

Multichannel Ship-Borne Digitizer System

This paper describes the design and performance of a microprocessor based ship borne multichannel digitizer, for use during oceanographic cruises. Besides its general purpose digitizing features the system software includes programs for acquiring data from ship-borne instruments such as waverecorder and the CTD (conductivity, temperature and depth) profiling system. The instrument has a keypad and display for digitization control and entry of header information. The digitized data can be stored on 12.7 mm magnetic tape or paper tape in a computer compatible format. A numeric printer interface is also provided.

THE EIGHT CHANNEL digitizer was designed mainly to digitize and store voluminous data from ship-borne instruments during long oceanographic cruises. Many of these instruments like the Waverecorder (used to record ocean wave height) and the CTD profiling system (used to record conductivity and temperature along with depth as the instrument is lowered in the sea) are provided with analog outputs and require continuous digitization during long operations on sea thus generating large amounts of data. Storage of digitized data on 12.7 mm magnetic tape and paper tape allows its economical storage. The use of keypad and display allows header information storage such as day, date, station number, ship position, sampling interval and thus data can be easily identified during computer processing. The printer interface facility to the digitizer allows an operator check on the digitizing process. The system description, software details and system operation are given in the following sections.

SYSTEM DESCRIPTION

The digitizer can be interfaced to any one of the following peripherals for storing the digitized data. These are (i) 12.7 mm Kennedy Magnetic Incremental Recorder, Model 1600, 800 bpi and 25 ips. (ii) Facit Paper Tape Punch (iii) 18-column numeric digital printer. The ship-borne digitizer is designed around the Intel 8-bit 8085 microprocessor single board computer (SBC) running at 2MHz. The other hardware functional parts are the 8-channel A/D converter circuit, the keypad/display circuit and the power supply. A simplified hardware system block diagram is shown in Fig 1. The SBC contains 6K EPROM memory, 1K RAM (random access memory) and two parallel I/O ports (Intel 8255).

The analog-to-digital (A/D) converter card uses a fast 12-bit ADC80 Burr Brown A/D converter. An 8-channel analog multiplexer and a monostable for initiating the conversion are also provided. The keypad/display card is based on the Intel 8279 programmable keypad/display controller for control of the keypad and display operation. A 24 key, keypad and an 8 digit LED display are provided on the card. The power circuitry on the digitizer provides $\pm 5V$, $\pm 15V$ and $-15V$ to the electronic circuitry from the 230 V a.c mains.

The Kennedy recorder interface to the SBC 8255 I/O port consists of the recorder data and control lines consisting of the Ready, Gap in process, Write command, End of record mark, End of file mark and the error status lines [1]. The Facit tape punch interface to the digitizer utilizes seven tape punch data lines and control lines consisting of the ready and the punch command line. The Numeric printer interface consists of sixteen data lines and a print control line to initiate printing.

SOFTWARE DESCRIPTION

The software is written in 8085 assembly language on the Intel microprocessor development system (MDS) and is modular in structure.

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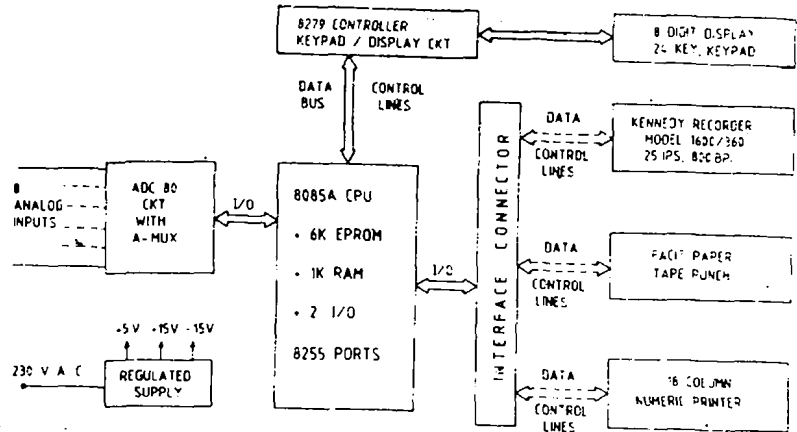


Fig 1 System block diagram

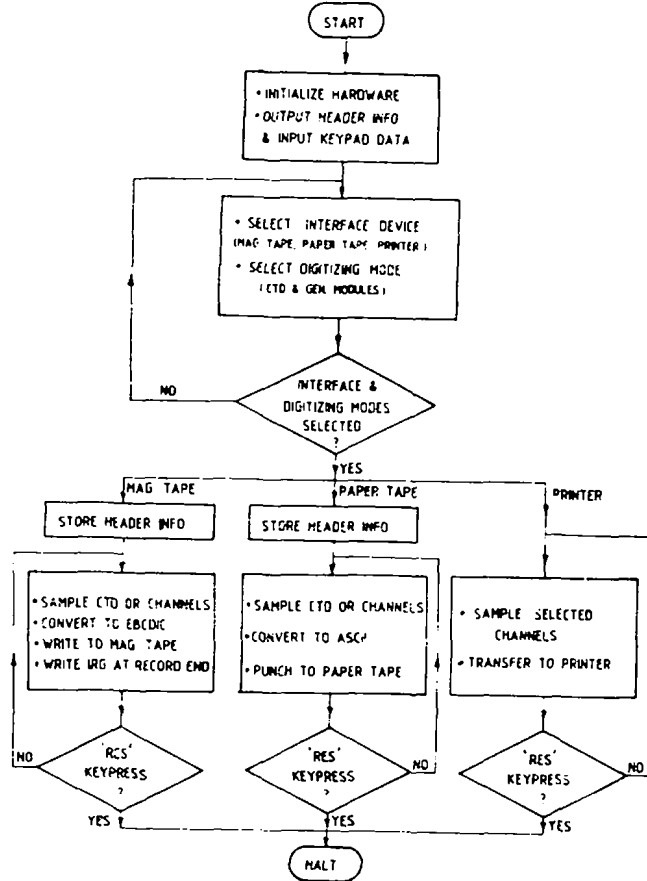


Fig 2 Simplified system flow diagram

The simplified system flow diagram is shown in Fig 2. After system initialization on power-up the program outputs sequentially header information on the display and waits for data entry from the keypad which is also displayed and stored in memory. A look-up table is used for decoding the BCD and special characters to seven

segment display. The CTD, the general digitization and the interface data transfer modules are also selected through the keypad.

The CTD program module is written to digitize the analog signals from the ship-borne CTD profiling system. Here the conductivity and temperature channels are sampled only after a two-bit difference is detected (approximately equal to one meter depth difference) between the successive sampling of the depth channel. A magnetic tape transfer routine is called if data is to be stored on 12.7 mm magnetic tape. The digitized binary data has to be converted to EBCDIC format before the transfer. The data transfer to the Kennedy recorder is fast and does not affect the sampling rate. For storing the data on paper tape, the binary data is converted to ASCII and then punched on the paper tape.

The general module written is also used to record data from the waverecorder. Here different sampling intervals and analog channels can be selected through the keypad for digitization. After selecting the output interface device for data storage, the program starts digitizing and data is transferred to either the 12.7 mm magnetic tape, the paper tape or the numeric printer. The eight analog channels can also be sampled sequentially. Pressing the 'res' key stops the data acquisition.

The magnetic tape transfer routine [1] used, transfers digitized data that is in EBCDIC to 12.7 mm magnetic tape in a computer compatible format. The tape punch routine is written to transfer the digitized ASCII data to paper tape. The Ready line of the Tape punch is monitored, and if high, a punch command is given to punch the data present on data lines to the paper tape. In the printer routine, the ready status of the printer is monitored and if high, the digital data in BCD format is output to the printer which prints the data after a print command.

SYSTEM OPERATION AND DATA PROCESSING

On ship-borne operation, the Digitizer is normally connected to either the wave recorder or the CTD profiling system. The Digitizer is set up for the appropriate input voltage range through a DIL switch provided on the A/D card. After selecting the medium for storing the digitized data, either the Kennedy recorder, the Facit paper punch or the printer is connected to the Digitizer using the appropriate interface connector provided. Also the 1/2 inch magnetic tape or the paper tape has to be appropriately loaded and the system kept ready. On switching on the Digitizer, header information appears and appropriate data is entered through the keypad. Special keys are marked

on the keypad for selecting the different digitizing modes of operation. After entering all the information prompted through the display, the digitizing and data transfer process starts. It can be stopped by pressing the 'res' key.

Since the digitized data is stored in a computer compatible medium, it can be directly taken to the main computer for processing. Hence a requirement for pre-processing of the data was not felt. Important parameters for oceanographic studies are derived from the processed waverecorder and CTD data.

From the wave records obtained from the ship-borne waverecorder, wave parameters like the significant, mean and maximum wave height, wave periods, wavelength are obtained and these are subjected to statistical analysis. Also the spectral density profiles of waves are computed from this data.

Significant ocean parameters are obtained from the processed CTD data collected. Conductivity is the capacity of seawater to transmit electric currents and its measurements along with temperature help to determine the salinity of seawater. Temperature varies widely in different parts of the ocean and also at different depths. From the processed data thermocline profiles are identified. This is extremely useful in knowing the behaviour of sound travel in the ocean.

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