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Welcome to the Silent Falcon™ sUAS

The Choice for the Operator Who Needs:

- Long endurance
- Silent and safe operations
- Quick and effortless assembly
- Easy transportability
- Cost-effectiveness

The following pages detail the complete Silent Falcon™ sUAS
A Complete Silent Falcon™ Small Unmanned Aircraft System (sUAS) Including Two Aircraft, Launcher and Ground Control System

The Silent Falcon™ sUAS integrates Thin Film Photovoltaic panels, leading edge modular design, silent, slow spin, high efficiency electric propulsion and state of the art ground control and communications systems to create a logistically independent UAV platform that has exceptional endurance and the electrical power to support state of the art payloads—giving the system capabilities found only on larger, more complex and more expensive systems.

The Silent Falcon™ sUAS is an open interface system and that accommodates a wide variety of payloads. The payload bay is located on the aircraft’s center of gravity and is approximately 230 mm long, 140 mm wide and 200 mm deep. As long as the payload can fit within these dimensions and weighs ≤ 3 kg, the Silent Falcon™ sUAS can carry it. Over a dozen different payloads have been successfully integrated, and new payloads are being introduced regularly. One of the most common payloads requested for military, law enforcement and security applications is the Ascent Vision CM100.

The Ascent Vision CM100 gimbal offers an unparalleled combination of small size and superior performance characteristics to include High Definition dual imager capabilities in a very low SWaP gimbal. It has 1280 x 720p High Definition video, as well as 640 x 480 infrared sensing abilities. It has 30X optical zoom, and advanced capabilities usually reserved for much larger and expensive gimbals.
The CM100's advanced capabilities and characteristics are typically found in much larger SWaP classes of gimbals that are unsuitable for sUAS applications due to size and weight. Its unique features are made possible through the integration of onboard video processing, which provides capabilities such as high definition electro optic sensing, video stabilization, object tracking and variable H.264 mpeg2 imagery data compression.

CM100 Payload

The CM100's unique electronics provide it with the widest operating temperature range in its SWaP class which allows it to operate in extreme climates without an onboard heating and cooling system—reducing significantly weight and power consumption. The CM100 is equipped with a Hitachi DISC120R 720p HD digital color camera with 30x optical zoom and a FLIR 640 Quark 2 IR camera with 19mm lens.

The CM100 Dual Sensor Gyro Stabilized Gimbal is specifically designed for use on unmanned aircraft. It is ideal for day and night observation and surveillance.
Key Features of the CM100 include:

- Size (D x H): 100mm x 190mm | 3.9in x 5in
- Weight: 800g | 1.8lb
- Power: 12W
- Position Accuracy: 0.022° or 380 µrad
- Elevation: ±115°
- Azimuth: 360° Continuous
- Slew Rate: 105°/s or 1.83 rad/s

Video Output

- Analogue Output: Composite
- Digital Output: H.264 up to 10 Mbps
- Snapshots: HD (Stored on Board)
- Streaming: EO 1280 x 720 and IR 640 x 480

The CM100 is currently being used in many different applications around the globe, to include:

- Day and Night Observation
- Surveillance
- Anti-Smuggling Surveillance
- Coastal and Border Control
- Anti-Terrorist and Law Enforcement
- Maritime Surveillance
- Infrastructure Inspection
- Damage Assessment
- Search & Rescue
- Traffic Surveillance
- Fire Control / Spotting
- Wildlife Spotting
Silent Falcon™ UAS System Components

**Silent Falcon™ sUAS Platform:** The Silent Falcon™ platform is a rugged, reliable, stealthy, all composite modular airframe. The airframe also has modular components and is mission flexible. The system is extremely quiet with a very low thermal signature, which allows it to avoid detection. Using a patent pending process, thin film photovoltaic panels are integrated in the wings to generate electrical power during daylight hours.

Silent Falcon™

The airframe is made with carbon fiber, producing an uncompromised ratio of weight to strength. Emphasis of the design is on weight, acoustic signature and aerodynamic efficiency. The airframe has an optimal cruise envelope of 50 to 60 kmh. The design of the airframe delivers the lowest stall speed practical of ~42 kmh.

Silent Falcon™ is a small electric tactical sUAS capable of meeting both portable mission requirements, as well as extended flight endurance mission profiles. Using current Commercial Off the Shelf (COTS) custom-sized thin film photovoltaic panels (TFPV) and Silent Falcon’s patent pending TFPV integration process, the airframe can be expected to fly missions that require long flight endurance. Silent Falcon™ gets its exceptional endurance capabilities by the integration of:

- Advanced aeronautical design with extraordinary lift/drag ratio glider wing profiles
- Integrated thin film photovoltaic panels on the wing surfaces provides significant electrical power generation capabilities
- High efficiency and near silent electric propulsion system with a proprietary 6-bladed propeller
- High-density lithium ion/polymer batteries
The system’s configuration includes catapult launch and parachute recovery, a wide variety of payloads, the Horizon Ground Control System run on a rugged laptop computer and a number of different communication systems. For the longest range and greatest bandwidth, customers typically specify the SF MANET communications system with an automatic tracking antenna to extend the system’s range to up to 100km.

The systems are Export Administration Regulations (EAR) compliant and do not typically require ITAR compliance. They are packed in easily transportable cases, and include all spare parts, manuals and accessories necessary for operations. Silent Falcon™ will also provide training for system and payload operators.

**Transport and Assembly at Operations Site:** The Silent Falcon™ aircraft is transported to the field in a single case with integrated set up stands for easy assembly and disassembly at the operations site. Assembly of the aircraft takes approximately 30 minutes and requires a single Phillips head screwdriver to tighten the eight (8) Dzus fasteners joining the upper and lower fuselage, and a wrench to attach the propeller. The horizontal and vertical tail sections, wings and wing tips attach with quick snap fasteners to the fuselage and require no tools.
The steel spring powered catapult launcher is also transported to the operations site in three (3) cases. Its assembly at the operations site requires no tools as the four (4) sections fit together by hand. The 12-volt electric winch that cocks the launcher also compresses the 4-launcher sections together for a tight and robust fit.
Two of Four Catapult Launcher Sections in Case

Catapult Launcher Assembled at Operations Site
Volt Winch at Aft End Cocks Launcher

The Silent Falcon™ aircraft is then easily carried to the launcher where it rests on pins on a launch cradle. The steel spring is then energized or cocked in about 30 seconds by the electric winch, and the aircraft is now ready to be launched. The entire process from arrival at the operations site to launching the aircraft can be completed in approximately 30 minutes.
Aircraft on Catapult Launcher
**Silent Falcon™ Silent Propulsion System:** Silent Falcon™ incorporates an electric propulsion system, including a proprietary six (6) bladed folding propeller that is both extremely energy efficient and near silent in operation. Internal testing demonstrates that in an inside environment, the system is virtually silent within 200 meters AGL (Above Ground Level). In a real world flight environment with ambient environmental noise, the Silent Falcon™ is nearly silent at almost any distance.

![Six Blade Folding Propeller](image1.png)

![Silent Falcon™ Flying Off Catapult Launcher](image2.png)
**Parachute Recovery:** To recover the aircraft, a single push of a button on the ground station computer display deploys the parachute, inverting the aircraft to land upside down and thereby protect the payload. The parachute releases from the aircraft immediately upon landing to prevent the plane being dragged on the ground should the parachute re-inflate due to high winds.

**Aircraft Electrical Subsystems:** Silent Falcon™ instrumentation subsystems encompass four (4) separate subcomponents—flight instrumentation, airborne electronics, radio communication systems and digital sensor integration. A major component of the digital integration is the development of the embedded software and hardware that control the aircraft (autopilot). Silent Falcon™ incorporates a state of the art, MicroPilot 2128 g2 open architecture autopilot. This allows for seamless integration between the autopilot, gimbal and sensors, flight controls, communications and the ground control system, using industry standard “open system” software protocols.

Other airborne electronics include the RF communication systems, GPS, aircraft control and flight computer—all integrated with the autopilot, gimbal and ground control system. The system can be equipped with an optional Mode S ADSB Out transponder for safe operation in controlled airspace. The transponder meets both FAA and EASA standards.
**Ground Control System (GCS):** Silent Falcon™ includes a technologically advanced, state of the art ground control system. The GCS is the element within the overall system enabling the user to control the aircraft without actually having to fly it.

All of the elements of the GCS are transported to the field in a rugged Pelican case containing a large monitor, a rugged laptop computer for flight controls and mission programming, an integral joystick to control the aircraft in RPV mode, and all cabling for power, communications and network access. A separate rugged laptop computer and PlayStation type controller is provided to control the real-time video and data feeds from the various payloads and sensors. This allows the pilot to concentrate on the aircraft while the sensor operator concentrates on the critical video and real time data streams from the sensors.

For example, while flying a mission, the payload operator can toggle the screen view on his laptop to view the EO or IR imagery from the systems cameras and may identify an object on the ground that requires closer inspection, causing the aircraft to break from its pre-programmed flight path. Through the GCS interface, the payload operator simply clicks on the object and gives its coordinates to the aircraft operator who then selects the “loiter” option and the vehicle automatically breaks from its programmed pattern and begins to loiter around the assigned object. At any time, the operator can select the “resume” feature and the aircraft will go back to its original flight plan. In short, the GCS enables the payload operator to focus on watching potential threats and the aircraft operator will respond accordingly based on what the payload operator wants to see.
**Communications System:** The Silent Falcon™ RF communications are typically performed by the SF MANET communications system including the optional automatic tracking antenna system.

The Silvus Technologies Streamcaster® MIMO 4200 is an advanced mobile ad hoc networking (MANET) solution that goes beyond the standard “self-forming” and “self-healing” mesh network. Instead, Streamcaster® quickly and continuously adapts to fluctuations in terrain and other difficult environmental conditions to maximize connectivity and communication performance. The communications system has low latency bandwidth, up to 37 Mbps, and when used with the Tracking Antenna System, and depending on terrain, it extends the range of the system to up to 100 km and greatly adds to mission flexibility.
Depending on Terrain—
Motorized Tracking Antenna Can Extend the Range of the System up to 100km
Exhibit A
Export Regulations

For international sales, Silent Falcon™ UAS Technologies’ (SFUAS) will require licenses, permits and prior approval from various government agencies of the U.S. or other applicable jurisdictions. SFUAS will comply with all applicable U.S. laws, rules and regulations, including but not limited to the Arms Export Control Act (AECA) and the Export Administration Act (EAA), and the regulations promulgated pursuant thereto including the Export Administration Regulations (EAR), International Traffic in Arms Regulations (ITAR), Foreign Corrupt Practices Act (FCPA), and other laws administered by the U.S. Customs Service.

The customer must identify the ultimate end user (Customer), and any intermediary consignees to SFUAS as soon as practicable. SFUAS will endeavor to obtain, with the Customer’s good faith cooperation, all such necessary approvals and licenses in compliance with all U.S. and foreign laws regulating, by way of example, the export of goods or persons to a foreign state; however, SFUAS will not be responsible for (i) any fees, tariffs, or expenses required to comply with any foreign law, rule, or regulation or imputed by any foreign government body, or (ii) any delay or non-performance caused by any act or omission of any government body.

SFUAS will seek US Commerce Department approval under the EAR to export the products defined in a sales proposal to the Customer. The Silent Falcon unmanned aircraft system falls under the EAR Commerce Control List category 9 – ECCN 9A012 non-military unmanned aerial vehicles, airships, associated systems, equipment and components. This ECCN is controlled for National Security, Missile Technology and Anti-Terrorism reasons.

The Customer will be required to make normal and customary warranties and representations as to export and FCPA compliance, such as that they are not purchasing the aircraft systems for resale or use, directly or otherwise, in any country in which such resale or use would be prohibited or restricted by the applicable export control laws and regulations of the United States.
Exhibit B
Product Specifications

The patent-pending Silent Falcon is a solar electric, carbon fiber, modular, small Unmanned Aircraft System (sUAS) with a highly-sophisticated communication system and open interface/open architecture payload bay designed for meeting numerous application requirements with long range, long endurance mission profiles. All while supplying superb, encrypted and secure data to anyone, anywhere around the world. The entire system fits in the back of a pickup truck and can be set up in 30 minutes. After launch, it’s virtually silent at 100 meters. Tailor made payload and communication system solutions are available to satisfy most any mission purpose.

PAYLOADS
Open interface/open architecture payload bay accommodates off-the-shelf sensors and payloads as well as tailor-made payload solutions.

PERFORMANCE SPECIFICATIONS
Range: Depending on terrain, up to 45 kilometers or up to 100 kilometers with mesh network, communication system and tracking antenna
Endurance: Under optimal flight conditions, up to 5-hours
Optimal Cruise Envelope: 50-60 km/h (27 – 33 knots)
Operating Altitude: 75 meters (250 feet) AGL to 6,000 meters (20,000 feet) MSL

PHYSICAL SPECIFICATIONS
Wingspan: 4.2 meters (13.9 feet) including propeller and spinner
Length: 1.9 meters (6.4 feet) including propeller and spinner
Maximum Payload Weight: 3 kg (6.6 pounds)
Weight: 14.2 kg (31.4 pounds) excluding payload

COMMUNICATIONS SPECIFICATIONS
Autopilot: MicroPilot MP 2128 g2
Comms: SF MANET; multiple frequencies; other communication systems available
Antenna: Dual 3 dBi Blade 2.4 GHz on aircraft; other frequencies available

GROUND CONTROL STATION
GCS: SF Flight Planning and Control Unified Ground Control Station on rugged laptop computer; payload control on second laptop; large monitor and all communication and power cabling on standalone GCS integrated into a single Pelican case.

OTHER
Launch & Recovery: Catapult launch, parachute recovery
Fuel Source: Electric (LiPo Battery) | Solar (Integrated Thin Film Photovoltaic)
Exhibit C

Typical Payload Options

1. LiDAR Sensor

We can integrate several LiDAR sensors. The most popular are the Riegl mini VUX-1UAV (http://www.riegl.com/products/unmanned-scanning/new-riegl-minivux-1uav/) or the ACS Peregrine 3D Flash LIDAR (http://www.advancedscientificconcepts.com/products/peregrine.html). However, if all the customer only needs a digital surface model, customers are currently having good success with an optical 3D mapping solution using Structure-from-Motion algorithms as found in PhotoScan or Pix4D software. In addition to the surface model, this also provides a very nice ortho image.

2. ISR Payloads

SF has integrated 4 different ISR payloads on the Silent Falcon system. The most requested ISR payloads is the AV-CM100 made by Ascent Vision. The HD25 made by Trillium is a less costly ISR payload with fewer capabilities but still capable of meeting many mission requirements. We have integrated other ISR payloads as well.

**ASCENT VISION CM100 EO/IR ISR GIMBAL**

<table>
<thead>
<tr>
<th>Size (D x H):</th>
<th>100mm x 190mm</th>
<th>3.9in x 5in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight:</td>
<td>800g</td>
<td>1.8lb</td>
</tr>
<tr>
<td>Power:</td>
<td>12W</td>
<td></td>
</tr>
<tr>
<td>Position Accuracy:</td>
<td>0.022° or 380µrad</td>
<td></td>
</tr>
<tr>
<td>Elevation:</td>
<td>±115°</td>
<td></td>
</tr>
<tr>
<td>Azimuth:</td>
<td>360° Continuous</td>
<td></td>
</tr>
<tr>
<td>Slew Rate:</td>
<td>105°/s or 1.83rad/s Video Output</td>
<td></td>
</tr>
<tr>
<td>Analogue Output:</td>
<td>Composite</td>
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<tr>
<td>Digital Output:</td>
<td>.h264 up to 10Mbps</td>
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</tr>
<tr>
<td>Snapshots:</td>
<td>HD (Stored on Board)</td>
<td></td>
</tr>
<tr>
<td>Streaming:</td>
<td>EO 1280 x 720 and IR 640 x 480</td>
<td></td>
</tr>
<tr>
<td>KLV Tags:</td>
<td>Data added to video stream (target location, platform position, pan and tilt angles)</td>
<td></td>
</tr>
<tr>
<td>Scene Tracking:</td>
<td>Automatically steers the gimbal to keep the camera scene in frame</td>
<td></td>
</tr>
</tbody>
</table>

**TRILLIUM ORION HD25 EO/IR ISR GIMBAL**

**EO Camera:** Aptina MT9F002 sensor, h.264 Video Encoding, image stabilization, recording and playback capabilities

**IR Camera:** FLIR 9 Hz Quark 640 with 35mm Lens

**KLV Tags:** Data added to video stream (target location, platform position, pan and tilt angles)

**Scene Tracking:** Automatically steers the gimbal to keep the camera scene in frame
3. Hyperspectral Sensors
We have integrated 2 different hyperspectral imagers. For the 400-1,000nm spectrum we suggest a Headwall nano-Hyperspec camera. For the 900 – 2500 nm SWIR spectrum, we recommend the Headwall M-series micro-Hyperspec.

HEADWALL nano-HYPERSPECT
- 400-1,000 nm
  - 270 spectral bands à 2.2 nm sampling interval
  - 5nm Spectral resolution lens 17mm
  - 640 spatial bands (resolution)
  - FOV 15.9 deg (0.025 deg/pixel)
  - Max frame rate: 275 Hz
    - At typical altitude of 150m cross track spatial resolution will be 6.5 cm
    - At typical speed of 55 kmh along track spatial resolution will be 5.6 cm

HEADWALL M-SERIES MICRO- HYPERSPEC
- 900 – 2500 nm (the longer wavelength portion of the SNL requirement)
  - 6nm spectral resolution (meets SNL requirement)
  - 640 spatial bands
  - Max frame rate: 150 Hz
    - Can meet SNL spatial resolution requirement
  - 20 W power
  - 1.8 kg

4. High Performance Photogrammetric Mapping Payload
Consists of a Sony Alpha 7 - 42 Megapixel DSLR camera interfaced with a GeoSnap Pro GPS/IMU integrated metadata and camera triggering system. One of the most sophisticated and high performance photogrammetric payloads available. Also included is an IP video camera to provide situational awareness to the operator on the ground during the mapping mission.

5. Gas Imaging Payload
Niatros Gas Imaging Camera. This is a proven payload for detecting gas leaks in gas distribution and transmission pipelines and for detecting fugitive hydrocarbon emissions in oil and gas production and exploration. Features include:

- Most advanced cooled thermal infrared sensor package on the market—used to optically image and detect hydrocarbon gases
- Available in a choice of FPA formats
- Patented technology for optical gas imaging
- 320 x 256; or 640 x 512; InSB sensors
- Standard & extended lifetime Sterling cooler options
- 14-bit digital output
- Flexible outputs include Camera Link, Gig-E, H.264 & Analog video options
- Image enhancement with LAP & noise reduction filters
6. Multispectral

**MICASENSE REDEEDGE MULTISPECTRAL AGRICULTURAL SENSOR**

- An advanced multispectral camera that provides accurate multiband data for agricultural remote sensing
- Simultaneous capture of five calibrated discrete spectral bands (blue, green, red, red edge, near IR)
- Optical filters provide full imager resolution for each band
- 1 Hz rate capture rates for all bands, 12-bit RAW format
- Global shutter for distortion-free results
- Single SD card stores all images with geotags
- Host aircraft interface for full configuration, status, and control of the camera during operation
- 47.2-degree field-of-view
- 8cm per pixel spatial resolution at 120m altitude
- Image size 1280 x 960 pixels = 104.8m x 76.6m at 120 m altitude

7. Custom Payloads

Silent Falcon has worked with customers to design, develop and integrate custom payloads for specialized customer applications. Examples include a spectrometer for geologic surveys; a multi camera fire watch payload for detecting forest fires and aiding in their management; and specialized photogrammetric payloads.