Next-Generation Land-Based Seismic Data Acquisition Systems

The Perfect Tools For:
- Mining
- Engineering
- Exploration

Cabled and Cable-Free Configurations Available

See Why It’s Called One. Smart. System.
COMPANY PROFILE

AN EARTH-SHAKING HISTORY

Seismic Instruments, Inc., based in Austin, Texas, was founded in 2002 with the goal of developing revolutionary single-sensor-per-channel seismic acquisition systems. Geza Nemeth, founder, president, and CEO of Seismic Instruments, has more than forty years of experience in the development of seismic acquisition technologies. In 1998, his first company, CompuSeis, Inc., was purchased by industry-leader Input/Output Inc. (now ION Geophysical). Current key personnel of Seismic Instruments include Zoltan Czismadia, Director of Software Development, and Tamás Szabó, PhD, Lead Engineer for Hardware Development and Applied Geophysics.

Today, Seismic Instruments represents the industry’s specialists in single-sensor, high-sensor-density seismic acquisition systems. The company sells complete data acquisition and recording systems for seismic surveys, and is continually involved in the development of next-generation seismic acquisition hardware and software. These systems include sensors, data gathering hardware (in both wired telemetry and autonomous recording node configurations), and central system software for data-acquisition control, monitoring and recording in industry-standard formats.

SI has sold its seismic data acquisition systems in Europe, the United States and China. Each new system has incorporated the latest and most sophisticated technology available, maintaining SI’s reputation for developing some of the most technologically advanced products in the seismic industry. Currently, Seismic Instruments has two patents and one patent pending.
ONE SMART SYSTEM

THE “SINGLE-SENSOR” SOLUTION TO DIGITAL RECORDING

For most of the 20th century, seismic survey technology was limited to conventional methods of data acquisition and distribution. The options for feasible approaches to seismic surveys were incredibly limited by the high costs of both analog-to-digital conversion and digital components. In traditional seismic acquisition systems, large groups of analog coil geophones are connected together and the summed signals are digitized at relatively spread-out intervals along widely spaced receiver lines.

The summed signals acquired by these systems are subsequently impossible to separate or differentiate from one another during recording and processing, which can mask local variations in elevation and geophone response. In addition, traditional analog string and line connectors are susceptible to picking up noise and interference. These factors can degrade the quality of the recorded data and can be difficult to correct for with data processing after recording.

Recently, however, breakthroughs in digitization technologies have allowed Seismic Instruments to become part of the revolutionary high-resolution, single-sensor-per-channel approach to seismic data acquisition with the Smart System. SI’s Smart Geophone® (SMG) incorporates signal conditioning electronics and a geophone in a compact package, and is ideally suited for point-sensor based recording, in which each sensor is recorded on an individual data channel. This means that, during a seismic survey, the user has access to vastly improved data quality control. Each sensor in a spread can be individually tested for performance and correct deployment, as well as calibrated and self-corrected utilizing SI's innovative and intuitive proprietary software.

Since each SMG's signal is digitized at the sensor, and SMG string wires carry digital data and power, the noise pick-up common to analog wiring is eliminated. Each SMG has built-in self-testing, calibration and over-current protection capabilities. This single-sensor-per-channel approach also enables the measurement and subsequent correction of each individual geophone’s signal, allowing the user to mitigate or eliminate the problems common to conventional systems.
Figure 1, below, highlights data as acquired by the conventional, data-summed technique as compared to data acquired from the same location using the Smart System’s single-sensor approach.

By using the single-sensor approach, the Smart System provides a more thorough, flexible, and correctable image of the acquired data. Noise can be easily filtered out during post-recording processing using real space varying filters, a process known as digital group forming.

In contrast to the fixed spatial filtering utilized in the traditional method of dumping groups of many conventional geophones into each channel, the user is not encumbered by rigid, preset signal averaging. No irreversible changes to the data occur during recording, allowing the user to generate an accurate final result that exactly suits the needs of their individual seismic survey. Figure 2, found on the following page, demonstrates the advantages of using single-sensor-per-channel systems to correct for static perturbations during recording.
The Smart System's built-in capability for testing the performance of both the electronics and sensors ensures high-fidelity data recording. Using the Smart Geophone as a building block, Seismic Instruments can produce anything from sub-100 channel 2-D systems to 100,000+ channel, ultra-large, 3-D point-sensor data-acquisition systems. SI's Smart System is the most energy efficient on the market and requires only one battery for every 48 channels—a major advantage for the user in large scale deployments.

The modular design of the Smart Geophone allows easy field replacement of SMGs. Intra-string segment connectors enhance sensor configuration flexibility and reduce string carrying weight for easier, faster deployment. Simply put, the Smart System is rugged, robust, and compact, and among the most cost-efficient seismic acquisition systems available today.

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UNPARALLELED VERSATILITY

INTRODUCING THE WORLD’S MOST FLEXIBLE SEISMIC ACQUISITION SYSTEM

Traditional systems have numerous limitations, not least of which are the crossline cables that connect the greater system and transmit acquired data back to the user. Terrain such as rivers, roads, cliffs, and valleys can all act as obstacles, driving up costs of a seismic survey by confining the feasible recording range, decreasing productivity, and even damaging the equipment.

Seismic Instrument’s latest product, the S-Flex System, is capable of surpassing these limitations using a ground-breaking new component: the Autonomous Recording Node (ARN).

In 2009, SI began marketing its Smart Antenna Module® (SAM), a unique wireless product that allows GPS-based continuous recording. The S-Flex System utilizes Autonomous Recording Nodes, each recording independently of one another, but the data and equipment are flawlessly synchronized and easily monitored via radio and GPS (Global Positioning System). Instead of transmitting acquired data down the line to be recorded at the survey’s control center, each individual connected ARN records sensor data directly to a high-capacity CompactFlash Memory Card which is housed inside each SAM.

Each Autonomous Recording Node is composed of several key elements. At the center of every ARN is a Hybrid Smart Line Interface Module (HSLIM), an updated, advanced and highly versatile version of the Smart System’s more traditional Smart Line Interface Module (SLIM). HSLIMs provide power, control, and data gathering functions for the connected SMG strings. Two strings of sensors—each consisting of 12 SMGs—can be connected to each of the HSLIM’s two string connectors, allowing for a total of 48 SMGs on every ARN.

Since each ARN requires only a single 12 volt battery, the S-Flex System has an incredible ratio of one battery to every 48 sensors, an unparalleled achievement in currently available “cable-free” seismic acquisition systems. This helps to reduce the system’s overall cost, increase on-site productivity, and significantly decrease the bulk weight of any seismic survey’s hardware.
Figure 3 The layout of a 24-Sensor Autonomous Recording Node. Depending on the user’s needs, a single ARN can record data from up to 48 sensors when two additional 12-sensor SMG strings are connected.

One significant advantage of the S-Flex System is—as its name implies—its flexibility. The user has the option of using the S-Flex’s HSLIM units in a traditional “cabled” spread. Line connectors located on either end of each HSLIM allow them to make traditional line connections to other HSLIM units. In this way, HSLIMs can be utilized as components in either conventional, fully-cabled configurations or in the “cable-free” configuration which uses SAMs to record the data. With the right equipment, a user of the S-Flex system could actually switch back and forth between cabled and cable-free configurations using the same basic components, all dependent on the needs of any given survey and location.

Although the HSLIM is a central component in the Autonomous Recording Node configuration, the most crucial and revolutionary element of the S-Flex System is the Smart Antenna Module. All data acquired by a given ARN is recorded directly to the aforementioned memory cards built in to these SAMs. Depending on the storage capacity of the utilized memory cards and the recording interval specified by the user, SAMs can independently record hours or even days of seismic data before being collected for downloading. Since the memory cards used by SI are commercial-off-the-shelf models, users of the S-Flex System can easily upgrade any of their SAMs with expanded memory capacity.
SAMs are equipped with a GPS antenna, used to synchronize acquired data and provide geographical coordinates for every ARN. In addition to the GPS antennae, each SAM is also equipped with a radio that transmits a continuous signal back to the central system software, allowing the user to remotely monitor the current battery levels and remaining memory capacity of each ARN. Energy monitors corresponding to each SMG that is connected to the ARN can also be accessed in the central system software.

Above: From this window, available in SI’s proprietary Central System Software, the user can monitor each Autonomous Recording Node’s memory capacity, battery levels, coordinates, and active channels (each corresponding to a single sensor).

For more accurate, real-time quality control, the user also has the option of connecting a laptop directly to any HSLIM and, using SI’s intuitive software, access an oscilloscope view of all connected channels—as well as run system tests on the equipment.
**Central System Electronics**

*The “Brains” of the Operation*

At the center of every S-Flex System are the Central Electronics, a network of hardware that helps make the S-Flex one of the most versatile and intuitive seismic acquisition systems available today. Configurations of the Central Electronics vary based on the individual needs of the survey and the user. From large-scale operations with dedicated or stationary central recording stations to smaller surveys which utilize a basic truck or other mobile central recording station, the central electronics of any S-Flex System can be custom-tailored by Seismic Instruments to fit the requirements of any customer.

**Figure 4** Demonstrational arrangement of the Central Electronics of an S-Flex System as might be found in a more stationary central recording station (more commonly referred to as the “doghouse”), such as a trailer or small structure.
The **Operator Console**, which uses SI’s proprietary **Central System Software** can be any PC with a modern Windows™ Operating System installed. For more mobile surveys, Seismic Instruments recommends using a rugged laptop or notebook computer. Larger surveys with a more stationary central recording station may wish to use a desktop PC. The Central System program can be used in a multi-monitor setup to facilitate quick and easy access of QC data, acquired record logs, and other program functions such as GPS-based mapping.

**A Time Stamp Generator and Base Radio Unit** is connected to the Operator Console in all configurations of the Central Electronics. This unit has two external antennas. The first receives intermittent radio communications from the SAM units, allowing the Central System program to indicate each Autonomous Recording Node’s remaining memory capacity, battery levels, map coordinates, and the functionality of active channels connected to the node. The user may also open a window in the program corresponding to any ARN that displays energy monitors for its connected sensors. The second antenna receives a GPS signal that helps synchronize time break data. This antenna can be attached directly to the unit, or mounted on an exterior location for better GPS reception.

The Time Stamp Generator and Base Radio Unit is also responsible for providing time break signals to the Central System Software that are used to synchronize data during harvesting. Depending on the needs of the user and the energy source utilized (e.g., explosives, impact, or Vibroseis), the unit can be triggered to create a time break and begin recording based on a simple trigger or energy switch, or may utilize an arrangement based on AUX sensor channels (see Figure 4 on the previous page for a sample configuration of the latter).

Following acquisition, or at any point before or when the ARNs’ memory cards reach capacity, each SAM is collected to begin the data downloading process. Up to six SAMs can be simultaneously connected to the **Data Harvester Unit (DHU)** which may be connected directly to the Operator Console at any time for quick and easy downloading. The built-in GPS antenna in each SAM synchronizes the acquired data with the central system software during the downloading process, allowing for extraordinary accuracy in aligning data with the logged time breaks that have been generated by the Time Stamp Unit. Even when recording data from sensors which cover an extremely large area—such as in oil and gas exploration surveys which target deep sub-subsurface geological features—the S-Flex provides incomparable synchronization, remote quality control, and data gathering utility.
SOFTWARE SOLUTIONS
THE RIGHT TOOLS FOR THE JOB

Any purchase of a complete seismic acquisition system includes Seismic Instruments’ propriety software, which comes in several program iterations suited for multiple configurations of the system hardware. SI’s programs offer the user a simple and intuitive means of accomplishing a variety of tasks related to generating plans, organizing data, and compiling results based on any seismic survey’s needs.

Within each version of SI’s software, the user is able to design complex spreads and prospects, specifying relative placement of receiver and energy source points using easy-to-learn setup tools. Logs can be generated, saved, and numbered according to the user’s exact desired specifications. As records are generated during the data acquisition process, the status of each shot is easily tracked, and faulty records may be deleted and re-recorded.

In the S-Flex System, when data is harvested from Smart Antenna Modules, the downloaded raw data from each SAM is automatically synchronized with the records log generated by the user during recording. This is accomplished by

Above: A screen capture of SI’s Central System Software, demonstrating its received radio communication from field units, GPS mapping (based on Google Earth™ mapping service), live energy monitors, and an active records log.

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referencing the GPS-based time signals from each SAM, which accomplishes synchronization accurate to within ±50 nanoseconds. Conveniently, SAMs can be harvested in any order and at any time. Partial or incomplete records will be indicated as such until the rest of the data for that record has been downloaded from relevant SAMs. This grants the user maximum flexibility in collecting and assembling the raw data when using the S-Flex System.

Data quality control is an emphasis in Seismic Instruments’ software, both in traditional and cable-free configurations of the system. In cable-free configurations, energy monitors are transmitted via radio from each Smart Antenna Module to the software, constantly updating the user on the signal amplitude and general functionality of each connected sensor. For more in-depth system monitoring, SI software also allows for system performance testing and real-time data quality-control to ensure the reliability and functionality of any and all connected equipment. In cabled configurations of the system, these system tests and data quality-control functions can be accessed at any time.

In cabled configurations (and when connecting a console to HSLIMs in cable-free configurations), an oscilloscope view of the connected sensors is available, allowing the user to monitor the data as it is received in real-time. The software is also capable of running a number of system tests on any connected equipment in these configurations, which cover the electronics, sensors, timing and environment.

When recording is complete or, in the case of the S-Flex System, all records have been associated with data harvested from the SAMs, all versions of SI’s software are capable of generating results in the form of industry-standard SEG-Y files. Surveyors can therefore preview the compiled data and be assured of accurate results before it is delivered for processing.
CUSTOMER SUPPORT

THE SEISMIC INSTRUMENTS GUARANTEE

In addition to the latest, cutting-edge seismic data acquisition technology, Seismic Instruments proudly offers some of the best customer support available. Upon purchasing an SI system, customers have the option of attending a 2-week training course for up to two people at SI's headquarters in Austin, Texas free of charge. The Seismic Instruments philosophy on training users of the system is to train the customer's service engineers to the same level as our own service engineers. Anyone attending this course will walk away with the same level of expertise with the system as one of Seismic Instruments' own employees.

Beyond initial training, SI also provides a 12-month warranty for the entire system starting on the day of delivery. This warranty covers any and all replacement parts made for the system during the warranty period. In addition, electronic circuit boards that are manufactured by Seismic Instruments are covered by an extended 2-year warranty period.

Customer support isn't limited to SI's training and warranty features. Our friendly, courteous, and helpful staff is available at the Austin, TX headquarters to assist any customer with their SI system via phone or e-mail. If any problem with a system persists, SI will go to whatever lengths that may be necessary to ensure that the hardware and software are bug-free and fully operational, including shipping replacement components, providing updated software, and sending a representative to troubleshoot the system in person.
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