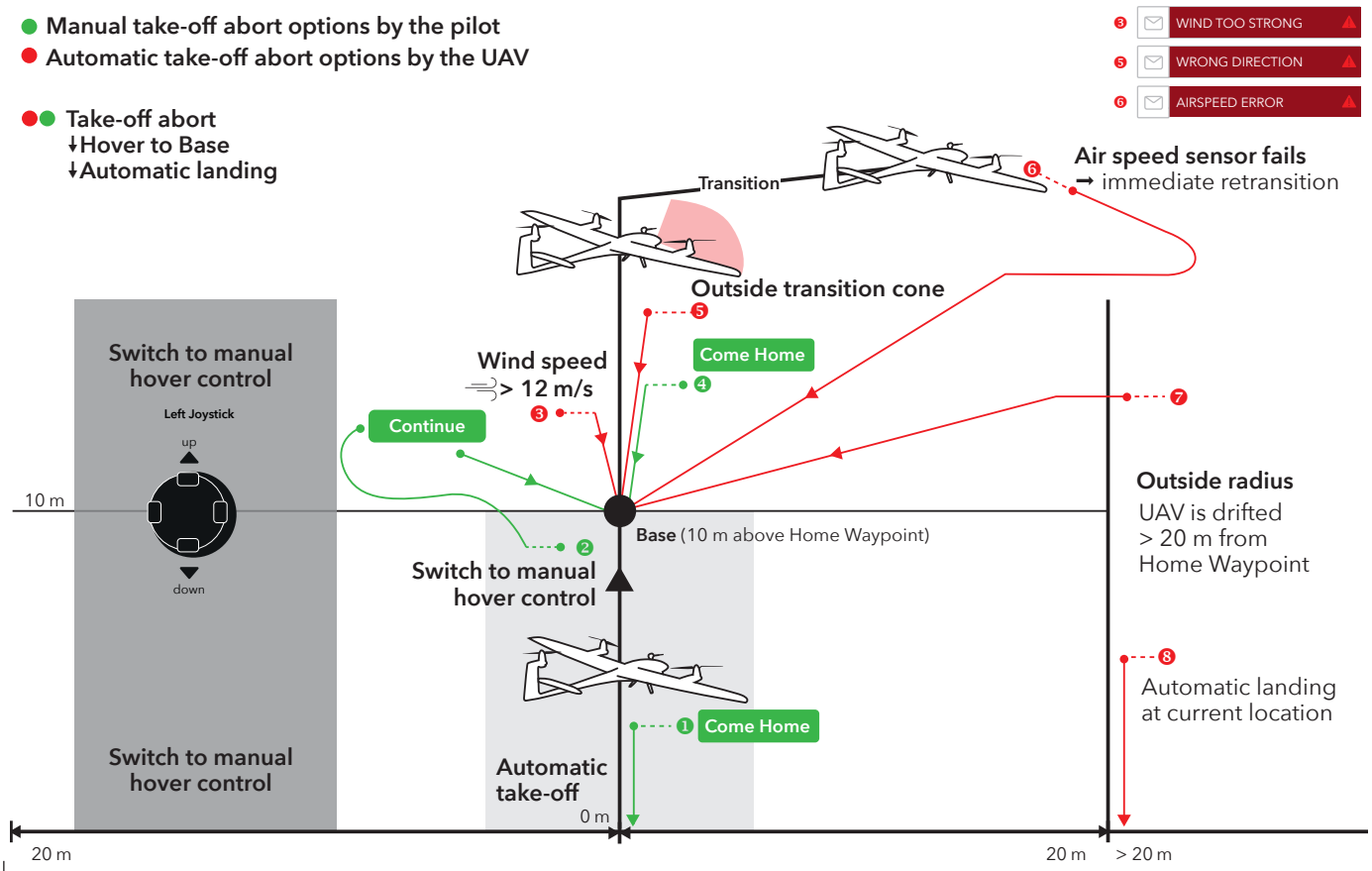
Take-off Location

No obstacles around the Home Waypoint (20 m radius)

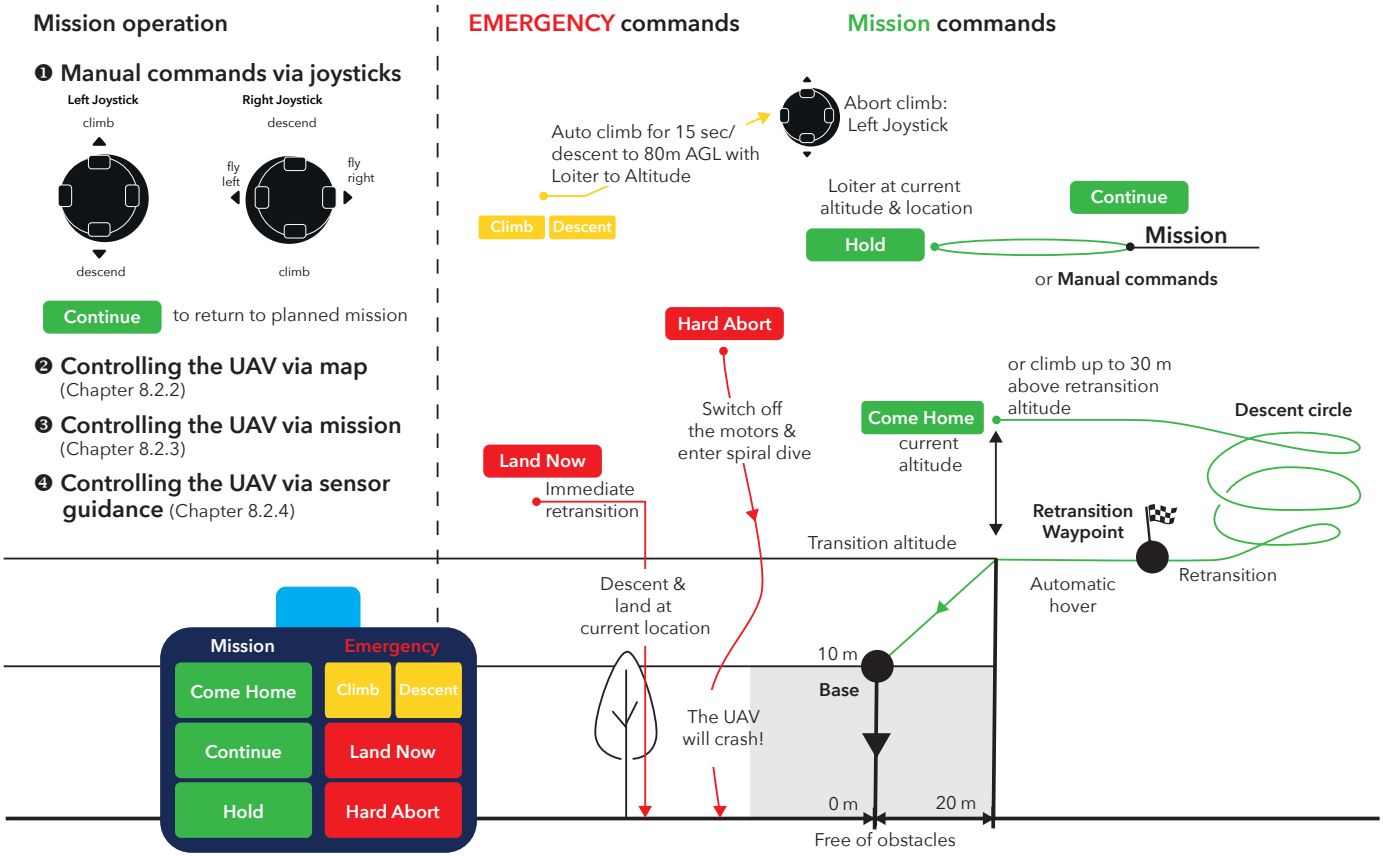
Transition altitude: 20 m (66 ft) higher than obstacles

Take-off direction: facing the wind

7.1.2 Manual & Automatic Take-off Abort Scenarios

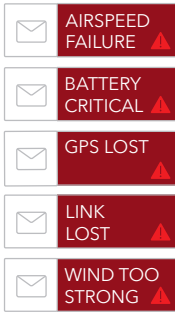


7.1.3 Mission, Emergency & Mission Commands

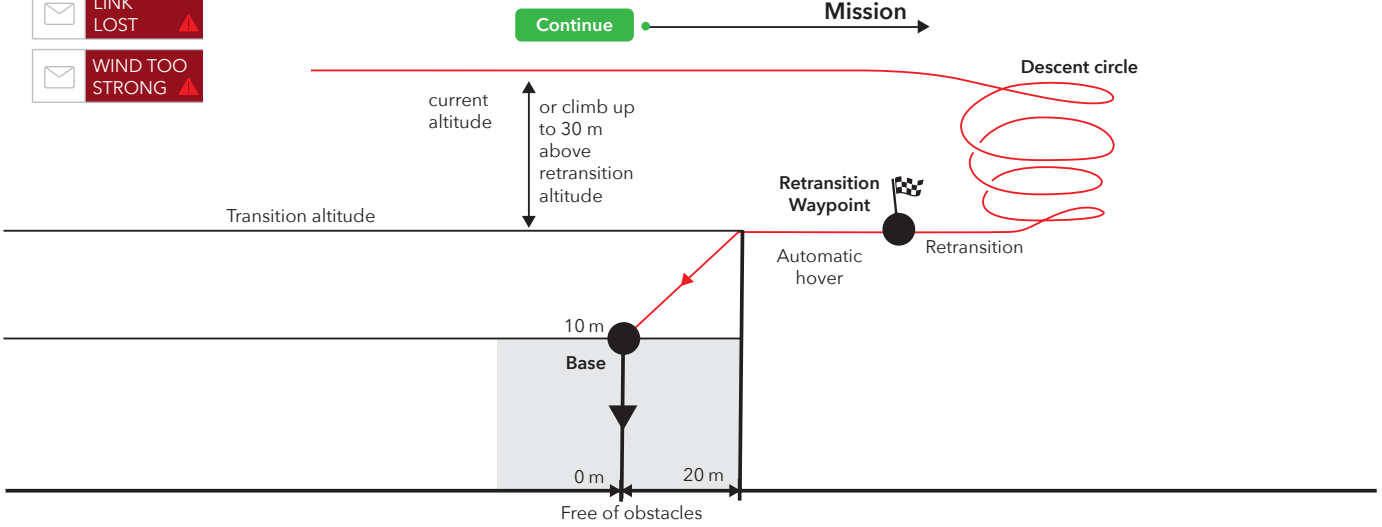


7.1.4 Warning Messages

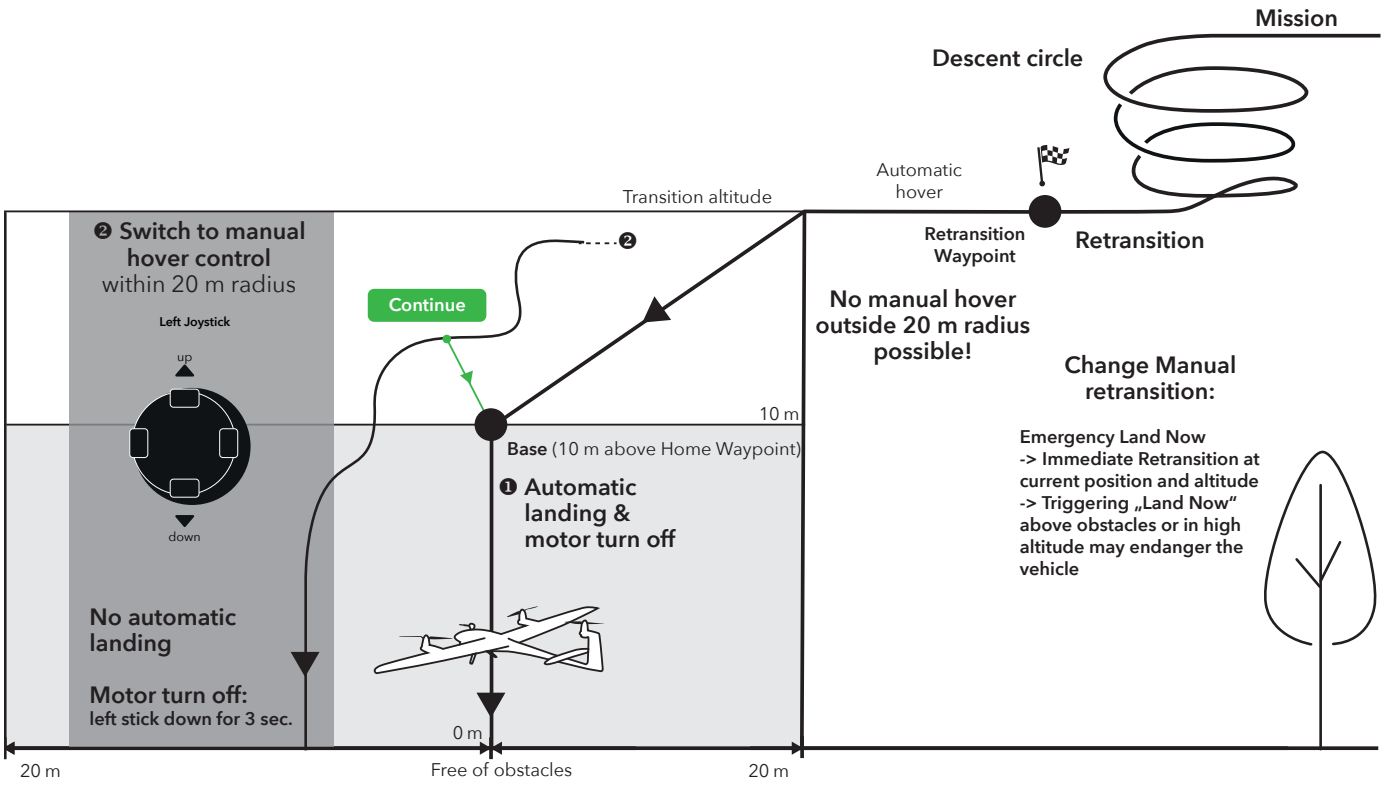
See chapter 12.1 for detailed explanation of the error messages



Warning Message	Automatic Mission Coming Home		
AIRSPEED FAILURE Possible reason is a blocked air-speed sensor.	No	LINK LOST The data link connection is lost	Yes (Will return to link loss area)
BATTERY CRITICAL The remaining capacity is needed to return and to land.	Yes	WIND TOO STRONG Wind exceeds 12 m/s.	No
GPS LOST Please read chapter 7.1.8 for further information.	No		



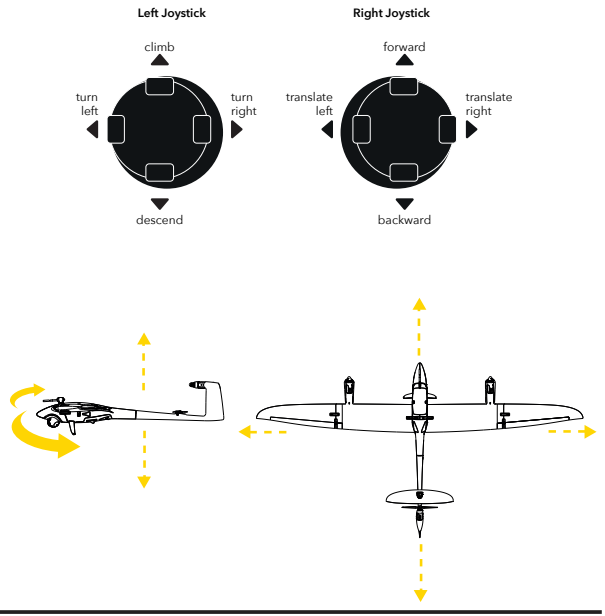
7.1.5 Retransition & Landing



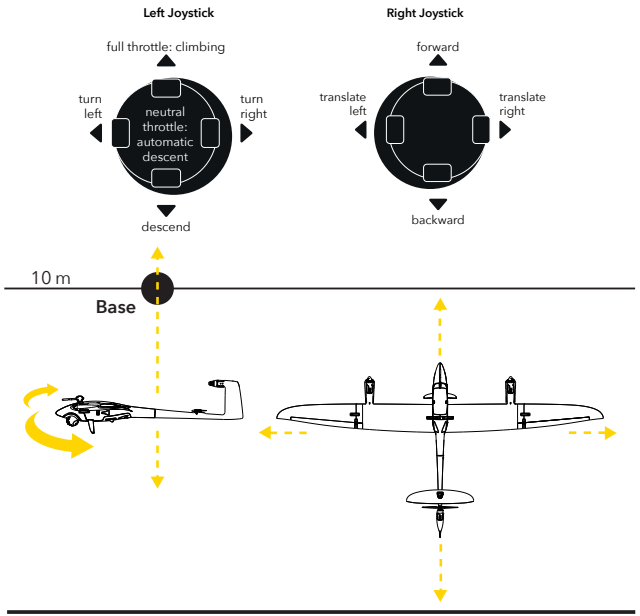
7.1.6 Hover Commands

Note: During the automated landing procedure only the vertical speed can be controlled above 10m AGL. Horizontal control is enabled once the vehicle is 10m AGL or lower.

Manual hover commands

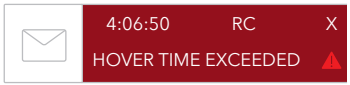


Automatic landing commands below 10 m AGL

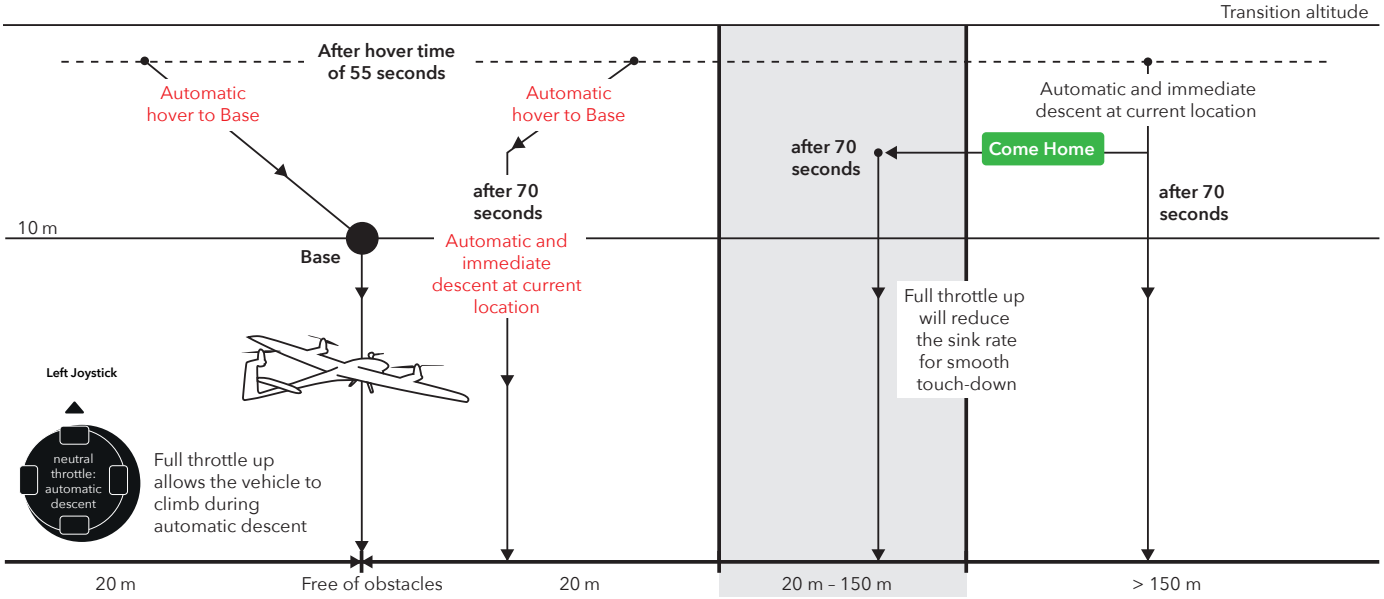


7.1.7 Maximum Hover Time

55 seconds: HOVER TIME
Inside 20 m radius: Automatic hover to Base
>150 m radius: Automatic and immediate descent at current location



70 seconds: HOVER TIME EXCEEDED
Automatic and immediate descent at current location



7.1.8 GNSS denied mode

GNSS failure during Mission
In case the Vector does not receive reliable GNSS position data, the Vector will enter the GNSS denied mode. QBase will display a warning.
As no GNSS positioning is available the current position is estimated indicated by the dotted circle in QBase. The radius increases with the position uncertainty over time. In GNSS denied mode, the position in the map is not accurate.

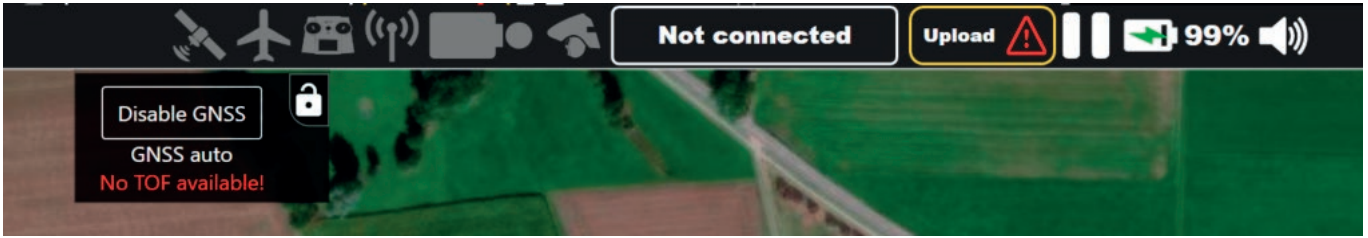
Option to Disable/Enable GNSS
QBase Tactical offers the option to turn the drone's GNSS reception on or off. However, it is strongly recommended to always fly with GNSS guidance. *GNSS Auto* should always be enabled if possible. The satellite symbol was added to the QBase header for this reason. By clicking on this icon, a drop-down menu appears. Here you have the option of selecting *GNSS Auto* and *GNSS Disable*. A status field below the button indicates the current status. If GNSS assistance is turned on, GNSS Auto is displayed.

By clicking on the satellite icon in QBase, a drop-down menu appears. Here you have the option of selecting GNSS Enable and GNSS Disable. A status field below the button indicates the current status. If GNSS assistance is turned on, GNSS Auto is displayed there.

Mode	Description
GNSS Auto	This is the default setting. It is recommended to fly always with this setting. In case there is no GNSS reception during aero flight the Vector automatically switches to GNSS denied operation. If the autopilot receives GNSS signal again during the flight, it automatically switches back to GNSS guided automatic flight.
Disable GNSS	The GNSS of the Vector is switched off and the Vector operates in GNSS denied operation **(not recommended).** The TOF (Time of Flight) signal is used for a more precise position estimation of the Vector.

Please note the following important recommendations:

- Only use the Disable GNSS function after you have received an appropriate training, since hovering this function requires significantly higher control skills from the pilot.
- Always fly in automatic GNSS mode (GNSS Auto) if possible.
- Landing including descent circle should always be flown in automatic GNSS mode (GNSS Auto).
- The switchover between GNSS Auto and Disable GNSS should always be made in Cruise Flight.



Note that after enabling the GNSS Auto again, 10 seconds will pass until the autopilot starts using the GNSS signal again for flight control. In QBase, however, Auto GNSS is displayed immediately after clicking the Enable GNSS button.

Our recommendation is to fly the Vector in Auto GNSS mode (previous regular mode where the Vector flew with satellite guidance), since this mode has been further improved and the Vector now remains in Full Nav in Auto GNSS mode even with a lower satellite number.

Please be aware that a large drift of the Vector's position can occur if GNSS support is disabled. This may occurr in particular when the message "No TOF available!" is displayed in the satellite drop-down menu. In order to correct the large inaccuracy caused by the GNSS disabled the operator is encouraged to perform manual position adjustments of the vehicle directly in QBase. This functionality is explained in the section below.

Position adjustments in GNSS denied mode

Updating position in GNSS denied mode
When the GNSS is denied, the vehicle estimates its position based on some sensor data and on the antennas relative distance. However, the influence of the wind and the inaccuracy of the measurements results in a increasingly large inaccuracy of the position. The best way to esnure that the vehicle will safely return home using the automatic "Return Home" features, and therefore without the need for manual flight, is to manually correct the position of the vehicle in QBase, if it can be determined by the operator.
In GNSS denied mode, a new button will appear on the left side of the screen (Map View). 

Important: updating the position manually is the most efficient way of preventing a fly-away of the vehicle!

If the current vehicle position can be determined using the gimbal or operator judgement, the position can be set in the map.

1. Click on the button
2. Click on the map to set the current vehicle location in the map

Note: Setting GeoLocks in Camera View on clearly identifiable targets shows the current displacement in the map. Direction and distance between the position estimation and the actual position is reflected in the displacement between the objects

position and the GeoLock marker in the map.

Limiting the position drift in GNSS denied mode

The position drift will be limited to approximately 300m if following four criterias are met:

1. The vehicle is operated within link distance
2. The Silvus Ground-Link is stationary
3. The Silvus Ground-Link is within 10m of the Vehicles Takeoff position
4. The vehicle is more than 400m away from the takeoff position

Hover in GNSS denied Mode

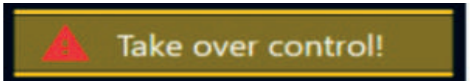
With the following steps, you can safely hover in GNSS denied mode, nevertheless we recommend to always leave GNSS on Auto.

If you fly in GNSS denied mode during the hover, after the retransition, you can take over the Vector manually. The manual flight mode is then active. In manual flight, the operator must control the attitude of the aircraft. When you release the right stick, the Vector goes into a neutral flight attitude of 0° for both roll and pitch. You should align the Vector so that the nose of the drone points into the wind. To do this, you can yaw the Vector around the vertical axis by moving the left stick to the left or right. As soon as the drone is pointing into the wind you have to pitch the Vector down with the right stick (moving right stick up), so that a part of the thrust vector points into the wind. This causes the Vector to better maintain its position and not be drifted away by the wind.
Additionally, there are two sensors that allow a stable and easier manual hover of the vehicle:

- Lidar: depth sensor, it gives a measure of the distance from the ground (if height <60m).
- Optical Flow: pixel analyzing sensor to enhance stability.

If both of this sensors are available, the vehicle is in the "Velocity Control Mode", that makes it easier for the operator to manually hover and land the vehicle.

If the aircraft is in hover, has no GNSS, and has no flow sensor data, the warning below appears and the controller starts to vibrate.



Disabling Optical Flow support for training purposes

If GNSS denied hover is practised during training, the optical flow support can be switched off in QBase Tactical.

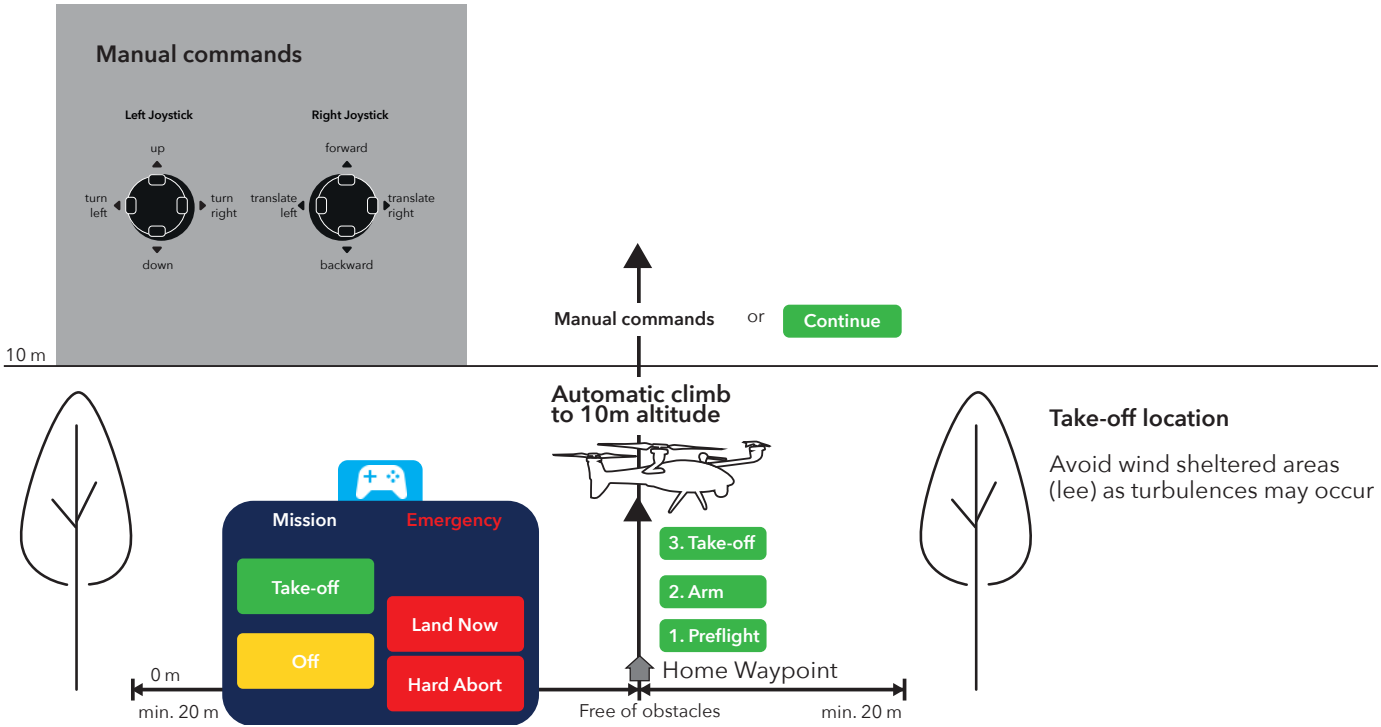
GNSS denied Take-Off

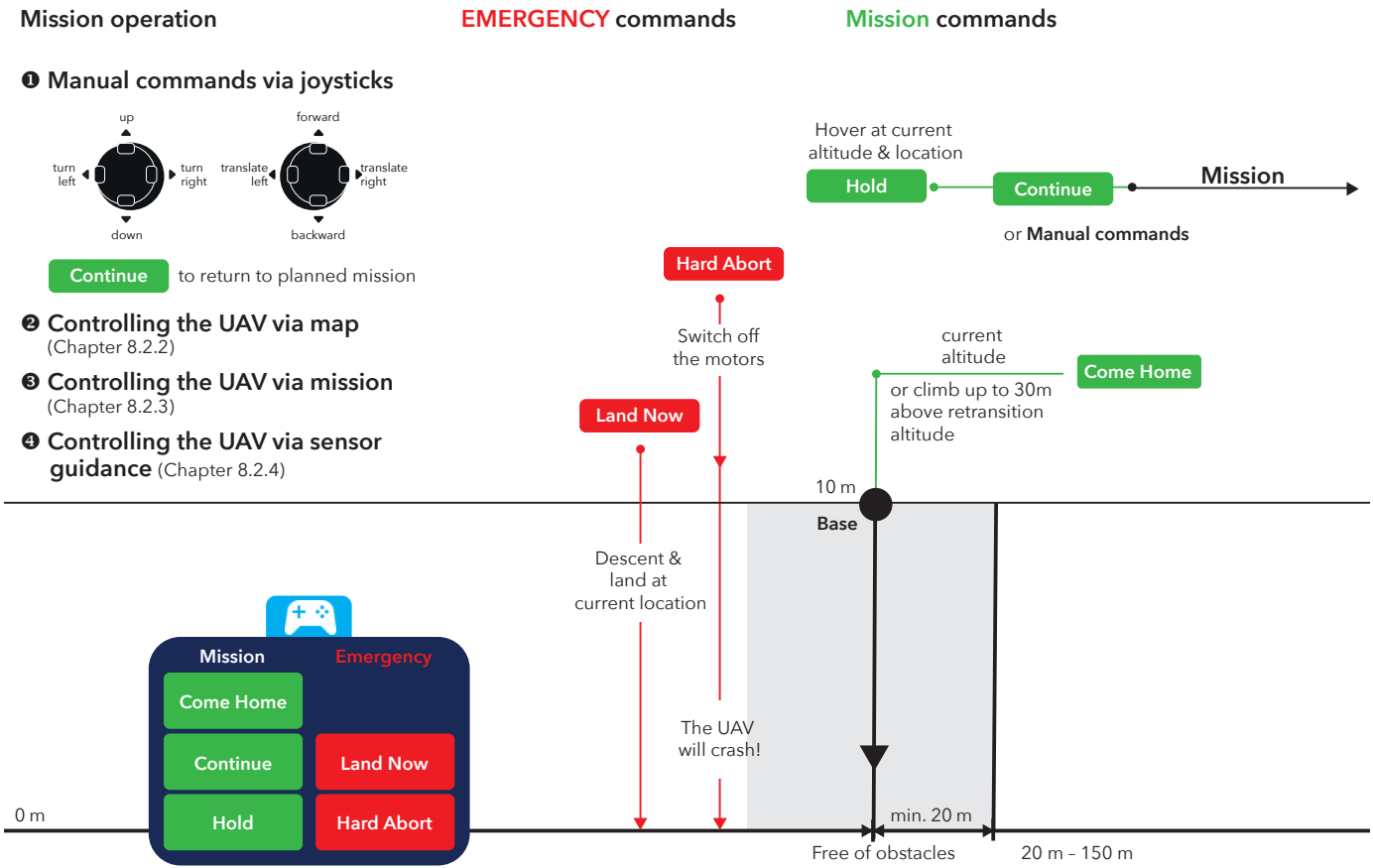
Change with "QOS" only release introduces the feature GNSS denied take-off function. In order to take-off in the event of GNSS denied, a GNSS fix shall be available for a short time on the ground prior to take-off. After the inizialization process is finished the GNSS signal can be switched off manually in the QBase header.

During the take-off, the autopilot no longer requires GNSS reception.
If GNSS is lost after arming or during take-off, autoclimb or transition, the climb and transition are continued without GNSS.

Note: If optical flow stabilization is available during take-off, it will be used. Otherwise, direct manual control is required to prevent position drift of the aircraft during take-off.

7.2.1 Take-off


Manual commands
Left Joystick
up
turn left
turn right
down
Right Joystick
forward
translate left
translate right
backward
10 m
Manual commands
or
Continue
Automatic climb to 10m altitude
Mission
Emergency
Take-off
Land Now
Off
Hard Abort
3. Take-off
2. Arm
1. Preflight
Home Waypoint
0 m
min. 20 m
Free of obstacles
min. 20 m
Take-off location
Avoid wind sheltered areas (lee) as turbulences may occur

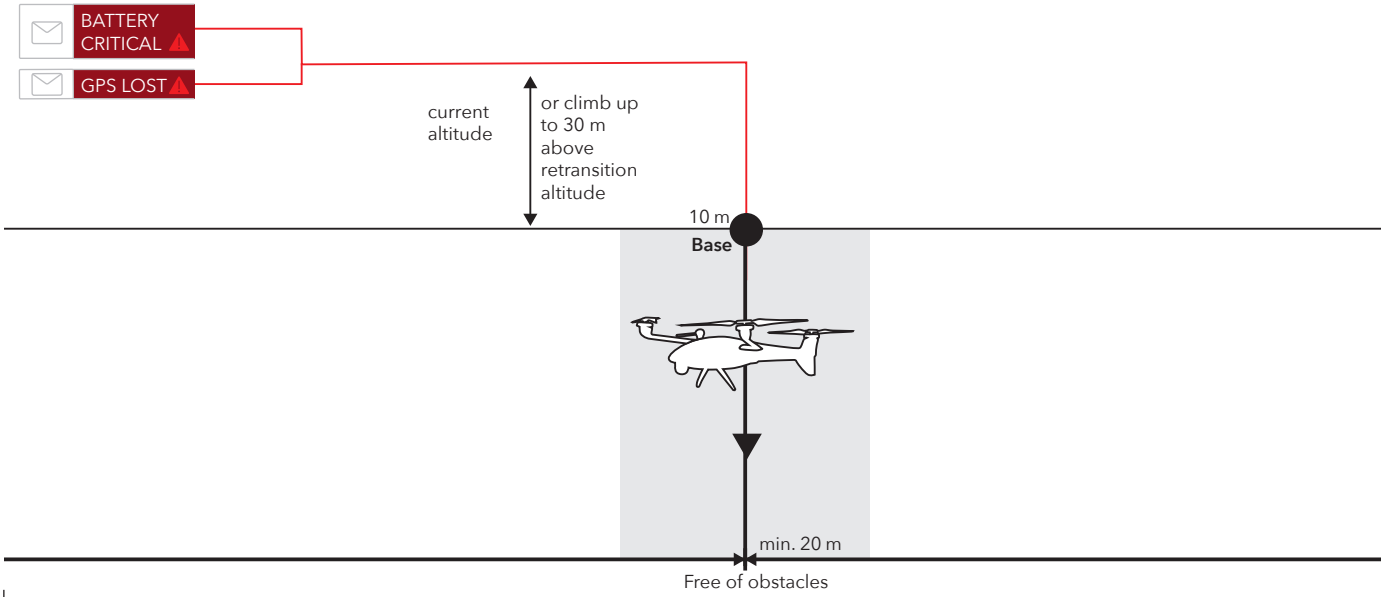

Mission operation
EMERGENCY commands
Mission commands
❶ Manual commands via joysticks
up
down
turn left
turn right
forward
backward
translate left
translate right
Continue
to return to planned mission
❷ Controlling the UAV via map
(Chapter 8.2.2)
❸ Controlling the UAV via mission
(Chapter 8.2.3)
❹ Controlling the UAV via sensor guidance (Chapter 8.2.4)
Hover at current altitude & location
Hold
Continue
Mission
or Manual commands
Hard Abort
Switch off the motors
Land Now
current altitude
Come Home
or climb up to 30m above retransition altitude
10 m
Base
Descent & land at current location
The UAV will crash!
Mission
Emergency
Come Home
Continue
Land Now
Hold
Hard Abort
0 m
min. 20 m
Free of obstacles
20 m – 150 m

7.2.3 Automatic Mission Coming Home

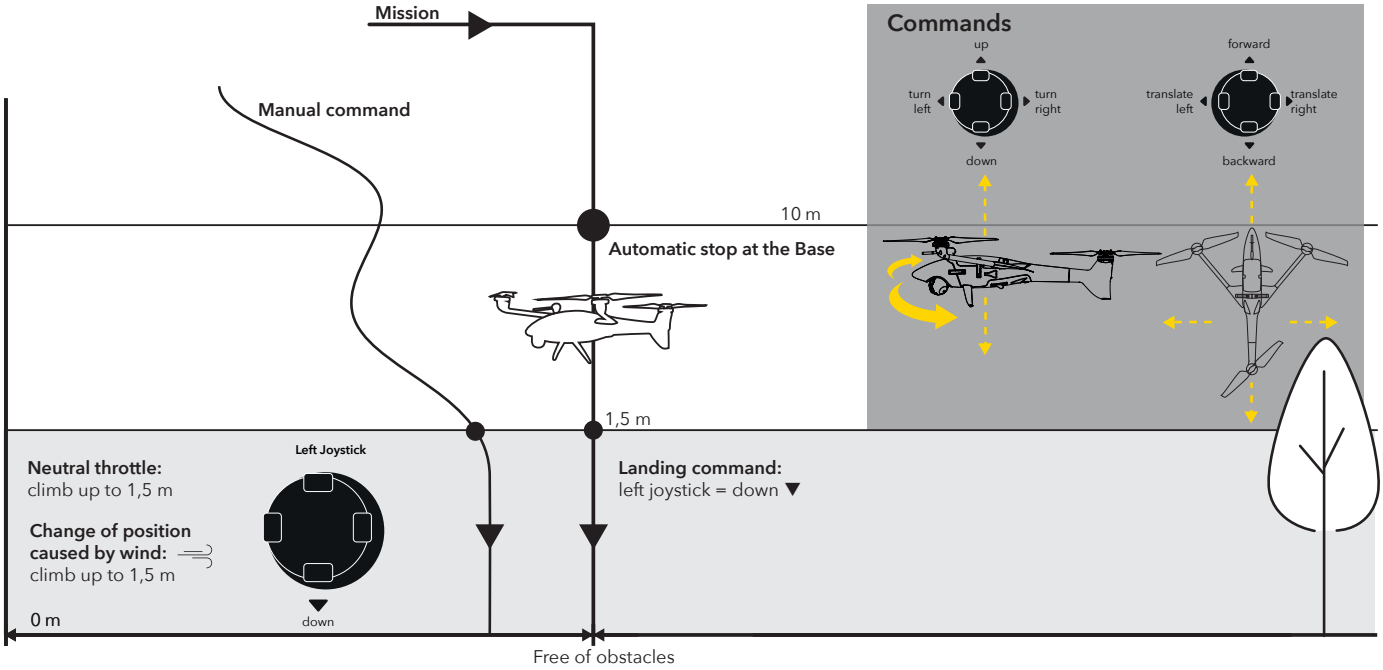
See chapter 12.1 for detailed explanation of the error messages

BATTERY CRITICAL
The remaining capacity is needed to return and to land.
The Scorpion must not be operated with state of charge below 20%!

GPS LOST
Please read chapter 7.2.5 for further information.



7.2.4 Landing


Mission
Manual command
10 m
Automatic stop at the Base
1,5 m
Commands
up
turn left
turn right
down
forward
translate left
translate right
backward
Neutral throttle:
climb up to 1,5 m
Change of position caused by wind:
climb up to 1,5 m
Left Joystick
down
Landing command:
left joystick = down
0 m
Free of obstacles

7.2.5 GNSS denied mode

In case the GNSS position is no longer available, the Scorpion will will remain stable using its internal sensors. The vehicle may drift due to wind influence.

The Scorpion will not come home automatically in case of GNSS signal loss. Please fly manually towards the targeted landing location and press either "land now" or descent by pulling the left joystick down. GNSS Denied conditions can be triggered manually when GNSS assistance is turned off (Disable GNSS).

Note: manual hovering in GNSS denied conditions can lead to flight attitudes that are very challenging to recover. For this reason, we ask you kindly not to fly the Scorpion in Disable GNSS mode. Quantum Systems recommend always leave the GNSS Auto function active.

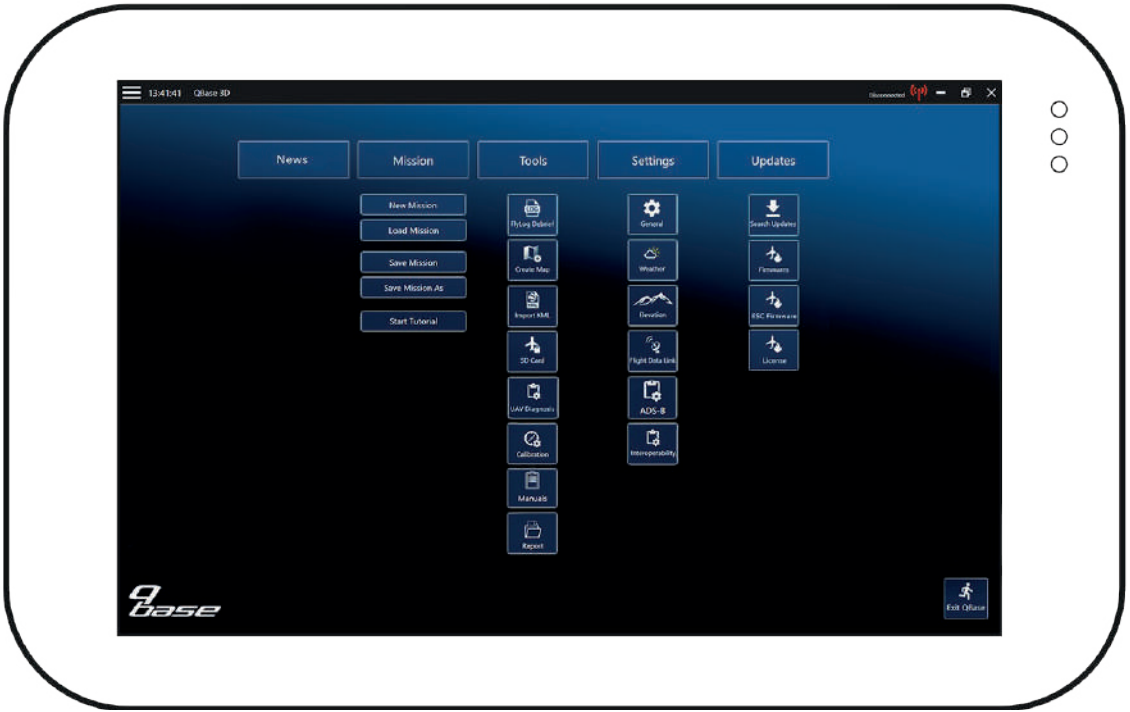
8. MISSION OPERATION

8.1 User Interface
8.1.1 Main Menu
8.1.2 Header
8.1.3 Map Screen
8.1.4 Sensor Screen
8.2 Controlling the UAV and the sensor
8.2.1 Overview
8.2.2 UAV via map
8.2.3 UAV via mission
8.2.4 Adjusting the time of the manual flight
8.2.5 Sensor settings
8.2.6 UAV via sensor guidance
8.2.7 Sensor via joystick
8.2.8 Sensor via FPV mode
8.2.9 Sensor via Geo-Lock
8.2.10 Sensor via tracking
8.2.11 Multi-Pilot Control
8.3 Point of Interest (POI)
8.4 Integration into Battle Management System (BMS)

8.1 User Interface

8.1.1 Main Menu

The UAV and its subsystems are controlled by the Skynav Ground Control device and/or a Toughbook with controller, running the QBase Tactical software.



Main Menu

FlyLog Debrief
See chapter 9.1

SD Card
See chapter 9.2

Create Map
Offline maps are generated based on the information of the online maps. During the creation process QBase/the Ground Control device needs to be connected to the internet.

1. Select Pan To in the left section and search for the area that you wish to create the offline map of or zoom to the desired location.
2. Boundaries are marked with a green rectangle. Please add some margin between the boundaries of the offline map and the desired flight area. It is possible to switch between horizontal and vertical orientation.
3. The Max. Zoom (maximum level of detail) is displayed in the top left corner. In order to change it please use the scroll bar in the right panel. **Recommended zoom level: 17 – 18.**
4. Set a name for the offline map.
5. Select *Download* in order to save the offline map. If the Download button is disabled either decrease the Max. Zoom (maximum level of detail) or decrease the area of the offline map.

The map is saved in Documents > QBase > Maps.

UAV Diagnosis
The autopilot wil
l start an internal diagnosis of the sensors and parameters. The diagnosis file will be saved on the SD card as 'SYSLOG'.

Report
Send feedback, like bug reports, feature requests.

Elevation
Download elevation data for offline use of QBase Tactical. You can also import your own elevation data. Make sure the imported file is a .tif file with WGS 84 coordinates.

ADS-B Settings
The ADS-B transponder configuration can be changed.
Call-Sign: Individual name or number. Call-Sign should be suitable for identification.
ICAO-Code: A unique code that is provided by the ICAO. Only use those codes provided by the authorities. Do not use the transponder without allocated ICAO-Code.
Squawk: Standard VFR (visual flight) Squawk in Europe is 7000. Use this as default. If in contact with Air Traffic Control please change your squawk upon request.
Modes:
Mode A: Only Squawk is sent to the radar station
Mode C: Squawk and flightlevel are sent to the radar station
Standby: No data transmission

Updates
See chapter 11

8.1.2 Header

Select the header icons to open the corresponding widget.

Display widgets permanently by activating the **lock symbol**

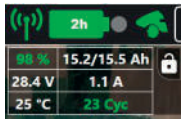
Header icon colorcodes:
Unknown Status
Operational
Warning
Error (Either flight or mission critical)

UAV Status
1. EO/IR strobe lights on/off
   Activates/deactivates the strobe lights for visibility. Located on top and on the bottom of the UAV. IR Light is only visible with night vision goggles.
2. UAV type
3. Autopilot version
4. Flight time
5. Serial number
6. Sensor status information

GCS Controller Status

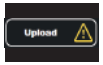
GNSS status

Connection Status
1. Connection type (USB, data link status (not connected, no data, active))
2. Connection quality over time
3. Mesh network & details about each node's temperature, voltage & connection quality

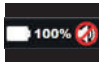


Battery Status
1. State of Charge
2. Voltage
3. Temperature
4. Capacity (Remaining/ Total)
5. Current
6. Cycles

Mode Display
Current autopilot mode



Upload Status
1. Write flight plan:
   Upload your mission to the UAV
2. If a different mission is stored on the UAV, the upload mission box appears with a Warning or an Error.



Ground Control device Status
1. Current volume
2. Ground Control device battery state of charge in %
3. Loss of internet connection
4. Setting brightness
5. Setting volume

Replay Status
1. Video timeline
2. Play/Pause
3. Change to Live View
4. Replay speed
5. Export the replay
6. Live/Log replay

Gimbaled sensor Status
Start/stop on-board recording

8.1.3 Map Screen

The map screen offers access to all map related information, controls and settings.

Message dialog
Info, Warning, Error

Lock Map to UAV
The map stays focussed on the UAV.
Button switches from:
• unlocked, • locked to UAV,
• locked to UAV & target

Zoom in

Zoom out

Pan to …
Select the button *Pan to* if you wish to pan to the UAV, to the mission or if you wish to search for an address.

Select Map
The list includes online and offline maps. To use online maps, make sure QBase/ the Ground Control device is connected to the internet.

Map Settings
Adjust the display settings of the map.

Switch to 3D view.

GDAL
The user provided custom elevation files are used as the single data source.

SRTM Downloading
The required SRTM elevation files are currently being downloaded.

UAV Type
• Displays wind speed, direction, groundspeed & airspeed.
• Transparent UAV icon: estimated shadow (based on time & coordinates).

Sensor Footprint
• Shows the part of the ground visible in the sensor view.
• The dashed line connects the UAV with the position of the sensor screen crosshair on the ground.

Live Elevation Plot (Plots)
• Current altitude above ground (AGL)
• Current altitude above mean sea level (MSL)
• Altitude of the last 10 seconds
• Predicted altitude for the next 50 seconds.

Sensor Screen
Reduced functionality of the sensor screen

Switch to sensor screen

Hide/show sensor screen

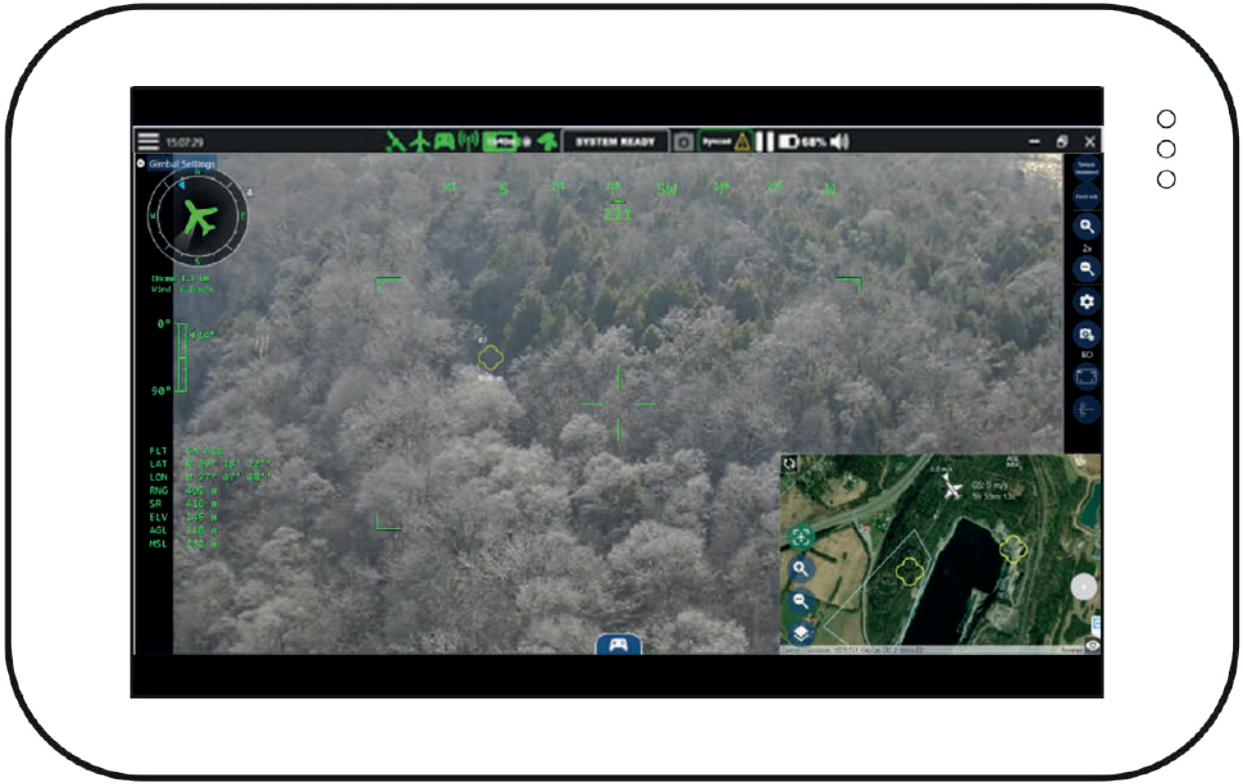
MIXED
Both the SRTM data set and the user provided custom elevation files are used as data sources. This is the case if not all flight path elements are covered by the user provided file.

Missing Elevation
One or more SRTM elevation files could not be downloaded. This can be caused by the following reasons:
- A connection error occurred.
- The requested elevation data is not available. This applies to regions which are not covered by the SRTM data set.

Reset UAV position
When flying in GNSS denied mode, this button appears to recenter the UAV in the position the user sets.

8.1.4 Sensor Screen

The sensor screen offers access to all sensor related information, controls and settings.



Orientation Display
- Gimbal settings
- UAV heading
- Wind direction and strength
- Gimbal azimuth and field of view
- Direction and distance to home (text “DHome”)
- Gimbal elevation (0° – 90°)

Target Information
- Current sensor center position
- **FLT:** Flight time since take-off
- **LAT, LON:** WGS84 coordinates of the current sensor center
- **RNG:** Ground range from current UAV position to current sensor center
- **SR:** Slant range from current UAV position to current sensor center
- **ELV:** Elevation of current sensor center with respect to MSL
- **AGL:** Altitude above ground of UAV
- **MSL:** Altitude above sea level of UAV

Controlling the Sensor
See chapter 8.2.5 – 8.2.8

Sensor Setting
See chapter 11.5

Decluttering
Reducing the amount of information displayed in the sensor view.

Map Screen
Reducing functionality of the map screen.

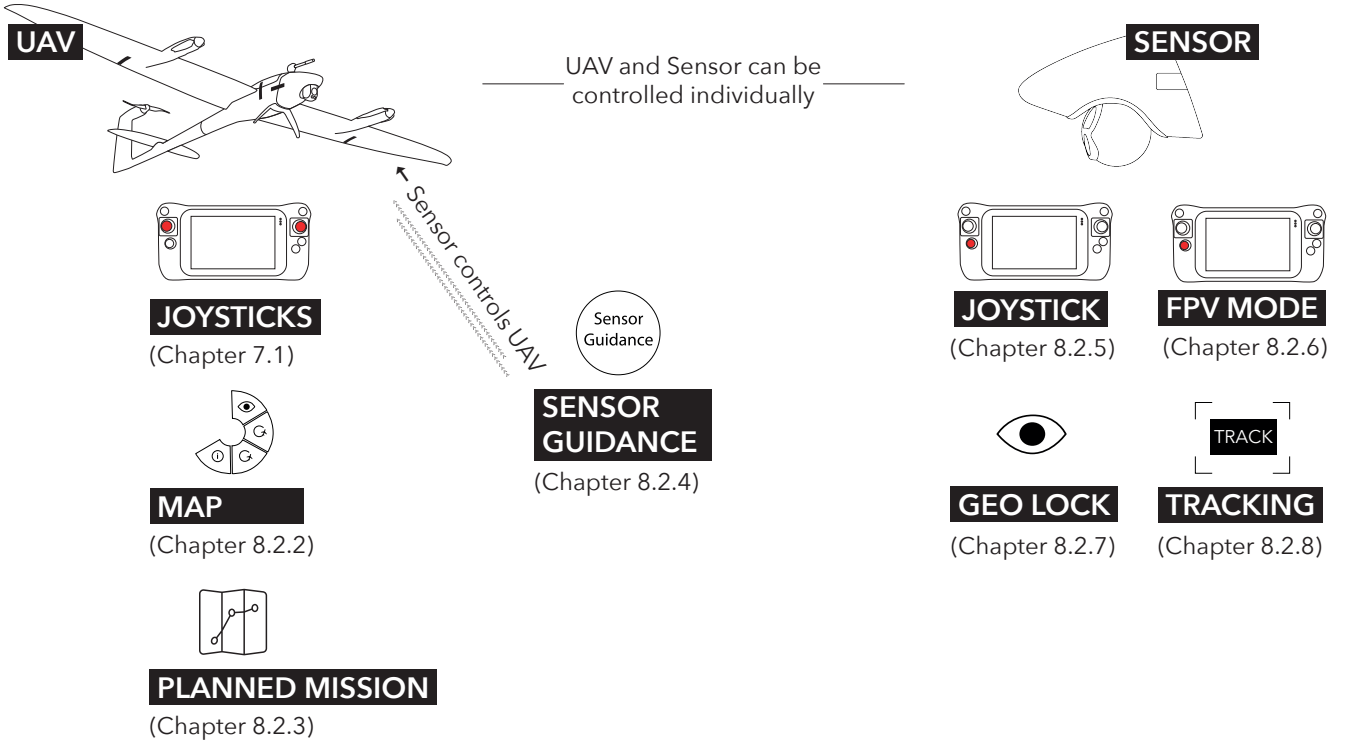
Switch to full map

Hide / show full map

8.2 Controlling the UAV and the Sensor

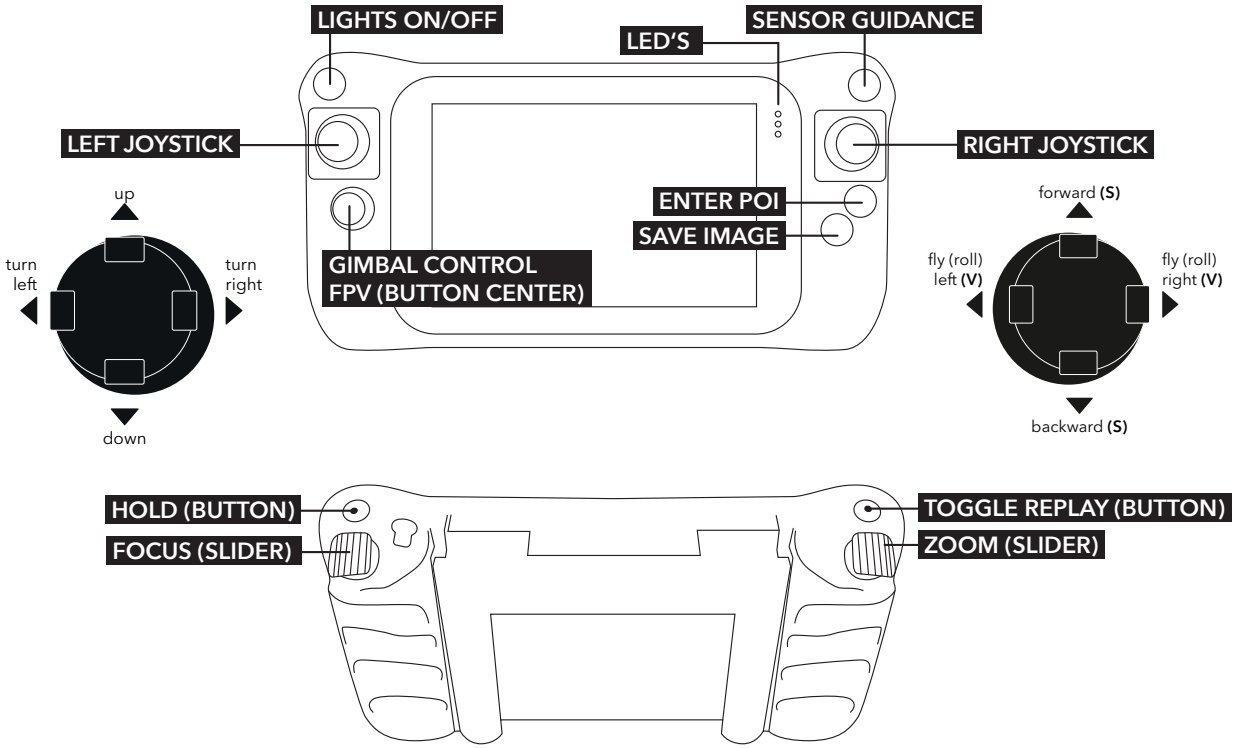
The UAV and the sensor can be controlled individually. There are four options to control the flight path of the UAV and four options to control the orientation of the sensor.

8.2.1 Overview



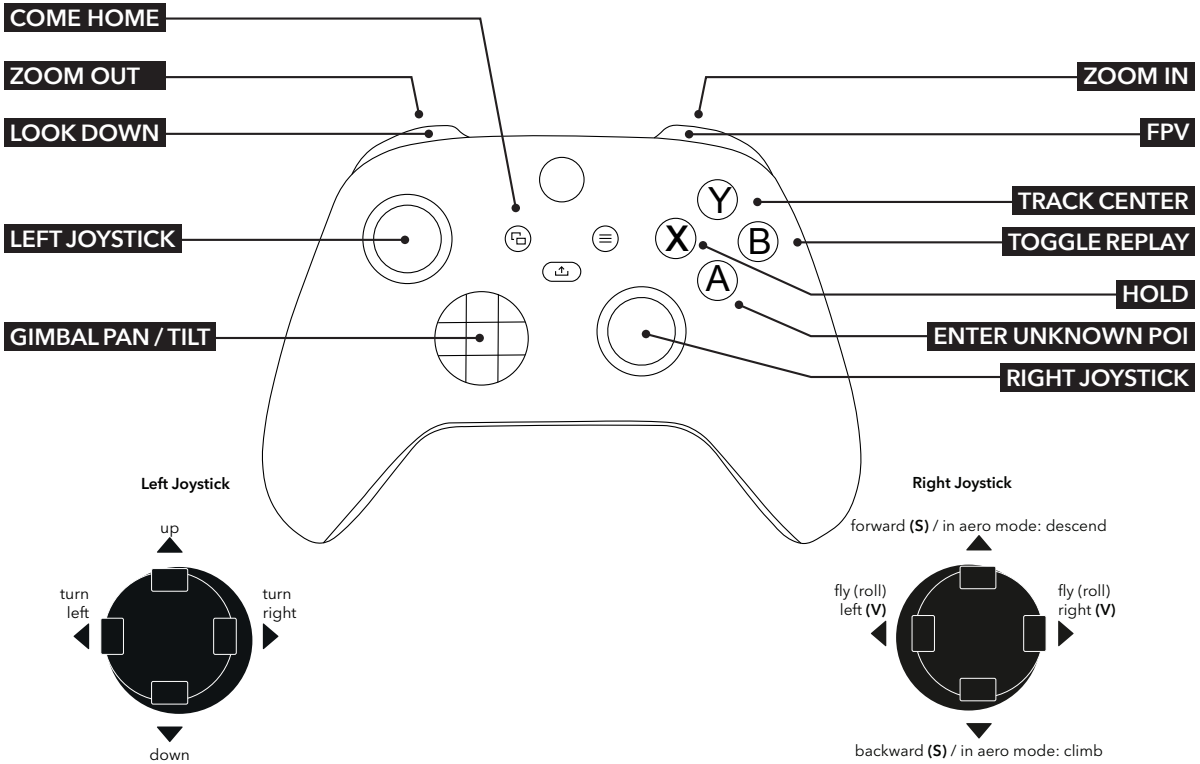
SKYNAV GROUND CONTROL DEVICE

The UAV and sensor can manually be controlled via the joysticks. Furthermore, the Ground Control device offers quick access to selected
sensor functions.



TOUGHBOOK CONTROLLER

In case the Vehicle is supposed to be controlled without a Skynav Ground Control device, the Toughbook controller can be connected directly to the Toughbook. The UAV and sensor can manually be controlled via the joysticks. Furthermore, the controller offers quick access to selected sensor functions.



8.2.2 Controlling the UAV via Map

Map screen:
- Command the UAV to loiter at specific position
  - Click on a free part of the map & select “fly to” option in context menu
  - By default, the target AGL will be the AGL altitude at the current UAV location
  - Flight path is simulated & displayed

UAV altitude warnings in path:
1. Warning appears
2. Flight is not started
3. Confirm to ignore the altitude warning
4. Flight will start

8.2.3 Controlling the UAV via Mission

- Mission: Collection of waypoints, take-off & landing
- Missions can be created & edited
- Missions can be uploaded to the UAV before take-off, or during flight
  - Uploading while airborne:
    1. The UAV will loiter during upload
    2. Start executing the mission from the specified starting point

Wind Settings Dialogue

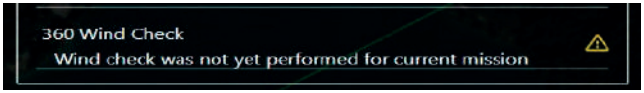
↓Auto Settings ↓Manual Settings

• Auto: Get the wind data online.

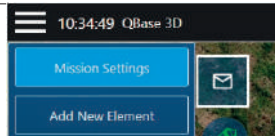
The wind is automatically updated as soon as the the first waypoint is defined

• Manual: Set the wind manually by selecting:
  - the corresponding BFT intensity in the dropdown menu
  - the current wind direction with -30/-5 or +5/+30

• 360 Wind Check: analyzes the planned mission for strong wind for all major wind directions to reduce the ground collision risk if unexpected strong wind occurs during flight. If the user wants to upload a mission without performing a wind check before he will receive a warning "360 Wind Check - Wind Check was not yet performed for current mission".



Mission Settings



• To be found in the top left corner
• Choose UAV and sensor

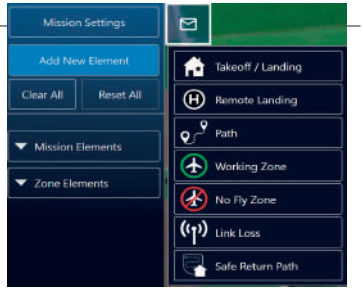
Link Loss Tolerance
If the RC link as well as the flight data link is lost during the flight, the UAV returns to the link reestablishing waypoint after the selected time expired.

Link Loss Loiter Time
At the link reestablishing waypoint, the UAV loiters for the selected time and tries to reestablish the telemetry connection to QBase and the transmitter.

Maximum Altitude ATO
To comply with local regulations, the maximum attainable altitude can be limited in the

mission settings. It is the remote pilots responsibility to familiarize and respect the local regulations. The UAV will not go higher than the planned limit during the mission or assissted flight. It is recommended to set it slightly higher than how intended to fly to take into account the ground elevation.

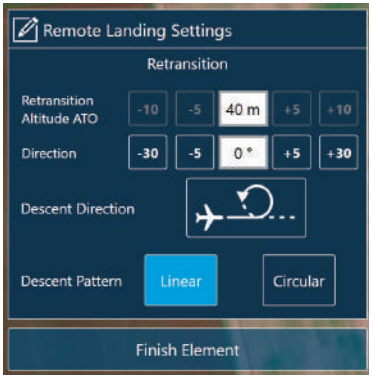
Add New Element



Add a new element by clicking one of the following buttons:

Set Take-Off/Landing
Location and settings of Take-Off/Landing and retransition can be individually adjusted afterwards.

Remote Landing
Location of Remote Landing, in case the desired landing location does not coincide with the take-off posiiton.
In the figure below the settings for the remote landing are displayed.



The remote landing requires setting of parameters:
- Retransition Altitude (ATO): make sure to set it at least 20 m above any obstacles.
- Direction: Suggested to have the nose of the vahicle against the wind.
- Descent Direction: Clockwise/Counterclockwise.
- Descent Pattern: Linear/Circular (last 2 points do not apply for circular descent pattern).

Draw New Path
The path is created by defining waypoints through a click on the map.

Zone Elements

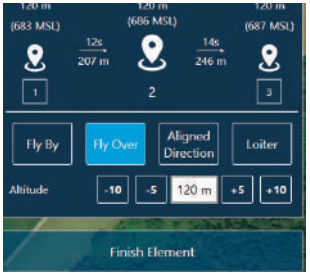
- Define/adjust the corners of an area with a click on the map.
- The Working Zone consists of 3-10 corners. The Working Zone is supposed to increase situational awareness. The Working Zone will not trigger actions.
- NoFly Zones are supposed to increase situational awareness. NoFly Zones will not trigger actions if breached.

Link Loss

By default, the Link Loss Loiter Circle is equal to the retransition circle. Set it separately using this element.

Path

Simple path: Specifying waypoints in order to fly around obstacles or delay the flight by loitering.



Delete selected waypoint Delete all waypoints Finish editing the geometry

1. Select + on the map: add new waypoint between two existing waypoints.

2. Change settings in the element on the left side or in the map.

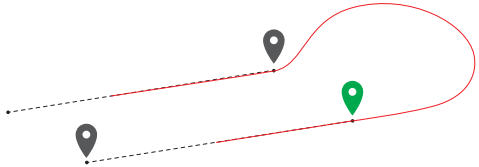
Altitude

- Flight altitude: Altitude above ground.
- Do not exceed the maximum altitude that is allowed for your region.

Waypoint types
The selected waypoint is displayed in green.

Fly By
- The waypoint is not directly overflown.
- The UAV turns before reaching the waypoint to smoothly align with the next leg.

Fly Over
- The waypoint is directly overflown.
- The UAV realigns with the next leg after the waypoint.



Aligned Direction
- The flight track is automatically determined in order to match the waypoint and the direction of the next leg.
- Subtypes can manually be selected in the waypoint property menu. For photogrammetry missions it is recommended to set the subtype to Auto. Not all subtypes are applicable for every scenario. Non applicable subtypes are indicated by a red dotted line between the waypoints.

Loiter
- The UAV enters a circular trajectory around the waypoint. The radius of the trajectory, the circling duration and the circling direction can be set in the waypoint property menu.
- The UAV approaches and leaves the trajectory from the outside.

Note: For the first waypoint, there is no option (Fly By, Fly Over,...) ti be delected. The vehicle automatically performs a fly over.

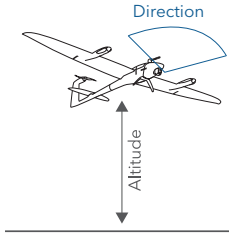
Take-off /Landing

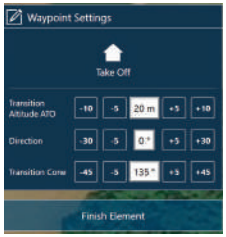
- If no remote landing option is inserted, the UAV will take off and land at the exact same position.
- Take-Off/Landing is performed in hover mode.
- Define the planned take-off and landing position by clicking on the map.
- Move the position by dragging. The real take-off position is automatically adjusted right before the start of the flight.

Important:

- Make sure no obstacles are within a radius of 20 m around the Home Waypoint.
- Always take off against the wind direction.
- Do not take off in a wind sheltered area (lee), as turbulences may occur.
- Transition cone:
  - Green = Transition cone (allowed transition direction)
  - If there is an obstacle: transition altitude must be 20 m (65.6 ft) higher than the obstacle.

- Select the Take-Off or the Retransition location on the map or select Take-Off/Landing in the left section in order to set the waypoint settings.





Planning an area

 **Undo the last change**  **Redo the last change**  **Delete selected point**  **Finish editing the geometry**

 **Start/Stop adding points**

By selecting + a new point between two existing points can be added.

After planning the area the settings dialog appears. You can always edit the settings by selecting the element on the left side or in the map.

Altitude: The flight altitude is defined as the altitude above ground.
Please do not exceed the maximum altitude that is allowed for your region. This value is linked to the GSD.

Legs can be extended at the entry and the exit of the flight area. By default the legs at the entry are extended by 30 m to ensure allignment of UAV and leg before starting to take pictures.

Flip Legs: Change the waypoint order of the area. While planning a PPK mission in QBase it is recommended to choose the option **Flip Legs** for optimum PPK quality. This option is necessary so that the **first waypoint is as far away as possible** from the Home Waypoint.

Invert Legs: Change the entry and exit direction on a leg.

Optimize Leg Sequence: Optimize the leg order based on turn radius of the UAV and the current leg distance.

Cross Legs: Create additional legs perpendicular to the main legs.

Above Max. Area Altitude: The flight is perfomed on a constant flight altitude (MSL). The altitude is based on the max. area terrain elevation.

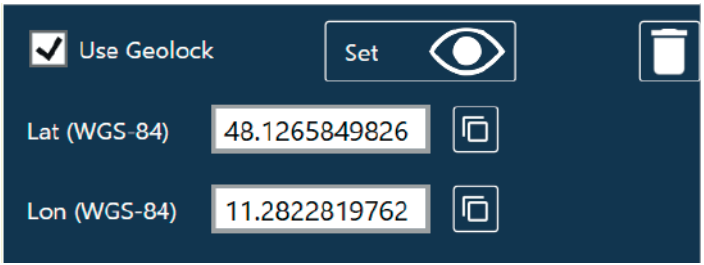
Terrain Following (Above Max. Leg Altitude): The flight altitude per flight leg is based on the corresponding max. terrain elevation.

Terrain Following (Above Avg. Leg Altitude): The flight altitude per flight leg is based on the corresponding average terrain elevation.

Advanced Terrain Following: Additional waypoints inserted for more accurate terrain following. Possibility to adjust distance between the inserted waypoints.

Finish Elements: Stop editing the element.

Geolock in path



- QBase Tactical offers the possibility to define a geolock for each waypoint. To activate the feature tick the "use geolock" box when creating/editing path-waypoints.
- To set the geolock either type in the coordinates in the respective box or click on 

and place the geolock in the map.

Note: To use predefined geolocks in the path, there needs to be a connection between Ground Control Station and the Vehicle during the mission.

Transition Altitude ATO (above take-off)

- Set the transition altitude as low as possible (if the surrounding permits).
    - Save energy by reducing the hover duration to a minimum.

At this altitude the UAV will switch from hover mode to fixed wing flight.

Direction of the Transition/Retransition
Note: Choose the transition direction based on the surrounding. If possible, set it against the wind direction.

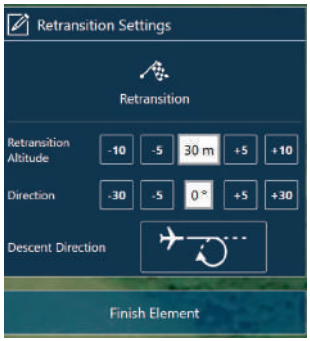
Transition Cone
- The transition is performed within the defined cone.
- If the direction of the UAV does not match the cone ➞ UAV will not enter the transition phase ➞ mission will be aborted.
- Select the angle of the transition cone as wide as possible (if the surrounding permits).

Take-off /Landing – Retransition

Retransition Waypoint
During the retransition the UAV will switch from fixed wing mode to hover mode. The retransition waypoint is the location at which the UAV finishes the retransition. At this location the UAV is in hover mode. The retransition track is indicated by the dashed path and is by default 150 m (492 ft).

- The retransition waypoint should be located close to the home waypoint (take-off and landing location) (ideal < 50 m; max. 100 m). The distance between the two waypoints is covered in high energy demanding hover mode.
- Depending on the wind condition, the real retransition location might not correspond to the retransition waypoint in QBase.
- If there are obstacles within a 50 m (164 ft) radius around the retransition waypoint, make sure that the retransition altitude is 20 m (65.6 ft) higher than the obstacles are.

- Select the *Take-Off* or the *Retransition location* on the map or select *Take-Off/Landing* in the left section in order to set the waypoint settings.



Retransition Altitude ATO (above take-off)
Defines the hover altitude at the end of the retransition. If the flight area allows for it, set the retransition altitude as low as possible in order to save energy by reducing the hover duration to a minimum.

Direction

- It is recommended to set the direction against the wind direction.
- In case it is not possible to carry out the retransition against the wind direction, be aware that the real retransition location does not match the retransition waypoint that was set in QBase (~ 20 m drift per 1 m/s tail wind).
- If there is an obstacle in the retransition track, make sure the retransition altitude is 20 m (65.6 ft) higher than the obstacle.

Descent Direction

- Before the retransition, the UAV enters the descent circle automatically in order to descend to the required retransition altitude.
- The radius of the circle is by default set to 60 m (197 ft) and cannot be changed.
- In case no link reestablishing waypoint is set, the UAV will use the descent circle as the link reestablishing waypoint.
- Set the direction of the circle depending on the surrounding and obstacles.

If there is an obstacle in the flight track of the descent circle, make sure the retransition altitude is at least 20 m (65.6 ft) higher than the obstacle.

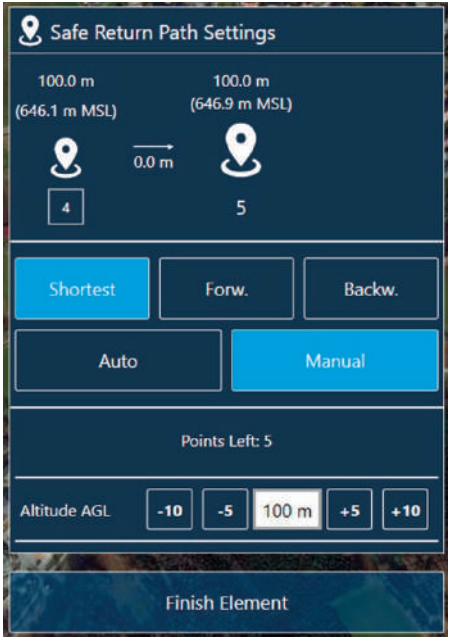
Safe Return Path

Background: In case "Coming Home" is initiated due to malfunctions or link loss, the drone will return home on the direct path and at the current altitude. In case there are any obstacles between the take-off/landing area and the mission area the safe return path has to be used.

General behaviour if Safe Return Path is activated:
If the mission is finished or if "Coming Home" is triggered at any point in the mission, the vehicle will fly to the safe return path directly and then come home following the defined safe return path. In case the current altitude and the targeted altitude of the safe return path differ, the vehicle will climb/descent with the maximum rate to the altitude set for the safe return path.

Safe Return Path Settings

- When selecting "Auto", the safe return path is automatically definded according to the path of the mission.
- When selecting "Manual", the safe return path has to be defined by creating waypoints in the map. It is possible to set up to 10 waypoints for the safe return path.
- By selecting "shortest", "forward" or "backwards", the direction in which the drone returns to the landing position can be definded. The arrows indicate the direction in QBase. When selecting "shortest", the drone will take the shortest path depending in the location where the coming home is initiated.
- Please definde the altitude (AGL) of the waypoints of the safe return path.

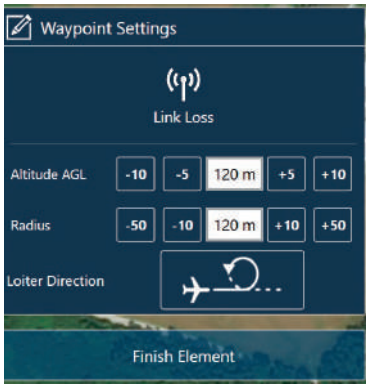


Note: If Safe Return Path is activated, the vehicle will always use the defined Safe Return Path for

- regular Coming Home once the mission is finished
- Emergency Coming Home (e.g. Battery critical)
- Coming Home triggered by the operator

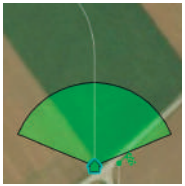
Note: The Link Loss Waypoint will not be considered if the mission contains a Safe-Return-Path.
The vehicle will return home if Link Loss Tolerance time is exceeded.

Set Link Loss



Link Loss Waypoint

- Select *Set Link Loss* in the category Add New Element.
- After link loss timeout the UAV returns to and circles around the defined waypoint.



If possible the link between QBase and the UAV or between the RC transmitter and the UAV is reestablished. If the connection is successful, either *Continue* the mission or select *Coming Home* on the transmitter. Locate the Link Loss Waypoint close to the Home Waypoint to ensure the data link can be reestablished.

Altitude AGL (Above Ground Level)

Set the altitude of the link reestablishing circle.

Radius

Define the radius of the link reestablishing circle.

Direction

Define the direction of the link reestablishing circle.

8.2.4 Adjusting the time of the manual flight

QBase Tactical provides the feature of setting a maximum time for the drone to remain in manual mode. During this time, the operator can make control inputs via the Skynav or Gaming Controller and fly the drone manually. After this set time has passed, the drone will switch to automatic flight mode and fly the shortest way to the last set waypoint.

Figure: Menu to set the time the drone stays in manual flight mode

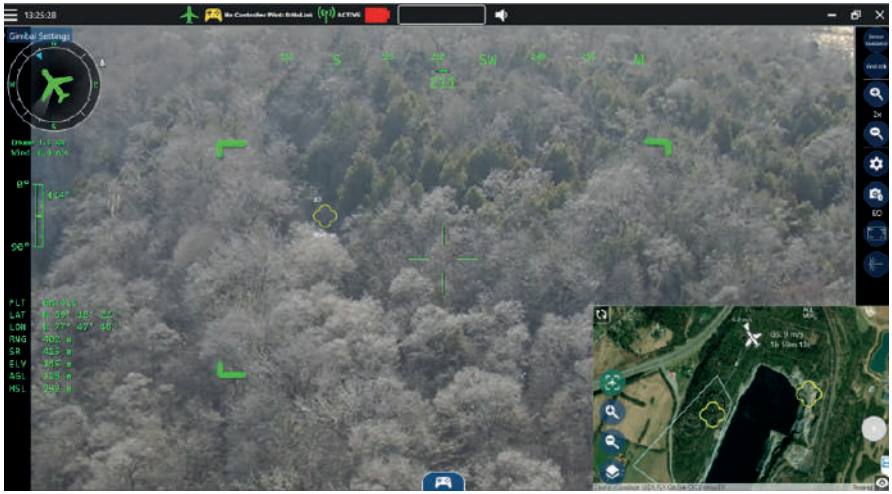
A maximum of 60 seconds can be set. This setting can also be changed in flight.

8.2.5 Sensor settings

The gimbal controls toolbar, found on the right of the sensor screen, provides access to the zoom settings, the camera selection and the camera settings.

Zoom

The zoom can be set in fixed steps by the + and - button, with the current settings displayed between them. To allow assessing if a target will be still be visible when zooming in, the image section visible in the next zoom step is marked by the green corners in the image.

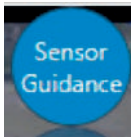


Camera Selection
The current camera can be selected with the camera switch button, if multiple cameras are available.

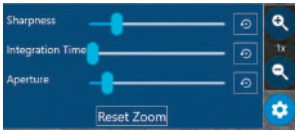
Camera Settings
The camera settings panel is opened by clicking the gear button. It features camera specific settings like sharpness, integration time or aperture.

8.2.6 Controlling the UAV via Sensor Guidance

When following a target or scanning an area, it is more convenient to just control the sensor and to have the aircraft follow the sensor target point automatically at a distance. This is possible with the *Sensor Guided* Mode.



- Activate: Select the control button in the top right of the sensor screen
    - Two circles appear around the UAV on the map.
- When the gimbal target position on the ground moves into the inner circle, the UAV will automatically move away, to avoid detection.
- When the gimbal target position leaves the outer circle, the UAV will automatically move closer to improve sensor image quality.



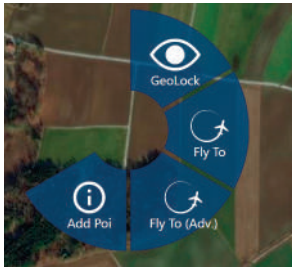
8.2.7 Controlling the Sensor via Joystick

The sensor pan and tilt angles can be defined manually via the small stick on the left side. The *stabilization mode* can be selected via the gimbal mode menu on the right of the sensor screen.
Scene stabilization uses the image information to smooth out the movement of the UAV. This leads in general to a more stable image, but is depending on enough variety in the sensor image. It will not work if large parts of the image are similar, e.g. large meadows, snowy fields or smooth waters.
Scene stabilization cannot handle parts of the UAV appearing in the image, due to low tilt angles, and will lose the set orientation. To avoid this, fly higher or use *Rate stabilization*. In addition, when coming close to the Gimbal Lock position (directly below the UAV), Scene stabilization also might lose its orientation.
Rate stabilization uses rate sensors to smooth out the movement of the UAV. It is generally less stable than Scene stabilization, but robust to image disturbances.

8.2.8 Sensor via FPV Mode

The sensor can be commanded to point forward in order to support piloting of the UAV. This is done using the FPV button on the gimbal control stick. The gimbal mode will display “Pos” for Position mode.

8.2.9 Controlling the Sensor via Geo-Lock



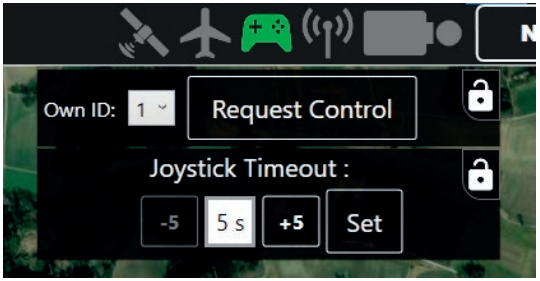
Activate: Click on the map, select *GeoLock*
• Use in sensor screen: Clicking on the ground in the image will align the sensor to this position.

8.2.10 Controlling the Sensor via Tracking

• Activate: Select *Tracking mode* from the Gimbal Mode Menu in the sensor screen
• Click on sensor image to select a target

  ◦ A rectangle around the closest identified object will appear and the sensor starts tracking this target. Since tracking is depending on image information, it can be disturbed by objects getting between the sensor and the target, like UAV parts at low tilt angles, trees, houses, etc. The track can also be lost, if the target changes too much in appearance (e.g. a person changing clothes, a car turning around fast).

8.2.11 Multi-Pilot Control



Joystick control can be taken over by another QBase instance connected to the same aircraft.
To take over control, open the joystick header widget, assign a pilot ID, and click the "Request Control" button

Note: "Ensure to assign a different pilot ID for each QBase instance."

8.3 Point of Interest (POI)

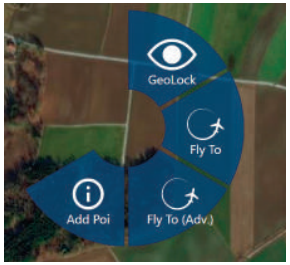
POIs are used to mark objects or events in location and time. There are 4 types:

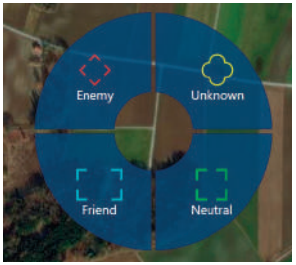
- Enemy
- Friend
- Neutral
- Unknown

POIs are visible on the map, the sensor image, if in view, and in the sidebar under the POI tab.

Adding

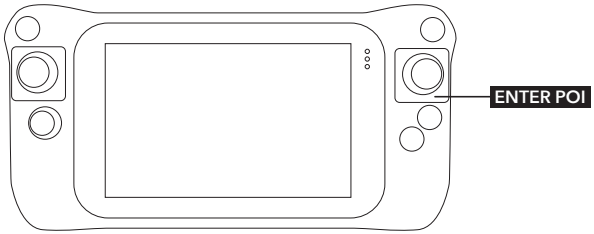
1. Enter a POI by clicking on the map, selecting the *Add POI* button and choosing the type. The POI is created at that location with the current timestamp.





2. Activate the POI by long clicking on the ground in the sensor image. The POI is created at the projected ground position of the gimbal view.

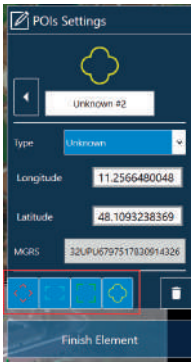
3. Enter a POI of type Unknown at the current gimbal target position by using the Enter POI button on the Skynav/Toughbook Controller.



Editing

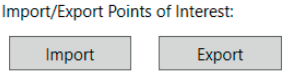
POIs can be edited by selecting them on the map and clicking Edit, or under the POI tab in the sidebar. In the popping up POI settings window the name, type and location can be changed. Clicking the trash button deletes the selected POI. In addition a selected POI can be dragged on the map to a new location.

Filtering
The POI settings view allows to filter out the display for POIs of any type on the map and in the sensor image.



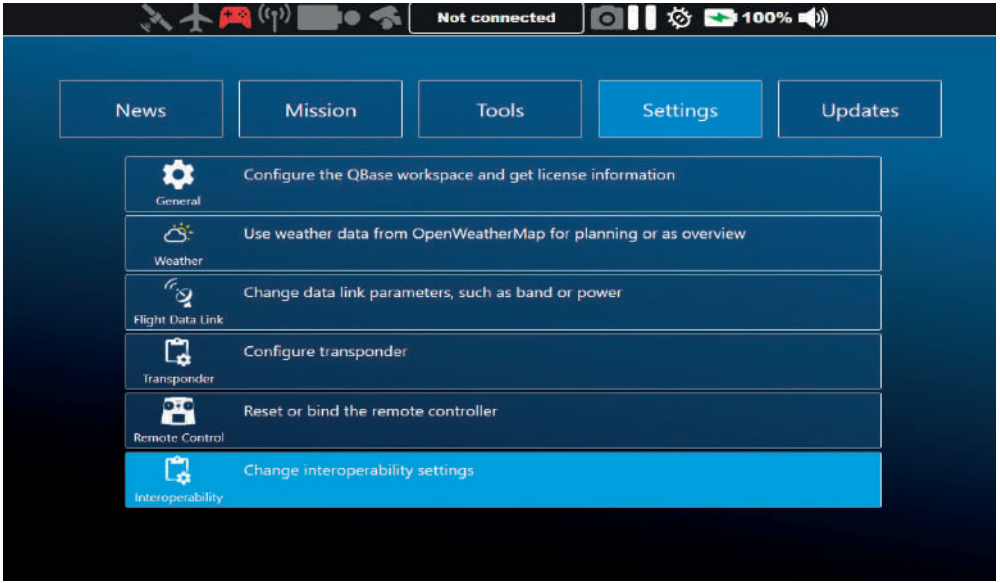
Storage and Import/Export
POIs are automatically saved in the current recording. This means during a mission they are stored in the mission recording and during replay in the selected replay recording. POIs can be added, edited and deleted during a replay. The timestamp for adding is then the current replay time. The timestamps of all POIs are displayed in the replay progress bar as yellow markers.

POIs can be exported and imported from Menu > Settings > Interoperability.
Upon import they are added to the currently available POIs.



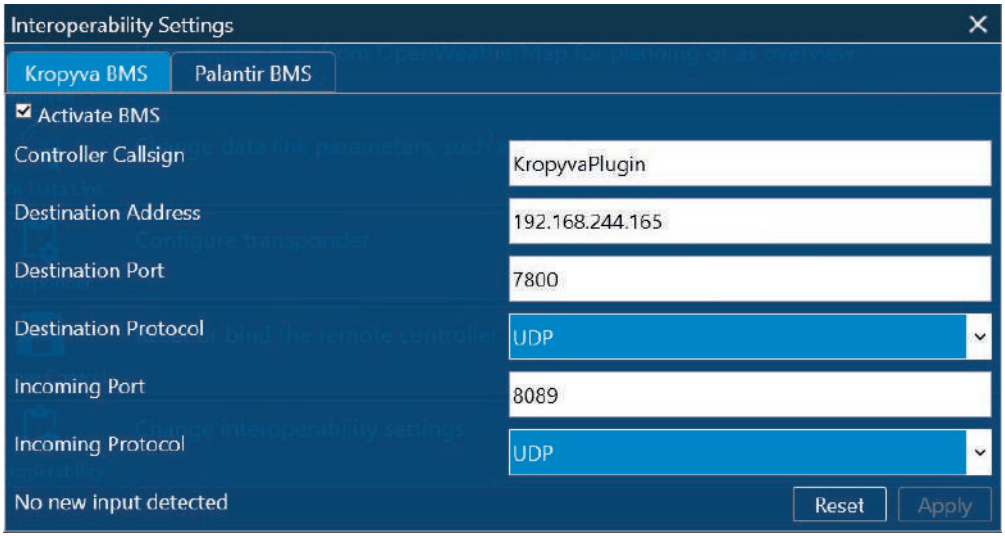
8.4 Integration into Battle Management System (BMS)

QBase offers the possibility to integrate some Battle Management Systems.
QBase Tactical is currently supporting Kropyva, ATAK and Palantir Battle Management Systems. To use the BMS plugins select Settings in the main menu and then select Change interoperability settings in the list. This will launch a new window with two tabs. One tab is for Kropyva and ATAK. The second tab is for Palantir BMS.



8.4.1 Kropya Plugin

The current functionality displays only one plugin between Kropyva and ATAK depending on which feature flag is set to true in Features.json.

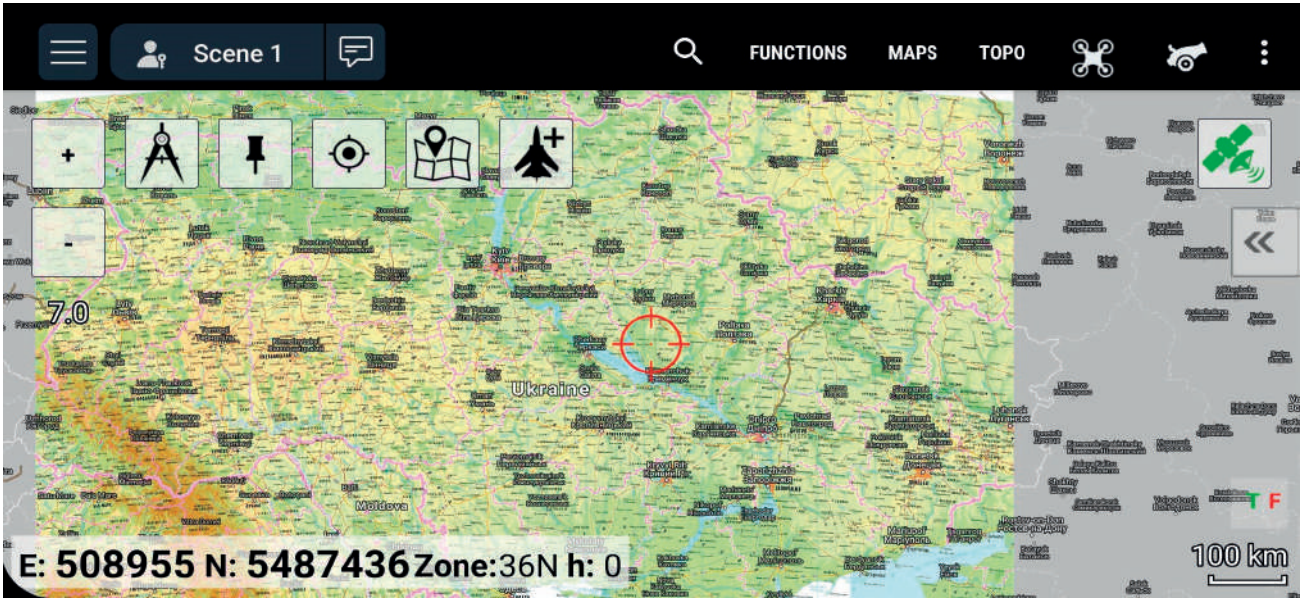


QBase sends Points of Interest (POIs) to Kropyva after clicking Apply.

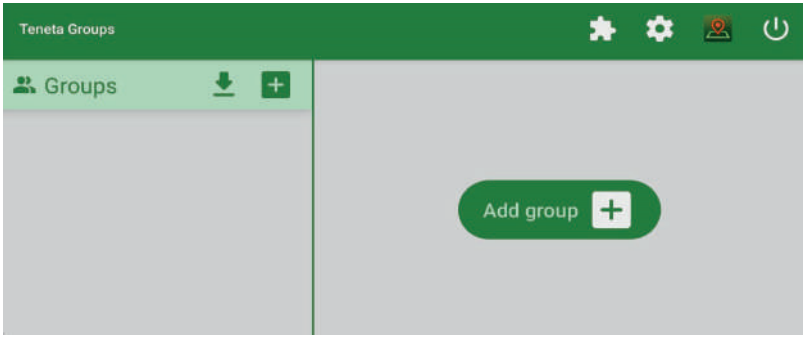
Steps to use Kropyva Plugin

To test kropyva plugin features, you will need to install two applications on your mobile phone - Kropyva Mapa and Tenata Groups.

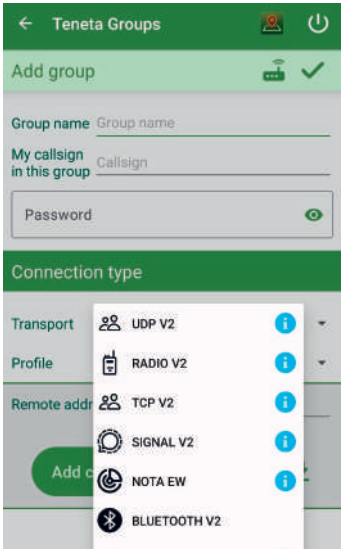
1. Install Kropyva Mapa application on your Mobile Phone.
   a. Get NOTA EW Plugin
   b. Unzip to get “TG_NOT_EW-plugin-v1.jar”
   c. Connect Kropyva Phone via USB and allow data transmission
   d. Place plugin into ...\tenetagroups\plugins
2. Login to the Kropyva Mapa application. (Password: QSUKR2023)
3. In the main screen you will see a map view with other options.



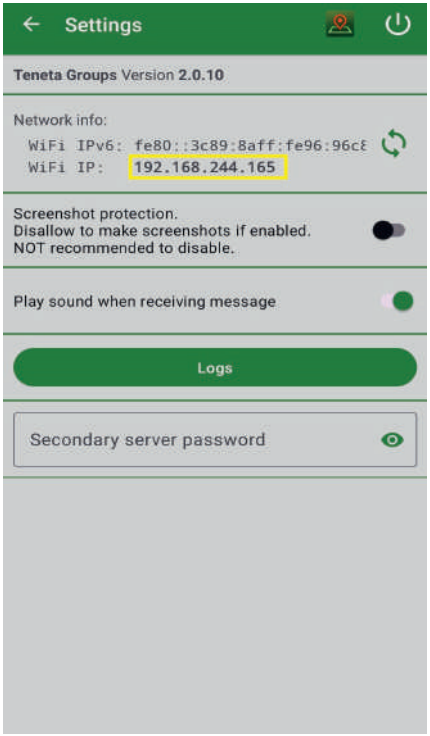
4. Now open Tenata Groups App
5. Create a new group. A new screen opens. Here Select Transport option. From the list select NOTA EW



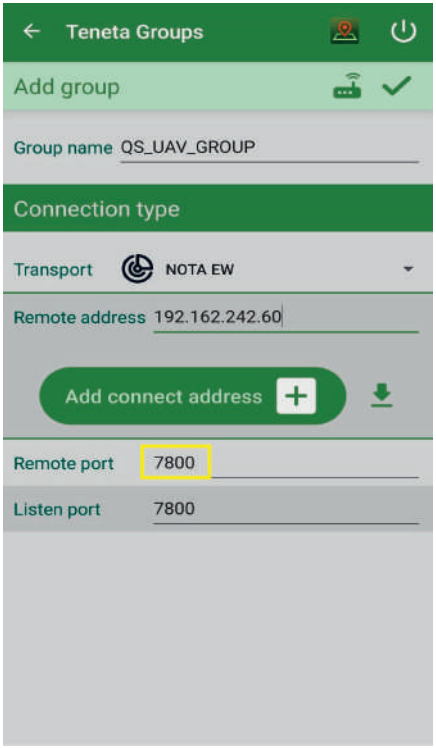
6. Give the Group name. And Provide the Remote IP Address. We will not be using the Remote Address so it need not be accurate.
7. Click on the Create button on top right.
8. Now in the main screen click the settings button on the top. Settings screen is opened.



9. Use the Wifi IP as the **Destination Address in QBase.**

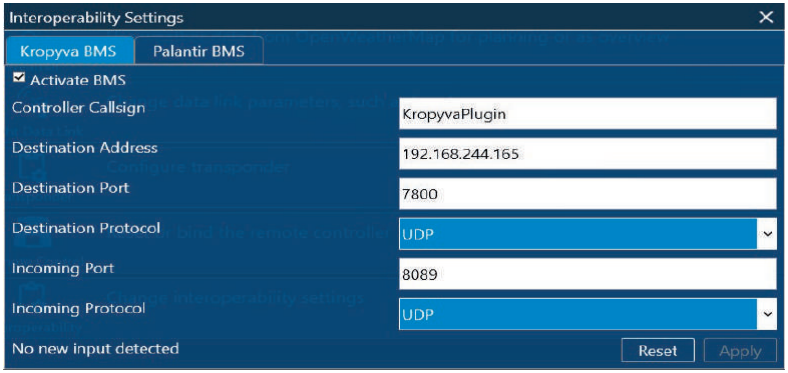


10. To find the destination port, click on **edit** on the Group and use the **Remote Port**.



11. Select UDP under **Destination Protocol.**
12. Keep the default values for **Incoming Port** and **Incoming Protocol** fields and click Apply.

The values entered here are persisted when user clicks **Apply** and are used as default values when QBase is restarted.

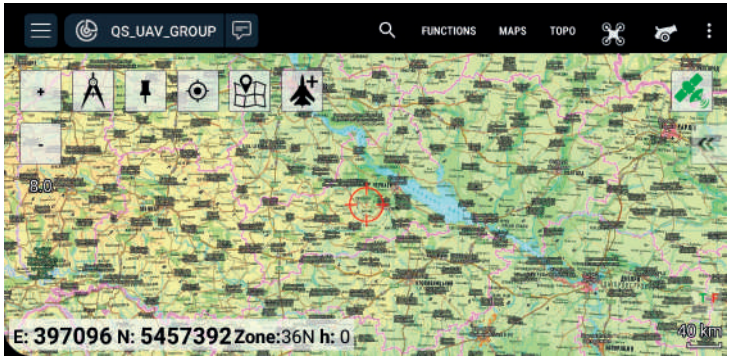


Apply button is clickable only when Activate BMS field is checked AND the input fields have new information compared to values used in previous session or the default values (during the first attempt).

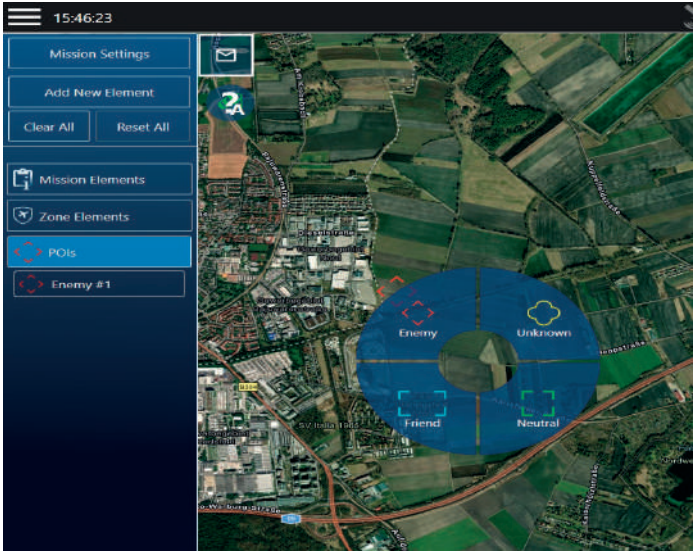
13. Edit the Controller Callsign field to activate teh Apply button.

Note: Activate BMS check button toggles the activated state of the plugin. If the field is uncheched, the transmission between QBase and Kropyva Mapa App is stopped.

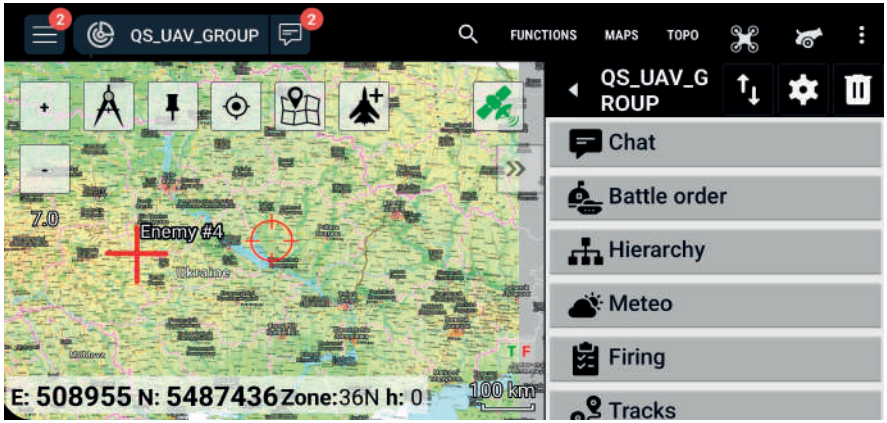
14. Now Kropyva Mapa should receive the information about an Enemy POI. Open the Kropyva Mapa App and upon successful connection with QBase, you will see the created Group on the top left of the app.



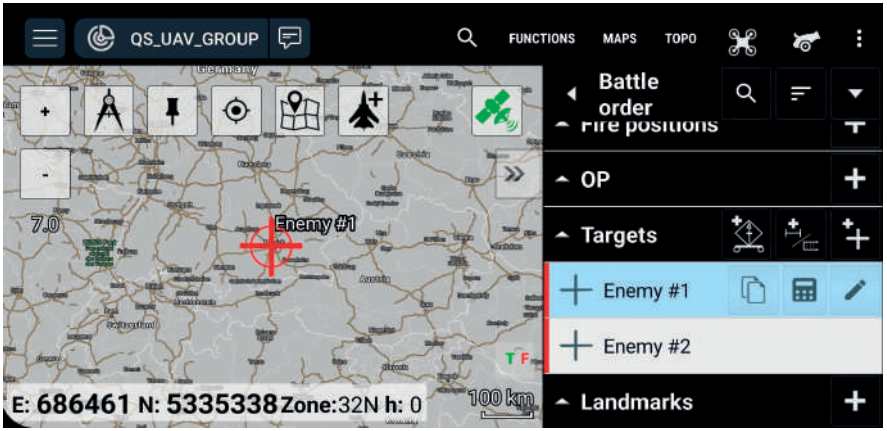
15. To test successful data transmission via UDP between QBase and Kropyva Mapa, create a POI on QBase map view.



16. Kropyva Mapa should receive these POIs (Type Enemy). Click on the Group name on the top left. It will show a list of options in the right. From the list, select **Battle Order.**

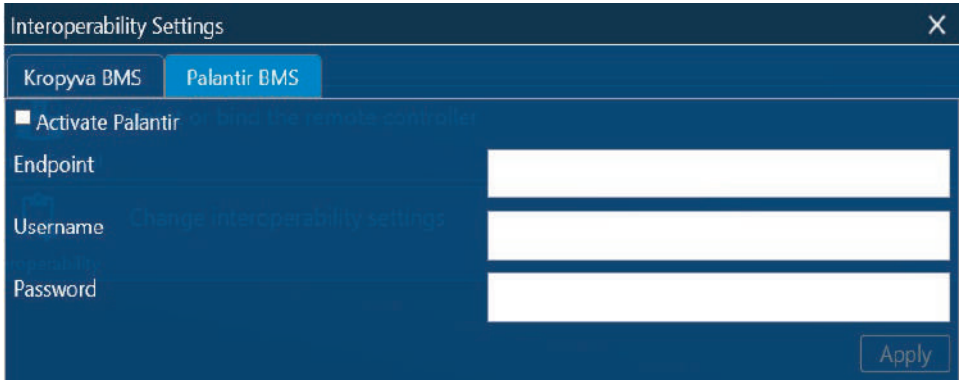


17. It will show the list of POIs transmitted.



8.4.2 Palantir Plugin

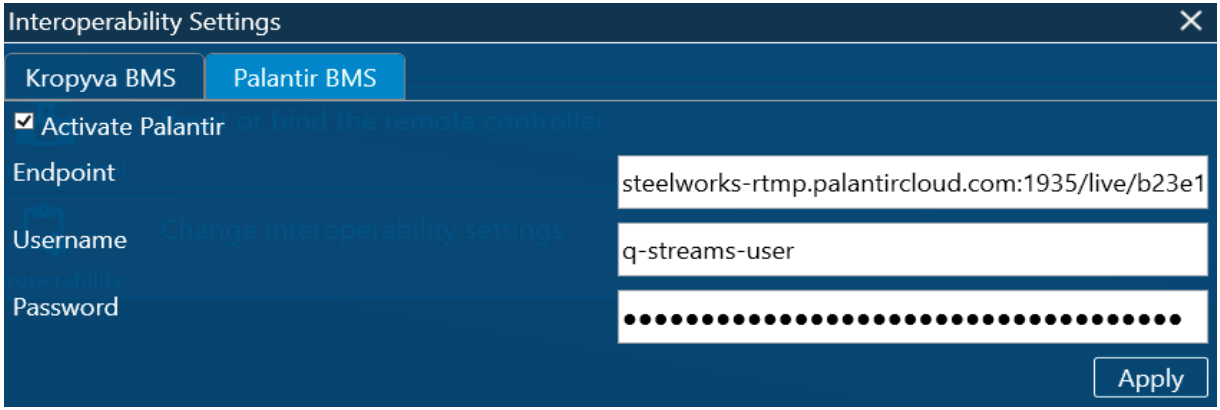
Palantir BMS has a dedicated tab and is displayed only when “PalantirPluginFeature” flag is set to true in Features.json.
Palantir BMS plugin streams video from Gimbal to Palantir server.



Steps to use Palantir BMS Plugin

1. Install OpenVPN. Find palantir.txt file and paste it in the bin folder of OpenVPN installation folder.
2. Launch and start the OpenVPN.
3. Lanuch QBase and connect the Raptor Gimbal.
4. Use the following fields in QBase to verify that the video stream feature works correctly:
   - **Endpoint**: steelworks-rtmp.palantircloud.com:1935/live/b23e1955-0743-41fd-a7e9-4ad69fc161fd/test
   - **Username**: q-streams-user
   - **PW**: 70baf5e7-a007-4982-886c-c0bd2401b882

5. To activate the Apply button, check the “Activate Palantir” checkbox.



6. Upon successful connection, the status message should read **Streaming.**
7. If errors occur, they should be dusplayed in red next to the apply button.

9. DATA-LINK HANDLING

9.1 Datalink Setup
9.1.1 Datalink Pairing
9.1.2 Datalink Monitoring
9.1.3 Datalink Settings
9.2 Antennas
9.3 Sources of Interference
9.4 Signal Parameters
9.5 Best practice
9.6 Multiple Datalink Setup

Datalink Link

This chapter covers the Silvus data link, which is used for the encrypted transfer of telemetry and video data from Vector and Scorpion to QBase tactical on the Skynav Tablet and on Panasonic Toughbook.
It discusses the nature of a radio transmission itself, as well as how to establish the connection between the UAV and the GCS, and possible adjustments to the data link by the user.

9.1 Radio Frequency (RF) basics

Multi-Radio Mesh Network (MANet)
Vector and Scorpion use a mesh-IP datalink by Silvus, allowing maximum flexibility paired with robust high bandwidth connection using Multi-Radio Mesh Network (MANET)

A Multi-Radio Mesh Network, also known as **M**obile **A**dHoc **N**etwork (MANet), is a radio communications network with a transmission topology that can be represented as a mesh. The network is decentralized, and doesn't rely on predefined network infrastructure, such as routers or access points. Instead, each node routes the traffic accordingly, so that packages are sent from its source to its destination. This happens by an automatic routing algorithm, that seeks out the best routes to deliver traffic as efficiently as possible.
The advantages are a highly performing network, no single point of failure, no additional setup, and scalability.
The Quantum-Systems Vector 2-in-1 System uses this technology. One radio is in the UAV, another acts as ground radio next to the operator. This creates a "one-to-one" connection. Adding radios to the network will increase network size. The network can be set up in different configurations to cater to the desired mission parameters.

MIMO technology

Next to MANET, the radios used in the Vector System also have the capability of using certain MIMO technology such as:
- Adaptive beamforming: By making use of the two-channel antenna configuration of each radio, the signals can be shifted to create constructive interference, effectively increasing signal strength. The phase shift necessary for this is calculated automatically and adjusts to changing circumstances, making it adaptive beamforming.
- Spatial Multiplexing: By dividing the stream into separated streams in space (in this case two differently rotated polariza-

tion planes). This allows for two separate streams, effectively doubling throughput

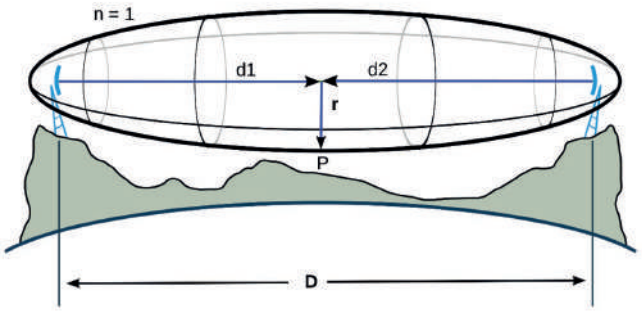
- Frequency-division Multiplexing: Making use of coded orthogonal frequency-division multiplexing (COFDM), a higher throughput can be achieved

Interference

In radio transmission, there are many sources of interference, that can reduce signal strength and thus reduce performance of a datalink. Below is some information about the most common sources of interference, and how to avoid them.

Fresnel Zone

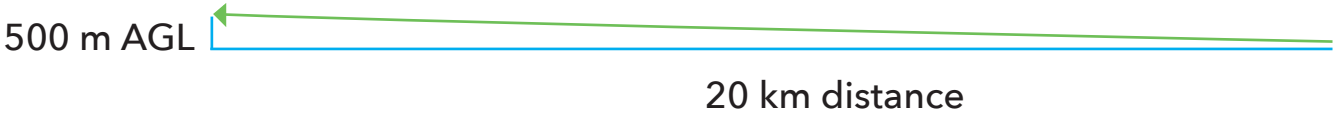
Contrary to intuition, radio waves travel not only directly, but also in an ellipsoidal pattern. This is visualized in below picture. A Fresnel zone is an imaginary ellipsoid between the antennas, which are located in the focal points of the ellipsoid. In the adjacent figure the Fresnel zone is shown above a hilly earth surface. Mounting antennas close to the ground can therefore reduce signal strength by partially blocking signal transmission. As a countermeasure, e.g. for achieving long distance, mounting the radio or antenna on a pole may increase signal strength.



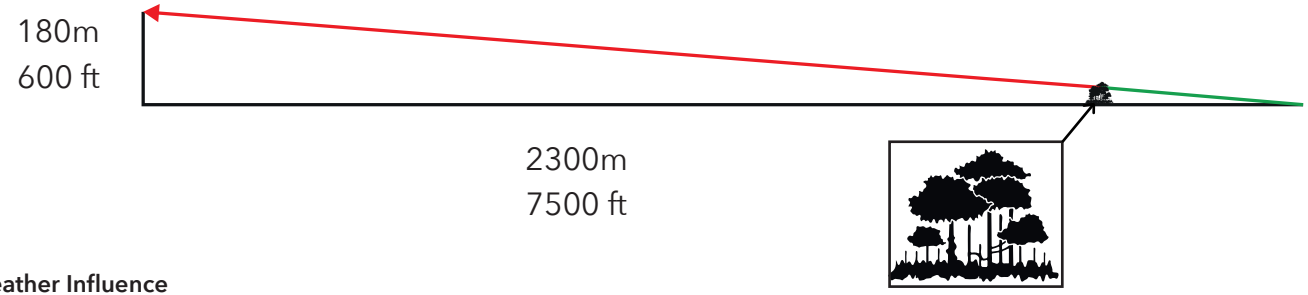
n	number of the Fresnel Zone	D	distance between transmitter
r	radius		and receiver
		P	point at half of D, d1 and d2

Geographical Influence

When flying long distance mission, it is important to recognize the scale of the geographical influence. Below graphic is a true to scale representation of the distance, altitude and angle of a long-distance radio signal path (simplified without Fresnel zone). The angle of the signal path is very low, therefore objects in the way can have big negative impact on the signal strength (e.g. trees close to the ground radio).



At such distance, the earth's curvature can decrease the effective height of the antennas. Think of the horizon you can see at the seashore. It is roughly 5km (or ~3 miles) away from the viewer. At 20m above ground this distance increases only to 17km (~11 miles). Having this in mind regarding to antenna positions (either fly high, or mount ground radio on antenna pole) can greatly increase performance.



Weather Influence
Water particles in the air cause diffraction, reflection and scattering of radio waves and hence attenuation. Therefore, it should be noted, that in misty conditions, high humidity or rain, a reduction of signal strength needs to be accounted for.

Noise
Noise is considered unwanted radio frequency electrical signals. The frequency, magnitude and source of noise can differentiate, yet commonly reduces the signal-to-noise ratio and thus the received signal of a transmission signal.

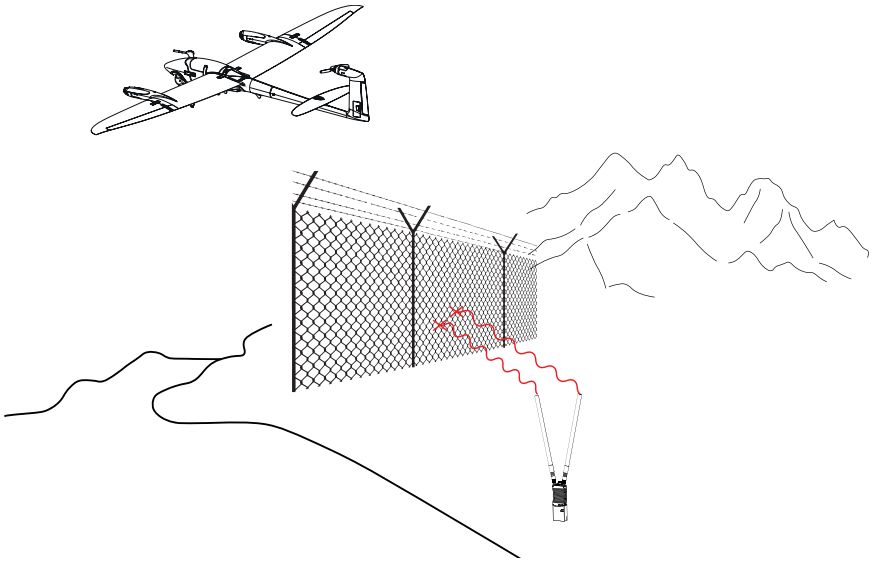
Imagine trying to converse with your partner in a busy restaurant, but your partner is sitting on the other side of the room. You either need to raise your voice or silence the other people. Both ways are rather tedious. In the radio domain, a common way to evade noise is to switch frequency or avoid noise polluted frequencies. In our restaurant domain, this would mean to either speak in a very high pitched or very baritone voice.

Noise pollution can have different sources, but most common are the unlicensed frequency bands (ISM bands – Industrial, Scientific, Medical)), such as the Wi-Fi (2.4 GHz) or comparable bands (833MHz, 500MHz). But heavy electric machinery (Generators, electric motors, big DCDC converters) can also create electromagnetic interference, that creates noise. Try to stay clear of noise polluted frequencies. The Silvus radio is capable of switching frequencies.

Isolators

In certain conditions, metal objects near the antenna can reduce, isolate, or block the radio signal. In most cases, the operator should try to avoid any metallic object in the vicinity of the antenna. A metal container or vehicle in the line of sight to the UAV can block the transmission completely in the worst case. A good way to get out of the influence of metal parts is the use of an extendable antenna pole.

Other objects to avoid: Metal railings, heavy metal concrete structures, high voltage pylons, etc. Ask yourself what around you can conduct electricity. If there is a lot, try changing position.



Signal parameters

RSSI
RSSI is an abbreviation and stands for “Received Signal Strength Indicator”. The RSSI is a measurement taken by the radio receiver and indicates the received signal strength.

SNR
The Signal to Noise Ratio (SNR) compares the communications signal level to the background noise level. The SNR is a crucial indicator of the performance and quality of a communication or signal processing system. It measures the strength of the desired signal relative to the interference or noise present in the system.

Signal Bandwidth
The signal bandwidth with Silvus radios can be adjusted 5Mhz, 10MHz or 20Mhz. Generally, a greater signal bandwidth increases throughput and traffic performance, but reduces SNR due to higher susceptibility to noise. Due to this fact, try reducing bandwidth in noisy or long-range conditions. If you have a high traffic load, and larger network, a greater bandwidth may increase performance.

Airtime
The Airtime is the time a node needs to transmit data. It is represented in percent. The time to transmit is limited to a fixed value and shared for the whole network, and depends mostly on set signal bandwidth, RSSI and SNR. The network algorithm allows for only one node to transmit at the time or to say, “go on air”. That’s why, if the traffic load is too high for current network conditions, the airtime can reach up to 100%. At this point not all data can be transmitted in real time, thus triggering errors such as compression artifacts, frame loss, etc. Try to keep airtime below 100% as much as possible.

MCS
The modulation coding scheme (MCS) is used to modulate the data onto the signal. A more efficient MCS has a higher data throughput. The MCS is chosen automatically by the Silvus system based on the RSSI. A higher RSSI results in a more efficient MCS. Thus, it is desirable to attain a high RSSI and SNR by reducing noise and increasing signal strength.

9.2 General Knowledge Silvus Streamcaster

The StreamCaster family of MIMO radios was designed with operator ease of use in mind. Each radio is capable of operating in a multitude of configurations that are accessed via simple web pages within the radio. Settings such as transmit power, frequency, channel bandwidth, link adaptation and range control can be accessed by simply using a web browser to log into any radio within the network.

Currently, two types of Streamcaster radios are available to Vector and Scorpion users:

- Silvus Streamcaster 4200 handheld device
- Silvus Streamcaster 4400 ground station

All Silvus Streamcaster radios combine

- Robust and reliable data connectivity
- Multiple frequency bands
- Mature MIMO and mesh technology
- IP67-tested housing

Technical specifications of the datalink

Bandwidth	5, 10, 20 MHz	Sensitivity	-99 dBm @ 5 MHz BW
Data encryption	DES Standard, AES/GCM 128/256	Battery life	4200: up to 12h 4400: external power supply
Data rate	100 Mb/s (adaptive)	International protection code	IP67
Output power	1 mW – 4 W (8 W for 4400)	Latency	7 ms average @ 20 MHz BW

All Silvus streamcaster radios can be used configured as single or dual band radios.

In the dual band variant, a variety of possible combinations from the available wavelength ranges are available for selection.

The radios used for Vector and Scorpion are equipped for use in the wavelength range 2.2 to 2.5 GHz.

Other wavelength ranges are possible depending on customer requirements.

The Antennas must match the frequency band of the radios.

In the figure the antennas for the wavelength range of 2.2 - 2.5 GHz.

Band (Freq. Code)	Frequenz Bereich
UHF (042)	400-450
ISM 900 (091)	902-928
L Band (137)	1350-1390
Upper L (181)	1780-1850
BROADCAST B (206)	2025-2110
FEDERAL S (225)	2200-2300
S BAND (235)	2200-2500
2,4 GHZ ISM (245)	2400-2500
LOW C BAND (455)	4400-4700
FEDERAL C-1 (467)	4400-4940
FEDERAL C-2 (469)	4400-4990
HIGH C BAND (485)	4700-5000
5,2 GHZ ISM (520)	5150-5250
5,8 GHZ ISM (580)	5725-5875

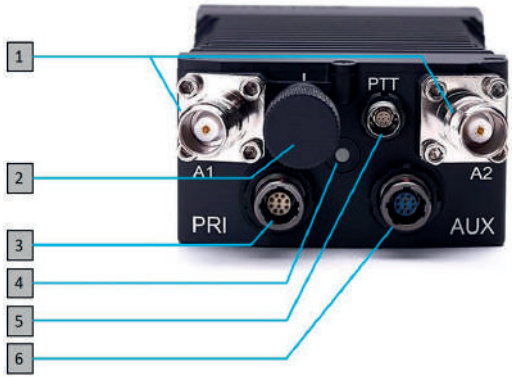
Silvus Streamcaster 4200

1. Antenna connector 1-2
2. Power Switch (15-Position Rotating)
3. Ethernet and Serial Port Connector
4. Bi-Color Status LED

- Red – Radio is in the process of booting up
- Flashing Green – Radio is fully booted but not wirelessly connec ted to any other radio
- Green – Radio is wirelessly connected to at least one other radio
- Flashing Red – Spectrum Scan in Progress
- Flashing Red – Radio has recovered from a bad state
- Rapid Flashing Red for 1 second – The battery is less than or equal to 20%. LED will blink red rapidly for 1 second then go back to normal. This will repeat every 5 seconds

- Rapid Flashing Green – When the multi position switch is rotate to a new position, LED will rapidly flash green while new settings are being applied. LED will resume normal indication after settings have been applied.

5. Push-to-Talk (PTT) Connector
6. AUX Connector



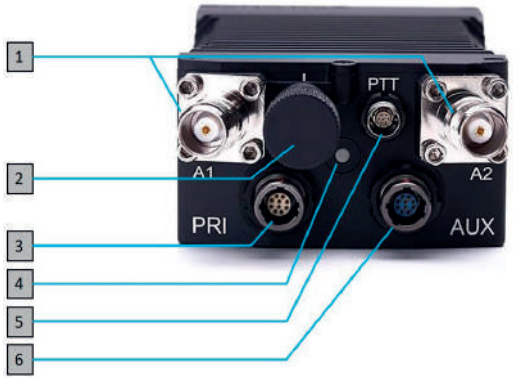
Mechanical and Operating Specifications

Mechanical

Ambient Temp.	-40° to +65° C	Voltage / Current.	9 – 20 VDC (±5%), 5A
IP Rating	IP-68 (Dust / Submersible in Water up to 20m)*	Power Consumption	4.8 W – 24 W @ 4W TX Power
Dimensions	10.16 cm x 6,68 cm x 3,84 cm (4.00" x 2.63" x 1.51")	Battery Life	Up to 12 Hours
Weight	0.43 kg (0.94 lbs.)	(*) Must have all connectors mated with IP68+ cables/antennas	

Silvus Streamcaster 4400

1. Antenna connectors
2. Bi-Color Status LED
   - Red – Radio is in the process of booting up
   - Flashing Green – Radio is fully booted but not wirelessly connec ted to any other radio
   - Green – Radio is wirelessly connected to at least one other radio
   - Flashing Red – Spectrum Scan in Progress
   - Flashing Red – Radio has recovered from a bad state
3. Power (9-20V), Ethernet, and Serial Port Connector
4. Push-to-Talk (PTT) Connector
5. AUX Connector
6. Power Switch (2-Position Rotating)



Mechanical and Operating Specifications

Mechanical

Ambient Temp.	-40° to +65° C	Voltage / Current.	9 – 20 VDC (±5%), 5A
IP Rating	IP-68 (Dust / Submersible in Water up to 20m)*	Power Consumption	8 W – 43 W @ 8W TX Power
Dimensions	13.33 cm x 11,43 cm x 4.57 cm (5.25″ x 4.5″ x 1.8″)	Battery Life	Up to 12 Hours
Weight	1.13 kg (2.5 lbs.)	(*) Must have all connectors mated with IP68+ cables/antennas	

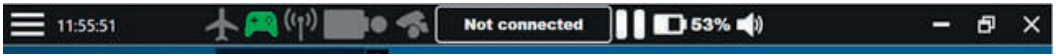
9.3 Establish a Datalink Connection

Connect the Silvus Streamcaster to the Skynav tablet with the matching cable and open QBase tactical. The Skynav is connected to the Silvus Streamcaster with an ODU AMC connector. The Skynav is connected with the 8 pin connector, the Streamcaster with the 10 pin end of the cable.

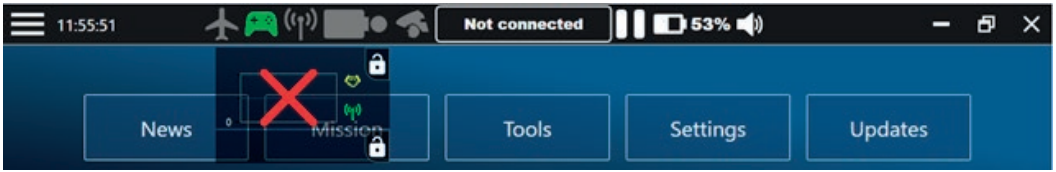
ODU AMC8 pin connector

ODU AMC 10 pin connector

To check the data link connection or to establish a new data link connection, click on the antenna icon in the top bar of QBase tactical.

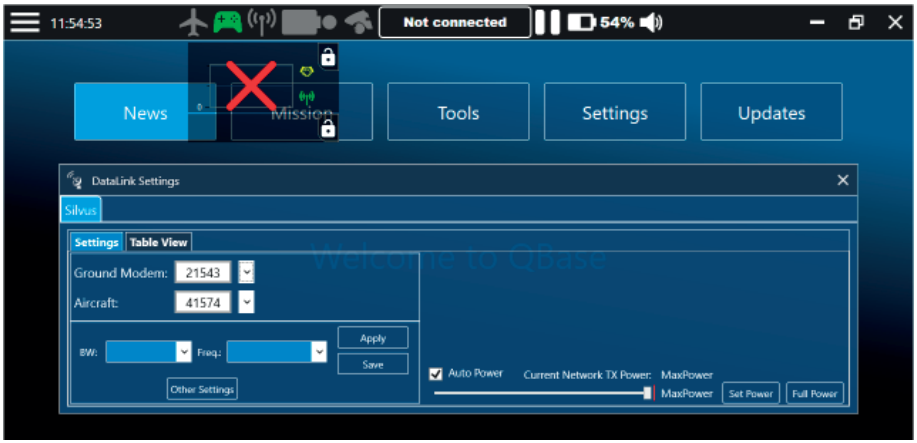


The data link status display will open.



If no active, connected data link is found, a red X is shown in the data link status display.

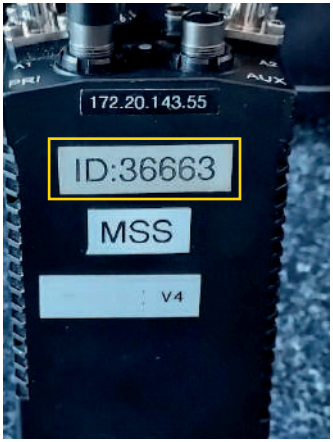
To establish a connection between the Silvus Streamcaster connected to the Skynav tablet and the Vector / Scorpion, the Ground Modem and the Aircraft must be set the appropriate ID

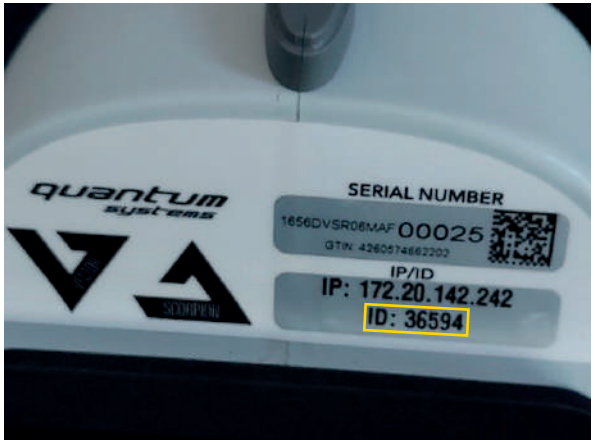


If the Silvus Radio and the Vector / Scorpion do not have the correct ID, no active connection can be displayed.

The ID of the Silvus Streamcaster is directly sticked on the radio (here 36663) and the ID of the UAV is on a sticker under the battery cover (here 36594).

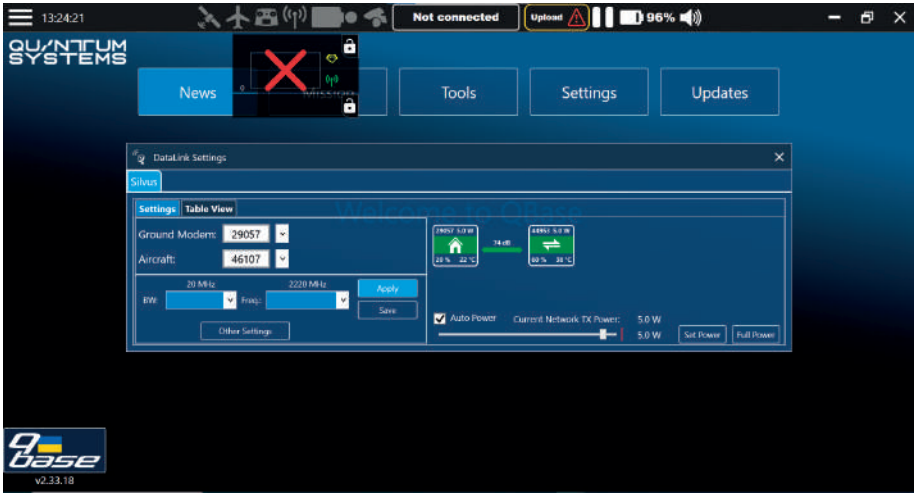
By correctly entering the ID for the ground modem, all other Silvus radios on the same network can be detected. However, one of these active radios must first be assigned as the corresponding UAV (Aircraft).

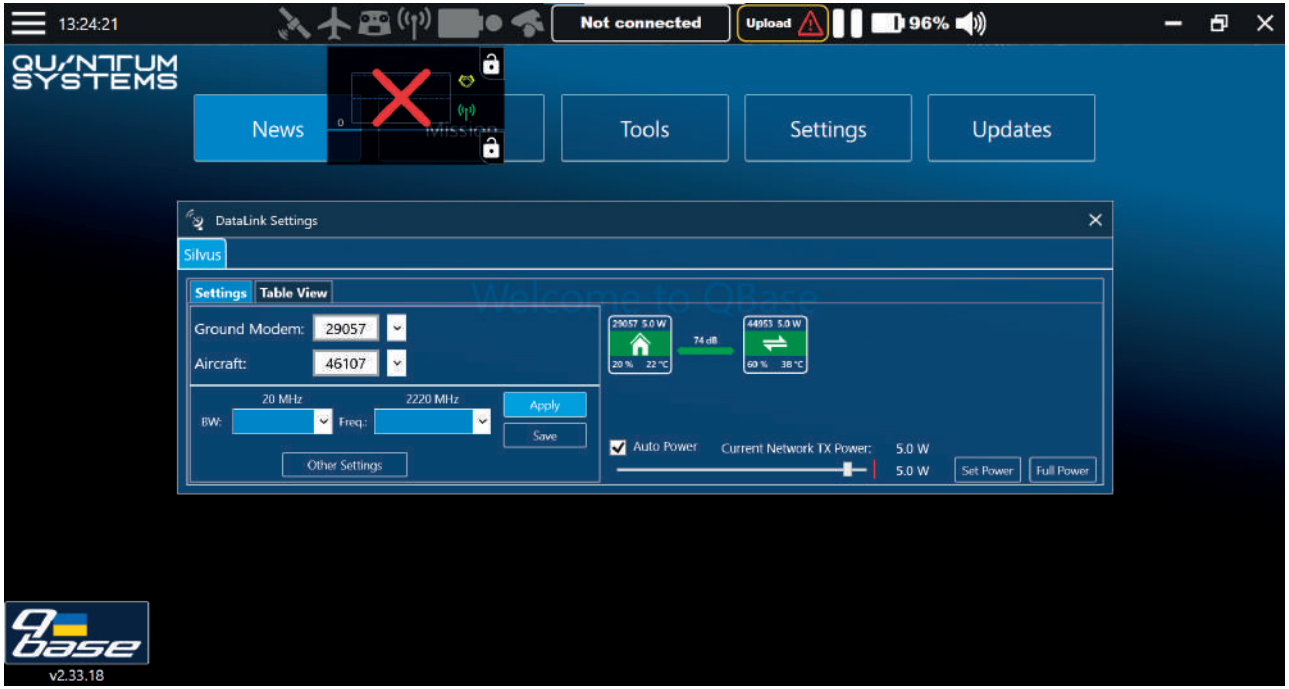




Here in the example a Silvus Radio with the ID 36594 is displayed, but as Aircraft ID 41574 is noted. Therefore, no connection between Ground Modem and Aircraft could be established yet.

Since the Silvus Radio with the ID 36594 is displayed as Active and it belongs to the used UAV as seen above, this ID must be entered in the Aircraft field or selected from the dropdown menu.





The last 4 used ground modems and aircrafts are saved and accessible via the corresponding dropdown menu

After that, the established connection will be displayed in the Datalink Settings window as well as in the Datalink header widget.

The Ground link is marked with a house icon, the Aircraft link with an aircraft icon and all other Silvus radios in the same network with this icon:

Any number of Silvus radios can be involved in a network, but only two of them have a fixed assigned task as Groundlink or Aircraft Link. The following figure shows a network with three radios.

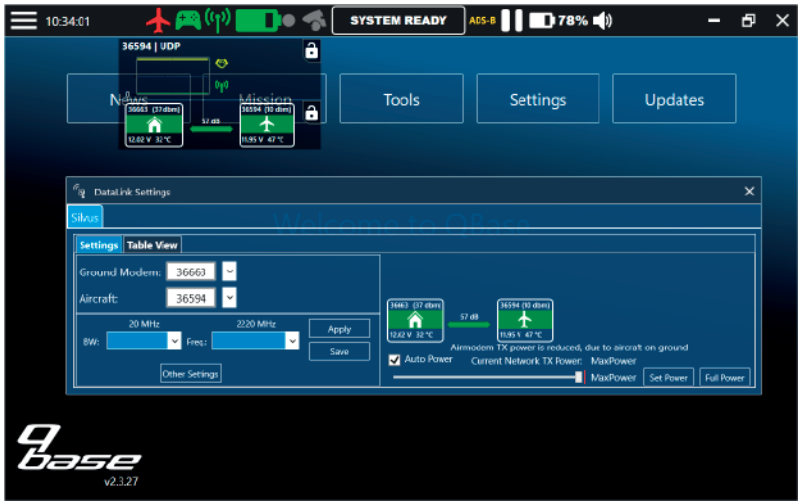
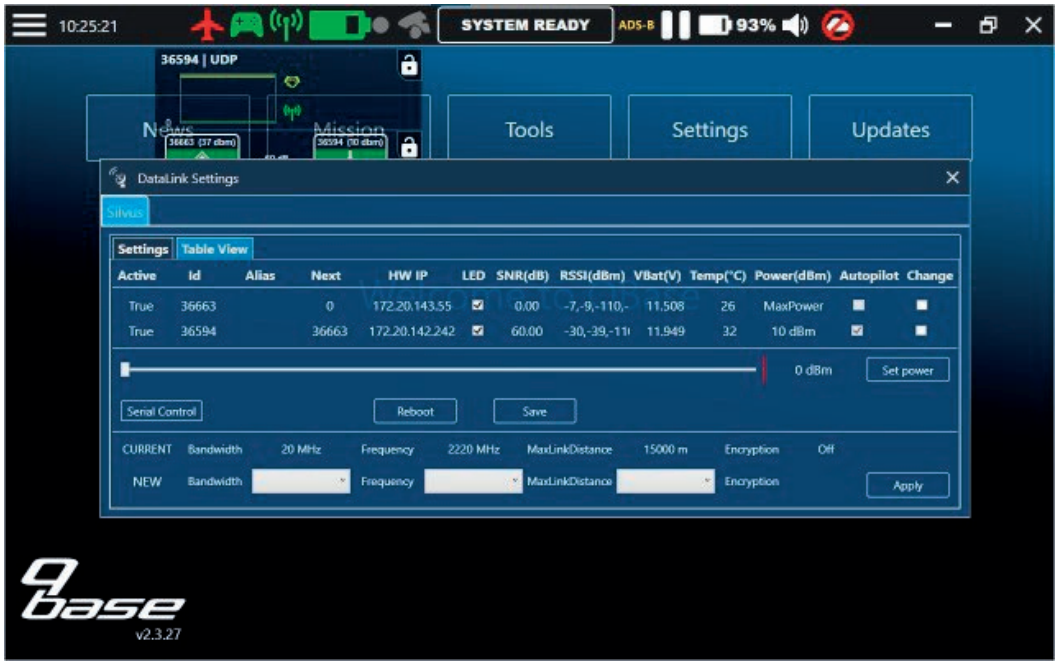


Table view

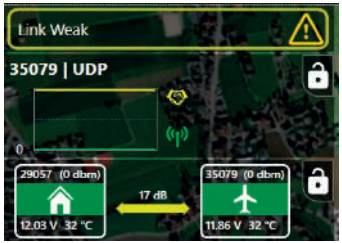
The table view shows all nodes in the network and allows changing settings for each node individually. Changing the values in this view might reduce link stability and quality!

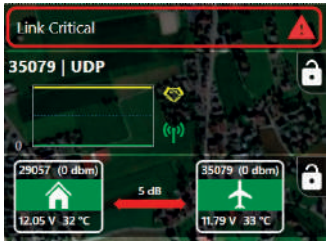


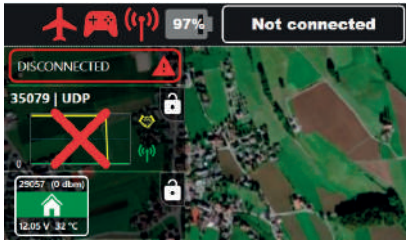
9.4 Solving Connection problems

Link Loss

In case of a Link Loss the UAV will fly to the link reestablishing waypoint automatically after link loss timeout and try to reestablish the communication (see chapter 10 Safety). Either select Come Home or Continue in QBase tactical.







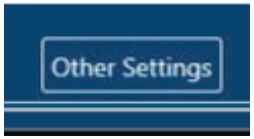
Link Weak ⚠ Link Critical ⚠ Disconnected ⚠

The reasons for a weak link or a critical link can be diverse. Among others, the following are possible:

- The aircraft is too far away and out of link range (Pay attention to the curvature of the earth)
- The aircraft is no longer in the line of sight, e.g. behind a hill or a dense forest
- The aircraft is located directly above the ground link. The way the antennas are radiated means that no data link is available directly above the ground modem.
- Fog and moist air can negatively affect the range of the data link.
- As a result of EW interference.

If no data link can be established at all, the interface of the Silvus Streamcaster should be accessed directly via **Other Settings**.

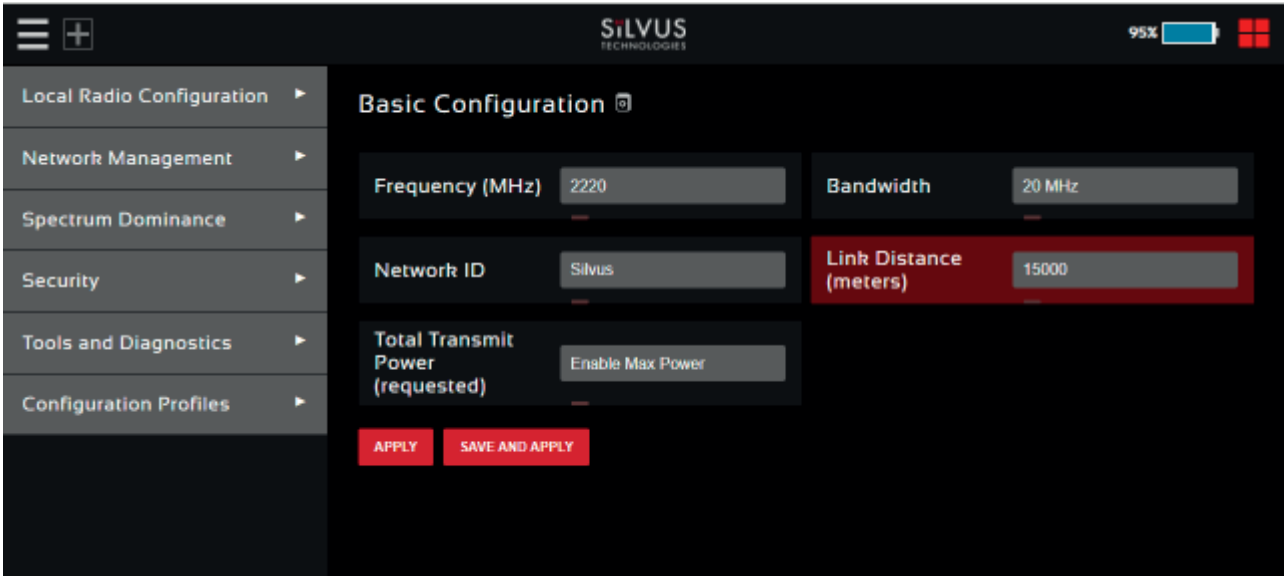
9.5 Advanced Silvus Settings



If a Silvus terminal is not displayed, even though it is powered and within range of the network, the network settings must be checked.

The Ground Modem can be accessed and configured through the description below, while in order to configure the Air Modem, if no connection is established, is necessary to conncet the Main to the Laptop through the DSub to Ethernet Cable

Frequency (MHz) and Network ID must match here. The Link Distance (meters) must also have the same value for all Silvus data links involved.



This page is used to set basic configurations. A brief description of each parameter is given below.

- Frequency: This defines the frequency of the signal. There is a drop-down menu for frequency selection. The frequency choices will vary depending on the StreamCaster model(s) you are using. In the additional information section of the frequency section (click on the red bar directly below), you can select a link that will take you to create custom frequencies.

- Bandwidth: This defines the RF bandwidth of the signal. A higher bandwidth will allow more throughput while a narrower bandwidth will be susceptible to less noise.

- Network ID: Network ID allows for clusters of radios to operate in the same channel, but remain independent. A radio with a given Network ID will only communicate with other radios with the same Network ID. The Network ID is limited to alphanumeric characters, spaces, and the special character '-'. Character limit is 32 characters.

- Link Distance: Set to an approximate maximum distance between any two nodes in meters, e.g., 5000 for 5km (default). It is important to set the link distance to allow enough time for packets to propagate over the air. Failing to set the link distance to an approximate maximum distance can result in over the air collisions and a degradation of performance. It is recommended to set the link distance 10-15% greater than the actual maximum distance. Please note that this value should be set the same on all radios in the network.

- Total Transmit Power: This defines the total power of the signal (power is divided equally between the radio antenna ports). There is also an option to 'Enable Max Power' which will allow the radio to push to the highest TX power it can support. This will be slightly different on each radio.

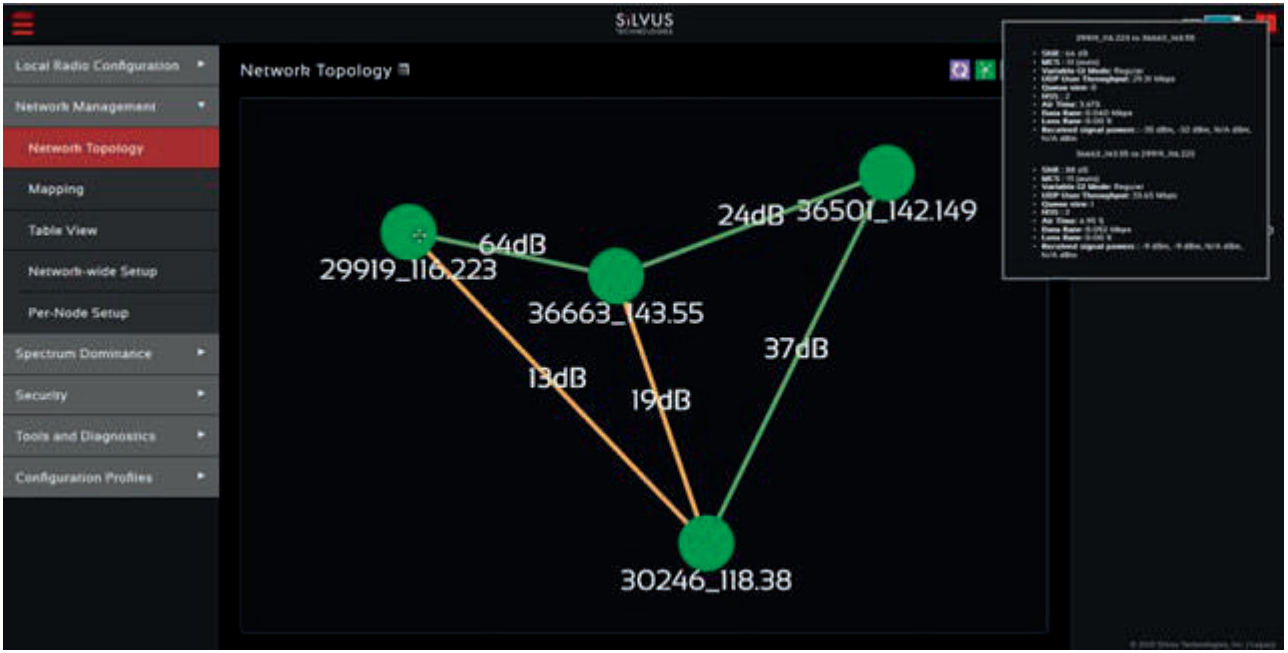
- Apply: Apply the new values. Values will change back to the default setting after reboot.

- Save and Apply: Apply the new values and set the new values as the default.

Network management

Using Network Management - Network Topology, all nodes involved in a network can be displayed graphically, showing their connection strength.
Here in the example, it can be seen that the nodes 29919 - 36501 and 30246 are connected to each other via a strong connec-

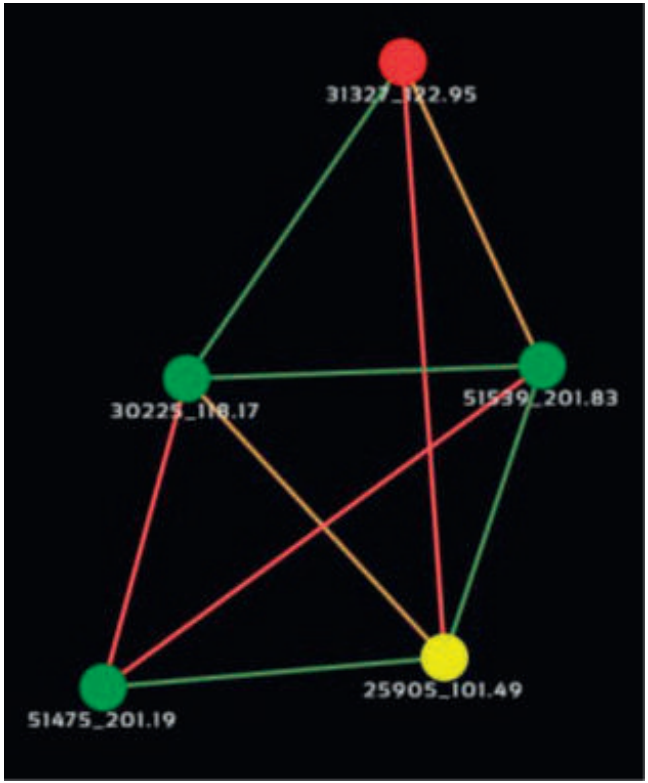
tion. Shown with a green connection line.
In contrast, 29919 and 30246 as well as 36663 and 30246 have only a weak connection. Shown with an orange line.



The network topology provides the user with real-time visual feedback of the network. Users will be able to determine several network characteristics at a glance with the following features:

- Color Coded Link Health – Color coding of each link in the network allows the user to quickly identify the weak links within a network. A link between two nodes will transition from green to yellow to red as the link weakens while also displaying the signal-to-noise ratio (SNR) of the link. See example below.

- Route Health – The Silvus StreamScape Utility will alert the user when too many packets are being routed through a single node. In such cases, a node will change from green to yellow to red as the packet queue increases (see '31327_122.95' and '25905_101.49' in Example Network Topology). This will allow the user to recognize the issue and configure the network accordingly. Table below also shows the values for each scenario.



	Green	Orange	Red
Link	>20dB	10 – 20dB	<10dB
Node	<10 Packets in Queue	10 – 100 Packets in Queue	>100 Packets in Queue

The Silvus web interface offers a whole range of other setting options. However, these should only be made if the effects on the network and the transmitting powers are precisely known.

A deeper knowledge of how Silvus radios work is a prerequisite here!

9.6 Non standard connection possibilities

Having an additional QBase tactical on a larger screen can give you additional insight in the mission status or can help you to support the pilot in command on the Skynav. Alternatively, the video stream can be received by third party software (e.g. VLC). The video signal can of course also be passed on, e.g. via an HDMI connection or via an online meeting.

Required for this configuration:

- Silvus Streamcaster 4200 or 4400

- SkyNav tablet with QBase tactical
- Laptop with QBase tactical
- Switch
- Cables:
  - Ethernet (RJ45) to Ethernet (RJ45
  - Ethernet to Silvus (ODU AMC 10 pin connector)
  - Ethernet to SkyNav (ODU AMC 8 pin connector)

To establish a connection between Vector or Scorpion and QBase tactical on a laptop using a switch, the following settings are required:

Windows Start Menu -> Windows Settings -> Network & Internet -> Network and Sharing Center -> Change Adapter Settings -> Ethernet –> Right Click -> Properties

IPv4 Properties

IP 172.20.1.XX (for XX 1 – 255)

Subnet 255.255.0.0

Standard Gateway 172.20.1.1

10. UPDATES, SETTINGS & POST-FLIGHT

10.1 Updating QBase
10.2 VS Ground Connection
10.3 Description of QOS
10.4 Updating of QOS
    10.4.1 Updating QOS via QBase
    10.4.2 Updating QOS via Browser Interface
10.5 FlyLogs Download
10.5.1 On-Board Recordings Download
10.6 Recordings Download
    10.6.1 GCS Recordings Download
    10.6.2 On-Board Recordings Download
10.7 Updating the Raptor Payload
    10.7.1 TRIP2 Update Instructions
    10.7.2 Raptor Camera Update Instructions
10.8 Updating the Smart Battery
10.9 VS Calibration
    10.9.1 Calibrating Magnetometer
    10.9.2 Calibrating Accelerometer
10.10 Exceptional Updating Procedures
    10.10.1 Updating FMU Firmware
    10.10.2 Updating ESC Firmware
    10.10.3 Updating PDB Firmware
    10.10.4 Updating PMBV Firmware

10.1 Updating QBase

QBase will notify about available QBase updates upon startup.

To manually check for new updates:
1. Open the Main Menu of QBase and open the Updates menu.
2. Open Search Updates
3. A window will open the Updates window, showing the Detected Version and the Newest Version of each Firmware.
4. If a new version for the QBase Tactical is available, the download will start automatically. If not, download it manually by clicking on download.
5. When the download has finished and the green Update button appear next to the firmware.
6. Select Update to start the installation.
7. QBase is closed and the installer opens automatically.
8. Follow the instructions of the Setup Wizard. The old version of QBase is automatically overwritten.

10.2 VS Ground Connection

For updates, changing settings and post-flight procedures, VS can be connected to the GCS via cable. Proceed as follows:

1. Power the Smart Battery and insert it into the Main Body.
2. Connect the USB-C cable (4) (refer to chapter 3) supplied with the standard accessories kit to the Main Body (A)
3. Connect the cable to the GCS via USB port.

10.3 Description of QOS

The QOS consists of the firmwares of Autopilot, ESC, PDB and PMBV and is essential for the safety of the flight. When a new QOS firmware becomes available the user is informed via QBase.

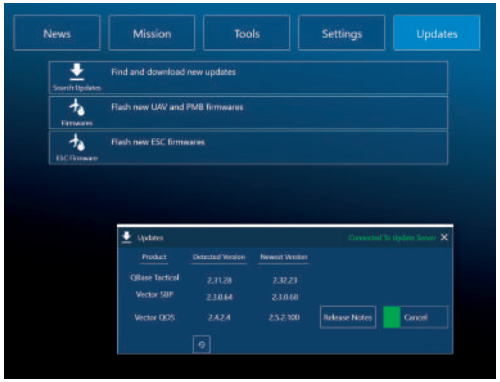
Attention: The highest level of flight safety can only be achieved with latest software release. Therefore, Quantum-Systems can only offer warranty if the UAV and QBase are up to date as soon as an update becomes avalible.

10.4 Updating QOS

The update of the QOS to the latest version is highly recommended.

10.4.1 Updating QOS via QBase

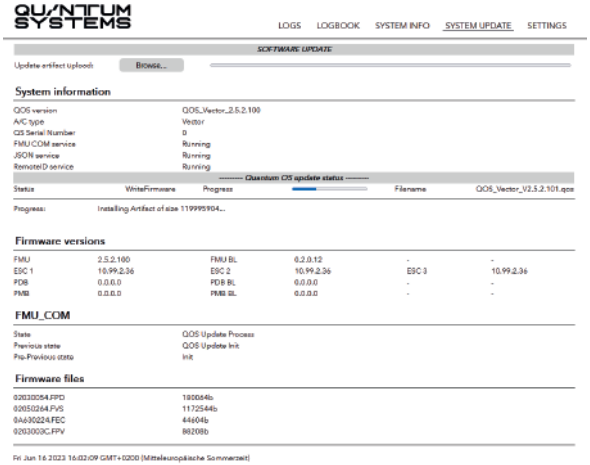
Instructions to download and install the aircraft firmware QOS via QBase. This includes all firmwares of the aircraft: Autopilot, ESC, PDB and PMBV.



1. Follow the pairing procedure as described in chapter 9.3.
2. Make sure to have internet connection.
3. Open the Main Menu of QBase and open the Updates menu.
4. Open Search Updates
5. A window will open the Updates window, showing the Detected Version and the Newest Version of each Firmware.
6. If a new version for the Vector QOS is available, the download will start automatically. If not, download it manually by clicking on download.
7. When the download has finished and the green Update button appear next to the firmware, follow chapter 10.2.
8. Select Update to start the installation.
9. The Browser Interface of the VS will open and the update installation start automatically.
10. Once the update is installed successfully, the newest firmware version will be displayed under the system information and in QBase in the Updates window.

10.4.2 Updating QOS via Browser Interface

Instructions to download and install the aircraft firmware QOS via Browser Interface. This includes all firmwares of the aircraft: Autopilot, ESC, PDB and PMBV. This instruction is an alternative to the update of the QOS via QBase.

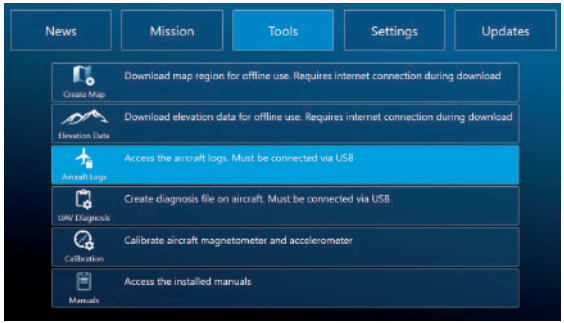


1. Follow the Ground Connection instructions of chapter 10.2.
2. Open the browser of the GCS and insert the IP in the search bar: 10.41.1.1
3. The interface of the UAV will open on the LOGS tab.
4. Select System Update.
5. Select Browse. The firmwares folder will open.
6. Double-click the latest version of the QOS.
7. The download and installation will start automatically.

Note: "To ensure a successful system update, closely monitor the update status. The system may reboot multiple times during the process. Interrupting the procedure prematurely can result in system damage, often referred to as "bricking." Vigilance is crucial to avoid such issues."

10.5 FlyLogs Download

FlyLogs are generated during the flight and saved on the autopilot board of the UAV. The file includes all data of the flight and might be needed by QS customer support for troubleshooting. Please note that only the last ten FlyLogs are saved on the autopilot. To prevent loss of data, please download the FlyLogs regularly, at least after every 10th flight.
Note: the reading of the FlyLog files is only possible by QS customer support, as they are encrypted for security reasons.



In order to download the FlyLogs please follow the following steps:

1. Connect the battery to the main body.
2. Connection of the main body

Connect the main body of the UAV to your computer, laptop or tablet via the **USB-C connection**.

- Open 10.41.1.1 in your browser

OR

Connect the main body of the UAV to your computer, laptop or tablet via the **WIFI connection**.

- Connect the Vector Skynode via Wifi.
  Network:
  Password:
- Open 10.41.2.1 in your browser

3. An online interface will be opened in the browser.
4. Open the first tab LOGS to show all the logs stored on the vehicle. The logs are ordered accoding to the date.
5. Please download the corresponding log by selecting it. A log indicating the flight is marked with PFC - the download includes the FlyLog (.FMU) wuth the corresponding preflight recording (.FMU_PRE).
6. Save the files on your computer.

To prevent lodd of data please always download the logfiles regularly. The autopilot overwrites previous files if the internal storage is full.

10.5.1 Logging

QBase writes different kinds of log files, which can all be found in the folder Documents/QBase/Logs.

GCS Logs
Format: GCS Log - 2023-09-20 + 11-44-45.log
The GCS logs are the main QBase logs and contain information about application errors, warnings, and notifications, as well as general application information.

Full Silvus Logs (QBase Tactical only)
Format: FullSilvusLog - 2023-08-17+11-30-45.txt
Full silvus logs periodically capture information about the Silvus network that the GCS is connected to.
They are primarily used for troubleshooting Silvus issues.

TOF Logs (QBase Tactical only)
Format: TOF Log - 2023-09-20 + 18-15-52.log
TOF logs contain information about Silvus Time-Of-Flight (TOF) measurements that QBase retrieves from the Silvus ground modem and sends to the autopilot. They are primarily used for troubleshooting problems with the Silvus time-of-flight measurements.

See **GNSS Denied** for more information about Silvus TOF measurements.

Comm Logs
Format: CommLog - 2023-09-20 + 18-15-52.log
Comm logs contain information about the Mavlink communication between QBase and the Aircraft and are used for development and debugging purposes.

Position Logs
Format: Position Log - 2023-03-17 + 12-27-15.log
Position logs periodically capture the current aircraft position and orientation as well as the raw GNSS position.
They are primarily used for troubleshooting customers' issues and for locating lost aircrafts.

PPK Logs
Format: FLY_2073_DBG.LOG
PPK logs capture debugging information from Post-Processing-Kinematics.

10.6 Recordings Download

The recordings of the missions are saved in two. The first one is automatically set and is recorded on the GCS with a lower quality, due to compression needed during the flight. Is it also possible to manually set before every flight to start On-Board Recordings, with a higher video quality. Set the On-Board Recording in the Sensor Widget of the Header (see chapter 8.1.2).

10.6.1 GCS Recordings Download

QBase automatically saves all relevant data to disk while it is running.
The recordings are stored in the Windows directory/Documents/QBase/Recordings folder.

1. Inside QBase the recordings are accessible via Menu > Missions inside the Recorded tab.
2. The recordings can be displayed as a list, sorted by modification date or on a map.
3. Click the load button on a recording to start the replay.
4. Use the replay control header widget to play and pause the replay or jump in time, using the slider.

The replay speed is also adjustable.
The export button allows creating a video file of the currently selected recording, which is stored in the Windows directory/Documents/QBase/Recordings folder.
POIs created during a mission are stored in the recording.
POIs of an existing recording can be modified during replay.

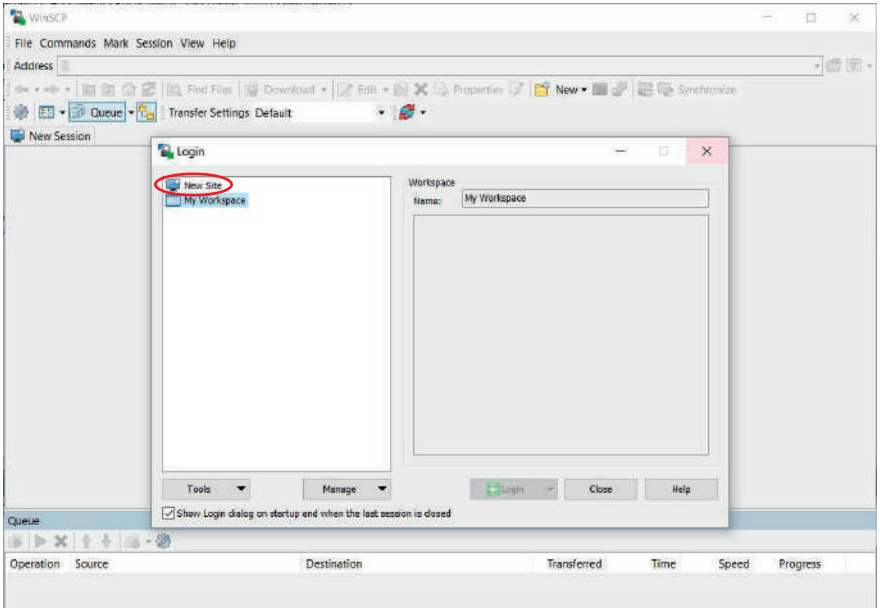
10.6.2 On-Board Recordings Download

As described in chapter 8.1.2, it is possible to record videos on board of the vehicle.

To download recordings from on-board please install WinSCP (www.winscp.net).

Please connect the vehicle via Silvus-Link.

After the installation you are presented with a log-in screen.
Please click on "New Site". The login dialog appears.

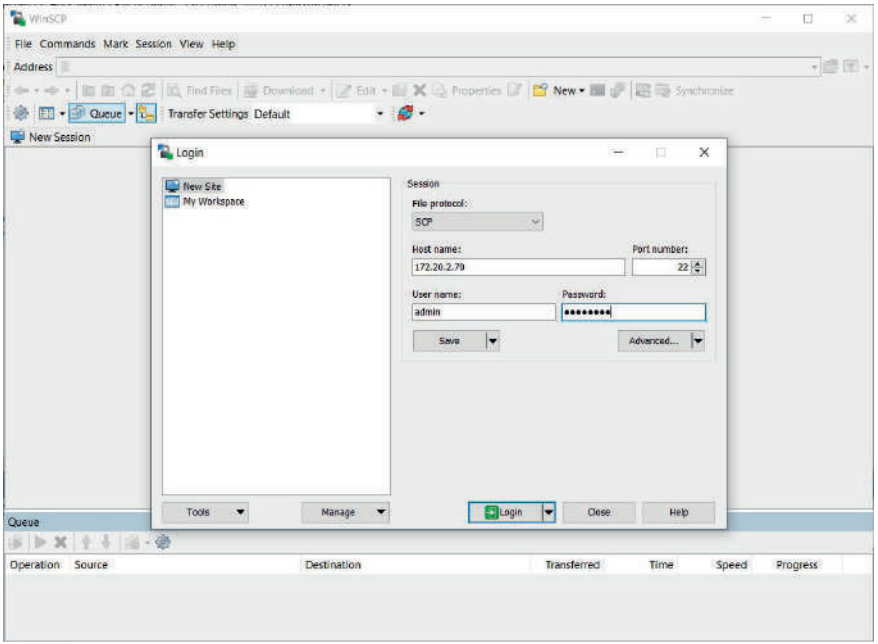


Use your gimbal IP as host-name.

User name: **admin**
Password: **microcam**

Please click on "login" afterwards.

In case a warning message appears about adding a host please confirm.



10.7 Updating the Raptor Payload

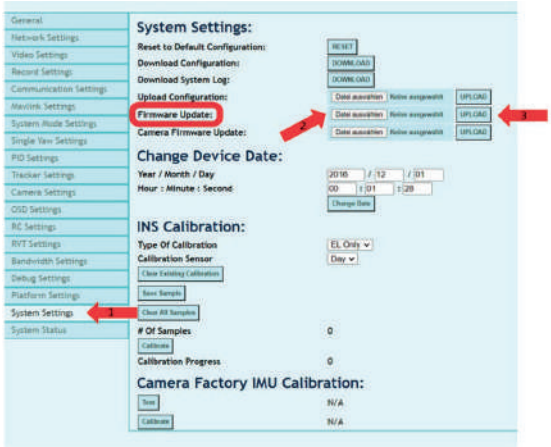
Note:

- disassembling the payload is **not** necessary.
- it is recommended to provide airflow to the Raptor Payload while it is powered. The user can place a fan next to it.
- before updating the Raptor Camera (as explained in this manual), please ensure that the TRIP2 is running Firmware 1.4.20 or a newer version.

The TRIP2 refers to the video processor inside the Raptor Payload. In the second step, the Raptor Camera will be updates through the TRIP2. Therefore, it is important to have Firmware 1.4.20 or a newer version installed on the TRIP2.
Note: Raptor camera and Trip2 FW is **NOT** updated with QOS

10.7.1 TRIP2 Update Instructions

- Note the IP address of your Raptor PL (can be found on the silver sticker).
- Connect the payload to a Vector main body (only the main body is needed).
- Power on the main body using a charged SBP (at least 50%).
- Ensure the SIlvus ground modem is powered on and has a stable connection (solid green LED).
- Connect the Silvus ground modem to your Toughbook or Skynav device.
- Open the Google Chrome web browser and enter the Raptor PL's IP address (first step) in the address bar. Please use Google Chrome as Firefoy may cause issues.
- Enter the following credential when prompted:
  Username: **admin**
  Password: **microcam**



1. Go to the "System Settings" tab.
2. Choose the TRIP2 update File " update.img.gz.1.4.20" with the button next to "**Firmware Update**".
3. Click "UPLOAD".

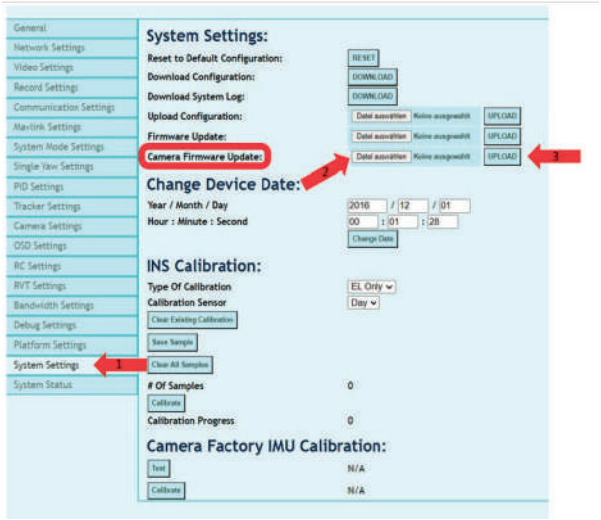
Once the update is successful, power cycle the Vector by briefly removing and reinserting the SBP in the main body.

10.7.2 Raptor Camera Update Instructions

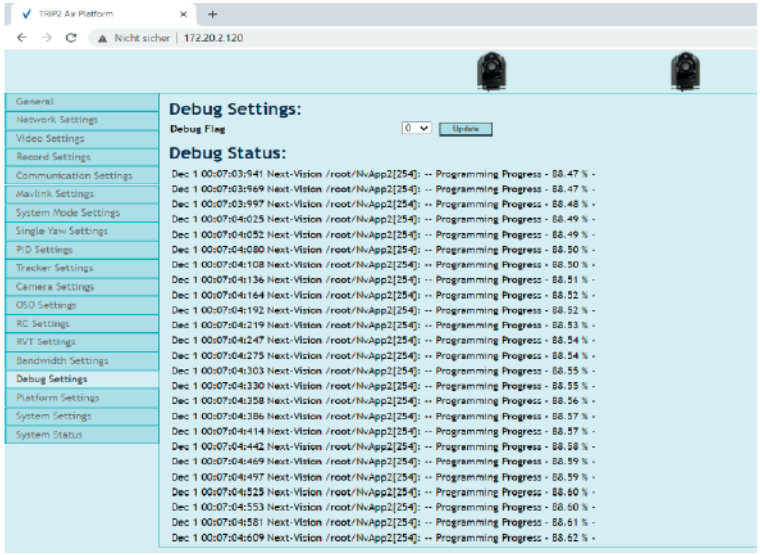
Note: ensure TRIP2 is updatesd to FW 1.4.20 or newer beforehand (see previous section).

- Connect the payload to a Vector main body. Only the main body is required.
- Power on the main body using a SBP that has at least 50% charge.
- **IMPORTANT:** Do not disconnect power from the Raptor payload or the main body during the update process!
- Power up your Silvus ground modem and ensure a stable connection is established (indicated by a solid green LED).
- Connect the Silvus ground modem to your Toughbook or Skynav device.
- Open the Google Chrome web browser and enter the previously memorized IP address of your Raptor PL into the address bar. Please use Google Chrome as Firefox may encounter issues.
- When prompted, provide the following login credentials:
  Username: **admin**
  Password: **microcam**

1. Go to "System Settings" tab.
2. Choose the camera update File “cam_update1_383.7z” with the button next to “Camera Firmware Update:”
3. Click “UPLOAD”
4. A count down will appear on the screen. Wait until this disappears. Please wait until the countdown reaches zero.



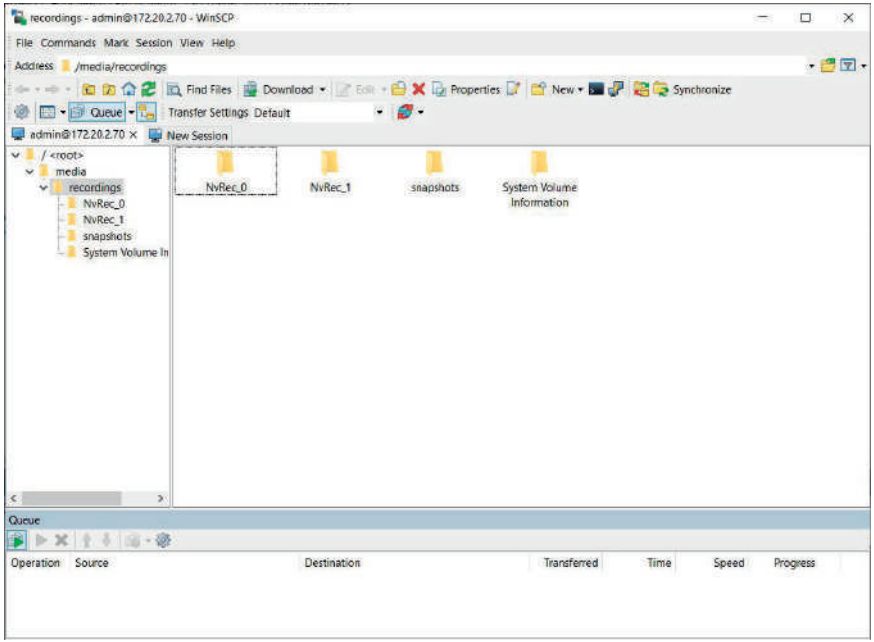
Important: The update is not yet finished. To monitor the progress of the update, click on the Debug Settings tab. The update progress is displayed there as a percentage.



- A notification will appear. Dismiss it by selecting "OK".
- The Raptor payload will automatically reboot at this point.
- The user can now power down the system. The system is ready to be flown.

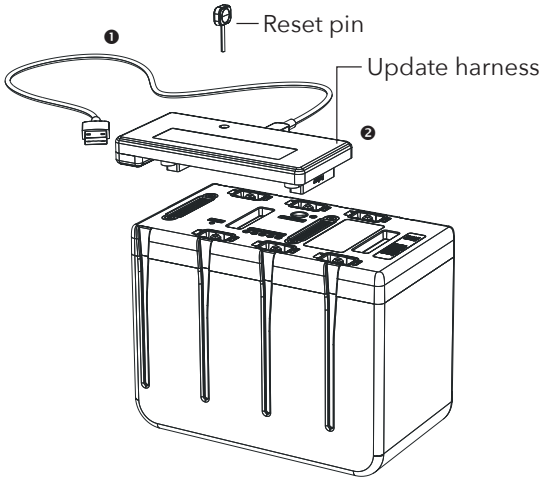
You can now find the recorded files inside the folders on the SD-Card.

Every recording start creates a new folder.



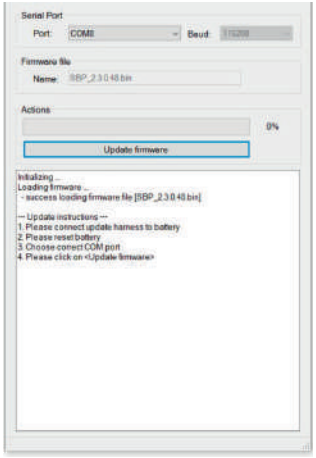
10.8 Updating the Smart Battery

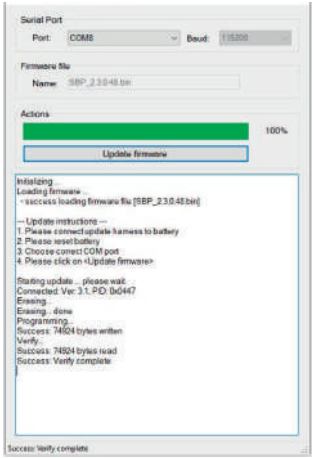
In order to do the Smart Battery Update a special prgramm is needed. The program will be provided with every update via email.
The update procedure is the same for both versions of the Smart Battery (120 and 180).



Please note that the battery pack needs to be ready to fly.

1. Please reset the battery with the reset pin.
2. Choose the correct COM port until the "Update firmware" button is available.
3. Please select "Update firmware".
4. The process is completed when "Success: Verify complete" is displayed.





10.9 VS Calibration

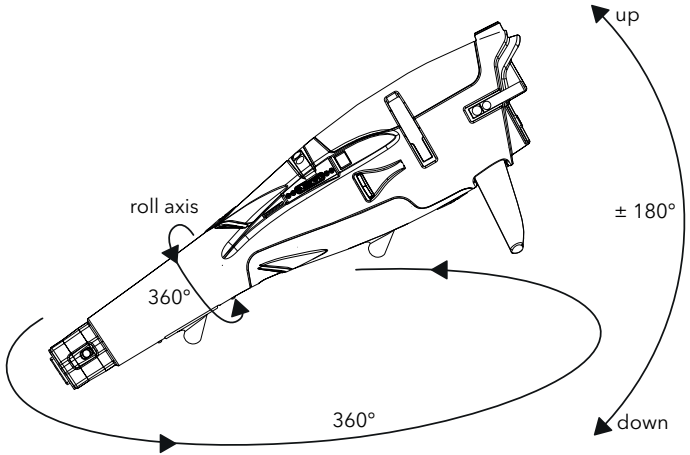
10.9.1 Calibrating the Magnetometer

The magnetometer needs to be calibrated if the **heading of the UAV is not correct** or the actual flight location is **more than 50 km away** from the location where the magnetometer was calibrated before.

Always calibrate the magnetometer outside. Make sure no buildings, cars or other obstacles that distract the calibration are within 10 m (33 ft) around you.

Also make sure that no metal (like parking decks, steel buildings or other metal structures, ships, cars or other machines) or any devices causing electric or magnetic fields (power lines, generators, mobile phones and watches) are close.

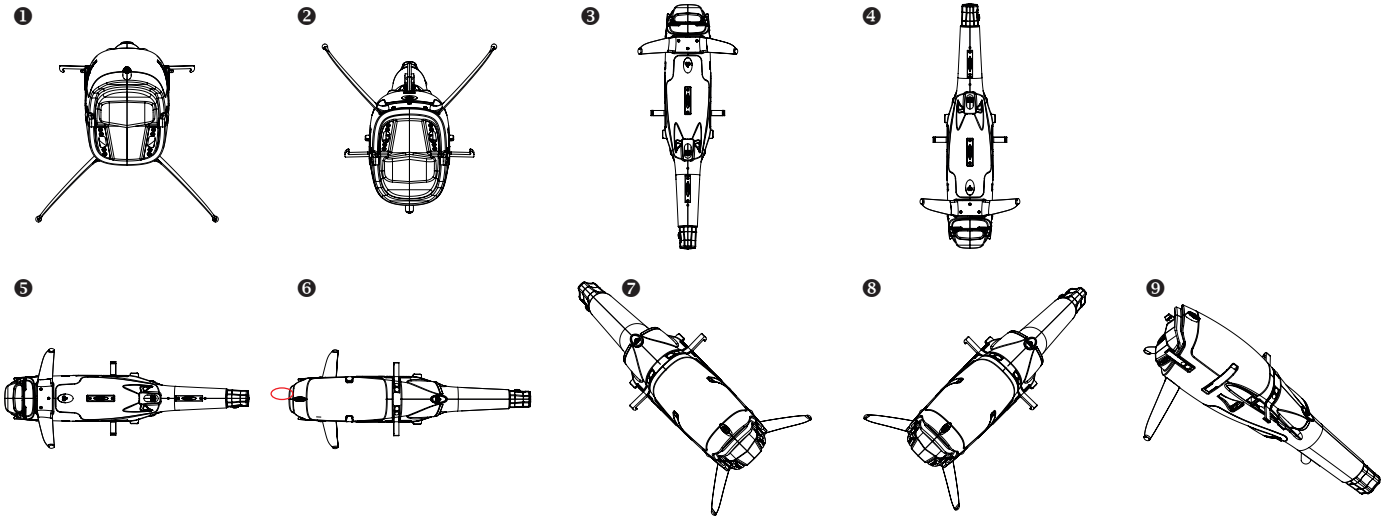
1. The data link handheld, the Skynav/Toughbook, the main body & the batteries are needed.
2. Connect the battery packs. Attach the cover to secure the batteries.
   The UAV will power automatically.
3. Open QBase and connect the data link handheld to the Skynav/Toughbook.
4. Ensure the connection between the UAV and the Skynav/Toughbook is established.
5. Open QBase > Main Menu > Tools > **Aircraft Calibration > Magnetometer**
6. The calibration mode starts.
7. **Move the main body like this:**
   1. Hold the main body in the front and in the back.
   2. Turn around yourself while simultaneously moving the UAV around its roll axis and moving the front up and down.
   3. During the calibration, 200 measuring points are recorded. The counter in QBase counts up until 200.
   4. An audio signal informs you about the successful calibration. If the Calibration was not succesfull, error message will be displayed. Please try again.



10.9.2 Calibrating the Accelerometer

1. The data link handheld, the Skynav/Toughbook, the main body & the batteries are needed.
2. Connect the battery packs. Attach the cover to secure the batteries.
The UAV will power automatically.
3. Open QBase and connect the data link handheld to the Skynav/Toughbook.
4. Ensure the connection between the UAV and the Skynav/Toughbook is established.
5. Open QBase > Main Menu > Tools > **Aircraft Calibration > Acceleration**

6. During the Calibration nine measuring points are recorded. Place the main body as shown below and follow the steps in QBase.

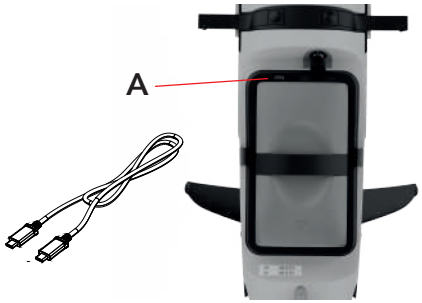


10.10 Exceptional Updating Procedures

If for some reason the update of QOS as described in chapter 10.3 is not working, the following instructions explain how to update the different components of the QOS. These should only be used as backup solutions. Please contact our Quantum Systems Support Team before proceeding.

10.10.1 Updating the FMU Firmware

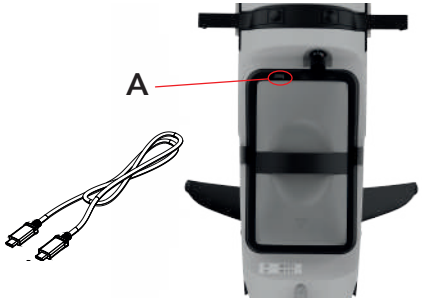
If for some reason the update of QOS as described in chapter 10.3 is not working, the FMU Firmware has to be updated singularly by cable. This is not a standard procedure and has only to be done if explicitly requested by the Quantum Systems Support Team.



1. Connect the USB-C Update Cable (number 4 referring to chapter 3) provided with the Standard Accessories Set via the USB-C connector to the Main Body (A).
2. Connect the cable via USB to the laptop.
3. Open QBase.
4. Select Updates and select Search Updates.
5. Select Download to start downloading the update.
6. Select Update and confirm with Yes.
7. The Firmware Update window opens.
8. Please follow the instructions in QBase.
9. Afterwards the writing process starts automatically. After the update, please select OK.
10. After a successful writing process, the new firmware version is displayed in the top right corner of QBase. Please be aware that displaying the new version might take several seconds.

10.10.2 Updating the ESC Firmware

If for some reason the update of QOS as described in chapter 10.3 is not working, the ESC Firmware has to be updated singularly by cable. This is not a standard procedure and has only to be done if explicitly requested by the Quantum Systems Support Team.



1. Connect the UAV & ESC Update Cable (number 4 referring to chapter 3) provided with the Standard Accessories Set via the USB-C connector to the Main Body (A).
2. Connect the cable via USB to the laptop.
3. Start QBase.
4. Select Updates and select Search Updates.
5. Select Download to start downloading the Firmware.
6. Select Update and confirm with Yes.
7. The ESC Firmware Update window opens.
8. Please follow the instructions in QBase. When requested please select the downloaded ESC firmware in the User > Documents > QBase > Firmware > ESC folder.
9. After the update, please disconnect the battery from the UAV.

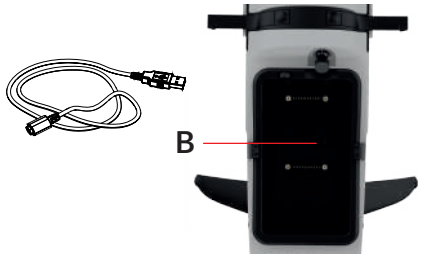
In order to validate the update please follow the following four steps.

10. Connect the battery to power the UAV.
11. Connect the data link handheld or Silvus Stationary to the Ground Control device. The UAV connects to QBase automatically.
12. Select Updates and select Search Updates.
13. Please confirm that the detected version corresponds with the newest Version.

10.10.3 Updating the PDB Firmware

When a new PDB firmware becomes available the user is informed via QBase.

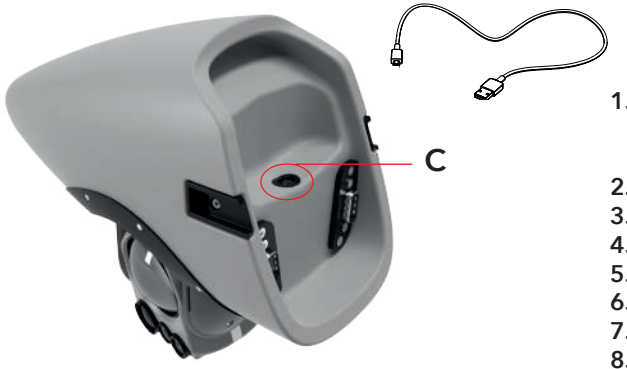
1. Unplug the battery from the aircraft.
2. Connect the PDB Update Cable (number 3 referring to chapter 3) provided with the Standard Accessories Set to the Vector Main Body (B)
3. Connect the cable via USB to the laptop.
4. Start QBase.
5. Select Updates.
6. Select "Firmware – Flash new UAV and PMB firmware".



7. Please follow the instructions in QBase.
8. The update should start automatically.
9. Remove the USB-cable when the update process is finished.

10.10.4 Updating the PMBV Firmware

When a new PMBV firmware becomes available the user is informed via QBase.



1. Connect the magnetic PMBV Update Cable (number 1 referring to chapter 3) provided with the Standard Accessories Set to the Gimbaled Nose (C).
2. Connect the cable via USB to the laptop.
3. Start QBase.
4. Select Updates and select Search Updates.
5. Select Download to start downloading the Firmware.
6. Select Update and confirm with Yes.
7. The PMBV Firmware Update window opens.
8. Please follow the instructions in QBase.

11. FAIL SAFE PROCEDURES

11.1 Barometer Failure
11.2 GNSS Signal Loss
11.3 Gyroscopic IMU Failure
11.4 Magnometer Failure
11.5 Propulsion Stops

11.1 Barometric Failure

The Vector system uses three different sources for altitude data:
1. Primary barometric sensor (in airspeed sensor)
2. Secondary barometric sensor (inside mainbody)
3. GNSS altitude

In case one of the above mentioned barometric sensors fails, a majority voting algorithm between the two barometric pressure altitude signals and the GNSS altitude signal ensures safe operation.
The user receives a notification **"Altitude sensor error"** in QBase mission software and the vehicle flies back home automatically. The operator has the opportunity to cancel the automated landing and force the vehicle to continue the mission. However,it is not recommended to force to continue the mission, but to let the automatic landing happen.

11.2 GNSS signal loss

In case of GNSS signal loss, the system counteracts it with a method called "Sensor Fusion". Sensor Fusion is an algorithm in the flight control unit that uses all available sensors to interpolate the aircraft position. This allows a safe continuation of the respec tive mission with slightly degraded positioning precision. In case the system is operated in an GNSS denied environment, the navigation filter switches from the standard operating mode to a degraded mode.
In case of GNSS signal loss the QBase mission software issues a notification "GNSS signal loss".
For a detailed explanation of the operation is GNSS denied mode, please refer to section 7.1.8.

11.3 Gyroscopic IMU Failure

In the unlikely event of a IMU malfunction, as additional safety measures, there are two active IMUs that are monitored throughout the whole flight. In case the FMU detects an implausible value from the IMU, the FMU switches to the secondary IMU immediately. QBase mission software issues a notification “Backup IMU active”. The mission can be continued. It is recommended to land the drone as soon as possible.

11.4 Magnetomer Failure

A failure of a magnetometer is mitigated by through autopilot algorithms and through operational procedures.
QBase mission software issues a notification “Mag calibration required”.
No user input required in the course of the flight. Magnetometer recalibration is required before the next flight operation.

11.5 Propulsion Stops

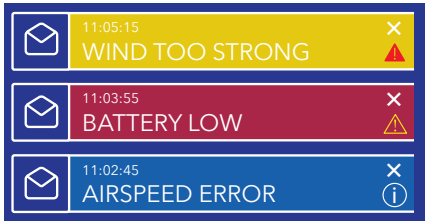
A partial loss of the propulsion system will allow the unit to come back home towards the home position. A safe landing will not be possible but the ground risk can be reduced drastically as the point of impact can be determined. The loss of single motors can be compensated by the remaining other motors.
QBase mission software issues a notification “Drive train error”.
No user input required. Make sure that the takeoff/landing area is clear. Instruct people nearby to be cautious.

12. TROUBLESHOOTING

12.1 Error Messages & notifications in QBase
12.2 Troubleshooting
    12.2.1 Data Link Connection Troubleshooting

12.1 Error Messages & Notifications in QBase

Messages are shown in the top left corner of QBase planning or monitoring view.



Red = Error
Yellow = Warning
Blue = Info

TEXT	DESCRIPTION	WHAT TO DO
ABORTED	The calibration was aborted manually.	–
ACC ERROR	An acceleration sensor error occurred during the preflight check.	1. Disconnect the battery from the UAV and connect it again. 2. Make sure the UAV is not moving during the preflight check. 3. Repeat the preflight check.
ACTUATOR MALFUNCTION! REMOVE BATTERY IMMIDIATELY!	A malfunction of an actuator has been detected.	Remove the battery immediately to prevent further damage. Contact your Quantum-Systems sales agent. The actuator has to be replaced.
ADP CALIB TIME TOO SHORT	Flight time was too short for a successful inflight airdata probe calibration. This case only happens if an uncalibrated ADP has been used.	Perform another flight mission with at least 10 minutes flight time.
ADP CALIBRATION ENABLED (ADP UNCALIBRATED)	Notice to the customer, that the airdata probe calibration has been enabled for the flight.	**Just fly as usual.**

ADP FACTOR ABNORMAL	The airdata probe calibration factor is out of bounds.	Contact your sales agent.
AILERON MALFUNTION!	There is a malfunction in the roll movement.	1. Automatic Come Home is initiated. 2. Please check if the ailerons / the wings are connected correctly.
AIRCRAFT GROUNDED	Aircraft has experienced severe malfunction. Further flying is denied by the autopilot.	Contact your sales agent.
AIRSPEED ERROR	An airspeed sensor error occured during the preflight check or during the transition. Possible reasons are a transition with tail wind or a blocked airspeed sensor tube.	During preflight check: 1. Disconnect the battery from the UAV and connect it again. During flight: Two options are available • Select Come Home – the UAV returns to the home waypoint. • Select Continue – the UAV will continue the mission in downgraded Fixed Pitch Mode (without airspeed data, with a reduced efficiency) During transition: 1. The transition is aborted and the UAV returns to the home waypoint. 2. Please land the UAV manually at the home waypoint by carefully pullling the left stick towards you.
AIRSPEED INITIALIZATION ERROR	Sensor Init Error during Startup	Disconnect the battery from the UAV and connect it again.
ASSISTED FLIGHT	The UAV is controlled manually in assisted mode.	Control the UAV according to the commands of the assisted mode or select Continue to switch to automatic mode.
AUTO START DRIFTED TOO FAR AWAY	The aircraft drifted too far from the takeoff location during auto start.	Turn the nose of the aircraft into the wind prior to takeoff. Measure the current wind speeds to confirm you are operating the aircraft inside the flight envelope.
AUTOPILOT INFO ERROR	Autopilot configuration error.	Contact your sales agent.
BARO ERROR	A baro sensor error occured during the preflight check.	1. Disconnect the battery from the UAV and connect it again. 2. Repeat the preflight check.
BARO INITIALIZATION ERROR	Sensor Init Error during Startup	Disconnect the battery from the UAV and connect it again.

BATTERY CRITICAL	During Preflight Check: The remaining battery capacity is below minimum. During Flight: The remaining capacity is needed to return and to land.	The UAV initiates a coming home automatically. Please land the UAV manually at the home waypoint by carefully pulling the left stick towards you.
BATTERY LOW	During Preflight check: An error appears during preflight check.	Please charge the battery.
BATTERY LOW	During fligth: A warning 10 minutes before the UAV returns home due to battery capacity	Please select Come Home.
CAL ERROR	One of the sensors is not calibrated correctly.	Please check QBase for detailed information.
CAL ERROR ACC	The accelerometer has not been calibrated correctly.	The last accelerometer calibration failed. Please calibrate the accelerometer and try again (see chapter 11.7).
CHECK LINK REEST. ALTITUDE	There is an issue with the link reestablishing waypoint.	Adjust the altitude of the link reestablishing waypoint in QBase and upload the flight plan to the UAV again.
CHECK LINK REEST. LOITER RADIUS	There is an issue with the loiter radius.	Adjust the radius of the link reestablishing waypoint in QBase and upload the flight plan to the UAV again.
CHECK LINK REEST. LOITER TIME	There is an issue with the loiter time.	Adjust the loiter time of the link reestablishing waypoint in QBase and upload the flight plan to the UAV again.
CHECK QBASE	An error occured.	Please check the message box in QBase for additional information.
COULD NOT REACH AUTO START CLIMB SPEED	The autopilot was unable to reach the commanded auto start climb speed.	Check that the battery is not too cold or damaged and fully charged. Turn the nose of the aircraft into the wind direction.
ELEVATOR IS MISSING	The elevator on the rear is attached or incorrectly attached.	Attach the elevator to the rear locking device or relocate it properly.
EMERGENCY LANDING	Land immediately was selected. The landing is carried out automatically. Please be aware that the landing process might damage the UAV.	
ERROR	An error during the calibration occured.	1. Disconnect the battery from the UAV and connect it again. 2. Repeat the calibration process.

ERROR LOADING MISSION	Error loading the mission from the SD card.	1. Repeat write mission to UAV (see chapter 8.1.2). 2. Repeat the preflight check.
ESC VERSION MISSMATCH	The ESC firmaware is not on the lastest version.	Follow the update procedure of chapter 10.3 before take off.
FINISHED	The automated flight is finished.	Please land the UAV manually at the home waypoint by carefully pulling the left stick towards you.
GPS ERROR	A GPS sensor or reception error occured during the initialization.	Disconnect the battery from the UAV and connect it again.
GPS LOST	The GPS signal is lost during the preflight check.	Please wait until enough satellites are found.
GYRO ERROR	A Gyro sensor error occured during the preflight check.	1. Disconnect the battery from the UAV and connect it again. 2. Repeat the preflight check.
HARDWARE FAILURE CAN	Communication problem to PMB during initialization.	Disconnect Battery, check the connection and latching of gimbaled sensor compartment and try again.
HOME WAYPOINT TOO FAR AWAY	The home waypoint in QBase can not be adjusted to the actual take-off position as the two positions are too far apart.	1. Ensure that the correct mission was uploaded to the UAV by downloading the flight plan from the UAV. 2. If the mission is correct: adjust the home waypoint and the retransition waypoint manually. 3. Upload the flight plan to the UAV again. 4. Repeat the preflight check.
HOVER TIME	A warning after 55 seconds of hovering.	Please land UAV as soon as possible. Please select Come Home.
HOVER TIME EXCEEDED	A warning after 70 seconds of hovering.	An automatic landing is initiated after 70 seconds hover time at the current location.
IMU INITIALIZATION ERROR	Sensor communication Error during Startup.	Disconnect the battery from the UAV and connect it again. If the Error still occurs please contact your sales agent. An autopilot exchange might be required.
IMU SELFTEST FAILED	Sensor Error during Startup.	
LINK LOST	The UAV will fly to the link reestablishing waypoint automatically after link loss timeout and try to reestablish the communication.	Either select Come Home or Continue in QBase.
MAG ERROR	A magnetometer sensor error occured during the preflight check.	

MAG HEADING INCONSISTENT RECALIB. MAG. AFTER LANDING	A magnetometer sensor inconsistency was detected during the flight.	Please perform a magnetometer calibration.
MAG INITIALIZATION ERROR	Sensor Init Error during Startup	Disconnect the battery from the UAV and connect it again.
MAG NOT CALIBRATED	The magnetometer has not been calibrated correctly.	The last magnetometer calibration failed. Please calibrate the magnetometer and try again.
MAG SELFTEST FAILED	Sensor Init Error during Startup	Disconnect the battery from the UAV and connect it again.
MAGNETOMETER DEVIANCE TOO HIGH	Problem with the magnetometer detected.	Please perform a magnetometer calibration.
MISSION ERROR	Mission is incorrect.	Please check the message box in QBase for additional information.
MISSION FINISHED	The automated flight is finished.	Please land the UAV manually at the home waypoint by carefully pulling the left stick towards you.
MISSION NOT COMPLETE	Missing data in mission.	1. Repeat uploading the flight plan to the UAV. 2. Repeat the preflight check.
MOTOR (NR) RPM TOO HIGH OR TOO LOW	Error during arming.	Please make sure that the UAV is aligned horizontally during arming.
MOTOR CONTROLLER ERROR	Motor (1,2 or 3) RPM too high or too low or motor current too high or too low. Error during arming.	RPM: Please make sure that the UAV is aligned horizontally during arming. Current: Disconnect the battery from the UAV and connect it again.
MOTOR TEMP. TOO HIGH	Temperature monitoring during hover mode. Temperature of at least one motor controller is too high during the Preflight Check or during hovering. green: <65°C = fine yellow: >65° C = warning red: >95°C = emergency landing	During Preflight Check: Let the UAV cool down and try again. After Retransition: Land the UAV carefully as normal. Let the UAV cool down. green: no need to react yellow: Let the UAV cool down after flight until it is green again red: automatic emergency landing
MOTORS ERROR	Motor error during the preflight check or during arming. One of the motors / propellers does not run correctly.	1. Disconnect the battery from the UAV and connect it again. 2. Repeat the Preflight check.
NEW ADP FACTOR: V{ #.### }	Notice that an airdata probe has been calibrated inflight.	

NO BALANCE WEIGHT FRAME INSERTED	The Balance Weight on the rear is missing.	Follow chapter 6.3.1 to insert the missing weight properly before take off.
NO BALANCE WEIGHT IDENTIFIER BOARD FOUND	Hardware error in the Vector tail. The Balance Weight identification electronics are not communicating with the autopilot.	Power - off the Vector. Disconnect the rear and re-connect it. Re-power the system. If the problem still persists contact QS support.
NO CONTROLLER DETECTED	The controller of the laptop GCS is not connected.	Please connect the controller to the GCS.
OK	The calibration was succesful.	–
OUT OF TRANSITION DIRECTION	The direction of the Vector does not comply with the allowed transition cone during auto climb.	Automatic hover to base and landing is initiated.
THE UAV DETECTED A POSSIBLE COLLISION AND INITIATING SAFETY LOITER.	The UAV detected a possible collision and initiating safety loiter.	
REAR TILT MALFUNCTION!	Occurs when hardware is defective or there is a tilt mechanismus malfunction	1. Automatic Retransition and Landing is initiated 2. Do not fly! Contact your sales agent.
RTR TOO FAR AWAY	The retransition waypoint is too far away from the take-off position.	1. Locate the retransition waypoint closer to the home waypoint (see chapter 8.2.3). 2. Write mission to UAV again (see chapter 8.1.2). 3. Repeat the preflight check.
SD CARD ERROR	An error with the autopilot SD card occured during the preflight check.	1. Disconnect the battery from the UAV and connect it again. 2. Repeat the preflight check.
SENSOR ERROR	A sensor error occured during the preflight check.	1. Disconnect the battery from the UAV and connect it again. 2. Repeat the preflight check.
SENSOR INIT ERROR	Error during the sensors initialization.	1. Disconnect the battery from the UASand connect it again. 2. Turn on the UASagain.
TAIL IS NOT CONNECTED	The Tail is not or incorrectly connected to the main body.	Please reconnect the tail to the main body and make sure it is connected properly.
TOO MANY WAYPOINTS	Too many Waypoints	Please adjust the number of waypoints. It is limited to 300.
TRANSITION AIRSPEED TOO LOW	The airspeed could build up during transition. Possible reasons are a transition in tail	The transition is aborted and an automatic hover to Base is initiated. Contact your Quantum-Systems sales agent in case the transition was correctly planned into the wind.

WIND SPEED / WIND TOO STRONG	The wind is too strong either during launch or in-flight.	Launch: The UAV will abort the mission and returns to the launch point. In-Flight: If reaching 12 m/s, an automatic Come Home is initiated.
WRONG BALANCE WEIGHT	The Balance Weight at the rear is wrong for the selected take off setup.	Follow chapter 6.3.1 to insert the right weight before take off.

12.2 Troubleshooting

In case of any malfunctions (e.g. battery) perform the following steps:
1. Soft Reset
2. Hard Reset

12.2.1 Data Link Connection Troubleshooting

Problem	Symptom	Solution
CONNECTION BAD (LOW SNR)	Bad SNR due to high noise	• Try decreasing sources of noise. • Move antenna away from noise source (e.g. Wifi, electrical machines) • Change to other network frequency
	Bad SNR due to low RSSI	• Use antenna with higher gain • Increase transmission power • Increase flying altitude • Arrange GCS antenna so that high gain is obtained towards the UAV • Fly closer to GCS antenna • Remove Isolators from antenna (e.g. metallic objects in proximity) or move antenna away from isolators (car, reinforced concrete, metal railing, people) • Increase antenna mount height • Ensure line of sight Antenna - UAV
	Airtime too high	• Reduce number of nodes in network • Reduce number of video streams connected • Increase SNR • Increase Bandwidth

VIDEO TRANSMISSION DISTURBANCES (TRANSMISSION ARTIFACTS)	Video shows artefacts and is not fluid	• Reduce Noise • Increase RSSI (e.g. better antennas, better position, higher output power) • Check Airtime of total network. Try reducing airtime by removing unnecessary nodes or traffic.
NO CONNECTION TO AIRCRAFT	Silvus modems are connected, but no data is shown, yellow line is low	• Add an exception for Qbase to your firewall • Turn off all firewalls
NO CONNECTION TO OTHER SILVUS MODEMS	Silvus modems don't connect to each other	• Check Silvus Settings in Silvus Interface • Reset to QS Settings * Please refer to the settings described in Chapter 9
NO CONNECTION TO BASE MODEM	Qbase does not connect to the base modem	• Check if base modem is powered and turned on • Check the physical connection to the base modem • Check network adapter settings • Check correct modem ID is set in QBase
NO CONNECTION TO AIRCRAFT	Silvus Ground Modem is connected but no other node in the Silvus interface is visable	Check the Encryption Settings of Ground and Air modem and turn them on/off"

13. TECHNICAL SPECIFICATIONS

13.1 Vector (equipped with Smart Battery 120)
13.2 Vector (equipped wirh Smart Battery 180)
13.3 Gimbaled Sensor
13.4 Scorpion
13.5 Skynav Ground Control system
13.6 Thoughbook Ground Control System
13.7 Data Link Handheld
13.8 Silvus Stationary
13.9 Smart Battery 120
13.10 Smart Battery 180

13.1 Vector (equipped with Smart Battery 120)

Max. Take-off Weight	7.4 kg / 16.3 lbs
Max. Flight Time	120 min
Maximum flight altitude (MSL)	3000 m / 9842 ft
Maximum operation altitude (MSL)	4000 m / 13123 ft
Command, control and video range	15 – 45 km / 9.3 – 15.5 mi (Ground link dependent)
Cruise Speed Range	15 – 20 m/s / 29 – 39 kn
Optimal Cruise Speed	15 m/s / 29 kn
Wind Resistance (ground)	10 m/s / 19.4 kn
Wind Resistance (cruise)	12 m/s / 23.3 kn
Wingspan	2.80 m / 9.2 ft
Backpack size	80 x 54 x 34,5 cm (31.5'' x 21.3'' x 13.6'')
Backpack weight	9.2 kg / 20.3 lb Cover incl. foam inlay
IP Rating	IP 54
Operation temperature	-20°C to +45°C
Average power consumption	165–185W
Maximum power consumption	2.700W
Battery System	Quantum-Systems Smart Battery 7S5P Li-Ion 25,4V/15600mAh

13.2 Vector (equipped with Smart Battery 180)

Max. Take-off Weight	8.5 kg / 18.7 lbs
Max. Flight Time	180 min
Maximum flight altitude (MSL)	3000 m / 9842 ft
Maximum operation altitude (MSL)	4000 m / 13123 ft
Command, control and video range	15 – 45 km / 9.3 – 15.5 mi (Ground link dependent)
Cruise Speed Range	15 – 20 m/s / 29 – 39 kn
Optimal Cruise Speed	15 m/s / 29 kn
Wind Resistance (ground)	10 m/s / 19.4 kn
Wind Resistance (cruise)	12 m/s / 23.3 kn
Wingspan	2.80 m / 9.2 ft
Backpack size	80 x 54 x 34,5 cm (31.5'' x 21.3'' x 13.6'')
Backpack weight	9.2 kg / 20.3 lb Cover incl. foam inlay
IP Rating	IP 54
Operation temperature	-20°C to +45°C
Average power consumption	200W
Maximum power consumption	2.700W
Battery System	Quantum-Systems Smart Battery 7S2P Li-Po 26,95V/23500mAh

13.3 Gimbaled Sensor

HD40-LV

Zoom	EO: 10x optical, 2x digital	IR: 4x digital
Resolution	EO: 1280 x 720	IR: 640x480
Data rate	5 Mb/s (H264)	
Power consumption	15 W	
MISC	KLV-Stream, GeoLock, Image stabilization	

Raptor

Zoom	EO: 40 x optical, 2x digital	IR: 8x digital
Resolution	EO: 1280 x 720	IR: 1280 x 720
Data rate	5 Mb/s (H264)	
Power consumption	10 W	
MISC	KLV-Stream, GeoLock, Image stabilization, Object tracking	

13.4 Scorpion

Max. Take-off Weight	<7 kg / <15.4 lb
Max. Flight Time	45 min
Maximum flight altitude (MSL)	3000 m (9842 ft)
Maximum operation altitude (MSL)	4000 m / 13123 ft
Command, control and video range	15 – 25 km / 9.3 – 15.5 mi (Ground link dependent)
Cruise Speed Range	0 – 15 m/s / 0 – 29 kn
Wind Resistance (ground)	10 m/s / 19.4 kn
Wind Resistance (cruise)	10 m/s / 19.4 kn (gusts:12 m/s / 23.3 kn)
Wingspan without propellers	0.85 m / 2.8 ft
Length	1.37 m / 4.5 ft
Backpack size	76,5 x 38 x 28,5 cm (30.1'' x 14.9'' x 11.2'')
Backpack weight	5.7 kg /12.6 lb Cover incl. foam inlay
IP Rating	IP 54
Operation temperature	-20°C to +45°C
Average power consumption	600W
Maximum power consumption	1200W
Battery System	Quantum-Systems Smart Battery 7S5P Li-Ion 25,4V/15600mAh

13.5 Skynav Ground Control system

Operating system	Windows 10 Pro
CPU	Intel® Core™ i5-7Y57 vPro-Prozessor
RAM	8 GB RAM
Screen resolution	7" LC-Display 1280 x 800 (up to 700cd/m²)
Graphics	Intel® HD Graphics 615
Operating time	aprox. 8 hrs

13.6 Toughbook Ground Control System

Operating system	Windows 10 Pro 64bit
CPU	Intel® Core™ i5 1145G7 vPro™ Processor
RAM	8GB DDR4 RAM
Screen resolution	14" Active Matrix (TFT) colour LCD 1366 x 768 pixels (HD)
Graphics	Intel® UHD Graphics
Operating time	Approx. 38 hours with 2nd battery (Mobile Mark™ 2014)

13.7 Data Link Handheld

Frequency	2,2GHz – 2.5GHz
Output Power	max. 10W
Range	15 km / 9.3 mi
Modem weight	1.18 kg (Incl. antennas, battery and cable)
Operating time/battery set	up to 12 hrs

13.8 Silvus Stationary

Frequency	2.2GHz – 2.5GHz
Output Power	max. 10W
Range	35 km / 21,7 mi
Modem weight	4.9 kg modem (Incl. antennas and mount)

13.9 Smart Battery 120

Capacity	15600 mAh
Voltage	25.2 V
Energy	393 Wh
Battery Cells	Cell Li-Ion 7s5p
Weight	1.9 kg
Max. charging current	3.0 A

13.10 Smart Battery 180

Capacity	23500 mAh
Voltage	26.95 V
Energy	633 Wh
Battery Cells	Cells Li-Po 7S2P
Weight	2.7 kg
Max. charging current	23.5 A

QUANTUM SYSTEMS

Quantum-Systems GmbH | Zeppelinstr. 18 | 82205 Gilching | Germany
quantum-systems.com