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An Ocean Bottom Seismoemter (OBS) for long period Surveys

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I. Abstract

The wide technological progress in marine sciences in the last ten years allows a better profit of natural resources, and risk and hazards assessment in the marine environment. Thus, the more developed countries have importantly invested in marine technological innovation, which allows continuous sampling and supervision of different events to a regional scale.

Among the different marine instruments, Ocean Bottom Seismometers (OBS) have deserved growing attention from the geoscientific community during the last twenty years. OBS sensors are sensitive to the motions of the ocean floor, which hold key information in order to study offshore seismicity and to explore the Earth's interior. In a seismic survey, a series of OBSs are placed on the seabed of the area under study, where they record either natural seismic activity or acoustic signals generated by compressed air-guns. Signal recordings are subsequently used to model both the earthquake locations and the crustal structure.

Useful seismic surveys require long term deployment of dense OBS networks. Increasing the autonomy of OBS by reducing its consumption is therefore one of the main technological aims. In addition, it must be taken into account that modern seismic experiments require fast deployment of several tens of OBSs, therefore another

is goal to build small sized, light-weight and easy to use instruments. The purpose of this project, which integrates different scientific disciplines as electronics, mechanics, geophysics, acoustics, and communications, is to design a small and light autonomous OBS with large storage capacity and low power consumption capable of handling continuous recording for three months.

The instrument is equipped with a heavy anchor to sink it to up to 6000 meters depth. The OBS must be able to record continuously for about three months, allowing to do long term surveys as well as to plan different seismic experiments without recovering the equipment. Seismic signals are propagated within the sub-seafloor layers and recorded by the sensors: a hydrophone to record water vibration and a geophone to record seabed vibrations, this last one being composed of three 4.5Hz acclerometers placed perpendicularly, one for every axis, inside aluminium housing.

The equipment is recovered after sending an acoustic signal of a certain code from a telecommand deck unit placed on the surface, which starts the burn-wire process. After some time, which depends on water temperature and salinity, the anchor is released allowing the instrument to float to the surface. The tracking elements of the instrument on the surface are a radio beacon with a 4 miles range from the oceanographic vessel, a direction finding receiver on the vessel to locate the radio beacon and a xenon flasher, very useful in night recovery. Time release is also possible for bad communication situations.

In order to satisfy the power consumption requirements, a new low power datalogger based on Compactflash memory cards has been designed, giving rise to a high resolution acquisition system suitable for long term seismic data acquisition. The acquisition system is based on a 4 channel 24 bits CS5372/76 analog to digital conversion together with input signal amplification. The CS5372 are two channel high dynamic range, fourth order $\Delta - \Sigma$ modulators designed for geophysical and sonar applications. When used in combination with CS5376 digital filter, a unique high resolution A/D measurement system results, providing a higher dynamic range of 124 dB @411Hz bandwidth and lower total harmonic distortion than other industry modulators, while consuming significantly less power per channel. The modulators generate an oversampled serial bit stream at 512kbits per second when operated from clock frequency of 2.048 MHz. A MC68332 Motorola microcontroller is used to compress data coming from the A/D converters before storing in the Compactflash memory cards.

Hard disks are widely used as the storage element in OBSs, causing several problems that affect the autonomy of the instrument as well as the data quality. In this case, the hard disk is composed of an electric motor for rotation that results in a great deal of power consumption at power up and the electronic noise generated during this process is reflected on the data collected continuously. The power consumption of the SCSI harddisk is measured at power-up resulting in 12W of consumption at 1% of total time. Having a hard disk as mass storage element results in either discontinuous data recording or noisy data at disk power-up every certain time.

The development and expansion of Compactflash cards during the last years and their rapid increase in storage capacity are the main reasons to use this kind of memory, reducing the power consumption as well as improving the data quality. Consumption tests of the storage module have been carried out resulting in an average of 6mW, reducing the overall consumption of the storage module by 20. The Use of seven slots of Compactflash memory cards is possible with card storage capacity of up to 2GB, results in a small and light design of overall memory of 14GB, providing enough capacity for the expected autonomy.

Any marine seismic application needs a great stability of the timing unit with temperature as there is no access to the instrument for time synchronization. Therefore all the necessary signals for the datalogger to function correctly are generated from a single crystal and taking into account the stability requierment, a Vectron OC260 32.768MHz crystal offering a stability of $\pm$40ppb is used and an electronic module is designed and built integrating a ICS52701 phased locked loop.

At present, tests of different modules of the new OBS prototype are being carried out in the lab and tests under real environmental conditions are planned to take place in February 2005. The first prototypes will be built in summer 2005.