OVERHEAT
INNOVATIVE STRATEGIES FOR CONTAINERSHIP FIRES PREVENTION AND MANAGEMENT

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Authors of the document

Authors of the document - Representatives of beneficiaries involved in the project		
Name/Beneficiary	Position/Title within the project	Date
Francesco Russo/TopView S.r.l.	TopView PoC	24/06/2025
Lorenzo Porricelli/TopView S.r.l.	TopView Researcher	24/06/2025
Mariano Iadaresta/TopView S.r.l.	TopView Researcher	24/06/2025
Graziano Gagliarde/TopView S.r.l.	TopView Researcher	24/06/2025
Gianluca Luisi/TopView S.r.l.	TopView Researcher	24/06/2025
Alberto Mennella/TopView S.r.l.	TopView Researcher	24/06/2025

Reviewers of the document

Appointed reviewers of the document - Representatives of beneficiaries involved in the project		
Name/Beneficiary	Position/Title within the project	Date
Pedro Merino-Laso/ENSM	ENSM PoC	04/06/2025
Hasan Ahmad /ENSM	ENSM Researcher	05/06/2025
Théo Delferrière/CIRCOE	CIRCOE PoC	06/06/2025
Modestino Manfredi	IMAT Technical expert	10/06/2025
Diego Esposito	IMAT Technical expert	10/06/2025
Valentina Lasco/IMAT	IMAT Researcher	10/06/2025
Vittorio Sangermano/ISSNOVA	ISSNOVA PoC	18/06/2025

Responsible for the document approval

List of people approving the document - Representatives of beneficiaries involved in the project		
Name/Beneficiary	Position/Title within the project	Date
Marco Pasciuto/IMAT	OVERHEAT Project Manager	27/06/2025
Valentina Lasco/IMAT	IMAT Researcher	27/06/2025
Vittorio Sangermano/ISSNOVA	ISSNOVA PoC	27/06/2025
Bartosz Dziugiel/ILOT	ILOT PoC	27/06/2025
Fabienne Vallee/ Port of Brest	Port of Brest PoC	27/06/2025
Théo Delferriere/CIRCOE	CIRCOE PoC	27/06/2025
Diego Cioce/AKKODIS	AKKODIS PoC	27/06/2025
Pedro Merino-Laso/ENSM	ENSM PoC	27/06/2025

Gunnar Tietze/SeaTopic	Seatopic PoC	27/06/2025
Massimo Capozza/Peopletrust	PeopleTrust PoC	27/06/2025
Simone Panfiglio/Caronte	Caronte PoC	27/06/2025

ABSTRACT

This document represents the deliverable D4.1 – User Manual of the UAS Recharging Station.

It describes the mechanical design and specification of the recharging station including drone and its payload. The hangar is described in both versions “Port” and “Vessel”.

In addition, the document provides indications for proper maintenance of the recharging station, considering sensors and operative environment.

This document does not include the description of software to manage the autonomous drone, which is part of deliverable D4.2 – User Manual of the UAS Recharging Station Software.

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ACRONYMS

CMOS - Complementary metal–oxide–semiconductor

GNSS - Global Navigation Satellite Systems

IEC - International Electrotechnical Commission

IP – Ingress protection

RTK - Real-Time Kinematics

SCB – Surge Protection Circuit Breaker

SPD - Surge Protective Device

UAS – Unmanned Aircraft System

INTRODUCTION

The OVERHEAT autonomous drone is an aerial system that integrates high-end industrial solutions with customized designs tailored specifically for maritime operations. The system is designed to ensure efficient and effective fire detection and firefighting support, both in port environments and on board the vessels.

The figure below shows the vessel segment architecture related to the connection between the operations on the vessel and ashore. In **Errore. L'origine riferimento non è stata trovata.**, the O VERHEAT drone is highlighted in red.

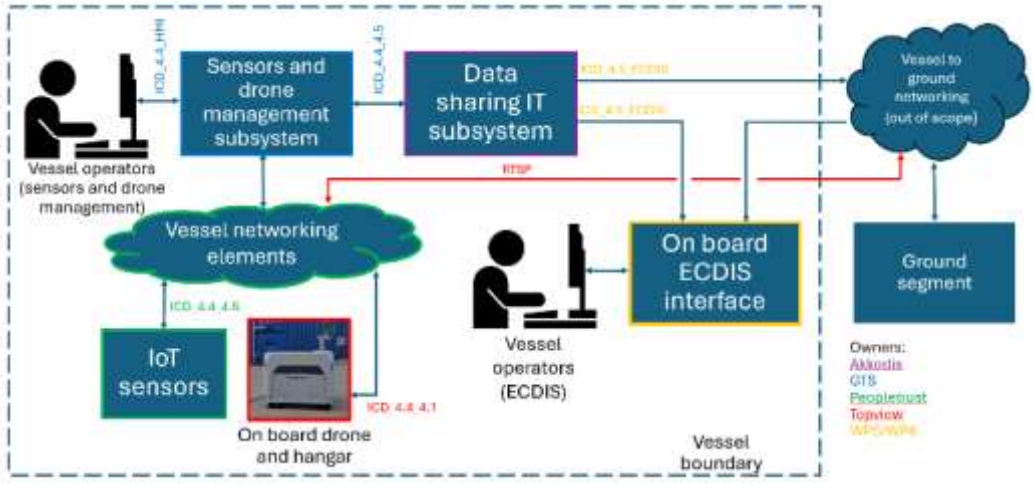


Figure 0-1 Vessel segment architecture

The **Errore. L'origine riferimento non è stata trovata.** shows the ground segment architecture. The O VERHEAT drone is highlighted in red.

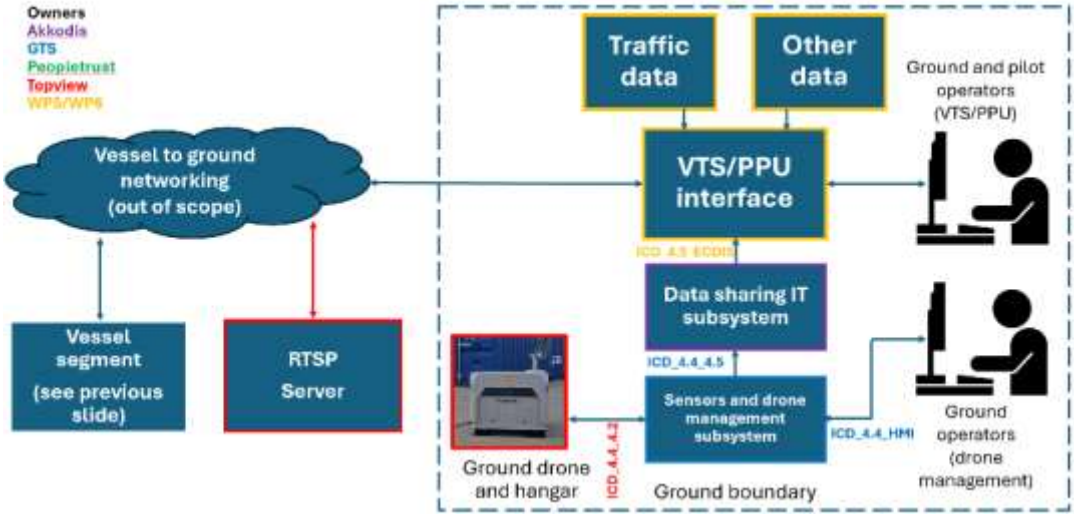


Figure 0-2 Ground segment architecture

The core of the system is the DJI Dock 2: a high-performance, automated hangar that features a lightweight and compact design. This advanced docking station is engineered for rapid deployment, allowing two operators to carry and install it with ease. Its integrated body structure simplifies setup, reducing installation time and ensuring a hassle-free experience.

The drone itself, the DJI MATRICE™ 3TD, is a state of the art in autonomous aerial technology. This sophisticated aircraft boasts a six-directional vision system, providing comprehensive obstacle detection for enhanced flight safety. Additionally, its infrared sensing capabilities enable precise environmental awareness, making it well-suited for complex missions. The RTK (Real-Time Kinematics) system ensures highly accurate positioning, crucial for precision-based operations. With an IP54 protection level, the drone is resilient against dust and water, enabling reliable performance in various conditions.

Adding to its versatility, the vessel version of the system includes satellite-based internet connectivity via Starlink for Maritime. This ensures uninterrupted communication and seamless data transmission, allowing users to operate the drone remotely from virtually anywhere. With Starlink's reliable, high-speed internet, operators can conduct real-time flight task planning, remote aircraft controls, live site monitoring, and debugging, enabling efficient mission execution even in remote oceanic regions.

1. AIRCRAFT

OVERHEAT's system features the DJI MATRICE™ 3TD, which offers six-directional vision for advanced obstacle detection, infrared sensing for enhanced environmental awareness, and an RTK (Real-Time Kinematics) system to deliver precise positioning. With an IP54 protection level, the drone withstands dust and water exposure, making it highly suited for maritime conditions.

The figure below shows the main components of the drone.

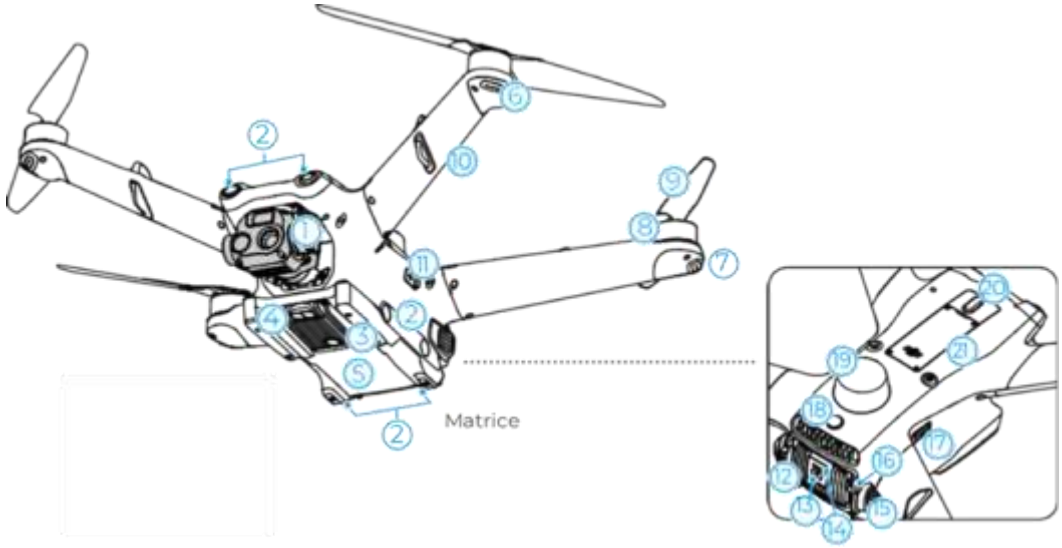


Figure 1-1 Drone Overview

1. Gimbal Camera	12. Intelligent Flight Battery
2. Vision System	13. Power Button
3. Auxiliary Light	14. Battery Level LEDs
4. Infrared Sensing System	15. Battery Buckle
5. Internal Charging Modules	16. Battery Locking Arm
6. Front LEDs	17. MicroSD Card Slot
7. Aircraft Status Indicators	18. Beacon
8. Motors	19. GNSS/RTK Antenna
9. Propellers	20. E-Port
10. Frame Arms	21. Dongle Compartment
11. USB-C Assistant Port	

Table 1-1 Drone's components

1.1 Aircraft LED Indicators

Figure 1-2 LED on the topside of the drone

When powered on and without running motors the front LEDs glow red to show the aircraft's orientation. The status indicators display the flight control system's status. Refer to the table below for details.

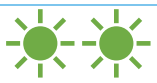
Normal states		
LED Colour	LED Colour Frequency	Description
	Blinks red, yellow, and green in alternate	Powering on and performing self-diagnostic tests
	Blinks yellow four times	Warming up
	Blinks green slowly	GNSS enabled
	Blinks green twice	Vision system enabled
	Blinks yellow slowly	GNSS and vision system disabled (ATTI mode)

Table 1-2 Drone's LED indicators – Normal states

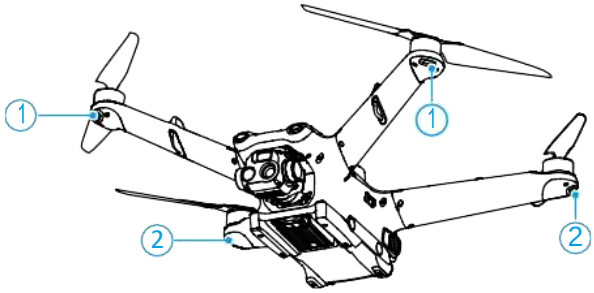


Figure 1-3 Drone LED indicators

1. Aircraft Front LEDs
2. Aircraft Status Indicators

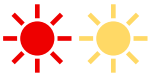
Warning states		
LED Colour	LED Colour Frequency	Description
	Blinks yellow quickly	Control signal lost
	Blinks red slowly	Take-off is disabled, e.g. low battery
	Blinks red quickly	Critically low battery
	Solid red	Critical error
	Blinks red and yellow in alternate	Compass calibration required

Table 1-3 Drone's LED indicators – Warning states

1.2 Thermal Camera Payload

DJI MATRICE™ 3TD features wide-angle, tele, and infrared cameras for visible light and thermal imaging, ideal for safety, security and inspections. It offers continuous 28× zoom for easy comparison with the infrared and tele cameras.

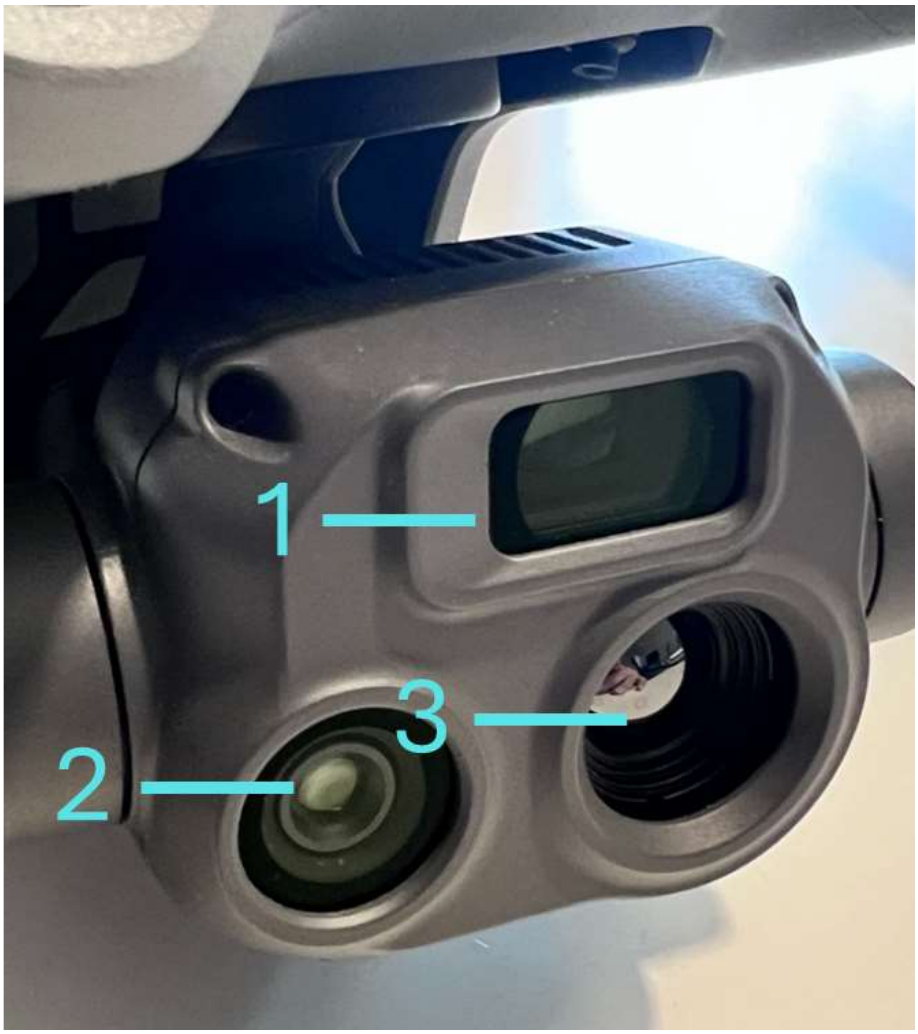


Figure 1-4 Payload's camera typology

1. **Tele-Camera**, offering 28× continuous zoom, enabling long-range inspections and precise object identification. The tele-camera has a 1/2-in CMOS sensor, 48MP photos, f/4.4 aperture, and shoots from 3 m to infinity, with up to 56× Max Hybrid Zoom.
2. **Wide-angle Camera**, capturing broad picture frames and detailed overviews, essential for situational awareness. The wide-angle camera has a 1/1.32-in CMOS sensor, 48MP photos, f/1.7 aperture, and shoots from 1 m to infinity.
3. **Infrared Camera**, providing thermal imaging capabilities for heat signature detection, anomaly identification, and enhanced visibility in low-light conditions. The infrared camera has a 640×512 resolution and supports 28× zoom alongside the tele camera.

This triple sensor configuration enables to seamlessly compare data across different imaging modes: the continuous 28× zoom allows to closely examine areas with the tele and infrared cameras, making it ideal for thermal analysis, security surveillance and containers inspections.

Figure 1-5 Example of shoots from the drone's cameras

2. HANGAR

The drone's hangar achieves an IP55 protection level (IEC 60529 standard). It includes a quick-charging module and an air conditioning system, cooling and charging the battery from 20% to 90% in about 32 minutes.

The drone's hangar integrates multiple environment sensors to provide information on wind speed, rainfall, temperature, and humidity, allowing users to monitor the real-time environment conditions and ensure safe flight.

Figure 2-1 OVERHEAT's autonomous drone hangar deployed near a container

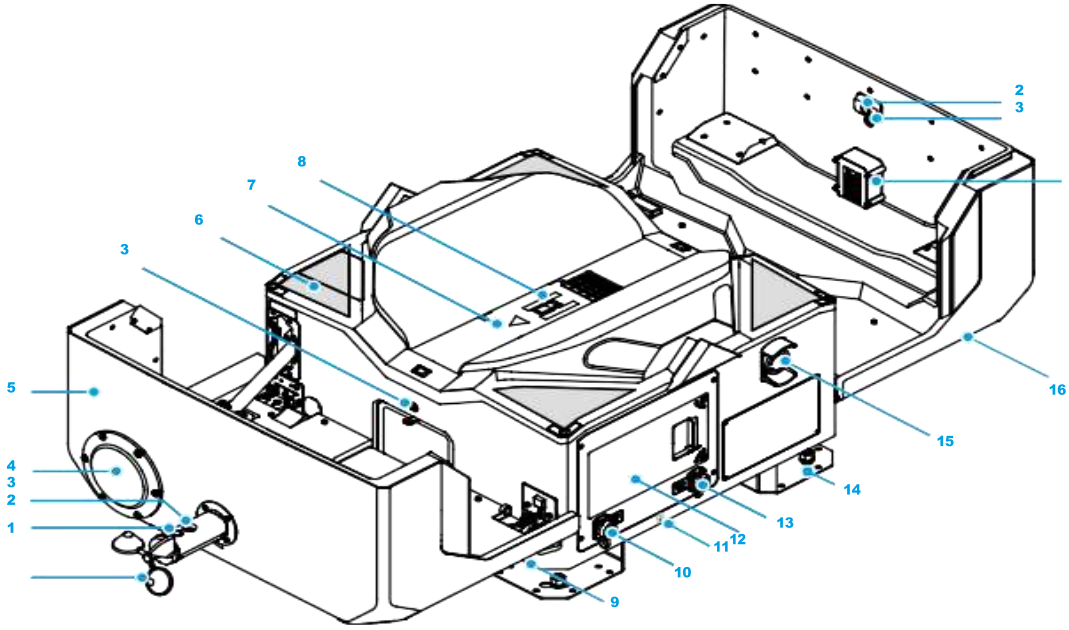


Figure 2-2 OVERHEAT's autonomous drone hangar components

1. Wind Speed Gauge	10. AC-IN Port
2. Security Camera	11. Earth Wire (located underneath the hangar)
3. Camera Auxiliary Light	12. Electrical Cabinet
4. Rainfall Gauge	13. LAN-IN Port
5. Hangar Cover	14. Mounting Base Brackets
6. Positioning Markers	15. Emergency Stop Button
7. Landing Pad	16. Status Indicators
8. Aircraft Orientation Marker [1]	17. Dongle Compartment
9. Carrying Points	

Table 2-1 Hangar's main components

2.1 Hangar LED Indicators

When powered the hangar has four LED indicators, one for each side. The LEDs' status scheme presented in the table below.

Normal states		
LED Colour	LED Colour Frequency	Description
	Blinks white	The hangar is working normally, and the aircraft is ready to take off
	Blinks blue	The hangar and the aircraft are linking, and the buzzer emits a short beep
	Blinks green	The aircraft has taken off from the hangar and is performing a flight task.
	Solid blue	The hangar is updating or debugging (including remote debugging and on-site debugging).

Table 2-2 Hangar LED normal states

Warning states		
LED Colour	LED Colour Frequency	Description
	Blinks red quickly	The hangar cover is moving, or the aircraft is taking off or landing, and the buzzer emits a long beep. Keep a safe distance from the hangar to avoid injury.
	Blinks red and yellow in alternate	The emergency stop button on the hangar is pressed.

Table 2-3 Hangar LED Warning states

2.2 Electrical cabinet

The system includes a specialized electrical cabinet, which serves as a central hub for managing power and connectivity requirements.

Figure 2-3 View of the electrical cabinet switches and ports

The electrical cabinet is equipped with essential components to facilitate power management, connectivity, and operational control, including:

- AC Power Switch: enables main power control for efficient energy distribution.
- Backup Battery Switch: allows seamless transition to backup power in case of interruptions.
- Surge Protective Device (SPD): safeguards the system against electrical surges and voltage fluctuations.
- Multiple USB Ports: supports peripheral connections for additional accessories and external interfaces.

This electrical cabinet serves as the primary interface for connecting the power supply, wired network connection, and external grounding cables for the drone hangar. By ensuring stable electrical flow and data transmission, it enhances the system's overall reliability and efficiency.

To access the electrical panel, follow these steps:

1. Utilize a 2.5mm hex key to loosen the two screws on the cabinet door.
2. Carefully open the door and inspect the internal panel operations.
3. Check proper connectivity for power, network, and grounding cables before initiating drone deployment.

2.3 Wind Speed Gauge

The wind speed gauge is used to measure wind speed near the drone's hangar. The wind speed gauge features self-heating and is able to work in low-temperature environments. To ensure flight safety, the aircraft cannot take off or land when the wind speed is above wind force 5 in Beaufort scale (about 8 m/s).

Figure 2-4 Wind speed gauge

The wind speed gauge can only measure the wind speed near the drone's hangar, which may be different from the wind speed provided by the local meteorological department. If the aircraft ascends to a high altitude, the wind speed and direction may change significantly. Fly with caution when the measured wind speed is close to 8 m/s.

2.4 Rainfall Gauge, Temperature and humidity sensors

The rainfall gauge is used to measure rainfall information near the drone's hangar. The rainfall gauge features self-heating and can work in low-temperature environments. To ensure flight safety, the aircraft cannot take off in heavy rain.

- There is a pressure sensing module in the rainfall gauge. DO NOT press hard on the surface of the rainfall gauge. Otherwise, the pressure sensing module may be damaged.
- Regularly clean the rainfall gauge surface. Replace the rainfall gauge immediately if it is deformed or damaged.
- If the drone's hangar is installed near a vibration source such as near railways, false detection of rainfall may be triggered. Try to keep the drone's hangar away from areas with strong vibration sources or strong noise.

Figure 2-5 Rainfall Gauge, Temperature and humidity sensors

The drone's hangar features temperature and humidity sensors, which are used to measure external temperature and the temperature and humidity inside the drone's hangar.

2.5 Differences between port and vessel version

The vessel version differs significantly from the port-based version, primarily due to its specialized tilting mechanism. This advanced system is engineered to dynamically compensate for the movement of the ship, ensuring optimal conditions for both take-off and landing of the drone in maritime environments.

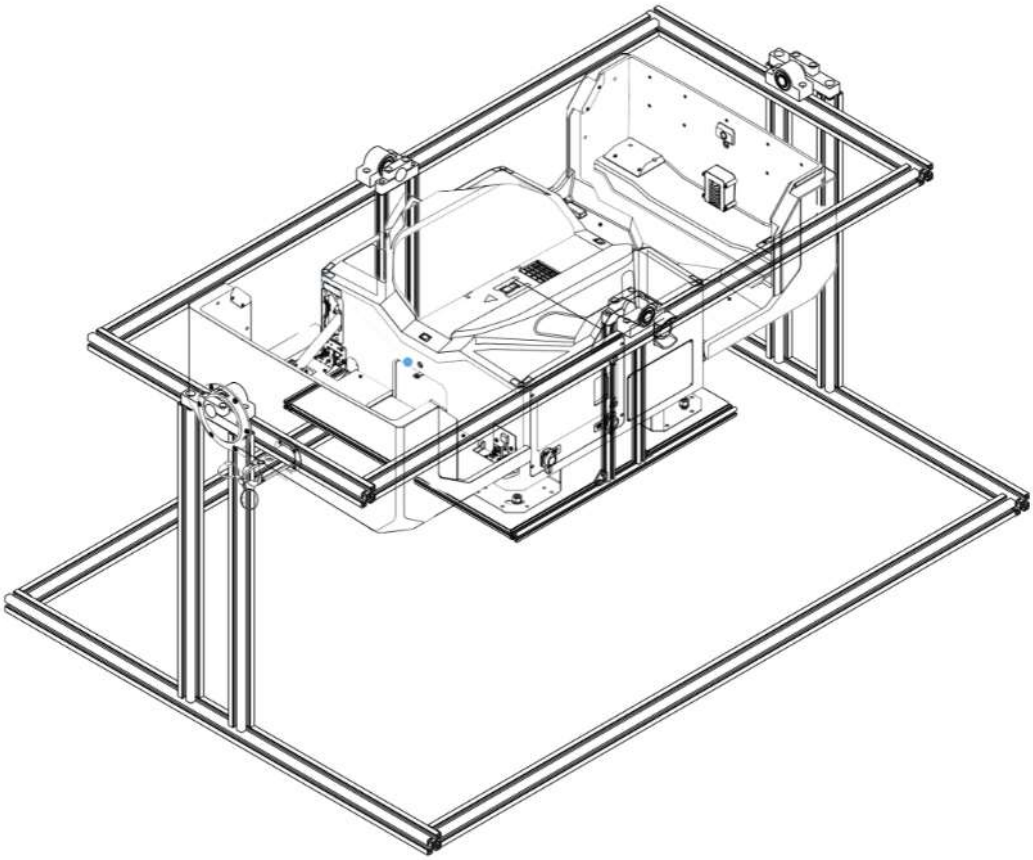


Figure 2-6 Hangar tilting mechanism in vessel version

Unlike stable, land-based platforms, vessels are constantly subjected to motion from waves, currents, and wind forces, which can make drone operations unpredictable and challenging. To address this issue, the tilting mechanism integrates precision stabilization technology that actively adjusts the docking platform's angle in real-time. This ensures that during take-off, the drone launches from a level surface, preventing erratic movement or unwanted drift. Similarly, during landing, the mechanism fine-tunes its positioning to accommodate shifts in the vessel's orientation, enabling a smooth, controlled touchdown even in turbulent sea conditions.

This capability is particularly valuable for autonomous operations, where human intervention is limited. By continuously sensing ship movement patterns and making rapid compensations, the

system significantly reduces operational risk, enhances flight accuracy, and optimizes efficiency in maritime drone applications.

With this sophisticated tilting mechanism, the vessel-based version of the OVERHEAT autonomous drone system ensures reliable and precise aerial operations, even in the unpredictable conditions of open water, further reinforcing its role as a vital technological asset for maritime industries.

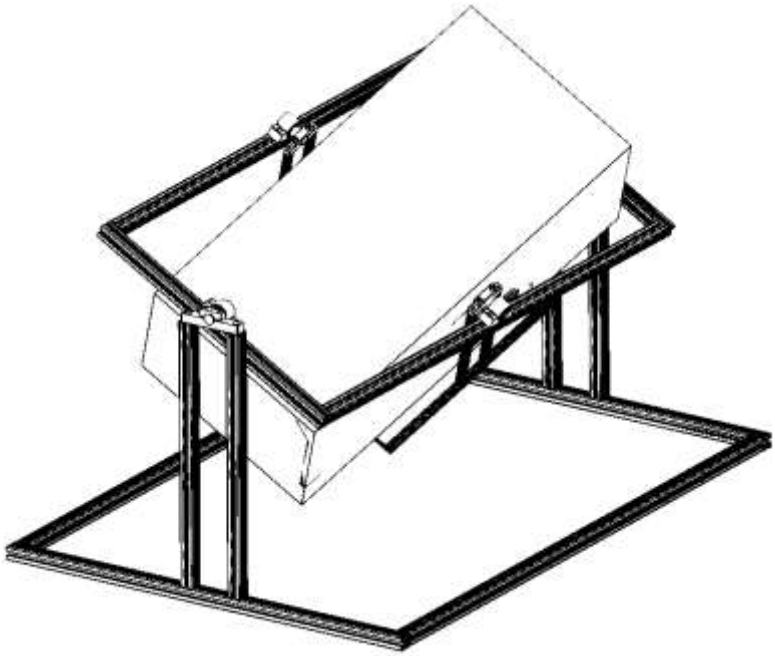


Figure 2-7 Example of tilting movements on two-axis

The vessel version features an advanced two-axis tilting mechanism, providing precise roll and pitch adjustments to compensate for the movement of the vessel during take-off and landing.

This tilting system allows for +30º to -30º degree freedom in both roll and pitch, ensuring the drone can launch and land smoothly. The mechanism is designed for unlimited real-degree rotation. By dynamically adjusting to wave-induced movements and vessel instability, this system enhances flight safety, precision, and operational efficiency in harsh maritime conditions.

Key specifications of the vessel version include:

- Two-axis tilting system: compensates for vessel movement with +30º/-30º roll and pitch freedom and unlimited rotational capability.
- Compact dimensions: 1780 x 1250 x 850 mm, optimized for maritime deployment.
- Structure Weight: 33.5 kg, ensuring a balance of durability and portability.

2.6 Satellite internet connection

The vessel version of the system includes satellite-based internet connectivity via Starlink for maritime. This ensures uninterrupted communication and seamless data transmission, allowing users to operate the drone remotely from virtually anywhere.
This solution is easy to install featuring a self-orienting antenna which find automatically the best satellite constellation.
Once installed, the Starlink antenna shares the internet connection to the drone's hangar using a wired network.

Figure 2-8 Example of installation of a Starlink antenna on a vessel

3 MAINTENANCE

This section describes the steps for maintaining the system efficient.

Before performing any maintenance procedure make sure to:

- NOT use any tools that are not insulated, such as a screwdriver with a bare metal handle.
- Wear protective equipment when performing maintenance, such as a safety helmet, goggles, insulated gloves, and insulated shoes.
- Power off the drone's hangar before checking the movable parts, such as the fan of the air conditioning system, the drone's hangar cover, and the drone's hangar cover driving arms to avoid injury.
- That there is no flight plan to be performed, and that the aircraft has landed inside the drone's hangar. Make sure to press the emergency stop button on the drone's hangar before any operations.

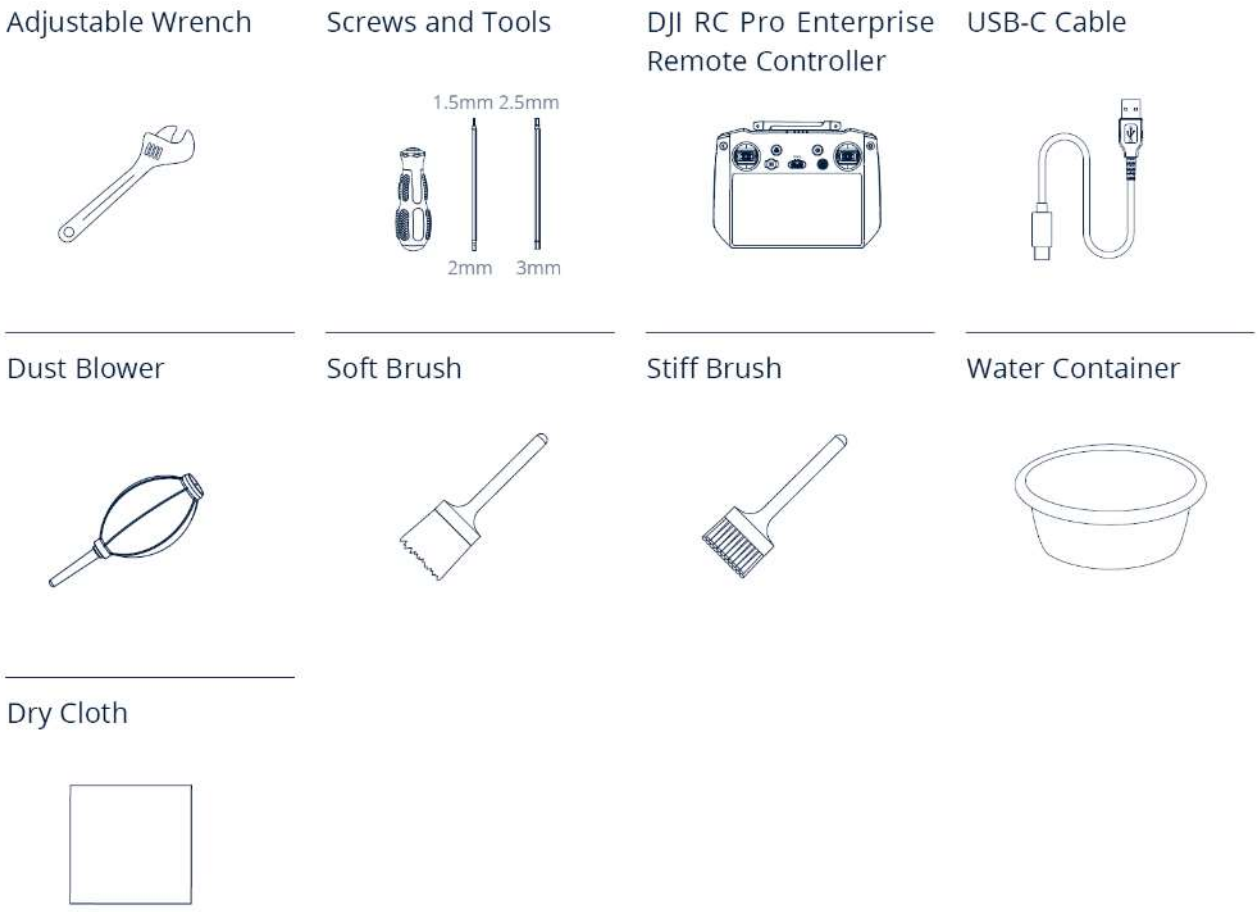


Figure 3-1 Suggested tools for maintenance

In the following table the suggested maintenance intervals and actions

Part	Suggested maintenance	Maintenance interval
Hangar	Deep cleaning, environment inspection, updates and calibrations, device and parts inspection	Every six months / each 1500 flights
	Replacement of wearing parts	Every year / each 3000 flights
Drone	Deep cleaning, parts inspection, updates and calibrations	Every six months / each 1500 flights
	Replacement of wearing parts	300-hours flights / One year / 1000 flights
	Replacement of propulsion system	900-hours flights / Two years / 3000 flights

Table 3-1 Suggested maintenance intervals

3.1 Hangar maintenance

This section lists the suggested maintenance steps for the hangar.

3.1.1 Surroundings inspection

To ensure flight safety, it is recommended to regularly check the environment near the drone's hangar as follows.

Step	Description
S01	Clear overgrown plants or animal infestations that can affect normal operation of the drone's hangar, such as weeds, trees, ant nests, and rat nests.
S02	Check if there are new buildings near the drone's hangar that may block the signal. Select another location to install the drone's hangar if the signal obstruction becomes strong.
S03	Check the ground conditions near the drone's hangar, and make sure to clear hidden risks that may cause water immersion or inclination of the drone's hangar.
S04	Check the environment near the alternate landing site, and clear debris that might affect the aircraft landing.

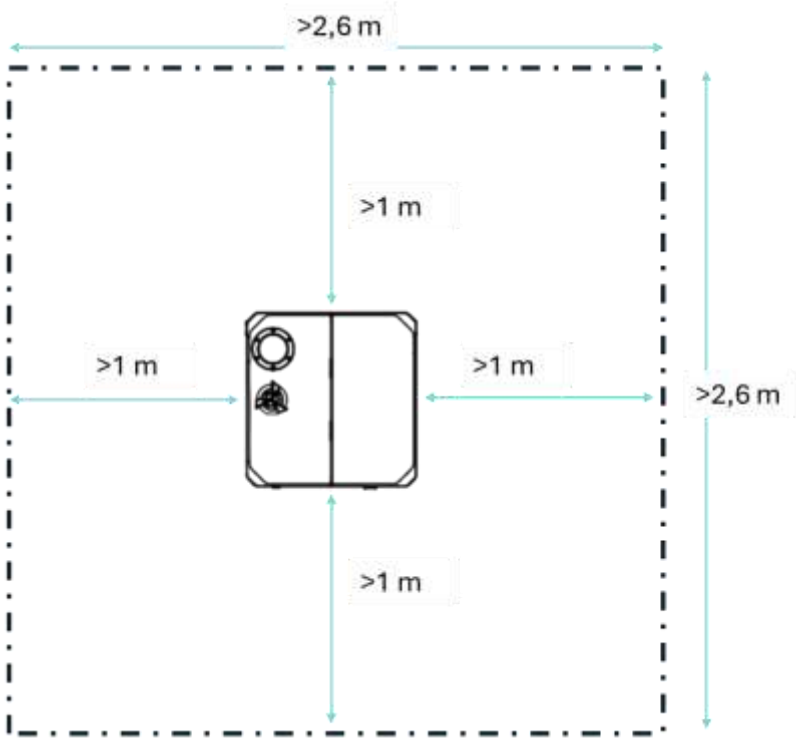


Figure 3-2 Minimum space need around the port version of the hangar in meters

The vessel version of the hangar needs wider clean surroundings as shown in Figure 3-3

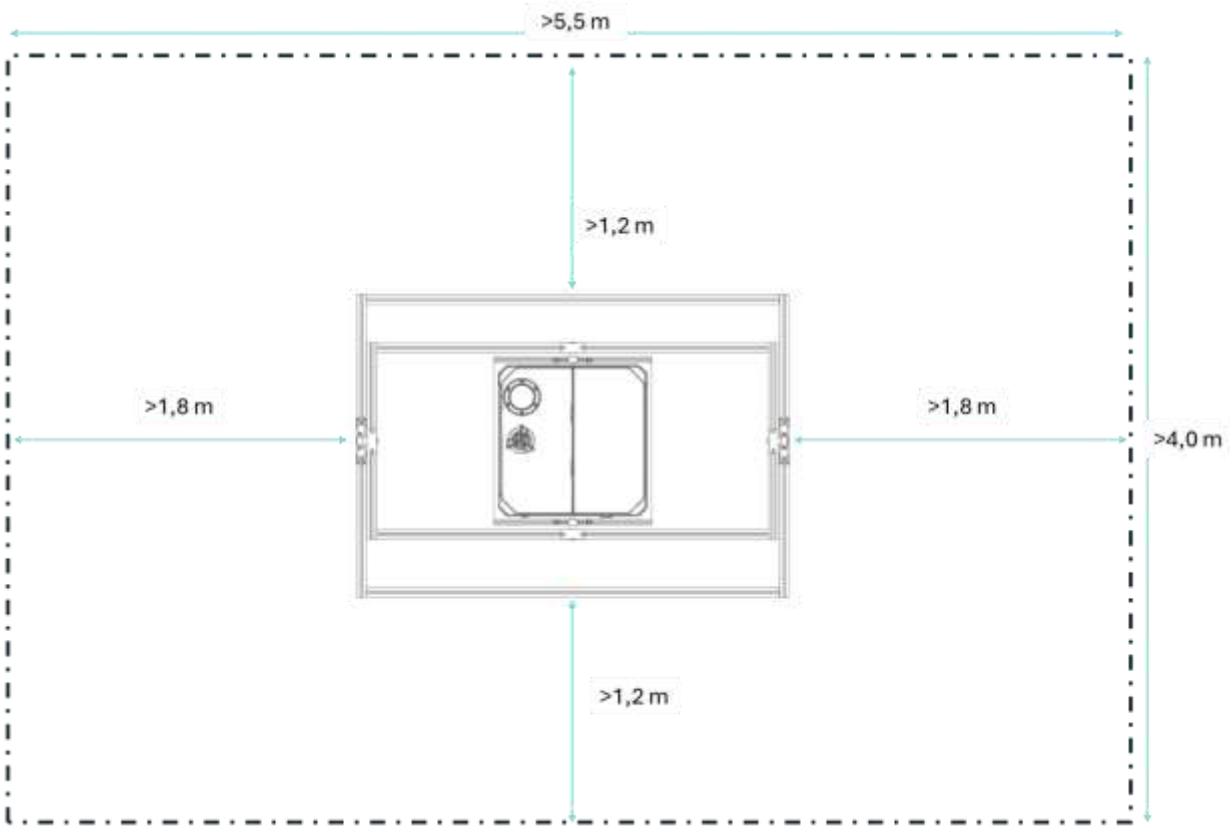


Figure 3-3 Minimum space need around the vessel version in meters

3.1.2 Body inspection

To properly perform the inspection of the body, follow this procedure.

Step	Description
S01	Clean the drone's hangar shell with a soft, dry cloth and make sure the drone's hangar shell is clear of dirt or foreign matter.
S02	If there is any noticeable damage or deformation, contact TopView in time.
S03	Make sure the four expansion bolts are securely mounted. If loosened, tighten the bolts using an adjustable wrench to ensure that the drone's hangar is securely installed

Table 3-2 Steps for Hangar body inspection

3.1.3 Electrical cabinet inspection

To properly perform the inspection of the electrical cabinet, follow this procedure.

Step	Description
S01	Use a 2.5mm hex key to loosen the two screws on the electrical cabinet door.
S02	Pull the door to open the electrical cabinet and check the panel.
S03	Check the SPD status indicator. Contact TopView to replace and repair the SPD if the indicator turns red.
S04	Make sure the surge protector circuit breaker (SCB), the AC power switch, and the backup battery switch can be turned on/off normally.

Table 3-3 Steps for Hangar body inspection

3.1.4 Cover inspection

To properly perform the inspection of the cover, follow this procedure.

Figure 3-4 Hangar cover details

Step	Description
S01	Power on the drone's hangar. Press and hold the open button to open the drone's hangar covers. Check if the drone's hangar covers can move smoothly without jamming when opening. It is normal for the drone's hangar covers to make a sound after extended use, this does not affect normal use.
S02	Make sure that the hangar cover rubber seal strip is in good condition and is securely attached to the hangar cover.
S03	Make sure that the hangar cover propeller bumpers are not damaged or deformed, and the screws are securely mounted.
S04	Moisten a soft cloth with clean water or a neutral cleaning solution and clean the hangar covers.

Table 3-4 Steps for Hangar body inspection

Figure 3-5 Hangar cover rubber detail

3.1.5 Landing pad inspection

To properly perform the inspection of the landing pad, follow this procedure.

Figure 3-6 Hangar landing pad

Step	Description
S01	Power off the hangar, and make sure the landing pad surface, the return vent and the supply vent are not deformed, dented, cracked, or broken.
S02	Make sure the Aircraft Orientation Marker (H) and the Positioning Markers are clear and not worn.
S03	Make sure the six water-resistant rubber covers are not loose or damaged.
S04	Moisten a soft cloth with water or a neutral cleaning solution to clean the landing pad surface and the vents, and make sure the return vent and the supply vent are clear of foreign matter.

3.2 Drone maintenance

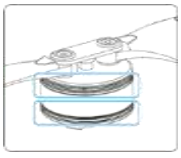
This section lists the suggested maintenance steps for the drone.

3.2.1 Body Inspection

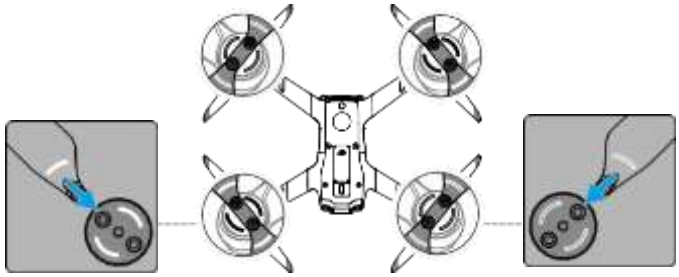
To properly perform the inspection of the drone's body, follow this procedure

Step	Description
S01	Make sure the aircraft body is clean and not damaged.
S02	Clean the aircraft body with a dry, soft cloth paying special attention to the lenses of the infrared sensing and vision systems and the heat dissipation vents.
S03	Make sure the front LEDs and the aircraft status indicators are clean and not damaged.

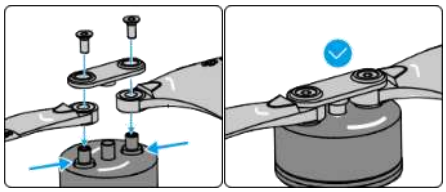
3.2.2 Propulsion System

Step	Description
S01	CHECK MOTOR ROTATION  Rotate the propeller motors to check if the propellers are jammed or make any abnormal sounds, and whether the rotor and stator of the motors scratch the motor base.
S02	DO NOT fly the aircraft if the propellers are jammed or make any abnormal sounds. If there are any abnormalities, make sure to return the aircraft to the factory for repair.
S03	CHECK MOTOR AIR FILTERS  Make sure the air filters are not severely damaged or deformed.
	If they are severely damaged or deformed (such as being bumped), return the aircraft to the factory for repair.

3.2.3 Propellers



Step	Description
S01	Check the propellers for visible deformation, severe wear, nicks, and cracks, and if there is any foreign matter on the propellers.
S02	Clean the propellers with a dry, soft cloth.
S03	Replace the propellers immediately if there are any visible deformations, nicks, cracks, or severe wearing occurs. Make sure the air filters are not severely damaged or deformed.
S04	The propellers are wearing parts. Replace the propellers, washers, and screws in time when necessary



In the table below in step to check the propellers adapter.

Step	Description
S01	Make sure the propeller adapter screws are securely tightened.
S02	If the screws are loose, apply screw glue and tighten the screws.
S03	Make sure the propeller adapters are not damaged or deformed.
S04	Replace the propeller adapters if they are damaged or deformed.

3.2.4 Gimbal Camera

Step	Description
S01	Make sure the gimbal dampers are not damaged, loose, aged, or deformed.
S02	Make sure the screws connecting the damping plate and aircraft body are firmly secured.
S03	The gimbal dampers are wearing parts. Return the aircraft to the factory and replace them when necessary.

TECHNICAL SPECIFICATIONS

Hangar	
Type	**Specification**
Weight	34 kg (without aircraft)
Tilting mechanism weight	33,5 kg
Tilting degrees	+30º/-30º roll and pitch
Hangar Dimensions (Cover Opened) L×W×H	1228 × 583 × 412 mm
Hangar Dimensions (Cover Closed) L×W×H	570 × 583 × 465 mm
Tilting mechanism dimensions L×W×H	1780 x 1250 x 850 mm
Operating Temperature	-25°C to 45°C
Ingress Protection Rating	IP55
Max Landing Wind Speed	Wind force 5 in Beaufort 8 m/s
Hangar Backup Battery Life	> 5 hours
Ethernet	10/100/1000 Mbps adaptive
Environmental sensors	Wind Speed, Rainfall, Ambient Temp, Water Immersion, In-Cabin Temp & Humidity

Aircraft	
Type	**Specification**
Dimension L×W×H	335×398×153 mm (without propellers)
Camera Payload	Wide-angle + Telephoto + Thermal
Max Flight Time	Approx. 50 minutes
Max Take-off Weight	1.6 kg
Obstacle Avoidance	Omnidirectional (6-directional sensing)
Ingress Protection	IP54
Operating Temp.	-20°C to 50°C
Charging Time (Hangar)	32 minutes (20% to 90%)

REFERENCES

1. DJI Dock 2 User Manual V2.02
2. DJI Dock 2 Maintenance Manual V1.0
3. Starlink - Flat High Performance Kit Specifications

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