

# STRATIS

SIX DEGREE-OF-FREEDOM SEISMOMETER



Simultaneous six degree-of-freedom output, from a single geometric centre, for translation data unpolluted by the rotation

## KEY FEATURES

- > Full six degree-of-freedom motion analysis from a single sensor
- > Transverse and vertical rotations
- > Improved earthquake source characterisation
- > Advanced structural response modelling
- > Portable, compact and low-power
- > Integrated industry standard digitiser with advanced data communication features

## APPLICATIONS

- > Local, regional and global monitoring
- > Volcano monitoring
- > Structural health monitoring
- > Tsunami early warning
- > Explosion monitoring

# Stratis

Stratis integrated six degree-of-freedom seismic sensor

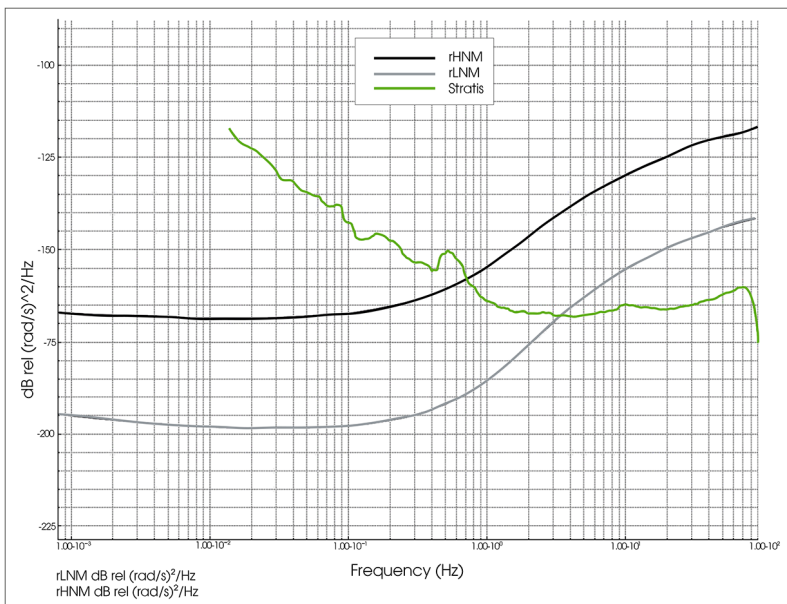
## STRATIS DIMENSIONS:



## Applications

- > Local, regional and global seismic monitoring and analysis
- > Volcano monitoring including tremor analysis, inflation of volcanic reservoirs and tracking of dyke intrusions
- > Structural Health Monitoring with ability to improve understanding of torsional responses and enhance Finite Element Models
- > Tsunami early warning
- > Explosion monitoring

## SELF NOISE:



Theoretical rotational noise floor of Stratis.

Stratis is the world's first fully integrated seismic sensor capable of simultaneously measuring both translational ground motion and rotational motion around a single coincident point.

By combining six concurrent outputs within a single instrument, Stratis delivers a complete six degree-of-freedom (6DoF) representation of seismic wavefields from a single sensing point.

Stratis provides three orthogonal displacement channels (Z, N and E) proportional to ground velocity (m/s), together with three rotational channels measuring angular velocity (rad/s) in the corresponding planes. This integrated approach enables more accurate characterisation of seismic events and permits derivation of the elasticity tensor using a single compact sensor.

Conventional 6DoF seismic measurements typically require complex arrays of seismometers or separate co-located rotational and translational instruments. These methods can only approximate rotational motion because measurements are taken at different physical locations. Stratis overcomes this limitation by measuring all six parameters at the same geometric centre within a single instrument, ensuring true point co-location of translational and rotational data.

**By integrating all sensing elements into one compact device, Stratis significantly simplifies deployment and installation while expanding accessibility to rotational seismic monitoring technologies.**

## Key features

Complete six degree-of-freedom (6DoF) representation of seismic wavefields from a single sensing point

"Pure" displacement output in which rotational effects are removed from the translational measurements

Low latency outputs available (approx. 0.04 s data packets) relevant for Tsunami warning?

Compact form-factor measuring  $\varnothing 240$  mm  $\times$  92 mm and weighing just 8.6 kg

Streaming and storage of instrument response and calibration parameters dramatically simplifies data management (RESP, Station XML and Dataless SEED formats)

Accurate time-base provided by either surface GNSS, Precision Time Protocol (PTP), or internally trained clock (< 1 ms drift per day without GNSS)

The system also produces a unique "pure" displacement output in which rotational effects are removed from the translational measurements. This delivers exceptionally high-fidelity seismic data, free from tilt contamination, enabling improved analysis of earthquake dynamics and subsurface processes.

In addition to enhancing translational measurements, the rotational channels provide valuable standalone data for advanced seismic analysis and research applications. Further advantages of Stratis include low power consumption, high sampling capability, and advanced signal averaging techniques that improve overall noise performance.

In academia, Stratis enables improved characterisation of ground motion associated with volcanic and seismic activity. Industrial users can incorporate rotational and tilt measurements for improved structural health monitoring systems. Other applications include explosion monitoring, tsunami warning and offshore monitoring.

By providing the functionality of a seismic array within a single instrument, Stratis enables advanced array-processing techniques from a single station contributing to a ~3 dB reduction in sensor noise; reducing deployment complexity; and lowering cost, particularly in harsh or remote environments.

### Earthquake monitoring:

- > Complete representation of seismic wavefields
- > Increased accuracy for fault orientation, rupture direction and slip distribution
- > Greater accuracy for earthquake early warning algorithms
- > Resolve wavefield ambiguity
- > Analyse wave polarisation, crucial for determining seismic anisotropy or sediment layer behaviour
- > Reduction in translational self-noise

### Volcano monitoring:

- > Volcanic tremor analysis
- > Inflation of volcanic reservoirs
- > Tracking of dyke intrusions

### Structural health monitoring

- > Increased understanding of torsional responses for the design of more resilient structures
- > Validate and improve Finite Element Models of critical infrastructure

## SPECIFICATIONS

BROADBAND SEISMOMETER SYSTEM	
Configuration / Topology	6-axis inertial sensor that measures around one central point
PERFORMANCE: BROADBAND SEISMOMETER AND TRANSLATION DATA	
Maximum frequency response bandwidth	120 s (0.0083 Hz) to 100 Hz
Output sensitivity	1000 V/ms <sup>1</sup>
Sensor dynamic range	149 dB
Self-noise	-173 dB at 10 seconds
Operational tilt range	±90°
Cross axis rejection	> 65 dB
Linearity	> 95 dB
Lowest spurious resonance	> 450 Hz
Centring	Automatic / can be disabled
Transfer function	Measured sensitivity, frequency response and instrument poles and zeros are stored within the instrument and accessible via web interface
PERFORMANCE: ROTATION SENSOR	
Bandwidth	120 s (0.0083 Hz) to 100 Hz
Self-noise	5 nrad/s @ 1 Hz
ENVIRONMENTAL CHANNELS	
Sensor mass positions	Independent sensor mass position outputs (integrator)
Orientation sensors	MEMS based accelerometer (three component) Magnetometer (three component)
Other sensors	Temperature, humidity, pressure, input voltage
DIGITISER PERFORMANCE	
ADC converter type	Delta-sigma
Output format	32-bit
Dynamic range	>142 dB at 100 samples per second
Decimation filter rejection	170 dB
DATA PROCESSING	
Output rates available	1 sample per hour up to 4000 samples per second for primary channels, user-selectable*  Up to 5 samples per second for environmental channels
Decimation filters	÷2, ÷3, ÷4, ÷5 (Causal / Acausal)
Data transmission modes	Continuous
TIMING AND CALIBRATION	
Timing source precision	Accuracy when GNSS locked ±50 ns. Typical drift when unsynchronised (without GNSS) <1 ms per day
Timing sources	GNSS (GPS and GLONASS, BeiDou optional)
Calibration signal generator	Step, white noise with selectable amplitude

USER INTERFACE	
Configuration and control	(Ethernet) Güralp Discovery - free download (Windows and Linux), web browser interface
DATA COMMUNICATION	
Data recording formats	miniSEED (metadata stored in Station XML and dataless SEED formats)
Data streaming protocols (via Ethernet)	GCF (Scream!), GDI-link <sup>1</sup> and SEEDlink <sup>1</sup> ( <sup>1</sup> metadata sent in RESP, StationXML and dataless SEED file formats)
Communication technologies supported	Ethernet (10/100BASE-T1) with Power over Data Lines (PODL)
ON-BOARD DATA STORAGE	
Flash memory and storage	64 GB microSD card (fixed) Option for 128 GB
OPERATION AND POWER USAGE	
Operating system	Windows and Linux compatible
Operating temperature	-20 to +60 °C
Relative humidity range	zero to 100 %
Power supply	110-240 V AC, 10 - 36 V DC* or Power over Data Lines (PODL)
Power consumption	10 W standard operation
<i>*Power voltage for operation of this unit only. Connection to additional instrumentation or use of longer cables may result in a higher input voltage requirement</i>	
PHYSICAL	
Casing type	Environmentally sealed, hard anodised aluminium
Environmental sensor	Humidity and temperature
Weight	8.6 kg (disconnected)
Diameter	240 mm
Height with feet	92 mm
Height (sensor only)	82 mm
Connector type	D-Coded M12 Automation Connector  SMA type GNSS connector
Environmental protection	IP68 - protection against effects of prolonged immersion at 3 m depth for 72 hours
Stratis package includes	Power cable, GNSS (GPS or GLONASS, BeiDou optional) antenna with coaxial cable, power/Ethernet assembly