HOVERFLY

LIVESKY™
TETHER-POWERED UAV

Operations & Maintenance (O&M) Manual

LSP-6205

Version 2.3

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Revision History

Table 1. Document Revision History

Version Number	Date	Author/Owner	Description of Change
1.0	11/13/2017	C. Tate, Chief Pilot	Baseline Version 6204
1.1o	06/08/2019	S. Quigley, Chief Engineer	Updated to 6205 Configuration
1.1w	PENDING	R. Topping	Interim Release
2.0	11/15/2019	Alexander Perez	SkyBox revision; 6205 configuration updates
2.2	2/13/20	Michael Miranda	Including Troubleshooting Information
2.3	5/8/2020	Michael Miranda	Minor edits

THIS DOCUMENT IS NOT A SUBSTITUTE FOR TRAINING

DO NOT OPERATE THE LIVESKY SYSTEM WITHOUT 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 IN THIS DOCUMENT AND
OBSERVE AND OBEY ALL SYSTEM MESSAGES
THAT APPEAR ON THE CONTROLLER

VISUALY INSPECT ALL EQUIPMENT PRIOR TO FLIGHT, AND DO NOT OPERATE IF DAMAGE IS VISIBLE TO AIR VEHICLE, THE PROPELLERS, THE TETHER, OR ANY PART OF THE EQUIPMENT

DO NOT OPERATE WITHOUT CORDON AREA

DO NOT OPERATE OVER PERSONNEL AND DO NOT OPERATE OVER CRITICAL INFRASTRUCTURE

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

DO NOT MODIFY THE CONFIGURATION OF THE SYSTEM, EQUIPMENT, PAYLOADS, OR SOFTWARE

DO NOT OPERATE OUTSIDE OF SPECIFIED ENVIRONMENTAL CONDITIONS INCLUDING WINDS, HAIL, OR ICING CONDITIONS

DO NOT OPERATE IF LIGHTNING IS PRESENT WITHIN 10 MILES OF EQUIPMENT POSITION

DO NOT OPERATE IN THE PRESENCE OF RADAR EMISSIONS

Reference Names: LiveSky System Configuration Items

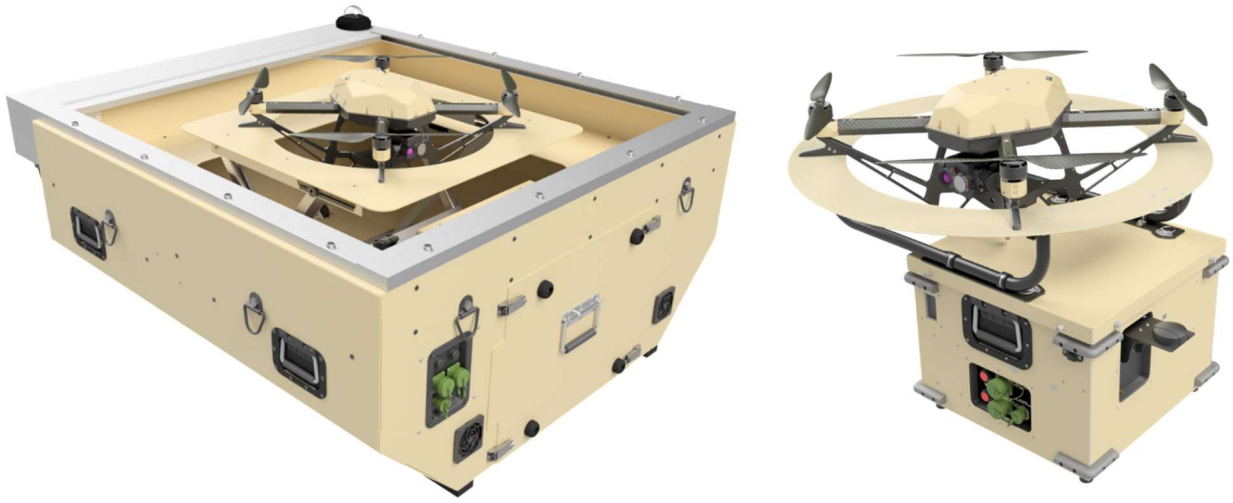

Figure 1. LiveSky Configuration Items Reference Images

Table 2. Dismounted Configuration Item Description

System Configuration Item	P/N Designation	MFG	Operators and Maintenance Document Source
LiveSky Dismounted System	*LSP-6205-EOIR30*		*This Document*
A. Air Vehicle	*LVS-6205*	*Hoverfly*	*This Document*
B. Tether Kit	*LVS-6205-TK*	*Hoverfly*	*This Document*
C. EO/IR Payload	*LVS-62-EOIR30*	*Hoverfly*	*This Document*
D. Controller	*HF-TBC*	*Panasonic*	*This Document*
E. Embedded Software	*HF-FMS*	*Hoverfly*	*Document: HF-FMS*
F. Field Replaceable Unit (FRU) Kit	*LSP-6205-FRU*	*Hoverfly*	*Document: MM-LSP-6205-FRU*

Table 3. Options – Optional Dismounted Configuration Items

Option Configuration Item	Part Number	MFG	Operators and Maintenance Document Source
Mobility Option:	*LVS-OTM-01*	*Hoverfly*	*Separate Document: OMHF-OTM-01*
Software Option:			
A. Hoverfly Software Development Kit (SDK)	*HF-SDI-API*	*Hoverfly*	*Separate Document: SMHF-SDI/API-19C*
Payload Options:			
A. WaveRelay MANET S/C/L Band Payload	*LVS-WRMPU-X*	*Hoverfly*	*Separate Document*
B. TrellisWare TW-850 Power Deck	*LVS-PM-TW850*	*Hoverfly*	*Separate Document*
C. Silvus SC4200 Power Deck	*LVS-PM-SC4200*	*Hoverfly*	*Separate Document*
D. Upiquity UniFi AP WIFI Router	*LVS-UniFi-AP*	*Ubiquity*	*Separate Document*

Referenced Documents

Table 4. U.S. DoD Referenced Documents

Document Name	Document Number and/or URL	Issuance Date
USA DEVCOM Airworthiness Approval	*<Document Location and/or URL>*	*<MM/DD/YYYY>*
USA Cyber Assessment	*<Document Location and/or URL>*	*<MM/DD/YYYY>*
USA JVAB Assessment	*<Document Location and/or URL>*	*<MM/DD/YYYY>*
USA ATEC Approval	*<Document Location and/or URL>*	*<MM/DD/YYYY>*
DOD Exception to Policy (ETP)	*<Document Location and/or URL>*	*<MM/DD/YYYY>*
USA Exception to Policy (ETP)	*<Document Location and/or URL>*	*<MM/DD/YYYY>*
SPECIFIC User ETP	*<Document Location and/or URL>*	*<MM/DD/YYYY>*

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1. Introduction

This Operations and Maintenance Manual (OM) covers the LiveSky Tether-Powered Unmanned Aerial System (TUAS) **Dismounted System** and **SkyBox** configuration. The LiveSky **Dismounted System** is for use in fixed position and provides a 200-foot capability for reconnaissance, communications, and other tactical missions. The LiveSky System includes the Hoverfly LVS-EO/IR payload. There are a variety of other payload options. The **SkyBox** is for use in mobile or fixed position and provides a 200-foot capability for reconnaissance, communications, and other tactical missions.

Some payloads may be flown simultaneously with the LVS-EO/IR payload, provided they conform to maximum payloads gross weight limitations in the Section called "Payloads."

This OM is organized to provide sections on **System Description, Operating Procedures, and Maintenance Instructions for the LiveSky Dismounted System and SkyBox**.

This OM is APPLICABLE ONLY TO LiveSky TUAS controlled by a Hoverfly supplied touch-screen controller using the Microsoft Windows operating system. Other control methods, including control over local or remote networks, including beyond visual line of site (BVLOS) control, are available. SEE SEPARATE DOCUMENTATION on Hoverfly Software Development Kit for remote control or network applications.

1.1 System Description

The LiveSky TUAS consists of an air vehicle (the LiveSky), one or more payloads, the Automatic Tether Kit (TK), and a controller.

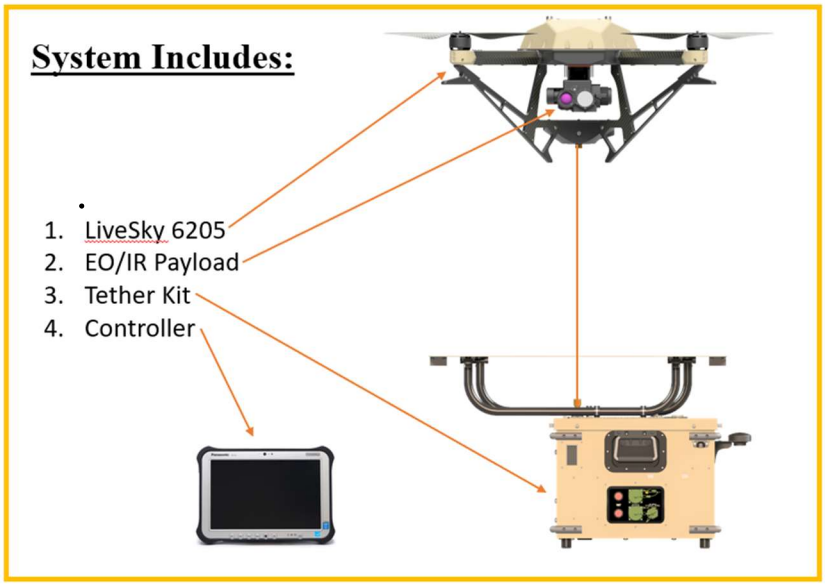


Figure 2. LiveSky Dismounted System Configuration

The Dismounted configuration of the LiveSky System is man-portable, rapidly deployable, simple to operate, and tactically repositionable. The LiveSky TUAS is capable of unattended remote operation and remote network control. Advanced features include GPS-denied operations and the ability to provide dual-stream day/night imagery over networks, while simultaneously providing airborne communications relays and other functions with certain tactical payloads.

The SkyBox allows for continuous flight of the aircraft as well as a safe means of landing and storing the aircraft. Figure 3 provides a visual of the Ground Station. The SkyBox contains a motherboard, tether reel, backup battery, and network router. The SkyBox motherboard contains the flight

management system (FMS), which governs the commands being sent to the craft, and a high voltage DC power supply. The tether reel is a system which is designed to maintain a constant tension on the aircraft with the tether attached. The tether is used as the command and control link to the aircraft as well as the power source for flight. The tether reel is attached to backup battery in the event of a power loss the tether will continue to maintain a constant tension on the craft which will allow the aircraft ATS system to perform a precision landing. Finally, the router in the system allows all the components to be connected over IP. This allows for monitoring and communication between all system components. The SkyBox works as a stationary or mobile platform for 200’ aerial surveillance or radio transmission. The SkyBox enclosure is comprised of a scissor lift, a roll top shutter, and two cameras for observing the aircraft.

1.2 System Functions

This section provides an overview of the major functions of the LiveSky System for persistent intelligence, surveillance and reconnaissance (ISR), force-protection, and communications relay missions. Other functions can be integrated in Hoverfly OpenFly payload interface as required.

The OpenFly plug-in modular payload hot shoe interface to LiveSky and BigSky will accept an EO/IR dual camera payload, or a Persistent Systems WaveRelay embedded-module radio or other approved payloads. Contact us for payload compatibility. Special and new payloads can be integrated using Hoverfly's Interface Control Document (ICD) for the hot-shoe payload interface.

In certain cases, the LiveSky System can carry both an EO/IR payload AND a light-weight tactical radio like a TrellisWare TW-850.

These primary functions and their implementations are summarized below.

Table 5. Functional Implementation Overview

Function	Implementation
ISR	*EO/IR Payload with 120X Zoom (10X optical) 1080p HD Visible Camera and Co-Boresighted 640x512 8X Zoom Thermal Imager with 30Hz Update*
Comms Relay	*Persistent Systems WaveRelay Embedded Module (either S, L, or C bands)*
ISR and Comms Relay	TrellisWare TW-850/870/9XX TSM/TSMX Radio or Silvus 4200 StreamCaster plus: EO/IR Payload with 120X Zoom (10X optical) 1080p HD Visible Camera and Co-Boresighted 640x512 8X Zoom Thermal Imager with 30Hz Rate

The LiveSky System relies on a ground power supply (portable or fixed) and its persistent hard-wired connections. The LiveSky TUAS **DOES NOT USE** RF signals for command and control or to receive or deliver imagery from the LiveSky EO/IR dual camera payload.

Command and control and sensor data are transmitted over a secure tether network up and down the tether between the LiveSky air vehicle and the Automatic Tether Kit (TK). This Ethernet compatible data network from the air vehicle terminates at the TK or the attached wired Controller.

1.2.1 System Dependency

In order to provide its functions, the LiveSky System and its installation or environment must meet the five (5) major requirements as shown in the Table below.

Table 6. Dependency, Requirements, and Impact of Dependency

Type of Dependency	Requirement	Impact (If Dependenacy Fails)
LiveSky Dismounted System	*Continuous Conditions for Operation*	*System Response*
A. Source of Continuous Power from Grid/Mains, Generator Set, or Power Inverter on Vehicle / Vessel	*120VAC, 15A, 2,000Watts 50/60 Hz*	*Will not arm if landed and will land if flying using power from Safety Landing Battery; will require Safety Landing battery swap or re-charge*
B. Ethernet Connection *C. System Health and Safety* *D. Environmental*	*Hardwired Ethernet Connection to a Controller with Hoverfly Software (See Advanced Mode Dependency)* *Pass all Built-in-Test, Interlock, and Health Monitoring Conditions* *Operation Within Environmental Constraints, Wind, Motion, Lightening – SEE LIMITATIONS*	*Will Not Arm, Will Not Launch, or if in Flight,* *Will Land on Normal Power; No Safety Landing Battery Swap Required*
E. Safety Landing Battery (SLB) State of Charge	*Safety Landing Batteries (in LiveSky and Tether Kit) Must Be Charged*	*Will Not Arm, Will Not Launch, or if in Flight, Will Land; May Require Battery Swap*
F. Spare Safety Landing Battery Readiness Level	*Spare SLB Must Remain Charged*	*Mission Readiness Impacted by 4 hours*

If any of the six requirements above (A-F) are not satisfied, the impacts are shown in the column marked “System Response” in the above Table.

The LiveSky will LAND if at ANYTIME DURING OPERATION, built-in-test fails, or data monitoring software identifies an exceedance in monitored parameters.

Figure 3. LiveSky Dismounted System - Landed

1.3 Physical Description

The TUAS consists of the LiveSky, a TK with removable Landing Ring, and a wired controller that connects using an Ethernet cable to a port on the TK. Power is plugged into the TK from an external source.

The Tether Kit contains an automatic tether reel assembly, power conversion and interface electronics, a network router, and hosts the software (the Flight Management System) that provides for autonomous operation.

The wired controller running Windows, hosts the Hoverfly's executable software that generates the operators Graphical User Interface (GUI).

The wired controller can also be a touch screen Windows compatible computer, like a ToughBook/Pad, or other user supplied computer running Windows and Hoverfly's executable software.

Control functions can also be extended over the Ethernet interface to other, remote host control software. To remotely control the LiveSky System from other processing environments or remotely located computers requires using the Optional Hoverfly Software Development Kit (SDK).

Android Tactical Assault Kit (ATAK / TAK) compatibility of the Controller and the Hoverfly software is addressed in a separate document. If TAK is required, please contact Hoverfly Support Services at +1 407-985-4500 Extension 6205.

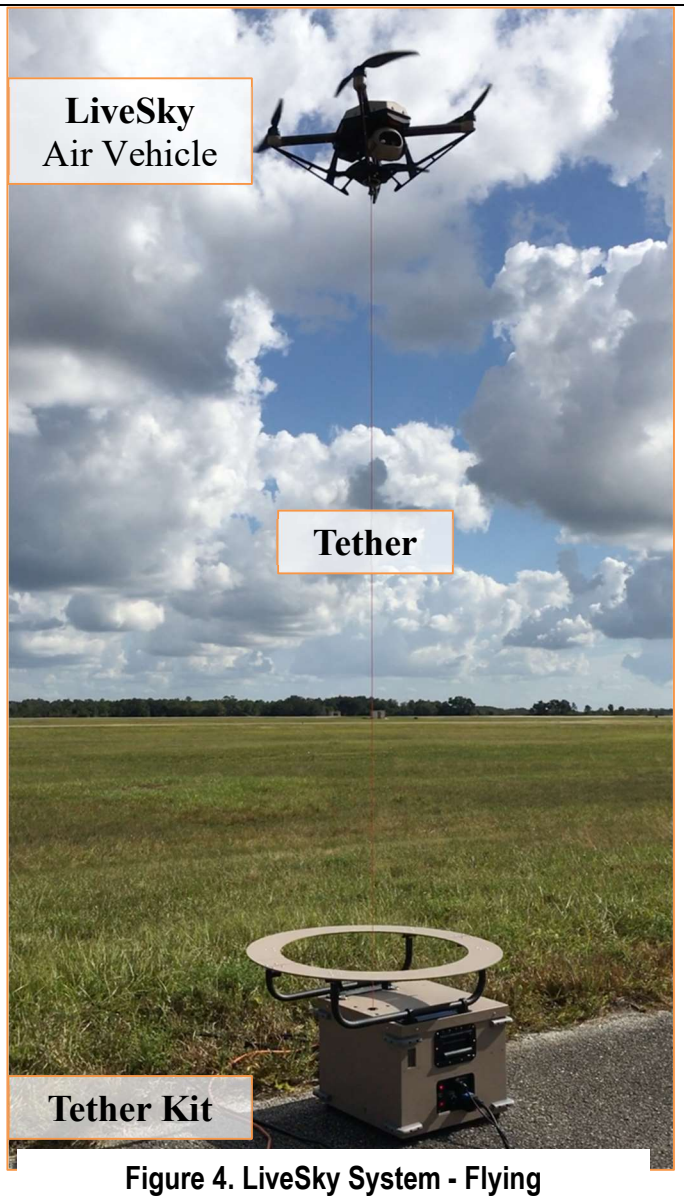


Figure 4. LiveSky System - Flying

Figure 5. Typical System Controller

2. Operation Procedures

This Section defines the sequence and procedures for operating the LiveSky System. In each subsection of the operations sequence there are SAFETY WARNINGS that are CRITICAL TO SAFE OPERATION. The format for those messages is shown immediately below.

EXAMPLE CRITICAL SAFETY WARNING SYMBOL AND TEXT

Failure to follow the Operation Procedures in this Section and the CRITICAL SAFETY WARNINGS IN ANY SECTION OF THIS OM MAY RESULT IN DAMAGE TO PROPERTY, OR **INJURY TO HUMANS, INCLUDING SERIOUS INJURY INCLUDING THE POTENTIAL LOSS OF LIFE**.

Operations Sequence Overview

There are four (4) distinct sequences of operations when a LiveSky System is deployed. These are listed below and described in the detailed sections that follow.

1. *Unpack, Install Payload, and Setup in Clear Overhead Conditions*
2. *Flight Operations*
3. *Inspection and Maintenance Activities*
4. *Disconnections and Pack-in*

Understanding the detailed procedures for these Sequences is **critical to achieving the operational goals and objectives** in deploying the LiveSky System.

2.1 Unpack, Payload Installation, and Setup

Identify the two (2) transit cases marked Hoverfly LiveSky LSP-6205 and LiveSky LVS-TK and pack-out / remove the LiveSky 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 MAKE ANY POWER CONNECTIONS DURING SETUP. ALL SYSTEM POWER CONNECTIONS ARE MADE LATER

1. *Remove the Tether Kit (LVS-TK) from its transit case and place it on the ground where there is a clear unobstructed view of the sky.*
2. *Remove the LiveSky (LSP-6205) air vehicle from the LiveSky transit case and place it upside down on the top of the empty Tether Kit transit case as a firm base so the payload can be installed.*

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

3. *Remove the EO/IR payload from the LiveSky transit case and install it into the LiveSky payload bay (hot shoe payload adapter) per the procedure that follows.*

SkyBox operation is very similar to the operation of a Dismounted LiveSky system. The LiveSky and Tether Kit are the same as in a dismounted unit.

The operator must ensure all 8 tow-straps are secured between the SkyBox and the bed of the truck or mounting platform in a stationary position. This is the proper method of operation in an on-the-move scenario.

FAILING TO PROPERLY SECURE SKYBOX TO MOVING VEHICLE COULD RESULT IN DAMAGE OR INJURY

To operate the SkyBox the operator must connect the power and ethernet cable to the corresponding connections.

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

Figure 6. Payload Hot Shoe Tab Slot Reference

a. *While the LiveSky is upside down, place the payload into the area of the of the hot shoe payload adapter.*

b. *Start by placing the payload at a low angle in the payload bay while tilting the payload slightly forward, and then aligning the tabs on the rear portion of the payload towards the Payload Tab Slots that are shown above. A sequence of images is shown in Figure 7.*

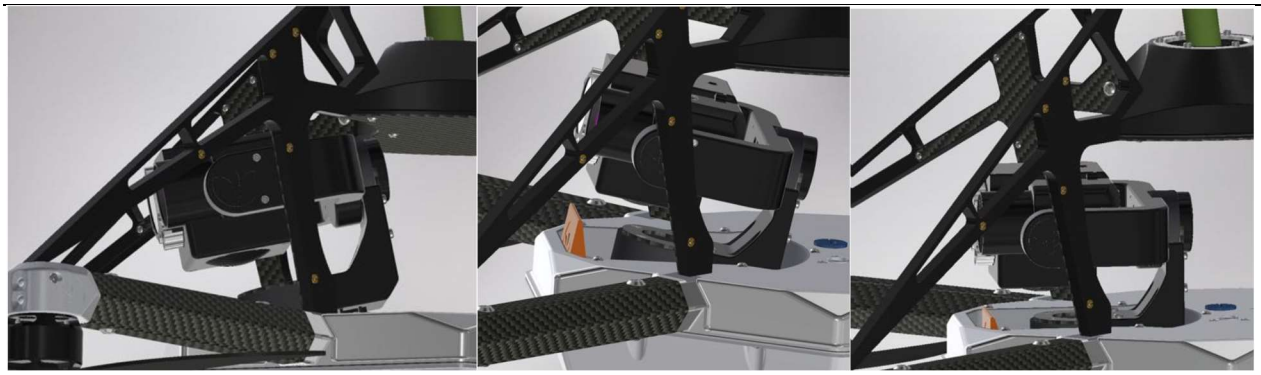


Figure 7. Payload Insertion Reference Images

c. *Rotate the front of the payload down to contact the push-pin electrical connections in the payload bay and apply pressure until the payload attachment lever latches as shown in Figure 7. The correct exposure for the payload attachment lever is shown in Figure 8. The payload attachment levers are red or orange in color. The payload must be secure both at the rear tabs and in the front attachment lever to be functional and safe to operate.*

Figure 8. Correctly Inserted Payload Attachment Lever Exposure

4. *Remove the Landing Ring from the LiveSky transit case and unfold the ring and rotate the Landing Ring bracket legs into vertical position perpendicular to the unfolded ring.*
    a. *For SkyBox: leave Landing Ring inside of transit case*

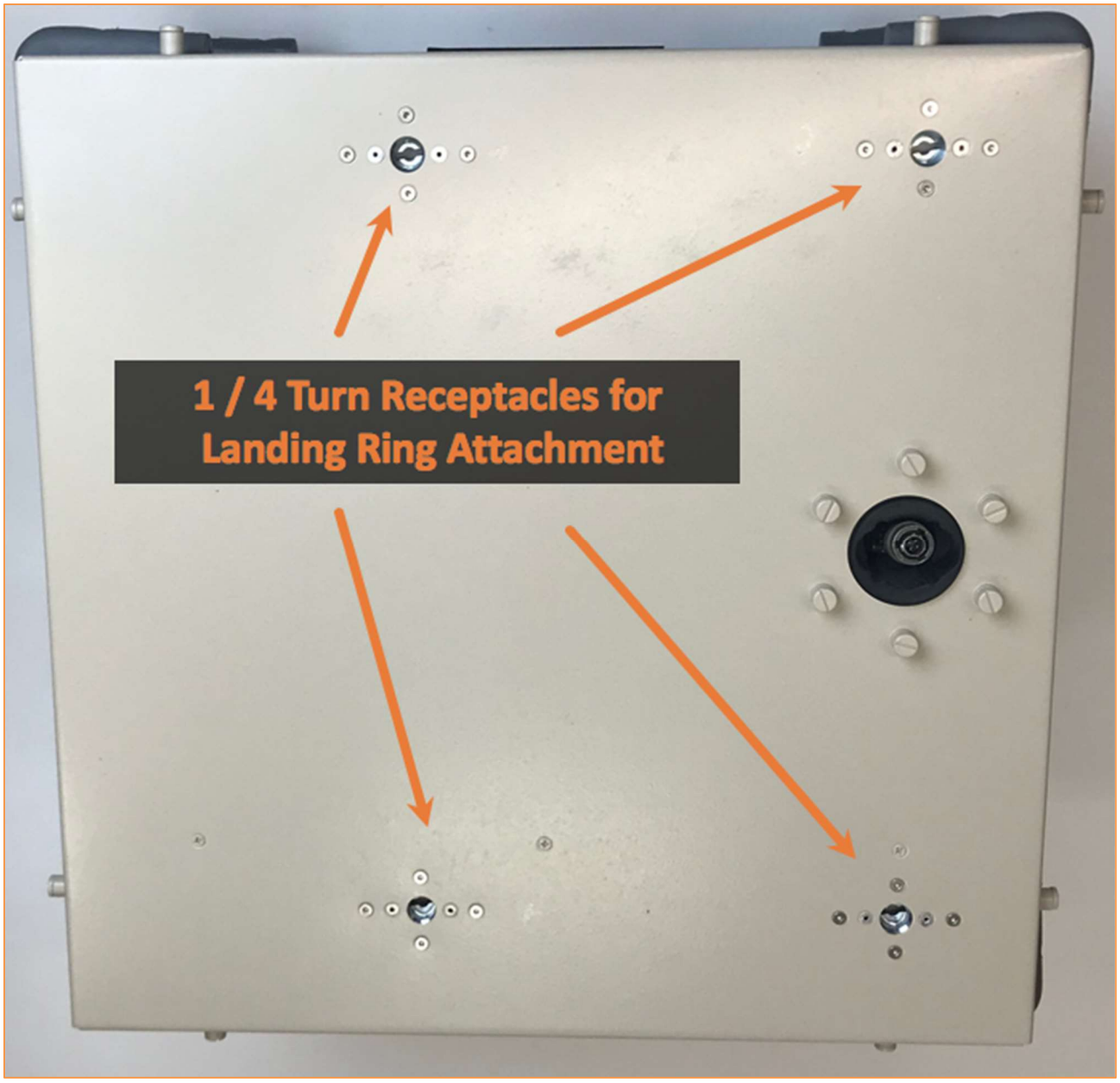


Figure 9. Landing Ring Receptacles Reference Image

Figure 10. System Setup Reference Image (Dismounted left, SkyBox/mounted right)

5. *Install the Landing Ring onto the top of the Tether Kit by aligning the ¼ turn fasteners on the Landing Ring bracket legs with the mating receptacles on top of the Tether Kit. Note that the Landing Ring will only fit on the Tether Kit one way and the Landing Ring is centered over the Tether connector, the Landing Ring 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.*
    a. *Skip if using SkyBox configuration*

DO NOT CONNECT AC POWER. ENSURE TETHER KIT POWER SWITCHES (TWO PLACES) ARE IN THE OFF POSITION

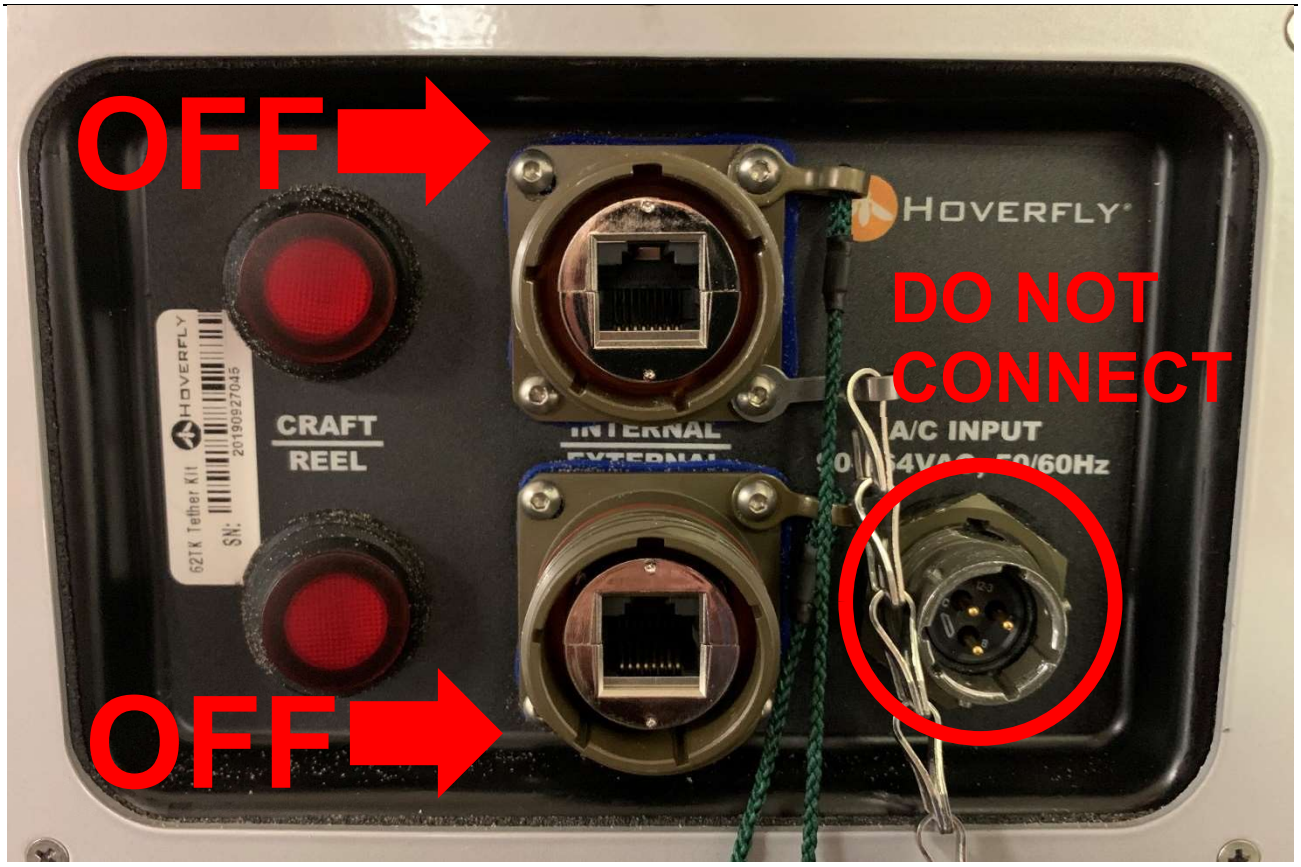


Figure 11. Tether Kit Power and Connection Panel

PANEL IS ROTATED 90 DEGREES ON THE SKYBOX

6. *Retrieve the LiveSky (with payload installed) and pull approximately sixteen inches (16") of Tether out of the Tether Kit or SkyBox and connect the Tether to the LiveSky. Note the connector is a "one-way keyed" Amphenol connector. Connect this to the bottom of the LiveSky and twist the connector after insertion until it reaches the detent and "clicks."*
    a. *For SkyBox: Remove fairlead cover by loosening the large spring-loaded captive fasteners and feed the tether through the fairlead.*
7. *Place the LiveSky in the Landing Ring, centered over the opening.*
8. *Remove the touch-screen Controller from the LiveSky transit case and set it aside or place it on the Tether Kit transit case.*
9. *Connect the Controller with the supplied Ethernet cable by plugging it into the "Internal" Ethernet port on the TK. An alternate high quantity MIL type twist lock all weather Ethernet cable can be used.*

10. *Connect the A/C Power Cable supplied with the System to the A/C Input receptacle on the TK. Connect the other end of the A/C Power Cable to a source of power capable of supplying 2,000W (2KW).*

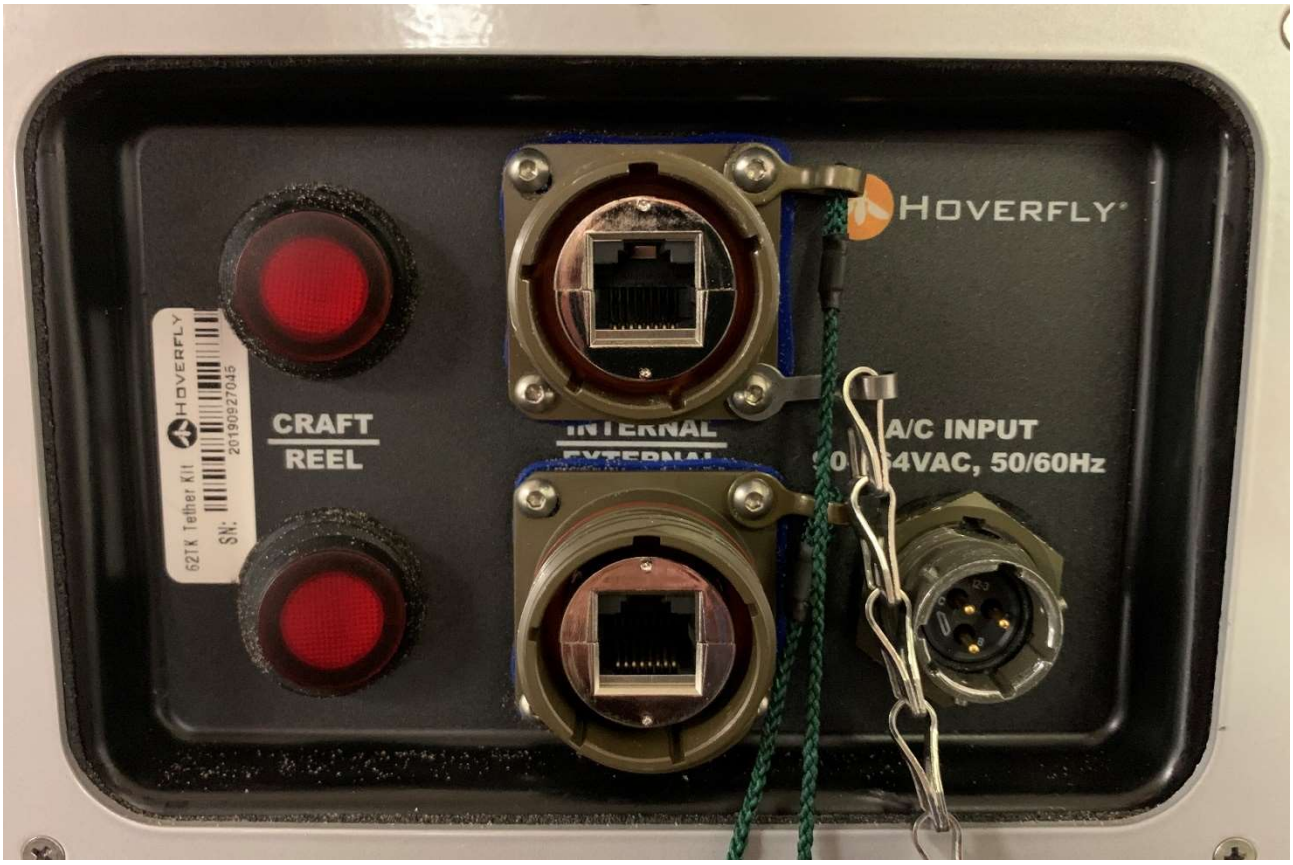


Figure 12. Ethernet and Power Connections to TK

11. *Cordon off a minimum of six feet (6') or 1.8M clear circular area around the TK. DIRECT ALL PERSONNEL OUT OF CORDON AREA*

DO NOT OPERATE WITH LESS THAN 6-FEET DIAMETER CORDON WITH AT LEAST 3-FEET FROM EACH SIDE OF THE TETHER KIT.
KEEP THIS CORDON AREA CLEAR OF ALL PERSONNEL.

2.1.1 Disconnections 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*

a. *Two power switches for Tether Kit*

b. *One power switch for the SkyBox*

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

2. *Disconnect both the A/C power cord and the Ethernet Controller cable.*
3. *Disconnect the Tether connector from the LiveSky.*
4. *To retract the Tether fully into the TK, you may temporarily turn ON the REEL switch on the TK. Turn it OFF after the Tether is retracted.*
    a. *Not applicable for SkyBox, tether will reel-in automatically*
5. *Using the payload latch, remove the payload from the LiveSky air vehicle.*
6. *Turn the LiveSky upside down and place on the transit case or other safe, clean surface*
7. *Remove the Landing Ring from the TK and collapse it for storage in the LiveSky transit case. Stow it in the transit case, then place the LiveSky, payload, and controller in the case appropriately and with care. Do not carry or lift the LiveSky by the propellers. Always handle the LiveSky by the motor booms*
8. *Stow the TK in the TK transit case*
    a. *Not applicable for SkyBox*

2.2 Flight Operations and Data Distribution

In order to operate the LiveSky System, both electrical power and the Controller must be connected to the Tether Kit or SkyBox. The Tether connector must also be connected from the TK or SkyBox to the LiveSky air vehicle. Ensure these connections have been made before proceeding.

2.2.1 Applying Power (ONLY AFTER ALL CONNECTIONS HAVE BEEN MADE)

Ensure that the Setup has been properly accomplished before applying power to the LiveSky System. To apply power, turn ON both red power switches on the TK.

AVOID DANGEROUS HIGH VOLTAGE and NEVER CONNECT or DISCONNECT THE TETHER WITH SYSTEM POWER ON

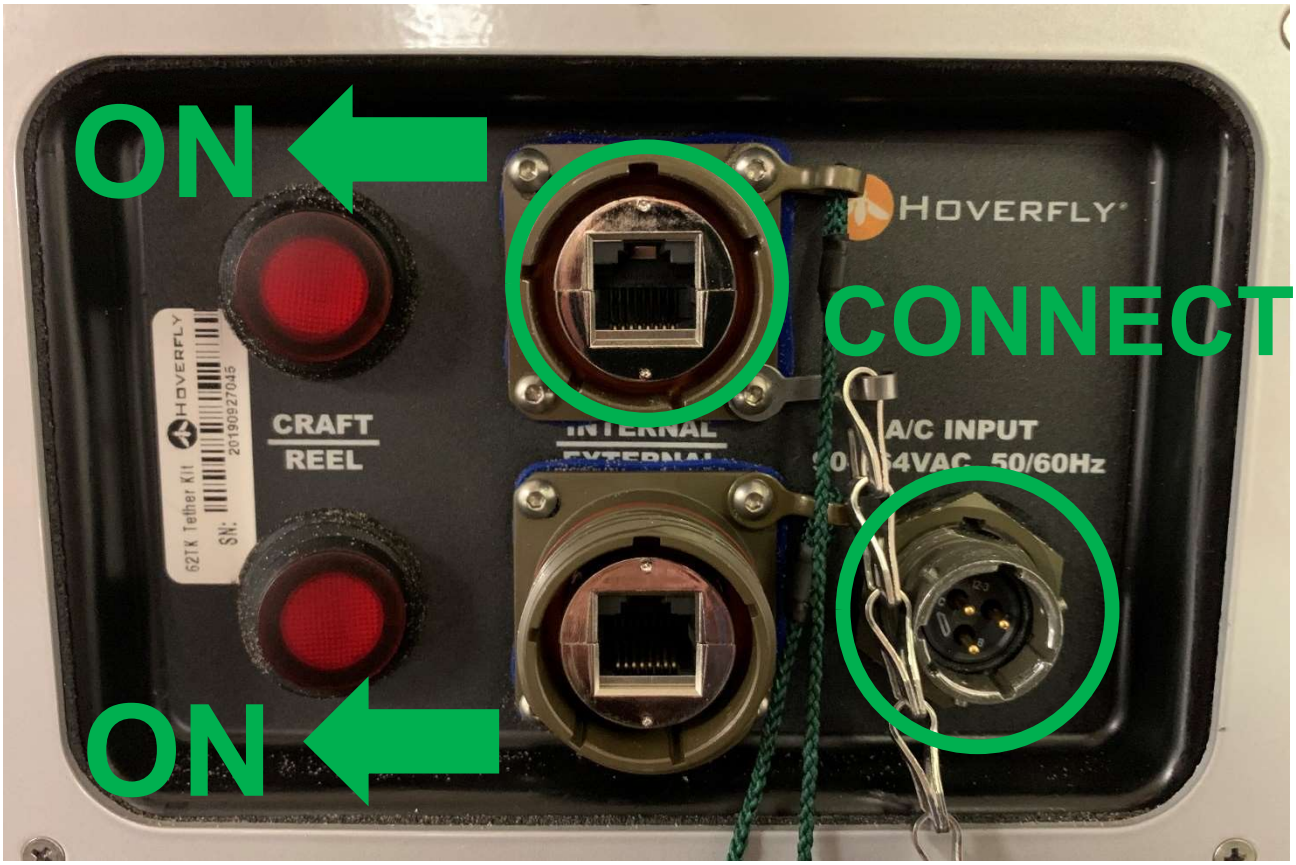


Figure 13. Ethernet and Power Connections to TK (SWITCHES ARE DIFFERENT FOR SKYBOX: the BOTTOM SWITCH is for POWER and the TOP SWITCH is a 3-position switch to control opening and closing of the shutter.)

Ensure that the Setup has been properly accomplished before applying power to the LiveSky System. Using Figure 13 for reference, enable power to the system.

2.2.2 Power-Up Controller and Establish Connection

Apply power or turn on power to the Controller. Activate the Hoverfly Graphical User Interface (GUI) by double clicking on the LiveSky Control Software on the Controller.

The GUI will appear as indicated in the figure below. The GUI is organized to provide maximum area for imagery, with information and controls around the perimeter.

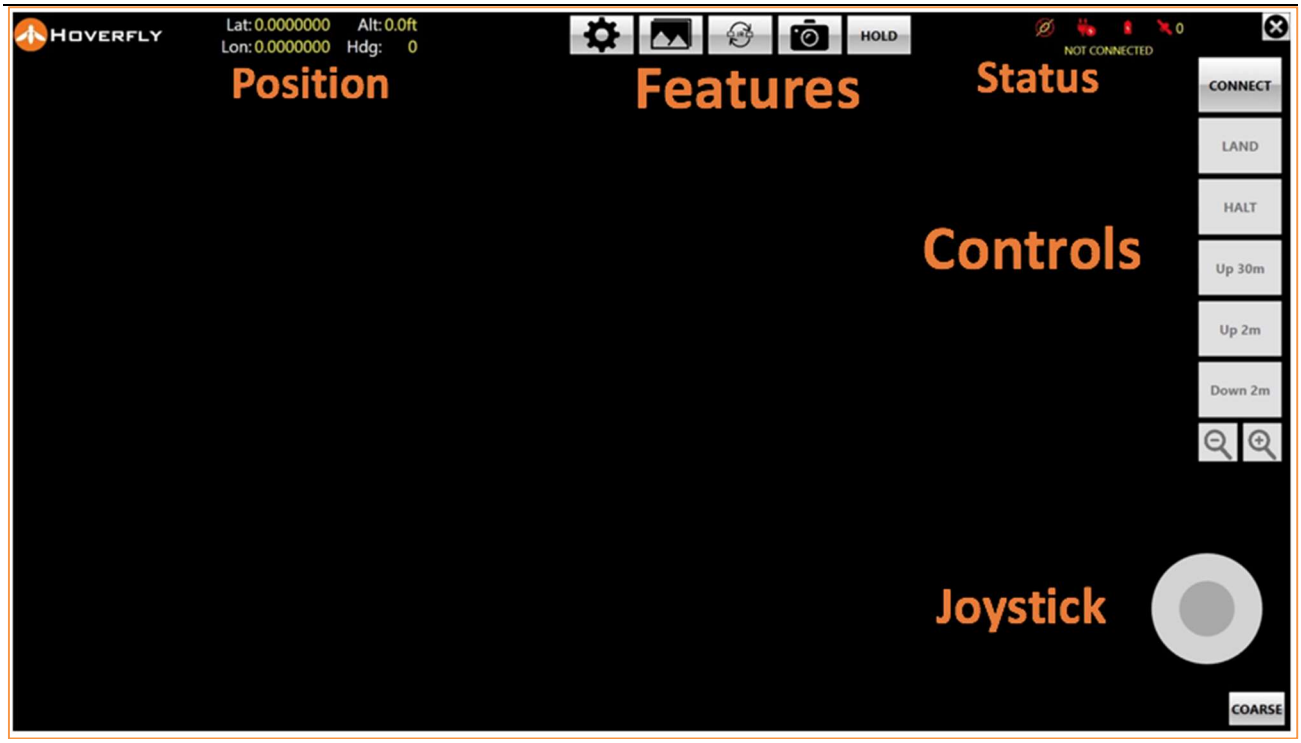


Figure 14 Controller GUI Overview (not applicable for SkyBox)

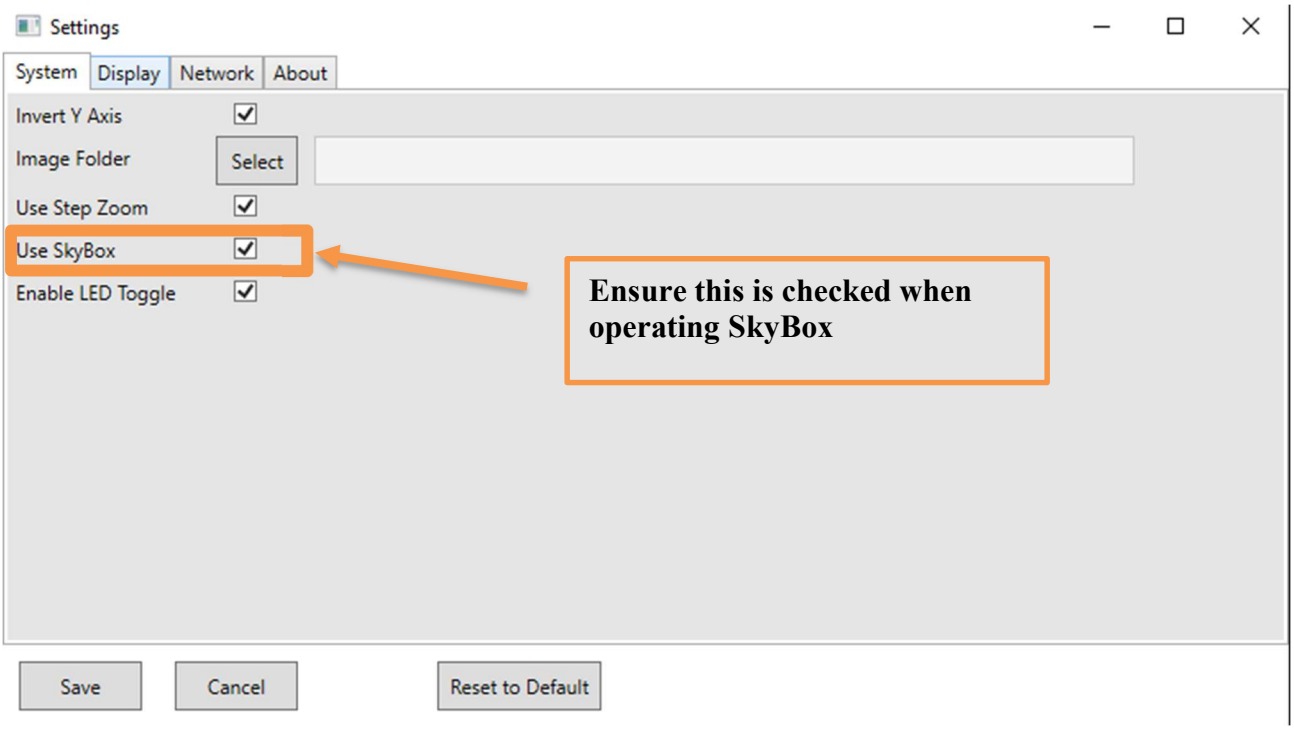


Figure 15 Directions for Selecting SkyBox GUI

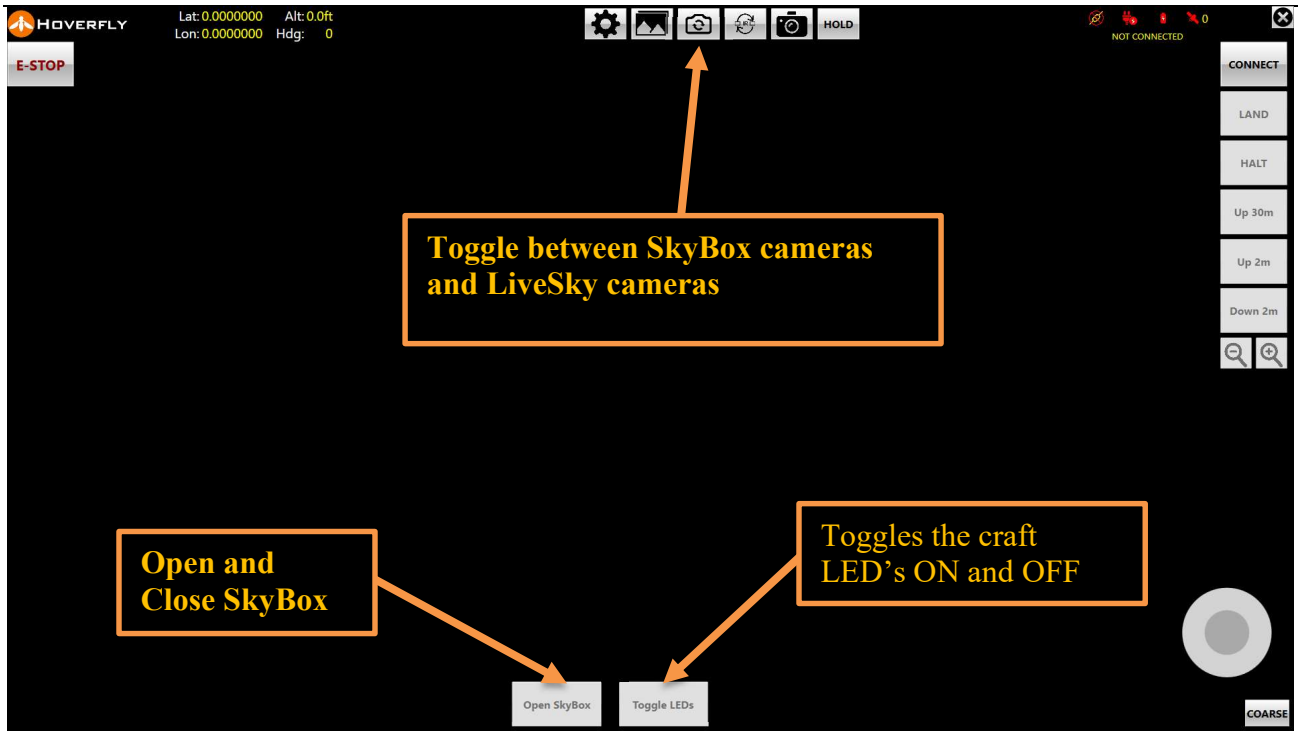


Figure 16. SkyBox Controller GUI Overview

Status Indications are provided at the top right in the GUI and show a progression of messages as the System establishes internal and external connectivity and passes built-in-test and functional checks.

2.2.3 Status Indications

At the top right of the GUI are four indications which are visual representations of System status. These are: (left to right), Ethernet connection status, System power status, Safety Landing Battery (SLB) status, and GPS status and number of GPS satellites detected.

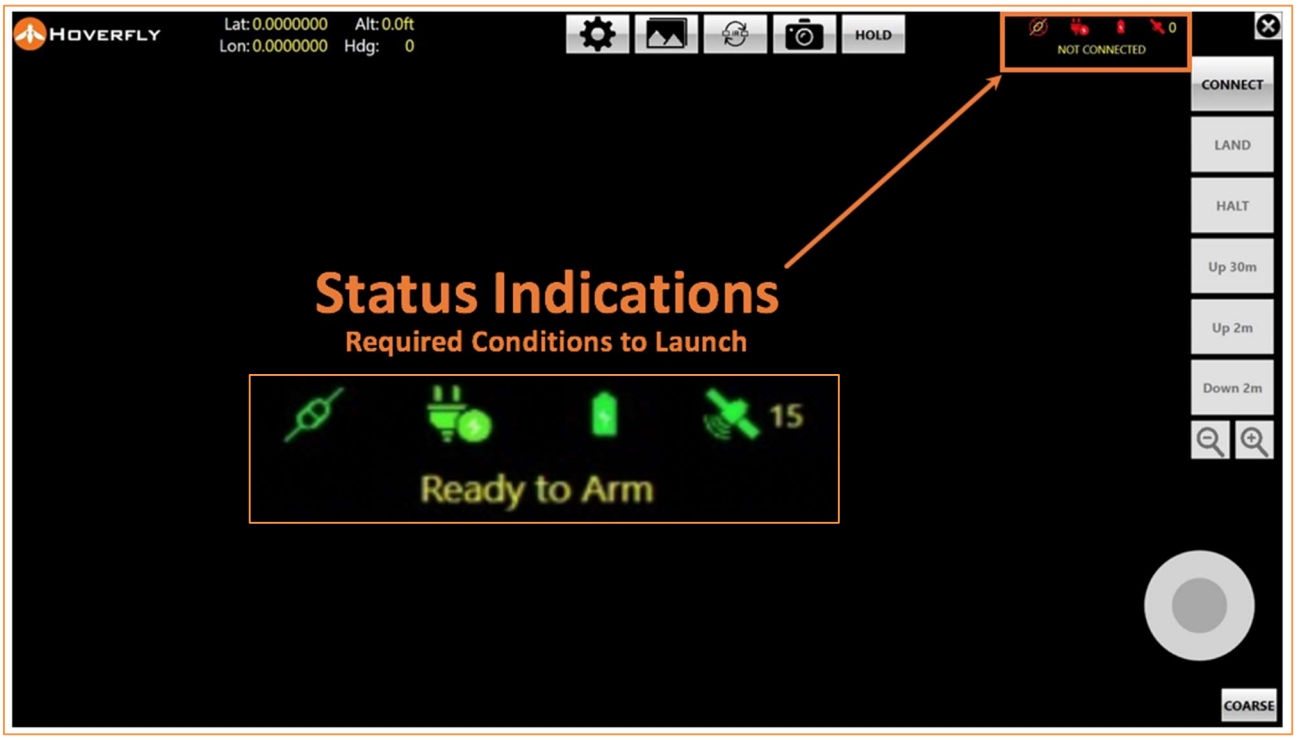


Figure 17. Controller GUI Overview

All Status Indications must be GREEN for the System to have Launch capability. If any Status Indication is RED, the System will not Launch.

The Controller must be Connected to the TK to start the System. If a valid connection exists between the embedded software in the Controller and the TK, the Ethernet connection status indicator will turn GREEN.

If the power input to the TK is between 90VAC and 264VAC, and the System can provide power to the LiveSky air vehicle, the Power status indicator will turn GREEN.

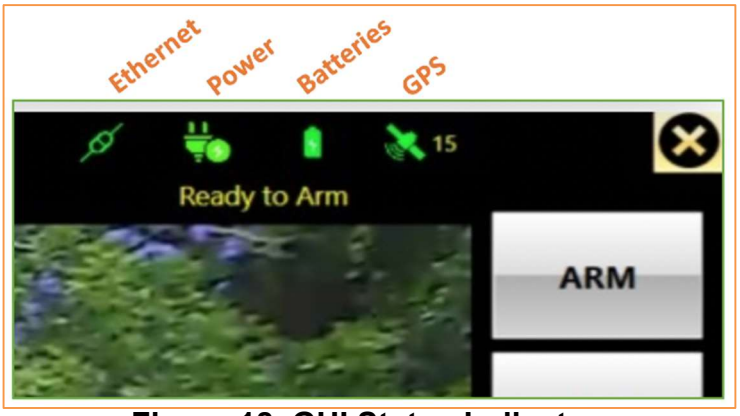


Figure 18. GUI Status Indicators

If the Safety Landing Battery ("SLB") in the LiveSky air vehicle, **and** the TK Safety Battery ("TSB") **are both at their specified voltage**, then the Battery status indicator will turn GREEN.

If GPS accuracy and the number of satellites is within specified limits, then the GPS status indicator will turn GREEN and the System will be capable of entering the ARM State. 10 Satellites are recommended before launch. After moving more than 100 miles since the last flight or not flying for 30 days, a GPS update is required. In order 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 and are used for every flight. A description of the One-button Launch sequence is in the following text. Using only the System Controls and Joystick, complete missions can be flown.

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

The One Button Launch Control capability of the LiveSky System allows the operator to Arm and Launch the LiveSky by pressing a single button to advance the state of the System into Launch and the LiveSky into the air. The multi-state button must be pressed three times to Launch the LiveSky System. Clear the cordon area before launch.

CLEAR CORDON AREA PRIOR TO PRESSING "ARM" BUTTON

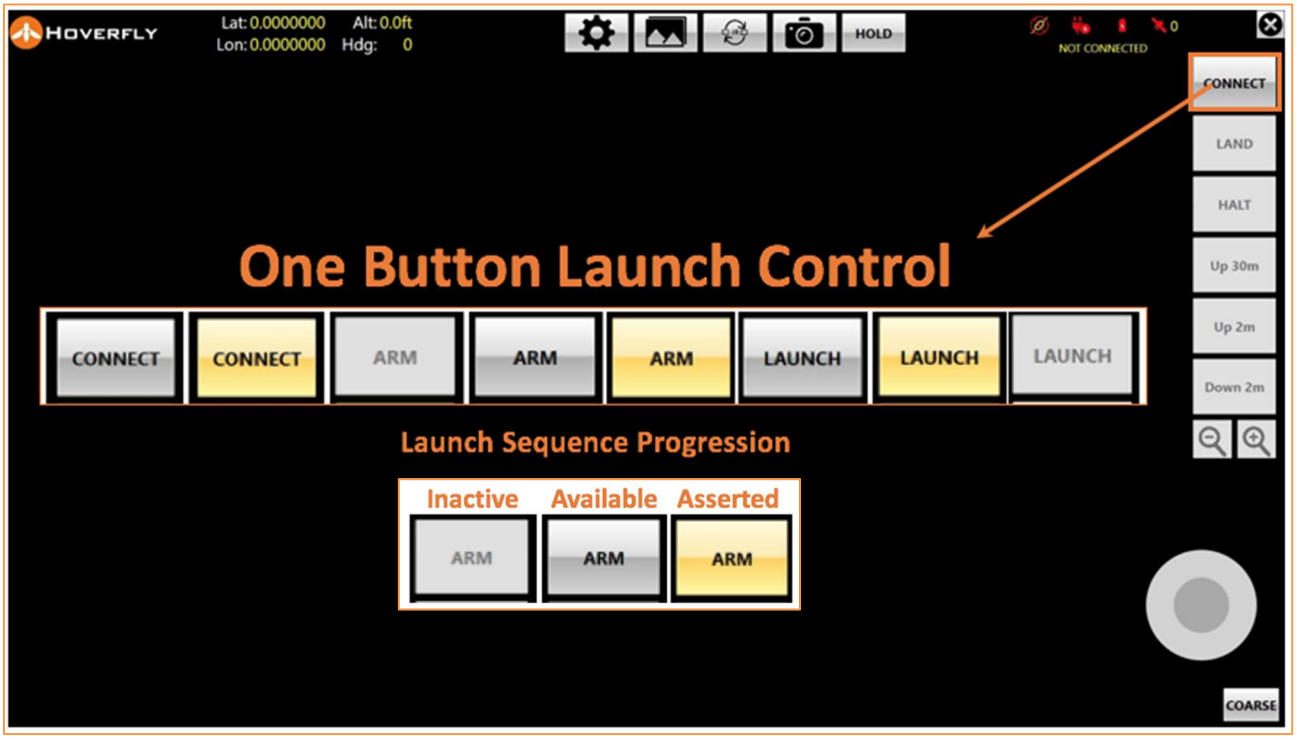


Figure 19. Controller GUI Launch Control Progression

Note at Start-Up, the video feed is not yet active, and the operator must press the "CONNECT" button in order to establish and provision the video stream to the controller. The buttons conform to a simple visual standard that is described below.

2.2.4 Button State Reference

Figure 20. GUI Button States

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, and when the button is active, the color turns to GOLD. An illustration of Controls during the Connect, Arm, and Launch states. Only after Launch do this change in state is in the following Figure. The Figure shows the availability the Up/Down controls become available.

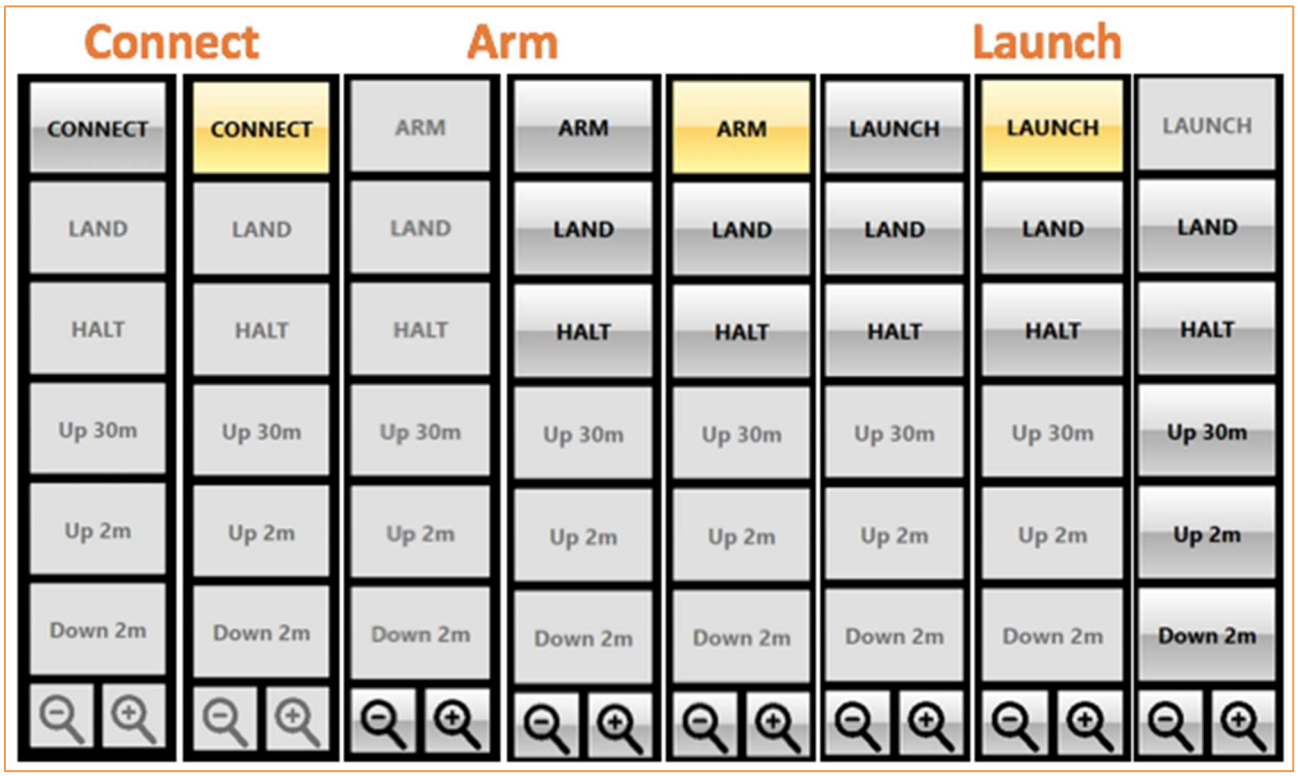


Figure 21. GUI Button State Indications for Launch Sequence

To begin the Launch sequence and ready the system for operation, press or 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, 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 2 minutes for video to appear on the Controller. This is normal, and the LiveSky 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.

2.2.5 Control and Status Sequence

The state of operational readiness for the System is shown in the progression of Status Indications as the CONNECT/ARM/LAUNCH sequence progresses. See the Figure.

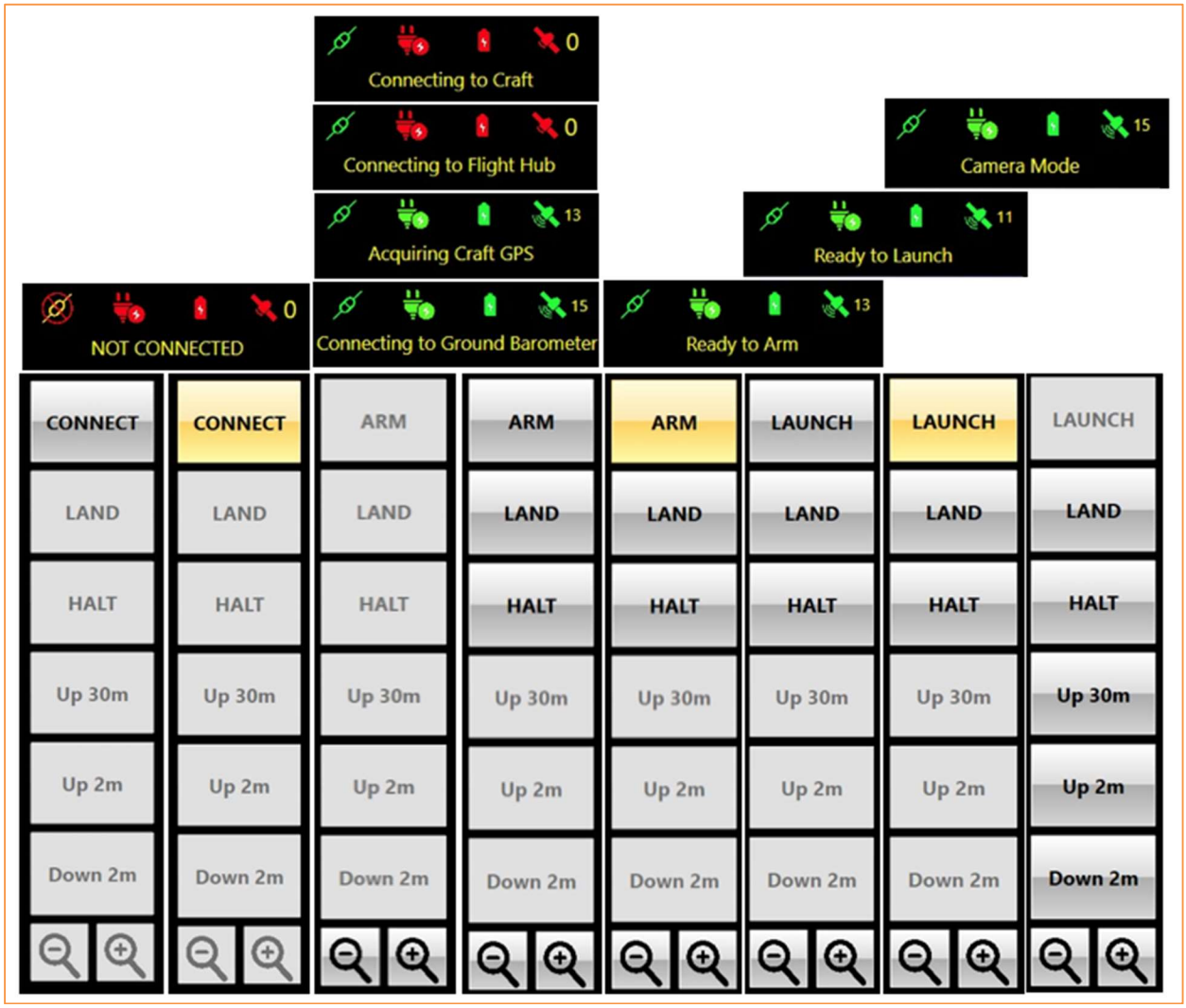


Figure 22. GUI Button State Indications and Messages Status During Launch Sequence

2.2.6 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 (like "Up 30m") 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 2m" asserted three times will cause LiveSky to ascend 6m from its present altitude.

Figure 23. Flight and Sensor Controls Overview

2.2.7 “FOLLOW” and “HOLD” Position Feature

After launch, if the LiveSky System is equipped with On-The-Move (OTM) capability, and it is enabled and available, then the “HOLD” button will change to “FOLLOW” once clicked. The “HOLD” button change will state after the launch is complete and LiveSky is at Minimum Altitude.

Figure 24. HOLD Button State Change to FOLLOW

When the LiveSky System is in FOLLOW MODE, the airborne LiveSky will follow the position of the Tether Kit or Ground GPS Antenna in the Optional OTM Capability Kit.

2.2.8 Thermal Palette Toggle Feature

The color palette used to display thermal imagery can be changed under "Settings." 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.

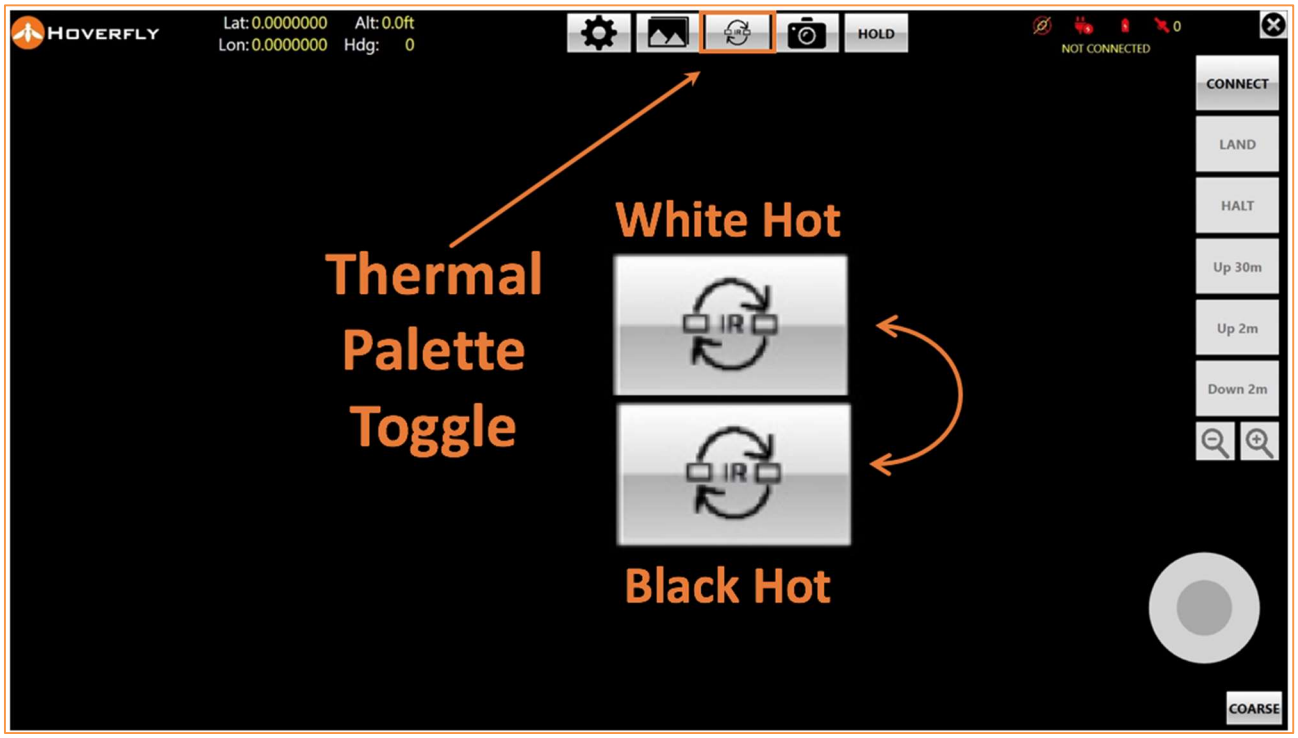


Figure 25. Thermal Palette Toggle Feature Example

2.2.9 PIP Sequence Feature

The Picture-in-Picture (PIP) Sequence Feature selects one of four imagery options for the Controller display. The four options are: visible camera, thermal camera, visible with thermal PIP and thermal with visible PIP. The Thermal Palette Toggle Feature may be asserted while in PIP modes.

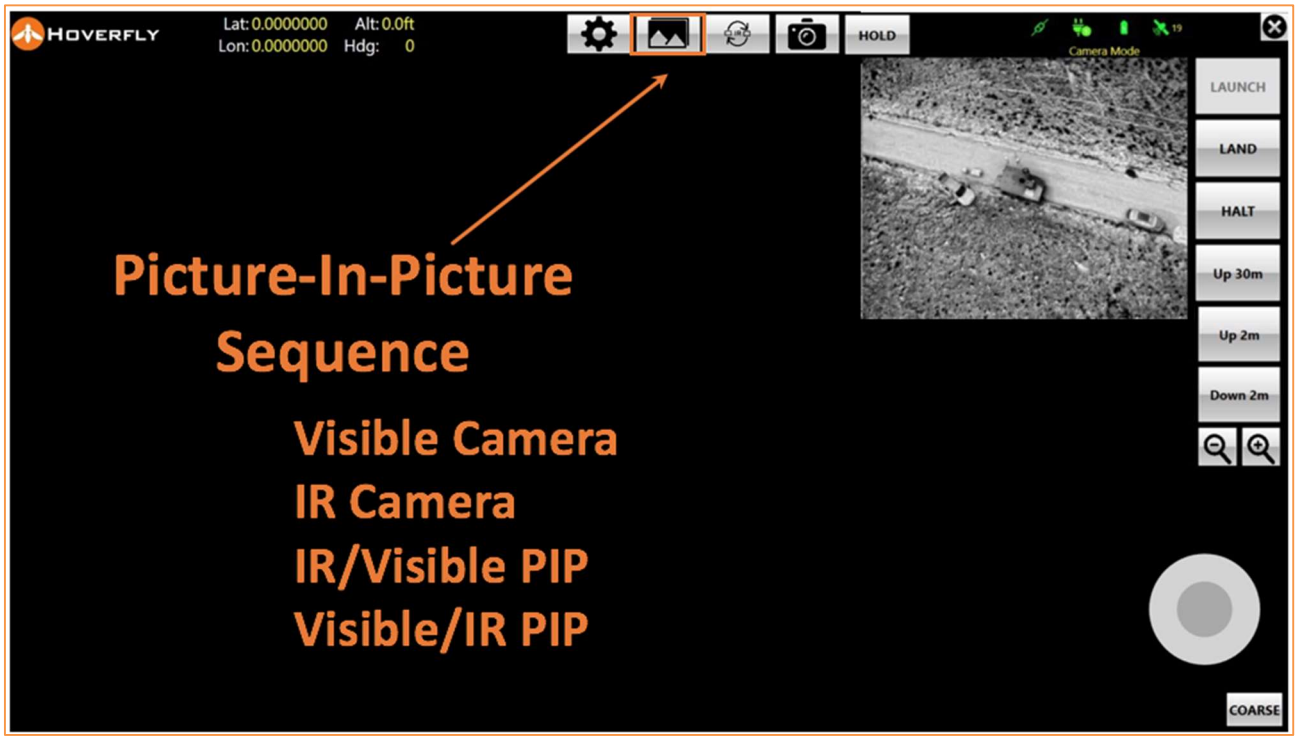


Figure 26. PIP Sequence Rotator Feature

2.2.10 Settings Access Feature

Additional Features can be accessed by asserting the “Settings” button, which looks like a gear and is located at the top of the GUI in the row of Feature buttons.

Under the “Settings” Feature, a center Reticle can be activated / deactivated; the IR Palette options can be selected; detailed System Settings can be changed; and flight cone translation can be activated using the Navigation Feature.

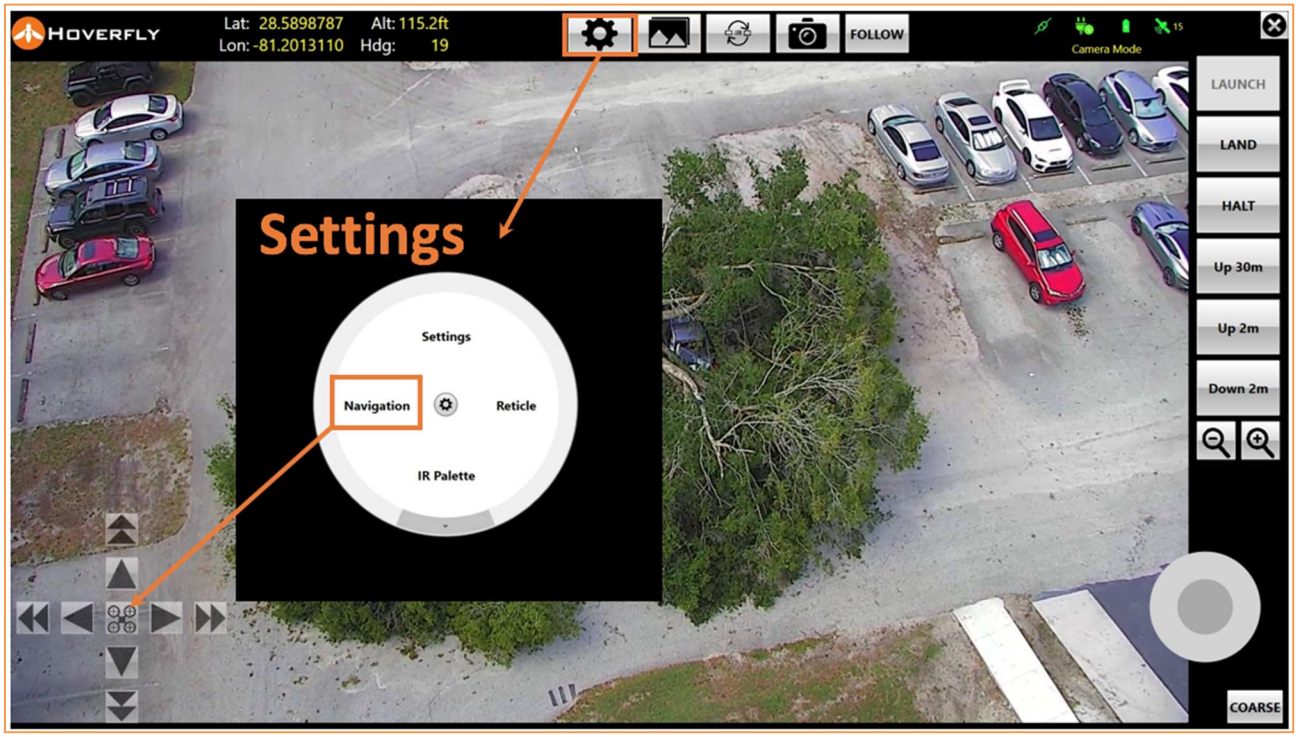


Figure 27. Settings Sub-menu, Enable Translate Feature

2.2.11 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.

The LiveSky can translate in X and Y horizontal position while in flight by using the Translate Controls. Using the Translate Controls does not change altitude; however, the limit of horizontal translation is a function of altitude and is set to a maximum of 10 meters. Custom settings of this Feature are available with Hoverfly's Software Development Kit (SDK). This Translate feature is useful for a variety of missions and can also be used with On-the-Move (OTM) capability, for instance, to look over a wall while moving in a vehicle.

If the "LAND" Control is asserted after the Translate Feature has been asserted, the LiveSky will move to a normalized position over the TK while landing and manual Translate functionality will be abandoned until the landing is complete and a new Launch occurs.

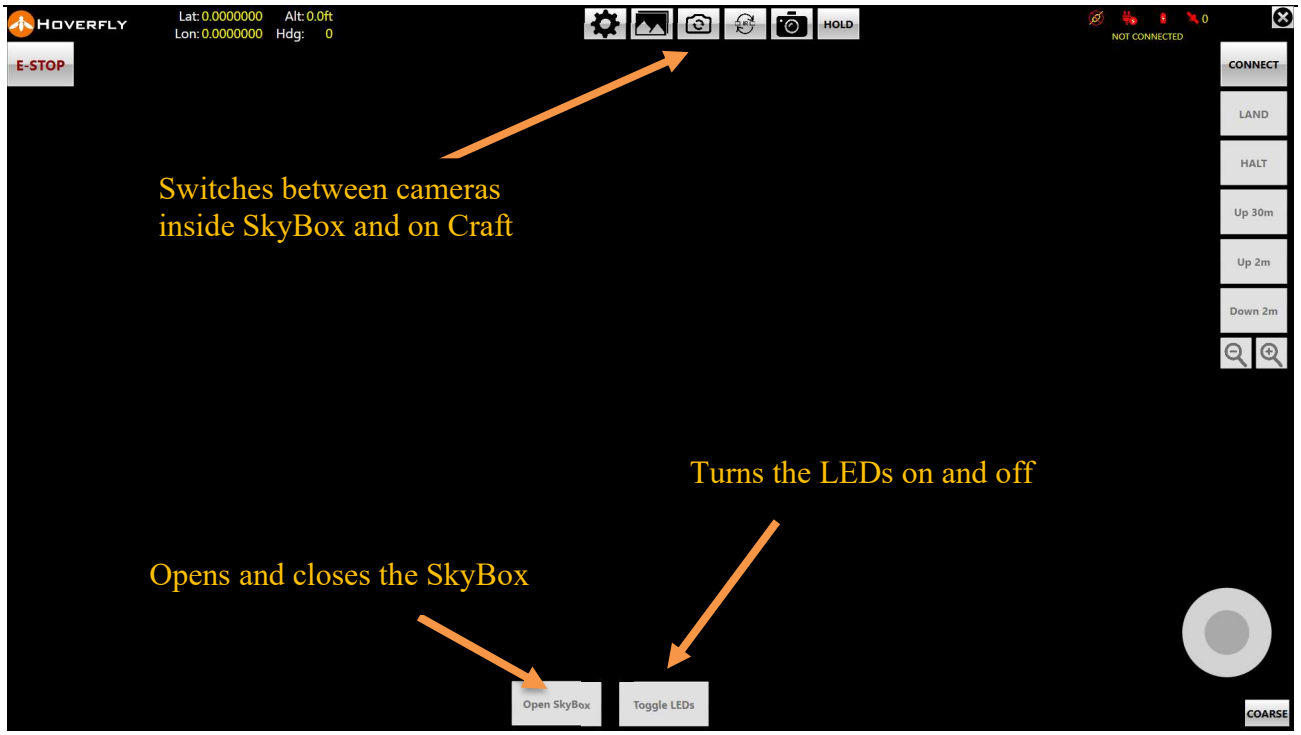
Figure 28. Activate Translate Feature to Move LiveSky System in Flight

The 90-degree frame of reference for the Translate Feature is dependent on initial the Launch heading. For instance, if the front of the LiveSky and its sensors are pointing North at Launch, then the Translate Controls will be in map North orientation. If the front of the LiveSky is pointed, for instance, to 34 degrees from zero degrees North, then X, Y movements will be oriented at 34, 124, 214, and 304 degrees from zero North.

2.2.12 Detailed Settings Feature

If the Settings Feature is asserted, 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 Feature information.

Figure 29. Settings Network Feature Tab – DO NOT CHANGE



For SkyBox Operations

2.3 Inspection and Maintenance Activities

2.3.1 Inspections at Each Setup

Inspections are required after each unpacking and setup procedure of the LiveSky System. Inspection points are the entire System for physical damage, the propellers, and physical attachment points of the motor booms.

2.3.2 Inspections on Interval

Every 500 hours, with the System power OFF, and both power switches turned OFF, and NO A/C Power cord attached, slowly pull out the Tether from the TK and visually inspect it for kinks or damage. Pull it out until the END of TETHER INDICATOR is observed. As the tether is extracted from the TK, coil it up very loosely and carefully. Place the tether on a CLEAN SURFACE.

The Tether can be retracted by turning on the power to the REEL on the TK and gradually feeding in the Tether under REEL power. DO NOT LET THE REEL DRAG THE TETHER ON THE GROUND. Foreign Object Damage (FOD) in the Tether Reel Will Result.

FEED THE TETHER BACK INTO THE REEL BY HAND

If damage to the tether and/or kinks in the tether are discovered, replace the entire Tether Reel Assembly. The tether itself is not replaceable in field locations.

2.3.3 Predictive and Mandatory Maintenance Actions (P/MMA)

The LiveSky System includes advanced self-diagnostics, health and utilization monitoring and predicts maintenance actions based on a variety of factors. HOWEVER, regardless of on-condition maintenance and predictive maintenance analytics, there are Mandatory Maintenance Actions that are strictly time based.

Table 7. Mandatory Maintenance Actions (MMA)

Interval	Activity	Parts Required
As needed	*Propeller Replacement*	*2 CW Props* *2 CCW Props* *P/N LVS-6205-4PK*
1500 hours	*Motor Boom Replacement* *Tether Reel Replacement*	*4 Motor Booms* *P/N LVS-6205-4MB* *Tether Reel Assembly* *P/N LVS-62-TK-LWII*

3. Network Connections

For users that are operating the LiveSky System from remote locations, or from 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 LiveSky 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 LiveSky System, please refer to Hoverfly Document HF-FMS and Hoverfly SDK Document SMHF-SDI/API.

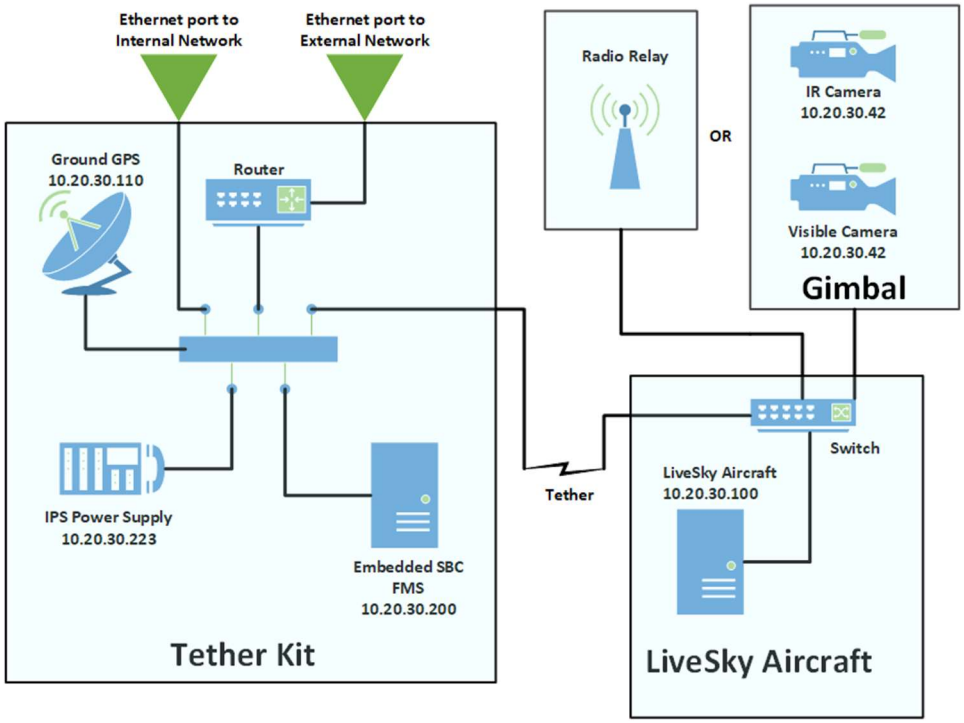


Figure 30. LiveSky Network Components and Addresses

3.1 Network Video Connections

In some cases, while the Controller is connected to the External Ethernet Network connection on the TK, 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.

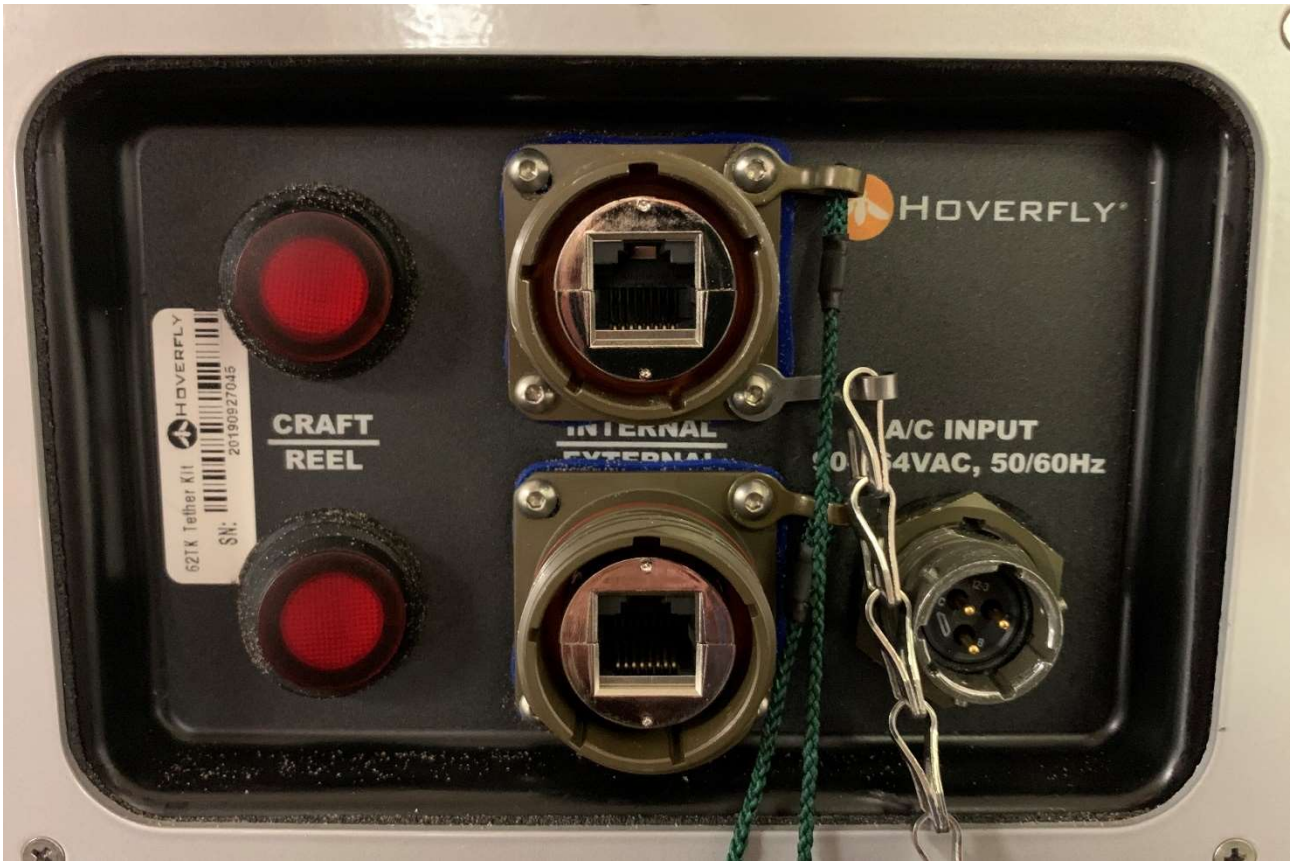


Figure 31. Internal and External Network Connections

On the Internal network four (4) simultaneous video streams are available (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.

3.1.1 Video Imagery Stream Connections

A 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

3.1.2 Remote Access to Video Streams when Controller is Remotely Located

If you are connecting to the LiveSky System from an operations center, and the Controller or the Hoverfly Software Development Kit (SDK) is being used on user-supplied computer equipment, to access the video streams it is also necessary to also specify the port address (10420) as shown in the addresses below.

The primary visible stream is:

rtsp://admin:admin@192.168.1.20:10421/videoinput/1/h264/1 , or

http://admin:admin@192.168.1.20:10420/services/media.ion?sel=jpeg&source=videoinput_1

(assuming an external router is at 192.168.1.20), or if connected to the Internal Network Port on the TK, 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

For more information on remote control operations and video stream management and distribution consult the Hoverfly Document SMHF-SDI/API-19C or contact Hoverfly's Support Services at: +1 407-985-4500 extension 6205.

4. System Logs and Data

The LiveSky System generates System Logs for post mission review, predictive and condition-based maintenance, built-in-test, warranty administration, and safety.

Data is maintained in the System by several computers, processors, and data stores. The flight controller, the 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, is 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 five of the available System logs are stored in the onboard computers in the Tether Kit (TK). One additional and very important log file is stored aboard the LiveSky air vehicle itself. When collecting logs for analysis it is important to collect all relevant logs.

4.1 System Logs in the TK

There are four (4) logs stored in the TK. All of these may be downloaded through a web-interface by connecting a computer to the TK network. It is also possible to use the Hoverfly touch-screen Controller for this procedure.

If the computer (or Controller) is connected to the "Internal" Ethernet port on the TK, it should be configured to use a dynamic (DHCP) network address. The router in the TK 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 the computer (or Controller) is connected to the "External" network port, then simply navigate to the IP address that has been assigned under DHCP to the TK on your network.

Once the computer or Controller is connected, a web page entitled "Hoverfly Access" will be displayed. This web page has clickable options that include View Logs", "View Settings", "Utilities", and "About" which looks like the nearby Figure. Click on the link "View Logs" to view the log files.

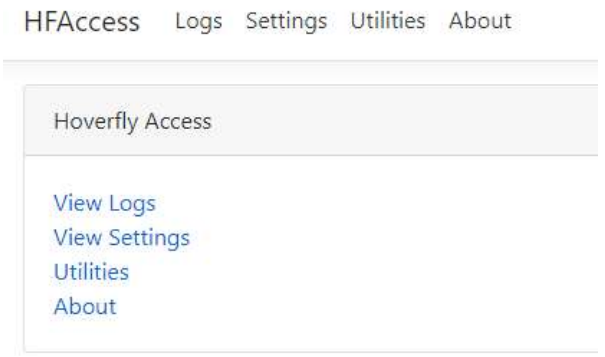


Figure 32. Hoverfly Access

A new screen will appear after "Log File Access".

From this screen, access is provided to the four (4) different types of TK logs; the BGU log, the BGU Server log, the FMS log, and the HUB log. Simply click on the link for each type of log to have access to the directory structure for that Log File. Once inside of the directory structure, Log Files from the TK can then be downloaded, or deleted.

All logs are generated each time the System is powered on. These logs are labelled with a timestamp and can be sorted in time order to make it easy to find the desired log from any flight. Those screens look like this:

The timestamp format is YYYYMMDDTHHMMSS, thus a log with the title:

"BguDataLog_20190213T174523"

is from 02/13/2019 at 5:45:23pm.

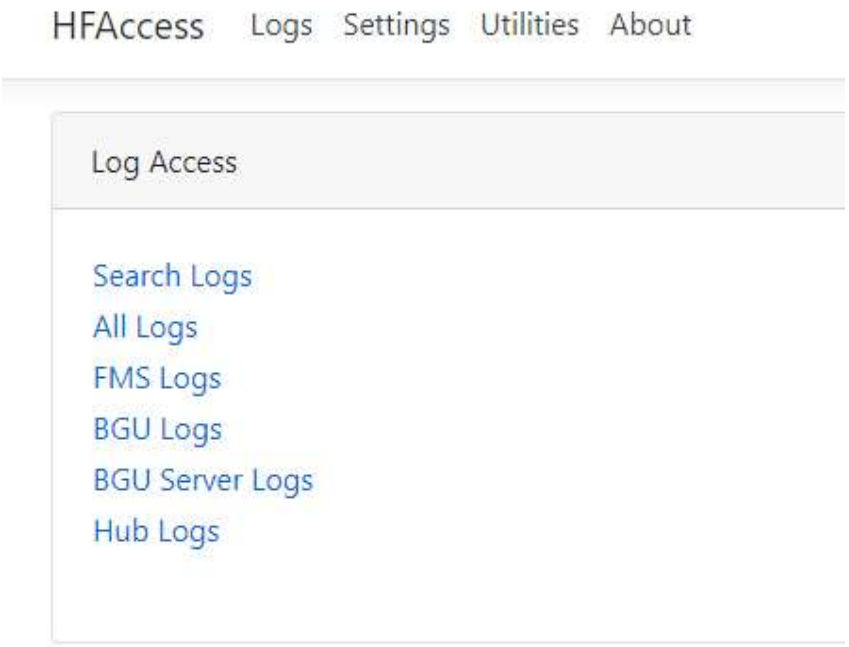


Figure 33. Hoverfly Sequential Flight Logs - TK

4.2 System Log in the Air Vehicle

The LiveSky air vehicle log is obtained by using a micro-USB cable connected between the LiveSky and any computer running the Ardupilot "Mission Planner" software (which can be found at: http://ardupilot.org/planner/).

The procedure for extracting the logs is simple. After you have obtained and installed the software. Plug the micro-USB cable into the port inside the LiveSky Safety Landing Battery compartment. Connect the cable to your computer and start the ArduPilot software.

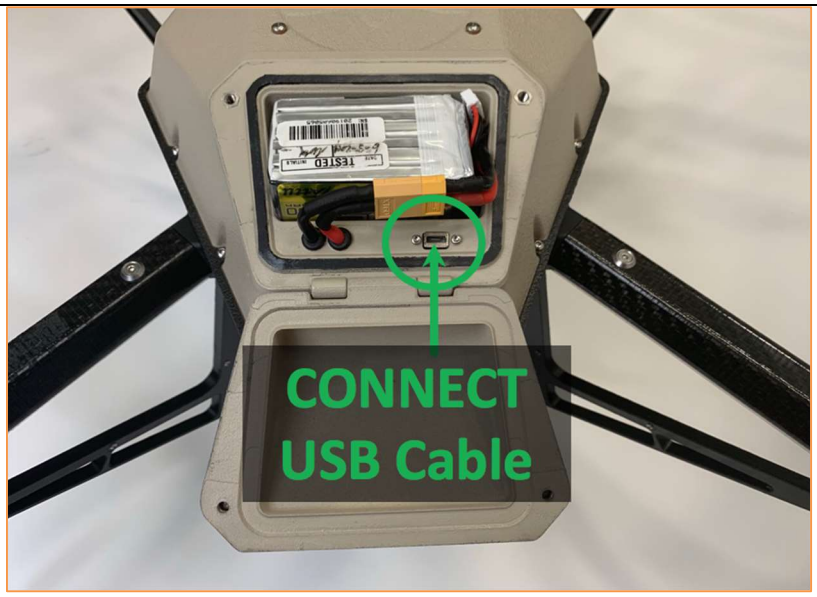


Figure 34. Connecting the USB to Obtain the LiveSky Log File

Figure 35. Mission Planner Connect / Start-up Screen

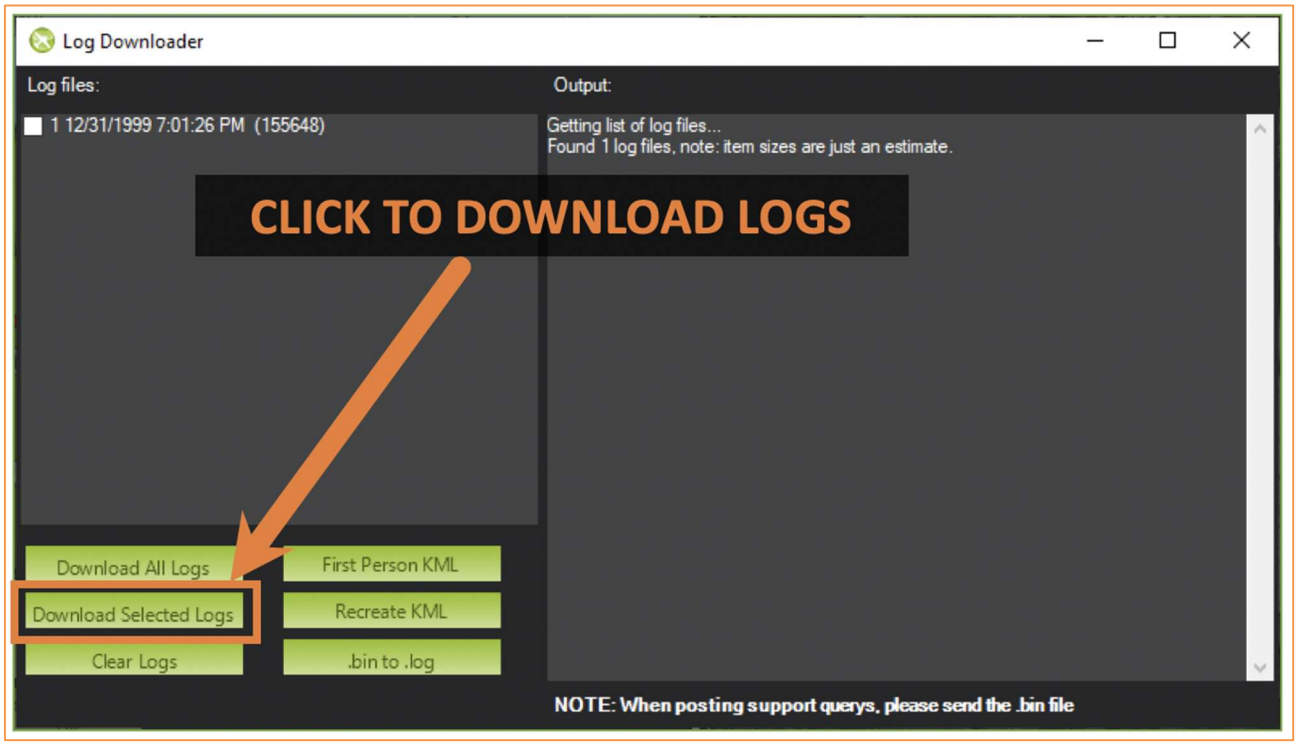
WHEN CONNECTED, MISSION PLANNER MAY ASK ABOUT UPGRADING FIRMWARE. DO NOT UPGRADE FIRMWARE!!

LIVESKY USES SPECIAL SOFTWARE, DO NOT UPGRADE FIRMWARE

On the center left of the screen, below the artificial horizon, there are a series of tabs. Select "DataFlash Logs".

Then click the button "Download DataFlash Log Via Mavlink".

This will bring up a window showing all the logs on the craft. The log files are dated. Select the appropriate log(s) and click “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! LOGS 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). Contact Hoverfly’s Support Services at: +1 407-985-4500 extension 6205.

5. Safety Landing Battery

There are two (2) back-up power safety landing batteries in the LiveSky System. One (1) in the LiveSky air vehicle, and one (1) in the TK. The purpose of these safety landing batteries is to allow the LiveSky air vehicle to land if input power is lost for any reason.

These batteries are also involved in the safety interlock built-in-test sequence. If either battery is not fully charged, the System will not ARM. If the Safety Landing Battery ("SLB") in the LiveSky air vehicle is at its required voltage level, the Battery status indicator will turn GREEN and LAUNCH can be asserted.

If **the SLB is not at the specified voltage**, replace the battery immediately to start or continue a mission or turn on System Power and wait until the respective battery charges to the required voltage and capacity.

Apply System Power to charge the TK Safety Battery ("TSB"). Recharging either the TSB from the internal System Power can take up to 8 hours depending on ambient temperature and other factors.

Figure 36. Safety Landing Battery Compartment - Open

5.1 Replacing the Safety Landing Battery (SLB)

Replace the Safety Landing Battery (SLB) after a safety landing using SLB Power.

If the SLB is discharged for any reason and its capacity is less than necessary for a safety landing, then the SLB must be replaced or recharged.

Recharging the SLB using an external charger takes several hours. In order 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 LiveSky System.

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

When replacing the SLB, first open the battery bay on the LiveSky and then disconnect the battery connector. Then carefully remove the SLB and replace it with a fully charged battery.

USE ONLY HOVERFLY SUPPLIED BATTERIES.

Route the wires exactly as shown when re-installing an SLB in the battery bay. Install with the battery connectors to the right and with the balance charge connector positioned at the top right of the compartment as shown in Figure 37. **LiveSky Safety Battery Replacement**

Figure 37. LiveSky Safety Battery Replacement

6. Field Repairs

When instructed by Hoverfly Factory Support or as a result of System Messages, field repairs can be made to the LiveSky System. The following Sections provide information on replacing the Tether Reel and the Power Wall assemblies in the Tether Kit. Afterward, instructions on replacing the Propellers on the LiveSky are provided.

6.1 Tether Kit Maintenance and Repair

The Figure below shows the exploded view of the Tether Kit and its Field Replaceable Units (FRUs). FRUs are assemblies designed to be replaced in dry field environments using the tools included with the System. Tether Kit FRUs can be replaced without special tools using two screwdrivers.

Figure 38. Exploded View of Tether Kit

In addition to the TK FRUs, there are cable assemblies inside the TK which must be disconnected and re-connected when the Reel Assembly or Power Wall Assembly are replaced. Pay strict attention to the orientation and placement of cable assemblies inside the TK.

6.1.1 Removing the Tether Kit Cover

Fourteen (14) captive fasteners must be loosened in order to remove the TK cover. Six (6) are around the tether opening, and eight (8) are around the perimeter of the TK cover itself.

Figure 39. Fasteners on Tether Kit Cover

Do No Remove the TK Cover fasteners; simply loosen them to remove the TK Cover. After loosening the six top fasteners around the tether connector opening, loosen the eight fasteners around the perimeter of the TK Cover.

6.1.2 TK Field Replaceable Unit Identification

After the TK Cover is removed the internal areas and the four (4) TK Field Replaceable Units (FRU) components become visible and are identified in the Figure below. It which shows the Tether Kit Heatsink Wall assembly, the Tether Reel, the Safety Battery, and Router.

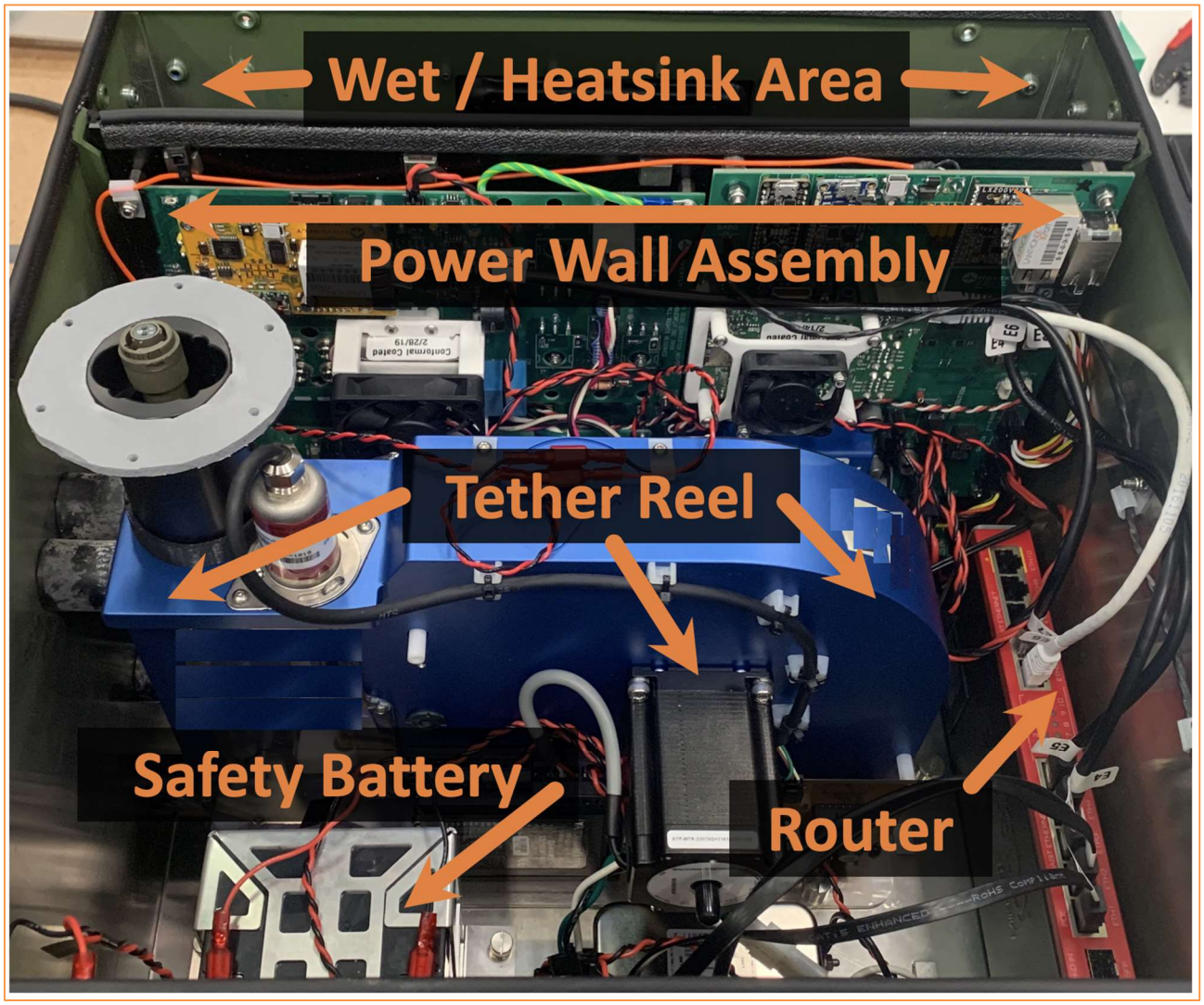


Figure 40. Identification of TK FRU Components

6.1.3 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 CONNECTOR.

DANGER HIGH VOLTAGE. DISCONNECT SYSTEM POWER.

To remove and replace the Tether Reel, first there are three (3) electrical connections that must be released before the Tether Reel assembly can be removed. These are the HIGH VOLTAGE connection on the top of the Tether Reel, Tether Reel power connector, and the Reel Dehumidifier shown in Figure 42.

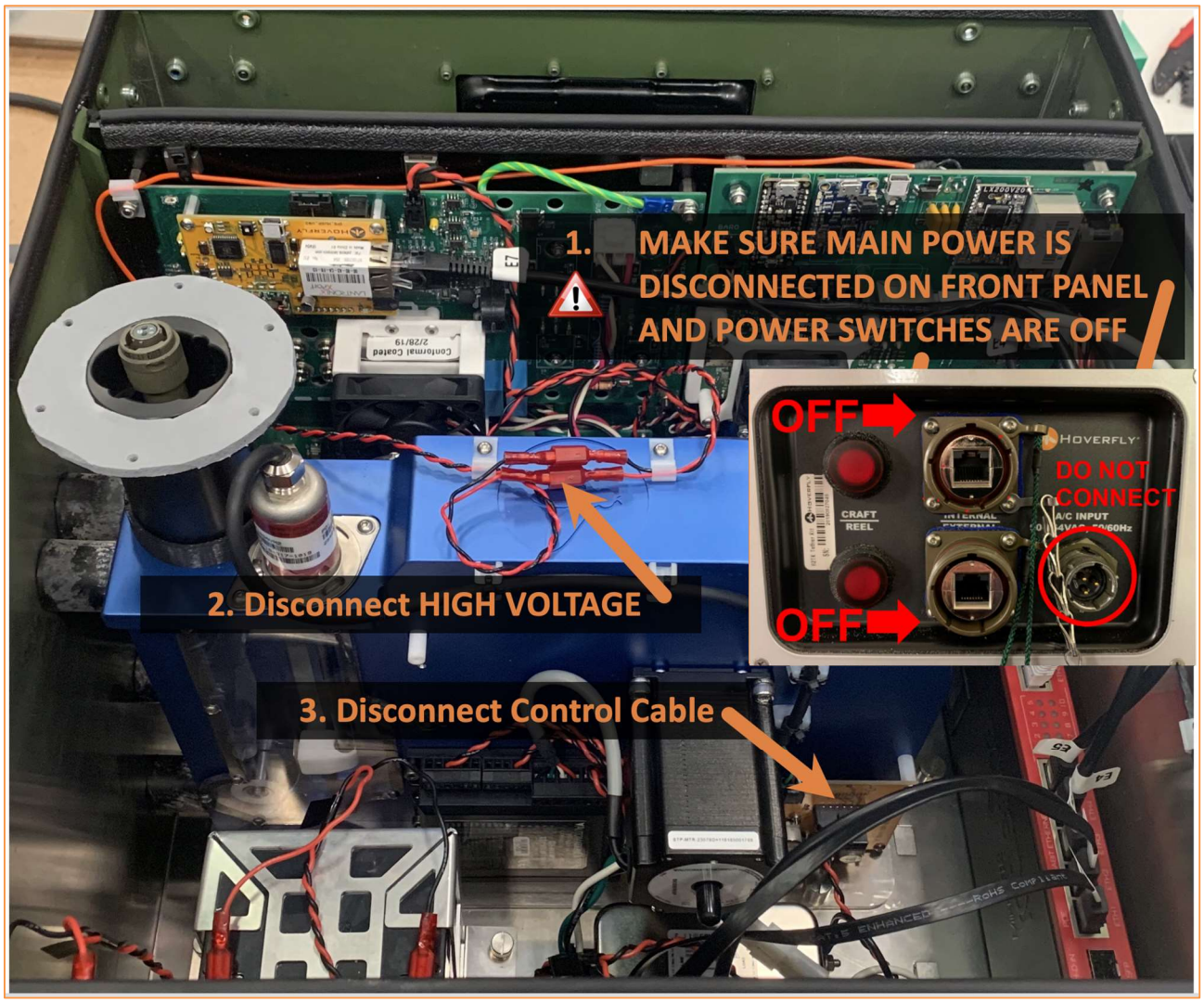


Figure 42. Fasteners on Tether Reel Assembly

Next remove the four (4) fasteners from the **side of the Tether Kit.** Keep the fasteners handy for installation of the new Tether Reel. Next, loosen the five (5) captive fasteners on the mounting deck of the Tether Reel assembly. Use a long flathead screwdriver and do not contact other surfaces or areas. If the captive fasteners are adequately released, then the Tether Reel assembly can be removed by **PULLING STRAGHT UP.**

Figure 41. Fasteners on Tether Reel Assembly

When installing a new Tether Reel, carefully lower the assembly into the Tether Kit making sure that no wires are pinched or trapped underneath the Tether Reel. Align the drain holes with the drain hole receptacles on the bottom of the Tether Kit. Re-align the captive fasteners and tighten with a long-handle screwdriver, reconnect the control cable, re-install the four (4) outside wall connectors, and reconnect the high voltage connectors.

RECONNECT HIGH VOLTAGE - RED TO RED, BLACK TO BLACK

6.1.4 Replacing the Tether Kit Heat Sink Wall

Replace the Tether Kit Heat Sink Wall when instructed by the Controller or Hoverfly support team. When replacing the Heat Sink Wall, first remove the moisture control weather strip seal on the top of the assembly and set aside for installation on a new Heat Sink Wall. Then, disconnect each of the many connectors that connect the Wall to the other subsystems inside the TK shown in Figure 44. Pay attention to wire routing and gently release the connectors by squeezing or lifting the locking tabs as required. Disconnect and remove the connectors connected to the Wall.

DO NOT LIFT BY COMPONENTS OR CABLES. ONLY LIFT WALL BY TOP EDGE OR BY HEAT SINK RIBS FROM WET SECTION SIDE

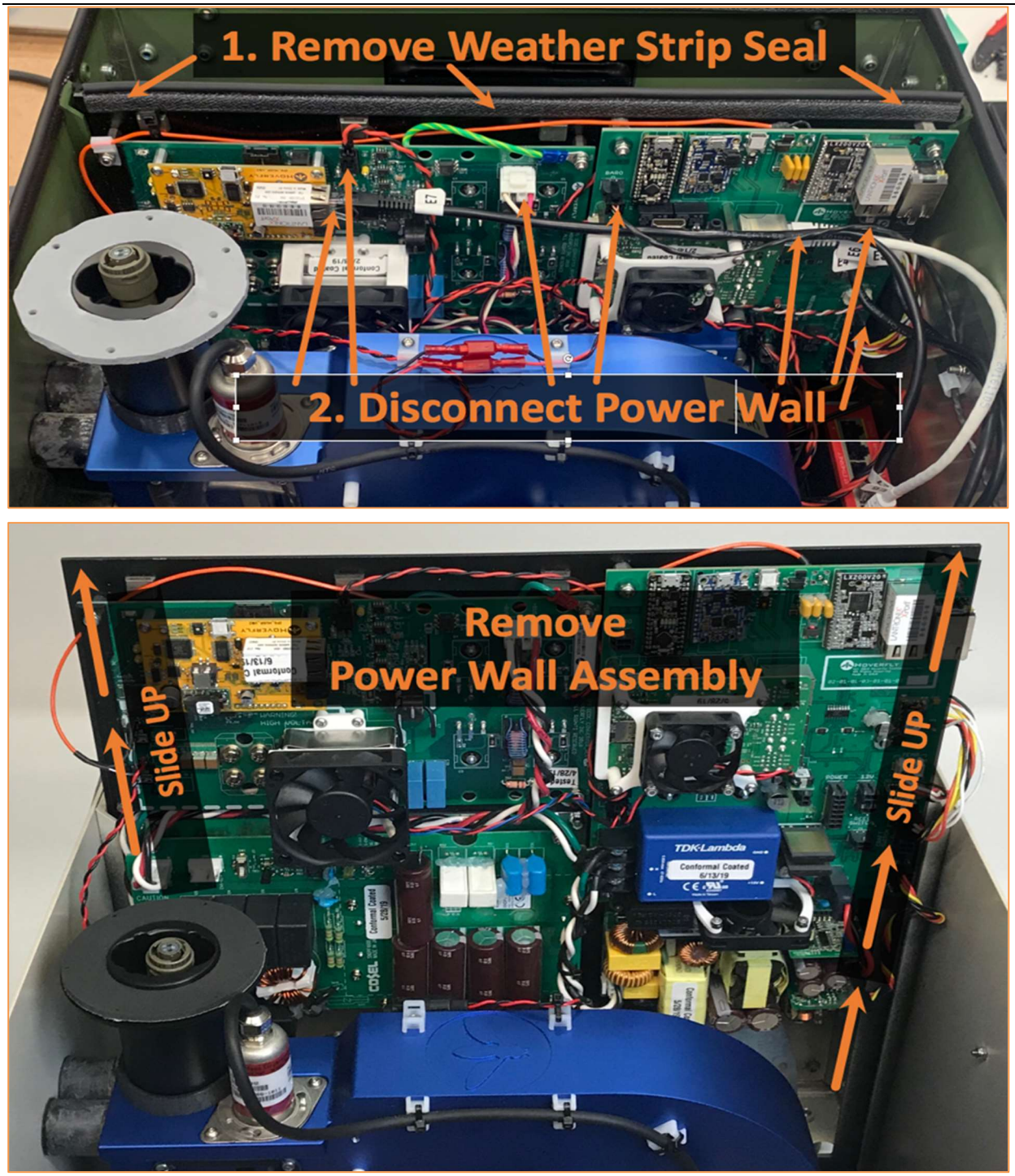


Figure 42. Removing the Tether Kit Heatsink Wall

After removing the connectors from the Tether Heatsink Sink Wall, gently lift and pull it straight up, sliding it up through the guides on the sides of the TK.

Remove the new Tether Heatsink Wall from its anti-static storage bag and put the old Tether Heatsink Wall in the storage bag for return to Hoverfly for repair.

DO NOT DISCARD THE OLD TETHER KIT HEATSINK WALL

Slide the new Tether Heatsink Sink Wall into the slots, connect all the connectors, and replace the weather strip seal on top of the Tether Heatsink Sink Wall.

REINSTALL THE MOISTURE CONTROL WEATHER STRIP SEAL

After replacing the Tether Heatsink Sink Wall and reinstalling the seal, reinstall the TK Cover using the top six (6) fasteners and eight (8) fasteners around the perimeter of the cover.

After reinstalling the TK Cover, then proceed to a Cordon Area and install the Landing Ring.
To restart operations, follow the procedure at Section 2.1 Unpack, Payload Installation, and Setup.

RETURN THE OLD TETHER KIT HEATSINK WALL TO HOVERFLY FOR REPAIR. CALL +1 407-985-4700 ext. 6205 FOR PREPAID SHIPPING INFORMATION

6.2 Propeller Replacement

Four or more propellers are supplied with the LiveSky Kit. **NOTE THAT THE PROPELLERS ARE ROTATION DIRECTION DEPENDENT AND NOT INTER-CHANGEABLE!**

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

INSTALL PROPELLERS ONE AT A TIME AND MATCH TYPE CW OR CCW AT EACH POSITION. CW and CCW PROPS EACH MUST BE INSTALLED CORRECTLY – REPLACE ONE AT A TIME & MATCH TYPE

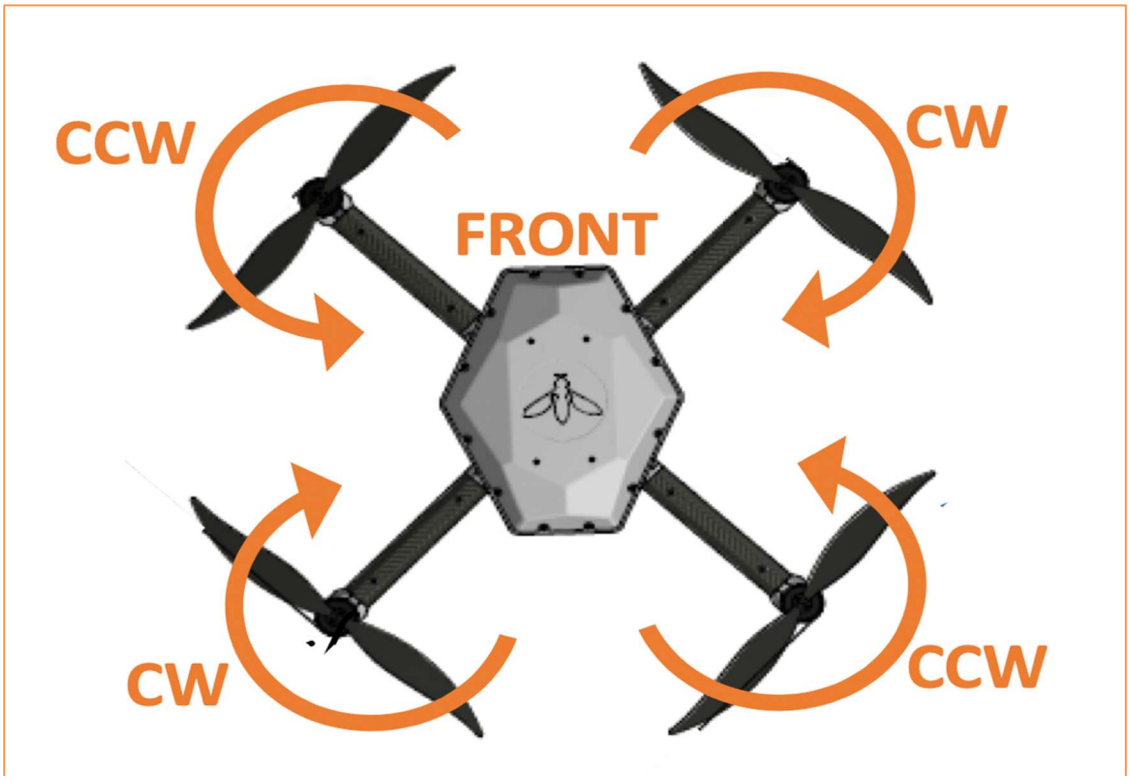


Figure 43. Propeller Rotation Direction

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

VERIFY THE CORRECT INSTALLATION OF PROPS. LEADING AND TRAILING EDGE SHAPES ARE SHOWN BELOW. THE TRAILING EDGES ARE CURVED. LEADING EDGES ARE FLAT. INSTALL LOGO UP!!!

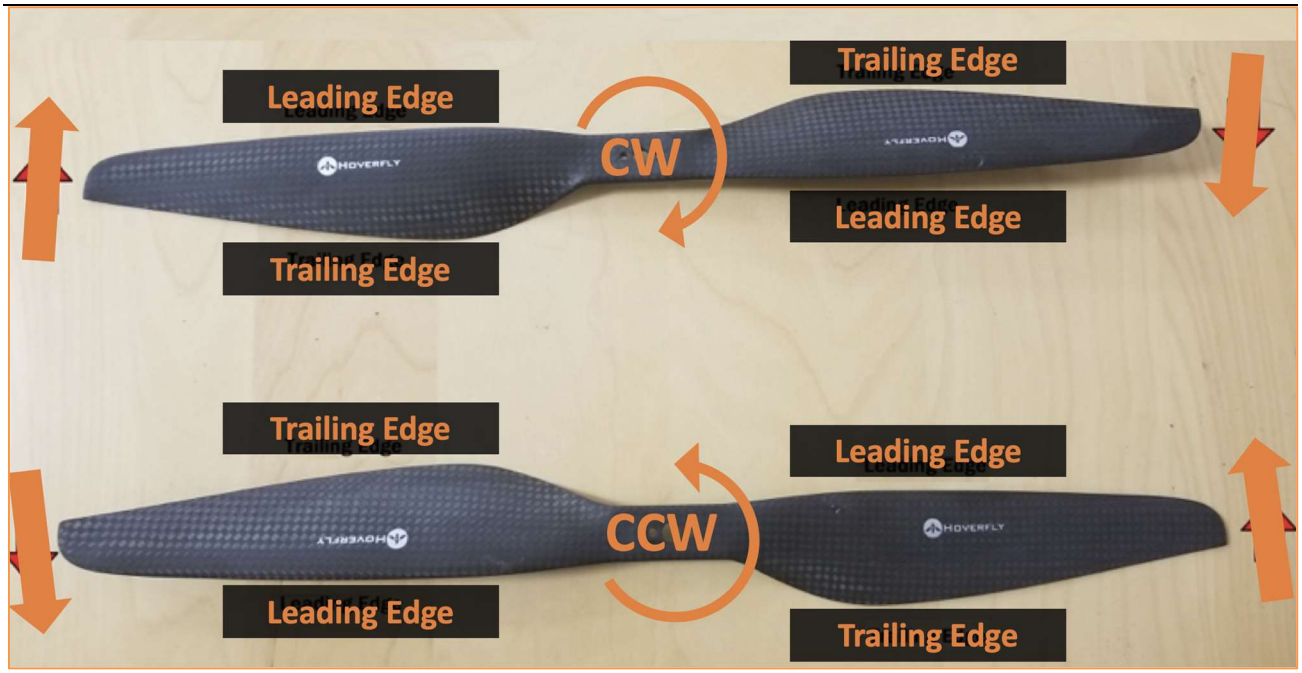


Figure 44. Propeller CW, CCW Shape Reference

Install each propeller with the Hoverfly logo on top and pointed up towards the open sky as shown in Figure 44. Propeller CW, CCW Shape Reference.

INSTALL NEW PROPS WITH THE HOVERFLY LOGO FACING UP!!!

6.3 LiveSky Air Vehicle Replaceable Assemblies

Other than propellers, the LiveSky air vehicle has five FRU assemblies that can be replaced in dry field environments. When replacing FRU assemblies on the LiveSky air vehicle, retain all fasteners removed during the process in a cup or other container for re-use during reassembly.

CANOPY FASTENERS HOLD EVERYTHING IN PLACE. RETAIN ALL FASTENERS FOR REASSEMBLY.

Figure 45. LiveSky 6205 Air Vehicle Exploded View and FRU Assemblies

The Canopy fasteners go through Canopy components and then through the Inner Seal, BGU Bezel Deck, and the Main Electronics Assembly. When the Canopy fasteners are removed, each of these items will be "floating" inside the LiveSky main body. During re-assembly, it is critical to align this "stack" precisely, pressing the Canopy down while installing the four-corner fasteners first.

CANOPY FASTENERS HOLD EVERYTHING IN PLACE. RETAIN ALL FASTENERS FOR REASSEMBLY. REALIGN THEM PRECISELY.

6.3.1 LiveSky Motor Boom Replacement

If damage to a motor boom occurs, or when instructed by the Controller, replace the motor boom assemblies. The replacement motor boom kit contains four motor booms. All motor booms should be replaced at the same time if the threshold in Table 7. Mandatory Maintenance Actions (MMA) has been reached. In this case, the Controller will provide instructions and create a log entry.

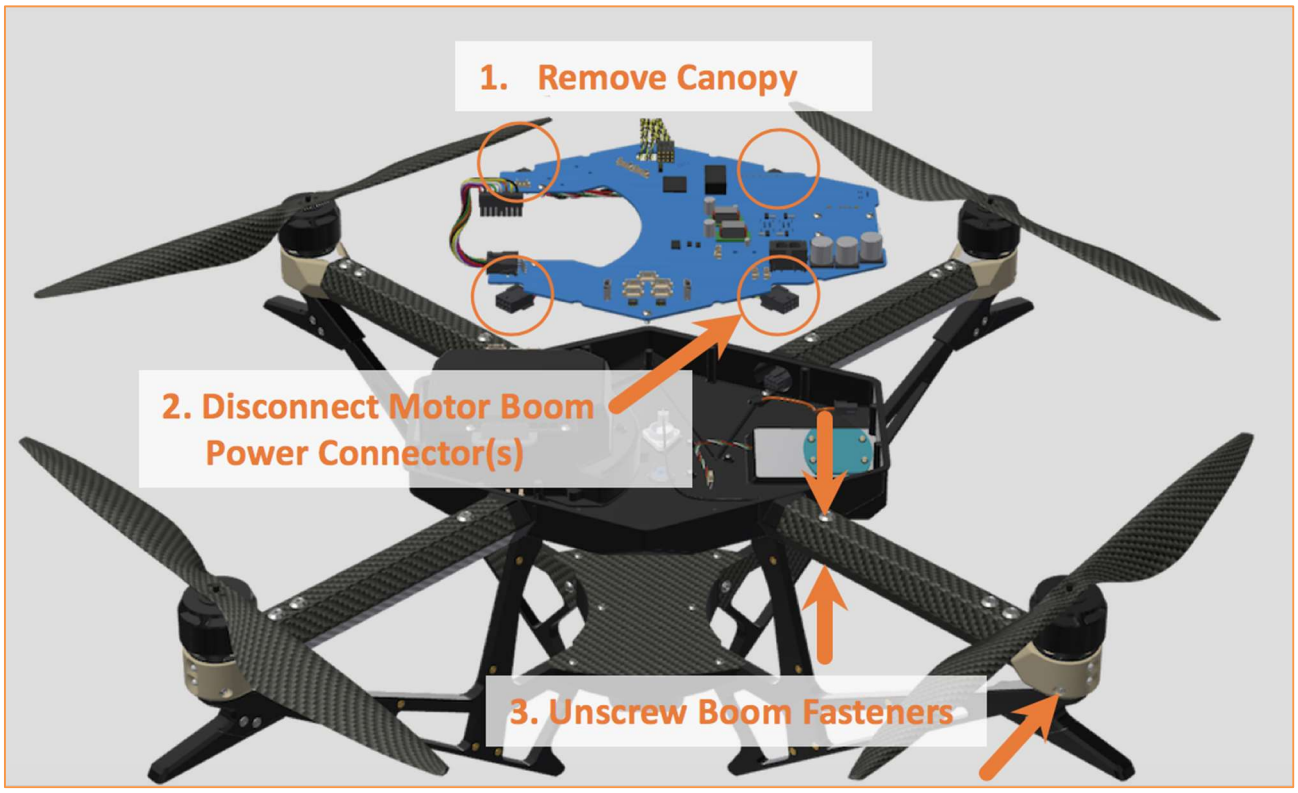


Figure 46. Motor Boom Replacement

To replace a motor boom, carefully lift the Main Electronics Assembly above the LiveSky main body and disconnect the Motor Boom Power Connector. Then remove the motor boom itself by first removing the fastener at the nacelle below the motor, and then the two fasteners at the root of the motor boom close to the main body. Save these fasteners for reinstalling the motor boom.

Attach the new motor boom, connect it to the Main Electronics Assembly and use the screwdriver included in the LiveSky System to properly fasten and torque the new booms to the main body. Reinstall the fastener on the motor nacelle to re-attach the LiveSky landing skid.

Reverse the Canopy disassembly process and carefully align the "stack up" of Inner Seal, BGU Bezel Deck, and the Main Electronics Assembly. Then, apply the Canopy, Outer Bezel and fasteners, starting with the four corners first. If misalignment of the "stack" occurs, use the T6 driver to align the Canopy and other items below to make room for the fastener.

6.3.2 LiveSky Air Vehicle Main Electronics Assembly

As instructed by Hoverfly Support Services, or as instructed by the Controller, replace the LiveSky Main Electronics Assembly.

Figure 47. Main Electronics Assembly Replacement

After the BGU Bezel Deck is exposed by removing the Canopy, numerous connectors must be disconnected from both the flight controller on the Deck and from the Main Electronics Assembly.

Using a cell phone, take a picture for reference at any time during this process for later reference.

Before removing the BGU Bezel Deck, disconnect the Flight Controller wire harness. Disconnect the connectors on the Main Electronics Assembly paying attention to the orientation and position of each connection.

Remove the Main Electronics Assembly and put it in the shipping bag from the replacement assembly. Return the replaced assembly to Hoverfly.

Reverse the process above to install the new Main Electronics Assembly.

operations, follow the procedure at Section 2.1 Unpack, Payload Installation, and Setup.

RETURN THE OLD MEA ASSEMBLY TO HOVERFLY FOR REPAIR.
CALL +1 407-985-4700 ext. 6205 FOR PREPAID SHIPPING INFORMATION

7. Environmental Operating Limits

The following strict limits on operating environment must be obeyed. In general, flight operations beyond these environmental Limits will result in an automatic autonomous safety landing when the LiveSky detects conditions which exceed the Limits.

Table 8. Environmental Operating Limits

Environmental Parameter	Minimum	Maximum	Description
Flight Duration	*1 minute*	*1500 hours*	*Replace Boom Arm and/or Tether Reel as needed*
Operating Temperature	*-9C*	*55C*	*Take Precautions During High and Low Temperature Operation*
Storage Temperature	*-30C*	*70C*	*Take Precautions at Temperature Extremes and Bring to Operating Temperature Range before Launch*
Precipitation	*None*	*MIL-810G*	*NON-ICING CONDITIONS ONLY*
Wind Speed During Operation	*0 mph*	*25 mph*	*Sustained Wind Speed Limit, Does Not Including Gusts*
Wind Speed During Landing	*0 mph*	*15 mph*	*Sustained Wind Speed Limit, Does Not Include Gusts*
Maximum Wind Speed	*0 mph*	*30 mph*	*1 Second Gusts*

8. Specifications and Dimensions

This Section provides specification and dimension information on the LiveSky Dismounted System.

Table 9. Specifications

Specification Parameter	Value	Description
Maximum LiveSky Operating Altitude above Launch Level	*200' / 60M*	*Software Limited*
System Power Required	*90-264VAC 50/60Hz Maximum 2000W*	*Nominal power required at 120VAC is less than 2000W at sea level. More power is required at altitude.*
LiveSky Air Vehicle Weight	*7.0lbs / 3.2Kg*	*AUGVW including payload(s)*
Tether Kit Weight	*45.2lbs / 20.5Kg*	*Including Landing Ring*
Total System Weight	*52.5lbs / 23.8Kg*	*Exclusive of Controller and Cables*
Total Shipping Weight	*99lbs / 45Kg*	*Two (2) Transit Cases with System and Accessories including EO/IR Payload*
Command and Control Method	*Wired*	*C2 and Video over Tether Network. No RF C2. Operator Control Via Wired Hoverfly ToughPad, Hoverfly API or SDK over Wired Ethernet Connection.*

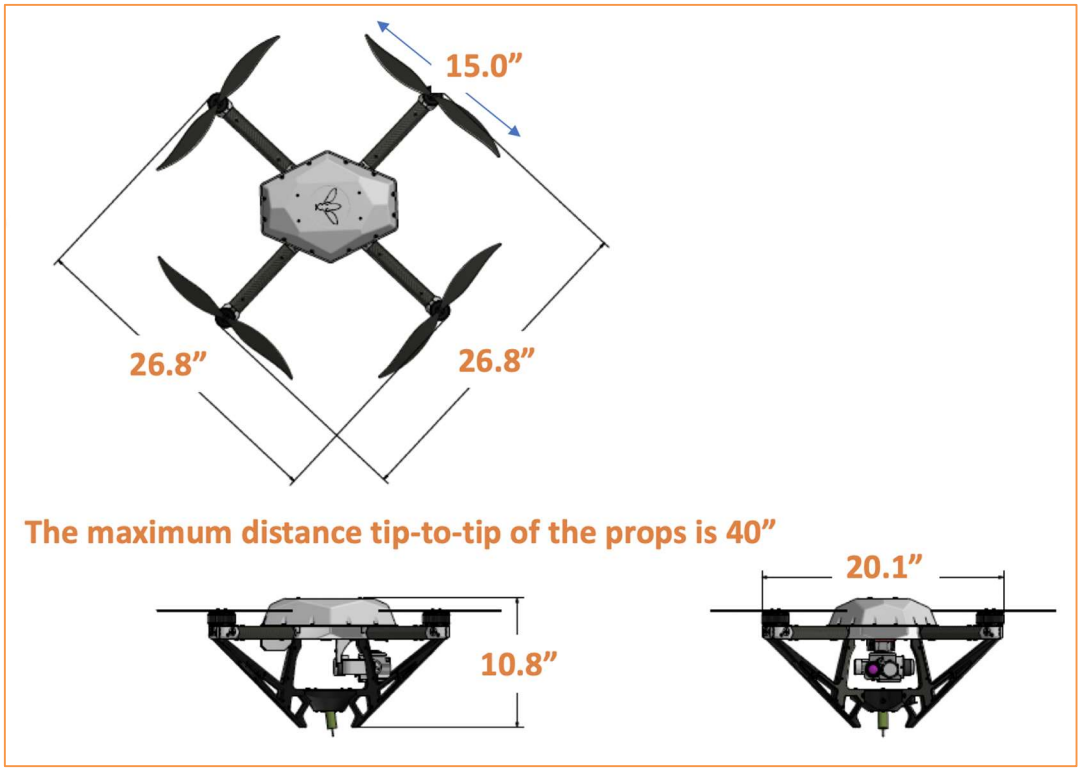


Figure 48. LiveSky Air Vehicle Dimensions

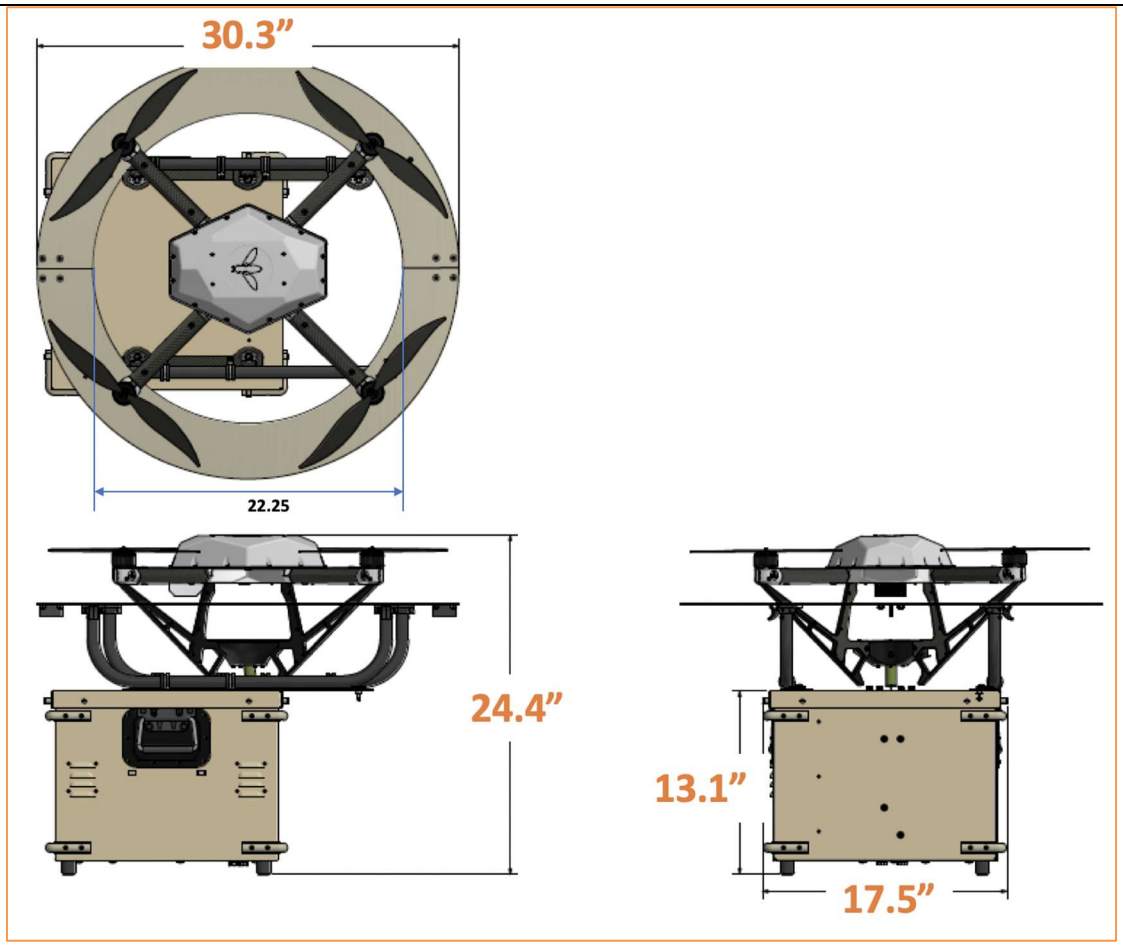


Figure 49. LiveSky Dismounted System Dimensions

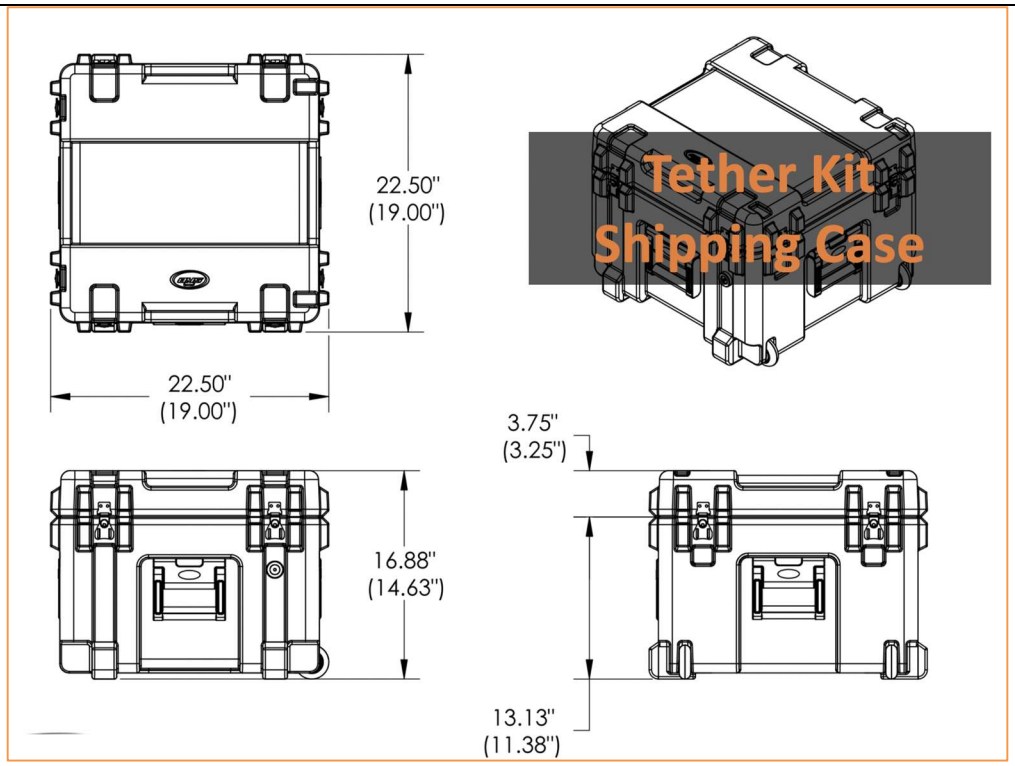


Figure 50. LiveSky Tether Kit Shipping Dimensions

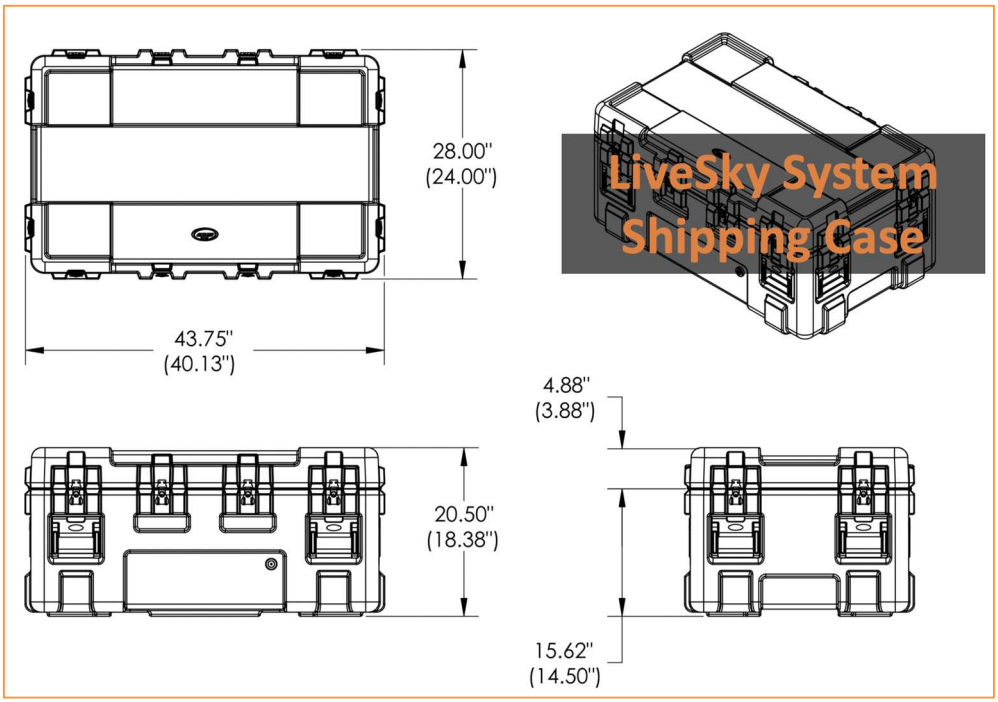


Figure 51. LiveSky System Shipping Dimensions

9. Part Numbers and Spares

LiveSky System Configuration Items and LiveSky Spares are shown below. Spare or replacement assemblies, subassemblies, and consumables can be obtained under Warranty conditions, under contract terms, or by direct purchase from Hoverfly. Call +1 407-985-4500 Extension 6205 for more information. Have the LiveSky System serial number or contract number ready.

Table 10. Hoverfly LiveSky Part Numbers

Category	Part Number / SKU	Name
LiveSky Configuration Items	LSP-6205-EOIR30-S	LiveSky SENTRY with EO/IR Payload
	LSP-6205-EOIR30-D	LiveSky DEFENDER, EO/IR Payload, NON-GPS Ops Capability
	SBM-LSP-6205	LiveSky SENTRY with SkyBox Mobile
	SBCM-LSP-6205	LiveSky SENTRY with SkyBox - Covered
	HF-TPC	LiveSky ToughPad Touch Controller with LiveSky Executable
	LVS-OTM-01	LiveSky On-The-Move Vehicle Kit (Not Required for SkyBox)
	LVS-MPU5-C/L/S	LiveSky Persistent Systems Wave Relay MPU5 Payload
	LVS-PM-SC4200	LiveSky PowerMount for Silvus SC4200 Streamcaster
	LVS-PM-TW850	LiveSky PowerMount for TrellisWare TW-850 Ghost
	HF-SDK-API	LiveSky Software Development and Integration Kit
	LVS-620X-EXWA	LiveSky Extended Warranty
	LVS-620X-SLA3	LiveSky Service Level Agreement
LiveSky Spares	LSP-6205-FRU	LiveSky LSP-6205 Field Replaceable Unit Spares Kit (sans payload)
	LVS-62-EOIR	LiveSky LSP-6205 EO/IR Payload
	LSP-6205-AV	LiveSky LSP-6205 Air Vehicle Only
	LSP-6205-TK	LiveSky 6205 Series Tether Kit Only
	LVS-6205-BGU	LiveSky 6205 Air Vehicle Main Electronics Assembly Kit
	LVS-6205-ATS	LiveSky 6205 Advanced Tether Sensor Assembly
	LVS-6205-4MB	LiveSky LSP-6205 Motor Booms Kit (4 Motor Booms Included)
	LVS-62-TK-LWII	LiveSky Replacement Reel Assy (includes Tether and Connector)
	LVS-62-PWA	LiveSky Infini-FLY Power Wall Assembly
	LVS-62-RNG	LiveSky Precision Landing Ring
	LVS-6205-CAN	LiveSky Canopy
	LVS-6205-4PK	LiveSky Propeller Kit (Quantity 4 each CW, CCW types)

10. Tools

The LiveSky System comes with the basic tools necessary to replace the FRUs. The following tools are provided in the LiveSky air vehicle transit case. Keep these tools available and with the System if deployed away from the transit cases in order to make field repairs.

Table 11. LiveSky System Tools List

Tool	Applicability	MP/N	Manufacturer
Torque Handle – Preset 8lbs *Ball End Hex Blade 2.0*	*LSP-6205-EOIR30 Air Vehicle Canopy Fasteners and Internal Fasteners, Motor Boom Nacelle*	*29209* *28034*	*Wiha - Germany* *Wiha - Germany*
#2 Phillips Screwdriver, Profilated, 4”	*LSP-6205-EOIR30 Air Vehicle, Motor Boom Root Fasteners, LSP-6205-TK Tether Reel Side Fasteners*	*BD-122*	*Klein - USA*
3/8” Keystone Screwdriver 12-in Shank	*LSP-6205-TK Top Cover, Tether Reel Assembly, Tether Kit Battery, EMI Filter, and Router*	*602-12*	*Klein - USA*

11. Troubleshooting

There are several common issues which could cause inconvenience when operating the LiveSky system. This section of the manual is designed to help sort through some of those issues. Follow the procedures listed below if you encounter listed issues.

Craft does not power on

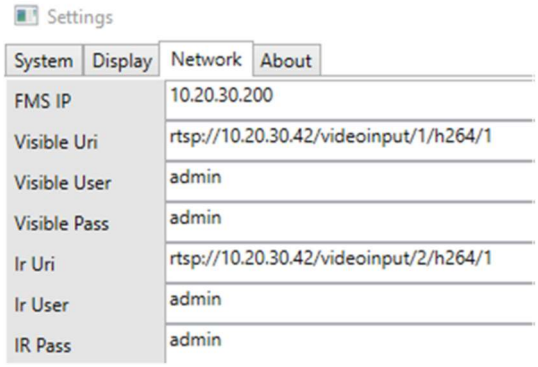
- Check tether connector and tether for damage while system is powered off
- Check ground power supply, cables and connections
- Reboot the system

Craft 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 craft and EO/IR gimbal are powered
- Lens cap removed and lens free of debris
- Ensure the system has been powered on for at least 5 minutes
- Ensure you have connected to the craft
    - In the Settings/Network Tab of the GUI ensure the following is set



Craft will not arm

- Ensure the craft 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

Craft 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

12. Emergency Procedures

This section describes the aircraft system emergencies that may occur and presents the relevant emergency procedures. A table of all fail-safe (automated landings due to fault detection or subsystem failure) is listed at the end of the section. A condensed version of these procedures is listed in the aircraft abbreviated checklist.

Information that requires special emphasis to the operator is expanded upon in the form of a note, caution, or warning, as follows:

NOTE:
An operating procedure, condition, or statement, which is essential to highlight.

CAUTION:
An operating procedure, practice, condition, or statement, which if not strictly observed, could result in damage to or destruction of equipment, loss of data, loss of mission effectiveness, or long-term health hazards to personnel.

WARNING:
An operating procedure, practice, or statement, which, if not correctly followed, could result in personal injury or loss of life.

Summary of Critical Aircraft Commands and Definitions

MINIMUM ALTITUDE: When the aircraft is launched it will ascend to a stabilized hover at 15' (5 m) and wait for the next command. The aircraft will not descend below minimum altitude until the **LAND** button is pressed.

HOME: The HOME button will reposition the aircraft above the tether kit within the proximity of the ground GPS unit (+/- 3m) unless RTK GPS equipped.

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: The **LAND** button will command an autonomous landing meaning the aircraft will descend and land in the landing ring. The **LAND** command can be initiated 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 initiated, 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 AT ANY POINT, IMMEDIATELY REMOVE THE ETHERNET CONNECTION TO THE CONTROLLER TO INITATE A LOST COMM FAIL-SAFE LANDING. WAIT 10 SECONDS (unless lost comm delay settings have been extended, then add appropriate number of seconds), IF THERE IS STILL NO RESPONSE, THEN REMOVE POWER CONNECTION AT THE SOURCE, IF SAFE TO DO SO, TO INITIATE A LOST POWER FAILSAFE LANDING.

E-STOP: The **E-STOP** command should only be activated in 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 and will likely result in the damage or destruction of the aircraft. To initiate **E-STOP** command press the **E-STOP** button. A new window will open instructing the user to tap three (3) times to confirm **E-STOP**.

CAUTION
USING THE E-STOP FUNCTION WILL LIKELY RESULT IN DAMAGE OR DESTRUCTION OF THE AIRCRAFT, SINCE THE MOTORS WILL IMMEDIATELY CEASE OPERATION AND THE AIRCRAFT WILL FALL TO THE GROUND

WARNING
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, THE OPERATOR SHOULD CLEAR THE AREA UNDER THE AIRCRAFT OF ANY PERSONELL TO AVOID INJURY

Description of Emergency Procedures by Event

ABORT TAKE-OFF

Indication:
LAUNCH button has been pressed and the aircraft has begun take-off sequence to minimum altitude.

Emergency procedures to follow:
1. Immediately initiate **LAND** command
2. Pressing the **LAND** button after **LAUNCH** will abort the take-off and land the aircraft.

UNCOMMANDED FLY AWAY

Indication:
Aircraft begins moving in one direction, without being commanded to do so.

Emergency procedures to follow:
1. Immediately initiate **LAND** command
2. When aircraft begins returning press the **HALT** button
3. Reposition the aircraft, centered over the landing ring
4. Initiate **LAND** command
5. Repeat steps 2-4 as necessary to land the aircraft

UNCOMMANDED ROTATION/SPIN

Indication:
The aircraft begins to spin rapidly un-commanded

Emergency procedures to follow:
1. Immediately initiate **LAND** command
2. Visually observe that the rotation has ceased, and landing has begun
3. Clear the area and wait for the landing sequence to complete

MAGNETOMETER FAILURE/EMI

Indication:
The aircraft begin flying in a circular pattern un-commanded. Its critical to initiate the **LAND** command immediately or the circular flight pattern will get larger.

Emergency procedures to follow:
1. Immediately initiate **LAND** command
2. Immediately clear the area and wait for the landing sequence to complete
3. Visually observe that the aircraft is landing. The aircraft will continue flying in a circular pattern until it lands and may or may not land in the ring.

TETHER LOCKUP

Indications:

- Listening to the motors straining
- If the aircraft is not climbing to a commanded altitude
- If the tether is completely taught and not reeling out.

Emergency procedures to follow:

1. Immediately initiate **LAND** command
2. Immediately clear the area and wait for the landing sequence to complete
3. Visually observe that the aircraft is landing and ensure it lands in the ring using **HALT** function as needed

ABORT LANDING

Indication:
For long duration flights or sudden changes in weather conditions, the aircraft may be launched within wind limitations, however, may have to be recovered in wind conditions (or other environmental conditions) outside the limits of the aircraft. In rare cases the aircraft may catch a gust of wind, just prior to landing in the ring resulting in an apparent landing outside the ring. The pilot should be very vigilant in these conditions and be ready to take the following actions if it appears the aircraft will miss the landing ring:

Emergency procedures to follow if:
The **LAND** button has been pressed to initiate a landing and the aircraft has descended below MINIMUM ALTITUDE and within a 2-3 feet of touchdown, but appears to be missing the landing ring:

1. Immediately press the **HALT** Button
2. Allow the aircraft to climb back to MINIMUM ALTITUDE to a stabilized hover
3. If necessary, reposition the aircraft, centered over the landing ring
4. Wait for wind gusts to subside and press **LAND** button
5. Repeat as necessary

COMMUNICATION FAILURE

Indication:
The aircraft is not reacting to command inputs or data is not updating in the GUI.

Emergency procedures to follow:

1. Unplug and reconnect ethernet cable that goes to the control tablet or computer
2. Close and reopen the control GUI, then attempt to reconnect to the air vehicle
3. If unsuccessful, continue to step 4. Otherwise, resume normal operations
4. Unplug ethernet cable from control tablet or computer, leave cable unplugged
5. Immediately clear the area and wait for the landing sequence to complete
6. Disconnect power if observed that the craft will not land in the ring

APPENDIX A – LIPO Safety Tips

Lithium Polymer Safety Tips:
Lithium Polymer cells are a tremendous advance in battery technology. However, due to the chemistry of lithium cells, there is a possibility of fire if charging is not properly done.

This is no different from many things we use in daily life – knives, kitchen cleaners, automobiles, for a few examples – which are inherently dangerous, but which can be used safely by adhering to simple rules and precautions.

SAFETY AND HANDLING INSTRUCTIONS:
CHARGING & DISCHARGING

- NEVER leave a LiPo battery unattended at any time while being charged or discharged.
- Ensure that the Lithium Polymer charger settings are correct for the battery pack being charged – both voltage (cell count) and current settings.
- ALWAYS charge and discharge LiPo batteries in a fireproof location, which could be a container made of metal (such as an ammunition box), ceramic tile, or a bucket of sand.
- ALWAYS have a fire extinguisher available.
- NEVER charge LiPo batteries at currents greater than the “1C” rating of the battery (“C” equals the rated capacity of the battery). For example, the “1C” rating for a 1300mAh battery is 1.3A.
- NEVER allow LiPo cells to overheat at any time! Cells which exceed 140°F [60°C] during charge or discharge can and USUALLY WILL become damaged and MAY CATCH FIRE.
- Always inspect a battery which has previously overheated and do not reuse it if you suspect it has been damaged in any way.
- ONLY use a charger specifically designed for LiPo batteries.

LIPO STORAGE

- For long term storage it is recommended to store them to 50-60% of their capacity (3.8V/Cell). For example, a 6 cell LiPo would be at 22.8 volts.
- Store batteries at room temperature in a cool area, ideally between 40-80°F. Temperatures exceeding 170°F for greater than 1 hour may cause damage to battery and cause a fire.

DISPOSAL OF LIPO BATTERIES

- Unlike NiCd batteries, LiPo batteries are environmentally friendly. The batteries must be cool before proceeding with disposal instructions.

To dispose of LiPo batteries:

1. Place the LiPo battery in a fireproof container.
2. Connect the battery to a LiPo discharger. Set the discharge cutoff voltage to the lowest possible value. Set the discharge current to a C/10 value, with “C” being the capacity rating of the pack. For example, the “1C” rating for a 1300mAh battery is 1.3A, and that battery’s C/10 current value is (1.3A / 10) 0.13A or 130mA.
3. Discharge the battery until its voltage reaches 0V per cell.
4. Dispose the LiPo battery in the normal trash.

MONITORING LIPO HEALTH

- Over time & use LiPo batteries will degrade, decreasing their capacity.

To determine the health of a LiPo:

1. Using a LiPo charger with discharge capabilities & display that shows mA, discharge the battery down to the minimum safe voltage (3.2 volts per cell).
2. Allow the battery to cool then recharge the battery. Note the milliamps (mA) the charger put back into the battery. This should be very close to the rated capacity of the battery.

Repeat this approximately once a month. When the milliamps (mA) put back into battery drops 10% below the rated capacity, stop using the battery.