GEOLORE: Migration from an Experiment to a versatile Instrument

By: Rainer Roßberg; rossberg@geophysik.uni-frankfurt.de

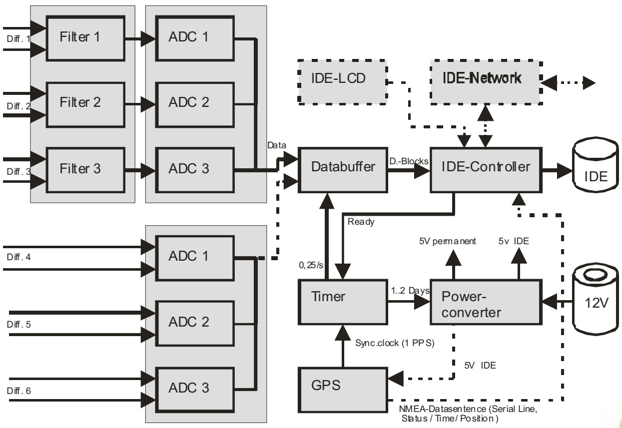
Introduction

Originally the datalogger GEOLORE (**Geo**phyical-**lo**ngtime**re**corder) was designed for recording of electrical fields on a lake bottom in Iceland. The system design has been strongly focused on low power consumption to allow long time recording with standard batteries. The principle was presented at the EMTF-meeting in 2003 /1/ and in an electronic magazine /2/. The successful practical operation was been presented in the poster /3/. During the last four years other applications came up and the technology of the datalogger was improved extensively.

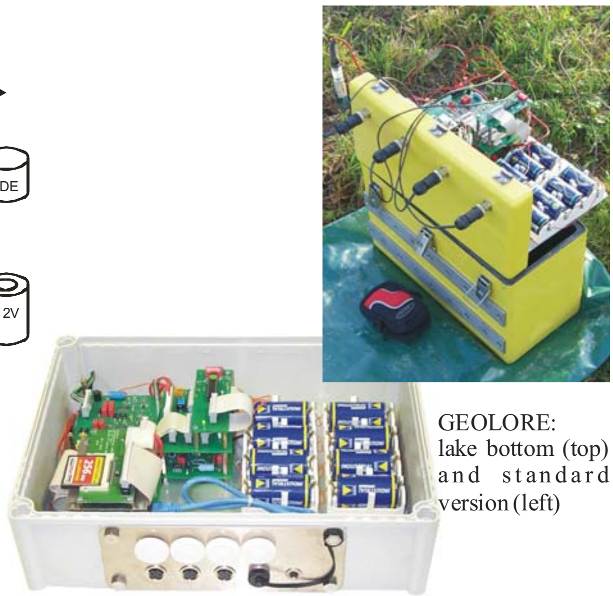
All hard- and software components were individually developed and optimized during the last years, and are presented in this poster.

System Overview and Principle of Operation

The datalogger GEOLORE is designed for logging voltages over long time intervals typically for several months without service. All components were optimized for low power consumption, using modern microsystem technology. For easy upgrading or modification the system is devided up into separate units, each on a printed circuit board.



Blockdiagram of GEOLORE, the basic system is outlined, the options are dotted. Each printed circuit board is shaded grey.



GEOLORE: lake bottom (top) and standard version (left)

The datalogger is divided into two main units. The interaction between the units is controlled by the timer module. The timer and aquisition unit are powered continously. The power intensive components are operated temporally on demand. The timer module generates the sample clock and the power management signals to control the special designed DC/DC-converter. The input signals are digitized by a 24-bit ADC and are stored intermediately in the SRAM databuffer unit. When the buffer is filled (or on user request by a push button) the intelligent IDE-controller is switched on and the data are copied to the CF®-card. The IDE-controller is shutdown after the copy procedure.

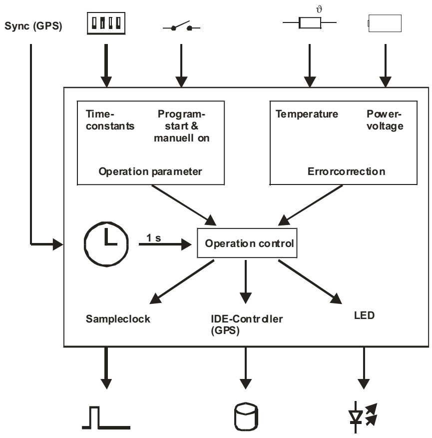
Addon 6 Input Channels

In the first experimental setup GEOLORE was equipped with a databuffer of 1 Mbyte and one ADC-board comprising three input channels. Because the 3-channel board was well approved and the RAM-chips of the first version of the databuffer are obsolete a new databuffer with 2 input connectors for 2 ADC-boards was designed. The buffersize, equipped with modern SMD-chips, has been extended to 2 Mbyte to avoid modifications in the timer system and keep interchangebility. Now GEOLORE can be equipped with one or two ADC-boards without configuration in firmware.

For a planned experiment in Iceland also a new active high impedance input and lowpass filter were designed.

New Timersystem

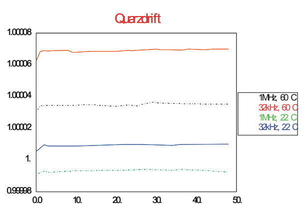
The sampleclock is generated by the microcontroller, including the temperature error compensation. The sample rate can be adjusted via a DIP-Switch in steps up to 8 Hz. The powerconsumption is proportional to the selected samplerate.



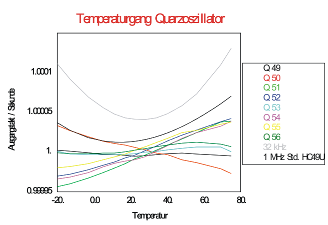
The timer is driven by an external crystal with a frequency of 32.768 kHz (for lowest power consumtion) or 1 MHz. The deviation from the nominal frequency results from three major items: **deviation from nominal** resonance frequency, temperature drift and long term stability. The first two parameters can be compensated by the timers firmware. The last one results from fabrication process [and can only be influenced by the manufactorer].

To enhance clock accuracy of two options are available. The standard crystal can be replaced by a special fabricated custom specific AT-cut crystal with higher accuracy and well defined minimum ageing (only with > 1 MHz available). The highest accuracy can be achieved by the external synchronization with an external high precision clock, e.g. a commercially available GPS-receiver, which is more power consuming. In our system the timebase is resynchronized periodically once an hour.

Intelligent crystal based Timebase



Ageing of a standard consumer crystals with 32kHz (tuning fork) and 1 Mhz (AT-cut). With high precision AT-cut crystal (fabricated by KVG) no ageing could be observed.



Drift versus temperature of typical (uncompensated) crystal oscillators

Interfacing external Devices

The CF®-card is connected to the system via the IDE-bus (known as a harddisk interface from PC's). The DOS-Filesystem FAT16, used in standard PC's, has been implemented to keep compatibility. The DOS code has been optimized in program (ROM) and working (RAM) space with respect to the limited resources of the microcontroller. The IDE-bus has been chosen to avoid changes in hardware for easy integration of new data devices also.

Disk Operating System

Up to now a filesystem based on the FAT16-structure is used for easy interchanging data. This filesystem is commonly used in PC-systems and allows the handling of datafiles up to 2 Gbyte. In the originay system the recording file had to be created prior to operation. This procedure was optimized by implementing a lean real disk operating system to establish easy handling of the system.

Tasks which create, write or delete FAT based data files, modify the directory entry or FAT. Therefore a RAM-memory with significant more then 512 Byte is needed, because sectors to be modified have to be buffered during the update process in the RAM. A higher sophisticated software system has been implemented with the new pin compatible microcontroller of type PIC18F252. The codesize, including the BIOS for interfacing the memory card, amounts to approximate by 10 kBytes. In the present system a new, unprepared CF®-card can be inserted and the system can be started for aquiring the data. The operating system can manage a filesize up to 2 Gbyte.

LC-Display

Optionally the network and GPS can be controlled by an LC-display.

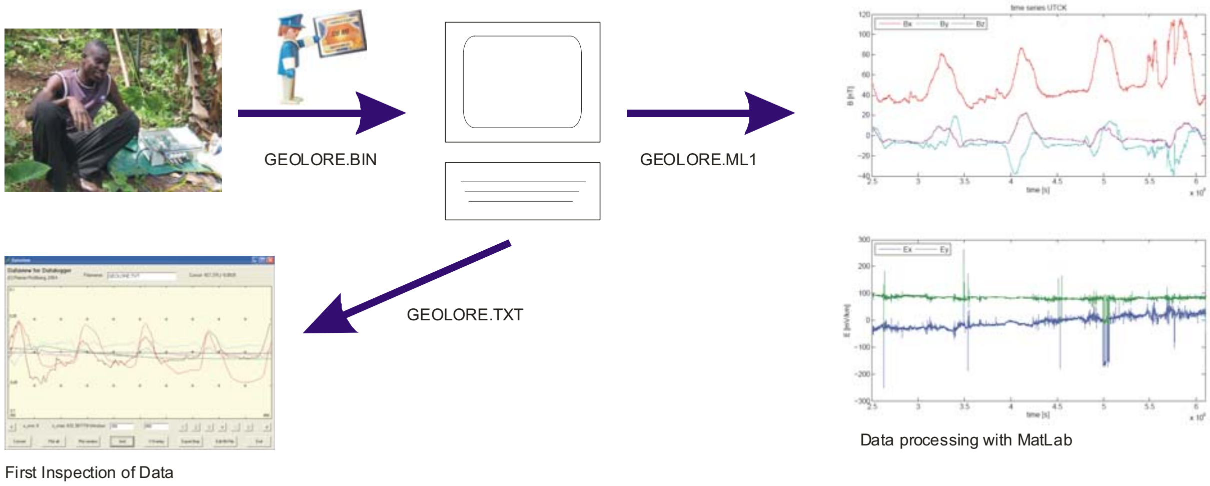
Network Interface

A network server, based on the ethernet and IP, has been added for remote monitoring. The most common IP protocols HTTP (for monitoring via standard browser) and TFTP (for bidirectional filetransfer) **are** implemented.

Application and Data Management

Longtime recordings produce large volume of data, typically binary filesizes of more then 500 Mbyte have to be managed. GEOLORE is designed to handle most of the software tasks with standard software packages, supplied by the modern operation system of standard personal computers. Interchanging of data can be done easily and rapidly with a standard USB-cardreader.

ADC-data are stored in a compact binary format. For first verifications of the recordings in the field a visualizing software tool DATAVIEW, running under Windows, has been programmed to check data quality in field. The software displays the complete recording without limits in size. Using a zoom function the recording can be studied in more detail.



Conclusion

With the integration of new functions the datalogger GEOLORE has been developed to a multifunctional easy to handle instrument. The system has been used successfully in various geological field campagnes for recording passive and active induced EM-fields and will be employed in future experiments. An add on for remote controlling is planed in the future.

Literature

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