

# Communications

## A Geological Data Logger

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**Abstract**—A novel data logger has been designed and tested for logging data from a satellite navigator, magnetometer, and a deep-sea echosounder. The logger exploits the interrupt structure of an in-house 8085 single-board computer (SBC) to service requests from the satellite navigator and real-time clock chip. The real-time clock interrupt forces the 8085 central processing unit (CPU) to fetch data from the magnetometer and echosounder at a user-selected interval. At present, up to four days of data can be stored on a single DC-100 tape cartridge. All recorded data are displayed on a dumb CRT terminal. The data-logging software is written in PLM/85—a higher level language for the 8085 microprocessor.

### I. INTRODUCTION

The design of the geological data logger was implemented in response to a requirement to log data from a satellite navigator, magnetometer, and a deep-sea echosounder installed on one of the Institute's research vessels. Typical geological oceanographic cruises extend over a period of 45 days, and it is therefore necessary to collect and store large amounts of routine data, which can be processed later when the ship returns to port.

User needs were taken into consideration at the outset, and the logger's specifications were drawn up as follows.

- a) Data logging software (stored in Read Only Memory (ROM)) needs to be implemented in a higher level language so that all future modifications can be introduced easily by the users.
- b) The logger should be able to intercept all incoming satellite data at any time, and be able to selectively sample magnetometer and echosounder data at a user-defined interval, e.g., 10 s.
- c) The logger should have no front panel controls so that it performs essentially as a remote recording device.
- d) A high-density tape storage device to record data requiring a minimum number of tape changes.

The description of the data logger is organized in three sections. The first section describes the data format of the three instruments interfaced to the logger, and the hardware details of the 8085 single-board processor. The second section briefly outlines the logger's software, and a concluding section discusses the merits of the system and modifications that will be introduced in the design after its first cruise performance.

### II. DATA FORMAT OF LOGGED EQUIPMENT

#### A. Satellite Navigator

The MX-1107 Dual Channel Satellite Navigator (Magnavox) receives signals from the TRANSIT satellites, and computes the latitude and longitude of the ship's position to within approximately

35 m, and Greenwich Mean Time (GMT) to within 1 s [1]. The navigator also dead reckons the ship's position based on inputs from the ship's speed and heading. Satellite fixes and dead reckoning are transmitted asynchronously to the logger through an RS-232 serial channel at baud rates from 75 to 600. Each serial burst of data contains a 266-character block displayed on the navigation console. It takes about 3 s to transfer navigation data to the logger at 600 Bd.

#### B. Magnetometer

The marine version of a Geometrics Proton Magnetometer was interfaced to the input/output (I/O) ports of the data logger. (The magnetometer is used in the mapping and exploration of underwater mineral ores having anomalous magnetic properties.) The magnetic-field intensity output (in gammas) of the magnetometer is in five-digit binary coded decimal (BCD) format [2]. The print command line of the interface updates the magnetometer output once every 3 or 6 s, but this was not used as the logger samples the magnetometer output on a real-time clock interrupts once every 10 s.

#### C. Deep-Sea Echosounder

As in the case of the magnetometer, the five-digit BCD output of a Deep Bathymetric System (Raytheon Ocean Systems) was directly connected to the I/O ports of the data logger [3]. At a typical depth of 5000 m, the data ports of the echosounder are updated every 8 s. The logger samples the echosounder output every 10 s without the need to check the data ready line.

### III. HARDWARE DESCRIPTION

Fig. 1 is a photograph of the geological data logger. The functional block diagram of the electronics is shown in Fig. 2.

The logger consists of an 8085 single-board computer (SBC) developed in-house for general purpose tasks, and a tape transport (Microdrive Model 125—Moya Corp.) which uses data cartridges to store data.

The SBC uses an Intel 8085 microprocessor running at 6.144 MHz. There is on-board provision for 6K EPROM and 2K RAM, or a jumper selectable option for 4K EPROM and 4K RAM. On-board decoding logic provides two RS-232 serial ports (Intel 8251), two parallel I/O ports (Intel 8255), a real-time clock chip (MM 58167A), and six extra decoded outputs for future expansion to other memory and I/O devices. As shown in Fig. 2, the RST 7.5 pin on the CPU connects directly to the RxRDY pin of the 8251 USART receiving satellite navigator data, while the RST 6.5 pin connects directly to the interrupt output pin of the real-time clock (MM 58167A).

The parallel I/O ports on the SBC interface directly to the BCD lines from the magnetometer and echosounder. The serial port receiving satellite data is also used for displaying recorded data on a CRT terminal, while the other serial port is used exclusively for the Microdrive tape transport.

The Microdrive tape transport used here is capable of reading or writing data at a recording density of 1600 bit/in on two tracks of a standard 3M DC-100 tape cartridge. An RS-232 I/O card support accessory on the tape transport allows it to communicate with the 8085 SBC at fixed baud rates of 2300, 4800, 9600, or 19.2 K. The tape storage capacity of 1.344 megabytes makes it possible to record

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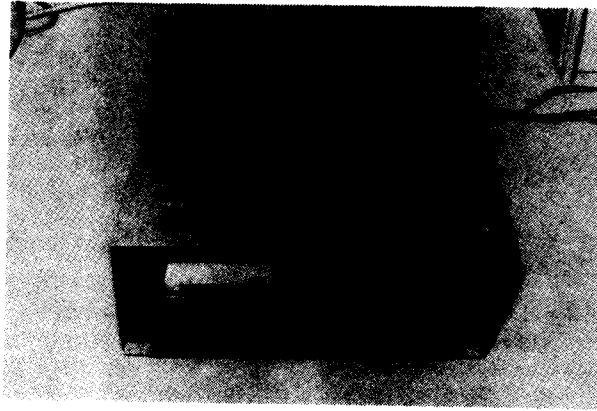


Fig. 1. Photograph of the geological data logger.

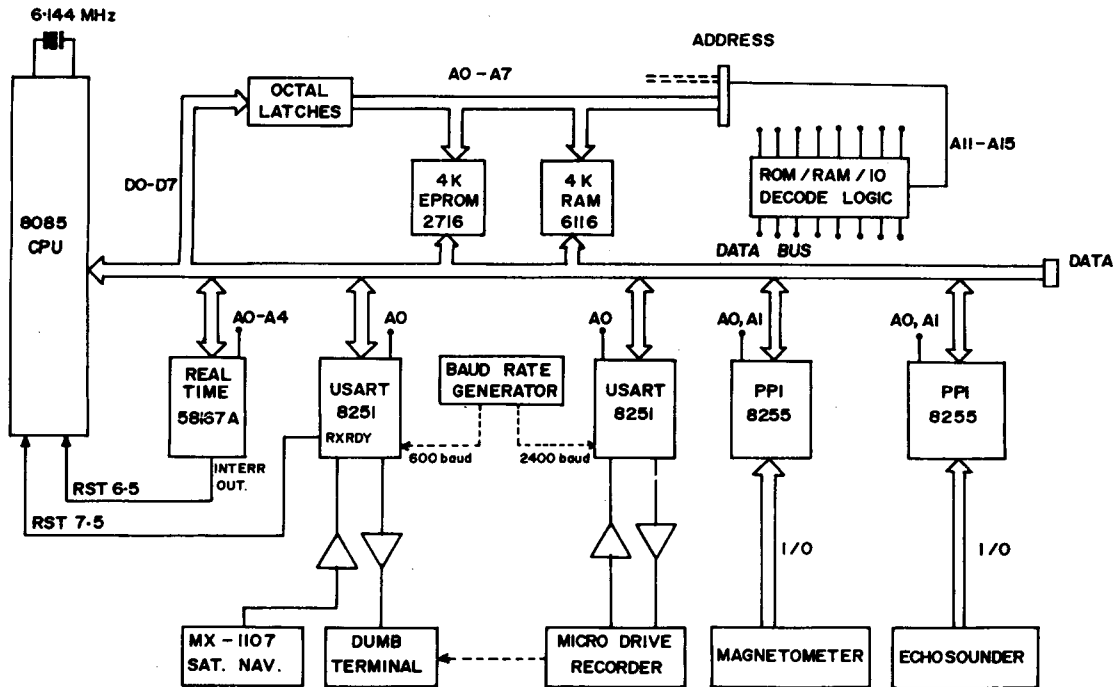


Fig. 2. SBC 8085 board of the data logger.

approximately eight days of data assuming that the satellite navigator interrupts the logger every 10 min and the magnetometer and echosounder ports are sampled every 10 s.

IV. SOFTWARE DESCRIPTION

The data logging software was written in PLM/85 and 8085 Assembly Language on an Intel Microprocessor Development System (MDS). A flow chart of the main PLM program summarizes the flow in Fig. 3. The essential functions are the following.

a) On power-up, I/O ports are initialized, memory and interrupt pointers are set, and system interrupts are enabled. A 1024-byte buffer (partitioned into two 512-byte half-buffers) is allocated for storing data from external devices.

b) The main program copies magnetometer and echosounder outputs from two 6-byte memory locations into a 512-byte buffer after the interrupt routines for these devices are serviced upon an RST 6.5 interrupt from the 10-s real-time clock. The half-buffer flag is set true if it is filled with data.

c) As in step b), the main program copies data from a separate 266-byte buffer containing satellite navigator data to an empty 512-byte buffer.

d) When either one of the half-buffers is full, the main program writes the buffer data onto cartridge tape. After writing to tape, the buffer status is set to false so that it can be used again.

The real-time clock interrupt procedure, on power-on, programs the real-time clock to interrupt the CPU every 10 s on the RST 6.5 interrupt line. Subsequent RST 6.5 interrupts call the magnetometer and echosounder routines to read five-digit BCD data from the I/O ports. Retrieved data are stored in ASCII format.

The satellite navigator interrupt procedure is executed on an RST 7.5 interrupt generated by the 8251 USART on its RxRDY line (see Fig. 2). This procedure works on a character-by-character basis. As each ASCII character of the satellite message is ready for retrieval, the RxRDY line interrupts the CPU. All 266 characters of the satellite data block are accessed by the main program on a buffer-full indication.

In order to simplify data processing of recorded data, each data value is identified by a tag. The tags +, -, and \* identify echosounder, magnetometer, and satellite data, respectively. The tagging of data is done within the interrupt procedures.

A sample plot of processed data taken over a survey line is shown in Fig. 4 from a test cruise of two days. Plotted outputs are

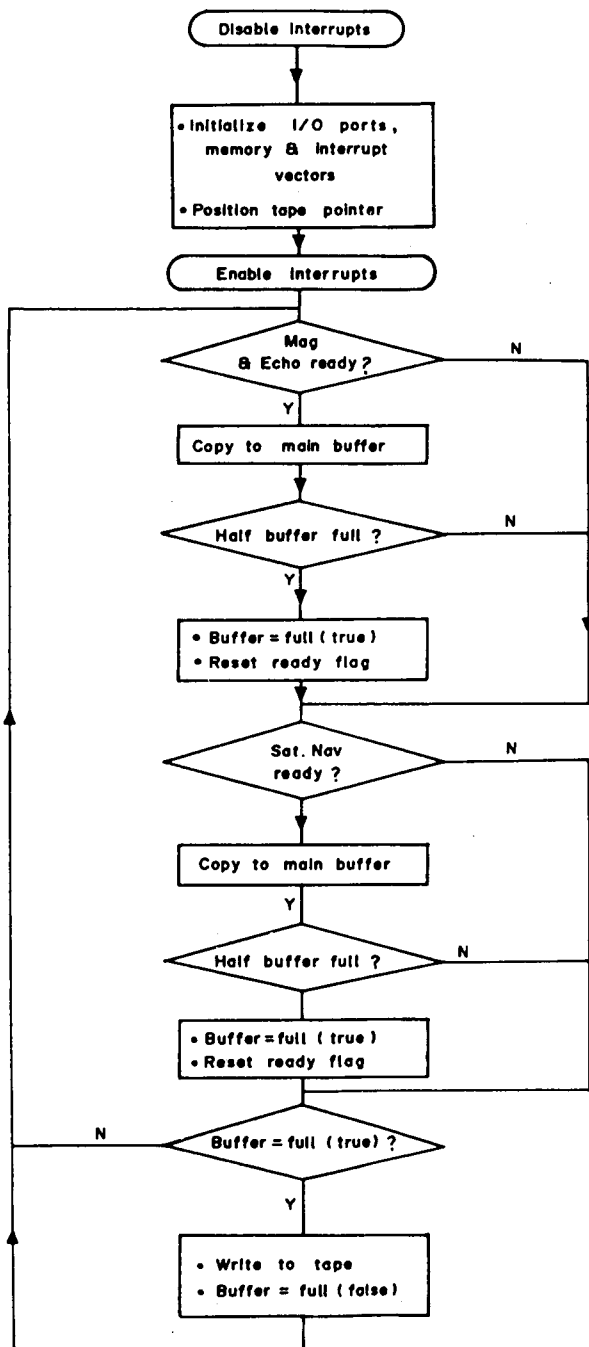


Fig. 3. PLM/85 main program flow diagram.

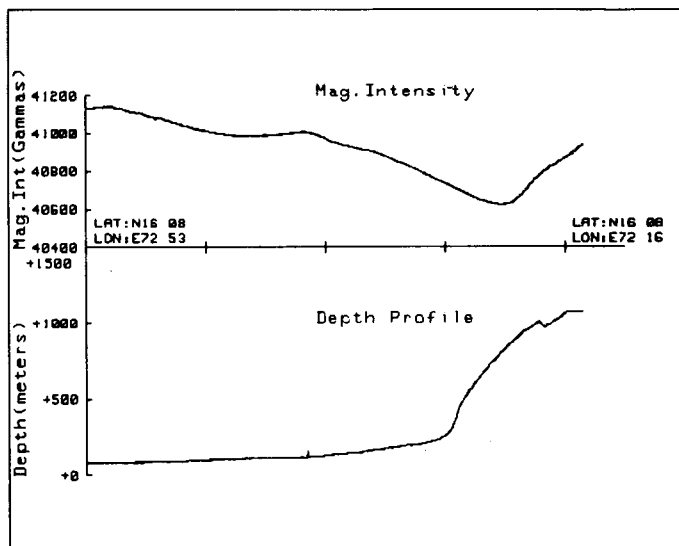


Fig. 4. Sample plot of data stored by the logger.

conveniently obtained by connecting the tape transport to an HP9845 desktop computer (or any personal computer) running on a simple BASIC program written for this purpose.

### V. CONCLUSIONS

A description of a geological data logger using the interrupt structure of the 8085 microprocessor has been given in this paper. User needs were taken into account before implementing the final design of the data logger. The combination of an expandable general purpose 8085 SBC, CPU interrupts, PLM programming, and a versatile tape transport has simplified both the hardware and software aspects of the design. The logger is capable of logging an additional device by using the RST 5.5 interrupt with minor hardware changes. The technique to handle several devices can be easily implemented by using the Intel 8259 Interrupt Controller and associated software.

At its present stage, two simple modifications will be introduced to increase the usefulness of the instrument.

a) The Microdrive tape transport is capable of controlling up to two tape recorders with no additional hardware. By writing on both tracks of the tape cartridge (presently data is written on one track only), tape changes can be reduced to once every 16 days.

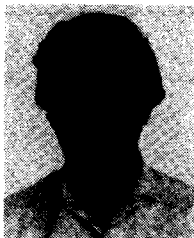
b) A minor change in the software will be made to synchronize the real-time clock to the GMT value updated by the satellite navigator. In this way, data will be logged as a function of real time.

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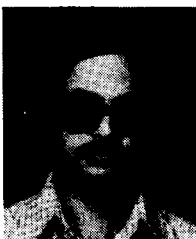
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