

Downwelling Light Sensor (DLS) Integration Guide and User Manual



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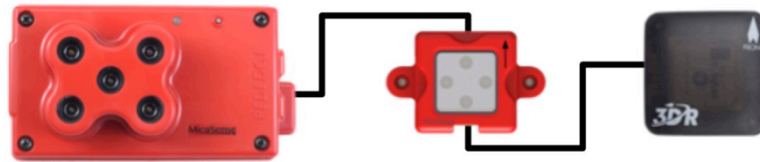
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1. Overview

The Downwelling Light Sensor (DLS) is a 5-band light sensor that connects directly to a MicaSense RedEdge camera. The DLS measures the ambient light during a flight for each of the five bands of the camera and records this information in the metadata of the images captured by the camera. When properly installed and calibrated, the information sensed by the DLS can be used to correct for lighting changes in the middle of a flight, such as those that can happen due to clouds that cover the sun during a flight.

This guide provides instructions for installation and calibration of the DLS to enable gathering of good data. You should note that there are two primary configurations for the RedEdge camera with DLS:

1. RedEdge Camera + DLS + 3DR GPS Module



- In this configuration, the 3DR GPS module provides GPS data (lat/lon/alt) to the camera via the DLS.
- The 3DR GPS module also has a 3-axis magnetometer inside it to measure magnetic heading and it provides magnetic field information to the camera.
- This magnetometer **must** be properly calibrated as shown in Section 5.3 in order for data from the DLS to be useful.

2. RedEdge Camera + DLS + Autopilot Data (Serial / Ethernet Connection)



Autopilot

- In this configuration, a device such as a Pixhawk autopilot or similar autopilot or payload computer provides attitude data to the camera. The following messages **must** be sent to the camera via serial or Ethernet connection (MAVlink or HTTP API) in order to achieve good irradiance data results:
 - Pitch Angle, Roll Angle, and Yaw Angle (Heading) (attitude)
 - Latitude, Longitude, and Altitude
 - UTC Timestamp and Date
- In this configuration, ensure that the magnetometer in your system is well calibrated and provides **accurate** heading data that is not affected by electromagnetic fields in the aircraft.

2. Quick Start Guide

Each step is explained in further detail in the section identified:

- ✓ Mount the DLS and GPS module on a pole (or poles), away from electromagnetic interference and away from any shadowing objects such as propellers or other poles (Section 4.1.1)
- ✓ Mount the DLS and GPS module such that they are **both** pointing forward with respect to the aircraft (Section 4.2)
- ✓ The plate the DLS and GPS module are mounted on needs to be a flat surface that is parallel to the X-Y plane of the aircraft (Section 4.2)
- ✓ You must perform the 6-axis magnetic calibration detailed in the video (Section 5.3)
- ✓ Verify the magnetic calibration is consistent using a compass and verify that the aircraft does not cause electromagnetic interference that affects the heading measurement (Section 5.5)

Note: The checklist above assumes you are using the included 3DR GPS and are mounting the camera and DLS on a multirotor aircraft.

3. Connections

The DLS is connected to a RedEdge camera through the RedEdge’s 6-pin connector labeled “GPS”. If a GPS module is used with RedEdge, the DLS is a “pass-through” for communications between the GPS module and the camera.

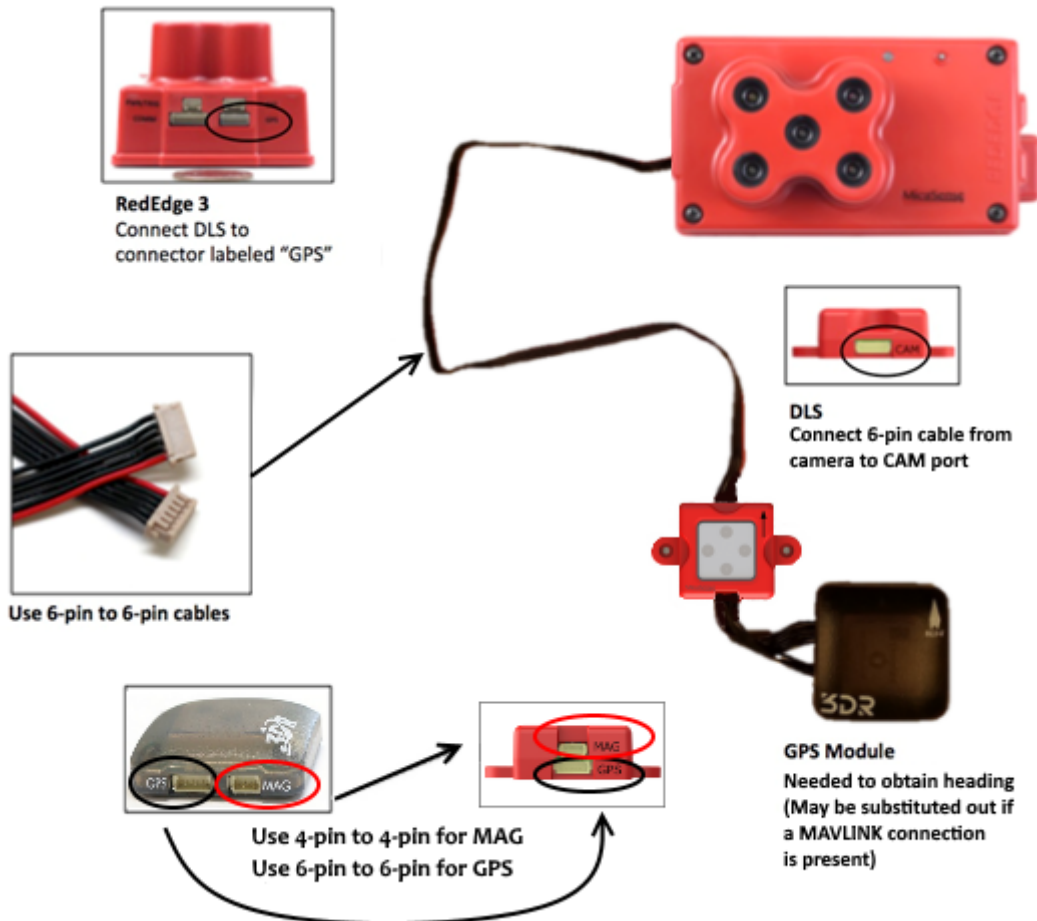


Figure 1: DLS with RedEdge camera and GPS module

CAUTION

All connections should be done **BEFORE** applying power to the camera. Failure to do so could result in damage to the camera, the DLS, or the GPS module.

4. Mounting Considerations

4.1. Mounting Location

4.1.1. Multirotor Installation

Installation of the DLS onto your drone should be done by mounting the DLS onto the top of a pole attached to the drone. The height of the pole needs to be such as to place the DLS above any sources of shadowing from the drone, such as propellers or other equipment, from any angle the drone will be flying at.

If a GPS module is used, it is also typically located on top of the aircraft. It is expected that the GPS Module will be mounted close to the DLS as the cable that connects the two is short. Secure any excess wire length between the DLS and the camera with a tie.

The GPS module should be mounted on a pole or similar structure to avoid magnetic fields generated by electrical equipment on the aircraft.

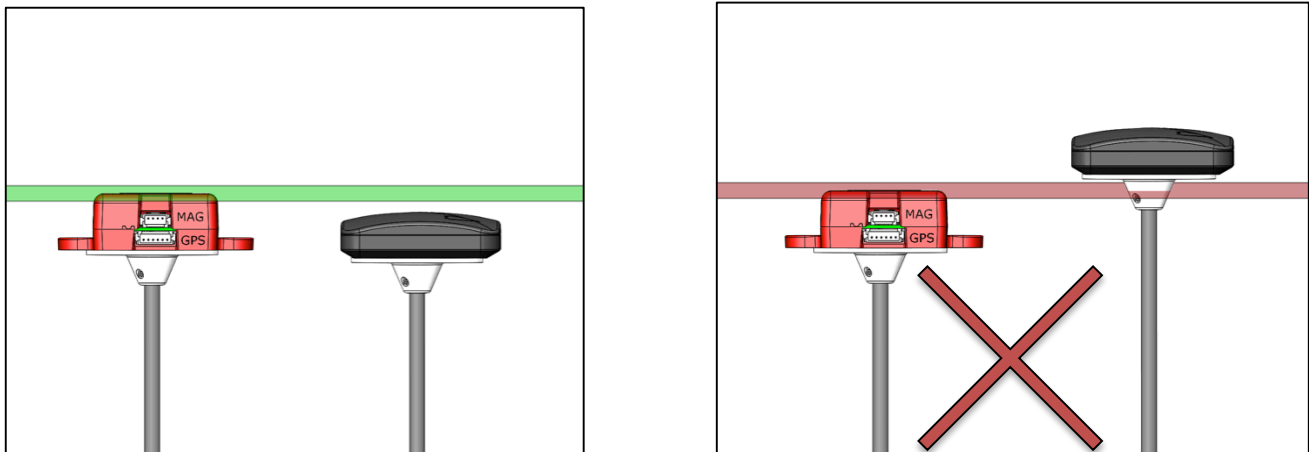


Figure 2: (Left) DLS and GPS correctly mounted

(Right) GPS mounted incorrectly above DLS

NOTE

The configuration on the left shows a proper mounting style. The top of the DLS is seated above (or at least at the same level as) the GPS module and away from any shadowing. The configuration on the right shows the DLS **under** the GPS module, which may cause the GPS module to cast a shadow over the DLS and produce incorrect irradiance data.

You may also choose to mount the DLS and GPS module on the same pole, the images below show an example of this mounting configuration.

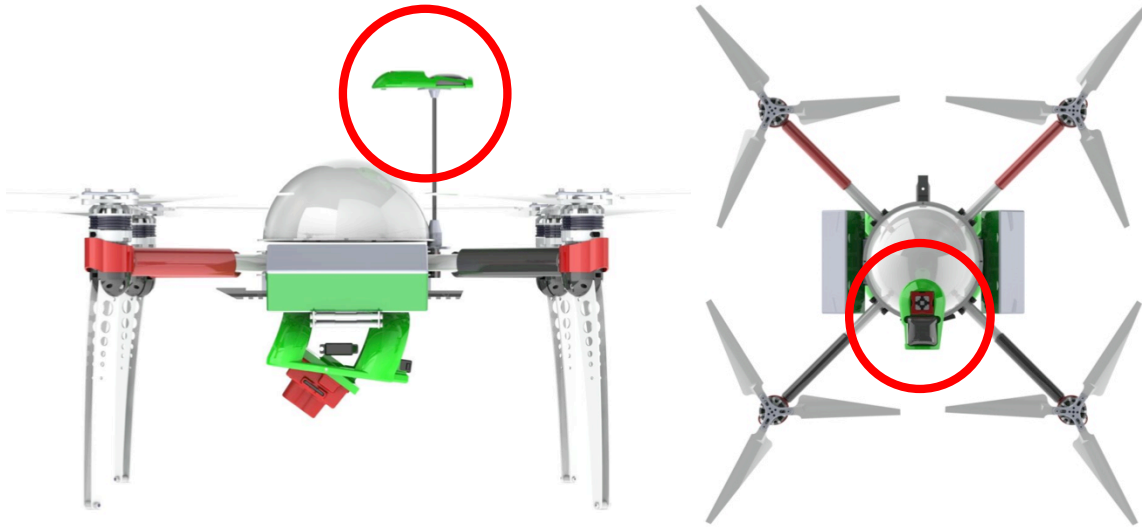


Figure 3: DLS and GPS mounted together on one pole

NOTE

It is **critically important** that the GPS module be mounted away from electric current sources which can produce electromagnetic interference (EMI), such as batteries, wires, and other electrical equipment on the drone. See section 5.5 for how to perform a magnetic interference check after calibration.

The figure below shows an example of a GPS module mounted away from potential interferences.

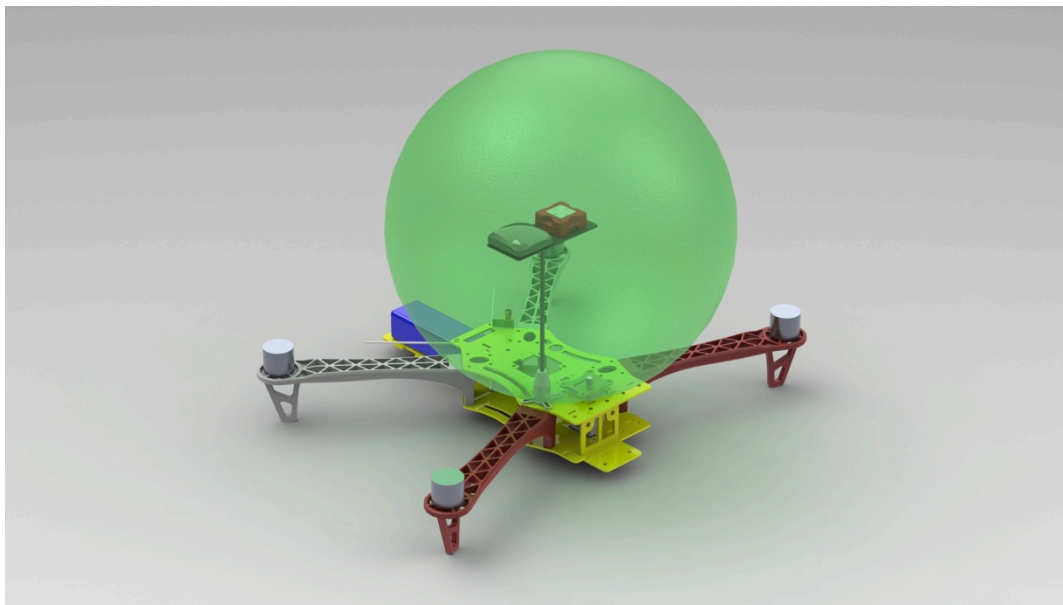


Figure 4: GPS is outside of potential magnetic interference

4.1.2. Fixed Wing Installation

Installation of the DLS and GPS module onto a fixed wing platform will likely require the units to be mounted on the drone itself, as attaching a pole to the drone may not be a viable option. The DLS should be installed such as to prevent shadowing by any parts of the airplane.

NOTE

It is **critically important** that the GPS module be mounted away from electrical current sources which can produce electromagnetic interference (EMI), such as batteries, wires, and other electrical equipment on the drone. See section 5.5 for how to perform a magnetic interference check after calibration.

The figure below shows an example installation of a DLS and GPS on a fixed wing drone.

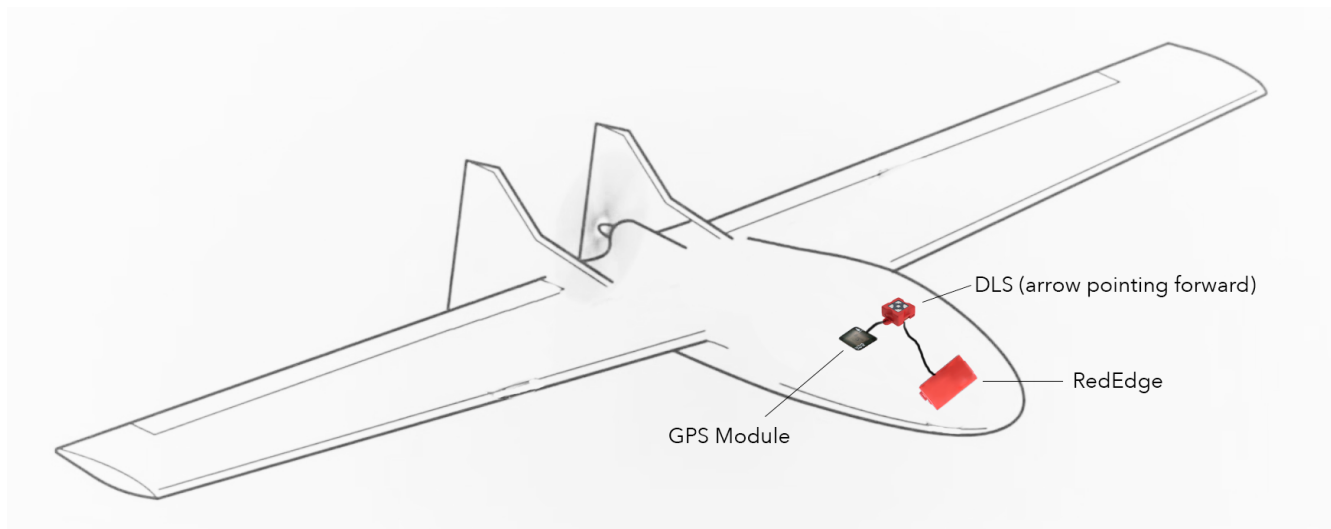


Figure 5: DLS and GPS installation on a fixed wing airframe

4.2. Orientation

The DLS should be mounted such that the arrow on the top surface is pointing forward (in the direction of flight) and is aligned with the direction of the GPS module. The figure below shows an example configuration.



Figure 6: DLS and GPS with front facing arrows shown

Also, the DLS should be mounted such that in straight and level flight (fixed wing aircraft) or hover in no-wind conditions (multicopters/helicopters), the top surface of the DLS (and GPS module if used) is parallel to the horizon (pitch and roll angle of approx. zero with respect to the earth).

The figure below shows an example of a DLS and GPS resting on a surface parallel to the surface of the drone in hovering flight.

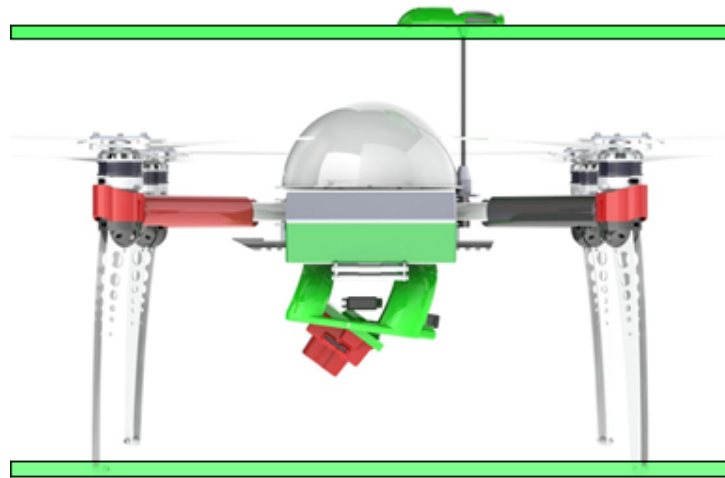


Figure 7: DLS is mounted parallel to the ground

The pole on which the DLS is mounted should have a smooth flat surface plate that can be used to mount the DLS (and GPS module).

NOTE

Whatever pole or poles are used to mount the DLS and GPS module should be sturdy enough to hold the weight of the units and not vibrate/oscillate during flight.

4.2.1. Orientation When Using a Pixhawk/Autopilot

When attitude information is coming from an autopilot or payload computer, it is very important that the orientation in which the DLS is mounted mimics the X and Y plane of the autopilot. Otherwise the pitch, roll, and yaw data from the DLS will not match the data the autopilot is reporting.

4.3. Securing

Use either double-sided tape (a strong-adhesive tape such as VHB is recommended) or the two screw mounts to secure the DLS to the top of the pole or the aircraft (if using a fixed wing). The screw holes are sized for a #2 or M2 screw or bolt.

5. Power-On and Configuration

5.1. DLS Status

After all connections have been completed, apply power to the camera in the standard way (5 Volts DC, 2 Amps).

There are two small green LED lights on the DLS, one on either side of the unit. The meaning of the LEDs is as shown in the table below. The LEDs are small and may not be easy to see without getting close to the unit.

LED Signal Type	Meaning
4 simultaneous flashes on both LEDs	This occurs upon boot-up of the DLS
Sporadic flashing	Communications received. This is normal behavior
Alternating blinking between the two LEDs	Indicates a hardware problem – contact MicaSense at support@micasense.com
Both LEDs solid ON	Indicates a software/hardware problem. If the problem persists, contact MicaSense at support@micasense.com

5.2. Configuration

Connect to the Wi-Fi user interface of the camera per the instructions in the RedEdge User Manual. Verify that the software version is 1.5.27 or later (the version number is viewable in the Settings page) – update the firmware if needed.

In the Settings page, click on the Advanced Configuration link.

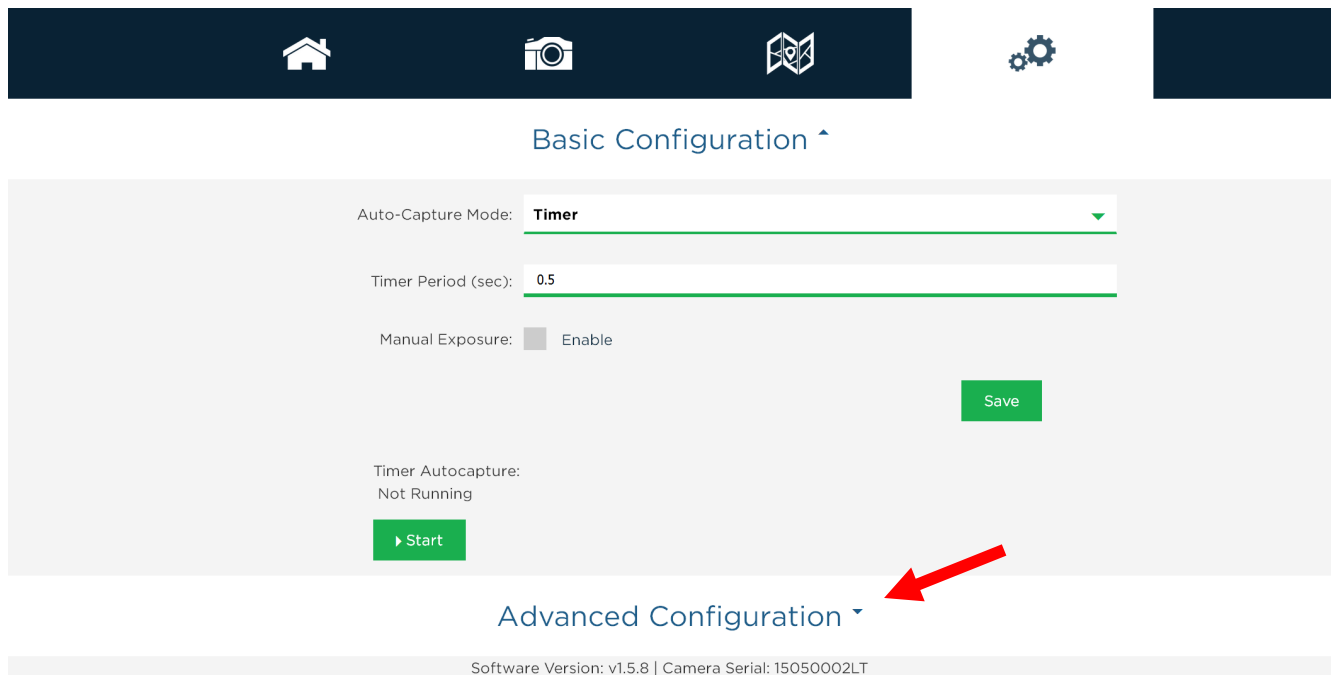


Figure 8: Basic configuration menu for RedEdge

In the Advanced Configuration section, verify that the DLS is present in the table as shown below. Note that the software version shown for the DLS is the software of the microcontroller in the DLS itself. It is a different software version than the one that powers the RedEdge camera. The Multi-Camera Configuration and Ethernet Configuration menus are for advanced uses. These settings should not be modified.

Format for RAW files

DNG: **Smaller files, not compatible with all software**

TIFF: **Larger files, most compatible file format**

RAW format: **TIFF (16-bit)**

Enabled SD Output files

Select type of file(s) to be saved to SD card for each band

Camera	Raw
1	<input checked="" type="checkbox"/>
2	<input checked="" type="checkbox"/>
3	<input checked="" type="checkbox"/>
4	<input checked="" type="checkbox"/>
5	<input checked="" type="checkbox"/>

Multi-Camera Configuration

Network Mode: **Master**

Multi-camera setups must have exactly one master

The camera must be rebooted for a mode change to take effect

Type	Mode	Serial	Software	GPS
camera	master	15050002LT	v1.5.8	
dls	slave	DL01-1532009-MS	v0.2.36	direct

Figure 9: Advanced configuration menu for RedEdge showing DLS entry in table

5.3. Magnetometer Calibration

If the configuration for your RedEdge and DLS is one that uses the 3DR GPS module for GPS and magnetometer data, a calibration process for the magnetometer is needed.

From the Settings page, access the DLS Configuration section:

Advanced Configuration ▾

DLS Configuration ▲

Calibrate DLS Mag

Figure 10: DLS configuration menu

Click the “Calibrate DLS Mag” button to start the calibration process. This calibration process is for the magnetometer sensor that is inside the 3DR GPS module.

First, ensure that the DLS is connected to the GPS module. Additionally, your DLS and GPS module should be rigidly mounted to your aircraft frame.

NOTE

Before beginning the calibration routine, position yourself and the drone away from large metal objects such as cars and buildings. Also, avoid paved areas, which may have metal rods inside the cement. An open field is preferred to avoid interaction with any sources of magnetic interference or objects that may perturb the Earth’s natural magnetic field.

Once the startup sequence has finished, you will be shown a screen (Figure 11) with instructions for which orientation your drone should be in for each of the calibration steps.

To calibrate the magnetometer, a 6-axis calibration routine needs to be performed. During the routine, the drone (specifically the GPS module) should remain in a fixed position while being rotated, i.e. the user performing the calibration should be moving around the magnetometer. The on-screen rotation guide will show you when you have successfully completed one orientation and can move on to the next.

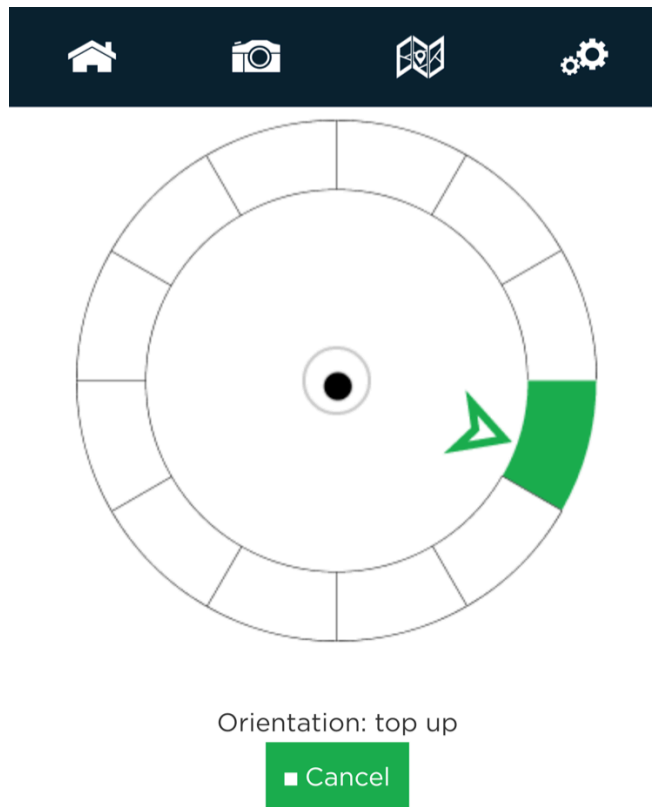
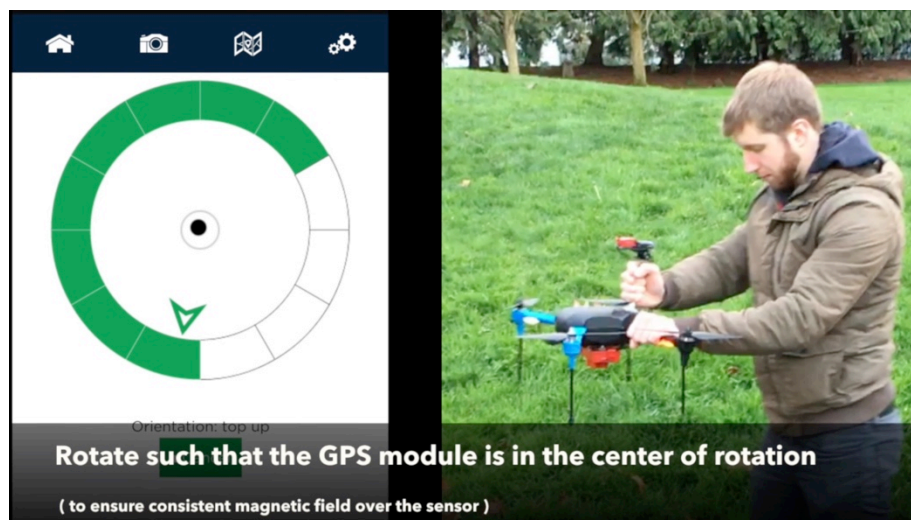


Figure 11: Magnetometer calibration helper screen

The black dot in the middle of the calibration circle is a bubble level representing the magnetometer in the 3DR GPS unit.

Please see the calibration video for a detailed demonstration of this procedure.



NOTE

If you are using a MAVLINK or Ethernet connection to supply GPS and attitude information to the RedEdge camera, you do not need to perform the magnetometer calibration described above.

5.4. Magnetic Heading Check

Once the calibration routine has been completed, it is important to verify that the magnetometer information displayed in the Heading section of the RedEdge Home Page is accurate.

A handheld compass has been provided with your DLS kit that will allow you to verify this in the field. Access the camera's Home Page and use the "Heading" field to check the four cardinal directions (North, East, South, West) and ensure a good match between the compass and the reading by the camera. You should see an error of less than +/- 5 degrees. If this error is exceeded, redo the magnetometer calibration.

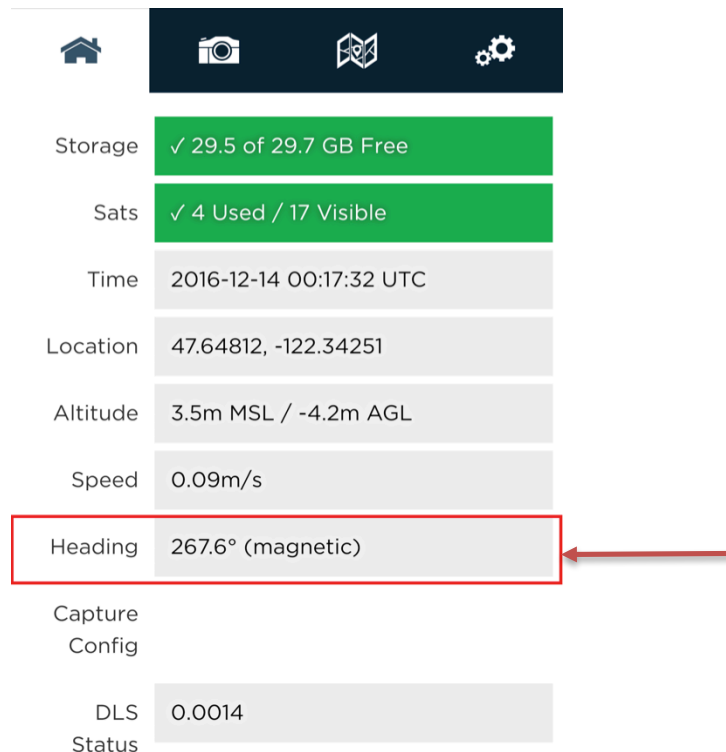


Figure 12: Magnetic heading on RedEdge status page

Additionally, you will want to perform a magnetic interference test (Section 5.5) to verify that your drone will not affect the heading readings during flight.

5.5. Magnetic Interference Check

A test procedure should be conducted any time electrical equipment is added or removed from the drone to ensure the magnetic field profile of the aircraft has not changed.

To test for any magnetic interference from the drone that is effecting the magnetometer, start by placing your drone facing North (you can use the magnetic heading from the Wi-Fi page to align yourself).

WARNING

The next section involves spinning up the motors of your drone.

If you have a fixed wing aircraft this will require holding the plane in place while keeping clear of the propeller.

If using a multicopter, set up the aircraft as if it was ready for a normal take off, but you do not need to actually take off, just spin up of motors.

You **DO NOT** need to provide full power to the motor(s).

Throttle up the motor(s) on your drone and ensure that the heading reading has not changed, then throttle back down. Repeat this for each direction (North, East, South, West) to ensure there is no magnetic interference in any of the four cardinal directions.

WARNING

FAILURE TO FOLLOW INSTRUCTIONS TO KEEP CLEAR OF SPINNING BLADES COULD RESULT IN INJURY OR DEATH.

NOTE

Electromagnetic interference during the operation of your drone can cause errors in the magnetic heading readings.

This can cause the irradiance data generated by the DLS to be not usable during processing.

6. Operation

6.1. Reflectance Panel Considerations

There are no special operations with the DLS (except for slight changes in reflectance panel captures as indicated below). For every capture done by the RedEdge camera, the value of each of the 5 sensors of the DLS (each with its own filter that matches the filters in the camera) is automatically recorded in the metadata of the image files created by the camera.

For best results, an image of the calibrated reflectance panel is still needed both before and after flight (to confirm the calibrations of the camera and DLS). When performing the panel capture, ensure that **both** the panel and the DLS are being exposed to direct light from the sky, without shadowing and without reflections from other objects.

It is also important that the aircraft (and therefore the DLS) is as close to straight and level as possible during panel captures. Adjust the position of the aircraft and the panel such that the camera is as close to directly overhead the panel as possible, without causing shadows on the panel, and at a level attitude.

6.2. DLS Connection Verification

You can verify that the DLS is connected to the camera from the camera configuration home page. If connected, the DLS status should be green and display “Connected”.

DLS Status ✓ Connected

In the DLS settings page, under “Advanced Configuration” in the “Multi-Camera Configuration” section, the DLS serial number and software version should be displayed.

Multi-Camera Configuration

Network Mode: Master ▼

Multi-camera setups must have exactly one master

The camera must be rebooted for a mode change to take effect

Type	Mode	Serial	Software	GPS
camera	master	1551052	v1.5.28	
dls	slave	DL02-1645018-MS	v0.3.27	direct

6.3. DLS Firmware Upgrade


RedEdge camera firmware upgrades will periodically contain DLS firmware updates as well.

To update the firmware on your DLS, you can either have it plugged into the camera at the time you are upgrading the camera's firmware, or plug the DLS in later after you have upgraded the camera's firmware and are ready to use the DLS. Remember to not connect the DLS to the camera with the camera powered ON.

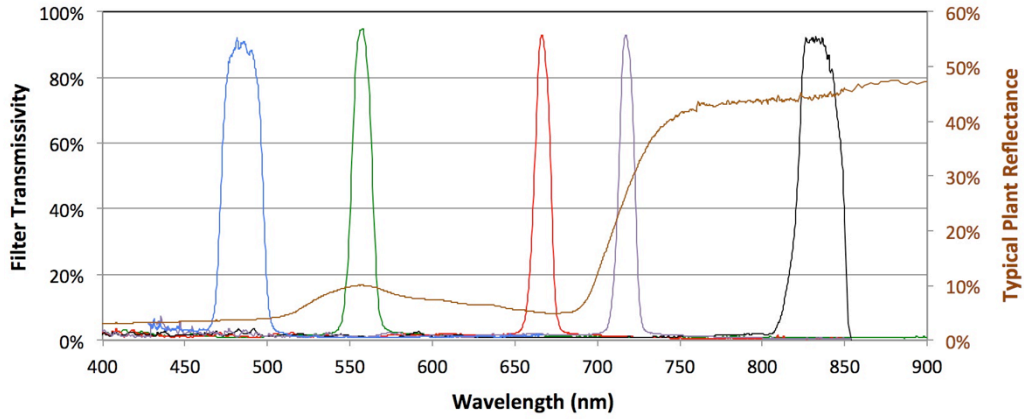
The camera will automatically update the firmware on the DLS if it contains a newer version.

7. Specifications

Basic Specifications

Weight	14 g	
Dimensions	3.3 cm x 3.3 cm x 1.5 cm (1.3" x 1.3" x 0.6")	
Spectral Bands	Narrowband: Blue, Green, Red, Red Edge, Near IR	
Capture Speed	1 capture per second (all bands)	

Spectral Bands (Standard Configuration)



Band Number	Band Name	Center Wavelength (nm)	Bandwidth FWHM (nm)
1	Blue	475	20
2	Green	560	20
3	Red	668	10
4	Near IR	840	40
5	Red Edge	717	10

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