

# SIGMA4 Seismograph System



## Advanced Seismic Acquisition System

**SIGMA 4** is the most advanced, field-proven acquisition system in the world. It works seamlessly to provide the most fully integrated source control/recorder solution!

- Autonomous Operation using Internal Storage
- "Real-Time" status, Command and Control
- "Real-Time" Data and Status Return
  - WiFi – Meshed or standard WiFi
  - Cellular Phone Interface
  - Cabled option
- USB External Storage for Fast Data Collection
- Internal battery
- Internal 3C geophone elements or external Geophone/Hydrophone sensors



SIGMA 4 with  
Internal GPS & MRN

## Acquisition Applications

### Vibroseis Data

- Fully integrated with SourceLink software. Use SSC UE2 & Force 3 electronics for high production.
- Mesh Radio Network option for real-time status.

### Dynamite Data

- Fully integrated with SourceLink software. Use SSC UE2 & Boom Box 3 electronics for fast acquisition.
- USB data collection for quick data collection.

### Impulsive Data

- Fully integrated with SourceLink software. Use SSC UE2 & RTM 3 electronics for high production.
- Cable-free design for operation in tough environments.



## Monitoring Applications

### Hydraulic Fracture Monitoring

SIGMA 4's real-time Wi-Fi network provides continuous data

### Induced Seismic Monitoring

Use internal or external sensors to detect the smallest of events

### Long-term Event Monitoring

SIGMA 4 provides long-term reliability

### MASW and ReMi Data Acquisition

Easy to deploy, easy to monitor, and easy to collect data and generate output files



SIGMA 4 for External GPS  
& with Wi-Fi Bracket



# SIGMA4 Acquisition Features



## Autonomous Mode

Acquire data with minimal system interaction  
Disciplined GPS provides timing and node locations  
Use USB-Compatible Memory to offload data  
**Simply Connect Power and Record Data**



## Network Command

Real-time status and control  
MRN shows GPS, battery, memory, and node information  
Use USB-compatible memory to offload data  
**Low-Power Network provides Status from All Nodes**



## Wi-Fi Data Return

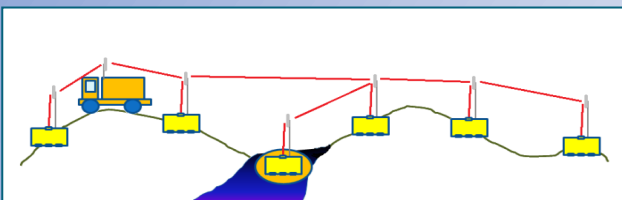
Real-time status, control, and seismic data  
High-speed network collects status and data from nodes  
Use standard "off the shelf" network hardware  
**Ethernet Downloads Seismic Data as it is Recorded**



## Cellular System Operation

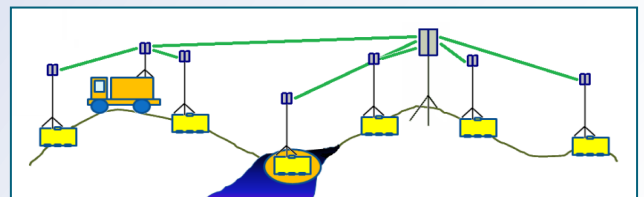
Remote control of seismograph nodes via Internet  
Internet provides status, control, and data upon command  
Use any available cellular vendor  
**QC Operating Nodes from Anywhere in the World**

## NETWORK CONFIGURATIONS



With the WiFi Mesh Network Topology, the data packets travel from node to node. The nodes determine the optimum path and configure the network. This makes the network extremely robust.

In the Station to Access Point WiFi Network Topology, the data packets travel from a node to a collection point. The network paths are determined by the operation before acquisition starts. This makes the network extremely fast.





# SIGMA4 Acquisition Options



## HARDWARE SPECIFICATIONS:

### Seismograph Node

- 3 channels (4 channels optional)
- 32 bit ADC sampling (24 bit stored)
- GPS disciplined clock (internally or externally mounted)
- 8 Gbytes internal data storage (expandable to 128GB)
- USB compatible external data collection
- 100base-T Ethernet onboard
- Internal 3C - 2 Hz geophones
- Single 26 pin 3C connector (including 12v power) for External sensors (including accelerometers)

### Wi-Fi Data Network

- 900 MHz, 2.4 GHz, or 5 GHz license-free communications
- Real Time Seismic Data Return
- Also provides node status and unit control

## SOFTWARE SPECIFICATIONS:

### Observer

Observer provides command and control of the SIGMA4 nodes and enables system monitoring before and during acquisition.

- Node Inventory Control
- SEG-P1 & GPX Survey Data Import
- Station Deployment
- Instrument Testing & Report
- Sensor Testing & Report
- Mesh Communications
- Spread Noise Display

### Data Collector

Data Collector offloads seismic data from the SIGMA4 nodes via network or USB connections.

- Real-Time Collection Status
- Reads in data from USB sticks
- Reads in data from WiFi / Ethernet
- Reads in data from Cell Modems
- Shot Status Reports
- Supports Active & Passive seismic
- Collect Minute's Worth of Data in Seconds of time

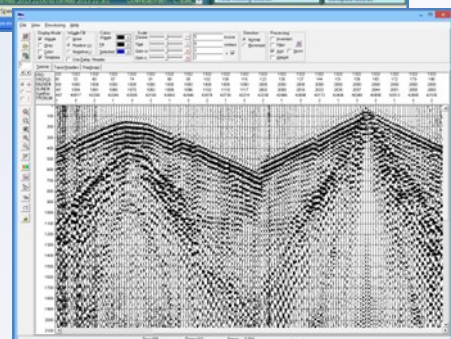
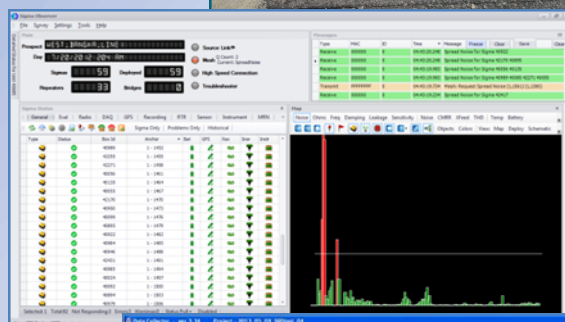
### Harvest

Harvest reads in the "raw" SEG-Y data files, spatially aligns them according to their deployment, windows traces in time, and output records.

- Outputs either SEG-D or SEG-Y
- Outputs complete trace headers
- Includes both Vertical and Diversity Stacking of Data Files

### SourceLink

SourceLink provides complete integration for active operation. Real time control of the Vibrator units, Dynamite units, or other land sources is provided and integrated with the real time receiver layout in the Observer software.



# SIGMA4 Monitoring Options



## EVENT MONITOR FOR LOCAL AND INTERACTIVE MONITORING

The computer running Event Monitor is directly connected to seismographs via either a cabled or Wi-Fi network.

### Benefits of local control

- Interactive seismograph operation
- Real-Time event alert

### Event Analysis

- Peak Velocity versus Frequency chart
- Octave Velocity vs Frequency chart
- Peak Amplitude vs Time graph
- Filtered RMS Amplitude vs Time graph
- Dominant Frequency vs Time graph

### Data Display

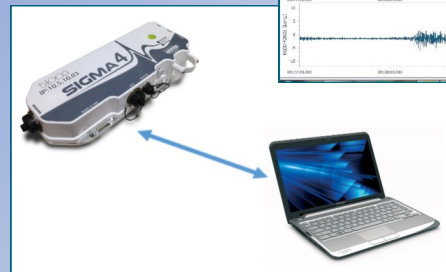
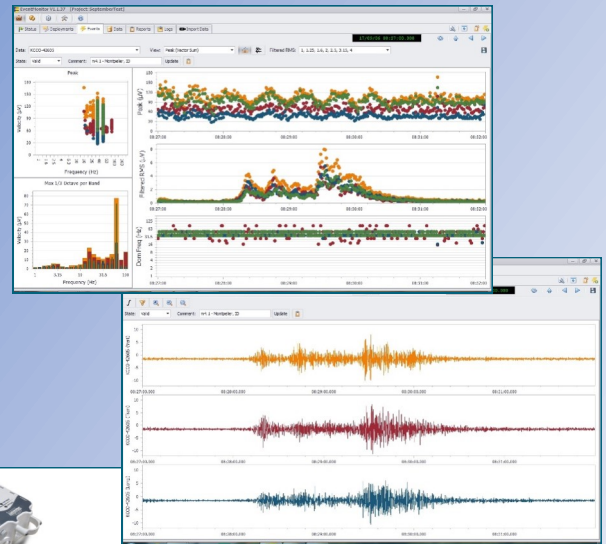
- Single and multiple node data displays
- X, Y, and Z Channels
- High-Cut, Low-Cut, DC reject and inverse filter

### Data transfer and Archive

- Save data to SEG-Y files

### Automated Report Generation

- Weekly, Monthly and customized



M4.2 earthquake from Montpelier, Idaho, USA

## TREMOR CLOUD FOR REMOTE & UNATTENDED MONITORING

The computer running Tremor Cloud sends parameters and commands to a server (the "cloud") and receives data from the cloud. The seismographs communicate with the cloud via Linux-based ruggedized computers.

### Benefits of remote control

- Setup and maintain large seismograph networks
- Operate multiple networks at once
- Emailed event notifications

### Event Analysis

- Same analysis tools as Event Monitor!

### Data Display

- Same display options as Event Monitor!

### Data Display

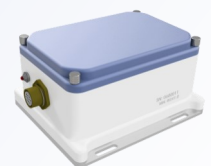
- Same data options as Event Monitor!

### Automated Report Generation

- Same report options as Event Monitor!

### Ruggedized Linux Field Computer

- Lightweight, single-board Linux computer - Draws power from Sigma
- Upload unit receives parameters and commands from cloud and uploads data to cloud
- Each Upload box serves one to ten seismograph stations





# SIGMA4 Monitoring Features



## HARDWARE SPECIFICATIONS:

Both Event Monitor and Tremor Cloud software can be used with any SSC/iSeis seismograph, e.g. a Sigma 4:

### Sigma 4 Unit

- 3 channels standard - 4 channel option available
- 32 bit ADC sampling - 24 bit stored
- Preamp Gains: x1, x4, and x16
- Sample Rates: 125, 250, 500, 1000, 2000, 4000, 8000, 16000, 32,000 and 64,000 samples per second
- GPS disciplined clock
- 8 Gbytes internal data storage
- USB compatible external data backup
- 100base-T Ethernet onboard (optional MRN)
- Internal 3C- 2 Hz Elements (1 vertical & 2 horizontal)
- Single 26 pin 3C connector / External Sensors can be used



## SOFTWARE SPECIFICATIONS:

Both Event Monitor and Tremor Cloud contain similar features:

### Trigger Options

- Includes trigger criteria or trigger levels
- Peak and RMS Amplitudes
- Filtered Peak and RMS Amplitudes
- STA/LTA

### Both Event Monitor and Tremor Cloud

- Peak Velocity vs Frequency chart
- Octave Velocity vs Frequency chart
- Peak Amplitude vs Time graph
- Filtered RMS Amplitude vs Time graph
- Dominant Frequency vs Time graph

### Data Display

- Single and multiple node data displays
- Particle Velocity (Tremor Cloud Only)
- X, Y, and Z channels
- High-Cut, Low-Cut, DC reject and inverse filter

### Saved Data Files

- Save events as miniSEED or SEG-Y files
- Save windows data as miniSEED or SEG-Y files

### Automated Report Generation

- Weekly, Monthly and customized reports



# SIGMA4 - 3 channel Option



- Versatile seismograph for acquisition and monitoring
- 3 data channel version:
  - Low Noise 32-bit (24 bits stored) ADC
  - Optional Internal 2 Hz 3C sensors
  - By-pass connector for calibration or external sensors including accelerometers
- Internal or External GPS module
- Two networking options:
  - Optional internal Mesh Radio Network
  - Internal 100Base-T network with FTP server
- Internal and expandable 8GB memory
- IP-67 All Aluminum Case
- External USB-based removable memory
- Battery options include:
  - Internal 99 watt-hour battery - Provides roughly 66 hours of operation
  - External user-supplied 12 volt battery



## SIGMA 4 (3 CHANNELS) SPECIFICATIONS

Electrical	
A/D Converter	32 bit sigma delta (24 bits stored)
Preamplifier Gains	x1, x16 (0 dB, & 24 dB)
Max Input (x1 gain)	5.0 volts (peak to peak)
Max Input (x16 gain)	313 millivolts (peak to peak)
Sample Rates	125, 250, 500, 1k, 2k, 4k SPS
Bandwidth	DC to 85% Nyquist
Input Impedance	20k Ohms
Clock Sync	GPS or VHF/Wire
Sensor Supported	Passive & Active
	12 v available for external sensors
3C Internal Sensors	2 Hz (1 vert & 2 horz) (optional)
Memory (Internal)	8 Gb (standard, can be upgraded)
Memory (External)	16 Gb (standard, can be upgraded)
Network (Internal)	Mesh Radio Network (optional)
Network (External)	100Base-T (Cabled or Wi-Fi)

Performance (at 500 sps)	
Dynamic Range	126 dB (x1 gain)
	122 dB (x16 gain)
Distortion	0.0001% (x1 gain)
	0.0001% (x16 gain)
Noise	0.8 $\mu$ V RMS (x1 gain)
	0.09 $\mu$ V RMS (x16 gain)
CMRR	< -125 dB (x1 gain)
	< -121 dB (x16 gain)
Trigger Accuracy	$\pm 1 \mu$ s at all sample rates
Physical	
Case Type	Aluminum
Size	15.0 in x 5.5 in x 2.3 in
	38.1 cm x 14.0 cm x 5.8 cm
Weight	6.9 lbs
	3.2 kg
Power Requirement	9-28 volts DC
	1.3 watts
Internal Battery	LiOn 11.5 volt (optional)
	99 watt/hrs (can be shipped)





# SIGMA4 - 4 channel Option



- Versatile seismograph for acquisition and monitoring
- 4 data channel version:
  - High Speed 24-bits high-speed ADC
  - Optional Internal 2 Hz 3C sensors
  - By-pass connector for calibration or external sensors including a microphone
- Internal or External GPS module
- Two networking options:
  - Optional internal Mesh Radio Network
  - Internal 100Base-T network with FTP server
- Internal and expandable 8GB memory
- IP-67 All Aluminum Case
- External USB-based removable memory
- Battery options include:
  - Internal 99 watt-hour battery - Provides roughly 66 hours of operation
  - External user-supplied 12 volt battery



## SIGMA 4 (4 CHANNELS) SPECIFICATIONS

Electrical	
A/D Converter	24 bit sigma delta (24 bits stored)
Preamplifier Gains	x1, x2, & x16 (0 dB, 12dB & 24 dB)
Max Input (x1 gain)	6.5 volts (peak to peak)
Max Input (x16 gain)	434 millivolts (peak to peak)
Sample Rates	125, 250, 500, 1k, 2k, 4k, 8k, 16k, 32k & 64k, SPS
Bandwidth	DC to 85% Nyquist
Input Impedance	20k Ohms
Clock Sync	GPS or VHF/Wire
Sensor Supported	Passive & Active
	12 v available for external sensors
3C Internal Sensors	2 Hz (1 vert & 2 horz) (optional)
Memory (Internal)	8 Gb (standard, can be upgraded)
Memory (External)	16 Gb (standard, can be upgraded)
Network (Internal)	Mesh Radio Network (optional)
Network (External)	100Base-T (Cabled or Wi-Fi)

Performance (at 500 sps)	
Dynamic Range	125 dB (x1 gain)
	121 dB (x16 gain)
Distortion	0.0001% (x1 gain)
	0.0001% (x16 gain)
Noise	1.2 $\mu$ V RMS (x1 gain)
	0.15 $\mu$ V RMS (x16 gain)
CMRR	< -125 dB (x1 gain)
	< -121 dB (x16 gain)
Trigger Accuracy	$\pm 1 \mu$ s at all sample rates
Physical	
Case Type	Aluminum
Size	15.0 in x 5.5 in x 2.3 in
	38.1 cm x 14.0 cm x 5.8 cm
Weight	6.9 lbs
	3.2 kg
Power Requirement	9-28 volts DC
	1.3 watts
Internal Battery	11.5 volts (optional)
	99 watt/hrs (can be shipped)



## EXPANDABILITY AND FLEXIBILITY - SOURCES



Sigma 4 seismograph nodes are compatible with the entire line of Seismic Source Co source control electronics. This includes the Force 3 Vibroseis controller, the Boom Box 3 dynamite synchronizer and the RTM 3 remote trigger module. Sigma 4 nodes are also compatible with the Universal Encoder 2. Use the UE2 for precise source operation with any source type.



## EXPANDABILITY AND FLEXIBILITY - SENSORS



Sigma 4 seismograph nodes have a bypass plug on the front of the unit. This plug allows calibration of the internal sensors, or the use of other sensors like accelerometers, broad-band sensors, hydrophones, and difference geophone types. Sigma 4 nodes also provide battery power to the sensor port to power these other sensors.



## SEISMIC SOURCE AND ISEIS

Seismic Source / iSeis is a manufacturer of seismic instruments and data acquisition systems. Its products are used in a broad range of applications: Seismology, Structural Monitoring, Seismic Site Evaluation, Civil Engineering, Gas and Oil Exploration, and Industrial Vibration Monitoring.

