GeoWatch

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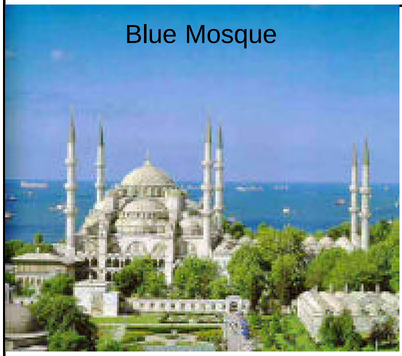
GeoSIG Research & Development Center conducts Istanbul Radio TRANSMISSION Study


Blue Mosque

The Kocaeli, Turkey earthquake struck near the city of Izmit on August 17, 1999. According to official government estimates it killed 17,127, and injured more than 43,953 people. Estimates of property losses according to the World Bank range from US$ 3.0 to US$ 6.5 billion, which is equivalent to 1.5 to 3.3 percent of the Gross National Product of Turkey. It was the most devastating earthquake to strike Turkey since the 1939 Erzincan earthquake killed 30,000 people. The sequential westward progression of damaging earthquakes along the North Anatolian fault during the 20th century has enabled Kandilli Observatory and Earthquake Research Institute of Bogazici (KOERI-BU) to receive approval and funding for a Istanbul Earthquake RAPID RESPONSE AND EARLY WARNING Project.

GeoSIG was contracted by KOERI-BU, as a preliminary step to installing the Earthquake RAPID RESPONSE AND EARLY WARNING System (ERRWS), to conduct a radio transmission study of the planned seismic data radio sittings and transmission system. The planned Early Warning System Stations (EWSS) located at geographically interesting sites in Istanbul and surrounding areas are planned to continuously send the measured seismic data by radio transmission to the KOERI-BU data center for collection, storage and evaluation.

Currently the two most cost effective and reliable technical solutions being considered for radio transmission from the EWSS to the data center are the UHF and Spread Spectrum radio modem technology. Engineers Lukas Gätzi, Markus Spuler and Talhan Biro from GeoSIG Ltd., Glattbrugg, Switzerland traveled to Istanbul in early March to assist the KOERI-BU engineers in conducting a 5-day study and test of the planned Kandilli Observatory Early Warning Station sittings and radio network topology.

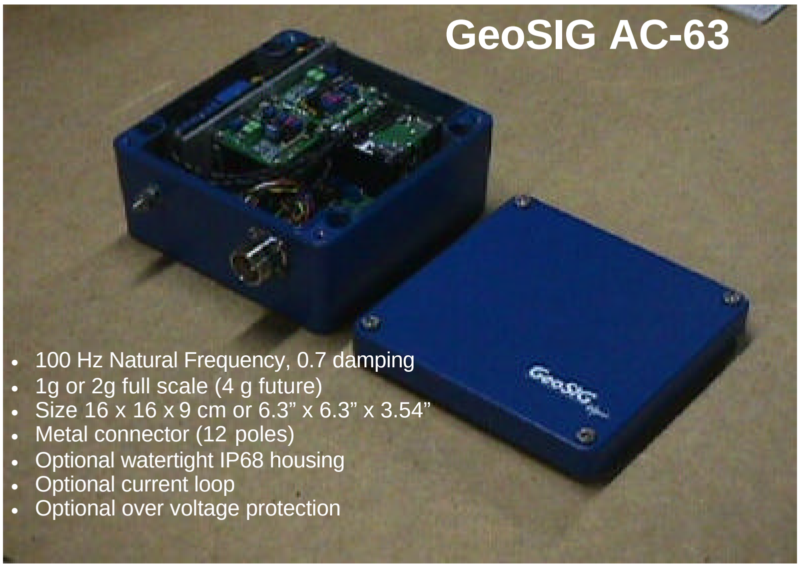

Markus Spuler at test site

Before the test in Istanbul engineers performed a topographical profile analysis of the planned radio links to confirm that all of the selected sites complied with the pre-requisites for unobstructed line of sight between radio transmitter and receiver. The "unobstructed line of sight rule" is considered especially critical in the application of Spread Spectrum because of the higher frequency (2.4 GHz) used with this technology. Spread Spectrum radio test conducted at the GeoSIG research and development center in Switzerland confirmed that strict compliance to this "line of sight rule" is necessary to assure a reliable 2.4 GHz radio network.

Radio system test and sitting study is one of GeoSIG's areas of expertise offered to customers to assure successful and reliable radio network implementation.

GeoSIG introduces NEW Accelerometer at SSA in April 2001

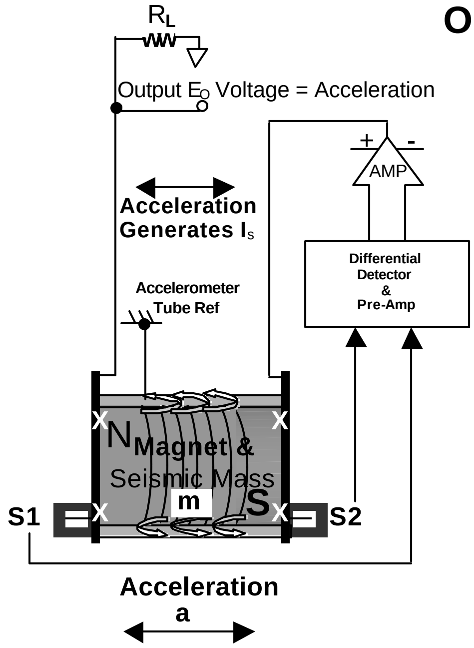
Visit our booth at SSA 17-23 April in San Francisco and see how GeoSIG has addressed some of the problems you may be experiencing with accelerometer installation, offset stability and linearity.



GeoSIG's will show a **NEW** highly effective **force balance servo accelerometer solution**. Learn how the AC-63 works and see why this product should be considered in your future project planning. If you did not have an opportunity to attend the SSA this year please contact your local GeoSIG representative or the GeoSIG Head Quarters in Glattbrugg, Switzerland for more information about this interesting new accelerometer.

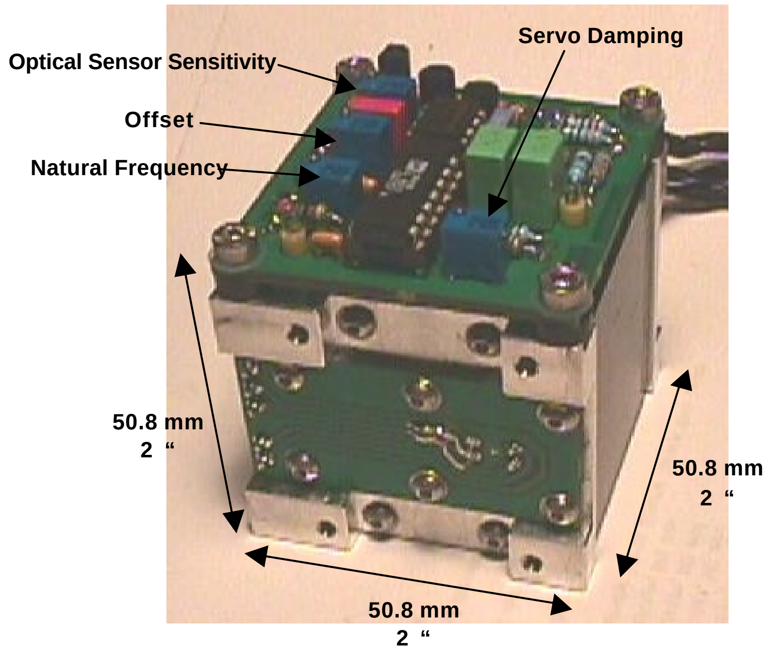
The AC-63 has 2 principal packages the internal mounted for integrating in GeoSIG's GSR product line of Strong Motion Recorders (see below) and an external mount shown here. The AC-63 is available in uniaxial, biaxial and triaxial version.

GeoSIG
Force Balance Accelerometer with Digital Sensor Control
Operation Theory



S1 & S2	=	**Photoelectric sensors**
R_L	=	**Load (sampling) resistor**
a	=	**Acceleration**
m	=	**Mass**
↔	=	**Motion of the servo mass**
I_S	=	**Servo Current**
(symbol)	=	**Mechanical Ground**
(symbol)	=	**Electrical Ground**
E_O	=	**Output Voltage**

Uniaxial Module



Equations

F_c = ma (internal force = mass x acceleration) (Newton Law)
F_c = BLnI force generated by current flowing in magnetic gap

Where: B = Magnetic field strength
L = Length of wire in magnetic gap
n = Number of turns of wire
I = Current flowing through the coil


Integrated AC-63 Accelerometer
For GSR-12, -16, & -18

AC-63 Key Benefits & Features

- Robust Suspension system
- Larger mass improving signal noise ratio
- Stable Offset
- No drift
- Temperature compensated
- Elegant cost effective design
- No installation adjustments including H to V
- Simple install, plug & play
- Digital Sensor Control (DSC) smart sensor
- Disable my smarts and do it the old way

As we published issue 13 of GeoWatch all of the test results of the first AC-63 production had not yet been released. Through the summer of 2001 GeoSIG engineering will continue to test and release more advanced configurations and some of the missing specification characteristics. Updates will be published in GeoWatch quarterly. **Stay tuned!**

AC-63 Current Specifications

Accelerometer type:…..	Servo Force Balance	Power supply:	
Output Standard:………	Voltage 0 ± 5 V	Voltage range:………..	9 to 15 VDC, single supply
Output Optional:……….	• 2.5 ± 2.5 V (default)	Power consumption:….	< 72 mA @ 12 VDC
	• 0 to 20 mA	Suspended mass:…….	• 3.7 gr (0.0037 kg)
	• 0 ± 20 mA		• Two springs as bellow
	• 4 to 20 mA		• Robust mechanical construction
	• Pseudo-differential output become 0 ± 5 V or 0 ± 2.5 V	Current to balance 1 g:.	1.82 mA
		Standard Interfaces :.	• Over-voltage protection
Full scale:…………….	±2g standard, ±1g or ±4g optional		• Reverse voltage protection
Optional range:………	2.5 ± 2.5 V		• EMI / RFI protection
Nonlinearity:………….	< 0.1 %	Packaging options:……	External Uniaxial V or H
Hysteresis:……………	< 0.01 %		External Biaxial HH or VH
Crossaxis:……………	< 0.1 %		External Triaxial
Bandwitdh:……………	100 Hz (200 Hz optional)		Integrated in GSR recorders
Damping:……………..	0.7 (adjusted)		Downhole (not in this release)
Dynamic range:……..	> 16 bits$_{rms}$,96 dB (Current rel.)	Digital Sensor Control:.	Simplified Installation
Test mode:…………..	Damped (normal) & undamped		Offset stability
Vertical Compensation:.	Fully automatic plug & play		Temperature compensation

Scientist use GBV-316 to conduct Antarctic study

Scientist Prof. Dr. Boyko Ranguelov, Bulgarian Academy of Sciences uses a GBV-316 to make more than 300 seismic records generated by icefalls, icebreaks, stonefalls, stonecracks, ocean wave noise and breaks, local earthquakes and strong wind.

These measurements were part of a Ministry of Science and Education project called Seismic Investigations in Antarctica and a New Bulgarian University, Sofia Department of Earth Sciences and Environmental project entitled "Geodynamic investigations on Livingstone island (Antarctic South Shetlands)". These records were generated during the 40 day 2000-2001 campaign to Livingstone island (South Antarctic Shetlands). From all of these verities of recordings Dr. Ranguelov underlined the usefulness of the GBV in generating records of stonefalls, measuring of acceleration generated by waves breaking on the almost vertical rock site simulating the effects of tsunamis in port areas and counting of the strong waves attacking the cliffs on the shore.

TREMOR Product Development Progress reported at SSA

Based on extensive experience in strong-motion instruments, **the USGS and GeoSIG** work jointly under a Cooperative Research and Development Agreement (CRADA) to develop a high performance instrument, code named **TREMOR**, that may be sold for an unusually attractive price and also exhibits exceptionally low long-term maintenance costs.

The product officially named **GT-316** is a three-channel 16-bit strong-motion recorder with matching, internal accelerometers.

In addition to the features typically found in a state-of-the-art strong-motion recorder, the **GT-316** provides telemetry options, such as **wireless Internet trigger messaging and waveform delivery** through an always-on-line cellular modem (CDPD). This information is transmitted to software called **HomeBase**, running on a conveniently located PC Anywhere on the Internet. A trigger message is sent immediately after each event occurs, enabling **rapid evaluation of shaking strength and emergency response needs**. This message contains critical summary information, including the Peak Ground Velocity (**PGV**) and Peak Ground Acceleration (**PGA**).

HomeBase is used to manage the network, capture data, and forward the PGV and PGA **to any other designated computer via the Internet within seconds following an event** for ShakeMap generation or other needs**. A short while later, the waveforms are forwarded from each** GT-316 **to HomeBase and stored there for additional analysis.** HomeBase also performs automated analyses of these waveforms, including generation of S_a and additional shaking-strength metrics which are also forwarded for downstream processing. Ultimately, the waveforms too can be forwarded to other computers for downstream processing.

Central System Software (HomeBase)

Using a cellular Internet modem permits consistent timing to be maintained automatically by HomeBase to an absolute accuracy of a few tenths of a second or better without the investment and installation and maintenance problems of a GPS receiver at each instrument site. The central PC, running the GeoSIG/USGS jointly-developed HomeBase software, monitors each instrument's four-times-daily State-of-Health Messages to track the drift of each GT-316's internal clock against the GPS-locked time of the central PC. HomeBase then adjusts the time stamp of transmitted records to correct for this drift using a robust algorithm. Optionally the GT-316 can be equipped with its own GPS receiver for full time precision and synchronization to UTC.

State of Health Messages

State-of-Health Messages are monitored and logged continuously, and the times of arrival of these messages are noted against the PC's (GPS-locked) internal time standard. Hence, the drift rates of every **GT-316** Instrument's clock are known and monitored to a precision of a few tenths of a second (limited only by the consistency of minimum Internet times-of-flight). In the worst case, the times of waveforms are recoverable to this timing precision.

Robust Sensor

The standard **GT-316** uses a fully temperature compensated ICS-3028 solid-state sensor in order to achieve high resolution, high linearity, as well as gain and offset stability, **using a CRADA-developed technique**. This rugged micro-machined sensor can withstand 2,000 g of shock without damage and has no measurable long-term spring sag. These features greatly reduce the dominant long-term costs of ownership while providing high sensitivity performance.

Why use CDPD ? The Cellular Digital Packet Data (CDPD) transmits digital packet data at 19.2kBaud**, using idle times between cellular voice calls on the cellular telephone network**. Using CDPD technique voice and data co-exist over the same cellular airwave without the interruption of or knowledge of the presence of the other. To improve reliability the CDPD encodes each block using a systematic **Reed-Solomon forward-error-correcting code**. Reed and Solomon managed to get a coding system that was based on groups of bits (bytes) rather than individual 0s and 1s.That feature makes **Reed-Solomon code particularly good at dealing with "bursts" of errors typically found in radio transmissions.**

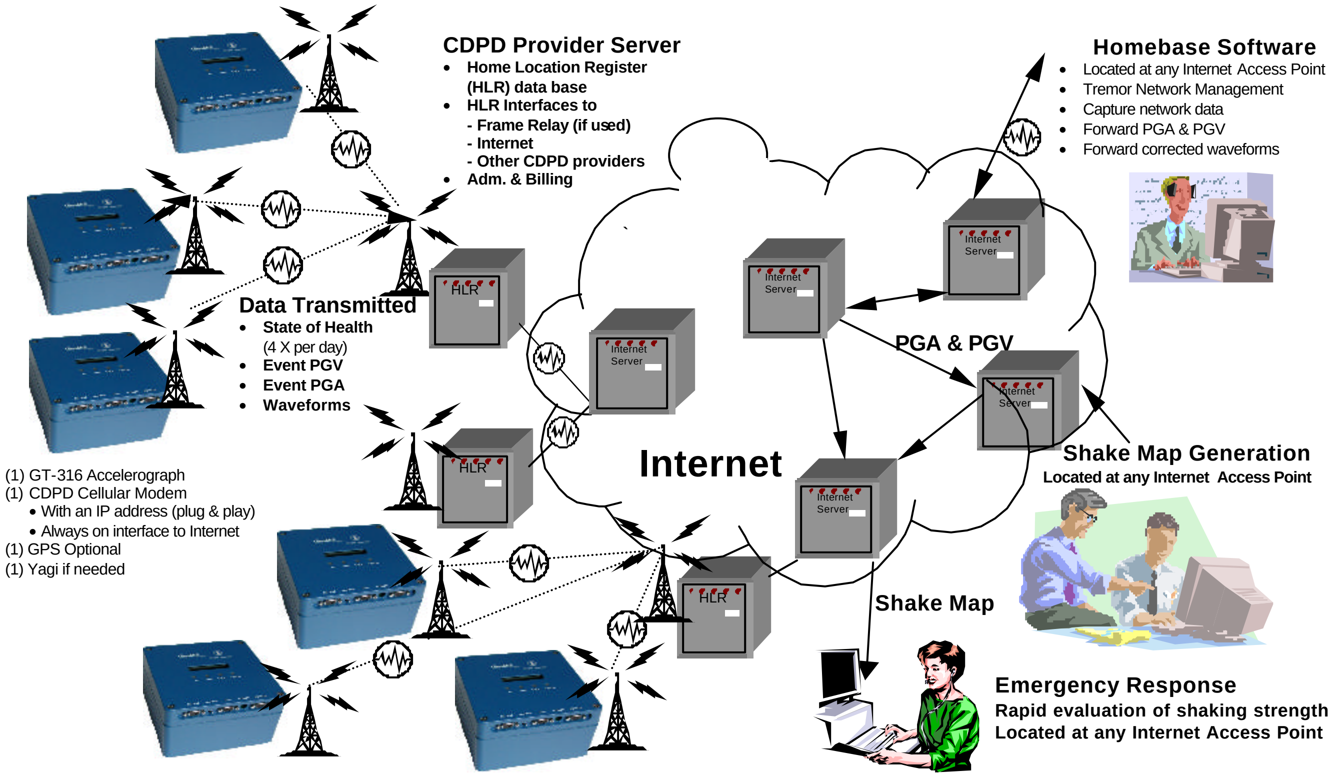
System Benefits

- Scaleable
- Fast implementation
- Easy to install
- Secure
- Reliable
- Robust
- Lowest Cost
- Fast Response

Summary:

The CRADA development program has allowed us to learn how to produce a small and relatively inexpensive 16 bit accelerograph that is temperature stable. This can be quickly and easily installed in mass for dense array deployment. During the summer of 2001 we will be performing **shake test** to confirm the performance of the accelerometer and GT-316 digitizer as well as conduct CDPD **cellular modem and HomeBase software test**. By the Fall of 2001 we anticipate being **ready to deploy and support a minimum of 2 production prototype networks**. These networks will be used to make final adjustments to the product. Implementers interested testing a small network of Tremors or interested in learning more about the GT-316 or any of GeoSIG products please contact GeoSIG at **info@GeoSIG.ch**.

Managing a Network of GT- 316 Accelerographs



A report on CDPD vs other technologies and more about the Reed-Solomon forward error correcting code is available from GeoSIG. Please contact Marv Crumb at mcrumb@GeoSIG.ch or info@GeoSIG.ch.

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