

Airborne Natural Gas Demonstration for Digester Doc



DIGESTER DOC

With Pergam Technical Services LF - DL Equipment January 2021

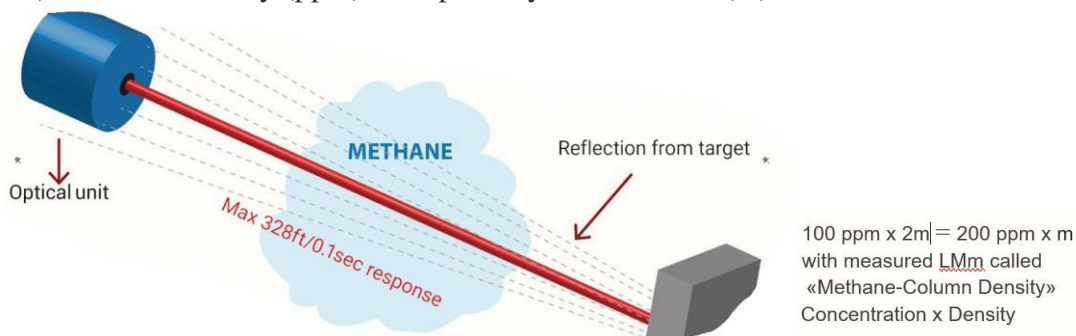
Background

On January 22nd, 2021 Pergam Technical Services performed an airborne methane inspection at one of Digester Doc's digesters. The Pergam Technical Services LF - DL methane detection system was mounted on a M600 Pro and flown by a part 107 certified drone pilot. The inspection covered approximately 1 digester located in Jerome ID.

A value of noise was set as an offset value for the sensor. This value will be in PPM*M and represents variation in sensor measurement without the presence of methane. Noise as it is described previously can be caused by a multitude of reasons with altitude and topography being the most impactful. While noise will introduce a certain level of error it is the delta between this ambient noise and captured methane readings that need to be considered. Per specification on the Falcon sensor taken from the manufacture's technical documentation, this value was set to 125ppm*m.

Principle of measurement

Laser Methane is based on utilization of laser absorption spectrophotometer of methane gas for gas measurement. The system detects natural gas leaks by emitting a Laser at specific wavelengths and analysing the light reflected from the ground to determine how much was absorbed by the methane in the natural gas. The measured gas volume is expressed by the methane column density (ppm-m): methane density (ppm) multiplied by the thickness (m)



All the data contained in this report is for informational purposes only. TDLAS technology does not currently meet Method 25 regulatory standards. Use report in conjunction with traditional Method approved technologies.

Flight Specifications

The inspection was carried out using a m600 drone equipped with a Laser Falcon sensor and SkyHub data logger known together as LF-DL. A radar altimeter was attached to enable TTF (True Terrain Following) A flight profile of 15mph at 80-100ft with a grid spacing of 15ft.

Description of LF – DL System

LF - DL, Laser Falcon – Down Link, is an instrument for remote detection from UAV's of increased methane gas concentration in ambient air (the gas cloud coming from a leak or other sources). The LF - DL is based on infrared laser technology with a tuned diode to the wavelength ~ 1650 nm of which Methane absorbs. A laser beam is emitted from the Sensor and hits a topographic object (soil, grass, trees, concrete, asphalt, etc.). The system analyzes the laser light back scatter to determine how much if any of the laser energy was absorbed by the methane in natural gas. A unique detection algorithm allows for real-time measurement of total methane content along the laser light path from the OU to the topographic object. Using UgCS desktop client, the drone can be sent along pre-planned flight path autonomously. All flight information will be saved and can be played back real-time using a built-in telemetry player. During flight, a live methane data stream can be viewed using the Custom Payload Monitor. Data will be stored in the Sky Hub data logger in the form of a text, and CSV file.

Table 1 - LF Technical Parameters

Maximum measurement distance	40 m
Measurement Sample Rate	0.1 Hz, recorded at .2Hz
Detection limits	1 – 50,000 ppm*m
Laser wavelength	1.65 µm
Laser power (Measurement)	10 mW Class 3R Wavelength: 1653 nm
Laser power (Guide Light)	5 mW Cass 3R Wavelength: 532 nm
Operating Time	Approx. 5 hours
Total weight	0.75 kG
Operating temperature range	-17 - +50 °C
Operating Humidity	30 – 90 %
Laser Beam Diameter: At 10m Altitude At 20m Altitude At 30m Altitude	0.08m 0.18m 0.27m
Flight Speed	Best Results: 2 m/s Max: 5 m/s

Table 2 – M600 Drone Technical Parameters

Dimensions	166.8 cm x 151.8 c x 72.7 cm
Max Take off Weight	15.5 kg
Weight (With TB48S Batteries)	9.5 kg
GPS Accuracy	Vertical +/- .5m Horizontal +/- 1.5m
Flight Time (With Payload)	30 min
Max Climb Rate	5 m/s
Max Sink Rate	3 m/s
Max Speed (No Wind)	65 km/h

Pictures of LF - DL Installed on M600

The LF - DL system consists of 4 parts:

- LF Sensor
- Laptop (Running UgCS and CPM)
- DL (Sky Hub data logger)
- M600 Controller (Running UgCS for DJI)



Figure 1 – m600 with LF -DL Mounted

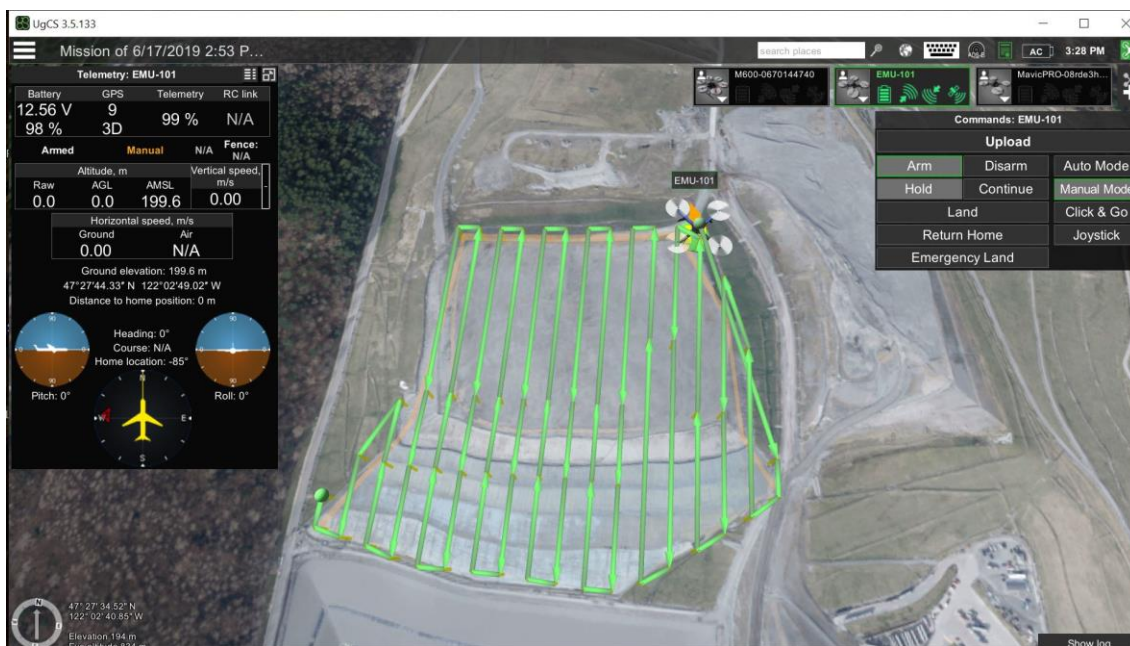


Figure 2 – UgCS desktop running on Laptop



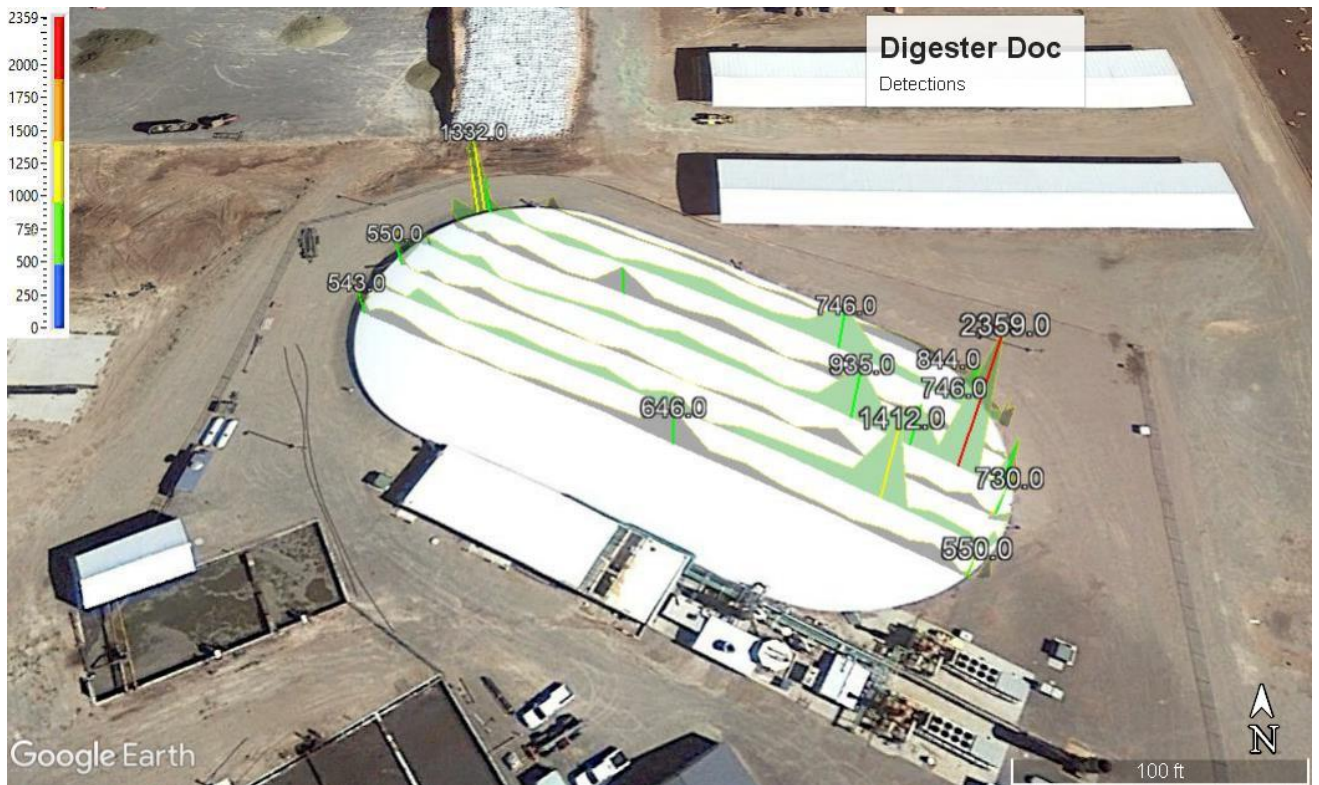
- 1 Ethernet connector**
Communicates with Ethernet-based payloads (see [Ethernet](#))
- 2 Antenna connector**
For connecting Wi-Fi/Bluetooth antenna or antenna cable (see [Antenna](#))
- 3 12V LED (red)**
Indicates the presence of 12V power output
- 4 12V power output**
Feeds the payload (see [12V Power Output](#))
- 5 Power input**
Main power input (see [Power Input](#))

Figure 3 – Sky Hub data Logger



Figure 4 – Controller Running UgCS for DJI.

Map of Inspection Flight Paths:



Note - Only detections of 500ppm*m and above are shown.

Summary of Detections 6m Average

Detection	Date	Time	Lat	Long	Methane	SCFH
1	1/22/2021	11:15:05	42.7159633	-114.6234383	844	115.2
2	1/22/2021	11:15:10	42.7160433	-114.62363	746	101.8
3	1/22/2021	11:15:29	42.716295	-114.6242417	1332	227.3
4	1/22/2021	11:16:14	42.7158733	-114.6234717	2359	322
5	1/22/2021	11:16:16	42.7159	-114.62354	746	101.8
6	1/22/2021	11:16:18	42.7159367	-114.623625	935	127.6
7	1/22/2021	11:16:44	42.716195	-114.624375	550	112.6
8	1/22/2021	11:17:10	42.715805	-114.623435	730	99.7
9	1/22/2021	11:17:27	42.715825	-114.6235983	1412	192.7
10	1/22/2021	11:17:54	42.7161117	-114.6244217	543	74.1
11	1/22/2021	11:18:07	42.715895	-114.6239017	646	88.3
12	1/22/2021	11:18:19	42.7157267	-114.6234967	550	75.1

Note – SCFH measurements are estimates could be +/-50%

Drone Pilot – David Hels