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Product Catalog

SmartSolo Scientific
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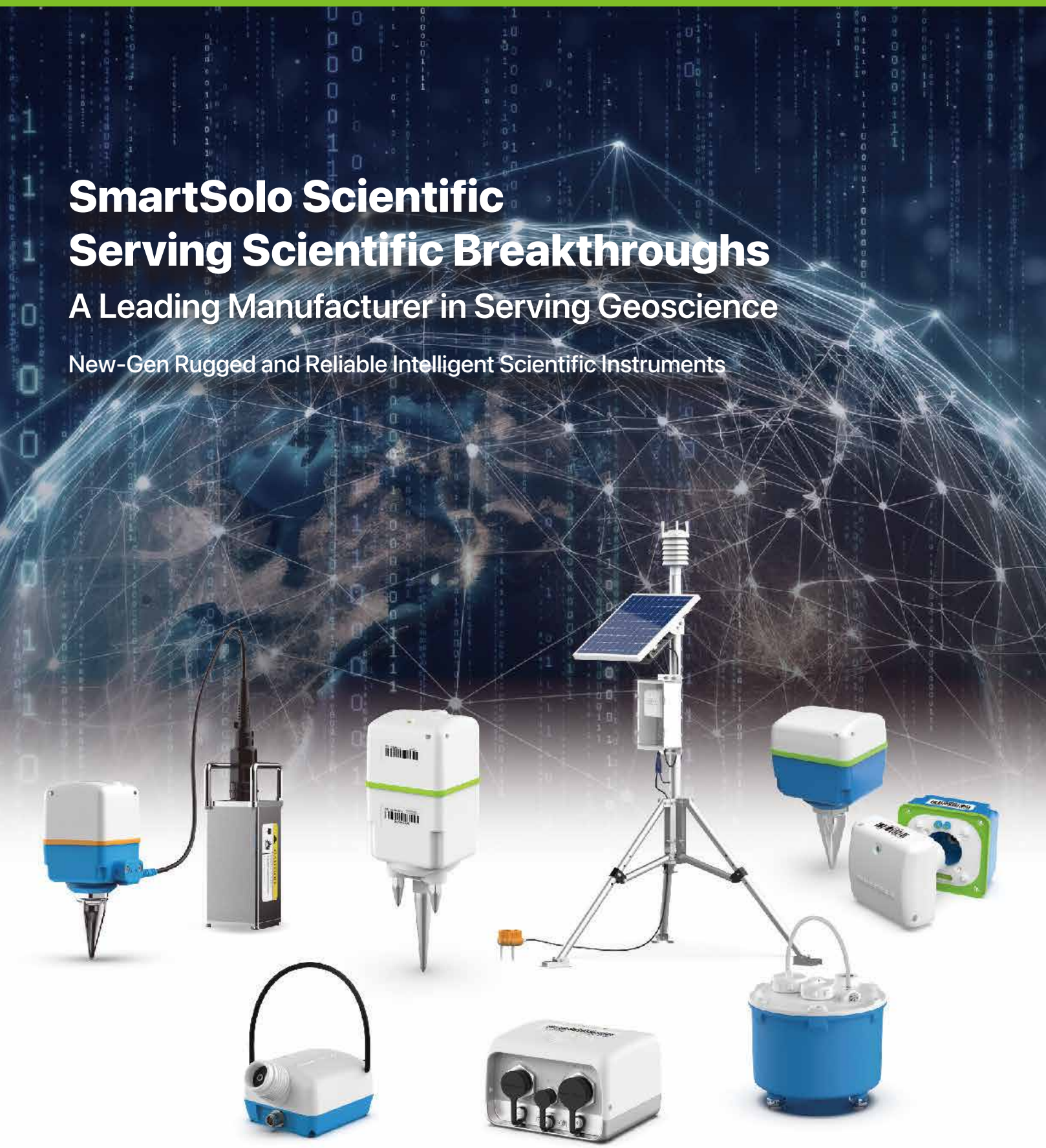
A Leading Manufacturer in Serving Geoscience

New-Gen Rugged and Reliable Intelligent Scientific Instruments



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A Leading Manufacturer in Serving Geoscience

Our mission at SmartSolo Scientific is to enable our customers to make the world safer, greener and better. We help our customers accelerate earth sciences research, solve complex analytical challenges of field measurement and monitoring, increase scientific research productivity, deliver accurate and credible measurement and monitoring data of various physical quantities to market and accelerate scientific research.

SmartSolo Scientific provides customers with New-Gen rugged and reliable intelligent scientific instruments.

Product Directory

SMARTSOLO SCIENTIFIC
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1C Series

SmartSolo IGU-16 Smart Seismic Sensor 02

SmartSolo IGU-16HR High Resolution Smart Seismic Sensor 05

SmartSolo IGU-16HR-IES High Resolution Smart Seismic Sensor with Internal and External Geophones 08

Case Study
The Role of Passive Seismic Imaging in Mineral Exploration 10

Crustal Structure, Sedimentary Layer Structure 11

3C Series

SmartSolo IGU-16HR 3C 3-Component High Resolution Smart Seismic Sensor 13

SmartSolo IGU-16HR-EB 3C
3-Component High Resolution Smart Seismic Sensor With Internal and External Battery 16

SmartSolo IGU-BD3C-5 3-Component Broadband Smart Seismic Sensor 19

SmartSolo IGU-16HR 3C 2Hz 3-Component Smart Seismic Sensor 22

SmartSolo IGU-16HR 3C AIO 5Hz 3-Component Smart Seismic Sensor 25

Case Study
Assessment of Seismic Vulnerability Using HVSR Method in Haenam, Korea 27

Research on Shallow Crustal Structure in the Beichuan Area with Short-Period Dense Seismic Array 29

Antarctic Ice Cover Ambient Noise Observation 30

Passive Seismic Exploration in Swiss Urban Environments 31

Monitoring

SmartSolo IMU-22 1C Single Channel Intelligent Monitoring Unit 33

SmartSolo IMU-3C 3-Channel Intelligent Monitoring Unit 36

SmartSolo M1000 New Generation Nodal Data Logger 39

Case Study
Fracturing Monitoring of Geothermal Production Wells in Tangshan, China 41

The New Generation Research Grade
Field Seismic and Meteorological Data Acquisition System-WSMS100 43

Case Study
Microseismic Monitoring Three Gorges Dam 48

China University of Geosciences Successfully Completes
Deployment of Seismic Meteorological Scientific Observation System in Nyingchi, Tibet 49

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IGU-16

The IGU-16 node instrument can conveniently and quickly form various networked seismic arrays, combined with active and passive source methods, to obtain massive data for high-density array spatiotemporal measurement (DAM).
Suitable for scientific research and enterprise survey needs in different scale regions.

Applications:
- Geological structure research
- Natural earthquake observation research
- Volcano observation research
- Observation and research on geological hazards
- Exploration of oil and gas, geothermal energy
- Coal exploration
- Metal mineral exploration
- Infrastructure geological assessment

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SmartSolo IGU-16

Smart Seismic Sensor

Features

- High quality, high sensitivity, high reliability
- Low distortion, low cost
- Compact size, lightweight
- Extremely wide operating temperature range
- Extended battery life
- IP68 waterproof
- No external connectors in the field, flexible wireless deployment
- Flexible system configuration, comprehensive software assistance
- Built-in high-precision clock
- Built-in large-capacity storage, expandable storage
- Lowest cost per channel in the seismic exploration

Descriptions

The SmartSolo IGU-16 is an intelligent seismic node that can implement large-scale, high-density, and cost-effective exploration solutions. Building upon the foundation of the highly sensitive geophone DT-SOLO.
SmartSolo is dedicated to pursuing the essence of seismic exploration-delivering high-fidelity seismic wave signals along with precise data timestamps and locations, while incorporating the electronic and software technologies of the mobile internet era. IGU-16 is widely recongnized as it is a comprehensive, high-quality, intelligent, reliable, user-friendly, and structurally simple seismic exploration data logger that can be used in any harsh environment, all at an excellent price-to-performance ratio.

Applications

- Active source reflection and refraction seismic exploration
- Seismic imaging
- Energy exploration
- Seismic exploration
- Geothermal resource exploration
- Seismic disaster early warning
- Mudslide and landslide disaster early warning
- Urban building health monitoring

Flexibility

The IGU-16 smart seismic sensor is compact and lightweight, weighing only 1.1 kilograms, including the battery and spike. It can be easily carried and deployed without any external connectors, eliminating any additional burden work. Even for small-scale teams that require multiple deployments, the equipment transportation can be easily accomplished.

Reliable Performance

The IGU-16 smart seismic sensor is designed to operate reliably in a wide temperature range from -40 °C to +70 °C. It features a built-in high-precision disciplinable clock and a large-capacity expandable local storage card. Additionally, it supports IP 68 waterproof and dustproof ratings, hence there's no need to worry about water immersion, clogging, or moisture. It is fully capable of working in various harsh environments.

Rich Peripheral Equipment

The IGU-16 smart seismic sensor equipped with a wealth of peripheral devices and auxiliary support, including various auxiliary software such as the Data Management Center (DMC) and the Data Collection Center (DCC), as well as a range of hardware auxiliary devices including the Data Download Rack (DHR). By using these peripherals, it is easily to complete harvest the acquisition data which up to 3000 channels @ 2 ms & 20 working days less than 3.25 hours, providing invaluable assistance for seismic data acquisition.

Extended Battery Life

The SmartSolo IGU-16 smart seismic sensor boasts an exceptionally long battery life to meet the demands of extended operations. In the standard conditions, the IGU-16 smart seismic sensor can support continuous operation for up to 50 days @ 1 ms sampling after a single charge, and in segmented working mode (12 hours working/12 hours sleep), it can last for an impressive 100 days. Its outstanding battery life makes the IGU-16 ideal for mid to long-term monitoring applications.

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Typical Node Specifications

Seismic Data Channel	1
Size	103 mm(L) x 95 mm(W) x 118 mm(H) (without spike)
Weight	1.1 kg (including battery and spike)
Ingress Protection	IP 68
Operating Temperature	-40 °C ~ +70 °C
Charging Temperature Range	+3 °C ~ +45 °C
Operating Life @ 25 °C	50 days @ 1 ms, 24 hrs/day operation
	100 days @ 1 ms, 12 hrs/day operation
Data Storage	8 GB (expandable to 16 or 32 GB)

Sensor Specifications DT-SOLO 5 Hz

(All parameters are specified at +22 °C in the vertical position unless otherwise stated)

Natural Frequency(Fn)		5 Hz
Spurious Frenquency		>170 Hz
Coil Resistance		1850 Ω
Damping	Open Circuit Damping	0.60
	Damping with 43 kΩ	0.70
Sensitivity		
(Open Circuit Intrinsic Voltage Sensitivity)		80 V/m/s (2.03 V/in/s)
Distortion		< 0.1% @ 12 Hz, (0°~10°) tilt

Sensor Specifications DT-SOLO 10 Hz

(All parameters are specified at +25 °C in the vertical position unless otherwise stated)

Natural Frequency(Fn)		10 Hz
Spurious Frenquency		>240 Hz
Coil Resistance		1800 Ω
Damping	Open Circuit Damping	0.51
	Damping with 20 kΩ	0.70
Sensitivity		
(Open Circuit Intrinsic Voltage Sensitivity)		85.8 V/m/s (2.18 V/in/s)
Distortion		< 0.1% @ 12 Hz, (0°~10°) tilt

Acquisition Channel

(@ 2 ms sample interval, 31.25 Hz, +25 °C unless otherwise indicated)

ADC Resolution	32 bits (The ADC has 32-bit resolution, the noise-free resolution is no more than 24-bit)
Sample Interval	1, 2, 4 ms
Preamplifier Gain	0 dB ~ 24 dB in 6 dB steps
Anti-alias Filter	206.5 Hz @ 2 ms (82.6% of Nyquist)
	Selectable - linear phase or minimum phase
DC Blocking Filter	1 Hz to 10 Hz,1 Hz increments or DC removed
GPS Time Standard	1 ppm
Timing Accuracy	±10 µs, GPS disciplined
Maximum Input Signal	±2.5 V peak @ 0 dB
Equivalent Input Noise	0.71 µV @ 2 ms @ 12 dB (Typical)
Total Harmonic Distortion	<0.0005% @ 0 dB
Common Mode Rejection	≥100 dB
Gain Accuracy	<1%
System Dynamic Range	140 dB
Frequency Response	0~413 Hz@1 ms

Note: Follow SEG polarity rules(When shocked by seismic motion, sensor upward motion as the channel record is Negative signal,sensor downward motion as the channel record is Positive signal)

Specifications are subject to change without prior notice.

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IGU-16HR

The IGU-16HR node instrument can conveniently and quickly form various networked seismic arrays, combined with active and passive source methods, to obtain massive data for high-density array spatiotemporal measurement (DAM).
Suitable for scientific research and enterprise survey needs in different scale regions.

Applications:
- Geological structure research
- Natural earthquake observation research
- Volcano observation research
- Observation and research on geological hazards
- Exploration of oil and gas, geothermal energy
- Coal exploration
- Metal mineral exploration
- Infrastructure geological assessment

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SmartSolo IGU-16HR
High Resolution Smart Seismic Sensor

Features

- High quality, high sensitivity, high reliability
- Low distortion, low cost
- Compact size, lightweight
- Extremely wide operating temperature range
- Extended Battery Life
- IP 68 waterproof
- Capable of handling various complex field environments
- Flexible system configuration, comprehensive software assistance
- Built-in high-precision clock
- High-speed data download
- Optional 10 Hz and 5 Hz geophones

Descriptions

The SmartSolo IGU-16HR high resolution smart seismic sensor is an intelligent seismic node that can implement large-scale, high-density, and cost-effective exploration solutions. Building upon the foundation of the highly sensitive geophone DT-SOLO. SmartSolo is dedicated to pursuing the essence of seismic exploration-delivering high-fidelity seismic wave signals along with precise data timestamps and locations, while incorporating the electronic and software technologies of the mobile internet era. IGU-16HR is widely recongnized as it is a comprehensive, high-quality, intelligent, reliable, user-friendly, and structurally simple seismic exploration data logger that can be used in any harsh environment, all at an excellent price-to-performance ratio.

Applications

- Active source reflection and refraction seismic exploration
- Seismic imaging
- Energy exploration
- Seismic exploration
- Geothermal resource exploration
- Seismic disaster early warning
- Mudslide and landslide disaster early warning
- Urban building health monitoring

Flexibility

The SmartSolo IGU-16HR high resolution smart seismic sensor is compact and lightweight, weighing only 1.1 kilograms, including the battery and spike. It can be easily carried and deployed without any external connectors, eliminating any additional burden work. Even for small-scale teams that require multiple deployments, the equipment transportation can be easily accomplished.

Reliable Performance

The SmartSolo IGU-16HR high resolution smart seismic sensor is designed to operate reliably in an wide temperature range from -40 °C to +70 °C. It features a built-in high-precision disciplinable clock and a large-capacity expandable local storage card. Additionally, it supports IP 68 waterproof and dustproof ratings, hence there's no need to worry about water immersion, clogging, or moisture. It is fully capable of working in various harsh environments.

Rich Peripheral Equipment

The SmartSolo IGU-16HR high resolution smart seismic sensor equipped with a wealth of peripheral devices and auxiliary support, including various auxiliary software such as the Data Management Center (DMC) and the Data Collection Center (DCC), as well as a range of hardware auxiliary devices including the Data Download Rack (DHR). By using these peripherals, it is easily to complete havest the acquisition data which up to 3000 channels @ 2 ms & 20 working days less than 3.25 hours, providing invaluable assistance for seismic data acquisition.

Extended Battery Life

The SmartSolo IGU-16HR high resolution smart seismic sensor boasts an exceptionally long battery life to meet the demands of extended operations. In the standard conditions, the IGU-16HR smart seismic sensor can support continuous operation for up to 35 days @ 1 ms sampling after a single charge, and in segmented working mode (12 hours working/12 hours sleep), it can last for an impressive 70 days. Its outstanding battery life makes the IGU-16 ideal for mid to long-term monitoring applications.

Typical Node Specifications

Seismic Data Channel	1
Size	103 mm (L)×95 mm (W)×118 mm (H) (without spike)
Weight	1.1 kg (including battery and spike)
Ingress Protection	IP 68
Charging Temperature Range	+3 °C ~ +45 °C
Charging Time	<3.25 hours
Operating Temperature	-40 °C ~ +70 °C
Operating Life @ 25 °C	35 days @ 1 ms, 12 hrs/day operation
	70 days @ 1 ms, 12 hrs/day operation
Data Storage	16 GB (expandable to 32 GB)
GNSS Mode	Support GPS, BEIDOU, GLONASS, single mode or double mode optional

Sensor Specifications DT-SOLO 5 Hz

(All parameters are specified at +22 °C in the vertical position unless otherwise stated)

Natural Frequency(Fn)		5 Hz
Spurious Frenquency		>170 Hz
Coil Resistance		1850 Ω
Damping	Open Circuit Damping	0.60
	Damping with 43 kΩ	0.70
Sensitivity (Open Circuit Intrinsic Voltage Sensitivity)		80 V/m/s (2.03 V/in/s)
Distortion		< 0.1% @ 12 Hz, (0°~10°) tilt

Sensor Specifications DT-SOLO 10 Hz

(All parameters are specified at +25 °C in the vertical position unless otherwise stated)

Natural Frequency(Fn)		10 Hz
Spurious Frenquency		>240 Hz
Coil Resistance		1800 Ω
Damping	Open Circuit Damping	0.51
	Damping with 20 kΩ	0.70
Sensitivity (Open Circuit Intrinsic Voltage Sensitivity)		85.8 V/m/s (2.18 V/in/s)
Distortion		< 0.1% @ 12 Hz, (0°~10°) tilt

Acquisition Channel

(@ 2 ms sample interval, 31.25 Hz, +25 °C unless otherwise indicated)

ADC Resolution	32 bits (The ADC has 32-bit resolution, the noise-free resolution is no more than 24-bit)
Sample Interval	0.25, 0.5,1, 2, 4 ms
Preamplifier Gain	0 dB ~ 36 dB in 6 dB steps
Anti-alias Filter	206.5 Hz @ 2 ms (82.6% of Nyquist)
	Selectable - linear phase or minimum phase
DC blocking Filter	1 Hz ~ 10 Hz, 1 Hz increments or DC removed
GPS Time Standard	1 ppm
Timing Accuracy	±10 µs, GPS disciplined
Maximum Input Signal	±2.5 V peak @ 0 dB
Equivalent Input Noise	0.18 µV @ 2 ms 18 dB
Total Harmonic Distortion	<0.0002% @ 0 dB
Common Mode Rejection	>100 dB
Gain Accuracy	<0.5%
System Dynamic Range	145 dB
Frequency Response	0~1652 Hz@0.25 ms

Note: Follow SEG polarity rules(When shocked by seismic motion, sensor upward motion as the channel record is Negative signal,sensor downward motion as the channel record is Positive signal)

Specifications are subject to change without prior notice.

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IGU-16HR-IES

The IGU-16HR-IES node instrument can conveniently and quickly form various networked seismic arrays, combined with active and passive source methods, to obtain massive data for high-density array spatiotemporal measurement (DAM).
Suitable for scientific research and enterprise survey needs in different scale regions.

Applications:
- Geological structure research
- Natural earthquake observation research
- Volcano observation research
- Observation and research on geological hazards
- Exploration of oil and gas, geothermal energy
- Coal exploration
- Metal mineral exploration
- Infrastructure geological assessment

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SmartSolo IGU-16HR-IES

High Resolution Smart Seismic Sensor with Internal and External Geophones

Features

- Highly reliable, resistant to harsh environments
- Multi-point networking, building a high-density spatiotemporal monitoring network
- Supports wireless QC and wireless data retrieval
- Connect to various geophones, hydrophones, or other sensors externally
- Built-in GNSS module and high-precision clock
- Built-in large-capacity local storage card
- Ultra-low power consumption, long battery life
- Compact, lightweight, suitable for field applications
- The most cost-effective system in the market

Applications

. Active and passive source seismic exploration
. Geological environmental monitoring
. Subsurface resource exploration
. Seismic disaster monitoring
. Structural health monitoring
. Security monitoring
. Building smart sensors and systems

Descriptions

The SmartSolo IGU-16HR-IES high-resolution internal and external smart seismic sensor is a high-precision, cost-effective smart seismic data logger that can connect to various sensors. It incorporates the industry-recognized DT-SOLO high-sensitivity seismic sensor and offers the option of 5Hz/10Hz natural frequency geophones, enabling precise collection of seismic data. Additionally, it utilizes an ultra-high-precision AD conversion circuit along with peripheral circuits to achieve minimal input noise and harmonic distortion. This allows it to capture seismic wave signals with accurate data timestamps and locations, all of which are stored on a local storage card.Its external interface can be configured to different input impedances according to user requirements, accommodating various geophones, hydrophones, or other differential analog voltage output sensors. Users can also utilize a mobile app for device deployment, technical support, and to enable Bluetooth for wireless QC, device locating, and data retrieval/download functions. Furthermore, the device features sensor self-check and GPS positioning capabilities, recording device operating status and its location during operation.

SmartSolo Scientific makes extensive use of mature, highly reliable, and cost-effective electronic and software technologies from the mobile internet era to manufacture smart sensors and data loggers that are intelligent, reliable, user-friendly, and cost-effective, capable of operating in any harsh environment.

Typical Node Specifications

Seismic Data Channel	1
Size	139.6 mm (L)×95 mm (W)×131.7 mm (H) (without spike)
Weight	1.3 kg (including battery and spike)
Battery Capacity	8.4 V, 6700 mAh
Ingress Protection	IP 68
Operating Temperature	-40 °C ~ +70°C
Charging Temperature Range	+3 °C ~ +45 °C
Charge Time	<3.25 hrs
Operating Life @ 25 °C	32 days @ 2 ms, 24 hrs/day operation 64 days @ 2 ms, 12 hrs/day operation
Data Storage	16 GB
GNSS Mode	Support GPS, BEIDOU, GLONASS, single mode or double mode optional
Wireless Communication	Bluetooth low energy

Sensor Specifictions DT-SOLO 5Hz

(All parameters are specified at +22 °C in the vertical position unless otherwise stated)

Natural Frequency(Fn)		5 Hz
Spurious Frenquency		>170 Hz
Coil Resistance		1850 Ω
Damping	Open Circuit Damping	0.60
	Damping with 43 kΩ	0.70
Sensitivity (Open Circuit Intrinsic Voltage Sensitivity)		80 V/m/s (2.03 V/in/s)
Distortion		< 0.1% @ 12 Hz, (0°~10°) tilt

Sensor Specifications DT-SOLO 10Hz

(All parameters are specified at +25 °C in the vertical position unless otherwise stated)

Natural Frequency(Fn)		10 Hz
Spurious Frenquency		>240 Hz
Coil Resistance		1800 Ω
Damping	Open Circuit Damping	0.51
	Damping with 20 kΩ	0.70
Sensitivity (Open Circuit Intrinsic Voltage Sensitivity)		85.8 V/m/s (2.18 V/in/s)
Distortion		< 0.1% @ 12 Hz,(0°~10°) tilt

Acquisition Channel

(@ 2 ms sample interval, 31.25 Hz, +25 °C unless otherwise indicated)

ADC resolution	32 bits (The ADC has 32-bit resolution, the noise-free resolution is no more than 24-bit)
Sample interval	0.25, 0.5,1, 2, 4 ms
Preamplifier gain	0 dB to 36 dB in 6 dB steps
Anti-alias filter	206.5 Hz @ 2 ms (82.6% of Nyquist) Selectable - linear phase or minimum phase
DC blocking filter	1 Hz ~ 10 Hz. 1 Hz increments or DC removed
GPS Time Standard	1 ppm
Timing Accuracy	±10 µs, GPS disciplined
Maximum Input Signal	±2.5 V peak @ 0 dB
Instantaneous Dynamic Range	125 dB @ 2 ms 0 dB
Equivalent Input Noise	0.18 µV @ 2 ms 18 dB
Total Harmonic Distortion	<0.0002% @ 0 dB
Common Mode Rejection	>100 dB
Gain Accuracy	<0.5%
System Dynamic Range	145 dB
Frequency Response	0~1652 Hz @ 0.25 ms
Input Resistance	20 KΩ, 43 KΩ, 2 MΩ optional

Note: Follow SEG polarity rules(When shocked by seismic motion, sensor upward motion as the channel record is Negative signal,sensor downward motion as the channel record is Positive signal)
Specifications are subject to change without prior notice.

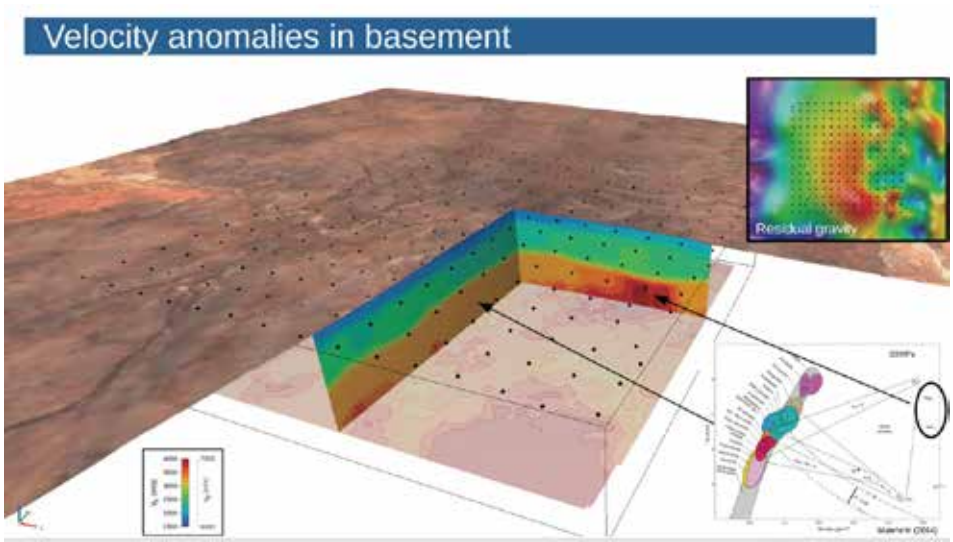
The Role of Passive Seismic Imaging in Mineral Exploration

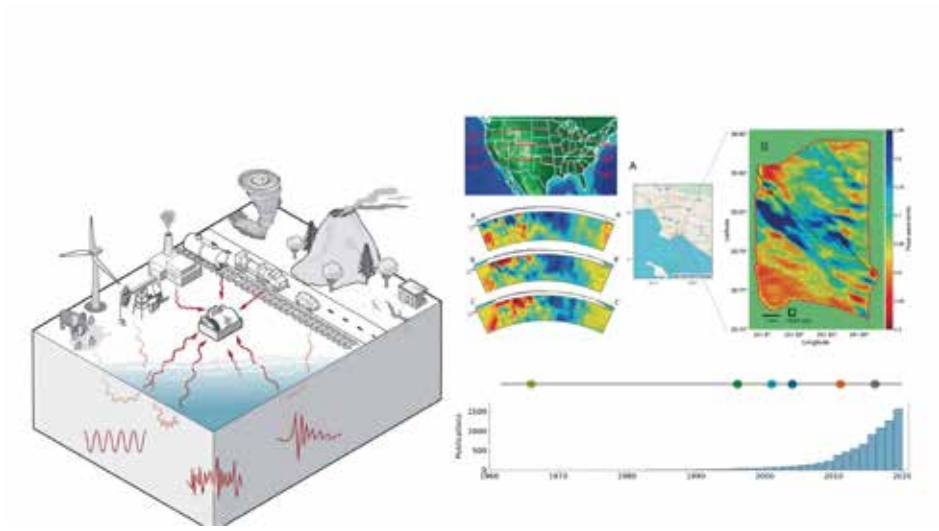
Equipment type: SmartSolo IGU-16
Equipment quantity: 225

Research Overview

Australia's Institute of Mine Seismology (IMS), a globally renowned research institution specializing in mine seismology and equipped with cutting-edge passive-source seismic data tomography processing technology, conducted a one-month research project on the Tamar Fault located within the island of Tasmania, Australia. The primary objective of this study was to achieve higher-resolution imaging of anomalies identified in a low-resolution exploration survey conducted in 2013, with the ultimate goal of advancing the development and utilization of geothermal and mineral resources within the island of Tasmania.

Following the retrieval of equipment, IMS obtained high-resolution seismic data. The anomalies identified in the processing results closely corresponded to those observed in the previous dataset, and the new results provided a clearer depiction of the depth and extent of the Tamar Fault Zone. Through meticulous data processing, IMS constructed a 3D subsurface velocity structure for the surveyed area, enabling more precise localization of velocity anomalies in proximity to the fault zone, surpassing initial expectations.





Crustal Structure, Sedimentary Layer Structure

Equipment type: SmartSolo IGU-16 HR
Equipment quantity: 100

Research Overview

From June 19 to August 25, 2018, the Institute of Geology and Geophysics of the Chinese Academy of Sciences carried out 100 single-component short-period intensive seismic observations in the Kalatongke mining area in Xinjiang for a period of two months (Figure 10-a, b). The observation area is 12 km×3 km, and the average station spacing is 500 m.
The background noise imaging method was used to analyze the two-month continuous waveform data, and the three-dimensional shear wave velocity structure of the shallow crust (0–1.3 km) below the mining area was obtained (Fig. 10-c).
The study found that within the depth range of 0-0.5 km, the main ore-bearing rock masses in the mining area exhibit different velocity characteristics, and it is speculated that the velocity difference between the ore-bearing rock masses is mainly related to the mineralization degree of the rock mass. An obvious low-velocity zone is found within the depth range of 0.7-1.3 km in the middle of the mining area, which may be an early magma channel, a mining strata, or a possible mineralized area. High-speed areas were found in the 0.7-1.3 km depth range in the northwest and southeast of the mining area, which may be related to the gabbro and olivine gabbro left by the early magma upwelling.

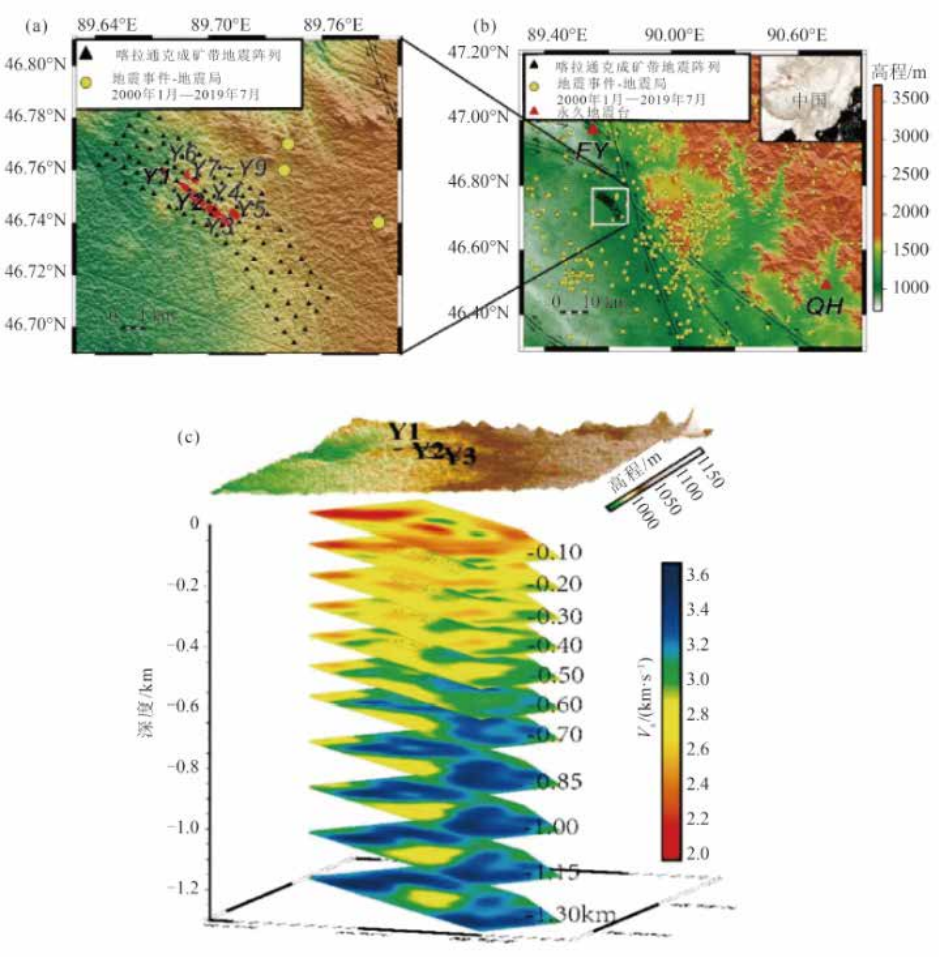


图 10　喀拉通克矿集区地震台阵部署位置及剪切波速度结构[26]

Fig. 10　Location of the seismic array and shear wave velocity structure in Karatungk mine area

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IGU-16HR 3C

The IGU-16HR 3C node instrument can conveniently and quickly form various networked seismic arrays, and combine active and passive source methods to obtain massive data for high-density array spatiotemporal measurement (DAM). Suitable for scientific research and enterprise survey needs in different scale regions.

Applications:
- Geological structure research
- Research on surface and body waves
- Natural earthquake observation research
- Observation and research on volcanoes and tsunamis
- Infrasound research
- Observation and research on geological hazards
- Mineral resource exploration
- Infrastructure geological assessment

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SmartSolo IGU-16HR 3C

3-Component High Resolution Smart Seismic Sensor

Features

- High quality
- High sensitivity
- High reliability
- Low distortion
- Low cost
- Low power consumption
- Compact, lightweight, and user-friendly
- IP68 waterproof
- Strong resistance to extreme and harsh environments
- Optional 10Hz and 5Hz built-in geophones

Descriptions

SmartSolo IGU-16HR 3C is a new generation 3-channel intelligent seismic sensor and offers the best cost-performance ratio in the market, IGU-16HR 3C supports multiple sampling rates and provides comprehensive and high-quality seismic data exploration, It is user-friendly, has a simple structure,and is both intelligent and reliable. With long battery life and excellent resistance to extreme and harsh environmental conditions,IGU-16HR 3C can operate stably even in complex environments.It has become a powerful assistant for numerous researchers conducting seismic research, contributing to the success of scientific research end eavors.

Applications

- Dense array
- Energy exploration
- Geological structure exploration
- Geothermal resource exploration
- Seismic disaster warning
- Mudslide and landslide disaster warning
- Shallow three-dimensional structure detection
- Mountain bedrock structure detection

High-resolution

High-resolution data

32-bit Σ-Δ, high-resolution ADC

Up to 0.25 ms sampling rate

Built-in GPS and high-precision clock

Large Channel Count, Flexible Deployment

DT-SOLO high-sensitivity geophone

Optional 5 Hz and 10Hz geophones

Expandable to a million-channel system

Ultra-low Power Consumption, Low Cost

Lightweight, compact

Shares a set of auxiliary equipment with IGU-16

Significantly reduces equipment investment

The most cost-effective system in the market

Up to 30 days of battery life

Convenient and Highly Efficient

Integrated modular design

Greatly improves production efficiency

Reduces maintenance costs

The main body and battery can be separated

Allows for easy battery replacement

The Future of the Seismic Exploration Industry

Smaller team sizes, reduced manpower, simplified equipment, lower operational costs

HSE (Health, Safety, Environment) assurance

Efficient data download and management

High density, capable of handling millions of channels

Typical Node Specifications

Seismic Data Channels	3
Size	103 mm (L) × 95 mm (W) × 187 mm (H) (without spike)
Weight	2.4 kg (including battery and spike)
Ingress Protection	IP 68
Operating Temperature	-40 °C ~ +70 °C
Charging Temperature Range	+3 °C ~ +45 °C
Charging Time	<6 hrs
Operating Life@25°C	30 days @ 2ms, 24 hrs/day operation
	60 days @ 2ms, 12 hrs/day operation
Data Storage	64 GB
GNSS Mode	Support GPS, BEIDOU, GLONASS, single mode or double mode optional

Acquisition Channel

(@ 2ms sample interval, 31.25 Hz, +25 °C, unless otherwise indicated)

ADC Resolution	32 bits (The ADC has 32-bit resolution, the noise-free resolution is no more than 24-bit)
Sample Interval	0.25, 0.5, 1, 2, 4, 8, 10, 20 ms
Preamplifier Gain	0 dB to 36 dB in 6 dB steps
Anti-alias Filter	206.5 Hz @ 2 ms (82.6% of Nyquist)
	Selectable - linear phase or minimum phase
DC Blocking Filter	1 Hz to 10 Hz, 1 Hz increments or DC removed
Dynamic Range	125 dB @ 2 ms 0 dB
Equivalent Input Noise	0.18 μV @ 2 ms 18 dB
Total Harmonic Distortion	<0.0002% @ 0 dB
Common Mode Rejection	>100 dB
Gain Accuracy	<1%
GPS Time Standard	1 ppm
Timing Accuracy	±10 μs, GPS disciplined
Cross Feed	<-110 dB
System Dynamic Range	145 dB
Frequency Response	0 ~ 1652 Hz @ 0.25ms

Sensor Specifications DT-SOLO 5Hz

(All parameters are specified at +22 °C in the vertical or horizontal position unless otherwise stated)

Natural Frequency(Fn)		5 Hz
Spurious Frenquency		>170 Hz
Coil Resistance		1850 Ω
Damping	Open Circuit Damping	0.60
	Damping with 43kΩ	0.70
Sensitivity (Open Circuit Intrinsic Voltage Sensitivity)		80 V/m/s (2.03 V/in/s)
Distortion		< 0.1% @ 12 Hz, (0°~10°) vertical tilt (0°~3°) horizontal tilt

Sensor Specifications DT-SOLO 10Hz

(All parameters are specified at +25 °C in the vertical or horizontal position unless otherwise stated)

Natural Frequency(Fn)		10 Hz
Spurious Frenquency		>240 Hz
Coil Resistance		1800 Ω
Damping	Open Circuit Damping	0.51
	Damping with 20kΩ	0.70
Sensitivity (Open Circuit Intrinsic Voltage Sensitivity)		85.8 V/m/s (2.18 V/in/s)
Distortion		< 0.1% @ 12 Hz, (0°~10°) vertical tilt (0°~3°) horizontal tilt

Specifications are subject to change without prior notice.

Note: Follow SEG polarity rules(When shocked by seismic motion, sensor upward motion as the channel record is Negative signal,sensor downward motion as the channel record is Positive signal)

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IGU-16HR-EB 3C

The IGU-16HR-EB 3C node instrument can conveniently and quickly form various networked seismic arrays, combined with active and passive source methods, to obtain massive data for high-density array spatiotemporal measurement (DAM).
Suitable for scientific research and enterprise survey needs in different scale regions.

Applications:
- Geological structure research
- Research on surface and body waves
- Natural earthquake observation research
- Observation and research on volcanoes and tsunamis
- Observation and research on geological hazards
- Infrastructure geological assessment

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SmartSolo IGU-16HR-EB 3C

3-Component High Resolution Smart Seismic Sensor with Internal and External Battery

Features

- Built-in 64 or 128 GB non-volatile memory
- Compatible with commonly used 7-15 V DC batteries
- External battery is primary power supply, automatic switch to internal battery when power is out
- 110 days battery life @ 2 ms sample interval @ 25 °C
- The device can be used independently after the external connector is removed
- A safe robust aluminium casing protects the external battery
- Highly reliable waterproof connectors and cables
- Compatible with SmartSolo IGU series 1C & 3C peripherals, reduce equipment cost

Descriptions

IGU-16HR-EB 3C is along-term operation high-precision autonomous nodal seismic data acquisition device, based on the very successful IGU-16HR 3C. With the same exacting standards of reliability but with greatly extended operating time, it meets the requirements for surveying and research applications that call for very long-term recording

Applications

- Dam inspection
- Isolated rock karst detection
- Void detection
- Geological survey
- Geothermal and water resource exploration
- Structural health monitoring
- Landslide monitoring
- Energy and mineral exploration
- Real-time railway warning
- Short-period array observation
- Microseismic hydraulic fracturing monitoring
- Natural seismology research

High-resolution

High-resolution data

32-bit Σ-Δ, high-resolution ADC

Up to 0.25 ms sampling rate

Built-in GPS and high-precision clock

Large Channel Count, Flexible Deployment

DT-SOLO high-sensitivity geophone

Optional 5 Hz and 10 Hz geophones

Expandable to a million-channel system

Red-green bicolor LED indicator lights

Green indicates 'good', red light indicates 'bad'

Ultra-low Power Consumption, Low Cost

Lightweight, compact Shares a set of auxiliary equipment with IGU-16 Significantly reduces equipment investment The most cost-effective system in the market Up to 110 days of battery life with external battery

Convenient and Highly Efficient

Integrated modular design

Greatly improves production efficiency

Reduces maintenance costs

The main body and battery can be separated

Allows for easy battery replacement

The Future of the Seismic Exploration Industry

Smaller team sizes, reduced manpower, simplified equipment, lower operational costs

HSE (Health, Safety, Environment) assurance Efficient data download and management High density, capable of handling millions of channels

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Typical Node Specifications

Recording Unit Specifications

Seismic Data Channels	3
Size	103 mm(L) x 95 mm(W) x225 mm(H)(with quadrangular spike)
	103 mm(L) x 95 mm(W) x 254 mm(H)(with conical spike)
Weight	670 g (quadrangular spike, without cables)
	780 g (conical spike, without cables)
Data Storage	64~128 GB
Ingress Protection	IP 67
Internal Charge Time	≤3.25 hours
Charging Temperature	+3 °C ~ +45 °C
Operating Temperature	-40 °C ~ +70 °C
Internal Battery Life @25°C	15 days @ 2 ms continuous
GNSS Mode	Support GPS, BEIDOU, GLONASS, single mode or double mode optional

Channel Performance

(@ 2ms sample interval, 31.25 Hz, +25 °C, unless otherwise indicated)

ADC Resolution	32 bits
Sample Interval	0.25, 0.5, 1, 2, 4, 8, 10, 20 ms
Preamplifier Gain	0 dB to 36 dB in 6 dB steps
Anti-alias Filter	206.5 Hz @ 2 ms (82.6% of Nyquist) Selectable - linear phase or minimum phase
DC Blocking Filter	1 Hz to 10 Hz, 1 Hz increments or DC removed
Maximum Input Signal	±2.5 V peak @ 0 dB
Dynamic Range	125 dB @ 2 ms 0 dB
Equivalent Input Noise	0.18 µV @ 2 ms 18 dB
Total Harmonic Distortion	<0.0002% @ 0 dB
Common Mode Rejection	>100 dB
Gain Accuracy	<1%
GPS Time Standard	1 ppm
Timing Accuracy	±10 µs, GPS disciplined
Cross Feed	<-110 dB
System Dynamic Range	145 dB
Frequency Response	0 ~ 1652 Hz @ 0.25 ms

Sensor Specifications DT-SOLO 5Hz

(All parameters are specified at +22 °C in the vertical or horizontal position unless otherwise stated)

Natural Frequency(Fn)		5 Hz
Spurious Frenquency		>170 Hz
Coil Resistance		1850 Ω
Damping	Open Circuit Damping	0.60
	Damping with 43kΩ	0.70
Sensitivity (Open Circuit Intrinsic Voltage Sensitivity)		80 V/m/s (2.03 V/in/s)
Distortion		< 0.1% @ 12 Hz, (0°~10°) vertical tilt (0°~3°) horizontal tilt

Sensor Specifications DT-SOLO 10Hz

(All parameters are specified at +25 °C in the vertical or horizontal position unless otherwise stated)

Natural Frequency(Fn)		10 Hz
Spurious Frenquency		>240 Hz
Coil Resistance		1800 Ω
Damping	Open Circuit Damping	0.51
	Damping with 20kΩ	0.70
Sensitivity (Open Circuit Intrinsic Voltage Sensitivity)		85.8 V/m/s (2.18 V/in/s)
Distortion		< 0.1% @ 12 Hz, (0°~10°) vertical tilt (0°~3°) horizontal tilt

External Battery Specifications

Dimensions	259 mm (L)×90 mm (W)×112 mm (H)
Weight	3.15 kg
Battery Cell	18650 (16p2s) Li-ion
Rated voltage	7.2 V (3.6 V/cell)
Capacity	53.6 Ah
Standard Charging Current	4 A
Short-term Storage	< 6 months
Storage Temperature	-20 °C ~ +60 °C
Storage Humidity	65% ± 20% RH
Storage Voltage	7.4~7.8 V
Long-term Storage	> 6 months
Storage Temperature	+10 °C ~ +25 °C
Storage Humidity	65% ± 20% RH
Storage Voltage	7.4 ~ 7.8 V
Operating Temperature	-40 °C ~ +70 °C
Ingress Protection	IP68

Specifications are subject to change without prior notice.

Note: Follow SEG polarity rules(When shocked by seismic motion, sensor upward motion as the channel record is Negative signal,sensor downward motion as the channel record is Positive signal)

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IGU-BD3C-5

The IGU-BD3C-5 node instrument can conveniently and quickly form various networked seismic arrays, combined with active and passive source methods, to obtain massive data for high-density array spatiotemporal measurement (DAM).
Suitable for scientific research and enterprise survey needs in different scale regions.

Applications:
- Geological structure research
- Research on surface and body waves
- Natural earthquake observation research
- Observation and research on volcanoes and tsunamis
- Infrasound research
- Observation and research on geological hazards
- Infrastructure geological assessment

SmartSolo IGU-BD3C-5

3-Component Broadband Smart Seismic Sensor

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Features

- High quality, high sensitivity, high reliability
- Easy to deploy, high operate efficiency
- Wireless design, not limited by site
- Strong interference resistance, data remains undistorted
- Low cost, low power consumption, wide bandwidth
- Industry-leading, high cost-performance ratio

Descriptions

IGU-BD3C-5 is a low-cost, wide-band width, low-power three-component broadband smart seismic sensor. Building upon the foundation of the high-sensitivity seismic geophones DT-SOLO, produced by DTCC, it combines electronic and software technologies from the mobile internet era with the currently popular and reliable electronic bandwidth extension technology. This allows its frequency band to reach a range of 0.2 Hz to 150 Hz.

Applications

- Active and passive source seismic exploration
- Natural microtremor detection
- Transient surface wave exploration
- Karst area detection
- Underground spaces and void detection
- Engineering safety risk assessment
- Disaster early warning

New Generation 3-channel Smart Seismic Sensor

Lower the bandwidth limit down to 5 s

Built-in battery supports continuous operation for up to 30 days

Supports external power supply and Bluetooth QC

Reliable Performance, High Resolution

Built-in GPS and high-precision clock

32-bit Σ-Δ high-resolution ADC

Up to 0.25 ms sampling rate

Dual-status indicator lights

Indicate Bluetooth, charging, and operational status

Real-time Data Transmission and Storage

Real-time QC of seismic data and instrument status

Built-in 64 GB storage, 128 GB optional

The peripheral equipment for IGU-BD3C-5Hz

Combined download and charging device

16 Slots all-in-one

SoloLite software

High-speed data download

USB 3.0 @ 20 MB/s

Portable data download and charging all-in-one device

Flexible system configuration

Comprehensive software assistance

Combined download and charging device

16 Slots all-in-one

Typical Node Specifications

Seismic Data Channels	3
Size	Φ158 x 160 mm (without spike)
Weight	2.8 kg (including internal battery and spike)
Ingress Protection	IP 68
Operating Temperature	-40 °C ~ +70 °C
Charging Temperature Range	+3 °C~ +45 °C
Charging Time	<7.5 hrs, Fully charged (standard battery)
Operating Life@25°C	30 days @ 2 ms, 24 hrs/day operation 60 days @ 2 ms, 12 hrs/day operation
Data Storage	64 GB (expandable to 128 GB)
GNSS Mode	Support GPS, BEIDOU, GLONASS, single mode or double mode optional
Data Harvesting	USB 3.0
Bluetooth QC	Available
External Power Supply	7 ~ 15 V DC (single supply)

Sensor

(All parameters are specified at +22 °C in the vertical or horizontal position unless otherwise stated)

Frequency Bandwidth	0.2 Hz ~ 150 Hz
Distortion	<0.1% @ 12 HZ (0°~ 10°) vertical tilt, (0°~3°) horizontal tilt
Sensitivity	200 V/m/s (5.08 V/in/s)

Acquisition Channel

(@ 2 ms sample interval, 31.25 Hz,+25 °C unless otherwise indicated)

ADC Resolution	32 bits
Sample Interval	0.25, 0.5,1, 2, 4, 8,10, 20 ms
Instrument Self-noise	Whole frequency band lower than the NHNM curve 5 s ~ 1 Hz lower than the NLNM curve
Maximum Input Signal	±2.5 V peak @ 0 dB
Instantaneous Dynamic Range	120 dB @ 2 ms 0 dB
Common Mode Rejection	>100 dB
Gain Accuracy	<1%
GPS Time Standard	1 ppm
Timing Accuracy	± 10 µS, GPS disciplined
Cross Feed	<-110 dB
Inter-channel Phase Offset	<0.1 ms
Transverse Vibration Rejection	Better than 0.1%
Inter-channel Amplitude Coherence	5%
System Dynamic Range	145 dB
Frequency Response	0~1652 Hz @ 0.25 ms

Note: Follow SEG polarity rules(When shocked by seismic motion, sensor upward motion as the channel record is Negative signal,sensor downward motion as the channel record is Positive signal)

Specifications are subject to change without prior notice.

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IGU-16HR 3C 2Hz

The IGU-16HR 3C 2Hz node instrument can conveniently and quickly form various networked seismic arrays, combined with active and passive source methods, to obtain massive data for high-density array spatiotemporal measurement (DAM).
Suitable for scientific research and enterprise survey needs in different scale regions.

Applications:
- Geological structure research
- Research on surface and body waves
- Natural earthquake observation research
- Observation and research on volcanoes and tsunamis
- Infrasound research
- Observation and research on geological hazards
- Infrastructure geological assessment

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SmartSolo IGU-16HR 3C 2Hz

3-Component Smart Seismic Sensor

Features

- New generation smart 3-component seismic sensor
- High resolution data with up to 0.25ms sampling and 32-bit delta-sigma ADC
- Low frequency signal can be recovered as low as 15s
- Built-in GPS receiver and disciplined high precision clock
- Based on the most highly regarded DT-SOLO geophone with 2Hz
- Up to 40 days of continuous recording
- Compatible with vibroseis and pulse sources
- Support external power supply and Bluetooth QC function
- Dual status indicator to indicate Bluetooth, charging and working status
- Real-time QC seismic data and instrument status
- Light weight and compact size
- Share the same peripherals as IGU-BD3C-5, saving equipment cost
- Most cost-effective system on the market

Descriptions

SmartSolo IGU-16HR 3C 2Hz is the latest integrated smart seismic sensor introduced by SmartSolo. It features a high-precision2Hz three-component geophone built-in and comes equipped with Bluetooth communication capabilities. This allows real-time monitoring of battery status, satellite connection, data acquisition scripts, and the ability to view seismic data waveforms in real-time. With its integrated design, it is suitable for various data collection tasks involving both active and passive sources, such as long-term background noise monitoring, microtremor acquisition, MASW (Multi-Channel Analysis of Surface Waves), and hydraulic fracturing monitoring, among others.

Applications

- Dense array
- Active and passive source seismic exploration
- Natural microtremor detection
- Transient surface wave exploration
- Karst area detection
- Underground spaces and void detection
- Engineering safety risk assessment
- Disaster early warning

New Generation 3-channel Smart Seismic Sensor

Lower the frequency limit down to 15 s

Built-in battery supports continuous operation for up to 40 days

Supports external power supply and Bluetooth QC

Reliable Performance, High Resolution

Built-in GPS and high-precision clock

32-bit Σ-Δ high-resolution ADC

Up to 0.25 ms sampling rate

Dual-status indicator lights

Indicate Bluetooth, charging, and operational status

Real-time Data Transmission

Real-time QC of seismic data and instrument status

Built-in 64 GB storage

The Peripheral Equipment for IGU-16HR 3C 2Hz

Combined download and charging device

4 Slots USB HUB

Power adapter

High-speed data download USB 3.0 @ 20 MB/s

Portable data download and charging all-in-one device Flexible system configuration

Comprehensive software assistance

Combined download and charging device

4 Slots USB HUB

Power adapter

Typical Node Specifications

Seismic Data Channels	3
Size	ϕ158 x 160 mm (without spike)
Weight	3.5 kg (included internal battery and spike)
Ingress Protection	IP 68
Operating Temperature	-40 °C ~ +70 °C
Charging Temperature Range	+3℃ ~ +45℃
Charging Time	<7.5 hrs, Fully charged (standard battery)
Operating Life @ 25 °C	40 days @ 2 ms, 24 hrs/day operation 80 days @ 2 ms, 12 hrs/day operation
Data Storage	64 GB (expandable to 128 GB)
GNSS Mode	Support GPS, BEIDOU, GLONASS, single mode or double mode optional
Data Harvesting	USB 3.0
Bluetooth QC	Availiable
External Power Supply	7 ~ 15 V DC (single power supply)

Sensor

(All parameters are specified at +20 °C in the vertical or horizontal position unless otherwise stated)

Natural Frequency	2 Hz
Bandwidth	15 s ~ 500 Hz
Distortion	≤0.3% @ 12 Hz, (0° ~ 7.5°)vertical tilt, (0°~ 0.5°)horizontal tilt
Damping	0.70
Sensitivity	260 V/m/s (6.60V/in/s)

Acquisition Channel

(@ 2 ms sample interval, 31.25 Hz, +25 °C, unless otherwise indicated)

ADC Resolution	32 bits
Sample Intervals	0.25, 0.5, 1, 2, 4, 8, 10, 20 ms
Preamplifier Gain	0 dB ~ 36 dB in 6 dB steps
Anti-alias Filter	206.5 Hz @ 2 ms (82.6% of Nyquist) Selectable - linear phase or minimum phase
DC Blocking Filter	1 Hz ~ 10 Hz,1 Hz increments or DC removed
Maximum Input Signal	±2.5 V peak @ 0dB
Instantaneous Dynamic Range	125 dB @ 0 dB
Equivalent Input Noise	0.18 μV @ 2 ms 18 dB
Total Harmonic Distortion	<0.0002% @ 0 dB
Common Mode Rejection	>100 dB
Gain Accuracy	<1%
GPS Time Standards	1 ppm
Time Accuracy	±10 μs, GPS disciplined
Cross feed	< -110 dB
Phase difference between channels	<0.1 ms
Transverse vibration suppression	Better than 0.1%
Consistency of amplitude between channels	5%
System Dynamic Range	145 dB
Frequency Response	0~1652 Hz @ 0.25 ms

Note: Follow SEG polarity rules(When shocked by seismic motion, sensor upward motion as the channel record is Negative signal,sensor downward motion as the channel record is Positive signal)
Specifications are subject to change without prior notice.

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IGU-16HR 3C AIO 5Hz

The IGU-16HR 3C AIO 5Hz node instrument can conveniently and quickly form various networked seismic arrays, combined with active and passive source methods, to obtain massive data for high-density array spatiotemporal measurement (DAM).
Suitable for scientific research and enterprise survey needs in different scale regions.

Applications:
- Geological structure research
- Research on surface and body waves
- Natural earthquake observation research
- Observation and research on volcanoes and tsunamis
- Infrasound research
- Observation and research on geological hazards
- Infrastructure geological assessment

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SmartSolo
IGU-16HR 3C AIO 5Hz
3-Component Smart Seismic Sensor

Features

- New generation 3-channel smart seismic sensor
- 32-bit Σ-Δ high-resolution ADC, with a sampling rate of up to 0.25ms
- Lower the frequency limit down to 5 s
- Built-in GPS and high-precision clock
- DT-SOLO high-sensitivity 5Hz geophones
- Continous operation for 40 days @ 24 hrs/day operation
- Support external power supply and Bluetooth QC function
- Supports external power supply
- Dual-status indicator lights for Bluetooth, charging, and operational status
- Real-time QC of seismic data and instrument status
- Lightweight and compact
- Shares a set of auxiliary equipment with IGU-BD3C-5, greatly reducing equipment costs
- The most cost-effective system available in the market

Descriptions

SmartSolo IGU-16HR 3C AIO 5Hz is the latest integrated smart seismic sensor introduced by SmartSolo. It features a high-precision 5Hz three-component geophone built-in and equipped with Bluetooth communication capabilities, which allows real-time monitoring of battery status, satellite connection, data acquisition scripts, and the ability to view seismic data waveforms in real-time. With its integrated design, it is suitable for various data collection tasks involving both active and passive sources, such as long-term background noise monitoring, microtremor acquisition, MASW (Multi-Channel Analysis of Surface Waves), and hydraulic fracturing monitoring, among others.

Applications

- Dense array
- Active and passive source seismic exploration
- Natural microtremor detection
- Transient surface wave exploration
- Karst area detection
- Underground spaces and void detection
- Engineering safety risk assessment
- Disaster early warning

New Generation 3-channel Smart Seismic Sensor

Identifiable lower frequency limit down to 5s

Built-in battery supports continuous operation for up to 40 days

Supports external power supply and Bluetooth QC

Reliable Performance, High Resolution

Built-in GPS and high-precision clock

32-bit Σ-Δ high-resolution ADC

Up to 0.25ms sampling rate

Dual-status indicator lights

Indicate Bluetooth, charging, and operational status

Real-time Data Transmission and Storage

Real-time QC of seismic data and instrument status

Built-in 64GB storage, 128 GB optional

The Peripheral Equipment for IGU-16HR 3C AIO 5Hz

Combined download and charging device

16 Slots all-in-one

SoloLite software

High-speed data download

USB 3.0 @ 20 MB/s

Portable data download and charging all-in-one device

Flexible system configuration

Comprehensive software assistance

Combined download and charging device

16 Slots all-in-one

Typical Node Specifications

Seismic Data Channels	3
Physical Size	Φ158 × 160 mm (without spike)
Weight	2.8 kg (included internal battery and spike)
Ingress Protection	IP 68
Operating Temperature	-40 °C ~ +70 °C
Charging Temperature Range	+3 °C ~ +45 °C
Charging Time	<7.5 hrs, fuly charged (stadard battery)
Operating Life @ 25 °C	40 days @ 2 ms, 24 hrs/day operation 80 days @ 2 ms, 12 hrs/day operation
Data Storage	64 GB (expandable to 128 GB)
GNSS Mode	Support GPS, BEIDOU, GLONASS, single mode or double mode optional
Data Harvesting	USB 3.0
Bluetooth QC	Availiable
External Power Supply	7 ~ 15 V DC (single power supply)

Sensor

(All parameters are specified at +22 °C in the vertical or horizontal position unless otherwise stated)

Natural Frequency	5 Hz
Coil Resistance	1850 Ω
Distortion	<0.1% @ 12 Hz, (0° ~ 10°) tilt, (0°~3°) horizontal tilt
Damping	Open Circuit Damping : 0.6 Damping With 43kΩ : 0.7
Open Circuit Sensitivity	80 V/m/s (2.03 V/in/s)

Acquisition Channel

(@ 2 ms sample interval, 31.25 Hz, +25 °C, unless otherwise indicated)

ADC Resolution	32 bits
Sample Interval	0.25, 0.5, 1, 2, 4, 8, 10, 20 ms
Preamplifier Gain	0dB ~ 36 dB in 6 dB steps
Anti-alias Filter	206.5 Hz @ 2ms (82.6% of Nyquist) Selectable - linear phase or minimum phase
DC Blocking Filter	1 Hz ~ 10 Hz, 1 Hz increments or DC removed
Maximum Input Signal	±2.5 V peak @ 0 dB
Instantaneous Dynamic Range	125 dB @ 2ms 0 dB
Equivalent Input Noise	0.18 μV @ 2ms 18 dB
Total Harmonic Distortion	<0.0002% @ 0 dB
Common Mode Rejection	>100 dB
Gain Accuracy	<1%
GPS Time Standards	1 ppm
Time Accuracy	±10 μs, GPS disciplined
Cross Feed	< -110 dB
Phase Difference Between Channels	<0.1 ms
Transverse Vibration Suppression	Better than 0.1%
Consistency of Amplitude Between Channels	5%
System Dynamic Range	145 dB
Frequency Response	0~1652 Hz @ 0.25 ms

Note: Follow SEG polarity rules(When shocked by seismic motion, sensor upward motion as the channel record is Negative signal,sensor downward motion as the channel record is Positive signal)

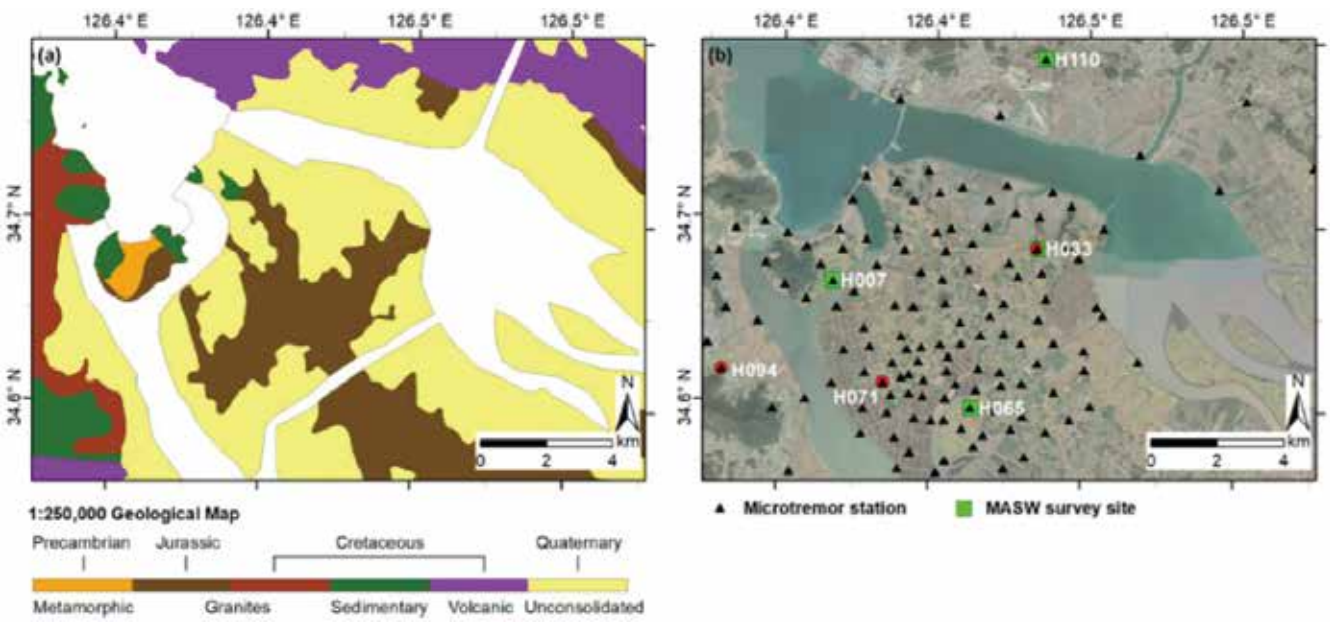
Specifications are subject to change without prior notice.

Assessment of Seismic Vulnerability Using HVSR Method in Haenam, Korea

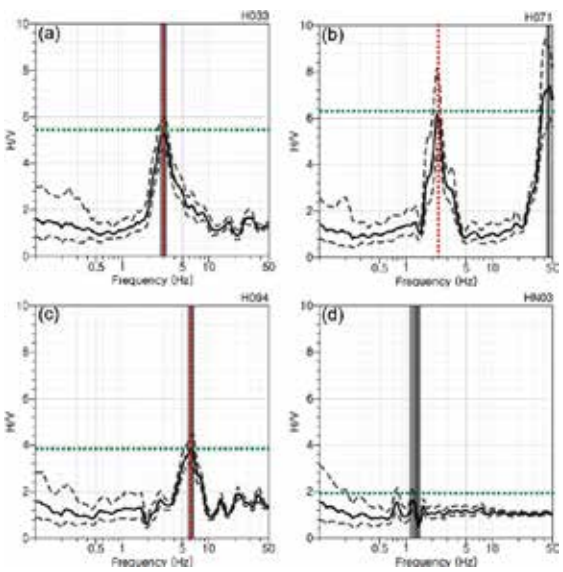
Equipment type: SmartSolo IGU-16HR 3C 5Hz
Equipment quantity: 144

Research Overview

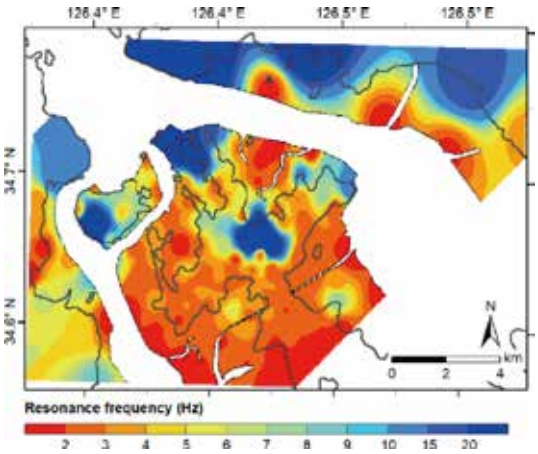
The town of Haenam in southwest Korea lies partially on reclaimed coastal land and experienced an unprecedented earthquake swarm during April and May 2020. Construction of a new town in the area means that there is a demand to evaluate the seismic hazard caused by site-specific amplification of seismic ground motions by artificial unconsolidated cover. Professor Kim and his group used a microtremor horizontal-to-vertical spectral ratio (HVSR) method to identify resonance frequencies, image depths to bedrock, and assess seismic ground vulnerability across the epicentral area of the recent earthquake swarm.



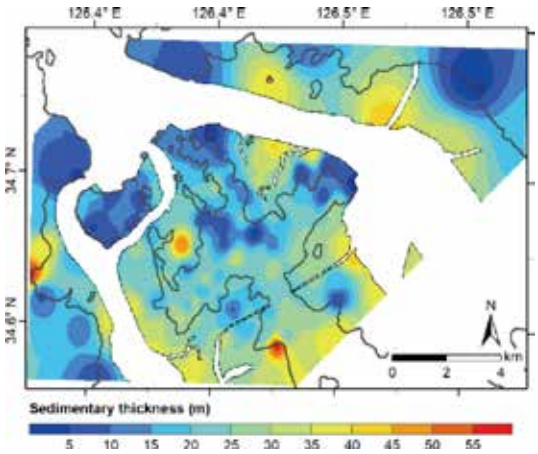
(a) Geological map of the study area (modified from KIGAM(2020)).
(b) Locations of 144 seismic stations where ambient noise measurements were recorded for HVSR.



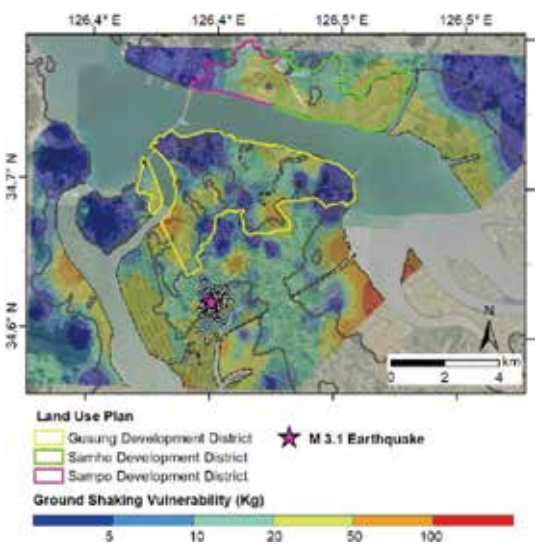
(a) HVSR curve with a single peak at a medium frequency.
(b) HVSR curve with multiple peaks.
(c) HVSR curve with a single peak at a higher frequency.
(d) HVSR curve with no peak.



Distribution of resonance frequencies across the study area from HVSR analysis.



Distribution of depths to bedrock across the study area, calculated from HVSR-derived resonance frequencies and MASW shear-wave velocities.



Ground shaking vulnerability (based on the distribution of the seismic vulnerability index (Mg)) in the study area is overlain by a land use plan for the SolaSeaDo urban development.

Reference

Su Young Kang, Kwang-Hee Kim & Byungmin Kim, 2021, Assessment of seismic vulnerability using the horizontal-to-vertical spectral ratio (HVSR) method in Haenam, Korea. Geosciences Journal 25, 71–81 (2021).

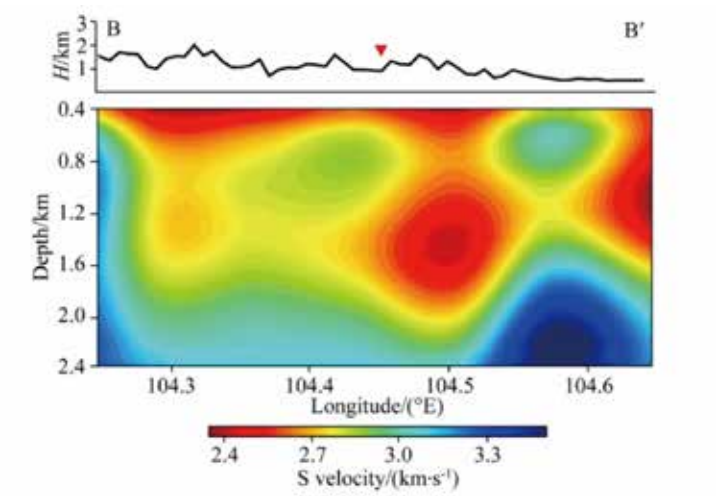
Research on Shallow Crustal Structure in the Beichuan Area with Short-Period Dense Seismic Array

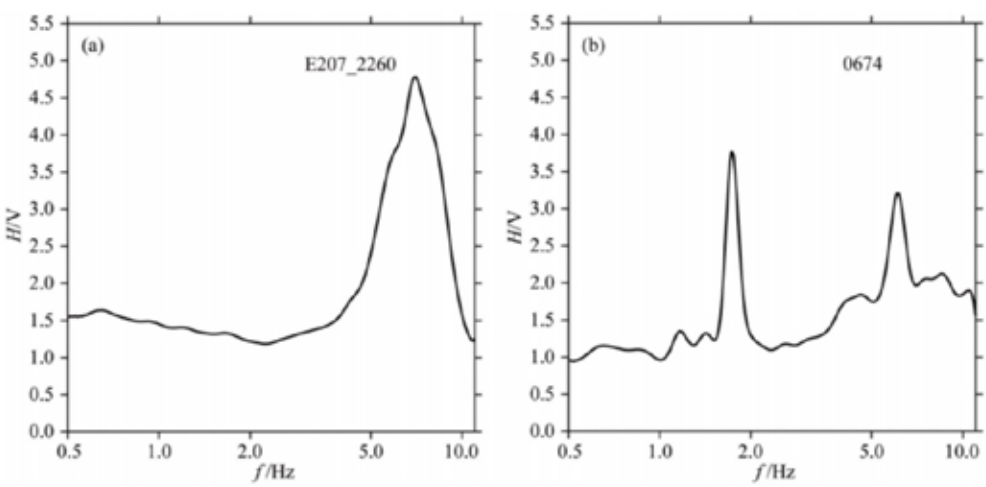
Equipment type: SmartSolo IGU-16HR 3C 5Hz
Equipment quantity: 242

Research Overview

In 2008, the Wenchuan earthquake left numerous surface rupture zones in the old county town of Beichuan, making it susceptible to various geological hazards such as landslides and subsidence. Therefore, a short-period dense seismic array method was employed to investigate the subsurface structure of this area.

This study employed a short-period dense seismic array to conduct background noise tomography and Horizontal-to-Vertical Spectral Ratio (HVSR) analysis in the Beichuan area. The research identified three low-velocity shear wave anomaly zones, one of which is located approximately 2 kilometers deep near the surface rupture zone of the Wenchuan earthquake. Stations near the surface rupture zone exhibited bimodal features in their HVSR curves, while those farther away from the rupture zone displayed unimodal characteristics. The maximum thickness of sedimentary layers in the study area was found to be up to 200 meters.





(a) Example of a single-peak HVSR curve for station E207_2260.
(b) Example of a double-peak HVSR curve for station 0674.

Antarctic Ice Cover Ambient Noise Observation

Equipment type: SmartSolo IGU-BD3C-5
Equipment quantity: 100

Research Overview

In December 2019, the School of Earth and Space Science of Southern University of Science and Technology used 100 SmartSolo IGU-BD3C-5 to make intensive observations on Antarctic Ice Cover. The survey line started from Zhongshan station and ended at Taishan station, conducted good structure imaging of the eastern ice cover.
More than 95% of the Antarctic continent is covered by extremely thick ice and snow, known as the "white continent". The annual average temperature of Antarctica is -25°C, the average temperature of the inland plateau is about -52°C, and the extreme minimum temperature ever reached -89.2°C, making it the coldest land in the world.

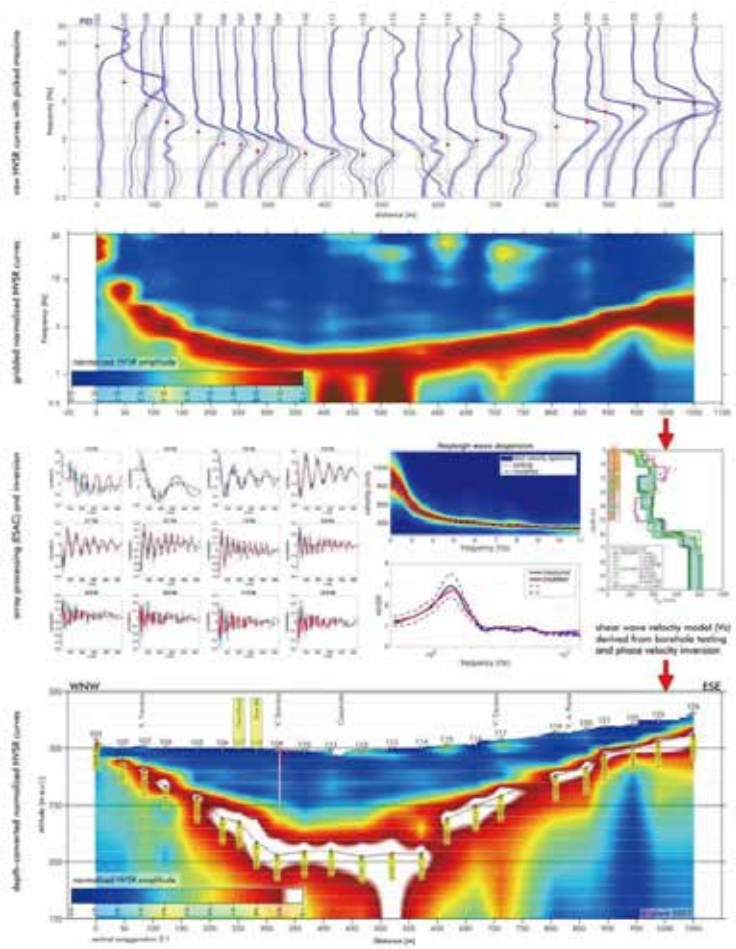
This scientific expedition carried out by the School of Earth and Space of Southern University of Science and Technology was extremely difficult and had a profound impact, which added another flag to China's Antarctic scientific expedition of Earth science. The availability and effect of SmartSolo instruments were also confirmed.

Passive Seismic Exploration in Swiss Urban Environments

Equipment type: SmartSolo IGU-BD3C-5
Equipment quantity: 24

Research Overview

Analysis Method: H/V
The H/V (Horizontal-to-Vertical) spectral ratio, also known as the ratio between the horizontal and vertical components of the seismic background noise recorded at different frequencies on the Earth's surface.This method is sometimes also referred to as the HVSR (Horizontal-to-Vertical Spectral Ratio) or QTS (Quasi Transfer Spectrum) method.
Through the use of ambient noise in passive seismic exploration, we can obtain the nearsurface and subsurface structures as shown below.
SmartSolo offers high-resolution, highly reliable and rugged seismic nodes most suitable for reducing environmental impact and operating costs as well as improving operational efficiency.
Image by: Lorenz Keller, roXplore



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IMU-22 1C

The IMU-22 node instrument can conveniently and quickly form various networked seismic arrays, combined with active and passive source methods, to obtain massive data for high-density array spatiotemporal measurement (DAM).
Suitable for scientific research and enterprise survey needs in different scale regions.

Applications:
- Geological structure research
- Natural earthquake observation research
- Volcano observation research
- Observation and research on geological hazards
- Exploration of oil and gas, geothermal energy
- Coal exploration
- Metal mineral exploration
- Infrastructure geological assessment

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SmartSolo IMU-22 1C

Single Channel Intelligent Monitoring Unit

Features

- New generation 1 channel intelligent monitoring unit
- High resolution data with up to 1 ms sampling and 32-bit delta-sigma ADC
- Externally connected with various sensors

  Built-in GNSS module
- External power supply, support solar or lead-acid battery power supply, 7 ~ 15 V DC
- Built-in 4G module (supports SIM card replacement), achieve real-time data transmission, and remote parameter configuration
- Built-in WiFi module, to achieve close data download,remote parameter configuration
- Built-in 4G and WiFi antenna

Descriptions

IMU-22 1C is a data monitoring unit designed for use in harsh outdoor environments and equipped with real-time communication capabilities. In environments with smooth network connectivity, it can remotely access data and configure measurement parameters through the built-in 4G or WiFi connection. It supports real-time data streaming Windows and Linux systems and offers features like event threshold triggering, self-testing, remote configuration updates, and remote firmware upgrades.IMU-22 1C deployment is straightforward. It has an IP 68 protection rating, can operate stably in a temperature range from -40 °C to +70 °C for extended periods, and can be used independently without the need for additional protective equipment. It boasts extremely high reliability and offers the ultimate cost-performance ratio, making it one of the top choices for long-term monitoring tasks in harsh environments.

Applications

- Dam inspection
- Isolated rock karst detection
- Void detection
- Geological survey
- Geothermal and water resource exploration
- Structural health monitoring
- Landslide monitoring
- Energy and mineral exploration
- Real-time railway warning
- Short-period array observation
- Microseismic hydraulic fracturing monitoring
- Natural seismology research

IMU-22 1C Download Cable

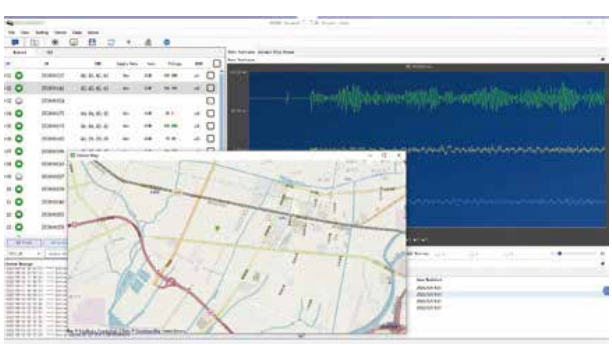
Up to 20 MB/s fast data download

IMU-22 1C Power Cable

Low-cost fast power supply solution

Excellent Auxiliary Software

You can use the SoloSWDCC software for remote parameter configuration, real-time monitoring of device status and data transmission, and real-time data waveform display. This software also supports configuring event trigger modes.



Typical Specifications

Seismic Data Channel	1
Size	100 mm (L) x 100 mm (W) x 60 mm (H)
Weight	0.7 kg
Ingress Protection	IP 68
Operating Temperature	-40 °C ~ +70 °C
Data Storage	16 GB (expandable)
GNSS Mode	Support GPS, BEIDOU, GLONASS, single or dual mode operation
Data Transmission Mode	4G mode (4G, USB, WiFi)
External Power Supply	7~ 15 V DC (single supply)

Sensor

Natural Frequency	2 Hz ±15%	5 Hz ±7.5%
Distortion	≤ 0.30% @ 12Hz, 0.7 in/s measured at peak-to-peak velocity	< 0.15% @ 12 Hz, 0.7 in/s measured at peak-to-peak velocity, 0°~ 10° vertical angle, 0°~ 3° horizontal angle
Coil Resistance	6000 ohm ± 10%	1850 ohm ± 5%
Damping	0.70 ± 15%	0.60 ± 7.5%
Sensitivity	260 V/m/s (6.6V/in/s)±10%	80 V/m/s (2.03 V/in/s)± 5%
Remark	All parameters are tested under +20 °C, vertical or horizontal angle unless otherwise indicated.	All parameters are tested under +22 °C, vertical or horizontal angle unless otherwise indicated.
Inertial Body Mass	60 g (2.12 oz)	22.7 g (0.801 oz)
Maximum Coil Displacement p-p	3 mm (0.12 in)	3 mm (0.118 in)
Diameter	38.5 mm (1.52 in)	30.5 mm (1.2 in)
Height	47 mm (1.85 in)	40.7 mm (1.6 in)
Weight	260 g (9.17 oz)	138 g (4.87 oz)

Acquisition Channel

(@ 2 ms sample interval, 31.25 Hz, +25 °C, unless otherwise indicated)

ADC Resolution	32 bits
Sample Interval	1, 2, 4 ms
Preamplifier Gain	0 dB to 24 dB in 6 dB steps
Anti-alias Filter	206.5 Hz @ 2ms (82.6% of Nyquist) - linear phase
DC Blocking Filter	DC removed
	±2.5 V peak @ 0 dB
Equivalent Input Noise	0.71 µV @ 2 ms 0 dB
Total Harmonic Distortion	≤ 0.0005% @ 0 dB
Instantaneous Dynamic Range	116 dB @ 0 dB
Common Mode Rejection	>100 dB
Gain Accuracy	<1%
GNSS Time Standard	1 ppm
Timing Accuracy	±10 µs, GPS disciplined
System Dynamic Range	140 dB
Frequency Response	0 ~ 413 Hz @ 1 ms

4G IoT Frequency Band

It can access to 4G cellular networks, and can be used in the Asia-Pacific, the United States, Europe and other countries and regions.

Performance	TD-LTE:3GPP Release 13 CAT1 downlink 7.5 Mbps，uplink 1 Mbps
	FDD-LTE:3GPP Release 13 CAT1 downlink 10 Mbps，uplink 5 Mbps
	GSM:GPRS Class12 downlink speed 384 kbps uplink speed 128 kbps
Frequency band	TD-LTE:Band 38/39/40/41
	FDD-LTE:Band 1/3/5/8
	GSM:Band 3/8

Note: Follow SEG polarity rules(When shocked by seismic motion, sensor upward motion as the channel record is Negative signal,sensor downward motion as the channel record is Positive signal)

Specifications are subject to change without prior notice.

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IMU-3C

The IMU-3C node instrument can conveniently and quickly form various networked arrays, obtain massive data, and perform high-density array spatiotemporal measurement (DAM).
Suitable for scientific research and enterprise survey needs in different scale regions.

Applications:
- Various long-term observation and research in the field (e.g. earthquakes, volcanoes, tsunamis, tides, glaciers, hydrology, lakes, ecology, forests, meteorology, grasslands, deserts, drylands, ports, etc.)
- Observation and research on geological hazards (e.g. debris flow, landslide, rockfall, seabed geology)
- Structural health monitoring (e.g. bridges, tunnels, buildings)
- Environmental monitoring

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SmartSolo IMU-3C

3-Channel Intelligent Monitoring Unit

Features

- Supports external various geophones
- 32-bit Σ-Δ high-resolution ADC
- Supports various data transmission methods such as Ethernet, 4G and WiFi, and supports multiple real-time data transmission and QC
- Built-in GNSS module, supports both internal and external GNSS antennas
- Built-in 64 GB storage, expandable to 128 GB
- IP 68 waterproof
- Supports both built-in and external power supply
- Ultra-long battery life
- Ultra-wide operating temperature range
- Dual-state indicator lights, indicating data collection and transmission status
- Simple field deployment, no need for additional protective equipment

Descriptions

IMU-3C is a data monitoring unit designed for use in harsh outdoor environments and equipped with real-time communication capabilities. In environments with smooth network connectivity, it can remotely access data and configure measurement parameters through the built-in 4G, WiFi or Ethernet connection, It supports real-time data streaming under both Windows and Linux systems and offers features like event threshold triggering, self-testing, remote configuration updates, and remote firmware upgrades.

IMU-3C deployment is straightforward. It has an IP 68 protection rating, can operate stably in a temperature range from -40 °C to +70 °C for extended periods, and can be used independently without the need for additional protective equipment. It boasts extremely high reliability and offers the ultimate cost-performance ratio, making it one of the top choices for long-term monitoring tasks in harsh environments.

Applications

- Dam inspection
- Isolated rock karst detection
- Void detection
- Geological survey
- Geothermal and water resource exploration
- Structural health monitoring
- Landslide monitoring
- Energy and mineral exploration
- Real-time railway warning
- Short-period array observation
- Microseismic hydraulic fracturing monitoring
- Natural seismology research

IMU Data Download Cable

Up to 20 MB/s fast data download

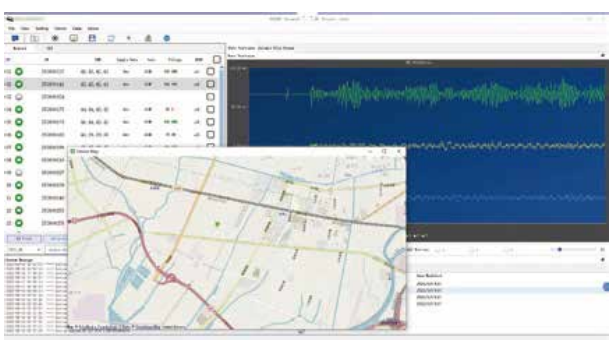
IMU Power Adapter

Single-port charging device

Low-cost fast charging solution

Excellent Auxiliary Software

You can use the SoloSWDCC software for remote parameter configuration, real-time monitoring of device status and data transmission, and real-time data waveform display. This software also supports configuring event trigger modes.



Typical Specifications

Seismic Data Channels	3
Size	136 mm (L) x 120.7 mm (W) x 88 mm (H)
Weight	1.4 kg
Ingress Protection	IP 68
Operating Temperature	-40 °C ~ +70 °C
Charging Temperature Range	+3 °C ~ +45 °C
Charging Time	≤7 hrs
Operating Life @ 25 °C	10 days for ethernet transmission @ 2 ms 25 days for offline working mode @ 2 ms 80 hours for 4G transmission mode @ 2 ms
Data Storage	64 GB (expandable to 128 GB)
GNSS Mode	Support GPS, BEIDOU, GLONASS, single mode or double mode optional
Data Transmission Mode	Ethernet mode (ethernet, USB, WiFi) 4G mode (4G, USB, WiFi), SIM card support by local telecom operators
Data Harvesting	USB 3.0
External Power Supply	7~ 15 V DC (single supply)

Acquisition Channel

(@ 2 ms sample interval, 31.25 Hz, +25 °C, unless otherwise indicated)

ADC Resolution	32 bits
Sample Interval	0.25, 0.5, 1, 2, 4, 8, 10, 20 ms
Preamplifier Gain	0 dB ~ 36 dB in 6 dB steps
Anti-alias Filter	206.5 Hz @ 2ms (82.6% of Nyquist frequency) - linear phase
DC Blocking Filter	DC removed
Maximum Input Signal	±2.5 V peak @ 0 dB
Equivalent Input Noise	0.18 μV @ 2 ms 18 dB
Total Harmonic Distortion	≤0.0002% @ 0 dB
Instantaneous Dynamic Range	128 dB @ 0 dB
Common Mode Rejection	>100 dB
Gain Accuracy	<1%
GNSS Time Standard	1 ppm
Timing Accuracy	±10 μs, GPS disciplined
Cross Feed	< -110 dB
System Dynamic Range	145 dB
Frequency Response	0~1652 Hz @ 0.25 ms

Note: Follow SEG polarity rules(When shocked by seismic motion, sensor upward motion as the channel record is Negative signal,sensor downward motion as the channel record is Positive signal)

Specifications are subject to change without prior notice.

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M1000

The M1000 node instrument can conveniently and quickly form various networked seismic arrays, combined with active and passive source methods, to obtain massive data for high-density array spatiotemporal measurement (DAM).
Suitable for scientific research and enterprise survey needs in different scale regions.

Applications:
- Various long-term observation and research in the field (e.g. earthquakes, volcanoes, tsunamis, tides, glaciers, hydrology, Lakes, ecology, forests, meteorology, grasslands, deserts, drylands, ports, etc.)
- Observation and research on geological hazards (e.g. debris flow, landslide, rockfall, seabed geology)
- Structural health monitoring (e.g. bridges, tunnels, buildings)
- Environmental monitoring

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SmartSolo M1000
New Generation Nodal Data Logger

Features

- New Generation Data Logger
- High resolution data with up to 1 ms sampling and 32-bit delta-sigma ADC
- Externally connected with various sensors
- Built-in GNSS module and disciplined clock
- Connect with other nodal instruments to realize intelligent monitoring of physical quantities in many fields
- Connect intelligent monitoring gateway or wireless transmission module, real-time data return
- The extreme cost-effective system on the market
- Light weight, small size
- Green indicates 'good', red light indicates 'bad'

Descriptions

The M1000 is the latest generation of intelligent networked node scientific instruments launched by SmartSolo Scientific, which can be used for comprehensive scientific data measurement.
It has high-precision differential analog voltage measurement and single-ended analog voltage and current measurement interfaces, which can measure high-precision analog voltage and current signals at high sample rates, and RS485 and SDI-12 digital interfaces and can be connected to a variety of digital output sensors.
It has a built-in GPS module that supports GPS, Beidou, and Glonass single-mode or dual-mode operations, and can realize positioning and time synchronization of multiple measurement systems. Its powerful measurement and sensor access capabilities, spatiotemporal synchronization, and extensive external communication access capabilities help scientists and technology innovators easily build scientific research-grade high-density field spatiotemporal monitoring systems.

Applications

- Geological survey
- Geothermal and water resources exploration
- Real-time earthquake warning
- Real-time environmental monitoring
- Structural health monitoring
- Landslide monitoring

Power Supply Capacity:

M1000 has no internal battery and requires an external power supply, which is suitable for short-term or long-term monitoring. SmartSolo has the ability to provide a variety of battery pack solar systems, and can also provide customized power solutions.

Positioning and Time Synchronization:

M1000 has a built-in GPS module, which support GPS, Beidou, Glonass single-mode or dual-mode operations to achieve positioning and time synchronization. It suit for spatiotemporal monitoring in various field environments.

Data Storage:

M1000 has an 8 GB storage by using the high-speed USB3.0 interface downloading.

Data Transfer:

M1000 has a special RS485 interface, which is used to connect the external communication module such as 4G/WIFI/ Bluetooth/Ethernet/satellite communication, to obtain measurement data easily and quickly.

Typical Node Specifications

Acquisition Specifications

Sensor Interface	1× ±2.5 V differential voltage channel (can be configured as 1× ±5 V differential analog voltage channel, or configured as 2× 0~5 V single-ended analog voltage interfaces and 2× 0~20 mA current interfaces) 1× RS485 digital interface 1× SDI-12 digital interface

Differential Analog Voltage Measurement Channel

Channel	1
Maximum Input Signal	± 2.5 V peak @ 0 dB ± 5 V peak @ 0 dB (configurable)
ADC Resolution	32 bits
Sample Interval	1, 2, 4, 8, 16 ms
Preamplifier Gain	0 dB to 24 dB, 6 dB Steps
Antialias Filter	206.5 Hz @ 2 ms (82.6% Nyquist) linear phase or minimum phase selectable
DC Blocking Filter	1 Hz to 10 Hz, 1 Hz increments or DC removed
Equivalent Input Noise	0.71 µV @ 2 ms, 12 dB
Instantaneous Dynamic Range	116 dB @ 4 ms, 0 dB
Total Harmonic Distortion	-115 dB @ 0 dB
Common Mode Suppression	>115 dB
Gain Accuracy	<0.3%
System Dynamic Range	140 dB

Single-ended Voltage Measurement Interface (Configurable)

Number of Interfaces	2
Input Voltage Range	0-5 V
ADC Resolution	32 bits
Accuracy	±10 µV
Sample Interval	Single channel acquisition (-5 V~+5 V): 1 second to1 hour Dual channel acquisition (-5 V~0, 0~5 V): 2 seconds to 1 hour (Note: In dual-channel mode,the sampling rates for both channels cannot be set separately)

Analog Current Interface (Configurable)

Number of Interfaces	2
Input Current Range	0-20 mA
Accuracy	>0.1%
Sample Interval	Dual channel acquisition: 2 seconds to 1 hour (Note: In dual-channel mode, the sampling rates for both channels cannot be set separately)

Digital Ports

Ports	1× RS-485 half duplex output/ input port
	1× SDI-12 communication port
Supports Digital Protocols	RS-485: MODBUS, ASCII polled SDI-12
Sample Interval	1 second to 1 hour

Communication

Communication Interface	Two IN&OUT interfaces have one common RS-485 half-duplex port and one common power interface for connecting with other devices to form a multi-sensor system
Communication Extension	M1000 can be connected to 4G modules/ WiFi modules/Ethernet modules/ Bluetooth modules/satellite communication modules to achieve real-time or timed communication Utilizing one communication module, it can be connected in series with up to 15 pieces M1000 to achieve data collection of up to 90 sensors

Physical Specification

External Input Voltage	7-15 V DC The power input has protection functions for surge, overvoltage, overcurrent, reverse power supply, and lightning protection
Output Voltage	12 V DC typical (consistent with the voltage of the input power supply) Can supply power to external sensors
Maximum Output Current	1 A @ 12 V DC
Data Storage Format	CSV format, containing sensor data and time information DLD format, containing high sampling analog signal data, time and location information
GNSS Mode	Supports GPS, Beidou, Glonass, and single or dual-mode operations Intermittent work (optional 90 seconds to 1 day) or long-term work (Always On)
Timing Accuracy	± 10 µs @ GPS discipline 8 minutes/circle
	± 250 µs @ GPS discipline 24 hours/circle
Data Storage	8 GB (expandable to 16 GB)
Working Temperature	-40 °C ~ +70 °C
Protective Performance	IP 67
Physical Dimensions	147.7 mm (L) × 111 mm (W) × 60.9 mm (H)
Weight	0.8 kg

Note: Follow SEG polarity rules(When shocked by seismic motion, sensor upward motion as the channel record is Negative signal,sensor downward motion as the channel record is Positive signal)

Specifications are subject to change without prior notice.

Fracturing Monitoring of Geothermal Production Wells in Tangshan, China

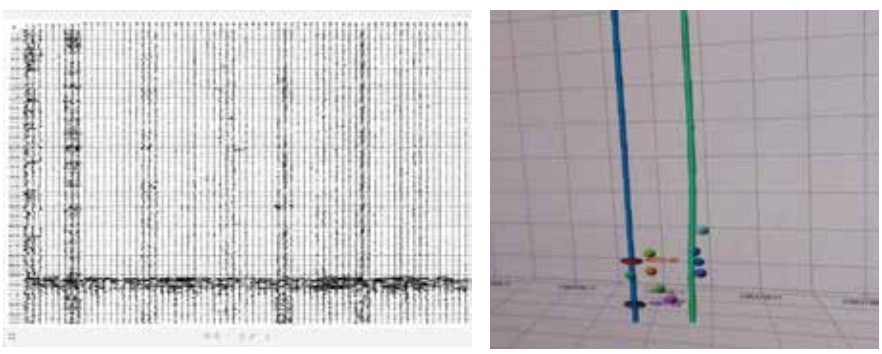
Equipment type: IMU-3C + 3C geophone 5Hz
Equipment quantity: 24

Research Overview

The Tangshan fracture monitoring project and the dry hot rock fracturing project in Gonghe, Qinghai were the first projects to utilize and develop the usage of dry hot rock geothermal resources in China.
ENN used SmartSolo IGU-16HR 5Hz to acquire fracturing data of their first well and achieved useful data results after data analysis. ENN intends to use the IMU-3C to achieve real time monitoring to guide the fracturing production.

Deployed alongside the IGU-16 5Hz for data acquisition as a backup, the deployment covered 35sq.km.
The industrial and agricultural conditions on the west side of the fracturing well was complex, and no stations were deployed in this area.
On the east side, meter-shaped equipment is deployed for the operation partner in Daqinghe Salt Farm.

The SmartSolo equipment deployed on ground surface was able to clearly identify the micro seismic events underground at depths of 4 kilometers and provide real-time data for event location. Thousands of effective micro seismic events have been identified in this project, which guided the fracturing production work effectively.



Event record and event location

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WSMS100

WSMS100, the new generation research-grade field comprehensive weather data acquisition system, is a highly reliable automatic data acquisition system launched by SmartSolo Scientific, which can be used to measure temperature, humidity, wind speed, wind direction, atmospheric pressure, rainfall, hail and other parameters.

Applications:
- Simultaneously measure high-frequency seismic and meteorological data
- Easily build a high-density spatial-temporal monitoring network
- Long-term unattended automatic measurement system
- Local storage and wireless data transmission
- High reliability, high precision, high consistency
- Stable data collection and high data retrieval rates
- Easy operation, quick installation, no maintenance
- Adapt to the extreme field environment

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The New Generation Research Grade **Field Seismic and Meteorological Data Acquisition System -WSMS100**

Perfect Combination of Seismic and Meteorological Data Contributes to Scientific Success

Features

- Simultaneously measure high-frequency seismic and meteorological data
- Easily build a high-density spatial-temporal monitoring network
- Long-term unattended automatic measurement system
- Local storage and wireless data transmission
- High reliability, high precision, high consistency
- Stable data collection and high data retrieval rates
- Easy operation, quick installation, no maintenance
- Adapt to the extreme field environment

Descriptions

WSMS100, the new generation research-grade field comprehensive weather data acquisition system, is a highly reliable automatic data acquisition system launched by SmartSolo Scientific, which can be used to measure temperature, humidity, wind speed, wind direction, atmospheric pressure, rainfall, hail and other parameters.

The core of the WSMS100 system is derived from the SmartSolo nodal scientific technology. We have successfully sold 510,000 sets of node scientific instruments. Our system covers an area of thousands of square kilometers through up to tens of thousands of nodes, synchronously measuring highly dense spatial-temporal seismic, temperature and GPS data. The data recovery rate is as high as 99.9%. SmartSolo Scientific refreshes history and is favored by scientists and technology innovators around the world.

The WSMS100 system combines the advantages of high reliability, high density, and high consistency in the field, providing high reliability, extraordinary temperature stability, and data redundancy. The system is also compatible with various parameters. Using our outstanding capabilities in the field of geophysical prospecting, we are committed to providing high- density deployment systems to achieve high-resolution, high-density, and networked measurement and monitoring data in the interested research area. SmartSolo scientific contributes to scientific breakthroughs.

The WSMS100 system has large-capacity storage, which ensures the integrity and security of data, providing researchers with reliable, comprehensive, and complete research data.

The WSMS100 system supports local data downloading, and a dedicated downloader can be used on the field to download the data to the terminal. Meteorological data can also be displayed on the SmartSolo EnviroLink Portal cloud platform through a wireless network, and downloaded to a local terminal through the EnviroLink cloud platform.

WSMS100 Specifications

MWS-536 Multi-parameter Weather Station

Barometric Pressure

Range	500~ 1100 hPa
Accuracy (for sensor element) at 600~1100 hPa	±0.5 hPa at 0 °C ~+30 °C ±1 hPa at -52 °C ~+60 °C
Output Resolution	0.1 hPa / 10 Pa / 0.001 bar / 0.1 mm Hg / 0.01 in Hg

Air Temperature

Range	-52 °C ~+60 °C
Accuracy (for sensor element) at +20 °C	±0.3 °C
Output Resolution	0.1 °C

Relative Humidity

Range	0 ~100 %RH
Accuracy (For sensor element)	±3 %RH at 0~90 %RH ±5 %RH at 90~100 %RH
Output Resolution	0.1 %RH

Wind Speed

Range	0~ 60 m/s
Reporting Range	0~ 75 m/s
Response Time	0.25 s
Available Variables	Average, maximum, and minimum
Accuracy	±3 % at 10 m/s (22 mph)
Output Resolution	0.1 m/s (km/h, mph, knots)

Wind Direction

Azimuth	0~ 360°
Response Time	0.25 s
Available Variables	Average, maximum and minimum
Accuracy	±3.0° below 10 m/s
Output Resolution	1°
Averaging Time	1~3600 s, sample rate 1, 2, or 4 Hz (configurable)

Precipitation

Collecting Area	9.3 in² (60 cm²)
Rainfall	Cumulative accumulation after the latest automatic or manual reset.
Output Resolution	0.001 in (0.01 mm)
Accuracy for Daily Accumulation	Better than 5%, weather-dependent
Duration	Counting each 10-second increment whenever droplet detected
Duration Output Resolution	10 s
Intensity	Running 1-minute average, 10 s steps
Intensity Obsevation Range	0 ~ 200 mm/h (broader with reduced accuracy)
Intensity Output Resolution	0.1 mm/h
Hail	Cumulative number of hits against collecting surface.
Output Resolution	0.1 hits/cm², 1 hit
Intensity Output Resolution	0.1 hits/cm²h , 1 hit/h
Sampling Rate	1 s~1 hour, Configurable
Storage	8 GB (Optional 16GB)
	520 days @1s sampling, FIFO mode
Data Retrieval	USB3.0 Local download, digital bus communication
GNSS Mode	GPS, Beidou, Glonass, single mode or dual mode
Time Accuracy	±10 µs, GPS Disciplined 8min/time ±250 µs, GPS Disciplined 24h/time
Operating Environment	-52 °C ~ +60 °C 0~100 %RH non- condensing
Ingress Protection	IP 65

BaroM2 Barometric Data Logger

Pressure Range	600~1100 hPa/mb
Resolution	±0.01 mB
Accuracy	±0.5 hPa/mb (@ +20 °C) ±1.0 hPa/mb (@ 0 °C to 40 °C) ±1.5 hPa/mb (@ -20 °C to +50 °C) ±2.0 hPa/mb (@ -40 °C to +60 °C)
Long Term Stability	0.1 hPa/yr
Non-linearity	±0.4 hPa/mb
Hysteresis	±0.05 hPa/mb
Non-repeatability	±0.03 hPa/mb
Warm-up Offset	<1 Sec. from shut-mode (warm-up <0.1 mb Max.)
Proof Pressure	1500 hPa
Burst Pressure	2000 hPa
Sampling Rate	1 s~1 hour, configurable
Storage	8 GB (expendable to 16 GB) 9 years @ 1 s sampling, FIFO
Data Retrieval	USB3.0 local download, digital bus communication
GNSS Mode	GPS, Beidou, Glonass, single mode or dual mode
Time Accuracy	±10 µs, GPS disciplined 8 mins/cycle
	±250 µs, GPS disciplined 24 hrs/cycle
Operation Environment	-40 °C ~ +60 °C altitude: -609.6~3657.6 m

Specifications are subject to change without prior notice.

WSMS100 Specifications

5Hz Three-Component Seismic Sensor

The three-component seismic sensor includes two horizontal geophones and a vertical geophone that are orthogonal to each other.

Natural Frequency*	5 Hz ±7.5%
Spurious Frequency*	>170 Hz
Distortion*	<0.1% @ 12 Hz,0° ~ 10° vertical tilt, 0° ~ 3° horizontal tilt
Damping (open circuit)*	0.6 ±7.5%
Coil Resistance*	1850 ohm ±5%
Sensitivity*	80 V/m/s (2.03 V/in/s) ±5%
Sample Interval	0.25, 0.5, 1, 2, 4, 8, 10, 20 ms
Preamplifier Gain	0 dB to 36 dB in 6 dB steps
Anti-alias Filter	206.5 Hz @ 2ms (82.6% of Nyquist)
	Selectable - linear phase or minimum phase
DC Bblocking Filter	DC Removed
GNSS Mode	GPS, Beidou, Glonass, single mode or dual mode
Time Accuracy	±10 µs, GPS Disciplined 8 mins/cycle
Storage	64 GB (expandable to 128 GB)
Operating Life	Single channel-76 days @ 1 ms sampling, FIFO mode
	Three channels-25 days @1 ms sampling, FIFO mode
Operating Environment	-40 °C ~ +70 °C 0~100 %RH non condensing
Ingress Protection	IP 67
Data Collection	USB3.0 local download, cloud download
Data Communication**	4G (for details, please consult your local cellular operator)

* Unless otherwise specified, all parameters are tested at +22°C in a vertical or horizontal position.

** 4G wireless transmission is related to the local 4G signal strength.

Others

System operating voltage	12 V DC
Battery capacity	12 V/60 Ah (please inform in advance if the altitude is above 2000 meters) with external solar power plant power supply
Solar Panel Power	100 W
Operating Environment	-40 °C~+60 °C
Charging Temperature Range	-30 °C~+4 5°C
Total Power Consumption	1 W (without 4G communication) 3~4 W (with 4G real-time communication, power consumption is related to signal strength)
Battery Life (sufficient solar recharge)	Long-term
Battery Life (without solar recharge)	Max 7 days (with 4G real-time communication) Max 25 days (without 4G communication)
Ingress Protection	IP 67
Allowable Wind Speeds	≤Beaufort wind scale 10
Diameter	900 mm (L) x 1000 mm(W) x 2750 mm (H)
Installation	Cement cured four-legged ground cage, screw lock fixed

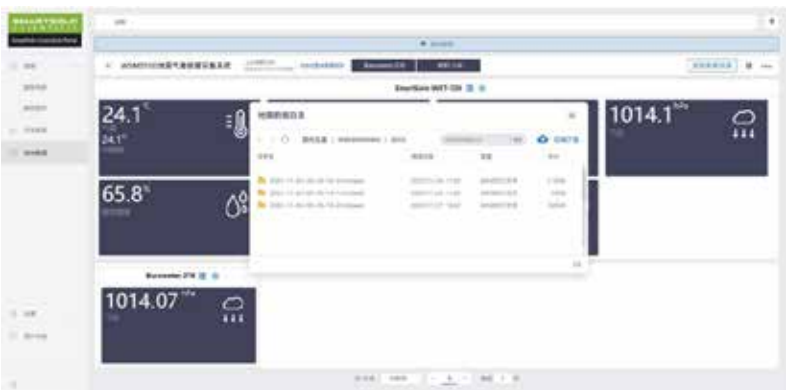
Specifications are subject to change without prior notice.

SmartSolo EnviroLink Portal

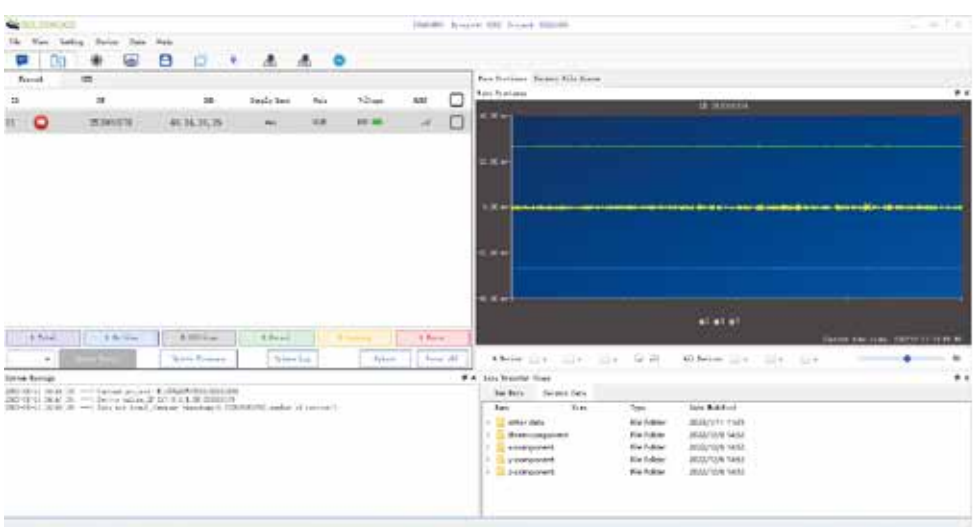
When network communication is available, users can select the gateway and data logger nodes for the current data acquisition system through the SmartSolo EnviroLink Portal, and then set the sampling rate. After the configuration is completed, the data will be transmitted to the cloud platform or stored on the specified cloud drive. Real-time data or the data status will be displayed on the EnviroLink Portal.

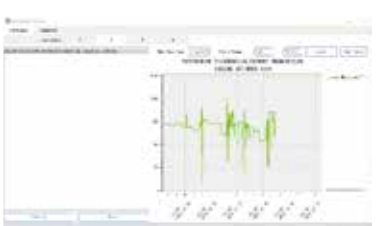
Historical meteorological data can be displayed on the cloud platform according to the set time. And the meteorological data, which will be stored on the cloud server for 12 months, could be downloaded from the cloud server through the [Download] button. At the same time, all meteorological data will also be stored on the specified cloud drive. After logging in to the cloud drive, users can access all historical meteorological data.

When the threshold is triggered, the EnviroLink cloud platform sends warnings in almost real-time. According to various applications, the user can set trigger thresholds for the measured parameters. When the threshold is triggered, the cloud platform system will send the user warnings via.



SmartSolo SoloSWDCC Software

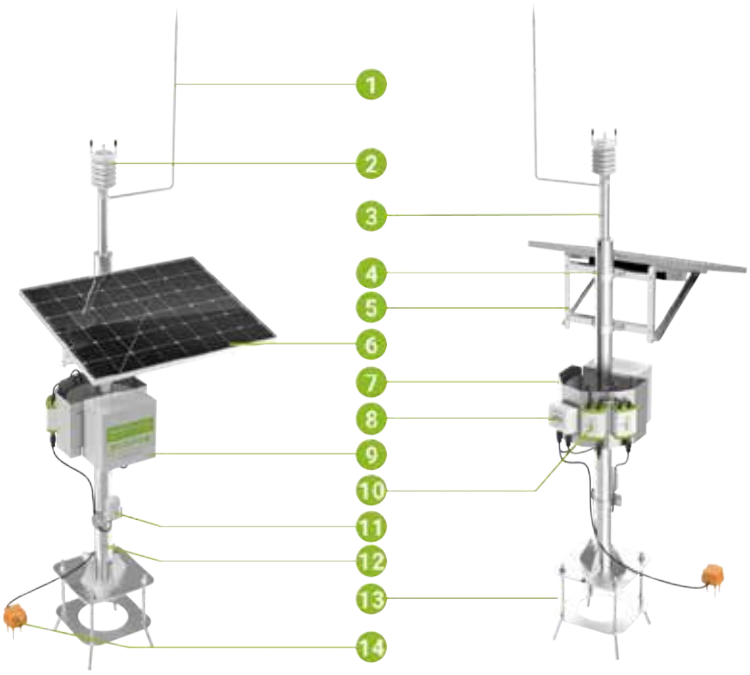




SoloSWDCC is a wireless data collection and real-time display software platform (running on Windows systems). When network communication is available, users can configure the gateway or wireless communication module through the software configuration interface. The data can be transmitted in real-time or the historical data can be downloaded.

For seismic data, there is a real-time display window on the SoloSWDCC software interface, which can display real-time seismic data of three channels, and the seismic data will be saved in the local folder. For historical data, the data can be re-downloaded through software. For meteorological data, SoloSWDCC also provides real-time data collection, displaying, and saving in the local folder.

WSMS100 System Diagram



1 Lightning rod
2 MWS-536 Multi-parameter weather station
3 Weather station mounting pole
4 Pole buckle
5 Solar panel mounting bracket
6 Solar panel
7 Data logger mounting plate
8 IMU-3C Pro(4G) smart real-time montoring unit
9 12 V/60 Ah Solar battery
10 M1000 data logger
11 BaroM2 Barometric data logger
12 Main mast(ϕ88mm)
13 Four-legged ground cage
14 5Hz 3 components seismic sensor

Solar Power System Introduction(optional)

SP-601100B2 Solar Power System

Supply Voltage	12 V DC
Battery Capacity	60 Ah (Other battery capacities are optional)
Minimum Discharge Cut-off Voltage	8 V
Maximum Continuous Discharge Voltage	10 A
Solar Panel Power	100 W
Solar Panel Maximum Output Voltage	18 V
Controller Maximum Charging Current	10 A (Please inform in advance if the altitude is above 2000 meters)
Operating Temperature	-40 °C ~ +60 °C
Charging Temperature Range	-30 °C ~ +45 °C
Ingress Protection	IP 67
Allowable Wind Speeds	≤Beaufort Wind Scale 10
Diameter	900 mm (L) x 545 mm (W) x 1175 mm (H)
Installation	Four-legged ground fixed

Specifications are subject to change without prior notice.

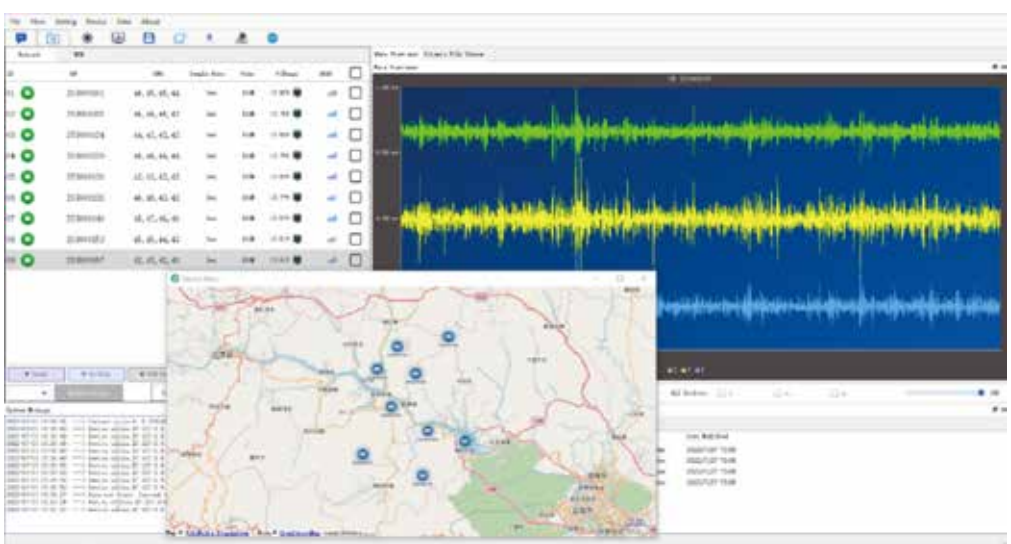
Note: Follow SEG polarity rules(When shocked by seismic motion, sensor upward motion as the channel record is Negative signal,sensor downward motion as the channel record is Positive signal)

Microseismic Monitoring Three Gorges Dam

Equipment type : SmartSolo IMU-3C external 5Hz detector
Equipment Quantity: 10
Monitoring time : More than 1 year (starting from 04/2022)
Data transmission mode: 4G real-time data transmission

Research Overview

Induced earthquake monitoring around dams
The Three Gorges Dam (the largest hydroelectric power project in the world): long-term monitoring of the solar system; exposed installation, no need for a protective box; reliable monitoring for more than one year.



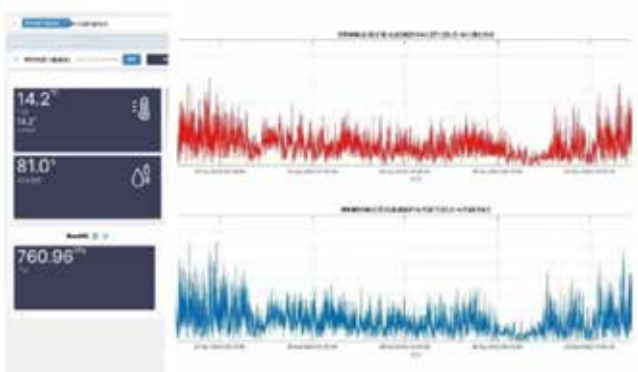
China University of Geosciences Successfully Completes Deployment of Seismic Meteorological Scientific Observation System in Nyingchi, Tibet

Equipment type: SmartSolo WSMS100

Research Overview

Recently, China University of Geosciences purchased multiple Smartsolo WSMS100 (Weather and Seismic Monitoring System) units, which were deployed in Hubei Daye National Seismological Observatory, Nyingchi, Tibet, Karzang Glacier, and other locations. These places have complex environments and rugged terrains. By acquiring and processing a large amount of seismic and meteorological data, scientists can gain a better understanding of the correlation between seismic and meteorological factors, providing essential references for earthquake prediction and disaster prevention. The successful development of this scientific project at China University of Geosciences marks a significant milestone in earthquake research. In the future, the seismic meteorological data collection system will continue to accumulate and improve, making greater contributions to unravelling the mysteries between earthquakes and meteorology for more scientists. We look forward to China University of Geosciences achieving further research breakthroughs in the field of earthquake studies!






This scientific expedition carried out by the School of Earth and Space of Southern University of Science and Technology was extremely difficult and had a profound impact, which added another flag to China's Antarctic scientific expedition of Earth science. The availability and effect of SmartSolo instruments were also confirmed.

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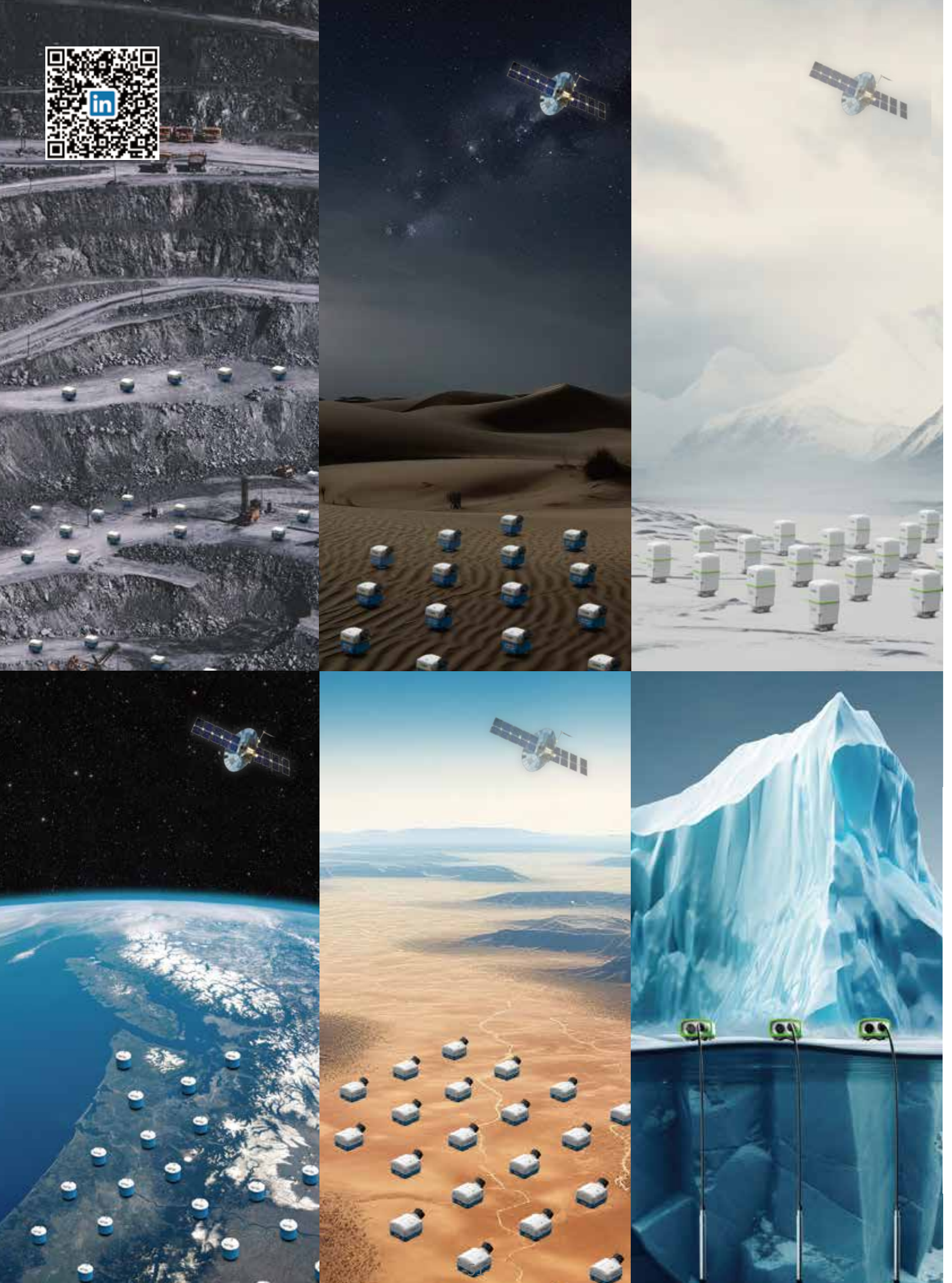

Dense Array Monitoring
Ambient Noise Tomography
Microseismic Monitoring
Microtremor Analysis
Passive Seismic Monitoring
Coda Wave Interferometry
H/V Spectral Ratio
Remi

Mineral Exploration / Cross-border Mining Monitoring / Mining Safety Monitoring / Seismology / Near-surface Engineering Geophysics / Hydrogeophysics / Geological Hazard Monitoring / Environmental Vibrations / Structural Health Monitoring / Fracturing Monitoring / Crustal Structure / Sedimentary Structure / Urban Subground / Meteorological Monitoring / Volcano Monitoring / Precipitation Measurement / Oil, Gas, And Coal

Over 510,000+ Nodes Have Been Used in the Field For Geoscience.

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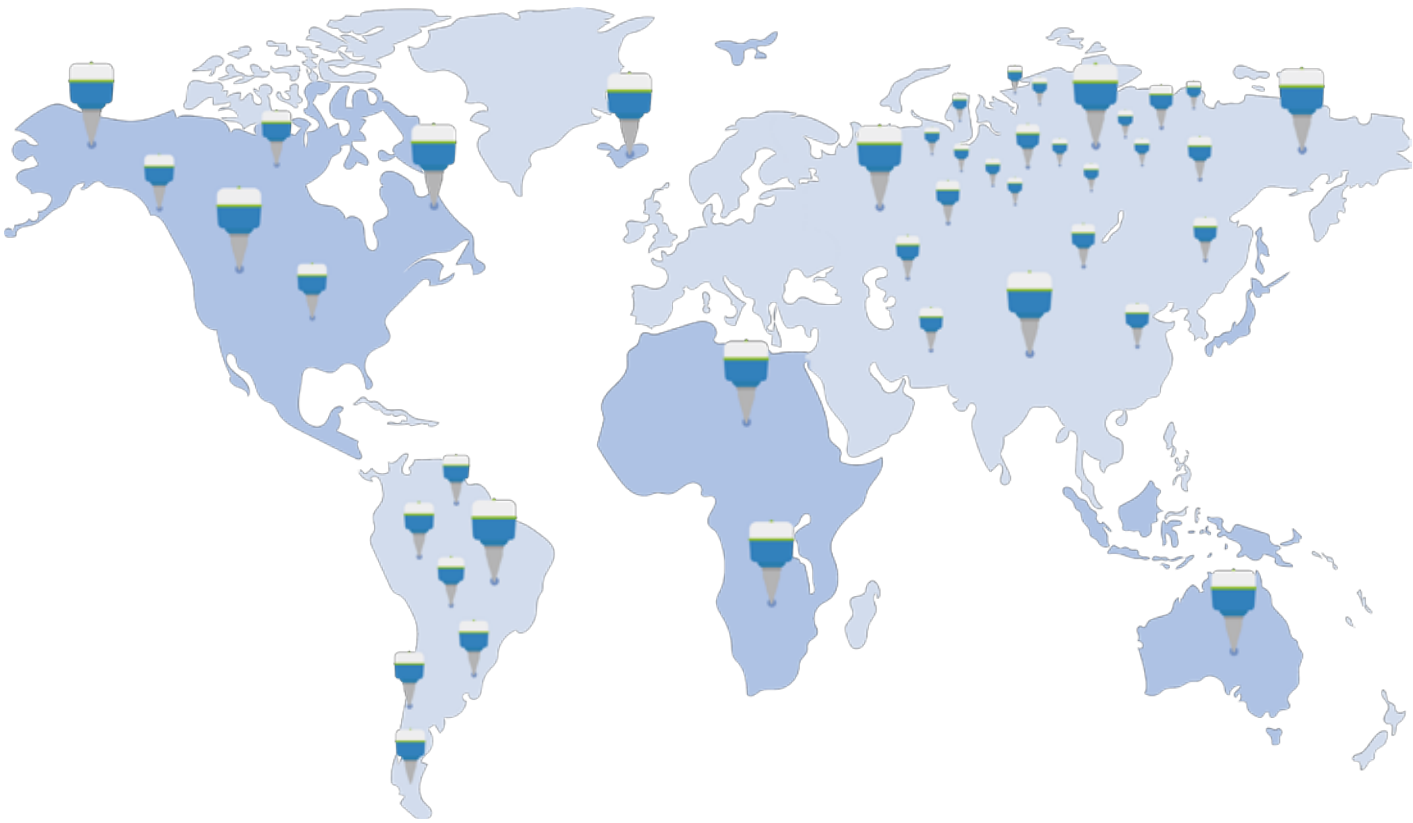

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