HOVERFLY®

SPECTRE 2.0

Operations & Maintenance (O&M) Manual

R00

DCN 1002005


HOVERFLY

Limited Warranty Summary Statement

Hoverfly provides a **LIMITED WARRANTY ONLY** if the system has not been modified or altered from its original condition, and if the software is intact and maintained in an authorized configuration.

No warranty or obligations shall apply to any portion of the system that has been either: (A) Operated or maintained in a manner inconsistent with this O&M Manual, or (B) Operated in a manner inconsistent with the provisions of the contract, or (C) Damaged by negligence or misuse, fire, casualty, or other external cause(s).

Other than replacement of Customer Serviceable Items, this Warranty shall be null and void if any service, repair, changes, or modification of the System or Software is performed by any party other than Hoverfly or a Hoverfly authorized service agent.

This Warranty shall be null and void if any unauthorized payloads are installed and/or flown on the Hoverfly system.

Other warranty conditions apply. Review the entire warranty under the applicable contract.

THIS DOCUMENT IS NOT A SUBSTITUTE FOR TRAINING

DO NOT OPERATE THE SPECTRE SYSTEM WITHOUT FLIGHT TRAINING. IF YOU HAVE EXPERIENCE AND ARE OPERATING IN A NEW ENVIRONMENT, YOU MUST RE-FAMILIARIZE YOURSELF THOROUGHLY WITH THIS DOCUMENT. OBEY ALL SAFETY WARNINGS AND OBSERVE AND OBEY ALL SYSTEM MESSAGES THAT APPEAR ON THE CONTROLLER.

VISUALLY INSPECT ALL EQUIPMENT PRIOR TO FLIGHT. DO NOT OPERATE IF DAMAGE IS VISIBLE TO AIRCRAFT, PROPELLERS, TETHER, OR ANY SYSTEM COMPONENT.

DO NOT OPERATE WITHOUT CORDON AREA.

DO NOT OPERATE OVER PERSONNEL OR CRITICAL INFRASTRUCTURE.

DO NOT MINIMIZE SYSTEM GUI WINDOW IF OPERATING FROM A CONTROLLER NOT SUPPLIED BY HOVERFLY.

DO NOT MODIFY SYSTEM CONFIGURATION, EQUIPMENT, PAYLOAD, OR SOFTWARE.

DO NOT OPERATE OUTSIDE OF SPECIFIED ENVIRONMENTAL CONDITIONS, TO INCLUDE >25 MPH WIND, HAIL, OR ICING CONDITIONS.

DO NOT OPERATE IF LIGHTNING IS PRESENT WITHIN 10 MILES OF THE SYSTEM.

DO NOT OPERATE IN THE PRESENCE OF RADAR EMISSIONS.

WAIT 60 SECONDS AFTER DISCONNECTING POWER BEFORE WORKING ON FIELD REPLACEABLE UNITS.

Acronyms

Acronym	Meaning	Acronym	Meaning
A	Amp	IP	Internet Protocol
AC	Alternating Current	ISR	Intelligence, Surveillance and Reconnaissance
AGL	Above Ground Level	kg	Kilogram
Ah	Ampere Hour	kph	Kilometers Per Hour
AIO	All-In-One	kW	Kilowatt
API	Application Programming Interface	lbs	Pounds
ATAK	Android Tactical Assault Kit	LED	Light Emitting Diode
ATS	Advanced Tether System	LiPo	Lithium Polymer
AUGVW	All Up Gross Vehicle Weight	LWIR	Long-Wave Infrared
BGU	Board of Grand Unification	m	Meter
BVLOS	Beyond Visual Line of Sight	mm	Millimeter
C	Celsius	MMA	Mandatory Maintenance Actions
CCW	Counterclockwise	mph	Miles Per Hour
cm	Centimeter	MS	Microsoft
COTS	Commercial Off-The-Shelf	O&M	Operations and Maintenance
CW	Clockwise	OTM	On-The-Move
C2	Command and Control	PCB	Printed Circuit Board
DHCP	Dynamic Host Configuration Protocol	PIP	Picture-in-Picture
EMI	Electromagnetic Interference	P/MMA	Predictive and Mandatory Maintenance Actions
EO/IR	Electro-Optic Infrared	PTZ	Pan-Tilt-Zoom
F	Fahrenheit	RF	Radio Frequency
FMS	Flight Management System	SDK	Software Development Kit
FOD	Foreign Object Damage	SLB	Safety Landing Battery
FRU	Field Replaceable Unit	TAK	Tactical Assault Kit
ft	Foot	TK	Tether Kit
g	Gram	TSB	Tether Kit Safety Battery
GPS	Global Positioning System	TUAS	Tether-Powered Unmanned Aerial System
GUI	Graphical User Interface	UAV	Unmanned Aerial Vehicle
HD	High-Definition	UHF	Ultra High Frequency
HL	Heavy Lift	USB	Universal Serial Bus
hrs.	Hours	V	Volt
HTI	Hoverfly Technologies, Inc.	VAC	Volts Alternating Current
http	Hypertext Transfer Protocol	VHA	Variable Height Antenna
Hz	Hertz	W	Watt
IMU	Inertial Measurement Unit	WAN	Wide Area Network
in.	Inch		

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CONTENTS

SYSTEM OVERVIEW

SYSTEM OVERVIEW

This manual provides instructions for the safe and effective operation and maintenance of the Hoverfly Spectre TUAS. It is applicable **ONLY** to the Spectre TUAS controlled by a Hoverfly-supplied touch screen controller using the MS Windows operating system. Other control methods, including control over local or remote networks and BVLOS control, are available. Refer to the **Technical Support** section on page 79 of this manual for more information on the Hoverfly Software Development Kit (SDK) for remote control or network applications.

This document is intended for use by Hoverfly operators to ensure operational efficiency, maximize system lifespan, and promote safety. It is organized into the following sections:

- **System Overview**
- **System Components**
- **Operating Procedures**
- **System Logs and Data**
- **Safety Information**
- **Inspection and Maintenance**
- **Troubleshooting**
- **Technical Support**

Spectre TUAS

The Spectre TUAS consists of an air vehicle (the Spectre), one or more payloads, a Tether Kit, and a controller. The system is man-portable, rapidly deployable, simple to operate, and tactically repositionable. It is also capable of unattended remote operation and remote network control. Advanced features include the ability to provide dual-stream day/night imagery over networks, airborne communication relays and other functions (with certain tactical payloads). Only Hoverfly-authorized payloads may be installed or flown on the system; any deviation will void the warranty.

Figure 1: Spectre TUAS

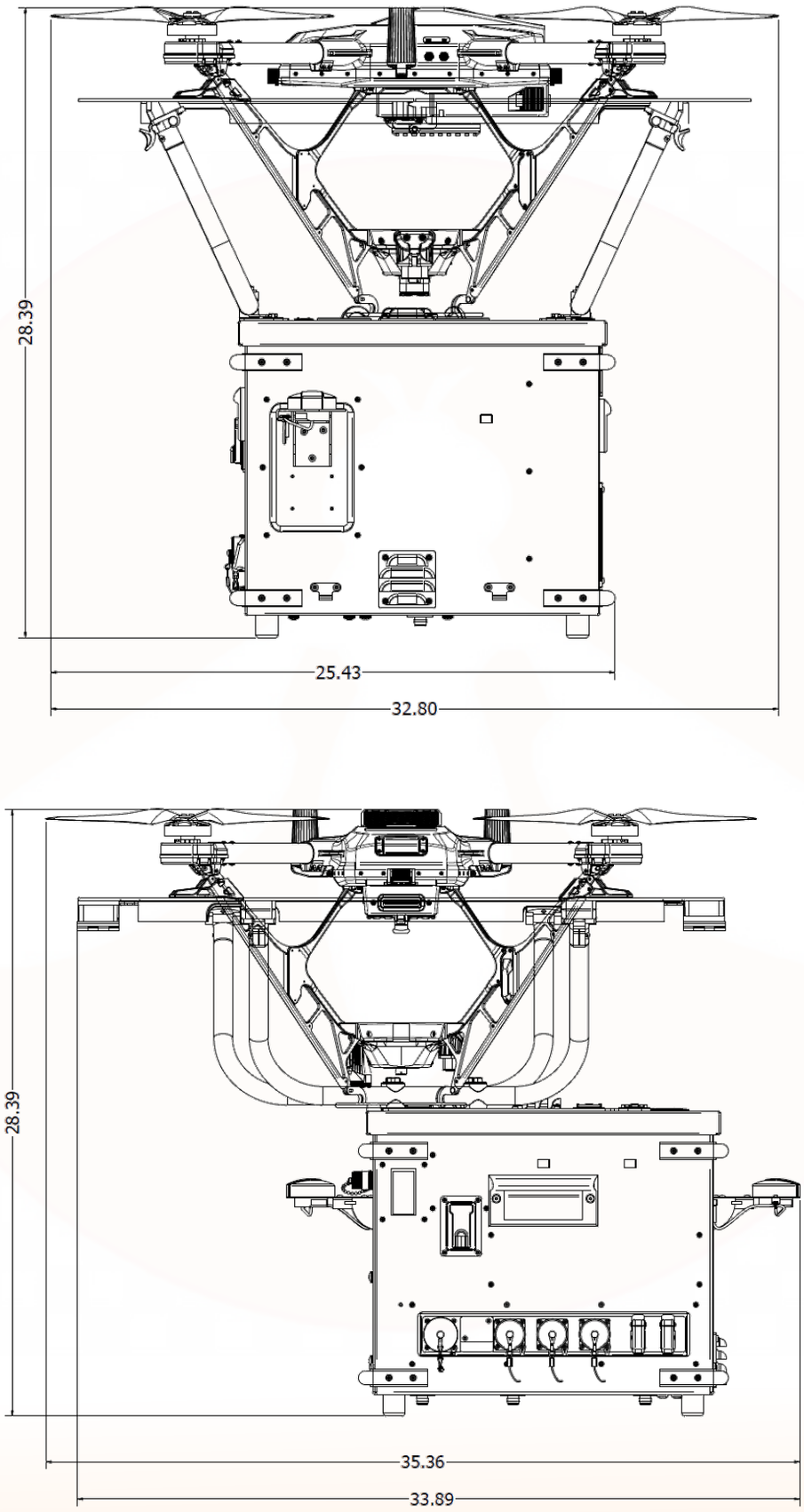

Figure 2: Spectre TUAS Side View (Top) and Front View (Bottom) Dimensions

Table 1: Specifications - Mechanical

Specification Parameter	Value	Units
Total System Weight - Aircraft, Tether Kit & Max Payload	83.8	lbs
Full System Size - LWH	32.8 x 35.6 x 28.39	in

Table 2: Specifications - Electrical

Specification Parameter	Value	Units
Input Power (Max Continuous)	*2,400	W
Input Voltage	90-264	VAC
Input Frequency	50-60	Hz
Tether Voltage (Nominal)	410	VDC
Tether Current (Max Continuous)	4.75	A

*When not running the system on shore power, HTI recommends a 3kW generator (or inverter) to account for derating due to altitude and temperature.

Table 3: Specifications - Environmental

Specification Parameter	Value	Units
Wind Speed During Operation	25	mph
Gust During Operation	3s @ 30	mph
Wind Speed During Landing	15	mph
Min Operating Temp	-4	°F
Max Operating Temp	120	°F
Min Storage Temp	-35	°F
Max Storage Temp	150	°F

Table 4: Specifications - Operational

Specification Parameter	Value	Units
Min Payload Weight	1.7	lbs
Max Payload Weight	5	lbs
Flight Duration	1,500	hrs
Min Density Altitude (MSL)	-1,400	ft
Max Density Altitude (MSL)	5,300	ft
Min Altitude (AGL)	30	ft
Max Altitude (AGL)	200	ft
Max Horizontal Range	32	ft
Ascent Speed	2.3	ft/s
Descent Speed	2.30 ft/s from 60-10 m 1.00 ft/s from 10-0 m	ft/s
Ascent/Descent Time to Max Altitude	2	mins
Max On-The-Move (OTM) Speed	15	mph

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SYSTEM COMPONENTS

SPECTRE UAV

TETHER KIT

CONTROLLER

SHIPPING CASES

SPECTRE PAYLOADS

Spectre UAV

The Spectre is a military grade tether powered UAV that provides infinite power, continuous operation and multi-site control. The system features a PTZ Hi-Def camera with 10x optical zoom, lead/flank/follow "on the move" technology, and 200 ft/60.8 m sustained vertical capability for reconnaissance, communications, and other tactical missions.

Figure 3: Spectre UAV Top View, No Payload

Figure 4: Spectre UAV Bottom View, No Payload

Tether Kit

The Tether Kit contains a backup battery that enables the tether reel to maintain constant tension on the aircraft and allows the aircraft's Advanced Tether System (ATS) to perform a precision landing in the event of a power loss. The tether is used as the command and control link to the aircraft, as well as the power source for flight. The system router connects all components onto a common network, which allows for monitoring and communication between system components.

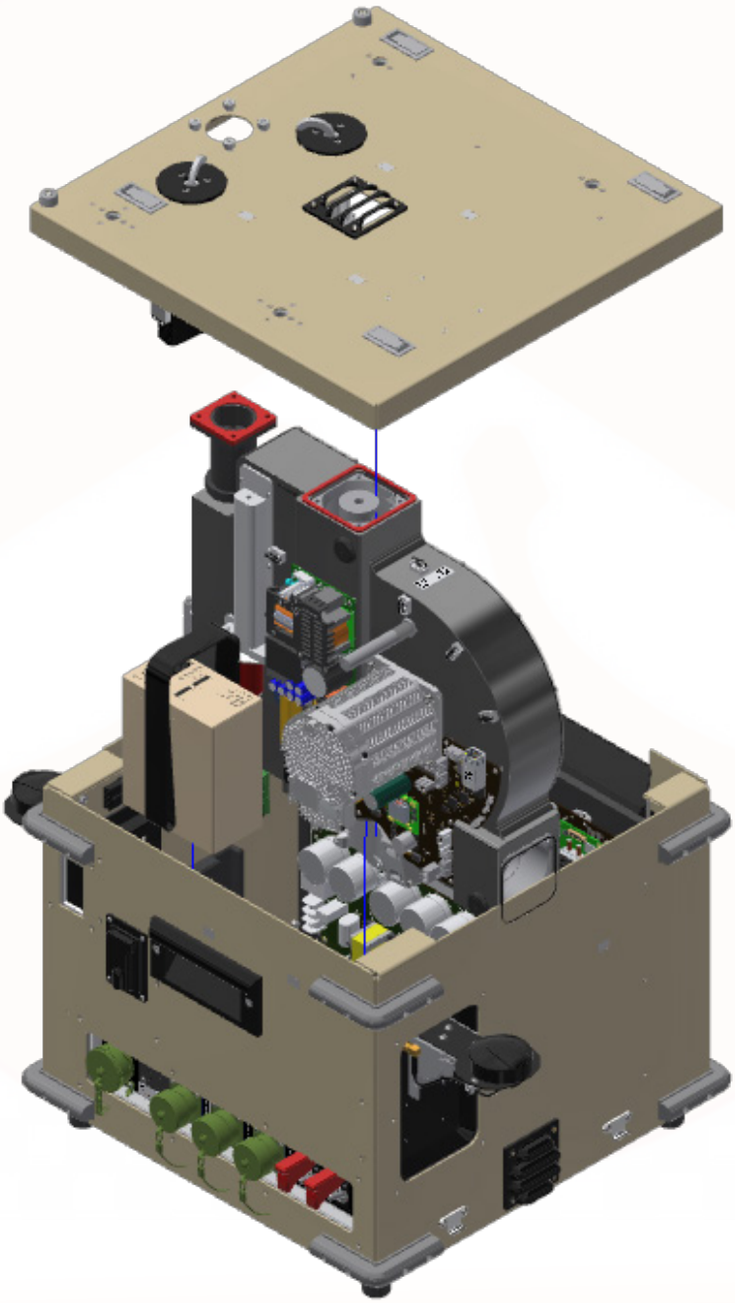

Figure 5: Tether Kit Exploded View

Controller

The wired controller (running MS Windows) hosts Hoverfly's executable software that generates the operator's GUI. The controller can be a touch screen, MS Windows compatible computer (i.e., Toughbook/Pad) or other user-supplied computer that runs MS Windows and Hoverfly's executable software. Control functions can also be extended over the Ethernet interface to other remote host control software. Controlling the Spectre system remotely from other processing environments/remotely located computers requires using the optional Hoverfly SDK. The Android Tactical Assault Kit (ATAK/TAK) is compatible with the controller and the Hoverfly software. Refer to the **Technical Support** section on page 79 of this manual for ATAK/TAK configuration information.

Figure 6: Xbox Controller Commands

UAV Shipping Case

- **Exterior Length**: 44.19 in/112.24 cm
- **Exterior Width**: 28 in/71.12 cm
- **Exterior Height**: 20.5 in/52.07 cm
- **Shipping Weight**: 56.51 lb/25.63 kg
- **Max Temp**: 180° F/82.2° C
- **Min Temp**: -40° F/-40° C

Tether Kit Shipping Case

- **Exterior Length:** 25.5 in/64.77 cm
- **Exterior Width:** 25.5 in/57.94 cm
- **Exterior Height:** 23 in/58.42 cm
- **Shipping Weight:** 32.52 lb/14.75 kg
- **Max Temp: 180°** F/82.22° C
- **Min Temp:** -40°F/-40° C

Spectre Payloads

The Spectre aircraft is highly customizable and many payload configurations are available. Refer to the **Technical Support** section on page 79 of this manual for Spectre payload options, and to **Appendix B** for EO/IR camera installation instructions.

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OPERATING PROCEDURES

NETWORK CONNECTIONS

NETAWORK VIDEO CONNECTIONS

SYSTEM SETUP

DISCONNECTION AND PACK-OUT

Network Connections

When operating the Spectre system from remote locations, or with computers or controllers not supplied by Hoverfly, the following network diagram may be useful.

In cases where third-party devices, controllers, or computers are used to operate the Spectre system, whether they are running Hoverfly executable software or not, it may be necessary to make connections to the internal router at IP address **10.20.30.1**.

For more information about access to addressable components of the Spectre system, refer to the **Technical Support** section on page 79 of this manual.

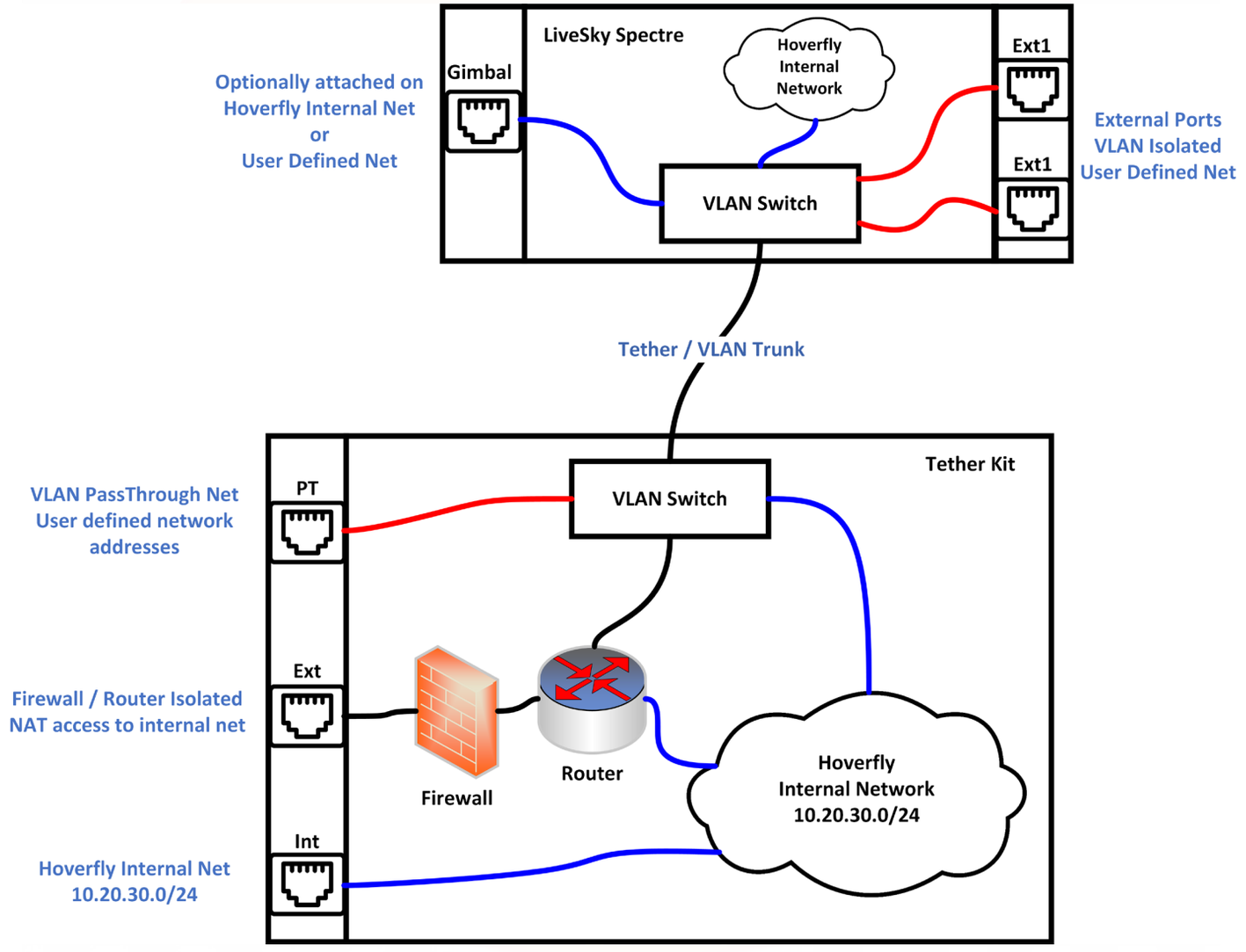


Figure 7:Spectre Network

Network Video Connections

In some cases, while the controller is connected to the external network connection on the Tether Kit, it is desirable to distribute video streams directly and simultaneously to other remote users. If so, a second Ethernet connection can be made to the internal network. Also, the **Pass Through** port, located to the right of the **Internal** port, allows the operator to have a direct Ethernet link to the payload connected to the aircraft external Ethernet port.

Four simultaneous video streams are available on the internal network, (visible and IR, primary and a secondary stream on each). Each of these streams come from the IP address **10.20.30.42**. The format for accessing the video directly is:

- **rtsp://admin:admin@10.20.30.42/videoinput/[STREAM TYPE]/h264/[STREAM NUMBER]**

where [STREAM TYPE] is **1** for Visible and **2** for IR and [STEAM NUMBER] is **1** for Primary and **2** for Secondary.

Video Stream Connections

An HD visible imagery stream in 1080p resolution is available at:

- **rtsp://admin:admin@10.20.30.42/videoinput/1/h264/1**

A secondary visible video stream, which can be configured for various resolutions, is available at:

- **rtsp://admin:admin@10.20.30.42/videoinput/1/h264/2**

Thermal (LWIR) video at 640x512 native resolution is produced simultaneously with the visible imagery streams, and is available at:

- **rtsp://admin:admin@10.20.30.42/videoinput/2/h264/1**

A secondary thermal video stream is also available at:

- **rtsp://admin:admin@10.20.30.42/videoinput/2/h264/2**

Video Stream Remote Access

If connecting to the Spectre system from an operations center and the controller, or the Hoverfly SDK, is being used on user-supplied computer equipment, to access the video streams it is also necessary to specify the port address (**10420**) as shown in the addresses below.

If connected to the external network port on the Tether Kit the primary visible stream is:

- **rtsp://admin:admin@10.0.0.2:10421/videoinput/1/h264/1**

or

- **http://admin:admin@10.0.0.2:10420/services/media.ion?sel=jpeg&source=videoinput_1**

If connected to the internal network port on the Tether Kit, then:

- **http://admin:admin@10.20.30.42/services/media.ion?sel=jpeg&source=videoinput_1**
- **http://admin:admin@10.20.30.42/services/media.ion?sel=jpeg&source=videoinput_2**

The Hoverfly's Tether Kit's internal network has the scheme **10.20.30.x/24**, subnet mask **255.255.255.0** with Router ID Address **10.20.30.1**.

The External port on the Tether Kit is connected to the internal router's WAN port. The WAN port is configured by default to have the following IP configuration:

- Router IP address: **10.0.0.2**
- Gateway IP address: **10.0.0.1**
- Subnet Mask: **255.255.255.0**

OPERATING PROCEDURES

If not connecting the Tether Kit to a network, the recommended usable IP address for an external device (i.e., laptop) is **10.0.0.3**. If connecting the Tether Kit to a network, changing the WAN IP settings of the internal router will be necessary unless the external network has the same IP scheme as described above.

To configure the Tether Kit router IP address setting to be compatible with Tether Kit External port, follow the steps below.

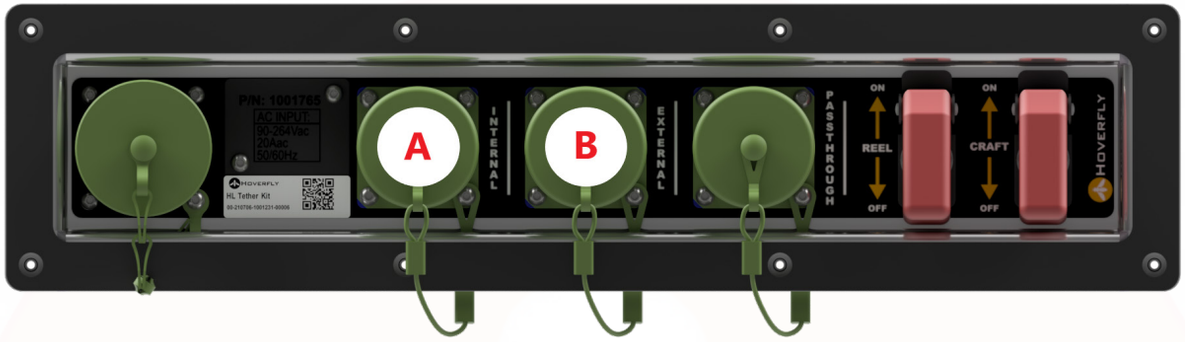
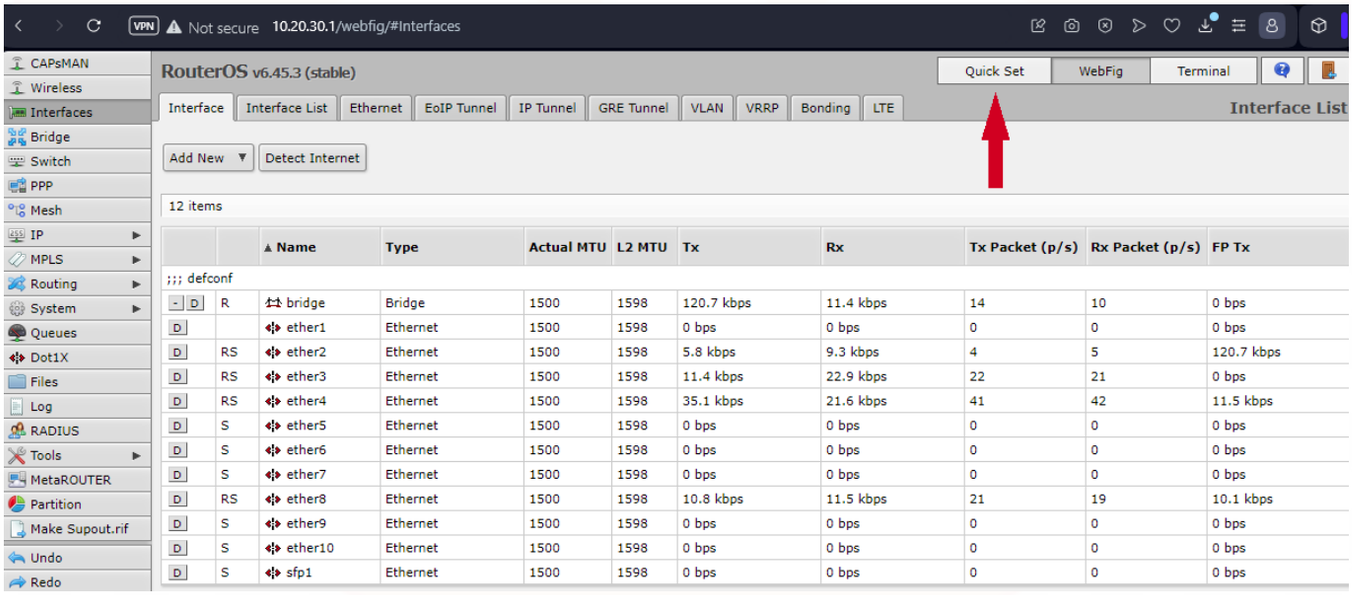


Figure 8: Tether Kit Internal and External Ports

1. Connect one end of an Ethernet cable to the Tether Kit **Internal** port (**Figure 8, A**).
2. Connect the other end of the Ethernet cable to MS Windows compatible device.
3. Open a web browser and type **10.20.30.1** into the address bar.
4. The **Router Interfaces** window will appear; click the **Quick Set** tab at the top-right of the screen.



		Name	Type	Actual MTU	L2 MTU	Tx	Rx	Tx Packet (p/s)	Rx Packet (p/s)	FP Tx
;;; defconf										
D	R	bridge	Bridge	1500	1598	120.7 kbps	11.4 kbps	14	10	0 bps
D		ether1	Ethernet	1500	1598	0 bps	0 bps	0	0	0 bps
D	RS	ether2	Ethernet	1500	1598	5.8 kbps	9.3 kbps	4	5	120.7 kbps
D	RS	ether3	Ethernet	1500	1598	11.4 kbps	22.9 kbps	22	21	0 bps
D	RS	ether4	Ethernet	1500	1598	35.1 kbps	21.6 kbps	41	42	11.5 kbps
D	S	ether5	Ethernet	1500	1598	0 bps	0 bps	0	0	0 bps
D	S	ether6	Ethernet	1500	1598	0 bps	0 bps	0	0	0 bps
D	S	ether7	Ethernet	1500	1598	0 bps	0 bps	0	0	0 bps
D	RS	ether8	Ethernet	1500	1598	10.8 kbps	11.5 kbps	21	19	10.1 kbps
D	S	ether9	Ethernet	1500	1598	0 bps	0 bps	0	0	0 bps
D	S	ether10	Ethernet	1500	1598	0 bps	0 bps	0	0	0 bps
D	S	sfp1	Ethernet	1500	1598	0 bps	0 bps	0	0	0 bps

Figure 9: Quick Set Tab

5. Within the **Quick Set** window, configure the External port settings as needed.

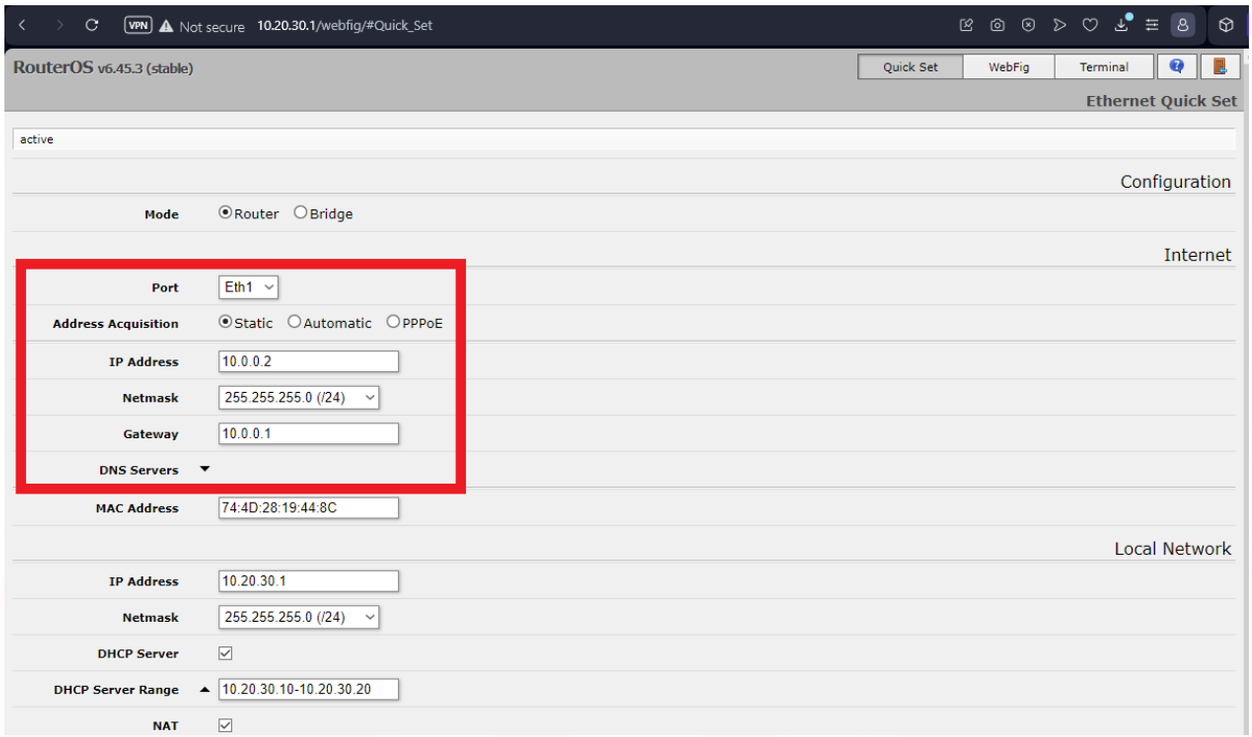


Figure 10: External Port Settings

6. Close out the web browser.
7. Disconnect the Ethernet cable from the Internal Tether Kit port (**Figure 8, A**) and plug it back in to the External port (**Figure 8, B**).
8. Ensure that the controller device's IP address matches the External Tether Kit port configuration.
9. For more information on remote control operations and video stream management/distribution, refer to the **Technical Support** section on page 79 of this manual.

System Setup

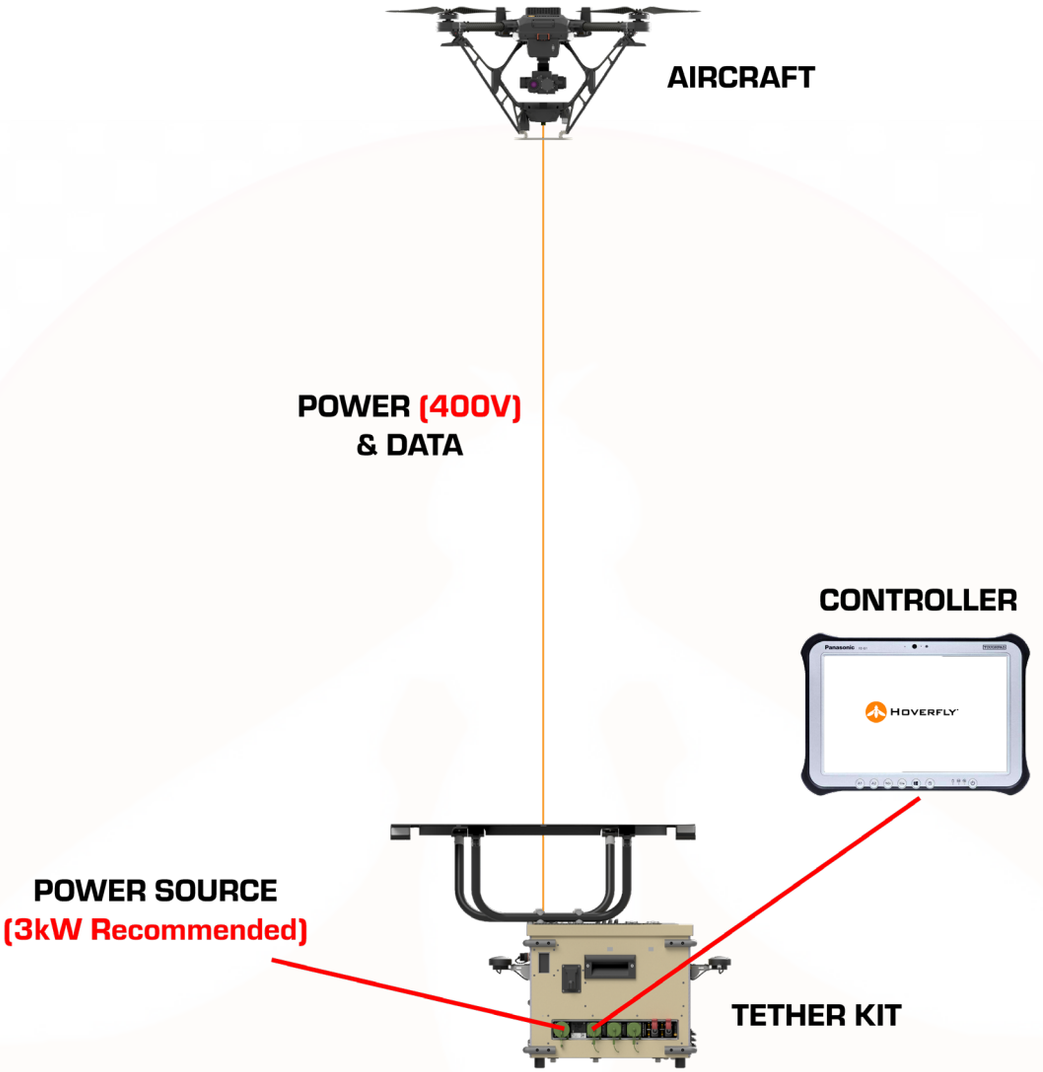


Figure 11: Spectre TUAS

Identify the two transit cases marked **Craft Spectre** and **Tether Kit Spectre** and pack-out / remove the system components in the precise order that follows, taking advantage of the transit cases as work surfaces for Landing Ring and Payload installation.

DO NOT ESTABLISH POWER CONNECTIONS DURING SETUP. ALL SYSTEM POWER CONNECTIONS ARE MADE LATER.

VISUALLY INSPECT ALL EQUIPMENT PRIOR TO FLIGHT. DO NOT OPERATE IF DAMAGE IS VISIBLE TO PROPELLERS OR ANY OTHER PART OF THE SPECTRE SYSTEM.

WHEN REMOVING THE SPECTRE AIRCRAFT FROM THE TRANSIT CASE, DO NOT LIFT BY PROPELLERS. LIFT ONLY BY MOTOR BOOM ARMS.

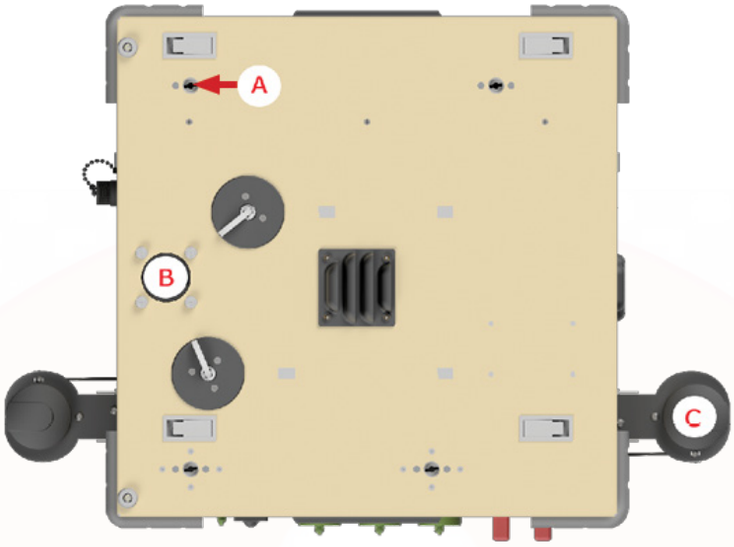


Figure 12: Tether Kit - Top View

1. Remove the Tether Kit from the transit case and place on level surface, noting the four mounting receptacles on top (**Figure 12, A**). These receptacles are used to mount the landing ring, which is described below (**see Step 8**).
    - Tether Kit must have less than 10° of tilt for take-off and landing
2. Verify screws around tether connector are secure (4x) (**Figure 12, B**). Do not over tighten as damage to funnel neck will occur.
3. Verify Amphenol strain relief screws (circled in figure below) are secure (2x) to the tether connector.

Figure 13: Amphenol Strain Relief Screws

4. Flip up ground GPS (2x) and verify unobstructed view of sky (**Figure 12, C**). Ensure click locks are engaged.
5. Turn the Tether Kit on its side and verify that the three drain ports on the bottom of the Tether Kit (red arrows, below) are free and clear of debris.

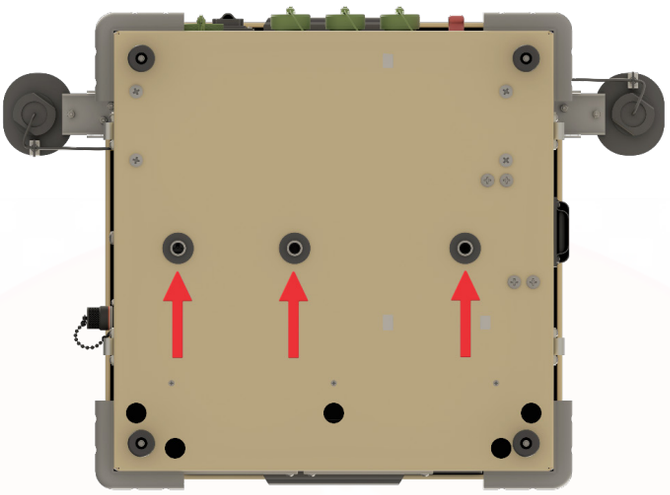


Figure 14: Tether Kit Drain Ports

6. Ensure the Tether Kit battery is sufficiently charged.
   - Ensure power is disconnected
   - Turn **ON** the **REEL** switch and ensure the tether retracts
   - Turn the **REEL** switch **OFF**
7. Remove the Landing Ring from the Spectre transit case, unfold it and rotate the Landing Ring bracket legs into vertical position perpendicular to the unfolded ring.
8. Install the Landing Ring onto the top of the Tether Kit by aligning the ¼ turn fasteners (**Figure 12, A**) on the Landing Ring bracket legs with the mounting receptacles on top of the Tether Kit.

   Note that the Landing Ring will only fit on the Tether Kit one way. The Landing Ring is centered over the Tether connector, it is **NOT CENTERED** over the Tether Kit itself. Turn the fasteners ¼ turn and verify that the Landing Ring is securely attached to the Tether Kit.

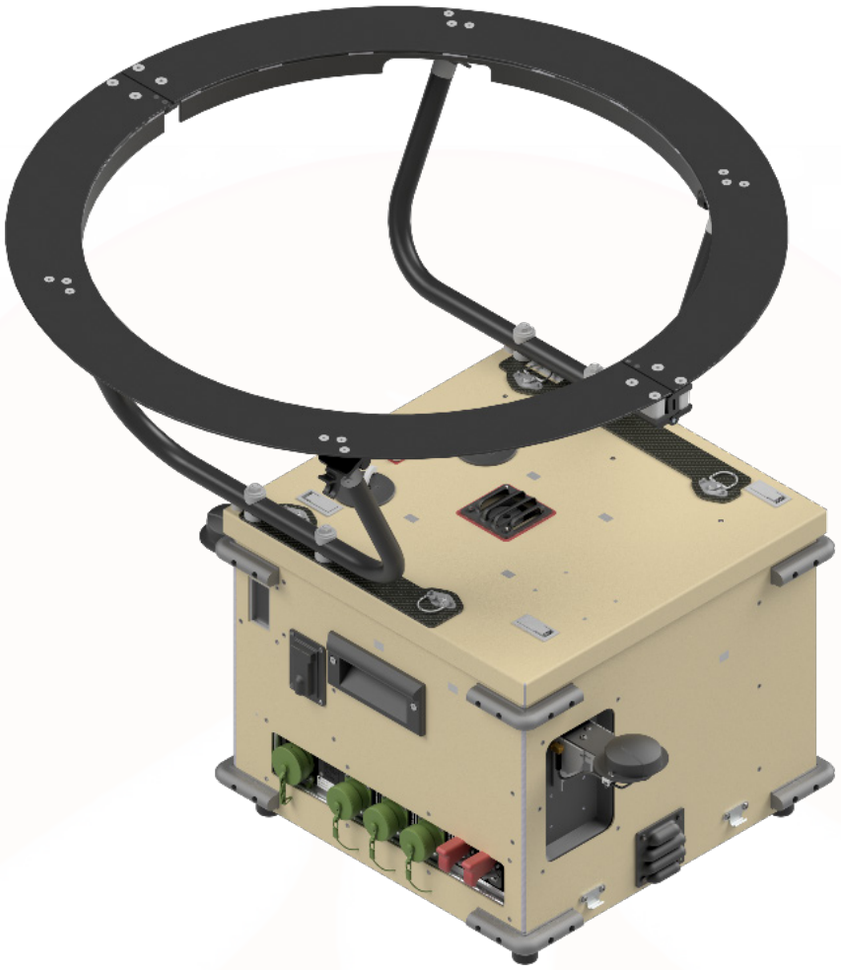


Figure 15: Tether Kit with Landing Ring Attached

DO NOT CONNECT AC POWER. ENSURE TETHER KIT POWER SWITCHES (2x) ARE IN THE OFF POSITION (FIGURE 18, C & D).

9. Inspect aircraft screws.
    - Verify aircraft lid screws are secure.
        - Side Screws (18x)
        - Front/Back Screws (8x)

Figure 16: Aircraft Lid Screws

- Verify motor booms screws are secure (6x per boom).

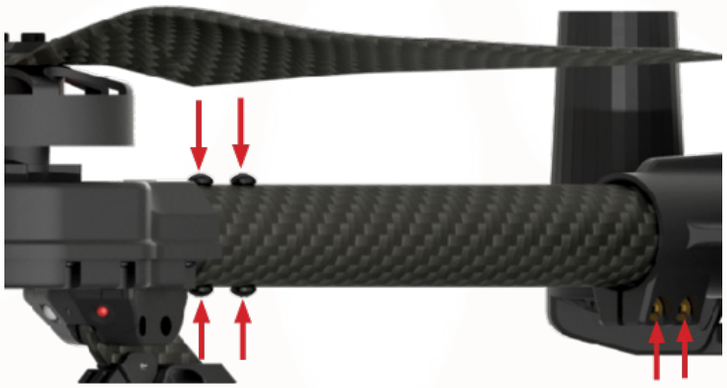


Figure 17: Motor Boom Screws

10. Pull approximately sixteen inches (16") of tether out of the Tether Kit and connect the tether to the aircraft (with payload installed). Note the connector is a "one-way keyed" Amphenol connector (**Figure 13**). Connect this to the bottom of the Specter and twist the connector after insertion until it reaches the detent and "clicks."

Figure 18: Tether Kit Power and Connection Panel

11. Flip the **REEL** power switch (**Figure 18, C**) and reel the remaining tether in.
12. Flip the **REEL** power switch to the **OFF** position.
13. Place the Spectre aircraft in the Landing Ring, centered over the opening.
14. Remove the touch screen controller from the Spectre transit case and set it aside or place it on the Tether Kit transit case.
15. Connect the controller with the supplied Ethernet cable by plugging it into the **Internal** Ethernet port on the Tether Kit (**Figure 18, B**) .
16. Connect the supplied AC power cable to the **AC Input** receptacle on the Tether Kit (**Figure 18, A**). Connect the other end of the AC power cable to a power source capable of supplying 3,000W (3 Kw).
17. Cordon off a minimum of 50 ft/15.24 m diameter clear circular area around the Tether Kit. **DIRECT ALL PERSONNEL OUT OF CORDON AREA**.

DO NOT OPERATE WITH LESS THAN 50 FT/15.24 M DIAMETER CORDON WITH AT LEAST 25 FT/7.6 M FROM EACH SIDE OF THE TETHER KIT. KEEP THIS CORDON AREA CLEAR OF ALL PERSONNEL.

Applying Power

FAILURE TO FOLLOW THE OPERATION PROCEDURES IN THIS SECTION AND THE CRITICAL SAFETY WARNINGS IN ANY SECTION OF THIS MANUAL MAY RESULT IN EQUIPMENT/PROPERTY DAMAGE, PERSONAL INJURY, OR POTENTIAL LOSS OF LIFE.

APPLY POWER ONLY AFTER ALL CONNECTIONS HAVE BEEN MADE.

To operate the Spectre system, both electrical power and the controller must be connected to the Tether Kit. The tether connector must also be connected from the Tether Kit to the Spectre aircraft. Ensure these connections have been made before proceeding. Understanding and executing the detailed procedures for these sequences is critical to achieving the operational goals and objectives when deploying the Spectre system.

1. Ensure that setup has been completed properly before applying power to the Spectre system.
2. Set the two red power switches on the Tether Kit to the **ON** position (**Figure 18, C and D**).

AVOID DANGEROUS HIGH VOLTAGE AND NEVER CONNECT OR DISCONNECT THE TETHER WITH SYSTEM POWER ON.

ONLY USE POWER SOURCES THAT GENERATE "PURE SINE WAVE" AC POWER; FAILURE TO DO SO VOIDS WARRANTY.

Power-Up Controller and Establish Connection

1. Apply/turn on power to the controller.
2. Activate the Hoverfly GUI by double clicking on the controller's Hoverfly control software. The GUI (**Figure 19**) is organized to provide maximum area for imagery, with information and controls around the perimeter.

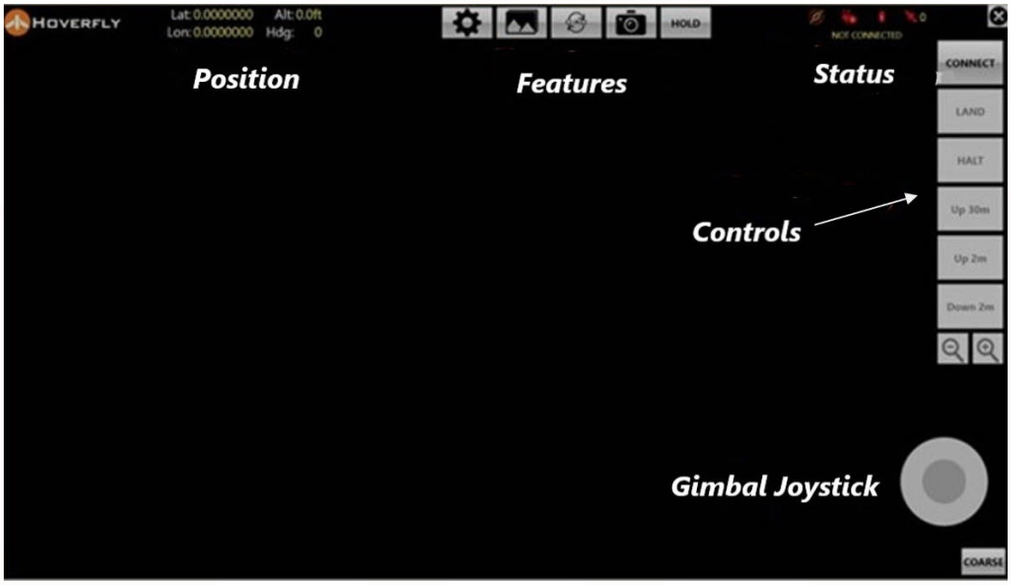


Figure 19: Controller GUI Screen

Initial Setup

1. From the Hoverfly GUI, click the **CONNECT** control button located on the right side of the screen once the aircraft is powered on.
2. If the **Conditions Checklist** window is displayed, check all items that apply and then press the **Submit** button at the bottom of the window.

Status Indications

Status Indications are provided at the top right in the GUI and display a progression of messages as the system establishes internal/external connectivity and passes built-in-test and functional checks. The four indicators are visual representations of system status.

Status Indications (left to right):

1. Ethernet connection status
2. System power status
3. Safety Landing Battery (SLB) status
4. GPS status and number of GPS satellites detected

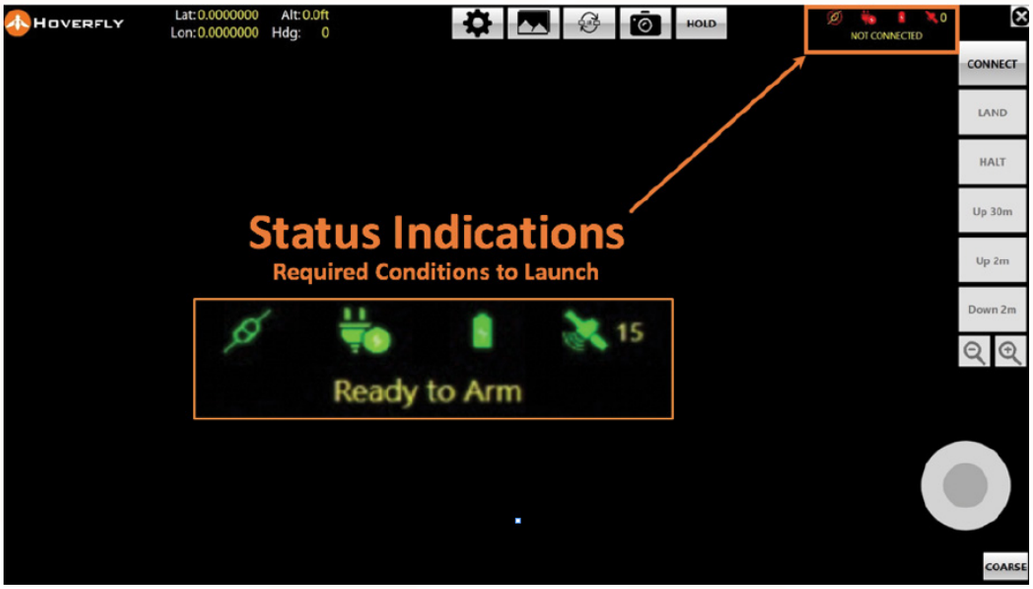


Figure 20: GUI Status Indications

All Status Indicators must be GREEN for the system to have launch capability. If any Status Indicator is RED, the system will not launch.

The controller must be connected to the Tether Kit to start the system. If a valid connection exists between the embedded software in the controller and the Tether Kit, the **Ethernet** connection status indicator will turn GREEN.

If the power input to the Tether Kit is between 90-240VAC, and the system can provide power to the Spectre aircraft; the **Power** status indicator will turn GREEN.

Figure 21: Power Status Indicator

When the Spectre SLB is **at the specified voltage**, the battery status indicator will turn GREEN.

If GPS accuracy and the number of satellites is within specified limits, the **GPS** status indicator will turn GREEN and the system will be capable of entering the **ARM** state. Ten satellites are recommended before launch. If the aircraft has moved more than 100 miles since the last flight, or if it has not flown for 30 days, a GPS update is required. To update the GPS, boot up the system and allow to sit powered and connected without launching for 15 minutes.

The system controls at the right edge of the GUI are used for every flight; complete missions can be flown using only the system controls and joystick.

The Spectre system is simple to operate, provided all the Critical Safety Warnings are obeyed. **CLEAR A CORDON AREA BEFORE ARMING THE SYSTEM**.

The Spectre one-button launch control capability allows the operator to Arm and Launch the aircraft by pressing a single button to advance the state of the system into **LAUNCH**. The multi-state button must be pressed three times to Launch the Spectre.

CLEAR CORDON AREA PRIOR TO PRESSING THE ARM BUTTON

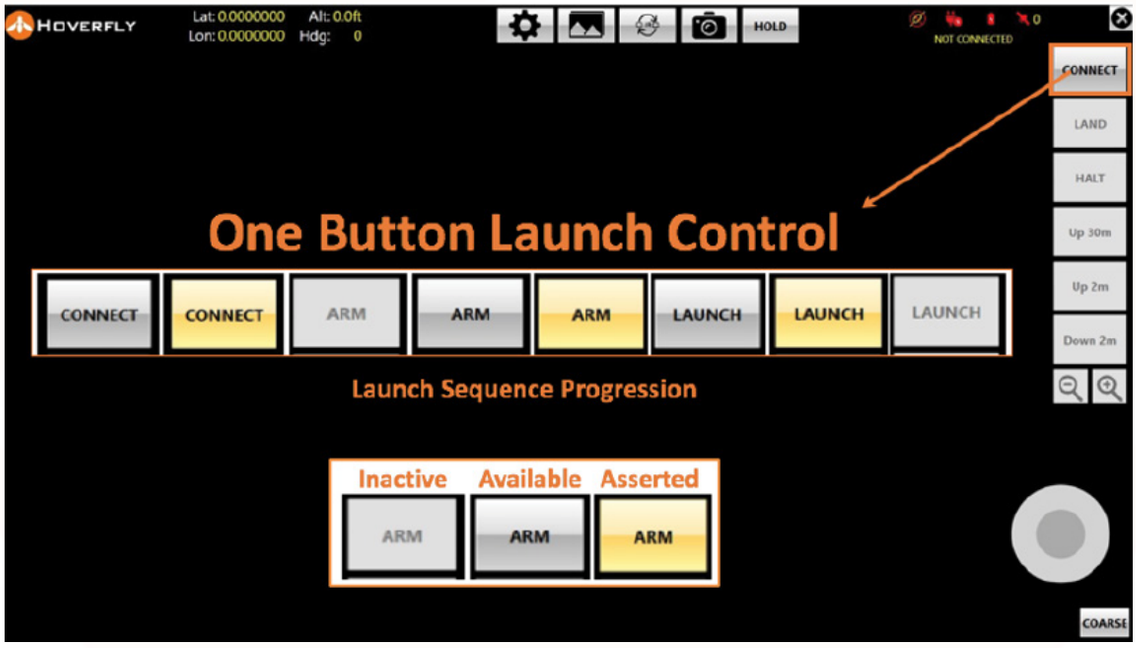


Figure 22: Controller GUI Launch Control Progression

At startup, the video feed is not yet active; the operator must press the **CONNECT** button to establish and provision the video stream to the controller. The buttons conform to a simple visual standard that is described below.

Button State Reference

The button controls for **Commands**, **Features**, and **Capabilities** have common attributes:

- When disabled, the button and text are GREYED OUT
- When they are available, buttons are HALF GREY and the TEXT IS BOLD
- When the button is active, the color turns to GOLD

Figure 23: GUI Button States

Figure 24 displays an illustration of controls during the **CONNECT/ARM/LAUNCH** states. It also shows the availability the **Up/Down** controls as they become available. After the aircraft is launched, these controls will change in state.

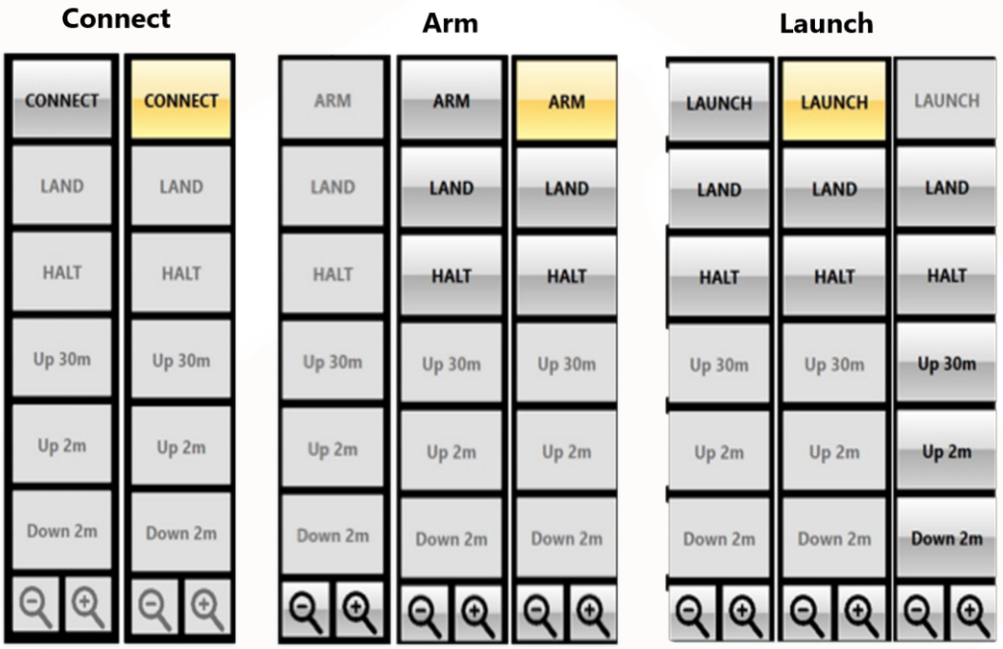


Figure 24: GUI Button State Indications for Launch Sequence

To begin the Launch sequence and ready the system for operation, click the multi-state **CONNECT** button at the top-right of the GUI. Be aware, this button is state-dependent and will cycle between **CONNECT**, **ARM**, and **LAUNCH** as successive, built-in tests are passed. The progression of the **CONNECT/ARM/LAUNCH** sequence will indicate the next available action or state in the controls. There is no bypass for this sequence.

After the **CONNECT** button is pressed, it may take up to two minutes for video to appear on the controller. This is normal behavior as the system is conducting built-in tests. As the **LAUNCH** sequence progresses, the progress of built-in tests is shown in **Status Indications** at top right in the GUI.

Control and Status Sequence

The state of system operational readiness is shown in the progression of Status Indications as the **CONNECT**/**ARM**/**LAUNCH** sequence progresses.

Figure 25: GUI Button State Indications and Messages Status During Launch Sequence

Flight Control Buttons

After **CONNECT** is asserted, the visible HD video and thermal display options will become available. Video will appear on the GUI after the automatic, built-in tests are performed. After the **ARM** state becomes available, as a precaution, the **LAND** and **HALT** functions also become available. After **LAUNCH** is asserted, other controls (i.e., Up 30 m/98 ft) will also become available.

LAND and **HALT** become active after a single assertion; any further assertions are ignored. Other flight control options are queued with successive assertions and executed the number of times the command is asserted. For example, **Up 2 m/6.6 ft** asserted three times will cause the Spectre to ascend **6 m/19.8 ft** from its present altitude.

Figure 26: Flight and Sensor Controls Overview

FOLLOW and HOLD Position Feature

After launch, if the Spectre system is equipped with On-The-Move (OTM) capability and it is enabled, the **HOLD** button will change to **FOLLOW** once clicked. The **HOLD** button will change state after the launch when the Spectre is at minimum altitude.

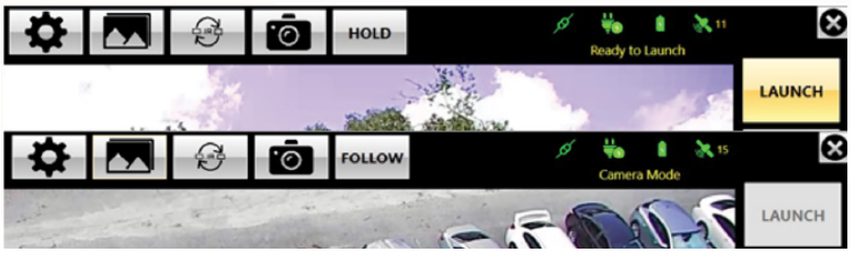


Figure 27: HOLD Button State Change to FOLLOW

When the system is in **FOLLOW** mode, the airborne Spectre will follow the position of the Tether Kit or Ground GPS antenna in the optional OTM capability kit.

Thermal Palette Toggle Feature

The color palette used to display thermal imagery can be changed with **Settings** button, which looks like a gear and is located at the top of the GUI in the row of feature buttons. The last two-color palettes selected under **Settings** can be toggled back and forth with the assertion of the **Thermal Palette Toggle** feature as shown in the figure below.

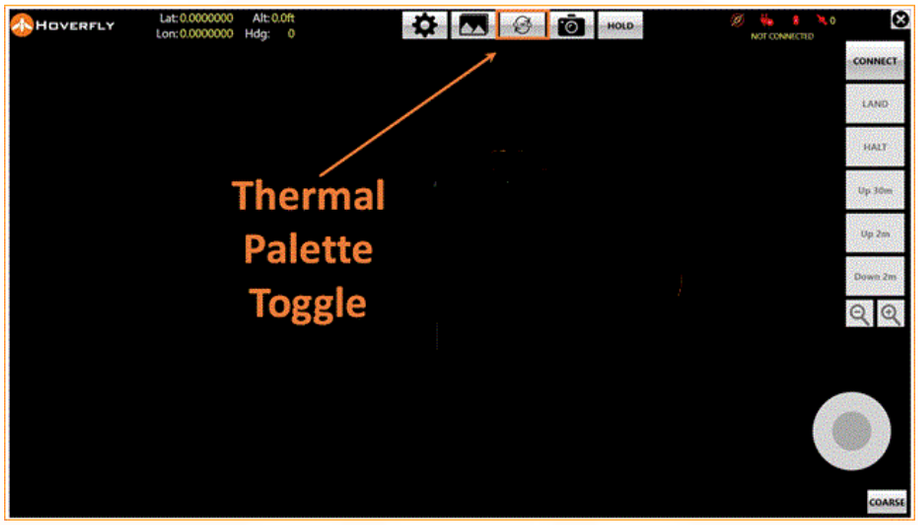


Figure 28: Thermal Palette Toggle Feature

Picture-in-Picture (PIP) Sequence Feature

The **PIP Sequence** feature selects one of four imagery options for the controller display. The four options are:

1. Visible camera
2. Thermal camera
3. Visible with thermal PIP
4. Thermal with visible PIP

The Thermal Palette Toggle feature may be asserted while in PIP modes.

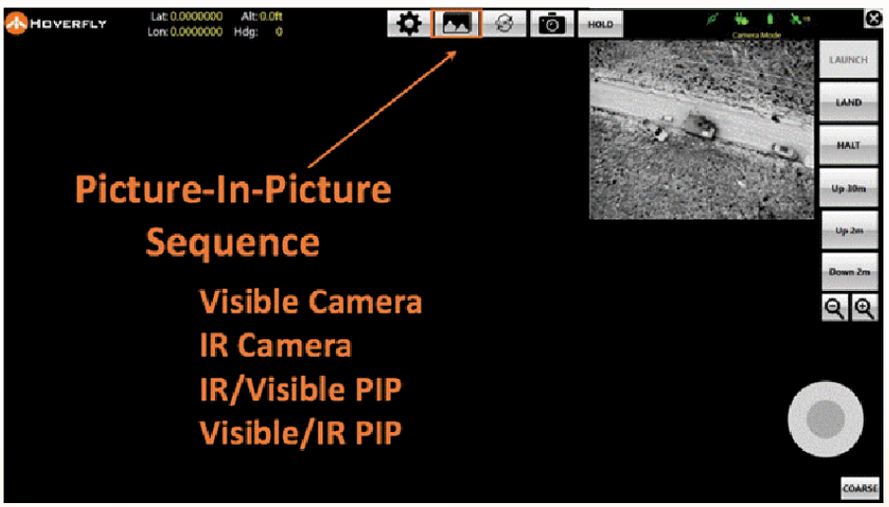


Figure 29: PIP Sequence Rotator Feature

Settings Access Feature

Additional features can be accessed by asserting the **Settings** button. Within the **Settings** screen:

- A center reticle can be activated/deactivated
- The IR Palette options can be selected
- Detailed System **Settings** can be changed
- The flight cone translation can be activated using the **Navigation** feature.
- Aircraft lateral movement can be activated using the **Navigation** feature
- **Display** and **Video Stream** settings can be changed
- LEDs can be configured
- **Precision Landing** feature can be enabled/disabled
  - **Enabled**: When **Precision Landing** is enabled, the aircraft will attempt to land in the Landing Ring.
  - **Disabled**: When **Precision Landing** is disabled, the aircraft will no longer land in the Landing Ring; it will land straight down from where it is hovering.

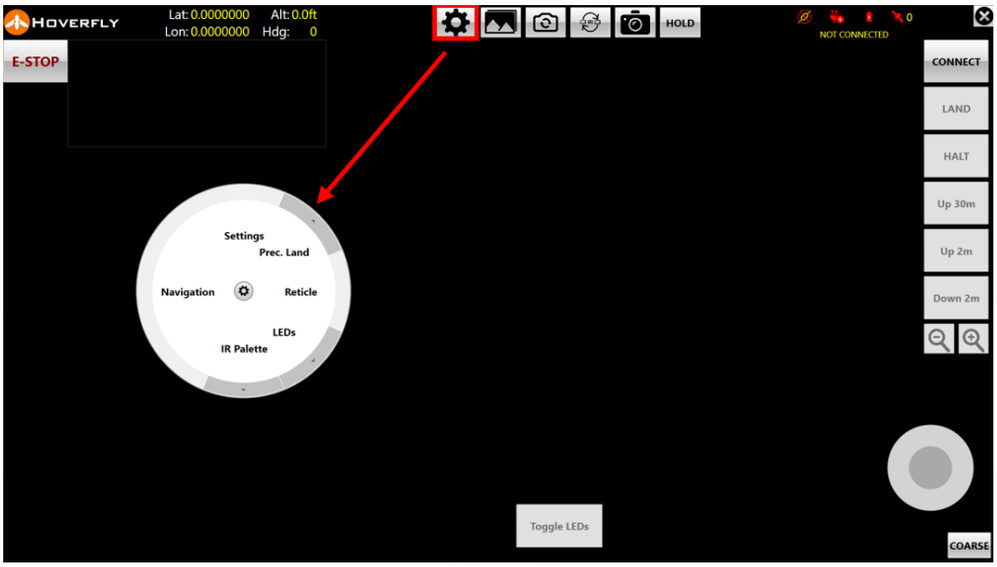


Figure 30: Settings Sub-Menu Enable Translate Feature

Navigation or "Translate" Feature Controls

At any time after **LAUNCH**, and unless **HALT** is asserted, activating the **Navigation** feature causes the Translate Controls to appear in the lower left corner of the GUI.

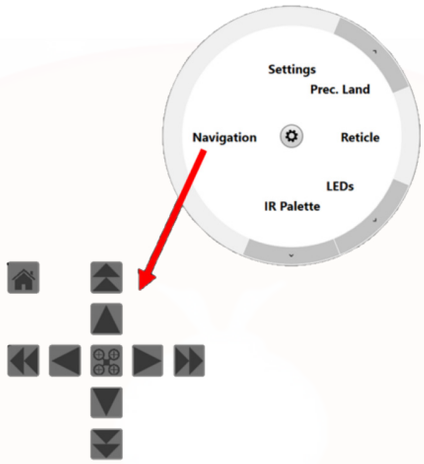


Figure 31: Navigation Translate Controls

The Spectre can translate in **X** and **Y** horizontal position while in flight by using the Translate Controls. Using the Translate Controls does not change altitude. Custom settings are available for this feature with Hoverfly's SDK. The **Translate** feature is useful for a variety of missions and can also be used with OTM capability, for instance, to look over a wall while moving in a vehicle.

THE MAXIMUM RECOMMENDED TRANSLATION DISTANCE IS 10 M/33 FT OR LESS. LANDINGS INITIATED OUTSIDE OF A 10 M/33 FT RADIUS HAVE A POSSIBILITY OF MISSING THE LANDING RING.

If the **LAND** function is activated after the **Translate** feature has been asserted, the Spectre aircraft will move to a normalized position over the Tether Kit while landing, and manual Translate functionality will be abandoned until the landing is complete and a new launch occurs.

Figure 32: Activate Translate Feature to Move the Spectre in Flight

The 90° frame of reference for the **Translate** feature is dependent on the initial launch heading. For example, if the front of the Spectre and its sensors are pointing North at launch, then the Translate Controls will be in map **North** orientation. If the front of the Spectre is pointed, for instance, to 34° from 0° North, then X, Y movements will be oriented at 34°, 124°, 214°, and 304° from 0° North.

Detailed Settings

Selecting **Settings** (circled, below) will enable the **Settings** sub-menu.

Figure 33: Settings Feature

The **Settings** sub-menu offers another level of settings where **System**, **Display**, **Network**, and **About** features become available. Unless advised by Hoverfly or your System Administrator, **DO NOT CHANGE** detailed **Settings** information.

Figure 34: Settings Network Feature Tab; DO NOT CHANGE

Disconnection and Pack-Out

In general, the procedure for Disconnection and Pack-Out is the reverse of the **Setup** procedure. Follow the steps below:

1. Turn off power:
   - Two power switches on the Tether Kit

TO AVOID DANGEROUS HIGH VOLTAGE, NEVER DISCONNECT THE TETHER WITH POWER APPLIED TO THE SYSTEM.

2. Disconnect both the AC power cord and the Ethernet controller cable.
3. Disconnect the tether connector from the Spectre aircraft.
4. To retract the tether fully into the Tether Kit, you may temporarily turn **ON** the Tether Kit **REEL** switch. Turn it **OFF** after the tether is retracted.
5. Using the payload latch, remove the payload from the Spectre aircraft.
6. Turn the aircraft upside down and place on the transit case or other safe, clean surface.
7. Remove the Landing Ring from the Tether Kit and collapse it for storage in the Spectre transit case. Stow it in the transit case, then place the Spectre, payload, and controller in the case appropriately and with care. Do not carry/lift the Spectre aircraft by the propellers; always handle it by the motor boom arms.
8. Stow the Tether Kit in the Tether Kit transit case.

SYSTEM LOGS AND DATA

TETHER KIT SYSTEM LOGS

AIRCRAFT SYSTEM LOG

SYSTEM LOGS AND DATA

The Spectre generates logs for post mission review, predictive and condition-based maintenance, built-in tests, warranty administration, and safety.

System data is maintained by several computers, processors, and data stores. The flight controller, flight management system, and various system sub-assemblies keep system logs of data. Extensive analysis of this data over thousands of flights helps Hoverfly deliver a system that is tactically effective, highly available, and exhibits very long duration mission capabilities. System logs that contain this data may be extracted in the field and sent to Hoverfly for system performance evaluation, product support, warranty administration, or problem resolution.

Four of the five available system logs are stored in the onboard computers in the Tether Kit. One additional and very important log file is stored aboard the Spectre aircraft itself. When collecting logs for analysis, it is important to collect all relevant logs.

Tether Kit System Logs

There are several logs stored in the Tether Kit; all of which may be downloaded through a Web interface by connecting a computer to the Tether Kit network. It is also possible to use the Hoverfly touch screen controller for this procedure.

If a computer (or controller) is connected to the **Internal** Ethernet port on the Tether Kit, it should be configured to use a DHCP network address. The router in the Tether Kit will assign it an address on the internal **10.20.30.0/24** network. Open a Web browser and navigate to **http://10.20.30.200**.

If a computer (or controller) is connected to the **External** network port, then simply navigate to the IP address that has been assigned to the Tether Kit by your network.

Once the computer or controller is connected, the Hoverfly Access GUI will be displayed. This page has options that include **Logs**, **Settings**, **Utilities**, **Documentation**, **Upgrade**, **About** and **Account**. Click on the **Logs** link to view the log files.

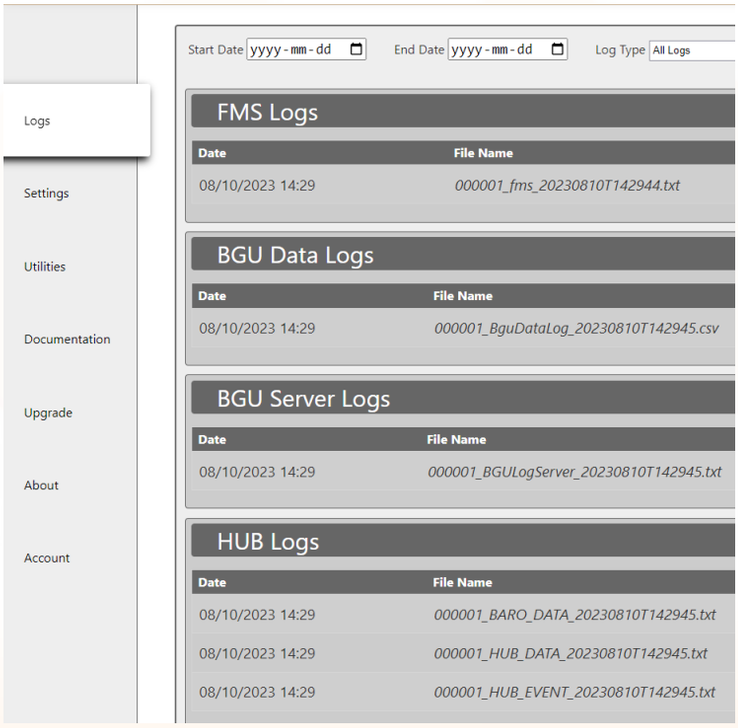


Figure 35: Hoverfly Access GUI

A new screen will appear after **Log File Access**. From this screen, access is provided to the different types of Tether Kit logs:

- FMS Log
- BGU Data Log
- HUBDATA Log
- HUBEVENT Log
- BARODATA Log

Click on the link for each type of log to access the directory structure for that log file. Once inside of the directory structure, log files from the Tether Kit can then be downloaded or deleted.

All logs are generated each time the system is powered on. These logs are labeled with a timestamp and can be sorted in time order to make it easy to find the desired log from any flight.

The timestamp format is **YYYYMMDDTHHMMSS.** Therefore, a log with the title **BguDataLog_20190213T174523** is from **02/13/2019 at 5:45:23pm**.

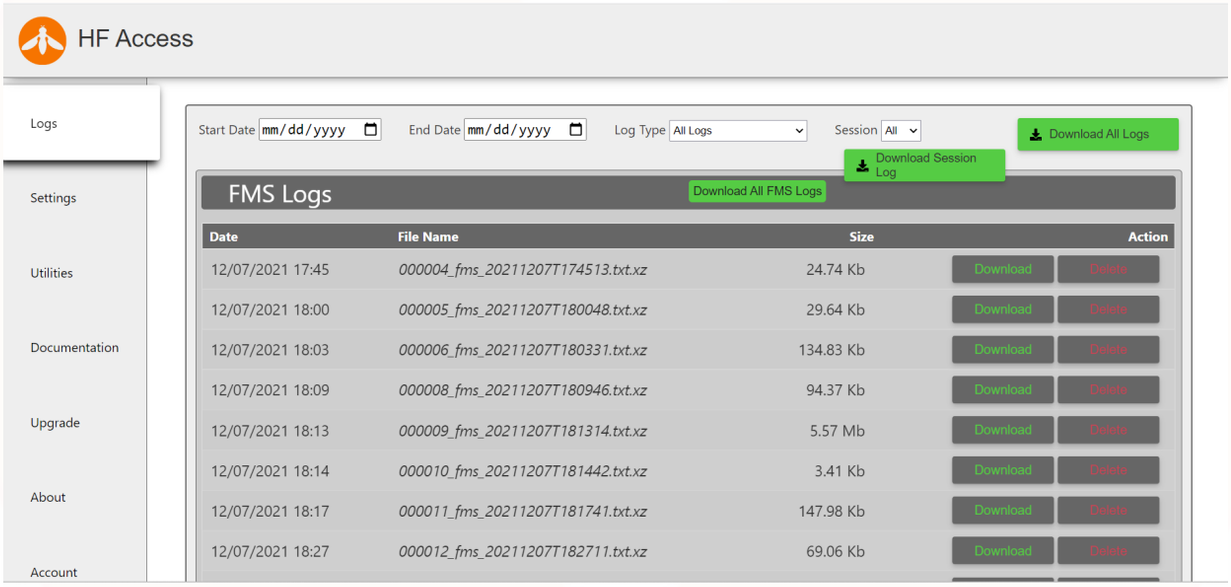


Figure 36: Hoverfly Sequential Flight Log - Tether Kit

Aircraft System Log

The Spectre aircraft log is accessed by using a USB-C cable connected between the aircraft and any computer running the ArduPilot Mission Planner software (which can be found at: **http://ardupilot.org/planner/** or the Toughpad).

Required Hardware

- USB-C Cable
- Computer/Device with ArduPilot Mission Planner Software Installed

Required Software

- ArduPilot Mission Planner Software

Aircraft logs may be downloaded in two ways:

- From a computing device
- From the Micro SD card

Follow the steps below to extract the logs after obtaining and installing the software:

Download Logs From Micro SD Card

Figure 37: Spectre Programming Hatch

1. Use a Phillips screwdriver (included) to remove the four screws from the programming hatch lid located at the front of the aircraft (**Figure 37**).
2. Remove the Micro SD card from its receptacle location in the programming hatch.
3. Download all relevant logs.

Download Logs Using a Computing Device

1. Use a Phillips screwdriver (included) to remove the four screws from the programming hatch lid located at the front of the aircraft (**Figure 37**).
2. Plug one end of a USB-C cable into the USB-C port located inside of the programming hatch.
3. Connect the other end of the USB-C cable to a computing device equipped with ArduPilot Mission Planner Software (a laptop computer, for example).
4. From the computer, navigate to the ArduPilot/Mission Planner start-up screen.

Figure 38: Mission Planner Connect/Start-Up Screen

WHEN CONNECTED, MISSION PLANNER MAY ASK ABOUT UPGRADING FIRMWARE. DO NOT UPGRADE FIRMWARE!

SPECTRE USES SPECIAL SOFTWARE; DO NOT UPGRADE FIRMWARE.

5. In the center left of the screen, below the artificial horizon, there are a series of tabs. Select **DataFlash Logs.**
6. Click the **Download DataFlash Log Via Mavlink** button.

Figure 39: DataFlash Log

7. This will display a window showing all the logs on the aircraft; the log files are dated. Select the appropriate log(s) and click **Download Selected Logs**.

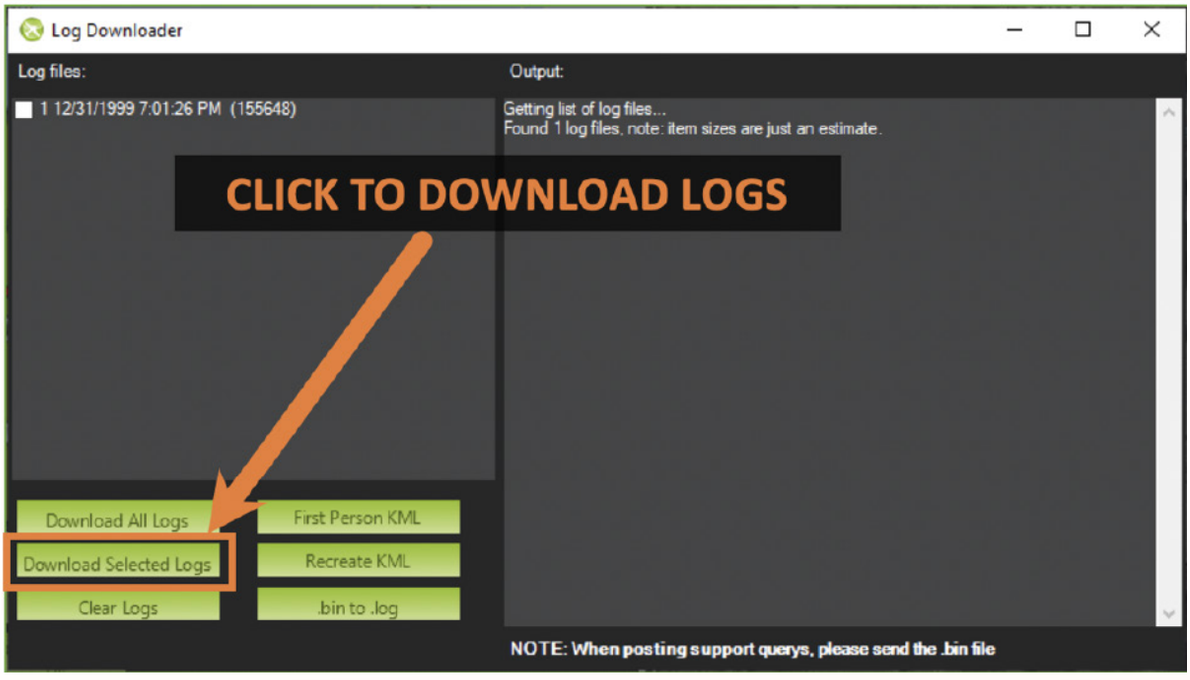


Figure 40: Download Selected Logs

This will download the selected logs to the computer. These logs will have a **.bin** extension and may be large depending on the duration of the flight.

DO NOT CLEAR LOGS! THEY CONTAIN IMPORTANT DATA.

In some cases, and depending on the organizational security policy, it may be necessary to clear the logs. However, the logs must be retained for warranty and service coverage. **Clearing the logs will VOID THE WARRANTY**.

IF YOU MUST CLEAR LOGS, DOWNLOAD THE LOGS FIRST AND RETAIN FOR WARRANTY AND SERVICE PURPOSES.

If position information, such as **LAT/LON**, is sensitive to operational security, Hoverfly can provide a technique to strip position information from the log(s). Refer to the **Technical Support** section on page 79 of this manual to contact Hoverfly's Support Services for details.

SAFETY INFORMATION

LIMITATIONS

PRECISION LAND FAILURE

CRITICAL AIRCRAFT COMMANDS

EMERGENCY CHECKLIST

SYSTEM FAIL-SAFE FEATURES

Limitations

The system will automatically detect if the aircraft is drawing too much power. The aircraft will not climb above the maximum altitude limit once set; the user must land the aircraft and reboot the system to reset the altitude limit.

During operation, the user can view the current wind speed and direction as measured by the aircraft. Wind data is displayed at the bottom of the screen next to the flight time information. The wind data displayed is calculated by an algorithm on board the aircraft which generates an accurate average measurement of the wind the aircraft is experiencing. It should be noted that the wind speed displayed will not account for gusts and sudden changes in wind. The measurement displayed on the GUI is an average but should be used to make decisions about limitations and aircraft performance.

The environmental operating limitations defined in this section must be followed when operating the Spectre UAV. In general, flight operations beyond these environmental limits will result in an automatic, autonomous safety landing when the Spectre detects conditions which exceed the Limits.

Refer to the Specifications tables on pages 6 and 7 of this manual for additional limitations information.

Precision Land Failure

Figure 41:Precision Land Failure Message

If the **Precision Land Failure** message appears on the GUI, it indicates that the aircraft has detected an in-flight ATS failure. The ATS, though not essential for flight, is required for precision landing in the ring. If this message appears, perform the following steps:

1. Use caution and translate the aircraft 25 ft/8 m away from the Tether Kit, people, and obstructions to a clear landing area.
2. Once translated, turn the tether reel switch **OFF** to allow for slack in the tether.
3. Land the aircraft outside the ring using situational awareness to avoid causing any damage or injuries in the process.
4. Once the aircraft lands on the ground, engage the **E-STOP** function to avoid possible damage from the aircraft tipping over on uneven terrain.

IF PRECISION LAND FAILURE APPEARS ON THE GUI, THE AIRCRAFT WILL NOT LAND IN THE RING. THE OPERATOR MUST TRANSLATE THE AIRCRAFT 10-20 FT/3-6 M AWAY FROM THE TETHER KIT, PEOPLE, AND OBSTRUCTIONS. DISABLE THE TETHER REEL TO ALLOW SLACK IN THE TETHER, INITIATE A LAND AND, UPON LANDING ON THE GROUND, INITIATE E-STOP TO PREVENT ANY DAMAGE FROM TIPPING OVER DUE TO UNEVEN LANDING SURFACE.

Critical Aircraft Commands

MINIMUM ALTITUDE: When the aircraft is launched it will ascend to a stabilized hover at 24 ft 7 in/7.5 m and wait for the next command. The aircraft will not descend below minimum altitude until the **LAND** button is pressed.

HOME: This button will reposition the aircraft above the Tether Kit within the proximity of the ground GPS unit (+/- 3 m/10 ft).

HALT

Aircraft Above Minimum Altitude: The **HALT** button overrides the last command and stops the aircraft at its current altitude and position.

Aircraft Below Minimum Altitude: The **HALT** button overrides the last command, keeping the aircraft at its last position and returning it to Minimum Altitude.

LAND: This button initiates an autonomous landing, meaning the aircraft will descend and land in the Landing Ring. The **LAND** command can be utilized at any altitude or position; however, it is recommended that the aircraft is centered above the Tether Kit prior to initiating the **LAND** command. Once the **LAND** command has been activated, the aircraft camera may translate horizontally to reposition itself over the Landing Ring, and the camera and aircraft will not accept further commands until the aircraft lands or until the **HALT** button is pressed.

NOTE: IF THE AIRCRAFT IS NOT RESPONDING TO A LAND COMMAND, IMMEDIATELY REMOVE THE CONTROLLER'S ETHERNET CONNECTION TO INITIATE A LOST COMM FAILSAFE LANDING. WAIT 10 SECONDS (UNLESS LOST COMM DELAY SETTINGS HAVE BEEN EXTENDED, THEN ADD APPROPRIATE NUMBER OF SECONDS). IF THERE IS STILL NO RESPONSE, REMOVE POWER CONNECTION AT THE SOURCE, IF SAFE TO DO SO, TO INITIATE A LOST POWER FAILSAFE LANDING.

E-STOP: This command should only be activated during an emergency to prevent injury of personnel or other catastrophic events. The **E-STOP** command will stop the motors and the aircraft will fall to the ground immediately; this will likely result in damage to the aircraft. To initiate the **E-STOP** command, press the **E-STOP** button. A new window will open instructing the user to tap three times to confirm **E-STOP**.

USING THE E-STOP FUNCTION COULD RESULT IN PERSONAL INJURY, SINCE THE MOTORS WILL IMMEDIATELY CEASE OPERATION AND THE AIRCRAFT WILL FALL TO THE GROUND. IF AT ALL POSSIBLE, CLEAR THE AREA UNDER THE AIRCRAFT OF ANY PERSONNEL TO AVOID INJURY.

EMERGENCY CHECKLIST

NOTE: If On-The-Move (OTM), each Emergency procedure MUST begin with stopping the ground vehicle.

1. **INDICATION**: ANY anomaly observed during the takeoff sequence and/or to prevent injury or damage to personnel or property.
   ABORT TAKEOFF.....**LAND**
   - On GUI, press **LAND**
   - Xbox controller; press **RED B**

2. **INDICATION**: ANY anomaly observed below 24 ft 7 in/7.5 m and/or to prevent injury or damage to personnel or property.
   ABORT LANDING BELOW 24 ft 7 in/7.5 m.....**HALT/REPOSITION/LAND**
   - On GUI, press **HALT**
   - Xbox controller; yellow **Y** or green **A**
   - Allow the aircraft time to climb back to **MINIMUM ALTITUDE** to stabilized hover
     - Reposition the aircraft to center over the Landing Ring
     - Reinitiate the **LAND** command
     - Repeat, as required

3. **INDICATION**: ANY landing sensor anomaly observed during flight.
   PRECISION LAND FAILURE.....**HALT/REPOSITION/LAND**
   - The system will automatically disable Precision Land and the text notification **Precision Land Disabled** will be displayed in red on the GUI
     - Lower the aircraft to minimum hover altitude
     - Translate the aircraft away from the Tether Kit
     - Ensure the aircraft is 25 ft/8 m away from the Tether Kit and from personnel
     - Ensure the aircraft is over **FLAT** and **LEVEL** ground
     - Manually disable the automatic tether reel
     - Wait for wind gusts to subside (if any) and press the **LAND** button
     - Be ready to abort the landing following the **ABORT LANDING** emergency procedures
     - Repeat as necessary
     - E-Stop AFTER the system lands to avoid damage

4. **INDICATION**: Aircraft begins moving in one direction, without being commanded to do so.
   UNCOMMANDED FLYAWAY.....**LAND**
   - On GUI, press **LAND**
   - Xbox controller; press **RED B**
     - After the aircraft begins to return, press **HALT**
     - Use D-pad or GUI to reposition over the Landing Ring
     - Reinitiate **LAND** command
     - Repeat, as required

5. **INDICATION**: The aircraft begins to spin rapidly, uncommanded.
UNCOMMANDED ROTATION/SPIN.....**LAND** and **AREA CLEAR**
   - On GUI, press **LAND**
   - Xbox controller; press **RED B**
     - Visually observe that the rotation has ceased and landing has begun

6. **INDICATION**: Aircraft begins flying in a large, uncommanded circular pattern.
MAGNETOMETER FAILURE/EMI.....**LAND** and **AREA CLEAR**
   - On GUI, press **LAND**
   - Xbox controller; press **RED B**
     - Repeat **HALT** and **LAND** commands, as required
     - Most likely to occur at lower altitudes; recommend flight above minimum altitude (15-30 ft/4.5-9 m, as equipped) for best performance

7. **INDICATION**: Aircraft is unable to climb to a commanded altitude and tether is not reeling out.
TETHER LOCKUP.....**LAND** and **AREA CLEAR**
   - On GUI, press **LAND**
   - Xbox controller; press **RED B**
     - Visually observe that the aircraft is going to land in the Landing Ring
     - Use **ABORT LANDING BELOW 24 ft 7 in/7.5 m**, as needed

8. **INDICATION:** User cannot control aircraft and/or data fails to update on the GUI.
COMMUNICATION FAILURE.....**AREA CLEAR AND PERFORM STEPS BELOW**
   - Unplug/reconnect Ethernet cable that connects to the control tablet or computer
   - Close/reopen the control GUI, then attempt to reconnect to the aircraft
   - If unsuccessful, continue. Otherwise, resume normal operations.
   - Unplug Ethernet cable from control tablet/computer; leave cable unplugged
   - Immediately clear the area and wait for the landing sequence to complete
   - Disconnect power if observed that the aircraft will not land

9. **INDICATION:** Any GUI status indicator is **RED**, or the aircraft is observed to be descending uncommanded.
UNCOMMANDED LANDING.....**STOP GROUND VEHICLE**
   - Observe for anomalies
   - If aircraft is not going to land in the Landing Ring.....**POWER OFF**

10. **INDICATION:** Warning messages appear on GUI screen: GPS Interference/GPS Disabled.
GPS DENIED.....**AIRCRAFT WILL LAND**
   - Confirm that aircraft is landing
   - Ensure area around Tether Kit is free of personnel
   - Confirm aircraft has landed.....**POWER OFF**

IF THE SYSTEM CRASHES, E-STOP IS ACTIVATED, OR THE TETHER IS CUT, DO NOT APPROACH THE SYSTEM UNTIL DISCONNECTING THE POWER SOURCE. HIGH VOLTAGE MAY BE PRESENT UNTIL THE POWER SOURCE IS DISCONNECTED.

System Fail-Safe Features

PRECISION LAND DISABLED: ATS INERTIAL MEASUREMENT UNIT (IMU) FAILURE DETECTED. AIRCRAFT WILL "NO PRECISION" LAND. EXERCISE EXTREME CAUTION IF THIS INDICATION IS SEEN, AS THE AIRCRAFT WILL DESCEND IN PLACE AND WILL NOT LAND IN THE LANDING RING.

CAUTION: *Communication Fail-Safe*: If communication is interrupted with the controller for 60 seconds, or as user defined, the aircraft will Autoland. If communication fails between the Tether Kit and aircraft for 5 seconds, the aircraft will Autoland. Ensure the area is clear.

CAUTION: *Battery Landing Fail-Safe*: If the Tether Kit power is interrupted, or the battery falls below 24.0V, the aircraft will Autoland. Ensure the area is clear. If tether power to the aircraft is interrupted, the aircraft will land using battery power.

INSPECTION AND MAINTENANCE

INSPECTIONS AT EACH SETUP

INSPECTIONS AT INTERVALS

FIELD REPAIRS

Inspections at Each Setup

Inspections are required after each unpacking and setup of the Spectre system. Spectre inspection points include the entire system for physical damage, the propellers, and physical attachment points of the motor booms.

Inspections at Intervals

The tether requires maintenance after 50 hrs. of usage. With the system powered **OFF** and **NO AC** power cord attached, slowly pull out the entire tether from the Tether Kit and visually inspect it for kinks or damage. As the tether is extracted from the Tether Kit, coil it up very carefully and ensure the tether is placed on a clean surface.

The tether can be retracted by turning on the power to the **REEL** on the Tether Kit and gradually feeding in the tether using **REEL** power. **DO NOT LET THE REEL DRAG THE TETHER ON THE GROUND** as foreign object debris (FOD) in the tether reel may occur.

FEED THE TETHER BACK INTO THE REEL BY HAND.

If damage and/or kinks in the tether are discovered, replace the entire tether reel assembly. The tether itself is not replaceable in field locations.

Hoverfly recommends performing the tether inspection, as described above, every 25 hrs. of operation to ensure system longevity and continued performance.

Field Repairs

When instructed by Hoverfly, or because of system messages, field repairs can be made to the Spectre system.

The sub-sections below provide information on replacing the following Field Replaceable Units (FRU):

Tether Kit

- Tether Reel
- Tether Kit Safety Battery (TSB)
- Tether Kit Fuse

Spectre Aircraft

- Propellers
- Safety Landing Battery (SLB)

Tether Kit FRUs

Tether Kit FRU Identification

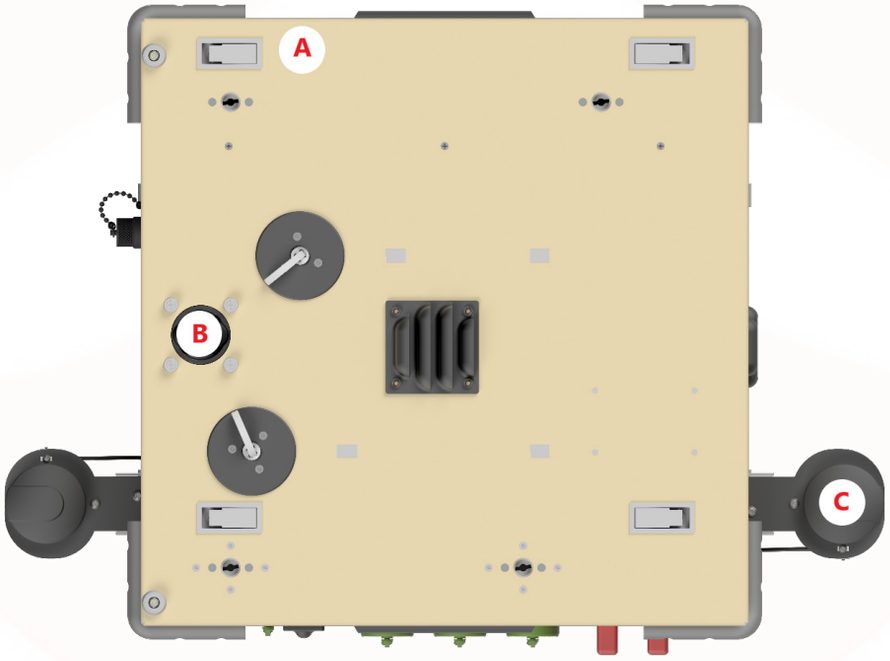


Figure 42: Fasteners on Tether Kit Cover

One Tether Kit FRU is located on the outside of the Tether Kit (Fuse), while the other two are inside (Reel and TSB). To identify the FRUs within the Tether Kit, first remove the Tether Kit cover.

Four latches (**Figure 42, A**) and four captive fasteners (**Figure 42, B**) must be loosened to remove the Tether Kit cover. The fasteners encircle the tether opening, and the twist lock latches are located around the perimeter of the lid.

Do not remove the Tether Kit cover fasteners; simply loosen them to remove the Tether Kit cover. Next, loosen the four latches around the perimeter of the Tether Kit cover and lift the cover to disconnect the power and Ethernet connections.

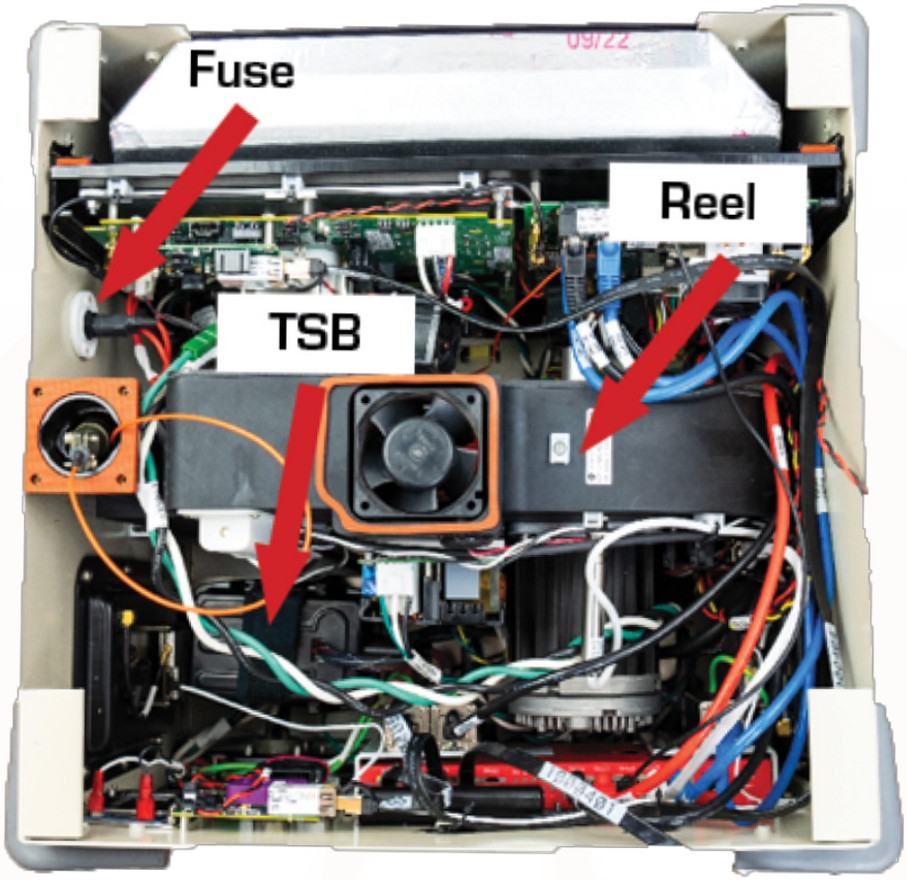


Figure 43: Tether Kit FRUs

After the Tether Kit cover is removed, the Tether Reel and TSB are visible (**Figure 43**). Tether Kit FRU assemblies are designed to be replaced in dry field environments using the tools included with the system. They are designed to be replaced without the use of specialized tools; only a 2.5 mm hex wrench (included) is required.

Pay special attention to the orientation and placement of the cable assemblies inside the Tether Kit which must be disconnected and re-connected when the replacing the FRUs.

Tether Reel Replacement

Replace the Tether Reel when instructed by the maintenance schedule or the Hoverfly support team.

First, make sure there is **NO POWER APPLIED TO THE TETHER KIT. DISCONNECT THE MAIN EXTERNAL POWER CABLE**.

DANGER HIGH VOLTAGE! DISCONNECT SYSTEM POWER.

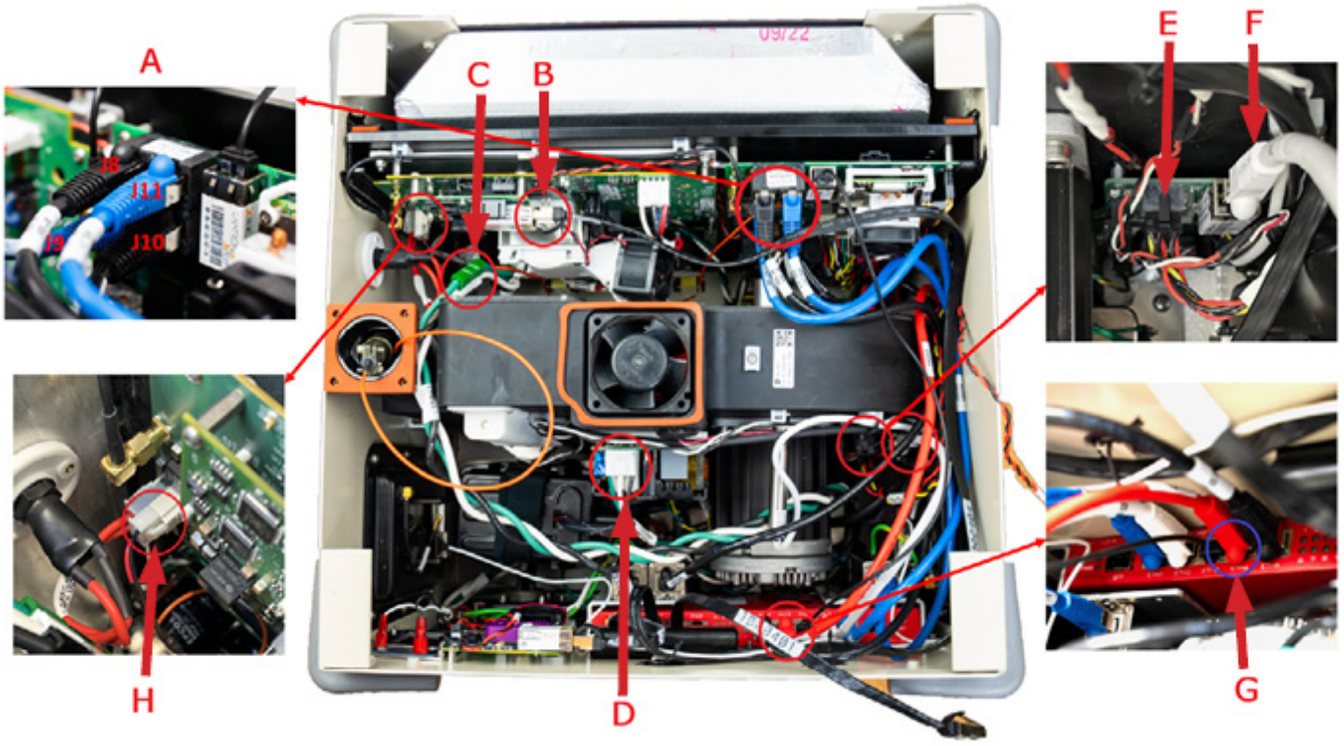


Figure 44: Tether Reel Connections

1. To remove and replace the Tether Reel, there are several electrical connections that must be released before the Tether Reel assembly can be removed. Use caution as some of these connection are **HIGH VOLTAGE**
    - Disconnect the four Ethernet Connectors from the TK Motherboard J8, J9, J10, and J11 (**Figure 44, A**)
    - Disconnect IPS Ethernet (**Figure 44, B**)
    - Disconnect AC Power (**Figure 44, C**)
    - Disconnect 48V supply power (**Figure 44, D**)
    - Disconnect Reel to motherboard (**Figure 44, E**)
    - Disconnect Reel Ethernet (**Figure 44, F**)
    - Disconnect PI router Ethernet (**Figure 44, G**)
    - Disconnect HV connector (**Figure 44, H**)

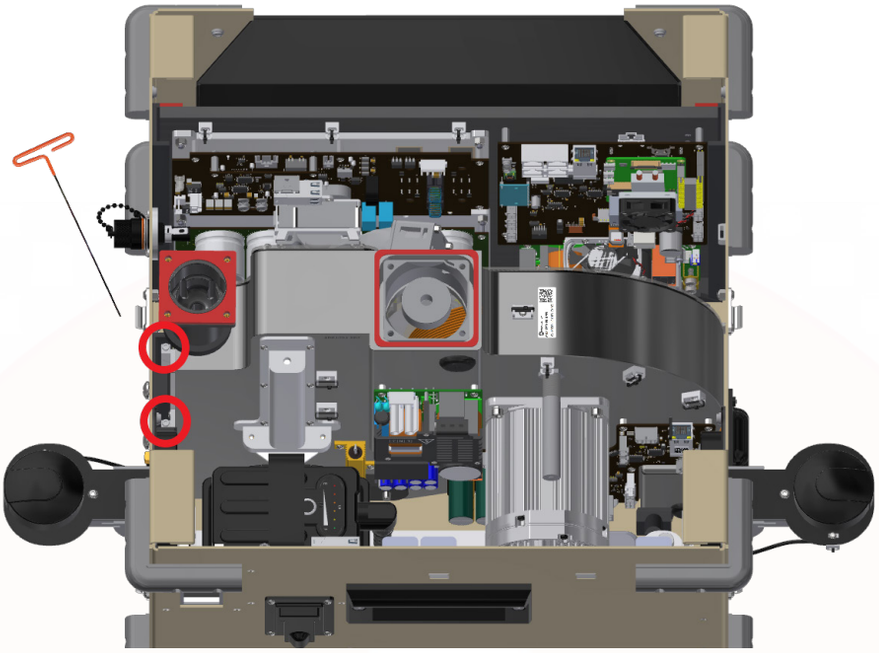


Figure 45: Loosen Tether Reel Fasteners

2. Use the long 2.5 mm hex key (included) to loosen the two Tether Reel fasteners located on the side of the Tether Reel (**Figure 45**).
3. When the fasteners are adequately loosened, the Tether Reel assembly can be removed by **PULLING STRAIGHT UP**.

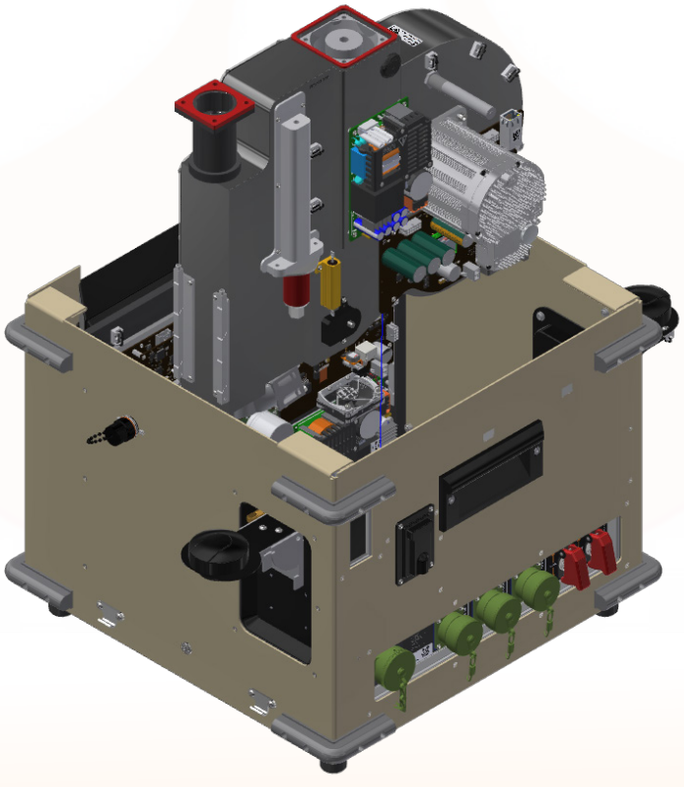


Figure 46: Remove Tether Reel

4. When installing the new Tether Reel, carefully lower the assembly into the Tether Kit, making sure that no wires are pinched or trapped underneath the Tether Reel.
5. Align the drain holes with the drain hole receptacles on the bottom of the Tether Kit.

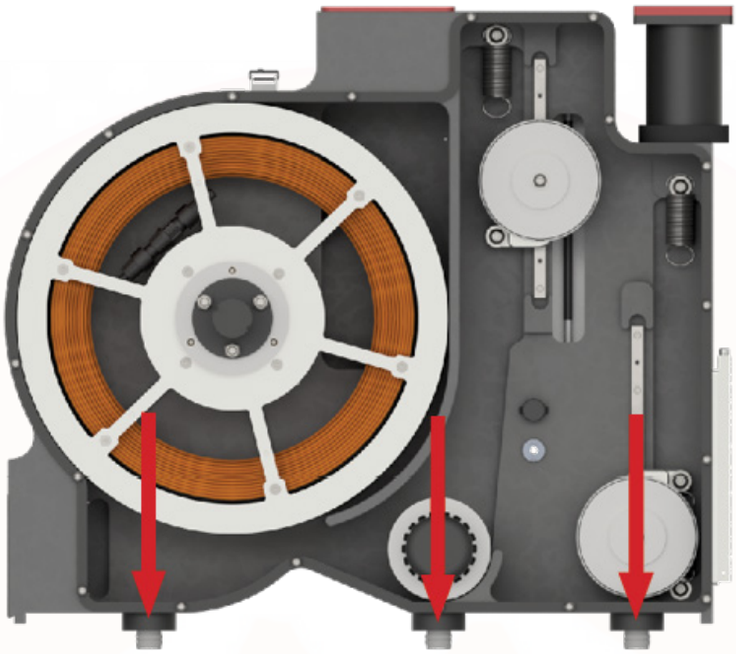


Figure 47: Tether Reel Drain Holes

6. Re-align the Tether Reel fasteners and tighten with the hex key.

Figure 48: 2.5 mm Hex Key

7. Reconnect the control cable.
8. Re-install the four fasteners to the side of the Tether Kit.
9. Reconnect the high voltage connectors.

RECONNECT HIGH VOLTAGE CONNECTORS RED TO RED, BLACK TO BLACK.

Tether Kit Safety Battery (TSB) Replacement

There are two backup-power safety landing batteries in the Spectre TUAS system:

- **Safety Landing Battery (SLB)**: Located in the Spectre aircraft (see **Replacing/Charging the SLB** sections, below)
- **Tether Kit Safety Battery (TSB)**: Located in the Tether Kit

These batteries allow the aircraft to land if input power is lost for any reason and they are also involved in the safety interlock built-in test sequence.

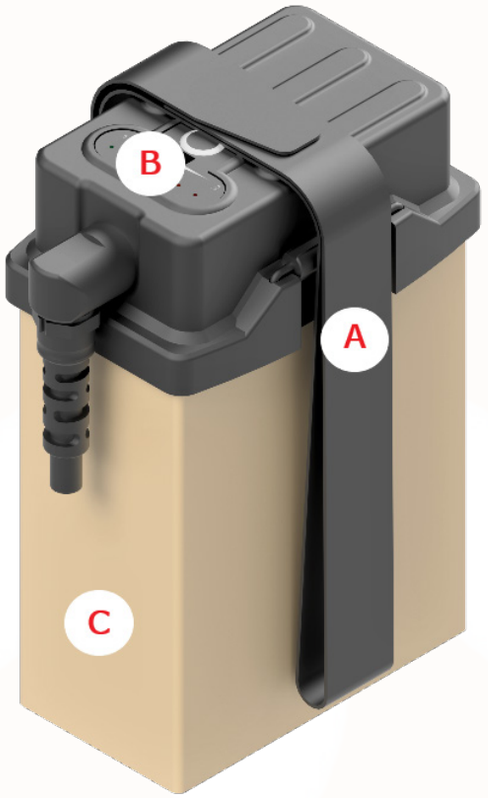


Figure 49: Spectre TSB

NEVER CHARGE OR USE A LIPO BATTERY OR PACK THAT SHOWS ANY DAMAGE OR DISFIGUREMENT OF ANY KIND. SWELLING IS A SIGN OF INTERNAL DAMAGE. ANY BREACH OF PROTECTIVE COVER, WIRING OR PLUGS IS ALSO REASON TO DISCONTINUE USE

Refer to **Appendix A: LiPo Battery Safety Instructions**, for addition safety information.

Follow the steps below to replace the TSB.

1. Remove the Tether Kit lid (**Figure 42**).
2. Loosen the battery strap but do not remove it (**Figure 49, A**).
3. Remove the battery charging cap (**Figure 49, B**).
4. Pull straight up on the battery (**Figure 49, C**) to remove it from the housing.

Figure 50: Remove TSB

5. Slide the new TSB under the battery strap and into the receptacle.
6. Connect the battery charging cap to the new TSB (ensure pins align).
7. Tighten the battery strap.

Charging the TSB

Connect the Tether Kit to an external power source and flip the **CRAFT** power switch **ON** to charge the TSB. Recharging the TSB from internal system power can take up to eight hours depending on ambient temperature and other factors.

Tether Kit Fuse Replacement

Figure 51: Tether Kit Fuse

Follow the steps below to replace the Tether Kit fuse.

1. Disconnect power to the Tether Kit.
2. Unscrew the fuse socket cap located on the side of the Tether Kit.

Figure 52: Tether Kit Fuse Socket Cap

3. Push in and twist the fuse holder counter clockwise (~1/4 turn) to release the fuse.
4. Remove the fuse from fuse holder.

Figure 53: Remove Tether Kit Fuse

5. Insert new fuse (6 A 600 VAC 600 VDC Fuse Cartridge) into the fuse holder and then slide the fuse holder into the fuse socket.
6. Push and twist clockwise to secure the fuse into the socket.
7. Twist the fuse socket cap back on.

Spectre Aircraft Replaceable Assemblies

The following sub-sections describe the following Spectre aircraft FRUs:

- Propellers
- SLB

Propeller Replacement

Figure 54: Spectre Propellers

Four or more propellers are supplied with the Spectre kit. **NOTE THAT THE PROPELLERS ARE ROTATION DIRECTION DEPENDENT!**

PROPELLER REPLACEMENT IS REQUIRED AFTER A MAXIMUM FLIGHT DURATION OF 1,500 HRS.

HANDLE PROPELLERS WITH CARE TO AVOID DAMAGE.

Figure 55: Propeller Screws (8x) and Covers (4x)

1. Use an Allen wrench (included in the Spectre Tool Kit) to remove the washer screws from the top of the propellers (8x), then remove propeller covers (4x) (**Figure 55**).

2. Remove old/damaged propeller(s).
3. Ensure that brass spacers remain on the motor shafts (4x).

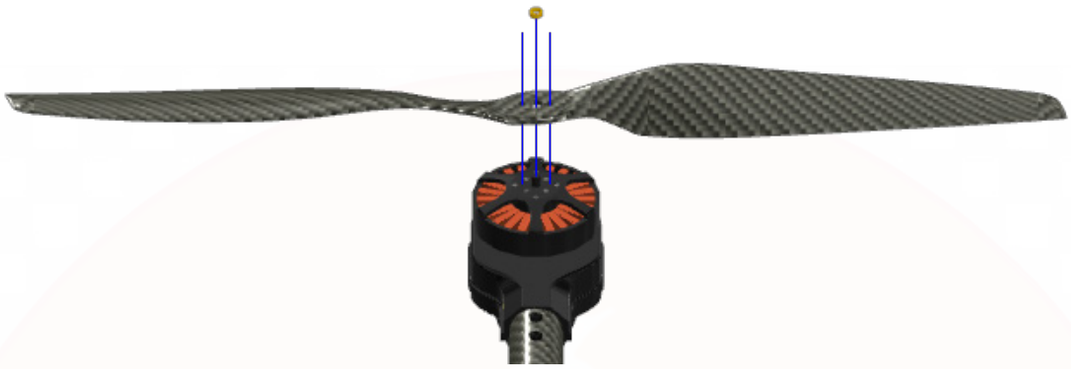


Figure 56: Propeller Brass Spacers

4. Install new propeller(s).

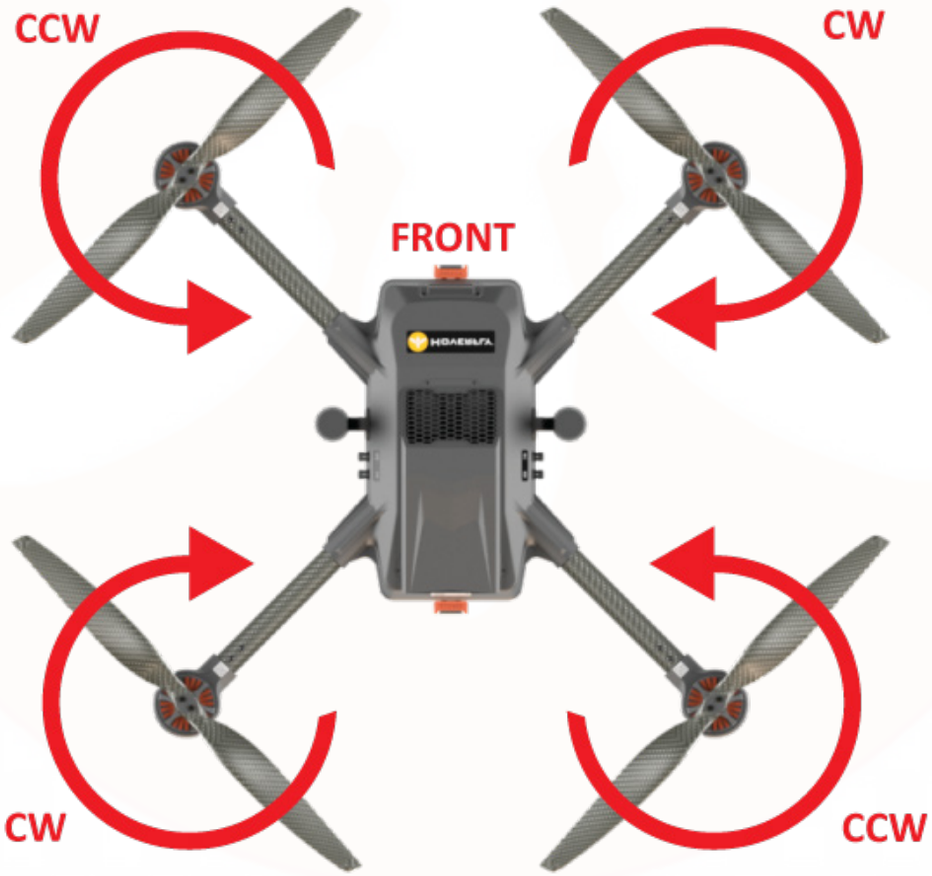


Figure 57: Propeller Rotation Direction

Propellers rotate either **CLOCK-WISE (CW) OR COUNTER CLOCK-WISE (CCW). THEY ARE NOT UNIVERSAL, and CAN ONLY BE INSTALLED IN A SPECIFIC LOCATION** on the Spectre aircraft. Propellers have a leading edge and a trailing edge. To install propellers correctly, first locate the front of the Spectre and then orient the aircraft as shown below.

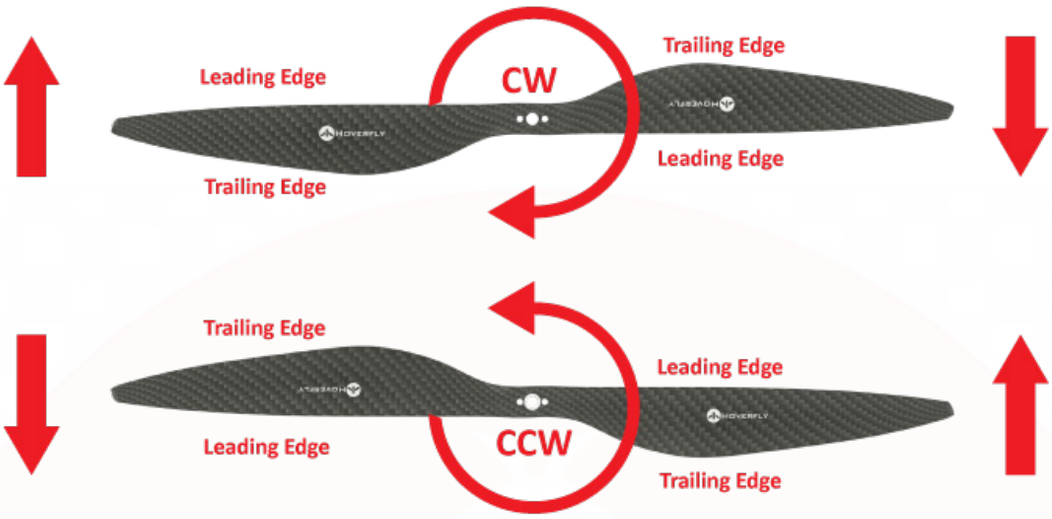


Figure 58: Propeller CW, CCW Shape Reference

INSTALL NEW PROPELLERS WITH THE HOVERFLY LOGO FACING UP!

INSTALL PROPELLERS ONE AT A TIME AND MATCH TYPE CW OR CCW AT EACH POSITION.

Failure to install each propeller in its correct location will result in an immediate crash after the **LAUNCH** command is asserted. Spectre will not fly with propellers installed incorrectly. If the Spectre aircraft immediately flips over when attempting to **LAUNCH**, then propellers are not installed correctly. Refer to the figures, above, for correct installation images and instructions.

5. Replace motor covers/screws and torque all screws (8x) to 8 in-lbs.

Safety Landing Battery (SLB) Replacement

OBSERVE ALL SAFETY REQUIREMENTS REGARDING LIPO BATTERIES. DAMAGED OR PUFFED BATTERIES CAN LEAD TO FIRE AND/OR EXPLOSION AND COULD CAUSE PERSONAL INJURY. DO NOT FLY WITH A DAMAGED BATTERY.

IF AMBIENT TEMPERATURES ARE BELOW 32° F/0° C, PRE-HEAT LIPO SLB TO 50° F/10° C PRIOR TO LAUNCH. LIPO BATTERIES RAPIDLY LOSE CAPACITY BELOW 32° F/0° C. EVEN THOUGH BATTERY VOLTAGE IS READING ABOVE 24.5 V, CAPACITY WILL BE DIMINISHED SIGNIFICANTLY IN COLD TEMPERATURES AND SLB MAY FAIL. IF MAIN OR TETHER POWER IS LOST WHILE SLB IS COMPROMISED, AIRCRAFT WILL LOSE ALL POWER AND FALL TO THE GROUND, CAUSING DAMAGE OR DESTRUCTION OF THE AIRCRAFT. ABOVE 120° F/49° C, SYSTEM MAY AUTO-LAND / SELF-PROTECT..

KEEP A SECOND SLB CHARGED AT ALL TIMES FOR MAXIMUM MISSION READINESS RATE. IMMEDIATELY RECHARGE ANY BATTERY USED FOR A SAFETY LANDING.

Figure 59: Spectre Battery Bay

Replace the SLB after a safety landing using SLB power. If the SLB is discharged and its capacity is less than necessary for a safety landing, the SLB must be replaced or recharged.

Follow the steps below to replace the SLB.

1. Carefully remove the existing the SLB from the Spectre aircraft.
    a. Pinch both sides and pull upward to remove the locking clip (**Figure 59, A**).
    b. Push the release mechanism to eject the SLB from the Spectre battery bay (**Figure 59, B**).
2. Insert a fully charged SLB into the Spectre battery bay.
    a. Ensure the pogo pins are securely connected to the mating receptacle located in the back of the battery bay (**Figure 59, C**).
    b. Insert the locking clip back into place.

USE ONLY HOVERFLY-SUPPLIED BATTERIES.

INSPECTION AND MAINTENANCE

Charging the SLB

If the SLB is not fully charged, the system will not **ARM** or **LAUNCH**. When at the required voltage level, the battery status indicator will turn **GREEN** and **LAUNCH** can then be asserted. If the SLB is not at the specified voltage, charge or replace it.

Recharging the SLB using an external charger requires several hours. To start, complete, or restart a mission after a safety landing, or when the SLB is otherwise discharged, immediately replace the SLB using a pre-charged, spare SLB. A spare SLB is included with the Spectre system.

Figure 61: SKYRC Charger/Discharger and Hoverfly Battery Pack

To charge the SLB:

1. Place the SLB into the charger receptacle, ensuring that the pogo pins align.
2. Press the **ENTER/Start** button.
3. Remove battery and turn off charger once the battery is fully charged to **25.2V**.

Testing the SLB

This section describes how to perform milliohm (mΩ) testing on the SLB using a SKYRC charger/discharger.

***NOTE*: Ensure battery is fully charged to 25.2V prior to testing.**

1. Insert the SLB into the charger receptacle, ensuring that the pogo pins align (**Figure 61, D**).
2. The SKYRC charger/discharger will power on and the message **LiPo BALANCE CHG** will be appear on the display screen. Press the **BATT/PROG/Stop** button (**Figure 61, A**).
3. The **BATT/PROGRAM** screen with sub-menu will display. Press the **DEC./Status** button until the **BATT RESISTANCE** sub-menu appears (**Figure 61, B**).
4. Press the **ENTER/Start** button (**Figure 61, C**). The mΩ reading for each battery cell is displayed.
5. Verify the internal resistance of each cell.

PASS CRITERIA:

- All battery cells read at or below **10 mΩ**
- Add all readings together and ensure the sum does not exceed **59 mΩ**

Part Numbers and Tools

Spare/replacement assemblies, sub-assemblies, and consumables can be obtained under warranty conditions, under contract terms, or by direct purchase from Hoverfly. Refer to the **Technical Support** section on page 79 of this manual for more information.

Have the Spectre serial number or contract number ready. The serial number will be clearly visible on the system or FRU and will resemble the image below.

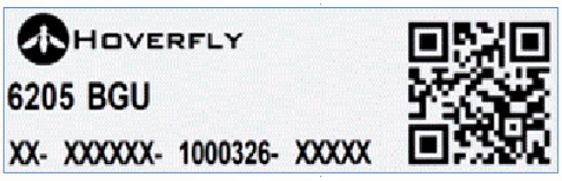


Figure 62: Serial Number Decal

The system comes with the basic tools necessary to replace the FRUs. The following tools are provided in the Spectre aircraft transit case. Keep these tools available and with the system if deployed away from the transit cases to make field repairs.

Table 5: Spectre TUAS Tools List

Tool	Use	SN/PN	Manufacturer	QTY
iFixit Mako Driver Kit - 64 Bit	Aids in various maintenance tasks for the tethered drone system	IF145-299-4	COTS	1
Hex Keys - 2.5 mm	Tether Reel screws	64925	COTS	1

TROUBLESHOOTING

TROUBLESHOOTING

There are several common issues which may be experienced when operating the Spectre aircraft. This section is designed to help sort through some of those issues. Follow the procedures listed below if any of these issues are encountered.

Aircraft Does Not Power On

- Check tether connector and tether for damage while system is powered off
- Check ground power supply, cables, and connections
- Reboot the system

Aircraft Will Not Connect

- Check Ethernet connection
- Ensure the Ethernet cable is plugged into the **Internal** port on the Tether Kit

No Video (EO/IR Gimbal Installed)

- Ensure the aircraft and EO/IR gimbal are powered
- Ensure lens cap removed and lens free of debris
- Ensure the system has been powered on for at least five minutes
- Ensure to click **Connect** on the GUI
- In the GUI **Settings/Network** tab, ensure the following are set:

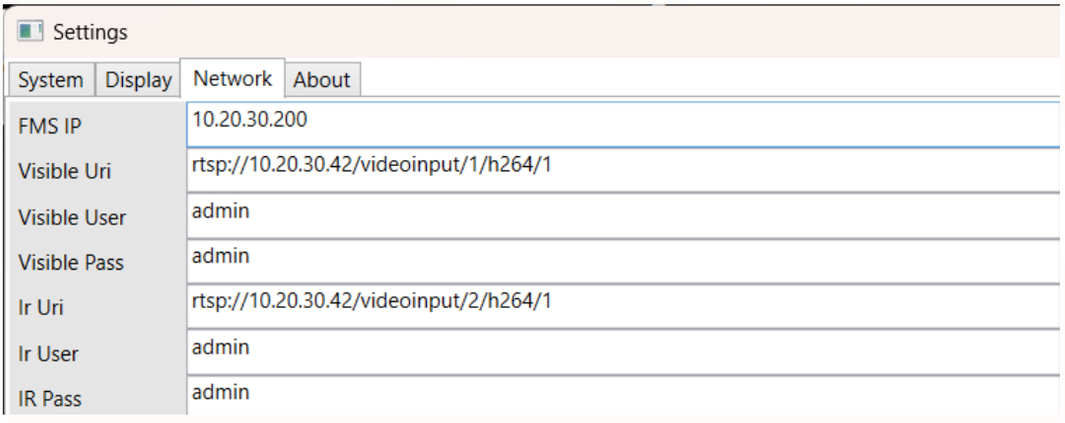


Figure 63: Network Tab Settings

Aircraft Will Not Arm

- Ensure the aircraft is in the **Ready to Arm** state
- Open **Settings** menu and turn on **Show Status Msg**
- Identify any error messages during **Arm** process
- Reboot the system

Aircraft Will Not Launch

- Check GPS signal and number of satellites
- Check battery voltage
- Check Ethernet connection
- In the GUI, check **Setting/Display** and enable **System Status Messages**
- Reboot the system

Aircraft Lands UnCommanded

- Check GPS signal and number of satellites
- Check backup battery voltage
- Check Ethernet connection
- Check power connection
- Check power supply

The system will land in the case of excessively high vibrations:

- Ensure all payloads are secure
- Ensure booms are not loosely fastened
- Ensure no loose hardware on board the aircraft

TECHNICAL SUPPORT

TECHNICAL SUPPORT

The Hoverfly support site contains valuable articles and "how-to" videos that cover a variety is topics. Answers to most questions and solutions to most issues can be found by browsing or searching our detailed support site. Please register for access at:

- www.hoverflytech.com/registration

To access Hoverfly's Technical Support site, navigate to:

- www.hoverflytech.com/techsupport

For further assistance, use the link below to submit a Technical Support Ticket. A Hoverfly representative will contact you after submitting the ticket. If the support needs are urgent, call Hoverfly at **(833) HVERFLY (483-7359)** after submitting ticket.

Support ticket link:

- www.hoverflytech.com/ticket

Or scan QR code to be taken directly to the support ticket:

Figure 64: QR Code

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APPENDIX A:
LIPO BATTERY SAFETY

APPENDIX A

Lithium Polymer (LiPo) batteries store a remarkable amount of energy, making them a powerful energy source for various applications. However, it's crucial to handle them with care to prevent accidents and ensure your safety. This guide provides essential instructions for the safe handling, charging, storage, and disposal of LiPo batteries.

CHARGING & DISCHARGING

- **Never Leave Unattended**: Never leave a LiPo battery unattended during charging or discharging. Monitor the process at all times.
- **Correct Charger Settings**: Ensure your LiPo charger settings match the battery's voltage (cell count) and current settings.
- **Fireproof Location**: Always charge and discharge LiPo batteries in a fireproof location, such as a metal container, ceramic tile, or a bucket of sand.
- **Fire Extinguisher**: Have a fire extinguisher on hand when charging LiPo batteries.
- **Safe Charging Current**: Avoid charging at currents greater than the battery's "1C" rating (capacity). For example, a 1300mAh battery should not be charged at more than 1.3A.
- **Prevent Overheating**: LiPo cells should not exceed 140° F (60° C) during charge or discharge. Overheating can damage cells and potentially lead to fires.

STORAGE

- **Optimal Storage Level**: For long-term storage, store LiPo batteries at around 50-60% of their capacity (3.8V/cell).
- **Temperature Range**: Store batteries in a cool area between 40-80° F (4.4-26.7° C). Temperatures exceeding 170° F (76.7° C) for over an hour may damage the battery.

DISPOSAL

- **Cool Before Disposal**: Allow LiPo batteries to cool before disposal.
- **Safe Discharge**: Place the battery in a fireproof container. Connect it to a LiPo discharger set to a C/10 value (e.g., 130mA for a 1300mAh battery) until the voltage reaches 0 V per cell.
- **Dispose of Safely**: Dispose of the discharged battery in regular trash.

MONITORING BATTERY HEALTH

- **Understanding Degradation**: Over time, LiPo batteries degrade, reducing their capacity.
- **Checking Battery Health**: Use a LiPo charger with discharge capabilities. Discharge the battery to the minimum safe voltage (3.2V per cell). Recharge it and note the milliamps (mA) put back; this should be close to the battery's rated capacity.
- **Regular Assessment**: Repeat monthly. If the mA returned drops 10% below the rated capacity, discontinue using the battery.

CONCLUSION

Safety is paramount when dealing with LiPo batteries. Adhering to these guidelines will ensure your safety, prolong battery life, and prevent accidents. Share this information with others using LiPo batteries to promote safe practices.

For any further information, refer to the manufacturer's recommendations and guidelines.

APPENDIX B:
CAMERA PAYLOAD INSTALLATION

APPENDIX B

ENSURE ETHERNET CABLE IS CONNECTED TO THE INTERNAL PORT ON THE CONNECTOR PANEL..

ONLY HOVERFLY-AUTHORIZED PAYLOADS MAY BE INSTALLED OR FLOWN ON THE SYSTEM. ANY DEVIATIONS WILL VOID THE WARRANTY.

Follow the steps below to install the EO/IR camera payload.

NOTE: EO/IR payloads must be installed IN DRY CONDITIONS ONLY.

Figure 65: Spectre Payload Bay

1. Pinch both sides and pull upward to remove the locking clip. (**Figure 65, A**)
2. Slide the camera payload into the payload bay area. Ensure that it "click" locks into place and that the pogo pins (**Figure 66**) are securely connected to the pogo pin mating receptacle located in the back of the payload bay (**Figure 65, C**).
3. Insert the locking clip back into place.

Figure 66: Camera Payload Pogo Pin Connection

Figure 67: Spectre with Camera Payload Installed - Front View

4. To remove that camera payload, push the release button (**Figure 65, B**) and then slide the camera out of the payload bay.


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