

# Gradient Magnetometer UAV

Utilising GEM's High Sensitivity Potassium Sensors



**GEM**  
SYSTEMS

**Since 1980**

**Leading the World of Magnetics**

**GEM Systems is the number one global leader in the manufacture and sale of high precision magnetometers.**

GEM is the only commercial manufacturer of Overhauser magnetometers, that are accepted and used at Magnetic Observatories over the world.

**Our Potassium Magnetometers are the most precise magnetometers in the world.**

Our Proton sensors are considered the most practical and robust magnetometers for general field use.

**Proven reliability based on R+D since 1980.**

We deliver fully integrated systems with GPS and additional survey capability with VLF-EM for convenience and high productivity

**Today we are creating the absolute best in airborne sensors and are leading the way in super sensitive potassium sensors specially designed for highly sensitive studies with super large sensors for research of Natural Hazards globally and now smaller and lighter sensors for practical UAV applications.**

Our Leadership and Success in the World of Magnetics is **Your key to success** in applications from Archeology, Volcanology and UXO detection to Exploration and Magnetic Observation **Globally.**



## Gradient Magnetic UAV Surveys

UAVs can now be used to perform airborne geophysical surveys. Map the spatial variations in the Earth's magnetic field for a variety of useful applications. Explore mineral potential, map UXOs and Archeology in high resolution.

- UAV borne magnetic and gradient surveys can be carried out in areas that are too dangerous, too remote, or too expensive for equivalent ground or airborne surveys featuring manned aircraft.
- UAV borne magnetic surveys can deliver quality data in environments where topography and safety standards prohibit manned aircrafts from acquiring data at optimum terrain clearances.

### Reliable and Stable Aerial Vehicle

GEM's MONARCH Magnetic Gradiometer UAV is built on a customized version of the tested Tempest aircraft airframe developed by UASUSA. The low carbon airframe has been customised by aerodynamic wing tip pods for the specialised magnetometer sensors. Modifications have been incorporated to the aircraft control hardware to minimize magnetic interference.

### Features

The GEM Gradient Magnetometer UAV System features two highly sensitive optically pumped Potassium Sensors for uncompromised measurement capability. The GSMP-35U magnetometers have been specially designed to provide our typical 0.0003 nT sensitivity and form the core of GEM's UAV solution. These light weight magnetometers offer the highest sensitivity available in the industry.



Two specially designed GEM Potassium GSMP-35U magnetometers with 0.0003 pT sensitivity

### Advantages of Potassium Optically Pumped Technology

- Highest sensitivity and absolute accuracy optically pumped magnetometers available on the market
- Potassium narrow spectral line minimizes heading and orientation errors
- Low maintenance cost on sensors
- High quality results in areas of high gradients

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Our World is **Magnetics.**

## Robust and Lightweight Components

### GEM data acquisition(DAS) & power distribution system

- The GEM DAS module provides interfaces for all onboard electronics via configurable RS232 Ports to GPS/DGPS receivers, for magnetometer sensors, and laser altimeters.

### Navigation, Launch & accessories

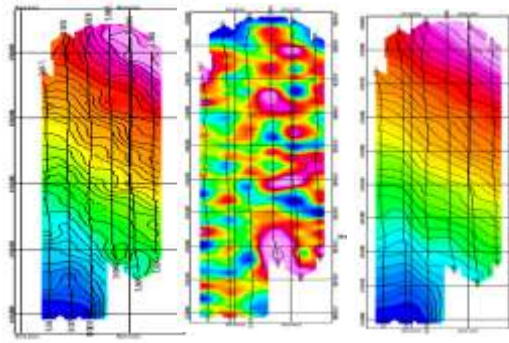
- U-blox NEO-7 GPS Receiver with Antenna
- Pixhawk Autopilot and Mission Planner Ground Station (features safety return to launch, auto takeoff/landing)
- Micro **Laser altimeter** for monitoring and controlling terrain clearance
- Catapult Launch device, open space landing
- Airtronics 10 channel 2.4GHz radio control
- Li-Po Batteries - 1.5 hrs flying capacity



Mission Planner and Controller



Safe, Low altitude flying



Data output of left and right sensor (Total Field)  
Measured Gradient nT/m (Scale 2nT peak to peak) from  
survey flown at 300ft height  
( Southern Ontario)

### Unmanned Aerial Vehicle

The airframe is V2(RIF) Radio Interference Free and has been tested in extreme weather and can fly in winds up to 80 km/hr. The aircraft has been deployed from weather balloons at 58,000 ft. (Also used in the study of tornado's) so the aircraft and its onboard systems are designed for extreme cold and winds. When compared to other UAV vehicles, the Tempest offers an excellent combination of available payload, extended range, affordable price, and most importantly minimal magnetic interference.

The magnetometers operate autonomously similar to the UAV. Magnetic data are marked with time and position from the UAV's GPS navigation system. Maps in spatial variations in the magnetic field intensity and gradient can be improved by applying digital compensation, available from GEM Systems.

### UAV Requirements for Permits

Regulations vary for different jurisdictions, therefore review local rules for operation of unmanned aircraft systems.



Monarch on catapult launcher

## Specifications

### Autonomous Aircraft

#### Speed

70 km/hr (Cruise)  
160 km/hr (Max)  
50 km/hr (Stall)

#### Range (with gradiometer payload)

Up to 1.5 hours at cruise speed

#### Production

100 linear km's per flight<sup>1</sup> (of high-res mag gradient data) with short ferry flights

<sup>1</sup> multiple flights per day are expected; changing aircraft batteries and re-launching the aircraft requires minutes

#### Weight

10kg (22 lbs)

#### Wingspan (sensor separation)

3.2 metres

#### Autopilot

standard operation within 13.0 km of guidance base station, upgradeable to 80.0 km

### Potassium Magnetic Gradiometer

#### Performance

Sensitivity: 0.0003nT  
Dynamic Range: 20,000 to 120,000 nT  
Gradient Tolerance: 50,000 nT/m  
Heading Error: +/- 0.05 nT @ 360° full rotation about axis.  
Samples at: 1, 5, 10, 20 Hz

#### Compensation Performance

Improvement Ratio (total field):  
10 – 20, typical

#### Absolute Compensation Accuracy

Standard deviation of ~ .02 nT for flight

#### Sensor Weight and Dimensions

GEM Potassium Sensor GSMP 35U .42kg  
GEM DAS data acquisition  
Acquisition Cabling (inc)  
Total for 2 sensors and electronics 1.7kg

#### Environmental

Operating Temperature: -40°C to +55°C  
Storage Temperature: -70°C to +55°C

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