

## 9.3 Lucie® Micro Drone Series 2

Each Lucie® Micro Drone Series 2 (vehicle) weighs only less than 68 grams and consists of four motor/propeller combinations, a battery, a guard and the electronic boards. All vehicles together form the fleet, all vehicles in the fleet are identical to each other except for their ID. The ID is an identifier number that can be found on the guard and is used in software to identify single vehicles for role mapping, vehicle status, etc.



*Figure 5: Lucie® Micro Drone Series 2*

For ESD (electrostatic discharge) reasons, only hold the vehicle from the guard. Always make sure to hold the vehicle from the outside to prevent coming in contact with the propellers.

### **REGULAR CHARGING PROCEDURE**

To recharge the vehicle, perform the following:

- Place the vehicle on the provided pod. Make sure that orientation is correct and that establishes contact with the pod.
- If off, the vehicle will automatically turn on when is connected to the charger.
- The red power LED on the vehicle turns on when is connected to the charger.
- The green power LED on the vehicle starts blinking when the charging process is started.
- The green power LED on the vehicle turns solid when the charging process is completed.

To prolong battery life, avoid charging the batteries for long periods of time. It is also recommended to turn on the chargers only shortly before the first flight of the day.

## TURNING VEHICLES ON/OFF

The vehicle will automatically turn on or off depending on certain conditions. The vehicle will turn on automatically when connected to the charger and will restart when removed from the charger. If they are not executing an important activity (e.g. executing a choreography), the vehicle will turn off automatically when their voltage level drops below 3.8V. If necessary, the push button near the battery connector can be used to turn the vehicle on and off.

## END OF DAY AND STORING PROCEDURES

When off, the vehicles enter a low-power mode, reducing their power consumption, but still drawing a small amount of current from their batteries. In addition, batteries gradually self-discharge even when not connected. If deep discharged, Li-Po batteries will be permanently damaged. Therefore, the following procedures are recommended:

- After a flight, if no other flight is planned for the day (or when the vehicles are stored for a longer period of time), the vehicles should be put on the charger until the battery voltage reaches 3.8V (Battery top-up). Once this threshold is reached, turn the charger off. The vehicle will stay on until the storage charge level is achieved, and then will turn off automatically.
- If vehicles are stored for more than one week, the battery must be physically disconnected to avoid deep discharging the batteries. Alternatively, a weekly battery top-up to 3.8V can be performed.
- If vehicles are stored for more than a month, the battery must be physically disconnected and a battery top-up to 3.8V must be performed every month to avoid deep discharging the batteries. Alternatively, to disconnecting the batteries a weekly battery top-up to 3.8V can be performed.

## MOTOR UNIT

In order to fly, each vehicle has 4 motors. Two of the motors spin in a clockwise direction and two anticlockwise. The motors are numbered 0 to 4 and have the following properties:

- Motor 0 and 2: Clockwise direction, black cables
- Motor 1 and 3: Anticlockwise direction, red cables

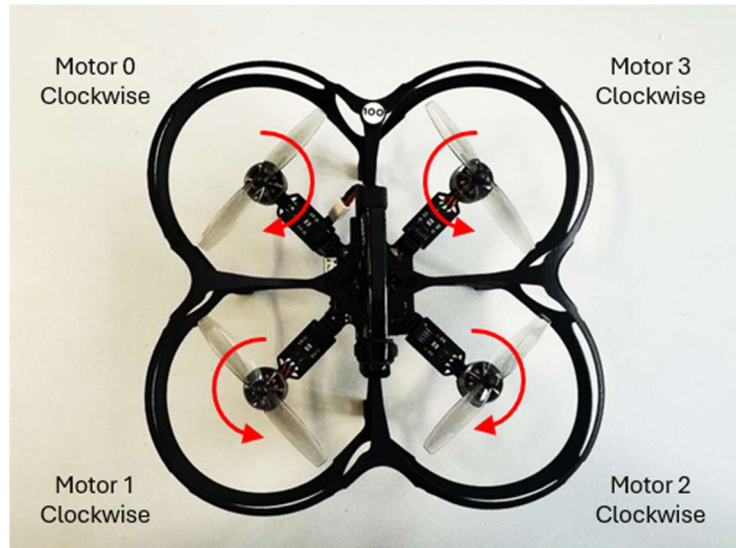


Figure 6: Motor Units including motor numbering and direction

The motors are part of the Motor Unit: which combines the motor, the motor controller (ESC), the propeller, a motor arm to physically connect the motor to the electronics boards and a cable for the electrical connection.

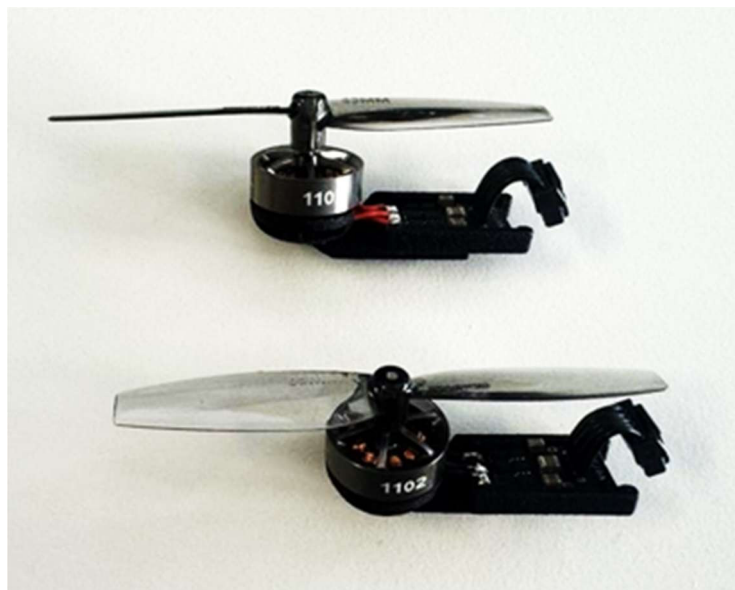


Figure 7: Two Motor Units: anticlockwise (left) and clockwise (right)

## BATTERY

Each vehicle contains a charging unit that handles the charging of the battery. Lithium polymer (Li-Po) batteries are used to power the vehicle. This type of batteries provides high specific energy and are suitable for high-discharge use, and are therefore the battery of choice for small and large drones. The battery is mounted on the vehicle guard in the battery holder. The battery is connected to the electronics boards via a cable and physically held into place with an elastic battery strap that goes over the battery and is connected to the guard on either side. In order to prevent overheating of the battery which could result in fire, the battery temperature is measured with a temperature sensor that is part of the electronics boards. The sensor itself is a little ribbon that is placed between the battery and the battery holder part of the guard to be in direct contact with the battery. Swollen or otherwise damaged batteries are a fire hazard and should be disconnected and be disposed of immediately in a safe manner.

The battery has a limited lifetime and wears out over approximately 150 flights, after which it needs to be replaced. The vehicle keeps track of the life of its battery and alerts the operator when the battery needs to be replaced. The vehicle also monitors the battery voltage in flight and performs a soft stop in case of a too low voltage to complete the flight. See [8 Maintenance and Repair](#) for detailed instructions on when and how to replace the battery.



Figure 8: Vehicle battery

- WARNING:** Only use the power supplies and batteries provided by Verity AG
- WARNING:** Place a CO<sub>2</sub> fire extinguisher near electrical equipment and only use it in case of a fire. Please make sure the fire extinguisher has been inspected and you are confident on how to operate it.
- WARNING:** Never leave batteries charging unattended
- WARNING:** Do not leave batteries charging for an extended period of time (overnight)
- WARNING:** Always store batteries in an appropriate container
- WARNING:** Only allow trained personnel to handle the batteries
- WARNING:** Swollen or otherwise damaged batteries are a fire hazard. Never fly or charge vehicles with a swollen or damaged battery. Disconnect the battery immediately and discard the battery safely
- WARNING:** Swallowing the battery may lead to burns, perforation of soft tissue, and death. Severe burns can occur within 2 h of ingestion. In case of ingestion of a battery, seek medical assistance promptly.

## GUARD

The guard is the plastic outer structure of the vehicle. The guard surrounds all four propellers; contains a holder for the vehicle battery; a location for the vehicle ID sticker; and provides

feet on which the vehicle can stand. The guard is designed to protect the vehicle from unexpected external objects and to protect a person or other unexpected external objects from the moving parts of the vehicle. It is also designed in a way to deform and potentially break upon impact with a person or other unexpected object to reduce the chance of harming the person or damaging the object. A broken guard can have sharp surfaces and should be replaced before flying the vehicle again. Guards should never be repaired but replaced completely to ensure their full safety provisions.



Figure 9: Vehicle guard

- WARNING:** Broken guards can injure people. Never fly vehicles with broken guards.
- WARNING:** Never attempt to repair broken guards, but replace them completely. Repaired guards can result in dangerous situations.

## ELECTRONICS BOARD

All vehicle components are mounted to the electronics boards. The electronics boards consist of two different boards:

- Main board: largest board, top board to which the Motor Units, and guard are mounted
- Payload board: smaller board, mounted underneath the main board

The electronics boards contain all control electronics; sensors and memory for logs and choreography. The battery temperature sensor is mounted on the main board. The payload board contains the show LED which contains RGBW LEDs and a diffuser. The payload board also contains the contacts through which the vehicles connect to the Charging Station.

## SPARE PARTS:

The following spare parts can be ordered for the vehicles through Verity. See [8 Maintenance and Repair](#) for detailed instructions on how to replace vehicle components.

- Lucie Maintenance Kit: consisting of all consumables needed for 100 flights. 2 clockwise Motor Units, 2 anticlockwise Motor Units and two batteries.
- Lucie Motor Kit: 2 clockwise and 2 anticlockwise Motor Units
- Lucie Battery: 1 spare battery
- Lucie Guard: 1 spare guard

## FCC Caution:

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

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

#### **IMPORTANT NOTE:**

Note: 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 reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used 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:

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

#### **FCC Radiation Exposure Statement:**

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

#### **ISED Warning**

This device complies with Innovation, Science, and Economic Development Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions:

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

Le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

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

The device is compliance with RF exposure guidelines, users can obtain Canadian information on RF exposure and compliance. The minimum distance from body to use the device is 20cm.

Le présent appareil est conforme Après examen de ce matériel aux conformité ou aux limites d'intensité de champ RF, les utilisateurs peuvent sur l'exposition aux radiofréquences et la conformité and compliance d'acquérir les informations correspondantes. La distance minimale du corps à utiliser le dispositif est de 20cm.