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RADIAN BOREHOLE

THE TRIAXIAL, BROADBAND, DIGITAL BOREHOLE SEISMOMETER THAT OFFERS UNPARALELLED FLEXIBILITY

The Radian Borehole system delivers advanced software communications for quick and easy instrument and data management.

KEY FEATURES

> Remote, user-selectable high-pass frequency corner up to 120 s
> Operational at any angle with hole-lock options for narrow (60 - 100 mm) or wide (100 - 140 mm) cased holes
> Multi-instrument strings for vertical seismic profiling
> Choose either acceleration or velocity response
> STA/LTA and threshold triggering
> The system can incorporate an additional analogue feed if required

APPLICATIONS

> Microseismic and induced seismicity monitoring
> To complement dense surface arrays
> Vertical seismic profiling
> Seismic monitoring in areas of high cultural noise

Radian Borehole

Unlike other borehole instruments, the Radian can operate at any angle, making it suitable for deployment in non-vertical boreholes. It can be deployed as a single instrument or, for vertical seismic profiling (VSP), multiple instruments can be strung together.

The Radians' triaxial, broadband, digital seismometer is housed in an ultra-slim corrosion-resistant water-proof casing constructed of SAE 316 stainless steel and fitted with a 250 Bar/25 MPa connector. Flexible hole-lock options means the instrument can be installed in either narrow, (60 mm - 100 mm) or wide (100 mm - 140 mm), cased holes.

The Radian system includes a Surface Interface Unit (SIU) that delivers data communication, timing and storage capability. The SIU records data on dual-redundant microSD cards and shares the data via Ethernet and Bluetooth connections. For deployments deeper than 100 m, a fibre optic cable and a compatible SIU is required.

GüVü, a Bluetooth App, displays waveforms, orientation, temperature and humidity data, for confident deployments.

Compared to short-period geophones, the Radian's active feedback sensor ensures consistent amplitude and phase response across the bandwidth of the instrument.

Low self-noise and a wide dynamic range allow accurate detection of small seismic events and recording of strong shaking in one instrument.

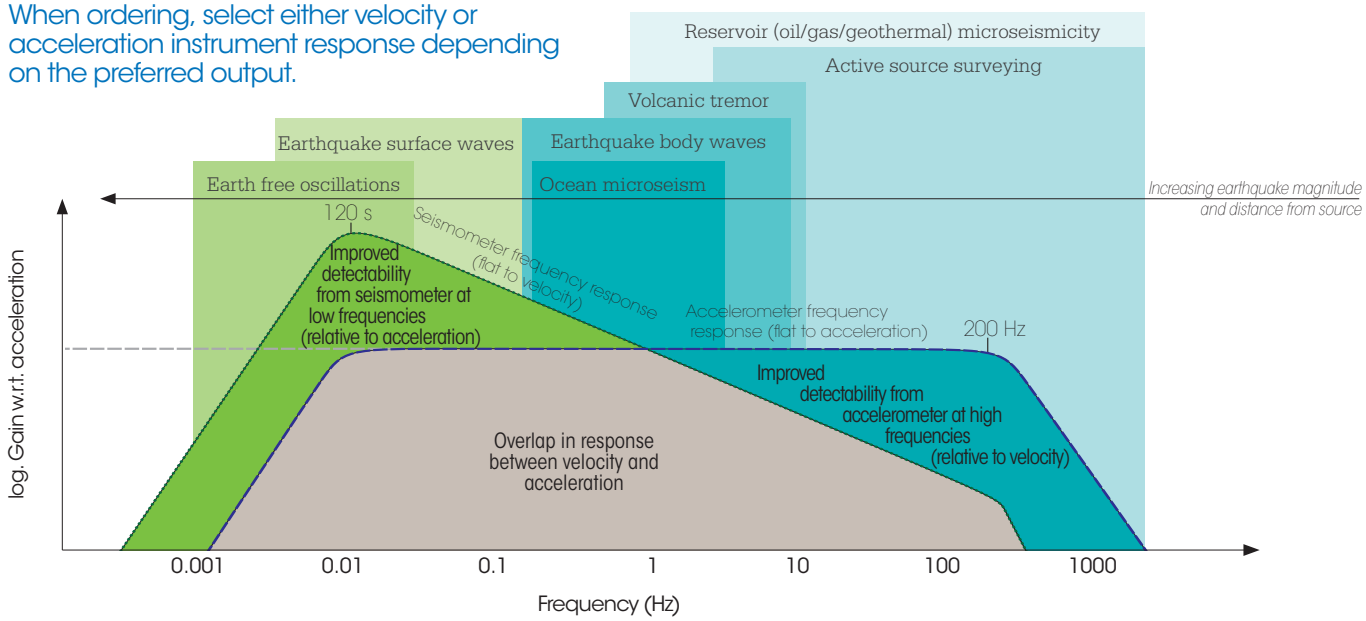
The ultra-wide frequency response between 120 s and 200 Hz makes the Radian ideal for seismic monitoring at all scales, particularly in areas of high cultural noise. For increased flexibility, the high-pass frequency corner can be remotely configured to suit the deployment environment.

An internal magnetometer and MEMS based accelerometer work together to provide tilt and horizontal orientation. The appropriate correction can be applied to deliver high-quality waveforms with no need for post-processing.

For subsurface installations where a cased hole is not practical the Radian Posthole is recommended. See the Radian Posthole datasheet for more information.

Response selection

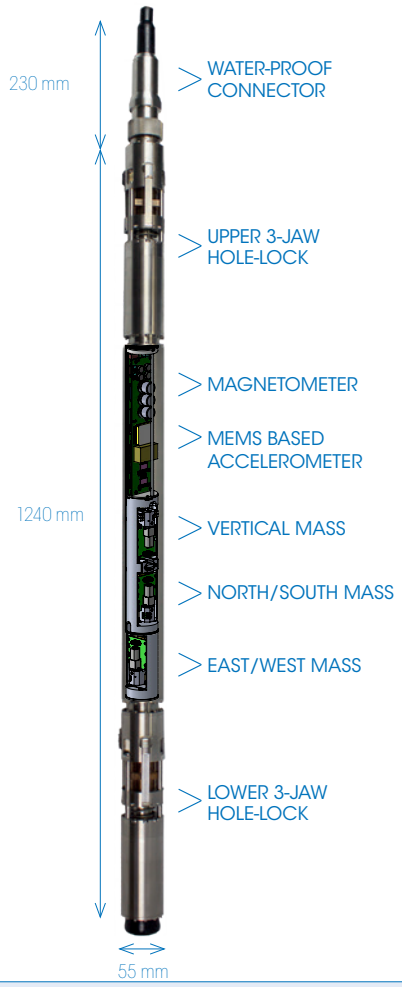
When ordering, select either velocity or acceleration instrument response depending on the preferred output.



Applications

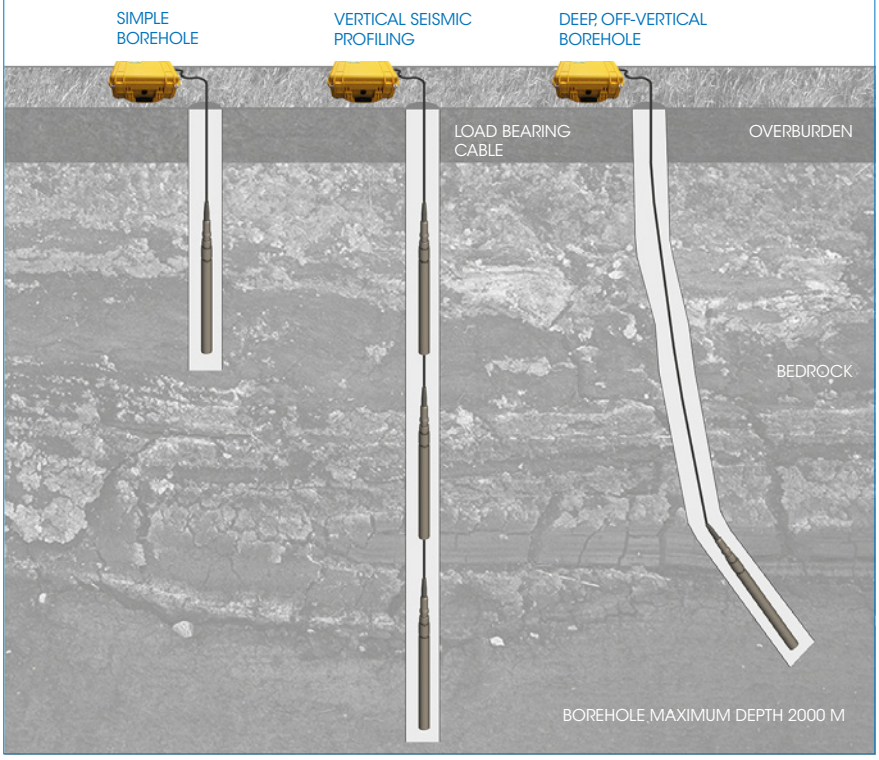
> Microseismic and induced seismicity monitoring
> To complement dense surface arrays
> Vertical seismic profiling (VSP)
> Seismic monitoring in areas of high cultural noise
> Traffic light systems for energy extraction or storage

The robust Radian Borehole is a true broadband downhole seismometer capable of withstanding the harshest conditions. Easily strung together for down-hole arrays, the surface interface unit gathers data from multiple instruments.



ROBUST VERSATILITY

– INSTALLATION IN OFF-VERTICAL HOLES
– CAN BE EASILY STRUNG TOGETHER FOR VERTICAL SEISMIC PROFILING (VSP)
– RECOVERY PERFORMED USING SECURE HOLE-LOCK RELEASE MECHANISM
– ROBUST LOAD-BEARING SENSOR CABLE



MAXIMISE YOUR NETWORK

THE SURFACE INTERFACE UNIT CAN ACCOMMODATE AN ADDITIONAL HIGH PERFORMANCE ANALOGUE SENSOR SUCH AS THE FORTIS ACCELEROMETER - IDEAL FOR EARTHQUAKE EARLY WARNING SYSTEMS

Key features

State-of-the-art seismic sensor allows full operation over a full tilt range of ±180° by automatically centring the mass

Triaxial orthogonal (ZNE) instrument with high cross-axis rejection (> 65 dB)

Remote, user-selectable high-pass frequency corner up to 120 s

Customer can select either velocity or acceleration variants depending on the preferred output (configurable prior to shipping)

Slim-line 55 mm diameter enclosure constructed from robust and water-proof, SAE 316 corrosion-resistant stainless steel with a 250 Bar/25 MPa water-proof connector to protect the instrument in wet holes

Low latency outputs available (approx. 0.04 s data packets)

Industry standard retractable three-jaw motorised hole-locks for either narrow, (60 mm - 100 mm) or wide (100 mm - 140 mm) cased holes

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

Free GüVü Bluetooth App for checking installation integrity is available for both Android and iOS devices

Dual-redundant 64 GB microSD cards (1 fixed, 1 hot-swappable)

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

Radian Borehole

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SPECIFICATIONS

BROADBAND SEISMOMETER SYSTEM	
Configuration / Topology	Triaxial orthogonal (ZNE)
PERFORMANCE: BROADBAND SEISMOMETER	
Maximum frequency response bandwidth	120 s (0.0083 Hz) to 200 Hz Other user selectable options available within this range Velocity or acceleration response (configurable prior to shipping)
Full-scale clip level	Velocity response nominal: ±25 mm/s (equivalent to differential output sensitivity of 2000 V/m/s) Acceleration response nominal: ±12.5 mm/s^2 (equivalent to differential output sensitivity of 200 V/m/s^2)
Sensor dynamic range	> 149 dB at 1 Hz
Self-noise	Below NLNM (New Low Noise Model) from 17 s (0.06 Hz) to 9 Hz < -155 dB from 120 s to 10 Hz
Operational tilt range	±180°
Cross axis rejection	> 65 dB
Linearity	> 95 dB
Lowest spurious resonance	> 450 Hz
Centring	Automatic / configurable
Transfer function	Measured sensitivity, frequency response and instrument poles and zeros are stored within the instrument and accessible via web interface
ENVIRONMENTAL CHANNELS	
Sensor mass positions	Three independent sensor mass position outputs (single-ended)
Orientation sensors	MEMS accelerometer (three component) Magnetometer (three component)
Other sensors	Temperature
INTERNAL DIGITISER	
Digital resolution/output format	24-bit
Dynamic range	> 120 dB
Anti-aliasing filter at Nyquist	> 172 dB
Sampling rates	1 to 5000 samples per second, user selectable
PHYSICAL	
Instrument diameter	55 mm
Borehole diameter options	Narrow borehole: 60 mm to 100 mm Wide borehole: 100 mm to 140 mm
Case height excluding connector	1240 mm
Weight	7.5 kg without hole-locks or connector
Sensor enclosure/materials	SAE 316 corrosion resistant stainless steel Gold plated contacts O-ring seals throughout
Connector	250 Bar / 25 MPa water-proof connector
Sensor and load-bearing cable	Kevlar-refinforced, AC-coupled
Orientation indicator	North vertical scribe mark on side on outer casing and inside connector

ENVIRONMENTAL	
Operating temperatures:	-30 to +60 °C
Maximum deployment depth	2000 m
Humidity	0-100% relative humidity
Robustness	IP68 to 2000 m depth

SURFACE INTERFACE UNIT (COPPER AND FIBRE)	
Dimensions	422 mm x 323 mm x 175 mm exc. connectors
Weight	7.5 kg
Operating temperature	-20 to +60 °C
DIGITISATION AND STORAGE	
Additional sensor inputs	Primary channels: Four at 24 bits. Differential input: 40 V peak-to-peak (± 20 V). Also compatible with single-ended inputs: 20 V peak-to-peak (± 10 V)
Secondary channels:	Three analogue channels for sensor mass positions. One internal callibration channel
Internal environmental channels:	Humidity Temperature Supply voltage MEMS accelerometer (three component) Magnetometer (three component)
Flash memory and storage	Dual redundant 64 GB microSD cards (1 fixed, 1 hot-swappable)
Data recording formats	miniSEED (metadata is stored in dataless SEED format)
Configuration and control	(Ethernet) Güralp Discovery - free download, web browser interface. (Bluetooth) GüVu free Android or iOS phone/tablet app
Data streaming protocols (via Ethernet)	GCF (Scream!), GDI-link and SEED-link (metadata sent in RESP/Dataless SEED file format)
TIMING	
Timing protocols	GNSS (GPS, GLONASS or BeiDou) or PTP (Precision Time Protocol) timing sources
GNSS connector	14-way Lemo connector (NMEA, PPS and Debug serial)
Timing drift without GNSS	Typical drift when unsynchronised <1 ms per day
SURFACE INTERFACE UNIT FOR DEPLOYMENTS UP TO 100 M DEPTH (COPPER CABLE SYSTEM)	
Full system power consumption with one Radian	8.7 W (no GNSS or Ethernet) 9 W (with GNSS and Ethernet)
SURFACE INTERFACE UNIT FOR DEPLOYMENTS OVER 100 M DEPTH (FIBRE OPTIC SYSTEM)	
Full system power consumption with one Radian	~ 20 W with GNSS and Ethernet Additional Radians will add approximate power consumption of 2.3 W per unit

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