INTEL® FALCON™ 8+

UNMANNED AIRCRAFT SYSTEM

ENGLISH
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USER MANUAL

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TABLE OF CONTENTS

1. INTEL® FALCON™ 8+ UAS 7
1.1. SAFETY FIRST 7
1.1.1. Intended Use 7
1.1.2. Safety Guidelines 8
1.2. UAS AND SAFETY CHECK 11
1.3. PRE-FLIGHT CHECK 13
1.4. POST-FLIGHT CHECK 16
2. DESCRIPTION OF THE SYSTEM 18
2.1. THE INTEL® FALCON™ 8+ UAV 18
2.1.1. Central Unit 19
2.1.2. Motor Rails Of The UAV 21
2.1.3. Actively Stabilized Camera Mount (Gimbal) 22
2.2. THE INTEL® COCKPIT CONTROLLER (CTR) 22
2.2.1. The Status Display 26
2.2.2. The Touchscreen Tablet 26
2.3. THE INDEPENDENT CAMERA CONTROL (ICC) 27
2.4. THE 2ND OPERATOR MONITOR 28
2.5. PAYLOADS - CAMERA OPTIONS 29
2.5.1. Changing a Payload (Camera) 31
2.5.2. Payload and Compass Calibration 33
2.5.3. Sony Alpha 7R Full Frame Camera 36
2.5.4. Inspection Payload 40
2.6. THE INTEL® POWERPACK BATTERIES 45
2.6.1. Charging the Intel® Powerpack Batteries 47
2.6.2. Operating The BMS Menu 48
2.6.3. .Battery Update 51
2.6.4. Battery Information Safety Instructions And Warnings 51
2.7. TRANSPORT CASES & INTEL® BACKPACK 55
2.7.1. Packing Instructions 56
2.8. SOFTWARE FEATURE PACKAGES 59
2.8.1. Activating Software Feature Packages 60
2.8.2. Checking Activated Software Feature Packages 61
2.9. INTEL® FALCON™ 8+ UAV FLIGHT LOGS 62
3. OPERATING THE SYSTEM 66
3.1. PREPARING THE INTEL® FALCON™ 8+ UAV 66
3.2. PREPARING THE INTEL® COCKPIT CONTROLLER (CTR) 68
3.3. THE TOUCHSCREEN TABLET 70

3.3.1. PATH Projects 74
3.3.2. AscTec Navigator Software Projects 82
3.4. AUTOMATED START-UP CHECKS 86
3.4.1. Regional Setting 86
3.4.2. Magnetic Field Warning 87
3.5. LINK LOSS PROCEDURE 88
3.6. FLIGHT MODES 91
3.6.1. GPS-Mode 93
3.6.2. Height-Mode 97
3.6.3. Manual-Mode 98
3.7. STARTING AND STOPPING THE MOTORS 99
3.8. TAKING OFF 99
3.8.1. Launching In GPS-Mode 100
3.8.2. Launching In Height-Mode 100
3.8.3. Launching In Manual-Mode 101
3.9. THE FLIGHT 101
3.9.1. Controlling The Intel® Falcon™ 8+ UAV From The CTR 103
3.9.2. Mission Planning 104
3.9.3. In-Flight 104
3.9.4. General Operating Tips 105
3.9.5. Battery Warnings 106
3.10. IN-FLIGHT EMERGENCIES 107
3.11. LANDING 114
3.11.1. Landing In GPS-Mode 114
3.11.2. Landing In Height-Mode 114
3.11.3. Landing In Manual-Mode 115
3.11.4. Switching OFF The UAS 116
3.12. WARNINGS 116
3.12.1. Magnetic Field Warning 118
3.12.2. Critical Battery Levels & Warnings Of The UAV And The CTR 121
3.12.3. Data Link Warnings 123
3.12.4. GPS Warning 124
3.12.5. Motor Failure Warning 125
3.12.6. CTR Warnings 125
3.12.7. AscTec Trinity Control Unit System Warnings 127
3.13. OPERATIONAL LIMITATIONS 135
4. STATUS DISPLAY 136
4.1. STATUS DISPLAY OVERVIEW 136
4.1.1. Status Display Menu Structure 137
4.1.2. The Main Information Screens 148

5. SPECIAL FUNCTIONS 153
5.1. CIRCLE OF INTEREST (COI) 153
5.2. PANORAMA 154
5.3. QUICK SURVEYING ASSISTANT 158
5.4. WAYPOINT NAVIGATION
Using AscTec Navigator Software 162
6. MAINTENANCE, TROUBLESHOOTING, AND SUPPORT 163
6.1. MAINTENANCE 163
6.1.1. Intel® Falcon™ 8+ UAS Firmware Updates 163
6.1.2. Caring for the Intel® Falcon™ 8+ UAV 168
6.1.3. Propeller Replacement 169
6.2. TROUBLESHOOTING 170
6.2.1. Establishing A Connection Between The CTR And The UAV 170
6.2.2. Analyzing Data Link Connection Issues 171
6.2.3. No Preview Video On The Touchscreen Tablet Of The CTR 172
6.2.4. Flight Logs 172
6.3. SUPPORT 174
7. TECHNICAL SPECIFICATION 176
LIST OF FIGURES 182
LIST OF TABLES 184
INDEX 185

1. INTEL® FALCON™ 8+ UAS

Thank you very much for choosing the Intel® Falcon™ 8+ UAS!

The Intel® Falcon™ 8+ UAV is the first-choice drone for the most challenging professional UAV inspections and surveying operations. Small and portable with a maximum take-off weight of only 2.8 kg, but with a payload weight of 0.8 kg, the Intel® Falcon™ 8+ UAV can carry professional cameras like the Sony Alpha 7R, offering the full quality of an airborne image studio. The in-house developed AscTec Trinity Control Unit - the world's first triple redundant, fully adaptive control unit for multi-rotor aircrafts - makes the Intel® Falcon™ 8+ UAV the most advanced and reliable unmanned aerial vehicle. Thanks to the modular concept, you can spontaneously exchange the payload at any time, and get the very best out of each project by using the most suitable camera.

In the following text, Unmanned Aircraft **S**ystem (UAS) is used if the whole system (including Intel® Cockpit™ Controller, payload, etc.) is referenced; Unmanned Aerial **V**ehicle (UAV) is used when only the aircraft itself is referenced.

1.1. SAFETY FIRST

The following sections contain important safety information. Any personnel operating the UAS must read, understand and accept these warnings and guidelines before operating the Intel® Falcon™ 8+ UAV.

1.1.1. Intended Use

This product is an Unmanned Aircraft System (UAS) that is intended for commercial use only, such as for visual inspection of infrastructure, surveying and mapping. It is not intended for any consumer or recreational use. Acrobatic flight is prohibited.

You must read, understand, and agree to all documentation before using the Intel® Falcon™ 8+ UAS. By using the Intel® Falcon™ 8+ UAS, you certify that you have read and understand all the material in this document, as well as all user documentation, and agree to abide by said materials.

Use the Intel® Falcon™ 8+ UAS only as intended. Always operate in accordance with the operating limitations stated in the later sections of this User Manual.

Operating the system while ignoring these guidelines and warnings may be illegal and subject to fine.

1.1.2. Safety Guidelines

Failure to adhere to the following guidelines and warnings and to operate within the limitations of the UAS could result in an accident and death, serious injury, property damage, or damage to the UAS.

- You are responsible for knowing and complying with all laws and regulations applicable to the airspace in which you operate. Jurisdictions have different safety rules pertaining to authorization for flying UAVs; flying near airports, manned aircrafts, or people; operation within visual line of sight; altitude limits; operation at night or twilight; operation of multiple UAVs at the same time; and airspace usage. Know and understand all applicable laws before you fly. Follow applicable laws at all times.
- Some jurisdictions also have rules that may affect your operation of UAS, such as laws relating to receipt of wireless signals, aerial photography, aerial surveying, privacy, and trespassing. You must know and follow all laws and regulations applicable to your region.
- In some jurisdictions, the operator may be required to have a pilot certification from the aviation authority or advance approval from the aviation authority or air traffic control. Check your local laws before operating the UAS. You are always responsible for operating the UAS safely and responsibility, and in compliance with all laws.
- Professional drone operators must comply with all applicable insurance and aviation-specific liability requirements.
- Completion of a UAS safety check, pre-flight check, and post-flight check according to the following sections before every operation is compulsory for every flight.
- Rotating propellers can cause serious personal injury and property damage. Keep a safe distance and/or wear appropriate safety equipment (e.g. safety goggles, gloves).
- Our UAS, like all comparable aircraft systems, can in rare cases, suffer electrical, mechanical, and/or other failures. This may lead to a partial or complete loss of flying capability. Therefore, the pilot is responsible for conducting all flights at a safe distance from people, moving vehicles, etc. such that in the event of loss of flight control no personal injury or property damage will occur.
- Operating the UAV close to power lines, power transformers or other areas with high electromagnetic disturbances, or in urban canyons, can have severe effects on the GPS stability and/or the magnetic field sensor, which ultimately also effects GPS stability. The Intel® Falcon™ 8+ UAV is designed to compensate for these errors in most cases, but the function is not guaranteed in any scenario. Therefore, a pilot must have the training and ability to fly the Intel® Falcon™ 8+ UAV in Height-Mode in any situation. Only operate in these environments if you have sufficient training!

- Risk of fire or explosion: Do not operate the UAV in potentially explosive environments such as fueling stations, fueling areas, fuel or chemical storage facilities, or areas where the air may contain chemical or dust particles, such as grain particles or metal powders.

  If possible, and if you can do so safely, physically remove this product from any such environment. Do not connect any accessory cables or press any of the product's buttons until outside of these environments.
- GPS-Mode will limit your maximum speed. Flying the Intel® Falcon™ 8+ UAV at wind speeds above 12 m/s is not recommended. Please note that wind conditions on the ground and in the air can differ.
- Do not fly the UAV outside the specified temperature range, see "TECHNICAL SPECIFICATION" on page 176 for further details.
- The UAS and payloads are not waterproof. Do not operate the UAS in adverse weather (sand storm, rain, fog, snow, etc.) or at night.
- Only operate the UAV on clear days and during daylight hours. The UAV has LED position lights, but not anti-collision lights.
- The UAV is not equipped with a sense-and-avoid system. The operator is responsible for seeing and avoiding all other traffic, persons, structures, and obstacles. We recommend two-person operations (pilot and observer). All sense and avoid is done by the pilot and observer.
- Avoid placing the UAV or the Intel® Cockpit Controller (CTR) next to heat sources, leaving it in the direct sunlight for extended periods, or leaving it in a place where the temperature may exceed the specified range (such as a parked car on a hot day).
- Do not disassemble the UAS.
- Do not transport the UAS in transport containers not approved by Intel.
- Do not modify the UAS. Any modifications may compromise safety features, increasing risk of injury, death, or property damage. There are no user serviceable parts inside this UAS. Refer all service to your local support.
- Using devices in combination with the UAS other than those approved by Intel (e. g. batteries, battery chargers, cameras, etc.) is prohibited. Any unapproved modification of the UAS is prohibited.
- The UAS is equipped with a 2.4 GHz radio link for remote control and a 5.8 GHz radio link for video transmission. Please note that local laws may apply and restrictions in using radio equipment may exist in your area. The UAV may only be used for flight with the original accessories and under the defined environmental conditions.
- The UAV is equipped with Global Positioning System (GPS) or Assisted GPS (AGPS) technology, which may be used to determine the approximate location of the UAV. Please check the settings of any installed applications to ensure that

you manage these location-based services in accordance with your privacy preferences.

- The pilot of an Intel UAV should always act according to his or her best judgment focusing on the safety of the populace and the environment within which he or she is flying.
- Every pilot must undergo intensive training to operate the UAV in all flight modes and to maintain the UAV in a safe and airworthy condition - this is mandatory.
- Do not operate the UAS under the influence of alcohol or drugs.

⚠ **CAUTION: HAZARDOUS MOVING PARTS; KEEP FINGERS AND OTHER BODY PARTS AWAY. THIS PRODUCT USES REPLACEABLE BATTERIES; THERE IS RISK OF EXPLOSION IF BATTERY IS REPLACED WITH AN INCORRECT TYPE. DISPOSE OF USED BATTERIES ACCORDING TO THE INSTRUCTIONS.**

⚠ **CAUTION: ALWAYS FLY SAFELY AND RESPONSIBLY.**

THIS MEANS, FOR EXAMPLE:

- Always keep a safe distance between the UAV and people.
- Do not fly too close to obstacles (e.g. houses, trees, etc.). The UAV could damage third party property and/or the GPS signal might suffer from shadowing and worsen the positional accuracy.
- Do not fly beyond the line of sight.
- Never fly in closed or restricted areas.
- Always keep both hands on the control sticks. You must be able to react at any time, to prevent critical situations.
- Be aware of dogs or birds as they might attack your UAV.
- Always give way to other aircrafts! Watch out for low flying helicopters!
- All control inputs are given to the UAV as if you were sitting in the UAV as a pilot.
- We strongly recommend attending the basic training and to frequently practice Height-Mode.
- Never exceed a speed of 16 m/s (35 mph) in Height-Mode.
- Never descend faster than 10 m/s (22 mph) in Manual Mode.
- In case of any problems close to the ground, ascend to a safe height.
- Always keep the left control stick, controlling the altitude, completely down when the UAV is on the ground and the motors are running.

These safety guidelines are subject to change without prior notice. Errors and omissions excepted.

Privacy and Property Rights

As the operator of a UAS, you must comply with all applicable laws, especially privacy, property, and copyright laws. This includes the below common types of rules that may apply in the jurisdiction in which you operate. Always consult the laws of your jurisdiction before operating the UAS, as jurisdictions have different laws.

- Monitoring and filming public areas where individuals are staying may be only permitted under limited circumstances, e.g. for safety reasons and provided sufficient notice is provided.
- Monitoring and filming private areas may require the consent of the owner and, potentially, any residents or visitors.
- Filming individuals and using their pictures (such as sharing them) may infringe an individual's rights of his/her own image.
- Under copyright laws, some pictures may only be used for private purposes. In addition, taking pictures of buildings may breach copyrights.
- Take-offs and landings of the UAV may only be allowed with consent of the owner of the property on which take-offs / landings occur.

Violations of the laws and regulations referred to above may lead to penalties, damage claims from individuals, or even criminal prosecution.

This information is provided for informational purposes and is not an exhaustive description of legal requirements. This information is not designed to provide any legal advice or include any kind of warranty regarding the usability of the UAS. Please contact legal counsel for any specific and binding advice on the use of the UAS in your jurisdiction.

1.2. UAS AND SAFETY CHECK

The UAS and safety check must be performed once per day before the first flight or any time it may be necessary (e.g. after any incident like a hard landing). If you notice anything unusual (any loose part, strange noise from the motors, or any other unusual occurrence), please contact support through your reseller, if you purchased through a reseller, or support at Intel, if you purchased directly from Intel. Please include a detailed description of your observation and photos if applicable.

You must follow these steps to complete a close UAS and safety check:

Table 1.1: Safety Check List

1. Is the transport case free of visible damage?	If there is new visible damage from the last transport, please take special care during the check of the complete UAS.	☐
2. Is the UAV free of visible damage?	If there is visible damage, please contact your support as noted directly above this table.	☐
3. Are all the propellers in good condition?	Replace propellers if there are any cracks, breaks or other damages.	☐
4. Are all the propellers firmly mounted to the motors?	Move each propeller gently while holding the connected motor. The nut on top of the propellers is self-tightening. It only needs to be finger tight (20 Ncm +- 5 Ncm). Never tighten it with too much force, as it might damage the motor. To tighten the nut, use the supplied screw-wrench. Put the screw wrench on the nut, hold the motor head with thumb and index finger of one hand, and use the index finger of the other hand to turn the screw wrench. As soon as the motor head starts turning as well, sufficient force has been applied	☐
5. Nudge every single propeller so that it turns, and check if any unusual sound can be heard, or if a propeller spins slower than the others and stops spinning abruptly.	If there is a scratching sound or if a propeller spins slower than the others without any unusual sound, this might come from an obstacle inside the motor. Please try canned pressurized air to clean the motor. If there is a rattling sound this might come from a propeller which is not attached tightly enough. In this case, carefully check the self-tightening nut on top of the propeller. Tighten the nut as described in step 4.	☐
6. Is the User SD card of the "Black Box" (flight logger) correctly inserted?	Check the User SD card in the back of the Intel® Falcon™ 8+ UAV. If on the Status Display of the CTR there is the message No user SD card, please take out the card, make a backup copy, format it and re-insert it into the Intel® Falcon™ 8+ UAV	☐

Table 1.1: Safety Check List (Continued)

7. Is the gimbal correctly attached, and its thumbscrew installed in the back of the Intel® Falcon™ 8+ UAV?	Make sure that the camera mount is pushed all the way in and that the thumbscrew is installed finger tight.	☐
8. Is the payload adapter firmly connected to the central unit?	Make sure that the connector plug of the adapter is connected to the equivalent at the front side of the UAV. Make sure that the ball of the ball link connector of the roll servo is fixed in the respective slot in the payload adapter.	☐
9. Are all the batteries fully charged?	Voltage level can easily be checked using the BMS of the batteries. It will be shown by the LEDs on the front of the batteries.	☐

WARNING **VIOLATION OF THESE SAFETY PRECAUTIONS RESULTS IN THE LOSS OF WARRANTY!**

1.3. PRE-FLIGHT CHECK

You must follow these steps for a close pre-flight check:

Table 1.2: Pre Flight Check List

1. Is the UAS in proper condition (according to the points listed in “UAS AND SAFETY CHECK” on page 11)?	☐
2. Make sure to have an empty and correctly formatted SD card inserted in the camera.	☐
3. Are there two batteries fully inserted into the Intel® Falcon™ 8+ UAV, with the colored label facing upwards and secured by the retaining clips?	☐
4. Is the battery of the Intel® Cockpit Controller (CTR) fully inserted, with the colored Intel label facing downwards?	☐
5. Is the Intel® Cockpit Controller in proper condition (no loose parts) and the antenna panel folded out?	☐

Table 1.2: Pre Flight Check List (Continued)

6. Place the UAV on the take-off location and verify the following: • There is enough space to take-off and land (no people, animals or obstacles within a radius of 10 m). • There are no obstacles around that could shadow the GPS signal. • The surface allows all propellers to spin freely. • There are no small rocks, dust or sand which could be sucked into the motors. • There are no magnetic fields to be expected.	☐

⚠ **CAUTION: TO AVOID INTERFERENCES WITH THE UAS PLEASE SET YOUR SMARTPHONE TO AIRPLANE (FLIGHT) MODE AS THEY USE THE SAME 2.4 GHZ AND 5.8 GHZ FREQUENCIES.**

Table 1.3: Pre Flight Checklist (Continued)

7. Always switch on the UAS in the following order: **1. Payload** **2. Intel® Falcon™ 8+ UAV** **3. Touchscreen tablet** **4. Intel® Cockpit Controller (CTR)** Wait for the link to be established.	☐
8. The end of the boot process is marked by a triple beep emitted by the Intel® Falcon™ 8+ UAV. During boot up, the Intel® Falcon™ 8+ UAV does not need to stand still. It can be moved - for example, it can be started from a moving boat.	☐
9. The start-up process is finished when camera mount stabilization starts working. A gentle buzzing sound can be heard from the gimbal.	☐
10. Make sure to comply with all points in the checklist presented on the touchscreen tablet. Confirm the checklist on the tablet.	☐
11. Confirm the preview video image is visible on the touchscreen tablet of the Intel® Cockpit Controller.	☐
12. Choose a Link Loss Procedure, which is suitable for the current flight mission.	☐
13. Confirm the displayed battery capacity of the CTR is sufficient for the planned mission (displayed in minutes in the Status Display - see “STATUS DISPLAY” on page 136).	☐

Table 1.3: Pre Flight Checklist (Continued)

14. Confirm the battery capacity of the UAV is at least 80% (displayed in the top line of the tablet).	☐
15. The bottom line in the Status Display shows OK.	☐
16. Is the GPS quality greater than or equal to 4 bars? This is mandatory if you want to fly in GPS-Mode.	☐
17. Confirm the wind speed is within the operational limits: 16 m/s in Height-Mode or 12 m/s in GPS-Mode.	☐
18. Choose the correct flight mode (usually GPS-Mode or Height-Mode).	☐
19. Switch the motors on (with both hands, only in idle mode). While the Intel® Falcon™ 8+ UAV is on the ground with running motors, always keep the left control stick, which controls the height, in the fully downward position.	☐
20. Are all the motors running correctly?	☐
21. Ready for take-off!	☐

WARNING **VIOLATION OF THE SAFETY PRECAUTIONS RESULTS IN THE LOSS OF WARRANTY!**

1.4. POST-FLIGHT CHECK

You must follow these steps closely for a post-flight check:

Table 1.4: Post-flight Check List

1. Before landing the Intel® Falcon™ 8+ UAV, adjust the camera to a horizontal position.	☐
2. Land the Intel® Falcon™ 8+ UAV. Always keep the left control stick, which controls the height, in the fully downward position when the system is on the ground with running motors.	☐

3. When the system is on the ground, switch off the motors.
Always switch off the system in the following order:
• Camera (depending on the payload, wait at least 10 seconds until the camera has stored all data and is fully powered down).
• Intel® Falcon™ 8+ UAV
  • Push and hold the power button.
  The LED position lights will increase brightness.
  The LED position lights will decrease brightness and simultaneously there will be a short beep from the UAV.
  • After the beep, let go of the button.
• Touchscreen tablet
  • Push and hold the power button until “Slide to shut down your PC” is shown.
  • Let go of the button.
  • Follow the instructions on the tablet to fully power down the touchscreen tablet.
• Intel® Cockpit Controller (CTR)
  • Push and hold the POWER button.
  The CTR will vibrate a few seconds later.
  • Let go of the button.
	☐

4. Remove all batteries of the Intel® Falcon™ 8+ UAV.	☐
5. Store the UAV safely in the transport case or in the backpack.	☐

Table 1.4: Post-flight Check List (Continued)

6. Remove the battery of the CTR.	☐
7. Fold in the antenna panel of the CTR.	☐
8. Remove the shoulder harness of the CTR.	☐
9. Store the CTR and all accessories safely in the transport case or in the backpack.	☐

⚠ **CAUTION: ALWAYS REMOVE ALL BATTERIES FROM BOTH THE INTEL® FALCON™ 8+ UAV AND CTR WHEN THE SYSTEM IS NO LONGER IN USE.**

WARNING **VIOLATION OF THESE SAFETY PRECAUTIONS RESULTS IN THE LOSS OF WARRANTY!**

2. DESCRIPTION OF THE SYSTEM

In this chapter, you find a description of the whole system and its components:

- The Intel® Falcon™ 8+ UAV
- The Intel® Cockpit Controller (CTR)
- Payloads/Cameras
- The Intel® Powerpack Batteries

2.1. THE INTEL® FALCON™ 8+ UAV

The following section describes the single parts of the Intel® Falcon™ 8+ UAV.

Figure 2.1: The Intel® Falcon™ 8+ UAV Components

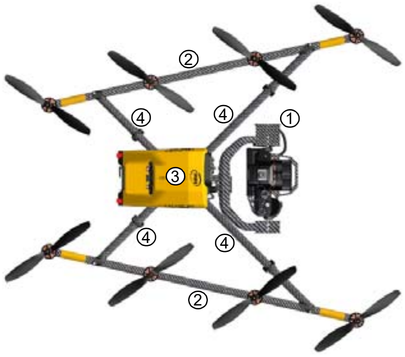
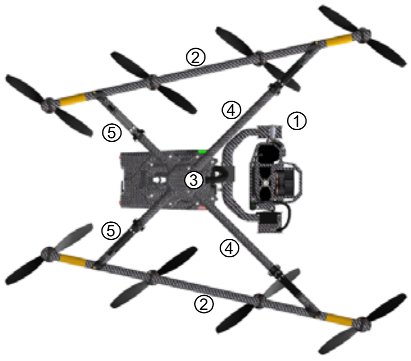
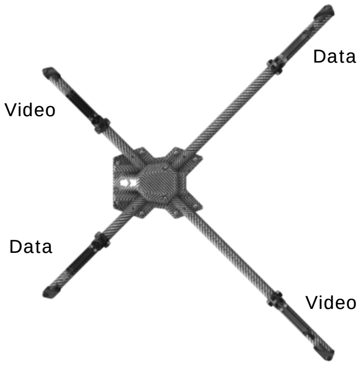
<table>
<tr>
<td>
</td>
<td>The Intel® Falcon™ 8+ UAV consists of several components:
(1) Actively stabilized camera mount (gimbal) with camera
(2) Motor rails
(3) Central unit
(4) Carbon cross</td>
</tr>
<tr>
<td>
</td>
<td>The Intel® Falcon™ 8+ UAV bottom view:
(1) Actively stabilized camera mount with camera
(2) Motor rails
(3) Center cross piece with LEDs
(4) Carbon cross
(5) Landing feet
For orientation reasons, the UAV has three LED position lights:
• white at the bottom
• green on the right side
• red on the left side</td>
</tr>
</table>

Figure 2.1: The Intel® Falcon™ 8+ UAV Components (Continued)

	The Intel® Falcon™ 8+ UAV bottom view, Carbon Cross with center cross piece, antenna arrangement: The data link antennas (2.4 GHz) as well as the video link antennas (5.8 GHz) are integrated into the landing feet. They are diagonally arranged as shown in the image to the left.

2.1.1. Central Unit

The following figures describe the single parts of the Central Unit.

Figure 2.2: Central Unit Back View without Gimbal (Camera Mount)

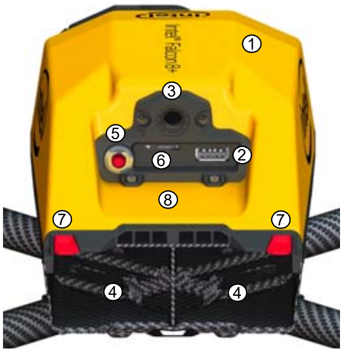
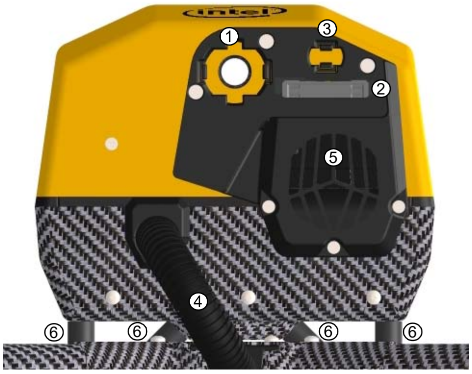
 intel Falcon 8+ ① ③ ⑤ ⑥ ② ⑧ ⑦ ⑦ ④ ④	The Central Unit consists of: (1) Carbon fiber chassis (2) USB stick slot (supports up to 16 GB, file system: FAT32, allocation unit size: 32 kilobytes) for firmware updates (3) Hole for the camera mount's carbon rod, see "Units of the Gimbal" on page 22 (4) Battery compartments with retaining clips (7) for batteries (5) Power button (6) Micro SD-card slot (SD card: speed class 10 minimum, supports up to 16 GB, file system: FAT32, allocation unit size: 32 kilobytes), for flight logs ("Black Box"), must be inserted contacts upwards (7) Retaining clips for the batteries (8) Place for the label with the serial number of the UAV Built inside: • The electronics for flight stabilization and power supply • Diversity Data Link modules • Video Transmitter module

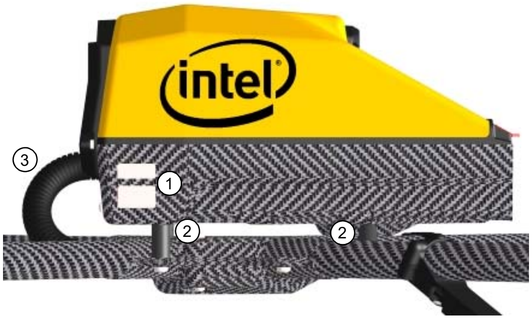
Figure 2.3: Central Unit Front View without Gimbal (Camera Mount)



Front view:

(1) Hole for the camera mount's carbon rod
(2) Connector slot for the plug of the payload adapter, (see no. (1) in "Units of the Gimbal" on page 22
(3) Retaining clip for the payload adapter
(4) Cable tube (contains the cabling of the antennas)
(5) Fan for the internal cooling behind the slots
(6) Vibration dampers

Figure 2.4: Central Unit Side View, Left Side without Gimbal (Camera Mount)



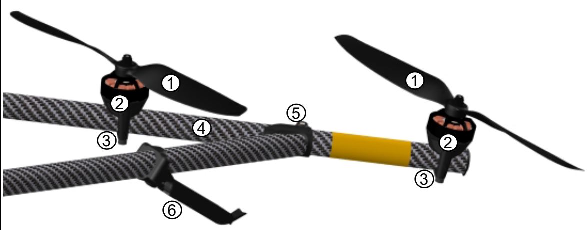
Side view (left):

(1) LED position light (red when UAV is running), same on the right side (green when UAV is running)
(2) Vibration dampers
(3) Cable tube (which contains, e.g., the cabling of the antennas)

2.1.2. Motor Rails Of The UAV

The following figure shows the front part of the left motor rail.

Figure 2.5: Motor Rails and Equipment

	The motor rails and the related elements consist of: (1) Propellers, mounted directly on the motors (2) Brushless motors, mounted directly onto the motor mounts (3) Motor mount (4) Carbon fiber tube (5) Connector between carbon cross and motor rails (6) Landing foot (front left shown): the video link antenna (or data link antenna as applicable) is integrated (see “The Intel® Falcon™ 8+ UAV Components” on page 18). Each motor rail consists of four motor controllers seated within the carbon tube.

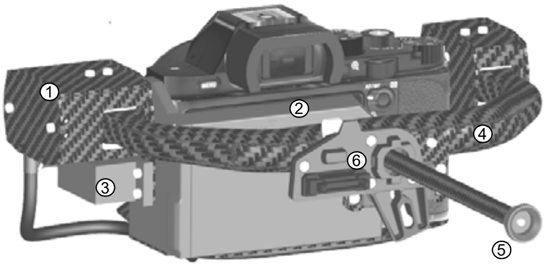
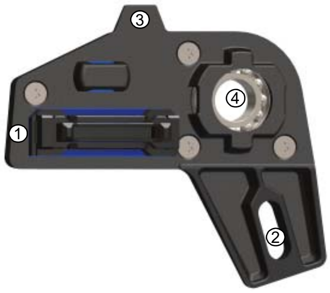
⚠ **CAUTION: HAZARDOUS MOVING PARTS, KEEP FINGERS AND OTHER BODY PARTS AWAY.**

The motor rails are connected by a carbon cross which consists of four carbon tubes connected by a center cross piece.
The antenna cabling is found inside the tubes of the carbon cross.

2.1.3. Actively Stabilized Camera Mount (Gimbal)

The following figure describes the parts (or sub-assemblies) of the gimbal.

Figure 2.6: Units of the Gimbal

	The actively stabilized camera mount consists of: (1) Circuitry for controlling the camera (2) Payload (e. g. Sony Alpha 7R) (3) Pitch servo (4) Carbon fiber structure (5) Knurled securing nut for the actively stabilized camera mount (6) Payload adapter (see below for details). The payload adapter is the connection between the camera mount and the central unit of the UAV. It is movable when mounted on the rod of the camera mount and connected by a cable.
	The payload adapter (backside) (1) Connector plug, should be connected to the equivalent at the front side of the UAV (see no. (2) in “Central Unit Front View without Gimbal (Camera Mount)” on page 20). (2) Adapter slot for the ball link connector of the roll servo (3) Releasing clip (4) Hole for the camera mount’s carbon rod

2.2. THE INTEL® COCKPIT CONTROLLER (CTR)

The CTR is the main control hub for the Intel® Falcon™ 8+ UAV and the attached payloads/ cameras. It is designed to be carried and operated by one person and displays all relevant flight information.

The communication between the CTR and the Intel® Falcon™ 8+ UAV is ensured by two independent 2.4 GHz digital data links. The preview video is transmitted digitally on 5.8 GHz. The CTR uses the same battery type as the Intel® Falcon™ 8+ UAV. The battery is in the battery compartment which can be accessed from the bottom of the CTR (see "Preparing the CTR" on page 68).

The CTR serves as an interface device to the flight system. It is pre-programmed and ready to use.

The Status Display is used for communication between the CTR and the Intel® Falcon™ 8+ UAV.

The touchscreen tablet displays the live video preview from the attached camera.

Figure 2.7: Intel® Cockpit Controller (CTR) Overview

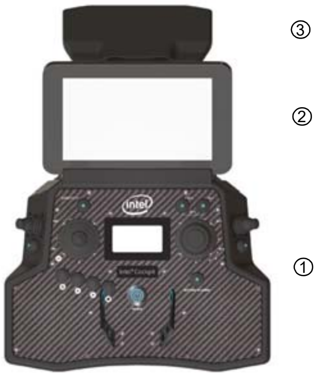
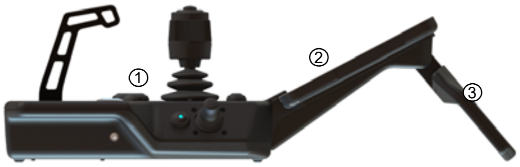
	Front view, with unfolded antenna panel. The CTR can be divided into (from bottom to top): (1) Remote control unit (2) Touchscreen tablet (for preview video and more, see "THE TOUCHSCREEN TABLET" on page 70), displayed without sun shade (3) Antenna panel (unfolded). All communication between CTR and the Intel® Falcon™ 8+ UAV is sent and received by the antenna panel. It features 2.4 GHz antennas for all control and telemetry communication and 5.8 GHz antennas to receive the preview video.
	Overview, side view right side. (1) Remote control unit (2) Touchscreen tablet, displayed without sun shade (3) Antenna panel (unfolded)
	To avoid reflections, there is a sun shield permanently attached to the touchscreen tablet. It folds away for storage and transport.

Figure 2.7: Intel® Cockpit Controller (CTR) Overview (Continued)

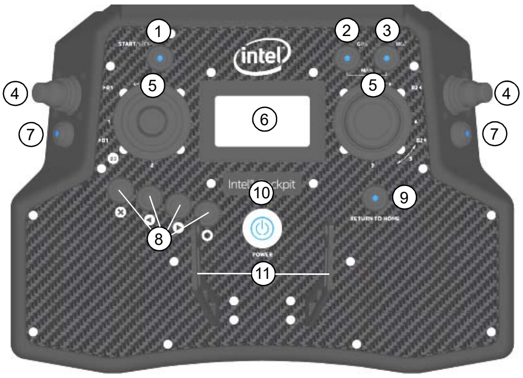
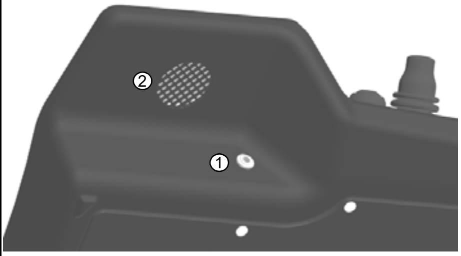
 1 2 3 4 4 5 5 6 7 7 8 9 10 11 intel Intel Cockpit RETURN TO HOME POWER	The functional elements of the CTR remote control unit are: (1) START/STOP button: starts/stops the motors when the left stick is simultaneously held down (see “STARTING AND STOPPING THE MOTORS” on page 99). (2) GPS button: GPS-Mode ON (3) HGT button: Height-Mode ON. When both buttons are switched ON/lit Manual-Mode is activated (4) Left rocker switch (R1) controls the camera pitch angle, right rocker switch (R2), controls different camera functions depending on the attached payload (5) Left and right control sticks (6) Status Display (see “STATUS DISPLAY” on page 136). (7) Left push button (B1) sets the camera to predefined angles +/- 90°, +/- 45° and 0° when the left rocker switch R1 (4) is pushed simultaneously, right push button (B2) controls different camera functions depending on the attached payload (8) Four function buttons for the Status Display (9) RETURN TO HOME button (10)POWER button (11)Integrated shoulder harness holders
USB 1 USB 2 USB 3 USB 4 HDMI	There are different connectors on the back of the CTR: • 4 X USB • 1 X HDMI The USB port labeled USB 1 can only be used to perform firmware updates from a USB stick. The other USB ports can be used to connect the Independent Camera Control (ICC) or USB sticks with pre-planned flight missions.

Figure 2.7: Intel® Cockpit Controller (CTR) Overview (Continued)

	A headphone port (mini jack) is located on the lower right-hand side of the CTR remote control unit (1). It is possible to connect headphones, which might be helpful under noisy conditions. Without headphones connected, acoustic warnings are played back through a small loudspeaker (2) inside the CTR.

⚠ **CAUTION: RISK OF PERMANENT HEARING LOSS FROM USING EARPHONES OR HEADPHONES WITH THIS PRODUCT AT HIGH VOLUME.**

BEFORE PLACING HEADPHONES OR EARPHONES NEAR THE EAR, 1) FIND A QUIET ENVIRONMENT, 2) TURN THE VOLUME DOWN ON THIS PRODUCT TO THE MINIMUM SETTING, 3) CONNECT THE EARPHONE OR HEADPHONE TO THE PRODUCT, 4) PLACE THE EARPHONE OR HEADPHONE NEAR OR ON THE EAR AND 5) SLOWLY INCREASE THE VOLUME ON THE PRODUCT TO A COMFORTABLE LEVEL. AVOID INCREASING THE VOLUME ABOVE THIS LEVEL.

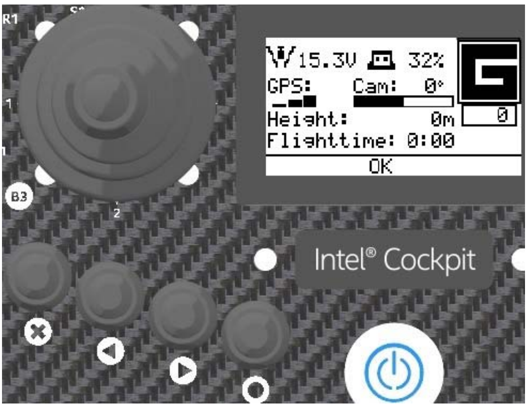
INCREASING THE VOLUME TO BE LOUDER THAN A NOISY ENVIRONMENT, SUCH AS A CITY STREET, MAY EXCEED SAFE LISTENING LEVELS. IF YOU EXPERIENCE DISCOMFORT OR BUZZING IN YOUR EARS, REDUCE THE VOLUME OR DISCONTINUE USE OF YOUR EARPHONES OR HEADPHONES.

RISK OF PERMANENT HEARING LOSS FROM USING THE LOUDSPEAKER IN CLOSE PROXIMITY TO THE EAR.

2.2.1. The Status Display

The Status Display shows all relevant information for flying. It is built into the CTR remote control unit. For further information about the handling of the Status Display see “STATUS DISPLAY” on page 136).

Figure 2.8: Status Display

 15.3V 32% GPS: Cam: 0° Height: 0m Flighttime: 0:00 OK G 0 R1 B3 Intel® Cockpit	Via the Status Display you can view the current settings and adjust specific functions of the UAV. In order to do so, use the four buttons under the lower left corner of the Status Display. ⊗ **Escape** (left side) is used to leave menus / sub-menus and to clear functions. In the following text, it is displayed as **ESC**. ◀ With the arrow **LEFT** button (middle, left side) ▶ and the arrow **RIGHT** button (middle, right side) you can scroll through menus or alter parameters. ◉ **Enter** (right side) is used to enter menus and activate functions. In the following text, it is displayed as **ENT**.

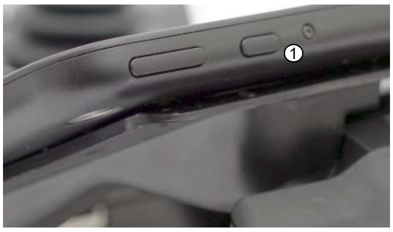
2.2.2. The Touchscreen Tablet

The Intel® based Windows® touchscreen tablet has an 8.3-inch screen with a resolution of 1920 X 1200 pixels. It is directly mounted on the remote control unit of the Intel® Cockpit Controller (CTR) and cannot be removed.

The tablet is powered by the battery of the CTR and must be switched ON before the CTR is powered ON.

The touchscreen tablet serves as a video monitor, displays flight information and gives access to extended functionality (see “THE TOUCHSCREEN TABLET” on page 70).

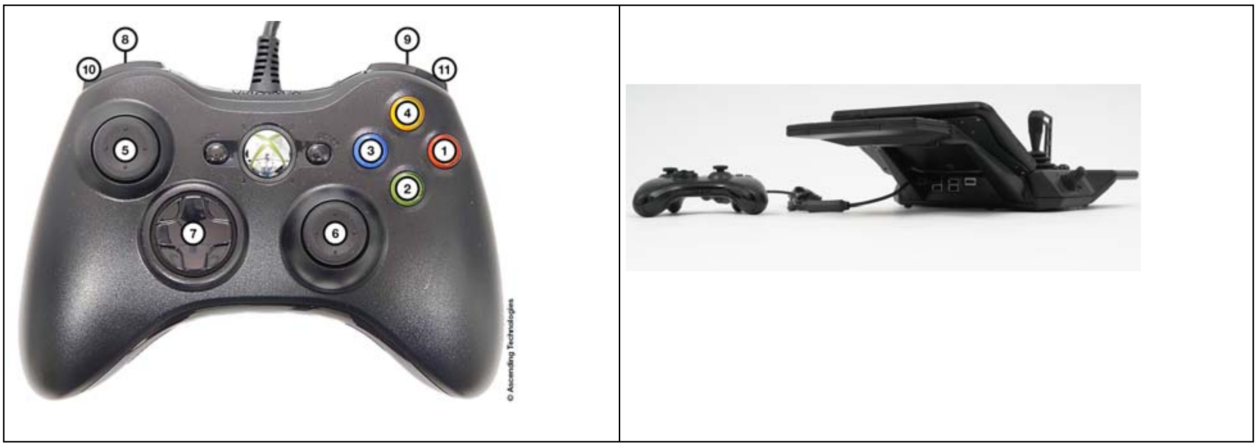
Figure 2.9: The Touchscreen Tablet

	Power button on the top edge, right side (1)

2.3. THE INDEPENDENT CAMERA CONTROL (ICC)

The Independent Camera Control (ICC) is an optional part of the Inspection Package (see “SOFTWARE FEATURE PACKAGES” on page 59). Thanks to the ICC, a camera operator can control the main camera functions from a gamepad, which is connected to the CTR via a USB port (USB port 2 – 4). The USB ports are in the back of the CTR in the upper left corner (see “Intel® Cockpit Controller (CTR) Overview” on page 23).

Figure 2.10: Independent Camera Control (ICC)



The following table presents an overview of the function assignment:

Table 2.1: Operating a Camera By ICC

BUTTON REFERENCED ON ICC	CAMERA	
	SONY ALPHA 7R	INSPECTION-PAYLOAD TZ71
(1)	Start/Stop video	/
(2)	Trigger photo	Trigger photo (both cameras)
(3)	View last image	/
(4)	/	Change color palette (when FLIR is active)
(5)	Camera tilt (up/down) Yaw (left/right)	Camera tilt (up/down) Yaw (left/right)
(6)	Camera tilt (up/down) Yaw (left /right)	Camera tilt (up/down) Yaw (left/right)

Table 2.1: Operating a Camera By ICC (Continued)

(7)	Horizontal tilt (adjust camera horizon) (left/right) Exposure compensation +/- (up/down)	Horizontal tilt (adjust camera horizon) (left/right) Switch camera (up/down)
(8)	Shutter speed -	Zoom - (when RGB camera is active)
(9)	Shutter speed +	Zoom + (when RGB camera is active)
(10)	Camera tilt velocity -	Camera tilt velocity -
(11)	Camera tilt velocity +	Camera tilt velocity +

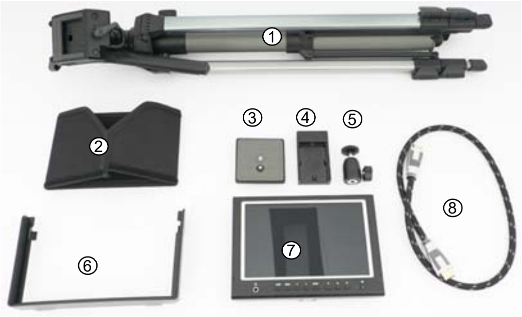
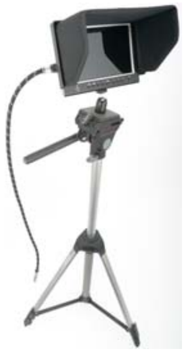
2.4. THE 2ND OPERATOR MONITOR

The 2nd operator monitor is an optional part of the UAS and can be delivered as an additional accessory.

It can be used as a video preview monitor for the 2nd pilot, especially when used with the ICC (see “THE INDEPENDENT CAMERA CONTROL (ICC)” on page 27). There is no further (flight) information shown on this monitor.

Thanks to the 2nd monitor, a camera operator can control the video preview of the camera used. It is connected to the CTR via the HDMI port by a cable. The HDMI port is in the back of the CTR in the upper left corner (see “Intel® Cockpit Controller (CTR) Overview” on page 23).

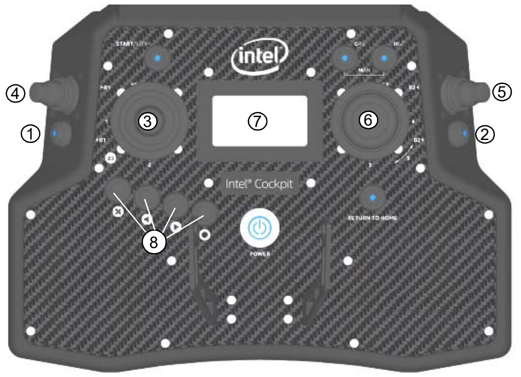
Figure 2.11: 2nd Operator Monitor Package

	The elements of the 2nd operator monitor package are: (1) Tripod (2) Sunshield (3) Adapter plate for tripod (4) Battery adapter (5) Monitor adapter (6) Frame for sunshield (7) Monitor (8) HDMI cable Not shown: • Battery • Charger
	The 2nd operator monitor fully assembled.

2.5. PAYLOADS - CAMERA OPTIONS

Because of the deep integration of cameras, it is possible to change settings like aperture, shutter speed or zoom (depending on the camera) directly from the Intel® Cockpit Controller (CTR), while the system is airborne. To ensure complete integration into the Intel® Falcon™ 8+ UAV, every payload must undergo mechanical and electrical modifications. Therefore, only payloads approved by Intel are allowed. Payloads which have not been integrated might affect the compass calibration due to magnetic emissions by the camera and could have detrimental effects on the flight performance. If you require assistance with determining which payload to choose for your application, please contact our support team: support@intel.com.

Figure 2.12: Camera Control Via the Intel® Cockpit Controller (CTR)



All cameras integrated on the Intel® Falcon™ 8+ UAV can be controlled via the CTR. Several switches on the CTR are assigned to camera controls.

(1) **Push Button B1**: sets the camera to predefined angles +/- 90°, +/- 45° and 0° when R1 (4) is pushed simultaneously (see below for details)
(2) **Push Button B2**: changes the function depending on the connected payload
(3) **Push Button B3**: trigger button on top of the left control stick **(S1)**
(4) **Rocker Switch R1:** camera tilt
(5) **Rocker-Switch R2:** changes its function depending on the camera used
(6) **Control Stick S2:** turning the right control stick **(S2)** controls the yaw axis of the UAV.
(7) **Status Display** and related control buttons
(8) **ESC, LEFT, RIGHT, ENT:** depending on the payload, additional options can be accessed via the Status Display. Pushing ENT and selecting Camera Options opens the respective menu (see “Status Display” on page 26 and see “STATUS DISPLAY” on page 136).

For exact details regarding accessible functions see the individual payload descriptions.

Figure 2.12: Camera Control Via the Intel® Cockpit Controller (CTR) (Continued)

Setting the Camera Angle

The **Main Screen** of the Status Display shows the camera angle. 0° means the camera is looking straight forward and is leveled horizontally. -90° means the camera is looking down, 90° means it is looking up.

Push the Rocker-Switch R1 away from you to tilt the camera downwards. Pull the Rocker-Switch R1 towards you to tilt the camera upwards. The further R1 is pulled or pushed the quicker the tilt movement.

When the camera is not at 0°, a single push of button B1 will set it back to 0°. When the camera is at 0°, pushing and holding B1 and simultaneously pushing R1 shortly, will set the camera to -45°, another short push of R1 while holding B1 will set it to -90°. When pulling R1 while holding B1 the camera can be tilted upwards accordingly in 45° increments.

2.5.1. Changing a Payload (Camera)

Cameras are designed to remain within their gimbal (camera mount). The complete gimbal with camera can be exchanged without tools. The Intel® Falcon™ 8+ UAV automatically identifies the attached camera and the menus of the Status Display on the CTR are changed accordingly.

Figure 2.13: Installing the Camera Mount

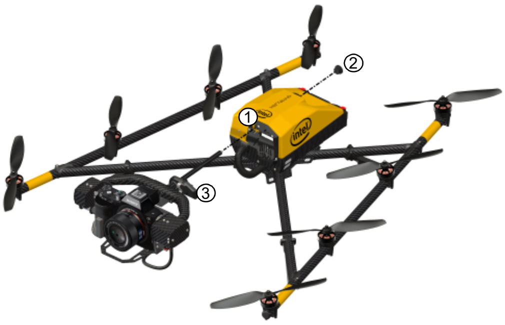
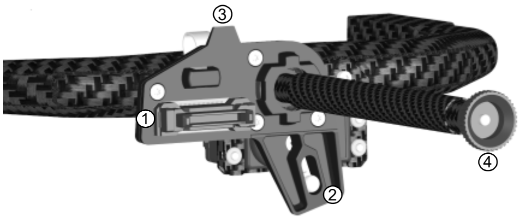
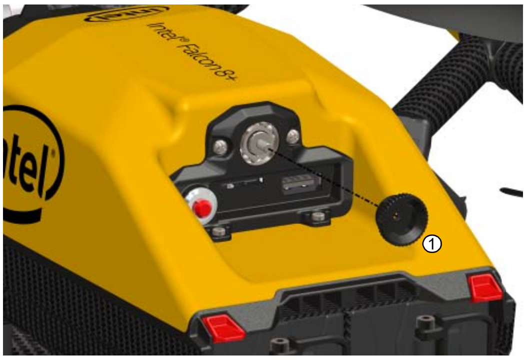
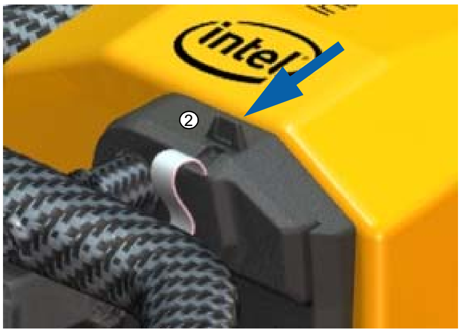
	To install the camera mount: 1. Feed the camera mount carbon rod into the front side of the central unit (1). The Thumbscrew (2) is not attached at this time. Make sure the carbon rod is not at an angle when it is inserted. 2. Fix the payload adapter (3). Take care that the connector plug of the adapter fits to the equivalent at the front side of the UAV. See detail #1 below. 3. On the roll servo, make sure the ball link connector ball is fixed in the respective slot in the adapter when you fix the camera mount onto the UAV. See detail # 2 below. 4. Press the releasing clip of the payload adapter into the respective counterpart opening at the front side of the UAV. See detail # 3 below. 5. Install the thumbscrew nut (2) on the back side of the central unit (Finger tight. See detail # 4 below.
	The payload adapter is the connection between the camera mount and the central unit of the UAV. The payload adapter is movable when mounted on the rod of the camera mount and is connected by a cable. (1) Connector plug (2) Adapter slot for the roll servo with ball link connector inserted (3) Releasing clip (4) Knurled securing nut of the actively stabilized camera mount

Figure 2.14: Removing the Camera Mount

	To remove the camera mount: 1. Remove the knurled securing nut (1) of the camera mount at the back side of the central unit.
	2. Carefully disconnect the payload adapter with pressure against the release clip of the adapter (2). 3. Disconnect the ball of the ball link connector of the roll servo out of the adapter slot. 4. Pull out the camera mount gently. Make sure it comes out straight (not at an angle)

2.5.2. Payload and Compass Calibration

CAUTION: WHEN INSTALLING A NEW PAYLOAD ONTO AN INTEL® FALCON™ 8+ UAV, IT IS NECESSARY TO PERFORM A PAYLOAD CALIBRATION AND A COMPASS CALIBRATION (STRICTLY IN THAT ORDER).

THE INTEL® FALCON™ 8+ UAV WILL SAVE THE CALIBRATIONS FOR THAT EXACT PAYLOAD AND REMEMBER IT THE NEXT TIME THE PAYLOAD IS USED.

IF YOU FAIL TO CALIBRATE, THE SYSTEM WILL USE DEFAULT PARAMETERS WHICH WILL LEAD TO DECREASED HEADING ACCURACIES.

TO PERFORM THE CALIBRATIONS, PLEASE FOLLOW THE STEPS BELOW.

The payload calibration is stored in the payload itself, and the compass calibration is stored in the UAV.

2.5.2.1. *Payload Calibration*

The payload calibration can be done indoors with the motors switched off.

1. Attach the payload you are performing the calibration on.
2. Switch the payload ON, then the Intel® Falcon™ 8+ UAV, then the touchscreen tablet and the finally the CTR.
3. On the CTR push the **ENT** button of the Status Display and navigate to `Settings` > `Payload calib` (see “STATUS DISPLAY” on page 136).
4. Make sure the camera can turn freely from the full down position to the full up position (with the Inspection Payload, you will need to raise the Intel® Falcon™ 8+ UAV to make sure the payload does not hit the ground and cause damage when it tilts downwards).
5. Push **ENT** to start the calibration. The camera will first rotate fully downwards and then progressively move to the fully upwards position. Do not touch the Intel® Falcon™ 8+ UAV during the process.
6. When the payload does not move anymore, switch off the payload, then the Intel® Falcon™ 8+ UAV, then the touchscreen tablet and finally, the CTR.
7. Restart the system in the specific sequence (see step #2 above).

⚠ **CAUTION: IT IS IMPORTANT TO RESTART THE SYSTEM IMMEDIATELY AFTER EACH CALIBRATION. THE NEW CALIBRATION PARAMETERS WILL ONLY BECOME ACTIVE AFTER RESTARTING THE SYSTEM.**

8. Repeat the above steps for each new payload to be used with the Intel® Falcon™ 8+ UAV. Once a payload has been calibrated, the Intel® Falcon™ 8+ UAV will recall the settings.

2.5.2.2. *Compass Calibration*

The compass calibration needs to be done outdoor in flight.

1. Attach the payload you are performing the calibration on.
2. Take the Intel® Falcon™ 8+ UAV out to a spot with good GPS reception and no magnetic disturbances.
3. Switch the payload ON, then the Intel® Falcon™ 8+ UAV, then the touchscreen tablet, and finally, the CTR; take off.
4. Have the Intel® Falcon™ 8+ UAV hover in GPS mode at about 30 m above ground level where no magnetic disturbances are to be expected.
5. On the CTR push the **ENT** button of the Status Display to navigate to `Settings` > `Compass Calib` (see “STATUS DISPLAY” on page 136).
6. Push **ENT** to confirm. The Intel® Falcon™ 8+ UAV will make a 400° turn.

7. Once the Intel® Falcon™ 8+ UAV has finished the turn, land, switch off the camera, then the Intel® Falcon™ 8+ UAV, then the touchscreen tablet, and finally, the CTR. Restart the complete system in the specific sequence (see step #2 above).

> ⚠ **CAUTION: IT IS IMPORTANT TO LAND AND RESTART THE SYSTEM IMMEDIATELY AFTER EACH CALIBRATION PROCESS. THE NEW CALIBRATION PARAMETERS WILL ONLY BECOME ACTIVE AFTER RESTARTING THE SYSTEM.**

8. Repeat the above steps for each new payload to be used with the Intel® Falcon™ 8+ UAV. Once a payload has been calibrated, the Intel® Falcon™ 8+ UAV will recall the settings.

2.5.2.3. Adjusting The Camera Horizon

The zero position of the camera horizon and/or tilt angle might occasionally need adjustment, as it might change due to temperature variations. The adjustment of the camera horizon can be done indoors with the motors switched off.

To re-adjust the zero position, follow these steps:

1. Switch the Intel® Falcon™ 8+ UAV and the CTR ON as usual.
2. Select the Link Loss Procedure.
3. Push the left control stick of the CTR fully upwards and hold it.
4. While holding the left control stick fully upwards, use the right control stick to adjust the camera. It now directly controls the camera angles.
5. When the position is set correctly, release both control sticks. This position will automatically be saved as the new zero position.

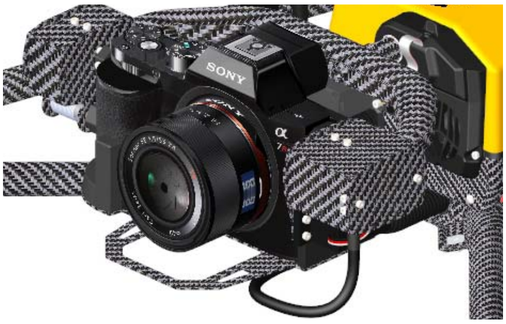
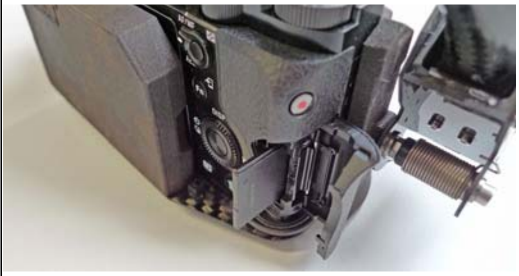
It is also possible to adjust the camera horizon in flight, but not the tilt angle.
To adjust the horizon in flight:

1. Enter the menu of the Status Display by pushing **ENT**.
2. Navigate to `Camera Options > Adjust Horizon`.
3. Push **ENT**.
4. Use the arrow **LEFT/RIGHT** keys of the Status Display to change the horizon.
5. Push **ENT** to confirm.

2.5.3. Sony Alpha 7R Full Frame Camera

The Sony Alpha 7R has two main function dials that can be controlled through the CTR (see "Camera Control By The CTR" on page 37).

Figure 2.15: Sony Alpha 7R and SD Card Slot

	Specifications: • Sensor size: 35.90 mm x 24.00 mm • Resolution: 36.4 Mpx (7360 x 4912 pixels) • Lens: Sonnar® T* FE 35 mm F2.8 ZA (SEL35F28Z) • Weight incl. lens and gimbal: ~ 790 g. • Approximate max. flight time: 16 min • Suggested applications: Aerial photography, inspection and surveying Approved lenses: • Sonnar® T* FE 35 mm F2.8 ZA (SEL35F28Z) Please note that all other available full frame lenses are too heavy and cannot be approved
	Images are stored on an SD card, which is inserted underneath a lid on the right back side of the camera. To transfer images to the computer, please use an SD card reader which is connected to the computer. For further information: https://esupport.sony.com/US/p/model-home.pl?mdl=ILCE7R&LOC=3#/manalsTab

2.5.3.1. General Care

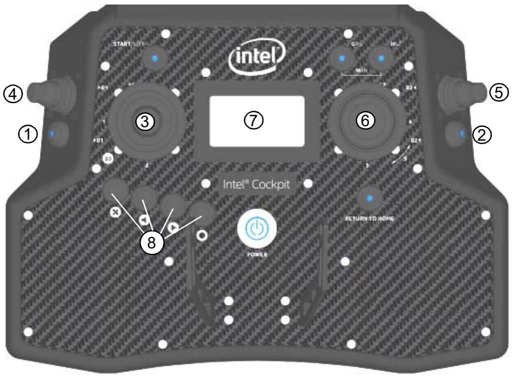
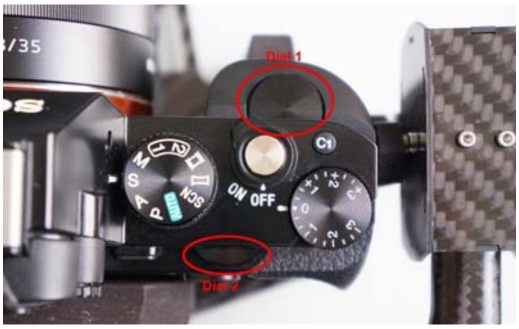
- Always handle the gimbal with care. If you need to tilt the camera manually (when not connected or while the Intel® Falcon™ 8+ UAV is switched off), please do so very cautiously. If too much force is applied, the gear wheels of the servo motors might break.
- The camera is powered by the Intel® Falcon™ 8+ UAV battery to save weight. When you switch off the system, switch off the camera first and wait for 10 seconds to allow the camera to fully power down and store all images and settings. Only then should you switch off the Intel® Falcon™ 8+ UAV. If you switch off the Intel® Falcon™ 8+ UAV too early, you will cut the power supply of the camera and risk losing data.

- Keep the airplane mode of the camera switched on, to avoid radio interference from the camera (MENU > 📶 > Airplane Mode > ON).

2.5.3.2. *Camera Control By The CTR*

This section describes how the Sony Alpha 7R can be operated by using the functional elements of the CTR.

Figure 2.16: Sony Alpha 7R CTR Control Layout

 ④ ① ③ ⑦ ⑥ ⑤ ② ⑧ intel Intel® Cockpit START RETURN TO HOME POWER	**Push Button B1** (1): sets the camera to predefined angles +/-90°, +/-45° and 0° when **Rocker Switch R1** (4) is pushed **Push Button B2** (2): changes the function depending on the connected payload **Push Button B3** (3): trigger button **Rocker Switch R1** (4): camera tilt; Dial 1 or Dial 2, depending on B2 **Rocker Switch R2** (5): camera tilt; Dial 1 or Dial 2, depending on B2 **Control Stick S2** (6): turning the right control stick (**S2**) controls the yaw axis of the UAV **Status Display** (7): see “Camera Options By The Status Display” on page 38 **ESC, LEFT, RIGHT, ENT** (8): Status Display control buttons (see “Status Display” on page 26).
	The Sony Alpha 7R has two main function dials that can be controlled by the CTR. The function of Dial 1 on the Sony A7R can be controlled by **R2**, when **B2** is in position 1 (LED off). The function of Dial 2 can be controlled by **R2**, when **B2** is in position 2 (LED on/blue) or via the Status Display by pushing **ENT** > `Camera Options > Dial 2`. The default functions of Dial 1 and 2 depend on the selected shooting mode on the camera. The table below shows the dependencies.

2.5.3.3. *Camera Options By The Status Display*

Table 2.2: Sony Alpha 7R Camera Control By Camera Functions

B2 POSITION	R2 FUNCTION	CAMERA SET TO S MODE (SHUTTER PRIORITY)	CAMERA SET TO A MODE (APERTURE PRIORITY)	CAMERA SET TO M MODE (MANUAL)
1 (LED off)	Dial 1	Shutter speed	Aperture	Aperture
2 (LED on/ blue)	Dial 2	Exposure compensation	Exposure compensation	Shutter speed

Push the **ENT** button of the Status Display to enter the menu. Navigate to `Camera Options`. The following options are available for the Sony Alpha 7R.

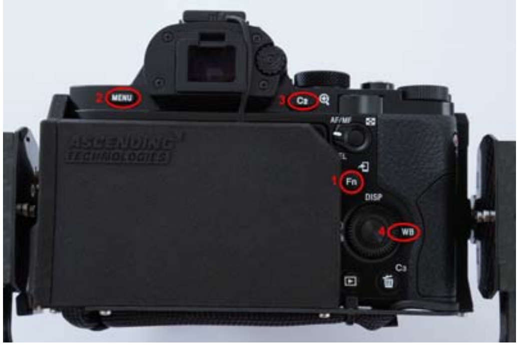
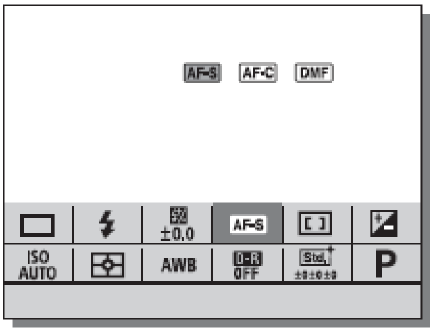
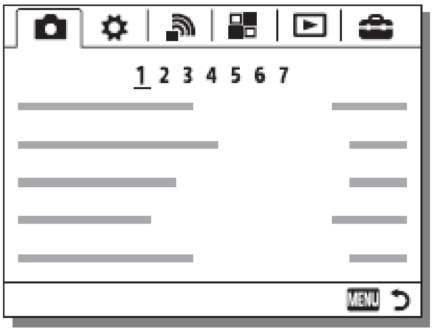
Table 2.3: Sony Alpha 7R Camera Control By Status Display

THE FOLLOWING OPTIONS ARE AVAILABLE FOR THE SONY ALPHA 7R.	
`Record/Stop`	Starts and stops a video recording
`Dial 2`	See previous table for details.
`Review`	Reviews images already stored on the SD card of the camera. Use **Rocker Switch R2** (no. 5 in figure above) to navigate.
`Adjust Horizon`	Occasionally the neutral position of the Gimbal's Servo Motors might need to be re-adjusted. Use this command to adjust the horizon (roll angle) while flying. If the system is still on the ground and the motors are not running this can also be done in both axes (roll and tilt) with the control sticks. see “Adjusting The Camera Horizon” on page 35.
`Roll Comp. On/Off`	Default = ON. When Roll Comp. = Off the gimbal will no longer compensate roll movements of the Intel® Falcon™ 8+ UAV. This can be useful when doing dynamic video flights.

2.5.3.4. *Camera Settings*

The following section describes the most important settings of the camera when used with the Intel® Falcon™ 8+ UAV.

Figure 2.17: Camera Settings By Camera Sony Alpha 7R

 2 MENU 3 C2 1 Fn 4 WB AF/MF DISP ASCENDING TECHNOLOGIES	The most important settings can be quickly accessed via the buttons: (1) Fn: see below (2) MENU: see below (3) C2: provides quick access to the Focus Mode (4) WB: provides quick access to White Balance. ISO can be quickly accessed by turning the control wheel in the back of the camera.
 AF-S AF-C DMF ±0.0 AF-S ISO AUTO AWB D-R OFF Std. P	After pushing the Fn button (number (1) above) by default the following parameters can be accessed: Top row: Drive Mode / Flash Mode / Flash Comp. / Focus Mode / Focus Area / Exposure Comp. Bottom row: ISO / Metering Mode / White Balance / DRO/Auto HDR / Creative Style / Shoot Mode
 1 2 3 4 5 6 7 MENU	The camera menu can be accessed by pushing the MENU button (number (2) above). On the first page of the menu, the Image Size and Quality can be set. Refer to the camera manual for further details.

2.5.4. Inspection Payload

The Inspection Payload consists of two cameras: Panasonic RGB camera and infrared (IR) camera FLIR TAU 2 640.

- Weight of the complete payload including gimbal: 550 g
- Approximate maximum flight time: approximately 18 minutes

Figure 2.18: Inspection Payload

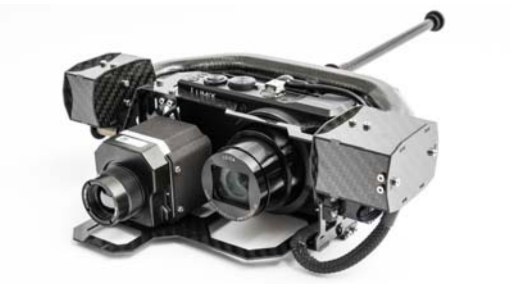
	Specifications of the Panasonic RGB camera: • Sensor size: CMOS Sensor 1/2.3”, 6.2 x 4.6 mm • Resolution: 12.1 Mpx (4000 x 3000 pixel) • Lens: LEICA DC VARIO-ELMAR F3,3 - 6,4 / Multistage Iris Diaphragma (F3,3 - 8,0 (W), F6,4 - 8,0 (T)) • Focal length: 4.3 - 129 mm (24 - 720 mm, 35 mm equiv.) • Optical zoom: 30x • Suggested applications: Inspection Depending on the model of Panasonic camera, you find further information here: TZ71: https://www.panasonic.eu/downloads/de_DE/popup.html ZS50: ftp://ftp.panasonic.com/camera/om/dmc-zs50_adv_om.pdf Please note that the WiFi functionality of these cameras is disabled for the use with the Intel® Falcon™ 8+ UAV. Specifications of the IR camera FLIR Tau 2 640: • Thermal Imager: Uncooled VOx Microbolometer • Resolution: 640 × 512 pixel • Pixel pitch: 17 µm • Spectral band: 7.5 - 13.5 µm • Focal length: 19 mm (~ 59 mm, 35 mm eqiv.) Further details: http://www.flir.com/cores/display/?id=54717

Figure 2.18: Inspection Payload (Continued)

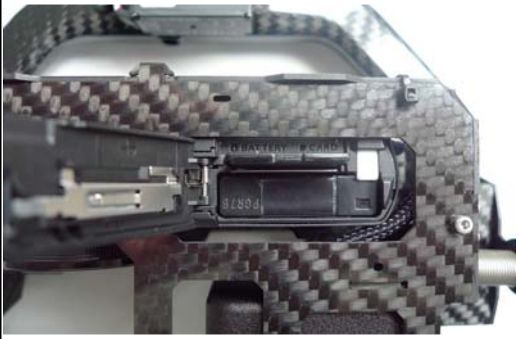
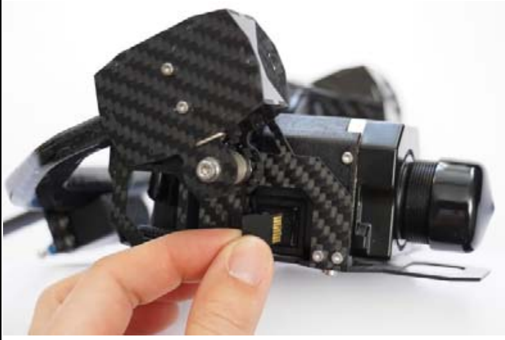
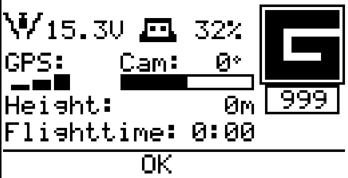
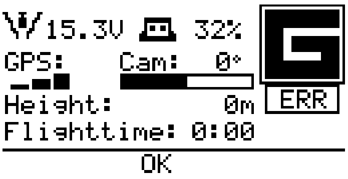
	The Panasonic camera needs its own fully charged battery to work. The battery slot can be accessed from the bottom of the payload. The SD card of the camera is inserted next to the battery. A separate charger for the Panasonic batteries is supplied with the payload.
	The FLIR Tau 2 640 camera is powered by the Intel® Falcon™ 8+ UAV battery to save weight, and does not need to be switched ON or OFF. The micro SD card of the FLIR Tau is inserted at the side of the camera, with the contacts of the micro SD facing towards the camera lens. Each time the Intel® Falcon™ 8+ UAV is switched on, a new, subsequently numbered sub-folder (FLIR0000, FLIR0001, FLIR0002...) is created on the micro SD card. Up to 128 image files are stored in one folder. If more than 128 images are taken during one flight, a new sub-folder will be created where the additional images are stored. Before the camera can be used, the black cap must be removed from the lens. The images are stored in a proprietary file format .ARA. The 14-bit RAW output from the camera is captured, which allows the displayed temperature range to be set during post processing. Using Thermal Editor (part of AscTec Navigator), the RAW images can be displayed and converted into a FLIR Tools-compatible Radiometric JPEG file. AscTec Navigator Software can be downloaded from the download area: http://intel.com/FalconDownloads A detailed manual of the software is available here: http://intel.com/FalconManual

Figure 2.18: Inspection Payload (Continued)

 15.3V 32% GPS: Cam: 0° Height: 0m Flighttime: 0:00 OK 999	When an Inspection Payload is attached, the number 999 will appear underneath the flight mode icon of the menu on the Status Display. This number signifies the number of images which can be stored onto the Micro SD card of the FLIR Tau 2 640. The maximum number that can be displayed on the screen is 999, however, the actual number of images the SD card can store is higher than 999. Therefore, the displayed number will not count down until the SD Card has a capacity of less then 999 images.
 15.3V 32% GPS: Cam: 0° Height: 0m Flighttime: 0:00 OK ERR	When the FLIR Tau 2 640 IR Raw Data Logger cannot access the SD card, an error message ERR will be displayed instead of the number of remaining images. In case this happens, please take out the SD card and troubleshoot. If after reinserting, if the error message remains, reformat the SD card. Format settings are: • File system: FAT32 • Allocation unit size: 64 kilobytes • Volume label: FLIRSD

> *Note* *The FLIR and the Panasonic RGB camera can record video. When a video actively recording on the Panasonic RGB camera, the camera will not output any preview video. This means that the preview video on the touchscreen tablet of the CTR must be switched to show the FLIR image (see "Inspection Payload Control By The CTR" on page 43).*

2.5.4.1. General Care

- Always handle the gimbal with care. If you need to tilt the camera manually (when not connected or while the Intel® Falcon™ 8+ UAV is switched off), please do so very cautiously. If too much force is applied, the gear wheels of the servo motors might break.
- Keep the airplane mode of the camera switched on, to avoid radio interference from the camera (MENU > Setup > Page 2 > Airplane Mode > ON).

2.5.4.2. Inspection Payload Control By The CTR

The following figure describes in detail how the Inspection Payload can be controlled by the functional elements of the CTR.

Figure 2.19: Inspection Payload: CTR Control Layout

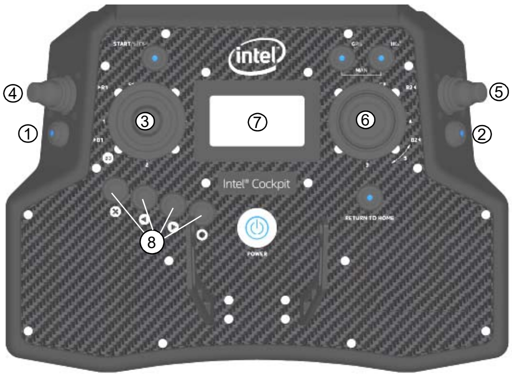
<table>
<tr><td colspan="2">FLIR Tau 2 640 performs flat field correction (FFC). The FLIR automatically performs a FCC every 10 seconds (for more information about the FFC please read: http://www.flir.com/cvs/cores/knowledgebase/index.cfm?CFTREEITEMKEY=327&view=35774</td></tr>
<tr><td>
</td><td>Push Button B1 (1): sets the camera to predefined angles +/-90°, +/-45° and 0°
Push Button B2 (2): Switches between the cameras for live preview (FLIR and Panasonic)
Push Button B3 (3): Trigger button. Both cameras will be triggered simultaneously, regardless of which camera is selected for the live preview.
Rocker Switch R1 (4): camera tilt
Rocker Switch R2 (5): Changes its function depending which camera is selected for live preview. See the table below for details.
Control Stick S2 (6): turning the right control stick (S2) controls the yaw axis of the UAV
Status Display (7): see “Inspection Payload Control By The Status Display” on page 44.
ESC, LEFT, RIGHT, ENT (8): Status Display control buttons. (see “Status Display” on page 26). The table below shows the available parameters depending on the shooting mode of the camera.</td></tr>
</table>

Table 2.4: Inspection Payload: CTR Control Layout

B2 POSITION	ACTIVATED CAMERA	R2 FUNCTION	
1 (LED off)	Panasonic camera	Zoom in/out	Parameters like shutter speed, aperture and ISO need to be set directly on the camera before take-off.
2 (LED on/ red)	FLIR	Up - Trigger flat field correction Down - Cycle through color palette	Parameters like isotherms and AGC (Automatic Gate Control) need to be set via configuration file on the FLIR SD card before take-off.

2.5.4.3. Inspection Payload Control By The Status Display

Push the **ENT** button of the Status Display to enter the menu. Navigate to `Camera Options`. The following options are available for the Inspection Payload:

Table 2.5: Inspection Payload Control By Status Display

THE FOLLOWING OPTIONS ARE AVAILABLE FOR THE INSPECTION PAYLOAD:	
`Switch Camera`	Switches the live image preview on the touchscreen between the FLIR Tau 2 640 and the Panasonic Lumix camera.
`Adjust Horizon`	Occasionally the neutral position of the gimbal's servo motors might need to be re-adjusted. Use this command to adjust the horizon (roll angle) while flying. If the system is still on the ground and the motors are not running this can also be done in both axes (roll and tilt) with the control sticks, see “Adjusting The Camera Horizon” on page 35.
`Roll Comp. On/Off`	Default = ON. When `Roll Comp.` = Off, the gimbal will no longer compensate roll movements of the Intel® Falcon™ 8+ UAV. This can be useful when doing dynamic video flights.

Notes *Shooting parameters need to be set directly on the camera before take-off.*

Additional cameras may be available. Please check http://intel.com/FalconManual for an updated version of the manual.

2.6. THE INTEL® POWERPACK BATTERIES

The Intel® Powerpack batteries power the Intel® Falcon™ 8+ UAV and the Intel® Cockpit Controller (CTR). The battery features a One-Button/Five-LEDs user interface, an intelligent Battery Management System (BMS), automatic balancing, storage mode and charging. It provides direct access to general information of the battery; for example, the remaining battery life, which is shown by the five LEDs (see “Operating The BMS Menu” on page 48).

The BMS safely monitors the status of each of the four cells of the battery to ensure a safe charging process. Its cell balancing technology assures the consistency in the performance of the batteries.

The following sections give you information about the Intel® Powerpack batteries you need for the Intel® Falcon™ 8+ UAV and the CTR.

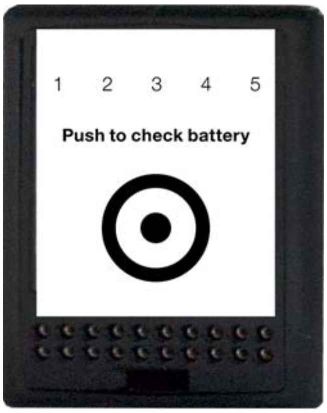
For charging an Intel® Powerpack Battery you need one of the deliverable power supply units.

Table 2.6: Technical Specifications of the Battery

BATTERY TYPES	ELECTRIC CHARGE [MAH]	VOLTAGE STANDARD [V]	VOLTAGE FULLY CHARGED [V]	VOLTAGE LOWEST RECOMMENDED (UNDER LOAD) [V]	NO. OF CELLS
Intel® Powerpack™ Battery	4000	14.8	16.8	14.0	4

On the front panel of the battery there is a sticker. An area is marked by a dot surrounded by a circle (see next figure The Intel® Powerpack Battery. This area has the function of a button.

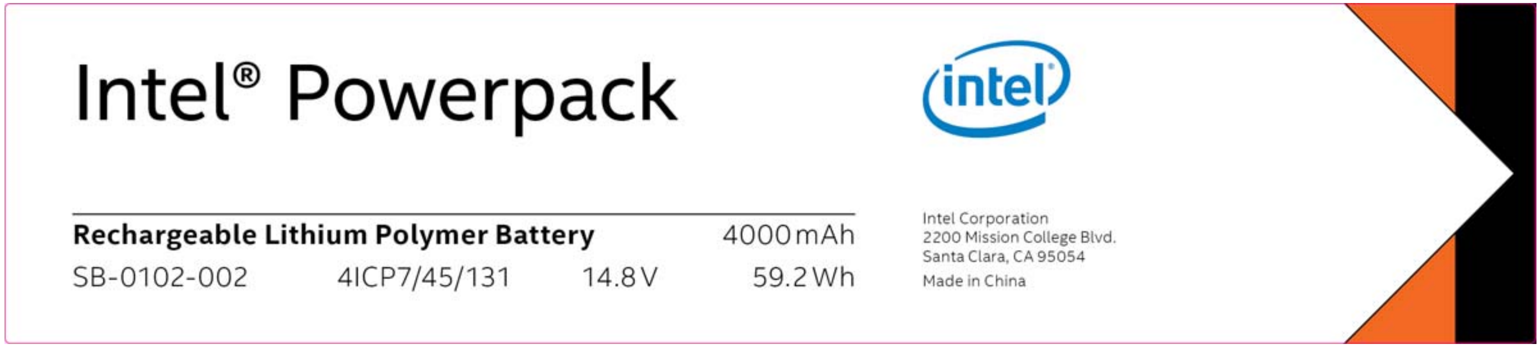
Figure 2.20: LED Description

	Led Description The LEDs are integrated in the front panel of the battery. LED number / color from left to right: • 1 / red • 2 / yellow • 3 / green • 4 / green • 5 / green

Please note the limitations mentioned on the labels of the Intel® Powerpack Battery.

Figure 2.21: The Intel® Powerpack Battery

The front of the Intel Powerpack battery



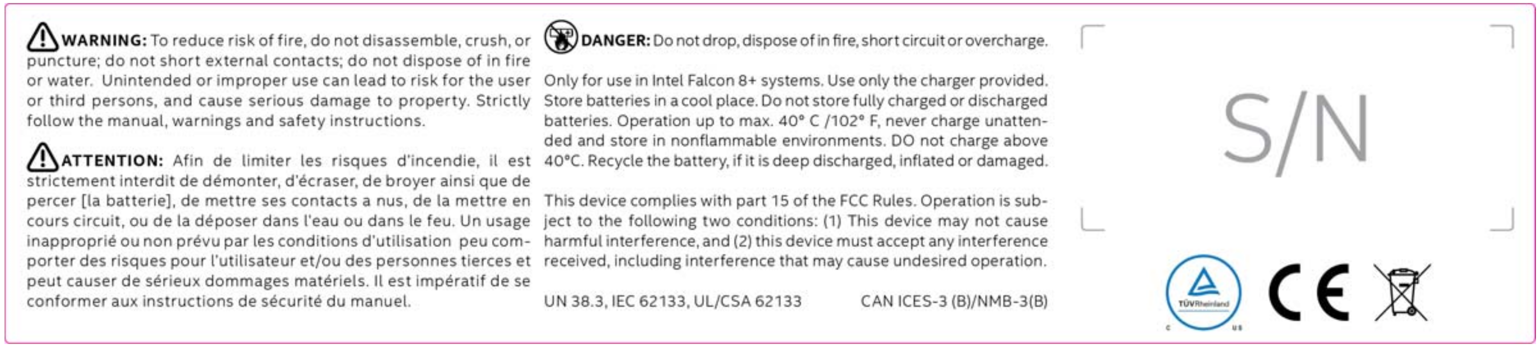
Intel® Powerpack

Rechargeable Lithium Polymer Battery 4000 mAh

SB-0102-002 4ICP7/45/131 14.8 V 59.2 Wh

Intel Corporation
2200 Mission College Blvd.
Santa Clara, CA 95054
Made in China

The back of the Intel Powerpack battery



⚠ **WARNING:** To reduce risk of fire, do not disassemble, crush, or puncture; do not short external contacts; do not dispose of in fire or water. Unintended or improper use can lead to risk for the user or third persons, and cause serious damage to property. Strictly follow the manual, warnings and safety instructions.

⚠ **ATTENTION:** Afin de limiter les risques d'incendie, il est strictement interdit de démonter, d'écraser, de broyer ainsi que de percer [la batterie], de mettre ses contacts a nus, de la mettre en cours circuit, ou de la déposer dans l'eau ou dans le feu. Un usage inapproprié ou non prévu par les conditions d'utilisation peu comporter des risques pour l'utilisateur et/ou des personnes tierces et peut causer de sérieux dommages matériels. Il est impératif de se conformer aux instructions de sécurité du manuel.

DANGER: Do not drop, dispose of in fire, short circuit or overcharge.

Only for use in Intel Falcon 8+ systems. Use only the charger provided. Store batteries in a cool place. Do not store fully charged or discharged batteries. Operation up to max. 40° C /102° F, never charge unattended and store in nonflammable environments. DO not charge above 40°C. Recycle the battery, if it is deep discharged, inflated or damaged.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

UN 38.3, IEC 62133, UL/CSA 62133 CAN ICES-3 (B)/NMB-3(B)

S/N

Even if the battery is not in use, it is possible to get information on the actual charging state by the BMS. One short push (< 2 sec) on the button (shown above) and the battery will show the charging state represented by the respective number of LEDs.

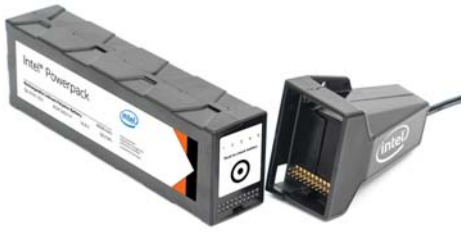
Table 2.7: Charging State

THE LEDS SHOW THE STATE / PHASE OF CHARGE OF THE BATTERY.	
STATUS OF LED NO. 1 2 3 4 5	CHARGING STATE
ON OFF OFF OFF OFF	0% - 20%
ON ON OFF OFF OFF	20% - 40%
ON ON ON OFF OFF	40% - 60%
ON ON ON ON OFF	60% - 80%
ON ON ON ON ON	80% - 100%

2.6.1. Charging the Intel® Powerpack Batteries

Upon receipt of new Intel® Powerpack Batteries, you should charge them to 60 - 80% to ensure batteries will not completely drain in storage. To charge the batteries, please use the provided power supply unit.

Figure 2.22: Charging



To charge the Intel® Powerpack:

1. Connect the Intel® Powerpack Battery to the adapter of the power supply unit.
2. Connect the power supply unit to a wall socket.

Charging will begin immediately indicated by flashing LEDs.

During the charging process (defined as when the battery is connected to the power supply unit and the power supply unit is connected to a wall outlet 100 V - 240 V AC 50 Hz - 60 Hz) the actual battery state and the progress of the charging process is automatically shown by the LEDs.

As displayed in the table above, the number of permanently lighted LEDs shows the actual progress of charging. Additionally, the next higher LED is flashing. This means that this charging step is not yet finished.

When the charging process is finished and the battery is at full capacity, all five LEDs will continue flashing simultaneously.
When charging is finished, unplug the battery and the AC adapter.

2.6.2. Operating The BMS Menu

For further information about the battery you can activate the BMS menu. The battery does not need to be connected to the power supply unit to activate the BMS menu.

To activate the menu:

1. Push/hold down the button (> 2 sec). When the first LED (no. 1, red) is flashing, the first menu option can be activated by another long push (> 2 sec) on the button.
2. Every further short push (< 2 sec) on the button navigates to the next menu option which can be activated by another long push (> 2 sec) on the button, indicated by the flashing of the respective LED.

If there is no user input, the LED menu will close after 33 seconds.

The five menu options are the following:

Menu Option 1, Charging State

When LED 1 is flashing, menu option 1 can be activated. When activated the LEDs show the state of charge of the battery (see “Charging State” on page 47). After showing the state of charge of the battery for 8 seconds, the menu is closed automatically (all LEDs off).

Menu Option 2, Storage Mode

When LED 2 is flashing, Menu Option 2 can be activated. When you select this option by pushing/holding down the button for more than 2 seconds, the battery Storage Mode is activated. When this mode is activated, all but one LEDs are on. The off-LED moves from right to left.

In the Storage Mode, the BMS automatically balances the battery down to 3.8V / Cell (= 15.2 V per battery). The battery Storage Mode can be deactivated by pushing the battery button for more than 2 seconds.

We recommend using this mode when you have fully charged the battery (80-100%), but plan to store the battery for 2 days or longer.

Since there is only a small resistive load, it will take a very long time to discharge full batteries to the storage voltage. To facilitate discharge, use fully charged batteries in the Intel® Cockpit Controller or Intel® Falcon™ 8+ UAV before they are stored.

Menu Option 3, Charging Cycles

When LED 3 is flashing, menu option 3 can be activated. The LEDs show the current battery charging cycles, i.e. how often the battery was charged.

The total number of charging cycles of the battery is shown by the LEDs in a binary system by powers of 2 from right to left multiplied by 10.

Table 2.8: Charging Cycles

THE LEDS SHOW THE TOTAL NUMBER OF CHARGING CYCLES OF THE BATTERY FROM RIGHT TO LEFT BEGINNING WITH LED 5 (GREEN) = 20, THIS NUMBER SHOULD BE MULTIPLIED BY 10	
STATUS OF LED NO. 1 2 3 4 5 (EXAMPLES)	**CHARGING STATE**
OFF OFF OFF OFF **ON**	20 = 1 X 10 ≙ 0 - 10
OFF OFF OFF **ON** OFF	21 = 2 X 10 ≙ 11 - 20
OFF OFF OFF **ON** **ON**	20 + 21 = 3 X 10 ≙ 21 - 30
OFF OFF **ON** OFF **ON**	20 + 22 = 5 X 10 ≙ 41 - 50
OFF **ON** **ON** **ON** **ON**	20 + 21 + 22 + 23 = 15 X 10 ≙ 141 - 150

Menu Option 4, Overall Capacity

Menu option 4 shows the current possible amount of charge the battery may hold when fully charged (as a percentage) compared to the factory battery capacity.

Table 2.9: Battery Capacity

THE LEDS SHOW THE CURRENT POSSIBLE BATTERY CAPACITY AS PERCENTAGE COMPARED TO THE FACTORY BATTERY CAPACITY	
STATUS OF LED NO. 1 2 3 4 5	**REMAINING CAPACITY**
ON OFF OFF OFF OFF	51% - 60%
ON **ON** OFF OFF OFF	61% - 70%
ON **ON** **ON** OFF OFF	71% - 80%
ON **ON** **ON** **ON** OFF	81% - 90%
ON ON ON ON ON	> 90%

Menu Option 5, Battery Status

Menu option 5 shows the difference (as a percentage) between the highest measured cell voltage and the lowest measured cell voltage, measured at the same time.

The BMS tries to balance the charging status of all 4 battery cells to the same level. By measuring the difference between the highest cell voltage and the lowest cell voltage, the actual battery status is determined. This status can be shown by activating menu 5.

Table 2.10: Battery Status

THE LEDS SHOW THE STATUS OF THE BATTERY		
STATUS OF LED NO. 1 2 3 4 5	**VOLTAGE DIFFERENCE**	**MEANING**
OFF OFF OFF OFF OFF	<= 5%	Best, the battery can be used
ON OFF OFF OFF OFF	> 5%	Still everything fine
ON ON OFF OFF OFF	> 10%	Battery still usable
ON ON ON OFF OFF	> 15%	Bad, think about changing the battery
ON ON ON ON OFF	> 20%	Very bad (the battery might still be used in the CTR)
ON ON ON ON ON	> 25%	Worst (e.g. 3.8 V on the highest and 2,85 V on the lowest cell, measured at the same time), the use of the battery is no longer possible

To get a comparable result, this battery status check is done best directly after use/ flight.

BMS Error Mode

If during the charging process the LEDs are lit alternatively LED2 and LED4 ON with LED3 ON, the charging process is interrupted for one of the following reasons:

- The battery cells are too hot or too cold
- Charge Control Circuitry too hot

The charging process will resume automatically once the temperature of the cells is normalized.

When the battery shows LED1 ON and LED5 ON alternating with LED2 and LED4 ON, the battery was operated out of specifications (e. g. too hot during discharge).

When a battery shows this behavior, it can still be used to discharge its remaining capacity, but it must not be used anymore.

When you have a battery showing this error mode, push the battery button once. As a result, a few LEDs will be lit. Please either take a photo of the lit LEDs or note which ones are lit (no. 1 is the LED most left, no. 5 is the LED most right). Contact the support team at Intel and provide the information which LEDs are lit. In case this state became active during a flight, please also provide a log file of this flight.

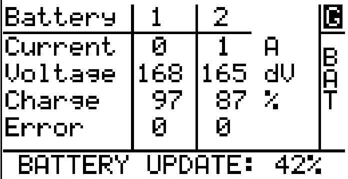
If you see any other behavior of the LEDs contact Intel Support.

2.6.3. Battery Update

The firmware version of the BMS is automatically managed by the firmware of the UAV. As soon as a battery is inserted into the UAV and used, the firmware version of the battery is checked. If the firmware version of the BMS on the battery is older than the one currently installed on the UAV, it will be noted and the battery will be updated automatically by the UAV.

During this process, which takes less than a minute, a message is shown in the status line at the bottom of the Status Display (see “STATUS DISPLAY” on page 136) and it is not possible to start the UAV.

Figure 2.23: Battery Update



```
Battery | 1 | 2      |G
Current |  0|  1  A  |B
Voltage |168|165 dV  |A
Charge  | 97| 87 %   |T
Error   |  0|  0     |
 BATTERY UPDATE: 42%
```

The progress of the battery update process is shown in percent in the status line at the bottom of the Status Display. It can take up to maximum 1 minute.
During this period it is not possible to start the UAV.

2.6.4. Battery Information Safety Instructions And Warnings

⚠ **CAUTION: PLEASE READ THE FOLLOWING SAFETY INSTRUCTIONS AND WARNINGS CAREFULLY BEFORE CHARGING OR USING THE BATTERIES!**

INTEL CANNOT ASSUME ANY LIABILITY FOR FAILURES TO COMPLY WITH THESE WARNINGS AND SAFETY GUIDELINES.

- Lithium Polymer (LiPo) batteries do not have any memory effect. Never fully discharge LiPo batteries, as it will permanently damage the batteries.
- Do not store batteries fully charged. It will lead to a shorter life span of the battery. Use the BMS battery Storage Mode for long-term storing (> 2 days) (See Operating The BMS Menu, “Menu Option 2, Storage Mode” on page 48.
- LiPo batteries are volatile. Failure to read and follow the below instructions may result in fire, personal injury and damage to property if charged or used improperly.
- The battery charging/discharging and storage area should be free from any materials which can catch fire such as: wood tables, carpet, or gasoline containers. The ideal surface for charging and storing LiPo batteries is metal, concrete or ceramic.
- Extinguishing Media: Water, CO2.

- Special Fire-Fighting Procedures: Self-contained breathing apparatus.
- Unusual Fire and Explosion Hazards: Cell may vent when subjected to excessive heat-exposing battery contents.
- Hazardous Combustion Products: Carbon monoxide, carbon dioxide, lithium oxide fumes.
- By purchasing this battery, the customer assumes all risks associated with lithium batteries. If you do not agree with these conditions, return the battery immediately before use.

General Guidelines and Warnings

- It is crucial that all cells in a LiPo battery maintain the same voltage across all cells at all times.
- Never charge batteries unattended. When charging LiPo batteries, you should always remain nearby to monitor the charging process and react to potential problems that may occur.
- Never continue to charge LiPo batteries if the battery LEDs fail to recognize full charge. Overheating of the LiPo cells indicates a problem. In the event of overheating, the battery should be immediately disconnected from the power supply and placed in a fireproof location.
- Since delayed chemical reaction can occur, it is best to monitor the battery as a safety precaution. Battery monitoring should occur in a safe area outside of any building or vehicle, and away from any combustible material. Always charge LiPo batteries in a fireproof location.
- A battery can ignite even after the charging process has been completed.
- In the event of a crash, you must remove the battery for observation and place it in a safe open area away from any combustible material for an appropriate period.
- Never store or charge a battery inside of your car in extreme temperatures, since extreme temperature could cause a fire.

Charging

- Before charging, visually inspect the battery. Look for any damaged connectors or other irregularities. Do not use it if you find any of the above issues with your battery.
- If any damage to the battery is found or if the voltage is significantly less for your battery than what is specified below, do not attempt to charge or fly with the battery; contact your supplier.

- You may witness a battery starting to balloon or swell up. This may lead to a deformed housing where the battery no longer fits into the UAV battery compartment. If you notice such a deformation, do not start charging this battery. If you already started charging, discontinue the charging process immediately. Disconnect the battery and observe it in a safe place for an appropriate period. Continuing to charge a battery that has begun to swell will result in fire. Never use a battery if you find it swollen or ballooned.
- Never charge batteries unattended.
- Charge in an isolated area, away from flammable materials. Use deliverable LiPo-safe bags or a non-flammable case for charging.
- Let the battery cool down to ambient temperature before charging.

Discharging

Do not discharge a battery to a level below 3.5 V per cell. Deep discharging a battery cell below 3.5 V can reduce battery performance or even destroy the battery.

Storage & Transportation

Preparing for storage: The battery is delivered with less than 30% charge, being in compliance with regulations which allow Li-Po batteries to ship over air. The battery slowly unloads itself using internal circuitry. Therefore, it is important to charge batteries, and periodically check batteries charge level to avoid deep discharge. However, storing a fully charged battery has negative effects on its life span. Therefore Intel recommends charging batteries periodically when in storage (see following table).

Table 2.11: Battery Storage/Charging Maintenance Recommendation

INTEND TO AIR TRANSPORT BATTERIES?	BATTERY % STORAGE RECOMMENDATION	CHECK/RECHARGE
Yes / Unsure	20-40% (LED 1 and 2 lit)	2 months or earlier
No	60-80% (LED 1, 2, 3, 4 lit)	5 months or earlier

- Whenever possible, store the batteries in the Storage Mode (see Operating The BMS Menu, “Menu Option 2, Storage Mode” on page 48) and only completely charge them immediately before the next flight.
- For transporting and storing the batteries, use LiPo-safe bags or cases.
- Always store batteries within the specified temperature ranges. “TECHNICAL SPECIFICATION” on page 176 for further details.
- Do not expose batteries to direct sunlight or heat for extended periods.

- Never leave the LiPo batteries with a full charge for more than 2 - 3 days. For longer intermissions, you need to activate the Battery Storage Mode (see Operating The BMS Menu, “Menu Option 2, Storage Mode” on page 48) for safe storage until you are ready to use the battery again. Recharge the batteries right before the next mission.

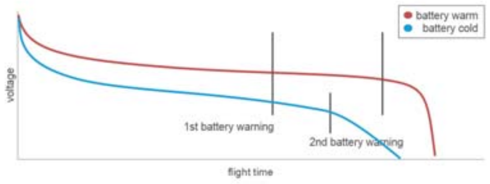
Caring for Batteries

- Please check the battery voltage after charging. It is shown on the **Main Screen** of the Status display and by the LEDs of the battery.
- The voltage for a 4-cell battery should fall between 16.4 V – 16.8 V.
- Do not discharge batteries to a level below 14 V. Deep discharge below 14 V will deteriorate the battery performance.
- Never puncture the battery cells. Punctured cells may cause fire.

Operating Temperatures

Refer to “TECHNICAL SPECIFICATION” on page 176 for details regarding operating temperatures.

Figure 2.24: Temperature Depending LiPo Battery Capacity

	The capacity of LiPo batteries drops dramatically if the temperature is below 5° C. Please keep the batteries warm when flying in cold conditions or heat them up before flying to approximately 30° C.

Battery Life

Batteries that have lost 20% of their capacity (see Operating The BMS Menu, “Menu Option 5, Battery Status” on page 49) must be removed from service and disposed of properly.

Disposal

For proper treatment, recovery and recycling, please take these products to designated collection points where they will be accepted on a free of charge basis. Alternatively, send the battery for disposal back to Intel. Disposing of this product correctly will help to save valuable resources, and prevent any potential negative effects on human health and the environment, which could otherwise arise from inappropriate waste handling. For disposal, please discharge the battery to 3V or below per cell, then wrap the battery in a bag for disposal.

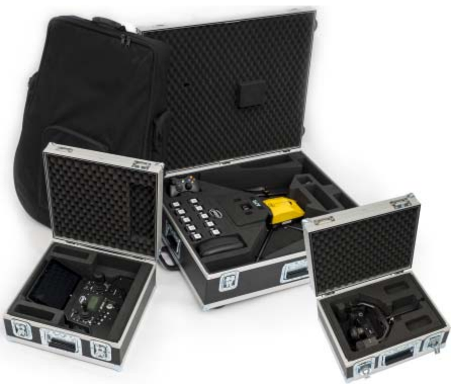
Product Warranty

Product warranty is limited to original defects in material and workmanship. Warranty does not cover collateral damage. Due to the nature and use of this product there is no long-term warranty. Misuse, abuse, incorrect charging, failure to comply with the above warnings and guidelines, and other inappropriate use of this product are not covered under warranty.

2.7. TRANSPORT CASES & INTEL® BACKPACK

The transport set consists of different cases with precision water jet cut inlays designed for the Intel® Falcon™ 8+ UAS with all its accessories. For easy one-person transportation, the Intel® Falcon™ 8+ UAS cases have retractable handles and wheels. The Intel® Backpack is not safe for air freighting, but very useful for missions in remote areas, since it is light and relatively compact.

Figure 2.25: Transport Cases & Backpack

	The transport cases offer great advantages: • Thanks to fold-able handles and wheels, they can be easily transported by one person. • The foam bolster inlay of the payload case can be used as load security for the payload when the UAV is transported with mounted payload in the Intel® Falcon™ 8+ UAV case. If transported by plane - please follow the prescribed guidelines from the air freight carrier.

⚠ **CAUTION: THE INTEL® FALCON™ 8+ UAV AND THE INTEL® COCKPIT CONTROLLER (CTR) MUST BE TRANSPORTED FULLY ASSEMBLED. FOR SECURE TRANSPORTATION WE RECOMMEND USING THE SUPPLIED CASES.**

2.7.1. Packing Instructions

To ensure a safe and optimal transport of your flight system, please see the images below for the right boxing.

> ⚠ **CAUTION: WHEN SHIPPING THE INTEL® FALCON™ 8+ UAV IN THE TRANSPORT CASE WITH A MOUNTED PAYLOAD, YOU MUST USE THE FOAM INLET OF THE PAYLOAD CASE TO AVOID DAMAGES DURING TRANSPORT OR YOU MUST TRANSPORT IT IN THE SPECIAL PAYLOAD CASE (SEE FOLLOWING).**

Figure 2.26: Packing Instructions for the Intel® Falcon™ 8+ UAS Cases

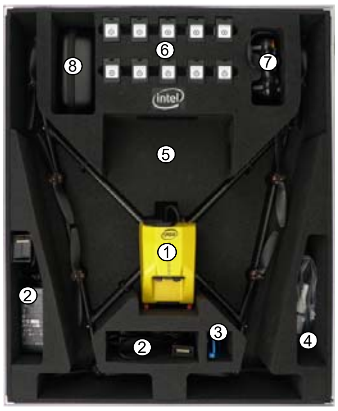
 	**Intel® Falcon™ 8+ System Case** This case is used for all necessary parts of your Intel® Falcon™ 8+ UAV. Following the numbers, the slots contains: 1. Intel® Falcon™ 8+ UAV without payload 2. Power supply units for charging the Intel® Powerpack batteries (6) 3. Space for accessories, e.g. sunglasses 4. Toolkit with spare propellers (see below) 5. Space for the payload when mounted directly on the UAV. For load security, you must take the foam bolster inlet supplied with the payload case. 6. Space for the Intel® Powerpack batteries (optional, shipped separately) 7. ICC gamepad (optional) 8. Space for extra equipment, if any, that is not part of the System, e.g. reflective safety vest or video goggles

Figure 2.26: Packing Instructions for the Intel® Falcon™ 8+ UAS Cases (Continued)

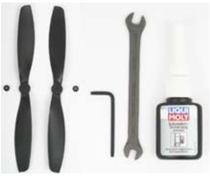
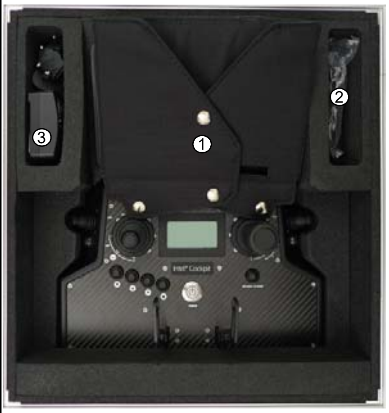
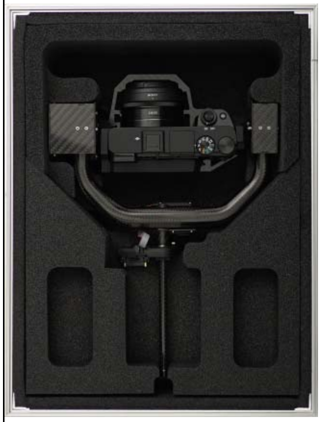
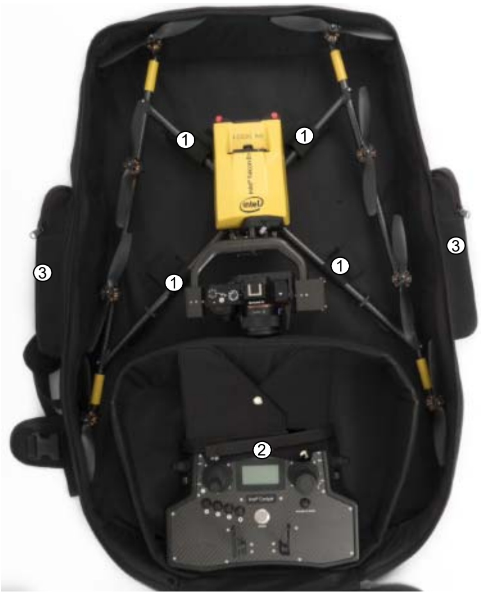
	Toolkit and spare parts
	**Intel® Cockpit Controller (CTR) Case** This case contains: CTR with mounted sun shield 1. When transporting the CTR in the case, the sunshield must be arranged like shown to provide extra protection of the touchscreen tablet against scratches during transportation. 2. Additional space 3. Additional space e.g. for an extra power supply Included in the case but not shown: Shoulder harness is underneath the sun shield protected touchscreen tablet.
	**Payload Case** The payload of the Intel® Falcon™ 8+ UAS must be placed as shown on this image. Make sure that it is placed conveniently inside of the foam bolster. The foam bolster cover (not shown) on top of the payload should be used to secure the payload when it is transported mounted on the UAV in the Intel® Falcon™ 8+ UAV case.

Figure 2.26: Packing Instructions for the Intel® Falcon™ 8+ UAS Cases (Continued)



Intel® Backpack

The backpack is the optimal solution to transport the complete UAS over rough terrain or on longer walks.

When placing the UAV into the backpack always align the bottom two propellers (in the image on the top, with the Intel® Falcon™ 8+ UAV facing down) parallel to the top of the backpack like shown in the image. The other propellers are oriented parallel to the motor rails.

1. Use the four big Velcro tapes to secure the Intel® Falcon™ 8+ UAV inside the backpack. They should be very tight so that they “lift” the system up, and away from the CTR.
2. At the bottom part, there is space for the CTR. Before placing it inside of the backpack make sure that the sun shield is arranged as shown in the image to protect the touchscreen tablet and that you secure it with the Velcro tape.
3. On the outside, there are two separate pockets for the Intel® Powerpack batteries.

Another large pocket is located on the lid (not shown in the image). There is enough space for items such as another Intel® Powerpack battery, the power supply unit or a notebook and the shoulder harness.

The images of the items above are just for illustration purpose and the actual item(s) packed with your Intel® Falcon™ 8+ UAS may differ from the one(s) depicted here depending on, for example, which payload you ordered.

2.8. SOFTWARE FEATURE PACKAGES

There are optional software feature packages available for the Intel® Falcon™ 8+ UAS. They offer useful functions for specific applications.

There are two different licensing models for obtaining the software feature packages.

- One option is a perpetual software license that remains on the UAV. The advantage of a perpetual license is that it remains on the UAV forever and can be used with any payload.
- The other option is an annual software license. This is stored on the payload, and the license terminates one year after the activation date if the subscription is not renewed. The advantage of an annual license is that it can be used with one payload on any UAV.

The available software feature packages can be purchased at any time and unlocked remotely by your Intel® Falcon™ 8+ UAS reseller. The Intel® Falcon™ 8+ UAS does not need to be sent back.

- When ordering a perpetual license, please provide the serial number of the UAV, which can be found on top of the central unit and as well via the Status Display (see “Perpetual Software Feature Packages” on page 61).
- When ordering an annual license, please provide the serial number of the payload. (see “Annual Software Feature Packages” on page 61).

Please find detailed instructions on how to unlock software feature packages in Chapter 2.8.1 Activating Software Feature Packages.

Table 2.12: Description Packages

FUNCTIONALITY	DESCRIPTION
	SURVEY PACKAGE
Flight planning	Fly and survey areas fully automated. You can plan complex waypoint missions on your notebook with the flight planning AscTec Navigator Software even before you go out in the field.
Quick survey	This function lets you generate an automated survey flight while in the field (without notebook) within seconds. Set the ground sample distance (GSD), the area to cover, and start the survey flight.
	INSPECTION PACKAGE
WP+P	With the Cockpit Control application, you can create, load, modify and save PATH projects and any related waypoints on the touch screen tablet of the Intel® Cockpit Controller (CTR).

Table 2.12: Description Packages (Continued)

ICC	Independent Camera Control (see “THE INDEPENDENT CAMERA CONTROL (ICC)” on page 27). This function enables a second operator to control the camera via a gamepad, which is connected to the CTR, while the pilot can fully concentrate on flying. Recommended for inspection flights. Usually video goggles are used so that the second operator has an independent video preview.
COI	With the Circle of Interest (COI) it is possible to fly an automated 360° circle around an object and take photos at predefined positions. These photos can later be processed by 3D modeling software such as Agisoft PhotoScan to build a 3D model of the object.

2.8.1. Activating Software Feature Packages

To purchase a software feature package, please contact your local Intel® Falcon™ 8+ UAS reseller. Once you have purchased your software feature package, you will receive an email with your license key file "f8p_license.asc" which is required to activate the software feature packages. It may come from Intel as an email attachment or from your sales representative.

It may be in the form of a ZIP file. Please store this file on your computer, if necessary unzip it and follow the step by step instructions below.

If you have questions regarding software feature packages or need assistance, please contact your sales representative.

1. Take the USB stick from your Intel® Falcon™ 8+ UAV.
2. Plug it into your computer.
3. Format the USB stick (file system: FAT32, allocation unit size: 32 kilobytes).
4. Copy the “f8p_license.asc” file onto the USB stick.
5. Plug the USB stick into the Intel® Falcon™ 8+ UAV.
6. Switch ON the UAV.
7. After the initialization of the Intel® Falcon™ 8+ UAV is complete, wait 10 seconds. Then switch OFF the UAV.
8. Remove the USB stick from the Intel® Falcon™ 8+ UAV.
9. Power on the UAS and check the activated software feature packages as described in “Checking Activated Software Feature Packages” on page 61.
10. Perform a test flight and try one function of every newly unlocked software feature package.
11. Check the **Main Screen** of the Status Display, making sure there are no messages displayed regarding missing packages.

2.8.2. Checking Activated Software Feature Packages

In the following section, you will find the instructions on how to determine which software feature packages are activated on your system.

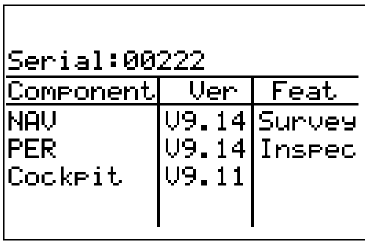
Perpetual Software Feature Packages

To check which perpetual software feature packages are activated on your system, turn ON the Intel® Falcon™ 8+ UAV, the touchscreen tablet and the CTR and confirm the Link Loss Procedure.

1. Push **ENT** to open the menu on the Status Display.
2. Use the arrow **RIGHT** button to navigate to Settings.
3. Push **ENT** to open the Settings menu.
4. Use the arrow **RIGHT** button to navigate to Falcon Info and confirm by pushing **ENT**.

The next screen shows the serial number of the UAV, the installed firmware versions, and the activated perpetual packages.

Figure 2.27: Show Activated Perpetual License



```
Serial:00222
Component| Ver |Feat
NAV      |V9.14|Survey
PER      |V9.14|Inspec
Cockpit  |V9.11|
```

Perpetual licenses:

In the example, there are two perpetual software feature packages activated:

- `Survey` = Survey package
- `Inspec` = Inspection package

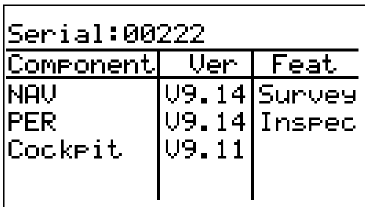
Annual Software Feature Packages

To check which annual software feature packages are activated on your system, turn ON the Intel® Falcon™ 8+ UAV, the touchscreen tablet and the CTR and confirm the Link Loss Procedure.

1. Push **ENT** to open the menu on the Status Display.
2. Use the arrow **RIGHT** button to navigate to `Settings`.
3. Push **ENT** to open the `Settings` menu.
4. Use the arrow **RIGHT** button to navigate to `Payload Info` and confirm by pushing **ENT**.

The next screen shows the serial number of the payload, the type of the camera used, and the activated annual software feature packages with the respective expiration date.

Figure 2.28: Show activated annual license

 Serial:00222 Component Ver Feat NAV V9.14 Survey PER V9.14 Inspec Cockpit V9.11	Annual licenses: In the example, there are two annual software feature packages with the expiration day (Year/Month/Day) activated: • `Inspec` = Inspection package • `Survey` = Survey package Only licenses/packages with an expiration date shown are valid.

2.9. INTEL® FALCON™ 8+ UAV FLIGHT LOGS

The Intel® Falcon™ 8+ UAV is constantly logging all flight controller data onto two different storage devices: an SD card inserted in the back of the Intel® Falcon™ 8+ UAV (User SD card) and an internal SD card, which can only be accessed by opening the canopy of the central unit (Internal SD card).

The data logged onto the different devices may differ, which is why in support cases we ask you to please always send logs from the User SD card. In rare occasions, we might also ask for the logs from the Internal SD card. In such a case, we will provide detailed instructions on how to access the Internal SD card.

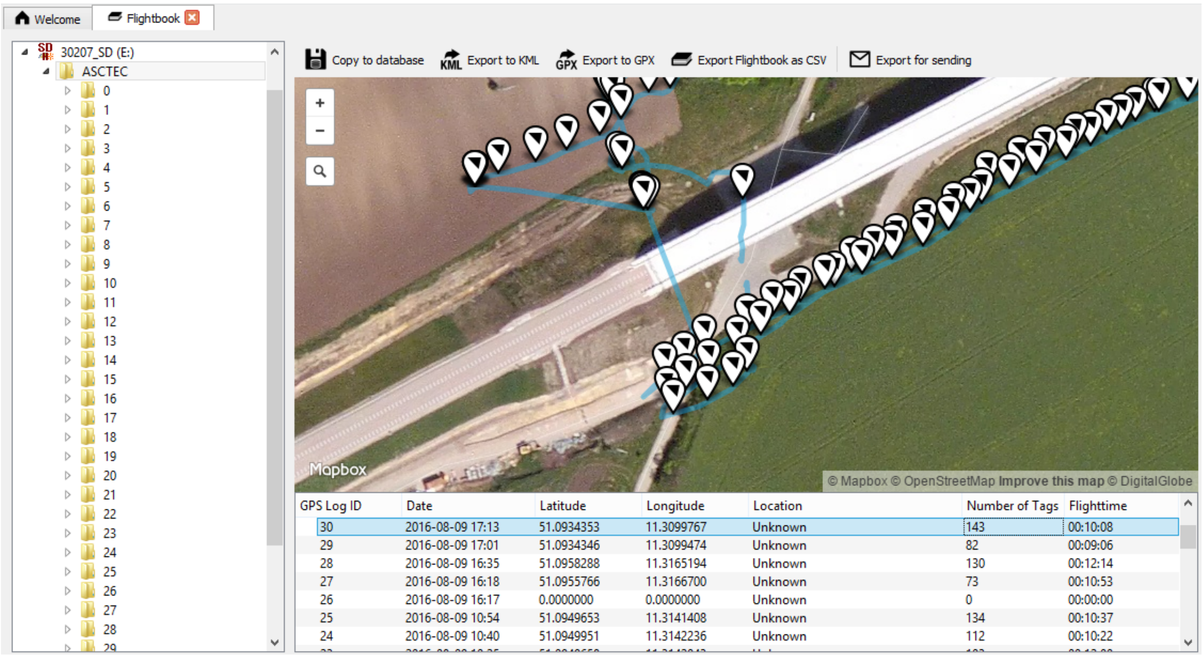
The file structure on all storage devices are identical.

Logs are always stored in a directory called ASCTEC. Every time the Intel® Falcon™ 8+ UAV is switched on, a new directory with a subsequent number will be created inside the ASCTEC directory. All files always have the same creation date and time, but if available, GPS time will be stored in the log. One log directory always contains four files: ASCHP.LOG, ASCTEC.IFO, ASCTEC.LOG, FLIGHT.KML.

None of these files can be accessed directly, but by using the AscTec Navigator Software, it is possible to get a map view of the flight, or export a flight track as .KML or .GPX file. AscTec Navigator Software can be downloaded from the download area http://intel.com/FalconDownloads (see “Intel® Falcon™ 8+ UAS Firmware Updates” on page 163). The corresponding manual can be found here: http://intel.com/FalconManual.

In the AscTec Navigator Software, the Flightbook gives a chronological overview of all flights stored on the SD cards (see following):

Figure 2.29: AscTec Navigator Software Flightbook


Welcome
Flightbook
30207_SD (E:)
ASCTEC
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
Copy to database
Export to KML
Export to GPX
Export Flightbook as CSV
Export for sending
Mapbox
© Mapbox © OpenStreetMap Improve this map © DigitalGlobe

GPS Log ID	Date	Latitude	Longitude	Location	Number of Tags	Flighttime
30	2016-08-09 17:13	51.0934353	11.3099767	Unknown	143	00:10:08
29	2016-08-09 17:01	51.0934346	11.3099474	Unknown	82	00:09:06
28	2016-08-09 16:35	51.0958288	11.3165194	Unknown	130	00:12:14
27	2016-08-09 16:18	51.0955766	11.3166700	Unknown	73	00:10:53
26	2016-08-09 16:17	0.0000000	0.0000000	Unknown	0	00:00:00
25	2016-08-09 10:54	51.0949653	11.3141408	Unknown	134	00:10:37
24	2016-08-09 10:40	51.0949951	11.3142236	Unknown	112	00:10:22

The map view shows the flight path and photo trigger positions, the list view underneath the map shows: the log ID (subsequent number), start time and date, the GPS position (WGS84), the number of image tags (triggers) during the flight, and the flight time. The buttons above the map view allow exporting a single flight as KML or GPX, or an overview of all flights into a CSV file. It is also possible to export a log file as a ZIP file to be able to send it by email.

Please see the chapter 5. Flightbook in the AscTec Navigator Software Manual for further details. The manual can be found here: http://intel.com/FalconManual.

It might happen that the Intel® Falcon™ 8+ UAV cannot access a logging storage device. Usually, it is caused by a mechanical connection issue or a corrupted file system on the storage device. If the Intel® Falcon™ 8+ UAV cannot access a storage device, a respective warning will be displayed (see following).

Table 2.13: Possible Warning

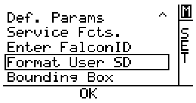
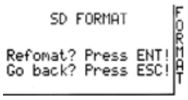
CAUSE	VISUAL SIGNAL	POSSIBLE FIX
User SD card cannot be accessed.	`<- Check Msg` appears in the status line of the Status Display. Push the related arrow **LEFT** button on the Intel® Cockpit Controller (CTR) until the Error Message Screen is shown. `No user SD card` will be shown.	Take out the User SD card, make a backup copy and format it (file system: FAT32, allocation unit size: 32 kilobytes). After reinserting the SD card into the Intel® Falcon™ 8+ UAV, it should again be accessible. If no backup copy is needed, the User SD card can also be formatted directly by the UAV. To do so: 1. Push **ENT** to open the menu on the Status Display. 2. Push the arrow **RIGHT** button to navigate to `Settings`. 3. Push **ENT** and use the arrow **RIGHT** button to navigate to `Format User SD`.  Def. Params Service Fcts. Enter FalconID Format User SD Bounding Box OK M SET 4. Push **ENT** to confirm. The shown screen appears:  SD FORMAT Refomat? Press ENT! Go back? Press ESC! FORMAT 5. Push **ENT** to confirm the formatting of the User SD card. The process starts, a progress bar is shown. Pushing **ESC** cancels the function and brings you back to the **Main Screen**. When the formatting of the SD card is finished, the Intel® Falcon™ 8+ UAV will immediately create a new log file and start logging again.

Table 2.13: Possible Warning (Continued)

Internal SD card cannot be accessed.	`<- Check Msg` appears in the status line of the Status Display. Push the related arrow **LEFT** button on the CTR until the Error Message Screen is shown. `No internal SD card` will be shown.	Switch OFF the Intel® Falcon™ 8+ UAV. Wait 10 seconds and switch it ON again. During boot up, the internal SD card will be formatted and it should again be accessible. If this does not help, contact the Intel support team to get instructions on how to proceed.

Note	*The Intel® Falcon™ 8+ UAV can fly without any active logging device. It is the responsibility of the user to make sure that all flights can be properly logged if it is a legal requirement in the country where the system is used.*

The User SD card will not be deleted or formatted by the flight system. We recommend to regularly make backup copies of these storage devices and reformat them afterwards. Especially when working on complex projects, during which the logs are needed for geo-referencing, it is helpful to start with clean storage media.

3. OPERATING THE SYSTEM

In this chapter, you will find a description how to operate the Intel® Falcon™ 8+ UAS.

3.1. PREPARING THE INTEL® FALCON™ 8+ UAV

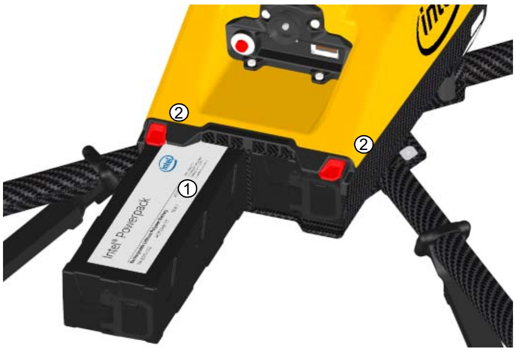
The following section shows and describes how to prepare the Intel® Falcon™ 8+ UAV for flight.

When using the Intel® Falcon™ 8+ system for the first time, some additional steps are required, which only need to be performed once. It might be necessary to repeat them only in rare exceptions. In detail, these steps are:

- Establish the initial connection between Intel® Falcon™ 8+ UAV and Intel® Cockpit Controller (CTR) (see “Establishing A Connection Between The CTR And The UAV” on page 170).
- Set the system date and time on the touchscreen tablet of the CTR (see “THE TOUCHSCREEN TABLET” on page 70).
- Perform a payload and compass calibration with every new payload (see “Payload and Compass Calibration” on page 33).
- Visit https://intel.com/FalconDownloads and install the latest firmware on the system (see “Intel® Falcon™ 8+ UAS Firmware Updates” on page 163). Regularly check the website for updates.

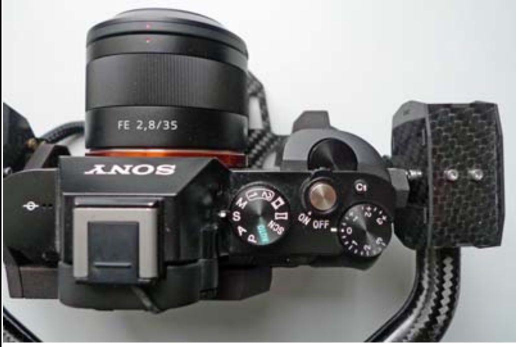
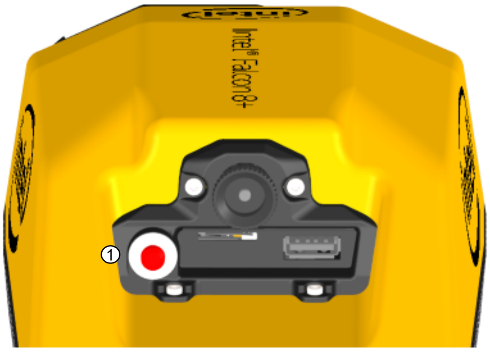
Always strictly follow the instructions in “PRE-FLIGHT CHECK” on page 13 to make sure that the UAV is in perfect condition and setup for flight.

Figure 3.1: Preparing the UAV

	1. Slide the batteries with the colored (“Intel”) label facing upwards (1) into the battery compartment. Slide them all the way in until they are stopped and flush with the ends of the slots. Check that each battery is locked by its retaining clip (2).

CAUTION: THE INTEL® FALCON™ 8+ UAV MUST ALWAYS BE FLOWN WITH TWO BATTERIES INSERTED.

Figure 3.2: Preparing the UAV (Continued)

	2. Switch on the camera and remove the lens cap. The image shows the Sony Alpha 7R as an example. Please note that the ON/OFF switch on each payload is different.
	3. Press the power button (1) for approximately 2 seconds until you hear a short beep. After approximately 3 seconds the LEDs on both sides of the Intel® Falcon™ 8+ UAV will be lit and you will hear the internal fan running. The UAV is initialized when the camera mount (gimbal) starts to automatically correct movements of the UAV, which also can be heard. It requires approximately 15 seconds to completely power the UAV ON, and is indicated by a triple beep from the Intel® Falcon™ 8+ UAV
The AscTec Trinity Control Unit allows you to start the UAV even from a moving platform, for example a boat. The UAS is ready for take-off as soon as the initialization has successfully finished and the link to the CTR has been established.	

3.2. PREPARING THE INTEL® COCKPIT CONTROLLER (CTR)

The following section describes how to prepare the CTR.

Figure 3.3: Preparing the CTR

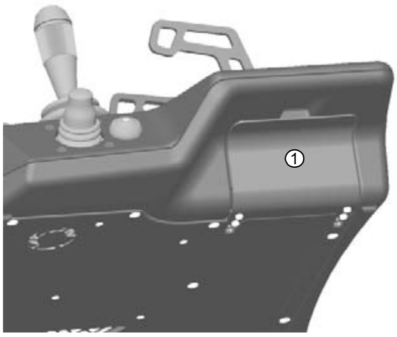
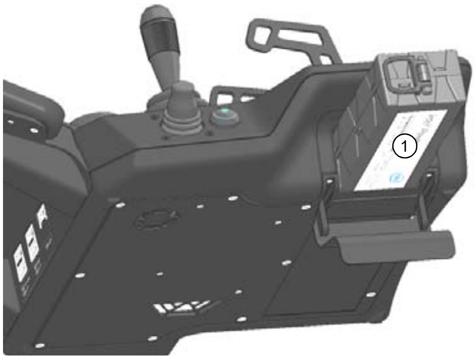
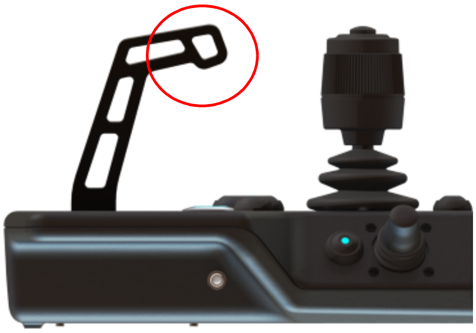
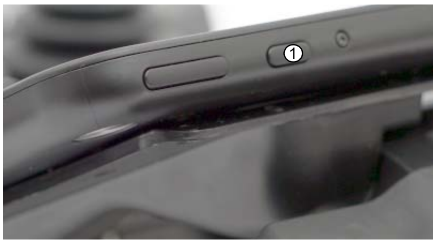
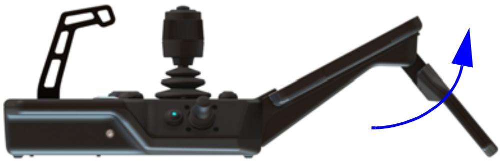
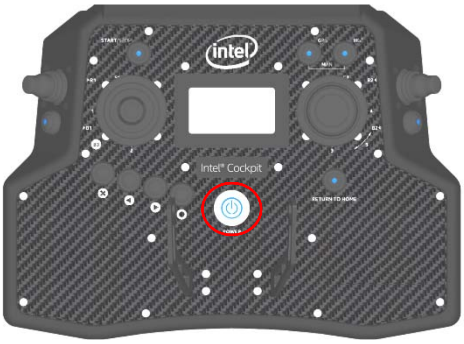
	1. Open the lid of the battery compartment (1). It is located at the bottom of the lower left-hand side of the CTR. The flap of the compartment is equipped with a magnetic closure. The Intel® Powerpack Battery provides power to the CTR as well as the touchscreen tablet.
	2. Slide the battery with the colored “Intel” label (1) facing downwards into the battery compartment. Slide it all the way in until it is stopped and flush with the end of the slot. The Intel® Powerpack battery provides power to the CTR as well as the touchscreen tablet (the battery is the same for the Intel® Falcon™ 8+; see “THE INTEL® POWERPACK BATTERIES” on page 45)
	3. Install the shoulder harness by connecting the carabiners of the harness to the first eyelet of the integrated holder (red circle in this image) on each side of the CTR.
	4. Switch on the touchscreen tablet by pushing the power button (1) on the top edge, right side for approximately 2 seconds until a short vibration is felt.

Figure 3.3: Preparing the CTR (Continued)

	5. Unfold the antenna panel on the backside of the touchscreen tablet. The antenna panel must always be pointed at the UAV to ensure best possible transmission quality.
 START intel GPS MAN Intel® Cockpit RETURN TO HOME POWER	6. Switch on the CTR by pushing and holding the POWER button for a few seconds until a short vibration is felt.

WARNING DO NOT POWER ON OR OPERATE THE CTR WITHOUT FULLY EXTENDING THE ANTENNA PANEL

⚠ CAUTION: WHEN SWITCHING ON THE CTR, THE CENTER POSITION OF THE TWO CONTROL STICKS IS CALIBRATED. MAKE SURE TO NOT MOVE THEM WHILE THE CTR IS POWERING UP. OTHERWISE THERE WILL BE AN ERROR MESSAGE “JOYSTICK ERROR” IN THE STATUS DISPLAY AND IN THE NOTIFICATION AREA OF THE TOUCHSCREEN TABLET AND THE MOTORS CANNOT BE STARTED. IF THIS OCCURS, SWITCH OFF THE CTR AND SWITCH IT ON AGAIN WITHOUT TOUCHING THE CONTROL STICKS.

3.3. THE TOUCHSCREEN TABLET

The Intel® based Windows® touchscreen tablet is directly mounted on the remote control unit of the Intel® Cockpit Controller (CTR) and cannot be removed. It serves as video monitor, displays general flight information and telemetry data, and allows the user to activate automated functions. The battery of the CTR provides power to the touchscreen tablet as well.

To switch the touchscreen tablet ON or OFF, you must push the button located at the top edge of the touchscreen tablet on the right side of the frame for a few seconds (see “Preparing the CTR” on page 68).

After switching the touchscreen tablet ON, you will initially see the blue welcome screen, which, after a few seconds, will change to display the Preflight Checklist where the most important safety aspects are listed.

When starting the touchscreen tablet for the first time, before the Preflight Checklist you will see the window for time and date settings (see following figure).

Figure 3.4: The Cockpit Control Application

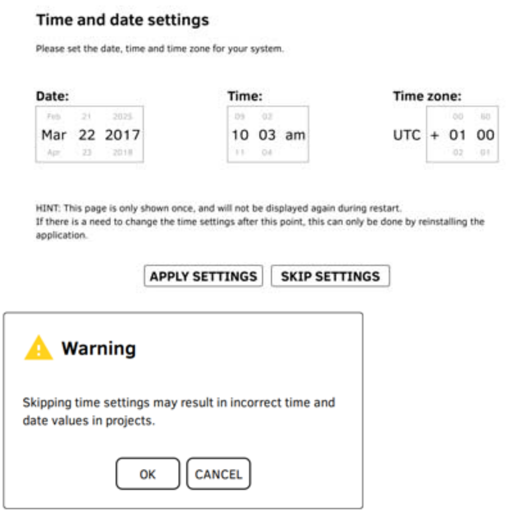
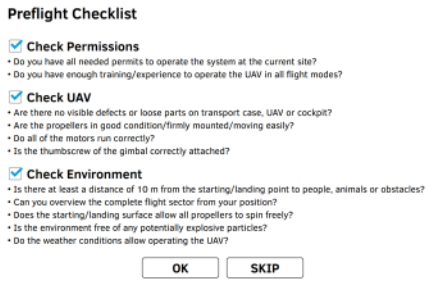
 Time and date settings Please set the date, time and time zone for your system. Date: Mar 22 2017 Time: 10 03 am Time zone: UTC + 01 00 HINT: This page is only shown once, and will not be displayed again during restart. If there is a need to change the time settings after this point, this can only be done by reinstalling the application. Skipping time settings may result in incorrect time and date values in projects. 	**Time and Date Setting** When starting the touchscreen tablet for the first time a window for time and date settings will appear before the `Preflight Checklist`. If necessary, you can make changes here and confirm by tapping on the APPLY SETTINGS button. If you tap on the `SKIP SETTINGS` button this screen will be shown every time you start the touch-screen tablet. Every time after installing new updates, this window will be displayed again. When tapping on the `SKIP SETTINGS` button a warning is shown. Tapping on the CANCEL button brings you back to time and date settings. Tapping on the OK button leads to the `Preflight Checklist` (see below).

Figure 3.4: The Cockpit Control Application (Continued)



Preflight Checklist

☑ **Check Permissions**
- Do you have all needed permits to operate the system at the current site?
- Do you have enough training/experience to operate the UAV in all flight modes?

☑ **Check UAV**
- Are there no visible defects or loose parts on transport case, UAV or cockpit?
- Are the propellers in good condition/firmly mounted/moving easily?
- Do all of the motors run correctly?
- Is the thumbscrew of the gimbal correctly attached?

☑ **Check Environment**
- Is there at least a distance of 10 m from the starting/landing point to people, animals or obstacles?
- Can you overview the complete flight sector from your position?
- Does the starting/landing surface allow all propellers to spin freely?
- Is the environment free of any potentially explosive particles?
- Do the weather conditions allow operating the UAV?

Preflight Checklist

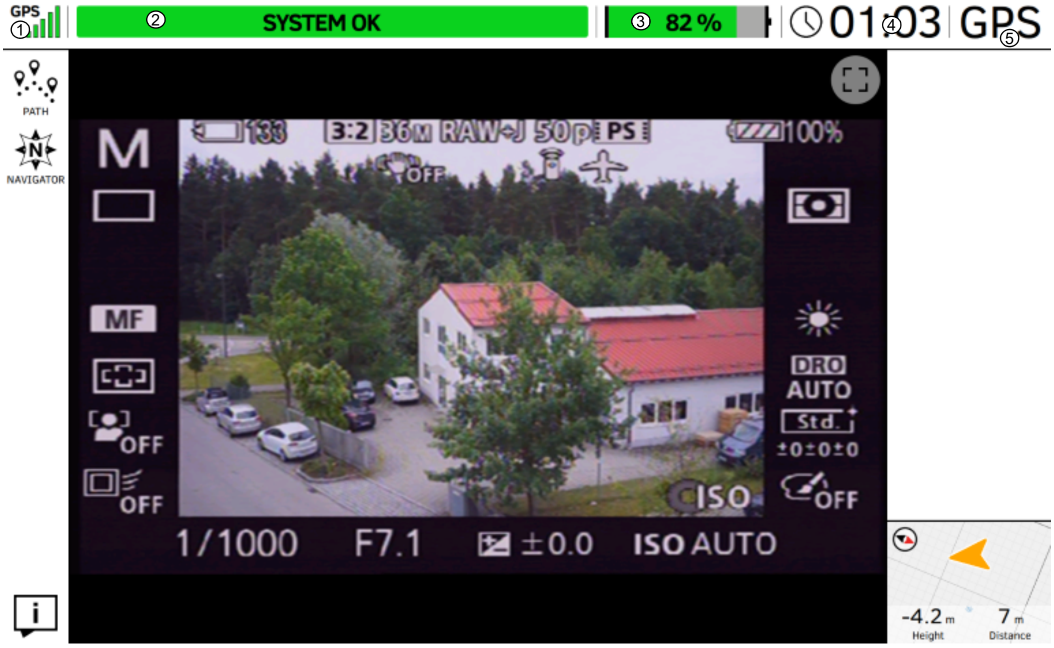
Make sure to comply with all aspects of the Preflight Checklist. Check all 3 topics: Check Permissions, Check UAV and Check Environment, and tap on OK before take-off. You may tap on SKIP, but it is recommended you follow the checklist and tap on OK.

After tapping on OK or SKIP, the main screen of the application is opened (see next picture).

Now you can:

- use the touchscreen as a preview video monitor;
- load, modify and save PATH projects and the related waypoints (optional);
- load and fly AscTec Navigator Software projects

Figure 3.4: The Cockpit Control Application (Continued)


GPS
①
②
SYSTEM OK
③
82 %
01:03
④
GPS
⑤
PATH
NAVIGATOR
M
MF
OFF
OFF
133
3:2
36M
RAW
50p
PS
100%
OFF
DRO
AUTO
Std.
±0±0±0
ISO
OFF
1/1000
F7.1
±0.0
ISO AUTO
-4.2 m
Height
7 m
Distance

Main Screen

The center of the screen shows the preview video of the mounted payload. All symbols and icons shown here are created by the camera, and do not have any touch functionality. In the above example, the Sony A7R is the payload used. Please refer to "Sony Alpha 7R Full Frame Camera" on page 36, and the Sony camera manual for further information. The Sony camera manual can be accessed online on the Sony support website: https://esupport.sony.com/US/p/model-home.pl?mdl=ILCE7R&LOC=3#/manuals

In the notification area at the top of this window, general flight information is given.

In the left corner under GPS (1), the quality of the GPS signal can be seen, indicated by 1 to 5 bars.

Next to the right of the window, you find the place for system messages (2). If everything is fine, `SYSTEM OK` is shown in a green bar. In case there are warnings, the field will turn red and display the respective warning. For possible warnings see "Error warnings and messages" below.

Next to the system messages, you find another green bar which indicates the remaining battery capacity of the UAV as a percentage (3) followed by the elapsed flight time (4) and the selected flight mode (GPS) (5).

Figure 3.4: The Cockpit Control Application (Continued)

Main Screen (continued)

Tapping on this button, located in the top right corner, displays the preview video in full screen mode (the notification area on top is hidden) and the button changes into the following.

Tapping on this button exits the full screen mode, and the notification area on top is shown again.

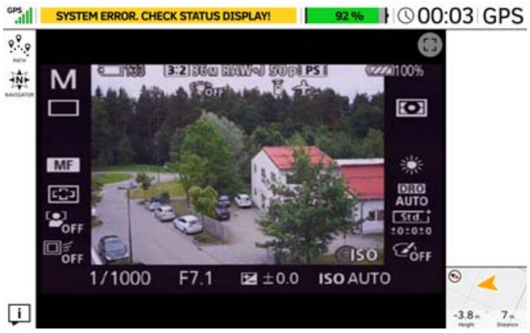
In the lower right corner, you find more flight information, which refers to the UAV: Orientation (shown graphically), `Height` and `Distance` from the take-off point. Tapping on that flight information field will toggle the view between the video preview and a map view (in case a map has been loaded from an AscTec Navigator project). Learn more about the AscTec Navigator in the at http://intel.com/FalconManual. In the top left corner (under GPS) the buttons for three different functions are found:

Tapping on the PATH button opens the PATH function where you can store and edit individual waypoints and paths (see “PATH Projects” on page 74). This function is an optional part of the Inspection Package (see “SOFTWARE FEATURE PACKAGES” on page 59).

Tapping on the `NAVIGATOR` button opens the `ASCTEC NAVIGATOR PROJECT` window, where you can load and fly existing Navigator projects (see “AscTec Navigator Software Projects” on page 82).

Tapping on this button opens a window which gives you information about the software (version, available updates, etc.). Tapping on the button again closes the window.

Figure 3.4: The Cockpit Control Application (Continued)

	**Error Messages and Warnings** If `SYSTEM ERROR. CHECK STATUS DISPLAY!` is shown in the notification area on top of the touchscreen tablet, you must check the Status Display on the CTR. If there is only one warning, it will be fully displayed in the notification area. If more than one warning is present, a popup & drop-down menu is shown. Tapping the drop-down button will display all warnings. The related text is shown: • in CAPITALS if an error occured which has to be checked via the Status Display, • small letters in the drop-down menu. If the warning is critical and can lead to an imminent crash, the text is shown in a red bar, if it is a warning message it is shown in yellow bar. The following warnings are only shown on the touchscreen tablet: `Tablet battery weak!` = The battery of the touchscreen tablet is low. `Tablet battery empty!` =The battery of the touchscreen tablet is empty. For further details of all possible warnings see “WARNINGS” on page 116

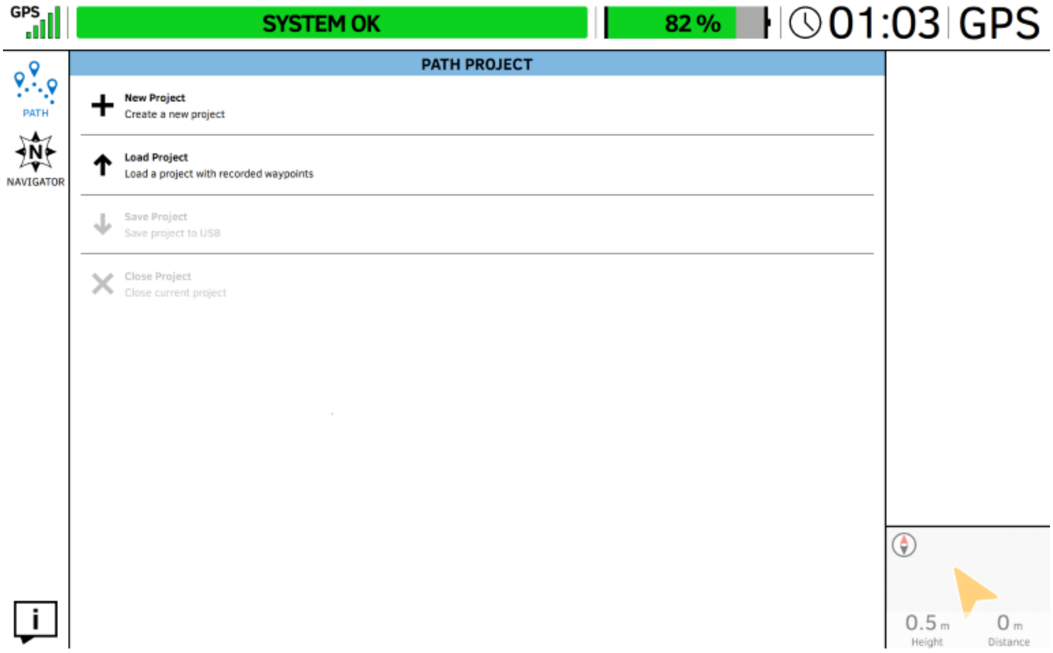
3.3.1. PATH Projects

This function is an optional part of the Inspection Package (see “SOFTWARE FEATURE PACKAGES” on page 59).

With the Cockpit Control application, you can create, load, modify and save PATH projects and any related waypoints. To use this functionality a USB stick (FAT 32 formatted) must be inserted into one of the USB ports, located at the back of the CTR.

It is possible to store and edit individual waypoints (GPS position, height, camera heading, and camera pitch angle) onto a USB stick, which is inserted into the CTR. A waypoint can later be recalled, and the Intel® Falcon™ 8+ UAV will fly to this position and take an image with the stored heading and pitch angle. Camera settings such as shooting mode, or zoom, cannot be stored, and must be set manually before flight. Multiple waypoints can be combined to create a path.

Figure 3.5: The Cockpit Control Application and PATH Projects


GPS
SYSTEM OK
82 %
01:03
GPS
PATH PROJECT
PATH
NAVIGATOR
New Project
Create a new project
Load Project
Load a project with recorded waypoints
Save Project
Save project to USB
Close Project
Close current project
0.5 m
Height
0 m
Distance

PATH PROJECT

Tapping on the PATH button in the main screen opens the window `PATH PROJECT`. Here you can create, save, and load individual Paths projects (including the GPS position, height, camera heading, and camera pitch angle).

Executing the PATH function via the touchscreen tablet:

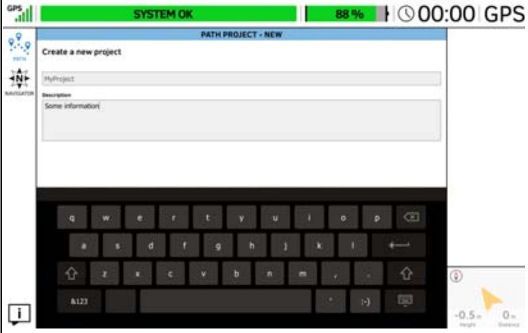
Tapping on `New Project` opens the window `PATH PROJECT - NEW` with an integrated keyboard (see below)

Tapping on `Load Project` opens a window in which you can load an already stored PATH project from a USB stick, which is inserted into the CTR.

`Save project:` This button becomes active after creating a new, or modifying, a new or existing project. Tap on this button to save the actual PATH project to the inserted USB stick.

`Close project:` Tap here to close the actual PATH project.

Figure 3.5: The Cockpit Control Application and PATH Projects (Continued)



Create a new project

MyProject

Description

Some information

PATH PROJECT - NEW

Preparing and planning a new mission, and generating a new project, is best done before launching the UAV, when you are still on the ground. Tapping on `New Project` in the `PATH PROJECT` window (see above) opens the window `PATH PROJECT - NEW`. In this window, you find a keyboard at the bottom.

With the help of this keyboard you may give a name to the new project by tapping on the related keys. Under the Name field the `Description` field is seen, where you can describe the project in more details.

⌨ Tapping on this button hides the keyboard. The keyboard can also be hidden by tapping anywhere in the empty area above.

After hiding the keyboard, you first must tap on the button in the lower right corner.

▶ Tapping on this button opens a window with a summary of the data of your new project, and some instructions how to use this function.

If you did not already insert a USB stick, you will see a corresponding warning in red. You can now insert the USB stick.

◀ Tap on this button if you want to make changes. You return to the input window, where you can make your changes.

If you want to accept the data of your project, tap on the check mark in the lower right corner.

✓ Tapping on the check mark saves your new project.

When creating a new project, it is stored in an automatically generated directory <USB stick>:\CockpitConrol\projects.

Figure 3.5: The Cockpit Control Application and PATH Projects (Continued)

New Project / Record Mode

This functionality allows the pilot to add/generate new waypoints during flight, by using the camera trigger (left control stick **S1**).

The so named teach-in mode, is activated by using the record button. Waypoints created accidentally can immediately be deleted by tapping the delete button.

The teach-in mode is stopped by tapping on the stop button.

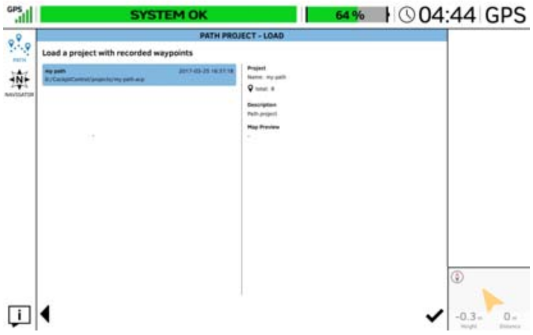
After finishing recording, an automatic flight to all stored waypoints can be executed by using the play icon.

Projects can be saved to the inserted USB stick, and can be reloaded at any time.

After entering the data of your new project, and tapping on the check mark (see above), you can start your new project.

1. Launch the UAV.
2. Climb to a minimum of 10 m height.
3. Tap on the record button ● to activate the record mode.
4. Fly to the first desired waypoint, and make sure the camera points towards the desired spot.
5. Push the camera trigger (left control stick **S1**) to store this and all following desired waypoints in your project.
   Waypoints created accidentally can immediately be deleted by tapping the delete button.
6. To stop recording at the end of your path, tap on the stop button.■
7. To save your new PATH project tap on the PATH button in the upper left corner. This opens the `PATH PROJECT` window again.
8. Tap on the `Save Project` button.
   The actual state of your project will be saved on the inserted USB stick.

Figure 3.5: The Cockpit Control Application and PATH Projects (Continued)



Load a project with recorded waypoints

Loading an Existing Project

Tapping on Load Project in the PATH PROJECT window (see above), opens the window PATH PROJECT - LOAD. In this window, you can select/ load an already stored project, with recorded waypoints, to be edited and/or flown, from an USB stick.

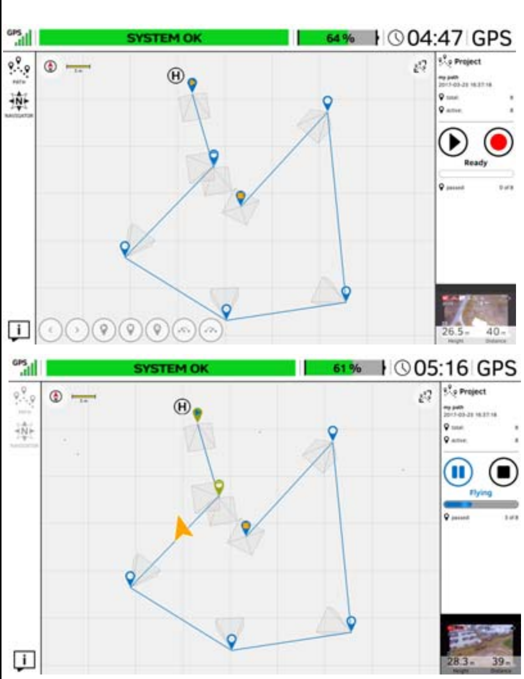
The USB stick must be inserted at the back of the CTR.

Tapping on the project name, in the left side window, highlights it and shows the related data.

- ✓ Tapping on the check mark, in the lower right corner opens the selected project (see next image).
- ◀ Tapping on this button in the lower left corner brings you back to the last screen.

In the lower right corner, the UAV is indicated by a yellow arrowhead with its actual orientation, `Height` and `Distance` if there is a connection between the UAV and the CTR.

Figure 3.5: The Cockpit Control Application and PATH Projects (Continued)



Flying an Existing Project

After loading an existing project, you can fly (and/or modify) the path and the related waypoints.

▶ Tapping on the play button causes the (already launched) UAV to fly the path, and to take pictures at the stored waypoints.

After tapping on the play button, it changes into the pause button as shown below.

● Tapping on this button starts the record mode (teach-in mode). Every time you trigger an additional picture, with the left control stick, you generate a new waypoint and any related data is stored (see above).

⤢ Tapping on this button zooms your project (all waypoints) back to fit into the window size; e.g. if you zoomed in or out by pinching and/or spreading.

⏸ Tapping on this button (only displayed during flight) sets the mission to stand-by.

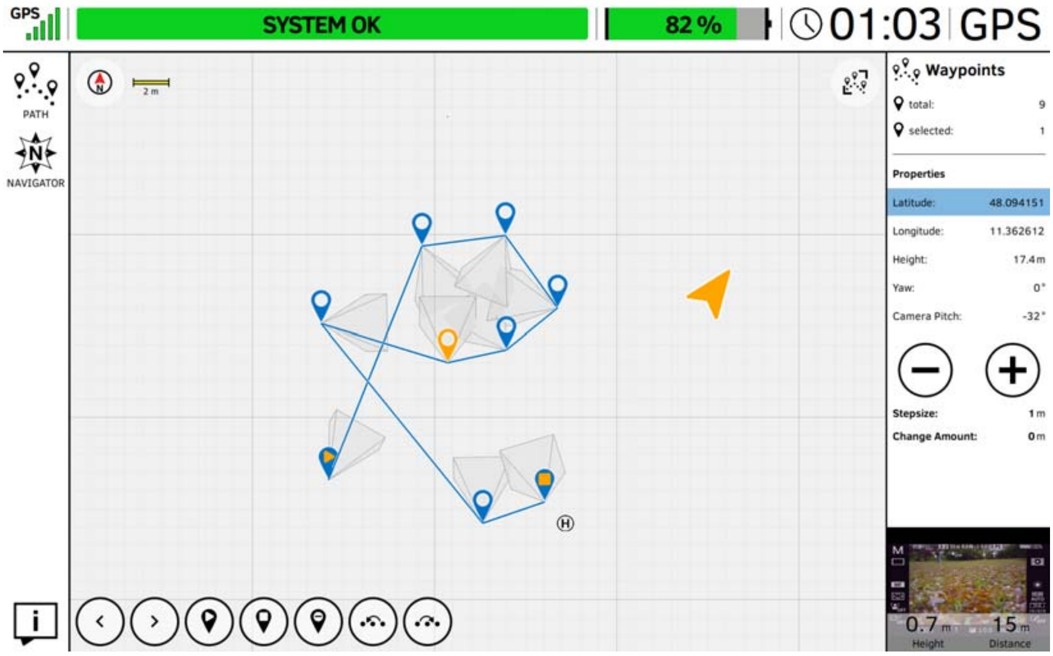
■ Tapping on this button stops the mission.

Ⓗ This icon shows the actual home position of the UAV.

Completed waypoints will be marked green in the preview of the touchscreen tablet.

⚠ **CAUTION: WHEN FLYING A PATH PROJECT, THE UAV FLIES A DIRECT STRAIGHT TRAJECTORY BETWEEN THE WAYPOINTS! KEEP THIS IN MIND WHEN TEACH-IN!**

Figure 3.6: The Cockpit Control Application and PATH Projects



total: 9
selected: 1

Properties

Latitude: 48.094151
Longitude: 11.362612
Height: 17.4 m
Yaw: 0°
Camera Pitch: -32°

Stepsize: 1 m
Change Amount: 0 m

Modifying an Existing Project

As soon as you selected one or more waypoints for modification by tapping on them, the buttons at the bottom, and the related properties on the right side of the screen, are activated accordingly. For easier selection, it is possible to zoom in and out by pinching and spreading the screen. To move the map/project sector drag to alter the view as needed. Tapping anywhere in the map area without selecting a waypoint will de-select all previously selected waypoints.

If only one waypoint is selected, the following described functions can be executed by tapping the related button.

If multiple waypoints are selected, only the “delete”, “move to right” and “move to left” buttons are active.

Figure 3.6: The Cockpit Control Application and PATH Projects (Continued)

Modifying an Existing Project (Continued)

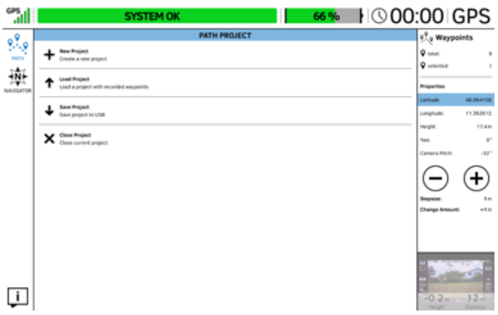
‹	Tapping on this button selects the waypoint next to the actual selected waypoint, against the direction of the teach-in order.
›	Tapping on this button selects the waypoint next to the actual selected waypoint, in direction of the teach-in order.
⦿	Tapping on this button sets the selected waypoint as the new start point.
⦿	Tapping on this button sets the selected waypoint as the new end-point.
⦿	Tapping on the “delete” button deletes the selected waypoint(s).
○	Tapping on the “move to left” button shows the notification “Choose the waypoint to follow the selected waypoints”. After tapping on the corresponding waypoint, the direction order of the selected waypoints is changed against the teach-in order.
○	Tapping on the “move to right” button shows the notification: “Choose the waypoint to precede the selected waypoints”. After tapping on the corresponding waypoint, the direction order of the selected waypoints is changed in direction of the teach-in order.

On the right side of the window you see the `total` number of waypoints, and the actual `selected` number of waypoints, contained within the selected project.

If only one waypoint is selected, the values of the related properties of this waypoint are displayed below.

`Latitude` and `Longitude` show the related coordinates of the (one) selected point. `Height` shows the height of the selected point. `Yaw` shows the heading at which the waypoint was stored. `Camera Pitch` shows the actual stored pitch angle of the camera. To change these properties, select the one you want to change to highlight it. The value of the selected property can be changed by tapping on the buttons depicted below.	⊖ Tapping on this button once, subtracts the value mentioned at Stepsize. ⊕ Tapping on this button once, adds the value mentioned at Stepsize. The size of a step can be changed by tapping on the number right to it. This opens a number keypad. With help of the keypad you can enter a new number. The number behind `Change Amount` shows how often you tapped on the related button (cumulated number of steps).

Figure 3.6: The Cockpit Control Application and PATH Projects (Continued)

 GPS SYSTEM OK 66 % 00:00 GPS PATH NAVIGATOR PATH PROJECT New Project Create a new project Load Project Load a project with recorded waypoints Save Project Save project to USB Close Project Close current project Waypoints Properties Latitude: Longitude: Height: Yaw: Camera Pitch: Stepsize: Change Amount:	**Save PATH Project** After modifying one or more waypoints you can save the modifications by tapping on the PATH button (top left corner). The window `PATH PROJECT` is opened again (shown to the left). Tapping on `Save Project` saves the modifications to the project.

3.3.2. AscTec Navigator Software Projects

With the help of the Cockpit Control application you can load and fly survey projects created in the AscTec Navigator Software. To do this, export the existing project from the AscTec Navigator Software by clicking in the AscTec Navigator Software in the Pull-down-Menu `File` on `Export Cockpit project`. A file with the extension .ANP will be created, which you must store onto a USB stick. Further information on the AscTec Navigator Software can be found here: http://wiki.asctec.de/display/APL/AscTec+Navigator+Manual

Insert the USB stick, containing the exported .ANP file, into a USB port of the CTR and tap on the `NAVIGATOR` button in the main screen of the Cockpit Control application (see "The Cockpit Control Application" on page 70).

Note	*AscTec Navigator Software missions can only be executed on the CTR. It is not possible to modify projects. If necessary, please open the project in the AscTec Navigator Software, make the modifications, and then export it to the CTR with help of the USB stick.*

Things to consider before flying a survey mission:

- During the complete mission, the pilot must always be able to take over control. Commands given on the CTR will override waypoint flight commands and stop the flight immediately.
- The flight system must always remain within line of sight.
- A good GPS signal needs to be available in the complete area in which the UAV will fly in (> 75% = 4 bars).
- The space in which the Intel® Falcon™ 8+ UAV will be flying, must be free of obstacles.

- Always plan missions with sufficient distance from obstacles and people. There will always be positioning errors of your UAV due to GPS drift and external influences like wind. In addition, the map file may not be absolutely accurate.
- In windy conditions, the UAV may not always fly in a straight line between two waypoints. Plan the mission accordingly.
- Always plan missions with enough height above ground. The UAV may temporarily lose as much as 5 meters of height when flying between waypoints (due to variations in barometric air pressure - drift in sensor values). Due to these variations, it is recommended to plan missions at a height of at least 15 meters above the highest object.

Figure 3.7: The Cockpit Control Application And AscTec Navigator Software Projects

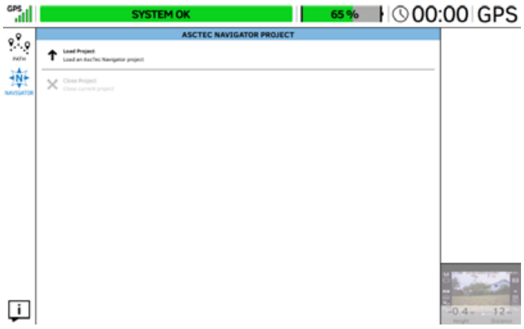
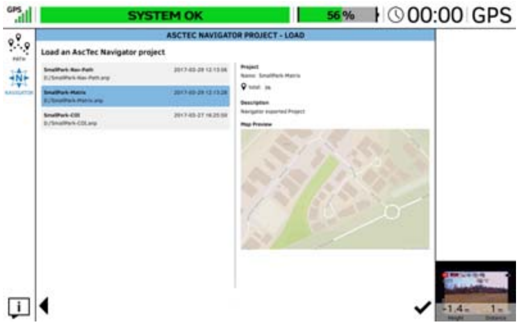
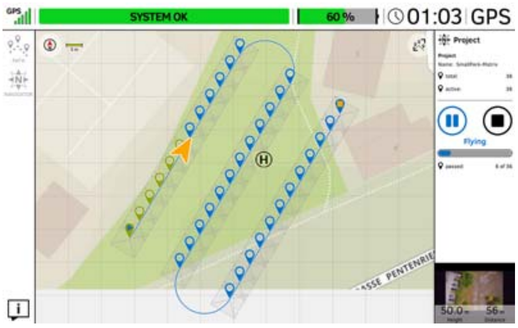
 GPS SYSTEM OK 65 % 00:00 GPS ASCTEC NAVIGATOR PROJECT PATH NAVIGATOR Load Project Load an AscTec Navigator project Close Project Close current project 0.4 12	**ASCTEC NAVIGATOR PROJECT** Tapping on the `NAVIGATOR` button in the main screen window of the Cockpit Control application (see “The Cockpit Control Application” on page 70) opens the window ASCTEC `NAVIGATOR PROJECT`. In this window, you can load an exported AscTec Navigator Software project from an inserted USB stick.
 GPS SYSTEM OK 56 % 00:00 GPS ASCTEC NAVIGATOR PROJECT - LOAD PATH NAVIGATOR Load an AscTec Navigator project Project Description Map Preview 1.4 1	**ASCTEC NAVIGATOR PROJECT - LOAD** Tapping on `Load Project` in the ASCTEC `NAVIGATOR PROJECT` window (see above) opens the window ASCTEC `NAVIGATOR PROJECT - LOAD`. In this window, you select the desired project by tapping on it. The previously stored waypoint path, and the map view of the AscTec Navigator Software, will be loaded. ✓ Tapping on the check mark in the lower right corner under the Map Preview, transfers the exported project onto the touchscreen tablet. The window with additional flight information, in the lower right corner changes to video preview

Figure 3.7: The Cockpit Control Application And AscTec Navigator Software Projects



Fly an AscTec Navigator Software Project

After loading an AscTec Navigator Software project you can fly the mission. First you must take-off and climb to a minimum of 10 m height.

▶ After reaching the minimum height, and tapping on the shown play button, the UAV starts the mission and flies to the next waypoint on the path. After tapping on the black play button, it changes into the blue pause button shown below.

After tapping on the play button, during flight, you see the following buttons on the right side:

⏸ Tapping on this button sets the mission to stand-by.

⏹ Tapping on the stop button stops the mission. The UAV stops and remains at the actual height and position.

For further information on the AscTec Navigator Software, see the AscTec Navigator Software Manual which can be found here: http://wiki.asctec.de/display/APL/AscTec+Navigator+Manual

Starting and Flying an AscTec Navigator Software Mission

1. When you are ready, take-off and climb to the approximate height and position of the first waypoint.
2. Tap on the play button (see before).

WARNING	**OBJECTS BETWEEN THE STARTING POSITION AND THE FIRST OR INTERMEDIATE WAYPOINT AND OBJECTS BETWEEN WAYPOINTS MUST BE CONSIDERED! THE UAV WILL APPROACH WAYPOINTS OF THE MATRIX IN A STRAIGHT LINE, ASCENDING (OR DESCENDING) CONTINUOUSLY BY ITSELF IF NECESSARY!**

3. Intel® Falcon™ 8+ UAV starts to fly the mission.
4. Completed waypoints will be marked green on the preview of the touchscreen tablet.

Note	*A green waypoint indicates that the Intel® Falcon™ 8+ UAV successfully passed the waypoint, sent a trigger command to the camera, and a tag was created in the log. It does not necessarily mean that the camera successfully triggered, and stored the image.*

5. When all waypoints are done, the UAV will stop at the last waypoint at the actual height.
6. The UAV can now be landed to change batteries, and be prepared for the next mission.

Interrupting A Mission

A planned flight may be interrupted at any time, for example to change the batteries during larger survey missions. There are three ways to interrupt a flight manually:

- Tapping on the pause button (see above): the upload of new waypoints will be stopped, and the UAV will stop and hover in the air, until you tap on the (blue) play button again.
- Tapping on the stop button (see above): the upload of new waypoints will be stopped, and the UAV will stop and hover in the air.
- Taking over manually, and giving the UAV a command from the CTR. This will stop the flight of the UAV immediately, as well as the flight mission.

Resuming A Mission

If a survey flight was interrupted, it can be resumed at the position where is was interrupted.

If you interrupted the mission by tapping on the pause button, resuming a mission is easily done:

1. Launch the UAV up to the minimum height of 10 m.
2. Fly close to the waypoint from which the flight shall proceed.
3. Tap on the play button.
   The UAV resumes the mission automatically by heading for the next waypoint.

If you had to abort a mission by tapping on the stop button, you should note the last waypoint passed when you tapped on the stop button. The number of this waypoint is shown on the right side of the map area on the touchscreen tablet. The number of already passed waypoints in comparison to the total number is shown right to `passed:` located at the right side of the screen.

To resume the mission, you must:

1. Tap on the waypoint (to select it on the touchscreen tablet) from which the flight will proceed.
2. Tap on the 📍 button to declare the selected waypoint as the new start point.
3. Launch the UAV and climb to a minimum height of 10 m.

4. Make sure that there are no obstacles in the direct trajectory between UAV, and the new start point.
5. Tap on the play button.
   The mission will be continued from the waypoint that was selected as the new start point.

3.4. AUTOMATED START-UP CHECKS

Approximately 15 seconds after switching on the UAV a triple beep from the autopilot electronics signalizes the end of the initialization phase.

During the initialization, the system performs an automated start-up check:

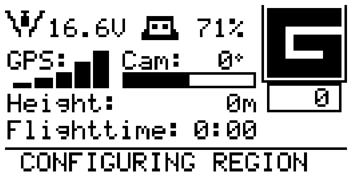
- Sensors are checked for functionality.
- Sensor data is checked for plausibility.
- All three flight controller units are checked.
- The “Black Box” (flight logger) SD card is checked.
- The firmware version of the battery is checked (see “Battery Update” on page 51)
- The regional settings regarding the transmission power are checked
- The current magnetic field is compared with the expected magnetic field.

Irregularities that might affect the flight behavior are reported by a corresponding error notification on the Status Display (for detailed descriptions of possible error messages, see “WARNINGS” on page 116). In case of an error, please try to start the system again at a different location. If the error persists, please contact your local support representative.

3.4.1. Regional Setting

If the Intel® Falcon™ 8+ UAV is switched on in a different region than last time, it will automatically check and if necessary configure all radio parameters to comply with the new region. This is necessary because different regions (e.g. FCC or CE compliant) may have different limits regarding the transmission power. As soon as a valid GPS signal is available this configuration starts. It can take up to 5 minutes. During this process `CONFIGURING REGION` is shown in the bottom line of the Status Display (see below) and the LEDs of the UAV flash fast. The power button of the UAV is disabled. Please wait until the process is finished and don’t interrupt manually.

Figure 3.8: Message Shown During Regional Settings



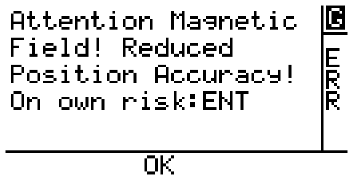
```
16.6V  71%
GPS:   Cam:   0°
Height:        0m   0
Flighttime: 0:00
 CONFIGURING REGION
```

During the procedure of automatic regional settings `CONFIGURING REGION` is shown in the bottom line of the Status Display.

3.4.2. Magnetic Field Warning

In flight, the Intel® Falcon™ 8+ UAV uses algorithms to detect possible disturbances of the compass sensors. If there are discrepancies between the magnetometer output and the expected orientation, the UAV's heading is estimated using the other available IMU (Inertial Measurement Unit) sensors. This technology enhances the robustness of the UAV against external disturbances of the magnetic field.

Figure 3.9: Magnetic Field Warning



```
Attention Magnetic
Field! Reduced
Position Accuracy!
On own risk:ENT
          OK
```

Since the IMU sensors (like accelerometers) are needed to estimate the heading, **the compass estimation does not work if the UAV is standing still on the ground.** During start-up, the current magnetic field is com-pared to the expected magnetic field. If there is a discrepancy, there will be an uninterrupted acoustic signal. The Status Display will display the shown warning.

If this warning occurs, never take off from that spot in GPS-Mode! It might lead to unexpected positional changes of the UAV.

The warning can be canceled by pushing the **ENT** button of the Status Display on the Intel® Cockpit Controller (CTR).

IMPORTANT:
As long as the Intel® Falcon™ 8+ UAV remains switched on, the canceled magnetic field warning will not be presented again. So, if the Intel® Falcon™ 8+ UAV is moved to a different location while switched on, there will be no warning, even if there is a magnetic disturbance present.

Usually disturbances on the ground come from underground lines and can quickly be resolved by switching off the Intel® Falcon™ 8+ UAS. Chose a different starting position, switch the UAS on again and check if the magnetic field warning is not shown again. In many situations, the disturbances are limited to small areas. If this is not possible, you can:

1. Switch to Height-Mode and take off in Height-Mode to avoid any position corrections by the system, which might occur unexpectedly in GPS-Mode.
2. Fly to open space and keep Height-Mode activated for at least 20 seconds (it will help the estimation algorithms to do some movements forward, backward, left and right).
3. Switch to GPS-Mode in open space. The magnetic disturbance will then be at a safe distance and the estimation algorithms will be active.
4. Always be prepared to switch back to Height-Mode anytime.

For more information about the different flight modes see “FLIGHT MODES” on page 91

3.5. LINK LOSS PROCEDURE

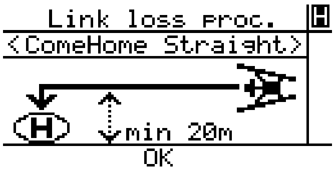
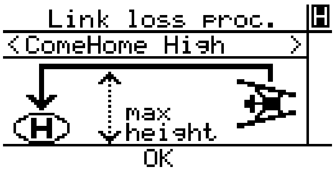
When the UAS has successfully initialized, an appropriate Link Loss Procedure must be selected each time the UAS is switched ON.

The Link Loss Procedure of the Intel® Falcon™ 8+ UAV is automatically activated when there is no data link connection between the Intel® Cockpit Controller (CTR) and the UAV. The UAV has a fully redundant data link, meaning that there are two independent transmitter / receiver connections. If only one of the data link connections is interrupted, the pilot still has complete control over the UAV. The warning `LINK WEAK!` will be displayed on the Status Display. Only if both links are lost, it will no longer be possible to control the UAV from the CTR. The warning `LINK LOST!` will be displayed and the Link Loss Procedure is activated. This can occur if the UAV is flown too far from the CTR and/or the antenna panel orientation is not ideal. External influences like shadowing (see “Shadowing” on page 95) or other networks (e.g. WiFi) can also disturb the data link.

There are three different Link Loss Procedures available. One of them must be chosen deliberately each time the UAS is switched on. Every flight may require a different procedure. Therefore, please chose the procedure carefully considering the current mission.

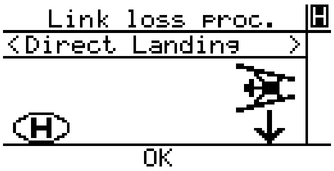
With the **RIGHT/LEFT** buttons you switch between the three procedures. By pushing **ENT**, you select the procedure shown on the screen of the Status Display.

Figure 3.10: The Link Loss Procedures

 Link loss proc. <ComeHome Straight> 	`ComeHome Straight` In case the connection between the CTR and the UAV gets lost (if it is higher than 20 m above the take-off height) the UAV will stop at its current position and fly back to the home position (where the motors were started) at its current height. If the UAV is lower than 20 m at the time the connection is lost, it will first ascend to approximately 20 m above take-off height and then fly back to the home position. Once the UAV has reached the spot above the home position, it will descend at 1.5 m/s until it lands.
 Link loss proc. <ComeHome High > 	`ComeHome High` In case the connection between CTR and UAV gets lost, the UAV will stop at its current position and ascend. After arriving at the maximum altitude, that was reached during this flight, it will fly back to the home position and descend with 1.5 m/s until it lands.

WARNING **IF THE BATTERY IS LOW AT THE END OF A FLIGHT, THE EXTRA POWER NEEDED FOR THE ASCENT COULD DEPLETE THE BATTERY AND LEAD TO A CRITICAL SITUATION.**

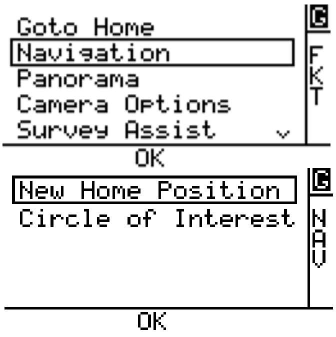
Figure 3.11: The Link Loss Procedures (Continued)

 Link loss proc. <Direct Landing > 	`Direct Landing` In case the connection between CTR and UAV gets lost, the UAV will stop and start a controlled descend at 1.5 m/s at its current position until it lands. If no GPS signal is available, the UAV will always use `Direct Landing`. Please note that in a situation without GPS signal, the UAV will drift with the wind while descending.

Home Position

The home position is set automatically each time the motors are started.

Figure 3.12: New Home Position



It is possible to define a new home position while the UAV is in the air.

To do so:

1. Push **ENT** at the Status Display.
   You enter the shown menu.
2. Push the arrow **RIGHT** button one time to highlight Navigation.
3. Push **ENT**.
   You enter the shown menu.
   `New Home Position` is highlighted.
4. Push **ENT**.

The new home position is set at the current location of the UAV at the moment the **ENT** button is pushed and you return to the **Main Screen.**

Please note the following points:

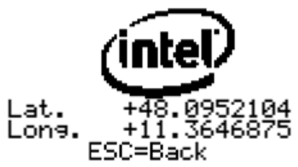
- The flight path back to the home position may not be a straight line, but it may be curved in windy conditions.
- When the UAV is flown in Height-Mode (an H is shown in the upper right corner of the Status Display) or in Manual-Mode (an M is shown in the upper right corner of the Status Display) and the Link Loss Procedure is activated, the UAV will automatically switch to GPS-Mode (a G is shown in the upper right corner of the Status display) if a GPS signal is available.

⚠ **CAUTION: IN CASE THE LINK LOSS PROCEDURE HAS BEEN ACTIVATED, IT IS RECOMMENDED NOT TO USE MANUAL-MODE. BECAUSE THE UAV WILL AUTOMATICALLY CONTROL THE HEIGHT, USING GPS- OR HEIGHT-MODE, WILL MAKE IT EASIER FOR THE PILOT TO REACT CORRECTLY WHEN THE DATA LINK IS REESTABLISHED AND THE LINK LOSS PROCEDURE IS INTERRUPTED.**

- Should the connection between the CTR and the UAV be re-established during the Link Loss Procedure, the UAV will immediately stop the procedure, enter the flight mode selected on the CTR and follow any control input from the pilot.

- If the UAV performed a direct landing because of a lost data link connection, and if you are having difficulties locating it, the last known position of the Intel® Falcon™ 8+ UAV (which is stored in the Status Display of the CTR) might be helpful.

Figure 3.13: Last Known Position

 Lat. +48.0952104 Long. +11.3646875 ESC=Back	Push the arrow **RIGHT** button of the Status Display once (while not connected) and latitude and longitude of last known position will be displayed.

Situations With Varying GPS Reception

- If no GPS reception is available, when a data link connection is lost, the Intel® Falcon™ 8+ UAV will use `Direct Landing.`
- If GPS reception is lost during an active `ComeHome` procedure, the Intel® Falcon™ 8+ UAV will immediately switch to `Direct Landing`.
- If no GPS reception is available while the motors are started, the home position cannot be set. If GPS reception becomes available later during the flight, the home position will be set to the location where a valid GPS signal was first received. This home position will be used for the `ComeHome` procedures. If this does not suit the flight situation, chose `Direct Landing`.

If the system has landed itself during a Link Loss Procedure, the propellers will continue to turn for 10 seconds when the UAV is already on the ground. After this the motors will be switched OFF automatically.

3.6. FLIGHT MODES

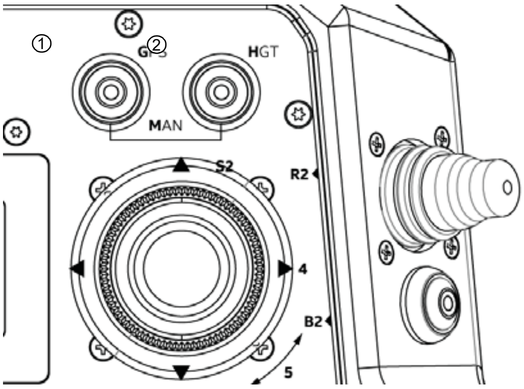
The Intel® Falcon™ 8+ UAV can be operated in three different flight modes:

- GPS-Mode
- Height-Mode
- Manual-Mode

Flying in GPS-Mode is easiest as it provides the highest level of automation.

Nevertheless, there will be situations where no GPS signal is available and therefore it is necessary that every pilot is capable to safely control the UAV in Height-Mode. We strongly recommend taking part in an Intel® Falcon™ 8+ UAS operator's training, to learn the basics of flying under qualified supervision. If you are interested in attending a training course, contact your local sales representative.

Figure 3.14: Selecting The Flight Modes



The flight modes can be selected with the two buttons on the upper right corner of the CTR (see “THE INTEL® COCKPIT CONTROLLER (CTR)” on page 22).

- When the button GPS is pushed and is lit, GPS-Mode is active
- When the button HGT is pushed and is lit, Height-Mode is active
- When both buttons are pushed simultaneously and are both lit, Manual-Mode is active

For most applications, the Intel® Falcon™ 8+ UAV is best to be flown in GPS-Mode. If necessary, Height-Mode can be conveniently and quickly activated or deactivated with the index finger of the right hand without letting go of the control stick.

When the system is switched on, GPS-Mode will be activated by default. If there is no sufficient GPS reception, Height-Mode will be activated automatically and the Height-Mode button will be lit. In this case, the GPS-Mode button will be flashing to indicate that the system will switch to GPS Mode as soon as there is a valid GPS signal. In such a situation, it is recommended to actively switch to Height-Mode by pushing the respective button before taking off. This way any unexpected switch of the flight mode can be avoided.

The different flight modes differ in the degree of automation.

Table 3.1: Controlled Parameters Depending On The Flight Mode

	GPS BUTTON	HGT BUTTON	ATTITUDE CONTROL	HEIGHT CONTROL	POSITION CONTROL
GPS-Mode	ON (lit)	OFF	√	√	√
Height-Mode	OFF	ON (lit)	√	√	-
Manual-Mode	ON (lit)	ON (lit)	√	-	-

⚠ **CAUTION: THE PILOT MUST BE ABLE TO CONTROL THE UAV NOT ONLY IN GPS-MODE BUT ALSO IN HEIGHT-MODE!**

IF THE SYSTEM SEEMS TO BE UNSTABLE OR HAS DIFFICULTIES IN KEEPING ITS CURRENT POSITION IN GPS-MODE, PLEASE IMMEDIATELY ACTIVATE HEIGHT-MODE. BE PREPARED THAT YOU NOW NEED TO CONTROL THE POSITION MANUALLY.

IF THE SYSTEM PERFORMS DRAMATIC CHANGES IN ALTITUDE WITHOUT ANY RELATED COMMAND FROM THE CTR, PLEASE IMMEDIATELY ACTIVATE MANUAL-MODE.

BE PREPARED THAT YOU NOW NEED TO CONTROL THE POSITION AND THE ALTITUDE MANUALLY.

3.6.1. GPS-Mode

Table 3.2: Controlled Parameters In GPS-Mode

	HGT BUTTON	GPS BUTTON	ATTITUDE CONTROL	HEIGHT CONTROL	POSITION CONTROL
GPS-Mode	OFF	ON	√	√	√

When there is no input from the pilot, the UAV will:

- Keep its orientation in the air.
- Maintain its position within the limits of the GPS accuracy (approximately 2 – 5 m).
- Keep its height within the limits of the height controller (approximately 1 – 3 m).
- Compensate for wind speeds up to 12 m/s.

For safety reasons and to make operation as easy as possible, there are some limitations:

- Roll and pitch angles are limited to 45°.
- Speed in horizontal plane is limited to 4.5 m/s.
- Ascend rate is limited to 3 m/s.
- Descend rate is limited to 3 m/s.

In this mode, the inputs via the CTR directly control the speed of the UAV. For example, moving the right control stick completely to the left (which controls pitch and roll) means the system will fly at 4.5 m/s to the left, independent of the wind strength and direction.

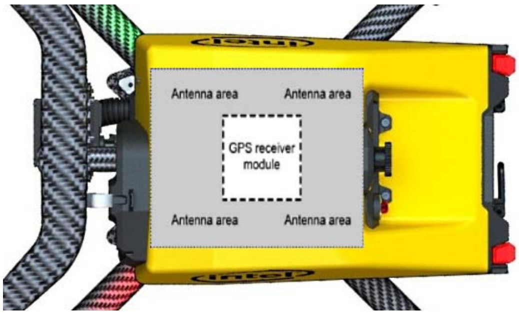
⚠ **CAUTION: WHEN THE GPS QUALITY IS INSUFFICIENT, HEIGHT-MODE WILL AUTOMATICALLY BE ACTIVATED. SHORTLY BEFORE THIS POINT, POSITIONAL ACCURACY MIGHT ALREADY BE TOO LOW AND IT IS STRONGLY RECOMMENDED TO ACTIVELY SWITCH TO HEIGHT-MODE IN SITUATIONS WITH INSUFFICIENT GPS QUALITY.**

IF THE SYSTEM AUTOMATICALLY SWITCHES FROM GPS-MODE TO HEIGHT-MODE, THE GPS-MODE BUTTON WILL BE FLASHING, WHILE THE HEIGHT-MODE BUTTON WILL BE LIT PERMANENTLY. THIS INDICATES THAT THE SYSTEM WILL SWITCH BACK TO GPS-MODE AUTOMATICALLY, WHEN A VALID GPS SIGNAL WILL BE RECEIVED.

IF THE SYSTEM SEEMS TO BE UNSTABLE OR HAS DIFFICULTIES TO KEEP ITS CURRENT POSITION IN GPS-MODE, IMMEDIATELY ACTIVATE HEIGHT-MODE. BE PREPARED THAT YOU NOW NEED TO CONTROL THE POSITION MANUALLY ON THE CTR.

Figure 3.15: GPS Accuracy

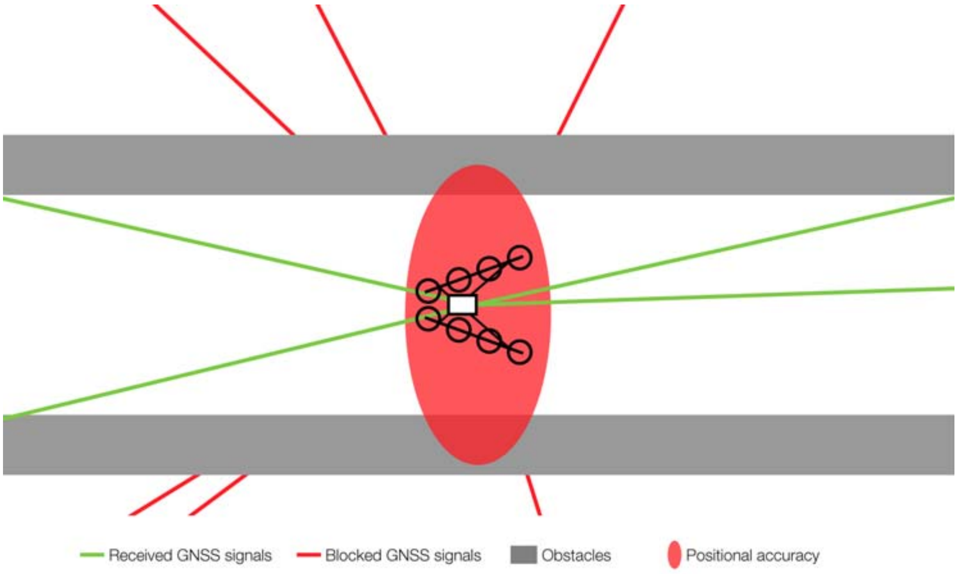
The GPS module of the Intel® Falcon™ 8+ UAV supports GPS and GLONASS. Under ideal conditions, the horizontal accuracy can reach around +/- 2 m. The short-term accuracy is usually higher, because of the data fusion with other available sensor outputs from the IMU. Vertical accuracy of GPS is lower and the measured altitude can vary up to 15 m depending on satellite constellation. A barometric measurement is used for altitude instead of relying on GPS. Height is always measured above ground level and is reset to zero when the rotors are being started. Throughout the duration of a mission there can be a drift of +/- 5 m due to all possible errors: temperature, drift, weather changes, etc.



IMPORTANT:

The GPS receiver module of the Intel® Falcon™ 8+ UAV is placed directly underneath the canopy of the central unit and is surrounded by an antenna. The canopy of the Intel® Falcon™ 8+ UAV is made from a material which does not influence the satellite signals, but anything on the top of the Intel® Falcon™ 8+ UAV can potentially disturb the signal. Never cover the GPS receiver module nor the antenna area to ensure best possible GPS reception.

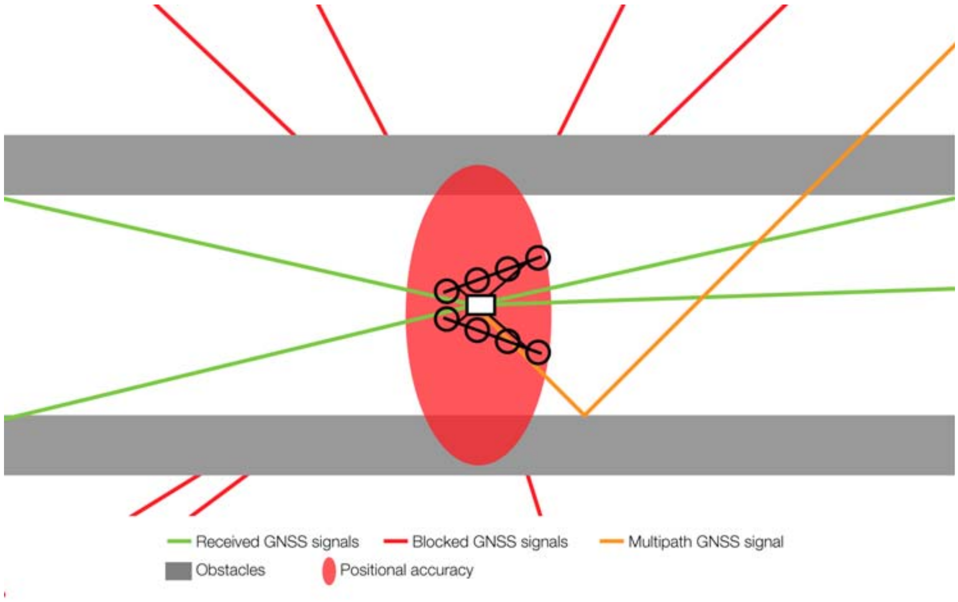
Figure 3.16: Shadowing



The position accuracy can be impaired when obstacles block the direct line-of-sight from many satellites. The obstacle virtually casts a GNSS-shadow over the concerned area. This results in fewer received satellite signals and a changed geometry of the signals themselves. This effect is very common in urban areas, where satellites can be blocked by tall buildings. You may experience one side of the street has good position accuracy, while on the other side position accuracy is extremely poor. If the UAV moves out of the shadow and more satellite signals can be used to calculate the position, the UAV can suddenly change its position due to the new calculation. Therefore, the pilot needs to pay special attention in such situations. Whenever there are potential shadings of the GPS signal, it is recommended to not use GPS-Mode but to activate Height-Mode on the CTR.

When the Intel® Falcon™ 8+ UAV detects a low GPS quality, it automatically activates Height-Mode and gives the respective GPS lost warning (see "GPS Warning" on page 124). Nevertheless, it is strongly recommended to actively switch to Height-Mode on the CTR beforehand, because it is unpredictable when the system will switch between flight modes. Additionally, the system might only switch to Height-Mode when the positional accuracy is already low for the current flight situation.

Figure 3.17: GPS Multi Path Effects



When the UAV is placed close to walls which can reflect the satellite signal, the GPS receiver has no possibility of identifying if the signal comes from a reflection or directly from a satellite. Therefore, there might be situations (often in narrow streets) where reflections are interpreted incorrectly and full GPS reception is displayed, but the actual position accuracy is very low. Therefore, the pilot needs to pay special attention in such situations. Whenever there are potential shadings or reflections of the GPS signal, it is recommended to not use the GPS-Mode.

Compass Error Estimation

In addition to the compass sensors of the Intel® Falcon™ 8+ UAS, the UAV is equipped with a compass error estimation algorithm.

The compass error estimation uses, among others, GPS-data to estimate the heading of the UAV. For this purpose, horizontal flight movements are necessary. The collected data is used to compensate for potential external disturbances of the compass sensors. Directly after launching it can take the compass error estimator up to 30 seconds to work properly.

The compass error estimator is active only in GPS-Mode. It is not active in Height-Mode and in Manual-Mode. Which means that in case of an external magnetic disturbance, the heading of the UAV might be influenced, resulting in an un-commanded yaw movement of the UAV, which must be compensated for by the pilot.

3.6.2. Height-Mode

Table 3.3: Controlled Parameters in Height-Mode

	HGT BUTTON	GPS BUTTON	ATTITUDE CONTROL	HEIGHT CONTROL	POSITION CONTROL
Height-Mode	ON	OFF	√	√	-

⚠ **CAUTION: THE SYSTEM WILL NEITHER KEEP ITS POSITION NOR COMPENSATE FOR WIND. THE POSITION MUST BE HELD MANUALLY BY THE PILOT.**

Attitude and height control is active. When there is no input from the pilot, the UAV will only:

- Keep its orientation in the air (system will be leveled).
- Keep its height within the limits of the height controller (approximately 1 – 3 m).

For safety reasons and to make operation as easy as possible, there are some limitations:

- Roll and pitch angles are limited to 50°.
- Ascend rate is limited to 3 m/s.
- Descend rate is limited to 3 m/s.

WARNING **AVOID FULL CONTROL STICK INPUTS IN HEIGHT-MODE! THE UAV CAN BE OVERSTRESSED IN CERTAIN SITUATIONS, SUCH AS FLYING ABRUPT MANEUVERS WITH A LOW BATTERY.**

In this mode the inputs, via the CTR, control the roll and pitch angles of the UAV. For example, giving full input to the left (using the right control stick, which controls pitch and roll) means the UAV will roll 50° to the left. With this configuration, the wind direction and speed will influence the direction and speed of the UAV.

3.6.3. Manual-Mode

Table 3.4: Controlled Parameters Depending On The Flight Mode

	HGT BUTTON	GPS BUTTON	ATTITUDE CONTROL	HEIGHT CONTROL	POSITION CONTROL
Height-Mode	ON	ON	√	-	-

⚠ **CAUTION: THE UAV WILL NOT KEEP ITS POSITION AND HEIGHT, NOR WILL IT COMPENSATE FOR WIND. CONTROLLING THE POSITION, AND HEIGHT, MUST BE DONE MANUALLY BY THE PILOT FROM THE CTR.**

Only attitude control is active. When there is no input from the pilot, the UAV will:

- Keep its orientation in the air (system will be leveled).

For safety reasons and to make it impossible to flip the system:

- Roll and pitch angles are limited to 50°.

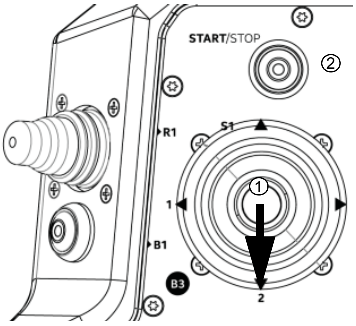
WARNING THE MANUAL-MODE IS FOR EXPERTS ONLY

In this mode the inputs, via the CTR, control the roll and pitch angles and the thrust of the UAV. The direction and the speed of the UAV is influenced by the wind direction and speed.

Having the left control stick in the middle (50%) does not mean the UAV will keep its height. This means the UAV will, depending on the weight of the payload, either ascend or descend when switching from any other mode to Manual-Mode! In most cases with full payload, the system will start to descend. Be prepared to give some thrust to counteract the described effect when switching to Manual-Mode.

3.7. STARTING AND STOPPING THE MOTORS

Figure 3.18: Starting The Motors

	To start the motors: 1. Keep the left control stick in the fully downwards position (1). 2. Use the right hand to push the START/STOP button (2) upwards and hold it for at least one second. The motors will start. Follow the same procedure to switch OFF the motors again. **As a safety measure, the motors will be switched OFF, if the left control stick is not kept in the fully downwards position while the motors are starting. Therefore, do not move the left control stick keep it down while the motors are starting.** **While the Intel® Falcon™ 8+ UAV is on the ground with running motors, always keep the left control stick, which controls the height, in the fully downward position to avoid any unintentional take-off.**

3.8. TAKING OFF

A precondition for successful flight missions is a take-off and landing area which is free of obstacles in a radius of at least 10 m, and with free air space, since buildings or trees can block or influence the GPS signal. The propellers need to be able to spin freely (if necessary remove any possible obstacles). The pilot needs to have an unobstructed view of the complete area of operation.

Please keep in mind:

- Always keep a safe distance from people when starting!
- While the Intel® Falcon™ 8+ UAV is on the ground with running motors, always keep the left control stick, which controls the height, in the fully downward position to avoid any unintentional take-off.
- To take off in GPS- or in Height-Mode, move the left control stick from the fully downward position to fully upwards in one, swift movement and ascend to a safe height. In Manual-Mode the ascent rate is much higher. The left control stick must still be moved with one, swift movement, but avoid maximum control stick input.
- In flight, always keep both hands on the control sticks.

3.8.1. Launching In GPS-Mode

Whenever possible, launching in GPS-Mode is recommended. The GPS quality indicated on the Status Display and on the touchscreen tablet must show at least 4 bars.

To launch the Intel® Falcon™ 8+ UAV in GPS-Mode:

1. Push the GPS button on the CTR; it will be illuminated.
2. Keep the left control stick completely pulled down (= descend).
3. Push the START/STOP button on the CTR up for at least 1 second to start the motors.
4. Keep the right control stick centered (no pitch and roll) and push the left control stick completely up (= ascend) to launch the drone.
5. Keep ascending until a safe height is reached. Be aware that the Intel® Falcon™ 8+ UAV may drift a little and correction might be required.
6. Once the safety height is reached, bring back the left control stick to the center. The Intel® Falcon™ 8+ UAV will then keep its current position, height and orientation as described in “FLIGHT MODES” on page 91.

3.8.2. Launching In Height-Mode

⚠ **CAUTION: LAUNCHING IN HEIGHT-MODE IS RECOMMENDED FOR EXPERIENCED PILOTS ONLY!**

It is necessary to practice this flight mode frequently, because it makes it possible to take off from enclosed areas, areas with magnetic disturbances, or areas with poor GPS reception.

To launch the Intel® Falcon™ 8+ UAV in Height-Mode

1. Push the HGT button on the CTR.
   It will be illuminated.
2. Keep the left control stick completely pulled down (= descend) while pushing the START/STOP button on the CTR up for at least 1 second.
   The motors will start directly.
3. Keep the right control stick centered (no pitch and roll) and push the left control stick completely up (=ascend).
   The UAV will lift off quickly.

Once in the air you will have to use the right control stick to compensate for the wind (by pitching and rolling the UAV accordingly).

3.8.3. Launching In Manual-Mode

⚠ **CAUTION: LAUNCHING IN MANUAL-MODE IS FOR EXPERTS ONLY.**

In Manual-Mode the pilot must control all axes. There is no automation regulating, nor preventing pilot errors. Normally this mode should not be used.

To launch the Intel® Falcon™ 8+ UAV in Manual-Mode:

1. Push the GPS and HGT buttons on the CTR simultaneously.
   Both will be illuminated.
2. Keep the left control stick completely pulled down (= descend).
3. Push the START/STOP button on the CTR up for at least 1 second to start the motors.
4. Keep the right control stick centered (no pitch and roll) and push the left control stick almost completely up (forward) to launch the drone.
   The UAV will lift off very quickly. Therefore, be prepared to reduce thrust quickly after a safety distance to the ground is reached. The actual safety distance depends on the specific circumstances of the take-off spot (wind, distance to obstacles, etc.).
   Be aware that all axes must be controlled manually!

The left control stick is now controlling the motor speed directly, so to ascend you must move the left control stick up with rather strong movements, but very carefully down to descend, because the UAV will automatically descend when there is not enough thrust. Normally you must give at least approximately 50% thrust to maintain your height (depending on the attached payload).

3.9. THE FLIGHT

Figure 3.19: Basic Flight Principles

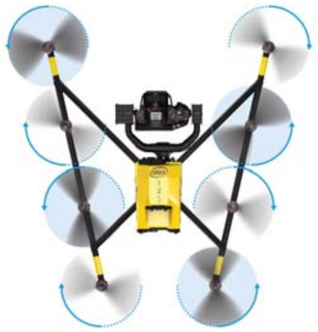
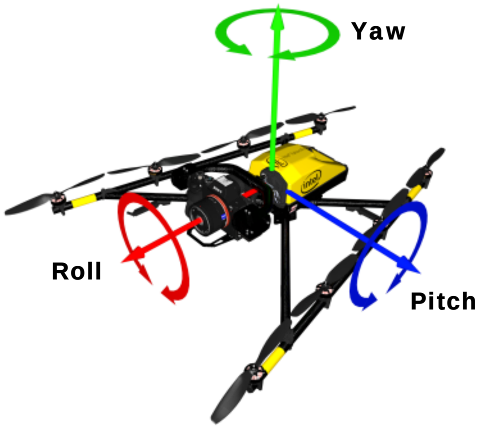
	For redundancy, the Intel® Falcon™ 8+ UAV has eight propellers. Four propellers turn clockwise, four turn counterclockwise as shown in the image. This eliminates the torque of the single propellers as much as possible. Nevertheless, the UAV has no inherent stability, and a control circuitry needs to constantly monitor and control the UAV to keep it stable.

Figure 3.19: Basic Flight Principles (Continued)

	By varying the turn rate of the different propellers, there are four controllable directions along three axes on which the UAV can be controlled: • Roll axis: movement to the left or right. For example, when rolling to the right, the propellers of the left motor rail are turning faster than the propellers on the right motor rail. • Pitch axis: movement forwards or backwards. For example, to fly forward, the four back propellers turn faster than the four front propellers. The UAV takes a certain angle along the pitch axis and flies forward. • Yaw axis: adjust the heading of the UAV. When yawing to the left (clockwise), all left turning propellers turn faster than the right turning propellers. • Thrust: ascend or descend along the yaw axis. All propellers turn faster or slower to ascend or to descend.

CAUTION: DOWNWASH

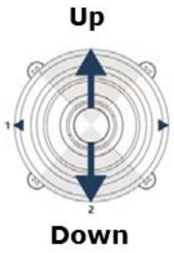
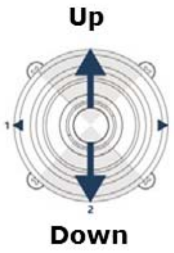
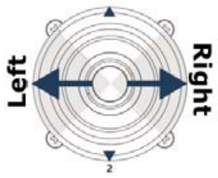
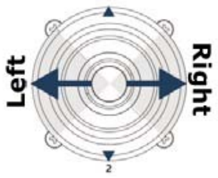
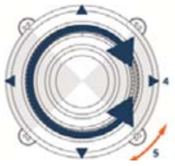
TRY TO AVOID FLYING THROUGH THE DOWNWASH (TURBULENT AIR UNDER THE UAV CAUSED BY THE PROPELLERS) TO SAVE ENERGY AND TO ENSURE A SMOOTH DESCENT. IT CAN BE AVOIDED BY DESCENDING AND SIMULTANEOUSLY FLYING SIDEWAYS OR BACKWARDS.

3.9.1. Controlling The Intel® Falcon™ 8+ UAV From The CTR

The standard control mode is called Mode 2. In this mode, the left control stick controls thrust and yaw. The right control stick controls pitch and roll.

The upper part of the right control stick can be turned, which controls the yaw movement of the UAV. This special function makes controlling the UAV very intuitive as all controls to move the UAV in the horizontal pane are accessible with a single hand.

Figure 3.20: Left And Right Control Sticks

	**Left control stick:** **thrust & yaw** Thrust Up = ascend Down = descend		**Right control stick:** **pitch & roll & yaw** Pitch Up = fly forward Down = fly backward
	Yaw Left = turn heading left Right = turn heading right		Roll Left = fly left Right = fly right
			Yaw The upper part of the right control stick can be turned, which controls the yaw movement of the UAV. This special function makes controlling the UAV very intuitive as all controls to move the UAV in the horizontal pane are accessible with one single hand.

Note *All directional indications are always referring to the point of view of the UAV. Depending on the heading of the UAV, directions may be different from the point of view of the pilot.*

⚠ CAUTION: TO ENSURE SAFE OPERATION ALL PILOTS MUST ALWAYS FOLLOW THE SAFETY GUIDELINES AND THE SAFETY PRECAUTIONS IN "SAFETY FIRST" ON PAGE 7. WE STRONGLY RECOMMEND ATTENDING BASIC TRAINING AND TO FREQUENTLY PRACTICE SESSIONS IN HEIGHT-MODE!

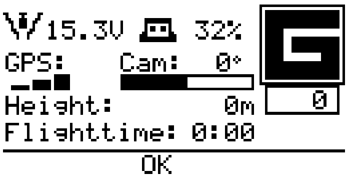
3.9.2. Mission Planning

You will maximize flight time when you take your time to plan your missions. Decide on a path and choose position and camera angle before taking-off. Be aware of the size of the area in which you plan to fly. Always ensure the Intel® Falcon™ 8+ UAV has enough battery capacity to fly back to the home position – even if the wind unexpectedly increases.

3.9.3. In-Flight

During the flight, all relevant telemetry information is presented on the **Main Screen** of the Status Display of the CTR. From top to bottom:

Figure 3.21: Flight Information On The Main Screen Of The Status Display

 15.3V 32% GPS: Cam: 0° G Height: 0m 0 Flighttime: 0:00 OK	From top to bottom: - Battery voltage of the UAV: `15.3V` - Remaining battery capacity of the CTR in percent: 32% - Letter `G` (= GPS-Mode), `H` (= Height-Mode) or `M` (= Manual-Mode) indicating the active flight mode - `0`: Counter of triggers sent to the camera. If no trigger has been sent yet, 0 is displayed. Display can vary depending on payload. For further details see "Inspection Payload" on page 40. - GPS: GPS quality up to 5 bars - `Cam`: Camera tilt level: 0° - `Height`: Current height: 0m - `Flighttime`: starts counting when the motors are started - Bottom line `OK`. If there are any system warnings, the bottom line will display `<- Check Msg`. Push the arrow LEFT button until the warning message is displayed. More regarding warning messages in "WARNINGS" on page 116.

Further details regarding the Status Display and its options can be found in “STATUS DISPLAY” on page 136.

3.9.4. General Operating Tips

Please keep in mind: The UAV is not equipped with a sense and avoid system. The operator is responsible for seeing and avoiding all traffic, persons, structures, and obstacles.

We recommend two-person operations (pilot and observer). All sense and avoid is done by the pilot and observer.

Try to avoid situations such as:

- Strong wind or turbulences
- Interference or lost data links
- Weak or shadowed GPS signal (“Shadowing” on page 95)
- Narrow flight areas
- Heights above 1,500 meters above sea level

Figure 3.22: Examples For Situations To Be Avoided

Turbulences may occur:	• Close to buildings or other large objects (e.g. trees, woods). • Close to thunderstorms. • Above a source of heat (e.g. fire).
Interferences that may affect the UAV may occur:	• Close to any sources of magnetic or electric fields (e.g. power lines, power generators, antenna poles, large ferromagnetic structures and/or nuclear radiation). • Close to strong wireless communication towers like cellular network towers or radar antennas.
Urban areas:	• The surrounding houses will probably affect the GPS signal. Wind blowing above the houses can cause turbulence, as well as local wind speed spikes due to the wind tunnel effect. In this situation, you can expect sudden movements of the UAV due to the relatively low positional accuracy, and strong external forces from the wind. Extra vigilance is necessary when flying near buildings.

Good preparation is the key to being able to react correctly in challenging situations.

Perform frequent training sessions, especially in Height-Mode, to become a skilled pilot. Analyze each mission regarding (but not limited to) the above-mentioned factors.

If you find that the Intel® Falcon™ 8+ UAV does not react to control inputs as expected, for example, inaccurate position control due to bad GPS reception), immediately activate Height Mode. Keep calm and try to carefully steer the UAV to a spot where less disturbances are to be expected.

3.9.5. Battery Warnings

There are several acoustic and visual warnings (in the bottom line of the Status Display and in the notification area at the top of the touch screen tablet) that caution you of low or empty battery.

Note	*The Intel Falcon 8+ takes many data points into account to calculate the remaining flight time. These include, among others, the current average power consumption, remaining charge of the battery and the potential of one battery being depleted sooner than the other. Due to this, battery warnings may appear sooner than expected or (when suddenly reducing the average power consumption) even disappear again. If in doubt, the pilot can check the battery voltage on the **Main Screen** of the Status Display. It is advised to prepare the landing procedure at 14.2 V and be on the ground at 14.0 V. Beyond 14.0 V, the system may become unstable.*

The following warnings refer to the UAV batteries:

- First warning (audio): “`Battery weak, land soon`” and a vibration of the CTR. The voltage display on the Status Display starts flashing. The audio warning is repeated every 20 seconds.
  The battery voltage is ~ <= 14.4 V or the remaining maximum flight time is < 4 minutes.
  Text on Status Display: `BATTERY WEAK!`

  Text on tablet: `Falcon Battery weak. Land soon!`
- Second warning (audio): “`Battery empty, land now`” and a vibration of the CTR. The voltage display on the Status Display is flashing.
  The battery voltage is ~ <= 14.1 V or the remaining maximum flight time is < 2 minutes.
  The audio warning is repeated every 10 seconds when the remaining flight time < 1 minute.

WARNING	**THE UAV MUST BE LANDED IMMEDIATELY AFTER THIS WARNING.**

The following warnings refer to the Cockpit battery:

- First warning (audio): “`Battery weak, land soon`” and a vibration on the CTR.
  Text on Status Display: `CP. BAT. WEAK!`
  Text on tablet: `Cockpit battery weak. Land soon!`
  The remaining operating time of the CTR display, shown as a percentage on the Status Display, starts flashing. The audio warning is repeated every 20 seconds.
- Second warning: “`Battery empty, land now`” and a vibration of the CTR.
  Text on Status Display: `CP. BAT. EMPTY!`
  Text on tablet: `Cockpit battery empty. Land now!`The remaining operating time of the CTR, shown as a percentage on the Status Display, is flashing.
  The audio warning is repeated every 10 seconds when the remaining operating time < 1 minute.

⚠ **CAUTION: THE SYSTEM MUST ALWAYS BE LANDED BY THE PILOT! THERE IS NO AUTO-LANDING IN CASE OF LOW OR EMPTY BATTERY.**

3.10. IN-FLIGHT EMERGENCIES

Interruptions to the regular control behavior can be caused by interference sources such as other transmitters near the UAV. They can disturb the video signal (5.8 GHz frequency band), the data link connection (2.4 GHz frequency band) and/or the GNSS module or other system electronics.

In some cases, malfunctions or electronic component failures can also lead to the abnormal behavior of the UAV.

Possible emergencies, and recommended responses, are outlined below.

Table 3.5: Operational Guidelines In Case Of Emergency

EVENT	POSSIBLE ACTION
In GPS-Mode: Position accuracy of the UAV is low, and it starts drifting from its current position.	Switch to Height-Mode and control the UAV in Height-Mode. With low GPS reception quality, the UAV might not have automatically switched to Height-Mode yet, and therefore drift from the current position prior to being detected by the sensors is possible.

Table 3.5: Operational Guidelines In Case Of Emergency (Continued)

EVENT	POSSIBLE ACTION
In GPS-Mode: The UAV does not seem to react to the control inputs of the pilot while the data link is not disturbed.	Switch to Height-Mode and control the UAV in Height-Mode. In GPS-Mode, the right control stick on the CTR commands a specific speed. If the speed accuracy is low because of low GPS reception quality (but not yet automatically activated Height-Mode), the reactions to control commands might be slow.
In GPS-Mode: The UAV is swiftly flying away from its current position during vertical take-off.	Switch to Height-Mode and continue the vertical take-off to get to a safe distance from the ground and other obstacles quickly. Control the UAV in Height-Mode. The compass sensors might have been disturbed on the ground and the compass error estimation algorithms do not yet have enough information from other sensors to work with sufficient accuracy. After receiving enough input from the IMU sensors, the compass error estimation algorithms are usually able to stabilize the position control even in GPS Mode. “FLIGHT MODES” on page 91 for further information.
In GPS- or Height-Mode: The UAV performs strong changes in altitude, which have not been commanded on the CTR.	Switch to Manual-Mode and perform a controlled landing. Get help from support to analyze the cause. Throughout the duration of a mission, there can be a drift of +/- 5 m in altitude due to all cumulative errors: temperature, drift, weather changes, etc. If stronger changes occur, there might be a malfunction of the barometric sensors, which needs to be analyzed. Because of the triple redundant flight control of the Intel® Falcon™ 8+ UAV there is a very low probability for this malfunction to occur.

Table 3.5: Operational Guidelines In Case Of Emergency (Continued)

EVENT	POSSIBLE ACTION
Loss of the data link connection between UAV and CTR	Check the antenna orientation. Try to shorten the distance to the UAV by walking towards it. Before take-off: • Analyze the flight situation and plan the routes to fly. • Based on this assessment, select an appropriate Link Loss Procedure for every single flight. • Always make sure that there will be no obstacles in between the UAV and its home position if Link Loss Procedure `ComeHome Straight` or `ComeHome High`, has been selected. The Intel® Falcon™ 8+ UAS features two fully independent data link connections. In case one link is disturbed, there is always a second independent link on a different channel in the 2.4 GHz band. In case that both data links are lost, the UAV automatically activates one of the three Link Loss Procedures you are forced to select before the start. As soon as the link is re-established you can take control again, and continue the flight. All Link Loss Procedures always go into a controlled descend.
Simultaneous loss of GPS reception, and data link connection, between UAV and CTR	Check the antenna orientation. Try to shorten the distance to the UAV by walking towards it. The Intel® Falcon™ 8+ UAV will activate the Link Loss Procedure because of the lost data link connection. As no GPS signal can be received, it is impossible to locate the home position and a `Direct Landing` will be performed. The UAV will drift with the wind in such a situation.

Table 3.5: Operational Guidelines In Case Of Emergency (Continued)

EVENT	POSSIBLE ACTION
A motor stops working in flight.	1. Steer the UAV with careful control commands and avoid strong control stick inputs. 2. Carefully land the system. 3. Identify and repair the cause of the failure before flying again. Should one of the motors become defective, it will be identified by the UAV and compensated for. A visual, and an acoustical warning signal are given and emitted from the CTR. With the notification, all you must do is bring the UAV back and land in a safe spot.
More than one motor stops working in flight	If possible, immediately land the system at its current location with careful control commands avoiding strong control stick inputs. Identify and repair the cause of the failure before flying again. If two or more motors are lost, depending on their position, stable flight characteristics can no longer be guaranteed. When sufficient thrust is missing, the system has the following priorities: 1. Attitude 2. Position 3. Altitude Meaning that if insufficient thrust is available, the system will first descend. If still not enough thrust is available, it will start drifting but still try to hold the attitude. Only if physically impossible, the attitude of the system will also be compromised.

Table 3.5: Operational Guidelines In Case Of Emergency (Continued)

EVENT	POSSIBLE ACTION
Gusts of wind above the drone limits / too much wind	In GPS-Mode the Intel® Falcon™ 8+ UAV can fly in wind speeds up to 12 m/s. If GPS-Mode is active and there are gusts exceeding 12 m/s you must: 1. Switch to Height-Mode. In this mode, the UAV can fly in wind speeds up to 16 m/s. 2. Descend to a lower altitude, as wind speed usually decreases at lower altitudes. 3. If you are in Height-Mode and wind speed exceeds 16 m/s, descend and if the wind is still too strong, land the system.
Loss of information on the Status Display of the CTR	As long as the flight characteristics of the UAV remain unchanged, fly back, land, and analyze the cause of the display failure. If flight characteristics changed regarding position or altitude control, consider changing to Height-Mode or Manual-Mode.
The UAV catches fire during start up on the ground	Keep the left control stick down and immediately push the START/STOP button again too switch off the motors. Extinguish the fire. Wait until the UAV has cooled down. Follow the post-flight checklist to store the UAS. Contact Intel support to get assistance in determining the cause.
The UAV catches fire in flight	Land the UAV immediately on a safe landing area. Push the START/STOP button to turn off the motors. Extinguish the fire. Wait until the UAV has cooled down. Follow the post-flight checklist to store the UAS. Contact Intel support to get assistance in determining the cause.

Table 3.5: Operational Guidelines In Case Of Emergency (Continued)

EVENT	POSSIBLE ACTION
The UAV flies outside (laterally or vertically) of the space previously dedicated for the flight.	**Action 1** (before take-off) Before you take off you can assure the UAV will stay in the allocated space. You can limit the maximum distance and height from the take-off spot the Intel Falcon 8+ UAV is started from by setting a specific distance and height which will not be exceeded by the UAV. To set these boundaries from the **Main Screen** of the Status Display (see "STATUS DISPLAY" on page 136): 1. Push **ENT** in the **Main Screen**. The menu is opened 2. Use the arrow **RIGHT/LEFT** buttons to select `Settings`. 3. Push **ENT**. The `Settings` menu is opened. 4. Use the arrow **RIGHT/LEFT** buttons to select `Bounding Box`. 5. Push **ENT**. The respective menu is opened. `Radius` is highlighted. 6. Push **ENT**. The field behind `Radius` is highlighted. 7. Use the arrow **RIGHT/LEFT** buttons to determine the radius the UAV should fly in. The radius can be set from 10 m to 1000 m. 8. Push **ENT**. The value is stored. `Radius` is highlighted. 9. Push the arrow **RIGHT** button one time to select `Height`. 10. Push **ENT**. The field behind `Height` is highlighted. 11. Use the arrow **RIGHT/LEFT** buttons to determine the height the UAV should not exceed. The height can be set from 10 m to 300 m. 12. Push **ENT**. The value is stored. `Height` is highlighted.

Table 3.5: Operational Guidelines In Case Of Emergency (Continued)

EVENT	POSSIBLE ACTION
	13. Push the arrow **RIGHT** button one time to select `Activate`. 14. Push **ENT**. The boundaries are activated.You return to the **Main Screen**. **Action 2** Stay calm and fly back into the operating area. If necessary switch to Height-Mode or Manual-Mode (see “FLIGHT MODES” on page 91). **Action 3** Try to activate the `RETURN TO HOME` function from the CTR to bring the Intel Falcon 8+ UAV back to where it took off by pushing the dedicated button on the CTR (see “Intel® Cockpit Controller (CTR) Overview” on page 23). **Action 4** Switch off the CTR to activate the Link Loss Procedure. Before take-off you are forced to choose one of three Link Loss Procedures to determine the automatic landing in the unlikely event that both data links are lost: `Direct landing`, `ComeHome Straight` (minimum 20 m altitude or at its current height if higher than 20 m) or `ComeHome High` (at max. mission height). For more information about the Link Loss Procedure see “LINK LOSS PROCEDURE” on page 88). **Action 5** Force an intentional crash at an uncritical position. All propellers will stop and the Intel Falcon 8+ UAV will fall down. To do so: 1. Switch to Manual-Mode. 2. Give full thrust down and simultaneously 3. Push the dedicated engine START/STOP button on the CTR upwards for about one second.

3.11. LANDING

It is recommended to use a wide-open space as a landing spot (approximately 10 m radius around the starting position should be free of obstacles).

⚠ **CAUTION: BEFORE LANDING THE INTEL® FALCON™ 8+ UAV, ALWAYS ADJUST THE CAMERA TO A HORIZONTAL POSITION TO AVOID DAMAGING THE LENS ON THE GROUND.**

3.11.1. Landing In GPS-Mode

Landing in GPS-Mode is recommended. The GPS quality indicated on the Status Display and the touchscreen tablet must show at least 4 bars.

1. Activate the GPS-Mode.
2. Fly the UAV to a position above the desired landing area at a safe height of at least 3 meters.
3. Descend slowly to a height of 1.5 meters and wait until the UAV is stabilized.
4. Keep the right control stick centered, while carefully moving the left control stick about half way down to descend slowly.
5. Right before touch-down – at 0.2 - 0.3 m – move the left control stick down gradually until the UAV lands on the ground. While the Intel® Falcon™ 8+ UAV is on the ground with running motors, always keep the left control stick in the fully downward position to avoid any unintentional take-off.
6. Keep the left control stick in the fully downwards position and use the right hand to simultaneously press the START/STOP button on the CTR for at least one second to stop the motors.
7. Follow the post-flight check (“POST-FLIGHT CHECK” on page 16) to safely switch off and store away the complete system.

3.11.2. Landing In Height-Mode

⚠ **CAUTION: LANDING IN HEIGHT-MODE IS FOR SKILLED PILOTS ONLY.**

1. Activate the Height-Mode.
2. Fly the UAV to a position above the desired landing area at a safe height of at least 3 meters.
3. Descend slowly to a height of 1.5 meters and wait until the UAV is stabilized.

4. Use the right control stick to maintain the current position as precisely as possible, while carefully moving down the left control stick to descend slowly.
5. Right before touch-down – at a height of 0.2 - 0.3 m – move the left control stick down gradually until the UAV lands on the ground. While the Intel® Falcon™ 8+ UAV is on the ground with running motors, always keep the left control stick in the fully downward position to avoid any unintentional take-off.
6. Keep the left control stick in the fully downwards position, and use the right hand to simultaneously press the START/STOP button on the CTR for at least one second to stop the motors.
7. Follow the post-flight check ("POST-FLIGHT CHECK" on page 16) to safely switch off and store away the complete system.

3.11.3. Landing In Manual-Mode

⚠ **CAUTION: LANDING IN MANUAL-MODE IS FOR EXPERTS ONLY.**

In Manual-Mode the pilot must control all axes directly as there is no automation assisting control, nor preventing pilot errors.

1. Activate the Manual-Mode.
2. Fly the UAV to a position above the desired landing area at a safe height of at least 3 meters.
3. Descend slowly to a height of 1.5 meters and wait until the UAV is stabilized.
4. Use the right control stick to maintain the current position as precisely as possible, while carefully moving down the left control stick to descend slowly.
5. Right before touch-down – at a height of 0.2 - 0.3 m – move the left control stick down gradually until the UAV lands on the ground. While the Intel® Falcon™ 8+ UAV is on the ground with running motors, always keep the left control stick in the fully downward position to avoid any unintentional take-off.
6. Keep the left control stick in the fully downwards position, and use the right hand to simultaneously press the START/STOP button on the CTR for at least one second to stop the motors.
7. Follow the post-flight check ("POST-FLIGHT CHECK" on page 16) to safely switch off and store away the complete system.

3.11.4. Switching OFF The UAS

Always switch OFF the UAS in the following order:

1. Camera (wait at least 10 seconds until it has stored all data and is fully powered down).
2. Intel® Falcon™ 8+ UAV:
    - Push and hold the power button.
      The LED position lights will increase brightness.
      The LED position lights will decrease brightness and simultaneously there will be a short beep from the UAV.
    - Let go of the button.
3. CTR:
    - Push and hold the power button of the touchscreen tablet for approximately 3 seconds until “Slide to shut down your PC” is shown.
    - Follow this instruction to fully power down the touchscreen tablet.
    - Push and hold the POWER button of the CTR. The CTR will vibrate briefly.
    - Let go of the button.

3.12. WARNINGS

The Intel® Falcon™ 8+ UAS displays all warnings which might occur, in the status line at the bottom of the Status Display and in the notification area at the top of the touchscreen tablet. When there is no warning to display, the status line shows `OK`. On the tablet `SYSTEM OK` is shown in the notification area.

A small loudspeaker is connected to a headphone port (mini jack), which is located on the upper left-hand side of the CTR (“Intel® Cockpit Controller (CTR) Overview” on page 23). It is possible to connect headphones there, which might be helpful under noisy conditions.

Table 3.6: Possible Warnings

SHOWN TEXT	REASON	SIGNALS
Status Display: `BATTERY WEAK!` Tablet: `Falcon battery weak. Land soon!`	The battery of the UAV is weak.	Vibration on the CTR Acoustic: Battery weak. Land soon! repeated every 20 seconds Visual: The voltage display of the UAV on the Status Display flashes.

Table 3.6: Possible Warnings (Continued)

SHOWN TEXT	REASON	SIGNALS
Status Display: `BATTERY EMPTY!` Tablet: `Falcon battery empty. Land now!`	The battery of the UAV is empty.	Vibration on the CTR Acoustic: Battery empty. Land now! repeated every 10 seconds if only one minute of flight time remains. Visual: The voltage display of the UAV on the Status Display flashes.
Status Display: `CP. BAT. WEAK!` Tablet: `Cockpit battery weak. Land soon!`	The battery of the CTR is weak.	Vibration on the CTR Acoustic: Battery weak. Land soon! Visual: The remaining operating time of the CTR shown as a percentage on the Status Display flashes.
Status Display: `CP BAT. EMPTY!` Tablet: `Cockpit battery empty. Land now!`	The battery of the CTR is empty.	Vibration on the CTR Acoustic: Battery empty. Land now! Visual: The remaining operating time of the CTR shown as a percentage on the Status Display flashes.
Status Display: `LINK WEAK!` Tablet: `Link weak!`	One of the two data link connections has failed.	Vibration on the CTR Acoustic: Link weak
Status Display: `LINK LOST!` Tablet: `Link lost!`	Data link connection is lost.	Vibration on the CTR Acoustic: Link lost
Status Display: `GPS LOST!` Tablet: `GPS signal lost!`	The GPS signal quality is not sufficient.	Vibration on the CTR Acoustic: GPS lost
Status Display: `MOTOR DEFECT!` Tablet: `Motor failure. Land now!`	There is an error with a motor, a motor controller or the motor bus.	Vibration on the CTR Acoustic: Motor failure. Land now!

Table 3.6: Possible Warnings (Continued)

SHOWN TEXT	REASON	SIGNALS
Status Display: `JOYSTICK ERROR!` Tablet: `Joystick error. Land now!`	The calibration of the control sticks failed.	Vibration on the CTR
Status Display: `CP TEMPERATURE!` Tablet: `Cockpit temperature high!`	The Cockpit temperature is outside of the allowed range.	Vibration on the CTR
Status Display: `<- Check Msg` Tablet: `SYSTEM ERROR! CHECK STATUS DISPLAY!`	A Trinity system warning is displayed on the **Error Message Screen** of the Status Display.	See as well “STATUS DISPLAY OVERVIEW” on page 136
Status Display: `BATTERY OVER-HEAT!` Tablet: `Falcon battery temperature high!`	The temperatures of the UAV batteries are outside the allowable range	Vibration on the CTR.
The following messages are only shown in the notification area on the touchscreen tablet.		
`Tablet battery empty!`	The battery of the touchscreen tablet is empty.	Shown only on tablet
`Tablet battery weak!`	The battery of the touchscreen tablet is low.	Shown only on tablet

3.12.1. Magnetic Field Warning

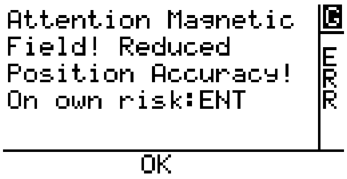
While starting the Intel® Falcon™ 8+ UAV, a magnetic field warning may occur.

Usually disturbances on the ground come from underground lines and can quickly be resolved by switching off the Intel® Falcon™ 8+ UAV, moving it to a different spot and starting from the new location.

Alternatively, it is possible to start in Height-Mode to avoid any position corrections by the system which might occur in GPS-Mode, and then only activate GPS once in the air.

The magnetic disturbance will then be at a safe distance and the estimation algorithms will be active.

Table 3.7: Acoustic And Visual Magnetic Field Warning

REGARDING	VISUAL AND ACOUSTIC SIGNAL	EXPLANATION
UAV	Acoustic: A constant loud beep is heard. Visual (on Status Display):  Attention Magnetic Field! Reduced Position Accuracy! On own risk:ENT G ERR OK	This warning only appears when the system is not yet flying. It means the UAV is close to a magnetic field, which disturbs the correct determination of the UAV's orientation. Thus, starting in GPS-Mode can lead to uncontrolled movement of the UAV in the attempt to hold the exact position. To resolve this warning: 1. Switch OFF the Intel® Falcon™ 8+ UAV, the touchscreen tablet and the CTR. 2. Move the UAV to a different spot and switch the complete system ON again. 3. If the warning is no longer present, you can take off in GPS-Mode. If the warning is not resolved or if taking off from a different spot is impossible, you can: 1. Switch to Height-Mode and take off in Height-Mode to avoid any position corrections by the system, which might occur in GPS-Mode. 2. Fly to open space and keep Height-Mode activated for at least 20 seconds (it will help the estimation algorithms if some movements forward, backward, left and right are performed). 3. Switch to GPS-Mode in open space. The magnetic disturbance will then be at a safe distance and the estimation algorithms will be active. 4. Always be prepared to switch back to Height-Mode anytime.

In flight, the Intel® Falcon™ 8+ UAV uses algorithms to detect possible disturbances of the compass sensors. If there are discrepancies between the magnetometer output and the expected orientation, the UAV's heading is estimated using the other available IMU sensors. This technology enhances the robustness of the UAS against external disturbances of the magnetic field.

Note	*Since the IMU sensors, like accelerometers, are needed to estimate the heading, the compass estimation does not work if the UAV is standing still on the ground. During start-up, the current magnetic field is compared to the expected magnetic field. If there is a discrepancy, there will be a warning as described above. The warning can be canceled by pushing ENT of the Status Display on the CTR.*

⚠ **CAUTION: IT IS IMPORTANT TO NOTE THAT AS LONG AS THE INTEL® FALCON™ 8+ UAV REMAINS SWITCHED ON, THE CANCELED MAGNETIC FIELD WARNING WILL NOT BE REPEATED.**

IF THE INTEL® FALCON™ 8+ UAV IS MOVED TO A DIFFERENT LOCATION WHILE BEING SWITCHED ON, THERE WILL BE NO WARNING, EVEN IF THERE IS A MAGNETIC DISTURBANCE PRESENT.

3.12.2. Critical Battery Levels & Warnings Of The UAV And The CTR

The following warnings may occur in the bottom line of the Status Display and in the notification area of the touchscreen tablet.

Table 3.8: Warnings Depending On Critical Battery Levels

REGARDING	SIGNALS	EXPLANATION
UAV	Acoustic: Battery weak, land soon Tactile: Vibration on the CTR Visual on Status Display: BATTERY `WEAK!` Text on the tablet: `Falcon battery weak. Land soon!` Additionally, the voltage display on the Status Display flashes.	Voltage of the UAV: ~ <= 14.4 V UAV remaining runtime is below 4 Minutes
	Acoustic: Battery empty, land now Tactile: Vibration on the CTR Visual on Status Display: BATTERY `EMPTY!` Text on the tablet: `Falcon battery empty. Land now!` Additionally, the voltage display on the Status Display flashes.	Voltage of the UAV: ~ <= 14.1 V UAV remaining runtime is below 2 minutes. You must land immediately. The battery and/or UAV can be damaged if the flight is continued.

Table 3.8: Warnings Depending On Critical Battery Levels (Continued)

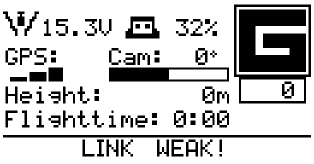
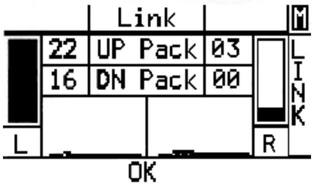
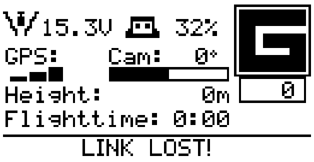
REGARDING	SIGNALS	EXPLANATION
CTR	Acoustic: Battery weak, land soon Tactile: Vibration on Cockpit Visual on Status Display: `CP. BAT. WEAK!` Text on the tablet: `Cockpit battery weak. Land soon!` Additionally, the remaining operating time of the CTR shown as a percentage on the Status Display flashes.	The battery of the CTR is weak.
	Acoustic: Battery empty, land now Tactile: Vibration on Cockpit Visual on Status Display: `CP. BAT. EMPTY!` Text on the tablet: `Cockpit battery empty. Land now!` Additionally, the remaining operating time of the CTR shown as a percentage on the Status Display flashes.	The battery of the CTR is empty. You must land immediately. The battery and/or UAV can be damaged if the flight is continued.

WARNING **THE PILOT IS ALWAYS RESPONSIBLE FOR LANDING AS THERE IS NO AUTO LANDING WHEN THE UAS HAS A LOW OR EMPTY BATTERY.**

3.12.3. Data Link Warnings

The following data link warnings may occur in the status line at the bottom of the Status Display.

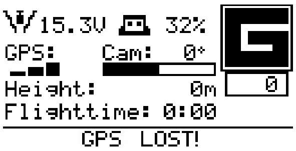
Table 3.9: Diversity Data Link Warnings

REGARDING	SIGNALS	EXPLANATION
Diversity data link signal	Acoustic: Link weak Tactile: Vibration on CTR Visual:  15.3V 32% GPS: Cam: 0° Height: 0m 0 Flighttime: 0:00 LINK WEAK!  Link 22 UP Pack 03 16 DN Pack 00 L R LINK M OK	The Intel® Falcon™ 8+ UAV has two fully independent data link connections. In case one link is disturbed, the `LINK WEAK` message is shown. Nevertheless, the system can still be fully controlled via the second independent link, on a different channel in the 2.4 GHz band. Check if the antenna panel of the CTR is completely unfolded and reduce the distance to the UAV until the signal strengthens. In case of the `LINK WEAK` message pushing the arrow **RIGHT** button three times opens the shown screen with details about the signal strength of both data link connections.
	Acoustic: Link lost Tactile: Vibration on Cockpit Visual:  15.3V 32% GPS: Cam: 0° Height: 0m 0 Flighttime: 0:00 LINK LOST!	The UAV has flown out of range and there is no data link connection between UAV and CTR anymore. In this case the preselected Link Loss Procedure is automatically activated.

3.12.4. GPS Warning

The following GPS warning may occur in the status line at the bottom of the Status Display.

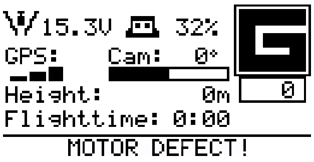
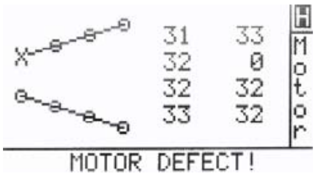
Table 3.10: GPS Signal Warning

REGARDING	SIGNALS	EXPLANATION
GPS signal	Acoustic: GPS lost Tactile: Vibration on Cockpit Visual:  15.3V 32% GPS: Cam: 0° Height: 0m Flighttime: 0:00 0 GPS LOST!	The quality of the GPS signal is not sufficient to reliably keep the position of the UAV. It will automatically switch to Height-Mode. **The pilot must always be capable of controlling the UAV in Height-Mode!** If the system automatically switches from GPS-Mode to Height-Mode, the GPS-Mode button will be flashing, while the Height-Mode button will be lit permanently. This indicates that the system will switch back to GPS-Mode automatically, when a valid GPS signal will be received. In situations where a loss of the GPS signal can be predicted, it is always better to manually switch to Height Mode.

3.12.5. Motor Failure Warning

The following motor failure warning may occur in the status line at the bottom of the Status Display.

Table 3.11: Motor Warning (Controller)

REGARDING	SIGNALS	EXPLANATION
Motors	Acoustic: Motor failure, land now Tactile: vibration on Cockpit Visual:  15.3V 32% GPS: Cam: 0° Height: 0m Flighttime: 0:00 G 0 MOTOR DEFECT!  31 33 32 0 32 32 33 32 Motor MOTOR DEFECT!	A motor, motor controller, and/or propeller is not working properly. In most situations, the redundant propulsion system will compensate one failing motor/rotor combination. Land immediately, controlling the UAV with careful, soft maneuvers and try to identify and fix the root cause. In case of the `MOTOR DEFECT!` message push once the arrow **LEFT** button of the Status Display, when the **Main Screen** is shown. This opens the shown screen which helps identifying the motor causing the warning.

3.12.6. CTR Warnings

The following warnings relating to the CTR may occur in the status line at the bottom of the Status Display and in the notification area of the touchscreen tablet. They may come together with other signals.

Table 3.12: Possible Warnings Which Refer To The CTR

SHOWN TEXT	REASON	SIGNALS
Status Display: `CP. BAT. WEAK!` Tablet: `Cockpit battery weak. Land soon!`	The battery of the CTR is weak.	Vibration on the CTR. Acoustic: Battery weak. Land soon! Visual: The remaining operating time of the CTR shown as a percentage on the Status Display flashes.

Table 3.12: Possible Warnings Which Refer To The CTR (Continued)

SHOWN TEXT	REASON	SIGNALS
Status Display: `CP. BAT. EMPTY!` Tablet: `Cockpit battery empty. Land now!`	The battery of the CTR is empty. Only a few minutes remain until it will shut down automatically.	Vibration on the CTR. Acoustic: Battery empty. Land now! Visual: The remaining operating time of the CTR shown as a percentage on the Status Display flashes.
Status Display: `JOYSTICK ERROR!` Tablet: `Joystick error. Land now!`	The calibration of the control sticks failed (see below for further information).	Vibration on the CTR.
Status Display: `CP TEMPERATURE!` Tablet: `Cockpit temperature high!`	The CTR temperature is outside of the allowed range (see below for further information).	Vibration on the CTR.

- `JOYSTICK ERROR!`

  When the CTR is switched ON, the joysticks are calibrated automatically. If this fails (e.g. because the user was pushing a joystick during turn-on or because something is actually broken), this warning will appear.

  Restart the CTR (take care not to exert pressure on any joystick) and see if the warning is still active. If so, the joystick electronics may be broken. In this case please get in touch with Intel support.

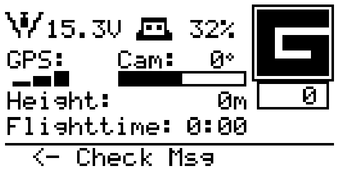
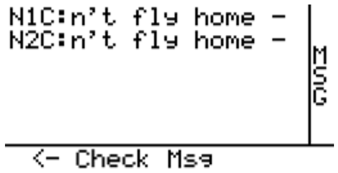
- `Cockpit temperature high!`

  The temperature of the CTR exceeds the recommended operating temperature. Check if something is blocking the fan's air stream and if the fan is working properly. Turn OFF the CTR to let it cool down and switch it ON again. If the problem persists, please get in touch with Intel support.

3.12.7. AscTec Trinity Control Unit System Warnings

Whenever there is a system warning, (shown as `SYSTEM ERROR` in the notification area on the touchscreen tablet), the bottom line of the Status Display will show `<- Check Msg`.

Figure 3.23: System Warnings

 15.3V 32% GPS: Cam: 0° Height: 0m Flighttime: 0:00 <- Check Msg 	If `<- Check Msg` is shown in the status line there is no acoustic warning. In this case push the arrow **LEFT** button five times (when starting on the **Main Screen** of the Status Display).
 N1C:n't fly home - N2C:n't fly home - <- Check Msg 	The Error Message Screen (shown on the left) is opened, and the details are presented.

The table below shows all possible warnings, their meaning, and possibilities for resolving them. All messages always have one of the prefixes N1U / N1C / N2U / N2C, meaning:

- N1 = Navigational processor 1
- N2 = Navigational processor 2
- U = message concerning the user - might be application critical but not flight critical
- C = message concerning the core - flight critical!

Table 3.13: AscTec Trinity Control Unit System Warnings

CATEGORY	WARNING/ ERROR	MEANING	CONSEQUENCE	POSSIBLE FIXES
License chip	`UUID chip malfunction!`	UUID chip not functional (cannot be installed / not programmed / defective)	Serial Number is 31000 (default), no flags can be stored	Contact support.

Table 3.13: AscTec Trinity Control Unit System Warnings (Continued)

CATEGORY	WARNING/ ERROR	MEANING	CONSEQUENCE	POSSIBLE FIXES
License chip	`License chip: too many read errors`	UUID chip not functional (cannot be installed / not programmed / defective)	May be none, may be no serial number/s	Contact support.
License chip	`License chip: too many write errors`	UUID chip not functional (cannot be installed / not programmed / defective)	May be none, may be no serial number/s	Contact support.
Parameters	`No parameter file found! Restoring default parameters.`	Trinity board fresh from production	None, solved after system restart	Restart System.
Parameters	`Parameter version conflict => auto update done!`	New firmware sometimes requires new parameter sets, which are automatically written to FLASH memory.	None, solved after system restart	Restart System.
Missing feature	`SURVEY PACKAGE not installed`	The feature needs to be unlocked.	Feature cannot be used	Contact support to acquire missing features.

Table 3.13: AscTec Trinity Control Unit System Warnings (Continued)

CATEGORY	WARNING/ ERROR	MEANING	CONSEQUENCE	POSSIBLE FIXES
Sensor data corrupt - critical!	`Position input data corrupt! Position fusion disabled!`		Unusual behavior	Restart system or contact support.
Sensor data corrupt - critical!	`GPS2COG compensated position data corrupt!`		Unusual behavior	Restart system or contact support.
Sensor data corrupt - critical	`Magnetic inclination/ declination data corrupt!`		Unusual behavior	Restart system or contact support.
Sensor data corrupt - critical!	`Data-fusion input data corrupt!`		Unusual behavior	Restart system or contact support.
Sensor data corrupt - usually not critical due to IMU redundancy	`IMU1/ IMU2/ IMU3 data corrupt!`	Any sensor value out of range	Usually none	Restart system.

Table 3.13: AscTec Trinity Control Unit System Warnings (Continued)

CATEGORY	WARNING/ ERROR	MEANING	CONSEQUENCE	POSSIBLE FIXES
SD Card	`No internal SD card!`	Internal SD card cannot be used (missing, full, file system corrupt)	No internal data logging (NAV1 data)	Insert / reformat SD card.
SD Card	`No internal SD card!`	SD card in front of central unit faulty (missing, full, file system corrupt)	No external SD data logging (NAV2 data)	Insert / reformat SD card; use a different SD card.
SD Card	`FAT Write to Sector 0???`	Error with SD card logger, possibly SD card defective	SD card logger not working in this flight	Restart system or contact support if it happens repeatedly.
Navigation	`Waypoint sanity check failed`	Waypoint transmission problem	No waypoint navigation	Resend waypoints / mission
Navigation	`Navigation data corrupt`	Spline calculation problem	No waypoint navigation	Resend waypoints / mission
Navigation	`Trajectory flight in progress -> CMD ignored!`		No reaction to data transmission	Resend waypoints / mission
Navigation	`Can't fly home - no home position set!`		*ComeHome* does not work	No GPS?

Table 3.13: AscTec Trinity Control Unit System Warnings (Continued)

CATEGORY	WARNING/ ERROR	MEANING	CONSEQUENCE	POSSIBLE FIXES
Navigation	`N2U: Trajectory flight in progress -> CMD ignored!`	The user tried to execute a survey flight while a previously started survey flight is still ongoing. The command sent to the UAV will be ignored and the current survey flight will be continued.		Abort the ongoing survey flight and send the new flight parameters again.
Calibration	`No calib on payload found`	Timeout: Not able to read a payload calibration from camera EEPROM within 15 seconds after start-up. Usually happening with new Payloads / Payloads never calibrated on an Intel® Falcon™ 8+ UAV.	Possibly bad yaw alignment	Run payload calibration. If no success: Check/ reformat the USB stick: Problems initializing the USB stick could make the PER processor stuck for too long => Timeout
Calibration	`Invalid payload calib - please recalibrate!`	Payload calibration invalid. The reason could be that less than 3 IMUs were available during the calibration process.	Possibly bad yaw alignment	Run payload calibration again.

Table 3.13: AscTec Trinity Control Unit System Warnings (Continued)

CATEGORY	WARNING/ ERROR	MEANING	CONSEQUENCE	POSSIBLE FIXES
Calibration	`No payload installed or payload config faulty`	Payload could not be found	Payload not working	Check Payload connection; re-initiate camera type EEPROM
Calibration	`Current calibration not successful!`	Motor current calibration failed	None, motor current calibration	
Calibration	`Payload calibration not successful`	Payload calibration failed		Run payload calibration again.
Calibration	`Could not write CC for PayloadID`	in-flight compass calibration with specific payload failed		Run in-flight compass calibration again
Calibration	`No c.calib. matching pID, using default.`	No in-flight compass calibration found matching the installed payload	Possibly bad yaw alignment	Run in-flight compass calibration.

Table 3.13: AscTec Trinity Control Unit System Warnings (Continued)

CATEGORY	WARNING/ ERROR	MEANING	CONSEQUENCE	POSSIBLE FIXES
Calibration	`No in-flight compass calibration found!`	No in-flight compass calibration found at all	Possibly bad yaw alignment	Run in-flight compass calibration.
Calibration - critical!	`No temperature calibration found!`			Contact support
Calibration - critical!	`Acc and/ or mag calibration missing!`			Contact support
Calibration - critical!	`IMU1/ IMU2/ IMU3 MAG calibration problem`			Contact support
Motor bus communication	`Not all Motors detected`	1 or more motor controllers have not given a status update.	Communication from at least 1 motor controller has failed. UAV will not start/ take off.	Hardware or connection problem, do not fly! Contact support.

Table 3.13: AscTec Trinity Control Unit System Warnings (Continued)

CATEGORY	WARNING/ ERROR	MEANING	CONSEQUENCE	POSSIBLE FIXES
Motor bus communication	`Too many CRC errors on motor bus! Land now!`	Communication to the motor controllers is disturbed.	Danger that motors will stop working.	Land immediately! Contact support. Please supply the flight log of the flight where the issue occurred.
Motor bus communication	`Motor bus not working! Land now!`	Communication loss from all motor controllers	Communication or complete hardware failure	Check connections.

3.13. OPERATIONAL LIMITATIONS

The Intel® Falcon™ 8+ UAS has the following operational limits:

- Wind speeds up to 16 m/s in Height-Mode respective 12 m/s in GPS-Mode. Above these limits the UAV will not be able to hold its position.
- Intel® Falcon™ 8+ UAV operating temperature: -5 °C and 45 °C (23 °F to 113 °F).
- Intel® Cockpit Controller operating temperature: -5 °C and 45 °C (23 °F to 113 °F).
- Intel® Powerpack battery operating temperature: -5 °C and 40 °C (23 °F to 104 °F).

The operating temperature of the UAS, i.e. the complete system including all components, is currently limited by the operating temperature of the battery. Therefore, the operating temperature of the Intel® Falcon™ 8+ UAS is -5 °C and 40 °C (23 °F to 104 °F). The upper temperature limit is likely to increase with the introduction of the new battery technology in the future.

Table 3.14: Payload Weight

PAYLOAD	ACTIVELY STABILIZED MOUNT	REMAINING PAYLOAD
800 g	~ 200 g	~ 600 g

- A maximum distance of 250 meters between the UAV and the pilot is recommended. Beyond this range the UAV becomes too small to see.
- The UAV is not waterproof. Flying in rain, fog or snow is undertaken at your own risk and not recommended.
- Flying in dusty or sandy areas may damage the cameras and motors permanently.
- Altitudes of more than 3,500 meters above sea level are risky. Flight time and stability decrease dramatically.
- Do not take off in areas with strong external magnetic fields if you are not used to flying in Height-Mode.
- Acrobatic flight is prohibited.

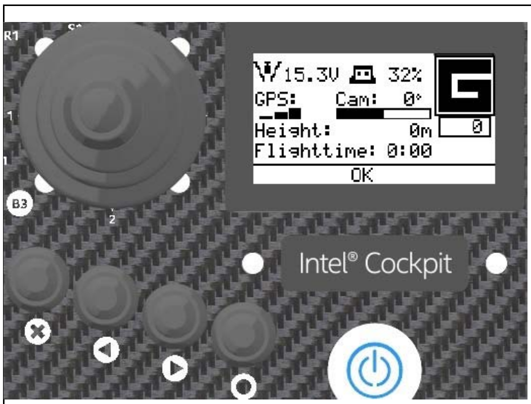
4. STATUS DISPLAY

In this chapter, you will find a description of all possible messages and operations using the Status Display.

4.1. STATUS DISPLAY OVERVIEW

The Status Display of the Intel® Cockpit Controller (CTR) shows all relevant information for flying.

Figure 4.1: Status Display



On the Status Display you can view the current settings and adjust specific functions of the UAV. To do so, you use the four buttons.

⊗ **Escape** (left side) is used to leave menus / sub-menus and to clear functions. In the following text, it is displayed as **ESC**.

◀ With the **LEFT** arrow button (middle, left side),

▶ and the **RIGHT** arrow button (middle, right side) you can scroll through menus or alter parameters.

◉ **Enter** (right side) is used to enter menus and activate functions. In the following text, it's displayed as **ENT**.

4.1.1. Status Display Menu Structure

For further information in terms of the Status Display see “The Status Display” on page 26.

Table 4.1: Status Display Menu Structure

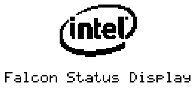
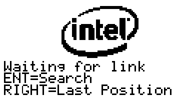
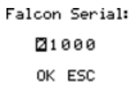
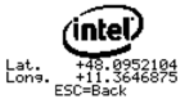
After switching on the CTR the first screen you see on the Status Display is the **Welcome Screen.**  Falcon Status Display				
After some seconds, the screen changes to the **Start Screen.**  Waiting for link ENT=Search RIGHT=Last Position	If the UAV is switched on and there is no connection established to the CTR, you should push **ENT**. The following screen appears:  Falcon Serial: 01000 OK ESC	For entering the serial number see “Establishing A Connection Between The CTR And The UAV” on page 170.	By pushing the **RIGHT** arrow button the latitude and longitude of the last known position of the UAV are shown:  Lat. +48.0952104 Long. +11.3646875 ESC=Back	Pushing **ESC** on the screen, with last known position, brings you back to the **Main Screen**.

Table 4.1: Status Display Menu Structure (Continued)

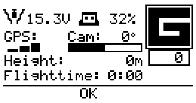
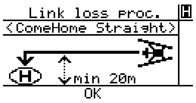
When the Falcon F8 is switched on and there is already an established connection with the CTR, after a few seconds the screen changes to the **Main Screen.**  15.3V 32% GPS: Cam: 0° G Height: 0m 0 Flighttime: 0:00 OK On this screen, you will find the following information: `15.3V`: Battery voltage level of the UAV	32%: Remaining battery capacity of the CTR GPS: GPS signal strength; at least four bars are required for flying in GPS Mode. `Cam`: Tilt angle of the camera gimbal. Values vary from approx. -100° to +100° (-90° means the camera is looking vertically downwards).	`Height`: Barometrically measured height above ground level (0m = where the propellers are started). `Flighttime`: The flight time counter will start when the propellers are switched on and is updated as soon as one battery is changed. G: Flight mode (G, H, M, see “FLIGHT MODES” on page 91)	`0`: Counter of triggers sent to the camera. OK: Status line. Everything is OK with the system. Otherwise there will be the warning `<- Check Msg`. In this case press the **LEFT** arrow button 5 times, until the Error Message Screen is shown. see “AscTec Trinity Control Unit System Warnings” on page 127.	
After a few seconds, the screen changes to **Link loss proc.**  Link loss proc. H <ComeHome Straight> H min 20m OK	Here you must select the mode determining how the UAV will behave in case of a lost link. For help selecting the mode, see “LINK LOSS PROCEDURE” on page 88.	After selecting the appropriate Link Loss Procedure by pushing **ENT**, confirming the screen changes to the **Main Screen**.		
Pushing the **RIGHT/LEFT** arrow buttons in the **Main Screen** leads you to different screens. For more information about these screens see “The Main Information Screens” on page 148.				

Table 4.1: Status Display Menu Structure (Continued)

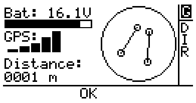
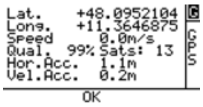
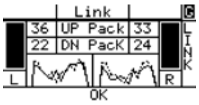
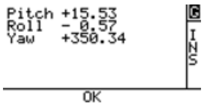
Orientation Screen	**GPS Info Screen**	**Data Link Screen**	**Attitude Angles Screen**	
 Bat: 16.1V GPS: Distance: 0001 m DIR OK shows: • Battery status • GPS signal strength • Distance to Home Position • UAV Orientation • Possible warnings • Flight mode	 Lat. +48.0952104 Long. +11.3646875 Speed 0.0m/s Qual. 99% Sats: 13 Hor.Acc. 1.1m Vel.Acc. 0.2m GPS OK shows: • Latitude • Longitude • Speed • Reception quality • Horizontal accuracy • Velocity accuracy • Possible Warnings • Flight mode	 Link 36 UP Pack 33 22 DN Pack 24 L R LINK OK shows: • Left and right transmitting and receiving packages • Graph • analyzer • Signal quality • Possible warnings • Flight mode	 Pitch +15.53 Roll - 0.57 Yaw +350.34 INS OK shows: • Pitch Angle • Roll Angle • Yaw Angle • Possible warnings • Flight mode	

Table 4.1: Status Display Menu Structure (Continued)

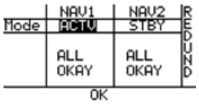
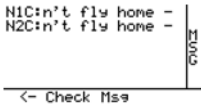
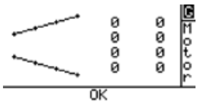
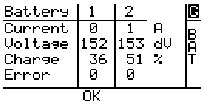
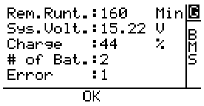
Flight controller Screen	**Error Message Screen** (optional)	**Motor Screen**	**Battery Screen**	**BMS Screen**
 NAV1 NAV2 Mode ACTV STBY ALL OKAY ALL OKAY REDUND OK shows: - NAV1 - NAV2 - Warnings - Redundancy - Possible warnings	 N1C:n't fly home - N2C:n't fly home - MSG <- Check Msg shows: - Possible flight controller (e.g. N1C/N2C) For system warnings see “AscTec Trinity Control Unit System Warnings” on page 127.	 0 0 0 0 0 0 0 0 Motor OK shows: - Graphic of the Intel® Falcon™ 8+ UAV with spinning propellers - Speed of each propeller (as a coefficient) - Flight mode	 Battery 1 2 Current 0 1 A Voltage 152 153 dV Charge 36 51 % Error 0 0 BAT OK shows for battery 1 and 2: - Actual current in ampere (A) - Actual system voltage in decivolt (dV) - Charge state of each battery in percent - Number of errors	 Rem.Runt.:160 Min Sys.Volt.:15.22 V Charge :44 % # of Bat.:2 Error :1 BMS OK shows: - Remaining runtime of the UAV in minutes - Actual UAV voltage - Charge state of the UAV in percent - Number of batteries inserted - Number of errors
Pushing the **RIGHT/LEFT** arrow buttons in these screens brings you back to the **Main Screen**.				

Table 4.1: Status Display Menu Structure (Continued)

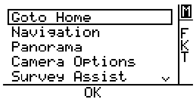
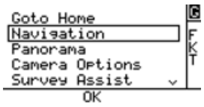
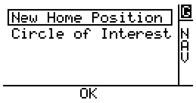
Pushing **ENT** in the **Main Screen** opens the following screen:  Goto Home Navigation Panorama Camera Options Survey Assist OK M FKT	Pushing **ENT** when `Goto Home` is highlighted activates the `Goto Home` function.	The `Goto` Home function can only be activated in GPS-Mode. When activated the UAV keeps the current altitude and returns to the home position (where the propellers were started) using the shortest trajectory	Make sure there are no obstacles between the UAV and home position. After reaching the home position, the Intel® Falcon™ 8+ UAV will wait at the current altitude. It will not land automatically.	
By pushing the **RIGHT/LEFT** arrow buttons you can select one of these menu points.  Goto Home Navigation Panorama Camera Options Survey Assist OK G FKT	Selecting `Navigation` and pushing **ENT** opens the following screen:  New Home Position Circle of Interest OK G NAV	Pushing **ENT** when `New Home Position` is highlighted sets the current position of the UAV as the new home position regardless if the UAV is in the air or on the ground, and brings you back to the **Main Screen.**	By default, the home position is set where the propellers are started. This function allows setting the home position to a different place.	It will affect the `Goto Home` function and the landing position if either `ComeHome Straight` or `ComeHome High` is selected as Link Loss Procedure.

Table 4.1: Status Display Menu Structure (Continued)

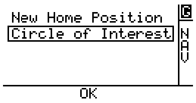
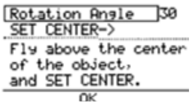
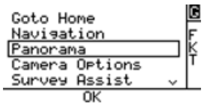
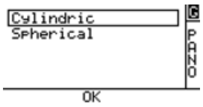
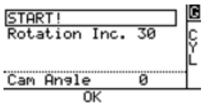
		Pushing **ENT** when `Circle of Interest` is highlighted  New Home Position Circle of Interest NAV OK opens the screen `Rotation Angle` you see to the right.	`Rotation Angle`  Rotation Angle 30 SET CENTER-> Fly above the center of the object, and SET CENTER. OK In this screen, you can define the angle and the radius of the circle the UAV should perform.	More information about the function `Circle of Interest` is found in “CIRCLE OF INTEREST (COI)” on page 153.
By pushing the **RIGHT/LEFT** arrow buttons you can select one of the menu points.  Goto Home Navigation Panorama Camera Options Survey Assist FKT OK	Selecting `Panorama` and pushing **ENT** opens the following screen:  Cylindric Spherical PANO OK Here you can decide if you want a cylindrical or a spherical panorama.	Pushing **ENT** when `Cylindric` is highlighted opens the next screen:  START! Rotation Inc. 30 Cam Angle 0 CYL OK In this screen, you can start the function, and decide how many pictures are taken during one rotation of the UAV.	More information about the option `Cylindric` of the `Panorama` function is found in “PANORAMA” on page 154.	

Table 4.1: Status Display Menu Structure (Continued)

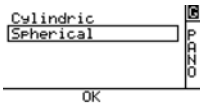
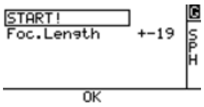
		Pushing **ENT** when `Spherical` is highlighted  opens the screen on the right.	 In this screen, you can start the function and modify the focus length.	More information about the option `Spherical` of the `Panorama` function can be found in “PANORAMA” on page 154.
By pushing the **RIGHT/LEFT** arrow buttons you can select one of the menu points. When selecting `Camera Options`, the next screen depends on the mounted payload (camera).	The information on how to control the specific payload (camera) with the Status Display is found in the respective section in “PAYLOADS - CAMERA OPTIONS” on page 29.			

Table 4.1: Status Display Menu Structure (Continued)

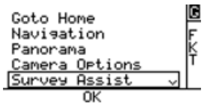
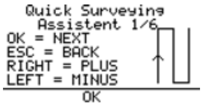
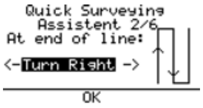
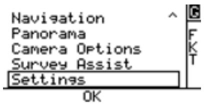
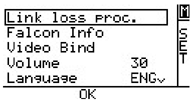
By pushing the **RIGHT/LEFT** arrow buttons you can select one of the menu points.  Goto Home Navigation Panorama Camera Options Survey Assist G FKT OK	Selecting `Survey Assist` and pushing **ENT** opens the following introductory screen:  Quick Surveying Assistent 1/6 OK = NEXT ESC = BACK RIGHT = PLUS LEFT = MINUS OK Here you see the commands for how to navigate through this function.	Pushing **ENT** (OK) opens the next screen.  Quick Surveying Assistent 2/6 At end of line: <-Turn Right -> OK Here you can start to determine parameters for a mapping flight for rectangular areas.	With this function, you can determine parameters for a mapping flight for rectangular areas.	More information about the function `Survey Assist` is found in "QUICK SURVEYING ASSISTANT" on page 158.
By pushing the **RIGHT/LEFT** arrow buttons you can select one of the menu points.  Navigation Panorama Camera Options Survey Assist Settings G FKT OK	Selecting `Settings` and pushing **ENT** opens the following menu screen:  Link loss proc. Falcon Info Video Bind Volume 30 Language ENG M SET OK By pushing the **RIGHT/LEFT** arrow buttons you can select the menu point you want to control.	Pushing **ENT** when the selected menu point is highlighted opens the respective screen. There are 12 different menu points available in the `Settings` menu: • `Link loss proc.` • `Falcon Info` • `Video Bind`	• `Volume` • `Language` • `Compass Calib.` • `Payload Calib.` • `Def. Params` • `Service Fcts.` • `Enter FalconID` • `Format User SD` • `Bounding Box`	For `Link Loss proc.` see "LINK LOSS PROCEDURE" on page 88. For `Compass Calib.` and `Payload Calib.` see "Payload and Compass Calibration" on page 33

Table 4.1: Status Display Menu Structure (Continued)

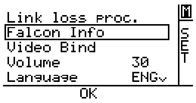
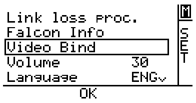
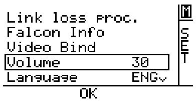
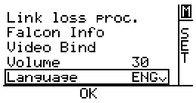
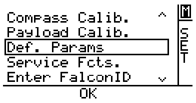
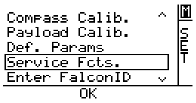
Selecting `Falcon Info`  Link loss proc. Falcon Info Video Bind Volume 30 Language ENG OK SET and pushing **ENT** opens an information screen.	Here you see the serial number and the firmware versions of the current hardware components. In the last column, the activated feature packages are shown.	For further details see “Checking Activated Software Feature Packages” on page 61. Pushing **ESC** brings you back to the menu.	Selecting `Video Bind`  Link loss proc. Falcon Info Video Bind Volume 30 Language ENG OK SET and pushing **ENT** establishes (again) the video connection between the UAV and the CTR.	
Selecting `Volume`  Link loss proc. Falcon Info Video Bind Volume 30 Language ENG OK SET and pushing **ENT** highlights the number behind.	By pushing the **RIGHT/LEFT** arrow buttons you can modify the volume of the audible messages of the Status Display of the CTR.	A range from 10 (low volume) to 100 (high volume) is available. Pushing **ENT** confirms the selection. Pushing **ESC** brings you back to the menu.	⚠ RISK OF PERMANENT HEARING LOSS FROM USING EARPHONES OR HEADPHONES WITH THIS PRODUCT AT HIGH VOLUME. RISK OF PERMANENT HEARING LOSS FROM USING THE LOUDSPEAKER IN CLOSE PROXIMITY TO THE EAR. see “Intel® Cockpit Controller (CTR) Overview” on page 23	
Selecting `Language`  Link loss proc. Falcon Info Video Bind Volume 30 Language ENG OK SET and pushing **ENT** highlights the field to the right.	By pushing the **RIGHT/LEFT** arrow buttons you can select between English (ENG) and German (GER). Pushing **ENT** confirms and pushing **ESC** brings you back to the menu.	Selecting `Def.Params`  Compass Calib. Payload Calib. Def. Params Service Fcts. Enter FalconID OK SET and pushing **ENT** opens a new screen. Here you can reset the CTR to factory defaults if the connection to the UAV was lost. A new pairing has to be done.	Selecting `Service Fcts.`  Compass Calib. Payload Calib. Def. Params Service Fcts. Enter FalconID OK SET and pushing **ENT** opens a special screen. This function is only for service personal.	For `Compass Calib.` and `Payload Calib.` see “Payload and Compass Calibration” on page 33

Table 4.1: Status Display Menu Structure (Continued)

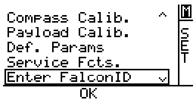
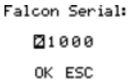
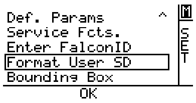
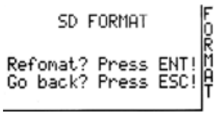
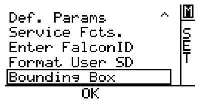
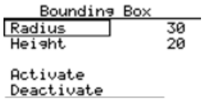
Selecting `Enter FalconID`  Compass Calib. Payload Calib. Def. Params Service Fcts. Enter FalconID OK M SET and pushing **ENT** opens the following screen.	 Falcon Serial: 01000 OK ESC Here you can connect to another Intel® Falcon™ 8+ UAV by entering the serial number (ID) of the respective UAV (see above) and pushing **ENT** (OK).	Pushing **ESC** brings you back to the **Main Screen**.		
Selecting `Format User SD`  Def. Params Service Fcts. Enter FalconID Format User SD Bounding Box OK M SET and pushing **ENT** opens the following screen.	 SD FORMAT FORMAT Refomat? Press ENT! Go back? Press ESC! This function allows to format the User SD card.	Pushing **ENT** confirms the formatting of the User SD card. The process starts and a progress bar is shown.	Pushing **ESC** cancels the function and brings you back to the **Main Screen.**	see “INTEL® FALCON™ 8+ UAV FLIGHT LOGS” on page 62 for further details.

Table 4.1: Status Display Menu Structure (Continued)

Selecting `Bounding Box`  Def. Params Service Fcts. Enter FalconID Format User SD Bounding Box OK M SET and pushing **ENT** opens the following screen.	 Bounding Box Radius 30 Height 20 Activate Deactivate This function is only available in GPS Mode. Here you can define a specific height and radius around the starting position to specify an area in which the Intel® Falcon™ 8+ UAV is allowed to move. When the UAV reaches the set radius or altitude it stops and will not fly any further.	By pushing the **RIGHT/ LEFT** arrow buttons you can switch between the settings for `Radius` and `Height` and `Activate` and `Deactivate`.	Pushing **ENT** when selected `Radius` or `Height` highlights the field behind. By pushing the **RIGHT/ LEFT** arrow buttons you can modify the selected value. Selecting `Activate/ Deactivate` activates/ deactivates the function. Pushing **ENT** confirms the selection and brings you back to the **Main Screen**.	

4.1.2. The Main Information Screens

The following section describes the nine main information screens of the Status Display in detail.

Figure 4.2: Main Information Screens

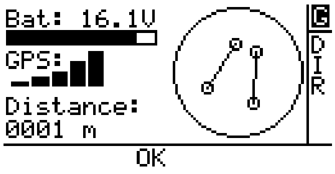
 Bat: 16.1V GPS: Distance: 0001 m G DIR OK	**Orientation Screen** Displays the UAV orientation regarding its starting position. The displayed V-shape of the UAV will turn respectively when the heading of the Intel® Falcon™ 8+ UAV is changed. This can be of help when the orientation of the UAV is difficult to see in low contrast situations such as when flying in front of dark trees. The screen shows the following information: `Bat: 16.1V` = Voltage level of the Intel® Falcon™ 8+ UAV battery. This is the same information as on the **Main Screen**. `G` = Flight Mode. This is the same information as on the **Main Screen**. `GPS` = Quality indicator of the GPS signal. This is the same information as on the **Main Screen**. `Distance` = Direct line of sight distance between UAV and Home Position, and only visible when airborne at a distance of at least 10 m. Graphical display of UAV orientation = Orientation of the UAV regarding the Home Position, and only visible when airborne at a distance of at least 10 m. `OK` = Status line. Same information as on the **Main Screen**.

Figure 4.2: Main Information Screens (Continued)

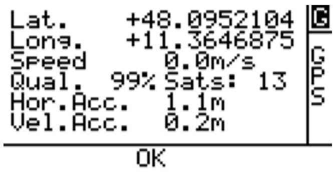
 Lat. +48.0952104 G Long. +11.3646875 Speed 0.0m/s Qual. 99% Sats: 13 Hor.Acc. 1.1m Vel.Acc. 0.2m GPS OK	**GPS Info Screen** Displays details regarding the GNSS reception quality. `Lat.` = Latitude of the UAV position. G = Flight Mode. This is the same information as on the **Main Screen**. `Long.` = Longitude of the UAV position. `Speed` = GPS measured flight speed of the UAV. `Qual.`= Satellite reception quality. `Sats:` = Number of satellites which can be received. `Hor.Acc.` = Horizontal accuracy in meters (m). `Vel.Acc.` = Velocity accuracy in meters per second (m/s). `OK` = Status line. This is the same information as on the **Main Screen**.

Figure 4.2: Main Information Screens (Continued)

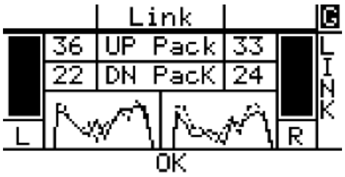
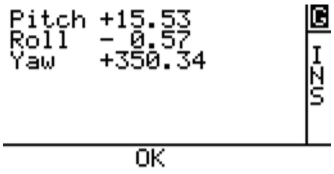
 Link 36 UP Pack 33 22 DN Pack 24 L R G LINK OK	**Data Link Screen** Displays the quality of both data links of the system. Helpful to analyze the situation if there are `Link Weak!` warnings. `G` = Flight Mode. This is the same information as on the **Main Screen**. Left (L) and right (R) bars = Signal strength of left and right data link (derived from the number of transmitted data packages). Left graph • solid line = signal to noise ratio (SNR) on the left data link of the CTR • dotted line = SNR on the right data link of the CTR Right graph • solid line = SNR on the left data link of the Intel® Falcon™ 8+ UAV • dotted line = SNR on the right data link of the Intel® Falcon™ 8+ UAV `UP Pack` = Uploaded data packages per second from the CTR to the flight system. `DN Pack` = Downloaded data packages per second from the flight system to the CTR. `OK` = Status line. This is the same information as on the **Main Screen**.
 Pitch +15.53 Roll -0.57 Yaw +350.34 G INS OK	**Attitude Angles Screen** Displays pitch, roll and yaw angles of the UAV. `Pitch` = Pitch angle of the UAV. `G` = Flight Mode. This is the same information as on the **Main Screen**. `Roll` = Roll angle of the UAV. `Yaw` = Heading direction of the UAV `OK` = Status line. This is the same information as on the **Main Screen**.

Figure 4.2: Main Information Screens (Continued)

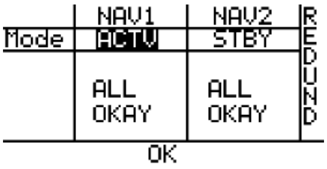
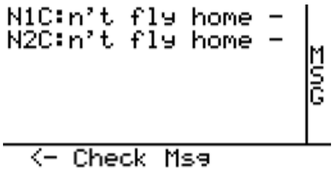
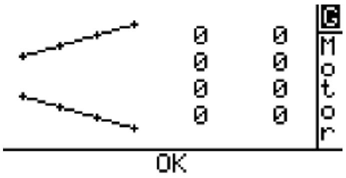
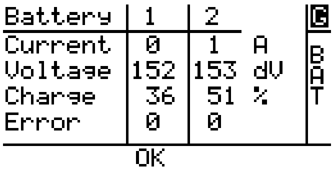
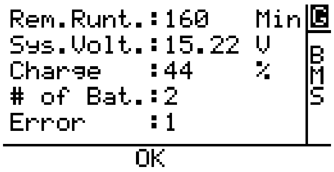
 NAV1 NAV2 Mode ACTV STBY ALL OKAY ALL OKAY REDUND OK	**Flight Controller Screen** Shows an overview of two Trinity flight controller modules (NAV1 and NAV2). The third flight controller (PER - peripheral processor) is monitoring these two. In flight, one controller is active and displayed as redundant. As soon as the third one detects an issue, it will switch to NAV2 and give an acoustic and optical warning. NAV1 = 1st Trinity flight controller module (navigational processor 1). NAV2 = 2nd Trinity flight controller module (navigational processor 2). `Mode` = Current mode of the NAV1 and NAV2 Trinity modules. `ACTV` = NAV1 is active. `STBY` = NAV2 is in standby. `ALL OKAY` = No issues detected by the system. REDUND = No issues detected by the system and the flight controllers are working redundantly. OK = Status line. This is the same information as on the **Main Screen**.
 N1C:n’t fly home - N2C:n’t fly home - MSG <- Check Msg	**Error Message Screen** (optional) This screen is only displayed if there are system warnings. In this case the status line will show `<- Check Msg.` In “AscTec Trinity Control Unit System Warnings” on page 127, you will find detailed descriptions and a list of possible system warnings. `N1C:n´t fly home -` (= can't fly home) warning from 1st Trinity flight controller (no GPS signal and `Goto Home` activated). `N2C:n´t fly home -` (= can't fly home) warning from 2nd Trinity flight controller (no GPS signal and `Goto Home` activated). `<- Check Msg` in status line. Shown whenever there is a system warning.

Figure 4.2: Main Information Screens (Continued)

 0 0 0 0 0 0 0 0 G Motor OK	**Motor Screen** The speed of each motor is displayed graphically and indicated by a number. The numbers are not rounds per minute, but rather a coefficient. The screen can be used to analyze a motor defect warning, see "Motor Failure Warning" on page 125 for further details. G = Flight Mode. Same information as on the **Main Screen**. `0` = Motors are right now not spinning `OK` = Status line. Same information as on the **Main Screen**.
 Battery 1 2 Current 0 1 A Voltage 152 153 dV Charge 36 51 % Error 0 0 G BAT OK	**Battery Screen** Shows the actual state for each of the 2 batteries inserted in the UAV `Current` = Actual current of each battery in ampere `Voltage` = Actual voltage of each battery in decivolt (dV) `Charge` = Charge state of each battery in percent `Error` = Number of errors `OK` = Status line. This is the same information as on the **Main Screen**.
 Rem.Runt.:160 Min Sys.Volt.:15.22 V Charge :44 % # of Bat.:2 Error :1 G BMS OK	**BMS Screen** Shows the actual state of the UAV. `Rem. Runt.:` = Remaining runtime of the UAV in minutes `Sys. Volt.:` = Actual system voltage Charge: = Charge state of the UAV in percent `# of Bat.:` = Number of batteries inserted in the UAV `Error:` = Number of errors `OK` = Status line. This is the same information as on the **Main Screen**.

5. SPECIAL FUNCTIONS

This chapter offers a description of several functions to perform semi-automatic flights directly from the Intel® Cockpit Controller (CTR). Most of these functions can only be executed in GPS-Mode and require a good GPS reception.

5.1. CIRCLE OF INTEREST (COI)

This function is an optional part of the Inspection Package (see Chapter 2.8 Software Feature Packages). With the Circle of Interest (COI) it is possible to fly an automated 360° circle around an object, and take photos at predefined positions. These photos can later be processed by 3D modeling software such as Agisoft PhotoScan, to build a 3D model of the object.

Figure 5.1: Circle of Interest

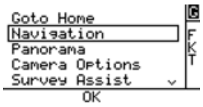
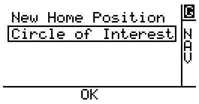
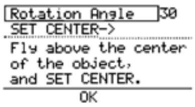
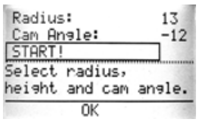
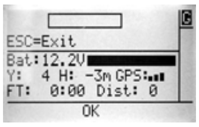
Pushing **ENT** in the **Main Screen** opens the screen below:  Goto Home Navigation Panorama Camera Options Survey Assist OK G FKT Selecting *Navigation* and pushing **ENT** opens the following screen:  	Selecting *Circle of Interest* and pushing **ENT** opens the next screen:  Fly above the center of the object, and SET CENTER. `Rotation Angle:` Sets the angle after which the next photo will be taken. For example, one image every 30° = 360° / 30° = 12 images. Push **ENT** to change the angle. Use the arrow **RIGHT/LEFT** button to increase, or decrease the angle. Confirm by pushing **ENT**. `SET CENTER->`: Sets the center of the Circle of Interest at the current position of the UAV. Fly to the exact center of the Circle of Interest. Tilt the camera down 90°, and use the preview video image to identify the center. At the desired position, push **ENT** to confirm `SET CENTER->`.

Figure 5.1: Circle of Interest (Continued)

Warning: **Make sure that there are no obstacles on the flight path of the Circle of Interest!**	The next screen is opened.  Radius: 13 Cam Angle: -12 START! Select radius, height and cam angle. Fly backwards. The distance of the UAV to the center, (which was set in the previous step) defines the radius of the Circle of Interest. If necessary adjust the altitude of the UAV (left control stick) to the desired height, if necessary. Adjust the camera tilt angle by using the rocker switch **R1** on the CTR to get the desired image framing. Confirm START ! by pushing **ENT**. The UAV will fly a circle with the set parameters.
 ESC=Exit Bat:12.2V Y: 4 H: -3m GPS: FT: 0:00 Dist: 0 	During the COI flight, the Status Display shows a progress bar. It also displays: `Bat:` battery voltage `Y:` yaw angle `H:` height `GPS:` GPS signal quality `FT:` flight time `Dist:` distance from home position The COI flight can be interrupted by giving a strong control stick command on the CTR or by pushing the **ESC** button of the Status Display.

5.2. PANORAMA

With the panorama function, the Intel® Falcon™ 8+ UAV can take images at predefined positions, optimized for later stitching the images into one, large panorama shot. The speed of the Intel® Falcon™ 8+ UAV is set automatically to always have 2 seconds in between images. Any photo editing software with panorama stitching functionality, or specialized panorama software, may be used to do the image post processing.

General tips for panorama photography

Recommended camera settings:

- Image quality: RAW (Because of the large amount of data, it is important to use a fast SD card in the camera. Otherwise, there is the danger that not all images of the panorama will be captured, all data cannot be stored fast enough.)

- White balance: manual
- Shooting mode: M
- Focus: manual
- ISO: manual
- Set the display to show the histogram

Steps to set the shooting parameters:

- On the ground:
    - Set the aperture wide open.
    - Adjust the shutter time so that the preview video can be clearly seen.
    - Focus manually to a point at hyper focal distance (never beyond the closest object in the image).
    - Depending on the light conditions, set the aperture to approximately 8 and the shutter speed to approximately 1/1000s.
- Take off and fly to the panorama position.
- Turn the Intel® Falcon™ 8+ UAV and camera towards the darkest area of the image.
- Adjust aperture and shutter speed (do not use shutter speeds slower than 1/640s and try to avoid apertures under 5.6 or over 14) so that the image is under exposed by a maximum of 1.3 f-stops.
- Turn the Intel® Falcon™ 8+ UAV and camera towards the brightest area of the image.
- Use the histogram to check the exposure. Make sure that the image is not over exposed more than 1.3 f-stops. If necessary, adjust the exposure.

Thanks to the RAW format, over and under exposed images can be corrected in post processing. To stitch the images, use any software with the respective functionality to create panoramas.

There are two options available, cylindrical and spherical panorama.

Figure 5.2: Cylindrical Panorama

To create images for a cylindrical panorama, the Intel® Falcon™ 8+ UAV will keep its current position and do one 360° turn around the yaw axis, with one fixed tilt angle of the camera. Follow these steps to do a cylindrical panorama:

Do all necessary camera adjustments, take off and fly the Intel® Falcon™ 8+ UAV to the desired position.
Adjust the camera tilt angle.

Figure 5.2: Cylindrical Panorama (Continued)

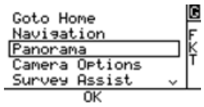
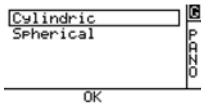
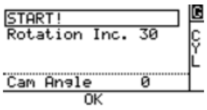
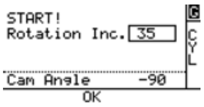
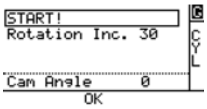
Push ENT on the **Main Screen** of the Status Display. The screen below is opened:  Goto Home Navigation Panorama Camera Options Survey Assist ⌄ G FKT OK	
Selecting `Panorama` and pushing **ENT** opens the following screen:  Cylindric Spherical G PANO OK	Selecting `Cylindric` and pushing **ENT** opens the next screen.
 START! Rotation Inc. 30 Cam Angle 0 G CYL OK	By default, the Intel® Falcon™ 8+ UAV will take an image every 30° while turning around the yaw axis. Meaning that 360°/30° = 12 images will be created. To adjust the rotation angle, use the arrow **LEFT** button to activate `Rotation Inc.` and confirm by pushing **ENT**. The field behind `Rotation Inc.` is highlighted.
 START! Rotation Inc. 35 Cam Angle -90 G CYL OK	Use the arrow **RIGHT/LEFT** button to adjust the angle in steps of 5° and confirm by pushing **ENT**. The camera tilt angle is also displayed and can still be adjusted by using the rocker switch **R1** on the CTR.
 START! Rotation Inc. 30 Cam Angle 0 G CYL OK	Use the arrow **LEFT** button again to select `START!` and confirm by pushing **ENT**. The Intel® Falcon™ 8+ UAV makes a 360° turn around the yaw axis and take all images with the settings determined in the previous steps. The panorama can be stopped anytime by the pilot by giving a strong control stick command on the CTR.

Figure 5.3: Spherical Panorama

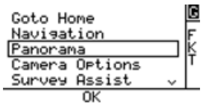
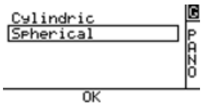
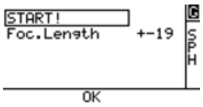
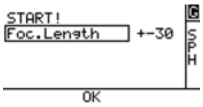
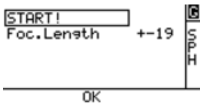
To create images for a spherical panorama, the Intel® Falcon™ 8+ UAV will keep its current position, and do multiple 360° turns around the yaw axis. The camera tilt angle is set to point downwards during the first turn. With every subsequent turn, the camera will be tilted upwards a bit further, until it will point fully upwards during the last turn. Follow these steps to do a spherical panorama: Do all necessary camera adjustments, take off and fly the Intel® Falcon™ 8+ UAV to the desired position.	
Push **ENT** on the **Main Screen** of the Status Display. The shown screen is opened:  Goto Home Navigation Panorama Camera Options Survey Assist G FKT OK	
Selecting `Panorama` and pushing **ENT** opens the following screen:  Cylindric Spherical G PANO OK	Selecting Spherical and pushing **ENT** opens the next screen.
 START! Foc.Length +-19 G SPH OK	There are two presets available for focal lengths of 19 mm and 30 mm (referring to APS-C sized sensors, equals approx. 28 mm and 45 mm referring to full frame). Use the arrow **RIGHT** button to activate `Foc.Length` and confirm by pushing **ENT**. The field behind `Foc.Length` is highlighted.
 START! Foc.Length +-30 G SPH OK	Use the arrow **RIGHT/LEFT** button to change the focal length. Confirm by pushing **ENT**.
 START! Foc.Length +-19 G SPH OK	Use the arrow **LEFT** button to activate START! and confirm by pushing **ENT**. The camera will be tilted downwards and the Falcon will start doing multiple 360° turns while slowly tilting the camera further upwards, until the spherical panorama is completed. The panorama can be stopped anytime by the pilot by giving a strong control stick command on the CTR.

Table 5.1: Image Positions of Spherical Panorama Set To 19 mm Focal Length

	CAMERA PITCH ANGLE (DEGREES)	UAV YAW ANGLES (DEGREES)											
Row 1	-74	0	90	180	270								
Row 2	-55	0	51	102	154	205	257	308					
Row 3	-37	0	36	72	108	144	180	216	252	288	324		
Row 4	-18	0	30	60	90	120	150	180	210	240	270	300	330
Row 5	0	0	30	60	90	120	150	180	210	240	270	300	330
Row 6	18	0	30	60	90	120	150	180	210	240	270	300	330
Row 7	37	0	36	72	108	144	180	216	252	288	324		
Row 8	55	0	51	102	154	205	257	308					
Row 9	74	0	90	180	270								
Total: 78 images													

Table 5.2: Image Positions Of Spherical Panorama Set To 30 mm Focal Length

	S.A.	UAV YAW ANGLES (DEGREES)																	
Row 1	-83	0	180																
Row 2	-69	0	51	102	154	205	257	308											
Row 3	-55	0	32	65	98	130	163	196	229	261	294	327							
Row 4	-41	0	25	51	77	102	128	154	180	205	231	257	282	308	334				
Row 5	-27	0	22	45	67	90	112	135	157	180	202	225	247	270	292	315	337		
Row 6	-13	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340
Row 7	0	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340
Row 8	13	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340
Row 9	27	0	22	45	67	90	112	135	157	180	202	225	247	270	292	315	337		
Row 10	41	0	25	51	77	102	128	154	180	205	231	257	282	308	334				
Row 11	55	0	32	65	98	130	163	196	229	261	294	327							
Row 12	69	0	51	102	154	205	257	308											
Row 13	83	0	180																
Total: 154 images																			

5.3. QUICK SURVEYING ASSISTANT

This function is available as part of the Survey Package. Survey Assist offers a quick and easy way to do a mapping flight over a rectangular area, directly from the CTR without any prior planning on a computer. To do so, the Intel® Falcon™ 8+ UAV is placed in one corner of the area to be mapped, and the key parameters are entered: attached camera / lens combination, desired ground sample distance, image overlaps, length of the lines and number of lines. With this data, the resulting flying altitude and flight path is calculated and carried out. An assistant guides the user through all required steps.

Images can later be processed with photogrammetry software as with any regular preplanned mapping flight. More complex flights should be planned and performed with the AscTec Navigator Software.

Figure 5.4: Quick Surveying Assistant

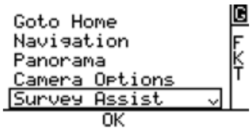
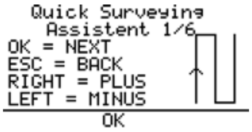
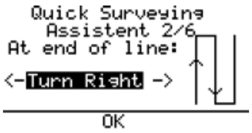
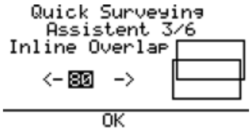
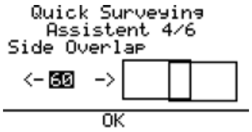
 Goto Home Navigation Panorama Camera Options Survey Assist G F K T OK	Pushing **ENT** in the **Main Screen** opens the screen to the left. Use the arrow **RIGHT/LEFT** button to select Survey Assist and push **ENT**.
 Quick Surveying Assistent 1/6 OK = NEXT ESC = BACK RIGHT = PLUS LEFT = MINUS OK	An introduction screen is opened, explaining the commands to navigate the menu. Pushing **ENT** opens the next screen. Pushing **ESC** brings you back to the previous screen. Use the arrow **LEFT/RIGHT** button to increase or decrease values.
 Quick Surveying Assistent 2/6 At end of line: <- Turn Right -> OK	At the end of line: Define the direction in which the Intel® Falcon™ 8+ UAV turns after completing the first line of images. Use the arrow **RIGHT/LEFT** button to select Turn Right *or* Turn Left and push **ENT**. The next screen opens.
 Quick Surveying Assistent 3/6 Inline Overlap <- 80 -> OK	Inline Overlap: Define the percentage of image overlap in the direction of flight (along track).
 Quick Surveying Assistent 4/6 Side Overlap <- 60 -> OK	Side Overlap: Define the percentage of image overlap between the lines (cross track).

Figure 5.4: Quick Surveying Assistant (Continued)

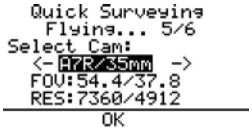
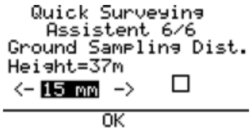
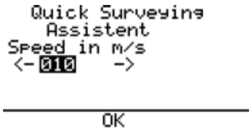
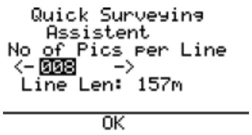
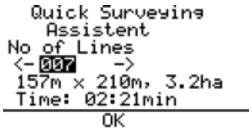
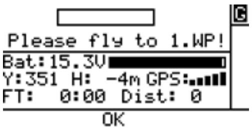
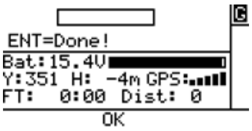
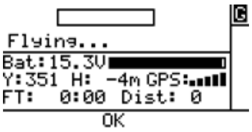
 Quick Surveying Flying... 5/6 Select Cam: <- A7R/35mm -> FOV:54.4/37.8 RES:7360/4912 OK	`Select Cam:` Select camera/lens combination attached to the Intel® Falcon™ 8+ UAV. The most commonly used cameras are available as a preset. `FOV:` shows the angle of the Field Of View. `RES:` shows the resolution of the single picture in pixels. The convention is to describe the pixel resolution with the set of two positive integer numbers, where the first number is the number of pixel columns (width), and the second is the number of pixel rows (height), for example as 7680 by 6876. If your camera is not available as a preset, chose one from the list, which matches the resolution and field of view.
 Quick Surveying Assistent 6/6 Ground Sampling Dist. Height=37m <- 15 mm -> ☐ OK	`Ground Sampling Dist.:` Define the required ground sample distance (GSD). The resulting flight altitude (Height) is calculated and shown above the value of the GSD.
 Quick Surveying Assistent Speed in m/s <- 010 -> OK	`Speed in m/s`: Define the speed with which the mapping flight shall be performed (1 m/s – 10 m/s). When setting the speed, always make sure that the camera has sufficient time between waypoints. The time required by the camera to reliably trigger and store all images of a waypoint flight, depends on: • Image resolution: The higher the resolution, the more data there is to process and store. • File format and image quality: RAW images contain the most information and are the largest files, high quality settings will need more time during JPEG compression and more space to store. • Writing speed of the SD card: If the card is too slow, this will slow down the saving process. • Image content: Motives with complex structures (i.e. meadows, forest) will need more time and space during JPEG compression than plain and simple motives (i.e. roads, flat unstructured surfaces).

Figure 5.4: Quick Surveying Assistant (Continued)

 Quick Surveying Assistent No of Pics per Line <- 008 -> Line Len: 157m OK	`No of Pics per Line`: Define the number of images per line. The resulting length, which is covered by the images is calculated and displayed (`Line Len:`) underneath the number of images.
 Quick Surveying Assistent No of Lines <- 007 -> 157m x 210m, 3.2ha Time: 02:21min OK	`No of Lines`: Define the number of lines which shall be flown. The resulting area, which will be covered by the images, is calculated and displayed in ha (hectare). The estimated required flight time to perform the flight is also presented.
 Please fly to 1.WP! Bat:15.3V Y:351 H: -4m GPS: FT: 0:00 Dist: 0 OK	`Please fly to 1.WP!`: Fly the Intel® Falcon™ 8+ UAV to the corner of the rectangle, where the mapping flight is supposed to start with the first image. Adjust the heading (yaw) of the system to define the direction of the flight. Use the video preview as a help to precisely define the direction.
 ENT=Done! Bat:15.4V Y:351 H: -4m GPS: FT: 0:00 Dist: 0 OK	`ENT=Done!`: When the system is at the right spot and oriented correctly, confirm by pushing **ENT**. The Intel® Falcon™ 8+ UAV will first fly to the calculated altitude and then perform the mapping flight with the set parameters.
 Flying... Bat:15.3V Y:351 H: -4m GPS: FT: 0:00 Dist: 0 OK	`Flying...`:During the flight a bar shows the progress. At the end of the matrix the Intel® Falcon™ 8+ will stop automatically. Push **ESC** to exit the screen and go back to the main menu. A Survey Assist flight can always be interrupted by giving a strong control stick command on the CTR or by pushing ESC.

5.4. WAYPOINT NAVIGATION USING ASCTEC NAVIGATOR SOFTWARE

This functionality is part of the Survey Package (see “SOFTWARE FEATURE PACKAGES” on page 59). The AscTec Navigator Software enables planning and performing complex flight patterns for remote surveying applications. Pre-planned AscTec Navigator Software flight missions are exported to an USB stick, which is plugged into one of the USB ports numbered 2-4 of the CTR. This flight plan can be loaded and executed using the NAVIGATOR function of the Cockpit Control application on the touchscreen tablet (see “AscTec Navigator Software Projects” on page 82). At each waypoint an image is triggered, and the current GPS position is stored in the Intel® Falcon™ 8+ UAV log. Images and GPS information can later be used in photogrammetry software to create orthomosaics, digital surface models or 3D models.

Please refer to the AscTec Navigator Software manual for detailed information. The manual can be found here:
http://wiki.asctec.de/display/APL/AscTec+Navigator+Manual.

6. MAINTENANCE, TROUBLESHOOTING, AND SUPPORT

This chapter provides you with answers for questions which might appear during your work with the Intel® Falcon™ 8+ UAS. In the first section, we inform you how to keep your Intel® Falcon™ 8+ UAS up to date and give instructions to preserve the functionality. In the second section, you find troubleshooting solutions to common problems with data links. The third section provides you with the necessary data when you need direct help.

6.1. MAINTENANCE

As described in the guideline and in “SAFETY FIRST” on page 7, the general condition of the system must be checked before each flight. Thoroughly follow the check lists to make sure that the system is in flawless condition. If anything unusual is detected - which cannot be resolved - do not fly, instead get in touch with the support team. Always make sure you have the latest firmware version installed on your system.

6.1.1. Intel® Falcon™ 8+ UAS Firmware Updates

The latest Intel® Falcon™ 8+ UAS firmware, and step by step update instructions are available in the download area: http://intel.com/FalconDownloads.

Regularly check this website for firmware updates.

The firmware update for the Intel® Falcon™ 8+ UAS consists of four separate files, which are packed into a .ZIP file. The .ZIP file is called IF8P_firmware_vx.x.ZIP, with x.x being the latest firmware version, e. g. IF8P_firmware_v1.0.ZIP. After the .ZIP file is unpacked there will be the following four files:

- TRINITY.ATF:
  Firmware update file for the Intel® Falcon™ 8+ UAV
- COCKPIT.ATF:
  Firmware update file for the Intel® Cockpit Controller (CTR)
- CockpitControlInstaller_vx.x.x.exe:
  Update file for the Intel® Cockpit Control application running on the touchscreen tablet
- Intel-OBL-Mobile-Computing-Platform-Software-Limited-License.pdf:
  Outbound license file (OBL). Please read the license file before installing the

firmware/software. By installing the firmware/software, you agree to the included OBL.

The firmware of the Intel® Falcon™ 8+ UAV consists of two different components:

- NAV: Navigational Processor = flight controller module of the AscTec Trinity Control Unit. There are two Navigational Processors, NAV1 and NAV2, built into an Intel® Falcon™ 8+ UAV.
- PER: Peripheral Processor = flight controller module of the AscTec Trinity Control Unit. In addition to the two Navigational Processors, there is a third flight controller module built in.

Each firmware/software (TRINITY.ATF, COCKPIT.ATF, and CockpitControl-Installer_vx.x.x.exe) has its own version number. The currently installed firmware versions can be checked in the menu of the Status Display. Pushing **ENT** in the **Main Screen** opens the menu. Navigate to `Settings > Falcon Info`.

To check the installed version of the Cockpit Control application, tap on the info button in the lower left corner when the application is running. The `About` screen displays the currently installed version.

After performing an update, we recommend checking in the `Falcon Info` screen of the Status Display and in the `About` screen of the Cockpit Control application if the newly installed firmware version is correctly displayed. If a different version is displayed, the update was not successful and must be repeated.

Updating the Intel® Falcon™ 8+ UAS

Visit http://intel.com/FalconDownloads and download the latest firmware IntelFalcon8+_firmware_vx.x.ZIP.

Note *On the website, there is also a file available, providing information regarding changes and known issues of the latest firmware/software. Before updating the UAS firmware/software, make sure to read the release notes in order to understand the expected behavior due to the changes made in the firmware/ software.*

CAUTION: WHEN PERFORMING A FIRMWARE/SOFTWARE UPDATE, AL-WAYS USE FULLY CHARGED BATTERIES. ALWAYS INSERT TWO BATTER-IES IN THE INTEL® FALCON™ 8+ UAV. WHILE PERFORMING AN UPDATE, NEVER REMOVE THE BATTERIES AND NEVER SWITCH OFF THE INTEL® FALCON™ 8+ UAV, THE CTR, OR THE TOUCHSCREEN TABLET. YOU MAY DAMAGE YOUR SYSTEM.

After you read the release notes and downloaded the IntelFalcon8+ firmware .ZIP file, unzip the file onto your computer. Please read the Intel-OBL-Mobile-Computing-Platform-Software-Limited-License.pdf (OBL). By installing the firmware/software you agree to the included OBL.

Copy the files TRINITY.ATF, COCKPIT.ATF and CockpitControlInstaller_vx.x.x.exe onto an empty USB stick (max. 16 GB, file system: FAT32, allocation size: 32 kilobytes) and safely remove the USB stick from your computer.

Note	*Please keep the original USB stick that was supplied with your UAS if possible and use this USB stick for all updates. If you experience any difficulties during the update process, e.g. that the USB is not detected by the UAV or the Cockpit Controller, try reformatting the USB stick with the aforementioned parameters.*

6.1.1.1. Updating the Intel® Falcon™ 8+ UAV

The Intel® Falcon™ 8+ UAV is updated by a file called TRINITY.ATF. This file must be copied onto the USB stick before you start.

Table 6.1: Updating the Intel® Falcon™ 8+ UAV

STEP	OPERATION
1.	Plug the USB stick containing the TRINITY.ATF file into the USB port on the backside of the Intel® Falcon™ 8+ UAV (see no. (2) in “Central Unit Back View without Gimbal (Camera Mount)” on page 19).
2.	Push the Intel® Falcon™ 8+ UAV power button until there is a short beep from the UAV.
3.	Let go of the power button. The LED position lights of the UAV will start flashing with the beginning of the update procedure. Depending on the updated components, the update can take between 10 and 45 minutes. The end of the update process is indicated by a short melody from the UAV and the LED position lights will stop flashing.
4.	To power OFF the UAV, push the Intel® Falcon™ 8+ UAV power button until a short beep from the UAV is heard.
5.	Let go of the power button.
6.	Once the UAV is OFF, unplug the USB stick. If the update was successful, the file on the USB stick will be renamed to _TRINITY.ATF.
7.	Check that the file was renamed, and additionally check if the new version is displayed in the `Falcon Info` screen of the Status Display.

6.1.1.2. *Updating the Intel® Cockpit Controller (CTR)*

The CTR is updated by a file called COCKPIT.ATF. This file must be copied onto the USB stick before you start.

> *Note* *The firmware update of the CTR can only be done with the port labeled USB 1 at the backside of the CTR (see Figure 2-7. Intel® Cockpit Controller (CTR) overview).*

Table 6.2: Firmware Update for the CTR

STEP	OPERATION
1.	Plug the USB stick containing the *COCKPIT.ATF* file into the port USB `1` on the backside of the CTR.
2.	Switch ON the touchscreen tablet and wait until the `Preflight Checklist` is shown.
3.	Switch ON the CTR. When the update process starts, the Status Display will show `Starting X%...` and the percentage number will increase as the update progresses. In addition, the Status Display will show several messages regarding the update status of internal components. Depending on the updated components, the update can take between 10 and 45 minutes. At the end of the update process Done will be displayed shortly and the Status Display will show the Start Screen.
4.	Switch OFF the touchscreen tablet.
5.	Switch OFF the CTR.
6.	Unplug the USB stick. If the update was successful, the file on the USB stick will be renamed to _COCKPIT.ATF.
7.	Check that the file was renamed, and additionally check if the new version is displayed in the `Falcon Info` screen of the Status Display.

> *Note* *To save time, it is possible to do the firmware update of the CTR and the Intel® Falcon™ 8+ UAV in parallel.*

6.1.1.3. Updating the Cockpit Control Application

The Cockpit Control application is updated by a file called CockpitControlInstaller_vx.x.x.exe. This file must be copied onto the USB stick before you start.

Note *The firmware update of the Cockpit Control application can only be done with the USB ports 2 to 4 on the backside of the CTR ("Intel® Cockpit Controller (CTR) Overview" on page 23).*

Table 6.3: Firmware Update for the Cockpit Control Application

STEP	OPERATION
1.	Plug the USB stick containing the CockpitControlInstaller_vx.x.x.exe file into one of the USB ports labeled `USB 2, USB 3 or USB 4` on the backside of the CTR.
2.	Switch ON the touchscreen tablet.
3.	Switch ON the CTR.
4.	Confirm the `Preflight Checklist` of the Cockpit Control application.
5.	Tap on the info button in the lower left corner of the touchscreen tablet.
6.	In the next screen tap on `Updates` in the lower left corner. All update files found on the USB stick will be displayed in the center of the screen.
7.	Tap on the update file that should be installed. A dialog will pop up.
8.	Tap on YES to confirm the dialog. The Cockpit Control application will be closed.
9.	Confirm the next dialog `Cockpit Control Setup Wizard` with tapping on `Install`. A progress bar will be shown. When the update is finished, there will be a respective message.
10.	Tap on `Finish` to confirm this message. You will be asked to restart the system.
11.	Tap on `Yes` to confirm. After the restart, the dialog for time and date settings is shown.
12.	If necessary, adjust the time and date.
13.	Tap on `APPLY SETTINGS`.

Table 6.3: Firmware Update for the Cockpit Control Application (Continued)

STEP	OPERATION
14.	Confirm the `Preflight Checklist`.
15.	Tap on the info button in the lower left corner.
16.	Check the installed Cockpit Control version in the about dialog. The newly installed version should be shown.

6.1.2. Caring for the Intel® Falcon™ 8+ UAV

Please consider the next points in order to keep the UAV in good condition; so it will be ready for use every time.

- Strict compliance with the Safety Guidelines and Safety Precautions ensures that defects are found before a flight (UAV and safety check, pre-flight check and post-flight check, see "UAS AND SAFETY CHECK" on page 11).
- We recommend an annual check from the manufacturer, during which the system is fully tested. For details please contact your reseller or Intel support.

Cleaning

If necessary, you should clean the UAV after the mission, and before storing.

⚠ **CAUTION: IF YOU USE WATER, NO MOISTURE/WATER SHOULD REACH THE MOTORS OR ELECTRICAL CONTACTS.**

- Use a soft lint-free cloth (e.g. microfiber) for cleaning the outer parts (motor rails, canopy, propellers) carefully.
- If indicated you can moisten the cloth with warm water, to which you can add a mild dish-washing detergent if necessary.
- A small, soft paintbrush can be used for dry cleaning.
- For cleaning (especially the motors) and drying you can also use canned compressed air, which is available at many computer stores.

⚠ **CAUTION: WHEN YOU USE COMPRESSED AIR FOR CLEANING THE UAV, IT IS MANDATORY TO HOLD/FIX THE PROPELLERS DURING THE BLOWING OUT PROCEDURE. OTHERWISE, VOLTAGES CAN BE GENERATED, WHICH CAN DAMAGE THE SYSTEM ELECTRONICS.**

Storing

- Always disconnect all batteries when the system is no longer in use.

- Store in a place that is not subject to large temperature fluctuations and direct sunlight.
- Make sure the storage place is dry and that no condensation moisture can come into contact on with the system.
- Best practice is to always keep the UAV in the closed approved case.

Transportation

Only transport the system in the case or the backpack as described, see "TRANSPORT CASES & INTEL® BACKPACK" on page 55.

6.1.3. Propeller Replacement

Before taking-off, check all propellers for any signs of defects such as scratches, cracks or stress points (whitening - color change of the propeller surface caused by abnormal bending). If a blade shows any defect, it should be replaced before the next flight.

Figure 6.1: Changing the Propellers of the UAV

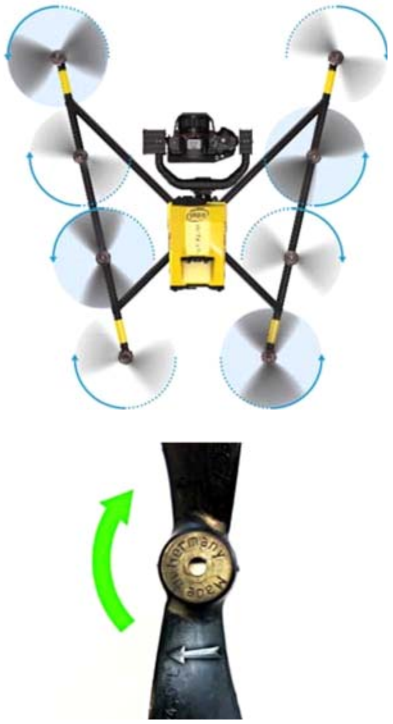
	The only tool you need for changing a propeller blade is the 5.5 mm wrench, which is delivered with your Intel® Falcon™ 8+ UAV. 1. Loosen the nut, of the defective propeller with the 5.5 mm wrench. 2. Lift the propeller carefully – without too much pressure downwards on the motor. **Note: There are two varieties of propellers (right- and left-spinning). The propeller direction is shown on the propeller by an arrow (see example for a right spinning propeller in the figure to the left).** 3. Check the propeller spin of the dismounted propeller. 4. Align the new propeller with the correct propeller spin to fit onto the propeller mount. 5. Press the propeller completely down on the mount. 6. Put the new self-tightening nut onto the motor shaft.

Figure 6.1: Changing the Propellers of the UAV (Continued)

	7. Hold the motor head with thumb and index finger of one hand to prevent the motor shaft from spinning. 8. Tighten the nut with the 5.5 mm wrench (20 Ncm +- 5 Ncm). To do so, turn the screw-wrench with the index finger of the other hand. As soon as the motor head starts turning as well, sufficient force has been applied. 9. Check if the propeller is spinning freely when you nudge it. Depending on the applied force, the propeller must make several turns. 10. Check the orientation of the propeller once more and compare the movement with the other propellers.

For more information on any other replaceable part, please contact Intel support.

6.2. TROUBLESHOOTING

This chapter describes solutions for special problems.

6.2.1. Establishing A Connection Between The CTR And The UAV

The UAV and the CTR are pre-configured ex works.

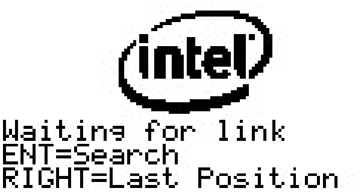
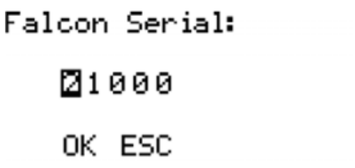
Nevertheless, when the Intel® Falcon™ 8+ UAV and the CTR are powered up for the first time, the Status Display will show the Start Screen and it is necessary to set up the connection between UAV and CTR.

If the UAV and the respective CTR have been linked before, the UAV will automatically connect to the CTR as soon as both are turned on.

In some cases, it may be necessary to establish the connection manually again.

Note *It saves some time to switch on the UAV first, so that the system check is being carried out. Then switch on the touchscreen tablet followed by the CTR.*

Figure 6.2: Connecting the CTR to the UAV

 Waiting for link ENT=Search RIGHT=Last Position	If the UAV and the CTR do not automatically connect, the Status Display will note it in the Start Screen. If this is the case, you must establish the connection manually. 1. Push the **ENT** button of the Status Display (see “STATUS DISPLAY” on page 136). You will see the screen to enter the Falcon Serial number (5-digit serial number of the Intel® Falcon™ 8+ UAV, printed on the top of the UAV, above the battery compartment, for example 31123). The first digit is highlighted (see figure below).
 Falcon Serial: 01000 OK ESC	2. Push **ENT** to activate the first digit. 3. Enter the first digit of the serial number by using the arrow **RIGHT/LEFT** buttons to increase/ decrease the number. **RIGHT** increases the number, **LEFT** decreases it. 4. Push **ENT** to confirm the first digit. The next digit can be entered. 5. Repeat this five times (for every digit) 6. Push **ENT** to confirm the serial number. *OK* is highlighted. 7. Push **ENT** and the connection will be established.

6.2.2. Analyzing Data Link Connection Issues

In some cases, the data link may be disturbed. If this happens please do the following:

1. Check that the antenna panel of the CTR is unfolded and oriented towards the UAV and that there are no visible defects like cracks or breaks.
2. When performing a test, make sure that there are no disturbing (WiFi) networks in the 2.4 GHz range. They will influence the results.
3. Use the Data Link Screen of the Status Display (see “The Main Information Screens” on page 148) to check if an issue always occurs on the same link.
4. If there is a persistent issue on one of the data links, it might be a defect either on the UAV transmitter / receiver modules or on the CTR transmitter / receiver modules. To check for this defect, please test the following if you have a second CTR / Intel® Falcon™ 8+ UAV available:
    - Take the CTR of the problematic Intel® Falcon™ 8+ UAV, and connect it to a different Intel® Falcon™ 8+ UAV and repeat the test.
      If the issue persists it is very likely the CTR, if the issue disappears it very likely comes from the Intel® Falcon™ 8+ UAV.

- Take a new CTR and connect it with the problematic Intel® Falcon™ 8+ UAV and repeat the test.
  If the issue persists it is very likely the Intel® Falcon™ 8+ UAV, if the issue disappears it very likely is coming from the CTR.

When the issue has been isolated, please contact the support team, describe your finding precisely and be prepared to provide log files of the flight tests.

If you do not have a second CTR / Intel® Falcon™ 8+ UAV available, contact Intel support.

6.2.3. No Preview Video On The Touchscreen Tablet Of The CTR

If there is no video preview image, please first check:

- The connection between the camera and the Intel® Falcon™ 8+ UAV
- That the camera, Intel® Falcon™ 8+ UAV, the touchscreen tablet and the CTR are properly switched ON
- Payload:
  The signal from the payload might not be fed correctly into the Intel® Falcon™ 8+ UAV. Please check the payload adapter. If you have a different payload available, please attach it and check the video reception.
- Video transmitter of the Intel® Falcon™ 8+ UAV:
  If you have one available, please use a different Intel® Falcon™ 8+ UAV system, and check if you can receive the video signal from that Intel® Falcon™ 8+ UAV with the original CTR.
  If you can receive video from a different UAV, there is an issue with the video transmission of the original Intel® Falcon™ 8+ UAV.
- Video receiver of the Intel® Falcon™ 8+ UAV:
  If you have one available, please use a different CTR, connect it with your Intel® Falcon™ 8+ UAV and check if you can receive the video signal with this CTR.
  If you can receive video with a different CTR, there is an issue with the video reception on the original CTR.
  When the issue has been isolated, please contact the support team, describe your finding precisely and be prepared to provide log files of the flight tests.
  If you do not have a second CTR / Intel® Falcon™ 8+ UAV available, contact Intel support.

6.2.4. Flight Logs

It might happen that the Intel® Falcon™ 8+ UAV cannot access a logging storage device (see “INTEL® FALCON™ 8+ UAV FLIGHT LOGS” on page 62). Mostly, the reason is a mechanical connection issue or a corrupted file system on the storage device.

If the Intel® Falcon™ 8+ UAV cannot access a storage device, a respective warning will be displayed:

Table 6.4: Possible Warnings

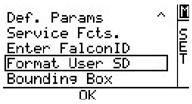
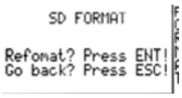
CAUSE	VISUAL SIGNAL	POSSIBLE FIX
User SD card cannot be accessed.	`<- Check Msg` appears in the status line of the Status Display. Push the related arrow **LEFT** button on the CTR until the Error Message Screen is shown. `No user SD card` will be shown.	Take out the User SD card, make a backup copy and format it (file system: FAT32, allocation unit size: 32 kilobytes). After reinserting the SD card into the Intel® Falcon™ 8+ UAV, it should be accessible. If no backup copy is needed, the User SD card can also be formatted directly by the UAV. To do so: 1. Push **ENT** to open the menu on the Status Display. 2. Push the arrow **RIGHT** button to navigate to *Settings*. 3. Push **ENT** and use the arrow RIGHT button to navigate to `Format User SD`.  Def. Params Service Fcts. Enter FalconID Format User SD Bounding Box OK SET 4. Push **ENT** to confirm. The shown screen appears: SD FORMAT Refomat? Press ENT! Go back? Press ESC! 5. Push **ENT** to confirm the formatting of the User SD card. The process starts, a progress bar is shown. Pushing **ESC** cancels the function and brings you back to the **Main Screen**. When the formatting of the SD card is finished, the Intel® Falcon™ 8+ UAV will immediately create a new log file and start logging again.

Table 6.4: Possible Warnings (Continued)

CAUSE	VISUAL SIGNAL	POSSIBLE FIX
Internal SD card cannot be accessed.	`<- Check Msg` appears in the status line of the Status Display. Push the related arrow **LEFT** button on the CTR until the Error Message Screen is shown. `No internal SD card` will be shown.	Switch off the Intel® Falcon™ 8+ UAV. Wait 10 seconds and switch it on again. During boot up, the internal SD card will be formatted and it should again be accessible. If this does not help, contact the support team to get instructions on how to proceed.

> *Note* *The Intel® Falcon™ 8+ UAV can fly without any active logging device. It is the responsibility of the user to make sure that all flights can be properly logged if it is a legal requirement in the country where the system is used.*

The User SD card will not be deleted or formatted by the flight system. We recommend to regularly make a back-up copy of this storage device and reformatting it afterwards. Especially when working on complex projects, during which the logs are needed for geo-referencing, it is helpful to start with clean storage media.

6.3. SUPPORT

Should you require support, do not hesitate to contact your local support partner. If you assume any kind of malfunction or if you happened to have had an accident with the UAV, please make sure to always supply the following information:

- Intel® Falcon™ 8+ UAV serial number (5-digit number of the Intel® Falcon™ 8+ UAV, printed on the top of the UAV, above the battery compartment, for example 31123, see “Central Unit” on page 19.
- Intel® Falcon™ 8+ UAS firmware versions:
  You get access to the above-mentioned information by using the Status Display.

1. Push **ENT** in the **Main Screen**.
   A menu is opened.
2. Use the arrow **RIGHT** button to select `Settings`.
3. Push **ENT**.
   A new screen is opened.
4. Use the arrow **RIGHT** button to select `Falcon Info`.
5. Push **ENT**.
   Now you see the serial number and the firmware versions of the current hardware components. In the last column, the activated feature packages are shown.

6. Push **ESC**.
   You return to the `Settings` menu.

Further information needed:

- Detailed description of the incident / defect.
- Images or videos if applicable (please also include comments or additional explanations along with the images if necessary). In case of an accident, please take pictures of the spot where the incident occurred to help us reconstruct the situation.
- Log files from the User SD card, see "INTEL® FALCON™ 8+ UAV FLIGHT LOGS" on page 62. Please indicate as precisely as possible the log file number in which the incident occurred, or note the exact local time at which the incident occurred.
- Reproduction scenario:
  Please describe step by step what you do and under which circumstances / conditions the failure occurs.
- If you want to report an incident or request support, please download and fill out the Support Request Form from: http://intel.com/FalconDownloads and send it to the Intel support team.

If the system needs to be sent in for repair, please contact the support team first. They will advise the next steps.

Note	*If the UAV performed a direct landing because of a lost data link connection and if you have difficulties in locating it, the last known position of the Intel® Falcon™ 8+ UAV (which is stored in the Status Display of the CTR) might be helpful. Click the arrow RIGHT button of the Status Display once (while not connected) and latitude and longitude of the last known position will be displayed.*

7. TECHNICAL SPECIFICATION

Figure 7.1: Technical Data

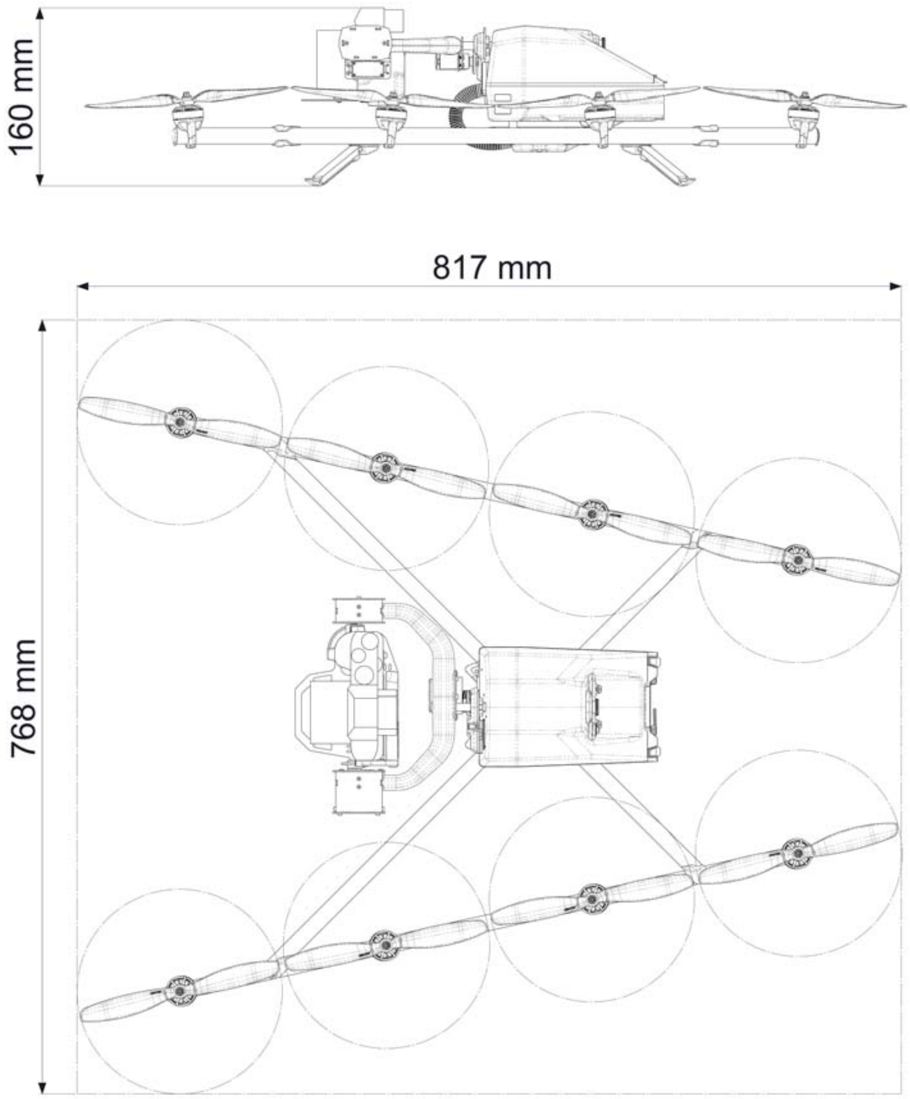

160 mm
817 mm
768 mm

Table 7.1: Technical Data

INTEL® FALCON™ 8+ UAV	
TYPE	V-Form Octocopter
SIZE	768 x 817 x 160 mm
ENGINES	8 electrical, brushless (sensorless) motors with 125 W max. power each
ROTOR DIAMETER	20.32 cm (8 in)
NUMBER OF ROTORS	8
ROTOR WEIGHT	6 g (0.21 oz)
EMPTY WEIGHT	1.2 kg (2.65 lbs)
MAX. PAYLOAD WEIGHT (CAMERA AND GIMBAL)	0.8 kg (1.76 lbs)
MAX. TAKE OFF WEIGHT	2.8 kg (6.17 lbs)
MAX. FLIGHT TIME WITHOUT PAYLOAD*	26 min
MAX. FLIGHT TIME WITH MAX. PAYLOAD WEIGHT*	16 min
MAX. FLIGHT TIME WITH A7R	16 min
MAX. FLIGHT TIME WITH INSPECTION PAYLOAD	18 min
MAX. RANGE DATA LINK**	1 km (FCC version) (3281 feet) 850 m (CE version) (1640 feet)
MAX. SERVICE CEILING**	4000 m MSL (13123 feet)
MAX. ALTITUDE ABOVE GROUND LEVEL**	Varies by country in which you operate the UAV and requires you to check the regulations that apply for your country of operation
MAX. RANGE VIDEO LINK**	500 m (FCC and CE version) (1640 feet)
MAX. TOLERABLE WIND SPEED	12 m/s (26 mph) (GPS Mode) 16 m/s (35 mph) (Hight Mode, Manual Mode)

Table 7.1: Technical Data (Continued)

MAX. PRECIPITATION	Not recommended to operate in any form of precipitation
OPERATING TEMPERATURE	-5 °C to 45 °C (23 °F to 113 °F)
SHORT TERM STORAGE TEMPERATURE (UP TO ONE MONTH)	-5 °C to 40 °C (23 °F to 104 °F)
LONG TERM STORAGE TEMPERATURE (BEYOND ONE MONTH)	-5 °C to 25 °C (41 °F to 77 °F)
POWER SUPPLY	2 x Intel® Powerpack 4000 (redundant setup)
NAVIGATION SENSORS	
ASCTEC TRINITY CONTROL UNIT	Triple redundant Inertial Measurement Unit (IMU: barometer, compass, accelerometers, gyroscopes)
GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)	GPS and GLONASS
MAX. AIRSPEED	
MANUAL-MODE	18 m/s (40 mph)
HEIGHT-MODE	18 m/s (40 mph)
GPS-MODE	4.5 m/s (10 mph) standard 8 m/s in GPS based video mode up to 10 m/s (22 mph) in mapping flights
MAX. CLIMB/SINK RATE	
MANUAL-MODE	6 to 10 m/s (13 to 22 mph)
HEIGHT-MODE	3 m/s (6 mph)
GPS-MODE	3 m/s (6 mph)
MAX. TURN RATE	
MANUAL-MODE / HEIGHT-MODE	115°/s
GPS-MODE	75°/s
MAX. PITCH AND ROLL ANGLES	
MANUAL-MODE / HEIGHT-MODE	50°

Table 7.1: Technical Data (Continued)

GPS-MODE	45°
WIRELESS COMMUNICATION	
2 INDEPENDENT (DIVERSITY) COMMAND AND CONTROL LINKS	2.4 GHz adaptive FHSS link with 100 mW (FCC compliant version)
DIGITAL VIDEO LINK	Low latency digital link. 5.1 Ghz to 5.8 GHz with up to 24 dBM / 250 mW (FCC compliant version). 5.1 Ghz to 5.8 GHz with up to 20 dBM / 100 mW (CE compliant version). Resolution depending on payload up to 1080 p Full HD
INTEL® COCKPIT CONTROLLER (CTR)	
DIMENSION (W X L X H)	320 x 380 x 135 mm (12.60 x 14.96 x 5.31 in)
WEIGHT	2.7 kg (5.95 lbs) (w/o battery) 3.1 kg (6.83 lbs) (with battery)
POWER SUPPLY	1 x Intel® Powerpack Battery
OPERATING TIME*	2 h
OPERATING TEMPERATURE	-5 °C to 45 °C (23 °F to 113 °F)
SHORT TERM STORAGE TEMPERATURE (UP TO ONE MONTH)	-5 °C to 40 °C (23 °F to 104 °F)
LONG TERM STORAGE TEMPERATURE (BEYOND ONE MONTH)	-5 °C to 25 °C (23 °F to 77 °F)
TOUCHSCREEN	Size 8.3", resolution 1980 x 1200 px
CONNECTIONS	4 x USB, 1 x HDMI
INTEL® POWERPACK BATTERY	
TYPE	Lithium Polymer (LiPo) 4S
CAPACITY	4000 mAh
VOLTAGE (NOMINAL)	14.8 V
ENERGY	59.2 Wh
OPERATING TEMPERATURE***	-5 °C to 40 °C (23 °F to 104 °F)

Table 7.1: Technical Data (Continued)

CHARGE TEMPERATURE	Recommended: 10 °C to 30 °C (50 °F to 86 °F) Max.: 5 °C to 40 °C (41 °F to 104 °F)
SHORT TERM STORAGE TEMPERATURE (UP TO ONE MONTH)	-5 °C to 40 °C (23 °F to 104 °F)
LONG TERM STORAGE TEMPERATURE (BEYOND ONE MONTH)	18 °C to 28 °C (64 °F to 82 °F)
RECOMMENDED STORAGE VOLTAGE	3.7 V per cell
MAX CHARGING POWER	80 W
TYPICAL CYCLE LIFE	150 cycles
WEIGHT	398 g (14 oz) (tolerance +/- 5%)
AC ADAPTER (CHARGER FOR POWERPACK PP4000)	
INPUT VOLTAGE	100-240 V, 50/60 Hz
MAXIMUM INPUT CURRENT	1.5 A
MAXIMUM OUTPUT CURRENT	4.74 A
OUTPUT VOLTAGE	19.0 V
* Data is based on having new batteries, fully charged, and at room temperature. Data collection flights were performed at approximately 0 m (0 feet) above sea level at outside temperature of approximately 15 °C (59° F), no wind, slow and steady flight maneuvers, no hovering. All measurements done at International Standard Atmosphere (ISA). Other factors may have influenced the results.	
** The pilot is responsible for knowing and complying with all laws and regulations applicable to the airspace in which the Intel® Falcon™ 8+ System is operated. Jurisdictions have different safety rules related to authorization for flying unmanned aircraft; flying near airports, manned aircraft, or people; operation within visual line of sight; altitude limits and others. Data collection flights were performed at approximately 120 m (393 feet) above ground in GPS Mode, drone facing away from pilot, Cockpit antenna oriented exactly towards drone, no obstacles in-between line of sight to drone and 400 m radius around drone and pilot, no external disturbance of the 2.4 Ghz and 5.8 GHz bands. All measurements done at International Standard Atmosphere (ISA). Other factors may have influenced the results.	

Table 7.1: Technical Data (Continued)

*** The maximum temperature for the Intel® Powerpack depends on the system and the configuration it is used with:

- The Intel® Falcon™ 8+ combined with the Intel® Cockpit Controller - operating temperature is 45°C (113°F)
- The Intel® Falcon™ 8+ without a payload attached and two fully charged batteries inserted - maximum operating temperature is 45°C (113°F)
- The Intel® Falcon™ 8+ with payload attached - maximum operating temperature is 40°C (104°F).
  Because of the necessary higher current, the batteries will produce more heat.

LIST OF FIGURES

2.1 The Intel® Falcon™ 8+ UAV Components 18
2.2 Central Unit Back View without Gimbal (Camera Mount) 19
2.3 Central Unit Front View without Gimbal (Camera Mount) 20
2.4 Central Unit Side View, Left Side without Gimbal (Camera Mount) 20
2.5 Motor Rails and Equipment 21
2.6 Units of the Gimbal 22
2.7 Intel® Cockpit Controller (CTR) Overview 23
2.8 Status Display 26
2.9 The Touchscreen Tablet 26
2.10 Independent Camera Control (ICC) 27
2.11 2nd Operator Monitor Package 29
2.12 Camera Control Via the Intel® Cockpit Controller (CTR) 30
2.13 Installing the Camera Mount 32
2.14 Removing the Camera Mount 33
2.15 Sony Alpha 7R and SD Card Slot 36
2.16 Sony Alpha 7R CTR Control Layout 37
2.17 Camera Settings By Camera Sony Alpha 7R 39
2.18 Inspection Payload 40
2.19 Inspection Payload: CTR Control Layout 43
2.20 LED Description 45
2.21 The Intel® Powerpack Battery 46
2.22 Charging 47
2.23 Battery Update 51
2.24 Temperature Depending LiPo Battery Capacity 54
2.25 Transport Cases & Backpack 55
2.26 Packing Instructions for the Intel® Falcon™ 8+ UAS Cases 56
2.27 Show Activated Perpetual License 61
2.28 Show activated annual license 62
2.29 AscTec Navigator Software Flightbook 63
3.1 Preparing the UAV 66
3.2 Preparing the UAV (Continued) 67
3.3 Preparing the CTR 68
3.4 The Cockpit Control Application 70
3.5 The Cockpit Control Application and PATH Projects 75
3.6 The Cockpit Control Application and PATH Projects 80

3.7 The Cockpit Control Application And AscTec Navigator Software Projects 83
3.8 Message Shown During Regional Settings 87
3.9 Magnetic Field Warning 87
3.10 The Link Loss Procedures 89
3.11 The Link Loss Procedures (Continued) 89
3.12 New Home Position 90
3.13 Last Known Position 91
3.14 Selecting The Flight Modes 92
3.15 GPS Accuracy 94
3.16 Shadowing 95
3.17 GPS Multi Path Effects 96
3.18 Starting The Motors 99
3.19 Basic Flight Principles 101
3.20 Left And Right Control Sticks 103
3.21 Flight Information On The Main Screen Of The Status Display 104
3.22 Examples For Situations To Be Avoided 105
3.23 System Warnings 127
4.1 Status Display 136
4.2 Main Information Screens 148
5.1 Circle of Interest 153
5.2 Cylindrical Panorama 155
5.3 Spherical Panorama 157
5.4 Quick Surveying Assistant 159
6.1 Changing the Propellers of the UAV 169
6.2 Connecting the CTR to the UAV 171
7.1 Technical Data 176

LIST OF TABLES

1.1 Safety Check List 12
1.2 Pre Flight Check List 13
1.3 Pre Flight Checklist (Continued) 14
1.4 Post-flight Check List 16
2.1 Operating a Camera By ICC 27
2.2 Sony Alpha 7R Camera Control By Camera Functions 38
2.3 Sony Alpha 7R Camera Control By Status Display 38
2.4 Inspection Payload: CTR Control Layout 44
2.5 Inspection Payload Control By Status Display 44
2.6 Technical Specifications of the Battery 45
2.7 Charging State 47
2.8 Charging Cycles 49
2.9 Battery Capacity 49
2.10 Battery Status 50
2.11 Battery Storage/Charging Maintenance Recommendation 53
2.12 Description Packages 59
2.13 Possible Warning 64
3.1 Controlled Parameters Depending On The Flight Mode 92
3.2 Controlled Parameters In GPS-Mode 93
3.3 Controlled Parameters in Height-Mode 97
3.4 Controlled Parameters Depending On The Flight Mode 98
3.5 Operational Guidelines In Case Of Emergency 107
3.6 Possible Warnings 116
3.7 Acoustic And Visual Magnetic Field Warning 119
3.8 Warnings Depending On Critical Battery Levels 121
3.9 Diversity Data Link Warnings 123
3.10 GPS Signal Warning 124
3.11 Motor Warning (Controller) 125
3.12 Possible Warnings Which Refer To The CTR 125
3.13 AscTec Trinity Control Unit System Warnings 127
3.14 Payload Weight 135
4.1 Status Display Menu Structure 137
5.1 Image Positions of Spherical Panorama Set To 19 mm Focal Length 158
5.2 Image Positions Of Spherical Panorama Set To 30 mm Focal Length 158
6.1 Updating the Intel® Falcon™ 8+ UAV 165
6.2 Firmware Update for the CTR 166
6.3 Firmware Update for the Cockpit Control Application 167
6.4 Possible Warnings 173
7.1 Technical Data 177

INDEX

A

AC Adapter 180
Actively Stabilized Camera Mount 22
Adjusting The Camera Horizon 35
Airspeed 178
Analyzing Data Link Connection Issues 171
AscTec Navigator Software Mission, Interrupting A Mission 85
AscTec Navigator Software Mission, Resuming A Mission 85
AscTec Navigator Software Mission, Starting and Flying an 84
AscTec Navigator Software, Waypoint Navigation 162
Automated Start-up Checks 86

B

Batteries, Caring for 54
Battery Capacity 49
Battery Disposal 54
Battery Information Safety Instructions 51
Battery Life 54
Battery Status 49
Battery Update 51
BMS Error Mode 50
BMS Menu 48

C

Camera Control, CTR 37
Camera Options, Status Display 38
Central Unit 19
Changing a Payload (Camera) 31
Charging 47
Charging Cycles 48
Charging State 48
Circle of Interest (COI) 153
Cleaning 168
Climb/Sink Rates 178
Compass Calibration 33, 34
Compass Error Estimation 96

Controlling The Intel® Falcon™ 8+ UAV, CTR 103

E

Emergencies, In-flight 107
Establishing a Connection Between the CTR and the UAV 170

F

Firmware Updates 163
Flight 101
Flight Logs 62, 172
Flight Modes 91

G

General Guidelines and Warnings, Batteries 52
Gimbal 22
GPS-Mode 93
GPS-Mode, Landing 114
GPS-Mode, Launching 100

H

Height-Mode 97
Height-Mode, Landing 114
Height-Mode, Launching 100
Home Position 90

I

Independent Camera Control (ICC) 27
In-Flight 104
Inspection Payload 40
Inspection Payload Control, CTR 43
Inspection Payload Control, Status Display 44
Inspection Payload, General Care 42
Intel® Backpack 55
Intel® Cockpit Controller (CTR) 22, 179
Intel® Falcon™ 8+ UAS 7
Intel® Falcon™ 8+ UAV 18, 177
Intel® Falcon™ 8+ UAV, Caring for 168
Intel® Powerpack Batteries 45
Intel® Powerpack Batteries, Charging 47

Intel® Powerpack Battery 179
Intended Use 7

L

Landing 114
Landing, GPS-Mode 114
Landing, Height-Mode 114
Landing, Manual-Mode 115
Launching, GPS-Mode 100
Launching, Height-Mode 100
Launching, Manual-Mode 101
Limitations, Operational 135
Link Loss Procedure 88

M

Magnetic Field Warning 87
Main Information Screen 148
Maintenance 163
Manual-Mode 98
Manual-Mode, Landing 115
Manual-Mode, Launching 101
Mission Planning 104
Motor Rails 21
Motors, Starting and Stopping 99

N

Navigation Sensors 178
No Preview Video on the Touchscreen Tablet of the CTR 172

O

Operating the System 66
Operating Tips 105
Operational Limitations 135

P

Packing Instructions 56
Panorama 154
PATH Projects 74
Payload Calibration 33, 34

Payloads - Camera Options 29
Post-Flight Check 16
Pre-Flight Check 13
Preparing the Intel® Cockpit Controller (CTR) 68
Preparing the Intel® Falcon™ 8+ UAV 66
Privacy and Property Rights 11
Product Warranty 55
Propeller, Replacement 169

Q

Quick Surveying Assistant 158

R

Regional Setting 86

S

Safety First 7
Safety Guidelines 8
Second Operational Moniter 28
Shadowing 95
Situations with Varying GPS Reception 91
Software Feature Packages 59
Software Feature Packages, Activating 60
Software Feature Packages, Annual 61
Software Feature Packages, Perpetual 61
Sony Alpha 7R Full Frame Camera 36
Sony Alpha 7R, Camera Settings 38
Sony Alpha 7R, General Care 36
Special Functions 153
Status Display 26, 136
Storage Mode 48
Storing 168
Support 163, 174
Switching Off The UAS 116

T

Taking Off 99
Technical Specification 176
Touchscreen Tablet 26, 70

Transport Cases 55
Transportation 169
Troubleshooting 163, 170
Turn Rates 178

U

UAS and Safety Check 11
Updating, Cockpit Control Application 167
Updating, Intel® Cockpit Controller (CTR) 166
Updating, Intel® Falcon™ 8+ UAV 165

W

Warnings 116
Warnings, AscTec Trinity Control Unit System 127
Warnings, Battery 106
Warnings, CTR 125
Warnings, Data Link 123
Warnings, GPS 124
Warnings, Magnetic Field 118
Warnings, Motor Failure 125
Warnings, of the UAV and the CTR
  Critical Battery Levels 121
Waypoint Navigation 162
Wireless Communication 179