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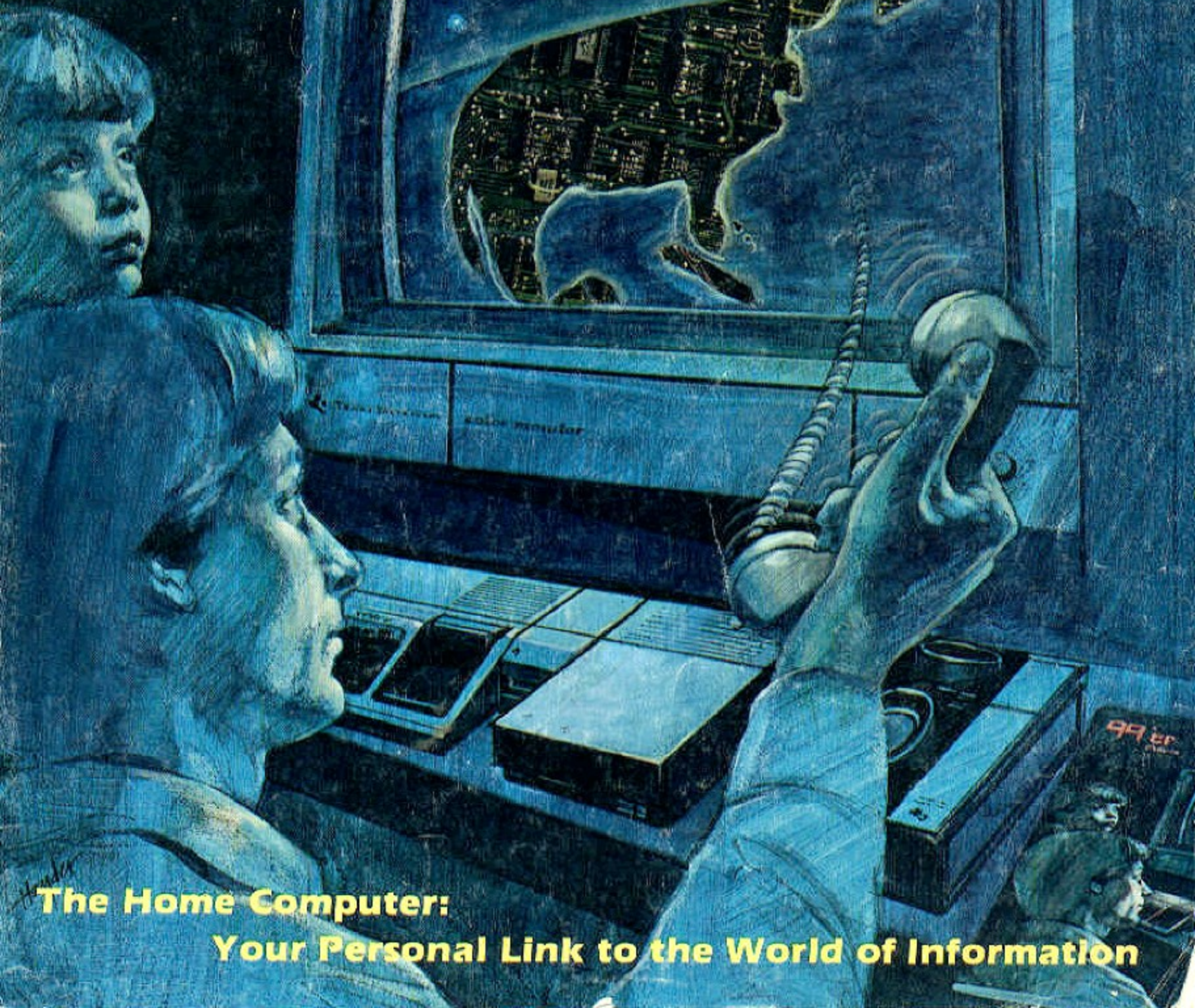
July/August 1981 Vol. 1, No. 2

For Users of the
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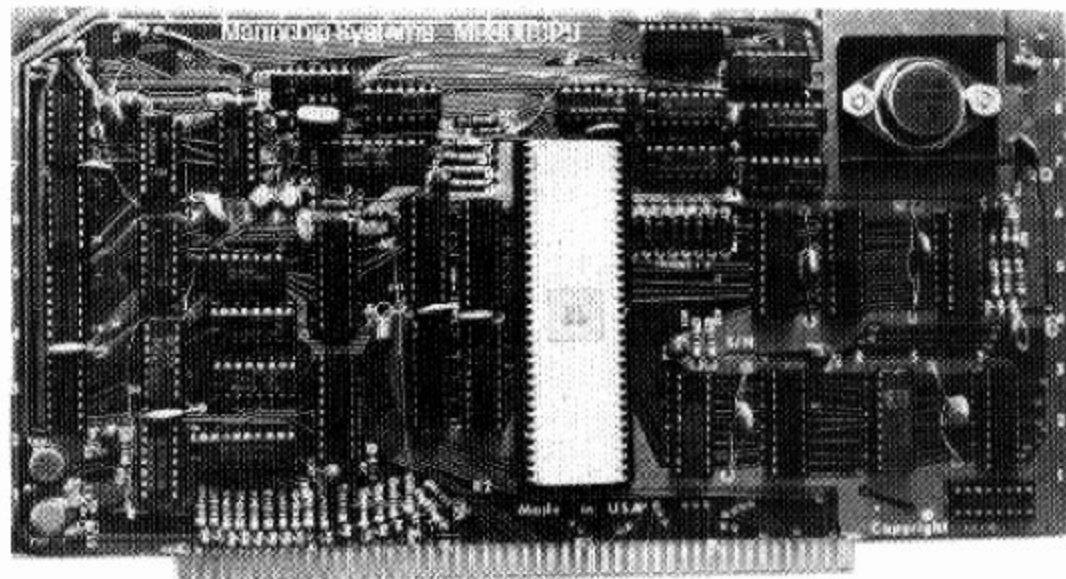
TI Unveils New Micro



**The Home Computer:
Your Personal Link to the World of Information**

AN INTRODUCTION TO THE MARINCHIP SYSTEMS M9900

By Duff Kurland



The Marinchip System M9900 CPU Board.
Notice the large TMS9900 16-bit microprocessor in the center.

What? Another 16-bit TMS9900-based personal computer system? You mean the TI-99/4 actually has company out there in the predominantly 8-bit micro world — a close relative who shares the same powerful instruction set and architecture in a landscape infested with the likes of Z80s, 6800s, and 6502s? Rejoice '99'ers. . . you are not alone. Welcome your California cousin, the Marinchip Systems M9900. Despite little publicity since its introduction in the spring of 1978, the M9900 has attracted many enthusiastic users. Marinchip's system is built around the 16-bit Texas Instruments TMS9900 microprocessor — the same chip used in the TI-99/4. Beyond that, however, the two computers differ dramatically. This article will serve as an introduction to the M9900 hardware and software. Future articles will explore specific programs and applications in greater depth.

We at *99'er Magazine* would like to take this opportunity to welcome M9900 users into our "99'er Family," and hope that you'll actively contribute

About the Author

Duff Kurland is a senior systems programmer for a computer service bureau, and has had eleven years of experience on large Sperry Univac computers. Having chosen computers as his hobby as well, Duff has assisted in the development of some of the Marinchip Systems software.

by submitting your tips, suggestions, and articles to us. [And as TMS9900 assembly language programming becomes readily available to TI-99/4 users with a soon-to-be-released assembler Command Module, there will be more in common, and more resource sharing between the two user communities — Ed.]

The S100 Bus

Unlike the portable, self-contained TI-99/4, the M9900 system consists of several circuit boards which plug into slots in an S100 mainframe. A video terminal is usually employed as the system console, and since Marinchip's software relies heavily on disk storage, a pair of 8-inch floppy disk drives rounds out the basic system.

The S100 bus was the first widely accepted microcomputer bus standard, and sports a broad range of compatible circuit boards from a multitude of vendors. The M9900 thus offers the 16-bit power of the TMS9900 CPU chip, along with the flexibility of the S100 bus — a combination that's hard to beat.

Flexibility? Attach a letter-quality printer, and you've got a word processing system. Connect a high-speed dot matrix printer, and you've got a small business system. Or connect a digitizer

and a color graphics display, and you've got an electronic or architectural design system. Or perhaps you're into computer music, speech synthesis, software development, household security, environmental control, or all of the above. It's quite conceivable for one S100 system to be equipped to do *all* these things and more.

With the TI-99/4 system, expansion is presently limited to 48K RAM, three 90K mini-disk drives, and two RS-232 ports. The M9900 system, however, has oodles of expansion room. You can have additional banks of 64K RAM for a multi-user system, have several serial peripherals connected at the same time, and even connect a multi-megabyte hard disk. But expandability isn't the only difference. Although both are based on the TMS9900 chip, the TI-99/4 and the M9900 have vastly different operating systems: Programs designed for one will *not* run on the other unless the differences in system calls and disk storage formats are taken into consideration, and conversion utilities provided.

Hardware

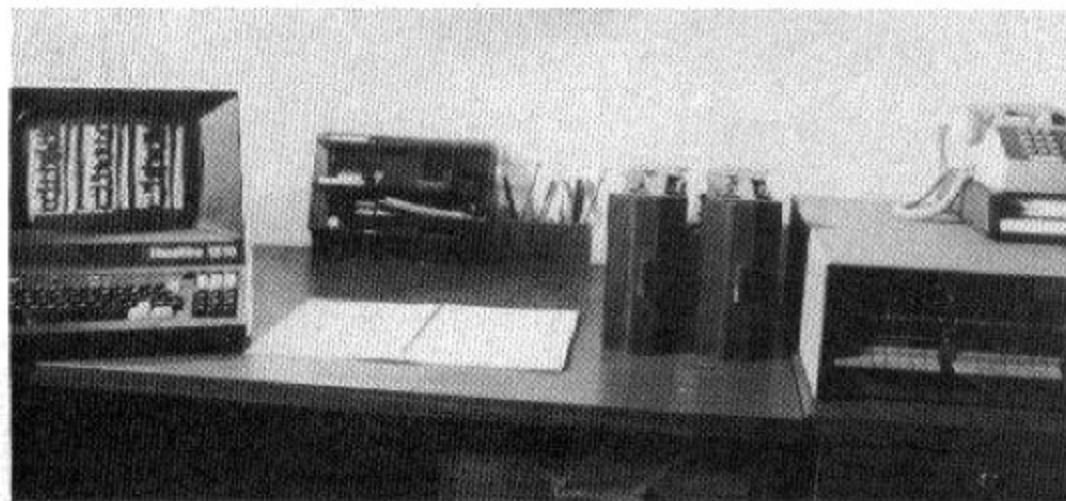
Marinchip Systems manufactures the boards which comprise the heart of the M9900 system, and recommends the products of various other vendors for other functions. A typical M9900 system includes the following Marinchip hardware:

- one M9900 CPU board
- one PROM/RAM board
- one or more 64K RAM boards
- QUAD SIO board (optional)

These boards are assembled, tested, and burned in at the factory, and are supplied with "Theory of Operation" manuals. Also, Marinchip is one of the few manufacturers to provide schematics for their hardware products.

To complete a basic system you'll need:

- a video or printer terminal
- two 8-inch floppy disk drives
- a disk controller board
- an S100 mainframe
- a printer (optional)



The author's system. The printer is not shown.

All items are available through Marinchip Systems, or can be purchased directly from other manufacturers or dealers. Let's take a quick look at each of the Marinchip circuit boards.

M9900 CPU Board

The M9900 CPU board connects the TMS9900 processor chip to the S100 bus, providing all the proper bus control signals. Circuitry to support Marinchip's 16-bit memory boards as well as most 8-bit S100 memory boards is found here, as is the memory mapping logic necessary to support S100-style I/O. (The 1K area from F000 to F3FF is used for this purpose.)

64K RAM Board

As mentioned above, the CPU board supports 8-bit and 16-bit memory. If you already have an S100-based system, you can probably use your existing memory boards with the M9900. Since most memory accesses made by the TMS9900 chip itself are for 16-bit words, logic on the CPU board will automatically make two accesses to adjacent bytes in order to read or write the desired 16-bit word. Use of 16-bit memory such as the Marinchip 64K RAM board, however, will avoid the need for this double memory access, and enable the system to run at least twice as fast.

The 64K RAM board provides 64K bytes organized as 32K 16-bit words. DIP switches permit any combination of the 16 4K blocks of memory to be disabled, to prevent conflicts with other memories or memory-mapped I/O devices. A bank switching capability is provided, permitting several 64K RAM boards to share the same addressing space. This technique is used in multi-user environments, where each user may be assigned his own 64K address space.

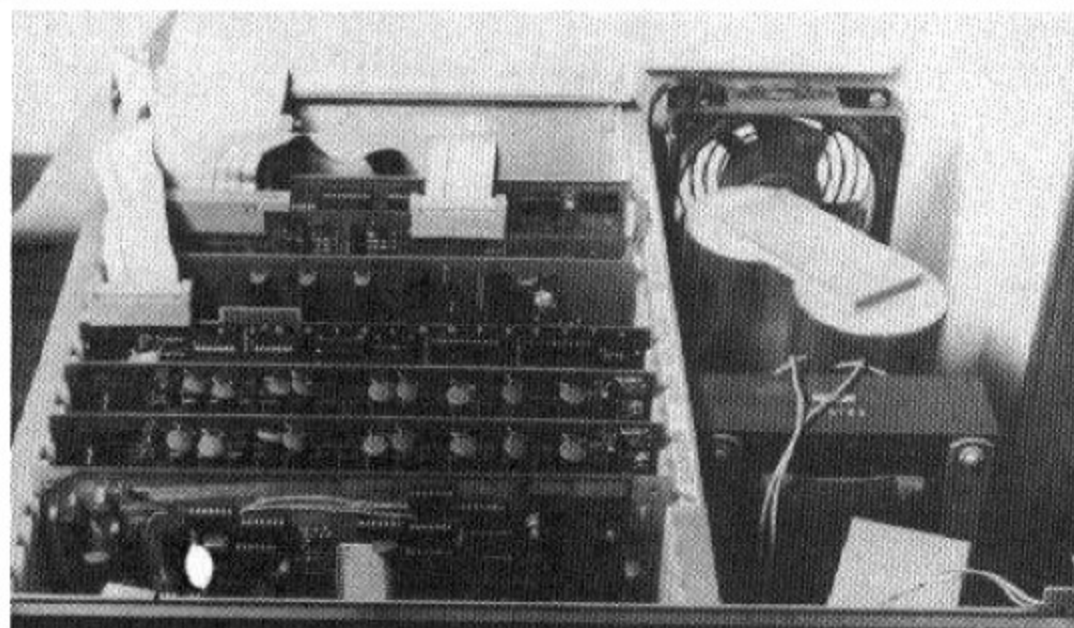
PROM/RAM Board

Marinchip's PROM/RAM board contains 1K bytes of 16-bit PROM (expandable to 32K), one serial I/O port, and a real-time clock. The 16-bit RAM may be used for the workspace registers, speeding up register access if your system has 8-bit memory boards. The PROMs contain the disk boot routine, and a debug monitor capable of dumping memory in several formats. The serial I/O port may be used for the console terminal, and the real-time clock is used by the NOS/MT multi-user operating system.

The debug monitor PROMs normally use the top 2K of the addressing range (F800 through FFFF), while the 16-bit RAM resides at F400 - F7FF.

QUAD SIO Board

Interfacing additional peripherals is easy with Marinchip's recent hardware offering, the QUAD SIO board. As its name implies, this board provides four serial I/O ports, each of which may be used to connect a printer, modem, or additional terminal.



A peek inside the mainframe. The first board is the M9900 CPU, followed by two 64K RAM boards and the PROM/RAM board.

Free Software

Marinchip Systems supplies a complete software package with the purchase (for \$700) of their M9900 CPU board. This package includes the Disk Executive operating system, BASIC, an assembler, linker, line-oriented text editor, document formatter, and debug monitor. You also receive a host of utility programs. Much of the software is designed to operate with as little as 32K bytes of RAM in the system, but 64K is recommended.

Disk Executive

The Marinchip Disk Executive provides a simple floppy disk file system. File names and maximum size are chosen by the user, and the operating system keeps track of where the files are located on disk. All disk I/O is file relative, and the system detects any attempts to read or write outside file boundaries.

Input/output operations are hardware independent. All I/O devices are treated simply as files with special names. If you design a program to write to a disk file, you can direct it to write to a hardware device (such as a printer) without any program modification.

The operating system performs all memory allocation for user programs in an address space organized as shown in Figure 2. Programs may expand to fill all available memory automatically, and need not be regenerated when a hardware or software change results in a different user memory space.

Input typed on the system's console terminal is assembled in a buffer that is internal to the operating system, and delivered to the user program only after the carriage return has been entered. The system provides backspace capability for error correction, and special control keys for deleting a whole word at a time and for retyping the current

input line if you've become confused. Inclusion of these important features in the operating system means that they need not be implemented in each and every program, and presents a consistent personality to the terminal user. A special system request permits a user program to take complete control of the console terminal in cases where character-by-character input is required.

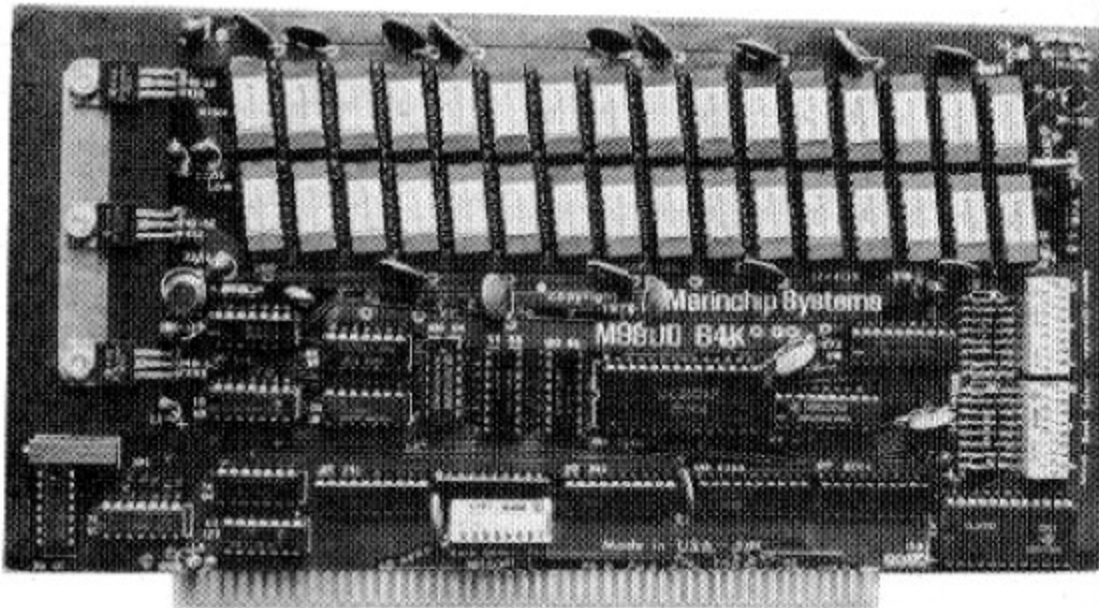
Programs running under the Disk Executive may issue system calls to request various services, or may call upon floating point arithmetic, output editing, buffer pool control, or linked list sub-routines built into the system. These features make the Marinchip M9900 system one of the finest systems I've ever seen for the software developer. Disk Executive system calls are upward-compatible with the multi-user NOS/MT operating system, so that your investment in M9900 programs is not wasted if you upgrade to the fancier operating system.

The Disk Executive also provides an easy way to add new system commands. The set of system commands which you enter from the console terminal can be easily expanded by writing a program and giving it the desired command name. You then can execute the new system command by simply typing the name of the file in which the program resides.

BASIC

The version of BASIC included in the CPU board purchase price is very similar to Microsoft BASIC. It offers two-character variable names, IF-THEN-ELSE, multiple-statement lines, single-line functions, disk I/O capabilities, and a statement trace feature.

If you notice a program error while running a program, you may interrupt its execution and enter command mode. While the program is thus suspended,



The M9900 16-bit 64K RAM Memory Board

any PRINT statement you type will be executed immediately, so that you may examine the contents of program variables. This feature may also be used to provide a simple "desk calculator." You may list or modify portions of the program, change variable contents, and continue where you left off.

Assembler and Linker

If you're like me, and enjoy developing system utility programs or just getting down to the bare nuts and bolts, an assembler and linker will be essential tools. Well, these are also included free with the M9900 CPU. The assembler produces relocatable object code, and the linker can pull several relocatables together to make an executable program. This allows you to develop a large, complex program in neat byte-sized chunks.

The assembler offers a few extra features worth noting. IF-ELSE-ENDF directives allow you to selectively assemble portions of a program, based on values

attached to program labels. A COPY directive lets you place common definitions in a disk file, and easily include them in any programs that need them. Also, the M9900 assembler recognizes several special instructions used by the Marinchip system. For instance, the system call feature is implemented using the TMS9900's extended operation facility (XOP). But, rather than saying "XOP 1" whenever you want the system to do something for you, you may say "JSYS" (meaning "jump to system").

Text Editor and Document Formatter

The line-oriented text editor (EDIT), and the document formatting program (WORD) comprise the final major elements of the basic software package included with the M9900 CPU board. Various file listers and copiers, file directory routines, the debug monitor, and diagnostic utilities round out the package.

Contents of IMSAI Mainframe

- M9900 CPU board
- M9900 PROM/RAM board
- 2 M9900 64K RAM boards
- Teletek FDC-II disk controller
- IMSAI SI02-2 serial I/O board
- Dual Systems Control Corp CLK-24 clock board, with battery backup

- Hazeltine 1510 video terminal
- 2 GSI 110-B 8-inch floppy disk drives
- NEC Spinwriter letter-quality printer
- Vadic 1200-baud modem

Figure 1 - The Author's System Components

0000	Standard workspace register area
0100	User address area begins here
.	
.	
----	User address area ends here, and operating system address area begins.
.	The exact address is dependent upon the hardware and software configuration.
.	On my system, it's around D100, leaving about 52K bytes for user programs.
.	
.	
EFFF	End of operating system address area
FOOO	1K input/output memory map area
F400	PROM/RAM board RAM area (1K)
F800	PROM/RAM board PROM area (2K)

Figure 2 - Disc Executive Memory Layout

I often use WORD to document the software I've written. Its automatic page and section numbering, table of contents generation, and heading/footer macro features make documentation a simple—even enjoyable—process.

File Format Commonality

It is important to note that most of the M9900 software was designed and implemented by one person, and that all the programs read and write text files compatibly with one another. Thus, a BASIC program could write a text file which is later edited using EDIT, then processed by WORD and written to a printer. The very article you are reading was written using the WINDOW screen editor. Its spelling was then checked using SPELL, and then was processed by WORD to produce the printed manuscript.

Text file compatibility seems like a simple enough idea, but don't take it for granted! There are numerous systems on the market whose Pascals, BASICs, and word processors all have different file formats.

Additional Software

The free software package described above is all you need to do software development in assembly language, simple BASIC, or to do word processing. However, Marinchip Systems also sells additional language compilers, operating systems, business packages, and other "application" programs.

An Extended Commercial BASIC provides all the features of the standard BASIC, plus PRINT USING, greater floating point precision, a program CHAIN capability, and random-access disk I/O.

Marinchip's Pascal is an implementation of Per Brinch Hansen's Sequential Pascal, and has no connection whatsoever with UCSD Pascal. All the standard structured programming and data structure definition capabilities are provided, but the I/O is nonstandard. The compiler makes seven passes over the program, and produces pseudo-code. Sequential Pascal is well suited to large system development: the compiler itself is written in Sequential Pascal, yet can be compiled without difficulty in a 64K M9900 system! Each program, however, must include a "prefix" defining the system interface. If you need formatted output, you must also provide a set of output editing procedures. For these reasons, as well as the fact that the pseudo-code must be interpreted at run time, you may find QBASIC more suitable for program development.

QBASIC is a language compiler which was actually written by an M9900 user. It is a compiler which accepts programs written in CBASIC-2 (A trade-

EDIT allows you to enter a program or save data in a disk file, or to correct, modify, or simply look at the text of an existing disk file. It is "line-oriented" in that the editor "looks" at one line of the file at a time. You can tell EDIT to move up or down in the file by using line numbers, or by searching for a particular string of characters. Once positioned at a line, you may use several commands to change the text on that line (or from that line for a few following lines, or for the rest of the file).

EDIT's most outstanding feature is its file paging capability. You may safely edit a file whose text is much too lengthy

to fit in memory all at once: EDIT will page portions of the file out to temporary disk files, and will automatically bring them back into memory when needed.

WORD, the document formatter, reads text files from disk, formats the text as directed by user commands inserted in the text, and writes the formatted version to a disk file or printer. Facilities are provided to handle form letter preparation, program documentation, and many other word processing chores. You control the formatting parameters by using numeric and string variables, macros, and library files.

mark of Compiler Systems) and produces actual TMS9900 machine code. The resulting program runs much faster than any interpreted BASIC or Pascal program. Many of the recent Marinchip utility programs, such as WINDOW and SPELL, were written in QBASIC.

Just in case you're not familiar with CBASIC-2, its major attributes are long variable names, structured WHILE-WEND constructs, formatted output (PRINT USING), and the nearly total elimination of BASIC's annoying line numbers. QBASIC supports separate compilation of program segments, access to assembly language routines by simply LINKing them in, and several extensions to the CBASIC-2 language.

Marinchip offers a second text editor called WINDOW. This is a screen-oriented editor which turns your terminal into a "window" looking into the text file being edited. You can move the window around in the file vertically (or even horizontally, if the file has lines longer than the width of your terminal's screen).

Control characters (or function keys, if available on your terminal) are used to move the cursor around on the screen and perform the desired editing tasks. A single keystroke puts WINDOW into a special command mode, allowing you to set various modes or request more complicated functions such as moving a block of text from one place to another. Like EDIT, WINDOW is capable of editing a file whose text far exceeds the amount of user memory.

I'm a horrible typist. Maybe you don't spel so gud. Both of us can benefit from Marinchip's SPELL program. SPELL looks up each word of a document in its dictionary, and reports any word that it hasn't heard of. Once you've weeded out the obvious abbreviations and acronyms, the remaining words are probably spelling or typing errors. Utility programs are provided to let you add new words to the dictionary.

A Multi-Tasking Network Operating System (NOS/MT) is offered as an alternative to the Disk Executive. This UNIX-like system can support several users on the same mainframe. Each user has his own terminal and his own memory area (up to 60K each), but all users share the same CPU, printer, disks, and other hardware. To add another user to the system, the only hardware that's needed is another terminal, an I/O port for it, and, perhaps, another memory board. A system generation procedure must be followed to customize the system for your particular hardware and software needs.

NOS/MT provides all the features of the simpler Disk Executive, plus print output spooling, disk file simulation in memory, background batch capability, dynamic file space allocation up to 4 billion bytes, directory files (hierarchical directory), hard disk drive sup-

port, a system clock, and numerous additional features.

If you're looking for off-the-shelf business software to run on the M9900, you're in luck. The folks at Marinchip have converted the well-known Osborne commercial packages (General Ledger, Accounts Payable and Receivable, and Payroll) to QBASIC. These programs are usable singly or as an integrated system. Additionally, there's a computer-aided drafting package called INTERACT, a terminal simulation program for communicating with a remote computer system, and some more exotic languages — FORTH and META — for aficionados of threaded structure and stack operations.

In future articles, we'll take an in-depth look at some of this software.

A Mini Editorial

Now that *99'er Magazine* is bringing together all formerly isolated TMS9900 family members, we would hope to see hardware and software producers adapting their products for these additional related markets. The software from Marinchip systems is a case in point: If TI-99/4 users, for example, would like to see an extremely fast compiled BASIC (e.g., Q-BASIC) available on their fully-configured TI system, the folks at Marinchip should be made aware of this by the interested users—Ed.