STANDARD OPERATING PROCEDURE

Radiometric Calibration & Servicing of UAV Multispectral / Hyperspectral Payloads

DOCUMENT TITLE:	**UAV Multispectral Payload SOP**	**DOC NUMBER:**	SOP-UAV-MS-001
TARGET HARDWARE:	MicaSense RedEdge-P / Sequoia / Headwall Hyperspectral	**REVISION / DATE:**	Rev 1.0 / Sep 16, 2026
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1. Purpose & Scope

This Standard Operating Procedure (SOP) defines field servicing, radiometric calibration, and pre-flight verification protocols for UAV-mounted multispectral and hyperspectral camera payloads. Accurate radiometric calibration converts raw digital number (DN) imagery into top-of-canopy surface reflectance, enabling reliable calculation of Normalized Difference Vegetation Index (NDVI), Enhanced Vegetation Index (EVI), and Soil-Adjusted Vegetation Index (SAVI) for soil moisture and crop water stress assessments.

2. Required Equipment & Reference Standards

- **Calibrated Reflectance Panel (CRP):** Calibrated diffuse Lambertian target with certified 8%, 16%, 64%, and 75% reflectance curves.
- **Downwelling Light Sensor (DLS 2):** Top-mounted irradiance sensor with integrated 3-axis magnetometer and GPS.
- **Field Spectroradiometer:** ASD FieldSpec 4 (350–2500 nm) for empirical line method (ELM) ground-truth validation.
- **Lens Cleaning Kit:** Optical lens paper, anhydrous isopropyl alcohol (99.9%), and compressed air duster.
- **UAV Gimbal & Vibration Damper:** Anti-vibration isolator plate and 3-axis brushless stabilization gimbal.

3. Step-by-Step Field Servicing & Calibration Procedure

3.1 Pre-Flight Inspection & Dark Current Noise Capture

1. Inspect all narrow-band optical filters (Blue 475nm, Green 560nm, Red 668nm, Red Edge 717nm, NIR 842nm) for dust, moisture condensation, or scratches. Clean with lens paper and alcohol.
2. Capture 10 dark-current calibration frames by placing opaque lens caps over all optical apertures. Execute dark-frame capture in sensor control software to establish thermal detector noise baselines.

3.2 Radiometric Calibration Target Capture (Pre/Post Flight)

1. Position the Calibrated Reflectance Panel (CRP) flat on level ground in an unshaded open area.
2. Hold the UAV payload 1.0 meter directly above the CRP, ensuring the operator and UAV frame shadow do not fall across the panel.
3. Ensure the panel fills 30–50% of the camera field of view (FOV). Capture 3 manual panel images before takeoff and immediately upon landing.
4. Verify panel image exposure values: peak digital number must fall between 65% and 85% saturation (DN 40,000–55,000 for 16-bit sensors) without clipping.

3.3 Downwelling Light Sensor (DLS 2) Alignment & Solar Azimuth Sync

1. Verify the DLS 2 sensor is mounted horizontally level on the top mast of the UAV frame, clear of propeller shadows.
2. Perform 3D magnetometer calibration by rotating the UAV along 3 orthogonal axes prior to first flight.
3. Verify live DLS solar irradiance telemetry on the ground station console during pre-flight motor spin-up.

4. Data Quality Control & Reflectance Conversion

Apply vignetting correction polynomials, optical exposure normalization, and DLS irradiance ratioing in post-processing. Compute vegetation indices using corrected band reflectances: $NDVI = (NIR - Red)/(NIR + Red)$ and $SAVI = ((NIR - Red)/(NIR + Red + 0.5)) \times 1.5$. Compare ground tarp reflectances against ASD spectroradiometer values to ensure RMSE ≤ 0.02.