UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

A hybrid microcomputer system for geological investigations

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ABSTRACT

The Hybrid S-100 is a medium-sized microcomputer utilizing 64K bytes of memory and an IEEE-696(S-100) bus. It can be configured and used for a variety of computing applications in geological research.

Five applications of the Hybrid S-100 are described:laboratory automation, process control, data inventory, field data reduction, and word processing.

Experience has shown that the Hybrid S-100 is a flexible device useful for many applications. A list of system components and vendors and photographs of a transportable Hybrid S-100 are presented.

INTRODUCTION

Geological investigations require computing support in three fundamental domains: the field, the laboratory, and the office. Typically a geologic project uses computers in at least two of these domains. Although the role of the microcomputer may differ with each application, recent advances in microcomputers have made them a valuable tool in each of these domains.

Microcomputers are very appealing because of their lower cost, portability, and ease of use compared with larger main-frame systems. Consequently, increasing numbers of microcomputers are finding their way into earth science applications.

This report describes a microcomputer system equipped with generally accepted standard accessories including floppy-disc drives, magnetic tape drive, printer, and terminal. This system, called the "Hybrid S-100", has been applied to geologic projects in the field, laboratory, and office.

The Hybrid S-100 has replaced an obsolete minicomputer as the off-line controller of a high-resolution rotating-drum micro-densitometer used in image analysis.

Because the physical location of the Branch Data Library makes direct-line access to the Branch multi-user system impractical, a Hybrid S-100 is used there for word-processing and data storage and retrieval.

In the sediment analysis laboratory, the Hybrid S-100 controls the flow of data from the analytical devices to the appropriate database, which is maintained in the main Branch multi-user system.

A Hybrid S-100 is being used aboard ship to display data as they are recovered from submersible ocean bottom data-capture

devices, permitting modification and refinement of subsequent device deployments.

The Hybrid S-100 is used on various Branch projects to prepare manuscripts and encode programs.

A wide range of S-100 compatible components is available, and can be integrated as needed into the system. Once in use, the S-100 is a reliable, simple and dependable system.

To assist those who might decide to pursue a similar endeavor, basic system features and brief descriptions of some typical applications are presented. A list of vendors and component parts is provided in Appendix II.

OVERVIEW

For applications discussed in this report, the Hybrid S-100 is a single user system that employs an 8-bit microprocessor. The nucleus of this system is a Z80 Central Processing Unit (CPU) complimented with 64K bytes of memory and various peripheral devices. Internally, an IEEE-696 (S-100) bus is used to interconnect the controllers of the peripheral components with the CPU and power supply. Major peripheral components, on separate circuit boards that plug into the S-100 bus, include a 9-track tape driver and an analogue-to-digital (A/D) converter. Peripherals connected directly to the Z80 computer board include two 8-inch floppy-disc drives, a printer, and a cathode ray tube (CRT) terminal. When portability is required, the Hybrid S-100 chassis, together with power supply and floppy-disc drives and 9-track tape drive, is housed in a shock-mounted rack in a hard fibreboard case fitted with four casters. Not included in the case are the terminal and printer, which are transported separately.

The S-100 bus was chosen for two principle reasons: 1) the ability to expand, change, and otherwise provide a dynamic system and 2) the wide selection (hundreds of boards) of modules available for the S-100 bus. The bus itself is merely a standardized medium by which component parts can communicate. The bus provides a means for power distribution and consists of a series of integrated connector sockets for insertion of circuit boards. These circuit boards are the functional parts of the system and they can perform a wide variety of tasks such as containing the CPU, memory, and peripheral interfacing. Indeed, the S-100 can consist of only one such board (which contains a microprocessor, memory, and some peripheral ports), or it can consist of more than 20 circuit boards, each capable of performing tasks that rival the capabilities of minicomputers.

The principal point to be made here is that a bus-structured system such as the S-100 can be tailored to the needs of the application without overkilling the job with unnecessary equipment or sacrificing real needs because of the lack of expansion capability.

The major disadvantage of bus systems like the S-100 is the burden placed on the end user to have the available expertise in both hardware and software with which to effectively assemble and maintain a viable system. A good working knowledge of digital electronics (and occasionally, analog) is required not only to resolve occasional bus interface problems, but also to interface the bus circuit boards with external devices. In addition, all S-100 boards are not created equal, and the user must be careful to ensure that components will interface properly on the bus before acquisition. Even though the Institute of Electrical and Electronic Engineering (IEEE) standards have done much to alleviate common S-100 interface problems, some still exist. After successful electrical interfacing, the specialized software needed to control the components on the bus is often complex. It may require a considerable knowledge, of not only the operating system and assembly language programming, but also of the peculiarities of the physical devices. Although some manufacturers provide software to be employed with their S-100 circuit boards, this cannot be taken for granted nor can the user be confident that the software supplied is appropriate to his task.

DESCRIPTION OF COMPONENTS

It is commonly accepted that the best computer hardware is useless without appropriate software to drive the system and serve the user. In general, it is wise to utilize software that is as close to accepted standards as possible. Therefore, we selected the 8-bit CP/M operating system with C as the principal programming language, the WORDSTAR word-processing program, dBASEII data-base management system, and a number of in-house and proprietary utility programs. The tape drives are driven through a series of in-house, C-language programs required by specific applications. At present, the equipment discussed in the following paragraphs is entirely operational.

Central Processing Unit

The CPU is a Teletek Systemaster Z80 (8-bit) microcomputer. The microcomputer and 64K bytes of memory occupy a single board which was designed for an S-100 bus. This board is a complete stand-alone computing system; it has two RS-232 serial ports and two parallel ports. It contains circuitry to drive either 8-inch or 5-inch floppy disc drives, or a mixture of both. This board (with software, printer and terminal) can function as a stand-alone word processor or even as a programming-development tool (again, with appropriate software).

Disc Drives

Two Qume DT-8 floppy-disc drives were installed in the Hybrid S-100. Eight-inch floppy-disc drives were chosen because of the broad selection of standard software available on 8-inch single-sided, single-density, floppy discs. These discs which are format-standardized to a much greater extent than are other floppy disc systems, can be used as a primary data and program dissemination (interchange) medium. The Qume drives are capable of reading both the standard single-sided discs and double-sided double-density discs.

Tape Drive

The Cipher F880X 9-track tape drive was chosen as the most desirable tape drive for this system because it generates tapes that can be read by any other computer (including large main-frame CPU's) using American National Standard Institute (ANSI) compatibility. It is a compact, horizontal, front-loading, self-threading device that can be rack-mounted and included in the transportable fibreboard case discussed later.

The tape controller is an Alloy ITS-100 (S-100 board) that is completely contained on one printed circuit board. The convenience of this interface greatly influenced the selection of this tape drive.

Chassis

The chassis of the hybrid computer is an Integrand 800RV/7, complete with power supply and S-100 bus. It provides for our current and anticipated needs, in this present application, of up to seven circuit boards. If required, other chassis configurations can be selected with as many 20 positions.

Terminal

The choice of terminal is the least critical decision made for system components. For simplicity and price, we selected a Televideo 910 terminal (CRT) with optional speeds up to 19.2M baud. This non-printing terminal can be configured for many programming applications (e.g., special key commands for word processing), and past experience has shown it to be acceptably durable and reliable.

Printer

An Epson RX-80 printer, equipped with a 2K buffer and an RS-232 serial interface, was added to the system. This provides dot-matrix impact output on 9-1/2" perforated paper.

Rack and Case

To contain the basic components of the system we designed a case that contained a foam-insulated, industry standard 19-inch rack. The case has removable front and back panels, and is fitted with four casters for mobility. The case was built by ATS Cases, Inc.

APPLICATIONS

The U.S. Geological Survey's Branch of Atlantic Marine Geology requires a full range of scientific computing for the broad spectrum of marine geologic projects that are generally in process. Most of the computing is carried out on in-house multi-user systems. There are, however, a few applications that are particularly well suited to the Hybrid S-100. These include laboratory automation, process control, data inventory, field-data reduction, and word processing.

Laboratory Automation

The sediment analysis laboratory performs grain size analyses on samples collected from the many regions surveyed by the Branch. Both a multichannel particle counter and a rapid sediment analyzer are used to determine the desired range of grain sizes in each sample. The particle counter outputs digital data directly into the Hybrid S-100. The rapid sediment analyzer generates voltages that are fed directly to an A/D converter S-100 board mounted in the Hybrid system. The digital data are then reduced and formatted for direct remote entry in the larger multi-user computer system that hosts the sediment analysis data base. The operator executes a telecommunications program, which allows him to link with the data-base host. He then transmits the data to the host machine, where the data are merged with an existing data base and further processing is performed.

The unique aspects of this application are: (1) the incorporation of an S-100 compatible analogue-to-digital converter as a peripheral device; (2) that data are reduced and reformatted; and (3) that by using a tele-communications program, the S-100 computer is used as a terminal for remote data entry to a host computer. Basic and C were the principal programming languages used for generating the necessary applications programs.

Process Control

One of the devices used in the analysis of image data is a high-resolution rotating-drum microdensitometer. In the past, the device was driven by a minicomputer for which neither spares nor support are now available. Rather than drive the device from a valuable port in our large system, we chose to drive the device with the Hybrid S-100. In this way the microdensitometer is a stand-alone device that will not interfere with other Branch

processing and unnecessarily occupy an I/O port on a busy system. Z-80 Assembler and C are the principal programming languages used.

Data Inventory

The Branch data library is situated such that a direct line to the principal Branch computer system is impractical. Further, only a few programs are needed to support the data-library activity. Because of this, and given the highly specific nature of the application, the S-100 was selected as the principal support computer for data-inventory processing within the Branch. This application further reduces the workload on the main system and provides dedicated support for the library, utilizing principally dBASEII and WORDSTAR.

Field Data Reduction

Most Branch data are collected at sea. Some of the data-capture devices, mounted in watertight recoverable containers, are designed to sit on the ocean bottom and record data on internal magnetic-tape cartridges. After recovery, some mechanism is required to immediately play-back and partially reduce the collected data so that the scientist-in-charge can determine parameters for subsequent deployments.

The Hybrid S-100, interfaced to a peripheral drum plotter and cartridge reader and utilizing an Alloy Engineering Co. S-100 interface card, was selected to perform the task of shipboard play-back and reduction. The system has been successfully tested in the laboratory, and at-sea testing will be undertaken in the near future. This application was programmed primarily in C language with some Z-80 assembler language.

Word Processing

This application has become popular with the programming and scientific staff for composing and editing letters, reports, and draft scientific manuscripts. It is also used to examine acquired data and to generate source code during application-program generation. Although word-processing programs are widely available for all classes of large and small computers, the personal aspects of the microcomputer seem to have universal appeal. Thus, when data are not being processed, the S-100 may be used to prepare a manuscript or encode a program. Word processing is usually done with WORDSTAR.

CONCLUSIONS

The Hybrid S-100 is a valuable single-user computing supplement to the multi-user computing systems that handle the bulk of in-house computing in a geologic research organization.

The Hybrid S-100 requires the availability of a person knowledgeable in digital electronics, particularly when the intended use involves a variety of S-100-compatible peripherals. Portability is one of the key factors in the utility of the Hybrid S-100, as is its flexibility of configuration, which makes it viable for many applications.

Appendix I

Photos showing various aspects of the configuration of a portable Hybrid S-100

Figure 1. Completely enclosed Hybrid S-100 prepared for shipment. Terminal and printer are shipped in separate cases.

Figure 2. Complete Hybrid S-100 ready for operation. Note the foam padding around the equipment rack.

Figure 3. Hybrid S-100, rear view, showing cables and ports.

Figure 4. Hybrid S-100 CPU chassis removed from fibre-board case. Floppy-disc drives are integral to the chassis.

Figure 5. Hybrid S-100, inner view, showing (A) power supply, (B) disc drives, and (C) slots for peripherals.

Figure 6. Hybrid S-100 showing tape drive open and in service position. A reel of tape is shown in loaded position. Tape is loaded through access door on front panel. Threading is automatic.

APPENDIX I

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Fig. 2

Fig. 3

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Fig. 4

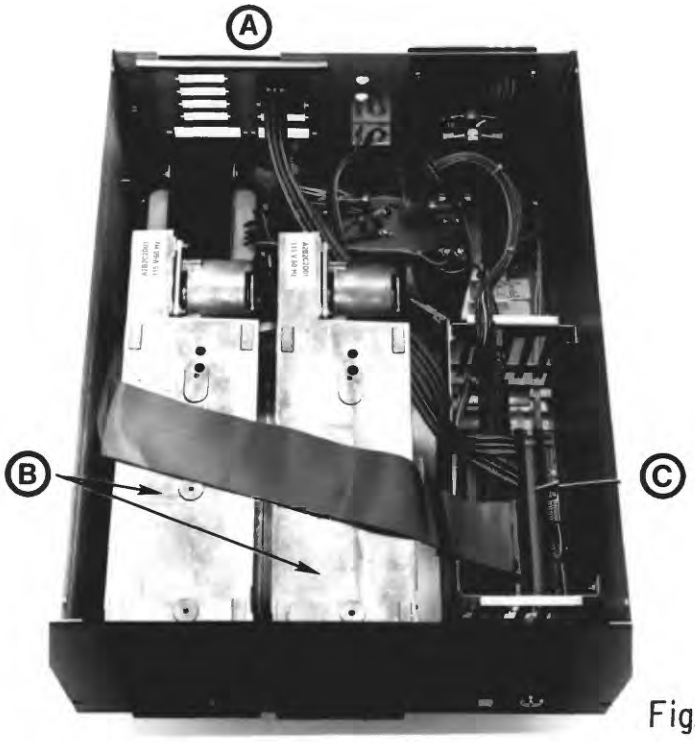

Fig. 5

Fig. 6

Figure 4.--Hybrid S-100 CPU chassis disc drives are integral to the chassis.

Figure 5.--Hybrid S-100, inner view, showing (A) power supply, (B) disc drives, and (C) slots for peripherals.

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Appendix II

HYBRID S-100 MICROCOMUTER: LIST OF COMPONENTS.

CPU	Teletek 4600 Pell Drive Sacramento, Ca. 95838 (916) 920-4600
Chassis	Integrand 8620 Roosevelt Ave. Visalia, Ca 93291 (209) 651-1203
Disc drive	Qume Corporation 2350g Qume Drive San Jose, Ca 95131 (408) 942-4000
Tape drive	Cipher Data Products, Inc. 10225 Willow Creek Road San Diago, Ca 92138 (619) 578-9100
Tape interface	Alloy Engineering, Inc. 100 Pennsylvania Ave. Framingham, Ma 01701 (617) 875-6100
Terminal	Televideo Systems,Inc. 1170 Morse Avenue Sunnyvale, Ca 94086 (408) 745-7760
Printer	Epson America, Inc. 3415 Kashiwa Street Torrance, Ca 90505 (213) 539-9140
Rack and case	ATS Cases, Inc. 25 Washington Street Natick, Ma 01760 (617) 653-6724
Modem	Hayes Microcomputer Products, Inc. 5923 Peachtree Industrial Blvd. Norcross, GA 30092 (404) 441-1617

Software	Vendor
dBASEII	Ashton-Tate 10150 West Jefferson Boulevard Culver City, Ca 90230 (800) 437-4329
WORDSTAR	Micropro International Corp. 33 San Pablo Ave. San Rafael, Ca 94903 (415) 499-1200