Trinity™ Pro

User Manual 2.5.2.12

01
General information

01 General information

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.

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 civil 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 user's sole responsibility.

If flying within the EU the EASA rules need to be followed.
https://www.easa.europa.eu/downloads/120853/en

For BVLOS operations under the Design Authorisation in Brasil, please respect the flight manual addition, available at your regional reseller.

Technical support
For technical support please contact your reseller.

C
Quantum-Systems GmbH declares that the products: UAV Battery pack, UAV aircraft system, QS Battery Charger and QBase Modem are in conformity with the CE regulations.

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The UAV is a UAV which combines hover capabilities with fixed wing flight. To ensure vertical take-off and landing (VTOL) the three motors are directed upwards, for cruise flight the motors are tilted forward. The thrust for forward flight is generated by the rear motor while the two front motors are turned off. Depending on the integrated sensor the UAV is suitable for a vast range of applications. The body of the UAV is made of Elapor® and molded around a rigid carbon fiber structure.

Attention

Following parts of Trinity F90+ are not compatible with Trinity Pro:
Main body, rear fuselage

To distinguish from older Trinity V1. Trinity F9 and Trinity F90+ models please consider theserial number and the decal sheet.
Trinity F9/V1: serial number YXXXXX, blue decal sheet.
Trinity F90+ : serial number XXXXX, grey decal sheet.

Trinity Pro: serial number XXXXX, yellow decal sheet.

The Trinity Pro includes the following items which can all be transported and stored inside the Trinity Pro transportation box:

1. Main Body (incl. autopilot board, ESC, Remote ID, Lidar Ground Sensor. Optional: ADS-B)
2. Rear Fuselage (incl. GPS module and antenna)
4. Wing left and right (incl. anti collision strobe lights)
5. Elevator
6. Battery pack
7. Airspeed sensor
8. Payload Compartment incl. camera and spare parts set
9. QBase modem
10. Trinity Pro controller
11. iBase Set (incl. power bank and USB-C cable)
12. USB - ADS-B Receiver set
13. Spare parts set incl. spare propellers
14. Anemometer
15. Manuals and documentation

1.1 Abbreviations

ACC	Acceleration
ADS-B	Automatic Dependent Surveillance–Broadcast
AGL	Altitude Above Ground Level
ALT	Altitude
ATO	Altitude Above Take-Off
BID	Battery Identification
BVLOS	Beyond Visual Line Of Sight
ELV	Elevation (Ground)
EVTOL	Electric Vertical Take-Off and Landing
GCS	Ground Control Software
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSD	Ground sample distance
ID	Identification
IMU	Inertial Measurement Unit
Incl	Including
IR	Infra-Red
KML	Keyhole Markup Language
LAT	Latitude
LED	Light-Emitting Diode
LONG	Longitude
MAG	Magnetometer
MF	Manual Focus
MSL	Altitude Above Mean Sea Level
QS	Quantum-Systems
PPK	Post Processed Kinematik
REEST	Reestablishing
RTR	Retransition
STBY	Standby
SRTM	Shuttle Radar Topography Mission
UAV	Unmanned Aerial Vehicle
VTOL	Vertical Take-Off and Landing
WGS	World Geodetic System

02
Safety instructions

02 Safety instructions

2.1 Operation

The UAV is not a toy and only intended for professional use.

1. Always obey the manual when using the system.
2. The Trinity Pro is a VTOL capable UAV (EU classification: C3). The main purpose is the efficient aerodynamic flight. Therefore, it is not made for long hover times and cannot be considered as a copter. The hover time limitations are listed in chapter 9 Flight Operation.
3. If the Trinity Pro shows no function or is not able to Shut Down please contact your reseller.
4. No changes to the system (hardware, software or firmware) are allowed.
5. In case of hardware damage or other issues due to careless handling or transportation damage, do not activate the drone and contact your reseller.
6. There are no safeguards or personal safety equipment foreseen for the operation.

Preflight

1. It is the operator's responsibility to follow the laws that regulate the use of UAVs for the desired flying area. Flying out of pilot's sight might be prohibited depending on the local laws, please inform yourself.
   For flight in visual line of sight, the distance between the pilot and the UAV should never exceed 2 km (1.24 mi).
2. Always keep a safe distance to spinning rotors of at least 10 m (33 ft) to avoid risk of injury and damage of property.
3. Always keep a safe distance between the UAV and humans at any time to avoid any personal injury in the event of a crash.
4. Always ensure proper GNSS coverage of the UAV. Do not fly in narrow canyons as it may cause malfunction of the GPS and/or the magnetic field sensors. GNSS failure might lead to uncontrollable flight state. In case of an additional C2 link loss the emergency functions cannot be triggered anymore.
5. The Trinity must not be operated
   - at temperatures below -12 °C (10.4 °F) and above 50 °C (122 °F).
   - in heavy rain, icing condition and fog.
   - at windspeeds above 11 m/s (21.4 kn) during hover and 14 m/s (27.2 kn) during cruise (See chapter 3.1.). Please note that the wind speed on the ground is always less than the wind speed at flight altitude.
6. Do not fly into bird flocks and thunderstorms
7. The use of third party products, such as batteries, chargers, ground modems, cameras and ground control software, 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.
8. It is not allowed to attach any other cameras than the ones available via Quantum-Systems. All cameras available at Quantum-Systems ensure the compatibility and the maximum take-off weight.
9. Each operator is responsible for ensuring the airworthiness of the UAV.
10. The UAV does not detect and avoid obstacles. Every operator is self responsible to plan a flight path that is free of obstacles.
11. Do not fly without a properly attached payload compartment.
12. It is mandatory for the remote pilot to receive proper training and to read the manual before the first flight.
13. It is the pilot's responsibility to ensure a mental and physical stable state. This includes but is not limited to the prohibition to fly when feeling sick, under the influence of alcohol, medication, drugs, sleep deprivation or unconsciousness. It is furthermore the pilot's responsibility to fully understand the given flight procedures. Furthermore, it is is forbidden to conduct flights under stress and time pressure. The sensory activity such as vision, hearing and sense of smell must be ensured at all times. The pilot must be able to make correct and conscious judgement at all times.
14. The operator should place the ground control equipment out of direct sunlight to prevent the risk of a loss of readability of the displays.
15. The device used for operating QBase should be plugged in to the power supply or be charged to a level sufficient for the intended operation.

Flight

1. In case of an emergency the pilot must be able to manually fly the UAV in assisted flight.
2. 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 GNSS and/or the magnetic field sensors.
3. 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 GNSS and/or the magnetic field sensors.
4. 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 QBase modem and the UAV during the whole time of operation.
5. The Trinity Pro is allowed to be operated during daylight.
   The Trinity Pro is equipped with lights for the purpose of conspicuity and controllability during night operations.
6. The flight path of the drone shall always be chosen above sparsely populated areas. It is the operators obligation to check the required safety margins with the local regulations.
7. Follow privacy regulation as UAV can obtain personal data with the cameras.
8. The maximum flight endurance of the UAV varies with the MTOM of the configuration among other factors (e.g. wind, temperature, battery-health etc.). The actual endurance is continuously calculated for every configuration and mission and displayed in QBase. 90 minutes flight time are calculated for all cameras which result in MTOM 5.2 kg.

Post flight

1. Due to the risk of an electric shock, do not open any Quantum-Systems products. For repair and maintenance work always contact your reseller (exceptions see chapter 13).
2. Transportation of the system is only recommended in the original Quantum-Systems transportation box.
3. 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.
4. The operation or storage in salty, sandy or dusty or similar environment might cause accelerated aging and degradation of the product.
5. After the flight please download the zipped log files from the Trinity Pro and store them on your computer for the case that they are required for analysis or for further post processing.
6. Please always download the pictures from the SD card of the camera after the flight and store them on your computer.
7. After data exchange between the UAV and an internet capable device check functions of UAV as software integrity is potentially at risk due to malware.

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 pack. The UAV battery pack is based on Murata / Sony Konion US18650VTC6 - 3120mAh, 3,6V - 3,7V cells.

2.2.1 Battery handling

1. Do not use any battery other than the original UAV battery pack by Quantum-Systems.
2. Do not use or charge swollen, leaky, or damaged batteries. Do not use a battery that was involved in a crash or any kind of heavy impact.
3. For flying the temperature of the battery must be at least 25 °C (77 °F).
   For outside temperature < 10 °C (<50 °F):
   - Heat up the battery to 25 °C (77 °F) for at least 5 hours.

   For outside temperature < 0° (<32 °F):
   - Heat up the battery to 25 °C (77 °F) for at least 5 hours.
   - The flight time will be reduced to max. 70 minutes.

4. Do not expose the battery pack to direct sunlight. Temperatures over 60 °C (140 °F) may damage the battery pack.
5. To prevent malfunction of the battery, never fly the UAV in strong electrostatic or electromagnetic environments.
6. Do not drop the battery or expose it to water. Never open the battery pack or manually short circuit the battery. Replace the battery pack if exposed to water.
7. If your eyes or skin make contact with any battery liquid, 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 pack 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.
11. The battery life may be reduced if it is not used regularly.
12. The Battery will age over time. Therefore, the warranty of the complete UAV system expires when batteries with more than 150 charging cycles are used.

2.2.2 Battery charging

1. To charge the battery follow the guideline as described in chapter 6.
2. Always use the Quantum-Systems battery charger to charge the battery pack. Quantum-Systems is not responsible or liable for damages caused by charging the battery with a third party charger.
3. Always charge the battery pack indoors at room temperature to prevent damage to the battery.
4. Do not charge the cells individually.
5. Never connect the battery pack to a wall socket or to the car charger outlets directly.
6. The battery must be charged under supervision. Never charge the battery pack close to flammable materials or on flammable surfaces.
7. Disconnect the battery when it is fully charged.
8. Do not clean the charger with flammable liquids like denatured alcohol.
9. Never use a damaged charger.

2.2.3 Battery storage

1. Keep the battery out of reach for children and animals . Do not leave the battery near heat sources such as furnaces or heaters.
2. Always store the battery at an ambient temperature of 25 °C (77 °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 30 % or lower than 20 %.
5. For long-time storage (>1 week), it is recommended to charge / discharge the battery pack to 75 % capacity.
6. Do not store the battery completely discharged.
7. Always remove the battery from the UAV when it is not in use.
8. Always apply the contacts protection cap if the battery pack is not in use. For transport of the battery in an airplane, attaching and securing the contacts protection cap is mandatory.

2.2.4 Battery warranty

1. Batteries are not covered as part of the standard warranty as rechargeable batteries are consumable components that become less effective as they chemically age.
2. Batteries are active elements and their life depends on the right handling and storage.

2.3 Disposal

For the disposal of the UAV battery pack, 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 cap 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 if not damaged. Dispose all Quantum-Systems products according to the local regulations for the recycling of electronic or electrical devices. The wings and the elevator of the UAV can be disposed along with plastic waste.

03
Technical specifications

03 Technical specifications

Technical data	Locked **<60 minutes**	Unlocked **90+ minutes**[1]
Max. Take-off Weight	5.75 kg (12.68 lbs)	5.75 kg (12.68 lbs)
Allowed C.G. from leading edge	86-91 mm	86-91 mm
Max. Flight Time	<60 min	90+ min[1]
Max. Range = Area	70 km ≙ 500 ha	100 km ≙ 700 ha
Maximum flight altitude (MSL)	5500 m (18,045 ft)[2]	5500 m (18,045 ft)[2]
Command and Control (C2) Range	5 – 7.5 km[3] (3.1 – 4.7 mi)	5 – 7.5 km[3] (3.1 – 4.7 mi)
C2 Latency	<60 ms	<60 ms
Optimal Cruise Speed	17 m/s (33 kn)	17 m/s (33 kn)
Optimal Cruise Speed (LiDAR/Oblique)	18 m/s (35 kn)	18 m/s (35 kn)
V_{NE} (Velocity never exceed)	35 m/s	35 m/s
Wind Tolerance		
Hover phase (take-off/landing)	up to 11 m/s (21.4 kn)[4]	up to 11 m/s (21.4 kn)[4]
Continuous (cruise)	12.9 m/s (25 kn)	14 m/s (27.2 kn)
Gusting (cruise)	12.9 m/s (25 kn)	18 m/s (35.2 kn)
Battery Capacity	12 Ah	12 Ah
Payload	max. 1 kg (2.2 lbs)	max. 1 kg (2.2 lbs)
Battery Weight	1.42 kg (3.13 lbs)	1.42 kg (3.13 lbs)
Maximum bank angle	43°	43°
Minimum turn radius	31.8 m	31.8 m
Maximum sink rate in aerodynamic flight	2 m/s	2 m/s
Maximum climb rate in aerodynamic flight	9 m/s (7 m/s)[5]	9 m/s (7 m/s)[5]
Maximum sink rate in hover flight	3 m/s	3 m/s
Maxium climb rate in hover flight	4 m/s (3.5 m/s)[5]	4 m/s (3.5 m/s)[5]

1 Subject to export regulation, may require export permission.

2 Please be aware that the flight time and max. wind tolerance are reduced with increasing flight altitude. Depending on the weather conditions; tested at 15° C (59° F). For further details read the user manual chapter 3.1.

3 Under optimal conditions.

4 Please be aware that the max. wind tolerance is reduced with increasing flight altitude.

5 With a Take-Off-Mass >5kg (Qube 240 LiDAR Payload)

Technical data	Locked **<60 minutes**	Unlocked **90+ minutes**[1]
Telemetry link (QBase Modem) frequency	2.4 GHz	2.4 GHz
Telemetry link (QBase Modem) power	0.1 W - 1 W[7]	0.1 W - 1 W[7]
Operating temperature range	-12 °C to 50 °C (10.4 °F to 122 °F) [8]	-12 °C to 50 °C (10.4 °F to 122 °F) [8]
Wingspan	2.394 m (7.85 ft)	2.394 m (7.85 ft)
Transport Case Dimension	1002 x 830 x 270 mm (39.4 x 32.7 x 10.6 inch)	1002 x 830 x 270 mm (39.4 x 32.7 x 10.6 inch)

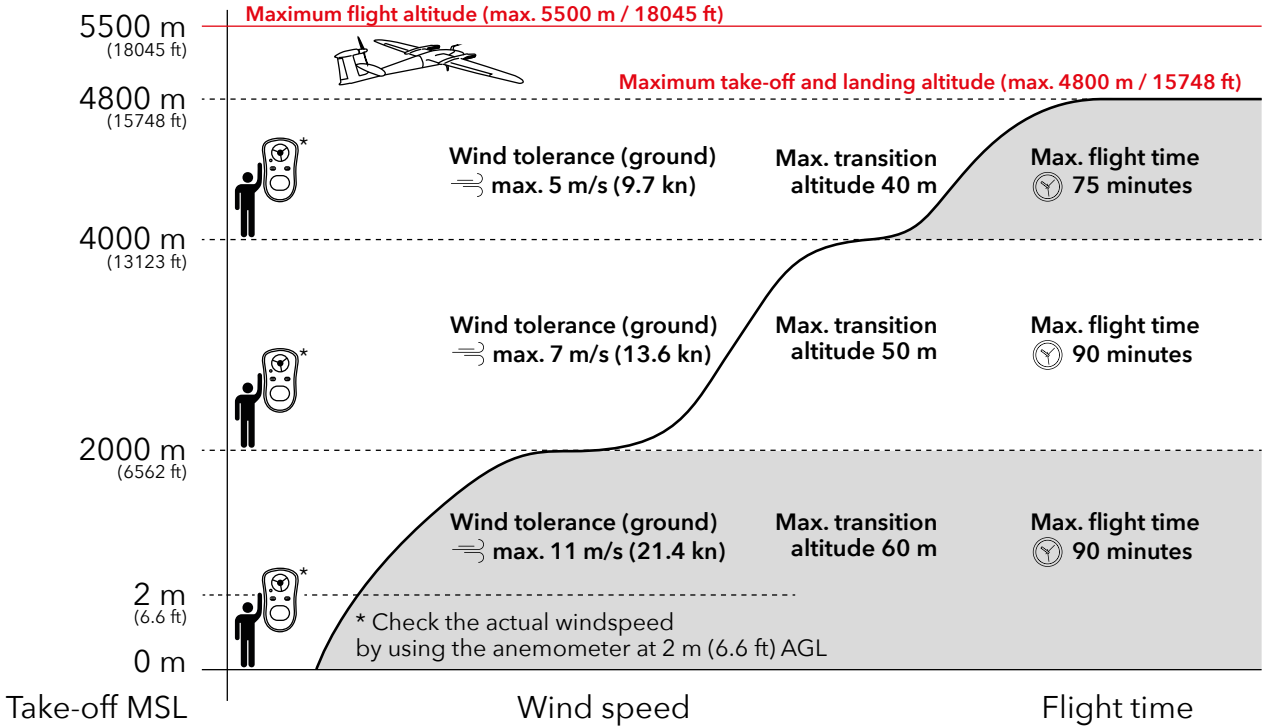
7 Please follow the local regulations for the maximum allowed transmission power.

8 For outside temperature < 10°(<50 °F):
- Heat up the battery to 25°C (77 °F) for at least 5 hours

For outside temperature < 0° (<32 °F):
- Heat up the battery to 25°C (77 °F) for at least 5 hours
- The flight time will be reduced to max. 70 minutes.

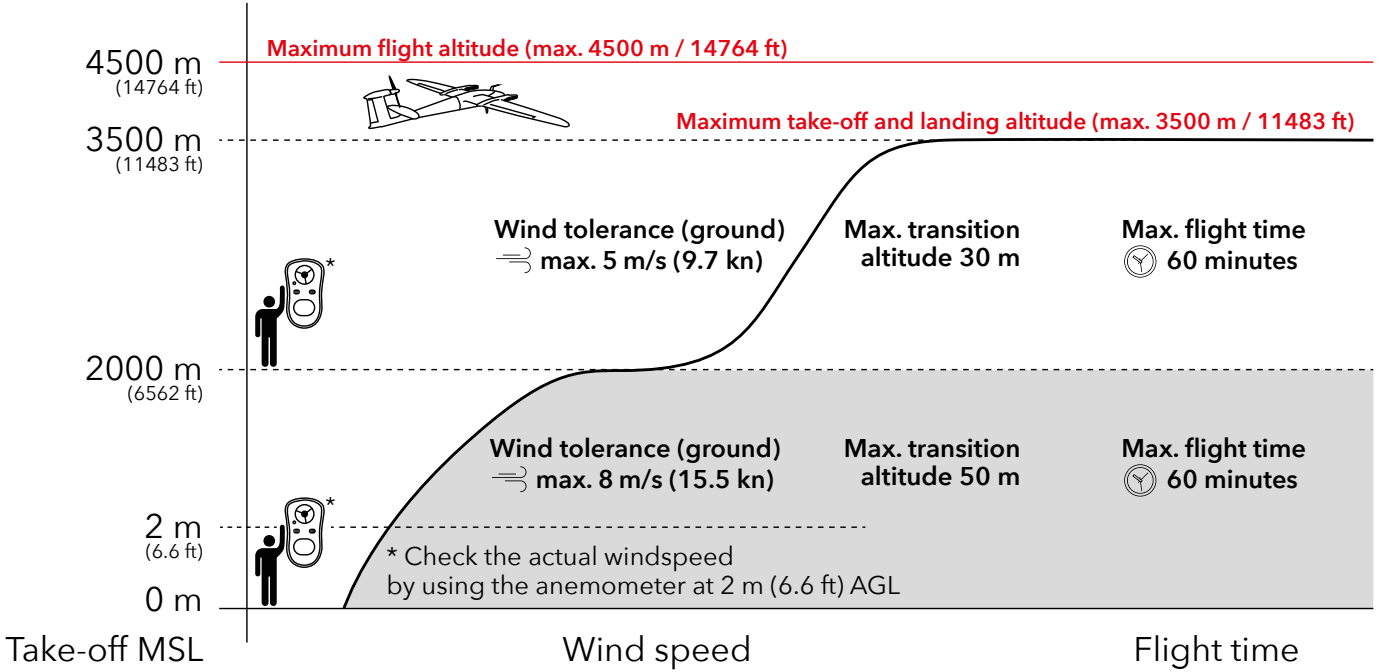
3.1 Maximum flight altitude & wind tolerance

Be aware that the wind tolerance (ground) is by default set to max. 11m/s.
There is no automatic adjustment for take-offs between 2000 m – 4800 m regarding the wind tolerance (ground) and maximum flight time.



3.2 Maximum flight altitude & wind tolerance with LiDAR Qube 240 and Oblique D2M

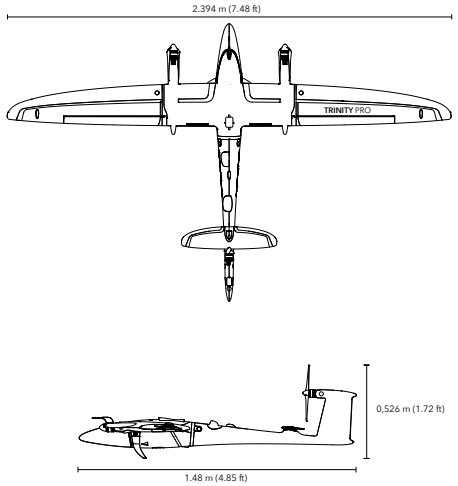
Be aware that the wind tolerance (ground) is by default set to max. 8 m/s.
There is no automatic adjustment for take-offs between 2000 m – 3500 m regarding the wind tolerance (ground).
The maximum flight time is restricted to 60 minutes and the airspeed adjusted to 18 m/s.



3.3 Dimensions and properties

Cameras	Weight	Dimensions (LxWxH)
Qube 240 LiDAR	935 g (33.0 oz)	221x149x104 mm
MicaSense Altum-PT	690 g (24.3 oz)	221x149x92 mm
MicaSense RedEdge-P	470 g (16.6 oz)	221x149x92 mm
Sony RX1R II	680 g (23.6 oz)	221x149x92 mm
Oblique D2M	730 g (28.6 oz)	221x149x92 mm

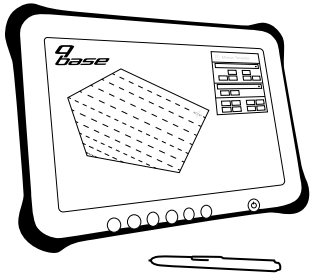
Item	Weight
Main Body	2075 g (73.2 oz)
Rear Fuselage	610 g (21.7 oz)
Outside Wing (2x)	187 g (6.6 oz)
Elevator	23 g (0.8 oz)
Battery	1420 g (50.0 oz)



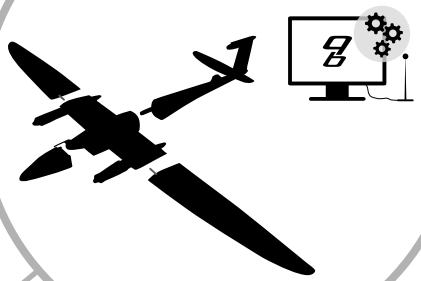
04
Process overview

04 Process overview

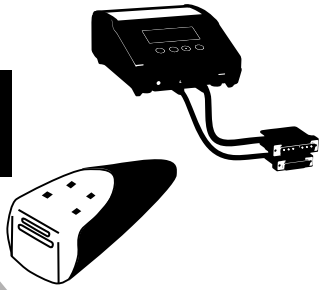
Planning a mission



Flight setup



Charging your Trinity battery pack



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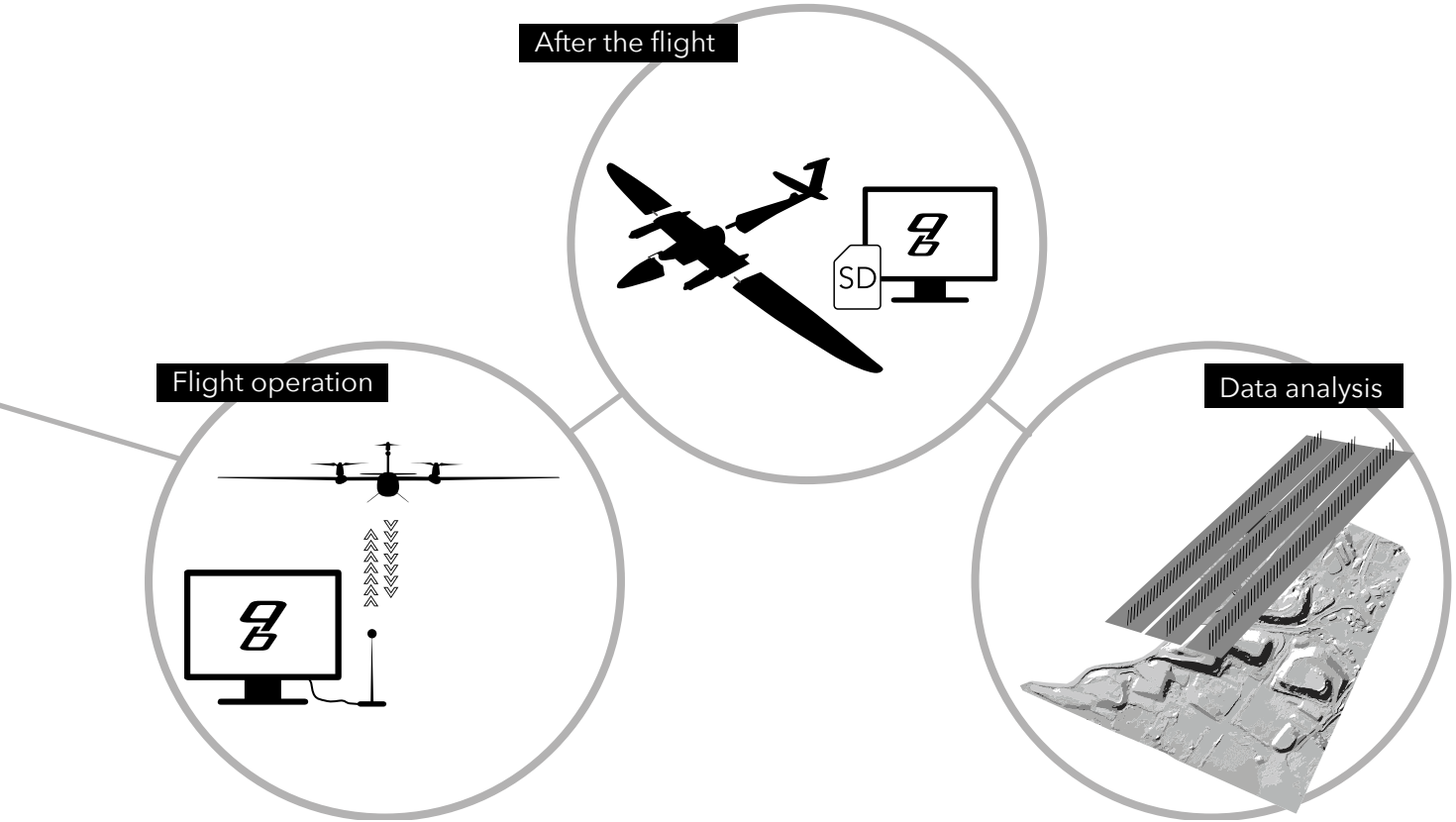
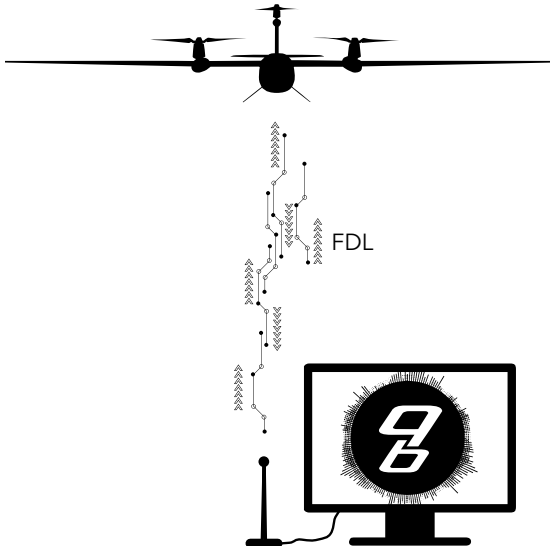


05
Communication link

05 Communication link



The UAV is connected to QBase via a 2.4 GHz flight data link, a downlink sending telemetry data from the Trinity Pro to QBase and an uplink sending commands from QBase to the UAV. The connection is ensured by the QBase modem.

In case of a loss of the flight data link, the Trinity Pro flies to the link reestablishing waypoint and tries to reestablish the connection after the link loss tolerance time has expired. If the connection is successful, either CONTINUE the mission or select COME HOME in QBase.

If the connection cannot be reestablished, a COME HOME will be initiated after the loiter time that was set in QBase expired. The UAV will land automatically.

The Trinity Pro is only allowed to be operated with the corresponding 2.4 GHz modem (PN: 4260574665821)

06
Battery

06 Battery

The Trinity Pro is powered by 6S 4P Li-Ion batteries with an overall nominal voltage of 21.6 V delivering 12 Ah. The four batteries are completely physically separated and located in the nose of the Trinity. Each battery provides an energy of 65 Wh.
The battery is enclosed by fire resistant ARPRO material. Do not open the Trinity Pro battery pack at any time.

6.1 QS Battery charger

The QS Battery Charger is suitable for charging the Trinity Pro battery pack from the wall socket at 100 V – 240 V AC and for charging the battery with the help of a 12 V car battery. Make sure your car is running while charging the Trinity Pro battery to prevent depleting your 12 V car battery.
The following settings are pre-set for charging the battery pack and cannot be edited:

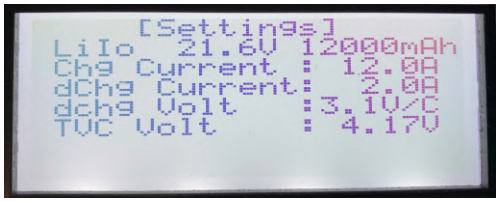
Charging current	12 A
Discharging current	2 A
Discharging voltage	3.1 V
TVC voltage	4.17 V
Charging time	Around 1h (depending on state of charge)
Charging current USB port	2.1 A

6.1.1 Menu overview

Change the menu of QS Charger by pressing STOP/ESC on the user panel.

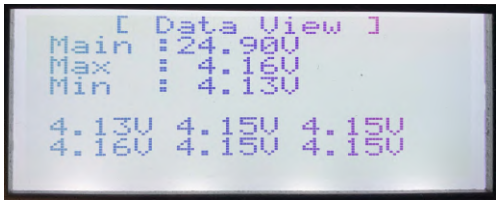
Scroll through the menu or the submenu by selecting + and − on the user panel.

Select a menu item by pressing START/ENT on the user panel. To go back select STOP/ESC.



[Settings]
Battery type, nominal voltage, nominal capacity

Chg = Charging
dChg = Discharging
TVC (Terminal Voltage Control) = Final charge voltage per cell
All settings are default settings and can not be edited.



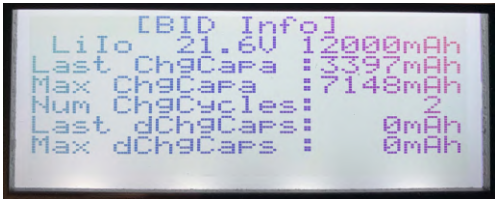
[Data View]
Main = Current total voltage of the six serial connected cells
Max / Min = Current minimum / maximum voltage of the cells
Current voltage of each cell

[User Setup]
Language = Set the language (English, German, Italian, French)

Key Beep = Mute / unmute the key beep.

Buzzer = Mute / unmute the audio signal. The signal notifies you when the charging process is finished or in case of an error.
Input Low = Set minimal input voltage (range 10.3 V – 11 V). Is used for safety reasons to not drain your car battery.

Note: Other settings than the one described above cannot be changed.



[BID (battery identification) Info]
It is possible to read out data saved on the battery.

ChgCapa = Charged capacity
ChgCycles = Charging cycles
dChgCaps = Discharged capacity

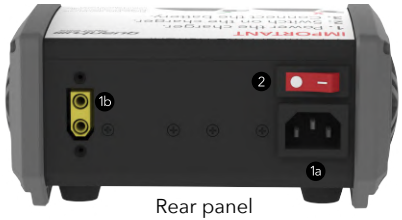
6.1.2 Error messages

ERROR MESSAGES	EXPLANATION
[BID Insert / Break]	If the battery is disconnected during the charging process, reconnect the battery and press START/ENT on the user panel. Restart the charging process.
[BID is not Connected]	Please do a cross check with another battery to find out if it is the battery or the charger that is causing the issue. 1. If the battery is causing the issue, please contact your reseller for repair. 2. If the charger is causing the issue, the charger has to be replaced.
[BID Error Data Invalid]	Please do a cross check with another battery to find out if it is the battery or the charger that is causing the issue. 1. If the battery is causing the issue, please contact your reseller for repair. 2. If the charger is causing the issue, the charger has to be replaced.
[Internal temperature]	An internal temperature is excessive. Allow the charger to cool down.
[Balance connector Error]	Make sure the plug is connected correctly.
[Charging Timeout]	Please continue charging/discharging the battery by starting a new charging/discharging cycle. Depending on the state of charge the warning will be triggered during discharging.

6.2 Charging / Discharging the battery pack

For charging the Trinity Pro battery pack use the QS Battery Charger only. Before charging please see 2.2.2 for the charging safety instructions.

6.2.1 Connecting the charger to the battery



Rear panel

1a. Connect the power cord to the AC 100 – 240 V port and connect it to a wall socket.

1b. Alternative: charging the battery with the help of a car battery. Connect the XT 60 power cord to the DC 11 – 18 V port and connect the black clamp to the minus pole and the red clamp to the plus pole of the car battery.

Note: To prevent draining the car battery the minimal input voltage of the QS charger can be set (see chapter 6.1.1).
Please follow your car manual for connecting the charger to the battery.

2. Turn on the charger.

3. Remove the cover from the contacts of the battery. Always apply the battery cover when the battery pack is not in use. It is mandatory to attach and secure the cover if the battery is transported in an airplane.

4. Connect the battery to the charger.
If the connection is successful an audio signal notifies you.

6.2.2 Charging process

1. Connect the battery pack to the battery charger according to chapter 6.2.1.

2. Press and hold the START/ENT **button** for five seconds. Make sure the [Settings] menu is selected while pressing the button.

3. Select if you would like to fully charge the battery, charge or discharge it to 75 % or to 30 % capacity.

Scroll through the menu by pressing + and − on the user panel. Make a selection by pressing START/ENT.

To go back select STOP/ESC.

Attention

Charging settings
100 %: Battery should be fully charged before each flight
75 %: For long time storage (> 1 week)
30 %: For shipping or transportation on an airplane

Find the UAV battery charging video tutorial on our YouTube channel.
Just search for www.youtube.com/c/QuantumSystems

4. The following display gives you an overview of the **charging process.**

5. When the charging process is finished, it is shown on the display ([End: Charge]). If the buzzer is active (see chapter 6.1.2) an audio signal notifies you as well.

6. Disconnect the battery from the charger and turn it off.

6.3 Battery storage

Please see chapter 2.2.3 for all battery storage safety warnings. Due to safety reasons, do not leave the battery connected to the UAV when stored in the transportation box:

- Charge / discharge the battery to 75 % capacity for long time storage (> 1 week) (see chapter 6.2).
- Always apply the battery protection cap to the contacts of the battery when the battery is not connected to the UAV.

Storage temperature
The battery pack should be stored at an ambient temperature of 20 °C to 25 °C (68 °F to 77 °F).

Storage location
Store the battery in a dry, non-humid location. Preferably inside a building.

6.4 Battery use

- We advise you to use fully charged batteries for each flight. If the charging Status is below 62,5%, the UAV will disable the take-off automatically.
- After **150 charging cycles**, it is recommended to exchange the UAV battery pack (see chapter 13.4).
- The Battery will age over time. Therefore, the warranty of the complete UAV system expires when batteries with more than 150 charging cycles are used.
- For an ideal flight performance, the temperature of the battery should be 20 °C to 25 °C (68 °F to 77 °F).

Attention

If the temperature of the battery is below 15 °C (59 °F), the flight time will be drastically reduced.

- If you fly at an ambient temperature of below 15 °C (59 °F), ensure that you leave the battery pack at a heated place, 20 °C to 25 °C (68 °F to 77 °F), for as long as possible (e.g. inside a heat box or inside a car). If you wish to fly at an ambient temperature below 0 °C (32 °F), make sure the battery is heated to 25 °C (68 °F) before the flight.

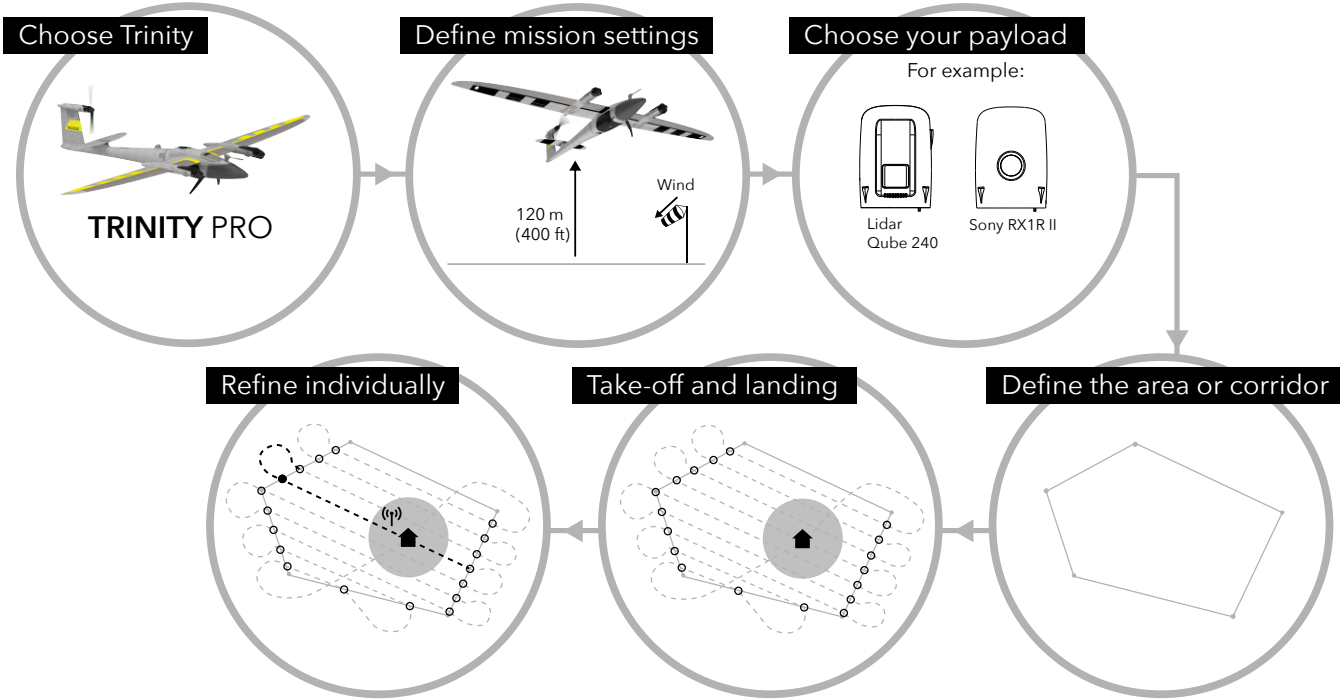
6.5 Travel notice

For shipping the UAV battery pack its state of charge is not allowed to exceed 30 % (based on IATA Lithium Battery Guidance Document: https://www.iata.org/whatwedo/cargo/dgr/Documents/lithium-battery-guidance-document-2017-en.pdf). When carrying the UAV battery pack on board of an airplane, please charge the battery pack to 30 % state of charge. It must be carried in carry-on baggage and the protection cap must be attached to the battery contacts and secured with the supplied screw. See chapter 6.2. to charge the battery pack to 30 %.
If the battery pack is shipped please always apply the short circuit protection and make sure it is screwed to the battery.

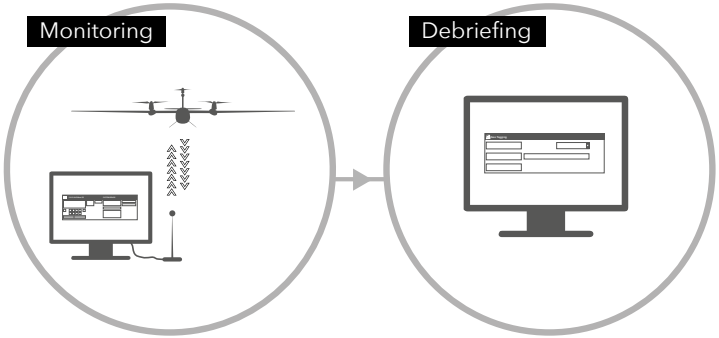
07
QBase – Ground control software

07 QBase – Ground Control Software

QBase is a Microsoft Windows based desktop software. QBase assists the user in planning a mission. The planning process is always accomplished in the following order:



After planning a mission, QBase assists the user in monitoring and controlling the UAV during the flight and also in debriefing the mission.



7.1 Install / Uninstall QBase

The following chapter will deal with the installating and the uninstalling of QBase.

7.1.1 Install QBase

1. QBase is provided by your reseller.
2. Open the QBase installer file and follow the instructions of the installation guide.
3. Open **Start QBase** to open the program.

Minimum system requirements	
OS	Windows 10 64bit or higher
CPU-Speed	2.5 GHz or higher (Hyper-threading or Multicore recommended)
RAM	2 GB or higher
Free Disk Space	500 MB
Display	24-bit color depth
Screen Resolution	1600 x 900 or higher at normal size (96 dpi)
Video / Graphic Adapter	64 MB RAM minimum, 256 MB RAM recommended; NVIDIA, AMD, and Intel chipsets supported; Accelerated graphics card driver; Be sure to use the latest available driver

If you have problems starting QBase, make sure your installation of Microsoft Windows is up to date.

7.1.2 Uninstall QBase

1. Open **Settings.**
2. Open **Apps & features.**
3. Search for QBase.
4. Select **Uninstall.**

Alternative: Uninstall QBase by using the uninstaller shortcut found under
C:\Programs\Quantum Systems\QBase 3D\Uninstall QBase 3D

7.1.3 Drivers

QBase Modem driver

For the connection between QBase and the UAV via the QBase modem a driver is required. If you have problems connecting the UAV to your computer via the QBase modem, make sure the driver is installed.

The required driver can be found in the Windows directory: Programs ➞ Quantum Systems ➞ QBase 3D ➞ Drivers ➞ QBase Modem

Open CDM21228_Setup.exe and follow the instructions of the installation guide.

Autopilot

When using Windows 8 for the connection between QBase and the UAV via USB a driver is required. If you have problems connecting the UAV to your computer via USB make sure the driver is installed.

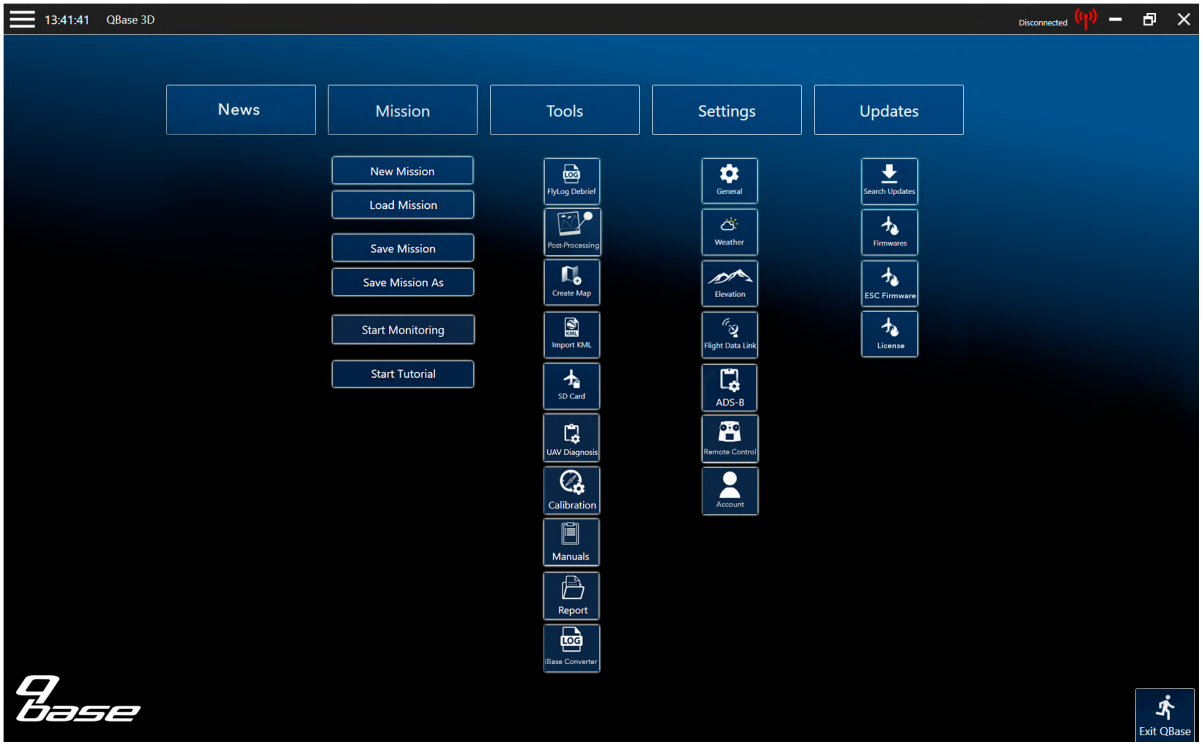
The required driver can be found in the Programs ➞ Quantum Systems ➞ QBase 3D ➞ Drivers ➞ Autopilot

Open Setup_W8_x64.exe (also for windows 10) and follow the instructions of the installation guide.

7.2 USER INTERFACE

The graphical user interface of QBase is divided into several sections.

7.2.1 Main menu



Create Map
Offline maps are generated based on the information of the online maps. During the creation process QBase 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.

Post-Processing
Geotagging the pictures with the accurate PPK coordinates. Please see chapter 7.4.3

Import KML
Import your KML file to improve your mission planning.

SD Card
Not relevant for Trinity Pro.

Calibration
Calibrate the magnetometer and accelerometer.

iBase Converter
Convert the iBase Log file to Rinex 2.11

Weather
This menu gives you an overview of the weather forecast for the specific location.

Elevation
Download the SRTM elevation data for offline use of QBase 3D.

Please note that the SRTM data in general is only available between 56° S and 60° N. SRTM was recorded with an accuracy of around 30 meters and might not correlate with the actual elevation profile.

Please note that the accuracy of 30 meters is especially critical when flying in hilly or mountainous areas. Therefore, it is recommended to use more precise custom elevation data by either downloading from corresponding providers or by flying the mission in a safe altitude in order to create a DTM which can then be used as an elevation model for the precise survey mission.

To import custom elevation data please see User DEM in the General Map Actions.

Transponder

ADS-B

To change the ADS-B settings a connection via the QBase modem must be established.

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

Remote ID
To comply with the local regulations it might be mandatory to have the remote ID set up correctly. The remote ID gives anybody the possibility to track the Trinity Pro via an external mobile App if the Trinity Pro is within the range of the cell phone. The aim is to give transparent information about the drone type, aim of the flight and the operator.
The information is permanently sent out from the Trinity Pro via Wifi. This information can then be accessed with the help of the App via Wifi connection.

To change the Remote ID settings a connection via the QBase modem must be established. If the Remote ID is not set up accordingly, the Trinity will not take off.

Operator ID:
Only use those an operator ID provided by the authorities.

Flight Description:

Please insert the aim of the flight.

Technical data:
Power: 20 mW
Frequency: 2.4 GHz (Wifi)

Flight Data Link
The network ID and password for the connection between the QBase modem and the Trinity can be changed.

Remote Control
In this menu you can bind the RC to the Trinity.

Account
QBase offers the possibility to create a user account. This allows to share missions between different computers.
The missions are automatically saved online to the corresponding account when being connected to the internet.

Furthermore, QBase3D can be used in the standard version or the Pro version. With every purchase of a Trinity Pro one Pro license is delivered. The Pro License can be activated by connecting the Trinity Pro to your computer while being logged into your account.

The license file is then saved in the correspondig account. When logging into the same account on a different computer the Pro license will also be available.

One license key from a Trinity Pro can be used with multiple accounts.

The Pro license enables the user to use the KML Editor functions (see chapter 7.2.3) as well as the elevation display in the 3D planning view.

Search updates
If new updates are available you can download them.
The release notes can be displayed as well.

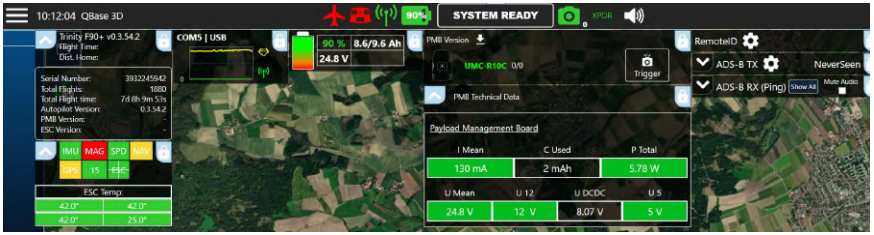
Firmwares
Not relevant for Trinity Pro.

ESC Firmware
Not relevant for Trinity Pro.

License
If a 90 minutes license is available the 90 minutes license can be activated. Please follow the steps described in this manual.

Mission Synchronization
When logged into the account missions can be uploaded to your account. This offers the possibility to open the same mission on a different computer when logged into your account.
The green check mark shows that the upload was successful.

7.2.2 Header



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

UAV Status
1. UAV type
2. Autopilot version
3. Flight time
4. Autopilot Serialnumber
5. Sensor status information

GCS Controller Status

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.

Battery Status
1. UAV battery status
2. State of charge in %
3. Cell voltage
4. Used capacity
5. Number of batteries

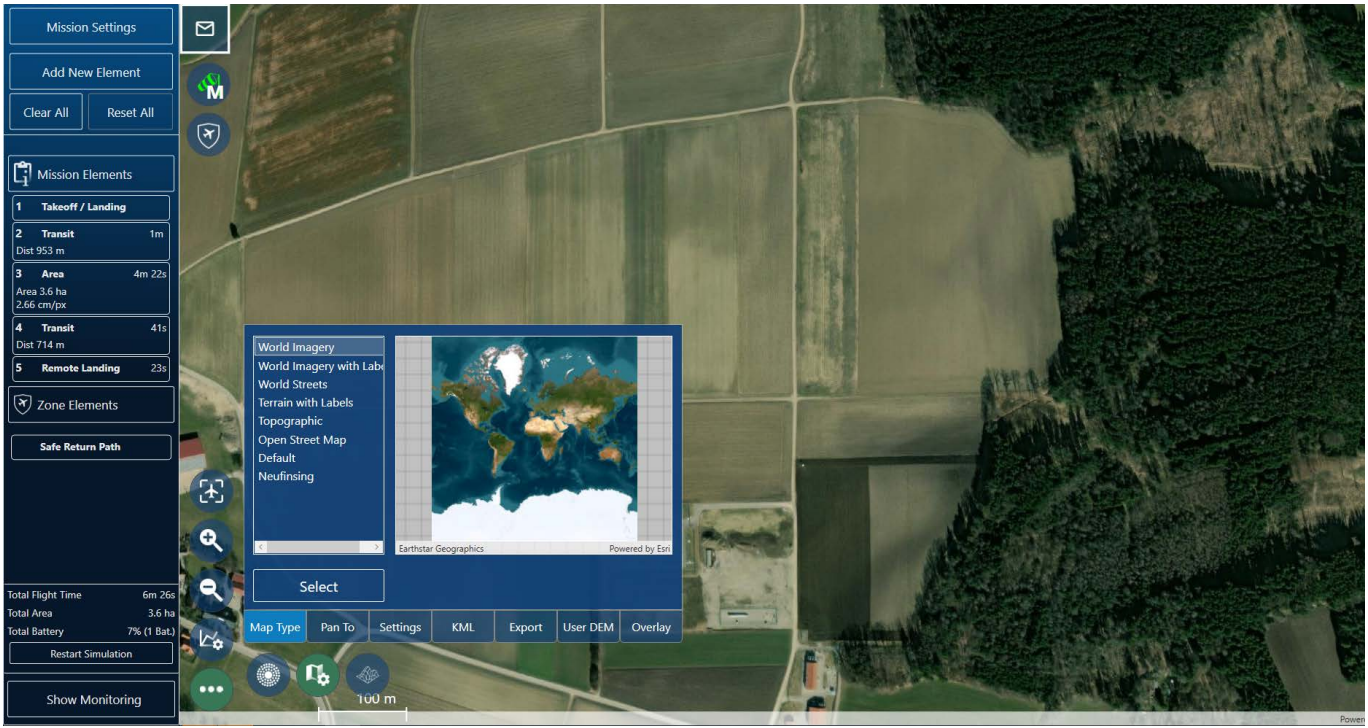
Display widgets permanently by activating the **lock symbol**

XPDR
Status of Remote ID and ADS-B Transponder and Receiver

Mode Display
Current autopilot mode

Camera status + Amount of pictures
Widget open:
1. Name of camera
2. Amount of pictures/Amount of trigger attempts

7.2.3 Planning screen



Map Navigation

The map can be moved by using left mouse button. Zooming is possible with the mouse wheel. Touch screen devices: Move the map with one finger. Use two fingers to zoom in and to zoom out.

Message Dialog
Info, Warning, Error

Lock Map To UAV
The map stays focused on the UAV.

Zoom in

Zoom out

Wind

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

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.

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

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.

Calculate Bearing
Get a bearing and range of the aircraft to your selected reference position. This helps communicating with ATC or other airspace users.

Map Type
The list includes online and offline maps. To use online maps, make sure your device is connected to the internet. **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.

Settings
Adjust the display settings of the map.

KML
This feature is only available if the QBase3D Pro license is activated, it features advanced KML import and managing possibilities.

The tool offers the possibility to import and display multiple KML files and its elements.
The kml elemnts can be used for planning a mission by drawing the mission elements accordingly.
Furthermore, it also allows you to automatically plan a mission element based on the imported kml file.

Therefore please select the kml element (highlighted blue), choose the corresponding shape from the drop-down and select Create. The kml shapes area and path are supported to either create a flight area or a flight corridor.

The imported kml files can also be used to create Working Zones and No Fly zones.
The operator is obligated to download the geo zone from a data base of the local authorities and upload them via the kml editor.

When planning a flight path inside the boundaries of the defined No Fly zone a warning is displayed when uploading the mission to the Trinity Pro. Furthermore the Trinity Pro will trigger in-flight warnings when approaching a No Fly zone.

Export
See crate map in the main menu.

User DEM
You can also import your own elevation data. Make sure the imported file is a .tif file with WGS 84 coordinates
with EPSG 4326 and EGM 96 geoid altitude. Please note that the use of custom elevation data is on your own risk. It is the responsibility of the user to ensure that the custom elevation data is correct. Please note that the elevation data is not stored in the mission file (.qbm) or the offline map file.

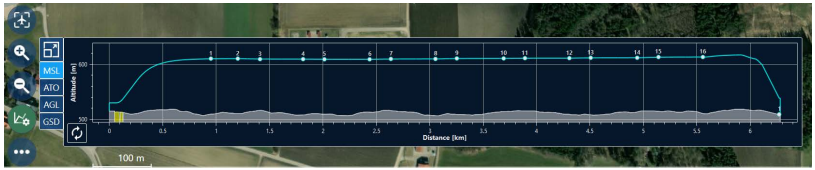
Overlay
It is possible to import a custom map layer. The format
needs to be a .tiff file.

Switch to 3D view

Location where the Trinity Pro will return due to 60 minutevs flight time restriction (if applicable).

Predicted location where the Trinity Pro will return due to battery low.

Plots



Plot colorcodes:

During Mission:	During Take-off and Landing:
Warning <50 m	Warning <19 m
Error <20 m	Error <10 m

MSL: Altitude above sea level of UAV
ATO: Altitude above take-off
AGL: Altitude above ground of UAV
GSD: Ground sample distance

Mission elements

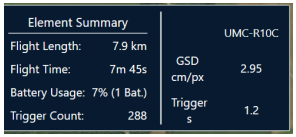
Deactivate element

Show/Hide Payload Triggers
(This will not deactivate the trigger-points)

Pan to Element

Delete element

Move element up/Move element down
(in order to change the order of the elements)



Element Summary: All Settings are displayed in the right corner.
If the selected camera cannot manage the required trigger speed, the trigger speed is displayed in red color. In this case, try to switch the side and forward overlap settings in the Mission Settings. Other options are selecting a higher flight altitude or changing the direction of the legs (cross wind).

7.2.4 Monitoring screen

Plot **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.

Mission & Emergency Commands

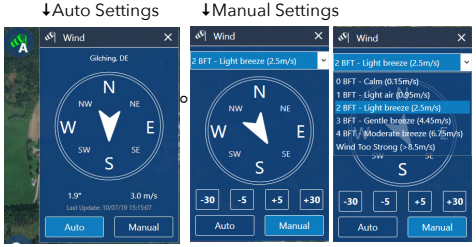
UAV Type

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

7.3 PLANNING A PHOTOGRAMMETRY OR LIDAR MISSION

In order to display the planning view, choose **New Mission** or **Load Mission** in the **Mission Menu.**

Wind Settings



• Auto: Get the wind data online.

The wind is automatically updated as soon as 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

When flying in challenging terrain (e.g. a valley or hilly areas) please simulate the wind coming from all possible directions.
Therefore, please set the wind settings to Wind too strong and manually turn the wind direction to all directions to check for possible collision.

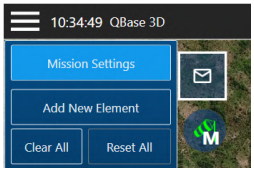
Mission Settings

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. The maximum allowable altitude limit in the „Open Category" in the EU is 120m ATO or 15m above the highest building nearby. It is the remote pilotes responsibility to familiarize and respect the local regulations.
The UAV will not go higher than the planned limit during the mission or assissted flight.

Zone Elements - Working Zone and No Fly Zone

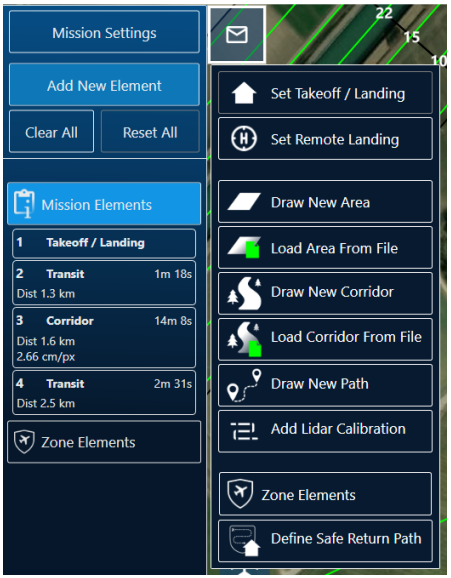
This feature ensures safe mission planning. When planning a flight path inside the boundaries of the defined No Fly zone a warning is displayed when uploading the mission to the Trinity Pro. No Fly Zones can be defined in 3D. Therefore, a minimum and a maximum altitude can be defined. Furthermore the Trinity Pro will trigger in-flight warnings when approaching a No Fly zone.
When leaving the defined Working Zone the Trinity will enter a coming home on the direct path or via the safe return path. Working zones and No Fly zones can either be imported via the kml editor or by manually defining them within Qbase via the Zone Elements in Add new elements. When importing them via the kml editor the Working Zones and No Fly Zones can be adjusted in Qbase afterwards.

Geo Awareness - UAS Geographical Zones and Authorized Zones

UAS Geographical Zones are treated as non - editable No Fly Zones. Please choose a kml file by selecting Load. Other than the editable Fly Zones the UAS Geographical Zones are treated as a 2D element. Therefore, a minimum and maximum altitude cannot be adjusted. The In-flight behavior is equivalent to the editable No-Fly Zones.

An Authorized Zone is a special version of a working zone. **Green dotted line:** The Trinity Pro will initiate a coming home on the direct path or the safe return path. **Green solid line:** The Trinity Pro will initiate a Land Now procedure. **Red line:** The Trinity Pro will never exceed this border. The distance between the red and the green solid line depends on the Maximum Mission Altitude that is set in the Mission Settings and the corresponding possible drift during the Land Now scenario.
In case of a violation of the Authorized zone during planning the green lines are displayed in yellow. A violation can be caused by crossing the dotted line or by the mission element exceeding the Maximum Mission Altitude that is set in the Mission Settings. To activate this feature please choose Display Geo-Awareness Tools in Planning in Qbase **Main Menu -> Settings -> General -> Map View.** The option will then be displayed in the top left corner of the planning screen.

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: If required a different landing location than take-off location can be defined which enables the possibility of A-B missions.
If the remote landing is set the Trinity will by default land at this location.

For the remote landing the same rules as for the standard landing apply.
The remote landing spot can only be planned when a safe return path is setup.

Draw New Area: The flight area is created by defining the corners of an area. Each click on the map defines a corner of the area. The orange highlighted circle represents the highlighted corner. To move a corner it must be selected.

Load Area From File: A .kml or .shp file can be imported into QBase. The flight area is automatically created based on the file.

Draw New Corridor: The corridor is created by defining the points of a polyline. The orange highlighted circle represents the selected point. To move a point it must be selected.

Load Corridor From File: A .kml or .shp file can be imported into QBase. The corridor is automatically created based on the file.

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

Zone Elements: The zone element is created by defining the corners of an area. Each click on the map defines a corner of the area. The orange highlighted circle represents the selected corner. To move a corner it must be selected.

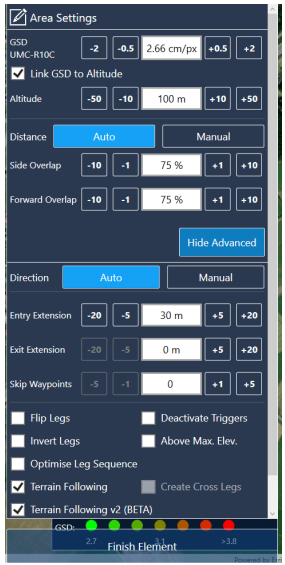
Safe Return Path:
In case "Coming Home" is initiated due to malfunctions or link loss, the drone will return home on the direct path and at the current altitude.
In case there are any obstacles between the take-off/landing area and the mission area the safe return path has to be used.

General behaviour:
If "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 define the altitude (AGL) of the waypoints of the safe return path.
- In case a remote landing is defined forward always triggers the safe return path towards the remote landing, backwards always to the home waypoint and shortest is depending on the position where the come home/land remote is triggered.

Planning a new area

Draw a new area according to chapter 7.3.



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.

GSD: The ground sample distance (distance on the ground between the mid of two pixels) is calculated based on the flight altitude and the camera properties for each camera. This value is linked to the altitude.

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.

Side and Forward Overlap: Overlap settings are dependent on the payload. Overlap default settings are based on the payload settings.

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.
Skip Waypoints: Skip the selected amount of waypoints at the beginning of an area.

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 optimal 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.

Deactivate Triggers: By default the payload is taking pictures within the area. If required for special cases it can be deactivated.

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.

QBase will prevent planning flight legs lower than in 50 m altitude. This also affects the „Above Avg. Leg Altitude“ terrain following model. If the chosen altitude depending on the average leg elevation is less than 50 m above the maximum elevation of the terrain within a flight leg, QBase will automatically increase the altitude of this flight leg to 50 m above the maximum elevation of this leg.

Please note that the turns between the flight legs are not affected by this.

Corridor planning features

In addition to the area settings the corridor provides the following settings.

Corridor Width: This defines the width of the corridor.

Initial Offset: This value shifts the legs relative to the center of the corridor.

Max. Turn Angle: This value determines if the UAV makes a turn before the new corridor segment or continues with the next one.
The aim is to always enter the next segment straight and level for the best photogrammetry results.

Even Leg #: Allows an even number of flight legs.

Attention

To improve the terrain following please locate the waypoints of the corridor in close distance to each other.

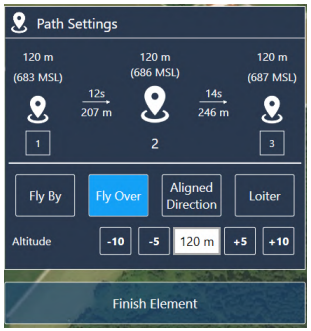
7

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. Setting dialog appears
3. 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

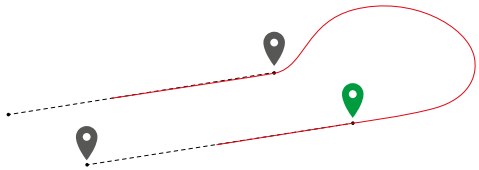
The selected waypoint is displayed in green.

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.

Take-Off /Landing

- 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.

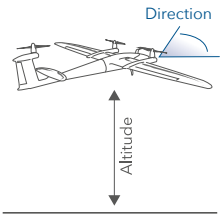
Important:

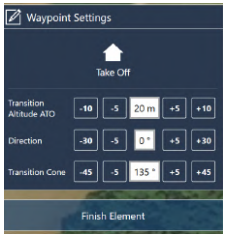
- No obstacles around the Home Waypoint within a radius of 20 meters
- Take-off against wind direction
- No take-off in a wind sheltered area (lee) as turbulences may occur

Attention

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

- Transition cone:
  - Green = Transition cone (allowed transition direction)
  - If there is an obstacle: transition altitude must be 20 meters (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.





Transition Altitude ATO (above take-off)

- **Set the transition altitude as low as possible (if the surrounding allows for it)**
  - Save energy by reducing the hover duration to a minimum

At this altitude the UAV will switch from hover mode to the 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
- 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 surroundings allows for it)

Take-Off/Landing – Retransition

Retransition Waypoint

During the retransition the UAV will switch from aero 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 waypoint should be located close to the home waypoint (take-off and landing location) (ideal <50 meters; max. 100 meters). 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 comply with the retransition waypoint in QBase.
- If there are obstacles in an area with a radius of 50 meters (164 ft) around the retransition waypoint, make sure that the retransition altitude is 20 meters (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 re-transition 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 (per 1 m/s tailwind ~ 20 meter deviation).
- If there is an obstacle in the retransition track, make sure the retransition altitude is 20 meters (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 orientation 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 20 meters (65.6 ft) higher than the obstacle.

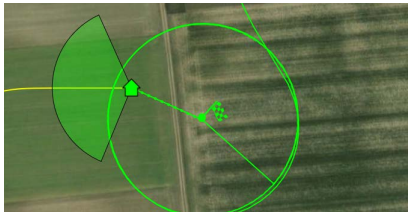
Descent Pattern

Linear: The Trinity Pro will approach the retransition point in a linear flight pattern. The Trinity Pro starts reducing altitude at the first linear approach waypoint. Please note that the descending pattern during the linear approach is not linear but split into two sections with a higher descending rate in the first part. Please always check the plot section for your individual flight.
Please also note that it is not possible to align the linear approach waypoints < 90° to each other. The corresponding waypoint will be highlighted in red.

- Up to 3 waypoints can be inserted to define the linear path

- Depending on the distance of the path an additional circle is inserted before entering the linear approach. This behaviour is simulated in QBase.

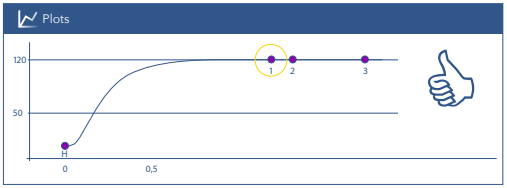
Circular: The Trinity Pro will reduce the altitude within the circular pattern located around the retransition waypoint.
The retransition is performed within the circular pattern and hovers via the retransition waypoint (retransition altitude) to the home point.



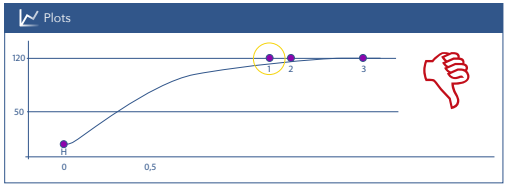
Checks

Open the **Plots**.

1. Please check in the MSL plot that the flight altitude is sufficient during the complete mission.
   Yellow: Flight altitude 20 meters to 50 meters above ground. **Red:** Flight altitude below 20 meters above ground.
2. Please also check the GSD plot for a consistend GSD of the recorded data.
3. Please check the estimated trigger points and the corresponding GSD for consistency by selecting **Show/Hide Payload** Triggers (see chapter 7.2.3).
4. Please check the minimum trigger speed in the Element Summary (see chapter 7.2.3).
5. Ensure that the distance between the home waypoint and the first waypoint of the flight area is sufficient to reach the required flight altitude.



Flight altitude is reached at the first waypoint of the flight area

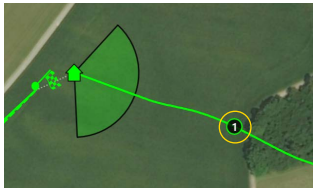


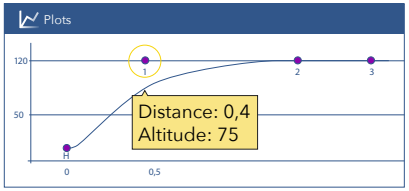
Flight altitude is NOT reached at the first waypoint of the flight area

If the altitude cannot be reached

- try to flip or invert the legs or
- extend the Transit by inserting extra waypoints in between.

6. If obstacles are in the flight track during climbing phase (between the transition and the first waypoint), ensure that the flight altitude is 20 meters (65.6 ft) higher than the obstacles are. Add a waypoint at the obstacle. Please always check the flight altitude for this position in the Plots.





7. Make sure that there are no obstacles between the flight area and the take-off and landing position. If a coming home is initiated the Trinity Pro will return on the direct path or safe return path.

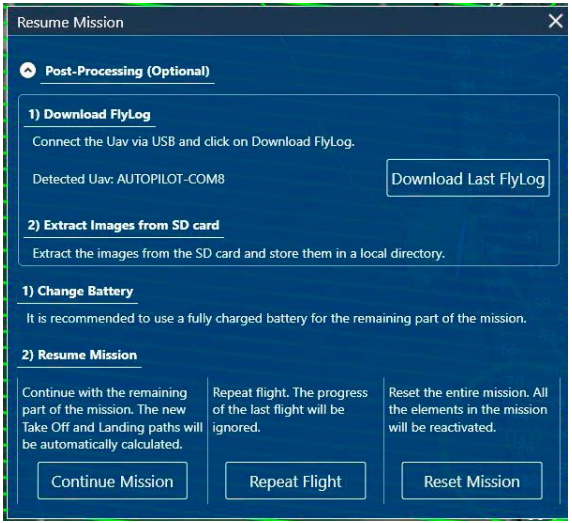
7.4 AFTER THE FLIGHT

7.4.1 Resume/Repeat

You can plan missions longer than the maximum flight time of the Trinity. **To use the resume mission feature, make sure there are no obstacles in the return way throughout the whole mission!** The mission will then be split into multiple parts depending on the following conditions:

- If you have a flight time restriction due to export permission rules, QBase will only upload the mission unto the waypoint that reaches less than one hour flying time. QBase indicates the last uploaded waypoint with a yellow circle and a dotted line to the retransition point.

- The amount of waypoints per flight is limited to 300. QBase indicates the last uploaded waypoint with a yellow circle and a dotted line to the retransition point.
- If the Battery Critical come home is triggered during the flight the UAV will return to the home waypoint in a direct line from the current position or on the safe return path. QBase estimates the last reachable waypoint and indicates it with a yellow circle and a dotted line to the retransition point. This waypoint is only estimated and can change due to wind conditions or battery age! **Therefore make sure there are no obstacles in the return way throughout the whole mission!**



After flying the first part of the mission and landing at the home position, the following dialog will appear:

Post Processing: Please see chapter 7.4.2
Change Battery: Change the battery of the Trinity.

Resume Mission:
1. Continue Mission: Continue with the remaining part of the mission. You will be redirected to the planning view and the flight plan is automatically adjusted to the remaining part.
Please check the adjusted flight plan and solve the conflicts, if any, before uploading it to the aircraft.

2. Repeat Flight: Repeat the last flown part of a multipart mission. Use this option to repeat the last flight. You will be redirected to the planning view and the flight plan is automatically adjusted.
Please check the adjusted flight plan and solve the conflicts, if any, before uploading it to the aircraft.

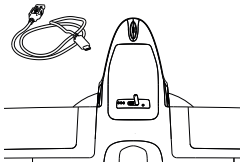
3. Reset Mission: Attention! This will reset the entire mission to the original state. You will be redirected to the planning view and the flight plan is automatically adjusted. **Please check the adjusted flight plan and solve the conflicts, if any, before uploading it to the aircraft.**

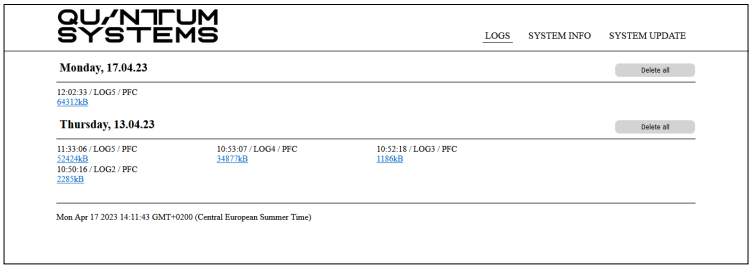
Note: The UAV will return to (home/take off) at the current altitude, after 1 hour flight time (if applicable) or after the estimated last reachable waypoint marked in yellow (see conditions at beginning of section).

The window Resume Mission also appears if a mission is aborted by Come Home.
Important: The adjusted flight plan needs to be uploaded to the UAV before the next flight!

7.4.2 Download the Payload Log and the LogFile from the Trinity Pro

Payload Log:
Contains all the coordinates of the pictures that are recorded during the flight.
During the geotagging process (see chapter 7.4.3) these coordinate tags are correlated with the corresponding pictures.
For every flight there is a new Payload Log written.





LogFile:
Includes all the sensor data of the flight and might be needed by your reseller for troubleshooting. For troubleshooting the Paylaoad Log and the corresponding LogFile is required.

In order to download the Payload Log and LogFile please follow the these 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.**

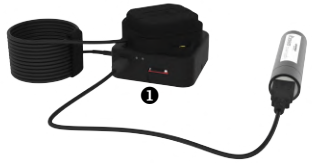
- please connect to the Trinity Pro via WiFi.
  Network: QS_Trinity_X
  Password: 1234567890
- Open 10.41.2.1 in your browser

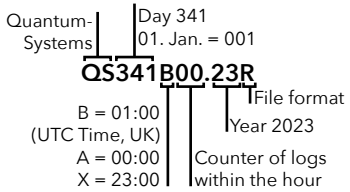
3. An online interface will be openend in the browser.
4. Open the first tab LOGS to show all the logs stored on the Trinity Pro. The logs are ordered according to the date.
5. Please download the corresponding log by selecting it. A log indicating a flight is marked with PFC - the download includes the payload Log (.PLD) and the LogFile (.FMU) with their corresponding preflight recording (.PLD_PRE and .FMU_PRE)
6. Save the files on your computer.

To prevent loss of data please always download the logfile and payload log regularily. The autopilot overwrites previous files if the internal storage is full.

7.4.3 Post Processing

The aim of PPK post processing is to geotag the pictures with very precise geodata.
Required files and data:
- Payload Log that is recorded during the flight and saved on the UAV
- iBase Log
- Pictures that are saved on the camera SD card





iBase:

1. **Insert the Micro SD card** ❶ of the iBase into your computer.
2. **Copy** the iBase Log file corresponding to your flight on your computer (the latest file on the SD card e.g. QS341B00.21R)

UAV Payload Log:

3. For downloading the **Payload Log** from the UAV follow the instructions described in chapter 7.4.2.

Pictures:

4. **Remove the storage device** from the payload compartment.
5. **Insert the storage device** into your computer, laptop or tablet.
6. **Save** the pictures on your computer, laptop or tablet.

Post processing in QBase:

7. Remove the pictures that were manually taken on the ground during the camera check as well as during the automatic camera start-up (2 pictures).
8. Open Tools and select Post-Processing.

The view is split into four sections:

Data input (A):

1. Please select the Payload Log from the Windows directory.
2. Please select the corresponding pictures from the Windows directory.

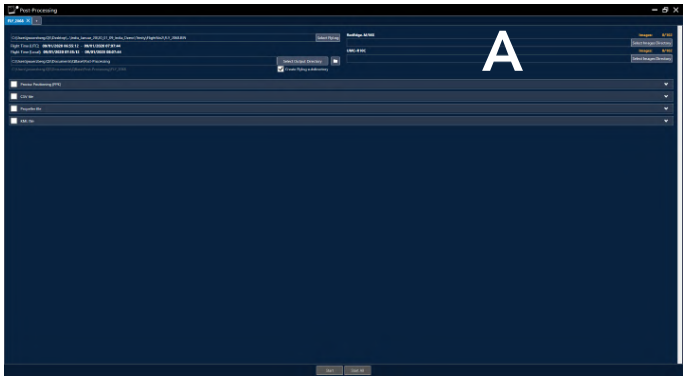
Depending on the type and amount cameras that were used different options are displayed.

Exporters (B):

3. Please select the type of exporters depending on the required files for the post processing in a 3rd party software (e.g. Pix4D or AgiSoft).

Depending on the flight type, different export options are available (e.g. PPK, GeoTagging).

Please find detailed explanations of the exporters in section Exporters in detail (B).

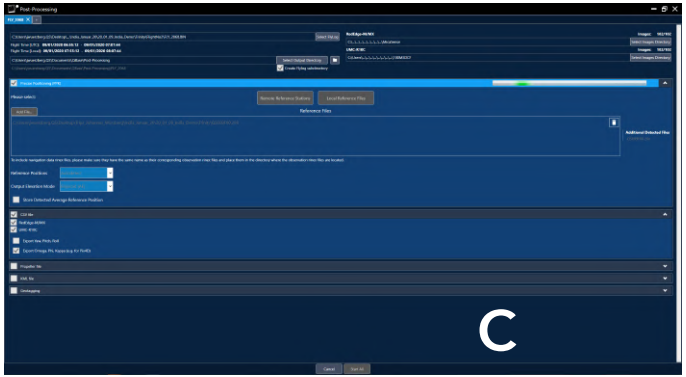


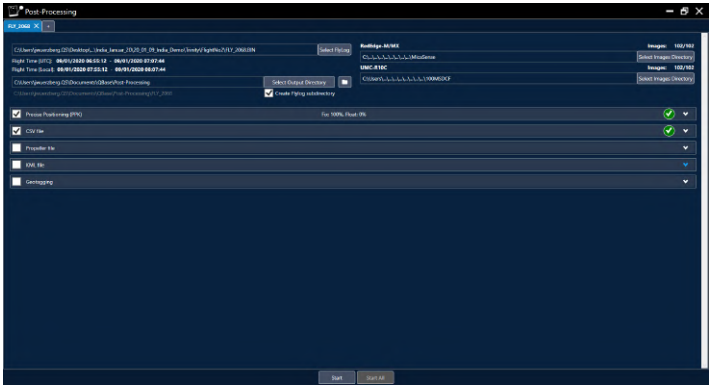
Start (C):

4. Please select Start to start geotagging of the pictures with the corresponding coordinate tags from the Payload Log.

5. Once the geotagging is completed please select the folder icon in section A to open the output directory.

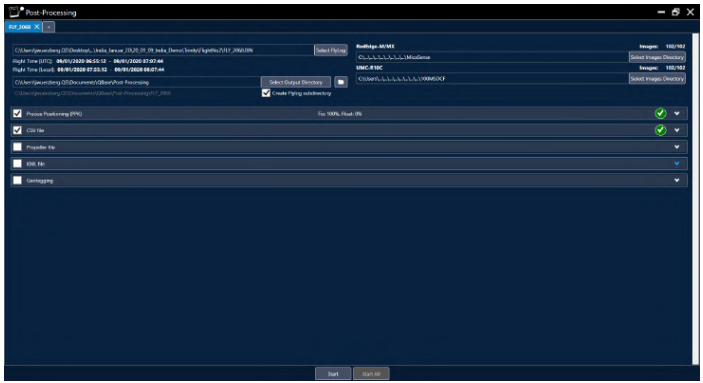
Below is an example of a successfully completed job:





Result:

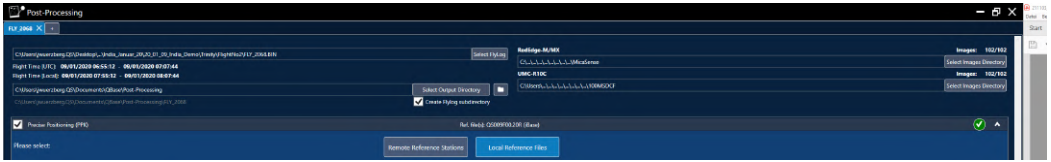
6. Please check the PPK Fix/Float value after successful processing (Section B).
The fix value should at least be 90 % for PPK accuracy.



Exporters in detail (B):

Precise Positioning (PPK)
For PPK, a reference file for a defined position is required. This can either be obtained via the Quantum-Systems iBase or by external providers.

Select **Remote Reference Station** or **Local Reference Files.**



Remote Reference Station
Choose a reference station in the list to download reference data from a remote reference station. Note that remote reference data is usually not available until a few hours after the flight.

Local Reference Station
a. Select + on the right side of the Post-Processing window
b. Choose a reference file from the Windows directory (iBaseLog or 3rd party Rinex file)

iBaseLog
iBaseLog file format: *.yyR
(yy in file extensions above are the 2 last digits of the year number. E.g. 21 is for the year 2021: *.21R, etc.)

3rd party Rinex file
Reference file from another receiver or from geodetic corrections service (e.g. SAPOS in Germany, Trimble VBS Now in USA, KOREC in United Kingdom).

3rd party reference receiver or a geodetic corrections service file format:
- a Rinex2 or Rinex3 observations file (possible extensions *.obs,* .o, *.yyo,* .yyO)
- a compressed Rinex file (possible extensions *.yyd and* .yyD)
(yy in file extensions above are the 2 last digits of the year number. E.g. 21 is for the year 2021: * .21o etc.)

c. Select the Reference Position from the dropdown menu

Autodetect the Reference Position
The position is automatically calculated based on the header of reference file or

Set Reference Position
Either choose a previously saved reference position from the dropdown list or define a new reference position.

New reference position:
- Latitude and Longitude must be inserted in decimal format and contain at least eight decimal digits.
- Antenna Vertical Offset for iBase.
  uBlox Antenna placed on top of iBase: 0.033 meters
  uBlox Antenna placed on the ground: 0.008 meters
- Input Elevation Mode (Geoid or Ellipsoid) based on the information from your reference file.

d. Choose the **Output Elevation Mode** (Geoid or Ellipsoid). Ellipsoid is the mode that should be used by default.
If Input **Elevation Mode „Geoid"** is selected only the **Output Mode „Geoid"** is available.
If the Input Elevation mode Ellipsoid and the Output mode Geoid is selected the transformation is made based on a 1 deg x 1 deg grid geoid model derived from EGM96.

CSV file: This exporter creates a .csv file with the relevant metadata for each image. It is possible to choose between yaw, pitch roll for AgiSoft or omega, phi, kappa for Pix4D as additional information.

Propeller Aero file: This exporter creates a .ubx and a .prop file required by the Propeller online service.

KML file: A KML file of the flight for visualization in Google Earth is created. The KML file includes all trigger and exposure events.

Geotagging: The geotags are written into a copy of the images using the exif tags.

Mismatches Solving Tool:
In case there are mismatches between exposures and pictures please access **"Solve Mismatches" in the "Job Summary (C)".**

Flight Path (A)
The complete flight path and the corresponding geotags and images are directly displayed in the map.

Flight Summary (B)
A summary of total active** exposures detected in Payload Log and the total amount of images found in the directory are displayed here. The data is updated based on the current selected payload, and the color indicates if there are mismatches detected for the current payload (Red\Green).

Flight Leg Summary (C)
The images and exposures are split and grouped flight legs and only these with mismatches are displayed. In this section, the current selected flight leg is displayed with information about the number, the time scope and the count of active** triggers and exposures.

**Active: Non-skipped entries

Map Interactions (D)
Pan to mission, selection of base map and export of debugging file can be done here.

Time scope (E)
This section provides a direct filter to define the current time scope. Only images and exposures below the selected time scope are visible.

Usage:

1. Please select the Flight Legs that contain mismatches between pictures and exposures in the top right corner (C)

2. Please individually check the flight legs and make sure that every picture correlates with a corresponding exposure

   Autodetection of Conflicts
   The images and exposures are automatically analyzed and possible conflicts are identified and marked in red. The marked entries are only a hint of the possible cause of mismatches.
   It is important to check the path and verify the detected conflictive entries before skipping them.

3. Please select the corresponding image or exposure to skip the entry.

   
   Skip Entries
   Skipped entries are displayed with a grey border. Skipped entries are ignored for any post-processing task.

   
   Display of Image (Only for Images)
   Use this action to display the current selected picture on the map.

4. After the mismatches are solved ** indicated by the green selected payload, the changes can be applied by clicking the

"Apply Changes" button. You will be redirected to the post-processing window to start processing the job. All skipped images and exposures are ignored for all tasks defined in the job.
**solved: same count of exposures and images.

Command Line Tool:
Post-Processing can be executed via the Command Line tool "PostProcessingCL.exe", which is automatically installed along the QBase.exe.
Use ".\PostProcessingCL.exe --headless" in a Windows PowerShell window to get more information about the usage.

7.5 UPDATES & SETTINGS

7.5.1 DataLink settings

The network ID and password need to match.

Ground modem
1. Enter the **target ID** and click **Configure** to set it.
2. By using a password no other user with the same ID can access your aircraft.Enter a password and click Set Password to set it.

Air modem
1. Connect the battery to the main body.
2. Please connect to the Trinity Pro via **USB-C**.
3. Open 10.41.1.1 in your browser
   Alternative: Connect to the Trinity Pro via the **WiFi** connection according to chapter 7.4.2.

4. Open the tab **SETTINGS** to adjust the modem settings. Make sure the ID and password match with the ground modem settings. The airmodem power can be adjusted.
   Please consider possible local regulations.

7.5.2 Updating QBase

QBase will notify about new available QBase updates upon startup. The release notes can be displayed as well.
To manually check for new updates, go to Updates menu and select Search Updates.

1. Select **Updates**.
2. Select **Download** to start downloading the update. The update consists of an installer file.
3. Select **Update** to start the installation.
4. QBase is closed and the installer opens automatically.
5. Follow the instructions of the Setup Wizard. The old version of QBase is automatically overwritten.

7.5.3 Updating the UAV

When a new UAV firmware becomes available the user is informed via QBase. The UAV firmware includes the autopilot firmware and the ESC firmware.

DO NOT attach modem to PC

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.**

- please connect to the Trinity Pro via WiFi. Network: QS_Trinity_X Password: 1234567890
- Open 10.41.2.1 in your browser

3. An online interface will be openend in the browser.
4. Open the third tab SYSTEM UPDATE to enter the update page.

5. Please select Browse... to choose the new update file.

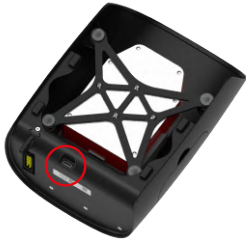
➡ It is important to always update QBase as well as the UAV firmware as soon as updates become available. ⬅

The highest level of flight safety can only be achieved with the 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 available.

7.5.4 Updating the Payload Management Board (PMB)

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

1. Start QBase.
2. Select **Updates** and select **Search Updates.**
3. Select **Download** to start downloading the Firmware.
4. Select **Update** and confirm with **Yes.**
5. **Please pay special attention that the paylaod compartment is connected to the computer AFTER selecting Detect Device.**
6. Afterwards the writing process starts automatically. After the update please select **OK**.
7. Disconnect the USB connection between the payload management board and your computer.



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

8. Connect the QBase modem to your computer.
9. Attach the payload compartment to the UAV (see chapter 11.1).
10. Connect the battery to power up the UAV. The UAV connects to QBase automatically.
11. Select **the Payload Icon.** The current software version is displayed.

7.5.5 Software and Firmware Versioning Schematics

Please always keep the software and firmware upto date. Warranty might expire in case of the use of an old firmware or software version. Downgrading the softwares and firmwares is not possible.

The second digit of the firmware and software version indicates the compatibility between QBase 3D and the Trinity Pro and the PMB.

08
Flight setup – step by step

08 Flight setup – step by step

After planning the mission in QBase follow the steps below for the flight setup.

Attention

The steps 8.1 – 8.12 must be completed in the following order.

8.1 Step 1 – Ensure that the weather conditions are suitable for flying

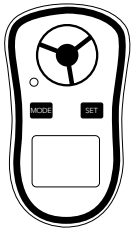
It is possible to fly the UAV under the following conditions:

1. Wind up to 9 m/s (17.5 kn) (See chapter 3.1.)

In addition to wind data provided by QBase or meteorological service check the actual windspeed using the **anemometer.**

First time start-up of the anemometer

- Switch on the anemometer by pressing and holding **MODE** for 2 seconds.
- Set measuring method to **MAX** by pressing **MODE** for 3 seconds till m/s is blinking. Press **SET** until **MAX** is shown blinking. Press **MODE** to confirm.
- To reset the **MAX-value** press **MODE** for 3 seconds till m/s is blinking. Then press **MODE** to confirm.



For more details see the brief manual delivered with the anemometer.

2. Temperature -12 °C to 50 °C (10.4 °F to 122 °F)
Below 0 °C (32 °F): non icing conditions, battery must be heated to 25 °C (77 °F) for at least five hours before the flight and the flight time is limited to 60 minutes. **Do not fly in rain or snow.**

8.2 Step 2 – Ensure that the battery is sufficiently charged

Before the flight, the battery of the UAV must be sufficiently charged. The required state of charge depends on the duration of your mission. It is not possible to take off if the battery is less than 62.5 % charged.

Attention

We recommend to use fully charged batteries for each flight.

8.3 Step 3 – Power bank for iBase

Make sure the power bank for the power supply of the iBase is sufficiently charged. The iBase can be powered for up to 10 hours with one power bank.

8.4 Step 4 – Ensure that QBase and the UAV firmware are up to date

If necessary, update QBase (see chapter 7.5) and the UAV firmware (see chapter 7.5).

8.5 Step 5 – Set up QBase modem

Do not use any other ground modem than the QBase modem for the connection between the UAV and QBase.

Modem setup

1. **Connect the QBase modem** to your laptop / tablet via USB.
2. **Open QBase and open the mission.**
3. **Place the modem.**
   The modem should be placed as high above the ground as possible.
   In order to guarantee the best connection, **please ensure the modem is not shaded by any obstacles and has a direct line of sight to the UAV.**

8.6 Step 6 – Connect the QBase controller

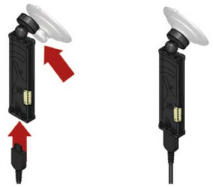
1. Connect the Trinity Pro controller to your laptop or computer.
2. The controller is recognized by QBase indicated by the controller symbol in the header section turninig green.

Attention

A safety pilot who is able to control the UAV with the help of the controller is always required. Be prepared to take over and control the UAV manually in assisted flight in case of an emergency. The contoller must be held by the pilot during the whole flight time.

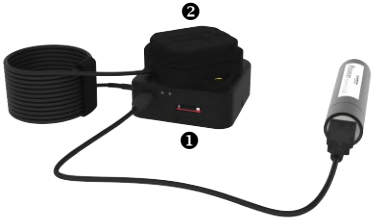
8.7 Step 7 – Set up ADS-B receiver

1. Insert a suction cup into the gimbaled mount.
2. Insert a microUSB cable into the pingUSB.
3. Connect the other end of the USB cable to your laptop or computer.
Please always hang up the pingUSB vertically.



8.8 Step 8 – Set up iBase

- Make sure the Micro SD card is inserted into iBase ❶.
- Place the antenna ❷ of iBase on your desired reference point (make sure the antenna center is exactly above the reference mark) or directly on top of the iBase.
  It is recommended that the iBase is not shaded by objects (trees, buildings,...).
  While logging, you should stay away (min. 5 meters) and not stand or run beside it!
- Connect the power bank to the iBase via the USB cable.
  (Please not: There is a gap between the iBase housing and the micro USB plug. Do not connect the plug with force.)
- Switch on the power bank by pressing the power button.
  The iBase will power up automatically (green LED).
  The iBase Log file is created as soon as the iBase determines its position within approx. 25 seconds after powered up (blue LED is blinking).



8.9 Step 9 – Check the UAV for damages

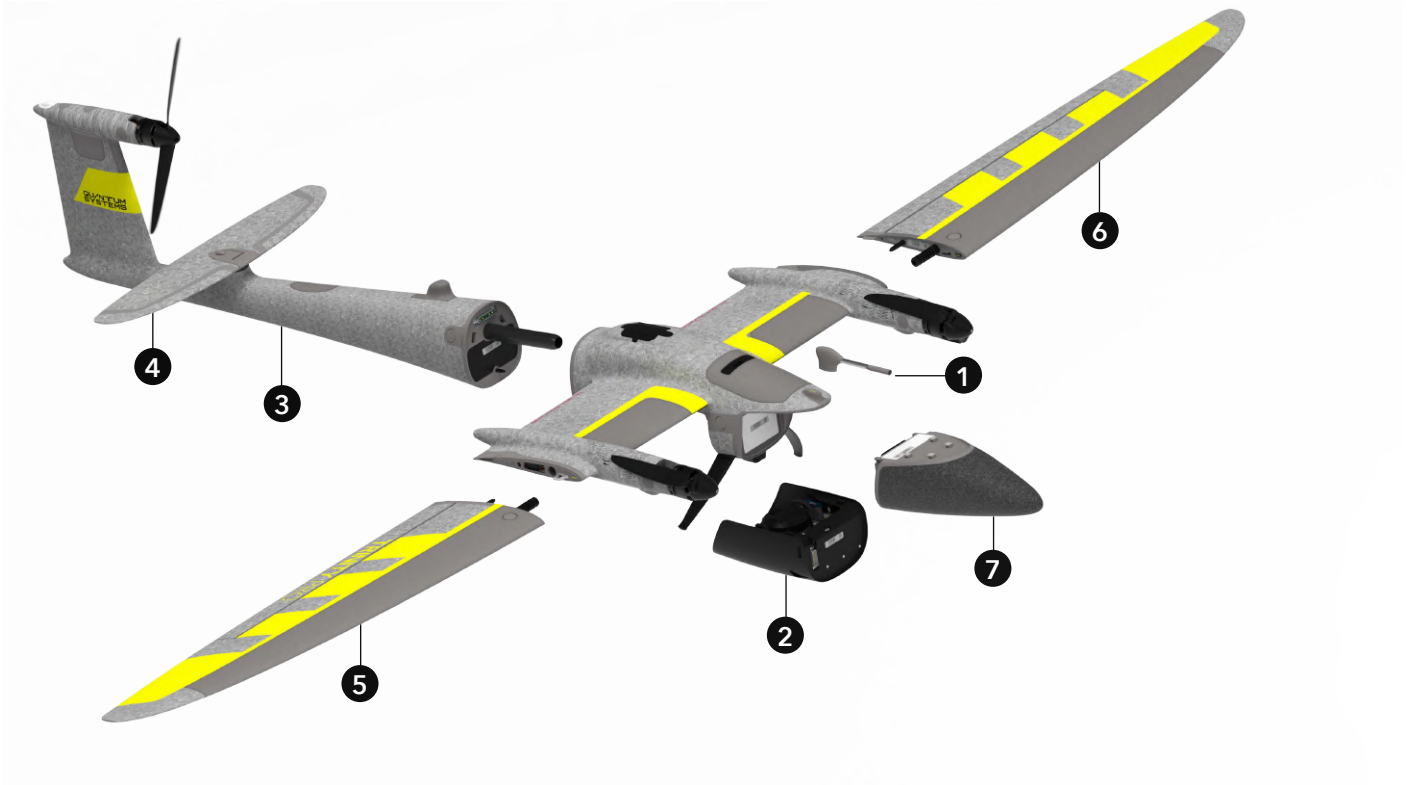
Please make sure every part is free of damages.

8.10 Step 10 – Magnetometer calibration (if required)

Obligatory: flight location > 50 km away from the last flight location

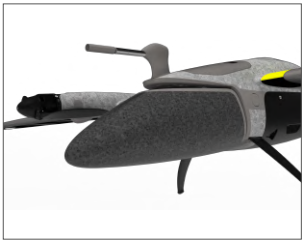
Calibration and take-off area is free of metal (parking decks, cars, metal structures) or any devices causing electric or magnetic fields (power lines, generators, mobile phones).

8.11 Step 11 – Assemble the UAV

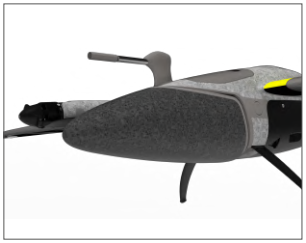


1. Please attach the airdata probe to the main body.
2. Remove the payload transport lock or attach the desiredpayload to the main body.
3. Attach the rear fuselage to the main body.
4. Attach the elevator.
5 & 6. Attach both wings to main body.
7. Connect the battery. **The UAV will power up automatically.**

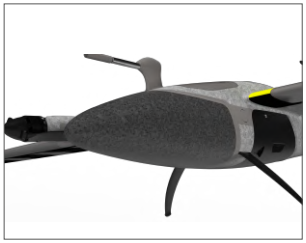
Nose lock mechanism



Align the battery according to the picture.

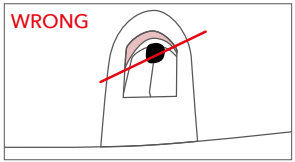


Connect the four mounting hooks on the top of the battery to the main body.

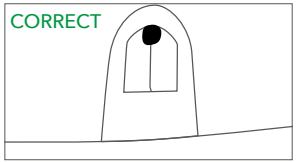


Slide the battery backwards. Make sure the locking mechanism is in place.

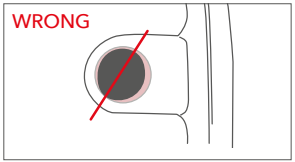
All parts are connected by a lock mechanism. No tools are required for the setup. Check all connections and ensure that the lock mechanism is in place.



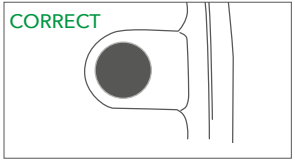
Elevator



Elevator

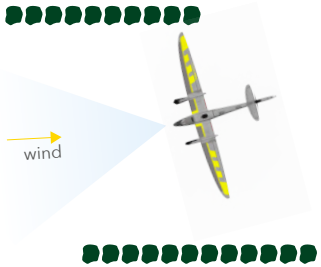


Wing / Rear Fuselage / Nose



Wing / Rear Fuselage / Nose

8.12 Step 12 – Choose the take-off position



- It is always recommended to take-off from the UAV transportation box as it provides a flat surface.
- If your take-off / landing position is in a dusty area, please cover the ground with a canvas cover. Please use weights to fix the canvas cover to the ground.
- Please do not land the UAV on the transportation box as it may fall off.
- To ensure the highest level of safety it is recommended to take off from the highest point of the flight area.

Please always consider the wind direction and wind speed when choosing the take-off position.
Do not take off in a wind sheltered area (lee) as turbulences may occur.
Please always check the wind not only at the take-off position but also in the immediate surrounding.

Because the correct take-off position will be transferred to QBase right before the start of the mission, the chosen take-off position does not have to match the home waypoint that was defined in QBase before.

Attention

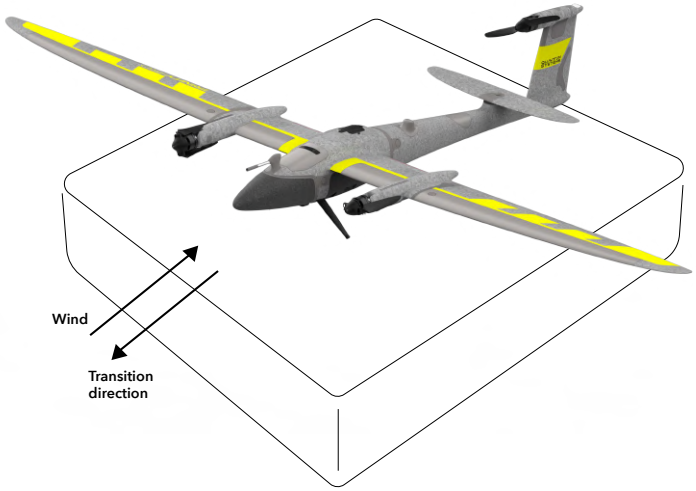
If there is an obstacle in transition direction (defined as the transition cone in QBase) make sure the transition altitude is at least 20 meters (65.6 ft) higher than the obstacle.
If possible choose the transition direction against the wind direction.

8.13 Step 13 – Place the UAV

Place the UAV on the transportation box on the take-off position facing the desired transition direction.

It is mandatory to position the transportation box leveled out. Do not take off on sloping ground

It is always recommended to do the transition facing the wind direction.



09
Flight operation

09 Flight operation

9.1 Flight operation – step by step

Normally the flight is carried out in automatic mode. The UAV is not controlled by the pilot but flies automatically based on the flight plan that was generated in QBase and transferred to the UAV. Waypoints must be set and transferred to the UAV in order to fly in automatic mode. Only in emergency situations, it is recommended to switch to assisted flight to control the UAV manually with the help of the controller that is connected to QBase. If switched to assisted flight, the waypoint mission is paused. It is possible to switch between the modes at any time.

For the flight operation, the UAV must be connected to QBase.

Step 1 – Flight setup

Ensure that the flight was set up correctly (see chapter 8.1 - 8.13).

Step 2 – Check the connection between QBase and the UAV

The connection status is displayed in the header section of QBase (green and yellow graph). Furthermore, the UAV is displayed on the map . If the UAV does not connect with QBase see chapter 14.1.

Step 3 – Check the camera

The camera can be triggered manually to check if it is working correctly.

1. Please use the trigger payload button in the header section of QBase.

2. If the camera works correctly, it emits a shutter sound and the picture count in the header section of QBase counts up. Please see chapter 14.3 if the camera does not work correctly.

Step 4 – QBase final check

Obstacle clearance in reality
- No obstacle within a radius of 20 m around Home Waypoint
- Re-/transition, descent circle, flight paths: altitude 20 m higher than obstacles

UAV heading
- Ensure the heading of the displayed UAV corresponds to the direction of the UAV on the ground
- Do not fly if the heading on the ground is not correct: **critical deviation ≥ 10°**

Wind direction
- Re-/transition is set against the wind direction!
- **Retransition with tailwind: per 1m/s tailwind ~ 20 meter deviation**
- Windcheck in the immediate surrounding
- Do not take-off in a wind sheltered area (lee) as turbulances may occur

Step 5 – Upload the mission

Upload the Mission 

Make sure the home waypoint in QBase  **is adjusted to the real take-off position**  .

Step 6 – Preflight check

The UAV will self-check and initialize the attitude and position algorithms.
After the **Preflight Check** it is recommended to wait at least **30 seconds** before you start your mission so that GPS data on the ground will be logged prior to flight. This enables a better PPK convergence in the post process.

Attention

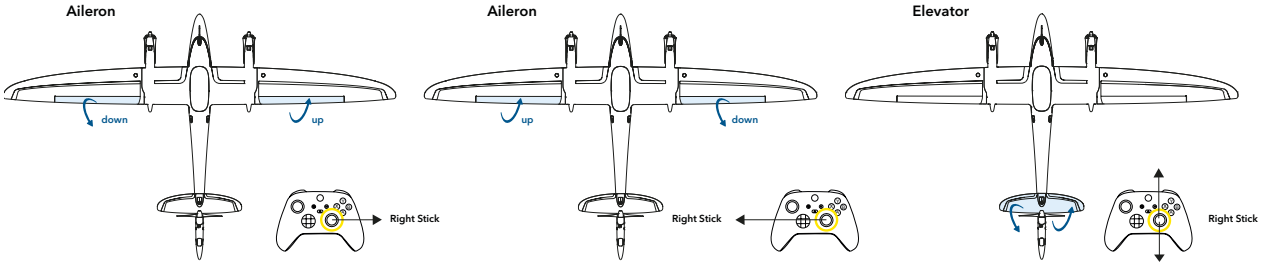
Please stand behind the UAV and keep a safety distance to the UAV of at least 10 m (33 ft) during the complete flight operation. **Make sure the UAV is not moving during the Preflight check.**

Preflight Select **PREFLIGHT (CHECK)** in QBase3D.

If the preflight check is not successful a message will be displayed in QBase.
During the preflight check the actual take-off position is transferred to QBase.

Step 7 – Check the control surfaces

Move the right stick to check the ailerons and elevator. If the stick configuration was changed, use the left stick to check the ailerons and the elevator.
Make sure left and right aileron always move in the opposite direction and ensure that the ailerons are moving according to the stick position as shown in the example below.



Make sure the control surfaces are moving while moving the stick. Do not fly if a control surface is not moving. See chapter 14.2 for troubleshooting.

Step 8 – Arm

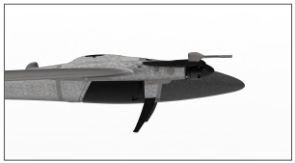
!!NEVER ARM AN AIRCRAFT WITH A DAMAGED PROPELLER!!

ARM

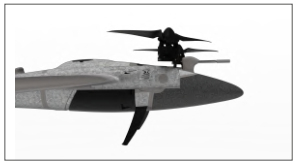
The arming process starts the motors.

1. Select **ARM** in QBase.
2. Confirm the arming process by selecting **Yes!.** Abort the process by selecting **No!**
3. The motors start running at idle. If you wish to turn off the motors, select **OFF.**

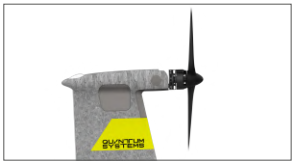
- Due to safety reasons the UAV will **turn off the motors automatically** after **30 seconds** if no button has been pressed.
- Make sure the motors are **spinning freely.** If the spinning of the motors emits an untypical sound, turn off the motors.
- Make sure **all three motors are tilted 90° upwards.** If not, turn off the system. Contact your reseller for further assistance.



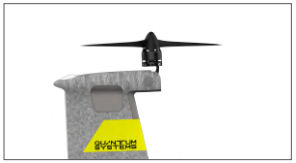
Front alignment: neutral position
CORRECT



Front alignment:
tilted upwards correct for take-off/landing
CORRECT



Rear alignment:
neutral position correct for forward flight
CORRECT

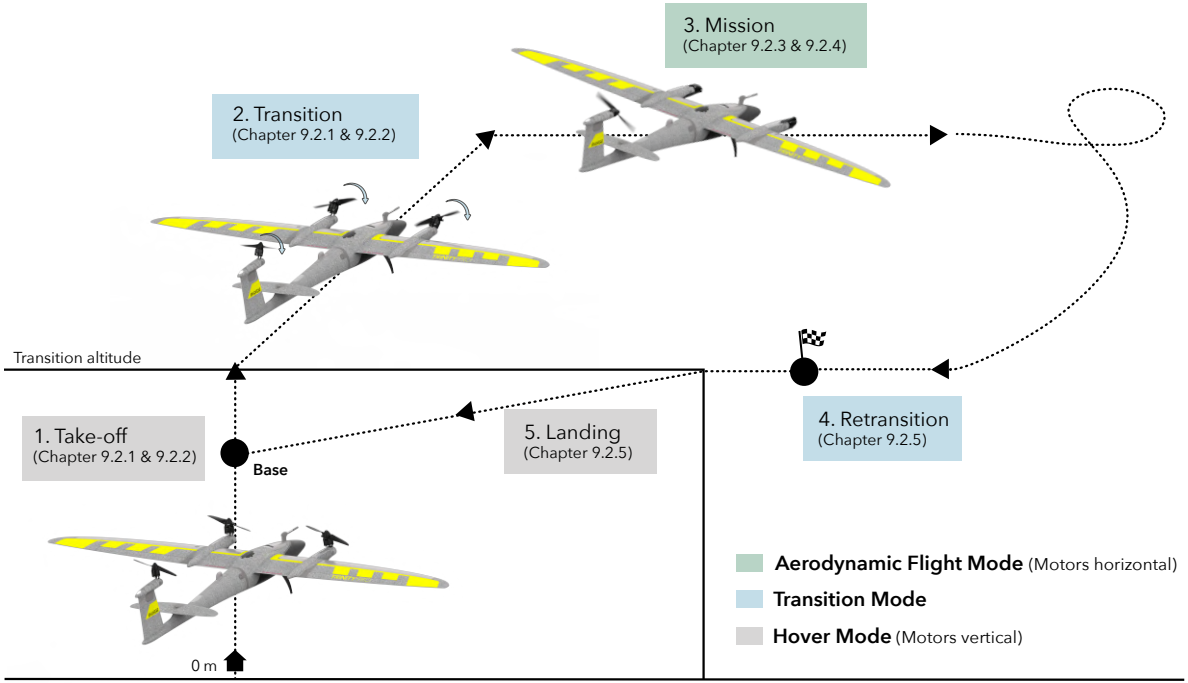


Rear alignment:
tilted upwards correct for take-off/landing
CORRECT

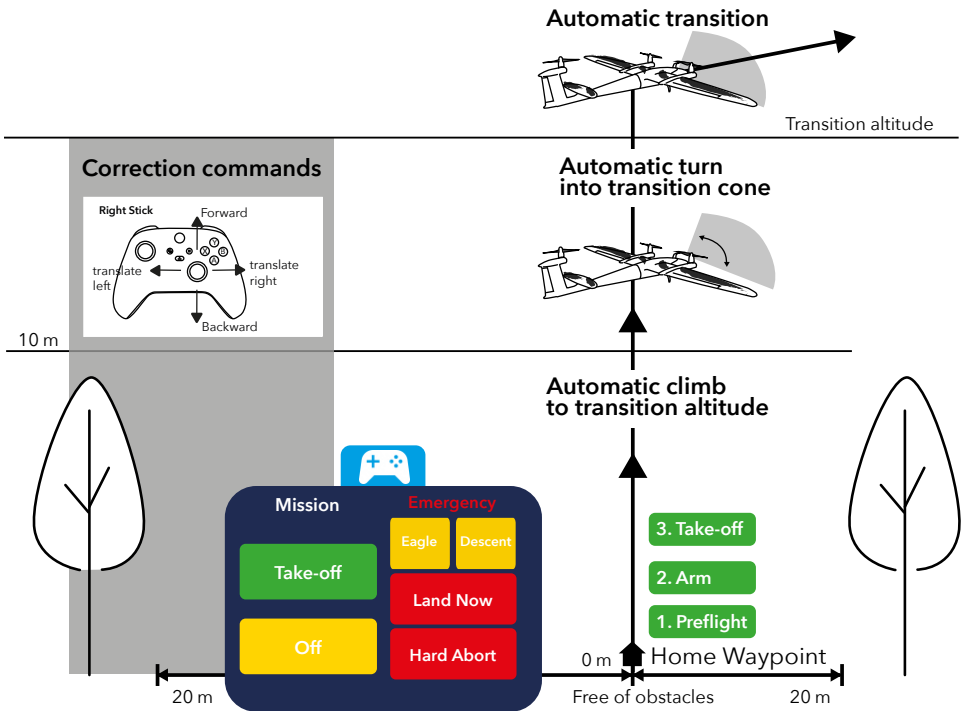
9.2 General flight operation

This chapter describes the general flight operation of the UAV 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 UAV is equipped with safety features that initiate an automatic coming home in case of an emergency.



9.2.1 Take-off & Transition



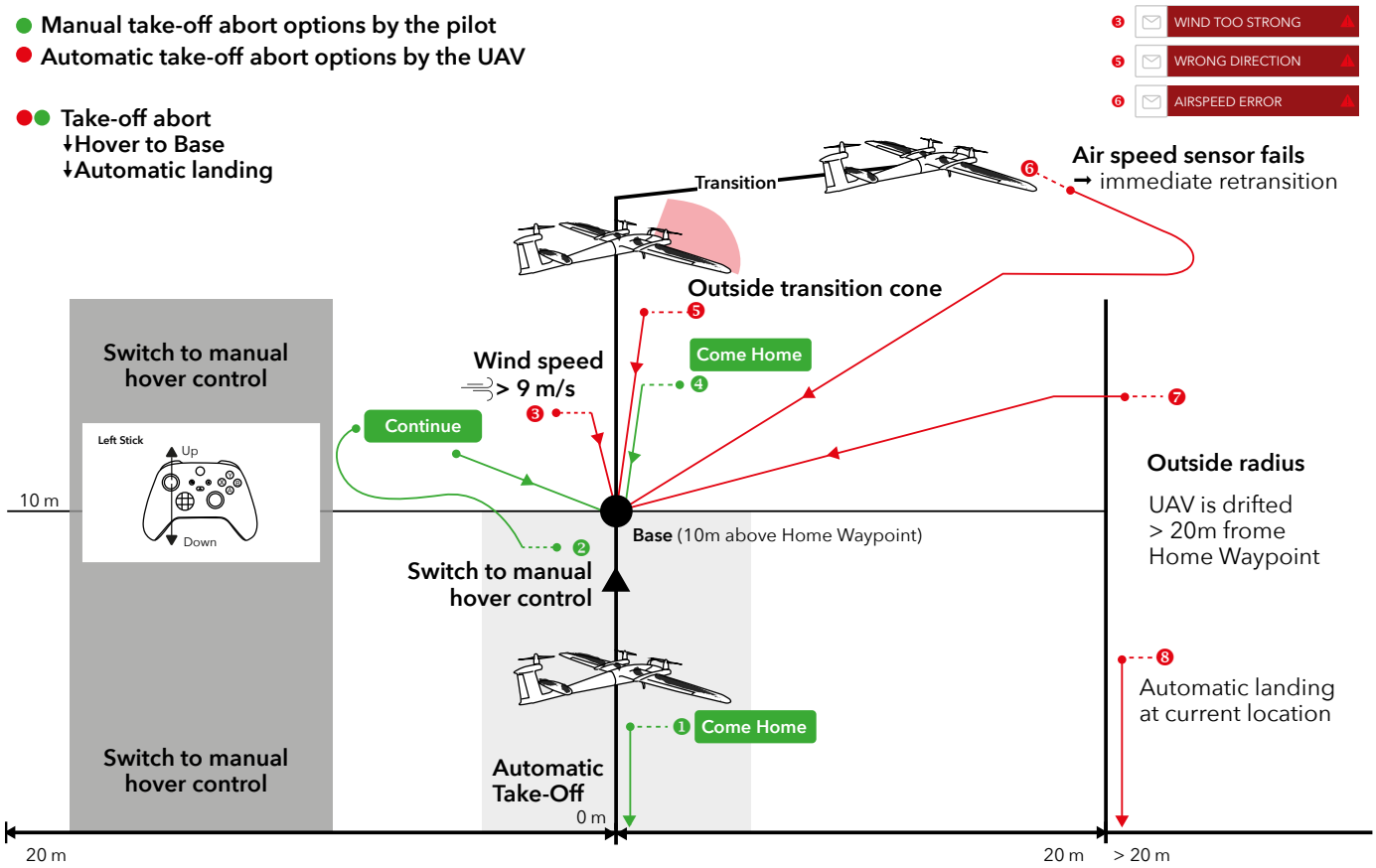
Take-off Location

No obstacles around the Home Waypoint (20 m radius)

Transition altitude: 20 m (65 ft) higher than obstacles

Take-off direction: facing the wind

9.2.2 Manual & automatic take-off abort scenarios

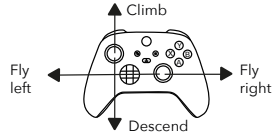


9.2.3 Manual & emergency & mission commands

+++ ONLY USE IN CASE OF AN EMERGENCY +++ IN CASE OF OBSTACLES IN THE FLIGHT-PATH DUE TO MISSION MISPLANNING.

Manual Commands

Min. flight altitude is **40 meters (ATO = above take-off)**



Continue → return to planned mission.

No mannual commands for >5 seconds → return to planned mission.

Emergency Commands

Abort: Left stick

Auto climb 15 sec. max. climb angle

Eagle **Descent** Decrease / Increase altitude to 80 meters AGL and loiter at current location

Mission Commands

Loiter at current altitude & location

Hold → **Continue** → **Mission**

or **Manual commands**

Land Remote current altitude and on direct path or safe return path. → **Remote Retransition Waypoint**

The UAV will crash!

Hard Abort

Descent in assisted flight mode

Land Now Immediate retransition

Switch off the motors & enter spiral dive

Come Home current altitude and on direct path or safe return path. or climb up to 40m above retransition altitude

Retransition Waypoint

Transition altitude

Retransition

Automatic hover

Descent & land at current location

10 m

Base

The UAV will crash!

0 m

20 m

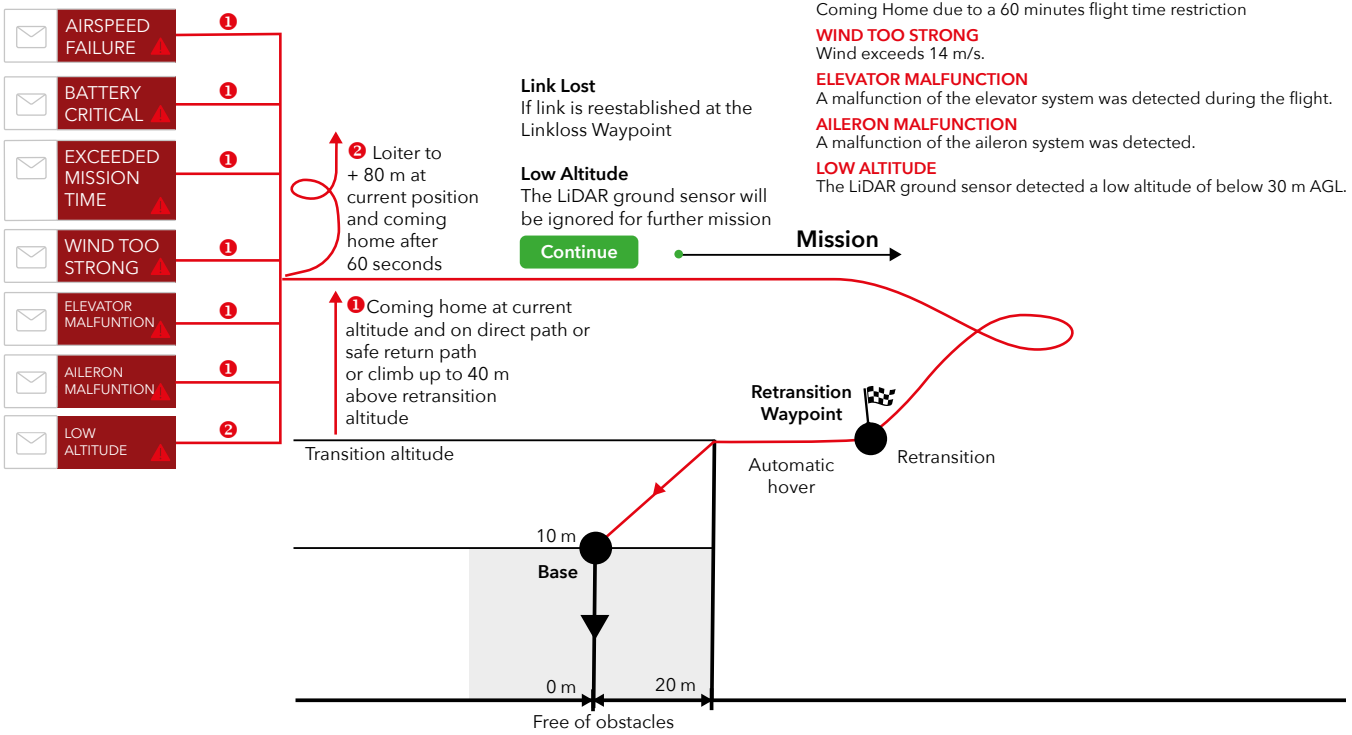
Free of obstacles

!!It is always necessary to keep the hover time as short as possible to avoid extensive heating of internal electronic components!!

9.2.4 Automatic mission coming home

See chapter 14.6 for detailed explanation of the Error Messages

Coming home is performed on current altitude and on direct path or on the safe return path. If a remote landing and a safe return path with the setting forward or shortest is defined the land remote is triggered.



AIRSPEED FAILURE
Possible reason is a blocked airspeed sensor.

BATTERY CRITICAL
The remaining capacity is needed to return and to land.

EXCEEDED MISSION TIME
Coming Home due to a 60 minutes flight time restriction

WIND TOO STRONG
Wind exceeds 14 m/s.

ELEVATOR MALFUNCTION
A malfunction of the elevator system was detected during the flight.

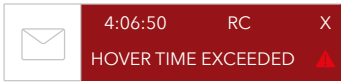
AILERON MALFUNCTION
A malfunction of the aileron system was detected.

LOW ALTITUDE
The LiDAR ground sensor detected a low altitude of below 30 m AGL.

9.2.5 Retransition & landing

Transit: Altitude (MSL) of last waypoint or automatic climb to 40 m above retransition altitude if last waypoint is below the altitude of the retransition waypoint

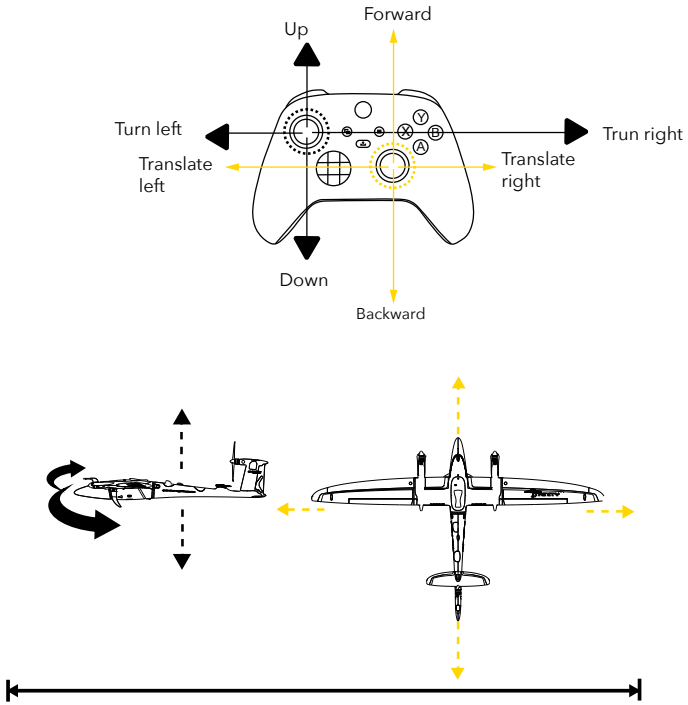
55 seconds: HOVER TIME
Notification after 55 seconds.



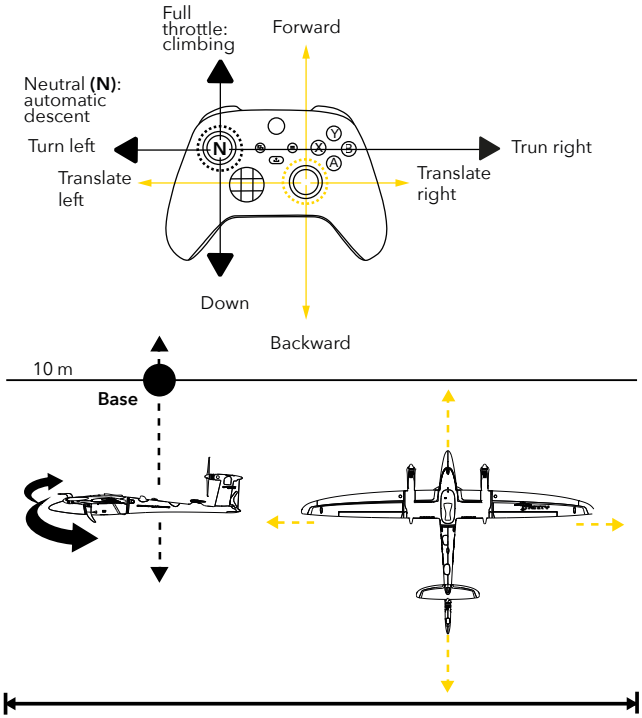
70 seconds: HOVER TIME EXCEEDED
Automatic and immediate descent at current location
Full throttle: will reduce the sink rate for smooth touch-down

9.2.6 Hover commands

Manual hover commands after manual take-off abort



Manual landing commands



9.2.7 GNSS denied mode

GNSS failure during Mission

The Trinity will enter the GNSS denied mode and give out a warning and a coming home is initiated.
As no GPS positioning is available the current position is estimated indicated by the dotted circle in QBase. Please be aware that the circle and therefore the estimated location will increase over time. The position is not accurate and can only roughly be determined according to the map.
For regulatory reasons, the manufacturer does not declare resistance against a GNSS loss.

Options during GNSS denied mode

1. Select Come Home: The Trinity will enter the descent circle and perform the retransition and landing at the estimated location. The vehicle will not enter the hover to base mode.

If the GNSS signal can be re-established during the come home, the Trinity will enter the hover to base mode after the retransition. Select „continue" during coming home to continue the mission if GPS is reestablished.

2. Fly Manually via sticks - this is recommended if the GNSS drift (displayed by the dotted circle) is too large and a safe landing is no longer guaranteed. Select „land now" at the desired landing location to initiate an immediate retransition. If no manual input is given for 5 seconds, the Coming Home is continued.

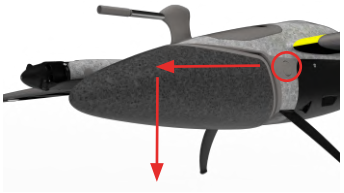
GNSS failure during Hover Mode (take-off or landing)
The Trinity will enter the GNSS denied mode and initiate an immediate landing at the current position. As no GPS positioning is available the current position is estimated indicated by the dotted circle in QBase.
Note: The vehicle will drift due to wind influence. Fly manually to compensate drift if necessary.

10
After the flight

10 After the flight

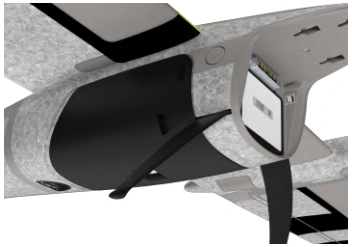
10.1 Disassemble the UAV

IMPORTANT: Before disconnecting the battery, please wait until the OK button on the transmitter is disabled. This ensures the best PPK accuracy.



1. **Disconnect the battery** from the UAV and cover the connections of the battery with the protection caps.

   Press  (A) on the left side and slide the battery forwards (B) and pull it down (C).
   Note: The UAV can only be switched off by disconnecting the battery.



2. **Shut down QBase.**
3. **Disassemble the UAV.** Disconnect the parts by pushing the lock mechanism button and simultaneously pulling the parts apart.
4. **Check all parts** of the UAV **for damages.**
5. **Clean the airframe** by wiping off the dirt with a moist cloth. If needed, use window cleaner to clean the airframe.
   Do not expose the UAV to water as it may damage the electronics.
6. **Store the parts inside the transportation box.**
   For storage and transport, leave the battery disassembled from the UAV and **attach the payload transport lock.**

10.2 Download the payload log

Payload Logs are generated during the flight and saved on board of the UAV. KML and tagging files can be generated from the Payload Log. See chapter 7.4.2 to download the Payload Log from the UAV.
Please note that only the last twenty fly logs are saved on the autopilot. In order to prevent loss of data, please download the fly logs regularly.

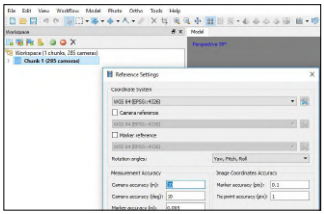
10.3 Download and geotag the pictures

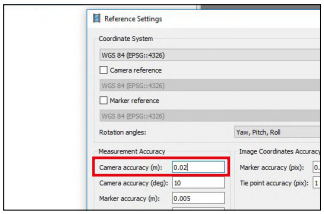
See chapter 7.4.4 to **geotag the pictures** with the geodata with the help of QBase.

10.4 Post processing

In order to post process the geotagged pictures please use a third party software like Agisoft, Pix4D, Propeller Aero or Trimble business Center.
For optimal accuracy results the recommandation is to adjust the accuracy settings in the software.
Therefore, please see the following screenshots:

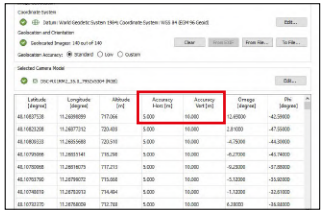
Agisoft Accuracy

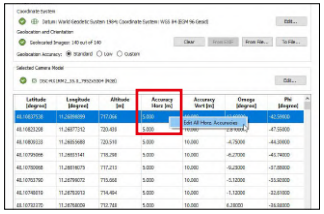




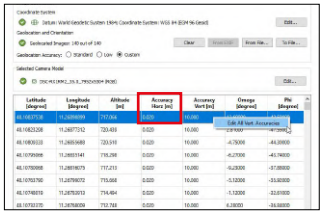
Adjust camera accuray to 0.02 m

Pix4D Accuracy

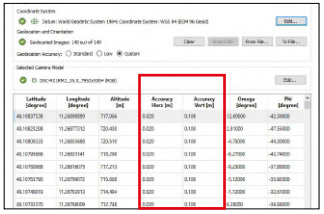




Edit all horizontal accuracy
Adjust to 0.020 m



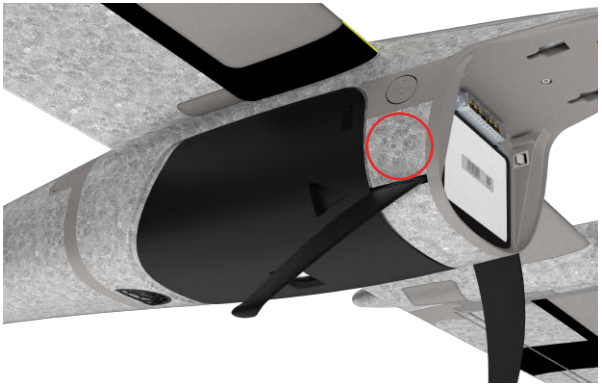
Edit all vertical accuracy
Adjust to 0.100 m



11
Payload compartment

11 Payload compartment

11.1 Payload compartment attachment



A: In order to attach the payload compartment to the main body, connect the four mounting hooks on the upper side of the payload compartment to the main compartment of the UAV.
B: Slide the payload compartment forward.
C: Make sure the lock mechanism is in place.

A: To remove the payload compartment from the UAV press on the right side.
B: Slide the compartment backwards.
C: Disconnect the compartment.

Attention

Make sure the D-Sub connector between the main body and the payload compartment is attached correctly.
Ensure that the SD card is connected and that it provides enough space for the pictures. After a mission, it is recommended to delete the pictures on the SD card after saving them on your computer, laptop or tablet.

Attention

Trinity F90+ payloads are compatible with the Trinity Pro.
If a Trinity F90+ payload is used with a Trinity Pro please make sure to use a payload compartment that does not have a remote ID installed.

11.2 LiDAR Qube 240

For further information please see the LiDAR Qube 240 User Manual.

11.3 MicaSense RedEdge-P/Altum-PT camera

General note: When the SD card of the MicaSense Red-Edge-P/Altum-PT is removed and attached again, it is important to always turn off and power on the UAV afterwards.
Important: If you don't do this, it is possible the camera might not save the pictures on the SD card.

11.3.1 Taking a calibration picture

For a correct post processing of the pictures, it is important to calibrate the Red-Edge-P/Altum-PT camera. Please take a calibration picture before and after every flight.
Before the flight, it is recommended to add this step during the flight setup before 8.11 Step 11 – Assemble the UAV.

Make sure the SD card is empty before every flight as the Red-Edge-P/Altum-PT takes five pictures simultaneously (size of each image: approx. 2.4 MB)

Please follow these steps in order to calibrate the camera.

1. If not already attached, attach the payload compartment.
2. Connect the battery to the main compartment. Do not attach the wings and the rear fuselage in order to prevent shadow on the calibration panel.
3. Turn on the UAV.
4. Make sure the connection between the UAV and QBase is established.
5. Establish a WiFi connection between your computer/laptop or tablet and the camera.
   Camera WiFi name: rededge[serial number], password: micasense
6. Ensure that the RedEdge-P/Altum-PT is chosen as the payload in the mission template of QBase
7. Open the Payload Info in the footer of QBase
8. Select RedEdge-P/Altum-PT Calibration to open the calibration window
9. When taking the picture of the calibration panel:
   - **a)** Stand beside the lower right side of the panel and make sure the sun is behind you (see picture) in order to avoid miscalibration because of reflections on you. Hold the UAV (without rear fuselage and wings) above the calibration panel as perpendicular as possible.
   - **b)** Furthermore pay attention to the following points:

- The panel is placed on the ground, far from any obstructions
- The panel fills about half the picture
- Camera is pointed as perpendicular to the panel as possible
- No shadows on the panel
- Direct sunlight illumination on the panel (no reflected lighting)

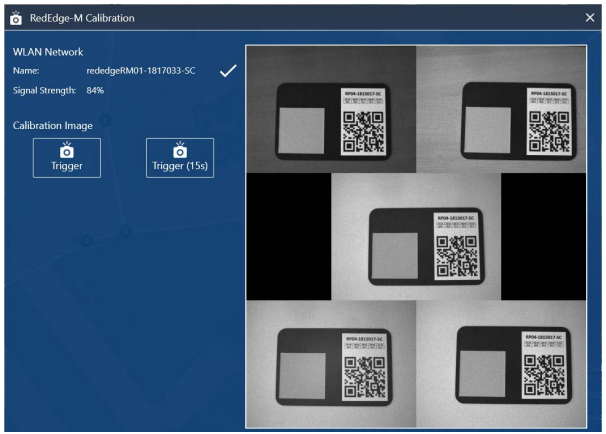
10. In order to take the picture, please select one of the following options

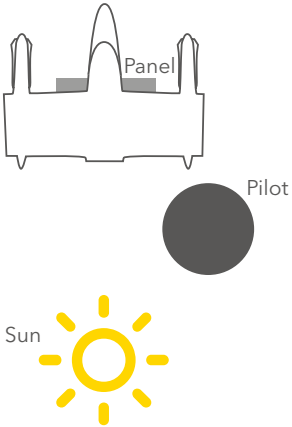
a) Instant Trigger

b) Delay Trigger (15s) – Recommended if the calibration is made by only one person

11. The picture is shown in QBase. Please make sure the panel itself as well as the QR code are in the picture.

Example:





Note: Please take at least two calibration pictures. **Please do not take the calibration picture by selecting the Trigger Payload button.**

12. Turn off the UAV again by removing the battery from the UAV.
13. Please continue with chapter 8.9 step – Assemble the UAV.

After the flight
After the flight, it is necessary to take the calibration picture immediately after landing.

11.3.2 Geotagging

The pictures of the RedEdge-P/Altum-PT are automatically geotagged. It is not necessary to geotag them in QBase.
In case PPK accurracy is required please follow the normal PPK geotagging according to chapter 7.7.2.

11.3.3 Notes

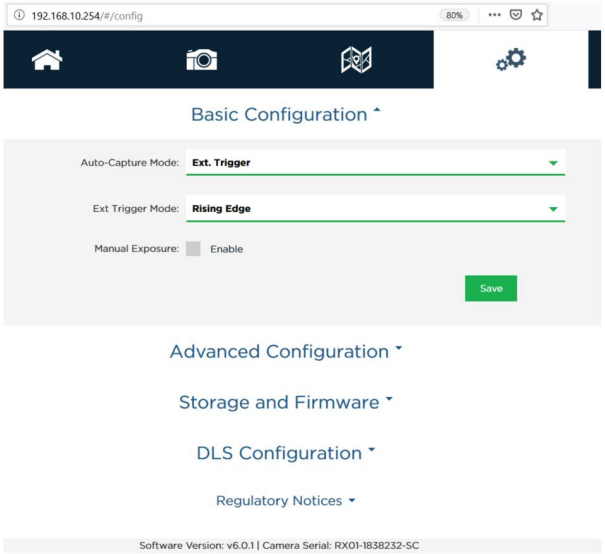
1. Depending on the amount of pictures, the RedEdge-P pictures are saved in multiple folders (1000 pictures per folder).
2. The calibration pictures are saved in the folders as well.
3. Please do not insert or eject the SD card when the UAV is powered.

11.3.4 MicaSense RedEdge-P configuration

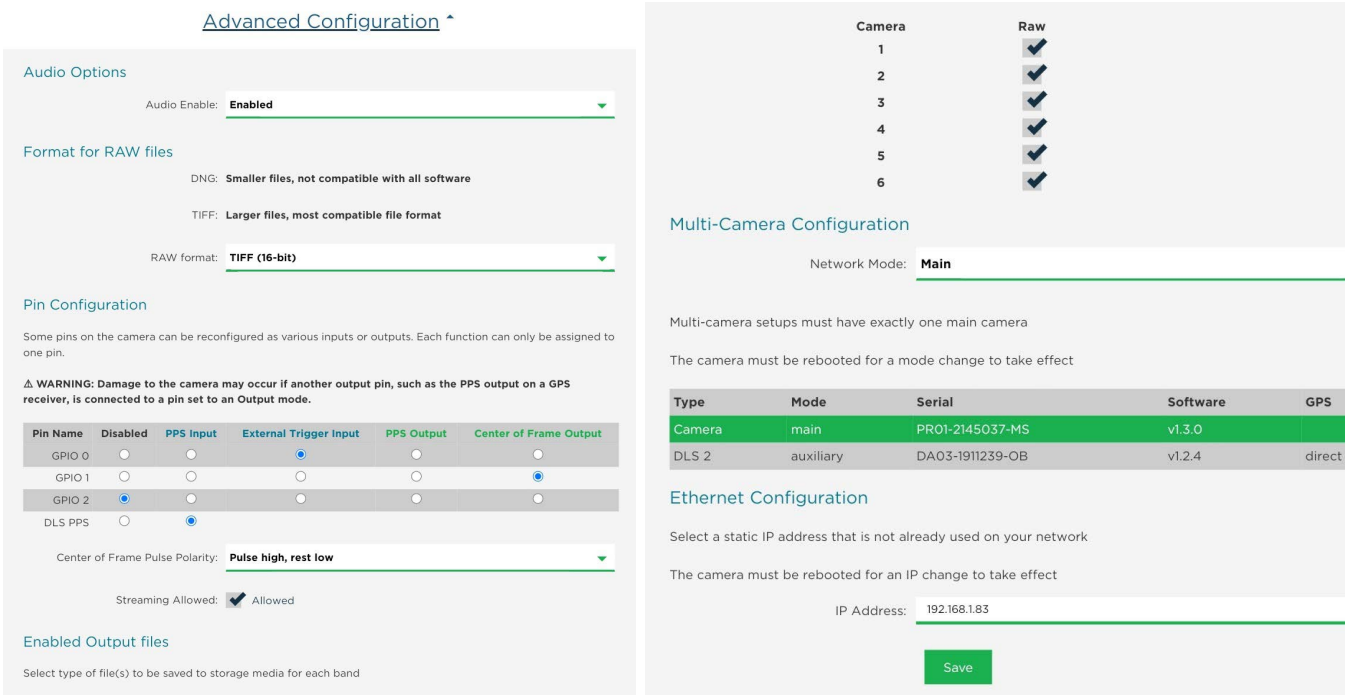
1. Connect the payload compartment to the Trinity. Please make sure the SD card is connected to the Mica Sense camera.
2. Connect the battery to the Trinity.
3. Establish the WiFi connection between the camera and your computer.
   Camera WiFi name: RedEdge P-[serial number], password: micasense
4. Open http://192.168.10.254 in your web browser in order to access the Mica Sense web interface.
5. Configure the RedEdge - P camera according to the following settings by opening the tab Settings in the MicaSense webinterface.

Basic configuration section

6. Click Save button on the bottom of this section to save the basic configuration.



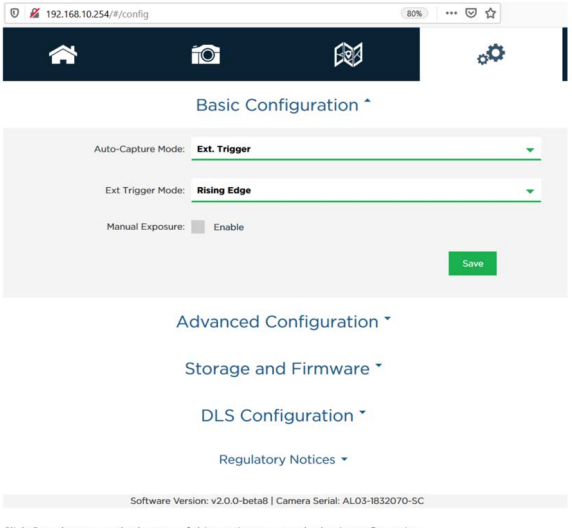
Advanced configuration section



7. Click Save button on the bottom of this section to save the advanced configuration.

11.3.5 MicaSense RedEdge Altum-PT configuration

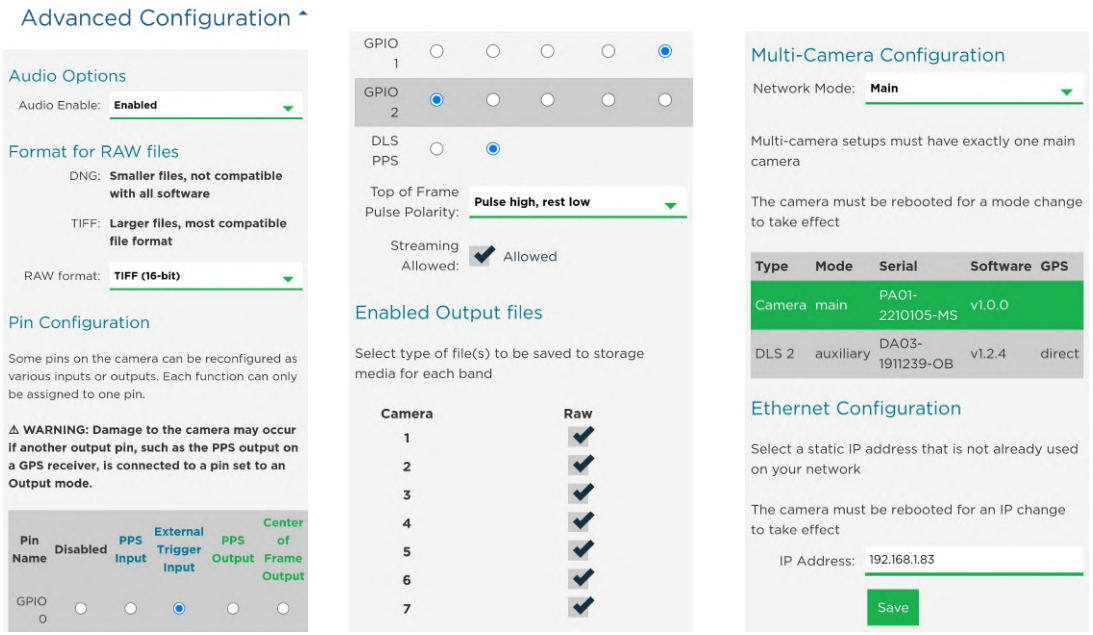
1. Connect the payload compartment to the Trinity Pro. Please make sure the SD card is connected to the Mica Sense camera.
2. Connect the battery to the Trinity Pro and power it.
3. Establish the WiFi connection between the camera and your computer.
   Camera WiFi name:
   Red: ALTUM-PT[serial number], password: micasense
4. Open http://192.168.10.254 in your web browser in order to access the Mica Sense web interface.
5. Configure the MicaSense Altum camera according to the following settings by opening the tab Settings in the MicaSense webinterface.



Basic configuration section

6. Click Save button on the bottom of this section to save the basic configuration.

Advanced configuration section



7. Click Save button on the bottom of this section to save the advanced.

11.4 Sony RX1R II camera

11.4.1 RX1RII settings

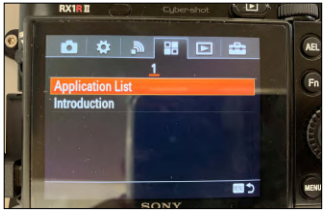
1. Disconnect the payload compartment according to chapter 11.1.
2. Remove the battery dummy.
3. Insert the original camera battery. Make sure it is charged. Charging is possible via the supplied charger.
4. Turn on the camera using the on/off switch on top of the camera.
The screen of the camera will power up.
5. Change settings:
Default settings via camera hardware controls
Access the settings by switching to Manual Mode M with the control wheel on top of the Camera.

Exposure: 1/2000 s (a small control wheel on the camera hind top right).
Aperture: F4 (The F-Stop wheel on the camera lens).
Focus: MF manual focus (a small control wheel on the front of the camera).
Focus: ∞ (via the manual focus wheel on the camera lens).

Default settings via camera display menu
- Access the settings menu by selecting **MENU.**
- Change the Menu by pressing the camera wheel left and right.
- In order to access the sub menus please press ↓.
- Navigate through the corresponding submenu by turning the camera wheel.
- To change the setting please use the silver button.

6. In order to save the settings please turn the camera off using the on-off switch on camera top. Wait for 3 seconds and switch the camera on.
7. Turn the camera off again and disconnect the battery.
8. Insert the battery dummy.
9. Turn the camera on.
10. Connect the payload compartment to the UAV.

RX1RII Menu default settings


1
Application List
Introduction
SONY


1 2
Delete
View Mode
Image Index
Display Rotation Manual
Slide Show
Rotate
SONY


1 2
Enlarge Image
4K Still Image PB
Protect
Specify Printing
SONY


1 2 3 4 5 6
Monitor Brightness Auto
Viewfinder Bright. Auto
Finder Color Temp. ±0
Volume Settings 7
Audio signals On
SONY


1 2 3 4 5 6
Tile Menu Off
Mode Dial Guide Off
Delete confirm. "Cancel" first
Display Quality Standard
Pwr Save Start Time 30 Min
NTSC/PAL Selector
SONY


1 2 3 4 5 6
Demo Mode Off
HDMI Settings
USB Connection Auto
USB LUN Setting Multi
USB Power Supply On
SONY


1 2 3 4 5 6
Language English
Date/Time Setup
Area Setting
Copyright Info
SONY


1 2 3 4 5 6
Format
File Number Reset
Select REC Folder
New Folder
Folder Name Standard Form
Recover Image DB
SONY


1 2 3 4 5 6
Display Media Info.
Version
Setting Reset
SONY

11.4.2 Trigger speed

JPEG (~32 MB/picture)

1.5 sec/capture for an indefinite picture row
1.4 sec/capture for a 500 pic flight leg
1.3 sec/capture for a 160 pic flight leg
1.2 sec/capture for a 95 pic flight leg
1.1 sec/capture for a 70 pic flight leg
1.0 sec/capture for a 55 pic flight leg

1.3 sec/capture is a reasonably safe trigger limit.

Compressed RAW (~43 MB/picture)

1.7 sec/capture for a 1470 pic flight leg
1.6 sec/capture for a 197 pic flight leg
1.5 sec/capture for a 115 pic flight leg
1.4 sec/capture for a 80 pic flight leg
1.3 sec/capture for a 57 pic flight leg
1.2 sec/capture for a 47 pic flight leg
1.1 sec/capture for a 40 pic flight leg
1.0 sec/capture for a 35 pic flight leg

1.5 sec/capture is a reasonably safe trigger limit.

Uncompressed RAW (~85 MB/picture)

2.2 sec/capture for a 173 pic flight leg
2.1 sec/capture for a 81 pic flight leg
2.0 sec/capture for a 55 pic flight leg
1.8 sec/capture for a 32 pic flight leg
1.6 sec/capture for a 24 pic flight leg
1.5 sec/capture for a 22 pic flight leg

2.2 sec/capture is a reasonably safe trigger limit.

11.4.3 Storage capacity

An RX1 picture with best resolution is in average 32 MB. For an 82 minutes flight and 1 sec/picture it results in ~153.8 GB required storage space, so a 256 GB SD card is recommended.

If the trigger speed is reduced to the relatively safe 1.3 sec/picture, 118.3 GB are required (which can be provided by a 128 GB SD card).

11.4.4 Deleting the pictures from the SD card

Please **do not format** the SD card to delete the pictures. Please only delete them.

In case the SD card is formatted please:

1. Insert the SD card into the camera
2. Directly power the camera via the Sony battery and turn on the camera.
3. Please confirm the start-up dialogue on the camera to reconfigure the root folders on the SD card.
4. Remove the battery without turning the camera off on the on-off switch.
5. Reinsert the battery dummy.

The root folders are required for problem-free connection between the camera and the SD card.

11.5 Oblique D2M

QBase Mission
It is recommended to use the default parameters at 70% forward and side overlap.

QBase Post-Processing

1. The general workflow is equivalent to the other cameras within the QBase Post Processing Interface.
2. Connect oblique storage module reader to download the pictures.
3. When selecting the pictures in the Post Processing Interface please select
Oblique Left (A) directory -> select A/DCIM/0000X/ directory.
4. The remaining 4 directories are filled automatically.
5. Select merge image directories.

Agisoft Metashape

1. Workflow -> Add folder and select parent directory of all image files.
2. If the pictures are geotagged (geotags in exif) please adjust the accurracy according to chapter 10.4.
The recommended workflow is nevertheless the use of csv where the accuracy is listed.
3. Workflow -> build dense cloud
4. Workflow -> build mesh
5. Workflow -> build texture

12
Storage

12 Storage

For storage, please keep the UAV as well as the QS modem and the battery charger in the transportation box and store the box inside a building at a normal room temperature.

The Trinity Pro shall be stored or transported inside of its transportation box. There is no strict limitation for the altitude or temperature when it is stored or transported. The humidity, during storage and transportation shall be low. It shall be prevented, to expose the box to any kind of percipitation during storage and transportation.

After long term storage, the maintenance measures specified in the inspection shedule chapter shall be performed. Before continuing the operations, extra care shall be given to the update of all relevant firmwares and softwares.

Battery pack
Always store the battery disconnected from the UAV. For battery storage instructions see chapter 2.2.3 & 6.3

13
Inspection & repairs

13 Inspection & repairs

Do not do any other repair or maintenance work than the one listed. Contact your reseller for further repair assistance.

13.1 Repairing and cleaning the airframe

Small cracks can be repaired by using polystyrene/styrofoam glue. In case of doubt, contact your reseller for further assistance. To clean the airframe please use window cleaner and a microfiber cloth. Make sure to only use a small amount when cleaning it.

13.2 Calibrating the magnetometer

If the heading of the UAV is not correct, the magnetometer needs to be recalibrated. The heading needs to be checked before each flight. The heading is not correct if the direction of the UAV displayed in QBase does not align with the direction of the UAV.

Also the magnetometer needs to be recalibrated if the actual flight location is more than 50km 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) are close.

For the calibration, the main body of the UAV, the battery pack and a succesful connection to QBase are needed. Please do not carry your mobile phone or similar items with you as they might disturb the calibration process.

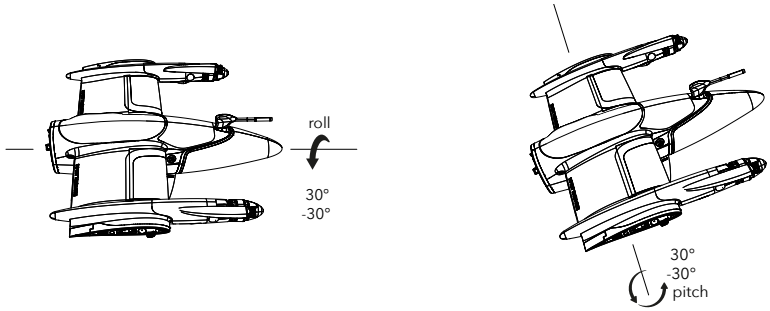
1. Open QBase and connect the ground modem to your computer.
2. Connect the battery pack to the main body of the UAV and power the UAV. The payload compartment must be attached to the main body of the UAV.
3. Ensure that the link between the UAV and QBase is established via the modem connection.

5. Open QBase > Main Menu > Tools > Aircraft Calibration > Magnetometer
6. The calibration mode starts.

During the calibration, 200 measuring points are recorded. The counter in QBase counts up until 200.

Move the main body like this

I. Hold the main body of the UAV on both nacelles.
II. Turn 360° around yourself while moving the UAV from +30° to -30° around the roll axis and simultaneously +30° to -30° around the pitch axis.
III. Flip the UAV main body 180° around the roll axis (the payload compartment is on the top).
IV. Turn 360° around yourself while moving the UAV from +30° to -30° around the roll axis and simultaneously +30° to -30° around the pitch axis.
V. Flip the UAV main body 180° around the roll axis (the payload compartment is on the bottom).



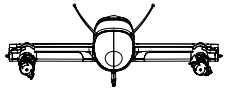
5. An audio signal informs you about the successful calibration. If the Calibration was not succesfull, error message will be displayed. Please try again.

13.3 Calibrating the accelerometer

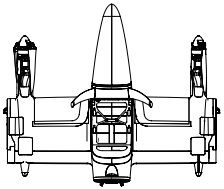
1. Open QBase and connect the ground modem to your computer.
2. Connect the battery pack to the main body of the UAV and power the UAV.
3. Ensure that the link between the UAV and QBase is established via the modem connection.
4. Open QBase > Main Menu > Tools > Aircraft Calibration > Acceleration.
5. During the Calibration nine measuring points are recorded. Place the main body as shown below and follow the steps in QBase.

❶

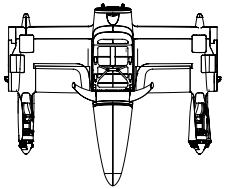
❷



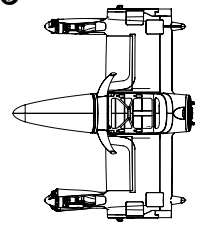
❸



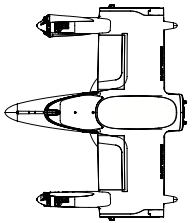
❹



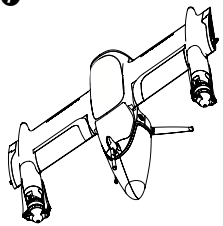
❺



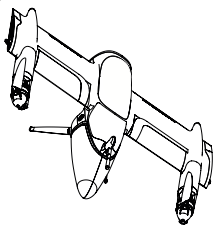
❻



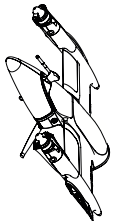
❼



❽



❾



13.4 Exchange a degraded battery pack

After **150 charging cycles** it is recommended to exchange the UAV Battery pack. In order to check the amount of charging cycles please check the BID Info menu on the charger – therefore, the battery must be connected to the charger.

The battery will age over time. Therefore, the warranty of the complete UAV system expires when batteries with more than 150 charging cycles are used. Batteries itself are not covered as part of the standard warranty (see chapter 2.2.4).

Note: The UAV is equipped with a feature to return home if the battery is low.

13.5 Inspection schedule

After every **10th flight** of the UAV it is recommended to perform a short maintenance check according to the following steps. In case the check shows any erratic behaviour please contact your reseller for further assistance. To display the total flight time of the Trinity Pro please establish a USB connection and open the aircraft symbol in the header section of QBase .

13.5.1 Battery voltage check

- Please connect the battery to the charger after every **10th flight of each battery.**
  This check must be done **after the flight, before recharging** the battery.
- Please check the [Data View] menu and ensure that the 6 single cells are within a range of 0.1 V to each other.

max-min <0.1V: **OK** ✓
[Data View]
Main: 21.30 V
Max: 3.59 V
Min: 3.50 V
3.50 V 3.55 V 3.59 V 3.59 V 3.50 V 3.57 V

max-min >0.1V: **NOT OK** ✕
[Data View]
Main: 21.29 V
Max: 3.63 V
Min: 3.50 V
3.63 V 3.50 V 3.55 V 3.50 V 3.60 V 3.51 V

13.5.2 Keep your UAV and the equipment clean

- Please clean the parts of the UAV and all additional equipment with a slighty moist cleaning tissue.
- Clean the transportation box with the help of a vacuum cleaner.

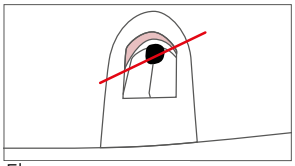
It is recommended to perform the following steps outside. Furthermore, a short mission must be planned.

13.5.3 Check the UAV for damages

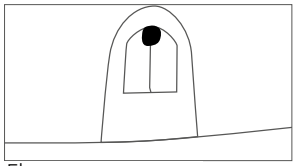
- Please carefully inspect every part of the UAV for damages.
- Thereby, please also check the propellers for dents, cracks and scratches.
- Check the engine housing for scratches and damages. Check the side motor openings for excessive dust or other foreign objects.
- Check if all connector plugs are clean and free from corrosion.

13.5.4 Check all connections

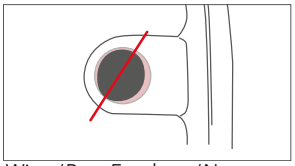
- Please assemble the unit and make sure that all lock mechanisms are locked correctly.
- Do not connect the battery.



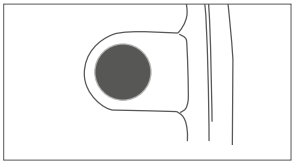
Elevator
WRONG



Elevator
CORRECT



Wing / Rear Fuselage / Nose
WRONG



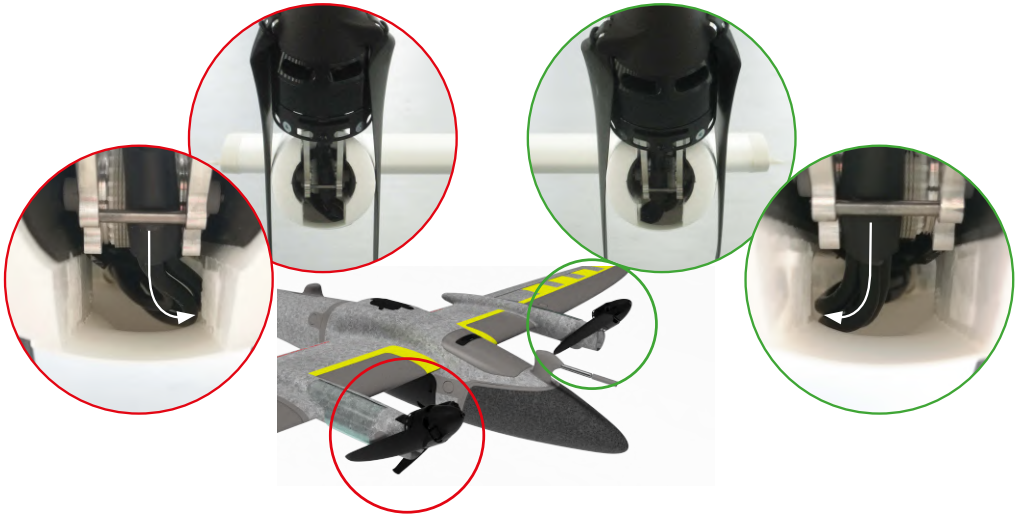
Wing / Rear Fuselage / Nose
CORRECT

13.5.5 Clean the Airspeed Sensor

- Please remove the airspeed sensor from the main body via the magnetic connection.
- Please make a visual inspection of the pilot tube. The pitot tube is open on both ends, it is therefore possible to see if the pilot tube is blocked.
- In case it is blocked please clean it by carefully blowing.

13.5.6 Check the tilt mechanism

- Please check the two front tilt mechanisms by carefully moving the motors up and down.
- Can the motor be moved smoothly? Is there any irregular friction or noise?
- Please check if the motor wires are aligned as shown in the picture.



13.5.7 Check the connections between the UAV and QBase

- Please connect the battery to the UAV main body.
- Open QBase and connect the QBase modem.

13.5.8 QBase final check

Obstacle clearance in reality
- No obstacle within a radius of 20 m around Home Waypoint
- Re-/transition, Descent circle, Flight paths: altitude 20 m higher than obstacles

UAV heading
- Ensure the direction of the displayed UAV corresponds to the direction of the UAV on the ground
- Do not fly if the heading on the ground is not correct: **critical deviation ≥ 10°**

Wind direction
- Re-/transition is set against the wind direction!
- **Retransition with tailwind: per 1m/s tailwind ~ 20 meter deviation**
- Wind check in the immediate surrounding
- Do not take-off in a wind sheltered area (lee) as turbulances may occur

13.5.9 Upload the mission

Upload the mission Upload ⚠ → Synced ⚠

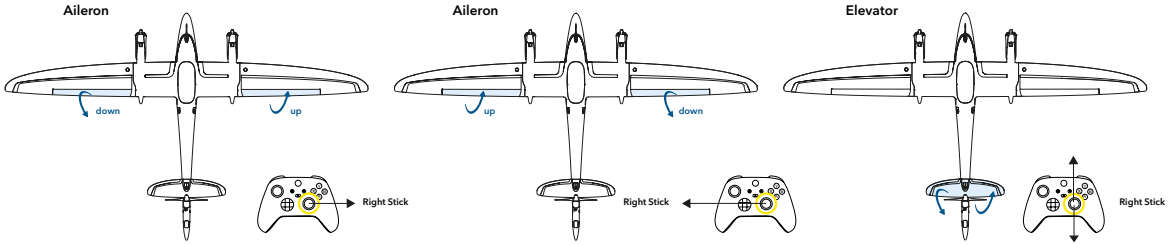
Make sure the H ome Waypoint in QBase is adjusted to the real take-off position .

13.5.10 Preflight check

Preflight Select **PREFLIGHT (CHECK)** QBase3D.

If the preflight check is not successful a message will be displayed.
Within the preflight check the actual take-off position is transferred to QBase.

13.5.11 Check the control surfaces

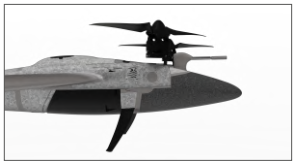


Make sure the control surfaces are moving while moving the stick. Do not fly if a control surface is not moving. See chapter 14.2 for troubleshooting.

13.5.12 Arm

!!NEVER ARM AN AIRCRAFT WITH A DAMAGED PROPELLER!!

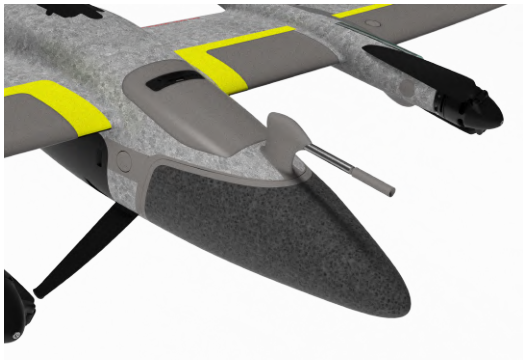
- Due to safety reasons the UAV will **turn off the motors automatically** after **30 seconds** if no button has been pressed.
- Make sure the motors are **spinning freely.** If the spinning of the motors emits an untypical sound, turn off the motors.
- Make sure **all three motors are tilted 90° upwards.** If not, turn off the system. Contact your reseller for further assistance.



Front alignment: tilted upwards
CORRECT

Rear alignment: tilted upwards
CORRECT

13.6 Clean the airspeed sensor



The airspeed sensor provides the user with the possibility to easily clean and exchange the pitot tube.

Please clean or exchange the pitot tube in case **AIRSPEED SENSOR MALFUNCTION** is triggered.

1. Please remove the airspeed sensor from the main body via the magnetic connection.
2. Please make a visual inspection of the pitot tube. The pitot tube is open on both ends, it is therefore possible to see if the pitot tube is blocked.
3. In case it is blocked please clean it by carefully blowing.

13.7 other sensors

The magnetometer, barometer and inertial measurement unit are placed inside the main body. The air data unit, which processes the air data from the Aispeed Sensor is an individual board, also based in the main body. The GNSS Sensor is located in the rear part of the Main Fuselage. Non of these sensors may be accessed as non of them requires mainentance within the product life cycle.

14
Troubleshooting

14 Troubleshooting

14.1 LED status main body

Color: green **Sequence:** fast blinking
- USB connection

Color: blue **Sequence:** normal blinking
- System is initializing/performing sensor self test
- System is waiting for a GPS lock
- System is waiting for payload to be connected

Color: blue green **Sequence:** alternating
- Magnetometer calibration

Color: green yellow **Sequence:** alternating
- Accelerometer (ACC) calibration

Color: blue **Sequence:** fast blinking
- System is armed

Color: blue Sequence: LEDs run left/right
- System is booting. This sequence is active right after connecting the battery

Color: green **Sequence:** breathing
- All sensor states are nominal and payload is connected
- System is ready for PFC/flight

Color: purple **Sequence:** fast blinking
- System is still logging PPK data

Color: yellow **Sequence:** fast blinking
- Sensor not found (e.g. Searching for GPS, Airspeed sensor not mounted, …)

Color: red **Sequence:** fast blinking
- System encountered a severe error during startup (e.g. sensor fault, sensor selftest failure, …)

14.2 Connection between QBase and the UAV cannot be established

To guarantee a stable connection between QBase and UAV via the QBase modem, ensure that both devices have the same temperature.

Option 1: Ensure that the QBase modem is recognized by the computer, laptop or tablet.

1. Check your Windows device manager for the modem (COM-Port).
2. If it is not recognized, try another USB port.

Option 2: Disconnect the battery and connect it again. Switch on the UAV again. Restart QBase. Do not disconnect the modem inbetween.

If none of the options is successful, contact your reseller.

14.3 The control surface check is not successful

1. Disconnect the battery from the UAV.
2. Make sure every part is assembled correct.
3. Connect the battery again.
4. Switch on the UAV again.
5. If the control surface check is still not successful, contact your reseller.

14.4 The weather conditions change during the flight

- If the weather conditions change during the mission and are unsuitable for flying, abort the mission by selecting **COME HOME** in the UAV command interface in QBase.

14.5 After a crash of the UAV

In the event of a crash follow the steps:

1. Select **EMERGENCY** and **Hard Abort** in the UAV command interface in QBase to ensure that the motors are switched off. Confirm to switch off the motors by selecting **Yes!.**
2. Locate the UAV and disconnect the battery pack.

Provide all necessary data and contact your reseller for further assistance. Do not use the UAV again.

14.6 Important messages

TEXT	DESCRIPTION	WHAT TO DO
ABORTED	The calibration was aborted manually.	–
ACC ERROR	An acceleration sensor error occurred during the preflight check.	1. Make sure the UAV is not moving during the preflight check. 2. Disconnect the battery from the UAV and connect it again. Turn on the UAV again. 3. Repeat the preflight check. 4. If the problem persists, contact your reseller.
ACTUATOR MALFUNCTION! REMOVE BATTERY IMMEDIATELY!	A malfunction of an actuator has been detected.	Remove the battery immediately to prevent further damage. Contact your Quantum-Systems reseller. The actuator has to be replaced.
AILERON MALFUNTION!	Reduced roll control effectiveness was detected in flight, pointing to a mechanical problem with the aileron control surfaces.	→ COME HOME is automatically initiated. In severe cases, an immediate retransition and landing is performed. → Wait for the UAV to come home. → Do not fly again, contact your reseller. → The UAV will undertake multiple actions to prevent a crash and come home but is not claimed resistant to an Aileron Error.

AIRSPEED ERROR	An airspeed sensor error occurred 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. 2. Turn on the UAV again. **During transition:** 1. The transition is aborted. 2. The UAV will return home and land automaticaly. 3. For Trinity Pro from serialnumber 00686: Please perform the airspeed sensor cleaning according to chapter 13.6 4. For Trinity Pro (other): Please contact your reseller.
AIRSPEED INITIALIZATION ERROR	Sensor init error during startup	Disconnect the battery from the UAV and connect it again.
AIRSPEED SENSOR MALFUNCTION	The airspeed sensor does not work correctly	**No manual input necessary** except for collision avoidance. **1. The UAV will return home and land automatically.** 2. The mission cannot be continued. 2. The mission cannot be continued. 3. For Trinity Pro from serialnumber 00686:Please perform the airspeed sensor cleaning according to chapter 13.6 4. For Trinity Pro (other): Please contact your reseller.
APPROACHING NOFLY-ZONE	The No Fly Zone might be breached. Warmimg 30 seconds before potentially entering the No Fly Zone.	If required please take over manually.
ASSISTED FLIGHT	The UAV is controlled manually in assisted mode.	Control the UAV according to the commands of the assisted mode (see chapter 9.1) or select CONT to switch to automatic mode.
AUTOPILOT INFO ERROR	Autopilot configuration error.	Contact your reseller.
BARO ERROR	A baro sensor error occurred during the preflight check.	1. Disconnect the battery from the UAV and connect it again. 2. Turn on the UAV again. 3. 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.	No manual input necessary except for collision avoidance. → The UAV will return home and land automatically. → The mission cannot be continued.

BATTERY LOW	A warning 10 minutes before the UAV will return home due to low 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 13.3).
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 PMB! (NIR / EO) EXPOSURE AND TRIGGER NOT EQUAL	10 or more missing exposures (per camera, NIR or EO)	1. If you have a stabil telemetrylink please be aware that there might be pictures missing afterwards. 2. This error occurs if you don't have a stabil link. Please check your SD card or the kml. file afterwards.
CHECK PMB! NOT TRIGGERING	Trigger count is 0 (per camera)	1. Check connection of payload compartment and manual trigger on ground. 2. This error also occurs if you are using a CPC Payload and one camera is not triggering. 3. This error occurs if you don't have a stable telemetry link. Please check your SD card or the .kml file afterwards.
CHECK PMB! TRIGGER NOT EQUAL	10 or more triggers difference between cam1 and cam2	Check connection of payload compartment and verify that both camaras are triggering through manual triggers on ground.
CHECK QBASE	An error occurred	Please check the message box in QBase for additional information.
ELEVATOR MALFUNCTION	Reduced pitch control effectiveness was detected in flight, pointing to a mechanical problem with the elevator or tilt nacelle actuators.	→ COME HOME is automatically initiated. In severe cases, an immediate retransition and landing is performed. → Do not fly again, contact your reseller. → The UAV will undertake multiple actions to prevent a crash and come home but is not claimed resistant to an Elevator Error.
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 occurred during the calibration.	1. Disconnect the battery from the UAV and connect it again. 2. Turn on the UAV again. 3. Repeat the calibration process.
ERROR LOADING MISSION	Error loading the mission from the SD card.	If the error still occurs please contact your reseller.
EXCEEDED MISSION TIME	The warning comes up at an automatic COME HOME due to a 60 minutes flight time restriction.	–
EXTERNAL BARO INIT ERROR	Baro Init Error during startup	Disconnect the battery from the UAV and connect it again. If the error still occurs please contact your reseller.
FINISHED	The automated flight is finished.	Please land the UAV manually at the home waypoint by carefully pulling the left stick towards yourself.
GEOCAGE ALTITUDE VIOLATION	The maximum mission altitude of the working zone is breached.	A coming home is initiated.
GEOCAGE MISSION DEVIATION	The current flight plan differs from the planned flight plan.	A coming home is initiated.
CLOSE TO GEOCAGE BORDER	The Trinity Pro is breaching the working zone.	A coming home is initiated.
GPS ERROR	A GPS sensor or reception error occurred during the initialization.	Disconnect the battery from the UAV and connect it again.
GPS LOST	The GPS signal is lost during the preflight check or during the flight.	Please wait until enough satellites are found. If lost during the flight Trinity will enter the GNSS denied mode.
GYRO ERROR	A Gyro sensor error occurred during the preflight check.	1. Disconnect the battery from the UAV and connect it again. 2. Turn on the UAV again. 3. Repeat the preflight check. 4. If still not working: contact your reseller.
HARDWARE FAILURE CAN	Communication problem to PMB during initialization.	Disconnect Battery, check the connection and latching of payload 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. An automatic landing is initiated after 70 seconds hover time.
HOVER TIME EXCEEDED	A warning after 70 seconds of hovering.	**No manual input necessary** except for collision avoidance. **→ The UAV will land automatically.** → The flight cannot be continued.
LINK LOST	• The flight data link between the QBase modem and the Trinity Pro is lost. . • The Trinity Pro will continue the mission until the link loss tolerance expired. Afterwards, it iwll fly to the link reestablishing waypoint automatically and try to reestablish the communication.	**If the flight data link can be reestablished during during the flight to the link reestablishing point:** • Either select COME HOME or CONTINUE in QBase. Continue will send the Trinity Pro back to the mission area on the direct way. Please be aware of obstacles. **The communication link cannot be reestablished:** • The Trininty Pro will return home after the expiry of the loiter time and land at the home location as normally planned in QBase.
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 reseller.
IMU SELFTEST FAILED	Sensor error during startup.	Disconnect the battery from the UAV and connect it again. If the error still occurs please contact your reseller for exchanging the autopilot.

- MAG ERROR **- MAG NOT CALIBRATED** **- MAG MAGNITUDE TOO HIGH** **- MAG VARIANCE ERROR** **- MAG NOT FULLY COVERED** **- MAG INCLINATION ERROR** **- MAG DIVERGENCE ERROR**	A magnetometer sensor error occurred during the preflight check.	1. Disconnect the battery from the UAV and connect it again. 2. Turn on the UAV again. 3. Repeat the preflight check. 4. If it is still not working please calibrate the magnetometer
MAG INITIALIZATION ERROR	Sensor initialization error during startup.	Disconnect the battery from the UAV and connect it again. If the problem persists, please recalibrate the magnetometer (see chapter 13.2).
MAG NOT CALIBRATED	The magnetometer has not been calibrated correctly.	The last magnetometer calibration failed. Please recalibrate the magnetometer and try again.
MAG SELFTEST FAILED	Sensor initialization error during startup.	Disconnect the battery from the UAV and connect it again.
MAGNETIC AIR DATA PROBE NOT ATTACHED	The connection between the magnetic airspeed sensor and the main body cannot be established.	Please make sure that airspeed sensor is connected.
MISSION ALTITUDE LIMIT EXCEEDED	The mission area is above the set maximum altitude ATO	If allowed please adjust the maximum Altitude ATO in the mission settings (chapter 7.3
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 yourself.
MISSION NOT COMPLETE	Missing data in mission.	1. Repeat uploading the flight plan to the UAV. 2. Repeat the preflight check.
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 (ESC) 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 action required. yellow: Let the UAV cool down after flight until it is green again. red: automatic emergency landing. If available please use the ESC cooling station as described in chapter 6.7
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. Turn on the UAV again. 3. Repeat the preflight check.
MOVING	The UAV is moving during the preflight check.	Ensure that the UAV is not moving to allow a correct initialization.
NAV	- GPS position unstable - Initialization successful - Initializing - Accelerometer calibrated? - Aircraft moving - Magnetometer calibrated? - Magnetic field disturbed - Aircraft not level	Please perform a accelerometer or magnetometer calibration depending on the exact message that is displayed next to the NAV symbol in the aircraft menu in the header section. Alternatively make sure the aircraft is not moving or is level or the GPS is not disturbed depending on the exact message that is displayed next to the NAV symbol in the aircraft menu in the header section.
NO FLY ZONE BREACH IMMINENT	The No Fly Zone might be breached. Warnimg 10 seconds before potentially entering the No Fly Zone.	If required please take over manually.
OK	The calibration was succesful.	–
OUT OF TRANSITION DIRECTION	The direction of the UAV does not comply with the allowed transition cone during auto climb.	Automatic hover to base and landing is initiated.
PAYLOAD ERROR	A communication error to the payload occurred during the preflight check.	1. Disconnect the battery from the UAV and connect it again. 2. Turn on the UAV again. 3. Repeat the preflight check.

POSSIBLE COLLISION IN RETURN PATH	Low altitude in come home path (come home path = path from current UAV position to re-transition waypoint including descend circle and landing path). Come home path is estimated in case of low battery, manual come home command, exceeding of flight time restriction or finish of the mission.	Check come home path displayed in map if necessary assume manual control to avoid collision
MOTOR (NR) RPM TOO HIGH OR TOO LOW	Error during arming.	Please make sure that the UAV is aligned horizontally during arming.
RTR TOO FAR AWAY	The retransition waypoint is too far away from the take-off position.	1. Relocate the retransition waypoint closer to the home waypoint 2. Write mission to UAV again. 3. Repeat the preflight check.
SD CARD ERROR	An error with the autopilot SD-card occurred during the preflight check.	1. Disconnect the battery from the UAV and connect it again. 2. Turn on the UAV again. 3. Repeat the preflight check.
SENSOR ERROR	A sensor error occurred during the preflight check.	1. Disconnect the battery from the UAV and connect it again. 2. Turn on the UAV again. 3. Repeat the preflight check.
SENSOR INIT ERROR	Error during the sensors initialization.	1. Disconnect the battery from the UAV and connect it again. 2. Turn on the UAV again.
TOO MANY WAYPOINTS	Waypoint limit has been exceeded.	Re-plan the mission with a lower number of waypoints.
PMB NOT FOUND	The connection to the payload could not be established during preflight check.	Disconnect Battery, check connection and latching of payload compartment and try again.
TRANSITION AIRSPEED TOO LOW	The airspeed could not build up during transition. Minimum flight speed could not be reached during transition.	1. The transition is stopped 2. The UAV will return home and land automaticaly. 3. For Trinity Pro (from serial number 00686): Please perform the airspeed sensor cleaning according to chapter 13.6 4. For Trinity Pro (other): Please contact your reseller.

WIND SPEED/WIND TOO STRONG	The wind is too strong either during launch or in-flight.	**Launch:** The UAV will abort the mission and return to the launch point. **In-Flight:** If wind speed exceeds 12 m/s, an automatic COME HOME is initiated.
WAYPOINTS HIGHER THAN MAX ALLOWED ALTITUDE	The mission area is above the set maximum altitude ATO	If allowed please adjust the maximum Altitude ATO in the mission settings (chapter 7.3)
WRONG DIRECTION	The current heading of the Trinity Pro is not within the transition cone. The Trinity Pro will try to turn into the cone, but in case this is not possible it will abort the transition.	Please do not take over manually except in emergency situations. For the next take-off please try to plan your take -off direction facing the wind direction.

15
Flying multiple UAV simultaneously

15 Flying multiple UAV simultaneously

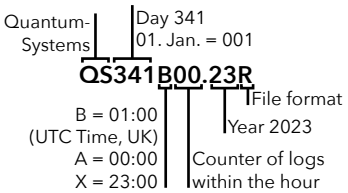
It is possible to operate multiple UAV simultaneously.
Please note that one tablet, laptop or PC with an attached ground modem per UAV is required.

The network ID of every air ground modem pair has to be unique. It is not possible to operate two UAV on the same network ID.

Remember: For every UAV that you wish to operate one safety pilot is required.

16
iBase file names

16 ibase file names



Year 2023

JANUARY				FEBRUARY				MARCH				APRIL				MAY				JUNE			
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JULY				AUGUST				SEPTEMBER				OCTOBER				NOVEMBER				DECEMBER			
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3	184	19	200	3	215	19	231	3	246	19	262	3	276	19	292	3	307	19	323	3	337	19	353
4	185	20	201	4	216	20	232	4	247	20	263	4	277	20	293	4	308	20	324	4	338	20	354
5	186	21	202	5	217	21	233	5	248	21	264	5	278	21	294	5	309	21	325	5	339	21	355
6	187	22	203	6	218	22	234	6	249	22	265	6	279	22	295	6	310	22	326	6	340	22	356
7	188	23	204	7	219	23	235	7	250	23	266	7	280	23	296	7	311	23	327	7	341	23	357
8	189	24	205	8	220	24	236	8	251	24	267	8	281	24	297	8	312	24	328	8	342	24	358
9	190	25	206	9	221	25	237	9	252	25	268	9	282	25	298	9	313	25	329	9	343	25	359
10	191	26	207	10	222	26	238	10	253	26	269	10	283	26	299	10	314	26	330	10	344	26	360
11	192	27	208	11	223	27	239	11	254	27	270	11	284	27	300	11	315	27	331	11	345	27	361
12	193	28	209	12	224	28	240	12	255	28	271	12	285	28	301	12	316	28	332	12	346	28	362
13	194	29	210	13	225	29	241	13	256	29	272	13	286	29	302	13	317	29	333	13	347	29	363
14	195	30	211	14	226	30	242	14	257	30	273	14	287	30	303	14	318	30	334	14	348	30	364
15	196	31	212	15	227	31	243	15	258			15	288	31	304	15	319			15	349	31	365
16	197			16	228			16	259			16	289			16	320			16	350		

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