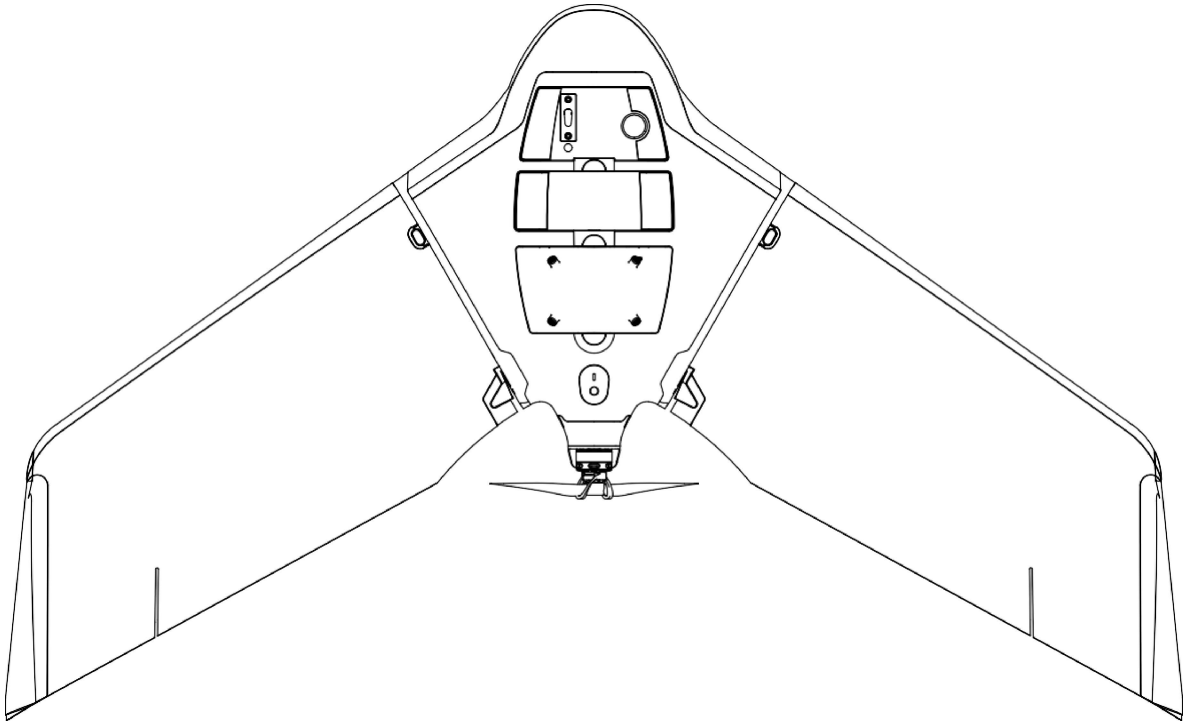
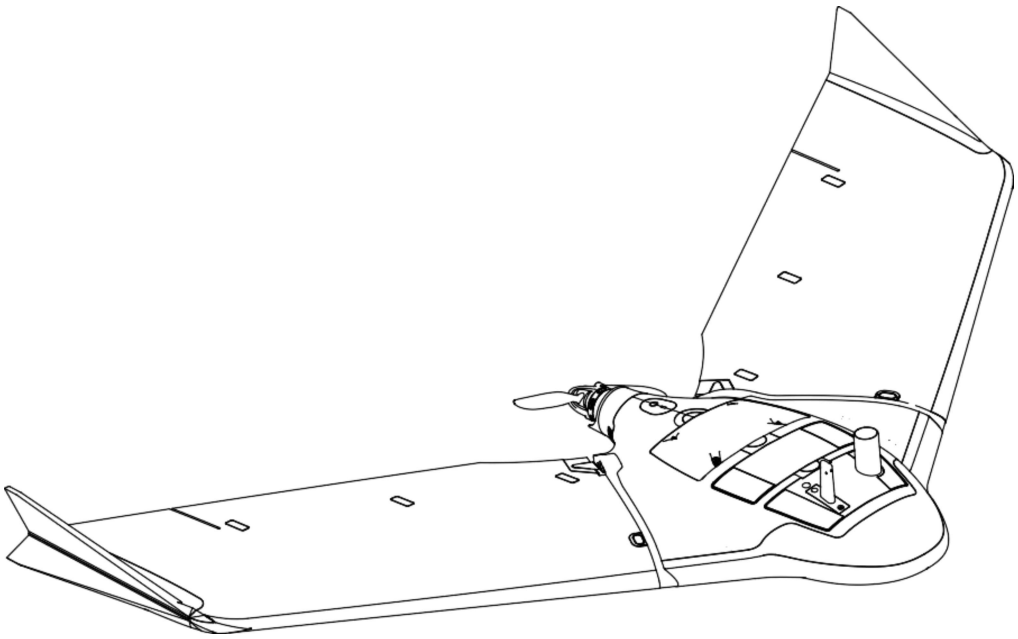
eBee X series drone User Manual

Revision 2.9 / February 2023



senseFly
AN AGEAGLE COMPANY

Welcome to your eBee X series drone



Congratulations on your purchase of your *eBee X series drone*, a large-coverage photogrammetric mapping system for survey-grade accuracy on demand.

*eBee X series drone*s include built-in RTK/PPK functionality that can be activated either out of the box or later when required, providing you with survey-grade accuracy, without the need for ground control points.

*eBee X series drone*s are compatible with different professional-grade cameras, all of which are optimised for professional drone photogrammetry. With *eBee X series drone*s, capture amazingly sharp aerial photos across a range of light conditions and produce detailed, vivid orthomosaics and highly precise digital surface models.

We take great care to develop and design the best possible hardware and software tools for quick, high-quality and easy-to-use 2D and 3D aerial mapping.

Contents

1 GENERAL INFORMATION

READ ALL USER MANUALS CAREFULLY BEFORE USING A SENSEFLY PRODUCT. USER MANUALS ARE AVAILABLE ON MY.SENSEFLY WEBSITE AND ON eMotion.

senseFly products (the "Product(s)") are intended for professional use only.

Always comply with Civil Aviation regulations and other applicable laws, act responsibly and follow the instructions in your senseFly User Manuals.

Civil aviation regulations

senseFly products ("Product(s)") are subject to Civil Aviation regulations. Regulations may vary depending on the country where you intend to operate your Product.

ALL USE OF THE PRODUCT INCLUDING, BUT NOT LIMITED TO, THE USE CONFORM TO THE APPLICABLE LAW OF THE COUNTRY IN WHICH THE PRODUCT IS OPERATED, IS UNDER THE CLIENT'S SOLE RESPONSIBILITY.

THE CLIENT SHOULD INFORM HIMSELF/HERSELF/THEMSELVES BEFORE USING THE PRODUCT. SOME COUNTRIES MAY HAVE LAWS THAT LIMIT THE USE OF UNMANNED AIRCRAFTS TO "LINE-OF-SIGHT" OPERATIONS AND/OR PROHIBIT THE USE OF UNMANNED AIRCRAFTS IN SOME SPECIFIC AREAS.

Other laws and regulations - privacy

Recording and circulating an image of an individual, a building or a creative work may constitute an infringement of the image rights, privacy or of intellectual property rights including copyrights of the author/owner for which you can be liable. Ask for authorisation before taking pictures of an individual, a building or creative work protected by intellectual property rights, particularly if you want to keep your recording and/or circulate images on the web or any other medium. Do not circulate degrading images or ones that could undermine the reputation or dignity of an individual. Do not use your Product for espionage purposes. Always comply, when using your Product and cameras on board, with applicable laws and regulations including but not limited to, laws and regulations on privacy, intellectual property rights and national security in the country where you operate your Product.

Compliance with Export Control Regulations

Products may be subject to export control regulations in which case:

- The Product must not be used to design, develop, manufacture or use any military equipment or any nuclear, chemical or biological weapons, nor missiles classified under the U.S. Munitions List, the Common Military List of the European Union and the Wassenaar Arrangement Munitions List.
- The Product must not be exported, re-exported, sold or transferred, either directly or indirectly, to any military end-user (defined as a national armed organisation) or to anyone else if the Client is aware that the Product will be subsequently exported or transferred to a military end-user.
- The Client must comply with the dual use regulations if such regulations apply.
- The Client must declare that he/she/they is/are not a "Person subject to Sanctions" and must not export, re-export, sell or transfer the Product, either directly or indirectly, to any "Persons subject to Sanctions". A "Person subject to Sanctions" is defined as any person, company or entity appearing on the list of specially designated persons established by the Security Council of the United Nations, the United States of America and the European Union.
- The Product must not be exported, re-exported, sold or transferred, either directly or indirectly to any "Country subject to Sanctions". A "Country subject to Sanctions" is defined as any country subjected to international economic sanctions adopted and applied by the Security Council of the United Nations, the United States of America and the European Union.

Limited warranty

The Supplier warrants that the delivered items will be free from defects in workmanship and materials for a period of twelve (12) months from the date that the item was first purchased by the client. During the Warranty Period, should the covered Product, in the Supplier's sole opinion, malfunction due to any defect in material and/or workmanship, the Client's sole remedy and the Supplier's sole liability shall be, at Supplier's option, to either repair or replace the malfunctioning Product with a similar product at no charge, or if repair or replacement is not possible, issue a credit note; provided that the malfunctioning Product is returned in accordance with the support and repair form together with all required flight logfiles, with proof of purchase in the form of the Client's original copy of the sales receipt, within the applicable Warranty Period.

Warranty does not apply, without limitation, in case: a) the delivered items are not stored, maintained or used according to their specifications, b) the delivered items are damaged due to carelessness, misuse, negligence, or wrong use by the user, c) of defects due to normal wear and tear including, but not limited to, normal degradation, misuse, moisture or liquids, dust, proximity or exposure to heat, contact with chemical agents, salt water, or other corrosive agents, accidents, excessive strain, abuse, neglect, misapplication, repairs or modifications made by third party other than senseFly, damage due to pilot error (associated, for example, with the use of manual, assisted or interactive flight modes), damage occurred while an encryption mode is in use, damage due to take-off or landing location with obstacles, damage due to low altitude or close object flight, damage due to lack or absence of data radio connection, damage due to strong wind, rain, water, humidity, corrosion, condensation, salt or other causes for which senseFly is not answerable and d) failure to properly update the flight control software and firmware. Any claim related to in-flight malfunction of the Product will be considered by senseFly only if accompanied with all related flight logfiles. Battery cells are excluded from warranty after first use.

The warranty shall be subject to the condition that the Client submits the Product, every 100 hours of Product flight, to the Supplier or to a Supplier-Authorised Service Centre for a service in accordance with maintenance schedules and service instructions available at Client's account on https://my.sensefly.com. A service may be performed in advance provided however that the next service is performed within the above mentioned time interval. It is the Client's own responsibility to monitor the number and duration of flights and decide when the maintenance check must be performed.

Any cost in relation with scheduled maintenance and service instructions, other than the return shipping costs, shall be borne by the Client only. The Product is always shipped at Client's sole risk, even in case of free delivery. The Supplier is responsible for loss or damage to the Product only when the Product is in the Supplier's premises.

The Client shall make available to the Supplier, at the Supplier's request, all data regarding the Product's flight and maintenance parameters. The Client further agrees and acknowledges that the Supplier is entitled, at any time, to access, analyse and use all data available on the Client's Account regarding the flight and maintenance parameters. If such data are not available for a reason over which the Supplier has no control or responsibility, including but not limited to an external service provider issue, network fault or power failure, the Supplier is under no obligation to provide the Limited Warranty coverage until such data is made available.

It is the Client's responsibility to check that the Product's airworthiness and level of maintenance are compliant with applicable requirements under local laws and regulations. Additional maintenance may be required by international or governmental authorities and the Client should make any and all necessary checks before operating the Product.

There are no express or implied warranties, representations or conditions other than those stated in this Limited Warranty. This Limited Warranty is made in lieu of all other warranties, representations or conditions, whether expressed or implied, including without limitation, merchantability or fitness for a specific purpose.

The remedy set forth herein shall be the sole, exclusive remedy with respect to the Product.

Limitation of liability

UNDER NO CIRCUMSTANCES WILL THE SUPPLIER BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES (EVEN IF THE SUPPLIER IS NOTIFIED OF THE POSSIBILITY OF SUCH DAMAGES) INCLUDING, BUT NOT LIMITED TO, ANY CRASH OR DAMAGES CAUSED BY THE CLIENT OR A THIRD PARTY WHILE OPERATING OR USING THE PRODUCT(S) (INCLUDING SIMULTANEOUS FLIGHTS OF PRODUCTS USING A SINGLE INSTANCE OF THE SOFTWARE, ENCRYPTION MODE) AND ANY DAMAGES CAUSED BY FAILURE OF THE AUTOPILOT, ELECTRONICS OR SOFTWARE (EVEN IF CAUSED BY A MALFUNCTION OF THE PRODUCT, AUTOPILOT, ELECTRONICS OR SOFTWARE), ANY LOSS OF REVENUE, LOSS OF PROFIT, OR LOSS OF DATA WHETHER BASED UPON ANY ALLEGED BREACH OF WARRANTY, REPRESENTATION OR CONDITION, CONTRACT, OR ANY OTHER CONDUCT INCLUDING NEGLIGENCE (INTENTIONAL OR OTHERWISE), GIVING RISE TO SUCH CLAIM. THE CLIENT SHALL NOT OPERATE THE PRODUCT(S) IN AREAS OR UNDER CIRCUMSTANCES WHERE A FAILURE COULD CAUSE DAMAGES AND/OR HARM TO PEOPLE, PROPERTY AND/OR ANIMALS.

Intellectual property rights

senseFly Products and software are protected by intellectual property rights. senseFly is the proprietor and legal and beneficial owner and/or the authorised licensee of any intellectual property rights within the Products, and senseFly is entitled to the benefit of all applications made for the grant of senseFly Intellectual PropertyRights.

senseFly, eBee, albris and related logos are registered trademarks of senseFly. You may not use or register, in whole or in part, registered trademarks without express authorisation from their respective owners.

FCC and IC Compliance statements

This device complies with part 15 of the FCC Rules and Industry Canada License-exempt RSS standard(s).
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.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide a reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and uses in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

1. Reorient or relocate the receiving antenna
2. Increase the separation between the equipment and the receiver
3. Connect the equipment into a an outlet on a circuit different from that to which the receiver is connected
4. Consult the dealer or an experienced radio/TV technician for help.

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

This equipment complies with FCC's radiation exposure limits set forth for an uncontrolled environment under the following conditions:

1. This equipment should be installed and operated such that a minimum separation distance of 20 cm is maintained between the radiator (antenna) and user's/nearby person's body at all times.
2. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Declaration of Conformity (DoC)

senseFly SA, Route de Genève 38, 1033 Cheseaux-Lausanne, Switzerland, declares under its sole responsibility that the product described in this user guide conforms with technical standards EN300328, EN303413, EN301489-1, EN301489-17, EN301489-19, EN62321,EN62368-1 in accordance with the provisions of the RED Directive 2014/53/UE, the RoHS Directive 2011/65/UE and the Delegated Regulation (EU) 2019/945 on Unmanned Aircraft Systems.

Disposal of this product at the end of its life

At the end of this Product's life, please do not dispose of this Product in your general household waste. Instead, in order to prevent possible harm to the environment or human health from uncontrolled waste disposal, please dispose of this Product separately in accordance with your local laws and regulation. For more information on the separate collection systems for waste electrical and electronic equipment that are available for consumers, near your home, free of charge, please contact your local municipal authority.

You can also contact senseFly or the reseller from which you purchased your drone who may provide recycling services or be part of a recycling scheme.

ANATEL - Brazil

ANATEL
Agência Nacional de Telecomunicações

06072-19-05976

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

Este equipamento não tem direito à proteção contra interferência prejudicial e não pode causar interferência em sistemas devidamente autorizados.

Hazard warnings

Take care with sharp edges

Keep clear of rotating blades

Do not misuse batteries: risk of fire

Beware of objects above you

Copyrights

Acknowledgements

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Address

senseFly SA
Route de Genève 38
1033 Cheseaux-Lausanne
Switzerland

Website: https://www.sensefly.com

Technical support

senseFly and our resellers are dedicated to providing you with full professional product support. To submit a support ticket and/or view your outstanding tickets, please use our customer portal my.senseFly (http://my.senseFly.com). Log in with the same account details you used to download your drone's software (see the separate software information document in your *eBee X series drone*'s case).

In addition to support access, my.senseFly includes:

- Details of all your senseFly drones, including their serial numbers.
- The Knowledge Base – packed full of helpful articles, tips, tutorials and webinars.
- Download links for the latest versions of our software.

2 European Open Category - C2

Since the 1st of January 2021, in relation with the introduction of the new European regulation, before flying your drone in the single European sky, you are submitted to a registration obligation and must display your registration number clearly on your drone. You are also submitted, at least, to an obligation to follow an online training and to pass the associated theoretical examination. For additional information of the matter, we are inviting you to take contact with your local aviation authorities. In particular, we advise you to keep up to date with the website of the following authority: www.easa.europe.eu/easa-and-you/civil-drones-rpas

To support the drone community in the safe operation of their drones, EASA is putting at everyone's disposal leaflets covering the main safety points related to drones in class from Class 0 to Class 6. The leaflets highlight the do's and don'ts for drone operators and pilots. You will find them in the packaging of any drone you buy – or you can download from this website. We encourage you to take full advantage of this material.
www.easa.europa.eu/document-library/general-publications/drones-information-notices

- **Open category Class 2 certified models**
  - The following models are C2:
    - eBee X
    - eBee AG
    - eBee GEO
    - eBee TAC Public Safety (the covert mission mode is not available on this version)
  - The following firmware shall be installed on the UA:
    - 3.22.0 or newer

- **Fly into the Open category – Class 2**
  - Add a payload and/or exceed the indicated MTOM in any way make the C2 certification invalid.
  - For an Open C2 flight, the operator must fill his own operator ID number given by his local regulation office:
    - Open the "Options" tab in the function tabs panel of eMotion.
    - Open "Regulatory preferences" and enter the ID in the first line.

- **Remote ID (The drone is by default equipped with a broadcast Remote ID feature)**
  - Purpose: To implement privacy by design and by default, and data controllers to carry out data protection impact assessments where processing operations present specific risks to the rights and freedoms of data subjects (i.e., citizens) by virtue of their nature, scope or purposes. The DRI data messages shall be then transmitted in plain text without encryption.
  - Wi-Fi beacon protocol: The transmission protocol is in conformity with IEEE 802.11 standard.
    - Wi-Fi 802.11 frame is type 0 and sub-type 8;
    - frequency band is Wi-Fi 2400 to 2483.5MHz.
  - List of broadcasting info: UA unique serial number, UAS Operator Registration Number, the timestamp, the position, the height, the speed, the direction, the emergency status of the UA, the position of the remote pilot (or take-off point). As a consequence, this document does not cover the Remote Pilot/Operator privacy and data protection by design, and by default.

- Refresh rate: Every 100 ms.

- Channel:
  - Channel: 6 (2437 MHz)
  - Bandwidth: 20 MHz
  - Harmonized standard: ETSI EN 300 328

- **Basics instructions for UA Operation in the Open Category**
  - Keep your UA in line of sight
  - Remain under 120m AGL
  - Keep a minimum horizontal distance from uninvolved people of 30 meters

- **Remote Pilot competencies**
  - You need to familiarize yourself with the manufacturer's instructions
  - You need to complete an online training and pass an online exam (this should be possible on your National Aviation Authority website)
  - You need to identify a safe area that meets the requirements for subcategory A3 (an area where no uninvolved persons are present in the range of the drone, at least 150 m away from residential, industrial, or commercial areas) and conduct a practical self-training
  - After those points, you can contact your National Aviation Authority to take an additional theoretical exam

- **Lighting considerations for operations in the Open Category**
  - Daytime flight
    - Without extra green flashing lights, you can fly when lighting conditions are sufficient.
  - Night flight
    - Night means the hours between the end of evening civil twilight and the beginning of morning civil twilight as defined in Implementing Regulation (EU) No 923/2012.
    - Green flashing lights are required for night flights in the EU Open category. Without lights, the eBee is not allowed to operate at night in this category[1].

- **Photos/Videos**
  - Do not infringe on other people's privacy. Before taking photos or videos, you must have the authorization of the people and/or the owner of the overflown field.

[1] Only light add-ons provided by senseFly and installed according to senseFly's instructions can be used to comply with the C2 requirement for night flights

3 SENSEFLY eBee X series

eBee X
The characteristics of the eBee X are described in this manual.
The winglets and stickers are yellow.
Compatible sensors: all the SenseFly payloads available (list in section *Compatible payloads* on page 83)

eBee Geo
The characteristics of the eBee Geo are described in this manual.
The winglets and stickers are blue.
Compatible sensors: S.O.D.A. multispectral camera

eBee Ag
The characteristics of the eBee Ag are described in this manual.
The winglets and stickers are red.
Compatible sensors: Duet M multispectral camera

eBee TAC Governmental
The characteristics of the eBee X are described in this manual.
The EPP is white/grey and black.
The winglets and stickers are grey.
Compatible sensors: all the SenseFly payloads available (list in section Compatible payloads on page 83)
Extra security features:

- Radio data link with AES-256 encryption
- Drone log file suppression
- Encrypted SD card
- Silent radio mission

eBee TAC Public Safety
The characteristics of the eBee X are described in this manual.
The EPP is Black.
The winglets and stickers are grey.
Compatible sensors: all the SenseFly payloads available (list in section Compatible payloads on page 83)
Extra security features:

- Radio data link with AES-256 encryption
- Drone log file suppression
- Encrypted SD card

4 Crew health precautions

To operate the eBee X series drone with maximum safety, we recommend that you answer these questions before each flight day:

I	Illness	Do you have any symptoms?
M	Medication	Have you been taking any pills?
S	Stress	Do you have any financial, family or health stressors?
A	Alcohol	Have you been drinking within the last 12 hours?
F	Fatigue	Are you tired and not adequately rested?
E	Emotion	Are you emotionally upset?

5 About this user manual

A complete guide to your senseFly *eBee X series drone* comprises:

- **The *eMotion* software user manual**
  An in-depth guide to mission planning and monitoring with *eMotion* software.
- **eBee X series user manual**
  A guide to your eBee X series hardware, completing and complementing the eMotion user manual.
- **A camera user manual**
  A guide to using your drone's camera.
- **A charger user manual**
  A guide to using your battery's eBee X series charger.

With these, you have a complete guide to using an *eBee X series drone*. You'll find all the user manuals you need within *eMotion*'s Help function tab. All senseFly user manuals are also available in my.sensefly[2].

Note: You can always find the latest version of *eMotion* in my.senseFly. An *eBee X series drone* requires

[2] http://my.sensefly.com

6 Units used in this user manual

In general, dimensions are given in the appropriate SI units with, when relevant, the Imperial unit in brackets, for example, 30 m (98 ft).

Dimension	Units used	
Distance	km (mi)	kilometres (miles)
Length	m (ft)	metres (feet)
Length	cm (in)	centimetres (inches)
Length	mm (in)	millimetres (inches)
Speed	m/s (kts)	metres per second (nautical miles per hour)
Climb rate	m/s (ft/min)	metres per second (feet per minute)
Mass	kg (lbs)	kilograms (pounds)
Mass	g (oz)	grams (ounces)
Temperature	°C (°F)	degrees Celsius (degrees Fahrenheit)
Frequency	Hz	hertz
Area	m^2 (sq ft)	square metres (square feet)
Area	km^2 (sq mi)	square kilometres (square miles)
Area	ha (ac)	hectares (acres)
Heading	°	degrees from true north
Angle	°	degrees
Thrust	kgf (N, lbf)	kilogram-force (newton, pound-force)

The Imperial unit used for speed is knot (kts).

1 kts = 1 nm/h (nautical mile per hour)

All headings are given in reference to true north (geodetic north), not magnetic north.

7 Package contents

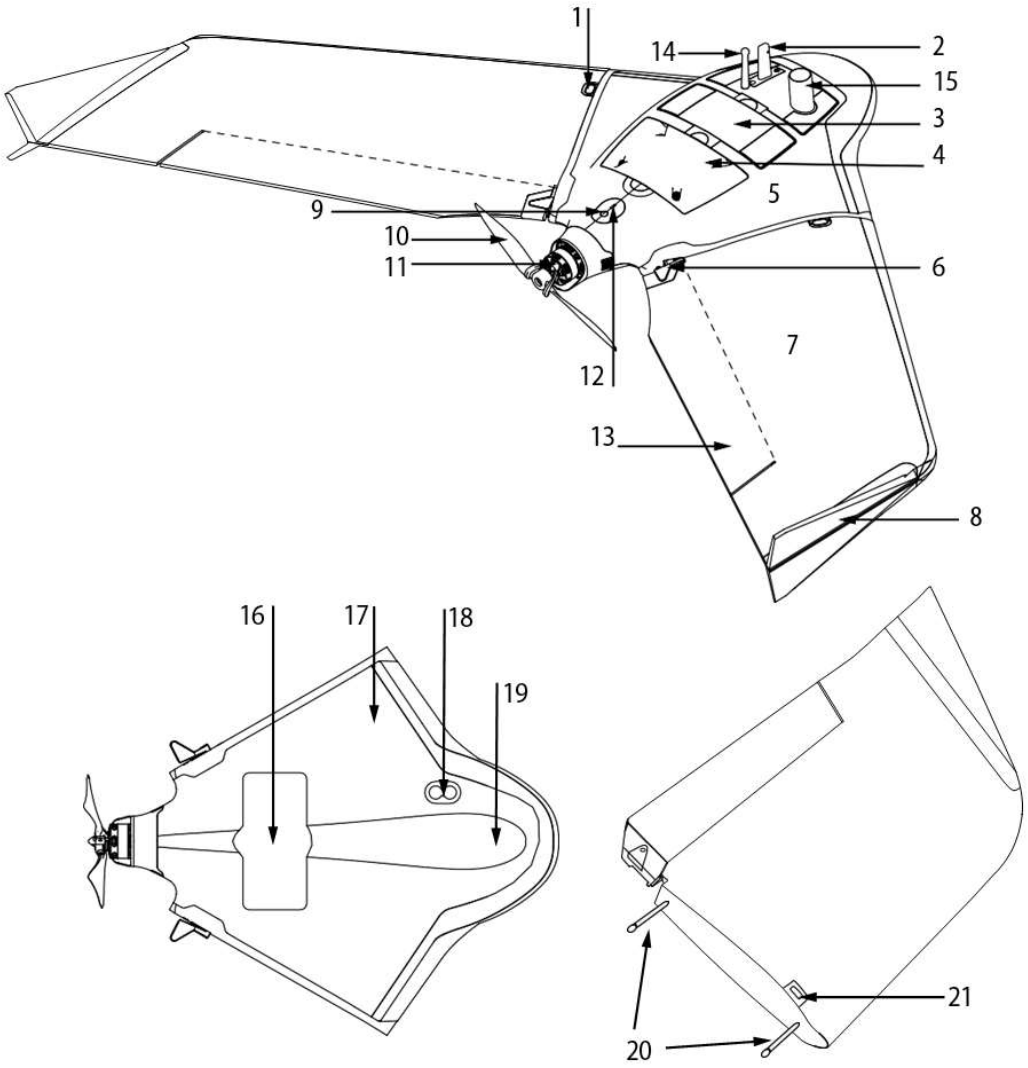
The standard *eBee X series drone* package contains the following items:

- 1x carrying case with foam protection
- 1x *eBee X series drone* central body with built-in autopilot
- 1x pair of detachable wings
- 2x spare propellers
- 10x spare propeller attachment rubber bands
- 2x Lithium-Polymer batteries
- 1x Lithium-Polymer battery charger (with cables)
- 1x USB ground modem
- 1x USB cable for connecting your computer to the drone and some cameras
- 1x tube of EPP glue

Depending on your order, your camera may be sold separately and your package may include other items, such as additional cameras. Please verify upon delivery that your package is complete. In case of a missing item, please contact senseFly or your *eBee X series drone* reseller immediately.

Note: Drone, camera and charger user manuals are also available to download from our Knowledge Base, part of my.senseFly*.

8 Hardware features



1. **Wing release:** Press to detach the wing.
2. **Status LED/Pitot probe:** The pitot probe is the sensor used by an *eBee X series drone* to calculate airspeed, wind and altitude. It must be kept clean and clear of obstructions to function properly. A coloured LED, housed underneath, lights up the entire semi-transparent probe in different colours, indicating the drone's status.
3. **Battery compartment:** An *eBee X series drone* is powered by a LiHV (High Voltage Lithium Polymer) battery stored within the battery compartment.

Caution: Safe charging and proper care of your battery are essential. Please read *Battery care and safety* on page 74 before using your drone for the first time.

4. **Camera compartment:** An *eBee X series drone* features a built-in camera for taking aerial images stored within the camera compartment.

5. **Central body:** This is the core of an *eBee X series drone* and includes all the electronics, actuators and communications hardware on-board the drone.
6. **Servo connection mechanism:** The ailerons are connected to the servo-motors within the central body of the drone through this connection mechanism.
7. **Wing:** An *eBee X series drone* wings are detachable for storage and replacement. Each wing has two wing struts and a clip to hold it in place within the central body.
8. **Winglet:** Contributes to the aerodynamic efficiency of the wing.
9. **Strobe light:** Indicates the drone's position in low-light conditions.
10. **Propeller:** Used to generate thrust while the drone is in flight.

Caution: When attached to the motor the propeller spins at high speeds and can be potentially dangerous if it comes into contact with exposed skin. Be sure to always keep your hands clear of the propeller when the battery is attached to the *eBee X series drone*.

11. **Motor:** Spins the propeller.
12. **Ambient temperature sensor:** Measures the temperature of the air outside the drone.
13. **Ailerons:** Used to control the *eBee X series drone* while in flight.
14. **Comms antenna:** Captures the telemetry signal from the Ground modem.
15. **GNSS/RTK Antenna:** The advanced GNSS antenna, capable of capturing several GNSS signals, is used for navigation and to increase geotagging precision.
16. **Camera opening**
17. **Central body**
18. **Ground sensor:** The LiDAR ground sensor is used to measure the distance to the ground.
19. **Skid plate:** The drone lands on this tough, plastic skid plate.
20. **Wing struts:** Reinforce the wings' connection with the central body and provide the wings with strength and rigidity.
21. **Wing release:** Press to detach the wing.

9 eMotion flight planning and control software

eMotion is the integrated software package that allows you to interact with your *eBee X series drone*. Its easy-to-use interface allows you to plan a mapping flight intuitively from the comfort of your office or directly in the field. Once the drone is launched, you can use *eMotion*'s wireless connection with your *eBee X series drone* to track its position, monitor the progress of your mapping flight and send commands.

Your *eBee X series drone* requires *eMotion* to fly.
Download the latest version at no extra cost[3] from https://my.sensefly.com.

You'll find *eMotion*'s user manual within *eMotion*.

10 About your eBee X series drone's license

To fly a *eBee X series drone* you need a license.

- **Standard**
  Purchased with the drone. Requires internet connection only once.
- **Always On**
  Purchased with the drone. Requires regular connection to the internet.

If you have a license that requires a connection to the internet, ensure that *eMotion*, running on your computer, can reach https://sensefly.io/alive at least once every 30 days. If it cannot, you will not be able to fly your drone.
With your drone connected to *eMotion*, you can find drone license information, including the date and time before which you must connect to the internet, in *eMotion*'s right-hand Drone panel's ⚙ Parameters tab.

[3] software access terms and conditions apply

11 About your eBee X series drone's RTK/PPK license

An *eBee X series drone* includes built-in RTK/PPK functionality that can be activated straight away or later, when required.

To simplify the process of activating the RTK/PPK license and updating the GNSS board, it is no longer necessary to use the RTK license file. The activation of the RTK/PPK features is automatically managed through eMotion. New process is only compatible with eBee X series drones which have been sold and shipped from our headquarters in Switzerland since December **15, 2021**.

RTK/PPK features will be automatically activated by connecting the drone to eMotion, making sure the computer has an internet connection, if the RTK contract has been set to the unlimited licence. Otherwise, eMotion will only offer to activate TRIAL licence.

12 How to activate RTK/PPK

12.1 New process for compatible drones.

1- Register your drone in my.senseFly.

2- Make sure the contract is on standard if you purchased an RTK activation with the drone

3- Connect the drone to eMotion making sure the PC has an internet connection.

4- RTK/PPK features should have been activated successfully.

You can find a dedicated article here:

https://sensefly.zendesk.com/hc/en-us/articles/360021402860-How-to-activate-RTK-PPK-full-or-demo-license-on-eBee-X-series

12.2 Former process for NON-compatible drones.

You will download an activation file during drone registration, then use *eMotion* to activate PPK/RTK on your drone:

1- Register your drone in my.senseFly. During registration process, you will be given the opportunity to download the activation file.

2- Download the activation file to the computer on which you have installed *eMotion*.

3- In *eMotion*, open or create a mission[4].

4- Click Connect and connect your *eBee X series drone* to *eMotion*[5].

5- Under eBee Plus upgrade in the right-hand Drone panel's ⚙ Parameters tab, click Browse.

6- Locate on your computer the activation file you downloaded from my.senseFly.

7- Click Start upgrade.

For full instructions on using your drone's RTK/PPK capability, see your *eMotion* user manual.

[4] See your eMotion user manual for full instructions
[5] See your eMotion user manual for full instructions

Using your eBee X series drone

13 Safety precautions

- **Drone**
  - **Keep clear of the propeller**
    The propeller spins at high speeds and can be dangerous if it comes into contact with exposed skin. Always keep all objects and all parts or your body clear of the propeller when the battery is installed in your *eBee X series drone*.
  - **Power the drone off before handling it**
    Power your *eBee X series drone* off before picking it up. Never attempt to pick an *eBee X series drone* up while the propeller is turning.
  - **Never attempt to fly without an approved camera**
    An eBee X series drone is not designed to fly without a camera in its camera bay.
  - **Never fly with the battery or camera bay exposed**
    The covers and integration kits protect the drone's ports and electronics.
  - **Know how to, and be ready to abort take-off or landing if necessary**
    There are procedures and buttons in eMotion's Control Bar that do this. See Take-off on page 44 and the eMotion user manual.
  - **Never fly a damaged eBee X series drone.**
  - **Never fly with any damaged equipment**
  - **The wings must be correctly attached and the servos properly engaged**
    See Getting your eBee X series drone ready to fly on page 31.
  - **The propeller must be correctly attached and in excellent condition for flight**
    Never try and start the motor without the propeller. See Getting your eBee X series drone ready to fly on page 31.

- **Environment (cf Drone specifications on page 81 for details)**
  - **Altitude**
    The higher you take-off, the less dense the air is. A high elevation take-off can affect the rate of climb and the performances of the drone. Altitude has no impact for transport and storage.
  - **Temperature**
    The drone must be used in the temperature range indicated in Drone specifications on page 81. Note that low temperature can affect the battery performance and significantly decrease the flight time. High temperature can affect the cells and make the battery unusable.
  - **Humidity**
    Fly in the rain is not recommended. The pitot tube performance can be affected and can lead to poor airspeed readings or crash of the drone. During transport or storage, never leave the drone in a humid atmosphere.
  - **Other**
    Never fly the drone in a critical meteorological atmosphere like salt spray, thunderstorm, sandstorm.
    Never fly the drone in a bird flock.
    Never store or leave the drone in a humid or fugus growth provoking atmosphere.
  - **Electric cables**
    Maintain a distance of at least 20m away from the powerlines not to disturb the radio link.
  - **Radiation field**
    The proximity of high intensity radiation field (e.g., high power radar or TV broadcasting antenna emitters) can disturb the radio link.
  - **Buildings**
    Horizontal distance to buildings less than 100m is not recommended (both for take-off and landing but also during the flight).

- **Transportation/Storage**
  - Do not let the battery connected to be drone during transportation
  - Always use senseFly case or backpack to transport your drone and accessories
  - In airplanes, place your batteries in LiPo safe bags
  - Store your drone and accessories in dry, cool, and non-magnetic environment
  - Immobilize moving parts

- **Ground Control Station (GCS)**
  - Configure your GCS (e.g. laptop) equipped with eMotion to receive an alert when it reaches 20% of battery[6]
  - Trigger a manual Return To Home (RTH) of your drone when this low GCS battery level is reached[7]

[6] Use the power options advance settings of Windows
[7] This feature is not automatic from eMotion

14 Operational guidelines

- **Only use approved senseFly batteries**
  Only fly with a senseFly battery. Flying with any other battery risks causing a malfunction and will void your warranty in case of an incident. The following models: SI050017 and SI050003; are the only one approved to be used with the *eBee X series drone*.

- **Only use approved senseFly SD cards**
  Only fly with SD cards that have been approved by senseFly.

- **Always land on a stable, level surface**
  Do not attempt to land on a steep slope or an area covered with large rocks, debris or holes. Do not land on a wet surface, soft sand, thick snow, dust, or mud.

- **Obey local flight restrictions**
  Unless authorised with, for example, a waiver from the relevant authority, do not fly above people, urban areas, near airports or beyond visual line-of-sight. Do not fly inside or less than 0.5 km (0.3 miles) from restricted zones. Obey local regulations concerning the distance from pilot to drone. Take care if flying near people or animals.

- **Do not fly in high winds**
  An *eBee X series drone* must not take off at all if the wind speed exceeds the maximum allowed for flight. See *Weather check* on page 30.

- **Do not fly in bad weather**
  Do not fly in rain, snow, hail, fog, a sandstorm or dust storm. Avoid icing conditions.

- **Avoid collisions**
  Always make sure there is enough space between the drone's trajectory, any obstacles and any other aircraft. Always double check waypoint altitudes and elevation data against the real terrain.

- **Check drone battery charge level**
  Make sure you have more than enough for your flight. Land well before the battery is empty. See *Battery care and safety* on page 74.

- **Set an appropriate working area**
  Set a working area that prevents your drone from flying outside communications range, above the legal altitude limit, into prohibited airspace such as private property or a nearby airport, or into a hazardous area. See the *eMotion* user manual.

- **Always fly with eMotion connected**
  Connect your drone to *eMotion* to provide situational awareness, extended communications range and a means of controlling your drone and initiating a landing in case of incident.

- **Check laptop battery charge level**
  Make sure your computer has more than enough battery charge for your flight. Avoid using your laptop's power saving mode – it may disable your graphics card causing *eMotion* to run slowly.

- **Always take off with a fully-charged drone battery**
  The power the drone can pull from its Lithium Polymer batteries is at its maximum when the battery is fully charged.

- **Provide eMotion with as much computing power as possible**
  Do not run memory- or processor-intensive software on the same computer as *eMotion* while flying. For example, do not process flight data, install software, update the operating system or run an anti-virus scan. Use a high-performance power plan. Enable your computer's graphics card (GPU).

- **Ensure you can hear the alerts**
  Enable your computer's sound and ensure that the volume is high enough so that any alerts are clearly audible.

15 Before you fly

15.1 Charging your batteries

Before leaving for the field to perform a flight, be sure to fully charge your *eBee X series drone* batteries[8]. An *eBee X series drone*'s camera takes its power from the drone's battery. It does not have its own battery.

About your charger

Your *eBee X series drone*'s battery charger independently balances the voltage of each of the battery's cells to ensure optimal performance and battery life.

The charger is capable of charging the battery to approximately 100% for flight, 70% for storage or 30% for shipping.

Charging for flight can take up to an hour and a half, depending on the charge level of the battery and the amount of cell balancing required. See *Battery care and safety* on page 74 for more information on maintaining your drone's batteries.

For security purposes, when charging or discharging your batteries please take into account possible differences between the indicated and actual charge level.

For the full charging/discharging procedure and the full list of safety precautions, see the full senseFly Smart Charger User Manual in our Knowledge Base on my.senseFly:

https://sensefly.zendesk.com/hc/en-us/articles/115003751013

Charging your battery for storage

Keeping LiHV batteries, like those used in your *eBee X series drone*, fully-charged or discharged for long periods can reduce their performance and lifetime. If you will not be using an *eBee X series drone* battery for more than 2 weeks, you must store it at approximately 70% charge.

Charging your battery for storage is similar to charging it for flight. Instead of using 100% flight charging mode, choose 70% charging for storage.

Caution: Selecting the wrong drone family charging program may dangerously affect your battery health, causing overheat, fire and irreversible damages to your battery.

Caution: Once the battery charge/discharge is complete, always unplug the battery from its cable. Do not store your battery with its cable attached.

[8] when delivered, an *eBee X series drone* battery may not be fully charged

15.2 Weather check

Before each flight, you should be aware of the weather conditions. The *eBee X series drone* is a small drone that cannot fly in heavy rain or strong wind conditions. Icing conditions must also be avoided. In case of doubt, make sure to check a weather bulletin including wind estimations in the flight area. Note that wind is often stronger at higher altitudes and that the wind perceived at the surface is not always a good reference to estimate the wind at flight altitude. Cloud velocity or tall tree movements can help you to estimate the wind speed once you are out in the field.

Weather forecasts may use various units to measure wind speed. As a reference:

1 m/s = 3.6 km/h = 2.24 mph = 1.94 kts (nm/h).

Caution: An *eBee X series drone* should not be launched if the wind speed exceeds 12.8 m/s (46.0 km/h, 28.6 mph, 24.9 kts).

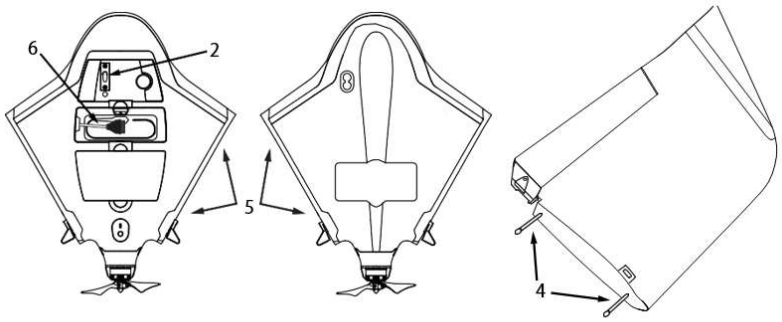
Caution: An *eBee X series drone* is not designed to fly in temperatures above 35 °C (95 °F). Avoid exposing the drone to high temperature for prolonged periods of time. In particular, leaving the drone exposed to the sun or in a hot car should be avoided.

16 Getting your *eBee X series drone* ready to fly

The *eBee X series drone*'s simple design means it can go from the box to being ready for flight in minutes. We recommend that you perform the following steps before every flight to ensure that the platform is best prepared for flight.

Note: Remove the warning sticker from the motor before your first flight.

Caution: Do not perform the inspection, propeller, camera or wing installation with the battery connected to the drone.



16.1 Step 1: Perform a general inspection

Visually inspect the drone for damage or wear using the following steps:

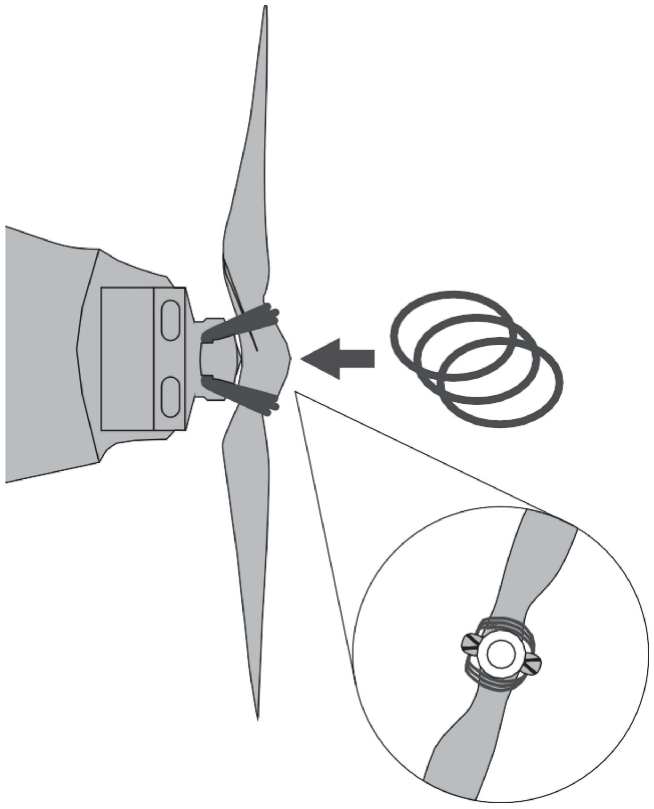
1. Check the central body and wings for cracks or other damage.
2. Verify that the pitot probe is properly attached to the airframe and that the holes in the probe are free of obstructions.
3. Verify that the ground sensor is clean, dry and free of obstructions.
4. Verify that the wing struts are not split or damaged in any way.
5. Verify that the tubes within the Central Body that hold the wing struts are not cracked or damaged in any way.

Caution: It is vital to carefully inspect the wing struts and tubes within the Central Body before every flight, as they may cause a crash if they are damaged in any way. This is particularly important if the wings were found separated from the Central Body after a previous flight.

6. Verify that the power cables within the battery compartment are well insulated and not damaged.
7. Verify that the propeller rubber bands are all in place and are in good condition.
8. Verify that the propeller is in good condition for flight and is properly attached.
9. Verify that the servos turn smoothly.
10. Verify that the camera's lens is clean.

Note: You must perform a general inspection before every flight. It is also good practice to perform a full airframe check regularly to keep your *eBee X series drone* in good shape.

See also *Full airframe and sensor inspection* on page 69.



16.2 Step 2: Install the propeller

Mount the propeller on the motor axis. Secure the propeller using three attachment rubber bands as illustrated above. Ensure that the propeller is lying flat against the motor mount, and that the rubber bands do not show cracks or any other sign of ageing.

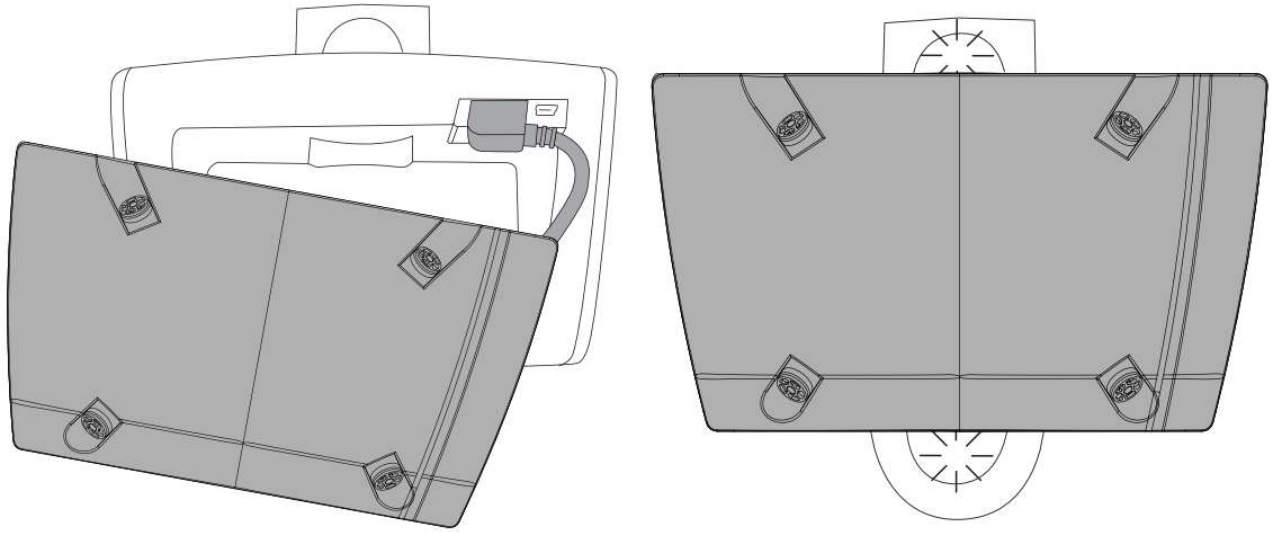
Caution: Always use 3 rubber bands to secure the propeller. Failure to do so may result in the loss of the propeller in flight.

Note: After extensive use, the rubber bands may develop cracks. This is normal and is caused by the ageing of the rubber material. Store the rubber bands away from UV light (sunlight) and heat sources, for example, in your drone's case. Inspect the rubber bands regularly and discard them if they show cracks. 10 spare rubber bands are included in the package.

16.3 Step 3: Install the camera

Follow these instructions to install the **S.O.D.A. 3D** into the drone's camera bay. To install other cameras, please refer to the camera's user manual[9].

Installing the camera into the drone

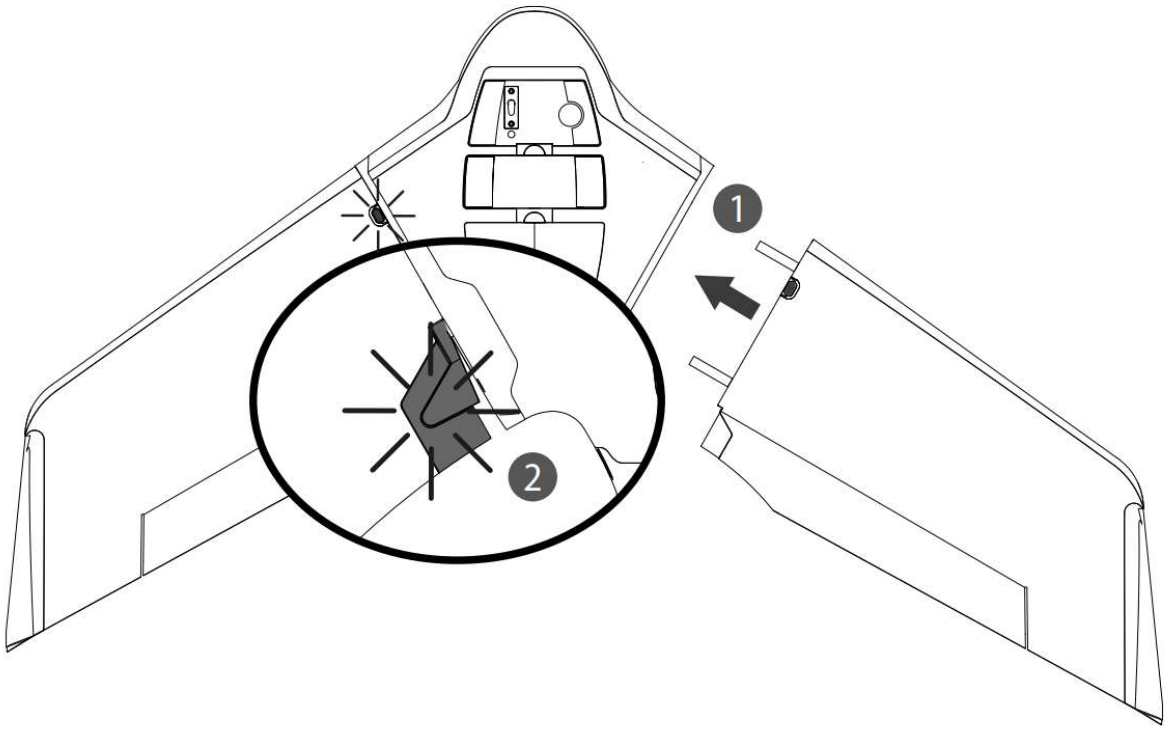


1. Ensure that nothing is connected to your drone. That is, your drone's battery is not connected, and your drone is not connected to a computer.
2. Make sure the SD card is not full. Insert it into the camera and close the cover.
3. Plug the camera connector into the socket within the *eBee X series drone*'s camera bay.
4. Install the camera into the drone's camera bay.

Caution: *eBee X series drone*s are not designed to fly without the camera. Attempting to fly without the camera may render the drone unstable, leading to a crash.

Caution: Connect only compatible senseFly cameras to the drone's camera port. Never try to connect anything else.

[9] some cameras may require a separate SD card. Please refer to your camera's user manual for full installation instructions.

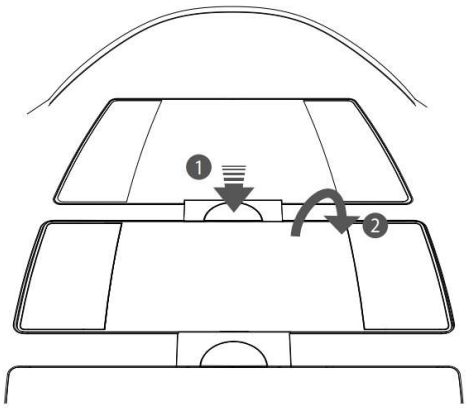


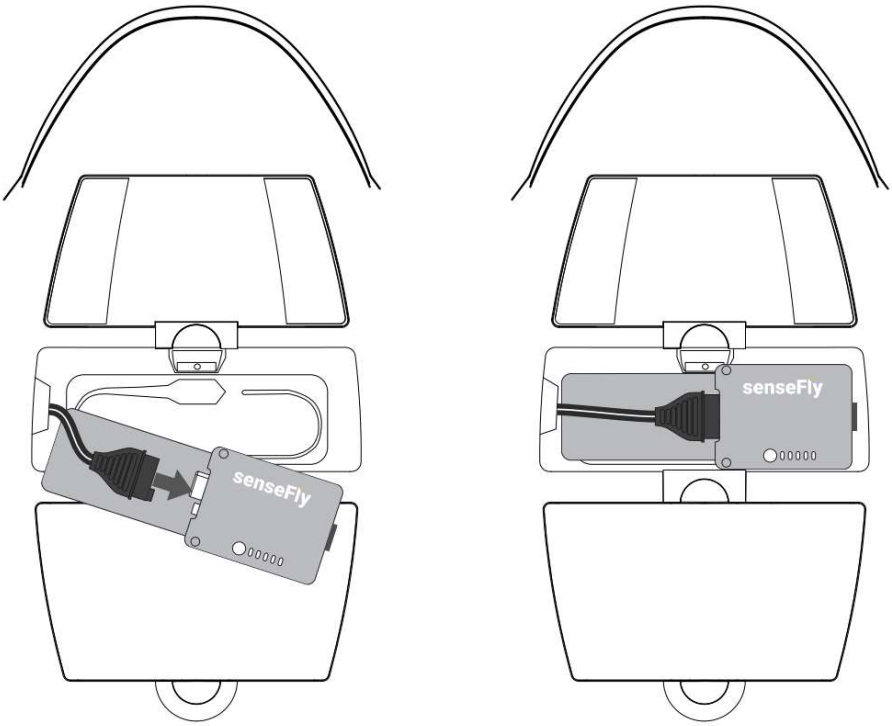
16.4 Step 4: Attach the wings

Attach the wings to the central body by inserting the wing struts into the receptacles in the central body (1). Ensure that the ailerons are properly aligned with the servo connection mechanism (2) before pushing the wings fully into the central body until they click.

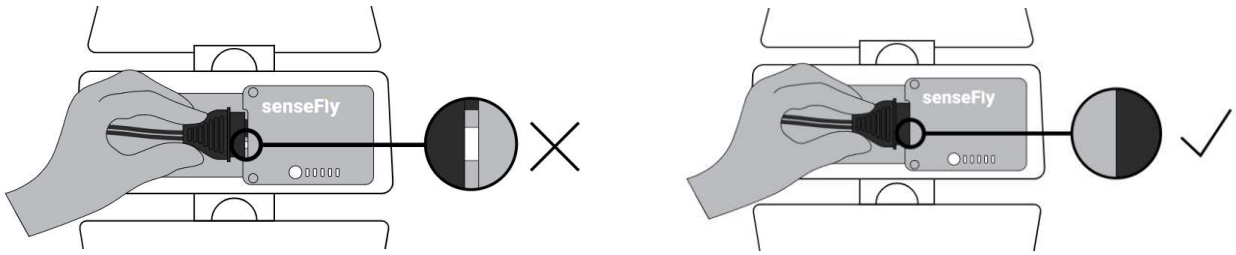
Caution: Flying with damaged wing struts, a badly-engaged servo connection mechanism or wings that are not properly attached may cause erratic flight and ultimately a crash. Carefully inspect the struts and make sure that the wings are properly attached and servos properly engaged before every flight.

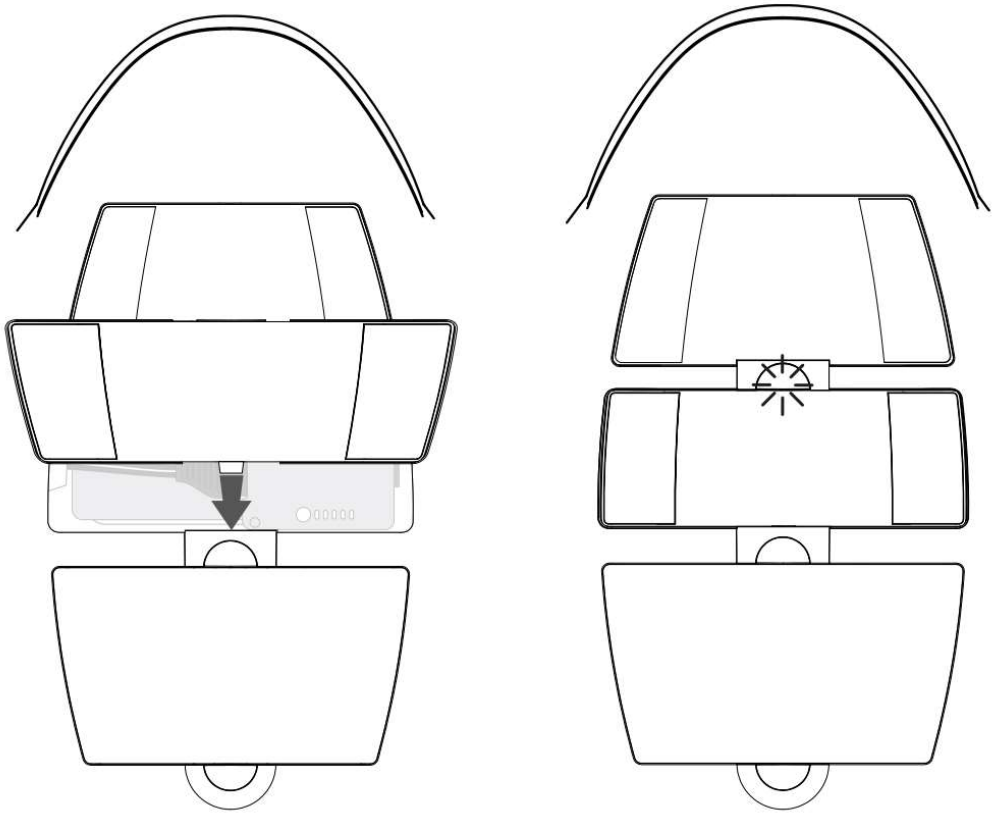
16.5 Step 5: Install and connect the battery for flight





Caution: When you plug the battery to the drone, make sure it is fully depressed. As shown below.





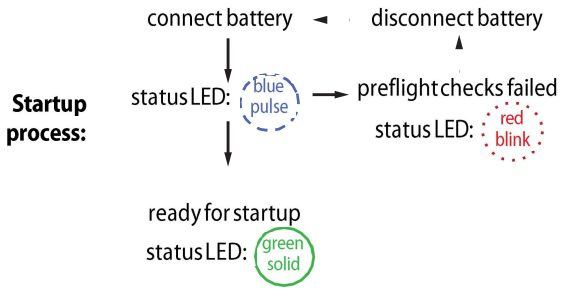
1. Lay the drone flat on the ground outside, on its belly, in a place that has a clear view of the sky, for example, where you intend to take off from. The drone must not be inclined more than 10° to start up properly.
2. Connect the drone's battery cable to the battery, pushing the connector firmly in.
3. Insert the battery into its compartment, fasten the strap and close the compartment lid.

Caution: Keep clear of the propeller in case it suddenly starts spinning.

Note: Only connect the battery cables to the drone when you are ready to fly. Do not leave the battery connected for extended periods of time when the drone is on the ground, as this may discharge the batteries and cause irreparable damage. When connected and not in flight, your *eBee X series drone* will briefly move its ailerons up and down every minute as a reminder that it is switched on.

Caution: With the drone powered on but not in flight, there is no air flow to cool the camera and it will rapidly heat up. Take off as soon as possible. Do not touch the hot camera.

As soon as the battery is connected the *eBee X series drone* will perform an automatic self-check of its sensors and acquire GNSS signals. Do not move the drone during these tests. Pre-flight checks may last from a few seconds to several minutes in the case of poor GNSS signal reception. As these satellite signals are required for the checks to complete, be sure to place the *eBee X series drone* outside with a clear view of the sky.

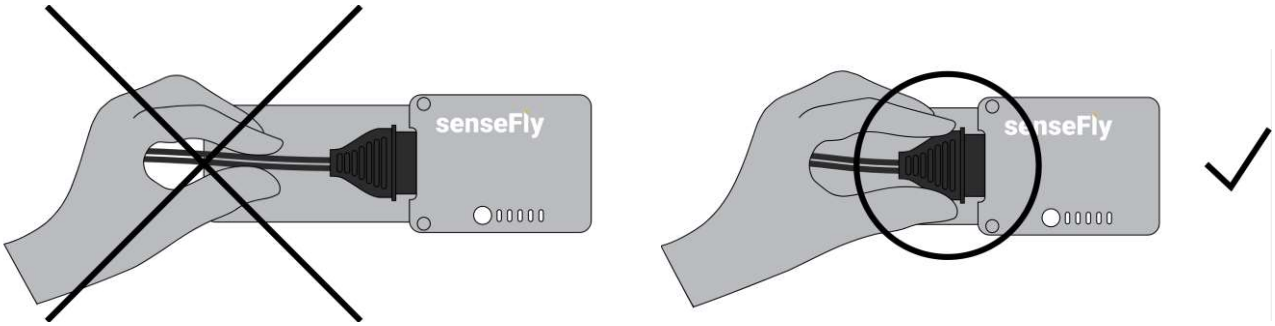


During the pre-flight checks the status LED will pulse blue. Once the pre-flight checks are complete the *eBee X series drone* will flip its ailerons up and down and the status LED will turn solid green to indicate it is ready.

You can connect the drone to *eMotion* during the pre-flight checks. *eMotion* will report the status of the checks.

Note: If there was any problem during the pre-flight checks performed by the drone this will reported in *eMotion* and the drone's status LED blinking red. See your *eMotion* User Manual for a description of possible pre-flight errors and how to handle them.

Caution: An aside on the disconnection of the battery. Never pull on the cable, pull on the triangular black part as shown below.



16.6 Step 6: Connect to *eMotion*

Just before the connection, visually inspect the modem and the laptop using the following steps:

1. Check the modem body for cracks or other damage.
2. Verify that the antenna is not damaged and properly connected.
3. Verify that the USB cable is not damaged and extremity connectors are in good condition.
4. Clean the laptop screen and increase the luminosity if necessary.
5. Make sure that the sound is ON.
6. Verify that the laptop battery is charge to 100%.

After this general inspection, start by connecting the USB ground modem to your computer. Then launch *eMotion* and follow the instructions in your *eMotion* user manual to connect your drone to *eMotion*.

Note: Each *eBee X series drone* is paired with the ground modem it is delivered with, and will only work with that modem.

Note: Do not use a USB cable that is more than 3 m (10 ft) long.

When a connection is established *eMotion*'s Status Panel will indicate the current state of the drone. While an *eBee X series drone* obtains its location the Status Panel will indicate 'GNSS: Waiting for signals...'. During this time the status LED on the drone will pulse blue.

Once your drone has set its position using GNSS signals, an icon of the drone will appear at its location on the map. If the drone's location is not on the map you can centre the map on the drone[10]. The drone's status on *eMotion* will be displayed as Idle and its status LED will shine solid blue.

You can now set take-off and landing spots, assign a mission plan and fly your drone. See your *eMotion* user manual for details.

[10] see your *eMotion* user manual

17 Flying your eBee X series drone

Note: We recommend that you perform your first flight in a large obstacle-free area and limit the length of the mission in order to familiarise yourself with your *eBee X series drone* in flight.

17.1 About the communication link

Your *eBee X series drone* must be in contact with *eMotion* through the ground modem at all times. To maintain this connection the ground modem's signal must be able to reach your *eBee X series drone*.

Data connection range can be affected by many external factors such as antenna height, terrain and obstacles or radio interference.

You may occasionally lose the data connection between *eMotion* and your *eBee X series drone* while in the field. Whether there is a loss in uplink or downlink communication, the drone will continue its mission and should re-establish the connection as it flies closer to the ground modem or changes direction.

If *eMotion* stops receiving messages from the drone (downlink direction), a Data downlink lost message will appear in *eMotion*. If there is still an active uplink connection, you may still command your drone to return to Home using *eMotion*.

The strength of the connection between the drone and *eMotion* is indicated in *eMotion* and by the LEDs on the ground modem (see *Understanding the ground modem LED indicator* on page 41).

If the communication link is lost for more than 300 seconds (this value can by modified (between 5 and 300 seconds) in the safety panel of *eMotion*), your *eBee X series drone* starts a return to home (RTH) procedure.

Once the eBee is loitering on the home waypoint, if the link is not established within 3 minutes of it reaching the home waypoint. the eBee X will begin its automatic landing procedure.

If the communication link is lost and the GNSS accuracy degrades, the drone will continue its mission until the value set in the safety panel of *eMotion* ("*Return to home if Ground Modem link is lost*") is reached or if the checkbox "*Return to Home if GNSS accuracy degrades*" is checked. Warnings are provided.

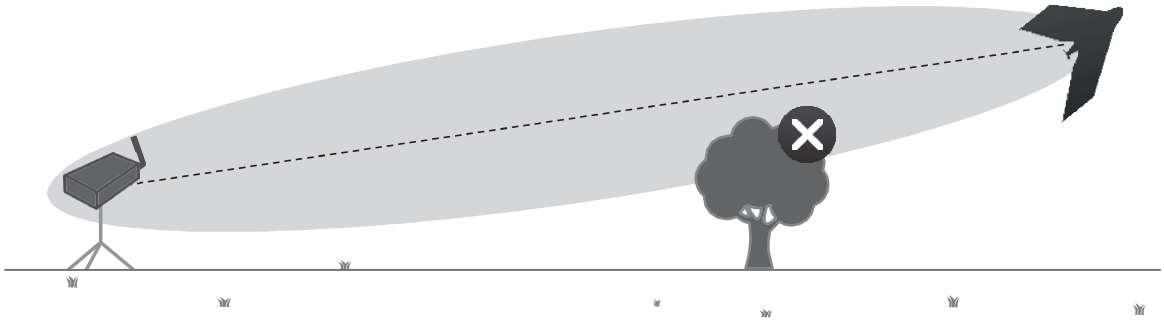
If the communication link is lost at the same time as the GNSS, the drone will start an emergency landing procedure in large circle.

Maintaining a good communication signal

A straight line between the ground modem antenna and the drone is called the radio line of sight. For a strong ground modem signal to reach the drone, the radio line of sight, and a zone a few metres wide around the radio line of sight, must be clear of obstacles.

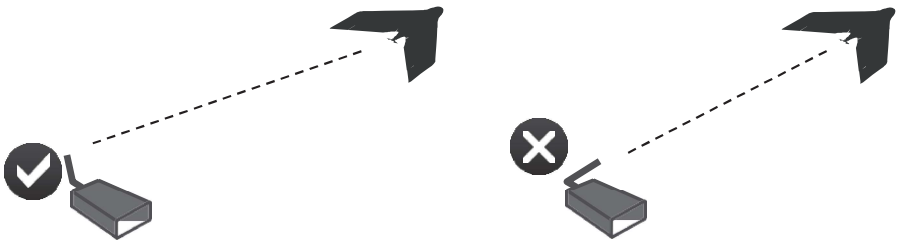
To prevent loss of contact with the drone:

- Position the ground modem at least 1.6 m (5.2 ft), ideally 3 m (10 ft), above the ground or any other surface.

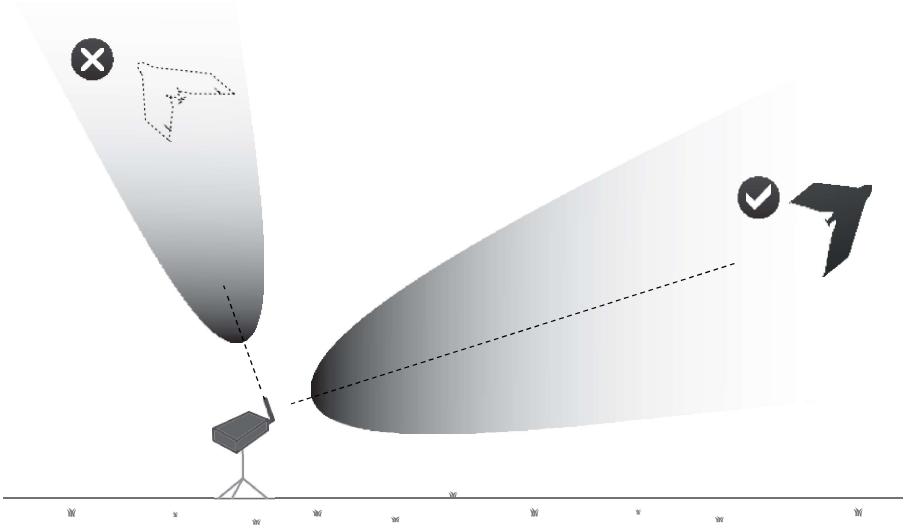


Tree too close to line of sight

- Do not sit the ground modem on a metal surface such as the roof of a vehicle.
- Bend the antenna up by 90° at its hinge.
- Do not position the modem with the antenna lined up along the radio line of sight. Instead, tilt it so that it is perpendicular to the line of sight.



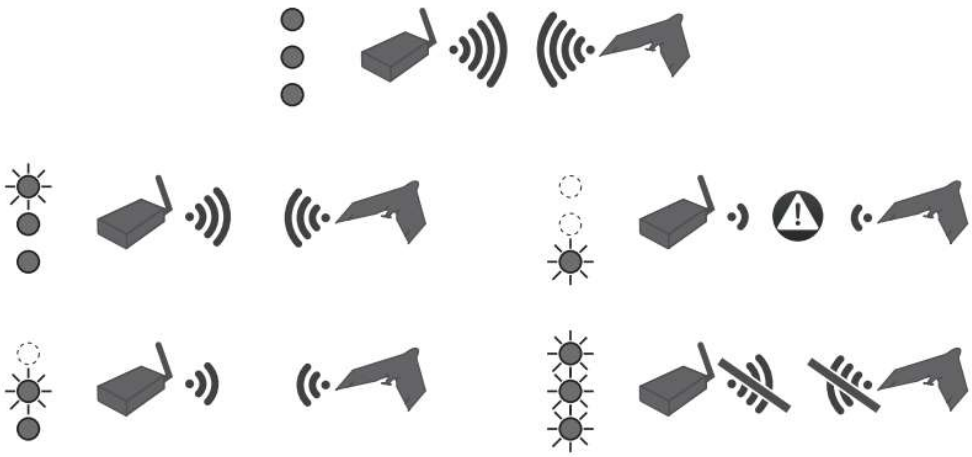
- Avoid flying in the zone directly in line with the antenna. For example, if the antennas are pointing upwards, avoid flying directly above the ground modem.



- Disable any 2.4 GHz-based communication devices (or put them into flight mode) in the vicinity of the USB ground modem. This includes all Wi-Fi devices, including mobile phones and the computer on which you are running *eMotion*.

Note: You can raise your ground modem up to 3 m (16 ft) using a tripod or light stand. An *eBee X series drone*'s ground modem is not equipped with a screw mount and will also need a holder. You can find senseFly accessory recommendations on my.senseFly:
https://sensefly.zendesk.com/hc/en-us/articles/227017867

17.2 Understanding the ground modem LED indicator



The ground modem has 3 red LEDs.

When you power on the modem by connecting it to your computer, the red LEDs will briefly shine, then switch off while the modem is starting up. After approximately one minute, when the modem is ready, the LEDs will indicate the status of the connection to your *eBee X series drone*:

LED(s)	Connection strength
2 LEDs lit + 1 blinking	Strong
1 LED lit + 1 blinking	Moderate
1 LED blinking	Weak
All (blinking)	No connection

17.3 Troubleshooting connection problems

If, during flight, the ground modem LEDs switch off, leaving only one blinking LED, you are at risk of losing the connection with your drone. You should take action to improve the connection.

If, during flight, all 3 LEDs start blinking and *eMotion* reports that you have lost the connection with your drone[11][4], the drone carries out a safety action. You should take action to improve the connection (e.g. modify the ground modem location, place it in a higher location, free of close obstructions or obstacles such as trees or buildings).

If, during flight, *eMotion* reports that you have lost the connection with your drone, but one or more ground modem LEDs are lit, this indicates a problem with your computer, the software, or the USB connection. Do one or more of the following:

- Restart *eMotion*.
- Unplug the USB cable from your computer then plug it back in.

[11] see your *eMotion* user manual

- Unplug the USB cable from your computer then plug it back into another of your computer's USB ports.
- Change the USB cable, for example, use a shorter cable.
- Restart your computer.
- Contact senseFly or your reseller.

17.4 Take-off and landing spots

The Take-off and landing phase of a flight includes the locations and actions related to the drone's take-off and landing and includes the following:

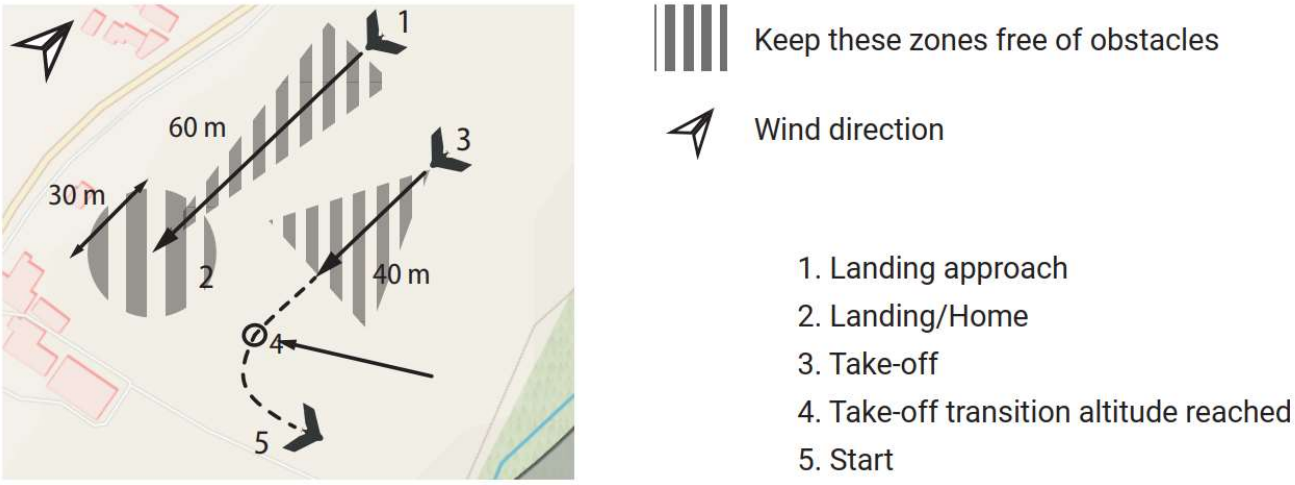
- **Take-off spot:**
  The point from which the drone is launched, automatically set to the location calculated from GNSS signals by the drone. This location defines the altitude of 0 m/ATO (0 ft/ATO) where /ATO stands for above take-off; the altitudes of all other waypoints, when defined in m/ATO (ft/ATO), are referenced to the altitude of this location.

- **Start waypoint:**
  The Start waypoint is the first point that the drone goes to when it starts an autonomous flight.

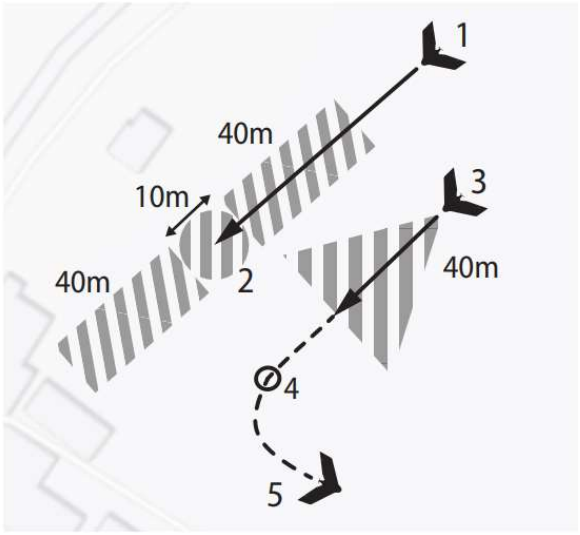
- **Landing spot:**
  The point, directly under Home, at which the drone will land at the end of an autonomous mission, after having visited Home.

- **Home waypoint:**
  The Home waypoint is the point that the drone will head to at the end of an autonomous mission. It is also the point it will head to if it encounters a problem during flight.

See your *eMotion* user manual for instructions on placing and editing take-off and landing spots.



Linear landing



1. Landing approach
2. Landing/Home
3. Take-off
4. Take-off transition altitude reached
5. Start

Keep these zones obstacle-free

Steep landing

It is important to carefully select the take-off spot, Start placement and the landing spot/Home waypoint to ensure your drone remains at a safe distance from obstacles.

An *eBee X series drone* should always be launched **against** the wind. Select a take-off spot clear of obstacles (buildings, rocks, power lines, hills, trees, etc) within a distance of at least 40 m (130 ft) in the upwind direction. Immediately after take-off the drone will keep its wings level and climb in the general direction it was launched until it reaches the take-off transition altitude[12], at which point it will start flying towards Start.

By default, Start is set at an altitude of 75 m/ATO (250 ft/ATO). It is good practice to place Start close to and upwind from the take-off spot to allow a smooth transition between take-off and waypoint-directed flight. You can move waypoints by clicking on them and dragging them within the Map Area[13].

Home is used as a safety position in case of an in-flight issue.

Note: There are several requirements that must be fulfilled to ensure a successful landing. *Landing* on page 53 describes in more detail the landing process and how to properly define your landing in more complex terrain. In particular, in some conditions, the precision of the final landing spot is reduced. Therefore, it is safer to plan for more clearance, especially along the landing axes.

17.5 Placing Home

By default, Home is set at an altitude of 75 m/ATO (250 ft/ATO). If a GO TO HOME procedure is triggered during flight[14] the drone will, by default, determine the highest altitude between its current altitude and Home's altitude, and climb in a circle towards that highest altitude (if required). Once it reaches this highest altitude it will then fly towards Home.

Set Home's altitude with care. It should be at least 20 m (66 ft) higher than the surrounding obstacles to avoid the risk of a crash, but should not be set too high to reduce the effect of potentially high winds and altitude and to prevent the drone from getting lost.

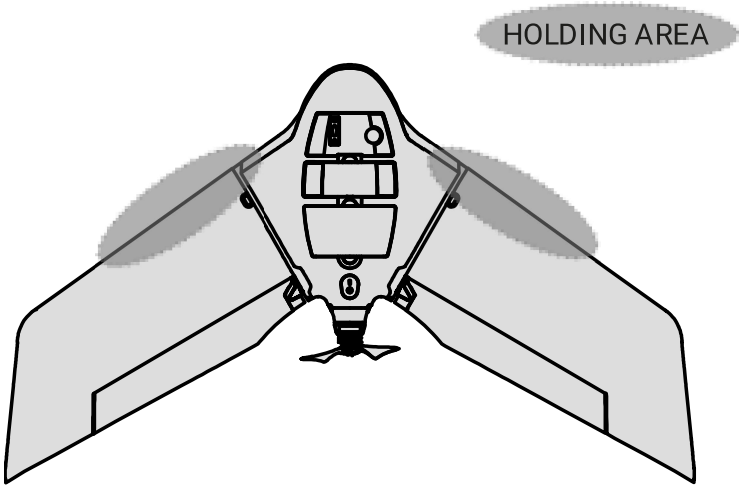
[12] by default, this is set to 20 m (66 ft). In difficult launch conditions you can set both the take-off heading and the take-off transition altitude in the take off parameters, as described in your *eMotion* user manual.
[13] see your *eMotion* user manual for more detailed instructions
[14] either automatically due to a Warning or manually using *eMotion*

17.6 Take-off

Once you've planned your mission and your *eBee X series drone* is powered on with a solid green status LED you are ready to launch it.

One hand launch

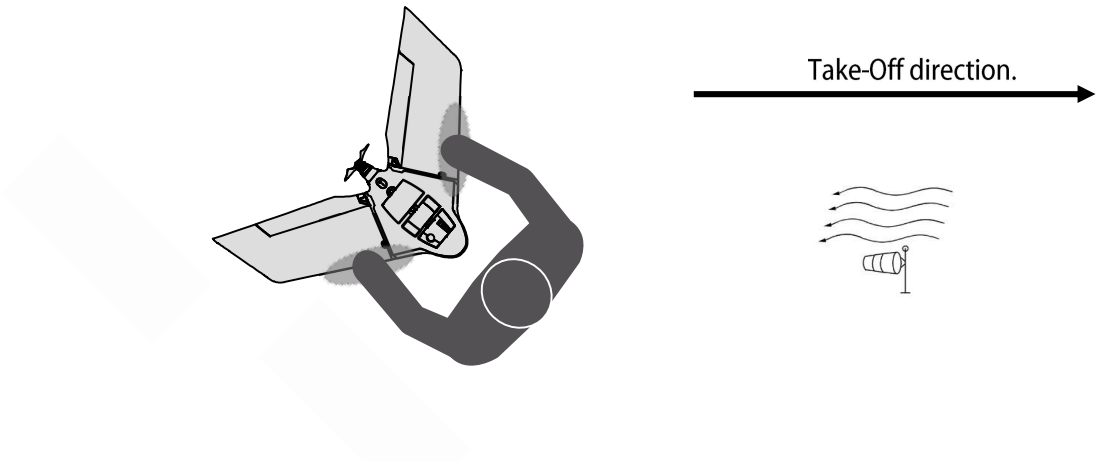
The best place for the hands is at the joint between the body and the wing. If it is too far, put your hand on the front edge of the wing (grey part on the sketch).



Caution: Keep the propeller area clear at all times during the launch procedure.

Step 1: Put your body 45° from the wind direction.

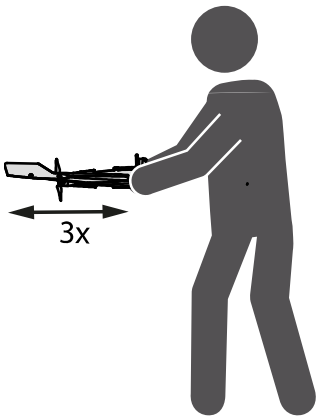
Confirm that the take-off direction (against the wind) is free of obstacles.



Caution: It is imperative to launch the drone directly against the wind, otherwise it will be unable to gain enough speed during take-off and likely crash. Likewise, launching the drone in high winds above the specified safe wind speed of 12 m/s (23 kts) is dangerous and can result in a crash.

Step 2: Put the eBee horizontally and shake it three times.

Shake your *eBee X series drone* back and forth 3 times longitudinally (within approx. 3 seconds) to begin the motor power-up sequence.



The led turns from green solid to blue pulse and the motor starts spinning.

Note: If the drone detects a condition that prevents correct take-off a Take-off veto will be displayed in *eMotion* and the status LED will start pulsing blue. For example, if the drone is not horizontal the status LED will start pulsing blue until you reorientate it horizontally, at which point the status LED turns solid green again.

The power-up sequence has 2 stages:

1. The motor runs at low power for a few seconds and at the same time, the drone moves its ailerons up and down several times. This is both an automatic test, and an opportunity to visually check the operation of the ailerons.

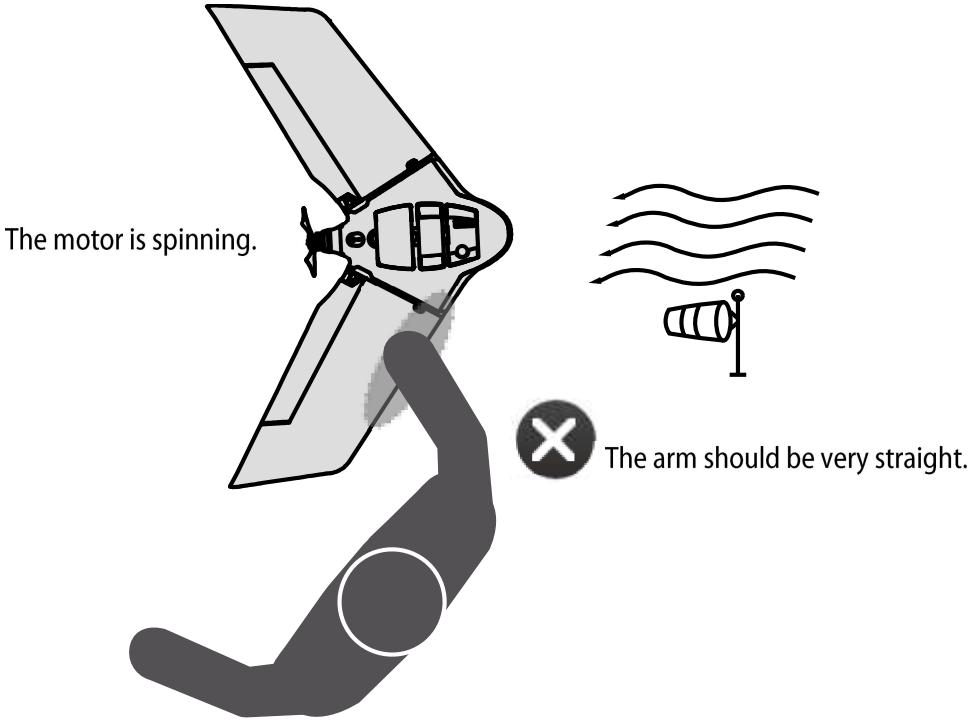
Caution: Look carefully at the ailerons as they move. Make sure they are moving freely and are properly engaged in the servos.

2. The motor spins up to full power, ready for take-off.
   The status LED will pulse blue until the motor is at full power and ready for take-off.

Caution: Take great care not to touch the spinning propeller with your clothes or a part of your body.

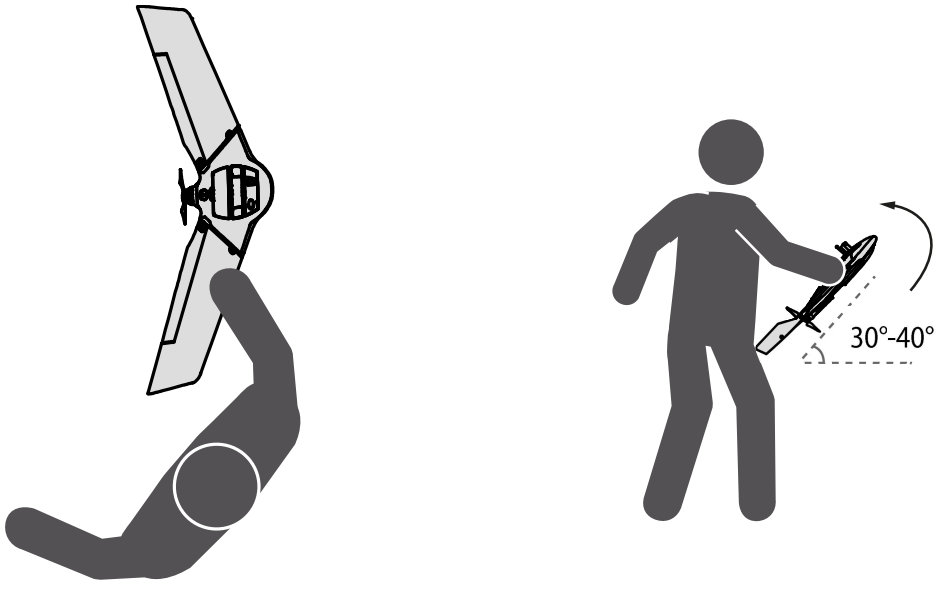
Note: To abort the take-off and shut off the motor, just shake the drone 3 times again, (repeat the back and forth action three times). Always wait at least 2 minutes between take-off attempts to allow the motor to cool.

Step 3: Keep the eBee horizontally and stretch out your arm putting the eBee face to the wind.



Step 4: Increase the take-off angle.

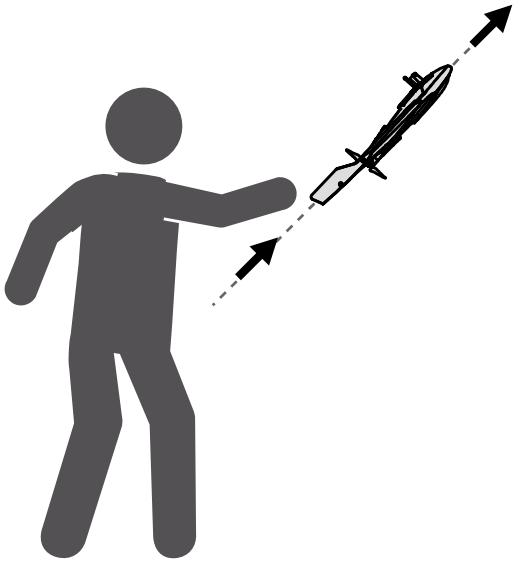
At the moment when the Led is turning from blue pulse to green blink increase gently the angle of the eBee's nose until approximatively 30°-40°.

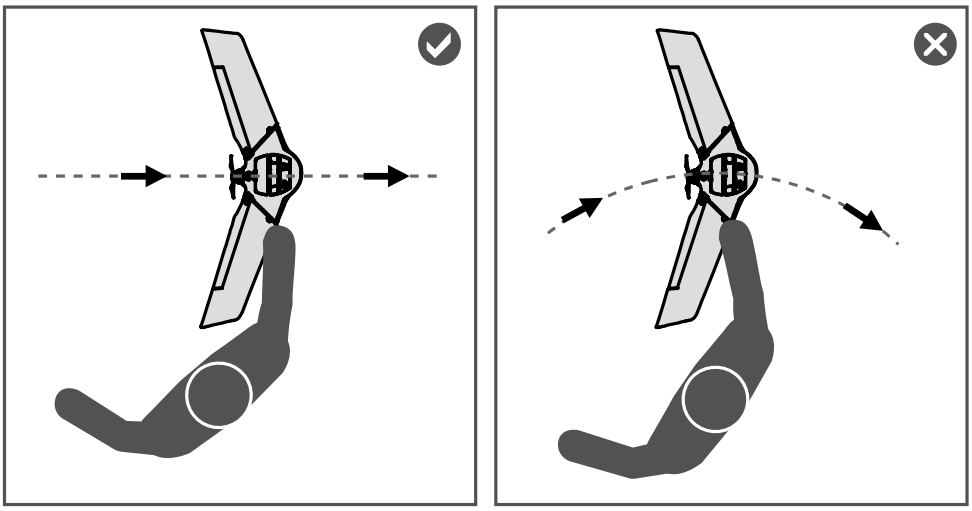


Step 5: Launch the eBee.

When the eBee reaches the appropriate angle, the Led turns green blink to green solid

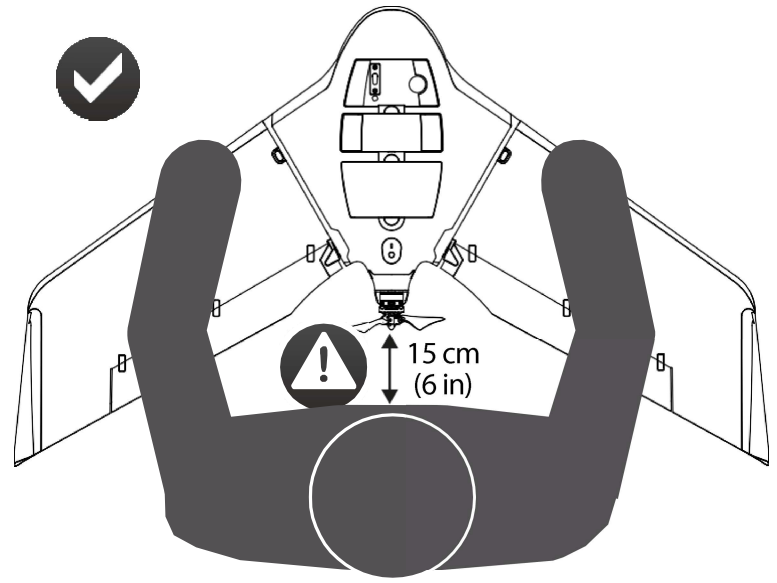
Keep the angle and the axis of the drone. By a movement from bottom to top give speed to the eBee. The strength of the movement should be adapted to the strength of the wind. The weaker the wind, the greater the force and vice versa.
Leave the eBee when it is at your shoulder height.

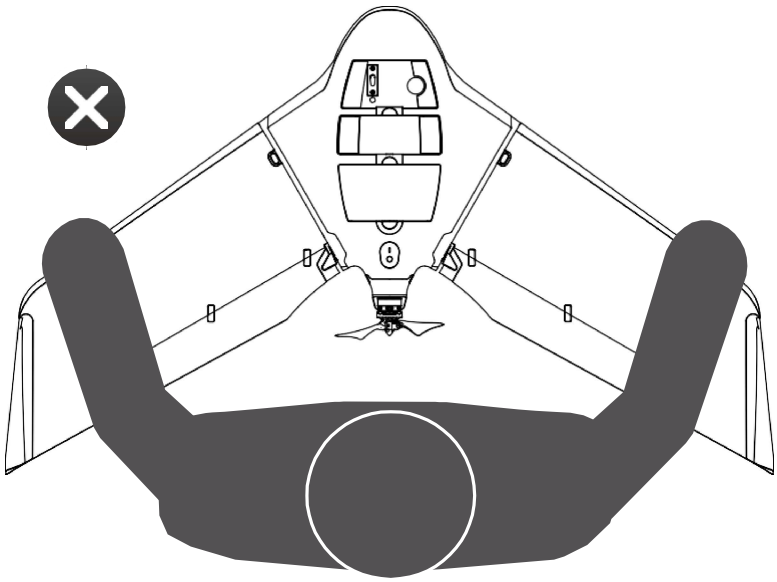




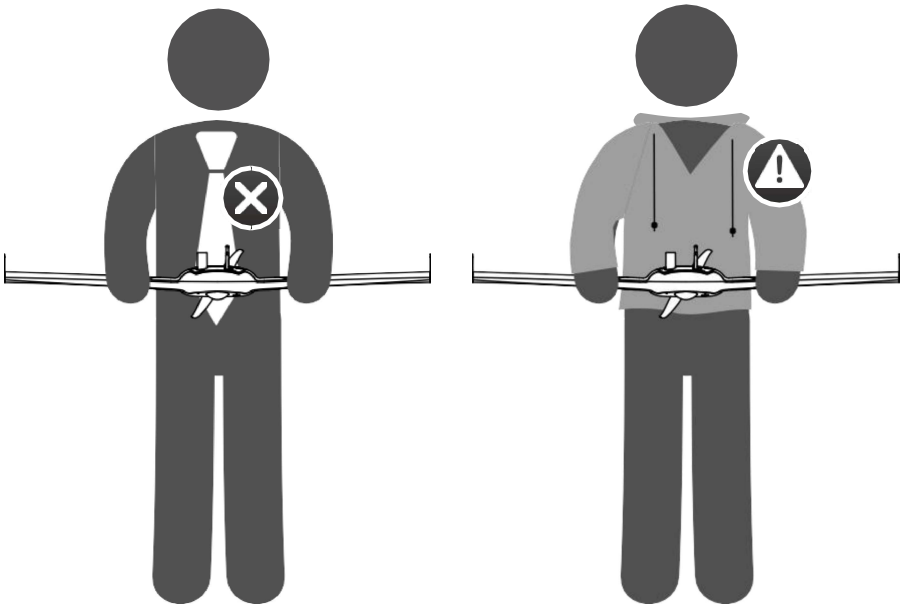
Caution: Once the motor is at full power and the LED is green, you have 15 s to launch the drone. After 15 s the motor cuts out and you cannot take off again for 2 minutes.

Two hands launch





Do not hold the drone near the ends of the wings



Caution: Keep the propeller area clear at all times during the launch procedure.

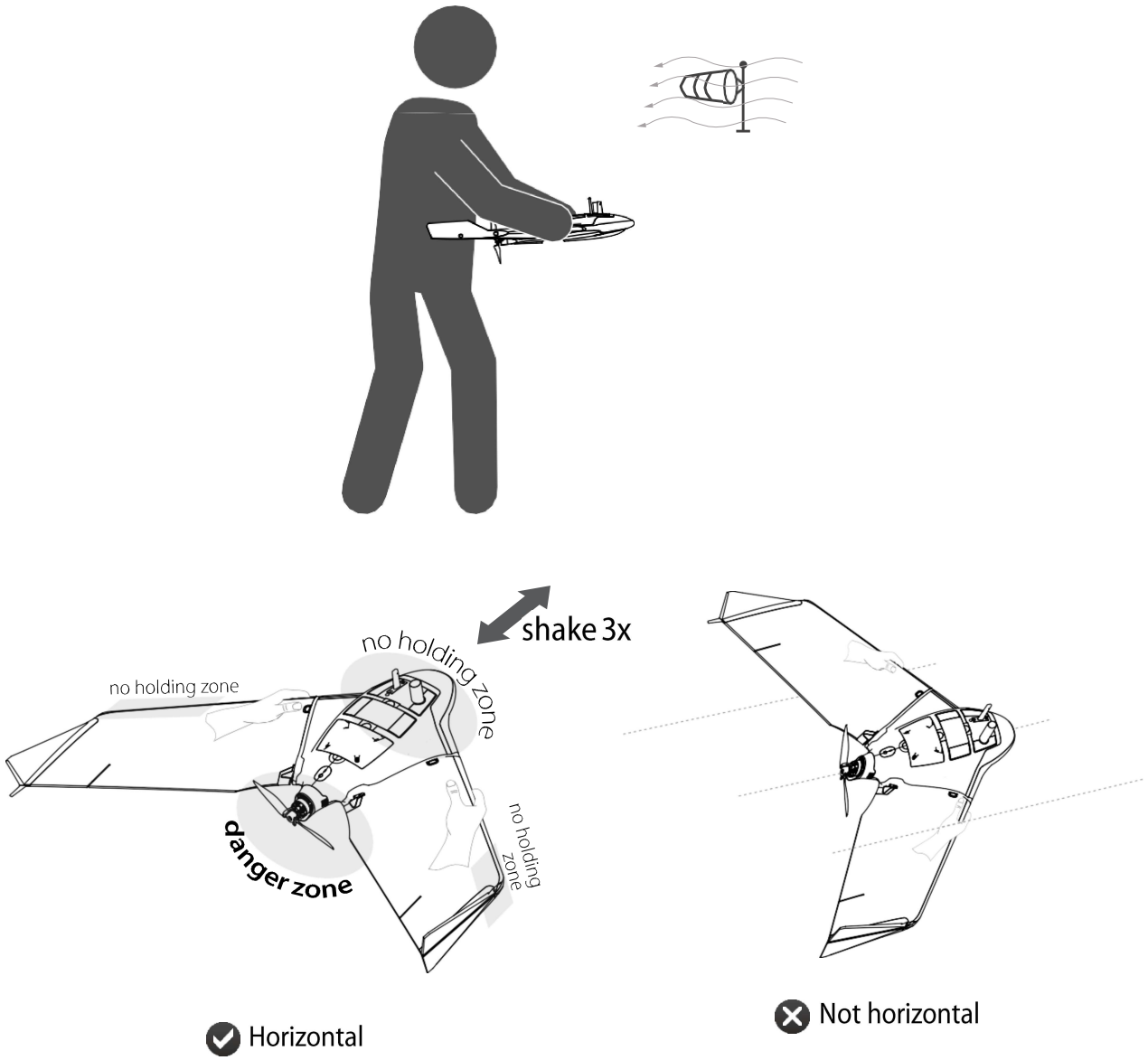
A safety distance of at least 15 cm (6 in) between the propeller and any part of your body, clothing or any object must be maintained.

Do not wear any item of clothing that hangs down in front of you. Do not wear a loose tie. Do not wear clothing that has strings or toggles hanging down in front, for example, a coat or hoodie with hood strings.

Take care when wearing bulky clothing, for example, a thick coat. Always maintain the safety distance between the propeller and your clothing.

Before starting the drone's propellers, hold the drone out in front of you and check that you can maintain the required safety distance from the propeller. If you cannot, do not attempt to launch the drone.

Step 1: Orientate horizontally and against the wind



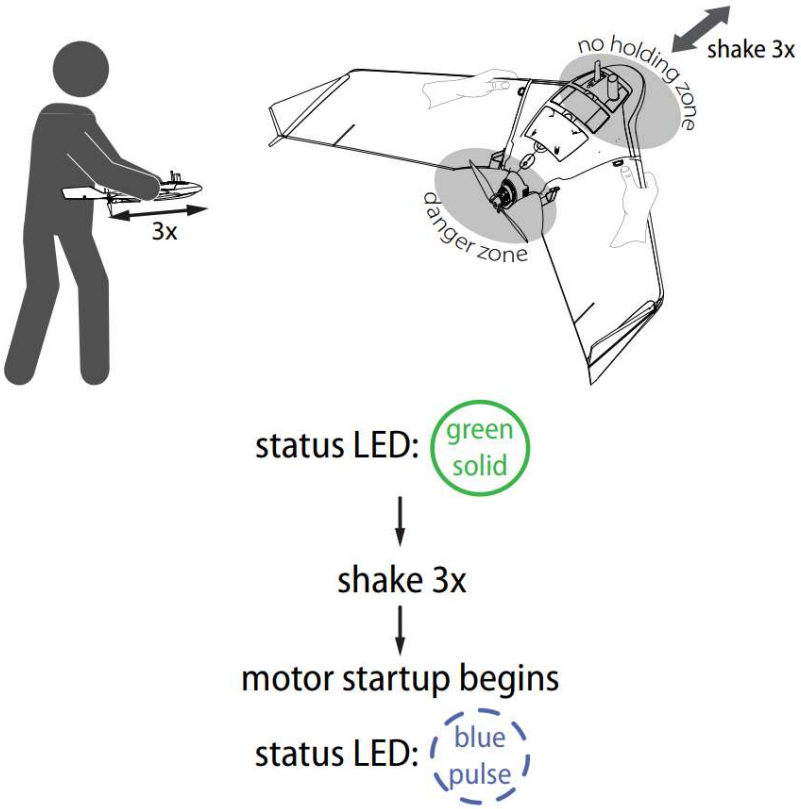
Orientate yourself against the direction of the wind and confirm that the take-off direction in front of you is free of obstacles.

Firmly grasp the drone with both hands, one hand on the front of each wing at the center of wing's leading edge, as shown.

Hold the drone horizontally with the nose pointed against the wind and level wings.

Caution: Do not hold the drone with your hands at the ends of its wings.

Step 2: Start the motor

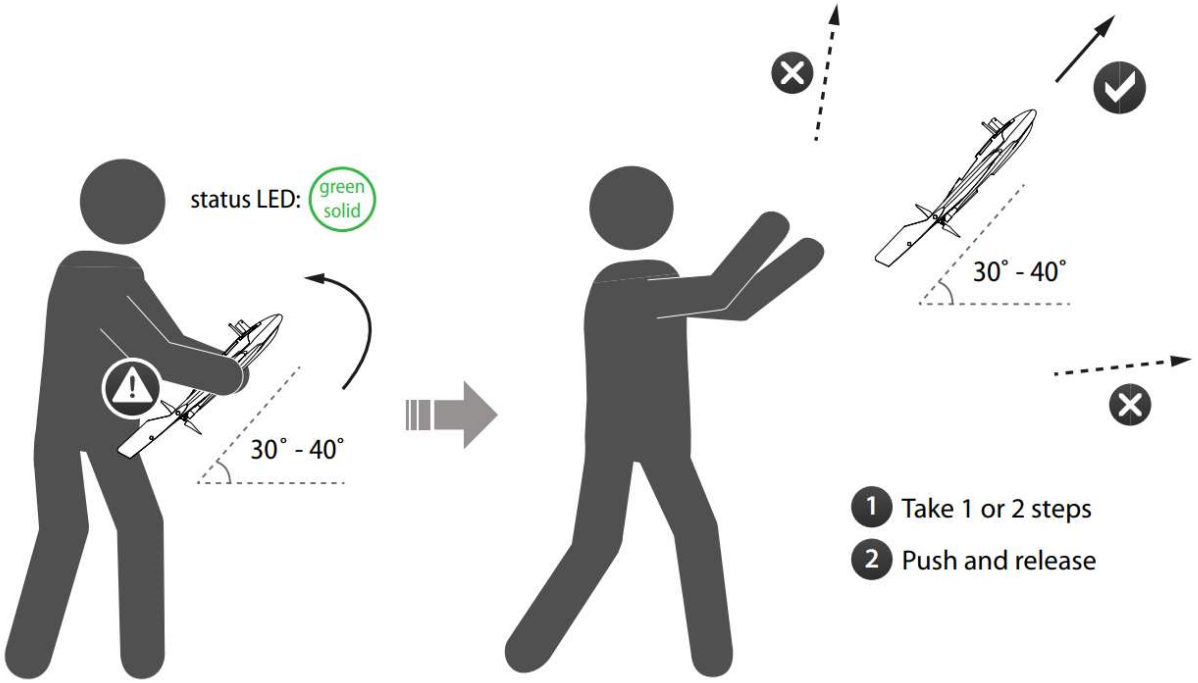


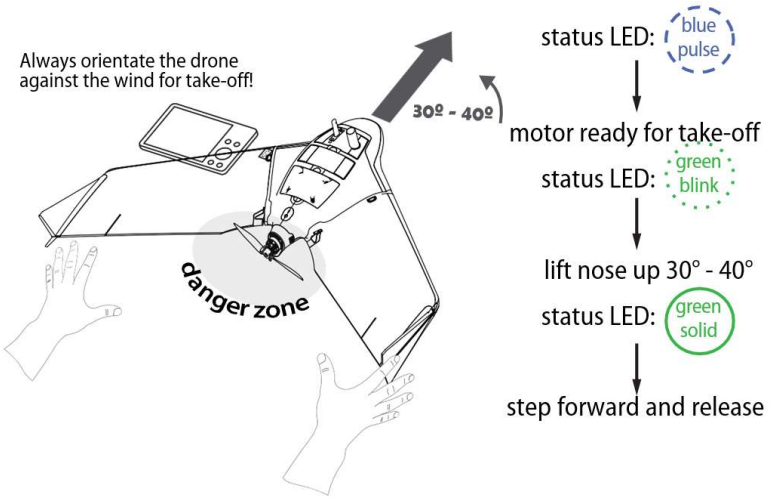
Shake your *eBee X series drone* back and forth 3 times longitudinally (within approx. 3 seconds) to begin the motor power-up sequence.

Step 3: Launch the *eBee X series drone*

Orientate the drone with its nose between 30° and 40° up and with level wings. When the nose-up angle is correct, the status LED will turn solid green, indicating that the drone is ready for take-off.

Launch the drone with a gentle push, walking 1-2 steps forward while gently guiding it forwards and up within the 30° - 40° range climb slope and releasing it from both hands simultaneously in a forward motion.





Once the motor is at full power the status LED will blink green.

After take-off, the drone tries to maintain its initial direction, or follow the directional take-off heading you set, by keeping its wings level with full thrust until reaching the take-off transition altitude (by default 20 m (66 ft)). At this point, it will switch into waypoint navigation mode and fly towards Start. Once it reaches Start, the drone will circle around the waypoint 1-2 times to estimate the wind and calibrate its sensors before starting its mission[15]

[15] The *eBee X series drone* may also be programmed to wait at Start for a command before starting its mission. See your *eMotion* user manual for more information.

17.7 Landing

After finishing a mapping mission the drone will, by default[16], return to Home and automatically initiate a landing.

An *eBee X series drone* can perform either a Linear or Steep landing. Linear landing is the default and recommended landing type.

The landing process uses an LiDAR ground sensor to detect the proximity of the ground.

Caution: Do not attempt to use the ground sensor as a means to avoid obstacles; in certain conditions it may fail to detect them.

Several conditions on the environment and the positions of Home and approach sectors must be met in order for the ground sensor to function correctly and ensure the accuracy of the landing:

- If the landing spot is not at the same altitude as take-off you must adjust the landing altitude in *eMotion*, as the drone uses this altitude to level out and slow down before landing.

Caution: Incorrectly setting the altitude of the Linear landing spot will decrease the accuracy of the Linear landing and may result in damage to your *eBee X series drone*.

- If possible, choose a landing spot that is flat beyond each approach sector (on the opposite side of the landing spot to the approach) and keep it free of obstacles, in case the landing needs to be aborted.
- During a landing the drone needs enough power to slow down its descent using reverse thrust. If the battery descends below 20%, *eMotion* will raise a Warning.
- The ground sensor must be able to accurately detect the height above the ground. Ensure that it is clear of dirt or other obstructions and do not attempt to land using the ground sensor through fog or thick haze.

Caution: Attempting a landing on sloped terrain, the top of a roof or the edge of a cliff or any other terrain that is not flat will likely result in false detection of the height above the ground during the approach and may result in damage to your *eBee X series drone*. In particular, landing downhill may cause a large overshoot and should always be avoided.

Caution: Landing between tall obstacles is not recommended; they may disturb the GNSS signals your *eBee X series drone* needs to be able to navigate.

Caution: Forcing the drone to land downwind or crosswind, or with certain warnings or critical failures active, may cause it to overshoot or undershoot its landing at high speed, resulting in potential damage to the drone.

If a landing is aborted before completion the drone will turn on its motor full thrust and gain altitude while continuing in a straight line in its approach direction. Once the altitude of 40 m/ATO (130 ft/ATO) is reached the drone will turn towards Home and continue climbing until it reaches Home. It then continues circling until it receives a further command.

Caution: Do not abort a landing if there are large obstacles beyond the landing spot, as the drone will continue flying in a straight line after an abort sequence while it gains altitude and may collide with those obstacles.

[16] see your *eMotion* user manual for information on changing the default behaviours of the drone

Caution: Aborting a landing after a low battery Warning is not recommended; the drone may not have enough power to attempt a second landing.

Once it has landed, disconnect the battery from the drone before picking it up.

We recommend you immediately import the images and flight data after each flight (see your *eMotion* user manual) before putting your *eBee X series drone* back in its case for storage. Your images and flight data are stored on the camera's SD card.

When disconnecting the wings, be sure to gently pull them straight out to prevent damage to the wing struts. Check the wing struts for any damage before putting them into the storage case. Remove the propeller if you don't plan on using your *eBee X series drone* for an extended period of time.

Linear landing

The drone descends at a shallow angle (approximately 20°) within one or several approach sectors you define.

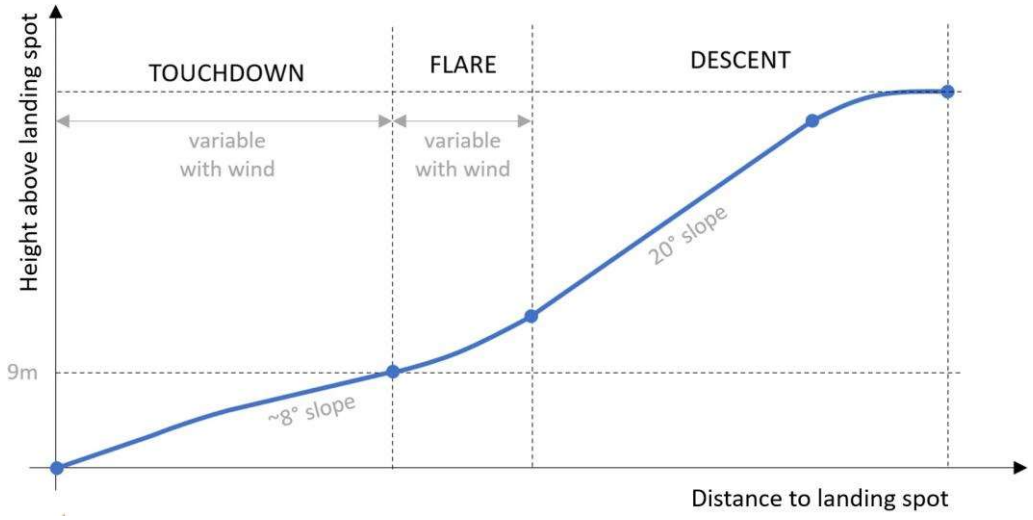


Figure 2: Linear landing procedure, descent to touchdown phases seen from the side

A typical linear landing contains the following steps:

1. The *eBee X series drone* flies towards Home (defined by the user within *eMotion*; default altitude is 75 m (250 ft) above the landing altitude). The drone will fly to Home at whichever altitude is the highest; its current altitude or Home's altitude. It will climb in a spiral first if needed.

2. Once Home is reached the drone circles the waypoint then either climbs or descends to the altitude at which it will begin its downwind landing leg. This altitude depends on the difference in altitude between Home and the landing spot:
   - If Home is more than 75 m (250 ft) above the landing spot, the drone will descend to 75 m (250 ft) before starting the downwind leg.
   - If Home is between 50 m (160 ft) 75 m (250 ft) above the landing spot, the drone will start the downwind leg at that altitude.
   - If Home is less than 50 m (160 ft) above the landing spot, the drone will climb to 50 m (160 ft) above the landing spot before starting the downwind leg.

3. The drone circles the designated landing spot to estimate wind speed and direction. An approach direction is then calculated as close to the upwind direction as possible within the allowable approach sectors (defined by the user within *eMotion*).

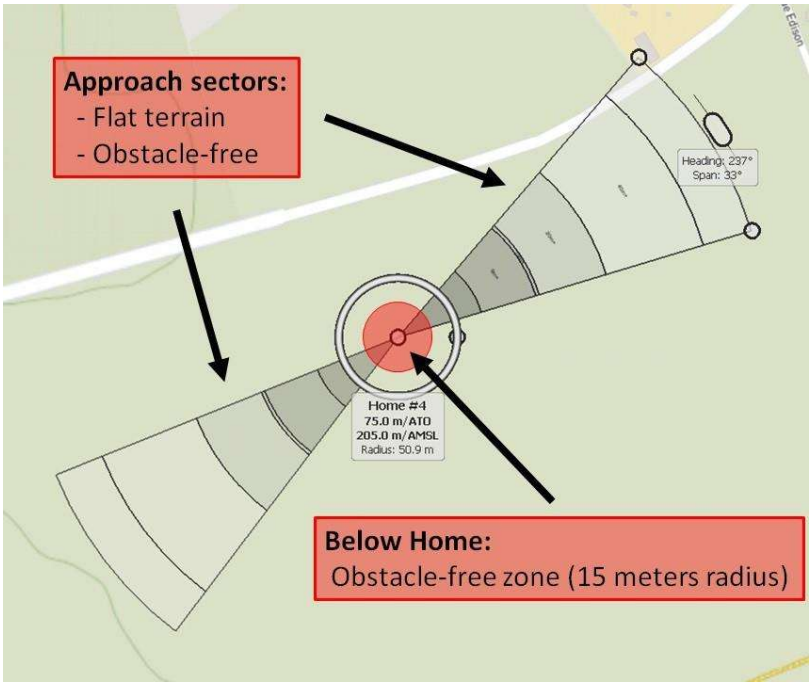
4. The drone flies downwind against the approach direction. After flying for a sufficient distance, it turns around to align itself with the approach direction.

5. Descent: the drone glides down in the approach direction at a controlled speed and descent angle of approximately 20°, braking by spinning its propeller in reverse if necessary.

6. Flare: Approaching a height of around 9 m (30 ft) to the ground, the drone will reduce its angle of descent to reach approximately 8° (might change depending on the wind speed).

7. Touchdown: the drone progressively reduces its speed to reach near stall airspeed until it touches the ground.

A linear landing can only be performed on flat terrain. Ensure that the ground is flat and at the same altitude as the landing spot for a distance of at least 100 m (330 ft) ahead of the landing spot within every approach sector. Ensure there is an obstacle-free zone with a radius of 15 m (50 ft) around the landing spot.



Note: Distance needed for the Flare and Touchdown phase:

The angle of descent is variable with the wind speed and direction during the final landing phases:

- The stronger the front wind, the steeper the descent angle and shorter the total approach distance needed.
- The stronger the downwind, the shallower the descent angle and longer the total approach distance needed.

Caution: Keep a safe distance from obstacles:

eMotion displays a predefined approach profile with the corresponding approach distances and altitude for a downwind landing condition at 4 m/s. To keep a safe distance with potential obstacles:

- Ensure that there are no obstacles within 60 m (197 ft) of the landing spot.
- Ensure that all potential obstacles are well below the approach profile.

Caution: In case of forced downwind landing with wind speed greater than 4 m/s, the actual landing trajectory may be below the predefined approach profile.

To limit the ground speed (and the ground contact strength) when landing and to achieve the best landing accuracy possible, only perform a Linear landing against the wind.

Linear landing approach sectors should be as wide as possible and in as many directions as possible to allow the drone to select the optimal approach direction based on its estimate of the wind direction. If your approach sectors only allow a downwind landing, *eMotion* will raise a Warning[17] at the moment the drone calculates its landing trajectory.

You can rotate and resize approach sectors in *eMotion*, confining them to zones that are completely clear of obstacles. You can also add additional approach sectors. These approach sectors will be used by the drone to plan its landing path while taking into account the wind. Defining multiple possible approach sectors can increase the chance that the drone selects a favourable landing against the direction of the wind.

The *eBee X series drone*'s ground sensor can typically begin detecting ground proximity at a distance of 60 m (197 ft).

If, during a Linear landing, the drone reaches an estimate altitude of 10 m/ATO (33 ft/ATO) – as estimated using the on-board GNSS receiver and pressure sensor – without a signal from its ground sensor, it assumes there is a malfunction with the ground sensor. This can be caused by fog, dirt on the sensor's lens assembly or a landing spot at a different altitude than the Take-off spot.

If this happens, the drone performs the braking and stall manoeuvre at an altitude of 10 m (33 ft) instead of 3 m (10 ft). This increased time while stalled can greatly reduce the accuracy of the final landing position and may cause damage to the drone.

[17] see your *eMotion* user manual

Steep landing

The drone descends at a steep angle (35°).

The landing strip has the landing point at its centre, giving the drone the choice of two approach directions. To avoid landing with a tailwind and overshooting, the drone decides itself from which of these directions it will land.

Align the landing strip with the wind so that one of the approach directions results in the drone landing directly into the wind.

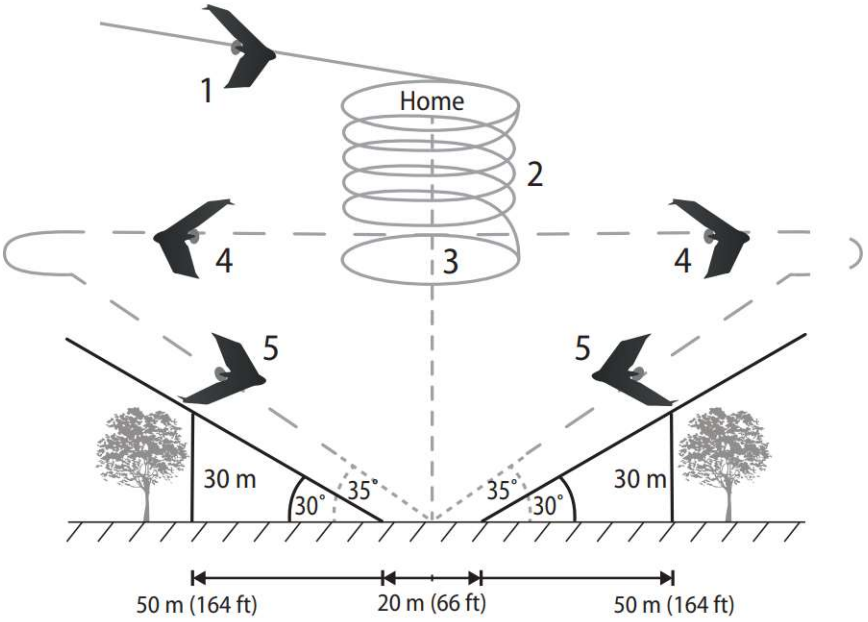


Figure 3: Steep landing procedure, seen from the side

1. Home approach
2. Spiral up or down to between 50 and 75 m above landing spot
3. Circle to measure wind
4. Fly downwind
5. Steep descent to ground

Move and rotate the landing strip so that both approach directions are free of obstacles (see your *eMotion* user manual).

A typical Steep landing follows these steps:

1. The *eBee X series drone* flies towards Home (defined by the user within *eMotion*; default altitude is 75 m (250 ft) above the landing altitude). The drone will fly to Home at whichever altitude is the highest; its current altitude or Home's altitude. It will climb in a spiral first if needed.
2. Once Home is reached the drone circles the waypoint then either climbs or descends to the altitude at which it will begin its downwind landing leg. This altitude depends on the difference in altitude between Home and the landing spot:

- If Home is more than 75 m (250 ft) above the landing spot, the drone will descend to 75 m (250 ft) before starting the downwind leg.
- If Home is between 50 m (160 ft) 75 m (250 ft) above the landing spot, the drone will start the downwind leg at that altitude.
- If Home is less than 50 m (160 ft) above the landing spot, the drone will climb to 50 m (160 ft) above the landing spot before starting the downwind leg.

3. The drone circles to estimate the wind speed and direction. An approach direction is then calculated, and the drone chooses from which of the two possible directions (defined by the landing strip) it will land.
4. The drone flies downwind against the approach direction. After flying for a sufficient distance it turns around to align itself with the approach direction.
5. The drone uses reverse thrust to enter a steep descent at an angle of approximately 35°until it reaches the ground.

- Ensure that the ground is flat and at the same altitude as the landing spot for a distance of at least 30 m (98 ft) ahead of the landing spot in both approach directions.
- Ensure that there are no obstacles within 40 m (131 ft) of the landing spot.
- Ensure that a circle of radius of 5 m (16 ft) around the landing spot is obstacle-free. If there are obstacles further away, ensure that the top of the obstacles is no higher than a line that ascends at a 30°angle from the landing spot.

Note: If your drone's ground sensor is obscured or is malfunctioning, it can still carry out a steep landing with reduced precision.

Caution: You cannot force the drone to choose one or the other landing direction. Ensure that the drone is free to land in either direction.

Caution: Hard Steep landings may be more common in winds below 5 m/s (10 kts). Short Steep landings may occur in winds above 10 m/s (19 kts). Take care in changing winds.

17.8 Potential in-flight errors

The drone can encounter two types of error messages while flying: Warnings and Critical failures. Warnings typically indicate a dangerous situation such as a low battery or strong winds and typically result in a safety action such as a return to Home.

See your *eMotion* user manual for a full description of Warnings and Critical failures that may occur.

Note: It is important to keep track of the location of the drone during a Critical failure until the moment it reaches the ground. Its position's coordinates can aid in finding it afterwards.

17.9 Understanding the drone's LED

The drone's LED indicates the drone's status. It will shine, pulse (or 'breathe') or blink different colours:

Pulsing Blue

Preflight Checks running

Pulsing Green

Preflight Checks OK

Blinking Green

Take off: Wrong angle

Constant Green

Take off: Ready for launch

Blinking Red

Preflight Check Issue

Constant Red

Update issue

Pulsing White

USB connection for reading logs and files ready

Intermittent Blinking White

Landing in progress

Pulsing Yellow

USB connection for update ready

Blinking Yellow

Update in progress on the drone

Off

Drone Off or in flight (or Recovery Mode)

17.10 Autonomous controller and modes of flight

During a typical flight the autonomous controller on the *eBee X series drone* will switch between various modes depending on its flight plan and the commands that it receives from *eMotion*[18].

The following mode changes might occur during a typical flight:

- After being switched on and running pre-flight checks the drone will enter Idle mode until it is ready to be launched. Shaking the drone back and forth three times initiates the take-off procedure[19] and changes to the Take-off mode.
- After take-off the drone climbs with level wings[20], gaining altitude until it reaches the take-off transition altitude[21]. At this point the drone heads for Start and changes to Circle Start Waypoint mode.
- Once it reaches Start, the drone circles the waypoint several times to estimate the strength of the wind. Once it calculates the estimated wind the drone either:
  - head towards the first mission waypoint (if instructed in *eMotion* to start mission after take-off) and change to Perform Mission mode.
  - continues circling Start until a command is received from *eMotion*.
- While in Perform Mission mode the drone flies between all enabled mission waypoints, taking images of the ground below. Once it reaches the final mission waypoint the drone either:
  - heads towards Home (if instructed by *eMotion* to land or go to Home after mission), and changes to Circle Home Waypoint mode.
  - heads towards Start (if instructed by *eMotion* to go to Start after mission), and changes to Circle Start Waypoint mode.
- Clicking HOLD in *eMotion* during flight will cause the drone to start circling its current position and change to Hold Position mode until it receives a new command from *eMotion*. This mode is also enabled automatically after certain Warning or Critical failure conditions[22].
- Triple-clicking the LAND NOW in *eMotion* will cause the drone to initiate an emergency landing procedure and spiral down to the ground at its current location and switch to Emergency Landing mode.
- After returning Home (if in Circle Home Waypoint mode) the drone will either:
  - Begin its landing procedure (as described in *Landing* on page 53) and change to Landing mode (if instructed by *eMotion* to land after mission).
  - Circle Home and remains in Circle Home Waypoint mode until a command is sent.
- After completing a landing procedure and detecting that it has successfully landed, the drone changes to Idle mode.

[18] see your *eMotion* user manual for details
[19] as described in *Take-off* on page 44
[20] or in a given direction when using the Directional take-off feature described in your *eMotion* user manual
[21] see your *eMotion* user manual for details on changing this altitude
[22] see your *eMotion* user manual for a full list of Warning and Critical failure conditions and the subsequent reactions of the drone

17.11 Flying the eBee X series drone manually

In regions where regulatory compliance requires it, your *eBee X series drone* may have been supplied with a Remote Control and fitted with a receiver.

Do not use the Remote Control unless you have been specifically trained to.

To change the default mode (automatic), follow the next steps:

When the drone is flying click on the "parameters" icon in the drone panel of eMotion.
Below "Manual control mode", choose the desired parameter.

(a) "Assisted manual control" permit to maneuver the drone with restricted angles (pitch and roll);
   i. Maximum rate of descent or climb: 3m/sec.
   ii. Maximum bank angle: 30°.

(b) Full manual control permit to fly the drone manually without any assistance.

Note: Manual flight is not allowed in the European Open Category under the C2 marking of the eBee X.

17.12 Post flight procedure

Disconnect the battery

After the landing, disconnect the battery first and remove the battery from the eBee X.
Take care to pull the cable from the main black part and not directly from the cable itself.
Visually inspect the battery for damage. In case of distortion, abnormal shape or cables wear don't use it anymore and destroy it following the local regulation.

Detach the wings

Detach the wings by pushing on the appropriate button and pull it horizontally.
Visually inspect each wing for cracks or wear. Do not use again a damaged wing.

1. Verify that the wing struts are not split or damaged in any way.
2. Verify that the joint between the wing and the aileron is not damaged or torn.
3. Verify that the winglet is in good condition.

General inspection of the central body

Visually inspect the drone for damage or wear using the following steps:

4. Check the central body and wings for cracks or other damage.
5. Verify that the pitot probe is properly attached to the airframe and that the holes in the probe are free of obstructions.

6. Verify that the antenna is properly attached to the airframe.
7. Verify that the tubes within the Central Body that hold the wing struts are not cracked or damaged in any way.
8. Verify that the servos turn smoothly.
9. Verify that the propeller rubber bands are all in place and are in good condition.
10. Verify that the propeller is in good condition and is properly attached.
11. Verify that the power cables within the battery compartment are well insulated and not damaged.
12. Verify that the camera's lens is clean.

The payload

If necessary, remove the camera from the drone and extract the payload SD card which withhold the images and basic flight log information from the flight.

18 Maintenance and repair of an *eBee X series drone*

Goal of this section: This section describes how to update the accompanying software and on-board firmware, keep your drone in good working condition and perform small repairs such as cracks in the airframe.

18.1 Updating an *eBee X series drone*'s software and firmware

Occasionally, senseFly releases an *eMotion* software and *eBee X series drone* firmware upgrade to provide additional features to our users or to correct potential issues. *eMotion* will check for new versions during start-up[23] and will display a message with update instructions if a new version is available.

We also recommend that you check my.senseFly[24] regularly for updates to ensure you have the latest version of the software. Download the installer from my.senseFly and follow the installation procedure described in your *eMotion* user manual. You do not need to uninstall the previous version before installing the new one.

It is important that the drone's firmware and *eMotion* version are kept in step. senseFly will always release *eMotion* and firmware updates together. Make sure that you keep both up-to-date and aligned.

To check which version of *eMotion* you have installed, click About eMotion on its Welcome page. Your *eBee X series drone*'s firmware version is also shown in *eMotion* when it's connected to your drone (see your *eMotion* user manual for details).

Caution: We are constantly working to improve the performance of our products and we are dedicated to providing our customers with the newest software as soon as it becomes available. Since the highest level of flight safety can only be achieved with the latest software release, senseFly can only offer warranty service for products that have been properly updated.

18.2 How to update an *eBee X series drone*'s firmware

Every version of *eMotion* is packaged with an accompanying firmware revision which must be installed on the drone before it can be used.

1. Remove the drone's propeller[25].
2. Connect the USB cable between the computer on which you installed *eMotion* and your drone's autopilot socket (inside the camera bay, marked).
3. Connect the battery to the drone. The status LED will pulse yellow.
4. Launch *eMotion*.
5. In *eMotion*, click the Updater tab and follow the instructions. While updating the LED blinks yellow. After a successful update, the LED pulses white. After a failed update, the LED shines red.
6. Once the update has completed, restart your drone. If it's still blinking yellow after 10 minutes, restart your drone.
7. Replace the propeller. Never try and start the motor without the propeller.

[23] provided that there is an internet connection
[24] http://my.sensefly.com
[25] there is a small risk that the propeller spins during the update

18.3 Full airframe and sensor inspection

Beyond the general airframe inspection that is performed before every flight[26], senseFly recommends that the operator performs a full airframe and sensor inspection every 10 flight hours, on removal from extended storage and after any repair, heavy landing or other unexpected incident. This will give the aircraft a safety rate comparable to manned aircraft and keep your *eBee X series drone* in good operating condition.

Caution: The autopilot, sensors and actuators within the Central Body of the *eBee X series drone* are specially calibrated and should only be modified by senseFly or a certified *eBee X series drone* reseller. Opening the Central Body of an *eBee X series drone* will void the warranty.

Caution: The propeller on an *eBee X series drone* spins at high speeds and can cause deep cuts if it comes into contact with exposed skin. Always wear gloves and safety glasses when any work is done requiring the battery to be connected to the drone.

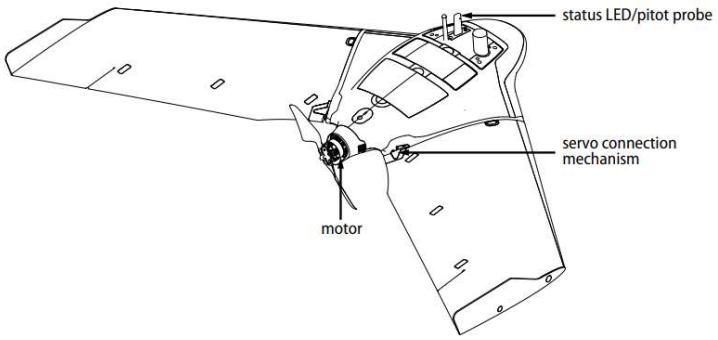
Carry out this full inspection with the wings and a propeller attached.

[26] See *Getting your* eBee X series drone *ready to fly* on page 31

Check 1: Motor and Servos

eBee X series drone uses a brushless DC motor to turn its propeller and generate thrust. The servos are the two actuators connected through a servo connection mechanism to both ailerons.

The motor must be clean and spin smoothly without friction to function correctly. The servos must turn smoothly. Damaged servos can prevent the drone from flying correctly and thus it is important to ensure their proper functioning.



To check the motor and servos, follow these steps:

1. Ensure that there is no sand or other obstructions within the motor. If there is something blocking the motor from spinning smoothly blow some air through the motor to dislodge the obstruction.
2. Turn the servos and ensure that they move smoothly and have the full range of motion.

In case of doubt, record a short video and follow the instructions in *Reporting a problem with your* eBee X series drone on page 77 for advice.

Check 2: Inertial sensors

The inertial sensors are used by the autopilot to compute the attitude (i.e. its orientation in space) of the drone. The attitude is displayed by the attitude indicator in *eMotion*. To check the inertial sensors, follow these steps:

1. Switch your *eBee X series drone* on by connecting the battery and connect to *eMotion*.
2. Put the drone on a flat surface (typically an office floor) and check that the attitude indicator is level.
3. Take the drone in your hands, tilt the nose up and down and tilt the wings to the left and right. Make sure that the attitude indicator in *eMotion* displays the corresponding orientation.

The attitude indicator should follow smoothly the motion of the *eBee X series drone* and it should not drift when the drone is not moving. In case of doubt, take a short video and follow the instructions in *Reporting a problem with your* eBee X series drone on page 77 for advice.

Check 3: Barometric pressure sensor

The barometric pressure sensor is used to measure the altitude from the take-off spot. To check it, follow these steps:

1. Switch your *eBee X series drone* on by connecting the battery and connect to *eMotion*.

2. Move the drone from your feet to above your head (about 2 m (7 ft) altitude variation).
3. Check the altitude shown in *eMotion*.
4. Move the drone back down, from above your head to your feet (about -2 m (-7 ft) altitude variation).

The displayed altitude should follow the drone motion, i.e. if the drone is raised by 2 m (7 ft), the altitude reading should increase by about 2 m (7 ft), then decrease again when the drone is lowered. When the drone is not moving, the altitude reading may slowly drift by up to ±10 m (±33 ft).

Check 4: Air speed sensor

The air speed sensor is connected to the pitot probe by a pair of tubes. To check it, follow these steps:

1. Visually check the pitot probe. Make sure that it is properly fixed to the airframe. The holes in the probe must be clear and free of dirt or other small obstructions.
2. Switch the drone on by connecting the battery and connect to *eMotion*.
3. Very gently blow into the front opening of the pitot tube from a distance of around 5 cm (2 in). The airflow direction should match the natural flow experienced in flight.
4. Check the air speed displayed in *eMotion*.

At rest, the displayed air speed should be close to zero (it may drift up to about 2 m/s (4 kts)). When blowing in the pitot probe the air speed indicated in *eMotion* that should easily reach values above 8 m/s (16 kts).

Check 5: Ground sensor

The ground sensor is a LiDAR sensor. The apertures must be clean and unobstructed for the sensor to work correctly.

To check it:

1. Make sure that it is properly fixed in place. Visually check the ground sensor. The lenses must be clear and free of dirt or other obstructions.
2. Place the drone on the ground and power it on by connecting the battery.
3. Connect the drone to *eMotion*.
4. Hold the drone approximately 1 m (3 ft) above the ground. Check that the Ground sensor height in *eMotion* is approximately that height. If it is incorrect or shows only a hyphen (-), your ground sensor is faulty.

18.4 Repairing your eBee X series drone

The senseFly support team or the certified *eBee X series drone* reseller need the logs to determine what happened during the flight in case of an incident. The flight logs files (.bbz) will be needed. Do as follow to recover the logs and be able to send them:

1. Connect the battery (blue status).
2. Connect the appropriate cable (modem's cable) from the drone to the computer (white status).
3. In your file explorer, open the folder called "LOGS".
4. Select "SFBBZ".
5. Download the desired flight.
6. Send it to the SenseFly support team or the certified eBee X series drone reseller.

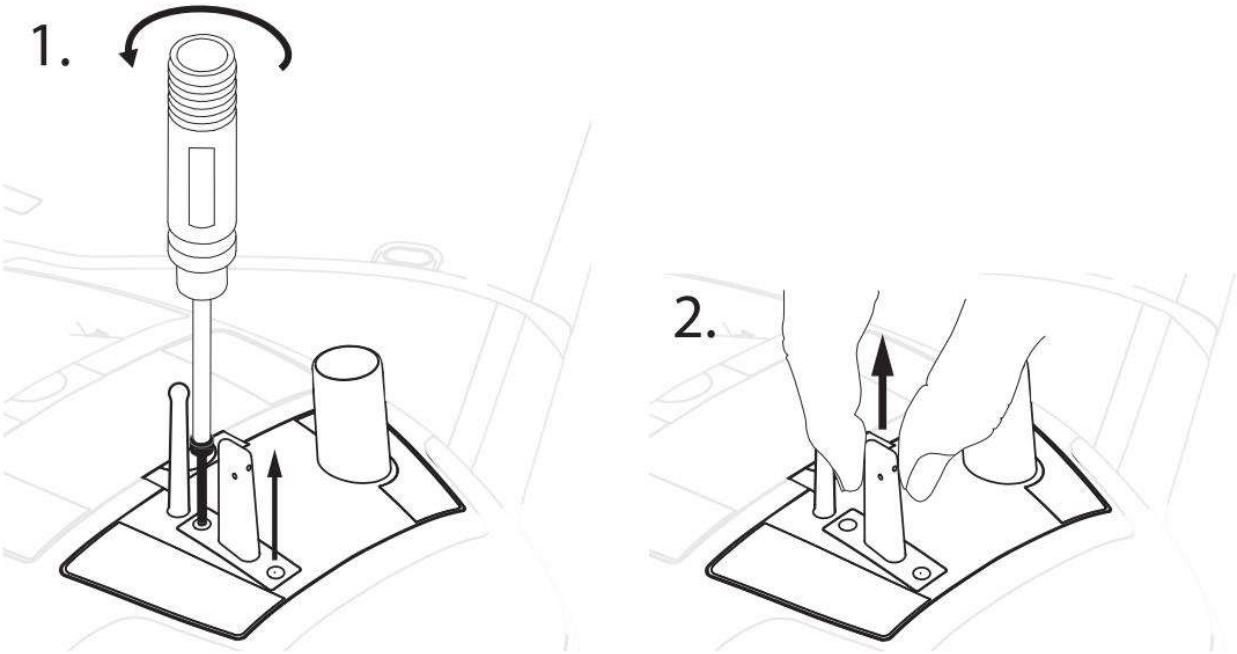
Caution: The *eBee X series drone*' advanced materials and construction mean that it has very few user- serviceable parts.

- Only carry out the basic repairs described in this user manual.
- Do not try and disassemble the drone beyond the procedures described in this manual.
- Do not try and repair carbon fibre parts, for example, the wing struts.
- If your drone is damaged, contact senseFly or a certified *eBee X series drone* reseller.

Caution: The autopilot, sensors and actuators within the Central Body of the *eBee X series drone* are specially calibrated and should only be modified by your *eBee X series drone* reseller. Opening the Central Body of the *eBee X series drone* will void the warranty.

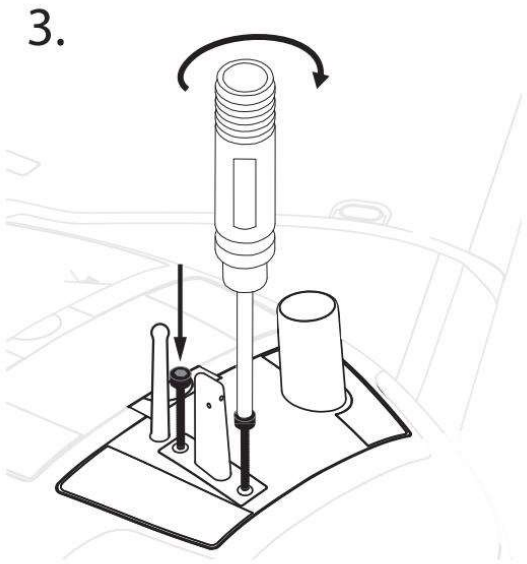
Replacing the pitot tube and airspeed sensor

If dirt, dust or excessive humidity reaches the drone's airspeed sensor, it may malfunction. Your *eBee X series drone* is supplied with a spare pitot tube and airspeed sensor unit.



1. Use a hexagonal 2.5mm screwdriver to remove the 2 screws that hold the air speed sensor in place.
2. Gently pull the old sensor out of its socket.

Caution: Ensure that the translucent white seal is correctly positioned on the replacement pitot tube.



3. Gently insert the new pitot tube into the socket on the drone. You should feel no resistance. Screw the 2 screws back in without over-tightening them.

Replacing the rubber bands and propeller

Rubber bands

A rubber band in good condition has no cracks in it. If cracks appear, replace the rubber bands with new ones. Always replace all three rubber bands.

We recommend regularly removing the rubber bands and inspecting them for cracks. It is especially important to inspect the part of the rubber band that passes under the propeller mount. This is an area where the rubber band experiences higher forces, and cracks can be hidden there.

The rubber's lifetime depends on the conditions under which it has been used, for example, external temperature, exposure to UV light and the number of flights. For this reason, although we recommend making a habit of checking the rubber bands regularly, we also recommend changing them every 6 months even if there are no apparent cracks.

Propeller

You should also check the propeller regularly. A propeller in good condition still has its original overall shape. Pay special attention to the tip where wear is most common. If any part of the propeller appears worn down, replace it.

Replacing the yellow vertical surfaces

The yellow plastic vertical surfaces onto which the wings clip need replacing if a clip is broken.

There are left and right-hand surfaces; make sure you have the correct one.

1. Carefully unscrew the 4 screws that hold the vertical surface in place.
2. Gently pull the vertical surface off and manoeuvre it around the servos.
3. Gently manoeuvre the new surface into place.

4. Screw all 4 screws back in firmly but without over-tightening them.

Repairing the EPP

Small repairs of cracks in the airframe can be done using contact glue such as UHU® POR glue. Take care to use only contact glues that are specifically designed for Expanded Polypropylene (EPP). If you have doubts about the extent of the damage, always contact a certified *eBee X series drone* reseller to verify if the damage can be easily repaired by yourself or if you need to send your drone in for repair to senseFly.

Caution: Never fly your *eBee X series drone* if it has cracks in it.

18.5 Cleaning an eBee X series drone

Use a damp cloth to wipe off dirt from the *eBee X series drone*' sensor modules, wings, body, motors and propellers. Use the cloth, cleaning fluid and cleaning tool provided to clean the camera lense and ground sensor.

Caution: Never bring an *eBee X series drone* into direct contact with water; this may damage its electronics.

18.6 Storing your eBee X series drone

Always clean the *eBee X series drone* before returning it to its case for storage. Whenever possible, store your *eBee X series drone* in the case it was supplied in.

If you must store the drone outside its case, to avoid wing deformation, store it on a flat surface at room temperature. Do not store the drone near a heat source, in direct sunlight or in a hot place.

Caution: As with most electronic equipment, to avoid a malfunction due to condensation forming inside the drone, avoid powering it on immediately after moving it from a cold to a warm environment.

18.7 Battery care and safety

Please, read the paper sheet provides in the package.

Proper care of your *eBee X series drone*'s battery is important to prevent damage to your drone and to maximise flight time. Frequent altitude changes, presence of wind, use of old batteries and/or frequent photo acquisition may significantly reduce the flight endurance. Batteries perform better at medium or high air temperature and it is normal to observe shorter flight times in cold weather.

The *eBee X series drone* is powered by a LiHV (High Voltage Lithium Polymer) battery composed of four cells connected in series. It has an empty battery voltage of 15.2 V and a fully-charged battery voltage of 17.4 V. A well-balanced and healthy battery should have all cells at a voltage very close to each other. Your battery's total voltage is shown in *eMotion* when the drone is connected.

The charger delivered with your drone automatically checks for healthy voltages of all cells and only attempts charging if they are within limits. If the cells are out of balance, the charger will take care of balancing them.

- Always charge **eBee X series drone** batteries using the supplied cable. Do not use the **eBee X series drone** charging cable to charge any other batteries.
- Always connect the battery to the charger with the correct polarity.

- Never leave or store a battery with its cable attached.
- Never leave the charger unattended while charging.
- Use the charger in a well-ventilated area, away from electrically conductive and flammable materials.
- The charger may become hot during use. Take care when handling it.
- If the battery or the charger behaves unexpectedly during charging (for example, overheating, smoking, melting, leaking, etc) immediately disconnect the mains and store the battery and charger in a safe location.
- Keep the charger away from dust, moisture, rain, heat sources, direct sunlight, and vibration. Never drop the charger.
- Only power the charger with the specified operating voltages.
- Place the charger and battery on a heat-resistant, non-flammable, non-conductive surface. Never place them on an upholstered surface such as a car seat or carpet.
- Keep all inflammable liquids and materials away from the battery and charger.

If the charger detects a charging voltage outside of the allowable range it will sound an alarm. Carry out the following procedure:

1. Check that the charging cable is properly connected with the correct polarity.
2. If the alarm continues to sound, the battery has developed a fault and should be discarded.

Caution: The batteries delivered with your drone are designed to be charged only with approved senseFly chargers. senseFly cannot be held responsible for any consequences resulting from using any other charger. In particular, using a charger improperly configured or designed for other types of batteries may lead the battery to be permanently damaged or to catch fire.

LiHV batteries do not exhibit any memory effect. You do not need to fully discharge them before charging them again. Recharging them when only partially discharged does not reduce their total charge, damage the battery or shorten its useful life.

When not using the battery store it in the carrying case provided with your drone. Avoid leaving the battery in direct sunlight. Don't store a fully charged battery for more than two weeks. Batteries should be stored charged to about 70%.

Caution: If any of the cells of your battery pack have been overly discharged the battery may be irreversibly damaged and dangerous to charge. If the battery swells beyond its regular size or if any of the cells are punctured it is also likely damaged and should be discarded. Forcefully charging a damaged battery may cause it to catch fire. **Do not attempt to charge an over-discharged or damaged battery. Dispose of the battery safely.**

Maximising safety and battery lifetime

If treated well, your *eBee X series drone*'s batteries have the potential to last for many cycles (charging then discharging).

As a general rule, the lower you push the battery charge during your flights, the shorter the lifetime of the battery will be.

In addition, flying with low battery isn't safe. At lower battery charge levels, less power is available for the motors to generate thrust. Unexpected wind conditions, the arrival of people or the arrival of an obstacle in the landing zone can force you to hold, abort the landing and climb, manoeuvre or counter the wind, all of which require battery power.

For trouble-free flight and long battery life:

- Land your drone before the battery runs out. Thanks to their smart-battery technology, the low endurance safety action (which brings the drone to Home) is based on accurate battery capacity. Leaving the low endurance safety action on is recommended to optimise flight time and safety[27]. You should consider returning the drone to the home waypoint before the low endurance Warning if you judge it necessary.
- Minimise the number of times you allow the battery charge to drop below 10%.
- Avoid taking the battery down to 0% charge. This can greatly reduce battery lifetime and reliability.

Deep discharge

eBee X series drone batteries' 4 cells must remain balanced and stay above a minimum voltage. Following a deep discharge—one or more of the cells are pushed below 2.5 V—they become damaged, affecting the reliability of the battery. If this has happened to a battery, it will be no longer possible to charge that battery.

Gradual discharge when not in use

Even when the battery is not in use, it will continue to gradually discharge (between 2 and 6% per month). Eventually, the battery could enter a state of deep discharge.

To avoid this:

- After flying, do not leave the battery in a low-charge condition for a long time. Recharge the battery as soon as possible.
- When batteries are in storage, check the battery level every 3 months and recharge to 70% when below.

18.8 Locating a lost *eBee X series drone* in the field

In case you lose your drone in the field for whatever reason, whether from a loss of communications, a Critical failure or an accidental collision, use the following steps to try to recover it:

1. Do not disconnect the connection in *eMotion*! If it is simply out of communication range the drone should reconnect automatically as it returns to Home after completing its mission.
2. Note the last known location of the drone in *eMotion* by printing the screen or writing down the coordinates displayed in *eMotion*.
3. Move towards this last known direction with the computer running *eMotion* in the hope of regaining a connection.

[27] see your *eMotion* user manual

4. Try moving downwind from the last known location in case the drone was pushed by the wind while still in the air.
5. Contact your *eBee X series drone* support provider as soon as possible and send them the corresponding *eMotion* flight log[28]; it can help to retrace the drone's trajectory.

You can write your address and phone number on your *eBee X series drone*, for example, put your business card on top of the battery (but not the camera) in case it gets lost and subsequently found by a third party.

18.9 Reporting a problem with your *eBee X series drone*

If there is a problem with your *eBee X series drone*, whether it is a software malfunction, damaged airframe or any other problem, carry out the following actions before flying again:

1. If there is an error message displayed in *eMotion*, begin by checking your *eMotion* user manual to see if there is a solution to the particular message.
2. Check our Knowledge Base, part of my.senseFly[29], to see if there is a solution to your problem.
3. If you have still not found a solution, contact your *eBee X series drone* support provider. Please include the following information with your inquiry:
    a. The serial number of your drone, in the format AB-XX-XXX. You can find this number inside the battery enclosure. Please include this serial number in the subject line of your message.
    b. A detailed description of the problem, including:
        i. any *eMotion* error messages
        ii. *eMotion* screenshots where possible and relevant
        iii. details of any troubleshooting or tests you have carried out
    c. The flight logs from the drone (.bbz and .bb3) for the flight that had a problem[30].
    d. If the drone's flight logs cannot be copied off the drone, the logs on the camera's SD card in the LOGS folder.
    e. The eMotion Flight Log (_em.bb3) file of the flight that had a problem. You can find this file in the eMotion/logs/ directory which is created in My Documents on Windows.
    f. Photos or video of the *eBee X series drone* airframe, if required.

Note: To provide support, senseFly may request the flight log files for inspection. Copy the logs off the drone before the next flight.

18.10 Refurbishment instructions

The user is only permitted to repair what is described in on page 71.

In the case of damage not described in this manual, please contact your reseller or the senseFly support team.

[28] see the *eMotion* user manual
[29] http://my.sensefly.com
[30] see your *eMotion* user manual for instructions on retrieving this file from the *eBee X series drone*

18.11 Replacement parts

		EBEE X	EBEE GEO	EBEE AG	EBEE TAC Public Safety	EBEE TAC Governmental
ASSEMBLY	COMPONENT	SENSEFLY PART NUMBER				
CENTRAL BODY	ASSEMBLY	SM051000	SM051000	SM051000	SM051000	SM054000
	Servos	MCMOT00033	MCMOT00033	MCMOT00033	MCMOT00033	MCMOT00033
	Motor	MCMOT00059	MCMOT00059	MCMOT00059	MCMOT00059	MCMOT00059
	Pitot tube	SI050004	SI050004	SI050004	SI050004	SI050004
	Skid Plate – Lower protection	MCPLA01630	MCPLA01630	MCPLA01630	MCPLA01630	MCPLA02065
	Battery Cover	MCPLA01706	MCPLA01706	MCPLA01706	MCPLA01706	MCPLA01706
	Body wing interfaces	MCPLA01752 (LH) MCPLA01751 (RH)	MCPLA02077 (LH) MCPLA02076 (RH)	MCPLA01754 (LH) MCPLA01753 (RH)	MCPLA02064 (LH) MCPLA02063 (RH)	MCPLA02064 (LH) MCPLA02063 (RH)
Wings	Assembly	SI050009 (LH) SI050008 (RH)	SI050009 (LH) SI050008 (RH)	SI050009 (LH) SI050008 (RH)	SI050009 (LH) SI050008 (RH)	SI054002 (LH) SI054001 (RH)
Peripherals	Payload (Cameras)	senseFly S.O.D.A SF050005 senseFly S.O.D.A 3D SF050054 senseFly S.O.D.A Corridor SF050006 senseFly AeriaX SF050018 senseFly Duet-T SF050027 senseFly Duet- M SF050036 Micasense RE- MX SF050029 Parrot Sequoia+ PF740000	senseFly S.O.D.A SF050005	senseFly Duet- M SF050036	senseFly S.O.D.A SF050005 senseFly S.O.D.A 3D SF050054 senseFly S.O.D.A Corridor SF050006 senseFly AeriaX SF050018 senseFly Duet-T SF050027 senseFly Duet- M SF050036 Micasense RE- MX SF050029 Parrot Sequoia+ PF740000	senseFly S.O.D.A SF050005 senseFly S.O.D.A 3D SF050054 senseFly S.O.D.A Corridor SF050006 senseFly AeriaX SF050018 senseFly Duet-T SF050027 senseFly Duet- M SF050036 Micasense RE- MX SF050029 Parrot Sequoia+ PF740000
	Battery charger	SI050022	SI050022	SI050022	SI050022	SI050022
	Tracking Device	SF200004	SF200004	SF200004	SF200004	SF200004

18.12 Life limited parts

	Systematic	Normal use
Wings	n/a	When necessary, depending on the condition
Pitot	100 hours inspection	
Blister		
Propeller		
Rubber bands		

19 Maintenance and inspection log

Date	A/C model	S/N	Hours	General/Full	Maintenance activity	Inspected by

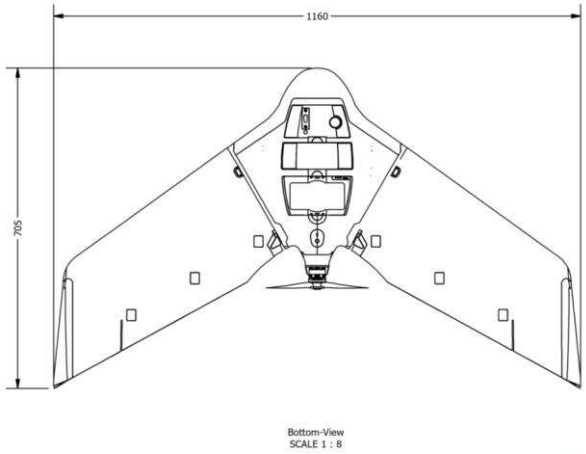
20 Specifications

20.1 Drone specifications

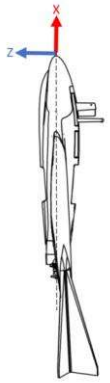
Wingspan	116 cm (45.7 in)
Maximum take-off weight	1.6 kg (3.5 lbs)
Central body drone weight	665 g
Standard battery weight	334 g
Endurance battery weight	420 g
Wings weight	195 g
Beacon weight	9 g
RC receiver weight	4.5 g
Add-on green flashing light	4 g each (2 are required)
Maximum allowed payload weight	300 g (all the cameras listed in the compatible sensors table are in compliance with the MTOM)
Propulsion	Low-noise, electric brushless motor
Maximum propeller speed	10322 tr/min
Material	EPP foam, carbon structure & composite parts
Standard battery	4-cell 3700 mAh LiHV (0.3 kg (0.7 lbs)) - model SI050003
Endurance battery	4-cell 4900 mAh LiHV (0.4 kg (0.9 lbs)) - model SI050017
Battery consumption	15.2 V DC, 3.7/4.9 A
Nominal endurance[31]	up to 59 minutes (flight time with standard battery)
Extended endurance[32]	up to 90 minutes (flight time with endurance battery)
Landing	Linear landing at 20° Steep landing at 35°
Cruise speed	12-17 m/s (43-61 km/h - 27-38 mph)
Standard climb rate	3 m/s (10 ft/s)
Maximum flight altitude	5000m AMSL
Maximum Take-Off altitude	3000m AMSL
Maximum climb rate	5.4 m/s (17.7 ft/s)
Maximum turn rate	69°/s
Minimum turn radius	50m
Maximum bank angle	60°
Maximum vertical speed at landing	5m/s (25° of airslope and 12 m/s of airspeed)
Wind resistance	up to 46.0 km/h (12.8 m/s, 24.9 kts)
Operating temperature	-15 to 35 °C (5 to 95 °F)
Navigation	Up to 500 waypoints
Carry case dimensions	75 x 51 x 33 cm (29.5 x 20.1 x 13.0 in)
Communication security during flight	Obfuscation link 2.4Ghz (AES transmission standard)
Communication security during firmware update	USB (information not visible)
Communication security during logs download	USB (obfuscation)

[31] endurance can vary depending on external factors such as wind, altitude change and temperature or payload and accessory
[32] endurance can vary depending on external factors such as wind, altitude change and temperature or payload and accessory

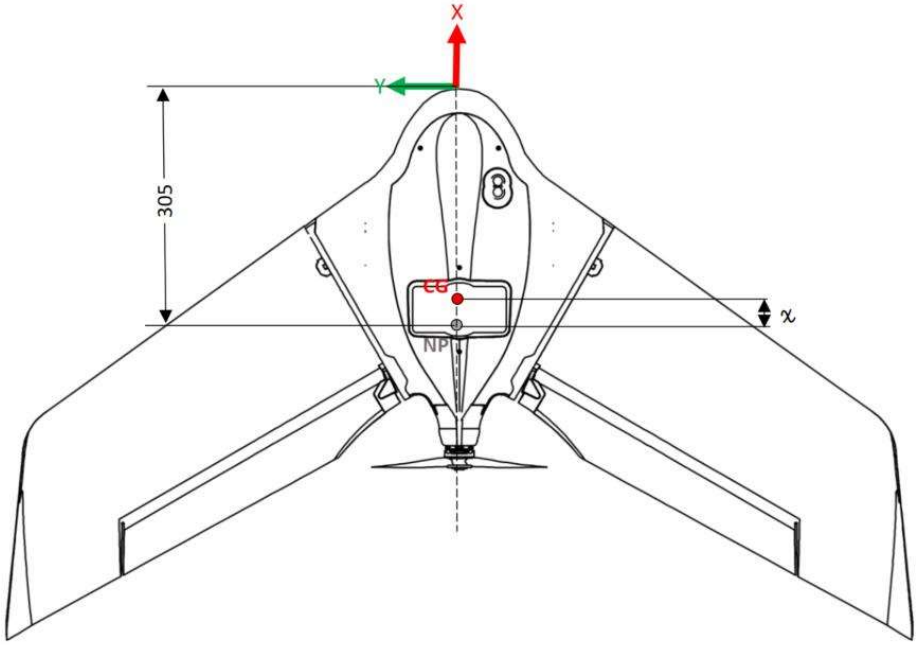
20.2 Drone dimensions and center of gravity



Bottom-View
SCALE 1 : 8



Side-View
SCALE 1 : 8



Top-View
SCALE 1 : 8

	χ	
Payload	eBee X with **Standard battery**	eBee X with **Endurance battery**
S.O.D.A.	26.4	32.7
Aeria X	25.1	31.9
S.O.D.A. 3D	26.8	32.1
Duet-T	25.9	32.5
Duet-M	28.1	32.3
Sequoia+	27	31.1
RedEdge-MX	26.5	32.8

21 Compatible payloads

Sensor model	Manufacturer	Weight	Dimensions (mm) LxHxW	Picture
S.O.D.A. 3D	senseFly	221 g	155x86x78 With lens protection: 155x86x85	
S.O.D.A.	senseFly	132 g 141 g (with protections)	155x86x68 With lens protection: 155x86x75	
S.O.D.A. Corridor	senseFly	137 g 146 g (with protections)	155x86x68 With lens protection: 155x86x75	
Aeria X	senseFly	274 g 285 g (with protections)	155x86x66 With lens protection: 155x86x67.5	
Duet-T	senseFly	260 g 272 g (with protections)	155x86x70 With lens protection: 155x86x72	
Duet-M	senseFly	273 g 284 g (with protections)	155x86x76 With lens protection: 155x86x83.5	
Sequoia+	Parrot	182 g 193 g (with protections)	155x86x69 With lens protection: N/A	
RedEdge-MX	Micasense	272 g 283 g (with protections)	155x86x62 With lens protection: 155x86x64.6	

Specifications of the payloads are available in each appropriate camera user manual.

Communication devices

Ground modem *Frequency*	2.4 GHz
Nominal range[33]	approx. 3 km (2 mi)
Maximum working range[34]	approx. 8 km (5 mi)
Certification	FCC, IC, CE, JP, BR, KCC, India

[33] can vary greatly depending on external factors such as cruise altitude, presence of obstacles and radio-frequency interference.
[34] can vary greatly depending on external factors such as cruise altitude, presence of obstacles and radio-frequency interference.

22 Glossary

ATO Above the Take-off Altitude
Your *eBee X series drone*'s altitude can be shown and set in *eMotion* using ATO. Altitudes in ATO are relative to the place your *eBee X series drone* started its motor just before take-off.

GNSS Global Navigation Satellite System
A network of satellites that transmit signals that GNSS receivers can use to calculate their position on the Earth. GPS (Global Positioning System) and GLONASS are examples of GNSS systems.

GPU Graphics Processing Unit
A computer component, often a chip on a computer's graphics card, that specialises in processing images and computer graphics. Computer performance can be improved by taking image processing off the CPU and onto the GPU.

LIDAR Light Detection and Ranging
A remote sensing method that uses light in the form of a pulsed laser to measure ranges (variable distances) to the Earth.

PPK Post-Processed Kinematic
This refers to the calculation that applies a global correction, after the flight, to the precise but inaccurate position of the cameras geotags that is recorded by its on-board GNSS receiver. With the GNSS receiver logs from a nearby base or reference station on a precisely known point, the correction needed at the time the drone recorded its position can be applied to the geotag of the camera and precisely correct its position based the GNSS receiver logs from the base station or reference station.

RTK correction Real-Time Kinematic correction
This refers to the calculation that applies to correct the geotag of the image taken on the payload, during the flight, to the precise but inaccurate position of the drone that is registered by its on board GNSS receiver so to accurately geotag the camera image with the corrected absolute position.

UAS Unmanned Aircraft System
A term used for drones or RPASs, the software and technology they use to navigate.

http://my.sensefly.com