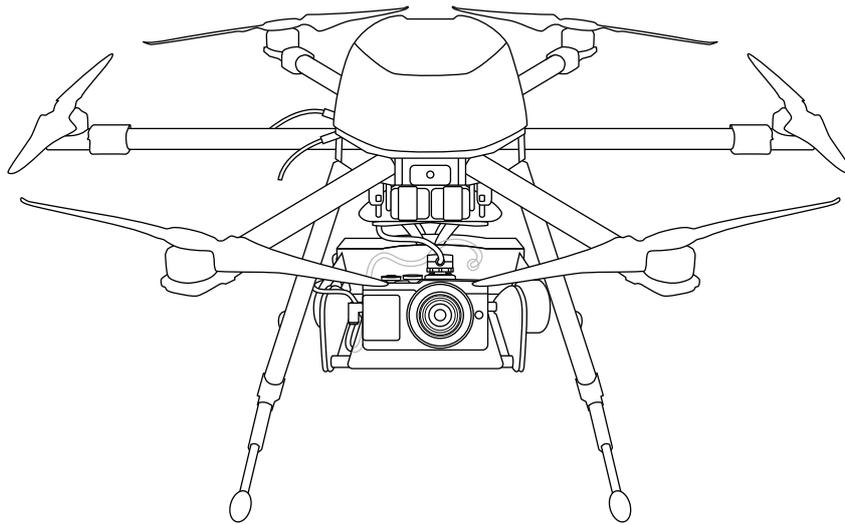


Trimble ZX5 Aerial Imaging Solution



Aerial Imaging Version 2.2
Revision A
April 2016



Legal Information

Trimble Navigation Limited
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Sunnyvale, California 94085
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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 18,000 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 ONTJETIDS16US; ONTJETIR5US.

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 10491A-JETIDS16US; 10491A-JETIR5US.

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 Navigation, declares that this product is in compliance with the essential requirements and other relevant provisions of:

- EMC Directive (2004/108/EC)
- Radio Equipment Directive (1999/5/EC)
- RoHS Directive (2011/65/EU)
- Machine Directive (2006/42/EC)



Japan

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

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 Navigation Limited.

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)
Battery	0	0	0	0	0	0
Lithium polymer rechargeable battery	0	0	0	0	0	0
Cables	0	0	0	0	0	0
Internal wiring	X	0	0	0	0	0
LCD Display	0	0	0	0	0	0
Keypad	0	0	0	0	0	0
Motor	0	0	0	0	0	0
Power adapter	0	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
Enclosure	0	0	0	0	0	0
Hardware	0	0	0	0	0	0
Paper manual	0	0	0	0	0	0

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Safety

 **WARNING** – Failure to read and follow the instructions, warnings and recommendations in this guide can lead to loss of control of the ZX5. Loss of control of the ZX5 can lead to a crash, causing damage to equipment and property and/or serious personal injury or even death. Make sure to familiarize yourself regularly with the contents of this guide.

 **WARNING** – The Trimble ZX5 is not a toy. Misuse of this aircraft may result in serious injury or death of the operator and spectators. The ZX5 must only be operated by trained personnel. Training is available from Trimble-certified trainers.

 **WARNING** – Always keep a minimum safety distance of **10 m (33 ft)** between the ZX5 and any person who is not directly responsible for operating the aircraft. Never fly directly over gatherings of people or traffic on the ground.

 **WARNING** – Contact with moving parts can result in serious personal injury. Do not touch the ZX5 when the propellers are rotating. Before starting the ZX5 make sure all personnel and objects are at a minimum safety distance of **3 m (10 ft)**.

 **WARNING** – For safety reasons, after landing the motor speed can increase again after 2 seconds under certain circumstances. To avoid injury from suddenly moving parts, immediately shut down the ZX5 motors completely, even if you intend to restart the ZX5. To do this, pull the throttle stick on the remote control all the way down and move the motor switch to the Off position. Attempting to restart the ZX5 when the motors are idling can cause loss of control of the ZX5 and lead to a crash directly after take-off.

 **WARNING** – Loss of control of the aircraft can result in equipment damage, property damage, serious personal injury, or death. To minimize the risk of loss of control, observe the following at all times:

- Do not fly near other objects in the air.
- Do not fly on rainy or windy days or at night.
- Do not fly near high tension lines, electrical substations, high structures, or communication facilities.
- Never fly this aircraft where damage to property or injury to persons may result if loss of control occurs.
- Always maintain visual line of sight between you on the ground and the ZX5 in the air.
- Always be prepared to make an emergency landing, without endangering others or damaging their property.

 **WARNING** – Always inspect the ZX5 carefully after a hard landing or a crash. Damage to parts can cause unstable flight characteristics, which may lead to loss of control of the aircraft.

 **WARNING** – Lithium polymer batteries are volatile. Make sure to read and understand all information regarding battery charging and use in this document and the *Trimble ZX5 Lithium Polymer Batteries Precautions* guide.

Introduction

- [The ZX5 aerial imaging solution](#)
- [System components](#)
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- [Projects, blocks, and flights](#)
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The *Trimble ZX5 Aerial Imaging Solution User Guide* provides detailed information about operating the components of the Trimble® ZX5 aerial imaging solution.

Even if you have used other unmanned aviation systems before, please read this user guide carefully to familiarize yourself with the ZX5 aerial imaging solution.

The ZX5 aerial imaging solution

The Trimble ZX5 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 ZX5 aerial imaging rover is able to follow 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.

The ZX5 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.

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

ISA conditions

All operating specifications provided in this guide for the ZX5 aerial imaging rover are determined using International Standard Atmosphere (ISA) conditions. The ISA conditions used to determine the specifications for the ZX5 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 ZX5 aerial imaging system comprises the following components:

- ZX5 aerial imaging rover
- Camera
- Ground control station

ZX5 aerial imaging rover

The ZX5 aerial imaging rover consists of the frame and the dome.

The ZX5 rover is built symmetrically. The front is between the two motor arms that are marked with yellow.

The dome is a box with a removable top cover that contains the main board that controls the ZX5. The main board is connected to a GPS antenna for navigation, and other electronic sensors such as gyroscope, accelerometer and compass for flight stability. The main board is also connected to a remote control receiver for communicating with the ground control station. If you have the optional Video Inspection Module, the main board is also connected to a video transmitter antenna for transmitting video data.

The dome protects the electronic components from humidity, dirt, and contact.

Camera

The camera captures images during the flight. The camera has a 16 megapixel Live MOS sensor that provides sharp, detailed images.

The camera is mounted on a gimbal, which is attached to the ZX5 frame below the dome. The roll and yaw axis of the camera gimbal are controlled by brushless motors and their own stabilizing unit. This setup provides a straight and stable image even if the ZX5 flies askew to move or to travel against the wind.

The camera position on the gimbal can be adjusted manually to define the needed pitch to focus on the desired object.

Ground control station

The ground control station is used to control the ZX5. It consists of a GPS-enabled tablet running the Trimble Access™ Aerial Imaging software and a remote control unit.

The remote control (RC) is linked to the ZX5 with a 2.4 GHz radio communication link. The RC receives and shows telemetry data from the ZX5, analyzes the received telemetry data received from the ZX5, shows the telemetry data on the RC screen and, if required, sends audible messages to the operator about the state of the ZX5 components. In addition, the RC sends data (such as geographical coordinates and waypoints) and flight control instructions to the ZX5.

The remote control is powered by its own lithium polymer battery. The top right corner of the remote control display shows the battery status of the remote control. Charge the battery with the

provided charging device. For more information, refer to the manual provided with the radio control unit.

If you have purchased the Video Inspection Module, the ground control station includes a monitor with video receiver. On the monitor the operator can see the live view of the transported camera. The monitor has its own lithium polymer battery, separate to the battery provided for the remote control unit. Low battery status for the monitor is indicated by a red LED on the front of the monitor.

The ZX5 can be controlled with the following models of remote control:

- Jeti DC-16
- Jeti DS-14

This user guide focuses on using the DC-16 model. For more information on using the DS-14 remote control, see [Remote control specifications, page 89](#).

Installing the Aerial Imaging software

Use the Trimble Access™ Aerial Imaging software to plan and manage 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, it allows for communication with the rover.

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 one block. If the estimated flight time for a block exceeds the maximum flight time, the block can be split into smaller parts.

For example, a farmer wants to aerially photograph his potato fields. The farmer has two potato fields, located 50 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 15 minutes. But one field is so large the estimated flight time is 30 minutes. It cannot be mapped in one flight because the maximum flight time is 20 minutes. Therefore, the farmer splits the block into two equal blocks of 15 minutes. This results in three separate blocks that must be flown as three separate flights.

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.*

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.
- **Flight operation:** Complete the flight checklist in the Aerial Imaging Tablet software to ensure that the system is ready for the flight. Use the remote control unit to monitor the flight. After the ZX5 lands, complete the post-flight checklist in the Aerial Imaging Tablet software 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.
- **Image processing:** Process the data collected during the flight using image processing software such as Trimble Business Center software.

Software overview

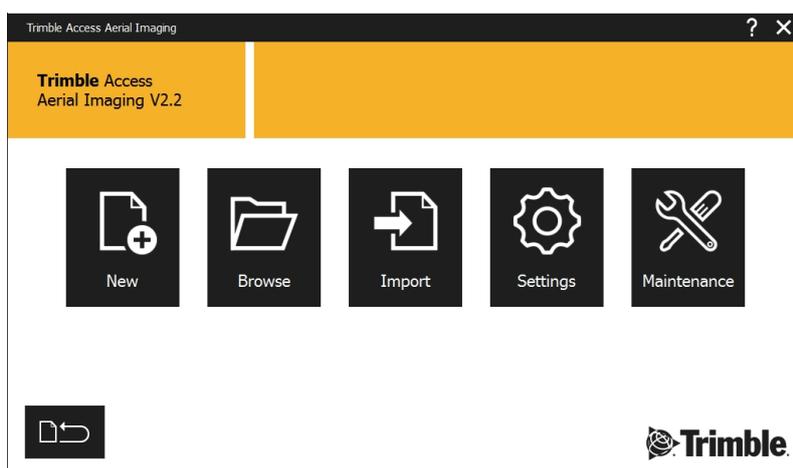
- [The Home screen, page 14](#)
- [The Projects screen, page 14](#)
- [Software tabs, page 15](#)

- [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 22
	Import a project GWT file.	Importing the project, page 59
	Export the project GWT file.	Exporting the project, page 37
	Export project data as JXL or CSV/TXT files for processing.	Exporting flight data for processing, page 76
	Copy the project and all its content.	
	Open the project. The <i>Map layers</i> screen appears.	Preparing the project map, page 23
	Delete the project and associated flight data.	

Software tabs

The Aerial Imaging software provides a tabular workflow. The tabs allow you to easily move between the different levels of project information and phases of a project.

Most screens in the software provide access to the following tabs:

Tab icon	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	Note – <i>The Dashboard tab is not available when using the ZX5.</i>
	<i>Post-flight checklist</i> tab	Transfer the flight data from the ZX5 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.
	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.
	The battery level of the tablet.	If you are using the Aerial Imaging Desktop software, this icon is not displayed.
	The current local 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.

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 USB dongle.

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 41](#).

To perform maintenance on system components, refer to the *Trimble ZX5 Aerial Imaging Solution Maintenance Guide*. If you note any issues not covered by the maintenance procedures, contact your Trimble distributor.

Checking the ZX5 firmware version

To check the version number of the software installed on the MCU1 and MCU2 processors:

1. On the remote control, use menu key **3** to page through the Telemetry data pages.
2. On Telemetry data page 4 (named "Jetibox"), press the **ESC** key, and then press menu key **2** twice to select the MX menu.
3. Press menu key **3** to enter the MX menu.
4. Navigate to the *Infos / Drone* menu and view the information in the *Software MCU1* and *Software MCU2* menus.

For a diagram of the MX menu functions, see [System errors and information, page 78](#).

Updating the ZX5 firmware

To update the ZX5 firmware, you need:

- The updater software, installed on a computer
- The firmware update file, unzipped and saved to a location on the computer



WARNING – For safety reasons, when updating firmware always follow the steps provided below strictly in the order listed.



CAUTION –To avoid damaging the electronics, avoid contact with the electronic devices and conducting paths on the board.

1. Insert the battery pack into the battery cavity of the ZX5 but **do not** connect the plugs into the sockets above.
2. Remove the top cover.
3. Connect the TTL cable to the computer where the updater software is installed. Insert the other end of the TTL cable into the firmware updater socket on the main board inside the dome of the ZX5 and then turn the plug so that it shows **1**.
4. Start the updater software and then:
 - a. Select the COM port used by the TTL cable.
 - b. Navigate to the location on the computer where the **MCU1** software update file is stored and select it.
 - c. Click **Start**.

5. To supply power, connect the ZX5 battery plugs into the appropriate sockets. They must be connected within 10 seconds of clicking **Start**. Update starts automatically.

Note – *If it takes you longer than 10 seconds to connect the battery, you must start again.*

Once the firmware has been updated, a confirmation message appears.

6. Unplug the battery connectors from the sockets.
7. Turn the TTL cable plug so that it shows **2**.
8. In the updater software:
 - a. Make sure the correct COM port is selected.
 - b. Navigate to the location on the computer where the **MCU2** software update file is stored and select it.
 - c. Click **Start**.

9. To supply power, connect the ZX5 battery plugs into the appropriate sockets. They must be connected within 10 seconds of clicking **Start**. Update starts automatically.

Note – *If it takes you longer than 10 seconds to connect the battery, you must start again.*

Once the firmware has been updated, a confirmation message appears.

10. Disconnect the battery and the TTL cable.

The ZX5 is now ready to use.

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.

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 ZX5 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.

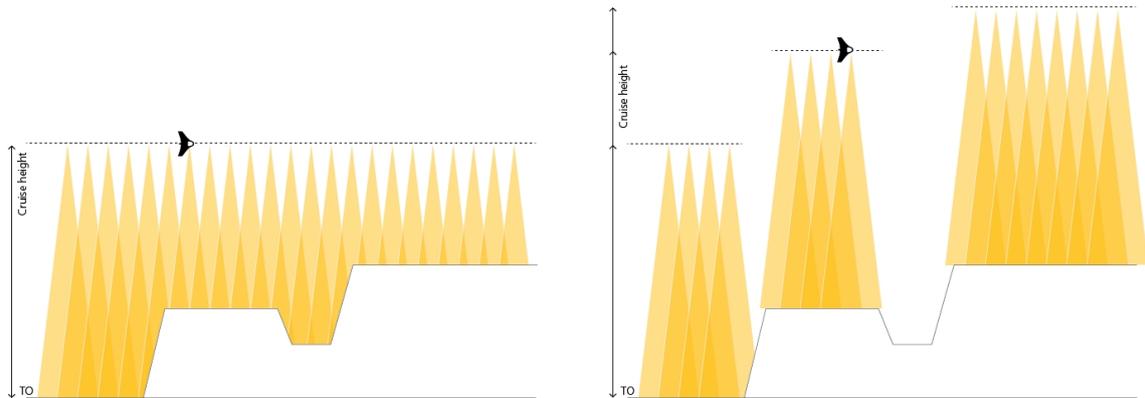
Other factors that impact the final output result include ground control points (GCPs), image overlap, and camera settings.

The absolute accuracy can be much improved by using ground control points (GCPs). 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.

2 Planning a Project



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.

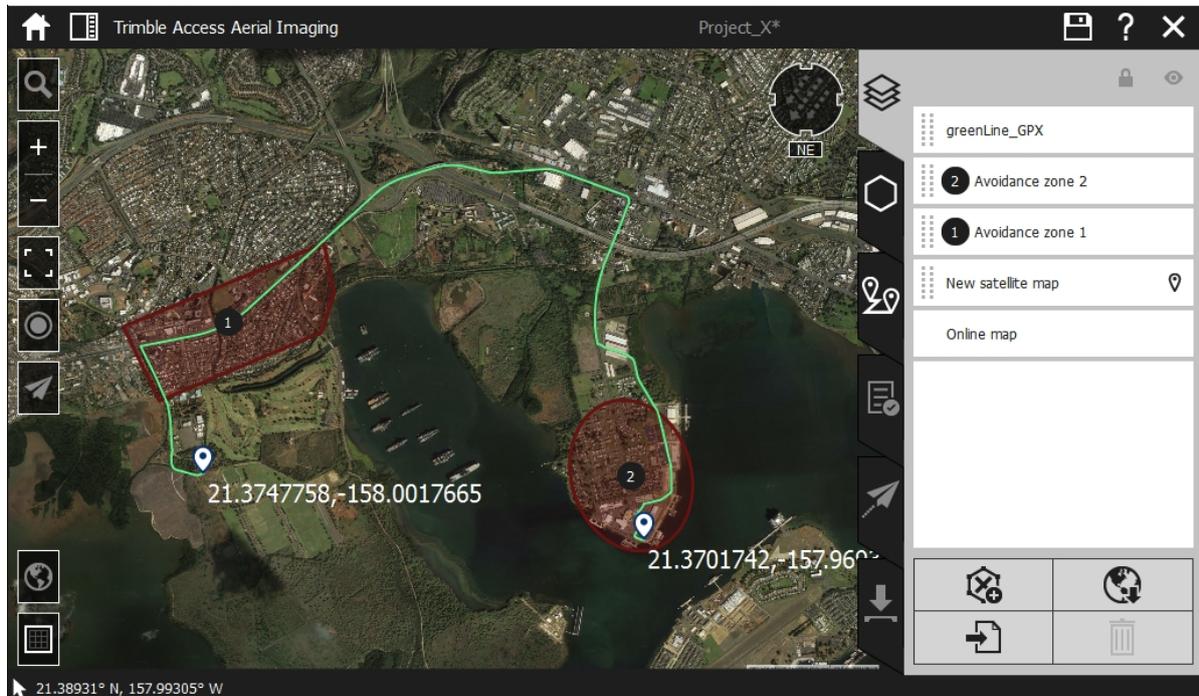
Note – Names of projects, blocks, and flights can contain the following characters: A-Z, a-z, 0-9, dash (-), space (), and underscore (_).

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 23](#)
- [Adding information to the map, page 24](#)
- [Managing map layers, page 25](#)

Adding a background map

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

- To use an online map:
 - a. Make sure you have Internet access.
 - b. 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](#)).
 - c. 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.

- To use 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.

- 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.

To draw the shape of the 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 .

To import the shape of the 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.

To edit the avoidance zone, select the zone on the map or in the map layers list.

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

- 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  to toggle between the map view and the satellite view of the online map.

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.

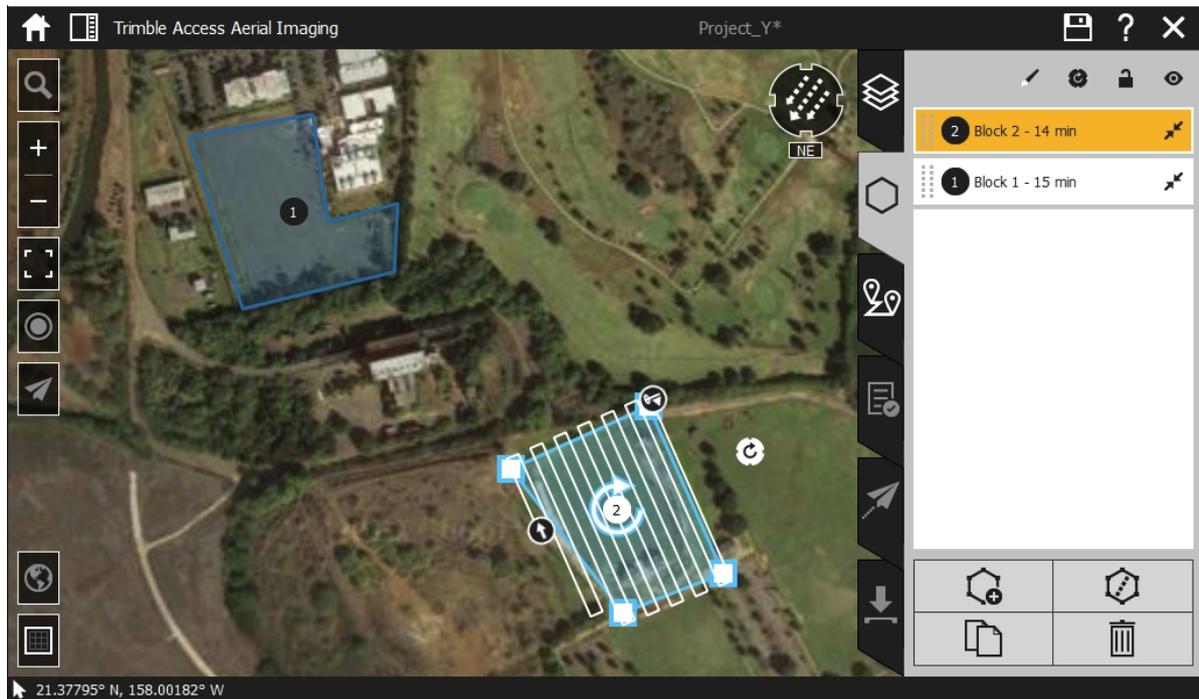
Defining the blocks

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 27](#)
- [Editing the block area, page 28](#)
- [Editing block properties, page 28](#)
- [Setting the direction the rover flies over the block, page 28](#)
- [Splitting a block, page 29](#)
- [Managing blocks, page 30](#)

Creating a block

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

To draw the shape of the 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 .

To import the shape of the 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.

Editing the block area

To edit the block area, select it on the map or in the list.

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

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

- 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

To edit the block properties, click  next to the block name in the list and then do the following:

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

- 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 ZX5 aerial imaging rover. To use a different rover, refer to the appropriate user guide.

- b. Set the ground sample distance (GSD)  or height . The default value is the GSD value obtained by flying at a height of 50 m/164 ft. For more information, see [GSD and height, page 30](#).
- c. Enter the image forward  and side overlap  values. The default value is 80%. For more information, see [Image forward and side overlap, page 31](#).
- d. To define the first waypoint that the ZX5 will fly to, click  or .

The block properties also show the estimated flight time and the size of the block area.

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 ZX5 will fly over the block.

The default direction of the flight lines is perpendicular to North. This does not necessarily correspond with the minimum flight time. To minimize the flight time, manually adjust the direction of the flight lines.

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.

To enable control of the flight lines by wind direction, tap  above the list. The  icon appears and the flight lines rotate so that they are perpendicular to the prevailing wind direction. 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, 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.

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.
6. 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 ZX5 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 ZX5 aerial imaging solution is 1.33 cm (0.52 ") when using the Olympus E-PL7 sensor.

Other example GSD values are:

Height	GSD
Minimum: 20 m (66 ft)	0.53 cm (0.21 ")
50 m (164 ft)	1.33 cm (0.52 ")
100 m (328 ft)	2.00 cm (0.79 ")
Maximum: 750 m (2460 ft)	20.00 cm (7.9 ")

Note – 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%.

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
- 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 and landing

Within an area of 10 m radius around the takeoff or landing location, there must be a clear area free of obstacles.

Obstacle clearance for cruise flight

During cruise flight, no obstacles must appear between the cruise flight height and 10 m (32 ft) below it.

Defining the flights

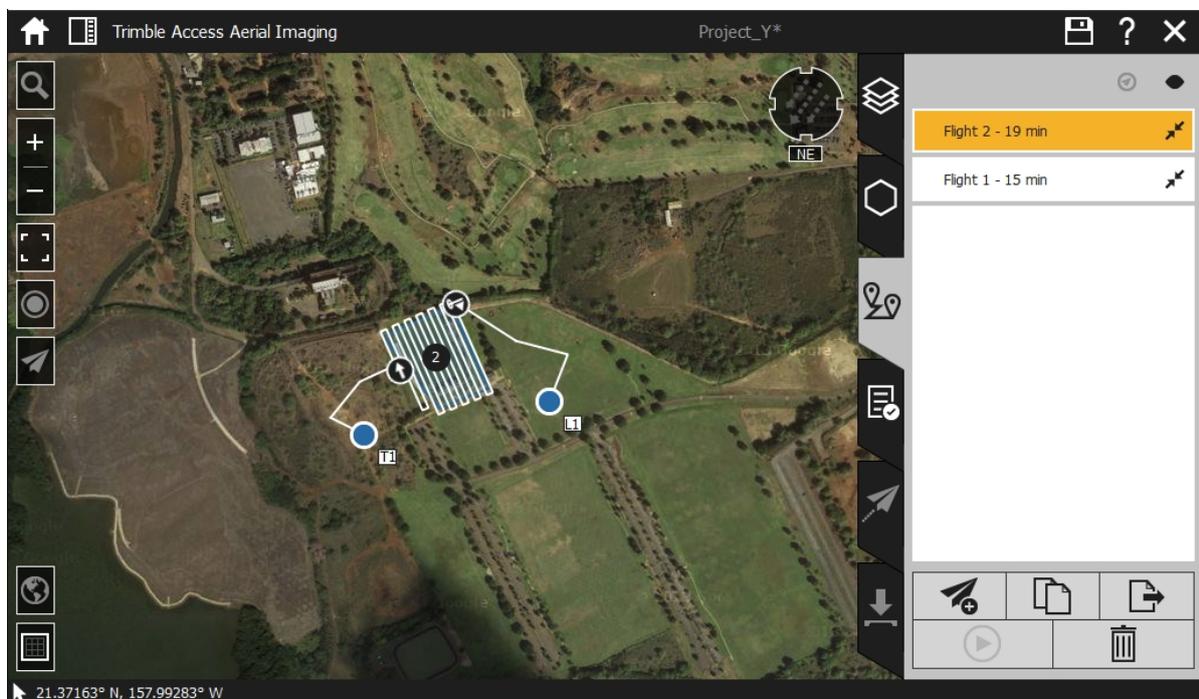
To define flights, select the *Flights*  tab.

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

A flight covers 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 33](#)
- [Setting the takeoff properties, page 34](#)
- [Setting the landing properties, page 34](#)
- [Adding a block to the flight, page 35](#)
- [Viewing the flight summary, page 36](#)

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 ZX5 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 a block to the flight, page 35](#).

Communication timeout

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

The communication timeout  is set to 20 seconds.

Note – *The country you are operating in may have regulations prescribing the minimum communication timeout setting that you must use. If the regulated minimum setting is lower than 20 seconds, you cannot fly.*

GPS speed

The GPS speed  determines how fast the rover flies. For the ZX5, the GPS speed is set to 3.0 m/s (9.84 ft/s).

Geofence

A geofence is a virtual perimeter around the first GPS-fixed location.

For the ZX5 the geofence is always enabled and is set to fixed values.

When the ZX5 reaches the geofence boundary, it goes into the Position Hold flight mode.

The geofence radius  for the ZX5 is set to 2,000 m (6,560 ft); the geofence height  is set to 1,000 m (3,280 ft).

Setting the takeoff properties

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

A toolbar appears on the map.

- 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 and shows the "Planned and not active" status icon . 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 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 takeoff locations as you want.
 - 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 .
- 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 define the first waypoint that the ZX5 will fly to, click  or  in the block properties in the *Blocks* tab . The takeoff route updates accordingly.
 - 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

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

A toolbar appears on the map.

- 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 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 appears on the map 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.
- 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 .
- When the flight has a block linked to it, the landing route is displayed. To edit the landing route, click and drag the waypoints  on the map.
- 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 a block 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 the block to link to the flight.

The selected block is highlighted, and the flight lines and connection routes appear on the map.

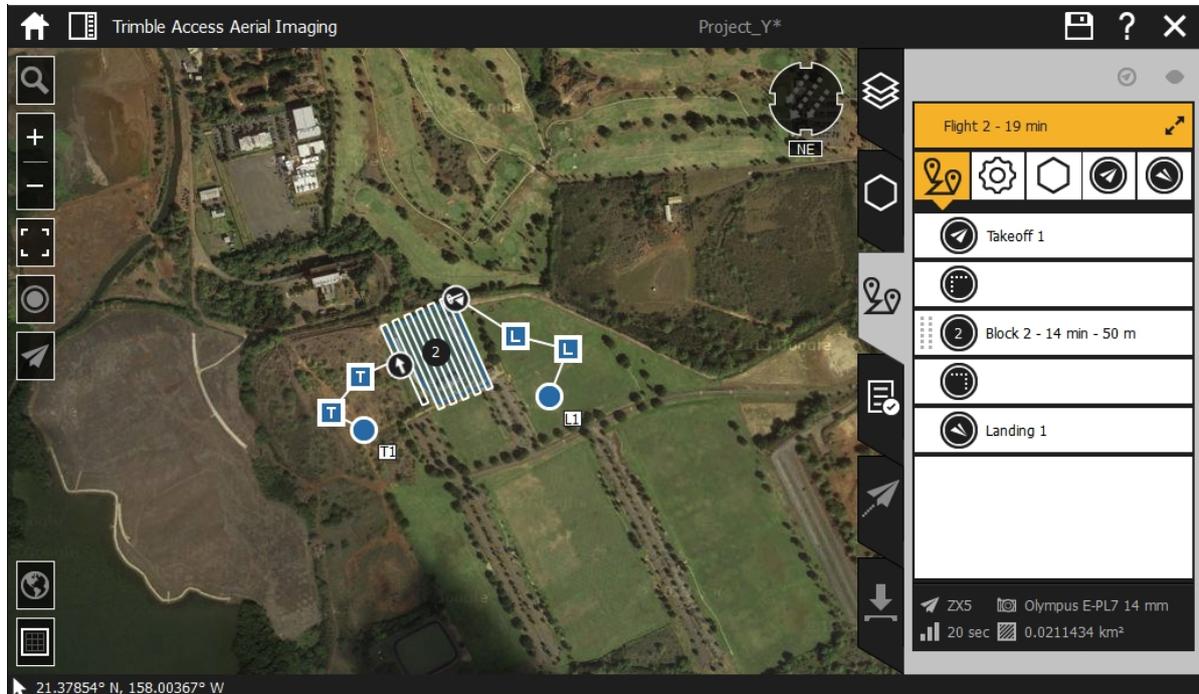
The selected block is added to the flight summary. To view the summary, tap .

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:



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 patterns and automatic failsafes.*

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 59.

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 84](#).

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 ZX5 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 97](#).



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	Limit
Endurance	20 minutes
Flight time without payload	25 minutes
Maximum operational ceiling	3,000 m (9,843 ft) AMSL
Flight AGL range	20 to 750 m (66 to 2,460 ft)
GPS satellite tracking:	
• 3D position fix (GPS functions are activated)	At least 4 satellites
• Accurate position data	At least 6 satellites
Weather limit	Stable in winds up to 36 kph (22 mph)
Control frequency	2.4 Ghz
Video frequency	5.8 Ghz
Communication and control range	Up to 2 km (1.2 miles)
Operator-UAS visibility	Visual line of sight
Live video stream resolution	480i
Recordable video resolution	1080p30
Temperature	-10 °C to +45 °C (14 °F to 113 °F)

Note – In low outdoor temperatures (less than 10 °C / 50 °F) the battery capacity reduces itself down to about 50 %. When using the ZX5 in very cold temperatures (less than 10 °C/50 °F), keep the ZX5 and the batteries in a warm environment for as long as possible before the flight.

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 ZX5.
- 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 ZX5 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 ZX5: 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 ZX5. 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 69](#).
 - 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

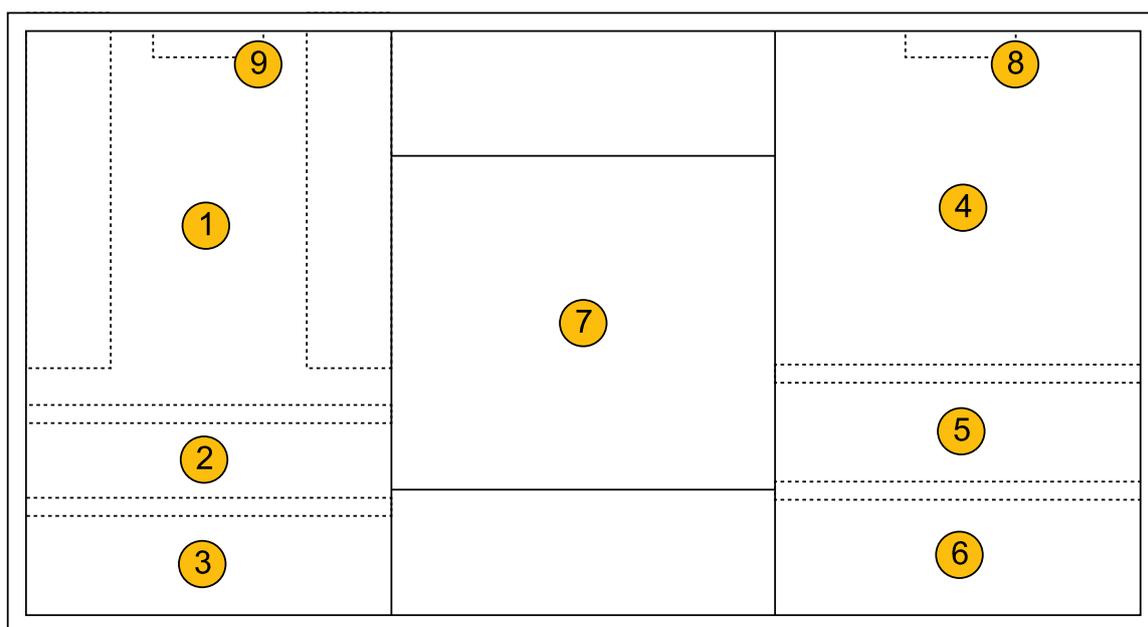
- Flight case contents
- Parts of the ZX5 aerial imaging rover
- Checking the ZX5 aerial imaging rover
- Checking the ZX5 battery pack
- Charging the ZX5 battery pack
- Charging the GCS batteries
- Charging the camera batteries
- Checking the camera
- Locating your equipment

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 Gimbal, camera, trigger, and hot shoe cable | ⑥ Tablet and data cable |
| ② ZX5 batteries and balancer cables | ⑦ Documentation |
| ③ ZX5 battery charger, camera charger, and cables | ⑧ Battery level checker, spare micro SD card, micro SD reader |
| ④ Remote control unit | ⑨ Spare parts |
| ⑤ Remote control unit charger and harness | |

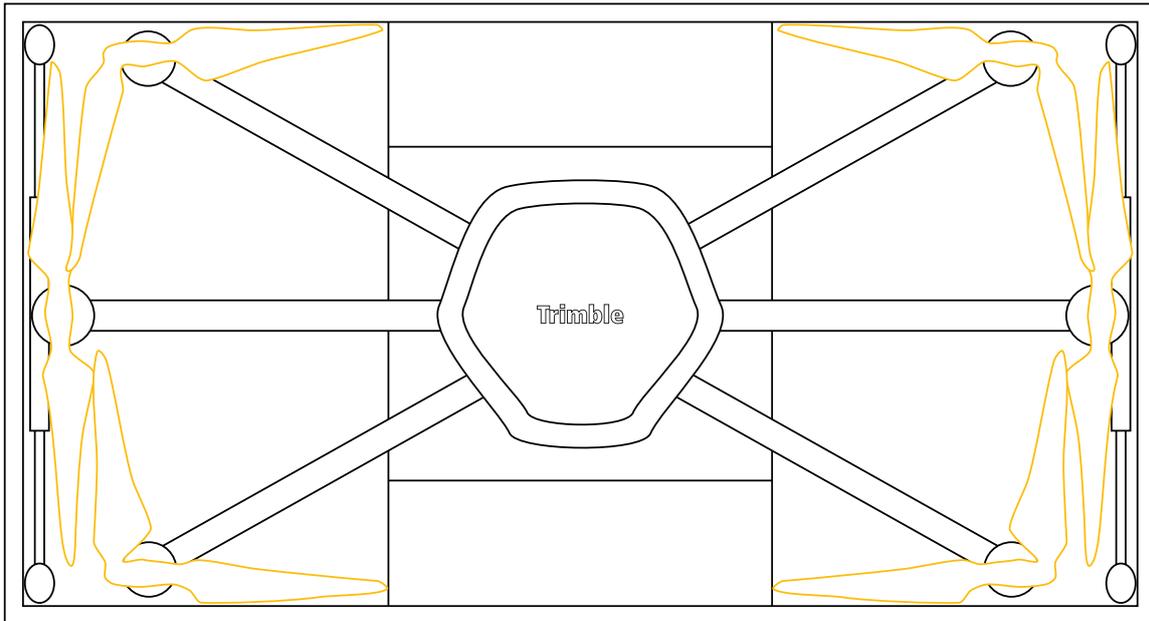
Note –

- 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.
 - Insert the micro SD card (used for flight recording) into the dome of the ZX5.
- According to ICAO/IATA regulations, lithium polymer batteries must be carried in hand luggage when transporting the system by air.

Storing the ZX5 in the flight case

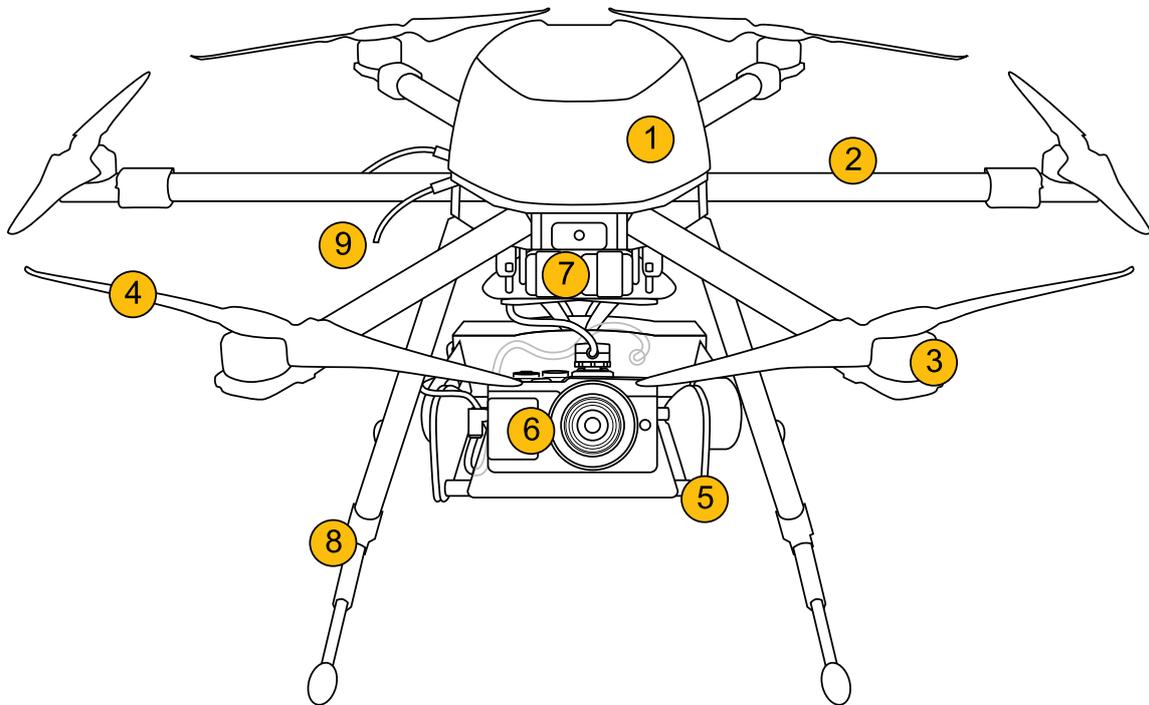
When storing the ZX5 in the flight case, take special care not to damage the propellers.

1. Fold the arms of the ZX5 frame.
2. Fold the legs of the ZX5 frame.
3. Store the folded frame in the flight case. Mind the propellers.
4. Fold the propellers as shown below.



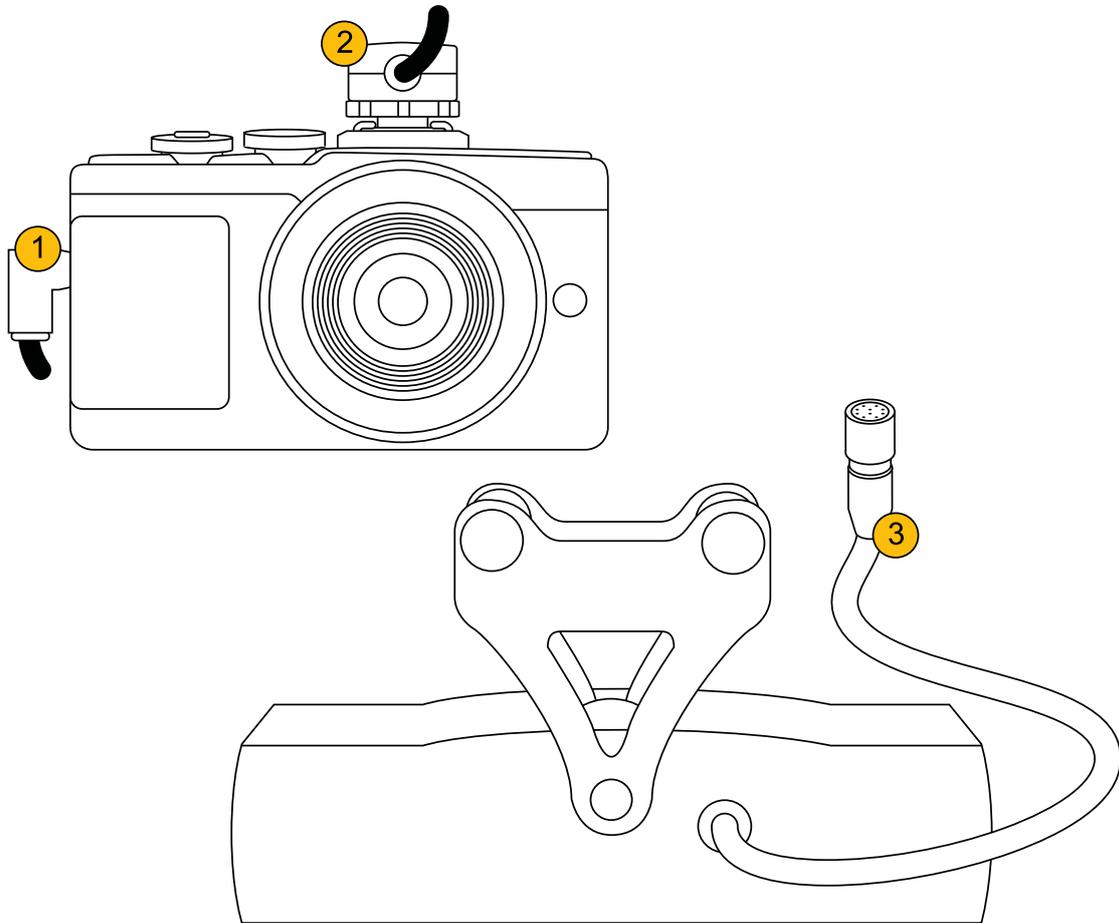
Parts of the ZX5 aerial imaging rover

The main parts of the ZX5 aerial imaging rover are shown below.



- | | |
|-----------------------|------------------------------|
| ① Dome with top cover | ⑥ Camera |
| ② Motor arm | ⑦ Battery compartment |
| ③ Motor | ⑧ Legs |
| ④ Propeller | ⑨ Communication link antenna |
| ⑤ Gimbal | |

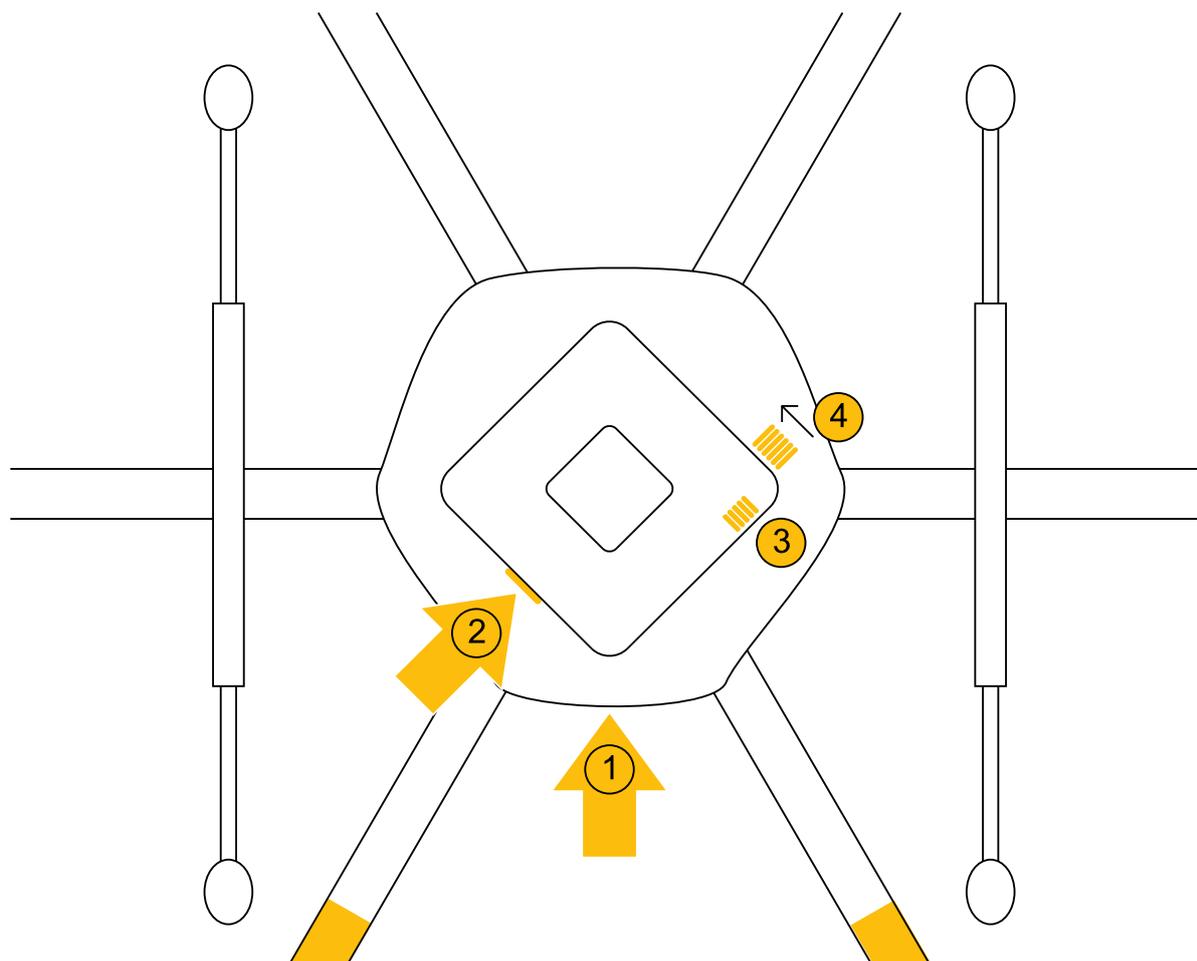
Camera and gimbal



- ① Trigger cable
- ② Hot shoe cable

- ③ Gimbal power cable

Dome



- ① Data connector
- ② Micro SD card
- ③ Firmware update connector
- ④ Gimbal servo connectors:
 - Roll compensation
 - Pitch compensation
 - Trigger for camera

Checking the ZX5 aerial imaging rover

Thoroughly check the ZX5 before each flight to make sure that it is undamaged from any previous flight.

 **WARNING** –Damage to parts can cause unstable flight characteristics, which may lead to loss of control of the aircraft. If you find any damage, do not fly. Exchange the part or contact your Trimble service provider.

Refer to the following sections:

- [Check the frame, page 47](#)
- [Check the propellers, page 47](#)
- [Check the dome, page 48](#)

Check the frame

1. Check all parts for cracks, abrasion, broken parts.
2. Visually make sure all bolted connections on the ZX5 fuselage, the six arms, and landing gear are secure.

Note – All screws and nuts are either self locking or sealed with loctite.

3. Check the antennas and make sure they are correctly aligned and free of kinks. If required, align the antennas in a straight line.

If any antenna has kinks, then signal transmission is limited. For more information, contact your Trimble service provider.

4. Check the landing gear and make sure:
 - a. The legs snap in correctly.
 - b. During folding/unfolding of the landing gear there is a grinding resistance to avoid flapping.
5. Check the six arms and make sure:
 - a. The arms snap in correctly.
 - b. During folding/unfolding of the arms there is a grinding resistance to avoid flapping.
6. Check the motors and turn them with your hand to make sure they move freely without making any unusual grinding or bearing noise.

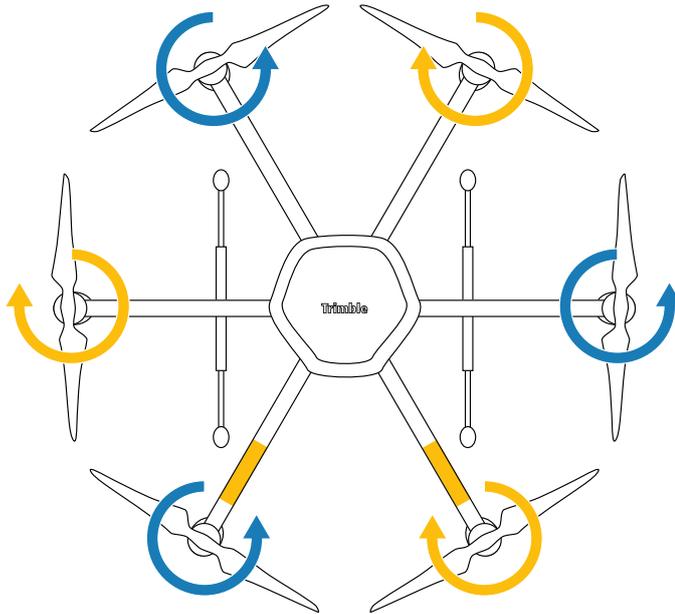
If a motor is difficult to turn or if you hear a grinding or bearing noise when turning it, contact your Trimble service provider.

If you find any damage to any part of the frame, refer to the *Trimble ZX5 Aerial Imaging Solution Maintenance Guide*. Alternatively, contact your Trimble service provider.

Check the propellers

1. Clean the propellers carefully using a damp cloth.
2. Check the propellers for cracks, abrasions, or broken parts.
3. Make sure each propeller is freely moveable and unfolds easily. If the folding mechanism is dirty, clean it carefully using a smooth brush or compressed air.
4. Make sure the propellers are fitted to the correct motor.

The clockwise rotating propellers must be installed on the clockwise rotating motors and the counter-clockwise rotating propellers must be installed on the counter-clockwise rotating motors.



5. If any propellers are damaged, cannot be cleaned, or are not correctly installed, replace them immediately. For more information, refer to the *Trimble ZX5 Aerial Imaging Solution Maintenance Guide*.

 **WARNING** – Never fly with a damaged propeller. Always replace a damaged propeller before the next flight. A damaged propeller can cause loss of control of the ZX5. Loss of control of the ZX5 may lead to a crash, resulting in equipment damage, property damage, or personal injury.

 **WARNING** – Dirt on the propellers can disturb the balance and cause unnecessary vibration. Vibration can cause blurred and out of focus images or affect the flight characteristics of the ZX5, causing damage to the ZX5 or loss of control.

 **WARNING** – If one or more propellers are fitted to a motor that rotates in the opposite direction to the propeller, the ZX5 cannot fly correctly. It cannot be operated by the operator, flips upside down and will be damaged. An uncontrolled ZX5 can also cause serious personal injury.

Check the dome

 **WARNING** – Always disconnect the battery pack before removing the top cover.

1. Make sure all wire connections inside and outside the dome are clean and free of damage. Clean any dirty connections with a smooth brush.
2. Make sure all connectors and soldered wires are fitted correctly.
3. Make sure the top cover can be securely fixed.

If you find any damage, contact your Trimble service provider.

Checking the ZX5 battery pack

Thoroughly check the ZX5 battery pack before each flight to make sure that it is undamaged.

 **WARNING** – Do not charge or use a damaged battery. Damage to the battery can cause fire or the emission of hazardous vapors when the battery is being charged or is in use.

1. Check the battery for pressure marks, cuts, cracks, swelling and any deformities.
2. Make sure the isolation on the battery is completely intact.
3. If the battery has been in a crash, take special care when charging the battery as although there may be no external signs of damage, it may have sustained internal damage.

If the battery balloons or expands, it cannot be used again and must be disposed of safely.

Charging the ZX5 battery pack

Carefully read this section to familiarize yourself with charging and storing ZX5 batteries.

Always recharge the batteries before use.

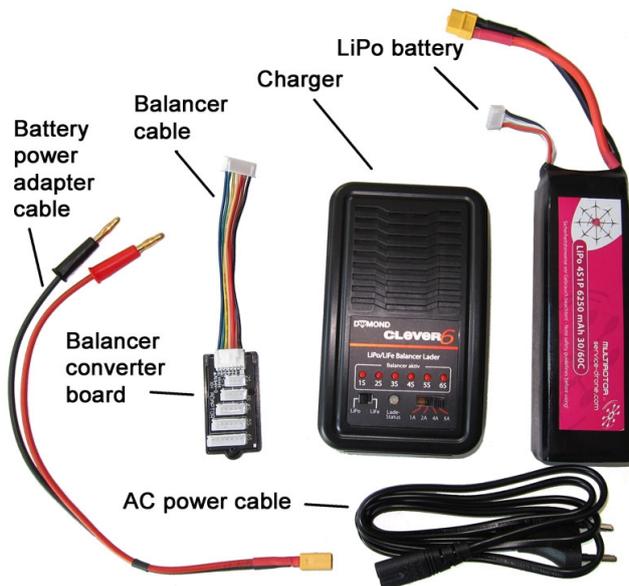
 **WARNING** – Lithium polymer batteries are volatile. Make sure to read and understand all information regarding battery charging and use in this document and the *Trimble ZX5 Lithium Polymer Battery Precautions* guide.

 **CAUTION** – Do not separate the battery pack. Always use the complete battery pack for the lifetime of the poorest battery. Attempting to separate the battery pack will damage the batteries.

In this section:

- [Charger overview, page 50](#)
- [Removing the battery from the rover, page 50](#)
- [Connecting the charger, page 50](#)
- [Charging the battery, page 53](#)
- [Disconnecting the charger, page 53](#)
- [Inserting the battery pack into the ZX5, page 54](#)
- [Storing the battery, page 54](#)

Charger overview



Removing the battery from the rover

1. Disconnect the main power connectors of the batteries from the rover.
2. Loosen the Velcro straps and remove the batteries from the battery compartment of the ZX5.

Connecting the charger



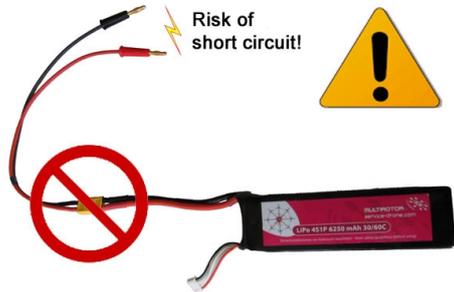
WARNING – Lithium polymer batteries are volatile. Failure to read and follow these instructions may result in fire, personal injury, and damage to property if charged or used incorrectly.

To prevent injury or damage:

- Use only the charger specified to charge the battery pack.
- Use the charger to charge only ZX5 battery pack.
- Do not use or charge a battery pack if the battery pack, charger or charging cables appear damaged.
- 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 pack from the ZX5 body for charging or storing.
- Do not attempt to recharge the battery if it is still fully charged.
- Do not recharge the battery directly after use. Always wait until the batteries have cooled down first.

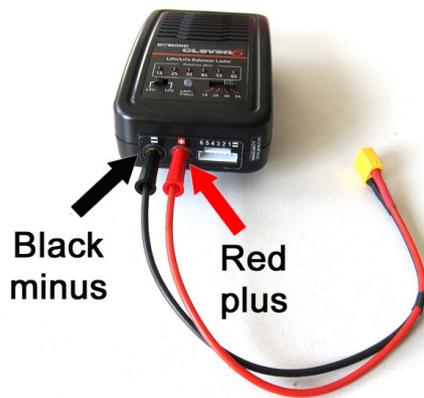
3 Preparing Equipment

WARNING – Never connect the battery power adapter cable to the battery without first connecting the adapter cable to the charger. Connecting the adapter cable to the battery risks short-circuiting the battery, which may result in fire, personal injury, or damage to property.



CAUTION – Always connect the balancer cable to the battery before charging. Failure to connect the balancer cable can cause the lithium polymer cells to overload, damaging the battery.

1. If the battery pack is fitted in the ZX5, remove the battery pack from the ZX5 body.
2. Connect the battery power adapter cable to the charger. Insert the red connector into the red socket and the black connector into the black socket:



3 Preparing Equipment

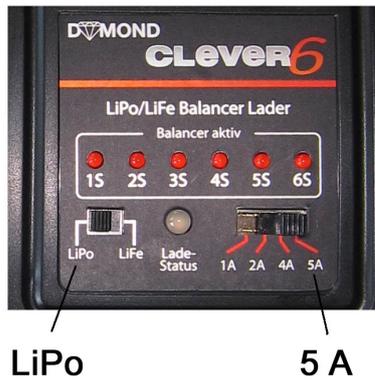
3. Connect the balancer cable adapter to the charger:



4. Connect the power cable adapter to the power connector of the battery and connect the balancer cable to the 4s socket of the battery:



5. Make sure the switches are set to the correct position on the charger. They should be:
 - Battery type: **LiPo**
 - Charge current: **5 A** for the ZX5 battery; **1 A** for the video receiver battery.



6. Connect the AC power cable to the socket on the charger.

Charging the battery

WARNING – *Never leave the charger unattended during use* and do not leave a battery to charge overnight. Place the battery on a fireproof base during charging and remove highly combustible materials from around the battery. Failure to observe and operate the charger properly can cause damage to the charger, battery, personal property and/or cause serious personal injury.

WARNING – If at any time you observe the battery swelling or ballooning while charging, *immediately* disconnect the charger and observe the battery carefully in a safe place away from flammable materials. If the battery balloons or expands, it cannot be used again and must be disposed of safely.

WARNING – Allow the charger and the battery to reach room temperature before connecting the charger to mains power and using it. This may take several hours.

1. Set up the battery and charger on a non-flammable surface, away from flammable materials and other objects.
2. Make sure the battery is connected to the charger correctly.
3. Connect the AC power cable to a mains power socket.

The battery status LED lights red and charging starts.

When the battery is fully charged, the battery status LED lights up green.

At typical room temperature it takes approximately 2 hours to charge the battery. Charging a fully discharged battery can take up to 3 hours. Charging time will vary depending on remaining battery life and ambient temperature.

The battery voltage should always be between 12.8 V and 16.8 V.

Disconnecting the charger

1. Disconnect the AC power cable from the power source and the charger.
2. Disconnect the power cable from the power connector of the battery.
3. Disconnect the balancer cable from the 4s socket of the battery.

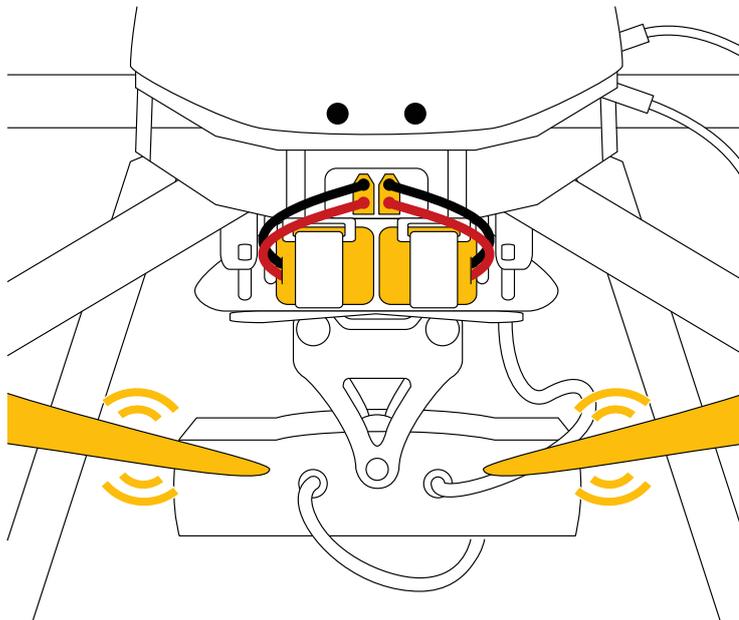
4. If you have not yet charged both batteries, connect the second battery and charge it using steps 4 through 6 in the section "[Connecting the charger](#)" above.

Inserting the battery pack into the ZX5

WARNING – Always fully charge the batteries before each flight. Only insert fully charged batteries into the ZX5. Using partially charged batteries will significantly reduce the flight time.

Note – In low outdoor temperatures (less than 10 °C / 50 °F) the battery capacity reduces itself down to about 50%. When using the ZX5 in such temperatures, keep the ZX5 and the batteries in a warm environment for as long as possible before the flight.

1. Insert the battery pack into the battery cavity above the camera gimbal at the rear of the ZX5 and then tighten the Velcro straps around it.
2. Connect the main power connectors of the batteries to the rover.



CAUTION – The propellers will rotate slightly as soon as one of the batteries is connected. Take care to avoid injury.

CAUTION – Do not separate the battery pack. Always use the complete battery pack for the lifetime of the poorest battery. Attempting to separate the battery pack will damage the batteries.

Storing the battery

WARNING – LiPo batteries should never be stored at full charge for more than a few hours.

Note – *The charger can only charge a battery; it cannot discharge a battery. Stored batteries should be recharged every three months.*

Battery storage recommendations

Store the ZX5 batteries in a cool, dry area (below 15–20 °C/59–68 °F) that is subject to little temperature change. Elevated temperatures can result in reduced battery service life.

Do not place batteries near heating equipment, nor expose to direct sunlight for long periods.

Do not store batteries above 60 °C (140 °F) or below 10 °C (50 °F). 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.

Charging the GCS batteries

Before leaving the office for a flight, make sure you fully charge the batteries for the ground control station (the tablet and the remote control unit) according to the instructions provided in the documentation for the components of your GCS.

Charging the camera batteries

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

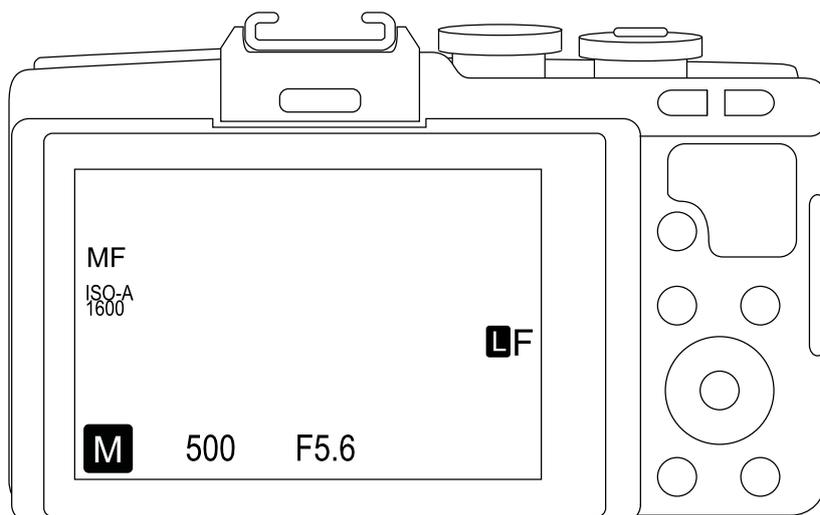
Note – *Make sure you charge both camera batteries before leaving the office for a flight. Trimble recommends always having a spare, fully-charged battery on hand.*

Checking the camera

1. Make sure there are no scratches on the camera lens. If the camera lens is damaged, contact your Trimble distributor.
2. Before each flight, check the camera screen to make sure it displays the correct icons.

Checking the Olympus E-PL7 camera display

Note – 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 more information, see [Olympus E-PL7 camera settings, page 87](#).



Icon	Description
M	Shoot mode is set to Manual.
MF	Focus mode is set to Manual.
L F	Image size is set to Large, Compression rate is set to Fine.
ISO-A	ISO is set to Auto.
1600	ISO high limit is set to 1600.
500	Shutter speed is set to 1/500 or above.
F5.6	Aperture value is set to 5.6.

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 42](#).

3 Preparing Equipment

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 card with a minimum write speed of 30 MB/s and a minimum capacity of 8 GB.*

Completing a Flight

- Importing the project
- Keeping an eye on the weather
- Validating the blocks
- Validating the flights
- Completing the flight checklist
- Launching the ZX5
- Monitoring and controlling the ZX5 during flight
- Landing the ZX5
- Completing the post-flight checklist

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 37](#)), 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.

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 ZX5 is in the air, see [Dealing with sudden weather changes during flight, page 66](#).

Validating the blocks

Tap the *Blocks* tab  and make any changes to the blocks, if required. For more information, see [Defining the blocks, page 26](#).

Validating the flights

1. 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 ZX5 could fly into or land on.
 - Make sure you will be able to maintain a visual line of sight to the ZX5 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 31](#).

2. Tap the *Flight* tab  and make any changes to the flights, if required. For more information, see [Defining the flights, page 32](#).
3. 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.
4. 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.
5. 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.

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

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.*

- [Preparing the rover, page 60](#)
- [Preparing the remote control unit, page 61](#)
- [Preparing the camera, page 61](#)
- [Attaching the gimbal to the ZX5, page 61](#)
- [Attaching the camera to the gimbal, page 61](#)
- [Positioning the ZX5 at the takeoff location, page 62](#)
- [Powering on the remote control unit, page 62](#)
- [Powering on the ZX5, page 62](#)
- [Powering on the gimbal, page 63](#)
- [Checking the camera trigger, page 63](#)
- [Transmitting the flight plan, page 63](#)
- [Removing the data cable, page 64](#)

Preparing the rover

1. Unfold the ZX5 legs. Make sure they click into position.
2. Unfold the four flexible ZX5 motor arms.

Note – *The six motor arms should be symmetrically arranged.*
3. Fasten the wing nuts of the motor arms hand-tight. Make sure all motor arms are firmly fixed.
4. Check the ZX5 to make sure that it is undamaged from any previous flight.

5. Make sure the top cover is secure.
6. Insert fully charged batteries into the battery compartment of the ZX5.



WARNING – Do not yet connect the batteries to the ZX5.

7. Secure the batteries using the Velcro straps.

Preparing the remote control unit

Make sure the remote control unit is fully charged and powered off.

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 camera, page 55](#).
3. Make sure the lens settings are appropriate for the weather conditions:

ISO	AUTO
Aperture ring	5.6
Shutter speed	1/500 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. Attach the hot shoe cable and the trigger cable.
5. 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.

Attaching the gimbal to the ZX5

1. Mount the gimbal onto the ZX5 and fasten the screw hand-tight.
2. Connect the power cable of the gimbal to the ZX5.
3. Make sure that the gimbal can move freely and is not obstructed in any way.

Attaching the camera to the gimbal

1. Mount the camera onto the gimbal so that the camera is straight and fasten the screw hand-tight.
2. Connect the trigger cable to the gimbal and connect the hot shoe cable to the ZX5.

Positioning the ZX5 at the takeoff location

1. Make sure the front of the ZX5 is facing away from the operator.
Note – *The front is indicated with yellow marks on the motor arms.*
2. Position the ZX5 legs securely on level ground.
3. Make sure there are no obstacles within 10 m (33 ft) of the takeoff location.

Powering on the remote control unit

1. Attach the remote control harness to the operator.
2. Check the position of the following switches:
 - **EASY/AHEAD** — neutral
 - **LAUNCH/LANDING** — neutral
 - **CH/PH** — neutral
 - **MAG/ALT** — forward (Mag control)
 - **MOTOR** — backward (OFF)
3. Make sure the **TILT** and **ZOOM** levers are in the neutral position.
4. Turn on the remote control unit and maximize the volume.

Powering on the ZX5

1. Connect the main power connector on the batteries to the power connector in the rover.



WARNING – Take care when connecting the battery. The propellers will rotate slightly as soon as one of the batteries is connected.

2. Make sure you can hear the following announcements from the remote control:
 - GPS OK
 - Height control

If the announcements are not made, check the Extended menu on the remote control unit for the last error that occurred. For more information, see [System errors and information, page 78](#).

Pre-flight acoustical signals

A signal transmitter located on the frame of the ZX5 provides audible signals to report different conditions:

Signal pattern	Signal description	Meaning
-----	1 short beep, 1 long beep, 2 short beeps	Everything OK
-----	1 continuous beep	Warning: Micro SD card or GPS not connected
---	3 short beeps	Warning: Can't receive remote control signal
-----	1 long beep, 4 short beeps	ZX5 does not stand straight
-----	2 long beeps, 3 short beeps	Malfunction: Motor switch is activated without minimum throttle or Coming Home mode is still active.
-----	2 long beeps, 3 short beeps	ZX5 is disabled: register with Trimble.

In addition, the motors buzz after powering up the system.

Other signals could also indicate malfunction. If you hear unusual signals, do not perform any further flights. Check the MX menu for the latest error message before contacting Trimble Support. For more information, see [System errors and information, page 78](#).

Note – *If there is an acoustic signal for low battery voltage during the flight, you cannot start the motors again after landing until you have disconnected the battery.*

Voice announcements from the remote control unit indicate status information during flight. For more information, see [Monitoring and controlling the ZX5 during flight, page 64](#).

Powering on the gimbal

Power on the gimbal, using the switch located at the side of the gimbal. Wait for the gimbal to align itself.

Note – *The gimbal beeps while it is aligning itself.*

After alignment is complete, make sure the camera is straight and level.

Checking the camera trigger

Pull the **SHUTTER** switch of the remote control unit to take a picture. Make sure that you hear the trigger sound from the camera.

Transmitting the flight plan

Attach the data cable to the data connector on the dome and to the tablet.

Tap  to check the cable connection.

If the cable connection is OK, the software automatically starts transmitting the flight plan to the ZX5. When data transfer is complete, the  button is enabled.

Removing the data cable

Disconnect the data cable from the data connector on the dome and from the tablet.

Launching the ZX5

1. If possible, wait until the GPS reception reaches a precision of better than 4 m (13 ft).
2. To start the motors, pull the throttle stick completely back and push the **MOTOR** switch forward.

Note – *This is a safety-lock switch. Pull the switch up to move it.*

3. Verify airspace clearances.
4. Push the throttle stick forward to lift off until the ZX5 is 5 m (16 ft) above ground.
When you release the stick, the ZX5 goes into *Hold* mode.
5. To start the flight, hold the **2.LEVEL** switch in the backward position and push the **CH/PH** switch forward.

Be prepared, at all times, to manually control the ZX5. Always observe the alignment and flight direction of the ZX5. For more information, see [Manually controlling the ZX5, page 68](#).

Monitoring and controlling the ZX5 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 tablet screen.
-

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 69](#).*

The RC receives and shows telemetry data from the ZX5, analyzes the telemetry data received from the ZX5, shows the telemetry data on the RC screen and, if required, sends audible messages to the operator about the state of the ZX5 components.

The top right corner of the remote control display shows the battery status of the remote control.

Telemetry data

Use the software on the remote control unit to view information about the connected ZX5.

Telemetry data is shown on the first three pages, which you can page through using menu keys 2 and 3.

Telemetry data page 1

Field	Description
<i>Voltage</i>	Voltage value of the ZX5 batteries. If the voltage drops below 14.0 V, an audible message warns "Warning, low battery".
<i>Capacity</i>	Spent battery capacity of the ZX5 batteries.
<i>Compass</i>	Compass alignment of the ZX5: 0° = N 90° = O 180° = S -90° = W
<i>Altitude</i>	Height related to the starting point.
<i>Distance</i>	Horizontal distance.
<i>Flight Time</i>	Flight time since motor start <hh:mm:ss>.

Telemetry data page 2

Field	Description
<i>Latitude</i>	Geographical latitude of the current GPS position.
<i>Longitude</i>	Geographical longitude of the current GPS position.
<i>Satellites</i>	Number of the current receiving satellites. The more satellites, the better the accuracy of the position.
<i>GPS Fix</i>	Quality of the specified position: 0D – No satellites, 1D – Up to 4 satellites 3D – 5 or more satellites Note – To use GPS mode, the ZX5 requires at least 3D fix.
<i>Position Acc</i>	Accuracy of position. A lower value means better accuracy of GPS functions.
<i>Speed Acc</i>	Accuracy of speed. A lower value means better accuracy of GPS functions.

Telemetry data page 3

Field	Description
<i>Speed</i>	Current flying speed.
<i>Current</i>	The current being used by the ZX5.
<i>Temperature</i>	Surrounding temperature in the ZX5.

In-flight announcements

Some conditions and events are announced via voice output. If there is a lot of noise around you, you can use earphones to understand better. The radio control provides a 3.5 mm connection.

During the flight the following announcements may occur:

Announcement	Action following the announcement
GPS OK	GPS satellite reception is very good. The GPS functions can be used.
GPS control	<i>Position Hold</i> flight mode is activated. The ZX5 maintains its position automatically.
Coming home	<i>Coming Home</i> function is activated. The ZX5 flies back to the starting point.
Easy Move Mode	<i>Easy Move</i> mode is activated.
Set rear orientation	<i>Go Ahead</i> function is activated. The ZX5 aligns itself once.
POI Mode	<i>POI</i> mode is activated.
Waypoint	<i>Waypoint</i> mode is activated.
Auto start	The ZX5 starts automatically.
Auto landing	The ZX5 lands automatically.
Attention: Emergency landing	The ZX5 conducts an emergency landing. The operator is able to readjust the position and height.
Warning: No flight recorder	There is no micro SD card (flight recorder) inserted.
Warning: No GPS	GPS functions are deactivated, due to very bad GPS satellite reception. The ZX5 now flies in manual mode, requiring the operator to hold the position of the ZX5.
Warning: Low battery	Battery voltage is reaching minimum level. Pay attention to the voltage and make sure to land the ZX5 before it reaches a voltage of 3.5 V per cell (equivalent to 14.0 V per battery).

Dealing with sudden weather changes during flight

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

Land the ZX5 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

Failsafes during flight

- [Loss of communication link during flight, with GPS reception, page 67](#)
- [Loss of communication link during flight, without GPS reception, page 67](#)
- [Low battery level, page 67](#)

Loss of communication link during flight, *with* GPS reception

If the ZX5 does not receive a communication packet for 1 second, it goes into *Hold* mode. If communication does not resume after 19 seconds (the total communication timeout value is 20 seconds), the ZX5 comes home and then activates an emergency landing. When the rover touches ground, the motors must be manually powered off.

If communication resumes during this automatic failsafe mechanism, the landing procedure is canceled. The ZX5 switches to *Hold* mode and can be operated as usual.



WARNING – After landing, the motors are idling, meaning that they spin at a low rate. To turn off the motors when there is no active communication link, carefully reach for the battery connections and disconnect the batteries from the ZX5.

Loss of communication link during flight, *without* GPS reception

If the ZX5 does not receive a communication packet for 1 second, the ZX5 automatically activates an emergency landing. When the rover touches ground, the motors must be manually powered off.

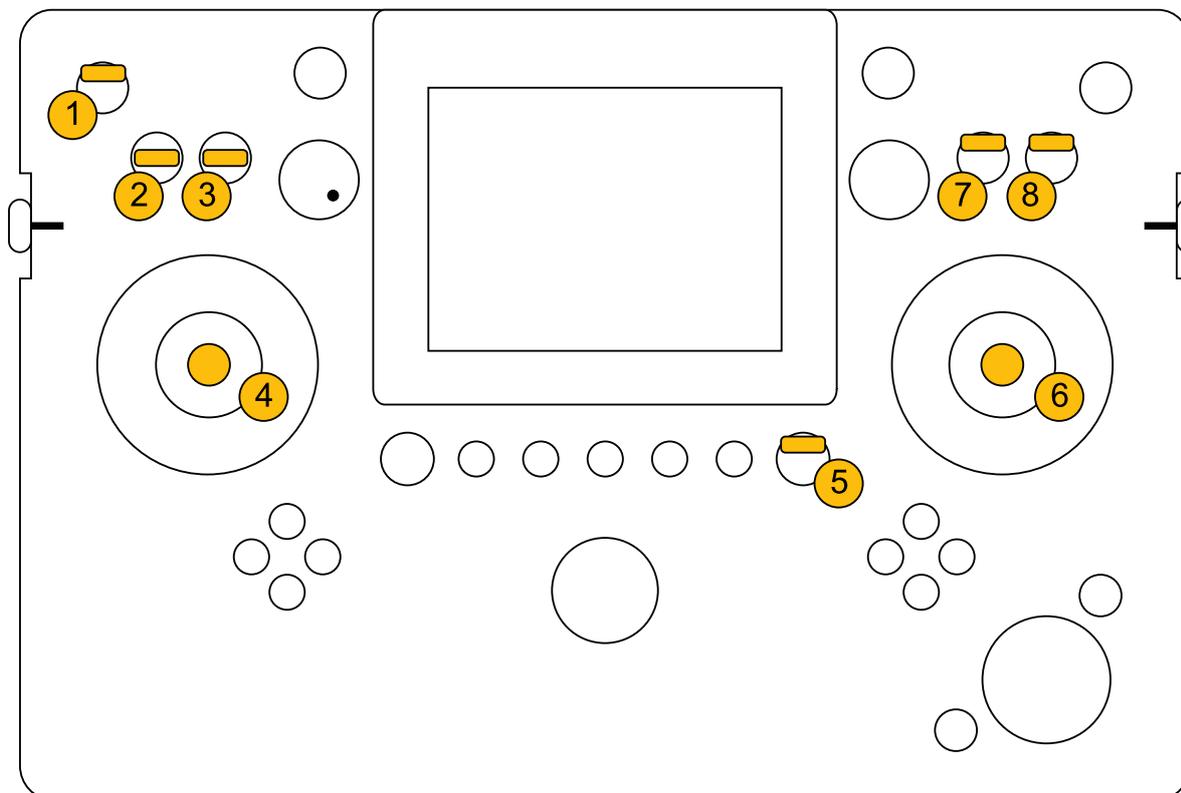


WARNING – After landing, the motors are idling, meaning that they spin at a low rate. To turn off the motors when there is no active communication link, carefully reach for the battery connections and disconnect the batteries from the ZX5.

Low battery level

If the battery voltage is 13.2 V or lower, the ZX5 goes into *Hold* mode and then activates an emergency landing. The operator can still control the rover using the right stick. When the rover touches ground the motors must be powered off using the remote control unit.

Manually controlling the ZX5



- | | |
|----------------------|--------------------------|
| ① 2.LEVEL | ⑤ MOTOR |
| ② EASY/AHEAD | ⑥ Direction stick |
| ③ LAUNCH/LANDING | ⑦ CH/PH |
| ④ Throttle/yaw stick | ⑧ MAG/ALT (do not touch) |

⚠ WARNING – The **MAG/ALT** switch on the remote control unit must be in the upper position at all times. By default, this switch is disabled but if used incorrectly it may confuse the system and cause loss of control of the ZX5. Failure to control the ZX5 can lead to a crash, resulting in equipment damage, property damage, or personal injury.?

Land

Move the **LAUNCH/LANDING** switch to the Landing (backward) position. The rover immediately terminates the flight plan and initiates a normal landing sequence.

To release *Land* mode and resume the flight plan, hold the **2.LEVEL** switch in the backward position and push the **CH/PH** switch forward. Move the **LAUNCH/LANDING** switch to the neutral position.

Land mode overrides all other modes except *Manual* mode.

Hold mode

The *Hold* mode can be activated and then deactivated in the following ways:

- Move the **CH/PH** switch to the neutral position. The rover immediately terminates the flight plan and hovers at its current location.

To release *Hold* mode and resume the flight plan, hold the **2.LEVEL** switch in the backward position and push the **CH/PH** switch forward.

- Move and release one of the sticks.

To release *Hold* mode and resume the flight plan, move the **CH/PH** switch to the neutral position, then hold the **2.LEVEL** switch in the backward position and push the **CH/PH** switch forward.

Home mode

Flip the **CH/PH** switch to the neutral position and then back to the upper position. The rover immediately terminates the flight plan and returns to the takeoff location.



WARNING – In *Home* mode, the ZX5 always takes the shortest, most direct way back to the starting location. Make sure the ZX5 is flying at an appropriate altitude, with no obstacles, before activating this mode.

To release *Home* mode and resume the flight plan, move the **CH/PH** switch to the neutral position, then hold the **2.LEVEL** switch in the backward position and push the **CH/PH** switch forward.

Manual mode

Move the sticks. The rover immediately terminates the flight plan and follows the direction of the sticks. Use the left stick to control the throttle (height) and yaw; use the right stick to control the direction. Each time you move one of the sticks, the ZX5 goes into *Manual* mode. Each time you release the sticks, the ZX5 goes into *Hold* mode.

Manual mode overrides all other modes.

To return to automatic flight and resume the flight plan, move the **CH/PH** switch to the neutral position, then hold the **2.LEVEL** switch in the backward position and push the **CH/PH** switch forward.

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.

The most common emergencies involve another aircraft entering the vicinity at approximately the same height as the ZX5.

Note – *Never assume that the aircraft has noticed the ZX5.*

To take evasive action:

1. Assess the situation.
2. Do one of the following:
 - Fly to a safe position using *Manual* mode.
 - Hover the ZX5 at its current position using *Hold* mode.
 - Return the ZX5 to its takeoff position using *Home* mode.

When the emergency situation is resolved, resume the flight plan.

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, land the ZX5 and then carefully check equipment for damage.

If at any time the ZX5 loses GPS signal, use the sticks to manually land the ZX5 (*Manual* mode). Reduce the throttle slowly and try to descend vertically. When the ZX5 is a few centimeters (1–2 inches) above ground, pull the throttle stick completely back to initiate touchdown of the ZX5. Once landed, push the **MOTOR** switch forward to immediately turn off the motors.

 **WARNING** – *Manual* mode without GPS control is suitable for advanced operators only. In windy situations the ZX5 can be pushed away, unless the operator navigates against it. Using this mode without the appropriate level of experience can cause loss of control, leading to a crash.

For more information, see [Manually controlling the ZX5, page 68](#).

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.*

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 ZX5

By default, the ZX5 lands automatically.

 **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.

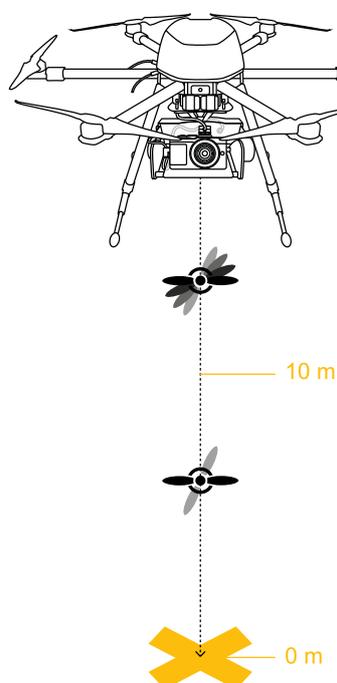
 **CAUTION** – If the ZX5 is not fitted with the camera, land manually. The lack of a camera changes the center of gravity of the ZX5 and relying on the ZX5 to land automatically may lead to a crash. For more information on how to land the ZX5 manually, see [Manual mode, page 69](#).

 **CAUTION** – On hilly ground the chosen landing place may be 10 m (33 ft) higher than the starting position. In this situation the ZX5 may descend too fast and touch ground with too much speed, which can cause damage. If you think the landing place may be higher than the starting position, land manually. For more information on how to land the ZX5 manually, see [Manual mode, page 69](#).

 **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.

After passing the last waypoint on the scan lines, the ZX5 terminates its flight plan and initiates a normal landing sequence. It flies at cruise height to the landing location, where it vertically descends at high speed until 10 m (33 ft) above the takeoff location and then reduces speed until it touches the ground.



After the ZX5 has landed, **turn off the motors**. To do this:

- Pull the throttle stick completely back and push the **MOTOR** stick to the backward position.
Note – This is a safety-lock switch. Pull the switch up to move it.

Completing the post-flight checklist

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

Note – Make sure that the batteries are connected to the ZX5 and the motors are powered off.

1. On the tablet, tap . The post-flight checklist wizard appears.
2. Connect the data cable to the tablet and to the data connector on the dome.
3. Tap  to check the cable connection.
If the cable connection is OK, the software automatically starts downloading the log file from the micro SD card in the dome to the tablet. When the download is finished, the  button is enabled.
4. Remove the data cable from the data connector on the dome and from the tablet.
5. Power off the system:
 - a. Power off the gimbal using the power switch.
 - b. Disconnect the batteries from the ZX5.
 - c. Power off the camera and install the lens protection cap.
 - d. Power off the remote control unit.
6. Remove the camera from the gimbal. 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 log (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 76](#).
 - 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 56](#)), or incorrect camera settings, contact your Trimble distributor.
7. Validate the block was successfully mapped during the flight.
8. 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.

4 Completing a Flight

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.

Analysis and Export

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

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 camera has no electronic communication with the external lens, the image properties (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

Note – 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 shutter feedback events recorded in the flight log file.
6. Click  to select the folder where you have stored the images for the flight.

The summary shows:

- the number of shutter feedback events recorded in the dome
- 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)

The ZX5 supports RGB images only.

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 56](#)), or incorrect camera settings, contact your Trimble distributor.*
7. Click .
 8. Navigate to the folder where you want to save the exported file. Enter the file name and then click **Export**.
 9. Click  to export another flight from the same project or click  to close the *Export* wizard.

Troubleshooting

- System errors and information
- Aerial Imaging software issues
- Calibrating the compass
- Technical support

System errors and information

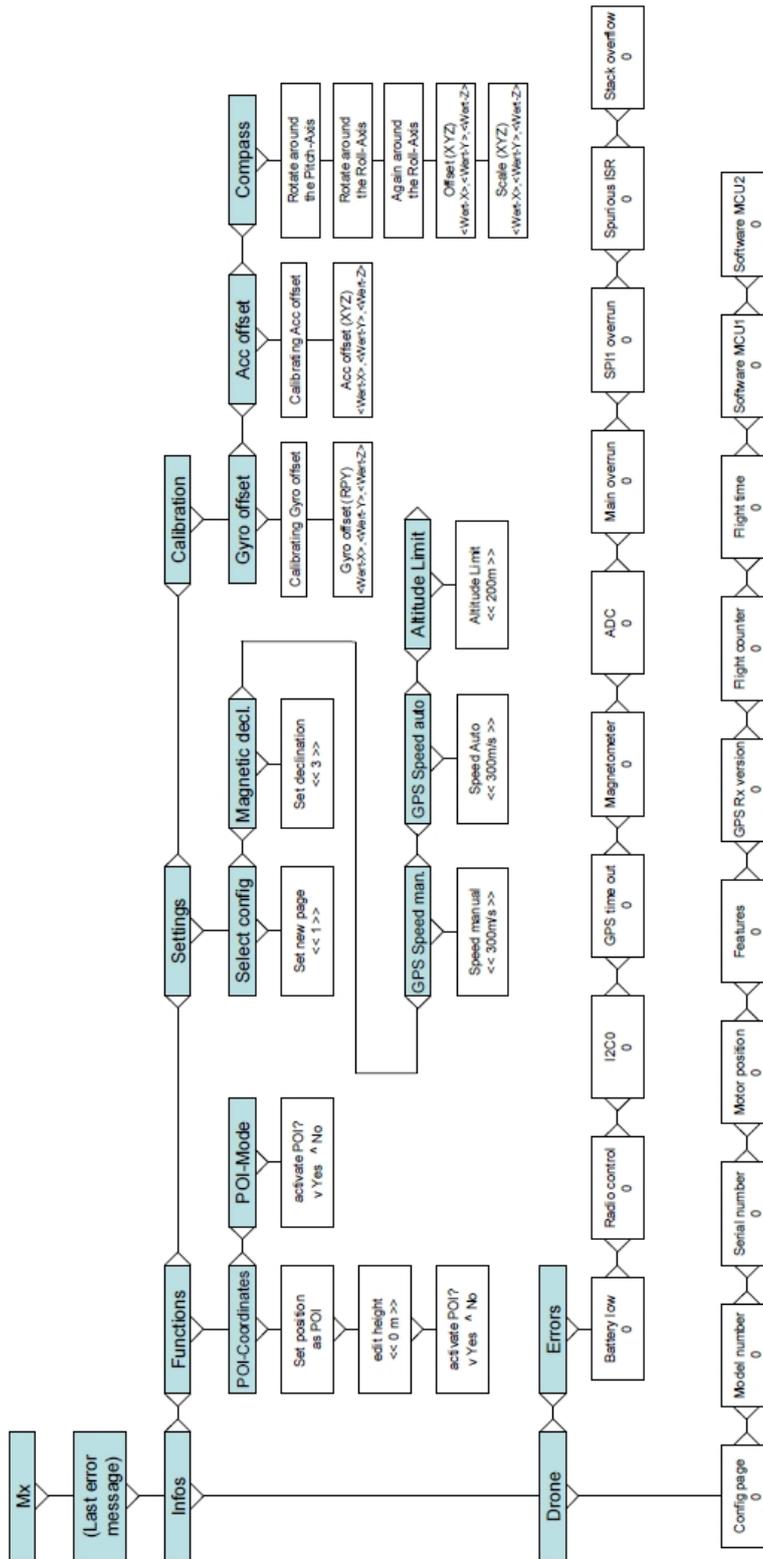
The most recent error and the number of error incidents can be viewed in the MX menu of the software on the remote control unit.

To view the MX menu:

1. On the remote control, use menu key **3** to page through the Telemetry data pages.
2. On Telemetry data page 4 (named "Jetibox"), press the **ESC** key, and then press menu key **2** twice to select the MX menu.
3. Press menu key **3** to enter the MX menu.

A diagram of the MX menu functions is shown below.

Mx-Menu ZX5 Remote Control



Menu item	Sub-menu item	Description
Calibration	<i>Gyro offset</i>	The ZX5 gyro sensors are calibrated on delivery. Do not change any settings without consulting Trimble.
	<i>Acc offset</i>	The ZX5 acceleration sensors are calibrated on delivery. Do not change any settings without consulting Trimble.
	<i>Compass</i>	Trimble recommends recalibrating the compass, along with setting the magnetic declination, before your first flight. For information on performing this procedure, see Calibrating the compass, page 81 .
 WARNING – If the gyro offset, acceleration sensors, or compass are incorrectly calibrated, the ZX5 cannot fly correctly.		
Infos Errors (Number of incidents)	<i>Battery low</i>	Battery voltage falls below 13.2 V during flight. This can occur if the flight was too long or the battery was strained. If this error occurs regularly, you should perform shorter flights or replace the battery pack.
	<i>Radio control</i>	Radio contact was temporarily lost during the last flight. This can occur if obstacles block the radio signal between the remote control unit and the ZX5 during flight.
	<i>I2CO</i>	Internal error.
	<i>GPS time out</i>	The GPS receiver delivers no data.
	<i>Magnetometer</i>	The magnetometer sends incorrect data.
	<i>ADC</i>	The analog digital converter sends incorrect data.
	<i>Main overrun</i>	Internal error.
	<i>SPI1 overrun</i>	Internal error.
	<i>Spurious ISR</i>	Internal error.
<i>Stack overflow</i>	Internal error.	

If any of these errors occur, please contract Trimble Support.

Menu item	Sub-menu item	Description
Infos Drone	<i>Config page</i>	Current configuration set. This should always show configuration 1.
	<i>Model number</i>	Shows the model number of the ZX5.
	<i>Serial number</i>	Shows the serial number of the ZX5.
	<i>Motor position</i>	Shows the current motor configuration of the ZX5.
	<i>Features</i>	Shows the GPS functions purchased for the ZX5.
	<i>GPS Rx version</i>	Shows the version number of the GPS receiver firmware installed on the ZX5
	<i>Flight counter</i>	Shows the number of flights completed by the ZX5.
	<i>Flight time</i>	Shows the overall flight time for the ZX5.
	<i>Software MCU1</i>	Shows the version number of the MCU1 processor in the ZX5.
<i>Software MCU2</i>	Shows the version number of the MCU2 processor in the ZX5.	

Aerial Imaging software issues

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.

Calibrating the compass



WARNING – If the compass is incorrectly calibrated, the ZX5 cannot fly correctly and may lead to loss of control of the ZX5. Failure to control the ZX5 can lead to a crash, resulting in equipment damage, property damage, or personal injury.

The compass must be recalibrated only in exceptional cases. Generally the calibration in the factory is sufficient.

If you notice that the ZX5 does not fly directly to a waypoint, but flies around it, it can mean that the compass is not calibrated correctly.

Testing the calibration of the compass

1. Take the ZX5 outside to a location where there are no metal objects within a 10 m (33 ft) radius.
2. Put the ZX5 on the ground and adjust it with the help of a commercially available compass so that the ZX5 faces toward north.

3. On the display of the remote control, telemetry data page 1, you should see a compass direction of about 0°. The tolerance is +/-2 degrees.
4. Tilt the ZX5 slightly to the front but keep it facing north. The display should change only very minimally.
5. Return the ZX5 to facing north and then tilt it to the left. The display should still remain at about 0°.
6. Turn the ZX5 90° to the right. The display should now show about 90°.
7. Turn the ZX5 again 90° to the right. The display should now show about 180°.
8. Turn the ZX5 again 90° to the right. The display should now show about -90°.

If any compass point is not displayed correctly (there is a difference of more than +/- 2°), the compass must be calibrated.

Calibrating the compass

1. In the extended menu select *Calibration – Compass*.
2. Press menu button 3 (arrow down) to display *Rotate around the Pitch-Axis*.
3. To calibrate the X-sensor, lift the ZX5 up, align it toward north and turn it around its pitch-axis until you hear a signal (peep). Now turn the ZX5 around this axis (at least one complete turn) and keep turning it until the signals stop. At the same time, move the ZX5 slightly to the left and right (about +/- 10 degrees).
4. Press menu button 3 (arrow down) again to display *Rotate around the Roll-Axis*.
5. To calibrate the Y-sensor, lift the ZX5 up, align it to 90° from north and turn it around the roll-axis until you hear a signal (peep). Now turn the ZX5 around this axis (at least one complete turn) and keep turning it until the signals stop. At the same time move the ZX5 slightly to the left and right (about +/- 10 degrees).
6. Press menu button 3 (arrow down) again to display *Again around the Roll-Axis*.
7. To calibrate the Z-sensor, lift the ZX5 up, hold it as before and turn it again around the roll-axis until you hear a signal (peep). Now turn the ZX5 around this axis again (at least one complete turn) and keep turning it until the signals stop. At the same time move the ZX5 slightly to the left and right (about +/- 10 degrees).
8. Press menu button 3 (arrow down) to display *Offset (XYZ)*.
9. Press the menu button 3 (arrow down) to display *Scale (XYZ)*.
10. Test the calibration as described above. If the display differs in just one of the four points of the compass, repeat the calibration process.

Technical support

If you have an issue or hear unusual signals, do not perform any further flights. Check the MX menu for the latest error message and then contact your Trimble distributor for more information.

Specifications and Settings

- Operation limitations
- ZX5 specifications
- Camera specifications
- Olympus E-PL7 camera settings
- Remote control specifications
- ZX5 battery safety

Operation limitations

The ZX5 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 97](#).*



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	Limit
Endurance	20 minutes
Flight time without payload	25 minutes
Maximum operational ceiling	3,000 m (9,843 ft) AMSL
Flight AGL range	20 to 750 m (66 to 2,460 ft)
GPS satellite tracking:	
<ul style="list-style-type: none"> • 3D position fix (GPS functions are activated) 	At least 4 satellites
<ul style="list-style-type: none"> • Accurate position data 	At least 6 satellites
Weather limit	Stable in winds up to 36 kph (22 mph)
Control frequency	2.4 Ghz
Video frequency	5.8 Ghz
Communication and control range	Up to 2 km (1.2 miles)
Operator-UAS visibility	Visual line of sight
Live video stream resolution	480i
Recordable video resolution	1080p30
Temperature	-10 °C to +45 °C (14 °F to 113 °F)

Note – *In low outdoor temperatures (less than 10 °C / 50 °F) the battery capacity reduces itself down to about 50 %. When using the ZX5 in very cold temperatures (less than 10 °C/50 °F), keep the ZX5 and the batteries in a warm environment for as long as possible before the flight.*

ZX5 specifications

Rover



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

Feature	Specification
Maximum takeoff weight (MTOW)	5 kg (11 lbs)
Payload capability	2.3 kg (5 lbs)
Dimensions	85 x 49 cm (33 x 19")
Type	Rotary wing
Propulsion	Electric pusher propeller, 6 brushless motors
Launch and recovery	Vertical takeoff and landing

System performance information

Feature	Specification
Climb rate	Approx. 8 mps (26 fps) with gimbal and camera
Descent rate:	
<ul style="list-style-type: none"> • Auto landing <ul style="list-style-type: none"> • Down to 10 m: 3 mps (9.8 fps) • Below 10 m: 0.9 mps (3 fps) • Manual descent: No limit 	<p>Note – If stick is fully down during manual descent then motors are idle and the ZX5 crashes to the ground.</p>
Turn rate	Approx 120°/s
Minimum cruise speed	No limit
Propeller pitch	15.5 x 5.5

Power/battery specifications

Feature	Specification
Battery type	Lithium polymer
Nominal energy capacity	6250 mAh
Nominal voltage	14.8 V
Maximum voltage	16.8 V
Storage voltage	15.6 V
Battery charging current	5 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)
<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	505 g (1.1 lbs) each; 1.1 kg (2.2 lbs) battery pack

Camera specifications

The camera has the following specifications.

Camera body

Feature	Specification (Olympus E-PL7)
Effective pixels	16.05 megapixels
Image sensor	4/3-inch Live MOS sensor
Shutter speed	1/4000 – 60 seconds
ISO sensitivity	ISO 200 – 25600, AUTO (ISO 200 – 1600)
Display	7.5 cm (3.0 ") tilting LCD monitor
Dimensions (width x height x depth)	114.9 x 67 x 38.4 mm (4.5 x 2.6 x 1.5 ")
Weight (body only)	309 g (0.7 lb)
Battery charging time	Approximately 210 minutes (if fully discharged)

Camera lens

Feature	Specification 14 mm
Focal length	14 mm (0.55 ")
F-aperture	2.5 – 22
Angle of view	75°
Filter size (diameter)	46 mm (1.8 ")
Maximum diameter	55.6 mm (2.2 ")
Length	20.5 mm (0.8 ")
Weight	55 g (0.12 lb)

Olympus E-PL7 camera settings

Refer to the documentation provided with the camera for camera operation instructions. However, to obtain good aerial images using the Olympus E-PL7 camera, Trimble recommends changing the camera settings to the following:

1. Set the *Mode* dial to **M** (manual mode).
2. Press the **Menu** button, select the *Setup* menu and do the following:
 - a. Set the correct date and time (Trimble recommends using UTC format).
 - b. Set *Rec View* to **Off**.
 - c. Set *Wi-Fi* to **Off**.
 - d. Make sure *Menu Display* is set to **On**, so that you can view custom menus.
3. Navigate to the *Custom* menu and do the following:
 - a. Select *AF/MF* and then set *MF Assist / Magnify* to **Off** and *Reset Lens* to **On**. This resets the lens to focus on infinity each time the camera is turned on.
 - b. Select **Exp/ISO** and then set the *ISO-Auto Set / High Limit* to **1600**.
 - c. Select **Disp/PC** and then set the *Sleep* option to **Off**.
4. If you do not want to manually have to press the shutter switch on the remote control unit to capture photographs, you can set photos to be captured at regular intervals. To do this, navigate to *Shooting menu 2* and select *Time Lapse Settings*.

You can set an interval of photos, for example 30 pictures every 2 seconds. You can trigger the interval with the shutter on the remote control. The interval can be restarted using the remote control shutter switch as soon as the previous interval is finished or if the number of photos which are set for the interval is high enough, then you will need to trigger the interval using the shutter switch only once per flight.

5. Exit the Menu screens to return to Shooting mode. Press the **OK** button to view the information display and use the control panel to set the following:
 - a. Set the *Image stabilizer* option to **Off**.
 - b. Set the *Image quality* option to **LF**.
 - c. Set the *Flash* mode to **Fill-in flash**.
 - d. Set the *Brightness* (metering) to **ESP**.
 - e. Set the *Focus* mode to **MF** (manual).

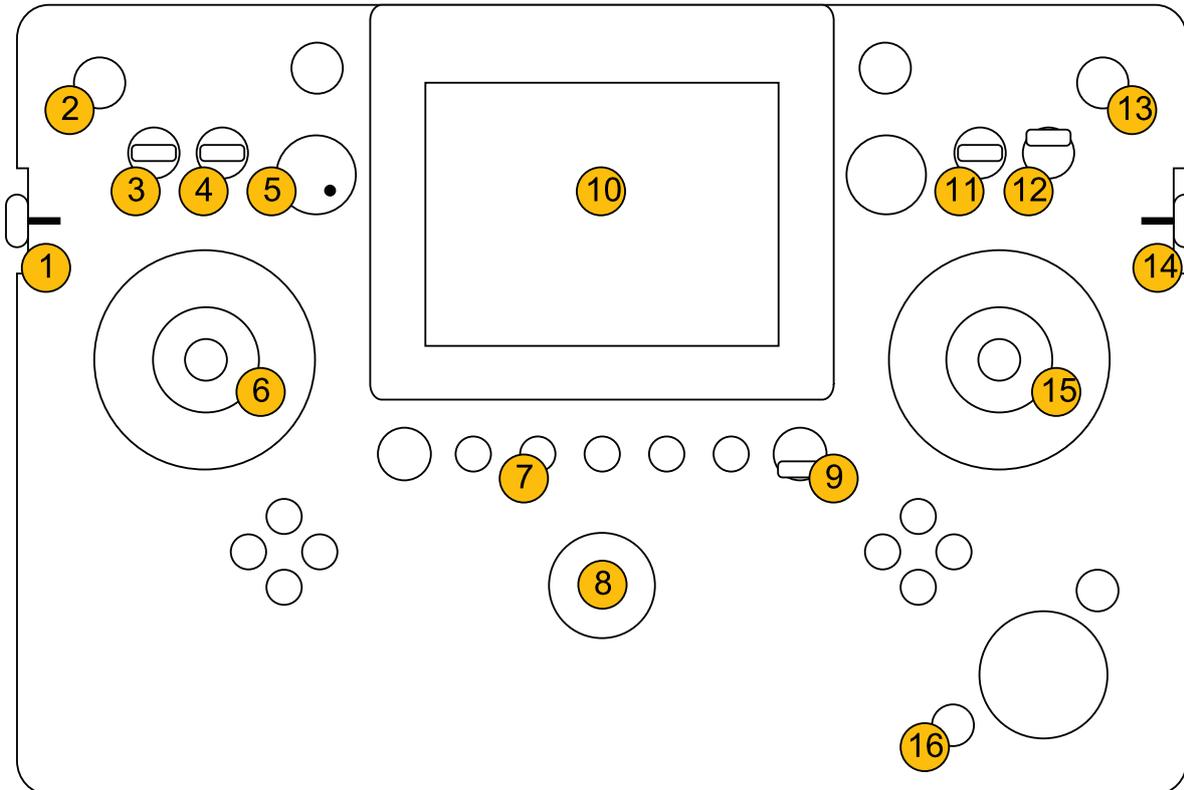
Note – Setting focus to manual and using a large depth of field gives better results than using auto focus. Resetting the lens to focus on infinity (step 3a above) and using the recommended ISO settings (below) gives a large depth of field.
 - f. Set the ISO settings to a minimum shutter speed of **1/500** with an f-stop value at **5.6** (minimum **4.0**).
 - g. Set the *Face priority* mode to **Off**.

Remote control specifications

Jeti DC16

Feature	Specification
Dimensions	235 x 270 x 40 mm (9 x 10 x 1.6")
Weight (including handrest, halter neck and straps)	1.5 kg (3.3 lbs)
Operating voltage	3.4 V
Frequency	2.4 GHz
Range	3000 m (9,842 ft)
Steering function	12
Power input	400 mA
Antenna	Patch

Jeti DC16 controls



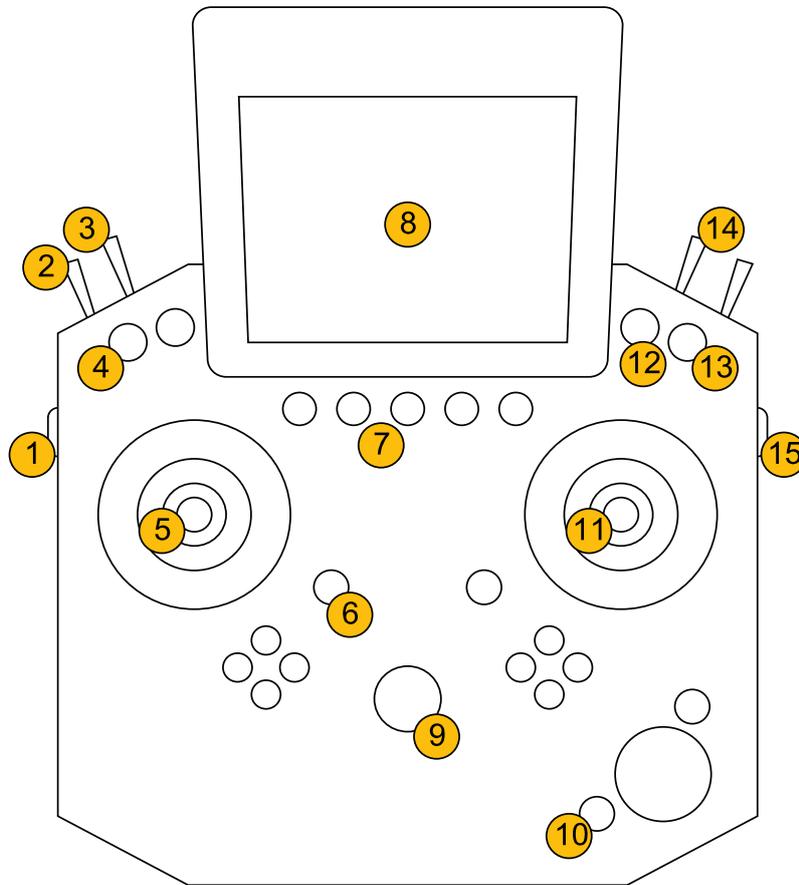
- | | |
|--------------------------------|--|
| ① TILT lever | ⑨ MOTOR safety-lock switch |
| ② 2.LEVEL spring-loaded switch | ⑩ Display |
| ③ EASY/AHEAD switch | ⑪ CH/PH switch |
| ④ LAUNCH/LANDING switch | ⑫ MAG/ALT switch
(must always be in upper position) |
| ⑤ Volume control | ⑬ SHUTTER spring-loaded switch |
| ⑥ Throttle and yaw stick | ⑭ ZOOM lever |
| ⑦ Menu keys 1–5 | ⑮ Direction stick |
| ⑧ Power key | ⑯ ESC key |

Note – Switches ③, ④, and ⑪ can be set to three positions: up, neutral, back.

Jeti DS14

Feature	Specification
Dimensions	194 x 233 x 40 mm (7 x 9 x 1.6")
Weight (including handrest, halter neck and straps)	1.25 kg (2.8 lbs)
Operating voltage	3.6 V
Frequency	2.4 GHz
Range	3000 m (9,842 ft)
Battery	Lithium ion 3200 mAh
Graphic display	320 x 240 px (3.8")
Antenna	Patch

Jeti DS14 controls



- | | |
|------------------------------|----------------------|
| ① TILT lever (6) | ⑨ POWER key |
| ② LAUNCH/LANDING switch (SA) | ⑩ ESC key |
| ③ 2.LEVEL switch (SB) | ⑪ Direction stick |
| ④ EASY/AHEAD switch (SC) | ⑫ CH/PH switch (SE) |
| ⑤ Throttle and yaw stick | ⑬ MOTOR switch (SF) |
| ⑥ Volume control | ⑭ SHUTTER lever (SG) |
| ⑦ Menu keys 1-5 | ⑮ ZOOM lever (5) |
| ⑧ Display | |

ZX5 battery safety

WARNING – *Never leave the charger unattended during use* and do not leave a battery to charge overnight. Place the battery on a fireproof base during charging and remove highly combustible materials from around the battery. Failure to observe and operate the charger properly can cause damage to the charger, battery, personal property and/or cause serious personal injury.

WARNING – If at any time you observe the battery swelling or ballooning while charging, *immediately* disconnect the charger and observe the battery carefully in a safe place away from flammable materials. If the battery balloons or expands, it cannot be used again and must be disposed of safely.

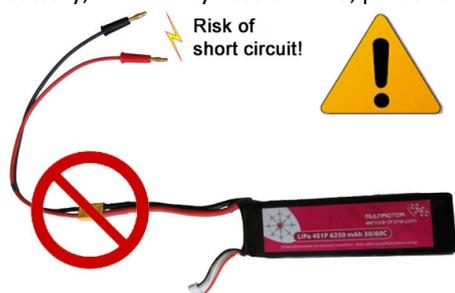
WARNING – Do not charge or use a damaged battery. Damage to the battery can cause fire or the emission of hazardous vapors when the battery is being charged or is in use.

WARNING – Allow the charger and the battery to reach room temperature before connecting the charger to mains power and using it. This may take several hours.

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 pack.
- Use the charger to charge only ZX5 battery pack.
- Do not use or charge a battery pack if the battery pack, charger or charging cables appear damaged.
- 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 pack from the ZX5 body for charging or storing.
- Do not attempt to recharge the battery if it is still fully charged.
- Do not recharge the battery directly after use. Always wait until the batteries have cooled down first.

WARNING – Never connect the battery power adapter cable to the battery without first connecting the adapter cable to the charger. Connecting the adapter cable to the battery risks short-circuiting the battery, which may result in fire, personal injury, or damage to property.



WARNING – LiPo batteries should never be stored at full charge for more than a few hours at most.

WARNING – Always fully charge the batteries before each flight. Only insert fully charged batteries into the ZX5. Using partially charged batteries will significantly reduce the flight time.



CAUTION – Do not separate the battery pack. Always use the complete battery pack for the lifetime of the poorest battery. Attempting to separate the battery pack will damage the batteries.



CAUTION – Always connect the balancer cable to the battery before charging. Failure to connect the balancer cable can cause the lithium polymer cells to overload, damaging the battery.

First aid measures

- **Emergency overview:** Burning and disassembly batteries may emit acrid smoke, irritating fumes, and toxic fumes of hazardous oxides of carbons, hydrofluoric acid and other toxic by-products.
- **Eyes:** Rinse thoroughly with plenty of water for at least 15 minutes. If symptoms persist, call a physician.
- **Skin:** Remove contaminated clothing and thoroughly wash with soap and plenty of water. If irritation persists, consult a physician.
- **Ingestion:** Swallowing a battery can be harmful. Contents of an open battery can cause serious chemical burns of the mouth, esophagus, and gastrointestinal tract. If open battery is ingested, do not induce vomiting or give food or drink. Seek medical attention immediately.
- **Inhalation:** Remove to fresh air. If breathing difficulty or discomfort occurs and persists, see a medical doctor. If breathing stopped, give artificial respiration and see a medical doctor immediately.

Unusual fire and explosion hazards

Cells or batteries may ignite or leak potentially hazardous organic vapors if exposed to excessive heat or fire. 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. Possible formation of hydrogen fluoride (HF) and phosphorous oxides during fire.

During water application, caution is advised as burning pieces of flammable particles may be ejected from the fire.

Hazardous decomposition products

When burned, hazardous products of combustion including fumes of carbon monoxide, carbon dioxide, and fluorine can occur.

Accidental release measures

- **Personal precautions:** Evacuate personnel to safe areas, ventilate the area, and refer to protective measure.
- **Environmental precautions:** Sweep up and place in a suitable container, dispose of waste according to local, state and federal laws and regulations.

Handling

- **Battery charge:** Charge according to manufacturer's specifications.
- **Battery disassembly:** The batteries should never be disassembled, or mechanically abused. Should a battery unintentionally open, thus releasing its content, rubber gloves should be used to handle battery components. The inhalation of any vapor that may be emitted should be avoided.
- **Short circuiting of a battery:** As with any battery, short circuit causes heating. In addition, short circuit reduces the life of the battery and can lead to ignition of surrounding materials. Physical contact with short-circuited battery can cause skin burns.
- **Reverse polarity:** Avoid reversing the battery polarity within a battery pack. This can cause the battery to be damaged or to ignite.

Country-Specific Regulatory Information

- FAA conditions and limitations of operation

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 Navigation Limited ZX5 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 ZX5 technician returning the ZX5 to service.
12. ZX5 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 ZX5 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 ZX5 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 ZX5 as an operator during the Type Rating module
- Minimum 2 flights on the ZX5 as visual observer during the Type Rating module
- When failed: Minimum 4 flights on the ZX5 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 (20 min).
 - One flight with a minimum measured wind speed of 18 kph (11.2 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 ZX5 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

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](#).

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.

block

A single polygonal area that defines the geographical area to be photographed at a defined overlap and GSD during a flight.

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](#).

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.

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.

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.

scan area

The block 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.