

Trimble UX5 HP Aerial Imaging Solution



Aerial Imaging Version 2.2.6
Revision B
May 2017



Legal Information

Trimble Inc.

www.trimble.com

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COCOM Limits

The U.S. Department of Commerce requires that all exportable GPS products contain performance limitations so that they cannot be used in a manner that could threaten the security of the United States. The following limitations are implemented on this product:

- Immediate access to satellite measurements and navigation results is disabled when the receiver velocity is computed to be greater than 1,000 knots, or its altitude is computed to be above 18000 meters. The receiver GPS subsystem resets until the COCOM situation clears. As a result, all logging and stream configurations stop until the GPS subsystem is cleared.

Notices

United States

Certification number:

FCC ID HSW-DNT2400P.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Changes and modifications not expressly approved by the manufacturer or registrant of this equipment can void your authority to operate this equipment under Federal Communications Commission rules.

Canada

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and

maximum (or lesser) gain approved for the transmitter by Industry Canada.

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions:

- (1) this device may not cause interference, and
- (2) this device must accept any interference, including interference that may cause undesired operation of the device.

This Class A digital apparatus complies with Canadian ICES-003.

Certification number: IC 4492A-DNT2400P.

This apparatus complies with Canadian RSS-210.

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada.

Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radioexempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

- (1) l'appareil ne doit pas produire de brouillage, et
- (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

Numérique de certification IC: 4492A-DNT2400P.

Cet appareil est conforme à la norme CNR-210 du Canada.

Europe

The product covered by this guide are intended to be used in all EU member countries, Norway, and Switzerland.

This equipment is classified as Group 1, Class A equipment according to EN 55011. Group 1 is applicable for all equipment within the scope of EN 55011 that is not classified as Group 2 equipment, which contains all ISM RF equipment. Class A equipment is equipment suitable for use in all establishments other than domestic. Using Class A equipment in domestic environments may cause difficulties ensuring electromagnetic compatibility.

CE Declaration of Conformity

Hereby, Trimble Inc. declares that this product is in compliance with the essential requirements and other relevant provisions of:

- EMC Directive (2014/30/EU)



- Radio Equipment Directive (2014/53/EU)
- RoHS Directive (2011/65/EU)
- Machine Directive (2006/42/EC)

Note– Deviation from Machine directive 2006/42/EC: The CE marking for the UX5 HP system is placed on the Trimble UX5 HP eBox and is only visible when the eBox is removed from the Trimble UX5 HP wing.

Japan

Certification numbers for the DNT2400P RFM radio module: 007WWCUL0739 and 003UVA110681

Brazil

Este produto está homologado pela Anatel, de acordo com os procedimentos regulamentados pela Resolução nº. 242/2000 e atende aos requisitos técnicos aplicados, incluindo os limites de exposição da Taxa de Absorção Específica referente a campos elétricos, magnéticos e eletromagnéticos de radiofrequência de acordo com as Resoluções nº. 303/2002 e 533/2009.

Manter distância mínima de 2,5 cm do corpo humano.

Para maiores informações, consulte o site da ANATEL www.anatel.gov.br.

Australia and New Zealand

This product conforms with the regulatory requirements of the Australian Communications and Media Authority (ACMA) EMC framework, thus satisfying the requirements for C-Tick Marking and sale within Australia and New Zealand.



Taiwan – Battery Recycling Requirements

The product contains a removable lithium polymer battery. Taiwanese regulations require that waste batteries are recycled.

廢電池請回收

Waste Electrical and Electronic Equipment (WEEE)

For product recycling instructions and more information, please go to www.trimble.com/Corporate/Environmental_Compliance.aspx.



Recycling in Europe: To recycle Trimble WEEE (Waste Electrical and Electronic Equipment, products that run on electrical power), call +31 497 53 24 30, and ask for the “WEEE Associate”. Or, mail a request for recycling instructions to:

Trimble Europe BV
c/o Menlo Worldwide Logistics
Meerheide 45
5521 DZ Eersel, NL

FCC Declaration of Conformity

We, Trimble Inc.
935 Stewart Drive
PO Box 3642
Sunnyvale, CA 94088-3642
United States
+1-408-481-8000

Declare under sole responsibility that DoC products comply with Part 15 of 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.

Environmental hazards

The product complies with international RoHS regulations.

Toxic and hazardous substances and elements

Part name	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr6+)	Poly-brominated biphenyls (PBB)	Poly-brominated diphenyl ethers (PBDE)
Lithium polymer rechargeable battery	X	0	0	0	0	0
Power supply	X	0	0	0	0	0
Printed circuit board assembly	X	0	0	0	0	0
Radio module	X	0	0	0	0	0
Chassis	0	0	0	0	0	0
Plastic enclosure	0	0	0	0	0	0
Paper manual	0	0	0	0	0	0

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Introduction

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- System components
- Installing the Aerial Imaging software
- Projects, blocks, and flights
- Project phases
- Software overview
- Changing the system settings
- Performing maintenance

The *Trimble UX5 HP Aerial Imaging Solution User Guide* provides detailed information about operating the components of the Trimble® UX5 HP.

Even if you have used other unmanned aviation systems before, please read this user guide carefully to familiarize yourself with the UX5 HP.

The UX5 HP aerial imaging solution

The Trimble UX5 HP aerial imaging rover is an unmanned aerial vehicle (UAV). An unmanned aerial vehicle is a generic term, and refers to an aircraft that is operated remotely. The UX5 HP aerial imaging rover follows a pre-programmed path where takeoff, flight, and landing require minimal human intervention. If required, the crew operating the aircraft from the ground can intervene to change the flight path or to land. In some cases, such as communications failure or loss of GPS signal, a pre-programmed intervention is automatically activated to re-establish signal loss or to terminate the flight early and complete a safe landing.

The UX5 HP aerial imaging rover holds a camera that takes aerial images over the defined area. During the flight, all pictures are acquired at a specified height, along parallel lines with specified overlap between the image exposures. At the same time, precision GNSS-based position information is recorded during a postprocessing kinematic (PPK) survey to achieve highly accurate position information for the captured images. When processed in image processing software such as Trimble Business Center software, the PPK data produces high absolute accuracy deliverables.

About postprocessed kinematic surveys

A postprocessed kinematic survey enhances the accuracy of position data derived from satellite-based positioning systems by using data from at least two GNSS receivers: a **base** (reference) receiver and a **rover** (moving) receiver.

The base receiver remains stationary at a site with precisely known coordinates. The coordinates of the rover are unknown. They are determined relative to the reference position using measurements recorded simultaneously at the two receivers. The positioning accuracy obtained with this technique is usually centimeter accuracy. This is mainly because the measurements of two (or more) receivers simultaneously tracking a particular satellite contain more or less the same errors and biases. The shorter the distance between the two receivers, the more similar the errors. By calculating the difference between the measurements of the two receivers, common errors are removed and those that are spatially correlated are reduced, depending on the distance between the reference receiver and the rover.

For a PPK survey, the data collected by the rover is processed and corrected **after** the measurements have been made. This provides the following advantages compared to a real-time kinematic (RTK) survey:

- More accurate results as the data throughput is not limited by the real-time communication link.
- Communication link-related problems, such as signal obstruction or limitation of coverage, are avoided.
- No accuracy degradation due to data latency.
- More accurate results due to more flexibility in editing and cleaning of the collected GPS data.

Typical applications

Image acquisition can be used for:

- Orthophoto creation
- Digital Elevation Model (DEM) or Digital Surface Model (DSM)

- Photogrammetry

The resulting data is useful for a range of applications, including:

- Topographical surveying, particularly in remote or difficult to access areas, typical in the mining and dredging industries
- Vegetation monitoring
- Infrastructure mapping

Postprocessed kinematic survey data is generally used in applications where centimeter-level precision is needed, such as:

- Mapping out a feature such as a fault scarp or a shoreline
- Recording the locations of sample sites
- Measuring the positions of markers such as stakes on a glacier to determine ice velocities

ISA conditions

All operating specifications provided in this guide for the UX5 HP aerial imaging rover are determined using International Standard Atmosphere (ISA) conditions. The ISA conditions used to determine the specifications for the UX5 HP aerial imaging rover are:

Specification	Value
Humidity	0 %
Air pressure	1013.25 hPa (760 mm Hg)
Temperature	15 °C (59 °F)
Air density	1.225 kg/m ³ (0.076 lb/ft ³)

System components

The UX5 HP aerial imaging system comprises the following components:

- UX5 HP aerial imaging rover
- Camera
- Ground control station
- Launcher
- Tracker (optional)

UX5 HP aerial imaging rover

The UX5 HP aerial imaging rover consists of the wing kit (or body), the eBox and the gBox.

The eBox is a removable box containing the autopilot that controls the UX5 HP. The eBox is connected to a GPS antenna for navigation and a radio antenna for communicating with the ground control station. It is also connected to the camera for sending trigger commands and recording shutter feedback events.

The gBox is a removable box containing a Trimble precision GNSS receiver that provides centimeter-level positioning technology. The gBox is connected to a GNSS antenna for recording positions and to the camera for recording the shutter feedback events.

Camera

The camera captures images during the flight. The full frame camera has a large 36.4 megapixel CMOS sensor that provides sharp, detailed images. The standard RGB solution includes a UV HAZE 1 filter. The optional NIR (near infrared) solution is for use in specialized applications such as agriculture and includes a B+W 040 (orange) filter.

The camera can be fitted with a 15 mm, 25 mm, or 35 mm lens.

Ground control station

The ground control station (GCS) is used to control the UX5 HP aerial imaging rover from the ground. It comprises a GPS-enabled tablet running the Trimble Access™ Aerial Imaging software. The Trimble UX5 HP modem is connected to the tablet to enable radio communication to the rover.

Launcher

The launcher is a mechanical device that provides a safe way to launch the UX5 HP aerial imaging rover in the direction of takeoff.

Tracker

The tracker consists of a transmitter inserted in the body of the UX5 HP aerial imaging rover and a receiver. If required, the receiver is used to track the transmitter signal so the UX5 HP can be located once it has landed. The exact type of tracker used depends on the country where the system is being used. Check with your Trimble distributor what is available for your location.

Installing the Aerial Imaging software

Use the Trimble Access™ Aerial Imaging software to plan, manage, and monitor your flights.

The Aerial Imaging Desktop software is installed on an office computer. The field version of the Aerial Imaging software is installed on the tablet. The field software provides all of the functionality included in the office software. In addition, you can use the field software to monitor the aircraft during flight.

Aerial Imaging Desktop installation

1. To install the Aerial Imaging Desktop software, use Trimble Installation Manager.

If you have:

- Not installed Trimble Installation Manager before, go to www.trimble.com/installationmanager for installation information. Make sure you download and install the Trimble Installation Manager

Online version.

- Previously installed Trimble Installation Manager, you do not need to reinstall it because it updates itself automatically.
2. Make sure you **do not** have a tablet or other Trimble controller connected to the office computer.
 3. Select *Start / All Programs / Trimble Installation Manager* to start the Installation Manager.
 4. Make sure *Aerial Imaging* is selected in the product bar.
 5. In the *Try software* tab, select the *Aerial Imaging* check box and then click **Create license**. The *Trimble Central Authentication Service* dialog appears.

If you do not have a CAS account, click the *Create an account* link to go to the web page where you can register. After registration, approve the verification email to create your account.

6. Enter your login details and then click **Log in**.

The Trimble Installation Manager window switches to the *Install updates* tab and shows the now licensed Aerial Imaging Desktop software.

7. Click **Install**.

When the software is successfully installed, a green check icon appears.

8. Click **Finish** to close Trimble Installation Manager.

For further information on updating the software, view the Help file in the Trimble Installation Manager.

Aerial Imaging Tablet installation

Note – Make sure Windows® 7 is installed on the tablet.

1. To install the Aerial Imaging software on the tablet, use Trimble Installation Manager.

If you have:

- Not installed Trimble Installation Manager before, go to www.trimble.com/installationmanager for installation information. Make sure you download and install the Trimble Installation Manager Online version.
 - Previously installed Trimble Installation Manager, you do not need to reinstall it because it updates itself automatically.
2. Select *Start / All Programs / Trimble Installation Manager* to start the Installation Manager.
 3. Make sure *Aerial Imaging* is selected in the product bar.
 4. In the *Install updates* tab, select the *Aerial Imaging* check box and then click **Install**.

When the software is successfully installed, a green check icon appears.

5. Click **Finish** to close Trimble Installation Manager.

For further information on how to install or update your software and license file, view the Help file in Trimble Installation Manager.

Software notifications

The software notification service is installed on your office computer or tablet along with the Trimble Installation Manager software. The service uses the Windows notification area, which appears at the far right of the Windows taskbar.

The service notifies you when newer versions of the Aerial Imaging software are available. Notifications occur once a week until you have updated your system.

To run Trimble Installation Manager and install updates, click the notification message. Alternatively, click the *Show Hidden Icons* arrow in the Windows taskbar and then double-click the Trimble Installation Manager icon.

To manually check for updates, click the *Show Hidden Icons* arrow in the Windows taskbar and then right-click the Trimble Installation Manager icon and select *Check for updates*.

Projects, blocks, and flights

A **project** consists of all activities needed to acquire aerial imagery of your area of interest. The area of interest consists of one or more **blocks** and blocks are added to **flights**. A flight can cover more than one block, as long as the total flight time is less than the maximum flight time. If the estimated flight time for a block exceeds the maximum flight time, the block can be split into smaller parts.

Projects, blocks, and flights can be copied so it is easy to set up similar projects or flights. Copy blocks to easily repeat flights at different heights or to redo a flight regularly, for example to track changes or progress over the block area.

Note – *Block and flight planning are usually done in the office but must be validated in the field after checking actual conditions.*

For example, a farmer wants to aerially photograph his potato fields. The farmer has two potato fields, located 500 m apart from each other. In his project, he creates a block for each field. One field can be mapped in an estimated flight time of 20 minutes. But one field is so large the estimated flight time is 40 minutes. It cannot be mapped in one flight because the maximum flight time is 35 minutes. Therefore, the farmer splits the block into two blocks. He could split the block into two equal blocks of 20 minutes, but then that would result in a total of three separate blocks that have to be flown as three separate flights. Instead, the farmer splits the larger block into one 10 minute block and one 30 minute block. Then the farmer adds the new 10 minute block to the flight for the existing 20 minute block. The farmer can now map both fields in two flights, each of 30 minutes duration.

Project phases

The typical phases of a project are:

- **Background map definition:** In the office you can prepare the background map, adding details such as avoidance zones.
- **Block definition:** Define one or more blocks to be aerially photographed. You can specify the planned direction the rover will fly over the block(s) in the office, but you must validate the block properties in the field to take into account the actual environment.
- **Flight definition:** Prepare one or more flights to cover the block(s) and suggest the takeoff and landing locations. If the flight preparation is done in the office, then you must validate the flight properties in the field, including the selected takeoff and landing locations.
- **Flight scheduling:** Flight scheduling is completed outside of the Aerial Imaging software. Complete checks for flight permissions, weather, and site suitability and schedule the flight. Before heading to the site, check all equipment for any damage from previous flights and fully charge all batteries.

- **PPK operation:** If you need centimeter-level absolute accuracy the rover should operate with PPK. PPK requires data from a reference station. This station can be a local base station (with or without a precisely known position) that you set up before the flight or a network reference station, such as CORS, that you access after the flight.
- **Flight operation:** Complete the flight checklist to ensure that the system is ready for the flight. After launching the rover, monitor the flight using the ground control station. After the rover lands, complete the post-flight checklist to transfer the flight data to the tablet.
- **Analysis and export:** Analyze the flight and captured images to make sure they are synchronized and then export the data in the appropriate file format for image processing.
- **Postprocessing:** Also known as baseline processing. Refine the GNSS data collected during the flight to achieve highly accurate image positions, using postprocessing software such as Trimble Business Center software. The output is called a trajectory.
- **Image processing:** Use the postprocessed data to create high absolute accuracy deliverables such as orthophotos and point clouds, using image processing software such as Trimble Business Center software.

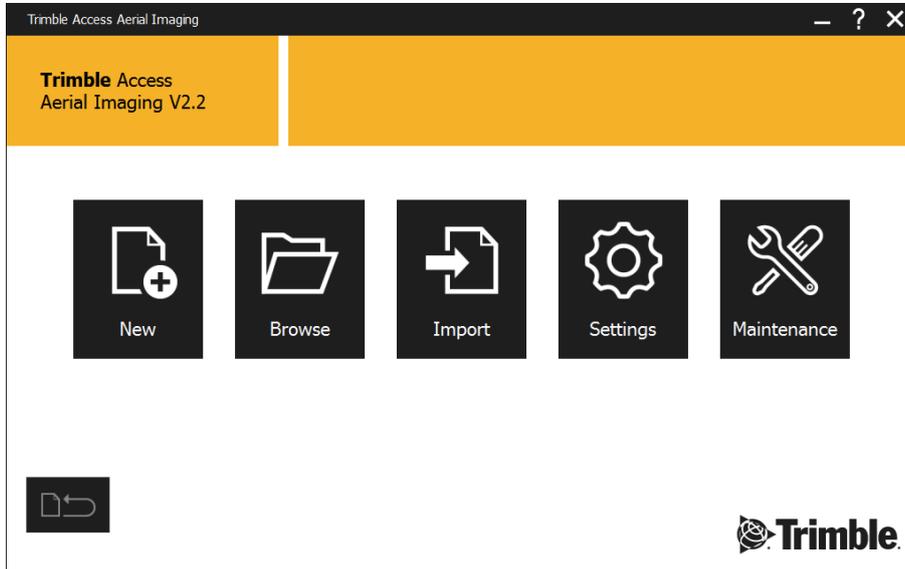
Software overview

- [The Home screen, page 14](#)
- [The Projects screen, page 14](#)
- [Software tabs, page 15](#)
- [Title bar buttons, page 16](#)
- [Status icons, page 16](#)

The Home screen

When you open the Aerial Imaging software, the *Home* screen appears.

The *Home* screen is shown below:



From this screen you can:

- Create a new project or import a project. Alternatively, browse to the *Projects* screen to view available projects. See [The Projects screen, page 14](#).
- Change system settings. See [Changing the system settings, page 17](#).
- Access the *Maintenance* screen. See [Performing maintenance, page 18](#).

To return to the current job, click .

The Projects screen

To view the *Projects* screen, click  in the *Home* screen. Existing projects are displayed in the thumbnail carousel on the left and in the list to the right.

To search for a project, enter the project name in the search bar above the list, or browse the project thumbnails.

To change the order of projects listed, toggle the *Sort by* icon above the list:

Click...	To list projects...
	Alphabetically from A to Z
	Reverse alphabetically from Z to A
	Chronologically from earliest date modified to latest
	Reverse chronologically from last date modified to earliest

To view project details, click  beside the project name.

You must select a project before some of the buttons are enabled. You can do the following:

Click...	To...	For more information, see...
	Create a new project.	Creating a project, page 24
	Import a project GWT file.	Importing the project, page 75
	Export the project GWT file.	Exporting the project, page 47
	Export a flight as a KML file or GPX file for viewing the flight trajectory in software such as Google Earth.	Exporting the flight trajectory for analysis, page 108
	Export project data as JXL or CSV/TXT files for processing.	Exporting flight data for processing, page 107
	Copy the project and all its content.	
	Open the project. The <i>Map layers</i> screen appears.	Preparing the project map, page 25
	Delete the project and associated flight data.	

Software tabs

The Aerial Imaging software provides tabs that allow you to easily move between the different levels of project information and phases of a project. When you open a project, the following tabs appear:

Tab	Tab name	Function
	<i>Map layers</i> tab	Define the background map and create avoidance zones.
	<i>Blocks</i> tab	Define the area to aerially photograph and set block properties, such as GSD and height.
	<i>Flights</i> tab	Add flights, and define flight properties, such as the takeoff and landing locations.
	<i>Flight checklist</i> tab	Complete the flight checklist.
	<i>Dashboard</i> tab	Monitor the rover during flight.
	<i>Post-flight checklist</i> tab	Transfer the flight data from the rover to the tablet.

Title bar buttons

The title bar of the software includes the following buttons:

Click...	To...
	Return to the <i>Home</i> screen.
	Return to the <i>Projects</i> screen.
	Show or hide the keyboard. If you are using the Aerial Imaging Desktop software, this button is not displayed.
	Save the project.
	View the <i>Aerial Imaging Help</i> and the software <i>About</i> dialog.
	Minimize the software screen.
	Close the software.

Status icons

At the bottom of each screen, the footer shows the following information:

Icon	Accompanying information	Notes
	GPS coordinates of the location of the cursor on the map.	If you are using the Aerial Imaging Tablet software, this icon is not displayed.
	GPS coordinates of the location of the GCS.	If the GCS has no GPS lock, the text "no GPS lock" is displayed. If the GCS has issues with its GPS hardware, the text "no GPS hardware detected" is displayed. If you are using the Aerial Imaging Desktop software, this icon is not displayed.
	GPS coordinates of the location of the rover.	If the rover has no GPS connection, this icon is not displayed. If you are using the Aerial Imaging Desktop software, this icon is not displayed.
	The battery level of the tablet.	If you are using the Aerial Imaging Desktop software, this icon is not displayed.
	The current local date and time (read from the tablet).	If you are using the Aerial Imaging Desktop software, this icon is not displayed.

Changing the system settings

To change settings for the Aerial Imaging software, click the Settings button  in the *Home* screen. After configuring the settings, do one of the following:

- Click ✓ to accept the settings.
- Click ✕ to discard the changes you have made to the settings and return to the *Home* screen.

General settings

Use the settings in the *General* group to specify:

- The language used for the Aerial Imaging software.
If you change this setting, you are prompted to restart the Aerial Imaging software.
- The source for online maps.
Note – Trimble does not guarantee the accuracy of any mapping data source. It is your responsibility to double-check the precision of the coordinates.
- The status of Wi-Fi® and Bluetooth® wireless technology during flight. By default, Wi-Fi and Bluetooth are turned off during flight.
- Preferred units for speed, distance, altitude, and area.
- The delimiter for the CSV file, exported for processing.

Network settings

Use the settings in the *Network* group to specify the proxy settings for the Internet connection.

Select the check box to enable proxy settings for the Internet connection and then enter the settings to use. If you change these settings, you are prompted to restart the Aerial Imaging software.

Note – You may need to configure the Internet proxy settings before you can view online maps. For the correct settings to use, consult your network administrator.

External GNSS

(Available only when using the Aerial Imaging Tablet software.)

Use the settings in the *External GNSS* group to specify the communication interface on the tablet for an external GNSS dongle.

The external GNSS dongle should:

- Support the NMEA 0183 data protocol
- Have a serial port (such as USB)

Privacy

Select whether to allow user feedback gathering.

At Trimble we believe that the data we collect should only be used to help us provide you with the highest quality products, services, and support. Trimble Access Aerial Imaging gathers information on how you use the software and on which platform it runs. It does not store any IP addresses, locations, or any other individually identifiable data.

Performing maintenance

Check all equipment after each flight to ensure the equipment is in good working order. For more information, see [Preparing Equipment, page 52](#).

To perform maintenance on system components, click  in the *Home* screen to view maintenance procedures. If you note any issues not covered by the maintenance procedures, contact your Trimble distributor.

To exit the *Maintenance* screen and return to the *Home* screen, click  in the title bar.

The following maintenance procedures are available:

- Rover:
 - Replacing the drive unit
 - Replacing a servo
 - Replacing a propeller blade
 - Replacing the camera filter
 - Replacing a winglet
 - Checking the pitot tube
 - Replacing the GNSS antenna
 - Replacing the hot shoe cable
- Camera:
 - Assembling the body and lens
 - Disassembling the body and lens
 - Adjusting the focus
 - Checking the trigger and eBox feedback events
- Launcher:
 - Replacing the launcher cord
 - Replacing the wheels of the launcher dock
- Communication:
 - Binding the modem and eBox
 - Unbinding the modem and eBox
 - [Binding the tracker transmitter and receiver](#)

- Firmware:
 - gBox:
 - Checking the firmware version
 - Updating the firmware
 - eBox:
 - Checking the firmware version
 - [Updating the firmware](#)

Note – Some maintenance procedures are only available in the Aerial Imaging Tablet software.

Updating the eBox firmware

The Aerial Imaging software automatically checks that the eBox firmware is up to date when the connection between the GCS and the rover is established during the flight checklist procedure. If firmware updates are available you are prompted to perform an update. It takes about 30 minutes to update the eBox firmware.

To manually initiate a firmware update, tap *Updating the firmware* in the *Maintenance* screen (see [Performing maintenance, page 18](#)). To check the firmware version, tap *Checking the firmware version* in the *Maintenance* screen.

1. When you are prompted to perform an update, do one of the following:
 - To dismiss the update checklist, tap ✕. The flight checklist is aborted because the software does not allow you to fly when the firmware version is not in sync with the Aerial Imaging software.
 - To start the firmware update, tap ✓. The update checklist appears.
2. When prompted, attach the modem to the GCS. Tap ➤ to update the modem firmware.
3. When prompted, connect the download cable to the eBox and the modem. Tap ➤ to update the eBox firmware.
4. The eBox firmware update consists of several automatic steps. When the firmware has finished updating, disconnect the download cable from the eBox and the modem.

Depending on whether the *Update firmware* checklist was started automatically or manually, either the start of the flight checklist or the *Maintenance* screen appears.

Planning a Project

- Designing a flight plan to meet the project requirements
- Creating a project
- Preparing the project map
- Defining the blocks
- Obstacle clearances
- Defining the flights
- Exporting the project
- Checking flight permissions and conditions

This chapter describes how to plan a project, including preparing the project map, and creating blocks and flights.

Designing a flight plan to meet the project requirements

There are many factors that can influence the success of a project. Good project planning is one of them. A carefully planned project will ensure that flights are executed safely and that the captured data can be processed successfully.

The quality of a project's deliverable is often linked to its accuracy, referring to the positional accuracy of the final output result. A project is processed based on geospatial coordinates, which are automatically acquired during the flight. The output result has a relative accuracy of several times the GSD.

The GSD (ground sample distance) specifies the distance on the ground represented by the pixel of a captured image. It depends on the camera sensor's pixel size and lens focal length. The smaller the GSD value, the more detailed the images. The GSD and the height at which the rover flies are linked. The higher the rover flies, the larger the distance on the ground represented by each pixel in the images acquired during the flight.

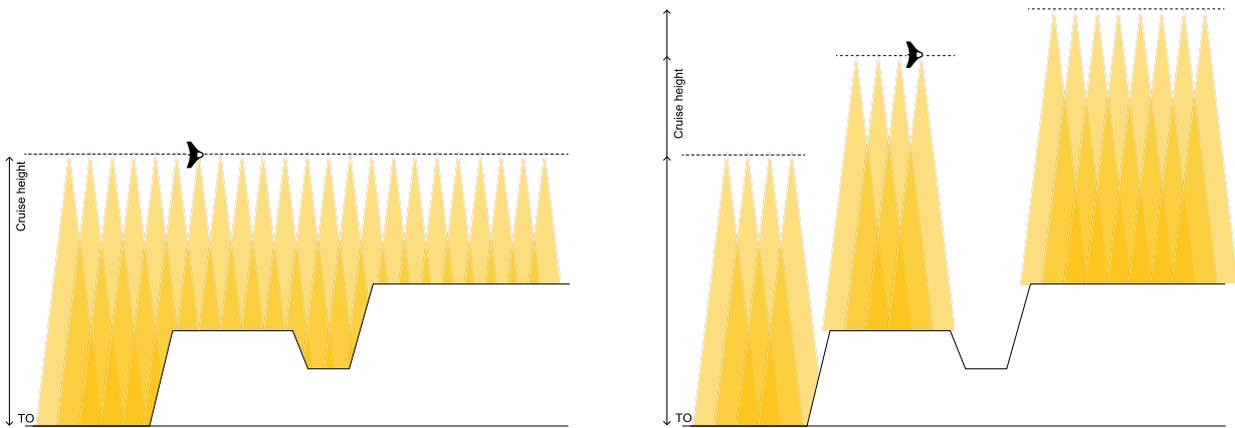
Other factors that impact the final output result include PPK, ground control points (GCPs), image overlap, and camera settings.

If you need centimeter-level absolute accuracy, the rover should operate with PPK. PPK requires data from a reference station. This station can be a local base station (with or without a precisely known position) that you set up before the flight or a network reference station, such as CORS, that you access after the flight.

The absolute accuracy can be much improved by using ground control points (GCPs) if PPK is not available. A ground control point is an accurately surveyed coordinate location for a physical feature that can be identified on the ground. Use at least 5 GCPs, which are evenly spread over the area of interest.

The percentage of image overlap allows processing software to correct for errors in the position and orientation of the aerial images (a rover is a dynamic platform with position and orientation sensors that are not that precise). Trimble recommends having a forward and sideward overlap of 80% which gives the most accurate results while minimizing flight and processing time. There are some cases where increasing the overlap may be beneficial. Examples are when flying over dense tree canopy, bodies of water, or large areas of sand or snow. These often have a shortage of identifiable features in the images that can be used as tie points for the image adjustment.

Image overlap also varies with changing terrain elevation and features. Use blocks at different heights to ensure the same level of overlap for all areas of interest (see the images below). The image on the left does not take into account the terrain elevation, which results in a varying amount of overlap. The image on the right does take into account the terrain elevation, ensuring the same level of overlap for all areas of interest.



Decreasing the overlap can have an impact on the quality of the orthophoto due to vignetting in the images. This effect can also occur when flying below a certain flight height for a specific lens size, or when the texture of the area of interest is homogeneous (for example bare soil like a desert, short grass or low growing crops).

Due to the image perspective, occlusions or hidden areas in vertical objects may occur, causing undesired distortion effects. Trimble recommends a minimum flight height of 120 m above vertical objects of interest, such as buildings or bridges, in order to avoid distortion in the images.

During image acquisition, the UX5 HP has an average speed of 23.5 meters per second. Because of the forward motion of the camera, and depending on the flight height, the shutter speed should be set fast enough to avoid blur effects on the imagery. Therefore, whenever ambient light conditions allow, Trimble recommends not to exceed half of the ground sample distance in forward motion during exposure.

Selecting the lens

The camera can be fitted with different sized lenses. The lens size you select depends on the tradeoff you choose between resolution and area coverage:

- A 15 mm lens offers wide coverage but lower resolution.
- A 25 mm lens offers normal coverage and resolution.
- A 35 mm lens offers lower coverage but high resolution.

Lens size	Resolution at 100 m (328 ft)	Diagonal view angle
15 mm	3.2 cm (1.3 ")	110.4 °
25 mm	2.0 cm (0.8 ")	81.6 °
35 mm	1.3 cm (0.5 ")	63.3 °

Note – Take into account that the lens size can have an impact on the processed orthophoto due to vignetting issues in the images. Trimble strongly recommends correcting the images for vignetting when using the NIR camera, or when using the RGB camera with a:

- 15 mm lens and flying below 100 m (328 ft)
- 25 mm lens and flying below 130 m (427 ft)
- 35 mm lens and flying below 260 m (853 ft)

For more information, see [Exporting flight data for processing, page 107](#).

When using a lens for the first time on a specific camera body, you must carefully assemble the camera and adjust the camera focus. For more information, refer to the maintenance procedures for the camera in the *Maintenance* screen.

Selecting the operating mode

Select one of the following operating modes:

- **PPK**: For centimeter-level **absolute** accuracy
- **No PPK**: For high **relative** precision

PPK

If you need centimeter-level accuracy, select PPK for the operating mode.

Coordinates	X, Y	Z
Absolute accuracy*	Down to 2.2 cm (0.88 ")	Down to 2.0 cm (0.79 ")
Relative accuracy*	1–2 x GSD	

* According to American Society for Photogrammetry and Remote Sensing (ASPRS) standards (aerial triangulation accuracy).

Note – The absolute accuracy depends on the accuracy of the reference station and the distance between that station and the rover (typically called the baseline length). The shorter the distance, the more accurate the results will be.

PPK requires data from a reference station. This station can be a local base station that you set up before the flight or a network reference station, such as CORS, that you access after the flight.

Local base station

A local base station is a GPS receiver located at a known fixed location or at a location with unknown coordinates. If the coordinates are unknown, then the local base station must be used with data from a reference network, such as the CORS network. For more information, see [Network of reference stations, page 24](#).

To set up the base station, follow the instructions provided by the base station user guide.

Note – It is the user’s responsibility to make sure that the base station is set up correctly.

The base station should be located within 5 km (3.1 miles) of the area to map: the closer, the better. Line-of-sight (visibility) is not required between the base and the rover. The exact location of the base station should be measured in the coordinate system you will use in the postprocessing software.

The base station should have a clear and unobstructed view of the sky. Be aware of likely multipath sources such as buildings, wire fences, high voltage power sources, and trees.

The rover receiver logs GNSS data at 20 Hz. Trimble recommends having a base receiver that logs the GNSS data as frequently as the logging interval used by the rover receiver.

Note – *Using a slower logging rate will affect the accuracy.*

Network of reference stations

A network of reference stations, such as a CORS or VRS network, is a network of base stations at a known fixed location. Each base station continuously collects and records GNSS observation data. Many reference networks exist over the world, some of them denser than others. The reference data from a network reference station is accessible via the Internet.

Trimble recommends selecting a network reference station that is GNSS-capable, preferably logs at a rate of 20 Hz (the rate of the rover receiver), and is located within 5 km (3.1 miles) of the area to map. If you do not have a network reference station within that limit, you can set up a local base station that is located within 5 km from the area to map. The distance between the local base station and the network reference station can be much larger than 5 km. You do not need to know the exact coordinates of the local base station you set up as the data from the network reference station is used to precisely define the position of the local base station using static postprocessing.

No PPK

If you do not have a base receiver available, you can use the Trimble UX5 HP Aerial Imaging solution without PPK. Use ground control points (GCPs) to achieve high accurate results.

Trimble recommends using at least 5 GCPs which are evenly spread around the perimeter of the area to map.

Creating a project

To create a new project, do one of the following:

- In the *Home* screen, click  and enter the name of the new project in the pop-up field. The *Map layers* screen for the new project appears.
- In the *Projects* screen, click  and enter the name of the new project in the pop-up field. The new project appears in the *Projects* list. Click  to open the project. The *Map layers* screen appears.

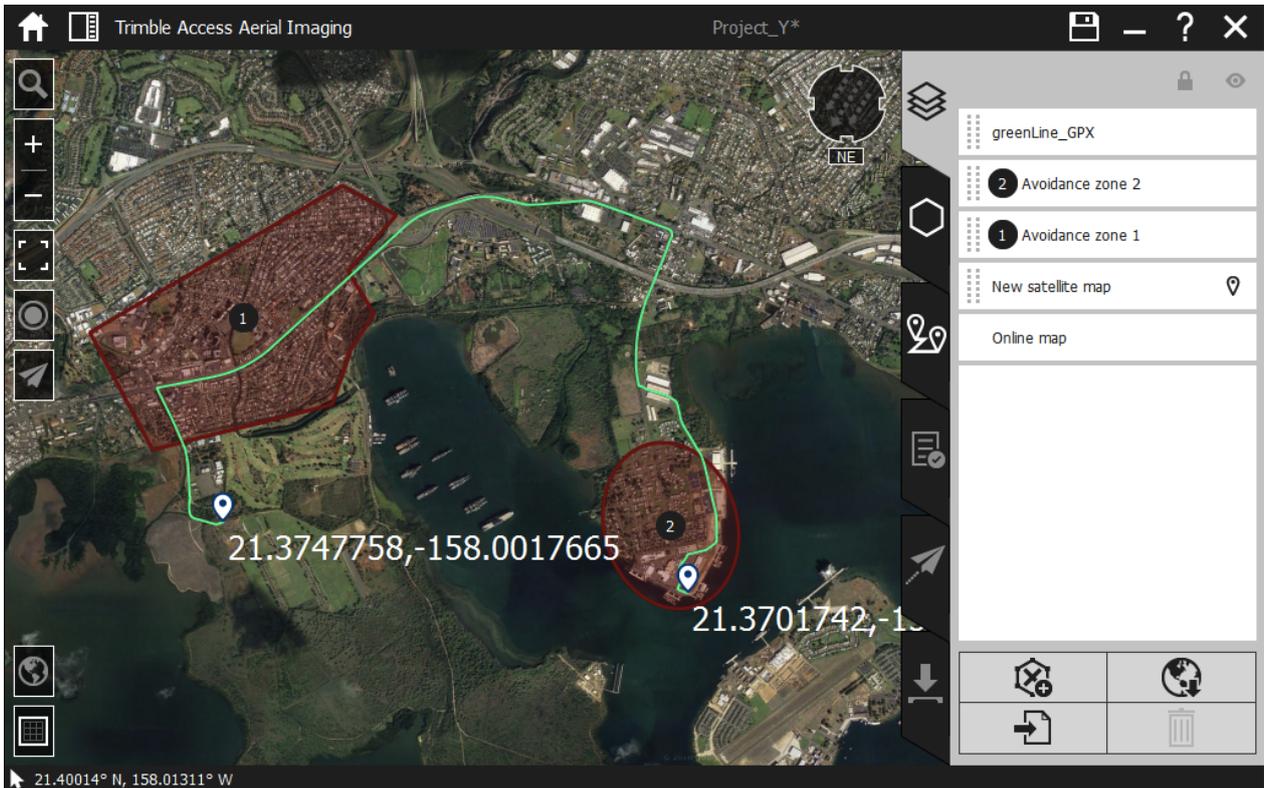
Note – *Names of projects, blocks, and flights can contain the following characters: A-Z, a-z, 0-9, dash (-), space (), and underscore (_).*

Preparing the project map

A project must have at least one georeferenced background map. Objects within a georeferenced map are associated with a unique geographical location.

To prepare the project map, select the *Map layers*  tab.

The *Map layers* tab, with an example map, is shown below:



For more information, see:

- [Adding a background map, page 25](#)
- [Adding information to the map, page 26](#)
- [Managing map layers, page 27](#)

Adding a background map

You can use an online map, an offline map, or you can add your own georeferenced map.

Using an online map

1. Make sure you have Internet access.
2. Click  on the map and then enter the location of interest. The map shows the area around the location using your preferred online map provider (see [Changing the system settings, page 17](#)).
3. Zoom in or out, or pan until you view the preferred map area.

Note – The online map is always available as a layer and cannot be deleted. You can have only one online map layer per project.

Using an offline map

Click . Use the toolbar that appears on top of the map to select the satellite map  or road map  for download. An area of 1680 x 1050 pixels (maximum) centered on the middle of the map, including two zoom levels, is downloaded as an offline map. The smallest area you can download has zoom level 17, which corresponds to approximately 0.75 m per pixel (2.46 ft per pixel). The largest area you can download has zoom level 10, which corresponds to approximately 95 m per pixel (0.06 miles per pixel).

The offline map layer ensures you will be able to view the map background during the flight, if you do not have an Internet connection in the field.

You can have multiple offline map layers in a project.

Using your own map

To use your own map, add a GeoTiff file that you have prepared earlier using software such as Trimble Business Center software.

The GeoTiff file must be georeferenced in the WGS84 UTM datum and be less than 120 MB in size. It must use no compression or only LWZ file compression.

To generate a background map using the Trimble Business Center AP module, create an orthomosaic, selecting "Low" resolution and "TIFF" for the file format.

To add the GeoTiff file in Aerial Imaging, click . Navigate to the location of the file, select it, and then click **Import**. The map shows the contents of the file you selected.

You can have multiple GeoTiff map layers in a project.

Adding information to the map

You can add the following types of information to the map:

- Avoidance zones
- Points, lines, polygons and text from a KML file
- Points, lines, and polygons from a SHP file
- Points and lines from a GPX file
- Ground control points (GCPs) from a CSV file

Adding avoidance zones

Add as many avoidance zones as required. To add an avoidance zone, click  and then draw or import the shape of the avoidance zone.

Drawing an avoidance zone

1. Click . A toolbar appears on top of the map, allowing you to add a polygonal, rectangular, or ellipsoidal area. Click the appropriate shape on the toolbar and then draw the area:

- For a polygon, click the mouse at each boundary point .
 - For a rectangle or ellipse, click the mouse on the map. A standard-sized shape appears. The location of the mouse click is the center of the shape.
2. To stop drawing and confirm the shape, click . The avoidance zone appears in the list to the right.
 3. To clear the shape, click .

Importing an avoidance zone

- From a KML file, click . All polygons in the KML file appear as avoidance zones on the map and in the map layers list.
- From a SHP file, click . All polygons in the SHP file appear as avoidance zones on the map and in the map layers list.

Editing an avoidance zone

Note – To disable editing of an avoidance zone, select the zone and then click  above the map layers list.

Select the zone on the map or in the map layers list and then do one of the following:

- To resize or reshape the avoidance zone, click and move the boundary points  on the map.
- To reposition the avoidance zone, click and move it on the map.
- To rotate the shape, click and hold the arrow  on the zone and drag your mouse over the map.
- To add a boundary point, click the edge of the shape.
- To delete a boundary point, click and drag the point to one of the other boundary points.

Note – It is not possible to add or remove boundary points for a rectangular or ellipsoidal zone.

Adding information from files

Click  to add the following types of files as a map layer:

- KML files containing points, lines, polygons, and text.
- SHP files containing points, lines, and polygons.
- GPX files containing points and lines.
- CSV files containing ground control points (GCPs).

The format for the CSV file is: Identifier, Latitude, Longitude, Altitude. The coordinates must be in decimal degrees in the WGS84 coordinate system and the altitude in meters. There should be no header.

Managing map layers

The **online map** is the map's default layer. The online map is always the bottom layer and cannot be moved up.

An offline or GeoTiff layer sits above the online map and below any other layer, such as avoidance zone, KML, SHP, or GPX file layers.

New layers always become the top layer. Layers at the top of the list appear as the top-most layers on the map. Click  next to the layer's name to move layers up and down the list.

The  icon indicates which georeferenced map is the master map. A master map is used as the reference for drawing shapes. The online map is always the master map when it is available (there is an Internet connection and the online map layer is visible).

To change the status of a layer, select a layer in the list and then toggle the buttons above the list:

Click...	To make the layer...
 / 	Visible / hidden
 / 	Unlocked / Locked (not editable) This button is available only for avoidance zone layers.

To remove a layer that is no longer required, select the layer in the list and then click  below the list. You cannot delete the online map layer and you cannot delete the master map if it is the only georeferenced map available.

To rename a layer, select the layer in the list and then click the layer's name. You can now edit the name. The online map cannot be renamed.

Click the appropriate icon to toggle between the satellite view , the road view , and the terrain view  of the online map. (Google Maps only).

Use the  and  buttons to zoom in and zoom out of the map.

Click  to display the map grid lines.

Use the  button to zoom the map and all of its layers to the best view.

If you are viewing the map on the tablet and it has a GPS connection, the  button is available. If you pan around the map, click  to center the map on the current GPS location.

During flight, the  button is available. Click  to center the map on the current rover location.

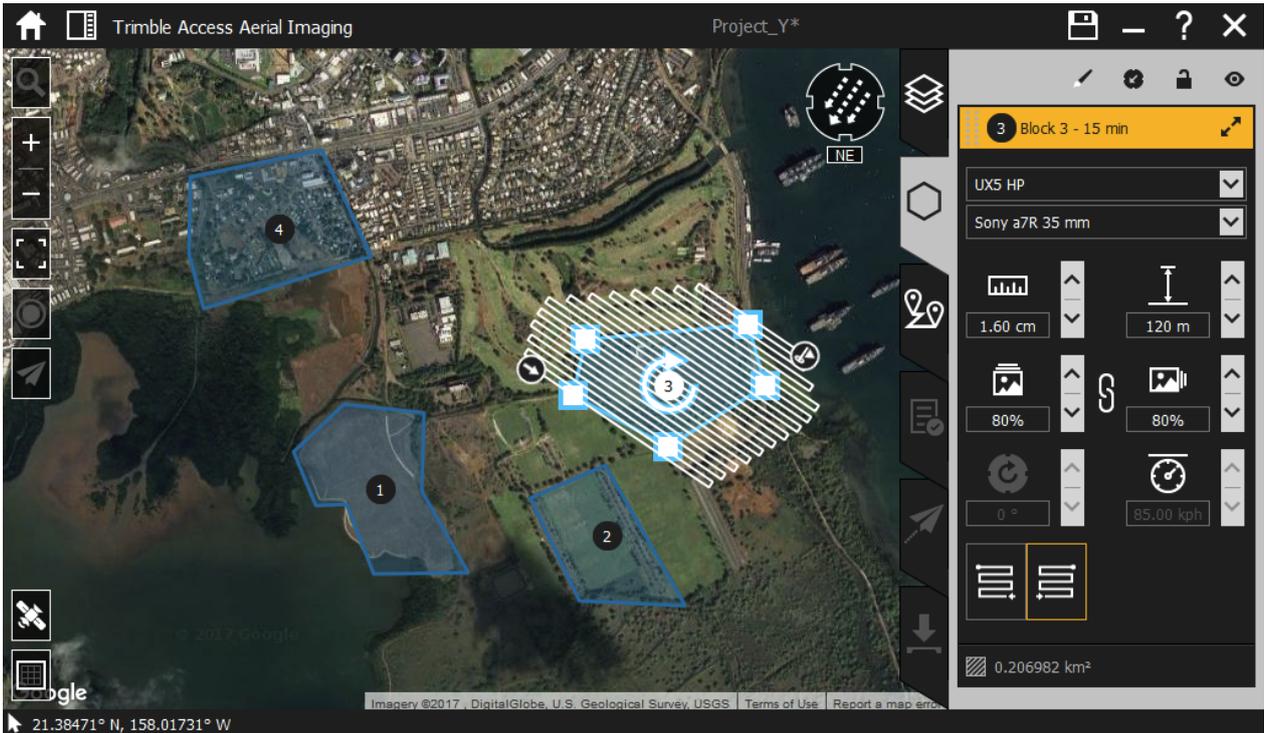
Defining the blocks

A block is the area to be flown over at a specified ground sample distance (GSD) and image overlap.

A project needs at least one block. To define blocks, select the *Blocks*  tab.

Note – You must validate in the field any blocks you have defined in the office.

The *Blocks* tab, for an example block, is shown below:



For more information, see:

- [Creating a block, page 29](#)
- [Editing the block area, page 30](#)
- [Editing block properties, page 30](#)
- [Setting the direction the rover flies over the block, page 31](#)
- [Splitting a block, page 31](#)
- [Managing blocks, page 32](#)

Creating a block

Add as many blocks as required. To add a block, click  and then draw or import the shape of the block.

Drawing a block

1. Click . A toolbar appears on top of the map, allowing you to add a polygonal or rectangular area. Click the appropriate shape on the toolbar and then draw the area:
 - For a polygon, click the mouse at each boundary point .
 - For a rectangle, click the mouse on the map. A standard-sized shape appears. The location of the mouse click is the center of the shape.
2. To stop drawing and confirm the shape, click . The block appears in the list to the right.
3. To clear the shape, click .

Importing a block

- From a KML file, click . All polygons in the KML file appear as blocks on the map and in the list.
- From a SHP file, click . All polygons in the SHP file appear as blocks on the map and in the list.

Note – An orange block area indicates the block overlaps an avoidance zone and you must move the block out of the avoidance zone. For the UX5 HP rover, the block area includes the +/- 200 m (+/- 656 ft) required for turns.

Editing the block area

Note – To disable editing of a block, select the block and then click  above the blocks list.

Tip – To hide the flight lines, select the block and toggle  above the list.

To edit the block area, select it on the map or in the list and then do the following:

- To resize or reshape the block, click and move the boundary points  on the map.
- To reposition the block, click and move it on the map.
- To rotate the shape, click and hold the arrow  on the block and drag your mouse over the map.
- To add a boundary point, click the edge of the shape.
- To delete a boundary point, click and drag the point to one of the other boundary points.

Note – It is not possible to add or remove boundary points for a rectangular block.

Editing block properties

In addition to the configurable settings below, the block properties also show the estimated flight time and the size of the block area.

Note – It is not possible to change the block properties when a block is locked.

To edit the block properties, click  next to the block name in the list.

- a. Select the type of aerial imaging rover you will use to fly the block.

Note – This user guide is specifically for use with the UX5 HP aerial imaging rover. To use a different rover, refer to the appropriate user guide.

- b. Select the type of sensor you will use to map the block. For more information, see [Selecting the lens, page 22](#).
- c. Set the ground sample distance (GSD)  or height . The default value is the GSD value obtained by flying at a height of 100 m (328 ft). For more information, see [GSD and height, page 32](#).
- d. Enter the image forward  and side overlap  values. The default value is 80%. For more information, see [Image forward and side overlap, page 33](#).
- e. To use a left turn or a right turn to enter the block during flight, click  or . This setting also defines the first waypoint that the rover will fly to.

The airspeed is automatically set to 23.61 m/s (77.46 ft/s).

Setting the direction the rover flies over the block

When you select a block, the flight lines that appear over the block indicate the direction the rover will fly over the block.

The UX5 HP should always fly perpendicular to the prevailing wind direction and all turns should be made into the wind. By default, the prevailing wind direction is a northerly wind. North is located at the top of the map.

To update the prevailing wind direction to match the expected conditions in the field:

1. Tap the wind direction arrow  in the top right corner of the map and drag it so that it indicates the direction of the wind at the site. The flight lines rotate accordingly.

Note – *To ensure smooth turns and limited headwind and tailwind during flight, it is important to correctly indicate the prevailing wind direction.*

However, it can be useful to disable the control of the flight lines by wind direction, for example when the block is a narrow rectangle, in which case you should always put the flight lines along the longest side, independent of the wind direction. To manually manipulate the flight lines, select the block and click  above the list. The  icon appears above the list and on the map. To manually adjust the direction of the flight lines, tap  on the map and drag the mouse over the map. Alternatively, enter the rotation angle of the flight lines in the  field of the block properties. As a warning, the manual flight lines icon  above the list turns red when the direction of the flight lines differs by less than 45 degrees from the wind direction.

2. If the flight lines change to red, this indicates that one or more flight lines (including the additional +/- 200 m (+/- 656 ft) required for turns) overlap an avoidance zone. Edit the block to move the flight lines out of the avoidance zone.

Splitting a block

The software estimates the total flight time needed to cover the block. The estimated flight time does not include the time to get to and from the takeoff and landing locations. If the estimated flight duration exceeds the maximum flight time, a warning indication  appears next to the block name in the list. If the warning appears then you must split the block:

1. Select the block and then click . A toolbar appears on top of the map that allows you to split the block.
2. Click . By default the block is divided through the center of the rectangular boundary box surrounding the block area, perpendicular to the wind direction.
3. To change the cut, manipulate the boundary points  of the dividing line.
4. Click  to confirm splitting the block. The original block is divided in two and both blocks appear in the list.

Note – *Splitting blocks can cause existing blocks to be renumbered.*

5. Repeat the steps above as needed until the estimated flight duration is less than the maximum flight time, also taking into account the takeoff and landing time.

- To undo a split, select one of the blocks that you want to combine and click  in the toolbar. Then select the other block to merge. You can only merge adjacent or overlapping blocks. Click  to confirm the merge. The properties of the first selected block are used for the merged block.

Managing blocks

Select a block in the list and toggle the buttons above the list to change the attributes of the block:

Icon shown...	Sets the...
	Block and flight lines to visible/ block only to visible / block and flight lines to hidden
	Block to editable / locked (not editable)
	Flight lines to follow the wind direction / to be manually manipulated
	Color of the flight lines to light / dark

Click  next to the block to move blocks up and down the list. Blocks at the top of the list appear as the top-most blocks on the map.

To copy a block, select the block in the list or on the map and then click  below the list. Copying a block is useful if you need to scan the same area using different GSD and overlap values.

To remove a block that is no longer required, select the block and then click .

To rename a block, select the block in the list and then click on the block's name. You can now edit the name.

A block can have the following status:

- No icon: Not flown
-  Successfully mapped, log files downloaded and settings frozen
-  Not successfully mapped and settings frozen
-  Flown and waiting for post-flight checklist to be completed to determine if the block was successfully mapped. Settings are frozen.

Note – Blocks with the status icon ,  or  cannot be renamed, changed, or removed. However, you can copy the block and then edit the copy.

GSD and height

The *GSD* (ground sample distance) field specifies the distance on the ground represented by each pixel.

The smaller the value in the *GSD* field, the more detailed the images. You should always specify a value equal to or smaller than the resolution required in the final orthophotos, after the images are processed. If the value in the *GSD* field is larger than the final resolution required, then the images acquired during the flight will not be detailed enough and the image processing software will need to interpolate additional pixels. This will result in images that do not have the expected resolution.

The *GSD* field and the height at which the rover flies are linked. The higher the rover flies, the larger the distance on the ground represented by each pixel in the images acquired during the flight.

The default resolution for the UX5 HP aerial imaging solution is 3.2 cm (1.3 ") when using the 15 mm lens,

2.0 cm (0.8 ") when using the 25 mm lens, and 1.3 cm (0.5 ") when using the 35 mm lens.

Other example GSD values are:

Height	GSD (15 mm lens)	GSD (25 mm lens)	GSD (35 mm lens)
Minimum: 75 m (246 ft)	2.5 cm (1.0 ")	1.5 cm (0.6 ")	1.0 cm (0.4 ")
100 m (328 ft)	3.2 cm (1.3 ")	2.0 cm (0.8 ")	1.3 cm (0.5 ")
150 m (492 ft)	4.8 cm (1.9 ")	3.0 cm (1.2 ")	2.0 cm (0.8 ")
Maximum: 750 m (2460 ft)	23.9 cm (9.4 ")	15.0 cm (5.9 ")	10.0 cm (3.9 ")

Note –

- Take into account that the height can have an impact on the processed orthophoto due to vignetting issues in the images. Trimble strongly recommends correcting the images for vignetting when using the NIR camera, or when using the RGB camera with a:
 - 15 mm lens and flying below 100 m (328 ft)
 - 25 mm lens and flying below 130 m (427 ft)
 - 35 mm lens and flying below 260 m (853 ft)

For more information, see [Exporting flight data for processing, page 107](#).

- The minimum and maximum heights given here are the limits for the system. Check the minimum and maximum heights for your project site with your local Civil Aviation Authorities (CAA) to ensure the system limits are within your local CAA limits. If they are not, you must fly within your local CAA minimum and maximum height.

Image forward and side overlap

The default value of the overlap between images is 80%. Image overlap can range from 40% to 90%.

Note –

- Trimble does not recommend using an overlap of less than 80%, as it may prevent (large) parts of the dataset being adjustable in the Trimble Business Center software due to the lack of tie points, especially where the flight height was low or where the area contains trees or other tall objects, or areas that lack texture.
- Take into account that an overlap of less than 80% can have an impact on the processed orthophoto due to vignetting issues in the images. In this case, Trimble strongly recommends correcting the images for vignetting. For more information, see [Exporting flight data for processing, page 107](#).

By default the forward  and side overlap  values are linked, so that when one value changes, the other value changes accordingly. To "break" the link so that the overlap values can be set independently, click . To re-establish the link, click .

A higher overlap results in:

- better accuracy
- a higher density of flight lines on the area
- a higher number of images to process

2 Planning a Project

- longer processing times for images
- longer flight duration for the same area

Select the overlap value for the block based on the accuracy, flight duration, and the number of images you require.

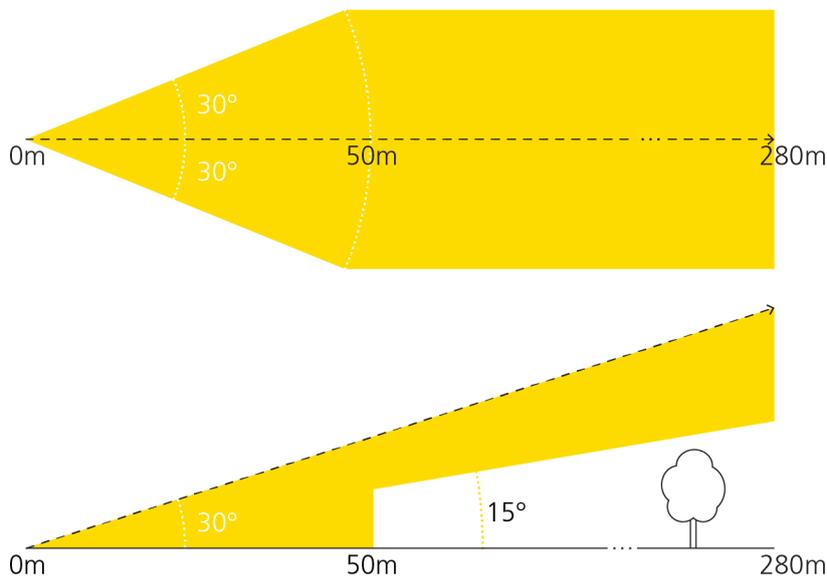
Obstacle clearances

When defining a flight, you must ensure that block area at the flight height and the selected takeoff and landing locations are clear of obstacles. Obstacle clearances for each stage of the flight are shown below. When you arrive at the site, visually check the takeoff and landing locations to ensure that the selected locations are free of obstacles.

Obstacle clearances for takeoff

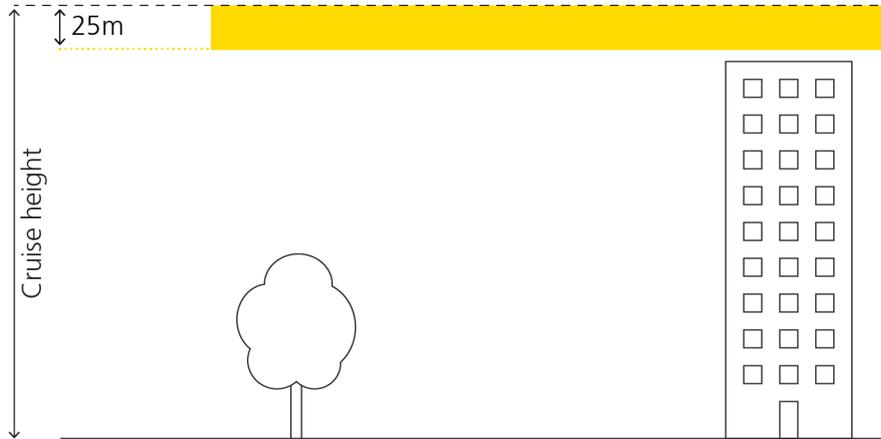
From 0 m (takeoff location) to 50 m: Within the first 50 m (164 ft), there must be a clear area free of obstacles within 30° to the left and right of the launch direction.

From 50 m to 280 m: From the first 50 m (164 ft) and within 280 m (919 ft), obstacles must not appear above the safety line determined by a 15° safety angle and within 25 m (82 ft) to the left and right of the launch direction.



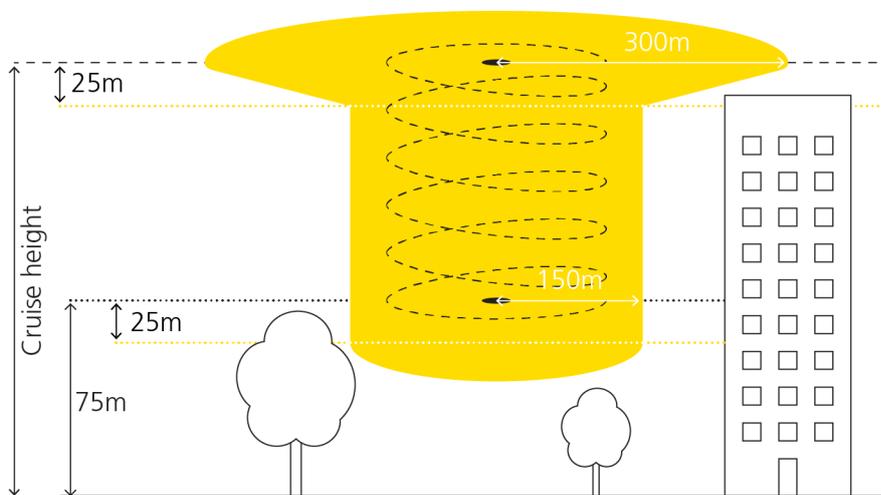
Obstacle clearances for cruise flight

During cruise flight, no obstacles must appear between the cruise flight height and 25 m (82 ft) below it:



Obstacle clearances for descent

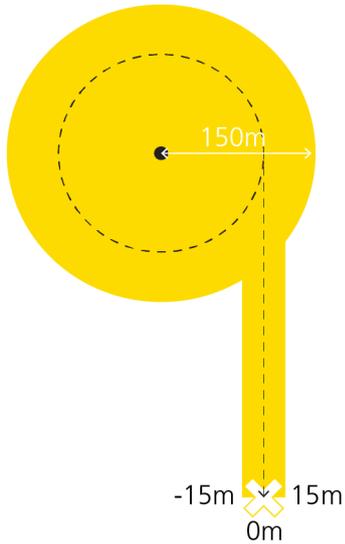
When entering the landing orbit, no obstacles must appear with a 300 m (984 ft) radius of the center of the orbit. Once the rover has descended 25 m from the cruise flight height, the required obstacle-free area has a radius of 150 m (462 ft).



Obstacle clearances for landing

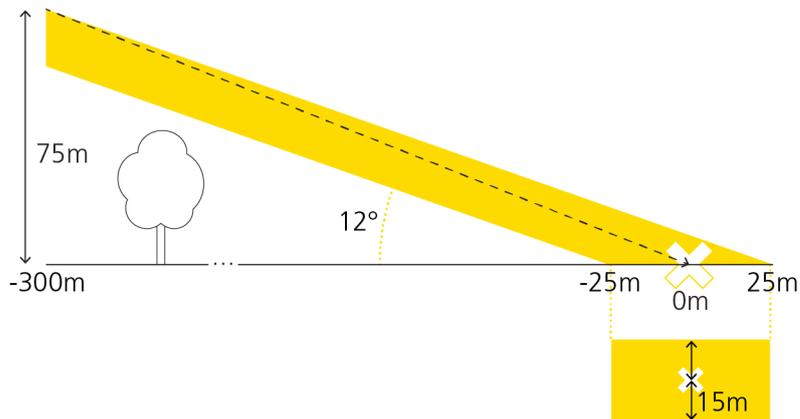
Once you confirm the landing, the rover starts the final leg of the landing.

Along the final leg of the landing, there must be a clear area free of obstacles within 15 m to the left and right of the landing direction.



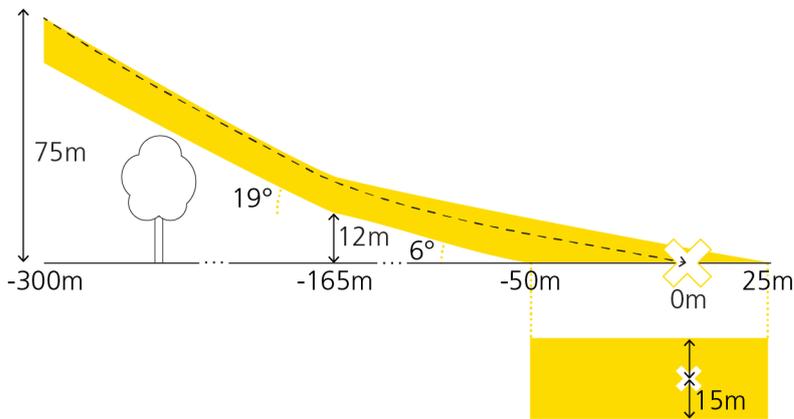
In the final leg of the landing, no obstacles must appear in the yellow zone shown in the vertical cross section of the landing. In addition, the landing location must be free of obstacles and meet the minimum size indicated:

- Linear landing



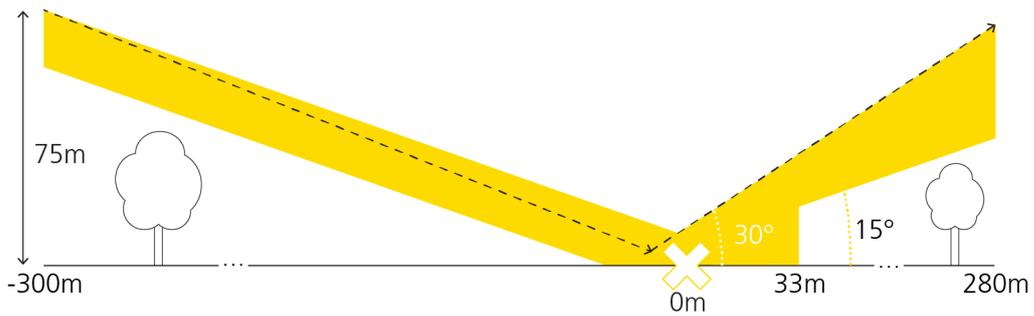
2 Planning a Project

- Curved landing

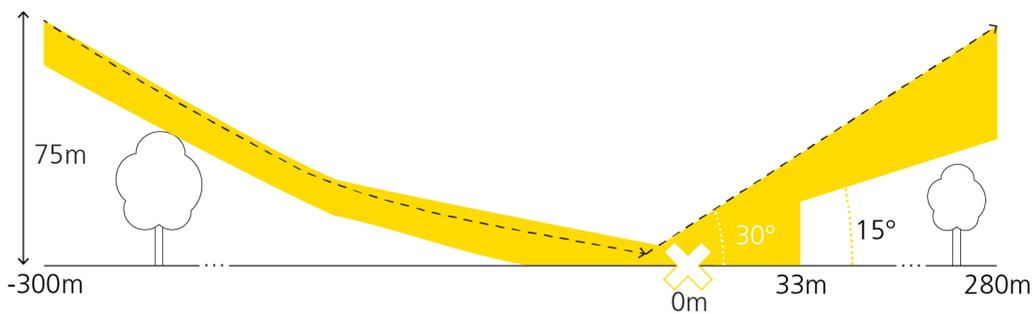


During the final leg of the landing it is possible to click the Abort button  (see [Handling emergencies during flight, page 97](#)). To successfully abort the flight, extra clearances should be taken into account:

- Linear landing abort clearance



- Curved landing abort clearance



Defining the flights

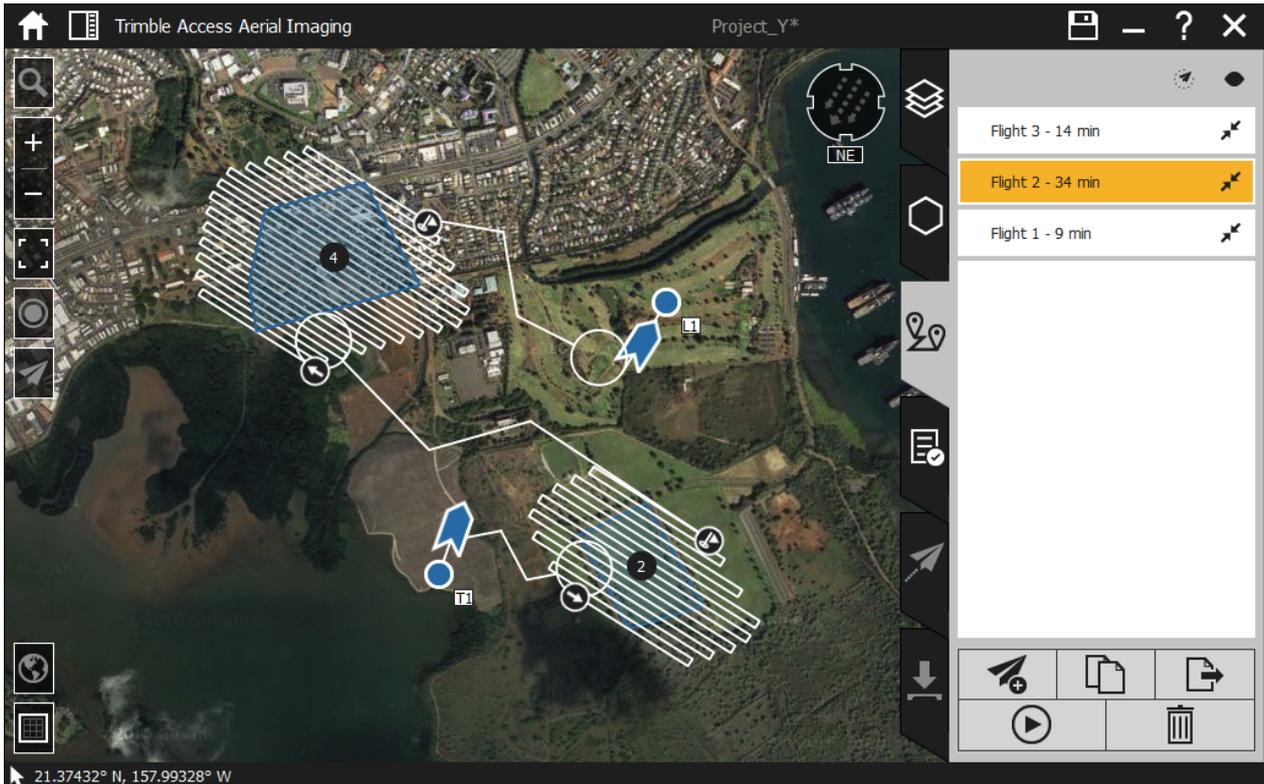
To define flights, select the *Flights*  tab.

Note – You must validate in the field any flights you have defined in the office.

A flight can cover more than one block.

Blocks can be linked to more than one flight. Depending on the number and size of the blocks you have defined in the *Blocks* tab, you may need several flights to cover all the blocks.

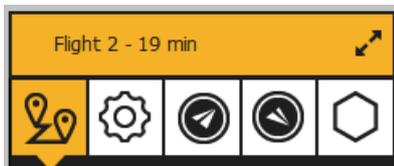
The *Flights* tab looks similar to that shown below:



To add a flight, click . A new entry appears in the list.

To copy a flight, select the flight in the list and then click  below the list. Copying a flight is useful if you want to repeat a flight.

To complete the definition of a flight, click  next to the flight name and then work through each item in the flight menu:



For more information, see:

- [Managing flight settings, page 40](#)
- [Setting the takeoff properties, page 41](#)
- [Setting the landing properties, page 42](#)
- [Adding blocks to the flight, page 44](#)
- [Viewing the flight summary, page 45](#)
- [Simulating the flight, page 46](#)

To remove a flight that is no longer required, select the flight and then click  below the list.

Note – This removes the flight data stored on the tablet for this flight.

To rename a flight, select the flight in the list and then click the flight name. You can now edit the name.

A flight can have the following status:

- No icon: Not flown
-  Flown and settings frozen
-  Flown, log files downloaded and settings frozen

Note – Flights with the status icon  or  cannot be renamed, changed, or removed. However, you can copy the flight and then edit the copy.

Managing flight settings

To define the flight settings, in the flight menu tap .

Rover and sensor

Select the type of aerial imaging rover and sensor you will use to fly.

Note – This user guide is specifically for use with the UX5 HP aerial imaging rover. To use a different rover, refer to the appropriate user guide.

The rover and sensor selection filters the blocks that can be added to the flight. For more information, see [Adding blocks to the flight, page 44](#).

Communication timeout

The communication timeout value defines when the rover should activate the emergency pattern in case of loss of the communication link.

- Enter a value in the communication timeout field  between 20 seconds and 900 seconds (15 minutes).

The default value is 120 seconds (2 minutes).

Note – The country you are operating in may have regulations prescribing the minimum communication timeout setting that you must use. Make sure you are aware of these and that you use the regulated minimum setting for your location.

Geofence

A geofence is a virtual perimeter around the GCS location. If there is no GCS location available, then the takeoff location is used. The perimeter is defined by a radius and height.

When the rover reaches the geofence boundary, it starts the HERE pattern. For more information, see [Emergency software commands, page 94](#).

To enable the geofence, select the flight in the list and then click  above the list. To disable the geofence, click  above the list.

To set the geofence boundary:

1. Enter a value in the geofence radius field  between 500 m (1640 ft) and 5000 m (16400 ft). The default value is 2000 m (6560 ft).
2. Enter a value in the geofence height field  between 75 m (246 ft) and 1000 m (3280 ft). The default value is 1000 m (3280 ft).

Setting the takeoff properties

To set the takeoff properties, in the flight menu tap .

A toolbar appears on the map.

1. To add a takeoff location, do one of the following:
 - **To add a new location without GPS:** In the Aerial Imaging Desktop or Tablet software, tap  and then tap on the map to set the location. The takeoff pin appears on the map with an arrow indicating the takeoff heading and shows the "Planned and not active" status icon . The takeoff pin includes an arrow to indicate the takeoff heading. A new entry appears in the list to the right.
You can add as many takeoff locations as you want. Click  to confirm the added locations.
 - **To add a new location using GPS:** In the Aerial Imaging Tablet software, physically go to the takeoff location and then tap . If the location you want to fix lies within 10 m of a planned pin, the planned pin is fixed. Otherwise, a new pin with the fixed status is added to the map. The takeoff pin appears on the map with an arrow indicating the takeoff heading and shows the "Fixed and not active" status icon . The takeoff pin includes an arrow to indicate the takeoff heading. A new entry appears in the list to the right with the  icon.
You can fix as many takeoff locations as you want.

Note – Each takeoff location comes with default parameters (for example, the heading is set into the wind direction). If you change the heading, the takeoff location is updated accordingly. If you use this location in another flight, the heading is set to the value of the latest change in all flights where the location is used.

2. To select any defined location for the flight, tap the takeoff pin on the map or select the radio button beside the takeoff location in the list. The takeoff pin status changes to "Planned and active"  or "Fixed and active" .

The selected takeoff location is added to the flight summary. To view the summary, tap .

3. To set the takeoff heading, click the arrow next to the takeoff pin and rotate to change the takeoff

direction and avoid any obstacles. For more information, see [Obstacle clearances, page 35](#). By default, the takeoff heading is set into the wind direction set in the *Blocks* tab. Alternatively, enter the heading for the selected pin in the  field.

The takeoff heading icon turns red when the takeoff direction deviates by more than 45 degrees from the default direction. (The default direction is into the wind direction, which is set in the *Blocks* tab).

Note – Always try to takeoff into the wind. This prevents a higher launch speed and a higher risk of launch failures.

4. When the flight has a block linked to it, the takeoff route is displayed. To edit the takeoff route, click and drag the waypoints  on the map.

Tip – To use a left turn or a right turn to enter the block, click  or  in the block properties in the *Blocks* tab . This setting also defines the first waypoint that the rover will fly to. The takeoff route updates accordingly.

5. To delete a takeoff location, click  in the toolbar on top of the map and then select the takeoff pin that you want to remove. Click  to confirm the deleted location.

Repeat this step to delete as many takeoff locations as required.

Setting the landing properties

Note – For additional safety, the Aerial Imaging software enables you to change the landing parameters during flight. For more information, see [Changing the landing properties during flight, page 92](#). This can be useful if:

- The preferred landing location is unavailable due to a sudden obstacle in the landing clearance zone.
- The wind direction changes during the flight and the alternative landing location is better suited to the new conditions.

To set alternative landing parameters, first use the steps below for the preferred landing location and then repeat the steps for the alternate landing location.

To set the landing properties, in the flight menu tap .

A toolbar appears on the map.

1. To add a landing location, do one of the following:

- **To add a new location without GPS:** In the Aerial Imaging Desktop or Tablet software, click  and then click on the map to set the location. The landing pin appears on the map with an arrow indicating the landing heading and shows the "Planned and not active" status icon . A new entry appears in the list to the right.

You can add as many landing locations as you want. Click  to confirm the added locations.

- **To add a new location using GPS:** In the Aerial Imaging Tablet software, physically go to the landing location and then click . If the location you want to fix lies within 10 m of a planned pin, the planned pin is fixed. Otherwise, a new pin with the fixed status is added to the map. The landing pin with fixed status has an arrow indicating the landing heading and shows the "Fixed and not active" status icon . A new entry appears in the list to the right with the  icon.

You can fix as many landing locations as you want.

Note – Each landing location comes with default parameters (for example, the heading is set into the wind direction). If you change the heading, the landing location is updated accordingly. If you use this location in another flight, the heading is set to the value of the latest change in all flights where the location is used.

2. To select any defined location for the flight, tap the landing pin on the map or select the radio button beside the landing location in the list. The landing pin status changes to "Planned and active"  or "Fixed and active" .

The selected landing location is added to the flight summary. To view the summary, tap .

3. To set the landing heading, tap the arrow next to the landing pin and rotate to change the landing direction and avoid any obstacles. For more information, see [Obstacle clearances, page 35](#).

Alternatively, enter the heading for the selected pin in the  field.

By default, the landing heading is set into the wind direction set in the *Blocks* tab. To help you define the landing heading in the field, zoom in on the map to the most detailed zoom level and then walk into the heading with the GCS for about 20 to 30 meters (65 to 100 ft). You will see the GCS location move on the screen. Now rotate the arrow and position the final leg of the landing circuit over the center of the GCS icon  on the map.

The landing heading icon turns red when the landing direction deviates by more than 45 degrees from the default direction. (The default direction is into the wind direction, which is set in the *Blocks* tab).

Note – Always try to land into the wind. This reduces the landing speed and reduces the risk of damage to the rover.

4. Set the landing zone offset .

Valid values are from -25 m to +25 m (-82 ft to +82 ft). A negative value means that the landing location is lower than the takeoff location. The default value is 0 m, which means that the takeoff and landing locations are at the same height.

5. Set the landing type to a linear  or curved  landing, depending on the landing surface and available clearances.

- The **linear landing** type requires less clearance and lands the rover on the ground more quickly, but has a larger impact on the aircraft.
- The **curved landing** type requires larger clearances but reduces the impact on the aircraft when it lands, and is especially suited for hard landing surfaces.

For more information, see [Obstacle clearances, page 35](#).

6. When the flight has a block linked to it, the landing route is displayed:
 - a. Set the landing entry to use a left  or right  turn, depending on which turning direction provides better visibility and is furthest away from any obstacles (see [Obstacle clearances, page 35](#)).
 - b. To edit the landing route, click and drag the waypoints  on the map.
7. To delete a landing location, click  in the toolbar on top of the map and then select the landing pin that you want to remove. Click  to confirm the deleted location.

Repeat this step to delete as many landing locations as required.

Adding blocks to the flight

To add a block to the flight, in the flight menu tap .

All blocks defined with a rover and sensor type that corresponds with the rover and sensor type selected for the flight are listed and shown on the map. Only blocks that if added will keep the flight time less than the maximum can be selected.

For each block the status is indicated on the map:

- No icon: Not scheduled
-  Scheduled
-  Successfully mapped, log files downloaded and settings frozen
-  Flown and waiting for post-flight checklist to be completed to determine if the block was successfully mapped. Settings are frozen.

From the map or the list, select one or more blocks to link to the flight.

Note – *The order that you select the blocks from the list defines the sequence that the blocks are flown, i.e. the first block selected is flown first, and so on.*

The selected blocks are highlighted, and the flight lines and connection routes appear on the map.

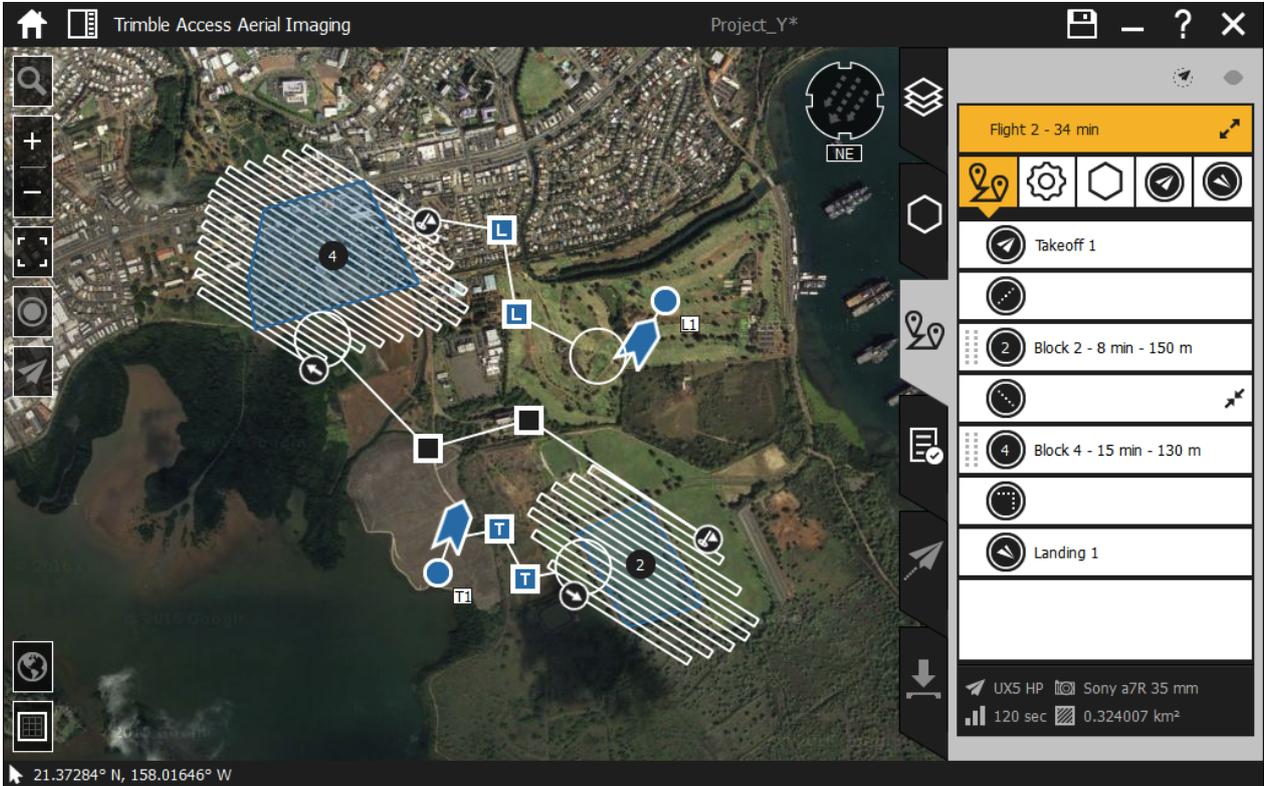
The selected blocks are added to the flight summary, together with the default connection types. To view the summary, tap .

Note – *A block can be linked to more than one flight. To remove blocks from a flight, deselect the block in the list or the map.*

Viewing the flight summary

To view the flight summary, in the flight menu tap .

The *Flight summary* screen looks similar to the example shown below:



Flight route

If a flight will cover more than one block, the software automatically connects the last waypoint of one block with the first waypoint of the next block. By default the connection is a straight line.

To change the connection type between blocks, click  to the right of the connection in the flight summary list and then:

Click...	For the rover to...
	Fly straight to the first waypoint of the following block. If it did not yet reach the height of this waypoint, it orbits up in 200 m diameter circles until it reaches the height.
	Orbit up in 200 m diameter circles until it reaches the height of the following block and then fly straight to the first waypoint of the following block. This works if the height of the next block is higher than the previous block.
	Fly to the following block keeping the same height of the last waypoint of the previous block and then orbit up in 200 m diameter circles until it reaches the first waypoint of the block. This works if the height of the next block is higher than the previous block.

Click...	For the rover to...
	Fly to the following block keeping the same height of the last waypoint of the previous block. This works if the height of the next block is the same as the height of the previous block.
	Fly straight to the first waypoint of the following block. If it did not yet reach the height of this waypoint, it orbits down in 200 m diameter circles until it reaches the height.
	Fly to the following block keeping the same height of the last waypoint of the previous block and then orbit down in 200 m diameter circles until it reaches the first waypoint of that block. This works if the height of the next block is lower than the previous block.
	Orbit down in 200 m diameter circles until it reaches the height of the next block and then fly straight to the first waypoint of that block. This works if the height of the next block is lower than the previous block.

Note – The connection type cannot be changed if sequential blocks have the same height.

To edit the line between blocks, click and drag the waypoints  on the map.

Changing the order that the blocks are flown

To change the sequence that blocks are flown, click  next to the block to move the block up or down.

Viewing the flight contour

To view the flight contour, select the flight in the list and click . An area appears on the map that indicates where the rover will fly, including a margin. This contour can be used to check obstacle clearances.

Note – The flight contour is an estimate and does not take into account environmental factors, such as wind, that could severely influence the actual flight path, or any manually initiated emergency patterns and automatic failsafes.

Simulating the flight

After creating a flight, click  to simulate the flight to check the following items:

- The rover uses the correct takeoff direction.
- The flight height, route, and turns used are all correct.
- The rover does not enter any avoidance zones.
- The rover uses the correct landing circuit.

Note – Be aware that the simulation is an estimate of the flight path. This is because the simulation cannot take into account environmental factors, such as wind, during the actual flight.

Tip – The  button is not available until you have exited the flight properties. To do this, click the arrow to collapse the flight.

Exporting flight information

Exporting the simulated flight trajectory

To export the simulated flight trajectory:

1. In the *Flights* screen, select the flight.
2. Click . The *Export* wizard appears.
3. Select the output format:
 - *KML, Keyhole Markup Language* to view the flight path.
 - *GPX, GPS Exchange Format* to view the flight path and waypoints.

Both outputs can be viewed in software such as in Google Earth and can help you, for example, to verify the obstacle clearances for the flight.

4. Click .
5. Navigate to the folder where you want to save the flight simulation, enter the file name and then click **Export**.
The simulated flight trajectory is exported to the selected folder.
6. Click  to close the *Export* wizard.

Exporting the flight overview

To export the flight overview that you see at the beginning of the flight checklist:

1. In the *Flights* screen, select the flight.
2. Click . The *Export* wizard appears.
3. Select the output format:
 - *PDF, Portable Document Format*.
 - *TXT, Text File Format*.
4. Click .
5. Navigate to the folder where you want to save the flight overview, enter the file name and then click **Export**.
The flight overview is exported to the selected folder.
6. Click  to close the *Export* wizard.

Exporting the project

Note – This step is required if you did the project planning in the *Aerial Imaging Desktop* software. You must complete this step so that you can import the project into the *Aerial Imaging* software on the tablet.

1. In the *Projects* screen, select the project to export.
2. Click . The *Export* wizard appears.
3. Select the GWT output format. Click .

4. Navigate to the folder where you want to save the project, enter the file name and then click **Export**.
The exported project is saved as a GWT file in the folder you selected.
5. Click ✓ to close the *Export* wizard.
6. If the folder you exported the project to is not a network folder that the tablet can access, transfer the exported project to a USB stick and then transfer it to the tablet.
7. To import the project to the Aerial Imaging software on the tablet, see [Importing the project, page 75](#).

Checking flight permissions and conditions

In the days before the flight, complete the following checks to make sure the flight can proceed.

Note – *The use of unmanned aircraft in any national airspace system is regulated by the applicable National Aviation Authority. The regulations for flying unmanned aircraft are subject to change, sometimes without warning. It is the user’s responsibility to know and adhere to the current laws for operating in the national airspace system. Trimble is not obliged to inform users of changes to unmanned aircraft laws.*

Trimble and Authorized Distribution Partners provide comprehensive training for the unmanned aircraft system which includes recommended procedures to ensure the safety for the remote crew members as well as the surrounding environment. It is the user’s responsibility to ensure safe operations and adhere to safety and security measures required by the National Aviation Authority. Trimble is not responsible for ensuring safe and secure operation of unmanned aircraft by the user.

Checking flight permission

- Check if you need a permit to operate an unmanned aircraft in the airspace above the site.
- Make sure you understand the legal context for safe operation of an unmanned aircraft.
- Check for existing rules and standards with your local Civil Aviation Authorities (CAA).
- Make sure you have permission from the landowner.
- Make sure you have all other relevant permissions required for photography flights using unmanned aircraft. In some countries you need permission from defense organizations, the police, or a national geography institute to take pictures.

Checking weather

- In the days before the flight, check the TV weather broadcast or weather websites. This gives you a good general idea of the weather for the next three to four days.
- For more accurate weather forecasts, consult and interpret aviation weather data through various weather websites. You can also contact the national meteorological office or a local meteorology office at an airport nearby.
- On the day of the flight, consult the Terminal Aerodrome Forecast (TAF) and METAR reports. These are meteorological reports used in aviation.
- Make sure the weather conditions are within the operating limitations. See [Operation limitations, page 121](#).

The table below shows the wind speed expressed in different units:

Bft	km/h	m/s	kn	SM	
1	1-5	0.3-1.5	1-3	1-3	
2	6-11	1.6-3.3	4-6	4-7	
3	12-19	3.4-5.4	7-10	8-12	
4	20-28	5.5-7.9	11-16	13-18	
5	29-38	8.0-10.7	17-21	19-24	
6	39-49	10.8-13.8	22-27	25-31	
7	50-61	13.9-17.1	28-33	32-38	

Operation limitations

The rover cannot safely fly in all weather conditions. The acceptable range for different conditions is shown below.

Note – Your country of operation may have different or additional operational requirements. Make sure you are familiar with the appropriate regulations for the country you are operating in. If you are flying in the United States see also [FAA conditions and limitations of operation, page 137](#).

 **CAUTION** – If any condition does not meet the acceptable range stated, the operator should abort the flight. Flying outside the acceptable range of conditions will void your Trimble warranty. Trimble does not guarantee good picture quality when flying in conditions beyond these limits.

Condition	Acceptable range
Time	Between sunrise and sunset
Distance from clouds	Clear of clouds and always within line of sight
Flight visibility	5000 m (16400 ft)
Operator-UAS visibility	Visual line of sight
Weather limitations	Light rain is acceptable. Avoid hail, snow, and heavy showers
Head wind (for cruise flight)	Maximum 55 kph (34 mph)
Cross wind:	
<ul style="list-style-type: none"> For takeoff/landing 	Maximum 30 kph (19 mph)
<ul style="list-style-type: none"> For cruise flight 	Maximum 55 kph (34 mph)

Condition	Acceptable range
Gusts (for cruise flight)	Maximum 15 kph (9 mph)
Turbulence	Avoid turbulence at all times
Temperature:	
<ul style="list-style-type: none"> Rover, including eBox and gBox 	-20 °C to +45 °C (-4 °F to 113 °F)
<ul style="list-style-type: none"> Camera* 	0 °C to +30 °C (32 °F to 86 °F)
<ul style="list-style-type: none"> Battery* 	0 °C to +30 °C (32 °F to 86 °F)
<ul style="list-style-type: none"> Launcher* 	+10 °C to 45 °C (50 °F to 113 °F)
* Pre-flight conditioned temperature	

Checking the site

Note – When checking the site you should refer to the relevant AIP and NOTAM documents for your region.

- Identify the airspace and geographic environment of the site.
- Check the relevant aviation charts and make sure the flight area is not near any of the following areas:
 - Forbidden airspace
 - Airports, airfields (except with prior permission)
 - Power plants (except with prior permission)
- Check the relevant aviation charts and take special care around:
 - Parachute and parasailing jumping areas
 - Winch areas
 - High-pressure gas-releasing units (documented in AIPs or NOTAMs)
 - Congested areas (for example, towns)
- Check if there are other aerial or ground activities planned, for example major public events.

Checking the operator

- Make sure the operator is certified to operate the rover.
- Check if the operator needs any additional permits, such as a remote operator license, a radio certificate for use of the 2-way radio for communication with air traffic control, and so on.
- Be aware that the operator has final responsibility for the operation of the rover and its components.
- Make sure the operator is in good condition, both physical and mental.
- Keep log files of the operator hours and equipment used for each flight.

Know your safe operating envelope

- Trimble recommends having a crew of two people that will control the rover: the operator and the observer. They must be able to communicate at all times. Check your CAA regulations to see if a two-person crew is mandatory.
- Make sure the crew understands the purpose and the phases of this particular project.
- Make sure the crew understands all aspects of safe operation of the rover. This includes:
 - Understanding all safety precautions described in the documentation provided with the rover.
 - Understanding how to handle emergencies during flight. See [Handling emergencies during flight, page 97](#).
 - Understanding the particular requirements of the project and site, including avoidance zones. See [Designing a flight plan to meet the project requirements, page 21](#).

Preparing Equipment

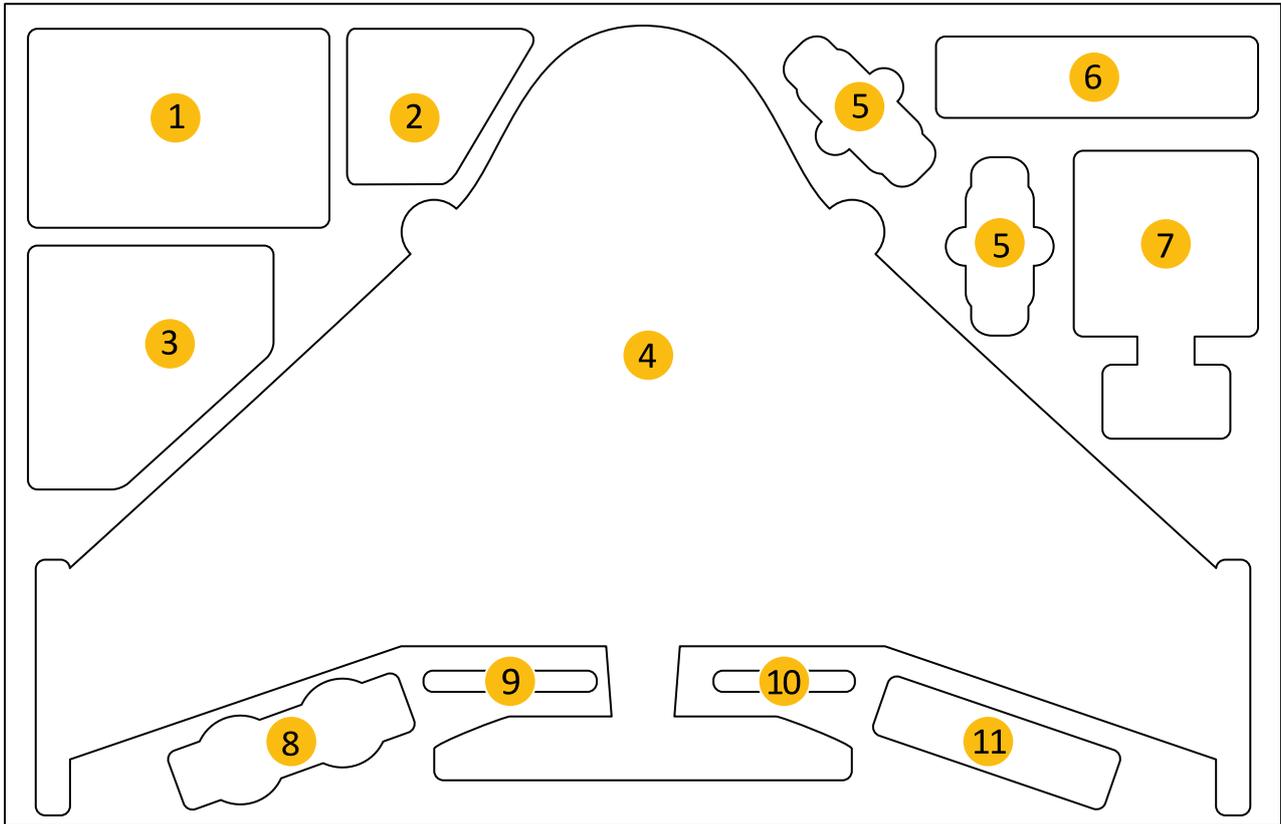
- Flight case contents
- Parts of the UX5 HP aerial imaging rover
- Inserting the eBox and gBox
- Checking the launcher
- Checking the rover
- Charging the UX5 HP batteries
- Charging the tablet batteries
- Preparing the camera
- Binding the tracker transmitter and receiver
- Locating your equipment

As part of your flight preparation, make sure all equipment is in good condition and well-prepared.

Flight case contents

When you receive your system components, unpack them and store them in the dedicated cavities in the flight case.

Check off the components against the illustration below to ensure that you have all of the components you need for a successful flight:



- 1 Tablet, tablet charger, modem and RF antenna, download cables
- 2 Extra parts such as winglets, propellers
- 3 Power strip, power cable and camera battery charger
- 4 UX5 HP body, with camera, eBox, gBox, and top cover
- 5 UX5 HP battery
- 6 Tracker transmitter and receiver
- 7 UX5 HP battery charger and charge cable
- 8 Extra camera lenses
- 9 Lens cleaning paper

3 Preparing Equipment

10 Pre-moistened lens cloth

11 Pitot cover, tools, spare camera battery and other optional spare parts

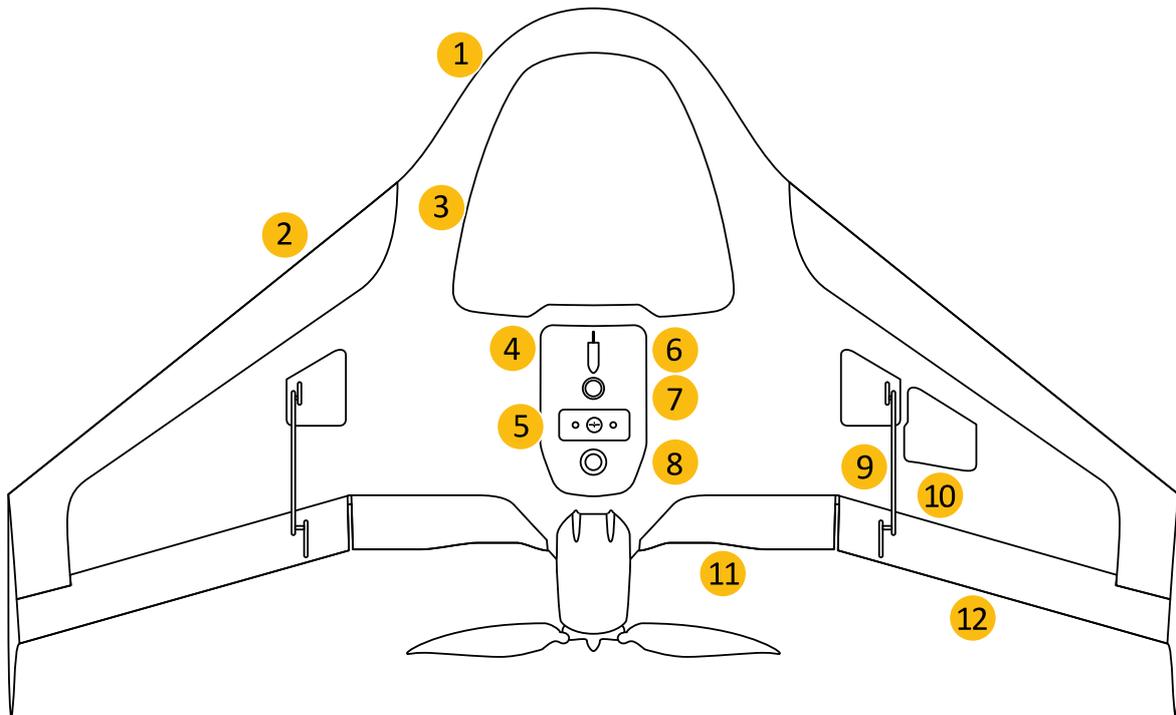
Note –

- *Some components are small parts that are easily lost. To avoid this, as soon as you unpack them:*
 - *Insert the camera battery and SD card into the camera.*
 - *Attach the GPS and RF antennas to the eBox. See [Inserting the eBox and gBox, page 58](#).*
- *According to ICAO/IATA regulations, lithium polymer batteries must be carried in hand luggage when transporting the system by air.*
- *The following parts of the system are considered dual-use: the eBox, tablet and launcher. Dual-use goods are products and technologies normally used for civilian purposes but which may have military applications. Under EU regulations, controlled items may not leave the EU customs territory without an export authorization. Additional restrictions are also in place concerning the provision of brokering services with regard to dual-use items and concerning the transit of such items through the EU. The same is true when exporting goods from any country outside the EU to any other country outside the EU.*

Parts of the UX5 HP aerial imaging rover

The main parts of the UX5 HP aerial imaging rover are shown below.

Top view

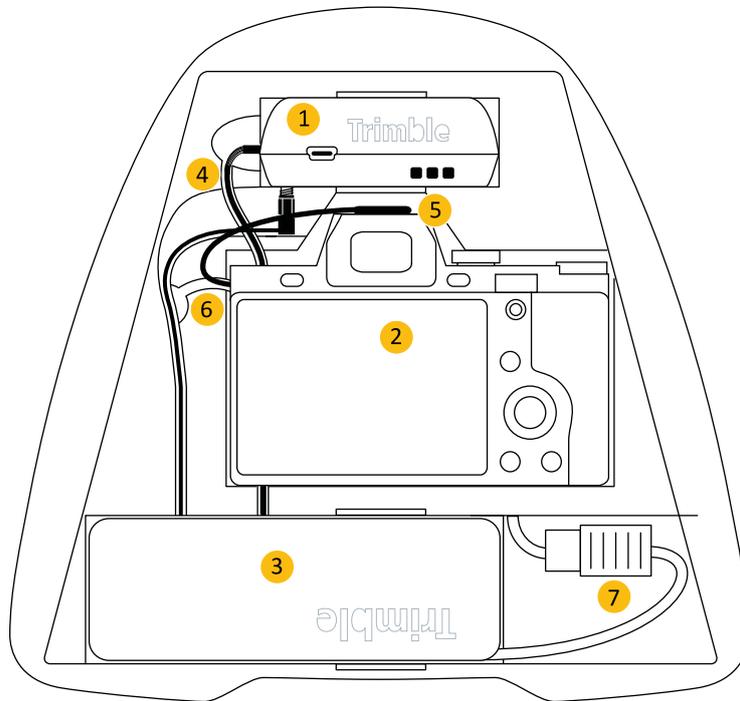


- | | | | |
|---|-------------------------|----|--------------------------|
| 1 | Aircraft body | 7 | GPS antenna |
| 2 | Leading edge | 8 | Download cable connector |
| 3 | Payload bay (see below) | 9 | Elevon servo |
| 4 | eBox | 10 | GNSS antenna |
| 5 | Mode button | 11 | Inboard elevon |
| 6 | Pitot tube | 12 | Outboard elevon |

3 Preparing Equipment

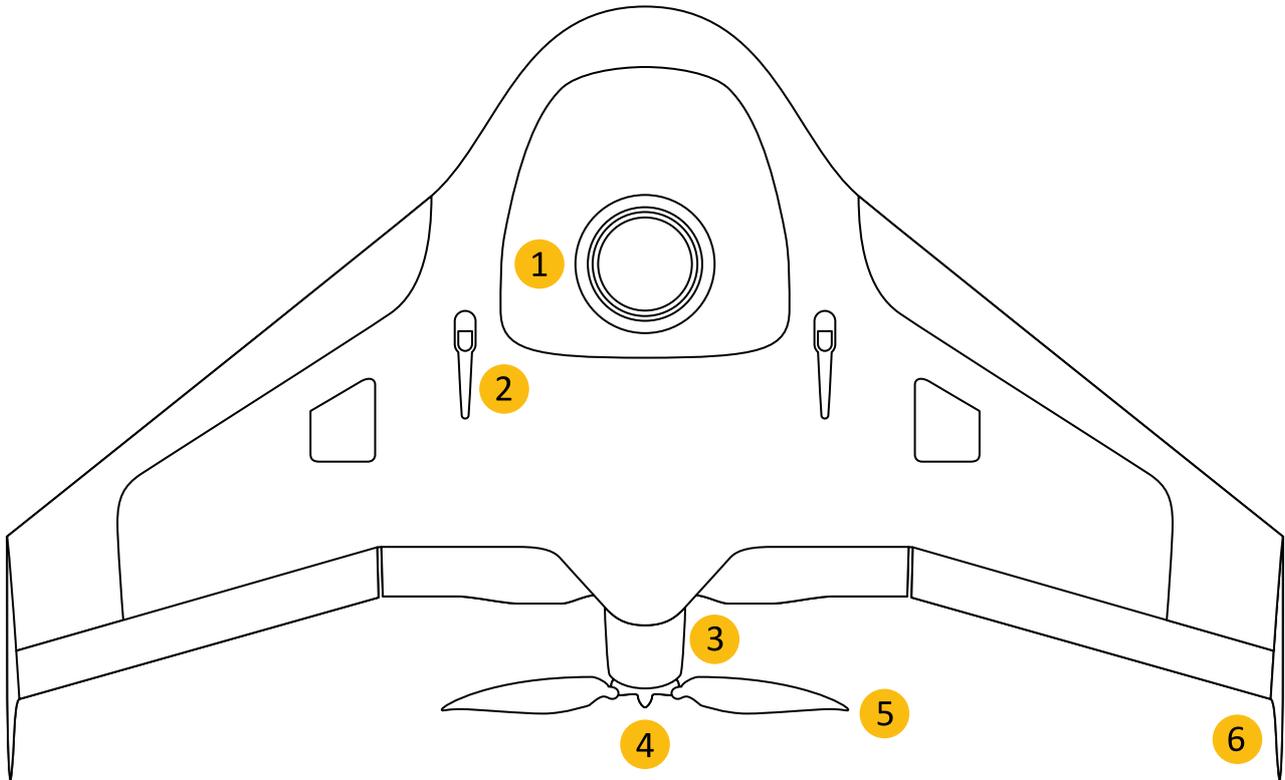
Payload bay

The contents of the payload bay are:



- | | | | |
|---|---------------------------|---|--------------------|
| 1 | gBox | 5 | Hot shoe cable |
| 2 | Camera | 6 | GNSS antenna cable |
| 3 | Battery | 7 | Power cable |
| 4 | gBox power & signal cable | | |

Bottom view



- | | | | |
|---|------------------------------|---|---------------|
| 1 | Camera lens hole with filter | 4 | Propeller nut |
| 2 | Launcher slat | 5 | Propeller |
| 3 | Motor | 6 | Winglet |

The camera filter is not prefitted into the UX5 HP body when you receive the system. You must insert the camera filter before using the system for the first time. To do this, click  in the *Home* screen, select *Rover / UX5 HP* and then select *Replacing the camera filter* or refer to the *Trimble UX5 HP Aerial Imaging Solution Maintenance Guide*.

Note – Using the incorrect filter will affect the quality of images captured during flight. Make sure you are using the correct filter for your camera, as detailed below:

Camera type	Filter type
Sony a7R RGB camera	Trimble UX5 HP UV filter, 77 mm, Tiffen
Sony a7R NIR camera	Trimble UX5 HP yellow-orange filter, 77 mm, Schneider Kreuznach

Inserting the eBox and gBox

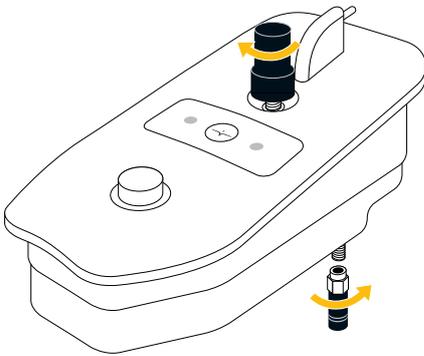
The eBox and gBox are stored in the flight case.

To complete these steps you will need to unpack the UX5 HP body, the eBox, GPS antenna, RF antenna, and gBox.

⚠ WARNING – Always disconnect the battery from the aircraft before inserting or removing the eBox or gBox from the UX5 HP body. If the battery is still connected, you risk damaging the electronics. For information on disconnecting the battery, see [Removing the battery from the rover, page 65](#).

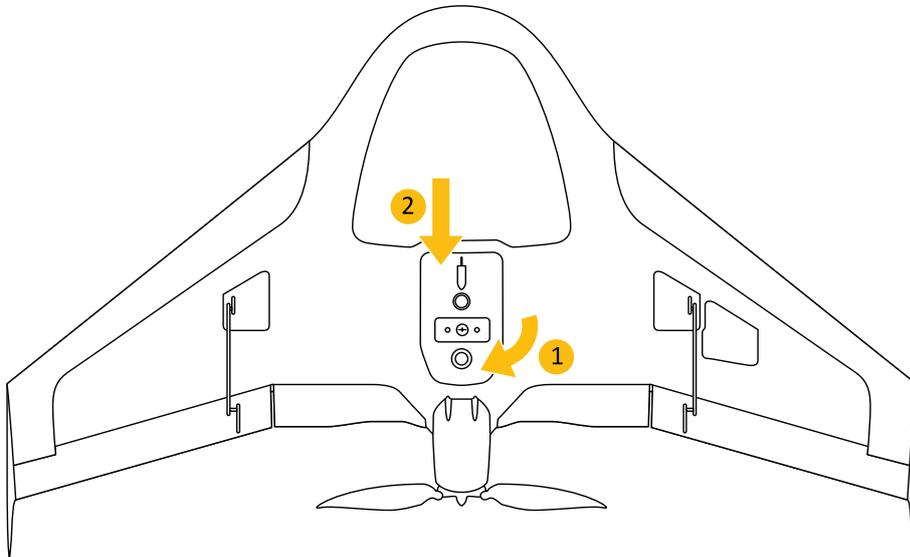
Inserting the eBox

1. Attach the RF antenna to the underside of the eBox.
2. Attach the GPS antenna to the top side of the eBox.

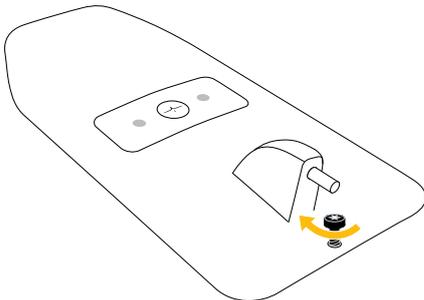


3 Preparing Equipment

3. Insert the eBox into the eBox cavity of the rover body, sliding the bottom end into the cavity and then pressing down so that the power and signal connector on the rear plugs into the connector in the rover body.



4. Insert the screw into the hole of the eBox and screw the eBox into place using a T10 Torx screwdriver. The top cover of the eBox should be flush with the rover body.



Inserting the gBox

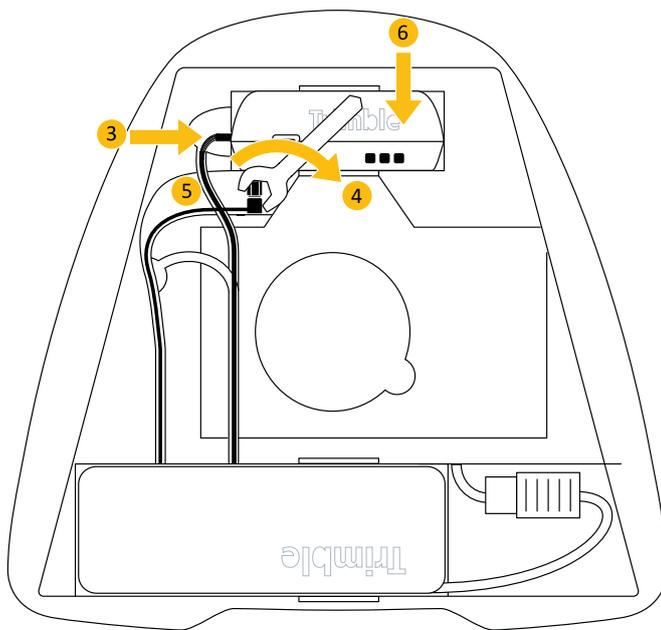
1. As much as possible, loosen the Velcro strap in the payload bay around the position of the gBox cavity.
2. Pull the power and signal cable and the GNSS antenna cable out of the ducts in the payload bay. Do not use any sharp tools. To identify each cable, see [Payload bay, page 56](#).
3. Connect the power and signal cable to the gBox.



CAUTION – The connector of the power and signal cable is fragile. Make sure to handle it with care.

3 Preparing Equipment

4. Connect the GNSS antenna cable to the gBox and firmly tighten the connector using the wrench provided with the gBox. Do not over-tighten. The wrench provided is designed to prevent over-tightening.
5. Insert the cables back into the cable ducts. Do not use any sharp tools.
6. With the LEDs facing upward, insert the gBox into the payload bay of the rover body.
7. Secure the gBox using the Velcro strap.



Checking the launcher

1. Make sure the launch slider is in good condition, and the launch dock moves freely along the slider. If the slider is damaged, contact your Trimble distributor.
2. Check the launcher cord is not worn, and make sure there is enough elastic in the cord when it is stretched tight. If the cord must be replaced, click  in the *Home* screen, select *Launcher* in the list to the right and then select *Replacing the launcher cord* or refer to the *Trimble UX5 HP Aerial Imaging Solution Maintenance Guide*.
3. Make sure the launch dock is in good condition. If it is damaged, contact your Trimble distributor.
4. Make sure the launch dock wheels are in good condition and move freely. If they are worn and must be replaced, click  in the *Home* screen, select *Launcher* in the list to the right and then select *Replacing the wheels of the launcher dock* or refer to the *Trimble UX5 HP Aerial Imaging Solution Maintenance Guide*.

Checking the rover

Thoroughly check the rover before each flight to make sure that it is undamaged from any previous flight. Refer to the following sections:

- [Check the rover body, page 61](#)
- [Check the pitot tube, page 62](#)
- [Check the winglets, page 62](#)
- [Check the propellers, page 62](#)
- [Check the drive unit, page 63](#)
- [Check the servos, page 63](#)

Check the rover body

The body of the rover must be clean for flight. Dirt and gravel on the body decreases the lift and increases the drag during flight.

1. Clean the body with a damp cloth.



CAUTION – Do not use high water pressure or a steel brush to clean the body of the rover. This can damage the surface of the rover body and affect the aerodynamics of the aircraft. Avoid the use of solvents to clean the surface of the rover body as they can negatively affect the materials. Always use lukewarm water and a soft brush.

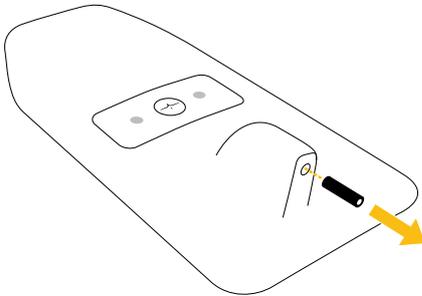
2. Check the body for cracks. If the body requires repair, contact your Trimble distributor.
3. Make sure there are no scratches on the camera filter. If the camera filter is damaged, click  in the Home screen, select *Rover / UX5 HP* and then select *Replacing the camera filter* or refer to the *Trimble UX5 HP Aerial Imaging Solution Maintenance Guide*.
4. Make sure that the camera filter is tightly screwed into the body. If not, gently tighten it, taking care not to over-tighten it.
5. Using first the wet camera wipes and then the dry camera wipes, thoroughly clean the camera filter. Make sure there are no specks of moisture or dust, as these will affect the image quality.

Note – Only use wipes that are specifically intended for cleaning camera lenses.

Check the pitot tube

The pitot tube must be in perfect condition as it is used to measure the total air pressure during flight.

1. Remove the pitot tube from the eBox.



2. Make sure the tube is not bent or broken.
3. Blow into the tube to make sure nothing is blocking it.



CAUTION – Only blow into the pitot tube after you have removed it from the eBox. Do not blow into the pitot tube when it is connected to the eBox because this will damage the barometric sensors.

4. If the pitot tube is blocked or damaged, click  in the *Home* screen, select *Rover / UX5 HP* and then select *Checking the pitot tube* or refer to the *Trimble UX5 HP Aerial Imaging Solution Maintenance Guide*. When in doubt, contact your Trimble distributor.

Check the winglets

To prevent roll stability issues, the winglets must be firmly attached to the rover body.

1. Make sure the winglets are intact.
2. Make sure each winglet is firmly attached with two screws.
3. If the winglets are damaged or not firmly attached, click  in the *Home* screen, select *Rover / UX5 HP* and then select *Replacing a winglet* or refer to the *Trimble UX5 HP Aerial Imaging Solution Maintenance Guide*. When in doubt, contact your Trimble distributor.

Check the propellers

1. Make sure the propeller blades are intact.
2. Make sure the propeller blades are well-positioned.
3. Make sure each propeller blade is firmly attached.
4. If a propeller blade is damaged or not well-positioned, click  in the *Home* screen, select *Rover / UX5 HP* and then select *Replacing a propeller blade* or refer to the *Trimble UX5 HP Aerial Imaging Solution Maintenance Guide*. When in doubt, contact your Trimble distributor.

Check the drive unit

Make sure the drive unit is:

- intact
- firmly attached

If the drive unit is damaged or not firmly attached, click  in the *Home* screen, select *Rover / UX5 HP* and then select *Replacing the drive unit* or refer to the *Trimble UX5 HP Aerial Imaging Solution Maintenance Guide*. When in doubt, contact your Trimble distributor.

Check the servos

The servos must be in perfect condition as they steer the UAS. When checking the servos, make sure that the servos:

- respond as expected
- are intact
- are firmly attached and flush with the surface of the wing

If a servo is damaged, click  in the *Home* screen, select *Rover / UX5 HP* and then select *Replacing a servo* or refer to the *Trimble UX5 HP Aerial Imaging Solution Maintenance Guide*. When in doubt, contact your Trimble distributor.

Charging the UX5 HP batteries

Note – This section is specifically for use with the Graupner Ultramat Plus field charger. To use the office charger, refer to the Graupner Ultramat 16S Office Charger Quick Start Guide.

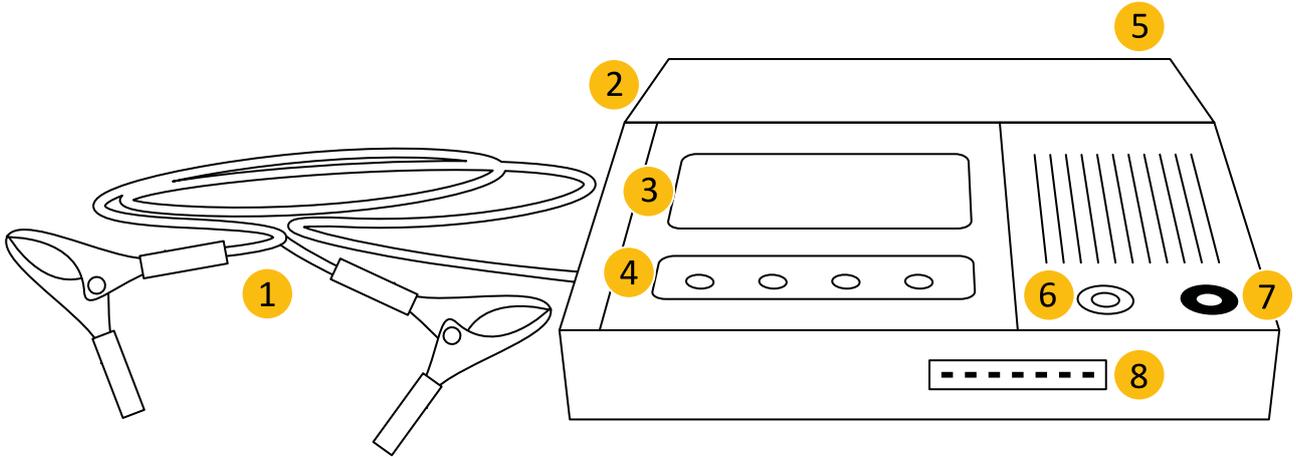
Carefully read this section to familiarize yourself with charging and storing UX5 HP batteries.

Note – Before using the charger for the first time, **make sure you are familiar with all battery safety precautions**, including emergency actions, safe battery disposal and transportation requirements. See [UX5 HP battery safety, page 128](#).

In this section:

- [Charger overview, page 64](#)
- [Removing the battery from the rover, page 65](#)
- [Connecting the charger, page 65](#)
- [Charging the battery, page 67](#)
- [Disconnecting the battery, page 67](#)
- [Inserting the battery into the rover, page 67](#)

Charger overview



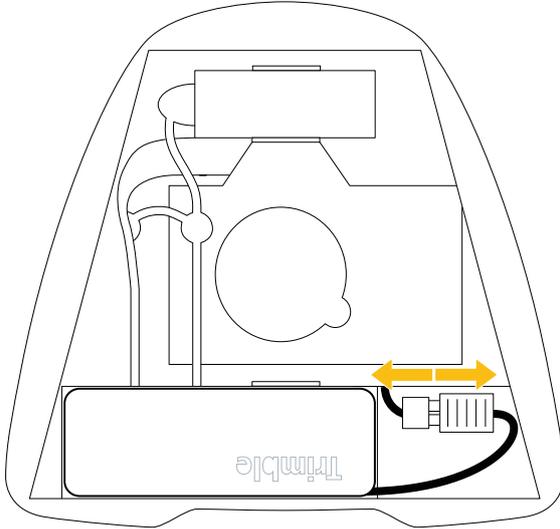
- | | |
|---------------------------|---------------------|
| 1 Car battery power cable | 5 Cooling fins |
| 2 Power connector | 6 Charge output - |
| 3 Display | 7 Charge output + |
| 4 Operating keys | 8 Balance connector |

Keys

Key	Function
PROG/MODE	<ul style="list-style-type: none"> Toggle between the different charge programs. To change the program, press and hold for two seconds. The following charge programs are available: <ul style="list-style-type: none"> LiPo/Lilo/LiFe manual Pb manual NiCd automatic NiMH automatic Toggle between screens within a charge program. Stop the charging.
DEC/INC	Change the setting values. The following settings can be changed: <ul style="list-style-type: none"> Lithium type Voltage per cell Charge current Battery capacity
ENTER/START	<ul style="list-style-type: none"> Select a setting. The setting blinks when it is selected. Start the selected charging mode. Press and hold for two seconds to start charging.

Removing the battery from the rover

1. Remove the top cover from the UX5 HP body.
2. Disconnect the main power connector of the battery from the aircraft.



3. Loosen the Velcro straps and remove the battery from the battery compartment of the UX5 HP.

Connecting the charger

⚠ WARNING – Lithium polymer batteries are volatile. Failure to read and follow these instructions may result in fire, personal injury, and damage to property if charged or used incorrectly. To prevent injury or damage:

- Use only the charger specified to charge the battery.
- Use the charger to charge only UX5 HP batteries.
- Always check that the settings on the charger are correct before charging the battery. Incorrect charger settings may result in damage to the battery, severe burning and fire hazards.
- Always remove the battery from the rover body for charging or storing.

⚠ WARNING – Never leave the charger unattended during use. Failure to observe and operate the charger properly can cause damage to the charger, battery, personal property and/or cause serious personal injury.

⚠ WARNING – The maximum charging current for the UX5 HP battery is limited to 5 A. This value must be lower than the maximum permissible current (6 A) for the battery. Incorrect battery charging parameters can destroy your battery and cause it to catch fire or explode.

3 Preparing Equipment

1. If the battery is fitted in the rover, [remove the battery from the rover](#) body.
2. Connect the Graupner Ultramat 14 Plus charger to one of the following:
 - 11–15 V DC (vehicle battery)
 - 100–240 V AC (power supply)

The charger powers on and displays the charge parameters.

3. Make sure the charger settings are correct. The parameters should be:
 - LiPo manual
 - C:5.0A 6600mAh

Press the **Prog/Mode** key to check the voltage per cell. When:

- Charging the battery for a flight, the voltage should be 4.20V/C
- Preparing the battery for storage, the voltage should be 3.90V/C

Press the **Prog/Mode** key to return to the main screen. If the settings shown are not correct, change them using the steps below.

If the charge program is incorrect:

- a. Press and hold the **Prog/Mode** key for two seconds to navigate through the charge modes. Repeat this action until the charger screen shows "LiPo/Lilo/LiFe manual".
- b. Press the **Prog/Mode** key and then press the **DEC** or **INC** key until the type is set to "LiPo".
- c. Press the **Prog/Mode** key to return to the main screen.

To change the voltage per cell:

- a. Press the **Prog/Mode** key to select the voltage per cell setting. The entry "X.XXV/C" blinks. Press the **DEC** or **INC** key to change the value until it is set to "4.20V/C" for charging or "3.90V/C" for storing.
- b. Press the **Prog/Mode** key to return to the main screen.

To change the charge current:

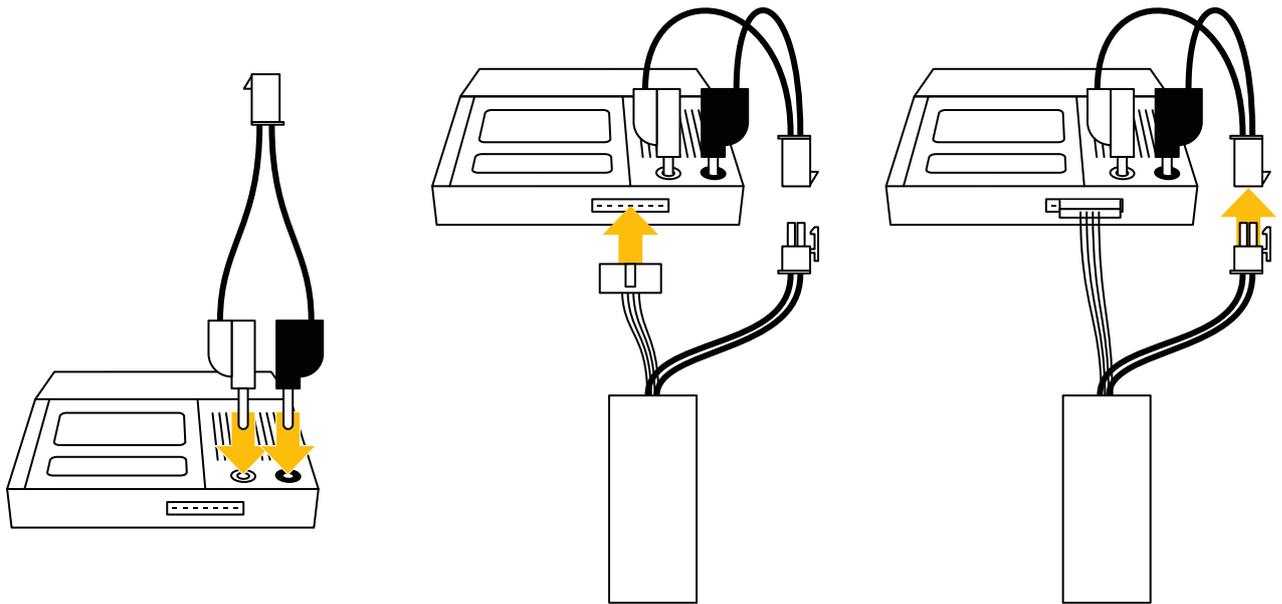
Press the **Enter/Start** key to select the charge current setting. The entry "C:x.xA" blinks. Press the **DEC** or **INC** key to change the value until it shows "C:5.0A".

To change the battery capacity:

Press the **Enter/Start** key to select the battery capacity setting. The entry "xxxmAh" blinks. Press the **DEC** or **INC** key to change the value until it shows "6600mAh".

4. Connect the battery to the charger:
 - a. Connect the charge cable to the charger.

***Note** – The charge cable to use depends on the rover battery type. Make sure you select the correct charge cable for the battery.*
 - b. Connect the balance connector of the battery to the charger. Align the connector to the right of the socket.
 - c. Connect the charge cable of the charger to the charge connector on the battery.



Charging the battery

1. On the charger, press and hold the **Enter/Start** key for two seconds. The battery starts charging.
2. Make sure the battery is properly balanced. For more information on how to check the battery health, refer to the *LiPo Checker Quick Start Guide*.

If an error occurs during charging, a message is displayed. For more information, see [Battery charger errors](#), page 117.

To interrupt the charging process, press the **Enter/Start** key. The charger returns to the main screen and displays the charge program. To resume charging, press the **Enter/Start** key for two seconds.

When the battery is fully charged, the charger produces an audible signal and stops charging automatically. The charger displays "END".

At typical room temperature it takes approximately 2 hours to charge a fully depleted battery. Charging time will vary depending on remaining battery life and ambient temperature.

Disconnecting the battery

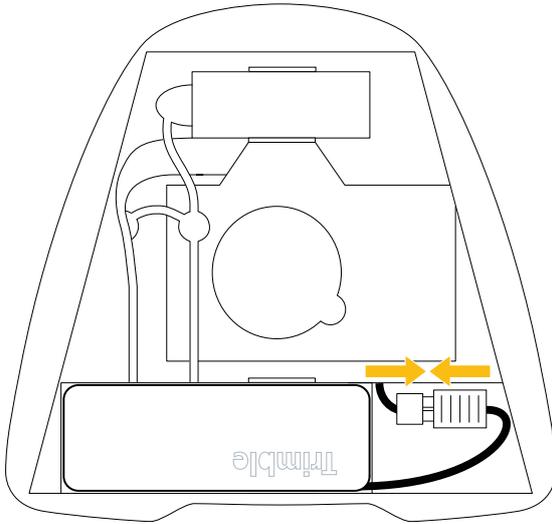
1. On the charger, press the **Enter/Start** key to put the charger in standby mode.
2. Disconnect the charge cable of the charger from the charge connector on the battery.
3. Disconnect the balancer connector of the battery from the charger.

Inserting the battery into the rover

1. Insert the battery into the battery compartment of the UX5 HP body and then tighten the Velcro straps around it.

3 Preparing Equipment

2. Connect the main power connector of the battery to the aircraft.



3. Fit the top cover to the UX5 HP body.

Charging the tablet batteries

Charge the batteries according to the instructions provided in the documentation for your tablet.

Note – Make sure you fully charge the tablet batteries before leaving the office for a flight.

Preparing the camera

Thoroughly check the camera before each flight to make sure that it is undamaged from any previous flight. Refer to the following sections:

- [Charging the camera batteries, page 68](#)
- [Checking the camera lens, page 69](#)
- [Checking the Sony a7R camera display, page 69](#)
- [Inserting the camera, page 71](#)

Charging the camera batteries

Install the camera battery and charge the batteries according to the instructions provided in the user documentation for the camera.

Note – Make sure you charge both camera batteries before leaving the office for a flight. Trimble recommends always having a spare, fully-charged battery on hand.

Checking the camera lens

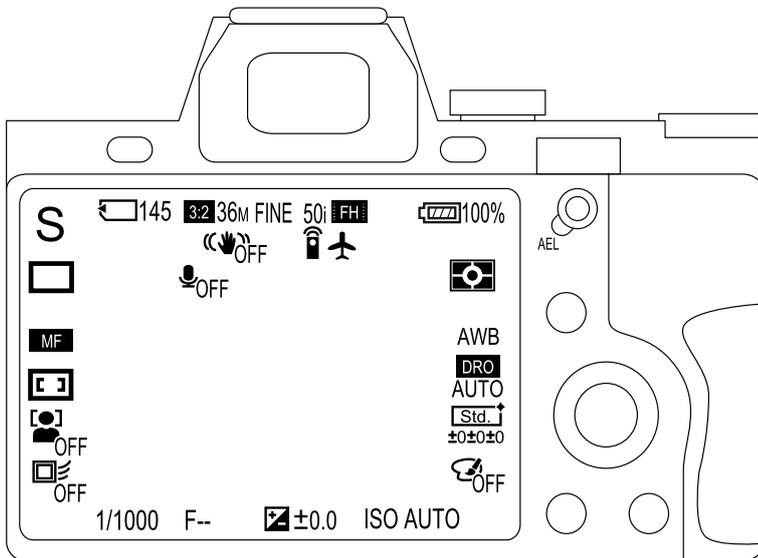
Make sure there are no scratches on the camera lens. If the camera lens is damaged, contact your Trimble distributor.

Note – When using a lens for the first time on a specific camera body, you must carefully assemble the camera and adjust the camera focus. For more information, refer to the maintenance procedures for the camera in the Maintenance screen.

Checking the Sony a7R camera display

The appropriate settings required to obtain good aerial images are set by Trimble before the camera is sent to you. Before each flight, check the camera screen to make sure it displays the correct icons.

The following image shows the main icons to check on the camera screen to ensure that your camera settings are correct and you will successfully capture images during the flight. If any of these icons are not shown, or if you believe other camera settings have been changed, adjust the settings back to the settings recommended by Trimble. For a list of all applicable camera settings, see [Sony a7R camera settings, page 124](#).



Icon	Description
S	Shoot mode is set to shutter priority.
	SD card is inserted.
3:2 36M FINE	Aspect ratio is set to 3:2; image size is set to 36M; image quality is set to Fine (all are default settings).
50i FH	Recording mode of movies is set to 50i FH.
	Steady shot is set to Off.

Icon	Description
 100%	Remaining battery is 100%.
	Drive mode is set to Single Shooting.
	Metering mode is set to Multi (the default).
	Focus area is set to Center.
 MF	Focus mode is set to Manual.
 OFF	Face detection is set to Off.
AWB	White balance is set to AWB (the default). For the NIR camera, use custom brightness/color settings. See Setting brightness/color settings for the NIR camera, page 70 .
 DRO AUTO	Brightness correction is set to automatic (the default).
 Std. ↑	Creative style is set to Standard (the default).
 OFF	Picture effect is set to Off (the default).
1/1000	Shutter speed is set to 1/1000 or above.
 ±0.0	± 0.0 When using the NIR camera, exposure compensation is set to +1.0 for the B+W 040 (orange) filter
ISO AUTO	ISO is set to Auto (the default).

Setting brightness/color settings for the NIR camera

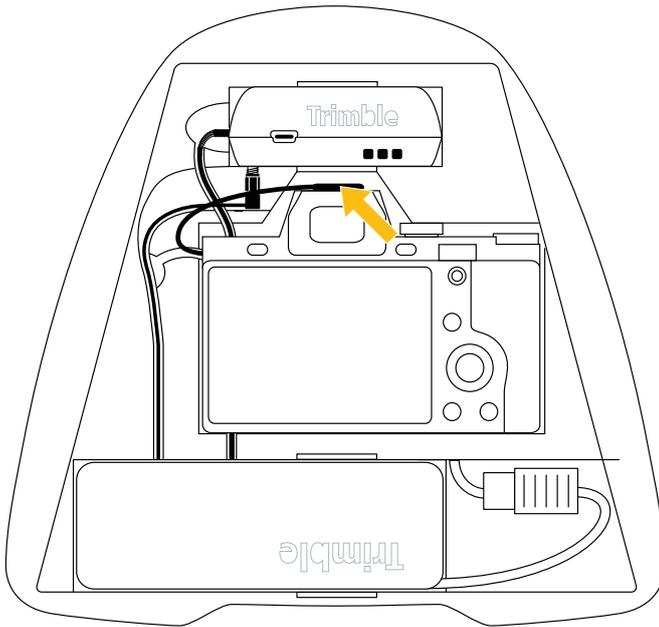
To obtain best results from the camera and selected filter, Trimble recommends setting the brightness/color settings as follows:

1. On the camera, select *Menu* /  / 4 / *White Balance*. Press the central button of the control wheel and then select *Custom Setup*. Press the central button of the control wheel to confirm.
2. Outdoors, in normal daylight conditions, hold the filter you will use in front of the lens, while aiming the central circle of the lens at a (nearly) white surface, such as a wall or blank piece of paper.
3. Press the central button of the control wheel.
The custom White Balance values appear. Ignore the error message ("Custom WB Error") – this message appears because the camera has been changed to an NIR camera in the factory.
4. Select the register to save the settings in. By default, register 1 is selected. Press the central button of the control wheel to confirm.
5. The color infra-red (CIR) display on the camera appears. When using the B+W 040 (orange) filter, vegetation appears blue and the sky appears brown.

Inserting the camera

The camera and lens are stored in the flight case.

1. Screw the lens onto the camera body and adjust the camera focus. For more information, refer to the maintenance procedures for the camera in the *Maintenance* screen or in the *Trimble UX5 HP Aerial Imaging Solution Maintenance Guide*.
2. Loosen the Velcro strap in the payload bay of the rover body and insert the camera into the payload bay.
3. Connect the hot shoe connector to the hot shoe of the camera.



4. Secure the camera using the Velcro strap.

Note – After inserting and securing the camera, check the shutter speed and the exposure compensation dial (which should be set to 0) as the settings control might have spun and changed the setting.

Binding the tracker transmitter and receiver

Note – You must complete this step only once, before using the UX5 HP aerial imaging rover for the first time.

To track down the UX5 HP aerial imaging rover fitted with a transmitter, the transmitter ID must first be stored in the memory of the receiver.

To view this procedure as a wizard in the Aerial Imaging software, click  in the *Home* screen, select *Communication* in the list to the right and then select *Binding the tracker transmitter & receiver*.

1. Press and hold the **ON/OFF** key for three seconds to power on the receiver.
2. Press the **MENU/OK** key to enter the menu.

3 Preparing Equipment

3. Use the navigation keys to select TRANSMITTER. Press the **MENU/OK** key to confirm.
4. Use the navigation keys to select ADD. Press the **MENU/OK** key to confirm.
5. Use the navigation keys to enter the missing digits of the frequency of the transmitter. Confirm each digit using the **MENU/OK** key.
6. Once you have entered all digits, select END. Press the **MENU/OK** key to confirm.
7. Follow the steps on the screen of the receiver to calibrate the transmitter.
8. Once the calibration is done, you are prompted to enter a name for the transmitter. Press the **MENU/OK** key to continue.
9. Use the navigation keys to enter the name you want to use for the transmitter. Confirm each letter using the **MENU/OK** key.
10. Once you have entered the name, select END. Press the **MENU/OK** key to confirm.
The receiver is now able to accurately track the transmitter.

Locating your equipment

Before you head out to the field:

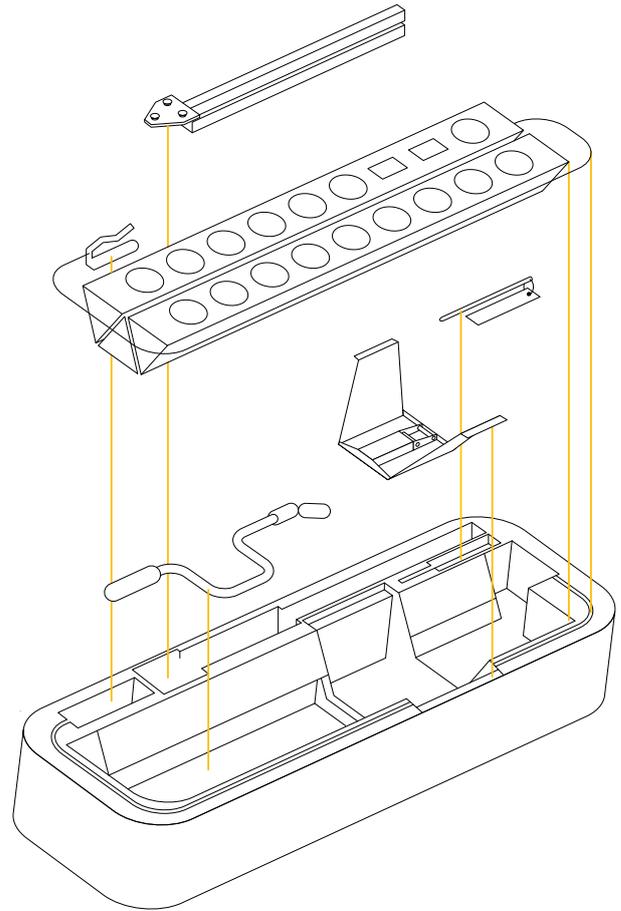
1. Make sure the flight case contains all of the required items. For more information, see [Flight case contents, page 53](#).
2. If you will be doing several flights before returning to the office, make sure you have one of the following:
 - an external storage device such as a laptop for transferring images to after each flight
 - a USB to SD card reader for transferring images to the tablet after each flight
 - an SD card for each flight

Note – Trimble recommends using a San Disk Extreme SDHC UHS-I card with a minimum write speed of 60 MB/s and a minimum capacity of 64 GB.

3 Preparing Equipment

3. Make sure the launcher bag contains the following items:

- safety pin
- launch dock with lock pin
- V-support
- crank
- launch slide with elastics
- *Trimble UX5 & UX5 HP Launcher Quick Start Guide*



Completing a Flight

- Importing the project
- Keeping an eye on the weather
- Validating the blocks
- Validating the flights
- Completing the flight checklist
- Launching the rover
- Monitoring and controlling the rover during flight
- Landing the rover
- Completing the post-flight checklist
- Disassembling the launcher

This chapter describes the tasks required in the field to complete a successful flight with good image data.

Importing the project

Note – This step is required if you did the project planning in the Aerial Imaging Desktop software and then exported the project so that you can view it on the tablet.

1. In the *Home* screen or the *Projects* screen, tap .
2. Navigate to the location of the GWT file you exported from the Aerial Imaging Desktop software (see [Exporting the project, page 47](#)), select it and then tap **Import**.
The project you imported is listed in the *Projects* screen and the project thumbnail appears.
3. Select the project and then click  to open the project and view the *Map layers* screen.

Keeping an eye on the weather

On the day of the flight, check that the current weather conditions are suitable for flight.

Note – Pay particular attention to the prevailing wind direction and speed. If the wind direction changes before the flight, if possible change the wind direction in the *Blocks* tab to align the flight lines perpendicular to the wind direction. Make sure you reposition the launcher and then update the takeoff and landing heading in the flight plan.

Cancel the on-site operations if one of the following weather phenomena occurs before the flight:

- Strong wind
- Heavy rain, hail
- Hurricane, tornado, or any kind of whirlwind
- Thunder and lightening
- Snow

If there are sudden weather changes when the rover is in the air, see [Dealing with sudden weather changes during flight, page 92](#).

Validating the blocks

Tap the *Blocks* tab  and make any changes to the blocks, if required. For more information, see [Defining the blocks, page 28](#).

Note – Pay special attention to the actual wind direction, which will influence the wind direction you have set in the software and possibly the flight time.

Validating the flights

- When you arrive on-site, examine the flight area to:
 - Check for obstacles in the flight area. Obstacles are objects such as trees, buildings, antennas, power lines, and water that the rover could fly into or land on.
 - Make sure you will be able to maintain a visual line of sight to the rover throughout the flight.
 - Identify a good takeoff and landing location.
 - Check the landing surface and obstacle clearances to make sure the most suitable landing type is selected.

For more information, see [Obstacle clearances, page 35](#).

- Repeat step 1 for each location that you consider as an alternative landing location.

Note – If you choose to check alternative landing locations during flight, be aware that this takes more time and keeps your attention from the flight.
- Tap the *Flight* tab  and make any changes to the flights, if required. For more information, see [Defining the flights, page 39](#).
- Make sure that the selected takeoff location is fixed to GPS. To fix the location, physically go to the location, tap  and then tap  in the toolbar.
- Make sure that the selected landing location is fixed to GPS. To fix the location, physically go to the location, tap  and then tap  in the toolbar. Repeat for each landing location that you consider as an alternative location.

Note – If you choose to check alternative landing locations during flight, be aware that this takes more time and keeps your attention from the flight.
- In the *Flights* screen, select the flight you will complete and then tap the *Flight checklist*  tab.

Completing the flight checklist

The *Flight checklist* tab  starts with an overview of the flight that you have selected and will execute.

Note – More information about the steps that require special care is given in the following sections. Read these sections carefully until you are familiar with all of the tasks required to perform these steps.

Use each step of the *Flight checklist* tab  to prepare the equipment for flight. The flight checklist guides you through each step.

- [Selecting the operating mode, page 77](#)
- [Configuring the operation mode settings, page 77](#)
- [Connecting the modem, page 77](#)
- [Connecting the battery, page 78](#)
- [Checking the rover and sensor type, page 78](#)
- [Checking the gBox status, page 78](#)
- [Entering the serial number of the lens, page 78](#)

4 Completing a Flight

- [Preparing the camera, page 78](#)
- [Inserting the camera, page 79](#)
- [Checking the camera trigger and shutter feedback, page 80](#)
- [Inserting the tracker transmitter, page 80](#)
- [Closing the payload bay, page 80](#)
- [Covering the pitot tube, page 80](#)
- [Checking the elevon trim, page 80](#)
- [Checking the elevon response, page 80](#)
- [Assembling the launcher, page 81](#)
- [Placing the rover onto the launcher, page 85](#)
- [Initializing, page 85](#)
- [Removing the pitot cover, page 85](#)
- [Checking the airspeed response, page 85](#)
- [Positioning the propellers, page 85](#)
- [Tightening the launcher cord elastics, page 86](#)
- [Verifying the position of the aircraft on the launcher, page 86](#)
- [Removing the safety pin, page 87](#)
- [Arming the system, page 88](#)

Selecting the operating mode

Options are:

- PPK using a local base station
- PPK using a network reference station
- No PPK

Configuring the operation mode settings

If you have chosen to use PPK with a local base station, the software reminds you to set up the local base station in the field.

If you have chosen not to use PPK, the software reminds you to get the ground control points in the field.

Connecting the modem

If you have not yet connected the modem:

1. Attach the antenna to the modem.
2. Attach the modem and antenna to the back of the tablet.
3. Insert the modem cable into the USB port on the tablet.
4. Tap **>** to prompt the software to check if the modem is connected.

When the connection to the modem is established, the software automatically moves to the next step in the flight checklist.

Connecting the battery

Note – Make sure you are using a properly balanced battery. For more information on how to check the battery health, refer to the *LiPo Checker Quick Start Guide*.

If you have not yet connected the battery:

1. Insert a fully charged battery into the battery compartment of the rover.
2. Connect the main power connector on the battery to the power connector in the aircraft. Once the battery is connected, the eBox goes from Off mode to On mode (see [eBox LED status, page 118](#)).

Tap **>** to prompt the software to connect with the autopilot and to check the rover and sensor type.

Note – If after this step you are prompted to update the eBox firmware, see [Updating the eBox firmware, page 19](#).

Checking the rover and sensor type

The software automatically checks if the rover and camera type that you are using corresponds with the rover and camera type selected during project planning.

When the rover and sensor type are correct, the software automatically moves to the next step in the flight checklist.

If the check is not successful, an error message appears. When you accept the message, the checklist is canceled. To continue with the project, update the project plan or use the correct rover and/or sensor.

Checking the gBox status

Make sure that the gBox is powered on and is locked with enough satellites.

The gBox is powered on when it has a steady or very slow blinking green LED.

The gBox is locked with more than 4 satellites when the orange LED is slowly blinking.

If the LED has a different status, see [gBox LED status, page 119](#).

When you have checked the status and confirm that it is OK, the **>** is enabled.

Entering the serial number of the lens

Your lens is uniquely identified with a serial number. Enter the serial number of the lens in the text field and tap **>**. The software checks if the lens that you are using corresponds with the one selected in project planning.

If the check is not successful, cancel the checklist and either update the project plan or use the correct size of lens.

Preparing the camera

1. Insert an empty SD card into the camera.
2. Turn on the camera and check the camera screen to make sure it displays the icons described in [Checking the Sony a7R camera display, page 69](#).

3. Make sure the lens settings are appropriate for the weather conditions:

ISO	Auto
Aperture ring	The aperture ring should always be set to: <ul style="list-style-type: none"> • f/4.5 for 15 mm • f/5.6 for 25 and 35 mm
Focus ring	When using the camera for the first time, the camera focus should be carefully adjusted. For more information, refer to the maintenance procedures for the camera in the <i>Maintenance</i> screen or in the <i>Trimble UX5 HP Aerial Imaging Solution Maintenance Guide</i> .
Shutter speed	1/1000 to 1/8000 The software recommends a minimum shutter speed based on the size of the lens and the flight height. If the flight has multiple blocks with different flight heights, the lowest height is used. Always take a picture before the flight to ensure that the picture is not over- or underexposed. If the picture does not look right, adjust the shutter speed.

4. Using first the wet camera wipes and then the dry camera wipes, thoroughly clean the camera lens. Make sure there are no specks of moisture or dust, as these will affect the image quality.

Note – Only use wipes that are specifically intended for cleaning camera lenses.

5. Make sure the camera filter in the rover body is also clean and that the camera filter is tightly screwed into the body. If not, gently tighten it, taking care not to over-tighten it.

The camera filter is not prefitted into the UX5 HP body when you receive the system. You must insert the camera filter before using the system for the first time. To do this, click  in the *Home* screen, select *Camera / UX5 HP* and then select *Adapting the payload bay* or refer to the *Trimble UX5 HP Aerial Imaging Solution Maintenance Guide*.

Note – Using the incorrect filter will affect the quality of images captured during flight. Make sure you are using the correct filter for your camera, as detailed below:

Camera type	Filter type
Sony a7R RGB camera	Trimble UX5 HP UV filter, 77 mm, Tiffen
Sony a7R NIR camera	Trimble UX5 HP yellow-orange filter, 77 mm, Schneider Kreuznach

Inserting the camera

Insert the camera into the camera cavity of the payload bay. Connect the hot shoe cable in the rover to the hot shoe of the camera. Secure the camera using the Velcro straps.

For more information, see [Inserting the camera, page 71](#).

Note – After inserting and securing the camera, check the shutter speed and the exposure compensation dial (which should be set to 0) as the settings control might have spun and changed the setting.

Checking the camera trigger and shutter feedback

In the Aerial Imaging software, tap . Make sure that you hear the trigger sound from the camera and observe one red LED flash from the gBox.

When the checks are successful, the  button is enabled.

Inserting the tracker transmitter

1. Turn on the tracker transmitter.
2. Make sure that you can hear the transmitter using the tracker receiver.
3. Insert the tracker transmitter into the body of the rover.

Closing the payload bay

Make sure the payload is secured with the Velcro strap. Attach the top cover to the payload bay and make sure it is secure.

Covering the pitot tube

Put the pitot tube cover on the pitot tube.

Checking the elevon trim

Make sure that the outboard elevons are leveled with the inboard elevons (the inboard elevons are fixed). The accuracy should be less than 1 mm.

 **WARNING** – When handling the rover, make sure that the elevons can move freely and are not obstructed in any way. Impaired movement of the elevons can cause the servo motor to burn up.

Checking the elevon response

Tap the **Move/Stop elevon** button in the Aerial Imaging software and watch the elevons on the rover. Make sure the elevons move fluently and in unison.

 **WARNING** – When handling the rover, make sure that the elevons can move freely and are not obstructed in any way. Impaired movement of the elevons can cause the servo motor to burn up.

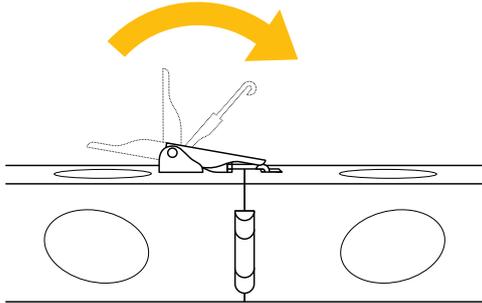
When the elevon response is checked, the  button is enabled.

Assembling the launcher

1. Unfold the launch slide.

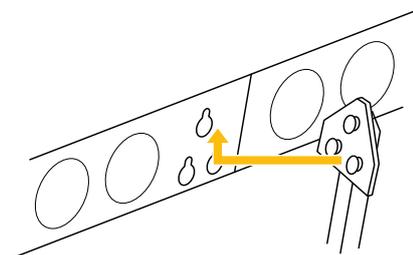
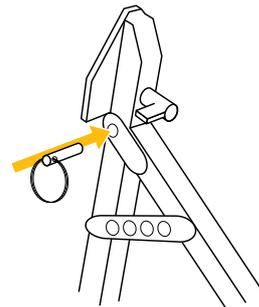
 **CAUTION** – Take care when unfolding the launch slide as there are sharp edges that can cause finger cuts.

2. Secure each section of the launch slide by lifting the appropriate handle and hooking it into the next section of the launch slide. Close the handles.

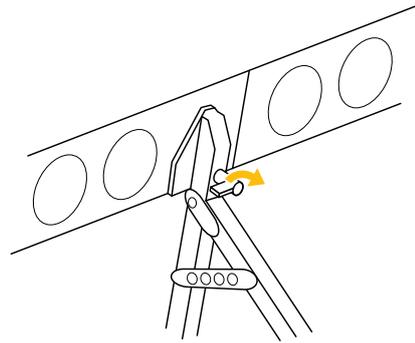


3. Unfold and secure the V-support with the lock pin

To attach the V-support to the launch slide, make sure the knob is pointing to the left and then insert the V-support pins in the reserved holes, situated approximately 2/3 of the length of the launch slide. Turn the knob to the right to tighten.



4 Completing a Flight

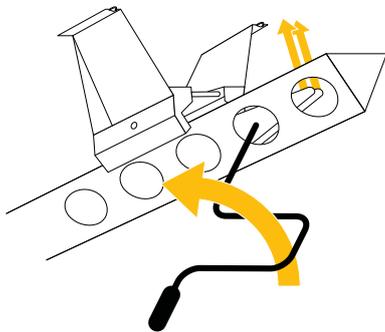


4. Pull the ends of the launcher cord out of the launch slide so that the cord lies on top of the launch slide.

Note – *If the launcher cord is blocked while the elastics are not tightened, pull the release handles upward to unblock them.*

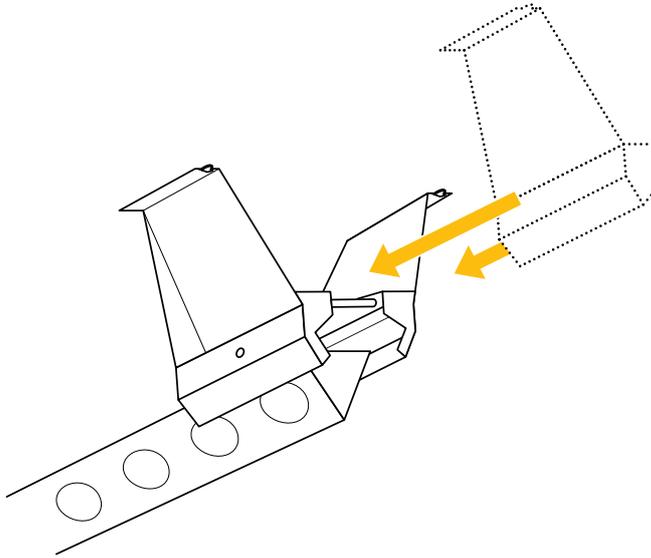


CAUTION – Never push the release handles when there is tension on the launcher cord. You will damage the elastics. If there is tension on the cord, insert the crank onto the nut located toward the front end of the launcher and use the crank to very gently release the force. At the same time, pull the release handles gently upward. This is safest done with two people, with one person carefully winding the crank counter-clockwise to counteract the force on the elastics.

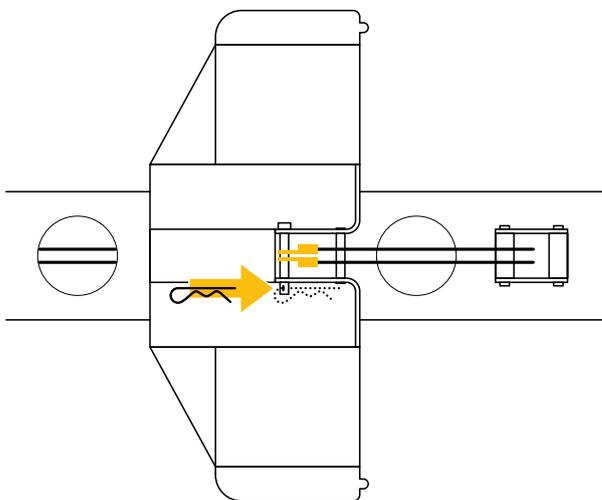


4 Completing a Flight

5. Position the launch dock on the end of the launch slide with the tabs on the launch dock pointing toward the direction of launch.



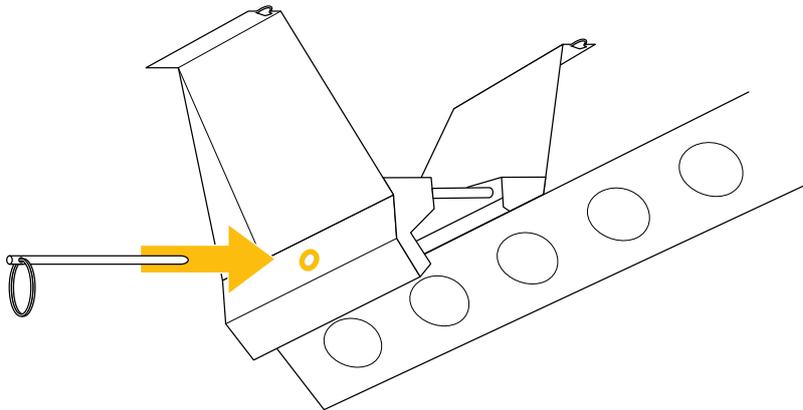
6. Slide the launch dock over the ends of the launcher cord.
7. To attach the ends of the launcher cord to the launch dock, remove the lock pin from the launch dock and then slide the lock pin through the holes in the launch dock, attaching the ends of the launch cord as you do so. Secure the lock pin.



8. Slide the launch dock over the launch hook at the beginning of the launch slide, making sure the launch dock clicks into position. Make sure the trigger is not blocked.

4 Completing a Flight

9. Insert the safety pin into the launch dock.



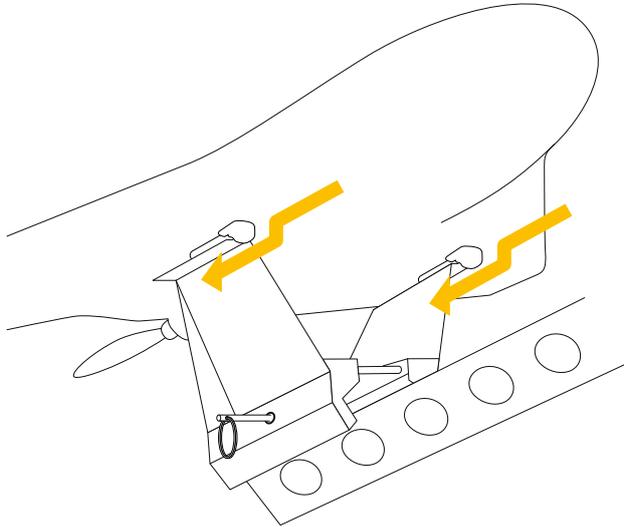
⚠ WARNING – Always keep the safety pin inserted in the launch dock. Remove the safety pin only just before launch. Early removal of the safety pin can result in accidental release of the launcher, causing serious personal injury and damage to the rover or launcher.

⚠ CAUTION – Never launch without the rover sitting on the dock as it will damage the launch dock. The design of the launcher takes into account the weight of the rover sitting on the launch dock.

10. Position the launcher at the planned takeoff location, with the launch direction pointing into the takeoff direction you have indicated in the software.
11. Make sure the takeoff location is free of obstacles. For more information, see [Obstacle clearances](#), page 35.

Placing the rover onto the launcher

Position the rover at the front of the launch dock and use your finger tips to guide the launcher slats on the underside of the rover onto the lips of the launch dock.



Initializing

At this step in the flight checklist, the eBox initializes. It must acquire lock on at least 4 usable GPS satellites. The GPS receiver in the eBox determines the usability of the satellites, based on the characteristics of each satellite.

Removing the pitot cover

Check the airspeed on the tablet. If the airspeed is below 20 kph (12.4 mph), you can safely remove the pitot cover.

Checking the airspeed response

Press and hold the pitot tube for no more than 5 seconds. Make sure that the value in the black arrow at the left of the artificial horizon in the status panel of the Aerial Imaging software changes. The airspeed should reach at least 50 kph (31 mph).

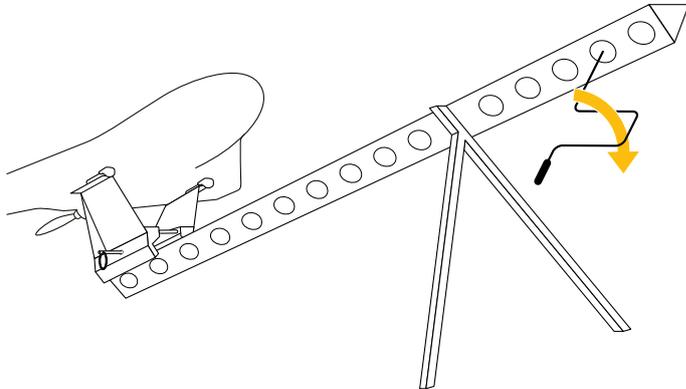
Positioning the propellers

WARNING – Always take care when touching the propeller blades. If the rover receives a sudden shock while armed, the motor can unexpectedly start causing the propeller blades to move. Contact with moving propeller blades can result in serious personal injury.

1. Check the position of the propellers on the rover and make sure they are pointing backward as shown in the Aerial Imaging software.
2. If the propellers are not positioned correctly, carefully adjust them.

Tightening the launcher cord elastics

1. Insert the crank onto the nut located toward the front end of the launch slide.
2. Stretch the launcher cord using the crank. In normal circumstances, the node between the cord and elastic should be in the middle of the hole numbered "4" on the launcher.



CAUTION – The launcher cord stretches with every launch. When you can easily reach the last hole when tightening the cord, replace the launcher cord to prevent unsuccessful launches and damage to the launcher or the rover. For more information, refer to the maintenance procedures in the *Maintenance* screen, or refer to the *Trimble UX5 HP Aerial Imaging Solution Maintenance Guide*.

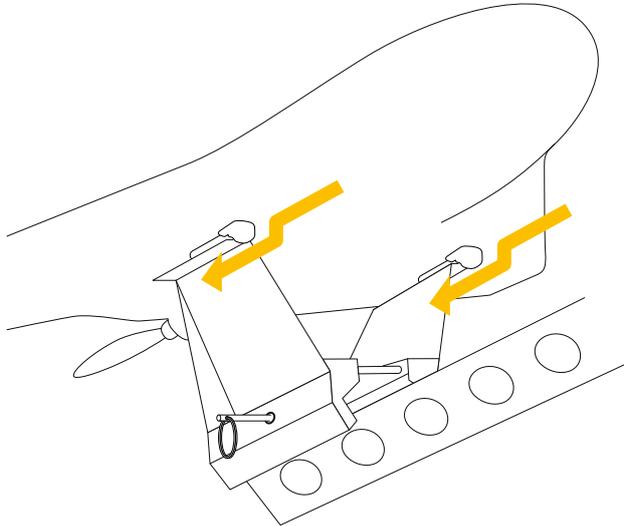
3. Remove the crank.

Verifying the position of the aircraft on the launcher

WARNING – Take care to ensure the rover is correctly positioned on the launch dock. An incorrect position can result in launch failure, causing serious personal injury and damage to the rover or launcher.

4 Completing a Flight

Use the artificial horizon indicator in the Aerial Imaging software to check the pitch and roll of the rover on the launch dock. The pitch angle should be between 20° and 30° and the roll angle should be between -5° and 5°. The horizon should be positioned parallel to the rover on the artificial horizon indicator. If you need to adjust the horizon, reposition the launcher.



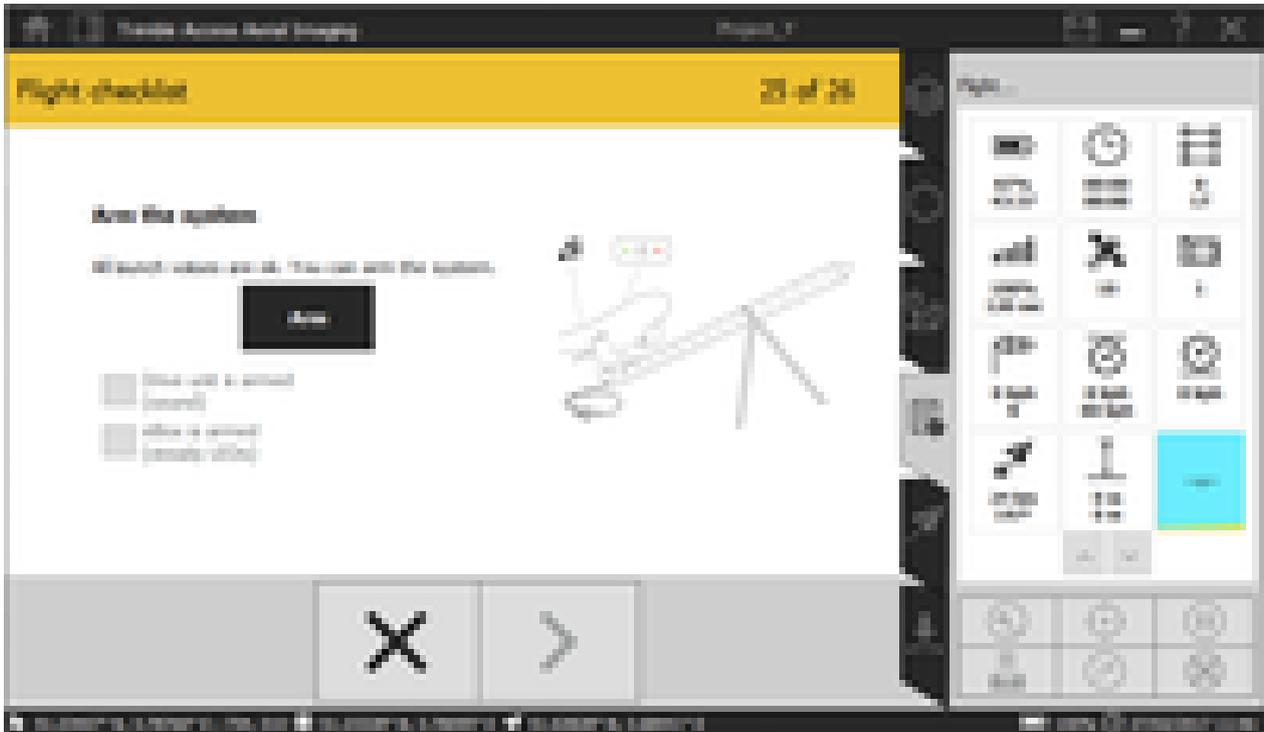
Removing the safety pin

⚠ WARNING – Always take care to avoid contact with the propeller blades. If the rover receives a sudden shock while armed, the motor can unexpectedly start causing the propeller blades to move. Contact with moving propeller blades can result in serious personal injury.

To remove the safety pin, position yourself behind the launcher, reach carefully under the rover and then pull out the safety pin.

Arming the system

This step of the flight checklist verifies if the system is ready for launch. If there is an issue with any of the launch values, a message appears.



A warning message appears if the:

- Rover battery life is less than 75%.
- Tablet battery life is less than 90 minutes.
- Number of satellites is between 4 and 6.
- Rover pitch and roll values are not within the desired range.
- Current air speed is too high.
- Total flight time exceeds the maximum endurance.

The system will not allow you to arm if the following errors are reported:

- The eBox is not in the correct state.
- Rover battery life is less than 35%.
- The takeoff sensor is not OK (this means that the yaw, pitch, and roll values are not yet stabilized).
- The takeoff status is not OK.
- eBox logging has not started.
- The GCS has no GPS connection.

- The number of satellites is less than 4.
- The flight plan contains a waypoint located outside the geofence.

To resolve these errors, see [Unable to arm the system, page 110](#).

To arm the system, tap **ARM**. Verify that you hear the drive unit beep and that the eBox has steady LEDs.

Tap **>** to go to the *Dashboard* screen where you can monitor the flight telemetry and follow the launch of the rover.

Launching the rover

1. Just before launch, perform the following safety checks:
 - a. Make sure there are no aerial objects inside the zone of operation.
 - b. Make sure you have a clear line of sight to the rover.
 - c. Make sure there are no obstacles or people near the front of the launcher.

 **WARNING** – Make sure you complete each of the safety checks listed at this step. Failure to do so could result in serious personal injury and damage to the rover or launcher.

2. When you have made sure that everything is clear in front of, above, and behind the launcher, stand behind the launcher and press the launch handle to launch the rover.

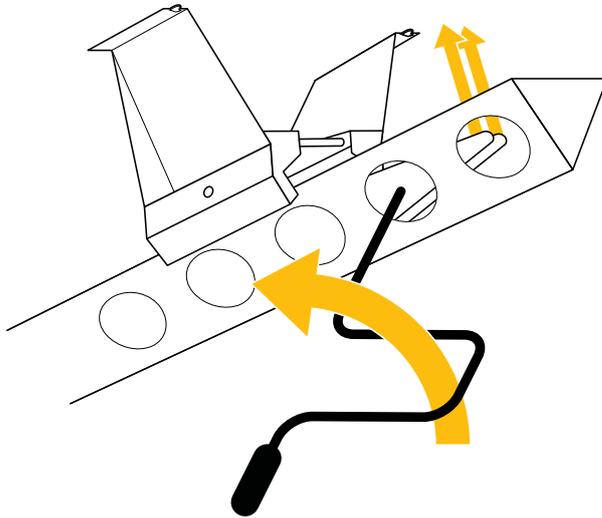
 **CAUTION** – Never launch without the rover sitting on the dock as it will damage the launch dock. The design of the launcher takes into account the weight of the rover sitting on the launch dock.

3. ***If an obstacle such as a person or animal suddenly appears in the obstacle clearance zone during takeoff***, tap  in the Aerial Imaging software. The rover immediately powers down and returns to the ground. For more information, see [Emergency software commands, page 94](#).

After launch, the rover flies to the first waypoint, which is highlighted on the map in the *Dashboard* tab. If the rover is not yet at the flight height when it reaches this point, it climbs in 200 m (656 ft) diameter circles until it reaches the desired height.

4. After launch, release the tension on the launcher cord elastics. Leaving tension on the launcher cord elastics for extended periods can damage the elastics.

To release the tension, release the force with the crank very gently while pulling the release handles in the front of the launcher upward. This is safest done with two people, with one person carefully winding the crank counter-clockwise to counteract the force on the elastics.



Monitoring and controlling the rover during flight

CAUTION – It is your responsibility to take action during flight when the safety of the rover or its surroundings is compromised. To do this you must:

- Have visual contact with the rover at all times.
- Observe the zone of operation for the rover and look out for other aerial objects.
- Ensure obstacle clearance.
- Keep an eye on changing weather conditions.
- Locate the rover on the tablet screen.
- Monitor the flight telemetry on the GCS.

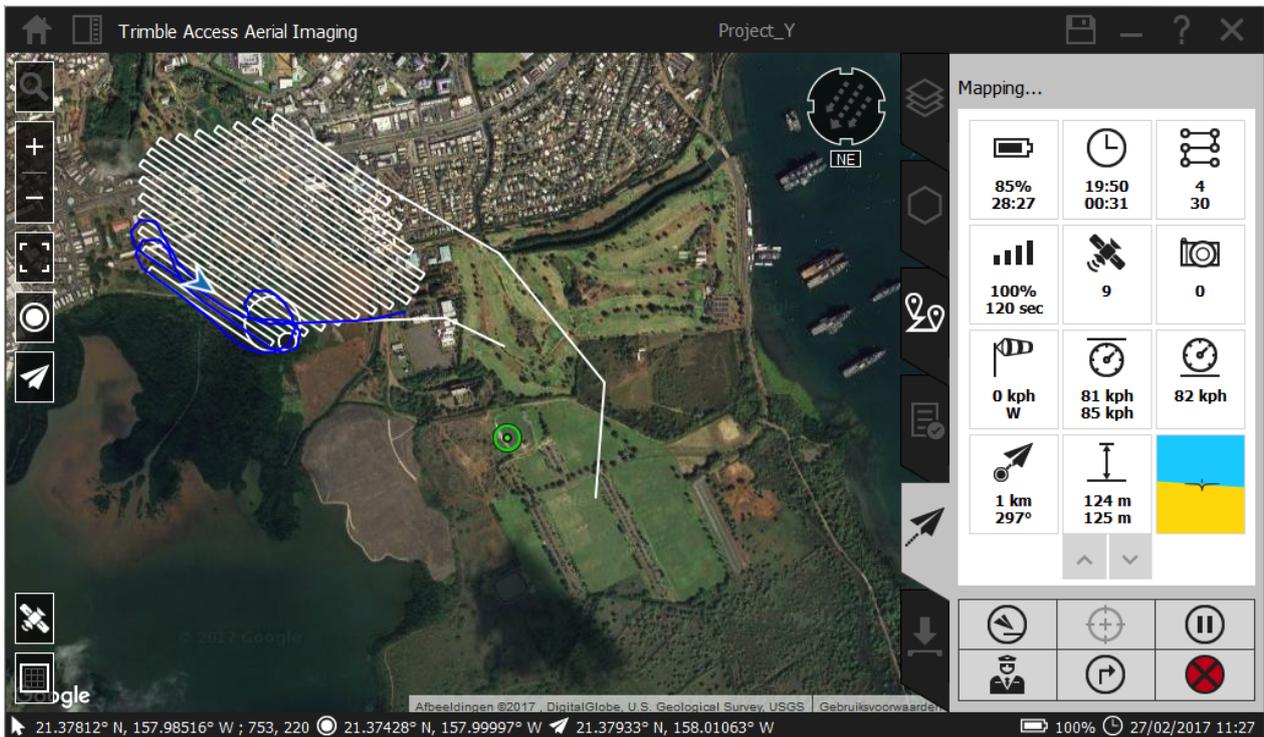
After takeoff, the rover climbs to the specified cruise height.

Once the rover has passed its first waypoint, the second waypoint is initiated. From this point, the rover follows the pre-programmed flight path.

Note – For information on the appropriate action to take if you see an oncoming aerial object at any point during the flight, see [Handling emergencies during flight, page 97](#).

4 Completing a Flight

The *Dashboard* tab with an example flight is shown below:



You must use the Aerial Imaging software on the tablet to monitor the rover during the entire flight:

- The trajectory of the rover on the map must be close to the programmed flight path.
- Monitor the level of power in the rover battery. In the battery status bar , the value is expressed as a percentage and as time remaining in minutes.
- Monitor the flight time . The value is expressed as the flight time remaining and as the flight time done, both in minutes.
- Monitor the number of flight lines flown against the total number of flight lines .
- Monitor the strength of the communication link .
- Monitor the number of usable satellites 
 - No signal: No GPS lock (0–3 satellites)
 - 1 signal line: 4–6 satellites
 - 2 signal lines: 7 or more satellites
- Monitor that the number of eBox feedback events increases as expected .
- Monitor the wind speed and direction measured by the eBox .
- Compare the actual airspeed with the desired airspeed , which is 85 kph (53 mph) during cruise flight. The actual airspeed can be higher than the desired speed when the UX5 HP is coping with a high head wind. The maximum airspeed is 90 kph (56 mph).
- Monitor the ground speed .

- Monitor the distance between the GCS and the aircraft, projected perpendicular onto the GCS reference plane, and the azimuth from the GCS to the aircraft .
- Compare the actual flight height \bar{I} with the desired flight height set during block and flight planning.
- Monitor the pitch and roll of the rover using the artificial horizon.
- Monitor the software for in-flight warnings and errors such as loss of GPS lock and loss of communication link. For more information on these warnings and the appropriate action to take, see [Failsafes during flight, page 93](#) and [System errors and warnings, page 110](#).

Dealing with sudden weather changes during flight

On the day of the flight, check that the current weather conditions are suitable for flight.

Note – Pay particular attention to the prevailing wind direction and speed. If the wind direction changes during the flight, change the landing heading in flight or select an alternative landing location, if it is more suited. See [Changing the landing properties during flight, page 92](#).

Land the rover as quickly as possible if one of the following weather phenomena occurs during the flight:

- Strong wind
- Heavy rain, hail
- Hurricane, tornado, or any kind of whirlwind
- Thunder and lightening
- Snow

Changing the landing properties during flight

If conditions change during the flight, it may be advisable to alter the landing parameters set in the flight plan while the rover is still in flight.

Note – Once you confirm the landing, you cannot change the landing parameters.

To change the landing parameters during flight:

1. Select the *Flights* tab. The *Flights* tab shows the landing properties for the flight.
2. Depending on the situation, do one of the following:
 - If the wind direction has changed and the landing clearances are not jeopardized, rotate the landing heading of the current landing accordingly.
 - If there is a sudden obstacle in the clearance zone of the current landing and you have defined an alternative landing location that is clear from obstacles, tap the landing pin on the map or select the radio button beside the landing location in the list to use this location. Adapt the landing heading according to the actual wind direction.

For more information, see [Obstacle clearances, page 35](#).

Note – For the current and any alternative landing setup, it is possible to change any other parameters. However, this requires more effort and time which you may not have. Make sure that if you change the landing location, the location is GPS fixed.

3. Tap to  accept the changes.
4. Select the *Dashboard* tab  to return to the monitoring screen.

Failsafes during flight

The following failsafe mechanisms activate when a technical issue occurs that reduces the safe behavior of the rover:

- [Loss of GPS lock during flight, page 93](#)
- [Loss of communication link during flight, page 93](#)
- [Low battery and loss of communication for more than 30 seconds, page 93](#)
- [Overspeed protection, page 94](#)
- [Geofence, page 94](#)

Loss of GPS lock during flight

If the rover does not receive GPS communications for a period of 4 seconds, then a notification appears on the tablet, and the following automatic failsafe mechanism is activated:

1. The rover banks at an angle of 25° while orbiting at its current location for 20 seconds. If the rover successfully reacquires GPS lock, then it flies to the specified landing location and begins a normal landing sequence.
2. If the rover is unable to reacquire GPS lock, then it activates the Flight Termination System (FTS).
During FTS:
 - a. The motor powers down and the speed lowers to 70 kph (43 mph).
 - b. The rover orbits down in 200 m (656 ft) diameter circles until it reaches a height of 10 m (33 ft).
Note – *During FTS without GPS lock, the rover attempts to circle but the outcome is elliptical circles as the rover is subject to wind drift.*
 - c. The rover levels its wings, slows, and glides to the ground.

Loss of communication link during flight

If the rover does not receive a communication packet for the time specified in the *Communication timeout* field in the *Autopilot settings* group of the *Settings* screen, or if the communication link is poor and communication packets are being received intermittently, then from the moment that communication is lost, a message appears on the tablet showing a timer counting down. The initial value of the timer is the communication timeout value. When the timer reaches 0, the rover flies to the specified landing location and begins a normal landing sequence.

 **WARNING** – When communication is lost, the dashboard does not receive any updates from the rover and all interaction with the rover is disabled. Make sure you have clear visual contact with the rover.

Unlike a normal landing, you are not prompted to confirm landing before the final leg of the landing. If communication resumes during this automatic failsafe, the rover continues the landing sequence.

Low battery and loss of communication for more than 30 seconds

If the rover battery life is less than 15% and the communication is lost for more than 30 seconds, then the rover flies to the specified landing location and begins a normal landing sequence.

 **WARNING** – When communication is lost, the dashboard does not receive any updates from the rover and all interaction with the rover is disabled. Make sure you have clear visual contact with the rover.

Unlike a normal landing, you are not prompted to confirm landing before the final leg of the landing. If communication resumes during this automatic failsafe, the rover continues the landing sequence.

Overspeed protection

If the rover detects a steep and fast decline, it will maximize drag to minimize the impact on the ground. The aircraft will descend in a "flat-spin"-like flight trajectory.

Geofence

If the rover reaches a geofence boundary, it activates the HERE pattern (see [Emergency software commands, page 94](#)) and returns to the vicinity of the GCS location.

The use of a geofence boundary is optional and can be set in the *Flight Settings* screen. For more information, see [Managing flight settings, page 40](#).

Emergency software commands

The *Dashboard* tab of the Aerial Imaging software provides several buttons for taking emergency action when the rover is in flight.

Note –

- *Tapping any button in this screen overrides any previous command, including any previous button press in this screen. If you initiate an emergency command and then initiate a second emergency command before the first command is completed, the rover immediately terminates the first command without completing it and begins the second command.*
- *The only button available when the rover is below 50 m (164 ft) during takeoff is .*

Land

Use the  button when the flight must be terminated and there is time and space for a pre-planned landing.

When you tap , the rover immediately terminates its flight plan and initiates a normal landing sequence. It flies at the desired flight height to the entry point which is located 300 m (984 ft) from the landing location. If the *Land* command is initiated during the transition between blocks which are at different heights, the **desired flight height** is the height of the next block. If the flight height of the next block is:

- **lower** than the previous block, the aircraft flies to the landing entry point while **descending**.
- **higher** than the previous block, the aircraft flies to the landing entry point while **ascending**.

When the aircraft has reached the landing entry point but is not yet at a height of 75 m (246 ft) + the landing offset, it starts circling downward in 200 m (656 ft) diameter circles until it reaches a height of 75 m (246 ft) + the landing offset. The aircraft then orbits until you do one of the following:

- To complete the landing, tap  in the message box on the map. The aircraft finishes circling when all landing conditions are met and then it starts the final leg of the landing.

- To release the *Land* command, tap the  button again. The aircraft returns to the start of the flight line it was on when the flight plan was interrupted, and resumes mapping when it reaches the point that mapping paused.

Fly to

Use the  button to move the rover from its current position to a location you choose.

To enable the  button, tap the location on the map that you want the rover to move to. When you tap , the rover flies to the specified location and then orbits there at the desired flight height in 200 m (656 ft) diameter circles. Mapping is paused. If the *Fly to* command is initiated during the transition between blocks which are at different heights, the **desired flight height** is the height of the next block. If the flight height of the next block is:

- **lower** than the previous block, the aircraft flies to the specified location while **descending**. If the desired height is not yet reached at the specified location, the aircraft circles downward until the desired height is reached.
- **higher** than the previous block, the aircraft flies to the specified location while **ascending**. If the desired height is not yet reached at the specified location, the aircraft circles upward until the desired height is reached.

When in the *Fly to* pattern, you can adjust the rover's desired flight height by 10 m (32 ft) up or down, if required. The software does not allow the height to be set lower than 75 m (246 ft) or higher than 750 m (2460 ft).

To release the *Fly to* command, tap the  button again. The rover returns to the desired flight height it was at before the *Fly to* pattern began. It flies to the previous waypoint and resumes mapping when it reaches the point that mapping paused.

Note – If you tap the map again while the rover is in the *Fly to* pattern, tap  in the message box on the map to fly to the new location on the map.

Hold

Use the  button when another aircraft in the vicinity is observed.

When you tap , the rover begins orbiting its current location at the desired flight height in 200 m (656 ft) diameter circles. Mapping is paused. If the *Hold* command is initiated during the transition between blocks which are at different heights, the **desired flight height** is the height of the next block. If the flight height of the next block is:

- **lower** than the previous block, the aircraft circles downward until it reaches the height of the next block.
- **higher** than the previous block, the aircraft circles upward until it reaches the height of the next block.

When in the *Hold* pattern, you can adjust the rover's height by 10 m (32 ft) up  or down , if required. The software does not allow the height to be set lower than 75 m (246 ft) or higher than 750 m (2460 ft).

To release the *Hold* command, tap the  button again. The rover returns to the desired flight height it was at before the *Hold* pattern began. It flies to the previous waypoint and resumes mapping when it reaches the point that mapping paused.

Here

Use the  button when the rover must be removed from the general area of mapping and you want to have it within close sight.

When you tap , the rover immediately flies to the location of the ground control station (GCS) and orbits there at the desired flight height in 200 m (656 ft) diameter circles. Mapping is paused. If the *Here* command is initiated during the transition between blocks which are at different heights, the **desired flight height** is the height of the next block. If the flight height of the next block is:

- **lower** than the previous block, the aircraft flies to the GCS location while **descending**. If the desired height is not yet reached at the GCS location, the aircraft circles downward until the desired height is reached.
- **higher** than the previous block, the aircraft flies to the GCS location while **ascending**. If the desired height is not yet reached at the GCS location, the aircraft circles upward until the desired height is reached.

When in the *Here* pattern, you can adjust the rover's height by 10 m (32 ft) up or down, if required. The software does not allow the height to be set lower than 75 m (246 ft) or higher than 750 m (2460 ft).

To release the *Here* command, tap the  button again. The rover returns to the desired flight height it was at before the *Here* pattern began. It flies to the previous waypoint and resumes mapping when it reaches the point that mapping paused.

Right

Use the  button when you want to move the rover rightward from its current position but have it close to its current location.

When you tap , the rover flies 300 m (984 ft) to the right of the current heading and then orbits there at the desired flight height in 200 m (656 ft) diameter circles. Mapping is paused. If the *Right* command is initiated during the transition between blocks which are at different heights, the **desired flight height** is the height of the next block. If the flight height of the next block is:

- **lower** than the previous block, the aircraft flies to the right while **descending**. If the desired height is not yet reached at the orbit location, the aircraft circles downward until the desired height is reached.
- **higher** than the previous block, the aircraft flies to the right while **ascending**. If the desired height is not yet reached at the orbit location, the aircraft circles upward until the desired height is reached.

When in the *Right* pattern, you can adjust the rover's height by 10 m (32 ft) up or down, if required. The software does not allow the height to be set lower than 75 m (246 ft) or higher than 750 m (2460 ft).

To release the *Right* command, tap the  button again. The rover returns to the desired flight height it was at before the *Right* pattern began. It flies to the previous waypoint and resumes mapping when it reaches the point that mapping paused.

FTS

Activate the Flight Termination System (FTS) when the rover must be removed from the air as quickly as possible. The  button can be used during takeoff, cruise flight, and landing.

To activate the FTS, tap  and if prompted, confirm FTS activation in the message box on the map.

Note –

- If you do not tap  in the message box, the rover continues the flight.
- Confirmation is always required, except during takeoff when the rover is still below 25 m (82 ft).

The rover immediately aborts the flight. During cruise flight, this involves:

1. The motor powers down and the speed lowers to 70 kph (43 mph).
2. The rover orbits down in 200 m (656 ft) diameter circles until it reaches a height of 10 m (33 ft).
3. The rover levels its wings, slows, and glides to the ground.

If you activate FTS when the rover is at a height of less than 25 m (82 ft) – that is, during takeoff or landing – then the rover slows to 60 kph (37 mph) and flies downward in a straight line at the current heading until it glides to the ground.

Abort

Note – The  button is available only during the final leg of the landing when the aircraft is more than 15 m (49 ft) above ground. Make sure you consider the obstacle clearances for the Abort manoeuvre before you tap . For more information, see [Obstacle clearances, page 35](#).

Use the  button to abort the landing.

When you tap , the rover climbs to 75 m (246 ft) in the direction of the landing heading and then turns to the landing entry point to start the landing circuit again.

To land you must tap  in the message box on the map again.

Handling emergencies during flight

If evasive action is required, you can manually interrupt the pre-programmed flight plan while the rover is in the air.

For all emergencies, you must assess the situation before taking action. Take into account the takeoff location, the current location, course, and speed of the rover.

Note – If the situation is **too critical** (for example, fast moving aircraft) tap  and when prompted confirm Flight Termination System (FTS) activation to **immediately abort the flight** and put the rover in an orbit toward the ground.

An approaching aircraft

The most common emergencies involve another aircraft entering the vicinity at approximately the same height as the rover.

Scenario	Action
The approaching aircraft will not cross the flight path of the rover.	<ol style="list-style-type: none"> 1. Assess the situation. 2. Tap , , , or  to move the rover to a safe position.
The flight path of the approaching aircraft and the rover are converging .	<ol style="list-style-type: none"> 1. Assess the situation. 2. Tap  to move the rover to a safe position.
The flight path of the approaching aircraft is diverging from the flight path of the rover.	<ol style="list-style-type: none"> 1. Assess the situation. 2. Tap , , or  to move the rover to a safe position.
The flight path of the approaching aircraft is intercepting the flight path of the rover.	<ol style="list-style-type: none"> 1. Assess the situation. 2. Tap  to move the rover to a safe position. (An aircraft intending to overtake an aircraft in front of them overtakes that plane on the right side.)
The approaching aircraft is approaching the rover head-on .	<ol style="list-style-type: none"> 1. Assess the situation. 2. Tap  to move the rover to a safe position.
The approaching aircraft intends to land.	A landing aircraft has priority over an rover at all times. Never assume that the aircraft has noticed the rover. Take the necessary safety measures depending on the situation.

When the other aircraft has left the vicinity, tap the emergency button again to cancel the pattern and continue mapping.

Occasionally other objects such as birds enter the zone of operation. Assess the situation and try to avoid collisions using the methods described above. If a collision does occur, immediately tap  in the Aerial Imaging software and if prompted, confirm FTS activation to abort the flight. Once the rover has landed, carefully check equipment for damage.

Other types of emergency

In case of other types of emergency, take the recommended action.

Scenario	Action
<p>Engine failure is rare but may occur. The following parameters in the Aerial Imaging software indicate engine failure:</p> <ul style="list-style-type: none"> • Altimeter decreases • Battery voltage increases • Throttle percentage increases until 100% 	<ol style="list-style-type: none"> 1. Assess the situation. 2. Tap  to immediately terminate the flight. <p>If no button is tapped, the rover glides downward, following the flight plan.</p>
<p>Aerial Imaging software freezes or crashes on the GCS when the rover is in the air.</p>	<p>Immediately restart the software. If you are unable to restart the software, restart the GCS and then restart the Aerial Imaging software.</p> <p>After restarting the software:</p> <ol style="list-style-type: none"> 1. The software detects if the rover is in the air and a message asks if you want to connect to the rover and continue the flight. 2. Tap  to confirm. <p>The Aerial Imaging software downloads the existing flight plan from the eBox. If the download is successful, the <i>Dashboard</i> screen appears and enables you to continue the flight.</p> <p>If the download was not successful:</p> <ol style="list-style-type: none"> a. Go to the <i>Projects</i> screen and open the project for the flight in progress. b. In the <i>Flights</i> tab, select the flight in progress. c. Select the <i>Flight checklist</i> tab. <p>When the connection to the autopilot is successful, the Aerial Imaging software downloads the existing flight plan from the eBox, goes to the <i>Dashboard</i> screen and enables you to continue the flight.</p>

For more information, see [Emergency software commands, page 94](#)

Dealing with a crash

A crash is an accident associated with the operation of an aircraft in which:

- a person is fatally or seriously injured
- the aircraft sustains damage or structural failure
- the aircraft is missing or completely inaccessible

Note – A landing on the intended landing site that causes damage to the aircraft due to the landing surface cannot be seen as a crash.

4 Completing a Flight

1. If a crash occurs which causes injuries or death, you must:
 - a. Contact the emergency services.
 - b. Help where necessary, without risking your own life.
 - c. Make a perimeter around the accident. Make sure no evidence disappears.
 - d. Notify your civil aviation authority (CAA).
2. If a crash occurs which causes damage to another object:
 - a. Contact the emergency services when necessary (for example, if gas, electricity, or water supplies are affected).
 - b. Contact the owners of the object that is hit.
 - c. Notify your civil aviation authority.
3. Take pictures of the crash site. Download the data files from the GCS and send all data and pictures to your Trimble distributor.

Landing the rover

 **WARNING** – Make sure there are no people or obstacles near the landing zone. Failure to do so could result in serious personal injury and damage to the rover.

 **CAUTION** – It is your responsibility to ensure the safety of the rover during landing. To do this you must:

- Have visual contact with the rover at all times.
- Observe the zone of operation for the rover and look out for other aerial objects.
- Ensure obstacle clearance.
- Locate the rover on the tablet screen.

By default, the rover lands automatically.

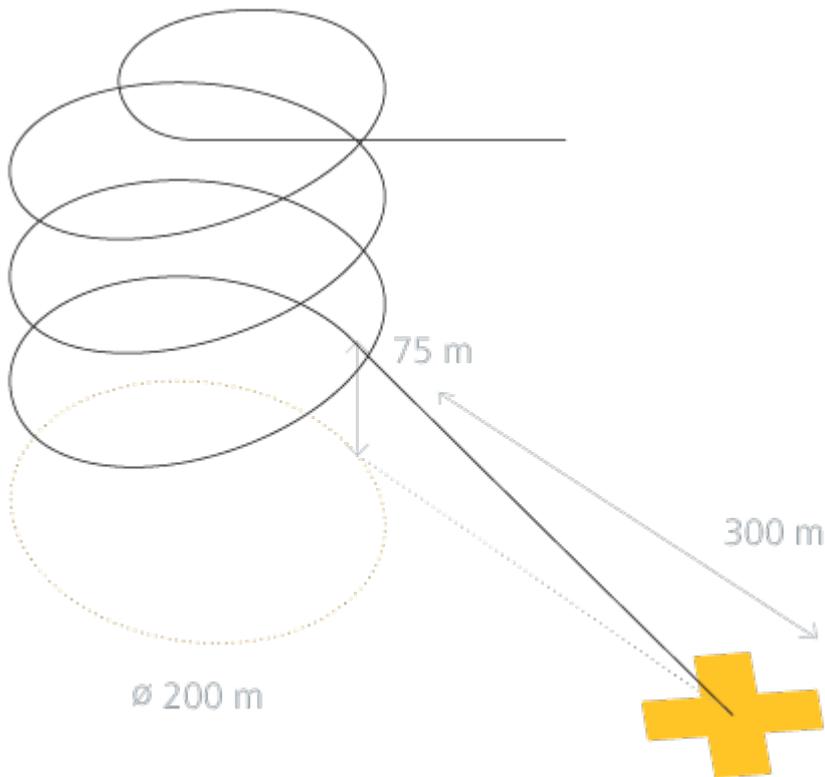
After passing the last waypoint on the scan lines, the rover terminates its flight plan and initiates a normal landing sequence. It flies at cruise height to the entry point which is located 300 m (984 ft) from the landing location. It starts circling downward in 200 m (656 ft) diameter circles until it reaches a height of 75 m (246 ft). It keeps circling in left or right circles, depending on the direction specified in the Aerial Imaging software, until you tap ✓ in the message box on the map.

1. To complete the landing, tap ✓ in the message box on the map.

The rover finishes its current circle until it reaches the intersection with the landing direction and then it starts the final leg of the landing.

4 Completing a Flight

The image below shows the linear landing circuit using a landing orientation set to right turns.



2. After the rover has successfully landed, tap . The eBox goes into standby mode.

Locating the rover after landing

As long as you do not start the post-flight checklist after the flight has finished, the map and the status bar still show the rover position, which can help you to locate the rover.

If the rover has landed somewhere in the field and you are not able to visually locate it, you can track it using the tracking system receiver.

1. On the receiver, press and hold the **On/Off** key for three seconds to power on the receiver.
2. Press the **Menu/OK** key to enter the menu.
3. Select the transmitter you want to track down using the **Scan** key and then press the **Menu/OK** key to confirm.
4. Fold out the four antennas on the receiver and then place the receiver on the palm of your hand, taking care not to touch any of the antennas.
5. Increase the gain as much as possible using the **Increase** key.
6. To pick up the first signal pulses, hold the receiver in front of you at high level and slowly turn 360°, scanning the horizon with the antenna.

Tip – Make sure the internal antenna is selected. The range of the receiver is wider if you track from an elevation. Always hold the receiver in front of you so that the receiver can distinguish between incoming signals from the front and the back.

Each received signal pulse and its strength are shown on the transmitter bar/received signal strength indicator and indicated with an audible signal.

7. Scan the area to determine the direction with the highest signal strength. If the signal strength is the same in all directions, reduce the gain using the **Decrease** key until the received signal strength is half the transmitter bar and then repeat the scan.
8. Follow the determined direction. Repeat the scan at intervals to verify the direction you need to head in to locate the rover.

Note – If you experience difficulties finding the rover following one direction, try doing the scan from a different location and locating the cross-section between the new and previously found direction.

For more information on using the tracker system, refer to the user documentation for the tracker transmitter and receiver.

Completing the post-flight checklist

Complete the post-flight checklist to validate the data collected during the flight.

1. After the rover has successfully landed, tap . The eBox goes into standby mode (red LED is flashing). If for some reason (such as communication loss), the eBox is not in standby mode, press the mode button for 3 flashes.

 **WARNING** – Do not pick up the rover when the eBox is not in standby mode. When the eBox is not in standby mode the motor can unexpectedly start, causing the propeller blades to move. Contact with moving propeller blades can result in serious personal injury.

2. Tap . The post-flight checklist wizard appears.
3. Make sure that the battery is connected. Tap .
4. Download the log files from the eBox:
 - a. Remove the download port cap from the eBox and then attach the download cable to the eBox and the modem.
 - b. Tap  to check the cable connection.
If the cable connection is OK, the software automatically starts downloading log files from the eBox to the tablet. When the download is finished, the  button is enabled.
5. Tap .
6. Download the log files from the gBox:
 - a. Attach the USB download cable to the gBox and the tablet.
 - b. Tap  to check the cable connection.
If the cable connection is OK, the software automatically starts downloading log files from the gBox to the tablet. When the download is finished, the  button is enabled.

7. Tap .
 8. Remove the download cables:
 - a. Remove the download cable from the eBox and modem. Reattach the download port cap to the eBox.
 - b. Disconnect the USB cable from the gBox and the tablet.
 9. Tap .
 10. Disconnect the battery. Tap .
 11. If you have selected PPK as the operating mode in the flight checklist, you are prompted to download the base station file. Tap .
 12. Remove the camera from the rover. Verify that the number of images taken during the flight is equal to the number of trigger commands and feedback events recorded in the flight logs (do not take into account the test images taken on the ground; Trimble recommends deleting the test images from the SD card). If these numbers do not correspond, the software can automatically correct for a mismatch. For more information, see [Exporting flight data for processing, page 107](#).
- Note –**
- *If there are more than three images missing or more than three additional images (excluding test images or images from another flight), Trimble recommends performing the flight again.*
 - *If the missing images are not due to obvious reasons such as a depleted camera battery during flight, an SD card with incorrect specifications (see [Locating your equipment, page 72](#)), or incorrect camera settings, contact your Trimble distributor.*
13. Validate the block(s) that were successfully mapped during the flight.
 14. Tap  to close the post-flight checklist and return to the *Flights* tab .

After completing the post-flight checklist, the status of the flight changes to  *Flown, log files downloaded and settings frozen*.

To redo this flight, make a copy of the flight. The settings of the new flight are editable.

In the *Blocks* tab , one of the following icons appears next to the block name in the block list:

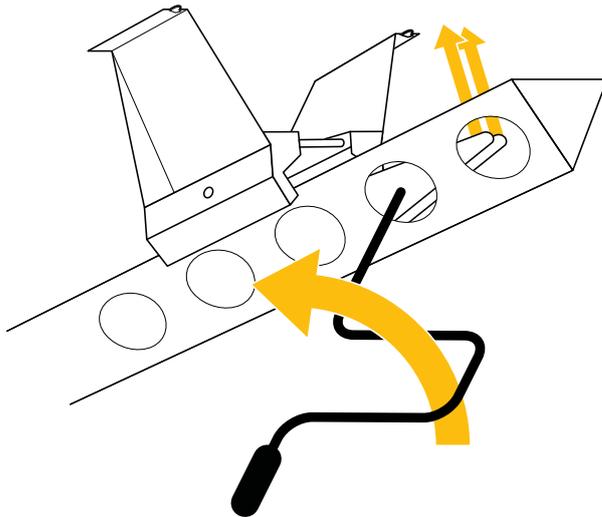
-  *Successfully mapped and settings frozen.*
-  *Not successfully mapped and settings frozen.*

A frozen block can still be scheduled in other flights. It will be flown again with the same settings. To map the block with different settings, make a copy of the block and change the settings as required.

Disassembling the launcher

1. If you have not yet released the tension on the launcher cord, then do so now.

To release the tension, release the force with the crank very gently while pulling the release handles in the front of the launcher upward. This is safest done with two people, with one person carefully winding the crank counter-clockwise to counteract the force on the elastics.



2. Remove the lock pin on the launch dock and detach the launcher cord.
3. Using the crank, tighten the launcher cord so that most of the cord is in the launch slide but the end remains out. Remove the crank.
4. Slide the launch dock off the front of the launch slide.
5. To detach the V-support, turn the knob upward and then slide the pins out of the holes in the launch slide. Remove the lock pin on the V-support to fold the legs and then reinsert the lock pin.



CAUTION – Take care when folding the V-support legs not to jam or cut fingers.

6. Open the handle fixes on the launch slide and fold the launch slide.
7. Return the following items to the launcher bag:
 - safety pin
 - launch dock with lock pin
 - V-support
 - crank
 - launch slide with elastics

For more information, see [Locating your equipment, page 72](#).

Analysis and Export

- Transferring the images
- Returning the project to the Aerial Imaging Desktop software
- Exporting flight data for processing
- Exporting the flight trajectory for analysis

Transferring the images

Note – If you already transferred the images from the camera to an external storage device in the field, then transfer the images from that device to a location on the computer running the Aerial Imaging Desktop software, or to a network location.

If you have not already transferred the images from the camera:

1. When you return to the office, remove the SD card from the camera.
2. Insert the SD card into an office computer and then transfer the images from the SD card to a location on the computer or a network location.
3. Delete the images from the SD card.
4. Replace the SD card in the camera.

Note – Because the Sony camera has no electronic communication with the external lens, the properties for images captured using a Sony camera (exif data) show a value 0 (zero) for the properties linked to the lens. These properties are: F-stop, focal length and max. aperture.

Returning the project to the Aerial Imaging Desktop software

Although you can use the Aerial Imaging software on the tablet to analyze and export the flight data for processing, it will typically be done in the office using the Aerial Imaging Desktop software. To be able to do this you must export the project from the Aerial Imaging software on the tablet and import it to the Aerial Imaging Desktop software.

To export the project from the Aerial Imaging software on the tablet:

1. In the *Projects* screen, select the project to export.
2. Click . The *Export* wizard appears.
3. Select the GWT format. Tap .
4. Navigate to the folder where you want to save the project. If the tablet cannot access a network folder, then insert a USB stick and then navigate to a folder on the USB stick.
5. Enter the file name and then click **Export**.
The exported project is saved as a GWT file in the folder you selected.
6. Tap  to close the *Export* wizard.

To import the project to the Aerial Imaging Desktop software:

1. Start the Aerial Imaging Desktop software.
2. In the *Aerial Imaging Home* screen or *Projects* screen, click .
3. Navigate to the location of the GWT file, select it and then click **Import**.

The project you imported is listed in the *Projects* screen and the project thumbnail appears.

Exporting flight data for processing

You can export flight data from the Aerial Imaging Desktop software, or from the Aerial Imaging software on the tablet, if you have copied the images to the tablet.

1. In the *Projects* screen, select the project to export flight data from.
2. Click . The *Export* wizard appears.
3. Select the format to export to. To process the flight data using:
 - Trimble Business Center software, select the JXL option.
 - Other processing software, select the CSV/TXT option.
4. Click .
5. Select the flight to export and click .

The summary shows:

- the number of camera triggers
- the number of shutter feedback events recorded in the gBox

If these numbers do not correspond and you continue the export, the software automatically corrects for the mismatch.

6. Click  to select the folder where you have stored the images for the flight.

The summary shows:

- the number of camera triggers
- the number of shutter feedback events recorded in the gBox
- the number of images in the selected image folder

If these numbers do not correspond and you continue the export, the software automatically corrects for the mismatch.

- the type of images (RGB or NIR)
RGB is selected by default. To change the image type, select the NIR option.
- whether to correct images for vignetting

The option to correct for vignetting is selected by default if flight conditions were such that Trimble strongly recommends correcting for vignetting.

Note –

- *If there are more than three images missing or more than three additional images (excluding test images or images from another flight), Trimble recommends performing the flight again.*
- *If the missing images are not due to obvious reasons such as a depleted camera battery during flight, an SD card with incorrect specifications (see [Locating your equipment, page 72](#)), or incorrect camera settings, contact your Trimble distributor.*
- *Correcting images for vignetting is resource-intensive and could take several hours depending on the number of pictures.*

7. Click .
8. If you have chosen to correct images for vignetting, you are prompted to select the folder where the

corrected images will be saved.

Once the folder is selected and confirmed, the correction starts. When the correction is finished, click  and continue with step 9.

9. Navigate to the folder where you want to save the exported file. Enter the file name and then click **Export**.
10. Click  to export another flight from the same project or click  to close the *Export* wizard.

Exporting the flight trajectory for analysis

1. In the *Projects* screen, select the project to export flight data from.
2. Click . The *Export* wizard appears.
3. Select the output format:
 - *KML, Keyhole Markup Language* to view the flight path.
 - *GPX, GPS Exchange Format* to view the flight path and way points.

Both outputs can be viewed in software such as in Google Earth.

4. Click .
5. Select the flight to export and click .
6. Navigate to the folder where you want to save the exported file. Enter the file name and then click **Export**.

The flight trajectory is exported to the selected folder.
7. Click  to export another flight from the same project or click  to close the *Export* wizard.

Troubleshooting

- System errors and warnings
- Landing issues
- Aerial Imaging software issues
- Battery charger errors
- eBox LED status
- gBox LED status
- Technical support

System errors and warnings

This topic describes error messages or warnings that may appear pre-flight or during flight. If the problem persists, contact your Trimble distributor.

Unable to arm the system

The system will not allow you to arm if the following errors are reported:

Error	To clear the error...
The eBox is not in the correct state.	Cancel the checklist. Disconnect the battery from the rover and redo the checklist.
The rover battery life is less than 35%.	Restart the checklist with a fully charged battery.
The takeoff sensor is not OK (this means that the yaw, pitch, and roll values are not yet stabilized).	If the issue does not resolve itself, cancel the checklist. Disconnect the battery from the rover and restart the checklist.
The takeoff status is not OK.	Cancel the checklist. Disconnect the battery from the rover and redo the checklist.
eBox logging has not started.	If the issue does not resolve itself, cancel the checklist. Disconnect the battery from the rover and redo the checklist.
The GCS has no GPS connection.	If the issue does not resolve itself, cancel the checklist. Disconnect the battery from the rover and redo the checklist.
The number of satellites is less than 4.	If the issue does not resolve itself, cancel the checklist. Disconnect the battery from the rover and redo the checklist.
The flight plan contains a waypoint located outside the geofence.	Verify the geofence. If this does not resolve the issue, cancel the checklist. Disconnect the battery from the rover and redo the checklist.

Low battery level

The battery level is checked	If the battery level is...
Pre-flight, when connecting with the autopilot	Less than 90%, an error message appears and you cannot continue the checklist until you replace the battery with a fully charged battery. Then you must redo the flight checklist.
Pre-flight, at ARM	<ul style="list-style-type: none"> Less than 35%, an error message appears and you cannot arm the system and continue the checklist until you replace the battery with a fully charged battery. (See Unable to arm the system, page 110.) Between 35% and 75%, a warning message appears. It is possible to arm the system but Trimble recommends replacing the battery with a fully charged battery and restarting the checklist.
Pre-flight, after ARM	<p>Less than 15%, the low battery icon on the <i>Dashboard</i> turns red . You must take the following action:</p> <ol style="list-style-type: none"> Tap  and then tap  to disarm the rover. The rover should be in standby mode. If it is not, disarm the rover by pressing the Mode button three times (three flashes) taking care to avoid the propellers. Tap  and complete the post-flight checklist. Replace the battery with a fully charged battery and then redo the flight checklist.
In-flight	<p>Less than 15%, a warning message appears. If the landing location is not too far from the location of the rover and the battery level is not too low, tap the  button. Otherwise, tap .</p> <hr/> <p> WARNING – You must take <i>immediate action</i> if you see this warning. Failure to land the rover in time and the battery runs out, the motors will shut down. The rover continues to control its flight but will rapidly lose height and eventually hit the ground at high speed.</p> <hr/>

Loss of GPS lock

If the message appears	Then...
Pre-flight, before ARM	You will not be able to ARM the rover. If the issue does not resolve itself, cancel the checklist. Disconnect the battery from the rover and redo the checklist. (See Unable to arm the system, page 110.)
Pre-flight, after ARM	<p>If the number of satellites is less than 4, the satellite icon on the <i>Dashboard</i> changes to .</p> <p>Make sure the GPS antenna has a clear view of the sky.</p> <p>If the issue persists:</p> <ol style="list-style-type: none"> 1. Tap  and then tap  to disarm the rover. The rover should be in standby mode. If it is not, disarm the rover by pressing the Mode button three times (three flashes) taking care to avoid the propellers. 2. Tap  and complete the post-flight checklist. 3. Disconnect the battery from the rover and then redo the flight checklist.
In-flight	The automatic failsafe mechanism is activated. See Failsafes during flight, page 93.

Communication loss

If the message appears	Then...
Pre-flight, before ARM	<p>There will be communication issues at checklist steps that required communication between the modem and the eBox. To resolve these issues:</p> <ol style="list-style-type: none"> 1. Make sure that the RF antennas are well connected and the communication link is not obstructed. 2. If the issue does not resolve itself, cancel the checklist. Disconnect the battery from the rover and redo the checklist.
Pre-flight, after ARM	<p>Do the following:</p> <ol style="list-style-type: none"> 1. Press the Mode button three times (three flashes) to disarm the rover. Take care to avoid the propellers. 2. Tap  and complete the post-flight checklist. 3. Make sure that the RF antennas are well connected and the communication link is not obstructed. 4. Disconnect the battery from the rover and then redo the flight checklist.
In-flight	The automatic failsafe mechanism is activated. See Failsafes during flight,

If the message appears	Then...
	page 93.

Camera errors

Issue	Solution
The camera is taking a picture every 20 to 25 seconds.	<ol style="list-style-type: none"> 1. Cancel the checklist. 2. Disconnect the rover battery. 3. Restart the checklist.

Autopilot errors

The appropriate action to take depends on the stage of the flight that the error occurs. For more information, see [Taking action when an Autopilot error occurs, page 116.](#)

Autopilot error message types

The table below explains the types of autopilot error that can occur.

Code	Description
2	There is an airspeed sensor hardware problem.
3	There is an autopilot configuration problem.
4	There is an autopilot configuration problem.
9	There is a pitch gyro sensor hardware problem.
11	There is a roll gyro sensor hardware problem.
13	There is a yaw gyro sensor hardware problem.
16	There is an autopilot configuration problem.
17	There is an invalid command in the flight plan.
18	There is an autopilot configuration problem.
19	There is an autopilot configuration problem.
20	There is an autopilot configuration problem.
21	There is an autopilot configuration problem.
22	There is a gyro sensor hardware problem.
23	There is an accelerometer sensor hardware problem.
25	The aircraft has flown past the 300 km limit.
26	The flight plan contains a waypoint that is outside of the geofence; or the aircraft has flown outside of the geofence.

Code	Description
35	There is an autopilot configuration problem.
36	There is a gyro sensor hardware problem.
37	There is an autopilot configuration problem.
38	There is an autopilot configuration problem.
39	There is an autopilot configuration problem.
40	There is an autopilot configuration problem.
41	There is an autopilot configuration problem.
42	There is an autopilot configuration problem.
43	There is an autopilot configuration problem.
44	There is an autopilot configuration problem.
45	There is an autopilot configuration problem.
46	The flight plan contains a waypoint that exceeds the maximum allowed distance from the takeoff location.
47	The aircraft is close to the 300 km limit.
49	There is an autopilot configuration problem.
50	There is an autopilot configuration problem.
51	There is an autopilot configuration problem.
52	There is a GPS receiver hardware problem.
53	There is an autopilot configuration problem.
55	There is an autopilot configuration problem.
56	There is an autopilot hardware problem.
57	There is an autopilot hardware problem.
58	There is an accelerometer sensor hardware problem.
59	There is a GPS receiver hardware problem.
60	There is an autopilot configuration problem.
61	There is an airspeed sensor hardware problem.
63	There is an autopilot configuration problem.
64	There is an autopilot configuration problem.
65	There is an autopilot configuration problem.
66	There is an autopilot configuration problem.
67	There is an autopilot configuration problem.

Code	Description
68	There is an autopilot configuration problem.
69	There is an autopilot hardware problem.
71	There is an accelerometer sensor hardware problem.
72	There are multiple errors.
73	There is an autopilot configuration problem.
74	There is an autopilot configuration problem.
77	There is an autopilot configuration problem.
78	There is an autopilot configuration problem.
79	There is an autopilot configuration problem.
80	There is an accelerometer sensor hardware problem.
81	There is an invalid command in the flight plan.
84	There is an autopilot configuration problem.
85	There is an autopilot configuration problem.
86	The aircraft is above the maximum altitude limit.
87	There is an autopilot configuration problem.
88	The flight plan contains a waypoint that is above the maximum allowed altitude from the takeoff location.
89	The flight plan contains a waypoint that is outside of the geofence.
90	There is a pitch gyro sensor hardware problem.
91	There is a roll gyro sensor hardware problem.
92	There is a yaw gyro sensor hardware problem.
93	There is an accelerometer sensor hardware problem.
94	There is an accelerometer sensor hardware problem.
95	There is an accelerometer sensor hardware problem.
229	There is a pressure sensor hardware problem.
230	There is a memory problem.
231	There is a memory read problem.
232	There is an autopilot configuration problem.
233	There is a current sensor hardware problem.
234	There is a voltage sensor hardware problem.
235	The motor has shut off.

Taking action when an Autopilot error occurs

If the message appears	Then...
Pre-flight, before ARM	You will not be able to ARM the rover. Cancel the checklist. Disconnect the battery from the rover and redo the checklist. (See Unable to arm the system, page 110.)
Pre-flight, after ARM	<p>Do the following:</p> <ol style="list-style-type: none"> 1. Tap  and then tap  to disarm the rover. The rover should be in standby mode. If it is not, disarm the rover by pressing the Mode button three times (three flashes) taking care to avoid the propellers. 2. Tap  and complete the post-flight checklist. 3. Disconnect the battery from the rover and then redo the flight checklist.
In-flight	If the landing location is not too far from the location of the rover and the battery level is not too low, tap  . Otherwise, tap  .

Landing issues

If the rover does not automatically power off the motor after landing, Trimble recommends manually powering off the motor as soon as possible to avoid motor damage. To manually power off the rover, tap the  button in the Aerial Imaging software. If that does not work, press and hold the Mode button on the eBox until the LED flashes **three times**.

 **WARNING** – Always take care to avoid contact with the propeller blades. Contact with moving propeller blades can result in serious personal injury.

Aerial Imaging software issues

If the Aerial Imaging software on the GCS freezes or crashes when the UX5 HP is in the air, see [Handling emergencies during flight, page 97.](#)

If the Aerial Imaging software crashes, a crash dump file is automatically created. You are prompted to select the crash dump location and you can then send the file to Trimble Technical Support.

Battery charger errors

Note – This section is specifically for use with the Graupner Ultramat 14 Plus field charger. To use the office charger, refer to the Graupner Ultramat 16S Office Charger Quick Start Guide.

When charging the rover battery, any errors are displayed in the battery charger screen and accompanied by a warning sound.

The following error messages may appear.

CAR BATT 9.00Vi

This error occurs when the voltage of the battery is below 10.0 VDC or above 18.0 VDC.

If the message appears	Then...
Before charging	Charging cannot be started.
When charging.	The charger stops charging automatically.

WRONG POLARITY

This error occurs when the charge outputs are connected to a battery with incorrect polarity.

The message appears	Then...
Before charging	Charging cannot be started.

CONTACT - BREAK...

This error occurs when the connection between the battery and the charger is interrupted.

If the message appears	Then...
Before charging	Charging cannot be started.
When charging.	The charger stops charging automatically.

BAT. VOLT 00.00Vo

This error occurs when the battery voltage is too high or too low during the charge process.

The message appears	Then...
During charging	The charger stops charging automatically.

OUTPUT CHECK

This error occurs when there is a short-circuit at the charge output.

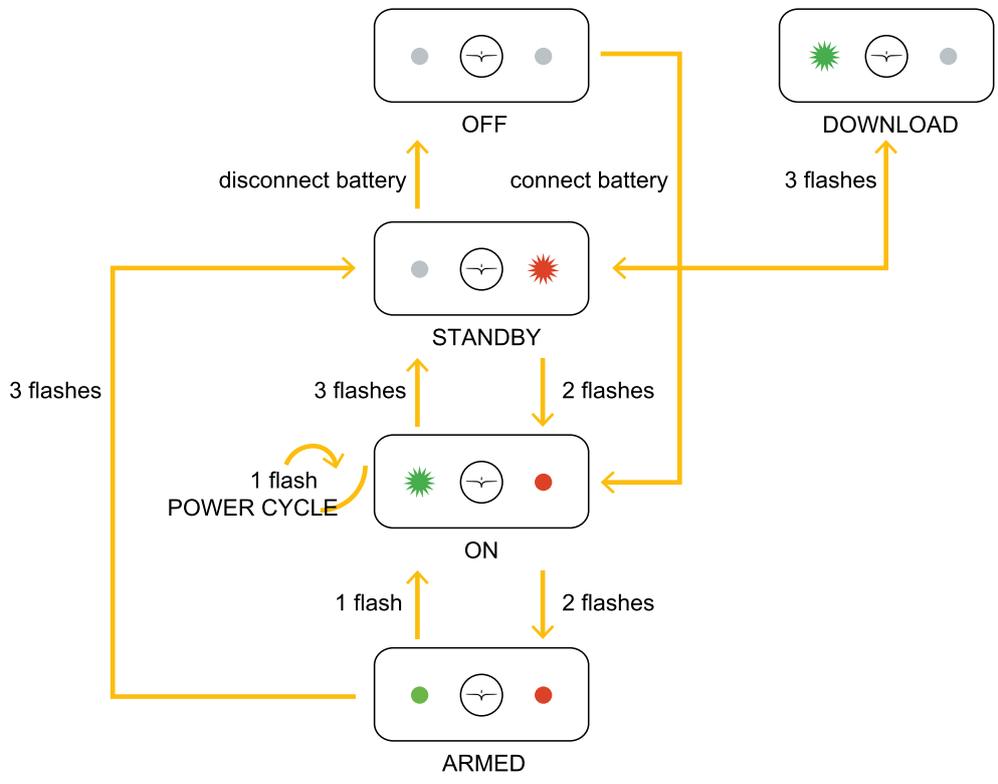
The message appears	To resolve this issue...
During charging	Eliminate the short-circuit and press the Prog/Mode key to return to the charge menu.

eBox LED status

The status of the eBox is indicated by the LEDs:

Green LED	Red LED	Status
Off	Off	eBox is off
Off	Blinking	eBox is in Standby mode
Blinking	Off	eBox is downloading data
Blinking	Steady	eBox is on
Steady	Steady	eBox is armed

The diagram below shows the manual intervention to go from one state to another.



gBox LED status

The status of the gBox is indicated by the LEDs:

LED state	Status
Green LED steady or slowly blinking	gBox is powered on
Orange LED slowly blinking	gBox is locked onto 4 or more satellites
Orange LED fast blinking	gBox is locked onto less than 4 satellites
Orange LED is off	gBox is not locked onto any GPS satellites
Red LED single flash	A trigger command has occurred

Technical support

If you have an issue and cannot find the information you need in the product documentation, contact your Trimble distributor.

Specifications and Settings

- Operation limitations
- UX5 HP specifications
- Launcher specifications
- Camera specifications
- Sony a7R camera settings
- UX5 HP battery safety

Operation limitations

The rover cannot safely fly in all weather conditions. The acceptable range for different conditions is shown below.

Note – Your country of operation may have different or additional operational requirements. Make sure you are familiar with the appropriate regulations for the country you are operating in. If you are flying in the United States see also [FAA conditions and limitations of operation, page 137](#).

 **CAUTION** – If any condition does not meet the acceptable range stated, the operator should abort the flight. Flying outside the acceptable range of conditions will void your Trimble warranty. Trimble does not guarantee good picture quality when flying in conditions beyond these limits.

Condition	Acceptable range
Time	Between sunrise and sunset
Distance from clouds	Clear of clouds and always within line of sight
Flight visibility	5000 m (16400 ft)
Operator-UAS visibility	Visual line of sight
Weather limitations	Light rain is acceptable. Avoid hail, snow, and heavy showers
Head wind (for cruise flight)	Maximum 55 kph (34 mph)
Cross wind:	
<ul style="list-style-type: none"> For takeoff/landing 	Maximum 30 kph (19 mph)
<ul style="list-style-type: none"> For cruise flight 	Maximum 55 kph (34 mph)
Gusts (for cruise flight)	Maximum 15 kph (9 mph)
Turbulence	Avoid turbulence at all times
Temperature:	
<ul style="list-style-type: none"> Rover, including eBox and gBox 	-20 °C to +45 °C (-4 °F to 113 °F)
<ul style="list-style-type: none"> Camera* 	0 °C to +30 °C (32 °F to 86 °F)
<ul style="list-style-type: none"> Battery* 	0 °C to +30 °C (32 °F to 86 °F)
<ul style="list-style-type: none"> Launcher* 	+10 °C to 45 °C (50 °F to 113 °F)
* Pre-flight conditioned temperature	

UX5 HP specifications

Rover

CAUTION – Any deviation leading to a different maximum takeoff weight (MTOW) must be approved by Trimble.

Feature	Specification
Maximum takeoff weight (MTOW)	2.9 kg (6.4 lbs)
Maximum launch altitude (AMSL)	4250 m (13493 ft)
Maximum operational ceiling (AMSL)	5000 m (16400 ft)
Endurance (ISA conditions and no wind)	35 mins
Nominal airspeed	85 kph (52 mph)
Maximum airspeed	95 kph (59 mph)
Dimensions (wing span x length x height)	100 x 65 x 13 cm (39.4 x 25.6 x 5.1 ")

Power/battery

Feature	Specification
Battery type	Lithium polymer
Nominal energy capacity	6600 mAh
Nominal voltage	14.8 V
Maximum voltage	16.8 V
Storage voltage	15.6 V
Battery charging current	3 A
Battery charging time (if fully discharged)	Maximum 2.5 hours
Operating temperature:	
<ul style="list-style-type: none"> Discharge (pre-flight conditioned temperature) 	0 °C to +30 °C 32 °F to 86 °F
<ul style="list-style-type: none"> Charge 	0 °C to +40 °C 32 °F to 104 °F
Storage temperature:	
<ul style="list-style-type: none"> Less than 3 months 	-10 °C to +45 °C 14 °F to 113 °F

Feature	Specification
<ul style="list-style-type: none"> More than 3 months 	Normal room temperature
Dimensions	4.4 x 14 x 4.6 cm (1.7 x 5.5 x 1.8 ")
Weight	570 g (1.3 lbs)

Launcher specifications

Feature	Specification
Weight	10 kg (22 lbs)
Dimensions – folded (length x width x height)	100 x 25 x 12 cm (39.4 x 9.8 x 4.7 ")
Dimensions – unfolded (length x width x height)	300 x 75 x 120 cm (118.1 x 29.5 x 47.2 ")

Camera specifications

The camera has the following specifications.

Camera body

Feature	Specification (Sony a7R)
Effective pixels	36.4 megapixels
Image sensor	Exmor CMOS sensor 35.9 x 24.0 mm (1.41 x 0.94 ")
Shutter speed	1/8000–30 seconds
ISO sensitivity	ISO 100–25600, AUTO (ISO 100–6400)
Display	7.5 cm (3.0 ")
Dimensions (width x height x depth)	126.9 x 94.4 x 48.2 mm (5.0 x 3.7 x 1.9 ")
Weight (body only)	407 g (0.9 lb)
Battery charging time	Approximately 210 minutes (using a Sony charger when battery is fully discharged)

Camera lens

Feature	Specification 15 mm	Specification 25 mm	Specification 35 mm
Focal length	15 mm (0.6 ")	25 mm (1 ")	35 mm (1.4 ")
F-aperture	4.5–22	4–22	2.5–22
Angle of view	110.4°	81.6°	63.3°
Filter size (diameter)	52 mm (2.0 ")	39 mm (1.5 ")	39 mm (1.5 ")
Maximum diameter	59.4 mm (2.3 ")	55 mm (2.2 ")	55 mm (2.2 ")
Length	38.2 mm (1.5 ")	30.3 mm (1.2 ")	23 mm (0.9 ")
Weight	156 g (0.34 lb)	144 g (0.32 lb)	134 g (0.3 lb)

Sony a7R camera settings

Note the following:

- Settings that are greyed out in the camera menus cannot be selected and so are not listed here.
- A value of "-" in the tables below indicates that the value for that setting is not set and is not required.

Mode dial

Shoot Mode

Setting	Value
Shoot Mode	S (Shutter priority)

Menu settings



Camera settings

Setting	Value
1 Image Size	L:36M
Aspect Ratio	3:2
Quality	Fine
File Format (movie)	AVCHD

	Setting	Value
2	Record Setting (movie)	50i 17M (FH)
	Drive Mode	Single Shooting
	Flash Mode	Fill-flash
	Flash Comp.	± 0.0
	Red Eye Reduction	Off
3	Focus Area	Center
	Focus Settings	–
	AF Illuminator	Off
	Exposure Comp.	± 0.0 For the NIR camera: +1.0 with the B+W 040 (orange) filter
	Exposure Step	0.3EV
	ISO	ISO AUTO
4	Metering Mode	Multi
	White Balance	Auto For the NIR camera, use custom brightness/color settings. See Setting brightness/color settings for the NIR camera, page 70
	DRO/Auto-HDR	D-Range Opt.
	Creative Style	Standard
	Picture Effect	Off
5	Focus Magnifier	–
	Long Exposure NR	Off
	High ISO NR	Normal
	Smile/Face Detect.	Off
	Soft Skin Effect	Off
6	Color Space	sRGB
7	Auto Slow Shut. (movie)	Off
	Audio Recording	Off
	Audio Out Timing	Live
	Wind Noise Reduct.	Off
	Memory	–

 **Custom settings**

	Setting	Value
1	Zebra	Off
	MF Assist	Off
	Focus Magnif. Time	No Limit
	Grid Line	Diag. + Square Grid
	Audio Level Display	Off
	Auto Review	Off
2	DISP Button	
	Monitor	Display All Info.
	Finder	Level
	Peaking Level	High
	Peaking Color	Red
	Exposure Set. Guide	Off
	Live View Display	Setting Effect ON
3	Zoom Setting	Optical zoom only
	FINDER/MONITOR	Monitor
	Release w/o Lens	Enable
4	AF w/ shutter	Off
	AEL w/ shutter	Off
	Exp.comp.set	Ambient only
	Reset EV Comp.	Reset
	Bracket order	--> 0 -> +
5	Face Registration	–
	APS-C Size Capture	Off
	AF Micro Adj.	
	AF Adjustment Set.	Off
	Clear	–
	Lens Comp.	
	Shading Comp.	Off
	Chro. Aber. Comp.	Off
Distortion Comp.	Off	

	Setting	Value
6	Function Menu Set.	All items "Not set"
	Custom Key Settings	All items to "Not set", except Focus Magnifier
	Custom Button 2	
	Dial Setup	Front dial: F/no. Rear dial: SS
	Dial EV Comp.	Off
	MOVIE button	Movie Mode Only
	Dial/Wheel Lock	Lock



Wireless

	Setting	Value
1	Airplane Mode	On
2	Edit Device Name	–
	Disp MAC Address	–
	SSID/PW Reset	–
	Reset Network Set.	–



Application

There are no relevant settings set in the *Application* menu.



Playback

	Setting	Value
1	View Mode	–
2	Display Rotation	Off



Setup

	Setting	Value
1	Monitor Brightness	Manual
	Viewfinder Bright.	Manual
	Finder Color Temp.	± 0.0
	Audio signals	Off

	Setting	Value
2	Tile Menu	Off
	Mode Dial Guide	Off
	Delete confirm.	"Cancel" first
	Display Quality	High
	Pwr Save Start Time	30 Min
	PAL/NTSC Selector	–
3	Cleaning Mode	–
	Remote Ctrl	On
	HDMI Resolution	Auto
	CTRL FOR HDML	On
	HDMI Info. Display	On
4	USB Connection	Auto
	USB LUN Setting	Multi
	Language	English
	Date/Time Setup	[set correctly at first use]
	Area Setting	[set correctly at first use]
5	File Number	Series
	New Folder	–
	Folder Name	Date Form
	Recover Image DB	–
6	Display Media Info.	–
	Version	–
	Setting Reset	–

UX5 HP battery safety

The following information has been provided by the manufacturer of the UX5 HP battery. You should familiarize yourself with the information in this section so that you know how to look after the battery and can take fast, appropriate safety action if required.

This section contains the following:

- [Hazards identification, page 129](#)
- [First aid measures, page 130](#)
- [Fire fighting measures, page 131](#)

- [Accidental release measures, page 132](#)
- [Handling and storage, page 132](#)
- [Exposure controls and personal protection, page 133](#)
- [Physical and chemical properties, page 133](#)
- [Stability and reactivity, page 133](#)
- [Toxicological information, page 134](#)
- [Disposal considerations, page 134](#)
- [Transportation information, page 134](#)

Hazards identification

Emergency overview

- Do not open or disassemble.
- Do not expose to fire or open flame.
- Do not mix with batteries of varying sizes, chemistries or types.
- Do not puncture, deform incinerate or heat above 85 °C (185 °F).

Potential health effects

The materials contained in this battery may only represent a hazard if the integrity of the battery is compromised or if the battery is physically or electrically abused.

(1) Physical:

The lithium-ion polymer rechargeable batteries described in this Material Safety Data Sheet are sealed units which are not hazardous when used according to the recommendations of the Manufacturer.

Under normal conditions of use, the solid electrode materials and liquid electrolyte they contain are non-reactive provided the battery integrity is maintained and seals remain intact.

Risk of exposure is only in case of abuse (mechanical, thermal, electrical) leading to the activation of safety valves and/or the rupture of the battery containers. Electrolyte leakage, electrode materials reaction with moisture/water or battery vent/explosion/fire may follow, depending upon the circumstances.

(2) Chemical:

Classification of dangerous substances contained into the product as per directive 67/548/EEC:

Substance		Melting point	Boiling point	Classification			
CAS no.	Chemical symbol			Exposure limit	Indication of danger	Special risk (1)	Safety advice (2)
473894-38-1 182442-95-1	LiCoO ₂ LiMnNiCoO ₂	>1000 °C	N/A	0.1mg/m ³ as Co 1.0mg/m ³ as Ni OSHA		R22 R43	S2 S22 S24 S26 S36
EC: 96-49-1	Organic solvents	EC: 38 °C (100 °F)	EC: 243 °C	None	Flammable	R21 R22	S2 S24

EMC: 623-53-0	(EC-EMC)	EMC: 4 °C (39 °F)	(469 °F) EMC: 90 °C (194 °F)	established OSHA		R41 R42/43	S26 S35 S37 S45
21324-40-3	LiPF6	N/A (decomposes at 160 °C (320 °F))	N/A	None established OSHA	Irritant Corrosive	R14 R21 R22 R41 R43	S2 S8 S22 S24 S26 S36 S37 S45

(1) – Nature of special risks:

- R14 Reacts with water
- R21 Harmful in contact with skin
- R22 Harmful if swallowed
- R41 Risk of serious damage to the eye
- R42/43 May cause sensitization by inhalation and skin contact
- R43 May cause sensitization by skin contact

(2) – Safety advice:

- S2 Keep out of reach from children
- S8 Keep away from moisture
- S22 Do not breathe dust
- S24 Avoid contact with skin
- S26 In case of contact with eyes, rinse immediately with plenty of water and seek medical Protective clothing
- S36 Wear suitable protective clothing
- S37 Wear suitable gloves

First aid measures

In case of battery rupture or explosion, evacuate personnel from contaminated area and provide maximum ventilation to clear out fumes/gases.

In all cases where first aid is applied, seek medical attention.

Eye contact

- Flush with plenty of water (eyelids held open) for at least 15 minutes.

Skin contact

- Remove all contaminated clothing and flush affected areas with plenty of water and soap for at least 15 minutes.
- Do not apply greases or ointments.

Ingestion

- Dilute by giving plenty of water and get immediate medical attention.
- Make sure that the victim does not aspirate vomited material by use of positional drainage.
- Make sure that mucus does not obstruct the airway.
- Do not give anything by mouth to an unconscious person.

Inhalation

- Remove to fresh air and ventilate the contaminated area.
- Give oxygen or artificial respiration if needed.

Fire fighting measures

Fire and explosion hazard

The battery can leak and/or spout vaporized or decomposed and combustible electrolyte fumes in case of exposure above 70 °C (158 °F) resulting from inappropriate use or the environment.

Cells or batteries may flame or leak potentially hazardous organic vapors if exposed to excessive heat or fire. Fire, excessive heat, or over voltage conditions may produce hazardous decomposition products.

Damaged or opened cells or batteries can result in rapid heating and the release of flammable vapors.

Vapors may be heavier than air and may travel along the ground or be moved by ventilation to an ignition source and flash back

Fire, excessive heat, or over voltage conditions may produce hazardous decomposition products.

Use a positive pressure self-contained breathing apparatus if batteries are involved in a fire. Full protective clothing is necessary. During water application, caution is advised as burning pieces of flammable particles may be ejected from the fire.

Extinguishing media

Suitable:	CO ₂ Dry chemical or foam extinguishers
Not to be used:	Type D extinguishers

Special exposure hazards

Following cell overheating due to external source or due to improper use, electrolyte leakage or battery container rupture may occur and release inner component/material in the environment.

Eye contact:	The electrolyte solution contained in the battery is irritant to ocular tissues.
Skin contact:	The electrolyte solution contained in the battery causes skin irritation.
Ingestion:	The ingestion of electrolyte solution causes tissue damage to throat and gastro/respiratory tract.
Inhalation:	Contents of a leaking or ruptured battery can cause respiratory tract, mucus,

membrane irritation and edema.

Special protective equipment

Use self-contained breathing apparatus to avoid breathing irritant fumes.

Wear protective clothing and avoid body contact with electrolyte solution.

Accidental release measures

The material contained within the batteries would only be expelled under abusive conditions.

Using shovel or broom, cover battery or spilled substances with dry sand or vermiculite, place in approved container (after cooling if necessary) and dispose in accordance with local regulations.

Handling and storage

The batteries should not be opened, destroyed or incinerated since they may leak or rupture and release in the environment the ingredients they contain.

Handling

Batteries are designed to be recharged. However, improperly charging a cell or battery may cause the cell or battery to flame.

Use only approved chargers and procedures.

Never disassemble a battery or bypass any safety device.

Do not crush, pierce, short (+) and (-) battery terminals with conductive (i.e. metal) goods.

Do not directly heat or solder.

Do not throw into fire.

Do not mix batteries of different types and brands.

Do not mix new and used batteries.

Keep batteries in non conductive (i.e. plastic) trays.

Storage

Do not store batteries above 60 °C (140 °F) or below -20 °C (-4 °F).

Store batteries in a cool (below 30 °C/86 °F)), dry area that is subject to little temperature change.

Elevated temperatures can result in reduced battery service life.

Battery exposure to temperatures in excess of 130 °C (266 °F) will result in the battery venting flammable liquid and gases.

Batteries should be separated from other materials and stored in a noncombustible, well ventilated, sprinkler-protected structure with sufficient clearance between walls and battery stacks.

Do not store batteries in a manner that allows terminals to short circuit.

Extended short-circuiting creates high temperatures in the cell. High temperatures can cause burns in skin or cause the cell to flame.

Avoid reversing battery polarity within the battery assembly. To do so may cause cell to flame or to leak.

Do not place batteries near heating equipment, nor expose to direct sunlight for long periods.

Other

Follow manufacturers recommendations regarding maximum recommended currents and operating temperature range. Applying pressure on deforming the battery may lead to disassembly followed by eye, skin and throat irritation.

Exposure controls and personal protection

No engineering controls are required for handling batteries that have not been damaged.

- Respiratory protection: *Not necessary under normal use.*
In case of battery rupture, use self contained full-face respiratory equipment.
- Hand protection: *Not necessary under normal use.*
Use gloves if handling a leaking or ruptured battery.
- Eye protection: *Not necessary under normal use.*
Wear safety goggles or glasses with side shields if handling a leaking or ruptured battery.
- Skin protection: *Not necessary under normal use.*
Use rubber protective working in case of handling of a ruptured battery.

Physical and chemical properties

Temperature range:

	Continuous	Occasional
In storage	+30 °C (86 °F) max.	-20 to +60 °C (-4 to +140 °F)
During discharge	-20 to +60 °C (-4 to +140 °F)	-20 to +60 °C (-4 to +140 °F)
During charge	0 to +45 °C (+32 to 113 °F)	0 to +45 °C (+32 to 113 °F)

Stability and reactivity

Conditions to avoid

- Heat above 60 °C (140 °F) or incineration.
- Deform, mutilate, crush, pierce, disassemble
- Short circuit
- Prolonged exposure to humid conditions.

Materials to avoid

N/A

Hazardous decomposition products

Fire, excessive heat, or over voltage conditions may produce hazardous decomposition products.

Toxicological information

1. Irritancy: The electrolytes contained in this battery can irritate eyes with any contact. Prolonged contact with the skin or mucous membranes may cause irritation.
2. Sensitization: No information is available at this time.
3. Carcinogenicity: No information is available at this time.
4. Reproductive toxicity: No information is available at this time.
5. Teratogenicity: No information is available at this time.
6. Mutagenicity: No information is available at this time.

Disposal considerations

Dispose in accordance with applicable regulations which vary from country to country.

(In most countries, the trashing of used batteries is forbidden and the end-users are invited to dispose them properly, eventually through not-for-profit organizations, mandated by local government or organized on a voluntary basis by professionals).

Batteries should be completely discharged prior to disposal and / or the terminals taped or capped to prevent short circuit.

When completely discharged it is not considered hazardous.

This product does not contain any materials listed by the United States EPA as requiring specific waste disposal requirements.

These are exempted from the hazardous waste disposal standards under Universal Waste Regulations. Disposal of large quantities of lithium-ion batteries or cells may be subject to Federal, State, or Local regulations.

Consult your local, state and provincial regulations regarding disposal of these batteries.

Transportation information

United Nations

UN No.: 3480

Classification: No

Individual lithium polymer cells and battery packs with respectively not more than 20Wh (Cell) and 100Wh (Battery) of watt-hours are **not restricted for transport**.

(5.0 Ah of Nominal Capacity: $5.0\text{Ah} \times 3.7\text{V} = 18.5\text{Wh}$)

Packing

Packing Instructions 965 for Air Transport

IMDG for Sea Transport

International conventions

Air IATA Yes

Sea IMDG Yes

Land ADR (road) Yes

RID (Rail) Yes

Other

In the USA Code of Federal Regulations (49 CFR Ch. 1 § 173-185)

Special packaging information

Cells and batteries must be packed in inner packaging that completely encloses the cell or battery.

Cells and batteries must be protected to avoid short circuits.

Each package must be capable of withstanding a 1.2 m (4 ft) drop test in any orientation without:

1. Damage to cells or batteries contained within the packaging;
2. Shifting of the contents allowing battery to battery contact; and
3. Release of contents.

Special shipping information

This battery has been tested to Section 38.3 of 'UN Manual of Tests and Criteria'. The amount of lithium contained in these batteries is below the limits set by the DOT in Section 49CFR173 and IATA. These can be shipped with the following label:



**LITHIUM ION or LITHIUM POLYMER
RECHARGEABLE BATTERIES INSIDE**
(No Lithium Metal)

The package contains lithium ion or polymer cell or batteries. The package must be handled with care and that a flammability hazard exists if the package is damaged. Special procedures should be followed in the event of the package is damaged. To include inspection and repacking, if necessary.

For emergency information, call CHEMTREC.
1-703-527-3887 [International]
1-800-424-9300 [U.S.A.]

FAA conditions and limitations of operation

The United States of America Department of Transportation Federal Aviation Authority (FAA) has granted Exemption No. 11110 for operation of Trimble unmanned aviation systems for the purpose of precision aerial surveys in the United States.

Failure to comply with any of the conditions and limitations of this grant of exemption will be grounds for the immediate suspension or rescission of this exemption.

The conditions and limitations of this grant of exemption are as follows:

1. Operations authorized by this grant of exemption are limited to the following aircraft described in the operator's manual which is a fixed-wing aircraft weighing less than 6 pounds: Trimble Inc.UX5 HP UAS. Proposed operations of any other aircraft will require a new petition or a petition to amend this grant.
2. The UA may not be flown at an indicated airspeed exceeding 74.5 knots.
3. The UA must be operated at an altitude of no more than 400 feet above ground level (AGL), as indicated by the procedures specified in the operator's manual. All altitudes reported to ATC must be in feet AGL.
4. The UA must be operated within visual line of sight (VLOS) of the Operator at all times. This requires the Operator to be able to use human vision unaided by any device other than corrective lenses, as specified on the Operator's FAA-issued airman medical certificate.
5. All operations must utilize a visual observer (VO). The VO may be used to satisfy the VLOS requirement as long as the Operator always maintains VLOS capability. The VO and Operator must be able to communicate verbally at all times. The Operator must be designated before the flight and cannot transfer his or her designation for the duration of the flight. The Operator must ensure that the VO can perform the functions prescribed in the operator's manual.
6. Provided the additional requirements identified in these conditions and limitations are added or amended, the operator's manual is considered acceptable to the FAA. The operator's manual and this grant of exemption must be maintained and made available to the Administrator upon request. If a discrepancy exists between the conditions and limitations in this exemption and the procedures outlined in the operator's manual, the conditions and limitations herein take precedence and must be followed. Otherwise, the Operator must follow the procedures as outlined in its operator's manual.

The operator may update or revise its operator's manual. It is the operator's responsibility to track such revisions and present updated and revised documents to the Administrator upon request. The operator must also present updated and revised documents if it petitions for an extension or amendment of this exemption. If the operator determines that any update or revision would affect the basis upon which the FAA granted this exemption, then the operator must petition for amendment to its exemption. The FAA's UAS Integration Office (AFS-80) may be contacted if questions arise regarding updates or revisions to the operator's manual.

7. Prior to each flight the operator must inspect the UAS to ensure it is in a condition for safe flight. If the inspection reveals a condition that affects the safe operation of the UAS, the aircraft is prohibited from operating until the necessary maintenance has been performed and the UAS is found to be in a condition for safe flight. The Ground Control Station must be included in the preflight inspection. All maintenance and alterations must be properly documented in the aircraft records.

8. Any UAS that has undergone maintenance or alterations that affect the UAS operation or flight characteristics, e.g. replacement of a flight critical component, must undergo a functional test flight in accordance with the operator's manual. The operator who conducts the functional test flight must make an entry in the UAS aircraft records of the flight. The requirements and procedures for a functional test flight and aircraft record entry must be added to the operator's manual.
9. The preflight inspection section in the operator's manual must be amended to include the following requirement: The preflight inspection must account for all discrepancies, i.e. inoperable components, items, or equipment, not covered in the relevant preflight inspection sections of the operator's manual.
10. The operator must follow the manufacturer's UAS aircraft/component, maintenance, overhaul, replacement, inspection, and life limit requirements, with particular attention to flight critical components that may not be addressed in the manufacturer's manuals.
11. Trimble must carry out its maintenance, inspections, and record keeping requirements in accordance with the operator's manual. Maintenance, inspection, and alterations must be noted in the aircraft logbook, including total flight hours, description of work accomplished, and the signature of the authorized UX5 HP technician returning the UX5 HP to service.
12. UX5 HP technicians must receive and document training referenced in the operator's manual.
13. Each UAS operated under this exemption must comply with all manufacturer System and Safety Bulletins.
14. Trimble UX5 HP maintenance personnel must make a record entry in the UAS logbook or equivalent document of the corrective action taken against discrepancies discovered between inspections.
15. The Operator must possess at least a private pilot certificate and a third-class airman medical certificate. The Operator must also meet the flight review requirements specified in 14 CFR 61.56 in an aircraft in which the Operator is rated on his or her pilot certificate.
16. Prior to operating for hire, the operator must have completed Trimble's five-day UX5 HP Training Syllabus as outlined in the Safety Checklist. The Training Manual must also be updated to reflect the specific five day Training Syllabus presented by Trimble. The Training Manual specifies the minimum flight and skill requirements for the Operator, Instructor and Examiner. Those Manuals and records of those requirements must be documented and made available upon request by the Administrator. Those minimum flight requirements are repeated here as conditions and limitations:

Operator

- Minimum 2 flights on the UX5 HP as an operator during the Type Rating module
- Minimum 2 flights on the UX5 HP as visual observer during the Type Rating module
- When failed: Minimum 4 flights on the UX5 HP for the failed part

Instructor

- A minimum of 25 flights and 4 hours where:
 - The flights occurred on 4 different calendar days.
 - Two long endurance flights that last near the maximum permissible endurance (40 min for operations conducted under this exemption) or have a minimum duration of 45 min for previously logged flights or flights not conducted under this exemption (per the Trimble operation's manual).

- One flight with a minimum measured wind speed of 30 kph (18.6 mph). If the wind speed cannot be measured, you can provide proof from METAR as close as 25 km from the weather station.
- One flight with a minimum programmed leg distance of 1 km (if possible by CAA regulations, otherwise as long as possible.)
- 11 flights with a different selected height where:
 - 2 flights are at the minimum height
 - 2 flights are at the maximum allowable height

Examiner

- 100 flights and 20 hours (regardless of aircraft type) or as approved by a team of examiners.

Prior documented flight experience that was obtained in compliance with applicable regulations may satisfy this requirement. Training, proficiency, and experience-building flights can also be conducted under this grant of exemption to accomplish the required flights and flight time.

17. If the UAS loses communications or loses its GPS signal, the UA must return to a pre-determined location within the private or controlled-access property and land or be recovered in accordance with the operator's manual.
18. The operator must abort the flight in the event of unpredicted obstacles or emergencies in accordance with the operator's manual.
19. The operator is prohibited from beginning a UX5 HP flight unless (considering wind and forecast weather conditions) there is enough power to fly to the first point of intended landing and, assuming normal cruising speed, to fly after that for at least 10 minutes.
20. The operator must obtain an Air Traffic Organization (ATO) issued Certificate of Waiver or Authorization (COA) prior to conducting any operations under this grant of exemption. This COA will also require the operator to request a Notice to Airman (NOTAM) not more than 72 hours in advance, but not less than 48 hours prior to the operation.
21. All aircraft operated in accordance with this exemption must be identified by serial number, registered in accordance with 14 CFR part 47, and have identification (N-Number) markings in accordance with 14 CFR part 45, Subpart C. Markings must be as large as practicable.
22. Before conducting operations, the radio frequency spectrum used for operation and control of the UA must comply with the Federal Communications Commission (FCC) or other appropriate government oversight agency requirements.
23. The documents required under 14 CFR 91.9 and 91.203 must be available to the operator at the Ground Control Station of the UAS any time the aircraft is operating. These documents must be made available to the Administrator or any law enforcement official upon request.
24. The UA must remain clear and yield the right of way to all other manned operations and activities at all times (including, but not limited to, ultralight vehicles, parachute activities, parasailing activities, hang gliders, etc.).
25. The UAS may not be operated by the operator from any moving device or vehicle.
26. UAS operations may not be conducted during night, as defined in 14 CFR 1.1.
27. All operations shall be conducted in Class G airspace.

28. All operations must be conducted under visual meteorological conditions (VMC). The UA may not be operated less than 500 feet below or less than 2,000 feet horizontally from a cloud or when visibility is less than 3 statute miles from the operator.
29. During operations in Class G airspace, the UA may not operate within 5 nautical miles of the geographic center of an airport as denoted on a current FAA-published aeronautical chart unless a letter of agreement with that airport's management is obtained, and the operation is conducted in accordance with a NOTAM as required by the operator's COA. The letter of agreement with the airport management must be made available to the Administrator upon request.
30. The UA may not be operated over congested or densely populated areas. These areas include but are not limited to the yellow areas depicted on World Aeronautical Charts (WAC), Sectional Aeronautical Charts (Sectionals), or Terminal Area Charts (TAC). However, aeronautical charts may not reflect pertinent local information. Ultimately, it is the operator's responsibility to follow COA altitudes and conditions when flying near congested or densely populated areas.
31. Operation of the UA must be conducted at least 500 feet from all nonparticipating persons, vessels, vehicles, and structures.
32. Operations of the UA may be conducted at distances less than 500 feet from participating persons, vessels, vehicles or structures that perform an essential function in connection with these special purpose operations. Operations closer than 500 feet from the Operator, VO, operator trainees and essential persons, are permitted when operationally necessary; but never so close as to present an undue hazard, per § 91.119(a).
33. Operations of the UA may be conducted at distances less than 500 feet from unoccupied vessels, vehicles or structures owned by the land owner/controller when the land owner/controller grants such permission and the Operator makes a safety assessment of the risk from operations closer to these objects.
34. All operations shall be conducted over private or controlled-access property with permission from the land owner/controller or authorized representative. Permission from land owner/controller or authorized representative will be obtained for each flight to be conducted.
35. Any incident, accident, or flight operation that transgresses the lateral or vertical boundaries of the operational area as defined by the applicable COA must be reported to the FAA's UAS Integration Office (AFS-80) within 24 hours. Accidents must be reported to the National Transportation Safety Board (NTSB) per instructions contained on the NTSB Web site: www.nts.gov.

Unless otherwise specified in the list of conditions and limitations above, the unmanned aircraft system (UAS) and operator must comply with all applicable parts of Title 14, Code of Regulations (14 CFR) including, but not limited to, parts 45, 47, 61, and 91.

Glossary

accuracy

The closeness of a measurement to the actual (true) value of the quantity being measured.

aerial imaging rover

A type of [unmanned aircraft](#) specifically designed for aerial photogrammetry.

aerial photo station

An aerial photo station is created each time an aerial photo is taken during a flight. It defines a point and includes raw sensor values (orientation and tilt), coordinate data, and an image.

aeronautical information publication

A manual containing thorough details of regulations, procedures and other information pertinent to flying aircraft in the particular country to which it relates. It is usually issued by or on behalf of the respective civil aviation administration.

AIP

See [aeronautical information publication](#).

airspeed

The speed of the rover relative to the air.

avoidance zone

Avoidance zones are used in the background map to indicate areas that the unmanned aircraft must not fly over, such as airports and forbidden airspace.

azimuth

Horizontal direction relative to a defined coordinate system.

base station

A base station is an antenna and receiver set up on a known location specifically to collect data to be used in postprocessing rover files. During a PPK survey, data is collected so that baselines (the position of one receiver relative to another) can be computed during postprocessing. The base station acts as the position from which all unknown positions are derived.

block

A single polygonal area that defines the geographical area to be photographed at a defined overlap and GSD during a flight. A flight may comprise more than one block.

CAA

Civil Aviation Authority.

CORS

Continuously Operating Reference Station. The CORS network is a network of base stations at a known fixed location. Each base station continuously collects and records GPS observation data. There exist many CORS networks over the world, some of them denser than others. The reference data from a CORS station is accessible via the Internet.

cross wind

A wind that blows from a sideways direction.

elevon

The movable flap on the back edge of each wing. The elevons move up and down to create uneven lift, which controls the aircraft's rolling and banking movement.

flight

The motion of the aircraft through the earth's atmosphere. The main part of the flight records aerial photo station images of one or more blocks. One flight can stretch over multiple blocks, depending on the area parameters.

flight plan

A set of parameters that defines the proper flight path the rover must follow during a single flight.

GCP

See [ground control point](#).

GCS

See [ground control station](#).

geofence

A geofence is a virtual perimeter around the first GPS-fixed location. The geofence prevents the rover from exiting the defined geofenced area.

georeference

The act of positioning an object at its true location (using two or more coordinates) in 2D or 3D space. Georeferencing is used, for example, to position an aerial photograph accurately in relation to other objects in a project.

georeferenced image

A photo taken from a ground- or aerial-based station that includes overlaid point coordinate data. See also [georeference](#).

GNSS

Global Navigation Satellite System (GNSS). This is the standard generic term for satellite navigation systems that provide geospatial positioning with global coverage.

ground control point

An accurately surveyed coordinate location for a physical feature that can be identified on the ground and is used to georeference images.

ground control station

The ground control station (GCS) is the equipment used to control the rover from the ground.

ground sample distance

In the Aerial Imaging software, the ground sample distance (GSD) is the distance on the ground represented by each pixel. The GSD and the height at which the aircraft flies are linked. The higher the rover flies, the larger the distance on the ground represented by each pixel in the images acquired during the flight.

GSD

See [ground sample distance](#).

head wind

A wind that blows from the direction that the aircraft is flying toward.

height

The height above the ground that the rover flies. The rover does not begin taking photographs until it reaches the height specified for the flight.

IATA

International Air Transport Association

ICAO

International Civil Aviation Authority

launch

The process of releasing the rover from the launcher. Launch immediately precedes takeoff.

launch dock

The platform that rests on the launcher. The rover sits on the launch dock. The launch dock moves forward along the launcher at speed when the rover is launched.

launcher

The launcher is a mechanical device that provides a safe way to launch the rover in the direction of takeoff.

METAR

A routine aviation weather report issued at hourly or half-hourly intervals. It is a description of the meteorological elements observed at an airport at a specific time.

multipath

Interference, similar to ghosting on a television screen. Multipath occurs when GNSS signals traverse different paths before arriving at the antenna.

NOTAM

A notice filed with an aviation authority to alert aircraft pilots and remote operators of potential hazards along a flight route or at a location that could affect the safety of the flight. The term NOTAM is commonly used rather than the more formal term Notice to Airmen.

photogrammetry

The use of photography in surveying and mapping to make measurements between objects.

pitot tube

The sensor used by the aircraft to detect airspeed. It must be kept clean and free of obstructions to operate correctly.

postprocess

To process satellite data on a computer after it has been collected.

PPK

A type of GNSS survey. Postprocessed kinematic surveys store raw and continuous observations. The data is postprocessed to achieve centimeter level precisions.

precision

A measure of how closely random variables tend to cluster around a computed value.

reference plane

A known and constant surface which is used to describe the location of unknown points on the earth. Since reference datums can have different radii and different center points, a specific point on the earth can have substantially different coordinates depending on the datum used to make the measurement.

remotely-operated

Control of an aircraft from a ground control station.

remotely-operated aircraft

An aircraft where the operator is not on board the aircraft. This is a subcategory of unmanned aircraft.

observer

A remote crew member who, by visual observation of the remotely-operated aircraft, assists the operator in the safe conduct of the flight.

RTK

Real-time kinematic, a type of GNSS survey.

scan area

The block(s) to be photographed during a flight.

segregated airspace

Airspace of specified dimensions allocated for exclusive use to a specific user(s).

TAF

See [terminal aerodrome forecast](#).

tail wind

A wind that blows from the opposite direction to the direction that the aircraft is flying toward.

takeoff

The initial ascent of the unmanned aircraft. Takeoff immediately follows launch.

telemetry

The science, and associated technology, of the automatic recording and transmission of data from a remote source to a receiving station for analysis.

terminal aerodrome forecast

A terminal aerodrome forecast (TAF) is a concise statement of the expected meteorological conditions at an airport during a specified period (usually 24 or 30 hours).

tie point

A point in a digital image or aerial photograph that represents the same location in an adjacent image or aerial photograph. Tie points are used to correctly orient aerial photo stations to each other and reference them to the ground based on autonomous GNSS positions recorded when the photo images are taken.

tracker

The tracker consists of a transmitter inserted in the body of the unmanned aircraft and a receiver. If required, the receiver is used to track the transmitter signal so the unmanned aircraft can be located once it has landed.

UA

See [unmanned aircraft](#).

UAS

See [unmanned aircraft system](#).

unmanned aircraft

An aircraft which is intended to operate remotely. See also [unmanned aircraft system \(UAS\)](#).

unmanned aircraft system

An aircraft and its associated elements which are operated remotely.

visual line-of-sight operation

An operation in which the operator maintains direct visual contact with the aircraft to manage its flight.

waypoint

A waypoint is a point between major points on a route, as along a track. In terms of the Aerial Imaging software, a waypoint is located at the beginning and end of each flight line in the scan area.

winglet

The extreme edge of the wing.